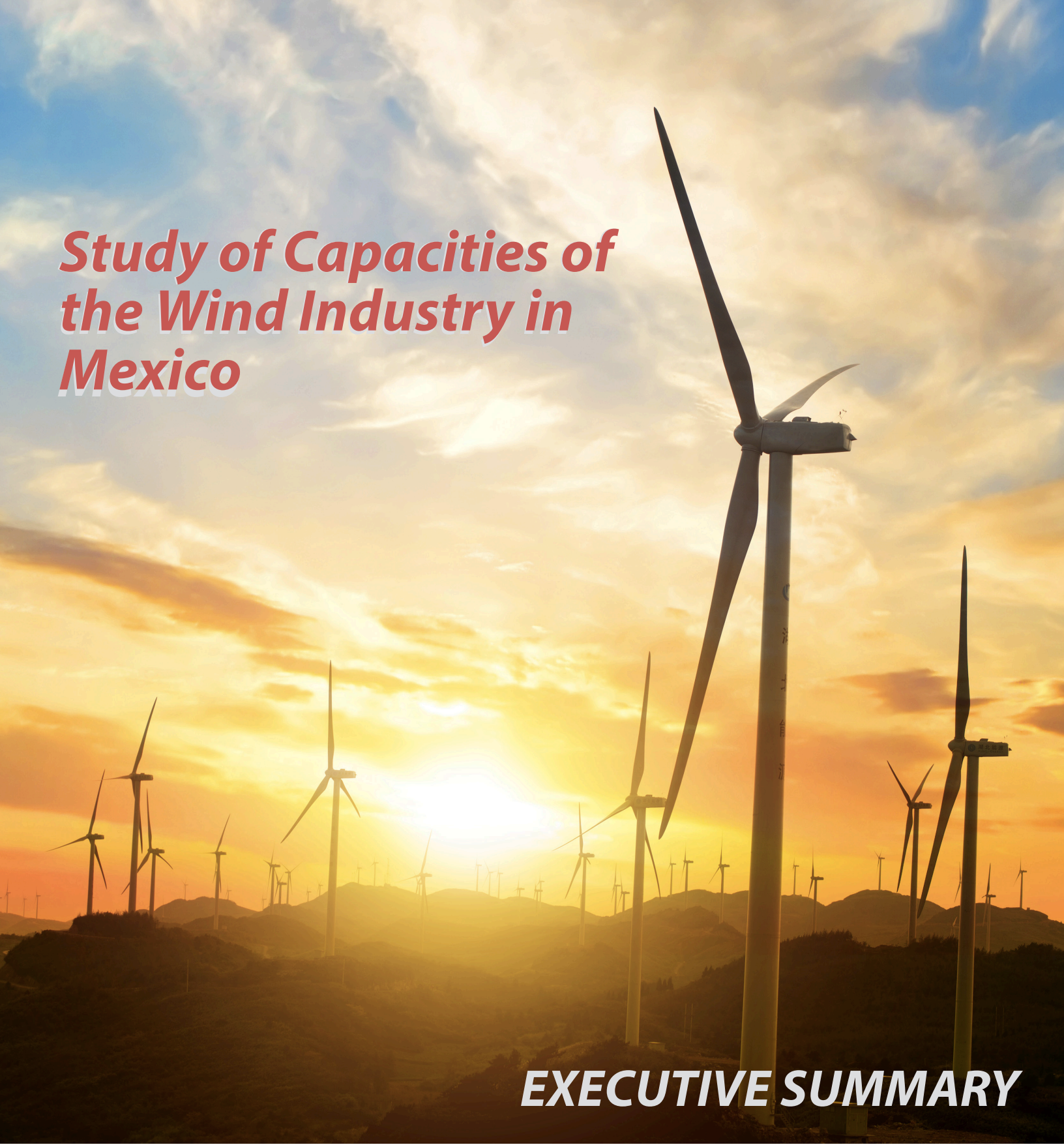


Study of Capacities of the Wind Industry in Mexico

EXECUTIVE SUMMARY

amdee
Asociación Mexicana de Energía Eólica

SE
Secretaría de Economía

Análisis y Prospectiva Tecnológica

This Executive Summary is part of the "Study of Capacities of the Wind Industry in Mexico", prepared for the Asociación Mexicana de Energía Eólica (Mexican Wind Energy Association – AMDEE) with the support of the Fideicomiso Público para el Desarrollo de Proveedores y Contratistas Nacionales de la Industria Energética (Public Trust to Promote the Development of Suppliers and National Contractors of the Energy Industry - PROENERGIA).

**COVER photo: https://www.citiesdigest.com/2017/03/23/eliminating-energy-related-carbon-emissions-can-achieved-according-irena/wind-turbines-in-oiz-eolic-park-basque-country/*

Table of Contents

PRESENTATION

The Mexican Association of Wind Energy (AMDEE) is a non-profit civil association dedicated to promoting the development of the wind sector in Mexico. Our Association represents the main players in the wind industry and collaborates with the authorities in promoting the regulation and policies necessary to promote the sustainable and sustained development of wind energy in Mexico.

In this sense, the present study called "Study of Capacities of the Wind Industry in Mexico" has as objective to identify the gaps in the technical and quality capacities of the national suppliers of the sector of the wind industry in Mexico, to strengthen the chain of national supply of the wind industry, increasing the national content of its acquisitions.

At the international level, wind farm developers and equipment manufacturers are highly integrated into global value chains, with specialized manufacturing capabilities installed in various regions that allow them to meet the demand generated based on the growth estimates of the wind sector international, which limits opportunities for the integration of components and subcomponents with national content.

Beyond proposing strategies for the manufacture of certain components that can be manufactured locally, the study also focuses on the identification of opportunities to integrate the value chain into services for the operation and maintenance of wind farms, where national companies have national procurement opportunities.

The dynamics of the wind market is causing that it is convenient to start producing parts, materials and other consumables locally that serve for the maintenance of existing wind turbines; generating value in the reduction of costs derived from imports, complex logistic processes, and mainly in the reduction of delivery times, achieving an opportune and reliable supply from Mexico.

Another great opportunity for the national supply, is that certain equipment and parts begin to be manufactured locally, identifying national suppliers with the capacity to manufacture critical parts, contributing to the design of continuous advanced manufacturing to incorporate future generations of wind turbines, so that those suppliers Not only are they competitive for their manufacturing costs, but they truly add value for the big manufacturers and operators of wind farms.

In this way, the development of national procurement would have a focus on the provision of operation and maintenance services, as well as on the supply of components that are gradually integrated into the complete equipment assembled in other countries. The latter will only be the result if in the short term, it is possible to meet the current needs of operation and maintenance services, and gradually, achieve greater involvement, make technological contributions and improve their capabilities.

With this type of strategy, AMDEE seeks for our companies to insert and consolidate their participation in global value chains. The leading countries in the world economy have invested in this type of projects as a way to favor the appearance of this new manufacturing, seeking to increase its participation in the international market. In this context, Mexico and the companies of the AMDEE must generate initiatives in line with international trends to increase our competitiveness and participation in the global economy.

Héctor J. Treviño

Executive Director

AMDEE

INTRODUCTION

The Mexican Association of Wind Energy (AMDEE) is a non-profit civil association dedicated to promoting the development of the wind sector in Mexico. The AMDEE represents the main players in the wind industry and collaborates with the authorities in promoting the regulation and policies necessary to promote the sustainable and sustained development of wind energy in Mexico.

One of the main challenges of our country lies in fostering economic growth, by boosting competitiveness, productive investments and the greater participation of national suppliers in the energy sector. The above can be achieved through a model of articulation of productive chains based on the improvement of technical and quality capabilities, in order to meet the demand factors required by contractors and suppliers.

The Ministry of Economy, through the Unit of National Content and Promotion of Productive Chains and Investment in the Energy Sector, has established a strategy to support the development of national suppliers and contractors based on the Public Trust to Promote the Development of Suppliers and National Contractors of the Energy Industry.

This Public Trust has convened chambers and / or business associations representing companies, manufacturers or services that participate in the supply chain of the energy sector, to submit requests for Technical Assistance Support to participate in Category I. Standards of the industry.

The Call for Category I. Industry standards focus on contractors and suppliers of the energy industry value chains overcoming the obstacles to compete with openness in the energy sector, by strengthening their technical and quality capacities, to that the supply chain gradually provides greater added value, through the increase of national content in the goods and services that they offer, expand the supply of available labor skills, improve the processes and quality of their products, among others .

Derived from the above, the Mexican Association of Wind Energy A.C. (AMDEE), as a civil association that brings together the main developers, manufacturers and service providers of the wind sector in Mexico, has expressed interest in participating in the Category I. Industry Standards, through the Concept of Support E. Studies, for the development of the Study of Capacities of the Wind Industry in Mexico aimed at reducing the gaps in technical and quality capacities of manufacturers and suppliers, increasing the degree of national content, so that they participate in the supply chain of the wind sector.

OBJECTIVE

The "Study of Capacities of the Wind Industry in Mexico" has as its general objective to identify the gaps in the technical and quality capacities of the national suppliers of the wind industry sector in Mexico, to strengthen the national supply chain of the wind industry, increasing the National Content of its acquisitions.

SPECIFIC OBJECTIVES:

- Identify the main gaps between demand and national supply by main wind turbine component(s);

- Evaluate the degree of national integration in manufacturing by principal (s) wind turbine component(s);

- Analyze the chain of production involved in manufacturing by principal (s) wind turbine component(s) with low degree of national integration or foreign manufacturing

- Analyze the productive factors that impact the competitiveness of manufacturing by principal(s) wind turbine component (s);

- Make a diagnosis of challenges and opportunities for the development of the national industry by principal (s) wind turbine component (s) for the wind sector.

INTERNATIONAL CONTEXT

Based on data obtained from the document "Renewable Energy Statistics 2018" of the International Renewable Energy Agency (IRENA), wind energy has become an important player in the renewable energy markets. The global capacity of wind generation has increased at an average annual growth rate (TCMA) of around 16% in the period of 2008 - 2017, contributing 24% of the generation capacity of renewable energies worldwide.

96% of the world's wind capacity is generated in onshore wind farms, compared to offshore wind energy, which contributes 4% of the world's generation; however, the generation of offshore wind energy has shown significant growth with an average annual growth rate (TCMA) of the order of 29% in the same period of 2008 - 2017.

In relation to the main countries with onshore wind capacity, China shows an important growth, derived from public policies to promote the use of renewable energies in regions with the largest volumes of usable resources, this country participates with 33% of the world's wind capacity (161,420 MW), a TCMA of the order of 34% in the period of 2008 - 2017, which has allowed to multiply by twenty its generation capacity from 2008 to date.

In the same way, the United States of America (USA) shows an important growth in terms of its wind capacity with a participation of 18% of the world capacity (87,514 MW), a TCMA of the order of 13%, followed by the countries from Germany, India and Spain, with a share of global wind capacity of around 10%, 7% and 5%, respectively.

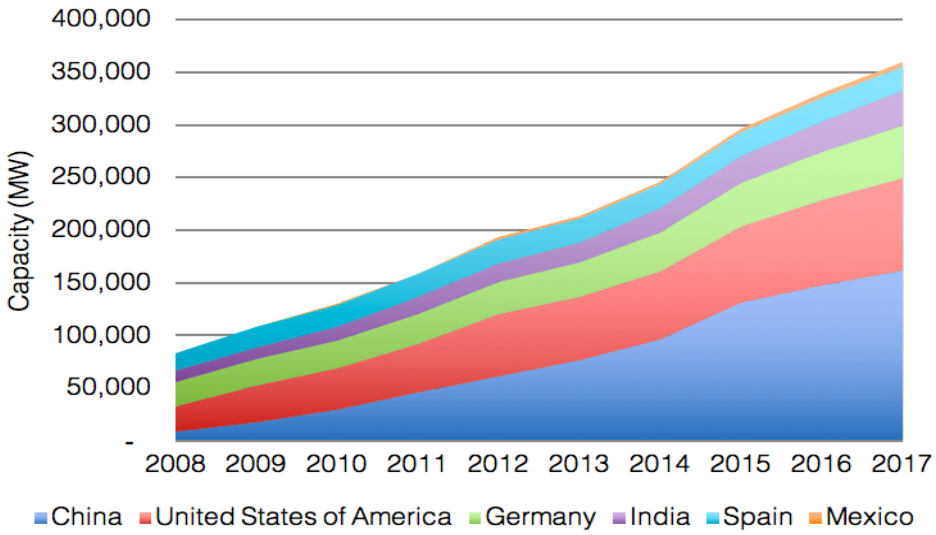
Mexico participates with only 1% of the world wind capacity with a total of 4,051 MW; however, our country has one of the highest average annual growth rates (TCMA) of around 44% in the period 2008 - 2017. In comparative terms the wind capacity of China and the US is 40 and 20 times respectively, larger than the installed capacity in Mexico in 2017. (Graph I.1)

As discussed in the previous section, the US shows significant growth in terms of its wind capacity with an 18% share of global capacity and a TCMA of around 13%. Based on the data from the Wind Technologies Market Report 2016, its wind capacity is distributed in 41 of the 50 American States, among which the State of Texas stands out with an accumulated capacity of 20,320 MW, which represents 25% of The total wind capacity of the US at the end of 2016, only the capacity of this American state is five times greater than the installed capacity in Mexico. Altogether the 10 major American States contribute 60,772 MW, which represents 74% of the installed capacity in the USA.

Based on the data from the 2016 Wind Technologies Market Report, several manufacturers have installed wind turbine manufacturing plants in the USA. At the end of 2016, there was a registry of 151 facilities dedicated to the manufacture of components and assembly of wind turbines and turbines.

The majority of manufacturing plants have been located in states with wind power generation capacity or close to original equipment manufacturers (OEMs). Among the main factors for the location of manufacturing plants are factors such as labor force, transportation costs, state incentives that drive location decisions. Of the 151 facilities dedicated to the manufacture of components and assembly of wind turbines, 37 manufacturing plants are dedicated to the manufacture and assembly

Graph I.1 Wind Energy Capacity (MW) by Main Countries



Source: Renewable Energy Statistics 2018, International Renewable Energy Agency (IRENA).

of Nacelles and its components representing 24% of companies, 10 plants dedicated to manufacturing of Towers (7%); 7 dedicated to the manufacture of Blades (5%); and 3 to the manufacture of turbines (3%).

Wind Sector in LATAM

The Latin American Region (LATAM) participates with 3% of the world's land wind capacity, with a TCMA of 41% in the period 2008 - 2017. In comparative terms, the wind capacity of our country represents 26% of the capacity of the Region of LATAM.

In the Region, five countries contribute 99% of the wind capacity, with Brazil being the leading country with a participation of 2% of the world capacity (12,294 MW) and 78% in the capacity of the region, with a TCMA of 40 % in the period 2008 - 2017. The installed capacity of Brazil is approximately three times greater than the installed wind capacity in Mexico. The countries of Uruguay and Chile participate respectively with 10% and 9% of the wind capacity of LATAM, with important TCMA of the order of 58.6% and 53.2%, respectively. In the case of Argentina and Peru, both countries have developed initial wind capacities, each country contributing 2% of the capacity of the LATAM Region, with Peru standing out with a TCMA of 73% in the period analyzed.

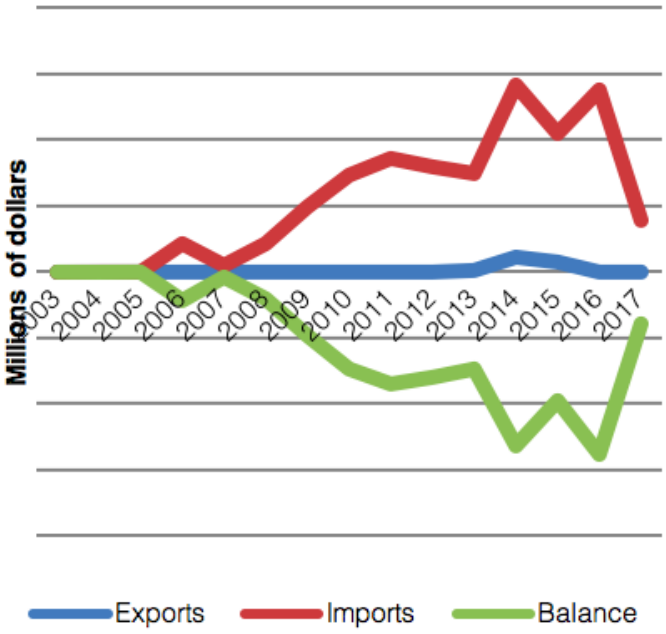
The estimation of the investment per MW in the LATAM Region, considering an average investment per MW of 1.25 MDD, was estimated an investment higher than the 19 MMDD in the period of 2008 - 2017, mainly in the period 2014 - 2017 in terrestrial wind farms in Brazil, a country that accounts for 78% of the investment. In relation to the number of wind turbines installed, considering an average capacity of 2.5 MW per wind turbine, a wind farm park of 6,289 units was estimated, of which 4,917 wind turbines are installed in Brazil, of which 82% would be less than a year old. 5 years of operation.

Foreign Trade of Mexico

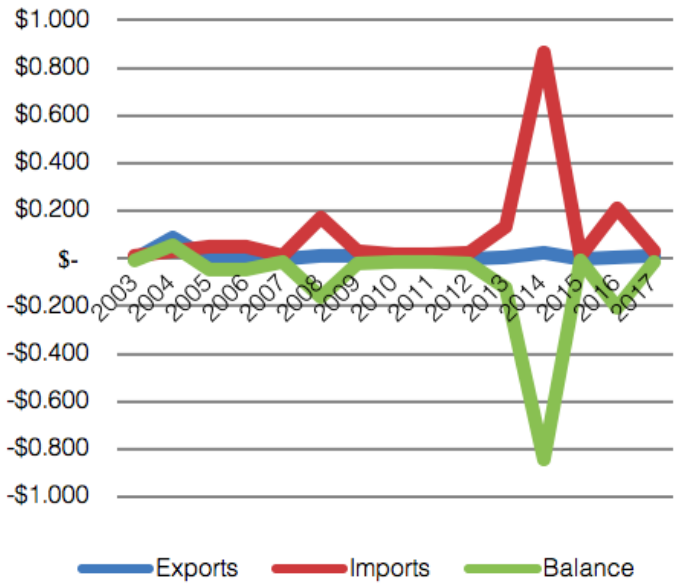
Based on the Internet Information System Via Internet (SIAVI) of the Ministry of Economy (SE), exports and imports were obtained by value (US dollars) and by volume (pieces) of tariff fractions 85023101 Wind turbines, and 85023199, The others, wind turbines.

With regard to the trade balance, relative to the value of exports and imports, of the Tariff Schedule 85023101 Wind Turbines, there is a highly deficit balance; mainly since 2006, when the wind farm development in our country begins, with significant increases in the period from 2014 to 2017. The trade balance relative to the value of exports and imports of Tariff Fraction 85023199, Other, we have a deficit trade balance, mainly due to an increase (peak) in imports in 2014. (Graphics I.1.1 and I.1.2)

Graph I.1.1 Commercial Balance by Value of the Wind Turbine Fraction (MDD)



Graph I.1.2 Commercial Balance by Value of the Tariff Fraction of the Others of the Wind Sector (MMDD)



Source: Via Internet Business Information System (SIAVI), Ministry of Economy.

PHASE 1. DESIGN

Demand Analysis

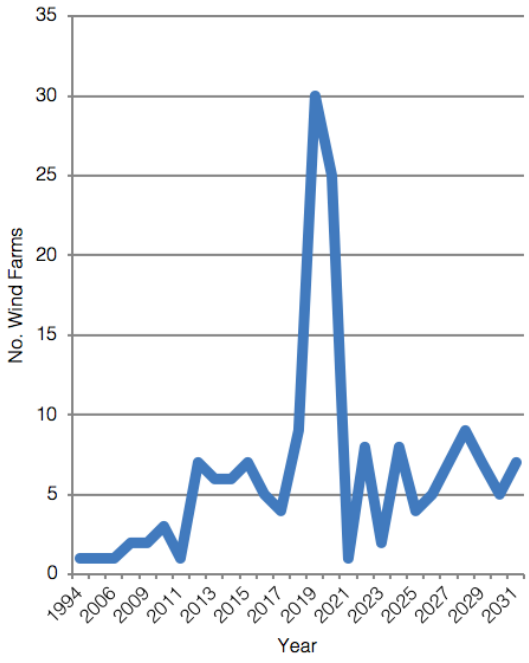
The analysis of the demand was made according to the data and information of the Wind Farm Inventory of Mexico of the AMDEE of 1994 - 2022 and of the Development Program of the National Electric Sector 2017 - 2031 (PRODESEN) for the period 2023– 2031. With the available information, the analysis of the growth projections was made in the number of wind farms, wind turbines and installed capacity in the period of 1994-2031, making a classification by type of wind turbine according to its capacity range: <1.5 MW,> 1.5 MW up to 3.0 MW, and> 3.0 MW.

Wind Parks

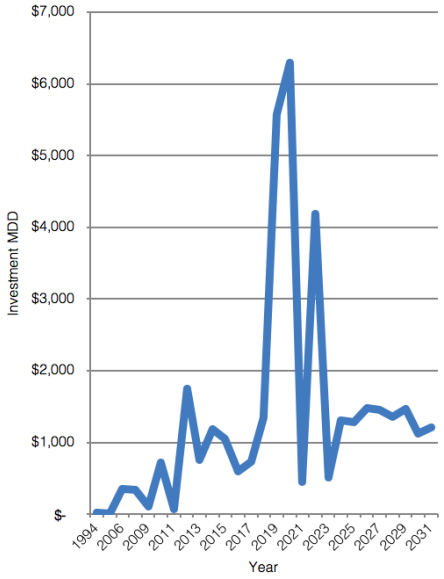
In the period 1994-2031, it is estimated that a total of 173 wind farms in Mexico will be reached, with an average growth rate of 7.5% per year. (Graph I.1.3)

In the years 2019 and 2020, it is where there is greater growth in the rating of wind farms, estimating to create 54 parks, which represent 31% of the total of wind farms, projected in the period 1994 - 2031.

Graph I.1.3 Total Wind Parks (1994 - 2031)



Graph I.1.4 Estimated Investment (MDD) in Wind Farms (1994 - 2031)



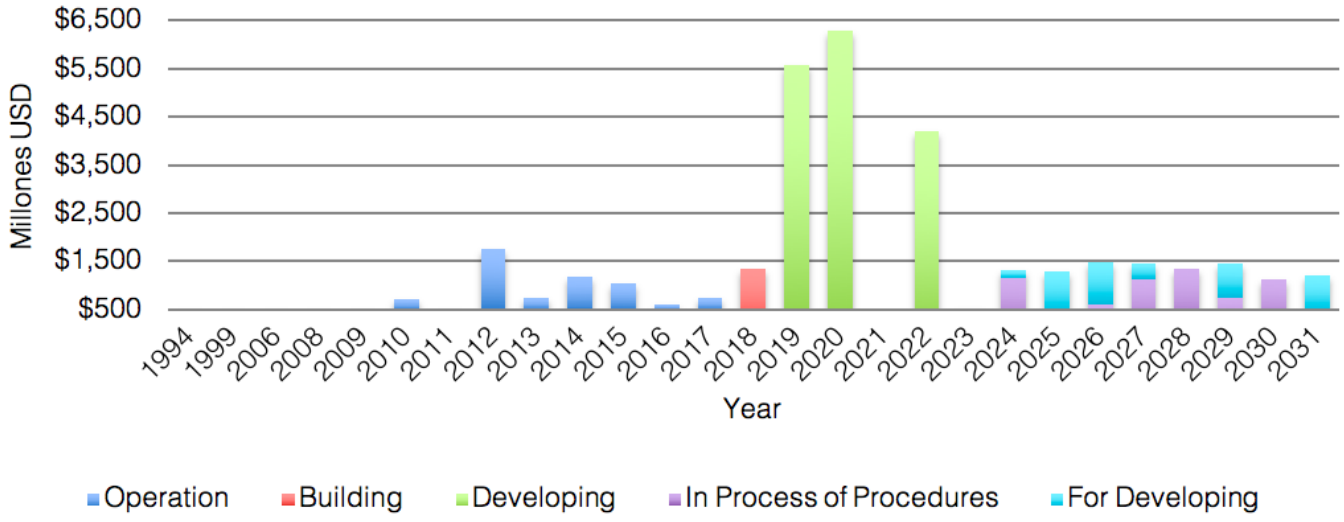
Estimated investment

In the period 1994 - 2031, there is an estimated investment of 36.7 billion US dollars (MMDD) with an average annual growth rate of 15.4%. (Graph I.1.4)

Only for the period 2019 - 2022, an investment of 16.5 MMDD is estimated, which would represent 45% of the projected investment in the period 1994 - 2013.

Regarding the parks already in Operation (1994 - 2017) an investment of 7.6 MMDD was estimated, which represents 21% of the total; for the parks under construction an investment of 1.4 MMDD (4%) is estimated; for the parks under development, an investment of around MM3.3 million is estimated, which represents 45% of the total investment; 7.2 MMDD (20%) for the Parks in Process of Procedures; and 3.9 MMDD for the parks to be developed (11%). (Graph I.1.5)

Graph I.1.5 Total Investment Amount (MUSD) by Project Status (1994 - 2031)

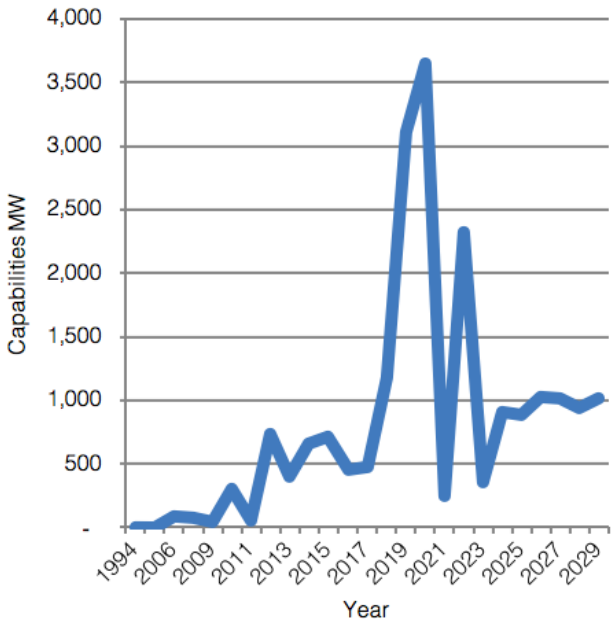


Source: Inventory Wind Parks Mexico, 2018, AMDEE for data 1994 - 2022, and Development Program of the National Electricity Sector 2017 - 2031 for data 2023 - 2031.Eléctrico Nacional 2017 – 2031 para los datos 2023 – 2031.

Installed Capacity (MW)

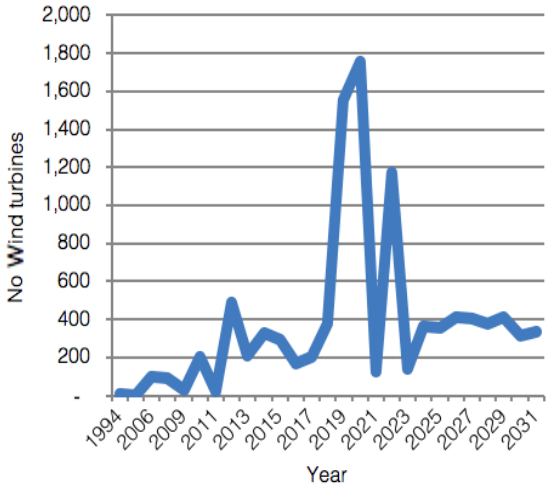
In the period 1994-2031, it is estimated that there will be a total of 22.3 thousand MW in the different wind farms with an average growth rate of 26.2% per year. The previous thing would imply to multiply by five times the current capacity of generation of wind energy to 2031, reaching a generation capacity similar to that currently have countries like India and Spain. For the years 2019 and 2020, it is estimated to develop a capacity of 6.7 thousand MW through the consolidation of the development parks, which represents 30% of the total projection. (Graph I.1.6)

Graph I.1.6 Total Estimated Capacity (1994 - 2031)



Wind turbines

Graph I.1.7 Total Wind Turbines (1994 - 2031)

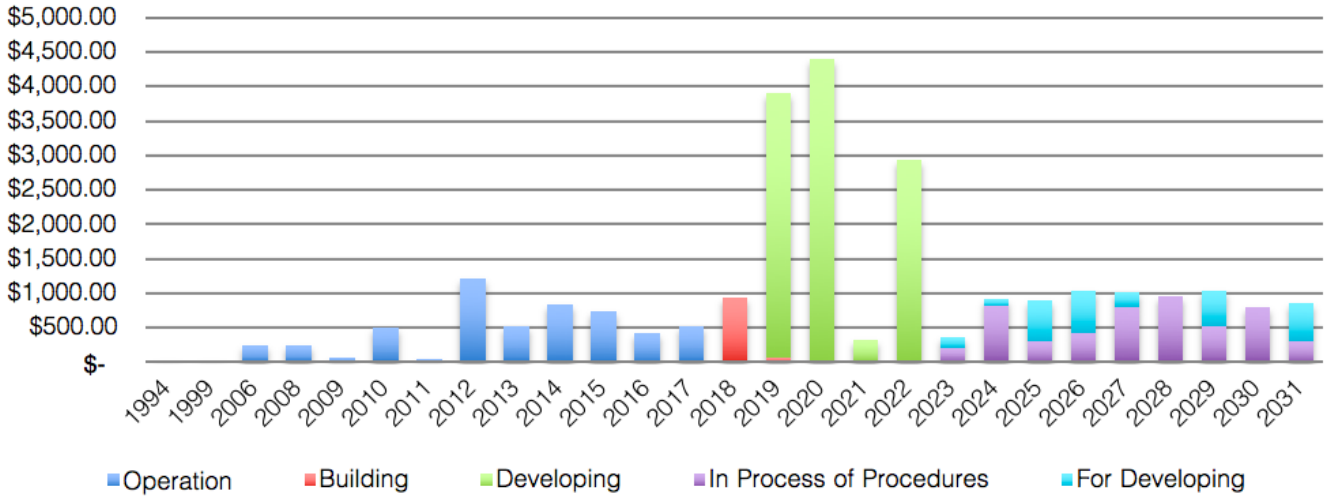


In the period 1994-2031, it is estimated that there will be a total fleet of 10,229 wind turbines in Mexico with an average growth rate of 15.4% per year. (Graph I.1.7)

For the years 2019 and 2020, a requirement of 3,306 wind turbines is estimated, which represents 32% of the projections of total requirements of wind turbines

The parks already in operation (1994 - 2017) involved investments for an amount of 5.3 MMDD in wind turbine systems (21%); in Construction an investment is estimated only for these systems of order 1 MMDD (4%); for the parks in Development it estimates an investment of 11.4, 45% of the total investment; 5.0 MMDD (20%) for the parks in Process of Procedures and 2.7 MMDD for the parks for Development (11%). (Graph I.1.8)

Graph I.1.8 Estimated Investment in Wind Turbine Systems (MUSD) by Project Status (1994 - 2031)



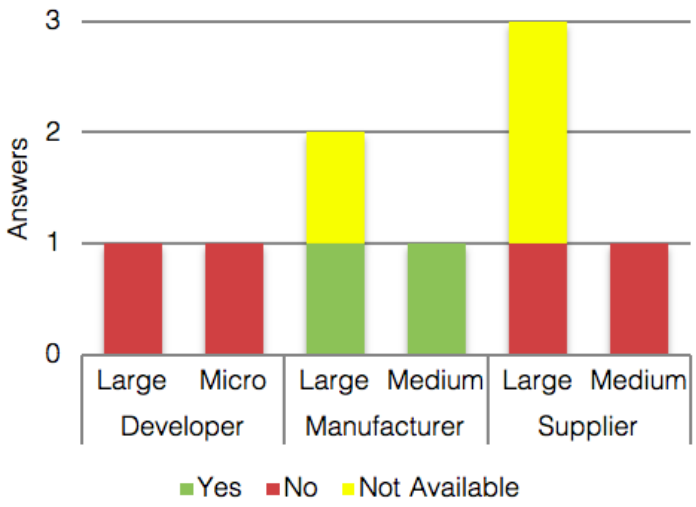
Source: Inventory Wind Parks Mexico, 2018, AMDEE for the data 1994 - 2022, and Development Program of the National Electric Sector 2017 - 2031 for the data 2023 - 2031. The estimated amounts of the value of the expected demand by were calculated based on the investment amounts presented in the Development Program of the National Electric System (PRODESEN) 2016 - 2030.

Analysis of the Offer

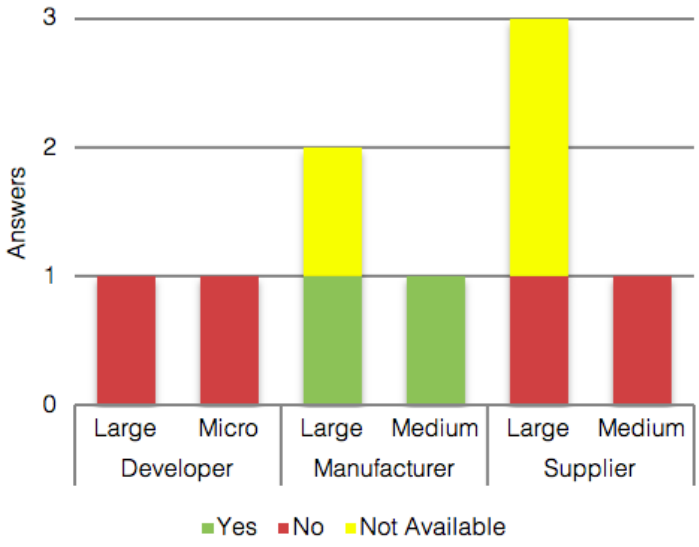
Analysis of Plant and Equipment

Regarding the question of whether they have a wind turbine assembly plant in Mexico, 90% of the companies do not count, with the case of Manufacturers without national production standing out, which has important repercussions in the national manufacture of wind turbines and the national content. (Graph I.1.9.)

Graph I.2 Subcontracts the manufacturing of some wind turbine system (s) in Mexico



Graph I.2 Subcontracts the manufacturing of some wind turbine system (s) in Mexico



Analysis of Subcontracting Processes

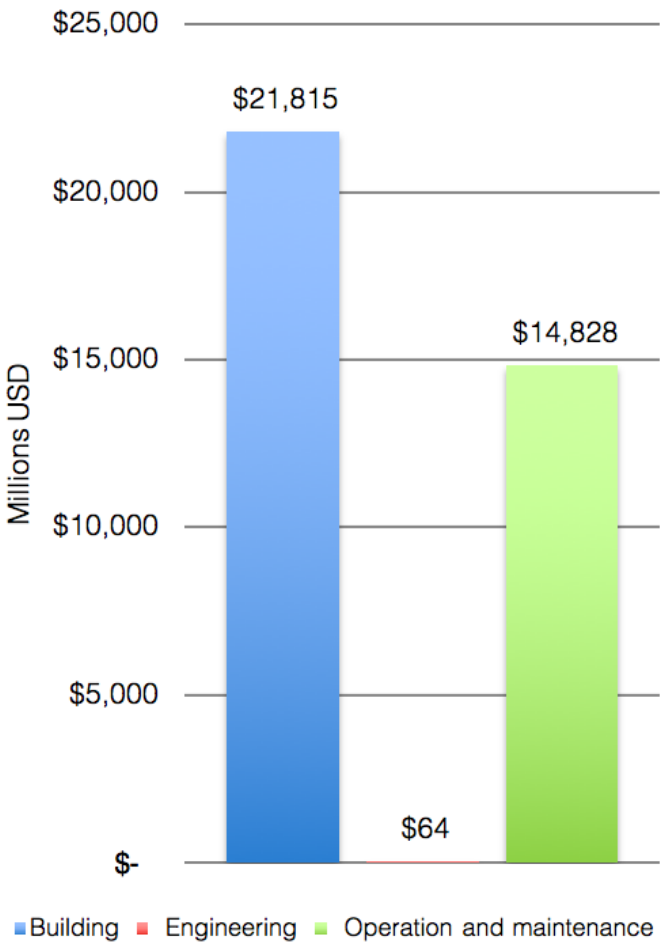
'With regard to whether they subcontract locally the manufacturing of any of the systems that make up the wind turbines, 66% of the Manufacturers companies carry out some type of subcontracting of parts and / or components of wind turbines, which opens up opportunities for their domestic manufacture and the potential increase in the degree of national content. (Graph I.2.)

Source: Results of Interviews Applied to Participating Companies.

Value Chain

Based on the Model, an analysis was carried out to measure the value of prospective demand and identify the opportunity areas for national suppliers, estimating that 59.4% of the investment is executed in the Construction Phase of the Wind Farm; 40.4% to the Operation and Maintenance Phase; and 0.2% in the Engineering Phase.

Graph I.2.1. Estimation of Investments by Wind Farm Project Phase (MUSD)

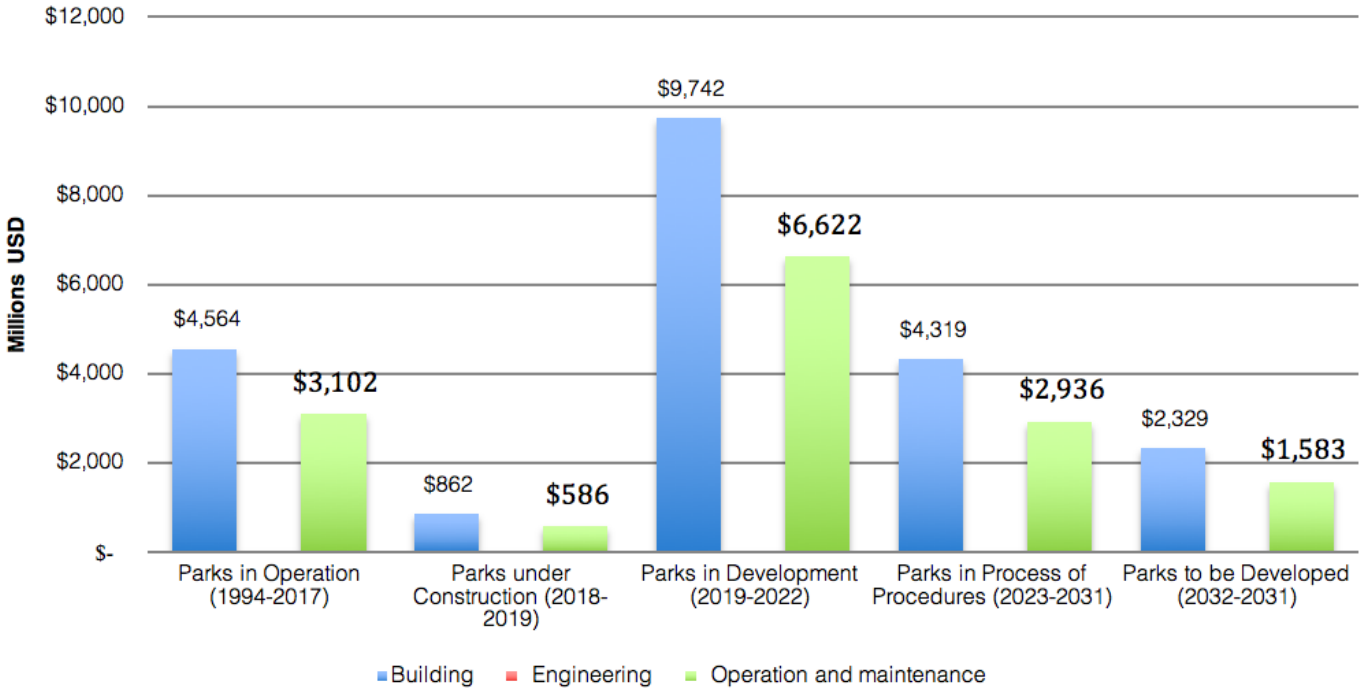


Derived from the above, considering the estimated investment for the growth projection of wind farms in Mexico in the period 1994 - 2031 of the order of 36,716 million dollars; 21,815 MDD would be executed in the Construction Phase; 14,828 MDD in the Operation and Maintenance Phase; and 64 MDD to the Engineering Phase. (Graph I.2.1.)

Source: Own elaboration with data from the Wind Generation Productive Chain Study, the Wind Farm Inventory Mexico, 2018, AMDEE for data 1994 - 2022, and National Electric Sector Development Program 2017 - 2031 for data 2023 - 2031.

For the different States of the Wind Projects in the period 1994 - 2031, an estimate of the investments required by each of the phases of the project was made chain productive of the wind sector. The following chart highlights a greater investment required in the Developing Parks. (Graph I.2.2.)

(Graph I.2.2.) Estimation of Investments by Phase by Project Status (MUSD)



Source: Own elaboration with data from the Wind Generation Productive Chain Study, the Wind Farm Inventory Mexico, 2018, AMDEE for data 1994 - 2022, and National Electric Sector Development Program 2017 - 2031 for data 2023 - 2031.

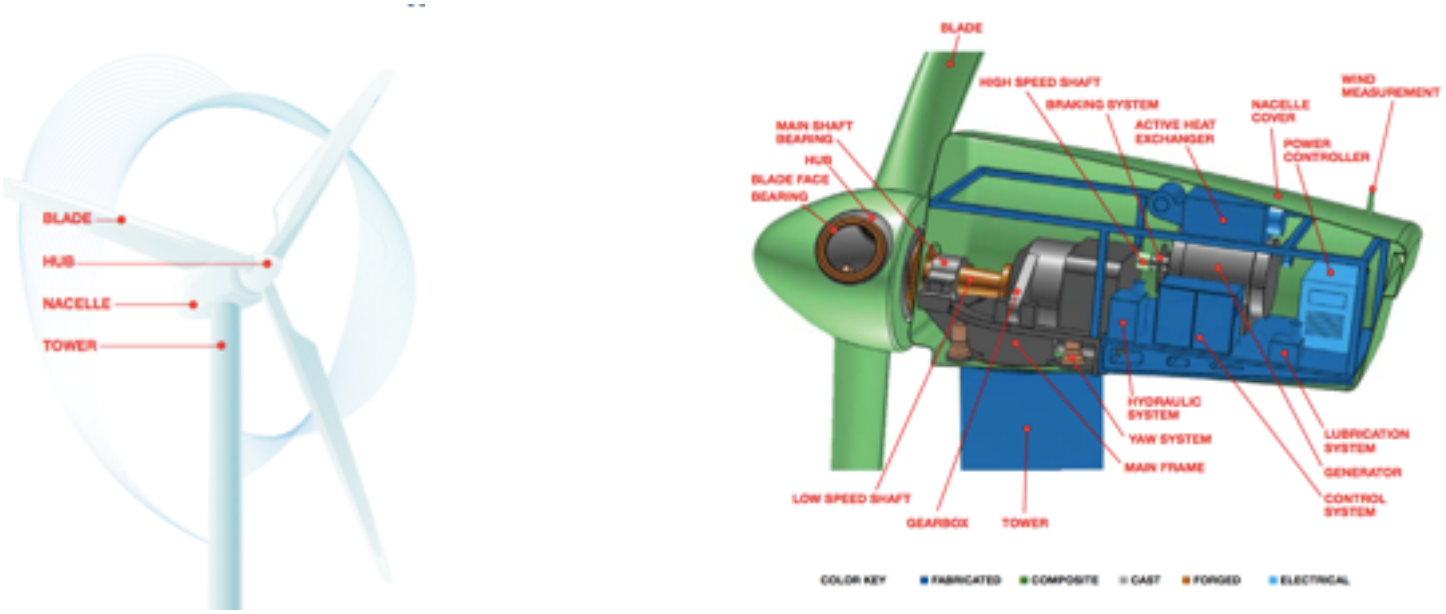
PHASE 2. ANALYSIS

National Content Analysis

Exploration of the Wind Turbine by Main Components

At an international level, several studies divide the wind turbine into three main components: 1) Tower, 2) Nacelle and 3) Blades. The Tower is usually steel tubular from 80 to 100 meters (about 260 to 330 feet) in height. The Nacelle contains the main components of the wind turbine such as the controller, gearbox, generator, and axes, among other components. The Blades are generally 30 to 50 meters (100 to 165 feet) long (Image II.13)

Image II.13 Exploded Main Components of the Wind Turbine

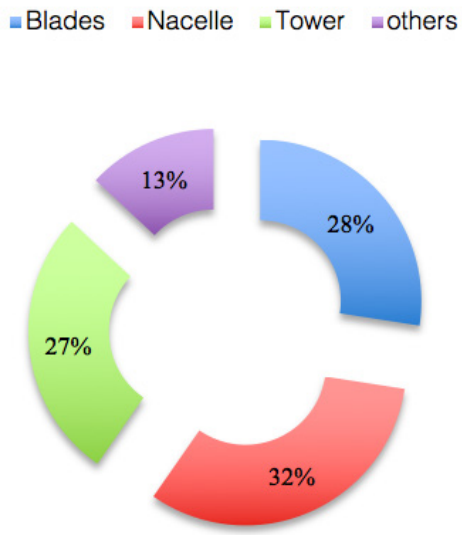


Source: Image taken from the Wind Energy Industry Manufacturing Supplier Handbook, 2011.

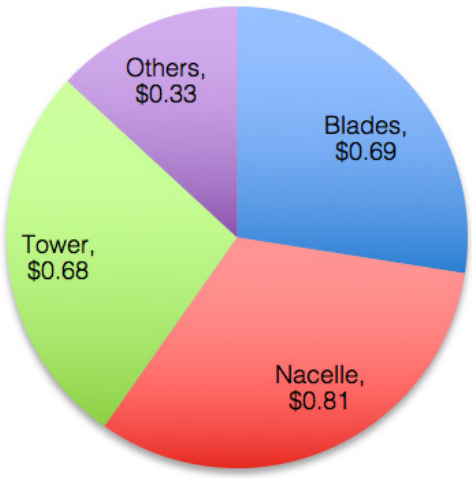
Based on various studies such as Wind Energy Industry Manufacturing Supplier Handbook and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, the cost structure of three main wind turbine components. In general terms, the Nacelle implies 32% of the total cost of the wind turbine, being the component that represents the highest cost, followed by the Blades with 28% of the total cost, and the Tower with 27%, finally Other components, imply a contribution of 13% of the wind turbine.

Based on the growth estimates of the wind industry of the AMDEE, where a cost of $ 2.51 Million of American Dollars (MUSD) is calculated, the Nacelle would have an approximate cost of $ 0.81 MUSD, the Blades of $ 0.69, and the Tower $ 0.68 MUSD (Graphics I.2.3.).

Graph I.2.3 Percentage of Wind Turbine Costs



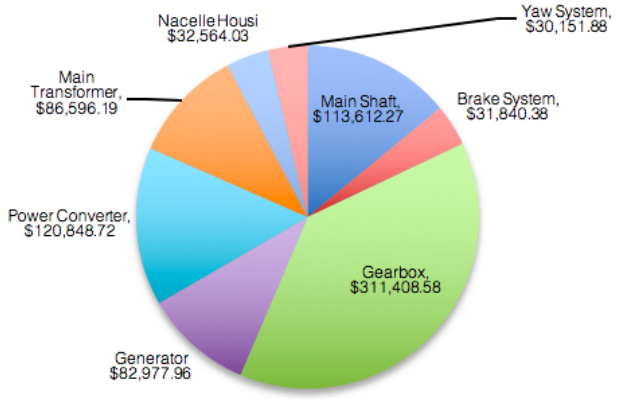
Graph I.2.3 Estimation of Wind Turbine Costs (MUSD)



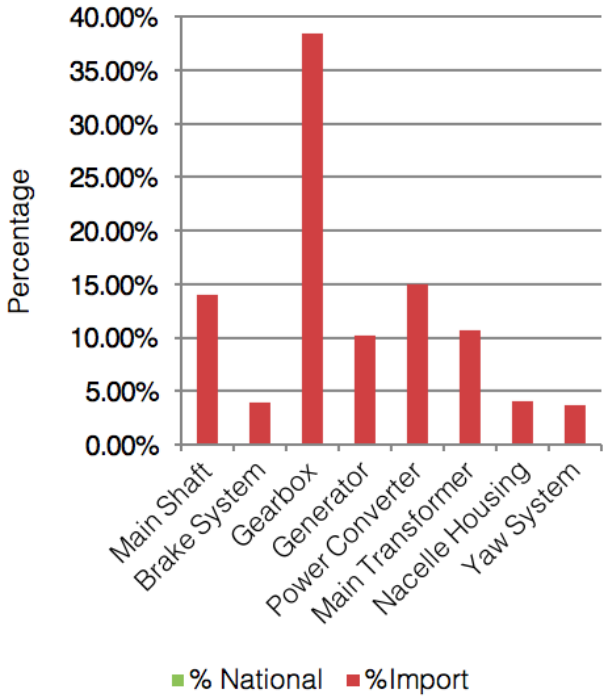
Source: Prepared by the authors based on the Wind Energy Industry Manufacturing Supplier Handbook, 2011, and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, 2011.

Graph I.2.4. Estimation of the cost by main sub-components of the Nacellle (USD)

With respect to the estimation of the costs by main sub-components of the Nacelle, a Gearbox would have an estimated cost of around 311 thousand dollars, and the Power Converter with 120 thousand American dollars, respectively. (Graph I.2.4.)

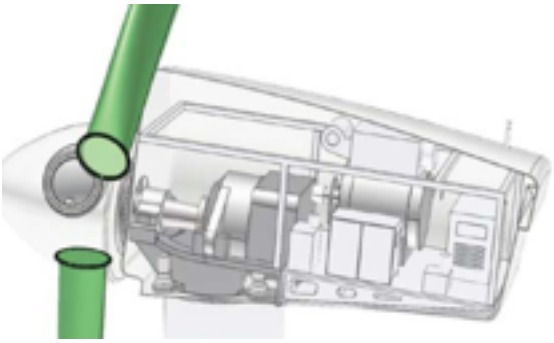


Graph I.2.5 National Content in Nacellle System

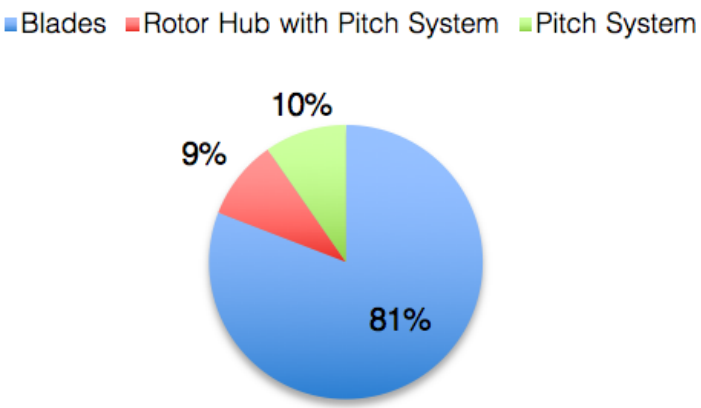


According to the results obtained by the companies surveyed, all the subcomponents are imported, so that there would be a national content of 0%. It is important to note that in Mexico there are companies with capacities for the manufacture of certain subsystems of the Nacelle, mainly in terms of electrical subcomponents such as the Generator, Power Converter, and Main Transformer. (Graph I.2.5.)

National Content of the Blades System



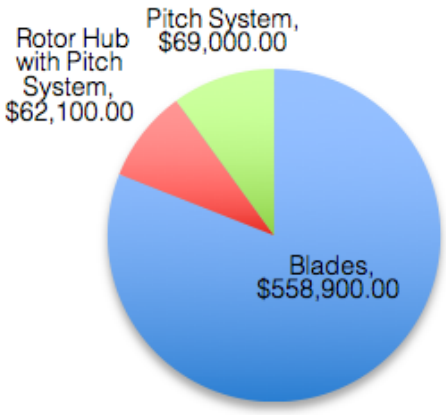
Graph I.2.6 Blade Costs Percentage



Regarding the structure of the Blades, 3 main subcomponents were identified: Blades, Rotor (Hub with Pitch System) and the Pitch System. The subcomponent of the Blades represent 81% with respect to the total cost structure, followed by the Incline System (Pitch System). with 10%, and the Rotor (Rotor Hub with Pitch System) with 9% of the total cost of the Blades System. (Graph I.2.6.)

Graph I.2.7. Estimation by main subcomponent of Blades (USD)

The estimation of the costs by main subcomponents of the Blades System indicates that the Blades would have an approximate cost of 558 thousand American dollars and the System of Inclination (Pitch System) of the order of 69 thousand American dollars. (Graph I.2.7.)

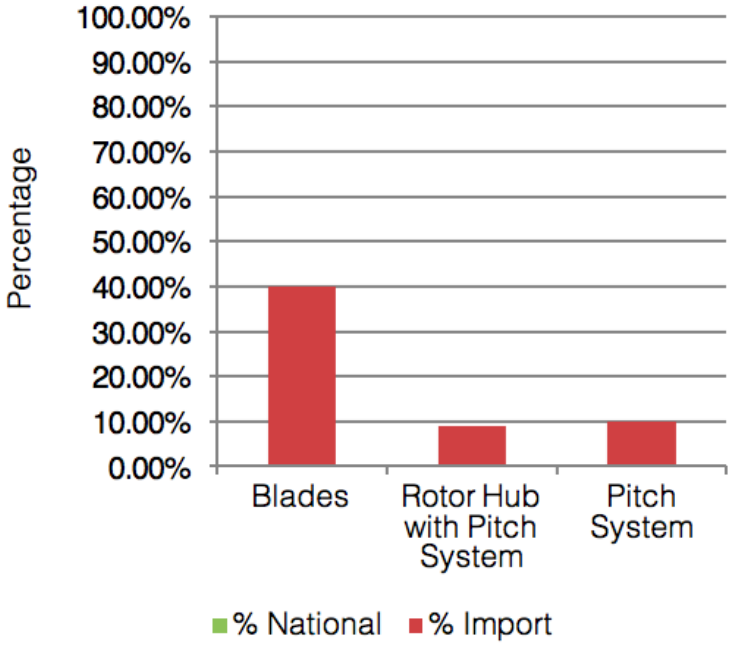


Source: Prepared by the authors based on the Wind Energy Industry Manufacturing Supplier Handbook, 2011, and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, 2011. Image taken from the Wind Energy Industry Manufacturing Supplier Handbook, 2011.

Graph I.2.8. National Content in the Blade System (n = 3)

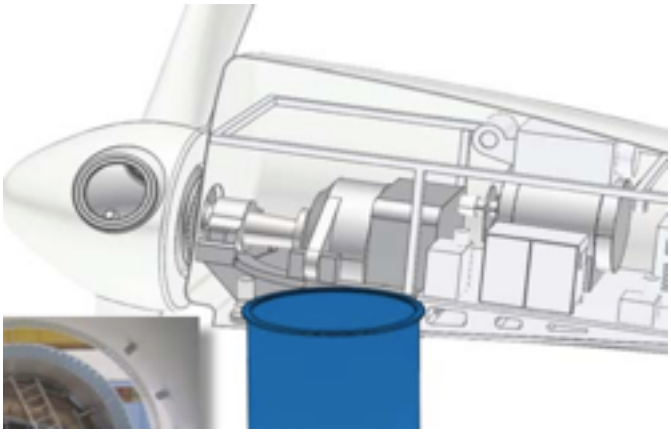
The results obtained by the participating companies, in terms of the National Content of the Blades System, obtained a national content of 0%, since the three main subcomponents are imported in their entirety. (Graph I.2.8.)

It is important to point out that in Mexico, companies dedicated to the manufacture of Blades are beginning to be located, which would allow increasing the degree of national content in the short term.

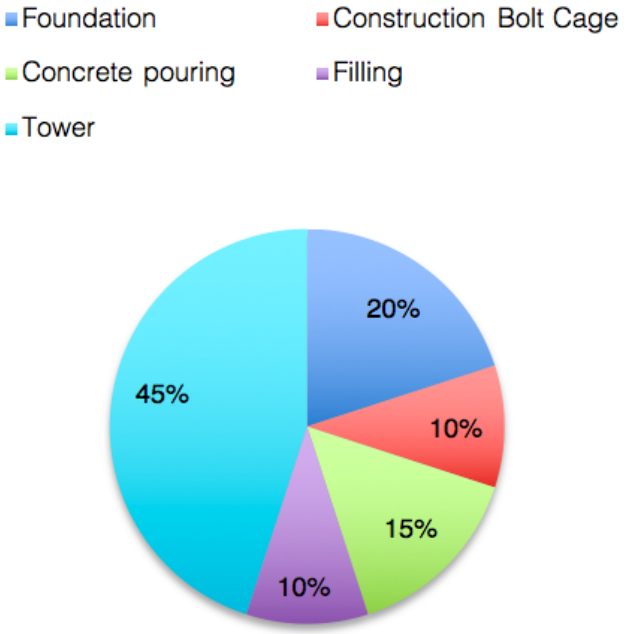


Source: Own elaboration with results of the Interviews Applied to Participating Companies, and the Study Wind Energy Industry Manufacturing Supplier Handbook, 2011, and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, 2011.

National Content of the Tower System



Estuctura de Costos del Sistema de Torre del Aerogenerador (n=2)



The Tower is made up of various subcomponents that involve the development of civil works for the anchoring of the towers as a foundation, bolt cage construction, concrete pouring and filling, subcomponents that are a function of the characteristics of the tower, the surface of the wind farm and generation capacity in MW. (Graph I.2.9.)

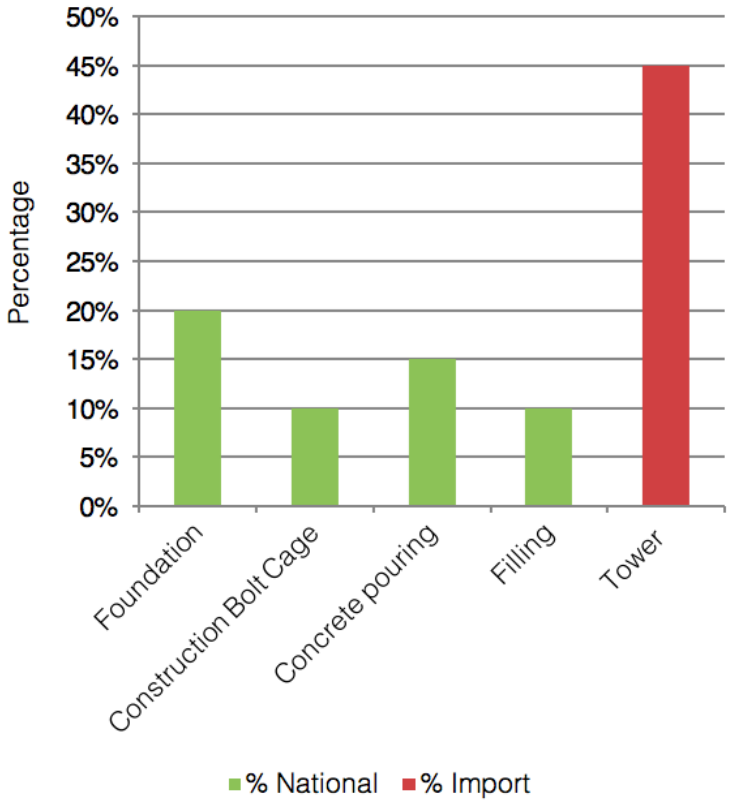
The Tower as a unit represents approximately 45% of the cost total, followed by foundation (20%) and concrete pouring (10%).

Source: Own elaboration with results of the Interviews Applied to Participating Companies. Image taken from the Wind Energy Industry Manufacturing Supplier Handbook Study, 2011.

Graph I.3 National Content in Tower System

According to the results obtained by the companies surveyed, in terms of the National Content, it was obtained that certain components of the Tower System can be supplied nationally, mainly those related to civil works.

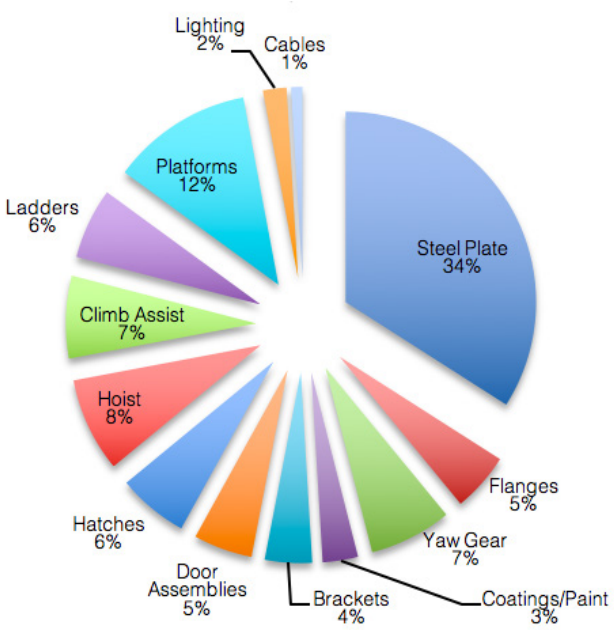
In this sense, there would be opportunities for national procurement for the development of civil works related to the foundation, the construction of the bolt cage, the pouring of concrete and the filling. In terms of the Tower, a national content of 0% was obtained, since the total of the subcomponents are imported in their entirety. (Graph I.3)



Source: Own elaboration with results of the Interviews Applied to Participating Companies, and the Study Wind Energy Industry Manufacturing Supplier Handbook, 2011, and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, 2011.

National Content of the Tower

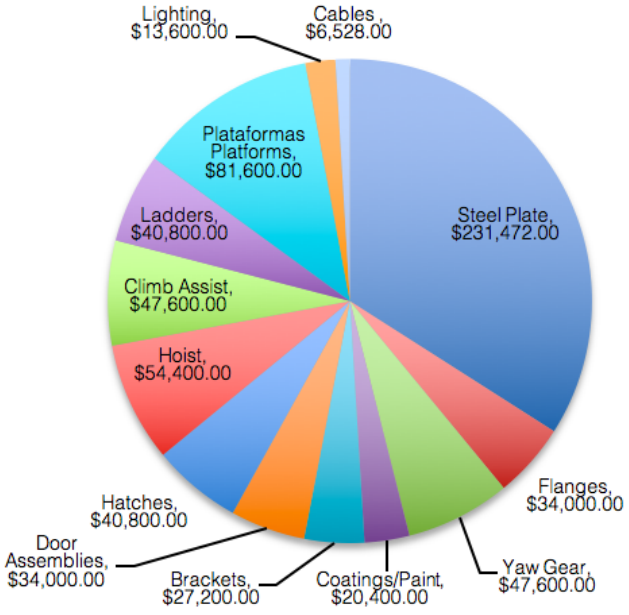
Graph I.3.1 Percentage of Costs of the Tower Component



The Tower of the wind turbine, is composed of various subcomponents such as Steel Plate, Flanges, Yaw Gear, Coatings/Paint, Brackets, Door Assemblies, Hatches, Hoist, Climb Assist, Ladders, Platforms, Lighting and Cables. (Graph I.3.1)

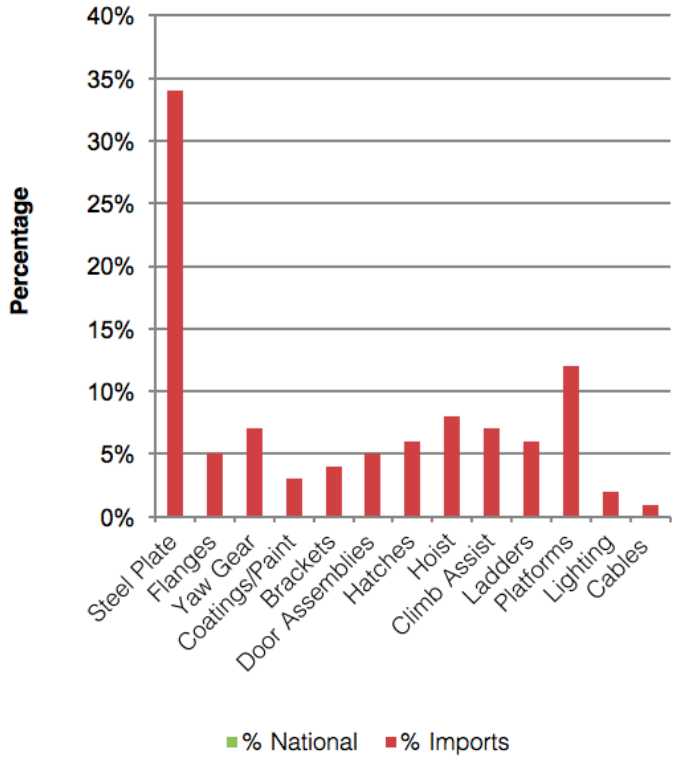
Graph I.3.2 Cost estimation by main subcomponents of the Tower (USD)

The estimation of the costs by main subcomponents of the Tower, indicates that the Steel Plates, that conform the structure shows the greater cost with 231 thousand American dollars, followed of the Platform with 81 thousand American dollars. (Graph I.3.2)



Source: Own elaboration with results of Interviews Applied to Participating Companies

Graph I.3.3 National Content of the Wind Turbine Tower (n = 3)



According to the results obtained by the companies surveyed, in terms of National Content, a national content of 0 was obtained, since the total of the components of the Tower are imported in their entirety.

In this sense, there would be national procurement opportunities for the development of certain components of the Tower. (Graph I.3.3)

Source: Own elaboration with results of the Interviews Applied to Participating Companies, and the Study Wind Energy Industry Manufacturing Supplier Handbook, 2011, and U.S. Wind Turbine Manufacturing: Federal Support for an Emerging Industry, 2011.

Capacity of the National Industry

As mentioned in previous sections, our country currently does not count wind turbine manufacturing. As the capacity of wind energy in Mexico has grown in recent years, the various manufacturers of foreign and domestic turbine equipment have not located operations in the different regions of our country, so the Mexican wind industry is highly dependent on imports.

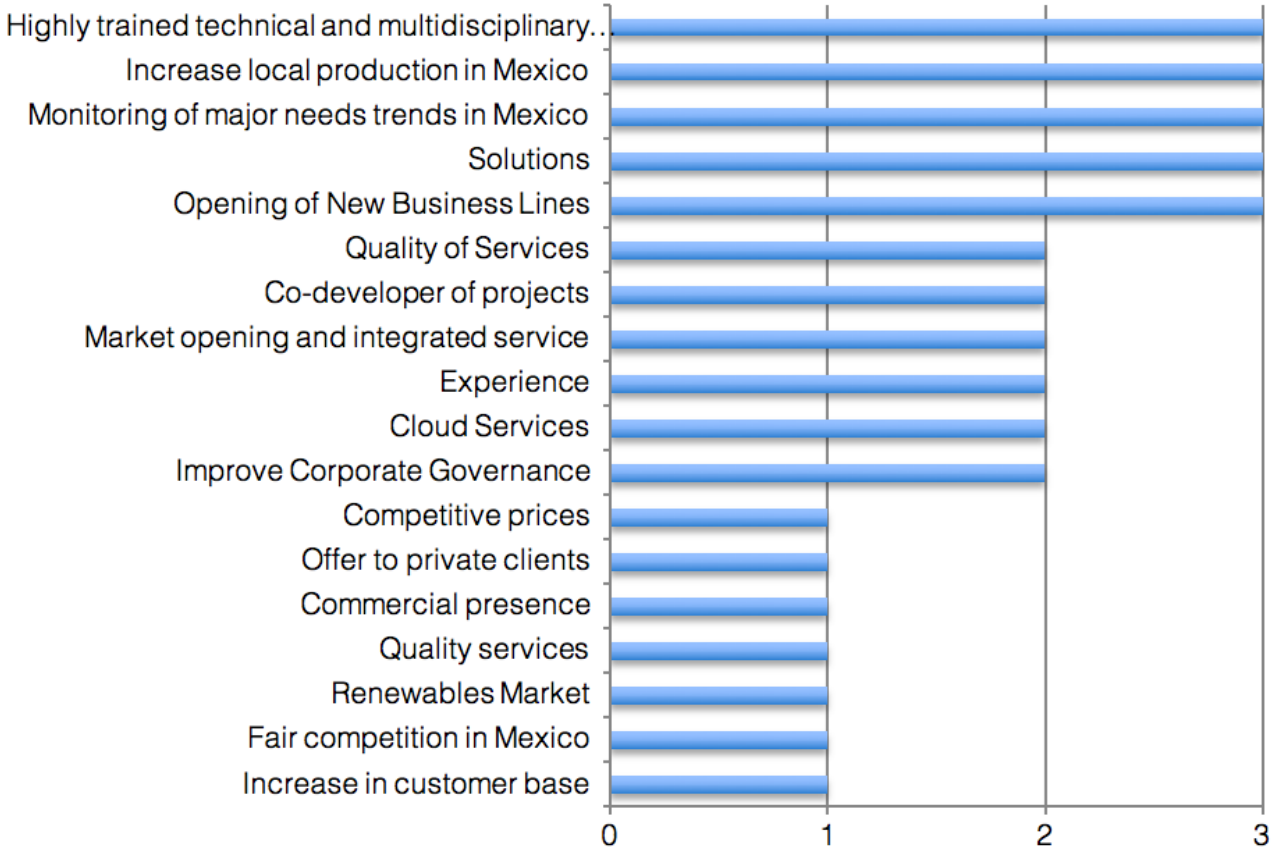
It is important to point out that, based on foreign trade data, the wind industry has deficit trade balances. Although in recent years companies have been located with manufacturing capabilities of certain components such as blades (TPI Composites) and Towers (Trinity), as well as some electrical subcomponents of the Nacelle (Industrial Power), the national industry does not have the Complete manufacturing capacity of wind turbines.

In this regard, the estimated demand in the period 2019 - 2031 shows that the national wind industry does not have the installed capacity to meet the estimated demand for wind turbine growth and estimated generation capacity in MW.

Main Factors for the National Value Chain

Among its main growth strategies in Mexico are the consolidation of its human resources, through the development of highly trained multidisciplinary technical teams; increase local production which opens opportunities for the integration of the value chain; have a better follow-up of trends and needs of the wind sector in Mexico; the implementation of integral solutions, and the opening of new lines of business for the diversification of its products and services. (Graph I.3.4)

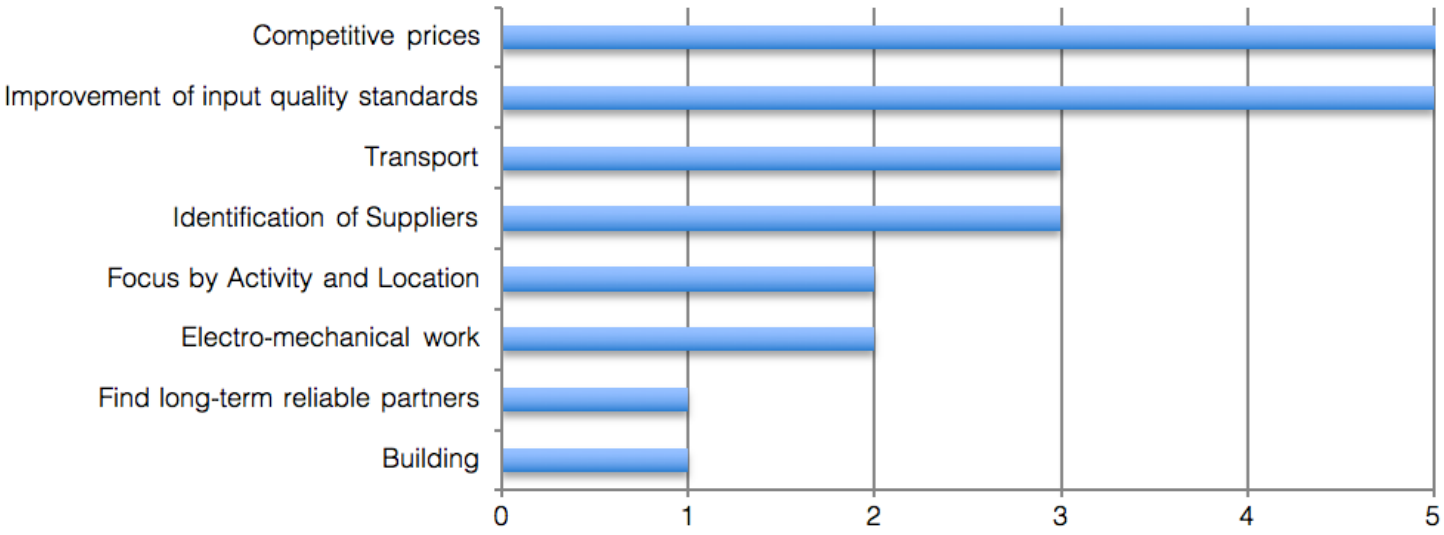
Graph I.3.4 Mention your three main growth strategies in Mexico? (n = 8)



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Regarding what would be its three main needs to integrate a national supply chain, the participating companies pointed out the following as the main ones: 1) Have competitive prices from national suppliers that allow them to compete in terms of costs with countries such as China and India, 2) Improve the quality standards of the products of the national suppliers, as well as in terms of compliance with the services. 3) The issues of transportation of equipment and materials imply an important need in the short term to integrate national suppliers, given the complexity of the processes logistics for the creation of wind farms, and 4) Identification of suppliers, that is, there are still limitations in the knowledge of the capacities of national suppliers to integrate the supply chains. (Graph I.3.5)

Graph I.3.5 What would be your three main needs to integrate a national supply chain (n = 9)



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Regarding what would be its three main problems for the development of its supply chain, the participating companies pointed out the following as the main ones:

1) Quality Standards, one of the main problems is the compliance with quality standards.

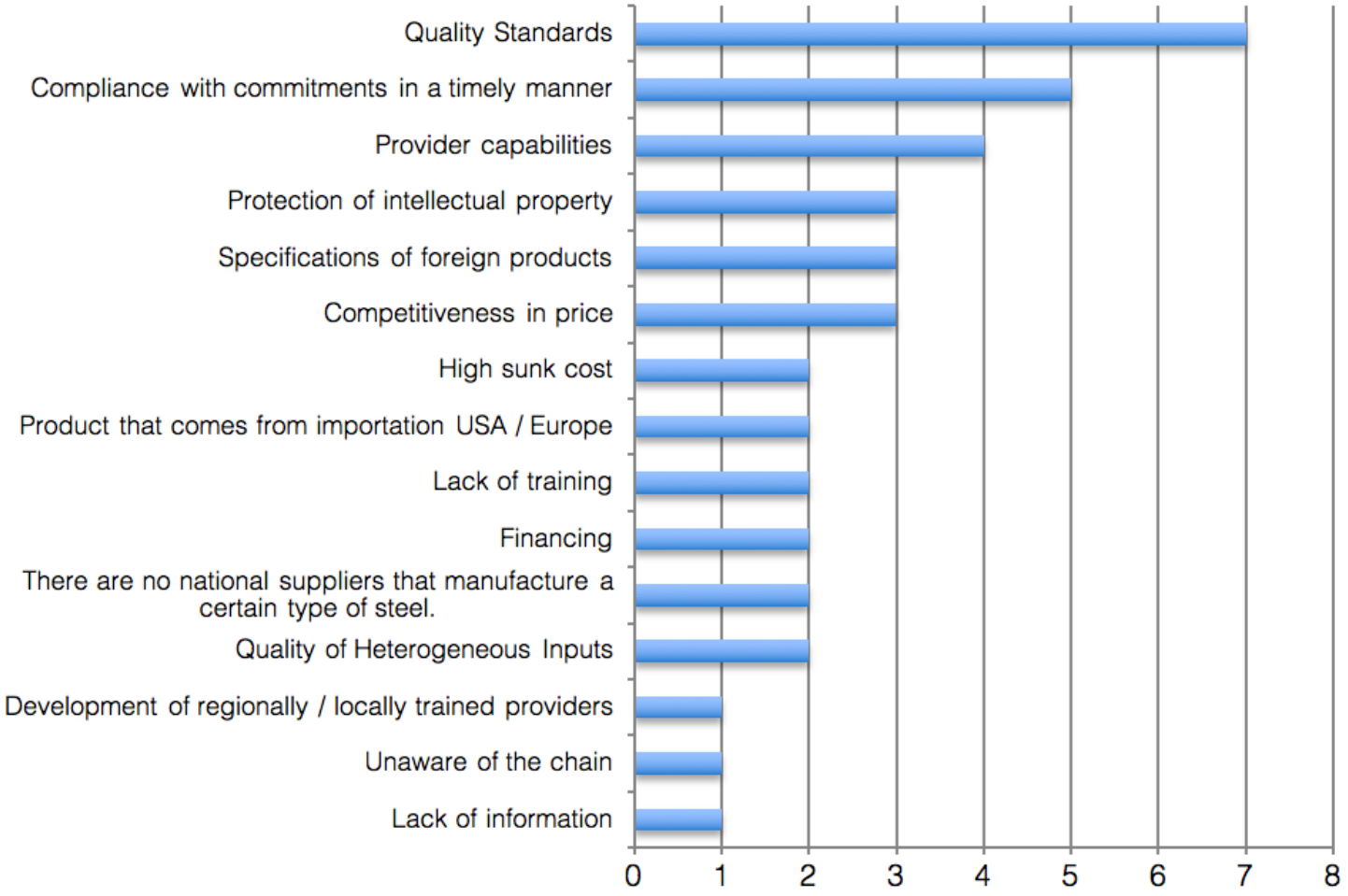
2) The low Reliability in the fulfillment in time and form of the delivery of products or services with the requested quality.

3) The limitations on the technical capabilities of national suppliers to develop products and / or services with the established requirements.

4) The lack of mechanisms for the protection of intellectual property, which allows companies to safeguard their technical and commercial confidential information.

5) Lack of compliance for the manufacture of products and / or services that comply with international specifications, 6) Lack of competitiveness in price, since national suppliers do not have developed economies of scale that allow them to compete with international suppliers, and 7) The high sunk costs of incorporating national suppliers in the value chain. (Graph I.3.6)

Graph I.3.6 What are the three main problems identified for the development of your supply chain (n = 10)



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

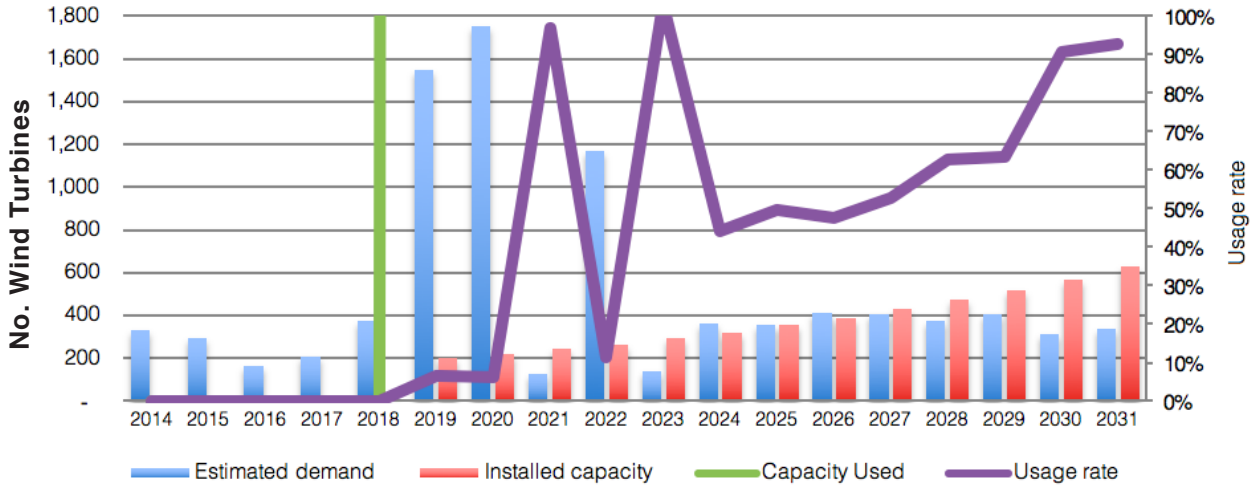
National Manufacturing Opportunities

Nacelle Subcomponents

Generator

In Mexico, there are supply opportunities for the Generator subcomponent, which is part of the Nacelle. The following graph shows the estimated demand in the number of Generators in the period 2019 - 2031. Mexico would have the capacity to meet the demand of the Generator. (Graph I.3.7)

Graph I.3.7 Analysis of the Gap between the Estimated Demand versus the Estimation of Installed and Used Capacity in National Manufacturing Generators



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Estimation of Increase in the National Content of the Nacelle Component.

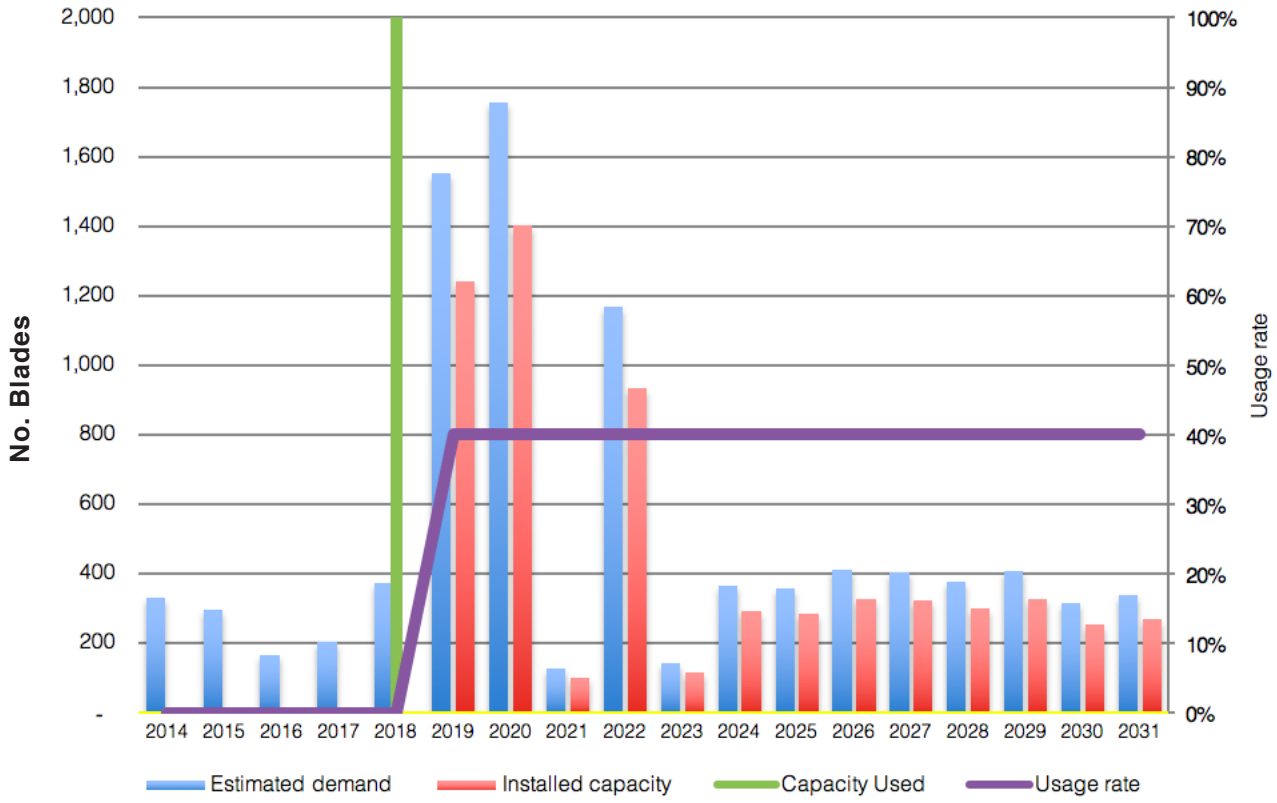
Main Subcomponents	Cost structure	Import (%)	Component Cost	Sale price	Import Cost
Main Shaft	14.03%	1	$113,468.22		$113,468.22
Brake System	3.93%	1	$31,800.01		$31,800.01
Gearbox	38.45%	1	$311,013.74		$311,013.74
Generator	10.24%	0	$82,872.76		$-
Power Converter	14.92%	0	$120,695.50		$-
Main Transformer	10.69%	0	$86,486.39		$-
Nacelle Housing	4.02%	1	$32,522.74		$32,522.74
Yaw System	3.72%	1	$30,113.65		$30,113.65
			$808,973.00		
				$808,973.00	
				$808,973.00	$518,918.36
					36%

Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Blades Subcomponents

In Mexico, there are supply opportunities for the Blades subcomponent. The following graph shows the estimated demand in the number of Blades in the period 2019 – 2031 (Graph I.3.8).

Graph I.3.8 Analysis of the Gap between the Estimated Demand versus the Estimation of the Capacity Installed and Used in National Manufacturing Blades



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

In the event that the Blades subcomponent is integrated into the supply chain, the national content could be increased by 81%.

Estimation of Increase in the National Content of the Component Blades

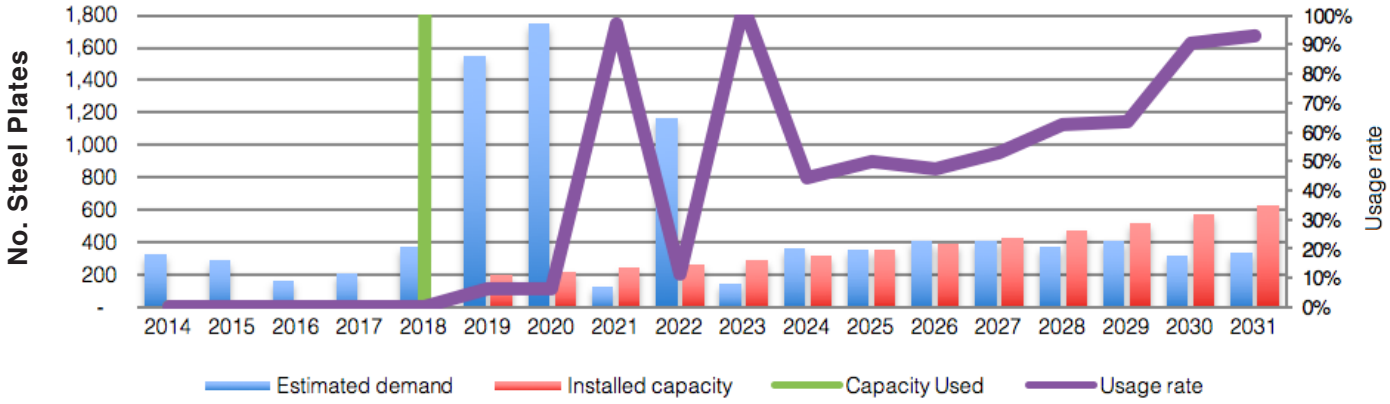
Main Subcomponents	Cost structure	Import (%)	Component Cost	Sale price	Import Cost
Blades	81.00%	0	$558,085.95		$-
Rotor Hub with Pitch System	9.00%	1	$62,009.55		$62,009.55
Pitch System	10.00%	1	$68,899.50		$68,899.50
			$688,995.00	$ 680,000.00	
				$690,000.00	$130,909.05
					81%

Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Tower Subcomponents

In terms of the subcomponents of the Tower, in the subcomponent of Steel Plates there would be opportunities to increase the national supply. The following graph shows the comparison between the estimated demand and the estimated capacity available and used in the period 2019 - 2031. (Graph I.3.9)

Graph I.3.9 Analysis of the Gap between the Estimated Demand versus the Estimation of Installed and Used Capacity in Nationally Manufactured Steel Plates



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

In the event that certain subcomponents of the Tower are integrated into the supply chain, the national content could be increased by 40%.

Estimation of Increase in the National Content of the Tower Component

Main Subcomponents	Cost structure	Import (%)	Component Cost	Sale price	Import Cost
Steel Plate	34.04%	0	$232,910.53		$-
Flanges	5.00%	1	$34,211.30		$34,211.30
Yaw Gear	7.00%	1	$47,895.82		$47,895.82
Coatings / Paint	3.00%	0	$20,526.78		$-
Brackets	4.00%	1	$27,369.04		$27,369.04
Door Assemblies	5.00%	1	$34,211.30		$34,211.30
Hatches	6.00%	1	$41,053.56		$41,053.56
Hoist	8.00%	1	$54,738.08		$54,738.08
Climb Assist	7.00%	1	$47,895.82		$47,895.82
Ladders	6.00%	1	$41,053.56		$41,053.56
Platforms	12.00%	1	$82,107.12		$82,107.12
Lighting	2.00%	0	$13,684.52		$-
Cables	0.96%	0	$6,568.57	$ 680,000.00	$-
			$684,226.00	$680,000.00	$410,535.60
					40%

Source: Own elaboration with results of the Interviews Applied to Participating Companies.

As a result of the development of national procurement in certain subcomponents of the three main components, the national content of the wind turbine would be increased by 45%.

Estimation of Increase in the National Content of the Wind Turbine

Main components	Cost structure	Import (%)	Component Cost	Sale price	Importation cost
Blades	27%	1	$688,995.00		$130,909.05
Nacelle	32%	1	$808,973.00		$518,918.36
Tower	27%	1	$684,226.00		$410,535.60
Others	13%	1	$327,806.00	$ 2,510,000.00	$327,806.00
	100%		$2,510,000.00	$2,510,000.00	$1,388,169.01

45%

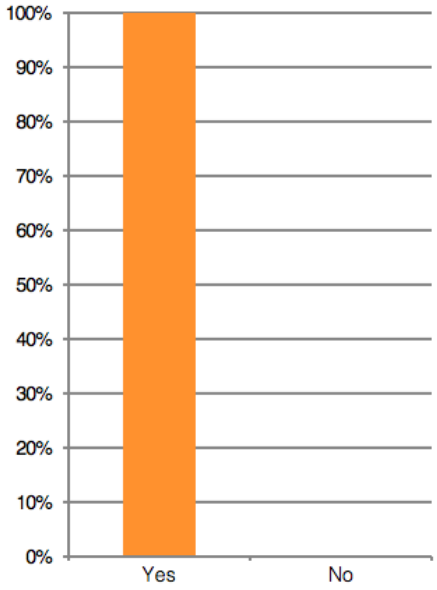
Source: Own elaboration with results of the Interviews Applied to Participating Companies.

Analysis of Opportunities

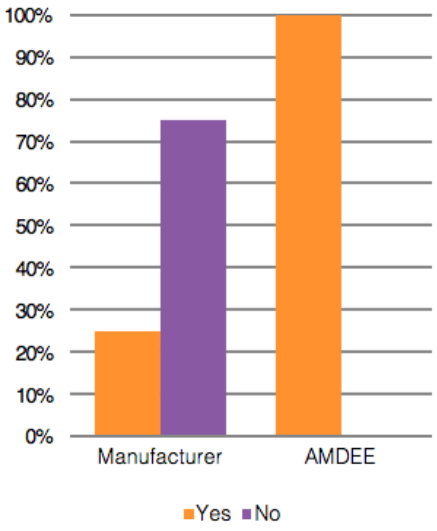
Currently, 100% of the Wind Farm Operators surveyed, hire national suppliers, whether they are equipment manufacturers and / or service providers for the acquisition of certain equipment and / or parts or the provision of services. In relative terms, 100% of the surveyed manufacturers associated with AMDEE (100%), currently manufacture some components, equipment and / or parts for the wind sector, with a lower proportion (29%) in the companies surveyed Register of National Manufacturers of the Energy Industry - Electric Sector.

In relation to the supply of services, the proportion is also higher in the companies associated with the AMDEE. The foregoing indicates that the companies included in the Suppliers Registry, although they are included as suppliers of the wind sector, have not necessarily developed a specialization, both for the manufacture of the equipment and components required and for the provision of services demanded by the wind sector. (Graphics I.4)

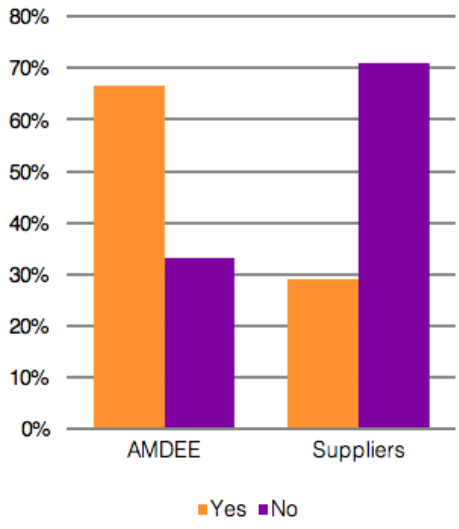
Graph I.4 Hire national suppliers, equipment manufacturers and / or service providers (n = 13)



Graph I.4 Currently, it is a manufacturer of components, equipment and / or parts for the wind sector (n = 9) (AMDEE = 5, Manufactures Registry = 4):



Graph I.4 Currently, it is an Operation and Maintenance (OM) service provider for the wind sector (n = 28) (AMDEE = 3, Suppliers Registry = 25):

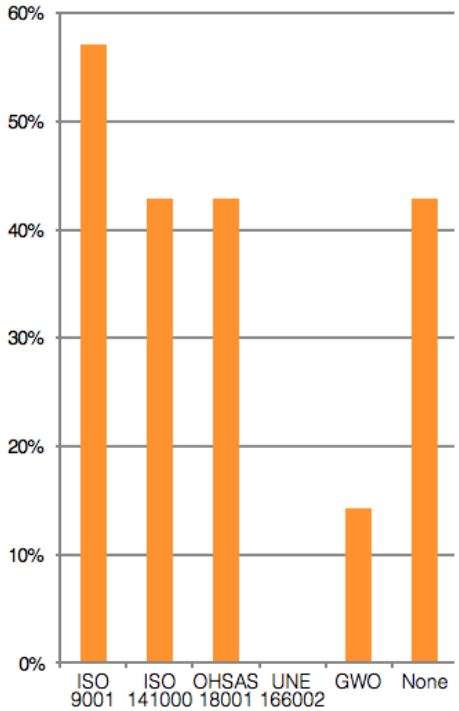


Source: Own elaboration with results of the Interviews Applied to Participating Companies.

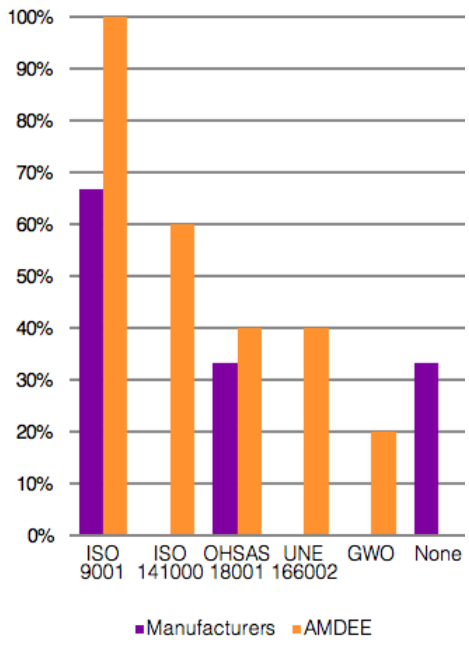
The certifications provide greater certainty in the manufacture of equipment and provision of services, surveyed Wind Farm Operators request in a greater proportion the ISO 9001 certification, followed by the ISO 14100, OHSAS 18001 certifications, and to a lesser extent the Global Certification Wind Organization (GWO). In relation to the equipment manufacturing companies, both the respondents associated with the AMDEE and the manufacturers of the Suppliers Registry, have prioritized in the ISO 9001 certification.

In the case of the companies providing services, those suppliers associated with the AMDEE have prioritized in obtaining the Global Wind Organization Certification (GWO), and the companies surveyed in the Registry of Suppliers in the ISO 9001 Certification, highlighting that the vast majority of service providers do not have certification is the provision of operation and maintenance services. (Graphics I.4.1.)

Graph I.4.1 Request some type of Certification by Farms Operators (n = 7)



Graph I.4.1 Has some certification (s) to sell components, equipment and / or parts required for wind farms (n = 9) (AMDEE = 5, Manufacturer registration = 3):



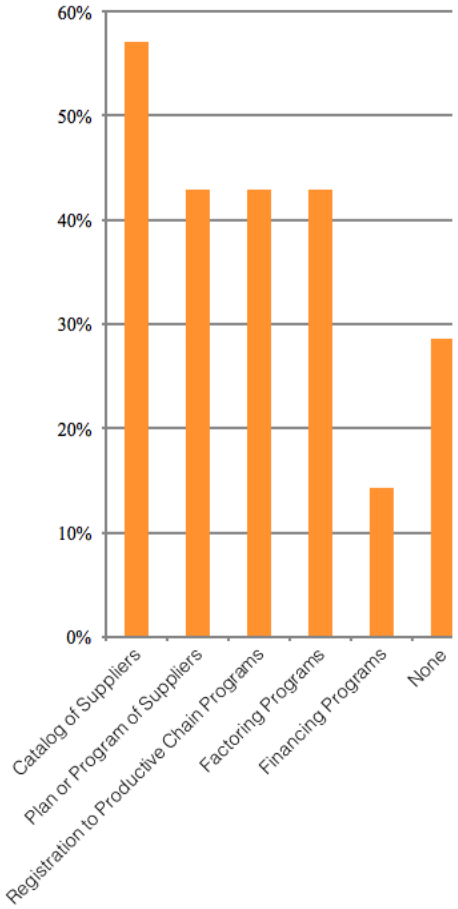
Graph I.4.1 Has some certification (s) to sell OM services (n = 28) (AMDEE = 3, Supplier Registration = 25):

Source: Own elaboration with results of the Interviews Applied to Participating Companies.

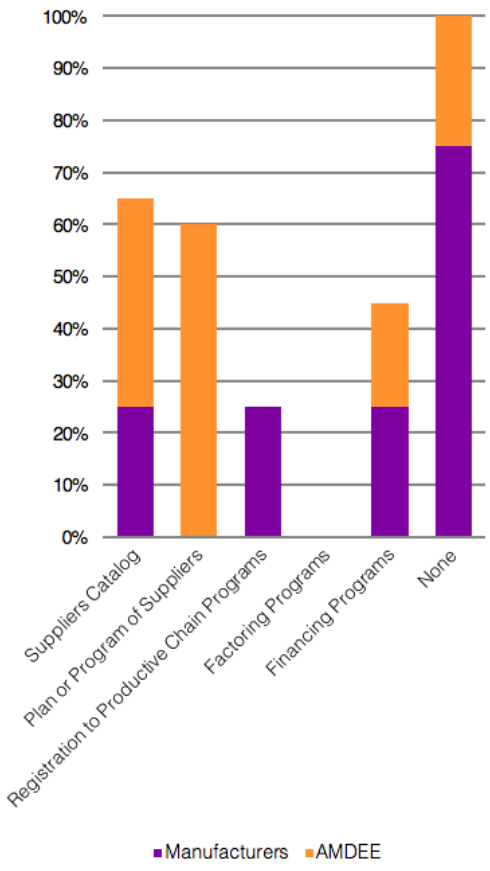
Regarding whether they have mechanisms for their development of national procurement, the operators of wind farms mainly pointed out the existence of a Supplier Development Catalog, both for equipment manufacturers and service providers (57%).

Regarding the equipment manufacturers, the manufacturing companies associated with the AMDEE indicated that they have participated in Supplier Development Plans or Programs (60%) and to a lesser extent in the Suppliers Catalog (40%). In the case of the manufacturers surveyed in the Suppliers Registry, 75% of the manufacturers indicated that they have not participated in any national supplier development program with the Operators of the Wind Farms. With regard to service providers, companies associated with AMDEE indicated that they have participated mainly in Supplier Catalogs (67%) and to a lesser extent in supplier development plans or programs. In the case of suppliers surveyed by the Registry, 64% indicated that they have not participated in any type of national supply development program in conjunction with the Operators of the Wind Farms. (Graphics I.4.2.)

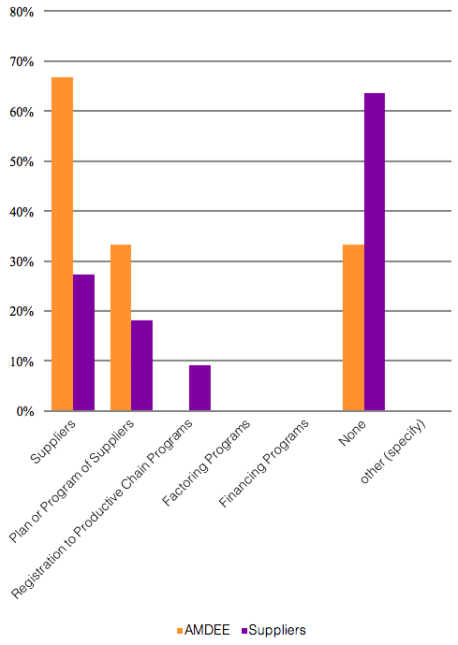
Graphics I.4.2 It has some of the following mechanisms for the development of providers (n = 13)



Graphics I.4.2 Has participated in some of the following programs with Wind Farm Operators (n = 9) (AMDEE = 5, Manufacturer registration = 4):



Graphics I.4.2 He has participated in some of the following programs with Wind Farm Operators (n = 28):



Source: Own elaboration with results of the Interviews Applied to Participating Companies.

PHASE 3. STRATEGIES AND LINES OF ACTION

General strategy

As a result of the execution of the Study, this section proposes a series of strategies and lines of action to increase its participation in the value chain, and gradually increase the national content in the manufacture of wind turbines. To address the identified opportunity areas, six general strategies are proposed, to which specific lines of action must be linked for the different profiles of companies that make up the Mexican wind industry. Based on this analysis, the general strategies are:

I. Training

Human resources are a critical element in the effort to have a competitive industry, the expansion of infrastructure and the development of technology will only be effective if there are trained personnel. 60% of the companies surveyed are interested in implementing courses, workshops, among other activities. The topics of greatest interest to the participating companies are: 1) Value Chain, 2) Corrective Maintenance and Preventive, 3) Inventory Management, 4) Quality, 5) Leadership, 6) Technological Innovation, 7) Purchasing Management and 8) Organizational Development.

II. Certifications

The adoption of standards and certifications required by the wind industry is a critical element to improve supplier capabilities and have a competitive industry. 30% of the participating companies responded that if they require some type of certification, mainly by suppliers and manufacturers, to influence the integration of the national value chain.

In particular, surveyed Wind Farm Operators request a greater proportion of the ISO 9001 certification, followed by the ISO 14100, OHSAS 18001 certifications, and to a lesser extent the Global Wind Organization Certification (GWO). The equipment manufacturing companies have prioritized ISO 9001 certification, and in the case of service providers, those suppliers associated with the AMDEE have prioritized in obtaining the Global Wind Organization Certification (GWO), and the companies

surveyed of the Suppliers Registry in the ISO 9001 certification, highlighting that the vast majority of service providers do not have certification is the provision of operation and maintenance services

III. Local Component Manufacturing

Currently, Mexico does not have manufacturers of components and assembly of wind turbines. The leading international manufacturing companies located in Mexico do not have equipment and component manufacturing plants locally. The integration of global value chains prioritize the development of economies of scale in the manufacture of wind turbines, and its three main components, which are manufactured in various regions of the world, and are sent to wind farms under development through complex Logistic processes In the vast majority of cases, the cost of shipping is economically more efficient than the installation of a manufacturing plant.

In the case of Mexico, our country currently participates with only 1% of the world wind capacity with a total of 4,051 MW, despite the fact that it has one of the highest average annual growth rates (TCMA) of around 44% in the period 2008 - 2017. The size of the market represents an important brake in investment make decisions.

In this sense, the estimated increase in the capacity of wind energy in our country, although it has increased steadily, has not managed to diversify the participation of manufacturers and suppliers of the main components of wind turbines in the local area, both through of the development of national suppliers as through the location of plants of international manufacturers.

The growth in the installation of manufacturers and suppliers of the main components of wind turbines in the local area, should be a gradual process with emphasis on the development of certain components and subcomponents, for example the Blades, where in the last year companies have been installed with manufacturing capacity, mainly for export to the Texas market, as well as generators and their parts, power converters, transformers, among others.

It is important to note that PRODESEN is an indicative program. In this sense, the growth estimate of the wind sector to 2032 will be reflected as the auctions, bilateral contracts and government projects occur.

IV. Innovation and Technological Development

The national wind industry has limited growth in its innovation and technological development practices. Only 40% of the companies interviewed are developing an innovation project, and only 30% of the companies interviewed mentioned that if they have specific research areas. In the same way, the linking practices are limited, only 30% of the companies interviewed maintain some type of link with Research Centers, and Universities and / or Educational Institutions, which opens opportunities for their involvement in research projects, development technological and innovation, training and access to human resources, which affect the integration of the national value chain.

V. Development of the Value Chain

Given the high integration of the global value chain and the market size of the wind sector in Mexico, one of the main opportunities for the integration of the value chain is through the provision of services for the operation and maintenance of the wind farms. Considering the estimated invest-

ment for the growth projection of wind farms in Mexico in the period 1994 - 2031, an amount of 14,828 MDD should be allocated for the Operation and Maintenance Phase.

VI.Funding

Schemes that allow the national industry to overcome entry barriers to financing mechanisms that facilitate the flow of financial resources and the feasibility of industry projects. One of the main considerations of the companies interviewed is the high opportunity cost to meet the demand of wind farm operators. Only 10% of companies have implemented financing mechanisms to support the development of suppliers for the integration of the national value chain; 40% of the companies indicated that they would be willing to support the development of national suppliers for the integration of the value chain; and 50% of the companies indicated that if they have any knowledge of government support programs that could have a positive effect on the integration of the value chain

The general strategies are based on specific lines of action for each of the components and subcomponents that can be manufactured locally. In this sense, the proposed lines of action should contribute to expanding the capacity of the national industry, whether high or potentially competitive, in terms not only of being a provider of the wind industry, but also of exporting to other markets, developing new participants, promoting alliances between national and foreign companies, and / or locate foreign companies in Mexico with production capacity.

CONCLUSIONS

The present study identifies the estimated demand based on the growth estimates of the wind industry in Mexico; information that is valuable for the national industry in the planning of its investment in the short and medium term.

The estimated demand opens up opportunities for the specialization of the national industry in the manufacture of certain components and subcomponents capable of being manufactured domestically, with the possibility of increasing the national content; either through the increase of its internal production capacities or through the subcontracting of national suppliers.

In general terms, the structure of the national wind industry can be divided into two large blocks: the foreign capital manufacturing and development companies, with a high diversity in the manufacture of equipment and services, which can participate both in the development of the park and in the manufacture of the main components, with economies of scale in their production located in different regions of the world and highly integrated into global value chains; and micro and small national companies, whether they are equipment manufacturers or service providers with limited production capacities, low economies of scale, underutilized resources, and with little or no integration to global value chains, mainly due to lack of human resources specialized, certifications, quality models, competitive costs and technical capabilities comparable to international suppliers.

Between both groups of companies, there is a limited integration of the national value chain, the developers and / or manufacturers import almost all of the main components required in the wind farms, whether through their own plants located in different regions or global suppliers. In the case of national companies, the low demand for products and / or services, has impacted on a lack of specialization and training of human resources, lack of local manufacturing capacity and loss of installed capacity, limitations on innovation practices and technological development, and prioritization towards the importation of equipment and supplies for commercialization on a national scale. Under these circumstances, the national content of wind turbines is practically null.

Our country does not have integrated processes for the manufacture of components and assembly of wind turbines. The leading international manufacturing companies located in Mexico, due to various factors, have not developed manufacturing plants for equipment and components, since economies of scale and the size of the national market do not justify investment in plants in our country, prioritizing on other locations, where in the vast majority of cases, shipping costs are economically more efficient than the installation of a manufacturing plant in Mexico.

Derived from the above, the national industry has limited capabilities to meet the growth demand of the wind sector. In general terms, the companies interviewed would have production capacities to meet the demand of certain subcomponents, with the complexity that the manufacturers and developers import the entire wind turbine, and the integration of subcomponents is not a common practice.

In this sense, the present study proposes two main strategies to improve or develop the production capacities and increase the national content and the integration of the value chain: 1) Increase national manufacturing in those subcomponents that can be manufactured locally, and 2) Improve the integration of the value chain in the Operation and Maintenance Services Phase.

The proposed strategies will allow the consolidation of national production in accordance with the estimated demand of the wind sector, so that differentiated lines of action should be implemented with a focus on specialization and the development of innovation and technological development practices, as well as through other productive factors required such as equipment, supply, technology, training and adoption of specialized standards, among others.

amdee
Asociación Mexicana
de Energía Eólica

SE
Secretaría de
Economía

Análisis y
Prospectiva
Tecnológica