Wind Energy Policy in Denmark: 25 Years of Success - What Now?

By Soren Krohn, Managing Director, Danish Wind Industry Association, February 2002

The successful growth of the Danish wind industry (see the article Danish Wind Turbines: An Industrial Success Story) has inspired many people around the world to speculate whether a similar success would be achievable somewhere else - either in the same or in a different industry. Likewise, there are good reasons for discussing whether current Danish industrial or energy policies for renewables need a change. This article does not give the answers, but is may provide a base for further thinking on these issues, by analysing the principal components of Danish policy - mostly in terms of energy policy and RD&D policy - and the industrial response.

A basic knowledge of current wind energy policy in Denmark is a prerequisite to this article. That knowledge is provided in the companion article Wind Energy Policy in Denmark: Status 2002.

1 Picking Winners - or Losers?

It would be naive to suppose that an industrial success can be carbon-copied and repeated elsewhere. Most industrial policies aimed at "picking winners" around the globe have been dismal failures, and governments have instead succeeded in "picking losers".

People tend to forget, however, that the Japanese Government in fact advised against car and motorcycle manufacturing as a strong manufacturing base for Japan. The Japanese government entered into mutual voluntary export restraint agreement with Italy in the 1950s, fearing that the Japanese market would be overrun by foreign cars. Conversely, it recommended investing in oil refineries which proved to be a very expensive exercise.

It would also be wrong to view the Danish experience in the wind industry as a result of clever, co-ordinated, long term political planning, involving several ministries and agencies. With clear hindsight, it is easy to construct such conspiracy-like theories: As everyone who has been in manufacturing industry knows, foreign competitors are inevitably alleged to be being subsidised or somehow helped by their own government, even if no proof is available.

In actual fact, in the Danish case much points in the opposite direction. Denmark e.g. implemented mixed credit schemes for medium-income developing countries some ten years after the US, Sweden or Britain, and the amount of money spent on public research in wind energy in e.g. the US (or Canada) was simply an order of magnitude larger, according to IEA statistics. In some sense, Denmark was lucky in terms of timing an in hitting the commercially right technology.

VINDMØLLEINDUSTRIEN
Vester Voldgade 106
DK 1552 København V
Tel : +45 3373 0330
Fax : +45 3373 0333
E-mail : danish@windpower.org
Internet : http://www.windpower.org

Historical circumstances also vary between yesteryear and today. In particular, there is a huge difference between entering an industry in its formative stage, and in entering a relatively mature industry with mature markets and economies of scale in both development and deployment of the technology. Wind energy projects above 100 MW or 100 million EUR are no longer unusual, and the development of a 5 MW machine is obviously much more demanding than developing a 5 kW machine.

The "first mover" advantage in particular cannot easily be copied within the same industry - except when a new technology or a new way of deploying the technology changes the basic conditions radically.

Interestingly, the wind industry is today facing such a switch, and possibly a bifurcation of the technology in relation to onshore versus offshore wind power.

This is a new window of opportunity, and at the time of writing it looks like the Danish wind industry may once again be able to grasp this opportunity, despite a perhaps somewhat more murky political outlook with the newly installed Danish right-wing government.

2 Research and Development

2.1 Which Technology?

In order to discuss the state of the wind industry, it is important to have some understanding of where wind energy technology is at present. Being a resource-based industry, there are really two groups technologies involved, plus a second tier of related technologies:

1. Wind resource technology, which may be subdivided into

    1. Wind resource assessment in a spatial sense, i.e. optimal siting of wind turbines and estimation of annual energy output.

    2. Wind resource assessment in a temporal sense, i.e. short term prediction of energy output for optimal scheduling and dispatch for both grid managers and electricity market actors.

    3. Wind climate characterisation statistically in an engineering sense, i.e. estimation of turbulence, maximum gusts in order to optimise the strength and fatigue properties of wind turbines and their components for each specific site. This knowledge is also used for establishing proper type approval (safety) requirements.

2. Wind turbine technology Wind turbines differ from other technologies by being the largest rotating machinery on earth, and by dealing with relatively slow moving wind flows, but with extremely variable forces. The fundamental aerodynamic and structural dynamic problems are no less complex than in helicopter construction.

3. Financial Engineering which is of course not specific to this industry, but which increasingly has very important spin-off industries for consultancy work, i.e. second opinions, due diligence verification etc., in all of the technology areas mentioned above.

2.2 Accent on Basic Research

Denmark has been in the forefront of basic research in wind energy technologies for the past 20 years. The Wind Energy department of Risoe National Laboratory is known worldwide for its expertise, but an important part of the research and its application is conducted at The Technical University of Denmark, and increasingly also at Aalborg University (electricity aspects).

An important difference between the Danish and other national governments' support for wind energy RD&D is that the Danish support has primarily been directed towards basic research, whereas other governments have tended to support wind turbine development. The difference is also remarkable when looking at the Ministry of Energy funding of energy research. The money in other areas of energy research tends to be spent much closer to the product development phase than is the case for wind energy.

An important corollary is that the publicly funded research tends to have a relatively low share of financing coming from the industry, which obviously focuses its attention on product development and the acquisition of proprietary knowledge.

This division of labour has been rather successful compared to what is known in other industries.

It is characteristic, that the know-how acquired from the Danish publicly funded projects is available (internationally) in the public domain, and that the know-how thus is available to the wind industry worldwide. This does not mean that this research has not been very beneficial to Danish manufacturers: On the contrary, the expansion of the international market for wind energy is clearly partly due to two key elements of this research.

1. The wind resource technologies mentioned above - not least the European Wind Atlas methodology for mapping wind resources has been extremely important in multiplying other technology advances by far better siting of wind turbines. In fact, most of the advance in productivity of early wind turbines installed in Denmark 1980-1985 was due to better siting of turbines.

2. The Danish type approval certification scheme has been a very dynamic tool to foster better design procedures in wind turbine manufacturing companies. It has also been important in winning the confidence of professional investors worldwide. This was clear already during the great California wind rush in the early 1980s.

A unique feature of the Danish type approval scheme has been its non-reliance on "cookbook" methods of standard approaches to turbine design (as seen in some other countries). On the contrary, the close relationship between the research community and type approval experts means, that the Danish type approval scheme has always allowed the best "state of the art" technology to be incorporated in the products. This is largely because the safety requirements are described in functional terms, allowing each manufacturer to use his own documented safety approach.

In practice, the initial model for safety for offshore wind turbines - internationally - has also been produced by the Danish type approval scheme, de facto giving yet another "first mover" advantage to the Danish wind community. It should be added, however, that this is an open procedure, i.e. German manufacturers of wind turbines were invited and have participated actively in the work leadning to the present safety requirements.

2.3 Evolution, not revolution

Hopeful inventors of, say, vertical axis machines or diffuser-based systems have constantly claimed that a huge technology jump is just around the corner, but the past 25 years have proven them wrong (so far). The three-bladed upwind machine, i.e. the classical Danish Concept, pioneered by the Gedser Wind Turbine in 1956, has overwhelmingly not just defended its place, but virtually wiped out competing designs.

Since most research and development money worldwide go into developing and further refining this concept, that design has achieved roughly the same reference status in the wind industry as the four-stroke car engine has done in the automotive industry 100 years earlier: It has been around since 1856!

Mainstream opinion among engineers in this industry is that we are much more likely to see an increasing number of refinements of the present concept rather than new radical departures. The economic risks in pursuing a radically different path are simply too large for the stakeholders in the industry, and there are no obviously promising alternative designs waiting around the corner.

Variable speed technology, indirect grid connection, and different generator types are in this analysis considered refinements of the existing technology rather than radical changes (as no doubt they are labelled by their proponents).

2.4 Offshore Technology is Different

There is little doubt, however, that offshore wind turbines are developing into a class of their own, although based on the same principles as onshore machines.

For offshore machines, there is clearly a premium on reliability. Simply because

1. access for maintenance purposes is more expensive offshore than onshore.

2. there may be long periods during which an offshore wind farm is practically inaccessible for service.

This means that even if wind turbines on land typically have availability rates of, say, 98%, this may translate into less than a 90% rate of production, if offshore turbines are only accessible, say, 20% of the time. The "less than" is important, because turbines at sea tend to be inaccessible precisely at the time when they would have been producing maximum power output.

Offshore turbines have economies of scale, however. It is more worthwhile to optimise preventive maintenance and surveillance systems for a 5 MW machine than for a 1 MW machine.

3 Danish Policy as an International Model

Denmark has in many ways been a full-scale laboratory for the Danish wind industry. This has not only helped the Danish industry itself, but has helped create confidence in this new technology to an extent which no single test wind farm could have done.

3.1 Public Planning Issues

With a highly visible technology such as wind turbines, the development of models for dealing with public planning (zoning) issues have been very important for many countries' acceptance of the technology.

In Denmark the public planning procedures were initially developed through local trial and error. In 1992 more systematic planning procedures were developed at the national level, with directives for local planners. In addition, an executive order from the Minister of the Environment and Energy ordered municipalities to find suitable sites for wind turbine siting throughout the country. This "prior planning" wit public hearings in advance of any actual applications for siting of turbines helped the public acceptance of subsequent siting of wind turbines considerably.

A similar planning model has since been introduced in Germany with considerable success. Other countries are studying these experiences with a view to overhauling their planning procedures.

Around 1997 another set of planning regulations we developed for offshore wind farms, with a central, national authority, the Danish Energy Agency, being responsible to hear all interested parties, public and private. This "one stop shopping" method has facilitated the planning process considerably, and is widely studied around the globe.

3.2 Electrical Grid Issues

In 1970 a report from the energy department in the Ministry of Trade analysed the possibility of introducing large amounts of wind power in the Danish electrical grid. The report was somewhat sceptical on the cost issues, and is conventional wisdom held that it would be possible to introduce up to 10 per cent wind power in the grid without a major inconvenience.

Experience has since proved that it has been practicable to operate the grid with a far higher degree of penetration of wind energy. In the western part of Denmark an average of 20 per cent of the electricity consumption is already coming from wind, and higher degrees of penetrations are foreseen in Danish energy plans, as explained in the status article on Danish Energy Policy.

This tested experience is already being sold to several foreign projects from power engineering companies such as SEAS and Techwise

The development of future offshore wind farms such as the Laesoe project is likely to give additional experience in designing wind farms with alternative grid connection strategies, such as HVDC (high voltage direct current).

3.3 Energy Policy Issues

The Danish energy policy for renewables has been a model for many markets in the world. In countries as close as Germany, France or Spain and as remote as China or Argentina, Danish support schemes for renewables have been copied and/or adapted to local circumstances.

Danish long-term energy planning and the analyses of the social costs and benefits of renewables have been widely quoted throughout the world. The remarkable continuity with which the policy for renewables has been running, at least until 1999, means that the policy has actually had the time required to demonstrate its effects clearly: Today one third of the Danish Kyoto commitments to reduce greenhouse gas emissions are being met due to wind energy, and wind supplies 18 per cent of Danish electricity consumption. (The dramatic energy savings in space heating - particularly in the private household sector - have been equally remarkable: 50% energy savings over 20 years).

4 Everyone Likes a Winner

4.1 The Danish Wind Industry Cluster

It has lately become popular to speak of clusters, or industrial complexes. The Danish wind industry sector is one such example, which many authors, including two Ph.D. theses (in Danish) by Peter Karnøe and Per Dannemand Andersen, Copenhagen Business University, have treated at length. (See the bibliography page in the Guided Tour on www.windpower.org). These authors have also published a number of English language papers on this subject, to which references may be found on the web. This is why this paper does not go into substantial detail on this issue.

As noted by these authors, one of the remarkable features of the Danish wind energy cluster is the fact that it comprises more than half of the world production of wind turbines (although less than half are physically manufactured in Denmark.

There is thus a critical mass present in every field of expertise related to wind energy in Denmark, including manufacturing, research, development, engineering services etc. Due to the relatively limited size of the country and the industry, there is ample opportunity for networking, and a certain flow of persons between the various segments of the industry.

Everyone likes a winner, everyone wants to be part of a success, and the Danish wind industry is no exception. Judging by the number of people and institutions who advertise themselves as being part of this success, one could get the impression of a concerted strategy.

4.2 By Accident or Design?

It is thus a popular pastime for political speech writers in Denmark and in environmentalist organisations worldwide to attribute the success of the Danish wind industry to a carefully planned strategy. Foreign competitors have often alluded to a Danish MITI-like [1] strategy in this sector. But in reality there is a lot of "cleverness with hindsight" in this type of history-writing. What has been remarkable in Denmark has been the stability of Danish energy policy (until 2002), and the careful long-term planning scenarios, such as "Energy 21" which have actually bee adhered to. This has given a sound base for decision making in the sector, and an international confidence in the Danish wind energy sector which has not waned - at least until today, 2002.

4.3 Confronting or Confounding the Public Policy and Public Subsidy Issue?

It would be easy to assume that the wind industry is just a business like any other, say manufacturing of pre-insulated pipes, insulation material, radiator thermostats, circulation pumps for central heating, or hearing aids, or the provision of telephone services.

These examples are not picked at random, of course. These industries have all come about largely due to Danish regulatory policies. The first four are strong areas for Danish industry of which the first four clearly owe most of their existence thanks to Danish energy policy, including building regulations, (Danfoss, Grundfos, Superfos, Roockwool), whereas the next example, hearing aids, (Oticon, Danavox, Widex), is based on Danish health care or social policy, providing free hearing aids for people with hearing impairment. Finally the telecom company TDC used to be state owned, and regulated as a monopoly.

Other examples of industries with a strong home base due to regulatory policies (socialised health care) would be the pharmaceutical and medico-technical industries with companies such as Novo-Nordisk and Coloplast. In this particular case, public policy has quite openly and blatantly been adjusted so as to accommodate the strategic need for high prices on the home market in order to allow high prices on exports markets, due to the interlinked regulatory policies concerning pharmaceutical prices on other markets

The public debate often mixes up support to industry, and support to the deployers of the product in question. (E.g. housing policy versus support to the constructions sector) This discussion shall not be pursued further here, but could conceivably be the subject of yet another paper...

1) **MITI is an agency under the Japanese industrial ministry, which is always used as an example by industrial policy proponents worldwide. Its success rate is highly questionable, as exemplified in the first section of this paper.**