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Bridging the gender gap in the energy transition: addressing unmet aspirations and repellent effect in education and early career pathways in Italy, Germany and UK

Abstract

The global energy transition requires not only technological innovation but also structural transformation in education and research cultures. Adopting a feminist analytical lens, we conducted focus groups with university students and academic staff across STEM and non-STEM disciplines in Italy, Germany, and the United Kingdom. Qualitative analysis reveals persistent gender disparities in energy-related higher education and professional trajectories. These disparities emerge through two interrelated dynamics: unmet aspirations and repelling effects. The former reflects a misalignment between student expectations and curricular engagement with socio-technical dimensions of the energy transition, compounded by gender-blind pedagogical content. The latter captures the persistence of cultural norms and gender stereotypes that operate as structural barriers, disproportionately affecting women. We argue that addressing these gaps requires a reconfiguration of curricula, pedagogical approaches, and epistemological foundations, alongside transformation of workplace cultures, to enable more equitable and socially engaged pathways into energy transition research and innovation.

Introduction

The energy transition can be understood as a complex multidimensional process, revealing the intrinsic interconnections between societal, economic, political and technological spheres that mutually reinforce each other. The systemic nature of the challenges it poses necessitates solutions that are equally inter-, and trans-disciplinary (European Commission, 2021; Foulds et al. 2022; Steg et al. 2021). In recent years, although the role of energy-related social sciences and humanities (energy-SSH) in energy transitions has gained greater recognition, significant challenges remain especially in integrating these fields into STEM disciplines (Foulds & Robison, 2018; Krupnik et al, 2022). This has significant implications for knowledge production, higher education and the power relations shaping research agendas among scientific communities driving the energy transition.

The emerging configuration in knowledge production and higher education on sustainability and energy transitions, rather than bridging scientific and disciplinary silos, risks reproducing mechanisms of exclusion and devaluation of certain categories of knowledge and expertise – a pattern deeply embedded in modern positivist science. This concern leads to the core of feminist literature on science. Feminist epistemologies have highlighted the historical and social constructs underlying scientific postulates and objectives, challenging the assumption of science as a neutral and value-free. By exposing how knowledge production is shaped by gendered power relations, institutional practices, and culturally situated perspectives, these approaches have emphasized that what counts as legitimate knowledge is contingent upon specific social and political contexts. In doing so, feminist scholars have called for a critical re-examination of dominant epistemic frameworks, advocating for more inclusive, reflexive, and situated forms of knowledge production (Harding, 1986; Keller 1985; Haraway, 1988). A relevant construct for this work is the polarization of knowledge according to gendered binary schemes, with the masculine pole being associated with valued, precise, and relevant knowledge, methodologies, themes, and competencies; while the feminine pole is conversely associated with care, secondary, and devalued knowledge domains (Allegrini, 2015; Schiebinger, 2000). This binary framework produces fragmented, sectorialized knowledge that proves insufficient to adequately address the underlying systemic complexity of global energy systems.

On the one hand, it results in individuals (predominantly women) who do not conform to the above mentioned masculine pole due to a combination of socialization, societal norms, individual interests, personal inclinations, as well as structural barriers being less attracted to traditional STEM pathways and are instead drawn to programs offering interdisciplinary training aimed at solving concrete socio-environmental problems (communal goals). On the other hand, it fosters biases, misogynistic attitudes, and microaggressions that function as barriers to entry, retention, and career advancement in STEM fields directly related to the energy transition, particularly for women (Bird, 2011; Kinahan et al., 2020; Cyr et al., 2021).

Drawing on a qualitative methodology grounded in fieldwork conducted within tertiary education settings in three European countries, namely the United Kingdom (UK), Italy, and Germany, the paper aims at answering two main research questions: How does the reproduction of gendered binary frameworks within higher education programs shape mechanisms of exclusion in students' educational and early professional pathways? In what ways do institutional cultures, pedagogical practices, and workplace environments in the energy sector contribute to – or challenge – gender inequalities and the persistence of a male-dominated professional culture?

Although we acknowledge that early gendered socialization plays a crucial role in disciplinary segregation (Bian et al., 2017; McGuire et al., 2022; Miller et al., 2024; Shenouda et al. 2024), our analysis focuses on exclusion mechanisms that are in place later in tertiary education and in the early professional experience. Our contribution complements a well establish body of literature that have explored the role of gender stereotypes both on women's educational choices, retention within STEM career paths (Bajka et al. 2025; Buquet Corleto, 2011; Dunlap & Barth 2023; Ewim & Dosunmu, 2025; McKinnon & O'Connell, 2020) and the integration of the gender dimension within the curricula on energy access and energy transition (Pailman & de Groot, 2022).

To the best of our knowledge, no studies have analyzed gender disparities in energy transition education and career development combining STEM, social sciences and interdisciplinary trajectories. The novelty and relevance of this contribution lie in its exploration of gender-based exclusion dynamics across a wide range of educational and professional pathways related to the energy sector, encompassing multiple disciplinary and interdisciplinary fields. Our contribution offers an analysis that engages with the complexity of the phenomenon, moving beyond the quantitative focus on gender gap in the energy transition education (e.g., increasing the number of women in STEM). Instead, we propose a qualitative approach that critically examines the binarism and biases that make energy transition education unattractive, exclusionary, and unwelcoming in both educational and professional contexts. The empirical research is based on focus group interviews (FGIs) conducted as part of the European funded research project gEneSys – Transforming Gender Interrelations of Power and Inequalities in Transition Pathways to Sustainable Energy Systems in Germany, Italy, and UK during 2024 and 2025. The selection of the three countries followed a purposive logic aimed at maximising the diversity of empirical findings. The cases span three distinct European regions – Southern, Central, and Northern Europe – thereby ensuring substantial contextual variation.

The paper is organized as follows. First, drawing on feminist theories and the relevant literature on educational choices and academic cultures, we propose an original lens of analyses on structural and systemic inequalities in energy-related tertiary education. We also introduce the higher education landscape across the three countries under study. Second, we describe the methodological steps for the collection of qualitative data. Third, we discuss the main findings highlighting two mechanisms underlying persistent gender inequalities in education and professional pathways. We conclude with a call for a fundamental rethinking of curricula, pedagogy, and institutional cultures.

1. Beyond numbers: feminist theories on educational choices and academic cultures

1.1 *Framing the energy gender gap in the "woman question in science"*

In our critical analysis of structural and systemic inequalities in energy-related educational contexts, we draw upon theoretical frameworks that will inform the interpretation of our findings. The issue of women's representation in science has traditionally been defined as "woman question in science" (Harding, 1986). In this initial perspective, which has its roots in the 1970s, the main issue addressed by feminist studies was the underrepresentation of women in the sciences. The object of analysis and critique was therefore primarily quantitative, and the proposed solutions focused on achieving equality through increasing women's participation in and contributions to scientific work. Situated within the debate that emerged with second-wave feminism, this paper shifts the focus to what has been defined as "the science question in feminism," namely the transition from a numerical concern to the ontological and epistemological question of women as distinct subjects of knowledge (Harding, 1986; Allegrini, 2015). Building on this perspective, today's primary concern is not merely the numerical presence of women in STEM but their unequal distribution across scientific fields (Allegrini, 2015). Indeed, a significant gender heterogeneity persists, with women being overrepresented in life and health sciences while remaining underrepresented in disciplines such as physics, mathematics, computer science, and engineering. According to the *She Figures* report, the main gender analysis on the EU R&I system, women account for only 22% of doctoral graduates in Information and Communication Technologies (ICT) and less than 40% in Engineering, Manufacturing, and Construction. By contrast, in Health and Welfare disciplines, women represent 59% of doctoral graduates (European Commission, 2025). The same report highlights the persistent *leaky pipeline* effect that although women constitute nearly half of early-career researchers (48%), their representation drops to 36% at senior academic levels. These data indicate not only that women remain underrepresented in certain disciplines, but also that their presence progressively declines along scientific and research career trajectories (European Commission, 2025). An international survey curated by the International Renewable Energy Agency (IRENA 2019) revealed that women represent 32% of the full-time employees of responding organizations in renewable energy sector and in average 22% in the global oil and gas industry.

This gender imbalance reflects a hierarchical order between male-dominated and female-dominated disciplines. Feminist criticism has challenged the notion of a neutral or "malestream" science (Allegrini, 2015), arguing that knowledge production is deeply shaped by cultural values, social constructs, and power relations. Gendered socialization and stereotypical assumptions permeate multiple levels of scientific practice, from theories and research methodologies to scientific language and academic institutions (McKinnon & O'Connell, 2020). From this standpoint, the feminist question in science extends beyond the goal of merely increasing the numerical representation of women in STEM fields; it encompasses a broader critique of the gender biases embedded within systems of knowledge production and legitimation. Beyond feminist theory, gender studies have also produced reflections on this aspect, specifically Gender Studies in Engineering is an interdisciplinary approach that has set itself the dual goal of integrating more women into engineering, but also of implementing changes in the male-dominated engineering culture (Ihsen, 2005; Phipps, 2002; Ewim & Dosunmu 2025). From this perspective, we analyze the following aspects, which are described in detail in the following sections: tertiary educational choices, gender blindness in teaching, and the "chilly climate" that together frame the gender gap in the energy transition (Figure 1).

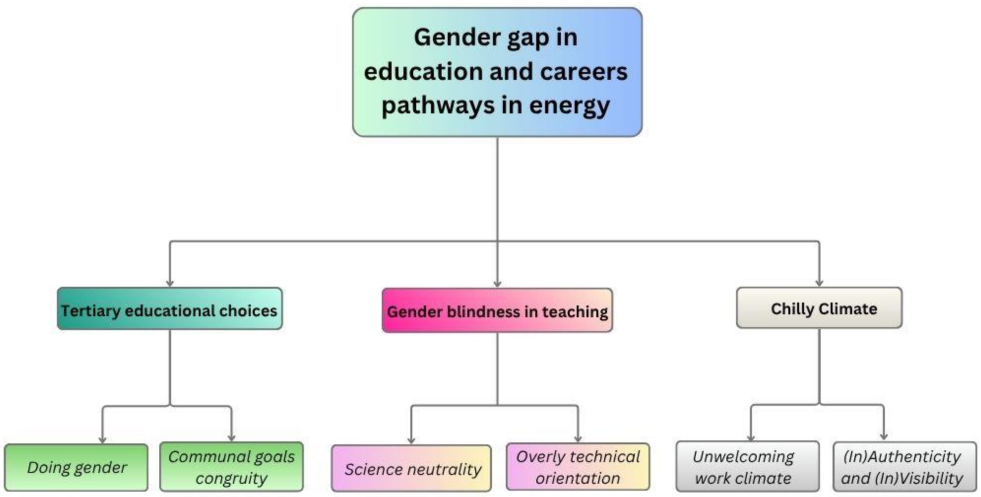

Figure 1 - *Framing the gender gap in the energy transition*

1.2 Tertiary education choice and "doing gender"

The feminist theory has developed and applied the concept of *doing gender* (Allegrini, 2015; West & Zimmerman, 1987) to explain gender differentiation in educational choices and professional paths, particularly in fields such as engineering. *Doing gender* refers to a complex set of socially oriented practices through which individuals learn and reproduce normative expectations associated with masculinity and femininity (Buquet & Moreno, 2021). This perspective aligns with gender identity theories that conceptualize gender not as a fixed essence but as a cultural and performative construct (Holmegaard et al., 2015). Identity dynamics, intertwined with tertiary education choice processes, contribute to the reproduction of idealized norms that sustain a symbolic division between “sciences for men” and “sciences for women” (Allegrini, 2025, p. 53). Gendered representations of science – historically linked to the idea that rationality and objectivity are masculine attributes (Keller, 1985) - further reinforce this divide. By conceptualizing *doing gender* as a performative and relational process, Allegrini (2015) identifies a double gender gap in educational pathways: women are underrepresented in STEM disciplines, while men are underrepresented in so-called “feminized” fields such as the social, life, and health sciences. The theoretical lens of *doing gender* thus provides an interpretive framework for understanding these dynamics as expressions of socially constructed representations and symbolic perceptions of disciplinary fields (Allegrini, 2015; Leslie et al., 2015; Makarova et al., 2019), which shape students’ imaginaries and structure unequal access to tertiary education.

1.3 The "goal congruity perspective" in tertiary education

Another relevant framework that guided our analyse is the "goal congruity perspective" that have suggested that STEM careers are often perceived as less likely to fulfil communal goals (e.g., working with or helping others, making a positive societal impact) compared to careers in other fields (Boucher et al., 2017; Dunlap & Barth, 2019; Dunlap & Barth, 2023). Such perceptions may disproportionately influence women’s career choices, as women due to socialization tend to place more value on communal goals than men (Diekman et al., 2010; Diekman et al., 2011; Diekman et al., 2017). Kilgore et al. (2006) have investigated this issue specifically in engineering studies and practices by examining how male and female students perceive. They found that women often approach engineering with a broader perspective, valuing collaboration, teamwork, and social impact. In contrast, male students tend to focus more on individual technical challenges and achievements (Kilgore et al., 2006). However, a more recent study shows that being perceived as an uncommunal discipline has a deterrent effect not only on women, but also on communally oriented men (Boucher et al., 2017). Similar conclusions were recently reached by Bajka et al. (2025), whose research found that while girls tend to show a clear aversion to technical and technology-related tasks and boys are generally more attracted to them, the communal dimension of work may appeal to individuals of both genders who display a stronger social orientation in their career expectations. This emphasis on communal goals opens an important avenue for rethinking STEM education: by integrating socially relevant challenges and sustainability concerns, STEM can become fields that align both with technical rigor and with students' broader societal aspirations. In this way, the perception of STEM as uncommunal can be countered by explicitly linking curricula to meaningful, globally relevant issues.

Engineering, like other STEM disciplines, offers the opportunity not only for technical problem-solving but also for driving meaningful global change. These differing perspectives suggest that traditional engineering education, which often emphasizes isolated problem-solving, may not resonate with many women who are drawn to the field's broader societal contributions. By rethinking engineering education to place greater emphasis on teamwork, interdisciplinary applications, and societal impact, higher education institutions could potentially attract and retain more women in academic and technological research. International agendas and debates on sustainable development have encouraged the creation of a new meta-discipline in sustainability science and engineering (Mihelcic et al., 2003), with the aim of integrating technological progress with a systematic focus on the interconnections between environmental, economic and social dimensions. This reorganization of knowledge around the principles of sustainability, coupled with the acquisition of technical and soft skills, facilitates the design of more sustainable energy products and systems that are in line with societal values and real needs. It also increases the attractiveness of educational curricula by promoting communal goals (Mihelcic et al., 2003). Given that the gender imbalance in engineering fields can be partly attributed to the poor link between the hard sciences and social concerns, strengthening this link could increase the social relevance of these disciplines and promote more equitable participation, thereby fostering greater women in science.

1.4 Gender blindness in teaching

The issue of gender gap in STEM fields cannot be reduced to a mere numerical imbalance; it also encompasses teaching methodologies, curricula contents and classroom dynamics. Gender-blind curricula have the potential to exacerbate existing societal disparities by skewing subject matter toward a particular gender, creating unequal opportunities for success, or even reinforcing role stereotypes. Gender-blindness in science education often reflect and reinforce the long-standing belief that science is inherently neutral and meritocratic, evaluated through objective standards alone (Harding, 1991; Longino, 1990). However, this assumption obscures how systemic biases and institutional structures shape who participates in science and whose contributions are recognized. By omitting gendered perspectives and social contexts, such curricula ignore the barriers—both visible and invisible—that disproportionately hinder women and other underrepresented groups (Subramaniam, 2009). The rhetoric of neutrality, rather than levelling the playing field, can act as a mechanism for sustaining existing power hierarchies in scientific institutions (Schiebinger, 1999). As such, challenging the myth of neutrality is essential to reimagining a more inclusive and reflexive scientific practice that acknowledges the sociocultural dimensions of knowledge production (Haraway, 1988). In highly theoretical and technological disciplines, the integration of a gender perspective has traditionally been overlooked based on the assumption that scientific concepts, theories, and methods are inherently neutral (Pascual et al., 2021). Furthermore, just as implicit biases influence students' educational choices, they can also profoundly shape the way professors assess their students (Lavy & Sand, 2015; Pascual et al., 2021).

1.5 Organizational climate in workplace

STEM and engineering educations has traditionally been a male dominated sector. One of the key aspects impacting this lack of gender and intersectional diversity has been identified by literature in persistent inequality in the workplace culture. Research overwhelmingly demonstrates the academic climate for women in STEM is chilly (Casad et al., 2019; Cheryan et al., 2009; Gunter & Stambach, 2005; Miner et al., 2019; Riffle et al., 2013; Settles et al., 2006; Willemsen & van Vianen, 2014). Chilly, unwelcoming, and threatening academic environments discourage women from entering in the field and predict women leaving academia (Riffle et al., 2013). Women and underrepresented groups faculty in STEM experience greater ostracism and microaggression compared to male faculty in STEM (Lester et al., 2017; Miner et al., 2019; Ong et al., 2018). Women in STEM often contend with stereotyped perceptions that influence hiring decisions and limit opportunities for career advancement (Casad et al., 2021; McKinnon & O'Connell, 2020). These stereotypes contribute to an unwelcoming academic climate, where female students frequently report experiencing hostility, discrimination, and lack of recognition. Furthermore, female students often face a lack of supportive social networks, which can be crucial for academic and professional success. In professional careers female engineers, for example, often encounter gender-based filtering, devaluation of their skills, and exclusion from key professional networks. This disparity exacerbates gender inequality, limiting the professional growth of women within academia and industry (Casad et al., 2021). Faulkner (2009) has theorized how engineering workplace cultures creates both a gender In/Authenticity and the In/Visibility Paradox. Faulkner argues that engineering is culturally coded as a masculine profession, making it difficult for women to be seen as "authentic" engineers. Women often feel pressured to either conform to masculine workplace norms or risk being seen as outsiders. But if they adopt behaviors traditionally associated with femininity, their competence as engineers may be questioned. Women in engineering also face a contradictory experience of being hyper-visible and invisible at the same time. They are highly visible as women often standing out as one of the few female engineers in a male-dominated environment. This visibility subjects them to extra scrutiny and stereotypes. However, they are also “invisible as engineers”—their contributions may be overlooked, and they may struggle to gain recognition for their technical expertise. These dynamics create barriers to inclusion and career advancement for women in engineering (Ihsen, 2005; Phipps, 2002; Ravines-Toledo et al, 2021). The in/authenticity dilemma forces women to constantly navigate gender expectations, while the in/visibility paradox makes it harder for them to establish professional authority. Addressing these issues requires structural and cultural changes in engineering workplaces and professional identity, such as diversifying leadership, challenging gender biases, and fostering more inclusive professional norms (Grzelec & Mauléon 2025, Lo Andersson & Landström 2023).

1.6 The STEM Education Ecosystem across Italy, the UK, and Germany

In the following section we present an overview of tertiary STEM education systems in the three countries examined in our study, to provide context for the data collection and interpretation of the results.

Italy’s STEM higher education system shows moderate but growing alignment with energy and sustainability priorities, driven largely by EU policies and national innovation needs. In 2022, around 18 out of every 1,000 young people aged 20–29 obtained a STEM degree. Although this figure is increasing (it was 16.1 in 2019), it remains below the EU average of about 23 per 1,000 (ISTAT, 2025). Universities and technical institutes increasingly integrate renewable energy systems, environmental engineering, and sustainable design into their curricula. Institutions such as Politecnico di Milano and Sapienza University of Rome are at the forefront, offering specialized programs focused on green technologies and energy transition. Many EU-funded projects and the National Recovery and Resilience Plan supported research and innovation, encouraging collaboration between academia and industry. A dedicated investment line of the plan was “New Skills and New Languages” that promoted the integration across the curricula of all levels of education - of activities, methodologies, and content aimed at developing STEM, digital, and innovation skills, following a fully interdisciplinary approach and ensuring equal access to STEM careers in all schools. Moreover, Italy’s strong manufacturing and energy sectors provide practical pathways for students through internships and applied research opportunities. Despite these advances, challenges remain, including regional disparities in educational resources and a need for stronger early STEM engagement and interdisplinarity. Most STEM degrees are obtained at universities in Central and Northern Italy, which account for about 77.3% of the national total. Southern Italy contributes the remaining 22.7%. In the North, the share of young men with a STEM degree is significantly higher than in the South: approximately 41.4% of all graduates in the same age group, compared to 27.5% (SVIMEZ, 2024). Efforts to modernize teaching methods—such as project-based learning and interdisciplinary approaches—are helping bridge this gap.

Sustainability is no longer treated as a niche topic but as a core component of STEM education. A significant gender gap persists. Among STEM graduates, women are less than half the number of men. Overall, only 16.8% of Italian women graduate in these fields (ISTAT, 2025). This persistent gap limits the available talent pool and may hinder innovation capacity in strategic sectors such as the energy transition.

The UK's STEM higher education system is increasingly shaped by the skills demands of the low-carbon transition. National enrolment data show a substantial science-related higher education base: in 2024/25, the Higher Education Statistics Agency (HESA) recorded 1,317,120 enrolments in its broad "science" subject grouping, representing around 46% of all UK HE enrolments (HESA, 2026). Energy and sustainability priorities are linked not only to specialist environmental programmes, but also to engineering education, professional training and curriculum reform. The expansion of the zero-carbon energy sector has increased demand for graduates with technical expertise as well as project management, systems thinking, data analytics, communication, commercial understanding and interdisciplinary skills (Rowley and Walker, 2020). Many UK universities now integrate sustainability into institutional strategies, research agendas and selected teaching activities. Among the Russell Group, a group of research-intensive UK universities, sustainability and the SDGs are increasingly visible across learning environments, research, external collaboration and curriculum initiatives, although definitions and approaches vary between institutions (Zhou, 2025). Examples include interdisciplinary sustainability projects at Imperial College London, sustainability-related institutes at Exeter and Leeds, SDG-linked research at University College London and Warwick, and curriculum initiatives at King's College London and Warwick (Zhou, 2025). Efforts to modernise teaching are strengthening sustainability learning in STEM. The 2021 Quality Assurance Agency for Higher Education (QAA) and Advance Higher Education guidance encourages universities to embed sustainability competencies, whole-institution approaches and active learning. In STEM subjects, sustainability can be introduced through applied case studies, design challenges, professional contexts and interdisciplinary learning that connects technical knowledge with social, ethical and environmental issues (Price et al., 2021). Gender inequalities also persist in STEM fields central to the energy transition. In 2024/25, women represented 22.1% of students in engineering and technology and 24.5% in computing, despite increases since 2014/15, when the figures were 16.9% and 17.3% respectively (HESA, 2026). In geography, which also contributes important knowledge to sustainability and energy transitions, women remain underrepresented in senior academic roles despite progress at student and early-career levels. Initiatives such as Athena Swan and the Gender Equality Charter Mark have encouraged universities to address gender disparities, but sustained leadership remains important for tackling everyday inequalities in academic workplaces (Maddrell et al., 2016).

Germany's education system is characterized by a decentralized federal structure in which the 16 federal states independently regulate curricula, examinations, and teacher education. This governance structure leads to significant regional variation in educational priorities and implementation strategies, including in STEM education. Consequently, analyses of the German education system need to account for substantial regional differences across federal states. Despite this regional heterogeneity in governance and implementation across the federal states, Germany demonstrates comparatively strong overall outcomes in STEM education at the national level, particularly in higher education. According to the publication *Education at a Glance* by the Organisation for Economic Co-operation and Development (OECD), around 35% of bachelor's or equivalent graduates in Germany earn their degree in a STEM field. This is the highest proportion among OECD countries and significantly above the OECD average of 23% (OECD, 2025).

This strong position is underpinned by policy efforts to strengthen STEM education throughout the education system. A key element is the federal *MINT Action Plan* by the Federal Ministry for Education, Family Affairs, Senior Citizens, Women and Youth (BMBFSFJ), which supports STEM learning across all stages of education, from early childhood to vocational and further education. It also promotes a wide range of extracurricular STEM initiatives, which help to broaden access and sustain interest in STEM subjects beyond formal schooling. In addition, so-called MINT clusters form part of a nationwide initiative aimed at strengthening STEM education across the German federal states by connecting schools, extracurricular learning providers, and other educational stakeholders within regional networks (Federal Ministry of Education and Research, 2019).

Furthermore, although STEM subjects remain a popular field of study, dropout rates are notably high. Around one in two students who begin a STEM degree either drops out or switches to a different subject. This proportion has increased significantly over the past decade: in 2012, the dropout and transfer rate was only about 16 percent, whereas since 2018 it is around 50 percent (National Academy of Science and Engineering & Joachim Herz Stiftung, 2024). In addition to the educational challenges within STEM, Germany faces persistent and structural shortages in STEM labor markets. The German Economic Institute (IW) reports a STEM labor shortage of approximately 133,900 professionals, even during an economic slowdown. Although this represents a decline for the fourth consecutive year, significant bottlenecks remain, especially in energy and electrical engineering occupations, where around 48,900 vacancies were recorded in March 2026 (IW, 2026).

2. Methodology

Grounded in feminist epistemology, within which this work is situated, the present study was conducted using a qualitative methodology to examine the structural, socio-cultural, and individual factors that contribute to exclusionary mechanisms affecting the educational and professional pathways of men and women in sectors related to the energy transition. The article specifically aims to understand how the reproduction of binary gender patterns in tertiary education programs influences these mechanisms, and how institutional cultures, teaching practices, and early work environments either reinforce or challenge gender inequalities and the persistence of a male-dominated professional culture.

To achieve these objectives, a focus group technique was employed, involving both lecturers and students from STEM, SSH, and interdisciplinary university programs who are engaged in or preparing for a career in the energy sector. This specific research method was chosen for its ability to foster dialogue among participants with diverse experiences and perspectives, allowing for the co-construction of meaning among individuals from various disciplinary backgrounds. Through collective discussion, it was possible to identify prevailing representations, expectations, and factors that facilitate or hinder participation and advancement in educational and professional pathways. Our findings contribute to the current debate on effectively gender mainstreaming in educational programs related to the energy transition. Specifically, it provides a unique perspective on the dynamics of exclusion that span various disciplinary and interdisciplinary contexts. The findings offer valuable insights for designing educational programs and pedagogical practices aimed at promoting more equitable participation and supporting the next generation of researchers and innovators in the sustainable energy transition.

2.1 Sampling methodology

Focus group interviews (FGIs) were conducted between 2024 and 2025 within the context of the EU-funded project *gEneSys,* across three countries: Germany, Italy, and UK. These countries represent different European contexts, respectively the Mediterranean, Central European and Northern European. A purposive sampling strategy was employed to capture a range of perspectives from both students and lecturers. The sampling criteria were defined to: (1) ensure gender balance among participants, with a minimum of 7 participants per focus group; (2) included students enrolled in curricula from Social Sciences and Humanities (SSH), Science, Technology, Engineering, and Mathematics (STEM), and Interdisciplinary programs related to sustainable energy; and (3) involve lecturers from SSH, STEM, or interdisciplinary fields with demonstrated expertise in topics concerning the sustainable energy transition. Participant's recruitment varied across countries and included collaboration with participants from previous projects, engagement through professional and academic networks, and snowball sampling. Two student FGIs were organized in each country (see Table 1). In Germany and the UK, these were organized in person, while in Italy, six out eight students participated in person, and two joined remotely. All participants provided a Consent to Participate Declaration (see template in Annex 1).

To accommodate the differences in national tertiary education systems and the structure of energy-related programs, a flexible approach was adopted in determining whether to include undergraduate (Bachelor's) or postgraduate (Master's) students. German participants were mainly from bachelor's programs, while UK and Italian participants were from master's programs. Within each country, students from STEM and SSH backgrounds were selected from the same academic level to ensure consistency across groups.

Further, FGI formats with lecturers (Table 2) also varied to maximize accessibility: sessions were conducted online in Germany and the UK, and in hybrid mode in Italy. Lecturers were drawn from STEM disciplines directly related to energy, as well as social sciences and interdisciplinary programs addressing energy transition and sustainability issues. A total of nine FGIs were conducted: one with lecturers in each country (three in total) and two with students in each country (six in total). Each session lasted between 90 and 120 minutes, was conducted in the local language of each country (Italian, German, and English respectively), and was audio-video recorded, transcribed, and subsequently translated into English for cross-national thematic analysis. To ensure systematic data management and facilitate cross-case comparison, interviews were coded according to country, participant type (lecturer or student), disciplinary field (STEM, SSH, or Interdisciplinary), interview number, and gender (W for women, M for men). The resulting coding scheme followed the structure: *IT/GE/UK_ LEC/STU_SSH/STEM/INT_[number]_[W/M]*.

Conducting focus groups across three national contexts entailed some methodological challenges. As is well established, group dynamics may give rise to social desirability effects, whereby participants moderate their views in response to perceived group norms or institutional hierarchies. To mitigate potential power asymmetries, students and academic staff were assigned to separate sessions. The partial reliance on snowball sampling, while carrying an inherent risk of selection bias, reflected a deliberate methodological choice aimed at recruiting participants with demonstrated expertise in gender equality and sustainable energy, thereby ensuring the analytical depth required by the research questions. Finally, the multilingual nature of the data collection process followed by the transcription into English, inevitably entailed some degree of semantic loss, which was addressed through systematic cross-author comparison during the interpretation of findings.

Table 1. Sampling for FGIs with students

Country	Date	N° of participants	Educational level	Field of study	Program	University
Germany	15.10.24	17 (8 women, 9 men)	First-year bachelor's degree	Inter-disciplinary	Technical communication	HM Hochschule München University of Applied Science
	15.10.24	20 (11 women, 9 men)	First-year bachelor's degree	Inter-disciplinary	Technical communication	HM Hochschule München University of Applied Science
Italy	10.12.24	8 (5 women, 3 men)	Master's level	SSH	Strategic management, innovation sustainability	Guido Carli Luiss University
					Social design for sustainability, gender innovation/inclusion	University of La Sapienza
	10.02.25	5 (3 women, 2 men)	Master's level (4), Bachelor's level (1)	STEM	Mechanical Engineering	University of La Sapienza
					Green Industrial Engineering for Sustainable Development	University of La Sapienza
United Kingdom	18.11.24	5 (3 women, 2 men)	Master's level	STEM	Sustainable Energy Futures	Imperial
	20.11.24	6 (4 women, 2 men)	Master's level	Inter-disciplinary	Environmental Technology	Imperial

Table 2. Sampling for FGIs with lecturers

Country	Date	N° of participants	Department	University
Germany	25.09.24	9 (5 men, 4 women)	Faculty of Technical systems, processes and communication	HM Hochschule München University of Applied Science
Italy	5.11.24	7 (5 men and 2 women)	Department of Astronautical, Electrical and Energy Engineering (4)	University of La Sapienza
			Department of Planning, Design, Architectural Technology	University of La Sapienza
			Department of Communication and Social Research	University of La Sapienza
			Department of Political and Social Sciences.	University of Trieste
United Kingdom	16.01.25	5 (3 men, 2 women)	Centre for Agroecology, Water and Resilience	Coventry University
			Energy Institute	University College London
			Faculty of Engineering and Physical Sciences and Sustainability Research Institute	University of Leeds
			Emeritus	University of Surrey
			Chemical Engineering Department	Imperial

2.2 Methodological framework and reflexive design of the study

All FGIs followed a common research protocol. Discussions with students focused on the factors influencing educational choices and career aspirations, as well as the barriers and enablers they faced in career progression. Among lecturers, the discussions explored the factors influencing women's interest in the energy sector, the organizational culture, and the integration of gender perspectives in teaching and research. Further topics included promising practices, persistent challenges, and policy recommendations to enhance gender diversity in the field. While the framework remained consistent across all countries, the qualitative design of the study enabled adaptability to national and institutional contexts. This flexibility allowed the emergence of context-specific themes and priorities, ensuring the study captured the diverse challenges and opportunities shaping women's participation in the energy transition.

This study was conducted by an heterogenous research team composed of six White women, two Other White women and one White man, including researchers from Poland, Italy, Germany, Mexico, and Brazil, with diverse social and cultural backgrounds, disciplinary expertise, age and degree of seniority. As a group composed of people with so many different characteristics, their positionality toward research also take on individual and personal dimensions, which are therefore difficult to categorize and generalize. However, what unites the research group is their doctoral level of education, their residence in privileged contexts (Europe and UK) with a middle-class lifestyle, and their roles as researchers in prestigious research institutions and universities. Furthermore, what the group has in common isa shared commitment to fostering spaces of knowledge production free from stereotypes and gender inequalities grounded in a feminist and reflexive standpoint. Our engagement with questions of inclusion, exclusion, and power relations within scientific and technical environments informed both the design of the study and the interpretation of the findings. At the same time, we remained attentive to how our own social and professional positioning could shape the research process.

Focus groups were facilitated by team members in their respective countries, helping build rapport with participants and ensuring linguistic and cultural familiarity with each national context. The presence of early-stage researchers among those conducting the focus groups may have further facilitated openness among participants, given their proximity in career stage and lived experience to many of those involved.

Analysis was carried out collaboratively across the full research team, bringing together diverse national perspectives and interdisciplinary expertise. The combination of sociological, anthropological, biological, geographical, and psychological perspectives supported a more nuanced and multidimensional interpretation of the findings.

All researchers share a strong engagement with the study's subject matter through their active involvement in the Horizon Europe project gEneSys, which focuses on the nexus between gender and energy transition. While this familiarity with the topic may have encouraged participants to engage more openly and freely, the research team remained mindful of the risk of interpreting the findings through the lens of prior assumptions and expectations. Throughout the research process, we therefore adopted a reflexive approach, consciously working to ensure that participants' voices and experiences guided the analysis.

This reflexive approach structured the analytical process in two interdependent phases. In the first phase, each national research team (Italy, Germany, and UK) conducted a thematic analysis of the interview corpus, in accordance with the main operational dimensions outlined in the research protocol. The qualitative material (interviews and written material generated through the projective techniques during the focus group interviews) was examined to identify relevant elements both in relation to the predefined dimensions and in connection with emerging themes, thereby capturing both expected aspects and novel interpretative patterns. Drawing on the reflexive thematic analysis approach developed by Virginia Braun and Victoria Clarke, themes are understood as “creative and interpretive *stories* about the data, produced at the intersection of the researcher’s theoretical assumptions, their analytic resources and skill, and the data themselves” (Braun & Clarke, 2019: 594). An iterative refinement process was employed to develop categories that allowed for comparison within individual focus groups as well as across all focus groups in particular country. The findings from this phase were systematized into three reports, corresponding to the respective national contexts. In the second phase, the Italian research team (National Research Council) carried out an integrated analysis of the three cases, with the aim of highlighting context-specific features and cross-cutting patterns in the different national and institutional contexts. After this process, the overall results were synthesized into two explanatory categories of exclusion mechanisms, “Unmet Aspiration” and “Repelling Effect” (see Figure 2), which capture the key processes shaping educational and professional pathways in the context of the sustainable energy transition.

2.3 Between design and reality: challenges of flexible approach

The flexible methodological design entails two main limitations. First, the sampling strategies across countries resulted in groups with different compositions. Specifically, the German group consisted of bachelor's students at the early stage of their academic careers, while the Italian and British groups consisted of master's students. The variation in participants' baseline knowledge, analytical sophistication, and familiarity with academic discourse meant that the depth and complexity of contributions differed substantially between groups. This difference inevitably influenced the depth and articulation of the reflections emerging: the contributions of bachelor's students tended to be less structured, less mature, less exposed to energy-related issues and supported by a narrower range of experiences than those of master's students. Consequently, the research team in the second phase of the analysis had to take into consideration that the iterative refinement of categories required reflexive consideration whether thematic difference represented variations in experiences or reflected differences in participants’ analytical skills. Additionally, there were differences in the students’ career orientations: while BA students were primarily focused on their studies, MA students had a clearer and more immediate vision of their future professional paths. This has further implications: BA students might rely more on academic knowledge or classroom discussions rather than first-hand experiences in the energy sector, limiting the practical depth of analysis. As a result, the empirical material collected was rich but also highly variable in terms of complexity and detail. Second, the diversity of the selected curricula – covering SSH, STEM, and interdisciplinary curricula – generated highly context-specific findings. Differences in disciplinary training could shape how participants understand and discuss energy issues - technical vs. social perspectives. Participants from different disciplines use distinct terminology, theoretical references, and interpretative frameworks when discussing the same phenomena. Broadening the perspective beyond technical issues responds to timely discussion on social dimensions of energy and identifies concepts used to frame energy-related topics.

3. Findings

Drawing on qualitative data collected in Italy, Germany, and UK, this study highlights the structural, sociocultural, and individual factors that shape educational and professional trajectories within sector related to energy transition. In particular, our findings identify two key mechanisms of exclusion and structural bias reproduction: the "unmet aspiration" and the "repelling effect" (Figure 2).

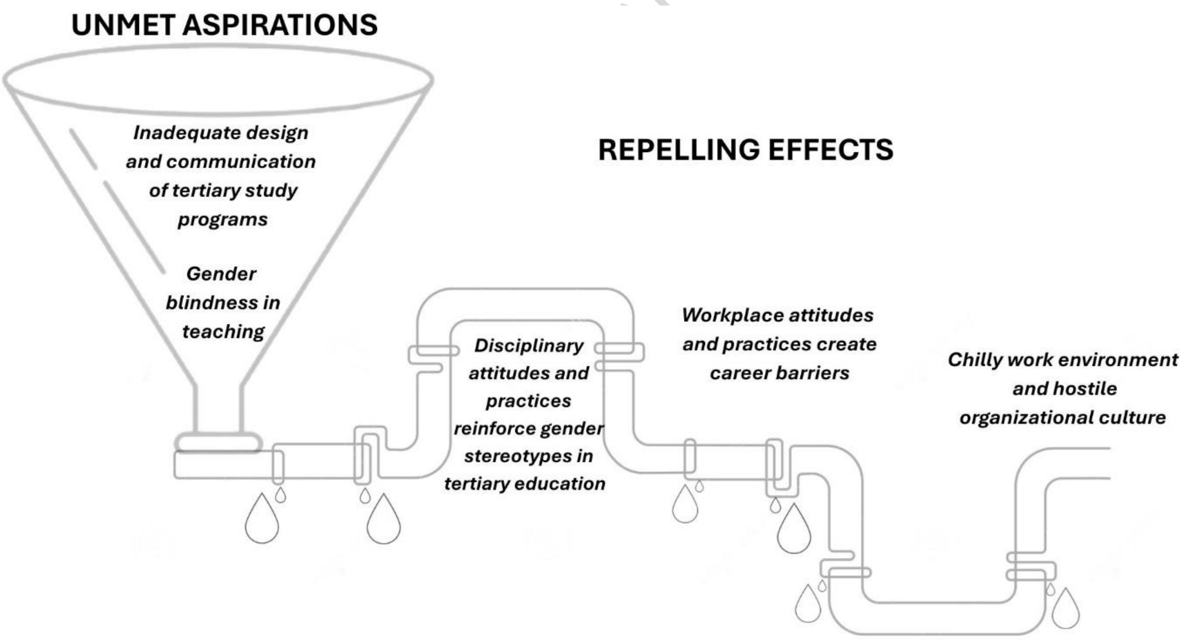

Figure 2. Two mechanisms of exclusion: unmet aspirations and repelling effects

Authors' elaboration

The mechanism of unmet aspiration manifests through inadequate program design and communication (subsection 3.1), as well as through teaching practices that often remain blind to gender issues and to the broader social implications of technology-related contexts (subsection 3.2). The repelling effect encompasses a set of cultural stereotypes and institutional biases that effectively discourage – particularly, though not exclusively, women – from entering and remaining in the sector (subsections 3.3 and 3.4). This second exclusion mechanism includes disciplinary specificities (that is, the ways in which attitudes and practices of disciplines contribute to exclusion dynamics), professional practices, and the prevailing organizational climate and culture (subsection 3.5).

Across contexts, both STEM and SSH students – especially women – express a desire to pursue meaningful and interdisciplinary educational paths aligned with the values of sustainability. However, structural barriers persist that constrain these aspirations. Study programs still tend not to integrate gender and social dimensions systematically, and women's contributions continue to face diminished recognition. These patterns extend into the workplace, where gendered expectations and unequal support structures constrain access and career progression opportunities.

The following sections explore in detail the different elements of these two exclusion mechanisms identified in our research results. They provide both a synthesis of the main findings by country, participant group (lecturers/students), and curriculum – illustrated through tables (see Tables 3, 4, 5, 6 and 7) – and a qualitative analysis of participants' discourses and narratives.

3.1. Unmet aspiration in tertiary education pathways related to the energy transition

The first exclusion mechanism – *unmet aspiration* – consists in the mismatch between the potential of STEM education to drive major socio-technical transformations, such as the energy transition, and how this potential is communicated and perceived.

Significant differences emerge among curricula in STEM, SSH, and interdisciplinary fields (Table 3). In STEM programs, both lecturers and students acknowledge sustainability as an attractive element; however, these curricula remain highly technical, embedded in a male-dominated energy sector, and often overlooked the broader social and environmental implications of engineering disciplines. In SSH programs, students highlight the relevance of their education for addressing energy issues – from public policy design to societal understanding – yet feel discouraged from entering the sector, which they perceive as constrained by technical specialism.

In contrast, interdisciplinary programs are viewed as integrating the strengths of both curricula, combining multidisciplinary with an ethical commitment to sustainability. From the lecturers' perspective, such programs also attract more women and help reduce gender imbalances in energy-related fields. These findings align with previous research indicating that academic content is frequently framed as isolated technical knowledge, detached from real-world applications and socio-political contexts (Hill et al., 2010; Mansour, 2025; Mei et al., 2023). Programs that remain narrowly disciplinary and compartmentalized – limiting students' ability to engage with complex sustainability challenges – are generally perceived as less appealing than interdisciplinary or SSH-oriented courses that explicitly connect technical expertise with societal relevance.

Table 3. Unmet aspiration in tertiary education pathways

Unmet aspiration in tertiary education pathways						
Factor	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling	• Sustainability boosts STEM interest		• Interdisciplinary program attracts more women • Interdisciplinarity as key element in reducing the gender gap in the energy fields	• Multidisciplinary relevance (policy, environmental, and social aspects) • Mixing technical skills with an ethical focus on sustainability		• Social studies inform energy policy and public understanding
Improvable		• Sustainability appealing but underpublicized				
Hindering	• Technical orientation • Masculinized fields • Failure to communicate the programs potential	• Masculinized fields • Engineering not linked to socio-environmental issues				• Technical skill gaps hinder direct energy-sector careers

Lecturers in Italy brought the example of electrical engineering frequently associated with technical skills, while broader aspects like managing complex electrical systems and strategic planning are often overlooked (IT_LEC_ST2M, IT_LEC_ST3M). Students also raised this issue, stating that engineering—unlike other subjects such as biology—is not perceived as a tool for addressing socio-environmental issues. As a result, this common perception may discourage female high school students, but also male students, interested in sustainability issues from enrolling (IT_LEC_ST4M). Engineering fields are considered by Italian and German lectures more attractive to men due to their association with activities historically associated with a stereotyped masculine identity -e.g. Formula 1, automotive, and space exploration- (IT_LEC_ST2M, IT_LEC_ST4M). In particular, the energy sector is perceived as masculinized field (GE_STU_IN3F, UK_STU_ST3W).

One of the discussed reasons for this problem is the lack of effective communication regarding the potential of engineering education in different job fields related to the energy and green transition. According to STEM lecturers in Italy, university departments often fail to effectively communicate the scope and potential of their engineering programs, reinforcing reductive and stereotypical perceptions on the discipline. In this vein, STEM students in Italy agree that engineering programs are not always well-publicized, resulting in very few enrollees (IT_STU_ST3W). A different picture emerges from the focus group conducted in UK with students with a STEM background enrolled in the MSc Sustainable Energy Futures, run by the Mechanical Engineering Department at Imperial. This program, aimed at graduates in engineering or physical sciences, offers a broad, comprehensive, prestigious, and internationally recognized engineering education, thereby also expanding the perceived range of potential applications of the discipline.

Several students with STEM backgrounds of both genders chose the master's program because of its interdisciplinarity, focus on sustainability and broader societal relevance (IT_STU_ST1M, IT_STU_ST2W, IT_STU_ST3W, IT_STU_ST04W, IT_STU_ST5M, UK_STU_ST3W, UK_STU_ST4W, UK_STU_IN1W, UK_STU_ST5M). Some female participants mentioned that they also wanted to play a role in climate change (UK_STU_ST4W, UK_STU_IN4W) and help address energy challenges (UK_STU_IN1W, UK_STU_IN1W). Energy fields are considered one of the most direct ways to address climate change, resource scarcity, and other global challenges. This aspect is also considered relevant for several male students, such as the exemplary testimonies reported below. "*I have an Engineering background, and I realised that there are so many aspects, while deciding: the policy, the social aspect, the environmental aspect, the legal aspect. This program will teach all the multidisciplinary aspect*" (UK_STU_ST5M). "*I am Interested in energy development […] I want to learn broader aspects of sustainability, not only technical, [such as] design policy and planning to achieve Net Zero [with a focus on] energy power*" (UK_STU_ST1M).

"I liked the idea of doing something socially useful, something that can really make a difference" (IT_STU_ST2W). One of the female participants from Italy with background in Aerospace Engineering reports her choice to enroll in a master's degree that combine management, governance, and technical aspects related to sustainability and energy. *"I think it's vital to combine ethical motivation with engineering tools. […] I have an ethical drive linked to sustainability. I feel a duty to listen to that drive*" (IT_STU_ST3W).

A similar tension is detected in the group of students with SSH and interdisciplinary background from Italy, Germany and UK. Some students expressed a preference for interdisciplinary roles that combine their social science background with aspects of sustainability and/or energy issues. They recognize that their expertise in social studies could contribute meaningfully to energy policy discussions and the public understanding of energy-related topics. However, there is a general concern that social studies background may not provide the technical expertise typically required in energy-related roles. This perceived gap in technical knowledge has led to hesitancy in pursuing careers directly within the energy sector, as they may feel underqualified compared to individuals with engineering or other technical degrees (IT_STU_SS5W, GE_STU_IN5W).

Similarly to students, the lecturers from UK, Germany and Italy agree that the desire to do meaningful work contributing to society and having positive impact on the world is a driver in career decision, especially for women. The interdisciplinary and sustainability approach fulfills this desire of purpose and can therefore be considered a key element to reducing the gender gap in energy-related fields. A lecturer from the Institute NOWUM-Energy and the Institute for Data-based Technologies stated that in Germany many women are motivated in their educational choices by this driver (GE_LEC_ST7M). A lecturer at the Energy Institute, University College London also declared that "o*ften the interdisciplinary courses attract more women*" (UK_LEC_ST2W); whilst an Assistant Professor at the Centre for Agroecology, Water and Resilience, Coventry University stated that "*once they feel that there is a sustainability aspect, then interest seems to grow*" (UK_LEC_S1M).

3.2. Unmet aspiration: the gender blindness in teaching contents

In relation to the mechanism of unmet aspirations, the integration of gender perspectives into course content and pedagogical practices emerges as a largely overlooked dimension (Table 4). The absence of explicit consideration of gender issues is evident across all contexts examined, albeit expressed through varying rationales and perceptions. In STEM programs, the purported neutrality of the curricula often aligns with a predominantly technocentric orientation. By contrast, in SSH and interdisciplinary programs, attention to gender, when present, remains limited and is rarely situated within an intersectional framework. Overall, the evidence suggests that the absence of gender perspectives, coupled with the depersonalized presentation of technical knowledge detached from its societal context, constrains the ability of educational programs to cultivate a critical understanding of the social and ethical dimensions of the energy transition.

Table 4. Unmet aspiration: Gender blindness in teaching

Unmet aspiration: Gender blindness in teaching						
Factor	STEM		Interdisciplinary		SSH	
	Lecturers	*Students*	*Lecturers*	*Students*	*Lecturers*	*Students*
Enabling	• Promoting networking opportunities for women • Gender-neutral language					
Improvable	• Higher pedagogical awareness among female lecturers and gender integration in teaching practices • Informal discussions among faculty members and doctoral students	• Limited integration of social and gender issues into course content and materials		• Gender issues are narrowly addressed • Gender analysis is often treated loosely	• Higher pedagogical awareness among female lecturers and gender integration in teaching practices	• Limited integration of social and gender issues into courses • Gender issues are narrowly addressed • Gender treated separately, not embedded in intersectional frameworks
Hindering	• Lack of gender lens in teaching • Technical nature of the subjects • Deliberate choices to avoid gender lens	• Depersonalized transmission of technical knowledge (largely disconnected from its social applications and implications) • Engineering neutrality	• Lack of gender lens in teaching	• Non-inclusive language in teaching		• Use of non-inclusive language persists in teaching, especially among male lecturers

From lecturers' perspectives in Germany, the UK, and Italy, the absence of gender stems from the technical nature of the subjects (UK_LEC_ST1M, IT_LEC_ST3M), as well as from deliberate choices made by lecturers to exclude such topics (GE_LEC_ST8M). Some justify the absence of references to gender-related content by asserting that students can interpret the masculine generic form as inclusive of all genders (GE_LEC_ST3M). Even when gender issues are addressed, integration tends to be limited to marginal initiatives, such as promoting networking opportunities for women (GE_LEC_ST4M, GE_LEC_ST7M), informal discussions among faculty members and doctoral students about the underrepresentation of women in the energy sector (IT_LEC_ST4M, IT_LEC_ST3M, IT_LEC_ST5M), or adopting gender-neutral language (GE_LEC_ST6W). These efforts, though limited in scope, are more commonly observed among female lecturers, who demonstrate heightened awareness of their pedagogical responsibilities and a more proactive approach to integrating gender and diversity considerations into their teaching practices (GE_LEC_ST2W, IT_LEC_SS1W).

Students' responses further affirm the limited integration of social and gender issues into course content and materials (UK_STU_ST3W, IT_STU_SS3W). STEM students criticized the depersonalized transmission of technical knowledge, which remains largely disconnected from its social applications and implications (IT_STU_ST1M). As argued by an engineering student:

"*When you talk about technological development, man, woman, humanity is not addressed at all. Engineering is like neutral [...] I mean in content, it is generally absent... but the being human is not really addressed, which is the problem in engineering. Or the human is treated as an object with mass M, at most, or with some other counting category*" (IT_STU_ST1M).

When gender analysis is addressed, it is often treated loosely (UK_STU_IN4M), and the use of non-inclusive language persists in teaching (IT_STU_SS6W), reflecting varying levels of lecturers' awareness, especially men (IT_STU_SS6W, IT_STU_SS5W, IT_STU_SS1W). In some cases, gender issues are narrowly addressed – for instance, by restricting the discussion to domestic energy access, such as cooking (UK_STU_IN6W) - or treated separately within SSH courses, without being fully integrated into an intersectional framework relating to the broader social domains, including the sustainable energy transition (IT_STU_SS3W, IT_STU_SS2W).

Overall, the perspectives of both students and lecturers highlight that the absence of gender-sensitive frameworks and the limited contextualization of technical knowledge significantly constrain students' ability to critically engage with the broader societal implications of the energy sector. The lack of a gender perspective may also reduce the attractiveness of these programs, particularly for female students. These findings align with a study conducted among computer engineering students in Spain (Pascual et al., 2021), which revealed that even when gender representation becomes more balanced, university teaching often remains gender-blind, thereby unconsciously reinforcing inequality. The study further emphasizes that teachers' implicit biases can influence student assessment, reflecting different levels of awareness and sensitivity to gender issues. Consequently, it highlights the importance of integrating gender perspectives into technical education.

3.3. The repelling effect: How disciplines specific attitudes and practices create exclusion

A second exclusion mechanism has been identified as repelling effect, encompassing all attitudes and practices that effectively discourage, particularly women—but not exclusively—from entering and remaining in the sector.

Table 5: The repelling effect: disciplinary attitudes and practices as drivers of exclusion

The Repelling Effect: Disciplinary Attitudes and Practices as Drivers of Exclusion						
Factors	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling		• Strong motivation among women to disprove stereotypes				
Improvable	• Strong motivation among women as a self-correcting factor					
Hindering	• Denial of the gender issues in energy curricula • STEM subjects linked to male practical skills • Persistent cultural norms (family, context and social influence) reinforce stereotyped gender roles	• Sexist stereotypes and misogynistic behaviours attributed to lecturers • Gender stereotypes influencing peer dynamics • STEM subjects linked to male practical skills		• Gender stereotypes influencing peer dynamics	• Persistent cultural norms (family, contex and social influence) reinforce stereotyped gender roles	

SSH lectures and both SSH and STEM students acknowledge that educational choices are deeply intertwined with the persistent cultural norms that associate specific disciplines/fields with stereotyped gender roles. These norms are shaped by family, social contexts, and broader societal influences (IT_LEC_SS1W, IT_LEC_ST5M, IT_LEC_SS2M). This issue is particularly evident in certain STEM fields (e.g. engineering), where female enrolment is still low. However, these considerations are largely absent among most STEM faculty, who report gender-blind perceptions regarding the imbalances in educational choices made by male and female students. We found a trend among engineering professors, especially in Italy, to deny the existence of gender issue in energy-related curricula, arguing that the underrepresentation of women results from independent decisions unaffected by societal expectations on gender roles (IT_LEC_ST3M). From this perspective, the energy-related engineering field is neutral and free from gender bias.

In contrast, the STEM students' experience in Italy reveals a very different picture, where the supposed neutrality of the field is replaced by an environment filled with sexist stereotypes and misogynistic behaviors. Some also reported that women are often perceived as less suited for careers in STEM fields (IT_LEC_ST5M). Misogynistic attitudes of lecturers have also been reported which hinders equal experience of engineering education. IT_STU_ST4W recalled professors making sexist and inappropriate examples on fluid dynamics that implicitly assumed a male audience, such as: "*We had an example in class of crossing a river faster if there's a pretty girl waiting on the other side. It just assumed everyone was a man interested in women"* (IT_STU_ST4W). From Italian STEM students focus group emerged that sexist attitudes were more frequently attributed to lecturers than to peers (IT_STU_ST2W, IT_STU_ST3W, IT_STU_ST4W).

It should be noted, however, that in some cases, the repelling effect triggers a response that produces the opposite outcome—namely, it increases the motivation of some women to pursue careers in male-dominated fields. In Italy and in the UK, we found that the fact that STEM fields are male-dominated motivated some female students to choose this path to demonstrate that women can succeed in these fields. A female student in Green Industrial Engineering for Sustainable Development master's degree affirms that in her educational choice "*there was some influence related to gender, honestly, because the STEM field often seems like a glass ceiling for women, especially when I had to choose my undergraduate degree a few years ago. So, I liked the idea—having also studied at a science-oriented high school—of entering a field that is traditionally male-dominated. That's why I was also drawn to STEM subjects"* (IT_STU_ST4W). A female student in the master program Sustainable Energy Future in the UK says she chose this program "*to prove that a woman can contribute [...] to prove the stereotype wrong*" (UK_STU_ST2W).

The strong motivation of female students is also acknowledged by some STEM lecturers. As reported by an engineering lecture: *"if I look at the proportion of women at the entry level, the percentage [of women] in our department is higher than I observe in the student group. In my opinion, this comes from a stronger motivation among women who decide to pursue these careers, probably because they are aware that they are a minority. So when they choose these careers, it is out of a strong motivation, which naturally tends to stand out*" (IT_LEC_ST2M). However, other lectures fail to perceive the high motivation displayed by female students in relation to—and as a consequence of—structural gender inequalities. From the perspective of some engineering professors, the energy engineering field is essentially "asexual" (IT_LEC_ST4M). According to this view, the inequalities observed in tertiary education are a natural consequence of an imbalance that begins earlier in the educational process. The few women who undertake this path tend to demonstrate strong motivation, and their individual choices are seen as a self-correcting factor in the overall gender imbalance in the field. This perception simultaneously genderize motivation (considering it a feminine characteristic) and naturalizes it (women are naturally more likely to be highly motivated). In fact, motivation is perceived as disconnected from the structural mechanisms that require women to work harder to achieve the same results.

As emerged from the various focus groups, the repelling effect does not manifest only at the university level but has its roots much earlier within the socialization process during the childhood, both in the school experience and in the family context. Participants from Italy and Germany highlighted differential treatment of children based on gender at the school level (IT_STU_ST4W) and gender stereotypes influencing peer dynamics, which could lead to bullying or discriminatory practices (IT_STU_ST3W, IT_STU_ST5M). Additionally, there is a tendency to associate STEM subjects with practical skills traditionally deemed more suited to men (IT_STU_ST1M). As expressed by an Italian lecturer, this issue is particularly evident "*in Southern Europe, including Italy, especially in the southern regions, where, until recently, a woman engineer was seen as an alien*" (IT_LEC_ST5M). Traditional mindsets assign women roles more consistent with family care responsibilities (IT_LEC_ST5M), implicitly limiting their professional aspirations.

3.4. The repelling effect: how professional practices create careers barriers and exclusion

The second mechanism of exclusion, defined as the repelling effect, examines the factors that influence women's career trajectories in the energy sector, drawing on insights from both lecturers and students. Lecturers were invited to reflect on the academic environments in which they operate and on how these contexts contribute to either reproducing or mitigating gender inequalities. Students, in turn, were asked to consider the opportunities and systemic disadvantages that women may encounter throughout their professional pathways.

The results, summarised in Table 6, highlight a range of enabling and hindering factors. Among the barriers were implicit and explicit gender stereotypes, manifestations of misogyny and microaggressions, as well as concerns about career advancement due to family responsibilities. Likewise, several good practices emerged, including the role of mentoring and support networks, which help challenge gender stereotypes and promote women's self-determination, professional advancement, and economic empowerment.

Table 6: *The repelling effect: professional practices as careers barriers and exclusion*

The Repelling Effect: Professional Practices as Careers Barriers and Exclusion						
Factors	STEM		Interdisciplinary		SSH	
	Lecturers	*Students*	*Lecturers*	*Students*	*Lecturers*	*Students*
Enabling		• Pivotal role of mentors in countering gender stereotypes and supporting women's careers • Promoting women's self-determination in professional advancement and economic empowerment				• Pivotal role of mentors in countering gender stereotypes and supporting women's careers
Improvable		• Gender motivations in career choices (economic goals for men vs. ethical and environmental values for women)		• Social competence awareness, but perceived inadequacy compared to the technical profiles in the energy sector		
Hindering	• Illegal practices disadvantaging women • Social norms and cultural expectations create forms of self-exclusion for women • Implicit and explicit gender stereotypes • Misogynistic attitudes make workplaces less accessible to women	• Misogynistic attitudes make workplaces less accessible to women • Limited career progression due to motherhood and care responsibilities • Microaggressions • Threats to professional legitimacy		• Misogynistic attitudes make workplaces less accessible to women • Limited career progression due to motherhood and care responsibilities • Limited awareness of career opportunities in the energy sector		• Limited awareness of career opportunities in the energy sector

From the lecturers' reflections emerged the persistence of both explicit and implicit gender stereotypes. Several lecturers noted that by internalizing social norms and cultural expectations, women themselves often appear more hesitant to take up professional opportunities, contributing to forms of self-exclusion. Some interviewees reported that "*women often may be more hesitant to put themselves forward*", (UK_LEC_ST4M), "*tend to be quite risk-averse*" (UK_LEC_ST5W), and often doubt their abilities and skills, even when proven to be superior to their male counterparts: "*frequently, you have female students who know more than a male student […] and yet, they tend to doubt themselves*" (UK_LEC_ST1M). However, more commonly, women face gender-based filters that hinder career progression (Casad et al., 2021). Lecturers shared concrete instances that challenge the legitimacy of women's expertise, such as comments about physical power: "*I need three strong men to lift this*" (GE_LEC_ST9M), or insinuations about gender quotas that devalue individual merit, like it was for a female student worker: "*during a high-level meeting with some new potential clients in my company, my manager introduced me as a 'gender quota. This calls into question my competence, as if I was only there to satisfy a number, not my abilities*" (IT_STU_ST3W). Furthermore, illegal practices have been reported that disadvantage women in the private sector. In some contexts, such as the offshore energy industry, recruiters tend to select only male candidates, who are considered more "employable": «*if we put forward women to work in the offshore industry, they will be turned down, because they're women... we don't get our fee, if we put forward people who aren't employable, so we would only ever put forward men*» (UK_LEC_ST3M).

An analysis of enabling factors and barriers conducted among students from all three countries, revealed a cross-cutting issue: limited awareness of career opportunities in the renewable energy sector, feeding uncertainty in career choices. The lack of clear references to communal goals in career education and guidance pathways contributes to this uncertainty (Boucher et al., 2017), with different effects depending on students' disciplinary backgrounds. Specifically, some students from SSH and interdisciplinary curricula reported a lack of recognition of how their skills can contribute to the energy transition (IT_STU_SS2W, IT_STU_SS5W, IT_STU_SS3W, GE_STU_IN1W, GE_STU_IN1M). While many acknowledge the relevance of their skills – especially in critical analysis, communication, and mediation – for shaping energy policy and fostering broader public understanding of energy-related challenges, they nonetheless express a perceived inadequacy compared to the technical-scientific profiles typically associated with the energy sector (GE_STU_IN1W, GE_STU_IN6W). The perceived lack of specialized technical expertise – often considered as a prerequisite for entering in the energy job market – contributes to a latent sense of exclusion, which in turn discourages students from actively pursuing roles associated with the energy transition.

In addition, career choices appear to be shaped by gender-differentiated motivations: while male students are often driven by economic goals, female students tend to favor ethical and environmental values, perceiving the renewables sector as more dynamic and inclusive (IT_STU_ST5M, IT_STU_ST2W, UK_STU_IN1W).

"*A boy, when offered the opportunity to work for an oil company where he can earn much more compared to pursuing a socially driven energy transition path, is – in my opinion – more easily convinced than girls, who are generally more focused on social and socio-environmental aspects*" (IT_STU_ST5M).

Among the enabling factors, students identified the pivotal role of mentors who can counteract gender stereotypes and support women's careers in male-dominated fields (IT_STU_SS5W), along with leadership skills that enhance individual skills. This requires the promotion of more informed and inclusive decision-making *styles* that are sensitive to gender equity (IT_STU_SS8M, IT_STU_ST4W). Special emphasis is also placed on promoting women's self-determination in professional advancement and economic empowerment (IT_STU_ST3W).

On the other hand, several barriers to women's careers have been identified. First, it is the persistence of stereotypes and misogynistic attitudes among employers. Such attitudes manifest especially during the transition to the labour market, leading to gender pay gap and discriminatory treatment based on looks rather than competence (IT_STU_ST5M, IT_STU_ST4W). Other students pointed out that physically demanding jobs in remote locations are perceived as less accessible or attractive to women, due to both cultural representations (UK_STU_ST3W, UK_STU_ST4W, GE_LEC_ST9M) and concerns about safety in male-dominated workplaces: "*safe work environment [...] because it is dangerous [...] it's too many men there*" (UK_STU_IN6W). In addition, lack of access to formal and informal networks hinders women's participation in decision-making processes and professional development opportunities, while strengthening male-exclusive niches (UK_STU_ST4W).

A wide corpus of studies has also highlighted the challenges women face in balancing work with caregiving responsibilities (Pace & Sciotto, 2022; Raukar & Mishkin, 2020; Tabassum & Nayak, 2025), particularly acute in the energy sector (Baruah & Biskupski-Mujanovic, 2021; Henriques et al., 2024), due to work intensity and frequent travel (Bhattacharya et al., 2024). Consistent with these findings, students identified motherhood and care responsibilities as critical factors limiting career progression (IT_STU_ST5M, IT_STU_ST4W, IT_STU_ST3W, UK_STU_ST4W).

"*Pregnancy is a very, very big obstacle in a woman's career. […] You either must decide to have a family or a career, and it's very difficult to combine the two*" (GE_STU_IN1W).

"*The woman simply must cut back. I can't have a child now. […] Of course, you must make sacrifices"* (GE__STU_IN4M).

Across the three national contexts analyzed, maternity leave is perceived as a potential obstacle to professional advancement, leading to downgraded responsibilities or career stagnation: "*once they come back to the office, they might never catch up [...] it's going a big job to compete*" (UK_STU_IN5W).

These reflections underscore the longstanding nature of organizational and cultural structures that perpetuate systemic gender inequalities, thereby preventing the full recognition of women's potential in the energy sector. Consequently, there is an urgent need for systemic interventions aimed at overcoming the institutional, cultural, and social barriers that still limit women's equitable access and advancement in professions related to the ecological transition.

3.5. The repelling effect: how work environment and organizational culture create exclusion

The repelling effect mechanism also includes considerations relating to the work environment and organisational culture, as factors that can facilitate or hinder women's entry and advancement in professional careers. This dimension emerged prominently during the focus group sessions with lecturers, while it was somewhat weaker among students, since only some of them – mainly from STEM disciplines – had already gained early professional experience.

Table 7 presents a generally discouraging overview: work environments, especially in academia, fail to offer inclusive contexts. Gender equality measures, even when in place, are often perceived as an additional administrative burden or as initiatives lacking sufficient resources and adequately trained personnel to ensure their effective delivery. Gender bias is also recognised by students during classroom interactions, reinforced by persistent gender stereotypes that influence not only the educational environment but also the professional field. Discriminatory practices in recruitment and promotion processes were reported, as well as the assignment of underqualified roles to women, which prevent the full recognition and enhancement of their skills.

Table 7: *The repelling effect: work environment and organizational culture as factors of exclusion*

The Repelling Effect: Work Environment and Organizational as Factors of Exclusion						
Factors	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling						
Improvable	• Meritocracy as objective criteria for academic evaluation					
Hindering	• Lack of awareness about measures to support women in the workplace • Poor consideration of the workplace climate in scientific organisations • Gender equality measures framed as bureaucratic and administratively demanding • Lack of resources and insufficient expertise among staff to effectively implement gender measures/initiatives • Structural gender gap linked to candidate entry imbalance	• Gender stereotypes (e.g., physical appearance) overshadow skills in recruitment and promotion • Gender stereotypes (e.g., physical appearance) reinforce outdated roles • Gender biases influence classroom interactions and professional environments				

Faculty generally perceive academic evaluation processes as meritocratic and gender-neutral process. The concept of meritocracy is not questioned, as it is perceived as objective. The interviews did not highlight any merit-related factors that could have an advantage or disadvantage for either gender. However, the general gender gap in the energy transition is referred mainly to the initial gender imbalance in applicant pools. Yet, informal cultural factors persist, as another faculty member observed, "*A range of practices persist that are not favourable for women, who still bear disproportionate family workloads compared to men*" (IT_LEC_SS1W). Similarly, GE_LEC_ST6W indicated a lack of awareness regarding supportive measures for women at her workplace indicating that the issue of workplace climate in scientific organizations has not been recognized as a topic worthy of attention. Interviews with lecturers reveal a tension often present in institutional approaches to gender equality: while the issue is widely recognized as important, its operationalization can become entangled in administrative complexity. As GE_LEC_ST7M notes, the proliferation of initiatives can generate substantial bureaucratic workload, making implementation uneven and heavily dependent on individual study programs. This suggests that, despite good intentions, gender equality measures may be perceived yet another layer of administrative responsibility rather than as integral to institutional culture. Similarly, GE_LEC_ST2W's concerns about ineffective implementation due to insufficient expertise point to a broader challenge: without proper resources and skilled personnel, even well-designed policies risk becoming symbolic rather than transformative. Together, these accounts highlight how the relevance of gender equality can paradoxically contribute to a sense of institutional fatigue when not matched by effective support structures.

From the students' perspectives gender biases persist, influencing classroom interactions and professional environments. As illustrated by a student's experience: "*Lab coats are only available in M-L sizes, while shoes exist only in large sizes. Since I am only 1.60 meters tall, my lab coat drags on the floor*" (IT_STU_ST3W). Other student testimonies point to a deeper, systemic issue within organizational cultures—namely, the persistence of appearance-based bias in the evaluation of women's professional worth. In Italy and UK student's FG reveals how physical appearance can overshadow skills and intelligence in recruitment and promotion processes. UK_STU_ST4W observation that some people "*don't pay for intelligence*" but instead "*value women from their physical appearance*" underscores a troubling norm: women's professional trajectories may be shaped not by merit, but by superficial judgments rooted in gender stereotypes. This dynamic not only distorts fair evaluation but reinforces outdated roles—evident in the comment comparing women to a "*type of joke, like for a secretary*" (UK_STU_ST4W). Such views diminish women's credibility and contribute to a workplace culture where competence is undervalued.

4. Discussion and Conclusions

The global energy transition represents not only a technical challenge but a societal transformation. At its core lies the question of who participates in shaping, guiding, and benefiting from this transformation. Our study, grounded in qualitative data from Italy, Germany, and the UK, highlights the deep-rooted gender asymmetries that continue to structure education and careers in the energy sector. Our findings point to a systemic misalignment between students' values and institutional configurations—particularly within STEM disciplines—where gendered exclusions persist in both explicit and implicit forms.

A critical insight emerging from the focus group interviews is that students across disciplines are increasingly motivated by a desire to contribute to socially meaningful work, especially in areas related to sustainability and justice. Women express a strong commitment to addressing global challenges such as climate change and resource equity. Yet, their aspirations often clash with educational structures that continue to valorize narrow technical expertise and masculinized professional cultures. This discord—between institutional supply and student demand—results in what we define as "unmet inclination," where students are deterred from certain educational pathways not due to a lack of interest or ability, but due to the sector's failure to signal relevance, inclusivity, and societal purpose.

A critical implication emerging from our findings concerns the relational and pedagogical responsibilities of faculty toward students. Across the focus groups, participants described how lecturers' attitudes, implicit biases, and everyday interactions can either reproduce or challenge gendered hierarchies within higher education. Instances of overt misogyny, gender-blind teaching, or the normalization of exclusionary language highlight the extent to which academic staff play an active role in shaping not only the learning environment but also students' sense of belonging and legitimacy within their disciplines. Faculty are not merely transmitters of disciplinary knowledge—they act as cultural mediators who model professional norms, expectations, and values. Their relational stance toward students therefore has direct implications for students' academic self-concept, motivation, and career aspirations. When faculty members fail to recognize or address gendered and intersectional barriers, they inadvertently reinforce the structural dynamics that deter women and other underrepresented groups from pursuing or remaining in energy-related pathways. Conversely, when educators adopt reflexive, inclusive, and mentoring-oriented practices, they can help counteract the "unmet aspiration" and "repelling effect" mechanisms identified in this study. Recognizing the central role of faculty thus calls for institutional investment in pedagogical training that integrates gender awareness, critical reflexivity, and intersectional sensitivity. Such training should not be conceived as an additional administrative burden but as a constitutive element of academic professionalism.

Addressing these gaps requires a fundamental rethinking of curricular design. Energy education must move beyond compartmentalized knowledge to foster integrative learning experiences that link technical skills with societal application. Interdisciplinary programs that bridge STEM and SSH are particularly promising in this regard, as they reflect the complexity of real-world energy challenges. Such programs also resonate more with students who seek careers aligned with ethical, environmental, and communal goals—goals which our data show are more strongly articulated by female students. Designing for this inclination does not mean feminizing curricula; rather, it requires reclaiming education as a *site* for democratic engagement with science and its social implications.

In this context, pedagogy emerges as a key site of intervention. The current absence of gender-sensitive and socially embedded teaching approaches in many STEM programs reinforces exclusionary dynamics. Participants frequently reported that engineering and related fields are taught in ways that ignore the social, ethical, and systemic dimensions of technology. This absence is not neutral—it shapes who feels welcome, who sees themselves as competent, and ultimately, who stays. Implementing feminist, critical, and intersectional pedagogies can help educators unearth implicit biases, include marginalized perspectives, and create classrooms that value a plurality of knowledges. Peer learning and co-teaching across disciplines are not ancillary to education quality—they are foundational to building epistemic diversity.

Beyond education, our study reveals that the transition to the energy workforce is similarly shaped by structural and cultural barriers. Female students reported facing skepticism, diminished expectations, and overt sexism during internships, job applications, and professional training. These challenges are compounded by a persistent myth of meritocracy that dominates both academic and industry discourses. While meritocratic ideals suggest fairness, they often obscure the invisible labor and structural disadvantages women navigate. Importantly, some institutions recognize the need for gender equity but implement solutions through bureaucratic checklists rather than through transformative, resourced commitments. As a result, well-intentioned initiatives risk becoming symbolic rather than effective.

The consequences of these dynamics are twofold. On the one hand, women who enter the energy sector often do so with a strong sense of purpose and a desire to disrupt gender norms. Their testimonies highlight resilience and ambition—but also the cost of constantly having to "prove" one's worth in male-coded environments. On the other hand, many potential contributors are dissuaded altogether. The loss is not only individual but collective: the energy transition suffers when diverse talents, perspectives, and knowledges are underrepresented or marginalized.

This exclusion becomes even more acute at the intersection of career and care responsibilities. Across all three countries, participants identified motherhood, caregiving, and family expectations as major obstacles to career progression. These constraints are intensified by the demanding nature of many energy sector jobs—long hours, travel, physical labour, and male-dominated environments. Moreover, prevailing organizational cultures continue to valorize presenteeism, linear career paths, and hierarchical authority, which disproportionately disadvantage women and others with non-normative professional trajectories. Creating truly inclusive workplaces will require not only gender-sensitive hiring and promotion practices, but also a redefinition of what leadership, competence, and commitment look like.

Institutional culture, then, is not a neutral backdrop—it actively shapes participation, performance, and belonging. Our study finds that even where formal equality measures exist, informal norms, language, and microaggressions continue to hinder women's full participation. The normalization of jokes, stereotyped assumptions, and appearance-based judgments corrodes workplace dignity and reinforces hierarchies of value. These dynamics not only harm individual careers, but signal to students and early-career professionals that the energy sector is not a space where they can thrive.

Finally, our study calls for a reframing of the energy transition itself—not merely as a technological shift, but as an epistemic and institutional transformation. Who we educate, how we educate, and what values are encoded in professional cultures will determine not only who leads the energy transition, but also what kind of future it enables. A gender-just energy transition is not only about balancing participation—it is about reimagining science and innovation as spaces of shared responsibility, social relevance, and collective flourishing.

Ethics Approval Declaration

Ethical approval for the project gEneSys – Transforming Gendered Interrelations of Power and Inequalities for Just Energy Systems (Grant Agreement No. 101094326) was submitted by the Institute for Research on Population and Social Policies (IRPPS-CNR), as project coordinator, to the Commissione per l'Etica e l'Integrità nella Ricerca (Commission for Ethics and Integrity in Research) of the National Research Council (CNR). The project received ethical clearance on 11 April 2024, under reference number 122584/2024.

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Unmet aspiration in tertiary education pathways						
Factor	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling	Sustainability boosts STEM interest		Interdisciplinary program attracts more women Interdisciplinarity as key element in reducing the gender gap in the energy fields	Multidisciplinary relevance (policy, environmental, and social aspects) Mixing technical skills with an ethical focus on sustainability		Social studies inform energy policy and public understanding
Improvable		Sustainability appealing but underpublicized				
Hindering	Technical orientation	Masculinized fields				

	Masculinized fields Failure to communicate the programs potential	Engineering not linked to socio-environmental issues			Technical skill gaps hinder direct energy-sector careers

Unmet aspiration: Gender blindness in teaching						
Factor	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling	Promoting networking opportunities for women Gender-neutral language					
Improvable	Higher pedagogical awareness among female lecturers and gender integration in teaching practices	Limited integration of social and gender issues into course content and materials		Gender issues are narrowly addressed	Higher pedagogical awareness among female lecturers and gender integration in teaching practices	Limited integration of social and gender issues into courses
	Informal discussions among faculty members and doctoral students			Gender analysis is often treated loosely		Gender issues are narrowly addressed Gender treated separately, not embedded in intersectional frameworks

Hindering	Lack of gender lens in teaching		Lack of gender lens in teaching	Non-inclusive language in teaching		Use of non-inclusive language persists in teaching, especially among male lecturers
	Technical nature of the subjects	Depersonalized transmission of technical knowledge (largely disconnected from its social applications and implications)				
	Deliberate choices to avoid gender lens	Engineering neutrality				

The Repelling Effect: Disciplinary Attitudes and Practices as Drivers of Exclusion						
Factors	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling		Strong motivation among women to disprove stereotypes				
Improvable	Strong motivation among women as a self-correcting factor					
Hindering	Denial of the gender issues in energy curricula	Sexist stereotypes and misogynistic behaviours attributed to lecturers		Gender stereotypes influencing peer dynamics	Persistent cultural norms (family, contex and social influence) reinforce stereotyped gender roles	
	STEM subjects linked to male	Gender stereotypes influencing peer dynamics				

	practical skills					
	Persistent cultural norms (family, context and social influence) reinforce stereotyped gender roles	STEM subjects linked to male practical skills				

The Repelling Effect: Disciplinary Attitudes and Practices as Drivers of Exclusion						
Factors	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling		Strong motivation among women to disprove stereotypes				
Improvable	Strong motivation among women as a self-correcting factor					
Hindering	Denial of the gender issues in energy curricula	Sexist stereotypes and misogynistic behaviours attributed to lecturers		Gender stereotypes influencing peer dynamics	Persistent cultural norms (family, contex and social influence) reinforce stereotyped gender roles	

	STEM subjects linked to male practical skills	Gender stereotypes influencing peer dynamics				
	Persistent cultural norms (family, context and social influence) reinforce stereotyped gender roles	STEM subjects linked to male practical skills				

The Repelling Effect: Professional Practices as Careers Barriers and Exclusion						
Factors	STEM		Interdisciplinary		SSH	
	Lecturers	*Students*	*Lecturers*	*Students*	*Lecturers*	*Students*
Enabling		Pivotal role of mentors in countering gender stereotypes and supporting women's careers Promoting women's self-determination in professional advancement and economic empowerment				Pivotal role of mentors in countering gender stereotypes and supporting women's careers
Improvable		Gender motivations in career choices (economic goals for men vs. ethical and environmental values for women)		Social competence awareness, but perceived inadequacy compared to the technical profiles in the		

				energy sector		
Hindering	Illegal practices disadvantaging women	Misogynistic attitudes make workplaces less accessible to women		Misogynistic attitudes make workplaces less accessible to women		Limited awareness of career opportunities in the energy sector
	Social norms and cultural expectations create forms of self-exclusion for women	Limited career progression due to motherhood and care responsibilities		Limited career progression due to motherhood and care responsibilities		
	Implicit and explicit gender stereotypes	Microaggressions		Limited awareness of career opportunities in the energy sector		
	Misogynistic attitudes make workplaces less accessible to women					
		Threats to professional legitimacy				

The Repelling Effect: Work Environment and Organizational as Factors of Exclusion						
Factors	**STEM**		**Interdisciplinary**		**SSH**	
	Lecturers	***Students***	***Lecturers***	***Students***	***Lecturers***	***Students***
Enabling						
Improvable	Meritocracy as objective criteria for academic evaluation					
Hindering	Lack of awareness about measures to support women in the workplace					
	Poor consideration of the workplace climate in scientific organisations	Gender stereotypes (e.g., physical appearance) overshadow skills in recruitment and promotion				

	Gender equality measures framed as bureaucratic and administratively demanding	Gender stereotypes (e.g., physical appearance) reinforce outdated roles
	Lack of resources and insufficient expertise among staff to effectively implement gender measures/initiatives	Gender biases influence classroom interactions and professional environments
	Structural gender gap linked to candidate entry imbalance	