

WASTE & ENERGY: WHERE DO WE GO FROM HERE?

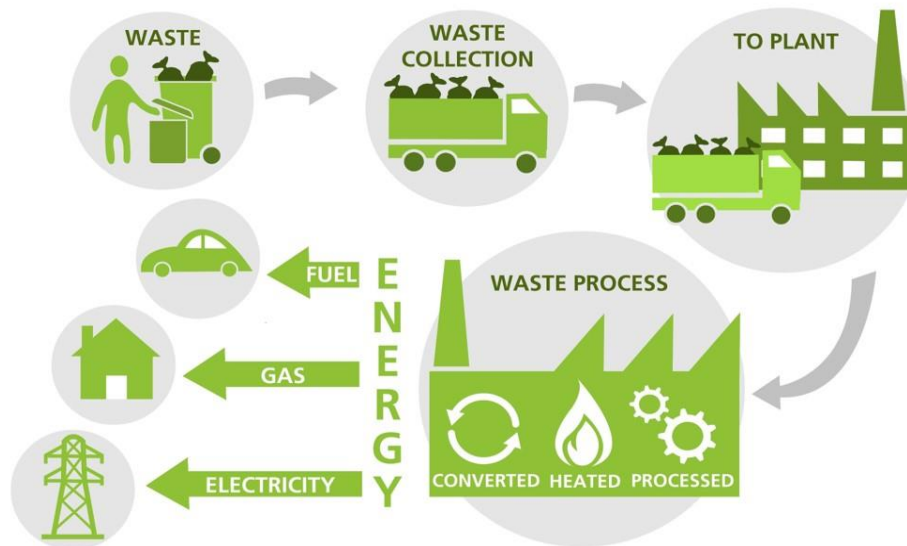
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WASTE TO ENERGY

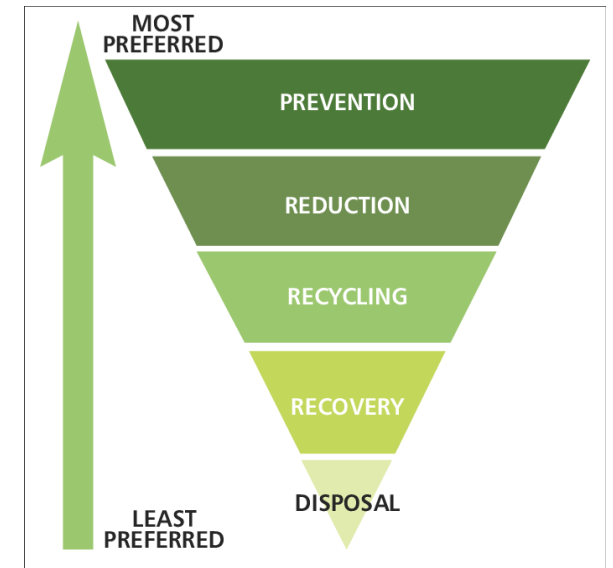
- Waste-to-Energy uses heat from the fire to make steam for generating electricity or to heat buildings.
- In 2019, 67 U.S. power plants generated about 13 billion kWh of electricity from burning nearly 25 million tons of combustible MSW.
- WTE plants reduce 2,000 lbs. of garbage to ash weighing about 300 – 600 lbs., and they reduce the volume of waste by 87%.
- Most European countries rely heavily on WTE as a way to manage solid waste.

Source: U.S. Energy Information Administration

WASTE TO ENERGY SYSTEM

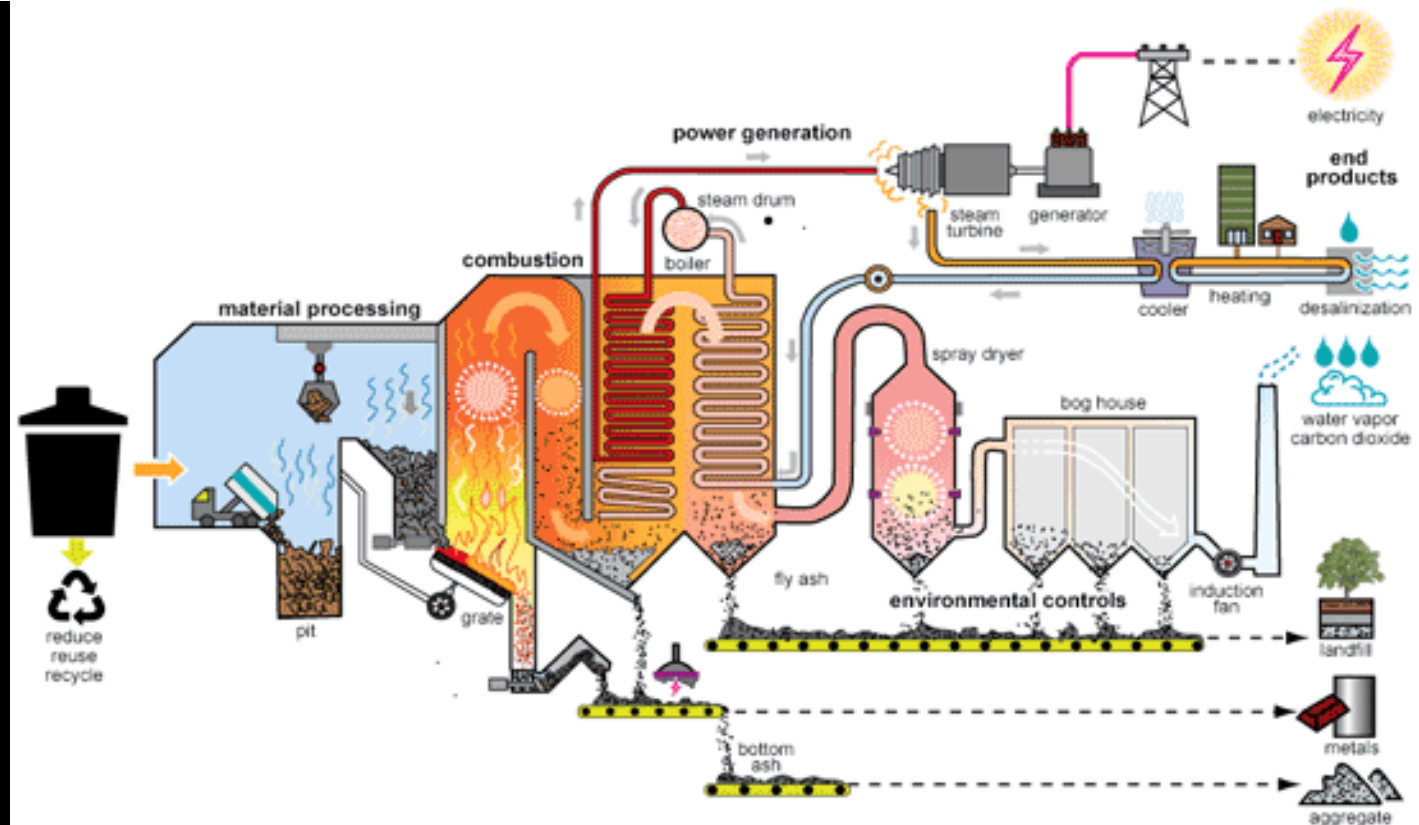


WASTE HIERARCHY



WASTE TO ENERGY PROCESS

1. Waste is dumped from garbage trucks to be shredded to turn into RDF
2. Waste is dumped into a combustion chamber
3. The waste (fuel) is burned, releasing heat
4. The heat turns water into steam in a boiler
5. The high-pressure steam turns the blades of a turbine generator to produce electricity
6. An air pollution control system removes pollutants from the combustion gas before it is released through the smokestack
7. Ash is collected from the boiler and the air pollution control system





WASTE-TO-ENERGY ENERGY SOURCE

- Recognized by the EPA as a form of renewable energy
- 4% of U.S. / 2% of MN renewable energy comes from biomass waste
- Potential to generate enough electricity to supply 13.8 million homes with power.
- Wilmarth Power Plant (Mankato): produces enough electricity to power 20,000 homes
- In 2019, 67 U.S. power plants generated about 13 billion kWh of electricity from burning nearly 25 million tons of combustible MSW
- Resource Savings: 200,000 barrels of oil each year
- 24/7 Availability: Reliable Baseload Power



WHAT'S BETTER?

WASTE-TO-ENERGY WASTE MANAGEMENT

2019	State of MN	Blue Earth County	GHG Emissions (CO2)
WTE	1,066,820 tons	27,837 tons	-2,850 metric tons
Landfill	2,137,606 tons	24,822 tons	6,035 metric tons

Total GHG Savings in BEC: -73,690 metric tons

- Removes annual emissions from 16,000 vehicles
- Conserves 8 million gallons of gasoline
- Conserves 12,000 homes' electric use for one year

Waste Management Practice

- Materials Recovery
- WTE typically reduces waste volumes by as much as 90% by diverting waste from landfills
- Net greenhouse gas reducer
- More environmental protections
- Potential to preserve more than 6,000 acres / year

BIG'S COPENHILL: WASTE-TO-ENERGY PLANT

- WTE plant with an environmental education hub and an urban recreation center comprising of a ski slope, hiking trail, and a climbing wall
- Copenhill was retrofitted by the Bjarke Ingels Group (BIG) in 2017 & opened the recreational ski area in 2019
- Capable of converting 440,000 tons of waste into clean energy for 150,000 homes annually
- Plant delivers the best environmental performance with hardly any environmental emissions which enables this industrial complex to have neighbors as close as a tenth-of-a-mile. It's the cleanest WTE plant in the world.
- Green roof created homes for birds, bees, & flowers, while absorbing heat, removing harmful air particles, and minimizing stormwater runoff.
- New breed of WTE: economically, environmentally, and socially sustainable and redefines the relationship between production and recreation.



RECYCLING FUN FACTS



- Aluminum can be recycled using 5% of the energy used to make the original
 - You can make 20 cans out of recycled material with the same amount of energy it takes to make one new one
- Recycling a single aluminum can saves enough energy to run a TV for 3 hours
- Recycling 1 glass bottle saves enough energy to light a 100-watt light bulb for 4 hours
- Enough energy is saved each year by recycling steel to supply L.A. with electricity for almost 10 YEARS!

LIFESPAN OF COMPONENTS



E-Waste

5 Years



Solar Panels

25-30 Years



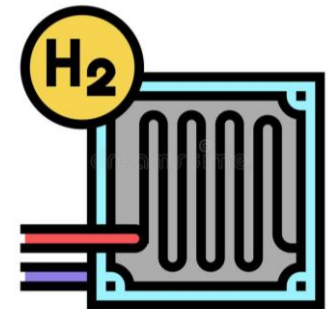
Wind Turbines

20-25 Years



Lithium-Ion Battery

10 Years



Fuel Cells

4.5 Years

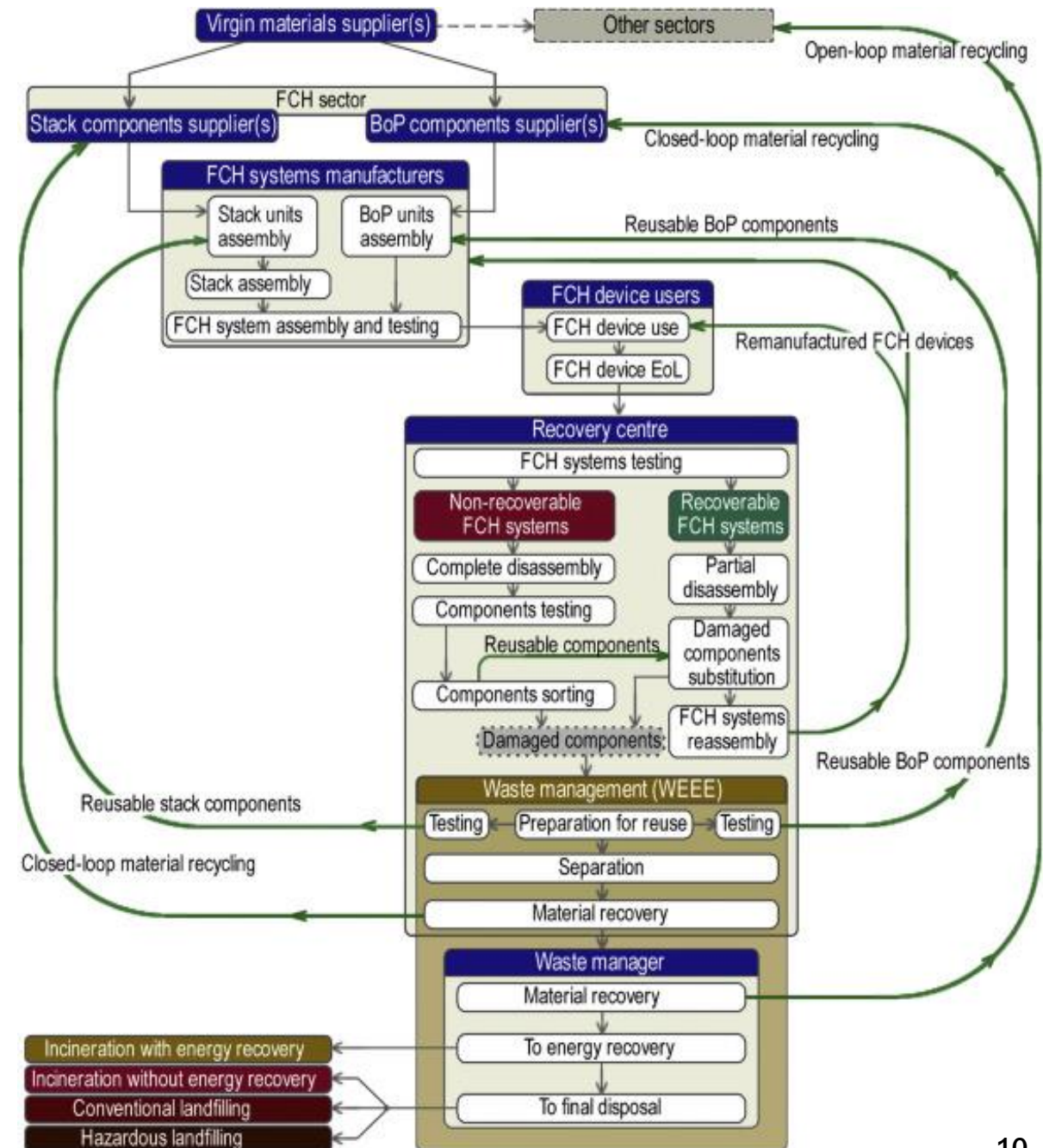
E-WASTE DISPOSAL

- E-waste makes up more than 5% of all municipal solid waste
 - Recycling Rate: 25%
- Minnesota Electronics Recycling Act 115A.1310
 - Video Display Devices
 - Product Stewardship
 - 207 collectors & 67 recyclers
- Working electronics enter reuse / refurbish process
- Obsolete electronics enter the recycling process
 - Dismantled & shredded to optimal sizes
 - Separate parts are sorted through magnets
 - Recycled parts are used to create a new product
 - TVs
 - CPUs
 - Phones
 - Circuit Boards



FUEL CELL DISPOSAL

- Fuel cells are environmentally friendly alternatives to polluting internal combustion engines & batteries with toxic materials
 - Contains no poisonous or hazardous materials
- Feasible to recover & reuse high-value materials from fuel cell membrane electrode assemblies such as platinum
 - Several chemical processes to recover metal in MEAs
 - 95% of precious metals are reclaimed during recycling
 - Other components such as hardware can be recycled normally
- Some places will refurbish fuel cells
 - Saves customers 30% of the cost of purchasing a new fuel cell stack



LITHIUM-ION BATTERY DISPOSAL

- Used in many products such as electronics devices, handheld power tools, small & large appliances, electric vehicles, & electrical energy storage systems.
 - Recyclable materials include: metal compounds, ferrous metal, aluminum, copper, graphite, & plastic
 - Li-ion batteries are made of materials such as cobalt, graphite, & lithium which are considered critical minerals.
 - Regulated under the Resource Conservation & Recovery Act (RCRA)
 - By 2030, the world will generate 2 million tons per year of battery waste
- DOES NOT GO IN THE TRADITIONAL RECYCLING SYSTEM!
 - Fire Hazard (video)
 - Recycle At: certified battery recycler, hazardous waste facility, or manufacturer
 - Process: high-temp melting & extraction or smelting
 - 5% of batteries are currently recycled
 - DOE's New R&D Recycling Program: ReCell
 - Encourages entrepreneurs to find innovative solutions



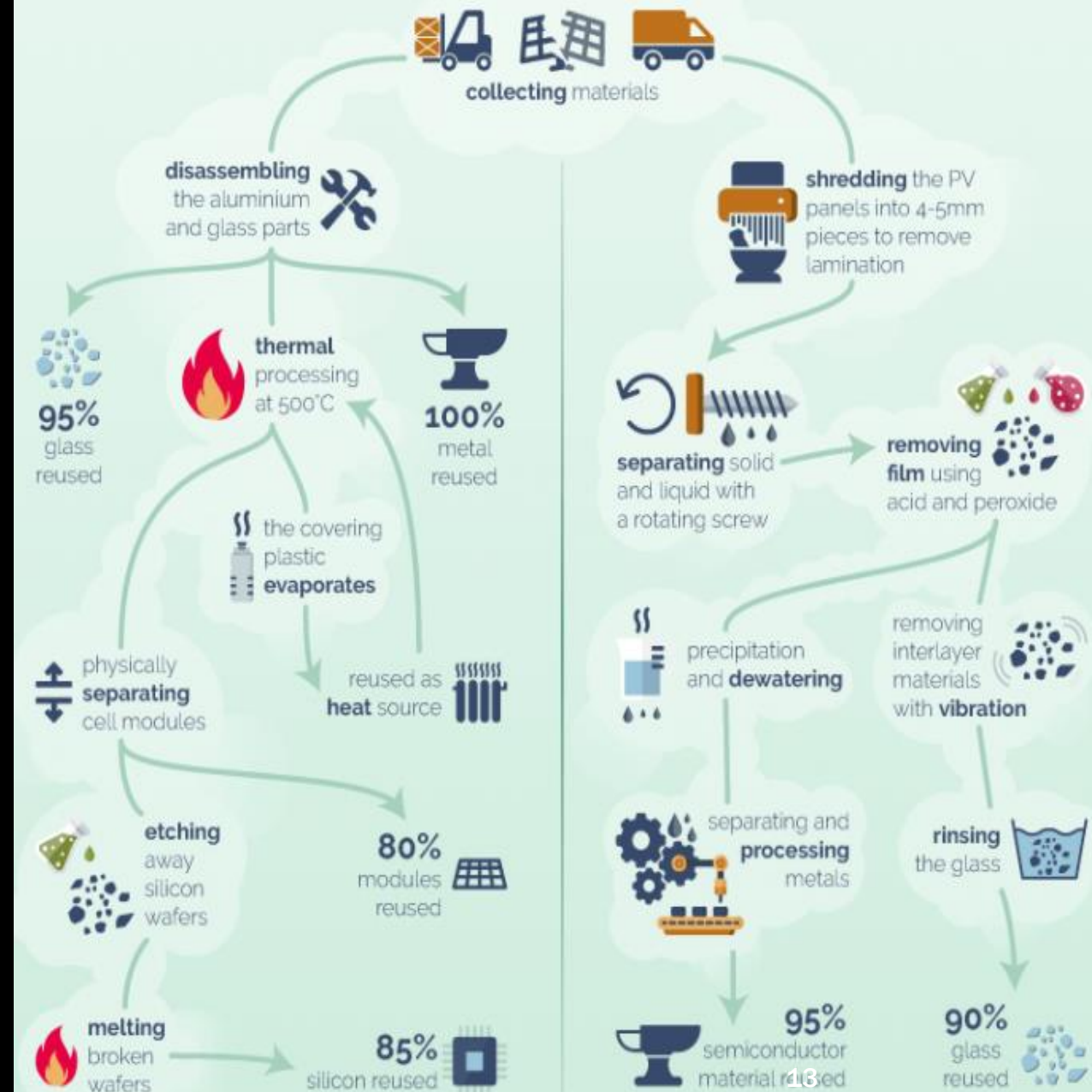


LI-ION BATTERY FIRE

SOLAR PANEL DISPOSAL

- Not mandated to be recycled in the U.S.
 - U.S. has the equivalent weight of 122 Empire State Buildings in solar modules installed
 - Should be recycled like e-waste through a certified recycler
 - Often contain toxic materials such as arsenic, cadmium & lead
 - Washington only state with product stewardship
- Minnesota Solar Panel Regulations
 - Commercial entities need to consider them 'hazardous waste'
 - Working with the Public Utilities Commission on policy
- Different recycling process for all 3 types of solar panels
- 96% of materials can be recycled
 - 90-95% of glass elements
 - 95% of semiconductor materials
 - 85% of silicon materials
- 60 million tons of solar panel waste by 2050

The Recycling Process





WIND TURBINE BLADE DISPOSAL

- A wind turbine blade can be longer than a Boeing 747 wing- 120 ft
- 32,000 to be removed in the next 4 years
 - By 2050, 0.015% of all municipal solid waste
- Can't easily be crushed, recycled, or repurposed
 - 85% of turbine components can be recycled or reused- steel, copper wire, electronics, & gearing
- Disposal Options:
 - Landfilling: costs thousands, takes up landfill space, most landfills do not accept this material
 - Recycling
 - GE Renewable Energy & Veolia Program 2020
 - 90% of the fiberglass will be repurposed for “greener” cement production
 - Net-positive environmental impact by replacing coal & other raw materials in the cement production process



WHERE DO WE GO FROM HERE?

Between 2018 & 2026, research estimates that the WTE industry will see a 70% growth rate in the global market.

- Many facilities are being retrofitted for newer, cleaner technologies
- Policy changes may assist in the expansion as more “dirty” energy sources become less available
- Continued use of an integrated waste management system

Clean energy components will become more recyclable as technology & markets improve.



THANK YOU!

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