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Tackling Local Conflicts Caused by Renewable Energy Sources: Lessons Learned from Real-World Case Studies

Gonzalo Gamboa[a], Giuseppe Munda[b,c] and Daniela Russi[c,a1]

a) Universitat Autònoma de Barcelona
Institute for Environmental Sciences and Technologies, building C
08193 Bellaterra (Cerdanyola del Vallès), Barcelona- Spain
e-mail: gonzalo.gamboa@uab.es

b) European Commission - Joint Research Centre (EC-JRC)
Knowledge Assessment Methodologies (KAM)
Institute for the Protection and Security of the Citizen (IPSC), TP 361
21020 Ispra (VA) - Italy
e-mail: giuseppe.munda@jrc.it

c) Universitat Autónoma de Barcelona
Dept. of Economics and Economic History, building B
and Institute for Environmental Sciences and Technologies
08193 Bellaterra (Cerdanyola del Vallès), Barcelona- Spain
e-mail: giuseppe.munda@uab.es
daniela.russi@uab.es

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Abstract

Since Kyoto Protocol, the international community is compromising itself to reduce greenhouse gases emissions. However, the implementation of energy policies, such as the construction of renewable energy installations, in many cases doesn't suit with local perceived necessities and causes conflicts. In this paper, some types of local conflicts originating by the introduction of RES are presented.

The relevance of social multi-criteria evaluation (SMCE) in dealing with this type of conflicts is discussed by means of theoretical and empirical arguments. SMCE supplies a structured process to gather, synthesize and evaluate information from several sources, which can be used as input for social debate and decision-making. In SMCE, the use of social research provides insights on the different and legitimate values and interests involved. Also, multi/inter disciplinarity gives information about the alternatives' impacts on different dimensions (environmental, social, economic, and so on). These data aren't translated in a common unit of measure, but they are presented in their original form. By combining social research with multi-criteria methodologies, transparency of the decision-making process is increased. In this way, the policy-maker is able to make sound decision and is hold responsible for his/her choices.

[1] Corresponding author

1 Introduction

Greenhouse effect is widely recognized as one of the most worrying environmental problems. For this reason, most industrialized countries agreed with the Kyoto Protocol to reduce their greenhouse emissions by 5% with respect to 1990 levels before 2012. The commitments taken with the Kyoto Protocol imply a big effort to reduce the use of fossil fuels, which are the main responsible of the greenhouse effect. One option might be a massive use of nuclear energy, which does not produce greenhouse gases. However, this alternative is considered unacceptable by large sectors of civil society, due to the environmental impact associated with radioactive wastes and risk of catastrophic accidents. Therefore, if they want to accomplish Kyoto's objectives, industrialized countries must set up an energy strategy that will allow them to significantly increase the efficiency of their energy systems as well as the use of renewable energy.

However, even though renewable energies are generally more environmental friendly than conventional fossil fuels and nuclear energy, they also imply some negative impacts on a local scale. For example, biomass cultivation requires large land and water use. Also, they are normally cultivated with intensive agricultural techniques, which imply a great use of pesticides and fertilizers (Giampietro et al., 1997; Ulgiati 2001). Wind energy provokes a visual impact on landscape which may not be easily accepted by local people and entails an extensive use of the territory, noise and a certain degree of risk for birds (Abbasi and Abbasi, 2000). Also, photovoltaic systems are responsible of greenhouse gas emissions, noise and water and soil pollution in the manufacturing, installing and demolition phase (Tsoutsos et al., 2005).

In many cases, a NIMBY ("Not in My BackYard") effect takes place. In fact, on the one side, on the global scale everyone agrees on the fact that greenhouse gases should be reduced and that the share of renewable energy should be increased. On the other side, on the local scale many people are not willing to suffer the disadvantages produced by the renewable energy production, such as the aesthetic impact of wind power plants or the lack of reliability of solar energy. Therefore, the rise of renewable energy might be associated with an increase of conflicts on a local scale if an agreement on the different interest and values of the involved social actors is not found.

2 SMCE to cope with the local conflicts caused by the implementation of renewable energy technologies

A proper evaluation of sustainability options needs to deal with a plurality of legitimate values and interests existing in society. In empirical evaluations of public projects and public provided goods, multi-criteria decision analysis seems to be an adequate policy tool since it allows taking into account a wide range of assessment criteria (e.g. environmental impact, distributional equity, and so on) and not simply profit maximisation, as a private economic agent would do. Also, the management of a policy process involves many layers and kinds of decisions, and requires the construction of a *dialogue process* among many social actors, individual and collective, formal and informal, local and not.

In general, these concerns have not been considered very relevant by scientific research in the past (where the basic implicit assumption was that time was an infinite resource). On the other hand, the new nature of the policy problems faced in this third millennium (e.g., the mad cow, genetic modified organisms, …), implies that very often when using science for policy-making, long term consequences may exist and scientists and policy-makers are confronting issues where, as stated by Funtowicz and Ravetz "*facts are uncertain, values in dispute, stakes high and decisions urgent*" (Funtowicz and Ravetz, 1991). In this case, scientists cannot provide any useful input without interacting with the rest of society and the rest of the society cannot perform any sound decision making without interacting with the scientists. That is, the question on "*how to improve the quality of a social decision process"* must be put, quite quickly, on the agenda of "scientists", "decision makers" and indeed the whole society.

An outcome of this discussion is that the political and social framework must find a place in multi-criteria decision analysis. An effective policy exercise should consider not merely the measurable and contrastable dimensions of the simple parts of the system, that even if complicated may be technically simulated (technical incommensurability[2]). To be realistic it should also deal with the higher dimensions of

[2] Inconmensurability is defined as the lack of a common measure across plural values and implies weak comparability (two different alternatives can be compared, but different indicators must be used, which belong to different dimensions) (Martinez- Alier et al. 1998). Munda (2004) introduces the

the system. In other words, it should consider those dimensions in which power relations, hidden interests, social participation, cultural constraints, and other "soft" values, become relevant, and unavoidable variables that heavily, but not deterministically, affect the possible outcomes of the strategies to be adopted (social incommensurability).

The main idea of *social multi-criteria evaluation (SMCE)* (Munda, 2004) is that the pitfalls of the technocratic approach can be overtaken by applying different methods of sociological research. For example, "*institutional analysis*", performed mainly on historical, legislative and administrative documents, can provide a map of the relevant social actors. By means of focus groups it is possible to have an idea of people's desires and it is then possible to develop a set of policy options and evaluation criteria. Main limitations of the focus group technique are that they are not supposed to be a representative sample of the population and that sometimes people are not willing to participate or to state publicly what they really think (above all in small towns and villages). For this reason anonymous questionnaires and personal interviews are an essential part of the participatory process.

One has to note that policy evaluation is not a one-shot activity. On the contrary, it takes place as a *learning process* which is usually highly dynamic, so that judgements regarding the political relevance of items, alternatives or impacts may present sudden changes, hence requiring a policy analysis to be flexible and adaptive in nature. This is the reason why evaluation processes have a *cyclic nature*. By this is meant the possible adaptation of elements of the evaluation process due to continuous feedback loops among the various steps and consultations among the actors involved. Flexibility and adaptability to real-world situations is one of the main advantages of social multi-criteria evaluation. In this framework, of course mathematical aggregation conventions play an important role, i.e. to assure that the rankings obtained are *consistent* with the information and the assumptions used along the structuring process.

A SMCE is carried out in six steps:

1) Definition of the problem
2) Institutional analysis:

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distinction between technical incommensurability (the impossibility to describe a system using a single unit of measurement) and social incommensurability (the existence of multiple and conflicting legitimate values and interests in a decision).

3) Generation of the policy options
4) Construction of the multicriteria impact matrixes (if using a NAIADE it is also possible to build an equity matrix)
5) Application of the mathematical procedure
6) Sensitivity analysis

Section 3 presents two examples of real-world applications of SMCE principles in renewable energy management.

3 Brief explanation of the case studies

3.1 The debate on rural electrification in Montseny Natural Park

3.1.1 The context and the conflict

Montseny is the biggest (301 km^2) and oldest Catalan natural park. It is also one of the most interesting ones under an ecological point of view, because of the variety of its ecosystems. It is only 40 km far away from Barcelona, so that it is very popular as a place for weekend outdoor excursions. It has a population of around one thousand people, mostly scattered inside the park (Boada and Juncà, 2002).

In 1994, the Park administration (Servei *the Parcs Naturals*, Natural Park Service, SPN), decided to solve the electrification deficit inside the Park and launched a rural electrification plan that would allow to install photovoltaic systems in the farmhouses without electricity. An agreement was reached with SEBA (*Associació de Serveis Energètics Bàsics Autònoms*, Autonomous Basic Energy Service Association), a non-profit-making association created in 1989 by solar energy users in order to support the installation of autonomous PV panels in isolated households. SEBA would have the task of managing the entire process, from determining energetic needs to installing the equipment. In exchange for a monthly share of about 20 €, SEBA would provide users with technical supervision, an insurance and free maintenance, in order to make the service similar to traditional energy (Vallvé and Serrasolses, 1997). The photovoltaic panels were subsidized: SPN financed 45% of the total expense and SEBA 34%, thanks to subventions granted by the Spanish Ministry of the Environment, the Energy Department of Catalan Government and the European Union.

The plan worked well. Between 1995 and 2000 it managed to electrify about 32 isolated farmhouses, that is, almost 30% of the permanently inhabited ones (Argemi and Serrasolses, 2001). However, in Tagamanent municipality (235 inhabitants, 43,48 km^2) solar energy was not really accepted. The owners of the isolated farmhouses and the mayor asked SPN to allow them to electrify their farmhouses extending the grid. The grid extension for rural electrification is subsidized by 50% by the Catalan government, but the owners and the mayor asked SPN to also finance it. Also, since two of the Tagamanent isolated farmhouses belong to SPN, the latter was asked to share the expenses of traditional rural electrification because otherwise it would have been too expensive for the other farmhouses. However, SPN rejected the project arguing that, since more than 8 km were planned to go through the wood, the environmental impact would have been unacceptable. In fact, a corridor of 6 metres and 2 metres would have to be deforested along respectively middle- and high- tension line. Also, the grid might have caused forest fires and endangered the bird population. Finally, would have had an impact on landscape.

In the following years, PV panels were installed in seven out of twenty-four scattered farmhouses. However, the conflict between the mayor, supported by most farmhouse owners and inhabitants (in favour of grid extension) and SPN (in favour of PV panels) has not been solved yet. During the last six years, many projects on rural electrification followed one another, comparing prices of PV and grid extension but the parts did not reach an agreement.

In order to understand the reasons of the conflict, a retroactive SMCE was performed, with the objective of understanding which factors favoured the affirmation of solar energy and which were the pros and cons of each option. This analysis might be useful because the debate on rural electrification is not over yet in Tagamanent municipality. In fact, the mayor has not given up the idea of promoting traditional electrification and some owners would support him in trying to convince SPN to allow and partially finance the grid extension. Also, the first photovoltaic systems have been installed ten years ago, so that they will be replaced soon. It is a good opportunity to try to find an agreement among the social actors. In this context, a retroactive analysis might constitute a useful basis for the public debate, because it

can contribute to explain the position of the social actors and the different impacts of the policy options.

The rest of this section shows step by step the analysis carried out and the results obtained. Table 1 presents the social actors involved in the conflict, and their position regarding the electrification schemes. This information was obtained through twelve open in- depth interviews with the owners and the inhabitants (six were interviewed telephonically and six personally), two interviews with the mayor and one with the SPN technician in charge with the issue.

Table 1. Social actors and their position regarding the electrification schemes

Social actor	**Scale of action**	**Observations**
Servei de Parcs Naturals (SPN)	Local	Its institutional task is the protection of Montseny's environment, so that it tries to hinder whatever might represent a danger in this sense. This position against traditional electrification has been very firm during the last ten years
Owners	Local	They mostly use their farmhouse as a weekend house or rent it to "neo-rurals", whereas some leave it unoccupied or use the land as pasture for their cattle, which they entrust to local breeders. Owners are interested in raising the value of their farmhouses. Traditional electricity seems to better suite this purpose because PV panels have a limited lifetime and they must be substituted from time to time. Also, some owners wish to set up an economic activity (in general associated with tourism), which requires a reliable and relatively abundant supply of energy
Inhabitants	Local	Most are "neo-rurals". The inhabitants suffer from the lack of services with respect to urban population probably more than owners. In fact, they experience everyday the discomforts and the difficulties of the life inside a Natural Park. Inhabitants want to have a sufficient amount of energy at a reasonable cost but most are not interested in the energy source itself. They are very interested in the reliability of the energy supply, especially if they are running an economic activity, such a restaurant or a pension
Mayor	Local	The mayor holds that the only way to encourage the park repopulation is to increase the comfort and the supply of services. The main reasons why the mayor wants to promote the grid extension are two. Firstly, traditional electricity does not imply limits on consumption, so that it increases comfort more than solar energy. Secondly, photovoltaic systems do not supply energy enough to found economic activities that require some machinery, such as for example little dairies. In other words, they have a very high opportunity- cost. It can be noted that this is a positive aspect of solar energy for SPN, because it contributes to hinder enterprises that could cause an environmental impact

3.1.2 Problem structuring

Once information has been gathered on the social actors, as well as on the reasons of their opinions and the resources they have at their disposal, the next step is to define the policy options to evaluate. The three alternatives here analyzed for the 14 households to be electrified (that is, excluding the farmhouses in a ruinous state

that were not planned to be rehabilitated) are the ones analyzed in SEBA's report (Trama Tecno Ambiental, 1998):

Table 2.Characteristics of the alternative electrification schemes.

Features	Grid 1	Grid 2	PV
Characteristics	Electric grid extension in one single stretch, such as in the original project that was drawn by the electricity company in 1996	Electric grid extension by means of two stretches and with some environmental measures, such as proposed by SEBA. The environmental impact is lower and the cost is higher than in Grid 1	PV panels. As electricity need the average electricity consumption of Spanish households is taken (192 kWh/month)
Power lines length	• 12,2 km of middle voltage line • 3 km of low voltage line	• 8,8 km of middle voltage line • 7 km of low voltage line Part of the grid is buried to reduce environmental impact	

Generally, in SMCE a unique impact matrix is built, which analyzes the options for the society as a whole, and then an equity matrix is used to evaluate the degree of conflict or of alliance among the interests of the various social actors. On the contrary, here an impact matrix was constructed for each group of social actors: SPN, the owners (plus the mayor) and the inhabitants. This decision was taken for two reasons. In the first place, the decision on rural electrification must be taken in three stages. First of all, the park administration must decide whether to allow grid extension and subsidize photovoltaic systems and/or traditional electricity. Secondly, if it decides to give the permission to traditional electrification, the farmhouses' owners must decide between solar and traditional energy. Thirdly, if they do not want to take upon themselves the expenses, leaseholders might decide to pay by themselves for electrification, and in this case they will weigh the pros and cons of the two options. In the second place, one criterion ("possibility of setting up an enterprise") was to be minimized for the public administration and maximized for owners and inhabitants.

With this procedure, distributional conflicts are dealt with directly in the building of the impact matrixes. The idea is that each group of social actors has a different point of view on the problem, or, in other words, each one considers

important different criteria when deciding among alternative energy sources. The power structure in the society determines which set of criteria (and therefore which final decision) will impose on the other ones. In Tagamanent case, the Park administration is the most powerful social actor: it is able to hamper one of the options, the grid extension. In this sense, multi-criteria evaluation increases the transparency and the public accountability of political processes. In fact, from the decision taken citizens can go back to the criteria (and to the objectives) that where considered important by the politicians and eventually argue about that.

In SMCE, the options must be evaluated through criteria, which indicate to what extent the alternatives help or hinder the social actors to reach their objectives. The criteria were derived from the interviews. They traduced all information that came out from the interaction with the social actors on what they considered important when deciding among different energy modalities. The impact matrixes are reported in Table 3.

Table 3. Impact matrixes

SPN					
Dimension	**Criteria**	**Unit**	**Score**		
			Grid 1	**Grid 2**	**PV**
Economic	1. Total cost	Thousand €	731	796	1328
	2. Cost for SPN	Thousand €	0	0	570
Environmental	3. Risk of fire	Qualitative	High	Low	None
	4. Deforestation	Thousand m^2	67	57	0
	5. Risk for birds	Qualitative	Low	Low	None
	6. Emitted CO_2	Kg CO2 eq.	96	96	0
	7. Limitation to enterprises	Qualitative	None	None	High
Social	8. Educational effect	Qualitative	None	None	High
	9.Impact on landscape	Qualitative	High	Low	None
OWNERS					
Economic	1. Cost per household	Thousand €	28	31	23

	2. Possibility of setting up an enterprise	Qualitative	High	High	Low
	3. Farmhouse's revaluation	Qualitative	High	High	None
Environmental	4. Risk of fire	Qualitative	High	low	None
Social	5. Discomfort	Qualitative	Low	low	High
	INHABITANTS				
Economic	1. Cost per household	Thousand €	28	31	23
	2. Possibility of setting up an enterprise	Qualitative	High	High	Low
Environmental	3. Risk of fire	Qualitative	High	Low	None
Social	4. Discomfort	Qualitative	Low	Low	High
Technical	5. Reliability	Qualitative	High	High	Low

It can be noted that the matrix was built with a genuine multi–disciplinary procedure. The scores were compiled thanks to the help of different experts in various disciplines: two PV installers, a technician of the electricity company in charge of rural electrification, an ornithologist that analyzes the impact of electric lines on Catalan bird population, an expert in forest fire prevention and an expert in life- cycle assessment who gave the figures on greenhouse emissions associated with electricity production.

3.1.3 Results

The final ranking of alternatives is obtained using NAIADE (Munda, 1995). Details of the models are given in Joint Research Centre (1996). The results are shown in Table 4. The first three columns for each group of social actors show all possible combination among the alternatives. The fourth column indicates the score of each ranking, which depends on the likelihood that the ranking is preferred. SPN prefers solar energy and, in the second place, the grid extension project characterized by a higher cost and a lower environmental impact. For the owners and the inhabitants, the photovoltaic panels are the worst option whereas they are indifferent between the two alternative electric grids (in fact, a certain degree of compensation among economic and environmental criteria is allowed). This result is coherent with the social actors' choices. The definition of the criteria can help to understand the reasons of their behaviour.

Table 4. Multi-criteria evaluation results

SPN				OWNERS				INHABITANTS			
PV	***Grid 2***	***Grid 1***	**1.9**	***Grid 1***	***Grid 2***	***PV***	**1.7**	***Grid 1***	***Grid 2***	***PV***	**1.7**
PV	*Grid 1*	*Grid 2*	1.7	***Grid 2***	***Grid 1***	***PV***	**1.7**	***Grid 2***	***Grid 1***	***PV***	**1.7**
Grid 2	*PV*	*Grid 1*	1.6	*Grid 1*	*PV*	*Grid 2*	1.5	*Grid 1*	*PV*	*Grid 2*	1.5
Grid 1	*PV*	*Grid 2*	1.4	*Grid 2*	*PV*	*Grid 1*	1.5	*Grid 2*	*PV*	*Grid 1*	1.5
Grid 2	*Grid 1*	*PV*	1.3	*PV*	*Grid 1*	*Grid 2*	1.3	*PV*	*Grid 1*	*Grid 2*	1.3
Grid 1	*Grid 2*	*PV*	1	*PV*	*Grid 2*	*Grid 1*	1.3	*PV*	*Grid 2*	*Grid 1*	1.3

In this exercise, all criteria received the same weight, which means that the dimensions weighted according to the number of criteria that belong to each of them. The problem is structured in order to reflect the preferences of each group of social actors: for SPN the environmental dimension has more criteria, whereas for owners and inhabitants the economic dimension weights more, because it has more criteria than the others. In fact, during the interviews both the owners and the inhabitants stressed the fact that for them the most important factors were the economic ones.

Finally, a sensitivity analysis was performed, in order to verify whether changing the distribution of weights would change the final results. Each dimension was given the same weight, which means that the criteria's weights depended on the number of criteria of each dimension. The sensitivity analysis shows that the new distribution of weights did not change the result very much: the only difference is that owners and inhabitants put Grid 2 in the second place and Grid 1 in the first one. Therefore the ranking obtained can be considered robust (at least with respect to weights).

3.2 Wind-parks in western Catalonia

3.2.1 The context and the conflict

As indicated in the Catalan Energy Plan for the period 2002-2010, Catalan government intends to increase the renewable energy share from 12,9% (4.920 GWh in 2000) to 15,6% (8.982 GWh in 2010). Wind energy is planned to increase from actual 0,27% (103.7 GWh in 2000) to 4,7% (2.360,4 GWh in 2010) with at least 1.073 MW of installed capacity (ICAEN, 2002).

The energy plan recognizes that an environmental impact is associated to wind-parks in terms of landscape degradation, noise and impact on fauna (temporal displacement of animals and/or birds collisions). It also declares that natural parks are

not compatible with wind- parks. However, it also stands that lack of ***objective*** criteria to evaluate wind-parks generally contributes to give priority to local criteria rather than to global criteria, and that the political and administrative structure of Spain fosters this situation.

One of the target areas for wind farms is Serra del Tallat mountains chain, which is located in the west sector of Catalonia central depression, between Tarragona and Lleida provinces. In that zone the five towns are located, which have been selected for this case study. They are involved in a conflict around, at least, two wind farm projects, namely Serra del Tallat and Coma Bertran. Initially, the former planned to install 66 windmills of 660 KW and the latter 16 windmills of 850 KW. In addition, there were two other projects planning to construct wind-farms of 75 and 15 windmills respectively, reaching 172 windmills in the area.

In a first moment, there were several positions regarding the construction of the wind parks. On the one side, some people started to argue against the wind farms in two senses. Firstly, they claim the right to participate in the planning process of their territory and, secondly, they see Catalan energy production scheme as unfair. On the other side, some municipalities and some citizens were in favour of the wind power plants construction. They saw the wind-parks as a good opportunity to increase their economic incomes, to improve social services and to revitalize the towns.

Finally, because of the conflict the companies proposed new projects. Basically, they included a lower number of windmills, but a higher capacity. However, the opposition against the projects did not decrease.

By developing an institutional analysis and applying various participatory approaches the socio-economic actors position was analysed. This information is synthesised in Table 5.

Table5. Socio-economic actors and their position in relation with the windparks.

Social actor	**Scale of action**	**Position regarding the windparks**
Catalan government	National	Catalan government launched the Renewable Energy Plan for the year 2010. It plans to increase the share of RES from 72.2 to 1.073 MW of installed capacity. However, they recently declared that they want to reach 3.000 MW.
Catalan environment and industry department	National	It is the governmental body that gives (or reject) permissions for the wind-farms installation. This task is mainly based on the environmental impact assessment of the projects.
Town council of Vallbona de les Monges	Local – Province	The municipalities want the wind- parks to be installed. They see the economic income as a good opportunity to improve some social services, and/or to create others (like elder nursing). They are negotiating with the companies to obtain better retributions. Some of them ask for higher economic compensation for the projects.
Town council of Els Omells de Na Gaia	Local – Province	
Town council of Rocallaura	Local – Province	
Town council of Senan	Local – Province	The town council is fighting together with the inhabitants of Senan against the wind-parks. They do not want to be surrounded by windmills, and they see the forest as an alternative very good opportunity to develop tourism in the future.
Consell comarcal de l'Urgell	Province - National	The president of the council offered her mediation to reach a compromise solution. But she shares the opinion of the mayors, in the sense that she argues that more economic income is needed to revitalize the towns, and to offer more and better services.
Politic representatives	Province	Representatives from different political parties signed a motion asking for a moratorium to the windparks *Coma de Bertran* and *Serra del Tallat*. They advocate for the promotion of local initiatives.
Coordinadora por la defensa de a terra (Urgell, Conca de Barberà, Segarra, Garrigues)	Province	They think that the towns can be revitalized without necessarily jeopardize their future, such as wind- park might do. They are not against wind energy, but they do not approve the way the process has been carried out. They think that the solution has to be discussed by all involved social actors.
Plataforma per Senan	Province	They see the projects as an *undesirable gift* from their neighbours. They do not like the way the process has bean carried out, and they argue that more equitable decisions can be reached by means of negotiation among all involved towns. (See the opinion of Town council of Senan)
Friends and neighbours of Montblanquet	Local	The proximity of one of the wind-farms projects to the town is the main reason of their opposition, because of the noise, visual impact, shadow effect, land value decrease, and so on
GEPEC	National	It is an environmental non-governmental organization, whose objective is to redefine the Catalan Energy Plan. They ask for a more decentralized electricity production system. Regarding the location of wind-farms, they ask for special attention to the habitats of rare and threaten species, and to the biologic corridors. They also ask for applying the Landscape European Convention.
Enegía Hidroeléctrica de Navarra	National	The company is the promoter of one of the wind- parks. They are one of the biggest RES producers in Spain, and one of their aims is to construct as big wind-parks as possible in order to support a significant change "*in the energy production culture*".
Gerrsa	National	It is the *Coma Bertran* project promoter. It was impossible to have a meeting with them due to their reluctance to talk with people that do not belong to the government.

Once the actors' perceptions are identified, the problem had to be structured in a multi-criteria framework. Next sections illustrate the multi-criterion process and the results obtained.

3.2.2 Problem structuring

Alternatives are constructed using information from several sources, such as the participatory process, the review of the projects, technical interviews, and so on. Firstly, *Coma Bertran's* preliminary and final projects and *Serra del Tallat's* project were reviewed. Based on the combination of these plans, four alternatives were proposed. They are called the *technocratic options*.

Then, other three alternatives are the submitted projects (*Coma Bertran* and *Serra del Tallat*) and their combination. We call these plans *technocratic and accepted by some part of the population.*

After this, and considering the worry of some people about the visual impact of the windparks, new alternatives were generated. They consider: ***a)*** the technical (and economic) feasibility, depending on wind availability, and ***b)*** a reduction of the original proposals' visual impact[3]

Starting from the combination of the preliminary plans and the combination of the submitted projects, two other alternatives are generated by reducing the height of the wind turbines and eliminating the windmills located closer than 1.5 kilometres from the towns (**L**s).

Other two alternatives (**R**s) are generated by redistributing windmills that are closer than 2 kilometres to the inhabited zones. The starting points are the submitted projects.

Finally, there is the possibility of constructing a windpark managed by a cooperative (e.g. local administration), and the last alternative is not constructing parks at all.

These 13 alternatives were discussed with social actors and within the scientific team. This process led to the choice of only seven alternatives, which are presented in Table 6.

[3] It has been considered the worry of *"living surrounded by windmills"*. On the other hand, the Danish Wind Industry stands that the windmills located further away than 500 to 1.000 metres do not produce shadow effect (i.e. to intercept sun rays).

Table 6. Characteristics of the alternatives.

Windparks features	*Alternatives*						
	Technocratic	*Technocratic and accepted by some part of the population*			*Modified*		*BaU*
	CB-Pre	*CB*	*ST*	*CBST*	*L*	*R*	*NP*
Number of windmills	16	11	33	44	26	24	0
Power capacity [MW]	13,6	16,5	49,5	66	39	36	0
Rotor height [m]	55	80	80	80	80	80	80
Blades diameter [m]	58	77	77	77	77	77	77

The evaluation criteria have been derived from actors' perceptions, desires and preferences, which are presented in Table 5. The selected evaluation criteria are shown in Table 7. It should be kept in mind that they are a *technical translation* of social actors' preferences and desires operated by the research team. Moreover, it is worth mentioning that the expected effects of the alternatives are not always foreseeable. The evaluation exercise is characterized by many uncertainties, such as future wind conditions (due to e.g. climate change), tourism trends, or human behaviour. To enlighten these uncertainties is one of the aims of the process.

Table7. Multi-criteria Impact Matrix

Criteria	*Units*	*Dir.*	*CB Pre*	*CB*	*ST*	*CBST*	*L*	*R*	*NP*
Owners' income	Thousands € per year	▲	48	33	99	132	78	72	-
Economic Activity Tax	Thousands € per year	▲	~12,8	~15,5	~46,4	~61,9	~36,6	~33,8	-
Construction tax	Thousands €	▲	~62	~55,8	~96,5	~152,3	~81,9	~67,7	-
Income distribution	%	▲	1,51	1,19	1,22	1,2	1,31	1,22	-
Number of jobs		▲	2	1	4	5	3	3	-
Visual Impact	Thousands Km^2	▼	76,6	71,5	276,6	348	220,4	163,3	-
Forest lost	Hectares	▼	8,4	8,1	6,6	14,7	3,9	2,6	-
Avoided CO_2 emissions	Thousands tons of CO_2 per year	▲	4,7	6	19,7	25,8	14,7	13,8	-
Noise (*)	dB(A)	▼	14,6	23,9	18,6	23,8	20,9	14,7	-
Installed capacity	MW	▲	13,6	16,5	49,5	66	39	36	-

(*) For noise annoyance, the average sound pressure level is shown, considering the five involved towns.

3.2.3 Results

After NAIADE parameters are defined, which are necessary to carry out the aggregation procedure, the multi-criteria evaluation is performed. In order to be short, only the results of the evaluation are reported here (for more detailed information about this step, see citar el informe uab con el nombre de los autores).

Figure 1 shows the ranking of the evaluation obtained with NAIADE. A sensitivity analysis shows that this result is very stable when the degree of compensation is modified.

Fig. 1. Results of the Social Multi- Criteria Evaluation

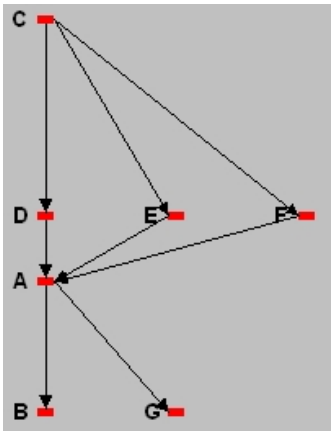


Figure 1. Multi-criteria evaluation results
A:= CB Pre
B:= CB
C:= ST
D:= CBST
E:= L
F:= R
G:= NP

Figure 1 shows that alternative ST ranks first due to its good performance in economic terms and the intermediate environmental impacts. Alternatives CBST, L and R rank second. The former might be vetoed by some social actors due to its proximity to some towns (such as Montblanquet) and the high amount of windmills to be installed. The other two are candidate options for a *second best* solution (see *Coalition formation* analysis below).

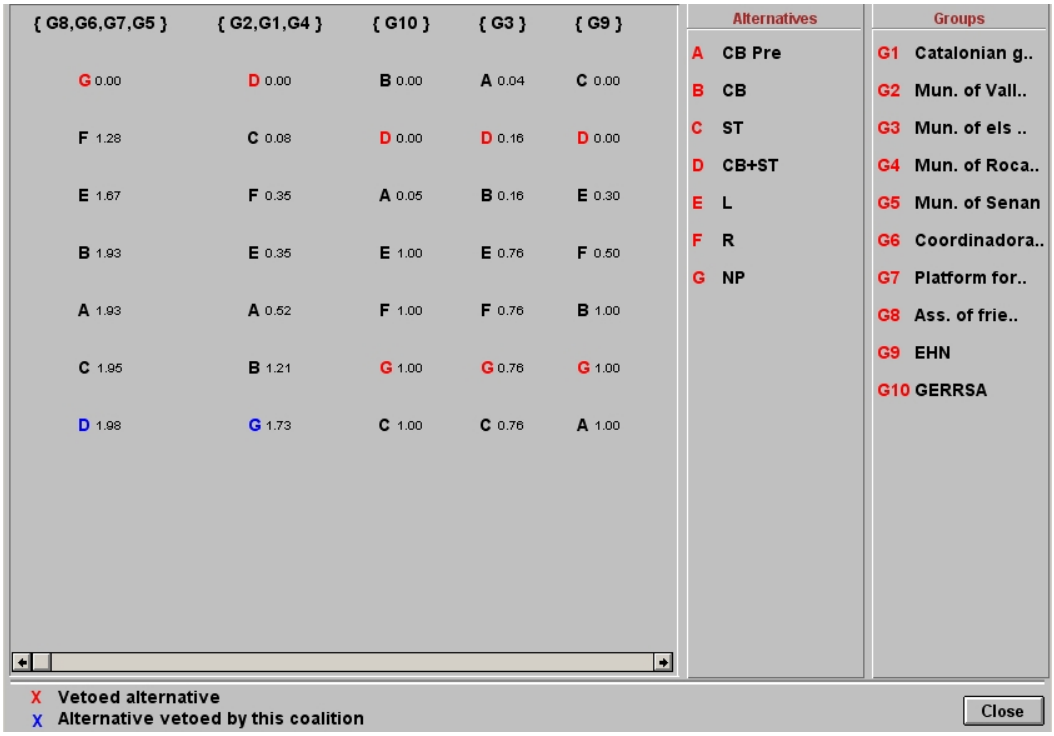
NAIADE also gives the opportunity to perform a *Coalition formation* analysis, which is carried out on the basis of the social actors' evaluation of the alternatives. This information is presented in Table 9.

Table 9. Equity matrix

Groups \ Alternatives	CB Pre	CB	ST	CBST	L	R	NP
Catalonian government	More or Less Good	More or Less Bad	Very Good	Perfect	Good	Good	Extremely Bad
Mun. of Vallbona de les Monges	More or Less Good	More or Less Bad	Very Good	Perfect	Good	Good	Extremely Bad
Mun. els Omells de na Gaia	Very Good	Good	Bad	Good	Bad	Bad	Bad
Mun. of Rocallaura	More or Less Good	More or Less Bad	Very Good	Perfect	Good	Good	Extremely Bad
Mun. of Senan	Very Bad	Very Bad	Very Bad	Extremely Bad	More or Less Bad	Moderate	Perfect
Coordinadora per la Defensa de la Terra	Very Bad	Very Bad	Extremely Bad	Very Bad	Very Bad	Bad	Perfect
Platform for Senan	Very Bad	Very Bad	Extremely Bad	Extremely Bad	More or Less Bad	Moderate	Perfect
Ass. of friends and neighbours of Montblanquet	Extremely Bad	Extremely Bad	Very Bad	Extremely Bad	Very Bad	More or Less Bad	Perfect
EHN	Extremely Bad	Extremely Bad	Perfect	Perfect	More or Less Good	Moderate	Extremely Bad
Gerrsa	Very Good	Perfect	Extremely Bad	Perfect	Extremely Bad	Extremely Bad	Extremely Bad

By means of applying NAIADE to the information contained in the *Equity matrix* (Table 9) it is possible to get some insights to support the decision making-process. In order to be short again, next figure shows the rankings for different coalitions with high level of credibility in their formation.

Figure 2. Dendrogram of Coalitions



According to the models' results, alternatives CBST and NP are vetoed by some groups. The former is considered as *an industrialization of the mountains*, and the last counters the municipalities plans and the official national renewable energy targets. Alternative ST, the first in the technical ranking, have very low positions for some social actors. Alternatives L and R present mid ranking positions for all

coalitions. Thus, they are possible compromise solutions for the wind-park location issue.

4 Learned lessons.

4.1 Learned lessons on SMCE

The two case- studies presented show how SMCE provides a framework that help to shed light on the real reasons of a conflict. In Montseny case, at the beginning the objective of the study was to analyze different options for rural electrification under an economic, social, environmental and technical point of view. However, the interviews helped to understand that the roots of the disagreement laid on the ideas that the different groups of social actors had on the Park's future. In fact, on the one side SPN wishes to protect the Park from an excessive flow of tourism, because it would imply an environmental impact, in terms of risk of forest fires, production of wastes, etc. Photovoltaic panels are functional to this objective because even though they allow privates to live inside the park, they hinder the establishment of enterprises. In fact, they supply a low and to a certain extent unreliable (dependent on the weather) amount of energy. On the other side, the park's inhabitants, the household's owners and the mayor believe that the economic activity inside the park should be supported, as a way to promote the repopulation of the park, so that traditional electricity is for them the best option for rural electrification.

In the case of Catalan wind- parks, the problem mainly arises because the process to design the wind-parks scheme (and, therefore, the regional future) left aside public participation. The initiative on wind planning is left to privates, which choose the wind- parks location on the basis of their own interest, not necessarily coinciding with other actors' aims. Some group of social actors see the facilities as new problems that do not solve the local necessities. (such as for example depopulation of rural areas). Others are against wind- parks because the decisions are taken with a top-down approach. Even if there are parts of the population that will be certainty affected by, for instance, the proximity of the wind farms and the extensive land use that they require. Again, the roots of the discontent does not lay in the energy issues only, but also do in the (whole) decision- making process/system.

This issue may be explained using Ravetz's distinction between *practical* and *technical* problems (Ravetz, 1971). The former are related to the different values and aims of a society (for example the wish of a fair income distribution or a healthy environment) and the latter are those that can be solved by a specialized and technical knowledge. The conflicts presented in both case studies can be explained with the underlying *practical* problems. There will not be agreement on how to provide the isolated farmhouses in Tagamanent with electricity (the technical problem) until an agreement is not found on the development strategy of the park (the practical problem). The social actors will not agree on the location of the wind parks in western Catalonia (the technical problem) if a different decision- making process (within a regional *participative* plan discussion) is not designed (the practical problem), in order to involve local people in the decisions on where to locate the wind-parks (and principally on the future of the region). Also, the wind power plants will be more easily accepted by local population if they help to solve some practical problems, such as lack of services or rural depopulation, which are not necessarily related to energy policy.

Therefore, it is necessary to find decision-making processes that allow to combine the right to decide locally, in order to solve *practical* problems, with the restrictions that global problems impose (such as the need to reduce greenhouse emissions).

In this sense, SMCE constitutes a useful tool to support public decision-making processes since it offers a structured procedure to gather information on the impacts in different dimensions of the policy options. In fact, Multi- Criteria Analysis allows presenting the criteria in their own unit of measurement (the contrary of what is done in Cost- Benefit Analysis, which translates all impacts in money). In this way, it offers the social actors clearer information on the consequences of the alternatives. Therefore, transparency is increased because all social actors can better argue to defend their interests and exert a certain degree of social control on public policies.

As it was shown in the case- studies presentation, in SMCE, participation and multi/interdisciplinarity provide inputs in all steps, from the alternative definition to the scores calculation. In order to facilitate public participation, the evaluation of the alternatives should be carried out as transparently as possible. It is very important to make clear which criteria were considered, how they were evaluated, which

distribution of weights were used and which degree of compensation among criteria was allowed. In this way, if some social actors do not agree with the decisions taken on these issues, they can argue about that. For example, the analysis of the Montseny case –study allows to explain which were the criteria that determined SPN's decision to hinder the grid extension and which were the pros and cons of the three options. The other social actors can eventually more easily defend their position using this information.

In this sense SMCE may play an important role in increasing transparency of public decision- making processes, because it provides a framework that requires the decision- makers to explicit their preferences.

Moreover, communication of the results must be as understandable as possible. For example, in the wind-parks case study, the possible noise annoyance (measured in decibels in the *A system,* dB(A)) is compared with well- known sounds when explained to the population. Creativity in this task must be encouraged.

4.2 Learned lessons on renewable energy policies

Finally, some conclusions on the renewable energy policies can be drawn from the two case- studies presented. As regards solar energy, it can be noted that, paradoxically, a shorter term horizon favours the acceptance of photovoltaic panels, because they must be replaced from time to time. On the contrary, the grid provides electricity for a virtually infinite period of time so that it might be preferred by user with a longer time horizon (i.e. owners instead of leaseholders). A possible solution might be to design a system that finances the substitution of obsolete or broken part of the photovoltaic systems thanks to a share that users pay each month or each year.

Also, the activity carried out is crucial in deciding solar energy's suitability. In fact, one of the main reasons that can explain the opposition to photovoltaic panels is that some of the owners and inhabitants of Tagamanent isolated farmhouses have in mind to set up a little enterprise. For this objective, traditional electricity is seen as more appropriate, because it supplies a virtually infinite and reliable amount of electricity. Solar energy seems at the moment to be more suitable for private households, which have lower energy needs.

Another issue that resulted from the case- studies is that incentives play a crucial role for the success of renewable energy policies. In fact, in most cases they do

not reach economic competitiveness with respect to fossil fuels yet. Therefore, the sector needs to be supported in order to rise the demand, which in turn would favours an increase in research and experience and a consequent cost reduction. In a second phase, when the renewable energy will eventually reach the break- even point, it will not need such support anymore (Goldenber et al., 2004; Masini and Frankl, 2002. See also Madlener and Stagl, 2005)

This holds especially for solar energy, which is further away from economic competitiveness than wind energy. For example, in Tagamanent municipality, even though PV panels are more expensive, they are cheaper for the final user, because the public administration contributes by 88% to the total expense, whereas grid extension is subsidized only by 50%.

Besides subsidies, other economic instruments have been created to promote renewable energies (see for example Madlener and Stagl, 2005). In Spain, *guaranteed feed-in tariffs* have been implemented, which imply that the price to be paid to the generation company is set by law for a certain period of time, and it is usually higher than the market price. Big companies are the likely beneficiaries of this subsidy. They have enough economic resources to afford the investment costs, which is needed to receive the benefit of the subsidy.

It often happens that on the one side the consumer do not benefit of any discount in his energy bill, and on the other side he suffers the disadvantages of renewable energy generation (for example because of the proximity of a windf arm) without being directly compensated. However, the municipality receives some economic income from the enterprises, which can be distributed by means of social investment. In this sense, cooperatives may play an interesting role to promote the implementation of wind-parks (at lower scale). Such initiatives should be promoted, for instance, by means of subventions.

Another aspect to consider in wind energy policies is its extensive land use, which can imply territorial inequalities. Lower valuated lands certainly have higher possibilities to host wind-farms because they can be rented at a lower price. Moreover, some zones can be affected by the proximity of a wind-farm without any kind of compensation, for example in the case of an affected town located outside of the municipality in which the installation is placed.

The extensive land use is also related to the fact that in Spain there is a lack of an adequate infrastructure to connect the wind-farms with the grid (as some of the companies' representatives have argued during the interviews). The future energy plans should consider the revision of the transport power lines system, in order to facilitate connection to the grid and to reduce electricity losses.

In this context, a transparent decision-making process based on participatory approaches and multi/inter disciplinary work, such as a SMCE, may serve as a integration tool to find a solution to *practical* problems at local scale.

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