In today’s power system, materials are...
Dispatchable generation can reduce electricity cost to the consumer by a factor of 4 as CO$_2$ emissions limits approach zero.

**BUT** these assets will be stressed by requirements of flexible operation, which exacerbate numerous materials-related challenges.

*Source: The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation* - ScienceDirect
An important sector of the economy

High Performance Alloy Domestic Value Chain

In today's power system, materials are...

Workforce development will play a key role in success of the materials value chain.

Regional Impacts

Mining

Alloy Production

Shaping

Finishing

Component

Fossil Energy Plant & Transmission

Value

JOBS

Avg Salary

TOTAL VALUE = $16.5 Billion

JOBS = 43,719

AVERAGE SALARY = $65k per year

1,269

$78k

6,646

$58k

11,667

$56k

24,137

$57k

$1.3B

$2.5B

$2B

$10.7B
The NETL Crosscutting program is organized to...
Develop diverse solution

The NETL crosscutting program is organized to...
The NETL crosscutting program is organized to meet challenges of today & the future with diverse technical approaches.

Innovating the production and use of advanced alloys...

In Advanced Energy Systems...

- Computational material design
- Advanced structural materials
- Advanced manufacturing
- Workforce enhancement
The NETL crosscutting program is organized to... 

**Increase Flexibility and Decarbonize**

<table>
<thead>
<tr>
<th>SEGMENTS</th>
<th>NEEDS</th>
<th>CHALLENGES</th>
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<tbody>
<tr>
<td>Existing fleet</td>
<td>Reliability</td>
<td>Asset management</td>
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<tr>
<td>Gas</td>
<td>Efficiency</td>
<td>Supply chain</td>
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<tr>
<td>Coal</td>
<td>Flexibility</td>
<td>Emissions</td>
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<td>Next Gen.</td>
<td>Decarbonization</td>
<td>Water use</td>
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<td>AUSC</td>
<td>Upkeep</td>
<td>Cybersecurity</td>
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<td>sCO2</td>
<td>Competitiveness</td>
<td>Workforce</td>
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<td>Hydrogen</td>
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**SOLUTIONS**

<table>
<thead>
<tr>
<th>Alloy development</th>
<th>Manufacturing</th>
<th>Repair</th>
<th>Life-prediction</th>
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<tbody>
<tr>
<td>Computational</td>
<td>Additive</td>
<td>Joining</td>
<td>Materials</td>
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<tr>
<td>Experimental</td>
<td>Novel</td>
<td>Coatings</td>
<td>Components</td>
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<td>Ferritic</td>
<td>Assembly</td>
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<td>Components</td>
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<tr>
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**U.S. DEPARTMENT OF ENERGY**
TECHNOLOGY DEVELOPMENT SCHEDULE

2015
- Develop 760C Materials (ComTest)
- Ni Superalloy Manufacturing
- SCO₂ Durability Research

2020
- AUSC ready
- Lower cost components
- Durability Demonstrated

2025
- Advanced Manufacturing, Joining
- Existing Fleet Flexibility R&D
- Alloy Development

2030
- Enable High Efficiency Power Cycles (NGCC, steam, SCO₂)
- Facilitate hydrogen, biomass, and CCS
- Better Repair, Improved Cycling, Trained Workforce
- Damage Mitigation
- Low-cost, high performance alloys
- Enhance Flexibility of Existing and Future Fleet
- Competitive Supply Chain (GDP/Jobs)
Our program impacts stakeholders with...
Our program impacts stakeholders with...

**Operationally meaningful outcomes**

**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.*
Benefits to the workforce

Advanced Welding Workforce Initiative

In collaboration with:

Appalachian Regional Commission
Opportunities to develop solutions

Extreme Environmental Materials for Power Generation
Phase I: $6M, Phase II: $TBD
Improving cyclic durability and reducing the costs of next-gen plants

Addressing material failure and repair in the existing fleet
$10M total funding
Cost-effective solutions to most prevalent causes of forced outages

Advanced Welding Workforce Initiative
$1M total funding
Forging a path forward to fill gaps in skills and jobs for welding

Spring 2021 Solicitation
The current portfolio is...
**Balanced across challenges/solutions**

The current portfolio is...

### Technical solution

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#### Total Crosscutting investment ($M)

- Light grey: 5
- Medium grey: 10
- Orange: 15
- Dark grey: 20

Total number of projects represented numerically.
Advancing existing & future fleets
Developing power plants of the future

Ni-Based Alloy/Superalloy Projects

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

- High-throughput Elastic Property Database
- Molecular Dynamics (MD) Modeling on Voids & Reinforcement Agents
- Dislocation Dynamics
- Microstructure-based Finite Element Analysis (FEA)

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

ComTest Consortium
Readying Materials for Advanced Power Cycles
We move forward, together, as...
A complete innovation ecosystem

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

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

Stakeholders
- Government and Regulatory
- Commercial value chain
- External Innovators
  - Academia, Small businesses, Research Institutes, National Labs
High Performance Materials Program Contacts

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

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