

Ames Resource Recovery System 2020 Report and Policy Recommendations

From the



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Table of Contents

Study Summary and Recommendations	1
Background.....	1
Current League Position Statement	1
Proposed Position Statement	2
League Recommendations	2
1. CLIMATE ACTION PLANNING.	2
2. VOLUNTARY PLASTIC RECYCLING	3
3. MANDATORY RECYCLING.	3
4. EXPAND COMPOSTING OF FOOD AND YARD WASTE.	3
5. LOCAL CONTROL OF SINGLE-USE PLASTIC BAGS.	4
6. CONTINUED SUPPORT FOR THE BOTTLE BILL.....	4
7. EVALUATE WASTE HAULING SYSTEM.....	4
8. IDENTIFY, MEASURE, AND REPORT ELECTRIC RATEPAYER SUBSIDIES.	5
Support for Recommendations Advanced in a Recent City Study.....	6
9. MECHANICAL IMPROVEMENTS AT THE RESOURCE RECOVERY PLANT.....	6
10. EDUCATION/OUTREACH.	6
11. BUSINESS RECYCLING.	7
12. EXPAND ON THE RECOMMENDATION FOR A LAST CHANCE RE-USE CENTER.....	7
13. MATTRESS RECYCLING.	8
14. EXPAND GLASS COLLECTION POINTS.....	8
15. COMMUNITY-DRIVEN DIVERSION.	9
16. COMPLETE FOOD WASTE COLLECTION FROM RESTAURANTS	9
17. OFFER FOOD WASTE COLLECTION FROM RESIDENTS.	10
18. EVALUATE ANAEROBIC DIGESTION.....	10
19. RUMMAGE RAMP.....	11
20. FOOD RESCUE.....	11
Current Waste Management Practice	11
Collection System.....	11
CURBSIDE AND COMMERCIAL COLLECTION.	11
CUSTOMER DROP-OFF OF WASTE MATERIALS.	12

Resource Recovery Plant	13
PROCESSING REFUSE DERIVED FUEL.....	13
FINANCING THE OPERATION.....	13
PROSE AND CONS OF THE CURRENT SYSTEM	14
Electric Department.....	14
ELECTRIC GENERATION.....	14
Waste Management at ISU	16
Recycling Plastic	17
Waste Management Facts and Trends	20
RECYCLING	20
INCINERATION	21
Innovation.....	21
APPENDICIES	22
Appendix A – Committee Members	22
Appendix B – Recognition of Local Information Sources	22
Appendix C - Iowa State University – Electricity Resources.....	23
Appendix D – Acronyms/Glossary	23
Appendix E - Resources.....	24

Study Summary and Recommendations

Background

Through its policy statements, the League has a long history of support for the Ames municipal electric utility and for the burning of refuse-derived fuel. In 1971, it was estimated that the city's landfill would be full in just three years. Tougher regulations for the siting of new landfills were also impacting other communities. Ames offered to cooperate with neighboring towns in finding a short-term solution to the pending landfill closing, if those towns would work with the city in the future. Measures were introduced to extend the life of the landfill while other options were considered, including a proposal to burn waste in the coal-fueled power plant. In April 1972, the League submitted a report to the council endorsing the burning of waste for heat recovery and, in the interim, urged adoption of a recycling program. In October of that year, it presented a full analysis comparing costs of the waste-to-energy proposal with other options. And on May 1, 1973, the city approved a contract to design a solid waste incinerator system with heat recovery. The waste to energy system began operations in 1975 and, with periodic improvements in the processing of refuse derived fuel, it has continued to serve the City of Ames (COA) and other communities in Story County ever since.

The study behind the current report began in June 2019 in response to a number of factors, including the need for action in response to the climate crisis, changes in markets for recyclable materials, maturation of the regional energy market, significant increases in utility operation and maintenance costs (especially those resulting from the increasing volume of plastic in the waste stream) and new and improved technologies for the generation and storage of electricity whose adoption may be limited by the necessity of operating the power plant to burn refuse. The study included interviews with personnel from the Resource Recovery Plant, the city electric department, Iowa State University's power plant and Sustainability Office, the Iowa Department of Natural Resources, and others, as well as a review of waste management literature.

Current League Position Statement

The League's existing policy statement is built on a prior study of the electric utility adopted in 1981 and updated in 1988 and 2004:

- ***Support for a municipally owned electric facility for the City of Ames.*** The League of Women Voters supports interconnection of power systems including possible expansion of the use of regional power pools; buying and selling of power; emphasis on the use of renewable resources (i.e., the utilization of refuse-derived fuel from the Solid Waste Recovery System and by-product steam for heating purposes, and wind generated power); a continued high level of reliable service; direct citizen access to the decision making process; a system of financial reporting that is accurate, accessible and understandable to the general public.
- ***An electric utility is a part of the total energy-planning picture.*** This planning must consider the economic consequences to the community. Continued priority should be given

to conservation efforts, including use of energy audits and exploration of load management techniques.

Proposed Position Statement

Under the title “Electric Utility and Solid Waste Management” the following position statement is proposed. While findings in this report include a number of specific recommendations, they can be summarized in the following revision/replacement of the current policy statement cited above:

- ***Support for a municipally owned electric facility for the City of Ames.*** The League of Women Voters recognizes the continuing value of a municipal electric utility. Local control of a municipal electric utility gave Ames and its neighbors the opportunity to find a truly innovative technology that has turned waste that would otherwise be buried in a landfill into electricity to power homes and businesses. Our community-owned, locally controlled electric utility will give Ames similar opportunities in the future to take greater advantage of energy efficiency, renewable energy, and new technologies for producing, storing, distributing and using electricity. **The League supports utility policies and investments that enable Ames to set and achieve climate action goals consistent with those recommended by science-based findings of the International Panel on Climate Change.**
- ***Support for climate action planning.*** We support establishment of a clear and specific timeline for the Ames Electric Department to meet goals for reducing greenhouse gas emissions.
- ***Support for measures to reduce, reuse, and recycle waste.*** Ames, Story County, and other local governments should adopt policies and support programs that promote reduction, reuse, and recycling of waste.

League Recommendations

1. **CLIMATE ACTION PLANNING.** Ames City Council, Story County Board of Supervisors, and other communities in the county should expeditiously adopt climate action plans with specific targets for greenhouse gases (GHG) emissions to inform infrastructure planning and investment, reduce the cost and difficulty of achieving future emission goals, and reduce the level of future technical debt (the cost of inefficient “built infrastructure”). Climate action will necessarily require changes in the management of solid waste. Specifically, the Ames City Council must establish a clear and specific timeline for the Ames Electric Department to meet goals for reducing greenhouse gas emissions, including a date certain for ending the combustion of fossil fuel and refuse for electric generation.

Background: Climate science is clear. The world faces an existential climate emergency. In the Paris Agreement, signatories endorsed the goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C. To the extent that these goals are reached, the risks and impacts of climate change can be reduced. More recent findings indicate that change is occurring at a faster rate than was assumed and governments at all levels need to act.

- 2. VOLUNTARY PLASTIC RECYCLING.** Until curb-side pickup is available from all haulers, Ames, Story County and other local governments should evaluate programs for voluntary recycling of clean plastic containers. The programs could be single-stream or for specific plastic types, depending on recycling markets or other factors, but participation should be free and convenient. A good model for such a program is the one the COA and other Story County communities make available for glass recycling, which provides yellow containers at multiple drop sites.

Background. The market for dirty, mixed plastic has changed dramatically, since China stopped accepting it for recycling. However, good options for clean and sorted plastic materials and new plastic processes are on the horizon. Recycling plastic, rather than burning it very likely results in lower carbon emissions than extracting and refining petroleum.

- 3. MANDATORY RECYCLING.** Local governments should set a deadline by which licensed waste haulers must provide curbside recycling.

Background. In general, recycling requires less energy and results in lower carbon emissions than extracting and processing virgin materials. Burning recyclable materials in the Ames power plant requires that for every Btu derived from refuse, 85 to 90 Btu of fossil fuel are burned. That process is not sustainable. Furthermore, the State of Iowa requires consideration of curbside recycling: *455D.21Local ordinance — curbside collection. A city council or county board of supervisors which provides for the collection of solid waste by its residents shall consider as a proposed ordinance, the mandatory curbside collection of recyclable materials which have been separated from other solid waste. The proposed ordinance shall be considered in accordance with chapter 331 or 380.1992 Acts, ch 1215, §17.*

- 4. EXPAND COMPOSTING OF FOOD AND YARD WASTE.** The city should require licensed waste haulers to offer curbside collection of yard and food waste and require owners of multi-unit residential buildings to provide facilities for the collection and pick-up of organic waste.

Background. Since 2018, the city has offered rebates on home composting systems. Home composting is the most efficient way to treat organic waste, but that does not work for residents of most multi-premise buildings and not everyone has a garden or other area to utilize compost. Organic material makes up 16 percent of the waste received at the resource recovery plant.¹ Keeping that waste off the tipping floor and turning into valuable compost is good for the RRP, good for the power plant (15% of organics end up in RDF), and good for the environment, creating a valuable soil amendment. The total potential organic and yard waste for resource recovery participants is about 1.5 times the amount composted by ISU – a significant, but manageable volume.²

¹ RSI Study, Appendix A

² Nationally, just over 13 percent of metropolitan solid waste (MSW) is yard waste, which the RRP does not accept. Assuming a similar ratio of yard waste to total waste for Story County and applying the total

- 5. LOCAL CONTROL OF SINGLE-USE PLASTIC BAGS.** The League supports the repeal of Iowa legislation prohibiting local government action to restrict the use of plastic bags and related materials. Our local governments are encouraged to join the effort to repeal the legislation. When local control is restored, local governments should adopt measures to prohibit the use of single-use plastic, such as grocery bags and drinking straws or impose a small recycling program fee of 10 cents/bag, to encourage consumer use of re-useable bags and provide revenue to support other waste-management best practices.

Background. Plastic grocery bags are made from fossil fuel in an energy intensive process, they are not easily recyclable, they do not fully degrade, they pollute our waters and land, and kill wildlife and marine animals. They also pose health risks for humans. Degraded particles contain trace amounts of hormone-disrupting chemicals. As they work their way through the food chain they are inevitably consumed by humans. California, Connecticut, Delaware, Hawaii, Maine, New York, Oregon and Vermont have banned or imposed fees on single-use plastic bags. Many local governments have also banned or imposed fees on plastic bags, including Boston, Boulder, Chicago, Los Angeles, Montgomery County (MD), New York, San Francisco, Portland (ME), Seattle, and Washington DC. Iowa is among several states that have limited the ability of local governments to take such action. Legislation limiting the power of local governments to restrict the use of plastic bags was distributed by the American Legislative Exchange Council (ALEC) and was approved by the Iowa Legislature in 2017. It is inconsistent with good practice in waste management, environmental protection, and action necessary to address the climate crisis.

- 6. CONTINUED SUPPORT FOR THE BOTTLE BILL.** The League supports legislation to increase the redemption fee on containers under the Iowa “Bottle Bill” and to expand its application to other containers, including plastic beverage containers.

Background. Support for the “bottle bill” is a current and long-held position of the League. It bears repeating here, because of its relevance to waste management practices.

- 7. EVALUATE WASTE HAULING SYSTEM.** The city should evaluate the sustainability of a system that has multiple firms driving heavy trucks down the same streets and alleyways compared with alternative systems. Among costs and benefits, carbon emissions and the wear and tear on streets and other city infrastructure should be considered.

Background. At the date of this report, there are 11 private firms licensed to haul waste in the COA. Nine firms offer curbside collection. (See Appendix B). Residents and businesses are able to contract with the firm of their choice to collect waste. Other cities coordinate waste pickup, using city-owned trucks and personnel or by contracting directly with waste collection firms for this service. A study by the Minnesota Pollution Control Agency found direct savings to residents as well as benefits in street repair costs and reduced emissions

annual waste at the RRP, Story Co. participants in resource recovery system generate 8,860 tons of organics or about 1.5 times the volume of material composted annually by ISU. (LWV analysis of data from RSI study, ISU, and EPA)

from an organized collection system. It is not the intent of this recommendation to prejudge the results, but to urge a fair evaluation of the pros and cons. The Minnesota study provides a reasonable study model (see resource list at the end of the report).

8. **IDENTIFY, MEASURE, AND REPORT ELECTRIC RATEPAYER SUBSIDIES.**

Customers of the Ames Electric System subsidize county-wide solid waste disposal. The benefits of these subsidies accrue disproportionately to customers of three other electric utilities operating within the city and residents of all other Story County Communities that use the resource recovery system. Whether these subsidies are reasonable and sustainable is an open question, but they should be clearly identified in any discussion of the current waste recovery system or its improvement or replacement. The city should identify, measure, and report these subsidies.

Background. If the subsidies provided by electric ratepayers are not known, the city may never know when a new approach to solid waste disposal becomes more cost-effective.

Examples of city ratepayer subsidies include:

- **Higher operating and maintenance costs associated with burning plastic.** The volume of plastics in the waste stream has increased dramatically since the city began burning RDF. Plastics currently represent about 36 percent of the RDF by weight. Burning plastic produces chlorine gas compounds, including corrosive chlorine compounds, that have corroded boiler tubes. Replacing damaged tubes with new ones that are coated in corrosion-resistant metal compounds has cost electric ratepayers millions of dollars and caused numerous outages. Similarly, glass that has not been removed from RDF has caused plant shut-downs and major repair costs to remove glass slag. The costs of these operation and maintenance costs are borne by ratepayers of the city electric utility for the benefit of a waste-to-energy system that serves customers of three other electric utilities operating within the city and residents of all other Story County Communities that use the resource recovery system. Replacement in similar plant designs where natural gas alone is the fuel should be compared to those experienced for the Ames plant. Some or all of the greater-than-average operation and maintenance (O&M) costs related to the combustion of RDF represent a subsidy by Ames electric ratepayers to the county-wide solid waste collection/disposal system.
- **Missed opportunities to take advantage of low wholesale market costs for electricity.** The local generating plant operates to burn RDF during times when it would be cheaper to purchase electricity in the wholesale market. In recent years, and for some time to come, the amount of wind energy produced in the state often exceeds demand and export capacity, so the price of energy in the MISO day-ahead market is relatively low. It is sometimes negative in the real-time market. When Ames is generating to burn RDF, the utility misses the chance to purchase energy at lower costs.
- **Operating the generating plant at sub-optimal capacity.** Steam plants run most efficiently at or near their design capacity, so at lower output levels it takes more fuel to generate the same number of kWh and we emit more pollutants.

Support for Recommendations Advanced in a Recent City Study

In January 2019, the COA received a Waste Diversion Enhancement & Recommendation Report from SCS Engineers (Clive, IA). It identifies opportunities to move more materials up the waste hierarchy toward “reduce, re-use, and recycle,” and to improve the quality of the RDF, and to reduce costs. The report includes twelve recommendations that deserve support from the League. Some include League-supported additions or changes (shown in **bold**). The full text of the SCS report can be viewed on the city web site. Click [here](#) for the link if you are reading this report electronically or search for “reports” on the City’s main site.



9. **MECHANICAL IMPROVEMENTS AT THE RESOURCE RECOVERY PLANT.**

The SCS report identified two mechanical changes that would improve the processing systems. To the extent they are found technically feasible, these cost-effective recommendations should have the full support of the League, Ames residents, residents of participating communities, and Iowa State University.

Background. Both mechanical changes are aimed at reducing the volume of materials rejected as refuse derived fuel, due to limitations in the processing equipment. The simplest and lowest cost (~\$30,000 to \$40,000) is the addition of air knife recovery systems at multiple points in the process. A mid-range solution is the addition of a high-speed spreader and optical scanning system (~\$700,000 to \$1.1 million). This option is estimated to have a payback of less than two years, using a conservative estimate in the reduction of rejected materials. At the time of the report, there was still uncertainty as to whether there is sufficient physical space for this equipment.

The report briefly suggested a third option, replacing the current Resource Recovery Plant with a mass burn facility that would not require the current level of processing. Advanced designs for mass-burn waste-to-energy processes have gained popularity in parts of Europe and Asia and are worth considering in the context of climate action. The electric department has budgeted for a preliminary study of this technology. It is too early to suggest that this technology merits support.

10. **EDUCATION/OUTREACH.** The report recommends capitalizing on the strong support for the resource recovery plant from the COA and Iowa State University by combining efforts to inform residents and students throughout the county about the local waste management process and various programs to encourage reduction, reuse and recycling of waste. The League supports this recommendation and the development of robust, well-funded programs of public education.

Background. Iowa State University also conducts a successful waste education program, introducing students in on-campus housing to its comprehensive recycling program.

Students living off campus and other new residents to Ames and other Story County communities find the absence of comprehensive recycling programs confusing. Many are unaware of the resource recovery plant and the waste-to-energy system or what to do with glass or hazardous materials. To be successful these programs and newer ones like Rummage RAMPage and the pilot project for composting of organic waste require well-funded public education. ISU, the City of Ames, and the Iowa Department of Natural Resources all provide information on waste management and should be encouraged to work cooperatively.

11. **BUSINESS RECYCLING.** The SCS study recommends “a concentrated effort” to assist businesses that indicated interest in expanding their recycling efforts. The study noted resources the city and the Iowa Department of Natural Resources already have in place and general agreement for that collaboration.

Background. As part of the study, a survey of area businesses was conducted concerning their interest in recycling and their cost tolerance. Nearly all respondents indicated a desire to recycle. A significant majority were willing to pay additional fees.

12. **EXPAND ON THE RECOMMENDATION FOR A LAST CHANCE RE-USE CENTER.** The report recommends a separate drive-through building where residents and small haulers could sort recyclable materials and items that may have beneficial re-use. Remaining waste materials would be transported by the city for RDF processing. **The City should consider expanding the concept of a re-use center to include a redemption center for bottles, cans, glass, clean plastic, and other recyclables. The center could also house equipment for deconstructing mattresses for recycling.** (See recommendation 13). Additional locations for convenient redemption of deposits on bottles and cans and for accepting clean cans, glass, plastic and other recyclable materials should be considered.

Background. The recommendation for the re-use center includes interesting detail on how the center is envisioned. The merit in expanding on the concept comes from the fact that Ames has not had a licensed recycling center since the recycling business on East Lincoln Way closed. Until the legislature acts to increase deposit fees or increase the one-cent handling fee on beverage containers, it’s not likely we will get one without some form of subsidy. The bottle bill allows retailers to refuse containers if they have an agreement with a licensed re-cycling center, so that may present a good opportunity to subsidize operation of a recycling center from fees collected from retailers as part of such agreements. Certified redemption centers can also offer less than the full five-cent deposit. For example, the Nevada center returns four cents for each container. Many customers would likely accept less, given the current inconvenience. Currently, local retailers are required to redeem containers, temporarily store them, and arrange for them to be picked up. And since retailers can refuse to accept containers of products they do not sell, consumers often have to make multiple stops to get rid of their bottles and cans. In some cases, retailers make their customers wait for machines in which to insert their cans and bottles. These machines

are prone to failure, and are typically located in confined spaces with excessive noise levels. A city or public/private partnership for staffing the re-use and recycling center would provide jobs, revenue, and convenience to residents.

13. **MATTRESS RECYCLING.** The study notes the need for a mattress recycling facility in central Iowa. In the absence of such a facility, the study addresses costs and benefits of shipping mattresses to a business in La Crosse, Wisconsin, but does not make a specific recommendation. **The League agrees that a mattress recycling facility is needed in central Iowa and urges the city to house the necessary equipment for the deconstruction of mattresses in conjunction with an expanded last-chance recycling center (above). Of the component parts, wood and plastic could be processed for RDF, metal could be recycled, and fiber could be condensed for shipment for remanufacturing or disposal. Additional study is required to assess options for recycling and/or disposal of memory foam mattresses, which represent a fast-growing share of mattress sales.**

Background. As a college town, Ames residents probably dispose of more mattresses than most communities our size. Those handled by the Waste Recovery Plant are sent to the Boone County Landfill. Iowa State University requires firms that supply mattresses for university housing to remove the old mattresses they are replacing. These are presumed to be recycled.

Whether the City owns and operates a mattress recycling facility or develops one through a public/private partnership, a local mattress recycling facility would reduce tipping fees at the Boone landfill, produce revenue from recycled materials, create jobs, and avoid the cost in dollars and carbon emissions related to transporting mattresses to La Crosse. The city should investigate whether such a venture would pay for itself and, if not, whether additional disposal fees or other subsidies might be required. That analysis should consider associated carbon emissions. Additional study regarding foam mattresses is needed for a number of reasons. Mattresses made from memory foam – primarily made from polyurethane – and other synthetic mattresses are gaining a significant share of mattress sales. The SCS report did not indicate whether there is a recycling market for these materials. To the extent that some of these mattresses may end up as a constituent of RDF, the products of combustion should be identified and their impact on human health and on power plant infrastructure be assessed, if possible.

14. **EXPAND GLASS COLLECTION POINTS.** The study recommendation regarding glass collection and recycling is to increase access to the glass collection bins located throughout the county and to explore options for glass collection with multi-family dwellings. **Window glass, mirrors, and cookware are not accepted for recycling. Information about how these materials as well as other non-recyclable materials like porcelain, ceramics, china, and pottery might best be handled should be developed.**

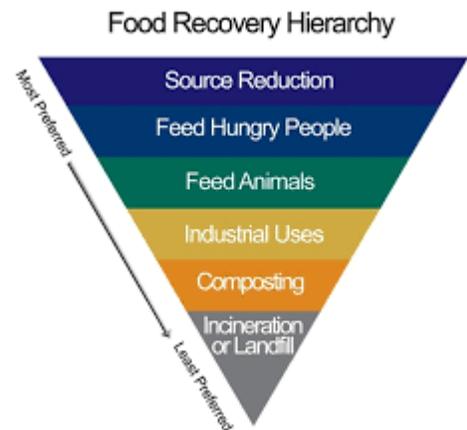
Background. The COA has an agreement with a Kansas City firm that accepts and recycles glass into bottles, jars, and fiberglass insulation. Removing glass from the waste stream is very important. While the current process removes most glass from the fuel that is sent to the power plant, the remaining molten glass forms as slag on the power plant's boiler tubes and is expensive and time-consuming to remove.



- 15. COMMUNITY-DRIVEN DIVERSION.** The study recommends more education and more drop off locations for non-beneficial materials, including efforts to facilitate diversion and recycling by residents of multi-family dwellings.

Background. A survey conducted as part of the SCS study found that 74 percent of respondents indicated an interest in additional recycling diversion. that the survey noted that the waste-to-energy system in Ames/Story County is unique and that some items that might otherwise be recycled or diverted from the waste stream are considered beneficial as refuse derived fuel, while others, such as wood, organics, bulky items, and textiles are not. So community-driven diversion requires both education and facilitation.

- 16. COMPLETE FOOD WASTE COLLECTION FROM RESTAURANTS.** The SCS study recommends a voluntary pilot project in which restaurants and caterers would agree to separate unwanted organic waste for composting. **Lessons from the pilot project should lead to an expanded program that includes grocery stores and uses incentives and/or disincentives to encourage participation. The program should be fully transparent, so that residents know which local businesses are participating.**



Background. The USDA estimates that Americans waste between 30 and 40 percent of the nation's entire food supply. The agency promotes a common-sense food recovery hierarchy that should guide food waste collection policy. This recommendation would move food waste from landfill (to the extent it is separated at the RRP) or incineration (RDF includes about 15% of food waste delivered to the tipping floor) to composting.

17. OFFER FOOD WASTE COLLECTION FROM RESIDENTS. Explore expansions of current yard-waste composting facilities to allow composting of food waste and the



possibility of food waste drop-off at specific locations. **The League supports the implementation of curbside pickup of separated food waste for composting or anaerobic digestion. Iowa City and Dubuque are among a growing number of cities that collect organic waste at the curbside. Until that service is available, we recommend expanding the current voluntary pilot project by adding drop-off sites. Collection should be convenient, free or very low cost and subsidized, if necessary, from savings in separation, landfill tipping fees, and revenue from the sale of compost. The COA already composts some yard waste and Iowa State University has also composted organic waste from its food service facilities for many years (see ISU’s current waste management practice in the main section of this report).**

Background. In 2019, the Resource Recovery Plant initiated a pilot project called Food Waste Diversion (FWD) intended to move food waste up the food hierarchy from incineration or landfill to composting. Under the voluntary program, customers receive a four-gallon bucket and lid for food scraps, five compostable bags, and a five-punch card for waste disposal. The participant must drop off the bag of food scraps at the Resource Recovery Plant. Additional punch cards cost \$10 or \$2 for each drop-off. While the League commends the city for initiating the pilot project, the study recommendation for food waste drop-off locations seems vital to get significant participation. It seems a lot to expect for residents to store food waste, even in a covered container, then transport it to the Resource Recovery Plant for a \$2 fee, when it would otherwise be included with waste picked up at curbside.

18. EVALUATE ANAEROBIC DIGESTION. The City of Ames operates an anaerobic digester system at its wastewater treatment plant. The study recommends “a separate feasibility study to determine quantities and types of feedstocks needed and available, locations, partnerships and other details to ensure a cost-effective organics management system.” If feasible, anaerobic digestion would likely be a preferable alternative to composting.

Background. Organic materials are a big problem in the production of refuse-derived fuel. Wet stuff does not burn well. Currently, most food waste and other organic material is separated at the Resource Recovery Plant and sent to the Boone Landfill. Over time, that material decomposes anaerobically and produces methane and nitrous oxide, both are potent greenhouse gases, many times more harmful than carbon dioxide. Depending on the feedstocks, process, and end-product use, composting results in some sequestration of carbon and lower volumes of carbon dioxide.³ If the material is processed in an anaerobic

³ Composting is a complex process. Generally, composting can be thought of as aerobic decomposition, which produces less harmful GHG and enables some carbon sequestration, whereas anaerobic

digester, the methane can be captured and burned to produce electricity, thereby reducing GHG emission. Ames operates a digester as part of its wastewater treatment facility. While the design of a digester for food waste and other organics might differ from the one the city now operates, the technology is well known to city personnel. Scale and operational economies might be found by processing industrial or agricultural biowaste, compatible with waste typically processed by the Resource Recovery Plant. Capturing methane from anaerobic digestion would be a beneficial component of a climate action plan.

19. **RUMMAGE RAMPAGE.** The report recommends continuation of the Rummage RAMPAGE event that has been successful in reducing waste through re-use of donated household goods. Linens, bedding, clothing, books, unused food, and school supplies were also collected and redistributed through local agencies.

Background. Modeled after a similar program in Iowa City, Rummage RAMPAGE has grown substantially since its inception in 2016. It deserves the community's full support. In 2018, the event kept 102,550 pounds of usable household goods out of the landfill. Sales also generated \$18,000 that was split among the local non-profit organizations that staffed the event

20. **FOOD RESCUE.** The study noted the double benefits of a food rescue program, i.e., "feeding the hungry and keeping organic material out of the RRP. Among obstacles to expansion noted are "liability, required short time-frames for pickup, and availability of containers." Four specific steps were identified to address these obstacles, including support for participation by ISU Dining and caterers, working with relevant public and private organizations to develop guidelines, which if followed can mitigate liability, support for service organizations to match donors with those needing prepared food, and funding for purchase of transport containers. Though the study recommendations address prepared food, the study's survey results also identified grocery stores that participate in food rescue programs. **The city could encourage wider participation by providing information to the public about which businesses participate in food rescue programs.**

Current Waste Management Practice

Collection System

CURBSIDE AND COMMERCIAL COLLECTION. There are eleven waste haulers licensed by the COA. Ten of these have residential curbside and/or commercial routes. Businesses and residents contract directly with these firms. In other cities, the city itself owns and operates the vehicles and equipment to collect waste or the city contracts on behalf of residents and/or businesses through a competitive bidding process, which may include zonal bidding. Nearly all of the waste, including waste from other Story County communities is delivered to the Resource

decomposition produces methane and nitrous oxide. A good explanation of these processes can be found on the BioCycle Website in "[Composting and Greenhouse Gas Emission: A producer's Perspective](#)" by Sally Brown and Scott Subler, BioCycle March 2007, Vol. 48.

Recovery Center for processing. Demolition materials are taken directly to the Boone County Landfill. Some other materials, such as waste cooking oil are also handled separately.

Services of Waste Haulers Licensed for Service in Ames and area									
Company	Residential	Ames Routes	Solid Waste	Yard Waste	Recycling	Type 1	Commercial	Demolition	Other Cities
Ankeny Sanitation	Y	Y	Y	Y	N	NA	Y	Y	Y
Arends Sanitation	Y	Y	Y	Y	N	NA	Y	Y	Y
Aspen Waste Sys.	N	N	Y2	N	N	NA	Y	Y	N
Chitty	Y	Y	Y	Y	Y3	Single	Y	Y	Y
Garbage Guys	Y	Y	Y	N	N	NA	Y	Y	Y
Jerry's Sanitation	N	N	N	N	N	NA	N	Y	Y4
Pratt Sanitation	Y	Y	Y	Y	N	NA	Y	Y	Y3
Stone Sanitation	Y5	Y	Y	N	Y4	Single	Y	Y	N
TWC	Y	Y	Y	Y	N	NA	Y	Y	Y
Walters Sanitation	Y	Y	Y	Y	N	NA	Y	Y	Y
Waste Mgmt.	Y	Y	Y	Y	Y	Single	Y	N	Y
1 Recycling Type: Single Stream			3 Ames & Nevada Only			5 Rural Story Only			
2 Commercial and ISU only		4 Zearing Only							

LWV Ames/Story Co.

CUSTOMER DROP-OFF OF WASTE MATERIALS. Waste that is not collected by commercial haulers, including certain exempted materials, are typically delivered directly to the Resource Recovery Plant by businesses and residents. Exempted materials include used motor oil, appliances, glass, hazardous waste, batteries, computers, TVs, and fluorescent lamps. Most of the exempted materials are separated when they are dropped off, but some require special handling. Examples include below.

- Hazardous materials require an appointment before being dropped off, so that staff know what is being delivered and ensure its proper handling,
- Batteries must also be dealt with by staff to ensure proper disposal or recycling,
- Appliances are accepted at the RRP or at commercial recycling services for a fee.
- Fluorescent bulbs are accepted without fee, but require special handling to avoid release of mercury vapor that some contain. Those and all other types of light bulbs are recycled through an agreement with Metro Waste Dropoff in Bondurant.

The Resource Recovery Plant has an excellent website that describes what is accepted. For materials that are not accepted, the site describes why each is not and how to dispose of it. If you are reading this report electronically, click [here](#) for a link to the site; if not, you can find it by entering "Ames resource recovery" in your web browser or going to the City's main web site.

Materials diverted to other locations. There are several types of materials that are not accepted at the Resource Recovery Plant or are diverted by staff. For example:

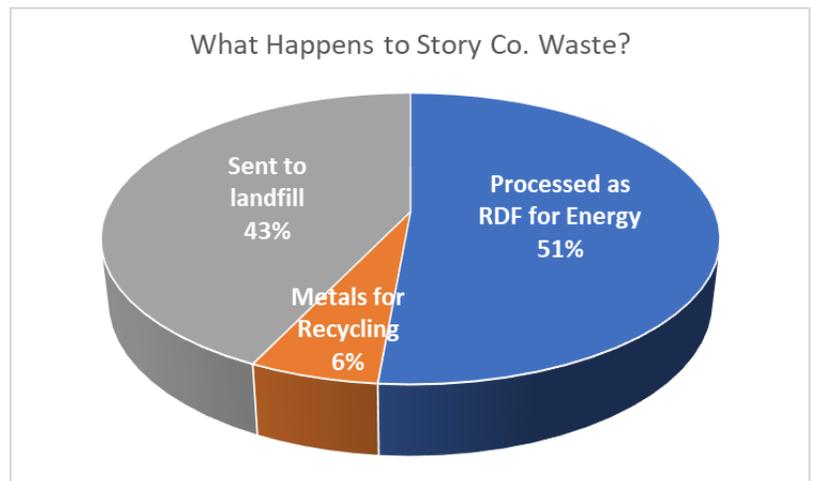
- Yard waste collected by trash haulers that provide that service is taken to a city composting site. Additionally, the city offers several no-charge yard-waste days for consumer drop-off in the spring and fall.
- Glass can be dropped off at any of a number of yellow bins throughout the area.
- Some pharmaceuticals can be taken to a disposal container in the Ames Police Office.
- Household goods donated to Rummage RAMPage
- Halloween pumpkins collected in RRP's Great Pumpkin Disposal Program are composted.
- Construction/demolition waste is diverted to Boone County landfill

Resource Recovery Plant

PROCESSING REFUSE DERIVED FUEL.

Materials delivered to the Resource Recovery Plant by licensed haulers and other Story County residents are processed through a series of shredders, magnets, and blowers that generally separate burnable and non-burnable materials.

This process also removes both ferrous and non-ferrous metals for recycling. The burnable materials are piped to the power plant as RDF and the remaining non-burnable materials are trucked to the Boone County Landfill. Based on the sample of waste from the tipping floor of the RRP that was sorted by material type for the SCS study, roughly 51 percent of the material delivered to the tipping floor could become RDF, 6 percent is made up of metals that could be recycled, and the remaining 43 percent would go to landfill.



The separation process is not perfect. For example, RDF includes 15 percent of organic material, 40 percent of miscellaneous undesirables, and 1 percent glass.

More information about the operation of the Resource Recovery Plant can be found on the city web site. Besides the excellent descriptions of the plant's operation and the materials it handles, the Resource Recovery Plant has two videos that show the plant in operation and describe its benefits and goals.

FINANCING THE OPERATION. In 2018, Resources Recovery Expenses totaled just over \$3.3 million. Over 95 percent of the revenue comes from just three sources: Tipping fees account for 54 percent, a surcharge on property tax generated 22 percent, and 19 percent came from the sale of RDF to the electric department. Operating expenses and debt service totaled \$4.4 million for

a net loss of a little less than \$1.1 million. Electric ratepayer subsidies noted in the explanation of the League's recommendation are not quantified or shown in the city's financial statement.

PROSE AND CONS OF THE CURRENT SYSTEM. A close look at the current waste management system identified both pros and cons in the current system.

Pro

- As a public, non-profit operation, the RRP is not driven by profit to maximize the volume of waste it handles. In fact, the RRP has demonstrated, through its many programs, strong support for the reduction, re-use, and recycling of waste. Local control can assure that the waste management system meets future challenges in the most responsible way.
- Burning waste to produce energy displaces fossil fuel, where fossil fueled generation is the alternative.
- The processing of waste to RDF not only removes materials that would otherwise use landfill space, it densified the non-burnable materials so they too take up less landfill space
- Modern landfill operations are able to collect a portion of the methane that is produced over time, but that process is far from perfect. The methane released from landfills is a powerful greenhouse gas. By contrast, burning the waste produces carbon dioxide, which is a less powerful greenhouse gas. [Methane is roughly 30 times more potent as a heat-trapping gas than carbon dioxide.]
- Avoided transportation costs to move waste to recycling facilities.

Con

- Burning waste releases more carbon dioxide per unit of electricity generated than does burning natural gas.⁴
- Although people will always produce waste, waste is not exactly a renewable resource. As noted above, plastic constitutes about 31 percent of the RDF burned in the Ames power plant. Plastic is a petroleum product that takes a lot of energy to produce.
- Burning waste produces harmful emissions. However, high temperatures achieved in combustion with the usual gas to RDF mixture greatly reduce emissions of dioxin and other pollution control systems keep other emissions within allowable limits.
- Recent experience with the need to replace boiler tubes corroded by chlorine compounds from combustion of plastic may indicate that burning waste in a conventional coal or gas power plant may not be the right solution for the current waste stream.

Electric Department

ELECTRIC GENERATION. The Electric Department has more than enough generating capacity to handle the combined city/ISU peak demand for electricity. Base-load generation is

⁴ "Is Burning Trash a Good Way to Handle it? Waste Incineration in five charts," by Ana Baptisa, The Conversation website, June 12, 2018.

provided by two natural gas and RDF fueled steam units. Unit 7, which has a generating capacity of 33 MW, was put into operation in 1967 at a cost of \$7.5 million. Unit 8 has a generating capacity of 65 MW. It was put into service in 1982 at a cost of \$46.7 million.⁵ Both units have had major improvements over the years. As is typical with generators nearing the end of their expected life, they are also experiencing higher operating and maintenance costs, including substantial costs and outages directly associated with the combustion of RDF. It is reasonable to consider the higher operating and maintenance costs that result from burning waste as a subsidy from electric ratepayers to the operation of the waste to energy system. (Specific problems associated with combustion of plastic and removal of glass slag are discussed elsewhere in this report.)

The two steam units are authorized to burn a fuel mix of up to 30 percent RDF, though waste is typically between 10 and 12 percent of the fuel.

Until 2016, the two steam units burned pulverized coal and RDF, but were converted to burn natural gas at a budgeted cost of \$26 million, plus the cost of a long-term contract to purchase natural gas transportation from Alliant Energy, which built a pipeline from north of Story City to Ames to provide the volume of gas needed to operate the power plant. The conversion reduced greenhouse gas emissions by 40 percent.

The Department also operates two combustion turbines. Combustion turbines have lower capital costs and higher operating costs than steam turbines, so are available during periods of peak demand or when a steam unit is not operating. Gas Turbine No. 1 has a generating capacity of 20 MW. It was put in service in 1972 at a cost of \$2 million. Gas Turbine No. 2 has a capacity of 29 MW. Installed in 2005 at a cost of \$16.8 million.⁶

As part of its portfolio of resources, the Ames Electric Department entered a 20-year agreement with Garden Wind LLC to purchase the output of wind turbines located near Zearing. The agreement was entered in 2009. The nameplate generating capacity of these turbines is 36 MW.

The electric department is soon to have another 2 MW of renewable energy from a community solar project. The Ames City Council unanimously approved the project, which will be located off Airport Road, in July 2019. Iowa State University is also participating in the project. Other renewable energy resources include a very small but growing number of consumer-owned solar arrays.

In addition to its local generating resources, Ames also purchases power from a regional energy market operated by the Midcontinent Independent System Operator (MISO). MISO is an independent, not-for-profit organization that manages the electric transmission grid across 15 U.S. states and the Canadian province of Manitoba and operates energy and capacity markets. Ames has a special relationship with the MISO market. Because it must operate to burn waste, it is exempt from the process by which MISO dispatches most generation on the basis of its cost of production, where the most economical generators are called on to run.



And because Iowa often generates more wind energy than it needs or can export, lower cost energy

⁵ COA web site, electric department.

⁶ Ibid

is typically associated with windy days. Consequently, Ames is sometimes producing power above the cost available from the market and emitting more greenhouse gases than generators meeting market demands. It is reasonable to consider these lost opportunity costs a subsidy from electric ratepayers for the operation of the waste to energy system.

Waste Management at ISU

Iowa State University participates in Resource Recovery with Ames, but in the League's meeting with representatives of the sustainability office and the power plant, we noted some unique features of the university's waste management program that are worth noting, including the following:

- ISU has a single stream recycling program for campus buildings and on-campus student housing. Paper and plastics are separated and transported to Mid America Recycling in Des Moines, which has current markets for plastic waste.
- It operates its own trucks for hauling waste to the city Resource Recovery Plant. A private hauler is used for transporting recycled materials.
- ISU has been composting animal waste from the Dairy Farm and other ISU farms and teaching facilities, yard and greenhouse waste, food waste from ISU Dining, wood shavings from the Hansen Learning Center, and materials from a variety of other university operations. Composting occurs in two hoop houses and is dried in uncovered windrows. The operation includes equipment to turn, haul, and load the materials. It takes about 12 to 16 weeks to process compost, during which it is turned 25 to 30 times. In 2018, the output of the facility included 222 tons of compost, 4,996 tons of amended soil (a blend of compost and top soil), and 92 tons of black dirt. Most of the finished products are used on campus. The facility began operation in 2008 and is self-supporting.
- Agreements with some university suppliers make the vendor responsible for recycling or disposing of used materials and waste, e.g., computer equipment and mattresses for university housing.
- ISU participates in The Sustainability Tracking, Assessment & Rating System™ (STARS), a self-reporting framework for colleges and universities to measure sustainability performance. The tracking system shows that the university hopes to achieve an 85 percent waste diversion rate by 2025. It also indicates completion of a baseline emission report, though that appears to be limited to emissions from the ISU power plant.
- ISU has agreements with various vendors that make the vendor responsible for recycling of products and packaging. As a result, ISU does not contribute to the number of mattresses received at the Resource Recovery Plant.
- ISU Food Services participates in diversion of prepared food to Food at First.

Recycling Plastic

The League's 1972 report supporting the development of a waste to energy system included support for a program of recycling. Unfortunately, that part of the recommendation was mostly ignored, except to the extent that materials – particularly metals separated during the processing of RDF – were sold for recycling. Because glass in RDF caused slag deposits on the boiler tubes and grate, recycling of glass became an important goal and containers were distributed throughout Ames and six other Story County communities. As for recycling of paper and plastic, those materials are the most valuable components of RDF. For plastic, recent costs for replacement of power plant boiler tubes should cause a reassessment of priorities to at least allow consideration of programs to recycle plastic types for which there is a market and/or the removal of PVC that is reasonably assumed to produce the most corrosive gases.

Recycling has another problem – limited markets for waste materials. In short, China is no longer taking our waste. In 2016 the US shipped 700,000 tons of plastic waste to China. We were not alone. China was taking 70 percent of the world's plastic waste, almost 7 million tons. In the past, the country had cheap labor for sorting materials for reprocessing. However, labor costs were rising and the country was being flooded with piles of material that could not be recycled and it called a halt to most imports, though illegal imports continued. In 2018, the country clamped down and, in that year, China imported less than one percent of what it imported in 2016. For a while, other Pacific Rim countries were accepting more waste, but many of those countries are also blocking imports.⁷ According to the Institute of Scrap Recycling, the US recycled over 9 percent of its plastic waste in 2015. That dropped to a projected 4.4 percent in 2018 and the rate for 2019 could fall below 3 percent.

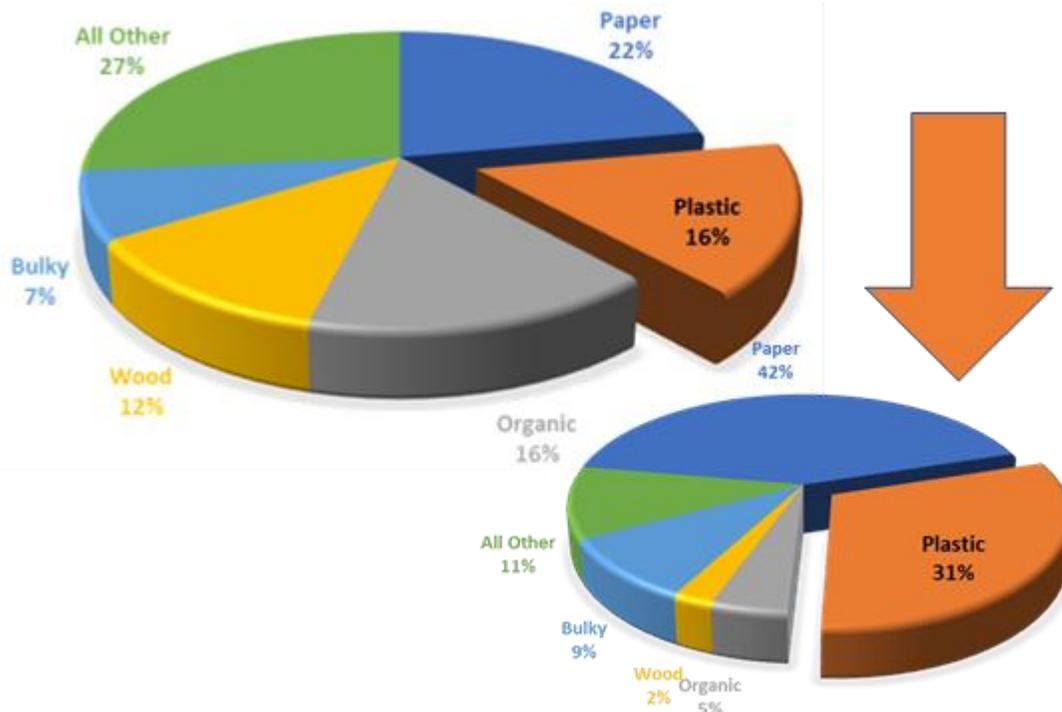
Story County has not suffered as a result of these changing markets, because we are burning our plastic and paper waste. And we are burning a lot more plastic than we used to. When the city began burning waste in the power plant, plastic very likely constituted less than one percent of the waste stream.⁸ In a sample of waste from the Ames Resource Recovery Plant, sorted as part of the SCS study, plastic made up 16 percent of waste, by weight. By the time the waste is processed, plastic constitutes 31 percent of the RDF burned in the power plant.⁹

⁷ "Where Will Your Plastic Trash Go Now that China Doesn't Want it?" National Public Radio, All Things Considered, March 13, 2019.

⁸ In 1960, plastic constituted only 0.4 percent of municipal solid waste material. In 2015, plastic made up 13.1 percent. From "Is burning trash a good way to handle it? Waste incineration in 5 charts" by Ana Baptista, Chair of the Environmental Policy and Sustainability Management graduate program at the Milano School of Policy, Management, and Environment, the New School, NY, NY. June 12, 2018

⁹ COA Waste Diversion Enhancement & Recommendation Report, SCS Engineers, December 2018.

From Waste to RDF



The growing volume of plastic in the Story County waste stream has made burning RDF an expensive proposition for customers of the Ames Electric Department. Burning plastic produces chlorine gas compounds that have corroded and destroyed boiler tubes. Replacing those tubes with new ones that are coated with an expensive nickel alloy cost \$7.3 million for boiler unit 7. Utility personnel estimated that 25 to 30 percent of that cost was for the coating alone. Some of the tubes in the larger boiler (Unit 8) were replaced a few years ago, but those that were not replaced failed from corrosion in the fall of 2019, causing an outage that lasted months. The tubes in that unit are also being replaced. If the new boiler tubes stand up to the corrosive gases caused by burning plastic, that problem may have been solved for many years to come. The question we have tried to raise in this investigation is whether and how long this approach is sustainable. To the extent possible, we ought to recommit to moving materials up the hierarchy of waste management toward reduction, re-use, and recycling – even where it is deemed to have value as fuel for electric production. Beginning a plastic recycling program, even if voluntary, that recycled the types for which there is a market and that possibly removing the worst types seems like a reasonable and prudent first step.

The thing about recycling plastic is that it's not all the same. Most plastic products are labeled with a recycling symbol and number. The numbers refer to the type of resin used to produce it. Some types, e.g., number 1 (Polyethylene Terephthalate or PET) and number 2 (High Density Polyethylene or HDPE) are easily recycled. Number 3 (Polyvinyl Chloride or PVC) is widely recycled in Europe, but not so much in the US. Ames Electric Department management considers PVC the worst type of

plastic in RDF, because of the corrosive chlorine gases that form during combustion. The other types, numbers 4-7, range from difficult or nearly impossible to recycle.

Plastic is slow to degrade. Plastic bags can take as long a thousand years to biodegrade in a landfill. Plastic bottles degrade in 70 to 500 years. Setting aside the preference to reduce and recycle plastic waste, the fact that plastic is so slow to biodegrade is an argument on both sides of the waste-to-energy versus landfill solutions for plastic waste. The following are some of the pros and cons of using Plastic Waste to Generate Electricity

Pro:

- Think of Plastic as a solid form of petroleum. It has nearly twice the heat value of paper.¹⁰ If it cannot be efficiently recycled, it is better to extract that heating value for energy than to waste it.
- Burning it close to the point of use, rather than shipping it to a distant recycling facility saves transportation energy and cost.
- In the absence of recycling options or where there is no market for dirty or mixed plastic, incineration keeps plastic out of landfills.
- Incinerating plastic is convenient. It requires no action by the consumer to clean or separate it from other waste or by type.

Con:

- The science is clear, there is a climate crisis. Keeping global temperatures from rising to as much 2 degrees centigrade above pre-industrial levels is becoming increasingly more difficult and governmental action is needed at all levels from international and national levels to city councils, county supervisors, and local school boards. Individual action and, yes, sacrifice is critical too. Plastic is petroleum that takes lots of energy to produce. It needs to be left in the ground.
- The convenience of incinerating plastic removes incentives for using less or recycling it. Recycling plastic is a higher use.
- A report on BBC News entitled "Should we burn waste plastic – or bury it?" identified arguments on both side of the issue, but cited Environmental Minister Terese Coffee's statement to the Commons that "In environmental terms, it is generally better to bury plastic than to burn it." The fact that plastic buried in a landfill is very stable led to the further statement "Indeed we could go one step further and make the case that burying waste plastic in landfill is actually a cheap form of carbon capture and storage... Burying plastic would have the same effect of locking up unwanted carbon at a fraction of the cost."¹¹
- Burning plastic causes emissions of toxic gases and particulates. The high temperatures achieved in the city power plant and other pollution control technology may reduce emissions to permitted levels, but the science is not clear. For example, a study of "Dioxin Formation from Waste Incineration" by Shibamoto T, Yasuhara A. and Katami T and

¹⁰ Appendix A of the SCS report to the COA includes a table showing that the specific energy content of paper at 7,117 Btu/lb. and plastic at 14,102 Btu/lb.

¹¹ BBC News, Science & Environment, February 20, 2018.

published by the National Center for Biotechnology Information¹² found that although dioxin emissions dropped substantially at temperatures above 850 degrees centigrade – temperatures likely achieved in the Ames power plant – they were “reduced significantly;” not eliminated. More importantly, they found “Even though it is possible to hypothesize reasonable formation mechanisms of dioxins produced in exhaust gases according to the results obtained from experiments in classical chemistry, the reactions involved in an incinerator are extremely complex and heterogeneous.” Other studies point out the risk of generalizing emissions from combustion of waste. For example, the products of combustion of polyvinylchloride (PVC) include highly corrosive gases, as well as dioxin, and appear to be dependent on what other materials are present in the waste.

Besides recycling, there are other things a city can do to reduce the amount of plastic pollution. Some suggestions can be found in the article “7 Ways for Cities to Reduce Plastic Pollution.”¹³

Waste Management Facts and Trends

We found numerous articles on waste management trends. Some focus on policies that reduce waste, such as bans, taxes, or fees on single use plastics. Another identifies new technologies that mechanize the sorting of plastic by type. Still others point to improvements in waste-to-energy incineration. For now, there is no silver bullet emerging among these approaches. What is true is that the decision by the Chinese government to stop importing vast quantities of the world’s waste is shaking up everything in waste management. At the same time, nations are committing to reduce carbon emissions under the Paris Climate Accord and to reduce waste under an amendment to the Basel Agreement on Transboundary Movement of Hazardous Waste aimed at stopping industrialized countries from dumping plastic waste in developing countries. There are some trends to watch, but much more research and innovation in planning and technology are needed.

RECYCLING. The fact that there are fewer options for dumping our waste in other countries may prove to be an opportunity. In the meantime, waste piles up and overwhelms the needs of domestic recyclers. The resulting crash in the market price for recyclable materials will likely lead to new entries in recycling industry and to new innovation, but there is also room for policies that lead to less waste and more recycling.

The US is ripe for market development and it lags behind other industrialized countries in policy development. Germany, Austria, South Korea and Wales all recycle more than half of their metropolitan solid waste (MSW)¹⁴ compared to just 25.1 percent in the US. What are the policies that top performing countries share? They make recycling easy, they adequately fund recycling, they provide financial incentives, and they have clear waste reduction targets and policy objectives.

¹² NCBI is part of the United States National Library of Medicine (NLM), a branch of the National Institutes of Health (NIH).

¹³ “7 Ways for Cities to Reduce Plastic Pollution” By Jan Dell, Meeting of the Minds web site May 15, 2019.

¹⁴ World Economic Forum, 2019

INCINERATION. Incineration has increased world-wide, but not in the US. Japan has seen a 78 percent increase in incineration from 1990 to 2014. Some European countries have seen increases in the range of 25 to 50 percent. By contrast, the US has seen a nearly 13 percent decrease in incineration.¹⁵ The decrease may be due to the “not-in-my-back-yard” (NIMBY) reaction to siting and the historic problem that such reactions tend to push incinerators into neighborhoods with the least political power. It may also result from the poor track record incinerators have with respect to emissions. “In 2011 the New York Department of Environmental Conservation found that although facilities burning waste in New York complied with existing law, they released up to 14 times more mercury, twice as much lead and four times as much cadmium per unit of energy than coal plants.”¹⁶

It is worth noting that new incinerators are designed to produce electricity, so they are waste-to-energy systems. Some new designs are also able to achieve high temperatures (>850 °C) that reduce formation of some of the worst pollutants, such as dioxin. On the other hand, new incinerators are very expensive and, despite improvements, are criticized for their air emissions and for the environmental justice issues related to their location. The Ames Electric Department has budgeted for a study of alternative incineration technology, so these competing arguments will have to be carefully assessed.

Innovation. Forty-five years ago, Ames and Story County found a whole new approach for dealing with waste – processing it and turning it into electricity. That technology does not appear sustainable in the face of a climate crisis. As we look for new solutions, we need to look to other communities that have taken other paths and borrow the best from their practices. For example, a successful recycling program in Davenport has earned national attention. Dubuque and Iowa City have also received positive attention for their waste management policies. And in this investigation, we note two examples of local innovation in waste management that provide hope for the future.

One is a private business that found a better use for plastic waste. For 30 years, Plastic Recycling of Iowa Falls has produced recycled products, including benches and picnic tables – collecting and recycling over 5 million pounds of scrap plastic.

The other is a story that came to our attention in an Iowa Public Radio interview with a Pella businessman, who with his partners in the Pacific Northwest began a non-profit enterprise that converts plastic water bottles into spools of material that international volunteers use in 3-D printers to produce free prosthetic hands for needy children.



¹⁵ “China’s Garbage Ban Upends US Recycling – Is it Time to Reconsider Incineration,” by Thomas Kinnaman, The Conversation website, August 21, 2018

¹⁶ “Garbage in, garbage out: Incinerating trash is not an effective way to protect the climate or reduce waste” by Ana Baptista, the New School, NY, NY, as published on the website The Conversation.

APPENDICIES

Appendix A – Committee Members

- Bob Haug and Mary Richards, Co-chairs
- Tasida Barfoot
- Jan Beran
- Becky Coats
- Cornelia Flora
- Linda Hagedorn
- Jane Halliburton
- John Klaus
- Larry Koehrsen
- Susie Petra
- Marsha Readhead
- Ralph Rosenberg
- Marlene Weisshaar

Appendix B – Recognition of Local Information Sources

We are grateful for the kind cooperation of personnel from the COA and others whose information and guidance was essential to the completion of this report:

Resource Recovery Plant

- John Joiner, Director of Public Works
- Bill Schmitt, Superintendent, Resource Recovery Plant
- Lorrie Hanson, Secretary (speaker at League general meeting)

Electric Department

- Don Kom, Director
- Brian Trower, Assistant Director
- Curtis Spencer, Power Plant Manager
- Kayley Lain, Energy Services Coordinator

Iowa State University

- Merry Rankin, ISU/Ames Director of Sustainability
- Ayodeji Oluwalana, Recycling Coordinator
- Jeff Witt, Director of Utilities
- Dr. Robert Brown, Director, Bioeconomy Institute

Appendix C - Iowa State University – Electricity Resources.

During the League’s investigation of the Resource Recovery System, the committee met with representatives of ISU’s Office of Sustainability and the university power plant. Since our study dealt so closely with the city power plant, it seemed natural to also learn about the power plant operated by ISU. Though the information is not particularly relevant to the focus of our study, we include it as an appendix to provide a more complete picture of power production in Ames. The following is a summary of our notes of that meeting:

The university power plant has four boilers for production of steam heating/cooling and electricity. Three stoker coal unit were modified in 2016 to burn natural gas. The fourth is a fluidized bed unit that burns Illinois and some Kentucky coal. Twenty-five percent of the power plant output is electricity, 50 percent is for heating and 25 percent for cooling. Because the power plant co-generates (steam and electricity), it achieves a high level of thermal efficiency (~60%).

In 2009, ISU joined with the COA in a power purchase agreement from Garden Wind LLC, near Zearing. It also committed to participate in 37.5 percent of the city’s community solar project.

A small wind turbine located near the ISU power plant also provides renewable energy to the university through a power purchase agreement. A small solar array is located in the same area.

The balance of ISU’s electricity demand is met by the Ames Electric Department. ISU does not participate directly in the MISO energy market.

It is worth noting that improvements in building energy efficiency and lighting have made a big difference in energy use. Though the campus has seen some \$80 million in improvements in the last ten years, it has not had to add generation. At the same time, greenhouse gas emissions have dropped due to a major modification in three steam units that were converted from coal to natural gas.

Appendix D – Acronyms/Glossary

Some of these terms are specific to this study, others are in more general use.

Btu	British thermal unit (unit of heat)
C&D	Construction and demolition (a category of waste)
COA	City of Ames
EPA	Environmental Protection Agency
GHG	Greenhouse gases
ISU	Iowa State University
MISO	Midcontinent Independent System Operator
MSW	Municipal Solid Waste

- MW Megawatts (measure of electric power/capacity)
- O&M Operating and maintenance (a category of expenses)
- RDF Resource Derived Fuel
- RRP Resource Recovery Plant
- SCS The engineering company that produced a study of the RRP in December 2018
- WTE Waste to Energy

Appendix E - Resources

The following articles and websites are among those used as background or cited quotations for this study:

TITLE	INFORMATION SOURCE
Advanced Sustainable Materials Management: 2017 Fact Sheet	EPA, November 2019
Arnold O. Chantland Resource Recovery System 2018 Annual Report	City of Ames website, 2019
Australia's Recyclable Export Ban Creates Opportunities...	Waste Dive website, 8-16-19
Biogas State Profile: Iowa	American Biogas Council , website updated, August 7, 2015
China's Garbage Ban Upends US Recycling – Is it Time to Reconsider Incineration	Thomas Kinnaman, The Conversation, August 21, 2018
Composting and Greenhouse Gas Emissions: A Producer's Perspective	Sally Brown and Scott Subler, BioCycle website, March 2007 .
Dioxin Formation from Waste Incineration	Shibamoto T., Yasuhara A., and Katami T, National Center for Biotechnology Information, NIH, 2007
Exactly How to Read Plastic Recycling Symbols	Brian Clark Howard & Amina Lake Abdelrahman, Good Housekeeping Institute, March 18, 2018 .
Facts and Figures about Materials, Waste and Recycling	US EPA website data for 2017
Garbage In, Garbage Out: Incinerating Trash is Not an Effective Way to Protect the Climate or Reduce Waste	Ana Baptista, The Conversation website, February 27, 2018
How Recycling Has Changed in All 50 States	Waste Dive website, Iowa's listing, Updated November 15, 2017

How the Plastic Industry Is Fighting to Keep Polluting the World	Sharon Lerner, The Intercept website, July 20, 2019
Iowa City Composting (from city website)	https://www.icgov.org/foodwaste
Iowa Company 'A Million Waves' Makes Prosthetic Hands from Ocean Plastic	Lindsey Moon & Charity Nebbe, Talk of Iowa, Iowa Public Radio, January 26, 2019
Is Burning Trash a Good Way to Handle it? Waste Incineration in 5 Charts	Ana Baptista, The Conversation website, June 12, 2018
Powering Our Future with Trash	Richard Ling, Kleinman Center for Energy Policy, Univ. of Pennsylvania, March 2019
Putting Garbage to Good Use with Waste-to-Energy	Renee Cho, State of the Planet, Earth Institute, Columbia University, October 18, 2016
Seven Ways for Cities to Reduce Plastic Pollution	Jan Dell, Meeting of the Minds website, May 15, 2019
Smart Plastics Guide	Institute for Agriculture and Trade Policy, Minneapolis, MN web site , September 2008. This document lists plastics by type and identifies whether and how it can be recycled.
The Benefits of Organized Collection: Waste Collection Service Arrangements	Minnesota Pollution Control Agency, February 2012
The ISU Compost Facility after 10 Years	ISU Ag Engineering/Agronomy, 2019
The Movement Against Single-use Plastic is Growing	Sher Watts Spooner, Daily Kos Community, June 16, 2019
The Plastic Monster	Greenpeace Compass, Fall 2019
The Plastic Waste Crisis is an Opportunity for the US to Get Serious About Recycling at Home	Kate O'Neill, The Conversation website, August 17, 2018
The Uncertain Future of Waste to Energy	Reloop web site, February 21, 2017
Trends in the Anaerobic Digestion of Food Waste	Ryan Cooper, Rubicon web site, June 25, 2019
U.S. Plastic Recycling Rate Projected to Drop to 4.4% in 2018	Plastic Pollution Coalition, Washington, D.C., October 4, 2018
Waste Diversion Enhancement & Recommendation Report	SCS Engineers to City of Ames, December 2018
Where Will Your Plastic Trash Go Now that China Doesn't Want it?	National Public Radio, All Things Considered, March 13, 2019