Considering Waste-to-Energy Facilities in the United States

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Introduction

Americans are no strangers to problems of waste management. In 2007, we produced approximately 4.6 pounds of garbage, per capita, every day, totaling nearly 254 million tons of municipal solid waste (MSW) that year (EPA 2009a). For a country with seemingly limitless space landfilling is an obvious solution, and indeed about 54 percent of our garbage went directly to such facilities (ibid.). Yet several events, including conflicts over landfill siting and operation procedures ("Down in the Dumps" 2009), demonstrate that this strategy is not without its challenges, including negative impacts on air, water, and soil quality.

Fortunately there are a number of alternative disposal methods to the sanitary landfill, including 'diversion' techniques like recycling and composting, but also the processes of incineration with energy recovery – waste-to-energy (henceforth WTE) – and energy conversion through pyrolysis, anaerobic digestion, and an increasing range of other technologies. Many of these technologies and processes, especially WTE, are already heavily utilized in other industrialized European and East Asian countries, but remain limited in the United States.

This white paper examines some of the factors that limit WTE and energy conversion in the US. After presenting arguments both for and against their use, it argues that these technologies – and especially mass-burn WTE – should be more widely deployed. Modern solid waste incinerators are clean and reliable alternatives to both traditional landfills and fossil-fuelled electricity generation (EPA 2010a), simultaneously addressing mounting concerns about electric power production and solid waste management in the United States. While opponents, and especially advocates of 'zero-waste' policies for waste management, argue that WTE represents a bad environmental policy, they frequently fail to recognize that the most lauded examples of WTE operation in the US directly contribute to increased recycling rates, reliable non-fossil baseload electricity, district heating/cooling supply, and enhanced community education about solid waste issues.

The paper proceeds with a background on the state of incineration and WTE in the US. Next, the barriers and drawbacks limiting WTE in the US are compared with the benefits of the technology. These benefits are illustrated with a brief case study of the 'ecomaine' facility in Portland, Maine. Then, some specific policy recommendations to improve uptake of WTE in the US are made. These include a mixture of changes to federal policies and the introduction of new policies in communities considering WTE projects. References are included at the end.

WTE in the United States

Waste incineration once played a much larger role in MSW treatment, accounting for over 30 percent of all MSW management in the early 1960s (Curlee et al. 1994, 4). Incineration was popular as it reduced the volume of MSW by about 90 percent; the remaining ash could be landfilled or in some instances re-used in road surfacing. But from a human health standpoint continued operation of older waste incinerators would be troublesome. MSW incinerators operated with limited emissions control technology, releasing carcinogens, heavy metals, and various types of particulates into the surrounding atmosphere (Rudzitis, Hochman, and Hwang 1981). Their spatial distribution on the outskirts of urban areas meant that low-income residents often received the brunt of the pollution, contributing to claims of environmental injustice. Furthermore, cities seeking to push their infrastructure to limits in response to tightening budgets and rising waste volumes frequently overloaded or otherwise improperly operated their incinerators, leading to incomplete combustion and mountains of unprocessed waste (Melosi 2005). In the 1970s and 1980s, the technique rapidly fell out of favor for precisely these reasons. In fact, the planned waste incineration capacity *cancelled* between 1982 and 1990 summed to more than the total capacity *existing* at the end of that period (Curlee et al. 1994, 4). Landfilling, almost by default, became the dominant method of dealing with trash.

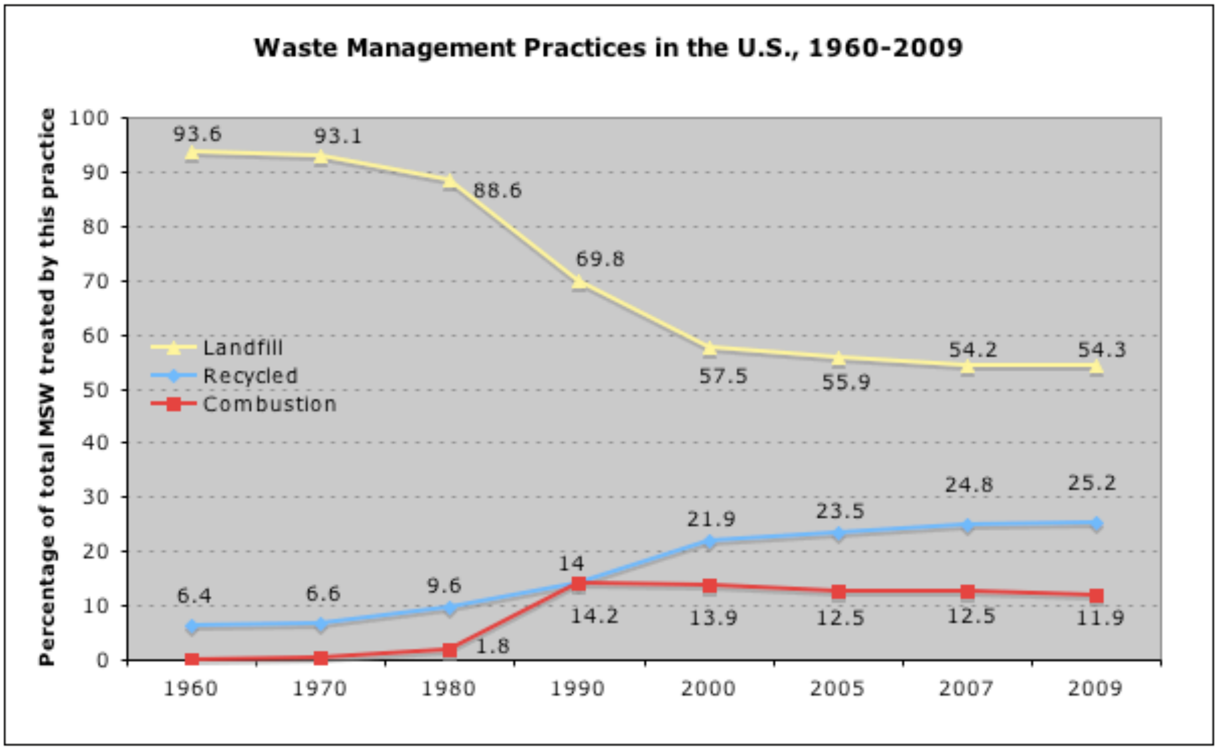

Figure 1: Waste management in the US, 1960-2009. Totals do not sum to 100 percent because not all treatments are shown. (After U.S. EPA 2010b, 2)

Historically, its elevated release of hazardous substances placed incineration under close scrutiny from the EPA and other environmental agencies. The Agency has long promulgated rules for controlling emissions and handling incinerator ash under the authority of the Clean Air, Clean Water, Safe Drinking Water, and Solid Waste Disposal Acts ("Standards of Performance…" 2009). Although admittedly dirty in the past, since the mid-1990s several studies have demonstrated that emissions and residues from WTE, properly maintained and operated, pose minimal threat to human health and the surrounding environment (e.g. National

Research Council 2000; Lima and Bachmann 2002; Lima and Saloca 2003). Contemporary WTE operates with very high-end pollution control equipment, removing dioxins, furans, nitrous oxides, sulfuric compounds, and particulates from flue gas before release into the atmosphere (Figure 2).

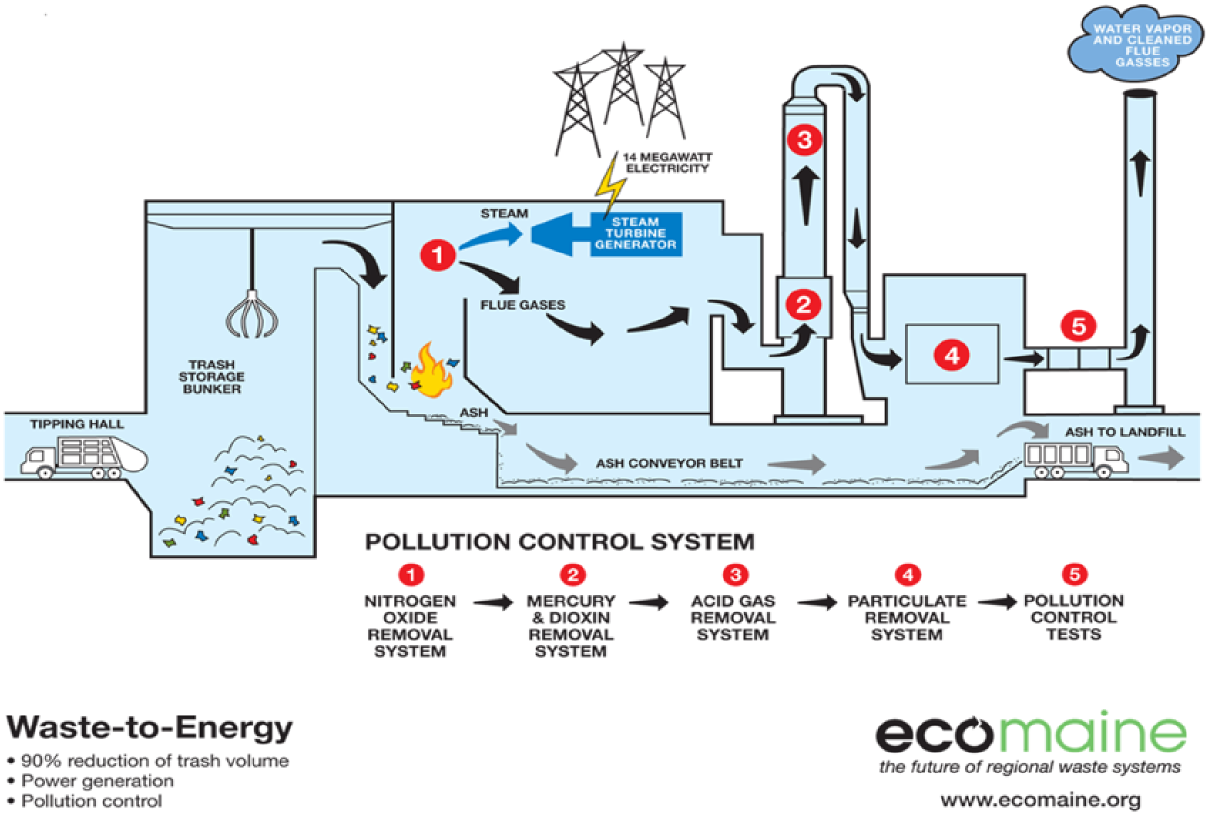

Figure 2: Schematic of a Waste-to-Energy Plant (ecomaine 2012a)

Despite this improving track record, incineration accounts for just 12% of all MSW management in the United States (EPA 2009a). As of 2007 only 87 modern WTE incinerators were in operation, distributed across 25 states (Michaels 2007, 1; Figure 3). This is in marked contrast with countries like Germany, Denmark, and Japan, which treat virtually all non-recyclable material by incineration using the same technology available to WTE facilities in the United States (Rosenthal 2010). The expansion of a facility in Florida that same year was the first 'new' WTE construction in a decade (ibid.), although a second facility is slated for a site in Palm Beach County, Florida; an expansion recently came online for the facility in Honolulu, HI; and a brand new plant is in the works for Durham, Ontario, Canada.

Advantages and Disadvantages of WTE

There are many reasons why the uptake of WTE is limited, some philosophical and others more practical. A common concern raised is that although it reduces the volume of solid

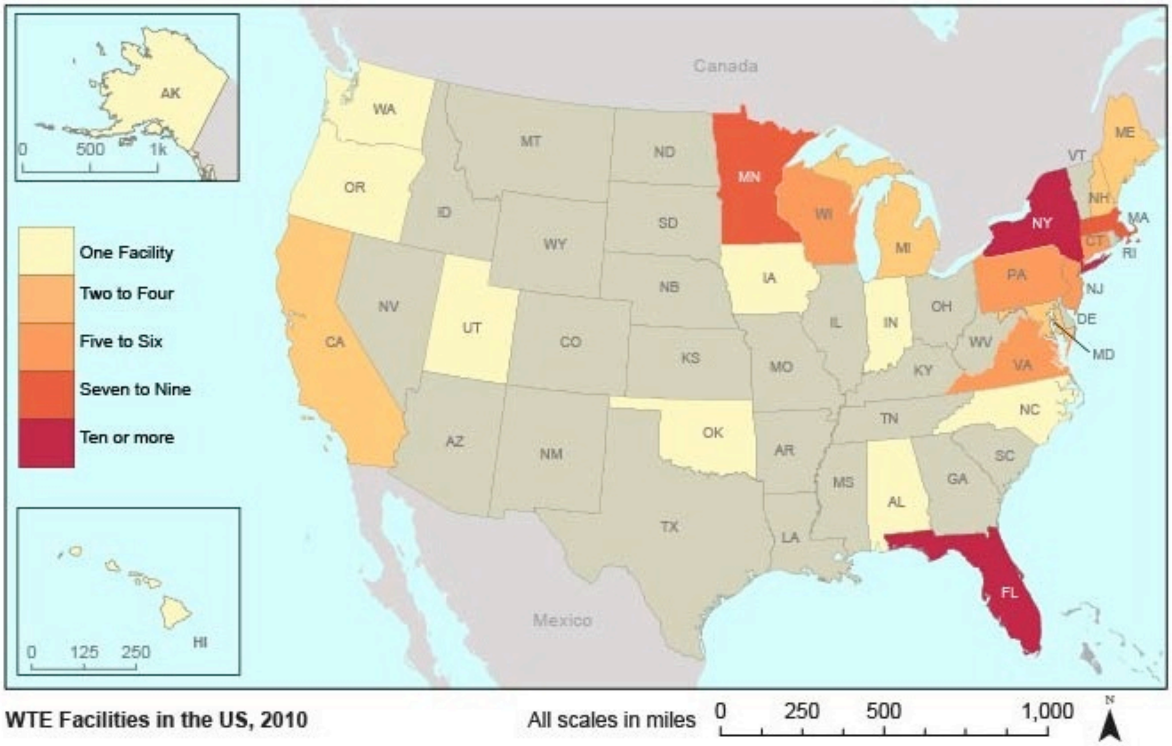

Figure 3: Map of WTE in the US. Map by author.

waste by some 90 percent, WTE does virtually nothing to reduce the root ‘problem’ of solid waste disposal – solid waste production. In fact, some WTE opponents argue that the technology hinders environmental protection because it reduces the apparent consequences of over-consumption; that is to say, because the waste is reduced to an ash and the capacity to combust waste is limited only by the number of hours in a day (as opposed to the inherent spatial constraints of the landfill), people are not really forced to confront their excessive consumption (Seldman 2012). While most WTE opponents are not advocates of landfilling, they do typically represent a segment of the public in favor of alternate disposal technologies and especially recycling and composting, arguing that the materiality of these practices encourages greater individual awareness of the volume and composition of the solid waste being produced (Royte 2005).

Many of those opposed to WTE make the general case that ‘we can do better’ as a society than burning solid waste suggests. Sometimes the argument is implicit, as in the previous paragraph, and other times explicit reference to technological alternatives to WTE is made. The perception that burning waste through WTE is ‘low-tech’ is a second significant barrier to WTE in the US. It’s true that WTE does face competition from other technologies in the energy conversion marketplace, many of which utilize highly advanced chemical processing techniques to transform solid waste into methane gas and/or synthetic liquid fossil fuels. Some are able to distill the inorganic fraction of solid waste into an ethanol-like product that can be used in motor vehicles. Others treat the organic components of waste through anaerobic digestion, using microorganisms to produce methane in a controlled environment. Still others, using pyrolysis or ‘plasma-arc gasification’ are very similar to WTE but operate at higher temperatures and result in different by-products. In comparison to these state-of-the-art technologies, WTE can look primitive since it remains fundamentally related to conventional incineration.

Third, and perhaps most practically, WTE is expensive in both absolute and relative terms. The economics of waste management in the US, and WTE technology in general, work to limit its deployment. According to research conducted by the non-partisan, technology-neutral Solid Waste Association of North America (henceforth SWANA), in 2005 the costs to construct a hypothetical 2,000 tons-per-day WTE facility would total nearly $350 million dollars, with annual operating costs of around $30 million (SWANA-ARF 2011). While that statement on its own is sometimes enough to terminate a policymaker's interest in WTE, those who delve deeper often perceive WTE to be a more expensive means of disposal relative to other options as well. For instance, SWANA estimates that the same hypothetical facility would have a tipping fee (the price to dispose a ton of MSW) of about $53 versus the $44 fee of using a regional landfill (ibid.).

However, the barriers that face WTE in the US – and especially the issue of costs – are not as cut-and-dried as they first appear. Consider that:

> The tipping fees at WTE facilities are comprised of three major components: 1) amortized financed capital cost of the facility, 2) the facility's operating costs, and 3) the revenues received from the sale of the electricity generated by the facility.
>
> Each of these components is based on contracted costs or revenues that are tied to published escalation rates. As a result, WTE facility tipping fees are both predictable as well as under the control of the local government that owns the facility.
>
> In contrast, the tipping fees charged at a regional private MSW landfill used by a community is generally set by the cost of the community to utilize the next closest competing landfill. This cost includes the cost of transferring and hauling the community's MSW to the competing facility in addition to the cost of disposal. Simply put, the tipping fee is established by competition from other regional landfills and is not necessarily related to the cost of disposal. As opposed to WTE facilities, the tipping fees paid by a community for disposal of its waste at a regional landfill are neither predictable nor under the control of the local government using the landfill. (ibid., 4)

Stable and predictable costs are critically important to local governments. However this is only one way in which WTE's predictability is a benefit. Another is technological: although it may not appear as futuristic as the distillation or pyrolysis processes mentioned earlier, modern WTE captures heat from the combustion process and uses it to safely generate steam and electricity in a process that has been studied and understood by engineers for decades. The technology's value has already been proven at hundreds of sites in western, central, and northern Europe, where modern WTE has been in use since the 1950s. Firms there – many of them suppliers and consultants to the WTE facilities in operation in the US – have made regular advances in efficiency and pollution control aspects of their products. The technology has progressed so far that a 2003 letter from the assistant administrator of the EPA's Office of Solid Waste and Emergency Response highlighted WtE as a "clean, reliable, renewable source of energy…with less environmental impact than almost any other source of electricity." (Horinko and Holmstead 2003) When communities publicly express an interest in WTE or energy conversion technologies, they are frequently 'pitched' emerging technologies with little to no track record beyond the demonstration phase of processing one to two tons of waste per day. In contrast, some of the largest WTE facilities around the world reliably process several thousand tons of waste per day, coming offline only for scheduled maintenance. Alternatives to WTE that 'exist' in the marketplace, with the exception of anaerobic digestion, remain to be commercially – and even technologically – proven, making them risky for communities seeking a proven solid waste solution on a limited budget (Kamuk 2012).

There are a number of environmental benefits that can be linked to WTE as well. Offsetting fossil fuel combustion precludes many emissions and water contamination problems associated with the extraction and use of coal, oil, and natural gas, especially as these resources are tapped in more remote and environmentally sensitive areas. As a power source, WtE currently represents only 2,500 megawatts of electric generating capacity, or just 0.3 percent of the nation's total (EPA 2009b), but the market for renewable and alternative energy is growing as many states implement so-called Renewable Portfolio Standards which set targets for non-fossil electricity production. Additionally, preventing MSW from entering a landfill limits both toxic leachate production and the release of methane from decomposing garbage (El-Fadel, Findikakis, and Leckie 1997). All of these impacts are magnified by findings suggesting that modern WtE facilities contribute directly to the recovery of ferrous metals and plastics (EPA 2009b), reducing the need for new products made from these energy-intensive materials.

Figure 4: Integrated disposal processes at ecomaine – single-stream recycling, WTE, and ashfill (photos by author)

For these reasons, WTE should be more widely implemented in the United States. Although it does not solve all of the environmental and economic problems associated with solid waste, there is a strong case that WTE represents an important tool for both mitigating pollution and transitioning to a lower-waste future. This claim is supported by examination of one of the most successful – economically, environmentally, and socially – WTE facilities in the US, 'ecomaine' in Portland, Maine (Figure 4).

Case study: ecomaine, Portland, Maine

ecomaine evolved from a small regional landfill serving communities in southern Maine to a comprehensive solid waste management 'park' with three components: a 550 tons-per-day WTE facility, a dedicated fill site for the ash from WTE, and a single-stream recycling facility (meaning that individuals do not need to sort recycling themselves). The WTE and recycling facilities are located on the same site and the ashfill is a few miles away, occupying land owned by ecomaine. The facilities currently serve the needs of 25 municipality member-owners in southern Maine, and the corporation operates as a non-profit.

Beginning operation in 1976 as a public landfill started in response to state laws seeking to phase out privately-owned landfill sites, the former Regional Waste Services started construction on a WTE facility in 1988. The facility, which entered service just a year later, was intended to provide two primary services: 1) to generate revenue through electricity sales, and 2) to reduce demands on the landfill and mitigate the need to expand the site (ecomaine 2012b). The facility has accomplished both goals. Currently, WTE at ecomaine generates approximately 100,000 Mwh of electricity each year, resulting in sales of more than $6 million (ecomaine 2012a). And the facility, still holding the same 240 acres since the mid-1970s, retains 75 unused acres with an expected capacity through the year 2038 (ecomaine 2012c).

But there are other environmental and economic benefits that complement ecomaine's solid waste management credentials. Recycling was introduced at the facility in 1990 and single-stream recycling in 2007 (ecomaine 2012b); in 2010 the facility processed nearly 36,000 tons of recyclable materials (ecomaine 2012d). Continuous emissions monitoring in addition to four distinct air pollution removal systems (electrostatic precipitators, carbon injection, spray dryer absorbers, and selective non-catalytic reduction) has kept ecomaine's emissions well below regulatory limits (ecomaine 2012e). Fly ash and bottom ash (by-products of the combustion process) are also regularly tested and remain far below regulatory limits for heavy metals. Updated environmental compliance information is published on the ecomaine website and available to anyone interested in the facility's performance.

Economically, the revenues associated with both WTE and recycling programs, in addition to the revenues associated with the disposal contracts between ecomaine and its member-owner communities, have helped the facility to eliminate all debt. Furthermore, the equipment necessary to implement single-stream recycling did not require additional municipal loans, instead being paid for out of ecomaine cash reserves. While it is true that ecomaine and its pollution control equipment was expensive to design, build, and install, it is equally true that the facility provides a number of economic and environmental benefits that simply cannot be matched by regional landfill projects and achieves waste management goals at a scale few to no recycling, composting, or alternative energy conversion technologies could hope to achieve.

Policy Recommendations to Increase WTE in the US

ecomaine is considered by many in the solid waste industry to be among the best examples of 'integrated solid waste management' in the US, if not the world. It is no surprise that WTE comprises a key aspect of the operation and that the technology plays a crucial role in economic viability of the non-profit corporation. Although some may argue that features of ecomaine, such as its cooperative business model and non-profit status are unique to the facility, Maine, or the New England region, in reality there are a number of policies which could be implemented to help communities elsewhere find similar success with WTE projects.

The first is perhaps the most simple: states should implement a redistributive tax on landfilling. Similar to the ways in which fuel taxes fund road construction and other programs, a tax on each ton of waste disposed of in a landfill would be collected by a state agency and deposited into a fund which communities could draw on to defray some of the costs of WTE design and construction. This tax would also serve to make the tipping fees at landfills more in line with the tipping fees at a brand new WTE facility, making the two processes more cost competitive.

Similarly, state or sub-state regional governments could implement 'flow control' policies to direct a particular volume of solid waste away from landfilling and towards WTE facilities. While flow control policies seeking to contain waste within a single county or state or else direct waste to a particular single facility have been controversial, and in many cases struck down by state courts and even the US Supreme Court, it is less clear if flow control could be designed and implemented not to direct waste to a particular facility but simply to mandate that a certain proportion of waste produced within a legislative unit be disposed of using WTE. This type of flow control is comparable to 'renewable portfolio standards' legislation which in many states requires utilities to produce some proportion of electric power from an approved list of sources.

Additional policies which could work at the state level but would be more effective in federal form could be implemented to improve the markets for both non-fossil electricity and also raw recyclable materials. Actually, such policies have existed in the US in the past and did contribute to greater use of WTE. The Public Utilities Regulatory Policies Act (PURPA) mandated in the 1970s and 1980s that electricity produced by approved 'alternative' sources (including things like solar, wind, and WTE) be purchased by utility companies at a relatively high cost, which made investments in alternative energy projects quite attractive. Although electricity markets in the US are quite different in 2013 than they were in 1980, similar policies could be enacted which would make electricity from WTE an economically attractive option. Likewise, federal subsidies for shipment and consumption of renewable materials (or at least tax benefits for firms preferring to use them) would improve and stabilize market conditions for raw recyclable materials, encouraging greater investments in recycling along with WTE.

Finally, individual WTE facilities as well as the WTE and solid waste industry itself must do more to inform the public about the benefits of WTE in order to increase citizen demand for alternatives to the landfill. Although traditional advertising and similar projects would be of use, an additional strategies should focus on the design of facilities themselves. In the US, current WTE facilities look like warehouses and industrial sites. In other countries where WTE plays a more prominent role, WTE facilities embrace daring architecture and design features in order to attract attention (Figure 5). In these places, the firms using WTE technology have nothing to hide – and neither should the facilities in the US!

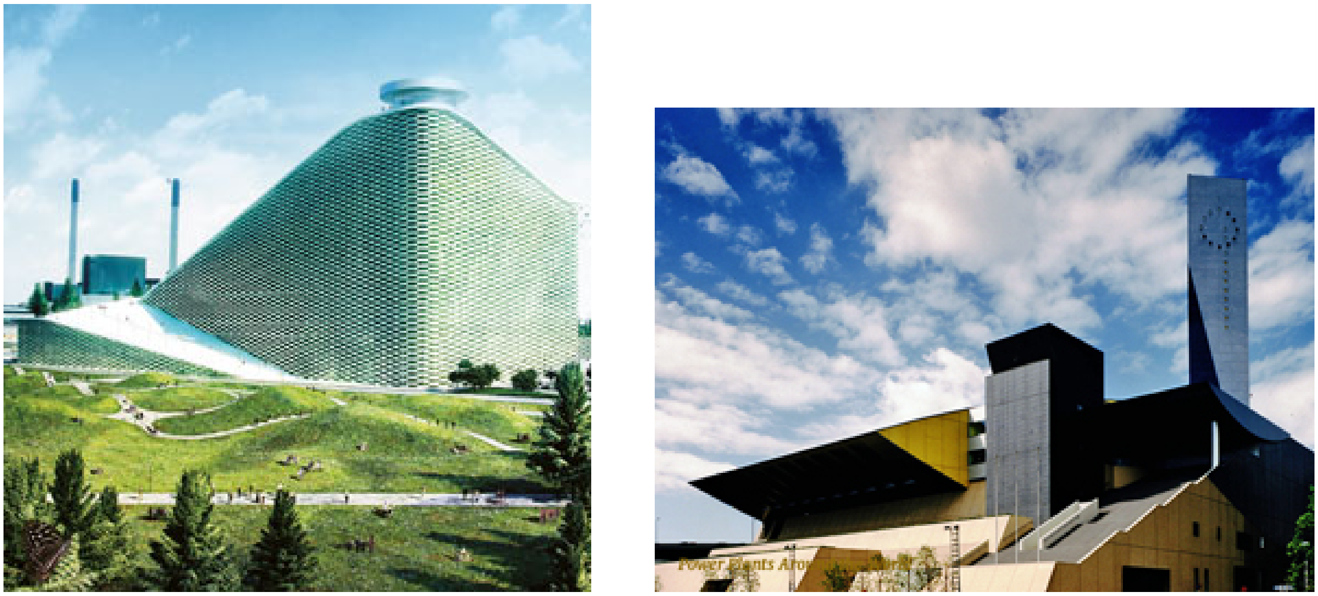

Figure 5: High-design meets WTE in advanced facilities outside the US. Left, artist depiction of proposed Amager Bakke WTE, Copenhagen, Denmark (RAMBOLL Engineering). Right: Ariake WTE, Tokyo, Japan ("Waste-to-Energy plants…")

Conclusions

Waste-to-Energy is an alternative to landfilling that produces a number of useful products, including steam and electricity which can offset the production of these same products by more polluting fossil fuel sources. WTE also reduces the volume of solid waste being processed by 90 percent, extending the life of existing landfills and mitigating the demand for new landfill sites. While WTE does not solve all of the environmental and economic problems associated with solid waste, it is clear that WTE can be an important tool for both mitigating pollution and transitioning to a lower-waste future.

Opponents of WTE, and especially those advocating for 'zero waste' policies, argue that the technology does not address the root problems of solid waste management in the first place because WTE does not moderate solid waste production. This is certainly true, but there is a demonstrated ability of a combined single-stream recycling and WTE facilities to increase a community's recycling rate, as has been the case at ecomaine, in Portland, Maine. Thus, 'zero waste' advocates should take a second look at WTE and the potential for the technology to play an important middle-term role in any transition towards a 'zero waste' future in which landfilling is avoided and waste production rates fall dramatically.

Even so, a number of barriers to implementing WTE in the US must be overcome, and especially those related to economic disincentives for project development. In this paper, several policy recommendations were made that could contribute to greater use of WTE in the US. Among these were a redistributive tax on landfilling that could subsidize WTE projects; changes to federal electricity purchase and materials policies that would make both raw recyclables and electricity from sources like WTE more attractive in the marketplace; exceptions to anti-flow control laws and court findings; and better public education about the benefits, drawbacks, and environmental impacts of WTE.

Some of these policies have in fact existed in the past, and proven to be significant in boosting the presence of WTE in the US. All of them are possible for the future, given the presence of both consumer demand for landfill alternatives and political will to see projects through.

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