Critical Minerals Sustainability

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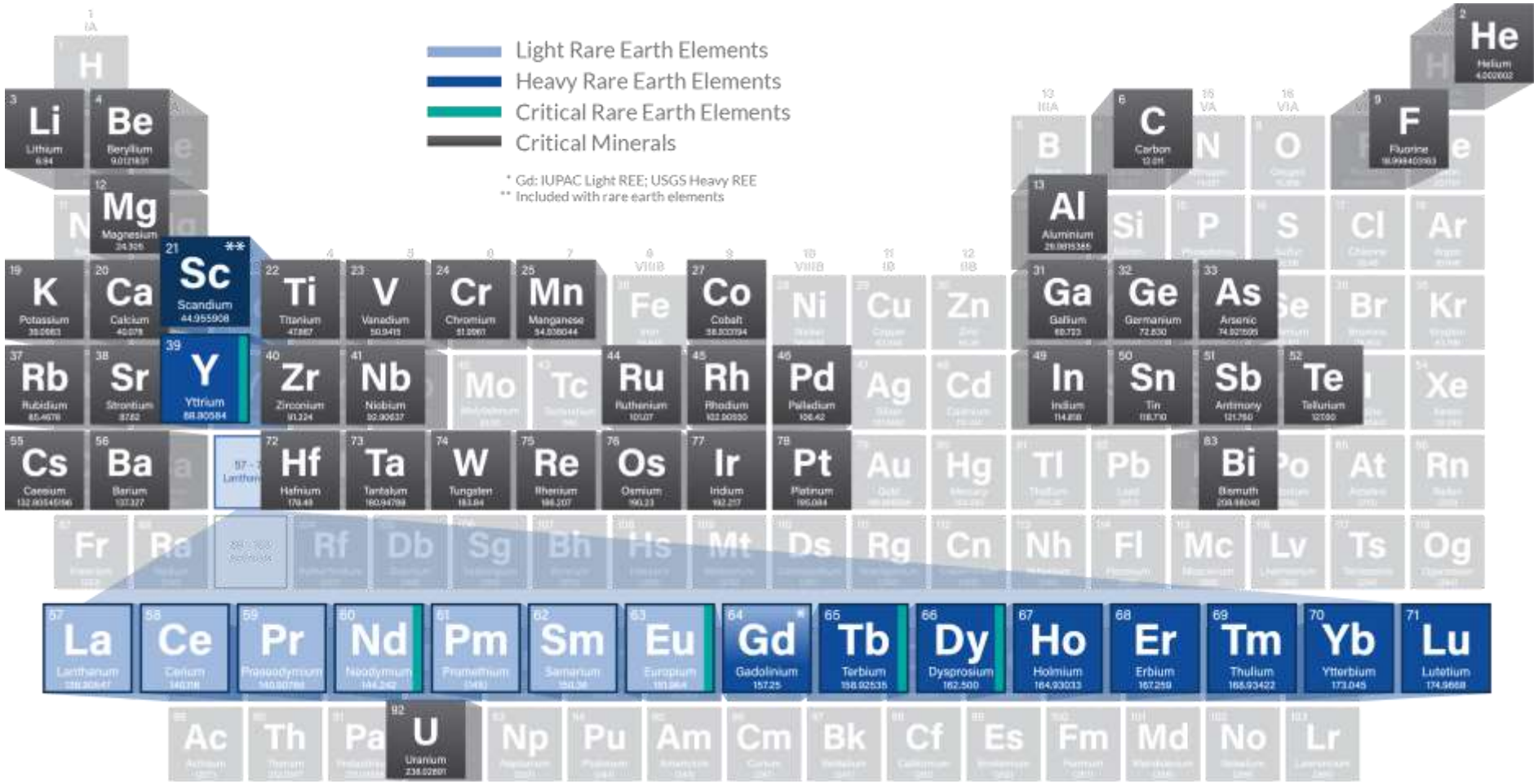
2021 Virtual International
Pittsburgh Coal Conference

Sept 20-23, 2021

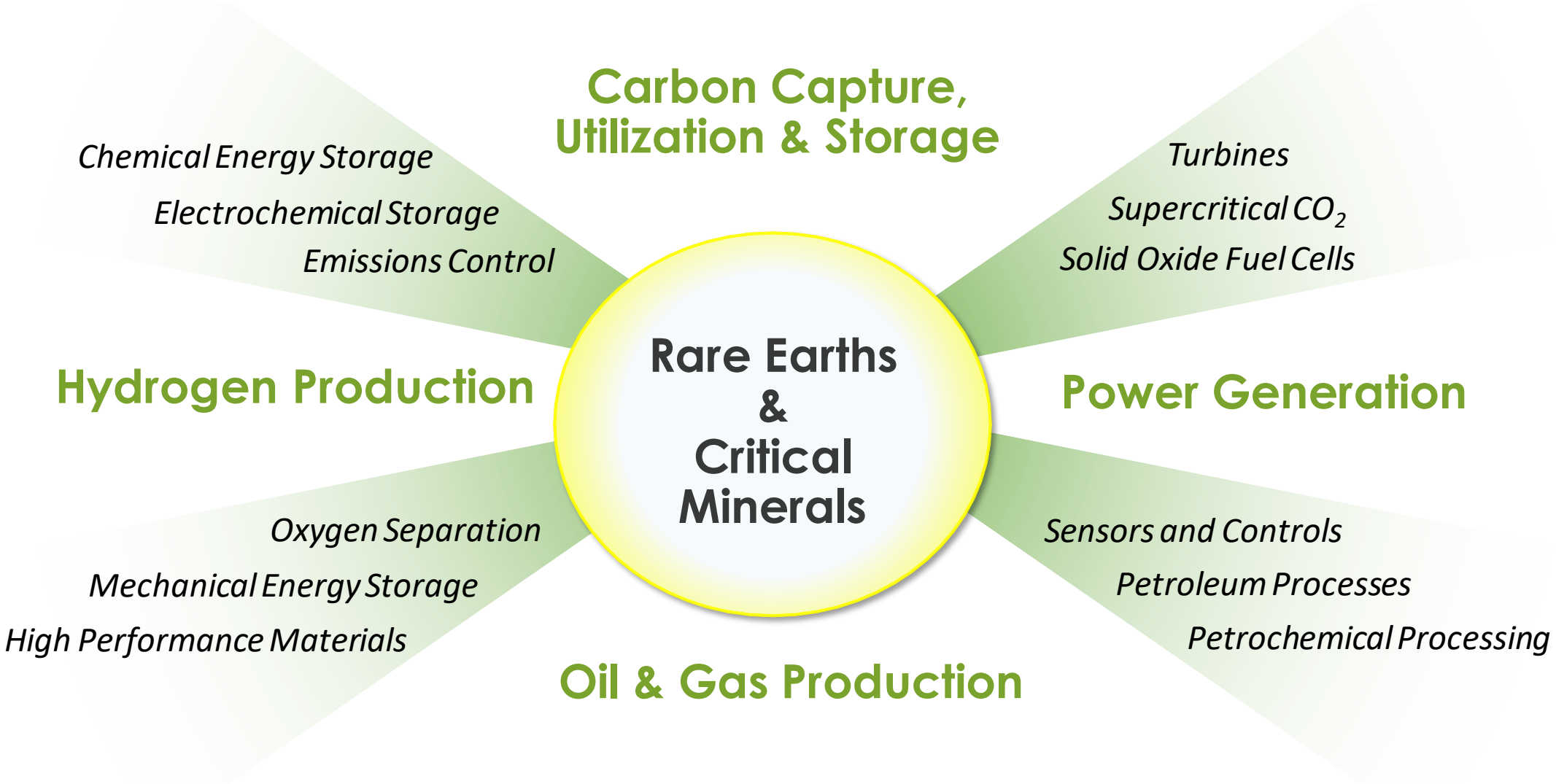
Courtesy of NETL REE-CM Website

NATIONAL ENERGY TECHNOLOGY LABORATORY

Rare Earth Elements and Critical Minerals



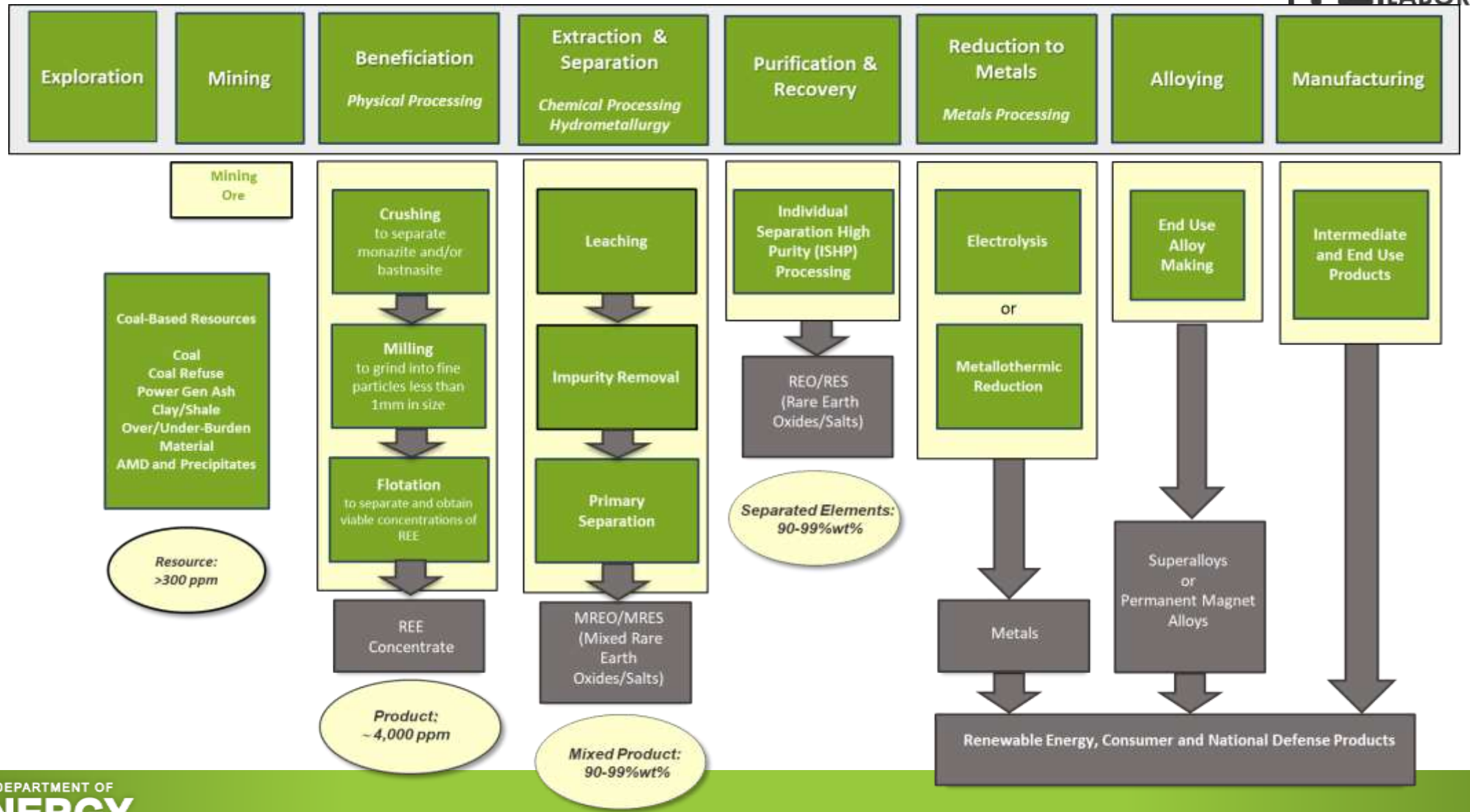
REE-CM Critical Commodity & Technologies



REE-CM Program Goals

Develop/rebuild U.S. leadership role in the extraction and processing technologies that support an economic, environmentally benign, and geopolitically sustainable production of domestic rare earth elements and critical minerals for use in clean energy and national defense applications

REE-CM Supply Chain



REE-CM Program – Commercialization Pathway

COMMERCIALIZATION
Technology available for wide-scale market use

DEMONSTRATION
System demonstrated in operational environment

SYSTEM TESTING
System performance confirmed at pilot-scale

DEVELOPMENT
Technology component validated/integrated

DISCOVERY

Program Initiated 2014

PROSPECTING | PROCESSING | PRODUCTION

University of Kentucky

West Virginia University

Physical Sciences Inc. & Winner Water Services

FOA-2003
REE System Optimization & Efficiency Improvements – **CM Production**

TRL 5-7

***Operational* – 3 First-of-a-Kind Bench & Small Pilot-Scale Facilities**

FOA-1718
Transformational Separation

TRL 3-5

FOA-1202
Conventional REE Separation & Recovery – **80-90% Purity**

RFP 9067 & RFP 10982
Field Prospecting

2015 2020 2025

Enabling Technologies – Sensors, TEA, LCA, REE-SED

REE-CM Program – Feedstock Materials

Unconventional Resources

Acid Mine Drainage; Mineral/Metal Mine Drainage
Legacy Impoundment Materials

Refuse/Tailings from Coal Preparation Facilities

Coal Seam Over/Under-Burden Clay and Shale Materials

Power Generation Ash

Produced Waters – Carbon Capture and Storage & Oil and Natural Gas Produced Brines

Associated Chemical Wastes or Waste Streams

REE-CM Program Focus – Resource Assessment

FOA-2364 – Carbon Ore, Rare Earth and Critical Minerals (CORE-CM) Initiative for U.S. Basins

Address the upstream and midstream REE and CM supply chain and downstream manufacturing of high-value, nonfuel, carbon-based products, to accelerate the realization of the full potential for carbon ores and REE-CM within regional U.S basins

REE-CM Program Focus – Processing

FOA-2003 – Process Scale-Up & Optimization/Efficiency Improvements for Rare Earth Elements (REE) and Critical Materials (CM) Recovery from Coal-Based Resources

Co-Production of CM in Pilot-Scale Facilities

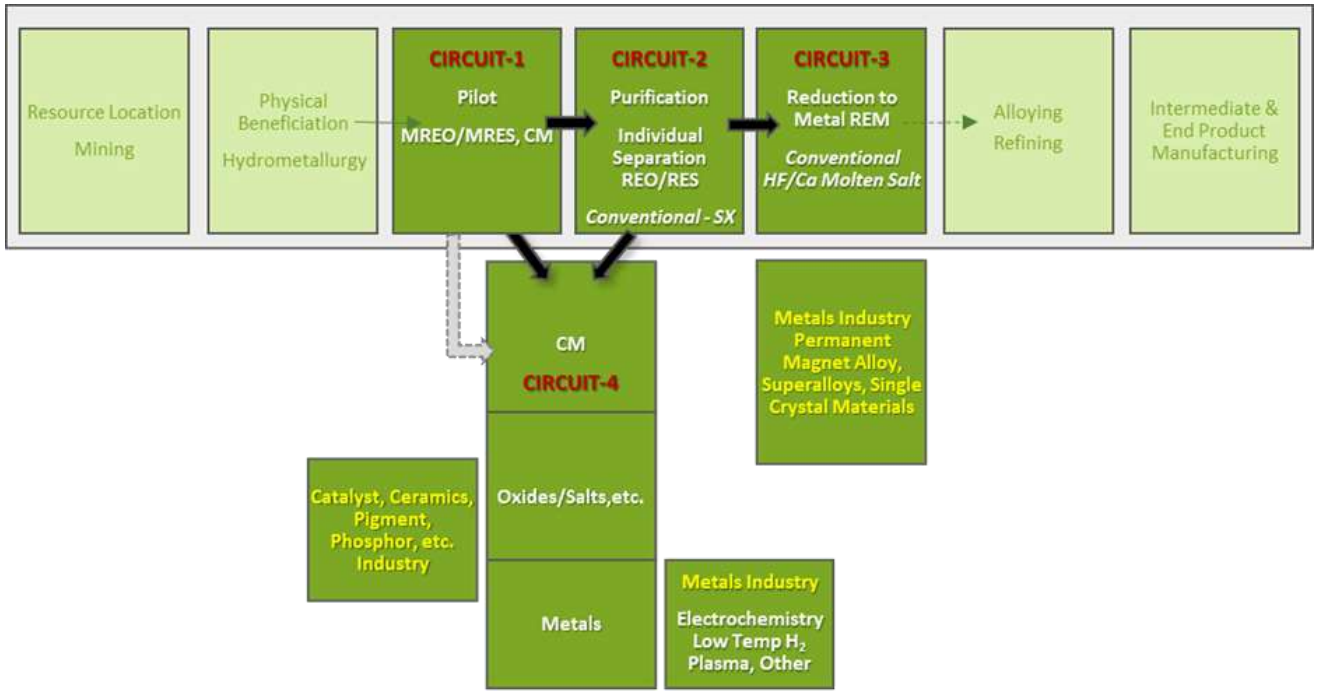
Higher Purity & Larger Quantities

Improved Economics

REE-CM Program Focus – Advanced Processing

FOA-2404 – Advanced Processing of Rare Earth Elements and Critical Minerals for Industrial and Manufacturing Applications

Develop advanced, reduced cost, environmentally benign, midstream, REE and CM separation, purification and reduction to metal processes



REE-CM Program Focus – Production

RFP-89243320RFE000032 – Production of Mixed Rare Earth Oxides (REOs) from Coal-Based Resources

Conduct concept studies focused on the design, construction and operation of an engineering-scale prototype facility that uses unconventional feedstock materials in conventional separation and recovery processes to produce 1-3 tonnes/day mixed rare earth oxides or salts (MREO/MRSE) at a minimum of 75% purity, the majority of which is produced from coal or coal-based resources.

Capabilities for further processing to rare earth metals (REM) at >99% purity were included in the follow-on feasibility (pre-Front End Engineering Design (FEED)) studies.

REE-CM Program – Commercialization Pathway

COMMERCIALIZATION
Technology available for wide-scale market use

DEMONSTRATION
System demonstrated in operational environment

SYSTEM TESTING
System performance confirmed at pilot-scale

DEVELOPMENT
Technology component validated/integrated

DISCOVERY

Program Initiated 2014

PRODUCTION
PROCESSING
PROSPECTING

TRL 7-8
Engineering-Scale Prototype Facility (Planned)
1-3 tonnes MREO/day & CM

TRL 5-7
***Operational* – 2 Additional First-of-a-Kind Small Pilot-Scale Facilities**

FOA-2404
Advanced Processing Phase 1

FOA-2346
CORE-CM Phase 1

RFP
Concept & Feasibility (Pre-FEED) Studies

FOA-2003
REE System Optimization & Efficiency Improvements – CM Production

TRL 5-7
***Operational* – 3 First-of-a-Kind Bench & Small Pilot-Scale Facilities**

FOA-1718
Transformational Separation

TRL 3-5
FOA-1202
Conventional REE Separation & Recovery – 80-90% Purity

RFP 9067 & RFP 10982
Field Prospecting

TRL 9
Commercial Facilities
(Tentative)

2030 – *8,000 tonnes MREO/yr*
2035 – *16,000 tonnes MREO/yr*

2015 2020 2025

U.S. DEPARTMENT OF ENERGY

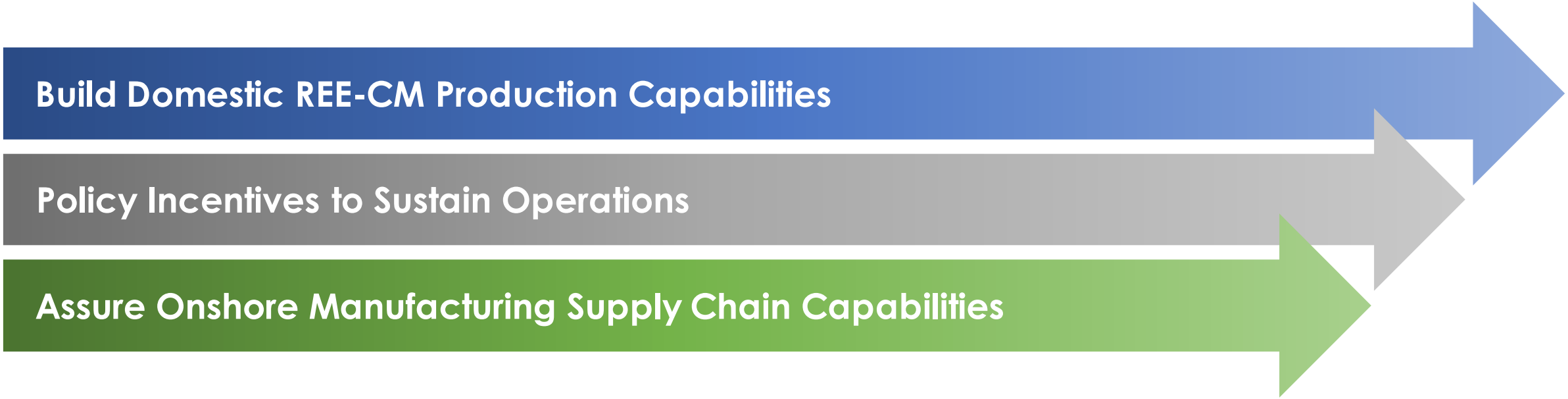
Enabling Technologies – Sensors, TEA, LCA, REE-SED

NATIONAL ENERGY TECHNOLOGY LABORATORY

Program Direction

REE-CM Program – Final Comments

Path Forward



REE-CM Program – Contact Information

Courtesy of NETL REE-CM Website

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National Energy Technology Laboratory

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