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Global Wind Patent Landscape Report

Q3, 2013

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  - Risk Profiles
  - Licensing Negotiation
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- Intellectual Property (IP) Capture / Patent Prosecution
- Competitor Patent Portfolio Benchmarking
- IP Portfolio Valuation
  - Portfolio Cost Estimator

New Product / Technology Development

- New Product Development (NPD)
  - Stage-gate
- New Technology Introduction (NTI)
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- R&D Funding Justification

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Introduction

Utility scale wind turbines have become so technologically advanced that they have improved the cost of energy (COE) of wind enough to compete with today's conventional energy sources. The ensuing reduction in COE has been the result of two governing forces: public policy and technological innovation. The technological trends which have emerged thus far and what might be in store for the future direction of wind turbine technology are explored in this report. Policy and governmental R&D support will continue to be essential, and barriers to wind technology commercialization must be further broken down.

Methodology

In an attempt to catalogue the usage and evolution of technology in the wind industry, we decided to conduct an investigation of the patent landscape. This landscape sheds significant insight into what technological trends have emerged thus far and what we might be able to infer for the future direction of wind turbine technology. The patent landscape analytics, as well as extensive analysis of forward looking competitive intelligence, helps shape our view of future technology trends for the industry.

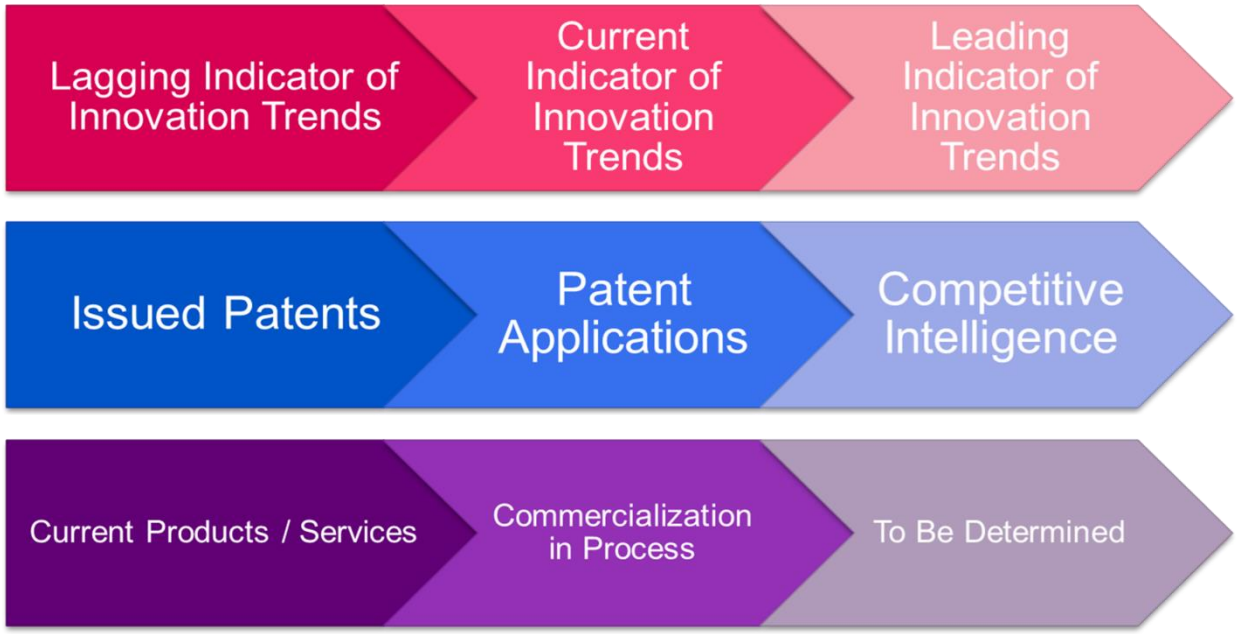

Figure 1 - Analysis Methodology

At the time when we began the study over 2.5 years ago, we decided to limit the assessment to the most prevalent sector of wind turbine technology – utility-scale, horizontal-axis wind turbines – since this is most reflective of the mainstream industry. However, we leave the possibility open to include small and medium scale / distributed wind, vertical axis, building and rooftop, as well as ducted rotor turbines in the future.

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The search was conducted utilizing a comprehensive approach, as well as thorough examination of results dating back to the year 1916, when some of the first grid connected technology took root. Patent database and search portals were used which cover over 100 worldwide jurisdictions, and results for all jurisdictions were harmonized to provide comprehensive portfolio analysis.

We first identified a set of keywords which would provide an all-inclusive set of search results. We also identified patent classes to search in order to ensure that relevant results would not be omitted. Lastly, a set of assignees of over 1,270 companies who have currently or previously produced wind turbine technology and components was searched for all relevant filings.

Aggregation of these results and elimination of duplicates as well as false positives has now led to a total set of over 32,834 issued patents and published pending applications from over 67 worldwide patent jurisdictions dealing with utility-scale, horizontal-axis wind turbines.

Next, the search results were read and analyzed to determine a keyword classification which indicates the specific component and technology of each patented invention. The component literally refers to the wind turbine component, i.e. blade, tower, generator, gearbox, etc. The technology refers to the nature of the improvement, and deals with such topics as performance improvement, reliability enhancement, manufacturing tools or processes, safety as well as grid compliance.

The search results are presented in a format in which each individual patent filing was assessed and classified, and all results were grouped by patent family. The 32,834 global filings can be aggregated into 8,665 patent families of relevance which have been identified and evaluated thus far. Further research into worldwide filings is forthcoming as the database is expanded.

In addition to the keyword classification, an assessment of the relevance of each patent filing to the industry was performed and results were classified as Low, Medium, Medium/High, and High. Definitions of this classification method are below. The assessment of industry relevance serves the purpose of indicating the degree to which the patent owner has asserted their patent rights in the past or would be able to seek licenses or otherwise enforce the patent due to usage of that patent protected technology by their competition.

Low	Medium	Medium/High	High
Patent / Application is not relevent to the pervasive set of technologies and products in the industry.	May have been relevant in the past or is simply not broadly applicable. Multiple methods of design around exist.	Important filings which the industry needs to be cognizant of, but these can likely be avoided / mitigated.	Critical filing which has been asserted, licensed or enforced, or is otherwise highly likely to be in the future due to claim breadth and use.

Figure 2 - Industry Relevance Assessment

In acknowledging that this type of landscaping activity and relevance assessment is subjective, we believe this type of analysis requires a certain level of technological and wind industry domain expertise; a deficiency of previously attempted wind IP landscapes by law firms or IP search firms.

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The following excerpt from the patent landscape is indicative of the keyword classification and relevance assessment methodology. The family members were evaluated individually, and differences in the design intent of each patent filing are noted in the keyword assignment.

Title	Component	Sub-Component	Technology	Sub-Technology	Relevance to Utility-scale WTG Industry	
ARTICULATED WIND TURBINE BLADES	Blade	Variable Diameter	Load Mitigation		L	
POWER CONVERTER SYSTEM AND METHODS OF OPERATING A POWER CONVERTER SYSTEM	Controls & Sensors	Converter	Frequency / Voltage Regulation		H	Did they bother to search for prior art? This is just a patent application on a converter.
METHOD FOR FEEDING A MULTIPHASE ELECTRIC NETWORK AND ASSOCIATED CIRCUIT ARRANGEMENT	Controls & Sensors	Converter	Frequency / Voltage Regulation		M-H	I believe this individual phase control of a grid connected turbine is already known in the industry.
FAULT RIDE THROUGH SWITCH FOR POWER GENERATION SYSTEM	Electrical	Converter	Frequency / Voltage Regulation	LVRT	M	

Figure 3 - Patent Landscape Classification

This assessment of relevance should be an indication of the proverbial landmines to watch out for when navigating a new technology or product through the landscape, and these results have already been used in freedom to operate investigations. There are numerous instances of infringement which we have identified during the course of our landscaping efforts that remain largely unknown to the OEMs, sub-component suppliers, or the owner / operators. These risks are often unaddressed through licenses or other means of risk mitigation, which presents a shared risk with the turbine purchasers who do not receive full indemnity in turbine supply agreements.

The landscape has also shown a vast number of areas in which relevant prior art was discovered which was not cited by the inventor(s) or examiner(s) during the patent prosecution process. Further complicating matters, there are also numerous instances where the inventors clearly should have known about the existence of the prior art references, but chose not to cite them anyway in

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their newly filed patent applications. This leaves the door open to the possibility of invalidation of many patents due to inequitable conduct, which could have been avoided.

The risk profiles which were developed based on the data set explore the relevance of each patent family and individual filing to a particular OEMs turbine architecture. They provide turbine OEMs, financiers, developers and insurance providers with clarity as well as a quantification of IP risk. This can defray project finance and commercial risks related to possible patent infringement.

Industry Results

With the results grouped by assignee (or patent owner), it should come as no shock to industry watchers who are the top assignees for wind patent filings. The list largely coincides with the top market share holders in the sector, and the chart below shows the number of patent families held by each company. The patent families represent individual inventions covered by multiple common patent applications filed worldwide, including divisional and continuation applications. For the sake of compactness, only those with 20 or more patent families were included in the chart.

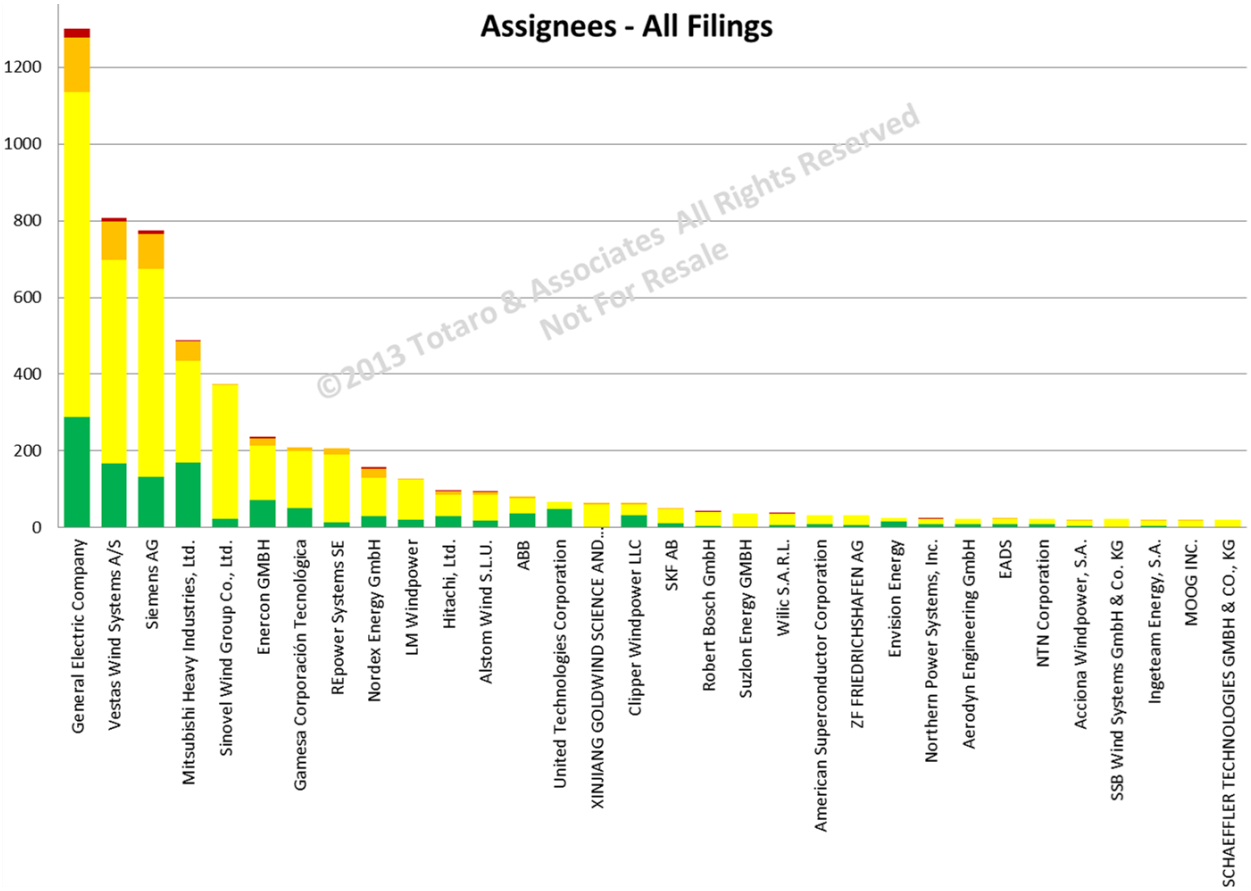

Figure 4 - Assignees (by Patent Family)

The industry relevance results indicate that only 0.8% of issued patents would have a high impact on the entire industry as a whole if those patents were universally asserted, with another 6.9%

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which may become relevant in the future depending on technology evolution and use. The remaining 92.3% of filings are merely providing owners with basic defensive IP protection on technologies they use in their own product lines, but are not widely used in the industry or could

The list of the top 10 turbine manufacturers who are the most prolific IP holders is shown in the table below. Note that the data combines all joint IP ownership as well as the combination of assets from Suzlon and REpower under one umbrella, although they still file applications separately. Some of the top patent holders who are not turbine OEMs have been omitted for the sake of clarity, since the OEMs have a broader technology focus with system integration in mind.

		Portfolio Evaluation Count and Percentage of Portfolio					Industry Benchmarking Percentage of Entire Industry Total				
		Total	L	M	M-H	H	Total	L	M	M-H	H
1	**General Electric Company**	1301	288	846	143	24	15.0%	9.9%	16.6%	23.8%	35.8%
	% of portfolio		22.1%	65.0%	11.0%	1.8%					
2	**Vestas Wind Systems A/S**	812	170	532	100	10	9.4%	5.9%	10.4%	16.7%	14.9%
	% of portfolio		20.9%	65.5%	12.3%	1.2%					
3	**Siemens AG**	789	137	552	91	9	9.1%	4.7%	10.8%	15.2%	13.4%
	% of portfolio		17.4%	70.0%	11.5%	1.1%					
4	**Mitsubishi Heavy Industries, Ltd.**	502	173	272	53	4	5.8%	6.0%	5.3%	8.8%	6.0%
	% of portfolio		34.5%	54.2%	10.6%	0.8%					
5	**Sinovel Wind Group Co., Ltd.**	373	23	348	2		4.3%	0.8%	6.8%	0.3%	
	% of portfolio		6.2%	93.3%	0.5%						
6	**Suzlon Energy GmbH / REpower Systems SE**	249	16	215	18		2.9%	0.6%	4.2%	3.0%	
	% of portfolio		6.4%	86.3%	7.2%						
7	**Enercon GmbH**	236	71	143	19	3	2.7%	2.5%	2.8%	3.2%	4.5%
	% of portfolio		30.1%	60.6%	8.1%	1.3%					
8	**Gamesa Corporación Tecnológica**	210	50	151	9		2.4%	1.7%	3.0%	1.5%	
	% of portfolio		23.8%	71.9%	4.3%						
9	**Nordex Energy GmbH**	157	29	102	23	3	1.8%	1.0%	2.0%	3.8%	4.5%
	% of portfolio		18.5%	65.0%	14.6%	1.9%					
10	**Alstom Wind S.L.U.**	93	19	67	6	1	1.1%	0.7%	1.3%	1.0%	1.5%
	% of portfolio		20.4%	72.0%	6.5%	1.1%					
	Entire Industry	**8665**	**2897**	**5101**	**600**	**67**	**54.5%**	**33.7%**	**63.3%**	**77.3%**	**80.6%**
	% of portfolio		**33.4%**	**58.9%**	**6.9%**	**0.8%**					

Table 1 - Portfolio Evaluation and Industry Benchmarking (Top 10 Companies)

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