Electric Power Industry Trends and the Role of Renewable Energy

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Product Portfolio

Large Engines

ORC Heat to Power

Power Systems

After market

Mobile Power

Wind Power

Marine
Gas Turbine & ORC Fleet Summary

Over 2000 Gas Turbines and 250 ORC’s Sold World Wide
### Global energy mix (by fuel source)

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>2008</th>
<th>2010E</th>
<th>2020E</th>
<th>2030E</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable¹</td>
<td>4,717</td>
<td>4,960</td>
<td>6,612</td>
<td>8,056</td>
<td>2.5%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>391</td>
<td>404</td>
<td>355</td>
<td>273</td>
<td>(2.1%)</td>
</tr>
<tr>
<td>Hydro</td>
<td>945</td>
<td>987</td>
<td>1,230</td>
<td>2,028</td>
<td>2.3%</td>
</tr>
<tr>
<td>Oil</td>
<td>438</td>
<td>423</td>
<td>1,667</td>
<td>2,748</td>
<td>2.7%</td>
</tr>
<tr>
<td>Gas</td>
<td>1,230</td>
<td>1,294</td>
<td>2,184</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>1,514</td>
<td>1,610</td>
<td>2,184</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Includes Wind, Solar, Biomass, Geothermal


### Energy investments (2008 – 2030E)

- **$T billions**
- **CAGR**

#### By type
- **E&P**: 1
- **Generation / T&D**: 1

#### By region
- **North America**: 5
- **Europe**: 3
- **China**: 4
- **India**: 2
- **Africa**: 2
- **Middle East**: 2
- **Other**: 6

100% = $26T
**Trends**

- **Coal**: Prices increased 84% from 2000-2009. Coal fired generation declined 11.6% in 2009 (lowest level since 1978)

- **Natural Gas**: Wellhead prices fell to lowest level in 7 years. NG based generation increased by 4.3% in 2009 to the highest level since 1970

- **Nuclear**: Decreased by about 0.9% in 2009 (outages and derates)

- **Petroleum**: Peaked in 1973 (17%), steadily decreasing since, 15.8% decrease in 2009 compared to 2008

- **Hydro**: Increased 7.3% in 2009 compared to 2008

- **Renewables**: Increased 14% increase in 2009 following a 20% increase in 2008. Wind power increased the fastest (34% increase), solar 3%.

* Energy Information Administration report, Nov. 2010
**Trends**

- **Coal:** Remains steady at 42% (2007-2035), annual increase of 2.3%

- **Renewables:** Highest rate of annual increase, 3% until 2035. Share of renewable generation is projected to increase from 18% (2007) to 23% (2035)

- **Natural Gas:** Increases at the annual rate of 2.1%

- **Nuclear:** Increases at the annual rate of 2% but considerable public concerns may hinder plans for new installations

• Renewable energy accounted for approximately 11% of the domestically produced electricity in the US in the first six months of 2010.

• Renewable Energy Capacity in the world and US has more than tripled between 2000 and 2009.

• Over the last three decades, US geothermal power-generation industry has grown to be the largest geothermal market in the world with over 3,100 MW of installed electrical capacity.
Figure 8. Global Wind Power Growth, Annual vs. Cumulative (MW)

Source: MAKE Consulting
## IHS / EER Base Case Global Wind Market Projections

<table>
<thead>
<tr>
<th>Year</th>
<th>Total GW Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>188.1</td>
</tr>
<tr>
<td>2011</td>
<td>225.8</td>
</tr>
<tr>
<td>2012</td>
<td>267.2</td>
</tr>
<tr>
<td>2013</td>
<td>310.0</td>
</tr>
<tr>
<td>2014</td>
<td>353.3</td>
</tr>
<tr>
<td>2015</td>
<td>398.4</td>
</tr>
<tr>
<td>2016</td>
<td>445.8</td>
</tr>
<tr>
<td>2017</td>
<td>493.7</td>
</tr>
<tr>
<td>2018</td>
<td>543.8</td>
</tr>
<tr>
<td>2019</td>
<td>595.4</td>
</tr>
<tr>
<td>2020</td>
<td>650.3</td>
</tr>
<tr>
<td>2021</td>
<td>706.5</td>
</tr>
<tr>
<td>2022</td>
<td>763.6</td>
</tr>
<tr>
<td>2023</td>
<td>821.9</td>
</tr>
<tr>
<td>2024</td>
<td>881.3</td>
</tr>
<tr>
<td>2025</td>
<td>941.0</td>
</tr>
</tbody>
</table>

- **Africa Middle East**: 1.2, 1.3, 1.7, 2.2, 2.7, 3.2, 3.8, 4.5, 5.2, 6.0, 6.9, 7.8, 8.9, 10.2, 11.5, 13.0
- **Latin America**: 1.4, 2.5, 3.8, 5.1, 6.3, 7.5, 9.0, 10.4, 12.2, 14.2, 16.4, 18.9, 21.5, 24.3, 27.2, 30.2
- **Asia Pacific**: 54.7, 73.3, 93.7, 114.9, 136.7, 159.1, 182.1, 205.8, 230.2, 255.3, 281.2, 307.3, 333.9, 360.9, 388.3, 416.1
- **North America**: 44.7, 52.5, 60.3, 68.4, 76.5, 84.5, 93.5, 101.8, 110.3, 118.8, 129.2, 140.4, 151.1, 161.7, 172.3, 182.8
- **Europe**: 86.0, 96.2, 107.7, 119.5, 131.3, 144.1, 157.5, 171.2, 186.0, 201.2, 216.7, 232.1, 248.1, 264.8, 282.0, 298.8
Global Geothermal Market

- Estimated 40% (~3000MW’s) new capacity is ORC

Source: GEA May 2010
Nine States generate the majority of this power in the U.S.: Alaska, California, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, Wyoming.

(Source: GEA)
Top States for Renewable Installed Nameplate Capacity – 2009 (Excluding Hydropower)

Total Renewables (excluding hydropower)
1. Texas
2. California
3. Iowa
4. Oregon
5. Minnesota

Per Capita Renewables (excluding hydropower)
1. North Dakota
2. Wyoming
3. Vermont
4. Iowa
5. Oregon

(Source: US DOE/NREL 2010 Study)
Top States for Renewable Installed Nameplate Capacity – 2009 (Including Hydropower)

**Total Renewables (including hydropower)**
1. Washington
2. California
3. Oregon
4. Texas
5. New York

**Per Capita Renewables (including hydropower)**
1. Washington
2. North Dakota
3. Montana
4. Oregon
5. Wyoming

(Source: US DOE/ NREL 2010 Study)
In the US, wind and Solar Photovoltaics (PV) are seeing large growth.

- Wind capacity increased by nearly 40% in 2009.
- PV capacity grew nearly 52% from 2008 to 2009.
- Competitive pricing pressures are prevalent in both Wind and Solar PV markets (China influence)
- Worldwide, wind is the fastest growing renewable energy technology.
- Renewables are capturing a growing percentage of new capacity additions accounting for more than 55% of new electrical capacity installations in the US, up from 2% in 2004. Will this trend continue???
Top Countries with Installed Renewable Electricity

Total Renewables (2009)

1. China*
2. U.S.
3. Brazil
4. Canada
5. Japan

*Majority of China’s renewable energy is from small hydropower.
Source: DOE/NREL 2010)
<table>
<thead>
<tr>
<th>Geothermal</th>
<th>Wind</th>
<th>Solar PV</th>
<th>CSP</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>US</td>
<td>Germany</td>
<td>US</td>
<td>US</td>
</tr>
<tr>
<td>Philippines</td>
<td>China</td>
<td>Spain</td>
<td>Spain</td>
<td>Brazil</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Germany</td>
<td>Japan</td>
<td></td>
<td>Germany</td>
</tr>
<tr>
<td>Mexico</td>
<td>Spain</td>
<td>US</td>
<td></td>
<td>China</td>
</tr>
<tr>
<td>Italy</td>
<td>India</td>
<td>Italy</td>
<td></td>
<td>Sweden</td>
</tr>
</tbody>
</table>

Source: DOE/NREL 2010
Incentives need to be longer than 1-2 years.

The investment community needs clear picture of future incentives.

Longer term incentives needed to support longer term investments.
• **Brief History of incentives**
  
  - Energy “subsidies” come in a variety of forms.
  - Subsidies go to all forms of energy, including fossil fuels and alternatives.
  - Oil and gas accounted for 60% of an estimated $725 billion in federal assistance between 1950 and 2003.
  - Wind, solar, geothermal and biofuels combined to account for only 6%.
President Obama said in a speech to the United Nations following the G20 Summit in 2009:

“I am proud to say we will phase out fossil fuel subsidies so that we can better address our climate challenge.”
The American Recovery Reinvestment Act of 2009 (ARRA) provided $1.64 billion for renewable projects, but many of those incentives have closed or close this year.

(Source: DOE)
Geothermal Growth

U.S. Total Investment

Global Total Investment

(Source: Bloomberg New Energy/Finance)
Geothermal Growth

U.S. total investment in geothermal grew throughout the year 2009.

Worldwide total investment also grew slightly in 2009.

U.S. Venture Capital and Private Equity investments in geothermal technology companies have been minimal compared to other renewable, such as solar and wind.
Germany's decision to phase out nuclear energy by 2022 will transform Europe's largest economy into a multibillion-dollar laboratory experiment on the rapid deployment of renewable energy and smart grid technologies…

OR

…if these initiatives fall short, it could leave consumers exposed to higher power prices and make German industry less competitive and the nation more dependent on fossil fuel sources and imports from France's nuclear plants.”
• Assistance for renewables has been debated in Congress and is often the subject of controversy, leveraging alternative tactics, and inconsistent policy. *This leads to market uncertainty, compromising investment opportunities, and technology development inefficiencies.*

• Renewable energy generation remote locations require electric power transmission grid infrastructure investments.

• Cyclic operating characteristics (non-geothermal) create electric power grid stability challenges.

• Ability for geothermal applications to attract investment/interest from the oil and gas sector, thus leveraging existing and characterized resources (co-produced fluids).
Questions?