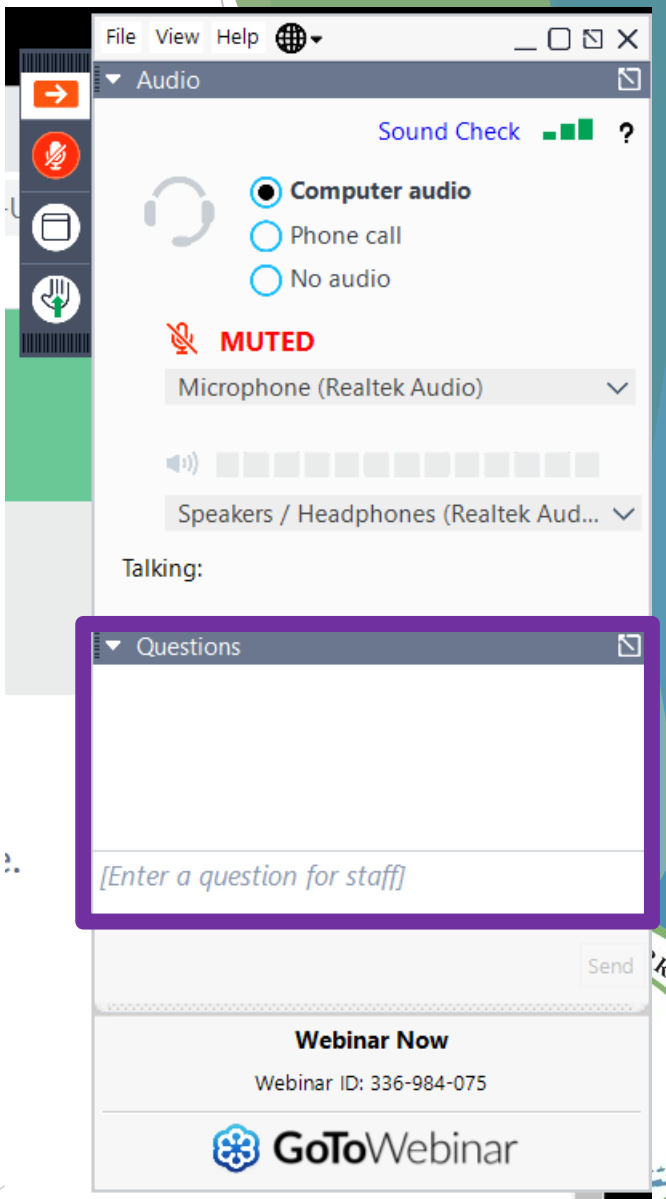
Emerging Wastes from Renewable Energy Sources

ASTSWMO Virtual Annual Meeting
November 3, 2021

Before we start

- All attendees will be muted throughout the webinar. During the question sections we can unmute people who want to raise their hands
- **Questions:** Use the **Questions Panel** in the dashboard to send questions to the speakers during the webinar.
- **Note who the question is directed to in your submittal.**
- Questions will be answered at the end of the webinar.
- The webinar is being recorded and will be made available on the ASTSWMO website.



James Jennings, IL

Chair, ASTSWMO Sustainable Materials Management Task Force

Welcome

Jody Weikart

Program Manager
Solid Waste Permitting & Corrective Action Program
Wyoming Department of Environmental Quality

Wind Turbine Blades

Emerging Wastes Session
Wind Turbine Blades

November 3, 2021

3:00–4:30pm Eastern

Jody Weikart

Solid Waste Permitting and Corrective Action Program Manager

Wyoming Department of Environmental Quality

What Are Wind Turbine Blades

Material

- Fiberglass

Lifespan

- 25 to 30 years

Size

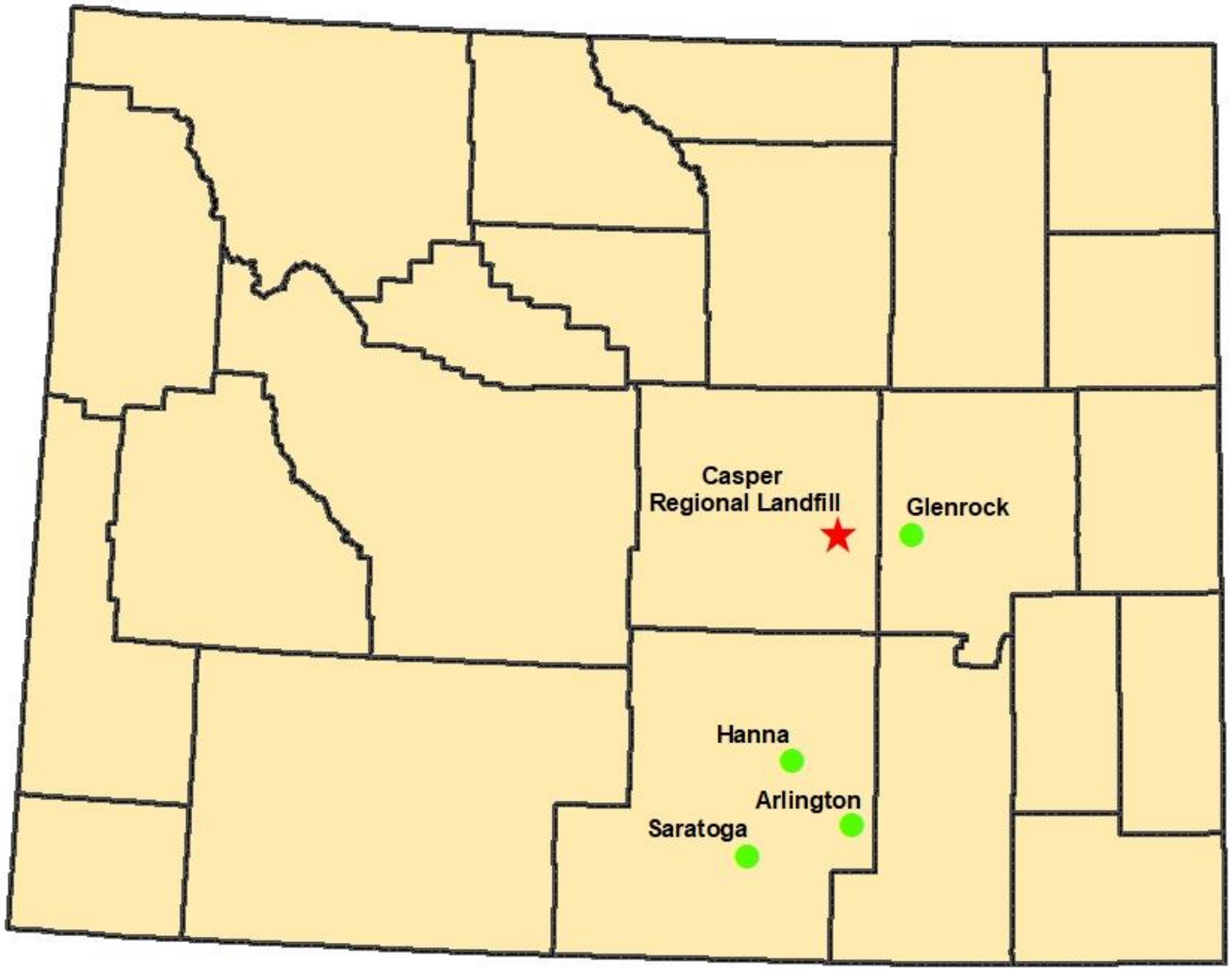
- Vary in size
- 120 feet long
- Longer than a Boeing 747 wing

Disposal in Wyoming

Casper Regional Landfill

- Over 1,300 wind turbine blades
- 10,252,220 cubic yards of MSW air space
- 2,606,300 cubic yards of construction & demolition (C&D) air space
- C&D cell built for special projects, such as, the disposal of wind turbine blades and motor housings

Where Are They From?



Transportation

- One wind turbine blade per semi-truck trailer
- Gross weight of each semi-truck trailer is approximately 25.2 tons
  - Wind turbine blade and motor housing weighs 5.9 tons
- Will receive over 1,000 loads

Long Term Disposal Solutions

Location (longitude, latitude, elevation) of the wind turbine blades is being recorded so they can be recovered

One turbine blade and one motor housing uses approximately 30 to 44 cubic yards of air space

Questions?

Chosu Khin

Senior Environmental Scientist
Hazardous Waste Management Program
California Department of Toxic Substances Control

Solar Panels

Photovoltaic (PV) Modules - Universal Waste Management Regulation

Department of Toxic Substances Control

ASTSWMO MEETING

November 3, 2021

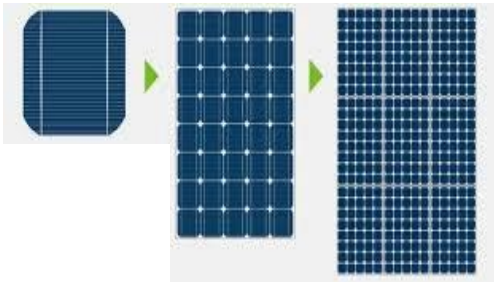
Rulemaking timeline

- SB 489 (Monning, Chapter 419) authorizes DTSC to adopt regulations to designate end-of-life PV modules that are identified as hazardous waste as a universal waste and subject those modules to universal waste management on October 1, 2015.
- U.S. EPA authorized California's universal waste management program, effective January 14, 2020.
- Final regulation package was approved by Office of Administrative Law on September 28, 2020.
- Regulation is effective starting January 1, 2021.

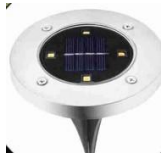
Universal waste criteria

- Low risk hazardous waste
- Generated by a wide variety of generators
- Not exclusive to a specific industry or group of industries
- Generated by a large number of generators and frequently generated in small quantities
- Close steward of the waste
- Divert from waste ending up in non-hazardous waste management systems
- Improve implementation of and compliance with the hazardous waste regulatory program

Regulatory definition of PV module



- Photovoltaic cells designed to convert solar radiation into electrical energy
- Includes integrated components that cannot be separated without breaking the photovoltaic module glass (e.g. protective glass, metal frames..)



- Composition (xSi, semiconducting materials); One cell or multiple cells
- Roof top solar panels, thin film, PV module with integrated components
- Excludes ancillary components that can be taken apart from PV module without breaking the PV module glass (e.g. batteries, junction box, inverters, wires)

CCR Sections 66260.10 and 66273.9

Not a PV module

- Solar concentrators
- Solar powered **electronic devices**

When do universal waste regulations apply to PV modules?

- When PV module is discarded and becomes **a waste***.
- When PV module has hazardous characteristic of toxicity:
  - ✓ Analytical test results that show that the module is hazardous
  - ✓ Using generators' knowledge of the materials in the panel
- All PV module waste can be managed as universal waste without requiring a hazardous waste determination.

***Universal waste management standards do not apply to PV modules that are <u>refurbished or reused</u>.**

Hazardous constituents in PV modules

- Lead
- Cadmium
- Chromium
- Antimony
- Gallium
- Selenium
- Tellurium
- Other metals

Test Methods

FEDERAL	CALIFORNIA
• Toxicity Characteristic Leaching Procedure (TCLP)	• Total Threshold Limit Concentrations (TTLC) • Waste Extraction Test (WET) - Soluble Threshold Limit Concentrations (STLC)

Affected businesses

- Universal waste handlers (generators, installers*, manufacturers, distribution, storage, etc.)
- Universal waste transporters
- Treatment facilities
- Recyclers
- Hazardous waste disposal facilities

*Installers may take part in removal of solar panels

Regulatory requirements

- Universal waste management standards (CCR tit. 22 div. 4.5 ch. 23)

Article 1. General

Article 2. [Reserved]

Article 3. Standards for Universal Waste Handlers

Article 4. Export and Import Requirements

Article 5. Standards for Universal Waste Transporters

Article 6. Standards for Destination Facilities

Article 7. Authorization Requirements for Universal Waste Handlers Who Treat Universal Wastes

Article 8. Requirements for the Disposal of CRT Panel Glass

Article 9. Recycling Concurrence Process for CRTs and CRT Glass [Repealed]

Article 10. Trade Secret Protection [Repealed]

Specific regulatory requirements for PV modules

- Notifications (Initial, authorized treatment, disposal)
- Annual reporting
- Labeling
- Containment
- Response to releases
- Accumulation time limit
- Tracking/Recordkeeping
- Transporting
- Authorized treatment activities

Universal waste PV modules disposal

- UW PV modules can only go from one UW handler to UW handler or to the disposal facility
- UW PV modules become a hazardous waste the moment handlers decide to discard them
- Nothing prohibits a facility from sending the waste to hazardous waste disposal; the waste must be managed according to all applicable HW regulations
- Make hazardous waste determination

DTSC Information

UW PV Modules:

https://dtsc.ca.gov/photovoltaic-modules-pv-modules-universal-waste-management-regulations/

Final Regulation:

https://dtsc.ca.gov/dtsc-final-regulations/

Emails:

PVmodules@dtsc.ca.gov

DTSC E-list:

https://dtsc.ca.gov/dtsc-e-lists/

Tim Coburn

Professor of Systems Engineering
Colorado State University

EV Batteries

EV Battery Life Cycle Management:

Observations & Perspectives from a Recent Colorado Study

ASTSWMO 2021 Annual Meeting,
Emerging Wastes from Renewable Energy Sources

Timothy Coburn, Professor of Systems Engineering

Thomas Bradley, Professor of Systems Engineering

Colorado State University

Introduction

- In the strictest sense, an EV is a vehicle that is fully battery-powered
  - In the media and in common vernacular, “EV” is often taken to mean any vehicle that is at least partially battery-powered … sometimes contributing to confusion
- Deployment of EVs is rapidly expanding throughout the U.S. (e.g., Hertz-Tesla partnership; Ford-SK Innovation battery plants in TN & KY)
  - Evolving consumer preference, federal/state/local policy changes, availability of new models, climate change mitigation, and more
- However, as in other states …
  - The Colorado EV market is relatively immature, although the state has adopted an aggressive strategy to grow the fleet
  - Management of the prospective battery waste stream in Colorado has seemingly lagged initiatives to put EVs on the road

www.pv-magazine.com/2021/08/09/hyundai-and-ul-ally-to-give-ev-batteries-a-second-life

Key Terminology

- Disentangling terminology around battery recycling, re-use, and end-of-life is key to an effective long-term battery life-cycle management strategy
  - ***Recycling*** (a definition for the battery industry)
    - Disassembly and extraction of usable parts
    - Logistics of getting batteries prepared for crushing / smelting / shredding
    - The crushing / smelting / shredding process
    - Extraction of critical minerals and materials
  - ***Recycling*** (a definition for the automotive industry)
    - Refurbishment, remanufacturing, reuse, redeployment for additional automotive applications
  - ***Battery 2nd Life***
    - Redeployment of used batteries for non-automotive applications

Distinguishing Battery Types

- The current debate about EV battery life cycle management is primarily focused on lithium-ion batteries (LIBs)
- Broadly speaking, LIBs are used to power today's advanced-technology EVs
  - Several different flavors of LIBs
- Earlier-generation hybrid vehicles use nickel-metal hydride batteries (NiMH)
  - (e.g., Toyota Prius, Honda Insight)
- LIB and NiMH are different "chemistries" that involve potentially different waste streams, in the same way that lead-acid batteries involve a different waste stream
- EV LIBs are different than other types of LIBs (e.g., consumer electronics) and, again, have a different waste stream

https://blog.ucsusa.org/hanjiro-ambrose/the-second-life-of-used-ev-batteries

LIB Situation Today

- Comparatively speaking, there aren't that many EVs powered by LIBs on the road yet
- The vast majority of EVs … and hence their batteries … are under warranty and will remain so for several years to come
- In-warranty LIB defects/failures/repairs are handled/processed by the original equipment manufacturers (OEMs) through the dealerships
- In Colorado, and in most other parts of the country, defective LIBs are sent out-of-state to be recycled or refurbished
- The thinking about how out-of-warranty LIB problems will be handled is still evolving within the OEM community
- Relatively few LIBs are currently languishing in salvage yards or storage facilities
  - These would only be early-generation models
- No evidence of LIBs going to landfills

https://en.wikipedia.org/wiki/Tesla_Model_S

LIBs do not present a significant waste management problem today, but in 5-10 years the picture may look different

Comparative NiMH Situation Today

- Many more used NiMH batteries than Li-Ion batteries
  - True in Colorado and most other states
  - These were the earliest advanced batteries used in hybrid vehicles
- Many of these are now out of warranty or soon coming off warranty and are available for repair, reuse, remanufacturing, or recycling
- Nonetheless, battery life-cycle management activity around NiMH batteries is still limited
  - A nascent, mostly independent, small business community exists to repair / recycle / refurbish / storage
  - Again, largely focused on earlier hybrid vehicles

www.automobilemag.com/news/2019-toyota-prius-awd-first-drive-review

If there is an “EV” battery waste stream problem today, it is centered around NiMH batteries, but the waste stream implications are different than for LIBs.

Current Status of EV Battery Recycling

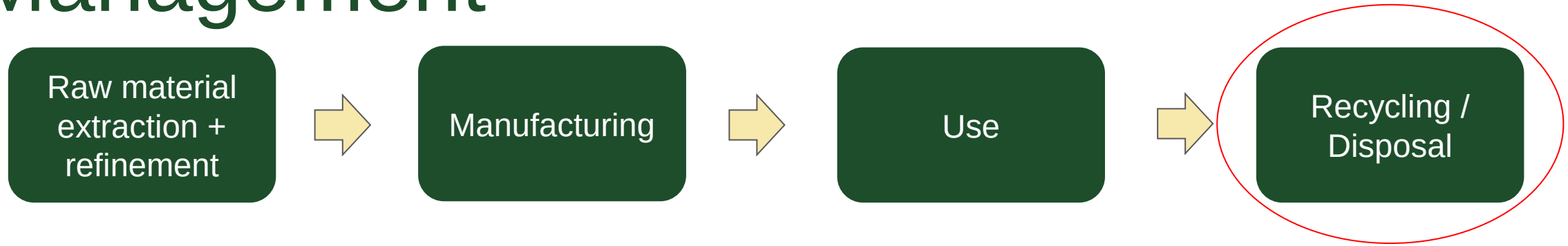
- In Colorado (and in most states), no entities are engaged in the recycling of advanced (LIB or NiMH) batteries
- Only a few companies/sites in the US are capable of recycling advanced batteries
  - Involves a significant permitting process
  - Economic viability requires battery volume
  - LIBs currently have little value and owners must pay to have them recycled
  - NiMH batteries do have value and recyclers will pay to acquire them
- Recycling is a costly and logistically-challenging process
  - For example, shipping/transporting universal or hazardous waste cross-country
- Recycling small lots of batteries is impractical and currently uneconomic

Ultimately, all EV batteries will need to be recycled or disposed of at end-of-life

EV Battery Recycling Headwinds

- All methods of recycling EV batteries require specialized and centralized facilities
  - Not directly analogous to the former problems encountered with lead-acid battery recycling
  - Fewer public safety, environmental health, and human health concerns (as long as waste streams can be mitigated)
  - Still, many cost and regulatory hurdles exist
- Not economically viable at present
  - Materials recovery benefits (Co, Ni, Li) are limited, and the volume of high value materials will decline with time as battery technology improves
    - For LIBs, present value is <0
  - Shipping/transportation costs are and will remain high
  - Not enough batteries available yet to justify the effort
  - Uncertainty surrounding state and federal regulations pertaining to the movement of hazardous and universal waste, both in and out of state
  - Inconsistency in the consideration of battery ownership and environmental responsibility (liability)
- Potential competition with 2nd life applications (but these have their own issues)

Approaches to EV Battery Life-Cycle Management



- Consumer-focused initiatives
  - Landfill ban – Relies on government to create a designated pathway for disposal
  - Disposal refund – Makes a buyer responsible for the costs of disposal, and incentivizes consumer returns
  - Educational programs
- Producer-focused initiatives
  - Extended producer responsibility – The producer is held liable for planning for end-of-life and all associated costs
- Other proposals
  - Labelling/tracking requirements, penalty enforcements, subsidies for affected parties, materials tracing

Other Impactful Entities & Factors

- Salvage yards (particularly the smaller, independent/private ones)
- Salvage vehicle auction houses
- Independent/private repair shops
- Battery aggregators (pre-recycling)
- Insurance companies (re: transfer of ownership and environmental liability when vehicles are “totaled”)
- Non-warranty battery repair/replacement performed by dealerships
  - Although not many dealerships are likely to accept such work due to liability issues

EV Batteries …

An emerging waste stream mitigation dilemma or an impending resource management opportunity?

Questions?

Colorado State University

The End.

Thank You!
Please respond to the Feedback Survey.