Technology & Customer Trends Impacting Coal-fueled Power Generation

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AEP Generation

Virginia Coal & Energy Alliance
Southern States Energy Board
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American Electric Power Company Overview

$31B
Current Market Capitalization

5.4 million
Customers in 11 States

31 GW
Owned Generation & PPAs

40,000+
Line Miles of Transmission
Generation Portfolio

1999 includes AEP and Central and South West generation combined. All periods presented include Purchase Power Agreements. Future excludes Cardinal, Conesville, Stuart and Zimmer plants.

* Energy Efficiency / Demand Response represents avoided capacity rather than physical assets.
Prudent Decisions ➔ Sustainable Results

**TOTAL AEP SYSTEM NOx & SO2 EMISSIONS**

- **SO2**:
  - 1990-2015 Actual: 88%
  - 1990-2017* Estimated: 94%
  - 1990-Future Estimated: 94%

- **NOx**:
  - 1990-2015 Actual: 87%
  - 1990-2017* Estimated: 89%
  - 1990-Future Estimated: 93%

**TOTAL AEP SYSTEM MERCURY EMISSIONS**

- **Hg**:
  - 2001-2015 Actual: 73%
  - 2001-2017* Estimated: 87%
  - 2001-Future Estimated: 89%

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*Reflects impact of sale of Lawrenceburg, Waverly, Darby and Gavin plants
Future excludes Cardinal, Conesville, Stuart and Zimmer plants
Demand Growth & Energy Efficiency

Energy Efficiency Technology Impacts to AEP’s Sales Forecast

- **2016 Technology**
- **Normalized Residential Base**
- **Normalized Commercial Base**

This chart reflects forecasted impacts of energy efficiency on residential and commercial sales within AEP’s service territory. The red line represents what our residential and commercial sales would have been if not for the increasing energy efficiency that is assumed will occur.
Drivers for Change

**Energy Efficiency Standards**

**ARKANSAS** (mandatory)
0.9% of 2015 retail sales in 2017 and 2018; 1.0% of 2015 retail sales in 2019.

**LOUISIANA** (voluntary)
Voluntary 2-phase EE plan.

**OHIO** (mandatory)
22% reduction of retail electricity sales by 2026 phased in beginning in 2009; but in 2014 SB 310 put a two year freeze on mandates.

**MICHIGAN** (mandatory)
1% annual reduction of previous year retail sales in 2012 and remaining at that level.

**TEXAS** (mandatory)
30% reduction in annual growth in demand until the goal is equal to 0.4% of previous year peak demand.

**VIRGINIA** (voluntary)
10% electricity savings by 2022 relative to 2006 retail sales (voluntary).

**Note:** Indiana–EE goals are determined through the Interated Resource Planning Process (SB 412).

There are currently no energy efficiency standards in Kentucky, Oklahoma, Tennessee or West Virginia.

**Renewable Portfolio Standards**

**Ohio** (mandatory): Phase-in program increasing to 12.5% by 2026 (SB 310) put a two year freeze on mandates.

**Michigan** (mandatory): Phase-in program increasing to 10% by 2015.

**Indiana** (voluntary): Phase-in program increasing to 10% by 2025.

**Oklahoma** (voluntary): Goal of 10% by 2015.

**Virginia** (voluntary): Phase-in starting at 4% in 2010 increasing to 15% by 2025.

**Texas** (mandatory): Starting at 2,200 MW in 2007 increasing to 10,000 MW statewide by 2025.

There are currently no renewable portfolio standards in Arkansas, Kentucky, Louisiana, Tennessee or West Virginia.
AEP 2016 Integrated Resource Plan

**AEP SYSTEM PLANNED GENERATION RESOURCE ADDITIONS**
regulated and AEP Ohio Purchase Power Agreement

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<td>400 MW</td>
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<tr>
<td>2032</td>
<td>100 MW</td>
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**Total MW**
- 3,400
- 5,400
- 3,000

Source: Current Internal Integrated Resource Plans, which largely do not reflect ITC/PTC extension, bonus depreciation or potential impact of Clean Power Plan. Wind and solar represent nameplate MW capacity.
Traditional Vs. Integrated Grid

- Centralized generation sources feed transmission/distribution network.
- Electricity flows “one-way” from centralized generators to consumers.
- Mature regulatory rate structure and market infrastructure.

- Greater integration of entire electric system.
- Distributed generation: supports localized demand along with central generation and supplies excess generation to grid (“two-way” flow).
- Energy efficiency and demand response program can augment and/or offset “steel-in-the-ground” generation capacity.
- Requires innovative rate design and cost transparency at the retail level.
Navigating a Path to the Future

We think we can see clearly the next generation energy company...

...but when we look more closely, it’s not completely clear how we get there.
Technology Plays a Key Role

- **Generation**
  - NGCC
  - Large-scale Wind & Solar PV
  - Innovative Power Cycles
  - Clean Fossil (CCUS)
  - Advanced Nuclear

- **Transmission**

- **Distribution**
  - Community Solar PV
  - Energy Storage
  - Microgrids
  - Recip Engines & Aero Turbines
  - Combined Heat & Power
  - Hybrid Technologies
  - Fuel Cells

- **Customer**
  - Options / Solutions / Satisfaction
  - Data / Feedback / Preferences
  - Rooftop PV Energy Storage
  - “Smart” Home

- **AMERICAN ELECTRIC POWER**

- Improved Technology
  - Monitoring & Diagnostics
  - Lean Principles

- Develop and deploy new generation technology, systems and equipment to support the integrated grid of the future.

Explore opportunities “Behind the Meter” to improve overall grid efficiency and maximize customer benefits.
Disruptive 3rd parties will threaten to take our load and our customers if we don’t take action.

The Premier Energy Company of the Future
The Value of Firm Fossil-fueled Generation Capacity

• Fundamental disconnect between energy and capacity and the value that capacity brings to the integrated grid and to the customer.
  • Steel-in-the-ground capacity makes today’s grid reliable and the integrated grid of the future, possible.
    • Startup power
    • Backup power / reserves
    • Voltage and frequency stability
    • Load following / peak power

Energy In = Energy Out
Energy + Capacity In = Grid Reliability Out!
Dispatch-able Generation - When You Need It – 24X7

• Dispatch-able, fossil-fueled generation is the reliability backstop for intermittent renewable energy.

• Utilities must plan for and provide generation during periods of little or no renewable energy output.

Challenges:
• Flexibility (e.g. ramping / load-shedding)
• Economic sustainability as more and more renewables are placed on the grid
Why Natural Gas Stays in the Mix

- Risk profile advantage relative to other dispatch-able capacity.
- Low emissions
- Efficiency
- Flexibility
- Size, Modularity and Constructability.
- Fuel availability and Cost
- Use Cases and Applications
  - Combined Heat & Power
  - Microgrid applications
  - Grid ancillary services
- New technologies under development – advanced NGCC, natural gas fuel cells, Oxy-gas-fired supercritical CO₂ power cycle (NET Power), etc.
21st Century Fossil-fueled Generation Technologies and AEP Focus

• Advanced Cycles (e.g. A-USC Steam, Supercritical CO₂)

• Advanced Fossil Combustion / Thermal Energy Conversion Technologies (chemical looping, pressurized oxy-fuel combustion)

• IGCC & Post-Combustion CO₂ Capture
  • Kemper IGCC
  • Petra Nova Post-combustion Capture w/ EOR
  • Selective CO₂ membranes
AEP Fossil R&D Engagement

- EPRI – Program and supplemental project involvement to support transformational fossil technology development
  - Supercritical CO₂ Power Cycles
  - Advanced Ultra-supercritical Advisory Committee
  - Advanced water research

- Ohio State University R&D Projects
  - Coal direct and syngas chemical looping
  - Prototype CO₂ membrane development

- Gas Technologies Institute
  - DOE/SwRI STEP sCO₂ Test Facility (10MW)

- Funding Partner since 2009 in DOE/Southern Co. National Carbon Capture Center
The timeline is real

- U.S. DOE 2017 Quadrennial Energy Review

*Figure 1-8. Current Age and Expected Life of Generation Fleet by Nameplate Capacity, 2015*
Technology Pathways are Needed

- DOE – Fossil Energy R&D budget appropriations
- EPRI – Long Term Research Imperatives that include low-carbon fossil energy
- Carbon Utilization Research Council (CURC) / EPRI Technology Roadmap
Balance is Essential

• A balanced diet is essential to good health.

• A balanced budget is essential to financial well-being.

• A good work / life balance is essential to personal happiness.

• A balanced stock portfolio is essential to sound wealth management.

A balanced energy infrastructure is essential to providing safe, reliable, and affordable electricity.

Limiting our fuel and generation resource diversity threatens the balance!
Thank You!