1.0 Overview
During 2013, 426 MW of new wind turbines were commissioned in México, bringing the total wind generation capacity to 1,551 MW. The Law for Renewable Energy Use and Financing of Energy Transition (enacted in November 2008) is successfully achieving its main objectives. Wind energy is now a competitive option within the Mexican electricity market, and the Secretariat of Energy (SENER) issued a Special Program for the Use of Renewable Energy. A 2,000-MW, 400-kV, 300-km electrical transmission line for wind energy projects in the Isthmus of Tehuantepec was commissioned. Presently, the construction of 316 MW of new wind power capacity has been secured. This will bring the total generation capacity to at least 1,867 MW by the end of 2014. It is expected that public and private companies will be capable of managing appropriately pending social requirements.

The Energy Regulatory Commission has granted permits for a total of 4,999 MW of wind power capacity. Currently, it is estimated that around 12,000 MW of economically-feasible projects could be implemented within the next ten years (by 2024). México’s largest wind energy resource is found in the Isthmus of Tehuantepec in the state of Oaxaca. Average annual wind speeds in this region range from 7–10 m/s, measured at 30 m above the ground. It is estimated that more than 6,000 MW of wind power could be commercially tapped there. Using reliable and efficient wind turbines in this region could lead to annual capacity factors around 40%. The Mexican states of Baja California, Chiapas, Jalisco, Nuevo León, and Tamaulipas are emerging as the next wind energy deployment regions in México.

2.0 National Objectives and Progress
2.1 National targets
It is expected that by the end of 2024 wind energy capacity in México would be around 12,000 MW. Assuming an average capacity factor around 30%, contribution of wind generation to national electric demand would be around 5%.

2.2 Progress
Remarks to Table 2:
• La Venta I, Guerrero Negro, and La Venta II (Figure 2) were first in the implementation of wind energy in México and are owned and operated by the Comisión Federal de Electricidad (CFE).
• Parques Ecológicos was the first privately owned wind energy plant in México (the main investor is Iberdrola Renovables) and is supplying electricity for a number of private companies.
• EURUS is the largest wind power plant in México and is aimed at supplying around 25% of the CEMEX Company’s electricity demand.
• La Rumorosa I is the first wind energy project for public municipal lighting.
• Certe-IIE is the first Mexican wind turbine test center and was supported by the Global Environment Facility (GEF) by means of the United Nations Development Program (UNDP). It is the first small wind energy power producer in México.

2.2.1 Contribution to electrical demand
During 2013, total electrical output from wind was around 3.9 TWh, which is equivalent to around 1.5% of national electric demand.

2.2.2 Environmental benefits
Reduction of CO₂ emissions due to wind generation for the year 2013 was 2.2 million tons, considering a mitigation rate of 0.58 tons CO₂ per each wind-generated MWh.

2.3 National incentive programs
The Law for the Use of Renewable Energy and Financing of Energy Transition is a sound signal from the government of México regarding both political will and commitment for implementing energy diversification toward sustainable development. The main elements of the strategy in the law include: presenting strategic goals; creating a special program for renewable energy;
A 2,000-MW, 400-kV, 300-km electrical transmission line was commissioned for wind energy projects in the Isthmus of Tehuantepec, where annual capacity factors could reach around 40%.

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**Table 1. Key National Statistics 2013: México**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installed wind capacity</td>
<td>1,551 MW</td>
</tr>
<tr>
<td>New wind generation installed</td>
<td>426 MW</td>
</tr>
<tr>
<td>Total electrical output from wind</td>
<td>3.9 TWh</td>
</tr>
<tr>
<td>Wind generation as % of national electric demand</td>
<td>1.5%</td>
</tr>
<tr>
<td>Average capacity factor</td>
<td>30%</td>
</tr>
<tr>
<td>Target:</td>
<td>12,000 MW by 2024</td>
</tr>
</tbody>
</table>

*Bold italic* indicates an estimate.

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creating a green fund; providing access to the grid; recognizing external costs; recognizing capacity credit; encouraging technical standards for interconnection and infrastructure for electricity transmission; providing support for industrial development; and providing support for R&D. Some of the regulatory instruments for this law have already been issued while others are still under development. The existing incentives are:

- Model agreement for the interconnection of renewable energy power plants to the national electrical grid (2001), allows administrative interchange of electricity among billing periods
- Accelerated depreciation (up to 100% in one year) (2004)
- Recognition of certain capacity credit for self-supply projects
- Reduced tariffs for electricity transmission

**2.4 Issues affecting growth**

There is a critical need to include fitting and fair social benefits to wind landowners (especially to peasants and fishermen) in the negotiation of wind power projects. Planning studies for deploying wind power at the national level have not yet been carried out.

**3.0 Implementation**

**3.1 Economic impact**

By the end of 2013, it was estimated that the total investment in the construction of wind power plants was around 2.18 billion EUR (3.0 billion USD). Assuming that around 80% of this amount corresponds to the cost of the wind turbines, the rest, around 435 million EUR (600 million USD) could be considered as the economic distribution to México. Nevertheless, a substantial portion of the work is carried out by foreign employees.

**3.2 Industry status**

At present there are more than 1,050 wind turbines installed in México. The Spanish wind turbine manufactures Acciona Windpower and Gamesa Eólica are leading the Mexican wind turbine market, but nowadays other companies like Vestas and
Alstom have been awarded important contracts. GE has started activity by installing eight wind turbines.

Several types of developers have emerged. CEMEX, a global leader in the building materials industry, is playing the main role regarding investment in wind energy projects for self-supply purposes. Iberdrola is playing the main role in implementing wind energy projects for sharing electricity with both big- and medium-sized electricity consumers under the creation of self-supply consortiums. With the support of the federal government, the government of the state of Baja California implemented a 10-MW wind energy project for public municipal lighting. This project was commissioned during 2010.

More than 200 Mexican companies have the capacity to manufacture some parts required for wind turbines and wind power plants. Trinity Industries de México, S. de R.L. de C.V. is manufacturing towers for a number of wind turbine companies. The Mexican firm Potencia Industrial S.A. de C.V. was manufacturing permanent-magnet electric generators for Clipper Windpower. The country also has excellent technical expertise in civil, mechanical, and electrical engineering that could be tapped for plant design and construction. The law for renewable energy instructs the SENER and the Secretary of Economy to promote manufacturing of wind turbines in México.

### 3.3 Operational details

Operational details for each of the wind power stations are not available to the public. In general terms, one can say that wind turbine manufacturers are learning to deal with the outstanding wind regime and particular conditions of the Isthmus of Tehuantepec. Some of them have had serious problems. As is happening in many parts of the world, some investors are worried because there is

<table>
<thead>
<tr>
<th>Wind power station</th>
<th>Number of Wind Turbines</th>
<th>Wind Turbine Size (kW)</th>
<th>Turbine Manufacturer</th>
<th>Station capacity (MW)</th>
<th>Owner type (1)</th>
<th>Year in service (2)</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Venta I</td>
<td>6</td>
<td>225</td>
<td>Vestas</td>
<td>0.9</td>
<td>FGOB</td>
<td>1994</td>
<td>OAX</td>
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<tr>
<td>Guerrero Negro</td>
<td>1</td>
<td>600</td>
<td>Gamesa</td>
<td>0.6</td>
<td>FGOB</td>
<td>1998</td>
<td>BCS</td>
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<tr>
<td>La Venta II</td>
<td>98</td>
<td>850</td>
<td>Gamesa</td>
<td>83.3</td>
<td>FGOB</td>
<td>2007</td>
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<td>850</td>
<td>Gamesa</td>
<td>101.9</td>
<td>POSS</td>
<td>2009</td>
<td>OAX</td>
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<tr>
<td>EURUS</td>
<td>167</td>
<td>1,500</td>
<td>Acciona</td>
<td>250</td>
<td>POSS</td>
<td>2009</td>
<td>OAX</td>
</tr>
<tr>
<td>Bii Nee Stipa</td>
<td>31</td>
<td>850</td>
<td>Gamesa</td>
<td>26.3</td>
<td>POSS</td>
<td>2010</td>
<td>OAX</td>
</tr>
<tr>
<td>Certe-IE (F1)</td>
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<td>300</td>
<td>Komai</td>
<td>0.3</td>
<td>I+D</td>
<td>2010</td>
<td>OAX</td>
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<tr>
<td>E. Valle de México</td>
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<td>Clipper</td>
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<td>2010</td>
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<tr>
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<td>Gamesa</td>
<td>10.0</td>
<td>SGOB</td>
<td>2010</td>
<td>BC</td>
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<tr>
<td>Fuerza Eólica</td>
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<td>2,500</td>
<td>Clipper</td>
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<td>POSS</td>
<td>2011</td>
<td>OAX</td>
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<td>Vestas</td>
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<td>850 &amp; 2,000</td>
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<td>OAX</td>
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<tr>
<td>DEMSA (F1)</td>
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<td>POSS</td>
<td>2013</td>
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<tr>
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<td>NL</td>
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<tr>
<td>Eólica Los Altos</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>1,551</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) FGOB=Federal Government, SGOB= State Government, POSS= Private owned self-supply, IPP= Independent Power Producer, I+D= Research and Development

(2) Commissioning year
too much uncertainty how much post-war-

3.4 Wind energy costs
Investment cost for installed wind energy
projects in the Isthmus of Tehuantepec are
around 1,450 EUR/kW (2,000 USD/kW).
In that region, the buy-back price for inde-
pendent power producer (IPP) generators
is around 0.049 EUR/kWh (0.065 USD/
kWh), depending of the project.

4.0 R, D&D Activities
4.1 National R, D&D efforts
The Sustainable Energy Fund created by the
SENER and the National Council for Sci-
ence and Technology (CONACYT), under
the mandate of the Law for Science and
Technology, is sponsoring the Mexican Wind
Energy Innovation Center (CEMIE-Eólico).
The main purpose of the CEMIE-Eólico
is to increase and consolidate the country’s
scientific and technical capacities in the field
of wind energy by means of building synergy
among national institutions so that activities
on innovation, research, and technology can
be oriented towards the construction of a
stronger national wind energy industry. The
CEMIE-Eólico is a consortium led by the
Instituto de Investigaciones Eléctricas (IIE).
It is integrated by six public research centers,
14 universities, and ten private companies.
The CEMIE-Eólico will start operations in
June 2014, developing 13 projects that will
be carried out during the next four years.
More institutions and private companies are
willing to play a part in the CEMIE-Eólico,
therefore it is expected that in the short term
synergy and collaboration is achieved both at
the national and the international level.
The Wind Turbine Test Center (CERTE)
sponsored by GEF by means of the UNDP
will be part of the CEMIE-Eólico. The
CERTE started operations in 2010, some of
the products of the R&D projects that will
be carried out within the CEMIE-Eóli-
co will be tested in the CERTE. The GEF
is also co-financing one of the projects of
the CEMIE-Eólico by means of the Inter-
American Development Bank (IDB).

4.2 Collaborative research
The IIE participates in IEA Wind Task 11
Base Technology Information Exchange. It is
expected that during 2014 México will be-
come a member of IEA Wind Task 25 De-
sign and Operation of Power Systems with
Large Amounts of Wind Power.

5.0 The Next Term
Presently, the construction of 316 MW of
new wind power capacity has been secured.
This will bring the total generation capacity
to at least 1,867 MW by the end of 2014. It
is expected that public and private compa-
nies will be capable of appropriately manag-
ing pending social requirements. If social re-
quirements are addressed, more wind power
capacity could be installed during 2014 ex-
ceeding 2,000 MW.

Opening photo: Eurus wind farm

Author: Marco A. Borja, Instituto de Inves-
tigaciones Eléctricas (IIE), México.

Figure 2. La Venta II 83.3-MW wind farm in the Isthmus of Tehuantepec, México

Figure 3. The Wind Turbine Test Center operated by the Instituto de Investigaciones Eléctricas