TECHNOLOGY AND PLACE: A GEOGRAPHY OF WASTE-TO-ENERGY IN THE UNITED STATES

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ABSTRACT

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The adoption of technologies differs across space, for reasons attributed to economics, politics, and culture, but also due to limitations imposed by both the physical environment and the technology itself. This dissertation considers the case of waste-to-energy (WTE) incinerators in the United States, and asks why this technology is used in some places but rejected in others. The answer to this simple question is remarkably complex, as understandings and arguments about technology and the environment are mobilized differently by various actors to champion, oppose, or in some cases remain ambivalent about the installation and operation of WTE facilities.

In this dissertation I explore the geography of WTE incineration in the United States since the 19th century. Informed by the insights of actor-network theory and the social construction of technology school, I employ the tools of discourse analysis to examine published and unpublished statements, papers, project studies, policy briefs, and archival materials generated alongside the development of WTE facilities in the United States, considering the specific case studies discussed below but also WTE technology in general. I look at federal, state, and local environmental agency documents as well as the papers of consulting firms, environmental and industry advocacy groups, and private companies. I also devote significant attention to the analysis of news media outlets in communities where WTE facilities are located or have been considered. In addition to these literal texts, I examine non-written and visual materials associated with WTE facilities, including films, websites, signage and logos,

advertising campaigns, facility architecture, and artwork, as well as more abstract 'texts' such as industry conferences, trade-show handouts, promotional materials, and academic and industry research programs. I build on this textual analysis with observations of WTE facilities in action

After an introductory chapter, I offer a review of relevant literature in the fields of geography, science and technology studies, and allied disciplines focusing especially on topics of solid waste, energy, and infrastructure. I then trace the historical geography of WTE around the world but focusing on the United States and the role of the federal government (especially the Office of Solid Waste at the US Environmental Protection Agency), engineering consulting firms, and professional solid waste management organizations in shaping understandings of both waste management problems and solutions to those problems. Next, I move into two case studies, employing a critical realist perspective to de-compose the arguments made for and against WTE: first, in an instance where WTE has been considered several times but never adopted (Maui, Hawaii), and second, where the technology was deployed amidst great controversy (Detroit, Michigan). In the final chapter, I summarize my main arguments and findings before examining a more limited case study of a site where WTE is accepted as an integral part of solid waste management, the 'ecomaine' facility in Portland, Maine. The case studies pay close attention to the unique environmental, political, cultural, and economic contexts surrounding the decisions made. While representing a wide array of circumstances, from these case studies I offer some conclusions about the processes of technological and environmental decision-making that have impacted WTE before making some policy recommendations for solid waste management in the US.

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Chapter One

Introduction

The adoption of technologies differs across space, for reasons attributed to economics, politics, and culture, but also due to limitations imposed by both the physical environment and the technology itself (cf. Bijker, Hughes, and Pinch 1987; Bijker and Law 1992). This dissertation considers the case of waste-to-energy (WTE) incinerators in the United States, and asks why this technology is used in some places but rejected in others. The answer to this simple question is remarkably complex, as understandings and arguments about technology and environment are mobilized differently by various actors to champion, oppose, or in some cases remain ambivalent about the installation and operation of WTE facilities.

Why WTE incinerators? There are three principal reasons. First is the recognition that every society throughout time has had to address the question of refuse. What do we do with unwanted materials? Whether re-purposed, buried, or burned, solid waste and solid waste management practices pose an array of questions (Rathje and Murphy 2001; Royte 2005; Pye 2010). Some of these questions are inherently spatial: where will we put our garbage? How does solid waste impact its surroundings, in terms of the physical environment, and how does the natural environment constrict the management of waste? Do waste management practices impact nearby economic and social activities? How do waste management sites impact human health?

My goal, however, is not to 'theorize' trash (on this matter, see Bennett 2010; Gregson and Crang 2010; or Davies 2011). Rather, my second reason for focusing on WTE stems from a desire to understand the relationship of this technology to other waste management practices. How does WTE fit into the constellation of disposal technologies available in the US? Complicating matters is the fact that WTE lives a double life: while significantly reducing the volume of solid waste, late-19th century engineers adapted the heat from combustion towards steam production and electricity generation. Thus WTE straddles two worlds, solid waste and energy, and therefore the ecological, economic, political, and cultural complexes that shape each one.

Finally, I focus on WTE because it has been a source of great controversy, especially regarding the toxic substances it may produce, its impact on recycling, and the questions siting WTE facilities have raised about 'environmental justice' (cf. Bullard 2000; Pellow 2002; Mohai, Pellow, and Roberts 2009). These factors simultaneously locate WTE at the 'active face' of research in human geography, environmental sociology, and science and technology studies, and also demarcate rich territory for innovative and meaningful interdisciplinary inquiry.

In this dissertation I explore the geography of WTE incineration in the United States since the 19th century. I begin with a review of relevant literature in the fields of geography, science and technology studies, and allied disciplines. I then trace the historical geography of WTE around the world but focusing on the United States and the role of the federal government (especially the Office of Solid Waste at the US Environmental Protection Agency), engineering consulting firms, and professional solid waste management organizations in shaping understandings of both waste management problems and solutions to those problems. Next, I move into two case studies, employing a critical realist (or 'mild constructionist', see Burningham and Cooper 1999) perspective to de-compose the arguments made for and against WTE first in an instance where WTE has been considered several times but never adopted (Maui, Hawaii) and second where the technology was deployed amidst great controversy

(Detroit, Michigan). In the final chapter, I summarize my main arguments and findings before examining a more limited case study of a site where WTE is accepted as an integral part of solid waste management, the 'ecomaine' facility in Portland, Maine. The purpose of this final 'mini' case study is to provide an example of WTE 'done right' and offer an illustration of where solid waste management could (or should) go in the US. Each of the two case studies and more limited study of ecomaine pay close attention to the unique environmental, political, cultural, and economic contexts surrounding the decisions made. While representing a wide array of circumstances, from these two major case studies and one abbreviated study, I offer some conclusions about the processes of technological and environmental decision-making that have impacted WTE before making policy recommendations for solid waste management in the US.

Waste and Energy in the United States

In 2009, the United States produced 243 million tons of municipal solid waste (MSW), or 4.3 pounds per person, per day (U.S. EPA 2010b, 1). MSW

> …consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, and batteries. Not included are materials that also may be disposed in landfills but are not generally considered MSW, such as construction and demolition materials, municipal wastewater treatment sludges, and non-hazardous industrial wastes. (ibid., 4)

The 2009 MSW production total and per capita amount of represents a slight decline from peak values reached in 2007, but is nevertheless continuing an upward trend since such values were first calculated in the mid-20th century. While volumes of MSW have increased in a steady, almost predictable fashion, trends in disposal practices have been far less regular. Some practices have become steadily more common, like recycling, while others, like landfilling, less so. Combustion – which in the EPA's accounting is not separated out into combustion for energy recovery (WTE) or the burning of other substances, like wood or tires – has seen periods of growth and decline since 1960.

While increases in both recycling and combustion of all sorts are welcome, landfilling nevertheless remains the dominant waste management practice in the U.S. Although arguably the least labor-intensive of the three practices, landfilling is prone to a number of serious problems. For instance landfills are linked to both toxic leachate production and the release of methane from decomposing garbage (El-Fadel, Findikakis, and Leckie 1997; Royte 2005), associated in turn with the pollution of groundwater and global climate change (not to mention foul odors). Furthermore landfilling represents a curious land use practice, especially in the wake of regional landfills collecting MSW from an entire metropolitan area (Figure 1.1).

Figure 1.1: The Oakland Heights Development landfill dwarfs the size of the 22,000-seat Palace of Auburn Hills basketball arena (green roof). The landfill has recently reached its maximum height of 1,270 feet (Drake 2010). Photo by author, 2011. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

In step with increasing MSW production is the rise in electricity consumption in the United States. Although the precise totals vary by state, in the country as a whole nearly half of all the electricity generated came from coal-fired power plants; a further 25% from natural gas plants (though this figure is rising); and about 20% from nuclear facilities (EIA 2010, 228). In contrast renewable fuels account for only about 5% of all electricity generated, and WTE makes up only a very small portion of that total. This is an important point, because the risks associated with heavy reliance on fossil and nuclear fuels are well-documented and politically, ecologically, and socially significant, ranging from the destruction of wetlands and coastlines (as with the Deepwater Horizon incident from 2010) to the support of oppressive regimes (as with the U.S.' ironclad alliance with Saudi Arabia and other petro-states) to the destruction of cities and regions (as with first, Chernobyl, and later, Fukushima Dai-ichi). Despite politicians and boosters hailing 'clean coal', shale gas, tar sands, and other hydrocarbon and nuclear pipe dreams, genuine alternatives to the scenarios outlined above rely first and foremost on significant conservation of electricity and next, on technologies like WTE and other 'renewable' fuels.

WTE as an Ecological Intervention

Modern solid waste incinerators are clean and reliable alternatives to both traditional landfills and fossil-fuelled electricity generation (Kaplan, Decarolis, and Thorneloe 2009; U.S. EPA 2010a), simultaneously addressing mounting concerns about electric power production and solid waste management in the United States. Both activities have harsh environmental and human health side effects, including the release of carcinogens and heavy metals from electricity generation, groundwater contamination and methane emissions from poorly-designed landfills, and landscape destruction occurring alongside both fossil fuel extraction and new landfill construction.

In contrast, WTE offsets electricity generated by fossil fuel sources and prevents trash from heading to the landfill. 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. Some estimates (Dooley 2011) suggest that WTE could power as many as 16 million homes in the United States at current levels of electricity consumption. Likewise, preventing MSW from entering a landfill limits both toxic leachate production and the release of methane from decomposing garbage. Just as fossil fuels are being sought in increasingly remote areas, so too are landfills being located further and further from the population centers that produce MSW (Royte 2005). Although admittedly dirty in the past, since the mid-1990s several studies have demonstrated that emissions and residues from modern waste incinerators, properly maintained and operated, pose minimal threat to human health and the surrounding environment (National Research Council 2000; Lima and Bachmann 2002; Lima and Saloca 2003) which means they can be safely located in populated areas (as WTE facilities are in much of continental Europe). These impacts are magnified by findings suggesting that modern WTE facilities contribute directly to the recovery of ferrous metals and plastics (U.S. EPA 2009), reducing the need for new products made from these energy-intensive materials.

A Brief History of WTE in the U.S.

WTE thus has the potential to radically alter both waste management and electricity production in the U.S. The basic technology, however, is over a century old. Waste incineration with energy recovery was first installed in 1896 in Hamburg, Germany (Curlee et al. 1994). Two years later, the first WTE system in the United States was deployed in New York City. While both of these early incinerators were designed to reduce the volume of solid waste and permit the recovery of steam, electricity generation was not implemented. It was not until 1903 that the first WTE facility designed to produce electricity was installed, again in New York City. Curlee et al. offer that the "conversion of garbage to electricity was not an immediate hit," though they do not provide any supporting evidence or explanations for this claim (ibid., 38).

At any rate, until the 1970s WTE capacity in the United States was minimal: of the 364 incinerators operating in 1969, just 43 had any sort of energy recovery system in place, and those that did favored energy recovery for limited on-site use rather than wider sale and distribution (ibid.). Efficiency and reliability improvements to WTE technology were made throughout the 1950s and early 1960s, however, led by U.S. and European firms' development of 'waterwall' type units (discussed in Chapter Three). The first waterwall facility opened in Switzerland in the late 1950s, but the technology did not appear in the U.S. until 1967. Though the first American waterwall was designed and installed by a U.S. firm, many subsequent U.S. systems were installed by German firms or companies licensing European technology.

In spite of emerging technologies and associated improvements in efficiency, WTE remained slow to catch on in the United States. One of the major reasons offered by both Curlee et al. and the U.S. Environmental Protection Agency (EPA) – the agency charged with enforcing standards of air, water, and land quality associated with incinerators, landfills, and solid waste management practices more generally – was the introduction of the 1970 Clean Air Act (CAA). According to the EPA,

> …in 1970, existing incineration facilities became subject to new standards that banned the uncontrolled burning of [MSW] and placed restrictions on particulate emissions. Many facilities that did not install the technology needed to meet the CAA requirements were forced to shut down. (U.S. EPA 2011).

Curlee et al. estimate that nearly 50% of existing incinerators closed as a result of the CAA requirements, either unwilling or unable to retrofit their facilities for emissions compliance (Curlee et al. 1994, 38).

Though the construction of incinerators was slowed significantly by the new laws, global energy concerns and subsequent U.S. federal government regulations spurred a boom in WTE facility growth during the 1980s. By many accounts (for instance Dunlap and Catton 1979; Schnaiberg 1980; or Howell 2010b) the 1973 'Oil Shocks', precipitated by the so-called Arab Oil Embargo, prompted newfound interest in energy issues among both policymakers and the public at large. One of the results of this was the 1978 passage of the Public Utilities Regulatory Policies Act (PURPA), which mandated that investor-owned utilities purchase electricity from approved renewable and alternative sources at a predictable cost. WTE was listed as one such source, and the combination of fears over an unreliable imported energy supply with legislation guaranteeing reliable revenues for facility operators (as an 'alternative fuel') the technology became much more attractive to investors, operators, and communities alike. According to the EPA, "the 1980s was a boom era for MSW combustion in the United States" (U.S. EPA 2011), so much so that by the early 1990s almost 15% of MSW was combusted for energy recovery – remarkable growth considering that just 20 years prior, less than 1% of waste was treated with WTE.

In spite of the dramatic increase in WTE facilities, the early 1990s also saw the introduction of a new slate of federal emissions regulations, which made lasting impacts on the WTE industry in the U.S. The 1990 Clean Air Act Amendments introduced new controls on toxic emissions, including mercury and dioxins, among others. The new MACT (Maximum Achievable Control Technology) rules called for retrofitting existing incinerators with new emissions control systems that, according to the EPA, the owners of many small WTE facilities simply could not afford (ibid.). While these rules, just like the previous set, prompted a wave of facility shut-downs, they were not offset by the introduction of later laws like PURPA which incentivized the operation of WTE plants. Accordingly, as of 2011 no new WTE facilities have been built in the U.S. (though several operations have been expanded).

Approaches, Methods, Goals

Approaches

The brief historical sketch in the previous section would suggest that the changing fortunes of WTE are entirely the product of federal environmental protection and energy provision laws. To say so, however, would be highly inaccurate. There are any number of technologies in widespread usage with the potential for dramatic socio-ecological impacts. For instance petroleum extraction, pipeline, and refinery operations can all severely impact the natural environment and human life. Oil spills, refinery explosions, and pipeline ruptures occur with alarming frequency, yet expansion continues in these industries – which are probably as highly-regulated as WTE, if not more so. In spite of their potential for catastrophe, then, we might conclude that petroleum technologies are supported by a host of other configurations, ranging from societal inertia to geopolitical and economic ideologies. So to say that heavy environmental regulations alone have shaped the fortunes of the WTE industry in the U.S. would be far too myopic. Instead, in this dissertation I demonstrate that a suite of political, economic, cultural, and ecological factors are involved in the decisions to open, operate, and shut down WTE facilities in the U.S.

Preliminary research (Howell 2010a) suggested that the barriers limiting deployment of WTE in the US center on:

1. Continued public fear over incinerator emissions and by-products
2. An unappealing and 'low-tech' image
3. Economic disincentives for project development

None of these barriers exists, however, as a 'given.' Instead, each has been constructed and is actively maintained. In other words, controversy surrounding the deployment of WTE technology in the United States exists because competing entities (pro-/anti-WTE; others) have mobilized resources (scientific papers, agencies, images, fear, 'the environment,' solid waste, etc.) in the construction and extension of their own positions (for or against WTE plants) in order to project power over both physical and ideological space (whether WTE plants are built; what people think of them).

My research examines these 'social' (in the Latourian sense, Latour 2005) challenges facing WTE. I combine the methods of discourse analysis with the theoretical orientation of actor-network theory to interrogate published and unpublished documents, archival materials, and other 'texts' (ranging from trade-show samples to facility architecture) linked to WTE projects. The purpose of this is to critically examine the attitudes, motives, tactics, and networks mobilized in efforts to both deploy and resist deployment of WTE. Thus, I seek not only to detail the 'where?' and 'why?' of WTE in the United States, but also the processes by which WTE is conceived and translated into the built environment.

The project is directly informed by the body of work known as 'actor-network theory' (ANT). ANT has its roots in the science and technology studies pioneered by Bruno Latour, Michel Callon, and John Law at the Centre de Sociologie de l'Innovation, École Nationale Supérieur des Mines in Paris during the 1980s. ANT emphasizes the relationships between entities, and considers equally the roles of human (e.g. regulators, planners, citizens, etc.) and non-human (for instance toxic emissions, WTE boiler technology, and solid waste) entities in the creation an extension of networks.

Sometimes called the 'sociology of translation' (Law 1992; Callon 1999), ANT was initially concerned with the construction of scientific knowledge, demonstrating, as Latour (1987) did, that such knowledge is always the product of a *network* of diverse materials, and that it is always *embodied* in material form (perhaps as a journal article, lecture, or patent application; Law 1992). In the specific case of laboratory science, for instance, that which results from an experiment is *not* an objective portrayal of some definite reality achieved through the execution of a universal 'scientific method', but rather *an assemblage and patterning of heterogeneous materials* (test tubes, chemicals, instruments, other scientific papers, even other scientists themselves) to achieve some desired effect (experiment results, a paycheck, fame, personal satisfaction, etc.).

John Law suggests that the same principles apply beyond the limited realm of scientific, academic, and technical knowledge, arguing that "the social is nothing other than patterned networks of heterogeneous materials." (1992, 381) Institutions, 'the family', 'economy', and 'government' are all networks comprised of human *and* non-human components which mediate and shape social relations, because "there is no reason to assume, *a priori*, that either objects or people in general determine the character of social change or stability." (ibid., 383) Elaborating further, Law argues that:

> …people are who they are because they are a patterned network of heterogeneous materials. If you took away my computer, my colleagues, my office, my books, my desk, my telephone I wouldn't be a sociologist writing papers, delivering lectures, and producing "knowledge." I'd be something quite other – and the same is true for all of us. So the analytical question is this. Is an agent an agent primarily because he or she inhabits a body that carries knowledges, skills, values, and all the rest? Or is an agent an agent because he or she inhabits a set of elements (including, of course, a body) that stretches out into the network of materials, somatic and otherwise, that surrounds each body? (ibid., 383-4)

ANT takes the position that these networks, and the 'structures' of all sorts (social, economic, political; but also including personal identities) that emanate therefrom are *never* actually made static, but are instead forever being assembled, reinforced, extended, and contested. The crux of ANT, then, is analysis of how actors organize, assemble, and speak for (collectively, 'translate') their constituent pieces and subsequently *maintain* the networks they have constructed in efforts to both conceal their component parts and also keep them from breaking away.

Thus it is ANT's core of "relational materialism" (ibid., 389) and insistence on equally weighting human and non-human actors in the analysis of networks that makes it both interesting and powerful. The emphasis on materiality offers an exit from the discussion and elaboration of apparently free-standing forces like 'capitalism' (or 'Neoliberalism'), 'poverty', or 'gender', and demonstrates that appeals to such categories – as though they were independent forces – are typically quite hollow. What, exactly, does 'Neoliberalism' look like? Does 'Neoliberalism' cause environmental destruction and social unrest, or is it the *components of the network of heterogeneous materials* referred to in abbreviation as 'Neoliberalism' – e.g., heavily mechanized agriculture, container ships, futures contracts, under-resourced environmental protection agencies (themselves shorthand for further actor-networks of genetically modified organisms, soil inputs, supertankers, longshoremen/women, law textbooks, papers, and parliament buildings [themselves shorthand for further actor-networks of…]) that cause the problem?

ANT underlines the weaknesses of searching for explanatory power in disembodied 'social' forces; likewise, it problematizes the 'post-modern' critique. Demeritt (1996) rightly points out that post-modernism is in many ways guilty of the same 'views from nowhere' that quantitative, nomothetic research is, trading on a self-imposed crisis of 'representation':

> It is one thing to say that…the world is socially constructed but it is quite another to say that the world itself is fabricated…To do so suggests that the world is entirely of our own making. It plays to the sense that social constructivism leads to a stark choice between, on the one hand, some kind of objectivity grounded in the rational evaluation of a subject's representations in terms of their correspondence to a real, objective world and, on the other, some sort of anything-goes relativism about a world absolutely of our own making. (ibid., 486)

Aimed squarely at the wave of deconstructionism ushered in by Derrida (1997) and other Francophone theorists, Demeritt and other ANT enthusiasts argue that this variety of post-modernism verges on the nihilistic, and as such is neither helpful in advancing debate on the construction of knowledge in science (leading "almost inevitably to endless schoolboy philosophy squabbles about the truth of scientific representations" [Demeritt 1996, 486]), nor addressing larger challenges about the destruction and manipulation of the natural environment.

It is precisely ANT's emphasis on materiality that makes it a useful remedy to much of the 'disembodied' theorizing that characterizes both post-modern critiques and quantitative modeling. By focusing on *specific* instances and episodes in which knowledge and interpretations of knowledge are made, modified, and contested, ANT bridges the (artificial) divide between the natural and the cultural, the abstract and the concrete. Many (but especially Murdoch 1997a, 1997b, 1998) have pointed to this ability to 'bridge' and link heterogeneous materials as ANT's most promising attribute; a viable means by which research can move beyond dualisms like micro/macro, local/global, subject/object, or technology/culture. Such dualisms weaken studies of culture, society, economy, and the natural environment by artificially isolating the research focus from a larger context of both human and non-human influences.

While actor-network theory lets us map the relationships, arguments, and entities mobilized in 'scientific' arguments, independently it cannot provide a complete picture. How are people/places/things enrolled, represented, and made to stay obedient? Many have critiqued the theory for its relative silence on the tactics used to construct and maintain actor-networks (for instance Murdoch 1997a; Murdoch 1997b; but see also Latour 1999; Mol 2002; Law and Urry 2004 for empirical responses). Thus, I also employ discourse analysis in conjunction with ANT to examine the tools of enrollment, which encompass everything from formal academic writing to films, news media to subway graffiti. Holding such 'texts' up to the light of discourse analysis is valuable, because of the method's "ability to…uncover issues of power relationships" (Waitt 2005, 166) and explode taken-for-granted concepts and arguments, affording us the opportunity to analyze their component parts (Roche 2005). The success of this approach has been comprehensively demonstrated in contemporary geography research (cf. Mitchell 1988; Jackson 1989; Cronon 1991; Dalby 1996, 2008; Goodman, Boykoff, and Evered 2008, as only a brief set of examples) and science and technology studies (Latour 1987, 1988, 1996; Latour and Woolgar 1979; all of the essays in Law 1991; Law 1994; Mol 2002) though the phrase 'discourse analysis' is not necessarily used.

Methods

Thus informed, in this dissertation I examine the published and unpublished statements, papers, project studies, policy briefs, and archival materials generated alongside the development of WTE facilities in the United States. I consider both specific case studies and WTE technology in general. I look at texts produced by federal, state, and local environmental agencies, environmental and industry advocacy groups, and private companies, in addition to legal documents, laws, and news media representations of WTE.

Given the importance of government oversight to the operation of the WTE industry, I examine documents produced by the U.S. EPA as well as state agencies charged with the regulation of solid waste and incinerators. Municipal records for case study sites are also explored as available and accessible. I also consider texts produced by interest groups like the Solid Waste Association of North America (SWANA) as well as those of private companies like Gershman, Brickner and Bratton (GBB), Covanta Energy and HDR, which design and operate WTE facilities in the U.S. and frequently act as consultants on WTE development projects. There have been historically only a handful of companies working with WTE technology in the U.S., and so the perspectives and information contained within those company papers is highly relevant to this project.

With regards to popular media representations, though coverage of WTE from major national and international publications like the *New York Times*, *Washington Post*, *The Economist*, and *Financial Times* is considered, I devote significant attention to the news media analysis of outlets in communities where WTE facilities are located or planned. These printed sources are augmented by consideration of radio and television reports on WTE technology and projects, including, for instance, National Public Radio.

Media representations are important to this project because they are the primary means by which the 'general public' are informed about WTE technology, both in general and as it relates to specific projects. In addition to these literal texts, I examine additional non-written and visual materials associated with WTE facilities, including films, websites, signage and logos, advertising campaigns, facility architecture, artwork, music, and sounds, along with more abstract 'texts' such as the conferences mentioned earlier (as WTE 'event'), trade-show handouts and promotional materials, and academic and industry research programs. I build on this textual analysis with observations of WTE facilities in action, collecting photos, drawings, and diagrams of WTE facilities.

The two case study sites were selected for a number of reasons. The Greater Detroit Resource Recovery Authority (GDRRA) facility was chosen because it was at one point the largest WTE project in the United States (in tons-per-day capacity) and birthed during a period of great uncertainty and change in solid waste management practices in Michigan. The facility has been a source of great controversy since the mid-1980s, not only on environmental and human health grounds but also for its impact on the image and finances of the ailing city. There is a degree of expediency to my selection of the GDRRA, as my location in East Lansing offers easy access to the site as well as relevant state-level documents housed in libraries around the capital city.

The site in Maui, Hawaii, was selected because solid waste management represents a perennial problem on the island and also because electricity prices were very high due to the need to import nearly 100% of the island's fuel. Thus, it seemed curious to me that in a situation seemingly tailor-made for a WTE facility, the island had rejected the technology more than once. Interest has returned to the technology since the mid-2000s, however, partially as a result of the expansion of a large WTE project in Honolulu. Thus the Maui County case study not only illustrates an historical instance of the rejection of the technology, but also a glimpse inside the debate about WTE as it is happening in real time. I traveled to the island during the summer of 2012 to work directly with news media and government archival documents there.

In contrast to both Detroit and Maui, the miniature case study of the ecomaine facility in Portland, Maine was chosen because it represents an alternative vision for solid waste management that integrates WTE into an holistic solid waste management program serving several municipality member-owners. Ecomaine encompasses WTE, intensive recycling, and also a disposal site for ash residue from WTE. I visited ecomaine in conjunction with attendance at the 2012 North American Waste to Energy Conference (NAWTEC) in Portland. ecomaine is considered by many to be among the best examples of integrated solid waste management in the US, if not the world, and a limited study of the recent history and operations of the facility offers many insights into how WTE technology can be 'done right' in the US context. Taken together, the two case studies and snapshots of the ecomaine facility offer a range of perspectives on WTE's role in solid waste management in the US, and also illuminate contingencies in the technology evaluation process unique to each site. Having such a range of perspectives is important for understanding the full spectrum of WTE projects in the US (successful, unsuccessful, and ambiguous outcomes) and represents a valuable resource for future policy making.

The costs of the project, including travel to case study sites, have been largely funded by a "Science to Achieve Results" Graduate Fellowship from the US Environmental Protection Agency (grant # FP-91737901-0), which includes an annual budget for research expenses. Other funding for the project has come from Michigan State University's Graduate Office Fellowships.

Goals

The mixed-methods, qualitative approach taken in this project is described elsewhere as the 'ethnography of infrastructure.' (Star 1999) Star goes on to say that:

> The fieldwork in this case transmogrifies to a combination of historical and literary analysis, traditional tools like interviews and observations, systems analysis, and usability studies. For example, in studying the development of categories as part of information infrastructure, I observed meetings of nurses striving to categorize their own work, studied the archives of meetings at the World Health Organization and its predecessors arguing about establishing and refining categories used on death certificates, and read old newspapers and law books recording cases of racial recategorization under apartheid in South Africa. **In each case, I brought an ethnographic sensibility to the data collection and analysis: an idea that people make meanings based on their circumstances, and that these meanings would be inscribed into their judgments about the built…environment.** (ibid., 382-383, **emphasis added**)

In defiance of the *zeitgeist* in which many university administrators, politicians, and business leaders discuss the efficacy of intellectual inquiry solely in financial terms (Readings 1996) – an attitude which fundamentally undermines the role and purpose of the university in society, the value of undergraduate and graduate training, and the ability of educated citizens to speak truth to power – I maintain that the primary purpose of my research is a better understanding of the human condition and the sharpening of my own critical thinking and writing skills.

However, the reserve currency of academic life is publications. From this dissertation project, I anticipate the publication of several peer-reviewed articles in prominent geography, science and technology studies, and environmental history journals like *Technology and Culture*; *Environmental History*; *Journal of Historical Geography*; *Social and Cultural Geographies*; *Science, Technology, and Human Values*; *Social Studies of Science*; *Technology in Society*; *Singapore Journal of Tropical Geography;* and

Environment and Planning D. I also plan to disseminate research findings at academic and professional conferences and workshops, like the annual meetings of the Association of American Geographers (AAG), the Society for the History of Technology (SHOT), and the Society for Social Studies of Science (4S), as well as waste management industry conferences like NAWTEC and WasteCon.

I hope to reach beyond these mainly academic audiences, however, by producing both policy white papers and materials for general readers. These will draw on my project findings, presenting them in an accessible way and making policy suggestions about waste management, energy supply, and the implementation of WTE technology. While all of these efforts will emanate initially from a faculty position, outside of the university setting I hope to become active in the policy-making and project management arenas through roles at consultancies, policy think-tanks, and international organizations like Resources for the Future, The Brookings Institution, UN-Habitat, and the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Conclusions

In this dissertation I ask why WTE has been embraced in some places but rejected in others. From the perspectives of human geography and science and technology studies, I examine a range of written documents and other texts to investigate the barriers limiting WTE implementation. I apply the insights of discourse analysis and actor-network theory to de-compose the decisions that have been made regarding WTE at sites in Hawaii, Michigan, and to a lesser degree, Maine. While this work contributes to academic literature, the research completed for the project will also inform work in the solid waste management and environmental protection arenas.

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Chapter Two

A Research Context

An important part of any research endeavor is understanding the successes and failures of earlier inquiries. This chapter considers research from geography, science and technology studies (STS), and similar disciplines (particularly environmental sociology) into the topics of energy, solid waste, and infrastructure that represent the core of this dissertation. I begin first with an examination of contributions from academic geography. While research on solid waste is somewhat rare in the discipline, concern with energy topics has a long tradition and represents a rapidly expanding body of literature, as evidenced by special issues of both the *Annals of the Association of American Geographers* in 2011 and *Geoforum* in 2010. In this section I also briefly present geographic studies of technology and infrastructure, which, although rarely recognized as such, are quite common to the discipline. I argue that great value is produced by re-framing this sort of geographic work in the terms of STS, and work which places the two literatures in conversation, as my dissertation does, is explored briefly at the end of this section.

Next, I look at the body of literature emanating from STS that deals with issues of waste management and energy. STS work interrogates the processes and motives behind each topic more thoroughly than its geographic counterparts, but an overwhelming concern with contingency makes generalizations across different times, places, and technologies sometimes impossible. Accordingly, I argue again that much can be gained from approaching the study of infrastructure from a hybrid perspective which blends the particularity of STS with the more 'global' tendencies of geography.

Then in a shorter section I consider the relationship between environmental sociology and solid waste, energy, and infrastructure research, focusing especially on studies of facility siting and environmental justice. The purpose of this abbreviated section is to provide an overview of 'socially'-oriented research as it relates to my dissertation topic. Finally, in the conclusion I lay out a model for research that brings together all of the insights from the preceding sections by way of two examples from STS: Susan Leigh Star's "The Ethnography of Infrastructure" (1999) and Bruno Latour's *Aramis, or, The Love of Technology* (1996).

Geography and…

...Solid Waste Research…

Despite its ubiquity in daily life and relevance to the urban, environmental, and economic/industrial processes that lie at the core of many practitioners' research, historically speaking solid waste has received very little attention from geographers – though this is changing, as the programs of the 2012 and 2013 Association of American Geographers Annual Meeting illustrate. These panels represent the sorts of work on solid waste that have typically come out of geography, and can be organized into four categories: historical, waste 'mobility,' governance (containing subcategories of research specific to both recycling and incineration), and cultural geography. Sewage and the closely related infrastructures of urban water provision have received greater attention within the discipline (for instance Jewitt 2011), but are not the focus of this dissertation. Thus, I will deal with each category of solid waste research in turn.

Historical geographies of solid waste management are few and far between, and focus primarily on garbage issues in the United States. This changes somewhat if we expand the definition of 'geography' to include the interdisciplinary field of environmental history, where studies of solid waste management are slightly more visible. The work of one scholar in particular – Martin Melosi – stands out in this body of literature. His earliest book on solid waste, *Garbage in the Cities* (1981), explores the history of solid waste management in the urban United States since the late 19th century, drawing garbage into a larger discussion of modernity and modernization as well as the changing social and environmental meanings of 'trash.' These are themes continued in his other major works, and especially *The Sanitary City* (2000) and *Effluent America* (2001) each of which locates garbage as a key component of larger industrial, environmental, energy, and even political processes. He argues – quite rightly – that solid waste is as central a part of urban infrastructure and an abstract 'city life' as electricity, mass transit, and housing. Melosi's work looms large in any historical study of American solid waste infrastructure, including this project, and will be dealt with in greater detail in Chapter Three of this dissertation.

Beyond Melosi's work a handful of other 'geographic' scholars have made valuable contributions to the study of solid waste. Colten (1994) expanded on Melosi's argument about the centrality of solid waste to urban life in his study examining Chicago's use of garbage as a building material starting in the mid-19th century. Colten shows how refuse was used to fill in quarries and marshland in order to generate more valuable real estate, simultaneously permitting physical expansion of the burgeoning metropolis. McGurty (1998) looks at the history of garbage collection in Chicago from the perspective of gender, arguing that women's roles within the home – especially the management of kitchen and food waste – translated into greater roles for them at the municipal policy and advocacy levels, especially as these impacted the procedures for the collection of garbage. Outside the United States, Cooper (2010) examined the rise of the landfill as the dominant mode of waste management in Great Britain after the first

World War, while Brownell (2011) considered the impacts of global North-South relations and especially the 1970s and 1980s 'oil shocks' on the practices and technologies of recycling. Both Cooper and Brownell pay close attention to the social, political, and economic contingencies that surrounded seemingly 'inevitable' technological decisions, illustrating that the various 'meanings' of solid waste and solid waste management options are not inherent but rather actively shaped and maintained.

The second category of solid waste research in geography deals with the movement of waste within countries but especially internationally. Waste 'mobility' (Davies 2011) research is typified by Collins' (1997) short study looking at the regulatory and environmental impacts of the movement of waste paper between U.S. states and European Union member states. More recently the issue of electronic waste ('E-Waste') has come under greater scrutiny by geographers, especially as the trend of Western countries exporting unwanted or non-functioning computers, cell phones, and similar devices to countries in southern Africa and South and East Asia for disassembly and ultimately disposal has increased with the turn of the millennium (Lepawsky and McNabb 2010; Lepawsky and Mather 2011). Such studies are important because they draw attention to the myriad legal and regulatory issues that govern the transport of solid waste.

Transporting trash, however, represents only one component of an array of larger regimes of garbage governance. These types of 'oversight studies' represent the largest category of garbage research in geography, and seek to address the legal, economic, and social policies that impact that production and storage/transformation of solid waste. In contrast to the historical geographies of solid waste outlined above, these studies are typically international in scope and offer a 'snapshot' of solid waste management in places like the United Kingdom (Gray 1997; Bulkeley, Watson, and

Hudson 2007; Bulkeley and Askins 2009; Bulkeley and Gregson 2009), Ireland (Davies 2007, 2008b; Desmond 2006), urban Africa (Myers 2005; Adama 2007), Bangladesh (Bhuiyan 2005), urban India (Angelene Grace 2010), Greece (Lasaridi 2009), Japan (Namie 2004), Hungary (Gille 2007), and Mexico (Moore 2008, 2009). This work is typified by detailed 'stock-taking' of solid waste infrastructure at a particular time and subsequent examination of a particular policy, controversy, or management technology.

As such this category of solid waste research contains two more specific subsets of literature examining recycling, and most germane to this dissertation, solid waste incinerators. While more general 'waste policy' research also discussed recycling practices and trends, recently scholars have examined recycling itself in greater detail both at the level of the city (or 'city-state' in the case of Singapore, Harvey 2010) and also from the perspectives of poverty alleviation (Gutberlet 2012) and rubbish scavenging (Lane 2011; Whitson 2011). These perspectives on waste management conflict with the aims of WTE, a point which is not lost on the two primary scholars contributing to incinerator research in geography. Matthew Gandy, writing just at the start of a significant WTE construction hiatus in the United States, argues in his book *Recycling and the Politics of Urban Waste* (1994) that the trend towards market liberalization in all areas of solid waste management makes incineration increasingly profitable, thus precluding both recycling and efforts to reduce the volume of waste at its sources. Despite the presence of this 'juggernaut' of capital, Gandy (1995) illustrates the political challenges that face incineration at various scales and make the adoption of WTE far from inevitable even in major metropolitan areas like New York City. Likewise, Anna Davies (2005, 2006, 2008a) examines civil society's role in a controversy surrounding the location and construction of a WTE facility in Ireland. At the heart of both scholars' work on WTE lie larger questions about society's relationship to excess value and the status of ‘worthless-ness’. Such questions are important because they point to the fact that, as Davies argues, disposal of something “does not mean that [waste] ceases to exist, rather it often marks the beginning of relocation and rematerialisation processes, which are conducted…from the molecular to the international over different time periods…” (2011, 1) In other words, waste has an ‘after-life’ that begins only when it has been relocated into a landfill, recycling center, or incinerator.

Exactly what that after-life entails, and indeed determining what, when, and where ‘counts’ as waste is the subject of the final category of research examining the cultural geographies of solid waste. Some of the studies in this category focus on the socially-constructed distinction between ‘waste’ and ‘value’ (Henderson 2011). Zimring (2004), for instance, explores changing conceptions of recycling and conservation in the United States, linking beliefs about the importance of re-use to changes in thoughts regarding both xenophobia and hygiene in the early 20th century. Most research on the cultural geographies of solid waste, however, deals directly with questions of materiality and thus bears close associations to STS literature. Some authors (Colten and Dilsaver 2005) have examined the processes by which governments and companies hide or disguise solid waste infrastructure, while others consider the “haunting spectre” (Mansvelt 2010, 229) of garbage and its impact on consumptive practices.

Most promisingly however has been the research emanating from a special issue of *Environment and Planning A*, which included four articles and an editorial on the “teleological fix” (Gregson and Crang 2010) that dominates solid waste research. In other words,

> …waste in the social sciences has hitherto been the primary concern of environmental policy and urban planning, whilst [garbage] and its treatment remain the preserve of the technical and thus the domain of engineering. The matter of waste becomes fixed and limited through

> management…that which is managed as waste is waste, and that which is waste is what is managed. (ibid., 1026)

The crux of these papers (Crang 2010; Gille 2010; Gregson and Crang 2010; and Cooper 2010 which was discussed earlier) is that waste is not something that 'is' – rather, waste is something that materials 'become'. Again, Gregson and Crang argue that

> …the symbolic comes to define various materials more or less arbitrarily as waste in ways that suit society. But, what is polluting waste in one society may not be treated so in another time and place. From this it flows that categories and social orders use materials but are not determined by those materials. This liberating move from waste as a self-evident category to waste as a social construction therefore begs the question of how different matters matter differently [*sic*]. (2010, 1027)

What makes these authors' arguments useful, however, is their willingness to move beyond abstract theorizing and make policy critiques and recommendations. Significantly, the contributors to this special issue argue that too often the 'technical' regime that dominates thinking about solid waste leads to the production of 'end-of-pipe' policy rather than effective interventions which re-write the definition of solid waste in the first place.

And so it is with WTE as I approach it in this dissertation: which 'wastes' are the source of the controversy? Is it the garbage itself? The people or entities that handle the garbage? Or rather the 'after-life' of waste treatment (incinerator ash and emissions)? Is one 'after-life' for solid waste preferable to society over another (landfill, recycling, incinerator)? Who makes these decisions and how are their perspectives informed by scientific research, theories of value, and social justice arguments?

Before answering these questions, we must recall that approaching WTE from the perspective of waste management only addresses half of the story. WTE lives a dual life, straddling the worlds of garbage and energy production. Even though Gandy

(1995) argues – correctly, in my opinion – that WTE is too frequently framed solely as a waste management technology, its contributions to a system of energy provision can be significant. It is to the body of geographic literature on energy supplies and systems that we now turn.

…Energy Research…

Geographic studies of energy[1], concerned initially with the location and description of fuel sources and reserves, stretch back perhaps as far as the 18th century when military geographers compiled various reports and maps as part of colonial and imperial operations (cf. Godlewska and Smith 1994). In academic geography, research on energy systems has a less nefarious, though not as lengthy, history stretching back to the 1920s. Since then, geographers have completed both quantitative and qualitative forms of energy research. While critical qualitative studies are arguably more prominent today, generally speaking, trends in energy geography mirror those of geographic research as a whole. Energy research from the first half of the 20th century tends towards the idiographic, concerned primarily with the countries of western Europe and North America and the development of massive infrastructure projects (such as the Grand Coulee Dam, see Barbour 1940) and post-World War II European reconstruction (e.g. Kish 1955). The second half of the 20th century saw energy geography produce formula-driven studies of power plant site location (see Smith 1973), nuclear disaster evacuations (e.g. Zeigler, Brunn, and Johnson 1981), and fuel

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1. I have documented the precise contours of the changes in energy geography in two papers, one unpublished (but available on my website) and the other (with David L. Baylis), dealing with trends in energy cartography, which is currently being prepared for publication. For this dissertation, I summarize the main findings of those two papers and then briefly discuss geographic research most pertinent to this project.

transportation modeling (such as Osleeb and Ratick 1983) in line with broader interests in quantitative and model-oriented research. Shortly thereafter arrived 'critical' energy geographies seeking answers to questions about the roles of government and economic processes like capitalism in deployment of energy technology (e.g., Overton 1976; Chappell 1977; Daultrey 1980). The late 20th century 'post-modern turn' has encouraged geographers to ask new questions about the linkages between energy resources and issues of identity (see Cupples, Guyatt, and Pearce 2007), gender (e.g. Routledge 2003), and landscape (such as Nadaï and van der Horst 2010), while also setting up 'energy' as a lens through which larger critiques of urban planning (Owens 1986; Melosi and Pratt 2007) and neoliberal economic policies can be made (Ahmed 2010).

Yet even as theoretical and methodological trends changed through time, four themes in energy geography remained fairly constant, namely: the 'inventory' of energy resources like fuel supplies and infrastructure; the deployment of energy technology in the name of economic and social 'development'; the notion of the energy 'crisis'; and finally, a concern with energy's future forms – energy futurism. While these categories are far from rigid, such broad groupings are helpful in identifying common patterns, practices, and limitations in existing energy geography research.

As with solid waste research, within these categories and through the timeline of energy geography, one can detect a certain teleological myth. In this instance, however, the myth is that degrees of energy use and infrastructure deployment represent steps on a continuum of 'progress' with an apparent ending point of economic prosperity, ubiquitous digital (or at least electric-powered) technology, and limited environmental impacts: energy consumption equals societal success. While this is rarely acknowledged directly, energy geographies from the earliest point surveyed present such high-modernist visions in which 'development' only comes about through the widespread uptake of energy technologies. Later writings perpetuate, albeit far more subtly, this same type of thinking, championing 'progress' not in the crude form of kilowatts generated or barrels of oil consumed but rather in the number of wind turbines installed, quantity of carbon pre-empted (or removed!) from the atmosphere, and the comparative tightness of environmental oversight laws and windfall profit redistribution provisions.

In both cases, energy technology itself is the key metric of progress. Though in many ways more palatable to 21st century sensibilities than the sort of 'slash-and-burn' progress characteristic of the early- to mid-20th century, the treatment of 'energy' (or some sub-set of energy: petroleum products, carbon emissions, renewable technologies, etc.) as a free-standing, monolithic entity operating outside of any larger physical, technological, political, economic, environmental, or (most commonly overlooked) cultural and historical context is problematic because of the normative effects such treatment produces, and the subsequent limits imposed on alternative conceptualizations and methodological approaches to energy studies.

Alongside the teleological myth are recurring problems of scale in energy geography. Research has tended to focus on the 'global' – like the global trade in natural gas, global emissions targets, or the 'global war on terror' and Petroimperialism (Jhaveri 2004), etc. – or else the national scale. The temporal scale from which many approach energy geography has emphasized projections for growth, historical shifts, and the risks of future disaster above the actual *moments* of energy's production and use. Such practices obfuscate the intensely *local* and *immediate* interactions that accompany actual energy use, and in turn generate a willingness to overlook the embodiment of 'energy' as it is found, fought over, and consumed *in places*, *during* *specific times*, and *at scales far smaller* than those most commonly studied. By conceptualizing 'energy' as something to be instituted, ('developed', measured, transformed, and improved) or else as a problem to be overcome, energy research in geography falls into many of the same technocratic, 'end-of-pipe' pitfalls that Gregson and Crang (2010) find plaguing research on solid waste management.

That's not to say that all geographic studies of energy issues are limited in this way; indeed there is a crop of recent scholarship that re-situates energy in the realms of identity and culture. Some of this research examines energy at the level of the individual or the household, for instance Hinchliffe's (1997) study of public responses to energy-related environmental problems from the perspective of Beck's (1992) "Risk Society" thesis; Cupples, Guyatt, and Pearce's work on notions of 'manliness' and home heating practices in New Zealand; Hitchings' (2007) case study of the outdoor patio heater; and Huber's (2009) critical analysis of the use of retail gasoline prices in various scales of the U.S.' political process. Akerman and Peltola (2006) examine the interpersonal relationships and conflicting professional practices that impacted the decision to switch fuel sources at a power plant in Finland; while Wills (2003) juxtaposed competing understandings of 'nature' with debates over land use and the construction of a nuclear power plant in an environmentally-sensitive part of California.

Many of the best studies bring long-term historical perspectives to bear on contemporary energy issues, as Buckley, Bain, and Swain (2005) do for the closure of a power plant – and demolition of an entire town – in Ohio; Howell (2010, 2011) does in an examination of Michigan's electricity infrastructure; Hemmingsen (2010) does with the debate on 'peak oil'; and Melosi and Pratt (2007) do in a volume linking the history of Houston's built environment to the vagaries of the oil and petrochemical industries. These historical approaches provide essential context for contemporary debates surrounding many energy issues, and add a great deal of value to the sorts of cultural and identity research outlined above.

In any case conceiving of WTE as 'only' an energy technology or 'only' a solid waste management technique limits the cast of our intellectual net. Instead, we ought to think about WTE as simultaneously the product of and component piece of larger networks of technology and infrastructure, each with important cultural, economic, environmental, and political dimensions. Fortunately, networks of infrastructure have long been a fruitful area of inquiry in academic geography, and there are numerous instances of exciting and insightful infrastructure research to examine.

…Studies of Technology and Infrastructure

For most of geography's existence as an academic discipline, issues of urban form and function – and the various technologies that underpin both – have attracted significant research attention. In the same way that energy research moved through different phases, from idiographic description to quantitative modeling and eventually critical social theory, so too has research on the various infrastructures necessary to make urban life possible. My aim in writing this section, however, is not to summarize the studies of technology and infrastructure most germane to this dissertation, since I have done so already in the preceding two sections. Instead, I will examine three texts which I consider excellent examples of what can be done with geographic studies of infrastructure, and then make a general argument about two ways in which this category of research could be improved.

The three texts I am highlighting have a great deal in common: all are primarily historical studies, all question the logic of the decisions made about infrastructure by those in power, and all are quite richly textured, selecting as their data not only traditional documents and policy statements but also artwork, popular cultural artifacts, architecture, and literature. Yeoh in *Contesting Space* (2003) examines the racialized power relations between British colonizers, Chinese, and other ethnic groups as they unfolded in conflicts over housing and especially sewerage infrastructure in the 19th and early 20th centuries in Singapore. Yeoh notes ways in which different communities visualized appropriate infrastructure for the city based on existing practices and norms; for instance, emerging European understandings of hygiene prompted British officials to demand certain standards for occupancy and waste management, while ethnic Chinese communities envisioned an alternate set of practices given distinctive labor and agricultural production traditions.

Likewise, both Harvey in *Paris, Capital of Modernity* (2003) and Dennis in *Cities in Modernity* (2008) examine conflicting meanings and understandings of the new technological systems emerging in major Western cities in the 19th and early 20th centuries. Both authors link new infrastructures, including electricity, sewerage, and transportation, to larger trends in governance and the expansion of capitalism. Both also take care to highlight the variations in access to infrastructure, along lines of race, class, and gender, which not only made practical impacts in the daily lives of residents but also impacted their very conceptions of both the city itself and the infrastructure comprising it.

While each of these studies is excellent in its own right, some characteristics common to all three serve to help me make two points about the limits of geographic studies of infrastructure. First, while studies of infrastructure and technology in geography are somewhat common, they are not always aware of their status as such; these studies would benefit from a more intensive theorization of both 'technology' and 'infrastructure.' Neither technologies nor infrastructures are innocent or value-free, as the instrumental role to which they are typically assigned in geographic literature would suggest. Technology is laden with meaning, both within the design process itself and also as it is eventually used (Bijker, Hughes, and Pinch 1987), purposes which do not necessarily align. For example, post-War German governments mandated certain construction standards for home bathrooms and kitchens, thinking that uses of these spaces and the appliances that filled them would be self-evident. Instead, officials and social scientists were shocked to find lumber stored in bathroom tubs and livestock in the shower (Lorkowski 2011). The point is that geographic studies of infrastructure many times overlook such gaps between intent and practice in the conception, installation, and usage of infrastructure, and are quick to subscribe to the belief that, as with energy issues, solving urban problems is simply a question of 'more' or 'better' infrastructure, or at the very least 'equity' in access. How can we be sure that these are the correct questions to be asked in the first place?

Second, while many geographic studies of infrastructure are well-versed in (radical) economic theory, post-modernist thought, and post-colonial discourse, they routinely neglect to consider the critical analysis of infrastructure found within other disciplines, and especially STS. Explicit studies of science and technology in geography, or produced by self-identified geographers, are relatively few and far between and center on the efforts of Livingstone (1992, 2003), portions of Godlewska and Smith (1994), Driver (2001), Hinchliffe (1996), and within the last year Furlong (2011), Peyton (2011), Caprotti (2011), and Saldanha (2011). Livingstone (1992), Godlewska and Smith (Godlewska and Smith 1994), and Driver (2001) examine the histories of geography itself, while Livingstone (2003) studies the physical spaces in which major scientific advances have taken place.

Alternatively, Hinchliffe (1996); a 2004 edited volume by Brunn, Cutter, and Harrington; and Furlong, Peyton, Caprotti, and Saldanha (all 2011) apply the insights of STS research to topics in geography rather than the discipline itself. Brunn, Cutter, and Harrington's edited volume (2004) published on occasion of the Association of American Geographers' 100th anniversary analyzed changes in the various technologies of geography, like cartography, computing, and aerial and satellite imagery. Caprotti and Saldanha examine the role of such technologies in two different colonial eras. Caprotti analyzes aviation and photography as a component of Italian imperialism in Africa during the 20th century, while Saldanha studied the role of a particular navigational guide in Dutch expeditions around the Indian Ocean during the early 17th century. Both authors incorporate the techniques of STS, and especially actor-network theory, into their studies to re-center the material aspects of colonialism and imperialism, pushing the traditional 'great men', battles, and Western orientation to the periphery. Peyton considers the efforts of British Columbia Hydro to build dams on several rivers during the 1970s and 1980s, examining – as this dissertation does – instances in which infrastructure went uncompleted. Peyton argues that this 'unbuilt environment' can tell us as much about changes to the nature of a particular project and the conditions it was intended to operate in as finished and functional technology.

Hinchliffe (1996) and Furlong (2011) take slightly longer views, each seeking to understand what precisely geographic studies of infrastructure have to gain from an engagement with STS, and vice versa. Fundamentally, geographic studies of infrastructure, according to Hinchliffe, "have tended to work with models of technology and innovation…as deterministic, linear, and external to the normal business of human activity…much of this geographical thinking tends to look for macro causes to explain the enormous scale of the effects which they successfully trace" (1996, 661-2) such as economic change and migration patterns associated with labor. Hinchliffe argues that the characterization of infrastructure as static and human-centered blinds researchers to the myriad ways in which large systems are actively modified or rejected (think of people illicitly accessing cable television or choosing to live 'off the grid' of electric power supply), and also the ways in which they evolve on their own accord (by wearing out over time or responding to changes in the natural environment like extreme weather, wildlife, etc.).

This is a theme continued by Furlong nearly 15 years later (2011). Using the example of 'mediating technologies' applied to urban water systems in the interest of reducing waste, Furlong illustrates how seemingly static large technical systems change over time, and the multiple scales at which such change occurs. Although infrastructures are typically represented as 'hidden' from public consciousness, except in the instance of system failure, Furlong argues that mediating technologies including such mundane objects as low-flow toilets function to foreground human-infrastructure relationships. Varied adoption of these technologies, however, proves to be a point of disruption between the intents of an efficiency or environmental protection regime and its actual effectiveness.

Finally, Furlong also argues that there is value for STS in closer engagement with geographic studies of infrastructure because of geography's more nuanced understanding of scale and also its deep theorization of space, two concepts which must be incorporated into any study of technology and infrastructure. Thus, while the geographic literature on solid waste, energy systems, and infrastructure provides a solid base from which to explore the issue of WTE in its own right, it is in conjunction with scholarship in STS that a more robust and ultimately more meaningful study of the subject can be made.

STS and…

…Solid Waste Research…

As is the case with academic geography, solid waste remains comparatively unexamined in the field of STS. Most of the work that exists falls into the same vein of environmental history that was explored earlier, with scholars like Martin Melosi and Joel Tarr leading the way. Other scholars have paid special attention to issues of gender in solid waste management, such as Bose, Bereano, and Malloy (1984), Hoy (1985), and Bix (2002), linking garbage to larger histories of home economics and housework.

Some research has been conducted on specific waste management technologies and their interactions with other environmental and technical systems. Zimring's (2011) study of the automobile shredder examined the contradictions of a device simultaneously lauded by professional engineers as a boon to enhancing recycling while coming under fire from the U.S. EPA for its emissions and other toxic byproducts. Geels and Kemp (2007) examined the processes and scales of technological change that shifted solid waste management in the Netherlands away from landfilling and towards increased recycling and incineration between 1960 and 2000. Similarly, Raven and Verbong (2009) studied the intersection of multiple socio-technical systems in the Netherlands, including biofuels (including some waste products), electricity, and district heating, focusing on the ways in which innovations in one system can impact the others.

All three of these studies go some way in illustrating STS' general stance that technical systems of any sort cannot be considered independently of not only the social and political contexts in which they exist but also the other technologies and infrastructures with which they interact. Likewise, we must put this limited body of STS research on solid waste in conversation with the much larger body of literature dealing with energy technologies.

…Energy Research…

Energy studies in STS have a venerable history, and some of the most central ideas in the field have emerged from work on energy infrastructure. Personally, STS research on energy systems and power plants is responsible for piquing my interests in the field in the first place, and thus scholarship in this tradition holds a special place in my heart and intellectual orientations.

One of the first and most prominent texts in the STS energy research tradition is called *Networks of Power* by T. P. Hughes (1983). Hughes investigates the electrification of London, Berlin, and Chicago in the late 19th and early 20th centuries, claiming that the ultimate form taken by the electricity system in each city was the direct outcome of different political and social configurations in each place. In Hughes' words,

> …an electric transmission system…means interacting components of different kinds, such as the technical and the institutional, as well as different values; such a system is neither centrally controlled nor directed toward a clearly defined goal…The rationale for undertaking this study of electric power systems was the assumption that the history of large-scale technology – not only power systems – can be studied effectively as a history of systems. (1983, 6-7)

In contrast to many geographic studies of electricity network development which posit the self-evident expansion of power lines, construction of new power plants, and social acceptance of increasing electricity consumption, Hughes argues that there is nothing so inherently 'obvious' about electricity systems. Instead, he offers a model for the growth of large technical systems (LTS) with five stages: invention and research development; technology transfer between places; systems growth; material and ideological momentum; and finally problem solving and regionalization. Hughes asks important questions about the definition process to determine just 'what' the given technology actually is and does, and how different conclusions are reached in different places. For in the three cases Hughes examines (Berlin, London, and Chicago),

> All three had the same pool of technology to draw from, but because the geographical, cultural, managerial, engineering, and entrepreneurial character of the three regions differed, the power systems were appropriately varied as well. The concept of style suggests that there was – and probably is – no one best way of supplying electricity. Embodied in the different power systems of the world is a complex variation on major themes that keeps the technology from becoming homogeneous and dull and that provides the historian with the challenging task of description and interpretation. (1983, 17)

Hughes' work has been interpreted and applied many times over among students of STS and energy research, and rightly so. But he is far from the only voice on energy technology in the discipline. Equally weighty contributions to energy research in STS have been the numerous books on electricity in American life produced by David E. Nye, and especially *Electrifying America* (1990), *Consuming Power* (1998), and *When the Lights Went Out* (2010). In these books, Nye seeks to explode the all-too-common conceptions of "'the home' or 'the factory' or 'the city' as passive, solid objects that undergo an abstract transformation called 'electrification'," (1990, x) arguing instead that electricity and similar energy systems (gas lighting, etc.) only effected change as they were incorporated and contested into people's individual and collective lives.

Gabrielle Hecht combines the approaches of Nye and Hughes in her book *The Radiance of France* (1998). Hecht examines the history of the French nuclear program, and specifically the admixture of engineering, politics, and public relations work that produced something identifiably "French". Drawing on Hughes' notion of technological style and also various components of actor-network theory, Hecht illuminates the ways in which engineering and seemingly mundane technical decisions about reactor design were imbued with greater meanings about the nation and France's place in the post-War world order.

While these three authors represent, in my opinion, the best models to follow for my dissertation research, there is an array of additional STS research on energy problems. Bowker's early work (1987, 1988) on the formation of Schlumberger, an oil-services company, introduces STS' concern with the various social constructions that have shaped the West's fossil fuel industries, including the ways in which crude oil reserves are estimated (Bowden 1985; Dennis 1985; Cole 1996) , the existence of an engineering-dominated oil 'fraternity' (Constant II 1989), and the landscapes of fossil fuel dependence (Jones 2010). STS researchers have also examined the formation and modification of the US (Hirsh 1989, 1999; McGuire and Granovetter 1998) and British (Winskel 2002b, 2002a) electricity industries. Finally, Dunford (1985) and Matsumoto (2005) have examined the political intricacies of funding alternative energy projects in Australia and Japan, respectively.

Such research lends a number of interesting questions to this dissertation. Should waste management be considered or framed as a 'large technical system'? What happens when LTS interact with one another, as is the case with WTE's garbage and energy components? How can the multitude of interpretations of a given technology, as Nye, Hecht, and Bowker offer, be corralled into a single vision of support or resistance for WTE? If this is truly impossible – as it seems it must be – how then do we end up with discursive categories like 'corporations', 'activists', 'the government', or 'scientists' taking action and impacting the implementation of various projects?

Environmental Justice and Environmental Sociology

One concern following organically from those outlined in the previous section deals with the social implications of completed and /or un-completed infrastructure. How are people impacted by the presence or absence of a particular waste management or energy technology? Scholars working under the umbrella of 'environmental justice' claim that toxins, emissions, and other harmful side effects associated with various industrial technologies are distributed unevenly across the general population to disproportionately affect the poor, ethnic minorities, and non-whites. Many case studies have focused directly on energy and waste management infrastructures in the US, and found that such facilities have had overall negative impacts on the lives of those living nearby – people who more often than not are among the least able to oppose facility siting proceedings in the first place.

Environmental justice research has a long tradition of studying the solid waste industry. In a review of environmental justice literature, Cutter (1995) details how the concern with the unequal distribution of industrial toxins began with opposition to the siting of a hazardous waste landfill in North Carolina in the early 1980s. The suspicion that poor and non-white communities bore a heavier environmental burden than their wealthier, white counterparts found support in a series of empirical studies completed by religious organizations, non-profits, and academics during the 1980s and 1990s. The publication of Bullard's *Dumping in Dixie* (1990) was followed by the formation of the Office of Environmental Equity at the US Environmental Protection Agency and a slate of environmental justice legislation at the federal level. Other work on the siting of solid, nuclear, and hazardous waste facilities confirmed the findings of earlier authors like Bullard (for instance Pellow 2002).

Despite a seemingly self-evident thesis – that poor people are disproportionately exposed to environmental toxins due to their closer proximity to hazardous industries and activities – and support from government at the highest levels, controversy continues to surround environmental justice arguments (Cutter 1995). Mohai, Pellow, and Roberts (2009) sift through the findings of environmental justice literature, emerging with an important caveat: while one can certainly locate unequal distributions of environmental risks which benefit wealthy, white populations, the methods for doing so are far from perfect. Mapping populations and determining their exposure to hazardous sites produces a range of results based on the source and scale of the data (zip code, geographic proximity, etc.) and the techniques used in calculation. Equally important is the fact that while industry and low-income populations may sometimes be found near each other, that does not suggest intentionality on the part of the facility operator – industry searches for the same low land prices and other 'rents' as do low-income populations.

Royte offers some insight into why this is the case in her popular book *Garbage Land* (2005) where she describes a paradox of waste facility siting that has emerged since the 1980s. Royte describes how the privatization of waste removal and disposal lead to competition among mostly poor and rural communities on the fringes of metropolitan areas to attract transfer stations and especially landfills via tax incentives and guarantees of low-cost, docile labor. That municipal governments would compete with each other to locate a suite of far-reaching environmental, social, and human health problems in their communities suggests a set of far greater political, economic, and cultural problems than have to do purely with waste management.

And indeed, there is another approach to answering the question posed at the start of this section that moves beyond issues of equity to examine the socioenvironmental impacts of economic and technological systems. Scholars working in the tradition of environmental sociology introduced two 'grand' theories to explain the logics that bind the environment, the economy, and society together: 'treadmill of production' and one alternative / response to it, 'ecological modernization'.

The treadmill of production theory was first introduced by Schnaiberg (1980). He examines the environment as the base of sustenance for society, and argues for an holistic viewpoint looking at the 'whole cloth' of ecology and ecosystems in relation to human economic production in order to understand the root causes of environmental degradation. Taking a fundamentally Marxist position, he describes a set of practices (capitalist accumulation and expansion) and a 'coalition' of the state, capital, and labor, coming together to generate a self-perpetuating 'treadmill' of production and concurrently, environmental problems. According to Schnaiberg, profit-seeking behavior, as supported (albeit sometimes indirectly) by both the state and labor, has no incentive to limit either the 'withdrawals' of natural resources or the 'additions' of harmful materials like toxins and pollution. Blindness to this fact results from what he terms the 'unpolitics' of economic growth – in other words, the uncritical acceptance of economic growth as an end in itself from actors across the political spectrum.

But not all environmental sociologists would agree that capitalism itself is a problem. Scholars in the tradition of ecological modernization, most notably Mol (1997) and Spaargaren (with Mol, 2002) argue that as environmental crises become more apparent and serious, societies will eventually correct the processes causing the damage without abandoning them completely. In other words, there is nothing inherently harmful to the natural environment within capitalism, it's just that the environment has not been 'valued' appropriately and technologies have not been designed to achieve the same productive ends as before while taking environmental issues into account. Thus, improved technology and new markets for ecological / ecologically-friendly goods and services can be engineered with positive results.

Ecological modernization has attracted an array of strong critiques, not least of which that it represents only a thin cover for Neoliberal policies and the financialization and marketization of everyone and everything (York and Rosa 2003; Harvey 2005). However, in the short- and middle-term, many ecological solutions can be found by charting a course between the competing positions, one entailing a dramatic overhaul of capitalist production and the other a 'simple' modification of capitalism to function in a more environmentally friendly way.

WTE is a technology which seems to chart such a middle course. Following from ecological modernization theory, WTE is a disposal technique that is 'greener' than landfilling, open burning, or indiscriminate dumping in the oceans or other bodies of water. Conversely, WTE does nothing on its own to limit the production of the fuel it needs to operate – solid waste – and could even be charged with exacerbating the problems of overproduction by reducing the imperative to confront the spatial and ecological problems associated with landfilling. However, in conjunction with other technologies and socio-political regimes like recycling and composting, which some WTE facilities incorporate directly into their operations, WTE can address some of the 'withdrawals' and 'additions' that go into a range of production practices involving plastics, metals, and organic materials. In this same way, it may also begin to address some of the concerns raised by scholars of environmental justice issues.

Thus, WTE is a technology – like all other technologies – which exists in a web of associations with political, economic, social, and environmental practices and perceptions.

Conclusions

In the preceding sections I have offered an overview of existing research into energy systems, waste management, and the more broadly-defined category of 'infrastructure' from the perspectives of academic geography, STS, and environmental sociology. The research presented covers an array of methods and approaches to studying these issues and subsequently makes a number of interventions, intentional or otherwise, into the policymaking arena ranging from simple critique to detailed outlines for action. The work represents a broad spectrum of intellectual effort, all of which makes an impact on this project.

The best way to illustrate these impacts is to examine two studies, both from STS, which I feel capture the diversity of research in the field and have directly shaped the methods employed and results intended for this project. They also relate the work on infrastructure to my general theoretical orientations towards actor-network theory. The first is Susan Leigh Star's "The Ethnography of Infrastructure" (1999), a journal article appearing in *American Behavioral Scientist*, and the second is Bruno Latour's book-length 'scientifiction' (sic) of Parisian mass transit called *Aramis, or, The Love of Technology* (1996).

The insights of Star's essay are so lucid that they must be included at length here:

> This article asks methodological questions about studying infrastructure with some of the tools and perspectives of ethnography. Infrastructure is both relational and ecological—it means different things to different groups and it is part of the balance of action, tools, and the built environment, inseparable from them. It also is frequently mundane to the point of boredom, involving things such as plugs, standards, and bureaucratic forms. Some of the difficulties of studying infrastructure are how to scale up from traditional ethnographic sites, how to manage large quantities of data such as those produced by transaction logs, and how to understand the interplay of online and offline behavior. Some of the tricks of the trade involved in meeting these challenges include studying the design of

> infrastructure, understanding the paradoxes of infrastructure as both transparent and opaque, including invisible work in the ecological analysis, and pinpointing the epistemological status of indicators. (1999, 377)

Star proceeds to define exactly what infrastructure is, namely, any system or set of practices with the properties of embeddedness (infrastructure is part and parcel of other social and physical structures); transparency (invisibly supports particular tasks); temporal and geographic reach or scope; it is learned as part of membership in a group (biologists, city-dwellers, etc.); linking with conventions of practice for that group; it embodies a set of standards; it is built on an installed base (in other words, infrastructure cannot exist apart from other infrastructures); it becomes visible upon failure or breaking down (i.e., people are only aware of the power grid during a blackout); and finally, it is modular, and changed/adapted/assigned new meanings differently in different places and times.

Thus, Star argues that infrastructure is fundamentally relational, and is best studied by giving voice to all of the 'things' that are typically silenced simply by an infrastructure's smooth functioning, like the standardization of various components or even the underlying narrative that a given infrastructure 'works' (or doesn't) or is needed (or isn't). For WTE, this might boil down to the analysis of seemingly mundane choices related to boiler design, or the selection of a particular system design for a facility. Star also recommends examining the 'invisible labor' behind any infrastructure, and the ways in which slight changes introduced by a new infrastructure to a pre-existing workflow may well de-rail an entire project.

Likewise, in *Aramis* Latour conducts an ethnography of a Parisian mass transit system, exploring the meta-narratives, invisible labor, and conceptual barriers that eventually ended the project. Latour, via examination of archival documents from transit authorities and private companies and interviews with engineers and policymakers involved in the project, brings a 'technological' object into the 'human' realm for the express purpose of rectifying an "intellectual universe, from which we have in effect eradicated all technology." (1996, vii) In Latour's telling, technologies and infrastructures are profoundly human, and humans are thoroughly imbued with technological objects and processes. It is this sensibility which informs his decision to write from multiple perspectives in the book, narrating the story from the perspective of a graduate student and his advisor while interjecting verbatim (we're told) interviews and documents unearthed during Latour's own field research on the project. He also writes a number of passages from the perspective of the mass transit project itself.

Although *Aramis* has the appearance of a one-of-a-kind project, there is a great deal to emulate, not least of which is the project structure. For in Latour's own words,

> Aramis was not only technologically superb but also politically impeccable. There was no 'Aramis affair,' no scandal in the newspapers. Better still, during the same period the very same companies, the same engineers and administrators, succeeded in developing the VAL automated subway systems whose background forms a perfect counterweight to the complex history of Aramis…How can people be condemned for failing when those very same people are succeeding elsewhere? (1996, ix)

Such is the case with WTE: the same handful of companies build and operate WTE facilities in some places even as those same companies' projects are denied elsewhere. And thus, the question at the core of this project: how can we explain these multiple understandings of a given infrastructure, themselves informed by conflicting calculations, design practices, and value systems?

Why are technologies adopted in some places but rejected in others?

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Chapter Three

An Historical Geography of Waste-to-Energy[1]

The history of solid waste incineration in the United States is not one of continual growth, but rather marked by alternating periods of intense interest and rush to build facilities followed by hesitation, disappointment, and malaise. There is no single factor, company, or government agency behind the expansion and contraction of WTE, but rather a host of forces coming together at different points in time to encourage or discourage its use. In this chapter, I develop an historical geography of WTE, focusing on the US and in particular the era since 1965 and passage of the federal Solid Waste Disposal Act. After offering a general outline of the development of WTE around the world, I shift attention to the role of the Office of Solid Waste at the US Environmental Protection Agency in shaping this geography through its funding of demonstration projects, production of guidelines for municipal decision makers, and offer of 'technical assistance' to communities considering WTE. In reality, provision of 'technical assistance' was direction towards the corps of engineering consulting firms responsible for design and development of disposal projects. As such, examination of these firms is the next section of the chapter, focusing on their influence on the US EPA as well as municipal officials' understandings of the possibilities for waste disposal technologies. The array of disposal technologies studied by engineering consulting firms was

1. Waste-to-Energy (WTE) henceforth refers to a specific type of incineration with energy recovery. WTE uses either unprocessed ('mass-burn') or processed waste ('refuse-derived fuel,' RDF) in a waterwall-type boiler. WTE, in this sense, first appeared in 1954 in Bern, Switzerland (Battelle Columbus Laboratories 1979, vi). In this chapter, 'incineration' refers collectively to all technologies disposing of solid waste via combustion whether or not they recovery energy. 'Energy conversion' includes WTE as well as competing technologies like pyrolysis. Further distinctions are made in the text.

frequently put on display at industry conferences, the production of which remains one of the major purposes of solid waste industry professional organizations. These are the final topic of this chapter, and these organizations' roles in shaping the geography of WTE in the US are explored before presenting some conclusions. Many sources were consulted for preparation of this chapter, but only those that have been directly cited or paraphrased appear in the bibliography section. The remainder of the narrative has been forged from careful consideration and analysis of a range of US EPA, engineering consulting, and professional organization documents.

An Argument

Before proceeding too far, I want to make a note about the entities selected for study in this chapter as well as their impacts in the world of WTE. Figure 3.1 illustrates the most prominent actor-networks shaping and enacting the WTE industry. These include municipalities, state governments, the federal government (and particularly the US Environmental Protection Agency), the 'concerned public' (in some sense informed by and existing through news media), equipment manufacturers and the products they sell, professional societies and advocacy groups, the corps of consulting engineering firms, and of course the solid waste itself, whose qualities and characteristics play a critical role in the success or failure of any WTE project.

The items with blue backgrounds in Figure 3.1 are those 'under investigation' in this dissertation. Why not study them all? The answer is because the items in blue have not made it necessary to investigate the rest: they acknowledge the existence and importance of other actor-networks, but do not question either. For instance, all of the blue items acknowledge the great power that the US EPA and state-level offices of air

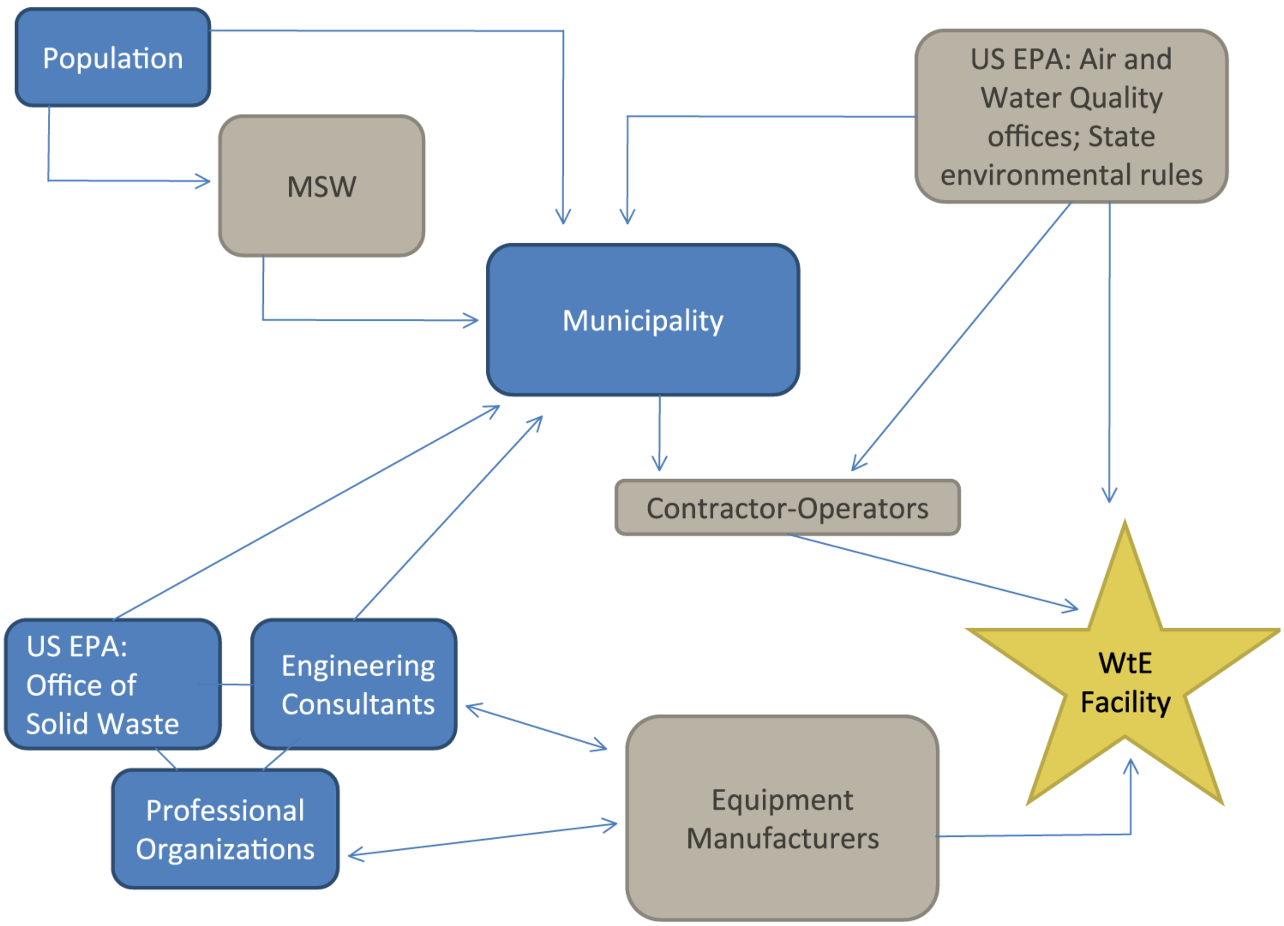

Figure 3.1: Key actor-networks in the incineration industry.

and water quality hold over the WTE industry through those offices' ability to create and enforce emissions rules. But, the story ends there – while discussions about the effectiveness or absurdity (depending on who you talk to) of the rules is common at industry events, little is done regarding the emissions rules except to thoroughly understand and implement them. Likewise, when engineering consultants work with a municipality, both parties are aware that what they can achieve in a given project depends to a large degree on what equipment is available in the marketplace. In the language of ANT, the items in gray might be called 'obligatory passage points' since the

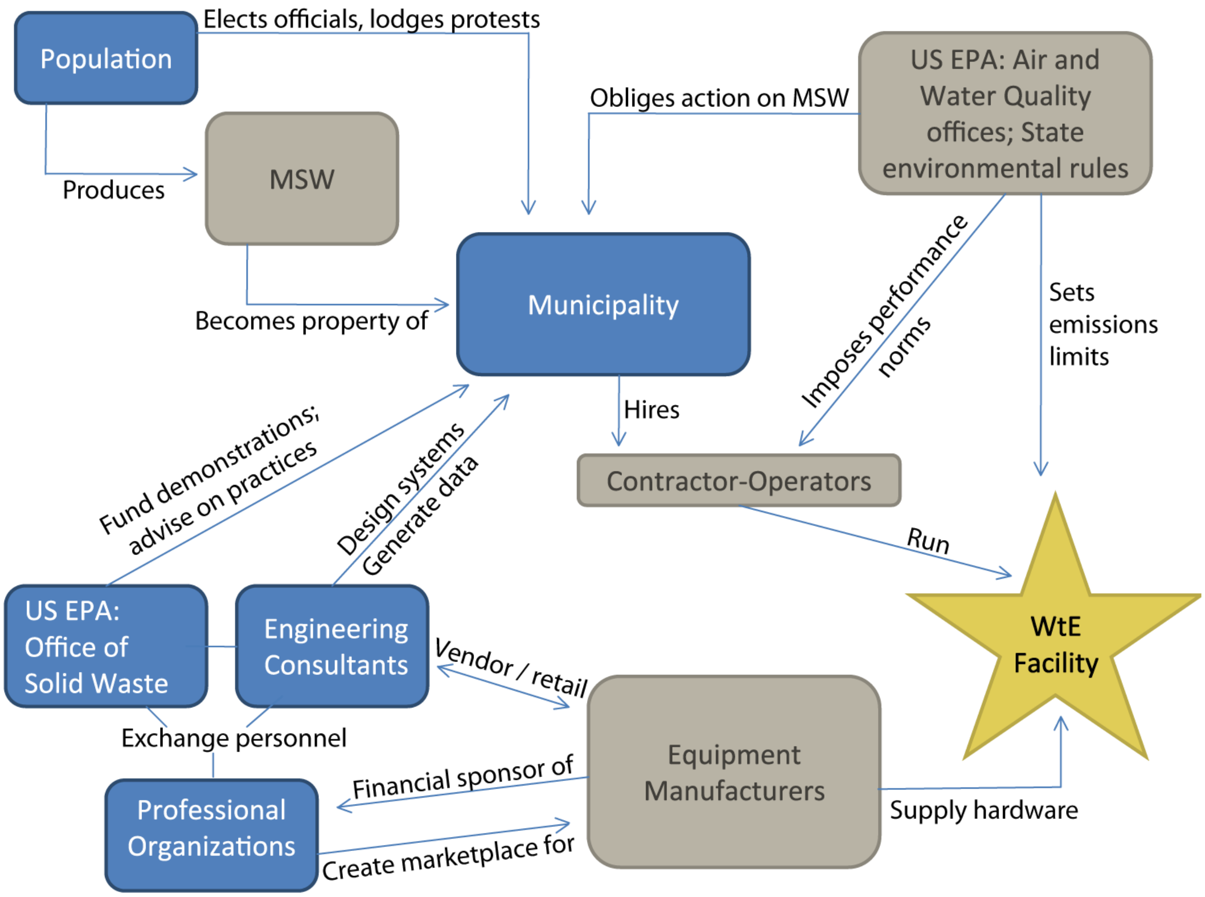

Figure 3.2: Summary of relationships between actor-networks.

rest of the world must pass through them or otherwise deal with them to achieve whatever their own ends are. A summary of the relationships is suggested in Figure 3.2.

Modern incineration in purpose-built facilities runs back to mid-19th century England, and was developed to reduce the volume and variety of solid waste into a more compact and manageable product: ash. However, by the end of the 19th century, some facilities and engineers sought to convert the excess heat from incineration into steam for industrial use and electricity production, first in Hamburg, Germany in 1896 (Curlee et al. 1994) but soon after elsewhere in the United Kingdom and North America. In the late 20th century when incineration for volume reduction alone all but disappeared in the US, the two tracks for incineration existed in parallel. But by that same time, the techniques for energy and other 'resource recovery' from incineration had multiplied.

This notion of multiple personalities characterizes well the history of 'incineration' in the US. As scholars of STS have illustrated (e.g., Latour and Woolgar 1979; Bijker, Hughes, and Pinch 1987; Latour 1987, 1988; Bijker and Law 1992; Latour 1996; Law 2002; Mol 2002; Bennett 2010) technologies have a degree of indeterminability about them. For public officials, engineers, news media, and an engaged public, the word 'incineration' would come to encompass a variety of meanings: disposal technology, health hazard, energy source, financial asset (or liability), etc. As close engagement with the historical record shows, however, none of these categories were fixed and stable. Incineration as a 'disposal technology' could mean, for instance, simple volume reduction, but also a range of additional or alternative energy and materials recovery technologies: should we recover heat to produce steam? Or electricity? How will we transfer the heat to another medium, like water? (Do we *need* to transfer heat to another medium? Can we generate electricity directly with a fluidized bed?) Must we use a cheap waste-heat refractory boiler? Or a more expensive but more efficient waterwall design? Should we bother with boilers at all or simply select theoretically promising – but commercially unproven – pyrolysis kilns? Can't we just sell shredded waste to the local power plant and have them burn it with coal? How do the EPA-funded demonstration projects translate to our city? What will the public accept? What do the consultants suggest to be the best course of action? Is the RFP acceptable as a fact-finding tool?

If the reader is overwhelmed with this onslaught of rhetorical questions, then the intended effect has been achieved. Many, including prominent scholars of solid waste history in the US (Melosi 2000, 2005), regulatory officials at the EPA (e.g., Mitre Corporation and EPA Office of Solid Waste Management Programs, 1976), and members of the professional corps of consulting engineers that have shaped nearly every single incineration project in the US since at least 1965 (e.g., Hale Jr. 1975), argue that incineration has been 'fundamentally' limited by improper bidding and contracting practices, lack of political will, or the selection of a facility design inappropriate for the task at hand. These are merely symptoms. **I assert instead that the most fundamental problem facing incineration with energy recovery in the United States – and from which all other challenges spring – is the fact that there is no universal agreement on what the technology 'is' or what its primary purpose is for**. Do cities incinerate to limit landfilling? Or do they incinerate to 'recover resources' from the solid waste stream? Subsidy or profit? Energy source or disposal tool? Is the technology environmentally benign or hazardous? It seems that no one can decide.

While the origins of these multiple personalities have roots in the 19th century, **I argue that it was during the period from 1965 to 1980 when the US Environmental Protection Agency Office of Solid Waste, in conjunction with a corps of engineering consulting firms and related professional associations, was most active in developing and promoting solid waste management options for municipalities, that 'incineration' became irreversibly fragmented in the US**. It was during this period also that the federal government for the first time involved itself in issues of solid waste management not only through a string of legislation beginning with the Solid Waste Disposal Act but also through a slew of air and water pollution regulations which directly impacted the universe of solid waste disposal practices but hit incineration especially hard. Finally, this was also a period when alternatives to both conventional incineration and WTE were developed and declared viable by a range of experts. The overall impact of all three factors unfolding simultaneously during this period was to frame WTE as both technologically and financially risky for US municipalities, even while the same technique was expanding in use elsewhere around the globe.

Solid Waste Disposal in the US Before 1965

Solid waste management did not emerge as a civic concern in the US until the mid- to late-19th century, when the problems of urban refuse became too large to ignore. While Progressive Era reforms tried to impose a moral imperative on civic cleanliness (McGurty 1998), early reformers were more concerned with the pragmatic issues of human health and proper city functioning. Prominent theories in public health argued that waste ('miasma', or 'filth') posed a threat to humans. Furthermore, mountains of solid waste were unsightly, and attracted insects and vermin. Early departments of sanitation focused primarily on simply removing the waste from the streets and relocating it to somewhere less of a nuisance to residents and businesses. Dumping waste onto vacant land or into the sea or another large body of water (like Lake Michigan) was the dominant disposal 'technique' employed through the 1960s (Melosi 2005). However, it was not the only technique, as cities also experimented with feeding organic wastes to swine (especially during wartime as a way to increase local meat supplies), recovering oils and other chemicals via waste rendering or 'reduction', and finally 'destroying' solid waste through incineration.

Melosi (2000, 2005) shows that cities were concerned primarily with issues of cost and public health. While dumping was certainly inexpensive and convenient, it was far from sanitary and a known pathway for the spread of disease. Reduction produced horrific odors and toxic by-products. Incineration, on the other hand, was celebrated by refuse management experts as a means to 'disinfect' solid waste while also reducing it to a minimal volume of ash (Melosi 2005, 38). However, when early generations of incinerators were brought over from Europe, their performance left much to be desired: low-temperature, batch-fed, slow-burning furnaces produced only incomplete combustion and significant noxious smoke. Efforts to disguise this pollution with higher stacks (a regular practice for power plants in the United States throughout the 20th century) were met with outrage, leaving many municipal governments dissatisfied with the technology (Melosi 2005, 40). Engineers would suggest that the poor performance of US incinerators was related to continental differences in solid waste composition and specifically that US waste had greater water content than European waste (ibid.).

However, those same engineers maintained that incineration was the most sanitary means of dealing with solid waste, and one that could be extremely cost-competitive with dumping and other processes. Advances in boiler design allowed steam and waste heat to be collected during incineration and channeled to industrial operations, including the generation of electricity. The possibility of offsetting collection and disposal costs through the sale of electricity or steam was appealing to many US cities, however the high initial costs of energy recovery equipment limited the technology's uptake. Furthermore, the temperatures achieved in early US energy recovery type boilers were not typically high enough to reliably produce steam for electricity generation, requiring the use of expensive supplementary fuels (Melosi 2005, 40). Thus incineration technology was being attacked from both ends of its existence: land and sea dumping remained far less expensive for waste disposal (though far from preferred), while coal and hydroelectricity proved to be less expensive options for power. As a result, many cities simply chose to install incinerators without the energy or steam recovery equipment.

During the first half of the 20th century, incineration, despite its (theoretical) cleanliness and efficiency, fell from its favored status among sanitary engineers to a secondary position as a versatile option for dealing with mixed waste or as a way to limit the impact of open dumping and organic waste reclamation practices like reduction. According to Melosi, by the mid 1930s the technology was most likely to be found as a replacement for open dumps in suburbs and smaller communities where suitable plant locations were available, where incomplete combustion was not typically problematic, and where there was no interest in using the furnace to generate power or industrial steam (Melosi 2000, 275-278).

Also by the mid-1930s however, what would become the dominant solid waste disposal technology in the US had emerged: the sanitary landfill. The sanitary landfill first appeared in the United States under the direction of Jean Vincenz, a municipal utilities official in Fresno, CA during the 1930s. The sanitary landfill differed from the open dumps of the past due to its systematic nature: cells, or trenches, were dug on the lot and then filled with alternating layers of solid waste and dirt (or another 'fill' material, like ash). Each day, the layers would be compacted and covered, with the intent of keeping out vermin and scavengers.

By the mid-1940s municipalities, engineering societies, and government actors (including the U.S. Army Corps of Engineers) had decided that sanitary landfills represented the most economical means of disposing of solid waste. Sanitary landfills accepted virtually any and all types of solid waste, and the sorting necessary for complete combustion or reduction processes was not required for landfilling. Furthermore, compacting the solid waste allowed more to be accepted at any given site, reducing expenditures for land, while the daily cover of each active trench apparently reduced citizen complaints (Melosi 2005, 182-184). Sanitary landfills appeared to both limit costs (relative to incineration, reduction, and early recycling programs) and prevent the public health and nuisance problems presented by open dumps.

Furthermore, in the same way that incineration offered the possibility of revenue to city governments via electricity, steam, and materials sales, a persuasive economic logic developed around sanitary landfills as well, especially the possibility for closed or completed landfill projects to be repurposed as recreational areas or even parking lots (though not housing or commercial buildings). Melosi examines exactly this tactic in San Francisco and New York City (2005) while Colten studies the practice in Chicago (1994). Later, the EPA itself would promote the sanitary landfill for its economic potential, citing the construction of LaGuardia airport in New York City and the transformation of a closed landfill to a solid waste transfer station in Santa Barbara, California (US EPA 1971, 5-6). Even as state governments began issuing warnings about the potential for groundwater contamination associated with the 'leachate' produced inside closed landfill cells, sanitary landfills were firmly entrenched as the dominant waste disposal technique in the U.S. by the early 1960s.

Solid Waste and / as Pollution: The Solid Waste Disposal Act of 1965

Post-War prosperity revitalized US consumer culture, and as it did for other types of utilities consumption like petroleum and electricity use, this made lasting impacts on solid waste management. The volume and composition of solid waste was changing rapidly and significantly: per capita production doubled from two to four pounds per day from the mid 1940s to the mid 1960s. The waste stream also came to include new materials, like plastics, toxics (many from post-War synthetic materials) and increasing amounts of paper, aluminum, and tin associated with packaging (Melosi 2000, 339). Mounting volumes increased collection and disposal costs and complexities for municipalities, problems only enhanced by rapid suburbanization and falling population densities (ibid, 341).

While many cities continued to pursue incineration systems without energy recovery equipment in conjunction with other disposal technologies, critics perceived incinerators as unable to keep pace with suburban growth and the attendant rapid increases in the production of solid waste. Incinerators were limited to a certain capacity of solid waste each day, and must be taken offline for regular maintenance, an obligation made only more onerous with the addition of steam or energy recovery equipment. Landfills, though theoretically limited in size, could in most instances be expanded with deeper trenches or additional layers -- or the purchase of additional land, potentially funded at significant discount via municipal bonds or federal dollars.

Mid-century critics of incinerators were proven correct as increasing numbers of cities pushed their boilers beyond their designed capabilities in attempts to meet growing demand, resulting in dissatisfactory combustion and the production of noxious smoke. These two problems came into sharp focus during the mid-1960s as a slew of public health studies began to draw a link between environmental degradation (especially air pollution and the toxicity of bottom ash) and solid waste incineration. For publics increasingly aware of the dangers of air pollution, the continuation of incineration in their cities was unthinkable, especially in comparison to the 'cleaner' sanitary landfill. Visual confirmation of toxins emanating from incinerator stacks led many to question the other major by-product of the process – ash. As a result nearly one-third of the cities with incinerators discontinued their use by the end of the 1960s (Melosi 2005, 185-187).

Questioning the environmental safety of incineration was, however, part of a larger trend. Although it was the dominant disposal technique, concerns were also emerging about sanitary landfill leachate, the general toxicity of the solid waste stream itself (in light of new materials, especially plastics and electronic items), the environmental impacts of raw material use in new packaging products, and the spatial 'crisis' emerging as landfills approached their designed capacity.

The federal government indicated its understanding of public concerns about solid waste management with the passage of the 1965 Solid Waste Disposal Act (SWDA). The act, finding that "the continuing technological progress and improvement in methods of manufacture, packaging, and marketing of consumer products has resulted in an ever-mounting increase, and a change in the characteristics, of the mass of material discarded," (section 202(a)(1)) had resulted in "scenic blights...serious hazards to the public health, including pollution of air and water resources, accident hazards, and…vectors of disease" (Section 202 (a)(4)).

Although the government acknowledged that "the collection and disposal of solid wastes should continue to be primarily a function of State, regional, and local agencies," the problems of solid waste disposal

> have become a matter national in scope and in concern and necessitate Federal action through financial and technical assistance and leadership in the development, demonstration, and application of new and improved methods and processes to reduce the amount of waste and unsalvageable materials and to provide for proper and economical solid-waste disposal practices. (Section 202 (a)(6))

The federal government's preferred answer to the 'garbage question,' as codified in the SWDA, was to find a new set of technologies, or at least radical improvements on old technologies, like incinerators and sanitary landfills. In this way, the SWDA represents an important turning point for solid waste management in the US: not only because it represents the first engagement[2] with the problem by the federal government, but also because it inserted various government agencies – and their contractors – into the field of solid waste technology development and selection. Among the most important was the newly-formed US EPA, and in particular its Office of Solid Waste.

The US EPA Office of Solid Waste

Initial implementation of the SWDA was split between the U.S. Public Health Service (municipal solid waste) and the Bureau of Mines (mining and fossil fuel wastes), but in 1970 the oversight of solid waste issues was transferred to the Office of Solid Waste (OSW) in the newly formed Environmental Protection Agency. The SWDA actually did not give government agencies, including the EPA, any power to create and enforce solid waste regulations, except as they might relate to air or water pollution. In any case, pollution regulations would not be managed by the OSW but rather the offices enforcing air and water quality rules.

Instead the SWDA, as amended in 1970, tasked the OSW with more investigative and guidance-oriented roles. Their three primary functions were, first, to channel federal funds to demonstration projects for solid waste collection and disposal technologies; second, to promulgate guidelines for solid waste management for cities, states, and project developers (similarly, they made limited efforts in direct public education); and third, to offer "technical assistance" on projects. This final task became, fundamentally, directing municipalities towards various engineering consulting firms

2 Technically speaking, President Franklin Delano Roosevelt's New Deal included funding for a number of solid waste disposal projects, including incinerators. But no attempts were made to develop comprehensive solid waste policies.

and professional organizations. This section of the chapter looks at the first two tasks in turn, while the question of ‘technical assistance’ is addressed in the next section of the chapter examining the role of engineering consulting firms.

There is good reason to believe that the agency shaped the trajectory of incineration technology in the US during the period between the passage of the SWDA and approximately 1980. In the Agency’s own estimation

> …the Federal Government is the focal point of information on technology, economics, markets, and institutional aspects of recovery system implementation…Through its demonstration programs, its evaluations and analysis of systems and markets, and its many contacts with States, cities, and industry, is ideally suited to be a 'third party' to transfer know-how and to ensure efficient and rapid implementation of recovery systems on a national basis.” (US EPA 1974b, 43)

Analysis of the historical record more or less confirms that the Federal Government did function as something of a clearinghouse of information on solid waste technologies for civic leaders during this time. The OSW pictured itself as an ‘honest broker’ between municipal officials needing solutions and the range of solid waste management technologies and techniques. The Agency, to its credit, assiduously offered technical, financial, and environmental information through numerous reports, guidebooks, and public forums. However, instead of supporting the growth of incineration with energy recovery, the most significant outcome of these efforts was to fragment understanding of the technology into a range of discrete and even mutually exclusive practices, while subsequently promoting the sanitary landfill. Energy recovery technology was made into something financially and technologically risky in the US, and thus in many ways unacceptable to city governments.

Demonstration Projects

One of the primary tasks assigned to the OSW was to channel federal monies to various solid waste collection and disposal projects claiming 'advanced' or 'improved' technology. Although the OSW and US EPA favored the sanitary landfill (as will be illustrated), they did also invest significant funds into alternatives, and especially those that recovered energy or material resources from the processing of solid waste. Indeed, this was a task that the Agency took quite seriously through the mid 1970s, so much so that just two years after the passage of SWDA, the Agency had already distributed nearly $9m in grants (Melosi 2000, 352). According to the OSW,

> Demonstration grants are awarded for study and investigations, and/or demonstration of new, unique, or improved methods of solid wastes storage, collection, processing, and disposal...Some are designed to demonstrate the feasibility of new and improved technology; others are designed to take advantage of existing knowledge that has not been fully utilized. (US EPA 1971, 115)

But what was the Agency truly seeking to 'demonstrate', especially with regard to incineration and energy recovery technologies?

You're my Waterwall

While the late 19th and early 20th century US experience with incineration left much to be desired, improvements had emerged rapidly from European manufacturers during the interwar period. Early incinerators that converted heat to steam were known as 'waste heat' or refractory boilers. According to Levy (1974), these designs place the boiler in the flue of a conventional mechanical grate incinerator.

According to Levy, "poor operating characteristics of refractor-lined incinerators…made this approach obsolete" by mid-century, and all but replaced by waterwall type designs (ibid., 18). In a waterwall design, the furnace walls themselves are lined with metal tubes through which water is continuously pumped, resulting in a far more efficient means of not only heating water but also cooling the flue gasses that result from any combustion process. A rough comparison can be made if the reader thinks about the efficiency of heating a mug of water inside the microwave (waterwall) versus placing the mug on top of the microwave vent (refractory boiler).

Waterwall furnaces were first implemented for the combustion of fossil fuels, particularly coal, perhaps as early as the 1920s (Battelle Columbus Laboratories 1979, vi), and the advantages of such a design over waste heat boilers were numerous and well-known in the US by the mid-1970s, though far earlier in Europe – where they were developed – and Japan. These included the more rapid and complete cooling of gasses leaving the furnace resulting in dramatically reduced volumes of gas running through pollution control devices (Levy 1974); smaller, easier, and cheaper facility design and construction (US EPA 1976b, 22); and greater values of heat energy recovered for transformation into steam and electricity (ibid.).

Specific to solid waste incineration, the waterwall design first appeared in Switzerland during the 1950s under the direction of R. Tanner at the Swiss engineering firm, Von Roll. According to a report completed on behalf of the US EPA (Battelle Columbus Laboratories 1979), the world's first waterwall furnace/boiler for solid waste combustion began operation in Bern, Switzerland in 1954. This is fundamentally the world’s first WTE system, with two 100 tons-per-day units working to produce steam, some of which was sent to nearby industrial operations while the rest was used in the local district heating system.

The report is keen to point out that while earlier efforts at converting waste heat to steam and electric power using refractory boilers were quite successful, in Europe at least, the waterwall design vastly improved on the process, so much so that by 1979 there were at least 522 facilities in the world using the technology, with some 943 waterwall boilers in Japan alone (ibid., vi-viii; also section B). The combination of solid waste volume reduction with (increasing) energy recovery capabilities and (decreasingly) less toxic emissions made the waterwall WTE design the dominant solid waste disposal technology in western Europe and Japan by 1970.

Waterwall in the US and Competing Technologies

By the mid-1970s the US EPA had acknowledged that "waterwall furnaces have almost entirely replaced refractory-lined combustion chambers in current incinerator design." (Levy 1974, 20), that "Combustion of solid waste on mechanical grates in waterwall furnaces to recover steam is the most thoroughly proven resource recovery technology," (US EPA 1976b, 5), and that "in Europe and Japan [the technology's] acceptance has been rapid and widespread and several hundred units have been built." (ibid., 22). Nevertheless, by the mid 1970s only 10 facilities had been built across the US and Canada – combined (ibid.).

While the OSW would acknowledge the prevalence of waterwall WTE, it was also quick to assign limits to the technology. Sometimes the Agency went out of its way to discredit successful European implementations of WTE. A 1976 guide would argue that "Although this is a proven technology, some technical uncertainties still exist…Boiler corrosion and air pollution control problems, for instance…The overall operating experience of waterwall incinerators varies…" (US EPA 1976b, 7), even as Europeans reported generally smooth operations. OSW documents would frequently lob charges that waterwall WTE was somehow not commercially viable or readily accessible to city officials (despite the fact that all major European manufacturers had US licensees and representatives by the late 1960s; cf. Mitre Corporation and Office of Solid Waste Management Programs 1976). Another common argument was that "The need for Federal fiscal stimulation of energy recovery [waterwall WTE] is far less clear," because the potential for private corporations to profit was already apparently well-established; though the Agency would argue against exactly this logic in other sets of documents and particularly the guidelines produced for civic officials, discussed in the next section (US EPA 1974b, 44).

This connects to another reason for the limited uptake of waterwall WTE in the US: the OSW neither invested in it through its grantmaking program nor strongly encouraged cities to implement the technology, as discussed in the following section. Instead, the agency made investments in a range of alternatives to WTE, most of which already had been – or would be soon – dismissed by European firms. Though one could surmise that since waterwall WTE had been around already for 20 years, it did not meet the OSW criteria for 'new' technology, at the same time the Agency acknowledged that waterwall WTE "has until quite recently received only scant attention" in the US (US EPA 1974c, 8). Regardless of the reasons for withholding funds from this technology, however, OSW and US EPA's investment in competitors to waterwall WTE served to fragment the notion of 'incineration with energy recovery' in the US and ultimately limit is implementation (Figure 3.3).

TABLE 1

ENERGY RECOVERY TECHNOLOGY AND PRODUCTS

	TECHNOLOGY \ PRODUCT	ELECTRICITY	STEAM (for use other than generating electricity)	SOLID FUEL (for use other than in producing steam or electricity)	GASEOUS FUEL	LIQUID FUEL
COMMERCIALLY OPERATIONAL	WATERWALL COMBUSTION (MASS BURNING)	Used extensively in Europe and Japan	Braintree, Mass (O) Harrisburg, Pa (O) Norfolk, Va (O) Chicago, Ill (O) Nashville, Tenn (O) Portsmouth, Va (C) Saugus, Mass (S) Montreal, Can. (O) Quebec, Can (O)	N/A†	N/A	N/A
	(SEMI-SUSPENSION)	Hempstead, N.Y. (C) Dade Co.,Fla. (D)	Hamilton, Ont. (O) Tokyo, Japan (O) Akron, Ohio (D)	N/A	N/A	N/A
	SOLID FUEL (RDF)	St. Louis, Mo. (P.O.) St. Louis, Mo (D) Chicago, Ill (C) Ames, Iowa (S) Milwaukee, Wis (C) Monroe County, N.Y. (D)	Columbus, Oh (D) Akron, Oh (D)	Los Gatos, Cal (P.O.) Bridgeport, Conn. (D) E. Bridgewater, Mass. (S) Palmer Twp., Pa (D)	N/A	N/A
DEVELOPMENTAL	PYROLYSIS GASIFICATION LOW BTU	Luxembourg (C)	Baltimore, Md (S) Grasse, France (C)	By-Product	Possible	N/A
	MED. BTU	Possible	Possible	N/A	S. Charleston, W Va (P.O.)	N/A
	LIQUIFICATION	Possible	Possible	By-Product	N/A	San Diego County, Cal (P,C)
	CONVERSION LANDFILL	Los Angeles, Cal (O,P)	Possible	N/A	Los Angeles, Cal (O) Phoenix, Ariz (S)	
EXPERIMENTAL	REACTOR	Possible	Possible	By-Product	Franklin, Oh (P) Pompano Beach, Fla (P-D)	N/A
	WASTE FIRED GAS TURBINE	Menlo Park, Cal (P)	By-Product	N/A	N/A	N/A

*Operating status is designated as:
P—Pilot or Demonstration
D—Design
C—Construction
O—Operational
S—Start-up
†N/A—Not Applicable

Figure 3.3: A table produced by the EPA detailing the universe of solid waste energy recovery technologies (US EPA 1976b, 6). The two most important OSW demonstration projects discussed in this chapter – RDF co-firing in St. Louis, MO and pyrolysis in Baltimore, MD – are included. Note that the chart puts waterwall WTE, "used extensively in Europe and Japan" on the same footing as technologies which did not yet physically exist like pyrolysis gasification conversion to syngas fuel. "Text in the Figure is not meant to be readable, but is for visual reference only."

Instead of furthering existing technologies, the Agency was proposing that it could support the development of far superior systems to the globally dominant waterwall WTE. "Prevailing disposal techniques – burning and dumping – continue to waste resources and frequently pollute the air and water…With these facts in mind, the US EPA has been studying various…processes for metropolitan areas: energy recovery, materials separation and reuse, and chemical conversion processes." (Horner & Shifrin 1972, n.p.) In particular, the OSW directed grants to operations involving the pre-processing of solid waste, especially shredding to produce 'refuse-derived fuels' or RDF, and an anaerobic conversion process called pyrolysis, which (theoretically) converts solid wastes into liquid and gaseous fuels which can then be used for a range of industrial purposes. The Agency sought to illustrate the effectiveness of each technology through pilot projects, and specifically with an RDF demonstration in St. Louis, MO and a pyrolysis project in Baltimore, MD.

The St. Louis RDF project might best be characterized as the most 'low-tech' of all the demonstrations the OSW undertook. The project aimed for "an environmentally acceptable means of solid waste disposal, conservation of natural resources, more effective control of land use, and economic advantages to both [utilities] and the public" using "existing technology, with equipment which already is commercially available." (Horner & Shifrin 1972, 1) Using industrial shredders, a coalition of municipal governments and a private investor-owned utility company would process municipal solid waste to a more or less uniform consistency and then simply feed it, along with pulverized coal, into the utility company's existing set of boilers to generate electricity. In this way, the capital expenditures of a dedicated incineration facility – complete with waterwall furnace, steam turbines, and the necessary support equipment – could be completely avoided.

According to Levy, in a report on energy recovery technology written for the US EPA:

> Electric utilities operating steam electric plants fired by fossil fuels are the most promising market for solid waste fuels for several reasons. They use very large quantities of fuel; electricity demand is influenced by the same factors that influence solid waste generation -- population and industrial and commercial activity; and the utility's generating plants are often located in close proximity to the urban area where solid waste is generated. Also the quasi-public structure of the electric utility tends to make it more conscious of community problems and more receptive to accepting the costs and risks associated with using these fuels...Savings in the cost of a solid waste fuel would be effectively passed on to the utility's customers, since most rate structures include automatic adjustments to reflect changes in the cost of fuel. (1974, 5)

The pilot project combusted about one pound of RDF with four pounds of coal (US EPA 1974c, 8-10). Early reports found that 'RDF co-firing', as the practice came to be described, made no significant changes on the type or quantity of power plant emissions nor the quality of the steam being produced. Accordingly, the Agency predicted massive growth in the practice at the expense of waterwall WTE, with some 30 cities predicted to be using RDF co-firing by 1980 (US EPA 1974a, 14), principally on the merit of investor-owned utilities realizing the benefits of burning RDF in conjunction with pulverized coal. As US EPA employee Robert Lowe explained:

> Most utilities have recognized the advantages of accepting processed waste: a stable supply of fuel at a net price comparable to other fuels, and the appreciation of the public in performing a service to the community. Utilities are now generally willing to cooperate with governments to study the local feasibility of the concept, to initiate large-scale trial firings, and to enter into long-term contracts to accept solid waste fuel. (US EPA 1975c, iii-v)

However rosy the picture painted by the Agency, however, investor-owned utilities presented an altogether different story. In the words of Carlyle W. Fay, of the Wisconsin

Electric Power Company, "The majority of utilities will not and do not care to make money by burning solid waste," as there were only

> …indirect economic benefits from firing solid waste. First, the utility is assured of a small but steady supply of fuel. Secondly, by firing solid waste, the utility earns a certain measure of political or public relations benefits. Conversely, some utilities are motivated to fire solid waste in order to avoid adverse public reaction that would result if the utility refused to fire solid waste. (ibid., 21)

Furthermore, boiler manufacturers, including Babcock & Wilcox, Combustion Engineering Inc, and Foster-Wheeler – all at the time involved in the engineering and construction of both fossil fuel combustion and solid waste incineration boilers – commented that the variable moisture content and chemical composition of solid waste made corrosion and ash collection serious challenges to widespread use of solid waste co-firing in utility boilers (ibid., 11-12). Thus, for utilities, the combustion of RDF would serve as a replacement fuel of equivalent or lower costs than fossil fuels, at best maintaining profit levels for utilities (though this was unlikely given the need to repair and replace boilers more frequently due to corrosion and at worst cutting into profits since most utilities oversight boards required fuel cost savings to be passed along to consumers. It has been well-demonstrated (cf. Howell 2010, 2011) that utility profits hinged on new construction, not in finding cost savings in existing operations, thereby leaving little incentive to adopt RDF co-firing and the additional maintenance expenses associated with it.

While RDF co-firing proved problematic in practice, in concept it did represent a comparatively low-cost means for cities to dispose of solid waste, avoiding the land use challenges posed by sanitary landfills while also perhaps achieving the energy conservation goals which had entered into the public consciousness alongside the Arab

Oil Embargo. Not so the case for pyrolysis, the first pilot demonstration of which was partially funded by the US EPA at Baltimore, MD and began construction in 1973.

Pyrolysis is fundamentally the 'cracking' of solid wastes in an anaerobic environment. It is similar to combustion in that high temperatures are necessary, but distinct from combustion because of the lack of oxygen. Pyrolysis itself is not a rare occurrence, indeed it takes place to some degree during such mundane practices as baking or using a charcoal grill; however, at the time of the US EPA demonstration grant, pyrolysis of solid waste represented only a theoretically possible procedure to reduce the volume of solid waste by converting it into a liquid or gaseous fuel. As such, the first efforts at pyrolysis proved quite costly: Monsanto Enviro-Chem Systems – the facility designers and operators – received an initial $6m from the US EPA in 1972 to go along with the matching amount from the City of Baltimore but also $4m more from the state of Maryland (Dvirka and Harrington Jr. 1980).

In the pilot project, the pyrolysis process was intended to produce a fuel that was burned on site to produce steam and generate electricity, although future projects would not necessarily be limited to such local uses. Indeed one of the reasons why the OSW seemed to be so interested in solid waste pyrolysis was its ability to produce portable liquid and gaseous fuels (US EPA 1974a, 23). As with RDF co-firing, the agency predicted that pyrolysis would be commercially viable by 1980 (e.g., US EPA 1974a) and in a report to Congress noted that private sector activity in pyrolysis was so strong, especially around companies like Monsanto, Garrett Research, and Union Carbide, that federal investments in the technology could be curbed (US EPA 1974b, 43).

Only a year later, the Agency reversed its position: uncertainty now clouded the potential of emerging technologies including pyrolysis to be either economical or efficient (US EPA 1975b). Delays and malfunctions plagued the OSW demonstration project at Baltimore, and even the injection of $4m ($1m of which came from the EPA) could not stop the project from being temporarily suspended in 1977 (Dvirka and Harrington Jr. 1980). When the facility eventually returned to service in 1979, it had been decided by industry observers that:

> …alleged “environmental benefits,” claimed by pyrolysis designers but never substantiated and quantified and which have been the moving force behind the implementation of pyrolysis systems, could not have been ascertained.
>
> As to the economic viability…a simple process overview indicates that, in absence of special funding procedures or subsidies, the system is not competitive when compared to traditional mass burning processes [waterwall WTE]…
>
> It is unlikely that the Baltimore…experiment, although now operational, will be duplicated elsewhere without significant further modifications. (ibid., 549)

The US EPA’s grantmaking program for solid waste collection and disposal projects resulted in something of a mixed bag. The RDF project in St. Louis worked properly, but it was difficult to convince utility companies to get involved because of the impact on their boiler equipment. Pyrolysis at Baltimore also worked to a degree, but at a high cost and low efficiency. Other demonstration projects, such as the pilot project in Lowell, MA, involving the recovery of mineral resources from incinerator residues both from the city's own facility but also from incinerators in nearby cities, ended more abruptly: the grantee actually requested to cancel the project and end the grant due to increases in the costs of meeting pollution mitigation obligations (US EPA 1975a). Though few would dispute the fact that there is as much value in failed experiments – properly conducted – as successful ones, the fact remains that the Agency did not fund all types of projects, including waterwall WTE.

As mentioned at the start of this section, this was somewhat against the dominant practices of the global waste industry. In fact, subsequent interviews with European solid waste officials would reveal confusion and perhaps mild contempt towards the demonstration grant program and particularly technologies utilizing RDF. For instance, an interviewee of the Battelle Columbus Laboratories report on European WTE systems asks, “'Why do the Americans waste all that effort and cost in preparing the refuse? We just throw it into the pit, mix to a relatively uniform charge and drop it into the furnace hopper" (Battelle Columbus Laboratories 1979, A-93). To fast forward somewhat, this attitude has only perpetuated; in a conference paper presented at an industry event in 2012, a representative of a major European WTE consulting firm argued that mass-burn, waterwall WTE still represented the **only** commercially proven, environmentally acceptable solid waste conversion technology, declaring that competing techniques like pyrolysis “have failed” time and again (Kamuk 2012).

At any rate, by the mid-1970s US EPA was actually recommending that Congress limit the funding for new demonstration grants, arguing that the “high level of additional expenditure on additional demonstrations is neither necessary nor justifiable." (US EPA 1974b, 43) While the process of funding demonstration and pilot projects had more or less ended by 1976 – with mixed results -- demonstration projects had already started to convince federal and municipal decision makers that advanced solid waste disposal technologies existed beyond, and improved upon, mass burn waterwall WTE. As a result, while ‘waste-to-energy’ meant one thing in the countries that used it most – mass burn waterwall – in the US the phrase actually came to comprise a range of competing technologies.

The result was that the US EPA and engineering consultant firms would expend a great deal of time and effort on trying to discern the best possible technology for a given situation, even if that technology may not be commercially viable or may not yet even exist. In the US context, then, mass burn waterwall WTE would compete not only with RDF co-firing but also future, unproven 'advanced technologies' like pyrolysis and also with the ever-present sanitary landfill.

There is strong evidence to support these claims. For instance, as Figure 3.4 illustrates, by the late 1970s a number of energy conversion projects were started or proposed across the US. But of the 88 projects depicted on that map, just 20 were waterwall WTE facilities (Figure 3.5). In contrast, virtually all of the facilities tabulated in Figure 3.6 outside the US were either waterwall or refractory boiler WTE systems. No other countries were interested in the risks of pyrolysis or other conversion technologies. Furthermore, as Figure 3.6 illustrates, facilities in the US tended to be very large capacity, centralized systems, with no relationship to district heating and cooling schemes as opposed to the smaller, more widely dispersed, and heating and cooling capable European and Asian systems. The caption to the data table underlying Figure 3.6, by the EPA contractors at Battelle Columbus Laboratories (1979, B-9) provides some useful insight:

> The United States, with 55 systems, has the broadest range of energy uses for systems…Interestingly, 31 of the United States systems have been major pilot plants or large demonstrations. This highlights a major difference between the USA and most other countries. The Americans have spent money looking for new systems while the remainder of the world has built systems based on the proven "European Technology". Of note is the absence of hot water systems in the US. This is consistent with US district heating practice of using only steam (in contrast to Denmark and Sweden). The single most common American energy use is production of electricity. The inventory includes 9 systems producing a methane based gas or pyrolytic oil. The inventory purposely excludes another 75 or so pyrolysis liquifaction, gasification, etc. developments that are not commercially relevant to include.

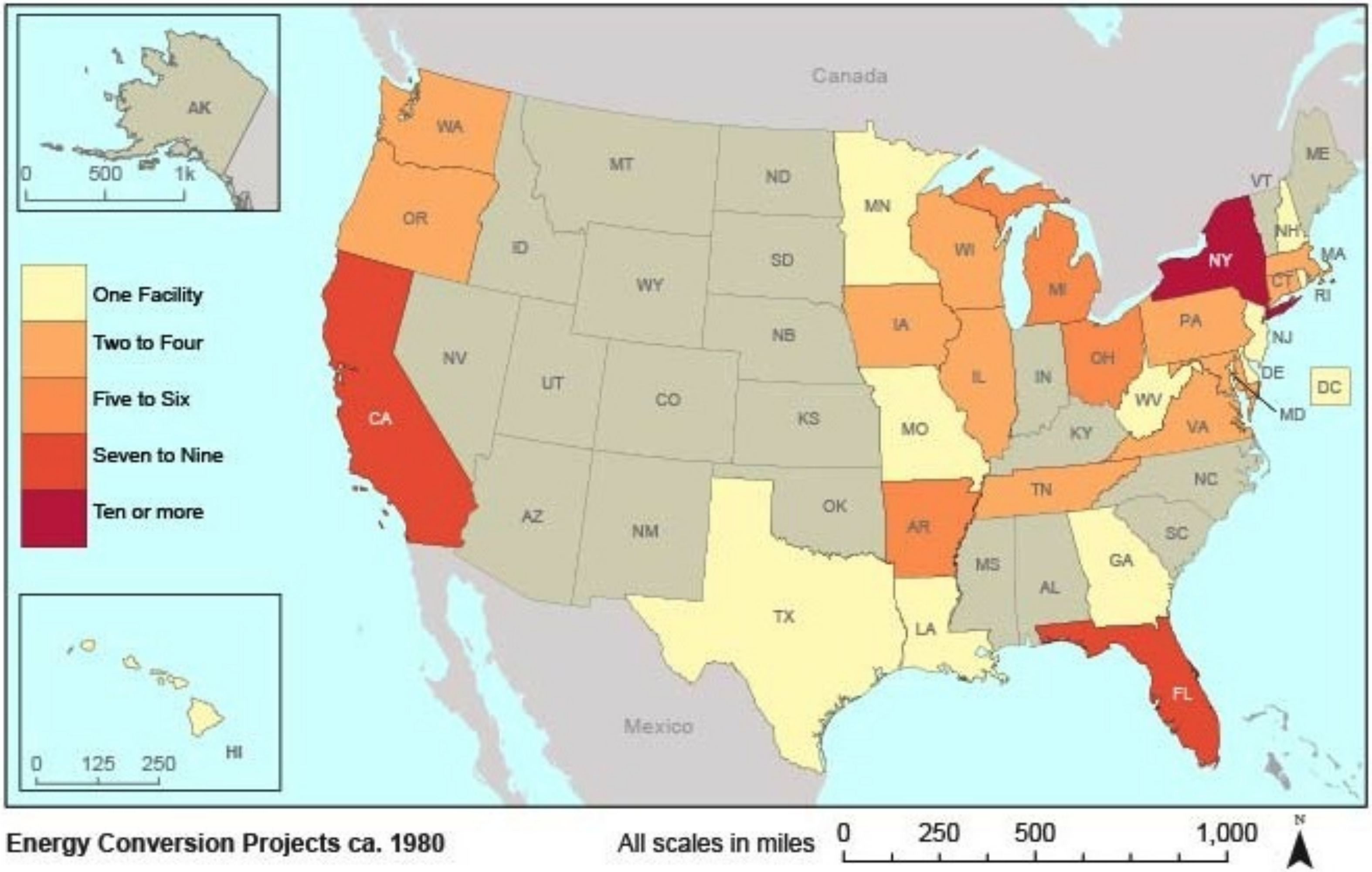

Figure 3.4: Map of energy conversion projects in the US, ca. 1980, including projects already started, proposed, or recently concluded (if demonstrations). Data from Battelle Columbus Laboratories (1979).

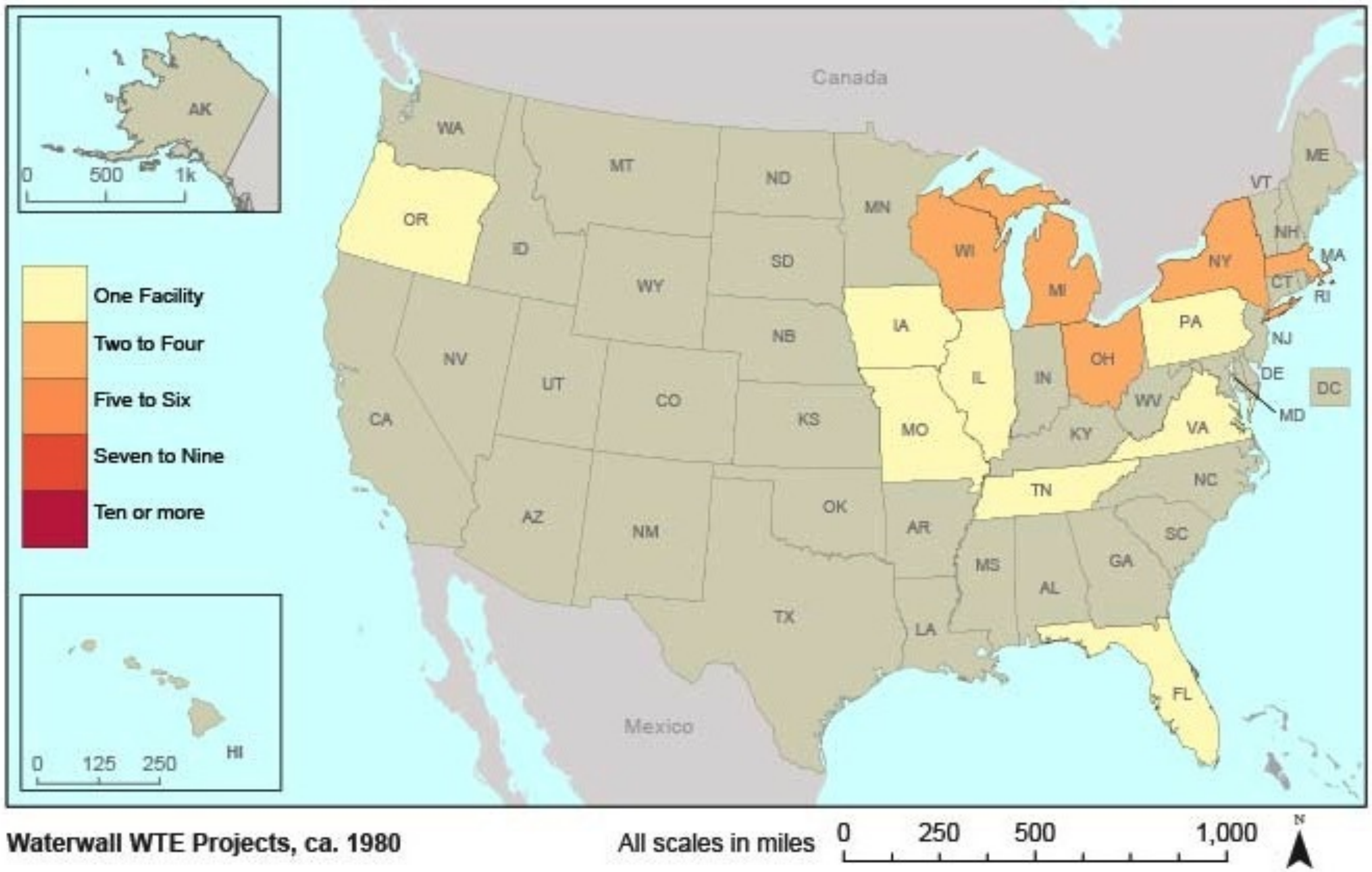

Figure 3.5: Waterwall WTE projects undertaken or proposed in the US, ca. 1980. Data from Battelle Columbus Laboratories (1979).

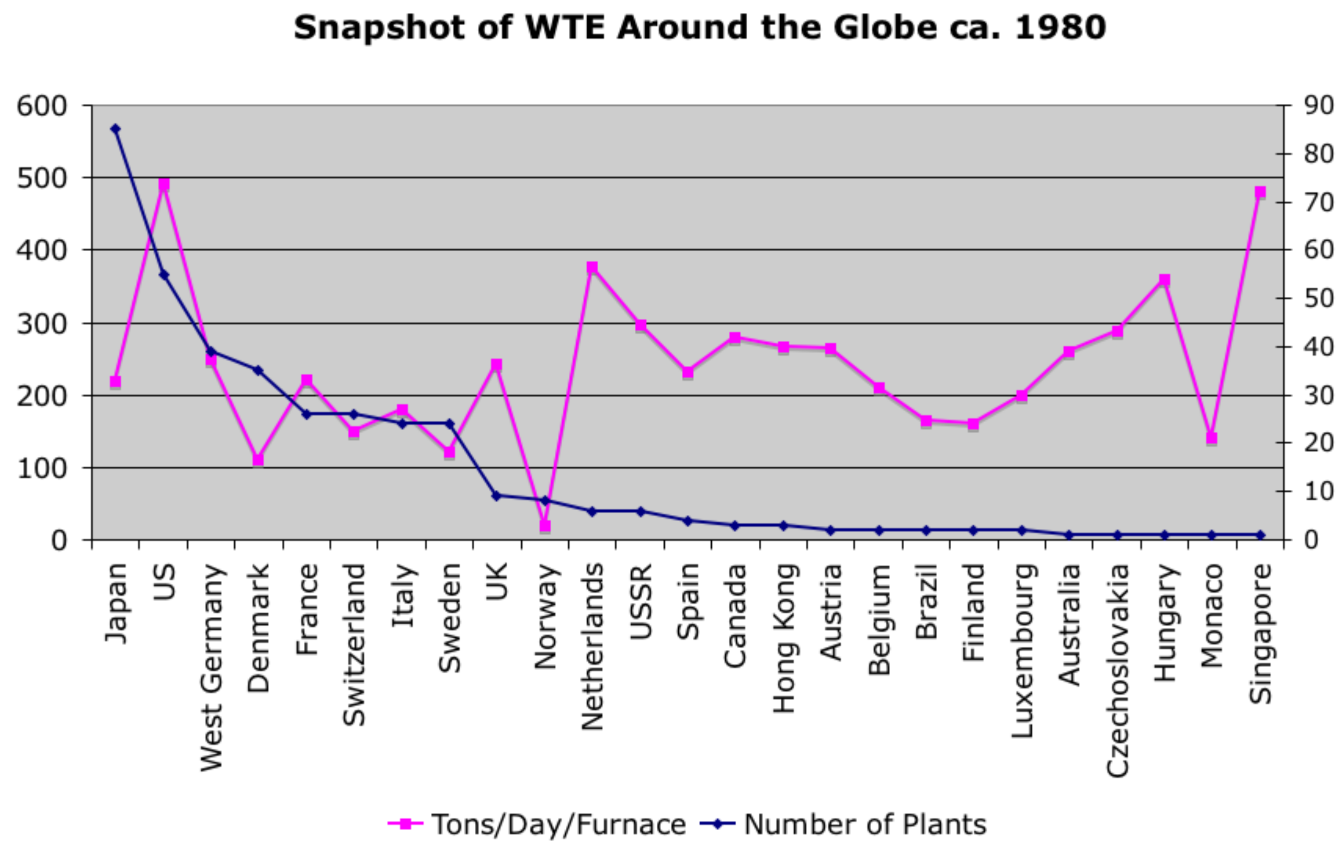

Figure 3.6: A snapshot of WTE around the globe ca. 1980. The left hand Y-axis (pink line) reports the tonnage consumed per day, per furnace unit in a county. The right hand Y-axis (blue line) shows the total number of WTE facilities in the country. As an illustration, you can see from the chart that the Netherlands has a comparatively limited number of WTE plants, but that each consumes a relatively high volume of waste daily. In contrast, Denmark has a greater number of facilities, but they are generally smaller and consume less waste daily. It is worth pointing out that the data tabulators, Battelle Columbus Laboratories (1979, B-57 to B-67) included in the US figures demonstration projects for pyrolysis and other energy conversion technologies, whereas the totals for other countries reflect only waterwall or refractory boiler WTE.

Guidelines for Municipalities

Cognizant of the fact that elected and appointed officials had to deal with the complexities of capacity planning and system design, the Agency took seriously another of its primary tasks assigned by the SWDA and subsequent legislation: producing guidelines for solid waste management for civic officials and leaders.

The various guide-type documents produced by the OSW (and its contractors), by influencing what civic officials thought of the options for solid waste disposal, directly shaped the trajectory of incineration with and without energy recovery technology in the US. The guides were produced to assist local elected and appointed officials in planning, financing, and operational decisions in areas of solid waste management. Although intended to provide an 'honest account' of practices and processes for disposal, the Agency's guidelines and reports contributed to the fragmentation of incineration technology in three ways:

1. By presenting incineration with energy recovery to US officials **not** in its most commercially and operationally successful form worldwide – the mass burn waterwall facility (or WTE) which dominated European and Japanese markets (US EPA 1976b, 6; Battelle Columbus Laboratories 1979) – but rather as a constellation of commercially and technically unproven systems of combustion, pyrolysis, and waste processing;
2. By framing incineration with energy recovery in purely financial terms; and
3. By treating the energy production and waste disposal aspects of incineration with energy recovery as separate and perhaps competing goals.

Among the first set of suggestions for civic leaders were the *Guidelines for Local Governments on Solid Waste Management* (1971). In the *Guidelines*, the EPA presents the open dump as the utmost in 'land pollution', and of equal environmental significance to the country as air and water pollution. Though cognizant of the range of disposal options available to most communities, the guide heavily promotes the sanitary landfill as "basic to any… solid wastes processing operation since all produce some materials which must be sanitary landfilled." (ibid., 84). In fact, the agency would argue that "a true sanitary landfill presents no problems of vectors, vermin, visual blight, or water pollution" (ibid., 5) and that “a sanitary landfill is a complete or final disposal method, compared to incineration and composting…a sanitary landfill is flexible; increased quantities of solid wastes can be disposed of with little additional personnel and equipment; submarginal land may be reclaimed for uses such as parking lots, playgrounds, golf courses, and airports." (ibid., 83).

In contrast to the positive image presented of the sanitary landfill, the *Guidelines* paint incineration in far more ambiguous terms. While "Incineration is an effective volume reduction method,” this is only true insofar as “land appropriate for sanitary landfill is limited, and money and water are abundant.” (ibid., 88). The *Guidelines* continue to say that

> The cost of incineration is high. Construction cost (including elaborate air pollution control devices) runs about $7,000 to $12,500 per ton capacity of the plant. Operating costs run about $5 to $9 per ton plus amortization. These high costs are spread among maintenance, power, personnel, and administration. Incineration equipment must be replaced at least every 15 to 20 years. Skilled operators and continued maintenance are essential. It is foolish to invest a million or more dollars in a plant and then fail to staff it with trained people at adequate salary. (ibid.)

According to the *Guidelines*, incineration is in no uncertain terms a technology with limited applications, to be used only when the financially, environmentally, and technologically preferred sanitary landfill is unavailable. This message was translated throughout the OSW’s early public education efforts, the most colorful instance of which being the publication of a children's book in 1972. *The Processing and Recovery of Jon Thomas – Cool Cat!* (Marceleno 1972) highlights innovations in solid waste collection and disposal via the adventure of an alley cat who gets caught while scavenging neighborhood garbage. The cat goes through the various stages of solid waste processing, starting with a transfer station. Our hero eventually survives being run through a baler and deposited into a sanitary landfill ("a disposal method started by our ancestors who taught us to cover waste with dirt," n.p.). Readers are informed that "the sanitary landfill today is the only system for the final disposal of solid waste on land that will not pollute the environment...by applying science and engineering principles to its design and operation." (n.p.) When the bale he is trapped in is improperly handled, it cracks open and the cat escapes, only to be rescued by a landfill employee who presents a little girl with the cat as a gift.

Although ostensibly an overview of solid waste technologies for children, *The Processing and Recovery of Jon Thomas* conveys a number of key OSW positions elucidated nowhere else as clearly as they are in this book. For instance, the book establishes a hierarchy for solid waste disposal with the sanitary landfill at the top. This is only apparent after close consideration of the image presented in Figure 3.7, which seems to locate sanitary landfilling at the end of the disposal chain, but in reality places it as the only disposal option: the flow the image describes is impossible, since materials would never go through the 'volume reduction' stage AND 'resource recovery' AND 'energy recovery' and finally end in a sanitary landfill with the option of some post-landfill processing.

Already in 1972, through its guidelines for civic officials OSW was fragmenting the practices of incineration with energy recovery into a number of seemingly incompatible and perhaps even irreconcilable pieces. Figure 3.3 suggests that incineration for volume reduction, incineration with energy recovery, and "new incinerator" (mass-burn waterwall WTE) were all separate practices. In reality, a municipality would choose only one, and European municipalities had been reliably using WTE for at least 15 years already, and made the others obsolete or impractical due to their uncertain nature (cf. virtually any section of the report from Battelle Columbus Laboratories 1979).

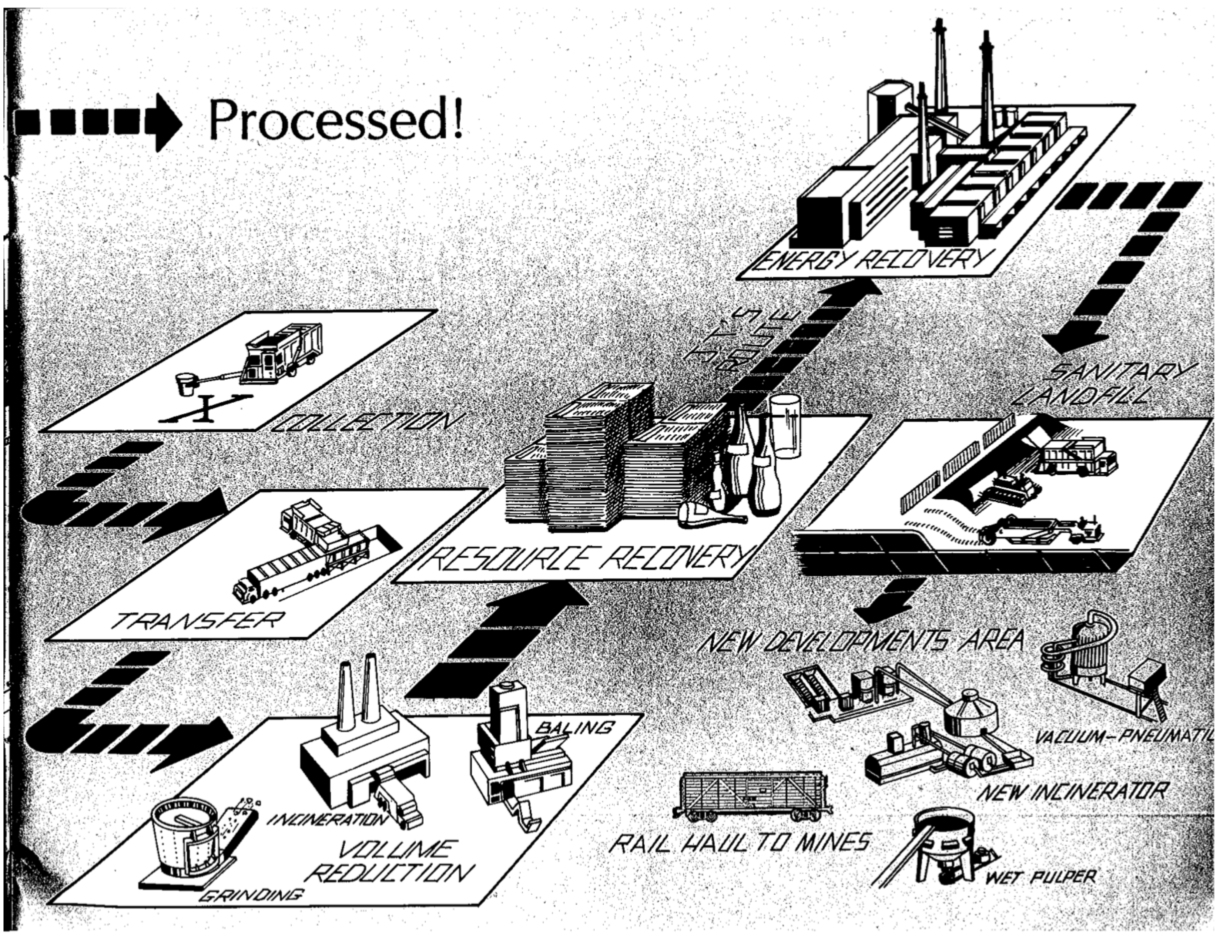

Figure 3.7: From Marceleno 1972 (n.p.). Incidentally, this schematic is not unlike the ecoMaine facility mini-case study presented in the final chapter of this dissertation, which features a WTE facility, a comprehensive recycling center, and an ashfill within a single 'park' facility. "Text in the Figure is not meant to be readable, but is for visual reference only."

The practice of presenting incineration with energy recovery as a collection of discrete technologies rather than promoting the one –WTE – with the longest history of commercial and operational success worldwide would become commonplace in OSW documents aimed at elected officials during the 1970s (for instance, US EPA 1976b). In a report to the US Congress, the OSW suggested that materials separation, composting, waste heat recovery in conventional incinerators, waste heat recovery in high temperature incinerators, direct firing of refuse-derived fuels, and pyrolysis of waste to produce steam or fuel were all viable conversion technologies, despite the fact that all of the processes demonstrated high net operating *costs* and some of them did not even exist at a commercial scale (US EPA 1973, 12).

The issue of costs became a recurring theme in the guideline publications, with the Agency framing construction and operation costs as the sole metric upon which the success of a given disposal technology be judged. For instance, in a 1973 conference paper by Samuel Hale Jr., then deputy assistant administrator of the OSW, presented at the 8th International Refuse Equipment Show and Congress in Denver, CO, Hale acknowledged that "space age technologies" exist to facilitate resource and energy recovery from solid waste, however "the cost of recovering, processing, and transporting wastes is so high that the resulting products simply cannot compete, economically…" and therefore cities ought to think twice before investing in them (Hale Jr. 1973, 15). At the same time, Hale and the Agency would clearly distance themselves from 'traditional' incineration for volume reduction (perhaps quite rightly), asserting that

> Some 70 percent of the country's municipal incinerators were judged to have inadequate air or water pollution controls – even in 1968 when standards were substantially more lenient than they are today. No more

> than a handful of the municipal incinerators currently in place meet EPA's existing Air Quality New Source Performance Standards. (ibid. 5-6)

According to the Agency, resource recovery technologies represented the way of the future, but posed financial risks unsuitable for cities to take; however, old modes of incineration were environmentally unacceptable and did not represent the best use of 'American ingenuity.'

By the late 1970s the OSW was advising civic leaders that "There is no universally 'best' or most economical recovery technology," and that processes like incineration were ultimately limited by "available markets and local prices, capital and operating cost projections, level of risk [cities] are willing to assume, and financing and management alternatives available for different systems." (US EPA 1976b, 2) For, according to the Agency,

> The most important factor to remember when assessing a technology is that the system must be able to produce marketable products. Technology selections should not be made until potential markets have been identified and the market requirements specified. (ibid.)

In other words, incineration with energy recovery was a bad bet unless there was guaranteed revenue at the end. Civic leaders following this line of thought to its logical conclusion would see any and all resource recovery technologies limited by the same manufactured problem. The "perplexing…capital requirements, the wide range of largely unproven alternatives, the market and operational uncertainties, and the range of procurement and management alternatives" that hovered around incineration with energy recovery all but ruled it out (US EPA 1976a, 1). In this way, every charge made against incineration with energy recovery became a credit for the sanitary landfill, making the technique the only acceptable disposal option for cities concerned with balancing the environmental challenges of solid waste collection and disposal with financial risk – that is, virtually all cities in the United States.

But alternative documents reveal contradictory findings and mixed messages. As Hale and others suggested caution because of a lack of market for recovered materials – including steam and electricity – other EPA reports found that as processing costs increased, the value of the recovered materials increased almost in step. In other words, though cities would spend the most to build the latest generation waste-to-energy type of facility, the value of the electricity sold was worth significantly more than any other type of recovered material, and many times more than the value of simply landfilling the waste (US EPA 1973, 12-15). In fact, a US EPA contractor reported that of any and all types of incineration with energy recovery, the single most promising technology is the newest generation of waterwall incinerators (WTE) because of the ubiquity of power companies, the uniformity of the product (electricity is electricity, versus paper fiber or glass), and the low risk of technical failures (Levy 1974, 23-24).

One way by which the OSW sought to resolve this contradiction was by expressing high levels of optimism for **future** waste disposal technologies and markets for recovered materials, and especially through accounting projections. For instance in its Second Report to Congress on Resource Recovery and Waste Reduction, the OSW estimated that by 1985 there would be at least 195 metropolitan areas in the US supporting some sort of energy conversion facility (US EPA 1974b, 39). The message conveyed to civic leaders was that they could bide their time on installing state-of-the-art resource recovery equipment, because the industry as a whole was poised to grow very rapidly through the mid-1980s, producing economies of scale for equipment manufacturers and a wealth of project expertise for consultants, the Agency, and municipalities alike (Mitre Corporation and US EPA 1976).

Finally, OSW guidelines for municipal officials fragmented incineration with energy recovery by treating the energy production and waste disposal aspects of the technology as separate and perhaps competing goals. Incidentally, the EPA thought quite highly of energy recovery from incineration **as a means to conserve natural resources**. For instance, a 1974 report estimated that incineration with energy recovery could displace some 190m barrels of oil per year (US EPA 1974a, 11), while simultaneously representing a "readily available, growing – rather than depleting – domestic source of energy." (ibid., 13)

However, it is also clear that the *Environmental Protection* Agency refused to substitute conservation goals for financial cost concerns as the chief determinant of desirability for a solid waste disposal technology. The best illustration of this is found in the Agency's multi-volume 1976 guide for civic officials. Here, the OSW suggested that communities decide on one single over-arching goal for their solid waste management program that should guide their practices and planning, and offered the following possibilities:

- <u>Goal</u>: Minimize Cost. <u>Possible Programs</u>: landfill close-in if possible; skim resource cream by separate collection.
- <u>Goal</u>: Minimize Land Requirements Locally. <u>Possible Programs</u>: stretch present landfill life through volume reduction (e.g., energy recovery); long-haul [disposal]
- <u>Goal</u>: Minimize pollution. <u>Possible Programs</u>: Clean up current activity (e.g., install precipitators on incinerator, collect landfill leachate); initiate new non-polluting modes (e.g., resource recovery)
- <u>Goal</u>: Maximize resource recovery. <u>Possible Programs</u>: Initiate separate collection; initiate high technology materials recovery system (US EPA 1976a, 8)

In contrast to the message presented visually in the children's book discussed earlier, subsequent Agency documents like these limited the scope of cities' solid waste management plans rather than finding ways for various disposal technologies to work together, not only to safely dispose of solid waste but also contribute to the protection of the natural environment and conserve other energy resources. In contrast, many European municipalities were moving towards the concept of an 'environmental park' where a range of solid waste disposal, industrial, and sanitary sewer functions were clustered together and fed each other various inputs like steam, organic materials, or electric power, something that the OSW was certainly aware of but seemed hesitant to endorse (Battelle Columbus Laboratories 1979, ii).

In guidelines for civic leaders produced during the 1970s, European political economy looms quite large though is rarely directly discussed. Typically, Agency documents would note that WTE facilities are quite widespread in Europe and Japan, but then proceed to offer a range of reasons why that model is not necessarily appropriate for use in the US. For instance, Levy (a US EPA contractor) reported that

> One reason this concept is widely used in Europe but not used at all in this country is that many European municipal governments unlike their American counterparts are responsible for solid waste disposal but also for power generation, distribution of steam for district heating, and the operation of electrically powered transportation systems. (Levy 1974, 20)

Alternatively, it was offered that Europeans were obliged to embrace different technologies out of geographic necessity – land and natural resources were 'scarce' (US EPA 1976b, 25) – or because existing facilities had been destroyed during the World Wars (Battelle Columbus Laboratories 1979, vi). Incidentally, at least one report from this period noted that Europeans and Japanese moved towards WTE because of fundamental dissatisfaction with the sanitary landfill (ibid., A-2).

These explanations of the various geographies of WTE implementation were part and parcel of the OSW and US EPA's efforts to provide municipalities with as much information as possible about the options for solid waste disposal. Though topically thorough and paying significant attention to incineration with energy recovery technologies, a clear preference for the sanitary landfill is evident. This preference emerges from the processes in which incineration technologies are made incomplete, expensive, and ultimately ‘too risky’ for municipalities to implement, though future technologies seemed more promising – or so the argument went. In this way, in the technologically fluid period immediately following the first significant federal attention to solid waste management issues with the passage of the SWDA, the US EPA and OSW cast significant doubt onto incineration with energy recovery technologies, even as those same technologies increased in prominence in other European countries and Japan.

The OSW and US EPA after 1980

The heyday of US EPA OSW involvement in the solid waste disposal industry ended around 1980. The passage of the Resource Conservation and Recovery Act (RCRA) in 1976 (subsequently re-authorized with the Hazardous and Solid Waste Amendments of 1984) focused the attention of the US EPA squarely on hazardous wastes. This, along with significant cutbacks for the agency imposed by the Reagan administration (though most curiously, advocated by some EPA officials), limited the federal government's role in actively setting solid waste policy through much of the 1980s. Limited budgets forced the OSW and the rest of the EPA to focus primarily on the most pressing projects and especially the cleanup of hazardous material “Superfund” sites, rather than careful studies of solid waste management (Melosi 2005, 200-205). RCRA prioritized hazardous wastes as national issues demanding federal attention while relegating solid waste to the state and local levels.

As a result, the sorts of documents that typified OSW involvement in the incineration industry during the 1970s, such as guidelines for municipal officials, and technical reports, all but disappeared during the 1980s, leaving the industry to grow under the auspices of consulting engineering firms, professional organizations and societies, and state agencies. When the OSW and EPA returned to the issue of solid waste in the late 1980s, they did so with an altered mission. Instead of developing guidelines for individual technologies, the OSW promoted above all else the goal of source reduction and pollution prevention, promulgating a hierarchy for 'integrated solid waste management' that emphasized (in order of decreasing preference) source reduction, recycling, incineration with energy recovery, and finally landfilling (US EPA 1989).

Though ostensibly turning the 1970s disposal hierarchy on its head, the OSW's new emphasis on source reduction further contributed to the fragmentation of WTE technology in an important new way, by creating within the Office competing perspectives on the limits and aims of 'solid waste disposal.' During the early 2000s, sharp divisions could be observed between those staffers at the OSW Waste Reduction program who believed that 'everything' could be recycled and those who felt that there were market limits to recycling efficacy. Supporters of the first proposition believed that WTE was in fact wasteful because all components of the solid waste stream could be recovered, re-used, or recycled, including the organic fraction (into compost). Those advocating a limit to recycling argued that WTE was an important component of the waste minimization goals set by the OSW because through efficient combustion, the caloric value of non-recyclable waste (read: products for which there is no market value) could be recovered and converted into steam or electricity (or both). Thus, WTE was plunged into a debate on its contribution to recycling programs and whether or not it did as much environmental good as some OSW officials felt that recycling did, further fragmenting understanding of the technology.

Regardless of the impacts of WTE on recycling – though this is still a quite relevant debate, as shown in the case study chapters – currently the most lasting effects of US EPA action on solid waste incineration have come not from the OSW but rather the offices of air and water quality. Most significantly the 1990-1992 Clean Air Act Amendments imposed strict limits on incinerator emissions, so much so that the number of incinerators in service dropped from approximately 160 in 1990 to around the 90 that still operate at the time of writing this dissertation (and acknowledged by the US EPA itself, 2011). Those that remain are exclusively WTE facilities.[3] Thus, although once playing a prominent role in shaping the trajectory of incineration with energy recovery in the US, the future role of the OSW looks more limited barring some sort of radical action from the US Congress.

<u>The Corps of Engineering Consulting Firms</u>

Despite the withdrawal of what had been a significant force shaping the adoption of disposal technologies, the early 1980s proved to be something of a boom time for WTE. 1978 saw the passage of the Public Utilities Regulatory Policies Act under the Carter administration which, among other things (cf. Brennan, Palmer, and Martinez 2002), was an attempt to both overhaul the provision of electricity in the United States and also introduce a range of new non-fossil, non-nuclear sources of energy. PURPA guaranteed 'qualifying facilities' (operating on renewable or alternative fuels, including solid waste) a particular rate for the electricity that they produced, and obliged utility companies to purchase electricity from such facilities. The Congress had introduced, by fiat, a guaranteed market for alternative sources of electricity. Federal action had also introduced a range of financial incentives to build WTE plants, which

3 Medical and hazardous materials incinerators excluded…An entirely separate issue.

were ended only when the 1986 Tax Reform Act reduced credits for building new facilities (Curlee et al. 1994, ch. 5; Melosi 2000, 406-411).

In many ways PURPA was something of a 'lifeline' and the legislation undoubtedly made a lasting impact on the industry: at least 53 WTE facilities came online between 1979 and 1989 (Energy Recovery Council 2011). With the OSW largely absent from these proceedings, municipalities turned to other sources for information and guidance. Chief among these was the corps of engineering consulting firms, which had long played a prominent role in the design and installation of incineration infrastructure and loomed large in many OSW publications during the 1970s under the code name of 'Technical Assistance.'

'Technical Assistance'

Though the demonstration projects and guidelines for civic officials were devised to help leaders select an appropriate technology, the installation and operation of new solid waste disposal equipment remained a highly complex task. For this reason, the OSW sought to provide municipalities with 'technical assistance', as mandated by the 1965 SWDA. More accurately, the OSW itself did not offer technical assistance, but rather directed municipalities towards private sorts of technical assistance in the form of engineering consulting firms. From the 1971 *Guidelines*:

> An incinerator plant is an extremely complex piece of equipment. Since most local government engineering staff members do not have the specialized knowledge to plan and design an incinerator plant, a consulting engineer is usually retained…This means that the consultant should be responsible for seeing that the plant can be and is operated for a continuous period of six months or more at design capacity by plant personnel trained be equipment manufacturers. (US EPA 1971, 87)

In particular, the Agency believed that:

> Especially today, with growing interest in resource recovery and rapidly emerging technology, some information is inaccurate and misleading. Systems, economics, market situations, financing, and other aspects of implementation are in some cases represented in ways that are either too optimistic or too pessimistic. Because of the proprietary nature of a number of systems, potential buyers [need an] objective third party to turn to for advice on the feasibility and desirability of specific systems. (US EPA 1974b, 43)

In research for this dissertation, I came across no instances of the US EPA directly advising municipalities on issues of technology installation and operation. Instead, the 'technical assistance' on offer from the Agency to civic officials was largely advice on how to select a consulting engineering firm. As the 1971 *Guidelines* argued:

> The importance of using competent consulting engineers both in the preliminary study phases and in the design of facilities cannot be overemphasized. Too often, ready-made solutions have resulted in failure or unreasonably high costs...an elected official should be careful to choose a qualified consultant. While the official himself [sic] will not make the study, he will be responsible for considering the solutions offered by the consultant and making final policy decisions. The decisions made will reflect on the official and will have a long-term impact on the community. Although each community's solid wastes problems are different, a great deal may be gained by retaining a consultant who has had experience working with many local governments and who is knowledgeable about the engineering of solid wastes management. (US EPA 1971, 165)

Engineering Consultant Firms and Incineration with Energy Recovery

According to Melosi (1988, 2000, 2001, 2005), the 'sanitary engineer' emerged in the 19th century, many times in association with the installation of new urban infrastructures like electricity, gas, and sewer lines. Since solid waste disposal was coming to be seen as a technical problem no different from the other infrastructures and also a municipal obligation, perhaps it is not surprising that many cities turned to professional engineers for advice and ultimately solid waste disposal solutions.

While some larger cities hired engineers to head sanitation and other public works departments, many cities turned to consultants to solve problems and manage projects on an ad hoc basis. Research for this project suggests that this trend has only increased since around 1970, when many major US cities first started to encounter serious budget problems and began to 'outsource' many traditional municipally-owned and operated tasks like transportation and electricity and gas provision. Melosi (2000, 2005) documents the changing patterns of direct municipal responsibility for solid waste collection and disposal and illustrates increasing movement towards privatization and contract work since the mid 1970s, though notes that contracts for collection and disposal were actually quite common in the early parts of the 20th century as well.

Contracting with sanitary engineering firms has also proven to be quite common at the federal level as well, particularly within the US EPA. Although many documents from the late 1960s through about 1980 were written by OSW staffers, many were also written by contractors, whether individuals or specialist firms. Though 'outsourcing' research to private firms is not uncommon among all branches of the US federal government, it is interesting to note the transfer of authority and expertise that results from such arrangements: the OSW, federally mandated to provide guidance to municipalities on their solid waste management issues, voluntarily transfers the ability to make such guidance to outside firms. Thus, the perspectives of those firms sometimes (though not always) become the official advice of the agency.

Sanitary engineers and engineering consultant firms thus had the potential to greatly impact the technologies and processes of solid waste collection and disposal for a community. Accorded 'independent' and 'expert' status by multiple levels of government, their reports and opinions would carry significant weight. Firms' assessments of not only technology but also the composition of the solid waste stream itself could circumscribe the future actions a city could take regarding collection and disposal. In this chapter, I look at the relationship between engineering consulting firms and the US EPA and the solid waste industry in general while in the following chapters I consider the efforts of engineering consulting firms in the context of the specific cities and projects analyzed in the case studies.

Influencing the USEPA and Solid Waste Industry

The historical record does not suggest any sort of nefarious conspiracies to promote particular technologies (or particular companies' versions of technologies) by the engineering consulting firms. In the same way that the OSW positioned itself as an 'honest broker' between the universe of technologies and municipalities needing help, so too did the engineering consulting firms, as they continue to do today.

In fact, it appears that the OSW would have continued to promote sanitary landfills above all other technologies had the corps of engineering consultants – frequently contractors for the US EPA and OSW – not been involved. For instance, it is by and large the reports and documents penned by external firms on behalf of the US EPA that are the most positive about alternatives to the landfill (e.g. Horner & Shifrin 1972; Levy 1974; Battelle Columbus Laboratories 1979). At times it seems as though preference for the sanitary landfill was so strong at the US EPA that even environmental and human health risks associated with the technology were willingly downplayed, as revealed in a study completed by Battelle Columbus Laboratories on behalf of the US EPA in the late 1970s:

> One of the reasons for the average American not being as concerned with leachate is the sanitary landfill program inspired by the US Public Health Service, US EPA and one leading earth moving equipment manufacturer.

> This developmental program evolved during the late 1960s and early 1970s. EPA has poured technical talent and promotional effort into the concept. (1979, I-11)

This points to one of the major roles played by the engineering consulting firms, and one analogous to a role played by the US EPA OSW: if the OSW positioned itself as a clearinghouse of information for municipalities, then engineering consulting firms positioned themselves as clearinghouses for technologies and 'solutions' for any type of solid waste problem. I think that a further comparison can be made between engineering consulting firms and do-it-yourself hardware stores: customers walk in with a particular problem, and leave with a set of advice and materials to solve the problem. This attitude is evident in many of the conference papers given by employees or directors of engineering consulting firms at industry events, as illustrated in the following excerpt from a contractor report to the EPA:

> Perhaps the lesson to be learned is: 1) let the elected officials and community leaders decide to build and finance the refuse burning plant; 2) let the engineers, planners and economists design and let the staff operate the energy plant for minimum cost to taxpayers.
>
> Occasionally at a resource recovery conference, a debate is held leading to an 'either-or' conclusion. Often after a series of speakers have discussed the technical aspects of their plant, an agitated local official will rise from the floor to explain, 'I don't really care about the energy. I've got 500 tons per day of garbage to get rid of. Can I burn it?' (Battelle Columbus Laboratories 1979, I-4)

Over time, firms like Gershman, Brickner, and Bratton (GBB); HDR; Wheelabrator; ABB Resource Recovery; and Combustion Engineering all took active roles in advising communities and overseeing the construction of new waste-to-energy facilities, opining on everything from finance to technology selection and environmental responsibility. These opinions were frequently made public at industry events. For instance, in a paper called "Marketing the Outputs: Energy Fuels, Materials" by Harvey Gershman (then the director of the Resource Recovery Division at Urban Services Group, Inc.) the argument is made that the right consulting firm can take whatever solid waste 'inputs' are present in a given waste stream, and help make them into marketable products (Gershman 1976). Likewise, engineering consultants would help cities navigate the labyrinth of financing as well, since

> Financing of solid waste resource recovery facilities is rapidly developing into a specialized field, due primarily to unique features of the business and the need of the investment banker to have an in-depth knowledge of the industry. It is unique because, by its very nature, resource recovery requires the combined resources of both the public and private sectors. (Aldrich 1976, 45)

These and similar themes would be repeated in an array of papers from engineering consulting firms throughout the 1980s and 1990s, delivered most publicly at the industry events and conferences discussed in the following section.

Despite the perception that consulting firms are hired to tell city officials ‘what to do’, this is almost never the case. It is clear from working with consulting firms’ documents that consultants present their clients with information on making changes to their solid waste management systems based on the information their clients provide. Consulting engineering firms help client municipalities react to external events, including the election of public officials and implementation of new environmental regulations and laws. Sometimes the firms even assist cities in securing permits from state agencies and the US EPA. Interestingly, there have been instances where those same firms served as technical advisors to the US EPA for the promulgation of new regulations.

During the 1980s, after the OSW had abdicated much of its interest in promoting solid waste disposal technologies, engineering consulting firms became the ultimate sources of expertise for communities interested in incineration with energy recovery. As mentioned earlier, this was something of a boom time for the industry, as approximately 194 projects were initiated between the late 1970s and 1990 (Curlee et al. 1994, 42). A wide range of firms were involved in the planning, design, and construction of energy recovery facilities, ranging from large vertically integrated consulting firms to one-off companies and small subsidiaries. The long lead times and complex financing noted by the engineering consulting firms favored companies which could afford delayed returns on investment. As a result, even as the number of projects mushroomed, the number of consulting firms shrank. Curlee et al. note that firms involved in the construction and operation of waste-to-energy facilities dropped from nearly 25 in the early 1980s to fewer than ten by 1990 (ibid., 41). Such consolidation led to remarkable steps towards uniformity in technology selection: of the 75 facilities coming online between 1979 and 1992, 52 of them used mass-burn waterwall designs; some 12 more also used waterwall furnaces but pre-processed fuel (or RDF; Energy Recovery Council 2011).

The consolidation of firms, building practices, and ideas was sometimes matched by the consolidation and exchange of personnel. Historically, there has existed an exchange of personnel between the US EPA (and specifically the OSW), the corps of engineering consulting firms, and professional organizations, though especially between the first two. For instance, while in the early 1970s Samuel Hale, Jr. was publishing as a Deputy Assistant Administrator for Solid Waste Management at the OSW (e.g. the foreword to Horner & Shifrin 1972; Hale Jr. 1973), by the middle of the decade he was writing as Vice President of Market Development for SCA Services International (a consulting firm – see Hale Jr. 1975). These transitions had the potential to entrench a particular position around the industry as ideas and people moved around, as they continue to do today.

Further Fragmenting 'Incineration with Energy Recovery'

Though during the 1980s the US energy recovery industry's interests largely coalesced around mass-burn, waterwall WTE systems, the engineering consulting firms still contributed to the fragmented understanding of 'energy recovery' through their promotion of competitors to the mass-burn waterwall WTE. This is especially evident in the public presentations of firms like GBB and HDR at industry events. For instance, a presentation from one GBB official at the most recent North American Waste-to-Energy Conference highlighted "Selected Waste Conversion Technology companies and their projects." (Gershman 2012) The paper featured the following graphics, some of which are assembled here in a collage (Figure 3.8).

Figure 3.8: Collage of possibly available technologies as presented by GBB firm at recent industry event (Gershman 2012). "Text in the Figure is not meant to be readable, but is for visual reference only."

In meeting their obligations for due diligence and helping clients assess their solid waste needs, the engineering consulting firms invariably explore technologies that are still somewhat speculative. Should a community express interest in a facility making use of unproven technologies, consulting firms do not necessarily discourage them, instead they offer a thorough analysis of the risks and suggest the ways they could procure such technologies.

As the collage indicates, consultants make clear that as of 2012 there were nearly 600 firms alleging viable energy recovery from solid waste technologies. While it seems certain that engineering consulting firms present this information to make their expertise necessary – to make themselves 'obligatory passage points' (Callon 1999) – it also serves to continually fragment the very notion of incineration with energy recovery in the minds of those same officials. Much in the same way that OSW guidelines for municipal officials predicted in 1975 that many technologies would be widespread by the 1980s – many of which still do not operate commercially today – optimistic consulting reports may go some way in persuading public officials to simply bide their time and wait for 'something better' and in the meantime make no investments in disposal facilities (Figure 3.9).

At the same time, affording equal attention to commercially proven and unproven but theoretically viable technologies undoubtedly encourages new investment, innovation, and interest in the solid waste disposal industry. One of the key arenas where such information is disseminated, where markets and hype are created, and where buyer-seller connections are made are at the industry conferences and trade shows conducted by professional organizations serving engineering firms, equipment manufacturers, and the world of solid waste management as a whole; organizations at the heart of the final section of this chapter.

Figure 3.9: Hope for the future, from Gershman (2012)

Professional Organizations and Trade Associations

The increasing interest in sanitation among civic officials was matched by increasing interest in the topic among engineers and engineering societies like the American Society of Municipal Improvements (subsequently the American Society for Mechanical Engineers, ASME), the American Public Health Association's Committee on the Disposal of Garbage and Refuse, the American Society of Civil Engineers, and the International Committee on Street Hygiene. Initially these organizations represented niche interests within larger engineering societies, but later became major specialty organizations within engineering societies if not freestanding organizations altogether (Melosi 2000, 2005).

Before the involvement of the US federal government in issues of solid waste, these bodies focused on the collection and dissemination of data about solid waste and solid waste disposal techniques, conducting a range of surveys since the end of the 19th century in the US and abroad (Melosi 2005, 77-86). This is significant because as Foucault might argue, knowledge is power (Foucault and Gordon 1980), and the combination of tranches of statistical data, project management experience, and 'expert' status accorded by city governments and the general public alike made the engineering community and its professional organizations a potent force in issues of solid waste management.

Melosi (1988, 2000, 2001, 2005) examines in greater detail the role of formal engineering societies like the ASME in US solid waste management (but for an instance of similar research in other industries, see Constant II 1989), and examines the content of these societies' publications. Accordingly in this section of the chapter I examine not engineering societies but rather the professional organizations and trade associations linked to the solid waste and incineration industries, such as the National Solid Wastes Management Association / Waste Equipment Technology Association (NSWMA); the International Solid Waste Association (ISWA); the Energy Recovery Council; and the Waste-to-Energy Research and Technology Council at the Earth Institute of Columbia University. I focus much of my attention on the Solid Waste Association of North America (SWANA) which lists a very diverse membership of industry professionals, civic bodies, academics, and engineers while also hosting an independent research arm (the Applied Research Foundation) and managing a number of major conferences for the solid waste industry every year.

The links between engineers/engineering consulting firms, professional organizations/trade associations, and technology selection are somewhat fuzzy, but clearly of significance. Individual engineers and engineering firms could disseminate findings and exert influence through their national organizations and publications, prompting the idea that there might be an 'ideal' set of answers to the question of solid waste. However, such conversations were largely internal to the engineering community. In contrast, the professional organizations and trade associations cast a wider net, and while still producing the sorts of surveys and industry-overview reports that characterized engineering societies in the early 20th century (e.g., ISWA 2006), also serve a much broader function by bringing together industry participants ranging from collection truck operators to city mayors, CEOs, and environmental regulators. Unsurprisingly these organizations also bring together a range of approaches to solving a given solid waste problem: at a single conference one might encounter information detailing why the sanitary landfill / anaerobic digester / waste-to-energy system is the best and most preferred means of solid waste disposal. In short, the professional organizations and trade associations are more of a marketplace – for ideas, equipment, and services alike – than the engineering societies examined by other authors, and offer the opportunity to see approaches to solid waste management and technology synoptically.

The Organizations and Their Stated Purposes

The very first organization to form was the precursor to SWANA, which emerged as a regional forum for Los Angeles, CA area solid waste supervisors under the name of the Governmental Refuse Collection and Disposal Association in 1961 (SWANA 2012b). Shortly thereafter, however, the first national organization was formed in 1962 as the National Council of Refuse Disposal Trade Associations. This organization, in contrast to what would later become SWANA, represented exclusively for-profit companies and in particular collection and landfill firms (NSWMA 2011a). Both organizations grew during the second half of the 20th century, along public-private lines: while the NSWMA argues that "communities save money, maximize efficiency, and achieve other benefits" through privatization of solid waste services and include in its membership no public bodies (NSWMA 2011c, 2011b), SWANA argues that "local government is responsible for solid waste management " and includes a surprising diversity of public bodies among its membership (SWANA 2012a). In contrast to both SWANA and NSWMA, the International Solid Waste Association (ISWA) functions more like a professional organization for academics, focused primarily on environmental sustainability, public education, and the publication of a peer-reviewed scientific journal, *Waste Management and Research* (available through SAGE). Though several US-based entities (both public and private) are part of ISWA, the membership is primarily drawn from outside North America.

There are also two organizations which focus exclusively on waste-to-energy: the Waste-to-Energy Research and Technology Council (WTERT), at Columbia University and the Energy Recovery Council. WTERT claims as its mission "to identify and advance the best available waste-to-energy (WTE) technologies for the recovery of energy or fuels from municipal solid wastes and other industrial, agricultural, and forestry residues" and pursues mainly 'technical' research on boiler design, combustion properties, and facility emissions and by-products (WTERT 2012). The Energy Recovery Council in contrast does not conduct its own research but rather provides information and legislative representation for both public and private entities in its membership, acting simultaneously as both lobbyist and library.

An overview of the mission statements for all of these organizations points to their general purposes in the universe of solid waste management: fundamentally, the professional organizations and trade associations act as clearinghouses of information, linking together news and information from the US EPA, engineering consulting firms, equipment manufacturers, and municipalities. SWANA, for instance, hosts a number of 'technical divisions' on topics like landfill management, methane collection, recycling operations, and WTE which disseminate operations advice and best practices to its membership. Frequently, the organizations produce policy statements (e.g., SWANA-Applied Research Foundation 2011), but unlike documents emanating from 1970s-era OSW or contemporary engineering consulting firms, these texts are rarely critical, preferring to provide supporting information for whatever arguments the membership would like to have made anyway. That's not to say that they are instances of 'research for sale,' especially documents from SWANA and ISWA, but rather that they rarely say anything that industry participants or government representatives haven't already said before.[4]

Here I analyze instead the other major clearinghouse function of these organizations: by hosting conferences. Industry-wide conferences as well as technology-specific gatherings are where many innovations are made public and disputes over technology, process, and practice are both conducted and resolved. These events are also critical in establishing markets for equipment manufacturers and consulting firms. Though all of the organizations discussed earlier (except the Energy Recovery Council) host conferences and other events, I focus on two conferences assembled annually by SWANA: WasteCon, an industry-wide event treating all aspects of solid waste collection and disposal, and the North American Waste-to-Energy Conference (NAWTEC), a gathering specific to the WTE industry.

4 These documents are also useful for the facts and figures they provide on specific technologies and waste streams, and will be revisited in the case studies.

Conferences

Solid waste industry conferences exist for two reasons: networking and education. Indeed, the conferences are designed for networking, building a marketplace for products, ideas, and personnel while also offering a space for engineering consultants, contractors, and equipment manufacturers alike to advertise their wares. The education component comes in the form of paper panels and 'technical sessions' detailing various insights into facilities operation but also the structure of the industry itself. As such, the papers and panels frequently function as spaces for (self) critique. As a researcher, the conferences represent excellent sites for the practice of ethnohistory (cf. Binford 1967) as interpersonal, scientific, and corporate competitions, relationships, and identities are on full display.

Marketplace of Ideas, Products, and Services

Industry conferences are common sites where engineers and company executives reveal new technologies and services available for purchase or contract. At the 2010 NAWTEC I attended there were no fewer than 12 papers (of 51 total) dealing with 'emerging' waste-to-energy technologies, many of them the same 'space age' technologies promoted by the US EPA some 40 years earlier, like pyrolysis gasification (SWANA 2010). In addition to specific technologies, papers and panels frequently (e.g. Zemba 2010) explore the theoretical implications of a potential technology adoption: what would be the environmental, financial, and regulatory impacts if a city should install WTE or another conversion technology?

The papers and panels offered at NAWTEC also reveal *longue durée* paradigm shifts within the incineration industry: whereas previously the industry was concerned with 'solid waste disposal', at recent conferences a greater emphasis has been placed on ‘environmental services’ and the various ways in which WTE and similar technologies are ‘green’ and can capitalize on various carbon-credit and renewable energy technology tax incentives (for instances, the eight-paper panel on the topic at NAWTEC 2010 and four multi-paper panels on sustainability and ‘zero waste’ at WasteCon 2011). In this way, industry participants seek to expand the marketplace through the commodification of labor, waste, and even nature itself (via ‘carbon credit-ization’) in novel ways.

While the immediate educational value of the papers is to those actively involved in industry operations and planning, it is nevertheless observable to a layperson or social scientist. From the perspective of this project, however, it is the contexts in which the papers and panels are given which reveals the greatest insights into the incineration industry. At NAWTEC, a specialist conference dealing exclusively with various waste-to-energy technologies and processes, mass-burn waterwall WTE is the elephant in the room: the technology is readily accepted as the global norm for incineration with energy recovery, the only type of system with any sort of foothold in the US, and for the near future, the only ‘serious’ system available to cities seeking conversion options (e.g., Kamuk 2012). Technologies like pyrolysis and plastic-to-oil conversion are discussed with enthusiasm in papers and panels but their limitations are quickly recognized by conference participants and even sometimes the engineers behind the alternative technologies themselves. In contrast, at an industry-wide event like WasteCon, WTE is reduced to a bit part, competing for a significant role in solid waste disposal with the far more prominent sanitary landfill, both ideologically (what should cities do with solid waste?) and also economically, since many of the booths on the trade show floor deal with the various supporting technologies and services necessary to run a sanitary landfill.

This links to the other way in which marketplaces are created at industry events: through the creation of various visual spectacles both on the trade show floor and on the facility tours that typically accompany the conference. Trade show spectacles typically involve the introduction of physical equipment into the show itself (Figure 3.10), prizes, food and drink. When physical specimens of a given technology are not available or not practicable, they are still made present through mock-ups, renderings (Figure 3.11), and 'showcases' (Figure 3.12).

Figure 3.10: A landfill compactor and customized bin (available in the design of your choice, inset) on display on the trade show floor at WasteCon 2011. Photos by author

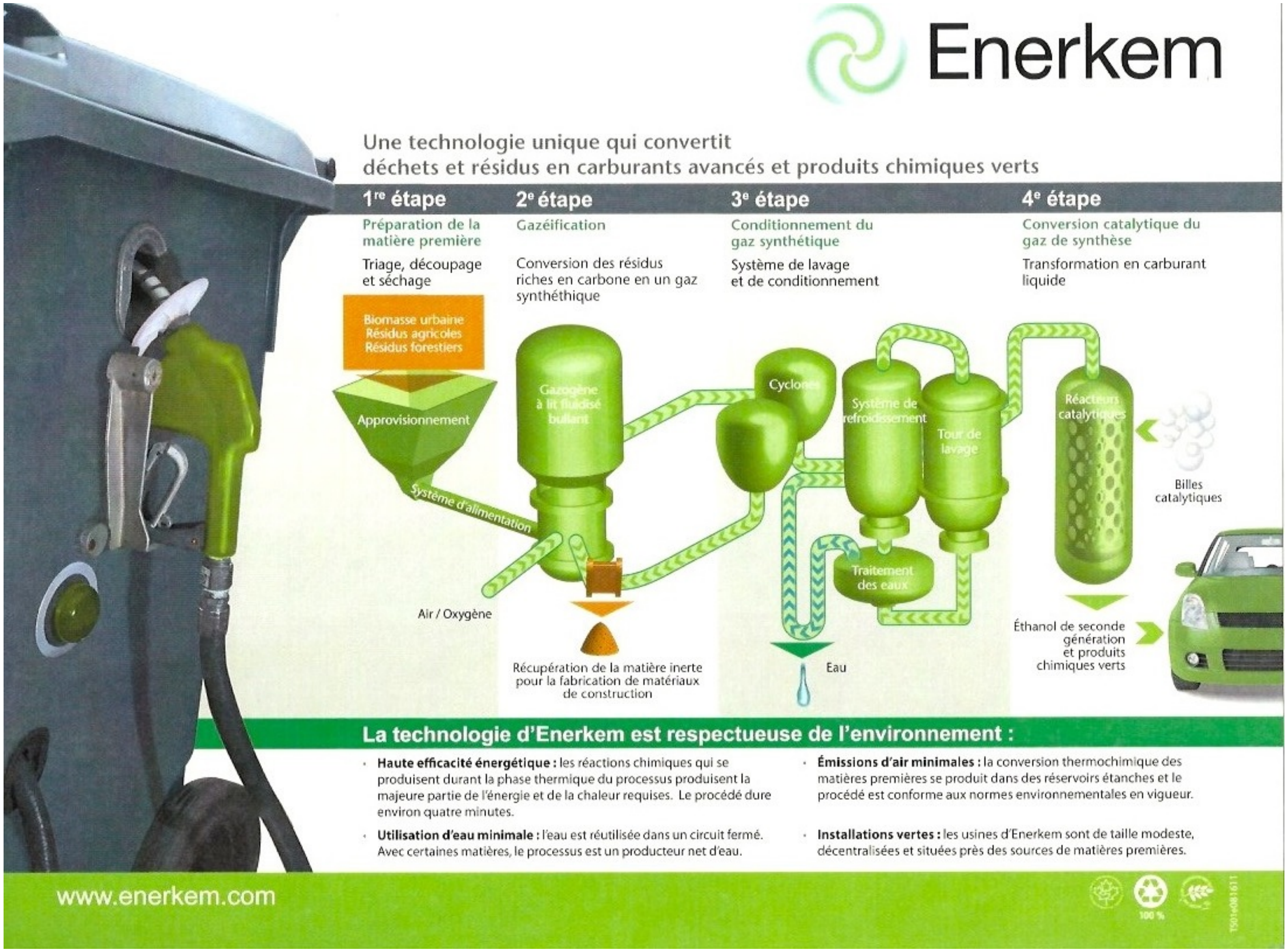

Figure 3.11: Making technologies 'present' even when not physically existing. Process diagram from Enerkem, obtained at WasteCon 2011. "Text in the Figure is not meant to be readable, but is for visual reference only."

Figure 3.12: Waste Conversion Technologies 'showcase' advertisement at WasteCon 2012 (SWANA 2012c). "Text in the Figure is not meant to be readable, but is for visual reference only."

Similarly, spectacles are produced on the facility tour: the guided visit to a particular solid waste management site to see a range of technologies, practices, and environmental protection measures in action. Facility tours serve one of two purposes: either to 'show off' an excellent site (like the NAWTEC 2012 tour of ecoMaine, or the five-night 'study tour' of Austrian WtE facilities offered by ISWA 2012), or else to disprove rumors or allegations that a system isn't working properly (like NAWTEC 2011 tour of the bankrupt Harrisburg, PA WTE facility). Having attended two WTE facility tours, it seems as though they are largely designed for skeptics, the indomitable questioner pestering Bruno Latour's scientists as they 'prove' their points via inscription devices and calculations (1979; 1987).

Figure 3.13: Collage of the 'spectacular' facility visit to ecoMaine as part of NAWTEC 2012, including visual confirmation of, from left to right, pollution control equipment, electrostatic particulate control functionality (via printout), complete combustion of solid waste, and a massive recycling operation. Photos by author.

Indeed, the spectacle of the facility tour encompasses all of these things: specialized equipment, printouts from various monitors, and the personal witness to expensive, complicated, and in these circumstances quite large pieces of equipment in action (Figure 3.13). Of course, the purpose of the spectacle at industry events is to attract new customers, convincing them that a given technology is reliable, practical, and commercially viable (Reno 2011).

Space for Criticism

Though industry events and the spectacles that accompany them play an important economic role by enhancing the image of the industry and the technology it uses, this is not their sole function. Industry events also act as spaces for criticism – papers and personal communications are venues for the airing of grievances with regulatory systems, competitors and their technologies, as well as the industry itself.

Both NAWTEC and WasteCon are replete with papers detailing what 'we' need to do as a solid waste industry to improve public image, enhance sustainability, and most commonly, turn a financial profit (e.g., Weidman 2012). Frequently at least one paper at an industry event would try to offer a 'real world' look at the state of the industry. One of the most bleak emerged at a 1975 conference, courtesy of Peter Vardy, then a Vice President at Waste Management Inc:

> During 1974, I said that there was general feeling of euphoria concerning development of resource recovery in this country and the great economic and technical promise which it held for the solid waste management industry. A number of EPA-funded resource recovery demonstration projects were receiving wide publicity and the construction of full-scale facilities was strongly encouraged by various government agencies...By fall 1975...the realities of life have become apparent and depression set in. The fallacies of rapid scale-up; the difficulties encountered in obtaining long-term financing on the strength of short-term, fluctuating markets for recovered resources; serious difficulties encountered in the effective control of waste; and the real impact on disposal fees of the highly capital intensive resource recovery systems were reported by all who tried their hand at this new area of opportunity. (Vardy 1976, 217-218)

Frequently, the problems associated with the industry are linked to the (in)action of government regulators (perhaps starting with Walter 1975). Much of the critique seems to have merit, however, as the history of the US EPA's involvement with the incineration industry has been quite varied. One paper (Wigmore 2012) extended criticism to the US political system more generally, by offering a sobering instance where a US Circuit Court required the US EPA to enforce air quality standards for medical waste incinerators that no facility in operation or planned for the near future could meet, essentially freezing the entire industry. An informal, consensus opinion among NAWTEC 2012 attendees was that the federal government could either build or destroy the WTE industry through its air pollution rules and ability to designate solid waste as a resource eligible for renewable energy credits, carbon offsets, and other similar financial incentives. While the OSW typically send at least one representative to both general and specialist industry events, staff from the US EPA offices of air and water quality have been noticeably absent.

At other times the industry has been subject to external critiques from invited speakers. For instance, at NAWTEC 2010 a member of the German Green Party (Weltzin 2010) was invited to talk about the 'zero waste' concept, and proceeded to examine the inherent problems with labeling technologies like WTE – whose main fuel is inherently 'bad' for the environment due to the resources need to produce it – as 'green' or progressive. His paper, though making a number of useful points, was not necessarily well-received in a room of professionals whose livelihoods depend on the production of solid waste.

However by far the most common type of criticism leveled at industry events is that of the technologies themselves, from one competitor about another. "Pipe dream," "woefully inefficient," "lacking of any type of realistic life-cycle accounting," and "claims that have not been demonstrated in the real world" are representative of the sorts of language associated with 'emerging' technologies like pyrolysis 'plasma arc' gasification, the conversion of waste plastics to liquid fuel, or any other "advanced – a word only used to describe unknown" technologies (Kamuk 2012).

Conclusions

Professional organizations and trade associations play an important role in the world of solid waste and the recent history of WTE in the United States. Acting as clearinghouses of information, communal 'water coolers' where rumors, revelations, and complaints are shared, organizations like SWANA, ISWA, NSWMA, ERC, and WTERT provide a useful lens through which to view the 'evolution' of the industry. For instance, it is perhaps through the professional organizations that one can glimpse most clearly the remarkable shift from waste management as a technical to an environmental problem that took place between the 1980s and 2010s, as evidenced by the changing nature of presentations made at industry events. While papers from the 1980s emphasized overcoming regulations and public opposition to projects, recent discussions have focused on working with the public and framing WTE as a green technology worthy of carbon credits, status as a renewable resource, and a valuable asset towards the goal of 'zero waste'.

In this way, professional organizations and trade associations accomplish their primary goal of expanding the marketplace for their members' good and services. Nevertheless, as with the US EPA itself and the corps of engineering consulting firms, professional organizations also serve to fragment the notion of WTE. At NAWTEC, for instance, engineers and professionals argue over fine points of boiler design and emissions control under the assumption that WTE is still the best and most 'sanitary' means of solid waste disposal, while at WasteCon WTE enthusiasts have to argue that the technology should be used at all. Likewise at NAWTEC WTE is a solid waste disposal tool still facing a number of 'environmental' problems linked to both facility performance and government regulations, while at WasteCon WTE is promoted as the most-promising (technologically and economically) means by which to 'green' the solid waste industry. Thus across the solid waste management industry, there remains great controversy over what WTE is for, when it should be used, and the contributions it makes to solid waste management goals, environmental protection, and the recovery of various resources.

Summary and Conclusions

This chapter examined the practices of solid waste disposal in the United States since the late 18th century, focusing on incineration with and without energy recovery technology. Use of incineration by cities has been marked by alternating periods of intense interest and profound disappointment. I have illustrated that there is no single factor, company, or government agency behind the expansion and contraction of this technology, but rather a host of forces coalescing at different times and places to encourage or discourage the adoption of waste incinerators. **The main argument that I make in this chapter is that the current limited usage of incineration with energy recovery – WTE – is the direct result of federal agencies like the US EPA's Office of Solid Waste, the corps of engineering consulting firms, and the actions of professional organizations and trade associations, who through the course of seeking to provide civic leaders with unbiased and thorough information irreparably fragmented the understanding of the technology into an array of discrete technologies, some more financially risky and technologically unproven than others and all less attractive to cities with limited resources than the sanitary landfill.**

This fragmentation began early. Though incineration for volume reduction in purpose-built facilities runs back to mid-19th century England, by the end of the 19th century, some facilities and engineers sought to convert the excess heat from incineration into steam for industrial use and electricity production, first in Hamburg, Germany in 1896 but soon after elsewhere in the United Kingdom and North America. Although the technology attracted a great deal of attention from civic officials and increasingly influential sanitation engineers and their professional societies, by the interwar period citizens and elected officials alike were disappointed with the incomplete combustion and associated toxic air pollution of the earliest generation of incinerators. At the same time, incineration with energy recovery technology was proving quite costly, prompting many cities to construct the cheaper and seemingly more effective sanitary landfills.

By the mid 1960s the federal government had involved itself in issues of solid waste management beginning with the 1965 Solid Waste Disposal Act. Shortly thereafter the newly formed US EPA became involved in making grants for demonstration projects and issuing guidelines for technology selection to civic officials. Through these two channels the EPA's Office of Solid Waste limited the uptake of the dominant European disposal technology, mass-burn waterwall WTE, preferring to promote instead competing technologies and especially the sanitary landfill.

When the US EPA withdrew from questions of solid waste management during the 1980s, cities were forced to turn to other sources of advice, and in particular the burgeoning corps of engineering consulting firms. These companies advised cities on issues of technology selection, providing detailed accounts of all possible technologies and courses of action. The corps of engineering consulting firms oversaw the general selection of mass-burn waterwall WTE as the energy recovery technology of choice during the rush to build new facilities that took place during the 1980s, however they never stopped investigating competing technologies like pyrolysis and RDF co-firing even as these and other technologies were consistently rejected in the more mature energy recovery markets of western Europe and Japan.

Cities interested in combustion could also turn to the growing professional organizations and trade associations that linked together government regulators, engineering consultants, and equipment manufacturers through lobbying efforts, policy white papers and reports, and perhaps most importantly, industry conferences. Conferences were venues where markets for technologies and services were made, and also where many innovations were made public and disputes over technology, process, and practice both conducted and resolved.

As a triad, the US EPA, the corps of engineering consulting firms, and the professional organizations have played an important role in advancing the discussion on solid waste management and disposal in the United States, however in exploring the universe of options for doing so they have continued to fragment understanding of a particular technology – WTE – in the minds of public officials and members of the industry alike. With so many technologies identified as 'just on the horizon' and claiming improved environmental and economic performance over WTE, the commercially-proven though unglamorous mass-burn waterwall designs have been framed as both technologically and financially risky for US municipalities even while the technology has only expanded in usage elsewhere around the globe.

At the time of writing this dissertation 86 WTE facilities are in operation in the United States, with the most recent facility coming online in 1996 (Figure 3.14, also Energy Recovery Council 2011). Many facilities were shuttered following the implementation of the Clean Air Act Amendments as well as a new set of air quality performance rules by the US EPA in 1992. Meeting the new pollution limits exacerbated the expenses of building and operating WTE facilities, which in the years prior to the CAAA and the new performance rules had come under attack for the emission of acid gases, dioxins, and the concentration of heavy metals into bottom and

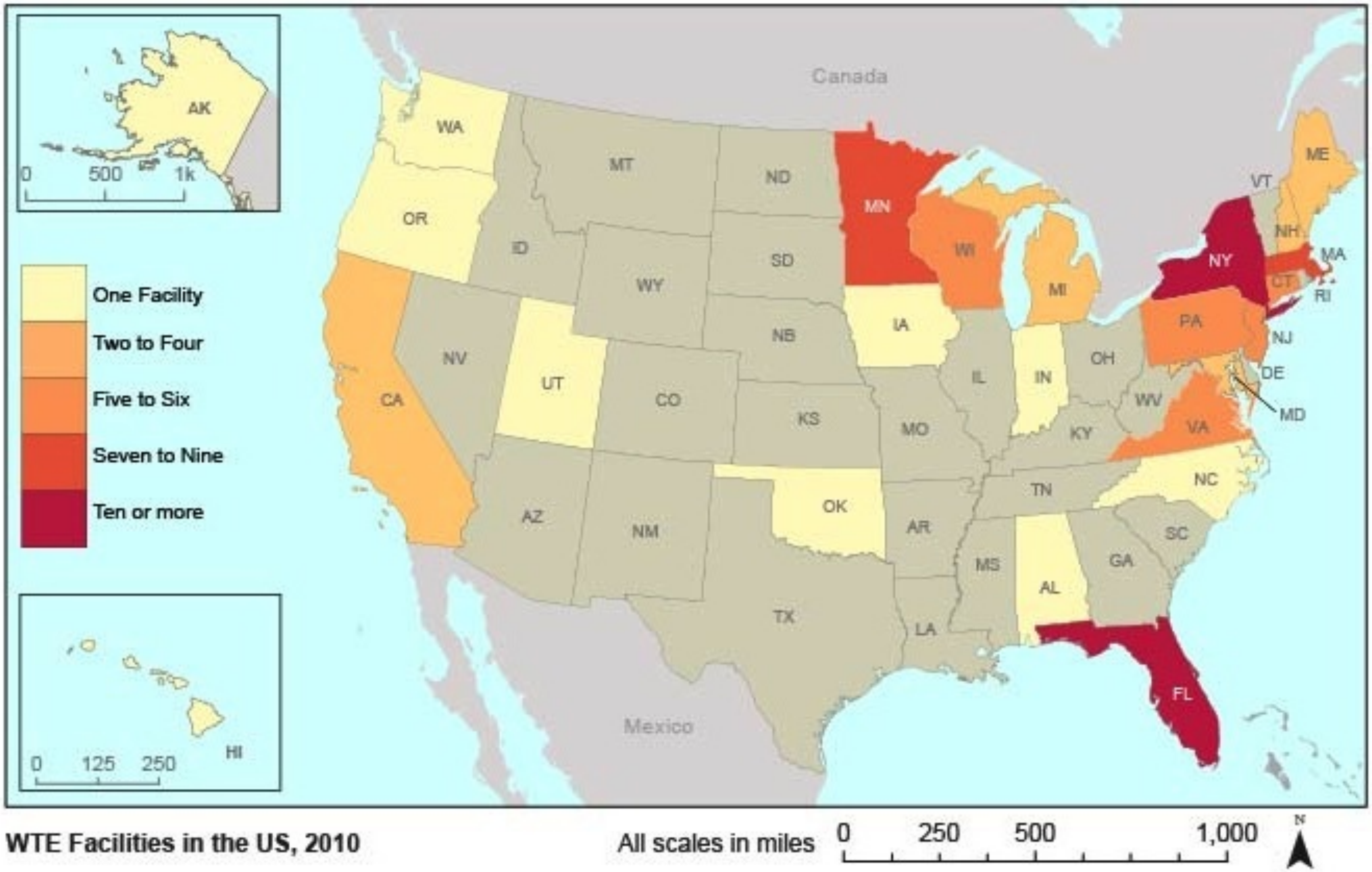

Figure 3.14: Operational WTE in the US, 2010. Data from Energy Recovery Council (2011).

fly ash (the remnants of the combustion process). These environmental concerns were translated into citizen activism groups which linked the siting of incinerators (and a range of other waste disposal facilities, including landfills) to low-income and/or minority communities. During the late 1980s, a number of WTE projects were resisted by citizen groups, backed in many instances by non-profit organizations and academic research, making claims of environmental racism. In at least two cases (New York City and south-central Los Angeles) plans for WTE were significantly delayed or even halted by these citizen organizations.

At any rate, such resistance to WTE was only symptomatic of changing public attitudes towards solid waste management, and especially disposal practices. Melosi (2000, 2001, 2005) argues that what the public was willing to accept in the 1960s and 1970s had changed drastically by the 1990s. The case for WTE was simply too complex: despite significant benefits (producing electricity, reducing the volume of solid waste by ~90%) and the potential to offset the costs of waste management via electricity sales and metals recovery, the apparent environmental risks of incineration (acid gas, dioxin, heavy metal pollution) alongside its higher initial costs (compared to landfilling) and apparent incompatibility with an emerging interest in source reduction and recycling made the technology a tough sell to most communities. As such, no new facilities have been built since the mid-1990s, though many have been considered including the location of next chapter's case study, Maui.

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Chapter Four

Not Yet, But Perhaps Someday? WTE on Maui

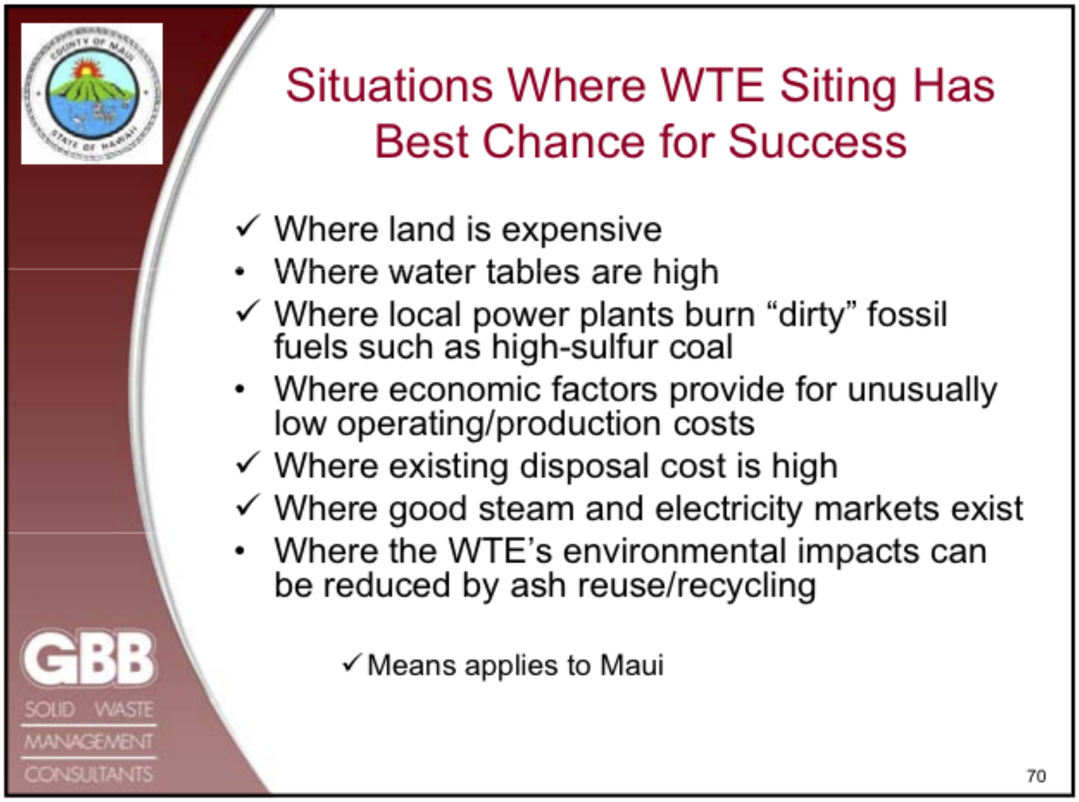

Figure 4.1: WTE is (mostly) perfect for Maui; so why aren't they using it? (Gershman Brickner and Bratton 2007)

On 20 September 2007, the Solid Waste Resources Advisory Committee (SWRAC) met near the County of Maui's main offices in Wailuku. The stated purpose of the Committee was to recommend a direction for the island's solid waste management program. Maui, one of the islands of the state of Hawaii, has always been faced with limited space for landfills; has, since the tourism boom of the 1960s, been faced with high land prices; and since electricity was brought to the island, been faced with the prospect of importing nearly 100% of the fuel necessary to generate power.

Aware of these limitations, the consulting firm working with the SWRAC on the county's solid waste plan – GBB – made the above argument for WTE (Figure 4.1).

Even prior to the consultants' presentation, Maui must have been suitable for both conventional incineration as well as energy conversion technologies like WTE. In Hawaii, county government is more or less the ultimate authority on solid waste (UH Environmental Health Dept. 1971), and indeed, County officials and private firms alike investigated the potential of energy conversion on the island several times in the past thirty years, twice issuing requests for proposals and one time even beginning negotiations with a finalist bidder. Yet, at the time of writing this dissertation, there is no WTE on Maui. Solid waste is currently sent to the Central Maui Landfill (CML), alongside recyclable and compostable materials even though the county and a range of private firms try to divert such materials. Given all of these circumstances, why has Maui not adopted WTE technology?

In this chapter, I address this question through an examination of the history of solid waste management in the County of Maui. Based on my analysis of county documents, and newspaper archives of *The Maui News*, *Honolulu Advertiser*, and *Honolulu Star-Bulletin* **I argue that the County never committed to WTE (or similar technologies) because landfill diversion tactics – though not necessarily 'solving' the problems of waste management – delayed a capacity crisis long enough to make WTE seem unnecessary**. Despite the introduction of landfill diversion programs to recover recyclable and compostable materials, all solid waste operations and planning are undertaken in the context of the landfill. How much landfill space is left? What will expansion cost – in dollar terms only? How long will diversion programs extend the life of the landfill? How can we increase compliance with diversion programs?

Much of this is the direct outcome of *private* diversion efforts. Private citizens, businesses, and non-profits have on several occasions taken collection and disposal into their own hands, leaving the County only to react later if there is some dissatisfaction with the results. For instance, the structure of waste collection on the island is such that there are neither penalties nor incentives for diverting green waste or recyclables. Accordingly, the effectiveness of recycling and composting efforts is lessened, reducing support, while the spatial crisis at the landfill deteriorates. A similar impact on WTE can be documented: the county has historically responded to outside proposals from project developers rather than actively pursuing the technology. Until recently, this strategy has left critical decisions about technology choice, facility design, and financing mechanisms to private interests rather than county leaders.

In this chapter I first provide an overview of solid waste management in Hawaii from the perspective of the state government, examining their organizational and planning documents as well as briefly discussing the development of solid waste management programs on the other islands of Hawaii. Next, I examine the history of solid waste management in Maui from the turn of the 20th c. through to the time of writing (autumn 2012). Finally, I summarize my findings and offer some concluding thoughts on the future of solid waste management on Maui and the prospects for WTE and other energy conversion technologies.

Solid Waste Management on the Hawaiian Islands

Hawaii is an archipelago, and in many ways its solid waste disposal issues are 'higher stakes' than places with more physical territory. This is true not only because there is less suitable land for disposal but also because the distance between population centers and landfills is smaller. In Michigan or Maine major regional landfills and the environmental problems they generate can be located far from urban centers and natural resource sites, but not in Hawaii. Hawaii also hosts a diverse topography and set of climatic conditions, particularly with respect to precipitation and hydrology, further limiting acceptable landfill sites amidst concerns about fresh water supplies and the presence of sensitive ecosystems (e.g., Belt, Collins & Assoc. Associates 1983, II-1).

Hawaii's human population distribution is also quite unique: approximately 70% of the state's population lives on just 9% of its land territory, on Oahu and specifically the city of Honolulu (US Census Bureau 2012). Other communities on Oahu and the 'Neighbor Islands', the counties of Kauai, Maui, and Hawaii, are more dispersed. Since World War II there have been a number of challenges matching economic activity to population densities and locations, not least of which has been the physical distance from mainland US and east Asian markets. These factors have made the task of prescribing solid waste management solutions quite difficult for policymakers, private consultants and companies, and the general public alike.

Two Problems: The Dump and Organization

Solid waste management in Hawaii both conforms and diverges from the historical experience on the mainland. For instance, refuse collection was seen as a critical government function in Hawaii well before it was viewed as such on the mainland. Chronicling its own history, the City of Honolulu's Department of Environmental Services explains that organized refuse collection on the islands started in the 1850s under the Hawaiian Monarchy and remained an important issue through the Territory period, at least in Honolulu (Young et al. 2005). The occupation of the Hawaiian Islands by the United States brought with it a range of political, economic, and identity issues, including new types of government and civil service obligations. As did many other states, Hawaii only looked to comprehensive solid waste planning after a push from the federal government and particularly the 1965 Solid Waste Disposal Act.

An appropriate starting point in Hawaii's experience is the 1971 publication of the state's first comprehensive plan for solid waste management (UH Environmental Health Dept. 1969, 1971). The concerns introduced by the governor of Hawaii, John A. Burns, and the state's director of the Department of Health, Dr. Walter B. Quisenberry, centered on economics, environmental degradation, and public health. Officials anticipated an increase in MSW volume that would quickly surpass available disposal options and bust county budgets. The 1971 plan estimated that:

> 454,000 tons of solid wastes were collected and disposed of by the Counties in 1968 at a cost of approximately $5m per year. It is estimated that in 1978 the amount will be 977,130 tons and in 1988 1,826,670 tons, If the same collection and disposal methods are used in 1988, the cost will be approximately $20m per year. (ibid., 6)

Environmental and health issues were directly linked to the Islands' ubiquitous self-service dumps. While open dumps were deemed unacceptable to the emerging class of sanitation engineers and public health officials on the mainland as early as the turn of the 20th century (Melosi 2000, 2005), in Hawaii they were more ambiguous, and remained prominent through the 1970s. Hawaiian dumps were frequently land reclamation projects, transforming ravines, wetlands, and other 'marginal' lands into 'useful' space. For instance, Honolulu used untreated waste and ash recovered from open burning on private lands and city dumps to fill 'marginal' lands in Oahu, including showcase areas like Waikiki. While mainland cities tried reclamation, including San Francisco, New York (Melosi 2005) and Chicago (Colten 1994), land-filling operations in early 20th century Hawaii represented significant public-private partnerships between landowners and the City, with owners offering land to the city in exchange for having the marginal portions filled in (Young et al. 2005). Most dumps made efforts to limit disease and nuisance odors through weekly burning. The 1971 plan showed that 52 of the 54 open dumps engaged in burning, primarily for volume reduction and to destroy putrescible materials, but also in some instances to use the ash as a soil amendment (UH Environmental Health Dept. 1971, 46).

In spite of prevalence and general public acceptance, open dumps were problematic from both solid waste management and environmental health perspectives. The 1971 plan states that "open dumps and open dump burning are no longer acceptable methods of solid waste disposal," (Director of Health's Statement, UH Environmental Health Dept. 1971), and argues that while low-cost, dumping produces public health dangers like odors, disease vector attraction, unsightliness, and the pollution of groundwater supplies which outweigh its reclamation benefits.

Sections of the public received the state's conclusions with skepticism. The League of Women Voters of Hawaii questioned the taxpayer costs (though partially shouldered by the US EPA) of the plan, especially after a two-year delay in its public release (League of Women Voters of Hawaii 1972, 1). Organizations like the League also doubted the State's ability to plan for solid waste issues given its lack of experience, and feeling that "the DOH [is] too lumbering a bureaucracy to ever move in imaginative new directions." (ibid., 3, 12) Recent experience was uninspiring: the US EPA had actually withheld funding from the State Office of Environmental Quality in the early 1970s pending progress on dump closures and the newly-formed Sanitation Branch in the State Dept. of Health had exactly zero employees (ibid.).

Furthermore since statehood Hawaii had benefited from huge sums of federal money, and despite benefits, organizations like the League feared the state's dependence on aid and the imposition of external controls that came with it. The

League suggested that the State and Counties of Hawaii proceed cautiously in accepting grants from the US EPA and other agencies, since "when there is a possibility of obtaining federal construction grants, localities delay action in the hope of not having to spend their own money for a project." (ibid., 12)

The League was essentially correct in their prediction that the number and type of disposal facilities would change very little during the 1970s, despite public reports covering topics from financing (HI Office of Environmental Quality Control 1971; White Weld & Co. 1977), recycling (Hopper 1972), hazardous wastes (HI Dept. of Health 1981), and energy conversion (SWERTF 1976). But by the mid-1970s there was progress on conversion of dumps to basic sanitary landfills and transfer stations.[1] The 1971 Plan made recommendations for immediate funding to 16 'hard-pressed' communities for conversion of dumps into sanitary landfills or transfer stations, including communities in each county and areas of Honolulu itself (UH Environmental Health Dept. 1971, 58-59). By the end of 1974 the County of Hawaii was set to close all ten of its open dumps; Maui County had closed five dumps; and Oahu had banned open burning in 1970 while pursuing new sanitary landfill and incinerator sites (League of Women Voters of Hawaii 1972, 7).

The question of alternatives to the dump loomed large. State officials voiced concerns about the long-term effectiveness of alternatives:

> None of the present processing and disposal methods...will serve the needs and desires of the people of the State in the decades after 1988, because of the quantities of waste to be handled, population densities, extent of urbanized areas and the need to prevent environmental pollution and to preserve natural resources. New technologies must be developed to meet the needs of the people of the State beyond 1988. In the interim,

1 A transfer station is a facility that functions as a depot where solid waste is collected into larger containers and stored until it is hauled by heavy trucks to a centralized facility, either sanitary landfill, incinerator, or materials recovery facility.

> until a new technology is developed, it is necessary to use the best features of existing methods with the improvements expected from the results of current and planned research and studies. (UH Environmental Health Dept. 1971, 6)

The implementation of alternatives also posed serious challenges. Though the closure of dumps was identified as a common state-wide goal, the 1971 plan recognized the delicate nature of comprehensive planning for an archipelago of distinctive topographies, economies, and populations. Thus, the other major goal of the 1971 plan was to establish an effective organizational structure for waste management on the islands starting with a State Waste Advisory Commission and the mandate that each County produce its own comprehensive solid waste management plan. The County of Hawaii and the City and County of Honolulu were the first to do so (Sunn Low Tom & Hara 1970; and Metcalf & Eddy 1971, respectively). The Counties of Kauai and Maui's plans did not appear until the update to the State plan in 1981 (State Dept. of Health et al. 1981). The City and County of Honolulu's plan has been the most regularly updated owing to its large population and rapidly mounting volumes of waste, while the Neighbor Islands' plans have been updated more sporadically, frequently at the behest of the Governor's office or legislature. Until the 2000 edition, the State plan for solid waste management was produced by either University of Hawaii or the State Dept. of Health while the county-level plans were always produced by engineering consulting firms, frequently based on the mainland.

Each 'tier' of planning has aimed at different targets: State-level plans set broad goals for all of the Islands, like closing dumps, increasing recycling and landfill diversion[2] rates, and reducing greenhouse gas emissions, while County plans typically address specific project sites and proposals along with financing mechanisms and compliance with state and federal laws. By the mid-1970s, the State and counties of Hawaii came to the conclusion that solid waste was an issue best dealt with at the county level, with technical and financial assistance from the State (e.g., SWERT 1976). Though in line with the trend on the mainland, such a structure also helped to shift most of the policymaking attention to Honolulu.

Interestingly, the plans at all levels in Hawaii did not directly address significant amounts of solid waste, and in particular agricultural, industrial, and military waste.[3] The 1971 plan argued that "The collection of waste from hotels and resort areas and from commercial and industrial establishments and building and demolition operations is generally considered to be the responsibility of the owners of the businesses." (UH Environmental Health Dept. 1971, 40). In reality, even though private haulers would collect refuse from commercial and industrial operations (including most tourist accommodations), they still disposed of it at public facilities, making the issue one well within the purview of State and County governments (Agena 1970; Mitter 1971; League of Women Voters of Hawaii 1972; Plasch 1972). In light of rapidly increasing resident and tourist populations through the second half of the 20th c., the amount of

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2 Landfill diversion refers to the amount of 'non-waste' material that does not go to the landfill. For example, in 100 tons of solid waste, if 30 tons are recovered as recyclable material and prevented from entering the landfill, then the diversion rate is 30%.

3 Military waste was, technically speaking, outside the remit of State and County governments, as both the facilities and the wastes they produced were federal property. A number of sources indicated that the military operated the premier solid waste management programs and facilities in the Hawaiian Islands (e.g., UH Dept. of Environmental Health 1971; League of Women Voters of Hawaii 1972).

commercial solid waste not ‘planned’ for was significant, encompassing several million tons per year across the state.

Agricultural wastes represented a more ambiguous challenge: although some 10m tons of waste material were generated each year by the sugar and pineapple industries alone, much of it was organic material and processed on-site either as soil amendments or burned as a power source for agricultural operations like irrigation pumps and canneries (UH Environmental Health Dept. 1971). In spite of such solid waste autarky, plantations would loom large in a number of solid waste projects across Hawaii during the 20th c.

Alternatives to the Dump

But what to do with the waste if not send it to a dump? In the period 1970-1980, actors in Hawaii’s solid waste management sphere considered a range of disposal technologies, resulting in many of the same types of fragmentation that were discussed in Chapter Three. From the earliest days of US EPA-funded conferences and demonstration projects, Hawaiian officials looked to the mainland for inspiration. For instance Richard Hopper, a special projects representative from the Governor of Hawaii’s office attended a symposium on Solid Waste Demonstration projects held in Cincinnati in 1971 (US EPA 1971). Four years later Robert Freitas, representing the Hawaiian Electric Company, attended a joint meeting of the US EPA and the Edison Electric Institute on solid waste co-firing (US EPA 1975). The links between US EPA-funded demonstrations and solid waste planning in Hawaii are quite clear, and especially the RDF co-firing project in St. Louis, MO and the pyrolysis gasification project in Baltimore, MD, both discussed in Chapter Three. The successes and failures of these projects directly shaped beliefs about the viability of various solid waste disposal technologies in Hawaii, both on Oahu and the Neighbor Islands alike.

To be sure, officials also investigated technologies with applications more or less unique to the Hawaii including sea dumping, sinking waste in deep ocean canyons, high-pressure baling (to use for land reclamation) and barging waste between islands and to the US mainland. Young et al. report that the Territory of Hawaii, State of Hawaii, and the City and County of Honolulu all experimented with dumping at sea, barging waste to currents at various distances from shore (Young et al. 2005). Sea dumping remained a viable disposal method until a federal ban in the 1970s, though investigations continued after the ban (cf. TerEco Corp. 1978). Other plans proposed compressing and sealing bales of inorganic waste for fill in lagoons around Oahu, perpetuating one of the legacies of the open dump (Ralph Parsons Company 1970; Bogost 1973, 1975).

More conventionally, the 1971 state plan spurred interest in recycling, composting, and energy conversion technologies like WTE and pyrolysis. The 1971 plan cited public interest in recycling and composting because of the potential to recover valuable materials, but concluded that too little was known about the economics of either process for Counties to pursue such systems (UH Environmental Health Dept. 1971, 48). Furthermore, since neither recycling nor composting significantly reduced the volume of solid waste, a 'nightmare' scenario was imagined where collected materials remained in warehouses or windrows indefinitely, only to be landfilled after some period of time and exacerbating the spatial problems of solid waste management. But public support for recycling and composting remained strong, as did belief in their economic viability. As a result in 1971 the state legislature mandated state-wide feasibility studies for recycling, finding that

> …businesses seemed oblivious to many of the potentials and technologies for recycling; and until such time as business created the markets for recycled goods, it made very little sense for government to expend large sums of money for waste segregation and pre-processing. Accordingly, the Office of Environmental Quality Control determined that the initial task of government to establish solid waste recycling in the State had to be a program…to develop new markets for recycled goods. (Hopper 1972, 1)

Disagreement over the economics and logistical practicalities of recycling and composting illustrates the two solid waste management 'camps' emerging in Hawaii during the 1970s. One believed that recycling and composting represented the pinnacle of solid waste management, since composting could offer practical improvements to Hawaii's frequently marginal soils, improve agricultural output, and decrease the amount of food imported each year while recycling could reduce costs for various manufacturing processes. The other camp believed that comprehensive recycling and composting were minimally suited to the Islands given Hawaii's already limited industrial activities, agricultural markets, and distance from mainland or Asian materials consumers.

Representatives from both camps were vocal and disagreements constant. A manager of the City and County of Honolulu's Division of Refuse Collection and Disposal claimed that "Recycling is impossible for the County to engage in" – at a conference aimed at promoting recycling in Oahu (Veary 1972, 21). Conversely an author at the Hawaii Center for Science Policy and Technology Assessment claimed that recycling was "inexpensive; [with] no special equipment needed" as it simply "re-uses solid wastes as raw materials." (Plasch 1972, 3). One self-described 'conservation activist' accused the authors of both the State and Honolulu solid waste plans of misleading the public and policymakers alike on the true costs of recycling and composting versus incineration and landfilling:

> …the summary of total annual costs of various processing methods [of the Honolulu plan] composting is given as ranging from $5 to $14 per ton. Whereas for incineration the range is given as $8 to $12 per ton [sic]. In the comparative analysis the final decision seems to have been influenced by the fact that incineration is not required to show a profitable market for its pollution products…For every thousand dollars they will spend for incinerators they will spend 87 cents on a composting plant.
>
> Thanks a bunch fellas [sic] but Conservation Council is not satisfied. It seems that our 'conservation activists' will have to be a public nuisance for a while longer. (Matthews 1972, 16)

One of the contributing authors to the 1971 state plan disagreed, claiming that composting was of dubious value given that "every true compost plant in the United States has failed economically, without exception" because "economic and customer acceptance are against the product, good as it is claimed to be." (Burbank 1972, 35) Resistance to the economic logic of the state and county officials remained stiff. One UH faculty from the Water Resources Research Center argued that

> In the Islands there is a great need for organic matter. On the Mainland it has failed as a business, and as a result Hawaii has been afraid to try composting. The failures on the Mainland, due to application and marketing problems, do not exist in Hawaii and should not be taken into account. (McGaughey 1972)

An early study of recycling likewise challenged those claiming that composting was frivolous. Based on calculations of the quantity and type of soil amendments[4] imported to Hawaii each year, Hopper estimated that composting could save Hawaiian farmers, gardeners, and turf grass operations the expenses of importing nearly 3,200 tons of soil treatment each year, or about $600,000 (Hopper 1972, 72-73).

Though there was disagreement about its environmental, economic, and aesthetic impacts, all parties agreed that one technology had proven effective in slowing

4 Specifically 'milorganite', a soil amendment derived from sewage sludge.

the impending spatial crisis of landfilling – incineration. Burbank, who earlier had spoken out against all composting and recycling save the recovery of scrap metal, noted

> Incineration is a proven process; it requires one-tenth of the land volume of a sanitary landfill, it exceeds the life of a landfill by that amount. When large quantities of waste must be handled, the proposed state plan suggests the use of properly designed, esthetically [sic] acceptable incinerators, which can reduce refuse to ash without air pollution or nuisance. (Burbank 1972, 34)

Practically speaking Hawaii has a long experience with burning waste. Nearly all of the open dumps catalogued in the 1971 plan engaged in burning, and 'backyard burning', especially in rural areas, was quite common. Agricultural operations, particularly on sugar and pineapple plantations, had long used combustion to dispose of organic materials either directly in fields or at centralized plantation facilities. Frequently bagasse, fronds, and other materials were burned to generate power for facility operations.

Beyond these small-scale and private operations, incineration had been taken seriously in Honolulu since at least 1905 (Young et al. 2005). Additional facilities were being considered during the interwar period (Hawai'i Bureau of Governmental Research 1929). Two incinerators came online in the 1940s on Oahu at Kewalo and Kapalama, and one more entered service in 1970 at Waipahu (Young and Services 2005). The US Military, among its other disposal sites, operated its own incinerator at Tripler Hospital on Oahu (League of Women Voters of Hawaii 1972, 5).

However these 'traditional' incinerators were falling out of favor by 1970 due to frequent equipment downtime, unsightliness and emissions concerns, and rapidly rising costs associated with air pollution equipment retrofits. As Honolulu and its suburbs expanded, the incinerators were also increasingly near residential areas. By the early 1980s incinerators for volume reduction were deemed as unacceptable as open dumps a decade earlier. The Hawaii Department of Planning and Economic Development argued that:

> [Incineration for volume reduction] has become increasingly expensive, to the point of being uneconomical, because of large staffing requirements for operations, equipment that requires extensive maintenance, and the high electrical costs to operate air pollution equipment. It is also considered wasteful as it does not recover either the heat energy produced or other valuable products which can be recycled and sold. (HI Dept. of Planning and Development 1983, 6)

Although new types of energy conversion equipment, like WTE, presented many of the same burdens as incineration in terms of equipment and staffing costs, these new technologies could offset their costs through the sale of steam, electricity, and recovered materials. These benefits in conjunction with increasingly limited space for new landfills (especially on Oahu) spurred the intensive study of energy conversion technologies in Hawaii. After the 1971 plan Governor Ariyoshi appointed the Solid Waste Energy and Resource Task Force (SWERT), which in 1976 released its first report and recommendations to the legislature based on the goal that Hawaii be a "waste-free society" by the year 2000 (SWERT 1976, I-2).

The SWERT sought to build consensus on energy conversion, and was comprised of government officials and representatives from the plantations and utility companies, environmental 'activists' and stakeholders in the solid waste industry. According to SWERT director, John Hylin, the task force represented "as accurately as possible the current attitudes of the population of the state of Hawaii on the subject of solid waste energy and resource recovery." (ibid., ii) The report identified pyrolysis, WTE, and RDF / bagasse co-firing as the most likely and economical forms of energy recovery in Hawaii, though "the final choice of WHAT TO BUY can be left open until receipt of proposals in response to RFPs." (emphasis original, ibid., I-10). SWERT suggested that conversion go hand-in-hand with other types of resource recovery like recycling, although it warned that "there is no gold in garbage" (ibid., II-25) and took a strong stance against composting, arguing that the process is "not feasible on a large scale," especially in light of the fact that "over 20 composting plants have been constructed and subsequently closed down during the last 10 years." (ibid., II-27)

The SWERT focused its efforts on Oahu, recommending that that the City and County of Honolulu "proceed as quickly as possible to implement processes to recover energy from solid waste, including trash collection from residences and wastes from agriculture, industry, and commerce." (ibid., II-5,II-6) However the task force did analyze energy recovery options for the Neighbor Islands as well, suggesting that they "continue and expand the use of solid waste as a supplement to bagasse for power generation in existing privately-owned plantation boilers" (ibid., II-6) tracing almost exactly the designs of EPA-funded demonstration boilers in St. Louis co-firing RDF with coal.

SWERT recommendations were taken seriously on Oahu, and after a 1977 engineering study found that Honolulu was an ideal candidate for a range of resource recovery systems (Lewis and The MITRE Corp. 1977) energy conversion gained momentum. Changes to Hawaiian law in the late 1970s made a push for the technology even stronger. The 1978 Hawaii State Plan was updated with language obliging state agencies to pursue conservation and renewable energy goals, specifically mentioning conversion projects, solid waste source reduction, and recycling programs (HI Dept. of Planning and Economic Development 1983, 9). That same year, the Honolulu Program Of Waste Energy Recovery (HPower) was initiated and the city issued a request for proposals, finally selecting an RDF WTE design. After more than a decade of delays, negotiations, and crises – mostly political and financial – Hawaii's first (and as of writing, only) dedicated solid waste-to-energy facility came online in May 1990. As of 2012, HPower is nearing completion of a third boiler, meaning that the facility will process nearly 60% of Oahu's solid waste and meet approximately 6% of the islands annual electricity needs in the coming years ('Mayor Breaks Ground...' 2009).

The HPower saga is lengthy, convoluted, and fascinating, illustrative of many of the controversies and debates in technology adoption that lie at the heart of the best work in both environmental history as well as science and technology studies. It is also rife with political grandstanding and tainted by scandals.[5] Significant research was planned to link the impacts of HPower to attitudes towards WTE on Maui, but after initial work with archival materials in Maui it was apparent that this connection was somewhat specious as the circumstances in each place were too dissimilar to generate any sort of correlations.

While Honolulu's experiments with energy conversion received the most attention, each Neighbor Island also explored energy recovery technologies as a solution to growing volumes of refuse and the problems with landfilling, especially transportation and the provision of daily cover material like dirt. The County of Hawaii conducted the first feasibility study on energy recovery in the state. A technical memo in the appendices of the 1976 SWERT report notes that by late 1975 the County had already contracted a consulting firm to investigate co-firing solid waste with bagasse (URS Research Company in SWERT 1976, A-79). While initially finding that such an operation was not cost effective (W.A. Hirai & Associates and CH2M Hill 1977), as the

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5 However I will not cover the HPower saga in detail in this dissertation, given its focus on Maui and that County's more tenuous relationship with waste-to-energy technologies. A full-length research article detailing HPower from its inception in the 1970s to its recent expansion in 2011 is planned immediately following completion of this dissertation, based on material gathered during field research in Maui.

sugar cane industry continued to decline in the late 1970s and early 1980s, many mill sites on the island of Hawaii were left unused and the county once again hired a consulting firm to study the feasibility of co-firing waste with bagasse (HI Dept. of Planning and Economic Development 1983, 15). However, in spite of this and several recent studies, officials have instead focused on creating fewer and more centralized landfills, though planners and county officials have publicly resumed their interest in some sort of energy conversion plant (cf. Callis 2012).

The County of Kauai, though the least populous of the counties, is also host to both deeply eroded landscapes and prime agricultural land, making landfill expansion and siting particularly problematic. In the early 1980s after the HPower project was well underway, the County contracted with consulting engineering firms for a number of feasibility studies on resource recovery (HI Dept. of Planning and Economic Development 1983, 20). As in the County of Hawaii, no infrastructure resulted from the studies, although the County does continue to maintain references to 'waste-to-energy' in its integrated solid waste management plans (R.W. Beck 2009). Since the most recent plan in 2009, however, a vocal minority has emerged on Kauai advocating for 'zero waste', and been influential to the point of seeing the County Council adopt a resolution to pursue 'zero waste' planning, which in their language excludes the possibility of energy recovery infrastructure on the island (County of Kauai 2011; Zero Waste Kauai n.d.).

The County of Maui fits somewhere in between the solid waste experiences of the other Neighbor Islands, and has experimented with a range of solid waste disposal schemes to meet burgeoning residential, tourist, and agricultural demands since 1900.

Solid Waste Management in Maui County

From Dumps to Diversion

Early issues of *The Maui News* demonstrate a community concern with solid waste disposal. In contrast to the Honolulu refuse workers' history of solid waste management on Oahu, which argued that various governments had taken seriously the responsibility for securing suitable disposal sites, on Maui disposal in the early 20th c. posed a number of problems:

> Wailuku [the county seat] has absolutely no place to dump its refuse trash and garbage. Formerly it was hauled out and dumped in the sand-hills but they are now fenced…The attention of the Board of Health is urgently invited to this condition, which should not exist one day longer. If nothing can be done, let the government begin condemnation proceedings or take other effective steps to secure a dumping spot for the garbage of Wailuku district. ('A garbage dump needed' 1902)

After securing a site for 'Wailuku Dump' in 1902, the collection of solid waste became an issue as households refused to take their trash to the dump:

> Every householder in Wailuku should be required and, if necessary, compelled to keep his premises swept clean. And there should be a paid inspector to see that this is done. There should also be means provided to haul off to some suitable place this accumulation of rubbish…This is all that it should be necessary to say on this point – but we may have to revert to it again. ('Editorial' 1903)

After this editorial, government's provision of waste services was adequate through the middle of the 20th century. The 1971 state plan catalogues 11 dumps in Maui County, including the islands of Lanai and Molokai. These, along with the uninhabited island of Kahoolawe, are part of the County.[6]

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6 It is worth noting at this point that my study focuses almost exclusively on the island of Maui, given the low populations and extensive private landownership of both Lanai and Molokai, though solid waste management did pose a number of problems in those places as well. The archipelagic nature of the county itself certainly impacted the solid waste planning process in terms of costs and the allocation of both equipment and employees.

Maui's dumps posed many of the problems identified by state planners and health officials in the 1971 state plan, including rodents and various insect-borne disease vectors. In spite of county officials' efforts to construct new and larger sanitary landfill facilities near Puunene (also the site of a major sugar processing operation), *The Maui News* reported that "Mauians are still hauling trash and depositing it there [at Wailuku Dump]…and the dump itself is inching farther and farther into the roadway. As a matter of fact it is creeping slowly but steadily up the hill towards Memorial Hospital." ('A growing threat' 1969) The episode is suggestive of the county's fundamental challenge with solid waste management: a fragmented system for collection and disposal leading to ad hoc arrangements that appear to be working properly but do not truly address key issues. At Wailuku, the county said its role in operating the dump had ended, and halted weekly burns and leveling out of the trash with heavy equipment. But for residents, still able to access the site, the dump was considered suitable. Here, and not for the last time, the county abdicated a measure of its authority, allowing solid waste disposal to become a private concern only to be dissatisfied with the result.

But officials' attention had turned to other disposal problems. Rapid property development for residents but especially tourists was ushered in by former mayor Elmer Cravalho after the founding of the Ka'anapali Beach Resort in the 1960s and continued under nearly 15 years of the Hannibal Tavares administration. Expanded property development pressured not only the wastewater and fresh water systems[7] but

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7 In 1972 a University of Hawaii scientist highlighted major flaws in Maui's proposed wastewater treatment site to serve the population center of Wailuku-Kahului ('In sewage plant...' 1972). County plans claimed injection wells would discharge sewage effluent several miles out to sea. In response Cox, the UH scientist, argued that the

also the solid waste infrastructure both in terms of the volumes needing to be disposed but also the collection system. As the 1971 state plan had suggested, the collection of 'commercial' waste from resorts, condominiums, and private housing developments was not considered the responsibility of the County of Maui, spurring the development of a number of private collection firms also disposing at county facilities. By the mid-1980s, the groundwork was set for the hybrid public-private system that would come to define solid waste management on Maui.

This appears to have limited the scope of county waste planning prior to 1989. Work before that point was far from comprehensive, focusing instead on individual problems and projects like the closure of a dump or plans for a transfer station. Furthermore, these plans were not entirely focused on solid waste. Although later administrations and county officials would suggest that the development of HPower in Honolulu had little bearing on solid waste planning and infrastructure on Maui, this was not so during the 1980s. A 1981 *Honolulu Advertiser* article details Mayor Hannibal Tavares' interest in and pursuit of a waste-to-energy system for Maui, modeled technologically and conceptually on HPower (Tanji 1981). According to the article, "Tavares was clearly in favor of some kind of project that would generate power while putting an end to the use of landfills for trash disposal." (ibid.) Designed to utilize either RDF or mass burn processes, Tavares' WTE system would be located on the grounds of Hawaiian Commercial & Sugar (HC&S) processing mills at Paia or Puunene, near the location of the main county facility. Tavares, advised by Honolulu's refuse

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County had an "inadequate understanding of the hydrogeology of the area" and apparently little familiarity "with the actual situation on Maui." (ibid.) According to Cox, sewage injected into wells – located near a sensitive wetlands area to begin with – would probably "emerge in the ocean at depths certainly not much greater than 100 feet and hence at no great distance from shore." Furthermore, Cox revealed that the proposed plant was located just 15 feet above sea level, making it susceptible to tsunami damage.

management chief, Frank Doyle, envisioned an RDF/bagasse co-firing operation with the sugar mills, but interest in such a system was quelled when HC&S representatives advised Tavares and the council that their boilers could not handle co-firing with solid waste.

Tavares' plan shared more than technical details with HPower. Public comments from HPower's 1983 revised environmental impact statement suggest the preliminary design of HPower had a bagasse co-firing component, prompting the proposed location on the grounds of an Oahu Sugar mill in Waipahu (Belt, Collins and Assoc. 1983). Honolulu newspapers also revealed that a major reason for the selection – and the decision of AMFAC, the mill's owner and one of Hawaii's 'big five' companies to submit a joint bid to design, build, and own the WTE plant – was to support the struggling firm with cheaper electric power and tax incentives (e.g., Matsunaga 1981, 1982). A privately-owned HPower facility meant that while the firm would be responsible for the costs of construction and operation, the company would receive revenue from tipping fees charged to the City and County of Honolulu and private haulers to dump solid waste at the site. These fees would continue indefinitely and most likely increase as Oahu's population and volumes of solid waste grew. Furthermore, passage of the federal PURPA legislation in 1978 mandating utility companies purchase electricity from sources like WTE at an 'avoided cost' rate meant an equally attractive revenue stream from power sales, since the main fuel for electricity generation in Hawaii is liquid fossil fuel like oil or diesel. Given the expense of these fuels in Hawaii, not least because of the recent 'oil shocks', the avoided cost for electric power on Oahu was quite high. Rising tipping fees and the tax benefits of plant construction and ownership made WTE attractive to Hawaiian conglomerates with the leverage to finance large projects.

As Maui's sugar industry faced economic difficulties in the 1970s and 1980s there is reason to believe that an energy recovery facility sited, financed, and operated by HC&S was as much about that company's solvency as it was alleviating solid waste problems. In 1982 the county issued a request for proposals (RFP) for the construction, maintenance, and operation of a mass burn facility processing 200 tons of MSW per day (HI Dept. of Planning and Economic Development 1983). The RFP received 15 responses, four of which advanced to bids. In early 1983 the county entered negotiations with two firms behind a joint bid, International Incinerator, Inc. and CH2M Hill, for a facility sited near the Maui Electric Company Maalea diesel plant or the HC&S mill at Puunene. The plant would meet nearly all of Maui's electricity needs, rated at 3-3.5 MW. However, the negotiations apparently stalled on a number of key issues including financing, operations, and management details as well as the county's obligation to provide solid waste to the facility.

It is not clear why this attempt to install WTE on Maui was abandoned, but it was not because the island's solid waste problems were resolved. Documents regarding the end of the negotiations and eventual cancellation of the project could not be located, however 20 years later an article in *The Maui News* simply stated that Tavares' found the final plan too costly to proceed (Loomis 2005).

At any rate, by 1983 the island was producing nearly 160 tons of MSW per day while the number of disposal sites fell to four (HI Dept. of Planning and Economic Development 1983). In 1988 the Tavares administration closed two more disposal sites, one in west Maui near Lahaina and the other serving the expansive 'Upcountry' area on the slopes of Haleakala volcano. The closures prompted public dumping along roadsides and cane fields and precipitated an increase in commercial hauling prices (Miller 1988a). As a counterweight, the county began service at the Central Maui

Landfill located between Kahului and Puunene, with the intent that this site become the principal disposal site for the island. However reports indicated that shortly after commencing operations the landfill was approaching capacity faster than anticipated, amidst fears that tipping fees at the facility would double to $36 per ton in just five years (Miller 1988a; Gershman Brickner and Bratton 1989; Tanji 1989). But two waste management techniques, previously dismissed by a range of officials, re-emerged to address the spectre of a stuffed Central Maui Landfill, skyrocketing tipping fees, and perhaps even a flood of sewage material[8]: recycling and composting.

With Wailuku Dump, the county's abdication of responsibility for solid waste spurred private action. Likewise, the Tavares' administration's closure of disposal sites in west Maui and Upcountry prompted private citizens and industry alike to tackle rising hauling rates themselves. In 1989 the managers of a west Maui residential area, Ken Hess and Chris Davidson, started collecting and storing recyclables separately from residents' garbage. The logic was simple:

> There are 26 dumpsters available for the 175 families in the planned development. Hess said they are now paying about $1,800 a month to have the dumpsters emptied twice a week. If the recycling program can reduce the need for trash collection, he said, the demand for the commercial dumpsters should be reduced as well. (Tanji 1989)

For these private firms it mattered little that markets did not yet exist on Maui, or anywhere else in Hawaii, for materials like glass and office paper. The markets that did exist for metals and newsprint were prone to boom and bust cycles. Rather, what

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8 Despite a looming crisis, once again the county's attention was drawn to sewage problems. The county had issued building permits to large developers without securing access to the island's sewer mains and wastewater plants, a strategy which had worked to some degree in the past because developers were obligated to build their own treatment facilities. However by the late 1980s the State Department of Health ordered that this practice be discontinued, throwing a major construction boom, especially in the once rural and drought-prone areas of Kihei, 'south Maui', and Wailea, into question (Miller 1988b).

mattered was that tipping fees (or their equivalent, like paying a hauling firm to empty residential dumpsters) were suddenly slashed. These materials, stored on or near site, would not decompose or attract pests. Hess and Davidson made use of an abandoned pumping station near their housing development to store the materials they collected (ibid.). For similar reasons, the pair also began collecting 'green' waste (like lawn trimmings) aiming to convert it to compost and use it within the housing development. Soon restaurants, resorts, and other housing communities joined in, citing up-front savings as the main reason for participating in recycling efforts (Tanji 1990).

Since the 1970s Maui was unique among the Hawaiian Islands for public and private efforts in recycling discarded automobiles (SWERT 1976, A-82) and firms involved in that activity, like Maui Scrap Metal, were soon part of the collection and storage of other recyclables. The incentive for these firms to collect recyclables is not clear. Company president Roger Apana said in 1990 that "Right now it's more of a community service, but we're hoping that it will be better…The return isn't there. But at some point it will be viable." (Tanji 1990) Apana's company absorbed many of the costs of collecting recyclable material, working through local charities, rehabilitation organizations, and community centers, stockpiling materials with uncertain or nonexistent markets on an eight-acre site in central Maui.

Early participants in recycling argued that the county should be leading efforts to collect recyclables since it was their landfill approaching capacity and pushing tip fees ever higher. Hotel executive David Scanlan noted in an interview alongside Roger Apana that

> Recycling reduces the amount of trash that must be buried in Maui County's landfill, which is rapidly approaching capacity. Maui County itself has yet to participate actively in recycling programs, although there have

> been discussions about the need to recycle to cut down on the loads going into the landfill. (ibid.)

Henry Tomizawa's platform for Maui County Council in 1990 included a plank on expanded county recycling programs, which he considered past due since all of Hawaii's other counties already invested in recycling (Fujimoto 1990). Again, officials hesitated: according to public works engineer Brian Hashiro, "We can collect it. But what do we do with it when we have it all? The cost of transporting recycled materials to markets is quite high." (Tanji 1989)

Despite county hesitation, the logic of recycling as a landfill diversion tool quickly found support, although questions about materials markets lingered. Growing volumes of waste, outcry over tipping fees, and a consultant's report recommending a recycling program for the County all coalesced in the early 1990s to prompt action (Gershman Brickner and Bratton 1989). Under Linda Lingle's[9] mayoral administration, the County implemented a full time recycling coordinator position and offered grants to business and non-profits shaping Maui's recycling system.[10]

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9 Formerly a County Council member during the Tavares administration and later governor of Hawaii. At the time of writing Linda Lingle was seeking to represent Hawaii in the US Senate. Lingle represents a number of 'firsts' in Hawaii politics, including first female governor, first Jewish governor, first County mayor to be elected governor, and first Republican governor of Hawaii since 1962.

10 The grants spurred innovations in surprising places, like road and concrete construction (through the addition of pulverized glass, cf. Tanji 1992) and synthetic lumber (Tanji 1993a).

Diversion: Stall Tactic or Solution?

Lingle embraced mandates on 'bio-solids'[11] to address two pressing environmental problems with a single project: solid waste disposal and sewage capacity. In 1992 the mayor proposed construction of a co-composting facility producing compost from a mixture of green waste and sewage bio-solids, both historically landfilled. The project could relieve pressure on two critical services, but met strong and persistent opposition. Like recycling, the county's initial reluctance to support composting had led to the development of private efforts, whose owners did not like the prospect of government competition. Ralph Natale and Ken Hess – the same Hess who initiated private residential recycling efforts on Maui – argued that Lingle's facility had unknown environmental and human health impacts unlike 'traditional' green waste composting "which has already proven to be a success on Maui" through Hess' own organization, Campaign Recycle Maui (San Nicolas 1992). Others worried that the compost produced would not meet farmers' requirements and could not be considered 'organic', whereas traditional compost could be used with little controversy (Eagar 1992).

The project proceeded despite admission from County Councilmembers that the market potential for compost was unknown (ibid.). In 1993 the county signed a $450k contract with the newly-formed Maui Composting Company for processing services at the Central Maui Landfill. Although Campaign Recycle Maui protested and advocated proprietary technologies, Doug Baughman and his partners had previously approached the County seeking approval for a co-composting operation (Conrow 1993). Sewage sludge represented an estimated 20% annually of landfill tonnage, so diversion made an

11 As an additional incentive both the US EPA and the State had issued directives that all counties stop landfilling sludge by 1995.

immediate impact even though revenue from compost sales had not yet materialized. According to the new recycling coordinator, Hana Steel, the project was a success from the County's perspective for the diversion savings alone (ibid.).

It wasn't long before both the recycling and the co-composting programs ran aground. Late in 1993 several firms collecting and processing recyclable materials existed on Maui, which, when coupled with still relatively low public and commercial participation rates created a situation wherein firms seeking to develop new products from recyclables could not secure enough of a supply for reliable manufacturing. For instance, Aloha Recycling's president Bill Pryor told the *Honolulu Advertiser* that

> If Haleakala Ranch were to come in and ask for 10,000 fence posts made to order, I can't tell them it will take nine months to get enough materials to produce that much. (Tanji 1993a)

While a materials shortage caused problems for the island's recyclers, concerns over adverse human health impacts and the operator's credentials threatened the co-composting plant. In late 1994 officials from the State Department of Health met with county representatives and a hostile crowd to discuss the co-composting. Several members of the public who worked near the facility complained of noxious odors and insect problems at their job sites, while one former Maui Composting Company employee claimed that he became ill as a result of working at the operation, which contains "every possible disease known to man." (Perry 1994) Allegations emerged that the company's founders and managers had no experience with industrial-scale composting and that the county had improperly reviewed their qualifications during the bidding process (ibid., Tanji 1994).

The Lingle administration refused to terminate the co-composting project, arguing that the project "was meant to be experimental, to find the glitches so they can be worked out." (Tanji 1994). Lingle also mentioned several County Councilmembers' political motives for targeting both the co-composting program and bidding process, namely that they would be challenging Lingle in her re-election campaign (ibid.). Resolution in maintaining landfill diversion efforts bore much fruit through the rest of the 1990s. Several businesses associated with composting and recycling grew through the aggressive capture of materials and introduction of innovative new technical processes. Aloha Plastics, founded in 1993, was by 1996 producing synthetic logs and other construction materials for the US Navy, requiring so much source material that plastics were imported from the mainland (to the dismay of local recycling enthusiasts, cf. Tanji 1996). Another firm, Pacific Biodiesel, collected used oils and fats from Maui's resorts and restaurants for conversion into a light biodiesel suitable for use in buses, boats, and other diesel engines. The firm succeeded on Maui to the extent that it began building plants in Japan and Hong Kong (Tanji 1997; 'Maui biofuel project...' 1999). The number of firms producing and selling compost also grew, converting nearly 28k tons of green wastes alone by 1999 and selling all of it in the state of Hawaii (Tanji 1999). By the time the year 2000 update of the State solid waste management plan was produced, Maui County was diverting approximately 26% of its waste stream from the landfill, tying Oahu for the highest rate in the State (Belt Collins Hawaii and Rifer Environmental 2000, II-43).

The county's solid waste challenges were far from over, though. Composting firms estimated that they received only half of all green waste with the remainder – some 25k tons per year in 1998 – buried in the Central Maui Landfill (Tanji 1999). Plastics processors like Aloha Plastics sometimes operated at just 15% of their capacity (Tanji 1996). While recycling and composting programs were firmly in place as a result of private efforts, county grantmaking, and State policies on biosolids and improving

Hawaii's diversion rate to 50% by the year 2000, a consulting report indicated that fully 85% of Maui's solid waste stream was recyclable or compostable and most of it ended up in the landfill (Tanji 1995).

Since the late 1980s Landfill diversion has been the *de facto* goal of Maui's solid waste management efforts. This being so, it is unclear why the county adopted such a laissez-faire approach to diversion, typically weak hybrids between private entities and public money (but not equipment or infrastructure beyond space at the Central Maui Landfill or a smattering of recycling and green waste drop boxes). Many of the problems with diversion stemmed from solid waste collection practices. Although Maui was the only Hawaiian county to require users to pay for collection, subscription was not mandatory. As recently as the year 2000 only 75% of eligible residences subscribed to county collection, while the remainder self-hauled to landfills or transfer stations (Belt Collins Hawaii and Rifer Environmental 2000, II-43). It also bears repeating that the county would not collect the majority of solid waste produced on the island anyway, being 'commercial' material from resorts, condominium developments, and businesses. Those solid waste producers were, and are, served by private haulers. Though attempts to reduce the costs of private hauling were behind the private sector's initial push for recycling and composting, by 1995 the additional costs of source separation, materials storage, and having to pay private haulers for a second collection of recyclable material and green waste was cited by businesses as a major reason for their limited participation in recycling programs (Tanji 1995). Curbside recycling and green waste collection did not exist for residences, except for occasional pilot programs during the late 1990s, therefore assigning the task of source separation to residents and businesses but offering them little incentive to comply.

In spite of these challenges an expansion of the Central Maui Landfill starting in the late 1990s made non-compliance less of an issue. County officials believed that they could double or even triple diversion rates, eliminating discussion of energy conversion throughout much of the 1990s and early 2000s[12]. In addition, the implementation of strict emissions rules for incinerators by the US EPA in the early 1990s introduced a range of financial uncertainties about construction and operation costs of WTE, making such a project extremely unlikely under the fiscally conservative Lingle administration. Maui's solid waste officials already wondered aloud about the financial implications of revised EPA landfill rules (for instance Tanji 1993a, 1993b) and were occasionally embroiled in labor disputes with county employees as the Lingle administration tried – unsuccessfully – to privatize many county functions, including at one time solid waste collection and management (Tanji 1996).

Although the question of privatization would not resurface publicly the spectre of an overflowing Central Maui Landfill haunted committees and mayors for years to come, especially when the plans to expand the landfill were halted by the state. In 1998 the county built new landfill phases without first notifying the state Department of Health or securing any permits (Loomis 2005a). Subsequently the State required significant post-construction design modifications initiating a nearly seven-year delay in operation. The county only commenced using the expansion after a chemical leak in the old section which hospitalized at least one landfill employee (ibid.).

Even as Central Maui Landfill rapidly approached capacity, the success of the county's ad hoc recycling and composting programs was not greatly extended despite

12 Save exploration of a federally-funded pilot biogas conversion plant using agricultural waste on Maui's north shore near Paia, which was never constructed, during the early 1990s.

the work of a 'Recycling Task Force' during the Apana administration. The island had no significant 'materials recovery facility' but relied on a patchwork of businesses and non-profits to actually do something with the materials. Separation and hauling of materials remained voluntary. The first steps towards improving diversion rates unfolded during the end of the Apana administration and early years of Mayor Arakawa's first term as automated refuse collection, using specialized bins and trucks with mechanical devices instead of 'manpower', was implemented in the County. Though not initially encompassing recycling or green waste, then-Director of Public Works Milton Arakawa was hopeful for the system's future:

> The manual – under the manual system, of course, we used to miss certain routes when we didn't have the manpower. However, with the automated system, it's a lot more reliable. People get their trash picked up a lot more frequent – well, not frequently, but it's a lot more reliable. If it's going to be on a certain day, usually it's there…
>
> We also want to implement a green waste curbside pilot in 2005…You know, assuming we circulate a different cart for green wastes, I mean, how much green wastes are people going to set out on a regular basis? And that would determine, of course, how often we go and pick it up…
>
> And the other area that we're looking at is possibly taking over the functions of the recycling drop boxes. As you know, we have a number of sites island-wide and also we are looking at possibly taking over the hauling for the Olowalu transfer station. Right now we contract these functions out. And as you know, once we move forward in automated collection, we'll have some extra bodies and positions available and this is one option to provide these services in-house. And, of course, if we can do that in-house, we'll save on paying for the construction services. So that's something we are thinking about.
>
> Beyond 2005 we're thinking we need to automate the remainder of the island, of course. We would like to move forward on semi-automation, getting all those routes set up. Initiate green wastes collection and try to work on how to resolve these – the twice weekly pickups that we currently have into some combination of perhaps a regular refuse pickup and a green waste pickup and a recyclables pickup and mix –, mix it in. And have a regular schedule so that people can rely on when to put out, you

> know, certain types of items. (Public Works and Traffic Committee 2003b, first para. 39, remainder 42-43)

The more efficient collection of solid waste without improvements to diverting recyclable and compostable materials only exacerbated the spatial crisis at Central Maui Landfill. By 2006 the landfill received some 600 tons of waste per day, sometimes spiking at 950 tons per day, up from an annual average of just 400 tons per day only a year earlier (Eagar 2006b). The jump in tonnage was directly received to automated collection, which had increased enrollment in the county solid waste collection program but still had no program for green waste or recycling pickup. While members of the public wrote in to the local newspaper explaining the problem in no uncertain terms – "If you do not make it very easy and convenient for people to recycle, they won't" (Barrows 2006) – county solid waste officials were instead seeking to acquire land for a fifth landfill expansion (Eagar 2006b).

In many ways this was all solid waste officials felt they could do. While the county received some assistance in diversion on account of the state 'bottle bill' passed in the early 2000s, placing a cash value on certain types of plastic and glass containers, by 2003 skyrocketing volumes of solid waste had officials scrambling for a solution, raising the question of energy conversion technologies once again. According to the minutes of one Public Works Committee meeting, by 2003 there were "a whole bunch of waste to energy proposals before the county" but no specific projects were ever mentioned publicly either to the County Council or news media (Energy and Economic Development Committee 2003a, 79). Although an official request for proposals was never issued, in 2005 Mayor Alan Arakawa told *The Maui News* that the County's long-term goal was a "trash-to-energy" plant located alongside a recycling center, or 'materials recovery facility' (Loomis 2005b).

Many, including members of the county's Public Works and Traffic Committee, were surprised by the claim. Any discussion of energy conversion was spurious, because the County was already facing numerous challenges simply keeping up with regulatory requirements in operating landfills and rectifying a range of operating violations levied by the State. The mayor's claim caught even the Public Works Director off-guard:

> COUNCILMEMBER KANE: …First, the question is if the Department [of Public Works] can give us any indications at this point regarding what is happening with the waste-to-energy program that the Administration was looking into?
>
> MR. [Milton] ARAWAKA [Director of Public Works]: Councilmember Kane, we are very interested in proceeding to some sort of a waste-to-energy initiative; however, at this point, what we would like to do is to update our Integrated Solid Waste Management Plan for the entire division, which should give us also a direction as to waste-to-energy.
>
> As you know, there are a number of vendors who have approached the County as far as trying to get into some sort of a venture on – on waste-to-energy. The field is also quite dynamic in that it's changing and the technological requirements also can be quite complex. So we would like to take a step back, figure out what we want to do in terms of the entire division, and for the County as a whole, and then proceed on that basis…
>
> COUNCILMEMBER KANE: Okay. So let me get this straight, now. So the two points that I made, Mr. Chairman, the waste-to-energy program which was - I believe was in the paper and was talked about, there's nothing happening because, according to your comments, that can't happen until we have an update. And you have also stated, and…and if I am not being clear with what you…then please clarify, that you folks have not even looked into the update of this Integrated Solid Waste Plan, because what you have told us now is that what you are hoping to get from this year's '07 Fiscal Year budget request from Administration is funding to hire a consultant to begin that update process; is that correct?
>
> MR. ARAWAKA: That's correct.
>
> COUNCILMEMBER KANE: Okay. Well, Mr. Chair, we are getting a lot of rhetoric…from -- from the Director. We are getting a lot of language about

> Integrated Solid Waste Plan, with getting -- about waste-to-energy, and nothing has happened, zero. We haven't even seen anything, but we got a lot of talk about it. So, thank you. (Public Works Committee 2006a, 35-40)

The episode was enough to prompt a performance audit of the solid waste division. It was easy to understand the Public Works Committee's skepticism about the division's plans for the since the last comprehensive study was over 12 years old. A budget proposal for purchase of the fifth phase of the Central Maui Landfill had come in more than double the initial estimate of $3m (Eagar 2006b). Recyclable materials were piling up rapidly as the county sought even temporary space to hold and process them (Figure 4.2), prompting one island recycling advocate to compare the county's solid waste infrastructure as "missing", and analogous to a situation where "you put a bunch of toilets in a house and there was no septic system to go to…It's the same concept." (Loomis 2005b)

While the solid waste division focused its efforts on closing the first two phases of the Central Maui Landfill, acquiring space for another landfill expansion, and dealing with a mountain of recyclables, it also investigated the possibility of installing a landfill gas collection and electricity generation system (Public Works Committee 2006b, 2006c). At the hearings it emerged that Maui Electric Company had also considered both landfill gas-to-energy and mass burn WTE during its most recent round of 'integrated resource planning'[13], in efforts to comply with new state rules on renewable energy. Both the company and the County Council concluded that too little was known about the future of the county's solid waste supply to proceed with either kind of project, and plans to implement the new technologies were once again put on hold.

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13 Also at these hearings company representatives intimated that such systems would not be feasible for them to own and operate independently, but that there might be scope for project cooperation and at the very least purchase of the power generated by county projects using the technologies.

SWRAC and the 2009 Integrated Solid Waste Management Plan

Shortly after the 2006 mayoral election of Charmaine Tavares, daughter of Maui's longest-serving mayor Hannibal Tavares, the county formed a Solid Waste Resource Advisory Committee to work with a consulting firm – GBB – on updating the county's solid waste plan. GBB's task was to produce a comprehensive study of all solid waste

Figure 4.2: Maui's "Plastic Wall" from 2003. According to the unidentified author's caption, "The plastic in the following photos, taken January 17, 2003 represent 18 months of plastic 'recycling' collected and hauled from businesses, homes and the county drop boxes. There are an estimated 400 bales of mixed plastic sitting in the sun at the Maui Central Baseyard…Maui's Central Landfill, aka Pu'u Opala (Mount Garbage) is already receiving 438 tons of material a day and may end up receiving this unwanted plastic as well…Maui plows about 250,000 cubic yards of material into this landfill each year. Without a County-run Material Recovery Facility, this will continue to be the fate of most of Maui's solid waste." ('Maui's homeless plastic' 2003)

operations in the county, including waste composition, analysis of infrastructure scenarios, and financing options. The SWRAC's main task between April 2007 and May 2008 was to shape the direction of the County's solid waste program in light of technology, collection and separation practices, and financing and regulatory challenges presented to the group by the consulting engineering firm. The SWRAC, like the SWERT thirty years earlier, was composed of representatives drawn from government (both elected and appointed), environmental advocacy, and private industry, including representatives from solid waste and recycling firms. The group took a tour of the waste processing facilities of several mainland cities, including Portland, OR, Monterey, CA, and San Francisco, CA.

The fine details of the SWRAC meetings need not be examined in this chapter,[14] but two major findings emerged from the SWRAC meetings to work through the Integrated Solid Waste Management Plan and become County policies or projects. The first was a newfound commitment to diversion and specifically moving the collection and separation of solid waste more directly into the oversight of the county. Gregg Kresge, from the county's environmental management office, noted that in 2005 some 70% of all waste in the county was 'commercial' material collected by private companies (SWRAC Committee 2007c, 7). Because of these figures, public education on diversion and separation – even for tourists – was no longer optional: in the words of one (unidentified) SWRAC member, the "plantation mentality" where residents assumed the county would 'just take care of' solid waste issues had led to an overstuffed landfill and limited public understanding of the reality that "reduce, reuse, recycle is not free." (SWRAC 2007c, 6) According to the Committee, public attitudes represented a major

14 Though a second article is under consideration detailing the extent to which solid waste planning can be tied to arguments about risk society and reflexive modernization.

barrier to landfill diversion because on Maui “there is a culture of being able to dump for free…Some may actually litter their trash rather than pay for the disposal or collection.” (SWRAC 2007d, 4) While no specific efforts in public education were discussed during the SWRAC proceedings, GBB lead consultant Harvey Gershman praised the county’s recent efforts (SWRAC 2007a), and the firm devoted a full chapter to effective public education in the final draft of the county’s Integrated Solid Waste Management Plan (chapter 6 of Gershman Brickner and Bratton 2009).

Also growing from the SWRAC meetings was a serious interest in energy conversion technologies. A consensus emerged that “we should go with what’s proven…biogas, anaerobic, many technologies.” (ibid., but see also SWRAC 2007d). The county had previously been ‘pitched’ a range of conversion technologies, including such exotic processes as plasma arc gasification during the first Arakawa administration. At SWRAC meetings consultants presented many of the same technologies, however in contrast to hype surrounding pyrolysis and other ‘advanced technologies’ during the 1970s and 1980s, GBB focused its attention on WTE, landfill gas-to-energy, and anaerobic digestion (Gershman Brickner and Bratton 2007). Consultants from the firm described processes like plasma arc as “spotty” and asked the SWRAC to consider exactly how much financial and technological risk they – and the County – should be willing to take in solid waste planning (ibid.). Consultants also examined biomass conversion technologies transforming organic material into a liquid fuel like ethanol, a process which had also recently been explored by the island’s utility, Maui Electric Company (Eagar 2006a). Ultimately, the consultants recommended that the county first pursue landfill gas-to-energy using methane from the islands’ closed landfills, and next, consider commercially available conversion technologies like WTE. ‘Developing’ technologies like plasma arc and liquid biofuel production could be monitored but were described as being too uncertain for serious consideration (Gershman Brickner and Bratton 2007). According to the consultants' population and solid waste generation projections, Maui would need a facility rated at between 870 and 620 tons per day (depending on recycling and green waste diversion rates), which would have an output of 14.6 to 20.5 MW of electricity.

While the consultants made a clear set of recommendations, understandings of WTE and similar technologies became quite fragmented during the SWRAC meetings. Some members saw the technology purely in energy-production terms, noting

> Waste to energy [is] important. Maui is a petroleum-dependent county in a petroleum-dependent state. We owe it to the county to examine the energy we consume, and to use waste to energy at every opportunity. (SWRAC 2007c, 6)

Other SWRAC members saw energy conversion technologies like WTE as competitors to landfill diversion tactics like recycling and composting: "WTE requires that we have a resource. What will happen to the other programs that are continually decreasing the amount of resource [sic]? They are in competition with each other." (SWRAC 2007e, 4). Additionally energy conversion could release substances like dioxin and heavy metals into the air, water, and land, and some SWRAC members feared, at a rate far beyond what government officials could estimate:

> Pollutants. What are the effects of these? To me it doesn't matter what EPA says. If it's bad for you it's bad for you. It's important to know because if I am going to advocate for something I have to know because I have to live with it. (ibid., 5)

Still others disagreed with the consultants' findings that biological processes outside the technological mainstream be ruled out of consideration, arguing that processes like "Fermentation [have] been going on for thousands of years, that is not an immature technology. Biological is not immature technology [sic], [and] may be more palatable here." (SWRAC 2007e, 6)

Indeed, energy conversion would become one of the more controversial issues of the SWRAC meetings. When the committee met to compose a final recommendation to GBB on the direction of solid waste planning, while curbside recycling and green waste collection, the construction of a MRF, and landfill gas-to-energy were strongly favored, the committee was split on even conducting feasibility studies of WTE. Some SWRAC members saw the technology as an obvious choice, since WTE would "stabilize electricity usage and saves land" and could be "used in partnership with other waste disposal means" (SWRAC 2007b, 8). Others saw even the feasibility study process as fundamentally flawed, since the engineering consulting firms responsible for such studies had a material interest in the construction of a facility, and took issue with the fact that the text of the recommendation specifically encouraged RDF and mass burn WTE at the expense other technologies.

While the study was eventually approved, energy conversion was irreparably fragmented. Subsequent meetings on the topic of were characterized by confusion and occasionally confrontation, as the issues of solid waste disposal, energy generation (both electricity and possibly a liquid fuel like ethanol or biodiesel), environmental protection and human health merged. In the words of one SWRAC member:

> I am confused what this will achieve [sic]. When I look at these alternatives, I fail to see how the biodiesel one is going to contribute to waste diversion in Maui. Are we trying to reduce the amount going to the landfill, or get more energy? (SWRAC 2007f, 4)

In spite of the consultants' recommendations, at the November 15 2007 meeting some committee members suggested that emerging 'advanced' technologies like plasma arc and pyrolysis gasification be at the heart of any future plans:

> We can use Anaerobic Composting, chemical cracking of the waste (chomping the molecules), lower temperature gasification, high temperature and Pyrolysis. There is a company that is already doing Pyrolysis in Japan, with significant tons per day. The low temp gasification and Pyrolysis would not need any more demonstration because already done commercially [sic]. My recommendation is source separation and low-temp gasification. (ibid.)

This specific comment was met with frustration, as "this is supposed to be a consensus decision but really it is based on one person's interpretation who spoke for 12 minutes." (ibid., 5). The uncertainty over which 'advanced' technology to include in any feasibility study continued through the consulting firm's final five recommended scenarios for county solid waste planning. Scenario 1 assumed a maintenance of the status quo; Scenario 2 a target of 60% recycling; Scenario 3, 60% recycling plus mass burn or RDF WTE; Scenario 4, 60% recycling plus some yet-to-be determined 'advanced' conversion facility; and Scenario 5, a 75% recycling target with expanded composting and construction debris recycling but no energy conversion at all (Gershman Brickner and Bratton 2008). At this point in the proceedings then-mayor Arakawa[15] also warned the SWRAC that any negotiations with the island's utility over electricity purchase were bound to be lengthy and complex, as the company was already considering a range of alternative and renewable energy projects. Furthermore, in contrast to his 2005 position that the county should move rapidly towards WTE, by 2008 Arakawa argued to the SWRAC that

> …landfill conversion may not be the best strategy. Wave energy is the most viable alternative. Putting 20 or 40 platforms out there would be better than a huge trash to energy project. (SWRAC 2008a, 7)

In the short term little consensus was reached as to the appropriate course of action, as some SWRAC members argued with the economics of energy conversion

15 At the time of writing, once again mayor of Maui

while others argued about the environmental ethics and the responsibility to future generations implicated by technologies like WTE. Frustrations ran high, especially over the feasibility of a diversion rates above 50% and the probability that volumes of solid waste would increase in the future. From one exchange between committee members:

> Let's not quibble with the data. California wastes millions of dollars…[doing so]…every 5 years. Like Frank said, this isn't rocket science. This is trash, not splitting atoms or anything like that. (SWRAC 2008b, 7)

The SWRAC's fragmentation of waste-to-energy systems permeates the Plan's approach to implementing any sort of energy conversion technology. From a footnote to a discussion about landfill capacity on Maui:

> Waste-to-Energy or WTE is used in this ISWMP in the generic sense; it does not imply a particular technology and could include mass burn, gasification by thermal or biological techniques or other approaches. (Gershman Brickner and Bratton 2009, III-2)

Indeed, the chapter on energy conversion is among the longest and most detailed of the entire Plan, covering everything from mass burn WTE to plasma arc gasification, along with the potential environmental, regulatory, and financial outcomes of each system.

The SWRAC eventually recommended a modified Scenario 3, 60% recycling with some form of energy conversion, as the best option for the county, since "In the long term, the island is short of land [and] energy." (ibid., 9) The recommendation earned the blessing of the county Department of Environmental Management (Dept. of Environmental Mgmt. 2008) and formed the primary focus of the final 2009 Integrated Solid Waste Management Plan (Gershman Brickner and Bratton 2009) as well as the spine of County solid waste planning since 2010.

From Plan to Reality?

The 2009 plan, despite its ambiguities on energy conversion technology, was well-received by the County Council and State Department of Health as well as the public. However, progress on implementation of the Plan's recommendations has been mixed. According to Cheryl Okuma, previous director of environmental management under Mayor Charmaine Tavares, implementing the SWRAC recommendations and the Integrated Solid Waste Management Plan created a host of "legal and financial issues" which were compounded by her predecessors who set aside nearly $500k for a materials recovery facility that was "not properly looked at and not properly planned." (Janes-Brown and Lordan 2010) Curbside pickup of recycling was budgeted at a pilot level only in 2011, and only started operation in late 2012 (Loomis 2011; Tanji 2012). The pilot program distributed to users three bins for waste, including one for recyclable materials, one for green waste, and one for everything else in a system modeled after the one used by the city of San Francisco. The delay in implementing the program has hinged on one thing: money. Furthermore, changes in collection practices can be very labor-intensive and impact county payrolls, and as a result must be carefully negotiated with employee unions. Accordingly, in the near term county money has continued to flow to various private firms and non-profits charged with the task of managing the islands' recyclable materials, permitting little headway in improving the county's diversion rate.

At the time of writing the County still does not have firm plans for a materials recovery facility, although two private MRFs have commenced operation on Maui. A feasibility study exploring a range of ownership, operations, and financing options was undertaken in 2010 (R.W. Beck 2010). Talks related to the expansion of composting facilities with the county's main contractor, EKO, as well as other firms accepting green waste and producing compost around the island, are also underway. The county has engaged in at least one high-profile effort to divert waste from landfills by banning single-use plastic bags from retail stores. The public response to these efforts has been mixed as well, with some hailing the efforts in recycling and diversion and others describing the moves as major steps backwards. While the plastic bag ban is considered an annoyance by some – "as we carry soggy paper bags to our cars instead of the reliable old plastic bags," (Rea 2011) source separation of waste represents a serious public health threat. As one resident told *The Maui News*

> Recently I received new recycling bins from the country. They included a small garbage pail which reminded me of the garbage pails we had when I was a small child, 60 years ago. I can still recall the smell and the maggots…
>
> So, now in our tropical environment, which is loved by infectious diseases, our all-knowing county has decided to regress 60 years and again have our raw garbage stored all over the county in garbage pails?
>
> Did anyone consider the unintended consequence? We will now have to deal with an exponential increase of household flies, rats and the diseases they will spread? Perhaps the countywide use of these garbage pails should be reconsidered? (Scheper 2012)

In spite of criticism the public response to solid waste planning for the county has been more acquiescent than anything else. A common position held by many policymakers and those in the solid waste engineering consulting business is that 'constituents don't care about solid waste so long as it is gone from their house' making most county actions acceptable to them so long as they are explained in advance.

Even energy conversion technologies, historically a point of great controversy in the United States – including on Honolulu during the initial phases of HPower – aren't as controversial on Maui. On Oahu a handful of citizen challenges to HPower were made, including from conservationist organizations like the Sierra Club, but on Maui little documented opposition to energy conversion projects – in principle, though not always practice (due to perceived nuisance and cost issues) can be located. The principal exception has been organizations and individuals advocating a 'zero waste' approach to solid waste management, including the county's former solid waste director John Harder. A presentation was made to SWRAC members about the zero waste philosophy (SWRAC 2007b), and in 2011 a zero waste forum was held at University of Hawaii – Maui College which was attended by county solid waste officials, the general public, and County Councilmembers alike (Stephens and Lordan 2011). But these organizations did not emerge in response to investigations of energy conversion technologies, but rather have existed on Maui for some time; many have their roots in the citizen recycling and composting efforts of decades past.

For as much attention as recycling and composting have received in the county, it is actually the processes to select and build both a landfill gas-to-energy project and an energy conversion facility of some yet to be determined type that are the most advanced. In March 2012 the County released a 'Request for Qualifications' notice for an energy conversion facility of any design. The RFQ asks for bids from

> …an experienced developer to finance, plan, design, permit, construct, own, operate, and maintain a facility at the [Central Maui Landfill] based on a proven waste conversion technology. The [Dept. of Environmental Management] sees great potential in this project due to the availability of various waste streams that are currently being landfilled and due to the high cost of electricity with respect to Mainland municipalities. The revenue stream for the project will primarily consist of the tipping fees paid to the developer by [the Dept.] and the sale of either fuel or energy to other parties…Moreover the [Dept.] is seeking the maximum energy generation…(County of Maui 2012, 1)

The RFQ attracted 23 responses from companies advocating a wide range of conversion technologies, from mass burn WTE to plasma arc gasifiers.[16] At the time of writing the County was evaluating the proposals and no decisions had been made.

In contrast to the public dumping, recycling and composting initiatives, and private proposals for both landfill gas-to-energy and WTE submitted in the past, the county looks to be taking a different tack on the implementation of energy conversion systems by keeping critical decisions in public hands. An unpublished memo between county solid waste and environmental management officials[17] detailed a request from private developers that the county not proceed with any type of energy conversion project, instead allowing the un-named private firm to use its own capital resources to select, install, and operate a plant. Though aware of the potential financial benefits to the county, the memo's authors' also note that "the loss of…tipping fee revenues [from the proposed facility]…could impact the costs of the County Residential Refuse Collection Program" and that by maintaining ownership of the project,

> The County will be the broker of technologies and can shop for the best technology / fit for the community, as well as would capitalize fully on the benefits, rather than a portion through a third party.[18]

This firm leadership position, along with indications that Mayor Arakawa has an interest in pursuing energy conversion projects, suggests that the county is closer than ever to developing a genuine alternative to landfilling solid waste.

While impossible to predict the future of the county's solid waste management program, it is clear that many of the recommendations from the 2009 plan are being

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16 Unpublished memo "County of Maui Waste Conversion Facility Project", dated 23 July 2012
17 Unpublished memo "County of Maui Waste Conversion Facility Project", dated 23 July 2012
18 ibid.

implemented. However significant challenges remain regarding energy conversion technologies. One comes from island's major 'industrial' actors, HC&S and Maui Electric Company. As the economic viability of the island's sugar industry wanes, HC&S is trying to re-invent itself as a 'bio-energy' company, potentially placing itself in competition with any future county funded energy conversion operations (Eagar 2006a; Hamilton 2011). Many of publicized HC&S plans relate to biomass or conversion of biomass to fuels. Regardless of the outcome of these plans, as a major landowner HC&S remains a force in island politics.

Maui Electric Company is also investigating new sources of power both independently and in conjunction with HC&S. Before the SWRAC hearings it emerged that Maui Electric was also investigating landfill gas-to-energy and WTE, but eliminated both from its construction program by 2006 (Public Works Committee 2006c). According to newspaper reports, the utility has also been investigating the potential of biomass operations and could benefit from some sort of joint program with HC&S (Eagar 2006a, 2011). As the main buyer of any electric power produced by county projects, partnering early with the utility for in planning and financing may be wise, though a number of practical and legal issues may complicate such efforts.

Another significant challenge may come from within government, and specifically disagreement among different branches of Maui's solid waste management program. Should the island achieve a 60% diversion rate there may not consistently be enough solid waste to supply an energy conversion plant, which would invoke some of the most feared clauses of the 'put or pay' contracts associated with such projects. Furthermore, a high tipping fee at the energy conversion facility could impact private haulers' decisions about where to deliver their loads, negatively impacting both diversion efforts and plant operations. Finally, the structure of County politics is such that, with four year mayoral terms on the island and councilmember term limits, it is difficult to predict how changes to the executive branch or the County Council will impact implementation of any program. In the coming years, the industry's eyes will be on Maui to see if the project has attracted enough political will to bring it to fruition.

Summary and Conclusions

While in the early parts of the 20th century residents worried about dump access and collection service, since the 1970s the main solid waste concern on Maui has been the landfill. How much space remains in the landfill? What can we do to preserve that space? Recycling, composting, and other types of landfill diversion have been undertaken in the context of extending landfill life rather than the benefits they might introduce on their own accord – benefits which, given Maui's limited industrial and non-plantation agricultural activity and distance from major markets, may have been difficult to enjoy anyway.

But even with limits to the effectiveness of recycling and composting and increasingly scarce space for landfill expansion, the ad hoc system of solid waste management on the island functioned well enough to delay the inevitable disposal crisis, leading many to believe that the day when there is absolutely nowhere to put garbage may never come. This problem is not necessarily unique to Maui, but the spatial stakes of landfilling on an island seem higher than they do on the mainland. However, in contrast to Maui's two previous periods of interest in energy conversion technologies, the government is currently taking a leadership role in the development of a genuine alternative to the landfill.

Indeed, energy conversion – and in particular WTE, because of its reliability and capacity compared to other technologies – seems inevitable for Maui and perhaps all of the Hawaiian Islands. Tourism remains the most important industry and one which seems poised to continue, as does the relocation of mainlanders to Hawaii for retirement or quality of life purposes. Rejecting energy conversion in favor of reusing construction and demolition debris, recycling plastics and papers, and composting green waste – already part of Maui's comprehensive solid waste plan – would require a radical, anarchical overhaul of the island's industrial and economic base, dramatic shifts in materials policy at the state level, and a commitment to autarky rivaling post-War Latin American or Soviet governments.

That isn't to say that such policies are impossible. Kauai County is taking dead aim at solid waste policy across the State and much of the mainland through its Zero Waste initiative. Constituents must decide whether Zero Waste is achievable as an absolute goal in light of the radical shifts necessary. Even if it is achievable – and given some sections of the public's outcry over the elimination of single-use plastic bags and the introduction of separate green waste collection on Maui – it must be a lengthy process, perhaps spanning several generations. The practical question for places like Kauai then becomes, what do we do with waste in the meantime? Does WTE (or similar) become a 'lesser evil' than landfilling and stockpiling recyclables and compost? Can officials and activists really claim to have 'solved' the problem of the landfill by diverting material and storing it for an indefinite amount of time somewhere else – just as MSW is 'stored' in a landfill? How much of a monetary loss is acceptable to taxpayers from the 'short sale' of cardboard bales, low-density plastic, or green glass?

Few Zero Waste advocates take this hard line however, offering the philosophy more as a guiding principle than an absolute goal. Maui seems to have adopted a compromise system with its target of 60% diversion and incorporation of energy conversion, even if unintentional. At any rate the era of one-off disposal sites and patchwork planning must end. A reliable WTE facility in conjunction with mandatory recycling and composting, a safe ash storage location in the landfill, and an ethic of re-use offer the possibility of truly 'sustainable' solid waste planning for the island.

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Chapter Five

The Greater Detroit Resource Recovery Authority: A Cautionary Tale

The previous chapter discussed the history of (thinking about) WTE on Maui, as well as the potential for such projects to be developed on the island. Instructive in considering what could happen if county government decides to pursue WTE or a similar technology is another in-depth case study, looking at the circumstances surrounding the installation of what was, at one point, the largest WTE facility in the US in Detroit, Michigan. Although WTE technology in general and the Detroit project in particular had received much positive attention from state and local governments since the early 1970s, the project, once undertaken, quickly became mired in political intrigue, environmental controversy, and a range of issues not directly linked to solid waste management in Metro Detroit but building on a long history of city-suburb mistrust, racism, and regional socioeconomic disparities. WTE in Detroit was deployed in a firestorm of controversy which has ebbed and flowed since the mid-1980s. As such, it is presented as something of a cautionary tale of what to avoid when pursuing the technology (or perhaps any environmental technology) in a politically contentious context.

First conceived in a period of impending crisis for solid waste disposal in the southeast Michigan region, Detroit's WTE project attracted early support from a broad coalition of politicians, planners, and even environmental activists. But when the proposed facility's emissions permit and pollution control equipment was questioned by an employee at the state air quality regulatory agency, the entire project was thrown into doubt, first for environmental but later financial and operational reasons. Although the problem could have been quickly and decisively resolved at a relatively low price, City officials chose to maintain their original plans as a means to assert their authority over the project and, symbolically, the administration of City affairs.

In this chapter, **I argue that controversy surrounding the Greater Detroit Resource Recovery Authority (GDRRA) stems not from the technology itself but rather City efforts to rush the project into operation without ever directly addressing the concerns raised by the opposition**. This is also why the facility remains controversial through the present day, as financial arrangements related to the GDRRA and the plant were entered into too quickly. The chapter first moves through a history of solid waste planning in Michigan since the mid-1960s, quickly 'zooming in' to the southeast Michigan region and the evaluation of WTE as a solid waste management option. Then, I examine the development of WTE in Detroit from the mid-1980s until the project's first (begrudging) public acceptance around 1993, relying primarily on news media analysis but also state documents.[1] Next, I consider the legacies of the Detroit WTE project in recent years before some conclusions for the chapter are presented.

<u>Solid Waste Management in Michigan</u>

From the perspective of physical geography, Michigan is quite stable -- the major geologic activity occurred thousands of years ago during the period of the glaciers, which deposited unique landforms and soil patterns which perpetuate to the present. Nevertheless, Michigan's glacially derived physical geography does impact patterns

1 Despite requests, I was not granted access to the papers of the quasi-public Greater Detroit Resource Recovery Authority, and thus was not able to examine that body of material in preparing this chapter.

and processes for solid waste disposal. According to the very first state comprehensive solid waste plan, Michigan's varied soils and hydrogeographic situation make siting even small landfills quite difficult due to wide disparities from site to site in terms of soil porosity and water table depth (Capitol Consultants 1973, 3). These challenges are frequently exacerbated by intense periods of cold and heavy snowfall in many parts of the state, causing problems with landfill operations and even the collection of solid waste as roads become hazardous or outright blocked.

If the state's deep environmental history impacts present day waste planning, so does its more recent human history and the introduction of population patterns associated with the intensive extractive industries that characterized the state's economic activity from the 18th to mid-20th centuries. Logging, mining, and agriculture have distributed small settlements across the state, and the promise of private land ownership coupled with intensive land surveying mean that "townships in Michigan cover every square inch of the state that is not incorporated into a municipality." (Resource Recovery Division 1978, V-14). The pioneer mindset coupled with a quest to document and legally control every land parcel over time resulted in a political situation in the state where local zoning decisions trump nearly any other legal intervention into planning activities (cf. Howell 2012).

Accordingly, while Michigan has historically been a state with very uneven demographic and economic patterns – where metro Detroit, Flint, and Grand Rapids have been among the most populated parts of the United States for most of the 20th century, vast expanses of the northern Lower Peninsula and the entire Upper Peninsula have very sparse populations spread out over large distances. However, even as population and industrial activity expanded during the 20th century and contributed to growing solid waste volumes, local and state leaders looking for new disposal sites were frequently stymied by opposition to new projects. As a result, gridlock with regards to waste planning and project implementation was a far too common feature of both state and local political scenes during the second half of the 20th century when such issues began to command greater attention.

While the 1963 State Constitution made reference to government's ability to 'do something' about solid waste on public health grounds, prior to the first comprehensive solid waste plan in 1973, solid waste issues in Michigan were characterized by a frontier mentality towards collection and cavalier attitude towards disposal. According to a survey conducted by the Michigan Dept. of Natural Resources (cited in Capitol Consultants 1973), 16m tons of MSW were produced in the state in 1970.[2] Only half of that amount was collected by any entity, public or private, while the other 8m tons were disposed of in ditches on private land, ubiquitous 'backyard burns,' roadside dumping, or by unidentified methods of 'salvage' (ibid., 3) Beyond the collection shortfall, these issues were typically identified as deficiencies in citizen education, and frequently appeals were made to first improve citizen education about waste prior to making substantive policy changes. For instance, Governor Milliken argued that

> …we must labor even harder in the field of public opinion. It's entirely possible that we could develop effective programs for the disposal of waste by local governments and industry, only to lose the war to the guerrillas – the private citizen. (Milliken 1969, 2)

Despite such rhetoric, issues of waste collection and citizen education both paled in insignificance to the looming questions of disposal raised from the earliest days of solid waste planning in the state. After the passage of the 1965 federal Solid Waste

2 As was the case in Hawaii, this figure does not truly capture the total volume of waste material produced in the state. The report says that there were 100m tons total, the other 84m tons being mining, agricultural, forestry, and industrial waste that the state did not feel the need to address.

Disposal Act, the Michigan Department of Public Health along with the Governor's Office held a conference to examine the state of disposal in Michigan (MI Dept. of Public Health 1969). In his opening remarks, Governor Milliken noted that "this conference is all about…[devising] more efficient ways of disposing with the increasing amounts of solid waste," (Milliken 1969, 1) and was subsequently followed by presentations from engineering consultants, state planners, and representatives of township, city, and county government. It seems as though the expectations for sweeping changes were set quite low. For instance, Fred Kellow, Chief of Environmental Health for the state, argued that Michigan was starting at a disadvantage, since "We [state agencies] have inherited some of the problems that developed as a result of improper disposal facilities of the past." (Kellow 1969, 11). Kellow included among these disadvantages his estimate that only about 10% of the state's population had its solid waste being disposed of properly – typically those in and around the major metropolitan areas – because there were no truly enforceable laws requiring smaller communities to collect waste (ibid., 12).

But small communities did not necessarily choose to shirk the public health duties of waste collection and disposal. Frequently, they did not have the money to fund such services. In a paper also presented at the Governor's conference, Executive Director of the MI Townships Association, Col. Joseph Parisi, pointed out to top lawmakers that under Michigan law, townships were *not allowed* to levy taxes for landfills or waste collection (Parisi 1969, 61). Indeed, until the late 1970s, there was little legal uniformity on most solid waste issues in the state, ranging from the authority to raise taxes by different types of governments, to landfill design and siting, to rules about transporting waste from county to county. Such disparities led to major headaches for local government. The City Engineer for the City of East Lansing, Robert Bruce, told lawmakers that

> Much has been said about research, planning, new techniques, etc., but sooner or later we get down to the 'nitty gritty' and the buck stops – somebody has to put out the garbage. Not when we develop better methods of handling it. Not when we can re-claim, recycle, or re-use it – but TODAY. Local government must provide adequate and convenient facilities and service to dispose of solid waste if the problem is to be solved.
>
> It is certainly essential that we continue to investigate new methods of disposal, but the truth of the matter is that we are not taking full advantage of existing technology. Our problems are more political and economic than technical in nature. (Bruce 1969, 63)

Bruce's comment about the political and economic hindrances to solid waste disposal in Michigan, even in the late 1960s, is telling. Nevertheless, concerns about the technical 'brass tacks' of waste disposal – facility siting, project funding, technology selection, and operating processes – would dominate state planning in Michigan until the early 1980s, possibly to the detriment of pursuing cohesive solid waste plans built around a single environmental, economic, or social goal.

The most significant early effort was the state's 1973 solid waste plan (Capitol Consultants 1973), which once more identified issues like collection, dumping, and 'backyard burning' as critical problems facing solid waste disposal in the state. The plan noted that just 30 percent of Michigan municipalities had organized collection process, and that some 40 percent of municipalities offered no oversight of waste collection and disposal whatsoever (ibid., 3). As of 1970, the plan identified 600 licensed land disposal sites in the state, but noted that only a third were modern sanitary landfills and the rest open dumps (ibid., 59; 4). Incineration was identified as the second most common method of disposal in the state but facilities were also noted for their regular violations of "air pollution codes and outmoded equipment." (ibid., 4) Both composting and recycling were dismissed as economically problematic.

In contrast to Hawaii, it is clear that at the time of Michigan's 1973 plan there was no apparent spatial crisis in landfilling, despite apparently tricky geological conditions, and thus no pressing need to answer the 'where do we put this' question facing policy makers in the island environment. While the plan noted that in more urbanized areas, some communities were within five years of landfill capacity, as a *statewide* issue there was not necessarily an impending crisis for disposal sites. To the extent that the spatial question is raised at all, the plan simply notes that "solid waste disposal in Michigan is limited by the fact that, considering methods of processing or disposal currently in use or contemplated, ultimate disposal of some portion of the waste must be on the land." (ibid., 51) Rather, the plan cites a lack of state enabling legislation as the major barrier to community financing, planning, and operation of solid waste facilities.

Many of these legislative barriers were overcome in the 1970s, allowing communities to finance and operate solid waste management programs. But what did communities choose to do when so enabled? There is no question that the landfill was, and remains today, the dominant technology for solid waste disposal in Michigan. This is directly the result of Act 641 of 1978, which

> …required counties to ensure disposal capacity for a number of years into the future - originally 20 years and currently 10. To do so, each county either must secure the ability to use landfill that currently exists, or provide for the siting of new landfill capacity within the county...According to some, these requirements have resulted in an abundance of landfill capacity…(Lowe 2005, 1)

But other technologies and processes were also considered and implemented in the state. While the 1973 plan does not specifically mention WTE and dismisses other forms of resource recovery, like recycling and composting, by the late 1970s strong interest had built around alternatives to the landfill. Many counties, or groupings of counties, were by the mid-1970s investigating traditional incineration, WTE and also recycling programs with the help of engineering consulting firms (e.g., Tri-County Regional Planning Commission 1975). Within state government, the Michigan Department of Natural Resources (MDNR) implemented a Resource Recovery Division as part of its offices on solid waste management. This branch of the MDNR often produced its own specialized reports and planning documents dealing with all types of resource recovery issues and technologies.

The first major statement from the Resource Recovery Division was the 1978 "Energy and Materials Recovery State Plan." This document sought to make a number of points about solid waste management in Michigan, not least of which was that

> …most of Michigan's solid waste is landfilled. Or to put it another way, very little of the state's processable solid waste is currently recycled either in terms of materials or energy. As a result, a great potential, depending on energy and materials markets, financing, and other factors, exists in Michigan for resource recovery. (Resource Recovery Division 1978, II-9)

The report claims that by the late 1970s some 80 percent of the state's waste stream is combustible and that the other 20 percent is composed of recyclable materials; about half of the recyclable materials have a strong market value as ferrous metals or aluminum (ibid.). In evaluating energy recovery technologies, and in particular waterwall WTE, RDF co-firing, and pyrolysis, the report authors make the claim that these technologies may also contribute to materials recovery, and that taken together, an energy and materials recovery operation represents a far more economical and environmentally-friendly system of solid waste management than the sanitary landfill (ibid., IV-1). This is in direct contrast to many US EPA findings from the mid- to late-1970s, but is only one way in which Resource Recovery Division opinions diverge from federal research. Another is that the Division viewed energy conversion technologies like pyrolysis with suspicion, arguing that

> Pyrolysis of solid waste may well be a technology of the future. To date, however, pyrolysis has not been proven in commercial operation…There are several drawbacks to pyrolysis systems and present pyrolysis technology is still in the developmental stage. (ibid., III-2)

Ultimately, this first report from the Resource Recovery Division is enthusiastic about WTE because "The use of solid waste as an energy source would eliminate both political and environmental problems currently associated with landfills in Michigan" and "It would also provide a useful by-product – energy from an often considered useless commodity – solid waste." (ibid., III-9) However, the authors also make a number of precautions related to market and political uncertainty:

> One of the primary factors in determining the viability of utilizing solid waste as an energy source is to locate or develop energy markets which fit certain criteria. Those criteria are primarily: 1) there must be an adequate demand for solid waste produced energy to make it economically feasible to construct the necessary processing and firing equipment; and 2) the market must have an agreeable attitude toward the utilization of the solid waste generated energy at a reasonable price. (ibid., III-1)
>
> Before local action is undertaken to provide solid waste as an energy source to potential users, considerable additional work is required, including the negotiation of commitments from potential users to purchase the solid waste and commitments from governmental authorities to provide it to potential users. (ibid., III-9)

Even as the Division remained bullish on WTE and materials recovery, it also produced a number of technology assessments for other solid waste processing technologies as well as implementation strategies for community leaders, emphasizing such topics as modular incineration (1980b), refuse-derived fuels (1980c), landfill methane recovery (1980a), shredders (1981a), and solid waste project financing (1981b).

Despite intensive study, many of these technologies were not implemented very widely, if at all, in the state. Some insights into the reasons for this can be gleaned from the synoptic reading of Resource Recovery Division documents with more general state and county plans for solid waste management. Frequently, comparing the two bodies of literature reveals internal disagreements among those making solid waste policy in the state. For instance, it is not uncommon to see the Resource Recovery Division comment negatively about the confusion caused by the fragmented nature of solid waste policymaking in Michigan:

> Solid waste management in Michigan is controlled or regulated in one fashion or another by the following institutions: DNR, the State Dept. of Public Health, local health departments…local governments (cities, counties, villages and townships), and private waste collectors and landfill operators. Institutional problems can be placed into four categories: 1) enforcement; 2) financial; 3) technical; and 4) public awareness. In all four categories, variations of two basic deficiencies for solid waste management in Michigan were found: lack of clearly defined authority and lack of adequate financing. These two deficiencies are at the root of many of the institutional problems noted herein. (Resource Recovery Division 1978, V-14)

In fact, one of the favorite pastimes of the early Resource Recovery Division was taking the state legislature, local government, and even private citizens to task for any number of problems, real or perceived, that limited development of any type of solid waste disposal sites in the state:

> There are extreme political difficulties in establishing landfills in Michigan. Yet landfills and other solid waste management facilities, located and operated safely in environmentally safe terms, are obvious necessities. The fact is, however, that although all of Michigan's residents produce waste, few if any want solid waste management facilities anywhere near them. One method to deal with this dilemma is to establish state (and perhaps, county as well) authority to override township and municipal zoning in the establishment of solid waste management facilities. This method should be considered for inclusion in a new state solid waste program. (ibid.)

> Neither at the state nor local level is adequate funding provided for effective solid waste management. This includes landfill disposal and alternative disposal methods; enforcement; planning; and other activities as well. Further, there appears to be much confusion, if not actual lack of knowledge, especially at the local level…(ibid., V-16)

But the Division also openly disagreed with other branches of the MDNR charged with solid waste management. For instance in a memo, the Division argued that the 1978 "State of Michigan Solid Waste Plan" (HDR 1978) did not fully account for the benefits of materials recovery nor properly evaluate all of the available landfill alternatives, and especially modular incinerators operating at below a 200-tons per day capacity. In particular, the Division took issue with the fact that

> Source separation was considered, but shown to be costlier than energy recovery alone. Therefore, the full potential of source separation programs was not evaluated. Recent experiences show that source separation could be an integral component of resource recovery activities. (Resource Recovery Division 1979a, 3)

It appears that there must also have been internal conflicts within the Resource Recovery Division over the relationship between materials and energy recovery. For instance, even though the 1978 report was enthusiastic about WTE, an unpublished memo dated July 1979 from Division specialist David Lenze argues that

> The problems of solid waste are often best met through recycling and waste reduction programs. Energy recovery and sanitary landfills should then be used for the remaining solid waste. Once an energy recovery facility is built, there is a strong interest in maintaining the volume of waste for which it was designed. This leads to antagonism toward waste reduction and recycling efforts which may be better options. (Lenze 1979)

Likewise, another memo titled "Items Needed in A Feasibility Analysis for a Resource Recovery Project, or, 'What to Know Before Deciding On A Resource Recovery Project'" (1979) urges readers to seriously consider recycling and other materials recovery prior to choosing incineration or energy recovery project development. The disagreement is interesting not only because major parts of the state government were pushing incineration while the Resource Recovery Division remained cautious, but also because of the trickle-down effect that such mixed policy messages had on local government officials seeking advice on solid waste problems in the early 1980s.

As waste officials at the US EPA turned their general attention to questions of hazardous materials and toxic waste cleanup in the early- to mid-1980s, so too did those charged with addressing solid waste management in the state government in Michigan. It was only in 1988 with the publication of the "Michigan Solid Waste Policy" document under Governor Blanchard did attention return to questions of waste disposal, and by then a great deal had changed regarding the relationship between environmental regulators and local governments implementing solid waste projects.

In the intervening years, the ad hoc nature of solid waste planning in the state produced a system of disposal infrastructure that was frequently mismatched and disjointed. There were very few guidelines for waste disposal, let alone hard and fast rules, that municipalities could look to for guidance in waste disposal. This left local government largely to its own devices in determining new infrastructure systems. Later when state regulators returned attention to solid waste, emphases had changed somewhat and environmental health issues – like heavy metals, groundwater pollution, and carcinogenic emissions – had assumed central importance over the more 'technical' issues of the 1960s and 1970s. In this way, a new type of relationship between city waste management officials and the state regulators who approved or denied their project permits was forged.

The Intermediary: County-Level and Regional 'Authority' Waste Planning in Michigan

Complicating the relationship between state regulators and municipal leaders even further was the intermediary level of government that many in Michigan believed to be the 'natural' scale for solid waste planning: the county government. Since the late 1960s, county officials in Michigan had claimed that solid waste planning was a task best completed by their offices; after all, counties are natural jurisdiction for waste because they are small 'regions' and already function as nuclei for public works funding and project implementation (Ruscett 1969). By the same token, the Resource Recovery Division argued that "There appears to be no incentive to counties for sound solid waste management planning and plan implementation," (Resource Recovery Division 1978, V-16) since they housed neither the same numbers of elected officials, could raise the same types of tax revenues, nor undertake solid waste management as municipalities did. Yet by almost all accounts, counties, or groupings of counties, were precisely the level of government targeted to connect state waste policies to physical infrastructure and actual solid waste management practices. Accordingly, Michigan Public Act 87 of 1965 required counties or a representative multi-county agency to produce comprehensive solid waste management plans. By 1979 only 31 (of 83 total) had been approved by the MDNR (Resource Recovery Division 1978, V-1), spurring an extension for submitting plans to the early 1980s.

At the scale of the county, solid waste management issues looked different than they did at the state level, and seemed especially dire, especially on questions of disposal in urban areas. As one Resource Recovery Division document noted,

> There are 64 counties that are in a critical situation. They either have no approved landfill, have a landfill that will not meet Act 641 requirements, or will be filled to capacity in less than two years. There are 10 counties that have landfills that will last up to five years. There are only nine counties

> that have landfill space sufficient to last beyond five years. (Resource Recovery Division 1979b, 1)

In Metro Detroit the picture looked even more ominous, as “Only 15 of 149 units of government [in the five counties comprising Metro Detroit] reported they had landfill sites expected to last 10 years or more. For the overwhelming majority, their provisions for solid waste disposal were either dangerously short-range or nonexistent.” (Reid 1969, 53)

For Metro Detroit a strong – and rational – argument was made for regional, multi-county, multi-government solid waste planning. The Southeast Michigan Council of Governments (SEMCOG) and its forerunner, the Detroit Metropolitan Area Regional Planning Commission (DMARPC) were selected to design official solid waste studies and plans for the region, and indeed, had been conducting their own studies of Metro Detroit’s solid waste disposal situation since 1961. In 1964 the DMARPC noted that “a condition bordering on the state of emergency exists in the Detroit region.” (DMARPC 1964, 2). Rapid post-War population and economic growth propelled the issue of solid waste management to the forefront of many community government agendas. Prior to the 1960s, regional hog farms, backyard burning, and informal open dumps in marshy areas and natural depressions were adequate for disposal. As hog farms and backyard burning were gradually eliminated, dumping also became more of a challenge. DMARPC noted that “Very few of the dumps and landfill sites are owned or are under the control of the municipalities dependent upon their use” (ibid.) and that this created difficulties in predicting remaining life, enforcing environmental or health laws, and also securing new dump or landfill sites.

As a solution, the more densely populated City of Detroit and the older, inner suburbs had experimented with incineration, and by 1964 there were eight incinerators (without energy recovery) operating in Metro Detroit. Four of these were within Detroit city limits and the other four scattered around Oakland, Wayne, and Macomb Counties. Ash from these incinerators was hauled to landfills in each county. Even without energy recovery equipment, these incinerators were expensive. Accordingly, those built outside the City of Detroit were actually funded through multi-community partnerships, products of small regional 'authorities' for solid waste disposal. For instance, the incinerator built in Madison Heights, Oakland County, was the result of an eight-community partnership initiated in the late 1950s. Rather than having an individual community fund and operate the entire facility, the combined 'authority' became the owner-operator, and was funded through a pool of municipal bonds but also the tipping fees the facility charged for disposing of waste at the site (ibid.). These types of multi-unit authorities existed in each county as the Southeastern Oakland County Incineration Authority, the Central Wayne County Sanitation Authority, and the Grosse Pointes-Clinton Refuse Authority.

At first, the City of Detroit was effectively excluded from these multi-community incinerator authorities as the City was, and is, responsible for its own waste collection and disposal; but the City did have a representative at the SEMCOG planning meetings. The main reason for being excluded from various multi-government authorities was the scope of Detroit's solid waste needs in comparison to those of the other SEMCOG communities. Paul Reid, the director of the planning division of SEMCOG, noted in a 1969 address to state policymakers:

> The mad scramble of the core city and the older, close-in suburbs for adequate disposal sites has become an anarchical race. Increasing tensions between the disposing unit of government and its agents and the receiving unit have resulted in frayed tempers, desperate and shifty methods, antagonistic attitudes, and even lawsuits. The central city bears the brunt of these feelings, because it has the most solid waste to dispose

> of, and because its needs cannot be served by a single waste disposal site. Much of the motive power that enacted our recent sanitary landfill law in Michigan came from suburban legislators, who joined shoulder to shoulder with public health officials. (Reid 1969, 53)

Many of the 'frayed tempers' resulted from a disparity in power between the City of Detroit and the communities able to form regional waste authorities: while regional authorities' members make solid waste disposal decisions and fund the majority of costs, other communities or private firms may also use disposal facilities given permission and willingness to pay the tipping fee. The power disparity emerges between the designers and the users of the system, since suburban regional authorities could refuse access to their facilities as these approached capacity. At the same time, suburbs could form further regional partnerships with communities still having land for fills and able to absorb excess capacity into those fills. Detroit had no similar 'spatial fix' for its disposal needs other than to pay for hauling trash to increasingly distant suburbs. According to one analysis of the relationship between the City of Detroit and SEMCOG member communities, no one wanted to enter into an authority-type agreement for waste with Detroit because:

> The [SEMCOG] Solid Waste Committee, composed primarily of local operating officials in solid waste management, was reluctant to approve any plan that would impinge upon their jurisdiction. The proposed regional solid waste authority proved difficult for the committee members to accept…since the City of Detroit is the largest waste generator, [and] members of the committee from the surrounding areas were hesitant to accept the city's disposal burden, believing that by so doing, they would decrease their capacity to dispose of their own solid waste. It is interesting to note that many of these counties are now receiving the city's solid waste at privately operated landfill sites. (Applied Management Sciences 1973, 23)

The City of Detroit thus found itself very early in a spatial bind, in that it must either pay for hauling to remote suburbs, pay for using facilities like incinerators in inner suburbs, or pay for new facilities within city limits amid an increasingly dismal set of public finances and administrative regimes during much of the second half of the 20th century. Furthermore, falling populations in the City of Detroit would produce problems of stranded costs and simultaneously, the inability to afford alternatives. Reid himself seems to have been thinking of precisely this scenario when he told state policymakers that “Cooperative good will in the solution just cannot be expected from all the units of government involved in the mess. A mandate involving all units must evolve as the framework for solution.” (Reid 1969, 56) To that end, by 1973 SEMCOG had floated a regional solid waste management plan calling for nine new incinerators in Metro Detroit designed around a system which would manage both City and suburban waste (Metcalf & Eddy of Michigan 1973).

This plan, however, would never gain any traction as local authorities remained hesitant to either relinquish jurisdiction for historically local solid waste issues to a regional authority or fund disposal programs for the City. Indeed, the original SEMCOG plan was stripped to a compromised form by the mid 1970s, as

> Members of this committee are now, for the most part, policy making officials from government and industry, and not the operating officials that comprised the previous committee. It is hopeful that this higher-level committee can take a relatively objective view of the situation, and have less concern for preserving vested interests of individual localities...the powers of the proposed regional solid waste authority will be limited solely to planning activities. Operational authority will still be retained by local units of government, while enforcement authority would be vested in state agencies such as the State Board of Health. By so doing, it is hoped that local fears concerning an all-powerful regional authority will be ameliorated. (Applied Management Sciences 1973, 24)

The SEMCOG vision of a comprehensive regional authority for solid waste management would grow increasingly distant with each update to its official set of solid waste policy recommendations through the 1970s, 80s, and 90s. As something of a counterweight, individual county planning rose to prominence for the Metro region in the 1980s. This meant that Wayne County, encompassing the City of Detroit, would be responsible for the City's comprehensive waste planning. At the same time, the waste disposal challenges facing Detroit made a truly comprehensive county plan quite difficult to formulate. This, coupled with the earlier failure of the SEMCOG plan, introduced a great deal of fragmentation into the City and Metro region's waste management policy, which can be traced through many of the problems that Detroit would later experience with WTE.

Solid Waste Management in Detroit

It is clear that there were, and still are, several layers of government vying for influence in determining solid waste policy in the state of Michigan. But the fact remains that very little municipal solid waste has ever been directly managed by state or county government, and indeed most waste management decisions have been taken by municipal officials for far longer than planning at either the state or county level has even existed. The situation is no different in the City of Detroit, which in spite of state and regional planning programs, has remained the primary provider of solid waste collection and disposal for its citizens since the late 19th century.

Like many US cities, the City of Detroit did not have immediate success with solid waste management. Local political platforms during the first half of the 20th century even had planks related to sanitation as an aspect of civic beautification measures (e.g., Mayor's Postwar Improvement Committee 1944). Like many Midwestern cities, Detroit long collected refuse separately from organic garbage, only combining collection in the early 1960s. The City's Sanitation Division within the Department of Public Works was responsible for this collection and also disposal in the various landfill sites and incineration facilities owned and operated by the City. In 1964 the city ended operation at its last remaining landfill site and started to rely fully on its set of four incinerators, many of which were operating beyond their intended life spans and without proper maintenance or pollution control equipment (Applied Management Sciences 1973, 17-20). One report cites high labor costs and frequent disagreements between unions and sanitation management as an important resource sink for the Division, limiting overall efficiency but also the amount of money available for equipment upkeep (ibid., 10-11).

At any rate, in 1968 three of the City's four incinerators were ordered by courts to be shut down on account of air pollution concerns. A fourth, the 'St. Jean' facility, was allowed to remain open, at partial capacity, and only for the disposal of special, hazardous, and pathological wastes. By 1973, the City of Detroit – population 1.5 million – had exactly zero operational solid waste disposal sites within city limits, and operated only a series of transfer stations from which collected refuse could be loaded onto large trailers and hauled to private landfills far outside the city. While this seems like a significant abdication of authority on the City's part, it may have actually been somewhat strategic since under the model Detroit found itself in:

> Private transfer station operators and private haulers are required to make all arrangements for the ultimate disposal of refuse in the landfill sites. Some private operators also own and operate their landfill sites. Nearly all sites are located in the outlying areas of Wayne County or in adjacent counties, at some distance from the [City of Detroit's] transfer stations. Since the sites are privately owned, there has not been the negative public reaction that might have resulted if the city had attempted to directly acquire and operate these sites… The Sanitation Division has no responsibility for the waste once it is discharged at the transfer stations. (Applied Management Sciences 1973, 52)

The appropriateness of this management strategy became a point of contention between City Sanitation officials and suburban governments, as represented by SEMCOG. For instance, while SEMCOG planners argued that the City's ultimate plan for disposal was unsustainable given the already critical status of most landfills in the Metro area, anticipated closure of 15 additional landfills by 1978, and the fact that "over 80 percent of the total area of the region is unacceptable for new landfill development based on demographic, hydrologic, and geologic criteria" (Metcalf & Eddy of Michigan 1973, 10) City of Detroit Sanitation officials "believe the situation is less critical and feel that landfill sites are relatively plentiful as long as they are owned and operated by the private sector." (Applied Management Sciences 1973, 24). Further complicating matters was the fact that "Surrounding counties have been vocal in their opposition to accepting Detroit's solid waste even though many are doing just that under the current system." (ibid., 52)

Metro Detroit communities would continue to take the City's wastes, even if begrudgingly, as the system of disposal just outlined continued virtually unchanged until the very early 1990s when Detroit's WTE facility finally came online. The intervening years – when the facility was planned, built, opposed, and debated ad infinitum – are marked by the interplay of complex and varied concerns about government competency, toxic materials, social justice, and environmental protection. Though challenging to pull together, they are truly representative of a period in which discussion about WTE's benefits and drawbacks was on the literal and figurative front page.

Though the initial impetus – other than a lack of disposal capacity – is not clear, the City of Detroit first began planning for a new WTE facility in the mid-1970s. The City's proposed facility did not apparently stir much controversy, at least directly, until one specific moment in 1986 when an unidentified MDNR employee raised a concern that the facility, as planned, was not using the most advanced air pollution control equipment – after air quality permits had been granted and funding secured on the bond market. The new technologies, if required, would add an un-funded $17m to the project's nearly $500m estimated cost. According to a *Detroit News* editorial,

> The DNR told [the City] that dry acid gas scrubbers and bag-house filters would produce less pollutants than the precipitators planned for the plant's smokestack system, and 'they [MDNR] told us [City and contractors] since lower is better, you ought to do it. We say, 'wait a minute, we've already met your standards and conditions and now you're throwing a very costly proposition at us.'
>
> City officials aren't saying much at this point. They know the project is in jeopardy…('DNR Trashes Detroit' 1986b)

The suggestion that the facility may not be 'safe' was enough to unleash a wide array of previously invisible opposition to the plant, cause previously supportive regulators to reverse their positions, and throw the entire premise of WTE into doubt. But before considering the implications of the MDNR suggestion about the plant's proposed emissions controls, it is worthwhile to explore why plans for the facility were relatively *free* of controversy until that point in January 1986.

From the news media analysis, a few themes emerge surrounding waste disposal during the period 1976-1986.[3] The first is the theme of a regional 'garbage crisis' existing in Metro Detroit. For instance a front page article in a 1979 issue of *The Detroit News* uses shocking statistics to convince readers of the magnitude of the problem, such as "The trash and garbage collected each year from Detroit-area houses, stores, and factories would fill Detroit's Tiger Stadium 244 times." (Tschirhart 1979) These reports typically emphasized the uncertainty surrounding 'solutions' to solid waste problems,

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3 The analysis relies primarily on *The Detroit News*, a conservative but well-respected publication. The *News* was the only indexed Detroit paper for the time period under consideration, though content from *The Free Press* and *Metro Times* is also analyzed starting from the late 1990s

noting that “there appears to be no simple solution to garbage disposal” given the need to balance ecological concerns about land and groundwater protection with economic costs (ibid.) Stories with headlines such as “Garbage Crisis: Metro Area Running Out of Dump Sites” (Schabath 1981) would frequently echo statistics from agencies like SEMCOG about an imminent disappearance of landfill capacity in the region.

Despite continual predictions about the landfill crunch, for most Metro Detroit residents the problems of solid waste disposal remained fairly abstract. Not so for Detroiters, as problems with solid waste collection stemming from labor disputes as well as faulty equipment left mountains of trash in the streets for weeks on end – more than one time – between 1980 and 1982. Coupled with summertime heat and power outages, public complaints that “garbage hasn’t been picked up in six weeks and that rats as big as dogs ‘walk right up to you’” depicted a nightmarish situation for many Detroit neighborhoods and must have driven the reality of a garbage crisis home (Brown 1980). As problems with collection, the first step in disposal, continued, citizens sought their own solutions for removing solid waste. One of the most popular was simply to dump waste on publicly-owned land (like school playgrounds, Eng 1982) or vacant lots (Ilka 1982). In light of this crisis, plans for the new 3,000 tons per day WTE facility near downtown Detroit may have been quite appealing ('Mining Garbage' 1979).

But concerns about garbage rotting near homes and schools were far from the only health issues raised regarding existing solid waste disposal practices in the period before 1986. Increasingly, both government agencies like the MDNR and the general public were voicing their concerns about toxic substances. While the state increasingly concerned itself with the enforcement of environmental laws related to collection and disposal of industrially-produced toxic materials (Bulgier 1981), local government and private citizens were alarmed about new evidence that Metro Detroit landfills were polluting the water supply. This concern frequently dovetailed with the notion of an environmental garbage crisis in the region, as “In the Detroit area several landfill sites have been shut down in recent years because of leaching of contaminants into groundwater or objections that odors seeped from the soil.” (Kerwin 1979). Closing landfills that were contaminating the water supply was an obvious measure, but many also acknowledged that it exacerbated the disposal problem. Frequently, incineration, even without energy recovery, was touted as the best solution to this problem. Noted one Macomb County farmer concerned about the drainage from a landfill onto her property, “Landfills should be a thing of the past…there are other solutions to the problem, such as resource recovery.” (Tittsworth 1983; see also Markiewicz 1985). Even in the moments before the controversy over Detroit’s WTE facility erupted, columnists argued that incineration was the best solution to the problem of “decaying garbage and toxic waste [seeping] into the underground water.” (Brown 1985) Indeed the process was hailed, like electricity generation earlier in the 20th century, as another example of the ‘technological sublime’ (Nye 1994, 1998):

> Some engineers have designed garbage incinerators that can burn tons of garbage in thirty minutes, at temperatures of 1,800 degrees Fahrenheit. The ash and non-burnable debris falls into chutes and is taken to landfills or is recycled. The heat produced by the furnace is used to turn water into steam, which then can be sold too as power. The gases that result from incineration are cleansed and then are expelled through 500-fot smokestacks, which ought to be high enough to prevent odors from drifting through the surrounding neighborhood. (Brown 1985)

Endorsements of incineration technology, with and without energy recovery, rolled in from seemingly every sector.

The technology was regularly characterized as one which not only ‘solved’ the garbage crisis by slashing reliance on landfills but also one which largely protected human health by precluding contamination of groundwater supplies. Though expensive up front, incineration and WTE had economic benefits by freeing land from conversion into potentially toxic fills, leaving it open for other uses. Community after community announced that it was investigating the technology, from inner Detroit suburbs like Lincoln Park (Margo 1978) to the more distant reaches of north-central Oakland County ('Oakland Solid Waste...'1981). Evidence that incineration was far superior to other forms of waste disposal convinced local and state officials alike. In 1983 the MDNR made public its proposals for updating State solid waste policy to reflect a new goal of cutting landfill disposal by 70% and dramatically increasing the amount of WTE in Michigan ('Garbage Recycling Backed...' 1983; Martin 1983). By 1984 a measure was introduced to State legislators to develop a $350m fund – the first of its kind in the US – to provide assistance to communities pursuing WTE and recycling programs (Kerwin 1984b). One report indicated that 86 percent of Michigan voters believed that trash should be 'recycled' using WTE or other resource recovery methods rather than sent to landfills (Kerwin 1984a).

Wayne County planners, ostensibly charged with overseeing waste management developments in the City of Detroit, in their 1984 Solid Waste Plan:

> endorses the City of Detroit's effort to develop a 3,000 ton per day incinerator…This extremely effective method of waste disposal achieves both volume reduction and energy recovery from waste material. The Committee recommends development of this facility…(Wayne County Planning Commission 1984, 5)

That same year, Detroit's WTE project secured operating permits from the Michigan Air Pollution Control Commission, the body to which the US EPA had delegated its authority to grant air quality permits in the state ('Pollution Panel Approves...' 1984). The facility was apparently an unstoppable force, and "Because the plant would salvage valuable scrap metal and reduce the use of landfills sharply, it has been lauded by environmentalists as well as city officials." (Capos 1985)

This made the events of late 1985 and early 1986 especially confusing. In late December 1985 MDNR officials sent letters to those involved with incineration projects across the state, demanding new air pollution control equipment for their facilities, letters which arrived, at least for Detroit's facility, after the Air Pollution Control Commission had granted operating permits (Pierson 1985). According to MDNR officials, new 'dry acid scrubber' and 'baghouse filter' technologies would remove more toxins from facility emissions, including the extremely carcinogenic dioxin. A nearly immediate response from a representative of Detroit-based engineering consulting firm Black & Veatch argued that the new technology's effectiveness was purely "speculative" (cited in Pierson 1985). City officials threatened that if they were ordered to install the estimated $17m pollution control equipment, the project would have to be scuttled since financing had already been sought based on the original facility price tag ('DNR Jeopardizes Resource...' 1986).

This was apparently enough. After responses from the City, news media, and even Governor's office supporting the original plans and price, Ronald Skoog, director of MDNR (who claimed to not even know his employees had sent the letters to Detroit officials) backed away from the demand for new pollution control equipment ('Kill the Letter...' 1986c; Pierson 1986a). But in the eyes of some – most notably, environmental organizations like the Sierra Club, Greenpeace, and the Evergreen Alliance – the fact that a facility was going to be built without the most advanced pollution control equipment available proved too much new information to ignore.

In reality, though incineration and Detroit's WTE were frequently celebrated in the decade since 1976, there had always been strains of doubt about the technology itself and the City's ability to implement it properly. As mentioned earlier the City of Detroit's incinerators were ordered to close in the late 1960s because of pollution concerns. Other incinerators in Metro Detroit had also experienced challenges from state and federal air pollution regulators on their violation of emissions permits. The Central Wayne County Sanitation Authority's incinerator near Dearborn, MI was ordered to shut down in 1982 because of recurring pollution problems (Ball 1982). In 1983 the US EPA leaked that it had discovered dioxins and furans in the emissions of a Hampton, VA incinerator ('EPA Traces Dioxin...' 1983), an episode which also revealed significant internal disagreements over air pollution standards at the agency: according to David Sussman of the Office of Solid Waste, the amount of toxins discovered were "so small it's ridiculous to be concerned about it" while scientist Frederick Kutz of the Agency's Field Studies Branch was "convinced that resource-recovery facilities are spewing furans and dioxins into the air." (ibid.) That same year, Macomb County publics sparred over siting procedures, with some groups arguing that incineration can be safe enough to locate near residential areas while others claiming that this is all but a death sentence for those living nearby (Twardon 1983).

While some had doubts about the safety of the technology, others worried about the ability of the City of Detroit to implement such a complex and expensive piece of solid waste infrastructure. The Department of Public Works had a fairly negative reputation among city residents, not only because of the collection problems outlined earlier but because of the cavalier fashion in which the Sanitation program was run. One letter to the editor of *The Detroit News* sarcastically took "this opportunity to thank the Sanitation Department for helping to maintain Detroit's sterling image…[as] our garbage is now so efficiently picked up that it is done only every two weeks at best." (Xuereb 1982) In particular, complaints emerged that Director of Public Works Jimmy

Watts was treating the department as his own private kingdom, involved in everything from using city vehicles to deliver firewood to his private residence (Waldmeir 1981b) to taking kickbacks from the firm he selected to design and deliver several million dollars worth of new garbage collection trucks (Waldmeir 1981a). Personality aside, under Watts' leadership some areas of the City did not have waste collection for a full month (Rosch 1981); when protesters arrived at the Mayor's office to complain, Watts referred to them as "a racist organization." (Walker 1981). Allegations later emerged that Watts was involved in an operation swindling the City of hundreds of thousands of dollars through grossly exaggerated garbage collection truck hauling weights, leading to overpayment of tipping fees which presumably returned to his own pockets (Waldmeir 1981c).

Incidents like these contributed to the City's image as a business gamble. In 1985 when bonds were first floated for the WTE facility, Detroit was the only major US city rated below investment grade by major Wall Street agencies (Alpert 1985), adding to the costs of financing. To put this in perspective, the contract with Combustion Engineering (the firm chosen to design and build the plant, also the builder of Honolulu's HPower facility) was worth only $230m. The interest on the bonds needed to pay for the plant totaled $240m – more than the cost of the facility itself (Smith 1985) and this before the additional demands from the MDNR. Furthermore, elements of the Detroit City Council expressed some skepticism towards the project, claiming that they were being "steamrolled" by the Coleman Young mayoral administration into approving 20-year contracts with Detroit Edison for steam and electric power purchases without clear understanding of the total costs involved (Eldridge 1985).

Though these elements of doubt about incineration existed before the MDNR's demands for better pollution control equipment came into play, by 1985 it was commonly held that WTE was "the front running option among…state officials, environmentalists, and local planners" (Pierson 1985) for alternatives to the increasingly problematic landfill. At the same time, it is worth noting that for as much attention as the technology was grabbing as the 'solution' to the solid waste crisis, by 1985 there were only two facilities in full operation in Metro Detroit; 20 years earlier, there were eight. The 1986 threat from the MDNR only served to open the floodgates for controversy surrounding Detroit's WTE facility. For the next six years, challenges from a range of federal, state, and local agencies, citizen organizations, and even private business would impede the development of the plant.

The MDNR actually backed away from its initial demands fairly quickly; just two months after notifying the city of the need for additional pollution equipment, Director Skoog changed course (Pierson 1986a). The agency – perhaps under pressure from Governor Blanchard, himself interested in improving the State's landfill diversion rates (Eldridge 1986; Resource Recovery Section 1988) – noted that while it would allow the project to proceed under the terms of the original permit, it would be watching operations at the facility very closely (Pierson 1986a).

However environmental organizations, upon learning of the MDNR's concerns, had already started to appeal to higher regulatory powers (Figure 5.1). In particular the Southeastern Michigan chapter of the Sierra Club, by early March 1986, had petitioned the US EPA to review the air quality permit issued by the state (ibid.). At the core of their concerns was a difference in opinion over the contributions to cancer rates that the facility could cause once fully operational:

> The incinerator's pollutants, according to the DNR, would cause an extra 38 cancer deaths for every million people exposed to the chemicals under certain conditions. The DNR is afraid the incinerator would emit acidic gas that would damage cars, plants, corrodible metals and health…Ironically,

the DNR issued a permit for the incinerator in 1984 based on an earlier health risk assessment that was more alarming. That assessment said that one person in 1,000 exposed to the chemicals for a lifetime at the maximum concentration point would die from cancer. (ibid.)

NEWS PHOTO / CHARLES V. TINES

Pickets opposed to incinerator march across from City-County

Figure 5.1: Protest opposing the WTE facility in Detroit (Pierson and Tinks 1986). The original caption reads, "Pickets opposed to incinerator march across from City-County Building." Many protesters are wearing surgical masks in the photo. “Text in the Figure is not meant to be readable, but is for visual reference only.”

By April 1986, the EPA decided to review the permits issued to the Detroit facility on the grounds that the facility could violate federal standards for particulates, sulfur dioxides, and carbon monoxide (Alpert 1986c). None of these were the pollutants identified by either environmental groups or the MDNR, which was mainly concerned with heavy metals and dioxins. Although reports emerged that members of the EPA panel reviewing the project were split on a decision (Alpert 1986b) in mid-May the Agency ruled that the facility would not meet Clean Air Act standards (Pierson and Alpert 1986b). Environmental groups opposed to the project, which had expanded to include the Detroit Audubon Society, the Environmental Defense Fund, and the neighborhood group called the North Cass Community Union, were "gratified" by the ruling, arguing that "we believed all along this facility didn't comply with the Clean Air Act." (ibid.)

The immediate impacts of the ruling were not clear, however, as the City had already begun construction on the plant. In the words of Mayor Coleman Young,

> Now, if they tell us after having given us permission, after calling us to extend damn near half a billion dollars in bond sales, to do something different, I don't know what we will do…We might say it is an EPA mistake or a DNR mistake and someone should pay, but not we. (ibid.)

Bella Marshall, the city finance director and ex oficio director of the Greater Detroit Resource Recovery Authority,[4] noted that

> We've been screwed. We did everything they asked. Nobody has said the city is at fault. The EPA says it was the DNR permitting procedure that was wrong. Yet we come out of this looking like the culprit, the polluter. That's not right and that's not fair. ('Detroit Gets the Shaft' 1986a)

The rulings spurred a number of local governments to raise their concerns about the plant as well. The mayor of the inner suburb of Melvindale requested "independent experts" to evaluate the potential cancer risks of the new plant (Pierson and Alpert 1986a), while city councilors, managers, and mayors from inner and outer suburbs like Warren, St. Clair Shores, Hamtramck, Madison Heights, and Roseville expressed new concerns about the exposure to toxic chemicals their constituents would face should the plant proceed without additional pollution controls (Twardon 1986).

Increasingly vocal environmental groups, through both public protests and legal challenges to facility plans, were fueling many of these concerns. One such

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4 Earlier it was noted that no communities would enter into 'Authority' type waste management agreements with the City of Detroit. By the early 1980s, however, the City had found one partner: the enclave of Highland Park, whose territory is completely within Detroit city limits and whose waste the City collected anyway.

demonstration involved the release of balloons from the WTE facility construction site, with notecards saying that "If this balloon reaches you, then so may the toxic fumes from the Detroit incinerator." (McAleenan 1986) Noted environmental scientist/activist Barry Commoner weighed in on the Detroit facility as well, arguing that "the incinerator project ought to be scrapped. It is a foolish, risky way to deal with the trash problem" because the plant would lead to "a cancer rate 42 times higher than is estimated" by engineers and city officials (Pierson 1986e). A broadening coalition of environmental groups contributed to the legal challenges facing the plant as well, and other sorts of civic and professional organizations like the League of Women Voters and United Auto Workers also expressed concerns about the plant (Pierson 1986b). Even the Province of Ontario was asking the City of Detroit for guarantees that the facility would be safe (Pierson 1986f; Alpert 1986a).

Nevertheless, the City refused to pay for the additional equipment. At one point, the City agency responsible for the WTE project, the Greater Detroit Resource Recovery Authority even filed suit against the EPA in federal court over that agency's authority to review and revoke air quality permits (Alpert and Pierson 1986). This stalemate was probably headed for years in the federal court system, except for a shocking development in late 1986 when the US EPA dropped all claims that the Detroit facility would not meet federal air quality standards. According to a Chicago-region EPA administrator, "we will not be able to pursue stricter controls for the Detroit incinerator." (Pierson 1986c)

But the controversy still was not resolved. The interim director of the MDNR wrote in a letter to the Governor Blanchard in July 1986 that "there will be very strong opposition to proceeding with construction of the incinerator without positive evidence that the latest technology is included to assure the minimum downwind contamination." (Pierson 1986d). EPA administrators, in their comments on dropping their regulatory claims over the City's WTE plant, made clear that fundamental problems still surrounded the plant, arguing that "While the facts in this case prevent us from taking any further action, the specific environmental issue remains." (ibid.) Mayor Young noted this strategy immediately:

> It is outrageous that the EPA, when conceding it was wrong in questioning the permit, does so in a sour grapes fashion which attempts to foster public doubts about the project. (ibid.)

Young's analysis was essentially correct. Public demonstrations have continued at and around the facility site to the present day, but increased in their intensity during the late 1980s and early 1990s. In 1987 Greenpeace activists climbed the site's construction cranes to hang banners calling to "Ban the Burn" (Dawsey 1987) but also to attempt to sabotage the cranes' operation ('Environmental Terrorism' 1987a). A year later, 19 protesters were arrested for trying to block construction workers' entry to the facility site (Pfaff 1988). In the spring of 1989, over 500 protesters massed at the facility demanding "[Mayor] Coleman Young, don't trash our lungs" (Bohland 1989), and two more chained themselves to office furniture in the Governor's office ('In Brief: Incinerator Protest' 1989). Protesters' concerns had evolved from a general dissatisfaction with facility safety to encompass a wide range of environmental justice issues, including questions of environmental racism (e.g., "This incinerator would never be built in Bloomfield Hills [a wealthy Oakland County suburb]", cited in Bohland 1989) and the ecological impacts of global capitalism.

While Mayor Young typically dismissed these activists as "screwballs and exhibitionists" (Alpert 1987b), promising that the incinerator facility would be safe, by 1989 it was clear that a number of serious environmental problems continued to plague the plant. Pressure was mounting from state regulators on testing the facility's ash output for heavy metals (Pfaff 1989a). Additionally, In September 1989 the plant, now in early stages of operation, failed emissions tests for both mercury and hydrogen chloride (Hughes 1989). Two months later the Wayne County Air Pollution Control Division ordered the plant that it could not burn waste between one and four inches in diameter, since "Trash of that size is causing the mercury problem – probably because it contains small batteries." (Pfaff 1989b)

Described first as an 'operational issue' (ibid.), mercury emissions would haunt the Detroit WTE facility for the next few years. The plant regularly exceeded its permitted allowance for mercury (Pfaff 1990b), but was otherwise managing "most of Detroit's trash [and had] capacity to handle much of the garbage generated in the rest of Metro Detroit." (Pfaff 1990a). Despite a suspected 'deal' between the City and State air quality regulators, in April 1990 the State Air Pollution Control Commission ordered the plant to shut down, citing the mercury tests.

City officials were outraged, citing "a greater prejudice against Detroit" (Councilman Nicholas Hood, cited in Pfaff 1990d) and claiming that the state was only interested in making a point about being tough on environmental rules (Figure 5.2). Mayor Young argued that "This is Earth Week, and they wanted a sacrificial lamb to lay at the altar of the environment. They got the big one – Detroit." (Cannon and Pfaff 1990) The mayor revealed that

> City officials had been guaranteed by Governor James J. Blanchard's staff and the state Department of Natural Resources that there were enough votes on the commission to approve an agreement that would have allowed the city to continue operating the plant…Young said…"There was obviously a big double cross involved somewhere." (ibid.)

Figure 5.2: Editorial cartoon from The Detroit News showing Governor (and candidate for re-election) Jim Blanchard telling the City to shut down its WTE project for being 'unacceptably toxic'. (Editorial Cartoon, 1990b)

While environmental groups celebrated the decision, City officials like Bella Marshall were "baffled" as to why only the Detroit facility was targeted, since WTE projects were also coming online in Jackson and Grand Rapids. Said Marshall, "I cannot understand, if there is such a health risk, why the people in Jackson and Kent counties are not falling over dead." (Pfaff and Cannon 1990). Mayor Young described the case as "Detroit-bashing…racism." (ibid.) Despite the rhetoric flowing from both sides, in reality the City may have been running into changes in the regulatory process taking place at the US EPA, which in the late 1980s and early 1990s began working on new emissions rules as part of the Clean Air Act Amendments (Alpert 1987a; 'The EPA Battering Ram' 1987b). Indeed, the Director of MDNR in commenting on the Detroit shutdown noted that "This isn't a Michigan problem" and went on to describe emerging EPA rules for municipal incineration and WTE ('Blowing Smoke' 1990a). This is supported by analysis of the second 'deal' that the City made with state regulators on the conditions for re-starting the Detroit facility. Only two weeks after the shutdown order, the City finalized an agreement with the State agreeing to the installation of the baghouse filters and scrubbers that had been the point of contention for the facility since the mid-1980s, technology later required by the US EPA for all WTE and incinerator facilities in the US (Pfaff 1990c).

Most environmental groups remained unhappy, however, as the deal struck to re-open the facility left a significant amount of room for the City to renege on its promises to install the equipment. For instance, the agreement required the City to install scrubbers initially only on one of the three waterwall boilers, and left baghouse filters to be installed only 'if necessary', and by a 1997 deadline (ibid.). In the words of one city critic, Pete Waldmeir,

> What happened in the past couple of weeks to make the incinerator safer? Well, not a whole helluva lot. The 'victory' for Detroit has nothing to do with removing any risks to its residents.
>
> In plain and simple terms, the administration of Detroit Mayor Coleman Young went to Lansing…to convince Gov. Jim Blanchard that…a whole ton of garbage would hit the fan between now and Blanchard's re-election effort in November. To convince Blanchard, Young's negotiators put forth a fairy tale proposal the promises everything and guarantees virtually nothing…
>
> The problem with all these promises is that the city has a horrible track record for keeping its word. (Waldmeir 1990)

In the subsequent years emissions tests improved, though the facility did continue to have sporadic problems with mercury (Askari 1991; Williams 1992). After the agreement with the state on installing additional pollution control equipment was reached, attention quickly turned to other the rapidly mounting financial problems the City was facing, some of which could be traced directly to the incinerator.

Actually, questions swirled around the sale of the WTE facility. After all of its struggles with the plant, in mid-1990 the Young administration saw a sale-leaseback agreement of the WTE facility as a possible way to plug a multimillion-dollar City budget deficit. Under a hypothetical agreement, the city would sell the facility for $54m and then lease it back from the purchaser, allowing the City to maintain revenues from tipping fees and also the sale of steam and electricity (Vance 1990). As such, the contract for sales to Detroit Edison was crucial to any agreement, but the utility charged that after nearly two years in operation the plant was not meeting its contracted volumes for steam. The sale, however, was desperately needed, as the City's finances worsened. In November 1990, the Detroit City Council even transferred approximately $9.5m from the Police Fund to the Greater Detroit Resource Recovery Authority simply to keep the plant operational (Toy 1990).

In 1991 a suitor approached the City. The Philip Morris Capital Corporation, in conjunction with a rate increase request from Detroit Edison, offered a deal which would get the City $54m immediately but cost the officials some $90m in the long term (Maynard and Kleinknecht 1991). For many City Council members, this represented a particularly bad deal for Detroit (ibid.). Nevertheless, Wall Street creditors informed the City that if they did not make a deal, the City's bond rating would drop even further (Cannon 1991), increasing the long-run costs of the bonds needed to install new pollution control equipment on the WTE facility – already approaching an estimated $231m (up from $17m just six years prior, Toy 1991). The City Council, however, would not budge and ultimately rejected the deal with Philip Morris and Detroit Edison, spurring a 1991-2 budget shortfall of between $54m and $88m (Prater 1991). Just weeks later, however, the Council reversed its decision and committed to the sale-leaseback agreement and also the contract with Detroit Edison.

Legacy of WTE in Detroit

The sale-leaseback of the facility more or less ended any immediate controversies surrounding the Greater Detroit Resource Recovery Authority's WTE facility. Since the final installation of the post-Clean Air Act Amendment pollution control equipment, the plant has operated with only minimal concerns about its environmental performance, at least from the perspectives of state and federal environmental regulators. But as might be surmised, the controversies that unfolded around the plant's construction, finances, operations, and environmental effects have made significant impacts on attitudes towards WTE and waste management in Metro Detroit. Furthermore, many continue to view the plant as a source of environmental, financial, and managerial problems for the City of Detroit and the surrounding region.

The legacy with most direct relevance to this dissertation is the impact that the City's experience with WTE made on attitudes towards that technology as well as other waste management technologies in Metro Detroit. While in the mid-1980s and early 1990s, plans for WTE systems could be found in nearly every community and county comprehensive waste plan in the region (e.g. Wayne County Planning Commission 1984, 1990; Oakland County Solid Waste Planning Committee 1981, 1990), by the new millennium no organizations were interested in the technology. As an even more stark example of the turnaround, it is worth noting that the 1988 State solid waste plan called for 35-40 percent of Michigan's waste to be disposed of using WTE (Resource Recovery Section 1988, 4); 15 years later, a plank in Jennifer Granholm's bid for Michigan Governor, the "Clean Water Forever" program, actually proposed a ban on new medical and solid waste incinerators in the state (Niemiec 2002). The 2007 State Solid Waste Policy makes no mention of WTE whatsoever (Michigan Dept. of Environmental Quality 2007).

Oakland County, having expressed interest in a series of WTE facilities since the mid-1980s, by 1994 had dropped the notion entirely as county governments witnessed the slow-motion catastrophe of financing, permitting, and operating the Detroit facility (Curlee et al. 1994). In the Metro region, only the Central Wayne County Sanitation Authority (CWCSA) serving a handful of inner suburbs, maintained interest in the technology, converting its existing incinerator (which had been shut down several times since the late 1970s due to pollution violations) into a WTE facility (Thomas 1995; Bakri 1998).

By 2004 the Detroit facility was the last WTE project operating in the region. Despite upgrades, the CWCSA plant continued to breach emissions rules, accumulating more than 1,200 violations between 1999 and 2004 and the agency operating the plant defaulted on an $80m bond (van Guilder 2004). A few years earlier the conventional incinerator serving the Grosse Points-Clinton Township Refuse Disposal Authority was closed and converted to a transfer station (Davis 1999b), as Authority managers cited high operating costs but also the presence of viable disposal alternatives (Davis 1999a).

The chief reason for the dramatic swing in economics was the explosive growth in landfill capacity that Michigan lawmakers and private companies had been engineering since the late 1980s. Although the absolute number of landfills in the state fell precipitously from several hundred in the mid-1960s to just 53 in the early 2000s (Dzwonkowski 2003), those sites were a new breed of expansive regional projects owned and operated mostly by private firms. Abetting landfill growth was a series of rulings from the US Supreme Court knocking down State and local “flow control” laws that tried to direct solid waste to particular disposal sites or restrict the transport of waste across state and county lines.

Since 1994 public officials and news media identified a new type of 'garbage crisis' which attracted attention away from WTE: Michigan had become a "Mecca" (St. John 1994) for imported solid and even toxic waste, from across the country and even places like Canada, Mexico, and Puerto Rico. The extremely low tipping fees coupled with a lack of acceptable disposal sites in other locations meant that "While operators burned, buried or recycled 184,000 tons of waste produced inside the state [of Michigan], they were busier with 239,000 tons of waste from outside state lines. (ibid.) But this wasn't only municipal solid waste:

> Hazardous wastes include a broad spectrum of corrosive, reactive, and ignitable materials as well as toxic wastes – such as mercury or lead and chemical compounds that pose direct threats to human health. Michigan's borders are open to all but radioactive wastes. The business has grown large in such small steps that it catches state regulators unaware. (ibid.)

But despite reports of a "garbage glut," prices remained low and capacity abundant (Truby 1999). While in the late 1970s, media and planning reports suggested the 'inevitability' of $100 per ton tipping fees at landfill sites, by 2000 some Metro Detroit landfills charged as little as $20 per ton (Davis 1999a). In contrast, when the GP-CTRDA incinerator facility closed down, the tipping fee there was (functionally) $48 per ton (ibid.). Despite the environmental impacts, cheap landfilling made the financing of future WTE projects look seemingly impossible and the economics of existing projects, like the one in Detroit, look increasingly ridiculous.

In 2008 the City approached the 20 year anniversary of operations at the Greater Detroit Resource Recovery Authority plant and closed out its payments on the facility's bonds. It emerged that the City had spent about $1.2 billion on the project over 20 years, far exceeding the original cost estimates of about $450m (Damron 2008). That year also marked an opportunity for the City to change course with the ownership and operation of the facility, including the option to buy it back from the entities that had purchased it in the early 1990s. While the City declined to purchase the plant, the opportunity to critically evaluate the complex relationship between the City, GDRRA, the WTE plant, utility companies, and the facility owners did arise and became the source of a new round of controversy between 2008 and 2011.

Many remained concerned about the plant's emissions. In particular, those who had lived downwind of the plant for the past 20 years complained about foul odors and respiratory problems (Lawrence 2008). In 2010 an estimated thousand people massed at the facility to demand its closure (Figure 5.3). Though alarming, of even greater concern to City administrators faced with a rapidly shrinking budget – and city population – were the comparatively high fees that Detroit paid for solid waste disposal versus the suburbs. By some reports, in 2008 the City was paying nearly $25 per ton to use the facility while communities in Oakland County paid just $18.75 per ton at a regional landfill (Guyette 2008). A 'put-or-pay' contract, meaning that the City must send a certain volume of waste per day to the facility or otherwise pay for the difference meant

Figure 5.3: 2010 Protest at the GDRRA facility (McInturf 2010)

that the City was tied to the higher prices. Most outrageously, the GDRRA charged private trash haulers from Detroit suburbs a lower tipping fee to use the facility than it charged City trucks, meaning that Detroit taxpayers were effectively subsidizing the suburbs' disposal costs (Lam and Gorchow 2008). On top of that, it emerged that the GDRRA may have been overcharging the City of Detroit for tipping fees to the tune of nearly $44m between 2008 and 2010, though GDRRA officials denied this claim ('Where There's Smoke...' 2011).

Claims that the plant was necessary to meet the City's steam and electric power demands were also starting to ring hollow. In September 2009, Detroit Thermal – the primary steam customer for the Detroit WTE plant – announced that it hadn't actually purchased any steam from the GDRRA in more than two months because it was able to produce its own steam more cheaply (Gallagher 2009), meaning that the WTE was no longer necessary to meet the central city's district heating and cooling needs.

Nevertheless the complexity of the agreements between the city, its quasi-public GDRRA, utility companies, and plant operators made a quick separation from WTE, even at a loss, legally uncertain. Clear enough, however, was the fact that by 2012 the system which had evolved around the GDRRA facility over the past three decades was dysfunctional to the core. The City is currently contracted with the GDRRA and the WTE plant until the mid-2020s, even while decreasing numbers of City officials remain in support of the facility.

Summary and Conclusions

During a period of apparent 'crisis' in solid waste disposal in southeast Michigan, the City of Detroit's proposal to circumvent the problems of landfilling with a state-of-the-art WTE project seemed like a sound fiscal and environmental bet. While the project enjoyed general support from broad sections of the public, including environmental groups, a lone regulator raising concerns about the efficacy of the plant's emissions control equipment was enough to plunge the project into turmoil which has continued, off and on, to the present day.

In many ways, a 'perfect storm' came together to challenge the GDRRA project in the period between 1986 and the present: controversy over environmental and public health impacts combined with confused regulators, overbearing City officials, and a rapidly deteriorating fiscal picture all coalesced to hinder public acceptance of WTE technology in general and the Detroit project in particular.

While the intricacies of Detroit's WTE facility since 1986 are infinite, the fundamental causes of the controversy can be traced to two issues, regulatory uncertainties and the perpetuation of competing scientific claims. The issue of regulatory uncertainty centers on a few key questions: who can issue permits and when? Who is responsible for health risks? In this instance, the fundamental 'controversy' centered on who should pay for improved pollution controls for the facility. These negotiations were complicated by divisions within and between different government units, as well as the uncertainty generated when state and federal regulatory agencies reversed their positions, as happened several times in this case study.

Second, competing scientific claims were perpetuated throughout the life of the GDRRA plant. Whose data is correct? How accurate are the estimates being used by different sides? This is a classic concern of STS scholars (e.g., Latour and Woolgar 1979). While environmental groups and regulatory agencies both employed scientific claims post-1986, the City of Detroit rarely did, preferring instead to rely on Mayoral assertions that the facility ‘is safe’ and appeal to an increasingly aged permit granted to the facility in 1984. The City never took into account the fluid nature of scientific findings, preferring obduracy to adaptation, and never fully addressed the concerns raised by project opposition.

Installing $17m worth of pollution control equipment in 1986 may well have eliminated environmental and health concerns associated with the project, and probably precluded the emissions challenges the facility faced in the early 1990s as well. This would not only have stabilized operations but also kept the long-term costs of the project down, which in turn could have improved opinions of WTE in the Metro Detroit region. A seemingly logical question emerges: if the State of Michigan embodied both concerns about the plant’s pollution impacts but also a desire to increase usage of WTE during the 1980s, why did it not just pay for or otherwise subsidize the pollution equipment for the city? Although this offer was hinted at several times in the mid-1980s, the measure was never passed and the City was left to deal with the equipment costs on its own. Discussion of this question, along with policy suggestions aimed at addressing it, is presented in the final chapter of this dissertation.

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Chapter Six

Summary, Alternatives, and Conclusions

This dissertation was undertaken to answer a seemingly simple question: why is WTE used in some locations but rejected in others? It turns out that there is no single, concise way to respond, for the processes of technology assessment and selection – to say nothing of the processes of identifying and acting on environmental 'problems' – are infinitely complex and highly contingent upon factors that vary across space and time. Nevertheless, there are some general lessons from this project that help to explain the history of WTE in the US and may also be useful for understanding the controversies that arise around any technology with significant and immediate environmental impacts.

This chapter begins with a brief re-cap of the preceding chapters, highlighting the major argument in each. Next, as an alternative to the in-depth case studies of Maui and Detroit, where WTE has been either rejected or deployed amidst great controversy, I examine the recent history and operations of the ecomaine integrated solid waste management facilities in Portland, Maine. This mini-case study is examined in the final chapter as a bridge between 'what has been' regarding WTE in the US and 'what could be' in the future, and also because the snapshot of ecomaine is instructive for imagining alternative models for waste management in the US than those which have dominated the thinking in Maui and Detroit. After the brief study of ecomaine, I offer some conclusions about the limits facing WTE in the US, and introduce my own perspectives on the role of WTE as a waste management technology. I also suggest some policy changes that could improve its uptake.

Chapter Summaries

As many texts do, this dissertation began with an introduction which not only outlined the purpose, scope, and methods of the project but also the theoretical foundations for the work itself. There is a tripartite rationale for choosing to investigate WTE: first, because waste management is a pressing environmental issue; second, because WTE has an interesting relationship not only with other solid waste disposal technologies but also sources of alternative energy; and third, because WTE has long been a source of controversy on environmental and social grounds. I suggest that there are three primary sets of barriers which have historically limited the deployment of WTE in the US:

1. Continued public fear over incinerator emissions and by-products
2. An unappealing and 'low-tech' image
3. Economic disincentives for project development

Before embarking on the research voyage to investigate these barriers, Chapter Two explores the bodies of research on waste, energy, and infrastructure emanating from academic geography, science and technology studies (STS), and environmental sociology. While each field has something of a tradition in each topical area, it is argued that new horizons may be opened through multidisciplinary work combining the specificity of STS projects with the scale-sensitivity and sensibility of interconnectedness associated with geography. Throughout this paper, the 'trails' followed and the means for doing so have been directly influenced by the traditions of actor-network theory, which suggest that only the actors embroiling themselves in a given controversy (in this case, whether or not to pursue WTE) need to be investigated. Thus, I employed the tools of discourse analysis to examine a range of government and news media texts while weighing equally the contributions of non-written and alternative sources.

This project has reinforced my understandings of actor-network theory and the power of discourse analysis. This research shows that WTE, like all technologies, is a fragmented entity whose true form changes in tune with the geographic and temporal contingencies in which it is being considered as a solution to a solid waste disposal problem. This relates back to the points raised at the start of this dissertation about the role of actor-network theory in 'bridging' and linking these fragmented dimensions. With regard to the social construction of technology, this project has shown how WTE is always being re-configured, both to meet particular technical demands but also, and perhaps more crucially, in the minds of the various parties considering its merits. Thus for some WTE is an economic issue, but for others a human health issue, and still others a set of questions about human-environment relationships. The social construction of technology school suggests (predicts?) that WTE was **always** going to be simultaneously all and none of these things, and this, I believe, adds a new dimension to work examining the relationships between space, place, and infrastructure.

These contributions to 'theory' are borne out through the case studies which are at the heart of this project. Chapter Three seeks to begin such work through the development of an historical geography of WTE around the world, but especially in the US and in the time since the passage of the 1965 Solid Waste Disposal Act by the federal government. The chapter presents a diagram of all the important actor-networks shaping the WTE industry in some way or another, but focuses on three in particular: the Office of Solid Waste at the US Environmental Protection Agency; the corps of engineering consulting firms informing both the EPA and municipal governments, and the professional organizations serving the solid waste industry through publications and conference events. These three sets of actor-networks are identified and examined because they, usually unintentionally, have done more than most others to fragment the various technologies of 'incineration' in such a way that most municipalities have no logical choice other than to pursue sanitary landfilling. I identify this fragmentation as disagreement over what exactly WTE is and what purpose it serves, and locate it as the foundation of the other problems that limit WTE in the US.

The insights and arguments from Chapter Three are brought to bear on two case studies in Chapters Four and Five. Chapter Four examines the historical rejection and contemporary reconsideration of WTE in Maui, Hawaii. The County of Maui has historically relied on dumps and landfilling to dispose of solid waste, despite the problems each poses in a tropical island environment. Despite the presence of disposal alternatives like WTE, citizens and the County alike instead have pursued a number of landfill diversion tactics like recycling and composting, even though these do not necessarily address the spatial problems of waste management on the island. WTE has been made to seem unnecessary because these diversion tactics have the extended the lifespan of the landfill while also supporting an environmentally progressive image. It remains to be seen how current negotiations over the possibility of introducing WTE – or a rival technology like pyrolysis or plasma arc gasification – will play out.

In contrast, Chapter Five presents the case study of the Greater Detroit Resource Recovery Authority WTE facility in Michigan, where the technology was actually selected and put into service. Although the plant eventually came to do its job properly and to the satisfaction of state and federal environmental regulators, the facility was never without controversy from the moment its pollution control equipment was called into question in the mid-1980s. On top of environmental and human health concerns, the facility has also raised serious questions about the financing of solid waste projects by cash-strapped local governments. Ultimately, these problems stem not from the technology itself, but rather the City of Detroit's efforts to rush the project into operation without fully addressing the concerns raised by project opposition.

There is no doubt that WTE projects are expensive, complex, and lengthy, requiring public support and political will far exceeding other types of infrastructure projects. However, WTE projects do not always need to end with an exhausted and dissatisfied citizenry. As a contrast to 'what went wrong' in Maui and Detroit, the following miniature case study of the recent history and operations of the ecomaine facility in Portland, Maine illustrates what can go right with WTE and offers a glimpse of what the future may look like for the technology in the US.

<u>ecomaine: WTE and Integrated Waste Planning</u>

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 21 municipality member-owners in southern Maine as well as 25 'contracted' communities, or a total population of about 330,000. The organization operates as a non-profit (ecomaine 2012d).

ecomaine started life in 1976 as a public regional landfill owned and operated as a consortium between Cape Elizabeth, Portland, South Portland, and Scarborough. Around that time, state government had introduced laws seeking to phase out privately-owned landfill sites. According to the Penobscot Energy Recovery Company, another firm operating a WTE plant in Maine,

> In 1977, 454 unlined "landfills" dotted the landscape, often located on or next to low-lying wetland areas or abutting streams. As environmental consciousness increased and the emerging science of hydrogeology demonstrated the harmful impacts to groundwater from unlined landfills, towns were encouraged to close their individual dumps in favor of regional landfill solutions. By 1989, when the Legislature enacted the Solid Waste Management and Recycling Act, only 185 local dumps remained in existence. Today, there are only seven municipal solid waste landfills in the state. (PERC 2010)

In the 1980s, while state environmental agencies closed dangerous dump sites, they also sought wholesale alternatives to landfilling. Momentum gathered behind WTE because it was seen as being able to generate revenue for the (mainly municipal) solid waste management bodies through electricity sales, and the volume reduction aspects of WTE would reduce spatial demands at existing landfills and therefore mitigate the need for expanding sites (ecomaine 2012a).

Additionally – and I think crucially – the state also "banned new commercial landfills, and directed communities to regionalize their programs for transportation and disposal of trash" (PERC 2010), meaning that most communities in Maine had 'something to lose' in solid waste management should a particular infrastructure plan fail. This can be contrasted with the experience in Metro Detroit, where communities *could* form regional authorities for waste, but these were frequently discriminatory (i.e., excluding Detroit) and did not necessarily result in truly regional comprehensive waste planning. As demonstrated, a number of solid waste authorities in Metro Detroit came to simply pool financial resources to pay for hauling to distant landfill sites, something that the Maine legislature effectively precluded.

At any rate, the forerunner to ecomaine – Regional Waste Services (RWS) – started construction on a WTE plant in 1986, and the facility began operations in 1989. Around the same time, WTE facilities also came online in Biddeford, Orrington, and Auburn, all the product of multi-community cooperative member-owner agreements. Those communities who did not buy-in as owners could still contract with the facilities for waste disposal, and this was a common option for smaller towns. Initially, WTE in Maine was predicated on guaranteed volumes of waste from member communities. This ensured both predictable revenue from tipping fees but also adequate fuel supplies to operate facilities and generate electricity. However in 1994, a US Supreme Court ruling on such 'flow control' regulations hit the WTE industry in Maine quite hard, and especially the operations of RWS (Richardson 1994). This was due in major part to the structure of the member-owner arrangements.

Although a *municipality* might be a member-owner and therefore not do anything to endanger the significant financial investment it had made in a regional WTE plant, the *privately-owned* waste collection and hauling operations did not feel the same pressure; after the flow control rulings, private firms were no longer obliged to bring waste to WTE plants if a lower tipping fee existed somewhere else. For RWS, this meant that Portland-area solid waste started to migrate to the WTE plant in Biddeford, which in 1995 charged about $15 less per ton (Richardson 1995b). RWS' budget shortfall was first estimated at a whopping $1.1m for 1995 (Richardson 1995a), but was eventually revised downward for two reasons: 1) the ability to ask member-owners to cover the short-term deficit, and 2) using proceeds from a growing recycling program to plug the debt.

About a year after the flow control rulings, the management board of RWS – composed of member-owner community officials – voted to increase the tipping fee charged at the WTE plant by about 50%, from $55 to $85 per ton (Hoey 1995). A number of policies were implemented to skirt the flow control ruling, either shifting collection from private contract to publicly-funded service or else stipulating in private contracts that haulers take their waste to a specific site.[1] At the same time, the board implemented new recycling programs which involved a mechanism for offsetting the higher tipping fees via rebates to member communities generated by the sale of recyclable materials. In other words, while tipping fees for using the WTE facility would be increasing, those higher prices could be offset through increased recycling (Thomsen 1995).

Recycling was not always a central feature of RWS: while accepting recyclable materials since 1990, the RWS board voted down the construction of a multi-million dollar recycling center in Gorham, ME in 1993. A rapid turnaround was needed to get a recycling program running, and especially one which could boost RWS' budget. The financial incentives proved enough for many communities to participate, however, and by 1996 RWS had earned a spot on Renew America magazine's "Environmental Success Index" for its recycling efforts ('Reporters' Notebook' 1996a), contributing to a 32% collective diversion rate for member communities ('Towns Miss Goal...' 1996b) and a projection to increase recycling tonnage by some 1,500 tons per year. ('Reporters' Notebook' 1996a). In just a few years recycling had become central to the finances and future planning of RWS' solid waste management program. By 1999 processing recyclable materials cost only $12 per ton while tipping fees for WTE hovered around $50, representing a significant incentive for member communities to collect recyclables and for RWS to process them (Pacillo 1999). Furthermore, in logic quite similar to that

1 This maneuver was permissible since the contract was one which haulers entered into 'voluntarily' (though some haulers noted otherwise, Hench 1996), not unlike the agreement between City of Detroit waste collection and the GDRRA.

observed regarding the Central Maui Landfill, each ton of waste diverted from the WTE boiler took pressure off the need to expand the facility. In this way, WTE and recycling came to operate in a somewhat symbiotic fashion.

That should not suggest that RWS' operations proceeded completely free of environmental challenges however. In 1997, the Maine Department of Environmental Protection charged RWS with violating state emissions laws more than 1,000 times since 1992 and sought over $500,000 in fines (Bradbury 1997a), and concerns were starting to emerge about mercury emissions from WTE plants across the state (Bradbury 1997b). While the facility in Detroit faced similar challenges earlier in the 1990s, questions about environmental performance there became a confrontation between City, state, and federal officials whereas in Maine they did. In fact, just a year after the pollution allegations were made, RWS settled with the State of Maine to pay an approximately $100,000 fine but also install new pollution control equipment within two years (Bradbury 1998). Furthermore, RWS agreed to begin collection of household hazardous waste (HHW) – the toxic, reactive, and corrosive materials behind the dangerous emissions in the first place – by mid-1999, leaving regulators, environmentalists, and RWS managers equally satisfied with the outcome (Bartlett 1999). By 2002, RWS had become the first municipally-owned and operated waste management facility in the US to achieve ISO 14001 certification for its environmental protection systems ('Regional Waste Systems...' 2002).

Changes to electricity regulation in Maine caused significant financial problems at RWS from 2002-2005, but this was an issue largely out of the hands of the organization. RWS emerged from the crisis in 2005 as 'ecomaine – the future of regional waste systems' with a new director, streamlined executive board, and growing customer base (ecomaine 2006). Recycling continued to play a significant role in the operation and finances of ecomaine. In 2007 recycling generated more than $2.1m in revenues, approximately $500,000 of which was 'profit' for the recycling operations. While the 'great recession' of 2008-2010 impacted solid waste volumes, ecomaine was able to maintain fiscal stability through creative use of its facilities. Like Michigan, there is a seasonal rhythm to solid waste management in Maine which sees volumes rise in warmer months. Typically ecomaine would utilize its ashfill facility as an overflow site to store waste for the WTE plant. When waste volumes fell in the late 2000s, the ecomaine could not utilize its excess seasonal waste but was also able to 'mine' the former landfill site from the 1980s and 1990s to use as fuel in the WTE boilers (Roche 2012).

Currently, WTE at ecomaine generates approximately 100,000 Mwh of electricity each year, resulting in sales of more than $6 million (ecomaine 2012c). 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 2012b). In 2010 the facility processed more than 35,000 tons of recyclable materials worth about $3.5m (ecomaine 2011). 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, allowed the facility to eliminate all debt (Bouchard 2012) – a remarkable feat given that not even ten years prior, RWS/ecomaine held an estimated $70m of debt on its operations ('Editorial' 2003) associated with revenues lost from electricity deregulation.

Environmentally, 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 2011). 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.

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; more importantly, ecomaine achieves waste management goals at a scale few to no recycling, composting, or alternative energy conversion technologies could hope to achieve. This runs entirely counter to the history of WTE in the US. For example, in *The Sanitary City*, Melosi argued that:

> the inability of incineration to become the dominant option was the result of...assumptions that incinerators could not overcome their environmental liabilities; their value met only specific disposal needs; and the production of usable by-products [like scrap metal and electricity] did not outweigh other liabilities. (2000, 407-8)

Incineration with and without energy recovery was seen as running counter to an emerging ethic of resource re-use, even as the industry and various circles of politicians sought to include WTE as an environmentally-progressive waste management strategy.

This is not the case with ecomaine. In many ways ecomaine is successful because it overcomes this type of fragmentation that plagues WTE elsewhere. It is clear that the technology plays a specific and central role in the context of ecomaine's facilities (Figure 6.1), but never do ecomaine officials suggest that the technology is by itself the best means of managing solid waste. According to ecomaine general manager Kevin Roche, "WTE is really just a step above landfilling," but a far preferable step, and that while "the facility does not claim to be perfect, it does claim to be better than all alternatives." (Roche 2012).

Taking a step back, there are a few points to be made about why ecomaine succeeds where the GDRRA and to some extent, Maui, have failed. First, is that ecomaine is a truly regional organization – from planning to operation – dealing with the issues of a 'waste-shed' (akin to a watershed) rather than a patchwork of individual community problems and preferences. Crucially, this regional approach is backed by the state. Second, and related to the first point, is that ecomaine has an holistic approach to waste management. Recycling is important not only for its environmental benefits, but also because it reduces demand on the WTE plant and generates revenue; likewise,

Figure 6.1: Integrated disposal processes at ecomaine – recycling, WTE, and ashfill (photos by author)

WTE not only reduces volume but generates electricity for sale but also to meet the needs of the recycling operations. ecomaine's ownership of a dedicated incinerator ashfill restricts costs and allows for the temporary storage of surplus waste. Finally, ecomaine approaches environmental concerns not as potential cost sinks, but rather an opportunity to flaunt credentials. Whereas GDRRA emissions tests are unpublished or made available years after the fact through a password-protected website that the operation must grant specific access to,[2] ecomaine's test results are published freely on its website and updated at least annually. ecomaine's commitment to environmental transparency keeps public debate focused on larger issues than individual test results while also limiting speculation that the plant is 'unsafe'.

ecomaine, the GDRRA, and Maui all use (or would have used) fundamentally similar WTE technology to process solid waste, and yet three widely divergent outcomes have been achieved. It is at this point that we have reached the end of this project and can reflect, by way of some conclusions, on the findings.

Conclusions: WTE and the Geographies of Technology

The Barriers Limiting WTE in the US

Chapter One suggested that the barriers limiting deployment of WTE in the US center on public health and environmental fears, a 'low-tech' and unappealing image, and economic disincentives for project development. At this point, it is worth evaluating the accuracy of this suggestion and the extent to which each set of barriers impacts WTE based on the research conducted for this project.

Concerns over the environmental impacts of WTE do certainly persist. However, fears over the toxic emissions associated with WTE seem to have largely abated with the passage of the federal Clean Air Act Amendments in the early 1990s and the requirement that facilities install additional pollution controls. Although fears over

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2 And to which, I was not granted access.

emissions toxicity continue to be raised at the Detroit WTE facility, I feel that this is more a result of the City refusing to directly address environmental concerns raised in the 1980s than a recurring issue with the facility violating emissions rules. Ecomaine has also seen these concerns about environmental impacts raised, but has chosen to address them in a completely different fashion than the GDRRA by opting for transparency and a willingness to embrace improvements in pollution control technology.

I do not get the sense that concerns about air, water, and land pollution will haunt WTE in the US if new facilities are pursued. It seems as though the industry has learned its lesson about accepting and working with environmental regulations rather than fighting them. In fact, as climate change becomes an increasingly prominent issue, WTE's more careful attention to its emissions has made it more credible in claims that it is a fairly 'green' technology, especially when compared to fossil-fuelled electricity and the methane releases associated with landfilling.

However, other types of environmental concerns about WTE will become more prominent. Chief among these is the sentiment that many environmentalists identify in their opposition to WTE, namely, that as a society, 'we can do better' than burning our waste because intensive recycling and composting represent a more efficient recovery of resources than combustion (e.g., Seldman 2012). This was witnessed to some extent in Hawaii, when in the late 1970s composting advocates argued that returning organic materials to the soil via composting would have greater environmental and food security benefits than landfilling or incineration. More recently, others have taken issue with the inclusion of WTE as an approved source in some states' renewable energy programs given the inherent 'un-sustainability' of its fuel supply (e.g. National Resources Defense Council commentator Allen Hershkowitz 2011).

As a slight digression, but also as a notice of intent for future research, it is worth consciously noting the distinction in phrasing between 'waste-to-energy' (US) or 'energy-from-waste' (European), 'incineration' (most environmental groups), and 'combustion with energy recovery' or 'energy conversion' (many engineering consulting firms). I did not anticipate at the start of the project that different groups would use the naming of the technology to achieve particular 'framing' outcomes. In other words, it is not accidental or entirely innocent that US WTE firms prefer the phrase 'waste-to-energy' while environmental advocacy groups, including some zero waste groups, describe WTE as 'incineration' and thereby link modern WTE to the toxic facilities of the mid-20th century. In retrospect an analysis of the language of WTE should have been an obvious topic for a project relying on discourse analysis, however it was not so. A future project investigating the origins of the phrase 'waste-to-energy' and the various contexts in which this language was born is intended as a follow-up to the dissertation.

The barrier that WTE is perceived as being 'low-tech' seems to be spot on, and has its roots in the fragmentation processes described in Chapter Three. I initially thought that this view would be held by the general public and observable in news media accounts of WTE project development and coverage of waste management. While this is true to some extent, perhaps among the most 'fundamentalist' environmental activists, the major wellspring of the perspective the WTE is low-tech is within the solid waste industry itself. To clarify, I'm not arguing that the solid waste industry sees WTE as primitive, but that at industry conferences like NAWTEC and WasteCon (discussed in Chapter Three), there is a great deal of hype generated around alternative energy recovery technologies *as improvements to what WTE could ever offer*. Sometimes, it seems as though the US solid waste industry itself is wringing its collective hands over the technological suitability of WTE, holding off on developing new projects because something 'better' might be just over the horizon. This line of thinking sometimes gets passed on to municipal decision makers, as has happened in Maui.

This seems only to be true for the US industry however, as European and Asian firms long ago dismissed alternatives to WTE as economically or environmentally unworkable. To further contrast the situation in these regions with that of the US – where WTE operations look typically like industrial warehouses – we can look to the ways in which European and Japanese WTE facilities actively draw attention to their locations in the center of heavily populated areas as well as their functions in the urban metabolism through bold architecture, vibrant colors, and even the incorporation of recreational activities (Figure 6.2). The Amager Bakke WTE facility, currently under construction in central Copenhagen will include a year-round synthetic ski slope running from the top of the facility into a nearby park and there are plans for its water vapor emissions to be shaped into rings and illuminated by lasers (designboom 2013).

Third, there is a significant barrier of economic disincentives limiting WTE project development. To anyone aware of the financial restrictions facing all levels of government, that the issue of costs is raised as a reason why certain types of infrastructure are chosen over others will come as no surprise. 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 Solid Waste Association of North America (SWANA, discussed also in Chapter Three), 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

Figure 6.2: High-design meets WTE in advanced facilities outside the US. Left, artist depiction of proposed Amager Bakke WTE, Copenhagen, Denmark (RAMBOLL Engineering 2012) . Right: Ariake WTE, Tokyo, Japan ('Waste-to-Energy Plants...' 2012)

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 hypothetical regional landfill (ibid.). We can also recall the situation in Maui, where officials stuck with flawed landfill diversion programs like recycling and composting – even though not necessarily 'solving' the spatial problems of waste disposal – because of their relatively low costs (being run mostly by non-profits and private citizen groups) and the contribution that such diversion efforts made to an ecologically-progressive image.

But the question of costs is not as cut-and-dried as it may first appear. Consider that, according to SWANA,

> 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, and WTE may (however, historically this is rarely absolutely true) offer such stability. However the question of facility costs can be computed in more than one way. 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 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. 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).

Furthermore, and to come full circle back to where this dissertation began, WTE is a technology which can mitigate many of the environmental costs of landfilling and producing electricity with fossil fuels. These sorts of costs are only beginning to be factored into federal and state, let alone county and municipal government decision-making. But if they are taken seriously and given weight equal to the pure financial costs of a given waste disposal project, then WTE may once more become an attractive choice to a range of cities and regional waste management bodies.

A Verdict on WTE and Some Policy Suggestions

An important factor in this research has been my personal concern with the protection and conservation of the natural environment. In a country facing rising solid waste volumes (U.S. EPA 2010, 3), but dwindling disposal and treatment sites; growing electricity consumption (U.S. EIA 2010, 258) bearing increasingly heavy environmental costs; and mounting pressure to address environmental issues of water and air quality, land degradation, and their associated potential for dramatic global environmental change; greater use of a technology which not only reduces the volume of solid waste by 80% but also offsets the use of more toxic electricity sources like coal and nuclear power seems like a smart idea. I think modern solid waste incinerators are largely beneficial in terms of environmental protection, and that we should embrace them in the United States in the same ways that our European and East Asian neighbors have in their cities.

However, I do not pretend that WtE is a technology without serious limitations regarding the goal of environmental protection – not least of which is the inherent un-

‘sustainability’ of its main fuel source, municipal solid waste, and the various capitalist predilections towards over-consumption and excess that underpin its production. Contemporary WtE may well exacerbate waste production trends, and thus any efforts at greater implementation must be carefully evaluated in terms beyond the simplistic cost-benefit analyses and environmental impact statements conventionally deployed, to include the impact WtE could have on raw materials extraction, transportation, and other industrial processes.

With all that in mind, my personal conclusion about WTE is that it is an excellent option for the indefinite medium-term of solid waste planning. The principles of waste reduction through source reduction, as embodied by Zero Waste advocates as well as the current administration of the US EPA, are admirable and necessary for any sort of ecologically ‘sustainable’ future. The transition to a zero waste world, however, where nothing is landfilled and everything recycled or composted, is undoubtedly decades if not centuries away. Radical shifts in manufacturing techniques, materials policies, and last but certainly not least, consumer behavior and expectations, will be slow to implement. This begs the question: what do we do in the meanwhile? To me, it seems preferable to recover both materials and energy through combined recycling and WTE programs like the one at ecomaine, until the day comes when no more fuel is generated for WTE boilers in the first place.

Melosi (2005) argues that debate over incineration-based technologies is on many levels related to the disagreement between those seeking a ‘technological fix’ and those seeking meaningful societal and behavioral change. While I think that this may have been so during the 1970s, 1980s, and early 1990s, at the time of writing I do not believe this to be the case any longer. 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. To me, it is no surprise that WTE comprises a key aspect of the operation and that the technology plays a crucial role in the economic viability of the organization. While accomplishing its waste disposal goals, ecomaine also creates opportunities for consumer education (for instance, on recyclable materials and the problems associated with household hazardous waste) and leaves open opportunities to embrace emerging re-use and recovery technologies involving organic materials (like composting or anaerobic digestion) that would be part and parcel of any sort of sweeping attitudinal shifts towards solid waste management.

Although some may argue that features of ecomaine, such as its cooperative business model and non-profit status are unique to that 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. Actually, this idea is not new; it was mooted in Michigan in the late 1970s but never adopted. Harvey Gershman, principal and founder of engineering consulting firm Gershman, Brickner and Bratton mentioned the exact same policy to me at the North American Waste-to-Energy Conference in Portland, Maine in 2012, but said that such action is limited primarily by a lack of political will.

Perhaps a more savory taxation policy would center on the funding of additional pollution control equipment. Money from a tax on landfilling could be distributed to a fund for purchasing state-of-the-art pollution control equipment for WTE plants new and old. Given the problems that changes in regulations caused the GDRRA facility – and the way in which quibbling over the cost of additional pollution control equipment almost ended the project – it makes sense to have a fund available that firms can draw on to install new technology. This may also assuage the fears of those worried about the negative public health impacts of WTE by making funds available for facilities to respond to advances in environmental science without resorting to pronouncements of either 'financial crisis' or 'regulatory meddling.'

Also on the financial end, 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. Also possible is a sort of reverse flow control of the sort associated with the 'authorities' for solid waste disposal discussed in Chapter Five, or also the sort of member-ownership illustrated in the snapshot of ecomaine. A reliable waste stream is essential for project financing, and these sorts of flow control options could perhaps keep such costs in check.

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.

The use of WTE, like all technologies, differs across space for reasons attributed to economics, politics, and culture, but also limitations imposed by the physical environment as well as the technology itself. This dissertation has illustrated that there is no single reason why WTE is used in some places but rejected in others. Each decision to adopt or reject WTE as a means of solid waste disposal is founded on factors unique to the times and places in which that decision is made.

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