Where has Electricity Demand Growth Gone in PJM and What are the Implications?

2014 EIA Energy Conference
Panel on Implications of a Zero/Low Electricity Demand Growth Scenario
July 14, 2014 Washington, DC

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PJM Interconnection
• 27% of generation in Eastern Interconnection
• 28% of load in Eastern Interconnection
• 20% of transmission assets in Eastern Interconnection

KEY STATISTICS
PJM member companies 850+
millions of people served 61
peak load in megawatts 165,492
MWs of generating capacity 185,600
miles of transmission lines 62,556
2013 GWh of annual energy 832,331
generation sources 1,365
square miles of territory 243,417
area served 13 states+DC
externally facing tie lines 191

21% of U.S. GDP produced in PJM

As of 1/1/2014
Why is it Important to Understand the Reasons For Flat to Declining Load Growth?

- The industry is facing an unprecedented turnover in generation capital stock
  - 26,000 MW of retirements since 2009 (nearly 14% of generation fleet) due to existing economic conditions and environmental rules
  - New entry of combined cycle gas and demand response resources…will there be incentives for continued new entry?
- Impending GHG regulations
  - How much reduction needs to be done and implications for the EE building block
- Load forecasts are key inputs into infrastructure planning and markets to maintain reliability
  - Transmission build outs and capacity markets
Trends in Load Growth
Regression of US Load Growth vs US GDP

1950s: $y = 0.9762x + 0.0511$
1960s: $y = 0.4008x + 0.0551$
1970s: $y = 0.5446x + 0.0279$
1980s: $y = 0.7392x + 0.0052$
1990s: $y = 0.0693x + 0.02$
2000s: $y = 0.9244x - 0.0106$

*Based on EIA “Net Generation”
**Chained 2009 GDP
• The relationship between load growth and GDP growth has appeared to slowly eroding since the end of WW II.
  – Simple OLS of load growth vs. GDP growth shows slight downward trend in the effect of GDP growth on load growth

• But the intercept term may be capturing other things:
  – Income effects at the household level
  – Saturation of electrification of our lives over the decades
  – Technology diffusion and the turnover in building and appliance capital stock to more efficient capital stock over time
Load Growth and GDP by Decade in the US (from EIA data)

- The 1990s show almost no relationship between GDP growth and load growth
  - Clinton boom years
  - High Tech diffusion keeping growth fairly constant and captured in the intercept term
- The last 13 years (2000-2012) shows it takes more than 1% GDP growth to keep load flat
  - Income effects at the household level?
  - Contraction in household formation and employment?
  - Energy efficiency programs?
  - Distributed resources?
Total Energy Not Bouncing Back with Recovery

RTO

Year

GWh

2005 2006 2007 2008 2009 2010 2011 2012 2013

Actual Energy

WN Energy
Total Energy Not Bouncing back with the Recovery

• In spite of GDP growth coming out of the trough of the recession, weather normalized total energy consumption is flat to falling...why?
  – Is it about declining median incomes?
  – Is it about the growth going to the top 1% and after a certain point, there is diminishing marginal utility to energy consumption?
  – Is it about the employment levels?
• We know it is not about energy prices which have fallen significantly since the peak when demand was highest
  – Does this point to an income effect story?
  – Is it energy efficiency measures?
PJM Wholesale Power Costs ($/MWh): Total and Major Components 2005 - 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Wholesale Power Cost</th>
<th>Energy</th>
<th>Transmission</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>$68.78</td>
<td>$63.46</td>
<td>$2.69</td>
<td>$0.03</td>
</tr>
<tr>
<td>2006</td>
<td>$58.38</td>
<td>$53.35</td>
<td>$3.16</td>
<td>$0.03</td>
</tr>
<tr>
<td>2007</td>
<td>$70.98</td>
<td>$61.66</td>
<td>$3.39</td>
<td>$3.91</td>
</tr>
<tr>
<td>2008</td>
<td>$84.66</td>
<td>$71.00</td>
<td>$3.56</td>
<td>$8.12</td>
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<tr>
<td>2009</td>
<td>$55.31</td>
<td>$39.05</td>
<td>$3.94</td>
<td>$10.79</td>
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<td>2010</td>
<td>$66.15</td>
<td>$48.34</td>
<td>$3.95</td>
<td>$11.97</td>
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<tr>
<td>2011</td>
<td>$61.65</td>
<td>$45.94</td>
<td>$4.34</td>
<td>$9.49</td>
</tr>
<tr>
<td>2012</td>
<td>$47.77</td>
<td>$35.23</td>
<td>$4.71</td>
<td>$6.02</td>
</tr>
<tr>
<td>2013</td>
<td>$52.97</td>
<td>$38.67</td>
<td>$5.00</td>
<td>$7.10</td>
</tr>
</tbody>
</table>
Wholesale Power Costs Falling since the Recession

- Natural gas prices have fallen and during peaks gas is the marginal fuel leading to lower peak prices
- Lower gas prices have implied more efficient combined cycle gas units have been dispatched ahead of coal units, but the cost of coal is not rising much
- Of course, lower prices are a result of lower overall demand, but if this were a price story, all else equal, we would see an increase in total energy...
  - Strong indicator it is likely an income effect at play
  - Strong indicator it could be energy efficiency…active policy or in the turnover of energy consuming capital stock is also at play
Average Annual Spot and Delivered Prices of Coal and Natural Gas

- Central App Spot Coal price
- Delivered Coal Price
- Delivered Gas Price
- Henry Hub Gas Price
Total Energy Forecasts Revised Downward

Changes in Forecast Energy (GWh) w/o EKPC

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>860,521</td>
<td>874,144</td>
<td>883,516</td>
<td>894,032</td>
<td>899,413</td>
<td>908,129</td>
</tr>
<tr>
<td>2012</td>
<td>831,898</td>
<td>851,726</td>
<td>870,636</td>
<td>888,097</td>
<td>895,748</td>
<td>905,401</td>
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<tr>
<td>2013</td>
<td>816,153</td>
<td>833,173</td>
<td>852,514</td>
<td>871,879</td>
<td>881,525</td>
<td>890,913</td>
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<tr>
<td>2014</td>
<td>816,153</td>
<td>821,985</td>
<td>837,421</td>
<td>853,355</td>
<td>860,433</td>
<td>867,760</td>
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Peak Load Forecasts Revised Downward

Changes in Forecast Peak Load w/o EKPC

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>162,489</td>
<td>164,772</td>
<td>166,506</td>
<td>167,847</td>
<td>169,443</td>
<td>171,067</td>
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<tr>
<td>2012</td>
<td>156,254</td>
<td>159,842</td>
<td>163,168</td>
<td>165,691</td>
<td>167,433</td>
<td>169,032</td>
</tr>
<tr>
<td>2013</td>
<td>153,716</td>
<td>156,813</td>
<td>160,321</td>
<td>163,176</td>
<td>165,226</td>
<td>166,810</td>
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<tr>
<td>2014</td>
<td>153,296</td>
<td>155,380</td>
<td>158,329</td>
<td>160,528</td>
<td>162,242</td>
<td>163,513</td>
</tr>
</tbody>
</table>
Implications of Lower Demand Growth for Transmission and Generation Capacity
PJM BOM Approved Backbone Transmission Lines

Legend
- Substation
- Transmission Facilities
- PJM Zones

8/24/2012
PJM BOM removes PATH and MAPP from RTEP.
Load Growth Trends and Transmission

• Lower total energy (along with fuel cost changes) have led to lower congestion levels than have been the case historically
  – January and February 2014 being excepted

• Lower load growth was a contributor to the cancellation of some anticipated backbone transmission projects needed to solve identified reliability violations further into the future
  – MAPP and PATH
Necessary Revenue to Continue Operating under CSAPR and MATS Policies

Required Revenues in $/MW-day of Installed Capacity

Avg Rev Req Low Gas 09-10
Avg Rev Req High Gas 07-08
Avg Rev Req All Gas 07-10
Evolution of Capacity Prices

RPM Base Residual Auction Resource Clearing Prices

$\text{$/MWh-Day}$

- 2007/2008: $40.80
- 2008/2009: $210.11
- 2009/2010: $237.33
- 2010/2011: $191.32
- 2011/2012: $174.29
- 2012/2013: $139.73
- 2013/2014: $245.00
- 2014/2015: $226.15
- 2015/2016: $136.50
- 2016/2017: $136.08
- 2017/2018: $167.46

Legend:
- RTO
- EMAAC
- SWAAC
- MAAC
Demand is a Key Participant to Meet Resource Needs…
Cleared Installed Capacity

- **COAL**
- **GAS**
- **NUCLEAR**
- **RENEWABLES**
- **DEMAND RESPONSE**

*Delivery Year:
- 2007/08
- 2008/09
- 2009/10
- 2010/11
- 2011/12
- 2012/13
- 2013/14
- 2014/15
- 2015/16
- 2016/17
- 2017/18*
Look Ahead to CAAA 111(d) GHG Compliance

PJM Market – Average Power Generation Emissions
Pounds Per MWh of Electricity Produced

PJM Average Emissions (lbs/MWh)

- Carbon Dioxide
- Sulfur Dioxides
- Nitrogen Oxides

2005 2006 2007 2008 2009 2010 2011 2012 2013

CO2

SO2 and NOx

950 1,000 1,050 1,100 1,150 1,200 1,250 1,300 1,350

9 8 7 6 5 4 3 2 1 0
PJM States System Emission Reduction Standards

- Bars represent 2012 Rate
- Red bars represent 2030 Goal
- Green line represents Percent Reduction

States included: Kentucky, West Virginia, Indiana, Ohio, Pennsylvania, Michigan, Delaware, Illinois, Maryland, Virginia, Tennessee, North Carolina, New Jersey