Attitudes and Expectancies about Wind Turbines and Wind Farms

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ABSTRACT

The paper summarises data from a number of studies carried out in The Netherlands during the last four years. The surveys covered both existing and planned wind farms and single turbine sites, as well as areas not concerned with wind power in any way.

Both the opinions expressed – indicating in general a fairly positive attitude to wind power – and the significance of the responses in the context of survey methodology are analysed in some detail.

INTRODUCTION

In most countries with growing numbers of wind turbines, like the United States, Denmark and the Netherlands, public acceptability of wind power developments has been shown to be a serious problem. Siting problems caused by opposition from the public and local authorities are even reported from countries like the United Kingdom, that have only just started planning some larger wind power installations. Public acceptability is felt to be a major constraint now in the development of wind power application.

In the last four years a number of surveys on attitudes to wind power have been carried out in the Netherlands on wind development locations. The first research project was a repeated measures design, set up around a large 1 MW turbine. The pre-test was carried out in 1985 and the post-test data were gathered in 13 months later. Together with three other survey projects the results will be discussed. The last and most important of these other projects is a survey carried out on three wind farm locations in November 1988.

These wind farms are a result of two current programmes on development and application of wind power in the Netherlands: the Integrated Programme on Wind energy (IPW) for market development, and the Environmental Premium MP (Milieu Premie) for siting in regions that are selected by environmental planning. Both subsidies have resulted in several wind farm projects. The MP arrangement is carried out by the Ministry of Housing and Environmental Management (VROM), who initiated a study on the public acceptance of the projects realized within the scope of the MP. The ministry subsidized the wind farm project as well as the NEWECS-45 survey experiment.

For the comparison of the data the questionnaires were identical for corresponding variables in the NEWECS-45 and other projects.

METHODS

Experimental and comparative studies

In November 1985 the first large wind turbine in the Netherlands, the 1 MW NEWECS-45 was started up near the small town of Medemblik. The individuals whose changes in perception have been studied were living around this turbine. In this field study two control groups were chosen: one national representative sample, and one sample referred to as potential areas, out of the populations in four regions that had been selected as very suitable for wind power. It was a repeated measures design with an untreated control group (see Table 1). The experimental factor was the NEWECS-45 wind turbine, a machine with a hub height of 60 metres and a rotor diameter of 45 metres. The plans already existed at the time of the pre-test, so there could have been some impact on public reactions already. This threat to validity was neutralized by the introduction of control groups. The trend effect was neutralized by the post-test control group measures.

Table 1 Survey Locations and Samples

Survey locations	n	time	experimental factors	
			project	*details*
Medemblik	208	May 85	plan	1 turbine 1 MW
idem post-test	147	June 86	turbine	1 turbine 1 MW
contr: 4 windy areas	158	May 85	none	
idem post-test	90	June 86	none	
Contr: Netherlands	155	May 85	none	
idem post-test	96	June 86	none	
Amsterdam North	116	Oct 85	plan	1 turbine 160 kW
Camperduin	38	Jan 86	turbines	2 turbines 30 kW
Herbayum	230	Nov 88	plan	10 turbines 250 kW
Zijpe	173	Nov 88	windfarm	4×3 turbines 50-85 kW
Noordoostpolder	176	Nov 88	windfarm	25 turbines 300 kW
TOTAL	1587			

The data on the wind farm locations have been gathered in three surveys around two existing farms, Zijpe and Noordoostpolder, and one to be constructed in 1989, Herbayum. The other projects were a small wind power project with direct electricity supply to houses (10) and a planned medium sized turbine in the rural vicinity of Amsterdam (9). These surveys took place in 1985 and 1986.

Measurements

For the measurement of attitudes two strategies were chosen. Direct attitudes were measured by means of fourteen questions that had to be answered on a five point bi-polar evaluative scale. A second way of measuring attitudes originated from the Theory of Reasoned Action, an expectancy-value model (12). In the basic model a distinction is made between a cognitive component, - expectancies about the results that will follow from siting wind turbines (attributions), - and an evaluative component of attributed results (values). We used this distinction to score the alternative answers provided in the questionnaire that were neither evidently positive (for instance 'air pollution will diminish') nor negative (noise interference). These alternatives were listed in the questionnaire and the respondents were asked to estimate the chance that a particular consequence would follow from the large scale application of wind power in the near future. These expactancies were scored on a scale from 1 (very slight chance) to 5 (very great chance). The evaluations varied from −2 (very negative) to +2 (very positive).

RESULTS

Cognitive structure

A general result of the measurements concerning knowledge was that the level of correct information about wind power application was low in all groups. As expected the respondents living at or near the locations of wind energy developments were slightly better informed. Knowledge of the general characteristics of wind turbines was low in all groups, just as knowledge of the amount of energy that wind turbines yield. The yield is often underestimated, as previous research has shown as well (3). When there is little information available, the influence of personal psychological factors on the attribution of results will be considerable. It will be easier for instance to influence the cognitive aspects (the expectancies of attributed consequences) when there is little exact knowledge. This might be influence in any direction, positive or negative.

Apart from the existence of physical environmental impact of wind turbines and the knowledge about it, people usually show a tendency to link positive results to objects that are viewed positively. This tendency affects the expectancy - scores of the results that wind power application will have. Yet another phenomenon is 'probability consistency', the tendency to link assumptions about objects or events to a more or less logical pattern. In the analysis of the data of both pre-test and post-test surveys (9,11) as well as in the wind farm surveys, similar logical patterns could be traced. More about this follows in the paragraph 'expectancies and values'.

Structural aspects: four attitudes.

Exploration of the 14 attitude items led to the conclusion that there is not one single attitude representing the range of opinions about wind power. Four attitudes have been distinguished. In the first place a general attitude representing the opposition and support for wind power, the general wind power attitude. A second attitude concerns opinion about authority regulation of stimulating wind power and the regulation of turbine siting. This attitude is influenced by the general windpower attitude, but is also dependent on other values, such as the belief that authorities have an important task in the field of the economy and physical planning. The regulation-attitude is more strongly related to political attitudes than are the other attidues (Figure 1).

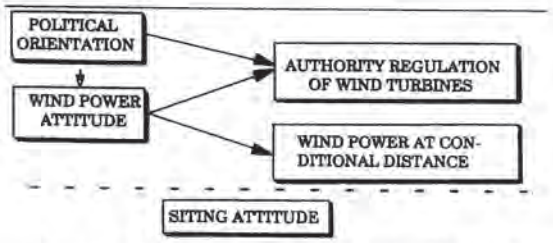

Figure 1. Relations between the distinguished attitudes to wind power application

Two other attitudes related to wind power can be distinguished. First there is an attitude representing the support for or opposition to turbines under the condition that they are sited at a distance from the built environment. This attitude is also moderately dependent on the general wind power attitude. In fact it is the same attitude with the conditional notion of minimal distances as a new dimension. The last attitude is the preference for scattered and solitary sited wind turbines on the one hand, or the option of siting turbines in wind farms on the other. This siting-attitude is not related in any way either to the general wind power attitude or to the other attitudes (Figure 1).

All four attitudes have been transformed to standard units (zero mean and unit variance) for further analysis. Therefore values around zero for the general wind power attitude still represent moderate support for the use of wind power. It is definitely a popular option compared to other ways of generating power.

Shape and stage of projects

The impact of the 1 MW turbine on the wind power attitude was surprisingly positive. The results of the 333 repeated measures in the experimental and control groups are summarized in Figure 2. While the control groups stayed at the same level, the attitude shift in the experimental group was considerable. A more extensive report of this experiment can be found in (11).

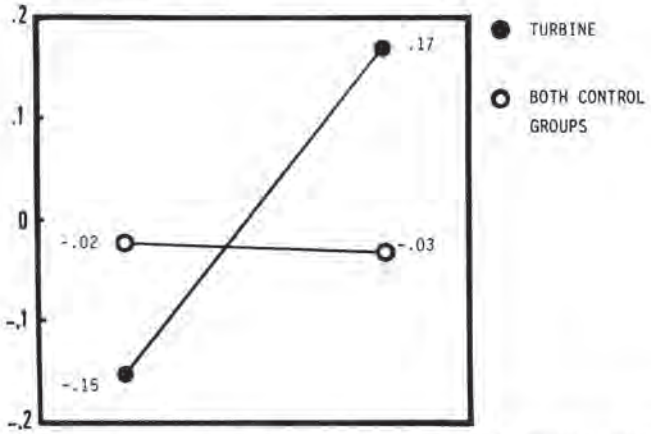

Figure 2. Wind power attitude-change caused by 8 months experience with 1 MW machine (standard units pre-test).

From these results the conclusion might be drawn that the introduction of wind energy developments will generate greater public support for wind power. Nevertheless, this conclusion turns out to be too simple when the data from all surveys (n = 1587) are re-analysed.

The results are shown in table 2A-D. All four attitudes are presented in mean scores for five conditions. First are given all data from locations without any wind power project. The data from project locations have been cross tabulated by two conditions: project stage (plan/realized) and project shape (stand alone/wind farms). Analysis of variance showed significant effects as indicated, and the following conclusions can be drawn:

- Realization of serious plans generates more opposition, which probably means that some already existent feelings are activated. So the attitude shift after realization in the positive direction appears to be a recovery of a previously demonstrated fall.
- Wind farm projects result in less support for wind power than stand-alone turbines; this effect is even more important than the stage of the projects.
- People are less supportive of wind power in cases of wind farm projects.

Remarkably, the last conclusion does not mean that people on wind farm locations are sceptical about large scale developments. On the contrary, people on wind farm locations show a significantly greater preference for application of wind power by means of building wind farms. The stage of the project does not matter as far as this attitude is concerned.

EXPECTANCIES AND VALUES

Structurally four dimensions of judgment

In Table 3 attributed consequences of wind power are presented in clusters that are internally homogeneously judged by the respondents. This means that all items in any cluster are highly correlated, not that the expectations of consequences are at the same average level. It means for instance that anyone who expects much noise, also tends to expect relatively many accidents and interferences with electricity supply. Of course these consequences are hardly linked in reality, but in the expectations of the respon-

dents they are corrrelated. The numbers in the table refer to the median expectancies ($1<x<5$) and median evaluations ($-2<x<+2$) for all surveys.

Table 2 Four Wind Power Related Attitudes by Stage and Shape of the Project; Analysis of (co-) Variance with Corresponding Figures 3A-3D.

A: wind power attitude (see Figure 3A)

effect	F	df	p<0.1
plan/realized	16.0	3	yes
stand alone/farm	39.2	1	yes
interaction	48.8	1	yes
regression*	1.5	1	

B: attitude authority regulation of wind turbines (Figure 3B.)

effect	F	df	p<0.1
plan/realized	0.7	1	
stand alone/farm	7.7	1	yes
interaction	1.0	1	
regression**	84.9	4	yes

C: attitude: windpower at conditional distance (Figure 3C).

effect	F	df	p<0.1
plan/realized	0.0	1	
stand alone/farm	24.2	1	yes
interaction	13.0	1	yes
regression**	75.9	4	yes

D: siting attitude: stand alone versus wind farms (Figure 4D).

effect	F	df	p<0.1
plan/realized	15.5	1	yes
stand alone/farm	42.5	1	yes
interaction	0.0	1	
regression*	0.8	3	

* Three covariates for sampling bias correction: political background orientation and energy policy issues.
** wind power attitude as fourth covariate; see Figure 1.

In general, positive opinions about wind energy are reflected in these figures. Most interference attributes show low expectancies and the general environmental advantages are ranked high. From the negative attributes the items of visual intrusion and interference with nature have significantly higher expectancies than the other potential interferences.

In the evaluation of attributions (table 3B), the average score for the phenomenon of many turbines in the landscape presents an interesting result. The average is about zero, indicating that it is an attribute that is evaluated both negatively and positively

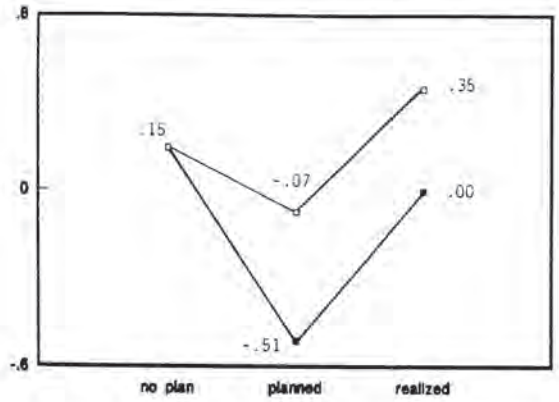

Figure 3A. Wind power attitude by planning stage.

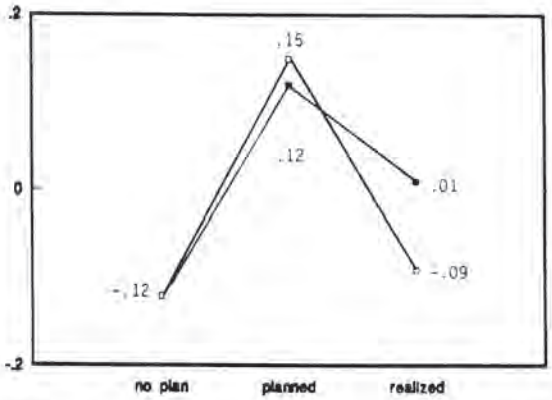

Figure 3B. Attitude of authority regulation of wind turbines.

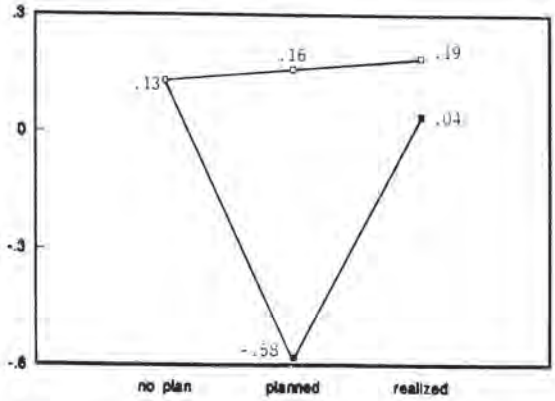

Figure 3C. Attitude to wind power application, at conditional distance.

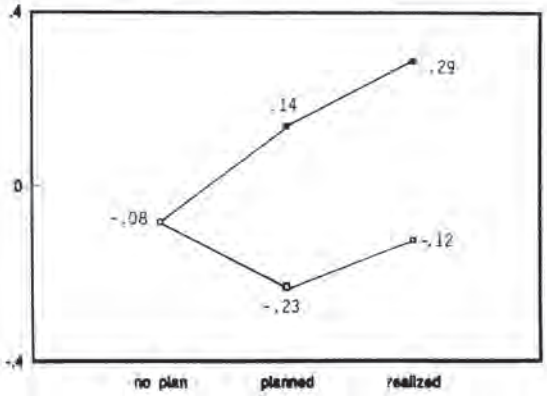

Figure 3D. Siting attitude by planning stage.

by a large number of people. Visual impact assessment research has shown that type of landscape has a strong influence on the scenic beauty ratings (12). The scenery is showing substantial variation in perceived beauty before the siting of turbines. Any decrease in scenic beauty will be strongly dependent on the ratings of the original landscape. The more beautiful the original situation, the more harm will be done. Generally the smallest decrease will occur on industrial area locations and in modern large scale agricultural areas. As a matter of fact a large part of the public will consider introduction of turbines an improvement in industrial areas. In fact we can also see here that wind turbines might sometimes offer an increased appreciation of landscape views, which is an underestimated effect in most visual impact and attitude studies (12).

The importance of attributed consequences

Covariance with attitudes. In table 3 the average subjective probability rates of attributed consequences are shown. This is not identical with the perceived importance of these consequences. The question is whether or not the expectancies and values attributed to certain consequences affect the attitudes. Because attitudes were measured in a direct way, separately from the attribute questions, an estimate of the perceived importance (psychological term salience) might be computed by the analysis of covariance structures. The result of regression analysis with the constructed variables (clusters) from table 3 is presented in table 4. The analysis of the NEWECS 45 project had indicated that two additional clusters with three items each existed but did not have significant meaning for the wind power attitude (11). Therefore these two clusters, 'electricity price' and 'decentralization of the electricity sector' were discarded from the wind farm questionnaire, with the exception of the last two items shown in table 3A.

The wind power attitude seems to be affected in the first place by the combination of expectancies and evaluations of the appearance of many turbines in the landscape. The visual significance of wind turbines largely explains the attitudinal variance. But three other attribute constructs have significance as well: the durable and clean character of wind power has a small positive weight and the local environmental interferences a small negative one.

Again, it is important to notice that the most salient factor is based on evaluative items with almost as many positive respondents as negative ones. The visual intrusion caused by wind turbines is only the negative part of this scale together with the landscape items in the cluster 'nature/landscape intrusion'. The latter did not add much to the variance in attitudes.

Table 3. Median scores for attributed consequences of large scale wind power application (n = 1587).

Attributed consequences	median score
A: Expectancies (1<x<5)	
many turbines in landscape	4.18
many turbines industrial zones	3.75
many turbines near buildings	3.23
air pollution diminished	4.29
nuclear becomes superfluous	3.26
oil and coal saving	3.26
new power plants become superfluous	2.93
spoiling of village or town views	3.34
interference with the landscape	3.26
danger for birds	2.86
interfernce scenic areas/nature	2.46
noise interference	2.46
shadow and light interference	2.35
(unreliable machines)*	1.85
interference radio or television	1.84
electricity supply unreliable	1.91
interference electricity supply	1.83
fluctuating electricity supply	1.58
accidents	1.54
less influence authorities/utilities	2.73
cheaper electricity	2.82
B: Evaluations (−2<x<+2)	
many turbines in landscape	−0.08
many turbines industrial zones	+0.66
many turbines near buildings	−0.83
nuclear becomes superfluous	+1.81
new power plants become superfluous	+1.04
less influence authorities/utilities	+1.04
* wind farm locations onlv (n = 579)	

Table 4. The Relation Between Attribute Categories and Wind Power Attitude.
(sign. effects; p<.001; n = 1587; Multiple R = .65)

Scale	Standardized regression coefficient
Evaluation of landscape	.41
Environmental advantages	.21
Interferences	−.16
Nature/scenic intrusion	−.13

Validation of salience. The covariance structure described leads to the conclusion that visual aspects are the most salient attribute of wind turbines, but at the same time this does not neccessarily cause negative feelings. This last conclusion has to be underlined, because in most psychological based landscape studies, and in social psychological research as well, only negative formulations for visual impact are included in the questionnaires. Sometimes people show a preference for a landscape with turbines above the same landscape without them (12).

The importance of visual intrusion was also established in the case of the Californian wind energy developments. In a landscape perception study the salience of attributes was measured by asking people to pick three advantages and disadvantages out of thirteen attributes. The people 'liking' and 'disliking' the wind farms were compared. The difference between these groups was the largest for visual intrusion ('it spoils the scenery', also only a negatively formulated attribute), indicating a larger influence on the evaluation of turbines than the other attributes (7). This analysis was mainly directed at landscape evaluation and not at attitudinal judgment, so Thayer and Freeman (p.396) concluded that "the relation between public attitudes and perceived aesthetic quality should be the subject of further study". Table 4 shows this effect of landscape evaluation on attitudes.

The method of asking the respondents to name the most important attributes, is one of the ways to establish the salience of attributes (8). There are other ways, such as the computation of the covariance with the attitude, as shown in table 4. A direct measuring approach is to ask people to name the aspects that come first to mind, without presenting a list of potential attributes. This kind of open question needs a subsequent content analysis of answers.

Both ways of measuring salience directly have been used, open questioning as well as selecting attributes from a presented list. The answers on the open question have been classified on a content analytic scheme that was based on the items of table 3. The procedure of picking six out of twenty was also based on that list. The consequences are listed in table 5, which also contains a column presenting the total scores for the scales that have been distinguished in table 3. Many answers on the open question, like 'clean energy', 'ugly', or 'good for the environment' could only be classified in these general terms.

Table 5. The Importance of Attributes of Wind Power Spplication, as Indicated by the Respondents on Wind Farm Locations (n = 579).

Attributed consequences	% picking 6 out of 20	% open question	total % of answers within item cluster
many turbines in landscape	30	9	
many turbines industrial zones	10	0	
many turbines near buildings	17	0	% naming number of turbines 13
air pollution diminished	73	19	
nuclear becomes superfluous	60	13	
oil and coal saving	55	9	
new power plants become superfluous	33	1	% environmental arguments 67
spoiling of village or town views	38	1	
interference with the landscape	31	10	
danger for birds	15	6	% negative about nature or landscape 21
interference scenic areas/nature	16	1	
noise interference	26	25	
shadow and light interference	11	1	
interference radio or television	10	1	
electricity supply unreliable	10	8	
interference electricity supply	7	1	
fluctuating electricity supply	15	1	
accidents/safety	13	6	% naming any interference 39
less influence authorities/utilities	9	1	
cheaper electricity	13	4	
other price aspects (general remarks)		26	34

A final remark on the methods that are used for research on the attitudes on wind power. An assessment of public opposition to wind power projects needs more than questioning which consequences people think of first, or which aspects are the most important ones. It needs an analysis of causal relations between attitudes and expectancies of attributed consequences.

CONCLUSION AND DISCUSSION

When people are asked which aspects of wind turbines are most important, they tend to point to their environmentally clean character. It fits with the positive attitude most people have. However, analysing the variation in attitudes, other attributes clearly contribute. In particular visual perception has attitudinal effects. Opposition towards wind turbines, that is a negative attitude, is mainly based on a negative landscape evaluation. This is a result of an analysis of covariation. At the same time one is pointing at other attributes, when asked what is important. People probably realize that this is not a strong arguement in formal procedures. They rationalize their opposition in terms of other objections particularly concerning interferences, for example noise, danger for birds, or sometimes even unreliability. This last aspect is a slowly growing new argument. When people have some experience with turbines, they start wondering why these expensive machines are out of order so often and for such a long time (7,10).

The phenomenon of pointing at other arguments than the ones that people actually have, is not uncommon. It has been recognized in California as well. Bosley and Bosley (2) thought this is a reason to believe that people are suffering from a 'not in my backyard' (NIMBY) syndrome. NIMBY is often used describing local opposition in cases of facility siting and particularly plants for hazardous waste treatment (5). Case studies have shown that it is dangerous for authorities or utilities to use this acronym, as it tends to offend the public and will generate stronger opposition. NIMBY often turns out to be a sarcastic dig or name-calling (4). In case the syndrome actually is a barrier, strategies of calculated public choice (5) or 'local control' (6) may help to overcome it. The first step in both strategies has to be that the distrust of local residents is accepted as a serious matter and that it is never said to be ridiculous or irrational. This is particularly dangerous for utilities, as people not only have attitudes about wind power, but about utilities as well: in most cases they are seen as arrogant organizations. A good example of it is the link that some people see between the unreliability of the wind turbines and the way utilities are financing turbines (7) or exploiting them (10).

This study shows that residents are not only opposed to wind turbines in their back-
yard. Planning a wind energy development in their neighbourhood is starting a cognitive process that is causing a real decrease in attitudes about wind power in general. In fact most people are only starting to think about wind energy when a turbine is planned. The weight of visual impact turns out to be the main source of opposition. Visual arguments are subjective but as real as other arguments. People only know that using visual criteria is probably not the best bet in formal decision making procedures. So there is no reason at all to believe that the opposition against wind turbines is irrational.

REFERENCES

1. **Azjen, I. and Fishbein, M (1980)** *Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs.*

2. **Bosley, P. and Bosley, K. (1988)** *Public Acceptability of California's Wind Energy Developments: Three Studies. Wind Engineering 12(5): 311-318.*

3. **Carlman, I. (1982)** *Wind Energy Potential in Sweden: The Importance of Non-technical Factors. 4th International Symposium on Wind Energy Systems, BHRA Fluid Engineers, Cranfield Bedford UK.*

4. **Krupar, K.R. and Krupar, J.J. (1989)** *Communication Strategies for resolving Environmental Issues. The International Journal of Environmental Studies 34 (1/2) 11-23.*

5. **O'Hare, M., Bacow, L. and Sanderson, D. (1983)** *Facility Siting and Public Opposition. Van Nostrand-Reinhold,, New York NY.*

6. **Stark Hasan, N. and Simmons, J.R. (1989)** *"Local" control as a model or a myth? The Westinghouse-Boomington Superfund Clean-up. Environmental Impact Assessment Review 33 9 (1) 9-32.*

7. **Thayer, R.L. and Freeman, C.M. (1987),** *Altamont: Public Perception of a Wind Energy Landscape. Landscape and Urban Planning 14: 379-398.*

8. **Van der Pligt, J. and Eiser, J.R. and Spears, R. (1986)** *Attitudes towards Nuclear Energy. Familiarity and Salience. Environment and Behavior 18 (1): 75-93.*

9. **Wolsink, M. (1986)** *Public Acceptance of Large WECS in the Netherlands. European Wind Energy Conference 1986 Vol.II. A. Raguzzi, Rome.*

10. **Wolsink, M. (1987)** *Wind Power for the Electricity Supply of House. The Netherlands Journal of Housing and Environmental Research 2 (3) 195-214.*

11. **Wolsink, M. (1988)** *The Social Impact of a large Wind Turbine. Environmental Impact Assessment Review 32, 8(4): 323-334.*

12. **Wolsink, M. and Van de Wardt, J.W. (1989)** *Visual Impact Assessment: A review of Dutch Research. European Wind Energy Conference 1989. Peter Peregrinus. London.*