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MÉXICO

In 2020, the wind power sector in Mexico had added 574 MW of new wind power to the national electricity grid, bringing the total capacity to 6,681 MW [1]. The growth rate for annual additions was 9% with respect to 2019, and representing about 8.6% of total installed capacity [1].

JOSÉ MANUEL FRANCO-NAVA, National Institute of Electricity and Clean EnergieS (INEEL Mexican Wind Energy Innovation Center (CEMIE-Eólico), México.

The new capacity represents 0.66% of the total new wind onshore world capacity for 2020 of 86.9 GW [2]. In the next four years, new policies will support an accelerated transition towards the generation, transmission and use of renewable and clean energy, as long as social inclusion is contemplated [3]. Three auctions performed so far resulted in 3,407 MW of wind power contracted; these projects should be installed before 2021.

México's R&D focus is on small and medium-size turbines. In 2020, efforts included design and

TABLE 1. KEY NATIONAL STATISTICS 2020: MÉXICO

Total (net) installed wind power capacity:	6,681 MW
Total offshore capacity:	0 MW
New wind power capacity installed:	574 MW
Decommissioned capacity (in 2019):	0 MW
Total electrical energy output from wind:	19.69 TWh
Wind-generated electricity as percent of national electricity demand:	8.1%
Average national capacity factor:	35.2%
National wind energy R&D budget:	[-]
Target	11 GW in 2022

manufacture of blades for a 1.2-MW scale wind turbine prototype, testing of a 2-MW horizontal wind turbine with a 100-m concrete tower.

Market Development

National Targets & Policies Supporting Development

México's wind power industry aims to reach 11 GW of wind power capacity by the end of 2022, and by the end of 2024 the sector will reach 15 GW by the end 2024, having the opportunity to generate 35,000 additional jobs. The temporary suspension of auctions, at the end of 2019, may present a challenge for reaching the clean energy targets which are, including renewables, 30% by 2021 and 35% by 2024 of the total electricity generation in México [4]. In 2020, the installed capacity to generate electricity through renewable energy was 31%, from which 7.5% was from wind energy [5].

México has potential wind power capacity of more than 50,000 MW but only 17,000 MW of additional installed capacity is required to reach the goal of generating 35% of electricity with clean technologies by 2024 [6].

The constitutional framework and the public policies for the wind power industry have not experienced any change with respect promotion for generating energy through renewable resources.

Progress & Operational Details

México added 574 MW of new wind power to the national electricity grid by the end of 2020 [1, 2], bringing the total capacity to 6,681MW in 70 wind farms. This represents an increase of 9% with respect to 2019.

The government has called for three long term auctions, to facilitate the clean energy transition, with the first two being held in 2016 and a third one in 2017. The three auctions have resulted in 7,563 MW of clean energy awarded. Wind power accounted for 3,407 MW contracted via the auctions; these projects should be installed before 2021. Investments for the new wind energy projects totalled 8.969 billion USD (8 billion EUR) [7].

The total number of turbines (land-based) by the end of 2020 was 3,175 [1]. The distribution of capacity of horizontal wind turbines per developer is shown in Figure 1.

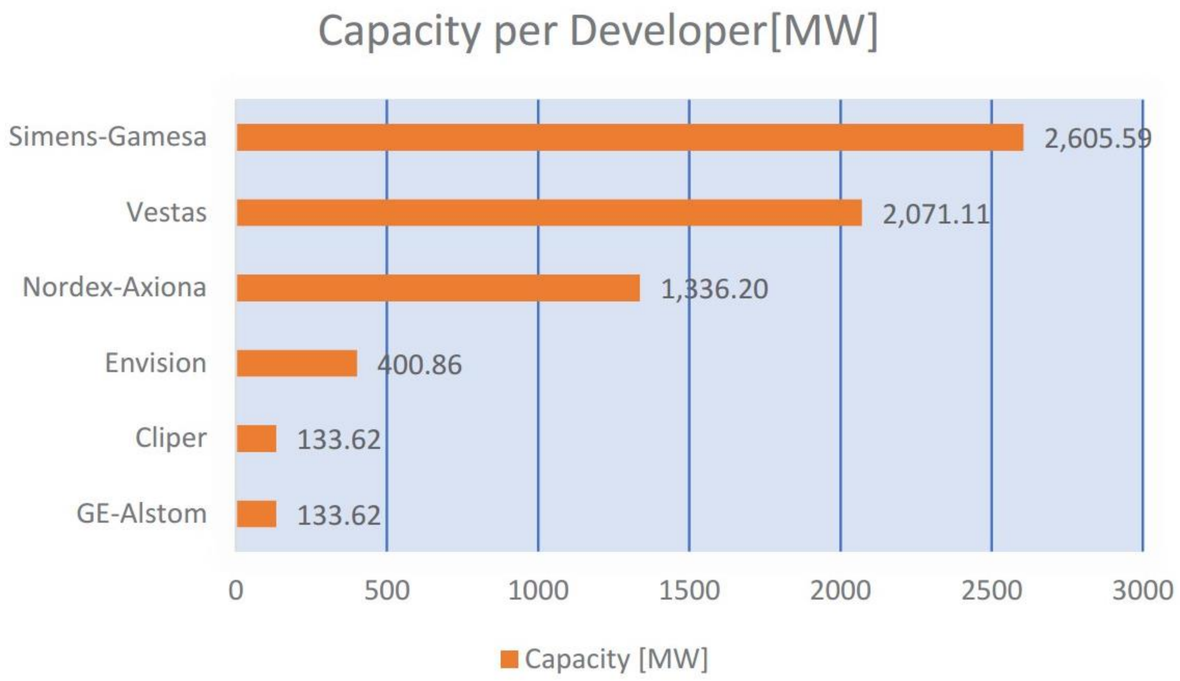

FIGURE 1. CAPACITY PER DEVELOPER. DATA SOURCE FROM AMDEE.

Matters Affecting Growth & Work to Remove Barriers

As mentioned above, since the end of 2019, CENACE is not calling to new long-term auctions, certainty for long-term investments and projects may present a challenge for continued build out of wind power. In addition, the following barriers still affect the growth of the wind power industry and need to be addressed for its deployment:

FIGURE 2: POWER TRAIN OF A PROTOTYPE 1.2 MW WIND TURBINE (PHOTO CREDIT: © CEMIE-EÓLICO).

- Lack of specialized personnel to participate in designing and installing wind power plants.
- Low integration of national components in the manufacturing chain value of wind power industry
- Lack of total social acceptance for leasing the land and signing contracts.

The Mexican Wind Energy Innovation Center (CEMIE-Eólico), have been working for the last five years on human resources capability building and generating synergies between researches, institutions of the consortium in order to increase the number of students to obtain Bachelor, Master and Doctoral degree on specialized topics related to wind engineering. In addition, as part of a strategic project, a Master degree course on Wind Energy was generated and now offers a unique engineering career in the wind sector. The course is given by a university that is located in the Oaxaca State were the 43% of the total wind capacity is installed.

In order to improve social acceptance, a new strategic project on design, development, implementation, and validation of an innovative methodology of increasing social impact under national and international standards is under approval and authorization by the Minister of Energy and National Council of Science and Technology (Conacyt), SENER-Conacyt Energy Sustainability Fund.

R, D&D Activities

National R, D&D Priorities & Budget

The SENER-Conacyt Energy Sustainability Fund supported the R&D on wind energy via the CEMIE-Eólico with 10.38 Million USD (9.86 million EUR) from 2014 to 2019. These funds supported the implementing technological solutions for the design, operation and maintenance of wind turbines through strategic projects developed by national experts of research institutes, universities, and private companies, with collaboration of international experts and universities. Additional resources to continue the R&D activities on wind energy are under approval and authorization by the SENER-Conacyt Energy Sustainability Fund.

National Research Initiatives & Results

The CEMIE-Eólico is a national effort of the Mexican government to address the collaborative research and technological development for the wind industry. The research topics for the members of the CEMIE-Eólico are: aerodynamics and aeroelasticity; medium capacity wind turbines; small wind turbines; control systems; applications of artificial intelligence and mechatronics; and training of specialized human resources.

The members receive finance support from the SENER-Conacyt Energy Sustainability Fund to build capacities regarding infrastructure, human resources, instrumentation and equipment and specialized software.

The results of the research and technological projects of the CEMIE-Eólico initiative have led to extend the funding and life of the Center for one additional year (under approval and authorization by the SENER-Conacyt Energy Sustainability Fund).

Test Facilities & Demonstration Projects

The CEMIE-Eólico has contributed to scientific, economic, social and technological national impacts thought research initiatives and demonstrative projects and also has encouraged the continuous capability building of specialized human resources on wind energy during the last five years; in 2020, the synergies generated between the participants of the CEMIE-Eólico have focused on the strategic project for the acquisition and manufacture of components for the integration of a prototype wind turbine medium power, (Figure 2), particularly on the design, manufacturing and testing of 30 m blades. This project has also support by Inter-American Development Bank, IADB.

Collaborative Research

Final activities for one strategic project continued with international collaborative research between CEMIE-Eólico members and international institutions. Activities for testing and validation of design and manufacture of blades for the 1.2 MW prototype between INEEL, Centro de Tecnología Avanzada, Centro de Ingeniería y Desarrollo Industrial and Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas from Spain. Work on site characterization through the development of the wind power Atlas is been carried out by DTU Denmark, INEEL and UNAM. CEMIE-Eólico led by the Instituto Nacional de Electricidad y Energías Limpias (INEEL) continues representing Mexican R&D efforts at IEA Wind Technology Collaboration Programme (TCP).

Impact of Wind Energy

Environmental Impact

The CEMIE-Eólico's strategic project on construction and testing of a prototype of a 100-meter-high post-tensioned concrete tower, integrating a 2 MW wind turbine at test facility (Regional Center for Wind Technology, CERTE) in Oaxaca, México, is reducing emissions by 3,250 tons of CO_2/year.

The development of 11,000 MW of wind power by 2022 would reduce emissions by more than 17.8 million tons of CO_2. In addition to the environmental benefits of reducing CO_2 emissions, wind technology development brings multiple economic and social benefits.

Economic Benefits and Industry Development

Mexico´s wind energy industry has developed incrementally for the last years, mainly due to investments of foreign power generation companies The 574 MW of new capacity installed in 2020 was lower with respect to that installed in 2019, however, this addition bringing the total national capacity to 6,681 MW. Economic spill and social benefits as a result of the generation of employment in the national industry due to its participation in the manufacture of components of the prototypes of wind turbines developed in the strategic projects of the CEMIE-Eólico. Mexico´s wind energy industry has produced 16,000 (direct and indirect) jobs [1].

Next Term

The Mexican wind industry expects to install between 1,000 and 2,000 MW in 2021; however, key issues could impact the wind industry during the COVID-19 crisis. CEMIE-Eólico´s R&D new strategic projects to help public acceptance are expected to be approved and authorized by the SENER-Conacyt Energy Sustainability Fund.

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