2017 DOE Advanced Manufacturing Office Peer Review

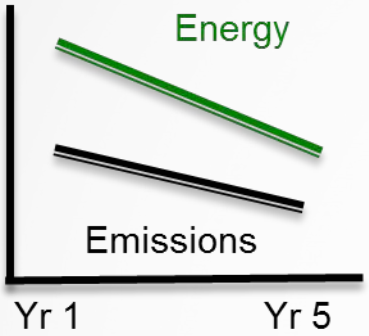
REMADE Institute Overview

Nabil Nasr
Magdi Azer

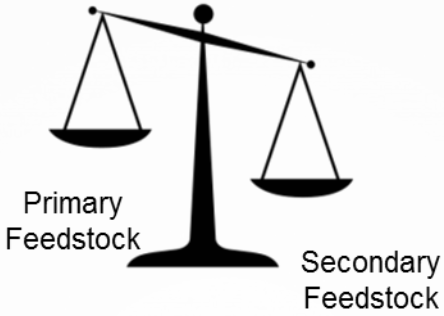
June 14, 2017

DE-EE0007897

REMADE Institute Focus – Early stage applied R&D
to reduce embodied energy & emissions



Reduce Primary Material Use



"Better than Cost and Energy Parity"

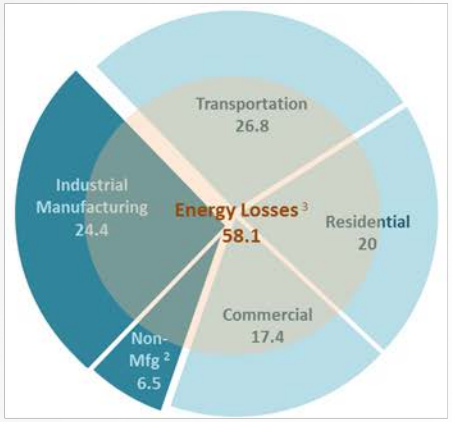
Widespread Application of New Technologies

Will develop technologies that

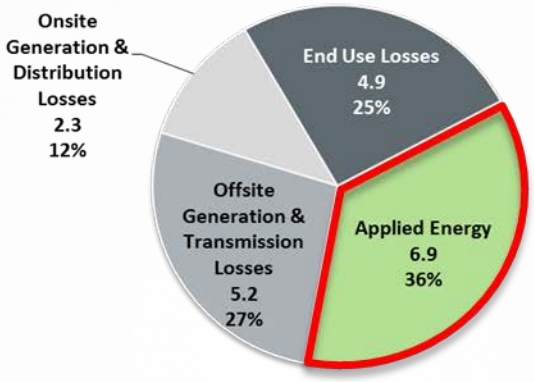
- enable **greater utilization of secondary feedstocks,** which require less energy to produce for key materials (metals, polymers, fibers),
- **reduce primary materials consumption** (and energy lost when they are landfilled)
- achieve feedstock **"better than cost and energy parity"** for key secondary materials,
- promote **widespread application of new enabling technologies** across multiple industries that expand material recycling, recovery, remanufacturing and reuse.

Current Manufacturing Landscape

U.S. Energy Consumption by Sector (2012) - 95.1 Quads[1]

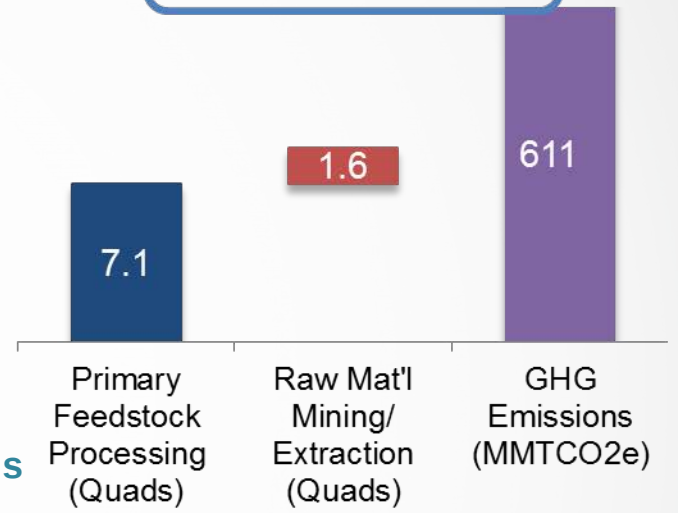


Mfg Energy Consumption (minus feedstocks) – 19.2 Quads



Energy Losses[4] – 12.4 Quads

Polymers, Metals, Fibers, & e-waste



Fibers (paper/composites)

Polymers (plastics)

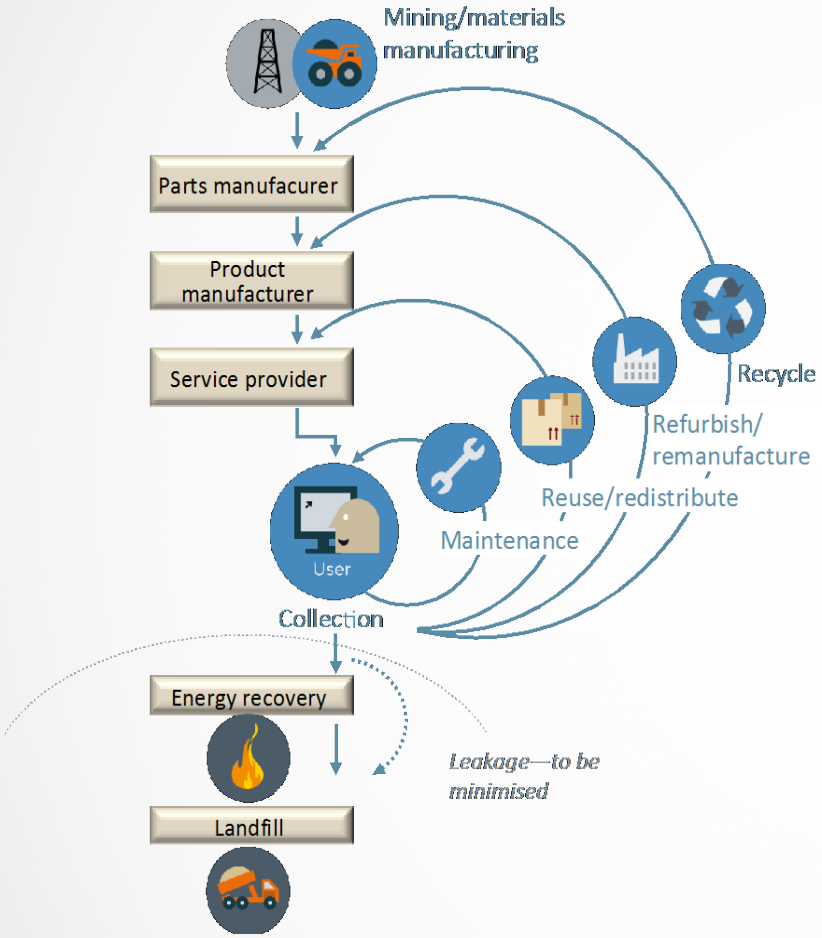
Electronics/e-waste

Metals

Four Material Classes Account for 37% of US Manufacturing Energy Consumption

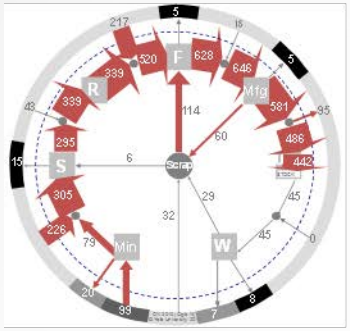
Technical Innovation – Today's Paradigm

Silos, Low Penetration, Slow Progress

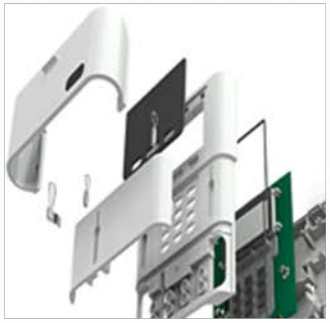


- Systems Analysis
  - No comprehensive lifecycle U.S. data sets for polymers and fibers
- Recycling
  - Typical recycling rate < 28%, challenges with separation and recovery
- Remanufacturing
  - Domestic remanufacturing penetration rate is ~ 2%
- Design
  - Current design tools do not address reuse/remanufacturing considerations
- Manufacturing
  - Manufacturing scrap treated as waste, often down-cycled.

Development of Widespread Technologies



Information Collection & Standardization Tools[1]



Design Tools for Reman, Reuse, Disassembly,

Rapid Sorting of Material Streams

Separation of mixed materials

Removal of Trace Contaminants

Reprocessing of Recovered Materials

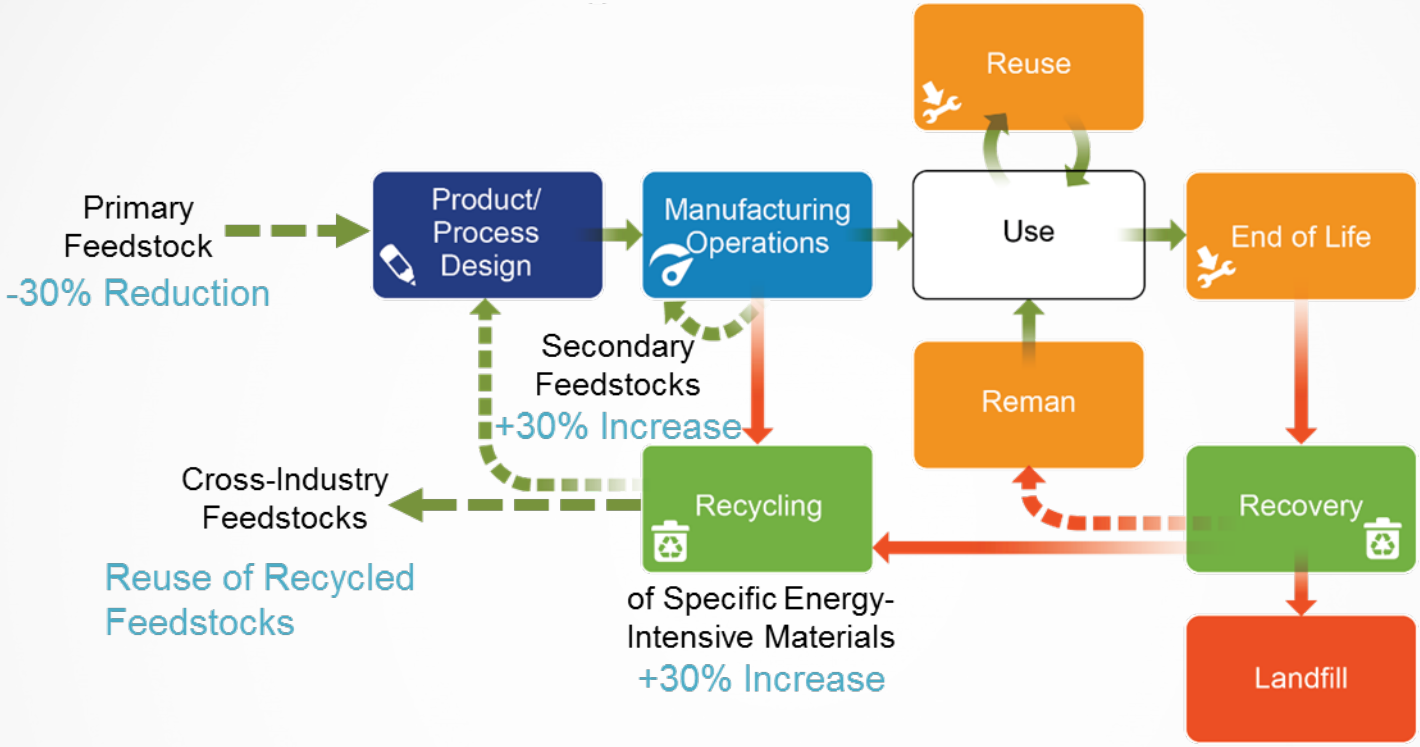
Directed towards innovations that will

- Dramatically reduce the energy required to manufacture key materials, and
- Improve overall manufacturing energy efficiency through increased material reuse, recycling and remanufacturing.

Example of Ni MFA in 2010

REMADE Institute Performance Metrics

Early stage applied R&D focused toward innovations capable of



Embodied Energy Efficiency Improvement

+25% (5 yrs.)
+50% (10 yrs.)

Energy Req'd to Process Secondary Feedstocks

-30% (5 yrs.)
-50% (10 yrs.)

Relative Cost of Secondary Feedstocks

Cost Parity with Primary Feedstocks

Process Demonstrations

10X Primary Feedstock Reduction

20% Decrease in Emissions

Potential REMADE Institute Energy Impact is 1,500 TBTU

REMADE Institute Members

26 Leading Universities

44 Industry Leaders & 26 Associations

7 National Labs

REMADE Institute CY17 Objectives/Milestones

Develop a Technology Roadmap for REMADE

- Compile/publish the draft REMADE Institute Technology Roadmap (Dec.)

Applied Research Projects/Foundational Projects

- Quantify Impacts/Scope of Foundational Projects for Q1'18 launch (Jul.)

Applied Research Projects/Institute Wide Projects

- Issue first REMADE Institute Project Call (Aug.)

Testbeds Integration and Access

- Finalize list of REMADE Institute testbeds (Nov.)

REMADE Foundational Projects

Systems Analysis and Integration

- MFA Landscape and Scenario Development
- Tools and Metrics for Project Impact Evaluation

Design for Reuse and Disassembly

- Design for REMADE Framework

Manufacturing Materials Optimization

- Embodied Energy Reduction in Metal Casting

Remanufacturing, EOL, Reuse

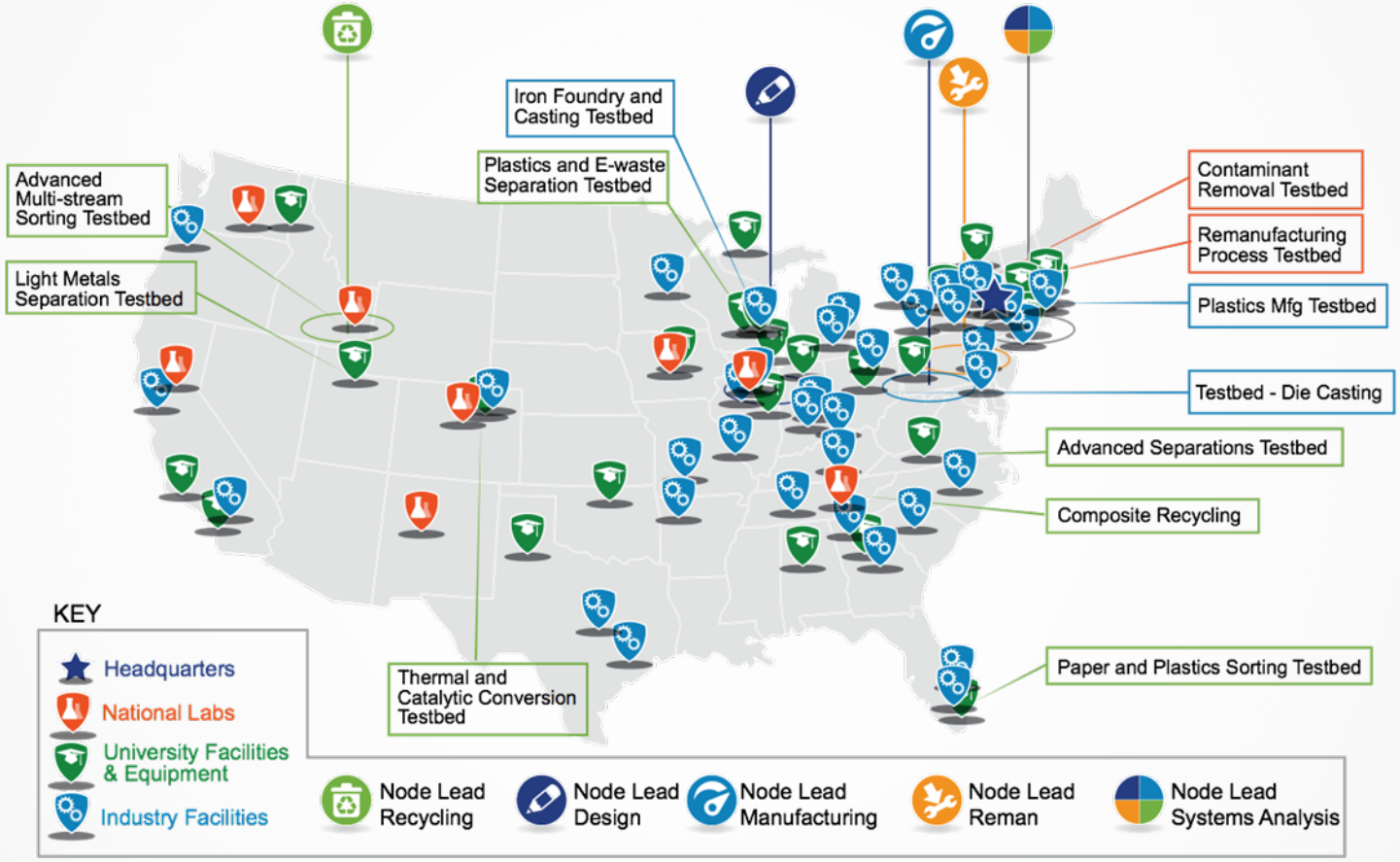
- Advanced Cleaning Technologies for Remanufacturing
- Condition Assessment Of Electronic Modules For Reuse

Recycling and Recovery

- Assessment of the Impact of Single Stream Recycling (SSR) on Paper
- Selective Recovery of Polymers and Residual Metals from E-waste
- Advanced Solid State Eddy-Current Sorting of Light Metals and Alloys

Using Testbeds to Aid Technology Transition

- 12 geographically distributed testbeds* provide mechanism to scale up early stage applied R&D



* Enable feasibility and validation in a relevant environment and are applicable to the four material classes and four material lifecycle stages targeted by REMADE.

REMADE Summary

Timeline

- Institute Start Date – Jan 2017
- Budget Period 1 (BP1) – 1/17–12/17

Budget

- BP1 Budget (CY 2017): $3,223K
  - Total Recipient Share: $1,611K
  - Total Federal Share: $1,611K

- REMADE Institute is the **first comprehensive national investment** targeted at reducing primary material consumption and increasing secondary feedstock utilization.

- Represents a significant opportunity to **reduce energy and emissions** associated with manufacturing of key materials.

- Team of 44 companies, 7 national labs, 26 universities, and 26 trade associations poised to **deliver impact through early stage applied research projects**