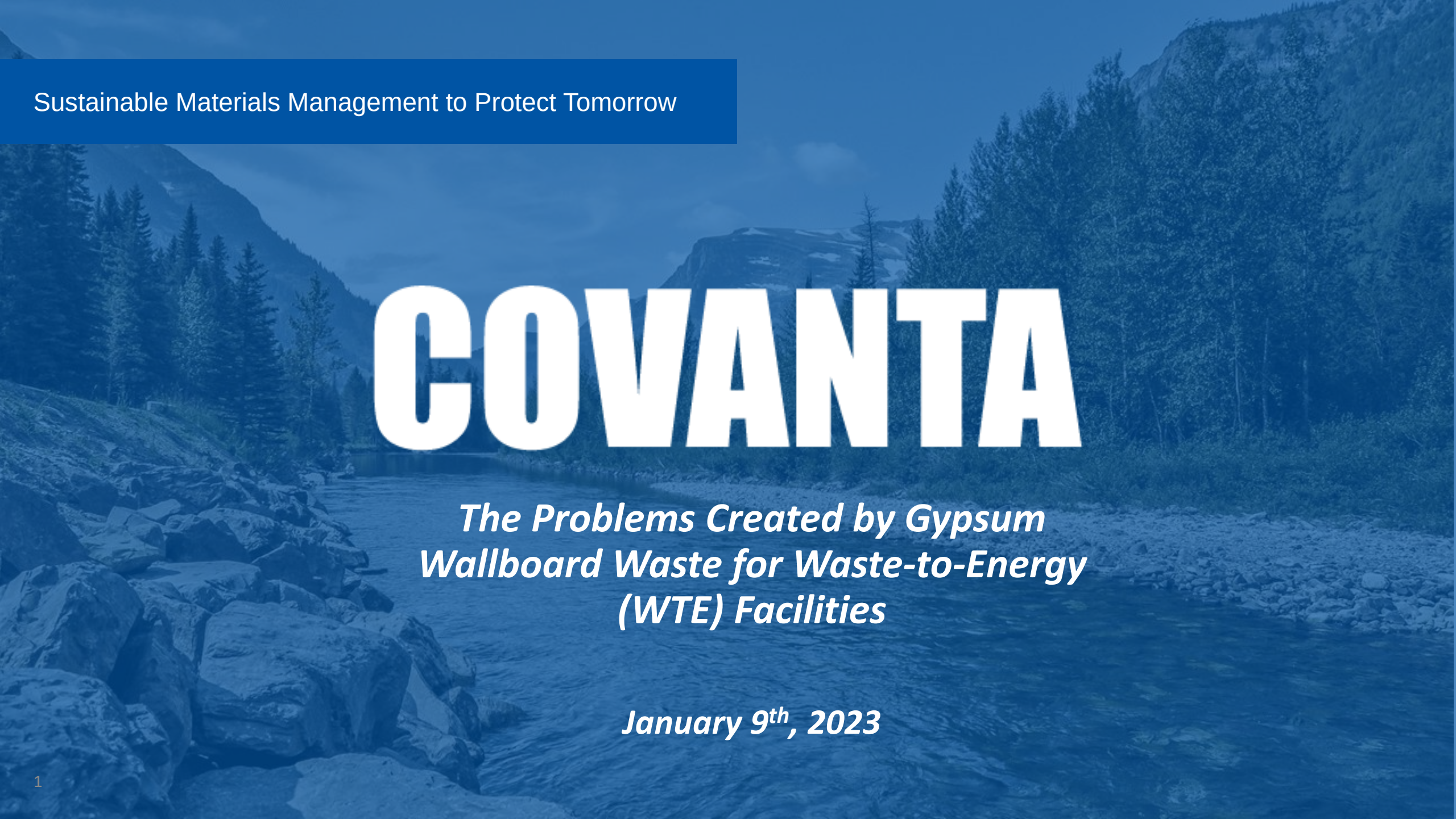
Sustainable Materials Management to Protect Tomorrow



The Problems Created by Gypsum Wallboard Waste for Waste-to-Energy (WTE) Facilities

January 9th, 2023

Covanta: World Leader In Waste-to-Energy

Over 50 sustainable material processing facilities, including WTE facilities in North America

Annual capacity to process **21 million tons** of waste

Generate 10 million megawatt hours—enough clean energy to power **over 1 million homes**

Annually recycle approximately **600,000 tons of metal** the equivalent amount of steel can build six Golden Gate Bridges

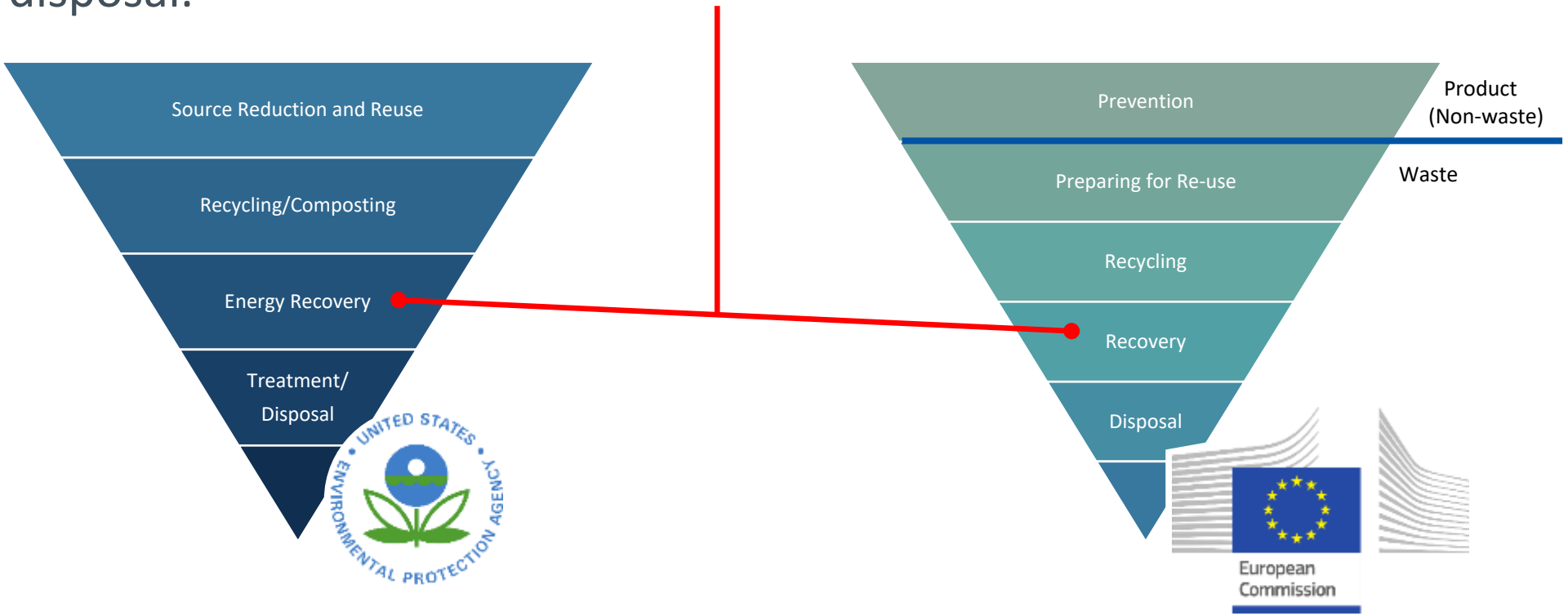
3,800 professionals employed in North America

High focus on improving **sustainability** and encouraging a **circular economy**

Waste-to-Energy and Sustainable Waste Management

Sustainable Materials Management

The EPA and the EU have ranked the most environmentally sound strategies for municipal solid waste. Source reduction (including reuse) is the most preferred method, followed by recycling, energy recovery, and lastly, treatment followed by landfill disposal.



Sources: Environmental Protection Agency European Commission

Two Choices for Waste after Recycling

Landfill

- Landfills are a major source of man-made methane
- Methane is more than 30X more potent than Carbon Dioxide
- Leachate generation: ground water contamination
- Non sustainable use of land
- Energy generation from landfills: **65 kWh per ton of waste**

Waste-to-Energy

- 90% reduction of waste in volume
- Clean base load power generation
- Recovers metals for recycling
- Offsets on average one ton of carbon dioxide equivalent for each ton of waste processed
- Renewable energy generation from WTE: **550 kWh per ton of waste**

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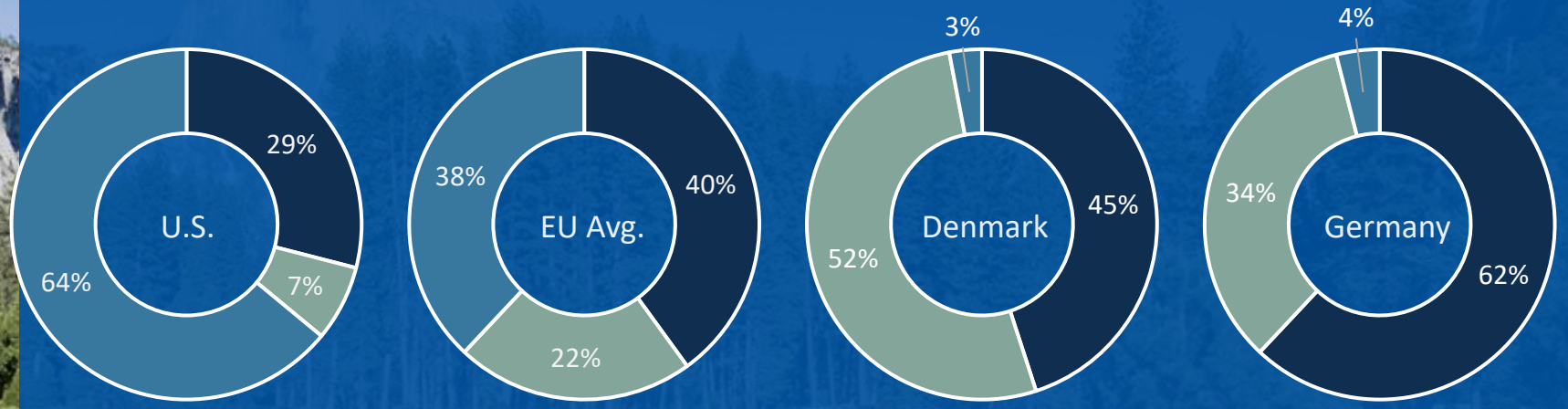
How Waste is Managed Around the World

The US has room to improve



Recycling/Composting Landfilling Energy-from-Waste

Covanta WTE in Massachusetts

Haverhill WTE Facility – 1,600 TPD

SEMASS RDF – 3,000 TPD

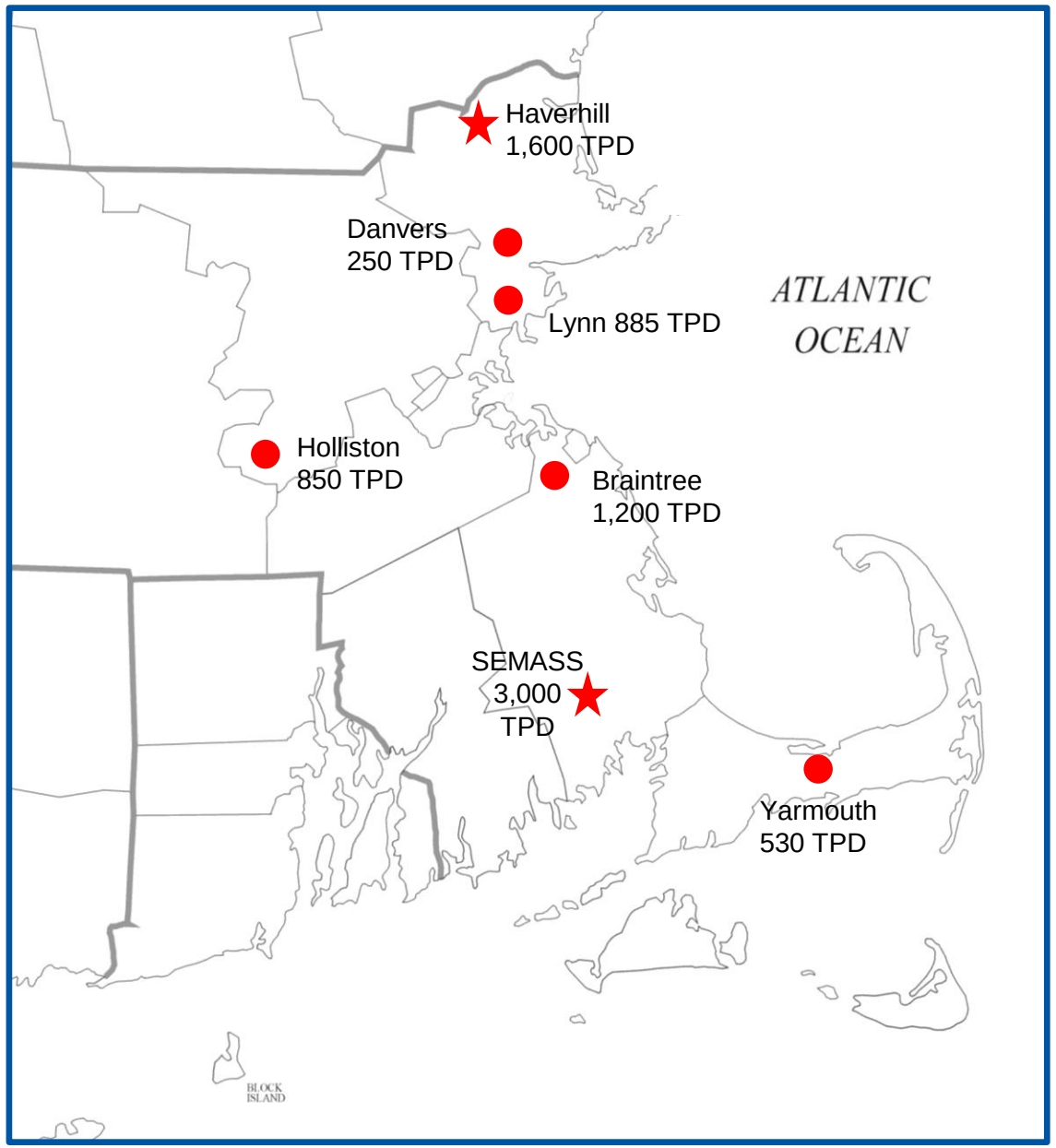
Transfer Stations support WTE Facilities

Covanta Facilities in MA:

- ★ Waste-to-Energy (WTE) Facilities: 2
- ● Transfer Stations: 5

*** 1,800,000 processed tons annually**
*** 900,000 tons redirected through transfer stations**

Only Holliston transfer station is permitted to accept C&D. All other facilities do not accept C&D of any type. Wallboard has been band for many years at all EFW.



Gypsum Wallboard – Problems for WTE

1. Sulfur Content, SO2 emissions
2. Increased chemical reagent (lime)
3. Particulate Matter (PM)
4. Increased Ash

Sulfur Content, SO_2 emissions

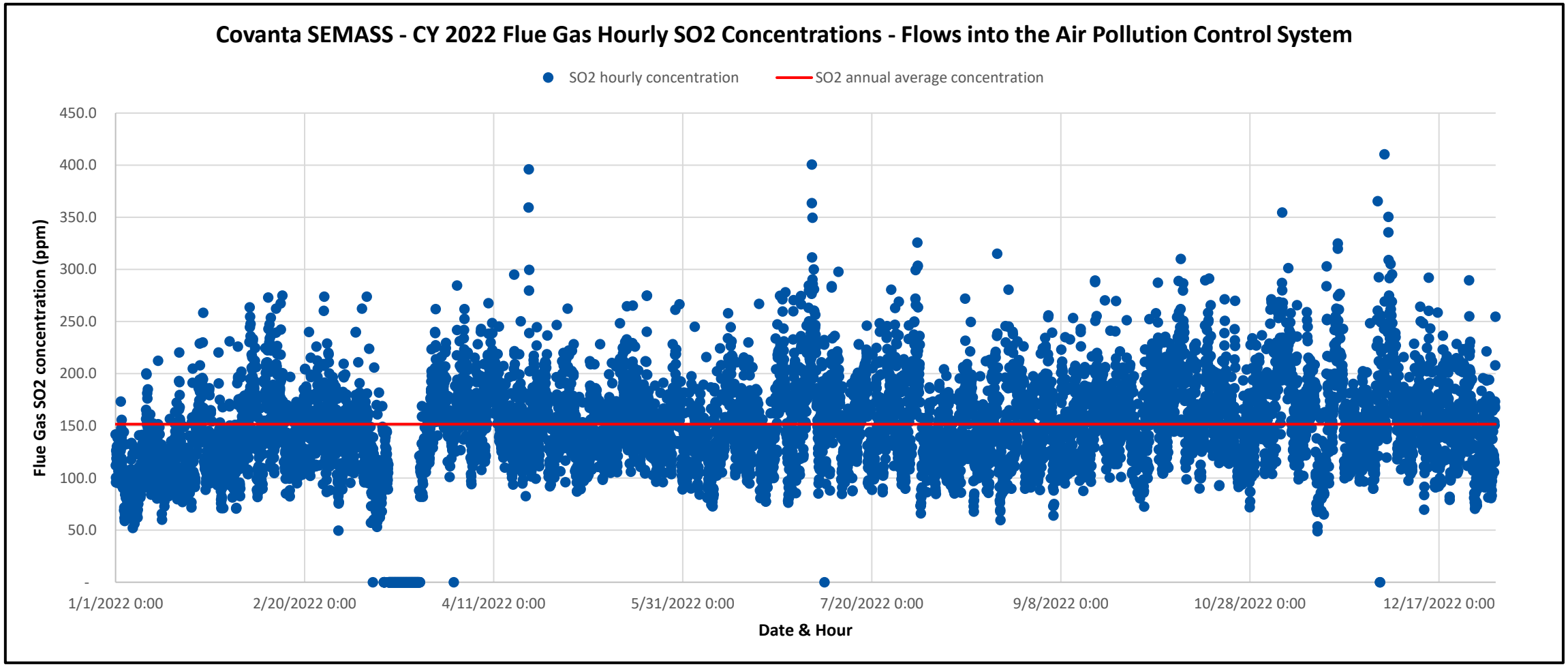
- Gypsum wallboard is mostly calcium sulfate dihydrate mineral combined with thin paper coating
- Sulfur in the wallboard directly increases sulfur content in normal MSW or trash
- Sulfur in the MSW converts to sulfur dioxide flue gas emissions when combusted in WTE boiler (increased SO_2 emissions)
- SO_2 is regulated U.S. EPA “criteria pollutant”

Simplified MSW Combustion in Waste-to-Energy (WTE) boiler when mixed with Gypsum Wallboard

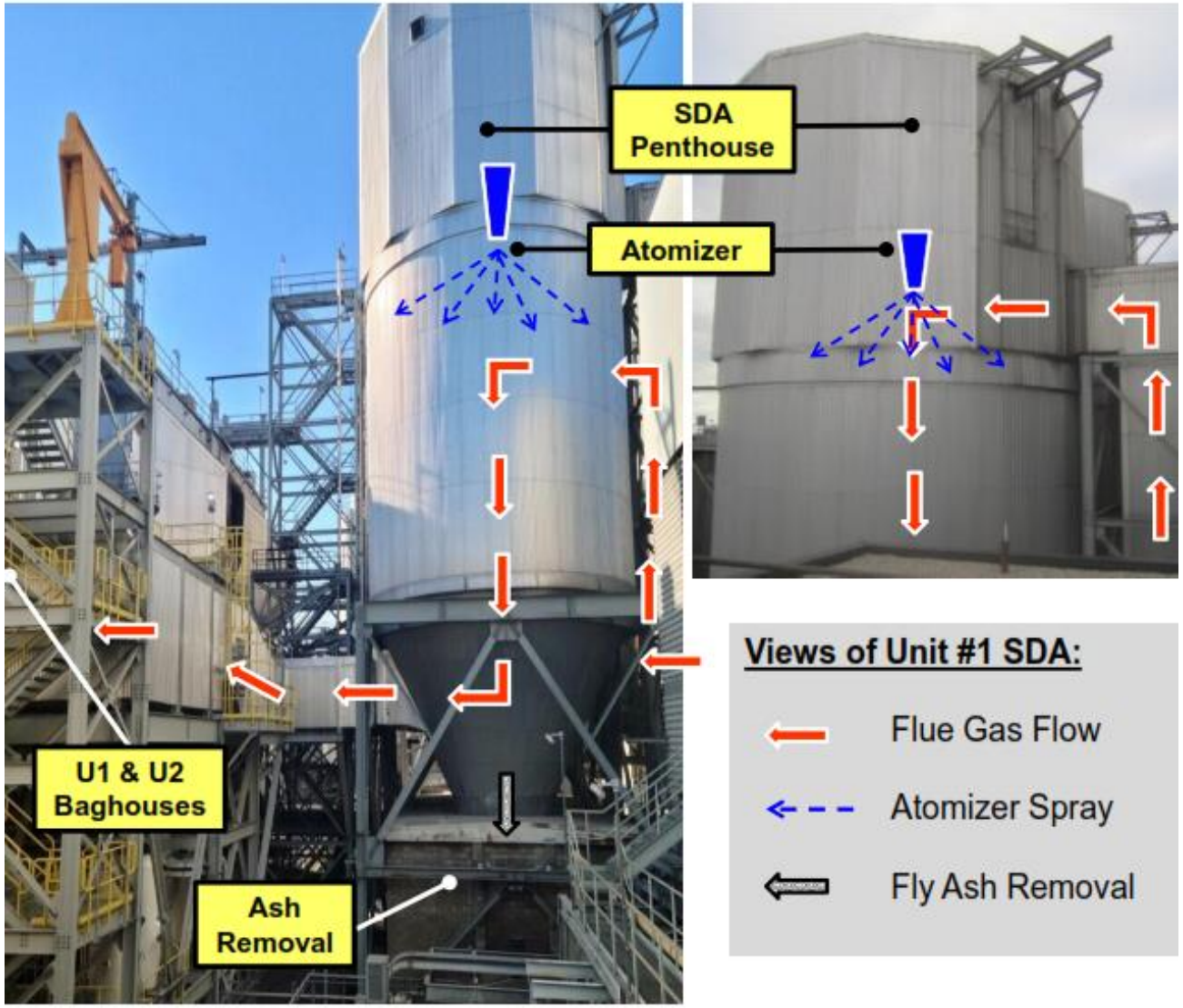
$1\ CaSO_4 \bullet \frac{1}{2}\ H_2O$	$+\ 1.5\ O_2$	$+\ 2\ C$	+ Heat →	$1\ SO_2$	$+\ 1\ CaCO_3$	$+\ 1\ CO_2$	$+\ 0.5\ H_2O$
1 part gypsum wallboard (“calcium sulfate hemi-hydrate”)	*1.5 parts oxygen (from “combustion air”)*	*2 parts carbon (from normal trash or “MSW”)*	*Boiler heat & WTE combustion reaction*	*1 part sulfur dioxide (“air pollutant”)*	*1 part calcium carbonate (“ash” for disposal)*	*1 part carbon dioxide vapor*	*0.5 parts water vapor*

Covanta SEMASS CY 2022: Sulfur Content of Waste

Gypsum wallboard in MSW causes sulfur dioxide (SO2) spikes in Combustion Flue Gas (values > 200 ppm)



CEMS (Continuous Emissions Monitoring System)

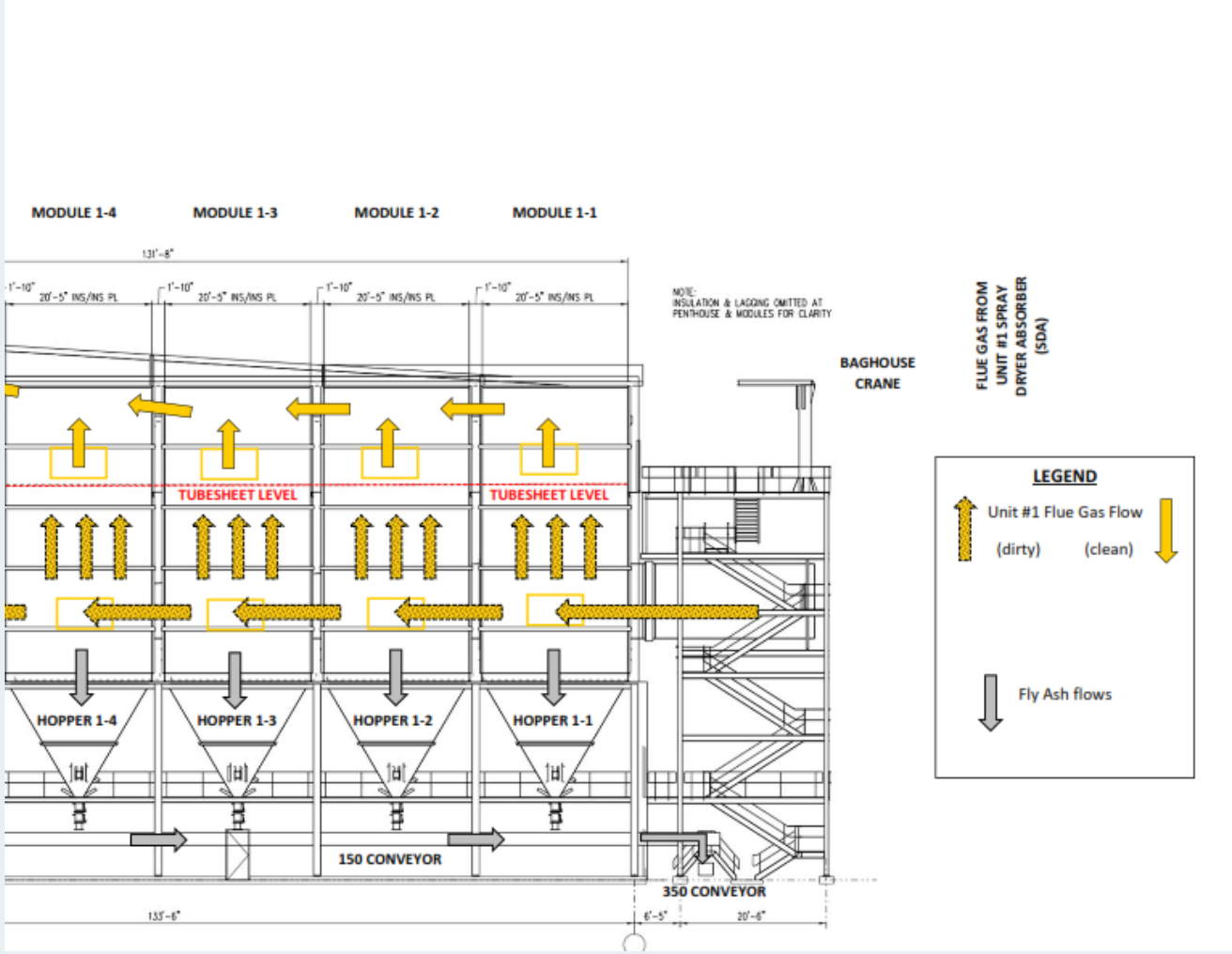


Increased chemical reagent (lime)

- Increased chemical reagent (lime or CaO) required in the Spray Dryer Absorbers (SDA's) to react and "scrub" sulfur dioxide (SO_2) acid gases
- Increased lime needed to meet SO_2 air pollution control limits.
- Increased lime adds operational costs plus generates more fly ash requiring landfill disposal

Particulate Matter (PM)

- Gypsum wallboard combustion adds to fine Particulate Matter (PM) loading to the baghouse filter air pollution control systems
- Requires increased operational costs for pulsing and cleaning baghouse filter compartments.



Increased Ash

- Gypsum wallboard directly adds to increased ash generation as most of it does not combust
- Gypsum wallboard also increases the use of chemical reagent (lime or CaO) needed to meet SO2 air pollutant limits. Reacted lime adds to the ash tonnage
- Ash requires off-site landfill disposal (transport + tip fee costs)

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Sustainable Path Forward:

- Promote C&D recycling/diversion and Facility Siting
  - Better C&D facility coverage in immediate Boston metro area; Cape & Islands (Martha's Vineyard)
- Work to Restore Market Balance in C&D world
  - C&D processing / recycling should be cheaper than MSW processing / disposal
- C&D Generator / Hauler / Processing Facilities - Outreach, Inspections, and Enforcement (if req'd)
  - Reduce the C&D / MSW "blended" loads; too many going to WTE

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Thank You

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