Welcome to the Webinar

NETL RWFI Energy 101- High Performance and Advanced Materials

- Everyone is on mute for duration of the call
- The webinar will be posted at netl.doe.gov/rwfi in our webinar archives section
- Please sign up to be notified of upcoming webinars, meetings, and other NETL RWFI activities by emailing us at NETL.RWFI@netl.doe.gov
- We will begin shortly

Energy 101 Series

- **About the Energy 101 Series**
- The NETL RWFI Energy 101 Series provides a basic primer on the research conducted at NETL from NETL Researchers and staff, including the challenges and potential economic and workforce opportunities that successful research into these topics and their related challenges may bring to the region and the nation.

  - Rare Earth Metals
  - Energy Storage
  - Sensor Technology
  - Modeling and Simulation
  - **Advanced Materials**
  - **Coal and CO2 to products**
  - **Updates in Advanced Manufacturing**

Webinar Archive:
www.netl.doe.gov/RWFI

NETL Regional Workforce Initiative (NETL RWFI)

NETL RWFI Mission Statement

NETL RWFI is a platform for engagement and collaboration with key stakeholders who are critical for the deployment of U.S. DOE and NETL Energy and Advanced Manufacturing technological research.

Supporting Regional Economic and Workforce Development opportunities.

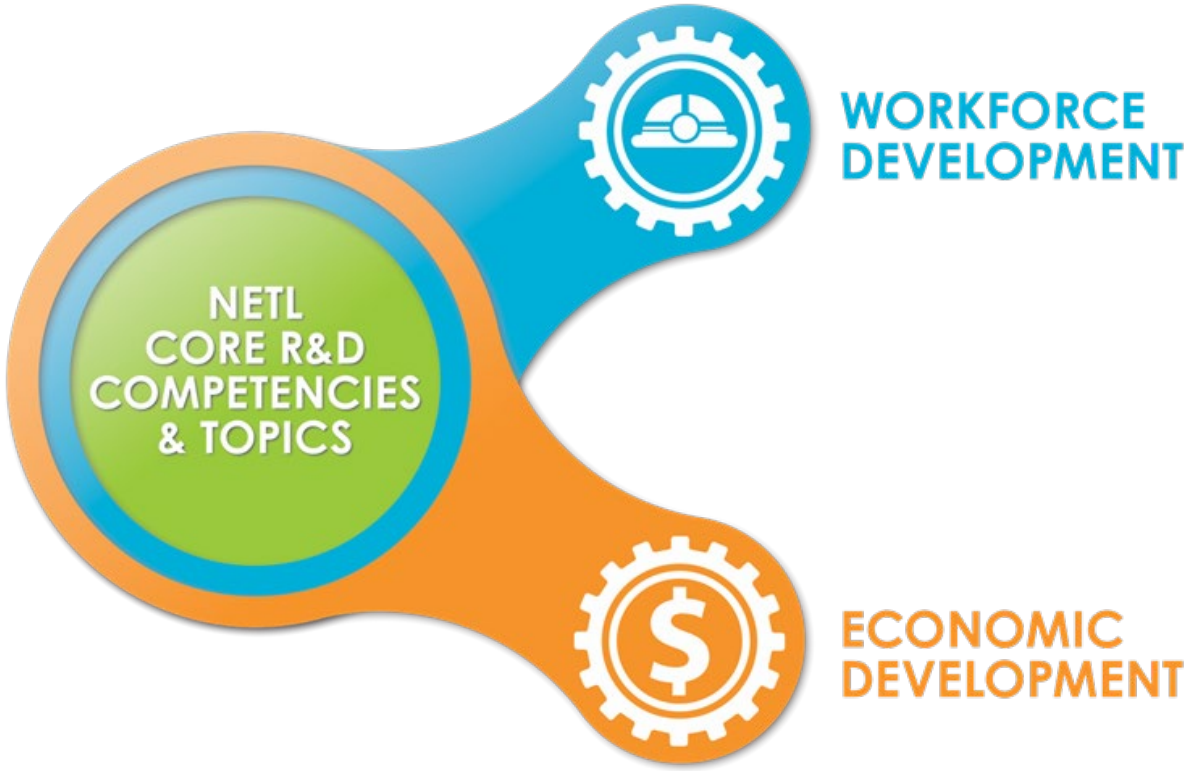
Collaboration, Coordination, and Communication

In the Energy and Advanced Manufacturing workforce

Collaboration with stakeholders and partners around workforce readiness and economic opportunities

Coordinating across economic development and workforce development initiatives

Communicating activities, research, and funding opportunities to stakeholders



Responsive to Administration Priorities

RWFI aligns with the Administration's efforts to connect R&D investment to economic growth, job growth, and development of a skilled technical workforce.

- Establishing the President's Council for the American Worker
- Establishing Apprenticeships in America
- Strengthening the Cybersecurity of Federal Networks and Critical Infrastructure

Key NETL RWFI Metrics

400+
individual regional and national stakeholders

150+
institutions and organizations represented

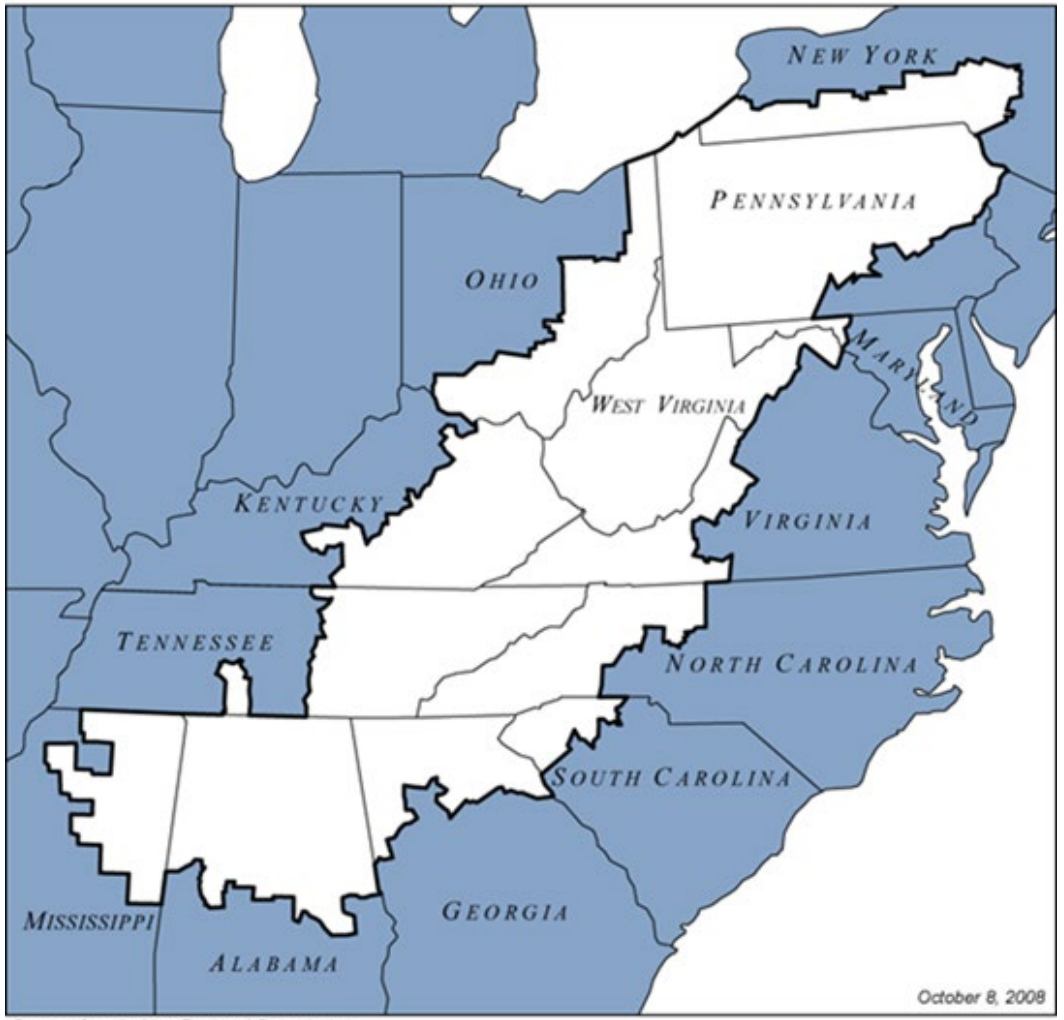
200+
subscribed to the NETL RWFI e-Note Monthly Newsletter

500+
registrants to the NETL RWFI Webinar Series

Appalachia at a Glance

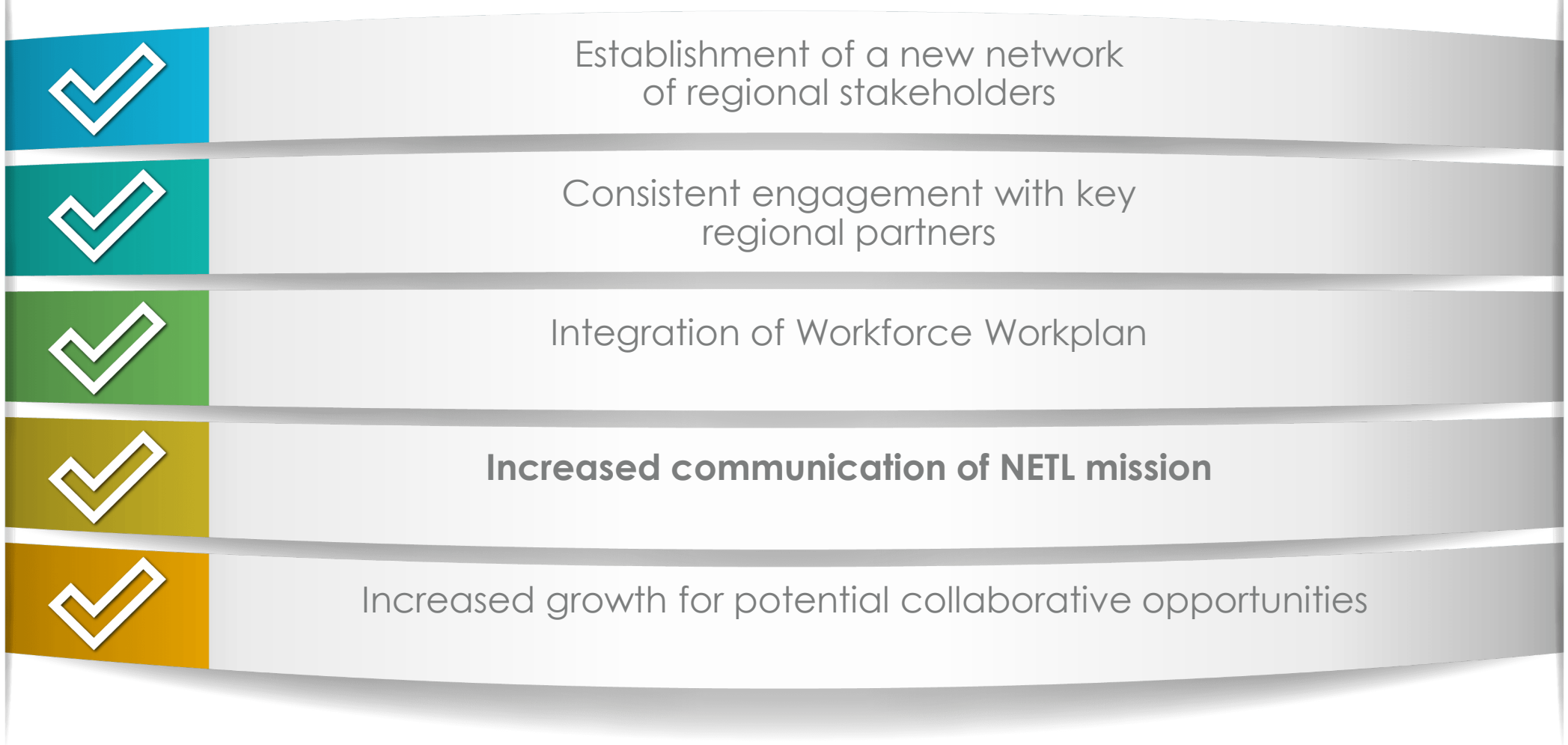
The Appalachian region is:

- a historically critical region for U.S. energy production, and will continue to be so
- a strategically important area for related technologies in advanced manufacturing and supercomputing
- expected to enjoy a manufacturing renaissance
- an area that has been adversely affected by changes in energy extraction and related manufacturing activity



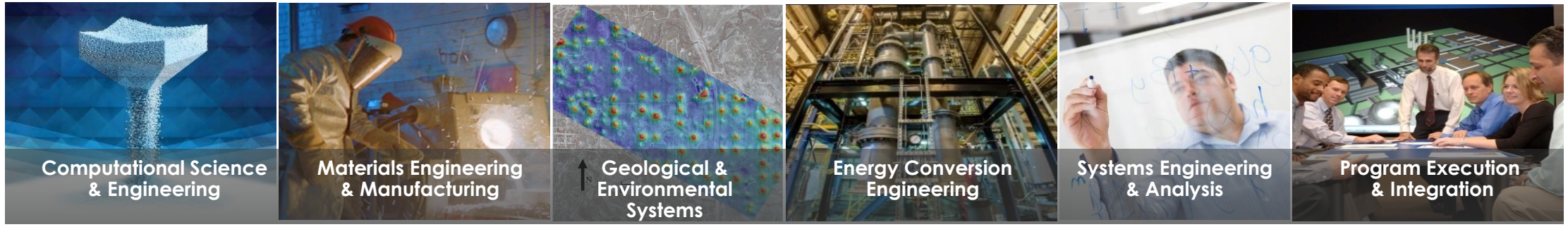
Source: Appalachian Regional Commission

Key Outcomes to Date



Core Competencies & Technology Thrusts

NATIONAL ENERGY TECHNOLOGY LABORATORY



COAL

- Carbon Storage
- Carbon Capture
- Sensors & Controls
- Advanced Materials
- Advanced Computing
- Advanced Energy Systems
- Water Management
- Rare Earth Elements

OIL & GAS

- Enhanced Resource Production
- Environmentally Prudent Development
- Methane Hydrates
- Offshore
- Natural Gas Infrastructure
- Unconventional

Support to Other DOE Offices

Energy Efficiency & Renewable Energy (EERE)

- Vehicles
- Solid State Lighting
- Geothermal

Office of Electricity (OE)

- Microgrid
- Energy Storage

Cybersecurity, Energy Security, and Emergency Response (CESER)

- Energy Security & Restoration
- Cybersecurity

Contact Information

NATIONAL ENERGY TECHNOLOGY LABORATORY

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High Performance Materials & Advanced Manufacturing

NETL RWFI 101 Webinar

Briggs White | April 7, 2020

Research Focus by Site

Multiple Sites Operating as 1 LAB System

NATIONAL ENERGY TECHNOLOGY LABORATORY

- Materials Performance
- Multi-environment Materials Characterization
- Alloy Development/Manufacture
- Geospatial Data Analysis

- Process Systems Engineering
- Decision Science
- Functional Materials
- Environmental Sciences
- Energy Systems Optimization

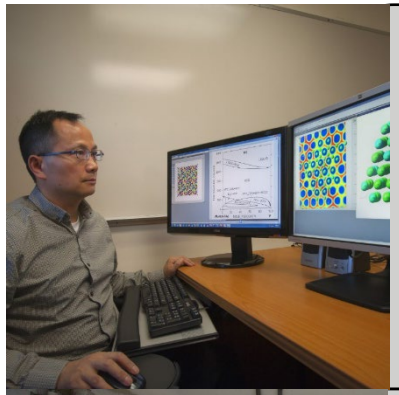
- Energy Conversion Devices
- Simulation-Based Engineering
- *In-Situ* Materials Characterization
- Supercomputer Infrastructure
- Diagnostics, Sensors, and Controls

Oil and Gas Strategic Office

Oil and Gas Strategic Office

Program Mission & Implementation

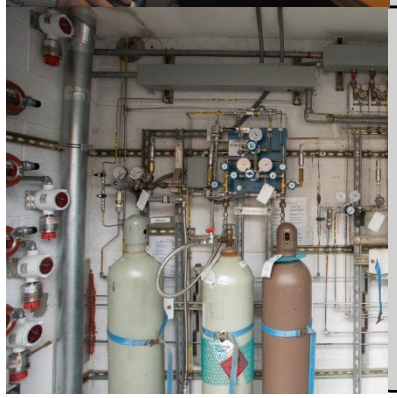
- Produce high performance materials suitable for extreme environments found in fossil power generation to support existing and new plants
- Encourage change and stimulate innovation in the high performance materials value chain to spur US competitiveness.



Computational Materials Design

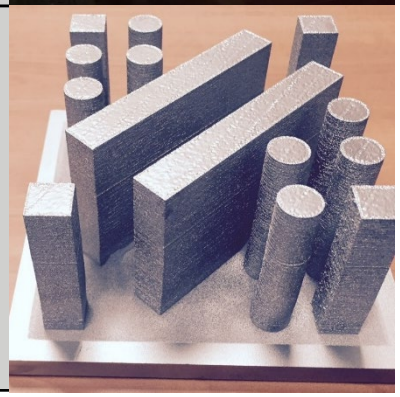
Advanced Structural Materials

Flex Operations
Efficiency
Cost
Assets Management



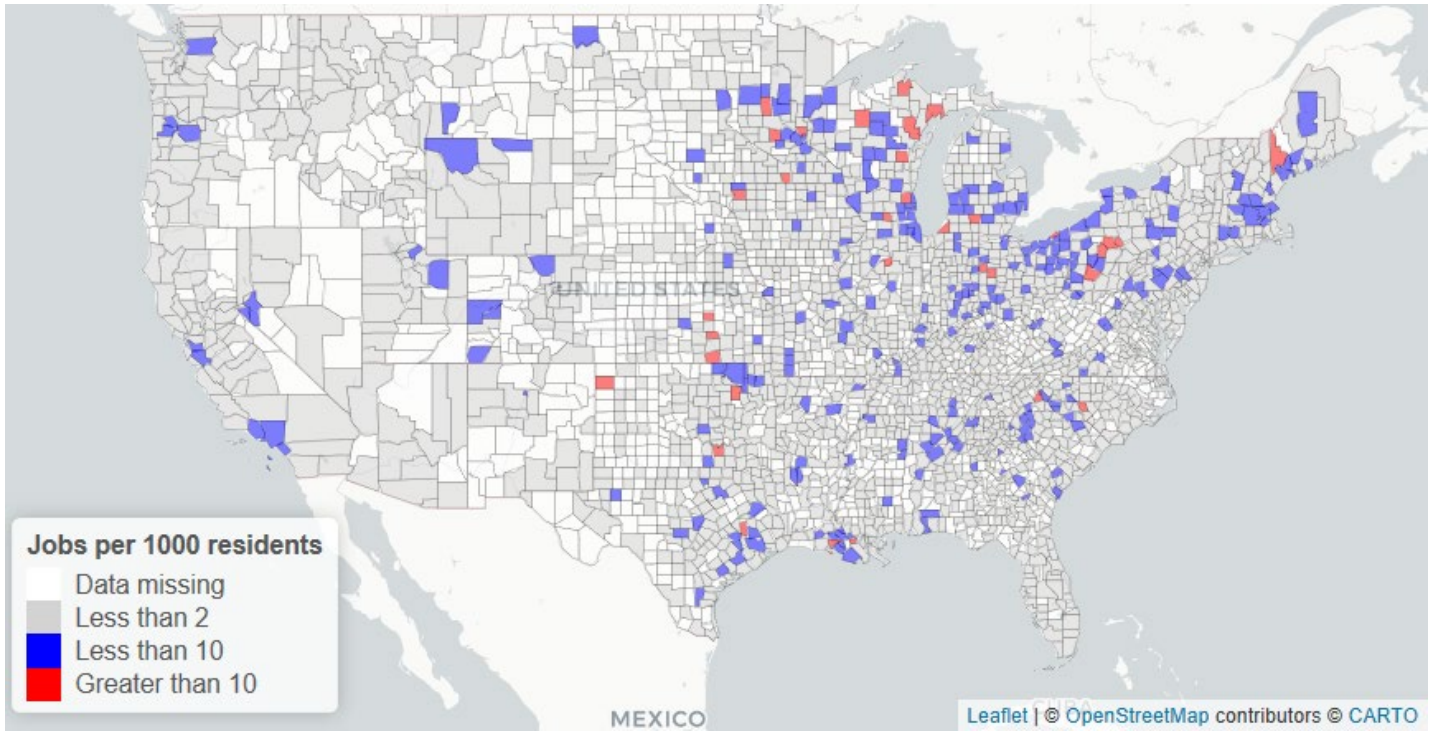
Functional Materials for Process Performance

Advanced Manufacturing



Fossil Energy Materials Value Chain

National program strengthening a **$7.8B** domestic value chain employing **>30,000**



Geographic Distribution of HPM Value Chain Employment

Source: Bureau of Labor Statistics, Census Bureau

Fossil Energy Plant

Component, assembly: $1.7B – 5318 jobs

Finishing: $3.4B – 19,445 jobs

Primary shaping: $1.4B – 4,905 jobs

Refining, alloying: $1.3B – 1,189 jobs

Mining

Superalloy Markets

Significant Growth Projected

$7 Billion market in 2023

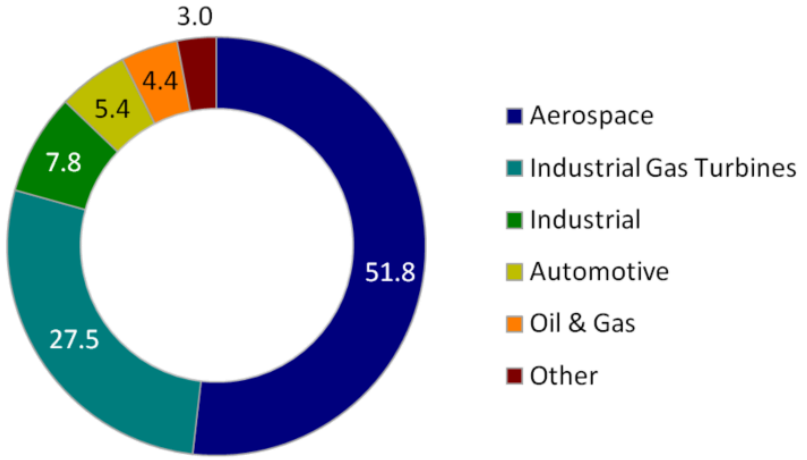
Strong regional footprint

Support employment and economy

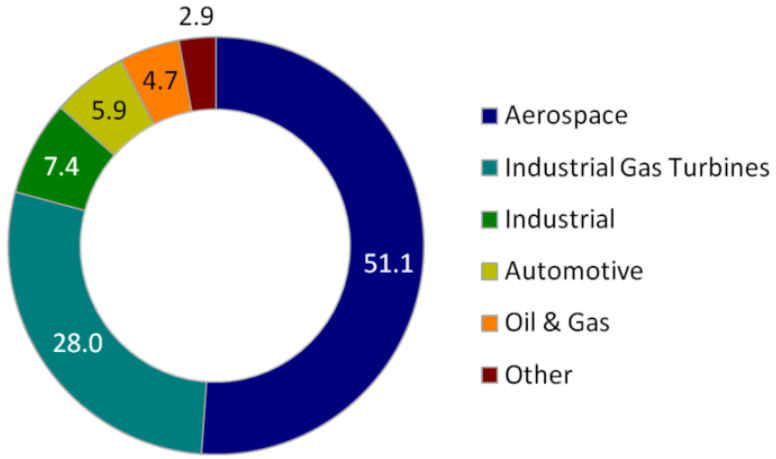
Advanced manufacturing

Workforce critical

2016 Revenue Share (%) of 4,158M

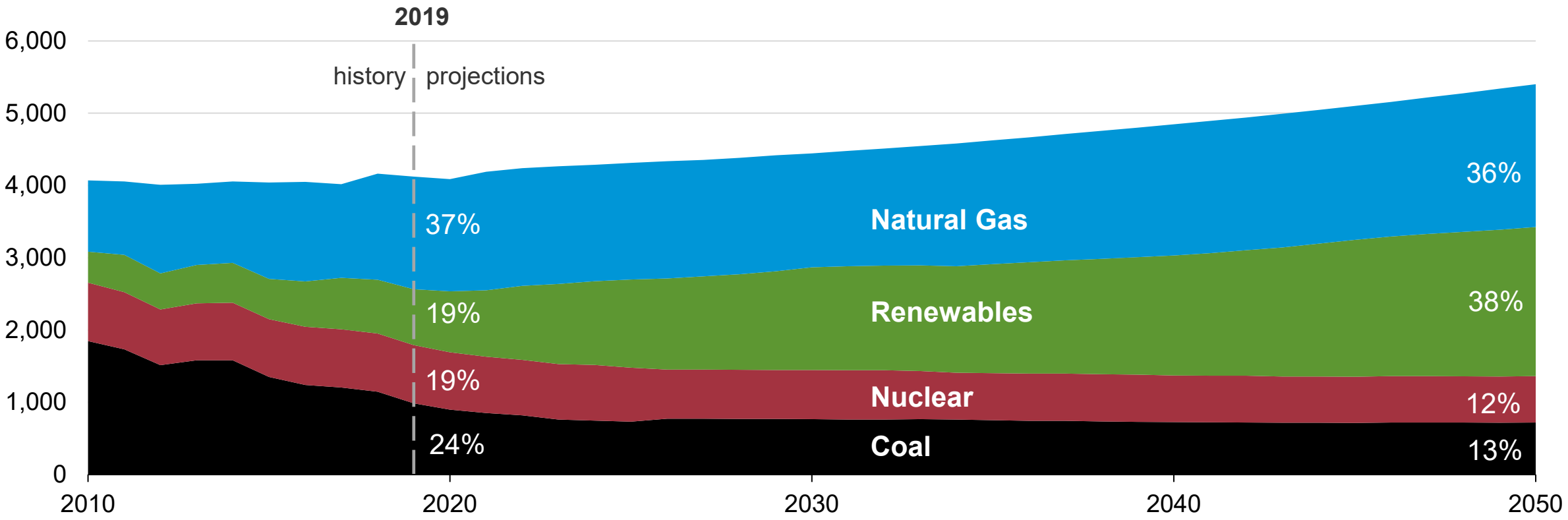


2023 Revenue Share (%) Forecast of 7,677M



Electricity Generation

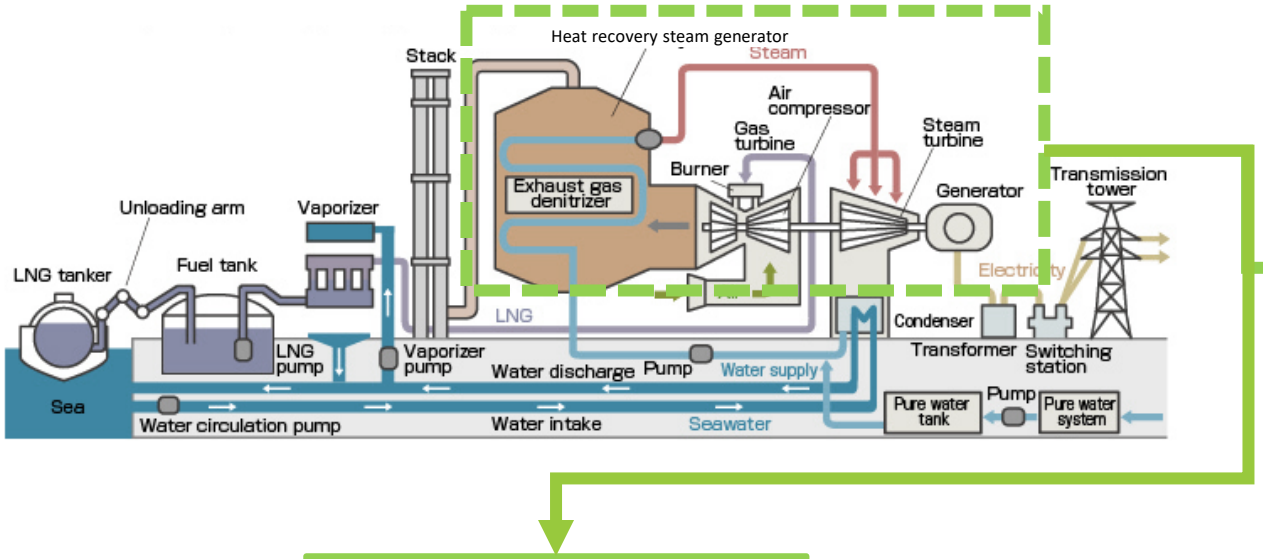
Fossil fuels in future as renewables double



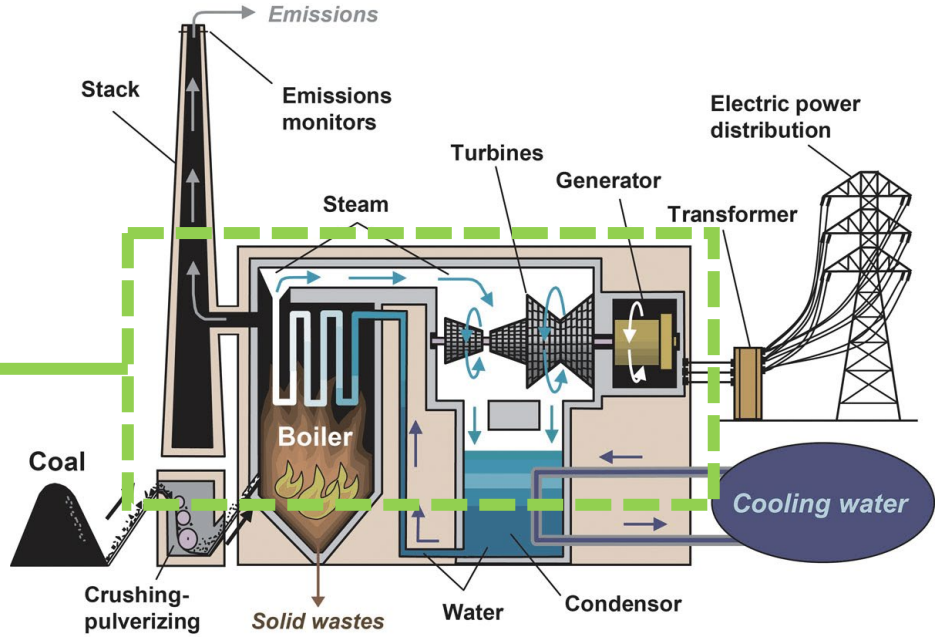
Key Fossil Generators In Today's Fleet

NGCC and PC power plants both experiencing cycling with common components

Natural Gas Combined Cycle (NGCC)



Pulverized Coal (PC) Power Plant



Common components

- **Boiler**
- **Steam turbine**
- **Generator**

1. https://www.ccsdualsnap.com/pressure-switches-in-combined-cycle-power-plant-switches/
2. https://www.climatetechwiki.org/technology/sup_crit_coal

Fossil Power Plant Challenges

Addressing existing and future challenges in efficiency, flexibility, and reliability.

Market Segments

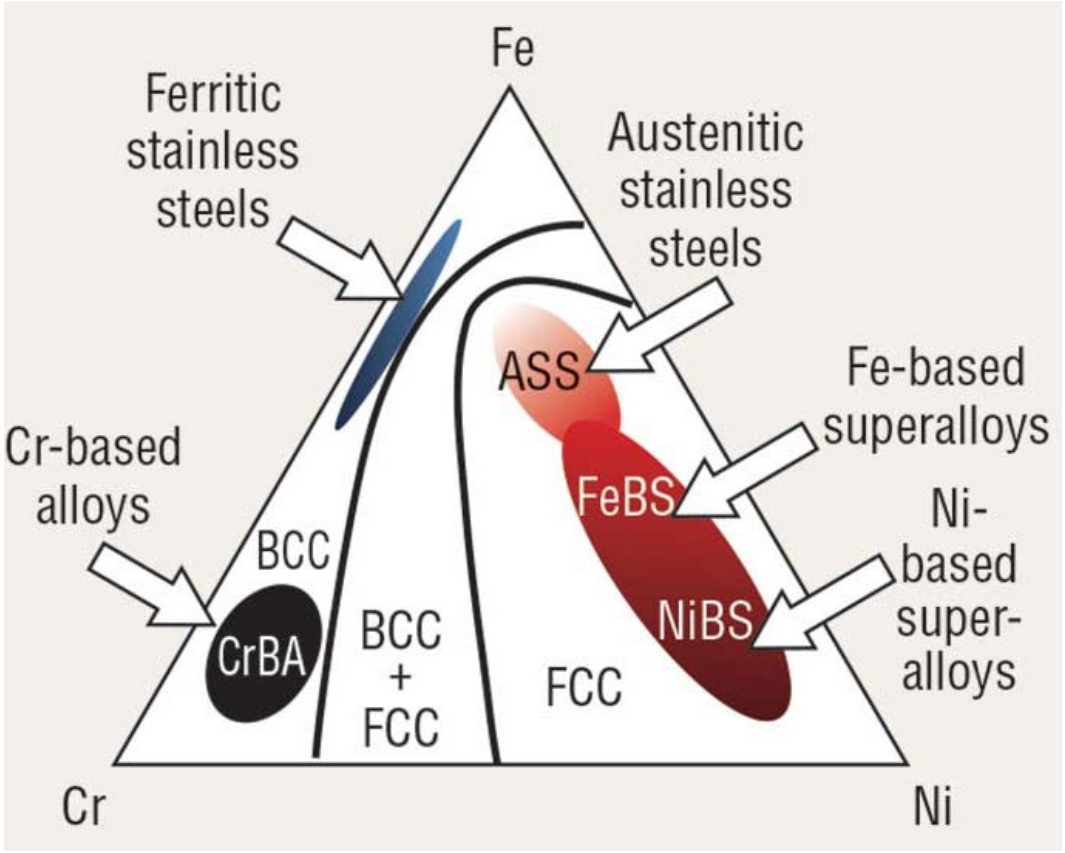
- **Existing Fleet**
  - **Coal**
  - **Gas**
- **Next Generation Plants**
  - **AUSC**
  - **Coal SCO_2**
  - Gasification
  - Next Gen Gas
  - Gas SCO_2

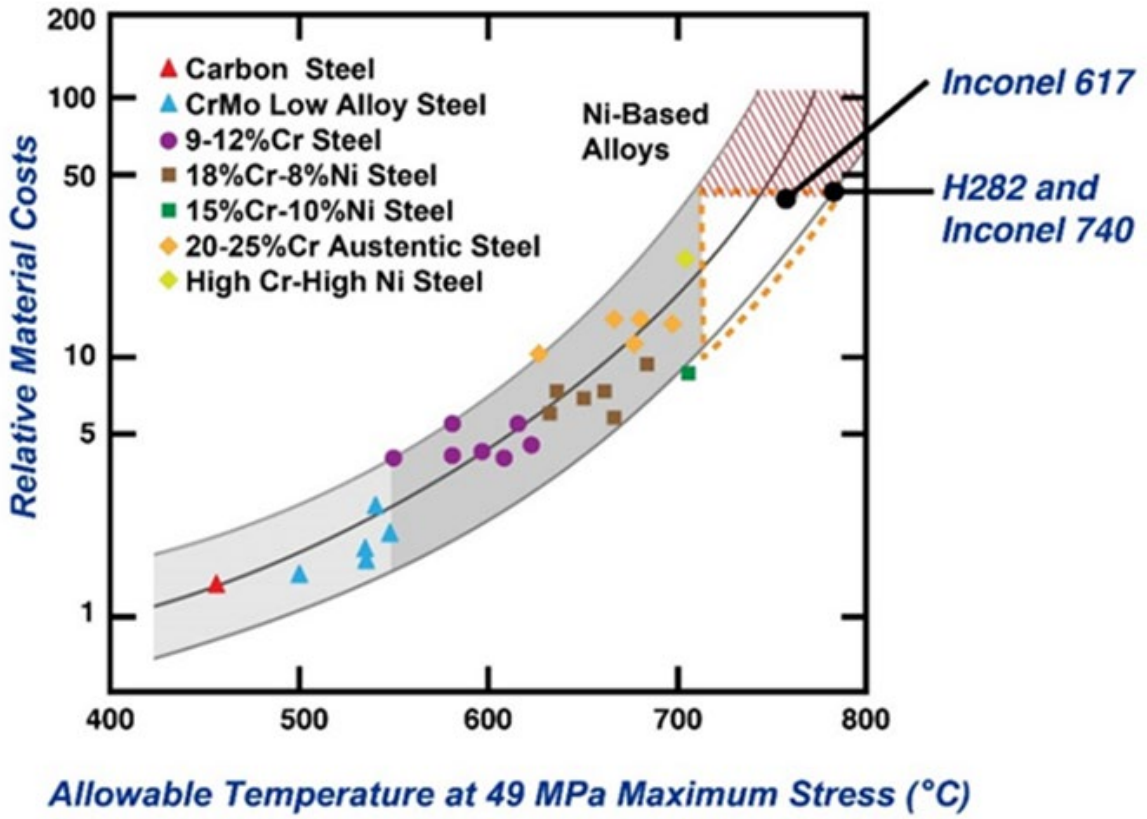
Technical Challenge Areas

- **Flexible Operation and Performance Optimization**
- **Asset Utilization**
- **Condition Based Management**
- **Performance Improvement**
- Cybersecurity
- Water use optimization
- Emissions control

High-Temperature Alloys

Variety of Compositions & Costs






PROGRAM OVERVIEW

Strategic Research Thrusts

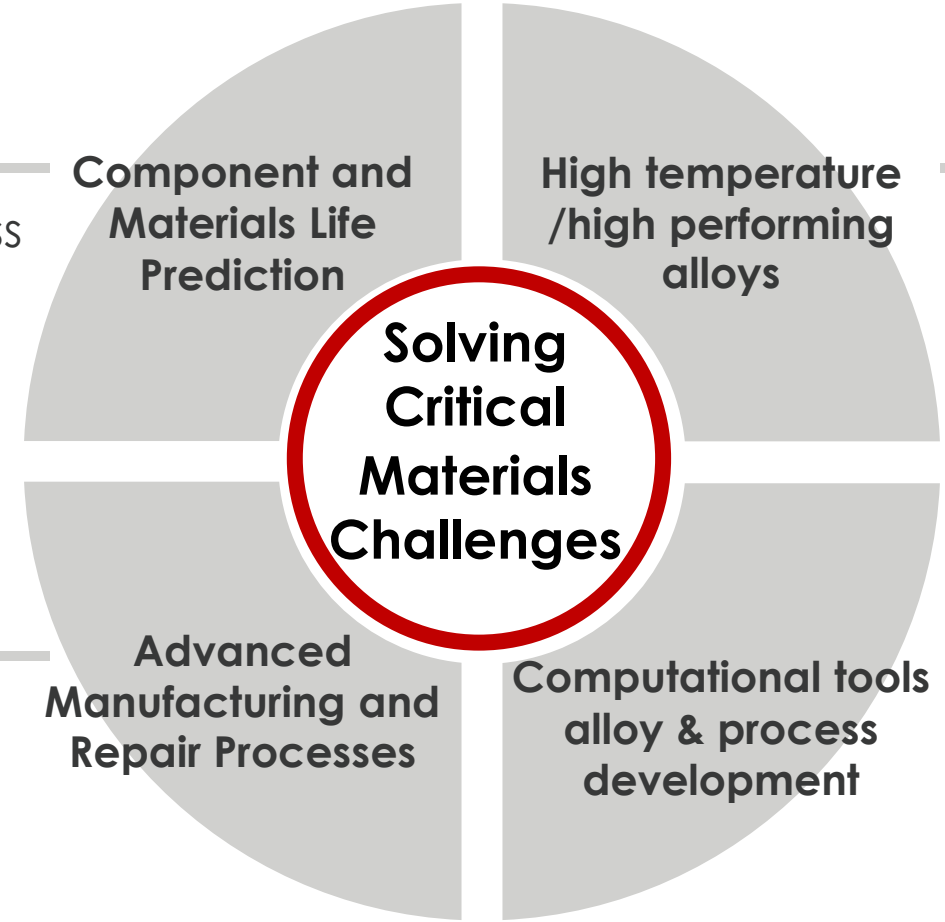
Recent spending addresses pressing challenges while aligning with broader technology trends

MARKET SEGMENTS

	Existing Fleet	Next Generation Plants
Objectives	Maintain cost competitiveness of existing assets	Commercialize a novel plant design with efficiency >44%
Barriers	Aging infrastructure; Unpredictable outages; Costly repair	Temperature and cycle alloy capability; High-costs of suitable alloys; Lack of domestic supply chain
Solutions	Component and Materials Life Prediction; Advanced Manufacturing and Repair Processes	High temperature/high performing alloys; Computational tools for alloy & process development

Technology Opportunities

Portfolio develops solutions that impact flexible operation and asset life extension



- Materials and Process Modeling
- Validation with Plant Data

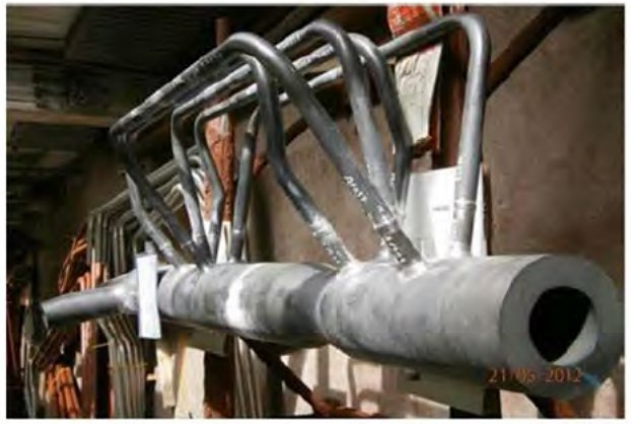
- Alloy Development
- Manufacturing Trials
- Code Cases

- Welding
- 3-D Printing

- Multi-scale Materials Modeling
- Data Analytics

High Performance Materials Themes

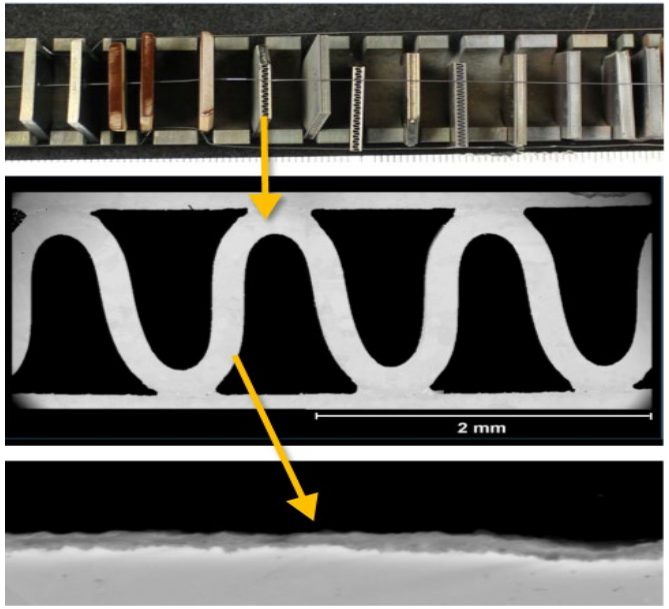
Improve Cycling



Advanced Ultra-Supercritical (AUSC) Materials Thick-Walled Cycling Header Development

Courtesy: Alstom Power, Inc.

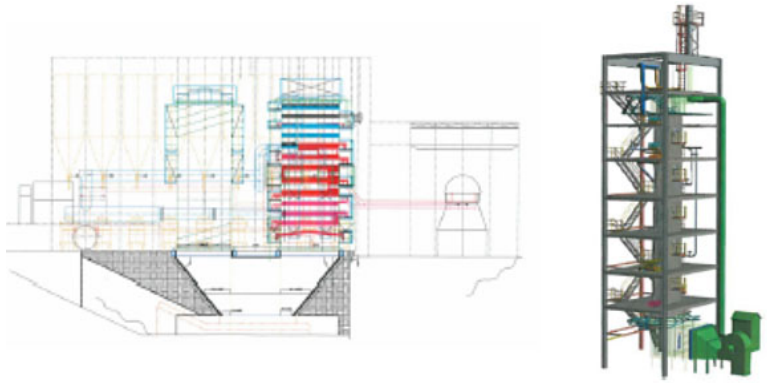
Enable High-Efficiency Cycles



Predicting the oxidation/corrosion Performance of Structural Alloys

Courtesy of: EPRI

Reduce Manufacturing Costs



Advanced Ultra-Supercritical Component Manufacturing

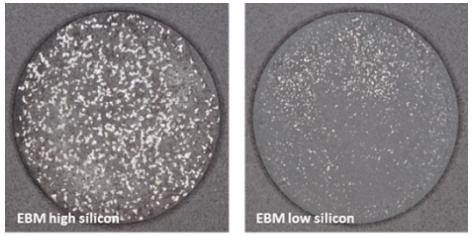
Courtesy of: Energy Industries of Ohio, Inc.

CURRENT PORTFOLIO HIGHLIGHTS

Materials Supply Chain for the Future

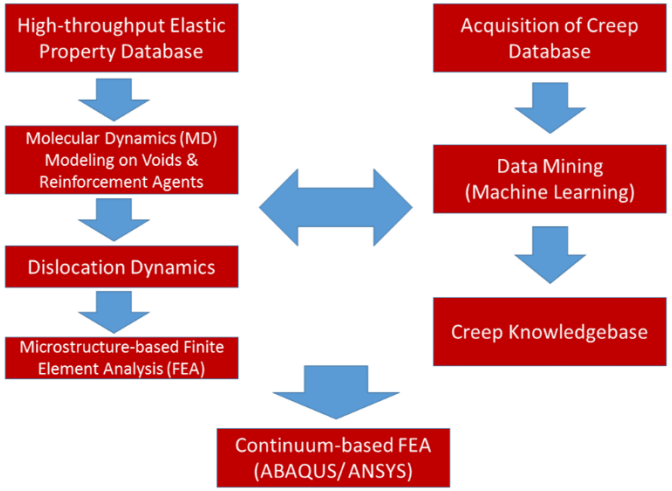
Nickle superalloys & ComTest develop materials, supply chains, for plants of the future

Ni-Based Alloy/Superalloy Projects



Microstructure and Properties of Ni-based Components fabricated by Additive Manufacturing

Multi-modal Approach to Modeling Creep Deformation In Ni-Base Superalloys



ComTest Consortium Readying Materials for AUSC

Existing Fleet Support

Collaborating to improve reliability, flexibility and cost

Robust Dissimilar Metal Welds (DMWs)

- **AM Graded Composite Joints –** cost-effective material solutions for joining dissimilar metals. (WVU, ORNL, Carpenter, GE)
- **Additive DMWs –** optimizing compositional profile of weld joint to improve flexibility. (ORNL &NETL)

Advanced Manufacturing (AM)

- **Additive Manufacturing of High Gamma Prime Alloys –** innovative manufacturing approaches enable high temp/high pressure components from attractive materials (ORNL)
- **Solid State Joining of Creep Enhanced Ferritic Steels** - Solid state joining technology enabling high performance Creep Strength Enhanced Ferritic steels (PNNL & NETL)

Surface Integrity

- **Steam-Side Exfoliation –** Shot peening and water treatments to reduce scale exfoliation and hot spot formation. (ORNL, NETL, EPRI)

Data Analytics

- **Steam-Side Exfoliation –** High performance computing, data analytics, and plant data inform component life prediction. (ORNL, NETL, SPS)

Broad Portfolio Reach

Advanced alloys, methods, and models that broaden the reach of our portfolio

Portfolio Technology	Technical Benefit	Adjacent Use Case
AM processing Hastelloy X	AM parameters optimized for desired microstructure, mechanical property	IGT complex components for high performance
Process modeling Haynes 282	Part analysis in service, large scale cast parts, understanding properties of additive parts	Widely used alloy in gas turbines including IGT and aerospace
Rapid testing austenitics and ferritics	Understanding performance under service conditions to build life prediction model	Applications for alloys studied in IGTs
Life-prediction modeling Super 304H and 316H steels	Database linking microstructural features to long term behavior under service conditions	Alloys currently in use in chemical processing and petrochemical applications

ENGAGEMENT OBJECTIVES & OPPORTUNITIES

Program Stakeholder Engagement

Routine collaboration with ecosystem to maximize success of performers and program

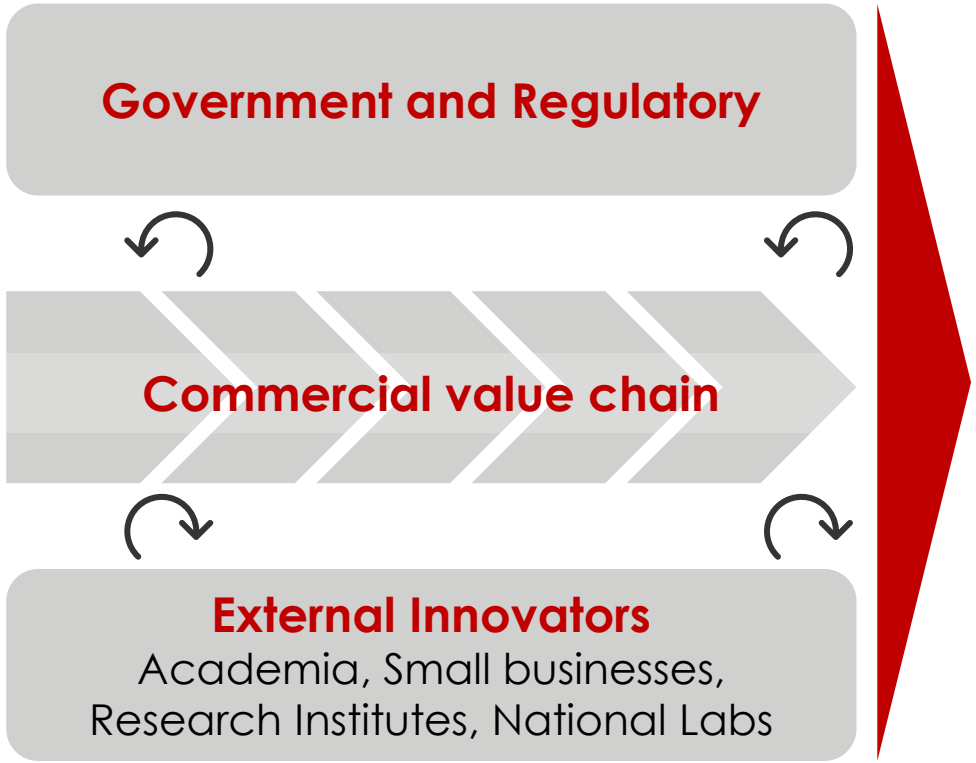
Roles in the Ecosystem

- Objectives & aspirations
- Systems-level planning
- Policy & impact analysis

- Problem definition
- Product specifications
- Scale-up

- Transformational tech
- Workforce development
- Vision for the future

S T A K E H O L D E R S



Collaboration Opportunities

- **Many ways to partner:**
  - Directly with lab
  - Through funded competitions
- **Engage with RFIs, Workshops**
- **Attend Project Review Meeting**
  - Learn about program
  - Network to propose ideas in response to FOAs
  - Provide feedback

High Performance Materials Program Contacts

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

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Webinar Agenda

- **About the Energy 101 Series**
- The NETL RWFI Energy 101 Series provides a basic primer on the research conducted at NETL, including the challenges and potential economic and workforce opportunities that successful research into these topics and their related challenges may bring to the region and the nation. NETL researchers present information on their work in an easy to follow and thus easy to communicate fashion.

- Agenda:
- Introductions & Webinar Instructions
- NETL Regional Workforce Initiative and NETL Research Background- Anthony Armaly- NETL RWFI Federal Coordinator
- Energy 101- Briggs White, NETL Technology Manager, High Performance Materials
- **Technology Workforce Discussion**
- Conclusion

Technology Workforce Discussion

- What type of training did you have prior to becoming involved with Advanced and High-Performance materials? What does the typical researcher at NETL have as their academic background?
- Immediately when people think about cutting edge research that NETL does they probably think of Scientists and PhD's working on the research and discoveries, but what type of downstream workforce activity do you think successful deployment of this type of research could have. (ex. Technical workforce).
- We hear a lot about energy efficiency and energy savings or being more efficient process wise when it comes to advanced and high-performance materials. Can you elaborate a bit on what type of knock on effects having more energy efficient processes and materials may have on a company's bottom line and on the amount of energy we use at a country?
- What are the biggest challenges in commercialization of this research? Where do you see this research going in the next 10, 20 years?

Thank you for your participation

- For updates on the NETL RWFI, Future Webinars, On Campus Meetings, Collaborations, and Funding Opportunities register for the NETL RWFI E-Note by emailing NETL.RWFI@netl.doe.gov
- Webinar will be posted on the NETL RWFI Website in our webinar archives page: www.netl.doe.gov/RWFI

NEXT WEBINAR ALERT: NETL Regional Workforce Initiative presents:

Regional Briefing on the 2020 US. Energy and Employment Report

David Foster, Former Labor and Workforce Advisor, US. DOE and Current Distinguished Associate at the Energy Futures Initiative

May 21st 11-12PM ET