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Alternative Waste Solutions for the Pacific Region: Learning from the Hawai‘i Experience

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SUMMARY With limited space and ever-growing trash, the islands of the Pacific share unique challenges managing their solid wastes. The traditional approach has been to collect waste in open dumps and landfills. But overwhelmed sites and unsanitary conditions are driving governments to seek alternative solutions. Hawai‘i has implemented “resource recovery” systems in past decades to deal with waste, including an innovative energy-from-waste project on O‘ahu, and a recycling/composting program on Maui that focuses on diverting material from landfills. While both have been successful in reducing waste and generating products, the programs have also endured unexpected delays and problems. Despite differences in scale and capacity, the Hawai‘i experience offers insights for other Pacific islands into how to tackle their own solid waste management issues, and create systems and policies that deliver the greatest ecological and economic benefits.

What Do We Do with Waste?

Every human community generates waste that must be disposed of and accumulated material that must be managed. The standard practice in many areas has been the use of open dumps or landfills. In dumps, waste is deposited straight into an open space. Landfills contain contaminates and improve sanitation by using liners, covers, and compression techniques. Costly to maintain, these sites can be unpleasant-smelling areas that host disease-spreading mosquitoes and rodents. Most challenging for island settings, dumps and landfills are dependent on abundant space, which can be in short supply.

Given the hazards and limitations, many communities are searching for alternative solutions for solid waste management (SWM). Finding the optimal system requires a mental shift: waste should be viewed not only as a problem to be solved, but also as a resource that can pay economic and environmental dividends.

Rich opportunities exist in the variety of "resource recovery" programs in place around the world, including Hawai'i and the Asia Pacific region. Resource recovery practices range from basic composting of organic materials and processing plastics, aluminum, and newsprint to advanced technologies such as anaerobic digestion, waste-to-fuel, and the incineration of waste to generate steam and electricity (energy-from-waste, or EFW). Among other benefits, these efforts can reduce the volume of solid waste, offset the need to import fuel, and spur local businesses.

Resource recovery projects often become muddled by a lack of agreement on purpose or desired outcomes

Despite the positive impacts of resource recovery, the policy contexts shaping these projects often become muddled by a lack of agreement on project purpose or desired outcomes. The result can be wasted funds, political infighting, and, ultimately, suboptimal infrastructure for solid waste management. Since the 1960s, the US state of Hawai'i has had experience with design and implementation of many resource recovery systems. In two particular cases—the urban area of Honolulu and the more rural island of Maui—both the successes and limitations of the programs suggest lessons for other island nations and territories in the Pacific.

Honolulu hosts Hawai'i's only—and one of the largest in the United States—energy-from-waste (EFW) facilities, burning the vast majority of O'ahu's waste while meeting up to 10 percent of the island's electricity needs. Maui, with a much smaller population and more limited economy, has relied instead on channeling both organic and recyclable materials from landfills to composts and recycling centers, largely through a network of public-private partnerships. In both instances, Hawai'i's experience with solid waste management over the past 50 years clearly illustrates the importance of simultaneously considering physical conditions, community dynamics, and the potential impacts and synergies on other environmental infrastructures.

Understanding how resource recovery programs work, and the challenges and benefits involved, provides insights into effective solid waste management policymaking, with applications across the Asia Pacific region. While Japan, China, and South Korea are already intense users of various resource recovery systems, and the economically expanding countries of Southeast Asia are beginning to express interest in these technologies, smaller and less economically developed islands in the Pacific region may benefit the most from looking at the Hawai'i experience.

Solid Wastes: Both Problem and Resource

While managing waste is a universal problem, communities in the Pacific region face important additional challenges. Many islands contend with debris and other ocean-borne solid wastes carried to shore by currents. Consumer habits and dietary practices, in addition to relative isolation, have led to a heavy reliance on imported goods, most of which come with disposable packaging materials. Typhoons, in addition to their tremendous human and economic tolls, also leave significant trails of building, automotive, and marine debris. Such disasters can place significant burdens on already strained solid waste management infrastructures.

Most islands have sharply limited land available for managing solid wastes, limitations further complicated by fragile ecological conditions, a desire (or obligation) to preserve spaces of cultural significance, and complex land tenure systems. Thus, construction and operating costs in the region are high, and governments

often ignore illegal disposal sites or invest in only minimally acceptable sites with low up-front costs. The most common waste disposal tactic has been the open dump, and virtually all Pacific islands utilize them, even when other disposal options are also in place.[1] Both dumps and sanitary landfills are prone to threats like sea-level rise (especially for atoll communities), tsunami damage, and flooding that can disperse wastes and toxic waste by-products into both freshwater and marine resource areas.

While dumps and landfills foreground the economic and ecological liabilities of waste, other practices highlight its potential as a resource. Recycling focused on plastic, paper, and metals can generate inputs for local economies, with sales offsetting the costs of collection and processing. Separating organic materials (green wastes, food wastes, and other biodegradable substances) from the waste stream not only extends the working life of dumps and landfills, but also produces valuable agricultural inputs through processes such as composting—useful in supporting local farming and offsetting the need to import food. Limiting the amount of material entering a landfill or open dump mitigates the risks of that facility.

Recycling and composting are increasingly common in the Pacific, yet rarely address the question of waste disposal

Recycling and composting are often the first steps taken to improve solid waste management systems, and are increasingly common components of systems used in the Pacific islands. However, while collecting wastes for recycling and composting can mitigate many problems, this rarely addresses the question of actual waste *disposal*, as there is little guarantee that the diverted materials will find a buyer or processor. More advanced technologies and processes can offer additional benefits in the form of guaranteed waste disposal and positive economic impacts. Controlled types of incineration, such as energy-from-waste, can reduce waste volumes by 90 percent while generating reliable flows of steam and electricity. Energy-from-waste residuals can be used for construction work calling for cement-like materials. Other technologies, such as plasma-arc gasification, transform waste into synthetic gasses that are useful as fuel. Still others, such as emerging plastics-to-oil technologies, convert waste plastics into a form of crude oil. Finally, anaerobic digestion can break down organic materials (including, potentially, wastewater treatment by-products) to produce gaseous fuels, along with a compost-like product substituting for synthetic fertilizers. These technologies could be beneficial for islands by eliminating volumes of solid waste while offsetting imported materials.

Trends Affecting the Pacific Region

Efforts to enhance solid waste management infrastructures in the Pacific region began more than two decades ago, but had only limited impacts. Since the early 2000s, a crucial partnership has boosted new developments in solid waste management. The research and capacity-building programs of the Secretariat of the Pacific Regional Environment Programme (SPREP) and its affiliated J-PRISM (Japanese Technical Cooperation Project for Promotion of Regional Initiative on SWM in Pacific Island Countries) are advancing the state of knowledge about solid waste management and serving as a regional forum for project discussion and collaboration.

While a great deal of "baseline" data for the Pacific islands—such as volumes of waste generated, seasonal variations, waste stream compositions, and inventories of facilities and equipment—remain incomplete, six significant trends can be identified.

First, sanitary landfills, even when properly constructed and maintained, are not suitable long-term alternatives to dumps in the majority of islands, since they are vulnerable to the same environmental threats as dumps.

Fortunately, and second, the majority of the waste stream in the region as a whole and also in most individual islands is recyclable, compostable, or reusable. One report estimates that approximately 60 percent of the regional waste stream (by weight) is composed of biodegradable materials that are manageable by non-landfill means.[2]

Third, although the ability to implement new infrastructures is frequently limited by financial and institutional concerns, many islands are taking the challenges of solid waste management seriously, especially as their economies and the volume of imported materials grow. In this arena, Tonga is typically highlighted as an example of progress. Public and private sectors alike have made considerable investments in the system there, including construction of a sanitary

landfill in a disused quarry site, coupled with intensive landfill diversion efforts such as recycling and composting aluminum and green wastes. Efforts have also expanded to encompass the management of more problematic materials, such as abandoned cars, used batteries, and hazardous chemicals. Many of these initiatives, led by the private sector, were facilitated by passage in 2005 of the Tonga Waste Management Act.[3]

Despite these improvements, additional trends point to challenges facing solid waste management in the Pacific.

Specifically, and fourth, is the reality that without strong local markets for recycled materials and composts, generating them is at best a stopgap measure. Even in larger economies, recovered materials can be difficult to sell, and an emphasis on them may result in multiple sorted volumes of waste, but no clear plans for disposal.

Without strong local markets for recycled materials, landfill diversion techniques are a stopgap measure

These problems are frequently compounded by a fifth trend, poor collection practices. Solid waste management systems premised on recycling or composting can only be as strong as the collection system feeding them properly sorted materials. Several reports indicate that in islands such as Tonga, as well as other communities in the broader Asia Pacific region such as Vietnam, Sri Lanka, and Cambodia, irregular or improper collection service will negate the benefits of recycling and composting programs.[4] One analysis by the Asian Development Bank estimates that fully one-third of all solid waste on Tonga goes uncollected, effectively starving the recycling process of the very materials it needs to gather and sell in order to remain economically viable.[5]

Sixth, and finally, concerns about financing permeate every aspect of solid waste management in the Pacific region, from constructing properly designed landfills and operating energy-from-waste or other conversion facilities to building a fleet of collection vehicles, paying workers, and developing markets for recovered materials. Each of these activities is expensive and requires long-term economic support. For many islands, buying and implementing the necessary technologies and processes are extremely difficult without substantial external financial support from the private sector, foreign governments and aid agencies, or international development institutions.

Policymakers and the public sector in Hawai'i have faced many of the same challenges managing solid waste as have their colleagues elsewhere in the Pacific. While Hawai'i's population and economic activities are an order of magnitude greater than those in other islands, and thus comparisons do not perfectly align, understanding the Hawaiian Islands' experience can inform the responses of other Pacific islands in meeting their pressing solid waste management challenges.

Lessons from the Hawaiian Islands

Solid waste management planning in Hawai'i began in the 1960s. State officials selected as their first goal the closure of all dumps in the islands, since they were unsightly and sources of both disease and groundwater pollution. Local governments were offered aid in their transition to alternatives. Though all agreed that dumps were problematic—and also that sanitary landfills were, at best, a temporary solution and, at worst, an ecological liability—there was conflict over what would replace them.[6]

Some argued that given the makeup of the islands' waste stream (which contains a significant amount of organic materials, similar to other Pacific islands), the reliance on imported materials, and the decreasing productivity of agricultural lands, an intensive program of recycling and composting (a dual strategy referred to as "landfill diversion") was the most desirable course of action. Those favoring combustion-based technologies—including not only some large landholders and commercial interests, but also other environmentalists—countered that technologies such as energy-from-waste offered even more benefits. Not only would the technologies reduce the volume of waste materials, but they would also—by generating electrical power—offset the need to import fossil fuels. Furthermore, with proper siting, an energy-from-waste facility could support struggling sugarcane or food processing operations by disposing of their wastes while subsidizing their electricity costs, thus building on a tradition of cane bagasse–to–energy combustion that had persisted for decades.[7]

State officials ordered the county governments to produce individual solid waste management plans reflecting local situations and sensibilities. A comparison

of the solutions reached by two different counties illustrates the variety of responses to their specific problems.

The City and County of Honolulu (Island of O'ahu). As an urban metropolis of several hundred thousand people, Honolulu generates significant waste volumes. Accordingly, while interest in recycling and composting was and remains strong on O'ahu, the argument for energy-from-waste has historically had great traction there. Owing perhaps to the fact that the US military, sugarcane plantations, and the city government had already operated incinerators around the island for much of the twentieth century, the City and County of Honolulu, in conjunction with the State of Hawai'i, conducted several studies on the feasibility of additional, high-capacity incinerators that would manage O'ahu's solid wastes. In the late 1970s, the city inaugurated the Honolulu Program of Waste Energy Recovery, or HPOWER, with the intent of largely eliminating the need for landfills on the island, while also generating a reliable flow of electricity.

As stakeholders wrestled over potential HPOWER locations, solid waste volumes mounted

Despite a clear "fit" between the energy-from-waste technology and the solid waste management needs of O'ahu, significant challenges dogged the project. Controversy erupted over facility siting. Arguments emerged in favor of different sites: an industrial area in western O'ahu (which could potentially disrupt important Native Hawaiian historical and archaeological sites), a site offered by sugarcane plantation owner Amfac (which had a whiff of back-room dealings surrounding it because of plans to also burn that facility's bagasse and provide its operations with cheap electricity), or a third site much nearer to downtown Honolulu (potentially disrupting tourism and exposing the population to toxic emissions). Each potential site came with its own unique financing, construction, and operational concerns, and each became the subject of such intense scrutiny that operations at HPOWER did not commence until 1990, nearly a decade after the proposed startup date. Compounding these struggles was a changing suite of environmental regulations from both the state and federal governments.

Honolulu's experience pursuing an energy-from-waste system offers important lessons for public officials and policymakers. The first is that technologies must be considered in tandem with the specific communities where they will be deployed. If this symbiotic relationship is ignored, then significant delays, problems, and cost overruns are likely. As stakeholders wrestled over potential HPOWER locations, solid waste volumes mounted and alternative landfilling became necessary—ironically exposing communities to the very problems that HPOWER was intended to prevent. Second, Honolulu's experience illustrates the importance of thinking through the impacts that waste management technologies have on one another. For example, the implementation of energy-from-waste in Honolulu sharply curtailed the value and importance of recycling and composting on O'ahu, since pursuing either of these activities would, in effect, limit the flow of fuel to the HPOWER facility. In many ways, all of O'ahu is "locked in" to the HPOWER system for the foreseeable future.

The County of Maui (Islands of Maui, Moloka'i, and Lana'i). Maui had long hosted several dumps and, despite efforts to comply with state demands to close them, was far slower in identifying and implementing alternatives. County officials investigated energy-from-waste, recycling, and composting systems in the 1980s, but all were dismissed in favor of the construction of a large, sanitary landfill near the center of the island. Inevitably, as the landfill approached capacity, disposal fees rose and strained the budgets of those paying for waste collection. As a result, by the early 1990s, the technologies and processes that emerged on Maui emphasized recycling and composting rather than waste disposal activities such as energy-from-waste. These efforts were led primarily by private-sector actors seeking to achieve cost savings, rather than to allay environmental concerns and recover materials.[8]

Several studies show that recycling and composting—beginning first with materials like glass, aluminum, and some plastics, but expanding in the 1990s to include green wastes and at one point sewage biosolids from the county wastewater treatment facility—were highly effective in extending the working life of the landfill.[9] These diversion efforts also spurred the growth of small businesses in areas like waste oil–to–biodiesel refining, synthetic lumber production, and compost production.

At the same time, around the turn of the twenty-first century, some estimates suggested that while as

much as 85 percent of Maui's waste stream was composed of recyclable or compostable materials, the vast majority of that stream was still sent to landfills due to inefficient collection practices. In the opinion of many on the island, it was, and remains today, quite difficult to rely on recycling and composting systems, which require residents and businesses to self-haul separated wastes to appropriate collection sites, rather than having them collected and delivered to county facilities. Despite the impediments to public participation, the *relative effectiveness* of landfill diversion on Maui was still strong enough to discourage officials and public institutions from considering additional improvements to waste collection. This lapse in planning will eventually cause new challenges, as continued landfill expansions become increasingly costly. Furthermore, the sale of recovered materials has proven highly reliant on international buyers and markets, introducing a degree of price volatility that makes long-term planning more difficult.

The Pacific region should devote attention to advanced disposal technologies

In contrast to Honolulu, Maui's experience offers insights to islands seeking to emphasize processes in their solid waste management systems that divert materials from landfills. The Maui case demonstrates that these processes can spur private-sector innovation and growth, but that careful attention must be paid to ensure that markets exist, or can be created, for the products that are collected. In addition, a reliable collection system must be in place to increase participation, and thus the quantity of material diverted from landfills.

Conclusions and Recommendations

Solid waste management in the Pacific region is in a period of rapid positive change, as many island governments, public institutions, and private firms seek to mitigate an increasingly significant ecological risk. Many Pacific islands, and especially those engaging with the advice and programs of the SPREP, are rightfully pursuing institutional capacity-building and basic improvements to solid waste management infrastructures. They are emphasizing the shift away from open dumps toward sanitary landfills, along with strategies such as recycling and composting.[10] Yet, the region should also devote attention to longer-term waste management strategies that emphasize advanced *disposal* technologies.

Disposal technologies are key. Around the world, advanced technologies such as energy-from-waste, anaerobic digestion, and other waste-to-fuel technologies dramatically reduce the volume of waste while offsetting the importation of fossil fuels and fertilizer. The combination of these two factors makes such technologies appropriate for Pacific islands. Most significantly, these technologies have proven to function properly at the scale necessary for small islands. More specifically, in places producing greater volumes of waste, efforts to "scale up" these processes to the capacities necessary to be economically viable have faced significant challenges.[11] However, experience demonstrates that they can work properly to process the volumes of waste common to the Pacific region (see Figure 1).

This conclusion arises from careful consideration of the Hawai'i experience in assessing and implementing solid waste management strategies. For instance, although sincere interest in landfill diversion practices such as recycling and composting exists, evidence from Maui shows that these are at best temporary fixes or supplemental activities to the larger problem of solid waste *disposal* in island environments. While Maui has pursued recycling and composting programs at different times since the late 1980s, a stable and effective recycling program remains elusive due to the relatively low quantities of materials collected and processed each week. In addition, long-term planning has been hampered by the price volatility inherent in selling recovered materials to international buyers and markets. Since most Pacific islands are demographically and economically smaller than Maui, it seems likely that landfill diversion will encounter serious viability issues in the medium- to long-term timeframe of 10 to 20 years.

In contrast, technologies such as energy-from-waste, anaerobic digestion, and waste-to-fuel conversion could provide a predictable waste disposal capacity and local substitutes for imported energy, as well as industrial and agricultural materials. Instead of stopping the conversation about improving waste management with proper sanitary landfills and landfill diversion techniques, islands should plan for strategically located

There is great scope for external financing for solid waste management projects in the Pacific region

biorefineries, anaerobic digesters, plastic-to-oil conversion facilities, or perhaps even modular energy-from-waste facilities. Any of these technologies could play an anchoring role in the development of complementary environmental infrastructures through planning for by-product synergy. For example, it might be feasible to link together the material flows from wastewater treatment, solid waste processing, and desalination facilities to provide these three necessary environmental services more efficiently than operating each individually. In the early- and mid-1990s, Maui was able to co-compost green wastes along with sewage biosolids and solve both solid waste and wastewater treatment problems simultaneously.

Disaster mitigation or an opportunity for growth. Regardless of the approach selected, whether by individual islands, multilateral collaborations, or the Pacific region as a whole, the Hawai'i experience illustrates the importance of thoroughly planning out the selected waste management system, and troubleshooting possible problems and impacts. Equally important is for communities to plan for financing. In this area, there are no specific lessons from the Hawai'i experience, because financing both individual facilities and continued operations has proven to be highly problematic in the islands. While there may be synergies between particular industries and an individual facility that could open opportunities for the co-financing of projects—such as the collaboration between HPOWER and one of Amfac's sugarcane processing facilities at a proposed energy-from-waste site—at the moment many Pacific islands simply lack the budget necessary to pursue the types of infrastructure mentioned in this article. Fortunately, there is great scope for external financing for solid waste management projects in the region. While some projects, like those in Tonga, have been supported directly by foreign governments (Australia, in the Tongan case), it seems likely that future projects, especially those utilizing advanced technologies to mitigate release of the greenhouse gasses carbon dioxide and methane, could qualify for different types of funding

Country Name	Total TPD	Compostable TPD	Plastic TPD	Glass/Ceramic TPD	Metal TPD	Paper TPD
Cook Islands	9	2	2	2	3	0
Fiji	368	269	25	14	5	42
Kiribati	32	16	2	4	3	2
Niue	1	0	0	0	0	0
Palau	5	0	2	0	1	1
Papua New Guinea	2654	1338	340	239	326	316
Samoa	86	56	8	2	7	7
Solomon Islands	321	207	54	14	20	19
Tonga	84	40	4	3	7	26
Tuvalu	4	2	0	0	0	0
Vanuatu	124	36	23	23	12	19

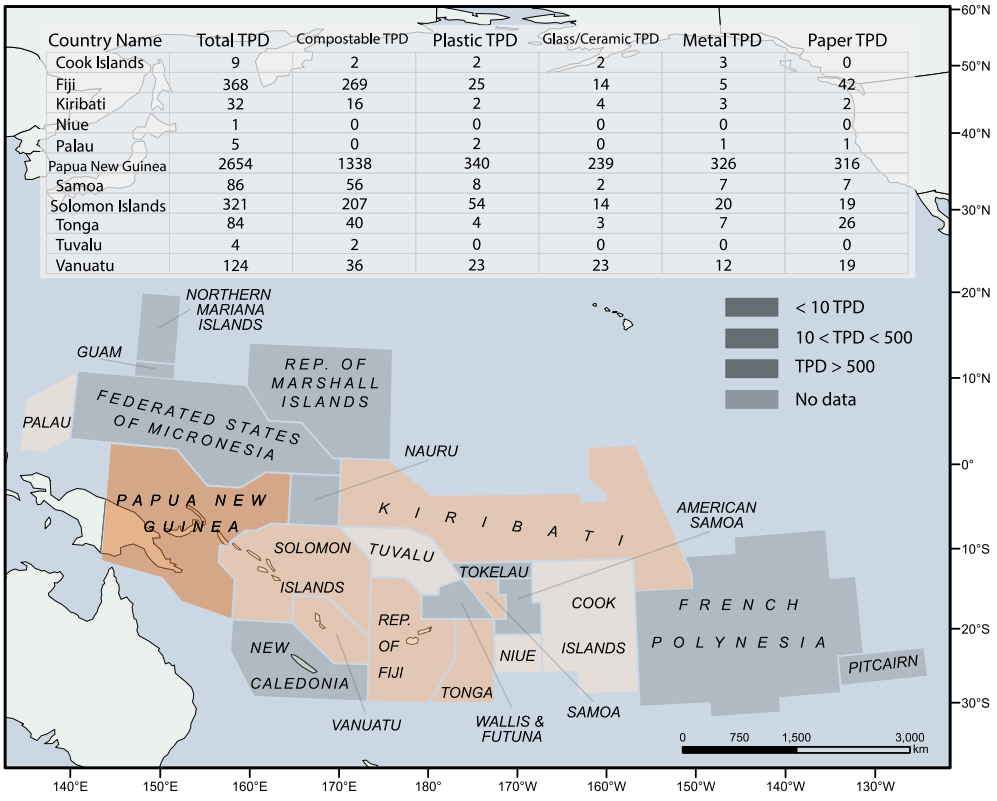

Figure 1.
This map details the average tons per day (TPD) of waste for selected Pacific countries and territories.

Data sources: SPREP 2009, Natural Earth.

support through systems like the Kyoto Protocol's Clean Development Mechanism.

In any location, solid waste management can be approached as either disaster mitigation or an opportunity for economic and ecological growth. In the Pacific region, this choice is made more stark due to unique geographical, demographic, and economic circumstances. However, a combination of careful planning and serious consideration of advanced disposal technologies has the potential to improve island economies and environments alike.

Notes

[1] Secretariat of the Pacific Regional Environment Programme, *Pacific Regional Solid Waste Management Strategy 2010–2015* (Apia, Samoa: SPREP, 2009), 19.

[2] Ibid., 7–8.

[3] J. Gildea and O. Tuikolovatu, *Challenging the Future: Innovation and Enterprise in Waste Minimisation in Tonga, a Small Pacific Island Nation* (Nuku'Alofa, Kingdom of Tonga: Solid Waste Management Project, 2007).

[4] Secretariat of the Pacific Regional Environment Programme, *Pacific Regional Solid Waste Management Strategy 2010–2015*; D. Storey, L. Santucci, J. Aleluia, and T. Varghese, *Decentralized and Integrated Resource Recovery Centers in Developing Countries: Lessons Learnt from Asia-Pacific* (Thailand: United Nations Economic and Social Commission for Asia and the Pacific, 2013).

[5] Asian Development Bank, "Solid Waste Management in the Pacific: Tonga Country Snapshot," Flyer No. ARM146616-2, June 2014.

[6] University of Hawai'i Environmental Health Department, *The Hawaii State Plan for Solid Waste Management* (Honolulu, HI: State of Hawai'i Environmental Health Division, 1971).

[7] J.P. Howell, "The Fate of Waste in Hawaii: Technology Assessment and Solid Waste Planning in Hawaii, 1968–78," *Singapore Journal of Tropical Geography* 36 (2015): 67–82.

[8] J.P. Howell, "'Modes of Governing' and Solid Waste Management in Maui, Hawaii, USA," *Environment and Planning A* 47 (2015), doi: 10.1177/0308518X15599286.

[9] J.P. Howell, *Technology and Place: A Geography of Waste-to-Energy in the United States*, PhD Dissertation, Dept. of Geography, Michigan State University, East Lansing, Michigan, 2013.

[10] J-PRISM, "Creating a Sound Material-Cycle Society in Small Islands: Japan's Cooperation in the Field of Solid Waste Management in the Pacific Region," brochure, June 2015.

[11] Illustrations of small-scale deployments of advanced waste technologies include a 45 tons-per-day (tpd) anaerobic digester in Michigan see http://msutoday.msu.edu/news/2013/new-msu-anaerobic-digester-to-supply-power-for-south-campus-buildings/; an "up to" 300 tpd plastic-to-liquid fuel facility in Alberta, Canada (see http://enerkem.com/facilities/enerkem-alberta-biofuels/); and the sewage biosolids co-composting program that unfolded on Maui during the early 1990s (see E. Tanji, "Lingle won't terminate 'model' compost project." *Honolulu Advertiser*, 4 November 1994:A7.)

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