Technology Transfer in the Wind Power Industry: Experiences from China, India and South Korea[1]

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Abstract

While modern wind power technology originated in Europe and the United States, the newly industrialized countries (NICs) of China, India and South Korea are quickly becoming important players the global wind power industry. This paper explores the strategies used by the domestic wind power technology companies in each of these three countries to develop wind turbine technology to understand how three newly industrialized countries have acquired and assimilated advanced technologies. It finds that the primary technology transfer and acquisition strategies utilized by firms in South Korea, China, and India included licensing arrangements and mergers and acquisitions that resulted in the transfer of technology ownership, and partnerships for the joint development of new technology.

1. Introduction

While modern wind power technology originated in Europe and the United States, the newly industrialized countries (NICs) are quickly becoming the center of the global wind power industry. India, the early emerging economy leader in wind power development, has now been surpassed by China, the largest wind energy market in the world for the year 2009. South Korea is still a relative newcomer to the wind industry, but the recent entry of many large Korean industrial firms makes it well positioned for future growth.

While there are many potential benefits to local wind manufacturing, there are also significant barriers to entry into an industry containing companies that have been manufacturing wind turbines for more than 20 years. In emerging economies, limited indigenous technical capacity and quality control can make entry even more difficult. International technology transfers can be a solution, although leading companies in this industry are unlikely to transfer proprietary information to companies that could become competitors. This is even riskier for technology

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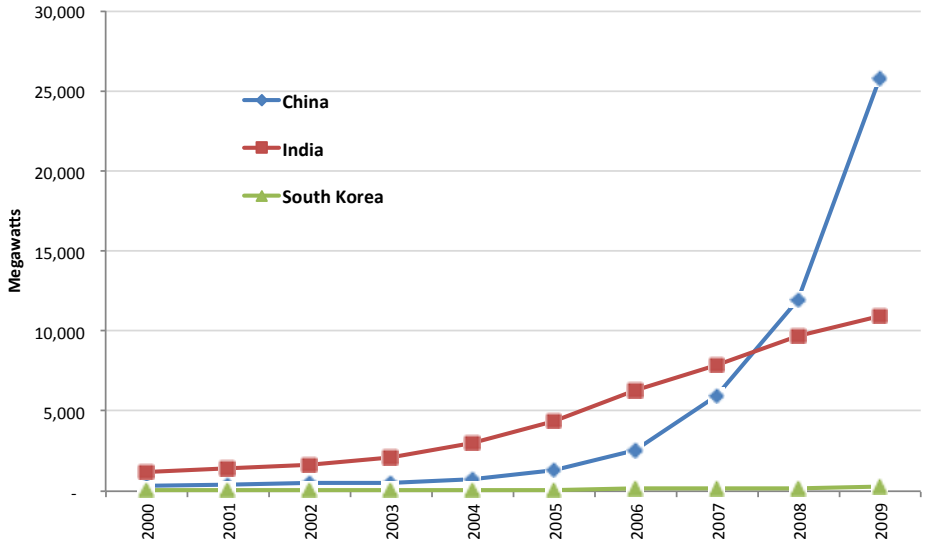
transferred from developed to developing countries, where an identical but cheaper turbine potentially could be manufactured.

Figure 1. Wind Power Development in China, India and South Korea 1990-2009[1]



2. Industrial Strategy in the Newly Industrializing Countries

Countries that were not part of the group of early wind turbine innovators—namely Denmark, The Netherlands, Germany, and the United States—have used different strategies to foster the development of their own domestic large wind turbine manufacturing companies. A common strategy has been to obtain a technology transfer from a company that has already developed advanced wind turbine technology. Technology transfers can occur through different models. One model is through a licensing agreement that gives the licensing firm access to a certain wind turbine model, often with some restrictions on where it can be sold. Another model includes establishing joint-venture partnerships between two companies, either to share a license, or for collaborative research and development (R&D). Firms also can opt to collaborate to jointly develop a new technology design, and then share the associated intellectual property. If a firm has the capacity and means, it can also obtain access to technology through the purchase of ownership rights in a company with the desired technology or other forms of mergers and acquisitions (M&A).

3. Chinese, Indian and Korean Wind Power Industrial Strategies Compared

3.1 Technology Transfers and Acquisition Strategies

Firms in China, Korea and India have used different strategies to acquire or develop wind power technology, with varied results. Although there are several technology transfer models available to a company looking to enter the wind industry, there are many similarities in the

models adopted by wind power technology firms from China, India and South Korea. Three primary models of technology development emerge: licensing, mergers and acquisitions (M&A), and joint development. In addition, there are several common sources of technology information that have worked with firms across these three countries.

Licensing

Several companies began their ventures into the wind industry by setting up licensing agreements, most commonly with small European wind turbine companies. The acquisition of technology from overseas companies is one of the easiest ways for a new wind company to quickly obtain advanced technology and begin manufacturing turbines that may already have been field tested or even have substantial operating experience.

There is a disincentive for leading wind turbine manufacturers to license proprietary information to companies that could become competitors, however, particularly when technology is transferred from developed to developing countries, where a similar technology potentially could be manufactured with less expensive labor and materials. Consequently, developing-country manufacturers often obtain technology from smaller wind power companies that have less to lose in terms of international competition, and more to gain in license fees. The technology obtained from these smaller technology suppliers may not necessarily be inferior to that provided by the larger manufacturing companies, but it likely has been utilized less and therefore has less operation experience. Alternatively, companies may be willing to license outdated models of their technology (often smaller turbine sizes), or to license technology that comes with restrictions on any turbine exports outside of the market in which the home manufacturer is based.

Suzlon of India began its wind turbine manufacturing with a license from German company Südwind. Goldwind similarly began its operations based on licenses from German firms Jacobs and REPower. More recently, Chinese newcomers Sinovel, Dongfang, CSIC and Beijing Beizhong have benefited from licenses acquired from Fuhrländer (Germany), REPower (Germany), Aerodyn (Germany) and DeWind (UK/US). Other Chinese licensing agreements include the licenses that A-Power from Norwin, CSIC from Aerodyn, Beizhong from DeWind, Windey from REPower, and Zhuzhou from Windtec. Korea's Hyundai also obtained a license from AMSC Windtec.

Mergers & Acquisitions (M&A)

As wind companies either become more established, or if they have sufficient financial resources, mergers and acquisition provide another strategy for technology transfers. M&A gives more authority and flexibility to the acquiring company in how it decides to use the technology, unlike a licensing agreement which typically has strings attached. Technology acquisitions through M&A can only be successful if the acquiring company has the ability to integrate the new business

knowledge into their current business. In addition, there can be a significant financial investment involved.

While Suzlon began its operations based on licenses, it later acquired majority ownership of REPower. Goldwind similarly began its operations based on licenses, and later acquired majority ownership of Vensys. In contrast, the large industrial Korean conglomerates Daewoo and STX used M&A to obtain wind turbine technology early on, purchasing American firm DeWind and Dutch firm Harakosan Europe BV respectively. While Goldwind's acquisition of Vensys seems to have resulted in the sharing of knowledge as witnessed through the joint development of new turbine designs, Suzlon's acquisition of REPower has until now been restricted by M&A regulations.

Joint Development

As firms develop their own design and manufacturing expertise, they may be more interested in co-developing wind turbine technology with firms that bring a different set of experience to the partnership. An advantage of joint development is that there is no initial concern about market competition, and when multiple manufacturers are involved, arrangements for the sharing of any resulting IPR are mare prior to the start of the joint work. This arrangement can be more straightforward when joint development involves a firm that primarily focuses on design working with a firm that primarily focuses on manufacturing. The risk with this model, however, is that the design firm has no manufacturing experience and manufacturers have no design experience, and the resulting product may look great on paper but fail in the factory or in the field.

Several Korean firms are pursing the joint development of wind turbine designs, including Hyundai with Avantis, Doosan with Windtec, Samsung with Roman and Garrad Hassan and Hanjin with Idaswind. This form of technology acquisition is also becoming increasingly common in China, particularly among the larger firms. Examples include Sinovel's joint development with AMSC/Windtec Dongfang's joint development with AMSC/Windtec and with Aerodyn, Goldwind's joint development with Vensys (which is also owns), A-Power's joint development with Norwin, and Hewind and Sewind's joint development with Aerodyn.

Global Learning Networks

The extent of the global reach of a firm's innovative activities can also play an important role in its technology development strategy. Of particular note is the difference in strategy pursued by Suzlon and Goldwind in this regard. Many of the differences between the original technology development strategies of the two companies are related to how they opted to position themselves with respect to domestic and global learning networks.[2]

Suzlon established many overseas operations in order to build upon the knowledge gained through its technology licenses even before it had established a substantial market share in its

home market of India. This combination of licensing arrangements with foreign firms and internationally-based R&D and manufacturing facilities, complimented by the hiring of skilled personnel from around the world, created a global learning network for Suzlon that was customized to fill in the gaps in its technical knowledge base. Suzlon has been able to draw upon this self-designed learning network to take advantage of regional expertise located around the world, such as in the early wind turbine technology development centers of Denmark and the Netherlands. This is in contrast to Goldwind's early years of technology development, where it remained almost exclusively focused on the Chinese market, and conducted very little R&D or manufacturing outside of China.

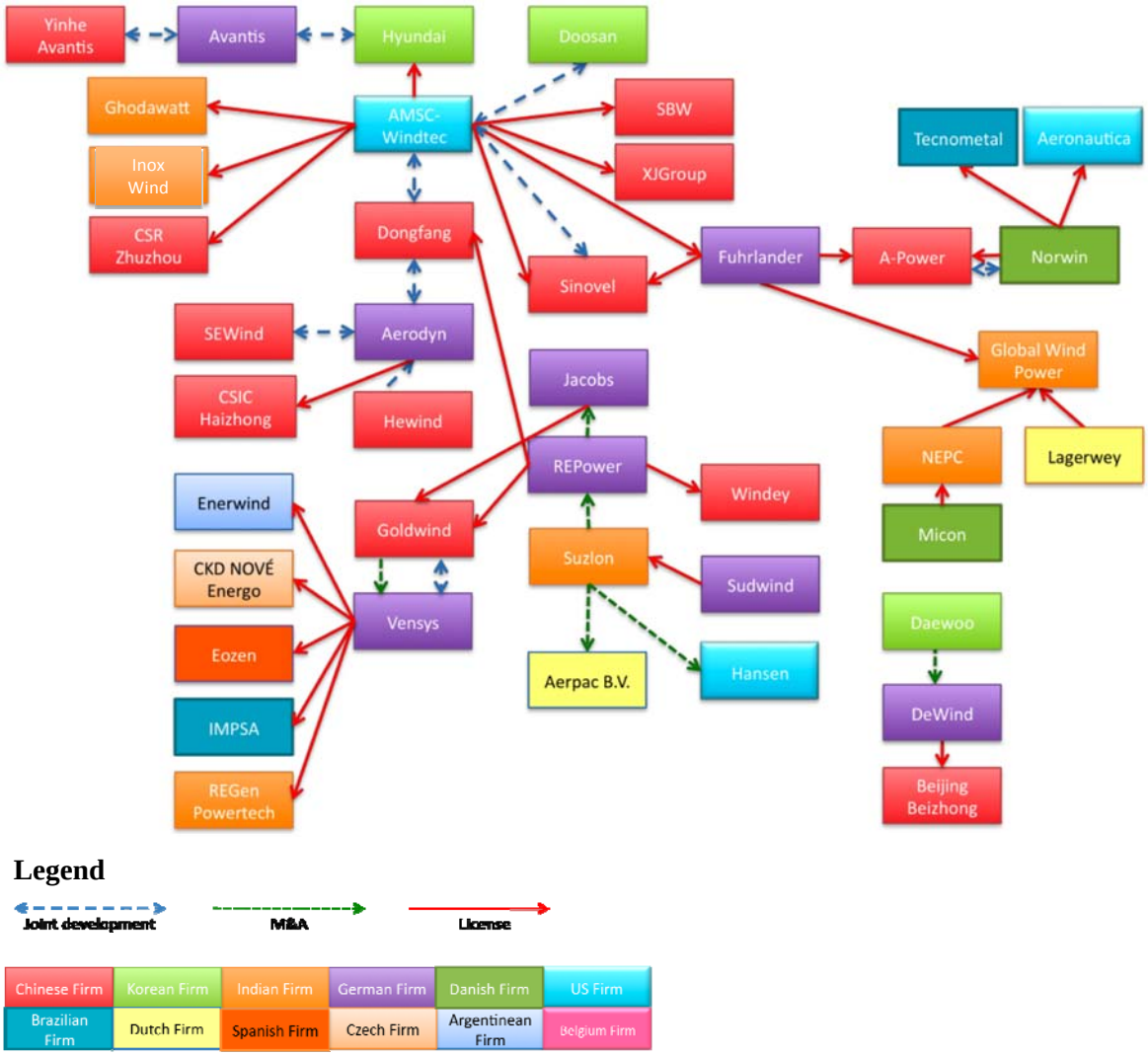
In recent years, however, Goldwind too has expanded its access to global learning networks, most notably through its acquisition of Vensys. This gave Goldwind access to a network of skilled engineers and a company with a different geographic focus, allowing it to better integrate European wind industry experience into its operations. Even more recently, as Goldwind looks to expand into the United States and Australian markets, it has hired American and Australian workers with extensive experience in their home markets to help it better understand how to operate within these domestic contexts.

While they are in an earlier stage of technology development, South Korea's new wind industry entrants are also looking globally for their technology partnerships. Since the Korean companies are already looking to export markets outside of Korea and need to be positioned to compete with global industry leaders, they are not restricting their technology development activities to within Korea.

3.2 Origins and Networks of Technology Transfer

An investigation of the origins of the wind power technology being acquired by firms in India, China and South Korea reveals the many common sources of such knowledge. When a firm shares licenses with multiple firms, or engages in joint development with multiple firms, this creates a network between firms through with knowledge can be shared. While such sharing of information is often restricted through contractual agreements, in other cases it is encouraged. This can have both positive and negative consequences for firms. Such networks increase access to global learning and experience worldwide which is likely beneficial. However, networks that facilitate information sharing in this way can also create competitors and make it harder to safeguard valuable or sensitive information.

Figure 2. Wind Power Technology Transfer Networks in China, India, Korea and Beyond[1]



There are several firms that have served as sources of wind power technology for firms based in China, India and Korea, as illustrated in figure 2. Key companies that have served as the source of wind power technology transfer for many of the key manufacturers located in China, India and South Korea (and beyond) are Avantis, Windtec, REPower, Aerodyn, Fuhrländer, Norwin, and Vensys. It is notable that these companies are either small manufacturers that are not competing with the companies they have licensed to in the Chinese, Indian, or Korean markets, or they are primarily engineering design firms with little to no manufacturing experience. One exception is REPower, which has become a top-ten global manufacturer in recent years and is now selling directly to many overseas markets.

As firms expand their presence around the world by expanding manufacturing bases or R&D

facilities they are also increasingly able to tap into an expanded global knowledge base. Just a few years ago, Goldwind was principally a Chinese wind turbine company, operating its manufacturing and R&D facilities primarily in China. This domestic focus changed with the acquisition of Vensys in 2008, when it then began to increase its R&D activities in Germany. In contrast, Suzlon has been a company with global presence for much longer than Goldwind, beginning with its European partners early on in its technology development process. It established many overseas operations to build upon the knowledge gained through its technology licenses, even before it had established a substantial market share in its home market of India. Suzlon also has overseas operations across five continents, including subsidiaries, research centers and sales offices. Although it conducts R&D abroad, Suzlon still relies primarily on components made in India, most of which are made in-house based on experience gained through its overseas research efforts.

3.3 Domestic Environments

While the leading wind turbine manufacturers in China, India and South Korea have to some extent used similar models of technology acquisition, they have different advantages and face different obstacles to their continued success based on the characteristics of their domestic environment. This includes their home country's wind resource regimes, the domestic policy environments in which they originated.

Historically, it has been common for wind turbine manufacturers to get their start in their home country markets. Home market experience was important for many of today's leading wind turbine manufacturers, with few exceptions. All of today's top 10 wind turbine manufacturers: Vestas (Denmark), GE (USA), Sinovel (China), Enercon (Germany), Goldwind (China), Gamesa (Spain), Dongfang (China), Suzlon (India), Siemens (originally Bonus of Denmark) and REPower (Germany), got their start in their home markets. In addition, all of them are dominant suppliers in their home markets, with the exception of the Danish manufacturers, because there is little remaining potential for onshore wind development in Denmark.

There are only a handful of leading global turbine manufacturing companies that did not primarily rely on their home market in the early stages of their technology development, including of Mitsubishi (Japan), which may be the model of the new Korean manufacturers. While China and India have proven to have sufficient wind resources to support a domestic market, South Korea would need to rely primarily on offshore sites to develop a domestic market for wind power. This is a key reason that Korean manufacturers have had to leapfrog directly to larger, offshore wind turbine technology, rather than starting with smaller onshore models as the Indian and Chinese companies did. Since the Korean manufacturers are well-established firms with sophisticated manufacturing and innovation capabilities, this was another way they could complete with more established manufacturers from other countries.

Despite the importance of national policy support, there are clear limits to understanding the

success of these firms based exclusively on the national innovation systems in which they operate. The presence of these companies in different international markets, the frequency with which these firms look globally to pursue forms of technology development or acquisition outside of their national borders, and the clear linkages between the origins of technological know-how among companies in different countries, point to the need for a more global model of innovation systems.

4. Conclusions

This examination of how China, India and South Korea acquired their ability to manufacture wind turbines provides a look at how three newly industrialized countries have acquired and assimilated advanced technologies in relatively short amounts of time. Such insights are crucial to facilitating international technology transfers, which will be an important component of any technological leapfrogging strategy to achieve lower greenhouse gas emissions in the developing world.

The primary technology transfer and acquisition strategies utilized by firms in China, India and South Korea included licensing arrangements, mergers and acquisitions that resulted in the transfer of technology ownership, or the joint development of new technology. All of these technology development or acquisition strategies were conducted within the constraints of national and international intellectual property law. As technology development becomes increasingly global, firms in the NICs can take advantage of their increasing access to technological know-how that was previously developed primarily by and for the developed world.

References

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2. Joanna I. Lewis, “Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India,” *Studies in Comparative International Development* 42, no. 3-4 (October 2007): 208-232.