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Wind Park Project Flumserberge

Final Report of Feasibility Study

worked out by

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at the request of the Swiss Federal Office of Energy

Program Director: Mr. Robert Horbaty

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Final Report

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FINAL REPORT of Feasibility Study

Project Director:

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Project Attendant:

Mr. Robert Horbaty

Project:

"Wind Park Project Flumserberge"

Date:

December 7, 2000

This study has been undertaken at the request of the Swiss Federal Office of Energy.

The responsibility for its contents and conclusions lies with the author of this report.

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1. Objectives of the Report

The purpose of this feasibility study is to supply the basis for a project ready to be implemented. However, this goal can only be reached if the results from the feasibility study turn out to be positive. The preliminary results of this study indicated that the initially selected site showed only an insufficient wind potential. For this reason, a different site was selected, and further wind measurements were arranged for so that the goal of the feasibility study, i.e., to form the basis of a project ready to be built, might be attained.

2. Coordination, Objectives and Results of the various Stages of the Feasibility Study

2.1 Considerations of Location / Choice of Site

The first negative results from the preceding intermediary reports of this study, which was undertaken at the request of the Swiss Federal Office of Energy, led to a new choice of location, requiring further wind measurements.

Several potential new sites were considered, and, in cooperation with Mr. R. Horbaty of the ENCO Company, a new location was chosen.

As soon as the Federal Government and the Canton had approved subsidies, the feasibility study, as well as further-reaching investigations, were initiated at new sites.

The sites were assessed in terms of the following criteria:

a) Is the Area Free from Obstacles in All Directions?

The area belongs to the Canton of St. Gallen, lying in the skiing area of the "Flumserberge." The newly selected site is located in the vicinity of the mountain station of the Maschgenkamm, a little over 2000 m above sea-level. The landscape opens towards the main wind direction coming from the West. The area is also most open in all of the other directions except for a few individual mountain peaks.

b) Is There Any Wind Potential?

According to the program "Wind" of the Swiss Federal Office of Energy, the firms of OEKOSKOP, METEOTEST and ENCO worked out a documentation

"Wind Power and Landscape Protection"

which showed this area to have a potential for wind-power development.

Statements given by people living in the area as well as by sportsmen (incl. paragliders and delta gliders, whose opinions were also sought), provided further information regarding possible "windy spots" in the area.

c) Feeding the Generated Power into the Electricity Grid

The planned wind park location is situated in the immediate vicinity of a highly developed tourist region (skiing and hiking).

According to statements made by the local electricity company, sufficient feeding capacities exist.

The local electricity grid provides feeding possibilities of about 2 to 4 MW. Consultations with the electric power station of the community of Murg, which, along with the electric power station of Quarten, is linked to the grid of the St. Gall-Appenzell Electric Power Stations (SAK), have already taken place.

d) Accessibility by Road

The Flumserberge are situated very close to a major European and Swiss road network (N3; N13; E43). To the East, at a distance of about 15 km, lies the town of Sargans. St. Gallen is situated about 40 km (air distance) north of the Flumserberge.

Zurich lies at a distance of about 90 km to the Northeast. Furthermore, due to the excellent state of the road system, the area is accessible by road up to the Prodalp, Prodkamm and the Maschgenkamm. This extension of the road system was a natural result of the development of the skiing areas. Thus, only a few points would have to be widened or strengthened so that the area could be reached by very heavy and/or overly long vehicles. According to statements issued by the community, these roads may be used as access ways for this project.

In résumé, there exists a road network up to the mountain stations of Prodkamm and Maschgenkamm, which can be reached with at least 25-ton vehicles.

However, it goes without saying that the local development is still to be worked out as a part of the implementation of the construction project.

d) Local Assessment of the Area

The newly selected sites on the Maschgenkamm and Prodkamm in the Flumserberge lie at an altitude of slightly over 2000 m above sea-level and are used as alpine grazing grounds only to a limited extent. As a result of the highly developed tourism, this area is already strongly marked by chair-lifts and ski-lifts. Tar roads and gravel ways guarantee easy access to these areas. In the North, East, South and West there are no substantial elevations, with the exception of a few individual mountain peaks, which however do not impede the main wind directions. In the planning, residential and commercial buildings (restaurants, hotels, etc.) have to be taken into consideration only to a limited extent, since they are situated at a certain distance from the planned site.

Below the topsoil layer there is a visible rock layer, which is excellently suited for forming the foundation. However, some erosion, gravel accumulations and clay deposits of relatively small extent still also have to be taken into consideration.

Owing to the already existing "industrial" use of the new sites through skiing and hiking tourism, no disfigurement of areas worthy of being protected is to be feared. The criteria stated below, such as the low population density, a rather limited agricultural exploitation due to the high altitude, and predominant winter tourism, are all factors creating ideal conditions for harnessing wind power for energy production.

2.2 Coordination with Community, Nature Protection and Authorities

During the various on-site inspections of the old and new locations and during the installing of the wind measurement devices, the following persons were present:

Mr. Balz Manhart, Mayor of Quarten
Mr. Joseph Gall, Mayor of Flums
Mr. Ernst Brandstetter, President of the Citizens' Association of Flums-Dorf
Mr. Anton Gubser, President of the Citizens' Association of Oberterzen
Mr. Markus Lendi, Alp Corporation of Mols
Mr. Christian Barbisch, Electric Power Station of the Community of Murg
Mr. Sager, Cantonal Office of Environmental Protection
Mr. Robert Horbaty, ENCO Company
Mr. Sven Ucke, Enercon Company
Mr. Stefan Kunz, Meteotest
Mr. Schlegel, Prodalpbahnen (skilift company)
Mr. Herbert Egli, Maschgenkammbahnen Flumserberg AG (skilift company)
Mr. Eberle, Maschgenkammbahnen Flumserberg AG
Mr. Rolf Engler, c+n Engineering Company
Mr. Reto Antenen, c+n Engineering Company
Mr. Otto Noger, c+n Engineering Company

These on-site inspections and personal conversations showed a very positive reaction on the part of the government authorities and communities concerned, as well as on the part of the Nature protection agencies. All of them principally support projects for alternative and renewable energies. However,

precise and binding statements could, of course, not be given at this project stage since a specific construction project would be required.

2.3 Subsidization

Financial assistance was promised from the Swiss Federal Office of Energy and the Building Department of the Canton of St. Gallen to the following extent:

Canton of St. Gallen: SFr. 25,000.-

Swiss Federal Office of Energy: SFr. 60,000.-

Additionally, subsidization of further wind measurements on the new site was offered amounting to: SFr. 20,000.-

Prospects of further assistance for planning and realization have also been offered. However, this kind of assistance strongly depends on the particular budgets. Moreover, these sums are mainly limited to additional costs incurred in the event of a construction project's being carried out. These additional costs are established on the basis of comparisons with projects that have already been carried out on level ground. In this case, too, precise figures and commitments cannot be given yet by the authorities, since for this purpose a positive preliminary study, a construction project and a cost estimate would be required.

2.4 Electricity Companies

a) Examination of the Technical Feasibility of Feeding the Generated Electricity into the Existing Power Grid

Owing to the fact that the planned site of the Wind Park is situated in the immediate vicinity of a highly developed tourist area (skiing and hiking), the local electric power station of Murg was in a position to declare that a sufficient feeding capacity of about 2 to 4 MW does exist. The tourist areas of the Prodkamm and Maschgenkamm with their snow guns, tow lifts, chair lifts and cable cars guarantee a sufficient feeding capacity of about 2 to 4 MW. Preliminary consultations have already been made in this connection. However, the precise details and concrete agreements have to be worked out during the realization phase of the construction project.

b) Coordination of Technical Parameters

Via the Enercon Company (wind plant manufacturers) and the c+n Engineering Company GmbH, St. Gallen, a direct coordination of technical parameters with the electric power station of the community of Murg and the "St. Gallisch-Appenzellische Kraftwerke AG" has already been discussed. The respective

energy carriers have been informed about all the relevant technical parameters, such as network compatibility and technical data of the ENERCON E40 wind generators. The same investigations still have to be made for the new site. Depending on the final location, the wind generators would be situated in the areas served by the electric power stations of Murg or Quarten. Since this preliminary project has led to a positive result, definitive coordinative steps would have to be taken and specific details worked out during the realization phase of the construction project.

2.5 Wind Measurements/Profitability

a) Wind measurements carried out on the first site

Initial disposition/Objective

- 10-minute measurements – average values

- Duration of measurement: 12 months

--> Short report on the wind conditions to be expected on the site (extrapolation to a period of 10 years on the basis of comparisons with long-term measurements).

Measuring System

Location A: 30 m mast:

Steel pipe, extendible 3 m elements, stay-wires to four sides on three levels (anchor radius 18.3 m), without foundation (base plate; stay-wires anchored with pegs). Measuring system: Campbell datalogger, wind speed measurements made at 30 m above ground, temperature measurements 2 m above ground.

Location B:

Aluminum pipe of about 2 m on cable-car mast, measurements of wind speed and direction.

The datalogger was programmed such that 10-minute values of wind speed and direction as well as values of wind speed changes were recorded. The temperature measurements allowed a better evaluation of measurement interruptions, such as the freezing-up of the wind sensors.

The measuring systems used were robust and tested in similar conditions and are of a high quality standard. Data failures of less than 10% were to be reckoned with.

Evaluation

Continuous (monthly) plausibility checks of the data were made. The raw data was also recorded for later statistical evaluation purposes.

For the extent of the measuring period, a protocol was made providing information about the annual variation, frequency distribution, wind-direction distribution, etc. In addition, the data was compared with measurements taken at similarly located stations of the SMA (Swiss Meteorological Institute). From this data, the long-term frequency distribution of the wind speed measured at the sites was derived (extrapolation of the wind data).

The results have been summarized in a short report, and the complete data collected in digital form.

Execution

These wind measurements were carried out by a renowned company called:

METEOTEST

Fabrikstrasse 29

3000 Bern

Phone: 031/307 26 26

Fax : 031/307 26 10

Project Director: Dr. Stefan Kunz (Dr. Phil. Nat.)

Collaborators: Jan Remund (Dipl. Natw. ETH)

Peter Mühlemann (Lic. Phil. Nat.)

Evaluation of the Wind Measurements Carried Out

The evaluation of the wind measurements was made in the form of reports by the METEOTEST Company itself. These reports have always been forwarded to the ENCO Company and are attached to the present report. For this reason, we will only repeat the final remarks in a slightly modified and abbreviated form.

The two initially chosen sites showed an average wind speed of about 2.0 to 2.4 m/s during the winter months measured. At a level of 50 m above ground, a maximum of 4.5 m/s is to be expected according to the METEOTEST Company. It is true that these results are not in contradiction to a potentiality study for Switzerland as a whole; however, they were not expected to turn out like that on this site. Statements given by staff members of the "Prodalpbahnen" about the possible use of chair-lifts, safety adjustments with greater wind forces, etc., seem to indicate that the months measured so far were rather below average.

All the same, these wind measurements indicated that the sites under consideration do not seem to be suitable for the harnessing of wind energy. Empirical data – including from Germany –, shows that with a basic installation, a yearly average wind speed of about 5.0 up to 6.0 m/s is required to achieve a minimum profitability.

After various discussions with the companies METEOTEST and ENCO, it was still considered possible to find suitable sites in the immediate vicinity.

On the basis of an on-site inspection, it was decided to shift the measuring apparatus from the 12 m mast to the top-most mast. This displacement was arranged on June 5, 1998. Within 2 months, the METEOTEST Company was able to collect sufficiently significant information about the wind forces prevailing in the immediate vicinity. With the help of the report made by the METEOTEST Company, it was concluded that further measurements would probably lead to significant results at other sites. This would make it possible to determine whether other areas in the immediate vicinity are likely to be suitable for the harnessing of wind energy. With relatively low additional costs and a positive assessment of the Maschgenkamm by the METEOTEST Company, further wind measurements were made for another year at an altitude of 2000 m above sea-level.

b) Wind measurements at the second site

Initial Disposition / Objectives

- 10-minute measurements – average values
- Duration of measurement: 12 months

Measuring System

Location: 8 m high telescopic mast

Installation of the mast on top of or on the side of the building

Altitude: 2019 m above sea-level (anemometer about 12 m higher), coordinates: 737 850/214 800

Measuring system: NRG datalogger, storing of the 10-minute average values of the wind speed and direction (identical apparatus to the one used on the Prodkamm)

The datalogger was programmed such that 10-minute values of wind speed and direction as well as values of wind speed changes were recorded. The temperature measurements allowed better evaluation of measurement interruptions, such as the freezing-up of the wind sensors.

The measuring systems used were robust and tested in similar conditions and are of a high quality standard. Data failures of less than 10% were to be reckoned with.

Execution

These wind measurements, too, were carried out by the company:

METEOTEST

Fabrikstrasse 29

3000 Bern

Phone: 031/307 26 26

Fax : 031/307 26 10

Project directors: Dr. Stefan Kunz (Dr. Phil. Nat.)

Martin Baumgartner (Lic. Phil. Nat.)

Collaborators: Jan Remund (Dipl. Natw. ETH)

Peter Mühlemann (Lic. Phil. Nat.)

Evaluation

Continual (monthly) plausibility checks of the data were made. The raw data was also recorded for later statistical evaluation purposes.

At the end of the measurement period, the METEOTEST Company analyzed the data and submitted an assessment of the site in a final report.

The evaluation of the wind measurements was made in the form of reports by the METEOTEST Company. These reports, as well as the intermediary communication of the wind measurement data, were regularly forwarded directly to the ENCO Company.

The newly selected site has an average wind speed of about 4.4 m/s as a long-term average. During the investigation period, the wind conditions were below average (at about 89% of the long-term average value). At a level of 50 m above ground, wind speeds of 5.1 to 5.5 m/s are to be expected according to the METEOTEST Company. The present results are consistent with a potentiality study covering all of Switzerland as well as with the measurements of the meteorological stations of the cable car company. An overview of the results registered at the sites of the snow guns is included in an Appendix to this report. This means that, according to the wind measurements made, the site is suitable for the harnessing of wind energy. Empirical values – among others, from Germany – show that with a basic installation, a minimum profitability can be attained with an annual average wind speed of about 5.0 to 6.0 m/s.

For calculating the potential capacity, the distribution of the wind speeds must be known. The distribution on this site can be described by means of a Weibull distribution with the parameters $A = 4.1$ and $k = 1.18$. For a wind turbine with a shaft height of 50 m, there results a value of $A = 5.41$ or $A = 5.77$ (according to whether the respective values of 5.1 or 5.5 m/s are taken as a basis for the calculation).

With these values, a randomly selected turbine of the type NEG Micon 750-200/48 (capacity: 750 kW) would generate approx. 930 to 1020 MWh per year, which corresponds to about 1240 to 1360 full-load hours. These projected values include a reduction of the capacity by approx. 81% due to the lower atmospheric density at this altitude in comparison with that at sea-level. However, further factors reducing the capacity, such as maintenance, technical failures and icing, will have to be considered as well. The factor of icing will have to be given special attention, as 3/4 of the yearly energy are produced in the winter season when the average temperature is about -2.7°C .

2.6 Availability of Land Plots

Preparatory talks with the property owners – also on the newly chosen sites – were held. It is planned to fix the terms by means of a lease contract. A preliminary draft has already been made.

However, contracts will only be drawn up along with the elaboration of the construction project. It is not meaningful to sign contracts at a project stage, where the sites have not yet been clearly defined, cost-benefit calculations are still imprecise, possible subsidies have not yet been granted, and where the exact time schedule is still undetermined. However, the reactions during various on-site inspections and personal discussions remained basically very positive.

2.7 General Conditions

Various legal aspects, such as the founding of a company, insurance policies (based upon examples from Germany as well as upon the opinions of local insurers), as well as the possible contract terms for leasing the land plots have already been examined.

3. Summary

3.1 Objectives of the Report

The objectives of the feasibility study are to form the basis for a decision and to allow the drawing-up of a project that is ready to be implemented.

3.2 The Chosen Solution

The chosen solution was to proceed via a wind potential study. In addition, the following points were considered:

- considerations of location / choice of site
- coordination with the community, Nature protection agencies and government authorities
- subsidization
- coordination with the electricity companies
- wind measurements/profitability
- availability of land plots

- general conditions

3.3 Main Results

In general, it may be said that the search for a suitable site resulted in finding a well-developed site considering its altitude. All the coordinative talks with the communities, Nature protection agencies, government authorities and electricity companies as well as with the property owners have also been very positive. Furthermore, the fact that considerable financial assistance is likely to be given with such promising projects is also a plus.

Both the intermediary results of the wind measurements – particularly in the case of the new site –, as well as the findings presented in the final report are positive. After completing the wind measurements, sufficiently significant data about the wind forces prevailing on the new site is available according to the METEOTEST Company. Thus, it can principally be said that the new sites, such as the Prodkamm and the Maschgenkamm in the immediate vicinity, are suited for the harnessing of wind energy.

Empirical values show that with a basic installation, profitability can be attained at average annual wind speeds of about 5.0 up to 6.0 m/s.

The METEOTEST Company determined that the average wind speeds at a height of 50 m above ground is expected to be about 5.1 to 5.5 m/s. With a randomly-selected turbine of the type NEG Micon 750-200/48 (capacity: 750 kW), approx. 930 to 1020 MWh could be produced per year, which corresponds to about 1240 to 1360 full-load hours. Special attention will have to be given to the factor of icing, as 3/4 of the yearly energy is produced in the six winter months of the year when the average temperature is about -2.7° C.

The general conditions and the final results are positive insofar as it can be concluded from these measurements that on the new sites, i.e., at the higher mountain stations on the Prodkamm and Maschgenkamm, the wind potential for the harnessing of wind energy is sufficient.

3.4 Significance for Science

This feasibility study will be of importance for the possible use of wind energy in Switzerland. The use of wind energy in Switzerland is still in its infancy. Particularly regarding the wind potential and the project's profitability resulting from it, there is still a considerable lack of information and experience. Accordingly, this study and a possible project resulting from it, will greatly contribute to filling these gaps.

On the basis of this feasibility study, the wind potential studies worked out by the Swiss Federal Office of Energy could thus far be verified and confirmed.

3.5 Possible Applications in Practice

As mentioned before, the goal of the feasibility study is to form the basis for a decision and to allow the drawing-up of a project that is ready to be implemented.

3.6 Unsolved Problems and Further Procedures

From the final report of the wind potential study carried out on the Prodalp, it became apparent that the average wind speed, at about 10 m above ground, is 2.6 m/s. At 50 m above ground, an average wind speed of about 2.9 m/s is to be expected. As can be seen in the application form, in the intermediary report and from experience, an average wind speed of at least about 5 m/s is required for achieving a minimum profitability. Thus, it can be said that the first site fulfilled all the prerequisites except for the insufficient wind potential. For this reason, talks were held with the METEOTEST Company, the local authorities and the property owners, and more promising sites in the immediate vicinity were discovered. Further wind measurements were arranged at a relatively low cost in order to find better wind potentials at new sites. It thus became apparent that, at the mountain stations on the Prodkamm and Maschgenkamm which are located at ~~at~~ higher altitudes the development may be somewhat more difficult but that, on the other hand, 40% to 50% more wind potential can be expected.

The evaluation of the wind measurements on the newly chosen site shows an average wind speed of about 4.4 m/s as a long-term average value. At 50 m above ground, wind speeds of about 5.1 to 5.5 m/s are to be expected according to the METEOTEST Company. This means that, according to the wind measurements made, the area is suitable for the harnessing of wind energy. The extended measurements have proven to be meaningful.

Therefore, the feasibility study no longer shows any obvious unsolved problems. The additional measurements allowed the unsolved problems which arose during the initial study to be clarified and solved.

The further procedure resulting from the feasibility study would be the working out and realizing of a construction project along with its financing.

The Project Director

Otto Noger