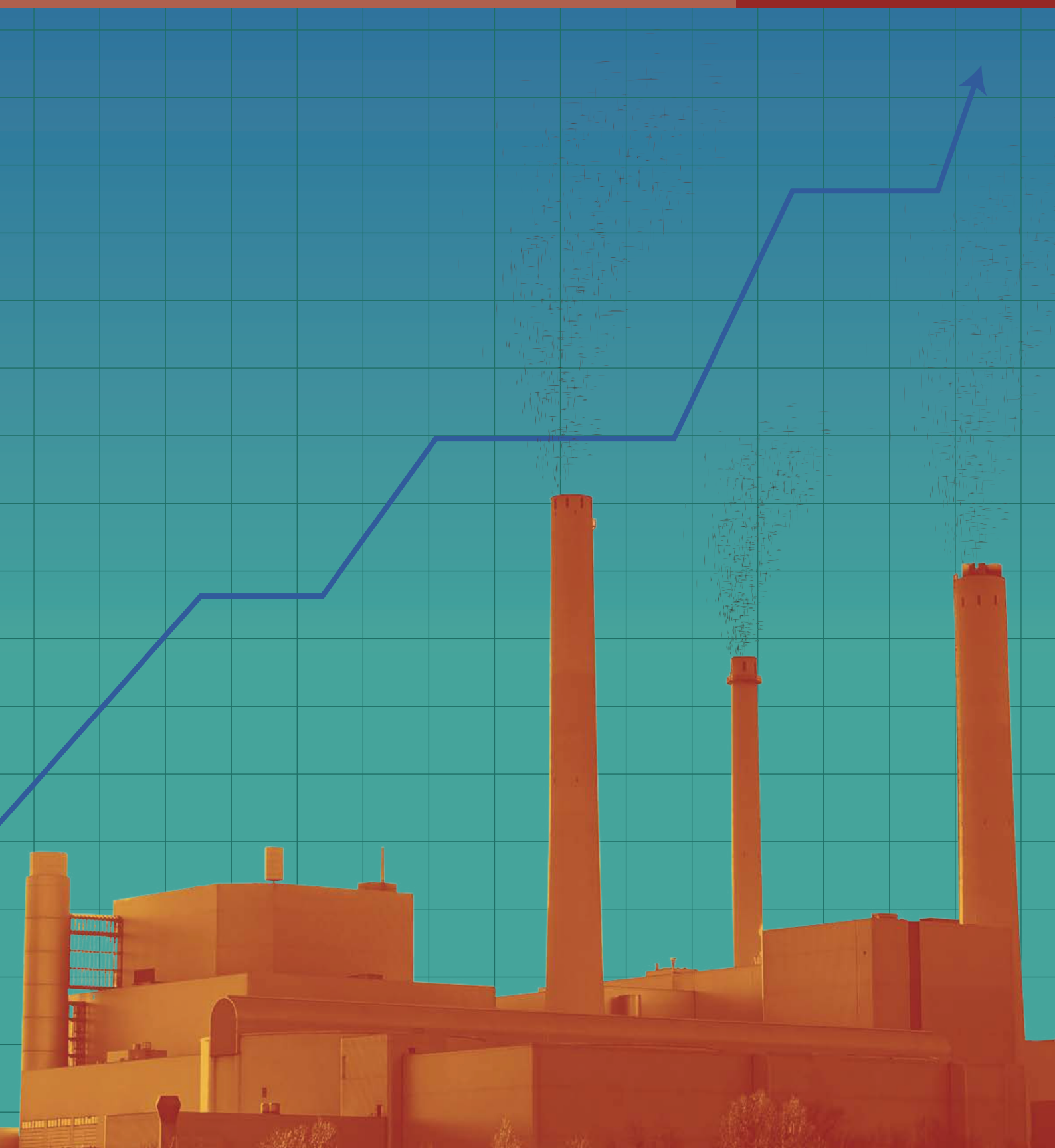


The High Cost of Waste Incineration



#Beyond Recovery





As the most expensive mechanisms for waste management and generating energy, so-called “waste-to-energy (WTE)” incinerators are a waste of money and resources that could otherwise be directed at more cost-effective and sustainable zero waste solutions.

Incineration is the most expensive way to handle waste

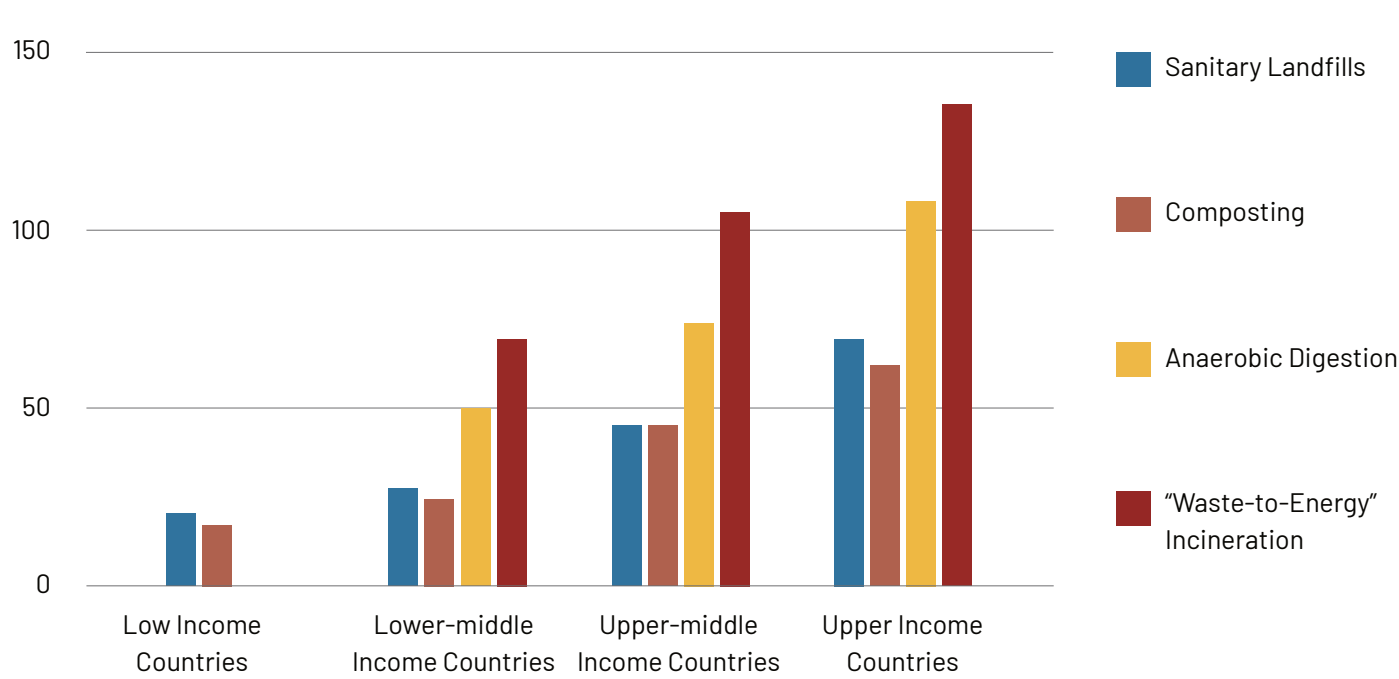
Waste incineration is undeniably costly and capital intensive. It is estimated to cost USD 190 million - USD 1.2 billion to build an incinerator with a capacity of processing 1 million tonnes of waste per year¹. Both capital expenditure and operational expenditure are among the highest for waste-to-energy (WTE) incineration compared to other waste management options such as composting, anaerobic digestion, and landfills.

Figure 1. Capital expenditure of WTE incineration and landfill

	WTE Incineration (USD/tonne/year)	Sanitary Landfill ² (USD/tonne over lifetime)
Europe ³	600-1200 ⁴	
USA	600-830	
China	190-400 ⁵	
Global		5-50 ⁶

Source: World Bank (2018). Decision Maker’s Guides for Solid Waste Management Technologies unless otherwise noted separately.

Figure 2. Operational expenditure of different waste management options (USD/tonne)



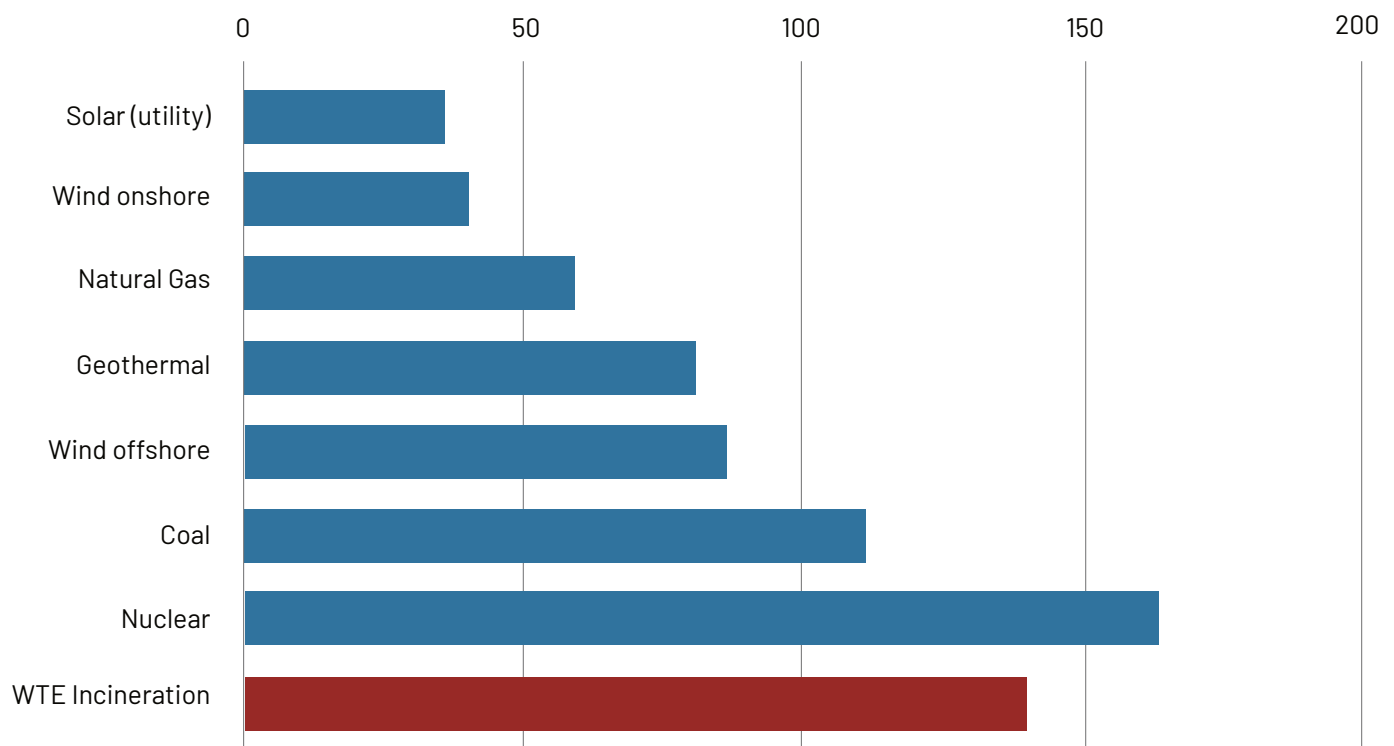
Source: World Bank (2018).⁷ Operational costs generally include labor, fuel, and equipment maintenance. For incinerators, additional expenditures occur during monitoring and compliance for air emissions, wastewater, and ash disposal.

WTE incineration is an expensive way to generate energy

Burning waste for energy recovery costs more than most existing energy sources per same unit of energy. **It costs nearly 4 times more than solar power and wind**

energy (onshore), and costs more than twice as much as natural gas; WTE incineration is even more expensive than coal power by 25%.

Figure 3. Global levelized cost of generation (USD/megawatt hour)⁹



Source: Lazard. (2020). Levelized Cost of Energy and Levelized Cost of Storage – 2020⁹; U.S. Department of Energy. (2019, August). Waste-to-Energy from Municipal Solid Wastes.¹⁰ See [data table](#) for more detail.

Proponents of WTE incineration argue that incinerators can take care of waste while generating electricity. However, municipalities can cut both waste management and electricity generation costs in half by deploying a zero waste approach and using solar power as an energy source.¹¹

• **USD 134,000** is required for **an incinerator** to burn 1,000 tonnes of municipal solid waste and generate 573,000 KWh during the process.

• **Total USD 56,000** is required to manage 1,000 tonnes of municipal solid waste through **separate collection, recycling, composting, and minimal landfilling** and generate 573,000 KWh through **solar power**.

Source: World Bank (2019). What a Waste 2.0; Lazard. (2020). Levelized Cost of Energy and Levelized Cost of Storage – 2020; U.S. Energy Information Administration. (2020). Biomass explained: waste-to-energy (municipal solid waste).



WTE incineration requires hefty upgrades

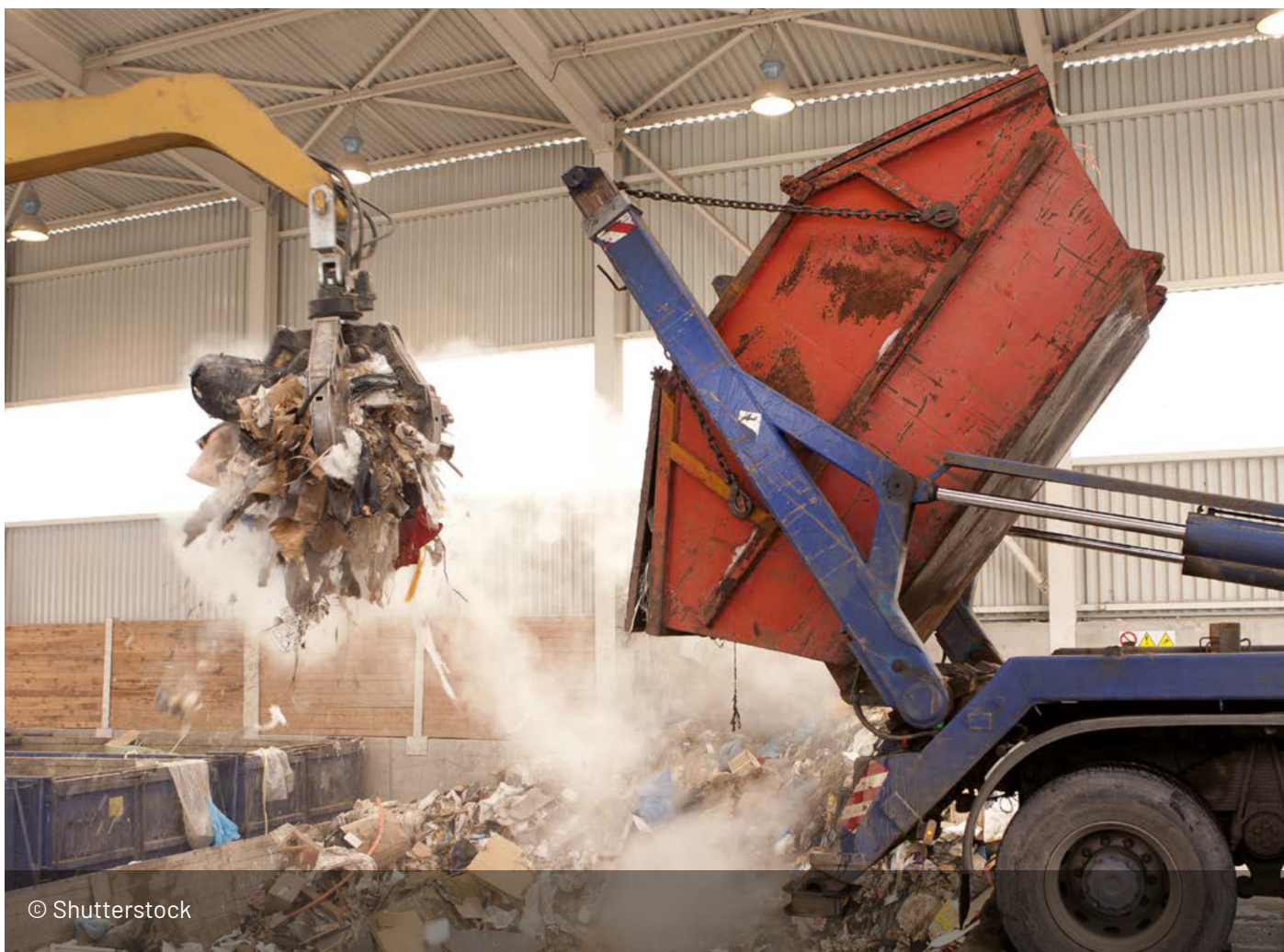
Incinerator operators need to keep improving pollution control equipment in order to comply with emission regulations. Costly upgrades often become a major factor in facility shutdown, as the revenues are not sufficient to cover the additional expenditure.

In the U.S., at least 31 municipal solid waste incinerators closed between 2000 and 2020, largely due to the financial burden caused by necessary pollution control requirements.¹²

- For three decades, the city of Detroit in the U.S. paid over USD 1 billion to build and operate a WTE incinerator: it cost USD 478 million to build the incinerator, and an additional USD 179 million was required for pollution control equipment.¹³ Following strong community resistance and legal actions against the company's 600 emissions violations between 2014 and 2019, the company abruptly shut

down the facility in 2019 as more costly upgrade needs were identified.¹⁴ While it was running, the city lost USD 2.6 million in health costs each year.¹⁶

- The infamous Amager Bakke incinerator in Copenhagen is not only known for the astronomical investments – at least 500 million euros – it consumed but also for costly technical failures.¹⁶ During its construction, the failed installation of combustion furnaces cost an additional 13 million euros and a seven-month delay.¹⁷ After the facility exceeded emission limits for dioxins for its third consecutive year since 2014, the Danish Environmental Protection Agency (EPA) issued an order to immediately comply with the statutory limits of toxic emissions through additional emission monitoring and continuous cleaning practices.¹⁸



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WTE incineration has a 'lock-in' effect

WTE incinerators require a constant supply of waste to be able to keep running, often hindering policies and programs designed to reduce waste at the source.

As seen in a number of countries including Sweden, Denmark, the U.K., Germany, the Netherlands, South Korea, and mainland China, municipalities have struggled with over-investments in WTE plants and unused capacity of the infrastructure (also called "plant overcapacity").¹⁹ In such situations, they may end up sourcing waste to burn from adjacent districts, effectively serving as a dumping ground for other places.

“A large scale modern thermal WTE plant requires at least 100,000 tonnes of MSW per year over its lifetime. As with all large investment projects, thermal WTE can potentially create lock-in effects that may lead to plant overcapacity and hamper efforts to reduce, reuse and recycle.”²⁰

- United Nations Environment Programme, 2019.



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There are affordable and sustainable zero waste solutions

With the same amount of money it takes to build one Best Available Technology (BAT) WTE incinerator (USD 1.2 billion for 1-1.5 million tonnes per year capacity²¹) we can instead:

- = Build approx. 3 in-vessel composting facilities (USD 240-350/tonne for approx. 1 million tonnes, Western European costs)²²
- = Build approx. 12-24 reuse centers and recovery parks²⁵ in Los Angeles, USA (USD 50-100 million/facility)²⁶
- = Build approx. 8 material recovery facilities (USD 80-150/tonne, for approx. 1 million tonnes Western European costs)²³
- = Build approx. 12,000 reuse drop-off sites²⁷ in Austin, USA (approx. USD 100,000/site)²⁸
- = Operate approx. 1200 years of separate collection systems for organic waste in Melbourne, Australia (up to USD 1 million/year)²⁴

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Endnotes

- 1** 300 operating days assumed on account of stops during yearly maintenance
- 2** Costs of material recovery and biological treatment (MRBT) should be considered in places with bans on direct landfilling; capital cost of MRBT is USD 240–480 per tonne in Western European countries. ARUP. (2019, June). Theme 3– Financing waste projects. <https://drive.google.com/file/d/1zGwX6gbAis-Pn7Wz4TuN0LoTilaOcp8y/view>
- 3** In Europe, the operational costs of an incinerator range from EUR 60 – 65, including costs associated with final disposal in landfills. Favoino, E. (2020, June). Building a Bridge Strategy for Residual Waste. Zero Waste Europe. https://zerowasteurope.eu/wp-content/uploads/2020/06/zero_waste_europe_policy_briefing_MRBT_en.pdf
- 4** In Europe, newer incinerators typically cost 1000 EUR per tonne to build. Favoino, E. (2020, June). Building a Bridge Strategy for Residual Waste. Zero Waste Europe. https://zerowasteurope.eu/wp-content/uploads/2020/06/zero_waste_europe_policy_briefing_MRBT_en.pdf
- 5** In many Southeast and South Asian countries, the capital expenditures for incinerators are significantly lower as the facilities are often built without air emission control equipment. See <https://youtu.be/Kaz9Vpcb9gQ>
- 6** Common industry benchmark for construction is USD 1 million per hectare and it typically costs approximately USD 30,000–200,000 per hectare. World Bank (2018). Decision Maker’s Guides for Solid Waste Management Technologies
- 7** Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Urban Development;. Washington, DC: World Bank. <http://hdl.handle.net/10986/30317>
- 8** The levelized cost of energy (LCOE) is a measure used to compare different energy sources on a consistent basis. World Bank (2018). Decision Maker’s Guides for Solid Waste Management Technologies
- 9** Lazard. (2020). Levelized Cost of Energy and Levelized Cost of Storage – 2020 <https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2020/>
- 10** U.S. Department of Energy. (2019, August). Waste-to-Energy from Municipal Solid Wastes. Estimates only. <https://www.energy.gov/sites/prod/files/2019/08/f66/BETO–Waste-to-Energy-Report-August–2019.pdf>
- 11** Operational expenditures of WTE incineration and a zero waste approach (maximized collection, recycling, and composting) were used in the calculation (source: World Bank’s What a Waste 2.0 report). For solar power costs, a levelized cost which includes both capital and operational expenditures was used (source: Lazard). Please see ‘Zero Waste Systems: Small Investment, Big Payoff’ for data tables relevant to cost estimates of waste management. <http://zerowasteworld.org/beyondrecovery>
- 12** Baptista, A. & Perovich, A. (2019). U.S. Solid Waste Incinerators: An Industry in Decline. The New School Tishman Environment and Design Center. <https://www.no-burn.org/industryindecline>
- 13** Baptista, A. & Perovich, A. (2019). U.S. Solid Waste Incinerators: An Industry in Decline. The New School Tishman Environment and Design Center. <https://www.no-burn.org/industryindecline/>; Guyette, C. (2008, April). The Big Burn. Detroit Metro Times. <http://www.metrotimes.com/editorial/story.asp?id=12748>
- 14** Baptista, A. & Perovich, A. (2019). U.S. Solid Waste Incinerators: An Industry in Decline. The New School Tishman Environment and Design Center. <https://www.no-burn.org/industryindecline>

- 15** Breathe Free Detroit. A Campaign to Shut Down the Detroit Trash Incinerator. <https://www.ecocenter.org/breathe-free-detroit>
- 16** Nicastro, C. (2017, October). Copenhagen Goes All in on Incineration, and it's a Costly Mistake. Zero Waste Europe. <https://zerowasteurope.eu/2017/10/copenhagen-goes-all-in-on-incineration-and-its-a-costly-mistake/>
- 17** Nicastro, C. (2017, October). Copenhagen Goes All in on Incineration, and it's a Costly Mistake. Zero Waste Europe. <https://zerowasteurope.eu/2017/10/copenhagen-goes-all-in-on-incineration-and-its-a-costly-mistake/>
- 18** Recupero, R. (2019, July). The Not-That-Well Hidden Risks of Incineration: the Case of the Danish Norfors Plant. Zero Waste Europe. <https://zerowasteurope.eu/2019/07/the-case-of-the-danish-norfors-plant/>
- 19** You, Ke. (2015, June). Joint Use of the Municipal Waste Incineration Infrastructure in Seoul. Seoul Solution. <https://www.seoulsolution.kr/en/content/joint-use-municipal-waste-incineration-infrastructure-seoul>; Shapiro-Bengtsen, S., Andersen, F., Münster, M., & Zou, L. (2020, July). Municipal Solid Waste Available to the Chinese Energy Sector – Provincial Projections to 2050. Waste Management: Volume 112. <https://www.sciencedirect.com/science/article/abs/pii/S0956053X20302415>; Shapiro-Bengtsen, S. (2020, August). Is China Building More Waste Incinerators Than it Needs?. China Dialogue. <https://chinadialogue.net/en/pollution/is-china-building-more-waste-incinerators-than-it-needs>; United Kingdom without Incineration. (2017). Part of the Bin the Burners Briefing Series: Incineration Overcapacity. https://ukwin.org.uk/btb/BtB_Incineration_Overcapacity.pdf; Sora, M. (2013, January). Incineration Overcapacity and Waste Shipping in Europe: the End of the Proximity Principle?. Fundacio ENT & Global Alliance for Incinerator Alternatives. <https://www.no-burn.org/incineration-overcapacity-and-waste-shipping-in-europe-the-end-of-the-proximity-principle>
- 20** Man, C. (2019). Waste to Energy: Considerations for Informed Decision-Making. United National Environmental Program <https://www.developmentaid.org/api/frontend/cms/file/2019/08/WTEfull-compressed.pdf>
- 21** Favoino, E. (2020, June). Building a Bridge Strategy for Residual Waste. Zero Waste Europe. https://zerowasteurope.eu/wp-content/uploads/2020/06/zero_waste_europe_policy_briefing_MRBT_en.pdf
- 22** ARUP. (2019, June). Theme 3– Financing waste projects. <https://drive.google.com/file/d/1zGwX6gbAis-Pn7Wz4TuN0LoTila0cp8y/view>
- 23** ARUP. (2019, June). Theme 3– Financing waste projects. <https://drive.google.com/file/d/1zGwX6gbAis-Pn7Wz4TuN0LoTila0cp8y/view>
- 24** City of Melbourne. (2019, July). Waste and Recovery Resource Strategy 2030. https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.com-participate.files/9615/6332/7045/WASTE_AND_RESOURCE_RECOVERY_STRATEGY_2030_2030_ATT_2.PDF
- 25** Typically an open area and/or warehouse where the public can drop-off and pick-up items for reuse or further processing for recycling (1-10 tonnes per day)
- 26** LA Sanitation. (2021). SOLID WASTE INTEGRATED RESOURCES PLAN (SWIRP). https://www.lacitysan.org/san/faces/home/portal/s-lsh-wwd/s-lsh-wwd-s/s-lsh-wwd-s-zwswirp?_adf.ctrl-state=t6ss7votm_306&_afLoop=5228597215430769&_afrWindowMode=0&_afrWindowId=null
- 27** Drop-off facilities for collection of reusable items, recyclables and hard-to-recycle materials
- 28** Austin Resource Recovery. (2011, December 15). Austin Resource Recovery Master Plan. http://austintexas.gov/sites/default/files/files/Trash_and_Recycling/MasterPlan_Final_12.30.pdf

