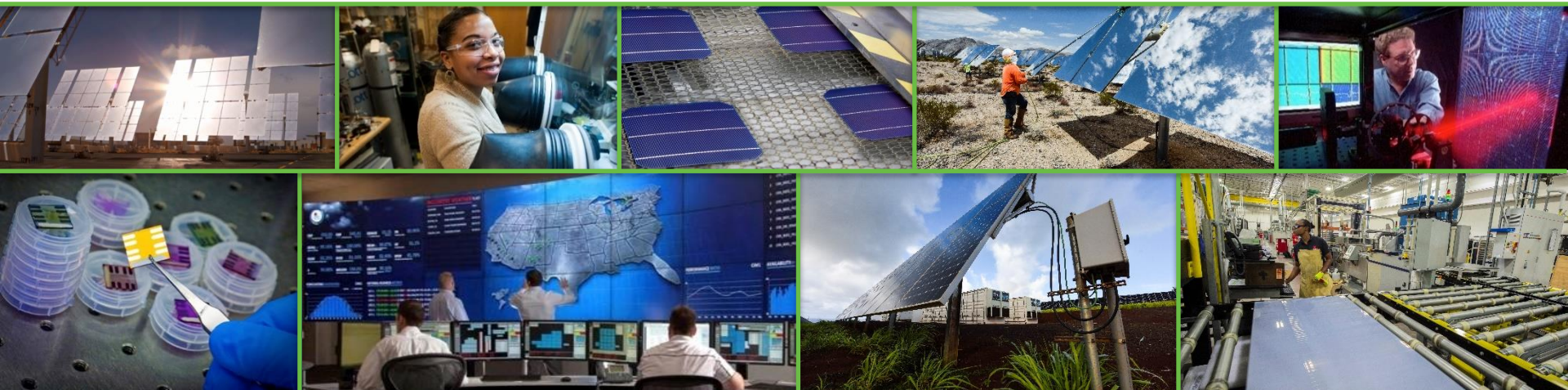
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Solar Energy Technologies Office: Photovoltaics End-of-Life Action Plan Update

Part 3: Federal Agencies Update

October 21, 2024



Agenda

1. **SETO**
   - PV EOL Action Plan
   - PV Environmental Impact
2. **PV EOL Projects**
   - UC San Diego
   - National Renewable Energy Lab
   - SOLARCYCLE
   - EPRI
3. **Federal Agencies Update**
   - Advanced Materials and Manufacturing Technologies
   - Manufacturing and Energy Supply Chains
   - Environmental Protection Agency

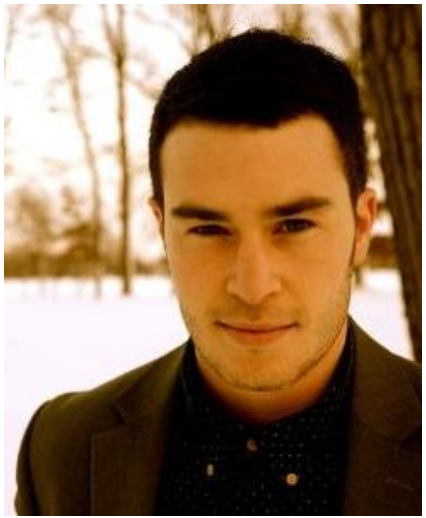
"How else would I keep my solar panels in the sun all day?"

Agency Spotlight

Advanced Materials & Manufacturing Technologies Office (AMMTO)
Allison Robinson Turner

U.S. DEPARTMENT OF ENERGY

Manufacturing and Energy Supply Chains (MESC)
Robert Sozanski



U.S. DEPARTMENT OF ENERGY

Environmental Protection Agency (EPA)
Phoebe O'Connor

EPA United States Environmental Protection Agency

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Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

ADVANCED MATERIALS & MANUFACTURING TECHNOLOGIES OFFICE

Advanced Materials and Manufacturing Technologies Office

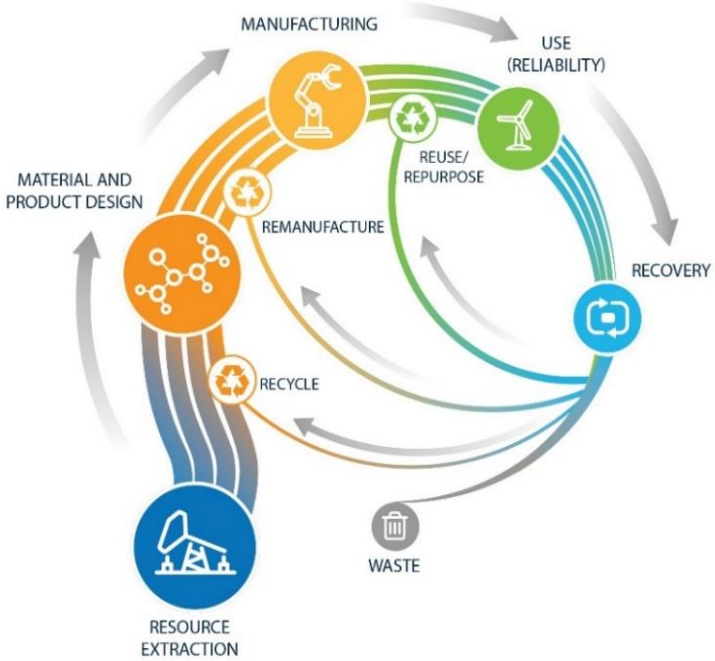
Ally Robinson Turner, PhD
Technology Manager, Circular Economy
allison.robinsonturner@ee.doe.gov

October 21, 2024

Circular Economy: Mission and Context

A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

- **Economy-wide Decarbonization**
  - Circular economy strategies and technologies enable economy-wide decarbonization through material efficiency, which reduces the demand of extracted materials.
- **Supply Chain Innovations**
  - Circular economy approaches, particularly when applied to elements of limited supply needed for clean energy technologies, can help secure domestic supply chains.
- **Manufacturing Competitiveness**
  - With requirements for recycled content and taxes on virgin materials being discussed, cost-effective circular economy solutions will be needed to remain competitive.

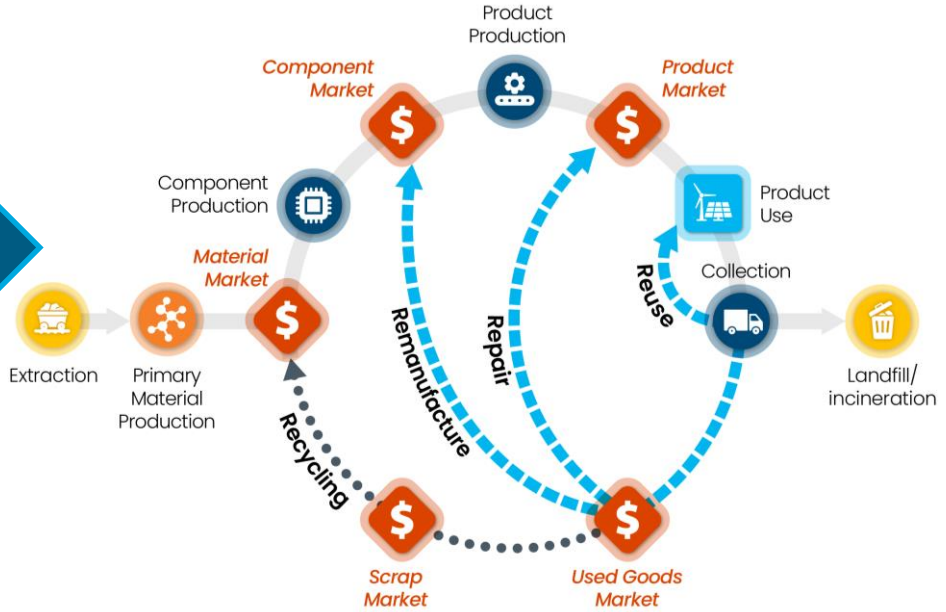


NREL, Circular Economy Model (2022)

Markets are a Key Aspect of the Circular Economy Model

Product and material circularity aims to minimize life cycle impacts though increasing recirculation of products and materials in the economy. This model only works if there are the required markets in place.

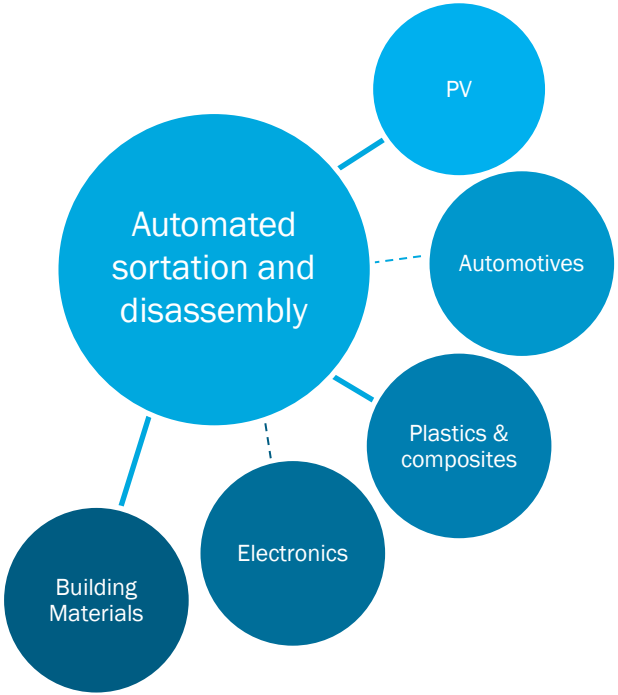
Current “linear economy” model



“Circular economy” model

Developing Crosscutting Technologies for Multiple Product and Material Classes

AMMTO's circularity portfolio spans many products and materials, including PV. This includes strategies for multiple Re-X pathways (e.g. recycling, reuse, repair, remanufacture)



One of AMMTO's focuses in circularity is to develop platform technologies that can be applied to a variety of materials and products.

These include:

- Design for Re-X tools/methodologies
- Advanced sortation and the required sensing and analytics needed
- Supply chain alignment
- Lifecycle analysis data, tools, and capability development

Circularity for Secure and Sustainable Products and Materials: A Draft Strategic Framework

EERE recently released a draft strategic framework with an RFI. We want to hear from you!

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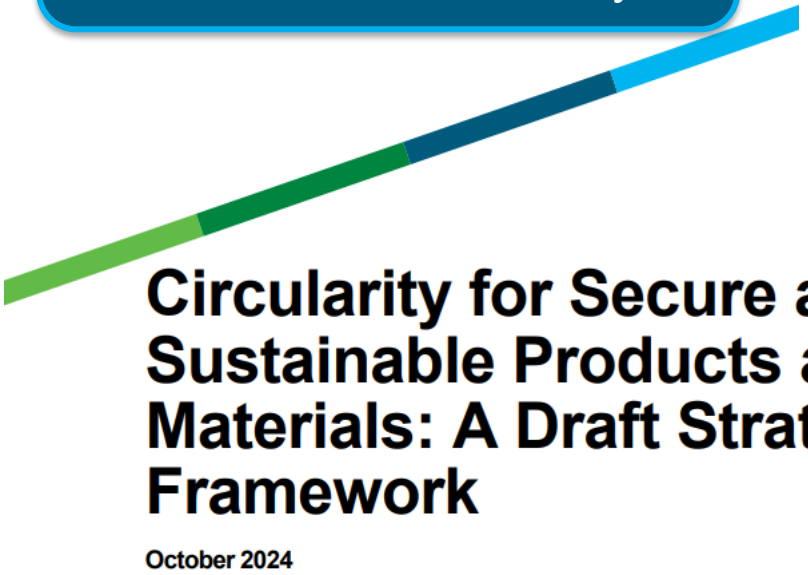


https://www.energy.gov/eere/articles/us-department-energy-solicits-feedback-its-plan-increase-products-and-materials

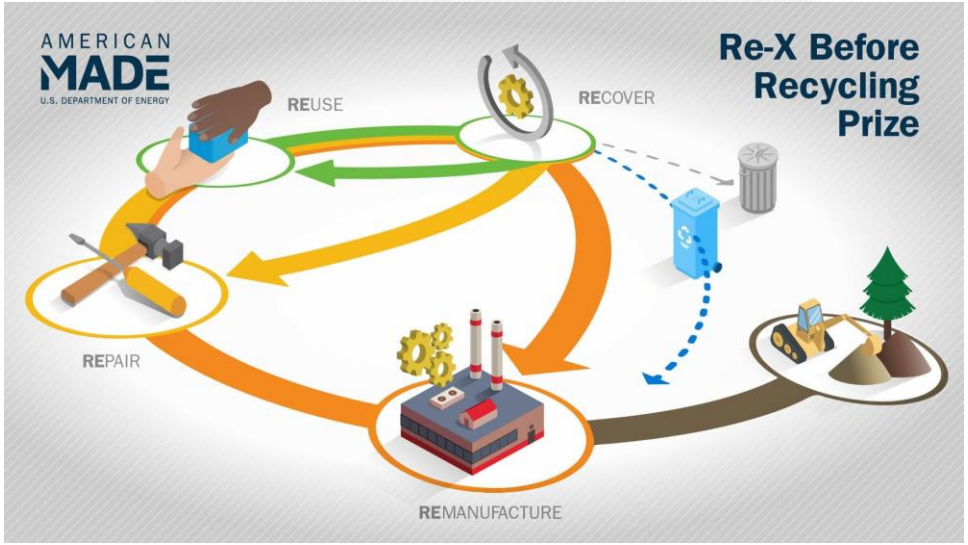
The document discusses:

- Activities across EERE in product & material circularity
- Opportunities, challenges, and enablers to unlock circularity
- A framework for R&D prioritization to drive impact
- The connection of product & material circularity to EERE's mission and to individual office missions
- Future plans related to product and material circularity

AMMTO's Re-X Before Recycling Prize – Phase II is Still Open!

Phase II Application Deadline Tomorrow, October 22!

https://www.energy.gov/eere/ammto/re-x-recycling-prize



Seeking innovations to unlock new or expanded supply chains that can reintegrate end-of-use products into the economy via re-use, repair, refurbishment, remanufacturing, and/or repurposing

Phase I Winners Include Two PV Circularity Projects

- California Product Stewardship Council (CPSC): Solar Panel Reuse Hub
- Electra: Track, Collect, Sort & Transport Used Solar Panels

AMMTO's Electronics Scrap Recycling Advancement Prize (ESCRAP)

Phase II Opens in December! New applicants that did not participate in Phase I are eligible

The prize aims to stimulate innovative approaches that reduce the costs and environmental impact of critical material recovery from electronic scrap (e-scrap), including PV.

https://www.energy.gov/eere/ammto/electronics-scrap-recycling-advancement-prize

MESC

OFFICE OF MANUFACTURING AND ENERGY SUPPLY CHAINS

MESC Program Overview

2024

Robert Sozanski
Senior Supply Chain Deployment Manager
Office of Manufacturing and Energy Supply Chains
U.S. Department of Energy

energy.gov/mesc

The Office of Manufacturing and Energy Supply Chains is focused on the "how" of the energy transition

PURPOSE

To **deliver the *how* of the energy transition** quickly, securely, and equitably

MISSION

The Office of Manufacturing and Energy Supply Chains (MESC) serves as the frontline of clean energy capital deployment to accelerate America's transition to a resilient, equitable energy future via $20B+ of direct investment in manufacturing capacity and workforce development.

VISION

To **eliminate vulnerabilities in US Clean Energy supply chains**, while driving unparalleled social, economic, and environmental impact through our programs & awards

Investing in America's Energy Future

VISION

To **eliminate vulnerabilities in US clean energy supply chains**, while driving unparalleled social, economic, and environmental impact through our programs & awards

Manufacturing Investing

Strengthening and securing the energy supply chains America needs for a secure, clean and equitable energy system

Workforce Investing

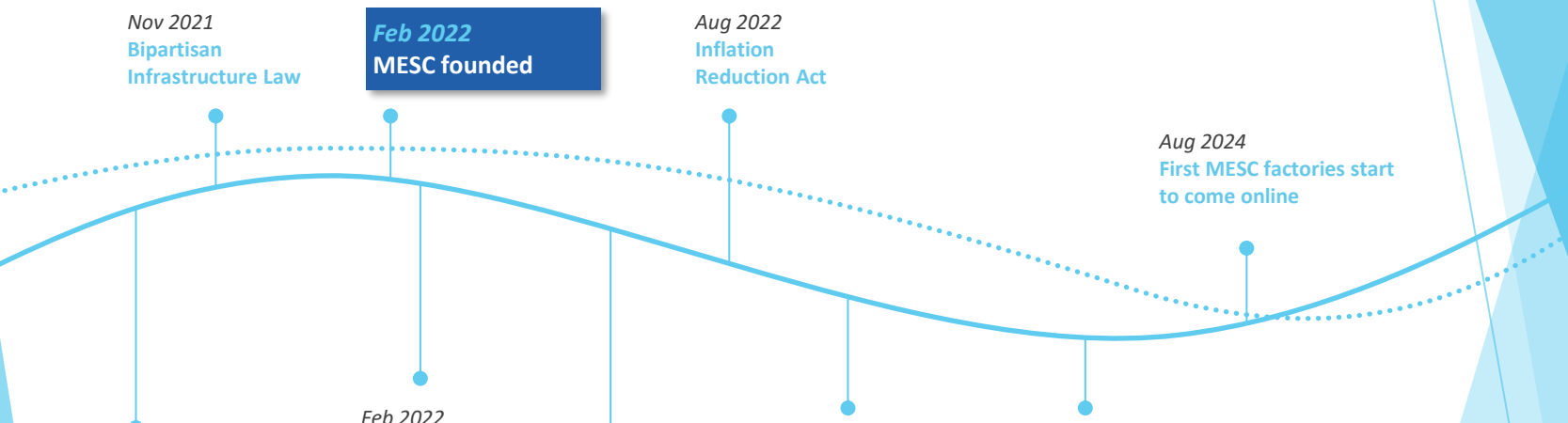
Supporting workforce skills development by directly funding cutting-edge energy manufacturing training programs

Manufacturing Analytics Backbone

Robust modeling to guide and support DOE strategy and investments, private sector collaborative investments, and federal policy recommendations

MESC
OFFICE OF MANUFACTURING AND ENERGY SUPPLY CHAINS

MESC was founded in 2022 to secure and strengthen critical manufacturing and energy supply chains



Feb 2021
E.O. 14017

E.O. directing a whole-of-government approach to assessing vulnerabilities in, and strengthening the resilience of, critical supply chains

Nov 2021
Bipartisan Infrastructure Law

Feb 2022
Securing America's Clean Energy Supply Chain Report

Report in response to E.O. 14017 outlining the USG's plan to build a secure energy sector industrial base

Feb 2022
MESC founded

Jun 2022
Biden invokes DPA

Authorizes DOE to utilize the Defense Production Act to accelerate domestic production of key energy technologies

Aug 2022
Inflation Reduction Act

Oct 2022
First investments announced

MESC selects 20 companies across 12 states, investing $2.8B into the first round of battery manufacturing

Jun 2023
First MESC groundbreaking

Anovion Technologies breaks ground in Georgia on facility supported by MESC investment through BIL funding

Aug 2024
First MESC factories start to come online

MESC's investment activities are underpinned by robust analytical modeling

MESC's Core Functions

Manufacturing Investing

Strengthening and securing supply chains needed to modernize the nation's energy infrastructure, while supporting a clean and equitable energy transition

Workforce Investing

Supporting workforce education and training through the direct funding of cutting-edge energy manufacturing programs

Supply Chain Analytics Backbone

Robust modeling to guide and support DOE strategy and investments, private sector collaborative investments, and policy recommendations to broader USG

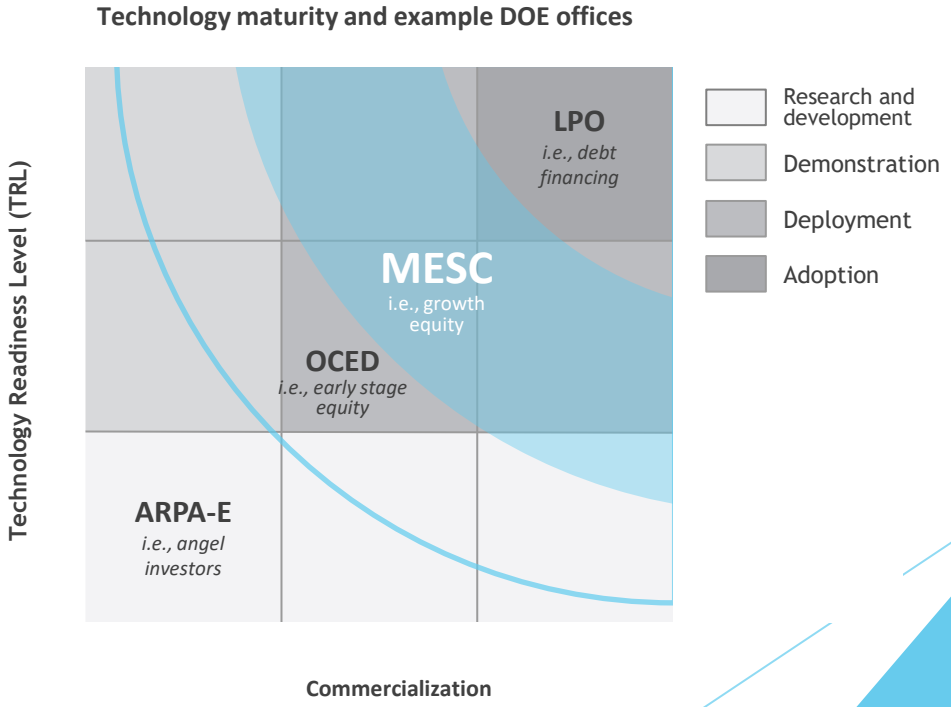
Our **strategic investment in critical materials, workforce, and essential manufacturing** enables DOE's other major project offices (OCED, GDO, etc.) by **de-risking the supply chains** for transmission, hydrogen, carbon capture, and other emerging clean technology projects.

MESC operates in late-stage technology development, driving large-scale deployment of new technologies

The Office of the Undersecretary for Infrastructure (S3) contains the commercial arm of the DOE

S3 has a spectrum of capital to invest in clean energy ventures as they scale, from non-dilutive equity (e.g., MESC), to debt financing (e.g., LPO)

Our capital complements private sector capital, coming in alongside the private sector to augment the speed and scale of the US clean energy transition



MESC's impacts to-date

$3.9B+ private sector investment catalyzed

9,205 construction and permanent jobs created

38% of investments in energy communities or J40 communities

1000+ students trained annually

1.3M+ EVs enabled annually

$54.5M+ in benefits flowing to communities through Community Benefits Plans

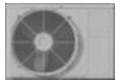
MESC
OFFICE OF MANUFACTURING AND ENERGY SUPPLY CHAINS

Manufacturing & Energy Supply Chains

Accelerating America's transition to a resilient, equitable energy future by strengthening and scaling clean energy supply chains through direct investments in ***manufacturing capacity, workforce development and*** cutting-edge ***energy supply chain vulnerability and innovation analysis.***

Domestic Manufacturing Conversion Grants ($2 B)

Industrial Assessment Centers Implementation Grants ($400 M)



Extended Product System (EPS) Rebate Program & Energy Efficiency + Transformers Rebate Program ($20 M)

Qualifying Advanced Energy Project Credit ($10 B)

Advanced Manufacturing and Recycling Grants ($750 M)

Battery Materials Processing and Battery Manufacturing Grants Round II ($6 B)

State Manufacturing Leadership Program ($50 M)

Advanced Energy Manufacturing and Recycling Grant Program (BIL 40209)

Advanced Energy Property Projects

Projects to establish, re-equip, or expand facilities to produce or recycle clean energy products

Greenhouse Gas Emission Reduction Projects

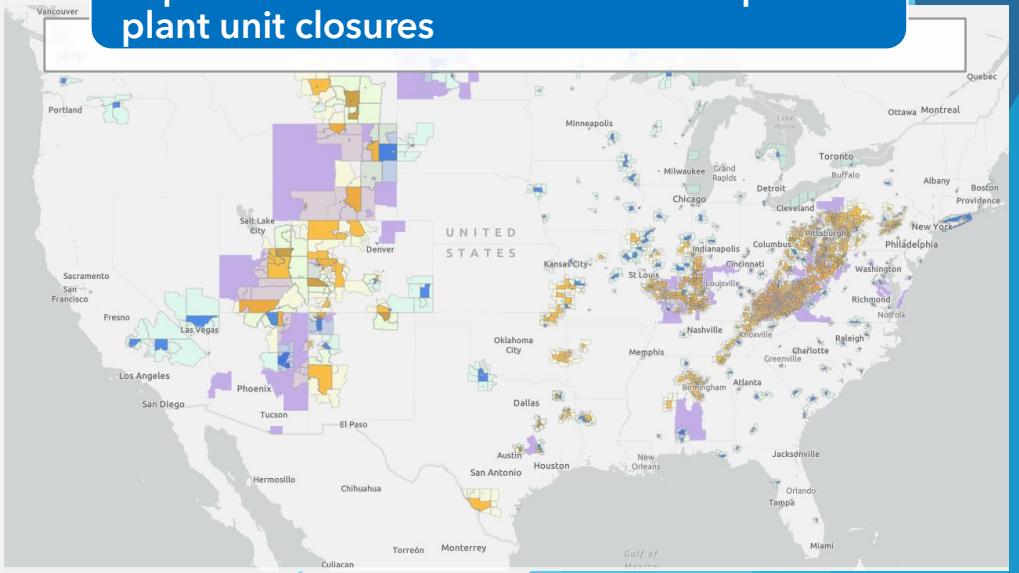
Projects to establish, re-equip, or expand industrial/manufacturing facilities with equipment designed to reduce GHG emissions through:

- *Energy efficiency and industrial waste reduction technologies*
- *Low- or zero-carbon heat systems;*
- *Carbon capture, transport, removal, utilization, and sequestration / storage;*
- *Manufacturing low embodied carbon materials and*
- *Other industrial technologies that reduce greenhouse gas emissions substantially below current best practices.*

$750 million in funding from the Bipartisan Infrastructure Law

Benefiting small- and medium-sized manufacturing firms

Projects in communities that have experienced coal mine or coal-fired power plant unit closures



Qualifying Advanced Energy Project Credit (48C)

Advanced Energy Property Projects

Projects to establish, re-equip, or expand facilities to produce or recycle clean energy products

Greenhouse Gas Emission Reduction Projects

Projects to re-equip existing industrial/manufacturing facilities with equipment designed to reduce the GHG emissions of a facility substantially below current best practices through:

- *Energy efficiency and industrial waste reduction technologies*
- *Low- or zero-carbon heat systems;*
- *Carbon capture, transport, removal, utilization, and sequestration / storage; and*
- *Other industrial technologies that reduce greenhouse gas emissions substantially below current best practices.*

$10 Billion in funding from the Inflation Reduction Act

Tax credit of up to 30% of qualified investments for certified projects

$4 billion set aside for projects in communities that have experienced coal mine or coal-fired power plant unit closures

Industrial Assessment Center (IAC) Implementation Grants

- $400M in funding available through FY 2026 ($80M made available to date for first year of program operation)
- Grants awards of up to $300,000 per manufacturer (covering one or multiple projects), at a 50% cost share
- Eligibility exclusively for small- and medium-sized[1] manufacturing firms & water treatment facilities
- To address recommendations by IACs, DOE Combined Heat and Power TAPs, or other assessments deemed equivalent by DOE

- **The grant application period is now open year-round**, with quarterly application reviews starting on December 31, 2023
- Request an assessment at https://iac.university/
- The program is hosting monthly office hour sessions to answer any questions starting on October 19; register at **https://energywerx.wufoo.com/forms/m1hay6be0bludmj/**
- **Keep an eye on https://www.energy.gov/mesc/industrial-assessment-centers-iacs for updates**

1. Small- and medium sized manufacturer is a firm with: a gross annual sales of less than $100M, fewer than 500 employees at the plant site, & annual energy bills between $100K - $3.5M

Next Steps: Connect with MESC

- LinkedIn: Office of Manufacturing and Energy Supply Chains, U.S. Department of Energy: Overview | LinkedIn
- Website: Office of Manufacturing and Energy Supply Chains | Department of Energy
- Email: MESC@hq.doe.gov
- Phone: (202) 586-5000
- Subscribe: DOE Office of Manufacturing and Energy Supply Chains (govdelivery.com)
- Consult our map of eligible communities for 40209 and 48c

EPA Efforts on End-of-Life Solar Panel Management

October 21, 2024
Phoebe O'Connor and Mary Beth Sheridan
U.S. EPA Office of Resource Conservation and Recovery
SETO Photovoltaics End-of-Life Action Plan Update

Overview

- Management of Solar Panels under RCRA
- Solar Panel Universal Waste Proposed Rulemaking
- New Solar Panel Recycling FAQs

The Resource Conservation and Recovery Act

- EPA regulates hazardous waste under RCRA
  - Requirements for entities that generate, transport, treat, store, and dispose of hazardous waste
- Some solar panels meet the criteria to be regulated as hazardous waste under the RCRA toxicity characteristic
  - Usually due to lead content
  - Does not mean that solar panels are hazardous during use
- EPA is addressing this emerging waste stream
  - Initiating new proposed rulemaking
  - Web guidance

Are Solar Panels Hazardous Waste?

- Hazardous waste determinations are made using analytical testing (Toxicity Characteristic Leaching Procedure) and/or generator knowledge
- Many solar panel manufacturers and designs are on the market
  - Can't make a blanket determination for all solar panels
- Making determinations on individual solar panels may also be difficult
  - Representative sampling difficulties can make TCLP testing a challenge
  - Obtaining manufacturer information on the lead content of a solar panel to use as generator knowledge may also be difficult
- Solar panels that are not hazardous waste at end of life are not subject to federal hazardous waste requirements
  - State laws may be more stringent

Current Options for Solar Panel Management Under RCRA

- Recycling
  - Solar panels that are hazardous waste and sent for recycling may be managed under the transfer-based exclusion (currently available in 36 states and territories)
    - Must be sent to a recycler that has a RCRA permit or financial assurance, among other requirements found at 40 CFR 261.4(a)(24)
- Disposal
  - Solar panels that are hazardous waste cannot be disposed of in municipal solid waste or construction and demolition landfills
    - Must be disposed in a hazardous waste landfill after treatment

Universal Waste Proposed Rulemaking

- EPA is developing a proposed rule under the RCRA universal waste regulations (40 CFR part 273) to streamline the management of solar panels that are hazardous waste
  - The rule will simplify management for system owners (“handlers”) by providing additional storage time and allowing solar panels to be shipped without a manifest
  - Provisions are designed to encourage handlers to accumulate and send solar panels for recycling
  - Material must go to a RCRA-permitted recycler or disposal facility, or a facility that does not store prior to recycling
- If finalized, the rule will allow handlers to manage solar panels as universal waste without making a hazardous waste determination

Universal Waste Proposed Rulemaking cont'd

- States are not required to adopt universal waste regulations, but state adoption is typically high
  - California and Hawaii have already added solar panels to their state universal waste regulations
  - Three other states are currently considering it
- The rule schedule is available in the Fall 2024 Unified Regulatory Agenda
  - Proposed rule is estimated to be published in summer 2025
- More information is available on the EPA webpage for the rule

Solar Panel Webpages

- Solar panel FAQs **(new)**
  - Fifteen new FAQs on solar panel recycling, solid and hazardous waste determinations, and transport, including:
    - Is a solar panel a solid waste when a generator reuses or repairs it or when they send it for evaluation for reuse or repair?
    - Does the definition of legitimate recycling apply to solar panel recycling?
    - How can a generator use acceptable knowledge to make a hazardous waste determination?
- Solar panel waste management
- Solar panel recycling

Thank you!

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Learn About Upcoming Funding Opportunities

EERE Funding Opportunity Updates

Promotes the Office of Energy Efficiency and Renewable Energy's funding programs.

SIGN UP NOW:

energy.gov/eere/funding/eere-funding-opportunities

SETO Newsletter

Highlights the key activities, events, funding opportunities, and publications that the solar program has funded.

SIGN UP NOW:

energy.gov/solar-newsletter