WASTING OPPORTUNITIES

How to Secure Environmental & Clean Energy Benefits from Municipal Solid Waste Energy Recovery

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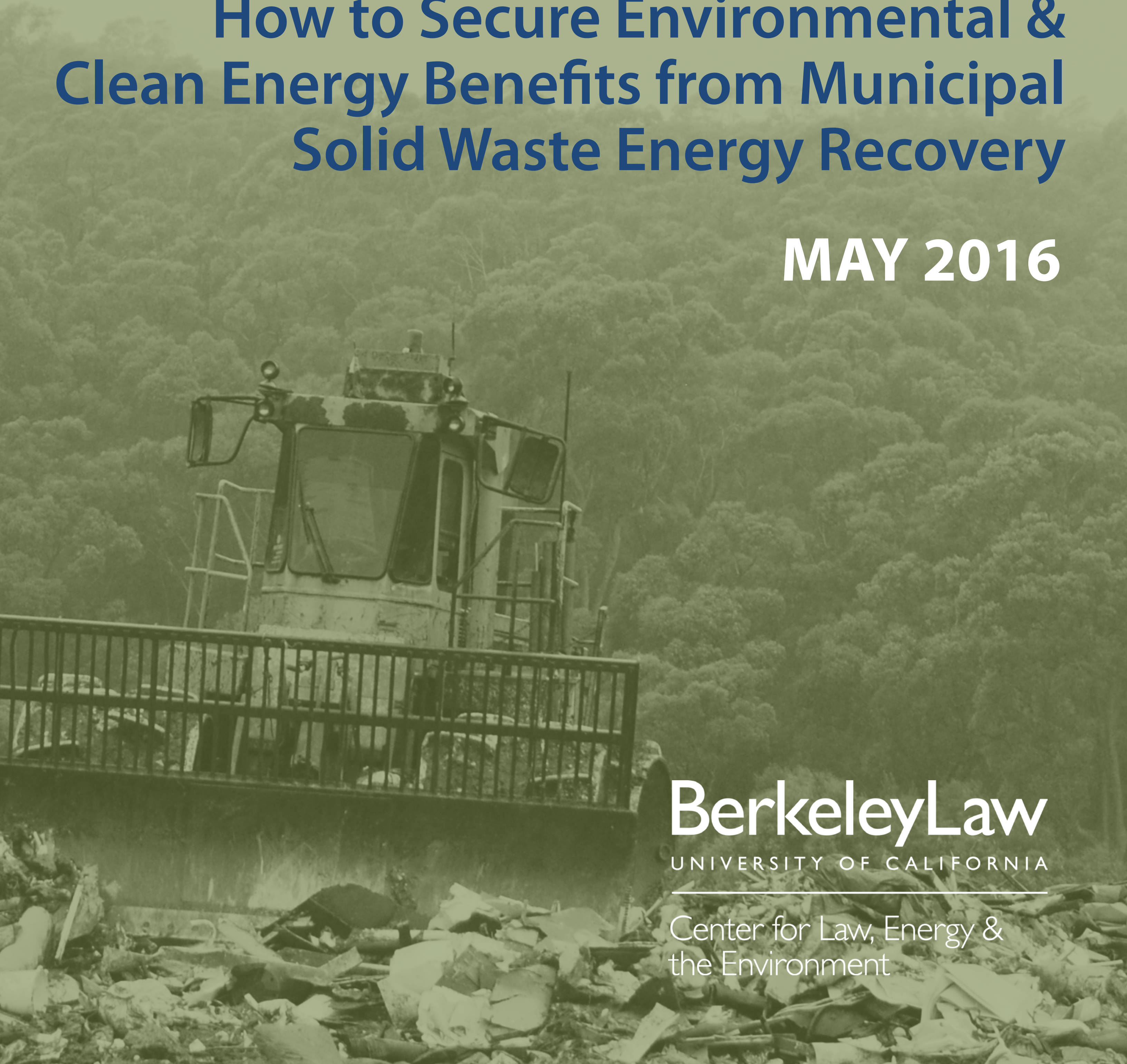

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ABOUT CLEE

The Center for Law, Energy & the Environment (CLEE) channels the expertise of the Berkeley Law community into pragmatic policy solutions to environmental and energy challenges in California and across the nation. The Center works with government, business, and communities on initiatives that focus on reducing greenhouse gas emissions, advancing the transition to renewable energy, and ensuring clean water for California's future.

ABOUT THIS REPORT

This policy paper resulted from a one-day convening at the UC Berkeley School of Law with Adrienne Alvord, Graciela Castillo-Krings, Tim Cesarek, Karen Coca, Grant Cope, Eric Herbert, Darby Hoover, Evan Johnson, Ted Kniesche, George Larson, Tim O'Connor, Rashael Parker, Cliff Rechtschaffen, Scott Smithline, Diana Tang, Michael Van Brunt, Chuck White, and Robert B. Williams. The report and recommendations are solely a product of the UC Berkeley School of Law and do not necessarily reflect the views of all these participants.

AUTHORSHIP

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INTRODUCTION: A NEW PROCESS TO EVALUATE WASTE-TO-ENERGY TECHNOLOGIES

The large volume of municipal solid waste that Californians generate has long presented an environmental challenge. Reduction, recycling and composting have helped reduce this trash stream, but Californians still send 30 million tons of waste to landfills annually.[1] With this waste, the state loses opportunities to utilize valuable materials, potentially reduce greenhouse gases, and conserve energy, water and other resources.[2]

To reduce this reliance on landfilling, the state is taking steps both to increase recycling via a 75 percent recycling goal and to limit the steady growth in waste projected for the future.[3] Source reduction, reuse, and recycling represent the highest rungs on the waste management hierarchy. Although the process of recycling can result in emissions from the processing facilities, the environmental impacts are generally significantly less than if the materials were to be created from virgin raw materials.

However, not all types of materials can be practically and economically recycled in an environmentally beneficial manner with current technology. As a result, after these ecologically beneficial options have been maximized and exhausted, the remaining solid waste in California presents an opportunity as a potential source for energy recovery.[4] Energy recovery captures the chemical energy (i.e. the heat content) inherent in discarded materials.

Harvesting these leftover materials as solid waste energy sources could provide multiple environmental benefits:

- complementing intermittent renewable energy, such as wind and solar, to offset fossil fuel-based energy sources and associated greenhouse gas emissions;[5]
- avoiding landfill emissions of methane (a potent greenhouse gas that is 28-34 times as strong as carbon dioxide over 100 years) by diverting wastes to energy, particularly organic wastes;[6]
- contributing to recycling of soil carbon and nutrients through anaerobic digestion of certain waste streams, particularly organics;

After other ecologically beneficial options have been maximized and exhausted, the remaining solid waste in California presents an opportunity as a potential source for energy recovery.

– creating liquid or gaseous renewable transportation fuels from solid waste;[7]
– decreasing the need for landfilling both in- and out-of-state.

These outcomes could potentially support California's greenhouse gas goals of reducing overall emissions to 1990 levels by 2020, with a further 80 percent by 2050.[8]

Yet "waste-to-energy" conversion processes face obstacles, particularly due to concerns about local air pollution (especially for low-income communities of color, which often bear a disproportionate impact from these facilities) or that energy production might inadvertently discourage source reduction or recycling.[9] Depending on the conversion process and feedstocks used, these facilities historically emitted harmful levels of local air pollution, although modern conversion processes and pollution controls resulting from the Clean Air Act Amendments of 1990 resulted in significant improvements.[10] Still, waste-to-energy conversion processes may simultaneously decrease emissions of one type of pollutant while increasing emissions of another type.[11]

Despite the challenges and potential opportunities, the state lacks an agreed-upon set of standards for measuring and balancing the life-cycle costs and benefits of various waste management methods, including energy conversion.[12] In addition, existing laws and regulations fail to contemplate advancements in existing waste-to-energy technologies, which have led to fewer emissions, higher efficiency processes, the potential for greater metal and other material recovery from processing residues, and the advent of new technologies, including gasification, pyrolysis, and waste-to-fuels processes.[13]

To address these challenges, this report describes policy actions that could help the state deploy waste-to-energy generation without compromising other environmental values and goals. (Policy makers should also address the significant environmental justice concerns related to siting any approved facilities; such a land-use process is not the subject of this report but should be a subsequent area of study for decision-makers.) The report draws on the recommendations of waste-to-energy producers, environmental experts, and state and local officials (see appendix) who gathered at the University of California, Berkeley School of Law in May 2015 for a discussion sponsored by the law school's Center for Law, Energy and the Environment (CLEE).

Some of the key recommendations include:

– The development of technology-neutral, performance-based standards for energy recovery of waste materials that will not discourage recycling;
– A revised waste disposal hierarchy that includes energy conversion that reduces overall pollution and contemplates "dispersion" as the lowest rung beyond disposal; and
– A revised landfill tipping fee that accounts for the full range of environmental costs.

These and other recommendations are described in more detail in this report.

Glossary of terms

Municipal Solid Waste (MSW): Commonly referred to as trash or garbage, it describes items and materials discarded by households, businesses or public institutions.

Waste Pile: A collection of solid waste materials.

Landfill: A site where solid waste is disposed of, typically by burying it and covering it with a layer of soil.

Diversion: The reduction of solid waste disposed of in landfills through source reduction, recycling, reuse or composting.

Dispersion: Referring to solid waste that falls out of the waste management hierarchy and disperses into the environment.

Material Recovery Facility (MRF): A facility where comingled recycling streams and/or solid waste is sorted to recover materials for recycling.

Waste-to-energy: The conversion of solid waste materials into useable heat, electricity, or fuel, utilizing different processes (sometimes referred to as "Thermal Resource Recovery" or TRR).

Waste Management Hierarchy: A set of options for dealing with waste, which lists the options in the order of priority and desirability.

Anaerobic Digestion: Anaerobic biological process that uses organic waste as a feedstock to produce biogas primarily composed of methane and carbon dioxide, as well as liquid and/or solid digestate matter.

Incineration (mass burn): The controlled combustion of solid waste to convert it into heat, flue gas, ash and fly ash.

Pyrolysis: Anaerobic thermo-chemical decomposition of organic waste, converting it typically into pyrolysis oil, syngas, and other byproducts (such as char, tar or flue gas).

Gasification: Thermal decomposition of waste in a controlled oxygen environment, converting it into syngas and solid byproducts (such as ash or slag).

Syngas: Synthesis gas composed of hydrogen, carbon monoxide and carbon dioxide.

Slag: A glass-like byproduct of waste-to-energy conversions, which can be used for example as filler in the construction industry.

CALIFORNIA'S CURRENT MUNICIPAL SOLID WASTE MANAGEMENT: WASTED OPPORTUNITIES FOR RENEWABLE ENERGY GENERATION AND GREENHOUSE GAS EMISSIONS REDUCTION

Current Solid Waste Disposal Practices Largely Avoid Energy Recovery

When waste hauling companies collect municipal solid waste, they either move it to transfer stations for further long-distance transportation and eventual disposal or processing, to recycling facilities for recycling, or to material recovery facilities for sorting and separation.[14] Collection companies transport sorted solid waste from the transfer centers and material recovery facilities either to recyclers, composting facilities, or landfills.[15] They also transport some solid waste to out-of-state landfills.[16]

California only recovers a small portion of solid waste as energy or converted fuel (see Figure 1). To serve the waste disposal needs of residents, the state has 476 transfer stations, an estimated 160 material recovery facilities, more than 180 composting facilities, and more than 130 landfills.[17] It has only three "thermal resource recovery" (waste-to-energy) facilities, located in Commerce, Long Beach, and Crows Landing.[18]

A notable exception is the use of urban wood waste, a segment of the waste stream for which state policy encourages energy recovery. Producers divert a significant quantity of urban wood waste to biomass-to-energy facilities in California for energy recovery. The state's waste management law considers this waste-to-biomass a "diversion."

New And Evolving Waste-To-Energy Technologies May Reduce Emissions

People have been generating energy from solid waste since ancient times. The first modern incinerators used for district heating and later for power generation, named "the destructors," operated in the United Kingdom from the 1870s.[19] Due to increasing concern about

History Of Waste Management Regulation In California

AB 939, the California Integrated Waste Management Act (Sher, 1989), established an integrated waste management hierarchy from the most desirable source reduction, through recycling and composting, to the least desirable environmentally safe transformation and land disposal. In addition, it mandated 25 percent solid waste diversion from landfills by 1995 and 50 percent diversion by 2000. It also restructured the institutional and planning background of waste management in California.

AB 341 (Chesbro, 2011) changed the California Integrated Waste Management Act and established a goal of 75 percent solid waste diversion from landfills through source reduction, recycling, or composting by 2020.

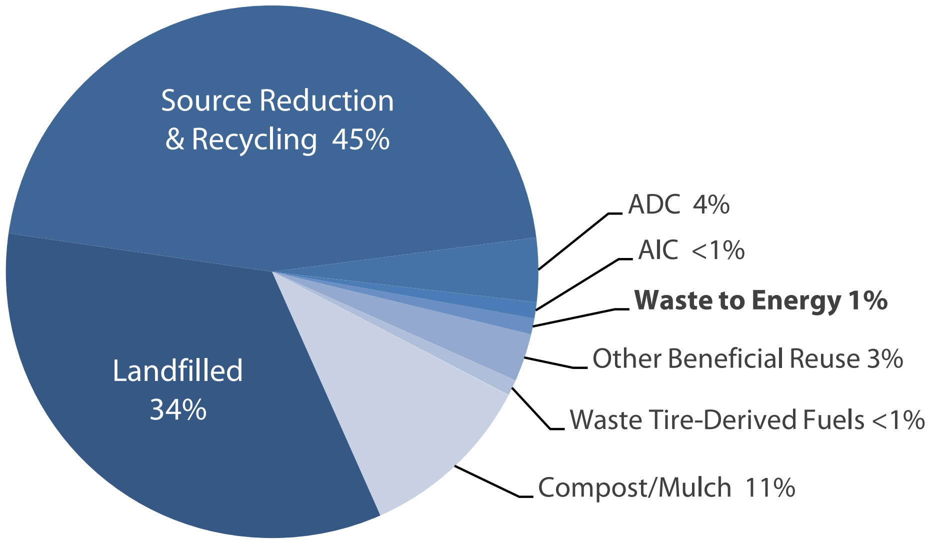


Figure 1. Municipal solid waste disposal in California in 2013 by disposal type.

Source: CalRecycle, "State of Disposal in California," March 2015.

environmental impacts, several waste-to-energy technologies have emerged, which can be divided into bio-chemical and thermo-chemical processes.[20] Some stakeholders consider landfilling with methane capture and anaerobic digestion to be bio-chemical resource recovery processes, although others consider it mitigation for pollution emitted off-site.[21]

Mass burning or incineration technology represents the oldest and most common thermal resource recovery technology.[22] It combusts solid waste to convert it to heat and other byproducts, such as ash and combustion gases.[23] Pollution from these facilities varies according to the air control technology and solid waste feedstock. Due to local pollution concerns, California has permitted just three thermal resource recovery facilities using mass burning technology,[24] although these kinds of facilities are more commonly deployed in other states, the European Union, Japan and China.[25] The three in-state facilities began operating in the 1980s and have since added new pollution control improvements and retrofits to comply with the federal Clean Air Act.[26] These retrofits, alongside newer facilities in the U.S. and European Union (EU), with new technologies, regulations, and monitoring, have lessened the overall impact on human health and the environment.[27] For example, Sweden imports solid waste from other countries in order to increase its solid waste incineration capacity; yet the country has decreased total emissions related to waste incineration.[28]

Pyrolysis and gasification represent two emerging thermo-chemical waste conversion technologies. Both of these technologies involve the thermochemical decomposition of solid waste (or more typically certain waste streams contained within) but with differences in the processes, such as the temperatures involved, as well as the products and byproducts.[29] For example, while pyrolysis typically results in pyrolysis oil, syngas, and byproducts such as char, tar or flue gas, gasification results in syngas and solid byproducts, such as ash or slag. And whereas mass burning of waste generates on-site energy, pyrolysis and gasification products can potentially be refined and transported to generate energy and fuels elsewhere, while byproducts could potentially be utilized as inputs for other chemical processes.[30] Recent research has indicated that gasification and pyrolysis can meet increasingly stringent environmental standards and may offer further reductions in emissions.[31] However, comprehensive data on environmental performance of pyrolysis and gasification are not yet available for commercial-scale operations.[32] New facilities, regardless of the thermal conversion process, will generate the same categories of emissions as existing facilities but may have improved air pollution control and conversion efficiencies.

Current Solid Waste Disposal Policies in California Do Not Encourage Energy Recovery

California policy does not support the use of new waste-to-energy conversion technologies as an alternative to landfilling, due to ongoing concerns about their impact on air pollution and recycling efforts.[33] In addition, new technologies face additional hurdles, due to the lack of long-term data. California laws instead favor source reduction, recycling, and energy recovery from landfill gas over thermal resource recovery. AB 939 (Sher, 1989), the California Integrated Waste Management Act, established the in-state waste management hierarchy, which determines how different types of waste disposal are treated.[34] The law does not include energy recovery, due to opposition to conventional incineration at the time of adoption.[35]

Despite the advances and evolution of waste-to-energy technologies, the legislature has not revised AB 939 since its adoption. As a result, no new thermal resource recovery facilities have been constructed in the state, landfilling rates remain high, and emerging technologies have not had an opportunity to be deployed in-state, despite their growing deployment in other states and countries. As discussed, evidence from these jurisdictions suggests that emissions have significantly decreased,

Because no new thermal resource recovery facilities have been constructed in the state since the 1980s, landfilling rates remain high, and emerging technologies have not had an opportunity to be deployed in-state, despite their growing deployment in other states and countries.

Figure 2. The waste management hierarchy of the EU, which is also endorsed by the EPA.

Source: Recyctec.se website.

if not completely vanished, from waste-to-energy plants built since the 1980s, although concern remains about the impact on recycling by destroying materials that could otherwise be reused.[36]

AB 939's lack of consideration of waste-to-energy technologies places the statute out of step with the hierarchy embraced at the federal level by the U.S. Environmental Protection Agency,[37] as well as the European Union (EU). The EU in particular has embraced resource recovery as an integral part of waste management (see Figure 2). As a result of these policies, the EU uses a significant and growing proportion of waste for energy generation, without impeding the growth of recycling.[38] At the same time, the EU's regulatory framework provides more support for emerging waste-to-energy technologies, in part by acknowledging both pyrolysis and gasification as possible methods of resource recovery and by adopting an efficiency standard and including leading air pollution control requirements.[39]

The California Legislature has not been able to address waste-to-energy opportunities. In early 2015, Assemblymember Travis Allen proposed AB 997 to amend the California Integrated Waste Management Act to include power generation from anaerobic digestion and landfills with methane capture. The bill also encouraged and called for the study of certain waste-to-energy and waste-to-fuel technologies for plastic, textile, and fiber feedstocks, but the bill did not pass its first committee hearing.[40] Although AB 997 would have provided policy direction to encourage deployment of waste-to-energy technologies, it did not include the newest thermal resource recovery technologies, such as pyrolysis and gasification.

OVERCOMING THE TOP THREE CHALLENGES: MAXIMIZING ENVIRONMENTALLY BENEFICIAL ENERGY RECOVERY FROM SOLID WASTE

Based on the convening discussion, this section summarizes the key challenges and solutions to help address them.

Barrier #1: Outdated Codes and Statutes Do Not Contemplate New Energy Conversion Technologies and Their Improved Environmental Impacts

California's legislation and regulations related to waste-to-energy technologies are outdated and inconsistent. First and foremost, the waste management hierarchy and definitions related to waste management all derive from AB 939.[41] Yet AB 939's definition of "transformation" does not reflect all new technologies; although it references incineration and pyrolysis, it does not include "gasification." In addition, its requirement for "zero emission and zero waste transformation" from waste-to-energy facilities is unrealistic (as is true for other waste management processes other than source reduction and reuse). The hierarchy of waste disposal also does not prioritize energy recovery over disposal, and the codes do not account for or contemplate new and emerging technologies that can achieve waste recovery with limited emissions. Finally, the state's cap-and-trade program under AB 32 (Nuñez, 2006) excludes landfills but covers energy recovery, which means that it burdens recovery but not landfilling. Ultimately, California does not define the "pile" of municipal solid waste that could or should be converted to energy, given specific performance attributes and assuming that all reasonable recycling options have been exhausted.

SOLUTIONS:

State leaders, through a stakeholder-informed process, should set performance-based waste management standards for energy recovery, addressing both emissions and feedstocks. These

The state should empanel expert representatives to inform performance standards based on the latest scientific knowledge, demonstrated performance, and technological feasibility.

standards, like emission standards, could allow for recovery processes that may result in greater-than-zero emissions but would still enable appropriate environmental and economic balancing among different waste management options. The state should empanel expert representatives to inform the performance standards based on the latest scientific knowledge, demonstrated performance, and technological feasibility. The panel could start by gathering empirical data on the three facilities operating in California, as well as by reviewing credible data from advanced conversion technologies deployed in other states and Europe.

In addition, the state should launch a similar process to determine feedstock standards. Most critically, the standards should determine what "pile" of solid waste material is suitable for thermal resource recovery ("consensus pile"). The standard should consider the economic and technical feasibility of recycling the material, as well as the differences in environmental impacts and benefits between recycling and energy recovery, as determined through lifecycle analysis. The process should also have flexibility to change over time to reflect improvements in waste characterization and to reflect the changing volume and composition of waste. The feedstock standard could also contemplate other metrics, such as optimizing energy savings and reducing emissions, including greenhouse gases, of an overall waste management system. Oregon's SB 2633 may provide a model, having established an alternative approach to calculating recovery rates based on the overall energy savings achieved.

State leaders should set feedstock performance standards by considering optimal life-cycle greenhouse gas emissions reductions, energy efficiency, ecological benefits and impacts, and comparison to more beneficial waste management methods such as recycling. To perform this analysis, stakeholders and agency staff will need to collect accurate data on all parts of the materials value chain, both upstream and downstream of the waste management processes. Such an evaluation may result in a system that does not follow the current waste hierarchy in all instances. As an example, EU member states may choose waste management options that do not comply with the waste management hierarchy if the study of life-cycle benefits and environmental impacts justify the decision.[42]

State leaders should ensure that the performance-based standards are realistic and technology neutral. Common regulatory principles, such as accounting for life-cycle costs and benefits, should be applied regardless of the technology. For example, natural gas generates sulfur oxide emissions during upstream processing but not at the point of combustion, like waste-to-energy facilities typically do. As a result, when viewed at the facility level, burning natural gas for power generation is perceived as a better option than waste-to-energy conversion, despite the possibility that waste-to-energy technologies may have other life-cycle environmental benefits beyond natural gas, such as waste and other emissions reductions. Notably, the analysis depends on the feedstock, which should consist only of solid waste that cannot otherwise be managed in an economically reasonable and ecologically beneficial manner like recycling. Yet because the current standard is not technology neutral and has a zero-emissions standard for sulfur oxide emissions, waste-to-energy facilities cannot comply.

State leaders should develop a new waste disposal hierarchy that includes, rather than excludes, waste-to-energy conversions that meet both the emissions and feedstock performance standards. The standard should remove thermal conversion from its current "bucket" in AB 939, which couples it with disposal. Although recycling may continue to be the more desirable waste management solution once the waste has been generated, performance-based "recovering" should be prioritized for material that cannot be recycled or otherwise managed in an ecologically beneficial manner, or that will not actually be recycled because of economic factors or contamination. In addition, policy makers could add a further category to the hierarchy of waste management: dispersion (into the environment). This lowest-rung, least-desirable category would acknowledge that worse options exist than disposal.

Barrier #2: Energy Recovery as a Perceived Competitor to Recycling

If California were to develop more robust energy recovery programs from solid waste, some advocates fear that the use of feedstocks for energy recovery would undercut traditional recycling efforts and divert municipal resources that would otherwise fund ecologically superior waste management options. Competition from recycling (real or perceived) therefore presents a challenge to energy recovery efforts. State law is also unclear: for example, the state lacks a clear and uniform definition of "recycling," which may discourage recycling and also the recovery of potential energy feedstocks. In addition, stakeholders lack a common definition of the term "post-recycling," while the state has not yet accounted for the marginal economic and environmental benefits of waste recovery. Finally, the state lacks monitoring processes and data on how much of the material that California categorizes as recycled is exported and actually recycled in other states and countries, as opposed to being used for energy recovery, landfilled, or dispersed, which could make recycling a less-desirable alternative in practice. Without such monitoring and data, state leaders do not know to what extent California is achieving its policy goals.

SOLUTIONS:

State leaders should encourage waste-to-energy conversions for feedstocks that remain after recycling and reusing options are maximized through a performance-based feedstock standard. The standard could ultimately allow waste-to-energy conversion technologies to use whatever solid waste is left over from the Material Recovery Facility (MRF) or robust source separation programs after recycling and reusing have occurred. The standard should also maximize the opportunities to recycle waste products instead of letting them fall to lower rungs of waste management options in the hierarchy.

State leaders should improve monitoring and enforcement of recycling. They should implement methods to determine whether waste exports claimed to be recycled abroad are actually recycled. Since these waste exports count toward recycling, even if they are not actually recycled in reality, their transport abroad does not necessarily reflect the highest and best use of these materials as determined by the waste hierarchy. Better monitoring would therefore provide a more realistic basis for what can be considered "recycling" and what should be exported or not and would ensure the actual environmental outcomes that waste managers expect in contracting for the services.

Barrier #3: Cheap Landfilling as a Competitor to Energy Recovery

Landfilling has been the primary method of disposing solid waste in the United States for almost a century. California is in fact home to the first modern landfill established in the country.[43] As the growing volume of waste provided ample need, the landfilling industry grew quickly in the latter half of the twentieth century. Yet cheap landfilling encourages waste management stakeholders not to explore other options, such as recycling or waste-to-energy. According to CalRecycle, negotiated tipping fees at California landfills average around $25 per ton, with the average of the publicly posted fees fluctuating between $45 and $54, which include the $1.40 per ton state disposal fee.[44] By comparison, the publicly posted tipping fees in New England and the Mid-Atlantic average above $70.[45] In the EU, the tipping taxes, despite having a wide range, average around $35.[46] These relatively low California tipping fees for the landfill system mean that alternative options lack long-term investment and the ability to compete on a level playing field. As a result, existing waste-to-energy facilities face an uncertain future, while new facilities face challenges securing financing (and both face uncertainty under the state's cap-and-trade system).

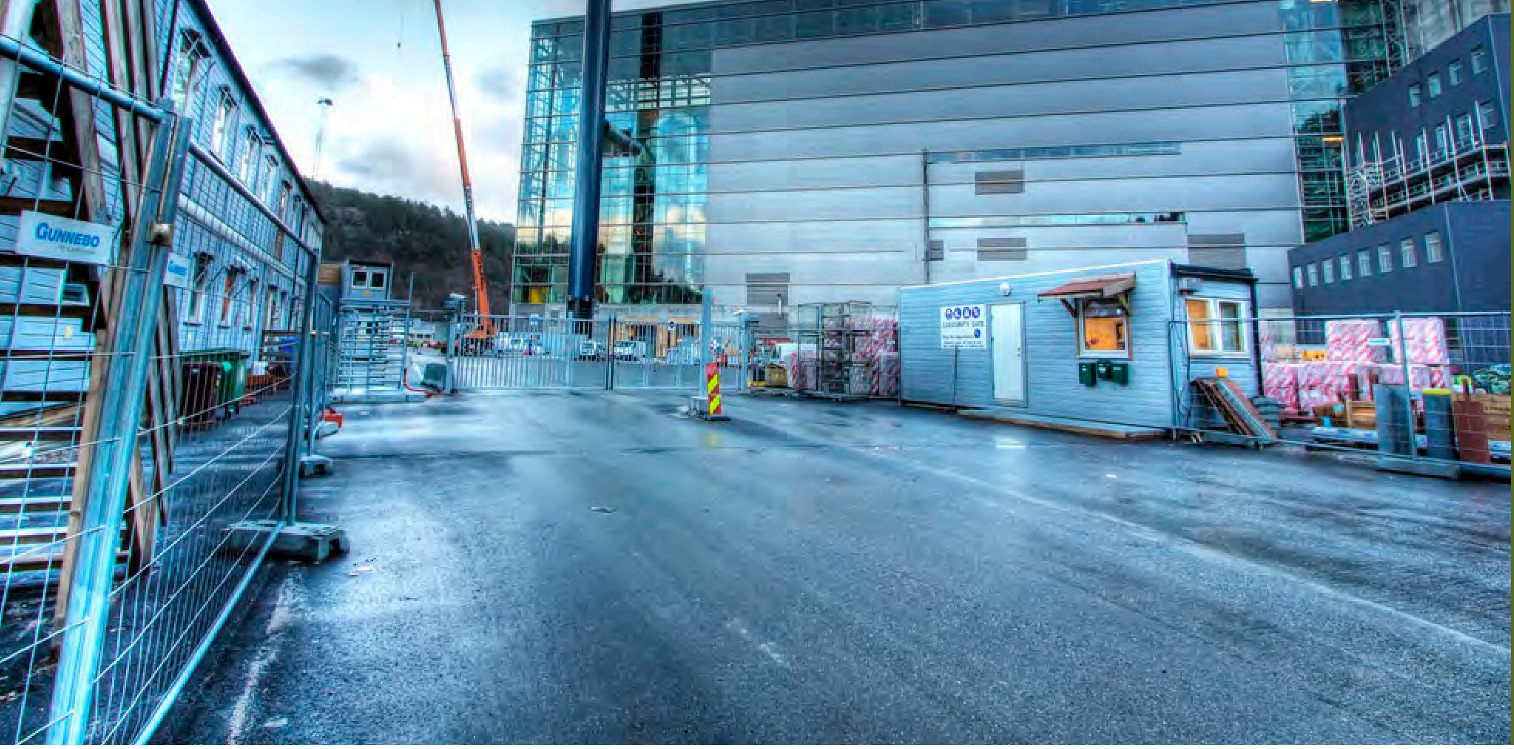
SOLUTIONS:

State leaders should consider revising the cost of landfilling to more accurately reflect environmental costs by increasing the state disposal fee from a maximum $1.40 to possibly $10 per ton

fee for landfilling solid waste. This fee, either through legislation or regulatory efforts possibly under AB 32, could be a direct charge to compensate for the full environmental and societal costs of landfilling based on the average landfill gas (mostly methane) leaks, as well as to better reflect long-term environmental liabilities associated with post-closure landfills. Although a fee based on the actual methane leaked by the landfill would be more precise, calculating these emissions with any degree of certainty may be impossible. Ideally, this fee would be indexed to inflation, providing a long-term economic signal to encourage advancements in sustainable waste management. As an example, AB 1063 (Williams) would have increased the tipping fee to $4 per ton but did not pass the Senate in 2015.[47]

State leaders should direct any new revenues from higher landfill fees to offset landfilling impacts on greenhouse gas emissions. If the fee is not enacted with a two-thirds legislative majority, it will become subject to Proposition 26, a 2010 state voter-approved initiative to amend the California constitution. Under this initiative, the fee cannot exceed the "reasonable costs to the State of conferring the benefit or granting the privilege to the payor."[48] As a result, state leaders would need to ensure that the new revenue is spent to offset state costs related to the landfilling. Mitigating the emissions from landfilling could be consistent with the Proposition 26 requirement and compel state leaders to fund landfilling alternatives that reduce the emissions according to the waste hierarchy, such as via emissions reductions from recycling or the capability of thermal resource recovery to provide baseload renewable power (as opposed to intermittent renewables like solar or wind).

State leaders should adopt a consistent, equitable, and permanent approach for waste management under California's cap-and-trade program. Currently, the program includes thermal resource recovery facilities in California under the cap while excluding landfills. This inconsistent treatment of two technologies within the same market segment creates an unequal playing field and may make landfilling the cheaper option for local governments, despite the recognized climate impacts of methane. In recognition of the lower greenhouse gas emissions of waste-to-energy facilities relative to landfilling, the three thermal resource recovery facilities have received temporary exemptions from the cap-and-trade program. However, the lack of a permanent and equitable solution creates significant financial uncertainty for existing facilities and suppresses development of new projects.



CONCLUSION: OPPORTUNITIES FOR MULTIPLE ENVIRONMENTAL WINS WITH WASTE

California has an opportunity both to maximize recycling and other beneficial waste management options and to encourage new waste management options that could help the state reduce overall impacts from waste management, as well as the disposal and dispersion of solid waste. New and evolving technologies and renewable energy and fuel needs, as well as the state's ambitious goal of achieving 75 percent recycling, should prompt state action to determine the optimal deployment of these technologies. The state will first need to revise its outdated codes and statutes in favor of a more sophisticated and holistic approach to waste management. State leaders should consider all the environmental benefits from the use of new and evolved waste-to-energy conversion technologies, instead of discouraging them without further study. At the same time, enabling alternative waste management methods should promote maximal efforts to increase the volume of recycling, composting and other ecologically beneficial options in California. Ultimately, through a stakeholder-led, science-based process, California can seek the sweet spot in better waste management.

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Endnotes

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