

## **Public beliefs about high-voltage power lines in Norway, Sweden and the United Kingdom: A comparative survey**

### **Abstract**

As countries worldwide, and particularly in Europe, move to increase deployment of low carbon energy sources, significant investments in new transmission networks are planned. However, past cases of public opposition – both to power line siting and large-scale renewable energy projects - indicate the importance of understanding public beliefs and acceptance, and using such knowledge to inform policy making and planning. This study conducted a comparative analysis of public beliefs across three European countries (UK, Norway and Sweden) drawing on representative samples of adults in each context (total n=5107). Findings show significant differences between countries, notably lower levels of acceptance and trust in the UK, but also similarities, for example that local residents are considered to have little involvement in planning- and decision-making processes. The results indicate two important principles: that acceptance can be empirically distinguished from support, and that general acceptance of energy projects is higher than local acceptance. Potential geographical, socio-historical and political explanations for the results are proposed and future research needs recommended.

**Key Words:** Electricity grids, networks, public beliefs, public acceptance, national comparisons

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# 1 Introduction

As countries worldwide move to increase deployment of renewable energy sources, significant investments in new transmission and distribution electricity networks are planned [1-3]. Many countries also need renewals and expansions to existing grids to improve capacity and security of supply. The construction of new high voltage power lines (HVPL) has lately sparked significant public opposition in many countries, particularly from local communities near where they are to be constructed [4-9], often due to their potential visual, auditory and health impacts. Such conflicts suggest that a techno-economic, top-down approach to energy planning traditionally adopted to implement this type of development is becoming increasingly insufficient, even if the limitations to traditional expert-driven processes are gradually being recognised among decision makers and reflected in grid policy documents [1,10]. Grid investments are linked to European as well as national policies and initiatives. The European Union has put forward binding directives for promoting and establishing renewable energy technologies (RET) [11], many dependent on new transmission lines and the European Electricity Grid Initiative was launched in May 2010 aiming to foster electricity cross-border exchanges [12]. The successful implementation of these pan-European initiatives will require adaption to varying national, regional and local legislation, traditions, modes of social organisation, cultures and so forth, if they are to be regarded as socially acceptable [13-15].

With regards to social acceptance, high voltage power lines are similar to low carbon energy technologies in sometimes meeting with fierce opposition from local communities, despite general public support for these technologies [14,16]. Issues such as visual impacts on the landscape, noise effects, health concerns, impacts on property values and complaints regarding procedural justice have figured in a range of case study research focused on local responses to projects such as nuclear power plants, onshore and offshore wind farms [17-21].

Similar concerns arise in the case of high voltage power lines, albeit derived from a smaller number of research studies [4,7,9,22,23].

Research into the factors underlying social acceptance of such technologies has followed two main pathways. The first is concerned with public responses (either of the residents of a local community or the citizens of a particular country) and the factors influencing those responses [e.g. 14,17,18,24]; and another more focused on how regulatory, institutional and socio-political contexts impact on the success or lack of it in the implementation of those technologies [19,20,25,26]. This paper aims to integrate aspects from the two strands of research mentioned above by investigating public beliefs about high voltage power lines in Norway, Sweden and the United Kingdom. This is novel since comparative analyses are scarce in a literature where case studies or opinion surveys of a single project or national context predominate. We selected these countries on the basis of three criteria regarding investment, governance and controversy: they have significant plans for upgrading existing grids and constructing new transmission power lines [1-3]; they possess interesting differences in terms of grid governance (see below) [27]; and Norway and the UK (but not Sweden) have had recent, severe conflicts over the siting of HVPL. In Sweden and in the UK the need for new grids has been strongly linked to the development of low carbon energy technologies, whereas in Norway, need arguments have focused more on security of supply [22,27]. Public responses to transmission lines were empirically investigated in the three selected countries, through considering some key factors relevant for understanding acceptance or opposition, notably issues of trust, familiarity and distinctions between general and local acceptance.

## ***1.1 Understanding public responses to low carbon and associated energy technologies***

Mainly since the 1990s [14,25], the recognition of the importance of taking into account the ‘social side’ of low carbon energy technologies has increased and research began to try to understand the factors underlying social acceptance [16,28]. Research into public attitudes towards different energy sources “shows that attitudes can be highly variable, dynamic and sometimes contradictory. They may be rooted in deep-seated cultural and ideological identities and formed from a variable and interacting mix of influences and sources of information” and “generalizing between places and across time can be hazardous and misleading” [14, p.49]. As noted above, two pathways of research may be identified in this literature: one concerned with public response and another more focused on the influence of institutional and political contexts.

The first line of inquiry can be further divided into two directions: first, focusing on personal and place related factors, such as age, education, feelings of rootedness and place attachment [e.g. 29]; and, second, project related factors, for instance trust [30], degree of information about the project proposals [4], and perceived fairness and legitimacy of the decision-making processes [31]. In an analysis integrating these two sets of factors to explain local acceptance of a high voltage power line to be constructed in South West England, personal and place related factors were each able to explain only 4% of the attitude towards the power line, while project-related factors (perceived impacts, trust in the developer and procedural justice issues) explained as much as 31% of the variance in power line acceptance [23]. Such findings were echoed in a survey in Germany with representative samples of the publics in two municipalities about the acceptance of new transmission lines proposed in the area [9]. A total of 40% of the residents were trying to prevent the construction. Factors such as the opportunities local residents had to participate in the decision-making process, as well as knowledge about it and about the project, were

highlighted as crucial. Another survey was conducted in southern Finland, among the public in an area with diverse characteristics regarding its population, density of power lines and landscapes [7]. Power lines were more negatively evaluated than telemasts and roads. Perceptions were not homogenous: 4% of the respondents had a positive perception and 27% were indifferent. The results suggest that a low level of knowledge concerning the transmission lines was related to negative attitudes - the latter being based on the visual, auditory and perceived health effects of transmission lines – whereas positive perceptions seemed to be related to perceiving power lines as necessary to contemporary societies [7]. Case-studies in the UK underline the importance of early public involvement, sufficient information and knowledge as well as processes fostering transparency and trust as central in achieving better public participation [18,32]. At the national level, a study of UK public beliefs about energy networks, drawing on a representative sample of adult citizens and using a survey with both open and closed questions, concluded that organisational invisibility - lack of knowledge - and low expectations of public involvement could be important sources for future conflicts over new HVPL [33].

None of these studies has looked at the potential differences and similarities that may exist in public beliefs about high voltage power lines in distinct countries and at the larger institutional, political and socio-cultural factors that can shape responses to HVPL at this level. However, previous cross-cultural study of other energy issues suggests it might be important to consider the differences between national contexts, as potentially “different cultures interpret the interaction between technology, environment and decision-making differently” [26, p.1132]. A recent survey of European citizens [34] investigated public health concerns based on the electromagnetic fields (EMF) of transmission lines and devices such as mobile phones. This showed that HVPL were the infrastructures more often perceived to affect health to a large extent (35%), and concern with the health impacts varied considerably

from country to country. While 78% of the respondents in Italy considered that power lines affect their health to a large extent, in Sweden and the UK only 24% and 15% of the respondents considered so, respectively. However, the differences and the factors that might explain them were not discussed. In sum, this strand of literature is predominantly case study based, lacking in systematic analyses of cross-national similarities and differences.

The second strand of literature looking at the social side of energy technologies has analysed how structural and institutional factors influence acceptance across several countries. Some of the suggested explanations has been labelled the ‘social gap’ in wind farm siting decisions, being defined as “the gap between the high public support for wind energy expressed in opinion surveys and the low success rate achieved in planning applications for wind power developments” – instead of the individual gap – “the gap that exists when an individual person has a positive attitude to wind power in general but actively opposes a particular wind power development” [19, p.461]. In a comparison between Denmark, Spain, Germany, Scotland, the Netherlands, and England/Wales, the effects of four institutional variables – planning rules, financial support mechanisms organised by the state, organisations concerned with landscape protection, and ownership patterns of wind farms – were examined for their impact on wind power deployment outcomes [26]. The study departed from the diagnosis that while, for instance, both Denmark and Spain have relatively good wind resources and also high quantities of electricity generated from wind power, England/Wales and Scotland, despite having large wind resources, in comparison have lower levels of wind power deployment. The authors concluded that landscape protection organisations (e.g. Campaign to Protect Rural England, John Muir Trust) can play a significant role in producing those differences, as these organisations according to the authors have been relatively weak in Spain, but quite strong in England/Wales and Scotland, where the countryside is highly valued as a rural ‘idyll’ [35,36]. The study also highlighted how Germany, Spain and

Denmark have ‘localised’ planning decisions for wind farms, and might, through this, be more successful at incorporating local concerns and perspectives into those decisions [26]. Another study compared 18 wind farm projects in England, Wales and Denmark, aiming at better understanding local community participation and stability of networks of individuals and organisations as factors influencing project success or failure [20]. No substantial differences between Denmark, England and Wales were found. Projects with higher levels of public participation and unstable networks of objection were more likely to be accepted by the public and to be successful in gaining consent, independent of country.

While these studies suggest that it might be important to take into account broader institutional and societal backgrounds when analysing public responses to energy infrastructure, few studies to date have crossed these two ‘approaches’ to look into public responses to low carbon energy infrastructures, and more importantly, they have not been used to date to examine perceptions of high voltage power lines in different national contexts. We expect that important differences as well as similarities in public beliefs in the three countries might be identified and that by studying these aspects in different socio-geographical contexts, a better understanding of public responses to HVPL will be gained. Specifically, the different historical trajectories of electricity networks, planning and public participation practices in Norway, Sweden and the UK, as well as the current differences in arguments put forward for grid development, might influence how publics in the three countries respond to high voltage power lines.

## ***1.2 Contexts: Norway, Sweden and UK and their transmission network history***

Norway, Sweden and the United Kingdom are countries in the north-western region of Europe. The UK has a population of more than 62 million people distributed on an area of

approximately 244 000 km<sup>2</sup>, mainland Norway has a population of around 5 million on 325 000 km<sup>2</sup> and Sweden a population of about 9.5 million people distributed on 450 000 km<sup>2</sup>. Outside developed and populated areas, the UK is dominated by agricultural land (farmland and pastures making up 70 %), while Sweden has vast areas of boreal forest (65 % of total area) and Norway much of mountainous areas and forests (50 % and 35 % respectively). Each country cooperates in matters of energy production and distribution, Sweden and UK as members of the European Union, and Norway through the European Economic Area. Norway and Sweden, as immediate neighbours, also have strong bilateral cooperation on electricity supply.

The development of transmission grids has in each country been strongly influenced by type of electricity production [27]. In Norway, local distribution grids were developed from around 1900, a consequence of geography, topography and political circumstances, and the fact that Norway is rich in hydro resources. To build small, local hydro-power plants was easy, being established all over the country in the 1920s and 1930s so electricity networks have historically had a strong local basis, in contrast to Sweden and the UK. Swedish watersheds were larger, more costly to develop for hydro-power, located in the north and away from the populated areas in the east and south. In the UK, much of the electricity was produced by coal-fired power-plants in the north, while the majority of consumption took place in the south. The central transmission grids in Sweden and the UK were established before 1940, while Norway did not have a completed national grid until the 1980s. All three countries have undergone a significant deregulation and liberalisation of the energy sector during the latter half of 1980s and the first half of the 1990s [27]. Systems for planning and consent for transmission lines see similarities as well as differences between the three countries. The Norwegian system is considered expert-driven, and national political involvement is limited in the early phases. The Swedish system is characterized by extensive

consultation and deliberation, with a strong role played by regional authorities. In England and Wales there is a centralized planning system and a strictly regulated schedule for grid projects and involvement, with a strong role occupied by the political arena, with nationally defined policies aligned to answer to national needs being the main driver and centre of decisions around energy infrastructures [27].

In summary, the national electricity grids in each of the three countries arose historically from diverse local circumstances, are governed differently but have similarly followed a process of liberalisation and privatisation in recent decades. Thus there seem to be institutional, geographic and socio-political differences that might impact on public responses to high voltage power lines in the three countries.

## 2 Method and material

Public beliefs were captured using a questionnaire survey developed using standard principles of survey design [38] and pretested ( $N=45$ ), which resulted in minor changes – mostly to wording – being made to the final version. The final survey was conducted with a representative sample of the adult population (+18 years old) in the three countries, by age, gender, socio-economic classification and region. The survey was conducted during November 2011-March 2012 and was web-based, relying on respondents randomly drawn from consumer panels<sup>1</sup> with a total of 60 000 people from Norway, 55 000 from Sweden and around 350 000 people in the UK. A total of 5107 completed responses were elicited, Table 1 shows the main characteristics of the samples in each country.

Regarding content, the questionnaire survey was developed by the researchers in the project and comprised questions aiming to grasp key beliefs and responses to high voltage

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<sup>1</sup> A review of the use of internet surveys including consumer panel populations and respondents in social and economic research points to both strengths and weaknesses with panels, but conclude that such panels become more and more sound as a basis also for research purposes [39].

power lines and associated factors<sup>2</sup>. More specifically, and relying on the social science literature referred to above [23,28], we included questions to tap into people's: 1) acceptance of high voltage power lines in general and local ones near where they live; 2) support for high voltage power lines in general and local ones near where they live; 3) perceived knowledge about power line systems; 4) Knowledge about/awareness of the national transmission system operator in each country (National Grid Plc., Statnett SF, Svenska Kraftnat); 5) trust in the national transmission system operator (National Grid Plc., Statnett SF, Svenska Kraftnät); and 6) beliefs about the degree of involvement in the decision-making processes regarding high voltage power lines of (a) local residents and (b) the transmission system operator. Exact wording for each question are presented in Table 1.

For all questions, responses were given on a five-point, appropriately worded Likert-type response scale. In addition, when relevant the option to answer "Don't know" was provided.

### 3 Results and Discussion

#### 3.1 *Public acceptance and support for high voltage power lines*

Regarding **general acceptance** of high voltage power lines, although mean responses were above the mid-point of the scale for all three national samples, acceptance was significantly lower in the UK ( $M=3.53$ ) in comparison to Norway and Sweden ( $M=3.77-3.85$ ) (see Table 1). Regarding levels of **general support**, there was a similar trend across the three countries, in that support was significantly lower in the UK ( $M=2.96$ ;  $SD=0.028$ ) in comparison to the Norwegian sample ( $M=3.18$ ), which was also significantly lower than the

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<sup>2</sup> The questionnaire was presented to respondents in the language of each country. However, we assess that all key terms and words were of similar meanings across the languages not causing possible errors in translation to English and in interpreting the findings and comparisons across the publics.

Swedish sample ( $M=3.52$ ). In all cases, public support was lower than public acceptance<sup>3</sup>, a finding that supports recent research suggesting the need to consider different types of public responses to energy infrastructures. Scholars have argued that support seems to imply “*a more active and favourable position towards power lines, whereas acceptance seems to be more related with a passive reception of those infrastructures, with people tolerating but not actually supporting them*” [28, p.4]. This is most clearly illustrated by Norwegian and UK responses - even if people do tend to accept high voltage power lines in general, when it comes to actually supporting them, there seems to be quite a significant ‘withdrawal’. This is still further highlighted if we focus upon the proportions of “Don’t know” responses to the questions about acceptance and support – “Don’t know responses” are significantly<sup>4</sup> higher, in all cases, for support than for acceptance.

**Table 1.** Overview of sample, key variables and analyses of country differences (One-way ANOVA and T-tests). Scheffe’s post-hoc test used to identify which samples were statistically different from each other.

**Local acceptance** of high voltage power lines was below mid-point average levels in all countries, and a similar pattern of results was found as for general acceptance – local acceptance was significantly lower in the UK ( $M=2.56$ ) than in both Sweden ( $M=2.88$ ) and Norway ( $M=2.98$ ). Similarly, **local support** was significantly lower in the UK ( $M=2.35$ ) than in Sweden ( $M=2.64$ ), which in turn was significantly lower than in Norway ( $M=2.77$ ).

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<sup>3</sup> T-tests:

UK:  $t=25.25$ ,  $df=1331$ ,  $p<0.000$   
 Norway:  $t=31.55$ ,  $df=1717$ ,  $p<0.000$   
 Sweden:  $t=12.24$ ,  $df=1240$ ,  $p<0.000$

<sup>4</sup> T-tests:

UK:  $t=9.12$ ,  $df=1518$ ,  $p<0.000$   
 Norway:  $t=7.82$ ,  $df=1910$ ,  $p<0.000$   
 Sweden:  $t=8.12$ ,  $df=1471$ ,  $p<0.000$

Looking across these findings, a number of conclusions can be drawn. First, public acceptance is always significantly higher than public support, suggesting a distinction in meaning between these terms [28]. Second, local acceptance is always significantly<sup>5</sup> lower than general acceptance – a ‘gap’ that literature on renewable energy has been trying to better understand and address for some time, while criticising NIMBY explanations for that ‘gap’ [14,16,40-42]. Third, UK citizens are consistently less positive about high voltage power lines, both generally and locally, and taking into account different types of responses - acceptance and support - than those in Sweden and Norway, which are more similar to each other than UK responses, although some differences are also evident (Table 1). This difference might be attributed to several factors: the fact that in the UK the deployment of transmission lines are decided upon at a national level; higher population density and the fact that landscape protection organisations are quite institutionalised and likely more active in the UK context as compared to the Norwegian and Swedish ones [26], associated with the important role that the landscape has in symbolising British cultural identity [35,36]. Finally, quite high levels of “Don’t know” responses were found, most evidently in Sweden for local acceptance, which suggests that particularly for Swedish respondents, a locally sited high voltage power line is not an issue salient enough for a particular belief to have formed.

### ***3.2 Familiarity, trust and involvement in decision-making***

Responses for perceived familiarity – both with the electricity system and with the TSO - were, in all countries, significantly<sup>6</sup> below the mid-point of the scale (Table 1),

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<sup>5</sup> T-tests:

UK:  $t=12.44$ ,  $df=1369$ ,  $p<0.000$

Norway:  $t=11.77$ ,  $df=1738$ ,  $p<0.000$

Sweden:  $8.96$ ,  $df=1337$ ,  $p<0.000$

<sup>6</sup> T-tests:

Familiarity with grid system:

UK:  $t=24.93$ ,  $df=1481$ ,  $p<0.000$

Norway:  $t=14.85$ ,  $df=1939$ ,  $p<0.000$

Sweden:  $t=23.00$ ,  $df=1559$ ,  $p<0.000$

suggesting that in all contexts of this research, levels of awareness of the grid system, how it works and who is responsible for operating it are low. Alongside these general patterns, national differences were found, but in contrasting directions. First, system familiarity was significantly lower for UK respondents ( $M = 2.26$ ) in comparison to those in Sweden ( $M = 2.49$ ), which in turn was significantly lower than those in Norway ( $M = 2.73$ ). Second, TSO familiarity was significantly lower for Swedish respondents ( $M = 1.85$ ) by comparison to those in Norway ( $M = 2.11$ ), which in turn was significantly lower than those in the UK ( $M = 2.47$ ). It is interesting to note that TSO familiarity was lowest (and system familiarity also quite low) in Sweden, where decisions about these infrastructures are taken at a more local level, and where more consultation and deliberation are fostered in institutionalised decision-making processes about high voltage power lines [27]. This finding is not an anomaly if we presume that in Sweden recent conflicts over transmission lines have not been as significant as those in the United Kingdom and Norway, where projects like the Lackenby-Picton-Shipton line in the Northeast of England, the Beauly-Denny line in Scotland and the “monster-pylon-conflict” in Hardanger, Norway have received extensive media coverage nationwide [6,23].

Trust in the TSO (Table 1) was below the mid-point of the scale ( $M = 2.76$ ) in the UK and significantly lower by comparison to Sweden where it was on average equal to the mid-point of the scale ( $M = 3$ ). TSO trust was highest in Norway ( $M = 3.22$ ), with a significant difference to both UK and Swedish responses. It is also notable that the proportion of “Don’t know” responses for this question was the highest for all questions (between 19.9% and 45% - see Table 1) which seems to further evidence general public unfamiliarity with the TSO in

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Familiarity with TSO:  
UK:  $t=17.46$ ,  $df=1518$ ,  $p<0.000$   
Norway:  $t=40.05$ ,  $df=1902$ ,  $p<0.000$   
Sweden:  $t=42.83$ ,  $df=1553$ ,  $p<0.000$

each country – and particularly in Sweden – as well as their difficulty in positioning themselves regarding these companies when it comes to trust.

Beliefs about involvement in decision-making processes about high voltage power lines shows three features. First, in all three countries, people generally perceive local residents as not very involved in decision-making - all means were well the mid-point of the scale (Table 1). Second, in all three countries, people generally perceive the TSO as being greatly involved in those decision-making processes (all means equal to or above 4.5). Third, there are differences as well as similarities between the three countries. While there are no differences regarding the degree to which publics' in each country perceive the involvement of the respective TSO, differences were found regarding the perceived involvement of local residents. Norway is where respondents perceive local residents to be relatively more involved in those processes ( $M=2.46$ ), followed by the UK ( $M=2.2$ ) and then Sweden ( $M=2.01$ ). Again, it is surprising that it is in Sweden, where more consultation and deliberation seem to be fostered by the regulatory frameworks for electricity grid development and where local and regional authorities play a stronger role, that people perceive that they are less involved in that process.

### ***3.3 Examining relationships amongst the constructs***

To examine patterns of association between acceptance, familiarity, trust and involvement, bivariate correlations were undertaken. Although most of the variables were correlated with each other at a statistically significant level (see Table 2), several key findings can be noted. First, the pattern of relationships found was highly similar across the three national contexts of the research. Despite mean differences as indicated in Table 1, patterns of association across these constructs show little variability between UK, Swedish and Norwegian respondents. Second, acceptance and support are strongly correlated, both at general and local levels of specificity. Even if the mean values for these items significantly

differ, the findings suggests a positive relationship overall. Third, familiarity responses are strongly correlated, with TSO and system familiarity generally showing a positive pattern of association overall. Related to this, familiarity with and trust in the TSO was moderately positively correlated (i.e.  $> 0.2$  for Norway and  $> 0.3$  for Sweden), but lower for UK respondents (0.136).

**Table 2.** Pearson correlation coefficient matrix for the samples from UK, Norway and Sweden.

Fourth, local acceptance of power lines is most strongly correlated (i.e.  $> 0.5$ ) with trust in the TSO and general acceptance. The relationship between trust and acceptance is similar to that found in other studies [18,33], clearly highlighting that trust in the developers of grid infrastructure plays a very important role in shaping public responses to them - in all countries, the more respondents trusted the TSO, the more they would accept and support HVPL. By contrast, the relationship between local acceptance and involvement in decision-making or with familiarity items were weak ( $< 0.2$ ).

Fifth, a significant, positive, yet weak correlation was found between acceptance, support and reported familiarity, suggesting some support for the often criticised ‘information deficit’ viewpoint concerning opposition towards power lines [43]. Our findings suggest that low levels of acceptance and trust are associated with low levels of familiarity. However, there is an important conceptual difference between factual knowledge and perceived familiarity [44]. In our survey, only the latter was measured. Viewing the public as “passive, ignorant and worried” is sometimes assumed by developers and experts along with the idea that if more and better information is given to the public, this will encourage them to adopt a more positive attitude towards technical proposals [32,45]. These results call attention to the importance for future research to identify and discuss in greater detail issues regarding

knowledge. In addition to clearly distinguish between factual knowledge and perceived familiarity [44], there is also a need to study what types of knowledge or familiarity can actually be important – knowledge about the project - potential impacts - the TSO - the decision-making process? And knowledge as information or knowledge as in familiarity and experience, that is, as having lived already near a power line for instance?

## 4 Conclusions

Understanding public beliefs and acceptance of energy infrastructure is an important basis for developing effective energy policies [16]. It is also important for assessing the general conflict potential in energy development issues, in addition to market and community acceptance [46] and institutional factors [25,26]. In Europe, major plans for constructing new transmission power lines exist, partly linked to development of renewable and nuclear energy projects, partly to improved security of supply and the upgrade of ageing infrastructure [12]. Several of these new projects have been met with strong public opposition, notably in two of the countries researched in this study - Norway and the UK. To the authors' knowledge, this is the first cross-national comparative research study into public acceptance of transmission power lines. Studies of this kind are important because they go beyond specific case studies or national opinion polls to offer the possibility to assess to what extent differences in governance, demography, culture, geography and landscape are reflected in different public beliefs regarding energy issues in general, and regarding electricity grids more specifically.

In terms of national comparisons, the study found both similarities and differences in beliefs among publics in Norway, Sweden and the UK. While there were consistently lower levels of acceptance, both generally and locally, in the UK in comparison to the Scandinavian countries, there was similarity in beliefs about who makes decisions about new power lines, with strong involvement of TSOs and weak involvement of local residents. Familiarity with

grid networks and operators was consistently low in all countries studied, yet trust varied, being significantly lowest in the UK and highest in Norway. Although mean differences existed for many variables, correlational analysis showed many similarities across the countries, notably in terms of the strongest associations with local acceptance – general acceptance and TSO trust.

Several possible explanations can be proposed for the national differences found. Differences in basic characteristics of geography, resource availability and patterns of settlement (notably population density and land use pressure) might be one such basic factor [46]. Linked to this, is likely different strengths of what is labelled “landscape protection organisations” between the three countries [26]. However, they might also reflect the fact that the three countries have different grid ‘histories’ and current regimes and planning systems [26,27]. Historically, the Norwegian grid development was much more strongly locally embedded when compared to the Swedish and UK grids. Recent grid governance and planning systems are strongly expert driven in Norway and lead by national policies in the UK, this in contrast to Sweden where the grid regime is characterised by stronger involvement from local and regional authorities [27]. Although it is somewhat surprising that the current planning system differences did not manifest itself by higher reported familiarity with grid issues among the Swedish citizens, this finding may be attributed to the lack of recent high profile social controversy over power line siting in Sweden (and thus a lower level of salience attributed to this issue amongst the general population), by contrast to the Beauly-Denny and Hardanger cases in the UK and Norway that featured in national media and were subject to political debate [6,23]. This points out that a governance system involving local authorities does not necessarily lead to greater involvement of citizens. In conclusion, the national differences in public beliefs we have identified are difficult to explain purely based in differences in institutional factors such as the planning system, more

likely are explanations linked to differences in land use attributes [46], landscape protection [26] and recent events.

Future research is required to investigate the Swedish responses in particular, and whether these patterns are found in other national contexts, both in Europe and elsewhere. All three countries studied belong to the western cultural sphere, located in the same global region (north-west Europe) with many similarities in terms of centralised grid infrastructures, governance, quality of life etc. In many ways the most striking difference found was the lower levels of acceptance in the UK compared to Norway and Sweden, as well as lower trust in the TSO. Future research could investigate whether similar findings arise in contexts of distinctively varying levels of population density (e.g. Netherlands, Spain and Australia) and stable networks at regional and national levels of groups protecting landscape qualities and characteristics, as has been the case in the UK [26]. Beyond this, studies of public acceptance, trust and perceived involvement in contexts of emerging grid centralisation, for example in India, could inform policy making and grid deployment.

The study suggests two higher level principles that can be derived from this literature over and above the specific technology, energy source or national context involved, which corroborate findings already observed in empirical studies of low carbon energy sources. First, that acceptance and support are terms that should not be presumed to be synonymous, despite a general tendency to do so in recent studies [28]. Although the variables were strongly correlated, consistent differences across the three countries studied suggest different meanings. Second, that local acceptance is lower than general acceptance, as has been found in this study of power lines, but also repeatedly found in empirical studies of other large-scale renewable energy projects and frequently discussed in previous research [e.g. 14,16,40-42].

Future research can ascertain to what extent public responses to novel energy sources (e.g. wave and tidal energy; shale gas) also fit these consistent general/local patterns of

results. Second, rather than conceiving the general-local ‘gap’ to be an anomaly or inconsistency amongst publics [42,47,48], future research should systematically investigate the reasons why ‘conditional acceptance’ [19] occurs – in essence to investigate the relative importance of personal, place and project specific elements (e.g. place attachments, perceived local impacts and benefits, trust in the developer, procedural justice) - that collectively determine to what extent general public acceptance of an energy source or technology may or may not ‘translate’ into acceptability of a locality sited energy project.

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**Table 1 Aas et al ERSS**

Variable	UK	Norway	Sweden	
Sample (N)	1519	1972	1616	
Age – mean	52.3	52.6	53.8	
Gender (Male)	48.1 %	49.8%	49.3 %	
<b>Themes</b>	<b>UK</b>	<b>Norway</b>	<b>Sweden</b>	<b>Statistics (df=2 in all tests)</b>
<b>General attitude statements<sup>1</sup></b>				
In general, I accept overhead powerlines – mean (S.E.)	3.53 (0.026)	3.85 (0.022)	3.77 (0.027)	F=49.36 p<0.000; UK<S, N
% “don’t know” responses	6.7	3.5	10.6	F=36.40 p<0.000; N<UK<S
I am in favour of overhead powerlines generally – mean (S.E.)	2.96 (0.028)	3.18 (0.027)	3.52 (0.031)	F=98.76 p<0.000; UK<N<S
% “don’t know” responses	12.2	6.9	15.4	F=32.16 p<0.000; N<UK<S
<b>Specific attitude to a new hV powerline near where you live<sup>2</sup></b>				

To what extent would you accept the construction of a new high-voltage power line near your community – mean (S.E.)	2.56 (0.029)	2.98 (0.028)	2.88 (0.033)	F=57.51 p<0.000; UK<S,N
% “don’t know” responses	9.0	4.0	11.9	F=41.02 p<0.000; N<UK<S
To what extent would you support the building of a new high voltage overhead powerline in the area near to where you live – mean (S.E.)	2.35 (0.030)	2.77 (0.026)	2.64 (0.029)	F=68.47 p<0.000; UK<S<N
% “don’t know” responses	8.7	6.9	14.2	F=28.47 p<0.000; N,UK<S
<b>Familiarity/knowledge<sup>3</sup></b>				
How familiar are you with the electricity powerline system – mean (S.E.)	2.26 (0.030)	2.73 (0.018)	2.49 (0.022)	F=86.76 p<0.000; UK<S<N
% “don’t know” responses	2.4	1.6	3.2	F=5.12 p<0.05: N,UK<UK,S
How familiar are you with the organization NG/Statnett/SK? – mean (S.E.)	2.47 (0.030)	2.11 (0.022)	1.85 (0.027)	F=136.45 p<0.000; S<UK<N
% “don’t know” responses	0	3.4	3.6	F=27.30 p<0.000; UK<N, S
<b>To what extent do you think each of the following are involved in decision making about new powerlines<sup>4</sup></b>				
Local residents – mean (S.E.)	2.20 (0.030)	2.46 (0.026)	2.01 (0.026)	F=71.75 p<0.000; S<UK<N
% “don’t know” responses	14.7	5.2	10.5	F=46.23 p<0.001; N<S<UK
National Grid/Statnett/Svenska Kraftnät – mean (S.E.)	4.50 (0.023)	4.57 (0.017)	4.52 (0.021)	F= 2.80 N.S.
% “don’t know” responses	14.4	15.4	17.2	F=2.40 N.S.
<b>Trust<sup>5</sup></b>				
How much trust do you have in this organisation (NG PLC/Statnett/Svenska Kraftnät)	2.76 (0.027)	3.22 (0.028)	3.00 (0.030)	F=66.12 p< 0.000; UK<S<N
% “don’t know” responses	19.9	20.9	45.1	F=176.65 p<0.000; UK,N<S

<sup>1</sup> Scale: 1 = “Strongly disagree” to 5 = “Strongly agree”

<sup>2</sup> Scale: 1 = “Not accept/support at all” to 5 = “Strongly accept/support”

<sup>3</sup> Scale: 1 = “Not at all familiar” to 5 = “Very familiar”

<sup>4</sup> Scale: 1 = “Not at all involved” to 5 = “Strongly involved”

<sup>5</sup> Scale: 1 = “Do not trust at all” to 5 = “Trust completely”

**Table 2 Aas et al ERSS**

		Acceptance HVPL in general	Support local HVPL	Acceptance local HVPL	Familiarity with power line system	Familiarity with TSO	Perceived involvement of local residents in	Perceived involvement of TSO in decision-making	Trust in TSO

							<b>decision-making</b>		
<b>Support HVPL in general</b>	UK N S	.671** .660** .757**	.537** .522** .499**	.472** .481** .473**	.061* .210** .148**	.049 .159** .162**	.157** .092** .154**	.039 .087** .075*	.363** .392** .315**
<b>Acceptance HVPL in general</b>	UK N S	- .416** .521** .438**		.431** .514** .439**	.065* .186** .138**	.079* .155** .142**	.092** .095** .140**	.099** .169** .134**	.288** .432** .278**
<b>Support local HVPL</b>	UK N S		-	.857** .808** .758**	.205** .212** .182**	.187** .193** .215**	.128** .137** .203**	.033 .082** .070*	.420** .480** .345**
<b>Acceptance local HVPL</b>	UK N S			-	.206** .195** .169**	.185** .178** .163**	.128** .113** .199**	.059* .099** .088**	.425** .481** .372**
<b>Familiarity with power line system</b>	UK N S				-	.599** .547** .525**	.097** -.001 .160**	.109** .085** .037	.229** .111** .251**
<b>Familiarity with TSO</b>	UK N S					-	.032 .035 .231**	.142** .143** .169**	.233** .136** .303**
<b>Perceived involvement of local residents in decision-making</b>	UK N S						-	.080* .018 .066*	.228** .190** .244**
<b>Perceived involvement of TSO in decision-making</b>	UK N S							-	.036 .056* .151**
<b>Trust in TSO</b>	UK N S								-

\*\* = correlation significant at 0.01 level  
\* = correlation significant at 0.05 level