Organics Disposal Bans And Processing Infrastructure

The implied logic is that if a supply of organic feedstock can be created, the infrastructure to process it will be built. Has that happened in New England states with bans?

Part I

Carol Adaire Jones

TO address a gap in organics processing infrastructure, four New England states — Connecticut, Massachusetts, Rhode Island and Vermont — and more recently California, as well as a number of cities, have adopted bans on landfill disposal of food waste, or recycling mandates. Inverting the logic in the movie *Field of Dreams* ("if we build it, they will come"), the implied logic of the bans is that if a supply of organic feedstock can be created, the infrastructure to process it will be built. This two-part article examines whether the New England experience has fulfilled this implicit promise.

The four states share some underlying drivers for recycling food waste, including high tipping fees for disposal, high electricity costs, and a strong conservation ethic. At the same time, substantial variations in state population size and density, economics, and solid waste policies influence their implementation approaches and outcomes. As a number of other states in the region and elsewhere evaluate whether to adopt food waste landfill bans, the lessons learned from these four pioneers can assist with their assessments.

FEATURES OF THE BANS

Table 1 summarizes components of the four organics bans, which went into effect in 2014 in three out of the four states, with the Rhode Island ban effective in 2016. Under a 2012 Vermont law (Act 148) establishing universal recycling in the state, food waste is the last material to be banned, following consumer recyclables, and leaves, yard trimmings and clean wood debris. Massachusetts and Connecticut already had banned yard trimmings, and Rhode Island implemented a yard trimmings recycling mandate.

The bans are similar in the sectors and size classes of food waste generators covered. Greater variation exists in several phase-in provisions, which are designed to accommodate the reality that bringing a waste processing facility online takes a substantial amount of time, in the best of circumstances. At the end of its several phase-in periods, Vermont's ban covers all generators, which is substantially more inclusive in terms of generators covered than the other three states.

In the U.S., nonfarm generated food waste is split about half and half between households (51%) and the industrial, commercial and institutional food service sectors (ICI), which includes industrial food manufacturing (2%), commercial grocery sector (15%), restaurants (22%), and institutions serving food, such as universities, hospitals, prisons (10%) (ReFED, 2016). Massachusetts' and Connecticut's profiles are similar to this national estimate (Rhode Island did not have the data to make an assessment). All of the bans cover ICI, though Connecticut excludes restaurants and most institutional food service operations. Vermont diverges from the national profile — two-thirds of disposed food waste is from households. Vermont is the only state that extends coverage to households, including them at the end of its phase-in period (2020).

The bans also lower, over time, the size threshold above which a generator is covered. After conclusion of the phase-in period (if any), they typically cover facilities generating 52 tons/year (tpy) or more. (According to rules of thumb in Massachusetts' guidance, this

Figure 1. County population per square kilometer

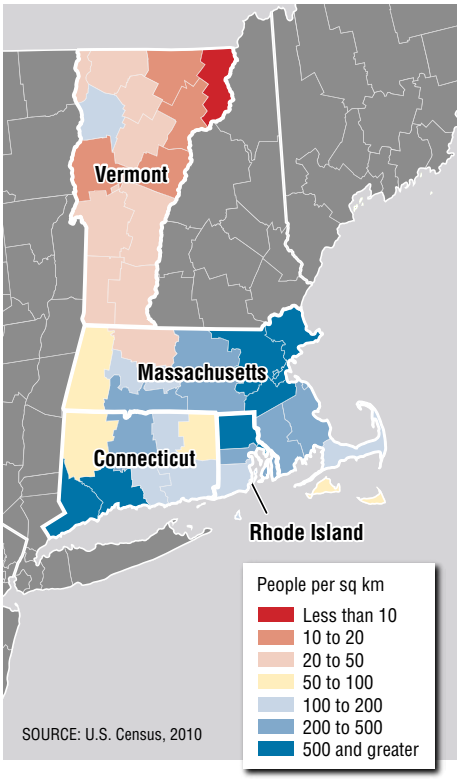

Table 1. Features of New England food waste landfill bans

State	Official Date	Effective Date	Covered Generator Classes	Distance Threshold To Processing Facility	Generation Threshold (tons/year (tpy))
Connecticut[1]	Original: 10/1/11 Amended: 10/1/13	1/1/2014	ICI only[2] (except restaurants, and most institutional food service)	<20 miles from a permitted facility	2014: 104+ 2020: 52+
Massachussetts[3]	1/30/2014	10/1/2014	ICI only	None	52+
Rhode Island[4]	7/1/2014	1/1/2016	ICI only	<15 miles from a permitted facility where tipping fees are less than noncontract RI Resource Recovery Corp. rate	2016: 104+ 2018: 52+ for covered educational facilities
Vermont[5]	7/1/2012	7/1/2014	2014: ICI 2020: ICI and households	2014: <20 miles from a permitted facility 2020: None	2014: 104+ 2015: 52+ 2016: 26+ 2017: 18+ 2020: All ICI and all households

[1]Conn. Gen. Stat. Ann. § 22a-226e; [2] Covers: *commercial food wholesaler or distributor, industrial food manufacturer or processor, supermarket, resort or conference center that is located not more than twenty miles from an authorized source-separated organic material composting facility* (Conn. Gen. Stat. Ann. § 22a - § 226e); [3]310 Mass. Code Regs. 19.006 and 19.017; [4]R.I. Gen. Laws Ann. § 23-18.9-7 [definition] and § 23-18.9-17 [ban]; [5]Vt. Stat. Ann. tit. 10, § 6605k and § 6602

is likely to occur, for example, in universities with more than 730 students, restaurants with 70 or more full-time employees, and supermarkets with 35 or more full-time employees.) The exceptions are that Rhode Island shifts only covered educational institutions down from the 104 tpy to the 52 tpy threshold as of 2018, whereas Vermont expands coverage to all size generators — household and ICI — as of 2020.

Another safety valve built into the Connecticut, Rhode Island and Vermont bans is a provision waiving coverage if there is no permitted processing facility within 15 or 20 miles of the generator. Rhode Island is unique in also waiving coverage if the nearby facility is charging a tipping fee higher than the state landfill noncontract rate of $90/ton, though this is not currently a binding constraint.

Table 2. New England food waste landfill ban states: Demography and economics

	CT	MA	RI	VT
Population (2016)[1]	3,576,452	6,811,779	1,056,426	624,594
Land Area (sq. mi.)[2]	4,842	7,800	1,034	9,217
Population/sq. mi.	739	873	1022	68
Median Household Income ($) (2015)[3]	72,889	67,861	55,701	59,494
Gross State Product ($ billions) (2015)[4]	266.60	511.40	58.50	31.50
Landfill Tipping Fees ($/ton)[5]	57-70	86	Municipal: 40 Commercial: 55-90	90
Retail Electricity Prices ($/Million Btu, 2015)[6]	52.09	49.54	49.86	42.22

[1]U.S. Census Bureau, *Annual Estimates of the Resident Population for the United States, Regions, and Puerto Rico: April 1, 2010 to July 1, 2016*, National Population Totals Tables: 2010-2016 Table 1, www.census.gov/data/tables/2016/demo/popest/nation-total.html (accessed July 20, 2017). [2]U.S. Census Bureau, *State Area Measurements and Internal Point Coordinates*, MAF/TIGER database, www.census.gov/geo/reference/state-area.html (accessed July 20, 2017). [3]U.S. Census Bureau, *Median Household Income by State*, Historical Income Tables: Households Table H-8, www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html (accessed July 20, 2017). [4]Bureau of Economic Analysis, *Current-Dollar Gross Domestic Product (GDP) by State, 2015:Q1-2016:Q4*, GDP by State: Fourth Quarter and Annual 2016 Table 3, www.bea.gov/newsreleases/regional/gdp_state/qgsp_newsrelease.html (accessed July 20, 2017). [5]National average landfill tipping fee was $48 in 2015, and $51, as of May 2017 (Waste Business Journal, nrra.net/sweep/the-cost-to-landfill-msw-in-the-us-continues-to-rise-despite-soft-demand/). MA tipping fee: Environmental Research and Education Foundation (2016) *Analysis of MSW Tipping Fees, January 2016.* Retrieved from www.erefdn.org. CT and VT tipping fees: Recycling and Disposal Fees, 2010. www.cga.ct.gov/2010/rpt/2010-R-0107.htm. RI tipping fees: legislatively set rates municipalities or commercial haulers pay to dispose of trash by the ton at RIRRC landfill, Fee Schedule FY2018, www.rirrc.org/. [6]National average is $30.66 per million Btu. U.S. Energy Information Administration, *Coal and Retail Electricity Price and Expenditure Estimates, Ranked by State, 2015*, State Energy Data System: 1960-2015 Table E18, www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_pr_cl_es.html&sid=US (accessed July 20, 2017).

STATE DEMOGRAPHICS AND ECONOMICS

New England states share several underlying economic similarities that drive food waste recycling. Foremost is rapidly declining landfill and incinerator capacity relative to projected future needs under past growth paths, combined with a limited ability to site new facilities. The result is high tipping fees, averaging $79/ton (compared to the national average of $51/ton (in May 2017)). High regional electricity prices may increase the attractiveness of energy recovery from recycling.

At the same time, the demographics and economics of the states vary widely (Table 2). Connecticut and Massachusetts have much higher populations and total state economic activity, as well as higher household incomes than Rhode Island and Vermont. Higher economic

Massachusetts and Vermont had made fairly robust down payments toward projected processing infrastructure needs, including composting capacity, when their bans became effective.

Table 3. Total solid waste profile and reduction goals

	CT	MA	RI	VT
Total MSW generated (tons)	3,780,000[1]	7,470,000[2]	1,146,000[3]	603,000[4]
Total MSW generated (tons) per capita	1.05	1.12	1.09	0.96
Total MSW disposed (tons)	2,480,000[1]	4,680,000 (2012)[2] 4,510,000 (2015)[5]	873,000[3]	391,000[4]
Total MSW disposed as a share of total generated (%)	66	63	75	65
Total MSW disposed (tons) per capita	0.69	0.66 (2015)	0.83	0.62
Solid waste reduction goals (disposal (-%) and/or diversion; year)	Disposal -60% by 2024	Disposal: -30% by 2020 -80% by 2050	Diversion: 50% by 2012 (all establishments that use RIRRC landfill)	Diversion: 50% Disposal: -25% by 2020

The year of the data are as follows except where otherwise indicated: CT, 2014; MA, 2012; RI, 2011-2013 avg., and VT, 2015; MSW does not include C&D, sludge, soils or incinerator ash. [1]p.2, www.ct.gov/deep/Lib/deep/reduce_reuse_recycle/Data/Average_state_msw_statistics_FY2014.pdf. [2]p. 4, www.mass.gov/eea/docs/dep/recycle/priorities/12swdata.pdf. [3]p. 2-4, RI Solid Waste 2038, www.planning.ri.gov/documents/LU/2015/SolidWaste2038_Approved_05142015_Final.pdf. [4]p.13,http://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/2015_Diversion_and_Disposal_Report.pdf. [5]p.3, www.mass.gov/eea/docs/dep/recycle/priorities/15swdata.pdf.

activity and incomes are associated with higher levels of solid waste and potentially with greater state financial resources to support local government initiatives to expand recycling.

In addition to the smallest population, Vermont also has a much lower population density in most of its counties than Connecticut, Massachusetts and Rhode Island, each of which have municipalities that range from densely populated central cities to rural areas (Figure 1). Low population density results in a very different cost structure for the waste management sector, and may be associated with limited local budgets and part-time local governments that constrain communities' ability to plan and deliver services.

SOLID WASTE PROFILE

Across the states, tons of solid waste generated parallel population size (Table 3). The quantities of municipal solid waste (MSW) generated per capita are similar, around 1 tpy per person. (The MSW measure includes residential and commercial waste, but not construction and demolition (C&D) waste, or ash, soils and sludge.) The variation across states in estimated per capita quantities may reflect the lack of standardization in accounting procedures, e.g., the extent to which C&D waste is excluded. Connecticut, Massachusetts and Vermont dispose around two-thirds of their MSW in landfills or waste-to-energy plants. Rhode Island disposes three-quarters of its MSW, primarily at the Central Landfill owned and operated by the quasi-public state level agency, Rhode Island Resource Recovery Corporation (RIRRC).

All four states have articulated goals to reduce solid waste, though the states vary in whether they focus on reducing disposal or increasing diversion (or in some cases both), as well as in their target rates of change over time. None, however, focuses on reducing total quantity generated. Massachusetts even stopped collecting data on total solid waste generated after 2012.

Further, all have clearly identified reducing food waste as critical to reaching their goals because, as one of the largest components in the waste stream and one with the lowest diversion rate, food waste has significant diversion potential. Both Massachusetts and Vermont published assessments of the impacts of their bans and action plans with an integrated set of policies for implementing them, and subsequently have published status reports. Connecticut and Rhode Island published information regarding their plans for implementing food waste recycling goals in their long-range solid waste plans.

FOOD WASTE PROFILE

A variety of information is essential to design plans to implement the organic bans. To estimate the quantity of food waste currently disposed, each state applied estimates of food waste shares from episodic waste composition studies to the more aggregated solid waste data reported annually (Table 4). To estimate the number of generators in a sector that exceed the food waste threshold, rule-of-thumb indicators of food waste disposal, such as number of employees or square feet of floor space, are utilized — which results in imprecise estimates on the total number of generators that fall within the compliance threshold. The implications for enforcement are that many firms are covered (i.e., above the state size thresholds). Further, effectively identifying and targeting the covered ones in a sector is challenging.

For Massachusetts and Vermont, the official state goals for total (additional) food waste processing capacity needed to accommodate diversion as a result of the bans are based on analyses of estimated feedstock supply that incorporate estimates of on-site food waste reduction as well as increased donations of edible food. For example, Massachusetts anticipates that 50,000 tpy of its goal of an additional 350,000 tpy diverted will be met by other strategies, including reduction, food donation and rescue, animal feed, and on-site systems. Given the scale of its processing needs (management of 300,000 tons), Massachusetts is looking to anaerobic digestion to provide a substantial share of the new processing

Table 4. Food waste profile and capacity processing goals

	CT	MA	RI	VT
Quantity of food waste disposed in MSW (tons)	519,000[1]	~1,000,000[2]	217,500[3]	60,000[4]
Food waste generators (#)	3,329 (large generators)[5]	6,861 (total) ~1700 (covered)[6]	NA	1,000-1,400 (18+ tpy)[7]
Goals: food waste processing capacity (tpy)	312,000 (60% diversion)	+300,000 by 2020 (relative to 2011 capacity of 100,000) (35% diversion)[6]	174,000 (80% diversion)	29,000 (60% diversion)
Food waste capacity when ban went into effect	2 large & 1 small composter	+120,000 tpy (relative to 2011)	1 small composter	22,000 tpy

[1]p.19, www.ct.gov/deep/lib/deep/waste_management_and_disposal/Solid_Waste_Management_Plan/CMMS_Final_2015_MSW_Characterization_Study.pdf. [2]MassDEP Fact Sheet Food Waste Composting, www.mass.gov/eea/docs/dep/recycle/reduce/m-thru-x/organics.pdf. [3]p. 56, Update to the RI Food Assessment: 2011 - 2016 and Beyond, http://rifoodcouncil.org/wp-content/uploads/2016/07/RI-Assessment-Update_FINAL_7.2016.pdf. [4]http://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/finalreportvermontwastecomposition-13may2013.pdf. [5]www.ct.gov/deep/cwp/view.asp?a=2718&q=325382&deepNav_GID=1645#2011. [6]www.mass.gov/eea/docs/dep/recycle/priorities/foodgen.pdf, "Food Waste Generators in Massachusetts" and personal correspondence, John Fischer, 4/2017. [7]Personal correspondence, John Fay, VT DEC, 8/22/2017.

Connecticut anticipates anaerobic digestion will provide a significant share of new processing capacity in the state. The Quantum Biopower facility in Southington (above) came online in early 2017.

capacity. Vermont explicitly addressed the regional distribution of the needed facilities. Assuming that the bulk of its organic waste will be composted, and 30 percent of the composting will occur on farms, it estimates that one centralized composting facility will be necessary for each county, complemented by a number of smaller commercial and farm-scale facilities.

For Connecticut and Rhode Island, the author has informally estimated implied capacity goals in Table 4 based on those states' unofficial food waste goals of 60 percent and 80 percent food waste diversion, respectively, and their estimates of food waste disposed. Both states are anticipating anaerobic digestion will provide a significant share of the new capacity.

As of the date their bans became effective, Massachusetts and Vermont had made fairly robust down payments toward their projected infrastructure needs to implement the ban. Massachusetts brought on line 120,000 tpy of additional capacity out of its target goal of adding 300,000 tpy of processing capacity, bringing its total to 220,000 tpy. Vermont had 22,000 tpy online out of its goal of 29,000 tpy. Connecticut had three composting facilities — two large and one small — with total capacity close to 200,000 tpy. Food waste represented a small share of the organics being processed. Rhode Island identified its collection and processing capacity for food waste as "virtually nonexistent" on January 1, 2016.

With this level of infrastructure development, the facility distance-based waiver for covered generators was triggered in three states with this feature, until more processing capacity comes online (or for Vermont, 2020, if it comes first). However the waiver affected a much smaller share of generators in Vermont than in Connecticut, or particularly Rhode Island. ■

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REFERENCE

ReFED, 2016. "A Roadmap To Reduce U.S. Food Waste By 20 Percent," ReFED (Rethink Food Waste Through Economic Data), www.refed.com.

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Food Waste Infrastructure In Disposal Ban States

Using various combinations, from reduction and recovery to composting and AD, the four New England states with organics disposal bans are advancing toward their capacity goals.

Part II

Carol Adaire Jones

PART I of this two-part article, "Organics Disposal Bans And Processing Infrastructure" (Sept. 2017), provided a demographic, economic and solid waste profile for the four New England states with organic waste landfill disposal bans. Part II highlights the progress that the four states have made in developing their organics processing infrastructure, along with key state policies that complement the bans to promote facility development.

To recap, organics disposal bans went into effect in 2014 for Vermont, Connecticut and Massachusetts, and in 2016 for Rhode Island. The size thresholds of generators covered by the bans decline over time (except in Massachusetts), achieving maximum coverage of these generators in 2018 (Rhode Island) and 2020 (Connecticut, Vermont). The laws in Connecticut, Rhode Island and Vermont include a waiver of coverage if there is no processing facility permitted by the state within 15 or 20 miles of the generator. Distance exemptions expire in 2020 in Vermont, but have no expiration date in Rhode Island and Connecticut. Based on those exemptions, state officials in Rhode Island and Connecticut characterize ban enforcement as triggered by the processing capacity of facilities. When permitted facilities indicate they could accommodate more food waste feedstock, the state will notify generators in the covered area regarding their responsibility to divert food waste.

Since the bans came into effect, all four states have advanced toward their processing capacity goals. Population density influences the types of facilities sited in an area. Stand-alone anaerobic digestion (AD) facilities or wastewater resource recovery facility (WRRF)-based digesters tend to be located to serve densely populated areas due to substantial economies of scale. Rural areas are typically served by composting and smaller farm-based digesters. Commercial composting and farm-based digesters may also scale up to serve more urban areas as well.

FACILITY DEVELOPMENT

Along with regional firms, some national and international developers have been attracted to the opportunities to build large facilities in Connecticut, Massachusetts and Rhode Island due to those states' high population densities, high tip fees and electricity costs, and strong environmental policies, including the landfill bans. In Vermont, farm-based operations are more attractive due to low population densities and resulting diseconomies of scale, as well as the small quantity of additional capacity needed to fulfill the recycling mandate.

The states' abilities to realize the potential of these landfill bans to expand organics processing capacity critically depend on the strength of a broader set of policies including: (a) updated solid waste regulations, b) policies to support markets in renewable energy and soil amendments end products, and c) financial and technical assistance.

All four states have revised their solid waste regulations to facilitate permitting of composting and AD facilities, though the elements included in the regulations vary. For example, neither Connecticut nor Rhode Island has a standard for codigestion of food waste at WRRFs. Permitting of stand-alone digesters has taken longer than expected in both states, delaying facilities coming online past the effective date of the bans. Developers and state officials have characterized permitting the initial facilities as a learning process, and attributed delays to the new and complex regulatory regimes, staffing constraints, and changes in technology choices during the permitting process. Rhode Island also cites the fact that its regulations (finalized in 2016) were being promulgated at the same time as the agency was reviewing the permit applications.

All four states also have developed various programs to support AD energy markets. Of particular note, all

Table 1. Food waste profile and capacity processing

	Connecticut	Massachusetts	Rhode Island	Vermont
Quantity of food waste disposed in MSW (tons)	519,000[1]	~1,000,000[2]	217,500[3]	60,000[4]
Food waste diversion goals (tpy)[5]	300,000[6]	450,000 by 2020[2,7]	174,000[8]	36,000 (29,000 offsite) by 2022[4]
Food waste facilities operating when ban went into effect (#)	3 compost[9]	34 compost; 4 AD; 3 animal feed & compost; 8 animal feed[10]	1 compost[11]	10 compost; 1 AD (scraps); 4 animal feed & compost[4]
Food waste being processed when ban went into effect (tpy)	2,361[9]	220,000; (100,000 in 2011)[7]	Minimal[11]	15,000[12]
Food waste facilities operating in 2017 (#)	3 compost; 1 AD[13]	27 compost; 8 AD; 4 animal feed & compost; 4 animal feed[7,14]	1 compost; 1 AD[11]	8 compost; 1 full + 2 pilot AD; 4 animal feed & compost[12]
Permitted food waste capacity at facilities operating in 2017	5,000 (compost)[15]; 40,000 (AD);[13]	152,000 (compost); 465,000[16] (AD)[7]	1,500 (compost)[17]; 73,000 (AD)[16,18]	18,600 (compost and AD)[12]
Food waste permitted facilities in development 2017 (#)	3 AD[13]	4 AD[7]	—	2 compost[12]

Note: Live links to documents cited in footnotes available in online edition of this article.
[1]*2016 Comprehensive Materials Management Strategy*, Connecticut Department of Energy and Environmental Protection (July 19, 2016), p. 19. [2]*Food Waste Composting Fact Sheet*, Massachusetts Department of Environmental Protection (July 2015), p. 1. [3]*Update to the RI Food Assessment: 2011 - 2016 and Beyond*, Karen Karp & Partners (July 2016), p. 25. [4]*Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermon*t, DSM Environmental Services (Oct. 21, 2013), p. 33. [5]Includes donation, animal feed operations, onsite processing, etc. [6]*2016 Comprehensive Materials Management Strategy*, p. 7. [7]Personal communication with Massachusetts Department of Environmental Protection (Oct. 13, 2017). [8]Author's calculation based on Rhode Island's goal of 80% diversion rate. See also *Solid Waste 2038: Rhode Island Comprehensive Solid Waste Management Plan*, Rhode Island Division of Planning (May 14, 2015). [9]Data queried on Dec. 28, 2016 from: Connecticut Department of Energy and Environmental Protection Solid Waste Database, Table 1 – CT Permitted Regional Solid Waste Facilities Reporting Receiving Food Scraps or Cooking Oil – CY2010 though CY2016. [10]*Sites Accepting Diverted Food Material*, Massachusetts Department of Environmental Protection (Sept. 2014). [11]Personal communication with Rhode Island Department of Environmental Management (March 31, 2017).
[12]Personal communication with Vermont Agency of Natural Resources (Oct. 20, 2017). [13]Webpage: *CT Permitted Volume Reduction Anaerobic Digestion and Food Waste Composting Facilities* (updated Sept. 2017). [14]*Sites Accepting Diverted Food Material*, Massachusetts Department of Environmental Protection (Oct. 2017).
[15]Actual quantity of food waste sent to composting facilities. The total permitted capacity for three Connecticut compost facilities is around 200,000 tpy. [16]Reflects capacity when new facilities are operating at full capacity. [17]Personal communication with Earth Care Farms (Jan. 5, 2017). [18]Personal communication with Rhode Island Department of Environmental Management (Oct. 12, 2017).

have Renewable Portfolio Standards (RPS) that cover electricity generated by AD and programs to support facility access to renewable energy credits (RECs). However, Amy McCrae Kessler of Turning Earth, which will be constructing an AD-composting facility in Connecticut, indicated that access to long-term renewable energy power purchase agreements for anaerobic digestion can be disadvantaged relative to solar, wind, and fuel cells.

"Many of the legislative and regulatory tools intended to help incentivize deployment of renewable energy facilities are drafted using vocabulary and metrics that do not fully capture the value and operational advantages of AD projects, including the environmental benefits," explains McCrae Kessler. "For example, many solicitations for Class 1 renewable long term power purchase agreements are drafted for 10 MW to 20 MW projects, automatically excluding AD projects which are typically in the 1-3 MW range. When you take capacity factor into account, a 10 MW solar project operating at the standard 25 percent capacity factor generates the same amount of kWh as a 1.4 MW AD project operating at standard 95 percent capacity factor. They are equivalent in terms of energy output, with AD providing additional environmental and grid stability benefits, yet it is arbitrarily excluded."

The levels of state agency staff and resources available to provide financial and technical assistance vary substantially across the states. Massachusetts has been able to deliver the most extensive program by tapping special funds set up through renewable energy programs, including targeted grants and loans and a technical assistance program for businesses and communities. Connecticut has provided Green Bank loans to AD developers, but only has one staff person spending quarter-time doing outreach and technical assistance for large generators. The state now relies on the Massachusetts-based contractor, Center for EcoTechnology, to provide assistance funded by external grants. In Vermont, agency staff provide outreach and technical assistance, and the Clean Energy Development Fund has provided small grants for 2 pilots. Rhode Island does not have the financial or staff resources to provide technical or financial assistance; only one-quarter of a staff person's time is available to cover all recycling in the state.

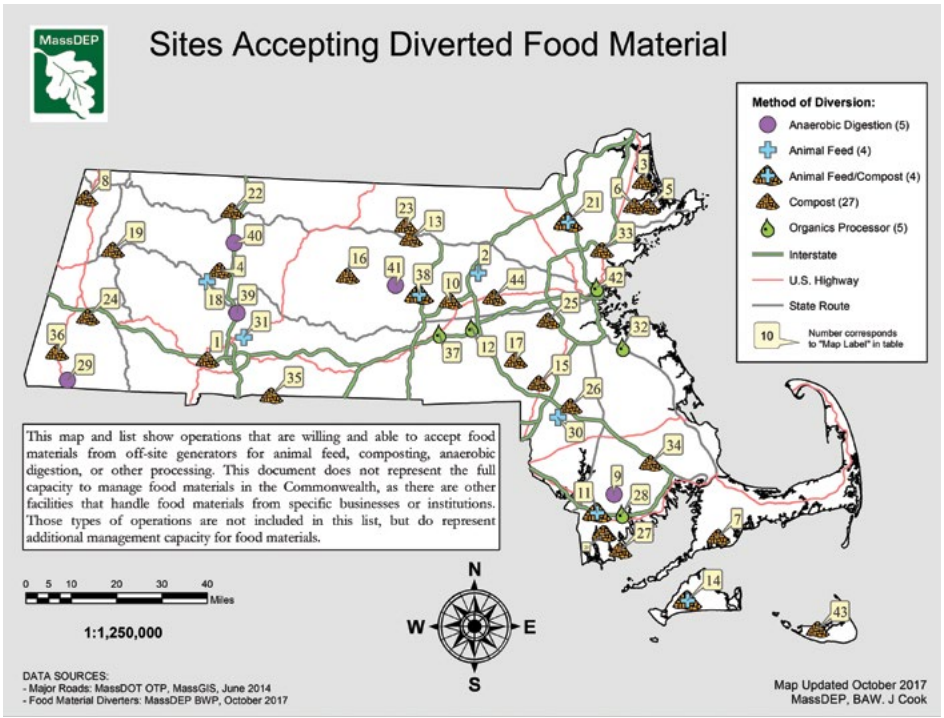
Table 1 provides a food waste profile and processing capacity — both AD and composting — for each of the four states. More information on each state follows.

MASSACHUSETTS

Massachusetts, the largest state of the four by population (6.8 million), generates an estimated 1 million tons/year (tpy) of food waste. Even prior to the ban taking effect in 2014, the state made substantial progress in adding permitted organics processing capacity. Starting from a base in 2011 of 23 permitted facilities with about 100,000 tpy of capacity, by 2014, Massachusetts had added an additional 120,000 tpy of permitted capacity — with 26 additional facilities receiving permits and ongoing facilities expanding the quantity of food waste accepted.

In 2014, the state articulated a goal of increasing diversion by an additional 350,000 tpy by 2020. Similar to the other three states, Massachusetts expects a share of diversion will come from on-site processing at generators' establishments, wasted food donations, and animal feeding operations. Working in collaboration with the state Clean Energy Results Program (an interagency

Figure 1. Massachusetts sites accepting food material



SOURCE: http://www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-l/fdcomlst.pdf

initiative launched in 2011 to promote clean energy, including AD at WRRFs), the state's complementary goal was to add 50 megawatts (MW) of electricity from AD.

According to John Fischer of the Massachusetts Department of Environmental Protection (MassDEP), the state will exceed its food waste diversion goal, and current and future facilities will provide geographic coverage of the entire state. Between 2014 and 2017, the number of anaerobic digesters doubled from 4 to 8, providing 465,000 tpy of total capacity (Figure 1). This includes the largest new project, a fourth digester — built specifically for food waste at the Greater Lawrence Sanitation District WRRF — when it reaches full capacity in 2018.

In addition, there are four farm-based digesters that accept food waste in Massachusetts, three of which are owned and operated by the farm-based AD developer, Vanguard Renewables. Two stand-alone digesters are colocated with grocery stores (their exclusive feedstock suppliers), and a third is at the Greater New Bedford Regional Refuse District's Crapo Hill landfill in Dartmouth. Four additional AD projects have been permitted and are in development, including three farm-based AD, along with the expansion of a WRRF-based facility.

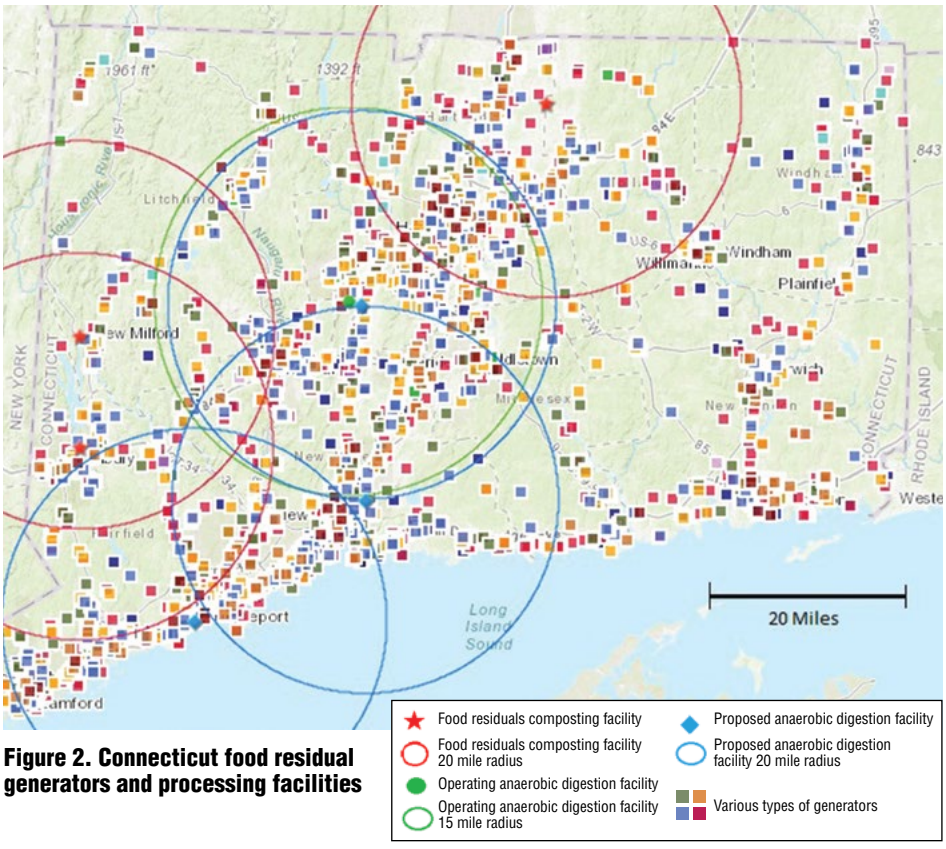
In contrast, there has been flux in participation by composting facilities in food waste processing. Over the last 3 years, 4 plants have begun taking food waste, but 10 plants have stopped. Operators who exited have cited problems with odor and contamination. In addition to the contributions from composting and AD, substantially more than 50,000 tpy of diversion are coming from on-site processing, wasted food donations, and animal feed operations.

CONNECTICUT

Connecticut is the second largest of the 4 states in population (3.6 million) and quantity of food waste disposed (500,000 tpy) — about half that of Massachusetts. Its stated goal is to divert 60 percent of municipal waste away from incinerators and landfills, and estimates it needs a minimum of 300,000 tpy of organic processing capacity by 2024.

When the disposal ban went into effect in 2014, Connecticut had 3 operating composting facilities located in rural areas near the borders of Massachusetts and New York. Though total permitted capacity was close to 200,000 tpy, those facilities processed just 2,361 tpy of food waste. Their operators report that the ban has not had a big impact on their business. For example, Chris Fields of Harvest New England said that the inconsistency and low quality of food scraps received by his farm-based composting facility would impose greater costs to separate out contamination than benefits accrued.

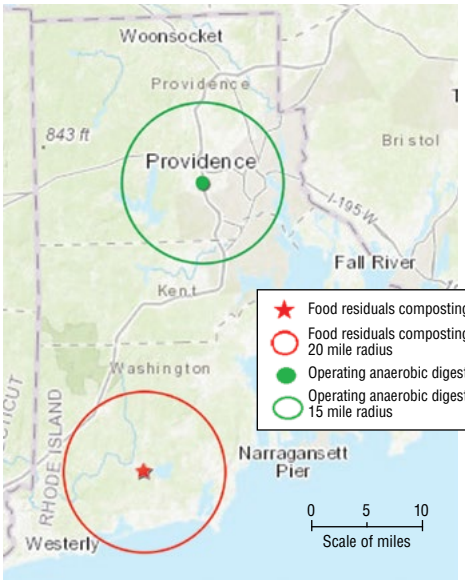
In contrast, developers of large AD facilities, which have provided the big increase in state capacity since 2014, cite positive impacts of the ban. Quantum Biopower's merchant plant in Southington is now online (see "Merchant Biogas Plant Services Food Waste Generators," July 2017), generating biogas, and running trials with food scraps from grocery stores. At full



SOURCE: http://www.depdata.ct.gov/maps/recycling/foodresidualmap.htm

Figure 2. Connecticut food residual generators and processing facilities

Figure 3. Rhode Island food residuals processing facilities



capacity, it will process 40,000 tpy of food waste. Two additional plants are permitted and in development — a merchant plant and a plant colocated at a WRRF but with a separate line for food scraps. Another merchant plant recently received a state notice of "tentative determination to permit."

Once all four AD facilities are online, Connecticut will have achieved substantial progress toward its food waste reduction target though there are areas in the east of the state that remain without coverage (Figure 2). To reach its target, Chris Nelson of the Connecticut Department of Energy and Environmental Protection said the state is seeking a diversified portfolio of facility types. Lacking any farm-based AD at this point, Connecticut developed an Agriculture AD Roadmap in 2016 to identify changes in policy to address the gap.

RHODE ISLAND

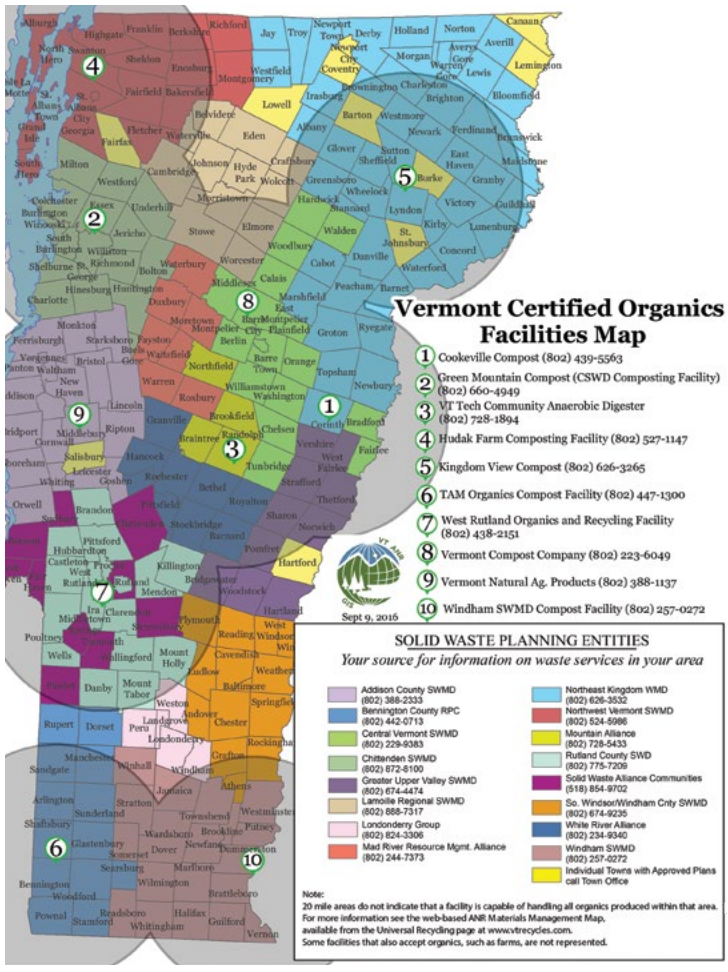
Rhode Island, the state with the smallest land area and highest population density (1.1 million people), generates an estimated 220,000 tpy of food waste. Its stated goal for diversion is 80 percent, or around 174,000 tpy. However, according to the Rhode Island Solid Waste Management Plan 2038 published in 2015, commercial collection and processing of segregated food wastes was "practically nonexistent" prior to the ban.

A big increase in the state's capacity is coming from a new merchant AD plant developed, owned and operated by Blue Sphere, an independent power producer with 4 plants in Italy and one in North Carolina (Figure 3). Running primarily on food waste and generating 3.2 MW of electric power, the plant has a 15-year power purchase agreement with National Grid, Rhode Island's primary electricity distributor. Permitted for 73,000 tpy of food waste, the facility's stated intention is to accept 125 to 150 tons/day (tpd) of food waste feedstock, or 47,000 tpy. During its current ramp-up period, only liquid food wastes are being accepted, but Blue Sphere has long-term supply contracts for food scraps from E.L. Harvey and Organic Waste Management.

The ban also breathed new life into the one small Rhode Island composting facility, Earth Care Farms, which has been accepting food scraps for the last 40 years. Now receiving 4 to 5 tpd of food scraps from generators including colleges and hospitals, Earth Care Farms is expanding operations and collaborating with The Compost Plant, the only licensed organic waste hauler in the state, to distribute its compost product, Rhody Gold. The Compost Plant is proposing to develop a new composting facility in Warren, which would provide geographical coverage on East Narragansett Bay, though it has not yet applied for a permit.

Mark Dennen of the Rhode Island Department of Environmental Management noted he was thrilled with the Blue Sphere plant's launch, describing the project as "groundbreaking" relative to the status quo of landfilling most food waste. Acknowledging that Rhode Island does not have any other facilities in development, Dennen welcomes all interested parties to bring new projects to the state in order to fully implement the ban and reach the state's capacity goals.

Figure 4. Vermont certified organics processing facilities



Until 2020, generators meeting the size threshold for coverage are exempt if they are farther than 20 miles from a permitted facility. In 2020, all households and all institutional, commercial and industrial generators are covered, regardless of distance from a permitted facility.
SOURCE: p. 11, Vermont's Universal Recycling Law Status Report, December 2016. http://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal.Recycling.Status.Report.Dec_.2016.pdf

VERMONT

With the largest land area (9 times the size of Rhode Island and 20% larger than Massachusetts) and the smallest population (624, 600, or one-tenth that of Massachusetts), Vermont generates an estimated 60,000 tpy of food waste. Its target is to divert 36,000 tpy — 29,000 tpy to composting and AD — complemented by source reduction and food donation.

Due to its very low population density and low quantity of total food scraps, as well as its large dairy sector, Vermont has substantially different solid waste economics from the other states. The merchant AD plants the other three states have developed are not economically viable in a rural state due to the much smaller scale of processing potential. Vermont's focus has been on developing composting facilities complemented by codigestion at dairy-based digesters dispersed across the state.

Like Massachusetts, Vermont had made substantial progress toward its capacity goal by the time its food waste diversion mandate went into effect. In 2014,

ties included 10 composting sites and one AD, with a combined capacity of 22,000 tpy. Additional farm-based activities (which do not require permits from the Vermont Department of Environmental Conservation) included 4 farm digesters that accepted only food manufacturing residuals and at least 4 farm-based animal feeding operations.

Vermont has experienced a flux in participation by composting facilities processing food waste. By 2017, two small composters had exited, continuing composters had slightly expanded their food scrap intake, and two new composting facilities have permits and are in development in areas not previously covered by permitted facilities (one in the north and the other in the south-central part of the state, near the border with New Hampshire). For AD, two farms are accepting food scraps under a pilot program, and 4 new farm-based ADs are being considered. Finally, an organics recycling facility that pre-processes food scraps for AD feedstock has been certified, which enables digesters to expand beyond liquid food waste to food scraps. Figure 4 illustrates that most of the land area in Vermont is currently within 20 miles from a processing facility, the distance beyond which compliance is waived until 2020.

WRAP-UP

An organics landfill ban can create greater certainty of a supply of organic feedstock, which provides greater security for developers and haulers to invest. However a ban is not a silver bullet: the economics of the facilities must be sustainable, regulations facilitating permitting must be in place, and planning, outreach and education are needed to provide the impetus.

The following are a few observations:

• The four New England states share critical underlying economic drivers: high disposal tipping fees, high energy prices, and — for all but Vermont — high population densities.

• Also critical to making facility economics work are policies to support markets in renewable energy and soil amendment end products, as well as technical and financial assistance.

• The lesson from Massachusetts' success in providing capacity to support its landfill ban, according to John Fischer of MassDEP, is the important role of the public sector in providing program resources for planning, education, and technical assistance, as well as strong policy incentives.

• Rhode Island and Connecticut have waivers for generators 15 or 20 miles from a facility, which they may continue to invoke for portions of their states after maximum coverage of generators is reached in 2018 and 2020, respectively. Vermont's waiver expires in 2020, and the state appears to be on a path to fulfill its relatively small mandate (compared to those of the other 3 states) by the target date of 2022.

• Even with limited program resources, a state can make progress toward its capacity mandates by getting permitting regulations and renewable energy market incentives in place.

• Echoing a refrain from agencies and facilities alike across the states, Josh Kelly of the Vermont Agency of Natural Resources said adopting organics recycling requires social change. The greatest need to promote this change, other than funding to spur investment, is more education.■

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