Global Inter linkages and Sectoral System of Innovation

Singh, Manish Kumar
EPFO, JNU

Wind power SIS is qualified as the industry in which scientific and product development processes are collaborative. As Malerba stated, Firms must engage in a wide variety of learning processes not only to improve their on-going production process or innovate with new products, but also to cope with rapidly changing technological landscapes (Malerba 1992).

In fact, this has quite important implications in knowledge intensive industries, for mastering a wide range of scientific and technical knowledge often proves unachievable for one isolated organisation. Instead, firms would rely on extra-organisational arrangements, supporting the view that firms are not isolated islands of production (Richardson 1972).

Empirical facts strongly support the view that firms are embedded in complex networks of alliances and collaborations. Behind the explanation of why firms establish ties lies in the assumption that firms naturally benefit from the complementarity of their partners' assets and competencies (Hite et al. 2001). Several studies tend to show that profoundly interacting firms tend to achieve higher levels of performance (Powell et al. 1996). In fact, it is not the mere number of alliances that proves important. Rather, the firm's central position and the density of its network boost their innovative performance, their market value and their operating income (Stuart 2000).

Because technology and economics interact, the conditions by which knowledge is created accumulated and exploited is central as to understand firms strategies and their sources of performance (Afuah et al. 1997).

Networks of collaborative relationships among firms and other institutions (public sector research organisations and universities) have been widely recognised as an important organisational form of innovative activity.

Powell et al. (1996) argue that in a field of rapid technological development, the locus of innovation is found within networks of inter-organisational relationships that sustain a fluid and evolving community. Yet firms aim at appropriating returns on R&D investments through the commercialisation of new products or new technologies so as to ensure the maximum of returns.

During the exploration phase, collaboration is the industrial organisation, which allows the different actors to explore a large number of hypotheses. Powell et al. (1996) state that, collaborative networks appear to be the locus of research (rather than innovation) during the exploration phase. When the industry matures and the scientific and technological environment change, the determinants of the firm's innovative performances may change.

Collaborations and Alliances in WTG Firms

In the wind power SIS in India collaborations by firms have played an important role in the growth of the sector. Consequent to the "push" given by the institutions Indian firms entered into the technology licensing with foreign firms. The international co-operation initially was fraught with many drawbacks. In the early stages of development of the wind power industry, foreign and in many cases inferior second-hand machines were purchased, notably from California. Developed for other systems, these turbines could not operate effectively within the Indian T&D system, which typically undergoes large fluctuations in frequency and where outages are common-place. WTG availability time was low and the production stagnated despite capacity addition.

Post liberalization the entire ecosystem has got changed and consequently through a number of joint-venture projects, local manufacturing capabilities have been developed. As such turbines are now designed to operate within the specific requirements of the local system and operating problems occur less frequently. The MNRE has set out to establish national policy guidelines, standards and specifications for local turbine manufacturers and imported components. Incentives are given only to projects that comply with these regulations. Although many wind turbine parts including the blades and gearboxes are still imported, a number of components are now manufactured locally. The MNRE claims as high as 80 percent indigenization of wind power components[1].

First international agency to show interest in the potential Indian wind power market was DANIDA that enabled the Danish manufacturer MICON to be the first to install

[1]http://www.cea.nic.in/power_systems/Design_&_Engg/Induction_of_New_Technologies.htm (accessed 12 Feb 2010)

wind power in India. In 1986 through a joint venture with NEPC a 1.1 MW demonstration wind project was set-up in Gujarat. [2]

Different WTG firms have acquired technology from foreign players that are enumerated in table 8.1. Technology transfer mode is quite common for the low

Table 1: Collaborations and Alliances in WTG Firms

S. No.	Manufacturer	Collaboration/JV/Subsidiary	Model
1	Enercon (India) Ltd.	Enercon Gmbh, Germany	E-48
			E-53
2	Gamesa Wind Turbines Pvt. Ltd.	Gamesa innovation & Technology, S.L. Spain	MADE AE59
			G52-850 KW 50 Hz
			G58-850 KW 50 Hz
			Gamesa G90-2.0 MW IEC IIA 50 Hz
			Gamesa G90-2.0 MW IEC IIIA 50 Hz
			Gamesa G80-2.0 MW IEC IA 50 Hz
			Gamesa G80-2.0 MW IEC IIA 50 Hz
			Gamesa G87-2.0 MW IEC IIA 50 Hz
3	GE India industrial Pvt. Ltd.	TOT with GE Infrastructure Technology International LLC, USA	GE 1.5sle 50 Hz
			GE 1.6-82.5, 50 Hz
4	Global Wind Power Ltd.	License agreement with NORWIN A/S, Denmark	NORWIN 750 kW
		License agreement with Fuhrlander AG, Germany	FL 2500-100/W2E-W100 2.5 MW, 50 Hz
		License agreement with Lagerwey Wind B.V. Netherlands	Lagerwey L-82 2 MW

[2] NEPC-Micon is now a major manufacturer of wind turbines, earlier activities of NEPC are within the clothes; steel; food and airlines industries.

5	Inox Wind Ltd.	License agreement with AMSTC-WINDTEC GmbH, Austria	WT2000DF
6	Kenersys India Pvt Ltd.	KENERSYS GmbH, Germany	K82
			K 100
7	Leitner Shriram Manufacturing Ltd.	LEITWIND BV, Netherlands	Leitner LTW 77-1.35 MW
			Leitwind LTW 77-1.5 MW
			Leitwind LTW 80-1.5 MW
			Leitwind LTW 80-1.8 MW
8	Regen Powertech Pvt Ltd	Sub-license agreement with Vensys Energy AG, Germany	VENSYS 77
		Sub-license agreement with VENSYS Energy, AG, Germany	VENSYS 82
9	RRB Energy Ltd.	Technological cooperation with Vestas Wind Systems A/S, Denamrk	Pawan Shakti-600 kW
			V39-500 kW
10	Shriram EPC Ltd.	License agreement with TTG Industries Ltd.	SEPC 250T
		License agreement with TTG Industries Ltd.	SEPC 250T
		License agreement with TTG Industries Ltd.	SEPC 250T with Rotor blade extender
11	Siva Wind turbine India Pvt. Ltd.	License agreement with Wind Technik Nord, Germany	SIVA 250/50
12	Suzlon Energy Ltd.	Suzlon Energy GmbH, Germany	S52/600 kW
			S64-1.25 MW/ MARK II
			S66-1.25 MW/ MARK II
			S82V3-1500 kW

			S88V3A-2100 kW
			S95 DFIG 2.1 MW
			S97 DFIG 2.1 MW
			S88 DFIG 2.25 MW
13	Vestas Wind Technology India Pvt. Ltd.	Wholly owned subsidiary of Vestas Group, Denmark	V82-1.65 MW
			V100-1.8 MW 50/60 Hz VCS Mk 7
14	Winwind Power Energy Pvt Ltd.	License agreement with Winwind Oy, Finland	WinWind 1 MW

Source: Compiled by the author

rated machines below 500KW. Technology for such WTG machines is very common and they are less technology intensive than higher rated machines. Small international firms have less to lose as technology is common and due to their size they find it convenient to license the technology than to enter the market on their own. Technology licensing fees ensures revenue also without any investment needed in foreign country.

Dominant international firms with large patent portfolio and advanced technology prefer to form wholly owned subsidiary than to form a joint venture. Large appropriation conditions provided by institutions have influenced their strategy. Further, International firms remain concerned about the design and technology leakages in the licensing and joint ventures. Gamesa which licensed technology from the Vestas in Spain, has become a competitor to the Vestas itself.

WTG manufacturing requires considerable engineering skills and experience. Indian engineering firms have also started coming in the wind power sector due to similar nature of business and demand creation. Shriram EPC, Batlioboi are few examples in this regard.

Firms have entered into multiple licensing for different WTG models from different firms. Shriram EPC has license agreement with TTG Industries Ltd. and Leitwind BV, Netherlands to manufacture SEPC 250T and Leitner LTW 77-1.35 MW models respectively.

Global Wind Power Ltd. a new firm has license agreement with Norwin A/S, Denmark, Fuhrlander AG, Germany and Lagerwey Wind B.V. Netherlands to manufacture NORWIN 750 KW, FL 2500-100 and Lagerwey L-82 2 MW models respectively. Firm has entered into license agreement with three foreign firms to manufacture three different models. These foreign firms are relatively small in size and thus find technology licensing as appropriate mode of technology transfer.

Suzlon's Acquisitions and Global Alliances

Suzlon has more than 50% market share in Indian wind power sector and has gained tremendously from its strategy of technology access by global acquisitions. Suzlon was started in 1995 and in 1997 it made its first international foray by takeover of the manpower of its bankrupt technology partner Sudwind and set up an R&D centre for turbines in Germany. This was followed by the acquisition of rotor blade manufacturer, AE-Rotor Technik BV, a bankrupt Dutch company that enabled Suzlon to design and manufacture rotor blades in Denmark. Suzlon acquired strategic wind energy supplier firms that ensured a reliable supply chain for its WTG machines.

Suzlon has created a diversified production base all over the world. Firm manufactures its turbines at two factories in India and has production base in USA also with a turbine-blade factory in Minnesota. Table below enumerates global production bases of Suzlon.

Table 2: Suzlon: Plant Locations

Components	Locations
Rotor Blades	US : Minnesota
	India : Daman, Maharashtra, Gujarat, Pondicherry
Gearboxes	Belgium: (Hansen Transmissions)
	China : Tianjin

Generators	India : Maharashtra (JV with Elin, Austria)
Control systems	India : Daman, Pondicherry
Towers	India : Gujarat, Maharashtra

Source:(Kumar, 2009)

Suzlon using its diversified production base all over the world has focussed on European markets to gain technology and USA market to export its WTG machines. Figure 8.2 shows exports of WTG sets by Suzlon India Ltd. As can be seen from the figure firm has used low cost production base in India to cater to the USA market.

Fig.2: Exports of WTG sets by Suzlon India Ltd.

Source: Suzlon, Annual Report (2010-11)

Suzlon by its strategy of mergers and acquisitions has become a global player. Suzlon acquired majority share in German firm Repower that made it a one of the leading firms in wind power sector. Suzlon gained considerable patent portfolio of Repower that has improved technological capability of the firm also. In addition, Suzlon has made a diverse product portfolio of different WTG models.

Table 3: Growth Strategies of Suzlon Ltd.

Firm Acquisition	Advantages and Gains	Deal
Repower Systems AG by Suzlon Windenergie Gmbh, a subsidiary of Suzlon Energy Ltd.	• Horizontal integration with adding of expertise in offshore wind generation capacity. • Growth in market share and access to international markets. • Access to Intellectual Property by leveraging of cutting edge technology and R&D prowess of Hansen.	US $ 1.8 bn. with a control of 90.7 % in Repower.
Hansen Transmissions International NV	• Vertical Integration by way of efficient supply chain that could ensure timely supply of critical components while maintaining superior quality and low prices. • Access to International markets. • Access to Intellectual Property by leveraging cutting edge technology and R&D prowess of Hansen.	Suzlon Energy Ltd.'s Dutch subsidiary, AE-Rotor Holding BV acquired from EVE Holding BV, a 50-50 venture of Allianz Capital Partners and UK Private equity firm Apax Partners Worldwide LLP. A deal worth US $ 563mn.

Source: extrapolated from Kumar (2009)

Acquisition of REpower has also given Suzlon exposure to offshore market which is the technology of the future. WTG machines for offshore segment are generally of 5 MW capacity that need considerable technological expertise. Suzlon has well placed itself in offshore segment even before its commercial exploitation in the India. It has given company a clear edge amongst its competitors.

Wind energy sector has many actors that do not manufacture WTG sets directly but contribute substantially by way of components and parts. WTG in itself contains diverse components that require advanced knowledge in different fields of technology such as chemical engineering, electronics and instrumentation.

Table 7.4 enumerates collaborations and alliances in private sector vendor firms in wind power sector.

Table 4: Collaborations and Alliances in Private sector Vendors in wind power sector

Domestic Firm	International Partner	Alliance
Batliboi Ltd.	enXco Denmark, as the subsidiary company of SIIF Energies of France (SIIF Energies is the affiliate of Electricite' de France (EDF))	enXco, a Joint Venture Wind Turbine/ Farm in Operation & Maintenance
Kemrock Industries and Exports Limited, Vadodara, Gujarat	Germanischer Lloyd SE, Hamburg, Germany	Epoxy resin EPOKEM 1150 for use in the vacuum infusion of rotor blades

Source: Compiled by the author

Batliboi Ltd. is a leading engineering firm in India with specialisation in different areas of engineering services and project development. Firm is engaged in the WTG, wind farm O&M service. New areas such as wind farm maintenance have emerged in the sector due to large wind farm set up in the country and IPPs in the wind power sector.

Kemrock Industries and Exports Limited has also acquired GPK's Germanischer Lloyd (GL) Approved epoxy resin EPOKEM 1150 for use in the vacuum infusion of rotor blades. Kemrock's fibreglass non-crimp technical fabrics are DNV approved for use in wind energy applications.

Collaborations and Alliances in Financing in Wind Power Sector

Financing RETs is a major bottleneck in the diffusion of these technologies as they have high capital cost with very low operational cost. The per unit cost of RETs although has come down particularly in wind power sector due to rapid scaling up but still it is very high compared to large pit head coal based power plants.

In a developing country foreign capital provides cheap capital that often comes with management expertise and adoption of international standards of accounting and auditing. Table below enumerates alliances in financing of wind energy with their partners and nature of alliance.

Table 5: Collaborations and Alliances in Financing in Wind Power Sector

Domestic Partner	**International Partner**	**Alliance**
Indian Renewable Energy Development Agency	• World Bank • Asian Development Bank • DANIDA • Netherlands Government • Swiss Development Co-operation • GEF	Financing of loans for Wind Power sector
Centre for Innovation, Incubation and Entrepre-neurship, Indian Institute of Management, Ahmedabad MNRE and Technology Development Board, Govt. of India	• International Finance Corporation (IFC) • BP Ventures	Indian Fund for Sustainable Energy (Infuse), a $25-million VC fund
ReNew Wind Power Pvt.	Goldman Sachs Group Inc.	$200 million VC investment for a majority stake in 1,000 megawatts of wind-generation capacity

Source: Compiled by the author

The Indian Fund for Sustainable Energy (InFuSE) at the Centre for Innovation, Incubation and Entrepreneurship of the Indian Institute of Management, Ahmadabad, is launched a $25-million fund. This fund will invest in entrepreneurial solutions across the clean-tech vertical. The fund has International Finance Corporation (IFC) as an investor, with a commitment of up to 20 per cent of the fund

size. Infuse is backed by BP Ventures, the Union ministry of new and renewable energy and the Technology Development Board[3].

Public-Private Partnership in Wind Power Sector

Public-Private Partnerships (PPPs) offer a new form of network society in which states and non state actors, for-profit and non-profit organisations, engage in less hierarchical and less bureaucratic horizontal collaborations (Archibugi & Bizzarri 2004). The main advantage of partnerships is the potential to combine government funding with private sector efficiency and expertise. Public research institutes often lack the competencies and resources necessary to manufacture technologies and carry out the complex and costly commercialisation. This assumption is particularly true as the research and development conducted in university or public sector institutes that are not in a better position to gauge the requirements and demands of the market than the private players. The need for private players is particularly felt at the time of technology transfer or commercialisation of that particular technology. Private players may hold the means and know how to manufacture a product but governments have the capacity to innovate as well as the power to dilute appropriability mechanisms, direct research and guaranteed market ensures better research output. By linking funding to pricing and intellectual property provisions, the sharing of technological innovation and progress is maximized allowing companies a reasonable level of ownership over the products and technologies developed. It is evident that the R&D productivity of the business sector increases when connected to public institutions and facilities.

Table 6: Public Private Partnership in Wind Power Sector

Public Institute	Private Firm	Alliance
• National Aerospace Laboratories (NAL) • Structural Engineering Research Centre (SERC), Chennai	Sangeeth Group of Companies, Coimbatore	New Millennium Indian Technology Leadership Initiative (NMITLI): 500 kW low cost, horizontal axis wind turbine

[3] http://www.business-standard.com/india/news/centre-at-iim-a-to-launch-25-mn-cleantech-fund/471460/ (accessed May 2012)

FRPD (Fibre Reinforced Plastics Division), NAL	Sangeeth Group of Companies, Coimbatore	NAL-Sangeeth wind turbine blades
National Aerospace Laboratories (NAL)	Kemrock Industries and Exports Limited	India's first carbon fiber production facility carbon fibre prepregs are undergoing qualification for rotor blade use.

Source: Compiled by the author

New Millennium Indian Technology Leadership Initiative

The New Millennium Indian Technology Leadership Initiative (NMITLI) is the largest public-private-partnership effort within the R&D domain by the Government of India.

It is objective is to synergise the competencies of publicly funded R&D institutions, academia and private industry. The Government provides finances and plays a catalytic role in the collaboration.

NAL is in the process of developing 500kW wind turbines in a project supported by India's New Millennium Indian Technology Leadership Initiative (NMITLI). The design and development of a 500 kW low cost, horizontal axis wind turbine is now being carried out by NAL under a collaborative programme with the Structural Engineering Research Centre (SERC), Chennai and an Industrial partner, Sangeeth Group of Companies, Coimbatore, with funding under the CSIR's New Millennium Indian Technology Leadership Initiative (NMITLI). The wind turbine which will be 2-bladed, downwind, teetered and stall regulated with a guyed tilt tower, is installed at the Sangeeth Wind Farm, Kethanur.

NAL-5 KW Wind Turbines

NAL has completed tower testing to quantify the field performance of this class of turbine systems. It has also started interactions in this regard with DRDO for remote

areas and with the Centre for Wind Energy Technology (C-WET), Chennai, for Urban Wind Turbines of 5 kW class.

NAL-Sangeeth Wind Turbine Blades

The Sangeeth Group has been a major Indian player in wind power generation. Their wind farms originally used blades fabricated by a UK based company. As blades failed over a time, Sangeeth asked NAL if it could reverse engineer similar blades. It coincided with NAL's vision of diversifying from wind resource assessment studies to actual wind turbine development for India's relatively low wind speeds and dusty environment. The NAL Sangeeth Group partnership to design and fabricate 300kW wind turbine blades is an example of public private partnership in commercial product development.

NAL-Kemrock's Carbon Fibre Prepregs

Carbon fibre is an important strategic material for the fabrication of advanced composite materials. Carbon fibre polymer composite matrix composites are being extensively used as light weight structural materials in a large number of applications. Aerospace structures, wind turbine blades, sports equipment, offshore platforms and transportation are some of the important areas where carbon fibre composites are widely used. The use of these materials result in products with high strength, high stiffness, and very low weight.

The Council of Scientific and Industrial Research and National Aerospace Laboratories has successfully transferred its carbon fibre technology to the private sector initiating the domestic commercial production of carbon fibre which is considered as a material of the future. Kemrock[4] commissioned India's first carbon fibre production facility in 2010, under a technology transfer from the Council of Scientific and Industrial Research and National Aerospace Laboratories. Initial capacity at its plant in Vadodara is for 400 tonnes of carbon fibre each year. Kemrock's carbon fibre prepregs are undergoing qualification for rotor blade use.

[4] Kemrock Industries and Exports Limited (Kemrock) is an Indian public company specializing in the manufacture of fibre-reinforced composite materials. Established in 1981, the company is based in Vadodara, Gujarat. Kemrock manufactures fibre-reinforced plastic and glass-reinforced plastic composite products for the domestic and export markets. It focuses on industrial segments, such as aerospace, renewable energy, railways, chemical processing, waste management, etc.

Globally they are undergoing testing and increasingly being used in the production of large rotor blades that are light in weight and have exceptional strength and durability. Carbon fibres composites are the spin-off of the NAL's research in light weight airframe for fighter jet and airplanes.

Kemrock Industries and Exports Limited has emerged as a leading firm in the wind power technology also. Active link up with domestic R&D lab and transfer of technology has led to make it an innovative firm.

It is also India's first company to manufacture 45 metres single piece mould for Rotor Blade (2 MW, WTG). Rotor blade production is done by resin infusion, an advanced technology setting highest international standards in moulding of rotor blades. It has a well-equipped sophisticated in-built heating, dedicated vacuum system and pneumatic controls for accurate mould profile alignment.

Public sector R&D facilities are thus playing a leading role in the domestic capacity building in strategic as well as renewable energy sector.

Indian Wind Atlas (CWET- RISO National Laboratory)

With active collaboration of RISO National Laboratory for Sustainable Energy, Denmark CWET has prepared an Indian Wind Atlas. It will serve the purpose of providing suitable wind power data for evaluating the potential site for large electricity-producing wind turbine installations. Advanced models at micro and meso scale like Wind Atlas Analysis and Application Programme (WAsP) and Karlsruhe Atmospheric Meso Scale Model (KAMM) are used for the preparation of the wind atlas. It has resulted in the revised wind power density map of India that has enhanced the estimated installable potential in the country.

Table 7: Collaborations and Alliances among R&D Institutes in wind power sector

R& D Institute	University/Firm/Lab.	Alliance
Centre for Wind Energy Technology (C-WET), Chennai	RISO National Laboratory for Sustainable Energy,	Wind Turbine Test Station (WTTS) near Kayathar in Tamil Nadu

	Technical University of Denmark.	
Centre for Wind Energy Technology (C-WET), Chennai	RISO National Laboratory for Sustainable Energy, Denmark	Wind Atlas Analysis and Application Programme (WAsP), an Indian Wind Atlas
Centre for Wind Energy Technology (C-WET), Chennai	Scottish Development International, UK	100-metre mast to measure offshore wind levels
Centre for Wind Energy Technology (C-WET), Chennai	NWTC, NREL, USA	NREL-CWET MOU under US India Energy Dialogue
National Aerospace Laboratories (NAL)	Centre for Wind Energy Technology (C-WET), Chennai	Urban Wind Turbines of 5 kW class.
Indian Institute of Tropical Meteorology, Bangalore	Tamil Nadu Energy Development Agency (TEDA)	wind resource assessment programme in Tamil Nadu

Source: Compiled by the author

Nature of Collaborations

A particular feature of Indian Wind power sector is that most of the linkages and sectoral dynamics emerged as a result of international collaboration are result of domestic opportunities present in the sector rather than on any export opportunity. As generally evident in developing countries that multinational enterprise exploit low cost production base of the country, rather in present case most of the growth is seen to cater to the domestic opportunities present in the sector and changed institutional regime there on. International collaborations have emerged in the sector not emanating from the demands of MNCs as customers for components and inputs but that of products which are to be locally deployed and used.

Another fact is that despite liberal FDI regime in the sector, foreign firms prefer to go by the joint venture with an Indian firm rather going fully on its own (see Table 8.3). This is particularly evident for small foreign firms but large firms like Enercon, Gamesa and GE prefer to go alone, this could be explained by the size of their investment and long term plans. These are also the firms that have considerable IPR in their domain. Domestic learning and development of technological capability by international joint ventures

Sources and Nature of Knowledge Flow

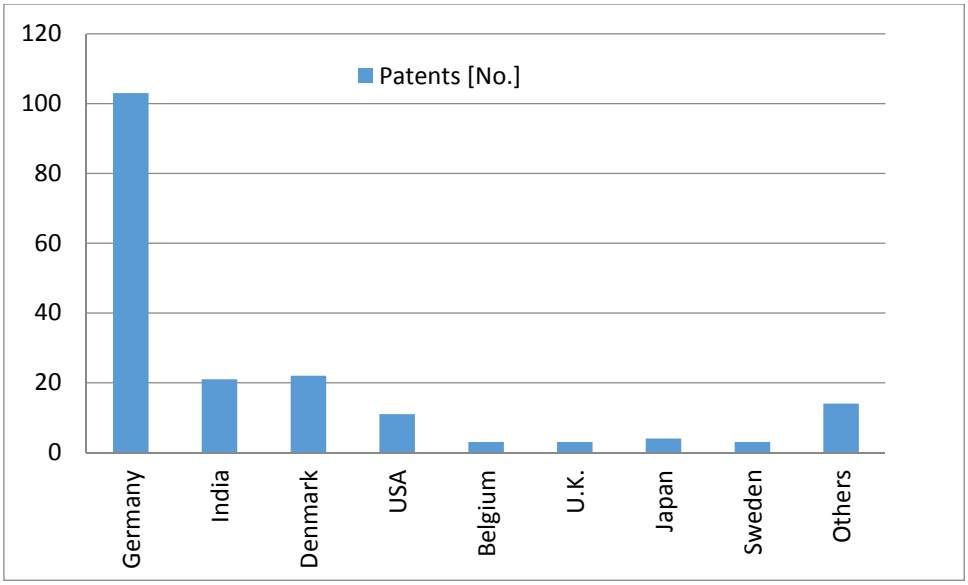
Indian wind power sector is traditionally being driven by the flow of knowledge and technology from foreign firms. One of the earliest venture used technology licensing approach as it was a popular form of gaining technology access in the pre-reform period. In the early 1980's entrepreneurs such as Dr. Rakesh Bakshi[5] formed RRB with technology licensing from Vestas a Danish firm. The firm is a leader in sub 1MW segment in the country. As Vestas has entered the country with its own higher rated WTG, firm is still marketing its machines, particularly 600KW WTG sets. Traditionally, the innovation-driven developed countries such as Denmark and Germany with more mature wind power Industry have been the major source of FDI and the associated knowledge flows. Very recently, a new and diversified pattern of FDI is emerging with an increasing participation of developing country firms in outward foreign direct investment, Suzlon Energy Ltd. is a striking example in this regard which has leveraged its low cost production base and ability to draw cheap finances to fuel its global ambitions. It has adopted the strategy as prevalent in the developing country to acquire known-how and skills first through technology licensing and then go for the acquisitions abroad to get advanced technology and skills. Suzlon incorporated in 1995, did a technical collaboration agreement in the same year with a German company, Sudwind GmbH Windkrafttanlagen to source the latest technology for the production of WTGs in India. The technical know-how relating to sub mega-watt turbines (0.27 MW, 0.30 MW, 0.35 MW, 0.60 MW and 0.75 MW) was acquired for a royalty payment with technology access in perpetuity. The company went for strategic assets and markets in the developed countries in

[5]Dr. Rakesh Bakshi, LFIMA, FIE, FNAE Chairman and Managing Director of RRB Energy Limited was honoured with "Padma Shri" Award, one of India's high civilian awards, for his pioneering endeavours in wind energy in India by Indian Government in 1991

later period (see Table 5.4). The acquisition of technology first through licensing and then developing new products deals with a lot of incremental innovation that demands domestic firms capacity to absorb and assimilate wide range of knowledge. A time lag can be seen in the technological acquisition and development of new products that are better suited for local conditions or are more efficient. (Bell and Pavitt, 1993) describes this in terms of a set of linked capabilities based on different types of knowledge. These include formal knowledge embodied in blueprints, manuals, machinery, or products on the one hand, and "tacit", non-codified, experiential knowledge on the other. Since technology is partly tacit, the full set of capabilities necessary for its optimal use often cannot be obtained through market transactions or imitation. Rather, the purchaser or recipient must make active efforts to assimilate and apply acquired technology in its own specific production routines. Such investments to imitate or master acquired technologies can be as costly as those required to generate entirely new innovations. The acquisition of new 600Kw turbine technology by RRB Energy Ltd. in 1987and its recent endeavour to manufacture a 2MW (PH1800) turbine out of its domestic R&D facility in Sriperambadur, Tamilnadu in 2011 can be contrasted with the Suzlon Energy Ltd. acquisition of WTG technology in 1995 and its introduction of 2MW (S88) turbine in 2005. Changed institutional regime is no doubt a driving factor in the introduction of higher rated turbine but the strategy adopted by two firms is entirely different. Where as one firm has moved on from a sub-MW producer to above MW producer of WTG using indigenous R&D and learning the latter has used aggressive acquisition of technology from collaboration and buy out of foreign firms. Acquisition of technology in module no doubt helps in rapid scaling up but that is entirely dependent on demand creation (Malerba 2004)

Fig. 3: Country of Origin of Patent Grantee in Wind Power Sector[6]

[6] see Annexure 1 for more details.



Source: Compiled by the author from the C.G. Patents, Design and Trademark of India

Summary

Emerging Collaborations between Indian firms and global players result in a form of partnership that can facilitate development of RETs in the developing world. The firms are interested in working with these groups for access to their expertise and resources in tackling global warming issues.

Entering into collaborative projects with foreign firms is yet another strategy for Indian companies to set the stage for innovation by gaining access to valuable skills, expertise and proprietary technology.

Development of products and technologies is sometimes mediated through joint ventures between Indian and foreign organizations.

Foreign firms interested in tapping into the large Indian market are partnering with local firms for their distribution networks and knowledge of the local regulatory landscape and legal system.

It is well understood fact that the majority of alliances in the wind power sector are not vertical. Much collaboration does not unite the efforts of two organizations that, at least under the parameters of the alliance contract, not engage in relatively distinct sets of activities along the value chain in the wind power.

Indian wind power firms engaged in WTG production are using strategic partnerships to expand their innovative capacity. One such partnership is the R&D collaboration with domestic as well as international research institutes which is evident from the preceding tables and information generated by the field work.

These collaborations are providing training opportunities for in house staff, improving access to research facilities and expensive equipment, expanding installation capabilities and providing access to government sponsored research funds.

The New Millennium Indian Technology Leadership Initiative program aims to bring together private firms, national R&D laboratories and academia to develop products of national relevance.

Exploring all the aspect of collaboration and partnership it will not be out of place to assert that both developed and developing countries require partnerships between public and private-sector organizations.