THE DANISH WIND CLUSTER: STRATEGIES, TRAJECTORIES AND FUTURE DEVELOPMENT

I: THE CLUSTER PHOENOMENON

In an industrial macro-environment, clusters and geographic conglomerates of economic actors, companies and institutions have emerged as one of the most fascinating events of the last 50 years.

The first to understand the complexity and the advantages arising from geographical proximity was one of the most inspiring economist of all time, Alfred Marshall. However, the emergence of the industrial districts has started in such a multifaceted environment was studied first by Giacomo Becattini in "The Marshallian industrial district as a socio-economic notion" (1992). According to Becattini industrial districts *"are socio territorial entity which are characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area. In the district, community and firms tend to merge"*.

Later on, in "The Competitive Advantage of Nations" (1990), Michael Porter added a fundamental contribution to the theoretical consolidation of the industrial district notion. According to Porter, a cluster is a *''geographic concentrations of interconnected firms, specialized suppliers, service providers, firms in related industries, and associated institutions in particular fields that not only compete but also cooperate"; "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. The geographic scope of clusters ranges from a region, a state, or even a single city to span nearby or neighboring countries"*.

A cluster is a winning model of an economic system as it triggers a sequence of important phenomena. First, in the cluster the presence of suppliers of specialized inputs makes the value chain more flexible and accessible. Moreover, clusters give the corporations access to accurate, pertinent and specialized information. This means that members have a privileged access to extensive market, technical and competitive information. Thirdly, in clusters, multinational enterprises may have an important role. In fact, they tend to supply sources of technology and innovation, modern managerial and learning-by-doing practices to the local firms. Furthermore, they generally furnish specific infrastructures to the firms' activity. They also link the local firms to the global value chain, increasing their productivity and efficiency. Finally, clusters influence the

competitive advantage in three ways. In the first place, they have a strong impact on *productivity*; on *innovation* and on the *formation of new business.*

Krugman recognizes that the economic benefits deriving from a cluster can be subsumed in a concept that he dubs as “Marshallian trinity”. In practice, localization happens when there is a pooling of the labor market; when there is a presence of intermediate inputs; and when technological spillover are very likely to happen. Starting from this standpoint, Krugman indirectly introduces the concept of external economies which Schmitz will deepen in his own analysis, when “agents cannot capture in the price of their product all the benefits of their investment” . In brief, the effect of an external economy is an involuntary benefit to external economic actors. Therefore, the main characteristic of external economies is their being incidental.

Another central issue, when analyzing clusters, is the concept of increasing returns. This phenomenon will be studied starting from the striking assumption that the classical economic mainstreams cannot explain how cluster works. As both Krugman and Schmitz admit, clusters are able to generate what in the typical conception of a Ricardian economy sounds absurd.

Finally, governments and legislation organisms can have a very important role in the expansion of clusters. But, this involvement should be totally functional to the intrinsic dynamics and should not be directed to interfere or control them. Government can have an extraordinary importance when it comes to upgrade obsolescent or traditional clusters. In order to do so, the political organisms should seek policies which are not just focused on the firm or industry levels. On the contrary, a government plan should put its attention on the whole cluster level.

II: ENERGY PROBLEM AND WIND POWER

It is quite easy to notice the vast influence and repercussions that the energy problem has over the contemporary economic and political dynamics. However, it is not completely clear what we generally mean when we refer to this issue. Thus, a general definition is required. The energy problem is that challenging situation that human kind has to face and that derives from three different causes: the fact that fossil fuel resources are not unlimited; the political issue deriving from the difficulty to provide a secure supply of these resources and, finally, the impact that these resources have on the global environment.

In such an uncertain and unpredictable situation, the risk of a gradual but unstoppable society breakdown is not anymore just a science fiction scenario. The capitalistic society and economy

relay almost completely on fossil fuels and the exhaustion of all the hydrocarbons seems to be a cataclysmic event that mankind has to seriously take into consideration.

However, a solution exists. In 1998, according to the UNDP report, *"renewable energy sources supplied about 14% of world primary energy consumption. The supply was dominated by traditional biomass (38 ± 10 exajoules a year). Other major contributions came from large hydropower (9 exajoules a year) and from modern biomass (7 exajoules). The contribution of all other renewables—small hydropower, geothermal, wind, solar, and marine energy—was about 2 exajoules. That means that the energy supply from new renewables was about 9 exajoules (about 2 percent of world consumption)."*

In the next 10 years renewable energies have reached a tipping point. Nowadays renewables account more than 25% of the total energy supply and 18% of electricity power share. The most outstanding growth and the source of renewable energy which seems to be the most affordable and reliable is by far, the wind power. Wind is the largest renewable energy for installed capacity (159 GW in 2009, with a 30GW yearly increase in 2009). From 2005 to 2009, wind energy was the fastest growing power source as well, with an average of 27% per year, which means that every year the installed capacity is more than 1/4 larger than the previous one.

The leader in wind power installation is China, that accounts almost 1/3 of the whole installed capacity whereas, just 5 years ago it did not reach 2%. In 2009, China added over 13.8 GW of wind power installed capacity; USA an additional 10GW and Germany 1.9GW. Together with this outstanding development, we have to include the power deriving from offshore wind farm, which nowadays account 641MW installed capacity, with a yearly increase rate of 72%. Wind provides large share of electricity to many countries. In Denmark, the 20% of electricity demand is faced by wind power; in Spain 14%; in Portugal 11.3%.

III. THE DANISH WIND CLUSTER

When it comes to wind power, it is rather impossible not to focus the attention on Denmark. The reason of this choice can be perfectly summed up by the words of Jan Hylleberg, the Danish Wind Industry Association (DWIA) CEO: *"Denmark is the first country in the world to pursue a climate plan for how to build an energy system that is independent of fossil fuels. Wind power already accounts for more than 20% of the total power consumption in Denmark. No other country has integrated so much wind power in its energy system. It is widely agreed that wind power will become the backbone of Denmark's future electricity supply. The Danish Wind Industry Association*

(DWIA) has defined a target that, by 2020, wind power should account for 50% of our electricity consumption. This target will drive developments in the wind industry – throughout the supply chain – so that Denmark, also going forward, will set high technological standards in terms of developing wind technology and the energy system of the future."

Going in depth with the analysis, in 2010, Denmark accounted an installed wind capacity of 3,752 MW, producing an average of 28,175 TJ (7.81 TWh) of energy, with an actual average of production of 905.90MW and a share of 21.9% of the total electricity consume in the country - even though this number has often been object of several disputes. In the following tables the trends of wind power in Denmark since 1977 are shown.

The history of the Danish wind cluster birth and expansion, is strongly linked with government interventions and political or institutional actions and directives. Denmark has a long tradition history when it comes to wind power that can be traced even before the 1973-1974 oil crisis. This certainly facilitated the decision of the political authorities to shift from fossil-fuel toward a "green energy" economy, already in the 1970s.

In 1981, the first target plan - Energy Plan 1981 - forecasted that by the year 2000, 10% of the national electricity should have been supplied by wind power. In order to do so, it was planned the building of more than 60,000 wind farms. This objective was reached in 1998. Moreover, in 1984 the wind power producers were subsidized with a 70–85% feed-in tariff on the retail electricity price and a State payment for the connection to the grid. In 1990, the government also signed an agreement with the utilities to install 100MW building capacity in the same year, the Energy Plan 2000. This agreement was enlarged in 1996, for the installation of 1500MW for 2005. In 1998 this plan was emended, and the so-called E-21 Plan (Energy for the 21st century) was born. This last objective-plan required the building of up to 750MW offshore wind power capacity.

Furthermore, the new technology investments were managed by the Energy Research Programme and the Development and Diffusion Programme for Renewable Energy, founded in 1992. And the Development of New Renewable Energy Technologies in 1997. In 1999, repowering and replacement mechanism for the old turbines were introduced in the new electricity reform, with a fixed monetary incentive of 0.60DKK/KWh, for the first 12,000 hours of activities. It has been calculated that in the period between 1997 and 1999 almost 130 Million DKK (17.5 million €) were given to the renewable energy industry from the government.

This is the reason why in 1999, the whole structure of public incentives was abandoned and a new enticement system introduced: the green certificate system. This new financing method stood on the benchmark that citizens had to commit to purchase a fixed amount of their electricity from wind and other renewable sources in general. Danish customers had to purchase at least a 20% of their electricity consumption from renewables by the year 2003. The "green certificate" price was set between a minimum of 0.10DKK/KWh and a maximum of 0.27DKK/kWh. This method implied a saving of over 300 million DKK (40 million €) with a conspicuous 66% reduction on the national budget. However, the green certificates' emission created a very unstable situation that was eventually restored in 2003, with the amendment of the Energy Reform, restoring feed-in tariffs.

As it emerges from the industry history, the three main events that amplified the technological sphere of the Danish cluster were the governmental action, the export boom, overall towards the American market, and the control and insurance system of the Danish companies. On the other side, the hampering events seemed to be some governmental restrictions in late 80s, the obvious doubts which were embedded in the entrepreneurial Danish setting about the efficiency and the profitability of wind turbines, and the 1986-1990 crisis given by the downturn in terms of export towards California. However, both the positive and the negative events, appear to be faces of the same medal. As a matter of the fact, it is very common that from a positive event, a negative one rose, and vice versa - see the expansion into the California's market and the consequent downturn in the whole Danish wind turbine industry. This means that all the events tend to form a sort of a chained subsequence of facts, a trajectory that shapes the emergence of an organic, systemic set of knowledge and technology.

In such a situation in which a switch point is highly foreseeable and probable, it is very likely to incur in first-mover advantage opportunities. This is true for the countries that are in a situation of technological supremacy which can lead to a strong increase in the export opportunities, such as Denmark for wind energy. Brandt and Svendsen (2004) identified two sources of this type of strategic advantage. In the first case study scenario, the first-mover advantage produces a mere increase in the exports towards those countries which are struggling to substitute the old technologies with new and more modern ones. In the second case, however, a first-mover advantages can lead to the creation of technologies which are competitive even in countries where there are not consistent pressures on the CO2 reductions. Of course the development of new technologies affects the occurrence of the switch point. Many countries, overall in Europe have large wind or renewables' potential. Thus, a development of new technologies in a certain country can trigger the production abroad. This virtuous circle is completed by the situation in the home

country which is actually undertaking the investments in the new technologies. Its products become more and more requested and this renders the investments in R&D very likely to create large margins of profit. As a conclusion to this analysis it is reasonable to state that offering a highly technological product at a price which was completely deprived by all the external cost influence, made Denmark able to enjoy a leading position.

Another important issue to consider are the technological spillovers. In the thesis I focused first on the so-called internal spillovers - namely those that affect the inside industry; whereas in the second part, the external spillovers i.e. the ones that spread their positive effect outside the domestic territory – have been deepened. In the last section of this paragraph, a particular approach, which will examine the spillovers in the Danish wind cluster, according to the contribution of three authors: Linda Manon Kamp (2002, 2004); Ger Klaassen (2003), and Martin Junginger (2004), will be adopted.

Finally, form a Porter's Diamond analysis it emerged that Denmark's most important resources are: a constant and relatively high wind speed of 4.9–5.6 m/s that in the Jutland and by the sea, reaches even higher values (around 9.0 m/s). Moreover, the most valuable and precious resource that Denmark owns is not wind itself but its high degree of innovativeness, the strong university and knowledge system and an incredibly high skilled and qualified labor force.

The demand is mainly composed by guilds and non-profit partnerships of wind turbine owners who pool their capital investment in local wind turbines. In 1999, 50% of Denmark's 3,200 turbines were owned jointly by 67,000 guild members, bringing significant economic benefit to Denmark's rural areas. The other 50% were individually owned.

The presence of related industries in the wind cluster has always represented one of the main drivers to success for the Danish wind turbine industry. This is true as coordination and cooperation among different industries provide a wide range of supply differentiation; a spread out of knowledge and technology and the possibility for the firms, operating within one industry, to learn and evolve in new and more competitive ways.

IV. TRAJECTORIES AND PROJECTIONS FOR THE GLOBAL WIND INDUSTRY AND THE DANISH WIND CLUSTER

The first part of this study concerns the shifts and the transformations that are likely to happen in the productive system of the Danish wind cluster in the near future. the wind industry has been

identified with a Danish affair for many years. There are two reasons behind this tendentially closed structure. In first place, the development of the industry has always been strongly linked and connected with the subsides and the government support. The second reason concerns the global economic trends of the wind industry over the past four decades.

In the last 7-8 years the wind industry has experienced a world-wide, vast increase in terms of overall output. Now wind has turned into a real industry. Especially after the financial crisis, people have started to see into the wind industry a promising market. So we have three main drivers that drives the change in the cluster: globalization, innovation and industrialization. The entrance in the industry of huge competitors has inevitably pushed the cost levels down. Comparing with the original, typical Danish wind cluster actors, new companies such as the Chinese Sinovel and Goldwind, or the Indian Suzlon, have a totally different, more pragmatic idea of how to make business within a globalized environment. The main reason is that these new actors have just one aim when it comes to commercialize a product: make money, notwithstanding the quality levels. Therefore, globalization into the wind industry has determined the emergence of two different strategies. The former sees the late comer, global actors strongly challenging the industrial pioneers on prices and low cost turbine production; the latter, undertaken by the wind industry pioneers, that focuses more on vast R&D expenditure and protecting clauses in order to hold their technological advantage safe.

Concerning the R&D system, there is a one of a particular that seems to affect the effectiveness of the Danish wind cluster and challenge one of the fundamental theoretical standpoints of the cluster theory. In the Danish wind cluster, as it has mentioned, non-disclosure and secrecy clauses seem to hamper the spreading and the leakages of both technology and competitive information. It is theoretically possible to divide spillovers into external and internal. In turn, the internal spillover can be categorized into direct and indirect. While indirect spillover seems to work perfectly in the Danish clustered configuration, the direct ones are strongly hindered by the non-disclosure policies of most of the what have been called “pioneer” companies all along this thesis.

However, it is difficult to analyze such a delicate topic without considering all the points of view. It is clear that small and medium firms, such as Eltronics and global competitors, such as Suzlon, perceive non-disclosure clauses and market obstacles as inefficient impediments to a real and effective competition within the cluster. As Mr. Degermann says: “*There is no much institutional spillover because you have to deal with disclosure agreements. It is difficult to share knowledge also in Århus. We make an agreement when we make a project and we are not allowed to share it*

with anyone else. This is very common in the wind industry for the wind industry for the moment therefore, it is very difficult to share knowledge outside the company so we need to do it from the inside. But again we need to be careful. That is why I think the in the industry is a little limited". The same goes for Suzlon.

However, there several reasons that is impossible not to mention in such a globalized industry like wind turbines. It could be harsh and perhaps politically incorrect to say but hinders to the spread and spillovers of technology, knowledge and information are vital to maintain the industrial technological standard at a high rate. In brief, non-disclosure agreements exist and somehow they enhance the technological advantage of the "pioneer" companies. However, thanks to the clustered configuration of the industry and the presence of wide indirect spillovers, they do not affect the cluster in such a way to hamper completely the information and technological flows. From this studies, I have found out that the Danish wind cluster will still remain the industrial élite center where research and even more development will reach the utmost in terms of effectiveness and technology. Indeed, it is in Denmark that the new frontiers of the wind industry have been experimented. Therefore, within the wind industry, the technological focus is shifting away from the mere productive process and moving towards new and innovative horizons that are connected with interesting and demanding challenges related to the consumption and the usage of wind energy. Overall, from the interviews, it appears rather clear that Denmark will keep on being on the front line of the technological research within the wind industry.

Finally, as far it concern the financing system, all over 1990s the feed-in tariffs for wind energy were about 85% of the consumer price of electricity (around 0.03 and 0.05 €/KWh, depending by wind fluctuation). Moreover, independent electricity suppliers could get reimbursed from the payment of the carbon tax for another 0.036 €/KWh. To give a precise idea of these specific numbers it is enough to say that a producer, whose turbine was operating in a poorly windy geographic area and therefore enjoying the lowest possible feed-in tariff, was averagely earning around 0.08 €/KWh - i.e., almost 0.05 €/KWh more than the global average of 0.0325 € a year.

This decrease in terms of State incentive to the onshore wind industry has also been confirmed by many turbine producers. No wind turbine supplier have any kind of government subsides nowadays and the facilities producing electricity have seen their privileges and incentives being cut back all over the 2000s - namely when the wind energy started to become a relatively marketable and competitive product. C*luster in Denmark has been shaped by the subsidy policy. It gave the industry a major boost and it gave us the competitiveness of developing a product before going*

*abroad. Now we don't get any subsides while in the old days from 1 to 12KW you get like 0.6DKK [*0.08 €/KWh*] and so on. It rendered the investments a good practice. Today the subsides are mainly in the offshore sector. From the government there has been a policy of picking the winner and it worked quite good because it gave a stable industry and it boosted the industry before going abroad.*"

In 1998 Denmark spent 75 million € in the wind industry creating a strong fiscal pressure on the national balance sheet and the Danish citizens who pays one of the highest electricity bill in the world. This was the main reason that lead the Government to reform the feed-in tariff system. The attempt to introduce a market-based incentive mechanism - the green certificate - showed a new necessity to incentivize the wind energy market not through direct incentives but through mechanism of auto adjustment of the market without burdening the citizens with new taxes.

The main reason why Denmark is not giving up this complex and expensive system is strongly linked with the evolution of the international market for electricity. Denmark is particularly attentive to maintain its competitive advantage in terms of technology and renewable source of energies for electricity against its main competitors. All the other Scandinavian countries introduced elements of competitions in the late period. Therefore, the Reform of 2003 was not simply an economic tool trying to sort out the main systemic inefficiencies of green certificates or to lower the amount of feed-in tariffs. Indeed, the Reform was a political step as well. The Danish Energy Agency and the Danish Parliament have opted for an opening and market based electricity production and distribution system but without revolutionizing what has been a winning model for more than 4 decades. The 2003 Reform for Denmark's energetic system has taken into account ambitious economic and political goals aiming to transform a State-incentive-based system in a market-competitive one revising the Danish historical development path. Focusing more specifically on the wind industry, the commercialization of the "wind product" seems to be direct proportional with the softening of the State intervention inside the cluster.