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Moving up the Waste Hierarchy in Maine: Learning from "Best Practice" State-Level Policy for Waste Reduction and Recovery

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Learning from "Best Practice" State-Level Policy for Waste Reduction and Recovery

by Cindy Isenhour, Travis Blackmer, Travis Wagner, Linda Silka, John Peckenham, David Hart, and Jean MacRae

Americans throw away huge amounts of trash each year, and despite efforts to recover more materials from the waste stream, U.S. recycling rates have stagnated and total waste generation continues to grow. This article builds upon a stakeholder engagement process that was designed to explore the waste-management challenges Maine faces. The authors review the policies enacted in other states and point out unfulfilled potential to take more significant steps toward Maine's long-term materials-management goals.

INTRODUCTION

Americans threw away 251 million tons of trash in 2012, three million more than the year before. And despite efforts to recover more materials from the waste stream, recycling rates in the United States have stagnated, and total waste generation continues to grow (U.S. EPA 2015a). Meanwhile, valuable materials are burned and buried, placing a burden on our economy, the environment, and future generations. Each year in the United States, for example, we invest significant resources (e.g., water, land, fuel, nutrients, labor) in the production of food, but the average American household throws away more than a quarter of the food it purchases each year, resulting in a collective loss of $125 billion annually. As a society, we spend another $733 million each year to landfill this wasted food (Buzby and Hyman 2012) and once buried, food waste produces leachate and the powerful greenhouse gas methane, both of which pose significant long-term economic and environmental costs.

This linear system of production-consumption-disposal is increasingly recognized as highly inefficient and unsustainable, leading many to adopt an alternative philosophy centered on materials, rather than waste management. Materials management focuses attention on reducing waste throughout the production-consumption system rather than continuing, without much success, to address the symptoms of a systemic problem with a limited focus on waste handling and disposal at the end of the product life cycle.

In Maine, the materials-management perspective was adopted in 1989 when the state instituted a waste-management hierarchy that prioritizes source reduction, reuse, recycling, and composting above disposal. This framework legislation along with relatively low per capita waste-generation rates and progressive product stewardship legislation helped Maine to gain a reputation as a national leader in materials management (Blackmer et al. 2015).

Yet despite past achievements, Maine is facing several significant challenges and is slipping behind other states that continue to make improvements toward waste-reduction and -recovery goals. Maine's goal to recycle or compost 50 percent of municipal solid waste tonnage by 2014 went unfulfilled. Similarly our goal to reduce total waste generation by 5 percent every two years starting in 2009 has also gone unmet. To make matters worse, there is significant uncertainty surrounding the future of materials management due to the dismantling of the State Planning Office, which provided data and coordinated planning, and due to the upcoming expiration of favorable energy rates for waste to energy.

This article builds upon an extensive stakeholder engagement process organized by the Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine. The process was designed to

collaboratively explore these challenges, visions for the future, and strategies to achieve the state's waste-reduction and -recovery goals. Nearly 200 stakeholders including representatives from private waste-management companies, local governments and state agencies have participated in this process, which included one statewide meeting, five regional planning meetings, an electronic survey, and the formation of four ongoing working groups. The results of these meetings (Isenhour and Blackmer 2015) and surveys (Blackmer and Isenhour unpublished) reflect a strong and nearly unanimous consensus that we should be moving toward a future with less waste and greater rates of recovery. Movement toward that vision, stakeholders agreed, would require many needs and barriers to be addressed. Several stakeholders, including state legislators serving on the Environment and Natural Resources (ENR) Committee, identified an immediate need for information about "best practice" policies for waste reduction and recovery in other states.

The report, originally submitted to the ENR Committee in November of 2015, is an attempt to respond to stakeholder-identified needs by providing a review of waste-reduction and -recovery policies enacted in other states. Several policies outlined in the report and discussed in this article were considered by the committee as they designed and debated LD1578—An Act to Update Maine's Solid Waste Management Laws. If successful, that legislation would create a new product stewardship program for small batteries; establish a food-waste hierarchy; extend the timeline for the achievement of recovery goals; shift waste-reduction goals to per capita measures; establish funding for recovery grant programs; provide authority for the Department of Environmental Protection (DEP) to impose municipal fees for solid waste disposal; and direct the DEP to implement pilot projects for composting food scraps. These programs would most certainly contribute to improved waste reduction and recovery in Maine, but this review also suggests there is unfulfilled potential to take more significant steps toward Maine's long-term materials-management goals.

In focusing "up the hierarchy," this review of best-practice state-level policies for waste reduction and recovery by no means suggests that waste-handling technologies, processing methods, and disposal practices are unimportant parts of the materials-management puzzle. They are certainly essential, but they are not our focus here. We also recognize that the term *best practice* is highly subjective and could be defined in a many different ways. All the policy options included here involve a series of complex tradeoffs. Some are popular and politically viable, but have limited potential for waste reduction and recovery. Others are extremely effective for waste diversion, but require significant investments of political capital, technological expertise, planning, and capital. Table 1 draws upon our reading of the existing empirical research and the results of an electronic survey completed by 175 key stakeholders in the fall of 2015. The table includes only a handful of the criteria that might be used to weigh policy options, including cost, political acceptability, and waste-reduction/diversion potential. Other important criteria not included range from potential for greenhouse gas mitigation to dimensions of social equity.

FIGURE 1: **Materials Recovery at EcoMaine**

Photo: Travis Blackmer

The organization of this article follows the logic of the waste hierarchy, beginning with comprehensive policy and then proceeding with reduction, reuse, and recovery. It thus defines best practice in terms of waste reduction, diversion, and recovery potential. Within each section, policy options are listed in order of waste reduction and recovery potential and include supply-side, demand-side, and regulatory efforts designed to address both. Again, we emphasize that there are multiple criteria to consider when implementing any of these policies. Reduction and recovery potential are important, but often must be balanced with cost and social acceptability. This study of policy in other states suggests that there is no magic formula for reducing waste and improving recovery.

TABLE 1: **Multiple Criteria for Evaluating State-Level Waste-Reduction and -Recovery Policy**

	Accept-ability	Effective-ness	Cost in Time	Cost in $	Responsibility	State Time	State $
General Policies							
Comprehensive planning	Top priority	High	High	High	State	High	High
Reduction and recovery goals	High	Mixed	Low	Low	State	Low	Low
Data-based decision making and full accounting	Top need	High	High	Low	State, towns	High	Varies
Reduction Policies							
Consumer education	Top priority	Low	High	Varies	State, towns, NGOs	High	Varies
Consumer dis/incen-tives (e.g. PAYT, EOW)	Mixed	High	Low	Altered	Citizens	Low	None
Environmentally preferred purchasing (e.g., buying cooperatives, tax deductions)	Uncertain	Mixed	High	Low	State	High	Low
Alternative business models (e.g., industrial symbiosis)	Uncertain	Mixed	Low	High	Towns, regions, business	Low	Low
Product stewardship and extended producer responsibility	Uncertain	High	High	Varies	State, producers	High	Varies
Product fees and sales bans	Low	High	Low	High	Citizens, producers	Low	Revenue
Reuse Policies							
Consumer education	Top priority	Low	High	Varies	State, towns, NGOs	High	Varies
Facilitate and support alter-native exchange models (materials exchange)	High	Mixed	High	Low	State, regions	High	Low
Incentives for reuse	High	Unknown	Low	High	State, regions, towns	Low	Varies
Mandatory reuse (e.g., CA green building code)	Low	High	Low	High	Citizens, state, businesses	Low	None
Recovery Policies							
Education	Top priority	Low	High	High	State, NGOs	High	Varies
Improved convenience/ coverage of collection	High	High	Low	High	Towns, businesses	Low	None
Support regional coopera-tion/market development	High	Mixed	High	High	State, regions	High	High
Incentives (e.g., container deposit laws, unit-based pricing, surcharges)	Mixed	High	High	High	State, citizens, businesses, towns	High	High
Mandatory source sepa-ration/collection	Low	Mixed	Low	High	Citizens, towns, businesses	Low	None
Landfill bans	Low	High	Low	High	Citizens, towns, businesses	Low	None

COMPREHENSIVE PLANNING AND DATA-DRIVEN DECISION SUPPORT

Perhaps the single most important finding to emerge from this review of materials-management policies and outcomes is the importance of comprehensive planning. Effective legislative framing and comprehensive long-term planning typically include a wide variety of policy tools (bans, incentives, and voluntary programs) enacted on multiple scales (national, regional, and local), and aimed at multiple sectors (residential, commercial, and institutional) and waste categories (toxics, beverage containers, organics) (Cox et al. 2010).

Here in the United States, several states including Oregon and Vermont have embarked on comprehensive planning for framework legislation. Oregon is one of the most successful examples. In 1991, the state set a goal of a 50 percent recovery rate by 2009 and established requirements for an annual survey to track progress. The legislature also set two interim goals. The first aimed to stabilize per capita waste generation by 2005, with no annual increases in per capita waste generation after that year. The second target aimed to stabilize total waste generation, with no annual increase after 2009.

The most recent data suggest that Oregon's comprehensive planning has resulted in significant progress toward achieving its goals. In 2013, the state recovered nearly 54 percent of municipal post-consumer waste generated in the state, marking the fourth straight year the state exceeded its 50 percent recovery goal. The state calculates that recovery efforts saved 30.6 trillion BTUs of energy during 2013 alone. This is equivalent to roughly 3.4 percent of the total energy used in the state that year and translates into avoided greenhouse gas emissions of 3 million megatons of CO_2 equivalent. Oregon has also made considerable progress on its reduction goals. In 2013, total waste was 16 percent lower (almost 1 million tons less waste) than it was at its peak in 2006, and per capita waste generation was down by more than 20 percent (Oregon DEQ 2014).

While many states have set similar goals, Oregon attributes its success, in part, to the Oregon Department of Environmental Quality's use of advanced metrics and life-cycle analyses to explore the tradeoffs between multiple options and to track progress. Policy evaluations are all too often based on economic costs alone and even then are often limited to short-term waste-handling and operations costs. Yet communities that contract for groundwater and methane-emissions testing, for example, routinely pay up to $40,000 annually, a cost that will continue long after landfill closure—a minimum of 30 years (Nowakowski 2010). Making the best decisions for sustainable materials management requires carefully weighing these various costs and benefits over the whole product life cycle. Good data and full cost accounting provide (1) insight into the most cost- and resource-efficient strategies, allowing for targeted plans with the greatest potential to deliver high return on investment; (2) a means to ensure that prices internalize environmental and long-term costs; and (3) an important means to track progress toward comprehensive goals.

If the necessary resources are not in place to implement full cost accounting and comprehensive planning and legislation for waste and materials management, waste-management hierarchies suggest that policy should focus first on waste reduction.

REDUCE: WASTE PREVENTION

Over the last decade, states across the country have expanded their recovery efforts, investing in infrastructure and processing more recyclables each year. Despite such efforts, recovery rates have failed to keep pace with growth in waste generation, resulting in a net increase in total waste (U.S. EPA 2015a). These trends draw attention to the need to focus on waste reduction. Whether measuring materials and energy use, handling costs, or the production of carcinogens and greenhouse gas emissions—the life cycle benefits of source reduction far outweigh other management options. For example, while composting uses the nutrients and energy in food waste much more effectively than incineration or landfilling, the benefits still do not compare to the upstream advantages of avoiding waste through programs to encourage residential and commercial consumers to purchase only the food they can use before spoilage (reduce) or programs that redistribute surplus food to those in need (reuse).

We begin with voluntary, soft policy options that are, in most cases, easy to implement (low cost, high social acceptance), but have lower waste-reduction potential. We then describe stronger policy options that are typically more costly to implement (political capital, legislative and regulatory planning), but tend to hold more potential for waste reduction.

Consumer Education for Reduction

One long-standing strategy in waste management is centered on consumer education and awareness campaigns. Posters and mailers in many communities have urged consumers to reduce first. Certainly many citizens are unaware of the true costs of waste and others are concerned, but could benefit from ideas and tools that make it easier to reduce their impact. On a national level, the EPA's Food Too Good To Waste program is running pilot projects in several states. Consumers are provided with shopping and measurement tools as well as tips for food storage and meal planning. So far, results suggest that the efforts have resulted in a 25 percent reduction in food waste for participating households. Similar programs could be adopted and implemented at a statewide level in Maine. That said, numerous studies have found that voluntary and passive education campaigns are often limited in their ability to change behaviors, particularly over the long term (Hobson 2006; O'Rourke and Ringer 2015). These limitations suggest that more effective waste reduction and recovery programs combine education campaigns with stronger measures such as incentives or mandates.

Consumer Dis/incentives for Reduction

In addition to providing households with good information, many researchers have demonstrated that behaviors can be nudged with the right set of incentives (positive or negative). Tools such as unit-based pricing for waste disposal, often referred to as "pay as you throw" (PAYT) are in place in more than 160 municipalities in Maine, but can also be used on a statewide basis, as in Iowa and Wisconsin. At the local level, methods such as reduced container sizes or less frequent trash pickup can encourage households to reduce total waste generation and become more mindful about the purchase of products with excessive packaging.

Institutional Environmentally Preferred Purchasing (EPP)

Interventions designed to reduce household waste are important, but are not nearly as effective as those that send a stronger market signal to producers upstream, helping communicate demand for products with less associated waste. Purchasing power can be translated into significant market influence. Governments are often the single largest purchaser of goods within a state. Several state and local governments, including Maine, have built on this understanding to encourage environmentally preferred purchasing (EPP) among institutional buyers. The EPA's comprehensive procurement guidelines cover 61 different products that can be assessed based on their environmental benefits. Several models for EPP exist, ranging from voluntary programs and incentive-based systems to legislative mandates.

Voluntary programs include buying cooperatives, such as the one set up by the Massachusetts Operational Services Division and Maine's Division of Purchases. The cooperative provides an opportunity for municipalities to participate in statewide procurement contracts for products with recycled content. These buying cooperatives significantly increase state buying power and influence on the market, which can help drive demand for less waste- and resource-intensive products.

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Montana uses an incentive system to encourage EPP. The state offers a recycled materials tax deduction to any business that purchases goods made from recycled materials. Participants can deduct 10 percent of the purchase from federal adjusted gross income to calculate Montana adjusted gross income. By encouraging the use of recycled materials, these programs reduce demand for virgin extraction and production (and the associated waste water, emissions, and materials).

In Washington State, all state agencies have been directed, under an executive order and broad legislative and policy mandates, to set a positive example by undertaking aggressive waste-reduction programs and participating in EPP. These directives include a provision that requires agencies to reduce the use of products with persistent bio-accumulative toxic chemicals, to phase out products and packaging with polychlorinated biphenyls, and to purchase printer and copier paper with 100 percent recycled content (http://www.ecy.wa.gov/programs/swfa/epp/laws_directives.html).

Alternative Business Models and Sustainable Design for Reduction

Governments can also help create incentives for more sustainable design and to support emerging forms of collaboration among businesses. The coordinated benefit business model is based on concepts from industrial ecology that aim to eliminate waste by encouraging cooperation among firms with complimentary processes. For example, products such as paper scraps or sawdust from one enterprise can become an input for another co-located business, significantly reducing resource use and waste. State governments can facilitate the formation of these industrial symbiosis projects with information and incentives for co-location. Governments can also invest in research and development for sustainable design. Eliminating unnecessary materials in the production, consumption, and disposal phases is important, but designing products for durability and zero waste is the most cost-effective means to reduce inefficiencies in the materials system.

Examples of state-level policies to support alternative business models and sustainable design are still relatively rare in the United States, but have become increasingly popular in the European Union. The United Kingdom, for example, has prioritized the development of resource-efficient business models and supply-chain innovations through significant investments and the establishment of a waste-prevention loan fund to develop more resource-efficient ways of doing business. The U.K. Government's Technology Strategy Board has also instituted an innovative design challenge (U.K. HM Government 2013).

Product Stewardship (PS) and Extended Producer Responsibility (EPR)

Sustainable design and alternative business models are important, but as they are voluntary, they are often not as effective as policies that can create incentives or require businesses to design for reduced waste. Product stewardship programs take various forms, but add a level of effectiveness because they typically require groups at multiple stages of the product cycle to share responsibility for managing product recovery and disposal (Wagner 2012). Maine became a national leader in PS programs in 2010 when the legislature passed the first PS framework law in the United States. Maine was also the first state in the country to require producers to take partial responsibility for household e-waste (Wagner 2009). Implemented in 2006, the program set up a shared cost system for producers, municipalities, and consumers, resulting in a 221 percent increase in the number of e-waste items collected and recycled by its third year (Wagner 2009) and enabling Maine to achieve some of the highest per capita e-waste-collection rates in the United States (Rubin et al. 2010).

Extended producer responsibility, like product stewardship, also uses the "polluter pays" principle, but places a stronger focus on manufacturers who, depending on the model adopted, are required to assume full organizational and/or financial burdens for end-of-life management. EPR strategies are intended not only to improve recovery rates, but also to focus efforts up the supply chain to create waste-prevention measures. EPR assumes that if forced to take responsibility for end-of-life management costs, rational manufacturers will have a strong incentive to redesign their products and will be most motivated to make changes in design and production when the "feedback loop of waste management costs goes directly to the individual producer" (Van Rossem, Tojo, and Lindhqvist 2006: v).

Several studies suggest that EPR programs can affect design and planning decisions. Tojo (2004), for example, documents product redesign by manufacturers of electronic equipment Hitachi and Sony. In both cases, the companies replaced plastic housings on televisions and laptops with magnesium alloy because of low recovery rates for plastic. Tojo's interviews with manufacturers also found that Swedish car manufacturers Volvo and Saab were designing to phase out toxic substances and to ensure easy disassembly and recycling (Van Rossem et al. 2006).

Today there are 89 EPR laws in 33 U.S. states (Lombardi and Bailey 2015) and many more internationally, targeting a wide variety of products most notably those with toxic content or unrecoverable materials. They include, for example, used oils, pharmaceuticals, refrigerant fluids, textiles, carpets, mattresses, paints, mercury thermostats, e-waste, batteries, and fluorescent lighting. Maine has long been a national leader in extended producer responsibility with programs for paint, e-waste, mercury auto switches, rechargeable batteries, mercury thermostats, and mercury-added lamps (HID bulbs and fluorescents). That said, there is unfulfilled potential.

An internationally acclaimed packaging ordinance, introduced in Germany in 1991, stipulated that the businesses that produce packaging waste are responsible for the take back of those products (Reichel et al. 2014).

Known as the Green Dot Program, the ordinance requires producers of a given type of packaging to pay into a common fund for reuse and recovery intended to pay for the take back of these materials (McKerlie, Knight, and Thorpe 2006). This highly successful program has been credited with helping Germany to exceed the EU's 50 percent recycling target more than 10 years early, the near elimination of landfilling, and reduced incineration rates (Fischer 2013). Perhaps even more encouraging, a survey conducted one year after the adoption of the ordinance found that 63 percent of the businesses responding to the survey reported they had discontinued the use of composite materials that were hard or impossible to recover (Broaddus 2015; Nakajima and Vanderburg 2006).

Like Maine, British Columbia instituted a "bottle bill" or container deposit legislation (CDL) in the 1970s that has significantly reduced roadside pollution (its original intent) and set the stage for the province's 80 percent recovery rate for beverage containers (Encorp 2014). In 2004 (B.C. Reg 449), the province implemented their recycling regulation with a more robust framework for extended producer responsibility that required producers who wish to sell or distribute products in British Columbia to submit a stewardship plan for approval by the Ministry of Environment. The program has since been expanded to include additional product categories including a wide variety of e-waste. Most recently British Columbia expanded its efforts with the inclusion of packaging and printed paper (PPP) in 2014. The program aims to "make businesses supplying packaging and printed paper responsible for collecting and recycling their products," and to "shift recycling costs from BC taxpayers to producers, and to give producers more incentive to be environmentally friendly by producing less packaging and waste" (Province of British Columbia 2015).

Product Fees and Sales Bans for Reduction

Sustainable design, new business models, and PS incentives present some of the most promising avenues toward total waste reduction. Product sales bans or fees are even more effective because they mandate or penalize the sale of products with significant disposal costs. British Columbia, for example, places eco-fees on certain paints and aerosol containers and the governments of Ireland and Scotland require fees on all single-use carrier bags. Evidence from Ireland suggests that its 2002 tax reduced use of plastic bags by 75 to 90 percent (Convery, McDonnell, and Ferreira 2007). In Portland, Maine, a single-use bag fee has been implemented, and similar measures are now being considered in other Maine communities.

Other governments have banned the sale of toxic and/or highly resource-inefficient single-use disposable products. Several U.S. cities have banned single-use products such as polystyrene foam food containers (Portland, ME), drinking water in single-serve PET bottles (Concord, MA), and single-use high-density polyethylene bags (Westport, CT). While these bans are highly effective for waste reduction, they are still relatively rare, particularly at the state level. Product sales bans are politically difficult to pass due to strong opposition from industry groups and, in some cases, low levels of citizen support.

Despite these limitations and significant opposition, the state of California recently passed a plastic bag ban (SB270), which requires groceries and convenience stores with more than 10,000 square feet of sales space to stop offering single-use disposable bags to customers after July 2015. These retailers are permitted to sell reusable bags, including sturdy paper bags, for a minimum fee of 10 cents. While industry opponents may have succeeded in forcing the ban to referendum, independent and peer-reviewed life-cycle analyses suggest that bans on the use of plastic bags can deliver significant benefits related to waste reduction, ecosystem toxicity, human health, and climate mitigation (Convery, McDonnell, and Ferreira 2007) as long as the bags are replaced with reusable bags (e.g., nonwoven polypropylene, low-density polyethylene) that minimize upstream impacts and are used more than once (U.K. Environment Agency 2011).

REUSE: EXTENDING PRODUCT LIFETIMES

When it is not possible to reduce waste, it is often possible to extend the lifespan of existing products through reuse. Reuse slows down demand for virgin production, ultimately leading to reduced materials throughput and energy use and waste reduction (U.S. EPA 2015a). Reuse is defined as any operation in which products and/or components are used again for the same purpose they were originally intended. Associated activities such as repair, refurbishing, and remanufacturing are included in the scope of reuse, but recycling is not. While the use of recycled materials is also an important strategy to reduce materials and energy

throughput, reuse has more significant benefits because it avoids the energy, materials, and expense necessary to recover, transport, process, and remanufacture recycled materials into new products.

Reuse is an important but often overlooked and understudied component of the waste hierarchy. As Lombardi and Bailey (2015: 27) write,

> Most communities have a fragmented network of independent reuse and resale outlets such as thrift stores, antique shops, building material resale stores, pawn shops, and online exchanges. There are also repair businesses for products such as computers, clothing and appliances. These facilities are a critical but often undervalued asset to both building a Zero Waste community and supporting a thriving local economy.

A recent study in the United Kingdom backs these claims, finding that current levels of reuse create financial savings to households of around £1 billion each year and reduce greenhouse gas emissions by one million tonnes—the same as taking 300,000 cars off the road. The authors write, "in terms of potential impact, this is clearly just the tip of the iceberg" (WRAP 2011).

Reuse is an important but often overlooked and understudied component of the waste hierarchy.

Education and Awareness for Reuse

Several cities in the United States have invested considerable resources in programs designed to educate consumers about the value of reuse. Portland, Oregon, has instituted "Resourceful PDX," a platform that offers guidance to citizens on reducing their ecological footprint through, in part, reuse. In Austin, Texas, residents can search several websites for local businesses involved in the reuse, repair, and sharing economies. ReMade, ReShare, and RePair logos identify shops in a city-sponsored branding scheme to promote zero waste, and the city has declared a "Reuse Week," which includes neighborhood swaps and repair cafes. Many state agencies, including the Oregon Department of Environmental Quality and the Minnesota Pollution Control Agency, are building on these efforts to improve awareness of the benefits of reuse in residential, commercial, and industrial sectors as part as the state's comprehensive plan for waste reduction.

Facilitate Alternative Exchange Models and Cooperative Reuse

Many communities have gone beyond encouraging reuse to facilitating exchange by, for example, providing online platforms or physical spaces for the exchange of second hand goods, surplus materials, or salvaged goods. Many of these are product specific and localized including tool libraries in Berkeley, California, and Portland, Maine, or generalized as in transfer station swaps. The state of Maine already has a vibrant private and informal reuse sector with a large network of secondhand shops, salvage operations, flea markets, yard sales, localized online exchanges, and various swap and freecycle groups. These concepts could be scaled at the state level, however, with support for, or investment in, platforms, organizations, or associations that can facilitate reuse in multiple sectors from household goods to commercial and industrial materials.

States might also work to encourage alternative business models such as product service agreements that favor producer rather than consumer ownership. These models can build brand loyalty, reduce the purchase of privately owned but underused products, promote collaborative consumption, provide convenience for consumers, and give producers an incentive to make goods more durable.

Incentives for Reuse

There are a wide variety of incentives that might help encourage reuse in multiple sectors. Any measures that increase the relative costs of waste disposal, such as Wisconsin's statewide, unit-based pricing, create incentives for actions up the hierarchy including reduction and reuse.

Tax credits for the donation of used goods contribute to a healthy system of thrift shops across the country, but other national governments, such as Australia's, have further examined tax systems to ensure that products that are resold multiple times do not compound taxation and thus create a disincentive for reuse. There are also incentives that might be used in specific economic and product sectors. For example, in California there are several programs designed to encourage "adaptive reuse"

FIGURE 2: **Beverage Containers Crushed, Bailed and Ready for Sale**

Photo: C. Isenhour

of the existing housing stock including tax credits, fast-track permitting, and fee reductions.

Mandatory Reuse

States can set mandatory salvage and reuse targets in exchange for permits in a number of different industries. Given the relative impact of construction and demolition debris, many states have considered instituting minimum salvaged material requirements for construction permits. Maryland's Zero Waste Plan, for example, lays out a plan to institute these requirements (Maryland Department of the Environment 2014). California has already instituted standards under their Green Building Code that require permit applicants to salvage at least 50 percent of their construction and demolition debris for reuse and recycling (U.S. EPA 2015b).

RECOVERY FOR RECYCLING

Recovery is defined as any process that separates salvageable materials from the waste stream, either at source or in facilities after collection. Recycling is an important element in sustainable materials management, ensuring that used or unwanted materials with residual value (nutrients, metals, plastics) are returned to the economy, maximizing efficiency. According to the EPA, recycling resulted in the avoidance of 183 million metric tons of carbon dioxide equivalent in 2006 alone. Increasing the recycling rate from 32.5 percent to 50 percent that year could have resulted in the avoidance of an additional 70 to 80 million metric tons (U.S. EPA 2009).

There are also significant cost savings associated with recycling and composting. Based on traditional accounting methods, the EPA has estimated that the average national savings of composting, compared to landfill disposal, is between $9 to $37 per ton, depending on the technology used (U.S. EPA 1999). Other analyses that include full lifetime costs and benefits have estimated the net benefits of as high as $120 per ton (Lombardi and Bailey 2015).

The United States continues to process more recyclables each year, but recycling rates, as a percentage of the waste stream, have stagnated. Markets have an effect on recycling rates, but most materials-management professionals agree that stronger levels of participation are also necessary. The largest opportunity for measurable improvements is in organics recovery. Discarded food is the single largest and least recovered waste stream in the nation (U.S. EPA 2015a). According to the U.S. Department of Agriculture (USDA) Americans wasted more than a third of all the fruits and vegetables they bought in 2010 (Buzby and Hyman 2012). Maine food waste makes up nearly 30 percent of the residential waste stream, and compostable papers and yard wastes make up another 12 percent (Criner and Blackmer 2012). These volumes suggest the significant potential for organics management to help the state to make progress toward its diversion and waste-reduction goals. Nationally, organics collection is growing and with it the organics management sector (http://www.wastebusinessjournal.com/overview.htm).

There are a wide variety of strategies that might be employed to improve waste-recycling rates. As in previous sections, we organize them according to their potential for waste diversion while recognizing the complex factors that influence decisions and weigh against diversion potential.

Education and Awareness for Recovery

Many state agencies given the task of improving recovery and recycling rates have developed education and outreach programs. Ranging from posters and infographics to interactive websites, these tools are designed to educate waste generators about the importance of recycling as well as the appropriate methods for separation. According to Broaddus (2015), well-designed and -executed education and outreach campaigns have been reported to improve a city's commercial recycling levels

by as much as 3 percent. Despite these gains, it is generally well accepted that such programs are even more effective when combined with other measures. As one analysis commissioned by the state of Massachusetts found, "stand-alone elements such as education or technical assistance for home composting, for example, are much more effective when combined with economic or policy incentives such as Pay-As-You-Throw pricing" (Tellus Institute 2008: 5).

Convenience and Improved Coverage for Recovery

Convenience is also an important factor for the success of diversion efforts. Many empirical studies confirm that habit and convenience are significant barriers to more sustainable behaviors (Hobson 2006; Isenhour 2010) Collection containers that are large and easy to use, such as roll-out carts, are more convenient and thus more effective than bins that are smaller and harder to transport (Lane and Wagner 2013). Others have also advocated for the convenience of single-stream collection and recycling to ensure greater participation. Analyses of the relative costs and benefits of universal single-stream compared to baseline scenarios and single-stream systems complemented with bottle bills, suggest that single-stream improves recovery relative to "business as usual," but may result in reduced residual value due to contamination. The highest rates of diversion are achieved with a combination of universal single-stream and bottle bills (Vermont ANR 2013).

States can mandate universal compost and recycling services, but this may prove a challenge to implement in Maine due to "home rule." Curbside pickup is not always an option due to the high costs of transportation in rural areas, but improved collection can be encouraged with access to convenient drop-off locations. Today it is common practice for both residential and commercial customers to have access to recycling of traditional materials, but organics collection/drop off is still relatively scarce. However, organics collection is increasing; as reported in a 2011 analysis, more than 121 municipalities in the United States and Canada had added organics collection by 2010 (Bush 2011).

Studies in cities such as Seattle, San Francisco, and Hamilton, Massachusetts, suggest that organics collection reduces landfill tipping fees, pressure on landfill capacity, and the frequency of waste pick up. In Hamilton, Massachusetts, for example, less than nine months after residents were offered organics collection, the community's trash had been reduced by 30 percent (Northeast Recycling Council 2015). States can also require haulers to offer collection and to collect and report data on tonnages of waste, compost, and recyclables in exchange for operating permits.

Support and Facilitate Cooperation

Curbside collection of organics and recyclables is not a viable option in many rural areas where transportation costs are prohibitive. Without an adequate or consistent volume of recyclable materials, many rural communities find it difficult to market recovered materials and ensure a fair return. In these cases, there may be a significant financial incentive to dispose of municipal solid waste at a waste-to-energy facility or landfill. Rural states such as Montana, Texas, and New Mexico are thus working to support regional cooperation. In New Mexico, a rural recycling marketing cooperative has helped set up a hub-and-spoke system that pools recyclable materials from rural communities for bulk sale. Not only does this cooperative system help with marketing and sales, but it can also reduce transportation costs by ensuring that resources are pooled for the most efficient transportation. Maine has a long history of municipalities working together on waste issues, including the efforts of the Maine Resource Recovery Association. States with large rural populations can consider investing in and supporting these efforts. In Utah, for example, the state has invested in recycling market development zones, which provide income tax credits for recycling businesses and potential buyers that locate in development zones.

Incentives in Multiple Sectors

There are a wide variety of strategies that might be used to encourage the separation and collection of organic and recyclable materials on multiple scales. Used in conjunction with organics and recycling collection, every other week (EOW) collection of waste has also proven effective for both reducing waste and recovering organics. In Portland, Oregon, municipal solid waste tonnages declined by nearly 40 percent within the first year of the implementation of EOW collection (Broaddus 2015; Northern Tilth 2013).

Pricing mechanisms can also be extremely effective. Container deposit laws (CDLs), for example, give consumers an economic incentive to separate their recyclables. Communities can also require waste

haulers to integrate the costs of collecting recyclables into a single fee so that businesses are not discouraged from participating in recycling programs due to additional costs. Unit-based pricing, or PAYT, systems are also attractive for recovery. By charging per unit of waste, these systems provide an economic incentive for generators to divert organics and recyclables from the trash. In addition, by asking those who generate the waste to pay for its disposal rather than all taxpayers, these programs are seen as more fair. Several states have implemented statewide PAYT programs including Iowa and Oregon (U.S. EPA 2015b) and many communities have reported as much as a 50 percent decline in waste after implementing PAYT (Broaddus 2015). These programs are particularly effective when recycling and composting services are free for waste generators.

At the municipal level, landfill surcharges can create incentives for programs to improve recovery rates. To meet the requirement of their Climate Action Plan to reduce waste by 75 percent by 2020, the Colorado Legislature passed the Recycling Resources Economic Opportunity Act in 2007, which added a 10 cent/ton tipping fee. Such fees have encouraged municipalities to reduce disposal and are intended to fund recycling and composting programs. By 2010, after only a few years of operation, the fund had generated $2.5 million (Nowakowski 2010).

Finally, states can also spur recovery and diversion by requiring or supporting resource management (RM) contracts. Traditional contracts between waste generators (typically municipalities) and waste service providers (e.g., haulers and disposal contractors) have been based on the volume and weight of the waste handled. These traditional contracts place the community's interest in reducing waste and improving recovery against those of waste contractors whose profits are tied to hauling and disposing of more waste. Resource management contracts change the incentive structure of waste disposal by rewarding waste contractors for achieving waste-reduction goals, thus providing an incentive to reduce rather than increase waste. After successfully instituting a number of pilot projects that proved effective for improving waste reduction and recovery, Minnesota's Pollution Control Agency has worked to support expanded RM by developing template language for RM contracts and requests for proposals (https://www.pca.state.mn.us/quick-links/resource-management).

Mandatory Source Separation, Collection, and Landfill Bans

While improved awareness of and access to recycling and composting programs are extremely important, as are economic incentives and convenience-based nudges, they cannot guarantee that waste generators and contractors will participate. Communities committed to ambitious goals for reduction and recovery have worked to ensure participation by mandating source separation and collection and/or banning the disposal of recoverable materials from the waste stream. San Francisco was the first city in the United States to require its citizens—residential and commercial—to compost and recycle.

There was already significant national precedent for preventing certain materials from being disposed of in landfills. According to the Northeast Recycling Council (2011), nearly every state in the country has banned at least one product or material from landfills (at the very least lead acid batteries and tires in Wyoming), and 19 have mandatory recycling for at least one commodity. In Wisconsin #1 and #2 plastics, aluminum cans, glass, and other high-volume recyclables are banned from landfills and incineration. Other states have targeted construction and demolition debris. In Massachusetts, asphalt, brick, and concrete have been banned from landfills since 2006. Maine bans disposal of several products including cathode ray tubes, mercury-added products, and cellular phones.

As states work to improve recovery rates and reduce climate impact, many are also focusing on preventing organic waste from ending up in landfills. More than 25 states have a ban on the disposal of leaves, grass clippings, or brush. According to Lombardi and Bailey (2015), these bans helped jumpstart the early composting industry. Connecticut became the first state to require large-scale generators of food scraps to recycle food wastes in 2011. Since then several of Maine's neighbors have expanded restrictions on the disposal of organic materials including Vermont and Massachusetts. Today one of the primary barriers to expanding composting and digestion capacity is an insufficient or unreliable source of organic tonnage (Broaddus 2015). Graduated bans of food waste, which start with large producers and gradually incorporate producers of smaller volumes, as in California's AB 1826, are seen as a key strategy to build an infrastructure for organics processing and to develop local industries. According to an article on the

website Biocycle.net (December 20, 2013), the executive director of the American Biogas Council has argued that food-waste bans provide "a shot of adrenaline to the growing biogas and compost industries" and "fulfill a fundamental need for biogas and composting project development: a predictable and reliable source of organic feedstocks."

The ban on commercial food waste in Massachusetts took effect in October 2014, targeting first large producers generating four or more tons of food and vegetative waste per month. Given that organic materials made up approximately 25 percent of the state's waste stream and nearly half of that was generated by businesses and institutions, the state decided to focus on commercial generators first. If successful, the ban is expected to help the state to meet its goal to reduce total waste by 30 percent before 2020 and 80 percent by 2050. It will also yield other benefits such as increased investment in the composting and digestion industry, infrastructure, renewable energy jobs, improved agriculture, and water conservation (http://www.mass.gov/eea/agencies/massdep/recycle/reduce/).

At their most progressive, bans can move beyond single products or high-volume waste categories to include all recyclables and organics in the residential, commercial, and self-hauled waste streams. Those who violate these mandates can be fined or excluded from collection if contamination exceeds a specifically defined percentage. Vermont has recently instituted one of the most progressive and comprehensive universal recycling laws. Act 148, passed in 2012, created the Universal Recycling Law, which added organics and recyclables (metal, glass, plastic #1 and #2, paper, and cardboard) to an already long list of products that cannot be "knowingly" landfilled in the state. It also requires universal access to recycling and organics collection and processing (2015); mandates that municipalities institute PAYT programs and pricing for households and businesses (2015); imposes a ban on leaf and yard waste in landfills (2016); and requires a phased requirement for separation of food waste starting with large generators (2014) and expanding to the residential sector with a universal ban of food waste in landfills by 2020.

This first-of-its-kind program's phased and all-in approach allows for advanced planning and the development of capacity to handle mandated collection and processing requirements (https://ilsr.org/initiatives/composting/). To enable capacity building, there are significant exemptions for large generators of food waste who are not within 20 miles of a certified compost facility with adequate capacity. As the ban applies to smaller-scale producers of food waste, these exemptions expire for larger producers. By 2020, the geographical exemption will expire in all cases under the assumption that capacity for organics management should be well developed. While it is too early to gather data on outcomes, the program is projected to reduce the state's carbon emissions by 38 percent, increase recycling rates to 60 percent, and reduce pressure on landfills in Vermont and surrounding states (Vermont ANR 2013).

CONCLUSIONS: POLITICAL WILL, DATA, AND LEGITIMACY

We hope this article makes it clear that there is no single policy that works in all situations to reduce waste and improve rates of recovery. All of the strategies mentioned here, while organized according to their potential for diversion, involve a series of complex tradeoffs that must be considered in relation to policy priorities, public support, financial costs, and environmental benefits for municipalities, businesses, institutions, and residents. What is clear is that political will and clear policy objectives are an essential prerequisite.

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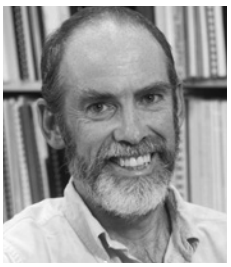

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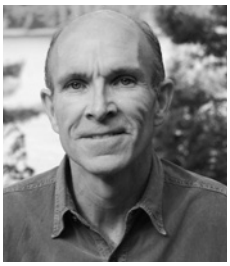

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