

Technology Maturation in Power Generation

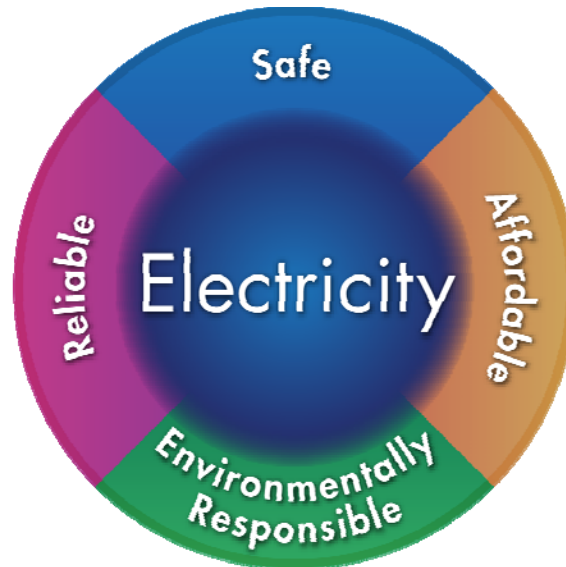
Tom Alley
Vice President – Generation
Electric Power Research Institute

2017 Crosscutting Review Meeting
March 21, 2017

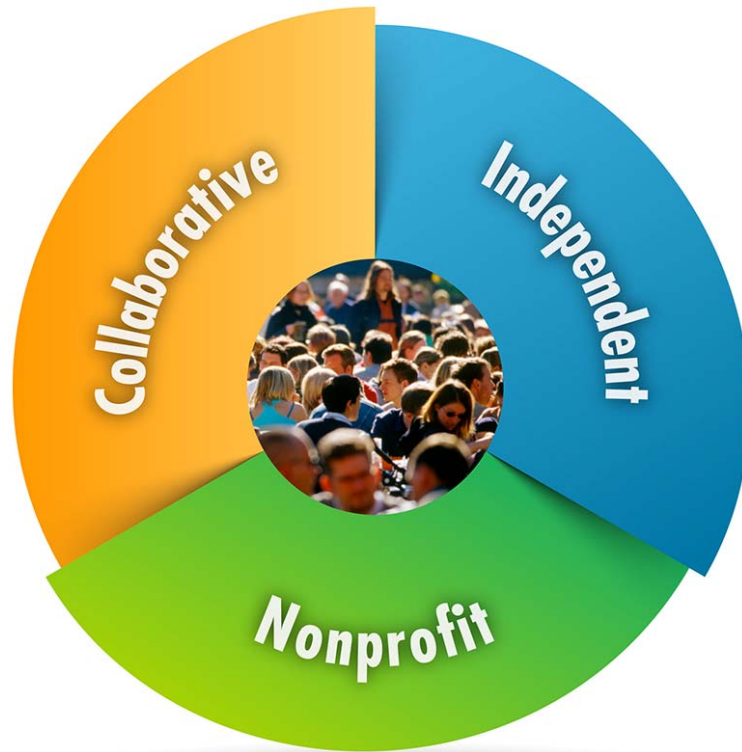


EPRI's Mission

Advancing ***safe, reliable, affordable, and environmentally responsible*** electricity for society through global collaboration, thought leadership and science & technology innovation



Three Key Aspects of EPRI



Independent

Objective, scientifically based results address reliability, efficiency, affordability, health, safety, and the environment

Nonprofit

Chartered to serve the public benefit

Collaborative

Bring together scientists, engineers, academic researchers, and industry experts

Our Members...

- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States
- International funding – nearly 25% of EPRI's research, development, and demonstrations



Conducting Research Today

Energy and Environment



- Environmental Sciences: Air and Multimedia
- Environmental Sciences: Groundwater and Land Management
- Environmental Sciences: Water and Ecosystems
- Strategic Analysis and Technology Assessments
- Workforce and the Public: Health Assessment and Safety

Generation



- Advanced Fossil Plants, Carbon Capture, Utilization, and Storage
- Combined Cycle
- Environmental Controls
- Major Component Reliability
- Materials and Chemistry
- Operations and Maintenance
- Power Plant Water Management
- Renewables

Nuclear



- AP Chemistry, Radiation Safety, and Decommissioning
- AP Equipment Reliability
- AP Safety and Risk Technology
- AP Strategic Initiatives
- Fuel Reliability
- High Level Waste and Spent Fuel Management
- Materials Degradation
- NDE Characterization

Power Delivery and Utilization



Distribution Utilization

- Distribution
- Energy Utilization
- Information, Communication, and Cyber Security

Transmission

- Grid Operations and Planning
- Transmission and Substations



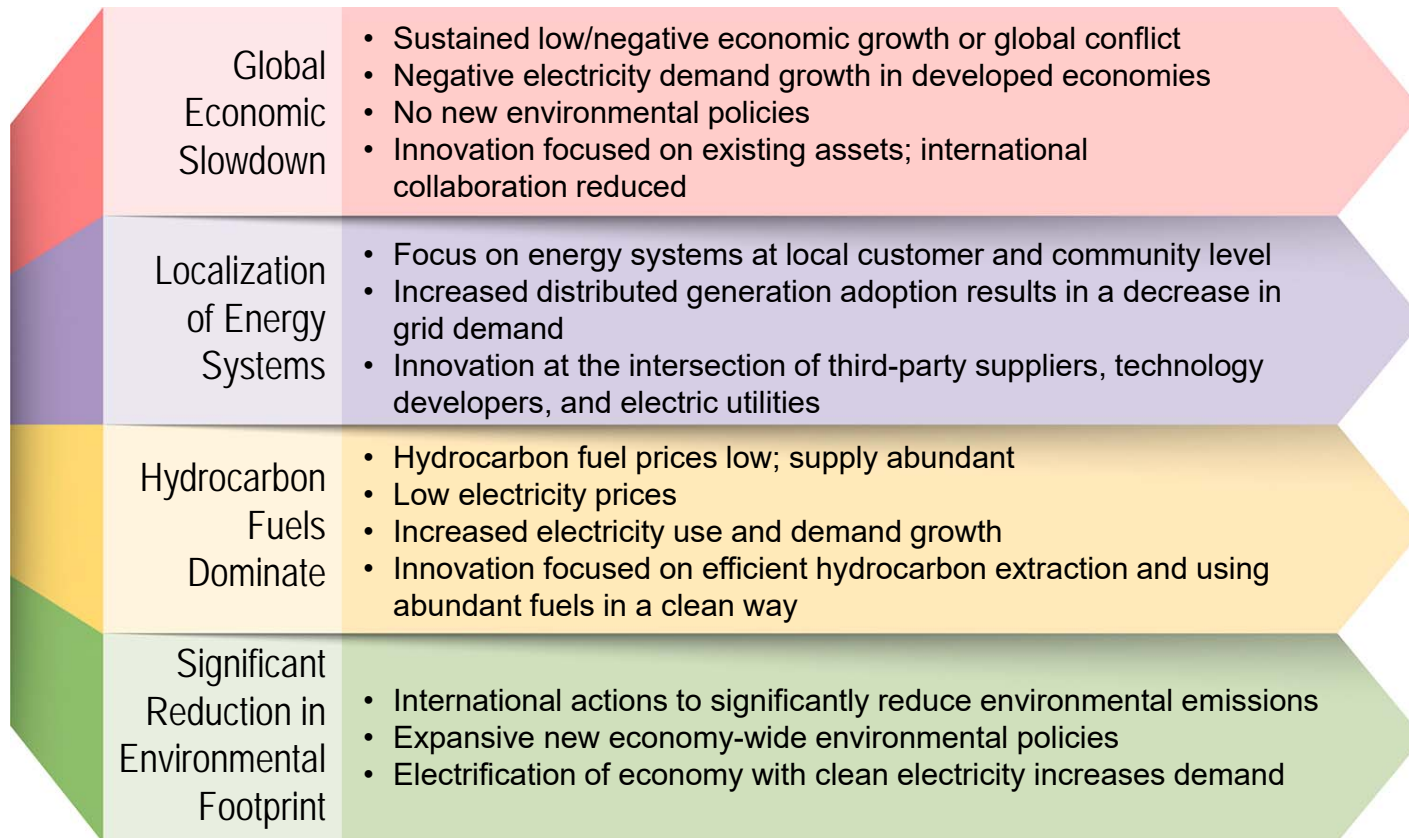


EPRI Thought Leadership History
Process
Scenarios
Global Points of View

The Integrated Energy Network Builds upon Decades of EPRI Thought Leadership



Bounding Scenarios to the 2030s and Beyond



Perspectives on how energy will be produced, transported, used, and regulated

Drivers and Critical Trends

HYDROCARBON FUEL PRICES	ENERGY AND ENVIRONMENTAL POLICY	DEMAND FOR GRID-SUPPLIED ELECTRICITY	INNOVATION AND CONSUMER BEHAVIOR
Fuel extraction	Public opinion and stakeholder/ community pressure	Economic development	Technology research and development
Fuel transportation	Government policies – views, opinions, and commitments	Building codes & standards	Public and private funding
Fuel demand	Regulations	Energy consumption of electric devices and appliances	Technology companies outside of the electricity industry
Availability of resources	Scientific evidence and breakthroughs	Demand-side management	Consumer needs and desires
Regulations affecting fuel	Other	Consumer self-generation and storage	Other
Local versus global market		Consumer perception of grid-supplied electricity	
Fuel producer activity		Grid technologies	
Futures pricing		Other	
Other			

EPRI will regularly re-evaluate these drivers and critical trends

Selected “Global Points of View”



Using Cleaner Energy

- Efficiency emerges across the energy sector
- Electricity demand outpaces energy demand
- Efficient electrification accelerates
- Transportation becomes more efficient and cleaner



Producing Cleaner Energy

- Energy reduces environmental footprint
- Central-station generation serves an anchor role
- Renewable energy deploys rapidly



Integrating Energy Resources

- Connections across energy sources important
- Integrated electric grid is key enabler
- Higher expectations for power quality/reliability
- Security/resiliency challenges and opportunities

Integrated Energy Network



Imagine an energy future where all forms of energy can be optimally integrated to connect customers with safe, reliable, affordable and clean energy resources

Transition to Cleaner Electricity Generation ~2030



Renewables



Distributed Energy Resources



Ultra Supercritical

**Renewable Growth will be Global;
Pace and Scale of Nuclear, Coal and Natural Gas Growth will vary from Region to Region**



Natural Gas



Nuclear

Generation Sector Strategic Issues

Provide the fossil & renewables generating fleet with **safe, reliable, economical, and environmentally responsible** technologies



Flexible
Operation



Intelligent
Generation



CO₂
Reduction



Renewable
Generation

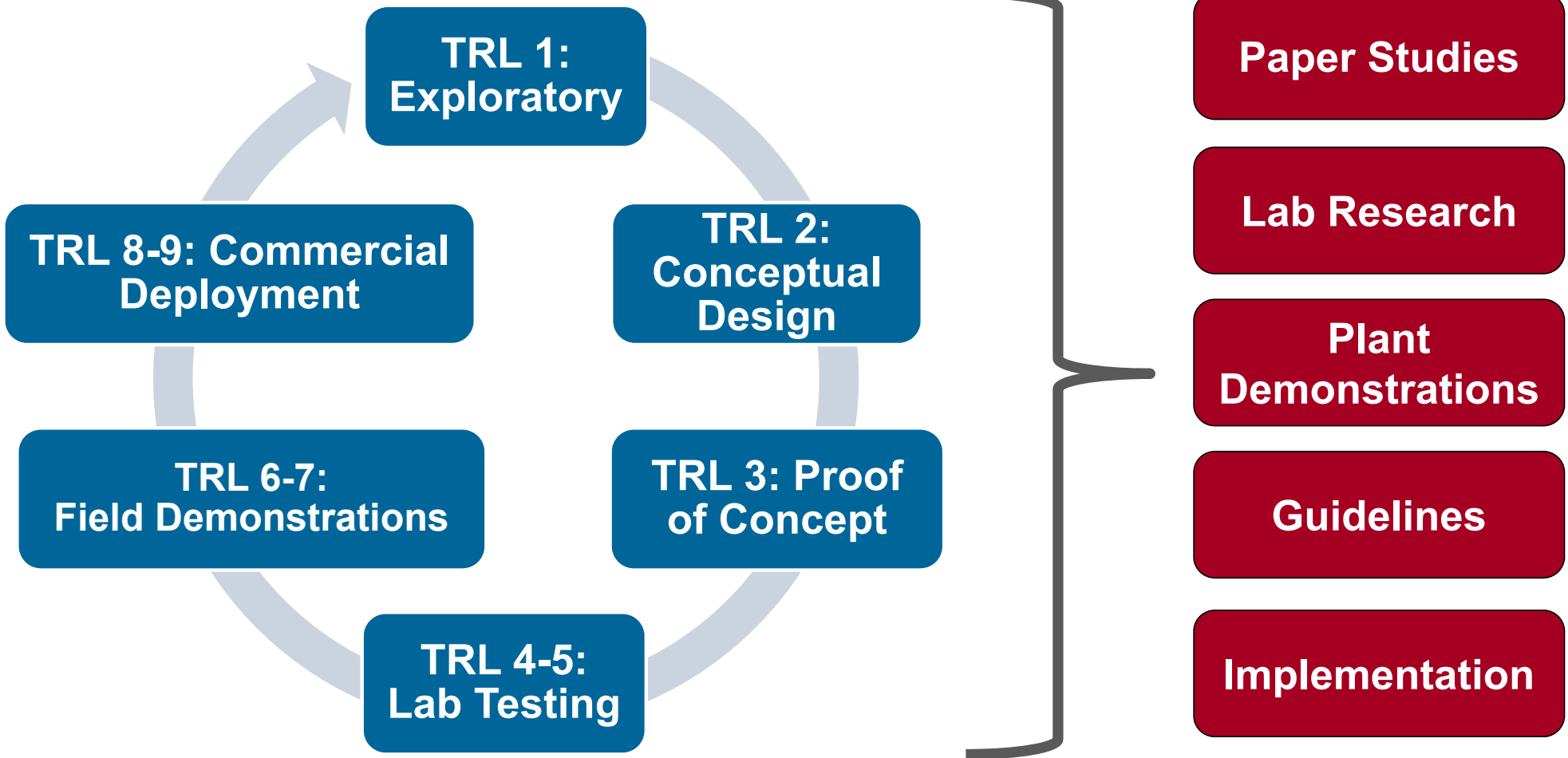


Environmental
Impacts



Asset
Management

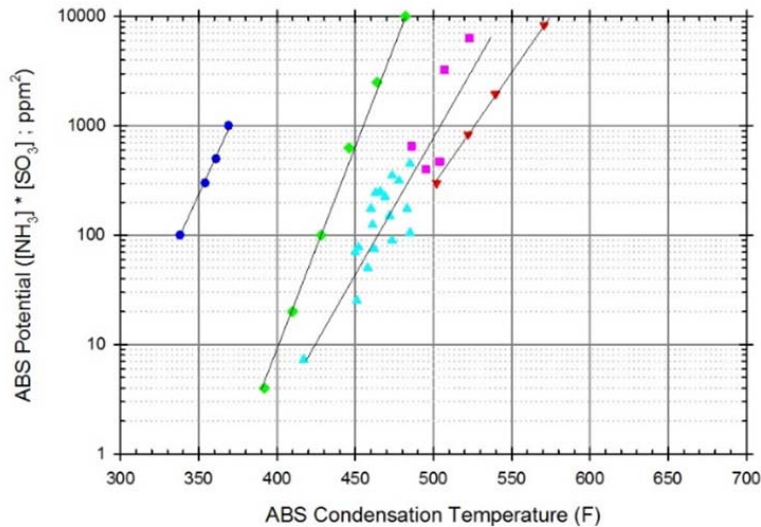
The Value of the Research Lifecycle



Long Term Value of R&D Engagement

Paper Studies

ABS Condensation Temperature
as a Function of ABS Potential



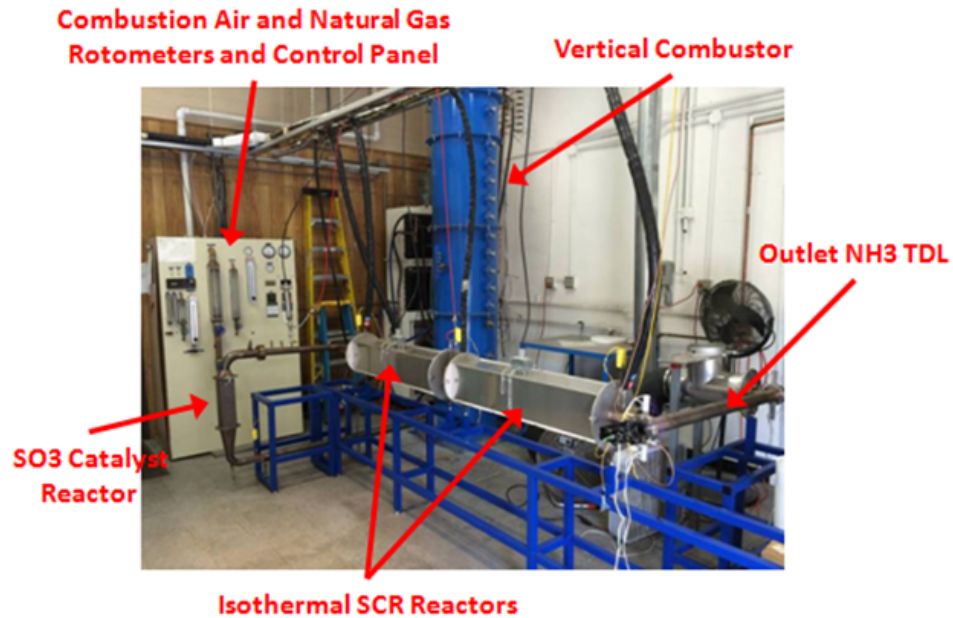
- **Technology Innovation (TI) Research with UC Irvine**
- **Determination of ABS formation temperature**

2006



Long Term Value of R&D Engagement

Lab Research



- Lab scale study evaluating catalyst impacts from ABS formation
- Confirm ability to recover catalyst performance

2006


2012 - 2013

Long Term Value of R&D Engagement

Plant Demonstrations

2014 EPRI TECHNOLOGY TRANSFER AWARD

Case Study: Systematic Approach to Lower Load Operation



Cyclical load demand, low natural gas prices, and the penetration of renewable energy sources was forcing Tennessee Valley Authority (TVA) to significantly pare back the output of its coal-fired generation fleet. Large base-load design units such as Cumberland offered limited shutdown capability, forcing smaller units to frequently cycle on and off line. A multi-phase EPRI case study enabled TVA to adopt a systematic approach to lower-load operation of its base-load plants.

Benefits

- The added flexibility of a combined 1,600 MW of shutdown versus cycling
- Minimized start-up fuel cost
- Increased component life
- Expanded temperature operating range for selective catalytic reduction (SCR) systems

Application

The study monitored performance of the boiler, SCR systems, and water chemistry, allowing TVA to increase the shutdown potential of its plants while simultaneously maintaining compliance with their environmental operating permits.

Applying innovative shutdown strategies at both Cumberland units provides TVA with 1,600 MW of shutdown capability, greatly increasing operational flexibility and significantly reducing operating costs by eliminating the need to cycle several smaller plants off line.

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

2014 Technology Transfer Award Winner



TVA performs first full scale demo at Cumberland (2.1% sulfur coal)

2006

2014

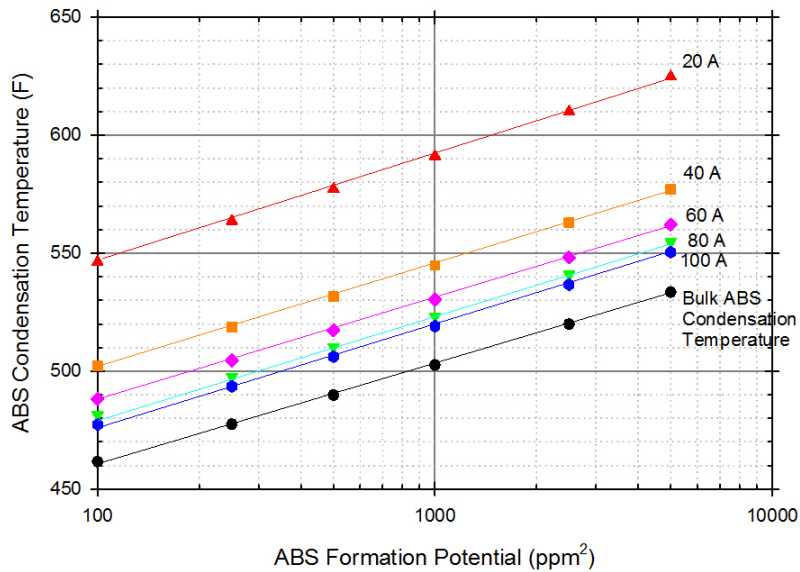


Long Term Value of R&D Engagement

Lab Research

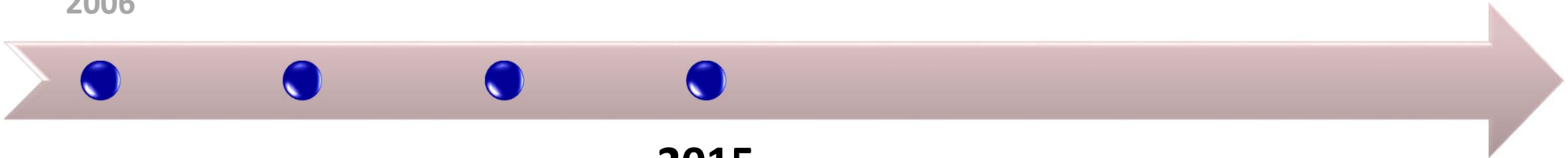
Guidelines

ABS Condensation Temperature as Function of Formation Potential and Catalyst Pore Diameter



- Assess ABS impacts on catalyst
- Develop methodology to determine SCR minimum operating temperature as a function of unit specific operating parameters

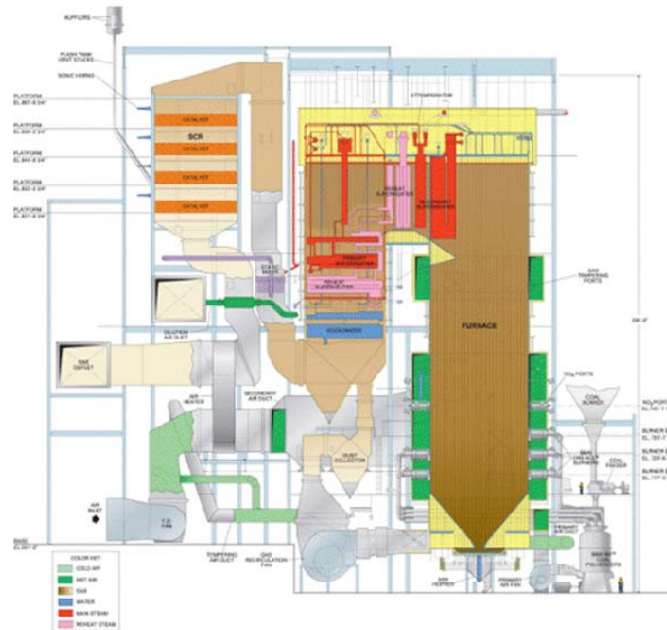
2006



2015

Long Term Value of R&D Engagement

Plant Demonstrations

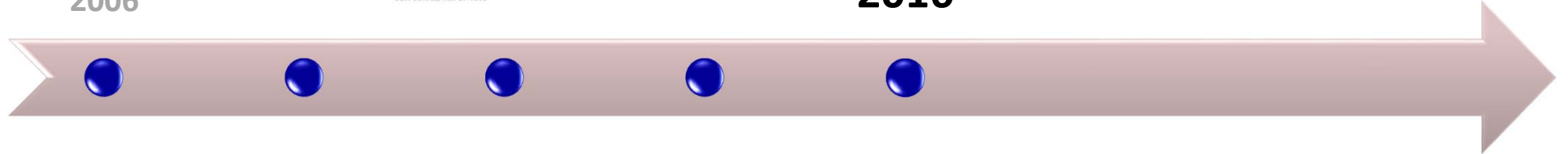


FIRST ENERGY
W.H. SAMMIS PLANT - UNITS 6 and 7
STRATTON, OHIO
BABCOCK & WILCOX UNIVERSAL PRESSURE (UP) BOILER
S&W Contract No.: UP-4666

- **First Energy Sammis: Testing new methodology for reduced load applications and impact of ABS on SCR (2.7% sulfur coal)**
- **First Energy Pleasants: Further testing of methodology with reduced load application at site firing 4% sulfur coal**

2006

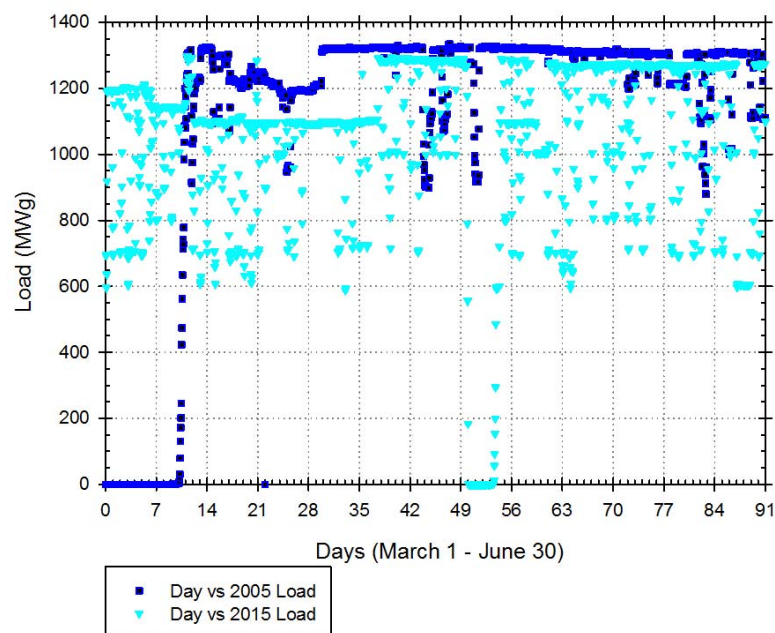
2016



Long Term Value of R&D Engagement

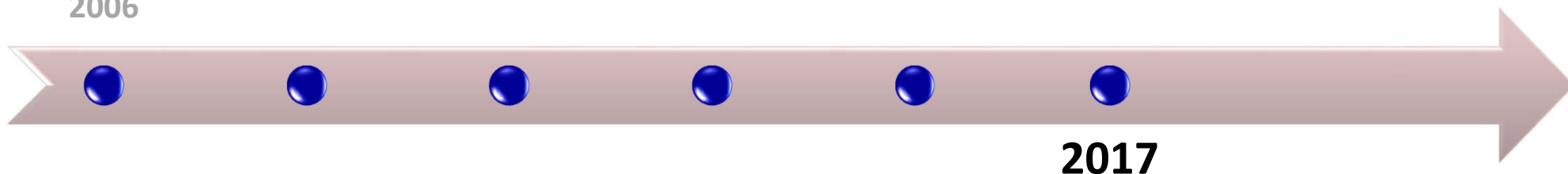
Implementation

Current Flexible Operations At TVA Cumberland



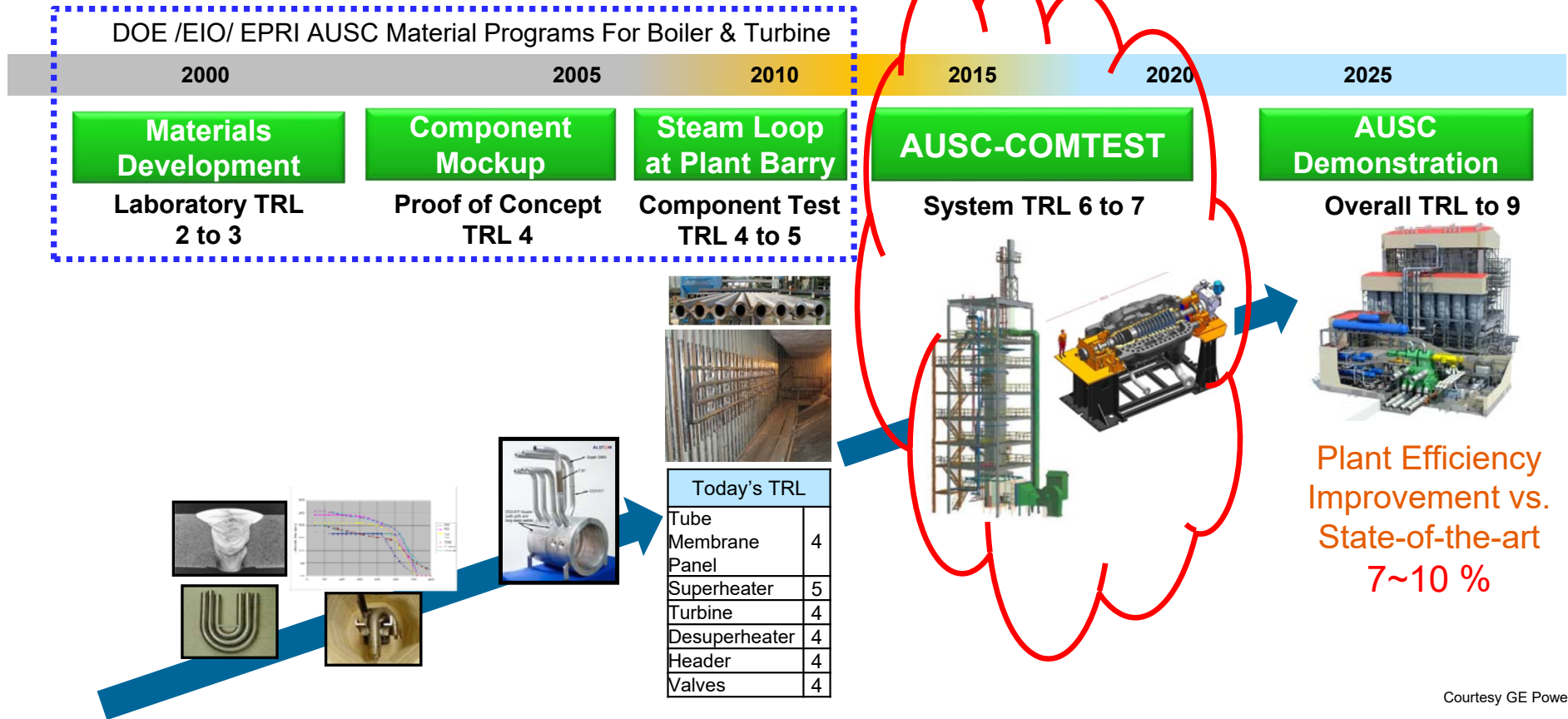
- Lab study assessing long term impacts from repeated ABS deposition
- Submittal of peer reviewed journal article on ABS formation temperature

2006



2017

Path to Next Generation AUSC Power Plant



AUSC ComTest will be a final step prior to a commercial scale first-of-kind Power Plant

Current Collaborations with NETL

National Carbon Capture Center



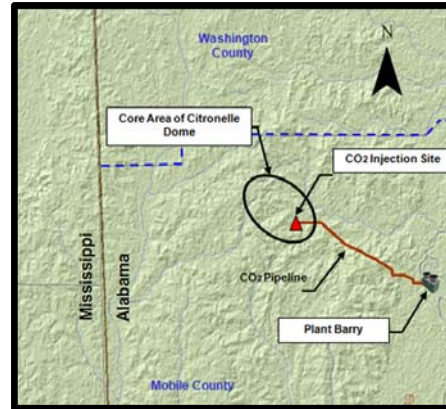
*Post Combustion
Test Facility*

AUSC Technology Path



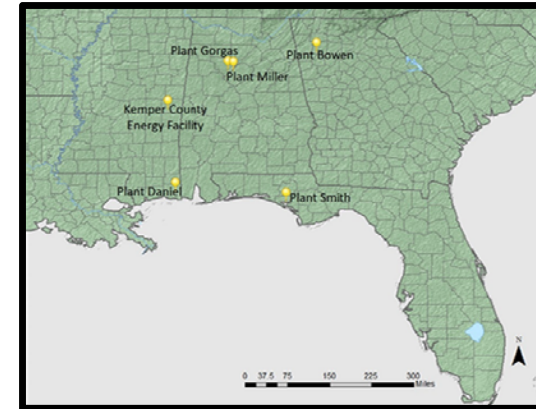
*World's first 1400°F
steam loop*

SECARB CO₂ Storage Demonstration



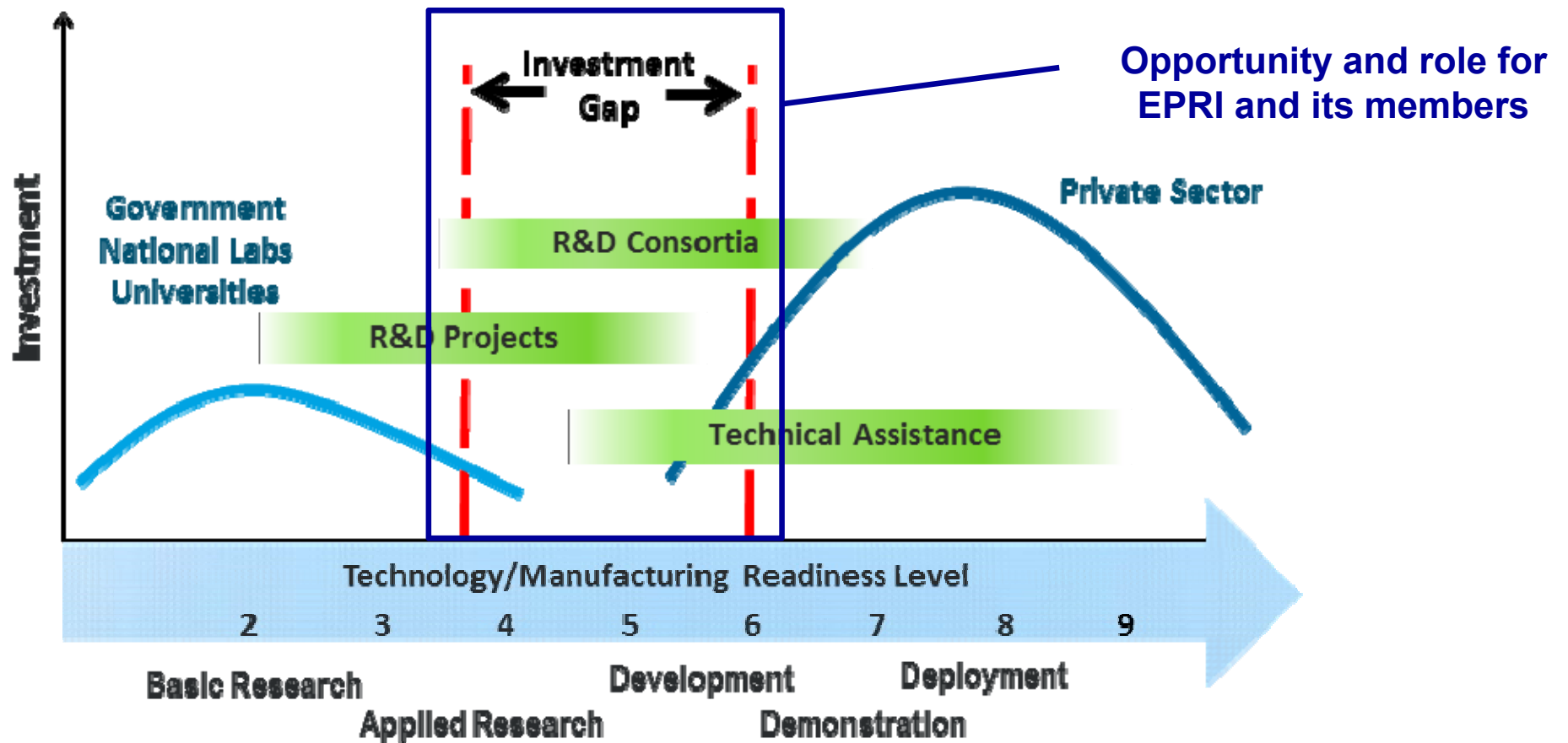
*SECARB Citronelle
Storage Test*

Brine Extraction Storage Test



*Plant Smith is located
near Panama City*

Addressing the Research Gap



DOE Advanced Manufacturing Office MYPP 2017 Draft

Technology Maturation Together

- Expansion of the range of solutions
- Rapid adoption of emerging technologies is needed
- Collaboration is essential



