

Solutions for Today

| Options for Tomorrow

Crosscutting Research

Annual Review Meeting

Pittsburgh, PA

April 9th, 2019



Briggs White

Crosscutting Technology Manager
National Energy Technology Laboratory



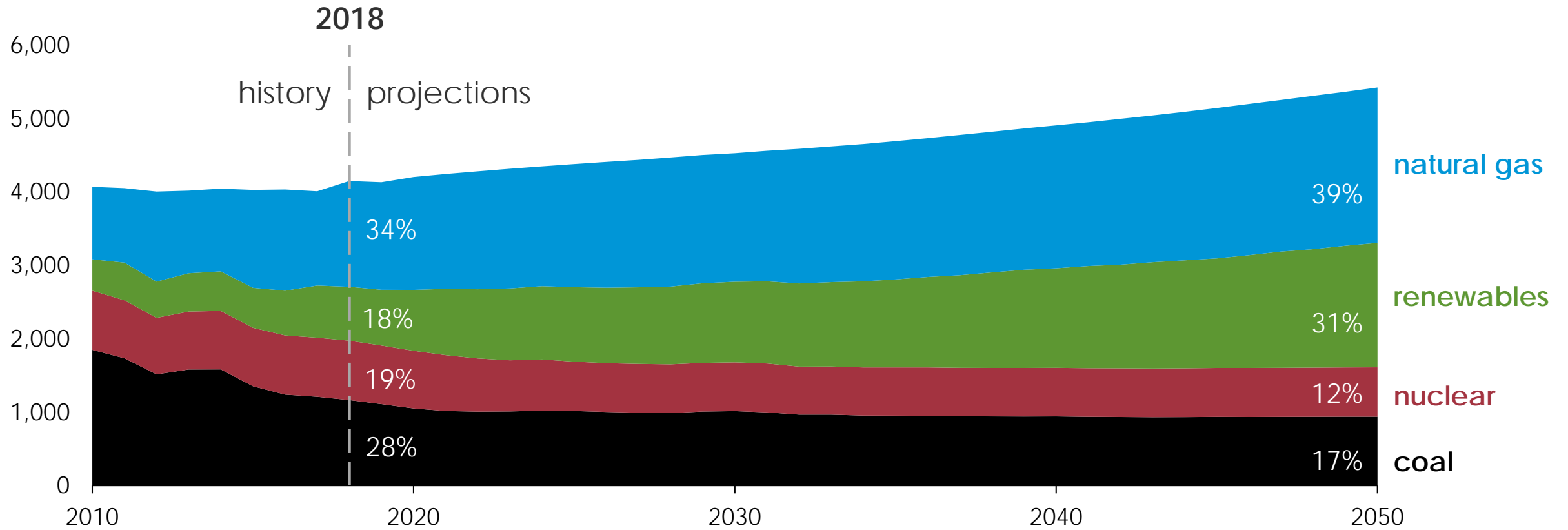
U.S. DEPARTMENT OF
ENERGY

Align Technology Development with Program & Market
Coordinate Portfolio to Maximize Effectiveness



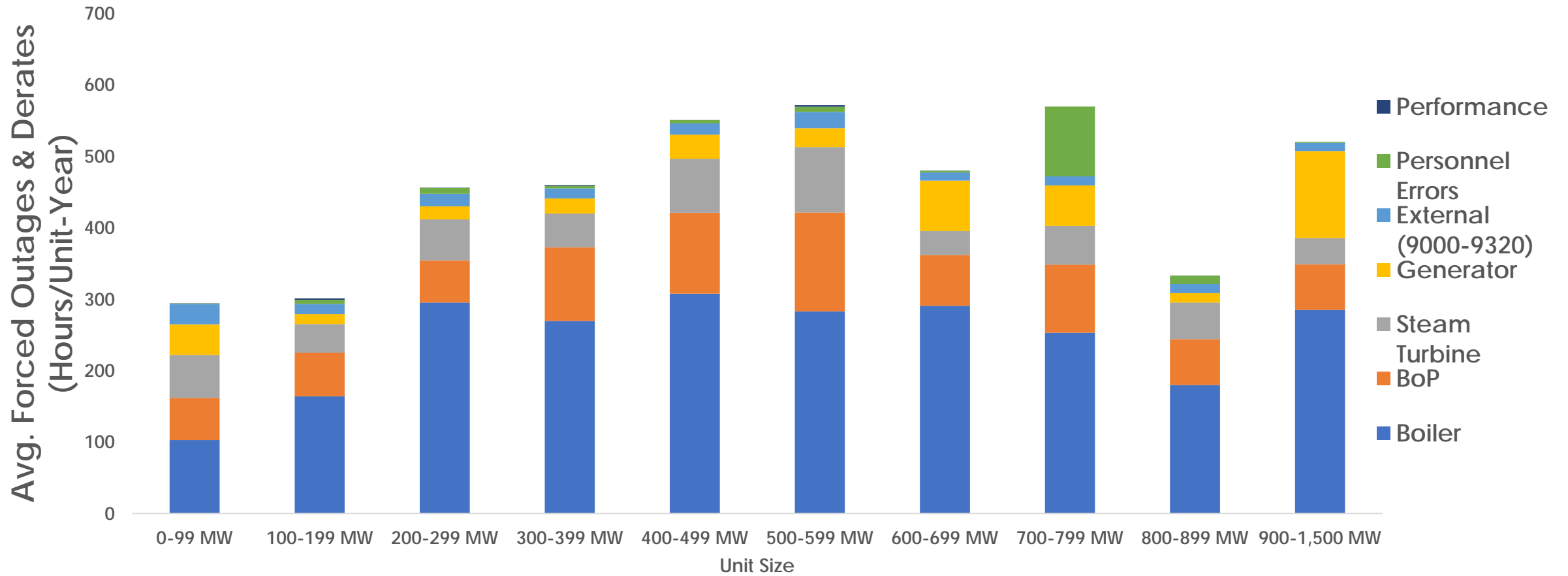
Electricity Outlook

Fossil Remains as Mix Evolves



Forced Outages & Derates

Coal-fired units (2013–2017)

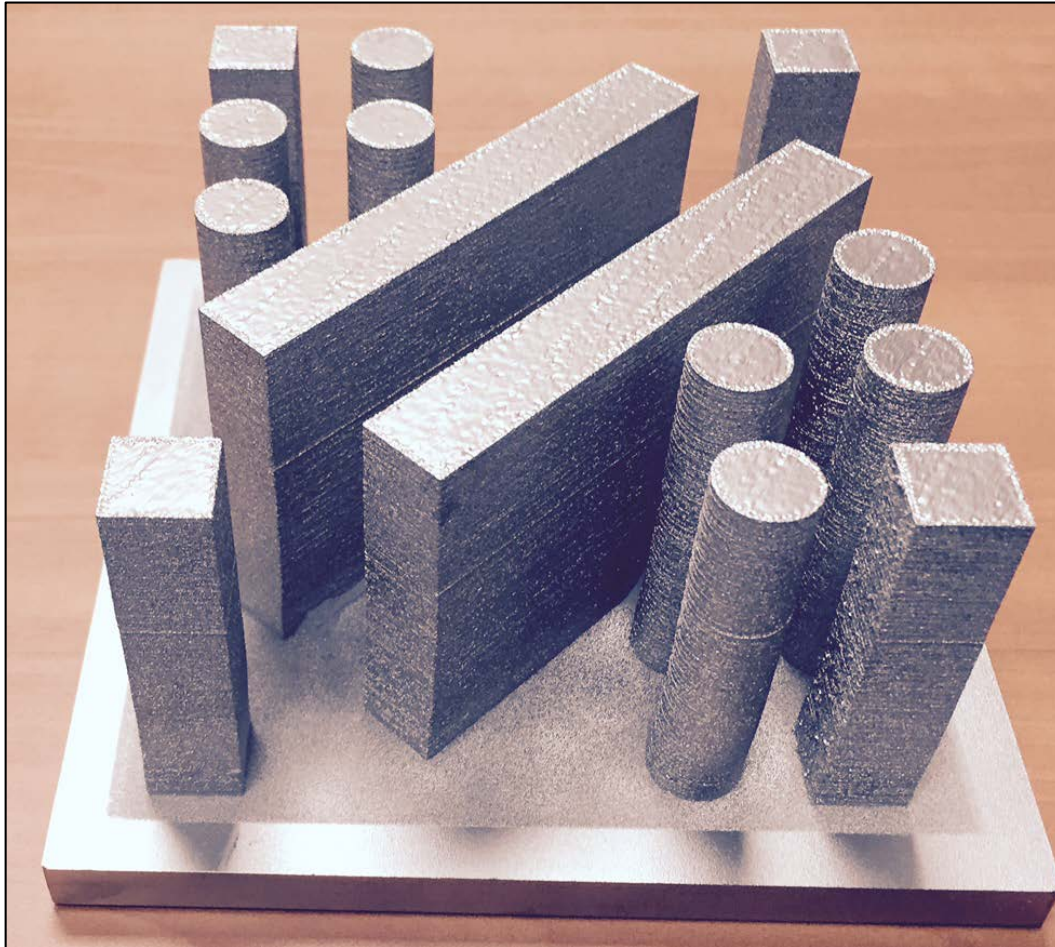


Program Themes

1. Cost of Electricity (COE)
2. Efficiency
3. O&M costs
4. Plant Revenue
 - Flexibility
 - Lower load
5. Reliability + Cybersecurity
6. Supply Chain
7. Water Consumption

Market Characteristics

1. Low Cost Technologies
2. Made for Flexible Operation
3. Clear Value Proposition
4. Aging/smaller Workforce
5. Low Effort Deployment
6. Heterogeneous Fleet



Repair Opportunities

Rapid Prototyping

New Possibilities

Automation & Robotics

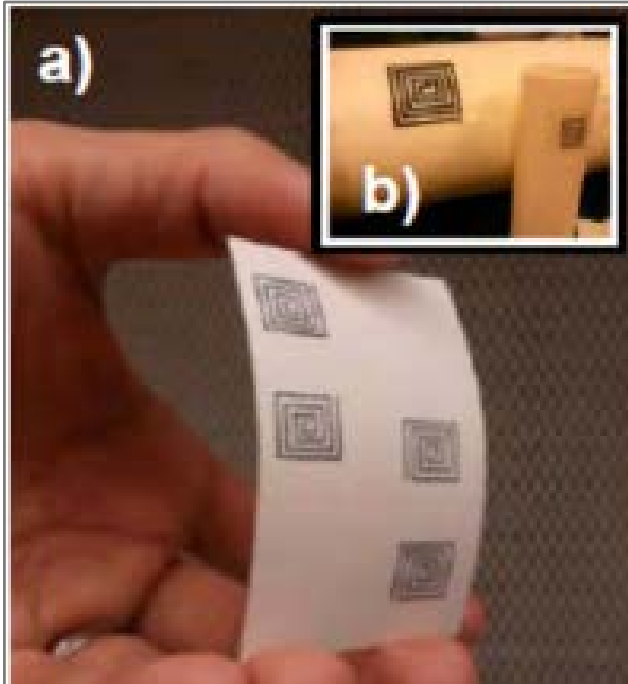
Numerous Fossil Applications



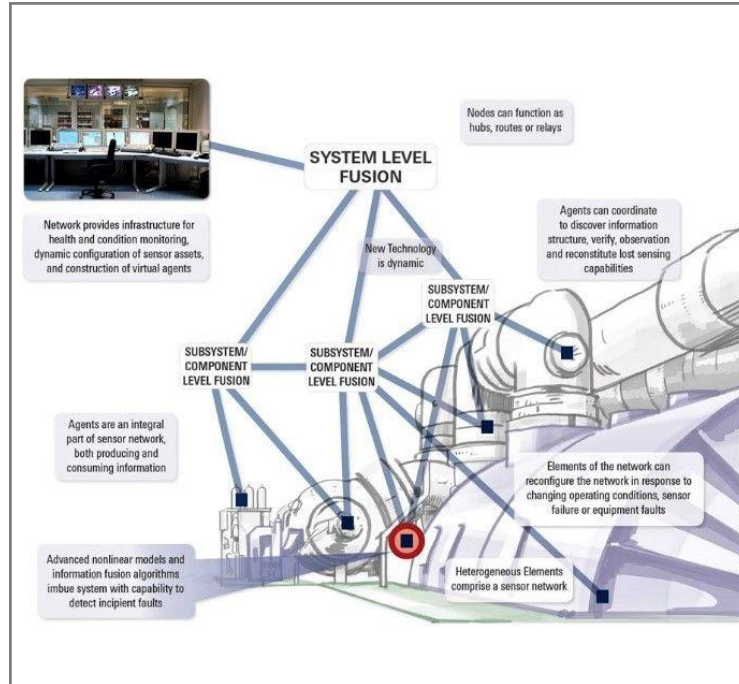
Pipe crawler allows for inspection without disassembly.

Robotics enable safer fossil energy exploration and improve efficiencies.





Proliferation
Distributed Wireless
Sensors



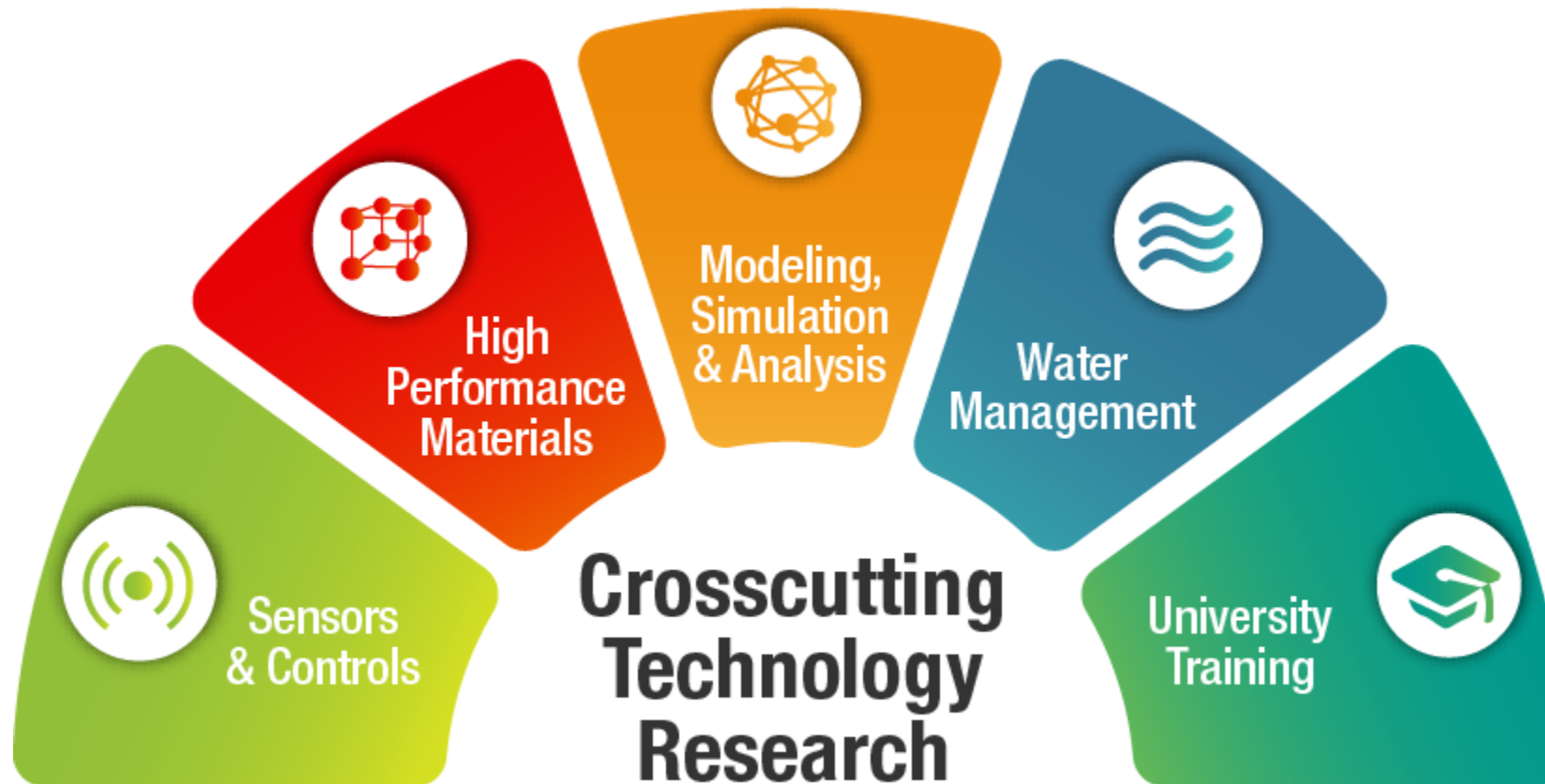
Advanced Control
Predictive Maintenance



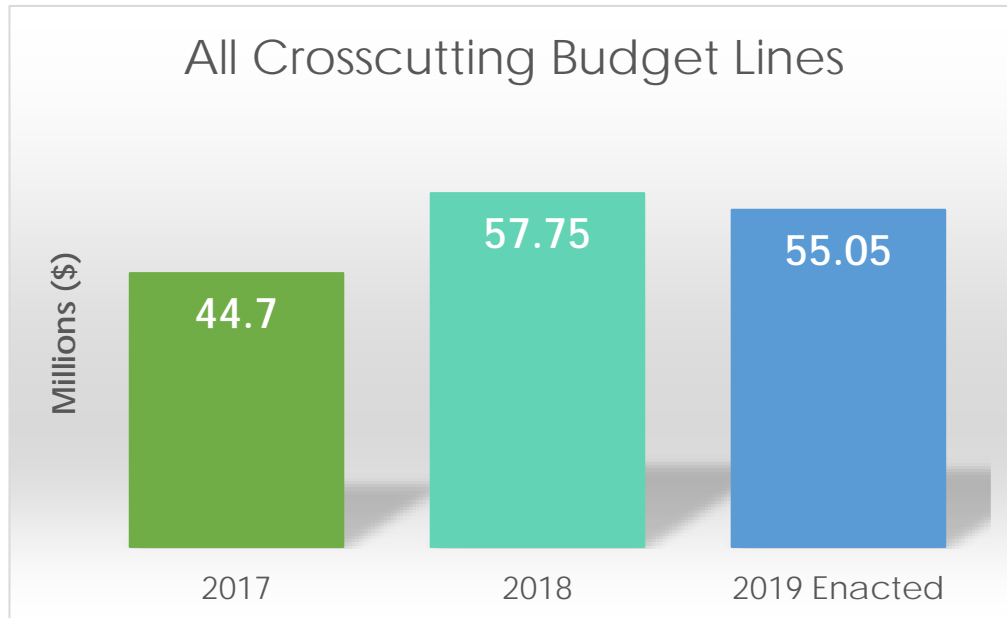
Fleet-wide Asset
Management Infrastructure

A Portfolio of Programs

Broad Applicability, Multiplier Impact

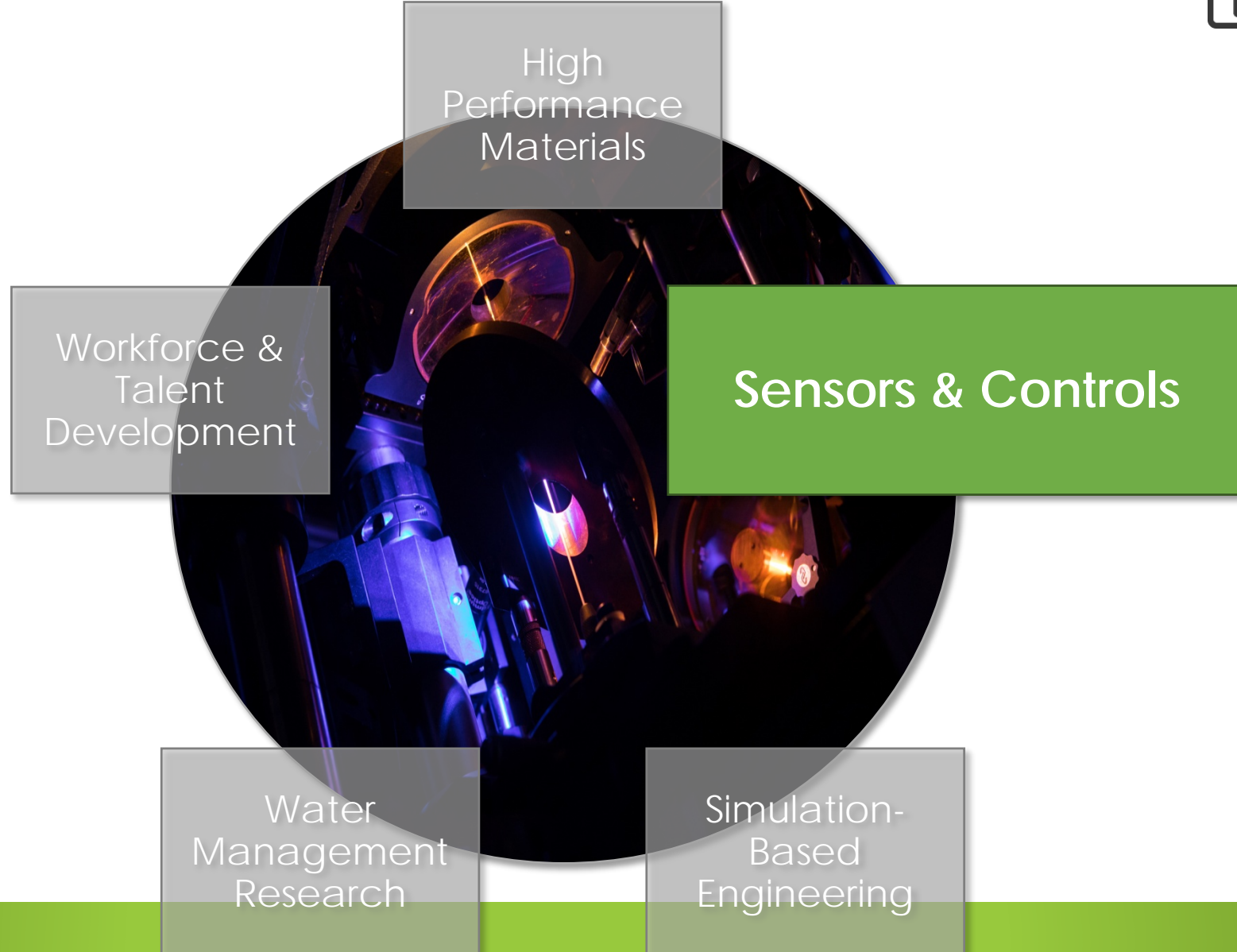


- **Strong:** Sensors & Controls, Water Management, and University Training
- **Flat:** Materials
- **Decrease:** Modeling & Simulation



Budget Lines	FY17	FY18	FY19
Sensors & Controls	\$3.65M	\$7.5M	\$8M
Modeling	\$20.85M	\$20M	\$14M
Water Management R&D	\$9.8M	\$7M	\$8M
Materials	\$8M	\$20M	\$20M
HBCU	\$1M	\$1M	\$2.05M
UCR	\$1.4M	\$2.25M	\$3M
Total	\$44.7M	\$57.75M	55.05M

Key Technology Areas



Predictive Maintenance



Cyber Security



Distributed Intelligent Controls



Automation for Ramping



Mission: Test and mature novel sensor and control systems operable in **coal-fired power plants** capable of real-time measurements, improvements to the overall plant efficiencies, and more effective ramp rates.

Technology Development Schedule

Sensors & Controls



Testing at NCCC and Wabash;
Raman Gas Sensor test at Solar Turbines;
Embedded Sensing test at NETL

Boiler Temp. & Corrosion Sensors Tested at Powerplants

Harsh Environment Sensors & Robotic Inspection

Sensors & Robots Commercialized

Sapphire Fiber Sensing Pilot

Agent-based control pilot test

Controls

Automation

Agent-based control cyber-physical model test

Risk Assessment

Cybersecurity

Secure Comms
Situational Awareness

Validate Value Proposition

Data Analytics

New M&D

Enable Flexible Operation

Predict Component Failures

Assess Fossil Cyber Risks
Retire Risks with R&D

Key Technology Areas

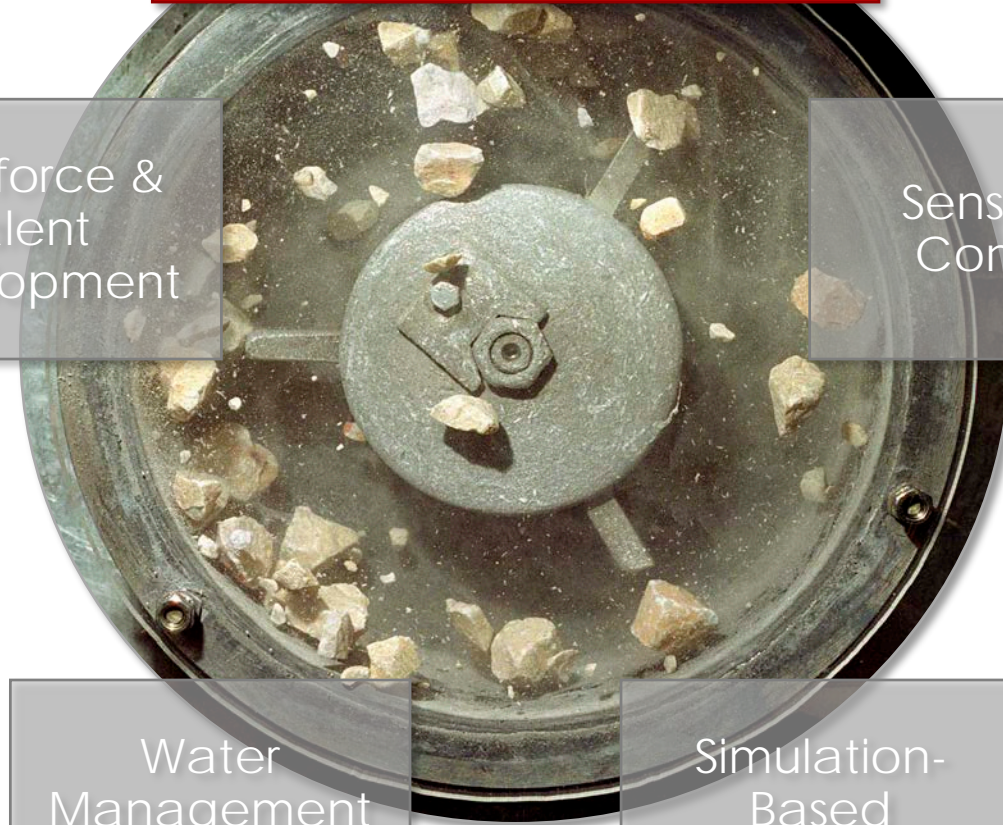
High Performance Materials

Workforce &
Talent
Development

Sensors &
Controls

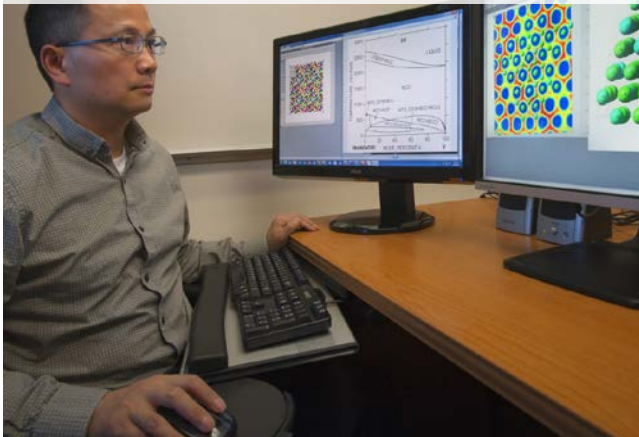
Water
Management
Research

Simulation-
Based
Engineering



Mission: Characterize, produce, certify cost-effective alloys and high performance materials suitable for extreme environments found in coal power generation to support existing and new plants.

Computational Materials Design



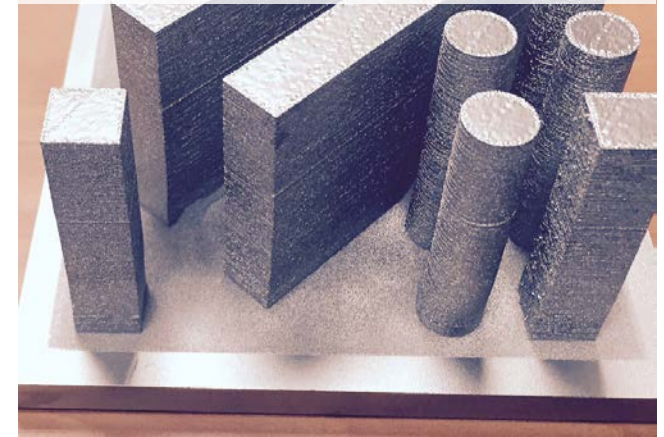
Advanced Structural Materials



Functional Materials for Process Performance

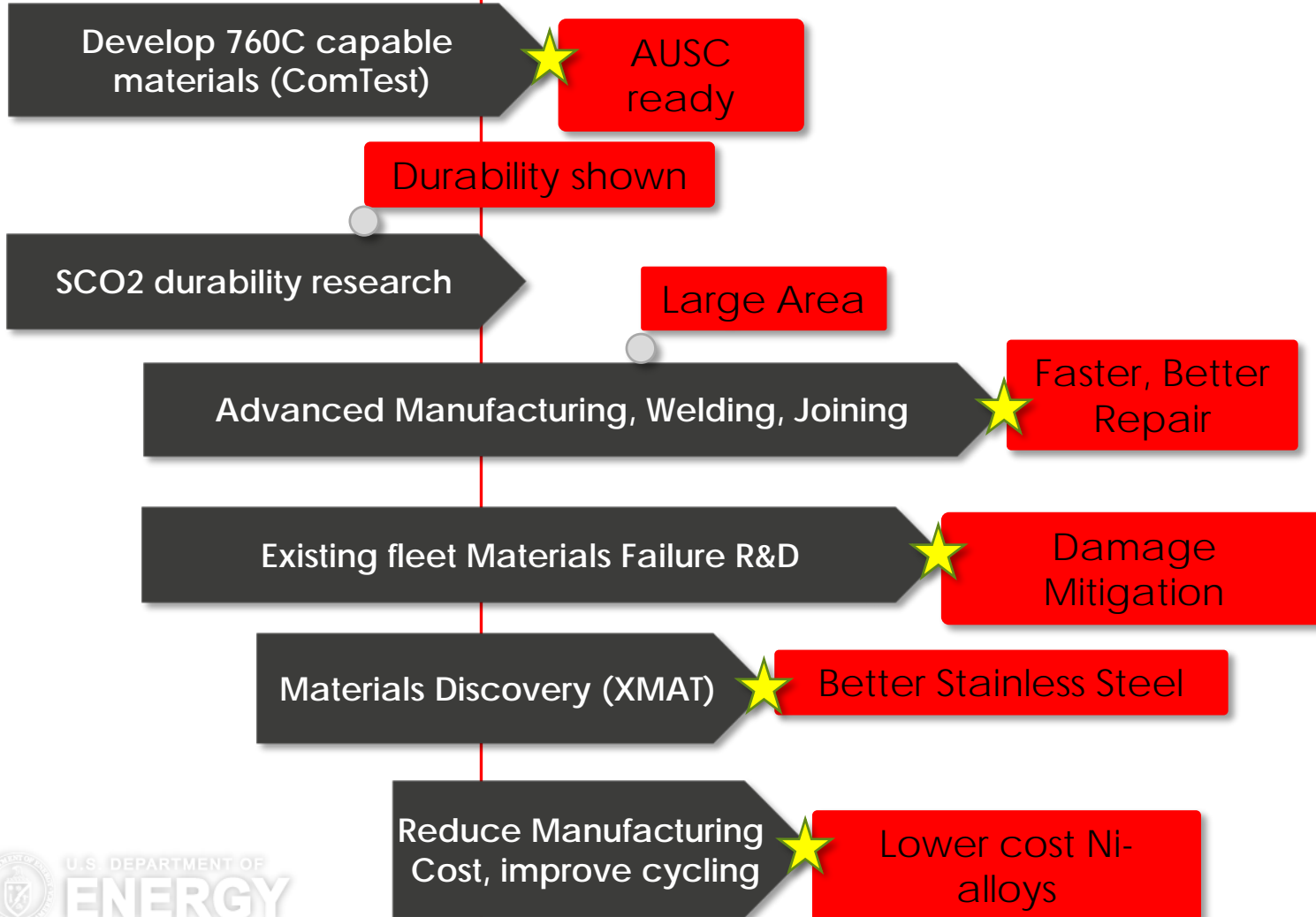


Advanced Manufacturing



Technology Development Schedule

High-Performance Materials



Enable AUSC Plants

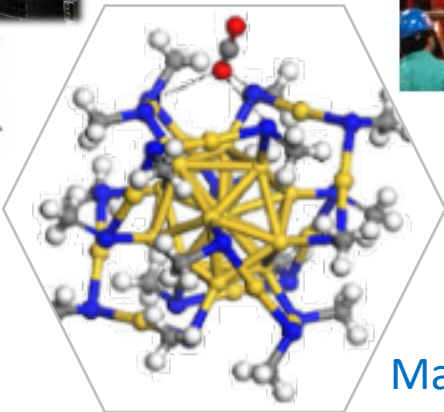
Enable SCO2 Power Cycles

Address Existing Fleet Materials Issues

Reduce Alloy & Component Costs

Materials Discovery, Cost Reduction,
Service Life Prediction, Rapid Qualification

ComTest Consortium Reading Materials for
AUSC

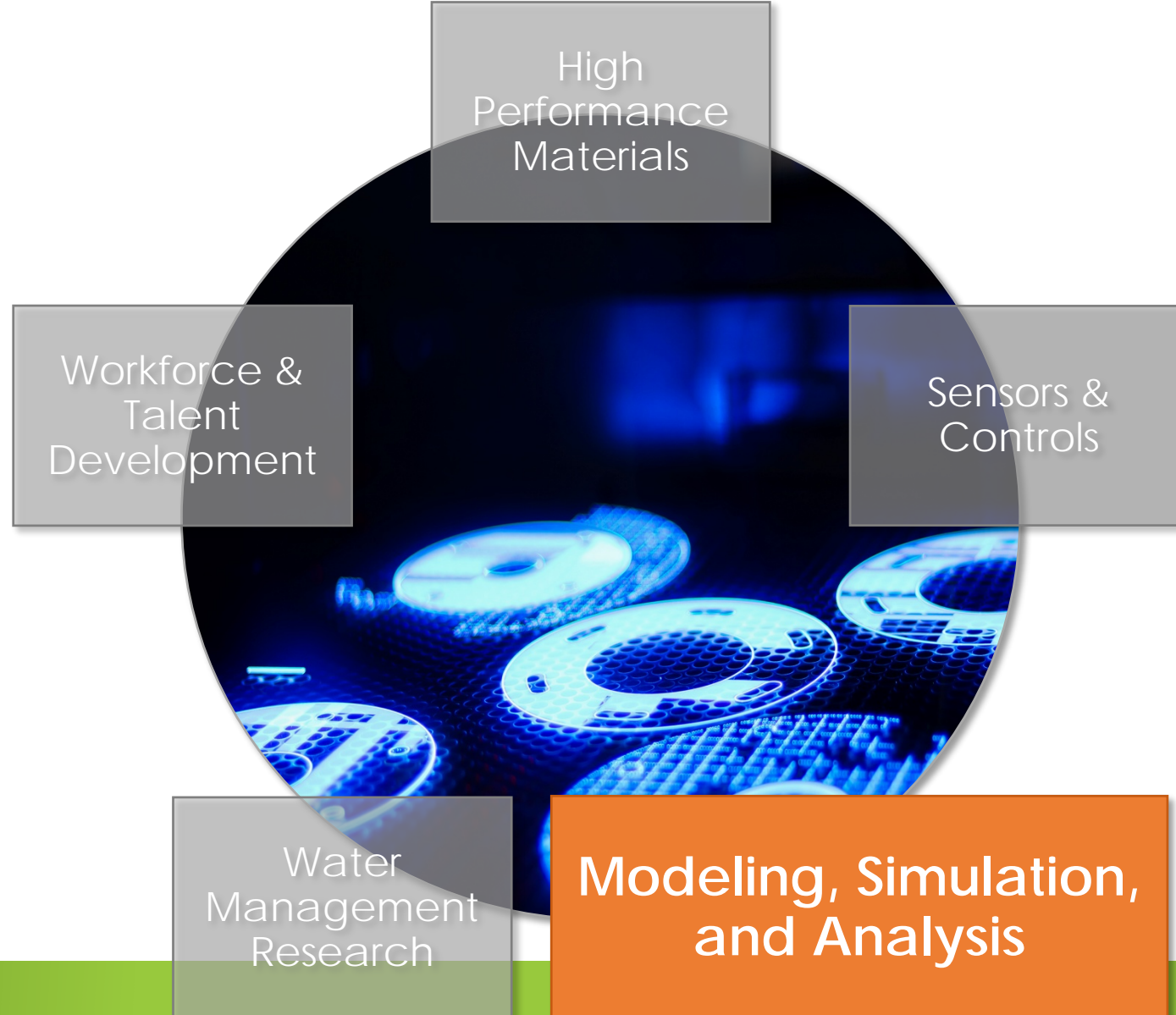


Machine Learning

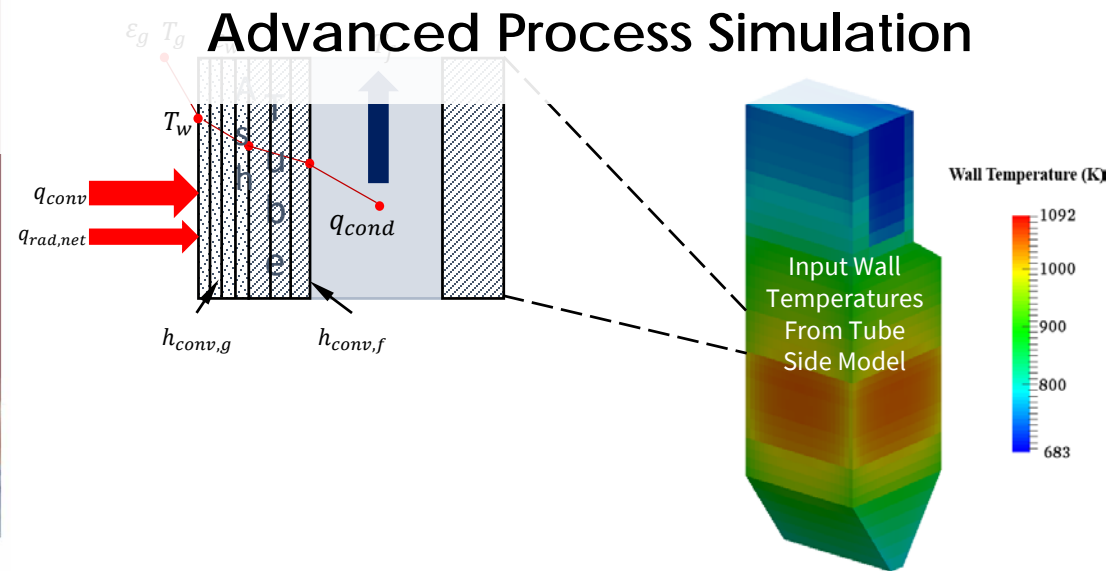
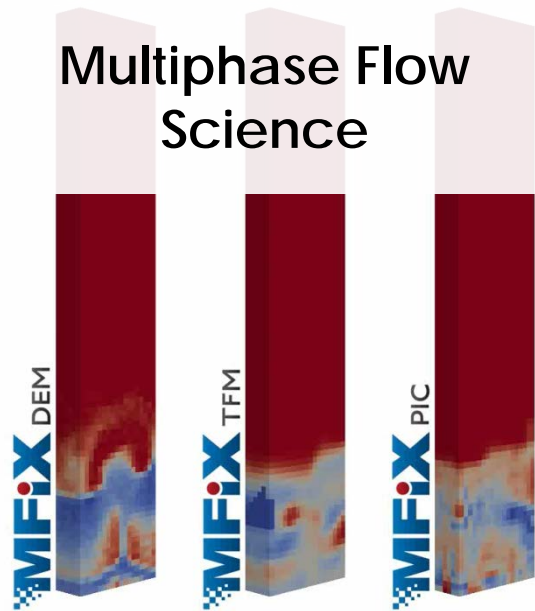
Validation



Key Technology Areas

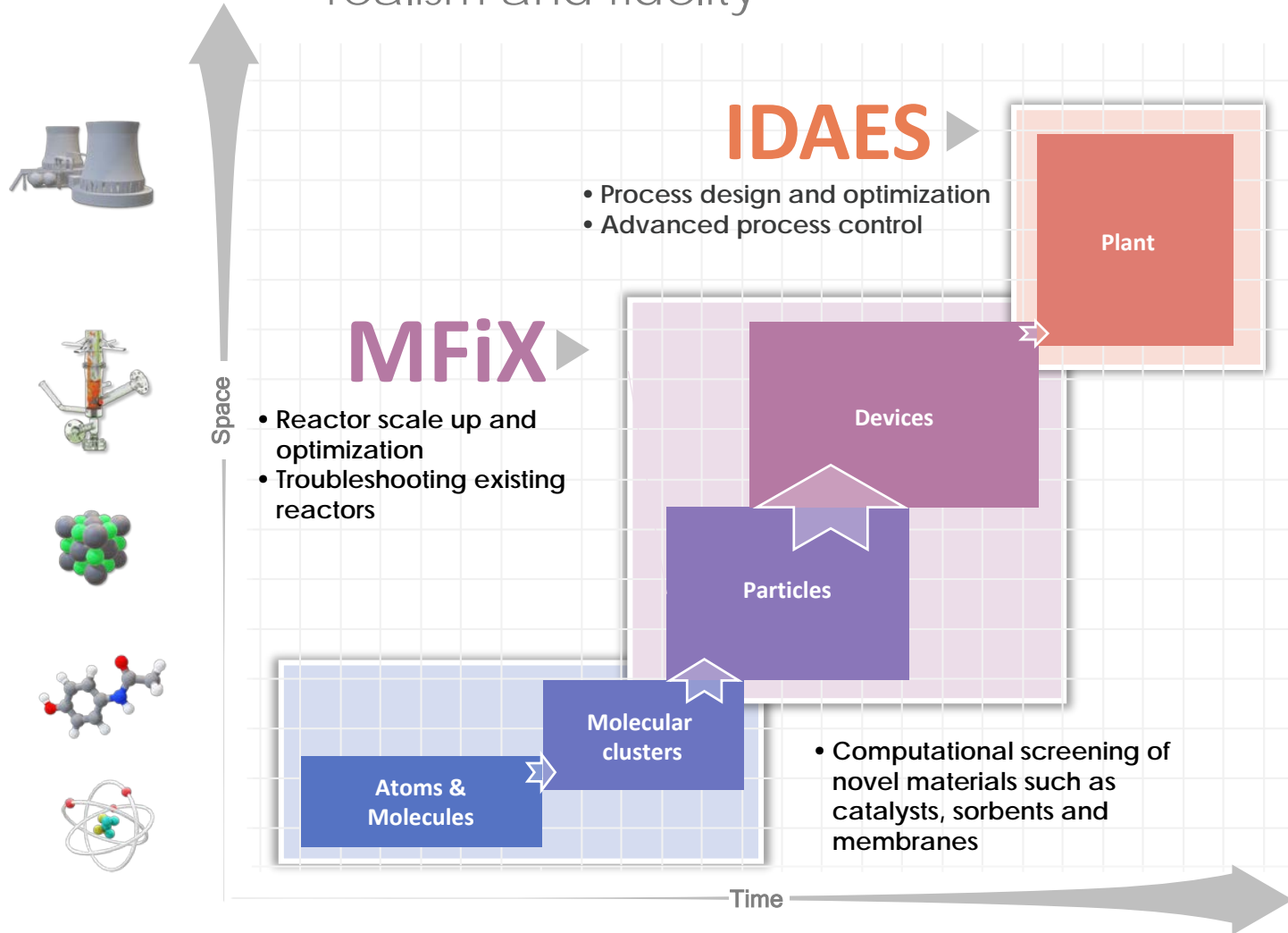


Mission: Simulate coal fleet challenges to lift-up technology solutions, apply computational tools at multiple scales to accelerate development and deployment.



NETL's Complementary Computational Tools

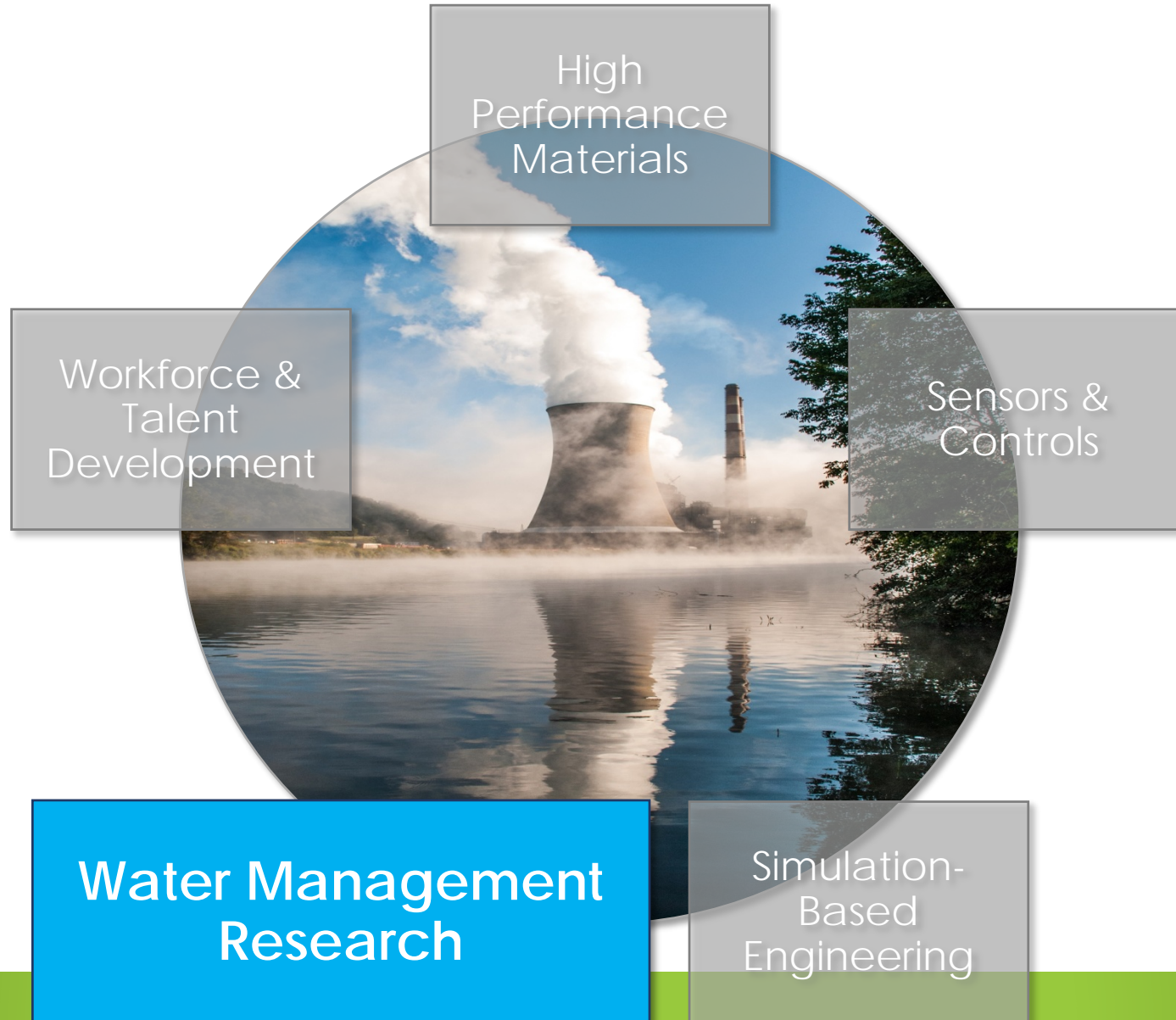
IDAES + MFIX: Working together to increase systems modeling realism and fidelity



COMPUTATIONAL TOOLS WORKING TOGETHER

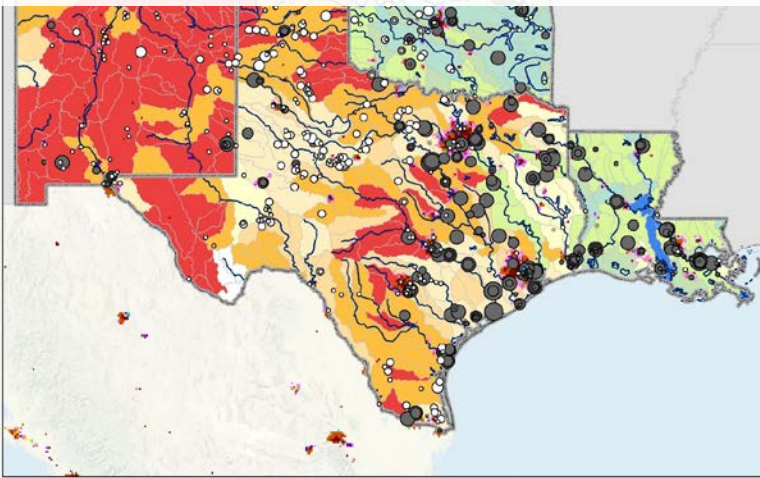
- **IDAES** - framework for design, optimization, and control of steady state and dynamic processes.
- **MFIX** - suite of multiphase flow simulation software for designing devices such as combustors.

Key Technology Areas

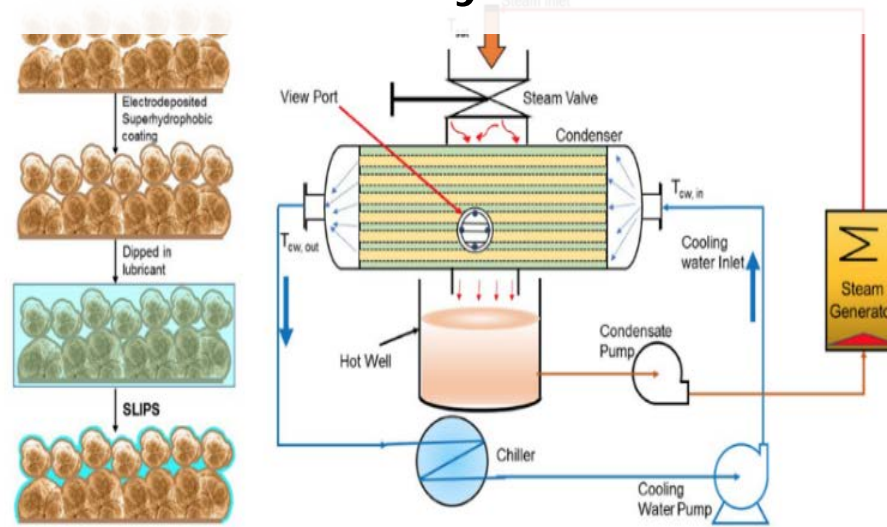


Mission: Provide leadership, raise awareness, and offer cost-effective technical solutions to potential national issues in water quality and availability.

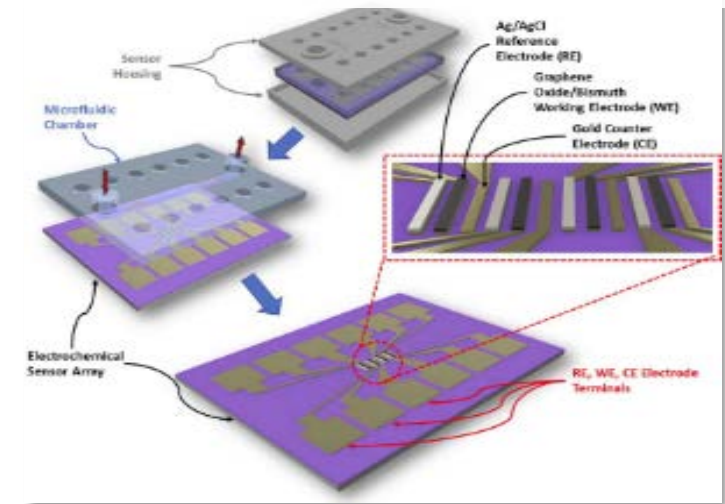
Energy Water Analysis



Water Efficiency and Reuse

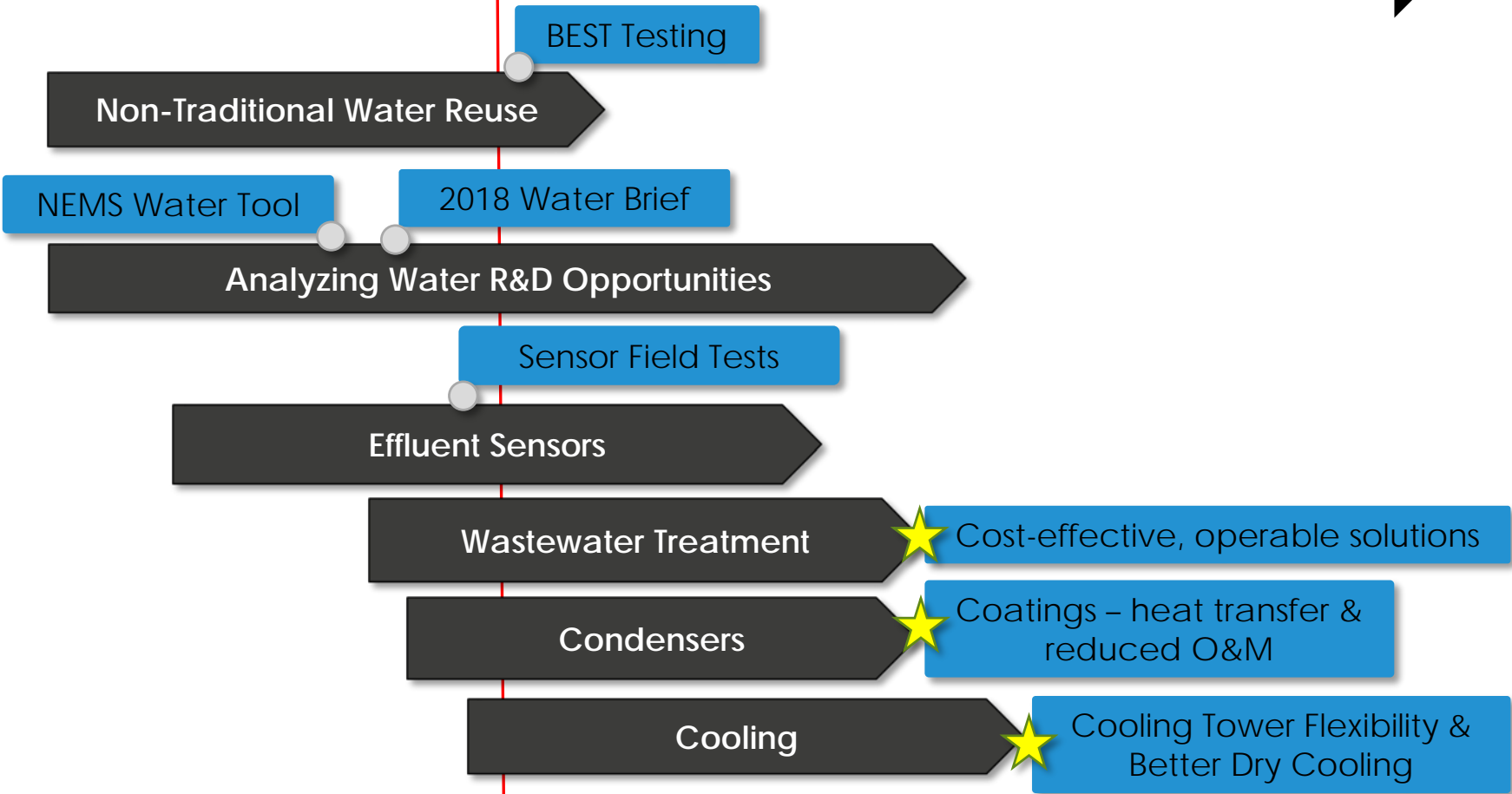


Flexibility & Cost



Technology Development Schedule

Water Management



Minimize water use and effluent generation

Enable flexible operation with reduced O&M

Advance water treatment technologies

Increase plant efficiency

Key Technology Areas

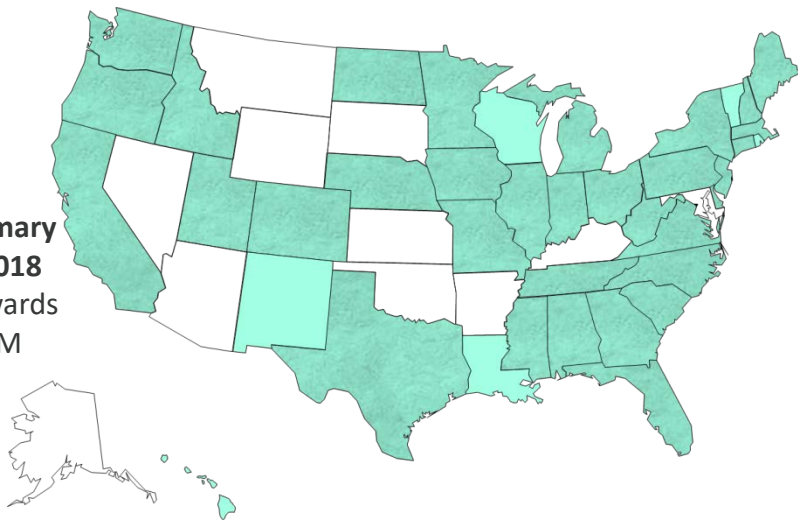


\$25M and 130 grants
3,000 student researchers
Fossil Energy research
STEM training addresses workforce gap

\$400,000 per award
No cost share requirement

**UCR Summary
2010 – 2018**

- 50 Awards
- \$16.7M



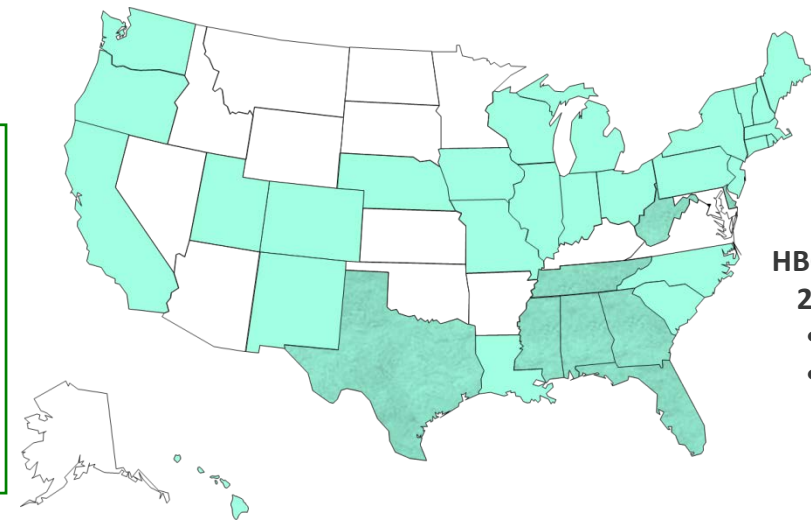
Since Program Inception

UCR Program Results:

- 1000+ Technical Papers
- 10+ Technical Awards
- 7 Patents Issued to Date

HBCU Program Results:

- 500+ Technical Papers
- 5+ Technical Awards
- 2 Patents Issued to Date



**HBCU Summary
2010 – 2018**

- 27 Awards
- \$5.9M

Create

- FOAs
- Opportunities at NETL

Deploy

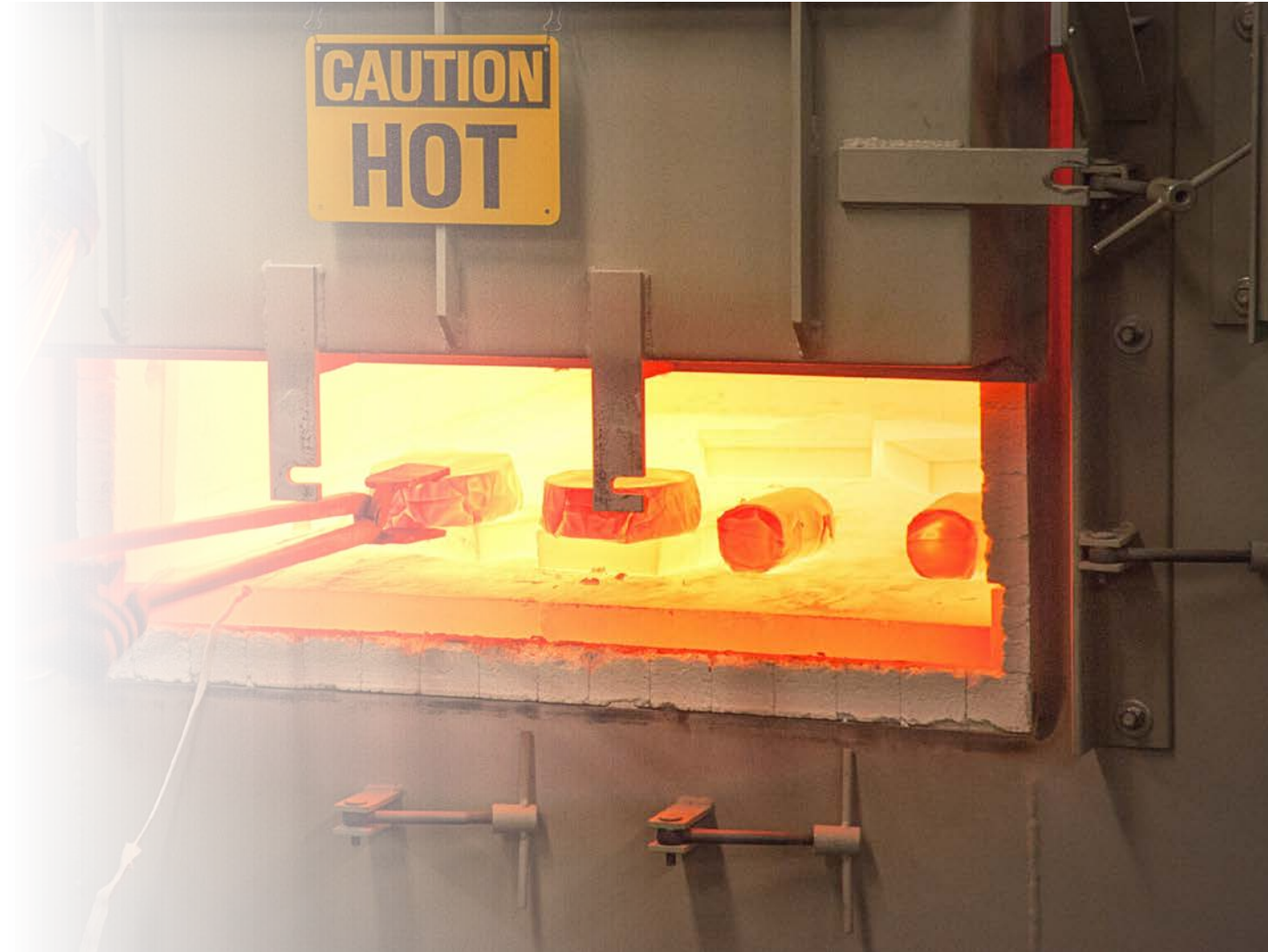
- Put work in context
- Assess value proposition
- Work with end-users

Share

- Coordinate with other researchers
- Tell us about your successes
- How can we help?



- FOAs
- HPC4Materials
- Industrial Advisory Boards
- Partner with researchers
- RFIs/Workshops
- Attend facilitated discussions
- Attend poster session
- Survey



Program Alignment and Market Deployment Critical

Portfolio Coordination

- How can we help?

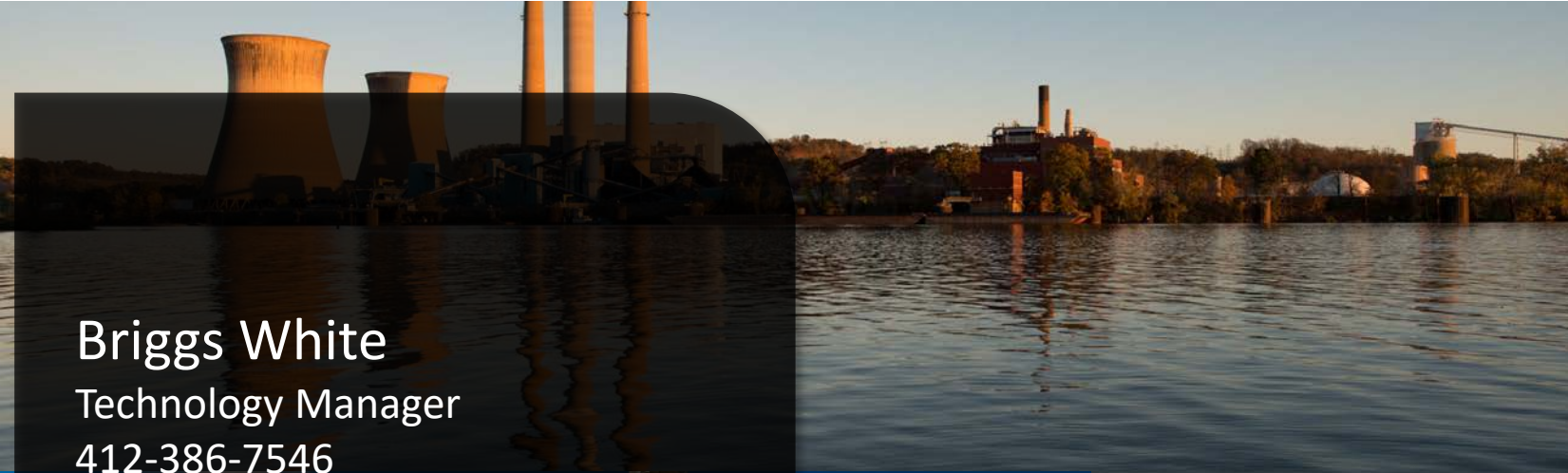
Contributing Toward

- Existing Coal Fleet
- Enabling New Power Cycles
- Domestic Materials Supply Chain

Thank You to Partners

Crosscutting Research Contacts

<https://www.netl.doe.gov/research/coal/crosscutting>



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