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Radikha Perrot and Sergey Filippov**

United Nations University – Maastricht Economic and social Research and training centre on Innovation and Technology
Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499, email: info@merit.unu.edu, URL: <http://www.merit.unu.edu>

Localisation Strategies of Firms in Wind Energy Technology Development

Radhika Perrot¹

Sergey Filippov²

¹ UNU-MERIT, Maastricht, The Netherlands. E-mail: radhika.perrot@gmail.com

² Delft University of Technology, The Netherlands. E-mail: s.filippov@tudelft.nl

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Abstract

The paper looks at the localisation strategies of multinational companies in wind energy sector in the emerging countries of China and India. It seeks to explain why western multinationals are localising new manufacturing and R&D facilities in emerging economies such as China and India, and how local knowledge and capabilities are being increasingly integrated into global technology and manufacturing networks of multinationals. It explores the reasons behind the localisation of multinational companies that helps them gain strategic access to wind energy technological capabilities in emerging economies. It examines the case of the company Vestas in expanding wind energy cluster of Tianjin in China and Chennai in India. At the strategic level, it explains the importance of the role of local capabilities and skills in the global production networks of multinationals. At the policy level, the discussions leading from the case focuses on the concrete steps necessary to integrate technology and innovation more closely into development of sustainable energy markets in developing countries.

Key words: renewables, multinational companies, emerging economies

JEL codes: F23, L72, O32, Q20, Q42

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1. Introduction

Renewable energy has emerged as one of the key societal and economic topics recently. Globally, investments in renewable energy and energy efficiency have been increasing rapidly. It has grown from \$33.4 billion in 2004 to \$148.4 billion in 2007, nearly quintupling over this period and increasing by 60 percent in 2006. Strong growth in 2007 was driven mainly by government policies to promote renewable energy and cleaner fuels, the \$100 per barrel price of oil, and rising firm and investor awareness of the opportunities in clean energy (New Energy Finance, 2009). This growth continues through 2010.

Clean energy has received a central role in policies of advanced economies. Similarly, emerging economies (such as China and India) have shown remarkable progress in the development of wind and solar energy technologies too. In 2008, the global new wind energy capacity stood at 27GW, and of which India contributed 6.7% while China contributed 23.3% (GWEC, 2008). In terms of installed capacity, China doubled its capacity over 2007 by adding about 6.3 GW to reach a new total of 12.2 GW in 2008. Researchers with the Pew Charitable Trusts calculate that China invested \$34.6bn in clean energy over the year 2009, almost double the US figure (Black, 2010).

China's government has taken a strategic decision to diversify its energy supply and set a target of having 30GW of installed renewable capacity in place by 2020. This target will soon be exceeded through wind energy alone (Black, 2010). The World Bank is also active in the Chinese market, working together with the Chinese government on a Wind Turbine Technology Transfer Program.

The growing wind power market in China has also encouraged domestic production of wind turbines and components, and the Chinese manufacturing industry is becoming increasingly mature, stretching over the whole supply chain. According to the Chinese Renewable Energy Industry Association (CREIA), the supply is starting to not only satisfy domestic demand, but also meet international needs, especially for components (GWEC, 2008). By 2007, China had the largest wind turbine manufacturing industry in the world, with more than 40 wind-component manufacturers including local firms like Goldwind, Sinovel Wind, Dongfang, Windey and Sewind. China is currently home to two top-10 global manufacturers, viz., Sinovel and Goldwind. And India added 1,800 MW of wind energy capacity added in 2008, bringing the total up to 9.6 GW. India is home to Suzlon, one of the top-10 wind turbine manufacturers in the world.

Government policies to promote renewable and clean energy were partly directed by international framework conditions like the Kyoto Protocol that made it mandatory for developed countries to reduce their green house gaseous (GHG) emissions. One such mechanism is the clean development mechanism (CDM), which encourages firms in developed countries to initiate GHG reduction projects in developing countries, while allowing them to gain emission reduction credits in their home country. Such projects are supposed to transfer low carbon and emission reduction technologies like wind and solar technologies to developing countries. CDM is commonly seen as a promising channel for sourcing and diffusion of modern clean technologies in developing countries and in this way putting them in a carbon friendly growth trajectory (Grubb et al., 1999; Jepma and Van der Gaast, 1999; Aslam, 2001). But CDM mechanisms are still rife with issues such as bogus offsets, double counting and issues around what can be defined as additionality. Technology transfer and technology commercialisation aren't central to the goals of the CDM (Franklin, 2009), and which

makes it sometimes doubtful as the sole source of low carbon technology transfer to developing countries.

Fortunately however, there are other forces, both market and policy, offering developing countries a unique opportunity of technological leapfrogging – where technical know-how and resources in renewable energy technologies of the developed countries are facilitating work opportunities and bridging the technical know-how gap of developing countries in low carbon technologies. More and more renewable energy firms are locating their research and development (R&D) and manufacturing facilities in countries like India and China. Technology manufacturing and R&D localisation strategies of foreign firms will be an important component of any technological leapfrogging strategy to achieve lower greenhouse gas emissions in the developing world. For example, the world's largest wind turbine manufacturer of Denmark, Vestas, is setting up research and manufacturing operations in India and China. Although the products are predominantly designed for the specificities of the local market, strategically these production facilities are expected to be utilised as a global manufacturing set-up (Vestas, 2006).

In the subsequent years, we expect to see fundamental changes in the location of wind turbine and solar PV manufacturing and R&D base away from Europe, and to emerging economies. Of particular importance will be a massive geographic dispersion of wind and solar PV manufacturing and R&D facilities in leading Asian countries, primarily China and India, and (silicon) solar PV manufacturing in Taiwan. For instance, Taiwan is emerging as a new primary location for the global solar PV industry, because of its existing manufacturing base in semiconductors and chip design, which is similar in requirements to solar PV modules manufacturing.

The dispersion of renewable energy technology manufacturing and R&D to China and India is quite different from the causes of geographical dispersion of chip manufacturing to China and Taiwan two decades ago. Other than factor price and factor endowment costs put forth by trade theorists, the real cause of the dispersion in chip manufacturing came out from being able to outsource different stages of the IC design to Asian firms, as a result of new developments in chip design (Ernst, 2004). And following the success of Taiwan in semiconductors, the country has now been playing host to solar PV manufacturing with great ease since 2000s, because of an overlap of technological capabilities in the two industries: the basic integrated chip design that uses silicon is used in solar photovoltaic development.

A corollary explanation of the location of R&D and manufacturing base in developing countries is the general trend of internationalisation of corporate R&D. R&D is the least internationalisation function of multinational companies, and it has traditionally been kept in the headquarters. Modern multinationals locate their R&D subsidiaries overseas. This trend started in the Triad countries, but it is increasingly involving emerging economies. Previously considered only as locations for low-cost manufacturing, emerging economies are turning to prospective destinations for knowledge-based activities of multinational companies. More specifically, emerging economies, particularly China and India, are attracting R&D investment projects of multinational companies operating in renewable energy technology development.

This reasoning defines the objective of this paper, which is to explore the main drivers and motives of the major renewable energy multinationals to move their renewable energy technology

development and manufacturing base to emerging economies. We employ a qualitative approach and present case studies of business strategies of multinational companies.

2. Literature Review and Context Setting

This section presents a review of literature relevant for the study of our analysis. We start with the examination of the stream of literature addressing the reasons behind corporate R&D internationalisation, which in our understanding have push and pull factors. Further, we focus on the development of renewable energy technology and the role of multinational companies therein.

2.1 R&D internationalisation and competences of multinationals

Push Factors

The academic and policy-oriented literature on multinational companies and foreign direct investment (FDI) has a long history. First publications emerged in late 1950s-1960s, following the birth and growth modern multinationals. John Dunning combined many of these contributions in his eclectic paradigm, or OLI model for analysing internationalisation patterns and the strategic behaviour of multinational companies. Dunning's (1977) eclectic paradigm became a prime framework for academic research on multinationals. According to the eclectic paradigm, a firm must possess three advantages in order to internationalise: (1) Ownership Advantage: a firm must own or control unique mobile asset it wishes to exploit, (2) Location Advantage: a firm must be cost efficient to exploit its unique asset overseas in addition or instead of its home country, (3) Internalisation Advantage: it must be in firm's interest to control the asset itself rather the contracting out the use of the asset to an independent firm.

In 1993, Dunning expanded the application of the eclectic paradigm to classify four types of FDI according to a multinational's motivations to invest abroad. They are: (1) resource-seeking (seeking natural resources); (2) market-seeking (horizontal FDI, seeking new markets); (3) efficiency-seeking (vertical FDI, seeking to restructure existing production through rationalisation and places some parts of the value chain overseas); and (4) strategic assets seeking (seeking created assets).

As traditionally understood, internationalisation implies international manufacturing of goods and internationalisation of supporting services (e.g. marketing and sales). Until recently, the technological capabilities of multinationals were far less globalised than these activities. However, the end of the 20th century witnessed increasing tempo of the internationalisation of corporate R&D. Conducting corporate R&D in foreign locations (overseas subsidiaries) relates to the strategic-asset-seeking FDI and the location advantage. A multinational company seeks to exploit its overseas location in order to enhance its competence base.

Internationalisation of R&D is not an entirely new phenomenon. Many foreign subsidiaries of multinational companies had long had R&D functions. The fundamental difference lies in the nature of R&D. Traditionally R&D in subsidiaries was aimed at adapting products and services to the needs of host countries and to local conditions close to "lead users"; i.e. R&D activities were performed to support local manufacturing overseas. Today, multinationals seek not only to exploit their

knowledge and competence generated at home in foreign countries, they increasingly sources technology internationally and tap into worldwide centres of knowledge.

Intensified global competition has forced companies to innovate and develop commercially viable products and services faster. At the same time, the needed knowledge has become more multidisciplinary and more broadly located, making innovation even more expensive and riskier than ever. Hence, innovation strategies increasingly depend on global sourcing. It has become a major motive for locating R&D outside the home country.

Cantwell and Mudambi (2005) make a distinction between the competence-creating versus competence-exploiting subsidiary mandates. A competence-exploiting subsidiary is involved in adaptation of the knowledge and technology for local needs and it essentially imply a one-way technology transfer from headquarters to the subsidiary in question. A competence-creating subsidiary generates competence and expertise, tapping into a local knowledge base, and this competence is then channelled to the entire corporate network (headquarters and sister-subsidiaries). Kuemmerle (1999) expresses the same idea, but specifically arguing about R&D investments rather than competence base. The author distinguishes between home-base exploiting and home-base augmenting investments.

Echoing the idea of competence-creating subsidiaries, Birkinshaw (1998), Holm and Pedersen (2000), Frost et al (2002) and other authors introduce the idea of subsidiaries as centres of excellence, in contrast to subsidiaries inferior to others in a corporate network. Centres of excellences are responsible for complete development of certain products and services; possess superior competence and share this competence with other unites in its multinational company.

To sum up, the role of overseas subsidiaries in creation of competence and performing R&D has taken a prominent role in the international business literature.

2.2 Development of renewable energy technology in emerging economies

Pull Factors

A recent study by Deloitte (2006) highlight attractiveness of emerging economies for corporate R&D. It observes that almost two-thirds of the companies surveyed with US\$1 billion or more in annual revenues that sell in emerging markets have also located R&D facilities there. The explanation of this phenomenon is that “many manufacturers are now locating research and development (“R&D”) facilities in emerging markets not only to reduce the costs of product development, through lower wages as well as tax credits and other government incentives, but just as importantly, to better incorporate local needs and expertise into product design” (Deloitte, 2006: 4).

Likewise, in the wind energy sector, the location of R&D and manufacturing in the emerging economies of China and India are not only based on the strategic decisions of firms to move to low-cost advantages. The location also has to do with the existing knowledge, technology and manufacturing base of the host country. High international transfers of low carbon and clean energy technologies are related to strong technology capabilities of China, while the lower rate of international transfer in the case of India is due to its own capability to diffuse domestic technologies (Dechezleprêtre *et al.*, 2008). In either case of international technology transfer,

whether high or low in new and emerging energy technologies, the essence is in having an existing knowledge and manufacturing base in renewable energy technologies. It has been reiterated by OECD (2009) that technology diffusion from foreign multinational companies to local firms through trade or investment cannot be taken for granted. Rather, it requires absorptive capacity of local firms, and skills and mobility of local employees, in addition to openness to trade and policies to induce foreign investors to bring appropriate technology to developing countries (OECD, 2009).

There are policy advantages in China and India that have helped built their local manufacturing and knowledge and skills base. Policy measures are what governments have at their disposal to encourage localisation of manufacturing (Lewis and Wiser, 2007). China has a local content requirement that mandates a certain percentage of local content for wind turbine manufacturing in some or all projects within the country. But the success of a local content policy requires a large market size in order to lure foreign firms to undertake the significant investments required in local manufacturing (Lewis and Wiser, 2007). China has sufficient market potential to attract foreign investments particularly competence-creating multinationals. The Chinese government has begun refunding value-added tax (VAT) and import duties on core wind power turbine parts and materials in a move to promote the development of renewable energy (People's Daily, 2008).

The policy has been reasonably successful, and China has attracted a number of foreign wind turbine manufacturers, as well as enabled establishment and growth of domestic firms in the sector (Table 1). Foreign subsidiaries rely primarily on the technological base of their parent companies, and the local competences too. China's major local firms in the sector use foreign companies as their technological source.

Table 1 Major Wind Turbine Manufacturers in China

Manufacturer	Ownership	Technological Source
Goldwind	Local	RE Power and Vensys Germany
Dongfang	Local	RE Power Germany
Sinovel Windtech	Local	Fuhrlander Germany, Windtec Austria
Zhejiang Windey Wind	Local	RE Power Germany
Baoding Huide Wind	Local	Fuhrlander Germany
Beijing Beizhong	Local	EU Group DeWind UK
Shanghai Electric Group	Local	EU Group DeWind UK
Nordex	Foreign	Nordex Denmark
Hunan Hara XEMC Wind	Local	Lagerway Netherlands, Harakosan Japan
Nantong CASCWanyuan	Local	Acciona Spain
RE Power	Foreign	RE Power Germany
Vestas	Foreign	Vestas Denmark
Gamesa	Foreign	Gamesa Spain
GE Energy	Foreign	GE USA
Suzlon	Foreign	Suzlon India

Source: Greenpeace, 2007

Lewis and Wiser (2007) claim that wind turbine manufacturers usually get their head start in their home country markets, a trend that is clear in the largest markets of Denmark, Germany, US, Spain and India. Firms like Vestas (Denmark), Suzlon (India) and Enercon (Germany) that are the world's largest turbine manufacturers have had large and stable home markets. The same is true of solar PV manufacturing, where stable markets in Japan and India have led to the global success of Sharp (Japan), Konarka (Japan) and Moser Baer (India) and BP-Tata Solar (India). A stable and sizable home market can provide local manufacturers with the necessary testing ground to sort out their technology and manufacturing strategies and experiment with technology designs (Lewis and Wiser, 2007). Once equipped with years of experience and technological know-how of building wind turbines and solar photovoltaic modules in the home market, firms are moving-out their R&D and manufacturing base to the emerging economies of China and India.

India, on the other hand, does not have a local content requirement mandate, but has an industrial regulatory environment requiring 51 percent, more or less, domestic equity ownership in virtually all

industries¹. This mandate is to give domestic firms access to new product and process technologies of the MNCs, and to facilitate the use of local content and skills in the development of the technology by multinational companies (Feinberg and Majumdar, 2001). By 2009, the Indian government allowed 100% FDI in the renewable energy sector and approved a generation-based incentive scheme in wind power projects for foreign investors who cannot avail benefits of accelerated depreciation available to domestic investors (Times of India, 2009). And in addition to which, India has sufficient renewable energy market potential, skills and an existing manufacturing base to attract foreign investors and undertake wind and solar energy volumes manufacturing. List of major wind turbine manufacturers in India is presented in Table 2

Table 2 Major Wind Turbine Manufacturers in India

Manufacturer	Ownership	Technological Source
Leitner Shriram	Local	Leitwind Netherlands
Pioneer	Local	None
Global Wind	Local	Norwin Denmark
Enercon	Foreign	Enercon Germany
Regen Powertech	Local	Vensys Energy Germany
RRB Energy	Local	Vestas Denmark
Siva Windturbine	Local	Wind Technik Nord, Germany
Southern Wind Farms	Local	None
Suzlon Energy	Local	Suzlon Energy Germany
Vestas Wind	Foreign	Vestas Denmark
WinWind Power	Local	WinWind Oy Finland
Elecon Engineering	Local	Turbowind Belgium
India Windpower	Local	None
Kenersys India	Foreign	Kenersys Germany

Source: The above is list compiled from the Centre for Wind Energy Technology (C-WET), India, detailing the models and manufacturers of Wind Electric Generators and Wind Turbine Equipments, published on 18 May 2010. The C-WET information is also published in www.windpowerindia.com under list of wind energy manufacturers in India.

¹ Foreign ownership of equity over and above 50% is subject to the requirement that the investors should balance all outgoings of foreign exchange on account of their operations with export earnings over a seven-year period (See Balasubramanyam and Mahabare, 2003)

3. Analytical Model

Based on the discussions above, an analytical model is constructed from the *push* and *pulls* factors that are behind the localisation strategies of companies in emerging economies. The *push* factors are those of stagnating markets at home that are encouraging host-firms, with their technological capabilities and experience in the home-market, to enter new and emerging markets. One of the conditions for the host firm entry into such markets is that the emerging market must have sizable market potential (Lewis and Wiser, 2007), which acts as a *pull* factor, luring the host-firm to set-up base in the emerging market.

In many instances, products and ideas have been designed to suit the local needs of the users of the technology or markets because they have a substantial market size. This is because user-initiated innovation is seen to be of great importance (OECD, 1999). Local users were recognised as best suited to understand the needs and possibilities of innovation (von Hippel, 1988; OECD, 1999). These products are technologically and cost-wise more suitable to the location needs than to the needs of other countries, particular the host-countries. Often in most cases, the technology and knowledge base of the multinational company is used to adapt their know-how to suit the local conditions.

The other condition alluring multinational companies to the new and emerging country is explained by the agglomeration theory of clusters. This category of agglomeration economies, which is typical for knowledge clusters, often attracts direct investments from outside (Lorenzen and Mahnke (2002). Multinational companies enter particular knowledge clusters in order to benefit from the agglomeration economies that they facilitate (Porter, 1990, 1998; Saxanian, 1994; Krugman, 1991; Frost, 2001). Such knowledge clusters are often sources of skills and knowledge-bases critical to the growth of multinational companies in the regional cluster (Saxanian, 1990; 1994). Within the knowledge cluster, multinational companies often want access to a whole group of suppliers or customers, and to knowledge institutions which are not owned by any particular firm (Lorenzen and Mahnke, 2002).

Many western multinational companies have established R&D units in emerging economies that are expected to contribute to the global R&D networks of respective companies. In fact, Kuemmerle (1998; 1999) and Patel & Vega (1999) have shown that multinational companies increasingly place such small-scale R&D units in knowledge clusters to augment the multinational companies' knowledge bases through monitoring regional knowledge bases. Frost (2001) has found that such local knowledge sources are particularly important for explorative innovation. Saxenian (1990); Almeida and Kogut (1999); and Patibandla (1998) have illustrated this for high-technology industries.

The renewable energy market like wind and solar, characteristic of high cost of implementation and low performance, are dependent on policies including production incentives and local subsidies and tax benefits. The local content requirement of Chinese wind development policies (Lewis and Wiser, 2007), and the requirement of local firms in the equity partnership of foreign firms are policies that are attracting multinational companies.

4. Case Examples of Localisation Strategies

Vestas is a multinational wind turbine manufacturer headquartered in Denmark. It has been specialising in wind turbines since 1975. Today, it is the world's largest wind turbine manufacturer, having grown mostly out of its thriving home wind energy market, building a strong technology and knowledge base, and adding up more than 30 years of experience in wind turbine manufacturing. But by 2009, Denmark had sourced nearly 80% of its electricity from renewable energy, most of which came from wind power. As its home market was stagnating, Vestas laid off 1900 employees from its office in Denmark in December 2009, whereas it increased its production capacities in the growing wind energy markets of the emerging economies of India and China. India and China are Vestas' two manufacturing and R&D locations outside of Europe, Singapore and the United States. Vestas is a good representative examples of a western multinational company in the wind turbine manufacturing sector, and currently expanding its presence in emerging economies.

4.1 Vestas in China

Vestas was the first wind turbine company to enter the Chinese market when it installed the first turbines in Shandong and Hainan in 1986. By 2009, it had 10% of the domestic market share, and had installed wind turbines in thirteen provinces of China, making it among the biggest accumulated supplier of wind turbines in China. The company has been building a strong value chain in China sourcing components from 80-odd local suppliers. It continually improves its sourcing capabilities, with the aim of finally having a 100 per cent Chinese-made content. Although some forty Chinese manufacturers have roughly three-quarters of the domestic wind turbine market, foreign firms like Vestas are trying to break in by capitalising on better technologies such as advanced blade designs and other components.

In 2009, Vestas for the first-time customized a turbine for a single, specific and low wind resource market. It developed a new V60-850 kW wind turbine design specifically tailored for China, particularly the region of Inner Mongolia. This new design has blade designs and temperature control systems that are adapted to the tough winters of Inner Mongolia. The turbine is most effective in low and medium winds, which make up 75 percent of China's unutilised onshore wind potential (Ritch, 2009). Over 90 percent of the new turbine machine's components are Chinese-made.

Previous to that, all wind turbines built in China were above 2MW of capacity. Over the years, Vestas has been building a strong manufacturing capacity in China. It built five production facilities in Tianjin and one wind turbine factory for the Chinese market in Hohhot, Mongolia. It built its first nacelle and assembly factory in Tianjin in 2007, where its main activity is to assemble nacelles and hubs for the Vestas' MW turbines, including the 2MW and 850 kW wind turbines. It also built a generator, control systems and blades production facilities in Tianjin. In 2009, the new production capabilities at the Tianjin facility included the production of control systems and machined parts, which has been added to existing generator and blades factories. This now makes the facility the most comprehensive and largest integrated wind energy complex built by Vestas, allowing the manufacture of nacelles, blades, generators, control systems and machined parts, in one centralised facility.

Tianjin: The emerging wind energy industrial cluster

The above new facilities are the ‘localisation’ of production chains of Vestas in China, for both the needs of the Chinese and the global wind market. The Tianjin location has been chosen because of “its good access to port, rail and major roads in China” (Renewable Energy Today, 2006). And Tianjin is China’s growing wind energy industrial cluster, which is home to 850 wind-power manufacturers and suppliers, including domestic and international giants such as Vestas, Gamesa and Suzlon. Tianjin boasts of an annual capacity of 5,600 MW of turbines, 14,000 wind turbine blades that can equip 4,900 three-blade turbines, more than 5,400 gear boxes, 1,500 engines, 3,200 control systems, 55,000 tons of resin and other materials for blade production (Enorth, 2009).

Vestas’ localization strategy in China is creating a global wind energy production chain, in components and fully integrated production facilities, for both local and global markets.

Table 3 Vestas’ network of subsidiaries in China

Production Type	Location	Est. Year
Blades	Tianjin	2006
Nacelles	Tianjin	2006
Generators	Tianjin	2006
Foundry	Xuzhou	2008
Machine and Controls	Tianjin	2008
Integrated Wind Turbine Factory	Tianjin	2009
Wind turbine Factory	Hohhot Inner Mongolia	2009

Vestas is creating a production value chain partnering with 80-odd local suppliers of components for its wind turbines. The new focus of the company is Inner Mongolia where it produces the V60-850kW turbine, which is the first market-specific turbine, designed to optimise performance and production in Chinese harsh weather conditions.

Vestas’ competitor and another multinational wind turbine manufacturer, Siemens, set up a new wind turbine manufacturing facility in China in 2009, and which also marked its entry into the Chinese wind energy industry. The wind turbines manufactured are for the Chinese market, as well as for exports. Although this is interesting as a localisation strategy of multinationals, a comprehensive analysis is beyond the scope of this paper.

4.2 Vestas in India

In 1987, Dandia, the Danish financial aid agency, selected Vestas to develop six wind energy projects in India. Soon Vestas entered into a 49% equity joint venture agreement with RRB Consultants and Engineers Pvt. Ltd., to manufacture wind energy generators in India. Although the technology for wind energy generators was from Denmark, they were manufactured to suit the Indian climatic conditions. Vestas RRB had been technologically indigenising components manufacturing such as blades and control systems. As a result of its localisation strategy, the company was able to achieve a 10-15 per cent cost reduction in blades manufacturing, cost-savings in terms of time and transportation, and closing the lead-time in getting the blades to the market (The Hindu, 2005).

In 2003, and back home, Vestas merged with NEG Micon, the other leading Danish wind turbine manufacturer of the time. So by 2006, Vestas strategically re-positioned itself in India and divested its 49% equity stake to RRB Consultants and Engineers, on condition that RRB only manufactures wind turbines for the market below 750kW capacity, and for which, Vestas will continue to cooperate as its technology partner. It renamed its now wholly owned subsidiary, NEG Micon India to Vestas Wind Technology India Pvt. Ltd., and began concentrating on turbines of 750kW and above in capacity.

Around that time, Vestas saw a major shift in the demand for high capacity wind turbines in the Asia-Pacific region, and made its Indian facility the manufacturing and export base for wind turbines above 750 kW. It built two manufacturing setups – one in Chennai which caters to the export market for components like hubs and nacelles and the other factory in Pondicherry which caters to the domestic market.

In 2008, Vestas started a R&D technology centre in Chennai, India, which is one of its key markets. The primary objective behind the R&D initiative is to improve turbine reliability, maximise performance and lower the cost of wind energy, and which contributes to R&D in almost all core wind technology areas. In fact, the primary driver for setting up the R&D office was not only cost, although costs were lower than in Europe and Singapore, but to gain access to local skills and talents (Hindu Business Line, 2008). Chennai is the centre for reputed and high quality engineering graduates particularly from the elite Indian Institute of Technology (IIT-Chennai).

Table 4 Vestas' network of subsidiaries in India

Production Type	Location	Description
Hubs and nacelles	Chennai	Assembly process consists of incoming inspection, sub-assembly, main assembly and final testing. The components are supplied by Vestas' own factories and vendors, and which they sell in international markets.
R&D centre	Chennai	The results of this research centre is incorporated into the main global R&D network
Hubs and nacelles	Pondicherry	Assembly for the domestic products

5 Analysis and Conclusions

Emerging markets are becoming increasingly important for western multinational companies. The companies discover new spots on their emerging markets' innovation landscape and existing strategies are redefined. With the rise of emerging multinationals, western multinational companies begin to feel competition at their home bases too. Success in this competitive battle will depend on innovation both in their home bases – advanced economies, but also in emerging markets. In other words, the world is witnessing the increased use of inventors located in emerging economies by western multinational companies as inputs into the creation of intellectual property which is used in advanced markets. So far the production of new knowledge has been dominated by inventors in the Triad; presently inventors in emerging economies, especially China and India, are making an increasing contribution.

Soete (2009) argues that if the recent trends in R&D continue then 'in 2025, the United States and Europe will have lost their scientific and technological supremacy for the benefit of Asia'. This assessment is consistent with the investment attractiveness of the world's regions. A 2010 report by Ernst & Young, based on a survey of world business leaders, states that 'Western Europe's appeal as the most attractive destination for FDI collapsed from 68% of votes in 2006 to 38% in 2010'. At the same time, China became the most attractive location for FDI in 2010 and together China, India and Eastern Europe are perceived as the most attractive regions for FDI over the next three years (Ernst and Young, 2010).

A recently published report on 'Wind Power: Opportunities in Emerging Markets' (RNCOS, 2010) maintains that emerging countries are faced with increasing power demand due to three main reasons. Firstly, most of the emerging economies are preferred destinations for industrial and manufacturing plant set up by developed countries and hence are in the need to electricity. Secondly, development of power grid connectivity has boosted up the power consumption. Thirdly, increasing population has fuelled the power requirement in these economies. And because rising fossil fuel prices may become prohibitive, these countries are adding renewable sources of energy into their power mix. In this respect, wind power represents the best choice to feed their growing energy demand. It is relatively low cost than other renewable sources and is a cleaner source of energy. Wind is to become a highly competitive source for power generation.

These developments go in parallel with localisation strategies of multinational companies and consistent with the insights from academic literature. In our literature review (summarised in the analytical framework) we identified a number of *push* and *pulls* factors that are behind the localisation strategies of firms in the wind energy technology development. The case studies exemplified these factors. As a typical western multinational company, Vestas is confronting with stagnating market at its home base, serving as a main push factor. At the same time, Vestas sees new opportunities opening up in emerging economies like India and China, offering dynamic market (a pull market-seeking motive).

Table 5 presents the summary of case studies and its relation to the analytical model. This model combines a set of push and pull factors explaining internationalisation and localisation strategies of firms in wind energy technology development.

Table 5 Analysis of case studies

	Push factors	Pull factors
Analytical model	<ul style="list-style-type: none"> – Stagnating markets at home that are encouraging companies of advanced western markets, with their technological capabilities and experience in the home market, to enter dynamic emerging markets. – Global competition, pressure to establish presence in emerging economies, and first mover advantage 	<ul style="list-style-type: none"> – Low-cost location – Existing (unique, specific) knowledge, technology and manufacturing base of the host country – Presence of knowledge clusters – Policy support by the host country (e.g. subsidies and tax benefits)
Vestas in China	<ul style="list-style-type: none"> – Stagnating market at home (Denmark), offering expertise and technological excellence. – A first-mover advantage in new markets 	<ul style="list-style-type: none"> – Prior presence in China – Emerging market of China and product adaptation to local conditions – Attractiveness of the Tianjin industrial cluster – Policy measures of the Chinese government
Vestas in India	<ul style="list-style-type: none"> – Re-definition of the business strategy (global research hubs, merger with NEG Micon, the leading Danish wind turbine manufacturer of the time – A first-mover advantage and a business opportunity to assist Danida in early wind projects 	<ul style="list-style-type: none"> – Changing market situation in the Asia pacific region, higher demand for high capacity wind turbines – Production under local conditions – Policy measures of the Indian Ministry of Non-Conventional Energy Resources (MNRES)

We find that push factors of the analytical model such as stagnating home market and first mover advantage are valid in both cases. In terms of pull factors, aspects such as adaptation to local conditions, local market, knowledge and industrial clusters, and host country policy measures play a crucial role.

As our analysis shows, it is not only the market as such that is attracting western multinationals to the emerging economies. The fact that western multinational companies place their corporate R&D centres there is a sign of asset-seeking motive. Many local subsidiaries established by Vestas in China and India are of competence-creating nature. They develop knowledge and technology, benefiting from local capabilities and skills, and collaboration with either local partners or subsidiaries of other western multinationals, usually being localised in a specialised cluster (the Tianjin emerging wind energy industrial cluster is a good example). Then the knowledge and expertise created in emerging markets are to be used and applied elsewhere in the global corporate network of this multinational.

Cantwell and Mudambi (2005, p.1124) view these subsidiaries as the 'product of a process that has been going on for a decade ... the emergence of global networks for innovation'.

In terms of policy implications, host countries (and specifically emerging economies) need to take more decisive steps in ensuring a sound regulatory framework and better policy environment, better resources mapping and exploration, adapting both institutions and infrastructures to the renewable energy. From the perspective of the home countries, concerns are often raised that international expansion of western multinationals is often proceeds at the expense of their presence at home, specifically in terms of jobs in manufacturing (layoffs of workers at home). The concerns are also raised in the case of R&D internationalisation.

However, the picture is slightly different here. It might be argued about complimentarily of R&D localised in different subsidiaries of a multinational company. Establishing an R&D function at an overseas subsidiary (based in emerging economies) does not by default lead to closure of a home country corporate R&D lab. Internationalisation of corporate R&D is not a zero-sum game. Multinational companies' ability to participate in international innovation networks, which provide diversified knowledge inputs, may strengthen home country innovation systems and enhance their ability to produce innovations.

Overall, the clean energy market is set to experience further growth. Globally, investment has more than doubled in the last five years, and even the recent economic turmoil did not affect it substantially (Black, 2010).

References

- Almeida, P. and Kogut, B. (1999). The localization of knowledge and the mobility of engineers in regional networks. *Management Science* 45(7): 905-18
- Aslam, M.A. (2001). Technology transfer under the CDM: Materializing the myth in the Japanese context? *Climate Policy* 1(4): 451-64
- Balasubramanyam, V.N. and Mahambare, V. (2003). FDI in India, *Transnational Corporations* 12(2): 45-72
- Birkinshaw, J. (1998). Corporate entrepreneurship in network organisations: How subsidiary initiative drives internal market efficiency. *European Management Journal* 16(3): 355-64
- Black, R. (2010). *China steams ahead on clean energy*, BBC News (26 March 2010), available at <http://news.bbc.co.uk/2/mobile/science/nature/8587319.stm>
- Cantwell, J. and Mudambi, R. (2005). MNE competence-creating subsidiary mandates. *Strategic Management Journal* 26(12): 1109-28
- Dechezleprêtre, A., Glachant, M and Ménière, Y. (2009). Technology transfer by CDM projects: A comparison of Brazil, China, India and Mexico. *Energy Policy* 37(2): 703-11
- Deloitte (2006). *Innovation in Emerging Markets*. Strategies for achieving commercial success. Deloitte
- Dunning, J.H. (1977). *Trade, location of economic activity and the MNE: a search for an eclectic approach*. *The international allocation of economic activity*. Proceedings of a Nobel Symposium held at Stockholm. P.H. a P.M. W.B. Olin. London: Macmillan

- Dunning, J.H. (1993). *Multinational enterprises and the global economy*. Wokingham, England: Addison-Wesley
- Enorth (2009). *Wind Power Cluster in Tianjin*, available at www.enorth.com.cn
- Ernst and Young (2010). *Waking up to the new economy: 2010 European attractiveness survey*. Paris: Ernst and Young
- Feinberg, S.E, and Majumdar, S.K. (2001). Technology spillovers from foreign direct investment in the Indian pharmaceutical industry. *Journal of International Business Studies* 32(3): 421-437
- Franklin, R. (2009). The Role of CDM in achieving Technology Commercialisation, *Cleantech Magazine*, January 2009
- Frost, S.T. (2001). The geographic sources of foreign subsidiaries' innovation. *Strategic Management Journal* 22(2): 101-123
- Frost, T., Birkinshaw, J. and Ensign, P. (2002). Centres of excellence in multinational corporations. *Strategic Management Journal* 23(11): 997-1018
- Greenwood, C., Hohler, A. and Hunt, G. (2009). *New Energy Finance*. Paris: UNDP
- Grubb, M., Vrolijk, C. and Brack, D. (1999). *The Kyoto Protocol: A Guide and Assessment*. London: Royal Institute of International Affairs
- Hindu Business Line (2008). *Vestas Opens its 2nd Largest R&D Center in Chennai*, available at www.eksporttilindien.um.dk/en/servicemenu/News/VestasOpensIts2ndLargestRDCentrInChennai.htm
- Holm, U. and Pedersen, T. (2000). *The Emergence and Impact of MNC Centres of Excellence: A Subsidiary Perspective*. London: Macmillan
- Jepma, C. J. and van der Gaast, W. (1999). *On the Compatibility of Flexible Instruments*. Dordrecht: Kluwer
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy* 99(3): 483-99
- Kuemmerle, W. (1998). Strategic interaction, knowledge sourcing and knowledge creation in foreign environments - an analysis of foreign direct investment in R&D by multinational companies, in Hitt, M.A., J.E. Ricarti Costa and R.D. Nixon (eds.). *Managing Strategically in an Interconnected World*. Chichester: Wiley
- Kuemmerle, W. (1999). Foreign direct investment in industrial research in the pharmaceutical and electronics industries – results from a survey of multinational firms. *Research Policy* 28(2-3): 179-93
- Lewis, J.J. and Wiser, R.H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy* 35: 1844-57
- Lorenzen, M., and Mahnke, V. (2002). *Global strategy and the acquisition of local knowledge: How MNCs enter regional knowledge clusters*. Paper presented at the DRUID Summer Conference on 'Industrial Dynamics of the New and Old Economy - who is embracing whom?' Copenhagen/Elsinore 6-8 June 2002
- Patel, P. and Vega, M. (1999). Patterns of internationalisation of corporate technology: Location vs. home country advantages. *Research Policy* 28: 145-55

- Patibandla, M. (1998). Structure, organizational behavior and technical efficiency: The case of an Indian industry. *Journal of Economic Behavior and Organization* 34(3): 419-34
- People's Daily (2008). *China's wind turbine manufacturers to receive tax-rebate*, available at <http://english.people.com.cn>
- Porter, M. (1990). *The Competitive Advantage of Nations*. New York: Free Press
- Porter, M. (1998). Clusters and the new economics of competition, *Harvard Business Review* 76(6): 77–90
- Renewable Energy Today (2006). *Vestas to build nacelles and hubs facility in Tianjin, China*, available at www.accessmylibrary.com
- Ritch, E. (2009). *Vestas launches China-only wind turbine*, Cleantech Group, available at <http://www.cleantech.com>
- RNCOS (2010). *Wind power: opportunities in emerging markets*, available at <http://www.rncos.com/Report/IM158.htm>
- Saxenian, A. (1990). Regional networks and the resurgence of Silicon Valley. *California Management Review* 33(1): 89-111
- Saxenian, A. (1994). *Regional Advantage*, Cambridge, MA: Harvard University Press
- Soete, L. (2009). *Malthus' revenge*, UNU-MERIT working paper 2009-030, Maastricht: UNU-MERIT
- Times of India (2009). *100% FDI in Renewables: Farooq Abdullah*, available at <http://timesofindia.indiatimes.com>
- Vestas (2006). The local press release 15/2006 on 8th December 2006, available at www.vestas.com
- Wind Energy Update (2009). *Vestas opens a facility in Inner Mongolia*, available at <http://social.windenergyupdate.com/news/vestas-opens-facility-inner-mongolia>

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