



MARYLAND ZERO EMISSION

Electric Vehicle Infrastructure Council

July 24, 2024

Agenda

- Welcome and Announcements
- Public Comments
- Executive Order on Implementing Maryland's Climate Pollution Reduction Plan
- EV Batteries and Recycling
- Is U.S. Battery Recycling Ready for Millions of EV's?
- Utility 2024 Highlights
- Closing Remarks



Welcome and Announcements

Deron Lovaas, ZEEVIC Chair & MDOT Chief of Environment and Sustainable Transportation

ZEEVIC Member Welcome



Emily Soontornsaratool

ZEEVIC Seat: DGS Secretary's Designee

Affiliation: Maryland Department of General Services (DGS)

Maryland By The Numbers

EVs registered in Maryland last month



Maryland By the Numbers*:



108,584
Registered EVs



17.61
EVs per 1,000 people



1,664
Charging
Stations

4,748
Ports



0.77
Ports per 1,000 people



23
Alt. Fuel Corridors

**As of June 30, 2024*

Announcement - DGS

- DGS Secretary Atif Chaudhry participated in the ribbon-cutting ceremony marking the installation of the **200th electric vehicle charging port** at the Ellicott City District Courthouse and Multi-Service Center on 7/16. An additional 82 state-owned charging ports are under construction at various state facilities.
- NASPO Awards: 13 new awarded master contracts through NASPO for EV Charging Equipment and Services. Contracts can be utilized by local governments, universities, community colleges, and eligible non-profits.



Product Categories		
ABM AutoFlex Blink Connected Kerb District Fleet EO Charging ezVoltz InCharge Energy IoTecha National Car Charging OpConnect Winn-Marion ZEF Energy	 Category 1 Level 2 – EV Chargers (Hardware/Software/Support Services)	 Category 2 Level 3 – DC Fast Chargers (Hardware/Software/Support Services)

Announcement - DGS

- New EVAL Gold Certifications for State Sites

DGS has received Gold level Electric Vehicle Adoption Leadership Certifications from Forth Mobility for a total of 15 DGS-owned locations across the state including courthouses and office buildings.

- EVAL is a national workplace charging certification program that provides recognition and technical assistance to organizations supporting the adoption of clean transportation.



Announcement - MEA

Rebates

- Electric Vehicle Supply Equipment Rebate Program (EVSE)

Grants & Loans

- MHD ZEV's Grant Program
- Open Energy Grant Program

Programs/Technical Assistance

- Maryland Clean Cities and Communities Coalition – tech assistance
- Empower Program

Future Programing: School Bus Electrification and Multifamily Unit EVSE program.



MHD Awardees List – Pending Approval	
Awardee	Type
Anne Arundel County Public Schools	On Road
Capital Logistics	On Road
Einride	On Road
Frederick County	On Road
Johns Hopkins University	On Road
Jubb's Bus Service Inc	On Road
Montgomery County On Road	On Road
New Carrollton	On Road
Savers	On Road
Sysco	On Road
Black Ankle Vineyards	Off Road
L&J Processing	Off Road
Linganore Wines	Off Road
Montgomery County Off Road	Off Road

**ELECTRIC VEHICLE
WEBINAR SERIES**
Explore EVs and EVSE basics






Thursday August 1st 2:00-3:00 ET
Webinar 1: The basics of EVs: How they work, the benefits of driving electric, and the different types of EVs available.

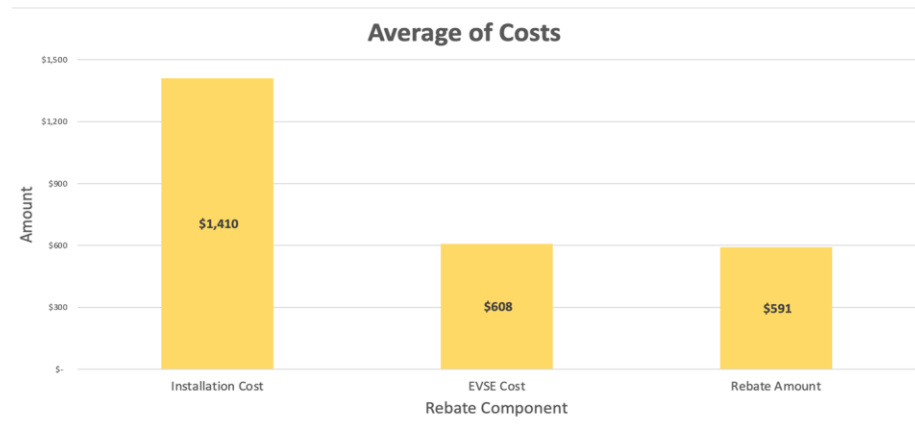
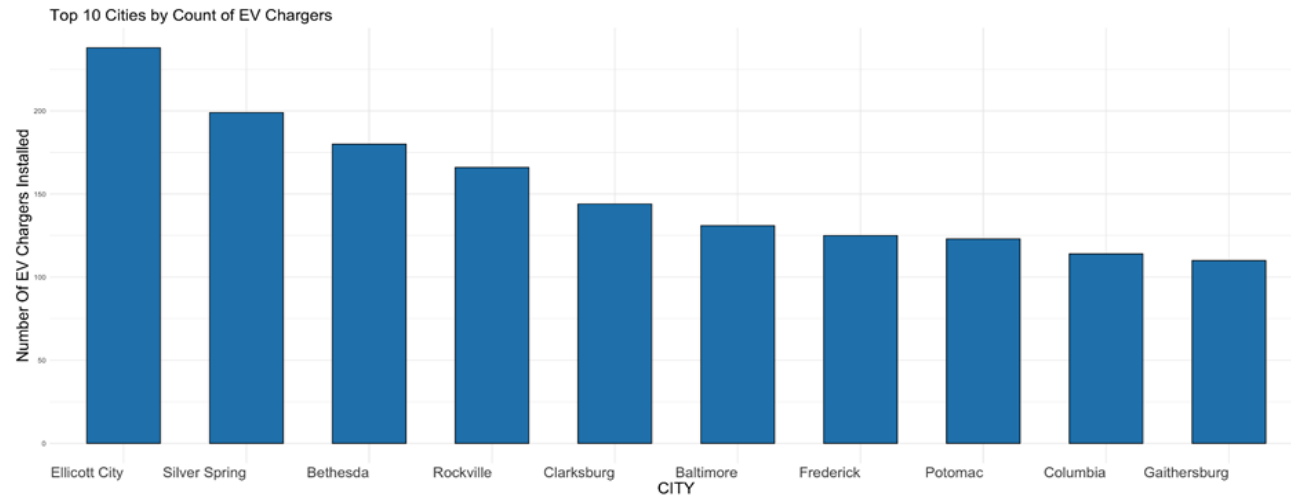
Tuesday August 13th 10:00 – 11:00am ET
Webinar 2: EV charging: Understanding different charging options, how to find charging stations, and how to charge your EV at home.

Thursday August 29th 9:00 – 10:00am ET
Webinar 3: EVs for fleets: How businesses can benefit from electrifying their fleets, including cost savings, environmental benefits, and improved efficiency.

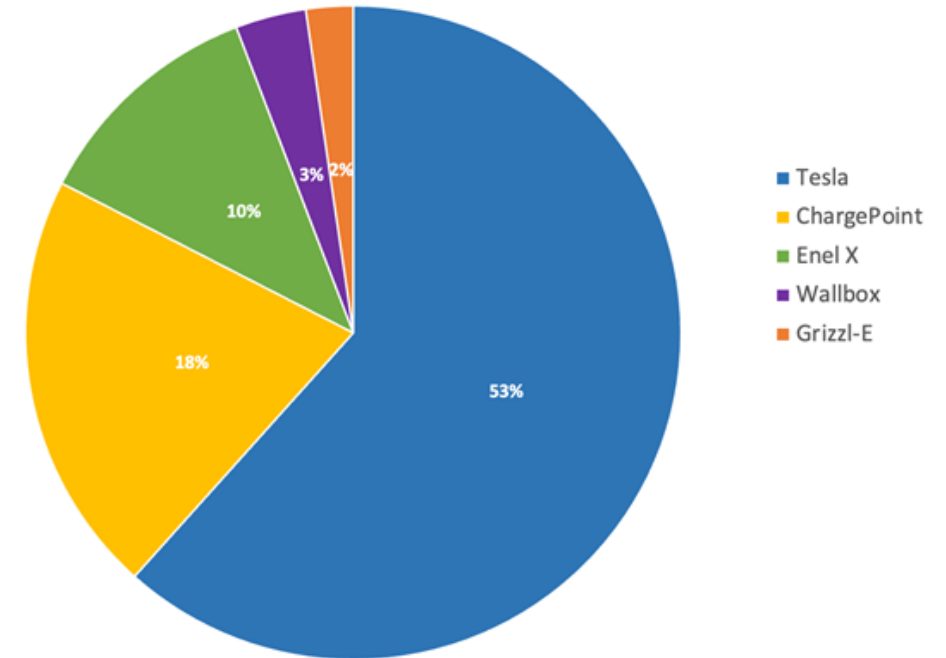
For more info visit <https://energy.maryland.gov/transportation/Pages/incentives.aspx>

Announcement - MEA

- EVSE Rebate - Statistics



Top 5 EV Chargers in MD (by Manufacturer)



Announcement – EVADC



- EVADC holds public events on a regular basis. Our complete schedule is available at <https://evadc.org/Events>
- Two key partners through early October are:



Avanza, an initiative of Citizen Energy, focuses on bilingual EV education and deploying chargers for use in multifamily housing.



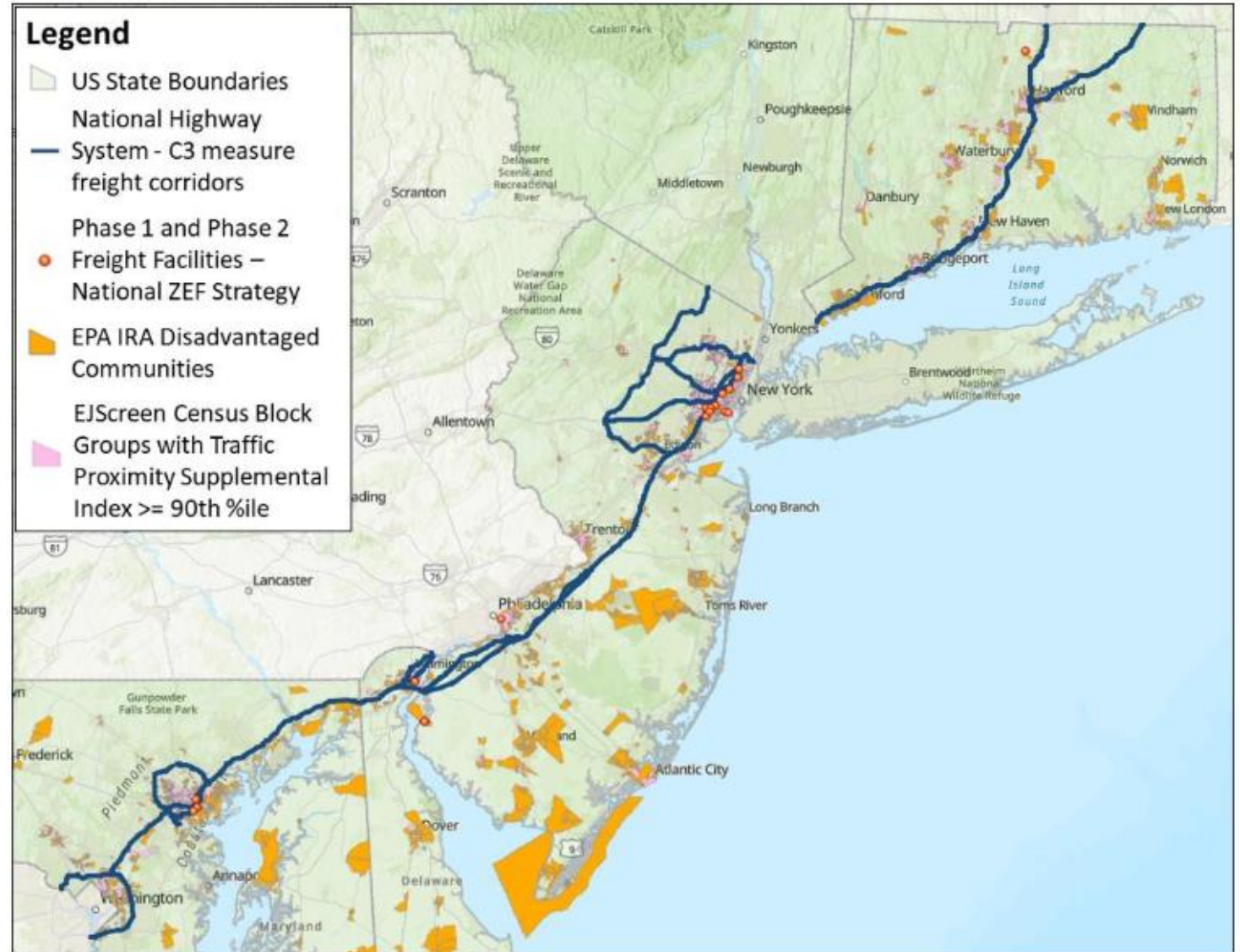
National Drive Electric Week is a nationwide focus on events that bring electric vehicle awareness to everyone. Hundreds of event, large and small, will be held across the U.S. between September 27 and October 6, 2024.



Announcement - MDOT

Clean Corridor Coalition (NJ-CT-DE-MD)

- Climate Pollution Reduction Grant (CPRG) Award: \$249 Million
- For deployment of EV Charging Infrastructure for commercial medium- and heavy-duty (MHD) zero emission vehicles (ZEVs) traveling along the I-95 freight corridor
- In Maryland, [\\$78 Million for 8 Charging Sites](#)
- The grant supports the Clean Trucks Act of 2023, enabling MD to set sales targets to increase Zero Emission MHD vehicles, starting in 2027.



Announcement - MDOT

NEVI Program Update

Round 1 Conditional Awards Issued July 10th

- 23 sites spanning 15 counties
- 130 new DCFC ports expected
- Sites include travel centers, shopping malls, gas stations and convenience stores
- Leverages over \$12.1M in federal funds and \$5.6M in private match
- Projects to begin operations by Fall 2025

Read Governor Moore's press release about the conditional awards [here](#).



Announcement - MDOT

NEVI Program Update

Webinar Presentations and Q&A Available Online

- Three repeating webinars hosted in June about vehicle electrification in Maryland and the NEVI Program
- Goals: Increase public awareness and gather feedback through interactive polling
- Over 250 participants; 77% found informative

View the presentations and comprehensive Q&A on our website [here](#).



Maryland National Electric Vehicle Infrastructure Webinar

June 2024

MARYLAND ZERO EMISSION
Vehicle Infrastructure Plan

MDOT
MARYLAND DEPARTMENT OF TRANSPORTATION

Public Comments





Executive Order on Implementing Maryland's Climate Pollution Reduction Plan

Meghan Conklin, Maryland's Chief Sustainability Officer



EXECUTIVE ORDER

01.01.2024.19

LEADERSHIP BY STATE GOVERNMENT:
IMPLEMENTING MARYLAND'S
CLIMATE POLLUTION REDUCTION PLAN



GOVERNOR.MARYLAND.GOV

“Addressing the climate crisis cannot be the
work of a single department;

If we want to protect our environment and
grow opportunity, we need to take action now;

We need to ensure that we leave no one behind
in the transition to clean energy.”

- Gov. Wes Moore



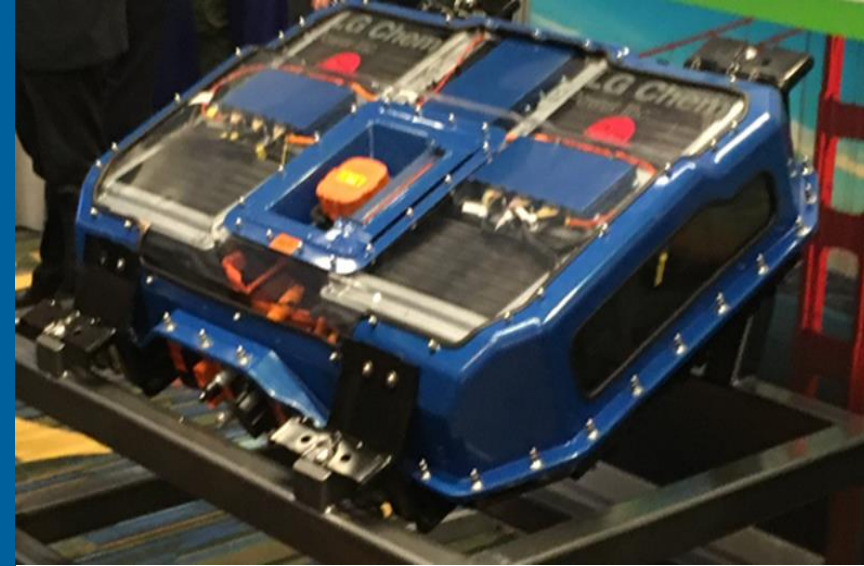
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EV Batteries and Recycling

Linda Gaines, Argonne National Laboratory

EV BATTERIES AND RECYCLING



Linda Gaines

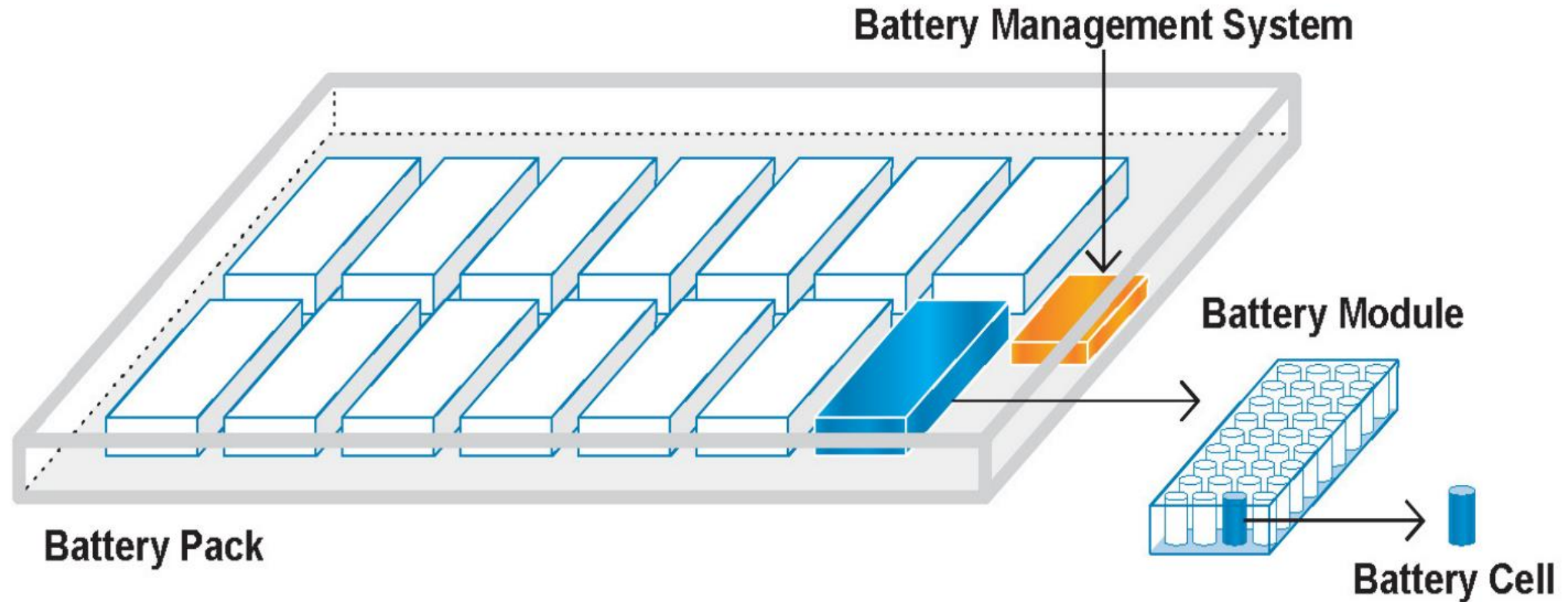
Transportation Systems Analyst
Energy Systems and Infrastructure Analysis Division
Argonne National Laboratory
lgaines@anl.gov



July 24, 2024

LARGE EV BATTERY IS BUILT FROM SMALLER PIECES

Each manufacturer has different designs



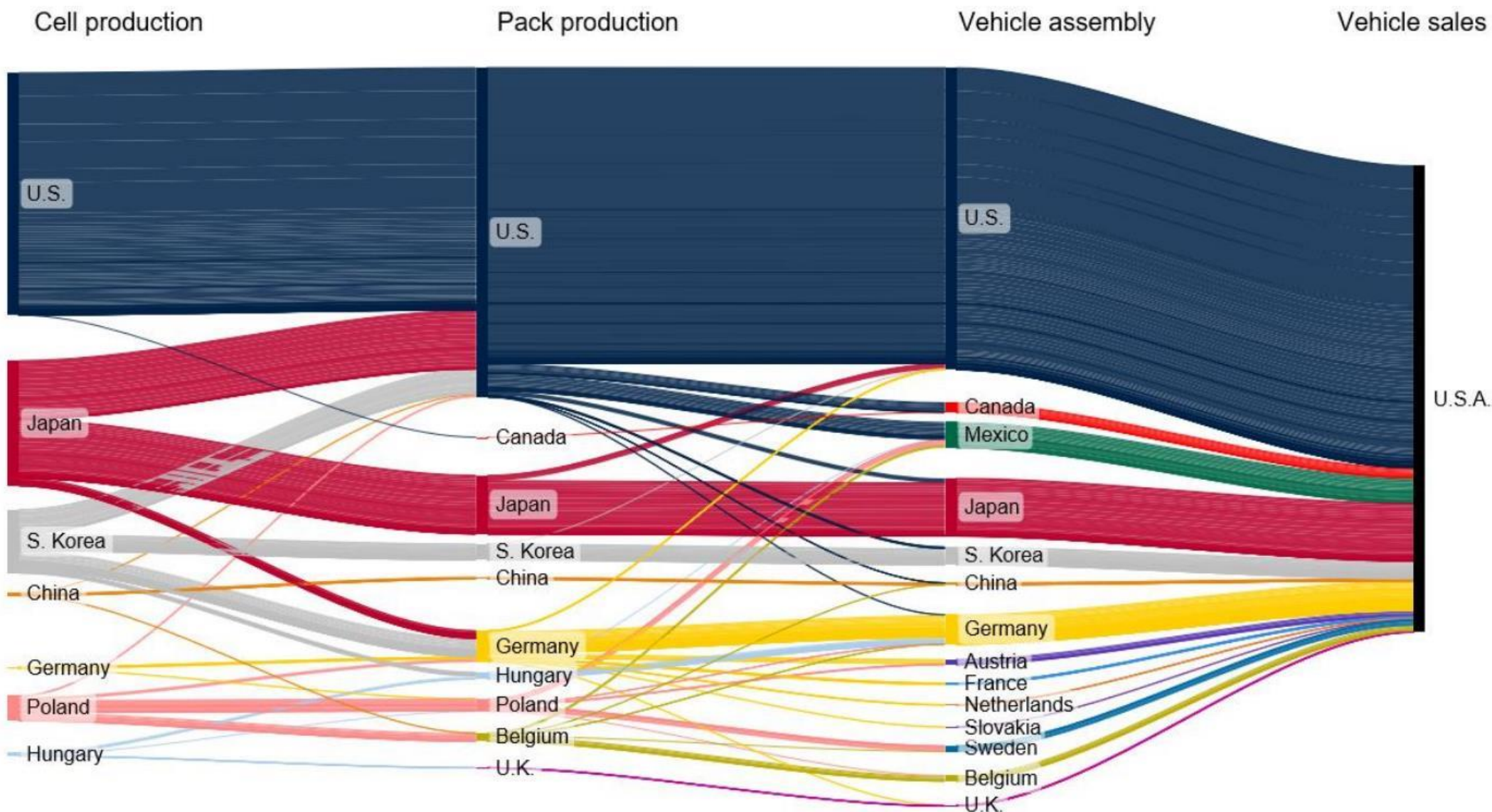
Vehicle Li-ion batteries consist of individual battery cells packaged into modules, which are assembled into multi-module battery packs.

RAW MATERIALS ARE PRODUCED AROUND THE WORLD AND PROCESSED IN CHINA BEFORE TRANSPORT TO THE US

Recycled materials are also be processed in the Far East



US DOES PRODUCE CELLS, PACKS, VEHICLES



OWNING AN ELECTRIC VEHICLE

Is just like owning a conventional car, except

- You can charge at home and save money
- You don't need to change the oil
- The lifetime cost of ownership is lower
- It's quieter and handles better
- Your contribution to climate change is reduced

WHAT DO EV OWNERS NEED TO KNOW WHEN THEY SELL THEIR CARS?

- EV battery life is more than 10 years (can be as long as 20), so most are still in use, though many are nearing the end of their lives.
- EVs in good functioning condition can be sold or traded in for any new vehicle.
- Battery life is warranted by the OEMs, so any battery failing during the covered period (usually at least 8 years) will be replaced under warranty.
- The battery often outlasts the vehicle and can be certified by Underwriters Laboratory for resale.
- Damaged EVs should be handled by a qualified repair shop, dismantler, or scrapper, found by consulting with an insurance company or OEM vehicle dealer.

BATTERY MATERIAL USE HIERARCHY

Most preferred outcome

↑

MATERIAL USE HIERARCHY	CATEGORIES	EXAMPLES
 Reused as originally intended and unmodified	Reuse as is	Use in another vehicle
 Repaired or reconditioned for original reuse	Repair	Restore functionality and use in a vehicle
 Repurposed for secondary applications	Repurpose	Use in home storage (possibly after reconfiguration or repair)
	Reuse components	Reuse module, cell or BMS
	Reuse intact compounds	Direct recycled cathode; Al and Cu from direct or hydro
 Recovered for raw materials for manufacturing	Break down into elements	Metals/salts from hydro or pyro
	Entrain as a filler	Metal hydride from Ni-MH smelting
 Disposal	Burn, vaporize, or neutralize	Electrolyte solvents
	Dispose of material	No recoverable value; landfill

↓

Least preferred outcome

January 2024

Argonne document APT #187244

THE BATTERY CAN BE USED AFTER IT'S TAKEN OUT OF YOUR CAR

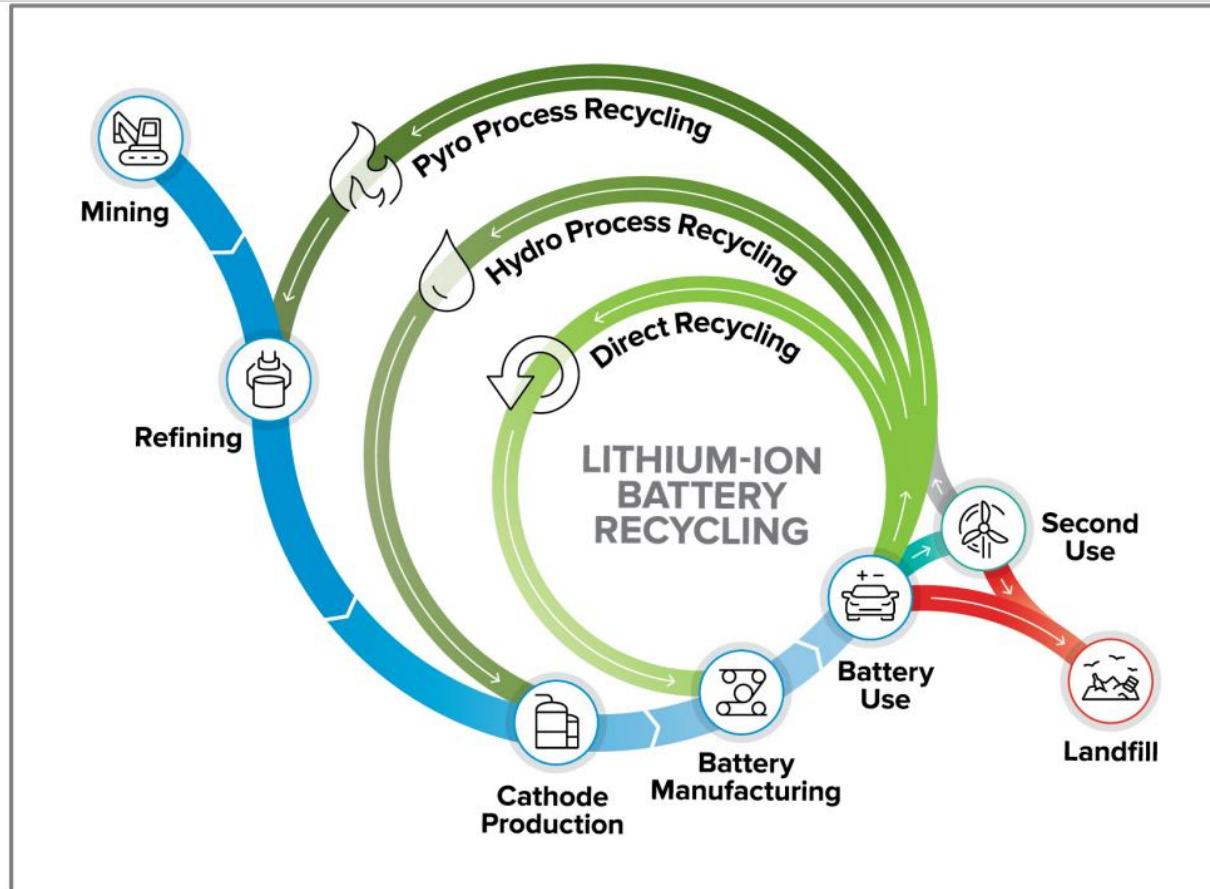
Potential second-life applications for used vehicle batteries include:

- Low-power EV uses, such as golf carts
- Energy storage for EV charging
- Replacement of lead-acid batteries
- Backup power for telecommunication services
- Residential energy-storage services
- Utility energy-storage service.

After second-life use, most Li-ion batteries can still be recycled.

SEVERAL RECYCLING METHODS ARE AVAILABLE

These all recover the most valuable battery materials



The goal of Li-ion battery recycling is preventing materials from ending up in landfills following second use, as shown above in red.

Direct recycling has the potential to decrease:

- Costs by 40%
- Energy use by 82%
- Greenhouse gases by 68%
- Water use by 77%
- Sulfur oxide emissions by 91%

Compared to production of batteries from raw materials.

USG ACTIONS ARE STIMULATING BATTERY RECYCLING

- In 2019, the DOE established the ReCell Center to make recycling economical and competitive, and to reduce material imports.
- DOE offers new funding annually to develop recycling technologies.
- The 2021 Bipartisan Infrastructure Law (BIL) funds new DOE R&D programs to move the U.S. economy toward a clean energy, lower carbon emissions future based on domestic materials and manufacture.
- The Inflation Reduction Act (IRA) of 2022 mandates significant tax benefits to battery producers for domestic production and materials extraction, and to consumers for purchasing vehicles with domestically produced batteries.

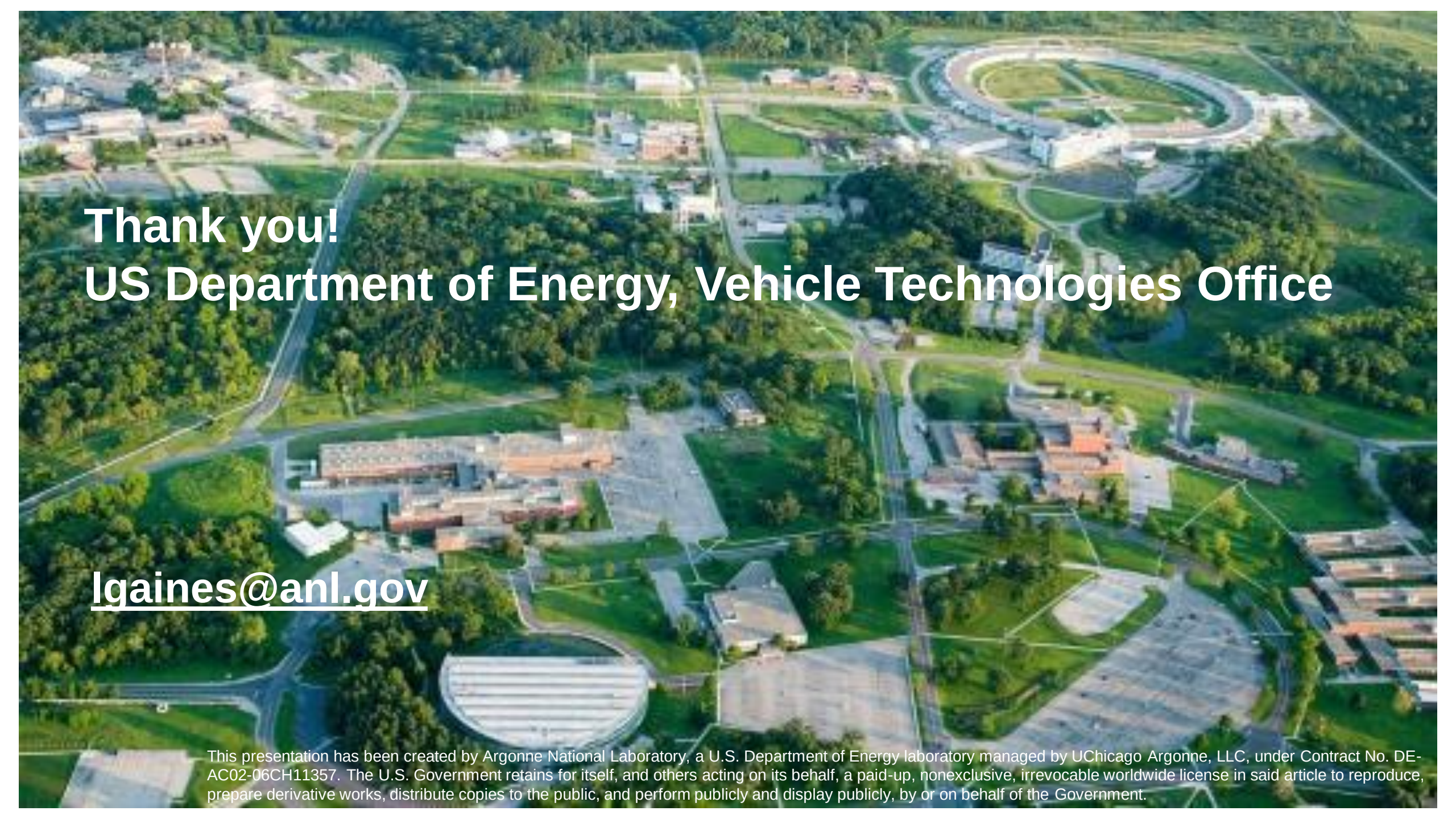
MORE INFORMATION IS AVAILABLE

Resources

- **Electric Vehicles**
U.S. Department of Energy Alternative Fuels Data Center
<https://afdc.energy.gov/vehicles/electric.html>
- **ReCell Center**
<https://recellcenter.org/>
- **Federal and State Laws and Incentives**
U.S. Department of Energy, Alternative Fuels Data Center
<https://afdc.energy.gov/laws>
- **Bipartisan Infrastructure Law Programs**
U.S. Department of Energy
<https://www.energy.gov/bil/bipartisan-infrastructure-law-programs>
- **Lithium-Ion Recycling Prize**
U.S. Department of Energy
<https://www.energy.gov/bil/lithium-ion-recycling-prize>
- **Energy Storage Grand Challenge**
U.S. Department of Energy
<https://www.energy.gov/energy-storage-grand-challenge/energy-storage-grand-challenge>
- **EverBatt**, Argonne's closed-loop battery recycling model
<https://www.anl.gov/amd/everbatt>
- **GREET**, Argonne's life-cycle analysis model
<https://greet.es.anl.gov/>
- **Electric Vehicle Community Preparedness Online Trainings**
National Fire Protection Association
<https://catalog.nfpa.org/Alternative-Fuel-Vehicles-Safety-Training-C4105.aspx>

Additional Resources

- **Electric Vehicle Fire Primer for Fleet Managers**
https://afdc.energy.gov/files/u/publication/Electric_Vehicle_Fire_Primer_for_Fleet_Managers.pdf?1eccf318cc
- **Local Fuel Savings**
<https://www.energy.gov/local-fuel-savings>



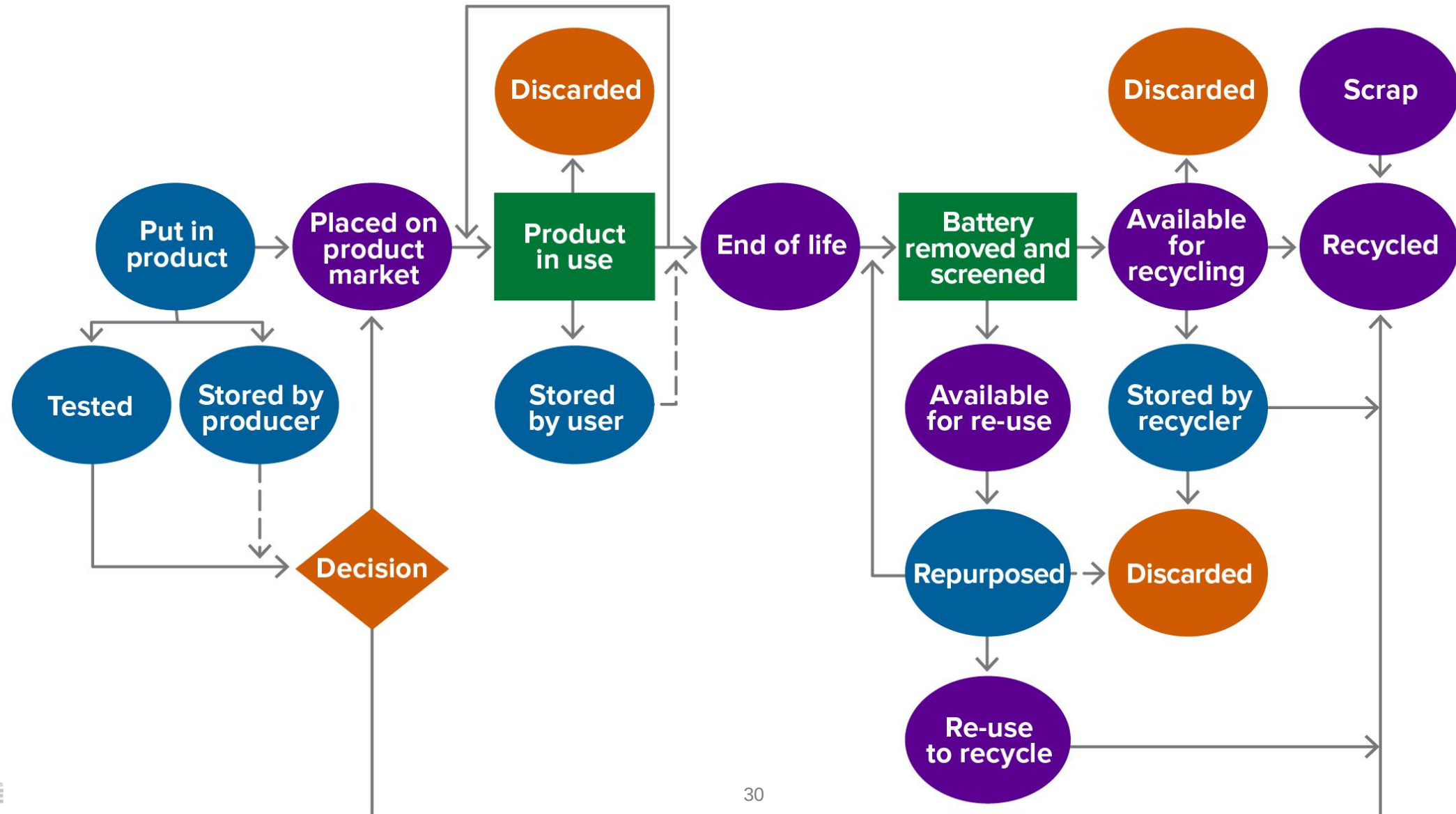
Thank you!
US Department of Energy, Vehicle Technologies Office

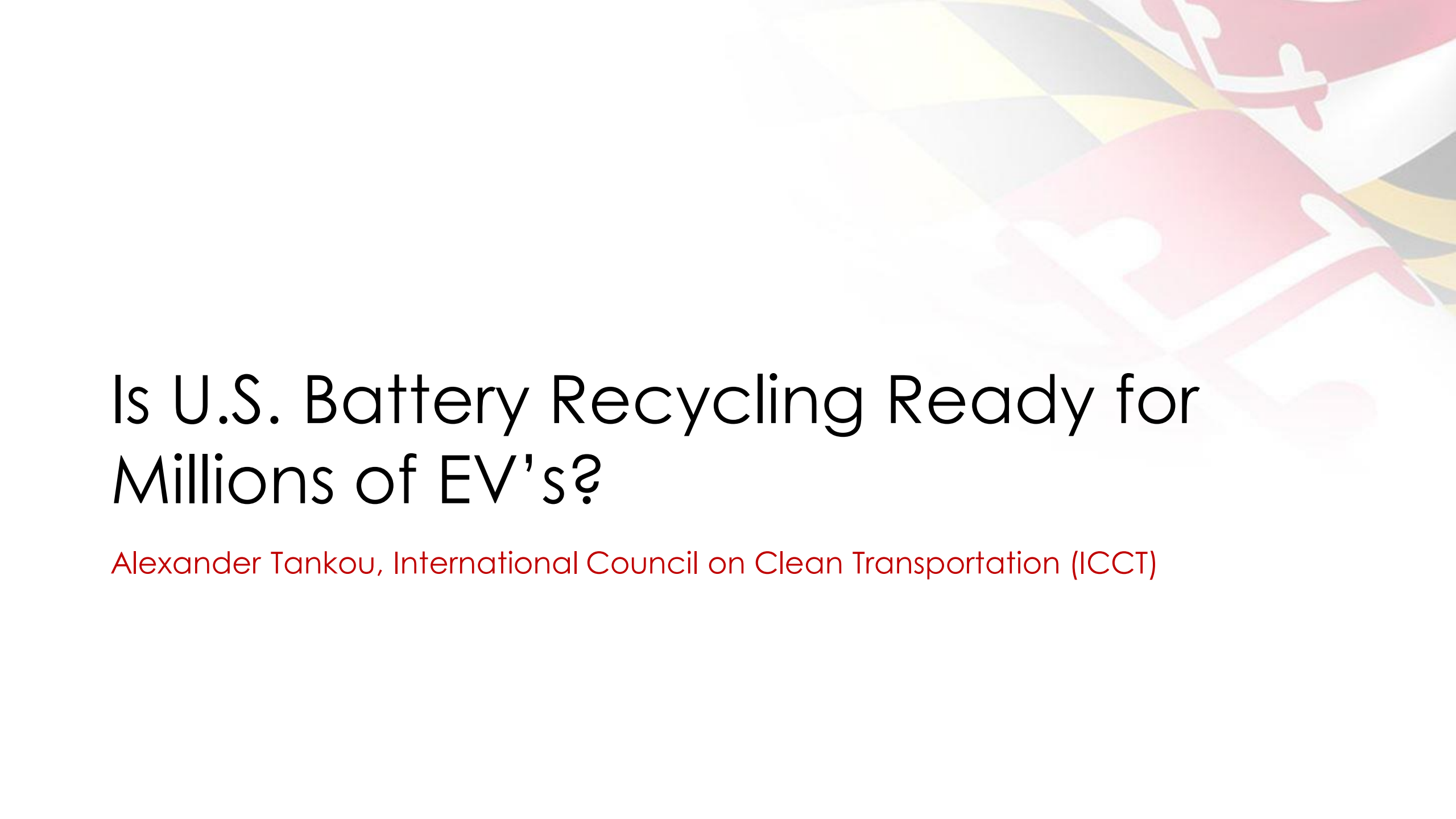
lgaines@anl.gov

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BATTERIES HAVE A VARIED ROUTES TO RECYCLING

Batteries (and scrap) can also be exported or discarded along the way





Is U.S. Battery Recycling Ready for Millions of EV's?

Alexander Tankou, International Council on Clean Transportation (ICCT)

Insights on Electric Vehicle Batteries Recycling in the U.S

Alexander Tankou

July 24th, 2024,

Maryland Zero Emission Vehicle Infrastructure Council

International Zero-Emission Vehicle Alliance

A network of leading national and sub-national governments demonstrating their deep commitment to accelerating the transition to zero-emission vehicles within their markets and through collective action.



For more information, see: <https://zevalliance.org>

ICCT/IZEVA report on battery reuse and recycling

On behalf of the **International Zero-Emission Vehicle Alliance (IZEVA)**, the ICCT conducted an analysis to understand the techno-economic feasibility of battery reuse and recycling.

The report builds on ICCT **modeling**, **literature review**, and **policy evaluation** to provide insights on:

- How many electric vehicle batteries will reach end-of-life in the next decades?
- What share of the future material demand can be met by recycling?
- What are the technical and economic challenges for reuse and recycling?
- What policy framework helps to scale up reuse and recycling practices?

Study is global but insights today will focus on recycling in the U.S.

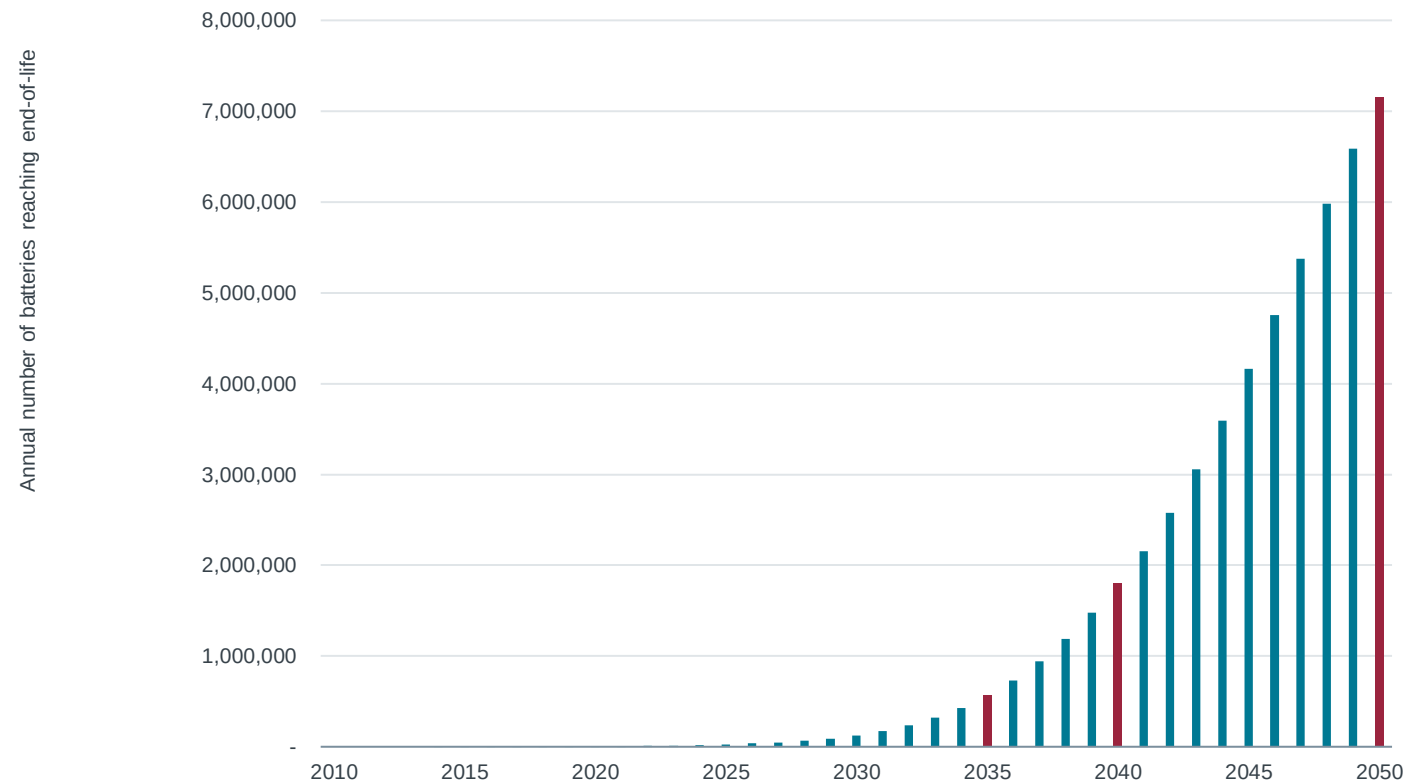
Millions of vehicles batteries will reach end-of-life in the next decade

Electric vehicle batteries reaching end-of-life:

- Based on expected BEV and PHEV uptake and **retirement**, light- and heavy-duty vehicles.
- Annual number of end-of-life vehicle batteries:
 - 2035: **561,000**
 - 2040: **1,700,000**
 - 2050: **7,000,000**

➡ Reuse and recycling frameworks need to be prepared today

Number of BEV and PHEV batteries reaching end-of-life in the U.S



Key assumptions:

- PHEV and BEV uptake based on current and proposed policies
- Vehicle retirement as currently observed for conventional vehicles

Efficient recycling in the US could reduce demand for raw material by 32% in 2050

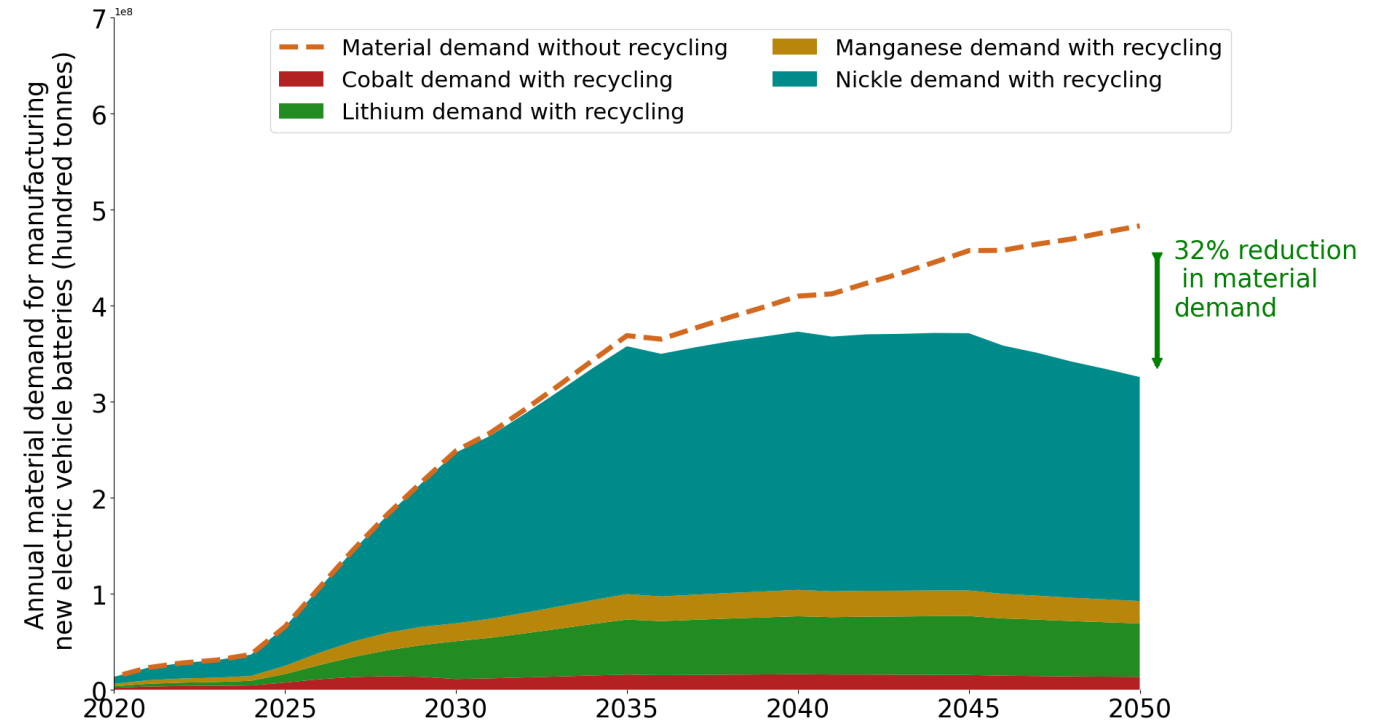
Global battery material demand:

- 2050 vs. 2022:
 - 16x more lithium and nickel
 - 6x more manganese,
 - 4x more cobalt

Recycling can reduce demand in raw material mining by

- 3% in 2035
- 9% by 2040
- 33% by 2050

Annual demand in battery materials



Key assumptions:

- Battery mix: share of LFP and high-nickel NMC increases
- 90% of batteries are collected; 50% of collected batteries are used for 10 years in second-life applications before being recycled, other 50% are directly recycled
- Recovery rates: 50%-80% for lithium, 90%-95% for cobalt, nickel, and manganese

Reaching the potential of recycling will require addressing technical challenges

1) Collection

Traceability of batteries

2) Transport

Long-distance transport
Licenses/safety standards

3) Inspection

Characteristics of battery might not be accessible.

4) Disassembly

Pack/module/cell design varies between models and not design to be dismantled

5) Recycling

Challenges depend on recycling pathway:

a) Pyro-/hydrometallurgical recycling

- Lithium, and aluminum typically not recovered
- More polluting than other pathways

b) Hydrometallurgical recycling

- Optimized for specific battery chemistries
- Graphite usually not recovered

c) Direct recycling

- Only a single type of cathode can be received as input
- Not proven on an industrial scale

At the Federal government level, policies to scale up recycling have mainly focused on funding schemes and Research & Development

The Infrastructure Investment and Jobs Act - 2021

- \$60 million for research/demonstration project on battery recycling;
- \$50 million for local governments and \$15 million to retailers to fund battery recycling programs (i.e., battery collection, processing)

The Inflation Reduction Act Clean Vehicle Credit - 2022

- Purchase incentive that encourage the use of recycled materials - although these can also be satisfied by using virgin minerals from a select list of markets

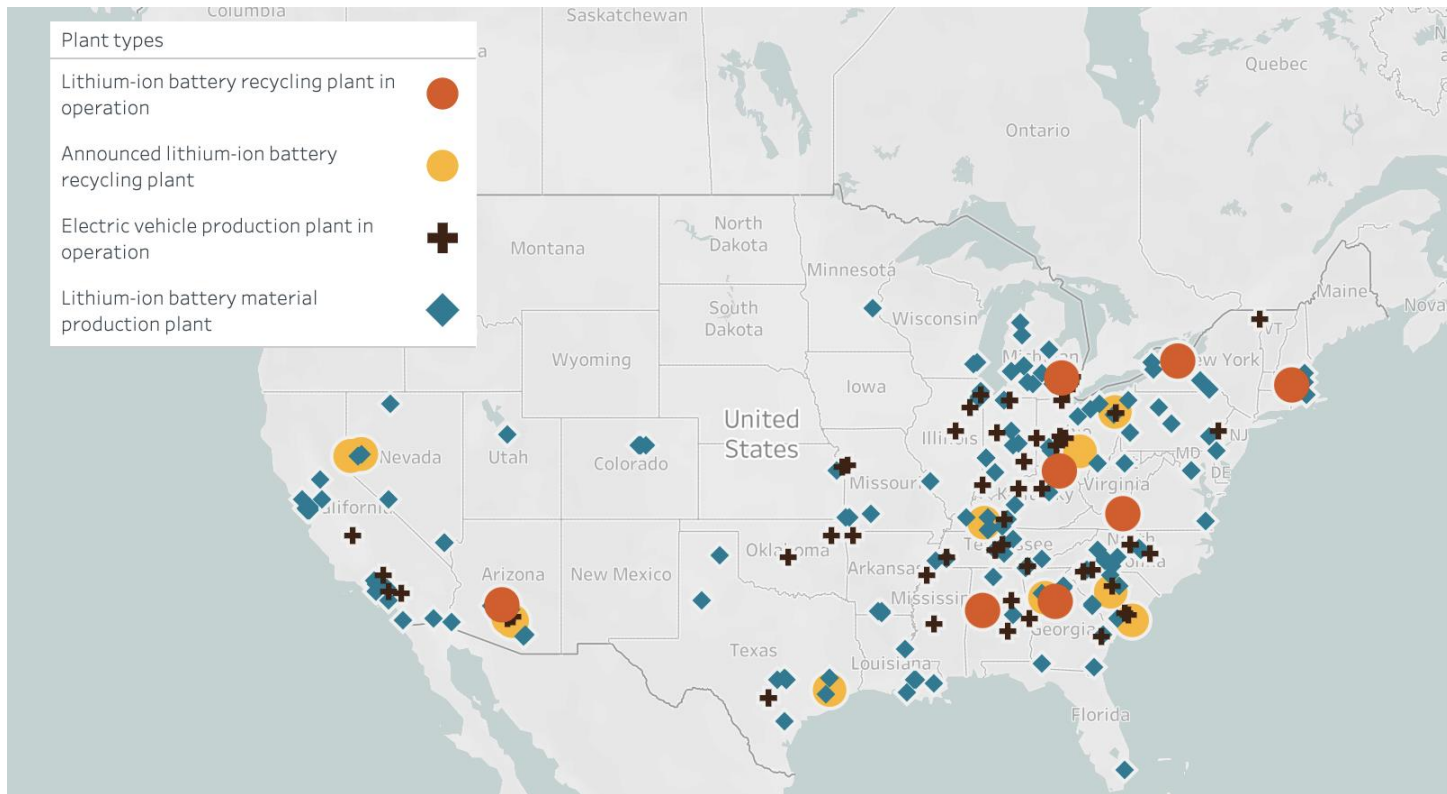
The U.S Department of Energy ReCell Center - 2019

- Aim to improve recycling efficiencies and make recycling profitable
- Development of new cost-effective technologies (i.e., direct recycling)

A few states are also showing leadership for policy efforts to scale up battery recycling

- California's Advanced Clean Cars regulations II (ACCII) introduce **battery labeling requirement and digital identifier** to make batteries more traceable and information more accessible
 - *This requirement extend to other states that have adopted ACCII (including Maryland)*
- In January 2024, New Jersey approved the **first nationwide Extended Producer Responsibility**, essentially making battery producers responsible for collection and reuse/recycling of end-of-life batteries

The U.S EV battery recycling infrastructure is taking shape

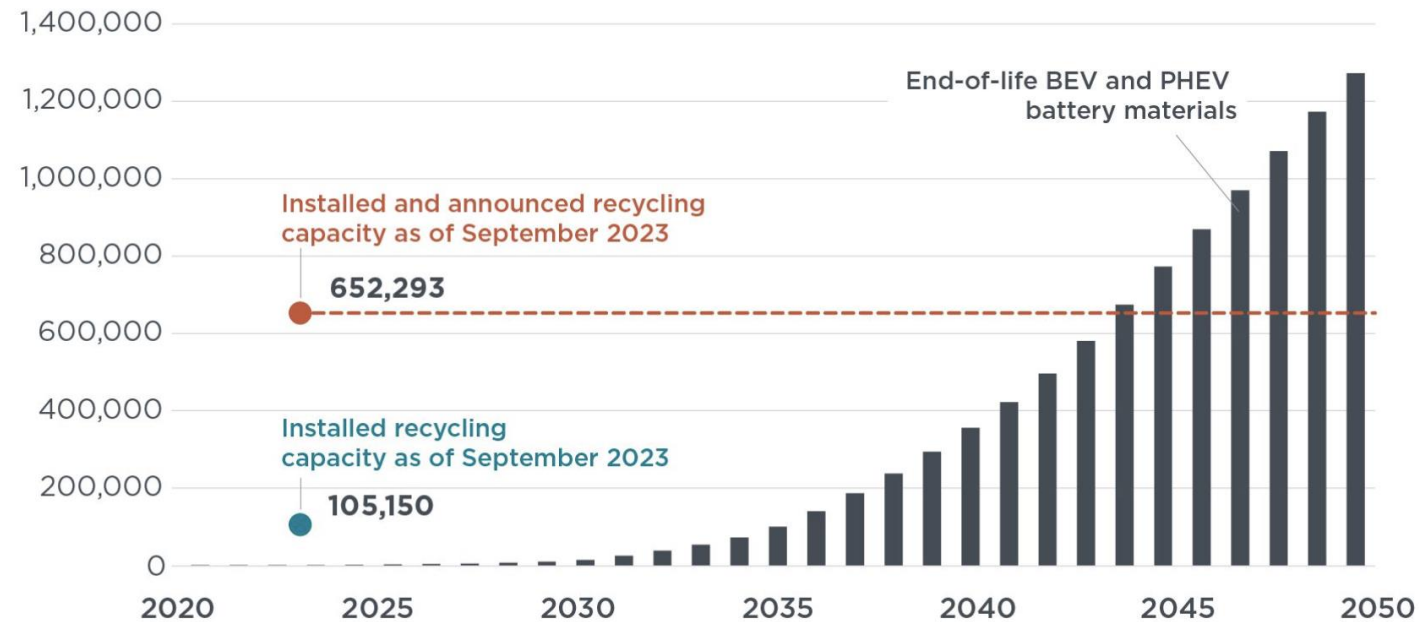


- ICCT estimated that at least **20 recycling plants** are operational or have been announced as of September 2023—pilot project plants not included.
 - **652,293 metric ton/year** ~1.3 million EV equivalent/
- Most of these plants produce **black mass as an end-product (i.e., pre-processing plants)**

Overcapacity for end-of-life feedstock is expected but refining capacity is critically missing

Recycling capacity versus projected end-of-life EV battery materials in the U.S.

Metric tons of end-of-life electric vehicle batteries



- Overcapacity for the production of end-of-life battery black-mass is expected up to 2044
 - Manufacturing scrap not accounted but expected to to the main feed up to 2030
- Yet the U.S is **critically missing capacity to refine the black mass into material for cathode productions ~ 20,000 mt/year**

Conclusions: is the US ready for the millions of EV batteries that will reach end-of-life?

- With million EV batteries reaching end-of-life in the US recycling become an imperative
- The US federal government and a few other US states have started introducing key policies but more needs to be done, for example:
 - Except for the state of New Jersey, **no EPR legislations** to ensure end-of-life batteries get collected and eventually recycled
 - Requirements for **battery removability and dismantling** are lacking
 - **Traceability battery mechanisms and labeling/data** sharing not in effect yet (TRACE Act and ACCII)
 - **Limited capacity to refine black mass** intro cathode materials
- Inclusion of **element specific recovery rates** and **recycling content** in newly manufactured batteries should also be considered

Please contact us:
a.tankou@theicct.org



THE INTERNATIONAL COUNCIL
ON CLEAN TRANSPORTATION



Utility 2024 Highlights



Utility Highlights: SMECO

- SMECO Recharge Public Chargers
 - 37 installed (34 Level 2, 3 DC Fast)
 - 3 waiting for commissioning (2 Level 2, 1 DCFast)
- Multi-Family Dwelling Chargers
 - First MUD construction start date of 8/1/2024
- Residential Charging Programs
 - Managed Charging
 - Data Share
 - Off-Peak Saving (EV TOU)
 - Continuing to work with OEM to add more eligible chargers and vehicles to residential programs



Utility Highlights: Potomac Edison/First Energy

- EVSE Pilot Program Updates
 - Filed for a Phase 2 – waiting on approval
 - Filed for a Reliability Business Plan
 - Onboarded a new maintenance vendor, ChargerHelp!, in February 2024

EVSE Program	Count	Notes
Public EV Chargers	39 – L2 20 - DCFC	Installed 59 throughout PE service territory
Residential Rebates	1,000 rebates paid out	Program is officially closed
Utility Owned Multifamily Chargers	3 – L2	Approved by MD PSC in 2022
EV-Only TOU Program	1,214 participants (as of 6/30/24)	Replaced the former Off-Peak Rewards program in May 2023

PotomacEdison™
A FirstEnergy Company



Utility Highlights: BGE



An Exelon Company

Utility Highlights: PHI



Closing Remarks

Next ZEEVIC Meeting: October 23, 2024

To receive ZEEVIC Meeting Notices, email: ZEEVIC@mdot.maryland.gov