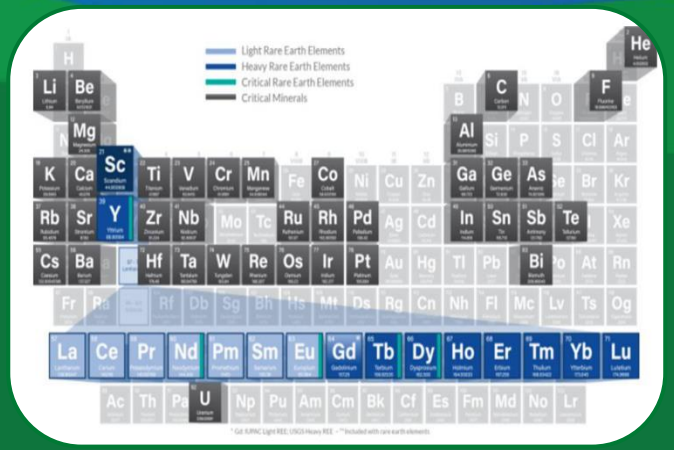
U.S. DEPARTMENT OF ENERGY

Fossil Energy and Carbon Management

Advanced Energy Materials Annual Review Meeting

May 9, 2022



Key Trends Enabling and Guiding the Program

FE to FECM – A New Mission

- New climate goals:
  - 50% emissions reduction by 2030
  - 100% clean electricity by 2035
  - Net-zero carbon emissions by 2050
- New goals on justice and equity:
  - Justice40 Initiative
  - Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization
- DOE/Office of Fossil Energy and Carbon Management (FECM)'s focus:
  - Mitigation of environmental impacts from resource recovery and use
  - Management of carbon dioxide emissions, including legacy emissions

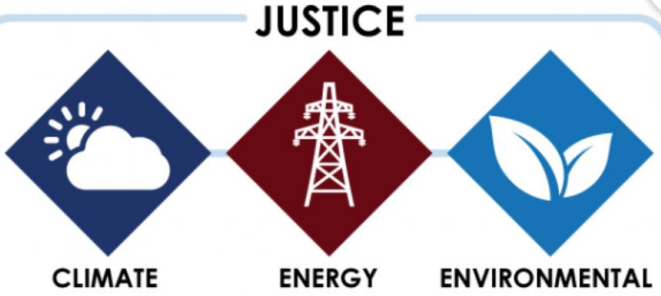
5 Things to Know About FECM's Strategic Vision

1

FECM's Strategic Vision establishes a framework that will be used by the office to help the United States make informed carbon management decisions in regard to achieving **deep decarbonization economy-wide** and **addressing legacy emissions.**

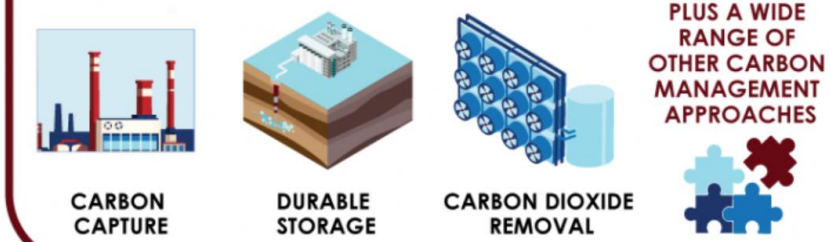
2

FECM outlines a vision with **climate, energy, and environmental justice** at the core of its work, as the office strives to enable decarbonization infrastructure in a **just and sustainable way.**



3

Advancing **clean energy**, with **carbon capture coupled to dedicated and durable storage** in both the power and industrial sectors, and **carbon dioxide removal** at gigatonne levels of removal are imperative to achieving net-zero emissions.



4

FECM prioritizes the following three strategic directions, and several other related priorities, as a part of its vision:

5

While FECM has a very important role to play, reaching these bold climate goals will take **historic domestic and international efforts**, and continued **collaboration** with offices across the Department, Federal agencies, other governments, industry, non-governmental organizations, and communities.

https://www.energy.gov/fecm/articles/infographic-5-things-you-should-know-about-fecms-strategic-vision

Solving America's Most Critical Energy Needs

The Advanced Energy Materials program focuses on **material discovery** and **development** that will lower cost and improve flexibility and reliability while **enabling high efficiency, low-carbon performance**.

Materials of interest are those that enable components and equipment to perform in the high-temperature, high-pressure, corrosive environments of an advanced energy system with specific emphasis on **durability**, **availability** and **cost.**

In accordance with the Fiscal Year 2022 Presidential Budget Request, NETL will evaluate the impacts of hydrogen on materials to develop models which are critical to understanding hydrogen-related impacts.

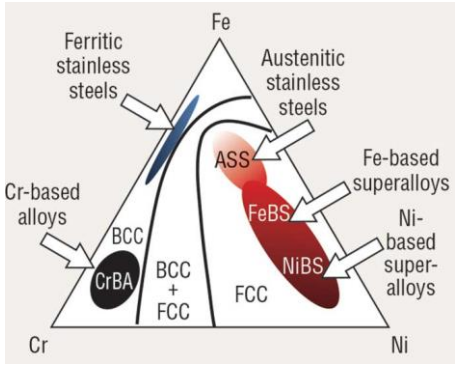
Four primary platforms:

Advanced Materials Development | Supply Chain Development

Work Force Development | High-Performance Computing for Materials (HPC4Mat)

Advanced Energy Materials – R&D Goals

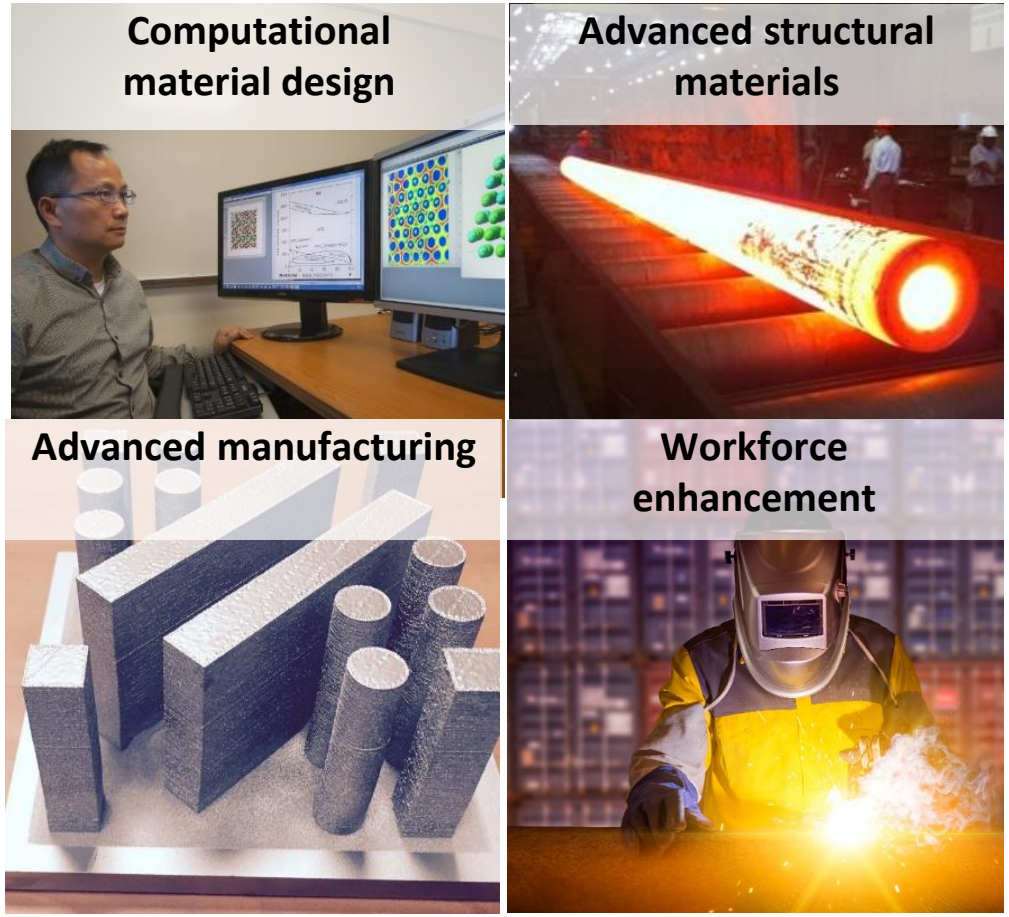
Innovating the production and use of **advanced** alloys…



in Advanced Energy Systems…

… to allow for components and equipment to perform under cyclic operation in high-temperature, high-pressure, corrosive environments …

with diverse technical approaches.



Achieve greater impact for a net-zero carbon economy by mid-century.

- Evaluate impacts of hydrogen on material to establish a new domestic supply chain of hydrogen resistant materials.
- Enhance the nation's supply chain for high-temperature materials to support a competitive U.S. industry base and create a skilled workforce.
- Develop Ceramic Matrix Composite (CMC) materials for turbines to address 70% efficiency and turbines firing 100% hydrogen.

Current FOA: DE-FOA-0002613

Advanced Energy Materials for Hydrogen Turbines for Stationary Power Generation

Applications are being sought for applied laboratory or bench-scale R&D to develop turbine components within the hot gas path using ceramic matrix composites (CMCs) to enable an additional 150°C of temperature capability beyond current CMC technology. Such improvement would enable an increase of 450°C over existing nickel-based materials, while reducing the amount of cooling air that must be diverted from the core working fluid.

AOI-1: Benchmark of CMC Performance with Predicative Modeling
AOI-2: Improvement to Temperature Performance of CMC Materials

Issued: April 7, 2022
Applications Due: May 18, 2022 (11:59 PM EST)

Solicitation | netl.doe.gov

Advanced Energy Materials Program Overview

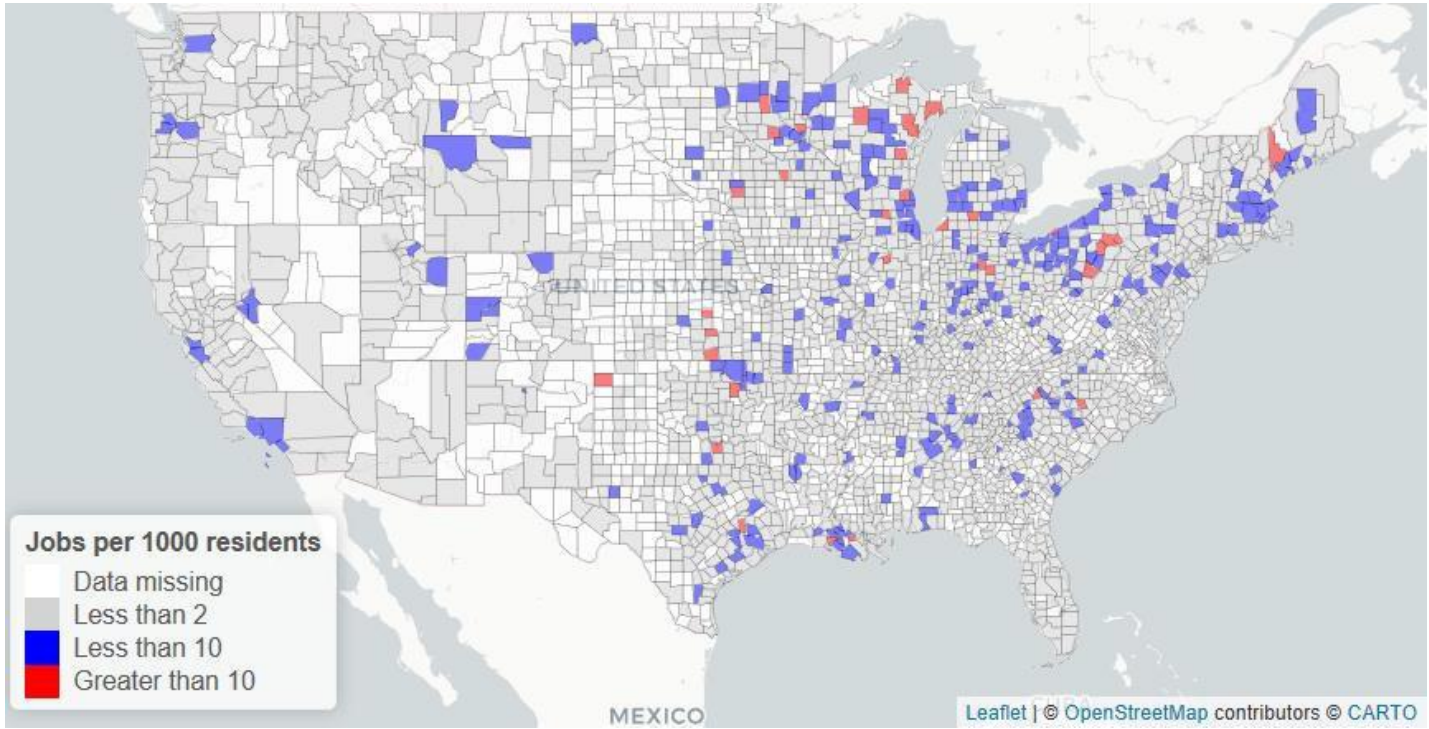
Advanced Energy Materials Program Goal

AEM PROGRAM GOAL

Reduce cost and increase efficiency of fossil power generation, while stimulating innovation in the US value chain for extreme environment materials

Fossil Energy Materials Value Chain

National program strengthening a **$16.5B** domestic value chain employing **>43,000**



Geographic Distribution of HPM Value Chain Employment

Source: Bureau of Labor Statistics, Census Bureau

Fossil Energy Plant

Component: $10.7B – 24,100 jobs

Finishing: $2.0B – 11,700 jobs

Primary shaping: $2.5B – 6,600 jobs

Refining, alloying: $1.3B – 1,200 jobs

Mining

Impactful New Materials Developed Under FOAs

Alloy Development and Characterization

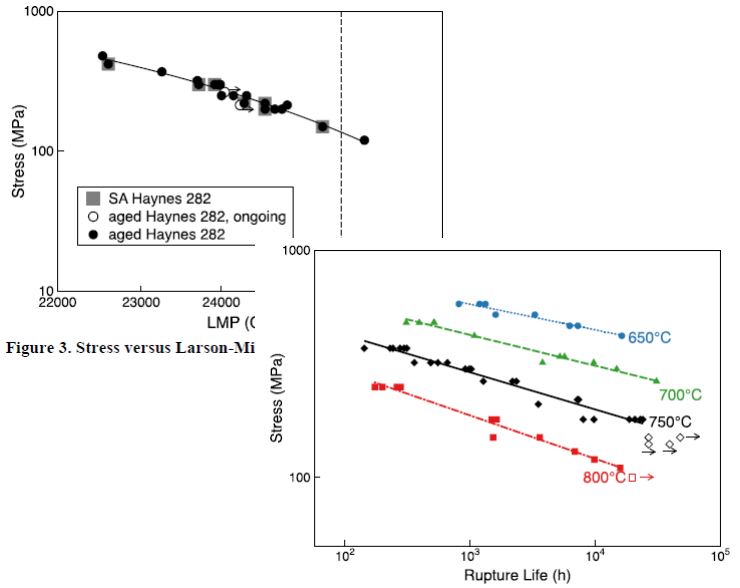


Figure 3. Stress versus Larson-Mi

Figure 1. Stress versus time for aged specimens of Inconel 740

Code Cases supported for new nickel superalloys Inconel 740 and Haynes 282

- Long term creep data generation

Alloy Manufacturing Support

Largest Inconel 740 and Haynes 282 ingots ever produced.

Alloy Fabrication Support

Largest Inconel 740 pipe extrusions.
Largest Haynes 282 casting.
SH/RH component fabrication and field erection simulation.

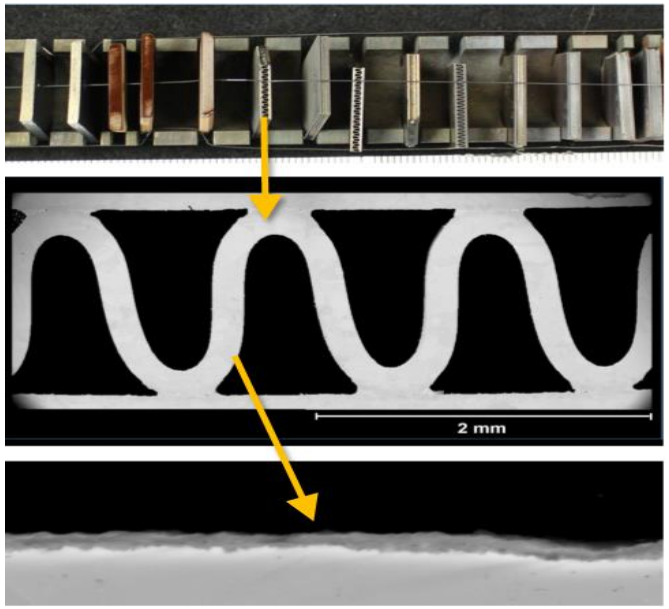
Advanced Energy Materials Themes

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

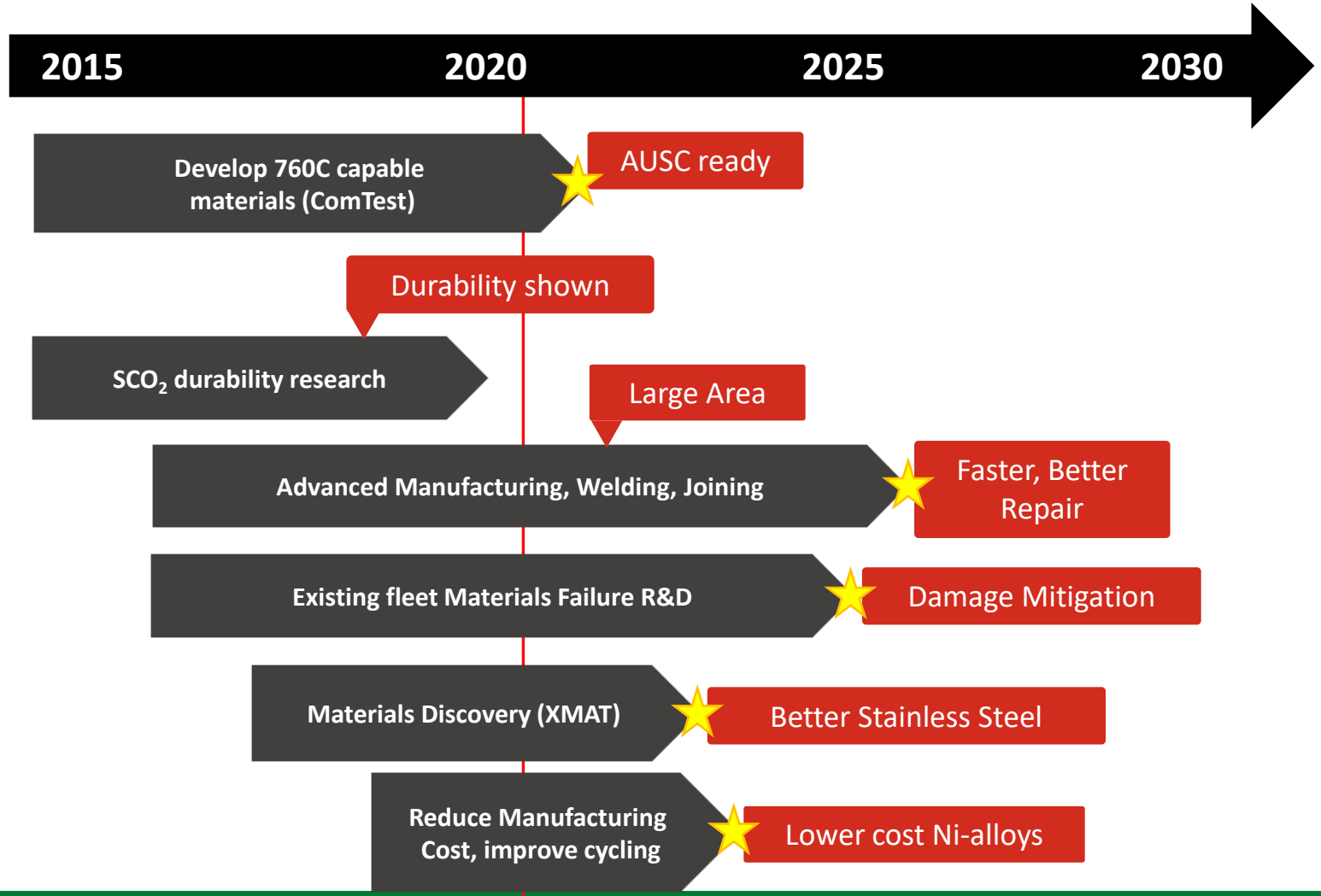
Courtesy of: EPRI

Reduce Manufacturing Costs

Advanced Ultra-Supercritical Component Manufacturing

Courtesy of: Energy Industries of Ohio, Inc.

AEM Technology Development Schedule



Enable AUSC Plants – DONE

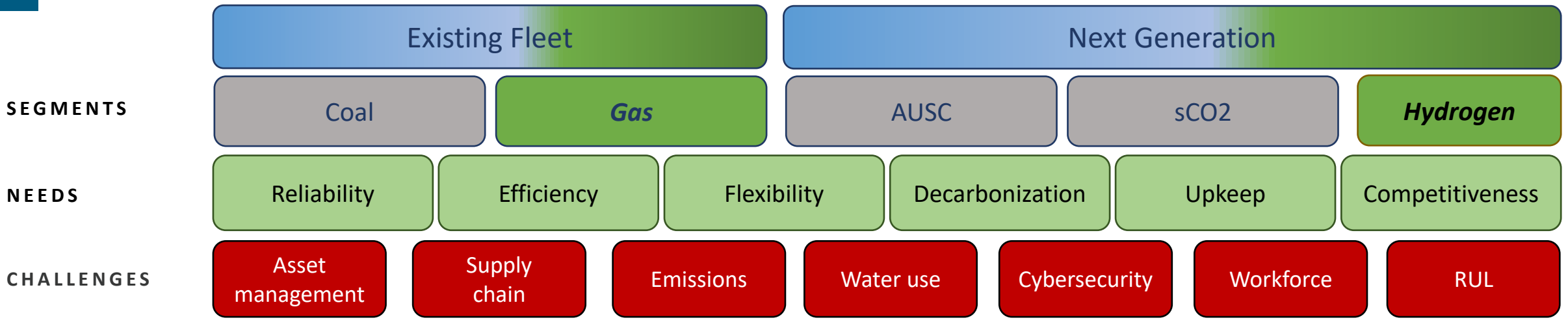
Enable SCO_2 Power Cycles – DONE

Address Existing Fleet Materials Issues – PIVOT TO COMB. CYCLE

Reduce Alloy & Component Costs – HYDROGEN APPLICATIONS

Advanced Energy Materials Portfolio Structure

GOAL: Low-cost, high efficiency fossil power supplied by a domestic value chain.



SOLUTIONS

Alloy development		Manufacturing		Repair		Life-prediction	
Computational	Experimental	Additive	Novel	Joining	Coatings	Materials	Components
Ferritic	Austenitic	Assembly	Convent.	FGM	High Nickel		
High Nickel	High Entropy	Components	Intermediates	WAAM			
Coatings	CMCs	FGM	High Nickel				
		DMW	CMC AM				

AEM Portfolio Overview

Statistics are as of February 2022.

COMTEST ($27M) accounts for 34% of portfolio value

Remainder is split among 14 unique performers

$68.6 Million Total Funding

24 projects

Recent FOAs bring 3 new projects into the portfolio as of Jan 2021

Since Jan 2021, 6 projects have closed out

What to Expect in Today's Review Meeting

Today (Monday, May 9)

- Advanced Manufacturing projects
- Advanced Structural Materials projects (Partial)

Wednesday, May 11

- Keynote: ComTest Project
- Advanced Structural Materials projects (Remaining)
- Computational Materials Design projects

Thank you!

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