Evaluation of Conceptual Alternative Disposal Technologies Update

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1.0 INTRODUCTION

SCS Engineers (SCS) has been contracted by the New River Resource Authority (NRRA) to perform an updated evaluation to supplement the document titled "Preliminary Evaluation of Conceptual Alternative Disposal Technologies" for the Regional Solid Waste Management Facility (Landfill) in Dublin, Virginia. This body of work aims to explore technical and legislative trends in alternative waste disposal methods (or supplemental processes to landfilling) to help inform future decision-making for the NRRA. SCS understands that the deliverables under this task will be used for internal educational purposes.

Previous iterations of this memo have considered several different technologies including anaerobic digestion, fermentation, waste-to-energy (WtE), pyrolysis, gasification, plasma arc gasification, and hydrothermal carbonization. They have also included short descriptions of example vendors currently using these technologies. This iteration provides an update on local trends in waste-to-energy, an overview of recent domestic waste management and recycling policy, and some notable policy/waste management strategies internationally.

2.0 LOCAL WTE TRENDS

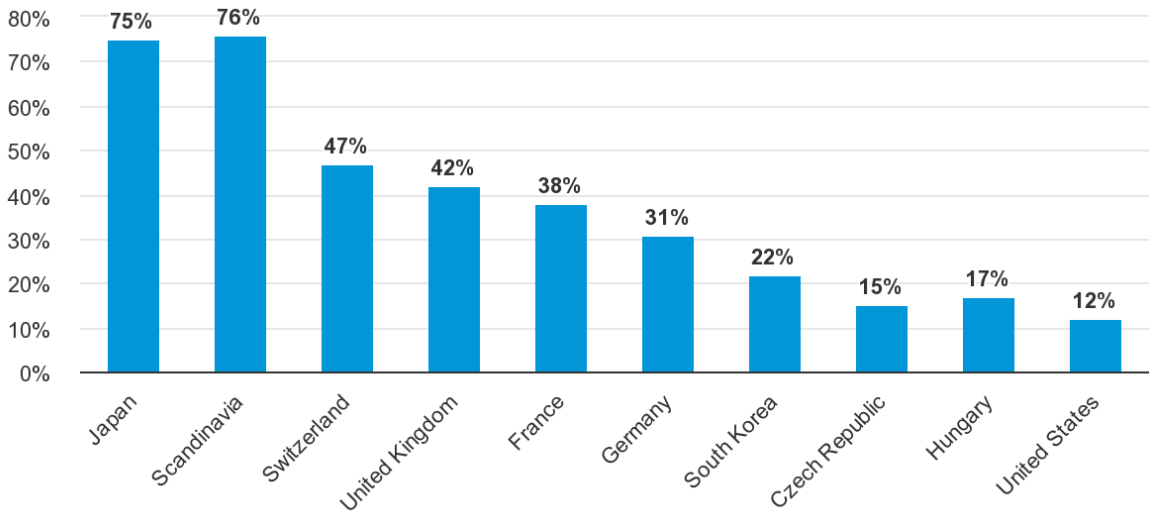
WtE facilities convert solid waste into heat, electricity, metals, ash, and recyclable materials. Waste can be pre-processed to remove plastics and bulky items before being combusted at high temperatures. Besides reducing waste volume by 87%, WtE facilities are crucial in areas with limited landfill space. There are 65 WtE facilities in the United States, three of which are in Virginia (Covanta Alexandria, Covanta Fairfax, and Wheelabrator Portsmouth), two in Maryland (Derwood and Montgomery), and 1 in North Carolina (Asheboro). These facilities are discussed in detail in SCS' 2022 report. A few notable updates on WtE in the region:

- In August 2022, Covanta completed installation of its proprietary NOx reduction technology (LN), in line with improvements made at the Montgomery County and Alexandria facilities. Covanta Fairfax had been the second largest source of nitrous oxide pollution in the DC metropolitan region behind Dulles International Airport prior to these improvements. Covanta's service contract was renewed in 2023 by Fairfax County for service until 2026, when the contract is set to be re-evaluated.
- A fire on a conveyor belt at the Wheelabrator Portsmouth facility in December 2022 caused a bridge closure for 2+ weeks, following a trend of fires at all kinds of solid waste facilities due to combustible incoming materials.
- The contract between Montgomery County and Covanta also runs until 2026, but there was significant pressure from both residents and government officials beginning before 2019. Montgomery County officials at the time told Bethesda Magazine that the County intended to go in a different direction with waste disposal, but not until alternative plans for waste disposal were finalized.
- Virginia's Bland, Smyth, Washington, and Wythe Counties have begun collectively exploring waste-to-energy as a solution for expensive waste shipping since the closure of Bristol Landfill, contracting AECOM to conduct a preliminary study on the potential benefits. The Mount Rogers Planning District Commission is also reaching out to VDEQ and Virginia Energy for potential grant opportunities for a more in-depth follow-up study.
- Pennsylvania DEP adopted more stringent limits for NO_x at WtE facilities.

2.1 MARKET OUTLOOK

The WtE industry is driven by population growth, industrialization, and urbanization. According to Polaris Market Research, the global WtE market was valued at 24.84 billion USD in 2022 and is expected to reach 48.13 billion USD by 2032. **Figure 1** shows the percentage of total MSW processed in WtE facilities by country.

Figure 1. Percent of Total MSW Disposed in WtE Facilities



Source: Organization for Economic Cooperation and Development (OECD), October 31, 2022.
Scandinavia includes Denmark, Norway, and Sweden.
Data for South Korea and Japan are from 2019. Data for the United States is from 2018. All others are from 2020.

Countries with high waste incineration rates, like Japan and some regions of Western European countries, are usually densely populated with limited land available for landfills. The industry is proliferating in regions that have government support for waste-to-energy facilities, limited landfill space, and strict environmental regulations. These regions are concentrated in Western Europe and Southeast Asia.

One WtE-related technology that may become more popular in the United States is gasification. Gasification involves exposing MSW to far higher temperatures than traditional WtE. The MSW does not combust, instead, MSW is converted to electricity, syngas, hydrogen for transportation fuels, and solid by-products. Virginia-based Cogent Energy Systems has created a small-scale, modular ionic gasification technology called the HelioStorm Gasifier. The estimated capacity is less than 5 metric tonnes per day and is designed specifically for small applications such as stabilizing decentralized microgrids. Cogent recently secured funding from the US Navy to build a HelioStorm Gasifier at a yet-to-be-determined Naval facility.

3.0 AMERICAN WASTE MANAGEMENT POLICY

American waste infrastructure and policy are slowly shifting towards more sustainable practices. There is a particular focus on managing organic waste (manures, food waste, sludges, and agricultural waste) and recyclable waste as sustainable resources.

3.1 FEDERAL WASTE MANAGEMENT POLICY

Recent developments in federal waste management policy have primarily consisted of ambitious grant programs to support the construction of sustainable waste infrastructure.

3.1.1 Bipartisan Infrastructure Investment and Jobs Act

The Bipartisan Infrastructure Investment and Jobs Act was signed into law in November 2021. The law commits $1.2 trillion in federal spending over the next five years, $550 billion of which will go directly to new infrastructure spending in a variety of sectors including transportation, the electrical grid, and water resources. This Act contributes the following to waste-related projects:

- $5 billion to expand Superfund site remediation efforts, including brownfield remediation grants for states and tribal governments
- $4.7 billion for methane reduction infrastructure, including orphaned well site plugging, remediation, and restoration
- $1 billion for electric vehicle battery recycling and reuse
- $3.4 billion for carbon capture demonstration and pilot programs
- $350 million for solid waste and recycling grants

Three solid waste and recycling grant programs are administered by the EPA under this law: the Solid Waste Infrastructure for Recycling Grant Program, Recycling Education and Outreach Grant Program, and Battery Collection Best Practices and Voluntary Battery Labelling Guidelines. These grants are available to several entities, including local governments, tribal governments, and some private entities, and are released on a rolling basis each year. Application deadlines for 2022/2023 have closed for these grant programs, but future application cycles may open as funds are still available. SCS believes that NRRA would be eligible for these grants if/when applications open.

3.1.2 American Rescue Plan Act

The American Rescue Plan was signed into law in March 2021. As it relates to the solid waste industry, the American Rescue Plan funds two project types: enhanced air quality monitoring and environmental justice. Both project types receive $50 million each to be distributed by the EPA to grant recipients. The following solid waste industry-related environmental justice grants and initiatives are covered by the American Rescue Plan:

- Environmental justice grants and technical assistance
- Diesel Emissions Reduction Act funding
- Civil and criminal enforcement of water and air pollution near sensitive communities
- Brownfield remediation and redevelopment
- Development and enhancement of EPA environmental justice tools
- Analytical projects under the Office of Air and Radiation
- Policy outreach

The following clean air grants and initiatives are covered by the American Rescue Plan:

- Grant competition for community air quality monitoring
- Direct awards to air agencies for continuous monitoring of common air pollutants
- Enhanced regional capacity for short-term community air monitoring

The application period for these grants has closed and grant funds dispersed to awardees. If any funds are made available in the future, SCS believes NRRA would be eligible for similar grants.

3.1.3 National Recycling Strategy

The EPA has developed a National Recycling Strategy as part of a broader national plan to encourage circular economy practices by reducing demand for raw materials, redesigning products to be less resource-intensive, and recapturing MSW to manufacture new materials and products.

The strategy is aligned with and provides recommendations for, meeting the National Recycling Goal of a 50% recycling rate by 2030. The National Recycling Strategy is an evolving document, and further changes will be made by the EPA in consultation with relevant partners. The document also outlines potential funding opportunities for public and private partners. It can be accessed here.

3.2 STATE WASTE MANAGEMENT REGULATIONS

Trends in new state-level waste management policies are emphasizing sustainable management of organic waste and recyclable waste.

3.2.1 Organic Waste Management

Multiple states including Connecticut, Massachusetts, Rhode Island, and Vermont have passed laws restricting the landfilling of food waste. California and Maryland have passed and begun to implement similar policies.

3.2.1.1 California's Short-Lived Climate Pollutant Reduction Strategy

California's Short-Lived Climate Pollutant Reduction Strategy (SB 1383) was signed into law in September 2016. The policy aims to reduce organic waste disposal in landfills by 50% by 2020 and 75% by 2025. The policy also seeks to rescue 20% of currently wasted edible surplus food by 2025.

SB 1383 requires county governments to collect organic waste as a public service. Cal Recycle estimates that California will need approximately 50-100 new or expanded organic waste recycling facilities to annually treat 20-25 million additional tons of organic waste. SB 1383 requires counties to submit plans for processing this additional waste stream, which must include:

- Capacity planning information from each jurisdiction within the county
- Identification of jurisdictions, including itself, that do not have enough verified existing, planned, or new capacity
    - A timeline for submitting the implementation schedule of additional capacity

The following facility types are considered qualifying organics waste processing facilities:

- Recycling Centers
- Compostable material handling facilities
- In-vessel digestion facilities (including anaerobic digesters and in-vessel aerobic composting)
- Biomass conversion facilities
- Soil amendment for erosion control, revegetation, slope stabilization, or landscaping at landfills
- Land application
- Animal feed

Since January 2022, 75% of communities report they have organic waste collection in place, and 100% of communities have started edible food recovery programs. The remaining jurisdictions have been given more time to comply with the law, and 142 rural local governments have been granted waivers to use self-haul organics collection with waste sorting.

3.2.1.2 Maryland's Organics Recycling and Waste Diversion Mandate

Maryland passed HB 264, "Solid Waste Management – Organics Recycling and Waste Diversion – Food Residuals", in 2021. The law requires commercial food waste generators that generate more than 2 tons of food waste per week (decreasing to 1 ton of food waste per week or more in 2024) to divert their food waste from landfilling towards organic recycling facilities like composting or anaerobic digestion facilities. Food waste diversion requirements only apply to entities within a 30-mile radius of organics recycling facilities that can accept said waste, are willing to accept said waste, and are willing to enter into a contract to accept and process the food waste.

At present, Maryland has 22 permitted compost facilities (20 in operation as of 2021). Of these facilities, 14 only accept yard waste. The others compost some combination of food scraps, yard trimmings, manure, hay, and straw. The Maryland Department of Environment has previously noted that at present most generators will be exempt from the law given that most of them do not fall within 30 miles of a facility capable of accepting food waste. This will change as more facilities open and feedstock becomes more available.

3.2.2 Recycling

In addition to new laws concerning organic waste management, other recycling legislation has been passed into law in California, Maine, Colorado, Illinois, Maine, Delaware, Connecticut, Oregon, and Maryland.

3.2.2.1 Styrofoam Bans

Styrofoam bans prohibiting the sale and distribution of foam or polystyrene of different types have been passed in several states including:

- Maine
- Maryland
- New Jersey
- New York
- Vermont
- Washington DC
- Colorado (effective January 2024)
- Washington (effective June 2024)
- California (effective 2025)
- Delaware (effective 2025)
- The majority of Hawaii (effective 2025)
- Oregon (effective 2025)
- Rhode Island (effective 2025)

Virginia became one of the first states to pass a ban on polystyrene food service containers in 2021. Restaurant chains with more than 20 locations were to comply with the ban by 2023, and all restaurants by 2025. Legislators pushed those dates back by 5 years with an amendment in the states' 2023 budget – to 2028 for restaurant chains with more than 20 locations, and to 2030 for smaller restaurants.

3.2.2.2 Plastic Pollution Prevention and Packaging Producer Responsibility Act

The Plastic Pollution Prevention and Packaging Producer Responsibility Act (SB 54) was passed into law in June 2022. The law addresses the impacts of single-use plastic packaging and food service ware by shifting the plastic pollution burden from consumers and to the plastics industry. The legislation sets the following objectives:

- Cut single-use plastic packaging and food ware by 25% by 2032.
- Recycle 65% of single-use plastic packaging and food waste by 2032.
- Make all packaging and single-use plastic foodware recyclable or compostable.

SB 54 seeks to establish a new extended producer responsibility (EPR) program, similar to EPR schemes adopted by Germany and discussed under this title. This law shifts plastic pollution responsibility to industry stakeholders by raising $5 billion in taxes from the plastics industry over the next 10 years to pay for cutting plastic pollution and supporting disadvantaged, low-income, and rural communities hurt most by the impacts of plastic waste.

4.0 INTERNATIONAL SOLID WASTE MANAGEMENT POLICY AND TRENDS

4.1 WASTE MANAGEMENT IN THE EUROPEAN UNION

The European Union (EU) has made the following ambitious climate-related commitments, driving waste trends in member states. Most of these commitments either set diversion goals or increase extended producer responsibility and aspects of circular economies. Extended producer responsibility (EPR) is a policy approach that assigns producers responsibility for their end-of-life products. This can be accomplished with funding generated from producers, oversight from government agencies, and/or producers using services to manage end-of-life products (at their expense).

4.1.1 European Climate Change Law

The European Climate Law codifies and sets benchmarks for the EU Green New Deal.

The law establishes a 55% emissions reduction target by 2030 compared to 1990 levels, and complete climate neutrality by 2050. The Climate Change Law incentivizes utilizing non-traditional waste management technologies that produce fewer fugitive GHG emissions than traditional waste management practices like landfills.

4.1.2 Waste Framework Directive

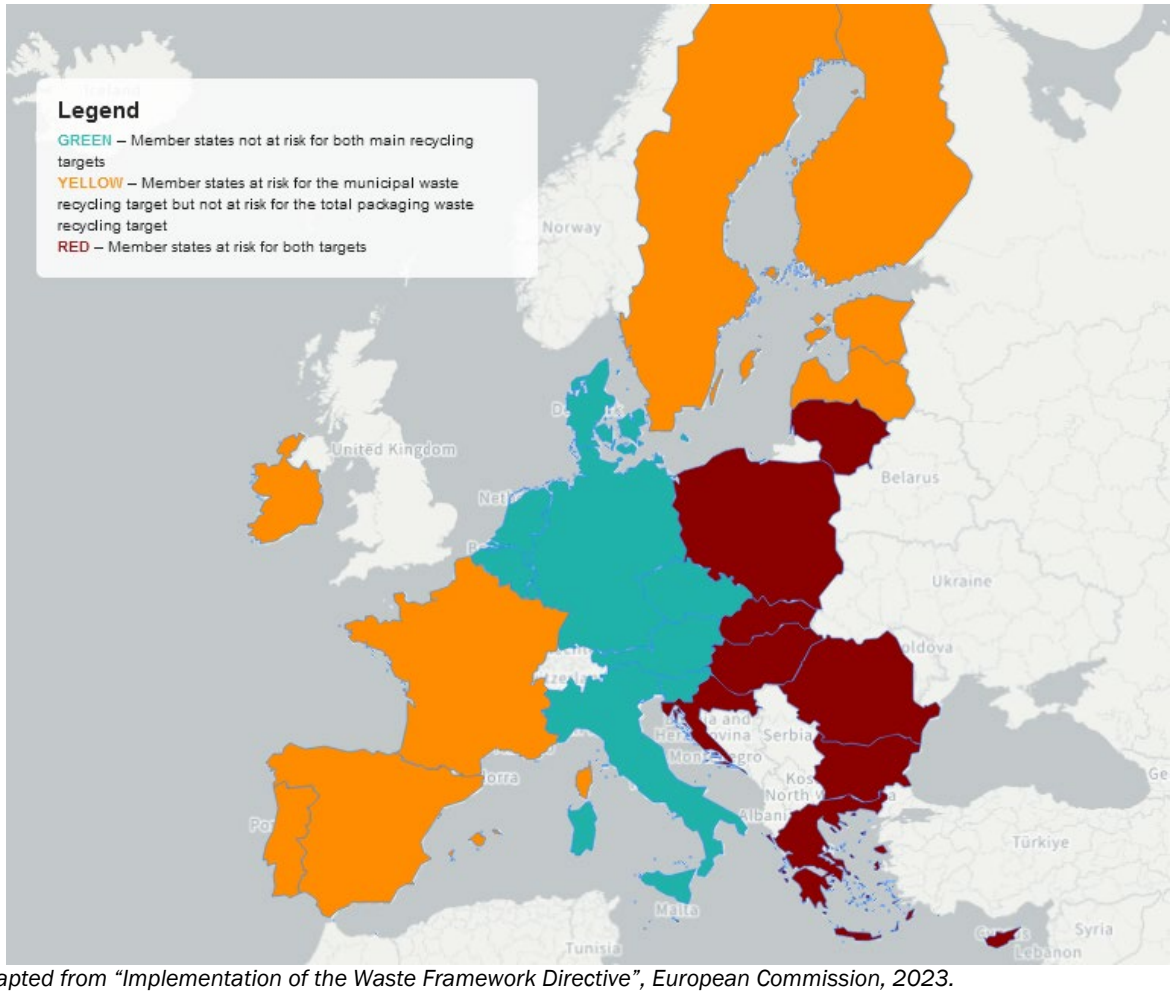
The Waste Framework Directive provides essential definitions, recycling and reuse targets, expanded labeling for hazardous wastes, a legal framework for managing waste, and introduces guidance for Extended Producer Responsibility (EPR) and polluter pays principle schemes.

In EPR regimes, the industry bears a degree of responsibility for the environmental impacts of their products throughout the product life cycle. The framework strengthens rules on waste prevention and waste generation, establishing these collection and disposal benchmarks and policies:

- By 2020, at least 50% by weight of reusable and recyclable materials (such as paper, metal, plastic, glass, etc.) from households must be recycled or reused. And at least 70% by weight of construction and demolition debris must be recycled or reused.
- By 2023, member states must ensure that all bio-waste is collected separately or source-recycled (for example with backyard composting).
- By 2025, at least 55% of MSW by weight will be recycled. By 2030 at least 60% of MSW by weight must be recycled, and 65% by 2035. Member states must also establish separate collections of textiles and hazardous waste generated by households.

Figure 2 summarizes which member nations have met the 2025 benchmarks. According to a 2023 report published by the European Commission, 9 member states are on track to meet the 2025 benchmarks (Austria, Belgium, Czechia, Denmark, Germany, Italy, Luxembourg, The Netherlands, and Slovenia) and 18 member states are at risk of missing one or more benchmarks.

Figure 2. Member State Compliance with 2025 Benchmarks



Adapted from "Implementation of the Waste Framework Directive", European Commission, 2023.

4.1.3 Landfill Directive

In 2001, the EU adopted The Landfill Directive, which acts much like the US EPA's federal landfill requirements. Before these permitting requirements were adopted, individual member nations set all requirements for landfill permits.

The Landfill Directive was amended in 2018 to add the following policies, among others:

- By 2030, waste suitable for recycling, material recovery, or energy recovery will be restricted from dumping at landfills.
- By 2035, the amount of MSW sent to landfills must be less than 10% of the total tonnage.
- Member states may use economic instruments and other measures to encourage the application of the waste hierarchy first proposed in the Waste Framework Directive.

4.1.4 Packaging and Packaging Waste Directive

The Packaging and Packing Waste Directive establishes baseline policies for managing packaging waste across the EU. Under this directive, by December 31, 2025, 65% (by weight) of packaging waste must be recycled, with individual targets established per material, i.e., 50% of plastic, 25% of wood, etc. By December 31, 2030, 70% (by weight) of all packaging waste must be recycled, with correspondingly increased targets per material (55% of plastic, 30% of wood, etc.).

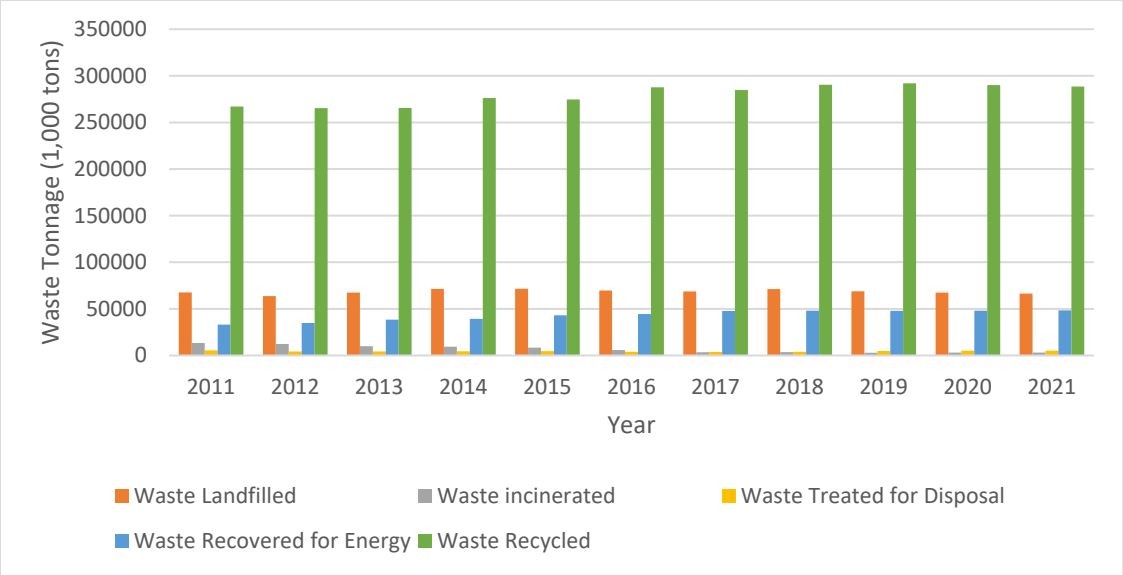
In addition, the Packaging and Packaging Waste Directive places specific requirements for producers and sets forward protocols for the calculation, reporting, and verification of data supplied by EU member states.

4.1.5 Waste Management in Germany

Part of this assignment was to examine the state of waste management in Germany specifically. Germany has already met and exceeded the recycling rates for MSW and packaging that are prescribed by the Waste Framework Directive and the Packaging and Packaging Waste Directive. It has also decreased its MSW landfilling rate as prescribed by the Landfill Directive. Germany has been the leader in the recycling industry in Europe for decades. Recycling targeting the raw materials for lithium-ion batteries like cobalt, manganese, nickel, and lithium is expected to grow significantly over the next decade, especially as EU regulations concerning the disposal of batteries are tightened while the electric vehicle market expands.

Germany has been able to meet the EU's goals for landfill diversion with a high recycling rate and widespread use of alternative disposal methods. Figure 3 summarizes the total weight of waste generated annually and a breakdown of the waste tonnages by treatment type.

Figure 3. Waste Tonnage by Treatment Type



Data sourced from the Federal Statistical Office of Germany.

The majority of waste recovered in Germany is either for energy production or to be recycled, with recycling making up the majority of overall recovery. Recycling rates have remained over 67% for over a decade, and rates of waste recovered for energy have remained similarly consistent (between 9% and 12% of the total waste treated) during the same period.

4.1.5.1 Transboundary Waste Movement

Despite these accomplishments, Germany was a still net importer of waste from other EU member nations until very recently. Increased waste import trends can be attributed to the WtE industry and indirectly to the recycling industry. Strong regulation and market preference for recycling in Germany created feedstock scarcity in these alternative disposal facilities. To deliver consistent energy and remain profitable, WtE power plants need consistent feedstock.

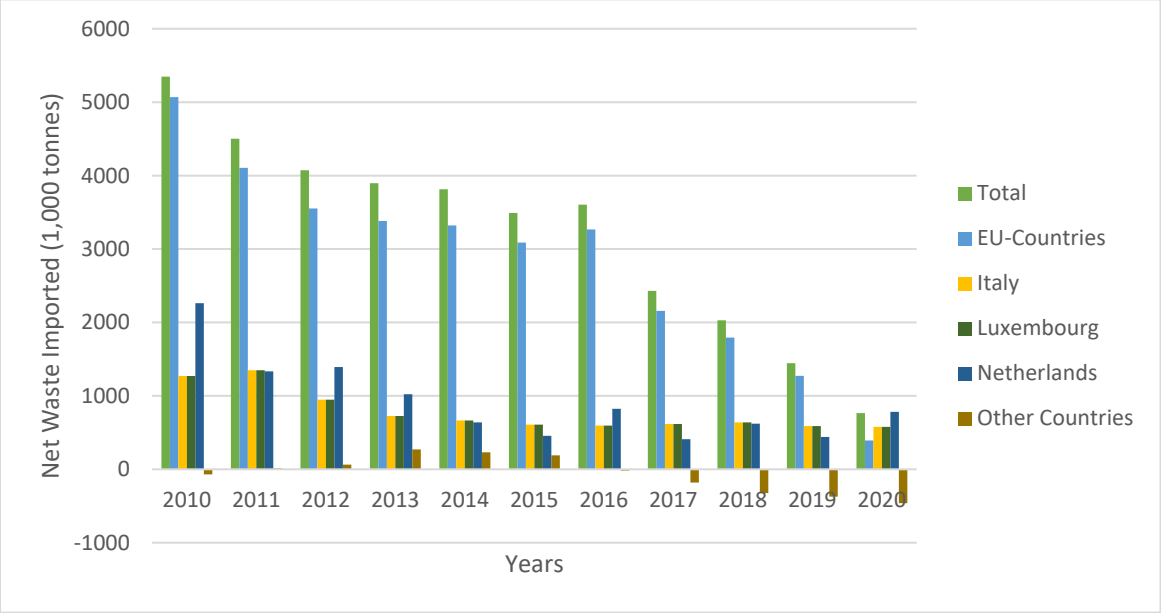
Germany has generated attention for importing larger quantities of waste than its neighbors until recently while maintaining high rates of waste recovery. The greatest amount of waste imported from EU countries comes from Italy and the Netherlands (**Figure 4**). Outside of the EU, Switzerland and the United Kingdom export the most waste to Germany (**Figure 5**). Over time, the net amount of waste imported to Germany has decreased from a high of over 5 million tonnes to just over 1 million tonnes in 2020.

Waste trends are changing. A greater percentage of electricity in Germany is coming from other renewable energy sources like wind and solar. In June 2023 renewable energy sources accounted for 50.3% of power production, almost double that same statistic a decade ago. The burst in renewable energy sources has decreased reliance on WtE. This trend is expected to continue as regulations and market pressures for renewable energy sources prevail over fossil fuel and combustion sources. Germany has made commitments to increase power production from renewable sources to 80% by 2030.

Waste to Energy facilities will likely be slowly phased out as recycling rates climb (resulting in less feedstock) and the prevalence of alternative energy rises. The problem is demand. Recycling is

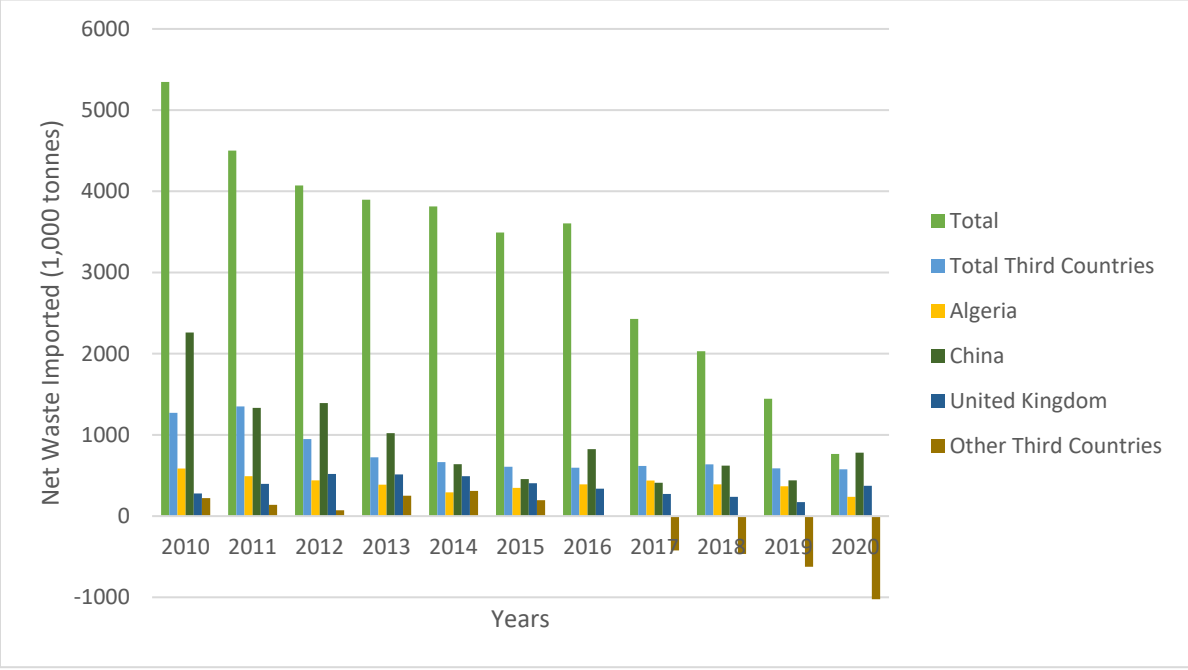
popular with customers and operators alike and lucrative, especially with backing from the EU. Waste-to-energy facilities simply do not have the market space to grow.

Figure 4. Net Waste Imported to Germany by EU Country



Data sourced from the Federal Statistical Office of Germany.

Figure 5. Net Waste Imported to Germany by Non-EU Country



Data sourced from the Federal Statistical Office of Germany.

4.2 WASTE MANAGEMENT IN SINGAPORE

Singapore is an example of novel adaptation of waste management techniques and technologies to physical constraints. Singapore is a large city and sovereign state in Southeast Asia, only slightly smaller and less dense than New York City. It is consistently ranked among the top 3 wealthiest countries globally, higher than the United States.

Since the late 1970s, Singapore has shifted towards using WtE technologies to dispose of MSW because of the growing population, increasing annual tonnage of MSW, and extremely limited land mass. Its first WtE facility was commissioned in 1979.

At present, 37% of Singapore's MSW is incinerated at one of 4 facilities, and 60% is recycled (NEA, 2023). The remaining 3% is landfilled at Semakau Landfill. Singapore has committed to reaching 70% of waste recycled by 2030. Recyclables are source-separated from other waste and sent to recycling facilities at the Sarimbun Recycling Park, and the rest is collected and sent to WtE facilities for incineration. The remaining ash from incineration is then sent to Singapore's main landfill.

Even Semakau Landfill has been adapted to limited land space: it is a marine landfill. It is located 8km south of Singapore and off the islands Pulau Semakau and Pulau Sakeng. The 7 km-long perimeter rock causeway is lined with an impermeable membrane and marine clay to minimize leachate escape to the ocean. Waste is delivered by barge and deposited within the causeway. Once cells have been filled to ground level they are sealed with layers of soil and replanted with vegetation.

Construction of a new waste recovery/disposal location, the Integrated Waste Management Facility (IWMF), will begin in 2025. This facility will serve as a central location for the disposal of different types of waste, including MSW, organic waste, and dewatered water treatment plant sludge.

This centralized waste management location is intended to increase resource recovery with its connection to the Taus Water Reclamation Plant (TWRP), optimize land use and maximize energy and resource recovery by minimizing transportation needs.

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