



# **Welcoming Address**

## ***What We Need from New Power Generation***

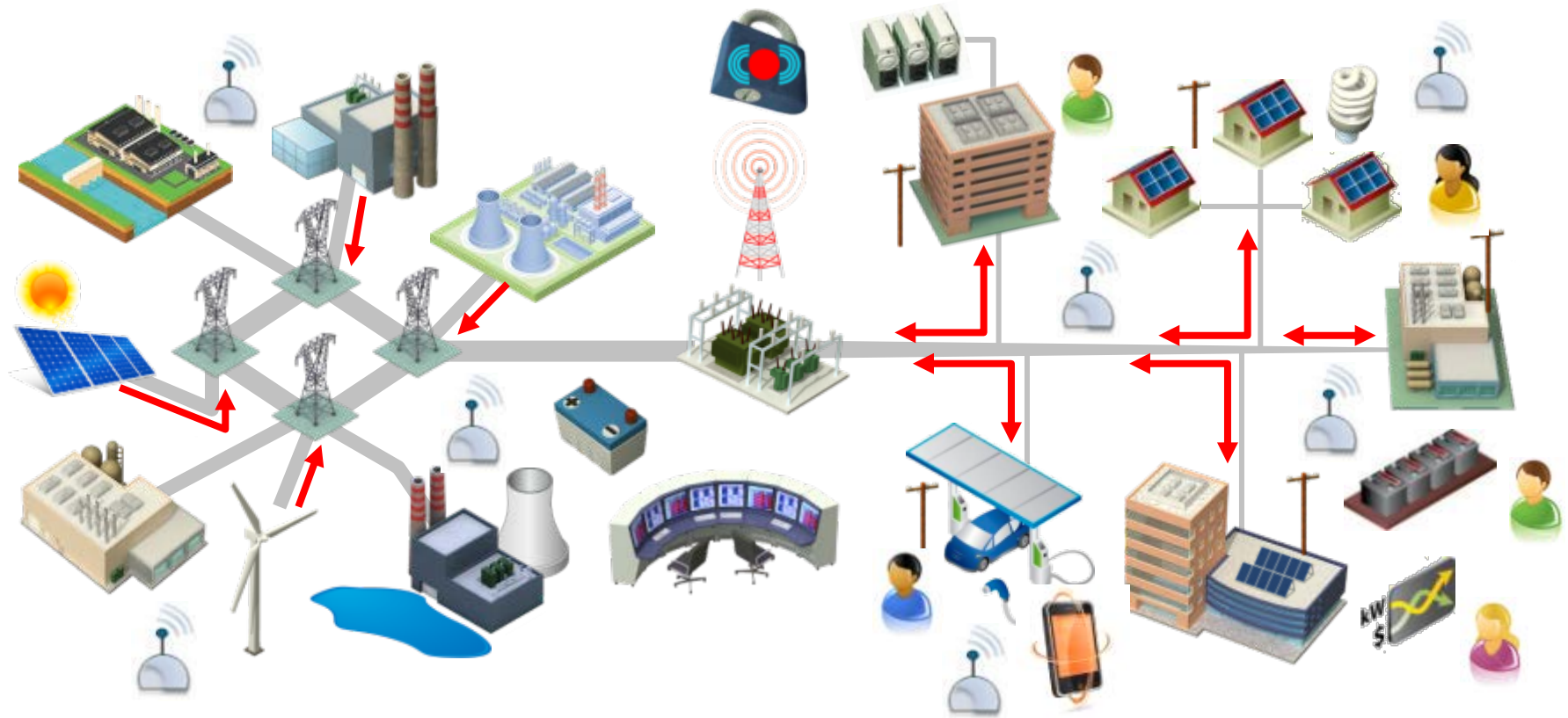
**Tom Alley**

Vice President, Generation

**4<sup>th</sup> International Symposium on Supercritical CO<sub>2</sub> Cycles**

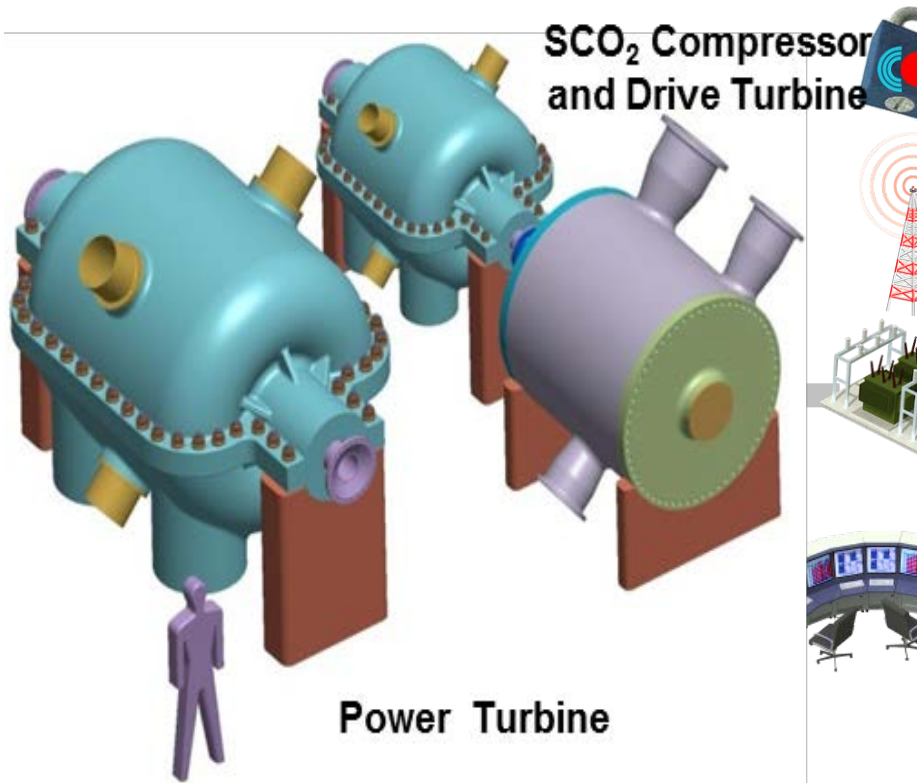
September 8, 2014

# Transformation of the Power System



**A Resilient, Flexible, and Connected System  
Driving a Need for Greater Flexibility**

# Transformation of the Power System



Curtesy - Areojet Rocketdyne



Curtesy - Echogen

Role of the Central Generating Fleet

# Power Generation Drivers and Externalities

Fuel  
Availability &  
Price (Natural  
Gas)

Water  
Management

Economic  
Viability

Renewables



Market  
Drivers

Emissions  
Constraints

Aging  
Assets

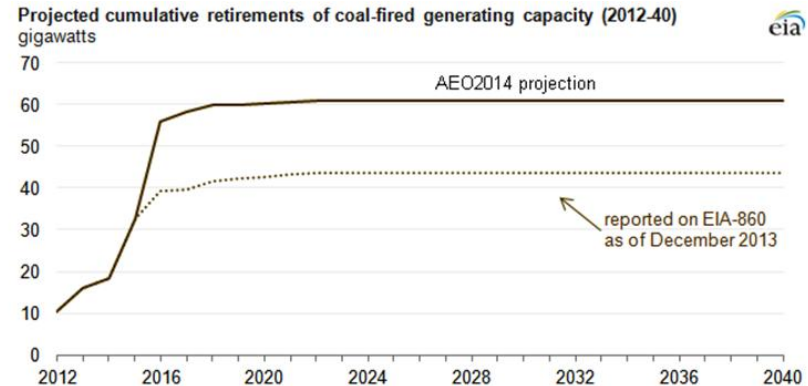
Demand  
Trends



# Coal Retirement Forecast

## Drivers

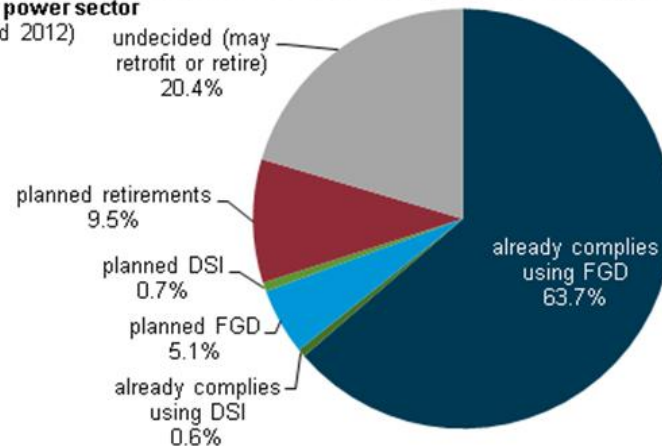
- Demand
- Economics
- Availability/Price of Natural Gas
- Environmental Regulations
  - Mercury and Air Toxics Standards (MATS)



Source: U.S. Energy Information Administration, Annual Energy Outlook 2014 Reference Case

## MATS compliance strategies for U.S. coal-fired generation capacity in the electric power sector

(year-end 2012)

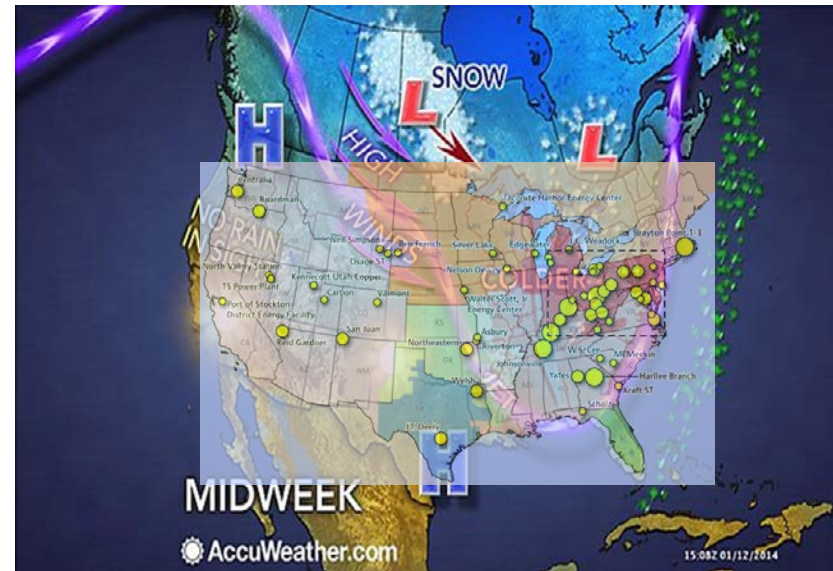


Source: U.S. EIA Annual Generator Report

MATS compliance is driving a large number of plant closures is 2016

# Polar Vortex: Fleet Response

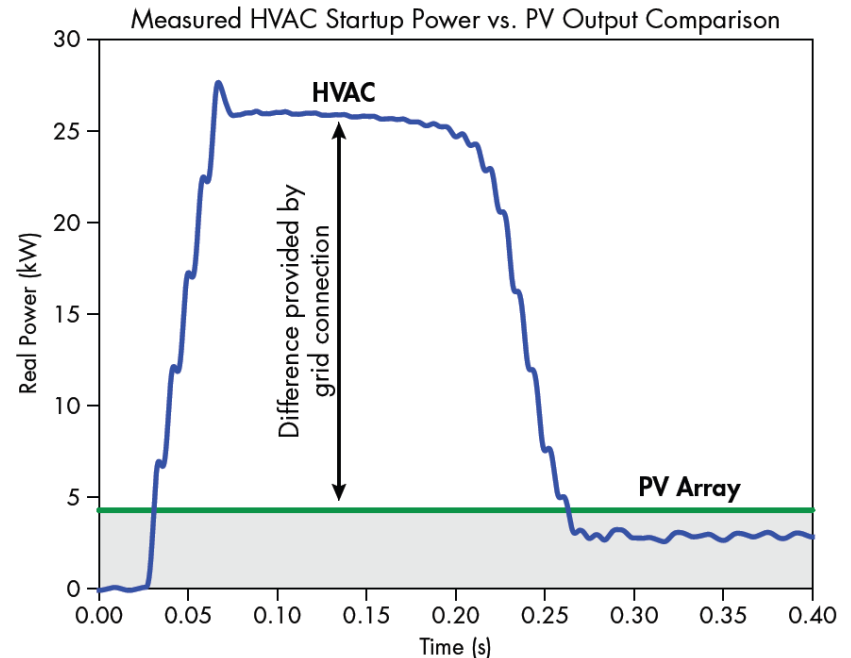
- Oil units had record runs
- Fleet required maximum flexibility
- Dual fuel switching
  - liquids were cheaper than gas
  - Delivery issues
- High gas prices – gas turndown
- Misalignment between dispatch and demand
- High forced outage rates
  - Fuel curtailments
  - Freezing instrument lines
  - Freezing HRSGs



Event demonstrates the need for fuel diversity

# Value of Centralized Generation

- Provides the backbone energy capacity
  - Startup Power
  - Backup Power/Reserves
  - Voltage and Frequency Stability
  - Load Following and Peak Power

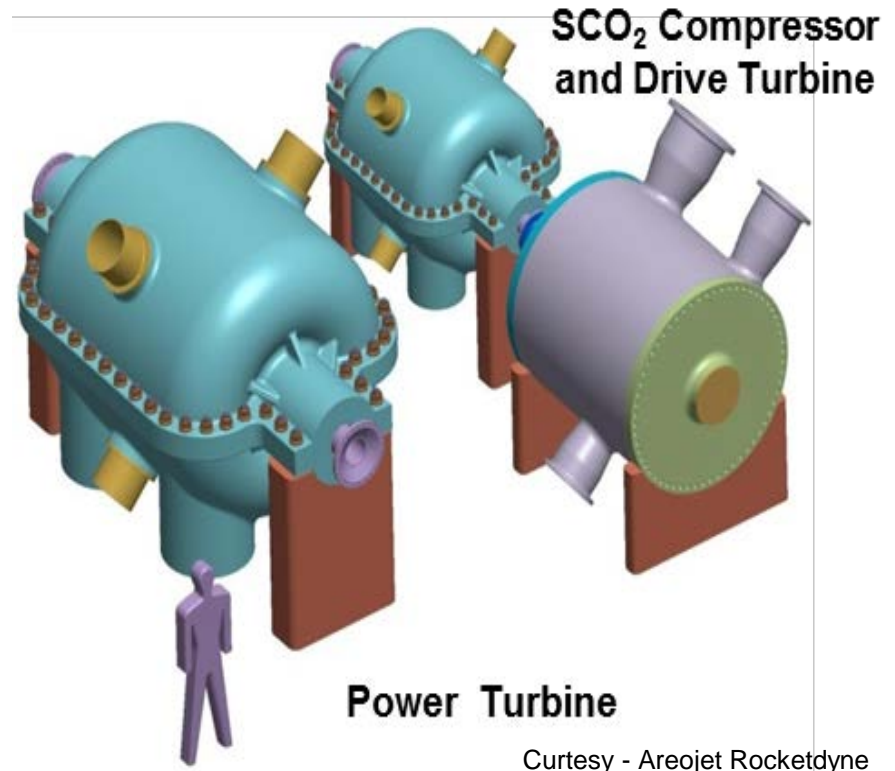


Central generating capacity is the backbone for maintaining grid stability and reliability

# The Challenge – Your Challenge

Advance the understanding and development of advanced power systems. Systems that are:

- Flexible
- Reliable
- Cost effective and efficient
- Low carbon



Courtesy - Areojet Rocketdyne

Greater Sense of Urgency - While There is Time



# ...and Low Cost



- Cost is the biggest pressure electric utilities are facing today
- EPRI's Advisory Council is very concerned about the cost impacts of electricity on consumers
- We need new ways to generate power, cleanly and reliably, that will not cause electricity prices to rise



... Low Emissions  
including CO<sub>2</sub>

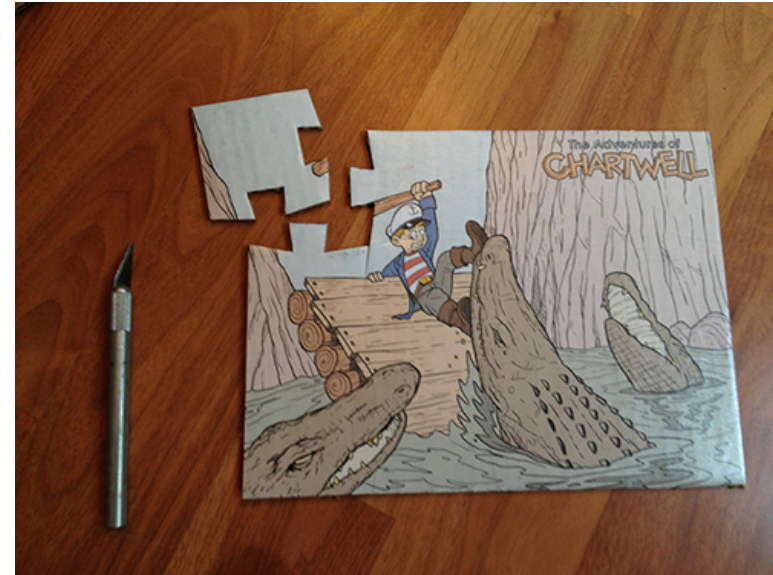
# Are Supercritical CO<sub>2</sub> Cycles the Answer?



# Together...Shaping the Future of Electricity

# The Challenge – Your Challenge

- Advance the understanding and development of advanced power systems
- Impact of the “Polar Vortex” on the northeast United States showed the importance of having a diverse generating portfolio
- But many of the coal plants that were used during the polar vortex are scheduled to be shut down next year



Key Corner Section to a very complicated Jig saw puzzle

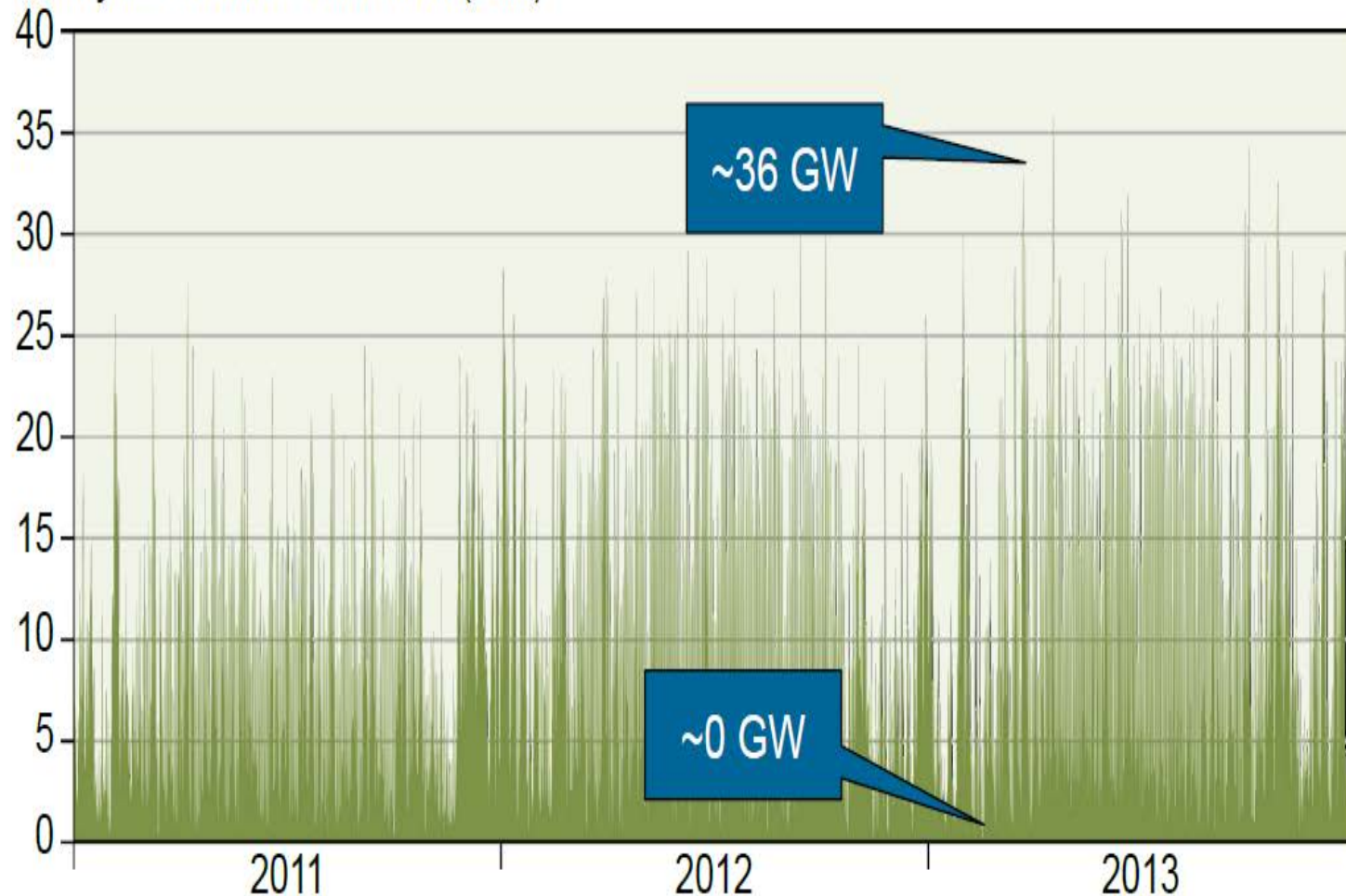


# What Do Power Generators Need?

- New technologies to replace the coal plants nearing retirement in the US and Europe & to meet the growing demand for power in developing nations
- These new technologies must offer . . .

# ...Flexibility

Hourly PV+Wind Generation (GW)



Insights from a  
Dynamic System

~80 days/yr  
variable generation  
5% below installed  
capacity

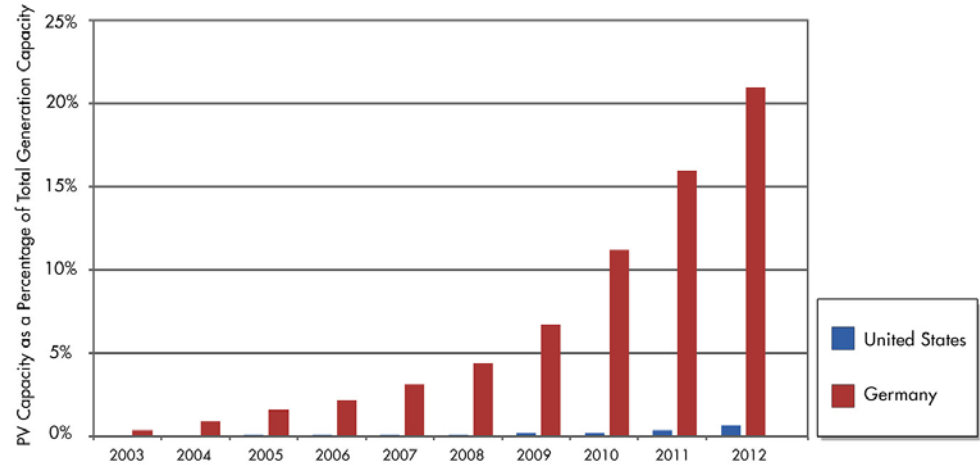
Maximum Hourly  
Ramp ~10 GW

Maximum Hourly  
Down Ramp ~7 GW

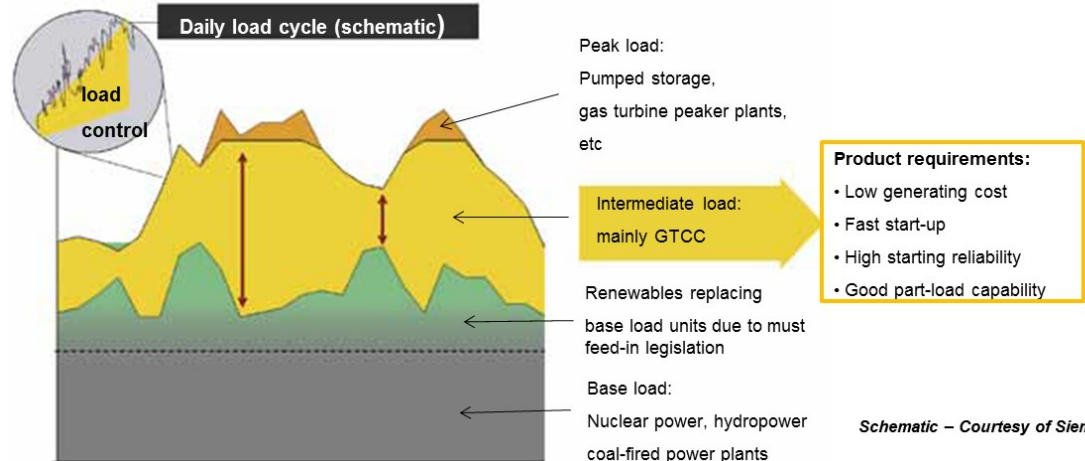
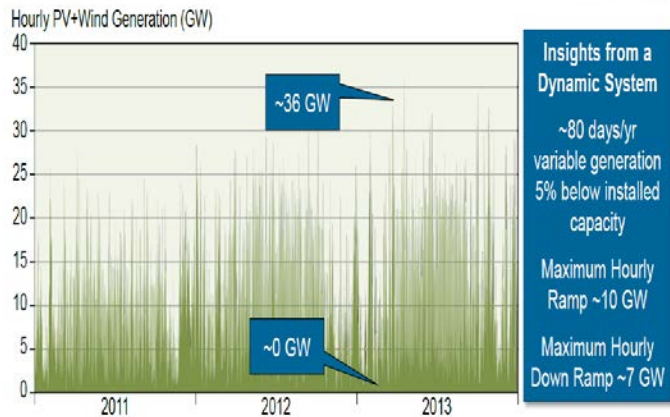
Data from Klaus Kleinekorte, Amprion, German TSO.

# European Power Generation Challenges

- RE deployment
  - Up to 30% by 2030
- Fossil flexibility required to support RE variability
- Fuel prices and risk
- Weak wholesale prices
- Low load factors (e.g., Spain)



Growth of PV in Germany

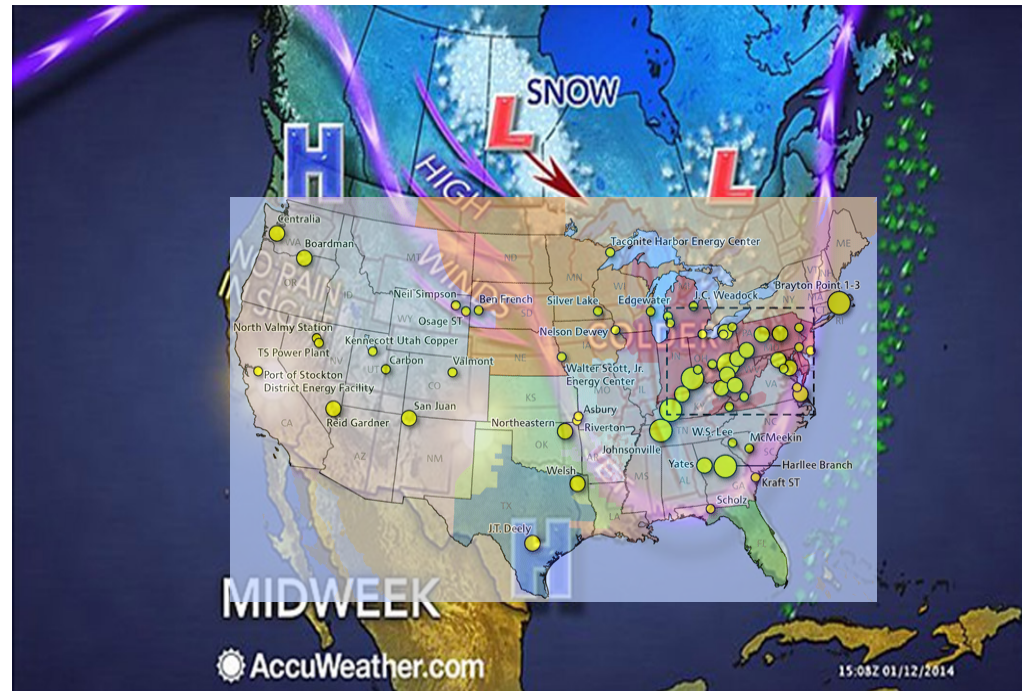


Schematic – Courtesy of Siemens

What we can learn from our international members

# Diversity in the Generation Mix is Critical

- Oil units had record runs
- Fleet required maximum flexibility
- Duel fuel switching
  - In some cases liquids were cheaper than gas
  - Delivery issues
- High gas prices – resulted in gas turndown
- Misalignment between dispatch and demand
- Availability and reliability of coal and nuclear generation fleet exceed natural gas fired, solar and wind generation
- High forced outage rates
  - Fuel curtailments
  - Freezing instrument lines
  - Freezing HRSGs

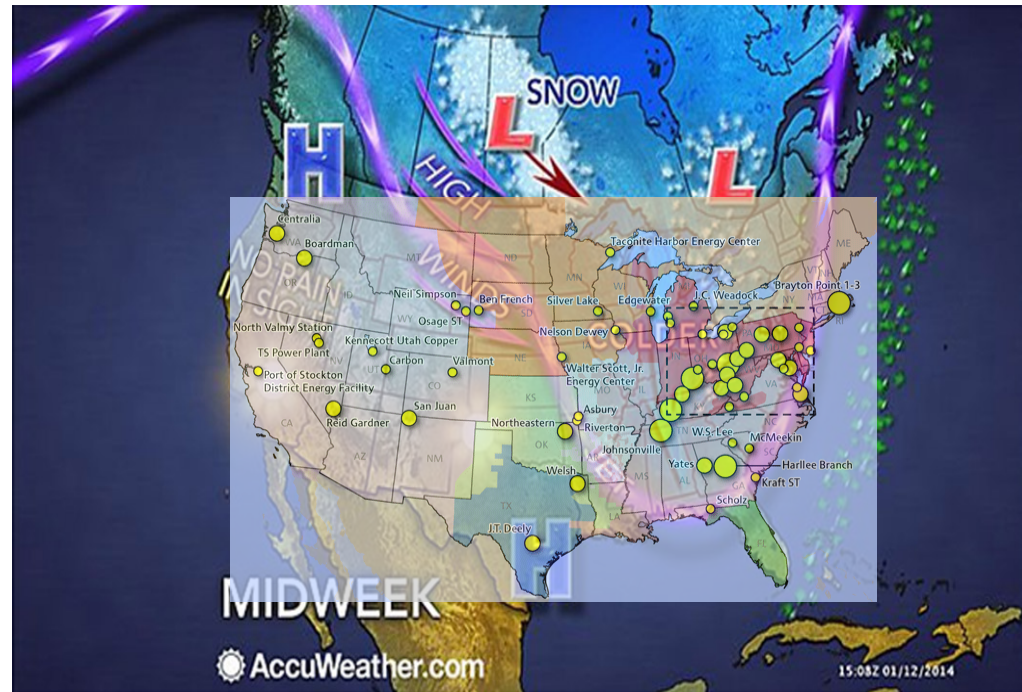


Large number of coal plant due to be retired by the end of 2016



# The Challenge – Your Challenge

- Develop the technology that will enable the power system of the future to evolve in a manner that is **Flexible, Resilient, Reliable, Efficient, Safe, and Environmentally Responsible.**
- The industry has a low risk tolerance and the risk of failure must be minimized
- Significant financial pressures
- Highly diverse opinions regarding technologies

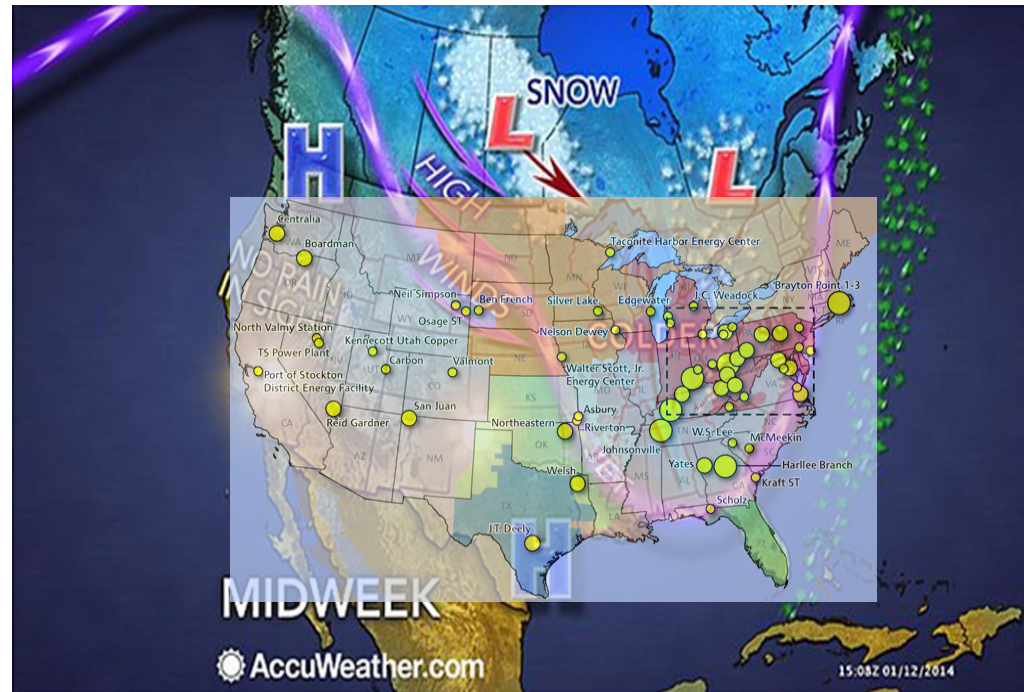


Diversity in the Generation Mix is Critical



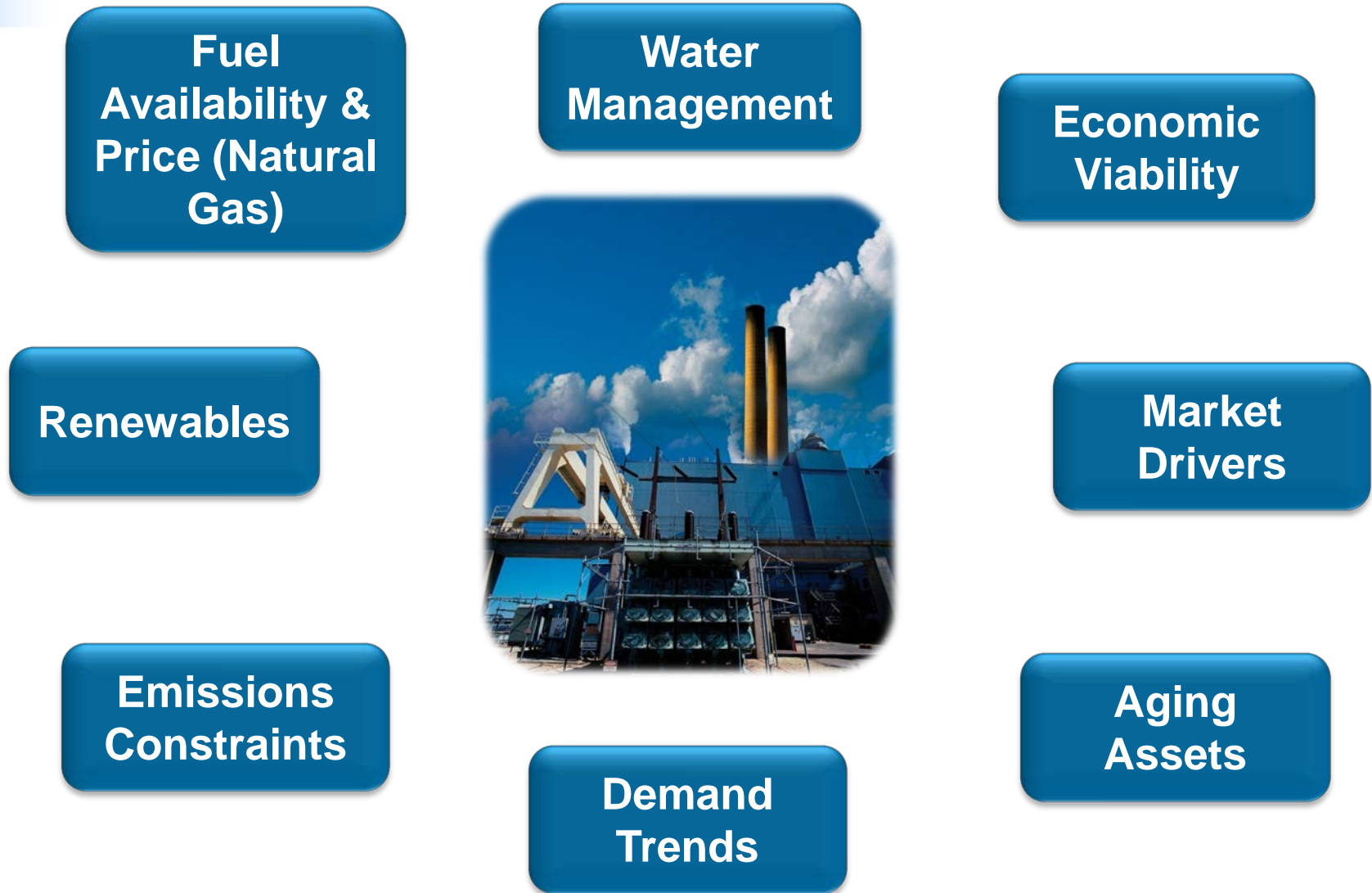
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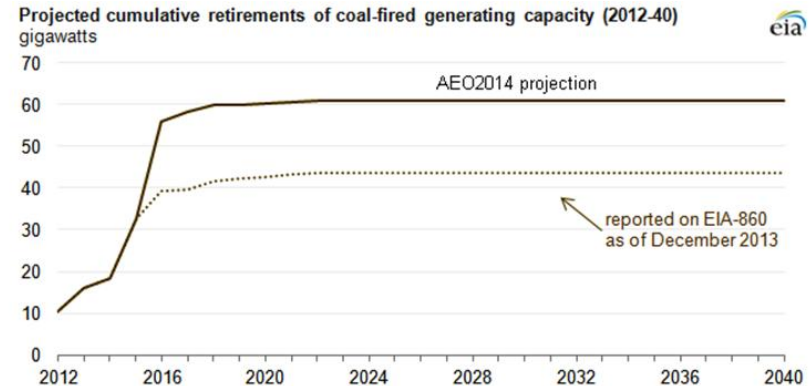
# Power Generation Drivers and Externalities



# Coal Retirement Forecast

## Drivers

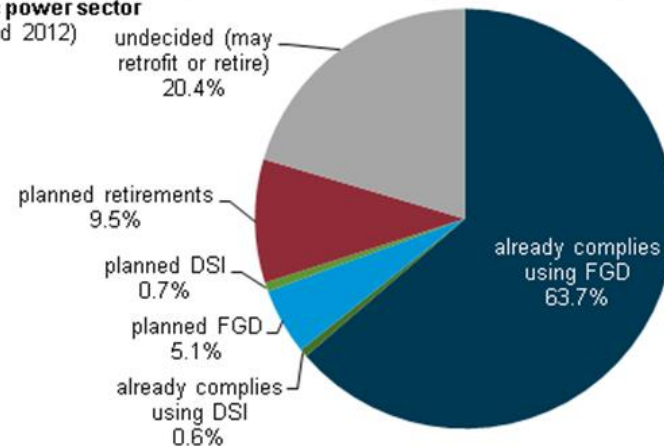
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**MATS Compliance driver for large number of retirements in 2016**

# Distributed Fossil Generation Impact on Local Air Quality

- Sources close to people
- Short stacks
- Cooler flue gas alters plume rise & buoyancy
- Strong impact of local micrometeorology and building topology



[power.cummins.com](http://power.cummins.com)



Diesel-powered backup generators, Santa Clara