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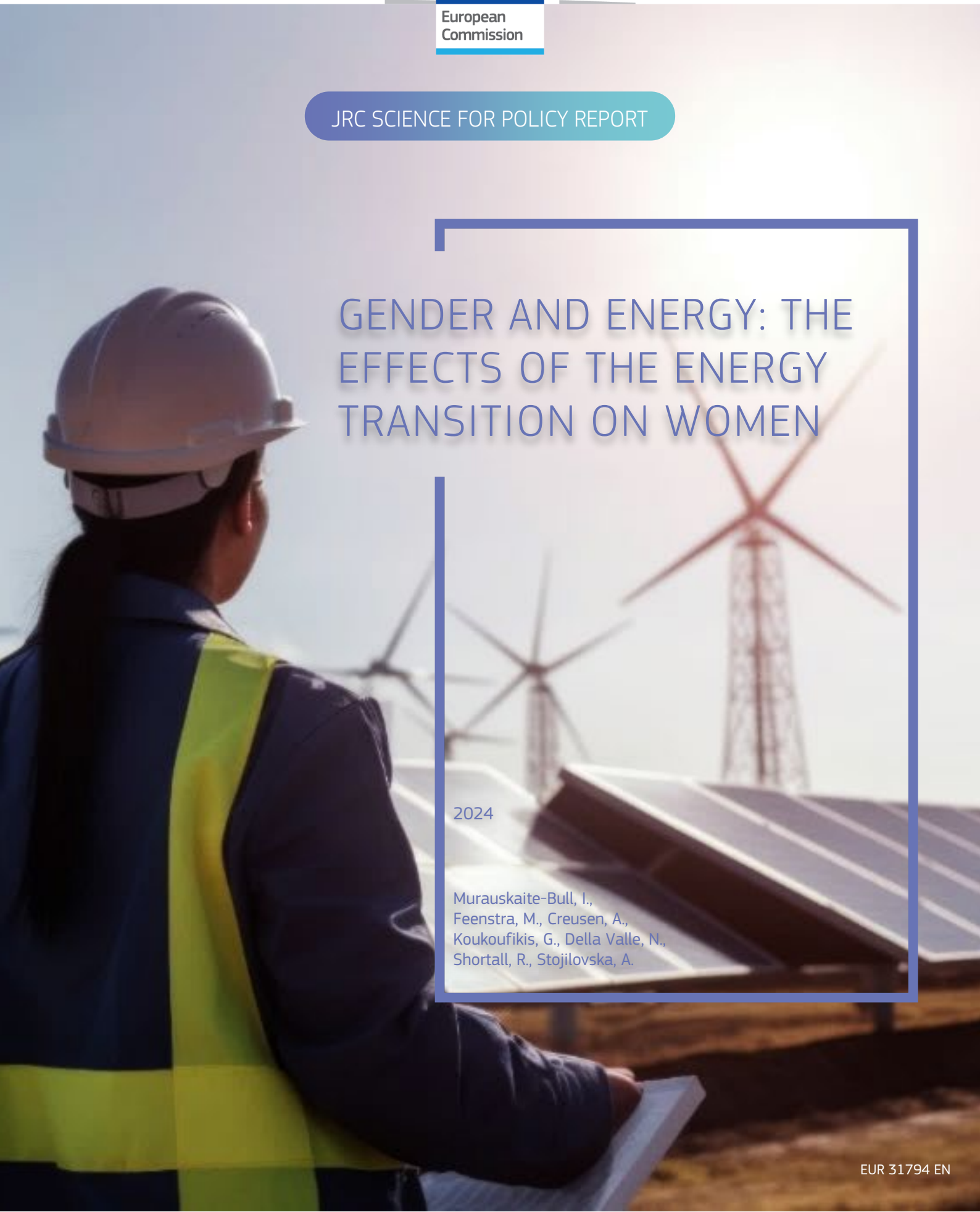
GENDER AND ENERGY: THE EFFECTS OF THE ENERGY TRANSITION ON WOMEN



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Contents

Abstract

In the midst of Europe's multiple crises, the link between gender disparities and the energy transition emerges as a critical element. This comprehensive study, carried out by the European Commission's Joint Research Centre in cooperation with the Dutch expert centre on diversity in the energy transition 75inQ, emphasises the urgent need to reduce gender gaps in the energy transition. It sheds light on the often-overlooked impact of gender disparities in access to clean, affordable energy, highlighting the need for immediate action to bridge the gap and foster social resilience. The report emphasises the importance of inclusive policies in guaranteeing women's active engagement and representation in the energy industry, not just as customers but also as decision-makers and innovators. It highlights the significance of breaking down traditional policy silos, providing a road map for a more integrated and comprehensive approach to addressing the complex causes of energy poverty. The findings of the study stress the need of strong data collection and monitoring methods for tracking the success of gender-inclusive energy transition activities, enabling for informed and targeted interventions at both the national and European levels. Recognising and correcting gender disparities as the energy environment changes not only assures a fair transition, but also sets the road for an empowered, resilient, and progressive European society.

Acknowledgements

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Executive summary

Europeans are facing a combination of crises: the aftermath of the COVID-19 pandemic, the ongoing climate crisis and the energy crisis caused by the rapid increase of energy prices due to the Russia's war against Ukraine. How people can anticipate, respond and counter a crisis is dependent on elements like their access to services, their ability to afford these services and their mental and physical resilience. These elements are not the same for all people. People's socio-economic position determines their resilience to crisis. Eliminating social inequalities and realising gender equality form an essential pillar of the European Union's strategic goal of social inclusion.

The objective of this study is to deepen our understanding of the connection between gender inequalities and participation in the energy transition. The findings rely on a comprehensive literature study of the complex relationships between the energy transition and gender. We analysed a range of policy interventions and good practices within energy poverty and related arenas, which can be used to reduce energy poverty for women, and increase women's representation in the energy sector and the overall empowerment of women during the energy transition. This report was led by the Joint Research Centre in collaboration with 75inQ, an expert centre on diversity in the energy transition based in The Netherlands.

Key conclusions

A successful energy transition requires attention to the social dimension. There is an urgent need to recognise the effects of the global energy transition at different policy levels and on societal groups and to understand how people can engage in the process on an equal basis. The energy transition then becomes a vehicle for a socially just and fair society that provides clean energy for all and leaves no one behind. To create the foundations for achieving an inclusive energy transition, we conclude that it is necessary to:

1. Mitigate gender inequalities in access to affordable and sustainable energy services in policies, instruments and mechanisms across the energy system and at all governance levels;
2. Acknowledge the intersecting and cross-cutting structural causes of the gender dimension of energy poverty by breaking silos in policy formulation and implementation;
3. Collect, report and monitor gender-segregated data on the inclusive energy transition at macro, meso and micro level to have a better assessment of the impact of energy transition on women;
4. Stimulate political and managerial engagement of governments and corporate partners in the energy system to ensure the equal participation and representation of women in the energy transition.

There is a growing body of good practice evident in initiatives for an inclusive and just energy transition which can serve as inspiration for the implementation of these recommendations. At the international and European levels, an increasing number of policy initiatives and directives demonstrates political commitment to a just energy transition. The policies of EU Member States serve not only to implement European guidelines but also to integrate national socio-political and cultural contexts. These national policies call for local partners, residents, local energy initiatives and companies to orient themselves towards a sustainable energy transition, but this should also be reflected in financial, legal and political support.

Main findings

1. Women are frequently more exposed to energy (and transport) poverty, often due to lower levels of disposable income and being overrepresented in single parent households.
2. As a result, women are more exposed to various consequences of energy poverty such as adverse health risks and social exclusion.
3. There are still gender-related inequalities in the energy sector that have to be better addressed to ensure a successful energy transition: women accounted for an average of 32% of the workforce in the renewables sector in 2019.
4. The relationship between gender inequality and the energy transition is gaining increasing attention. However, this subject deserves even more attention in the years ahead to address the remaining questions.

Quick guide

This report is structured in four sections. We begin by describing the state of play on the gender-energy connection, describing the policy background both at the international, EU and Member State levels. The Clean Energy Package puts the consumer at the centre of the energy transition with a clear right to produce and trade energy as an important pillar of EU Energy transition policy.

Then we identify women's roles in the energy transition by distinguishing between the role of consumer, producer and energy citizen. Women's overrepresentation as energy consumers and especially those vulnerable to energy poverty is in contrast with women's structural underrepresentation as producers working in the energy sector. The emerging role of women as energy prosumers through their participation in local energy initiatives and renewable energy cooperatives is highlighted. Producers and consumers as 'prosumers' are able to participate actively, individually or through communities, in all markets with decentralised and participatory concepts.

Thirdly we focus the gender lens on energy poverty in the EU by using an economic perspective, describing the health impacts of energy poverty, and identifying the socio-cultural characteristics and the behavioural aspects of energy poverty. The multiple crises framing the context of energy poverty, from the COVID-19 crisis to the current energy crisis, have significantly increased the problem of energy poverty in many countries. Energy poverty was present even before the energy crisis, but now it is no longer just a challenge for low-income households. The energy crisis, housing crisis, unemployment, and high inflation are challenging even for many middle-income households. People affected by energy poverty or living in social housing, and lower-middle-income households should be supported, and national-level measures need to be targeted as such.

Therefore, we conclude that gender and the energy transition, especially the issue of energy poverty, cannot be seen in isolation. There is a need to explore tailored policy interventions and instruments and multi-level governance structures as well as improved data collection for energy poverty indicators, energy debts, housing conditions and more. Gender imbalances for all energy consumers need to be addressed and women should be empowered not only in their role as consumers but also as producers and policymakers. In our final section, we provide examples of policy initiatives addressing gender and the energy transition at various levels of governance: EU, Member State, consumer, corporate and local.

1 Introduction

Europeans are facing a combination of crises: the aftermath of the pandemic, the ongoing climate crisis and the energy crisis caused by the rapid increase of energy prices due to Russia's war against Ukraine. How people can anticipate, respond and counter a crisis is related to elements like their access to services, their ability to afford these services and their mental and physical resilience. These elements are not the same for all people. People's socio-economic position determines their resilience to crises. Eliminating social inequalities and realising gender equality form an essential pillar of the European Union's strategic goal towards social inclusion. In this report, we dive deeper into two pressing issues and their interconnectedness: gender equality and the energy transition.

The European Green Deal pledges that in the face of the climate emergency, a just and fair transition towards carbon neutrality will be carried out to not leave anyone behind. There are still gender-related inequalities in the energy sector that have to be better addressed to ensure a successful energy transition. Recent studies illustrate that there are fewer women in decision-making roles (including policymaking) and women still clearly lack representation in the energy sector workforce, e.g., they accounted for an average of 32% of the workforce in the renewables sector in 2019 (IRENA 2019). Similarly, they are underrepresented in higher education in science, technology, engineering, and mathematics (STEM) sub-fields that are highly relevant to the energy sector and that remain heavily male-dominated. In 2021, less than a third of engineering, manufacturing and construction and less than a fifth of ICT higher education students were female (26.9%)[1].

Moreover, recent data show that women are more likely to live in energy poverty (Petrova et al. 2013) and that female-led households experience higher rates of energy poverty (Koukoufikis & Uihlein 2022). Women are frequently more exposed to energy (and transport) poverty due to smaller amounts of disposable income, being overrepresented in single parent households as well as other reasons related to various physiological characteristics. Being exposed to energy poverty comes with clear consequences such as health risks and social exclusion. There is growing attention to and recognition of the gender dimension of energy poverty and of the energy transition. Gender imbalances in the energy system need to be addressed in the energy sector supply chain and workforce, as well as in the distributional impacts of the energy transition itself.

1.1 Research objective

The objective of this study is to provide a deeper understanding of the determinants of gender gaps, of what hinders the empowerment of women in the energy sector and of the drivers of gender inequality in energy poverty. By analysing a range of policy interventions and good practices within energy poverty and related arenas, our findings can be used to reduce energy poverty for women, increase their representation in the energy sector and their overall empowerment during the energy transition.

1.2 Research questions

1. What is the current state of play in terms of:
    (a) women's representation in the energy sector and
    (b) women's vulnerability to energy poverty?
2. What are the main data gaps when assessing women's vulnerability to energy poverty and representation in the energy sector?
3. What are the specific EU policy development needs (in addition to existing instruments and mechanisms) to improve the situation of women in the energy transition, from the energy poverty and representation/empowerment point of view?

[1] JRC based on Eurostat [EDUC_UOE_ENRT03].

1.3 Methodology

This report is based on a combination of:

1. a narrative[2] literature review,
    (a) identifying women's roles in the energy transition, and
    (b) conceptualising the intersection of gender and the energy transition;
2. a desk review of policy documents; and
3. a statistical analysis of European data on the gender-energy nexus.

The desk review of policy documents analyses how energy transition policy interventions at EU and Member State level could improve the lives of women in the context of the energy transition and how these could be formulated and implemented. Statistical analysis reveals the gender dimension of energy poverty by identifying gender-disaggregated data, its key determinants and the main factors at play. These analyses contribute to recommendations for more energy-just transition policies that mitigate energy poverty and gender inequality, presented in the final chapter.

Concrete examples are provided from the Netherlands, where the commissioned authors are based. These are for illustrative purposes only and cannot be taken to represent the situation across the EU.

1.4 Structure of the report

This report is structured in four sections. We begin with the state of play and an overview of the key elements to consider when analysing the gender-energy nexus in the Chapter 2, also describing the policy background at the international, EU and Member State levels. Then we identify the role of women in the energy transition by distinguishing between the role of consumer, producer and energy citizen. The final section of Chapter 2 addresses the emerging role of women as energy prosumers through their participation in local energy initiatives and renewable energy cooperatives. Chapter 3 applies the gender lens to energy poverty in the EU from an economic perspective, identifying the health impacts, along with socio-cultural and behavioural aspects, of energy poverty. Chapter 4 provides examples of policy initiatives and recommendations addressing gender and the energy transition at various levels: EU, Member State, consumer, corporate and energy community.

[2] Narrative reviews are used to appraise, critique, and summarise the available research, not necessarily following systematic procedures. They can be read as a general and accurate guide to what is already known about a given topic.

2 Gender and the energy transition: the state of play

The fight against climate change necessitates a rapid energy transition, replacing fossil fuels with renewable energy sources (RES) and other clean energy solutions and reducing energy consumption. This challenge comes in addition to making access to sustainable energy universal. Global commitments such as the Paris Agreement, Sustainable Energy for All (SEforALL) and the Sustainable Development Goals (SDG) are important frameworks for government policy implementation in a socially just energy transition. SDG 7 addresses clean and affordable energy for all, SDG 13 climate action, and SDG 5 gender equality. Addressing climate and energy poverty goes hand in hand with alleviating structural inequalities, such as gender inequality. Neglecting the social and political factors that have contributed to climate change vulnerability can hinder progress, potentially exacerbating existing gender injustices, rather than contributing to their reduction (Djoudi et al. 2016).

The energy transition is often presented as depending on technological innovation and market mechanisms. Replacing fossil fuels like coal with RES in electricity production is highly beneficial, reduces emissions and ensures continued energy security. However, a successful low-carbon energy transition requires equal attention to the political and social dimensions. Gender is not always considered in technology- and policy-focused perspectives (Lieu et al. 2020). Furthermore, renewable energy projects do not contribute to gender and social equity on their own as technological interventions do not necessarily address the structural challenges embedded within sociocultural and socioeconomic contexts (Johnson et al. 2020). Therefore, there is an urgent need to recognise the effects of the global energy transition at different policy levels and on various social groupings and to understand how people can engage in the process on an equal basis.

Further, we need to understand how this knowledge can be translated into policies, interventions and communication. Given that energy access, its consumption and its services globally are gendered, establishing an energy system that reflects gender differences and that is aware of gendered relations in society is essential for a just energy transition (Feenstra 2021). Feminist energy systems give preference to human wellbeing over profit, are people-centred, and are more democratic (Bell, Daggett, & Labuski 2020).

The current context and future consequences of climate change require a change in how we produce and consume our scarce resources (such as water, energy and food) on macro, meso and micro levels. In order to secure a just and inclusive energy transition, there is a need to understand both the effects of a low-carbon energy transition on different policy levels and groups in society, and how people can engage in such a process on an equal basis. However, within society, there are existing inequalities among groups and between men and women in terms of how they can participate in the energy transition. With gender inequality as a social phenomenon, equal access to clean, sustainable and affordable energy sources is an international concern embedded in SDG 7 and the European Green Deal. The social impact of the energy transition is recognised not only in policy initiatives and social movements, but also in research. Social inequalities and energy justice are two key emerging streams in the energy policy literature, with limited but growing attention to gender equality (Feenstra 2021).

2.1 The gender dimension of energy poverty: the policy landscape

Energy poverty occurs when a household must reduce its energy consumption to a degree that negatively impacts the inhabitants' health and wellbeing. It is a phenomenon experienced in the developing world as well as OECD countries. UN figures show that globally, three billion people live in energy poverty without access to electricity or cooking on biomass. With only 12% of the world's population relying on clean fuels and technologies for cooking, the health of these populations is still at risk from dangerously high concentrations of household air pollution (Romanello et al. 2021).

Eurostat estimated that Europe counts more than 54 million people who have difficulty paying their energy bills or have limited access to high-quality energy, some even using biomass for cooking and heating. Many of them are living in uninsulated homes, using inefficient appliances (particularly for heating, cooking and hot water) resulting in high energy bills. Energy poverty has a gender imbalance. Due to the income gap between men and women, and the demographic fact that women live longer, it is estimated that women are disproportionately affected by energy poverty (Clancy et al. 2018). From a cost-effective point of view, many may want to invest in energy efficiency, but due to the lack of finances, they struggle to participate in the energy transition. Not only financially, but also legally they meet obstacles to improving their access to sustainable energy solutions. Many of the energy poor live in rented residential buildings, depending on a landlord to invest in energy efficiency. With extreme temperatures occurring more often as a consequence of climate change, more people globally experience the struggle to afford clean energy sources to stay cool and/or warm in their homes.

Despite the urgency of the situation, there is a policy gap in relation to gender in the low-carbon energy transition. At the policy level in developed economies, especially in the EU, there has been an emerging focus on engaging consumers to foster sustainable energy consumption and to empower people to become managers of their energy needs, focusing on behavioural change (Standal et al. 2019). The Clean Energy For All Europeans package of legislation (European Commission 2019) creates a first step towards an enabling policy framework for a more inclusive energy transition in the EU. Considering the free-market economy and non-discrimination law, the assumption is that industrial countries have gender-neutral energy policies that benefit both men and women equally (Clancy et al. 2017; Clancy and Röhr 2003). Thus, national energy policies do not consider that women and men have different opportunities and ways of engaging with energy on policy, research and corporate levels (Standal et al. 2018; Clancy and Röhr 2003). This lack of awareness may be due to the limited availability of gender-disaggregated data (Clancy and Feenstra 2019). Chapter 3 discusses gender dimension of energy poverty in further detail.

2.2 Women's roles in the energy transition

Given that energy access, consumption, and services globally are gendered (Clancy and Feenstra 2019), establishing an energy system that reflects gender differences, and that is aware of gendered relations in society, is essential for a just energy transition. Due to the socially constructed and dynamic nature of gender relations, energy policy should acknowledge differences in the social context and should contribute to the overall aim of gender equality (Feenstra & Özerol 2021). Additionally, women might have particular energy needs, rights and experiences, and unless they get these recognised, and their access to decision-making processes enhanced, it will be difficult to tackle the multiple injustices that prevent them from fairly participating in the energy transition (DellaValle & Czako 2022). Gender inequality embedded in societies might limit the agency of women to participate in the energy transition. Here, we define agency as the ability to define one's goals and act upon them by enacting changes (Coy et al. 2021). Policy interventions can create enabling conditions to strengthen the agency of women and men to participate and benefit from just transitions.

Three roles for agents of change have been identified within the energy transition (Clancy et al. 2018; DellaValle & Czako 2022):

1. Consumer – using energy services;
2. Producer – producing and supplying energy services to the end-user; and
3. Energy citizen – governing the energy sector as a social and political actor.

People assume the role of energy citizen when they engage in the energy transition in a meaningful way, without being reduced to the role of passive consumer or producer, through the creation and exploitation of new spaces for participation from the ground up, which can shape the energy system (Lennon et al. 2019). Therefore, acting as an energy citizen means actively interacting with energy in everyday life, while providing the basis for a more democratic, just and decentralised energy model (DellaValle & Czako 2022).

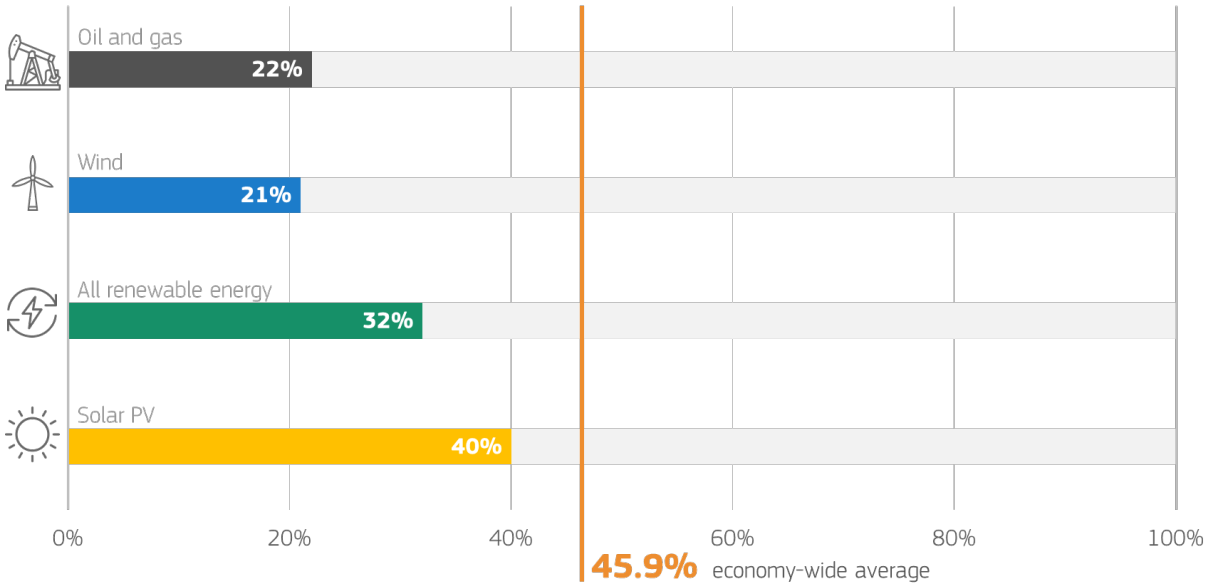
Acknowledgement of the potential for women to be agents of change and energy citizens is gaining momentum in both literature and policy (Feenstra 2021; Lennon, Dunphy, & Sanvicente 2019). Our analysis will examine these concepts of agency and energy citizenship, investigating the relationship between gender and the energy transition.

2.3 Women's representation in the energy sector workforce

Studies have addressed gender balance in those industries which are crucial to the fight against climate change (such as the energy sector), and in political representation in the climate change debate. Across all EU Member States in 2021, a consistent trend reveals a higher concentration of men working in the electricity, gas, steam, and air conditioning supply sector compared to women, accentuating the challenges faced by women in the energy transition (Papadimitriou et al 2023).

More women work in RES than in the traditional energy sector (IRENA 2019), though this varies across subsectors. According to the 2022 IRENA report, which tracked the participation of women in the solar PV industry, women make up almost 40% of the labour force in full-time positions within this sector (Figure 1). This is almost double the proportion of women employed in the wind industry (21%) and in the oil and gas sector (22%) (IRENA 2022).

Figure 1. Women's representation in renewable energy sectors



Source: 'Women in oil and gas, renewables overall, wind, solar PV, and economy-wide average', IRENA online solar PV survey, 2021.

However, these jobs are mostly low-paid and non-technical, and there is little prioritisation in the industry of the need for an inclusive energy workforce (Pearl-Martinez & Stephens 2016). It also remains the case that more men than women are enrolled in STEM education (Feenstra & Clancy 2019). According to IRENA, most women employed in solar PV work in administrative roles, representing 58% of the workforce. They are not very well represented in the category of non-administrative but also non-STEM positions such as procurement experts or lawyers, where they hold only around 38% of the jobs. Women's representation in STEM positions is even lower, at only 32% (IRENA 2022).

The enrolment of more women in STEM education is acknowledged as a prerequisite for improved participation and thus increased overall labour supply in the greening energy sector (Asikainen et al. 2021). It is important to note that the low-carbon energy transition also opens new opportunities for gender equality. Working with RES appeals more to women than conventional energy sector jobs (Feenstra & Clancy 2019) and providing universal access to clean energy offers new prospects and benefits for women such as reshuffling of work, new income-generating activities, as well as social and network support through enhanced communication. Furthermore, increased gender parity in professional groups results in more effective and inclusive results in decision-making. In addition, women are more likely to support sustainability and environmental action in the workplace, and companies with more women on the board of directors are more likely to invest in sustainability and strategies that reduce carbon emissions (Feenstra 2021).

Labour shortages are a growing a concern for the energy sector, and an urgent issue for policymakers, who face the challenge of accelerating the transition to mitigate climate change. Women have traditionally been under-represented in the industry, while the challenges within the transition require a diversity of insights and skills. According to IRENA, the number of jobs in the renewable energy sector worldwide is estimated to have reached approximately 12.7 million in 2021. If a comprehensive policy framework is established, this number is expected to nearly quadruple by 2050 (IRENA, 2021a; 2022; IRENA and ILO, 2022). In other words, the energy sector is growing with the energy transition, bringing the untapped labour potential into the spotlight to meet rising demand for skilled workers. However, studies on labour are blind to the effects of the transition on the quality of jobs, the evolution of working hours, and gender (Feenstra & Clancy 2019). These shifts in labour demands will subsequently shift investment and resources from the conventional energy sector to ultimately achieve a low-carbon and resource-efficient economic system. The challenge for labour markets and human capital agendas globally is to maximise the benefits for workers and ensure a fair distribution of unavoidable adjustment costs, such as direct and indirect job losses, skills shortages and bottlenecks. The rise of new technologies and digitalisation are disrupting traditional employment patterns, job quality and gender considerations.

Longitudinal data demonstrates that globally, the percentage of women employed in the global energy sectors has never exceeded 32%, meaning the energy sectors are, and have been, extensively dominated by male

employees. The tipping point of inclusive decision-making requires a 35% participation (Catalyst 2022; IEA 2020; IRENA 2019), a point which the energy sector has not yet reached. The situation is even more pronounced in the Netherlands. The participation of women in the Dutch energy sector has never exceeded 22%, dropping to 16% at senior levels of employment (Feenstra & Creusen 2021). The imbalanced gender distribution in leadership positions creates a disparity in the influence of women on policy recommendations, including those addressing issues such as energy poverty. This gender imbalance is further compounded by the underrepresentation of women in the energy sector.

2.4 Gender in renewable energy communities: prosumers as emerging actors in the energy transition

The energy transition is often presented as being dependent on technological innovation and market mechanisms. Replacing fossil fuels like coal with RES in electricity production is highly beneficial and has been hailed as a win-win solution that reduces emissions and ensures continued energy security. Men still participate more frequently in local energy initiatives and are overrepresented as prosumers (Standal 2018; Standal et al. 2018). In Norway and the UK, prosumers (who have invested in rooftop household solar systems) are also generally perceived and communicated in media and advertisements as 'techno-savvy, middle-class men with high environmentalist interests' (Standal et al. 2019). Though the decision to become prosumers was made jointly, there was a gendered division of labour where men took care of the process of becoming prosumers, while women had a notable disinterest in the technical side, but took responsibility to change their energy practices such as doing laundry when the sun was shining (Standal et al. 2019).

With the entry into force of the Clean Energy Package in 2019 and the introduction of new concepts such as active customers, renewables self-consumption and energy communities, the role of citizens in the energy system advanced from passive consumers to active participants and stakeholders (REScoop.eu & Client Earth, 2020). The EU setting the legal framework for renewable energy communities (RECs) encourages member states to prioritise the role of energy communities as essential partners in achieving energy access, reducing inequalities, as part of the energy transition. This approach has a possible effect far beyond sustainable energy transitions. It requires national legislators to enable formerly economically disengaged, passive households forced into economic lethargy by low wages or unemployment (a phenomenon particularly common among young people in Southern Europe) to become active energy transition co-owners with access to its benefits (Hanke et al., 2021). Vulnerable households become agents instead of energy subsidy recipients.

There is limited research available on women's economic and energy practices which highlights their specific needs in engaging with energy transitions, including their participation in RECs. The same applies to the participation of vulnerable consumers in local energy initiatives (Hanke & et al., 2021). RECs must find new ways of engaging with vulnerable and underrepresented energy consumers to serve their needs. DellaValle & Czako (2022) identify exemplary mechanisms enabling the energy poor to become energy citizens and express their full agency. Those mechanisms include smart-meter-based feedback programmes, tailored energy advice, training of energy actors, energy cafés, energy ombudsmen and energy communities. For instance, the Austrian Wien Energie utility-based ombudsperson has developed a comprehensive and broad set of features to detect severe social cases[3], among which some relevant gender-related indicators appear, such as single mothers and survivors of domestic violence (Stojilovska 2023). Women may also participate in the energy transition through civil society (Mang-Benza 2021).

However, while new opportunities for participation have emerged in energy communities, it's important to recognise that these opportunities do not necessarily translate into improved gender representation. Gender justice concerns come to the forefront, encompassing issues related to access, capacity, and the opportunity for women to engage in decision-making within these communities (Lazoroska, Palm, & Bergek 2021). It is crucial to acknowledge the influence of cultural, social, and political factors on an individual's agency to participate in renewable energy communities (Fraune 2015).

Moreover, interventions aimed at enhancing household sustainability often either overlook or inadvertently exploit gender dynamics (Murphy & Parry 2021). Despite women playing influential roles behind the scenes in decisions concerning retrofitting, the provision of gender-aware retrofitting packages remains a notable

[3] The notion of 'severe social case' is broader than energy poverty and refers to a customer who fulfils any of at least three different sub-criteria out of six main criteria (income, illness, housing situation, family situation, debts, and life crises).

absence (Sunikka-Blank, Galvin, & Behar 2018). These challenges underscore the importance of addressing gender disparities within the context of energy communities and sustainable energy initiatives.

To assess gender-inclusive engagement in energy communities, it is vital to consider the following questions, as suggested by Søraa et al. (2020):

- whether the value of gender perspectives is highlighted;
- whether gender goals are met in participant and stakeholder composition;
- whether there are research and training tools on gender issues;
- whether linguistic problems with the representation of gender are accounted for; and
- whether gender perspectives are understood in intersectoral contexts.

Although there are limited to non-existent official statistics on the demographics of participation in energy communities across the EU, there are multiple case study-based research papers documenting the general under-representation of women (Wierling et al. 2020). There are differences across countries in terms of participation rates and the effort of the communities themselves to promote gender balance and female empowerment (Lupi et al. 2021). However, the general profile of an energy community participant is that of a middle-aged male, and this is evident also for well-established cooperatives with large shareholder bases. This can be problematic not only for empowerment reasons but also for broader energy justice, especially since female participants of energy communities tend to favour energy justice principles more.

3 Energy poverty: a gender perspective

Energy poverty is understood as the inability to afford the energy consumption needed for a decent and comfortable life (Bouzarovski & Petrova 2015). Conceptually, energy poverty is rooted in the British term 'fuel poverty', established by Boardman (1991). Boardman recognised that cold homes were having detrimental impacts on the lives of their inhabitants (especially health impacts) and that these impacts were caused by a combination of low income, high energy bills, and energy inefficiency in households. The political agenda stemming from this has spread to other European countries and beyond, relabelled 'energy poverty' in the process. Between 2009 and 2019, the EU addressed energy poverty through various legislative measures. Directive 2009/72/EC on common rules for the internal market in electricity was the first to mention energy poverty as a growing problem in the EU and to urge Member States to put in place national criteria for the definition of vulnerable consumers and to develop national action plans aimed at decreasing the number of people suffering situations of energy poverty. More recently, as part of the EU Clean Energy Package, Regulation (EU) 2018/1999 and Directive 2019/944 supported the role of RECs to provide affordable clean energy for all Europeans. The pieces of legislation called for energy poverty criteria to be defined and policies developed by national governments to alleviate energy poverty, mentioning RECs as actors in this area. EU Members are obliged to report its incidence at Member State level through indicators, along with a mitigation target and policies where a significant number of energy-vulnerable households are identified, starting from the premise that any proportion of households in energy poverty can be considered to be significant.

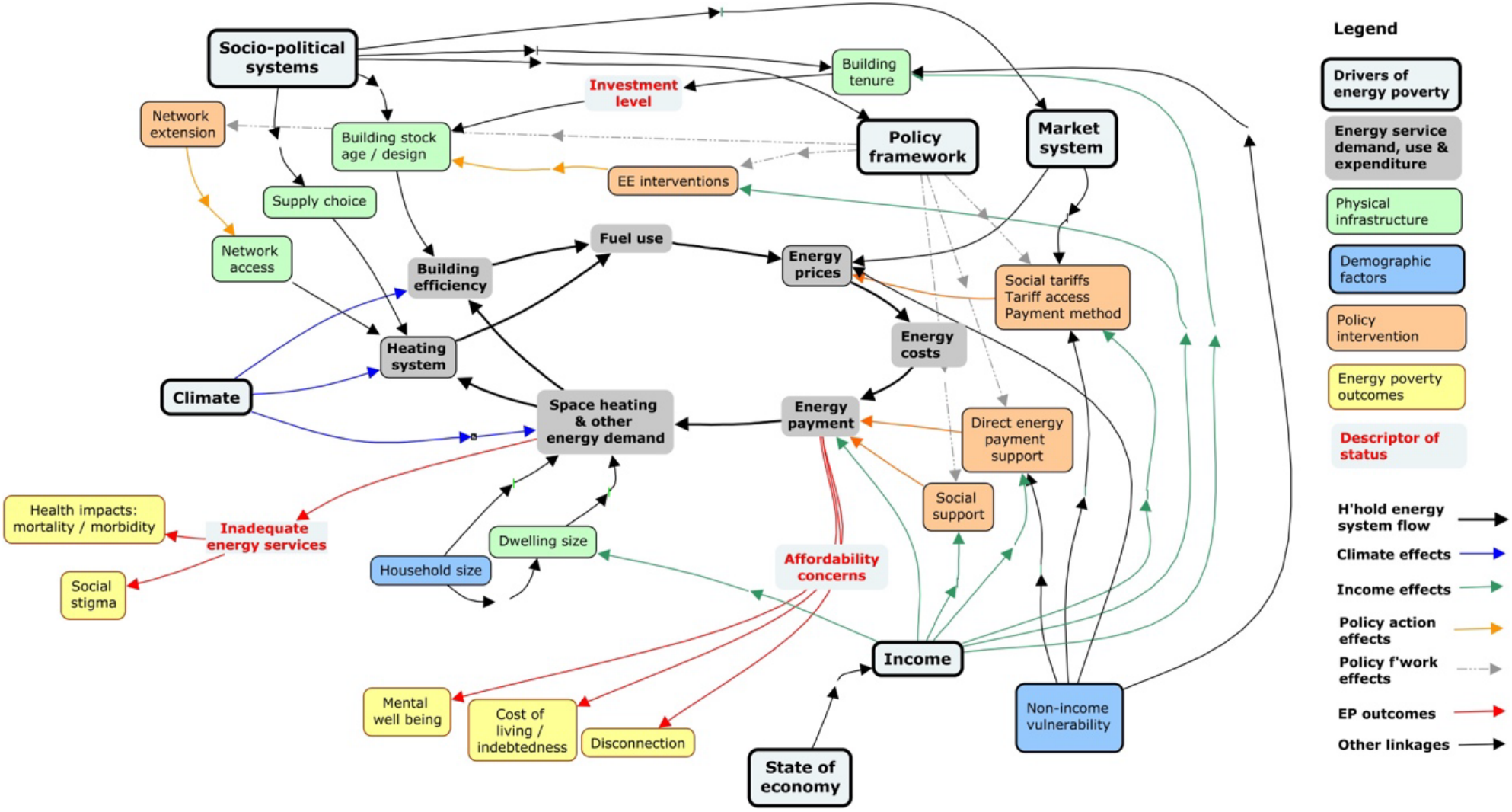
Transport poverty, which is often linked to fuel poverty, is also a significant issue that affects women differently to men, due to gendered mobility practices, transport systems and spaces in the built environment (Mejía & Murauskaite-Bull 2022). Women are more likely to have part-time and precarious jobs, which often come with lower pay and difficulties in accessing social protection. Additionally, women are responsible to a larger degree for escorting children and other dependents to different locations, resulting in more complex and multi-purpose trip patterns. Women have longer total trips divided into shorter, more frequent, more dispersed, and complicated trips during the day, making use of different transport modes, which is known as trip-chaining. Finally, women tend to avoid places at certain times due to security concerns, leading to time limitations and time poverty, which influences the opportunities available to them.

3.1 Measuring energy poverty: gender indicators

To identify and gain a deeper understanding of the circumstances of a population group to be targeted by a policy, sufficient data on key indicators are necessary as input to the policy design. The current data available within the EU Member States on energy poverty are not adequately gender-disaggregated and tend to be purely quantitative, lacking the qualitative explanations that can highlight variations across countries and regions. This creates difficulties in identifying target groups of policy interventions and the cause of their energy poverty. For example, Eurostat expenditure share data via the Household Budget Survey are only available at five-year intervals with a focus on household averages (Eurostat 2017a). This time interval means a slow response to one of the major causes of energy poverty: energy price increases. Focusing on households is also problematic since what constitutes a household is contested (Clancy et al. 2017). Households are fluid entities with a dynamic structure, varying in income, class, ethnicity and education (Bell et al. 2015). We would add demographics and civil status. Divorce, where children are involved, creates families living across multiple households. Demographic changes in the EU have led to a strong increase in the number of registered single-adult households.

Trinomics (2016) was one of the first to identify six main drivers of energy poverty in the European Union: income; socio-political system; policy framework; climate; market system; and state of the economy (Figure 2). These drivers particularly influence the affordability of household energy services, such as heating and cooling, which can lead both directly and indirectly to energy poverty. The previous and current political and economic systems influence energy market development, institutional structures, heating and cooling infrastructure, housing stock and tenure and energy supply. The type of energy market, including the extent of liberalisation and level of competition, influence the range of energy service tariffs/products available, and the type of measures for assisting with energy affordability. For example, countries in Eastern Europe made the transition from a centrally planned economy with state-owned utilities to a market-based economy with privatised utilities which has been accompanied by significant increases in energy prices. The social support measures targeted at groups regarded as vulnerable to these price increases have had limited success (Bouzarovski, Petrova, & Sarlamanov 2012). Also, within countries with an established market economy, there have been significant price increases.

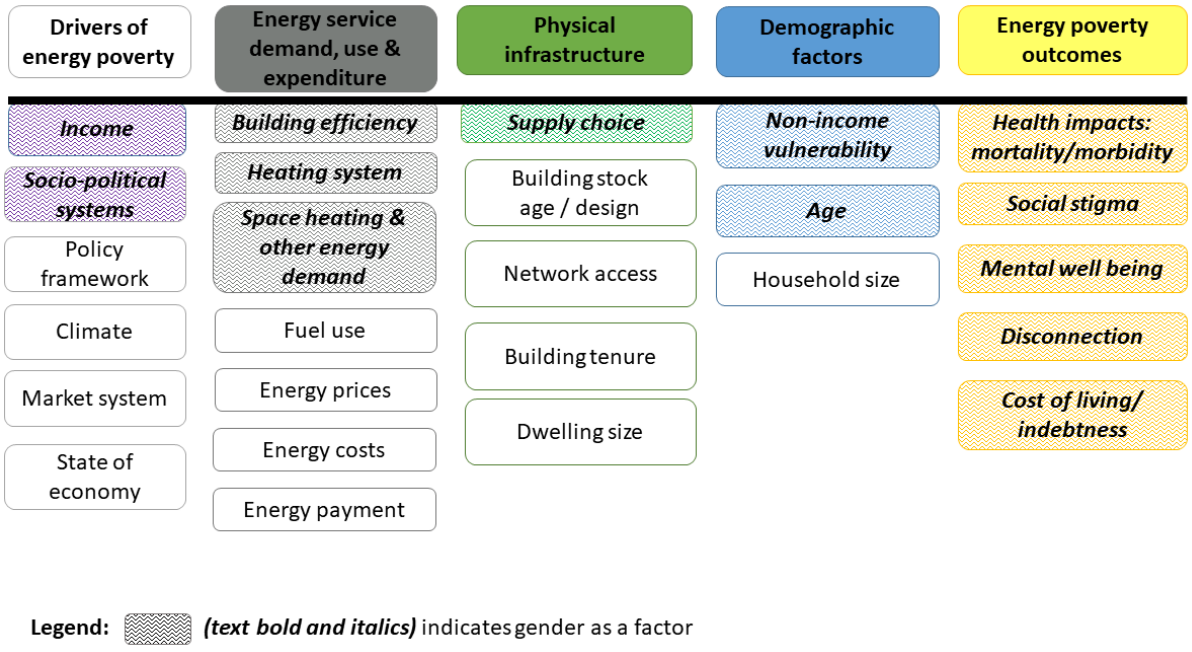
Figure 2. Conceptual map of the drivers, causes and effects of energy poverty in the EU



Source: Trinomics 2016

The authors recommend the use of the set of gendered indicators developed by Clancy et al. (2017) based on Trinomics (2016) for the formulation of indicators and framing of the policy responses which helps identify where the responsibilities to act lie. This set of gender indicators (Figure 3) shows that the energy sector is not always the sole actor responsible for addressing the causes of energy poverty which has a range of drivers, causes and effects with complex, cross-sectoral interlinkages. Energy poverty can be the result of poor-quality housing with inappropriate insulation and low incomes which would require actions from the housing sector and economic policy. When looking at the data collected and reported by Eurostat, the following gender-segregated energy poverty data can be found as summarised in Table 1.

Figure 3. A set of gender indicators operating in the drivers, causes and effects of energy poverty



Source: Clancy et al. 2017

Table 1. Indicators of gender-segregated energy poverty data with source

Indicators of gender-segregated energy poverty data	Source
Gender differences in the at-risk-of-poverty rate by age - EU-SILC survey	Eurostat
Gender employment gap	Eurostat
Gender gap in part time employment	Eurostat
Gender overall earnings gap	Eurostat
Gender differences in the relative income of older people - EU-SILC survey	Eurostat
Inability to keep home adequately warm by level of activity limitation, sex and age	Eurostat
Arrears (mortgage or rent, utility bills or hire purchase) by level of activity limitation, sex and age	Eurostat
Housing cost overburden rate by level of activity limitation, sex and age	Eurostat
At-risk-of-poverty rate before social transfers (pensions excluded from social transfers) by poverty threshold, age and sex - EU-SILC and ECHP surveys	Eurostat

Source: Authors' elaboration

What the above figures do not show is how the effects of energy poverty are influenced by economic, physiological and sociocultural factors which also need to be taken into account. Looking at energy poverty in Europe through an intersectional lens, it can be argued that due to their lower average income, women are at a greater risk of energy poverty than men. Energy poverty has a strong gender dimension. As demonstrated by EIGE (EIGE 2019), due to the gender pay gap, women are at a higher risk of poverty than men and combined with the demographic gender gap, women live longer in poverty than men. In the EU, this gender dimension of poverty implies that more women than men are living in energy poverty (Clancy et al. 2017). Gender and energy poverty can be analysed from four interlinked perspectives that are either causal or consequential:

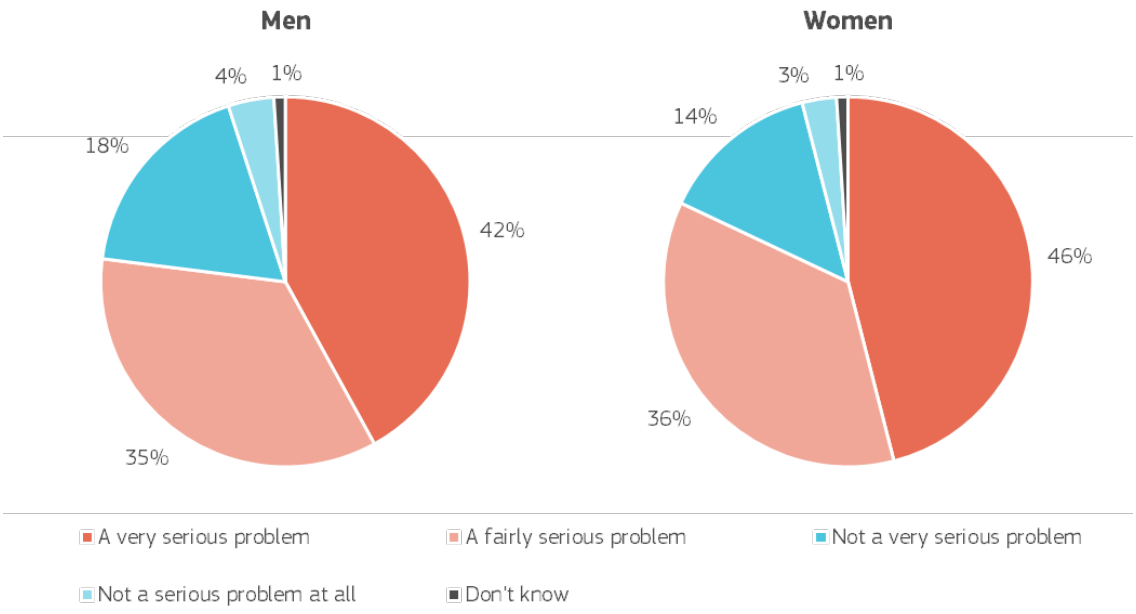
- Economic perspective: e.g., women with low incomes are disproportionately found as heads of households either as single-parent families or, due to their greater longevity than men, living alone at pensionable age.
- Health perspective: biological/physiological elements impact a gendered vulnerability to energy poverty e.g., age is a significant factor in dealing with heat and cold stress, with young children and older persons being particularly vulnerable. Men and women also have biological variations in body temperature regulation with women being more sensitive to extreme temperatures (further explained in 3.3 section below).
- Socio-cultural perspective: women's energy needs and consumption patterns differ than those of men but also among women, factors like marital status and employment influence energy consumption.
- Behavioural perspective: behaviour (cognition and perception aspects) plays a role in how energy poverty is gendered and is included in the analysis.

3.2 An economic perspective on gender and energy poverty

Gender inequality in income and wealth is one of the oldest and most pervasive forms of inequality in the world. It denies women their voices, devalues their work and makes women's position unequal to men's, from the household to the national and global levels.

Depending on the individual economic situation, people perceive the costs of essential services like energy or transport differently. For instance, regarding the perception of the seriousness of the problem of household energy costs (such as lighting, cooking, heating, cooling and running appliances), we see some differentiation when it comes to gender. The Eurobarometer on fairness perceptions of the green transition (Eurobarometer 2022) shows that on average in the EU, women find the costs of energy 'a very serious problem' more often than men (46% vs 42%) (Figure 4). This share and gender divide varies significantly among EU countries but the trend is only reversed in a few, where women express less worry about energy costs than men (e.g. Finland and Sweden). The biggest gender difference is detected in Germany, with 32% of men and 41% of women finding energy costs 'a very serious problem'.

Figure 4. How serious a problem is the current cost of your household's energy needs (lighting, cooking, heating, cooling, running appliances, etc.) by gender of reference person



Source: Eurobarometer 2022

Despite important progress in recent years to address economic inequality, women have not yet drawn level in any European country, and are still more likely to live in poverty than men. Women's economic inequality is characterised by:

- Low wages. Across the world, women are in the lowest-paid work. Globally, they earn 24% less than men and at the current rate of progress, it will take 170 years to close the income gender gap. 700 million fewer women than men are in paid work (Oxfam International 2022). In the EU, the gender pay gap stood at 12.7% in 2021 and has only changed minimally over the last decade. It means that women earn 13.0% on average less per hour than men[4].
- Lack of decent work. 75% of women in developing regions are in the informal economy – where they are less likely to have employment contracts, legal rights or social protection, and are often not paid enough to escape poverty. 600 million are in the most insecure and precarious forms of work (Oxfam International 2022).
- Unpaid care work. Women do at least twice as much unpaid care work, such as childcare and housework, as men – sometimes 10 times as much, often on top of their paid work. The global value of this unpaid care work each year is estimated at least EUR 10.14 trillion – more than three times the size of the global tech industry (Oxfam International 2022). In the EU, between carers, women tend to spend more time in unpaid caregiving than men – specifically, twice as many women spend at least 5 hours every day caring for children than men (EIGE 2023).
- Longer work days. Women work longer days than men when paid and unpaid work is counted together. That means that globally, a young woman today will work on average the equivalent of four years more than a man over her lifetime (Oxfam International 2022).

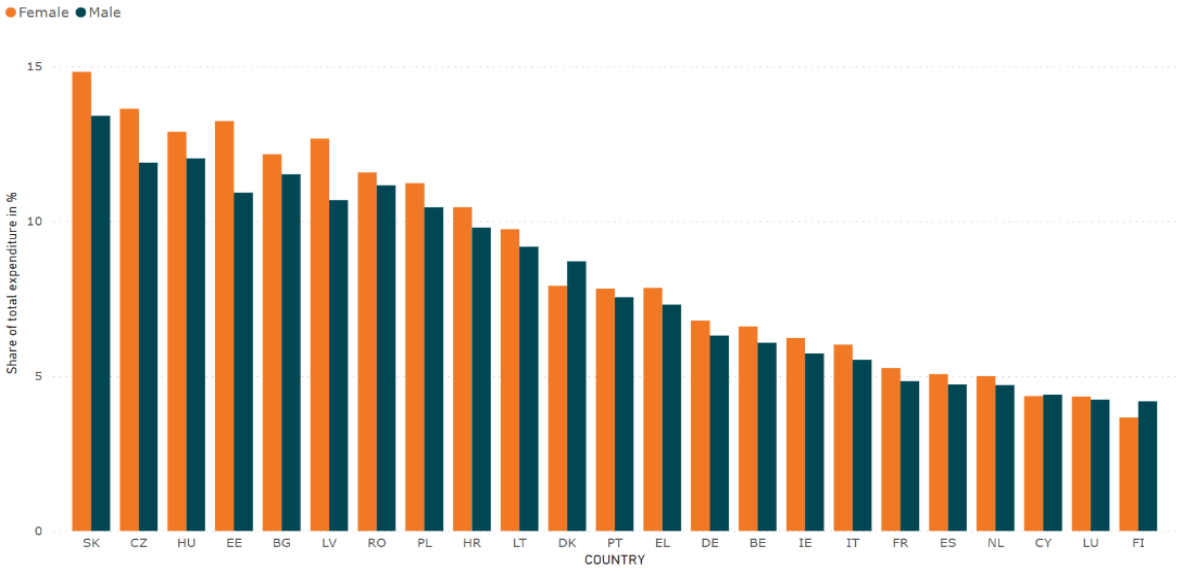
There is a strong link between female energy poverty and labour. Women are more often affected by energy poverty due to lower employment rates, part-time employment, provision of unpaid care, and even precarious jobs (Robinson 2019). Single-person households are also more often women than men living alone and facing an increased risk of energy poverty, especially when surviving on limited pensions (Clancy et al. 2018).

Notably, an effective way to alleviate the energy poverty burden on women is to enhance their employment opportunities. Research suggests that an increase in employment options for women is associated with a reduction in energy poverty, highlighting the potential for addressing this issue through economic empowerment (Nguyen & Su 2021).

On average, female-led households also score higher on classic energy poverty indicators. Across Europe, 8.1% of female-led households are unable to keep their home warm (as opposed to 7.5% for male-led) while 8.3% of female-led households appear to have arrears in utility bills (7.2% for male-led) (Koukoufikis & Uihlein 2022). An analysis of Eurostat data reveals that households with a female reference person spend a higher share of their household budget on energy compared to households with a male reference person (Figure 5). This is true for all countries except for Luxemburg and Finland. Larger differences can be seen in Croatia, Romania, Poland and Lithuania.

[4] Eurostat [earn_ses_hourly, earn_ses_monthly, lfsi_emp_a].

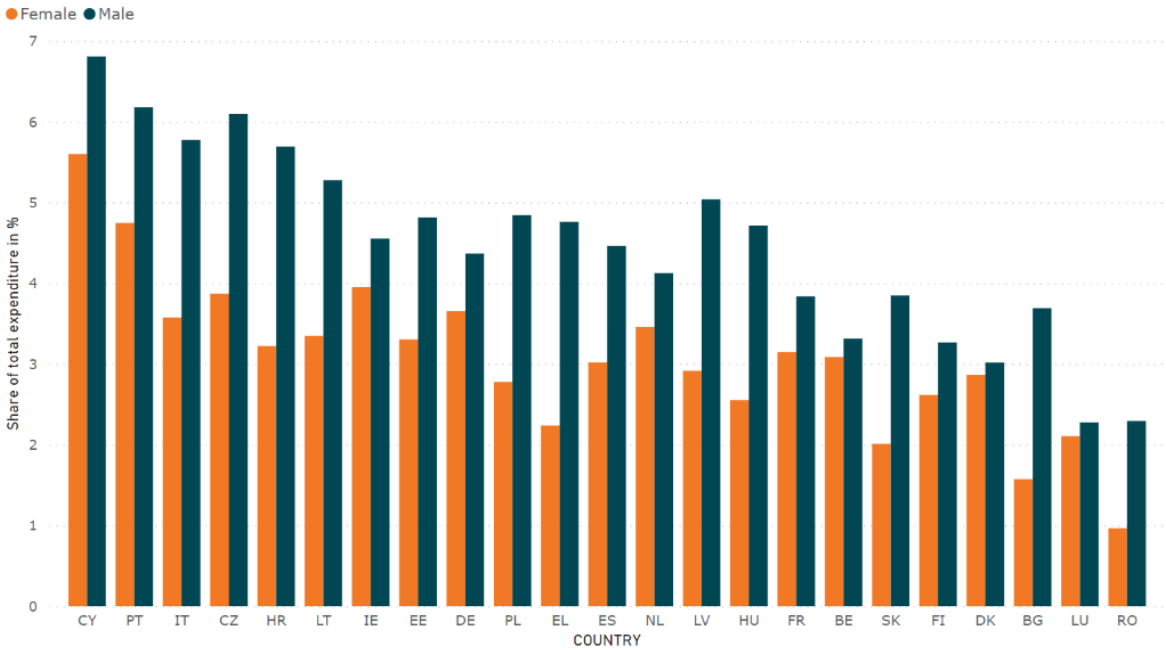
Figure 5. Share of expenditure for energy by gender of reference person



Source: Koukoufikis & Uihlein 2022, based on HBS 2015

In contrast, the share of expenditure for personal transport shows a drastic difference between male and female reference persons (Figure 6). On average, households with a male reference person spend twice the average in the European Union. In some Member States, the difference can be up to a factor of 5 to 6 (Romania, Bulgaria, Slovakia). This disparity in personal transport expenditure between households with male and female reference persons can be attributed to variations in economic stability within households, as well as cultural preferences regarding the car ownership versus the use of alternative modes of transportation.

Figure 6. Share of expenditure for personal transport by gender of reference person



Source: Koukoufikis & Uihlein 2022, based on HBS 2015

Box 1. Case study The Netherlands: socioeconomic patterns of energy poverty

The figures from TNO from September 2021, before Russia's war against Ukraine, show that approximately 550 000 households in the Netherlands are energy-poor. That is about 7% of all households. We use data from before 2021 to demonstrate the structural character of energy poverty. With increasing energy prices, even more Dutch households are now vulnerable to energy poverty. These households have a low income on the one hand and either high energy costs or a house with low energy efficiency on the other. By way of comparison, about 15% of households in the Netherlands are affected by income poverty; the number of low-energy households in the Netherlands is therefore about half the number of low-income households (Mulder, Dalla, & Straver 2021).

Within the group of energy-poor households, approximately 250 000 households have a relatively low income and a home with low energy efficiency and high energy costs. There are an estimated 140 000 households with hidden energy poverty; these are people who, due to financial problems, consume less energy than they would like to. Finally, the data show that almost half (48%) of all households in the Netherlands live in a house with relatively low energy efficiency that they cannot make sustainable on their own. More than half of these are tenants without the power to make the necessary changes, and the remainder are homeowners with insufficient equity or borrowing capacity to make large investments themselves (Mulder, Dalla, & Straver 2021).

An analysis of the characteristics of energy-poor households shows that single-person households and especially single-parent families are strongly overrepresented in the group of energy-poor households. Depending on the definition chosen, 17-22% of energy-poor households consist of single-parent families, while they constitute only 5% of all households in the Netherlands. In total, families with children (both single and two-parent families) make up about 30% of energy-poor households and about 60% of those homeowners who have insufficient financial capacity to make their relatively energy-inefficient home more sustainable (Mulder, Dalla, & Straver 2021).

In 2021 there were 593 871 single-parent families (approximately 23% of families), in the Netherlands; in most cases single mothers with one or more children (NJI 2021). Compared to 2020, the ratio of one-parent families to two-parent families has remained the same: 77% two-parent families and 23% one-parent families (NJI 2021).

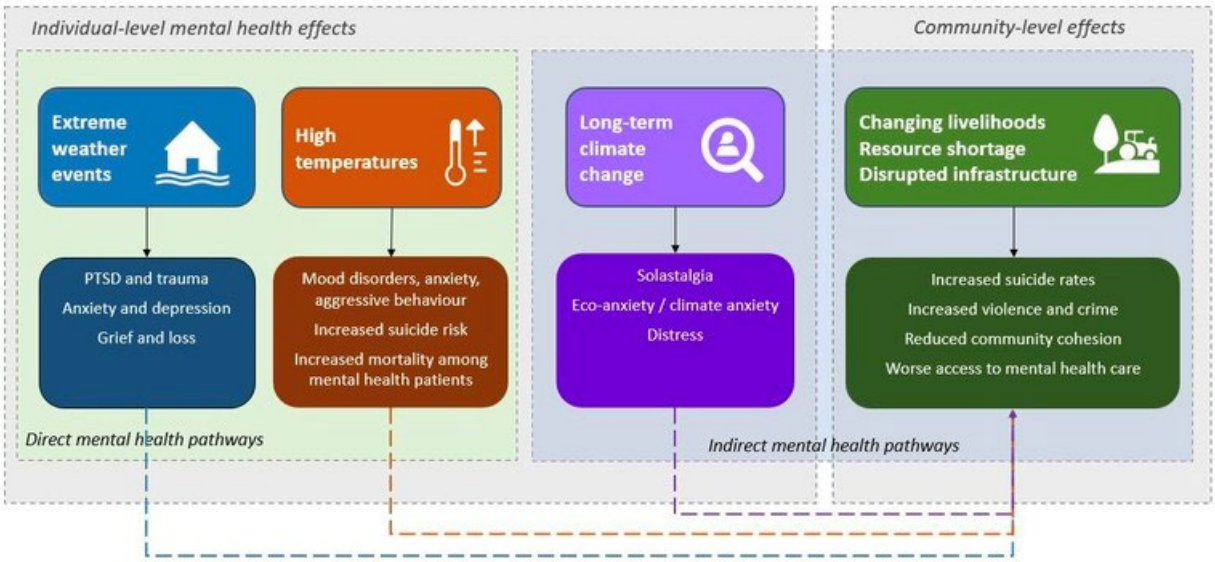
The number of children and young people up to the age of 25 growing up in a single-parent family has steadily increased in recent years. In 2021, 764 022 children and young people lived with one of their parents. That is almost 16% of all children and young people up to the age of 25. A year earlier, there were 760 920 children and young people up to the age of 25. Compared to 2010, over 100 000 more children are growing up in single-parent families. In 2021, 538 285 children lived with one parent. That is more than 16% of children and young people up to the age of 18 (NJI 2021).

3.3 The health impacts of energy poverty

Energy poverty contributes to adverse physical health impacts in several ways, many of which affect women more than men. For instance, in the Global North, women are more often caretakers and spend more time at home, and are thus more exposed to cold homes, while in the Global South, the health impacts are mostly seen through exposure to indoor pollution due to cooking with solid fuels (Jessel, Sawyer, & Hernández 2019). Even in Europe, women are overrepresented among vulnerable communities using wood as a fuel to cope with energy poverty (Stojilovska et al. 2023). Exposure to cold indoor environments exacerbates rheumatism (Oliveras et al. 2021). Research by Nguyen & Su (2021) has shown that efforts to reduce energy poverty have the potential to re-balance the gender inequality in health between women and men, particularly in terms of life expectancy and survival to age 65. Importantly, these efforts appear to have a positive effect by reducing the mortality of women more than men.

Health risks related to energy poverty demonstrate similarities with the mental health impact of climate change. As a result of coping with energy poverty, individuals experience anxiety and other mental health challenges (Fabbri 2015; Mould & Baker 2017). Climate change impacts mental health through several pathways. For instance, extreme weather events and the inability to keep sufficiently warm or cold can cause post-traumatic stress disorder, anxiety and depression; energy poverty affects mood, worsens behavioural disorders, increases suicide risk, and impacts the wellbeing of those with mental health issues; distress associated with ongoing or anticipated climate and environmental change causes climate anxiety; and impacts associated with changing livelihoods and social cohesion of entire communities take a toll on wellbeing (Romanello et al. 2021). Studies exploring cases of social exclusion as a result of coping with energy poverty more often depict cases of women being affected (Longhurst & Hargreaves 2019; Middlemiss et al. 2019).

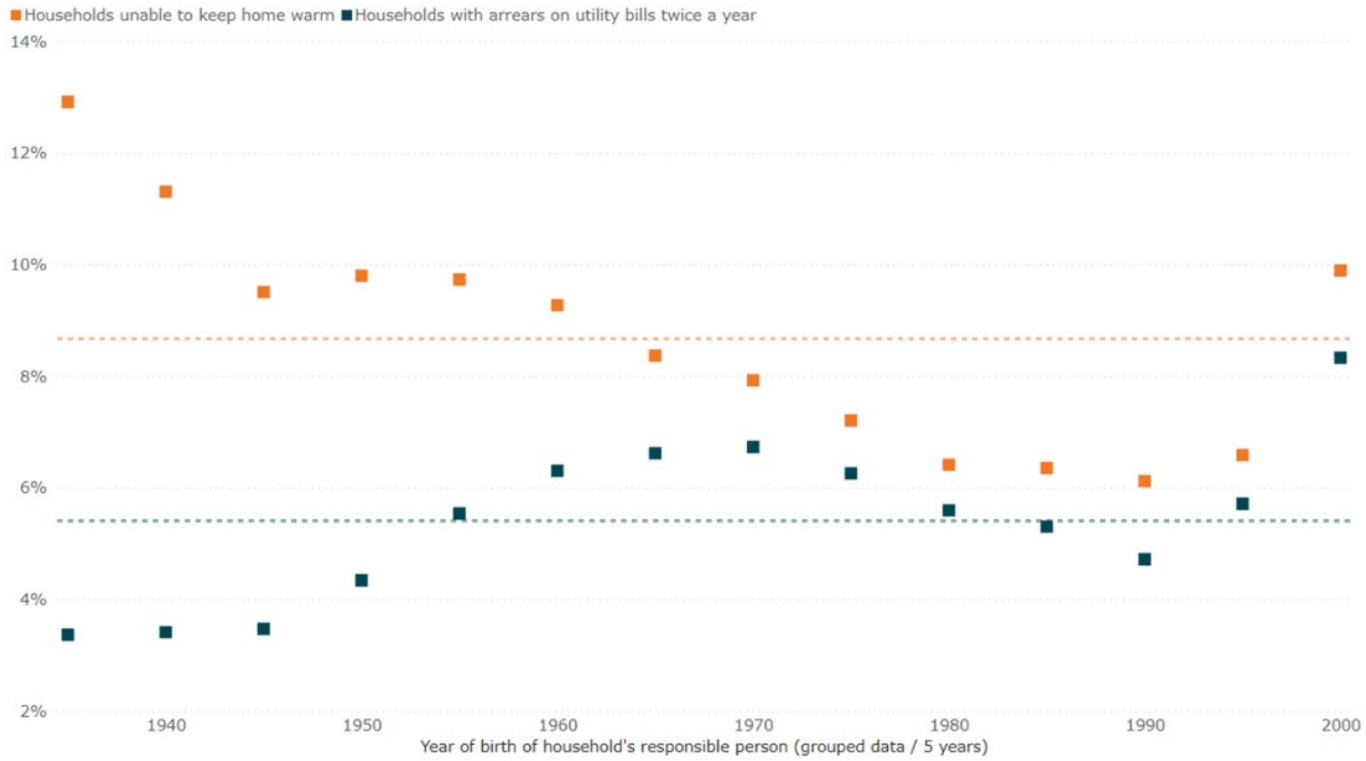
Figure 7. Health impacts of climate change



Source: Romanello et al. 2021

Elderly persons have a reduced body-temperature regulating function which makes them less resilient to extreme temperatures. They report higher rates of energy poverty than any other social group in the EU when it comes to thermal comfort (Figure 8). When the ambient temperature increases, sweating is a natural mechanism to reduce body temperature. With age, this function decreases and people are less able to reduce their body temperature by sweating (Romanello et al. 2021). Due to the demographic fact that on average, women all over the world live longer than men, older women are the most vulnerable to the health-related impacts of extreme weather temperatures. Even in advanced economies, older women suffer more from energy poverty and experience adverse health impacts (Porto Valente, Morris, & Wilkinson 2022). From ages 50 and over, women across the world make up a bigger proportion of the population, with their share of the population increasing in every age group thereafter. As many as 18 countries in Europe have less than two men for every five women aged 80 or over.

Figure 8. Energy poverty indicators and age (EU average 2019)

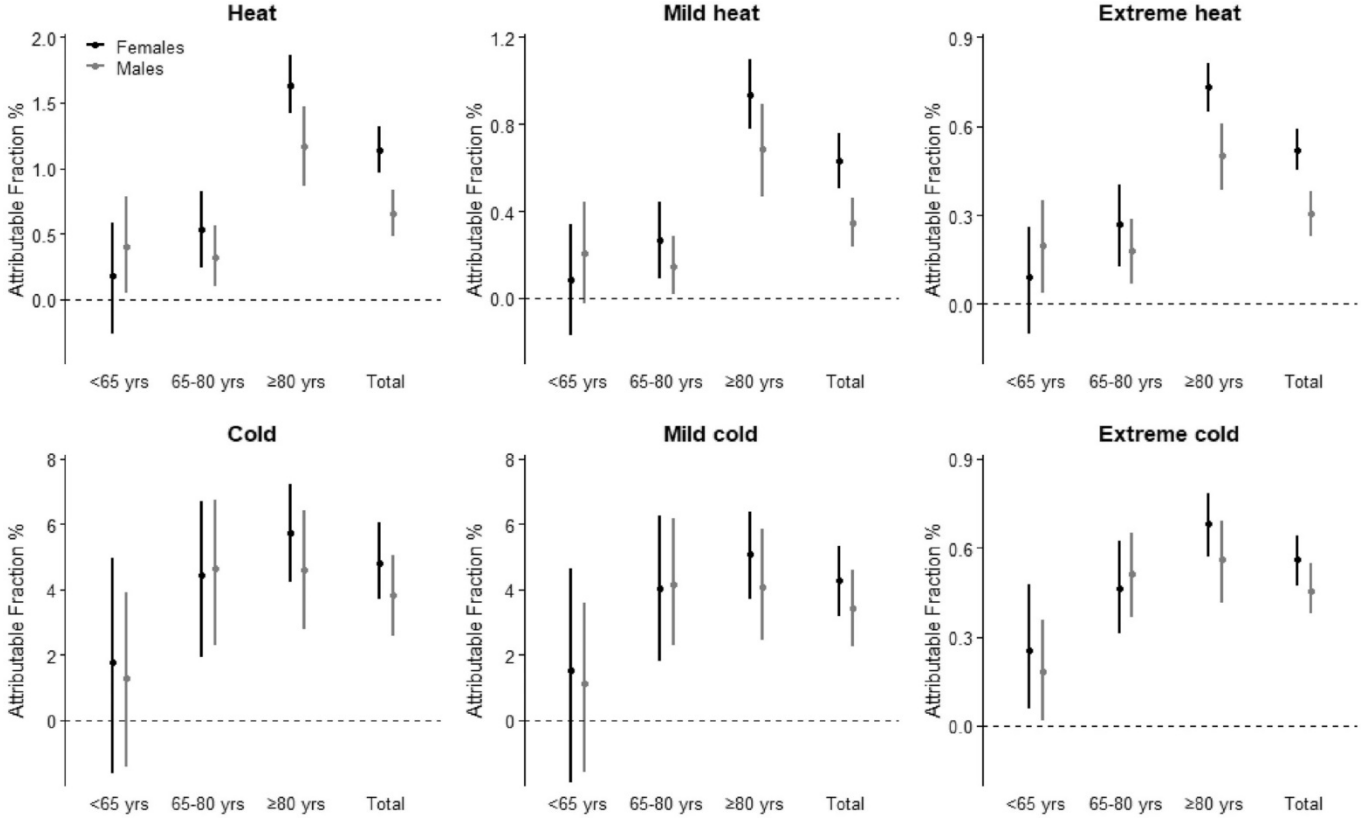


Source: Koukoufikis & Uihlein 2022, based on EU-SILC, 2019

Women have an ambient temperature preference difference of roughly 1.5 ^{0}C compared to men (higher or lower depending on the season). This is partly because of the biological difference in lowering body temperature through sweating: women sweat less than men. In cold temperatures, women struggle to stay warm enough due to their biological capacity for temperature regulation (Romanello et al. 2021). Additionally, women are more sensitive to extreme temperatures (Karjalainen 2007; Sánchez-Guevara Sánchez, Sanz Fernández, & Núñez Peiró 2020) which makes them more vulnerable to summer energy poverty. However, there is also a need to look beyond the male-female binary and employ intersectionality to unlock further features of vulnerability, such as socioeconomic status, ethnicity, nationality, health, sexual orientation, age and place (Kaijser & Kronsell 2014).

In a Dutch case study, Folkers et al. (2021) explored whether elderly women would die more often due to warm or cold temperatures compared to the men in their age group. As Figure 9 shows, there were no sex differences in cold-related mortality in this study, but females appear to be more susceptible than males to both mild and extreme heat when considering all age groups combined. Significant age-specific sex differences were only observed for the oldest group in extreme heat, but not in mild heat as for the total population. Knowing that women are overrepresented in the age group of over 80 years, elderly women have a higher risk of dying in extreme heat.

Figure 9. Daily mortality attributable to the heat and cold in the Netherlands between 1995–2017, subdivided into males and females for the total population and separated into three different age groups (< 65, 65–80, ≥ 80 years)



Source: Folkerts et al. 2021

Compared to people living in rural areas, the urban population is more vulnerable to temperature differences, especially during hot weather in the summer. Due to the heat-island effect caused by the lack of green areas and water, the temperature in urban environments is higher than in rural areas. Furthermore, buildings store the heat in summer, reducing the effect of natural cooling in the evenings. In cities all around the world, the female population is in the minority, but still, women and girls in urban areas are more exposed to heat stress than the female population in rural areas. In the EU, according to EU-SilC 2019 data, densely populated areas host the highest share of female-led households in the EU (45.8%), compared to intermediate and rural areas (39.5% and 38.2% respectively). Record temperatures in 2020 resulted in a new high of 3.1 billion more person-days of heatwave exposure among people older than 65 years and 626 million more person-days affecting children younger than one year, compared with the annual average for the 1986–2005 baseline (Romanello et al. 2021).

Lastly, newborn babies are also especially susceptible to variations in ambient temperature compared to older children and adults. Despite their relatively large body surface area-to-mass ratio, which aids heat regulation, they are entirely reliant on caregivers for managing their environmental exposure as they cannot regulate their own behaviour, by drinking more, staying in the shade and wearing different clothes for example. Since their main caregivers tend to be their mothers, due to the gendered roles in society, mothers with dependent newborns constitute vulnerable groups with limited resilience to extreme temperatures. When coping with energy poverty, women find it essential to be able to protect their children from the cold, performing the norm of a good parent (Stojilovska, Yoon, & Robert 2021).

3.4 Socio-cultural characteristics of energy poverty

Many household care tasks, such as cooking, washing clothes and cleaning, are energy-intensive. The gender division of labour across EU Member States is similar to elsewhere in the world; women bear the burden of care work (80% of women are involved daily in unpaid household work compared with only 45% of men) (EIGE n.d.). While many of these tasks are mechanised, the outcome is not necessarily women spending less time on household tasks. For example, washing machines have not reduced women's time spent on laundry. Increased

disposable income can result in family members owning more clothes with higher social standards of cleanliness requiring more frequent garment washing.

The behaviour patterns of women, particularly those of pensionable age, undergo changes influenced by their generational experiences. Women of pensionable age grew up in a time of austerity when coping strategies might have been frugal, which re-emerge if they find themselves with constrained finances in later life. Many of these women also change their behaviour patterns, for example, they cook less frequently. Younger women have grown up with greater familiarity with technologies, so using new pieces of energy-efficient equipment, such as microwaves, is less daunting (Feenstra & Clancy 2020).

To compensate for energy poverty, a wide range of relief and mitigation strategies have been implemented in the EU Member States. Energy poverty interventions are often delegated to the municipalities and interwoven with social welfare policy (Feenstra 2021). Many governments aim to reduce energy consumption and mitigate energy poverty through energy efficiency improvements to housing, along with retrofitting projects. However, among tenants, women are overrepresented, forcing them to rely on the energy-efficiency actions of their landlords to improve their thermal comfort.

3.5 Behavioural aspects of energy poverty

The rational choice theory has for decades served as the basis for economic modelling and policymaking. This theory assumes that individual behaviour results in decisions based on an analytical comparison of the costs and benefits associated with alternative options, and can be altered only by changing economic incentives and providing more information. However, this theory has been confronted with empirical failure to depict actual individual behaviour. A central theme in the field of behavioural economics is that of bounded rationality, which demonstrates that people use heuristics to deal with their inherent inability to perform rational calculations. These mental shortcuts enable one to navigate complex environments, but may also often lead to systematic and predictable errors, such as cognitive biases (Kahneman 2003; Simon 1957, 1955). As a result, the quality of decision-making in many domains, such as energy (Frederiks, Stenner & Hobman 2015), can be negatively affected. In all of this, suboptimal situational factors (such as when individuals live in a context where resources are scarce or where inequalities are prominent, such as the energy poor) play a key role in leading individuals to make more error-prone decisions (DellaValle 2019). As an example, because of the suboptimal conditions they face, the energy poor might forego applying for a subsidy programme, switching to a more convenient utility contract or to using a thermostat setting that saves more energy, because searching for information to change the status quo is too cognitively demanding. Therefore, to reduce individuals' cognitive demand, policymakers can thus provide the 'right' default, make the use of technology more straightforward, or make it easier to enrol in a programme or switch to a better contract (the so-called nudge in the form of default). At the same time, when the cognitive structure is strengthened, such as through boosting core competencies (like digital or risk literacy), the quality of decision-making can autonomously improve (Hertwig & Grüne-Yanoff 2017).

The field of behavioural economics has also proved that in addition to displaying cognitive deviations from rational choice assumptions, individuals are heterogeneous in their preferences, and in their degrees of self-interest and motivations (Della & Bertoldi 2021). As an example, individuals are differently motivated by inequality concerns and, depending on these, they will decide to engage or not in a certain behaviour. The empirical and experimental literature looking at individual differences, such as gender, points to gender differences in vulnerability to cognitive biases. As an example, men seem to be more vulnerable to overconfidence bias (i.e., people tend to overestimate the accuracy of their judgements) than women, while women seem to be more vulnerable to outcome bias than men (i.e., they tend to judge a decision based on its outcome rather than basing it on the quality of the decision when it was made) (Berthet 2021). When looking at gender differences in preferences, there exists extensive literature analysing gender differences in risk-taking. As an example, with regard to risk-taking decisions made when decisions are made jointly with others (joint decisions) or on behalf of others (social responsibility), it has been proven that women are more risk-averse than men because of inequality aversion concerns, meaning they are motivated to avoid unequal or unfair outcomes (Friedl, Pondorfer, & Schmidt 2020). Similarly, when looking at core competencies that can improve the quality of decision-making, the literacy rate in the EU demonstrates that more women than men struggle to understand functional written text and act upon it. Hence, the functional illiteracy rate is gendered as demonstrated by the Dutch example below.

Looking at energy-related decisions, even when women have the capital for the upfront costs, and legal ownership of their homes to invest in energy efficiency, they need to have a high financial literacy rate to apply

for financial assistance like subsidies and tax reductions. However, empirical evidence shows that a gender gap exists in energy-related financial literacy (Blasch et al. 2018).

Therefore, when researching functional literacy and core competencies for energy citizenship, we further investigate whether there are differences in energy literacy between women and men. This competence is of particular relevance for women's engagement and behaviour in the energy transition as it predicts many energy-related behaviours, including acceptance of time-of-use tariffs and willingness to invest in energy efficiency (Blasch et al. 2018).

In the Netherlands, the illiteracy data are rather shocking for a well-educated country (van Velzen 2018):

- 1.8 million Dutch people between 16 and 65 years old have trouble reading, writing and understanding numbers and calculations. They are considered functionally illiterate.
- A shortage of maths skills is a strong predictor of long-term poverty. Good maths skills help to manage personal finances and stay out of debt.
- People aged 16 to 34 who are deficient in maths skills are three times as often unemployed as those with good maths skills.
- Low-literate people have fewer functional language skills than non-illiterate people, while they are an important precondition for the development of digital skills.
- 300 000 Dutch people (16-65 years old) never use a computer and are low-literate.
- 740 000 employees are illiterate.
- Illiteracy costs roughly EUR 575 every year for those who are illiterate.
- 17.9% of 15-year-olds are at a high risk of illiteracy.
- Looking at the gender distribution, it is striking that women are slightly more illiterate than men (female illiteracy 12.7% versus 11.2% male illiteracy).

Overall, differences in cognitive biases, preferences and core competencies are key considerations, since they might negatively affect the economic outcomes of women, including participation in an energy community. However, several interventions, including traditional and behavioural policy instruments, like nudges and boosts (DellaValle & Sareen 2020), can be promoted to reduce such differences, improve the quality of decision-making and, as a result, women's economic outcomes.

4 Policy initiatives for an inclusive energy transition

This chapter describes existing instruments, initiatives and mechanisms to improve women's participation and mitigate gender inequalities in the energy transition. We start at EU level by listing the policy initiatives which have emerged since 2009 to tackle energy poverty and ensure equal access to sustainable energy services for all Europeans. How these policies are implemented depends on the national approaches of the Member States, which forms the second part of this chapter. We then look at individuals, at the micro-level of policy implementation, not only emphasizing the role of energy consumers but also the challenges faced by the more vulnerable energy consumers in light of the current energy crisis. Acknowledging that in the energy system, public-private partnership is crucial for an inclusive energy transition, the section on the corporate level describes the responsibility of industry partners to stimulate women's empowerment in the energy transition. We end this chapter with the emerging role of local energy initiatives and prosumers in the energy system by demonstrating the potential they provide for gender equality in the energy transition.

4.1 EU level

Recognition of the significance of addressing energy poverty within the European Union is evident through the evolution of EU policies and legislation. The groundwork for addressing energy poverty can be traced back to the vocabulary employed by EU institutions during the formulation of the Third Energy Package in 2009 (Bouzarovski et al. 2012). Over the subsequent years, from 2009 to 2018, several pieces of EU legislation aimed at tackling energy poverty were both proposed and approved (see Table 2 for details).

In 2017, the European Pillar of Social Rights introduced key principles to reaffirm the importance of equal treatment and opportunities for all genders. Principle 2 emphasized equal participation in the labor market, equitable terms and conditions of employment, and fair career progression. Principle 20 enshrined the right of every individual to access essential services of high quality, encompassing water, sanitation, energy, transport, financial services, and digital communications (European Commission n.d.). In December 2018, the EU further strengthened the gender link when it adopted the 'Clean Energy for All Europeans' package, a step in alignment with the EU's commitment to the Sustainable Development Goals (SDGs) and Sustainable Energy for All (SEforALL) initiative. An important novelty in the legislative framework was the obligation for Member States to assess the number of households in energy poverty. The requirement is laid down in Article 3(3)(d) of the 2018 Governance Regulation as one of the elements to be included in the national energy and climate plans (NECPs).

In response to rising energy prices in the autumn of 2021, the Commission issued a dedicated Communication, presenting a toolbox of specific measures that the Member States could utilise to tackle the immediate impact of the situation, particularly on the most vulnerable segments of society. The measures recommended in the toolbox include emergency income assistance to households, state aid for businesses, and targeted tax reductions. In May 2022, the persistence of high energy prices brought the introduction of the REPower EU Plan, aiming at mitigating the negative impacts, allowing Member States to set regulated prices for vulnerable consumers and micro-enterprises. Additionally, the 2014-2020 Common Provisions Regulation was amended to grant more flexibility to Member States. In October 2022, a regulation on emergency intervention was adopted to tackle energy prices, which is aimed at supporting vulnerable individuals and businesses in the EU by reducing electricity demand and collecting surplus and solidarity contributions from fossil-fuel based industry (Baptista & Marlier 2020).

In June 2022, the Council Recommendation on ensuring a fair transition towards climate neutrality (Council recommendation 2022/C 243/04), based on the guidelines provided by the International Labour Organisation (ILO), emphasised the importance of education and training initiatives to favour those who are most impacted by the green transition, recognised energy as a fundamental service and acknowledged that lack of access leads to energy poverty. The Council Recommendation also addressed the issue of transport poverty, emphasising the necessity for its more precise definition, enhanced monitoring and assessment.

In September 2023, the revised Energy Efficiency Directive included the first ever EU definition of energy poverty and put a stronger focus on alleviating energy poverty and empowering consumers. Member States now have to prioritise support for low-income citizens and people affected by energy poverty and vulnerable customers, when implementing energy efficiency improvement measures.

Lastly, in October 2023, the Commission published a new Recommendation on energy poverty that introduces a comprehensive framework to identify and address energy poverty. It encourages Member States to define energy poverty in their national laws, prioritise structural improvements, and diversify energy options for consumers while preventing the dependence on fossil fuels.

Table 2. Energy poverty in EU policy

Date	Policy
7/2009	Third Energy Package: develop definitions, elaborate action plans and strategies to tackle energy poverty protect vulnerable customers
11/2010	EC: call on Member States to replace direct subsidies for high energy bills with a support for improving the energy quality of the buildings
10/2011	EU Cohesion Policy 2014–2020: innovation, low-carbon economy, social inclusion
11/2016	Regulation on the Governance of the Energy Union: meeting the 2030 energy and climate targets
11/2016	Internal Market in Electricity Directive
11/2017	European Pillar of Social Rights (EPSR): principle, 20 supports decent access to essential services, such as water, sanitation, energy, transport, financial services, and digital communications
05/2018	Energy Performance of Buildings Directive: 2050 decarbonisation objective for EU buildings
06/2018	Energy Efficiency Directive: article, 7 more explicit requirements to tackle domestic energy poverty in the annual savings objectives and Governance Regulation by mandatory monitoring of domestic energy poverty in the Nation Energy and Climate Plans
12/2018	Renewable Energy Directive: new rights for communities to set up local energy projects and to facilitate participation by households in energy poverty
12/2018	Clean Energy for All Europeans Package
10/2020	Commission Recommendation (EU) 2020/1563 on energy poverty
7/2021	Recast of Energy Efficiency Directive: Stronger focus on alleviating energy poverty, empowering consumers, vulnerable social groups and target setting
10/2021	Commission Communication COM/2021/660 final on tackling rising energy prices: a toolbox for action and support
05/2022	Commission Communication COM (2022) 230 final on RePowerEU Plan
06/2022	Council recommendation 2022/C 243/04: requires integration of social and employment aspects of the green transition into the relevant national strategies
09/2023	The revised Energy Efficiency Directive (EU/2023/1791) puts a stronger focus on alleviating energy poverty and empowering consumers through a series of wide-reaching measures
10/2023	Commission Recommendation on energy poverty (C/2023/4080), together with a guidance document (SWD(2023) 647) and renewed the Joint Declaration on enhanced consumer protection for the winter, originally signed in December 2022.

Source: Authors' elaboration

On gender-specific actions, the EU has set out a gender equality strategy for the years 2020–2025 that aims to make concrete progress on gender equality in the EU (European Commission 2020). Some of its key objectives are challenging gender stereotypes; closing gender gaps in the labour market; achieving equal participation across different sectors of the economy; addressing the gender pay and pension gaps; and achieving gender balance in decision-making. Notably, the JRC is actively monitoring Member States' progress in these key dimensions through the Gender Equality Strategy Monitoring Portal[5], providing a comprehensive assessment of efforts and advancements toward gender equality.

Moreover, the European Parliament adopted a resolution to assess the progress made in women's rights over the past 25 years and the many challenges still ahead in February 2021 (European Parliament 2021a). Among other things, it calls on Member States to implement specific social measures to combat the risk of social exclusion and poverty with regard to access to affordable housing, transport and energy.

The EU Report on Access to Essential Services found that the programme, Interreg Europe 2014-2020, has provided support for energy poverty projects with a focus on social inclusion, for example by funding 'POVERTY-Renewable energy for disadvantaged groups' (2019-2023) and 'ComAct – Community Tailored Actions for Energy Poverty Mitigation' (2020-2023), as Horizon 2020 did with 'STEP – Solutions to Tackle Energy Poverty' (2019-2021). Following the EU policy on gender mainstreaming, the latter has explicitly requested to integrate gender considerations into projects such as 'SHAPE ENERGY', targeted at measuring improvements obtained with Social Science and Humanities (SSH)-Energy, a field of research which focuses on the social, cultural, economic, and political aspects of energy use and policy. Søraa et al. (2020) found that, although the project aimed to encourage women's participation, address their needs, and study the role of gender in research, there were still challenges such as resource limitations, institutional resistance and linguistic barriers. The paper suggests that addressing these challenges and adopting a broader, intersectional approach to gender could improve inclusion in future research projects.

4.2 Member State level

The EU Regulation on the Governance oof the Energy Union requires Member States to submit their National Energy and Climate Plans (NECPs) to support the EU's climate action and energy transition objectives - Regulation (EU) 2018/1999 (European Parliament 2018). The NECPs, due to be updated in 2024, need to convey State's national objectives, targets, and contributions to the Energy Union's various dimensions, such as decarbonisation, energy efficiency, energy security and the internal energy market, including social policy measures. Specifically, Member States must assess how many households live in energy poverty, taking into account the necessary domestic energy services needed to guarantee basic standards of living in the relevant national context and report on this, as well as policy incentives to mitigate energy poverty. These NECPs submitted by the national governments of the EU Member States reflect the policy choices of those nations towards a just energy transition. The NECPs serve as a reflection of the policy discourse at the national level.

Energy policy formulation seems to take place entirely at the national level and in a top-down manner. This is partly explained by the supply-oriented focus of energy policy until the 1990s. In the aftermath of the global oil crisis in 1973 and the 1979 energy crisis, the security of the energy supply was the main focus of national policymakers. They did not feel the need to consult users, although people might have varying preferences about what energy services to use (Feenstra 2021). The European Commission required an interactive stakeholder process in drafting the NECPs. National governments were obliged to consult stakeholders and create an interactive process with actors, such as online consultations. They had to report in their NECPs the extent to which they had consulted stakeholders.

Policies tackling energy poverty can be classified into two categories: protection policies and promotion policies (Drèze & Sen 1991). The former are short-term in nature, aiming to preserve a minimum level of access to energy: in immediate response to the increasing energy prices in 2021, Belgium, Croatia, Cyprus, Lithuania, Poland and Slovenia adopted tax reductions, mostly including a cost reduction for all consumers through a general VAT-reduction, with Belgium adopting a national social tariff for gas and electricity. Austria, Cyprus, Germany, the Netherlands, Poland, Slovenia and Spain adopted other general tax reduction measures, whereas Italy introduced a policy that provides direct assistance to low-income households (gas and electricity bonus). Price caps have been introduced in Bulgaria, France, Malta, Romania and Hungary.

[5] Gender Equality Strategy Monitoring Portal

In the context of promotion policies, e.i. longer-term measures, countries have targeted funding towards low-income individuals to ensure inclusiveness, as disadvantaged groups may face barriers in accessing these programmes. This is the case in the household retrofitting schemes that have been introduced in Ireland, France, Austria, Portugal, Cyprus, Estonia and Lithuania, as well as in the context of measures aimed at improving energy efficiency in Slovakia, Portugal, Croatia, Lithuania, Cyprus, Romania and the Netherlands, including incentives to switch to renewable energy sources in Sweden and Denmark (Baptista & Marlier 2020).

Member States offer various measures to support access to public transport for specific groups in the population, such as reduced tariffs, monetary benefits, tax rebates and in-kind benefits. These measures are usually based on demographic characteristics, such as age, disability, reduced mobility and student status, and benefit low-income groups more than the rest of the population. Women's risk of transport poverty is influenced by several characteristics, including a higher risk of poverty and social exclusion, therefore gendered targeted energy poverty mitigation measures should address the specific situations of vulnerable women (European Parliament 2021b). Some European countries recognise vulnerable groups including gender in their income, energy efficiency, energy prices, energy, and climate policies that impact energy poverty, leading to greater policy integration around energy poverty (Stojilovska et al. 2022).

4.3 Consumer level

Despite the political attention for just transitions that benefit all, there is a policy gap in relation to gender in the low-carbon energy transition. On the policy level in the EU, there has been an emerging focus on engaging consumers to foster sustainable energy consumption and to empower people to become managers of their energy needs (Standal et al. 2018). However, the dominant economic perspective observed in the NECPs, focusing on efficiency in the energy transition and decarbonisation, tends to ignore social aspects. Energy policies thus do not consider that women and men have different opportunities and ways of engaging with energy in policy, research and business (Standal et al. 2019; Clancy and Röhr 2003). In order to establish a better understanding of energy users' situation, more awareness is needed among national legislators for the particular needs and lived experiences of these groups.

In the search for a just energy transition, the question emerges of how to design an energy policy that reflects the rights and needs of all energy users. Energy technology innovations, such as renewable energy sources and reducing energy consumption, are core aspects of this aim of universal access to sustainable energy. Increasing awareness of the lack of access to sustainable and affordable energy services in the European Union is reflected in the Right to Clean Energy for all Europeans in the EU Electricity Directive 2019/944 of 14 June 2019. The rights and needs of vulnerable energy consumers are gaining attention from policymakers at all levels within the EU (Clancy and Feenstra 2019). National governments affirm the legally binding character of the EU directives, stating that inclusive participation is a legally enforceable right of underrepresented groups.

Energy policy discourses often lack a clear notion of who energy consumers are, and as a result, they fail to recognise gender-specific needs. As previously explained, gender-focused analyses of energy policies highlight a gender gap in energy access, with women, particularly those in single-parent households, being overrepresented among the 'energy poor.' This disparity is primarily attributed to income gaps between men and women, as well as demographic factors that put more women at risk of prolonged poverty and limited energy access. More research on the energy practices of these groups and especially the lived experiences of the vulnerable energy users in energy poverty could contribute towards a better understanding of existing injustices and inequalities in energy access.

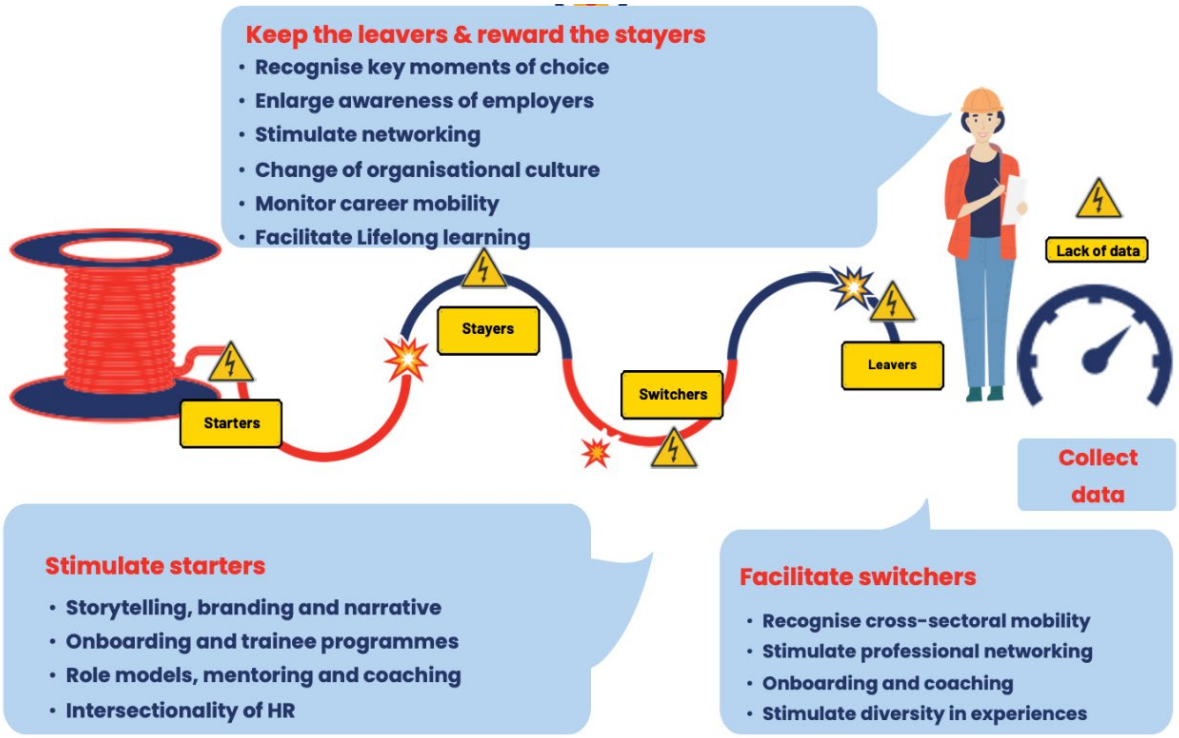
4.4 Corporate level

At the corporate level, attempts to improve gender equality are framed in corporate social responsibility with significant shortcomings in regard to achieving gender justice and equality in practice. Although adopting legislation that promotes gender equality has the potential to address gender inequalities in the corporate sector, the real challenge lies in its implementation (Warth 2009). EU regulatory intervention in the area of gender equality has not led to more women in the boardroom or senior management positions (Pieters 2012). One explanation is that equal rights do not translate to equal participation in corporate governance (Pieters 2012). For instance, gender quota legislation might not lead to better gender balance in corporate boards due to a lack of sanctions in case of non-compliance (Warth 2009). Women are prevented from sitting on companies' boards due to a combination of economic and non-economic issues (Pieters 2012). Furthermore, while gender equality information is being requested within corporate social responsibility reporting frameworks, these requirements are mostly limited in scope, or remain optional (Grosser & Moon 2005). On the other hand,

evidence shows that having more women in management increases the effectiveness of corporate social responsibility efforts aimed at achieving gender equality objectives (Larrieta-Rubín de Celis et al. 2015).

Finally, in academia, where the European Commission promotes gender equality plans, research about European universities reveals significant challenges in achieving gender justice through these gender equality plans (Clavero & Galligan 2021). Notably, gender equality is a key priority and a cross-cutting issue in Horizon Europe, which mandates that all public bodies, research organisations, and higher education establishments in the Member States and associated countries have a gender equality plan (GEP) in place. It is important to note that having a GEP is an eligibility criterion for participation in its research framework program. Despite such policy emphasis, gender equality plans face challenges, including the perception that gender equality is often seen as 'women's work,' a lack of gender-disaggregated data, and the persistence of masculinised ideals within academic profiles (Clavero & Galligan 2021). For example, the latest edition of She Figures (European Commission 2021b) highlights that women are under-represented among researchers in the business sector (20.9%), among professors and senior-level staff in academia (26%), and in decision-making positions in higher education (24%). Figure 10 shows examples of good practices to strengthen women's position in the energy sector.

Figure 10. Examples of good practice to strengthen women's position in the energy sector



Source: Feenstra & Creusen 2021

4.5 Local energy initiatives

The complexity of energy poverty and the social dimension of the phenomenon is gaining recognition among energy actors. Renewable energy communities (RECs) are increasingly aware of energy poverty and gender inequality in access to sustainable and affordable energy services. However, barriers are recorded by energy RECs to address energy poverty and to become more inclusive (Hanke et al. 2021). The lack of an enabling policy framework is mentioned as one of them. The European Commission continues to develop new legislation enforcing a just energy transition, and EU funding is available for implementation and decarbonisation projects. But the national governments of EU Member States need to implement and enforce this EU legislation in national action plans supporting local energy initiatives, like RECs.

The content analysis of the first wave of NECPs, assessed by the European Commission in 2020, revealed that a majority of Member States do not provide a distinct enabling framework for RECs in their NECPs. Out of 27, only 6, namely Bulgaria, Czechia, Greece, Italy, Portugal and Spain, mentioned the importance of enabling the participation of vulnerable households in RECs, i.e. as a means to fight energy poverty. Currently, only Italy,

Portugal and Spain provide more detailed policy measures to achieve this aim in their NECPs. Greece includes in its definition of a REC the social purpose it must fulfil. Tackling energy poverty is explicitly mentioned as one of its main purposes. The remaining NECPs do not establish this linkage yet, at least not in their NECPs. None of the first wave NECPs mentioned the specific needs of women when empowering their participation in RECs. Some NECPs mentioned the development of additional legislation to support RECs further, or refer to existing legislation.

The EU requires all European Member States to implement EU directives into national legislation. The NECPs include a description of how the respective national legislator plans to transpose the EU legislation. In this light, the current NECPs must transpose the recast renewable energy directive (REDII) into national legislation and Article 22 on RECs. In the context of the debate around energy poverty, paragraph 4 is of particular interest, which requires the national legislator to, 'provide an enabling framework to promote and facilitate the development of renewable energy communities' (REDII, para. 4). Such an enabling framework removes unjustified regulatory and administrative barriers for RECs. It also ensures the participation of 'all consumers, including those in low-income or vulnerable households' (REDII, para. 4 (f)). In addition, REDII provides 'opportunities for renewable energy communities to advance energy efficiency at household level and helps fight energy poverty through reduced consumption and lower supply tariffs' (REDII, Recital 67). These requirements entail a drastic shift in approaching vulnerable and energy-poor households. Participation in RECs usually means becoming a member and, with that, a co-owner of the community. Especially low-income households are usually not in the position to (co-)own anything.

In many countries, such as Germany, the distribution of wealth is highly skewed, with the bottom 50% of households collectively owning only 1.4% of the country's net wealth, and some incurring debt. In contrast, the top 40% of households possess a significant majority of the wealth, accounting for 94.8% (Grabka & Halbmeier 2019). This severe wealth disparity is further exacerbated by economic inequalities that exist throughout Europe. Given these circumstances, low-income households, who often struggle to make ends meet and have little to no savings, face significant challenges in becoming members or co-owners of renewable energy communities. The COVID-19 pandemic has likely exacerbated this wealth gap, making it even more difficult for these vulnerable groups to accumulate savings and participate in co-ownership opportunities (Piketty 2016).

So far, the EU has enabled the general benefits of RECs but has not provided details on the design of an enabling framework to achieve inclusive participation in RECs. It therefore lies within the responsibility and capacity of national legislators to provide a policy mix fit to achieve the empowerment of low-income and vulnerable households. In this light, the NECPs should outline national legislators' concrete policy steps towards this goal.

5 Conclusions

The objective of this study is to deepen the insight into the connection between gender inequalities and participation in the energy transition. We searched for and reviewed existing literature and data on the complex relationships between the energy transition and gender. We analysed the range of policy interventions and good practices within energy poverty and related arenas, which can be used to reduce energy poverty for women, and increase women's representation in the energy sector and the overall empowerment of women during the energy transition. This report was led by the Joint Research Centre in collaboration with 75inQ, an expert centre on diversity in the energy transition based in The Netherlands.

We started by describing the state of play on the gender-energy nexus, describing the policy background at international, EU and Member State levels. The Clean Energy Package puts the consumer at the centre of the energy transition with a clear right to produce and trade energy as an important pillar of EU Energy transition policy. Then we identified the role of women in the energy transition by distinguishing between the role of consumer, producer and energy citizen. Women's overrepresentation as energy consumers, and especially those vulnerable to energy poverty, is in contrast with their structural underrepresentation as producers working in the energy sector. The emerging role of women as energy prosumers through their participation in local energy initiatives and renewable energy cooperatives was highlighted. Producers and consumers as 'prosumers' are able to participate actively, individually or through communities, in all markets with decentralised and participatory concepts.

Thirdly, we focused the gender lens on energy poverty in the EU from an economic perspective, describing the health impacts of energy poverty, and identifying the socio-cultural and behavioural aspects of energy poverty. The multiple crises and the context of energy poverty, from the COVID-19 crisis to the current energy crisis, has significantly increased the problem in many countries. Energy poverty was a critical situation even before the energy crisis, but now it is no longer just a challenge for low-income households. The energy crisis, housing crisis, unemployment and high inflation are challenging even for many middle-income households. People affected by energy poverty or living in social housing, and lower-middle-income households, should be supported, and national-level measures need to be targeted.

Therefore, gender and the energy transition, especially the issue of energy poverty, cannot be seen in isolation. There is a need to explore tailored policy interventions and instruments and multi-level governance structures as well as improved data collection on energy poverty indicators, energy debts, housing conditions and more. Gender imbalances for all energy consumers need to be addressed and women should be empowered not only in their role as consumers but also as producers and policymakers. In our final section, we provided examples of policy initiatives on the different governance levels that address gender and energy transition: the EU, Member States, consumer, corporate and local energy initiatives.

A successful energy transition requires equal attention to the political and social dimensions. There is an urgent need to recognise the effects of the global energy transition at different policy levels and on societal groups and to understand how people can engage in the process on an equal basis. The energy transition then becomes a vehicle for a socially just and fair society that provides clean energy for all and leaves no one behind. To create the foundations for achieving an inclusive energy transition, it is necessary to:

1. Mitigate gender inequalities in access to affordable and sustainable energy services in policies, instruments and mechanisms across the energy system and at all governance levels;
2. Acknowledge the intersecting and cross-cutting structural causes of the gender dimension of energy poverty by breaking silos in policy formulation and implementation;
3. Collect, report and monitor gender-segregated data on the inclusive energy transition at macro, meso and micro level;
4. Stimulate political and managerial engagement of governments and corporate partners in the energy system to ensure the equal participation and representation of women in the energy transition.

There is a growing body of good practice evident in initiatives for an inclusive and just energy transition which can serve as inspiration for the implementation of these recommendations. At the international and European levels, an increasing number of policy initiatives and directives demonstrates political commitment to a just energy transition. The policies of EU Member States serve not only to implement European guidelines but also to integrate national socio-political and cultural contexts. These national policies call for local partners, residents, local energy initiatives and companies to orient themselves towards a sustainable energy transition, but this should also be reflected in financial, legal and political support.

This study has only scratched the surface of the intersection between gender and the energy transition in the European Union. It can be seen as a starting point for deeper investigation. We observe that there is a growing number of instruments and initiatives mitigating energy poverty and stimulating women's representation in the energy sector. Many of these are initiated at local level or directly within companies. It is hoped that this study serve as an invitation to share these good practices with a wider audience to inspire others to adopt them in the local context of other Member States. A more comprehensive mapping of these initiatives would be a welcome further study, combined with a repository of good practices.

When collecting and using gender-segregated data, progress towards an inclusive and just energy transition can be monitored. This enables policymakers and decision-makers to formulate, adjust and implement instruments and initiatives that stimulate equal participation and representation in the energy system. Our study identifies several gender-segregated indicators but also observes that many data are not collected, reported or monitored in a gender-disaggregated manner. This is a missed opportunity to inform policymaking and to monitor policy implementation. With the continuation of both the energy crisis and climate crisis, the political landscape of an inclusive and just energy transition will evolve and develop as well as the ongoing debate on how to ensure sustainable and affordable energy services for all. This creates the momentum to ensure a just and inclusive society that leaves no one behind.

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List of abbreviations and definitions

EUR	euro
EC	European Commission
ECHP	European community household panel
EPSR	European Pillar of Social Rights
EU	European Union
EU-SILC	European Union Statistics on Income and Living Conditions
GEP	gender equality plan
ICT	Information and communications technology
IEA	International Energy Agency
ILO	International Labour Organisation
IRENA	International Renewable Energy Agency
JRC	Joint Research Centre
NECP	National Energy and Climate Plans
TNO	Netherlands Organisation for Applied Scientific Research (*Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek*)
NJI	Netherlands Youth Institute (*Nederlands Jeugdinstituut*)
OECD	Organisation for Economic Co-operation and Development
PV	photovoltaics
REDII	recast renewable energy directive
REC	renewable energy community
RES	renewable energy sources
STEM	science, technology, engineering, and mathematics
SSH	Social Science and Humanities
STEP	Solutions to Tackle Energy Poverty
SWD	Staff Working Document
SDG	Sustainable Development Goals
SEforALL	Sustainable Energy for All
UN	United Nations
VAT	value added tax

List of boxes

List of figures

List of tables

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