Danish Wind Power in Brazil

Part 1

The future of wind power in Brazil - market analysis

by

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Abstract

This report presents a part of the work been done in the project "Danish wind power for Brazil". Following reports, inclusive this report, have been made as a part of the project:

Part 1:
The future of wind power in Brazil - market analysis.

Part 2:
Experience with danish 75 kW wind turbine - the first modern turbine in Brazil.

Part 3:
Brazilian wind conditions.

Part 4;
Investigation on ekstreme and fatigue loads for wind turbines in Brazil.

The project has been carried out in close relationship between Folkecenter for Renewable Energy, Denmark and the wind energy group Eolica, Brazil. The project has been supported by the Danish Ministry of Energy.

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Foreword

After years on the side line, the brazilian market for wind turbines has now matured and deserves attention from the Danish producers of wind technology. Even though many impediments still remain, the major being insufficient legislation, low energy prices, few wind data and the German Eldorado Program, things have been moving fast the latest years, and may move even faster the coming 3-5 years.

Folkecenter has for years supported the Eólica Group at the Federal University of Pernambuco in its patient struggle to promote wind energy in Brazil, and now the work seems to carry fruit. An official legislation for wind and solar energy is underway; anemometers is being installed in many states, and the general interest and activity level in the sector has been increased during the 90'ties. Furthermore, a coming energy deficit in several regions will raise energy prices substantially, forcing Brazil to consider new alternatives in a future supply portfolio.

Wind energy is ranked among the better alternatives, and even though the future potential of wind energy in Brazil at present is quite unpredictable due to strong reliance of political decisions and preferences, Brazil has now warmed up and seems ready to join the game.

1. INTRODUCTION AND BACKGROUND:

1.1 Brazilian energy sector:

Brazil is a hydro powered country. More than 95 per cent of the energy generation is carried out by large and highly efficient hydra power plants spread in many parts of the country. However, in several regions the hydropotential has become scarce, and further exploration of the hydrosource implicates huge investments, high marginal production costs and many ecological problems for the political decision makers. Assuming an average electricity consumption increase of 6 per cent per year, Brazil will experience serious shortage of electricity after year 2000. Faced with these facts, Brazil is now considering basic alternatives for future supply, wind energy being one of them.

1.2 The Northeast region:

The Northeast region of the country represents the biggest potential for wind turbines. It will be the first region to face severe supply problems, and at the same time it possesses huge wind resources. The last big hydropower station in Northeast with a capacity of 3.000 MW was inaugurated in 1995, and it is expected that this plant will assure energy supply 5-6 years ahead. After that the region has to seek alternatives. Being totally dependent of the São Francisco river for energy production, scarcity of electricity is already part of the daily life during dry season from June to October when the water flow rate is low. Hotels and private companies are not rarely forced to use diesel generators in order to dispose sufficient electricity. In this aspect, it is interesting that the seasonal variations of the wind speed compliments the water flow in a fortunate way. When the water flow is low, the winds are at their maximum[1]. Furthermore, the Federal Government has announced plans to irrigate 1.6 million hectares with water from the São Francisco river.

Basically five energy supply alternatives are being considered in the Northeast region of Brazil.

1. The construction of new hydroelectric plants in the Amazon region and transmission lines of 2.400 km to the Northeast
2. The construction of nuclear power plants
3. The use of biogass (sugar cane bagasse)
4. The use of large wind turbines
5. Natural gas

[1] See Enclosure A

Feasibility studies carried out by ELETROBRAS reveals that the five alternatives are quite even from an economic point of view[2]. However, the hydro plants in the Amazon region and the nuclear power plants both faces public resistance. The Amazon project because of the ecological consequences of flooding a large ingenious area, and the nuclear project because of the potential risk involved and the bad experiences Brazil has with nuclear power in general[3]. Furthermore, the high capital costs and the long planning and construction time of such projects are crucial factors. None of these alternatives can possibly be ready in 5 years.

All put together, it seems likely that biomass, wind energy and bio-gas, will be included in a future supply policy in the Northeast region of Brazil.

2. THE BRAZILIAN SECTOR FOR ELECTRIC ENERGY:

2.1 General structure:

Production and distribution of electric energy in Brazil is carried out by ELETROBRAS, a holding company under the Ministry for Mines and Energy (MME). ELETROBRAS controls the four Regional Utility Companies, responsible for generation and high voltage transmission lines. Under the four Regional Utility Companies we find the State Electricity Companies, whose primary activity area are distribution of electricity to the end-consumer. However, several of the State Electricity Companies are also involved in generation activities.

2.2 Privatisation

Generation, transmission, and distribution of electricity have until recently been reserved the state. However, the excessive privatisation program of the Brazilian economy has also reached the energy sector, and in May 1995 the partial privatisation of ELETROBRAS was announced[4]. The privatisation is carried out to insure the necessary capital in the future reconstruction and development of the energy sector. It is expected that US$ 60 billions will be invested in the energy sector in the next 10 years.

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[2] see Enclosure B

[3] Brazil has two nuclear power stations, Angra I and II. Due to many tecnical problems of the Angra I in the state of Rio de Janeiro, the Angra II has never produced energy, and is not expected to do so before year 2000.

[4] see Enclosure C - an article from Jyllandsposten.

2.3 Legislation

The legislation permits independent power producers to produce, distribute and sell electricity to third parties[5]. Though, prior to any such activities, permission should be obtained by the DNAEE (National Department of Water and Energy).

However, the most important part, namely a law defining tariffs and long term contracts still remains to be approved. But the politicians seems to be aware of the importance of defining the rules of the game, in order to attract foreign investments to the energy sector.

2.4 Tariff structure:

Along with the privatisation process, the federal government has also decided to remove most of the subsidies on end user prices of electricity. This led to a substantial increase of the consumer prices of electricity in November 1995. However, the electricity prices are still quite low in Brazil. Electricity in the Northeast region is produced at a cost around US$ 23-27MWh, and the average selling price to end consumers is around US$ 55-60 MWh. The end user tariff structure is quite complicated, and many industrial consumers pays up till US$ 100 MWh.

It is also important to mention, that the price of diesel is highly subsidised. The price of diesel oil is app. US$ 0,25 per litre. As the situation is at present, wind energy can therefor not compete commercially with electricity generated by diesel generators. However, this price is by many considered as not-sustainable in the long run, and is expected to go up in the coming years.

3. WIND ENERGY IN BRAZIL

3.1 Grupo Eólica:

For the last decade the wind energy group EOLICA at the federal university in Recife has played a central part in the development of the wind energy program in Brazil. Besides many efforts to divulge general knowledge about wind energy and arranging seminars and conferences, EOLICA has been conducting consultancy work for authorities, utility companies and private companies.

For the same reason, EOLICA has been and is at the moment involved in all wind energy projects in Brazil.

[5] see Enclosure D - an article from Diario Oficial da Bahia

3.2 International projects till date:
Until now, only smaller pilot projects have been realised in Brazil.

- A 75 kW wind turbine was installed June 1992 on the Fernando de Noronha island as a corporation between FOLKECENTRET/EOLICA and CELPE (Electricity company of the state of Pernambuco). Being the first of its kind in Latin America, it has been subject to a lot of attention in Brazil. Consult the report "Part 2".

- 1 MW in the state of Minas Gerais installed 1994. The four 250 kW turbines are produced by Tacke, and 70 per cent financed by the German Eldorado Program[6] and 30 per cent by CEMIG (Electricity company of the state of Minas Gerais).

- 1,2 MW in the state of Ceará will be installed in June 1996. Four 300 kW Tacke turbines, financed 70 per cent by the Eldorado program and 30 per cent by COELCE (Electricity company of the state of Ceará)

- A 22 kW turbine has just been installed in Recife. The turbine - a Hanstholm Mølle - is a donation from the danish company Hanstholm Møllen.
  The turbine is situated, where a Centre of Wind Technology will be build in the future.

3.3 Coming projects and activities:
Apart from the fact that various states are considering pilot projects, most of the focus is on the Ceará state, where two 30 MW projects will be subscribed an international tender in 1996. A Japanese bank will invest US$ 60 billion in two 30 MW projects located in the state of Ceará. It seems likely to expect that the tender will be shaped in a way favouring the Japanese Mitsubishi.

Other activities:

- A seminar on wind energy will be hold in Recife in the beginning of April.

- Conference for wind and solar energy in June 1996 in São Paulo. The Conference will be the III of its kind, and will be opened by the President of Brazil.

- On a longer run: a Centre of Wind Technology will be constructed in Recife.

[6] The german Eldorado program grants up till 70 per cent of the finansing of pilot wind and solar projects on developing markets.
[7] See Enclosure E

3.4 Wind conditions

Brazil is more than two times the size of Western Europe, and disposes an uninterrupted coast line of more than 8.000 km. It can therefore not surprise that good wind conditions can be found in many parts of the country, not only at the coast, but also in the inland regions of the country. In the state of Paraná in the southern part of the country 7,5 m/s has been found inside the state according to the state utility company, and in the Minas Gerais state in the inland, four Tacke wind turbines are enjoying 7 m/s.

As mentioned though, most focus has been put on the Northeast region due structural problems in the energy sector, and a very good wind potential. The trade winds hitting the coastline are characterised by a very uniform speed pattern (without occurrences of extreme wind speeds and long periods with low wind speeds), high consistency of direction and a very high Weibull shape parameter. Most of the 3.300 km coast line in the Northeast is still relatively unexplored when it comes to wind measurements, but it is considered realistic to find 7,5-8 m/s on many sites from the Bahia state in south of the Northeast region to the Maranhao state in the north.

Most focus has been put on the Ceará State in the Northeast, mainly because it is the first state to have carried out precise and reliable studies of the wind potential. In 1989 the first anemometer was installed at the Cofeco sight, and surprisingly the studies revealed a yearly average of about 8 m/s. This inspired to the installation of another 12 anemometers[8], which have led to the identification of several good sights along the coastline of the Ceará state. The total wind potential in the state is assumed to be 8.000 MW. Now further 15 anemoters are being installed in the state.

Several other states have started up wind measurement programs, but in many places the expected existence of excellent winds still remains to be confirmed.

3.5 Investment possibilities:

The lack of a adequate legislation defining tariffs and fiscal incentives, is a major impediment to concrete projects at the moment. No fully commercial wind projects have yet been carried out, leaving the marked without any reference projects to serve as a model. Another impediment is constituted by the low energy prices in Brazil. Furthermore, the German Eldorado Program seems to have spoiled the marked for the moment. With 70 per cent given by the German state, nobody seems willing to consider "normal" commercial projects at the moment.

However, the future looks promising. An official policy for wind energy is underway. The Ministry of Energy are in corporation with Dr. Everaldo Feitosa, Grupo Eólica, working on the definition of an official policy for wind and solar

[8] see Enclosure F

energy. This official policy is to be presented on a conference for Wind and Solar energy in June in São Paulo.

3.6 Folkecenters political activities

As a part of the project, Folkecenter has been involved in a number of conferences, work shops and meetings, involving people in high positions within the energy sector. In addition to that, meetings with locale and central municipalities have been held. Furthermore there have been several visits to Folkecenter by people from Brazil.

The following list shows some of the political activities, just before and during the project, of Folkecenters executive director Preben Maegaard.

June 15 th 1992
Main speaker at the first wind energy conference in Recife (enclosure).

June 16 th 1992
Installation of the wind turbine, located on Fernando de Noronha.

April 23 rd 1994
Main person at the work shop about wind energy (held in Recife).

April 25 th 1994
Invited speaker on wind energy conference in Belo Horizonte (Title "Danish Wind Energy").

April 26 th 1994
Work shop in Belo Horizonte : Plan of action for renewable energy in Brazil.

April 29 th 1994
Meeting in Recife with the president for CELPE about wind energy (CELPE is the electricity company in the state of Pernambuco).

June 2 nd 1995
Meeting in Recife: - with the president of CELPE about wind energy
- in the Ministry of Energy

June 2 nd 1995
Invited speaker at the international RE-Conference in Brasilia.

4. FUTURE DEVELOPMENT

4.1 What can we expect of the coming year ?:

Considering the structural problems of the energy sector in the Northeast of Brazil, and the good winds in the area, wind energy is not only considered an option in Northeast of Brazil, but rather as one of several necessary future supply sources. The coming energy deficit in Northeast is only five years ahead, and it seems certain that wind energy will be included in the coming reconstruction of the energy sector. Due to the excellent wind conditions along the coast line, it is believed that wind turbines can produce at a cost around 4-6 US cents per kWh, which is fairly competitive.

The 60 MW project in Ceará may very well serve as catalyst for the future development. The tender will be subscribed in 1996, and the wind park is expected to being installed in 1998-2000. However, many other States are beginning to consider wind energy as a serious source in a future supply policy, and wind measurement programs are being conducted in several states.

Unfortunately, many impediments still remains. The solutions to most of them seems to depend on political decisions, which makes the future development pace very hard to predict. The import taxes will have to be lowered, a legislation defining tariffs and long term contracts between state utility companies and independent power producers remains to be approved, and more information about the wind conditions will have to be provided.

Furthermore, the Eldorado Program seems to have set back the market development: *Why not - the German government pays* - seems to be the attitude. Depending on the coming legislation for the wind energy sector, it might take some years before the market is ready to consider projects on a more commercial basis.

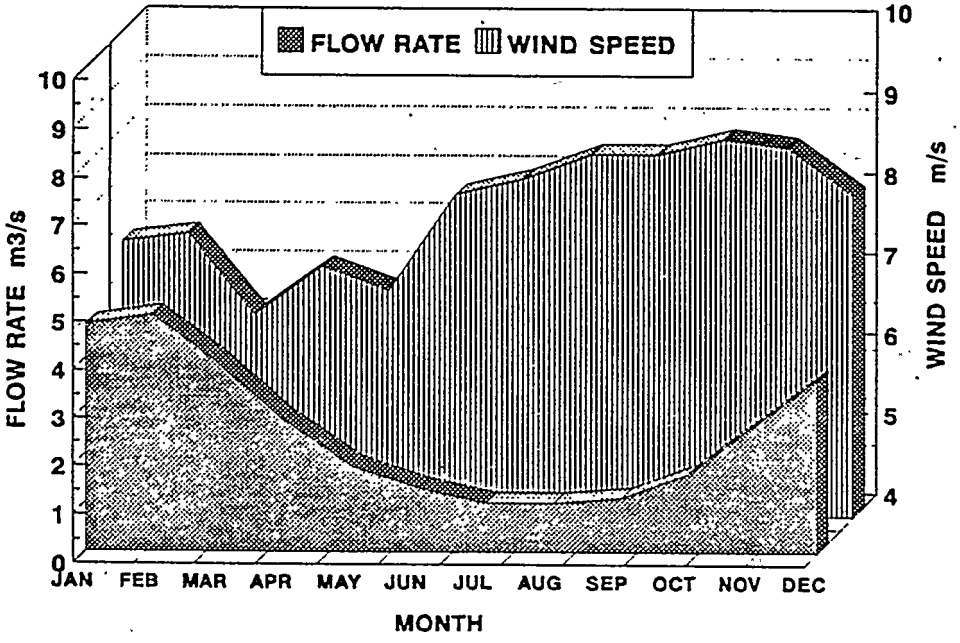
4.2 Folkecenter and Brazil in the future

Since the first contact was created between Folkecenter and Eolica in 1987, Folkecenter has used a lot of energy promoting renewable energy in Brazil, primarily wind energy. Being the driving force behind the first wind turbine in the country, it has gained respect in Brazil. Folkecenter has for years been monitoring the evolution in Brazil, and in all possible ways assisted the Grupo Eolica in promoting wind energy in Brazil, for instance during participation in conferences and training courses.

4.3 Potential for Danish technology:

Considering the unique position the Danish manufactures enjoys on the world marked today and the high experience of operating on remote markets, the possibility of capturing a major share of that might be a coming Brazilian wind energy marked is present.

However, only hard work and local presence can assure success in Brazil. Things often move frustratingly slow in Brazil, and it is necessary to be patient but insisting. Even though it might take some years before Brazil is ready for wind energy on a bigger scale, it must be recommended to take action now.



FLOW RATE : SAO FRANCISCO RIVER (1945 TO 1985)
WIND DATA : COFECO/CE (1993) h=10m

Figure 7 - Main primary generating sources

Generating Type	Potential (GW) - inventoried + estimated	Generating cost (US$/MWh)
Hydroelectric	179	up to 70
Biomass	27.7	38 to 78
Wind	28.9	39 to 84
Domestic Coal	17.5	50 to 65
Domestic Natural Gas	4.8	38
Imported Coal		49
Imported Natural Gas		47

Source: Information from Electrical Sector Plan 2015

Brasilien privatiserer elværkerne

Af JAKOB RUBIN
Jyllands-Postens
korrespondent

Rio de Janeiro, onsdag

Den brasilianske regering offentliggjorde i går en overraskende beslutning om at privatisere landets elektricitetsværker.

Den brasilianske elforsyning udgøres af atomkraftværker, vandkraftværker og traditionelle kraftværker. Beslutningen om at privatisere elsektoren kom overraskende selv for præsidenten for Electrobras, Mario Santos, der fik regeringens beslutning at vide på et seminar tirsdag.

Electrobras samlede aktiviteter menes at have en værdi på omkring 55-60 milliarder dollars (cirka 300 milliarder kroner). Hvor meget, der helt præcist sælges, er ikke fastlagt endnu.

Økonomiminister José Serra, der fremlagde planerne på et møde i Nationalrådet for privatisering, sagde, at detaljerne omkring salget vil være klar på rådets næste møde i maj.

På forhånd ligger det fast, at Electrobras deles op i to divisioner. Den ene bliver på statens hænder, og vil blandt andet omfatte atomkraftværkerne og distribuition af elektricitet.

Den anden division vil indeholde en lang række meget store elværker, der udbydes enkeltvis.

INVESTIMENTO PRIVADO

O monopólio estatal na geração e distribuição de energia caiu com a aprovação, pelo Congresso Nacional, das leis 8.987 e 9.074, que dispõem sobre a concessão de serviços públicos. "Isso permite que a iniciativa privada traga novos investimentos para a reestruturação do setor elétrico no país", explica o coordenador de energia da Secretaria de Energia, Transportes e Comunicações, Carlos Geraldo Lins Covas.

"O país precisa de mudanças profundas nos segmentos de geração e transformação, o que exigirá investimentos da ordem de US$60 bilhões nos próximos 10 anos", diz Covas. Isso só será possível com a abertura do mercado

Um exemplo é a Bahia, que acaba de identificar, através do Cogerba, um potencial de aproveitamento hidrelétrico de aproximadamente 1,2 milhão de quilowatts. Disposto a atrair investimentos do setor privado, o Estado já admite inclusive a privatização das hidrelétricas de Alto Fêmeas e Correntina, na Região Oeste.

A identificação de novos investimentos e associações eurobrasileiras nas áreas de cogeração, construção e exploração de centrais hidrelétricas é a principal vertente do Cogerba. Para replanejar o setor elétrico na Bahia, o convênio foi assinado em 9[illegible] e se encerra em dezembro. Ao todo, foram investidos US$3,5 milhões no projeto.

Jornal do Commercio

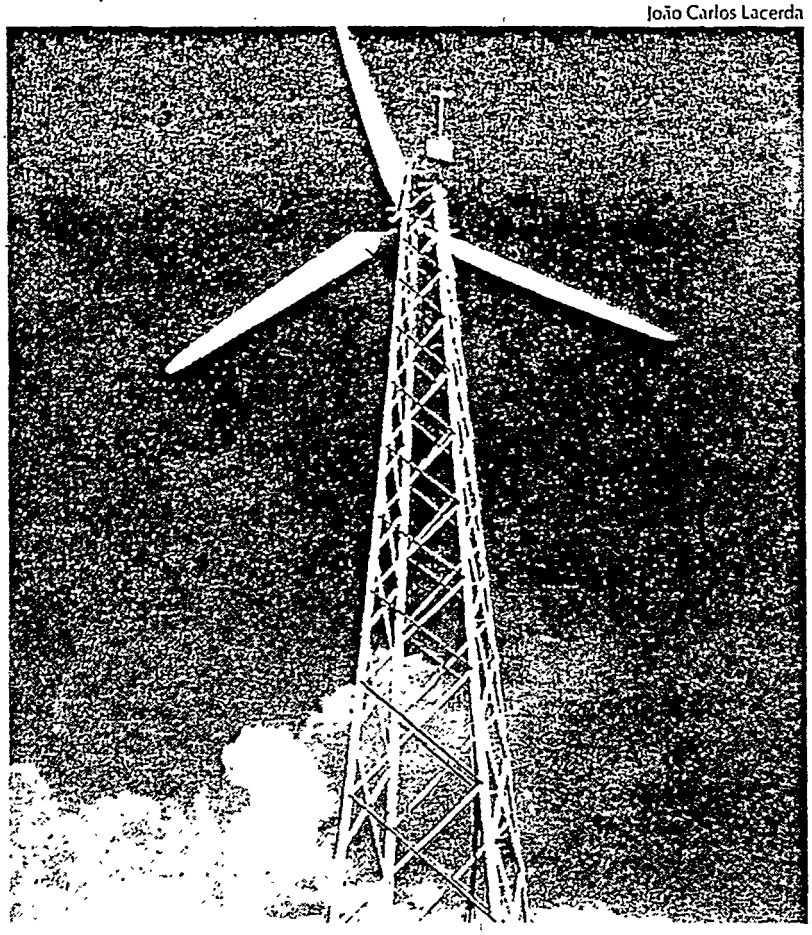
Ciência/Meio Ambiente

► *Energia*

Turbina eólica iluminará monumentos de Olinda

A energia produzida pela turbina será injetada na rede elétrica

João Carlos Lacerda



ENERGIA DO VENTO — *A primeira turbina do Centro de Testes está funcionando em caráter experimental e será inaugurada na terça*

A Catedral da Sé deverá ser o primeiro monumento de Olinda iluminado com a energia produzida pela turbina eólica instalada no Parque Memorial Arcoverde. Os refletores da igreja deverão ser acionados durante a inauguração da turbina, que acontece terça-feira (12), às 19h.

A turbina, em funcionamento desde o dia 24 de fevereiro em caráter experimental, é o primeiro passo para a implantação do Centro de Testes de Turbinas Eólicas, que deverá ser o primeiro do Brasil. O projeto resulta de um convênio entre a Universidade Federal de Pernambuco (UFPE) e a Prefeitura de Olinda, com apoio do Governo do Estado, da Facepe, da Celpe e do Banco do Nordeste do Brasil.

Segundo o coordenador do Grupo de Energia Eólica da UFPE, Everaldo Feitosa, a turbina, doada pelo governo dinamarquês, vai produzir cerca de 80 mil quilowatts/hora por ano, o suficiente para iluminar os dez principais monumentos do sítio histórico de Olinda.

Feitosa explica que a iluminação dos monumentos acontecerá de forma indireta, uma vez que os refletores estarão diretamente ligados à rede elétrica convencional, na qual será injetada a energia da turbina. Segundo ele, toda energia produzida pela turbina será descontada da conta da Prefeitura de Olinda, no final de cada mês. "Dependendo das condições de vento, a turbina pode produzir um excedente de energia ou ficar em déficit com a Celpe", explica.

O secretário de Ciência, Tecnologia e Meio Ambiente, Sergio Rezende, aposta na redução dos custos de produção desse tipo de energia e na adesão dos empresários. "Nos países desenvolvidos já é comum empresas privadas venderem seus excedentes de energia ao Estado", explica.

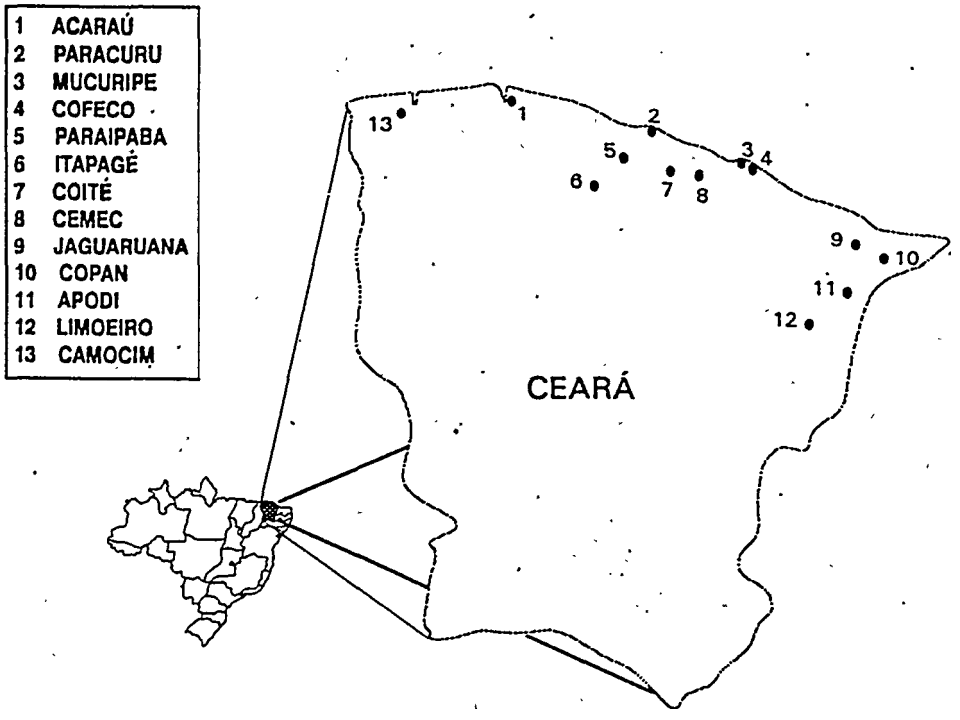


FIGURE 2. LOCATION OF WIND LOGGERS IN THE STATE OF CEARÁ

Enclosure G

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Paper presented at national energy conference, June 1995, Foreign Ministry of Brazil, Brasilia, Brazil .

"International Experience on Complementary Energy Generation"

by

Preben Maegaard
Executive Director,
Member of the Danish Renewable Energy Advisory Committee,
Vice-president of EUROSOLAR

Mr. Chairman - ladies and gentlemen,

Modern commercial wind power found its beginning in Denmark in the middle of the 1970's. We had just passed the most severe energy crisis in modern times. Denmark was almost 100% dependent on supplies form Arabian countries, so it was obvious to the politicians and the population that we should drastically change our energy policy.

There has since then for 20 years now been a consciousness to diversify and to develop domestic resources of energy. One of these resources was wind energy, which is a mode of energy which has always appealed strongly to the Danish people. Today we have 3,500 modern wind turbines installed which, however, are few compared to the situation before the second world war. At that time Denmark had 10 times more windmills, about 35,000 units which were vital for the mechanization of Danish agriculture at that time. It was before modern electrification was available to the rural areas, like it is the situation for around half of the world population today.

Series-production of wind power started around 1980 and there were 20 companies involved in this new industry. Some of them have been extremely succesful and have a leading position on the world market for wind power today, others have disappeared. 6 Danish manufacturers have a dominating position. It is characteristic for the Danish wind power sector that it is heavily based on specialized subsuppliers of blades, controls, towers etc. and a manufacturer of turbines was - and is - often a company that designs, assembles and markets wind power.

The sector has grown into a regular industry with 10,000 persons employed which should be related to size of the population of only 5 millions. It is today an export oriented industry, 90% of the production is delivered to the international market.

The industry got a strong boost in the years 1983-86 when the Californian market blossomed. We were ready with the right product at the right time and 10,000 units were exported to USA within a few years time.

Since then there has been ups and downs but today the wind industry is competitive and supplies to more than 40 countries in the world. 50% of all wind power equipment come from Denmark which maintains its strong position on the world market.

Various countries invested in the 1980's large amounts in wind power research and development, especially of large MW-type wind turbines. This was the case in USA, Germany, and Sweden. None of these MW projects have, however, got commercial relevance irrespective of very large corporations like Boeing, MBB etc. being involved.

The technology trend.

The historical background of the Danish success is without any doubt that in the 1950's we installed two well-functioning, experimental windturbines of 45 and 200 kW respectively. They were tested over a 10 years period so the transfer of experience from these prototypes to modern industrial production was the beginning and the basis of industrial standard now widely applied in many countries. Main characteristics of these windturbines were:

- they had 3 blades with airbrakes
- blades were placed upwind of the tower
- they used a simple induction generator with interfacing to the grid
- the rotor was constant speed, with stall regulation - only later follows variable pitch.

Materials used for blades are now fibre glass and polyester, the tower is usually tube type. All of this was a technology that could be handled by comparatively small and medium size industries. Most of them still employ less than 200 people, and there is only a few companies with approx. 1,000 employed.

The sizes of the windturbine unit were in the beginning quite small - 22 kW but gradually with the availability of larger blades, there came 55 - 75 - 150 - 200 - 300 and now 500 kW units are on the market.

In a retrospective we can say that every second year a new generation with increased capacity appeared on the market and immediately the market turned to the latest and most economical

type which forced the whole industry to pursue this trend. Today, only 18 months after the introduction of 500 kW turbines, the first 1,000 kW machines are being commercialized. It is especially the German market that calls for such large machines.

However, there is still some scepticism whether 1 MW will ever be the dominating size. Loads and some weights grow by the cube but power production only grows by the square. Also Megawatt types influences with their 60 meter towers significantly more on the landscape than 500 kW with 40 meter towers. Also logistically, Megawatt types are quite difficult to handle. It is obvious that especially for long distance shipment 25 meter long blades are difficult and expensive to transport, so in future, I assume, there will be a variety of sizes commercially available from 300 kW upwards, maybe to 1,500 MW.

Let this be the end of the story of the main trend of industry and technology.

Offshore wind power.

The next significant initiative that we will see from the Danish side is offshore wind-farms. A study has recently shown that with a few thousands large turbines offshore we have the perspective to supply 50% or more of the total electricity needs which today mainly come from 7,000 Megawatts of coal fired stations. Off shore installations produce 50% more than land-based units of the same size, but they also cost more.

So extensive use of wind power, however, necessitates joint operation with large-scale hydro-power and we find this in our neighbour countries, Sweden and especially Norway. For me it is obvious that Brazil has almost ideal opportunities to combine wind and hydro on a very large-scale and through this become one of the really large sustainable energy producers in the world and the example for many others to follow where there is a growing need for power. The technology and sites are available but the time required for implementation is of course considerable.

Small size wind power

The next step for us in Denmark is small-scale wind power for individual households. We have just launched a programm of windturbines up to 25 kW and there is a whole line of new-comers to this industry; for the domestic market but also for export where stand-alone and hybrid makes a huge potential, similar to the large-type windturbines.

Users' organization - cooperatives

Concering operation it has been our policy in Denmark from the beginning, that a harmonious, continuous, and comprehensive implementation of wind power can best take place with the concrete and active participation of consumers. - I have myself been out of the architects of the Danish cooperative model which means that now 100.000 families are owners of windturbines. 80% of the total capacity of 550 MW of wind power are private, some of the windturbines are owned by farmers but most are the property of local cooperatives.

Let me use an example how we organize this: A 200 kW turbine produces in a good wind

area 600.000 kWh. So 600 shares are offered to the local community where each family according to special legislation may own a maximum of 9 shares. So, in total 50-60 families participate in one turbine of that size. If the project is very popular there may be the interest for 2 or 3 or even 10 machines.

The shareholders sell the power to the grid and buy as usual from the grid. They share investments and profits; in practice a return of 10-22% is obtained on the investment, which is tax-free; this is important because in Denmark income-taxes are high, 50% or more. The investment per family is typically 5000 USD, which most families, who own a house and a car can afford.

The motivation for them is that they are doing something beneficial for the environment, through changing from coal to power from the wind and at the same time they make a modest profit. - Without these cooperatives appearing more than 15 years ago in Denmark there might not have been a basis for a commercial wind sector at all, because they were the loyal customers of a new industry at a time when all others were sceptical and hesitated.

Farmer operators.

Another important owner category is the farmers. A farmer is permitted to own one unit irrespect of size on his own land and this is quite popular in parts of the country where winds are abundant. He sells the power to the utility so harvesting the wind is for him a business like the other crops from his farm.

Government subsidies.

The private sector obtained in the beginning 30% subsidy from the government. With improved wind power technology the subsidy was gradually reduced and in 1989 finally abolished.

The sales price of power is today approx. 10 US cents consisting of an energy component and refund of energy tax, which is paid by all consumers. We have low electricity prices in Denmark compared to other European countries but though this refund-mechanism wind power producers in Denmark obtain almost the same prices as in most European countries.

A minimum price of 10 cents or so is however also necessary to make wind power attractive to private investors, so in Brazil you will need to find some kind of incentives, is my estimate.

Grid interfacing.

On my travels abroad, I often meet the question of how the interfacing to the grid is practiced. We have precise regulations of this, which all local utilities follow in order not to sacrifice the power quality, especially voltage and frequency.

We have absolutely no technical problems with connecting even large quantities of wind-power to the grid. Let me use an example. I live in a peninsula with 15,000 inhabitants. It

is a rural area with small towns and many farms. We have 150 windturbines in sizes from 55 to 500 kW each. They are all private and all grid connected. The total capacity is approx. 30 MW which covers more than 60% of the total annual consumption of electricity, which is certainly the highest in the world for a local community. At periods, especially in the summer, when wind is abundant and power needs are low the wind power may be two times more than the actual consumption. This is happening without affecting the power quality. I am stressing this point because I know, that many engineers in the utilities are deeply concerned about the consequences of connecting wind power to the grid. However, with proper guidelines and grid improvements it is possible to feed large quantities of power into a grid that was originally designed for one-way supply.

New local income and impact.

But there is another important spin-off of the active local involvement. In the municipality I just referred to, the average income per capita is around USD 700 originating exclusively by selling wind power to the grid, which is new income to the community, which everyone is benefitting from. However, this is a kind of income that would not have been available to the community in case the windturbines had been owned by investors from the outside, public or private.

And this leads me to my concluding statement. Windturbines make a very significant change of the local community, they are extremely visible which in more and more countries leads to people using their democratic right to protest against wind power. It is a crucial choice: Do you prefer acid rains and the risk of climatic changes or do you accept the view of windturbines.

Through the active, local participation, the windturbines have become a positive factor for the community, bringing new investment and income to the local people who are to look at and live with the wind power, which often also give new status to a region.

Differentiated local solutions.

I fully realize that the situation about local participation is very different within the various parts of the world. My preferred model certainly applies mostly to Europe and similar areas where the population density is high, whereas countries like India, China, Russia, USA and of course Brazil have huge areas with hardly any inhabitants, so other models of investment and installation may be best applied.

I was in India in May and saw how well they have attained the first 200 MW within a plan of 800 MW. This is significant in a developing country with a capacity shortage of over 30,000 MW. India is building up its own modern wind power industry and in some cases manufacturing 80% of the turbines, which of course, is extremely important in all countries in search of new, future-oriented industries and new employment for people.

In my institute we have had the privilege to participate in the first modern grid connected windmill in South America at the paradise island of Fernando do Noronah. It was in 1992, symbolic of the adaptation of Agenda 21 in Rio de Janeiro the same year.

I preferred today to give some perspectives of the use of wind power with special emphasis to the Danish development. Wind power has come to stay; it is clean energy and it has also become cheap energy. The vice-president of Brazil told us yesterday at the opening ceremony that energy is life. So, wind energy is life, it is renewable and unlimited in time. It will bring new energy and prosperity to the future generations.

FACEPE

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Coordenador do Grupo de Energia Eólica - UFPE

DIA: 15 de junho - Segunda-feira
LOCAL: Auditório da CELPE - Av. João de Barros, 111 Recife-PE
HORÁRIO: 09:00 às 12:00 horas

SECRETARIA DE PLANEJAMENTO
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Enclosure H