AT&T 10x Case Study:

Emerson's Grind2Energy™ integrates AT&T IoT to turn food waste into clean energy

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AT&T believes technology plays a critical role in reducing carbon emissions, so we're using the power of our network to create a better, more environmentally sustainable world. We've set a 10x carbon reduction goal to enable carbon savings 10x the footprint of our operations by the end of 2025.

To meet this goal, we're working companywide to make our operations more efficient. We're also working with our customers and technology partners to implement and scale carbon-saving solutions. This case study discusses and quantifies the carbon benefits of using AT&T technology to boost efficiency. This is one study in a series we're sharing as we progress toward our 10x goal.

For more information about our goals, our progress, and to view more case studies like this, go to AT&T's 10x website.

Summary:

Grind2Energy™, the food waste recycling system from Emerson, has created an industrial food grinder that helps address the costs and environmental impacts of food waste disposal from grocery stores, restaurants and stadiums. This equipment turns food waste from commercial kitchens into a nutrient-rich slurry that anaerobic digesters can turn into biogas — methane obtained from biological resources that can be turned into electricity or heat — and fertilizer, instead of being taken to a landfill where it decomposes and emits methane, a potent greenhouse gas. The first models of the food waste recycling system used a manual process to handle maintenance and the hauling of the slurry to the anaerobic digester, but the Grind2Energy team quickly realized they needed continuous data to optimize operations. They turned to AT&T to integrate Internet of Things (IoT) connectivity and robust reporting into the food waste recycling system, helping to increase scalability and increase the market competitiveness of the system.

2018 Projected Total Annual Benefits of Grind2Energy Food Waste Diversion

- Around 7,400 tons of food waste not dumped in landfills
- 1.3 million kWh of clean electricity generation, equivalent to powering 125 homes for a year[1]
- 420 tons of fertilizer[2]
- Around 5,000 metric tons CO_2e avoided, equivalent to not consuming 570,000 gallons of gas[3]

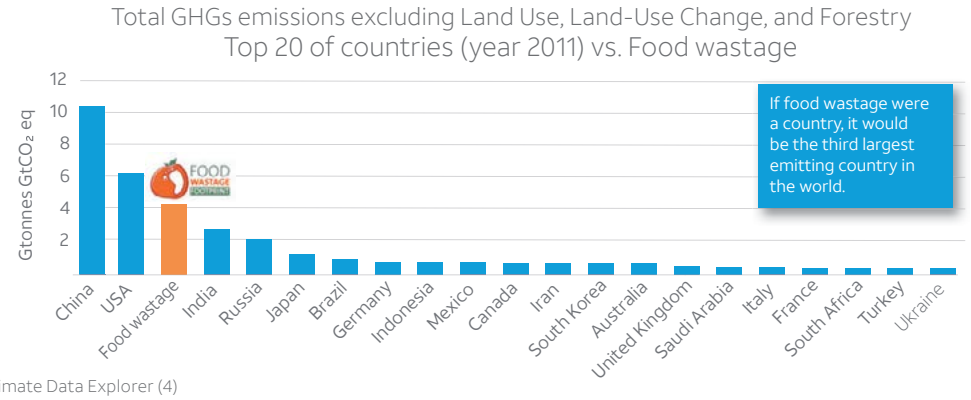
November 2018

The waste avoidance estimate used in this case study is based on food waste data from the Grind2Energy™ system at all facilities included in the case study from January 2018 to September 2018. This data was then extrapolated to estimate total avoidance for an entire year. Grind2Energy has helped their customers reduce food waste going to landfills by 7,400 tons, instead providing slurry to waste management facilities in their area that have anaerobic digesters. This recycled food waste has produced enough clean electricity to power 125 homes for a year[1] and 420 tons[2] of fertilizer. Doing so has reduced greenhouse gas emissions from the landfill by about 5,000 metric tons of CO_2e, which is like not consuming 570,000 gallons of gasoline[3], while keeping expenses competitive in the face of rising waste hauling costs.

The Challenge: Disposing of food waste in a way that minimizes environmental impacts and doesn't increase costs

The amount of food wasted in the U.S. is mind-boggling. In the U.S., the Environmental Protection Agency estimates that more than 38 million tons of food waste was generated in 2014, with only 5.1% diverted from landfills and incinerators.[4] Approximately one-third of all food produced for human consumption worldwide is lost or wasted.[5] In fact, more food reaches landfills and incinerators than any other single material in everyday trash, which is about 21% of the municipal solid waste stream.[6] In 2012, the National Resource Defense Fund (NRDC) estimated that up to 1 in 7 truckloads of perishables delivered to supermarkets is thrown away.[7]

The negative impacts of food waste also extend to the environment. Food waste that decays in a landfill generates methane, a greenhouse gas (GHG) that is 28 to 36 times as potent as CO_2 over 100 years.[8] In fact, the United Nations Food & Agriculture Organization estimates the total carbon footprint of food waste to be around 4.4 billion tons of carbon dioxide, which is more GHG emitted by any one country except for the U.S. and China.[9]



Source: WRI's Climate Data Explorer (4)

1 U.S. Energy Information Administration, "How much electricity does an American home use?," Frequently Asked Questions, Nov. 7, 2017.

2 M. Kim et al., "Synergism of co-digestion of food wastes with municipal wastewater treatment biosolids," Science Direct, March 2017.

3 U.S. Environmental Protection Agency, Greenhouse Gas Equivalency Calculator.

4 U.S. Environmental Protection Agency (EPA), "Sustainable Management of Food Basics," Sustainable Management of Food, Aug. 2, 2018.

5 Buzby, J., Wells, H. & Hyman, J., U.S. Department of Agriculture, The Estimated Amount, Value and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States, February 2014

6 U.S. Environmental Protection Agency (EPA), "Sustainable Management of Food," United States 2030 Food Loss and Waste Reduction Goal, Aug. 6, 2018.

7 Dana Gunders, "Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill," NRDC Issue Paper, August 2012.

8 United States Environmental Protection Agency (EPA), "Understanding Global Warming Potentials," Greenhouse Gas Emissions, Feb. 14, 2017.

9 Food and Agriculture Organization of the United Nations (FAO), "Food Wastage Footprint & Climate Change," Food Loss and Waste, 2011.

Food waste is also starting to impact the bottom line for businesses, as the costs to haul food waste to the landfill are on the rise. The average price to haul waste to a landfill has increased almost 17% from 2010–17[10] and those costs are expected to increase.[11] In some cases, state and local governments are setting aggressive waste diversion goals and implementing landfill waste diversion bans.[12] Five states have implemented state-level waste bans, prohibiting certain entities that generate specified amounts of food waste from sending this waste to landfills.[13]

The Solution: Grind2Energy™ gets an assist from AT&T Internet of Things (IoT) to turn waste into energy

Grind2Energy by Emerson uses AT&T IoT connectivity to help large food waste generators such as supermarkets, restaurants, hotels, hospitals and arenas minimize their environmental impact and boost their operational efficiency. The system uses industrial-strength InSinkErator® food waste grinders from Emerson to quickly process almost any type of food scraps — including meat, bones, cheese, bread, fruit, vegetables, fat, oil and grease — into a liquid slurry that is pumped into onsite holding tanks. The slurry is then transported to waste management facilities, where it is processed and can be converted into biogas and fertilizer depending on the availability of anaerobic digesters.

> "Because we're a non-sewer based system, our customers can put all of that food scrap material through our grinder into the holding tank safely, and the digesters love it."
>
> — Doug Brokaw, director of sales, Grind2Energy

Unlike old methods that use inefficient pick-up schedules and generate GHG, Grind2Energy efficiently turns food waste into energy and fertilizer.

10 James Thompson, "The Cost to Landfill MSW in the US Continues to Rise Despite Soft Demand," NRRA.net, Jul. 10, 2017.

11 James Thompson, "No End in Sight to US Landfill Cost Increases — Pacific Region to Experience Highest Growth," NRRA.net, Jun. 13, 2018.

12 Emily Broad Leib et al., "Fresh Look At Organics Bans And Waste Recycling Laws," BioCycle.net, November 2016.

13 Ibid.

Customers can buy configurable Grind2Energy™ equipment, which will be fitted to each customer's site. Emerson provides set-up services to help integrate the food waste recycling system into the blue print of buildings in order to offer more sustainable waste management infrastructure. Once Grind2Energy technology is installed and activated, waste management operations become streamlined, optimized and highly competitive compared to traditional waste hauling.

> "Before we had the IoT, we physically had to send somebody out to tables in the markets, open up the control panel, pull the data down. Everything was manual. Now, we can see how the systems are performing and track the data so much more easily."
>
> — Doug Brokaw, director of sales, Grind2Energy

The product design team at Grind2Energy realized they needed to reduce operating costs by optimizing pick-ups, system performance and maintenance. They turned to AT&T to integrate IoT into the workings of the system to give them and their customers constant visibility to the system.

AT&T worked closely with Grind2Energy in the development of the product, bringing technical and service delivery expertise to the project. AT&T provided end-to-end single source assistance with device selection, IoT integration via AT&T Control Center, security consulting and application development. The resulting product uses 16 industrial IoT sensors to track key performance attributes, such as water flow rate and pressure, percent full and temperature. This enables near real-time visibility that allows Grind2Energy and their customers to monitor system status and performance.

In addition to the IoT system development, AT&T also led the effort to integrate over 60 analytic calculations into dashboards and alerts for the Grind2Energy team and customers. This visibility enables optimized system performance in several ways:

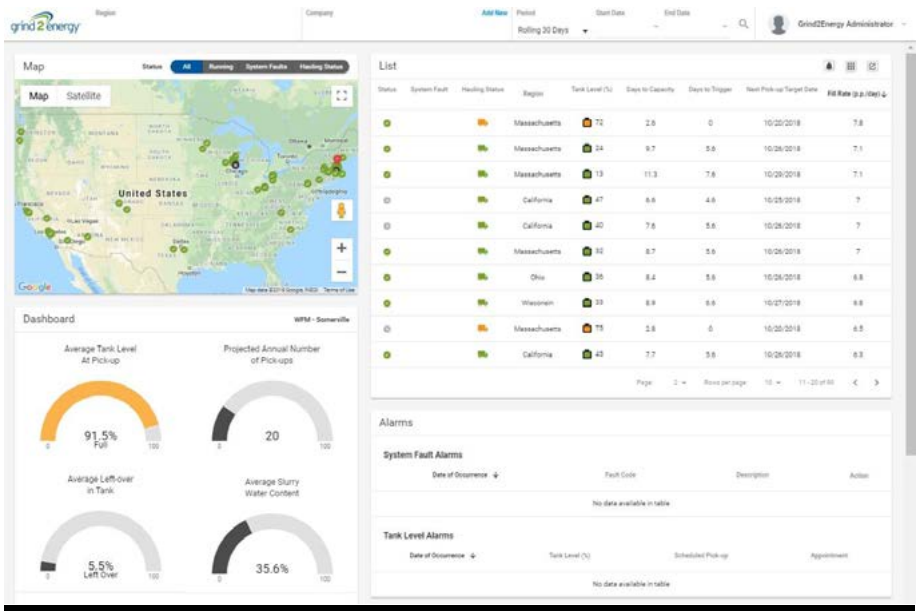
- **Maintenance:** The ability to remotely monitor systems across the country can reduce costs and emissions from technician trips. In addition, the systems alert Grind2Energy if key components aren't working properly or are broken. Having this information can prevent waste from piling up due to a broken part.
- **As-Needed Hauling:** The ability to monitor Grind2Energy tank level and volume data in near real-time optimizes the frequency of pick-ups and hauling, helping to reduce costs and emissions from truck transportation.
- **Getting the Mix Right:** In order to create a high-value mixture for the anaerobic digesters, the slurry needs to have the right mixture of water and food scraps. Grind2Energy is able to ensure optimal consistency by constantly monitoring the flow rate and velocity of the slurry and adjusting the water accordingly.

The ongoing visibility also creates benefits for the customer.

- **Performance Benchmarking:** Near real-time dashboards track total quantities of food waste processed at each site and allow benchmarking across sites.
- **Employee Performance:** The system can require employees to swipe their ID card when using the system. This enables active personnel management and the ability to address any performance issues.
- **Robust Reporting:** Periodic automated reports summarize sustainability impact, allowing customers to quantify the benefits of the system and communicate them to stakeholders.

AT&T's highly secure IoT connectivity is a fundamental component of the Grind2Energy solution because it provides accurate and timely information. Without this connectivity, Grind2Energy would have to dispatch technicians for scheduled or emergency maintenance calls, raising customer costs.

AT&T's technology helps to reduce those operational costs, overcome management hurdles that could hinder customer adoption and, in so doing, helps enable Grind2Energy bring a price-competitive solution to market. AT&T utilized wide range expertise and technology, including its cellular network and the AT&T IoT Platform, to develop the system that makes it possible for Grind2Energy™ to collect, organize and analyze data.



Dashboards allow Grind2Energy and their customers to monitor operations.

Implementation: National rollout from a centralized control center

Emerson has steadily expanded and enhanced the Grind2Energy product since it was introduced in 2012. The original systems used a manual process to manage pick-ups and maintenance. Grind2Energy engaged AT&T in 2016 to help increase efficiency and scale its operations. Because visibility is an essential part of the product's success, AT&T developed two separate online dashboards, one to manage Grind2Energy systems, and one for customers to measure performance. Grind2Energy is now installed at grocery stores, restaurants and stadiums across the country.

The environmental benefits of the system are already starting to add up. The waste avoidance estimate is based on food waste data from the Grind2Energy system at all facilities included in the case study from January 2018 to September 2018. This data was then extrapolated to estimate total avoidance for an entire year. Grind2Energy has helped their customers reduce food waste going to landfills by **7,400 tons**, instead recycling the waste by providing slurry to waste management facilities in their area that have anaerobic digesters. This recycled food waste has produced enough clean electricity to power **125 homes** for a year[14] and **420 tons**[15] of fertilizer. Doing so has reduced greenhouse gas emissions from the landfill by about **5,000 metric tons** of CO_2e, which is like not consuming **570,000 gallons** of gasoline.[16] And all of this is possible without paying a higher price than the traditional waste hauling to landfills.

14 U.S. Energy Information Administration, "How much electricity does an American home use?," Frequently Asked Questions, Nov. 7, 2017.

15 M. Kim et al., "Synergism of co-digestion of food wastes with municipal wastewater treatment biosolids," Science Direct, March 2017.

16 U.S. Energy Information Administration Greenhouse Gas Equivalency Calculator.

Sustainability impact potential

Recognizing the potential to create value out of waste, sustainability was at the heart of Emerson's mission when it began to develop Grind2Energy™. Emerson worked closely with AT&T to utilize IoT to bring the Grind2Energy solution to scale, and now it's working to increase usage in the marketplace. With more companies recognizing the need to reduce waste for cost and sustainability reasons, Grind2Energy is in a prime position to help its customers address the challenge.

In fact, if just 10% of the over 38,000 grocery stores in the U.S[17] — stores that are similar in size to the stores included in this case study and are located near an anaerobic digester — used Grind2Energy's sensor-driven industrial food waste systems to manage their food waste, GHG emissions could be reduced by up to **320,000 metric tons** a year.[18] For a one-year period, this is equivalent to:

Estimated Environmental Benefits if 10% of Grocery Stores used Grind2Energy

Taking almost 69,000 cars off the road[19]
or

Not consuming over 36 million gallons of gasoline[20]
or

Switching over 11 million incandescent light bulbs to LEDs[21]

USING AT&T CONNECTIVITY TO ENABLE EFFICIENT FOOD WASTE MANAGEMENT HAS THE POTENTIAL TO:

1. **Reduce greenhouse gas impacts associated with food waste.**
2. **Create valuable resources — electricity, compressed natural gas and fertilizer — out of material that was previously wasted.**

17 "Number of supermarkets and grocery stores in the United States from 2011 to 2017, by format," statista.com, April 2018.

18 38,000 (U.S. Grocery Stores) * 0.1 (10% adoption rate) * 84 (CO_2e avoidance per store)

19 U.S. Energy Information Administration Greenhouse Gas Equivalency Calculator.

20 Ibid.

21 Ibid.

Applying the 10x Carbon Impact Methodology

Carbon Trust and BSR collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's technology. Details of the methodology can be found on the AT&T 10x website. The table below summarizes how the 10x methodology was applied to estimate the environmental impacts described in this case study.

Description of the Enabling Technology	AT&T connectivity helps enable Grind2Energy™ customers to optimize their waste pick-up processes and optimizes the performance of the waste-to-energy generation system, avoiding GHG emissions associated with food waste going to landfill and providing alternative low-carbon energy sources. AT&T's highly secure IoT connectivity is a fundamental component of the Grind2Energy solution because it provides accurate and timely information that allows Grind2Energy to reduce operational costs and make the business model competitive in the marketplace.
Impact Category	This case study focuses on GHG emission impacts.
Materiality	The Grind2Energy system lowers GHG emissions associated with food waste and increases the use of low-carbon energy sources.
Attribution of Impacts	The avoided GHG emissions described in this case study result from the diversion of food waste from landfill and the generation of low-carbon energy in the form of biogas, which replaces the need for generation of energy from carbon-intensive sources like coal. Food waste slurry is created using industrial-style food grinders provided by Grind2Energy and then transported for anaerobic digestion. This process avoids methane emissions at the landfill site, and the biogas captured by the anaerobic digestion is used for generation of electricity. The service is provided by Grind2Energy and is enhanced by AT&T's connectivity, which enables timely and accurate information, allowing Grind2Energy to provide the service in a cost-effective manner. In addition, AT&T's connectivity improves the pick-up process, reducing overall fuel usage.
Primary Effects	The Grind2Energy system reduces methane emissions by diverting food waste from landfills and allows for the conversion of food waste into biogas, a low-carbon energy source, which replaces carbon intensive energy from sources like coal.
Secondary Effects	There are also reduced emissions from an improved ability to monitor tank level and volume data in real time, allowing Grind2Energy to optimize the frequency of pick-ups and hauling, which reduces total fuel use. (Note these reduced emissions are significantly small compared to the reduction in methane emissions). Further fuel reductions are enabled as the system provides the ability to remotely monitor systems, reducing the emissions associated with technician trips. However, due to insufficient data, this was not included in the analysis.
Rebound Effects	No rebound effects were identified.
Trade-Offs or Negative Effects	This technology does not appear to create other outsized or irreparable environmental or social impacts.
Carbon Burden from the Enabling Technology	The carbon from the enabling technology is the embodied and in-use phase carbon associated with the new food grinder equipment. This is assumed to be minimal in comparison with the overall emission reductions.

Scope	The carbon abatement calculations reflect estimated carbon avoided by Grind2Energy™ customers in 2018 resulting from the avoidance of landfill emissions from food waste; carbon savings from replacing grid electricity with lower carbon electricity generated from the biogas; and reduction in fuel use due to a reduction in the number of waste pick-ups.
Timeframe	Calculations in this case study were performed using food waste data from January 2018 to September 2018 and waste pick-up data for January 2018 to April 2018. This data was then extrapolated to estimate the savings for the entire year.
Functional Unit	The carbon abatement factor calculates the carbon savings (metric tons CO_2e) per site using the Grind2Energy service.
Methodology	The GHG emission reductions are the sum of the emissions reduction from: • Reduced methane emissions from diverting food waste from landfill. • Replacing grid electricity with lower carbon electricity generated from the captured methane. • Reduced pick-ups. The reduced methane emissions are calculated in combination with the replacement of grid electricity with lower carbon electricity generated from the captured methane. First, the methane emissions from food waste going to landfills are calculated using emission factors from the EPA Waste Reduction Model (WARM). Second, the emission savings are calculated from sending food waste to anaerobic digestion, which is then added to the reduced methane emissions from diverting food waste from landfill. The emission reduction resulting from a reduction in waste pick-ups were calculated by comparing the pick-ups post- and pre-implementation across all of sites. The number of pick-ups pre-implementation were estimated based on the average visits per site per month and applied to the total number of sites post-implementation. The total reduction of pick-ups were then multiplied by an average return distance for a pick-up and converted into emissions, using 2017 Defra emission factors for LVGs.

Key Assumptions	• It is assumed that the baseline for all customers (prior to use of Grind2Energy) was to send the food waste to landfills.
	• The following assumptions have been made to obtain the landfill and anaerobic digestion emission factor for food waste from the WARM model:
	  • National average grid electricity emission factor used to account for the avoided electricity-related emissions during the landfilling process.
	  • National average moisture conditions at landfill.
	  • Wet digestion anaerobic digestion process.
	  • No curing of digestate after digestion.
	  • Digestate land application.
	  • Default distances that occur during the transportation of materials to the management facility.
	• It was assumed that all food waste consists of the WARM model's typical food waste mix (beef, 9%; poultry, 11%; grains, 13%; fruits and vegetables, 49%; and dairy products, 18%).
	• It is assumed that the average one-way distance for a waste pick-up is 15 miles, and it was assumed that the trucks are 0% laden on the way to pick up the waste and 100% laden on the return trip.

Exclusions	• The embodied and in-use emissions of the food grinder equipment (previous measurement of the energy used by the food grinders showed this to be negligible). • Water consumption and the associated emissions of the food grinder equipment (water use is minimal). • Emissions from the use of fertilizer that has been generated (assumed that these would have been generated anyway by the fertilizer that is being replaced).
Data Sources	• WARM Model version 14, food waste anaerobic and landfill emission factors.[22] • Food waste data from Grind2Energy™. • Pick-up data from Grind2Energy. • 2017 Defra emission factors for an average Large Goods Vehicle (LVG).
Carbon Abatement Factor	84 Metric Tons CO_2e per site or 0.7 Metric Tons CO_2e per short ton of food waste.
Lessons Learned	This project highlighted how waste material can be converted into useful commodities. In the process of the analysis, we benefited from the existing research of the WARM model, reinforcing that existing methodologies can be applied to calculate positive impacts when evaluated in new tech-enabled business models.

22 Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM ver14), Tables 1-10 and 1-36; https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_organic_materials.pdf
and WARM model ver14; https://www.epa.gov/sites/production/files/2018-03/warm_v14_march13_2018.xls