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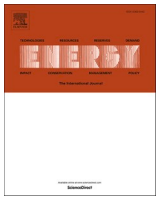

An energy union without interconnections? Public acceptance of cross-border interconnectors in four European countries

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ABSTRACT

Despite the importance of achieving a functioning and decarbonised European Energy Union (EnU) research addressing the public acceptance of cross-border energy interconnections at a European-wide level based upon public opinion polls is limited. To try to fill this gap in the literature, this article relies on a poll with 4000 respondents from the four big EU energy markets: France, Germany, Italy and Spain, including as a new explanatory variable their proximity to an electrical cross-border substation. Overall, 57,4% respondents have not heard about energy interconnections, and 69,2% have not ever heard about the internal energy market. Approaching public acceptance from a procedural justice framework, the article considers procedural justice as a pre-condition? For a fair policy-making process. By addressing the public acceptance of cross-border energy interconnections, the article aims to contribute to the existing literature on their linkages of said interconnections with the European energy policy-making process, deriving specific policy implications to foster cross-border interconnections and energy integration within the EnU.

1. Introduction

In 2015 the [1,2] launched the Energy Union (EnU) Strategy. One of its pillars is a fully integrated internal energy market to reduce and stabilize the price of energy through competition [3,4]. From a security perspective, a functioning internal energy market reduces supply risks in case of threat or conflict [5,6]. Achieving the internal energy market is also key to decarbonising the European economy, which is the overarching goal of the EnU. According to the European Green Deal [7], decarbonising the energy system is critical to reach the EU's climate objectives in 2030 and 2050. The energy transition has implications for the European energy market regarding both sources and networks. Concerning energy sources, renewable energies help diversify countries energy supply, both in terms of sources and providers [8,9], and enhance energy security [10].

Energy networks and interconnections provide the integration of renewable resources across EU markets, increasing European energy security and competitiveness while fostering decarbonisation [11]. Achieving a functioning internal energy market is a key intermediate objective in reaching the EU's climate, economic and energy security goals, which in turn requires prioritising interconnection projects. Furthermore, the COVID-19 crisis has stressed the negative impacts of climate change, foregrounding the interest of policymakers in the energy transition [12]. The EU's green recovery package, Next Generation EU, includes investments in cross-border and multi-country projects, including cross-border energy interconnections [13].

European citizens seem to widely support both the energy transition and green recovery. Polls reveal that climate change is among top European public concerns [14,15], and that renewables are usually perceived more positively than fossil technologies [16,17]. At a regional and local level, the increase of both wind and solar farms and transmission grids fosters the interdependence between the energy industry and the community, which has become the key stakeholder in the design of energy projects along the decision-making process [18]. Since the energy transition demands broader citizen involvement, public and social acceptance has become the cornerstone of public-policy making [12,

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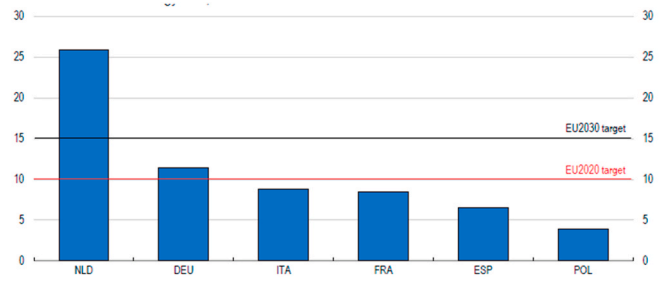


Note: The interconnection electric energy ratio is computed as the import capacity over installed net generation capacity (as of 08 January 2020). The 2020 and 2030 interconnection targets have been set by the European Council to politically and jointly steer the development and integration of electricity infrastructure of EU countries, in the frame of the Trans-European Networks for Energy (TEN-E) policy. They are not linked to legal sanctions.

Fig. 1. Interconnection electricity energy ratio (%) in the EU largest economies Source: OECD [26].

19–22].

Nevertheless, to our knowledge there is no published research exploring the public acceptance of cross-border energy interconnections based upon the same public opinion poll in the main European energy markets, which is a novelty within the literature. The article addresses the public acceptance of cross-border interconnections as a basic pillar for a functioning and decarbonised Energy Union based on a poll with 4000 respondents from the big four EU energy markets: France, Germany, Italy and Spain. Including respondents' proximity to cross-border substations. It also innovates by approaching public acceptance from the perspective of procedural justice [23]. By focusing on citizens' awareness and understanding, this article tries to offer new insights on public acceptance and its linkages with the European energy policy-making process regarding cross-border energy interconnections. This is of upmost relevance in the wake of the Russian invasion of Ukraine and the urgent call by the EU's REPowerEU plan to rapidly increase energy interconnections across Europe to both accelerate the energy transition and diversify away from Russian gas.

The article is structured as follows. Section 2 briefly provides an overview of the goals of the European Energy Union (EnU), the literature about public acceptance regarding energy, and citizens' involvement in a fair energy policy design. Section 3 presents the empirical design of the research, while the results are discussed in section 4. The last section concludes.

2. On the energy unions, interconnections and public acceptance

In general, acceptance is influenced by citizen attitudes towards broader socio-political dimensions that reflect fairness, justice and trust [24]. Nevertheless, large scale acceptance often involves other dimensions, urging a better understanding of citizens' perceptions regarding their broader socio-political environment [25].

2.1. Interconnecting the European Energy Union (EnU)

Interconnections are key for an EU wide energy market to function properly and efficiently, but also to boost decarbonisation efforts and energy security (European Commission, 2020), as well as to support the green recovery. They provide flexibility and allow to exploit the complementary elements between the different Member States' generation mixes, integrating renewable energies from resource-rich members into the European system and helping to balance their variability. Increasing flows of market-viable renewable electricity contribute to reduce market concentration and current wide electricity price differences across the EU. According to the EU's Lisbon Treaty (article 194 TFEU), the two key goals of European energy policy are ensuring the functioning of the energy market and promoting the interconnection of energy networks, thus achieving a fully integrated internal energy market.

To fulfil such goals, the EU had set a 10% electricity interconnection capacity target for 2020 that eight Member States (Cyprus, France, Ireland, Italy, Poland, Portugal, Romania and Spain) have not yet met. Furthermore, to reach the indicative 15% target set for 2030, new interconnectors are needed (Fig. 1). Efforts are also being made to optimise the use of existing interconnectors through Projects of Common Interest (PCIs), enabling EU's energy resources to be used more efficiently [2]. Besides the PCIs supported by the Connecting Europe Facility, the recently approved EU's Recovery and Resilience Facility also provides the possibility to fund infrastructures aiming at integrating renewables through modernised networks and enhanced interconnectivity.

However, despite the Commission's efforts to expand interconnections, several obstacles have so far prevented achieving the targets. Among these obstacles are the lack of information about their advantages, market concentration, political and regulatory risks, asymmetric costs, and a lack of acceptable mechanisms to balance interconnectors' benefits across countries [27]. The latter implies that each country supports only the cost of the infrastructure located in its territory, which even when there is agreement to share cost and benefits requires difficult and lengthy negotiations [28]. From a political perspective, European cross-border network planning has been hampered by "sovereignty-based contestation", because Member States seek for political benefits in keeping the upper hand in energy infrastructure decisions [29]: 71–72).

Aware of the barriers facing interconnections, the Commission created an Energy Infrastructure Forum with stakeholders to facilitate cross-border network development, including increasing its public acceptance [30]. The Guidelines for *trans*-European energy infrastructure (TEN-E Regulation) also advocates several principles for the involvement of national, regional and local stakeholders, providing extensive information and consultation procedures at an early stage [31].

2.2. Public acceptance, renewable energies and interconnections

Concerns about the social or public acceptance of energy projects can be traced back to the 1980s [32]. However, due to recent changes in the energy landscape (climate change, the energy transition, nuclear risks, geopolitical instability, etc.), the political discourse has increasingly focused on acceptance in an attempt to legitimise its actions [33]. Nowadays, acceptance is seen as a new dimension of energy policy [34]. Table 1 compiles some recent academic literature on renewable generation and transmission networks' acceptance in European countries, although related terms such as attitudes, perceptions, opinions or objections are sometimes used indistinctly or in a similar way [35,36,37,38] .

The table summarizes the literature review by countries covered, activity (generation or transmission), area of analysis/scope (local, regional or national), inclusion of the cross-border interconnections, methodology and keywords. The literature seems to pay more attention to generation than to transmission (references shaded in grey refer to research in transmission), notwithstanding the fact that a decarbonised and integrated EnU requires the expansion of the transmission grid, thus increasing community awareness regarding electricity transmission. Research on transmission rarely covers more than two Central European countries, not including national perceptions of South European countries such as Italy and Spain. Furthermore, Table 1 found just one study on cross-border interconnections [41], which contrasts with their increasing role in European energy policy.

2.3. Citizens' involvement for a fair energy policy design

This article approaches citizens' involvement in energy policy-making resorting to public participation theory, and specifically on procedural justice theories [23,64,65]. Procedural justice is associated

Table 1
Summary of the literature review on acceptance in European countries.

Authors	Activity	Area of analysis	Cross-border interconnectionsCross	Country	Data collection	Sample size (max.)	Key concepts
Azarova et al. [39]	Generation (renewables)	Local	No	Austria, Germany, Italy, and Switzerland	Survey	2000	• Public acceptance • Social acceptance • Renewable energy communities • Willingness to pay
Bertsch (2016) et al.	Generation (renewables) and transmission	National and local	No	Germany	Survey	996	• Public acceptance • Willingness to pay
Caporale & De Lucia [40]	Generation (wind)	Regional	No	Italy	Survey	375	• Social acceptance • Willingness to pay
Ciupuliga & Cuppen [41]	Transmission	Regional and local	Yes	France and Spain	Case study	–	• Acceptance • Public participation
Delicado et al. [35]	Generation (wind and solar)	Local	No	Portugal	Interviews and public discourse	150[a]	• Community perceptions
Devine-Wright [42]	Transmission	Local	No	United Kingdom	Survey	503	• Public acceptance
Friedl & Reichl [43]	Generation (wind) and transmission	National, regional and local	No	Austria	Interviews	16[a]	• Social acceptance
Gargallo et al. [36]	Generation (renewables)	Regional	No	Spain	Survey	231	• Perception • Willingness to pay
Hai [44]	Generation (solar)	Local	No	Finland	Interviews, workshops and public discourse	42	• Social acceptance • Willingness
Heras-Saizarbitoria et al. [45]	Generation (solar)	National	No	Spain	Public discourse	314[a]	• Public acceptance
Knoblauch et al. [46]	Generation (geothermal)	Regional and local	No	Germany and Switzerland	Survey	814	• Public acceptance • Willingness to pay
Komendantova & Battaglini [47]	Transmission	Local	No	Germany	Roundtables	105[b]	• Public acceptance • Social acceptance
Langer and Ben (2018)	Generation (wind)	National	No	Germany and New Zealand	Survey	3948	• Acceptance
Langer et al. [48]	Generation (wind)	National	No	Germany	Survey	1356	• Acceptance
Langer et al. [23]	Generation (wind)	National	No	Germany	Survey	1363	• Public participation • Acceptance
Langer et al. [49]	Generation (wind)	Local	No	Germany	Academic literature and interviews	N.A.[a]	• Acceptance
Liebe & Dobers [50]	Generation (renewables)	National	No	Germany	Survey	3400	• Acceptance
Liebe et al. [51]	Generation (wind)	Local	No	Germany and Poland	Survey	1801	• Local acceptance
Lienert et al. [52]	Transmission	National	No	Switzerland	Survey	515	• Public acceptance • Social acceptance
Musall & Kuik [53]	Generation (wind)	Local	No	Germany	Survey	200	• Local acceptance • Community co-ownership
Paravantis et al. [54]	Generation (renewables)	Regional and local	No	Greece	Interviews and survey	201	• Social acceptance • Willingness to pay
Ribeiro et al. [37]	Generation (renewables)	National	No	Portugal	Survey	3646	• Public opinion • Acceptance
Schumacher et al. [55]	Generation (renewables)	Regional and local	No	France, Germany, Switzerland	Survey	1049	• Social acceptance • Willingness to pay
Sposato & Hampl [56]	Generation (renewables)	National	No	Austria	Survey	1000	• Social acceptance

(continued on next page)

Table 1 (*continued*)

Authors	Activity	Area of analysis	Cross-border interconnectionsCross	Country	Data collection	Sample size (max.)	Key concepts
Stadelmann-Steffen [57]	Transmission	National	No	Switzerland	Survey	1129	• Public acceptance • Social acceptance
Strazzera & Statzu [58]	Generation (solar)	National	No	Italy, Spain and other Mediterranean countries	Survey	600	• Social acceptance
Tabi & Wüstenhagen [59]	Generation (hydro)	National and local	No	Switzerland	Survey	1024	• Social acceptance
Upham & García-Pérez [38]	Generation (wind)	Regional and local	No	Spain	Interviews and public discourse	14[a]	• Perception • Objection
Vuichard et al. [60]	Generation (wind)	Local	No	Switzerland	Survey	1202	• Social acceptance
Walker et al. [61]	Generation (wind)	Local	No	United Kingdom	Survey	311	• Social acceptance • Community benefits
Walter [62]	Generation (wind)	Local	No	Switzerland	Survey	919	• Local acceptance
Wolsink (2007)	Generation (wind)	Not specified	No	Various	Secondary analysis of other survey	Not specified	• Public acceptance
Zoellner et al. [63]	Generation (renewables)	Regional	No	Germany	Survey and interviews	349	• Public acceptance

[a] Participants in interviews (or documents analyzed in Heras et al. [45].
[b] Participants in different roundtables.

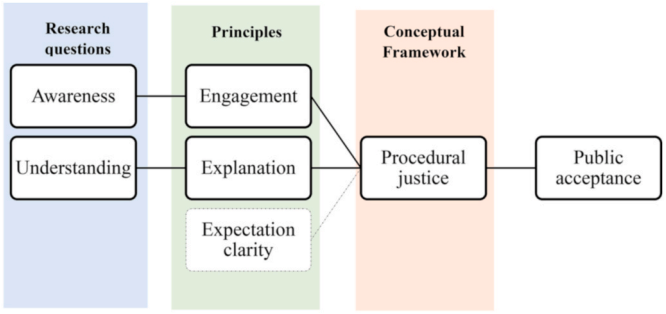


Fig. 2. Analytical framework proposal for public acceptance.
Source: Adaptation from Kim & Mauborgne [65] & Hanger et al.(2016)

with the public perceptions of renewable energies, and thus with the energy transition [48,61,62,66]. Relying on these two theories, this article proposes an analytical framework linking citizens' involvement in energy policy decision-making to public acceptance through citizen' awareness and understanding (see Fig. 2; the links studied in this article have their borders highlighted).

2.3.1. *Procedural justice*

Procedural justice has three principles [65]: engagement, related to involvement; explanation, related to information; and expectation clarity, related to communication. The latter refers to communication issues once a policy decision is made (ex-post policy analysis), and as such it is not considered in this research.

The engagement principle means involving individuals in the decisions that affect them by asking for their input and allowing them to discuss these decisions. Stakeholder's participation in EU energy policy can be achieved through inclusive governance, which assumes that collectively binding decision-making cannot be limited to governments alone [67]. On the one hand, integrating stakeholders' perspectives in environmental decision making may help to identify new solutions, improve legitimacy, and increase policy implementation effectiveness, efficiency and sustainability. According to Proedrou [68]; considering the perceptions of the citizens in the energy policy-making process counterbalances the top-down approach of the EnU's governance. On the other hand, the inclusion of stakeholders may also slowdown the decision-making process and benefit more powerful actors [69].

The explanation principle implies that citizens should understand public policy choices. In the renewable energy literature, public acceptance is a term related to the approval, support, rejection or resistance to innovative and usually disruptive technologies [70]. These technologies often require the construction of huge infrastructures with high social, environmental and economic impact, such as cross-border interconnections. However, to make decisions about a technology, people need accurate and understandable information [71]. In other words, they need an explanation. This is why some studies have addressed awareness and understanding as separate concepts from acceptance, since they are key elements that help citizens in forming an opinion [66,72,73].

Awareness and understanding have been used somehow loosely in the renewable energy sources literature, resorting to different terms related to public acceptance such as public awareness [72,73], community awareness [66] or public understanding [72,74] or knowledge [75]. For the purpose of this article, we use "awareness" to indicate that citizens know of the existence of cross-border interconnections [39,37,63], while "understanding" indicate that citizens can identify their impact by stating advantages/disadvantages [39].

Therefore, we consider awareness and understanding as factors related to the procedural justice dimension of public acceptance. Additionally, the literature review made evident the focus on generation rather than on transmission, the prevalence of Central European countries in the samples, and the lack of research on cross-border interconnections and the internal energy market as pillars of the EnU. Thus, this article addresses awareness and understanding of cross-border interconnections and the internal energy market in the main four EU energy markets: France, Germany, Italy and Spain. We propose two research questions related to awareness and understanding: one for energy interconnections, and one for the fully integrated internal energy market.

Research question 1: Do Europeans know what energy interconnections are and understand their implications?

Research question 2: Do Europeans know what the fully integrated internal energy market is and understand its implications?

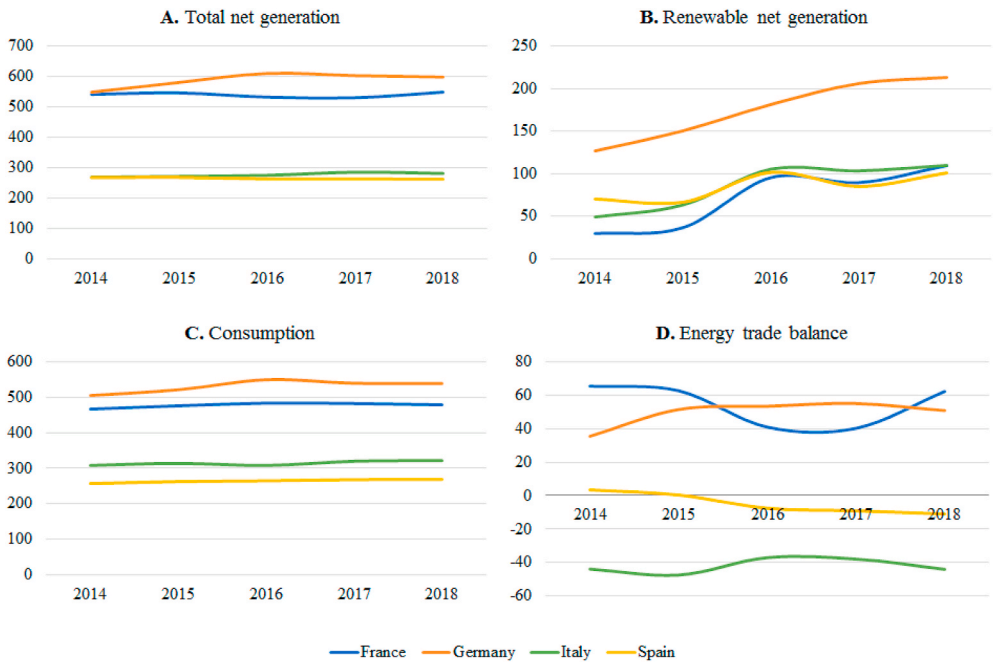


Fig. 3. Key energy magnitudes in TWh.
Source: ENTSO-E Statistical Factsheet (2015–2019)

Table 2
Survey characteristics.

Universe	Individuals residing in the sample countries aged 18 and over
Sampling	Stratified by regions, with application of quotas for sex and age proportional to the distribution of the population in each of the strata
Sample size	4000 respondents (1000 for each country of the sample)
Sampling error	For the global data of each country and under the assumption of a simple random sampling and a confidence margin of 95.5%, it stands at±3.2%
Interviews	Online interviews with a panelized sample of citizens from each country
Date	2018 (February–March in Spain and France; May in Germany) and 2019 (March in Italy)
Data processing	Toluna Market Research

3. Empirical design of the research

3.1. Sample countries

According to data provided by ENTSO-E [76]; in 2018 Germany, France, Italy and Spain accounted for 70% of EU-28 total net energy generation and 68% of energy consumption (Fig. 3) and 49% of GHG emissions [77]. Although guided by a common strategy, the energy policies of these four countries differ substantially, partly because of geopolitical reasons.

Map 1 shows the geographical location of electricity cross-border substations of interconnections in the countries included in the sample (data available upon request) (Annex I). Due to its central geographical position in Europe, Germany is the most interconnected country. Spain is the least interconnected country, with few interconnections with France and Portugal, and a double one with Morocco. The regions shaded identify the area of influence of each substation, as defined by a distance of 25 kms from the location of the substation. The regions are labelled according to the level 3 NUTS classification (Nomenclature of territorial units for statistics), which allows the analysis of the survey data using geographic information systems (GIS).

3.2. Survey

Data was collected using a survey whose questionnaire was designed to analyse public opinion regarding European public policies in several fields, including the EU internal energy market. The specific section of the questionnaire dealing with interconnections and energy market included 10 questions, some of them were open-ended (such as “Are there any disadvantages related to cross-border interconnections?), some of them dichotomous (“Have you ever heard about the European internal energy market?“), and some multiple-choice questions (“Who should pay for the construction of these interconnections?“) (Annex II).

Similar research questions have been included in previous surveys. Concerning awareness and understanding, Schumacher et al. [55] asked about the general knowledge of renewable energies and energy autonomy. Other forms of awareness are environmental awareness [53], technology awareness [37], or landscape preservation awareness [40]. The literature dealing with the understanding of the advantages and disadvantages of renewable energies is vast [34,39,44,61,78].

The questions included in this research were designed to address the research questions stated in the previous section (see Annex II), based on existing literature to assess the knowledge of Europeans about the internal energy market. The final survey was sent to 4000 participants, 1000 for each country, which were recruited using an online research service company that conducted the survey during 2018 and 2019 (Table 2).

3.3. Variables and models

The empirical design has two parts. The first one reports the results of the survey for awareness and understanding, both for energy interconnections (first research question) and for the internal energy market (second research questions). Respondents who are not aware of energy interconnections or the internal energy market are not asked about their advantages and disadvantages. Awareness results are provided by country and indicate if the respondents have or have not heard about energy interconnections or the internal energy market. Concerning understanding, the respondents could mention up to two advantages and disadvantages by question.

Table 3
Descriptive statistics.

	Frequencies					Percentages				
	Total	**Germa.**	**France**	**Italy**	**Spain**	**Total**	**Germa.**	**France**	**Italy**	**Spain**
Sex										
Woman	2062	512	515	524	511	51.6%	51.2%	51.5%	52.4%	51.1%
Man	1938	488	485	476	489	48.5%	48.8%	48.5%	47.6%	48.9%
Age										
18–29	612	161	171	147	133	15.3%	16.1%	17.1%	14.7%	13.3%
30–44	1005	214	237	251	303	25.1%	21.4%	23.7%	25.1%	30.3%
45–64	1312	367	331	274	340	32.8%	36.7%	33.1%	27.4%	34.0%
65+	1071	258	261	328	224	26.8%	25.8%	26.1%	32.8%	22.4%
Education										
Non-tertiary	2623	720	755	638	510	65.6%	72%	75.5%	63.8%	54%
Tertiary	1377	280	245	362	490	34.4%	28.0%	24.5%	36.2%	49.0%
Occupation										
Housewives	264	56	71	84	53	6.6%	5.6%	7.1%	8.4%	5.3%
Student	241	67	62	70	42	6.0%	6.7%	6.2%	7.0%	4.2%
Retired	1180	323	348	278	231	29.5%	32.3%	34.8%	27.8%	23.1%
Others	35	20	6	8	1	0.9%	2.0%	0.6%	0.8%	0.1%
Unemployee	282	27	58	82	115	7.1%	2.7%	5.8%	8.2%	11.5%
Worker	1998	507	455	478	558	50.0%	50.7%	45.5%	47.8%	55.8%
Population										
10,000 or less	1138	278	444	253	163	28.5%	27.8%	44.4%	25.3%	16.3%
10,001 and 100,000	1493	396	345	425	327	37.3%	39.6%	34.5%	42.5%	32.7%
More than 100,000	1316	316	194	305	501	32.9%	31.6%	19.4%	30.5%	50.1%
Don't know	53	10	17	17	9	1.3%	1.0%	1.7%	1.7%	0.9%
Cross-border										
No interconnection	3259	843	768	855	793	81.6%	84.5%	76.8%	86%	79.3%
Interconnection	734	155	232	140	207	18.4%	15.5%	23.2%	14%	20.7%
Politics										
Centre	1962	590	477	427	468	49.1%	59.0%	47.7%	42.7%	46.8%
Right	877	158	291	254	174	21.9%	15.8%	29.1%	25.4%	17.4%
Left	1142	246	227	312	357	28.6%	24.6%	22.7%	31.2%	35.7%
Don't know	19	6	5	7	1	0.5%	0.6%	0.5%	0.7%	0.1%

Table 4
Correlations.

	Intercon.	Internal	Sex	Age	Edu.	Occ.	Pop.	Cross.	Pol.
Internal	0.796[c]	1							
Sex	0.369[c]	0.250[c]	1						
Age	0.069[a]	−0.021[a]	−0.049[b]	1					
Edu.	0.241[c]	0.236[c]	0.079[c]	−0.159[b]	1				
Occ.	−0.022[a]	−0.087[a]	−0.184[b]	0.659[b]	−0.232[b]	1			
Pop.	0.016[a]	0.002[a]	0.041[b]	−0.002[b]	0.260[b]	−0.084[b]	1		
Cross.	0.035[c]	0.261[c]	0.005[c]	0.012[b]	0.0184[c]	−0.008[b]	0.000[b]	1	
Pol.	−0.002[a]	0.028[a]	0.019[b]	0.005[b]	−0.041[b]	0.007[b]	−0.061[b]	−0.075[b]	1
Country	0.052[a]	−0.054[a]	0.000[b]	−0.012[b]	0.239[b]	−0.023[b]	0.007[b]	0.169[b]	−0.051[b]

Notes: The type of correlation depends on the type of variable and it is as follows.
[a] Polyserial correlation.
[b] Polychoric correlation.
[c] Tetrachoric correlation.

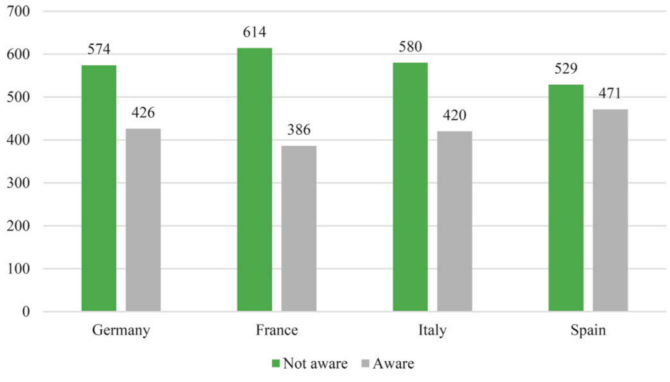


Fig. 4. Awareness of energy interconnections by country.

The second part of the empirical design is based on logistic regressions whose are useful in guiding the communication strategies of public policies aimed at promoting awareness and understanding as an essential step towards greater citizen participation in the design of energy policy. Logistic regression is a widely adopted method for data analysis (Ayer et al., 2010; Tabachnick & Fidell, 2001; Hosmer & Lemeshow, 2000). Logistic regression has good discriminant validity, the confidence intervals of the parameters are easy to calculate, and the computational time required to estimate the models is minimum. Additionally, model overfitting is less of a concern in comparison with other methodologies. However, this method fails to detect complex relationships between dependent and independent variables (unless stated by the modeler), it is extremely sensitive to correlations among predictor variables, and assumes a linear relationship between continuous predictors and the logit transform of the dependent variables.

We estimate two models using two different binary dependent

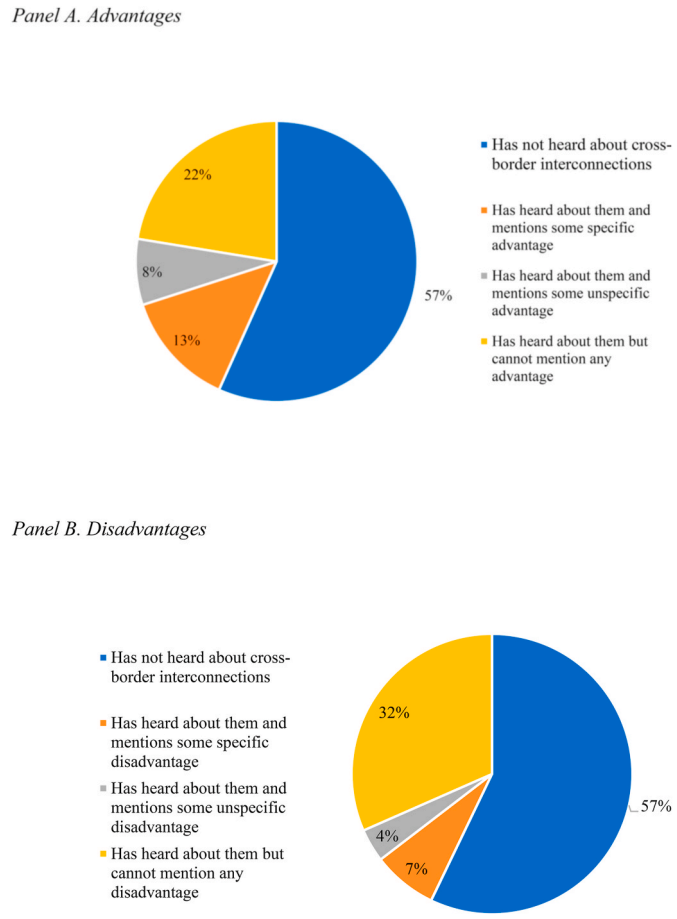


Fig. 5. A- Distribution of the respondents according to their awareness and understanding of energy cross-border interconnections.

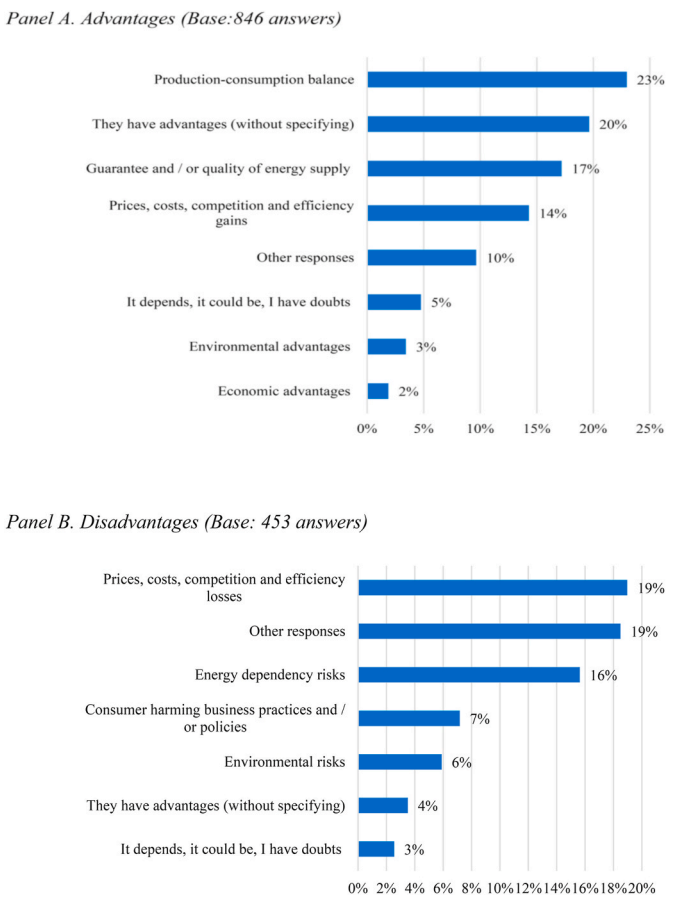


Fig. 6. Advantages and disadvantages of energy interconnections.

variables, one per model: awareness of energy interconnections and awareness of the fully integrated internal energy market. Concerning independent variables, they are retrieved from a set of questions included in the survey regarding the socio-demographic festures (sex, age, education and occupation), residence (country of residence and size of the population), and political preferences of the participants (see Annex III). We additionally create a variable measuring the proximity of the respondent to a cross-border interconnection substation, for a total of eight dependent variables. Using the postal codes of respondents, survey data was matched with the area of influence of the substations. Hence, it is possible to know if the respondents live in a level 3 NUTS region located in the area of influence of a cross-border interconnection substation.[1] It may be expected that respondents living in these areas of influence will be better acquainted with interconnections, showing greater awareness and understanding.

Both dependent and independent variables are included in logit models (Equation (1)). In addition, we estimate subsets of the main models, one for each country of this sample. Thus, for each dependent variable the results show one main model including all the observations available from the four countries, and four national models only including the observations from each country. The results of the model are provided in odds ratios (o.r.), confidence intervals (c.i.) and percentages of change (%).

[1] The area includes all level 3 NUTS region located withing a range of 25 km from a substation, as located in map 1. Additional variables within a range of 10 and 50 km have been also included in postestimations.

$$depvar_i = \alpha + \beta_1 sex_i + \beta_2 age_i + \beta_3 education_i + \beta_4 occupation_i + \beta_5 population_i + \beta_6 crossborder_i + \beta_7 politics_i + \beta_8 country_i + \varepsilon_i \quad \text{(Eq. 1)}$$

4. Results and discussion

Table 3 shows the socio-demographic features of the sample and Table 4 the correlations between variables. The category used as a benchmark for interpreting the odds ratio of categorical variables of the logit models is the most frequent profile in the sample: a woman between 45 and 65 years old, a worker (full or part-time) with non-tertiary education, with a "centre" political ideology living in a municipality between 10,000 and 100,000 inhabitants located in a region where there is no cross-border interconnection. The reference or more frequent category of each variable is shaded in grey. This category is used as a benchmark for interpreting the odds ratio of categorical variables of the logit models.

4.1. Awareness and understating about interconnections

4.1.1. Survey results

Fig. 4 shows the level of awareness of energy interconnections by country. Overall, 57,4% respondents have not heard about energy interconnections, while the remaining 42,6% have, which implies a low level of awareness. France is the country where most respondents are not aware of energy interconnections, in contrast to Spain.

Concerning the impact, i.e. advantages and disadvantages of energy interconnections, the results of these questions, posed only to those who previously had stated that they had heard about interconnections, show a low level of understanding. Only 846 respondents (21,2% of the total

Table 5
Logit analysis of awareness of energy interconnections.

	Complete sample	Germany		France		Italy		Spain		
	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%
Man	2644*** (2305–3033)	164,4 (2257–3984)	2999*** (2555–4544)	199,9 (1434–2487)	3407*** (2142–3752)	240,7	1888***	88,8	2835***	183,5
Age: 18–29	0,848 (0,662–1087)	−15,2 (0,350–0,978)	0,585** (0,326–0,912)	−41,5 (1112–3088)	0,545** (0,544–1450)	−45,5	1853**	85,3	0,888	−11,2
Age: 30–44	0,655*** (0,542–0,792)	−34,5 (0,326–0,732)	0,489*** (0,398–0,913)	−51,1 (0,703–1511)	0,603** (0,429–0,856)	−39,7	1031	3,1	0,606***	−39,4
Age: +65	1423*** (1128–1794)	42,3 (0,942–2320)	1478* (1123–2830)	47,8 (0,764–2041)	1782** (0,870–2472)	78,2	1249	24,9	1466	46,6
Tertiary	1947*** (1682–2254)	94,7 (1484–2740)	2017*** (1857–3573)	101,7 (1057–1874)	2576*** (1432–2485)	157,6	1407**	40,7	1886***	88,6
Oc.: Student	1131 (0,805–1588)	13,1 (0,293–1242)	0,604 (0,921–3616)	−39,6 (0,750–2792)	1825* (0,373–1670)	82,5	1447	44,7	0,789	−21,1
Oc.: Unemployee	0,664*** (0,503–0,875)	−33,6 (0,090–0,717)	0,254*** (0,258–0,996)	−74,6 (0,494–1358)	0,507** (0,471–1155)	−49,3	0,819	−18,1	0,738	−26,2
Oc.: Retired	0,898 (0,709–1138)	−10,2 (0,390–0,971)	0,616** (0,543–1405)	−38,4 (0,457–1259)	0,873 (0,872–2481)	−12,7	0,759	−24,1	1471	47,1
Oc.: Housewives	0,782 (0,570–1073)	−21,8 (0,316–1272)	0,633 (0,348–1325)	−36,7 (0,486–1565)	0,679 (0,469–1753)	−32,1	0,872	−12,8	0,907	−9,3
Pop: 10,000 or less	1070 (0,904–1266)	7,0 (0,748–1497)	1058 (0,780–1473)	5,8 (0,784–1526)	1072 (0,654–1482)	7,2	1094	9,4	0,984	−1,6
Pop: More than 100000	0,913 (0,777–1072)	−8,7 (0,560–1080)	0,778 (0,584–1281)	−22,2 (0,975–1836)	0,865 (0,604–1100)	−13,5	1338*	33,8	0,815	−18,5
Substation	1053 (0,897–1237)	5,3 (0,832–1702)	1190 (0,780–1598)	19,0 (0,932–1750)	1117 (0,651–1168)	11,7	1277	27,7	0,872	−12,8
Politicas: Left	1077 (0,916–1265)	7,7 (0,964–1862)	1340* (0,644–1322)	34,0 (1038–2005)	0,923 (0,644–1180)	−7,7	1443**	44,3	0,872	−12,8
Politics: Right	1117 (0,945–1321)	11,7 (1033–2186)	1503** (0,716–1381)	50,3 (0,841–1575)	0,994 (0,680–1400)	−0,6	1151	15,1	0,975	−2,5
Germany	1137 (0,940–1374)	13,7								
Italy	1068 (0,878–1299)	6,8								
Spain	1345*** (1104–1639)	34,5								
Constant	0,337*** (0,267–0,425)	(0,310–0,650)	0,449*** (0,195–0,461)	(0,208–0,471)	0,300*** (0,331–0,764)		0,313***		0,503***	
N	3900		966		976		969		989	
chi2	337,3		112,2		124,2		55,27		108,2	

***p < 0.01, **p < 0.05, *p < 0.1.

sample) were able to mention at least one advantage and the balance between energy production and consumption was the most frequently mentioned. Up to 25% of spontaneous answers are unspecific such as "They have advantages" (without mentioning any) or "It depends, it could be, I have doubts".

This limitation is even greater for the disadvantages of energy interconnections. Only 453 respondents (11,3% of the total sample) mention at least one disadvantage. As shown in Fig. 5 (panel B), the most cited disadvantages refer to economic ("Prices, costs, competition and efficiency") and security issues ("Energy dependency risk"). 8% of the answers are unspecific. These results point again to lack of understanding of energy interconnections. Fig. 5 shows the distribution of the whole sample according to these variables (awareness and understanding), while Fig. 6 details the advantages and disadvantages mentioned spontaneously by respondents, once codified and grouped.

Despite the low number of answers to the questions about advantages and disadvantages, the fact that the percentage of those mentioning any positive impact is much higher than that of those signalling any disadvantage implies that acceptance is stronger than refusal.

4.1.2. Logistic regression

Table 5 shows the results of the logit analysis for awareness of energy interconnections, while Fig. 7 shows the Receiver Operating characteristic Curves (ROC) of the logit models as goodness of fit measures. The ROC curve plots sensitivity (true positive rate) against 1-specifity (false-positive rate). The area under the ROC curve (AUC) provides an overall measure of the fit of the model, with values ranging from 0.5 (no discrimination power) to 1 (perfect discrimination). Excepting the case of Italy (AUC = 0.635), national models show greater sensitivity than the complete sample model (AUC = 0.676).

The odds ratios for sex and tertiary education are always significant, both in the complete and the national models. Men have higher odds of having heard about energy interconnections: in the complete sample, when the respondent is a man, the percent of change in odds increases by 164,4%. Regarding tertiary education, respondents with tertiary studies show higher odds than respondents with non-tertiary studies (odds 94,7% higher for the complete sample).

The odds ratios for unemployed and respondents between 30- and 44-years old indicate that these groups are less aware about energy interconnections than their respective reference groups. In the complete sample model, the odds of knowing about are energy interconnections are predicted to decrease 33,6% for unemployed, and 34,5% for respondents between 30- and 44 years old. These results are repeated in the models for Germany and France, although with higher percentages of decreasing odds.

Bertscth et al. [34] identify age and education as the main factors related to public acceptance of grid expansion policy. Our evidence confirms these results, but additionally we consider a key factor that dramatically affects the engagement principle of the procedural dimension of public acceptance: sex. Komendantova & Battaglini [47] found that young people are the least aware about energy infrastructure projects. Our analysis also supports these findings, since respondents 65 years old or older are more aware of energy interconnections than

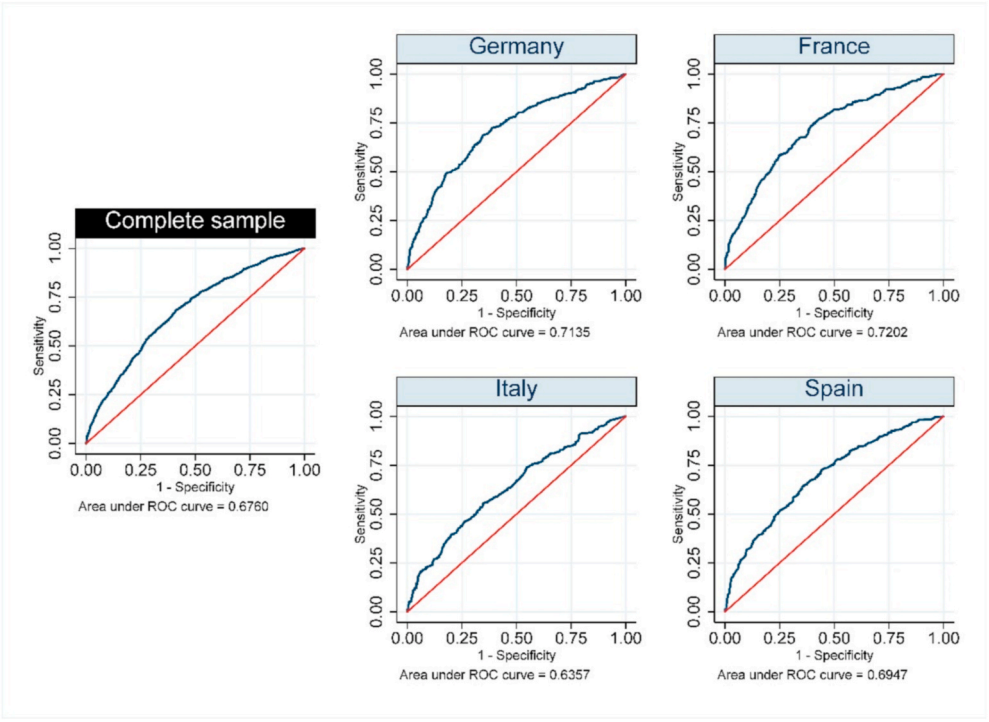


Fig. 7. Receiver operating characteristic curves of the logit models for energy interconnections models.

younger cohorts.

According to those results, awareness campaigns should target population on the basis of variables such as sex, age, education and occupation: women, population between 30 and 44years old, non-tertiary educated citizens and unemployed, that happen to be the less aware.

4.2. Awareness and understanding about the internal energy market

4.2.1. Survey results

The knowledge about the internal energy market is lower than that of energy interconnections. Once we add the figures of awareness regarding the internal energy market by country (Fig. 8), 2769 respondents (69,2%) have not ever heard about the internal energy market.

Only 1175 respondents (29% of the total sample) mention any specific advantage of the internal energy market. By far, the most cited is economic (37%) (Fig. 9, panel A). Again, a high percentage of responses are unspecific (31%), such as "I have doubts" or "Yes, they have advantages" without mentioning any. Concerning disadvantages, only 654 respondents (16% of total) mention some. The most mentioned disadvantages are also economic (19%), followed by energy dependency (12%) (Fig. 9, panel B), but half of the interviewees (50%) gave unspecific answers.

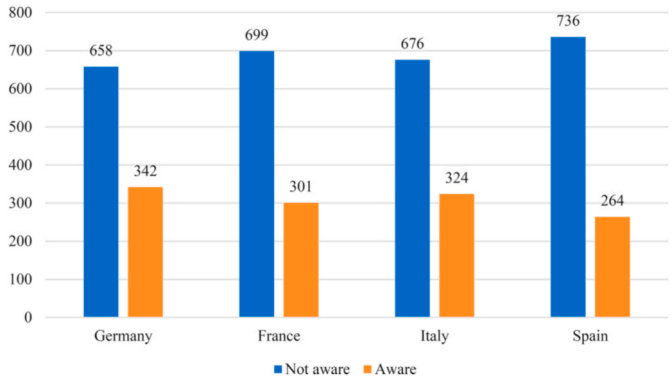


Fig. 8. Awareness of internal energy market by country.

Again, considering both the high percentage of unawareness (69,2%) and the rate of vague and unspecific answers both for advantages and disadvantages, the results indicate that both the awareness and understanding of the internal energy market are quite limited, providing a negative answer to the second research question on whether Europeans know what the internal energy market is and understand its implications. Nevertheless, as also stated above regarding interconnections, the balance between negative and positive mentions signals than acceptance is higher than opposition to the internal energy market.

4.2.2. Logistic regression

Table 6 includes the results of the estimations for the internal energy market while Fig. 10 shows their goodness of fit measures. The results of this section are similar to those of the logistic regression for energy interconnections. In this case, we add retired people and housewives, since these groups show lower odds of knowing about the internal energy market (−33,7% lesser for retired respondents, −27,1% lesser for housewives). Additionally, being Spanish implies a decrease of −28.4% in the odds of knowing about the internal energy market.

5. Conclusion

The article analyses a sample of 4000 surveyed citizens in four European countries (Germany, France, Italy and Spain) to assess whether they are aware of the existence of cross-border energy interconnections and a European internal energy market, and understand the implications of both. These are key for the achievement of an integrated European Energy Union and the energy transition. The significance of energy interconnections has recently been highlighted by the Russian invasion of Ukraine, which resulted in the EU presenting the REPowerEU Communication to fast-track intra-European energy interconnections, including streamlining approval procedures. Nevertheless, citizens should not be set aside of the energy transition policy-making process. According to

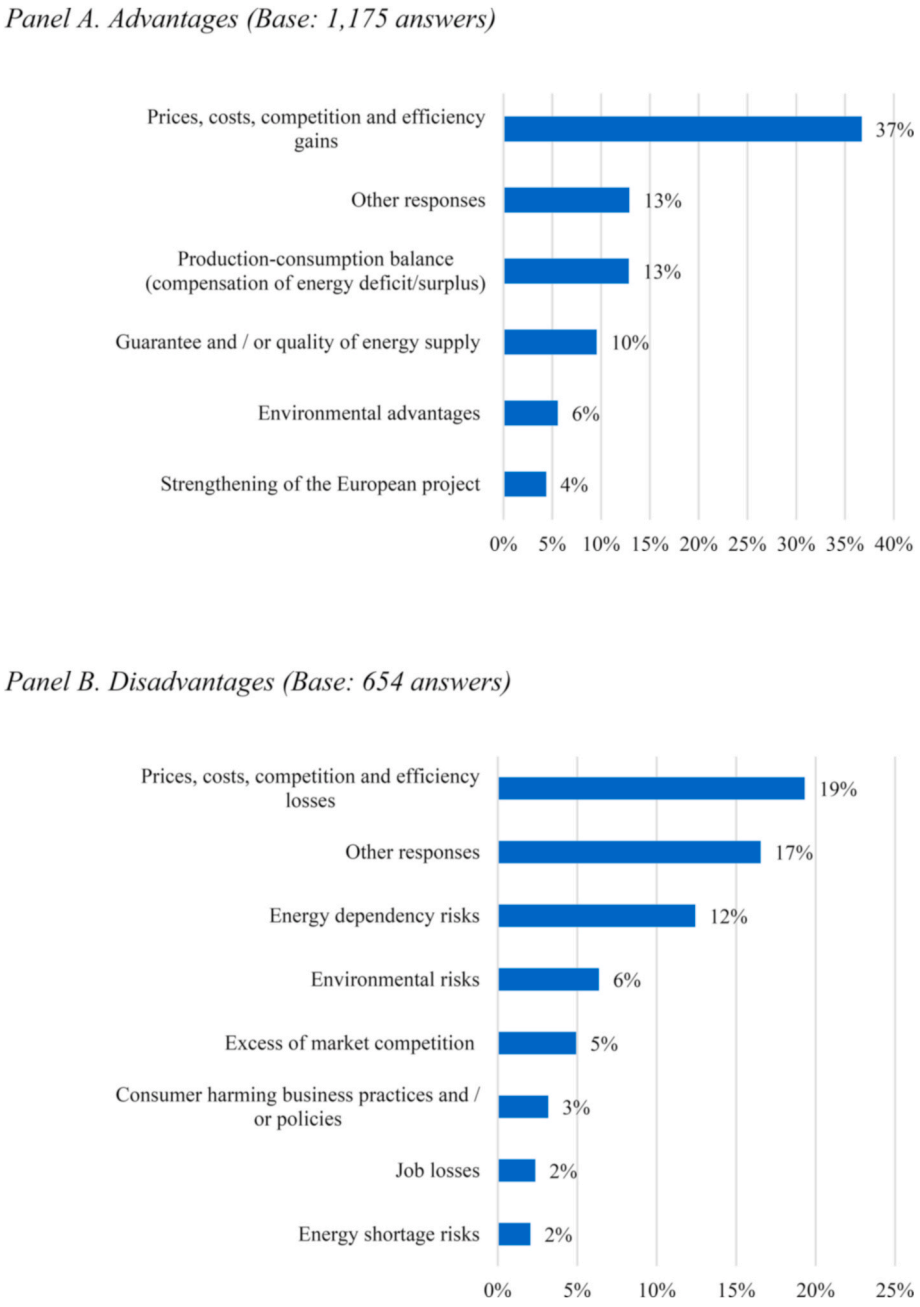


Fig. 9. Advantages and disadvantages of the internal energy market.

Table 6
Awareness of the internal energy market.

	Complete sample	Germany		France		Italy		Spain		
	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%	o.r. (c.i.)	%
Man	1875*** (1623–2165)	87,5 (1941–3499)	2606*** (1719–3077)	160,6 (1136–2021)	2300*** (1006–1829)	130,0	1515***	51,5	1356**	35,6
Age: 18–29	0,990 (0,766–1278)	−1,0 (0,386–1094)	0,649 (0,641–1769)	−35,1 (0,908–2610)	1065 (0,495–1485)	6,5	1539	53,9	0,857	−14,3
Age: 30–44	0,786** (0,647–0,955)	−21,4 (0,479–1073)	0,717 (0,531–1229)	−28,3 (0,552–1218)	0,808 (0,581–1212)	−19,2	0,820	−18,0	0,839	−16,1
Age: +65	1199 (0,932–1542)	19,9 (0,934–2417)	1502* (0,731–1928)	50,2 (0,561–1628)	1187 (0,664–2282)	18,7	0,955	−4,5	1231	23,1
Tertiary	1955*** (1680–2274)	95,5 (1845–3425)	2514*** (1463–2783)	151,4 (1075–1940)	2018*** (1338–2426)	101,8	1444**	44,4	1802***	80,2
Oc.: Student	1095 (0,778–1539)	9,5 (0,639–2568)	1281 (0,492–1848)	28,1 (0,640–2343)	0,954 (0,319–1868)	−4,6	1225	22,5	0,771	−22,9
Oc.: Unemployee	0,538*** (0,389–0,744)	−46,2 (0,054–0,677)	0,192** (0,246–1073)	−80,8 (0,441–1345)	0,513* (0,228–0,739)	−48,7	0,770	−23,0	0,410***	−59,0
Oc.: Retired	0,663*** (0,514–0,853)	−33,7 (0,287–0,732)	0,458*** (0,539–1466)	−54,2 (0,343–1035)	0,889 (0,419–1442)	−11,1	0,596*	−40,4	0,778	−22,2
Oc.: Housewives	0,729* (0,517–1028)	−27,1 (0,303–1430)	0,659 (0,455–1656)	0,6 (0,345–1252)	0,868 (0,323–1490)	−13,2	0,657	−34,3	0,694	−30,6
Pop: 10,000 or less	1084 (0,908–1293)	8,4 (0,699–1447)	1006 (0,827–1562)	−34,1 (0,888–1805)	1137 (0,605–1452)	13,7	1266	26,6	0,937	−6,3
Pop: More than 100000	0,966 (0,816–1144)	−3,4 (0,687–1352)	0,963 (0,563–1268)	−3,7 (1112–2165)	0,845 (0,531–1011)	−15,5	1551***	55,1	0,732*	−26,8
Substation	1141 (0,965–1349)	14,1 (0,942–1977)	1365 (0,758–1531)	36,5 (0,815–1596)	1077 (0,830–1562)	7,7	1141	14,1	1139	13,9
Politicas: Left	1103 (0,929–1309)	10,3 (0,972–1952)	1377* (0,605–1261)	37,7 (1199–2380)	0,873 (0,511–1007)	−12,7	1690***	69,0	0,718*	−28,2
Politics: Right	1293*** (1087–1538)	29,3 (1392–2943)	2024*** (0,847–1639)	102,4 (0,815–1591)	1178 (0,772–1633)	17,8	1138	13,8	1123	12,3
Germany	1182* (0,971–1438)	18,2								
Italy	1014 (0,828–1242)	1,4								
Spain	0,716*** (0,577–0,889)	−28,4								
Constant	0,274*** (0,214–0,351)	(0,169–0,370)	0,250*** (0,150–0,375)	(0,172–0,410)	0,237*** (0,220–0,525)		0,266***		0,340***	
N	3900		966		976		969		989	
chi2	211,1		110,8		58,60		54,32		43,04	

***p < 0.01, **p < 0.05, *p < 0.1.

procedural justice principles, the awareness and understanding of both energy interconnections and European energy integration paves the way to their public acceptance.

The results of our research show that currently awareness and understanding of both interconnections and an integrated Energy Union is very limited are very limited. Awareness (43% for interconnections, and 31% for the EU energy market) is, as expected, higher than understanding (13% and 29% respectively), as the second implies a more complete knowledge of the nature of the tested item. Differences among countries regarding awareness are small, negligible from the point of view of public policy. Concerning awareness, the article identifies the sociodemographic profile of those citizens who are less aware, concluding that information campaigns should target women, population between 30 and 44 years old, citizens without university studies and those unemployed.

Most respondents were not able to identify any specific advantage or disadvantage of energy interconnections or of a fully integrated European energy market. Although the analysis included a variable capturing the proximity of respondents to an electricity cross-border substation, it yielded no significant results. If awareness and understanding of both energy interconnections and a fully-integrated European Energy Union is limited even in locations near to cross-border substations, this may suggest a failure in the communication and public acceptance efforts within the European energy policy-making process. Nevertheless, positive answers about the impact of interconnections (13% of respondents) and the internal energy market (29%) are much more frequent than negative ones (7% and 16% respectively), which indicates that acceptance is much more extended among citizens than opposition.

Communication campaigns aiming to promote awareness and understanding of interconnections may foster greater citizen participation in energy policy design, and therefore increase the public acceptance of such core elements of the energy transition. Deliberative democracy initiatives such as citizens assemblies [79,80] that have taken place in France, the UK, Ireland, British Columbia and Spain, among others, could include the topic of interconnections and energy markets in future expert briefings and debates. Deepening 'energy democracy' and more active forms of 'energy citizenship' through more decentralised and participative decision-making in interconnections' planning may also help to increase procedural justice. The current European energy crisis constitutes an opportunity to foster a more compelling and appealing narrative from governments and the EU on the need to achieve an Energy Union and the role of interconnections for the energy transition; and now, for European energy security too. Regarding future avenues for research, analysing how distributive justice elements affects public acceptance seems a promising agenda.

Finally, there are some limitations in analysing the results. First, they are restricted to the four European countries with the biggest energy markets. Second, the field research was conducted before the 2021–2022 European energy crisis started, which has shown that the role of interconnections in Europe is not only an economic, but also strategic issue area; the public opinion may well assign a higher value to interconnections nowadays. Third, the 25 kms limit for the proximity to a substation was arbitrarily chosen, but modifying it to either 10 or 50 kms did not change the results. Also, the data were retrieved using

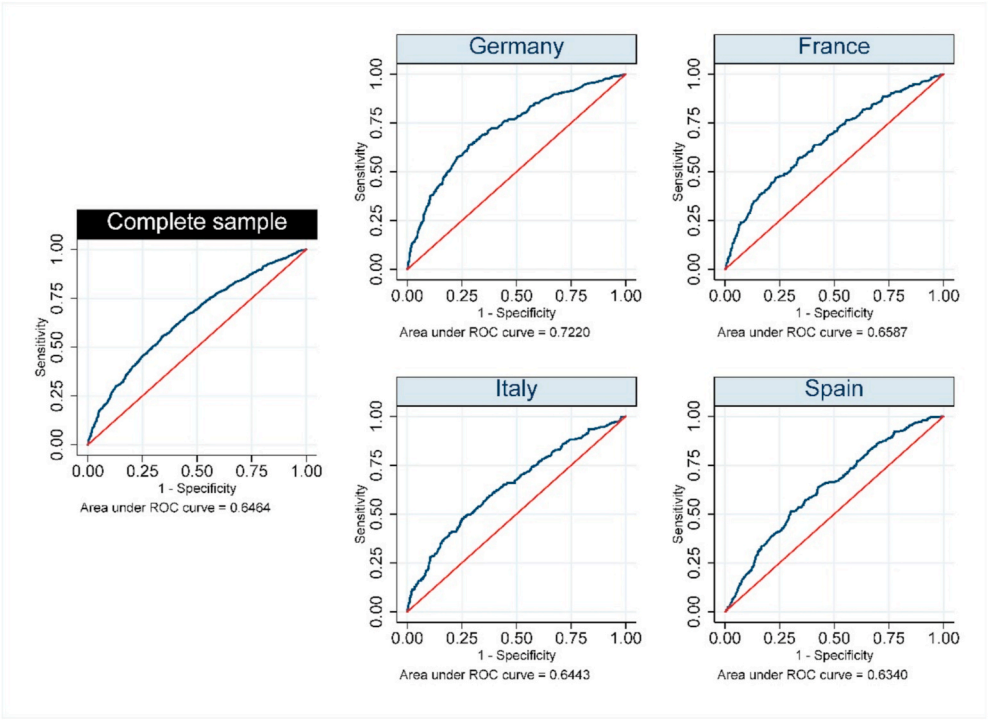
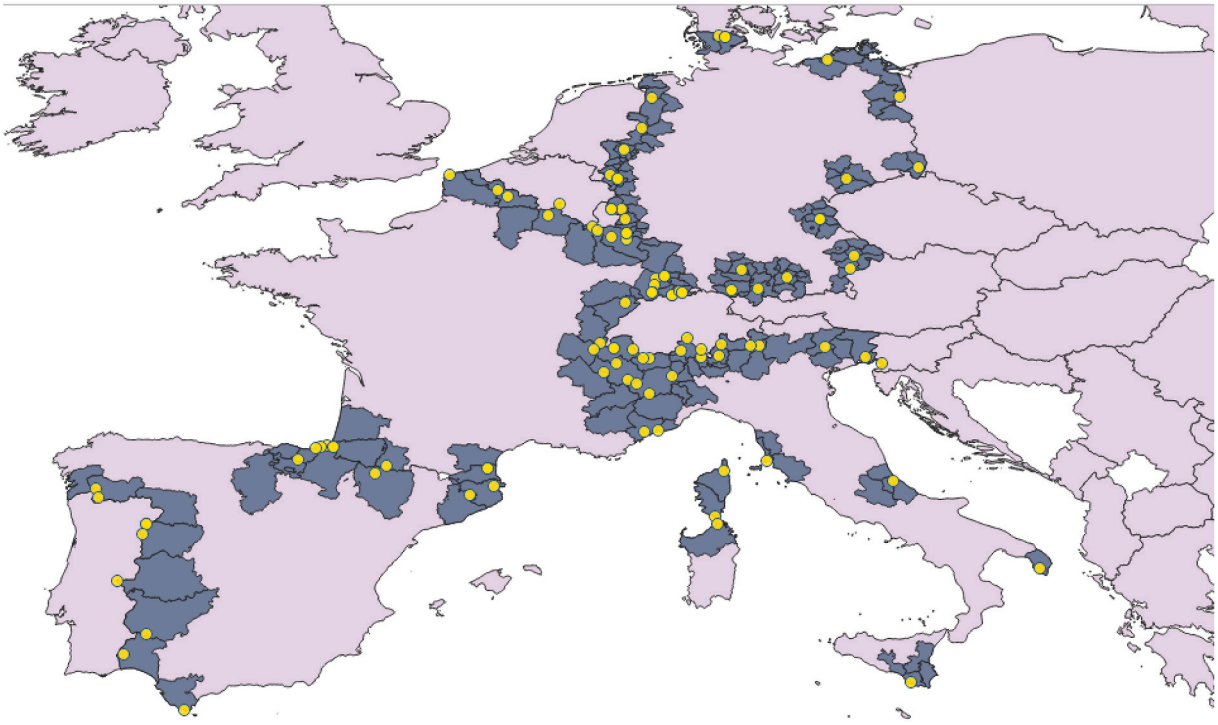


Fig. 10. Receiver operating characteristic curves of the logit models for the internal energy market models.



Map 1. Electricity cross-borders interconnections substations and regions.

online interviews, requiring basic computer skills to the respondents, which can slightly bias the results.

Credit author statement

Gonzalo Escribano: Conceptualization, Writing – original draft, Writing – review & editing, Project administration, Supervision. Carmen González-Enríquez:Investigation, Resources, Data curation, Writing – review & editing, Visualisation, Supervision, Funding acquisition. Lara Lázaro: Validation, Investigation, Resources, Data curation, Writing – review & editing. Juandiego Paredes-Gázquez: Conceptualization, Methodology, Software, Resources, Visualisation, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Annex.

Annex I

Cross-border interconnections of the countries of the sample

Substation (origin)	Substation (destination)	Country (origin)	Conutry (destination)	Region (FR-IT)/CCAA (ESP)/ Bundesland (AL)	CP Departament (FR)/Provincia (SP-IT)/ Regierungsbezirk (GE)
Errondenia	Irún	France	Spain	Aquitania	64XXX
Argia	Itxaso	France	Spain	Aquitania	64XXX
Pragneres	Biescas II	France	Spain	Occitania	65XXX
Baixas	Vic	France	Spain	Occitania	66XXX
Baixas	Sata Llogaia	France	Spain	Occitania	66XXX
Albertville	Rondissone	France	Italy	Auvergne-Rhône-Alpes	73XXX
Villarodin	Venaus	France	Italy	Auvergne-Rhône-Alpes	73XXX
Grance-Ile	Piossasco	France	Italy	Auvergne-Rhône-Alpes	73XXX
Trinité-Victor	Camporosso	France	Italy	Provence-Alpes-Côte d'Azur	06XXX
Bastia	Piombino	France	Italy	Córcega	20XXX
Bonifacio	S. Teresa	France	Italy	Córcega	20XXX
St. Avold	Ensdorf	France	Germany	Grand Est	57XXX
Vigy	Ensdorf	France	Germany	Grand Est	57XXX
Vogelgrun	Eichstetten	France	Germany	Grand Est	68XXX
Muhlbach	Eichstetten	France	Germany	Grand Est	68XXX
Sierentz	Kühmoos	France	Germany	Grand Est	68XXX
Irún	Errondenia	Spain	France	País Vasco	20XXX
Arkale	Argia	Spain	France	País Vasco	20XXX
Itxaso	Argia	Spain	France	País Vasco	20XXX
Biescas II	Pragneres	Spain	France	Aragón	22XXX
Vic	Baixas	Spain	France	Cataluña	08XXX
Santa Llogaia	Baixas	Spain	France	Cataluña	17XXX
Rondissone	Albertville	Italy	France	Piamonte	100XX
Venaus	Villarodin	Italy	France	Piamonte	100XX
Piossasco	Grance-Ile	Italy	France	Piamonte	100XX
Camporosso	Trinité-Victor	Italy	France	Liguria	180XX
Piombino	Bastia	Italy	France	Toscana	570XX
S. Teresa	Bonifacio	Italy	France	Sardegna	070XX
Ensdorf	St. Avold	Germany	France	Saarland	66XXX
Ensdorf	Vigy	Germany	France	Saarland	66XXX
Eichstetten	Vogelgrun	Germany	France	Baden-Württemberg	79XXX
Eichstetten	Muhlbach	Germany	France	Baden-Württemberg	79XXX
Kühmoos	Sierentz	Germany	France	Baden-Württemberg	79XXX
Cartelle	Alto Lindoso	Spain	Portugal	Galicia	32XXX
Las Conchas	Lindoso	Spain	Portugal	Galicia	32XXX
Aldeadávila II	Lagoaça	Spain	Portugal	Castilla y León	37XXX
Aldeadávila II	Pocinho	Spain	Portugal	Castilla y León	37XXX
Saucelle	Pocinho	Spain	Portugal	Castilla y León	37XXX
Cedillo	Falagueira	Spain	Portugal	Extremadura	10XXX
Brovales	Alqueva	Spain	Portugal	Extremadura	06XXX
Puebla de Guzmán	Tavila	Spain	Portugal	Andalucía	21XXX
Tarifa	Fardioua	Spain	Morocco	Andalucía	11XXX
Mandarins	Sellindge	France	United Kingdom	Hauts-de-France	62XXX
Avelin	Avelgem	France	Belgium	Hauts-de-France	59XXX
Mastaing	Avelgem	France	Belgium	Hauts-de-France	59XXX
Chooz	Monceau	France	Belgium	Grand Est	08XXX
Lonny	Achene	France	Belgium	Grand Est	08XXX
Mt. St. Martin	Aubange	France	Belgium	Grand Est	54XXX
Moulaine	Sotel	France	Luxembourg	Grand Est	54XXX
Sierentz	Asphard	France	Switzerland	Grand Est	68XXX
Sierentz	Bassecourt	France	Switzerland	Grand Est	68XXX
Mambelin	Bassecourt	France	Switzerland	Bourgogne-Franche-Comté	25XXX
Bois-Tollot	Verbois	France	Switzerland	Auvergne-Rhône-Alpes	01XXX
Genissiat	Verbois	France	Switzerland	Auvergne-Rhône-Alpes	01XXX
Cornier	St. Triphon	France	Switzerland	Auvergne-Rhône-Alpes	74XXX
Cornier	Riddes	France	Switzerland	Auvergne-Rhône-Alpes	74XXX
Vallorcine	Chatelard	France	Switzerland	Auvergne-Rhône-Alpes	74XXX

(*continued on next page*)

Annex I (*continued*)

Substation (origin)	Substation (destination)	Country (origin)	Conutry (destination)	Region (FR-IT)/CCAA (ESP)/ Bundesland (AL)	CP Departament (FR)/Provincia (*SP*-IT)/ Regierungsbezirk (GE)
Ragusa	Maghtab	Italy	Malta	Sicilia	970XX
Galatina	Arachthos	Italy	Greece	Puglia	730XX
Villanova	Lastva	Italy	Montenegro	Abruzzo	650XX
Padriciano	Divaca	Italy	Slovenia	Friuli-Venezia Giulia	340XX
Redipuglia	Divaca	Italy	Sslovenia	Friuli-Venezia Giulia	340XX
Soverzene	Lienz	Italy	Austria	Veneto	320XX
S. Fiorano	Robbia	Italy	Switzerland	Lombardia	250XX
Poschiavino	Campocologno	Italy	Switzerland	Lombardia	250XX
Bulciago	Soazza	Italy	Switzerland	Lombardia	238XX
Mese	Gorduno	Italy	Switzerland	Lombardia	230XX
Cagno	Mendrisio	Italy	Switzerland	Lombardia	220XX
Musignano	Magadino	Italy	Switzerland	Lombardia	210XX
Ponte	Airolo	Italy	Switzerland	Piemonte	288XX
Pallanzeno	Serra	Italy	Switzerland	Piemonte	288XX
Valpelline	Riddes	Italy	Switzerland	Valle d'Aosta	110XX
Avise	Riddes	Italy	Switzerland	Valle d'Aosta	110XX
Diele	Meeden	Germany	The Netherlands	Niedersachsen	26XXX
Gronau	Hengelo	Germany	The Netherlands	Nordrhein-Westfalen	48XXX
Niederrhein	Doetinchem	Germany	The Netherlands	Nordrhein-Westfalen	46XXX
Siesdorf	Maasbracht	Germany	The Netherlands	Nordrhein-Westfalen	52XXX
Oberzier	Maasbracht	Germany	The Netherlands	Nordrhein-Westfalen	52XXX
Oberzier	Lixhe	Germany	The Netherlands	Nordrhein-Westfalen	52XXX
Bauler	Vianden	Germany	Luxembourg	Rheinland-Pfalz	54XXX
Niederstedem	Vianden	Germany	Luxembourg	Rheinland-Pfalz	54XXX
Bauler	Flebour	Germany	Luxembourg	Rheinland-Pfalz	54XXX
Bauler	Roost	Germany	Luxembourg	Rheinland-Pfalz	54XXX
Trier	Heisdorf	Germany	Luxembourg	Rheinland-Pfalz	54XXX
Kühmoos	Asphard	Germany	France	Baden-Württemberg	79XXX
Kühmoos	Laufenburg	Germany	France	Baden-Württemberg	79XXX
Gurtweil	Laufenburg	Germany	Switzerland	Baden-Württemberg	79XXX
Tiengen	Laufenburg	Germany	Switzerland	Baden-Württemberg	79XXX
Tiengen	Beznau	Germany	Switzerland	Baden-Württemberg	79XXX
Grünkraut	Werben	Germany	Austria	Baden-Württemberg	88XXX
Grünkraut	Bürs	Germany	Austria	Baden-Württemberg	88XXX
Dellmensingen	Bürs	Germany	Austria	Baden-Württemberg	89XXX
Leupolz	Westtirol	Germany	Austria	Baden-Württemberg	88XXX
Oberbrunn	Silz	Germany	Czech R.	Bayern	82XXX
Simbach	St. Peter	Germany	Czech R.	Bayern	84XXX
Pleinting	St. Peter	Germany	Czech R.	Bayern	84XXX
Etzenricht	Prestice	Germany	Czech R.	Bayern	92XXX
Etzenricht	Hradec Zapad	Germany	Czech R.	Bayern	92XXX
Röhrsdorf	Hradec Vychod	Germany	Czech R.	Sachsen	09XXX
Hagenwerder	Mikulowa	Germany	Poland	Sachsen	02XXX
Vierraden	Krajnik	Germany	Poland	Brandenburgs	16XXX
Jardelund	Kasso	Germany	Denmark	Schleswig-Holstein	24XXX
Flensburg	Ensted	Germany	Denmark	Schleswig-Holstein	24XXX
Bentwisch	Bjaeverskov	Germany	Denmark	Mecklenburg-Vorpommern	18XXX

Annex II

Survey questions

Questions for RQ1	
Awareness: The European Union is promoting energy cross-border interconnections. Had you ever heard about this before or it is the first time you hear about time?	Yes, I have heard about this before No, it is my first time
Understanding (advantages): Do you think that energy interconnections have any advantage for your country? Please specify (Open-ended question)	Spontaneous answers, codified for the analysis
Understanding (disadvantages): Do you think that energy interconnections have any disadvantage for your country? Please specify (Open-ended question)	Spontaneous answers, codified for the analysis
Questions for RQ2	
Awareness: The European Union is promoting a European energy market/fully integrated internal energy market in which all states are electrically interconnected. Had you ever heard about this before or now is the first time?	Yes, I have heard about this before No, it is my first time
Understanding (advantages): Do you think that the fully integrated internal energy market has any advantage for your country? Please specify (Open-ended question)	Spontaneous answers, codified for the analysis
Understanding (disadvantages): Do you think that the fully integrated internal energy market has any disadvantage for your country? Please specify (Open-ended question)	Spontaneous answers, codified for the analysis

Annex III
List of variables in the survey

Category	Variable	Measure
Social structure	Sex	0. Woman 1. Man
	Age	0.18–29 years 1.30–44 years 2.45–64 years 3. +65 years
	Educational level	0. Not tertiary 1. Tertiary
	Occupation	0. Student 1. Worker (full or partial time) 2. Unemployed 3. Retired 4. Housewives
Residence	Country of residence	0. France 1. Germany 2. Italy 3. Spain
	Population	0.10,000 inhabitants or less 1. From 10,001 to 100,000 inhabitants 2. More than 100,000 inhabitants
	Proximity to substation	0. No cross-border region 1. Cross-border region
Politics	Political view	0. Left 1. Centre 2. Right

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