PJM Interconnection
12 February, 2014
Terms of Use

The accompanying materials were prepared by IHS CERA Inc. (IHS CERA) and are not to be redistributed or reused in any manner without prior written consent, with the exception of client internal distribution as described below.

IHS CERA strives to be supportive of client internal distribution of IHS CERA content but requires that

- IHS CERA content and information, including but not limited to graphs, charts, tables, figures, and data, are not to be disseminated outside of a client organization to any third party, including a client’s customers, financial institutions, consultants, or the public.
- Content distributed within the client organization must display IHS CERA’s legal notices and attributions of authorship.

Some information supplied by IHS CERA may be obtained from sources that IHS CERA believes to be reliable but are in no way warranted by IHS CERA as to accuracy or completeness. Absent a specific agreement to the contrary, IHS CERA has no obligation to update any content or information provided to a client.
Current trends in the US power sector

• Conventional wisdom
  • Increases in electric efficiency will produce little to no growth.
  • The disruptive technology process will produce more distributed generation.
  • Low and stable natural gas prices will increase natural gas-fired generation shares and diminish coal and nuclear generation shares.

• Conventional wisdom produces blind spots regarding the electric power future
  • Power demand is likely to grow faster than most people think.
  • Distributed generation is not a disruptive technology but rather a vision for transformational change.
  • Fuel diversity is undervalued and being lost because wholesale power prices are chronically too low.
Bearish Growth — bullish increases in energy efficiency
US electric efficiency, 1950-2011

Source: IHS CERA.
Data Source: EIA; The Bureau of Economic Analysis (BEA).

© 2013 IHS
Electricity use per customer, 2002-12

Source: IHS CERA.

© 2013 IHS
Deconstructing the increase in US electricity use per residential customer, 2002-12

Decomposing the increase in US average annual electricity use per residential customer, 2002-12

<table>
<thead>
<tr>
<th>Factor</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Household Income</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Average Temperature</td>
<td>3.6%</td>
</tr>
<tr>
<td>Efficiency Spending</td>
<td>-7.3%</td>
</tr>
<tr>
<td>Technology Turnover</td>
<td>-3.0%</td>
</tr>
<tr>
<td>Rebound Effect and other end uses</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Electricity Price</td>
<td>-8.0%</td>
</tr>
</tbody>
</table>

Source: IHS CERA.

© 2013 IHS
US ratepayer-funded expenditures to increase electric efficiency

Source: IHS CERA
Data Source: American Council for an Energy-Efficient Economy (ACEEE)
© 2013 IHS
US commercial electricity use per customer, 2001-2012

Source: IHS CERA.
Data source: Energy Information Administration (EIA).
© 2013 IHS
US manufacturing and GDP through business cycle phases

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>18%</td>
<td>-19.3%</td>
<td>34%</td>
</tr>
<tr>
<td>GDP</td>
<td>16%</td>
<td>-4.3%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: IHS Global Insight.
Note: Business cycle phases on the horizontal axis are in the format year: quarter–year: quarter.
Relative industrial electricity prices for top five US trading partners

Source: IHS CERA
Data sources: US Census Bureau, OECD/IEA
Note: Total trade = exports plus imports

© 2013 IHS
US and Canadian industrial retail electricity prices by state and province, 2011

Source: IHS CERA
Note: For Canada, retail industrial prices are the value of electricity sales of mining, manufacturing, and other industries divided by the quantity in those sectors. Canadian provinces and territories are displayed in green, and US states are displayed in blue.

© 2013 IHS
“California's staggering labor and energy costs—it has the nation's most stringent fuel and renewable standards—have helped kill hundreds of thousands of manufacturing jobs in California's interior. The Golden State has shed a third of its manufacturing base over the past decade. And while the U.S. has added nearly 500,000 manufacturing jobs over the past two years, California's heavy industry continues to erode.”

—March 4, 2013

Source: The Wall Street Journal

Sources: IHS CERA
© 2013 IHS
Distributed generation — disruptive politics versus disruptive technology
Indeed, to a growing number of experts in and around the utility business, Thomas Edison’s vision of the central power station as the sovereign source of electricity may be obsolete. “My fear is that we’re committing billions to a technology that’s not the newest but the oldest,” says Rosemary S. Pooler, a New York Public Service commissioner. “It’s like building an awesome horseshoe plant after Henry Ford had insight into the automobile assembly line.”

—Businessweek, 21 May 1984, “Are utilities obsolete? A troubled system faces radical change”

Source: IHS CERA.
Data source: Yahoo! Finance.
Note: Plug Power Inc., an alternative energy technology provider, involves in the design, development, commercialization, and manufacture of fuel cell systems for the industrial off-road markets and stationary power markets worldwide.

© 2013 IHS
Timeline of production tax credit (PTC) and investment tax credit (ITC) extensions

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>PTC</td>
<td>Expired on 31 December</td>
</tr>
<tr>
<td>2000</td>
<td>PTC</td>
<td>Extended through December 2001</td>
</tr>
<tr>
<td>2001</td>
<td>PTC</td>
<td>Expired on 31 December</td>
</tr>
<tr>
<td>2002</td>
<td>PTC</td>
<td>Extended through December 2003</td>
</tr>
<tr>
<td>2003</td>
<td>PTC</td>
<td>Expired on 31 December</td>
</tr>
<tr>
<td>2004</td>
<td>PTC</td>
<td>Extended through December 2005</td>
</tr>
<tr>
<td>2005</td>
<td>PTC</td>
<td>Extended through December 2007</td>
</tr>
<tr>
<td>2006</td>
<td>PTC</td>
<td>Extended through December 2008; ITC extended to 1 January 2009</td>
</tr>
<tr>
<td>2007</td>
<td>PTC</td>
<td>Extended through December 2009; ITC extended through 1 January 2017</td>
</tr>
<tr>
<td>2008</td>
<td>PTC</td>
<td>Extended through December 2009; ITC extended through 1 January 2017</td>
</tr>
<tr>
<td>2009</td>
<td>PTC</td>
<td>Extended through December 2012</td>
</tr>
<tr>
<td>2010</td>
<td>PTC</td>
<td>Extended through December 2013</td>
</tr>
<tr>
<td>2011</td>
<td>PTC</td>
<td>Extended through December 2013</td>
</tr>
<tr>
<td>2012</td>
<td>PTC</td>
<td>Extended through December 2013</td>
</tr>
<tr>
<td>2013</td>
<td>PTC</td>
<td>Extended through December 2013</td>
</tr>
</tbody>
</table>

Source: IHS Emerging Energy Research.
Utility-Scale Wind: Growing Up
(2.5 MW wind turbine)

Rotor Diameter: 330 ft.
Height: 245–280 ft.

Boeing 747-400
Wingspan: 218 ft.

Typical Turbine, c. 1980
Rotor Diameter: 32–50 ft.

Source: IHS CERA
Data sources: GE, Boeing
20605-6

© 2013 IHS
“To develop a broader growth strategy to boost international competitiveness and create jobs by making a decisive transition to a smarter and sustainable low carbon economy.”

PowerShares WilderHill clean energy portfolio (PBW) versus S&P 500, 2005–13 year-to-date

Source: IHS CERA
Data Source: Yahoo! Finance
Note: The PowerShares WilderHill Clean Energy Portfolio is based on the WilderHill Clean Energy Index (Index). The Index is designed to deliver capital appreciation through the selection of companies that focus on greener and generally renewable sources of energy and technologies that facilitate cleaner energy.
Undervalued generation diversity
US lower-48 generation: Coal gains in 2013 and 2014, but natural gas slowly erodes coal’s dominance by 2020

Note: Generation from facilities that primarily meet on-site industrial demand is not included in the above data. Data are for the US lower 48 only and exclude Alaska and Hawaii.
Sources: IHS CERA for outlook, EIA for historical data

© 2013 IHS
Delivered Monthly Fuel Prices to the Power Sector

Source: IHS CERA.
Data source: Ventyx Velocity Suite.
© 2013 IHS
Fuel diversity: Taken for granted and undervalued

<table>
<thead>
<tr>
<th>Actual v. All gas generation mix 2000–13 YTD (cents per kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Henry Hub</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Standard deviation</td>
</tr>
</tbody>
</table>

Source: IHS CERA.
Data source: Ventyx Velocity Suite.
Note: Converted the Henry Hub dollar per MMBtu price to cents per kWh using the average reported heat rate for all operating natural gas plants in the respective month.
© 2013 IHS
Monthly coal and natural gas–fired generation, 2007–13 YTD

Source: IHS CERA.
Data Source: Energy Information Administration (EIA).
Monthly wholesale power prices

**PJM West**

Note: MWh = megawatt-hour(s).
Source: IHS CERA; data source: Platts Megawatt Daily © 2013 IHS

**ERCOT-North**

Note: ERCOT = Electric Reliability Council of Texas.
Source: IHS CERA; data source: Platts Megawatt Daily © 2013 IHS

**AEP Dayton Hub**

Note: AEP = American Electric Power.
Source: IHS CERA; data source: Platts Megawatt Daily © 2013 IHS

**Illinois**

Source: IHS CERA; data source: Platts Megawatt Daily © 2013 IHS
# Capacity cost recovery mechanisms in place: North America

<table>
<thead>
<tr>
<th>Power system</th>
<th>Mechanism</th>
<th>Inherent missing money</th>
<th>Imposed missing money</th>
</tr>
</thead>
<tbody>
<tr>
<td>PJM</td>
<td>Capped forward capacity market anchored to cost of new entry (CONE)</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>PJM</td>
<td>Selective reliability must-run contracts</td>
<td>☀</td>
<td>☾</td>
</tr>
<tr>
<td>ISO-NE</td>
<td>Capped forward capacity market anchored to CONE</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>NYISO</td>
<td>Capped forward capacity market anchored to CONE</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>MISO</td>
<td>Capped energy market with resource adequacy mechanism</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>CAISO</td>
<td>Flat rate capacity payment + resource adequacy requirements</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>ERCOT</td>
<td>Capped energy market with scarcity pricing and resource adequacy requirement</td>
<td>☽</td>
<td>☀</td>
</tr>
<tr>
<td>Regulated utilities and public power</td>
<td>Cost of service-based rate mechanisms</td>
<td>☽</td>
<td>☾</td>
</tr>
<tr>
<td>Various (state level)</td>
<td>Competitive solicitation for power supply with long-term power purchase agreement</td>
<td>☽</td>
<td>☾</td>
</tr>
</tbody>
</table>