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# Sustainable Electricity Grid Development and the Public: An Economic Approach

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**Abstract**

Increasingly, local opposition to new electricity grid development projects cause lengthy delays and places financial and practical strain on the projects. The structure of the electricity industry is in transition due to the emergence of smaller but more numerous electricity generation facilities. Also, the general public and local communities are increasingly active and engage with energy and environmental issues. Thus, the traditional decision making frameworks and processes are proving less effective in solving the present time conflicts between local communities and other stakeholders. This paper proposes an economic approach to resolve such conflicts. This paper discusses how compensation, benefit sharing, and property rights can play a role in reducing community opposition to new grid developments. We argue that these methods need to be part of an overarching societal strategy and policy towards environmental effects of grid development. We then propose that such impacts can be addressed within the framework of 'weak' versus 'strong' sustainability. Finally, we suggest that the concepts of 'collective negotiation' and 'menu of options' in regulatory economics can be adapted to operationalize this sustainability-based approach to community engagement with new grid projects.

**Keywords** Electricity transmission; Social sustainability; public and local opposition; compensation and benefit sharing.

**JEL Classification** L43, L94, D23, D70

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Increasingly, local opposition to new electricity grid development projects cause lengthy delays and places financial and practical strain on the projects. The structure of the electricity industry is in transition due to the emergence of smaller but more numerous electricity generation facilities. Also, the general public and local communities are increasingly active and engage with energy and environmental issues. Thus, the traditional decision making frameworks and processes are proving less effective in solving the present time conflicts between local communities and other stakeholders. This paper proposes an economic approach to resolve such conflicts. This paper discusses how compensation, benefit sharing, and property rights can play a role in reducing community opposition to new grid developments. We argue that these methods need to be part of an overarching societal strategy and policy towards environmental effects of grid development. We then propose that such impacts can be addressed within the framework of 'weak' versus 'strong' sustainability. Finally, we suggest that the concepts of 'collective negotiation' and 'menu of options' in regulatory economics can be adapted to operationalize this sustainability-based approach to community engagement with new grid projects.

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## 1. Introduction

A timely development of national infrastructures is a prerequisite for economic growth and is generally associated with significant economic and social returns (Easterly and Servén, 2003). Such undertakings include electricity transmission networks, which following ambitious environmental targets need to connect a growing number of renewable energy facilities. Despite their economic benefits, grid development projects often involve adverse environmental impacts and give rise to community opposition[1]. Failing to reach agreement on deployment and siting of projects causes lengthy and costly delays to the planning process and even jeopardise the project altogether (Kunreuther *et al.,* 1996; RGI, 2012).

Although community opposition to major national infrastructure projects is not new, the implications of local resistance for the future development of the sector are on the rise. The context of decision-making in the electricity sector has gradually shifted from one of being a primarily technical matter to an increasingly social, environmental, and thus political one. Therefore, the established decision making framework and processes for grid development seem increasingly unable to effectively engage with more active communities.

There are three main reasons for this trend. First, the nature of the energy industry has been changing due to the emergence of smaller but more numerous generation facilities, thus increasing their visibility and potential local impact. Second, the public and community awareness and engagement in relation to the energy sector and environmental issues has increased. Third, as the nature of the energy industry and public engagement with grid development has changed, the institutional arrangements within which such policy decisions are made, have not changes. Thus, an innovative approach is required to adapt the decision-making framework to better suit the current and future needs of the sector.

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[1] Apart from transmission grid development, other examples of developments subjected to local opposition include airports, prisons, power plants and linear structures such as pipelines, and railways.

From an economic point of view, local opposition can be considered as the result of externalities caused by grid development and imposed on neighbouring communities. Given the standard assumptions of economic rationality, perfect information and zero transaction costs, a solution that internalises the local externalities can, in theory, be derived. With regards to single location facilities, the potential for providing compensation to affected communities is explored in an extensive body of literature, initiated first by O'Hare (1977).

However, the practical applications of a financial compensation are not trivial, including the difficulty in estimating the exact costs and benefits of the projects and the public perception of compensation as a bribe (Frey *et al.*, 1996). Other measures to foster acceptance and to increase the local retention of profits include the provision of community benefit schemes. These measures are particularly common in wind power developments and have been successfully implemented in countries such as the UK, Denmark and Germany (CSE, 2009; Cass *et al.,* 2010).

Relative to renewable energy project developments and other single location infrastructure facilities, transmission network developments have received comparatively limited attention from academic researchers (some notable exceptions include Ciupuliga and Cuppen, 2013; Cotton and Devine-Wright, 2013; Soini *et al.,* 2011). This is particularly the case with regards to compensation or community benefit provision schemes.

There are some shared characteristics between single location facilities and grid developments, such as large sunk costs, negative externalities, public goods, information asymmetries and similarities in resistance from local communities. However, the technical characteristics and economic regulation of transmission grids necessitate design of innovative approaches to organise local community impact and involvement in grid development. Therefore, there is a need for alternative modes of conceptualising community opposition and engagement with transmission grid development projects (Batel *et al.*, 2013).

Drawing from established economic theories and concepts, this paper suggests a new approach based on the environmental sustainability perspective to facilitate a sustainable and more efficient planning and implementation of transmission projects. The paper is structured as follows: Section 2 outlines the economic properties of electricity networks and developments. Section 3 discusses the economics characteristics of community engagement in developments. Section 4 outlines an analytical framework and Section 5 concludes.

## 2. Economics of Electricity Networks and Grid Development

Electricity networks are widely regarded as being natural monopolies. This implies that these networks are highly capital intensive and their cost structure is such that the fixed costs are large in relation to the total costs. This feature results in declining average costs as their scale increases. As a result, the provision of a given quantity of output by a single network is more cost efficient than by several competing networks. Consequently, such networks are subject to public ownership or some form of economic regulation.

Network utilities generally operate under licence agreements that oblige them to connect the generators and end-users in a timely and effective manner. The utilities are also expected to operate the network in a cost efficient manner. In return, the utility can charge the users for the use of network services and earn a regulated return or revenue (Joskow, 2007). The network charges are, in the first instance, accrued to generators and retail suppliers but are ultimately passed to end users through their bills. Many networks in Europe operate under incentive regulation models that reward firms for cost efficiency and penalises high costs (Joskow, 2013).

The costs incurred by network utilities can be classified into allowable controllable and non-controllable costs. Non-controllable costs are regarded as being beyond the control of the management and are generally treated as pass-through and thus do not affect the profits of the utility. On the other hand, controllable costs are subject to reward and penalty incentives. A cost type or item that is disallowed by the regulator will directly and negatively affect the revenue and profit of the utility. Allowed operating costs can be recovered and allowed investments will earn a specified return (Jamasb and Pollitt, 2001).

A key objective of the regulator is to maximise the socio-economic welfare of the consumers. Costs that are over and above the efficient level will reduce the net system benefits. Meanwhile, compensations or benefits to local communities become a distributional matter between the communities and the consumers of the frid services as a whole. However, prior to addressing the specific methods and mechanisms for compensation or community benefits, it is important to conceptualise the nature of community level environmental impact and entitlement to compensation in economic terms.

Transmission lines cross long stretches of land and each new project has a number of stakeholders, including the government, local authority, local businesses, landowners, local communities, and interest organisations. Each stakeholder perceives the grid projects differently and has own view and experience of the decision process. These heterogeneous views and objectives of stakeholders often cause conflict of interest and opposition. Moreover, information asymmetries among the actors can intensify the frictions between stakeholders further as it can induce rent-seeking behaviour and reduce trust between them. Consequently, the economics of grid development can be characterised as also having high transaction costs. Achieving agreements that internalise the externalities caused by transmission projects can become costly to negotiate, especially when the number of stakeholders involved is large (Tobiasson *et al*., 2014).

A grid project can be thought of as having two types of costs – i.e. private costs in the form of construction and maintenance costs as well as external costs accrued to third parties. The latter type of costs can include direct economic costs, for example, loss of revenue to owners of agricultural land, and as in the form of negative environmental externalities. The direct economic costs are generally observable and measurable through market prices or compensation methods.

For instance, there are established norms and formulas for compensating owners of farmlands for loss of use value of land in terms of lost output and revenue.

The main difficulty arises, however, when taking the external costs in the form of intrinsic value of environmental amenities accrued to third parties, i.e. affected communities, into account. Grid development projects can be viewed as having an effect on public goods characterised by non-excludability and non-rivalry in consumption. The communities along the new lines enjoy limited or no direct benefits from the development, similar to a new railway passing the community without stopping at the local station. The effects of these externalities such as negative visual, health, and environmental effects as well as financial loss such as reduced property values on local communities translate into reduced utility and economic welfare (Cohen *et al*., 2014). In the absence of market prices, public goods are implicitly assigned a monetary value of zero and when actions of one agent affect consumption of other users of the public good, there is no simple economic or legal remedy at hand and conflicts arise.

## 3. Economics of Community Engagement in Grid Development

### 3.1 The current state

Public and local opposition to new transmission lines is a common cause of delay and can become a barrier to the realisation of future low-carbon systems. Recent cases of conflicts include the Scottish Beauly-Denny line, which was the subject of the longest ever public inquiry in Scotland (Tobiasson *et al.,* 2014); the France-Spain interconnection project, first proposed in 1980 and met by considerable opposition bringing round a second proposal in 2003 and is now expected to be completed in 2014 (Ciupuliga and Cuppen, 2013); and the Norwegian Hardanger transmission line, which was one of the 2010's most reported news stories in Norway (Ruud *et al*., 2011).

A growing body of literature considers the motives behind and discusses possible measures to reduce community opposition to locally unwanted facilities. The pejorative label of NIMBY (not in my backyard) opposition is considered as outdated (Burningham *et al.,* 2006) and recent work has revealed a complex heterogeneous composition of opposition[2] (Batel and Devine-Wright, 2014; Cotton and Devine-Wright, 2013; Johnson and Scicchitano, 2012; Wolsink, 2000). However, the research to date is predominantly focused on single location facilities, such as renewable energy generation technologies (Jobert *et al.,* 2007; Wolsink, 2000; Devine-Wright, 2011), as well as waste and hazardous facilities (Johnson and Scicchitano, 2012; Kunreuther *et al.,* 1996).

Part of the difficulty in addressing the stakeholder conflicts in grid developments lies in the challenge to define, measure and compensate communities for the environmental impacts of the projects. The benefits of most infrastructure facilities are widely spread across the economy, whilst much of their adverse impacts tend to be local. This is also the case with energy generation plants. However, the large geographical span of linear infrastructures often affects multiple communities rather than one host community. Also, due to the complex design and technical nature of the networks, the added system benefits associated with an incremental network expansion or enhancement project are difficult to define or estimate. In contrast, for energy generation plants the capacities and outputs, and therefore the benefits, are easily measureable in both physical and monetary terms. Moreover, identification, estimation, and treatment of associated environmental costs also add to the complexity of the decision-making.

With regards to transmission development projects, the main reasons that trigger public opposition include strong place attachments to the local area; the type, level and quality of communication; lack of trust for the developer and governmental agencies; harmful effects on health and the environment; and unconvincing arguments for the need case of the new line and for any beneficial

[2] Rather than the homogeneous assumptions defining NIMBY opposition.

impacts arising from it (Ciupuliga and Cuppen, 2013; Cotton and Devine-Wright, 2013; Devine-Wright, 2013).

In order to increase public trust, reduce stakeholder conflicts, and therefore encourage acceptance of new developments, recent social science research suggests increased information provision as well as more emphasis on communication and community involvement at an earlier stage and in a more deliberative planning process (RGI, 2012; Newig and Kvarda, 2012; Cotton and Devine-Wright, 2012; CSE, 2009). Additionally, Ciupuliga and Cuppen (2013) highlight the role of dialogue in the planning process, which is argued to not only foster social acceptance of transmission developments, but also benefit the project through the access to local knowledge and insights.

Unlike local communities, landowners tend to be consulted at the initial stages of planning when the optimal route is being identified. Clearly, this is because they possess a legal right to their land and others cannot normally use the land without their consent. In theory, financial compensation is offered at the market rate of the land and should be accepted. In practice, this is not always the case, as seen in the case of Irish gas pipeline project leading to the imprisonment of five landowners refusing the developer access to their land despite a court order (Gilmartin, 2009). However, issues related to landowners are not considered in this paper as each sector has established norms and methods of addressing direct losses. Rather, the focus of this paper is on the environmental impacts of grid development projects on local communities which are often ignored.

### 3.2 Need for a new perspective on grid development

Although there are some shared characteristics with other energy facilities, the technical and economic features of transmission grid projects are different in several respects and thus require sector specific solutions. For instance, measuring the relevant output of an incremental new line for compensation and benefit sharing is considerably more complicated. Also, whilst generation of electricity from wind power is competitive, electricity transmission networks are natural monopolies and require economic regulation.

New grid projects are ultimately financed by electricity consumers through transmission fees collected on electricity bills. Thus increasing the project costs through either undergrounding lines or paying compensation is borne by all electricity users across the country. In terms of land-use, transmission lines are linear infrastructures, covering great stretches of land, thus affecting many stakeholders, types of land, land uses, and sensitive areas. Additionally, the physical features of networks complicate matters further as a change in one part of the network will also have an effect on the rest of the system. Consequently, specific benefits of grid upgrades are difficult to identify, quantify, and allocate. Rather than confined benefits of a single line, any upgrade benefits the reliability and security of the network as a whole.

Figure 1 illustrates the main insights from recent research and the economic characteristics of grid developments. The figure shows the key dimensions and features of community engagement when implementing a new grid project. On the one hand, issues related to private goods with few stakeholders are considered. Decisions are made based on individual preferences, choice and rationale. On the other hand, the issues related to public goods on a social level and rationale is represented.

The figure identifies two approaches to community engagement with grid projects. Goods, which have private ownership and entitlement, can be considered on an individual level as they involve few stakeholders. Issues on an individual level may therefore be managed through an instrumental approach. The term instrumental refers to a set framework that can be applied in different situations and without much modification. This is the current approach for compensation to landowners for structures placed on their land, for example, through offering a fixed amount per pylon or a wind turbine, dependent on its size or alternatively on its energy produced or transmitted.

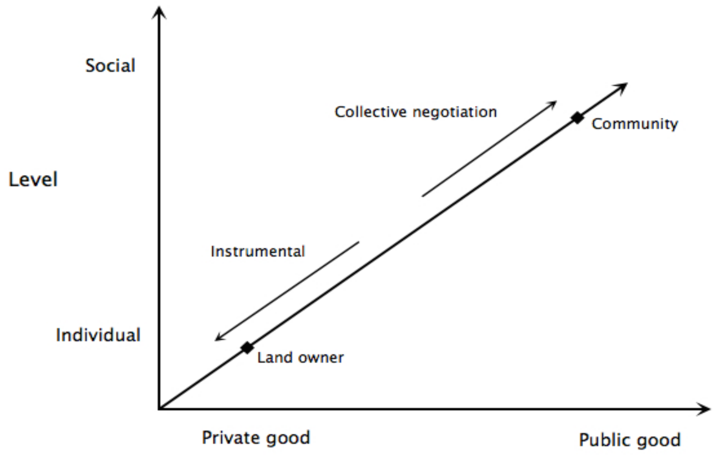


**Figure 1. Dimensions of community engagement**

**Source: Adapted from Vatn (2005, 419)**

Conversely, goods which are public in nature and entitlement, and thus must be considered on a social level, i.e. involve many stakeholders, require a collective negotiation approach. When the number of stakeholders is high, and a decision will affect large groups, the importance of communication increases, especially as two-way negotiations. As illustrated by the figure, communication on a collective level is the approach that could be adopted in engagement with communities. This is however seldom the case, giving rise to conflicts (RGI, 2012).

The insights emerging from the literature, the recent research on the diversity of opposition, and the difficulty of applying compensatory measures in practice suggest that there remain many issues to be resolved. Financial arrangements such as compensations and benefit sharing schemes have been suggested as practical measures to redistribute the costs and benefits of large projects in order to make the outcome of decision-making more socially acceptable and economically efficient. However, a broader theory-informed approach and conceptualisation of the community engagement with grid development projects is needed to better understand the issues involved and devise structured solutions to resolve them (Been, 1993).

# 4. Towards a Sustainable Grid Development Approach

## 4.1 Financial compensation and benefit provision

A common measure to assist the siting of locally unwanted facilities, which has long been the focus of particularly economic researchers, is that of monetary compensation to prospective host communities. This notion was first introduced by O'Hare (1977), declaring it to be necessary for an efficient siting process. More recently, Lesbirel (1998) find compensation to positively facilitate the siting of energy plants in Japan while McAdam *et al.* (2010) argues that failing to compensate the host country of a pipeline is linked to mobilised opposition.

Community compensation through financial arrangements can in principal be in the form of (i) one-off lump sum payments, (ii) a stream of payments; or (iii) some form of part-ownership. Alternatively, the developers can offer direct investments in the community benefits such as infrastructural upgrades (e.g. new, better roads, increased connectivity such as fibre optic broadband) or other benefits such as tax reductions or reduced energy prices.

Lump sum payments involve one-off payments to a community fund when the project starts operating. Assuming good management and careful investment the fund could generate continued income. Alternatively, a developer may offer annual payments. In wind power developments in the UK this is normally per megawatt (e.g. £5,000 per MW), linked to the generation capacity or energy output of the project, or a fraction of the revenues generated (CSE, 2009). As mentioned, given the nature of transmission development projects, the output and added benefits of a new line are difficult to determine rendering such measures difficult to implement. Instead a less direct option could be to link the size of compensation to total investments, number of pylons, or perhaps per km of grid length.

A share in the project can either be provided as a form of compensation from the developer or acquired as an investment (CSE, 2009). In a study conducted in

Scotland, Warren and McFadyen (2010) find that local ownership may have a positive effect on public attitudes towards wind farms and Allan *et al.* (2011) suggests that local community ownership and thus local retention of profits increase the economic impact of wind farms. However, direct application of the instruments used in wind power developments for transmission lines is difficult. For a regulated industry, where profits are generally earned through return on investment in assets rather than through operation, the nature of the risks is different. Additionally, the deposition of the electricity grid and dependency with other parts of the network make it difficult to integrate community ownership of one or part of a transmission line.

On the other hand, Frey *et al.* (1996) argues that offering compensation to prospective host communities will have a negative effect on acceptance and Kunreuther and Easterling (1990) and Oberholzer-Gee *et al.* (1995), find no link between financial compensation and efficient siting and local approval of nuclear-waste repositories. Instead, the perception of compensation as a bribe and the crowding out of the feeling of civic duty can increase the opposition to the project. This was shown to be the case in a Swiss study where the rate of community acceptance of a nuclear-waste repository was found to decline, from 50.8 to 24.6 percent, when compensation was offered compared to when no compensation was offered (Frey and Oberholzer-Gee, 1997).

As a result, rather than using direct financial compensation, Frey *et al.* (1996) suggests that in-kind compensation, intended to benefit the community as a whole, weakens the bribe effect and thus supports the siting process of locally unwanted projects. An example of local benefit sharing is the provision of 'Community Benefit Schemes'. Such sharing schemes, which may contain anything from "good-will" gestures, such as upgrading a road or a new playground, to financial arrangements, such as payments to a community fund or community ownership, have proven effective in increasing local support for wind power developments. This is particularly the case in countries such as Denmark and Spain, where local ownership, and thus greater local retention of profits, are more common (CSE, 2009; Warren and McFadyen, 2010; Allan *et al.,* 2011). However, UK communities remain unconvinced of the intentions behind the benefit provision with many still considering it as a method to silent opposition with bribes (Cass *et al.,* 2010). Even well intentioned developers seldom receive the trust of local communities, which may be partially due to the timing of the offered compensation (Aitken, 2010).

### 4.2 A property rights view of grid development

While the communities affected by grid development may oppose the projects, the nature of the community claim on the local environment needs some consideration. The affected communities do not normally have a private ownership right to the landscape in question. Nevertheless, they have the right to the use of their immediate natural environment along with the general public.

However, if a community have enjoyed the benefits of a public good, such as a landscape or scenery, this can over time give the impression of ownership entitlement or right to these[3]. Formation of entitlement or rights views is also common in the case of subsidies, licences, or quotas that are renewed for long periods of time. A community can assume or behave as having a property right or private entitlement to local aspects of public goods adversely affected by grid projects and thus the perception of entitlement to property or user rights becomes a central, though subtle, aspect of the opposition to the project.

Using a property rights view, we can consider a simple form of community compensation payment or benefit receipt to reach a resolution. In order to construct a new transmission line, there are two technical options: An overground line at cost (A) or, at a higher cost, a partially undergrounded cable at cost (B). The cost difference between the two options is thus (B-A) and

[3] Note that this view of entitlement and benefit is purely from an economic perspective, opinions of other fields of research, such as environmental phycology, would no doubt differ.

undergrounding is assumed to generate project acceptance[4]. If the general public holds the property rights to the affected landscape, the local communities can be thought as having a WTP (willingness to pay) to avoid the project. This WTP will be equal to (B-A) and to the WTA (willingness to accept) of the general public (or network utility) as they are indifferent between the two options and the project costs to them remain unchanged.

Alternatively, the environmental property rights to the landscape can be allocated to the affected local communities[5]. In this case, the community can accept the project through a WTA mechanism. In this case, the society or the developer will have a maximum WTP that is equal to the cost difference between the underground and overground options (B-A), which is also equal to the maximum WTA the communities can achieve. If the communities demand more than (B-A) they will receive nothing as the developer will choose to underground the line.

Following Coase (1960), the outcomes of the above two cases are equal in terms of economic efficiency as the WTA and WTP will be equal to (B-A). However, depending on the initial allocation of property rights, the distributional effects and the actual or perceived equity implications are significant and crucial from a political economy point of view. For example, the former case may be perceived as unfair that the communities should pay the society in order to avoid the negative impact of the project or have the line placed underground.

### 4.3 An environmental sustainability approach to grid development

The economic approaches to community engagement in grid development based on individual or collective compensation, benefit sharing, and property rights allocation can help reduce community opposition to grid development projects. However, these approaches have, on their own, methodological and practical

[4] Although this may not be a realistic assumption in real world situations we use this simplified view to illustrate our example.
[5] Note that transmission lines may affect other than local residents although not captured by this approach.

shortcomings. The main limitation is related to that of identification as well as the lack of clear property rights and assignment of such rights in the absence of clear entitlement to these. In addition, although such approaches could help reduce the level of conflict, they may not necessarily be desirable from an environmental sustainability point of view as they are generally short-term approaches without a sustainability and intertemporal rationale. Therefore, the above economic instruments can be more effective when used within a high level environmental strategy that links the individual and community interests to an overarching social policy and public decision rule and process (see Cain and Nelson, 2013). Given the above reasoning, we propose an economics informed environmental sustainability approach as the basis for a coherent and comprehensive decision framework.

This alternative economic approach can be explored based around the concept of environmental sustainability and the related notion of intergenerational equity. Within this perspective, the adverse environmental effects of grid projects can be viewed in terms of transformation of natural assets from one form to another. As first suggested by Hardwick (1977) and Solow (1986), the total value of a non-renewable environmental resource can be preserved over time by investing or transforming the benefits or rents from the use of a natural resource into other assets. This transformation can be in the form of strong or weak sustainability.

In a strong sustainability viewpoint, the total value of a resource or natural asset is to be maintained for current and future generations if an equivalent value of environmental asset can be created from the rents. On the other hand, within a weak sustainability view, some form of financial or social capital (in this case perhaps community capital) of the same value can be created from the benefits of the project. Other possibilities such as transforming the natural asset into physical or human capital can also exist in the spectrum of sustainability options (Ayres *et al.,* 1998; Dietz and Neumayer, 2007). Practical examples of weak sustainability policy in include the sovereign funds in resource rich countries such as the Norwegian Petroleum Fund that invest part of the petroleum proceeds in financial assets.

Similarly, the environmental impact of a grid development can be viewed in terms of weak and strong sustainability. If a grid development project is deemed to produce a net socio-economic surplus this implies the project can compensate for the environmental damage of the project. This compensation can be in the form of creating an equivalent benefit or value elsewhere. Within this framework, the wider society as a whole must decide on the acceptable form of the transformation and conversion of the value of the natural assets affected by grid development while preserving their total value – i.e. whether the natural asset affected should be transformed into another natural asset or into physical, financial, social, or human capital. This decision should be part of a high level and long-term sustainability strategy that informs the decision-making framework, rules, and processes.

### *4.3.1 From compensation and benefit sharing to community investment*

Compensation of a public nature can be perceived to be fairer and more honest compared to individual monetary compensation and is thus more likely to be successful (Terwel *et al.,* 2014: Frey *et al.,* 1996). However, grid projects have lasting inter-temporal environmental impacts. A weakness of ad hoc and narrow approaches based on compensation and benefit sharing is that they may result in one-off short-term solutions and settlements that do not ensure dynamic and inter-generational equity. Therefore, preserving the value of an environmental asset will often require investment in other assets that produce sustainable long-term benefits. It is, in principal, possible for the society to adhere to a strong or weak sustainability criterion and create 'community capital' through 'community investments' in another form of capital. For example, the Beauly-Denny transmission line project had an element of both strong and weak sustainability; the developers were required to improve the environment along certain sections beyond the effect of the new line. In two cases they were also required to provide financial compensation to affected communities.

Assigning compensation to individual members of a community is impractical as the transaction costs would increase significantly with allocating individual compensation rights. Also, the task of identifying *who* is entitled to compensation is difficult as there are often no defined criteria. Proximity to the new line may seem an obvious measure. For example, Sims and Dent (2005) find that proximity to a transmission line lowers property prices and Gibbons (2014) suggests similar results with regards to wind power developments. However, where the dividing lines for compensation should be drawn is difficult. A more suitable approach is therefore to aggregate compensations and the method agreed on through collective negotiations on a society-wide level.

#### *4.3.2 Community investment through collective negotiation*

As a complement to traditional regulatory approaches, some regulators in North America have used negotiated settlements between utilities and their costumers to determine cost, price and operating projections. Negotiated settlements have proved to limit the regulatory workload, decreasing delays and increase efficiency (Doucet and Littlechild, 2006). Similarly, community investments can benefit from applying the method of negotiated settlement, or here, collective negotiation.

Offering investments in community infrastructure or services is common in wind power developments, often labelled as 'community benefits'. Upgrading roads or recreational spaces gives a developer the opportunity to work directly with the community. Transmission developments involve several communities (rather than one host community which is the case in energy generation facilities) and each community has specific needs that can be identified through participation in the planning process and addressed when developing the compensatory approach. Furthermore, by encouraging the stakeholders to reveal private information about their preferences, negotiations between the developer and the community about the level and type of compensation can increase social welfare.

Oberholzer-Gee *et al.* (1995) find that granting authority to affected communities and two-way negotiations, thus customer and public participation in the planning process, increases local approval of the facilities. Such negotiation will open for innovative solutions that would not have been envisaged by policy makers and developers as local knowledge and needs is utilised, thus increasing the efficiency and welfare effect of the outcome (Doucet and Littlechild, 2006; Ciupuliga and Cuppen, 2013). This is further emphasized by Kunreuther and Easterling (1996), arguing the case for a voluntary siting process and negotiated compensation, rather than using predetermined compensation measures without community influence.

Moreover, compensating the communities rather than the individual members reduces the transaction costs low as the number of participants in negotiations is lower. Nevertheless, even when the number of participants is low, negotiations risk the possibility of a breakdown if the parties fail to reach an agreement. In order to reduce the probability of unsuccessful negotiations, an independent authority such as the sector regulator could step in as mediator, which will intervene in case that no agreement is reached. It is, however, in the interest of both parties to reach an agreement as, in case of failure to agree, the regulator can impose a socio-economically less favourable outcome (Doucet and Littlechild, 2006). Appointing an ultimate decision maker and arbitrator also limits the appeal of hold up or rent-seeking behaviour as it is less likely that one party to negotiations can uphold the process and rent seeking behaviour.

#### *4.3.3 Menu of options method for collective negotiations*

At the presence of uncertainty and information asymmetry it is difficult to form and maintain robust principal-agent relationships. The transaction costs are higher in negotiations, leading to inefficient outcomes. In regulatory economics, the use of a menu of options or contracts is expected to reduce the effect of uncertainty and information asymmetry (Laffont and Tirole, 1986; Laffont, 1993). Keeping consumer welfare constant, the regulator can offer the firm a choice of different regulatory contracts, which essentially consist of different combinations of cost sharing provisions (a fixed component and a component dependent on the responsiveness of the firm’s revenues to costs). The firm will choose the optimising contract depending on its cost opportunities (Joskow, 2007). Pareto improvements are possible since consumer welfare is kept constant and firms can increase their welfare due to the flexibility to choose an optimising contract based on private firm information which was previously unknown by the regulator (Crew and Kleindorfer, 1992).

A menu of contracts can thus be used in order to elicit information and increase efficiency. Drawing on the theory in regulatory economics, a similar approach may be developed to optimize the provision of sustainability based compensations for transmission grid projects. In this, the developer offers the affected community a set of compensatory measures. The cost of different alternatives can be held constant at a reference cost, for example in the above case at the difference between the cost of an overhead line and an underground cable. Given the knowledge in terms of different compensatory options, a menu of these options may, for example, consist of a choice between community fund payments, infrastructure developments, community ownership, and environmental investments.

By providing a menu of options, the communities can choose among a set of sustainable solutions that maximizes their welfare depending on their attributes and value to the community. This self-selecting process is preferable since choosing one contract or option is the equivalent of revealing internal information, which would otherwise remain unknown. Thus the process is more efficient than if the developer or the government were to design and implement a policy without consulting the community through collective negotiation within a sustainability framework.

## 5. Conclusions

The electricity networks need to upgrade and expand in order to meet the future demands of the sector, including connecting smaller but numerous conventional and renewable generation facilities. However, many new transmission lines are facing opposition from the affected local communities on the grounds of their environmental impacts. The conflicts cause delays and prolong planning thus adding to the project costs and foregone system benefits. The conventional decision approaches seem unable to resolve many of the conflicts. There is therefore a need for a new approach to address the community opposition to grid development projects.

In this paper we discussed direct compensation and benefit sharing methods, as well as property rights approaches and how these measures can play a role in reducing community opposition to grid development. However, these methods currently lack an overarching theoretical and methodological framework to structure and guide the process, which is important for gaining the trust and acceptance of communities and society as a whole.

We suggest an economic approach to grid development that is based on the concepts of weak and strong sustainability and that the environmental affected by grid developments, rather than the community per se, can be compensated within a sustainability approach. It is however ultimately for the larger society to decide, through public and social policy decision framework, on the nature of the compensation along the spectrum of weak to strong sustainability options - e.g. in the form of lasting investments in environmental, physical, financial, social, or human capital. This compensation can, to an agreed upon extent, accrue to the affected communities, although it is up to the society decide on how and on the level. While financial compensations appeal to the consumer dimension of communities and members as economic agents, compensation in the form of environmental assets appeal to the citizenship dimension of these.

The suggested mechanism can be in the form of collective negotiations between the communities and developer with the consent of the regulator and policy makers. The efficiency and acceptance of the outcome of collective negotiations can then be further improved through the use of a menu of options an established concept in regulatory economics. This paper provides a conceptual framework that unlocks an area of potential empirical research. Future studies should examine the practical application and the process of operationalizing the sustainability approach.

## References

Aitken, M. (2010), Wind power and community benefits: Challenges and opportunities. *Energy Policy*, *38*(10), 6066-6075.

Allan, G., Mcgregor, P. and Swales, K. (2011), The importance of revenue sharing for the local economic impacts of a renewable energy project: A social accounting matric approach, *Regional Studies,* 45(9), 1171-1186.

Atkinson, G., Day, B., and Mourato, S. (2006), 10. Underground or overground? Measuring the visual disamenity from overhead electricity transmission lines, in Pearce, D.W (Ed.), *Environmental valuation in developed countries: case studies*, Edward Elgar Publishing, pp. 213-239.

Ayres, R.U., van den Bergh, J.C., and Gowdy, J.M. (1998), *Viewpoint: weak versus strong sustainability*. Tinbergen Institute Discussion Paper, (No. 98-103/3).

Batel, S., and Devine-Wright, P. (2014). A critical and empirical analysis of the national-local 'gap'in public responses to large-scale energy infrastructures. *Journal of Environmental Planning and Management*, (ahead-of-print), 1-20.

Batel, S., Devine-Wright, P., and Tangeland, T. (2013), Social acceptance of low carbon energy and associated infrastructures: A critical assessment, *Energy Policy*, 58, 1-5.

Been, V. (1993), Compensated siting proposals: Is it time to pay attention? *Fordham Urban Law Journal*, 21(3), 787-826.

Burningham, K., Barnett, J., and Thrush, D. (2006), *The Limitations of the NIMBY Concept for Understanding Public Engagement with Renewable Energy Technologies: A Literature Review*, Beyond Nimbyism research project Working Paper 1.3.
http://geography.exeter.ac.uk/beyond_nimbyism/deliverables/bn_wp1_3.pdf

Cain, N.L. and Nelson, H.T. (2013), What drives opposition to high-voltage transmission lines?, *Land Use Policy*, 33, 204-213.

Cass, N., Walker, G., and Devine-Wright, P. (2010), Good neighbours, public relations and bribes: the politics and perceptions of community benefit provision in renewable energy development in the UK. *Journal of Environmental Policy & Planning*, *12*(3), 255-275.

Ciupuliga, A.R. and Cuppen, E. (2013), The role of dialogue in fostering acceptance of transmission lines: the case of a France–Spain interconnection project, *Energy Policy*, 60, 224-233.

Coase, R.H. (1960), The problem of social cost, *Journal of Law and Economics*, *3* (October), 1-41.

Cohen, J.J., Reichl, J., and Schmidthaler, M. (2014), Re-focusing research efforts on the public acceptance of energy infrastructure: A critical review, *Energy*, (ahead-of-print), 1-6.

Cotton, M. and Devine-Wright, P. (2013), Putting pylons into place: A UK case study of public perspectives on the impacts of high voltage overhead transmission lines, *Journal of Environmental Planning and Management*, 58(8), 1225-1245.

Cotton, M. and Devine-Wright, P. (2012), Making electricity networks "visible": Industry and actor representations of "publics" and public engagement in infrastructure planning, *Public Understanding of Science,* 21(1), 17-34.

Crew, M.A., and Kleindorfer, P.R. (1996), Incentive regulation in the United Kingdom and the United States: Some lessons, *Journal of Regulatory Economics*, *9*(3), 211-225.

CSE (2009), Delivering community benefits from wind energy development: A toolkit, Report to Renewables Advisory Board, Centre for Sustainable Energy with Garrad Hassan and Partners Ltd, Peter Capener and Bond Pearce LLP. Available at: http://www.decc.gov.uk (accessed 2012-08-11).

Devine-Wright, P. (2013), Explaining "NIMBY" Objections to a power line: The role of personal, place attachment and project-related factors, *Environment and Behavior*, *45*(6), 761-781.

Devine-Wright, P. (2011), Place attachment and public acceptance of renewable energy: A tidal energy case study, *Journal of Environmental Psychology*, *31*(4), 336-343.

Devine-Wright, P., Devine-Wright, H., and Sherry-Brennan, F. (2010). Visible technologies, invisible organisations: An empirical study of public beliefs about electricity supply networks. *Energy policy*, *38*(8), 4127-4134.

Dietz, S. and Neumayer, E. (2007), Weak and strong sustainability in the SEEA: Concepts and measurement. *Ecological Economics*, *61*(4), 617-626.

Doucet, J. and Littlechild, S. (2006), Negotiated settlements: The development of legal and economic thinking. *Utilities Policy*, *14*(4), 266-277.

Dyer, J.H. and Chu, W. (2003), The role of trustworthiness in reducing transaction costs and improving performance: Empirical evidence from the United States, Japan, and Korea, *Organization Science*, 14(1), 57-68.

Easterly, W. and Serven, L. (Eds.) (2003). *The limits of stabilization: infrastructure, public deficits and growth in Latin America*. World Bank Publications, Washington, DC.

Furby, L., Slovic, P., Fischhoff, B., and Gregory, R. (1988), Public perceptions of electric power transmission lines, *Journal of Environmental Psychology*, 8(1), 19-43.

Frey, B.S. and Oberholzer-Gee, F. (1997), The cost of price incentives: An empirical analysis of motivation crowding-out. *The American Economic Review*, 87(4), 746-755.

Frey, B.S., Oberholzer-Gee, F. and Eichenberger, R. (1996), The old lady visits your backyard: A tale of morals and markets. *Journal of Political Economy*, 104(6), 1297-1313.

Gibbons, S. (2014), Gone with the wind: Valuing the visual impacts of wind turbines through house prices, *SERC Discussion paper 159*, Available at: http://www.spatialeconomics.ac.uk/textonly/SERC/publications/download/sercdp0159.pdf (Accessed 11 April 2014).

Gilmartin, M. (2009), Border thinking: Rossport, Shell and the political geographies of a gas pipeline, *Political Geography*, *28*(5), 274-282.

Hartwick, J.M. (1977), Intergenerational equity and the investing of rents from exhaustible resources, *American Economic Review,* 67(5), 972-974.

Horowitz, J.K. and McConnell, K.E. (2002), A review of WTA/WTP studies. *Journal of Environmental Economics and Management*, *44*(3), 426-447.

Jamasb, T. and Pollitt, M. (2001), Benchmarking and regulation: International electricity experience, *Utilities Policy*, 9(3), 107-130.

Jobert, A., Laborgne, P., and Mimler, S. (2007), Local acceptance of wind energy: Factors of success identified in French and German case studies, *Energy Policy*, 35(5), 2751-2760.

Johnson, R.J. and Scicchitano, M.J. (2012), Don't call me NIMBY: Public attitudes toward solid waste facilities, *Environment and Behavior,* 44(3), 410-426.

Joskow, P.L. (2013), Incentive regulation in theory and practice: electricity distribution and transmission networks. In *Economic Regulation and Its Reform: What Have We Learned?*. University of Chicago Press.

Joskow, P.L. (2007), Regulation of natural monopoly. *Handbook of Law and Economics*, *2*, 1227-1348.

Kunreuther, H., and Easterling, D. (1996), The role of compensation in siting hazardous facilities, *Journal of Policy Analysis and Management*, *15*(4), 601-622.

Kunreuther, H. and Easterling, D. (1990), Are risk-benefit tradeoffs possible in siting hazardous facilities? *American Economic Review*, 80(2), 252-256.

Kunreuther, H., Linnerooth-Bayer, J., and Fitzgerald, K. (1994), *Siting hazardous facilities: Lessons from Europe and America*. Wharton Risk Management and Decision Processes Center.

Laffont, J.J. (1993), *A theory of incentives in procurement and regulation*. MIT press.

Laffont, J.J., and Tirole, J. (1986), Using cost observation to regulate firms, *The Journal of Political Economy*, 94(3), 614-641.

Lesbirel, S.H. (1998), *NIMBY politics in Japan: Energy siting and the management of environmental conflict*, Cornell University Press.

Linnerooth-Bayer, J., and Fitzgerald, K.B. (1996), Conflicting views on fair siting processes: Evidence from Austria and the US. *Risk: Health, Safety & Environment* ,7(2), 119–34.

McAdam, D., Boudet, H.S., Davis, J., Orr, R.J., Richard Scott, W., and Levitt, R.E. (2010), “Site Fights”: Explaining Opposition to Pipeline Projects in the Developing World1. In *Sociological Forum*, 25(3), 401-427. Blackwell Publishing Ltd.

Newig, J. and Kvarda, E. (2012), Participation in environmental governance: legitimate and effective? In Hogl, K., Kvarda, E., Nordbeck, R., and Pregernig, M. (eds) *Environmental Governance – The Challenge of Legitimacy and Effectiveness*, Cheltenham: Edward Elgar Publishing Limited, pp. 29-45.

North, D. (1994), Economic Performance Through Time*, The American Economic Review,* 84(3), 359-368.

Oberholzer-Gee, F., Frey, B.S., Hart, A., and Pommerehne, W.W. (1995), Panik, Protest und Paralyse Eine empirische Untersuchung über nukleare Endlager in der Schweiz, *Swiss Journal of Economics and Statistics,* 131(2), 147-177.

O'hare, M. (1977), *"Not On My Block You Don't" - Facilities Siting and the Strategic Importance of Compensation*. Massachusetts Institute of Technology Laboratory of Architecture and Planning.

Painuly, J.P. (2001), Barriers to renewable energy penetration; a framework for analysis, *Renewable Energy,* 24(1), 73-89.

RGI (2012), European Grid Report – Beyond Public Opposition, Lessons Learned Across Europe. Renewable Grid Initiative. Available at: http://renewables-grid.eu/uploads/media/RGI_European_Grid_Report_final_01.pdf

Richards, G. Noble, B., and Belcher, K. (2012), Barriers to renewable energy development: A case study of large-scale wind energy in Saskatchewan, Canada, *Energy Policy,* 42, 691-698.

Ruud, A., Haug, J.J.H., and Lafferty, W.M. (2011), "Case Hardanger": En analyse av den formelle konsesjonsprosessen og mediedekningen knyttet til den omsøkte luftledningen sima-samnanger. *Available at: http://www.sintef.no/upload/Case%20Hardanger_med%20engelsk%20summary.pdf (Last accessed 10.03.14)*.

Sims, S., and Dent, P. (2005), High-voltage overhead power lines and property values: a residential study in the UK. *Urban Studies*, *42*(4), 665-694.

Soini, K., Pouta, E., Salmiovirta, M., and Kivinen, T. (2011), Local residents' perceptions of energy landscape: the case of transmission lines, *Land Use Policy,* 28(1), 294-305.

Solow, R.M. (1986), On the Intertemporal Allocation of Natural Resources, *Scandinavian Journal of Economics,* 88(1), 141-149.

Terwel, B.W., Koudenburg, F.A., and Mors, E. (2014), Public Responses to Community Compensation: The Importance of Prior Consultations with Local Residents. *Journal of Community and Applied Social Psychology*, (forthcoming).

Tobiasson, W., Jamasb, T., Beestermöller, C, and Meier, H. (2014), Conceptualizing Public Engagement in Electricity Network Development: An Economic Approach, Cambridge Working Papers in Economics CWPE / Electricity Policy Research Group Working Paper EPRG, Faculty of Economics, University of Cambridge. (forthcoming)

Vatn, A. (2005), *Institutions and the Environment*. Cheltenham: Edward Elgar.

Warren, C.R. and McFadyen, M. (2010), Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland, *Land Use Policy,* 27(2), 204-213.

Wolsink, M. (2000), Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support, *Renewable Energy,* 21(1), 49-64.