Best Practices for Improving Public Acceptance of Energy Infrastructure

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ABSTRACT

One of the key issues for improving infrastructure and investing in renewable energy technologies is gaining public support for such investments. Without acceptance from the public, many potential projects that would increase sustainability and reduce fossil fuel consumption, would stall due to opposition. While in general, green infrastructure is favored by society, extensive developments can adversely affect nearby residents and lead to local opposition. An abundance of research has been conducted to study the process and driving factors of social acceptance. However, few papers directly address the policy relevant question of how to increase public acceptance of a project. We identify relevant factors for social acceptance of windfarms, transmission lines, and pump hydro-storage infrastructures. We then outline the strategies that have been proven to increase public acceptance, and thus advise policy on which strategies would be most appropriate for which infrastructure type. Finally, we add to these policy recommendations by showing that positive ancillary information about a new development will positively influence acceptance.

Keywords: social acceptance, local opposition, energy infrastructure

INTRODUCTION

Continued environmental awareness and concern over climate change among the global populace has catalyzed an increasing number of large-scale projects designed to decrease the use of fossil fuels and greenhouse gas emissions by building new energy infrastructure. The recent meeting of the UN Climate Conference in Doha renewed the Kyoto Protocol and discussed the possibility of stricter emission reduction plans in the future. One way member states can meet these emission reduction goals is by revamping their energy infrastructure. Indeed, many nations have already undertaken and completed projects to increase energy production from clean, renewable sources, and decrease carbon emissions.

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Public opinion across Europe of energy developments is generally favorable for many types of energy infrastructure, especially renewable sources (EC, 2006; Toke, 2005). Yet, many projects are met with local resistance or discontent, which in some cases is a significant barrier to development (e.g. Dimitropoulos and Kontoleon, 2009; Evans et al., 2011; Bronfman et al., 2012; Calero and Carta, 2004; Wuestenhagen et al., 2007). This phenomenon has been extensively studied in recent years by numerous disciplines and is interchangeably referred to as: social acceptance, public acceptance, or local acceptance. The oft-mentioned fear regarding social acceptance, or more appropriately social opposition, is that local groups will impede the progress of converting current energy infrastructure into renewable or “green" infrastructure. However, as yet, research has produced no unifying definition of social acceptance, and no measure of the cost to society that a lack of acceptance can impose.

Herein we use the surfeit of previous literature to develop a unified conceptual framework of social acceptance that draws on the economic principles of welfare and utility theory. We then synthesize previous findings to show which factors drive social acceptance of specific types of energy infrastructure. We focus on those infrastructures that are relevant for the development of a renewable energy sector (wind, power lines/pylons, and pumped hydro-storage) and developments that take place at the “meso" and “macro" levels (Devine-Wright, 2008).[3] We then turn our focus to the policy relevant question of how best to foster social acceptance by using the insights and results of past studies. In some cases these findings can be used to infer the best way to foster acceptance of infrastructure types that have not yet been researched explicitly. In these ways our results add to the literature on public acceptance, and can guide policy makers on how best to diminish local opposition to a planned development project.

A UNIFIED CONCEPT OF PUBLIC ACCEPTANCE

The disparity between the general public's acceptance of new infrastructure projects and the opposition exhibited by those groups residing closer to the planned development has been characterized as a NIMBY (not in my backyard) response. That is to say that while someone may enjoy the benefits or the idea of new infrastructure from a distance they are opposed to bearing the costs of having this infrastructure in their proximity. This response to planned construction is a reasonable one, as locals can be exposed to the negative impacts of development such as: diminished viewsheds, increased noise, pollution or traffic, and safety concerns (Wolsink, 2007). Furthermore, there can be a direct economic effect on local communities in the form of decreased property values (Filippova and Rehm, 2011; Sims and Dent, 2007). Despite the legitimacy of the NIMBY sentiment, the concept has been criticized for inadequately explaining the complexities of social acceptance (e.g. Wolsink, 2007; van der Horst, 2007; Devine-Wright, 2009). Van der Horst (2007) explicitly investigates the validity of the NIMBY construct, and finds that while proximity to a proposed project will, on average, lead to opposition, an emotional attachment to the proposed landscape of development plays a greater role in fueling such opposition.

[3] These infrastructure types are also the ones most relevant for the developments of Upper Austria, a province with ambitious supply security and green-energy goals, to which end they have numerous development projects planned to occur in the near future.

Some previous authors have set out to develop a conceptual framework for social acceptance (Devine-Wright, 2008, 2009; Bronfman et al., 2012; Wuestenhagen et al., 2007; Wolsink, 2007). Among them Devine-Wright (2009) proposes an alternative to NIMBY with place theory. This theory links a proposal for a new development with social action through the subjective interpretation and evaluation of the impending change. The evaluation of the development will be positive if the outcome on the location is deemed to be positive. Bronfman et al. (2012) proposes a model with strong links between trust in government, perceived benefits and risks, and social acceptance. This model is shown to fit the researcher's data in the cases of fossil fuel, hydro, and nuclear power. Wuestenhagen et al. (2007) shows that social acceptance can be broken into three dimensions each corresponding to different agents: socio-political acceptance, community acceptance, and market acceptance. Devine-Wright (2008) defines the factors influencing social acceptance by three broad categories: personal (demographics), social-psychological (perceptions and experience), and contextual (siting, type of development) (Devine-Wright, 2008). Finally, in Devine-Wright (2011) the author explains that the drivers of social acceptance are influenced by the locals' perceptions and awareness of both the outcomes of a new development, and the procedure of the development process.

Each proposed framework is useful in its own right when conceptualizing, or investigating the causes of social acceptance. However, the discussion of public acceptance suffers from the lack of a coherent definition of the term, and a unification of the above theories. Here we offer a definition of social acceptance stemming from economic utility theory and the concept of welfare.

Economists conceptualize welfare through the idea of individual utility. A positive change in utility can be understood as simply making the individual better off while a negative change makes the individual worse off. The aggregation of such changes in utility can be thought of as a change in social welfare. We take as given that if a governing body plans a new infrastructure project, then this project is predicted to lead to a positive increase in social welfare. However for a project to satisfy social acceptability it must satisfy the following definition for *all* agents.

Social acceptance of new infrastructure occurs when the welfare decreasing aspects of the project are balanced by welfare increasing aspects of the project to leave each agent at worst, welfare neutral and indifferent to the completion of the project, or better off and supportive of the project.

Welfare decreasing aspects of new infrastructure are those that are perceived as `bad' by local residents such as: diminished viewshed, safety concerns, noise, pollution, landscape destruction, ecological change, decreased property values, and procedural injustice.

Welfare increasing aspects of a new project are those that are seen as `good' by the locals such as: economic development, energy supply security, green benefits, community compensation, personal compensation, place distinctiveness (see Devine-Wright, 2011), and procedural justice. Thus we define social acceptance, not in terms of any action taken by residents, or as a lack of opposition, but as a set of outcomes and aspects that leave locals at least as well off as they were before the project.

The NIMBY response is often due to the fact that while new infrastructure is a benefit for the larger community, the residents near the project bear the majority of the costs of the new development, and thus are left at a lower utility level. This implies that locals should be compensated for this welfare loss with monetary compensation, or local benefits up to the amount that leaves them welfare neutral. Guidance for policy as to what the appropriate amount of compensation is can be found in numerous empirical welfare analyses (e.g. Dimitropoulos and Kontoleon, 2009; Kraeusel and Moest, 2012; Strazzera et al., 2012; Groothuis et al., 2008; Willis, 2006; Lu, 1977).

With this definition in mind we can synthesize the previous work outlined above to give a unified vision of what social acceptance is, and what factors influence it. Figure 1 shows that the welfare change associated with a proposed project has three dimensions: socio-political, community, and market (from Wuestenhagen et al., 2007). The effect on the agents associated with these three dimensions contributes to the overall welfare change and subsequent acceptance or opposition of society. The effect on each agent's welfare is driven by the agent specific, personal, social-psychological, and contextual factors (from Devine-Wright, 2008). These factors are in turn influenced by the project specific outcomes and procedures as perceived by each agent (from Devine-Wright, 2011).

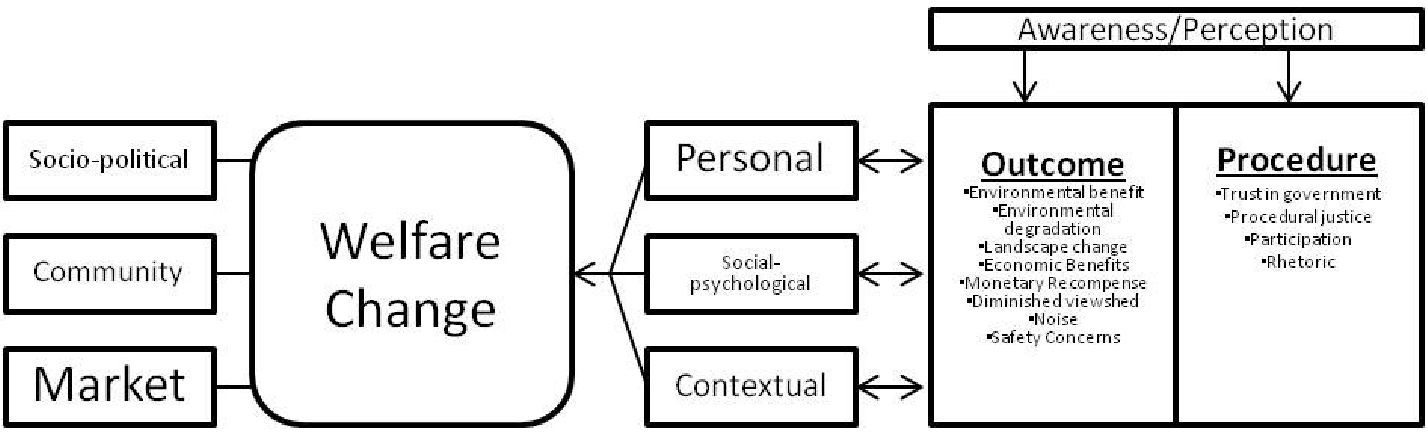

Figure 1. A unified conceptualization of social acceptance
Parts of figure taken from (Wuestenhagen et al., 2007; Devine-Wright, 2008, 2011)

THE DRIVERS OF PUBLIC ACCEPTANCE

This section identifies the major drivers of social acceptance as they pertain to energy infrastructure projects. We focus our effort on three types of infrastructure (wind, transmission lines/pylons, and pumped hydro-storage) as the former two are well researched and highly utilized, and the latter is rapidly gaining importance. Finally, we suggest an ordinal ranking of the factors affecting social acceptance based on previous findings, in order to allow policy makers to focus their efforts on the most relevant issue.

Wind

We first review the literature regarding wind power, which has been researched extensively in recent years (e.g. Dimitropoulos and Kontoleon, 2009; Evans et al., 2011; Calero and Carta, 2004; Strazzera et al., 2012; Groothuis et al., 2008; Gross, 2007; Nadai, 2007; Jobert et al., 2007; Pohl et al., 2012; Kaldellis et al., 2013; Firestone et al., 2012; Ellis et al., 2007). From Figure 1 we see that the drivers of social acceptance can be broken down into three factors: personal, social-psychological, and contextual. Since personal factors are beyond the control of the policy maker, we focus our analysis on the latter two categories. Also from Figure 1 we can see that these factors have two aspects: outcomes and procedures. Oft-cited outcomes that will decrease social acceptance are: diminished viewsheds, landscape intrusion, excess noise, ecosystem disturbance, technical issues (idle time, inefficiency, and repair work), decreased recreational opportunity, and safety concerns (Dimitropoulos and Kontoleon, 2009; Wolsink, 2007; Jobert et al., 2007). To maintain welfare neutrality these negative outcomes can be balanced with positive outcomes such as: greenhouse gas reduction, decreased fossil fuel dependence, place distinctiveness, economic benefits, energy supply security, and monetary compensation (Devine-Wright, 2011; Jobert et al., 2007). The procedures that will influence acceptance or opposition are summarized as the following: trust in governments, procedural justice, public awareness, rhetoric, and inclusion of the public in decision-making process (Strazzera et al., 2012; Evans et al., 2011; Devine-Wright, 2008).

The viewshed effect from windfarms is an obvious favorite for main factor fueling opposition due to the large obstructive nature of such installments. Indeed Ladenburg and Dubgaar (2007) found that residents have a significant willingness to pay to decrease their view of windfarms. Also Strazzera et al. (2012) found that visual impacts had a stronger effect on local perception than other concerns. Other research has suggested that the scope and design of windfarms is also an important aspect of social acceptance (Dimitropoulos and Kontoleon, 2009; Nadai, 2007). However, Dimitropoulos and Konoleon (2009), point out that siting and procedural issues are more important than windfarm size. For instance, siting a windfarm in a fragile or important ecosystem or near an archaeological site leads to greater opposition (Dimitropoulos and Kontoleon, 2009; Strazzera et al., 2012). Windfarms have powerful viewshed effects due to the size of turbines, and a windfarm has the potential to alter the landscape and the character of coveted locations which is a prevalent theme in the literature of factors driving public discontent (Dimitropoulos and Kontoleon, 2009; Strazzera et al., 2012; Ladenburg and Dubgaard, 2007; Devine-Wright, 2009). Since siting encompasses many other issues fueling social opposition (viewshed, noise, landscape/environmental degradation, place distinctiveness), we consider site selection the premiere issue regarding social acceptance of windfarms.

Many papers also deem important procedural issues such as public involvement and rhetoric during the planning and development processes (e.g. Dimitropoulos and Kontoleon, 2009; Evans et al., 2011; Gross, 2007; Nadai, 2007; Devine-Wright, 2008). For instance, Evans et al. (2011)

stress the importance of well-thought out rhetoric that engages the public without prior assumptions about local sentiments. Gross (2007) asserts that the perception of fairness in the procedural process influences how locals perceive the outcomes and acceptance of a project.

Finally, we consider local awareness of the issues surrounding a new development. One could assume that greater awareness of widespread environmental and economic benefits, and a better understanding of the technology and its related safety hazards would greatly increase acceptance. However, as noted by Devine-Wright (2008), the link between awareness and acceptance has not been proven by research.

Transmission lines and pylons

The social acceptance of pylons and transmission networks has also received attention in the literature, though not to the extent of windfarms (e.g. Soini et al., 2011; Cotton and Devine-Wright, 2012; Elliot and Wadley, 2012; Devine-Wright, 2012; Devine-Wright, 2013). Here we suggest that many of the issues and much of the inference from the previous section on wind farms can be generalized to pylons, as both are large structures that inhibit views, and whose installation alters landscapes. Pylons differ from wind turbines in three crucial aspects: the public will not perceive pylons as “green" infrastructure like wind turbines, pylons are already a ubiquitous landscape feature while wind farms usually are not, and pylons are static whereas turbines have moving parts and shifting shadows which may unnerve nearby residents. As shown by Soini et al. (2011), the development of new pylons elicits a greater negative response than the existence of current pylons. The authors' results also show that locals perceive landscape alteration negatively in almost all forms, which suggests that policy will be unable to completely neutralize the negative reaction to proposed change without giving recompense to local residents or communities.

In the case of pylons, the choice of site location remains paramount in determining social acceptance. Landscape level change, and the degradation of places that locals hold dear both lead to strong opposition (Devine-Wright, 2012). However, research has also suggested that this landscape effect can be ameliorated with the use of particular pylon designs, and infrastructure that `fits' the local aesthetic (Devine-Wright, 2011; Devine-Wright, 2012). New pylons will also diminish viewsheds, and can have environmental impacts if they are improperly sited, and the negative sentiment from these effects can be greater in areas currently without transmission lines (Soini et al., 2011).

Similar to windfarms, in the case of pylons procedures also play a role in determining public acceptance. In a case study of The UK, Cotton and Devine-Wright (2012) found that developer-led planning process with little input from the public increases social opposition to the development of new transmission lines. We consider that for pylon development, proper siting is again the most important tool authorities can use to garner social acceptance. However the best practices for siting pylons are different from the case of windfarms due to their previous existence in the most landscapes as seen in the next section.

Pump hydro-storage

Pumped hydro-storage (PHS) is a technology that allows the storage of electricity by pumping water between two storage tanks or reservoirs at different elevations. PHS will see increasing utilization as energy generation peaks become harder to control through the use of solar and wind power generators (Steffen, 2012). Despite the importance of PHS, only one paper has addressed the issue of social acceptance of new PHS facilities. Steffen (2012) explains the potential negative outcomes of PHS as: environmental degradation, watershed damage, malodor, noise and pollution during construction, and safety concerns. Based on the literature regarding other infrastructures we would add to Steffen's list: landscape change, potential viewshed effects, potential changes in recreation opportunities, and ecosystem change.

In the case of PHS it may be that procedural issues are actually more relevant than siting. Much of the logic for considering siting more important than procedural issues was due to the strong viewshed effects of both pylons and windfarms, and the potential of these two technologies to greatly change the landscape and the character of coveted locations. For PHS, viewshed and landscape effects are diminished as the bulk of the structure is low to the ground. Also PHS construction usually involves the creation of a reservoir which may enhance place distinctiveness or have a positive viewshed effect which would increase social acceptance (Devine-Wright, 2011). Furthermore, the construction phase of PHS can be long and intensive and thus social acceptance may benefit greatly by allowing local groups input into how/when construction will be undertaken.

In conclusion, the results of this section suggest that for wind turbines and pylons local governments or developers should focus primarily on choosing a location for construction that minimizes social opposition. In the case of PHS both location and the procedures of a new development should be considered of equal importance. The next section will give advice on how best to foster acceptance with regard to site selection and proceedings. The results of this section imply that the execution of a survey - measuring public opinion between different site options - would be beneficial. Local authorities should also consider how best to approach the procedure of engaging the public. Awareness campaigns should take a backseat to these more important aspects of garnering social acceptance.

BEST PRACTICES FOR IMPROVING PUBLIC ACCEPTANCE

Table 1 shows the result of our synthesis of past literature regarding the best practices to improve public acceptance. This is meant as a guide for policy makers to enable them to quickly understand the best approach to garnering social acceptance of a new development project. This is especially relevant for European policy makers, who, in the near future, have planned many developments of windfarms, transmission lines and PHS infrastructure.

These best practices are drawn from primary studies on the three types of energy infrastructure presented here. We find that the majority of past research has focused on the factors that influence social acceptance. Other studies qualitatively investigate the social acceptance of particular cases of infrastructure development. However we are still able to identify numerous best practices that have strong evidence supporting their use to reduce local opposition. Rigorous quantitative investigations into the efficacy of strategies to improve public acceptance is found lacking. Future studies would do well to study this aspect of social acceptance as it is now the more policy relevant question.

Table 1. Quick guide to improving public acceptance

Negative local effect			
	Viewshed	**Landscape Change**	**Procedure**
Windfarms	Use less intense sychronized lights (Kaldellis et al., 2013), monetary compensation to account for lost property values (Filippova and Rehm, 2011; Sims and Dent, 2007), and place windfarms futher from view (Groothuis, 2008)	Avoid siting in areas with high environmental or archaelogical value (Dimitropoulos and Kontoleon, 2009; Strazzera et al., 2012)	Include public in planning process using carefully worded rhetoric (Evans et al., 2011), have development spearheaded by organization that is most trusted by public (Dimitriopoulos and Kontoleon, 2009; Bronfman et al., 2012), promote outcome and process fairness throughout the development and aftermath of new infrastructure (Gross, 2007)
Pylons	Place pylons near existing pylons (Soini et al., 2011), monetary compensation to account for property value loss (Filippova and Rehm, 2011; Sims and Dent, 2007)	Use 'T'-pylon design to best fit pylon into rural landscapes (Devine-Wright and Batel, 2013), choose a place that is not coveted by public (Strazzera et al., 2012; Devine-Wright, 2012)	
PHS	No evidence of negative viewshed effects	Avoid building dams, or greatly changing the water environment (Steffen, 2012), avoid building in areas coveted by locals*	
Notes	Necessary compensation for residents near windfarms likely less than for those near pylons (Cotton and Devine-Wright, 2012)	*Inferred from research on pylons and windfarms	Procedural best practices are thought to be applicable to each infrastrucuture type.

EMPIRICAL WORK

In an effort to add to Table 1 and give grid developers an additional strategy for increasing public acceptance, we gathered survey data regarding the effect that positive ancillary information has on acceptance.

This effort involved the creation and realization of a full length survey that was given to approximately 300 respondents in each EU-27 nation. The survey included one question on the acceptance of new transmission lines near the respondent’s home. Each respondent was presented with the following baseline scenario while some respondents were additionally presented with one of three possible treatment scenarios[4].

Baseline - "Long term reliability of the electricity system can only be ensured by a bundle of measures, such as - but not exclusively - the construction of new power lines and pylons. Please imagine that your local government announced a large program of local infrastructure investments, contributing to the enhancement of the power grid in the whole of your country. As part of this program, during the next year a high-voltage power line with standard pylons would be built in your neighbourhood. This power line (including pylons) would be up to 60 meters high and be built at a distance of 250meters from your home."

Economic Treatment (T1) - This infrastructure program has significant benefits for your country's economy including, enhanced economic growth, especially in your region, resulting in the creation of new jobs and in greater independence from foreign energy supplies.

Environment Treatment (T2) - This infrastructure program has significant benefits for the environment and complements your country's measures to fight climate change - the strengthening of the national electric infrastructure being necessary for increased use of renewable energy sources, such as wind power.

Community Treatment (T3) - The government and electricity company would compensate you and your community by providing budget for measures to improve the quality of life in your neighbourhood. Possible improvements could include the construction of recreational areas and parks, or equipment for local schools. All people living in the community would have the chance to determine how this extra budget should be used by popular vote.

Next, respondents were asked the **acceptance question**: "How do you think YOU would react to the announcement of this power infrastructure program?" With the ability to choose between four possible reactions: "definitely not accept without opposition" (DNA), "probably not accept without opposition" (PNA), "probably accept without opposition" (PYA), and "definitely accept without opposition" (DYA).

Tabulating the percentage of responses to the question shows that on average 40% of Europeans would "definitely not accept without opposition" a new power line in their area while only 10% would "definitely accept without opposition". This highlights the acceptance issue as there is a strong initial opposition to new projects.

However, as shown in Table 2, those receiving either the economic (T1) or environmental (T2) treatment script had a greatly decreased proportion of DNA responses and increased proportion of DYA responses. The community (T3) treatment on the other hand, did slightly lower the proportion of DNA responses but did not increase the percentage of DYA responses.

[4] For the full explanation and text of the survey please see Gutierrez et al. (2013).

From this initial survey data shown in Table 2, we can draw the tentative conclusion that ancillary information regarding the positive benefits of a new development for the environment or economy will result in decreased opposition to the project.

Table 2. Survey results (%) for DYA and DNA categories

	DNA				DYA			
	Baseline	**T1**	**T2**	**T3**	**Baseline**	**T1**	**T2**	**T3**
France	55.24	22.92	40.74	38.89	1.9	10.42	9.26	4.17
Germany	26.02	19.12	22.22	41.79	13.82	7.35	12.7	11.94
Italy	48.44	37.7	39.34	36.59	9.38	4.92	9.84	12.2
UK	48.48	28.57	35.38	36.76	5.05	10	9.23	10.29
Austria	38.46	40.35	30	49.23	7.69	8.77	5	3.08
Belgium	41.59	27.66	20.93	26	7.96	6.38	18.6	8
Denmark	39.25	35.09	39.53	40.68	11.21	5.26	9.3	10.17
Finland	18.87	3.7	18.33	16.92	9.43	9.26	13.33	10.77
Netherland	43.36	48.15	26.53	46.48	5.31	11.11	22.45	7.04
Spain	45.61	25	29.23	33.96	4.39	16.18	10.77	5.66
Sweden	29.91	22.73	22	28.81	7.69	9.09	20	8.47
Portugal	50.81	31.48	37.74	37.5	13.71	12.96	11.32	10.71
Ireland	50	38.6	31.58	51.79	6.67	8.77	17.54	5.36
Luxembourg	32.65	27.42	31.94	31.82	5.1	14.52	9.72	6.82
Bulgaria	30.93	14.75	16.67	12.73	16.49	29.51	36.36	10.91
Czech	30.37	16.33	27.45	35	13.33	14.29	17.65	15
Estonia	42.61	49.02	29.69	42.31	8.7	5.88	7.81	9.62
Hungary	22.22	26.56	18.97	27.42	9.4	14.06	12.07	11.29
Latvia	35.29	30.36	33.33	37.7	15.97	12.5	10.42	6.56
Lithuania	33.04	26.79	16	25	12.17	17.86	14	18.33
Poland	29.2	10.77	20	18.64	12.39	21.54	13.85	11.86
Romania	15.09	8.06	12.24	10.42	33.96	48.39	34.69	27.08
Slovakia	32.76	24.53	16.98	35.42	13.79	30.19	16.98	16.67
Greece	62.83	37.88	37.31	34.48	3.54	15.15	10.45	13.79
Cyprus	65.12	36.73	38.3	50.85	6.98	12.24	19.15	3.39
Slovenia	52.38	34.04	25.76	39.34	9.52	14.89	19.7	6.56
Malta	44.33	36	32.76	28.57	11.34	18	22.41	16.07
Average	**39.4**	**28.2**	**27.8**	**33.9**	**10.3**	**14.4**	**15.4**	**10.4**

CONCLUSION

Social opposition to new infrastructure projects has the potential to slow the progress of new developments, and derail national goals of energy supply security and greenhouse gas reduction. This topic has been studied extensively, but both the concepts of social acceptance and the policy relevant findings of research were distributed thinly amongst a number of relevant papers, and would be relatively inaccessible to policy makers. This paper contributed to the literature by synthesizing these disparate threads. We first combine different conceptual frameworks and provide a definition of social acceptance that is based on economic utility theory. This offers a unifying conceptualization, and starting point for meaningful discussion of the issue (see Figure 1).

We then reviewed briefly what factors contribute to the social acceptance of each of three types of infrastructure (wind, transmission lines, and pump hydro-storage). Table 1 provides a quick guide for policy makers and future researchers on the state of the literature regarding how best to elicit social acceptance of a new development project. These insights will be useful in the near future for the development of green-energy economies. Our findings also make clear that there is a need for more quantitative assessments measuring the efficacy of different social acceptance strategies. We give a brief example of one such quantitative assessment by measuring the effect of positive information regarding a new grid development on locals' opposition. The survey data indicates that positive benefits to the economy and environment will lower opposition to new development projects. This information allows policy makers and developers to choose implementable tools for improving acceptance for a given infrastructure project.

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