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AEP perspectives on 21st century power generation

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AEP Generation

Perspectives on 21st Century Power Generation

Engineering Conferences International

CO_2 Summit II

Santa Ana Pueblo, New Mexico

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AEP Generation

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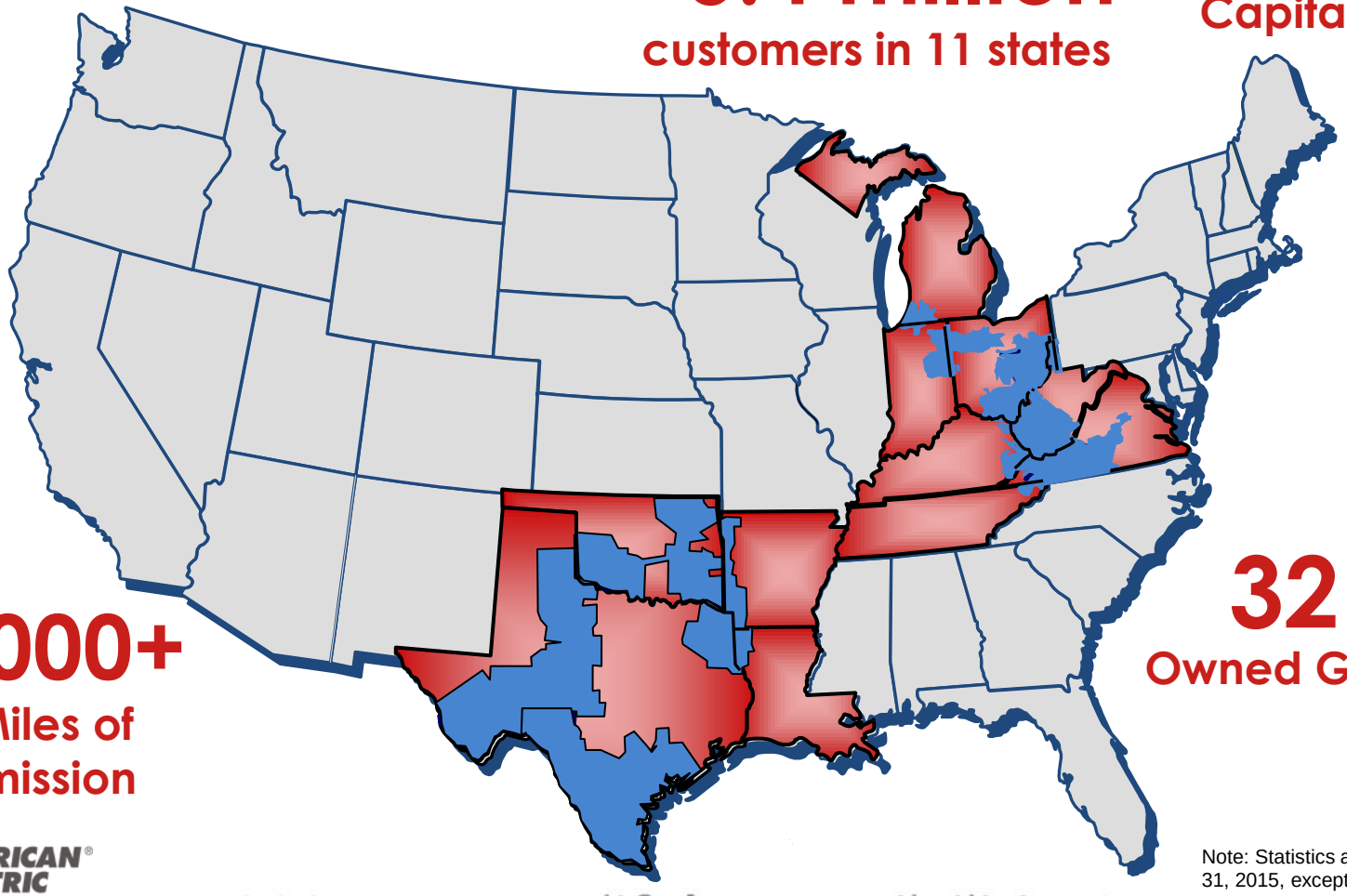
American Electric Power Company Overview

$62B
Total Assets

5.4 million
customers in 11 states

$31B
Current Market Capitalization



40,000+
Line Miles of Transmission

32 GW
Owned Generation

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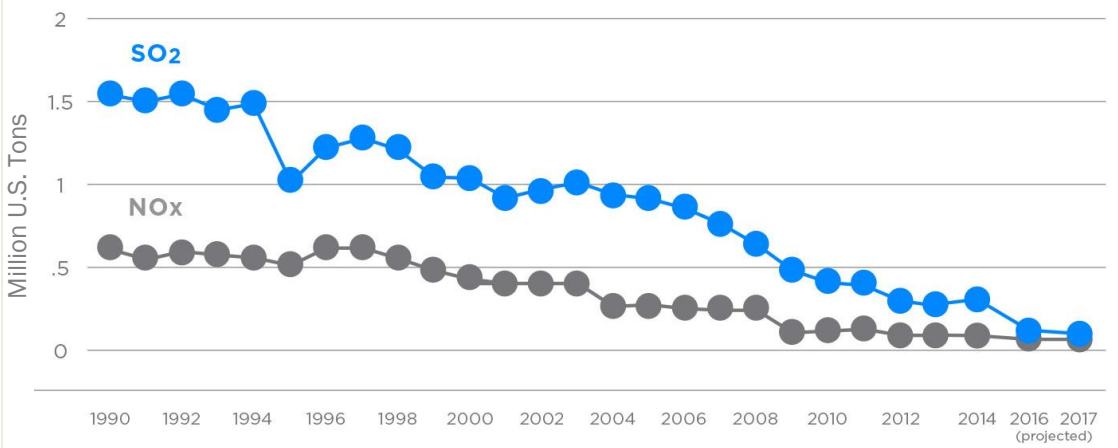
Note: Statistics as of December 31, 2015, except market capitalization which is as of February 25, 2016

Prudent Decisions – Positive Results

Total AEP System Emissions 1990-2017 projected



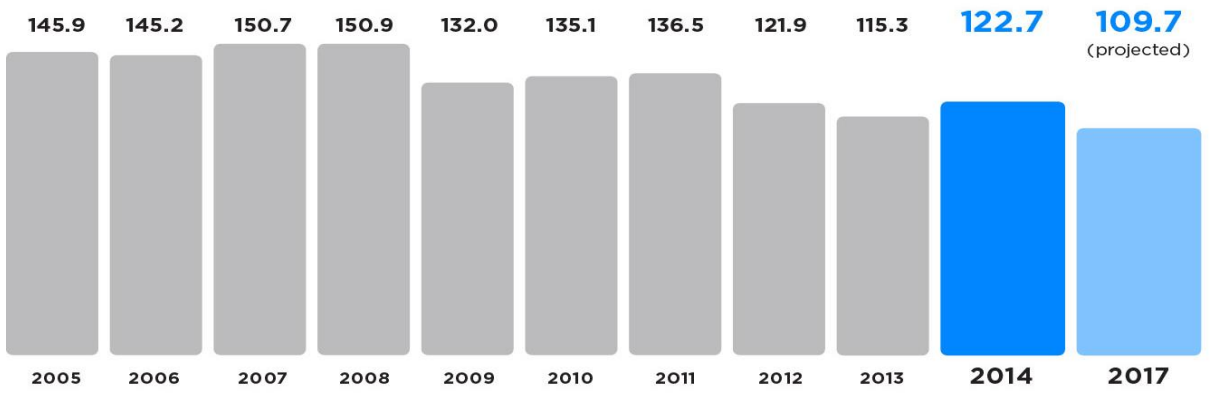
SO_2 projected 90%

NOx projected 85%

Hg projected 85%

Total AEP System Annual CO_2 Emissions

(in million metric tons)



25%

estimated reduction in CO_2 emissions from 2005–2017

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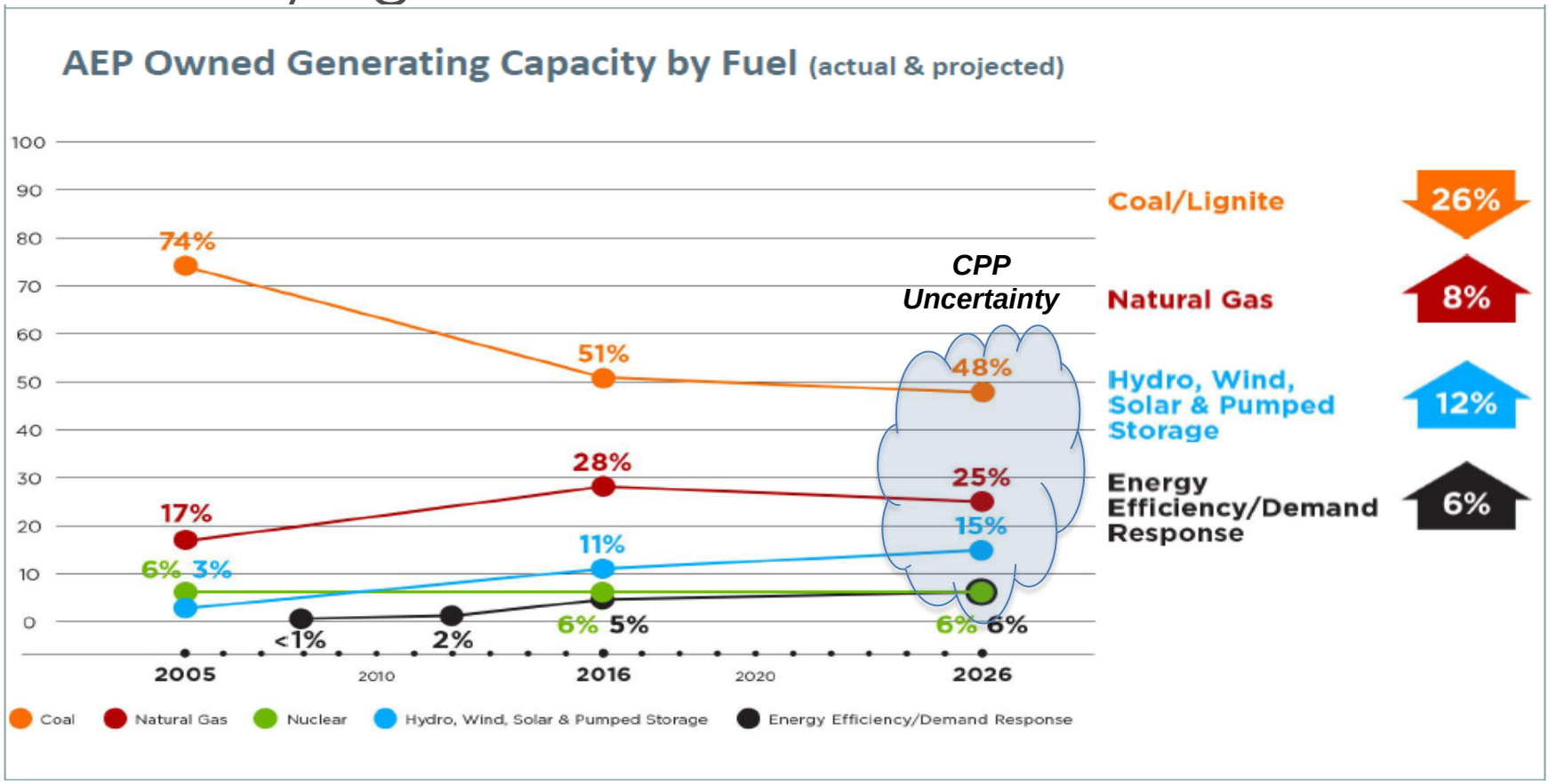
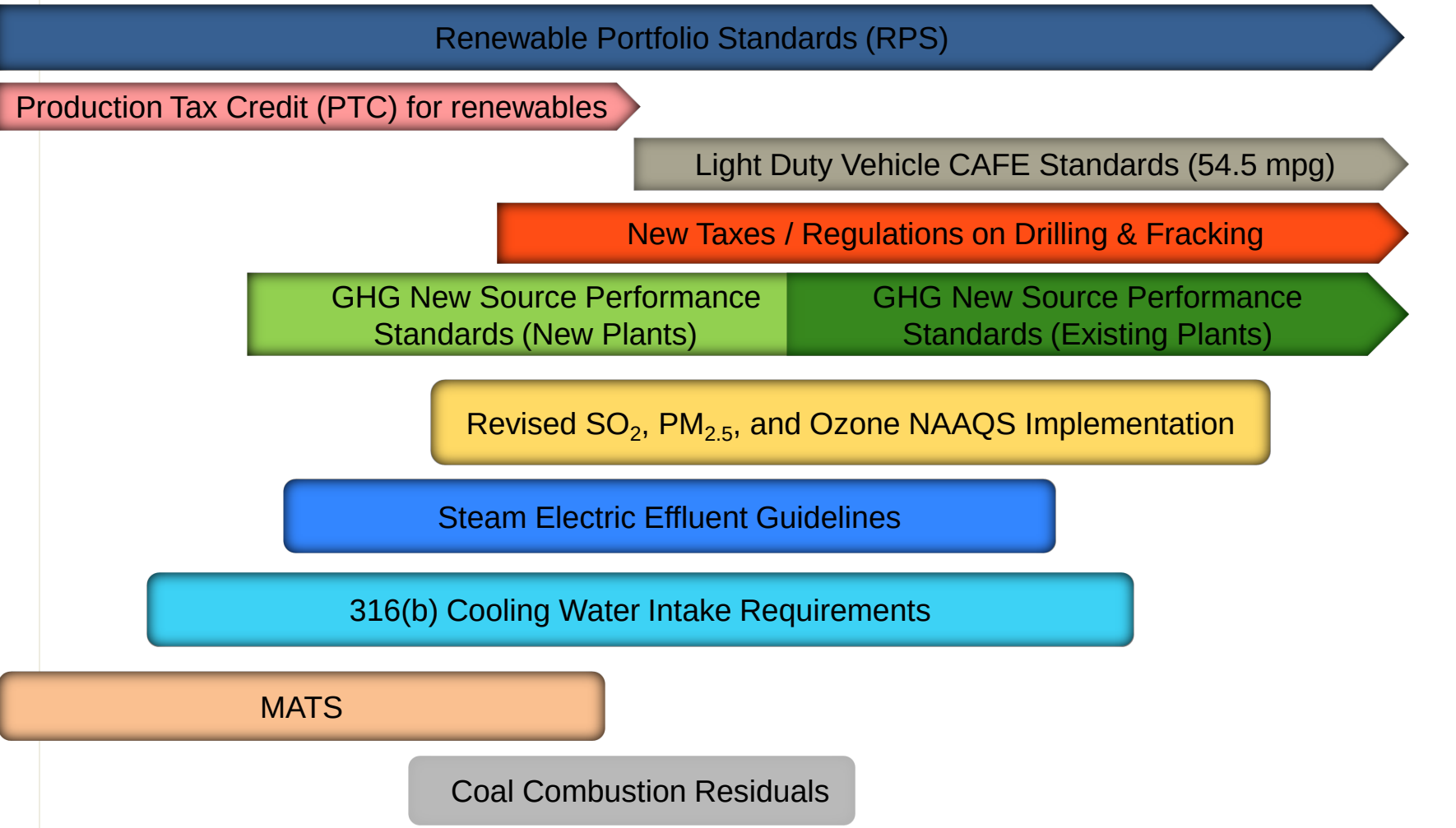
Diversifying our Fuel Portfolio



- 7,000+ MW of generation retiring by mid-2016
- Some planned coal to natural gas conversions and/or repower considerations
- No new fossil generation planned between now and 2020
- Utility Scale Solar PV under construction in Indiana (3-5 sites, 1-5MW each, 16MW total by 2017)

Environmental/Regulatory Signposts & Milestones



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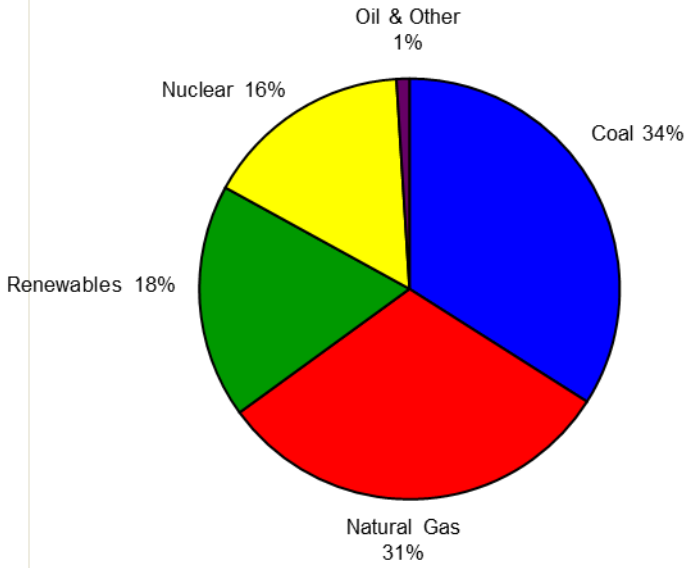
What Might the Future Look Like?

2040 Electricity Generation by Fuel (EIA AEO2015 Ref. Case)



Visible Trends Today

Ever-tightening environmental regulations for new & existing sources

Increased shale gas recovery

Renewable Portfolio Standards

Reduced Federal fossil energy R&D budgets

Federal & state renewable subsidies

Aging fossil & nuclear fleet

2040 Electricity Generation by Fuel

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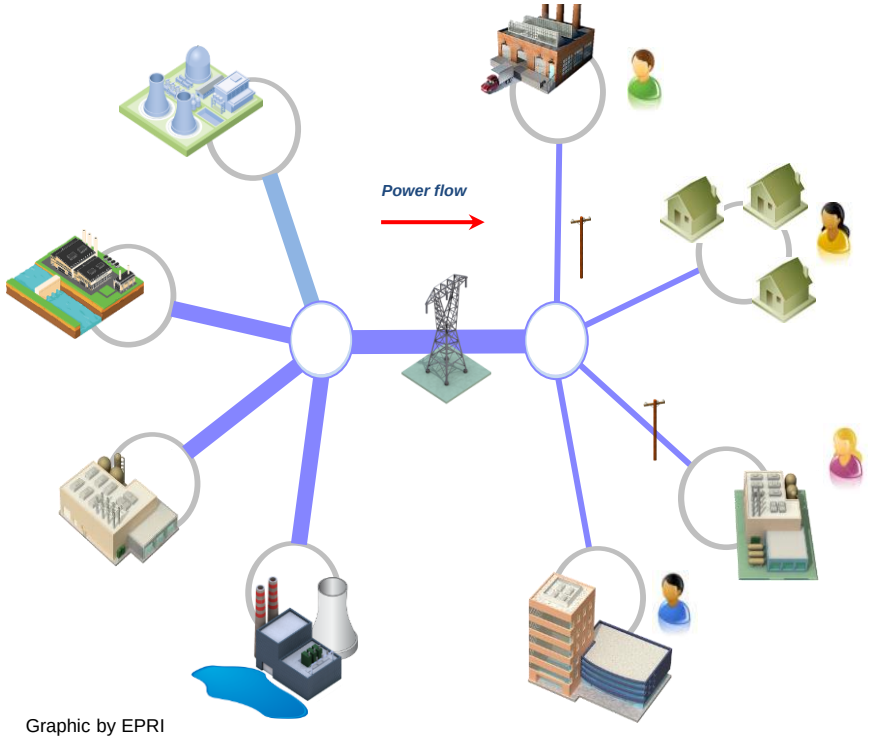
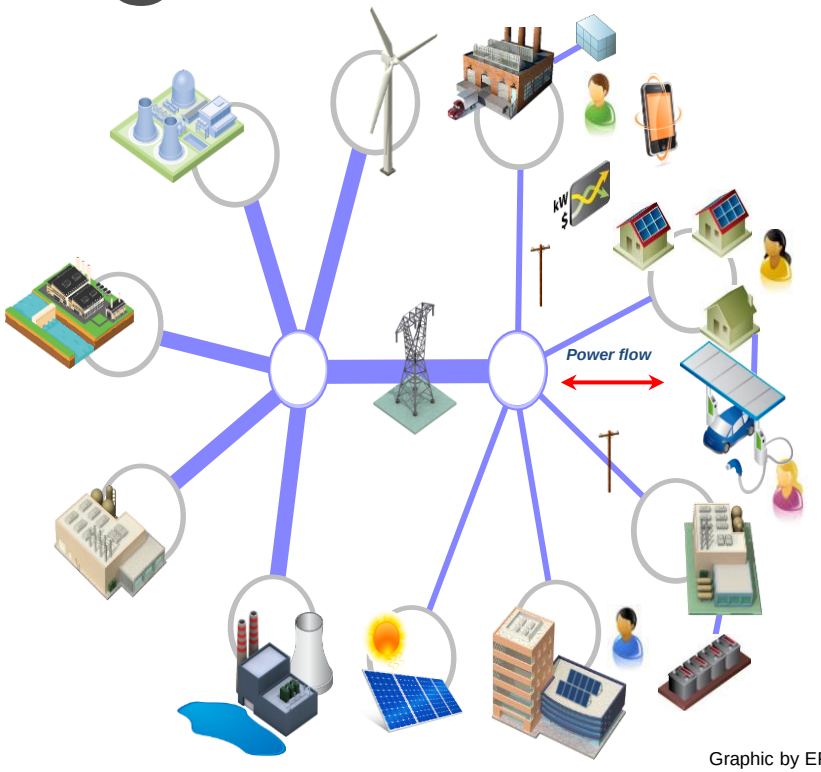
Traditional Vs. Integrated Grid



Graphic by EPRI

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



Graphic by EPRI

- 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

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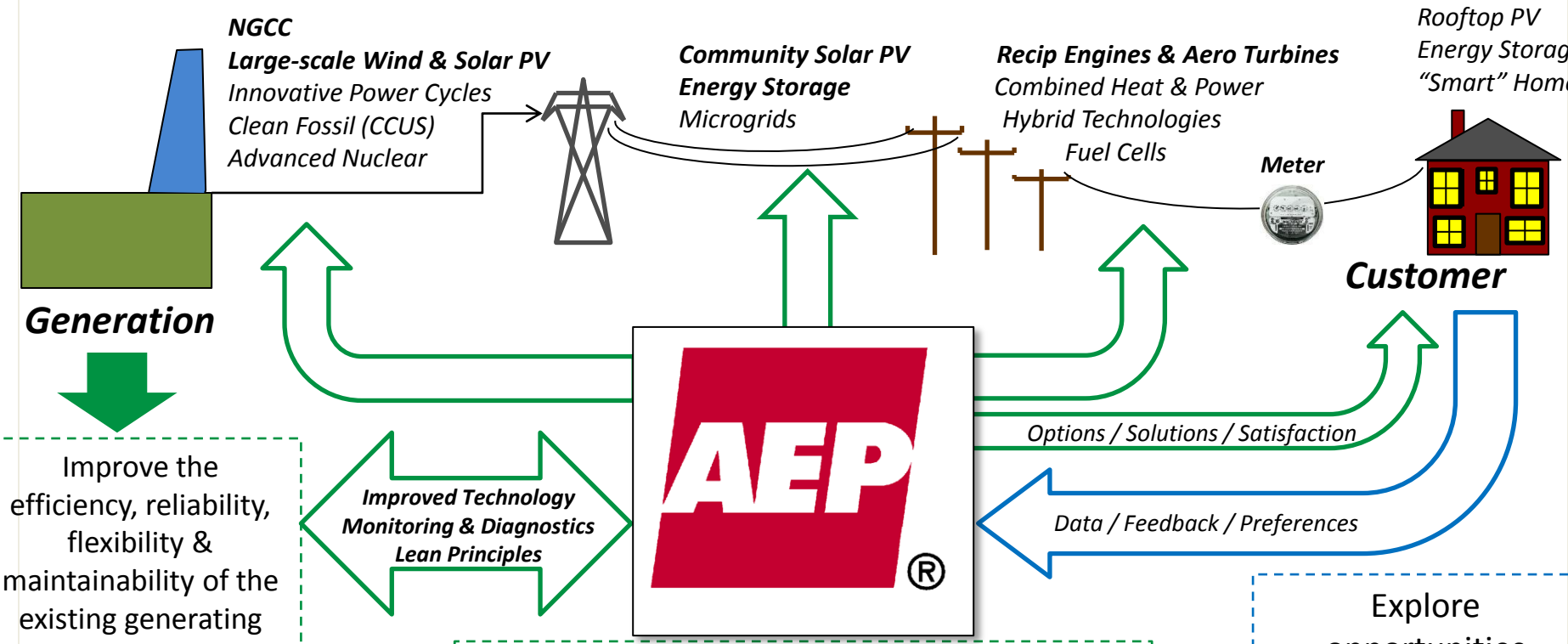
The Role of Technology



Improve the efficiency, reliability, flexibility & maintainability of the existing generating fleet.

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

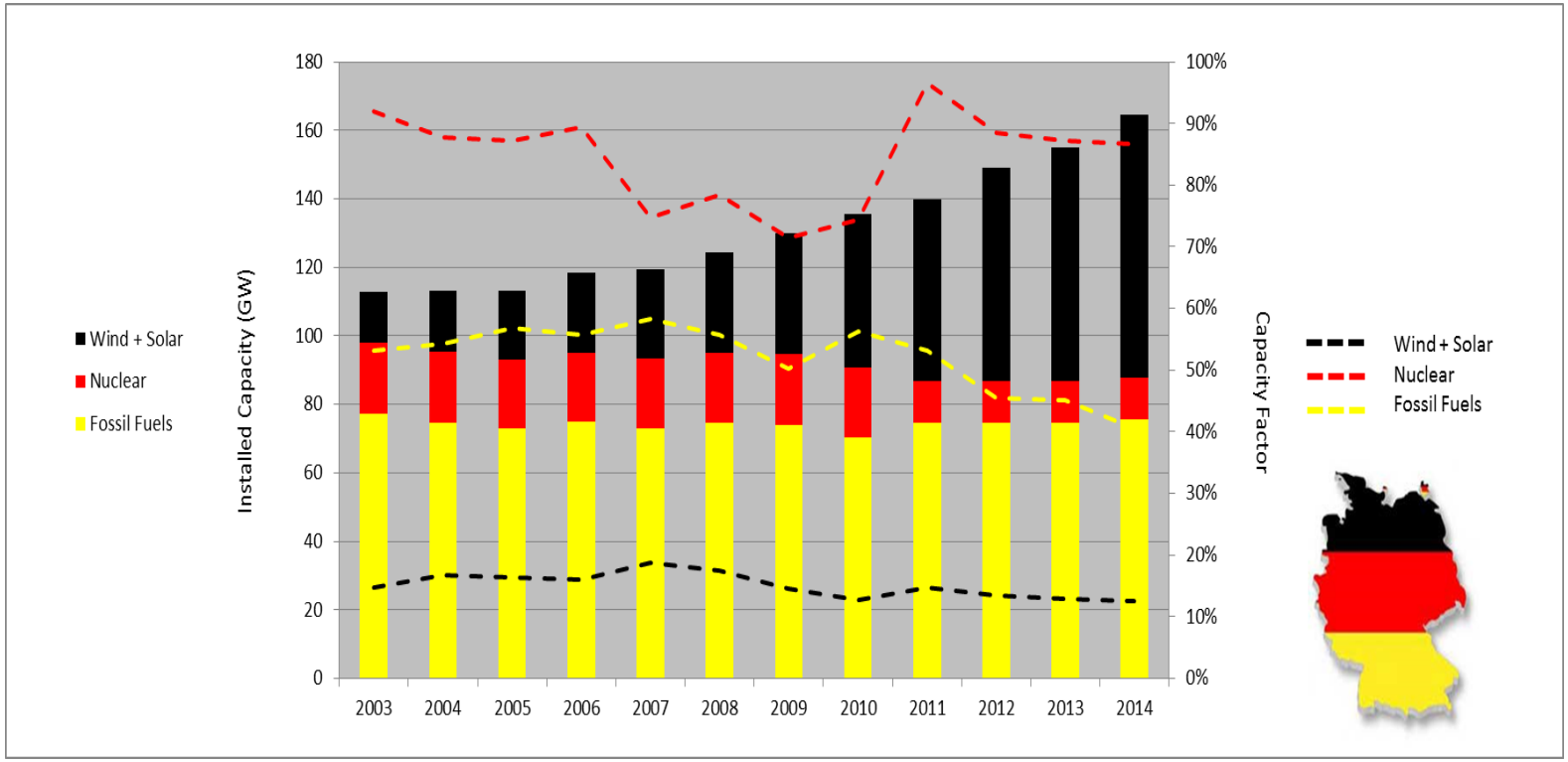
Explore opportunities "Behind the Meter" to improve overall grid efficiency and maximize customer benefits.

21st Century Technologies and AEP Focus

- *Distributed Generation & Renewables*
- *Virtual Power Plants and Microgrids*
- *Bulk Energy Storage*
- *Advanced Fossil Combustion / Thermal Energy Conversion Technologies (chemical looping, pressurized oxy-fuel)*
- *Advanced Cycles (e.g. Supercritical CO_2 direct & indirect-fired)*
- *IGCC & Post-Combustion CO2 Capture*
- *Advanced Nuclear*

Value Proposition for Fossil Generation

- Diverse fuel options promote reliability, security and affordability both today & in the future.
- Reliable, dispatch-able, low-cost fossil-fueled generation is the backbone for intermittent renewable energy.



Sources: Fraunhofer ISE & US EIA

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What is Needed?

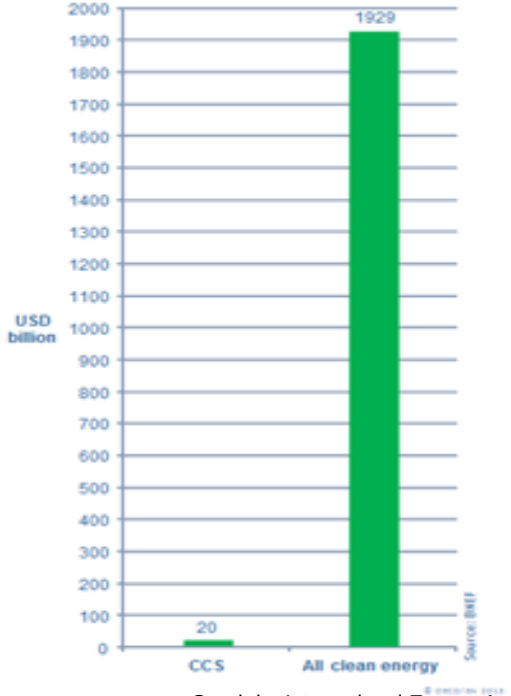
- With properly focused R&D investment and policies that minimize financial and technical risk we can have options to build cost- & performance-competitive, technology to satisfy the demand for new, clean, reliable, & flexible fossil-fueled capacity.
- Right now we are just “kicking the can down the road” when it comes to clean fossil technology innovation and policy

Strong policy drives investment

Clean energy investment* between 2004-2013 (USD):

CCS: **20** billion

All clean energy: **1929** billion



* Includes technology development, projects, M&A. Source: BNEF.

Graph by International Energy Agency

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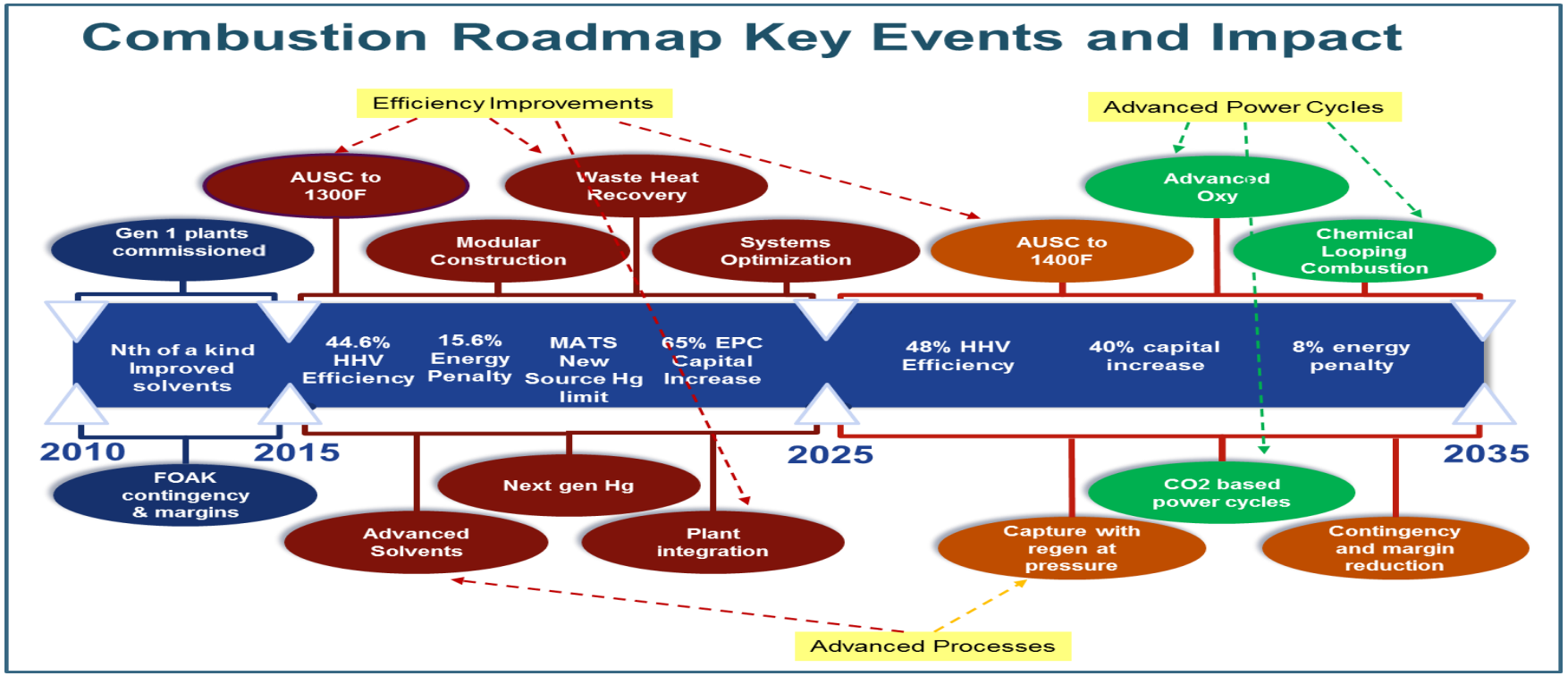
Technology Pathways

- U.S. DOE 2015 Quadrennial Energy Review, 2016 & 2017 Budgets
- EPRI – Long Term Research Imperatives
- Coal Utilization Research Council / EPRI Technology Roadmap



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Challenges to Overcome

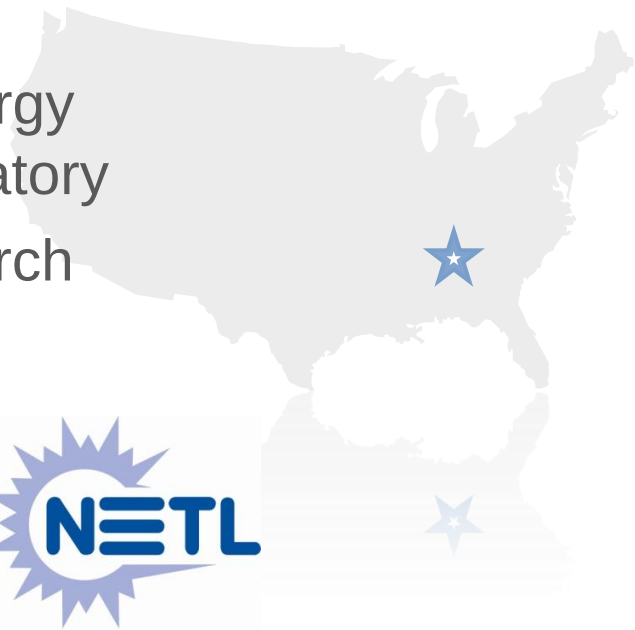
- We need technologies, equipment and components to support new generation paradigm and reduce ALL risk:
  - Increased efficiency and reduced emissions
    - Sustainable resource utilization (fuel, water, landfill)
    - Lower energy penalty
  - Scalability and practicality of use
    - Footprint
    - Constructability
    - Process Complexity & Operability
    - Utilities' first priority is to generate electricity
  - Ability to Accommodate demanding duty cycles (etc. startups, shutdowns, fast-ramping ability)
- Favorable policies and meaningful incentives toward developing and demonstrating clean coal technology at scale
  - Consider ALL risks to CCUS deployment (financial, technical, legal, practical)
  - Set example for the global community that the U.S. is serious about clean fossil technology development for the future, even in the midst of low-cost, abundant natural gas.

AEP Engagement

- EPRI – Program and supplemental project involvement to support transformational technology development
  - Supercritical CO_2 Power Cycles
  - CO_2 selective membrane research
  - Advanced water research
- Ohio State University R&D Projects
  - Coal direct and syngas chemical looping
  - Prototype membrane development
- Gas Technologies Institute
  - Proposed Oxy-PFBC Pilot Project (10MW)
- Funding Partner in DOE/Southern Co. National Carbon Capture Center

NCCC Overview

- Located in Wilsonville, Alabama
- Sponsored by the U.S. Department of Energy and its National Energy Technology Laboratory
- Partners include the Electric Power Research Institute and leaders in the power and coal industries



U.S. DEPARTMENT OF ENERGY

NETL

EPRI ELECTRIC POWER RESEARCH INSTITUTE

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What NCCC Provides

- A cost-efficient test site for numerous technology developers
- Real industrial conditions with coal-derived flue gas and syngas
- Capability for testing at multiple scales and for on-site scale-ups
- Expert staff for support of design, installation, and testing
- High quality data acquisition and gas/liquid sampling and analysis

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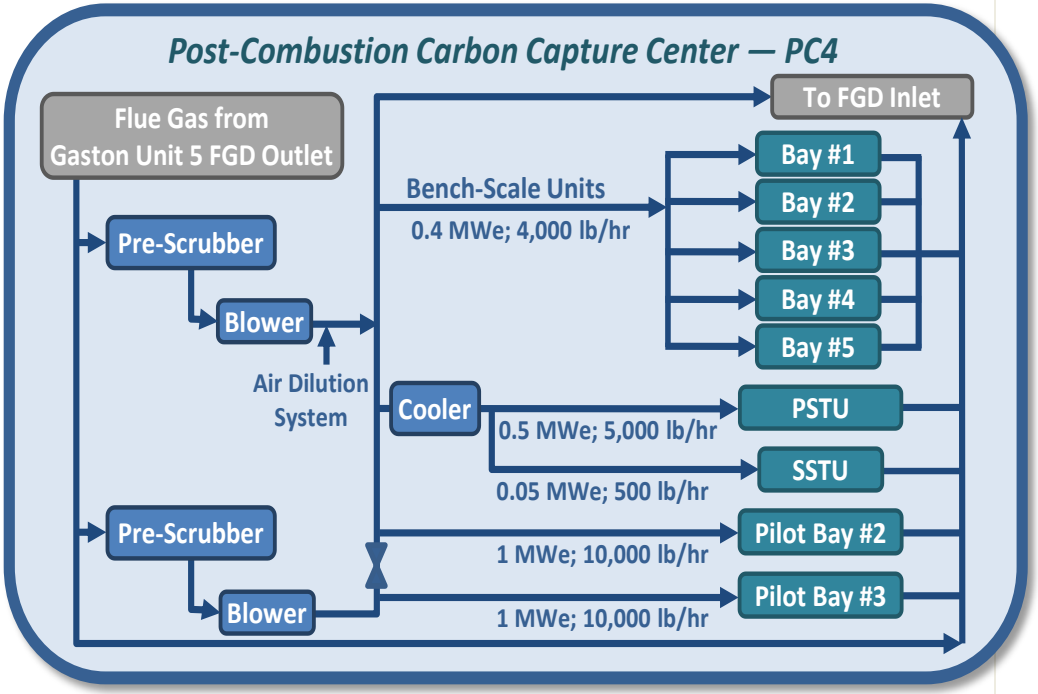
State-of-the-Art Capabilities

- **Real-World Conditions**
  Operates with flue gas from commercially dispatched coal-fired unit with full environmental controls
- **High Availability**
  Two to three campaigns per year with continued, long-term testing and new testing during each campaign
- **Infrastructure for Parallel Tests**
  Multiple test bays for bench- and pilot-scale developers' skids
- **Support for Solvent Testing**
  Fully integrated solvent units at bench- and pilot-scales
- **Flexibility for Natural Gas Conditions**
  Air dilution system for simulated natural gas-fired conditions when desired



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Thank You!