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Wind power in Finland up to the year 2025—‘soft’ scenarios based on expert views

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Abstract

In this article we present a method of constructing ‘soft’ scenarios applied to the wind power development in Finland up to the year 2025. We asked 14 experts to describe probable and preferable futures using a quantitative questionnaire and qualitative interviews. Wind power production grows in all scenarios but there were differences in the order of magnitude of 10. The growth rate of electricity consumption slows down in all scenarios. Qualitative arguments varied even within clusters, with wind power policy emerging as the main dividing factor. The differences revealed diverse values and political objectives, as well as great uncertainties in assumptions about future developments. These influence wind power policy and were also believed to have contributed to the slow development of wind power in Finland. Re-thinking of the Finnish wind power policy is recommended. The ‘soft’ scenario method is considered valuable in finding diverse views, constructing transparent scenarios and assisting energy policy making.

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Keywords: Wind power; Scenario; Expert interview

1. Introduction

Wind power made a remarkable entry to the energy sector during the 1990s. The growth of cumulative wind power capacity in the world was staggering, with growth ranging from 26 to 37 percent yearly from 1996 to 2001 (BTM Consult ApS, 2002) (Fig. 1).

Wind power is renewable, practically emission-free and at the same time very modern, using highly sophisticated technology, as the growth of wind power capacity has been accompanied by rapid technological development (see McGowan and Connors, 2000). Wind power represents both a reduction of emissions from the energy sector and a development of a new branch of industry (turbine manufacture). Therefore it may be seen as an example of ecological modernisation, which has been defined as a social development in which the interests of environment and economy are compatible (Massa, 1995; Andersen and Massa, 2000).

This has inspired Finnish policy makers and Finnish industries that produce components and materials for the wind turbines. So far, the growth of domestic capacity has been quite slow, however, leaving Finland in a unique position in which the current domestic wind power capacity was 44 megawatts (MW) in the end of year 2003 (Laakso, 2004), providing only 0.1% of electricity consumption, although a considerable wind power industry exists. In 2001 Finnish wind power components had a global market share of approximately 5%, even as the installed capacity in Finland was only about 0.2% of the global capacity (Holtinen et al., 2002). Despite (and because) the current limitations of the Finnish wind power sector, it has a great potential for growth and change.

In this article we present different expert view-based scenarios of the development of wind power in Finland up to the year 2025. A number of typologies of different methods of constructing scenarios have been presented in the literature (e.g. de Jouvenel, 1967; Hirschhorn, 1980; Amara, 1981; Nijkamp et al., 1998; Tapio, 2002). To frame the approach of the study, three basic methodologies of constructing scenarios can be discerned: (1) business-as-usual modelling, (2) what-if modelling and (3) heuristic images of the future (Tapio,

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Fig. 1. The growth of cumulative capacity of wind power in the world. Source: years 1980–1995 (Brown et al., 2000), years 1996–2001 (BTM Consult ApS, 2002).

2002). Deterministic business-as-usual modelling has long been the standard in technical and economic forecasting, although what-if modelling was increasingly used in the 1990s (e.g. Nakićenović et al., 1998). In this study, a ‘softer’ use of participants’ future images is implemented. This is usually considered relevant in the analysis of novel phenomena with potentially growing importance, that is, *weak signals* (see Mendonça et al., 2004). Although the growth of wind power is a rather strong signal in international energy discussion, in Finland it is still weak (see above).

The scenarios presented here are made of presumptive (Bell, 1997) or conjectural (de Jouvenel, 1967) beliefs about the future of wind power. The study of beliefs and expectations about the possible and the preferable future is important, because they are part of the decision-making process of today. For example, they influence the setting of policy targets. These, in turn, matter because global wind power capacity has grown largely as a result of determined policies of different countries (Sawin, 2001). The images of preferred and probable futures enable the setting of political goals, the search of means, as well as the comparison of different actors’ objectives, arguments and values.

This paper is a part of a study on wind power policy and its role in the development of the wind power sector in Finland. There are two objectives: first, we wish to widen the view of the possibilities of wind power in Finland and to compare it with current policy and its assumptions. The slow development of wind power in Finland, as well as the ongoing changes of the energy sector call for a new, close look at the issue. Second, we introduce a method for constructing expert view-based scenarios and consider its merits.

The Finnish wind power policy context is described in Section 2, and the material and methods used for creating the scenarios are presented in Section 3. We then describe the results in numbers (Section 4) and

through the arguments given by interviewees (Section 5). Our findings are discussed in the Section 6, and in the final section we present our conclusions.

2. Wind power policy context in Finland

The battle against climate change is one of the main motives for supporting wind power in Finland, although wind’s contribution is not expected to be very notable in the near future. The other motive driving wind power policy is the Finnish turbine manufacturing industry. The most important political plan for the development of Finnish wind power is the “Action Plan for Renewable Energy Sources” (Ministry for Trade and Industry, 1999a), extending to the year 2025. This plan is the result of a committee organised by the Ministry for Trade and Industry, which is responsible for energy policy in Finland. The committee was composed of members from e.g. different ministries, non-governmental organisations and other lobbying groups, as well as the research sector. The Action Plan was endorsed by the Parliament. A proposal for an update of the Action Plan was recently introduced (Ministry for Trade and Industry, 2003).

In the plan there is an official target for wind power development: 500 MW of installed capacity by 2010. For the year 2025 there was no numerical target in the Action Plan. In the update the target for the year 2010 was renewed, and an estimate of development possibilities for 2025 was given as 2000 MW of installed capacity. It was acknowledged that in the long run wind power has potential for a much greater use in Finland, but the working group considered that reaching this capacity by 2025 would be very challenging with regard to the present level.

Wind power is supported in Finland through information guidance to energy companies as well as to consumers, and through funding technological research. The main incentive, however, has been an investment subsidy, which has been approximately 30% of the investment costs. In addition, wind electricity producers receive a tax refund of 0.69 cents/kWh (Helynen et al., 2003).

Despite the subsidies, wind power growth has not been as fast as anticipated or hoped for. During the years 1999–2003 the Finnish capacity grew only from 38 to 44 MW (Holtinen et al., 2001; Laakso, 2004). Even though there is no systematic analysis of the reasons for this, many explanations for the slow development have been mentioned. Some barriers have already been overcome to a large extent; because of the harsh climate it has been necessary to develop Arctic applications, such as blade heating to prevent icing (Peltola et al., 1998). Not all barriers are technological, however. For example, Vesa (2001) described bureaucratic

constraints, such as the unclear legal requirements for wind power plant projects, and the land-use planning practices that do not take the needs of wind power into account.

Additional factor is the low prices of electricity that were experienced in Finland after the liberalisation of the market. These lessen the profitability of building any new electricity production capacity. Some uncertainty about the direction of Finnish energy sector development was experienced in recent years, as the debate on a new nuclear power reactor dominated the energy discourse. In 2002 the Parliament granted a private company the political blessing to build a new reactor, clarifying the situation to some extent. And finally, wind power represents a new and distributed form of production. The difficulties this causes to the dissemination of renewables have been discussed e.g. by Fuchs and Arentsen (2002).

There were many policy suggestions for supporting wind power in the working group proposal (Ministry for Trade and Industry, 2003), but these were mostly just recommendations for the further study and development of the policies. Policies based on free markets and voluntary action were emphasised, such as increases in R&D funding and tax credits. It was also recommended that bureaucratic constraints be removed and that land-use planning be improved.

Despite the apparent consensus presented by the Action Plan, the political debate on the future of wind power continues. We next move on to construct diverse scenarios by asking expert views of the development of the field up to 2010 and 2025.

3. Material and methods

The empirical material for the study was collected in the spring and summer of 2002 with a questionnaire which was followed by interviews. The questionnaire was sent to 22 experts of whom 18 returned it. Four participants filled in the questionnaire incompletely, and their views are not used in this article. Thus the material consists of 28 cases, of which there are 14 responses of the probable future and 14 responses of the preferable future. The quantitative responses were grouped by cluster analysis as 28 scenarios would be too many to be illustrative. The emerging clusters were constructed into scenarios using qualitative analysis of the interviews. The difference between the two is that clusters are groups of answers, formed solely on the basis of the closeness of numerical values. Scenarios, on the other hand, include also the ways and reasons for ending in these numbers, the qualitative arguments and expectations. A somewhat similar approach has been used previously by one of the authors in analysing the prospects of transport (Tapio, 2002, 2003).

3.1. Experts

The experts were chosen through co-nomination, in which the first ones suggest further experts to be included in the study. This method has been criticised, since if the original group is biased in some way, the final list of participants is likely to be skewed in a similar way. Therefore the original group was chosen carefully to cover the wind power sector in Finland, so that all relevant fields (research, policy making and implementation, business community and lobbying groups) were represented.¹ The first interviewees were chosen among those who participated in the working group that produced the Action Plan for Renewable Energy Sources (Ministry for Trade and Industry, 1999a). A full list of the interviewees is included in Appendix A.

Only two of the interviewees were female, and the gender bias seems to reflect the reality of the wind power sector in Finland. Most (12 of 14) had a degree in technological or natural scientific fields. In fact, only one had not graduated from a university. While it is clear that this group of experts does not mirror Finns in general, it is thought to be representative of the sectors influencing Finnish wind power. As it consists largely of companies producing turbines, their components and materials, as well as of the research sector, the Finnish wind power sector is dominated by technological and natural scientific expertise. The same largely applies to the lobbying groups representing industries and the energy sector, and even to the Ministry for Trade and Industry.

Some of the interviewees are part of the wind sector itself, others have wind power as only one of their professional concerns. Therefore, even though all of those interviewees who gave material used in the clustering have a good understanding of wind power and its technical properties, perhaps only some of them could strictly speaking be classified as experts of wind energy. The others have different type of expertise, for example on design of energy policy, which is equally valuable for the formation of scenarios and understanding the progress of wind power.

Defining expertise and granting the status of an expert are social constructions. The definition can be a form of struggle for power and have political importance (see e.g. Hajer, 1995). In part the definition depends on the actual education, knowledge and experience of a person, but in part it is defined in the social context. It is necessary to have a society or audience that defines the criteria for expertise (Kaivo-oja et al., 1997). Often it is formal education and titles, professions and positions in organisations that give experts the authority to talk

¹ The consumers of wind electricity were excluded from the study, as the emphasis was on wind energy policy, which the consumers influence only indirectly.

about their field (Saaristo, 2000). The struggle for authority has continued for hundreds of years, and requires the setting of boundaries between expertise and non-expertise, valid and invalid knowledge (see Gieryn, 1983).

There have been calls for widening the definition of expertise, especially when it comes to understanding and solving complex problems, such as environmental problems that involve ecological, economic and social aspects (e.g. Beck, 1994; Saaristo, 2000).

The inclusion of representatives of many sectors reflects the call for a wider expertise in this study: first, the experts are considered ‘informants’, sharing their knowledge. Different fields and organisations each have their own particular expertise to offer to the whole, but they also have their own “set of world views and patterns of interpretation” (Bogner and Menz, 2001) that influence how people working within them observe and discuss issues (see also Hajer, 1995). In order to widen the scope of views to be included in the design of scenarios, a “plurality policy” can be recommended in choosing the expert panel (Kuusi, 1999, p. 181).

Second, it is also valuable to understand what people *think* might happen, regardless of the expertise they use to reach those conclusions. Even if the discussion of issues more than two decades from now is necessarily speculation, it does not mean that discussing them would be irrelevant, as views about the future affect the decisions made today. Many of the experts included in this study have the power to make decisions about wind power policy or about investing the funds and efforts of private companies to different forms of electricity production, thereby influencing the development of the sector. For example, representatives of the Parliament, ministries and different lobbying groups each have a role in the formation of wind power policy.

Third, regardless of the level of expertise, all persons have subjective values. The respondents were chosen from different organisations, but in this study they only represented themselves, and were promised anonymity with respect to individual statements. This strategy allowed the interviewees to give their honest opinions instead of the political statements of their organisations. In addition, it was possible to discuss their values and other personal issues, which had an impact on the “preferable” futures. A downside of anonymity is that the analysis is less transparent, but it removes the arguments and views from the danger of being labelled on the basis of the person giving them, and allows us to consider them on their own merits (see e.g. Kaivo-oja et al., 1997; Kuusi, 1999).

3.2. Variables

The 28 cases of future images presented here were sampled from the numerical answers given by the

respondents in the questionnaire. Although the original questionnaire contained several issues, such as estimates about the political power of various wind power policy actors, only three key variables were chosen to construct the core of the scenarios, specifically, the installed capacity of wind power in Finland, the electricity produced with the said capacity, and the total consumption of electricity in Finland. These key variables best describe the end result of policy, and the progress of the wind power sector. All three figures were collected for the years 2010 and 2025, for both probable and preferable futures.

The installed capacity of wind power is often used as the yardstick with which to measure the progress of wind power. Official targets are most easily expressed as installed capacity, as capacity does not vary as a result of yearly wind conditions, for example. However, the electricity produced with the said capacity is more important, as it is electricity, which is in demand in society. The two variables can also be used to indicate how the productivity of wind power capacity develops over time, for example as a result of technological innovation or wind conditions at the sites that are taken to use.

To set wind power in a context, we also asked about the overall electricity consumption in Finland. This can be used to consider the share wind power will hold in the energy sector, as well as to examine how the electricity market itself is changing. Comparing this factor in probable and preferable futures also tells about the attitudes towards electricity consumption.

We also asked how the gross domestic product (GDP) would change in Finland. This information was meant to be used in combination with the total consumption of electricity, to see whether there would be changes in the electricity intensity of the economy. Unfortunately, the question was excluded from the scenarios as there were not a sufficient number of quantitative answers to it.

3.3. Time scale

The years 2010 and 2025 were chosen because they are the years used in the “Action Plan for Renewable Energy Sources” (Ministry for Trade and Industry, 1999a). It would have been analytically clearer to use the evenly spaced years 2010 and 2020, with the possible inclusion of 2030 as reference points in the scenarios. However, it was felt to be more informative to use the same years as those given in the Action Plan, as this made comparisons to official documents possible. In the questionnaire, background figures were given for the years 1980, 1990 and 2000. In those years, the installed wind power capacity was 0, 0.3 and 40 MW, respectively (Laakso and Holttinen, 2001); wind power production was measured at 0, 0.5 and 77 GWh, respectively (Laakso and Holttinen, 2001); and the total

consumption of electricity was given as 40, 60 and 80 TW h, respectively (Kara et al., 1999).

Many experts complained about the long time scale, stating that it was impossible to speculate about events, which will occur after such a long time span. However, a shorter time scale would not have revealed changes that take longer to emerge and include learning.

3.4. Probable and preferable futures

Each expert who participated in the study was asked to express his/her probable and preferable image of the future in the questionnaire. The probable future was defined simply as the future the expert considered most probable, whereas the preferable future was defined as the possible future he/she would like to see take place (see Amara, 1981). It is important to note that the response about the preferable future was supposed to be possible in technical, economic and social terms, according to the respondent. While the preferable future of one expert is not necessarily possible in the opinion of another, subjectively perceived possibility was used in the definition. Probable and preferable futures were examined separately, so that each person produced two cases. These have been marked as “pro” and “pre” in the following Table 1 and Fig. 2.

3.5. Cluster analysis

The cases were grouped by a hierarchical cluster analysis found in the SPSS 10.1 software, using the Furthest neighbour clustering algorithm (see Everitt et al., 2001). The furthest neighbour (i.e. complete linkage) method belongs to the group of *agglomerative* clustering methods, which consider all the cases separate in the beginning. *Divisive* methods in turn begin by regarding all the cases as one group. Furthest neighbour method begins by placing the furthest cases into different groups as opposed to the Nearest neighbour method, which begins by fusing the two closest cases.

As the three variables were on different numerical scales, they were standardised to the scale 0–1, that is, the highest value received the numerical value of 1.00 and the rest were given values linearly downwards. The normal Euclidean dissimilarity measure was used as all the variables were on a relative scale. These standardised values were summed up to calculate the total difference between cases presented in a dissimilarity matrix and to maximise the difference between clusters by the furthest neighbour method.

All three variables were given equal weight in the clustering. The first two (capacity and electricity produced with the said capacity) are obviously not independent. Although the wind power variables thus have more weight in the clustering, it was deemed acceptable to use no weighting as the main interest was

in the future of wind power. Including electricity consumption in turn sets wind power in a context (see Section 3.2), and gives more depth to the analysis, as factors other than those affecting wind power directly can be considered.

Cluster analysis cannot ultimately determine the number of clusters. How does a researcher know whether the number of clusters reveals the grouping present in the data? There seems to be no consensus on the matter in the literature of classification. Five strategies might be useful: (1) statistical stopping rules; (2) external material; (3) theoretical categorisation; (4) applicability to decision-making and (5) heuristic sense-making (Dubes and Jain, 1979; Milligan, 1996; Everitt et al., 2001; Tapio, 2003). We used strategies 2, 4 and 5.

One problem with statistical stopping rules is that the rules are made and tested by using artificial data in which clusters do exist. The artificial composition of the data might have a serious bias when applied to real data in which the grouping cannot be known beforehand and may not even exist. External material might be useful, but when tested quantitatively it would mean leaving some of the key variables out of the clustering. Hence, we used the qualitative material from the interviews as a test for sensibility, as this material was not used in the grouping. Some discussion of the internal consistency of the clusters based on the qualitative material is presented in Section 5. Theoretical categorisation might also be used, but we were not aware of an applicable theoretical typology of different views of the future of wind power.

The criteria of applicability to decision making and heuristic sense making were thus used. The first supposes a default number between 4 and 7, as 1 gives an idea of a ‘true’ description of the future, 2 easily gives the impression of a right and a wrong alternative and 3 could give the impression that an apparent middle course is being promoted. Higher numbers of scenarios than 7 would be unillustrative as people have limits to handling alternatives (Robinson, 1990; Tapio, 2003). The final choice was made by studying the clustering dendrogram (Fig. 2) and the differences between the clusters. The dendrogram is a tree-shaped hierarchy which shows each partitioning and includes a scale measuring the distance between combined cases/clusters (Everitt et al., 2001).

SPSS output also included a dissimilarity matrix showing the absolute distance between each pair of cases and a vertical ‘icicle’ displaying the order of partitioning of each case/cluster in the agglomeration process. The icicle is useful if there is question about the exact order of clustering or if there is a theoretical reason to form clusters not apparent in the dendrogram. The dissimilarity matrix is useful in large sets of data including very many variables but when the study sample and matrix are not too large, it is more illustrative to look at the

Table 1

Details of the cases grouped into five clusters and the working group proposal (WG) (Ministry for Trade and Industry, 2003)

	Case	Wind capacity 2010 MW	Wind capacity 2025 MW	Wind electricity 2010 GW h	Wind electricity 2025 GW h	Electricity consumption 2010 TW h ^a	Electricity consumption 2025 TW h ^a	Share of wind in el. cons. 2010% ^b	Share of wind in el. cons. 2025% ^b
Cluster 1	A-pro ^c	500	1250	1000	3000	93	100	1.08	3.00
	A-pre ^c	500	1250	1000	3000	93	100	1.08	3.00
	F-pro	300	2000	700	4800	90	110	0.78	4.36
	B-pro	300	2500	740	6200	95	100	0.78	6.20
	C-pro	200	700	447	1564	92	107	0.49	1.46
	D-pro	300	700	600	2000	90	105	0.67	1.90
	E-pro	200	1300	400	3000	90	100	0.44	3.00
	D-pre	300	1000	600	3000	90	100	0.67	3.00
	G-pro	200	500	400	1000	95	120	0.42	0.83
	H-pro	300	2000	650	4500	100	120	0.65	3.75
	I-pro	300	2000	720	5200	104	120	0.69	4.33
	J-pro	250	1500	500	4000	100	110	0.50	3.64
	G-pre	500	1500	1000	3000	100	130	1.00	2.31
Mean		319	1400	674	3405	95	109	0.71	3.11
Cluster 2	K-pro	500	2000	1200	6000	90	95	1.33	6.32
	L-pro ^d	450	2000	1200	6000	90	100	1.33	6.00
	L-pre ^d	550	2200	1320	7200	85.5	95	1.54	7.58
	F-pre	500	3600	1200	8600	90	100	1.33	8.60
	M-pro	500	3000	1100	8000	90	95	1.22	8.42
	B-pre	500	3000	1200	7500	95	100	1.26	7.50
	H-pre	500	4000	1100	10 000	90	90	1.22	11.11
	E-pre	500	2500	1000	6000	80	70	1.25	8.57
Mean		500	2778	1165	7413	89	93	1.31	7.96
Cluster 3	J-pre	750	3000	2000	8000	90	100	2.22	8.00
	M-pre	1000	3000	2000	8000	90	100	2.22	8.00
	I-pre	1000	4500	2700	12 000	95	100	2.84	12.00
	N-pro	500	5000	1000	12 000	95	120	1.05	10.00
Mean		813	3875	1925	10 000	93	105	2.08	9.52
Cluster 4	K-pre	1500	4000	4000	12 000	85	80	4.71	15.00
	C-pre	1500	4000	3352	8940	92	92	3.64	9.72
Mean		1500	4000	3676	10 470	89	86	4.15	12.17
Cluster 5	N-pre	3000	15 000	6000	37 000	88	100	6.82	37.00
WG		500	2000	1100	5100	93	106	1.2	4.8

^aThe value for consumption was not given directly in the WG, but is calculated from the figures given for electricity production from renewable sources, and the share of such electricity in total consumption.

^bMarket shares were not specifically asked for from respondents. They were calculated from figures in the previous four columns.

^cRespondent A gave ranges. The arithmetic means of the given ranges were used.

^dRespondent L gave numbers including the symbols <, > and >>. These were interpreted as $\pm 10\%$ (< >) and $+20\%$ (>>).

Fig. 2. Clustering dendrogram using the furthest neighbour method. The block letters stand for the respondents, the abbreviation “pro” stands for probable future and “pre” stands for preferred future.

newly grouped matrix of original data and consider whether the grouping makes sense (Table 1).

3.6. Interviews

The thematic interviews lasted 1–2 h each and covered a number of topics, such as the benefits and disadvantages associated with the use of wind power, the availability of knowledge on wind power, different actors’ influences on the growth of the sector in Finland, the likely development and desirability of policy instruments, and the development of wind power technology and costs. The questions were not identical in each interview, although the themes remained the same. Interviews were taped and transcribed before analysis.

After the cases had been grouped into clusters, explanations for the differences between clusters were sought from the arguments given in the questionnaires and interviews.

The clusters are presented below in figures and numbers (Figs. 3–5 and Table 1). Section 5 contains the arguments behind the numerical values. The combination of a quantitative cluster and the qualitative arguments of the cases within the cluster is here considered a scenario.

Fig. 3. Wind power capacity in Finland in 2000 and six scenarios for the years 2010 and 2025. Note that x-axis (time) is not on scale.

Fig. 4. Production of wind electricity in Finland in 2000 and six scenarios for the years 2010 and 2025. Note that x-axis (time) is not on scale.

Fig. 5. Consumption of electricity in Finland 1980–2000 and six scenarios for the years 2010 and 2025. Note that x-axis (time) is not on scale. Value for consumption was not given directly in the working group proposal (WG), but is calculated from the figures given for electricity production from renewable sources, and the share of such electricity in total consumption.

4. Clusters in numbers

The most illustrative output form of the hierarchical cluster analysis is the dendrogram (Fig. 2), as it shows clearly which cases are grouped together at each phase. Drawing vertical lines helps in determining the choice of an appropriate number of clusters. Considering this data, it seems that the possible number of clusters could be 3, 4, 5, 6 or 9. Choosing three or fewer would result in clusters of very different sizes. Nine would be too many to be very illustrative. Choosing six clusters seems to only produce another cluster of just one case as compared to choosing five. Shifting from four to five breaks a larger cluster into two, and as the number 5 falls into the range of 4–7 it would be useful for decision making. However, we invite the reader to ponder whether clusters 2 and 3 are similar enough to be combined. Or, should cluster 3 be divided into two, resulting in six clusters? The five clusters are presented in Table 1 in detail.

Figs. 3–5 display the arithmetic means of each variable in the clusters. For example, cluster 1 had 13 answers to “how much wind power capacity will there be in 2010”, and the mean 319 MW has been used in Fig. 3. Since the values for wind power capacity and wind electricity production were so small in 1980 and 1990, they are not given in Figs. 3 and 4. In addition to the five bars signifying the five clusters, there is a bar marked “WG”, which stands for the “target” (in the case of 2010) and “vision” (in the case of 2025) of the working group proposal for the update of the Action Plan (Ministry for Trade and Industry, 2003). Even though the proposal has not yet been formally adopted as the state policy, it represents the newest semi-official view of the future of wind power in Finland.

The capacity factor represents the average production of electricity from a certain capacity. It is given as a percentage of the total electricity that would be obtained if the wind power plant operated throughout the year at its nominal capacity. In Finland the capacity factor varied between 19% and 23% during 1994–2001, but it fell to 17% in 2002, as a result of lower than average wind speeds across the country and technical problems with some turbines. However, every year since 1997 some turbines at the best sites have reached a capacity factor of 30% or more (Laakso, 2003).

There was some variation in regard to this factor between clusters. However, as there was significant variation *within* clusters, and moreover as the differences levelled out between clusters and were fairly minor by 2025, no special emphasis should be given to such differences. Of more importance is the fact that all clusters included improvement. The capacity factor grew to 28–30% in 2025, in all clusters as well as in the WG. Increases in productivity were usually attributed to improving technology and to offshore installations (wind speeds are higher at sea, giving better yields).

Table 2

Annual growth rates of wind power capacity in the clusters, 2000–2010

	Annual growth 2000–2010 (%)	Annual growth 2011–2025 (%)
Cluster 1	23	10
Cluster 2	29	12
Cluster 3	35	11
Cluster 4	44	6.6
Cluster 5	54	11
WG	29	9.7

Before we move on to arranging these clusters into scenarios, the growth rates found in the clusters are noteworthy. Table 2 presents the approximate annual growth rates that would result in the capacities envisioned in the clusters.

It would be interesting to compare these to the growth rate before the year 2000, but the Finnish wind power capacity grew intermittently during the 1990s, and the annual growth rates varied between 0% and 281% (Laakso and Holttinen, 2001). However, if the growth had been constant, the capacity would have grown by 62% annually from 1990 to 2000. If such a rate were to continue, the capacity would reach nearly 5000 MW by 2010.

As long as the capacity is very small, an addition of even one or two power plants is significant, but the growth rates are likely to slow down over time. Nevertheless, very high capacity growth rates have been experienced recently in countries fairly rich in wind power. For example, in Germany the average annual growth was 43.2% during the years 1998–2000, in Spain, 76.9%, and in Greece, 111%. In Germany this meant adding 793–1665 MW a year, in Spain 368–1024 MW and in Greece 26–116 MW a year (BTM Consult ApS, 2001).

5. Scenarios: going behind the numbers

In this section the quantitative clusters are arranged into scenarios with the qualitative material from the interviews. In order to protect the anonymity of the respondents we refer to all respondents with the pronoun “he”.

5.1. Working group proposal

The numbers for wind power in the working group proposal are based mainly on the original Action Plan for Renewable Energy Sources (Ministry for Trade and Industry, 1999a) and in the Background Report for the Plan (Ministry for Trade and Industry, 1999b). The estimates for installed capacity in 2010 were based on data about wind conditions in different parts of the

country as well as information about the grids and existing land-use plans. However, the estimates were slightly higher than what the existing information allows for. For example, there was no reliable data on inland wind conditions, but in the Background Report 50 MW were estimated to have been built inland by the year 2015.

In the Background Report there are references to the lowering of the cost of wind power as a result of learning, but no estimates as to how fast the further development would be. There were no estimates about the increasing competitiveness of wind power in the working group proposal, even though competitiveness was named as the primary goal of renewable energy policy. Nor was this issue mentioned when discussing the future need for subsidies. Policies based on free markets and voluntary action were emphasised, as described in Section 2.

Estimates about electricity consumption were based on the business-as-usual scenario presented in the National Climate Strategy (Ministry for Trade and Industry, 2001). It was estimated that the production of energy intensive industries would grow more slowly than the production on average. Population growth would be slow and stop around the year 2015. Energy taxes were expected to be raised in 2003. All these factors would reduce the rate of growth of electricity consumption. However, the working group proposal does not discuss electricity consumption in detail but concentrates on the support of renewable sources instead.

5.2. *Scenario 1: Calm*

The first cluster showed the slowest growth of wind power, hence the name “Calm” for this scenario, although electricity consumption grows faster than in any other cluster. The working group’s scenario was the most similar to this one, even though it was also rather similar to scenario 2.

There were 10 responses of the probable future, and three of the preferable future that formed the Calm scenario. The preferable futures of respondents A, D and G were rather similar to their probable ones, and in the case of respondent A, the two were in fact identical. These three experts did not expect wind power to be competitive without subsidies even in the year 2025. Other respondents who contributed to this scenario were much more optimistic about competitiveness. However, even though they expected the production costs of wind power to diminish, their main argument for increased competitiveness was that the price of electricity would rise in general. This would result from internalising the external costs of other, more polluting energy sources, through e.g. environmental taxes.

Many of those who had probable futures in this cluster and more optimistic preferable futures in other clusters explained that they did not expect Finnish

energy policy to support wind power as much as they hoped. In some cases, criticism was directed towards the quantity of support, but many also considered the existing instruments, primarily investment subsidy, to be unsuitable for large-scale development. Unless new policy instruments were to be taken into use, wind power would develop slowly in Finland.

In this scenario, then, current policies would continue in a more or less similar way as now. Since the subsidy has been approximately 30% of the investment costs, and it was not expected that the funds for subsidies would be raised very much, subsidies would only be available for a relatively small number of turbines.

There are not yet any offshore wind farms in Finland. The rate of offshore building is rather slow in the scenario Calm. Respondent G did not believe in large-scale offshore development even in the long run, as he expected that it would be both environmentally and economically constrained. Most respondents, however, believed that offshore wind farms would meet with less public resistance, though building would be restrained by higher costs. Nevertheless, with better wind conditions and fewer siting problems it was expected that the majority of Finnish capacity would be found offshore by 2025. By 2010, however, there would be only one or two pilot projects, in which it would be tested how well the turbines and their foundations can withstand the pressure of ice.

According to respondent J, Finnish companies would hesitate to commit to notable offshore investments, but after 2010 foreign companies would discover the shallow waters of the Finnish coast.

Electricity consumption would grow at least until 2025 in the scenario, though most believed that the rate of growth would be slower than in the past decades. In the case of G-pre the rate would remain at the same level of approximately 20 TWh/decade that was experienced in 1970–2000. This he considered preferable not only because electricity is an important factor of production, but also because electricity would replace other forms of energy, especially in traffic. This would lower the total emissions from energy consumption. Most respondents, however, were unhappy about the continuous growth of electricity consumption.

The respondents doubted that Finns would begin to buy wind electricity voluntarily on a large scale. It was felt that there is a significant difference between Finns and people in other Nordic countries in the degree of willingness to buy environmentally better but more expensive products.

There were two views among the respondents of the Calm scenario about the importance of the green electricity market. Some argued that without demand there would be no supply, and that the state should not interfere with the market. Others called for the state to take responsibility for the change. They felt the

responsibility for the “greening” of the electricity market should not be left to individual consumers. Respondent D was the only one to express doubts about whether wind electricity is, in fact, environmentally beneficial.

5.3. Scenario 2: *Breeze*

There were eight cases in cluster 2, three probable ones and five preferable ones. The cases were more optimistic in terms of wind power growth than in the Calm scenario, but more pessimistic than in the other three, hence the name Breeze for this scenario.

In the Breeze scenario, the growth of wind power capacity is seen to be constrained by environmental and economic factors. Finding more suitable sites would be difficult. The respondents believed that especially in the short run (up to 2010) there would be bureaucratic constraints, such as land-use planning practices that do not take wind power sufficiently into consideration. Offshore development would not proceed rapidly before 2010.

Several respondents argued that the current Finnish wind power policy is not effective or pro-active enough. Some found the investment subsidy to be a rather practical tool, however. For instance, respondent L remarked that with this instrument it is possible to direct more support to certain energy forms. In contrast, if wind power had to compete against other renewables on equal terms, it would probably lose. He pointed out that electricity produced from biomass is currently cheaper than wind electricity.

Estimates about technological development are rather optimistic in the Breeze scenario. One contributing factor is the currently small turbine size in Finland, which the respondents expected to grow significantly, improving cost-effectiveness.

After 2010 wind power would become gradually competitive without financial support mechanisms. The price of other forms of electricity production, especially fossil fuels, would rise as a result of internalising their external costs. Of course, this would not only affect wind power: respondent B expected green electricity to become rather redundant by 2025, assuming that all electricity production would be less polluting than nowadays.

Electricity consumption grows in the Breeze scenario, but interviewees expected a saturation point to be reached. This would result largely from efforts in energy conservation, which would take place both in industry and households. In addition, “natural” factors such as the ageing of the population would contribute.

5.4. Scenario 3: *Brisk wind*

Cluster 3 consists of four cases, three of which were of the preferable future. The resulting Brisk wind scenario

is characterised by a relatively high growth of both wind power and electricity consumption. The share of wind power in electricity consumption would be almost 10% by 2025, signifying a great change from the current share of 0.1%.

As electricity consumption would also grow significantly, and presumably the economy with it (unfortunately it was impossible to use the GDP in the clustering), this scenario seems to represent ecological modernisation. Reduced environmental impact would coexist with economic growth.

All four respondents seemed to agree that the main impediment preventing the preferable future from being probable is the Finnish energy policy. Firstly, they did not consider the current policy consistent enough. Secondly, it was also argued that the main instrument, investment subsidy, is ineffective at least in its current form, in which subsidies are directed to pilot and demonstration projects. In addition to measures that support wind power directly, the respondents called for stricter taxes or other environmentally motivated instruments that would raise the price of more polluting energy sources.

According to respondents J, M and I, such policy measures could result in the preferable development seen here. In the theory of ecological modernisation it has also been expected that increased policy measures would be needed (Andersen and Massa, 2000). In this respect, as well, the Brisk wind scenario is in keeping with the theory.

However, N considered the wind power capacity of this case to be almost a minimum level, saying that “a share of at least some 10% seems to be inevitable” in spite of the virtual obstruction of renewables by the state policies. His preferable future case included much higher numbers. It was this case (N-pro) which would have formed a cluster of its own, if we had chosen six clusters instead of five. In the light of the arguments presented above, that might have been reasonable choice.

The criticism against Finnish policy makers was a unifying factor, however. For example, N accused the Finnish policy makers of almost wilful blindness to the positive experiences of other countries. Respondent M criticised environmental officials for paying too much attention to issues he considered to be of secondary environmental importance, such as turbine noise and the impact on landscape. The public sector was also urged to show good example through buying green electricity, which further emphasises the importance of the decision makers of the public sector.

In all the cases electricity consumption was seen to increase. One of the contributing factors, according to respondents J and N, is the recent decision to build a fifth nuclear reactor in Finland, which they believed would give the energy intensive industry a boost. Respondent I had similar thoughts about the impact

of nuclear power, but in his preferable future case the new power plant would not be built after all. Respondent M did not believe that wind power would suffer because of nuclear power, as he argued that the motive for building each differs (nuclear power provides a steady supply for industrial needs whereas wind power is useful for environmental reasons). Interestingly, M had a slightly higher figure for electricity consumption in his preferable future case than in the probable one. This development would be preferable for wind energy because it would mean an increased demand for it.

All respondents of the Brisk wind scenario were rather relieved, however, that the long nuclear debate was finally over. They stated that as the environmentalists had often brought up wind power as an alternative for nuclear power, and the powerful pro-nuclear faction had responded by downplaying the potential of wind power, the altercation had rendered any normal wind power planning and lobbying practically impossible.

5.5. Scenario 4: Storm

Cluster 4 was the first cluster that only contained cases of the preferable futures and is formed of just two cases. This Storm scenario is characterised by high growth in wind power but slow growth and later even a small decrease in the consumption of electricity. It indicates ecological structural change, i.e. “delinking economic growth from the consumption of ecologically significant resources, like energy and materials” (Simonis, 1994).

The respondents of the Storm scenario argued that stopping the growth of electricity consumption would be possible with a more efficient use of energy. This growth in efficiency would require political measures, which would raise the price of electricity. Prices set too low are likely to increase the use of electricity, in space heating, for example.

Respondent K especially emphasised the importance of knowledge and technology in the economy. As long as the price of electricity remains at a low level, there is an incentive to invest in energy-intensive industry, which he did not consider optimal for the development of the country, the environment, or the economy in the long run.

In K's opinion, the current energy discourse focuses too much on the price of electricity. He argued that in a free electricity market only price matters, and innovative technology or environmental issues do not give a significant edge in competition. Therefore, what is needed for a more sustainable future is political will, demonstrated in both declarations and environmental policy instruments.

Neither C nor K had a very high opinion about the environmental consciousness of Finns. They did not believe that consumers would start buying green

electricity, but they both agreed that wind power could benefit significantly from a market mechanism that differentiated between different sources of energy. Therefore in this scenario wind electricity would be sold primarily as green electricity, but this would result from officially set quotas.

Despite the respondents' scepticism about environmental awareness, in the scenario Storm people would grow used to seeing wind turbines and/or value their positive environmental impact, and consequently there would be few problems in finding sites for them.

Wind power would be competitive without financial support mechanisms sometime after the year 2010, certainly well before the year 2025. C and K referred to such technological advances as the growth of turbine size, and the ability to start electricity production at lower wind speeds. Additionally, the economies of scale achieved with larger projects would lower costs.

Even though the importance of political measures was emphasised, both respondents criticised the use of the investment subsidy, considering it a very inefficient tool for creating a viable market for wind power. The subsidy was considered suitable for assisting in technological development, especially in pilot and demonstration projects, but not for creating market demand.

5.6. Scenario 5: Hurricane

Cluster 5 consisted of only one case (N-pre). It is in a league completely of its own, with its 37% share of wind electricity in consumption, hence the dramatic name Hurricane. Here the capacity in 2025 is extremely high, in fact, it is three times as much as the second highest figure given in all the other cases.

Not surprisingly, N attached very positive values to wind power, emphasising the environmental benefits. He argued that even compared to other renewable energy sources, not to mention fossil fuels, the ecological impact of wind power is quite low. N also emphasised the huge resource that wind energy represents, stating that even in Finland only a small fraction of this resource would have to be utilised in order to provide a significant share of electricity (e.g. 20%).

Unlike previous scenarios, in which the current growth of wind power is perceived as a weak signal, N considers it to be a strong signal (see Mendonça et al., 2004), and believes a prosperous future of wind power to be almost inevitable. However, the extent of growth depends much on policies, and political will is the key to this scenario, as it was to scenario Storm. N proposed certain policy measures, which he argued would not cause undue financial strain to any actors. An example is legislation requiring that all municipalities appoint suitable areas for wind power development.

In this scenario, the very large capacity in 2025 (15,000 MW) would be achieved mainly through

offshore wind farms (12,000 MW), but also through the use of inland resources as well as small-scale applications. For example, structures from lampposts to radio link towers and the roofs of supermarkets could be utilised for small turbines, often using vertical axis solutions. The efficiency of such turbines, as well as large turbines in inland locations, is lower than that of large turbines in better locations. This will lower the productivity of the installed capacity, but allow for many more installations, which in turn will allow economies of scale to reduce the costs of wind power.

Unlike most other experts, N did not give the technological research of wind power a high priority. N argued that what matters most is taking the existing technology into large-scale use, instead of waiting for further technical development. Furthermore, he referred to learning curves, and estimated reductions of 20–40% in the costs of onshore wind power within the decade, simply as a result of capacity being built in the European Union. For offshore wind power the cost reduction would be even more remarkable, as its development is in an early phase.

One of the main measures that would improve the competitiveness of wind power in the scenario Hurricane would be the introduction of higher taxes for more polluting forms of energy. N believed that if all the costs were truly internalised, this alone would allow wind power to compete successfully. In the beginning (2010) wind power would be sold as green electricity, but by 2025 it would be able to compete on its price alone.

Problems in siting are expected to be less severe than envisioned by some other interviewees. People would grow accustomed to the turbines and learn to consider them normal and even beautiful additions to the landscape. This, according to respondent N, has been the case in countries where wind power is more prevalent.

Consumption of electricity would increase from the current level, but more slowly than during the last decades. It would even be possible to stabilise the yearly consumption to the level of 100 TWh, but this would require much more attention to energy saving than is the case today. A low price for electricity is considered also in the Hurricane scenario to deter the efficient use of energy.

6. Discussion

In this study, Finnish experts presented their images of probable and preferable futures of wind power. There were clear differences in the assumptions about the future of wind power: Some believed that wind power would remain marginal even in the renewable electricity sector in Finland, being always overshadowed by

biomass; others believed that wind power could supply 10% or even a third of all Finnish electricity.

These scenarios should not be considered in the light of probabilities. Instead, we should consider what causes the differences between them. Obviously, one of the factors is the experts' attitudes towards wind power as they were asked to create images of a future they personally considered preferable. This does not, however, explain all the differences.

It was also notable that the scenarios were found not to be entirely consistent, as the arguments varied among the different cases in some clusters. This obviously resulted from the dominance of the quantitative data in the construction of the clusters. Using the arguments as a test of the sensibility of the cluster grouping, we can see that some clusters should perhaps be further divided, especially scenario Calm, which included almost half of the cases. It seems that it was possible to arrive at similar numbers from very different perspectives. For example, the relatively slow growth of wind power capacity in the Calm scenario was blamed in some cases on the lack of a market for wind electricity and the high costs of the technology, and in other cases on the lack of the political will to create a market that would lead to lower costs. When making alternative scenarios for policy making, an attempt should be made to solve the remaining inconsistencies by logical analysis, empirical experience, negotiation and heuristic sense making. For our purposes, however, it is more valuable to note that the analysis reveals the great uncertainties lying behind the assumptions about future development.

Let us now look in more detail at some of the arguments behind the different responses, concentrating on factors contributing to the competitiveness of wind power.² All but three of the experts who contributed cases believed that wind power would be competitive without subsidies by (or much before) the year 2025. Few cited any numerical estimates about the costs of wind power, however, and the few estimates varied considerably. The prices were expected to be lowered through economies of scale, technological development and the increase of project management know-how. Perhaps most important, however, was the expected rise of electricity prices.

6.1. Rising electricity prices

Electricity prices were considered by many experts to be unreasonably low in Finland, and to have deterred the installation of any new production capacity. Prices

²While issues such as finding suitable sites for wind power development are obviously a crucial issue, and there were differences of opinion about them in the material, they were considered slightly outside the focus of this paper. Siting and related environmental issues are discussed in the reference Varho (2003).

were expected to rise as a result of new capacity that must be built in order to replace decommissioned plants as well as to fulfil a rising demand for electricity. The opening of the European-wide electricity market could also contribute to the rise, as electricity prices are higher in Central Europe than in Finland.

Respondents were all in agreement that the costs of fossil fuels would also rise as a result of political action, such as carbon quotas or environmental taxes, resulting in increased competitiveness of non-fossil energy sources. This issue of internalising the external costs of fossil fuels has been around for some time in visions about the development of wind power (e.g. Street and Miles, 1996). The view that CO₂ emission permits or similar measures support wind power more than policies that are directed at wind power dissemination has also been strengthened by the results of the bottom-up scenarios created for the USA by Hadley and Short (2001), and the recent study of Finnish energy sector by Honkatukia et al. (2003).

Given the policies of the European Union, the optimism about the rising costs of fossil fuels does not seem unfounded today. However, it should be noted that this process is hard to predict. For example, the negotiations on harmonising energy taxation in the EU have been extremely long and difficult, and there is still considerable uncertainty about the price of the new CO₂ emission permits. In addition, only in the scenario Hurricane was this internalising considered sufficient, in other scenarios also the need for improved technological and economic performance of wind power was emphasised.

6.2. Green electricity market

One of the ways to increase the competitiveness of wind power could be the creation of a market for environmentally friendlier electricity. There was great scepticism among the interviewees about the voluntary purchase of this so-called green electricity, as Finns were not considered environmentally conscious enough. Current experiences in Finland as well as in many other countries do not support the faith in the existence of “green” customers (e.g., Anderson, 2003).

Scenarios Brisk wind and Storm contained the idea of green electricity as a driver for wind power, but this was based on demand created by legislation (see Section 6.4) or public consumption. Some respondents feared that it would be against the regulations of the European Union for public bodies to buy green electricity. The same worry has influenced the green electricity market in Sweden (Kåberger, 2003). The use of renewable energy by companies was not considered probable in a large scale. This is consistent with the results of Luukkanen (2003) who studied the views of paper industry in Finland.

6.3. Technological development

Technological development of wind power was envisioned by all experts, and the main difference between the views was in how R&D efforts were valued. Respondent K, for example, emphasised the importance of education, research and innovation in economic development in general; respondent A stressed the importance of R&D efforts in reaching competitiveness; but respondent N saw little need for new R&D funding, emphasising instead the economies of scale. One expert argued that most of the technological development takes place outside of Finland, making domestic R&D input fairly insignificant in the process of lowering costs.

It is not difficult to imagine that these views reflect attitudes about much more than just technological development. For example, some respondents did not accept the use of such demand-side policies as minimum quotas of renewables for electricity suppliers, as they were not considered compatible with the liberalised electricity market. R&D funding, however, seemed a more neutral, politically acceptable way of improving competitiveness. It is also a measure that could be particularly helpful to Finnish wind power manufacturers who compete in the international market.

In the end, it is impossible to estimate the real impact of R&D. According to Hadley and Short (2001), there are no reliable quantitative methods to predict how R&D funding increases improve the cost and performance of advanced energy technologies. This uncertainty about future costs has also been observed by McDonald and Schrattenholzer (2001), who found a wide variety of learning rates³ for wind power in literature, ranging from 4% to 32%. Therefore it is not surprising that the scenarios were not very consistent in their views about technological development and its impact on costs.

Those who are most sceptical about wind power may also be most likely to believe pessimistic estimates about its development, whereas those who value wind power for its environmental benefits may be overly optimistic. As this issue has crucial political importance, there seems to be an ongoing lobbying struggle over estimates of the future costs of wind power.

6.4. Policy choices

Especially in the scenarios Brisk wind, Storm and Hurricane, the political will to support wind power was emphasised. Some experts contributing to scenarios Calm and Breeze thought that since everything that *can* be done for wind power also *will* be done, there is little

³The costs of technologies can often be seen to decline by a steady percentage (= learning rate) over each doubling of cumulative sales.

difference between probable and preferable futures. Others believed that additional, effective policy instruments could be taken into use if there was sufficient political will, but as this is lacking, the full potential of wind power will remain unrealised. However, policy choices are obviously not based entirely on the perceived effectiveness of the instruments. Instead, it is often a question of what is considered politically possible and acceptable in the market environment.

The suitability and effectiveness of policy instruments were argued rather heatedly in all interviews. Some considered the existing policies to be almost a hindrance to the development of wind power in Finland. There was not a single policy instrument suggested that would have won the approbation of all interviewees, although R&D funding and information guidance were fairly popular.

There is a variety of wind power policy measures in use around the world. In Germany, for example, the market grew dramatically as a result of a feed-in tariff that guarantees a market and minimum price for wind electricity. The system has been criticised, however, for having low impact on the technology costs. There are plans to harmonise the support to renewables within the European Union, which may affect Finnish policy in the future.

The interviewed were divided most strongly to those advocating instruments that would lower the costs of wind power technology (such as the investment subsidy directed at pilot projects) and those arguing for instruments that directly create demand (such as feed-in tariffs or mandatory quotas for green electricity). The first type of policy measures may benefit the Finnish wind power industry most. It would help the industry that relies on continuous innovation to test new inventions in Finnish projects, i.e. on the home ground, before introducing these innovations to the export market. However, these measures may not be as effective in increasing the installed capacity of wind power in Finland, as they emphasise pilot projects, not large-scale development. In this way the policy choices may reflect the priorities of interviewees, for many of whom the Finnish industry is an important motive for supporting wind power.

However, the policy choices also clearly reflect the respondents' opinions about the appropriateness of policies in the liberalised electricity market. In the ongoing liberalisation of the European electricity markets, Finland and other Nordic countries have been forerunners: the Finnish market was opened to competition already in mid-1990s. Many felt that there is no point in liberalising the market, if we then introduce mandatory quotas for renewable energy forms, or other instruments that they saw as incompatible with free competition. However, Sweden recently created mandatory quotas of renewable electricity for consumers in

spite of the market liberalisation (Swedish Energy Agency, 2003), and many interviewees recommended their use also in Finland. More on motives for wind power policy in Finland, see Varho (2003).

6.5. *Electricity consumption*

As opposed to wind power issues, when it comes to the total consumption of electricity, both the numbers and the arguments were much closer to each other among the different scenarios. Still, there were significant differences. The experts mainly believed that the growth of consumption would slow down but nevertheless continue, or at best stabilise after 2010. There were only two cases in which the consumption was less in 2025 than in 2010.

The reduction in the growth rate was expected to result from both "natural" factors, such as the ageing of the population, and from "political" factors, such as the rise of electricity prices as a result of environmental taxes and energy conservation policies. A change of focus in the national economy to less energy intensive fields in which knowledge and expertise are most important, was considered to be a partly natural process, and partly a result of technology and education policies.

The growth of electricity consumption was primarily seen as a negative development, which seems understandable given the problems associated with all forms of electricity production. Considering the current consensus on the need for energy efficiency and saving, it is surprising that a few interviewees had higher figures for consumption in their preferable cases than in the probable ones. Clearly there is still disagreement even on this issue about the preferable direction of development.

7. **Conclusions**

This paper had two objectives: to look at the future of wind power and wind power policy in Finland, and to introduce and evaluate a method of constructing 'soft' energy scenarios based on expert views. The views were grouped by using cluster analysis of the quantitative responses and constructed into scenarios using qualitative arguments. The results were discussed in detail in Sections 4–6, and here we present some conclusions on the overall objectives.

As a methodological conclusion, it can be said that

- (a) even though the qualitative arguments were sometimes very different, the numerical estimates were similar,
- (b) where the arguments were similar, the numerical results often were not.

This reflects the significant uncertainties underneath the assumptions, as well as the diverse values and political objectives of people influencing the Finnish wind power policy.

What can be said about the future of wind power based on these results? The method brought to light many factors that influence the development of the sector. Certainly wind power policy choices seem to matter. They should not be discussed in isolation, but rather as a part of the energy policy. For example, the (expected) rise of fossil fuel costs was seen as a very important part of wind power's improving competitiveness, and it should be taken into account when considering the need for future subsidies.

The choice of instruments that directly advance wind power should also be re-evaluated. The effectiveness of current policies has been criticised and the slow growth of capacity in recent years points to the same direction. It seems that if the policies remain constant, a radical change in wind power capacity is not to be expected. However, here different actors end in very different recommendations: some call for voluntary and market-based policies, even though they are pessimistic about the growth of demand for green electricity. Others demand public support, for example in the form of mandatory quotas for renewable or specifically wind energy, but they also seem pessimistic about the likelihood of such policies. In fact, few people expect any radical change in the policy environment or the increase of wind power capacity, though some very optimistic views were also presented.

The emerging scenarios were here compared with the “official” view of Finnish wind power, the new update of the Action Plan for Renewable Energy Sources (Ministry for Trade and Industry, 1999a, 2003). The assumptions this view was based on were not given in much detail in the documents. For example, even though the estimates for the technical potential of wind power have been updated in recent years (Kiviluoma et al., 2001), there was no reference to them in the working group proposal. There were also no estimates about the increase of wind power's economic competitiveness. This may be in part because wind power does not have a very high priority in the proposal. The main emphasis in all plans for increasing the share of renewables in the Finnish energy supply is on biomass, which the working group expected to fulfil 77% of the total increase in renewable energy production between the years 2001 and 2025 (Ministry for Trade and Industry, 2003).

As the targets set in the governmental working group proposal were not based on particularly detailed assumptions, there does not seem to be any reason to consider their figures to be significantly more realistic or ‘right’ than those presented in the scenarios of this article. Their impact on policy should not be under-

estimated, however. One respondent argued that he cannot create preferable and probable future images that are very different from one another, because he trusted in the numbers given by the experts in the Action Plan for Renewable Energy Sources and its Background Report. However, the person responsible for the wind power section of the Background Report also submitted two cases, and these were not identical. The reliance on expertise can be excessive, especially if expertise is defined very narrowly. It is very easy to lose the diversity of targets, arguments and values in a committee report, if the transparency of such differences is not considered a goal in itself. The method of producing ‘soft’ scenarios based on anonymous expert views seems to avoid this pitfall.

A further consideration is that some predictions may become self-fulfilling prophecies (e.g. van Vught, 1987). All interviewees were aware of the official target of 500 MW by 2010, in fact, many had been part of the original group that created it. The official status of the target was considered quite important: several interviewees said that as the government had committed to this goal, it would find the means to reach it, as well. (It is notable that some were pleased with this, while others considered it a less-than-rational approach.)

The vision of 2000 MW by the year 2025 was given in the working group proposal. The estimates of the experts interviewed for this study varied between 500 and 5000 MW in probable cases and 1000–15,000 MW in preferable ones. All of these numbers were considered possible by at least some respondents, and are given some credence by international statistics. The development of the global wind power market was very rapid during the 1990s, when some countries built over a thousand megawatts of wind power within 1 year. It is certainly difficult to make any kind of estimate about the state of wind power in Finland in 2025.

We should remember, however, that scenarios are not predictions. Instead, they are tools to be used when discussing the future and its possibilities. For example, the rise of fossil fuel costs as a result of environmental taxes was pointed out as a mechanism that would make wind power more competitive. Whether the costs will really rise is another question that a scenario cannot answer.

It is not the point whether any of these scenarios will ever be realised. In a same way, it does not necessarily matter whether the people who make decisions about wind power are experts of wind power or not, as long as they have views about the issue. The power of images of the future is in the way they influence the decisions made today. For example, the fact that some people believe that wind power will be economically uncompetitive in 2025 is reflected in the way these people think wind

power should, or should not, be promoted. After all, it makes little sense for policy makers or the decision makers of private companies to invest money, time and effort on an energy form that is not going to be standing on its own even after several decades of support. These views can therefore explain in part why Finnish companies may have been reluctant to build wind power, and why the policy instruments in Finland seem to favour the wind power export industry over increasing the wind electricity production capacity.

Are we constricted in our thinking by official targets and views, or are they an inspiring goal, an almost unattainable level? There is no simple answer to this, but certainly the official targets are rather conservative in relation to the scenarios put forward by the respondents in this study. It seems that it is necessary to continue to look at other, more varied visions of what is possible and preferable and to increase the transparency of views and arguments. On the whole, it seems that a re-evaluation of Finnish wind power policy as well as the policy-making process is needed. Hopefully the scenarios presented in this study contribute to this work.

Finally, we consider the usefulness of the method presented for creating scenarios. It seems that there is a special value in creating scenarios with a broad group of respondents. This method brought to light the importance of several sectors in society. Not only wind power itself, but many social and economic issues have an impact on its development. There were also great uncertainties, which were revealed through the analysis. Here the method of collecting both quantitative and qualitative responses, and using only the former to create clusters was useful. It showed clearly how very similar end results could be achieved with different assumptions. The qualitative analysis in turn revealed interesting factors resulting in the 'soft' scenarios which might not emerge through more formal methods. This seems to be important especially when dealing with a weak signal, a trend at the beginning of its development. In such a situation it is difficult to estimate the speed of growth, or quantitatively measure the impact of different factors on growth. Small changes in assumptions can affect the results significantly.

Depending on the use of scenarios it can be decided whether to construct more consistent scenarios, in which case it may be necessary to move away from the results of the cluster analysis (see [Siivonen and Grönholm, 2002](#)). For example, in this analysis we could have broken the scenario Calm in two based on the qualitative responses, even if the division would not reflect the clustering as shown in the dendrogram. There are also alternative clustering algorithms available that might find the structure

of the data better. We made a sensitivity analysis using the Ward method, which changed one case, N-pro from cluster 3 to cluster 2 (see [Table 1](#)). Another option would be to apply more sophisticated optimisation clustering algorithms and use a statistical stopping rule ([Everitt et al., 2001](#)). However, cluster analysis and stopping rules are tools to help thinking, not to replace thinking, and regardless of the choice of tools, the transparency of the method and arguments is essential.

One area where transparency is important are the motives for policy. The different scenarios presented in this paper reflected very diverse goals, such as the unhindered state of the electricity market, and the development of Finnish industry to less energy intensive direction. These kinds of motives influence the choice of policy instruments, and should be stated openly. When different interest groups are involved, their views and expectations should be made visible. Our study could be criticised for including rather many advocates of wind power and few antagonists, but even so the results showed a wide variety of views. Also, there are few open opponents of wind power in Finland, partly because of its marginal position in the energy sector where it is not perceived as a real threat to anyone. In addition, the opponents may not have the kind of expertise they themselves would consider necessary for giving numerical estimates. On a more general level, however, also the inclusion of strong antagonists should be considered in designing scenarios, in order to bring more views to the discussion.

All in all, we believe that when designing scenarios, expertise should be defined rather broadly, and uncertainties, options, values and wishes should be made transparent. Anonymity can help people to openness and to focus on issues rather than people, and the analysis of quantitative and qualitative answers systematically in a same study can reveal otherwise hidden uncertainties.

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Appendix A

See [Table 3](#).

Table 3
Experts participating in the study

Name	Organisation
<i>Provided quantitative material used in cluster analysis</i>	
Esa Holttinen	Electrowatt-Ekono (consultant)
Hannele Holttinen	Technical Research Centre of Finland
Aarne Koutaniemi	Lumituuli Ltd. (a small wind power producer)
Ari Lampinen	University of Jyväskylä
Peter Lund	Helsinki University of Technology
Folke Malmgren	Vindkraftföreningen (wind power association)
Bernt Nordman	Natur och Miljö (a nature and environment association)
Jaakko Ojala	Ministry of the Environment
Esa Peltola	Technical Research Centre of Finland
Jouni Punnonen	The Confederation of Finnish Industry and Employers
Bengt Tammelin	Suomen tuulivoimayhdistys (Finnish Wind Power Association)
Martti Tiuri	Member of Parliament, chairman of the committee for the future (2002)
Harry Viheriävaara	Finergy, Finnish Energy Industries Federation
Sirkka Vilkkamo	Ministry for Trade and Industry
<i>Were interviewed but did not provide sufficient quantitative information for the scenarios</i>	
Veli-Matti Jääskeläinen	WinWinD (turbine manufacturer)
Jorma Keva	Ministry of the Environment
Jerri Laine	TEKES, Technology Development Centre of Finland
Mauno Oksanen	Vapo Oy Energia (medium-size producer of wind electricity)
Leo Parkkonen	Ministry of Treasury
Gustav Tallqvist	Oy Synoptia Ab (agent of BONUS Energy turbines in Finland)
Pentti Tiusanen	Member of Parliament, chairman of the environment committee
Jyrki Virtanen	Metso Drives Oy (producer of turbine components)
<i>Interviewed abroad</i>	
Jochen Twele	Bundesverband WindEnergie e.V. (German wind power association)

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