Euroblades

(ESC Toulouse Team G)

Proposal For Wind Farm In Poland
for

JELB Power Associates Inc.

Message from the chairman

Following the oil shocks of the mid-1970's, the French state, as most European countries, started to search for alternative power sources in order to break its dependence on fossil fuel on so to minimise its exposure towards possible future economic turbulence. Alongside the *COGEMA* (the state nuclear agency), an organisation was created to carry out research on non-polluting energies and, in the longer term, find economic viable applications for them. First baptised *Agence gouvernemental pour le développement d'énergies renouvelables* in 1979, this infant unit started to specialise mainly on wind and solar power.

The changes in European politics towards the liberalisation of strategic sectors such as energy and transport, as well as the steady opening towards private investment revolutionised the energy sector and asked for a rapid adaptation. As a direct consequence and in preparation of its IPO, in 1991, the company name was changed to EuroBlades, thus reflecting its main economic field (wind power applications accounted then already for around 70% of revenues) and its desire to expand further into a homogenising European market.

Today, EuroBlades has its place amongst the five leading pan-European companies in wind energy supply tools and follows a vast expansion program including heavy investments in highly profitable wind farm projects located in Central and Eastern Europe. Our current projects include the managing of 4 wind farms (overall capacity 115 MW) in France, Belgium and Spain as well as main contractors to different sites in Denmark, Germany and Ireland.

Gordon FINKBEINER
CEO

Company description

Key figures

Creation : 1979
Headquarters : Toulouse
Capital : 10 millions USD
Turnover (2000) : 113, 452, 782 USD
Export (2000) : 34, 223, 967 USD
Employees : 3, 500 Europe-wide (600 based in Toulouse, France)
Export zones : Europe, North America, Australia
Main shareholders : EDF (25%), Alstom Group (20%) , General Electric (14%)

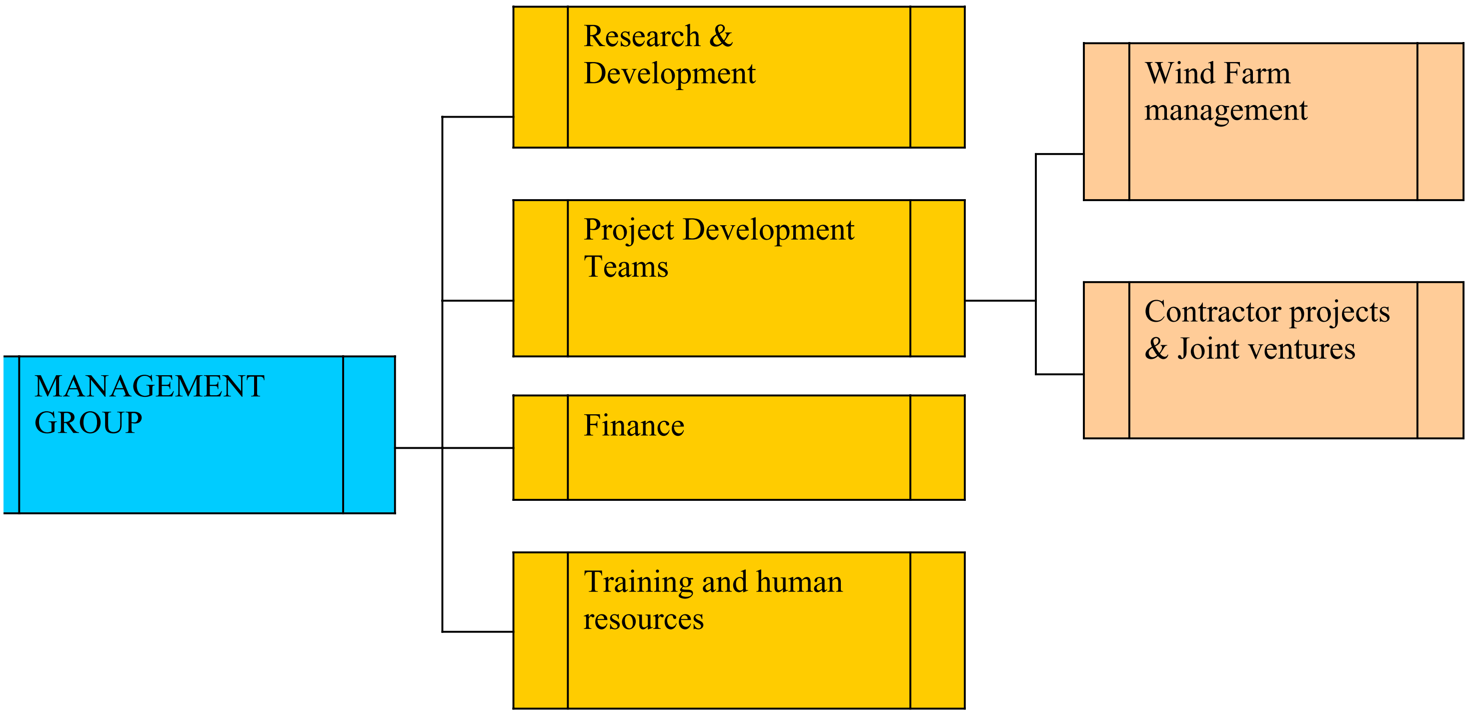
Your top management interlocutors will be :

-Gordon FINKBEINER-	Chief Executive Officer
-Elisabeth SANTINI-	R&D Managing Director
-Monica SUBIRI-	Project Development Managing Director
-Rapha l DUMEURGER-	Chief Financial Officer
-C cile RIVERA-	Human Resources

Quality Certification

Standards : ISO 9001
Organism : AFAQ
Certificate number : **1736**

Company structure



- Finance

The role of our financial service is, mainly, the cost-efficiency analysis of our various projects. This service also includes two consultants who are at total disposal of our partners in order to review and up-date business plans following the completion of our wind farms.

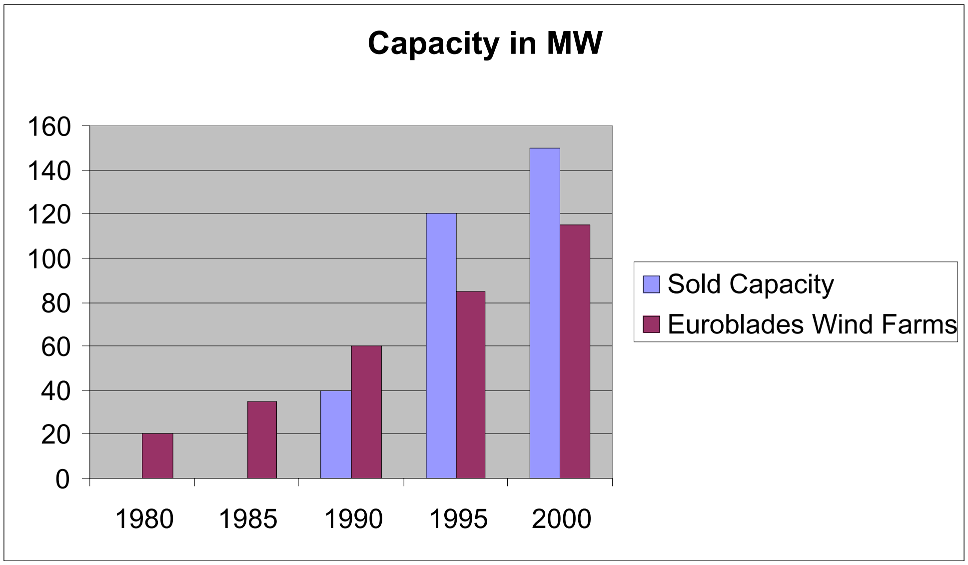
- **Research & Development**

Our R&D team is composed of researchers each of which has proven a most prestigious formation and hands-on experience in the field of alternative energy sources. We constantly invest a significant share of our budget into this domain in order to increase the reliability and the productivity of our wind farms and to maintain our position among the sector's biggest pioneer and innovator.

- **Project Development Teams**

Wind farms management

This department manages the wind farms of our own property, from the signature of the contract to the maintenance to the commercialisation of wind energy.



Contractor projects & Joint ventures

It is this service which manages the contracts signed within the framework of the Joint Venture. Project Teams work closely together with our corresponding partner and are composed of highly competent interdisciplinary staff.

- Training and Human Resources

Our Training Department would be put in charge of the operating staff's necessary formation.
Please check the following proposals' detailed specifications on this matter.

Our proposals

Why do we consider diversifying and investing in your country?

Poland prepares its integration into the European Union. Thus, in order to be in adequacy with the requirements of European regulation, the government of Poland is restructuring its energy sector and is replacing obsolete installations.
Currently, Poland produces all the electricity which it consumes. That said, demand for electricity is growing quickly. According to Poland's economic growth estimates, by 2010 the request for electricity is expected to have increased by 40 %. In addition, the wave of privatisations and of market liberalisation which is taking place supports this estimate (more economic activity meaning more power consumption).

Our experience of wind farm construction and management reinforces our desire to stand alongside your company as a strategic partner in order to introduce this new energy in Poland.

Our Proposals

Following your Request for Proposals and our IP conversation of recently, we have produced a proposal which we hope will suit your needs adequately. You are looking for a firm offering minimum maintenance costs as well as high technical performance.

This proposal's strengths are:

- technical performance

Our wind turbines' quality is universally accepted and an important reference on the European market. Our technological know-how allows us to produce cost-efficient machinery and therefore to offer an excellent price/quality ratio.

- reduced maintenance costs

The maintenance is our business. We strongly dominate the French market in this kind of services. Considering our collaboration project, we have pushed maintenance requirements –and therefore costs- to new limits.

- a pragmatic experience since 1979

Our hands-on experience developed in this particular field can only be beneficial towards a successful collaboration and we engage ourselves to put all our forces in terms of knowledge and assistance into this common project in order to create a basis of trust and thus benefit from this joint venture in all terms.

In other words, we believe we are the ideal partner for this project, and this thanks to our much-prized professionalism and proven infrastructure.

Our team will be glad to service you with any additional information you might require.

Technical specifications

Introduction

We have developed two technical proposals from which you will be able to choose. They were made according to the criteria of efficiency and low construction and maintenance costs. We also present two possible emplacements where we guarantee the best wind conditions in order to maximise energy production. The technical proposal and the emplacement have been designed to reach a sustainable production level with the least possible environmental impact.

1. Proposal

Proposal 1: Our proposal is an onshore wind farm of 25 600-kW wind turbines with a total power-producing capacity of 15 MW as the RFP requires.
Proposal 2: Our proposal is an onshore wind farm of 20 750-kW wind turbines with a total power-producing capacity of 15 MW as the RFP requires.
EuroBlades is a leading pioneer in the world of wind power. EuroBlades is an internationally operating company with own manufacturing facilities, offices and partners in a large number of countries all over the world. We focus our competencies on the development, manufacturing, installation, operation and maintenance of efficient wind turbines of high quality.

2. Reasons for choosing the EB8 wind turbine

The EB8-600kW reflects the most recent series of higher-performing machines developed by EuroBlades. The result is a simple, rugged, and attractive machine structure.
Features which have been characteristic for EuroBlades prototypes over time are also applied in this model: an ever-improving noise control, a heavy-duty structure with ample design margins, and a uniform high level of component and assembling quality maintained throughout the machine, from the overall concept down to precision details.

2. a. The main reasons for choosing a 600-kW wind turbine are the following:

- 600-kW wind turbines are standard performers whose manufacturing and maintenance are well known.

- Moreover, there is less fluctuation in the electricity output from a wind park consisting of a number of average machines than with larger turbines (from 750 kW to 2 MW), since wind fluctuations occur randomly, and therefore tend to cancel out.
- Besides, the local electrical grid may be too weak to handle the electricity output from a larger machine.
- Several average machines spread the risk in case of temporary machine failure, (e.g. due to lightning strikes) contrary to a reduced number of large ones.
- From a point of view of cost, in wind farm manufacturing there are economies of scale to be obtained, so a 600-kW wind turbine is not necessarily four times the price of a 150-kW wind turbine.
- Finally, 600-kW wind turbines profit from the best cost/performance ratio.

2. b. The main reasons for choosing a 750-kW wind turbine are the following:

- There are economies of scale in wind turbines, i.e. larger machines are usually able to deliver electricity at a lower cost than smaller machines. The reason is that the cost of foundations, road building, electrical grid connection, plus a number of components in the turbine (the electronic control system etc.), are somewhat independent of the size of the machine.
- In areas where it is difficult to find sites for more than a single turbine, a large turbine with a tall **tower** uses the existing wind resource more efficiently.

3. Services

A reliable product and a well-run service organisation help to ensure that the EuroBlades turbines be a good investment - year after year. In addition to their strong and reliable basic construction, all turbines delivered by EuroBlades are accompanied by a comprehensive guarantee. This ensures that our customers know that their EuroBlades turbine will provide the best possible operational reliability both during the guarantee period and beyond. More than 4,000 EuroBlades turbines world-wide testify the fact that the level of service we provide more than lives up to our customers' expectations.

4. Support

The division in France includes a support function manned by employees with a great deal of experience with all models of EuroBlades turbines. These technicians and service engineers, who are at the disposal for both customers and technicians, are responsible for replying the answers to questions and providing consultancy and advice in the areas of operation and trouble-shooting. It is a good idea for turbine owners to set up a remote monitoring system for their turbines. This allows the owners to call up their turbines in order to check on their operational situation. In addition, it is also possible to restart turbines by remote control if they have stopped due to an error that can be corrected in this way.

Just as any other machine, the initial cost of a wind turbine does not comprise the total cost over the life-time of the machine. Low service and maintenance costs are important to the financial success of the project. The quality of the machine plays a vital role in the level of these costs.

5. Quality

The quality assurance (QA) system of EuroBlades is certified according to the ISO 9001 norms. However, this system in itself is only a signal to our customers that we have control over the quality of our products. What is more important is the actual level of this quality, which is defined by ourselves. And as a clear goal of our company, we do not make any short-cuts. This means that our customers can expect to receive a project with EuroBlades wind turbines where there has been no quality-reducing compromises regarding quality in machine-development, manufacturing, project-development or after-sales service. Such a devotion is indeed a high standard to imply on ourselves - but necessary for our customers.

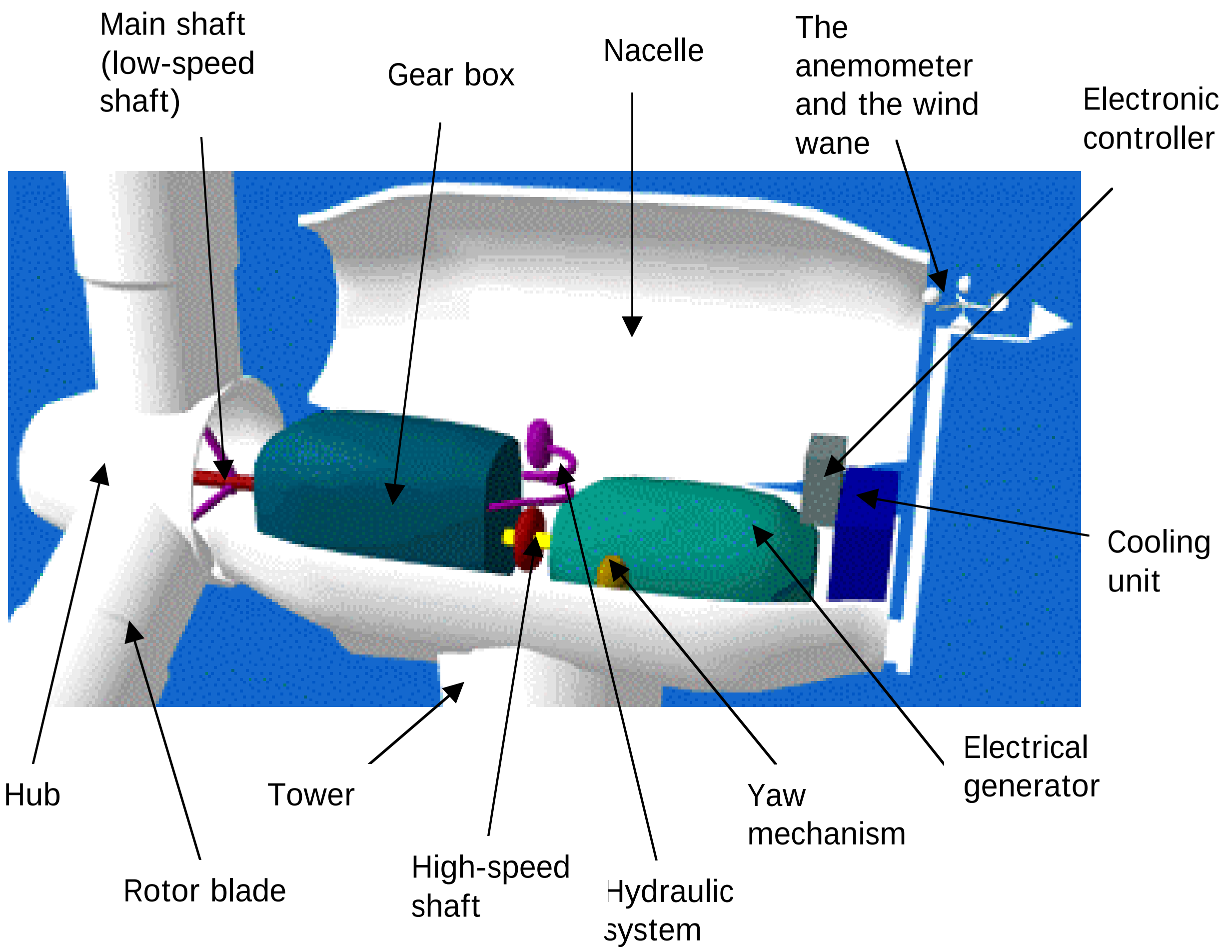
6. Communication

EuroBlades company' goal is to be a reliable and environmentally responsible partner. Achieving this goal involves working to improve knowledge about the environment and the renewable energy among the population living inside or close to the chosen zone of wind farm location.

At EuroBlades we think it is important to train and to inform the employees about all the technical and environmental issues.

7. Technical specifications

The pattern below shows the components of the turbine :



We propose two technical scenarios, please compare the two and make any comment you consider important according to both proposals.

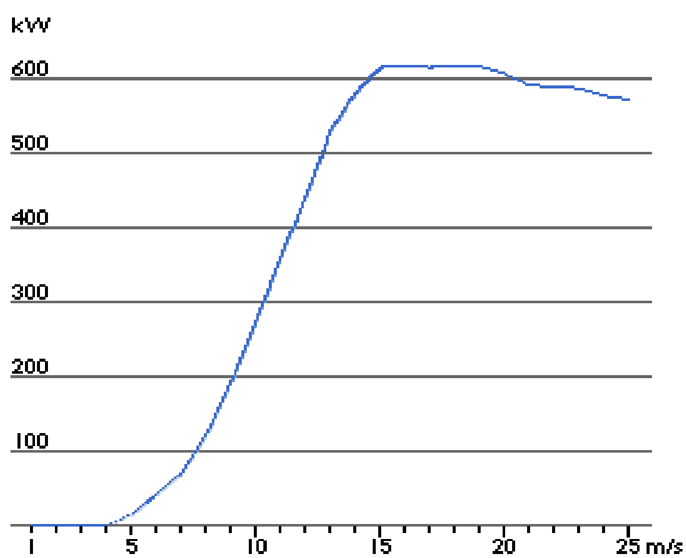
Proposal 1

The specifications of the turbines' main components are as following:

Rotor	
Type	3-bladed, horizontal axis, upwind
Rotor diameter	43 m. / 48.12 yd.
Swept area	1,452 m_ / 1736 yd_
Power regulation	Stall controlled
Cut-in wind speed	4 m/s
Cut-out wind speed	25 m/s
Rated wind speed	15 m/s
Survival wind speed	70 m
Speed revolution	Fixed 20 rpm
Gearbox	
Type	3-stage gearbox, 1-stage planetary, 2-stage helical
Manufacturer	CMD engrenages
Input speed	45 rpm
Output speed	1800 rpm
Ratio	40
Blades	
No.	3
Length	22 m.
Material	Fibre glass reinforced polyester
Minimum rotational angle	- 5°
Maximum rotational angle	+ 85°
Surface protection	Gel-coat anti-UV
Lightning protection	Copper
Generator	
Nominal output	600 kW
Type	Asynchronous
Nominal speed	1800 rpm
Tower	
Type	Tubular (cone-shaped)
Hub height	46 m. / 50.3 yd.
Tilt	2°
Outer diameter	3.3 m.
No. of sections	2
First section length	30 m.

First section weight	28,500 kg.
Second section length	15.4 m.
Second section weight	12,000 kg.
Corrosion protection	Sandblasted and epoxy painted
Braking system	
First type	Aerodynamic : passive stall controlled turbines
Second type	Mechanic disk brake system
Time to stop rotor	5 sec.
Weights	
Nacelle, excl. rotor and hub	30,200 kg.
Rotor incl. hub	15,000 kg.
Gearbox	x kg.
Generator	x kg.
Tower	40,500 kg.
Total weight	80,000 kg.

Power generation



The production per wind turbine per year is: 1,922,229 kWh.
So the total power capacity of the wind farm is: **48,055,725 kWh/year**.

Proposal 2

Rotor	
Type	3-bladed, horizontal axis, upwind
Rotor diameter	52 m. / 48.12 yd.
Swept area	2,124 m_ / 1736 yd_
Power regulation	Pitch controlled
Cut-in wind speed	4 m/s
Cut-out wind speed	25 m/s
Rated wind speed	16 m/s
Survival wind speed	70 m/s
Speed revolution	26 rpm
Operational interval	14,0 - 31,0 rpm
Gearbox	
Type	3-stage gearbox, 1-stage planetary, 2-stage helical
Manufacturer	CMD Engrenages
Input speed	45 rpm
Output speed	1800 rpm
Ratio	40
Blades	
No.	3
Length	24 m.
Material	Fibre glass reinforced polyester
Minimum rotational angle	- 5°
Maximum rotational angle	+ 85°
Surface protection	Gel-coat anti-UV
Lightning protection	Copper
Generator	
Nominal output	850 kW
Type	Asynchronous
Nominal speed	1800 rpm
Nominal data	50 Hz – 690 V.
Tower	
Type	Tubular (cone-shaped)
Hub height	55 m. / 50.3 yd.
Tilt	2°
Outer diameter	5 m.
No. of sections	2
First section length	40 m.
First section weight	28,500 kg.
Second section length	15.4 m.

Second section weight	12,000 kg.
Corrosion protection	Sandblasted and epoxy painted
Braking system	
First type	Aerodynamic: pitch controlled turbines
Second type	Mechanic disk brake system
Time to stop rotor	5 sec.
Weights	
Nacelle, excl. rotor and hub	30,200 kg.
Rotor incl. hub	20,000 kg.
Gearbox	x kg.
Generator	x kg.
Tower	50,500 kg.
Total weight	80,000 kg.

Power generation

The production per wind turbine per year is: 2,800,800 kWh.
So the total power capacity of the wind farm is: **56,000,000 kWh/year**.

For the two proposals, industrials implied in the integration of components on the windmills will be:

COMPONENTS	SUBCONTRACTOR	TOWN
Gearbox	CMD	Cambrai
Generator	Leroy Somer	Beaucourt
Tower	Petitjean	Troyes
Nacelle	Canam	Yutz
Breaks	ATV	Paris
Yaw drive and bearing	Rollix	Nantes
Rotor blades	ATV	Paris

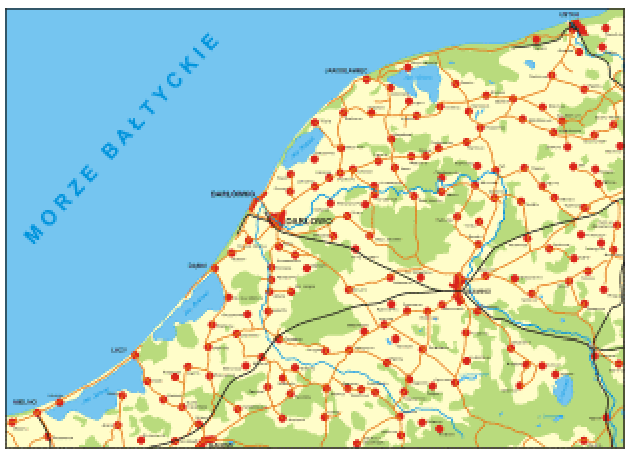
For more details please refer to annex.

We present you in the next pages, the two locations chosen by our company for the wind farm emplacement. We propose you to analyse the two sites, then we will be able to make the best choice concerting each other.

Wind Farm location

According to the Request for Proposal, we present two possible wind farm emplacements near the Baltic Sea Coast. After having analysed the technical, geographical, political and economical aspects, both proposals concern an onshore emplacement on the Rozewie Cape.

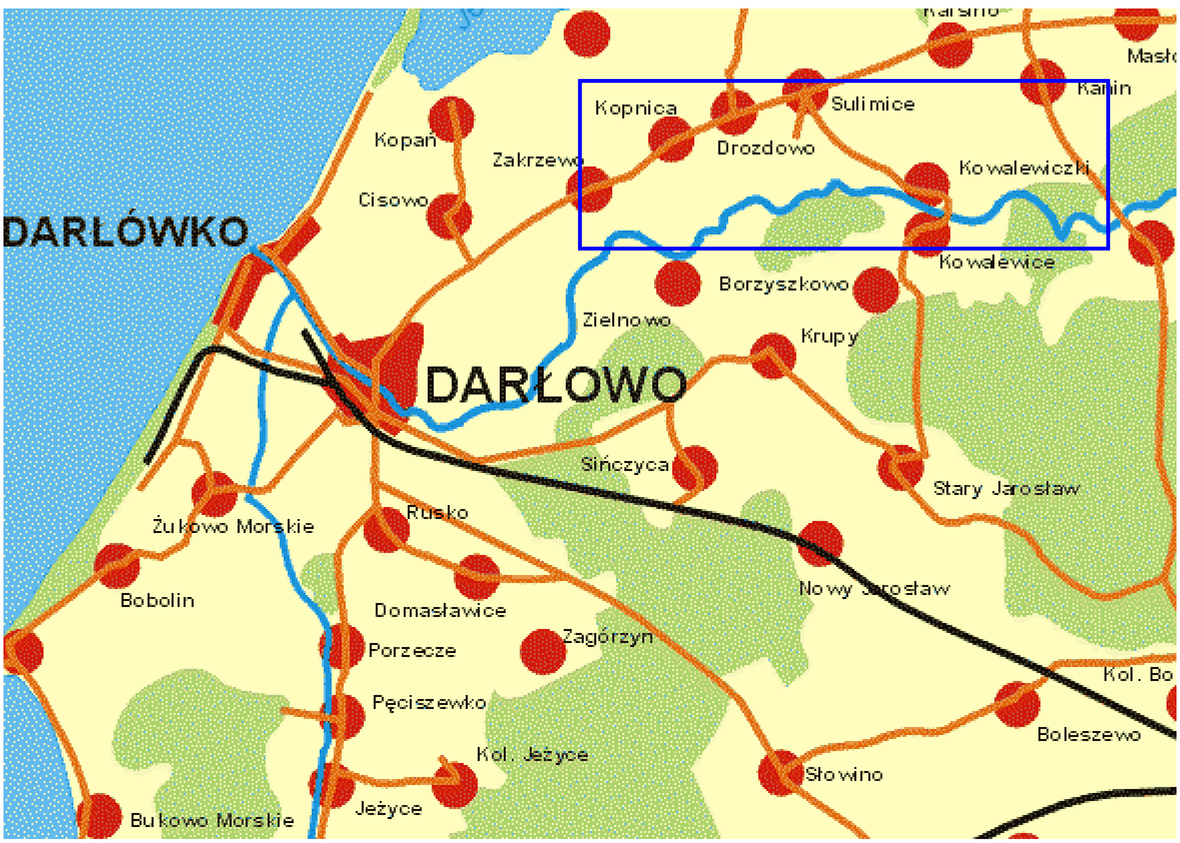
Picture 1. Baltic Sea Coast



Picture 2. Rozewie Cape

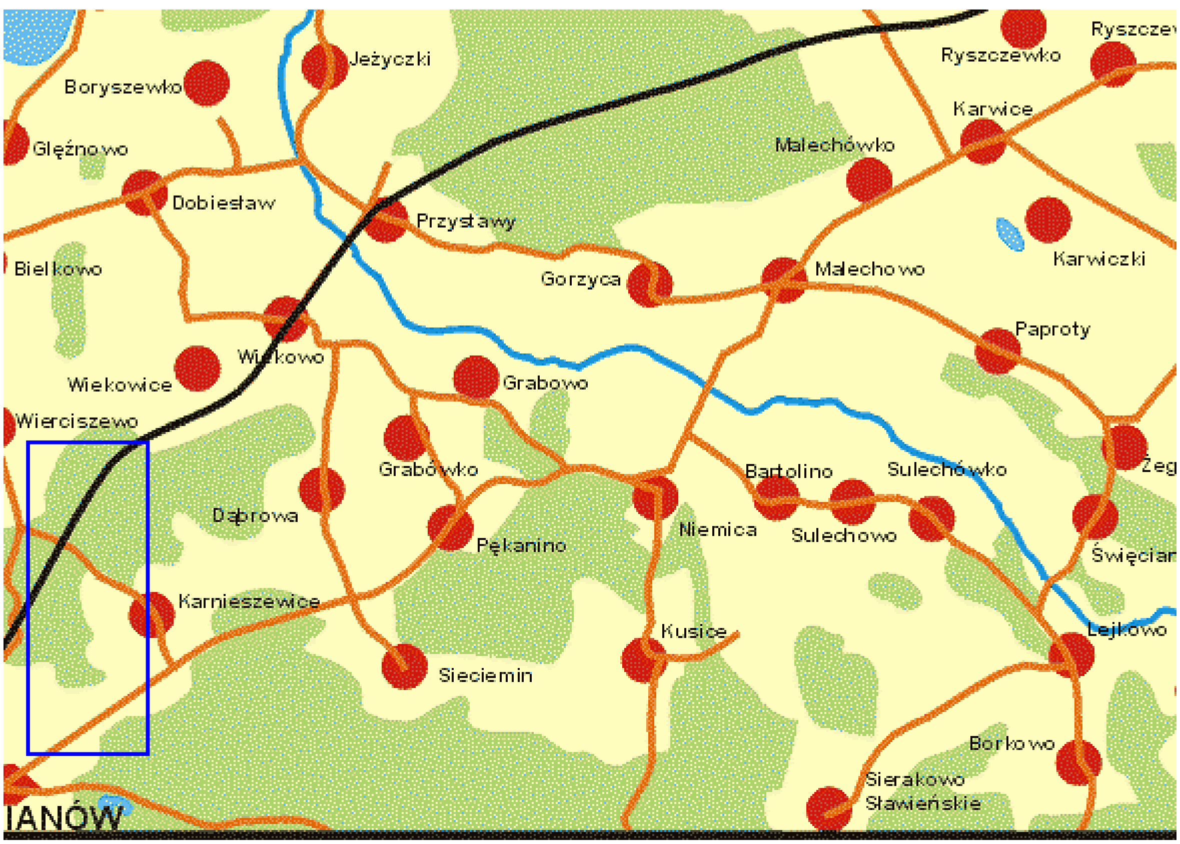
Table 1. Wind Farm Emplacement

Proposal 1	
Emplacement	Rozewie Cape. Moraine belt Cisowo - Zakrzewo - Kopnica - Drozdowo- Dzierzecin. About 3 km east north of Darlowo.
Wind Conditions	8 – 10 m/s; west-north-west direction
Soil Structure	Mixed clay/gravel/sand
Orientation of the Turbines	Opposed to the wind farm direction
Spacing between turbines	In the same sense as the dominant wind direction: 7 times the rotor diameter (301 m). Perpendicular to the dominant wind direction: 4 times the rotor diameter (172 m) **Total surface of the wind farm: 129 ha; 181 acres.**

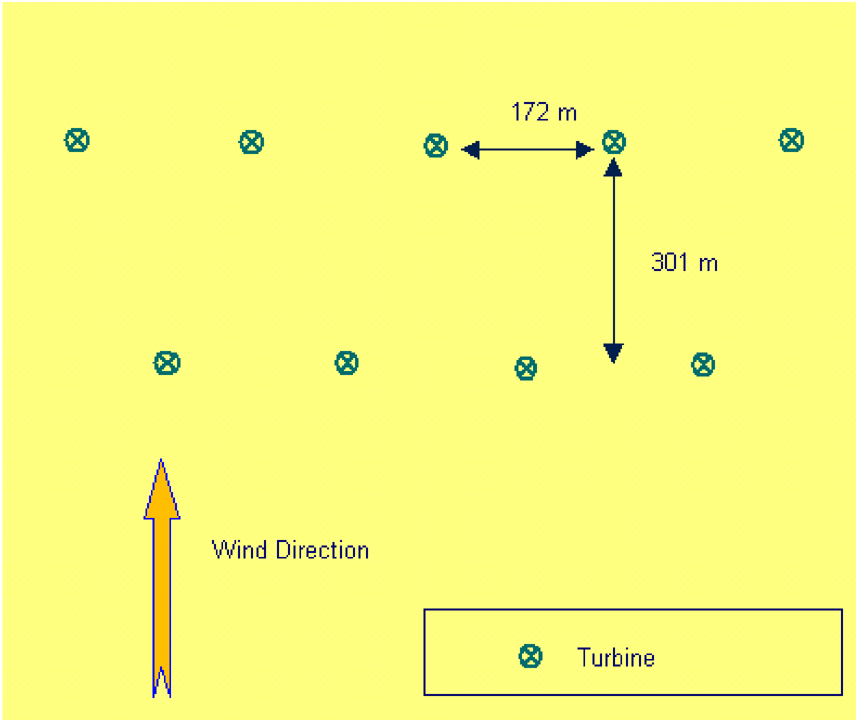


Picture 3. Proposal 1 localisation

Proposal 2	
Emplacement	Rozewie Cape. Hills located at 50 meters north of Sianow and 52.5 meters west, near Karniszewice).. (36.4 and 27.8, 18.4 meters of height)
Wind Conditions	8 – 10 m/s; west- northwest direction
Soil Structure	mixed clay/gravel/sand
Orientation of the Turbines	Opposed to the wind farm direction
Spacing between turbines	In the same sense as the dominant wind direction: 7 times the rotor diameter (371 m). Perpendicular to the dominant wind direction: 4 times the rotor diameter (212 m). **Total surface of the wind farm: 197 ha; 204 acres.**



Picture 4. Proposal 2 localization



Picture 4: Spatial distribution of the turbines. In the same sense as the dominant wind direction, the distance between turbines is 7 times the rotor diameter (301 m for the Proposal 1), and perpendicular to the dominant wind direction, 4 times the rotor diameter (172 m for the Proposal 1).

4.1 General Considerations towards determining the site's location

The most important aspect to justify the decision of elevating either site on land rather than offshore are explained as follows:

- **Impact on the native flora**: most of Poland's forests were exploited as a normal activity during civilization's history. On the other hand, the forests that are still present have serious ecological problems due to industrial pollution of the industry. Therefore, excluding the national parks, the emplacement of the onshore wind farm has a minimum impact on the native flora.

- **Impact on urban areas**: The north-west and north-east of Poland are the areas that present the least population density. Moreover, it is concentrated mainly in two cities; Szczecin, the most important port of the Poland Baltic Ocean, with 413 561 habitants and Gdansk with the highest concentration of population in the Pomeranian Region (465 000). The wind farm must be located in the rural area, or in the border of the cities to eliminate the acoustic impact. The design and appropriate vegetation distribution contribute to mitigate the impact.

- **Impact on soil**: The soils of the Baltic Sea coast present low fertility. The richest areas are located in meridian and central Poland.

- **Esthetical Impact**: The Baltic Sea Coast has the most appreciated tourist beaches in Poland, but they present high levels of pollution. The onshore alternative could be less visible and presents the possibility to reconvert polluted surfaces that currently are of no use.

- **Access**: Poland's road network consists of more than 360 629 km, its railway one of more than 26 520 km. There are also more than 4 000 km of navigable paths, but which need to be modernized to be used for commercial purposes.

- **Priority:** The Baltic Sea has always had a great economical importance for North European trade and it shows an intense traffic. The total surface of the Baltic Sea amounts to 414 400 km^2

- **Cost:** According to the size of the project, it is not economically viable to establish an offshore wind farm.

4.2 Technical and Environmental Requirements to be considered for an onshore site

The aspects considered to choose the local onshore emplacement areas are explained as follows:

Technical requirements

- **Medium speed required:** between 8-10 m/s presented in a prevailing direction, and with uniform intensity. This wind speed is guaranteed in the Baltic Sea Coast.

- **Speed-up effects:** On hills wind speeds are higher than in the surrounding area, for what we recommend the turbines to be placed on hilltops or ridges overlooking the surrounding landscape in the prevailing wind direction.

- **Obstacles:** It is required to have a minimum of obstacles and a low roughness in the prevailing direction of the wind.

- **Soil conditions of building foundations and to resist heavy tracks circulation:** Good drainage conditions and a proper texture (sand and clay in the same proportion) are a must.

- **Viability:** Should be located as near to the electrical grid as possible.

- **Road access:** Easy access to the wind farm, during construction as well as during maintenance activities.

Environmental requirements

- **Visual impacts:** Wind turbines are visible structures and it is better to be located in conspicuous locations, such as on ridges or hillsides.

- **Acoustic impact:** A turbine with a potential of 750 MW generates an acoustic contamination of 45 to 50 db from a distance of 500 m. This level is the equivalent to the noise generated in a department store.

- **Impacts on birds and other local wildlife:** The problem of birds, especially raptors, flying into wind turbines have been the most controversial biological consideration affecting wind energy sources. Wind developments have produced bird collisions and deaths to raise concern from wildlife agencies and conservation groups. On the other hand, some large wind facilities have been operating for years with only minor impacts on birds. Smokestacks and radio and television towers have actually been associated with much larger numbers of bird deaths than wind facilities have, and highways and pollution account for a great many as well. Because the dimension on the bird's impacts is not clear, it is important that the emplacement of the Wind Farm be far from the natural bird's habitats.

4.3 Baltic Sea Coast Analysis

According to the requirements previously presented, and with the collaboration of Mr Pomianowski, researcher at the Department of Cartography and GIS Institute of Geography and Spatial Organisation, Polish Academy of Sciences, we have produced an analysis of the Baltic area so as to where to situate the wind farm.

Baltic Sea Coast Characterisation:

- The Polish Baltic Sea Coast area is one of the windiest parts of Poland. 8-10 m/s are guaranteed. It is slightly stronger to the eastwards, towards cape Rozewie, which is the most northbound point. The wind is uniform, with prevailing directions from west and northwest.

- Coastal area may have three kinds of combined elevation/relief types:

a) Dune belts with heights of up to 10-40 m located just next to the shore.

b) Flat lowlands with river accumulation, marshes and irrigated pastures, located farther away from the shore, but sometimes crossing dune belts straight to the sea. This area also hosts major lakes.

c) Highlands of glacial origin, located deeper within the landmass. These area front moraines with mixed clay/gravel/sand sills, certainly most suitable for heavy construction.

- All towns along the coastline are subject to a heavy tourist industry. The same concerns long strips of shore in their proximity or between them. In addition, there are military training areas and substantial parts of the east coast are protected. The most important protected areas are Slowinski National Park, located between Ustka and Leba and Nadmorski Landscape. Agricultural areas are generally located farther away from the shore. It is equally important to mention that since 1990 a great privatisation process of farms and steelworks is being undertaken by the *Agency for Agricultural Grounds*, which effectively means that these objects wait to be bought by someone. This change has already taken place in the west of Poland and could generate negative impacts such as high unemployment and loss of purchasing power.

To sum up: promising areas should be sought 5-10 km away from the coastline.

Overview of the most important points from west to east of the Baltic Sea Coast:

1. Swinoujscie - Kolobrzeg
Not suitable: Wolin Island occupied by National Park, further relatively low highlands, a lot of tourist industry.

2. **Kolobrzeg - Cape Rozewie**
Selected Area. Details are given further down.

3. Hel Promontory - unsuitable: mostly military ground, the rest is heavily occupied by tourism.

4. Gdansk/Gdynia area - mostly unsuitable: densely populated, whole highland zone occupied by Landscape Protection Area

5. Zulawy Wislane lowlands and Mierzeja Wislana Promontory - unsuitable: low agricultural area (topographic depression) and shoreline occupied by tourism.

Selected Sites at Kolobrzeg - cape Rozewie

1 Moraine belt Cisowo - Zakrzewo - Kopnica - Drozdowo- Dzierzecin, starting about 3 km east-north of Darlowo. It is:

- Close to the shore
- High and quite steep on W/NW side, without obstacles on this side
- Close to major road and major transmission line (just south of the road)
- Not forested

2. Starting 50 meters north of Sianow and with Karniszewice to the east. There are some hills of a height of 36.4, 27.8 and 18.4 meters. It is:

- High and quite steep on W/NW side, without obstacles on this side
- Close to major road and major transmission line
- Not forested

Staff Training

During the construction phase, we will provide assistance on training employees in the operation and maintenance of the wind farm. We therefore propose you a training programme.

The Training departments of our firm considers pertinent to do two types of Training/Work shops which are explained as follows:

Maintenance & Operating

Oriented towards local Engineers and Technicians, it is designed to provide and/or improve the necessary skills to operate the wind farm.

The training will take place at the Wind Farm and/or at the Joint Venture's head office. The programme will be designed by experienced staff of our Training and Human Resources Department. The programme will consist of 2 periods:

1.- Technical Management of the wind farm: basic handling, control of energy flows, trouble-shooting, quality standards.
2.- Electrical and mechanical Management: maintenance and repair of rotor blades, turbine substitution, spare parts evaluation, manipulation of height voltages areas.

These training programme considers continued evaluation of the team, so as to guarantee high skilled handling.

Public Relations Events

Oriented towards surrounding population and environmental groups. The implantation of wind farms is generally associated to negative environmental impacts. It is therefore necessary to make the community understand the advantages of such a project and also to counter arguments brought forward. This activity will take place at the beginning of the project. This, as well as future regular guided visits free of charge for surrounding residents, will be essential towards gaining wide-spread acceptance.

FINANCING

1- Polish energy market demand

The wind power farm will be directly linked to the Polish Power Grid. The goal of this project is to provide further production capacity that responds to a modern society's demands such as cost-effectiveness and low economical impact. We are highly engaged towards keeping maintenance and operating costs at a minimum level.

2- Cost analysis

The following chart will give detailed explanation on cost analysis. It is divided into two parts. The first project is composed of 25 600-kW, the second of 20 750-kW wind turbines.
For better understanding of the financial analysis, we have established five different parts:

- Feasibility study
- Engineering
- Energetic equipment
- Linked infrastructures
- Other costs

Feasibility study
This sub-part is the same for both proposals, due to the fact that the feasibility study is a general study of the landscape, ground, environment and wind potential.

Engineering
Costs for the 20-wind turbine project are higher than those of the first proposal due to safety reasons regarding the size of the towers.
Concerning the engineering, costs of both mechanical and electrical conception are different. Nevertheless, the supervision of the building site takes longer in the case of the 25-tower project as there are more foundations to do and the electric network needed is much bigger. Thus, technicians will spend more time in on-site supervision.

Energetic equipment
As there are 20 towers in the second proposal, they are bigger and their manufacturing costs are more important. On the other, the

advantage of such a suggestion is to produce more energy because of the greater wind exposure, and you could upgrade the farm with more towers in the future in order to develop supplementary power generation.
The spare parts follow a ratio of the general cost of the tower and there is a five-year warranty on every spare part for each tower.
Transport is directly linked to the size, volume and the weight of the towers. The load will be shipped to Gdansk, the nearest harbour, and then delivered to the construction site by trucks.

Linked infrastructures

These costs are also directly linked to the nature of the towers, the number of towers, foundations and installation aspects. Further costs remain the same as only one electric network is needed. The same goes for maintenance buildings.

Other costs

For both interests and extraordinary expenses, there are ratios linked to the cost of the general project.
For training, it is very important to employ highly skilled technicians and operators on-site to guarantee the maintenance of the wind power farm. We recommend a 20-day training course for technicians and operators to be completely operational.

Costs Analysis - Wind power Farm

Investment Costs	Item	Quantity	Cost/Item	Amount
		600-kW Wind Tower		
Feasibility Study				
Site inspection	Day-person	6	$500	$3 000
Wind potential estimation	Meteorological tool	2	$18 000	$36 000
Environmental estimation	d-p	6	$500	$3 000
First conception	d-p	24	$500	$12 000
Detailed cost estimation	d-p	20	$500	$10 000
Report preparation	d-p	9	$500	$4 500
Project management	d-p	10	$500	$5 000
Travel and accommodation	Trip-person	4	$2 500	$10 000
Other costs	-	1	$1 800	$1 800
	Sub-total:			$85 300
Engineering				
Wind power tower localisation	d-p	70	$500	$35 000
Mechanical conception	d-p	150	$500	$75 000
Electrical conception	d-p	190	$500	$95 000
Civil Engineering	d-p	30	$500	$15 000
Work supervision	year-person	0,5	$350 000	$175 000
	Sub-total:			$395 000
Energetic equipment				
Wind Turbines	wind power tower	25	$500 000	$12 500 000
Spare parts	%	3%	$12 500 000	$375 000
Transport	wind power tower	25	$3 000	$75 000
	Sub-total:			$12 850 000
Linked infrastructures				
Wind power tower foundation	wind power tower	25	$58 000	$1 450 000
Wind power tower erection	wind power tower	25	$41 000	$1 025 000
Approaches	miles	1,5	$45 000	$67 500
Network and transformer	project	1	$650 000	$650 000
Maintenance building	building	1	$70 000	$70 000
Transport	project	1	$32 000	$32 000
	Sub-total:			$3 294 500
Other costs				
Training	d-p	20	$5000	$100 000
Interest	%	3,8%	$16 870 000	$641 060
Extraordinary expenses	%	5%	$16 870 000	$843 500
	Sub-total:			$1 584 560
		Total Investment Cost:		$18 209 360

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Euroblades

Cost Analysis - Wind power Farm

		750-kW Wind Tower		
Investment Costs	**Item**	**Quantity**	**Cost/Item**	**Amount**
Feasibility Study				
Site inspection	day-person	6	$500	$2 00
Wind potential estimation	meteorological tool	2	$18 000	$36 00
Environmental estimation	d-p	6	$500	$2 50
First conception	d-p	24	$500	$6 00
Detailed cost estimation	d-p	20	$500	$6 00
Report preparation	d-p	9	$500	$4 50
Project management	d-p	10	$500	$3 00
Travel and accommodation	trip-person	4	$2 500	$10 00
Other costs	-	1	$1 800	$1 80
	Sub-total:			$85 30
Engineering				
Wind power tower localization	d-p	70	$500	$35 00
Mechanical conception	d-p	150	$550	$82 50
Electrical conception	d-p	190	$550	$104 50
Civil Engineering	d-p	30	$500	$15 00
Work supervision	year-person	0,4	$350 000	$140 00
	Sub-total:			$377 00
Energetic equipment				
Wind Turbines	wind power tower	20	$800 000	$16 000 00
Spare parts	%	3%	$16 000 000	$480 00
Transport	wind power tower	20	$3 500	$70 00
	Sub-total:			$16 550 00
Linked infrastructures				
Wind power tower foundation	wind power tower	20	$60 000	$1 200 00
Wind power tower erection	wind power tower	20	$45 000	$900 00
Approaches	miles	1,50	$45 000	$67 50
Network and transformer	project	1	$650 000	$650 00
Maintenance building	building	1	$70 000	$70 00
Transport	project	1	$32 000	$32 00
	Sub-total:			$2 919 50
Other costs				
Training	d-p	18	$5 000	$90 00
Interest	%	3,8%	$19 931 800	$757 40
Extraordinary expenses	%	5%	$19 931 800	$996 59
	Sub-total:			$1 843 99

Total Investment Cost: 21 775 798

Outside financing

As to financing the initial heavy investment of the wind farm project, we consider it highly feasible to obtain liquidity from the EBRD (European Bank for Reconstruction and Development). This institution, created in the early 1990's to help finance Central and Eastern European countries' transition towards market economies, aims to reinforce private enterprise, restructuring, competition, corporate governance, etc. It doesn't compete with local financial institutions, but acts as a channel for funds, as it not only contributes to the investment (via debt and equity) but also encourages enterprise and helps to raise funds with other sources. It is increasingly providing financial muscle to infrastructure projects drawn to improve the region's productivity. It has been especially active in the energy sector, and more so wherever higher efficiency and environmental engagement could be proven.

Foreign joint ventures are one of the EBRD's main vehicles for financing; joint ventures offer partners an effective way to gain access to foreign and domestic markets, encourage foreign private investment in the region, reduce risk, and facilitate the transfer of technology and management skills.

- The EBRD funds up to 35 per cent of the total project cost for a green-field project or 35 per cent of the long-term capitalisation of an established company.
- Typical private sector projects are based on no more than two-thirds debt financing and at least one-third equity.
- Equity from sponsors need not be exclusively in cash but can be in the form of equipment, plant machinery, etc.
- According to its statutes and shareholders' (West European countries) aims it does never seek longer-term implication nor does it intend to get into operating control of a company.

Subsidies

Given the current political and economical context, Poland's Special Economic Zones (SEZ's) are to be dissolved in the near future, and so inaccessible to new projects wanting to benefit of their fiscal advantages. Poland's immediate entering the European Union requires the adoption of the latter's free-market conditions which disapprove of this kind of state subsidies. Therefore, it is impossible to apply for a wind farm location in one of these areas. Moreover, there is no SEZ close to the location of the future site we consider most adequate.

Planning

Beginning of the project : March 2002

Groundbreaking: March 2002
Completion: June 2002

Schedule:
late March - Early June : Overhead electrical systems designed and installed.

Early April : Ground is prepared for foundation construction. Underground electrical development begins.

Mid April - Late May : Construction of foundations under way. Towers and Turbines being constructed and erected

Mid April - Mid May: Electrical interconnections in progress.

Late April - Early June: Nacelles and rotors assembled and positioned.

May: Interconnections complete. Erected turbines being placed on site.

June: Project complete.

ANNEXES

The EB8-600 kW is a standard type of the EuroBlades products. The prototype was erected in 1990 and since then we have developed several hundred of this type in wind farms in Denmark, Germany and other countries.

DESIGN

The EB8-600 kW wind turbine is designed as a 3-bladed, horizontal axis, upwind and stall-controlled wind turbine. Moreover it has a constant rotor speed, an asynchronous generator coupled directly to the grid, and two independent, fail-safe brake systems.

All details are designed with best engineering practice. The distinct use of high quality components and the choice of leading sub-suppliers, secures for the customer the optimum choice for his investment.

All components are dimensioned with a high safety factor, which secures a 15 years lifetime of the entire turbine. Each component is designed for much higher loads than it will normally be exposed to.

ROTOR

The EB8-600 kW wind turbine has a rotor diameter of 48 m and a swept area of . This rotor is a three-blade self-supporting construction, mounted upwind of the tower. The power limitation is by stall regulation. This method of regulation is simple reliable and efficient, and it gives the lowest possible dynamic loads on the turbine.

The lightning protection system of the EB8-600 kW wind turbine is designed according to the IEC-1024-1 standard. If a lightning strikes the turbine blade or the nacelle, the advanced protection system will safely lead the lightning current to the wind turbine earthing system, with minimum risk of damage to any part in the wind turbine.

BLADES

Rotor blades are made of fibreglass impregnated with polyester (GRP = Glass fibre reinforced polyester).

The blades have been thoroughly tested by the () under both static and dynamic loadings.

The EB8-600 kW wind turbine is stall-controlled, therefore the blade tip can be turned 85 degrees relative to the main blade, thereby acting as an aerodynamic brake. The blade tip shaft material is carbon fibre and all other load supporting parts are manufactured in high-grade stainless steel. The blade tip is actuated hydraulically from the hub, and hydraulic pressure is required to keep the tip in the operating position. A built-in spring turns the tip to the brake position and during rotation the centrifugal force acts in the same direction. Any release of the hydraulic pressure, either intentionally by the control system or unintentionally by failure of the hydraulic system, will cause the tips to deploy and the turbine to shut down.

ROTOR HUB

The rotor hub is cast in nodular cast-iron. The hub is fitted to the main shaft with a large flange. It has oblong holes for easy blade adjustment at installation.

SHAFTS AND BEARING

The main shaft is forged in alloy steel, and it is centre-bored for the transfer of hydraulic pressure to the blade tip brakes. It is a low speed shaft between the rotor and the gearbox.
The second shaft is a high speed shaft between the gearbox and the generator.
The bearing is grease lubricated and it is protected with labyrinth seals requiring no maintenance.

GEARBOX

Why use a gearbox ? It is not possible to directly connect the wind turbine rotor which has a 40 rpm rotational speed to an ordinary generator rotating at a 1500 tr/min. So we use a gearbox in order to convert between slowly rotating, high torque power which you get from the wind turbine rotor and high speed, low torque power, which you use for the generator. The gear ratio is 37,5. The gearbox is a three-stage industrial design. The first, high torque stage is a planetary design, providing a compact high-performance construction. The intermediary and high speed stages are helical, providing the lowest possible noise level. The gearbox is splash lubricated and is cooled with a separate oil cooler. Temperature sensors are fitted to the high speed shaft bearing and in the oil sump to shut down the turbine in the event of insufficient lubrication.

GENERATOR

It is a dual generator system :
Double three-phase asynchronous generator generating 690 V three-phase alternating current. At low wind speeds the small 6-pole generator winding is used for power production, running at 2/3 nominal speed. At higher wind speeds the generator is switched to the 4-pole main winding, operating at nominal speed.
It is coupled with a battery and power electronics for the turbine to start. The grid connection is direct and the 690 V current is sent through a transformer to raise the voltage to 10,000 V according to the standard in the local electrical grid. The cooling system is accomplished by a large fan. By having a very efficient surface cooling the generator can be operated at temperatures well below the normal level of the standard insulation class, thereby providing the best possible lifetime of the winding insulation.

YAW SYSTEM

The yaw bearing is an externally geared ring with a friction bearing. The yawing motion is driven by two electric planetary gear motors. The yaw brake is passive, based on the friction of the yaw bearing. It keeps the yaw system rigid under most loading conditions. In case of highly eccentric peak loads the yaw brake will slide and the yaw motors will follow the motion passively, thereby unloading the system.

BRAKE SYSTEM

The primary braking system is the aerodynamic braking system consisting in turning the rotor blade tips 85 degrees (cf. Blades)

The second brake system is a mechanical one, failsafe, fitted to the gearbox high speed shaft. It is a disk brake system used as a backup system for the aerodynamic braking system, and as a parking brake, once the turbine is stopped. It is located on the high speed shaft of the gear box.

TOWER

The EB8-600 kW turbine is mounted on a conical tubular steel tower. Internal tower platforms are spaced sufficiently close to allow ascent without additional safety harness (under typical European safety regulations). Protection from the machinery, fire protection and electrical insulation protection is governed by a number of national and international standards.

The corrosion protection is assured by a grey painting.

NACELLE

The nacelle bedplate is a massive steel construction without weldings. It is cut out of a 120 mm steel plate. The top side has machined surfaces for the bearing and the gearbox supports, and the bottom side has similar surfaces for the yaw bearing.

As the nacelle weight is very important, its yaw mechanism is automatically guided by a hydraulic motor using anemometer data to make the nacelle faced the wind continuously.

CONTROLLER

The wind turbine controller consists of a number of computers which continuously monitor the condition of the wind turbine and collect statistics on its operation. There is two main controllers : one at the bottom of the tower and one in the nacelle. The communication between the controllers is usually done using fibre optics, which enables a reliable and fast exchange of signals.

The turbine controllers are industrial microprocessors, complete with power switchgear, protection devices, and a hand keyboard/display for easy readout of status and for adjustment of settings. When removed from the controller the hand terminal can be brought to the nacelle for assistance during service.

The electronics in the controller system are insensitive to electromagnetic fields and don't emit electromagnetic radiations.

GRID CONNECTION AND POWER QUALITY

The EB8-600 kW wind turbine is directly connected to the grid.

The term "power quality" refers to the voltage stability, frequency stability, and the absence of various forms of electrical noise on the electrical grid.

In order to keep a high power quality on the electrical grid, the EB-600 KW wind turbine is equipped with a bypass switch to minimise the amount of energy wasted. It connects and disconnects gradually to the grid using thyristors. But thyristors waste about 1 to 2 per cent of the energy running through them. Consequently after

the turbine has been soft started it is connected to the grid using a mechanical switch.
To prevent “islanding” the electronic controller constantly monitors the voltage and frequency of the alternating current of the grid. In case the voltage or frequency of the local grid drift outside certain limits within a fraction of a second, the turbine will automatically disconnect from the grid, and stop itself immediately afterwards.