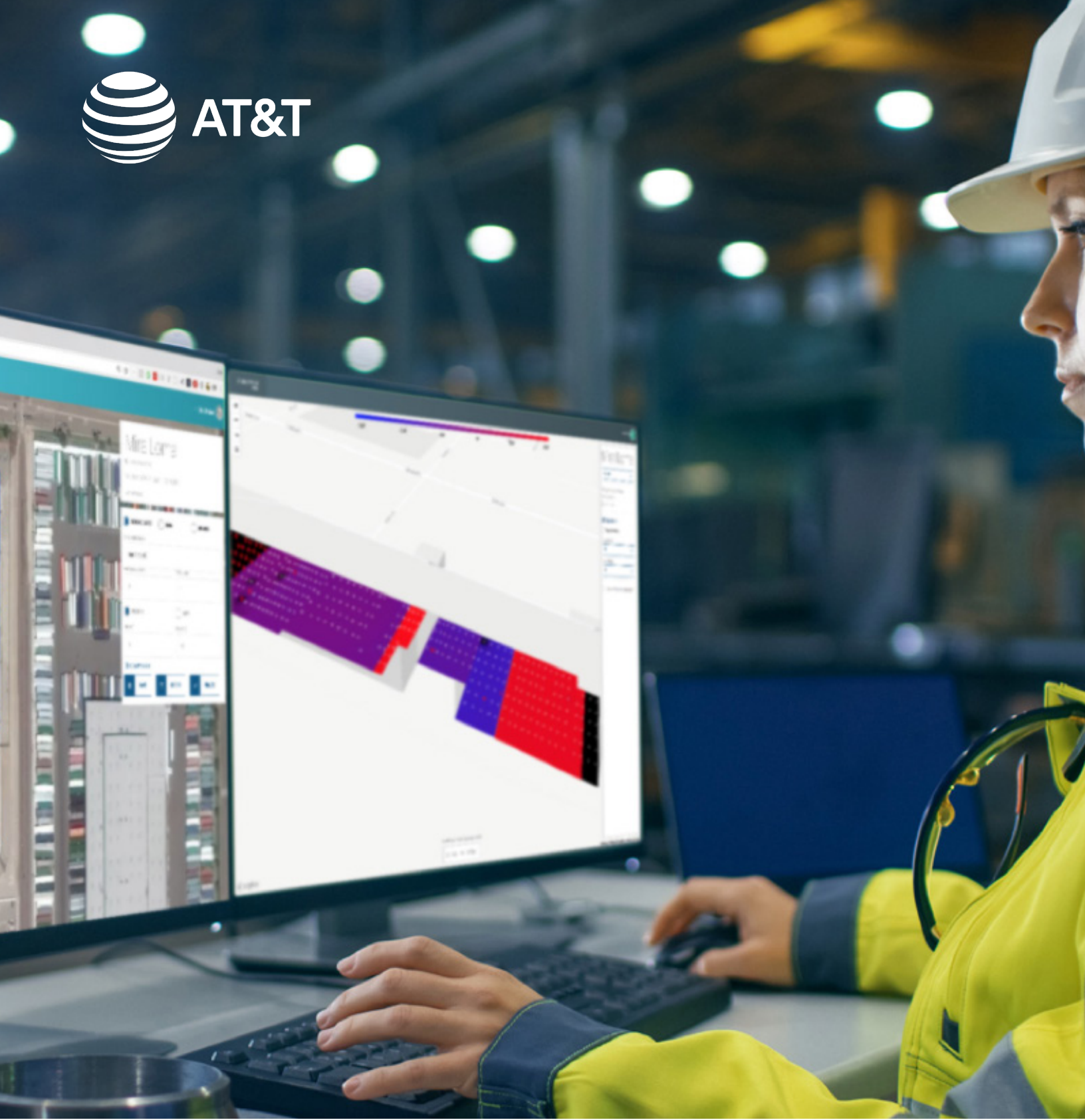


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AT&T 10x Case Study:

Energy Efficient Frozen Food - Lineage Logistics uses Industrial.io and AT&T Internet of Things (IoT) to reduce energy use in cold food storage facilities



AT&T 10x Case Study:

Energy Efficient Frozen Food - Lineage Logistics uses Industrial.io and AT&T Internet of Things (IoT) to reduce energy use in cold food storage facilities

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.

Learn about our goals, our progress, and more case studies like this at att.com/10x.

Summary

Lineage Logistics®, a leading food cold storage operator, engaged **Industrial.io** to optimize energy costs and usage at their warehouses. Using **AT&T** IoT connectivity to collect detailed temperature data, Industrial.io combines temperature, energy and food throughput data to create heat maps, alerts and reports that enable Lineage to actively manage its cooling operations. This information has enabled Lineage to develop cold storage management processes that have reduced cost, energy usage and greenhouse gas (GHG) emissions.¹

Annual Efficiency Gains

-  Electricity cost: \$4M reduction
-  Electricity usage: 33M kWh reduction
-  GHG emissions: equivalent to 2.4M gallons of gasoline avoided¹
-  Electricity spend/pound of food: 34% reduction

Background: Frozen food is convenient, helps ensure food safety and helps prevent waste.

It's easy to take frozen food and the food cold storage industry - the 'food cold chain' - for granted. After all, frozen and temperature-sensitive food has been available in our local grocery stores for decades and it represents a critical component of our diet. Americans have been freezing food as an effective and convenient way to preserve and distribute it for almost a century.

But the food cold chain isn't just about convenience. It's also about temperature control, which most food products require for quality and safety reasons from their origin to the end destination. The global food cold chain is expected to grow 13.9% through 2020, driven by the need for more efficient storage and distribution of food products and perishables.²

¹ U.S. Environmental Protection Agency, [Greenhouse Gas Equivalency Calculator](https://www.epa.gov/calculator). (Note, the average eGRID electricity factors have been used rather than the marginal AVERT electricity factors, this being a more conservative estimate of the savings).

² Zion Research (2015, October). Cold Chain Market for Fruits & Vegetables, Bakery & Confectionery, Dairy & Frozen Desserts, Meat, Fish & Seafood, and Other End-users: Global Industry Perspective, Comprehensive Analysis and Forecast 2014 – 2020. Retrieved from <https://www.foodlogistics.com/cold-chain/news/12161216/global-cold-chain-to-grow-139-through-2020>



And, while fresh food is recognized as an important part of a healthy diet, its shelf life is limited and can lead to unnecessary food waste. Freezing food can help reduce the risk of food spoilage from farm to table and is a convenient option for many food shoppers. A 2014 study from UC Davis also debunked the common perception that frozen food isn't as healthy as fresh. When evaluating ascorbic acid, riboflavin, α -tocopherol, and β -carotene, the study found that "the vitamin content of the frozen commodities was comparable to and occasionally higher² than that of their fresh counterparts."³

Lineage is a food warehousing and distribution company that operates more than 120 warehouses in 26 states and four countries. It handled over 35 billion pounds of consumer packaged goods, meat, seafood, fruits, vegetables and other food products in 2017, which is equivalent to about 25% of the third-party cold chain in the U.S., according to Elliott Wolf, VP and Chief Data Scientist at the Novi, Michigan-based company.⁴ Lineage provides processing and storage services to over 2,500 customers, including many large food companies that stock the shelves in the grocery store freezer aisles worldwide.



The Challenge: Frozen food is energy-intensive.

Unsurprisingly, freezing and storing such a significant amount of food at the proper temperature requires a lot of electricity. A majority of Lineage's facilities need to keep their temperatures at zero degrees. Some are refrigerated, and some have equipment used for blast freezing, requiring temperatures of -20 degrees. As context, each Lineage warehouse averages about 1 million square feet and has the freezing capacity equivalent to putting 10,000 home freezers together. The company's electricity bill, consequently, reaches tens of millions of dollars and is one of the largest line items in its budget.

Starting in 2014, the operations team at Lineage realized they needed to make a change to help drive down cost per unit and reduce their environmental impact. Supply chain sustainability had also become increasingly important to Lineage's customers, requiring the company to focus on increasing their energy efficiency in the cold storage supply chain. Moreover, as a business with plans for expansion, efficiency would be critical to continued profitable growth.

"We needed a data-driven system that could give us the Energy Key Performance Indicators we needed to drive efficiency. IoT sensors produced that detail for us."

– Sudarsan Thattai, chief information officer, Lineage Logistics

³ Bouzari, A., Holstege, D., & Barrett, D. Department of Food Science and Technology and Analytical Lab, University of California, Davis (2014, December). Vitamin Retention in Eight Fruits and Vegetables: A Comparison of Refrigerated and Frozen Storage. *Journal of Agricultural and Food Chemistry*, 63 (3), pp 957–962. Retrieved from <http://www.affi.org/assets/resources/public/2014-bouzari-et-al-vitamin-retention-in-8-f-v-140.pdf>

⁴ <https://www.networkworld.com/article/3144999/internet-of-things/using-iot-to-help-protect-the-us-food-supply.html>



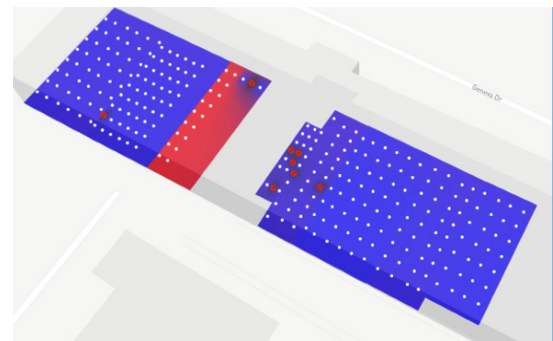
With an energized focus on energy, Lineage had a simple goal: do more with less by increasing the amount of food per square foot in their facilities while lowering electricity usage. To meet this goal, they would need to monitor usage at detailed levels in order to set measurable targets to lower costs and electricity usage.

The Solution: ndustrial.io and AT&T Internet of Things (IoT) creates visibility and control.

Lineage turned to **ndustrial.io**, a company focused on using detailed operational data to optimize energy use in industrial facilities.

As it evaluated Lineage's operations, ndustrial.io found the collection and use of data from the multiple warehouse and refrigeration management systems from across the Lineage portfolio to be challenging. To address this problem, ndustrial.io began by installing an additional 3-15 smart meters per facility in order to get more granular real-time electricity usage data at one-minute intervals. But even those meters couldn't provide the granular temperature readings on the ongoing basis that ndustrial.io needed.

To supplement data from the smart meters, Lineage and ndustrial.io installed sensors on the top and bottom racks across many of their warehouses. These sensors, approximately 1,000 in number, collect temperature data at a granular level, helping to identify opportunities for added energy efficiency. Lineage and ndustrial.io also developed a data analytics platform to compare food production and energy usage for each shelf in the warehouse. Superimposing the temperature data on a drawing of the racking system, the team created a heat map that can display the temperature gradient across the entire facility.



ndustrial.io uses sensor data to generate a graphic display of temperatures at Lineage warehouses.

Because the success of this solution depended on ubiquitous, highly secure and dependable connectivity to help ensure timeliness and accuracy, ndustrial.io worked with AT&T to integrate AT&T Internet of Things connectivity with the warehouse sensors. By integrating AT&T global SIMs and utilizing the AT&T Control Center, an automated connectivity management platform, ndustrial.io was able to send time-sensitive data from the warehouses to the analytics engine in the cloud with high security.

“Working with AT&T IoT was so easy and dependable. It eliminated all sorts of barriers for us. We tried using the local Wi-Fi network at first, but encountered serious control and reliability issues. So we quickly pivoted to AT&T. Set up and maintenance is so easy that we literally have one person managing the whole portfolio.”

-Jason Massey, CEO, ndustrial.io



Implementation Results: Energy and cost reduction in both expected and surprising ways.

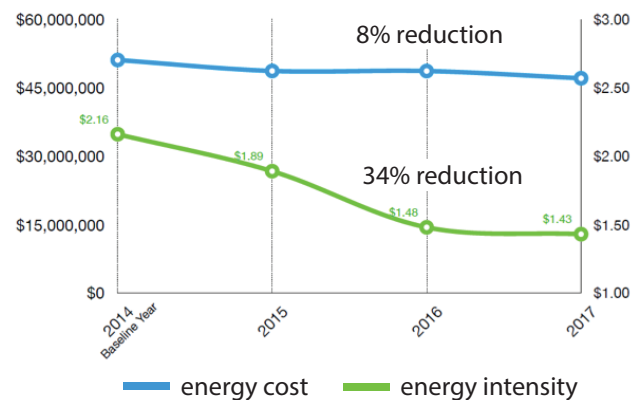
With ndustrial.io's robust platform and AT&T's highly secure and dependable connectivity, Lineage Logistics is now experiencing expected efficiencies while also uncovering new and unexpected opportunities to lower costs and reduce their environmental footprint. Most fundamental to their business, Lineage can use the high-resolution temperature data to confirm the food they handle is kept at the proper temperatures, ensuring food quality and safety. But the platform is opening other doors beyond food safety.

1. Reduction in absolute energy and energy per unit of food.

Precise temperature information enables Lineage to increase shelf utilization for food storage while maintaining the right temperature. The ndustrial.io cloud-based system, called Contxt, uses AT&T IoT connectivity to collect temperature and humidity data to generate optimized temperature "set points" throughout the facility. By having continuous insight into the temperatures on each shelf and comparing this information to these "set points," the system can signal for the chiller systems and variable frequency drives to turn on and off as needed. The system uses the temperature data along with dimensional data of the racking system to optimize the space and electricity used for each item of food. Because of the flexibility of the system, it can be rolled out across the entire network of facilities.

The results are impressive. The data collected by the systems shows Lineage that since 2014, yearly energy costs have declined 8% at the 78 warehouses where the system has been installed. Remarkably, the throughput at these warehouses actually increased over the same time period, meaning that energy intensity – the cost of electricity used for each item of food – has decreased by a staggering 34%.

This increased efficiency has given Lineage a new perspective on building additional warehouses to meet capacity demands. As an alternative, they can now look at re-racking existing warehouses with higher density to avoid new construction, a great example of technology-driven data that reduces investment costs and environmental impacts.



"We collect energy and temperature data from across these warehouses. By using the ndustrial.io platform and AT&T connectivity to get the whole picture, Lineage is able to tell a good KW from a bad KW and adjust the cooling equipment accordingly. This adds up to substantial savings where the cleanest watt is the watt not used."

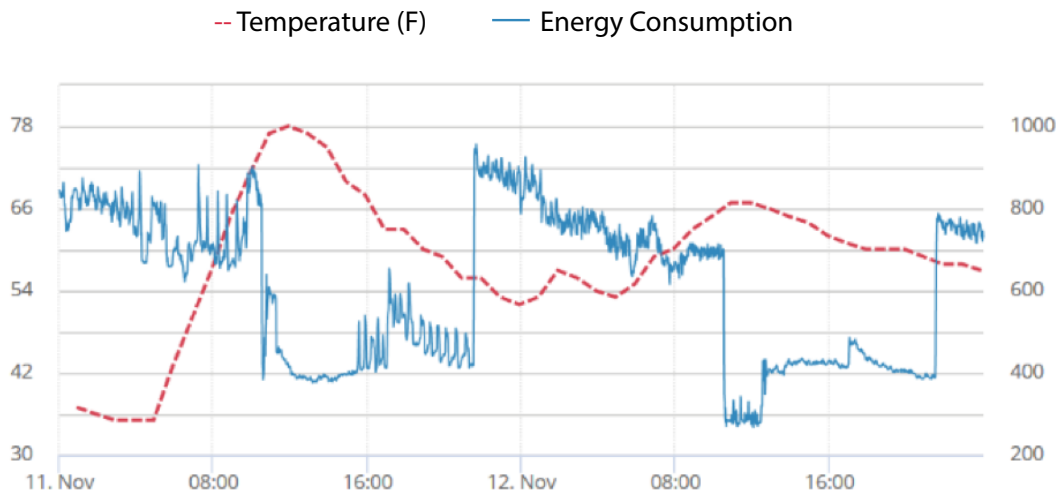
Jason Massey, CEO, ndustrial.io



2. Energy reduction during afternoon peak usage times lowers grid demand for the community and reduces costs for Lineage.

Electric utilities can add a “demand charge” – a higher rate or an extra fee – during peak usage times, typically during hot afternoons when need for air conditioning is high. Conversely, in the evenings when temperatures drop and there is lower demand on the electricity grid, electric utilities can reduce production and energy costs. This variation in electricity costs can create a serious cost strain for energy-intensive businesses like Lineage.

Recognizing the electric utilities’ patterns, Lineage utilizes the detailed and timely data from the ndustrial.io platform to super-cool their warehouses to much lower temperatures during low-demand times at night. This create a virtual “battery” of coldness. During the following hours, ndustrial.io’s system sends signals used to turn off the cooling equipment and lets the temperature rise, monitoring temperatures closely to ensure the thermoload in all corners of the warehouse doesn’t rise too high and compromise food safety. As a result, the warehouse uses substantially less electricity during the high-cost times when electricity demand on the grid is highest. In order to ensure food safety, accurate and timely temperature data across the warehouse is absolutely critical.



**By super-cooling at night when temperature is low (blue),
Lineage can reduce electricity usage when temperature is high (red).**

This process essentially turns the facility into a “battery” that reduces the need for power from the grid by 2-3 megawatts, which represents the amount of electricity capacity the grid would have needed to provide to operate the warehouse. This means that 2-3 megawatts of capacity aren’t needed during peak times, allowing power utilities to avoid the cost and environmental impact of having to build or turn on another power plant.

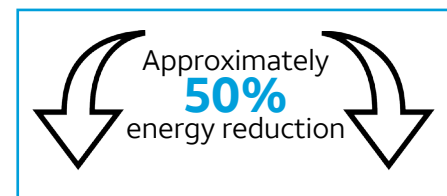


In addition to this practice of supercooling, active temperature management allows Lineage to work closely with certain utilities if grid usage is high. This is called “load-shedding,” and it occurs when a utility needs to reduce demand on the grid. The utility sends Lineage a demand signal two hours in advance of peak usage time. If temperatures are cold enough in the warehouse, Lineage will signal back that they will reduce usage at the agreed-upon time. In sum, the capacity to load-shed gives Lineage an opportunity to lower its electricity costs while ensuring product always sits within the required temperature range.

3. Faster blast freezing.

Blast freezing is a process in which food is frozen very quickly at extremely cold temperature. This can help ensure food quality due to lower cellular disruption during the freeze and improve the safety of the food system by reducing the likelihood of pathogens and other contaminants. It also presents another opportunity to use timely and granular temperature data to improve efficiency. Due to the seasonality of certain commodities, speed and efficiency in blast freezing is especially critical at different times of the year. Take peak strawberry season, for example, when Lineage freezes 4-6 million pounds of strawberries each day.

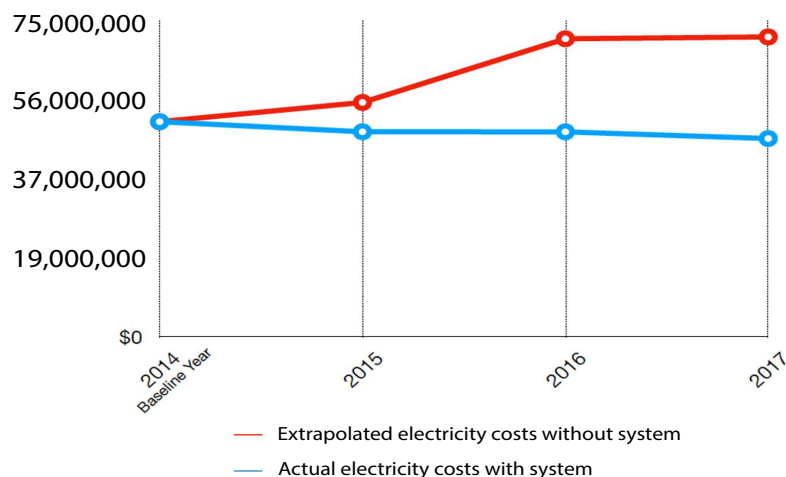
To accommodate that volume, Lineage added sensors in the freezer and worked with ndustrial.io to develop a customized dashboard to track the freezing process. The impact was dramatic, reducing the average freeze time from almost 100 hours to around 40, which represents a 50% reduction in energy. This helped Lineage reduce the amount of electricity needed for blast freezing.



The dashboard used sensors and AT&T connectivity to give the company more insight into the conditions inside the freezer and boost throughput. Alerts like “Food is frozen and ready to be removed” or “Airflow is restricted and causing hot spots. Remove top pallet” help keep food moving through the process in an efficient manner.

Sustainability Impact Overview

Since it started working with ndustrial.io using AT&T connectivity, Lineage has been able to increase the capacity at its facilities without seeing an equivalent rise in electricity usage. In fact, ndustrial.io has used its AT&T IoT-enabled system to help Lineage reduce costs during this period of growth.





This is especially impressive when considering how much electricity would have been used if energy efficiency had stayed the same as it was in 2014. If Lineage had not made the operational changes identified by the system, their electricity usage since 2014 would have increased by over 600 million kWh, which is equal to consuming over 37 million gallons of gasoline.⁵ Equally important is the financial impact of these systems, which have tallied annual energy spend reductions of \$4 million from 2014-2017 based on energy spend data collected by the ndustrial.io system.

"We're way past the 'show me' stage. The investment in IoT technology is proving to be a very efficient capital deployment with a very short payback of less than 1.5 years. And when you add in the significant environmental impacts, this is now one of the most important initiatives in the company."

- Sudarsan Thattai, chief information officer, Lineage Logistics

For Lineage, the focus now is on expanding the system into areas where demand charges make the payback even quicker. And for ndustrial.io, the possibilities are endless. This type of industrial data collection and cloud-based analysis platform could be used by biofuel plants for the process optimization, by the cement industry to apply optimization algorithms to legacy systems, or by data center operators looking to change electricity usage patterns similar to the freezer battery modeled by Lineage.

USING AT&T CONNECTIVITY AND ANALYTICS FROM ndustrial.io HAS THE POTENTIAL TO:

- 1. Provide detailed cooling and energy consumption data in a cold storage warehouse, resulting in higher cold storage capacity with lower ongoing energy costs and environmental impacts.**
- 2. Create new business models to reduce costs by shifting energy demand in a warehouse facility, potentially reducing costs or creating new revenue streams.**

⁵ U.S. Environmental Protection Agency, [Greenhouse Gas Equivalency Calculator](#). (Note, the average eGRID electricity factors have been used rather than the marginal AVERT electricity factors, this being a more conservative estimate of the savings).



Applying the 10x Carbon Impact Methodology

Carbon Trust and Business for Social Responsibility (BSR) collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's technology. The 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 | <p>AT&T's connectivity together with industrial.io's monitoring and analytics platform enables Lineage Logistics to optimize the energy performance of their cold storage facilities. This has resulted in reduced energy consumption and related reductions in greenhouse gas emissions.</p> <p>Detailed temperature and humidity data is monitored at the rack level and sent in real-time to a cloud based analytics engine. This allows for optimized temperature control, and optimized loading of food on shelves, which results in lower energy consumption per quantity of food that is frozen and stored.</p> |
| Impact Category | <p>This case study focuses on energy savings resulting from the temperature monitoring and control system, and the greenhouse gas (GHG) impact associated with these savings.</p> |
| Materiality | <p>The cold storage monitoring and control system reduces the electricity consumption required for the freezing and cold storage of food. The reductions in GHG emissions relate to the production of the electricity supplied via the grid.</p> |
| Attribution of Impacts | <p>The energy and carbon savings described in this case study are a result of industrial.io's temperature monitoring and analytics system, combined with the use of AT&T's IoT technology. Both AT&T and industrial.io play a fundamental role in enabling the environmental benefits that are delivered.</p> |
| Relationship to Systems | <p>Freezing and cold storage of food uses significant amounts of electricity. This innovative approach of detailed monitoring, temperature mapping, and temperature setpoint controls using real-time data transfer delivers much greater energy savings compared to less sophisticated temperature control systems.</p> <p>The financial and environmental benefits arising from this approach enabled by AT&T connectivity, could encourage widespread adoption of improved cold storage temperature management, thus delivering scalable environmental benefits.</p> |
| Primary Effects | <p>The cold storage monitoring and control system enables more efficient temperature control of cold storage facilities and thus reduces the electricity used for cooling the facilities. Reductions in GHG emissions follow related to the production of the electricity supplied via the grid.</p> |



| | |
|---|---|
| Secondary Effects | <p>Use of the cold storage facility as a “cold battery” allows peak electricity usage to be reduced. This reduces planned peak load on the electricity grid, thus reducing the need for carbon intensive stand-by generation capacity on the grid, and long-term reduction in need for new build power generation capacity.</p> <p>Similarly, demand response mechanisms (also known as ‘load shedding’) can react to unplanned spikes in demand on the grid, by temporarily switching off the cooling compressors, again reducing peak load on the grid.</p> <p>These two mechanisms are enabled by either cooling the facility below the required temperature at off-peak times, thus saving electricity consumption during peak times (effectively using the facility as a battery), or by temporarily allowing the temperature to rise slightly above the set level during a load shedding period, and then lowering the temperature after the peak has passed.</p> <p>These secondary effects were not included in the calculation of carbon savings, as they rely on specific assumptions about the grid base load, peak load, and stand-by provisions, which are difficult to establish and will vary both geographically and temporarily.</p> |
| Rebound Effects | No direct rebound effects were identified. Although it could be argued that if the improvements described here resulted in lower costs for freezing foods that might have the effect of increasing the demand for frozen foods, and thus the demand for energy to provide the cooling. |
| 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 monitoring devices, data communication and data processing. This will be minimal in comparison with the overall energy use of the cold storage facilities and with the emission reductions. |
| Carbon Abatement Calculation | |
| Scope | The scope for the study covers all the Lineage Logistics cold storage facilities using the Industrial.io monitoring and control system. |
| Timeframe | The data used in the study covers the years 2015, 2016 and 2017. This is compared to baseline data for 2014, which was prior to the installation of the system. |
| Functional Unit | The functional unit for the avoided GHG emissions is expressed as either kg CO ₂ e per facility, or as kg CO ₂ e per ton of produce frozen (inbound + outbound). |
| Methodology | <p>Electricity consumption data was collected for each facility for each year in the study. Production data was also collected by facility for each year. Some adjustment of the data was required to fill data gaps and to remove anomalies.</p> <p>The ratio of electricity use to production volume for the baseline year was applied to the production volumes for the three years 2015, 2016, and 2017. This calculated the electricity that would have been used for the production in each year if the monitoring and control system had not been installed. These calculated electricity consumption figures were then compared to the actual electricity figures for each year to give an electricity saving figure for each year.</p> <p>The electricity saving was converted to a carbon saving using the EPA eGRID average emission factor for the USA plus upstream and transmission and distribution (T&D) losses from DEFRA.</p> |
| Key Assumptions | Electricity use is correlated with production volume measured as the total weight of inbound + outbound produce. |
| Exclusions | • The embodied and in-use emissions of the monitoring devices, data communication and data processing. (This can be considered to be negligible in comparison with the overall energy use of the cold storage and with the emission reductions). |



| | |
|--------------------------------|---|
| Data Sources | <ul style="list-style-type: none">• Electricity data provided by Lineage Logistics• Production data provided by Lineage Logistics• EPA. Emissions & Generation Resource Integrated Database (eGrid 2016). Retrieved from https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid• DEFRA. Greenhouse gas reporting: conversion factors 2017. Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017 |
| Results | |
| Carbon Abatement Factor | Annual carbon savings were calculated as an average for the three years 2015, 2016 and 2017 as: 1,400 tCO ₂ e per cold storage facility, or 9.4 tCO ₂ e per ton of produce frozen (inbound + outbound weight). |
| Insights | This case study highlighted the significant energy and carbon savings possible for a cold storage facility from the application of real time temperature monitoring, analysis and control. The importance of baselining the electricity use against a suitable production metric was critical in establishing meaningful savings figures. |



AT&T 10x Case Study:

OmniMetrix uses AT&T IoT connectivity to help customers monitor oil and gas pipelines, helping reduce inspection time, costs, fuel usage, and emissions



AT&T 10x Case Study:

OmniMetrix uses AT&T IoT connectivity to help customers monitor oil and gas pipelines, helping reduce inspection time, costs, fuel usage, and emissions

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 goal to enable carbon savings 10x the footprint of our operations by the end of 2025.

To meet, we're working to make our operations more efficient across the company. We're also working with our customers and technology collaborators 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.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

There are more than 2.6 million miles of oil and gas pipelines criss-crossing the United States.¹ Even as energy companies strive to transition to less emission-intensive energy sources, it is critical that they monitor and maintain these pipes to limit leaks and address safety concerns. To that end, Federal regulations require inspections every two months to help identify and address damage to this critical infrastructure. OmniMetrix, a provider of critical asset management services, uses AT&T Internet of Things (IoT) to enable customers to monitor the condition of their steel pipelines. OmniMetrix customers use this technology to help reduce the time, fuel and costs associated with traveling to inspections. By extension, this efficiency helps reduce the greenhouse gas (GHG) emissions associated with these inspections. In addition, this remote monitoring system enables more detailed and timely information about the health of pipelines, creating the potential for reduced leakages. OmniMetrix provides this service to a range of pipeline companies, connecting thousands of sensors at the end of 2018, reducing inspection travel time by an estimated **8,500 hours**, saving approximately **\$300,000² in fuel and labor costs**, and shrinking gasoline usage by around **22,000 gallons** of gas a year³, equivalent to almost 200 metric tons of CO₂e.⁴

Annual estimated benefits of OmniMetrix pipeline monitoring



Over \$300,000

in reduced fuel and labor costs



Over 22,000

gallons of gasoline



Over 8,500
hours of reduced drive time



Almost 200
metric tons of CO₂e avoided³

1. "General Pipeline FAQs," Pipeline and Hazardous Materials Safety Administration, February 26, 2019, <https://www.phmsa.dot.gov/faqs/general-pipeline-faqs>
2. Average hourly wage based on "Average hourly and weekly earnings of all employees on private nonfarm payrolls by industry sector, seasonally adjusted," Bureau of Labor Statistics, September 06, 2019, <https://www.bls.gov/news.release/empsitt19.htm> and average cost of fuel based on "USA Gasoline prices, 23-Sep-2019," GlobalPetrolPrices.com, September 23, 2019, https://www.globalpetrolprices.com/USA/gasoline_prices/
3. Calculations are based on actual savings from 122 sites that were extrapolated across all pipeline monitoring connections provided by OmniMetrix.
4. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> (Nwote, the average eGRID electricity factors have been used rather than the marginal AVERT electricity factors, this being a more conservative estimate of the savings).



Background

Pipelines can provide an efficient way to transport significant volumes of liquid or gas across the country. However, when steel pipelines are in the ground, they will inevitably corrode, which is one of the leading causes of pipeline failure in the oil and gas industry. According to a study conducted by the National Association of Corrosion Engineers (NACE), pipeline corrosion can cost anywhere between **\$5.4 billion and \$8.6 billion** in the U.S. alone.⁵ To help prevent corrosion and keep the soil away, pipeline operators apply a coating to the exterior of the pipe to keep the dirt away from the pipe, but even this coating can deteriorate over time.

To further prevent the pipeline from deteriorating, pipeline companies use cathodic protection to provide an electrical protection against corrosion. Rectifiers are placed on the pipeline every 5-10 miles, generating an electric current that can help protect the pipeline when there are defects in the coating. If these rectifiers fail to operate properly, the current stops and the possibility of corrosion increases. To address this issue, pipeline companies install various remote monitoring devices to monitor the effectiveness of the cathodic protection.

\$5.4 - \$8.6 billion
Estimated costs due to
pipeline corrosion⁵



5. Krystal Nanan, "Pitting Corrosion in Oil and Gas Wells and Pipelines," Corrosionpedia, June 25, 2018, <https://www.corrosionpedia.com/pitting-corrosion-in-oil-and-gas-wells-and-pipelines/2/6778>



The Challenge: Pipeline inspections are critical but traditionally time, cost, and fuel intensive

The Pipeline and Hazardous Materials Safety Administration (PHMSA) requires pipeline operators to inspect pipelines every two months.⁶ Traditionally, this has meant that pipeline inspectors must drive to distant inspection points. Since these inspection points are typically 5-10 miles apart on the pipeline, and the pipeline does not necessarily follow the roads, the actual driving distance from rectifier to rectifier can be much longer. Because most inspectors are driving trucks to the sites, this means they can use lots of fuel to do just a few inspections a day. This is costly, time-intensive, and has an environmental impact in terms of fuel usage and the associated GHG emissions.

PHMSA requires frequent pipeline inspections

- Inspections every 2 months
- Detailed inspections every year

The Solution: OmniMetrix collaborates with AT&T IoT to collect remote inspection data

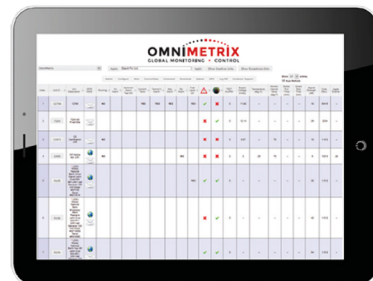
With a history of using wireless technology to monitor equipment that dates back to 1998, OmniMetrix provides greater visibility and control of critical assets for their customers. By working with AT&T IoT, OmniMetrix enables pipeline companies to reduce inspection-related time, costs and emissions by remotely monitoring cathodic protection rectifiers.



"Use data, not trucks."

OmniMetrix slogan

OmniMetrix adds a wireless sensor to the rectifiers on the pipeline and sends current, voltage and other data via AT&T IoT connectivity to the cloud. AT&T's network provides highly secure and dependable transmission of this data, an essential requirement since this data is used for compliance reporting. Customers can access this data, receive alarms, and monitor current and voltage to ensure that the cathodic protection equipment is operating correctly. OmniMetrix's StormSense™ feature works in conjunction with data from the National Weather Service to either disconnect itself from the AC voltage on the rectifier or suspend the gathering of data to protect itself in case of bad weather.



6. "PHMSA Regulations," Pipeline and Hazardous Materials Safety Administration, September 8, 2017, <https://www.phmsa.dot.gov/phmsa-regulations>.



“Our customers are motivated to reduce their costs and their environmental impact. Using AT&T IoT to power the OmniMetrix monitoring solution gives them the insights they need to tune their operations and drive efficiency, helping their bottom line and the environment.”

- Walter Czarnecki, President & CEO, OmniMetrix

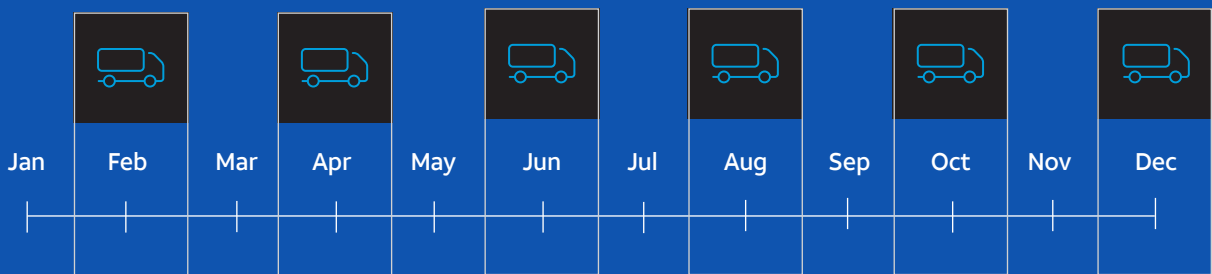
Previously, inspectors would travel long distances at least every two months to all rectifier sites along the pipeline to comply with PHMSA requirements. Now pipeline operators only need to dispatch an inspector to drive to the rectifiers once per year to visually inspect the equipment for physical damage from the weather or animals. This helps the pipeline operator maintain compliance and reduce costs, fuel usage and associated GHG emissions.



Wireless sensors added to the rectifiers on the pipeline send current, voltage and other data via AT&T IoT connectivity to the cloud.

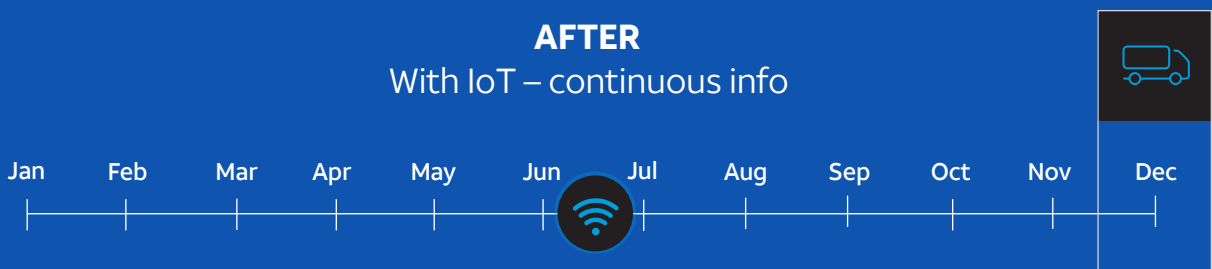
BEFORE

Without IoT – info every 2 months



AFTER

With IoT – continuous info





Sustainability Impact: Remote monitoring of long-distance pipelines can help dramatically reduce travel-related costs, time, and emissions

The compelling business case for this solution suggests that this type of remote monitoring and inspection could become the norm across the pipeline industry. In addition, this type of monitoring could also be used on storage tanks and filling stations, further reducing the needed inspection drive time and resulting emissions.

Wider adoption of this type of asset monitoring can help reduce emissions substantially. If pipeline operators used remote monitoring for just 10% of the 2.6 million miles of pipeline for their inspections and experienced benefits like the current OmniMetrix customers, they could lower fuel and labor costs by an estimated **\$4 million** and reduce GHG emissions reductions by **2,500⁷ metric tons of CO₂e** annually. This is equivalent to:



Taking almost **550** cars off the road



Not burning almost **287,000** gallons of gasoline



Switching almost **85,000⁸** incandescent bulbs to LEDs

7. $2,600,000 / 10 \text{ miles between sensors} * 10\% * 0.1 \text{ metric tons CO}_2\text{e per monitor emission reduction calculation} = 2,500 \text{ metric tons CO}_2\text{e}$

8. All equivalencies in this document are estimated using the methodology outlined by the U.S. Environmental Protection Agency, Greenhouse [Gas Equivalency Calculator](#).



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. The 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's connectivity enables the remote monitoring of cathodic protection rectifiers required to stop the corrosion of gas and oil pipelines, which can lead to leakages. Remote monitoring provides a more fuel and time efficient method to inspect pipelines by avoiding the need for the inspection team to travel long distances to inspect each rectifier site. Real-time scanning data is sent via AT&T's network to enable faster inspection. |
| Impact Category | This case study focuses on the reduced fuel usage resulting from the remote monitoring of rectifiers along the pipeline network and the GHG impact associated with these savings. |
| Materiality | <p>Using sensors to remotely inspect rectifiers on a pipeline reduces the cost, emissions and time associated with the traditional method of inspecting rectifiers.</p> <p>The environmental and financial benefits arising from this approach enabled by AT&T connectivity could encourage widespread adoption of improved pipeline maintenance and management, thus delivering scalable environmental benefits.</p> |
| Attribution of Impacts | The cost, emissions and time savings described in this case study are a result of changes to the pipeline inspection and maintenance practices supported by OmniMetrix sensor technology and AT&T IoT connectivity. |
| Primary Effects | The remote monitoring system reduces the need to frequently inspect each rectifier on site, and thus reduces the fuel and time used for inspecting and maintaining the pipeline. |
| Secondary Effects | The remote monitoring of rectifiers can potentially support the early identification of issues with the rectifiers. This allows for any potential risks of leakages to be addressed swiftly, thereby reducing leakages and the associated GHG emissions. It can also identify issues with ground beds, wiring (broken wires) and shorts on the pipeline. |



| | |
|---|---|
| Rebound Effects | No direct 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 embodied carbon emissions of the sensors and IoT devices, which is assumed to be minimal. |
| Scope | The scope for this case study covers the difference in travel emissions between the inspection of pipeline rectifiers with and without remote monitoring. |
| Timeframe | Savings were calculated on a yearly basis, even though in-person inspections occur each month without remote monitoring and once a year with remote monitoring. |
| Functional Unit | The functional unit for the carbon emissions reduction is metric tons CO ₂ e per rectifier from reduced maintenance trips per year. |



Methodology

The GHG emissions reductions were calculated by comparing the emissions associated with the number of inspections and the associated travel per year with and without remote monitoring. The distance travelled without remote monitoring was estimated by taking an average driving distance between each rectifier and assuming that each rectifier needs to be inspected in-person once per month. While PHMSA requires in-person inspections every two months if there is no remote monitoring, we've assumed a trip every month based on interviews with pipeline operators. The distance travelled with remote monitoring was estimated by assuming that each rectifier only needs to be inspected in-person once per year, per PHMSA requirements.

The difference in distances driven was then converted into carbon savings using the truck emission factor from BEIS 2019.

Key Assumptions

- Emission factor of a large diesel car: 0.4177 kgCO₂e/mile
- Average driving distance between rectifiers: 20 miles
- Average number of rectifiers visited per day: 15 (average of 10-20)
- Average distance between rectifiers: 10 miles
- Number of inspections per rectifier per year without remote monitoring: 12
- Number of inspections per rectifier per year with remote monitoring: 1

Exclusions

- Potential reductions in emissions from a reduction in pipeline leakages.
- Embodied and in-use emissions of the monitoring devices, data communication, and data processing. This is considered negligible compared to the overall energy use of the maintenance trips.



Data Sources

- Rectifier and remote monitoring sensors data provided by OmniMetrix
- BEIS. Truck emission factor. Retrieved from <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019>
- US pipeline network. Retrieved from <https://www.phmsa.dot.gov/faqs/general-pipeline-faqs>
- EPA equivalencies. Retrieved from <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>

Carbon Abatement Factor

The result of remotely monitoring rectifiers across the pipeline network leads to total carbon savings of 0.1 tCO₂e per rectifier per year. Extrapolating this to 10% of the US pipeline network would lead to 2,548 tCO₂e carbon savings per year.

Lessons Learned

As there are many factors impacting the reduction in methane emissions from pipeline infrastructure it is very difficult to collect data and assess the impact of remote monitoring on the reduction in methane emissions.



AT&T 10x Case Study:

Unlocking the Potential of Connected, Reusable Pallets



AT&T 10x Case Study:

Unlocking the Potential of Connected, Reusable Pallets

AT&T has a goal – our “10x” goal – to enable carbon savings for our customers that is 10 times the footprint of our own operations by 2025. To meet this goal, we are engaging with customers and technology partners to implement and scale up carbon-saving solutions. Through this process, we are publishing a series of case studies and concepts to share our progress and learning. 10x case studies will discuss and quantify the carbon benefits of using AT&T technology to improve efficiency. In order to be included in the evaluation of progress toward our 10x goal, AT&T technology must play a fundamental role. To discover more about our goals, understand how we’ll track our progress, and see status updates and case studies like this, visit AT&T’s Connect to Good [website](#).

The Challenge: Antiquated Pallets in the Modern Supply Chain

Every day, billions of goods—from bananas to cell phones—move through complex supply chains to destinations around the world. At some point in the chain, the majority of those goods depend on a shipping pallet. As unassuming as they might seem, shipping pallets once revolutionized how goods move around the world and facilitated enormous growth in global commerce. Today, there are approximately 10 billion¹ of these typically wooden pallets worldwide. However, despite their benefits to trade, wooden pallets present a variety of challenges for businesses and the environment (see box at right). In a modern supply chain with automated warehouses, digital-enabled logistics, and higher standards for food, employee, and consumer safety, the wooden pallet has not evolved to keep pace.

THE CHALLENGES OF WOOD PALLETS

- Financial and environmental costs of pallet disposal and replacement when no longer useful
- Food and consumer safety issues from porous surfaces
- Warehouse safety hazards from wood shards and nails
- Supply chain inefficiency from broken or lost pallets

More **durable, reusable pallets** made from composite materials address many of these challenges while also reducing pallet height, weight² and repair and replacement frequency. However, they are manufactured from advanced materials, making them cost more to produce. The ability for pallet users to effectively rent these durable pallets from a pool of pallets – called pallet pooling – eliminates the need for high up-front capital investment. Reusable, pooled pallets provide solutions to some traditional pallet challenges, but they fail to address one key problem: expensive pallet loss. The ability to effectively track pallets and control loss rates could stimulate widespread adoption of durable pallets and kick in their associated benefits.

¹ <http://packagingrevolution.net/will-pallets-be-the-biggest-application-for-the-internet-of-things/>

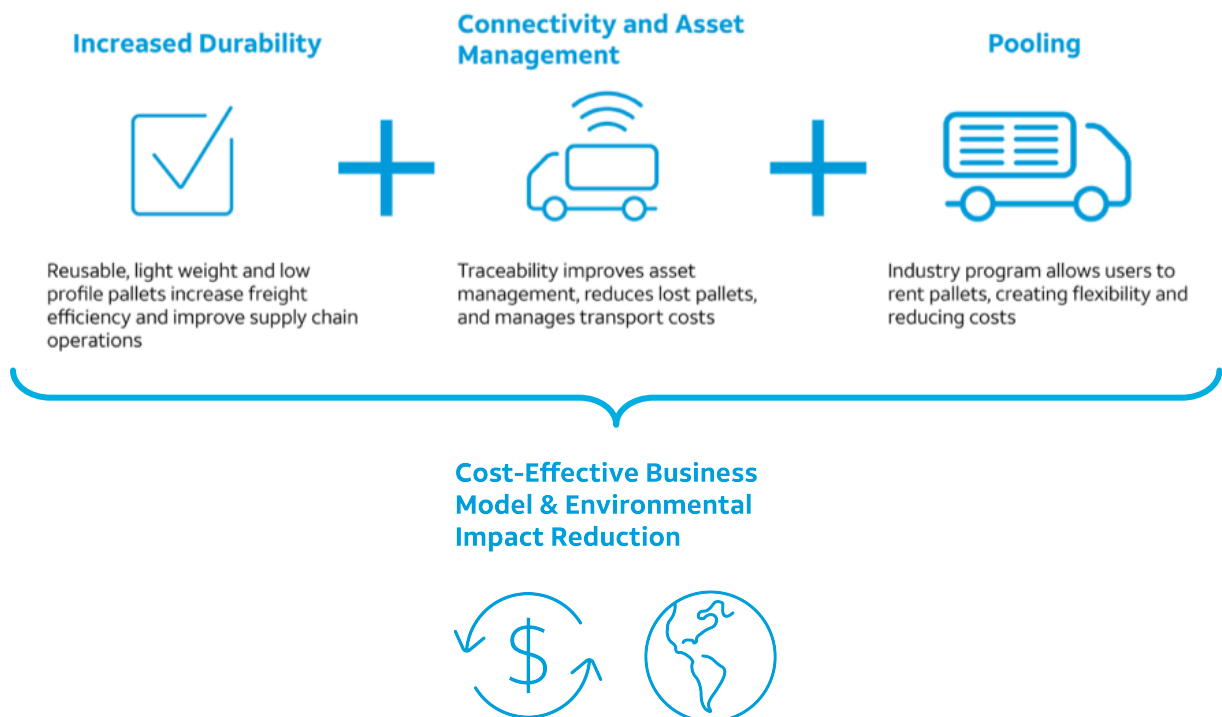
² Compared to pallets of the same strength.



The Solution: AT&T Connectivity Unlocks Potential of Reusable Pallets

Internet of Things technology connects objects to the internet, and provides the loss prevention necessary to make reusable modern pallets financially competitive in today's complex supply chain. A **connected pallet** unlocks the benefits of reusable pallets by empowering users to maintain oversight of inventory to prevent loss and by obtaining new data from segments of the supply chain that were previously invisible.

This connectivity changes the economics of reusable pallets, enabling more widespread adoption which, in turn, generates significant financial and environmental benefits. Reusable, connected pallets allow users to reduce fuel consumption (composite pallets are typically lighter and have a lower profile than wooden pallets), decrease wood waste from broken pallets, and decrease the amount of raw materials required to produce replacement pallets by reducing the average number of pallets that are lost or broken each trip. With connectivity, users can track pallets in the supply chain as they move from one location to another, dramatically reducing the risk of loss, and the costs and time associated with locating or replacing missing pallets. Meanwhile, supply chain operators benefit from new information about how pallets and inventory move through multiple, interrelated supply chains. This combination of elements creates a business model in which **a connected, reusable pallet can be used 162 times³ before it reaches end of life, resulting in a per trip cost up to 20% lower than non-reusable alternatives.⁴**



³ Based on comparative life cycle assessment (LCA) of wood and composite pallets that was independently carried out by Pure Strategies for RM2 and critically peer reviewed.

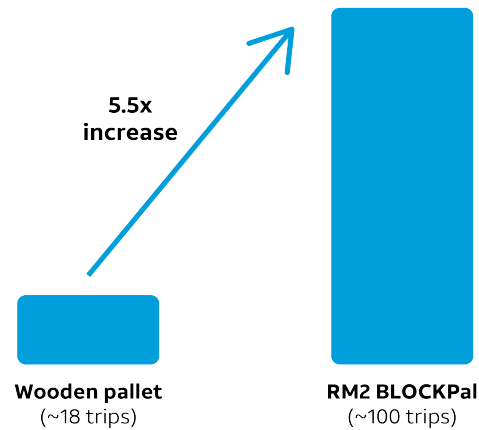
⁴ Based on RM2 analysis of supply chain models and costs.



Implementation: AT&T Provides Connectivity for RM2 Reusable Pallets

New reusable, highly durable pallets are entering the market, including the BLOCKPal™ pallet from RM2. AT&T is working with RM2 to embed an Internet of Things (IoT) based track and trace solution in every BLOCKPal pallet. This solution, called RM2ELIoT, pairs RM2's reusable pallet with AT&T's LTE-M low-power wide-area network, enabling longer battery life (expected up to 10 years) and better wireless coverage in difficult areas where pallets are often found: deep inside buildings, in below-ground storage areas, and on trailers, trains, and trucks. Together, RM2 and AT&T have created a model that lowers the final financial hurdle to reusable pallet adoption.

Average Trips Before Repair or Replacement



The BLOCKPal is made from robust, advanced composite materials making each pallet consistent in size and weight, and stronger and more durable than wooden pallets. The BLOCKPal meets ANSI, FM Global, and ISO standards for food safety⁵ and is built to withstand multiple trips. The BLOCKPal is assembled piece by piece allowing for repairs that extend its usefulness far beyond a traditional wood pallet, creating significant lifecycle advantages.

Sustainability Impact Overview

By overcoming the financial hurdles that deter widespread adoption, connectivity unlocks the full economic and environmental potential of reusable pallets. In a fully independent peer-reviewed Life Cycle Analysis (LCA), the BLOCKPal reduced water pollution, greenhouse gas emissions, and energy use when compared to wooden pallets on a per-trip basis.⁶

Widespread adoption of connected reusable pallets – particularly by large retailers and logistics providers that interact with thousands of pallets a day – could meaningfully reduce greenhouse gas emissions and other negative environmental impacts while increasing resource efficiency and lowering lifecycle costs. As companies around the world continue to set more ambitious sustainability targets, BLOCKPal and RM2ELIoT can provide new tools for reducing resource use and environmental impacts, while sustaining economic gain.

⁵ ISO 8611 & ASTM 1185 Standards. It is approved and accredited to the FM Global 4996 Approval Standard for Classification of Idle Plastic Pallets as Equivalent to Wood Pallets.

⁶ LCA conducted by Pure Strategies, in accordance with ISO 14040-14044 Standards.



Carbon Impact Measurement

If a company managing one million wooden pallet trips per year were to fully implement BLOCKPal pallets equipped with RM2ELIoT connectivity, that company could **reduce emissions by 640 metric tons of CO2e every year**. That's equivalent to:



A **21%** reduction in CO2e emissions



Taking **135** cars off the road



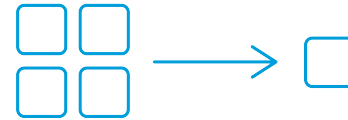
Not burning **72,000** gallons of gasoline



Switching **22,600** incandescent bulbs to LEDs

Increasing Efficiency in Logistics

One BLOCKPal pallet can replace four traditional wooden pallets.



This increases vehicle fill, resulting in:



A **17%** reduction in empty pallet traffic

1,588 fewer truckloads annually

Note: Savings calculated over six million pallet trips

COMBINING RM2 BLOCKPal WITH AT&T CONNECTIVITY HAS THE POTENTIAL TO:

1. Change the financial model of shipping pallets, enabling the business case for switching to durable pallets and reducing negative environmental impacts across the value chain.
2. Enable customers to gain increased visibility into and control over their logistics and inventory management.

RM2 International S.A. specializes in pallet development, manufacture, supply, and management. The goal is to establish a leading presence in global pallet supply and improve the supply chain of manufacturing and distribution businesses. We are doing this through the effective and efficient use and management of composite pallets. It is quoted on the AIM market of the London Stock Exchange under the symbol RM2.L. To move it better, visit www.rm2.com



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. The details of the methodology can be found on the AT&T Connect to Good [website](#). Here is a summary of the analysis:

The carbon abatement from the use of connected pallets relies on a comparative Life Cycle Assessment (LCA) of wood and composite pallets. This study was independently carried out by Pure Strategies for RM2 and was critically peer reviewed. A summary of the study is available at RM2’s website: <http://rm2.com/sustainability/>. The study covers a range of environmental impact categories, however, the focus for this case study is on the carbon impacts. Data and assumptions used in the LCA study are based on RM2 data, independent testing, and assumptions from a previous LCA study performed by Franklin Associates for CHEP.⁷

| | |
|---|--|
| Description of the enabling technology | AT&T connectivity enables traceability of the pallets, reducing pallet losses. This enables a business model supporting higher value pallets that are lighter in weight, more durable, and can withstand greater load capacity. |
| Impact Category | This case study focuses on carbon impacts. The LCA study more broadly covers carbon and other environmental impacts. |
| Materiality | The impact of connected pallets both reduced carbon emissions and enabled new sustainable business models. |
| Attribution of Impacts | The carbon savings described in this case study are a result of the design and manufacture of the RM2 BLOCKPal, combined with the use of AT&T’s IoT technology. Both AT&T and RM2 play a fundamental role in enabling the environmental benefits of the RM2ELIoT asset management technology solution. |
| Relationship to Systems | This connectivity-enabled product has the ability to impact the current logistics and shipping system by creating new financial models for reusable pallets and creating increased visibility to asset tracking, enabling the potential to drive greater efficiency. |

⁷ Franklin Associates: A division of ERG. (2009). *Life cycle inventory of three pallet systems: Peer-reviewed final report (detailed executive summary)*. Prairie Village, KS: Franklin Associates: A division of ERG.



| ENABLING AND REBOUND EFFECTS | |
|--|--|
| Primary Effects | Carbon savings are produced from reduced fuel used to transport the pallets. This is mainly due to the lower weight and height of the composite pallet compared to the wooden pallet. As the composite pallets are more durable than the wooden pallets, they last much longer and can withstand supply chains that take a toll on traditional wooden pallets. Additionally, due to the ability to track the pallets, the pallet loss is reduced. |
| Secondary Effects | <p>The greater load carrying capacity of the composite pallets allows additional product to be carried per load, further reducing the number of trips. This additional benefit was not included in the study as the range and variety of products carried make it impracticable to model.</p> <p>Similarly, there are other environmental benefits because of reduced damage to products transported by the composite pallets. These were also not included in the study because of the complexities of this modeling process.</p> |
| 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 embodied carbon emissions associated with the raw materials and manufacturing of the composite pallets is higher than for the wooden pallets. This is included in the overall results of the LCA study. |
| CARBON ABATEMENT CALCULATION | |
| Scope | The scope of the LCA study is the full life cycle of the pallets including raw materials, manufacturing, distribution, use, and end-of-life (EOL). The study compares a composite block pallet with a wood block pallet. |
| Timeframe | The LCA study was performed in 2014. |
| Functional Unit | The functional unit used in the LCA study was for 100,000 pallet trips. In order to apply the result to the number of pallets enabled by AT&T, the results are also expressed in this case study using a functional unit of a single composite pallet. |



Methodology

The LCA study covered the cradle-to-grave life cycle of the RM2 composite pallet and a typical wood block pallet. The life cycle was divided into the following stages:

Material Production: The acquisition of raw materials such as silica and wood, and the processing of raw materials into intermediate materials used in the pallets, such as glass fiber, and lumber.

Component Manufacturing: The manufacture of pallet components that are purchased by the pallet manufacturers, such as screws, nails, and leg inserts.

Component Transport: The transportation of materials (i.e. glass fiber roving, lumber) and components (screws, nails) to the manufacturing facility.

Pallet Manufacturing: The manufacturing and final assembly of the pallets.

Distribution: Transportation of the finished pallet to the initial customer or user.

Use – Loaded: The transportation of the pallet during use when it is loaded with product.

Use – Disposal of Lost Pallets: The disposal of pallets that are lost during use.

Use – Repair: The repairing of damaged pallets.

Use – Backhaul: The transportation of the pallet during use when it is not loaded with product (e.g., transport to the service center and/or the next user).

End of life (EOL): Transport to landfill of non-recycled pallets at end of useful life.

Removals and emissions of biogenic carbon from the wood pallets were excluded from the study (taking a net “carbon neutral” approach for biogenic carbon). Sequestration (storage of carbon) for the pallets is likely to be minimal, and end-of-life emissions from the wood are considered to be balanced by the CO₂ absorbed by the trees during their life.

To understand the impact of different methodologies and system boundaries on the results, a sensitivity analysis was carried out as part of the LCA study. This analysis indicated that no revisions to the methodology or system boundary were required.



| | |
|--------------------------------|--|
| Key Assumptions | <p>Key assumptions and data parameters used in the LCA study were as follows:</p> <ul style="list-style-type: none">▪ Pallet weight: 22.2 kg (composite)⁸, 29.5 kg (wood)▪ Number of lifetime trips per pallet: 162 (composite), 30 (wood)▪ Loss rate of pallets per trip: 0.5% (composite), 2% (wood)▪ Number of pallets required for 100,000 pallet trips: 899 (composite), 4400 (wood)▪ Distance from pallet manufacturer to first user: 600 miles▪ Distance from user to distribution center: 525 miles▪ Distance to next user: 100 miles. (For the wood pallet this is modeled as two transport legs of 50 miles via a service center)▪ Distance to landfill for disposal of pallets: 30 miles |
| Exclusions | <ul style="list-style-type: none">▪ Products that the pallet delivers in the use stage▪ Carbon sequestration from wood used for wood pallets▪ Recycling of pallets at EOL▪ Biogenic emissions from wood at its EOL |
| Data Sources | <ul style="list-style-type: none">▪ LCA study conducted by Pure Strategies for RM2▪ RM2 primary data▪ Independent pallet use testing▪ LCA study performed by Franklin Associates (2009) |
| RESULTS | |
| Carbon Abatement Factor | <p>The result of the LCA study is 64 metric tons CO₂e avoided per 100,000 pallet trips.</p> <p>Dividing this figure by the number of composite pallets (899) required for 100,000 trips gives 71.6 kg CO₂e avoided per composite pallet over its lifetime.</p> |
| Lessons Learned | <p>This case study utilized the work of the LCA from Pure Strategies and evaluated the role that connectivity can play in enabling the impacts identified in the LCA. An important lesson learned was to utilize existing, credible research to understand existing opportunities.</p> |

⁸ The LCA study did not include the weight of the RM2ELIoT tracking device, which weighs about 150-200 grams. Changes to pallet design since the time of the LCA and RM2ELIoT device life cycle have not been included in the scope of the case study.



AT&T 10x Case Study:

ChargePoint uses AT&T connectivity to help businesses scale access to electric vehicle (EV) charging stations and reduce greenhouse gas emissions



AT&T 10x Case Study:

ChargePoint uses AT&T connectivity to help businesses scale access to electric vehicle (EV) charging stations and reduce greenhouse gas emissions

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 goal to enable carbon savings for our customers 10x the footprint of our operations by the end of 2025.

To meet this, we're working to make our operations more efficient across the company. 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.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

There are many reasons for a business to consider installing electric vehicle (EV) charging stations: gaining customers, attracting talent, retaining employees, and supporting the transition to a low-carbon economy. Since 2007, ChargePoint has been helping businesses do just that by creating an integrated, smart EV charging network to help get people and goods moving on electric power.

Recognizing that an integrated experience is critical, whether you're an EV driver or a business operating the charging stations, ChargePoint has worked with AT&T to use dependable and highly secure Internet of Things (IoT) connectivity at many of their charging stations, providing useful and timely information to station operators and EV drivers alike.

By providing EV charging, a business becomes a part of the fueling network of the future, helping to reduce greenhouse gas (GHG) emissions in the emissions-intensive transportation sector. As of March 2020, ChargePoint used AT&T connectivity at around **37,000** stations, enabling their customers to avoid the use of over **15.5** million gallons of gasoline, which is equivalent to almost **138,000** metric tons of CO₂e avoided.¹²

Estimated benefits of AT&T connected ChargePoint EV charging stations



Over 37,000
charging stations



Over 15.5 million
gallons of gasoline avoided



Equivalent to:

Almost 138,000
metric tons of CO₂e avoided

Background: Electric vehicles and EV charging help drive a sustainable future

The shift to EV transportation can play an important role in transitioning to a low-carbon economy. Because electric vehicles are fueled by electricity rather than fossil fuels, EVs typically produce fewer lifecycle emissions compared to conventional vehicles. As more renewable energy such as wind and solar power is added to the electricity grid, EVs will run on a higher percentage of renewable energy, making it cleaner than in years prior. The bottom line is that driving an EV is good for the environment.³

And while EV sales are still a small fraction of car sales in the U.S., EV sales in 2018 were up **81%** over the previous year.⁴ And as more automakers join the EV market, the wider range of options at different price points suggest that the electrification of car transportation will not only continue, but accelerate over the next few years. Finally, the advent of autonomous vehicles over the next couple of decades is expected to further accelerate electrification, helping rapidly decarbonize the transportation sector.⁵

Companies are also feeling the pressure to include EV charging as part of their sustainability efforts:

- **Employees** – More and more employees expect their workplace to be socially and environmentally conscious. In fact, 92.1% of millennials believe working for an environmentally and socially responsible company is important,⁶ and EV charging is a clear and visible commitment to sustainability.
- **Customers** – Having a brand that is associated with sustainability can boost reputation and sales with customers. Research reveals that a third of consumers are now buying from brands based on their social and environmental impact.⁷
- **Investors** – As investors like BlackRock⁸ raise the pressure on businesses to adopt practices to reduce risks of climate change, a commitment to providing EV charging stations provides an opportunity for companies to take meaningful action to address climate change. In fact, at the end of 2018, there were 68 stock exchanges that had environmental listing requirements.⁹

81%
Increase in U.S. EV sales
from 2017 to 2018⁴





The Challenge: Finding the right EV charging solution that will scale with your business needs

Driving an electric vehicle is different compared to a traditional gas car. Whether you're a station operator or an EV driver, a networked solution is important to the EV experience.

A standalone, non-networked charger is not connected to a network, so there's no way for drivers to know if their EV was unplugged or stopped charging for some reason. That means drivers could return to their EVs and find their car did not charge sufficiently for whatever reason, creating a bad driver experience.

Networked or "smart" charging solutions are connected to a network so they can offer advanced features and get updates remotely. The benefits of networked charging make it a better choice than non-networked charging for businesses and EV drivers alike.

AT&T Workplace Charging

AT&T uses ChargePoint EV charging solutions at some of its facilities, with plans to expand its workplace charging footprint. Currently, AT&T utilizes ChargePoint's smart features that include the ability to: control who can charge and when; set pricing; allow drivers to get into a virtual line to charge, making the solution easy to manage.

The Solution: ChargePoint uses AT&T IoT to enable networked EV charging, making EV management easy

ChargePoint recognizes the need to help businesses meet the demand for charging stations so they are working with innovative companies like AT&T to accelerate the future of electrified transportation and further reducing greenhouse gas emissions worldwide. From the very beginning, ChargePoint realized that everything needs to be built on the network in order to provide scale, quality and service.

"Since its inception in 2007, ChargePoint's mission has been to make the transition to electric mobility as easy as possible, providing high quality charging experiences at every touchpoint. With more than 37,000 places to charge on AT&T's network alone, their technology enables the continued rollout of smart charging that benefits businesses, fleets and drivers alike."

- Colleen Jansen, Chief Marketing Officer, ChargePoint

By integrating highly secure and dependable IoT connectivity into their charging stations, ChargePoint can provide the fundamental services needed to make charging stations work. In particular, the remote control and monitoring enabled by AT&T IoT addresses several important needs:

- Allows remote software configuration changes
- Provides monthly reports and detailed quarterly reports of the station's performance metrics
- Enables proactive dispatch of station repair technicians when required
- Processes financial transactions
- Monitors station efficiency 24X7 to improve queue management

These smart capabilities are part of the reason that ChargePoint is leading the transition to an electric vehicle future. In particular, ChargePoint:

- Provides an integrated EV charging experience for businesses and drivers across every touch point and for every use case.
- Designs, develops and manufactures complete, integrated charging stations and software solutions.
- Delivers a top-rated mobile app and award-winning services and support.

Sustainability Impact: Charging station data via AT&T IoT unlocks potential for expansion

As more companies make sustainability a core piece of their business, tracking and reporting of environmental impacts will grow more important. When more businesses become part of the new fueling network of the future by adding ChargePoint EV charging stations, IoT-enabled reporting will make it possible for an organization to measure and monitor the progress they are making toward their sustainability goals.

If current growth continues and ChargePoint is able to provide **127,000** charging stations that utilize the AT&T IoT network by **2025**, and the average usage of those stations is consistent with the usage they're seeing today (a conservative assumption given the expected increase in EV drivers), AT&T IoT will enable GHG emissions reductions of an estimated **537,000** metric tons of CO₂e in **2025**. This is equivalent to:



Taking over
116,000 cars off
the road



Not burning
almost 60,600,000
gallons of gasoline



Switching more
than 20,000,000
incandescent
bulbs to LEDs¹⁰

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. The 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's IoT connectivity enables the remote control and monitoring of ChargePoint's network of EV charging stations. Specifically, this allows for remote software updates and enhancements, provides monthly and quarterly reports of the station's performance metrics, enables proactive dispatch of station repair technicians when required, processes financial transactions, and monitors station efficiency 24X7 to improve queue management. This creates an integrated EV charging experience for businesses and drivers, providing both with useful and timely information and support services, facilitating the overall transition towards more sustainable forms of transport.. |
| Impact Category | This case study focuses on the carbon impact of IoT connected EV charging stations. |
| Materiality | The implementation of EV charging stations increases the use of electric vehicles and thereby reduces the consumption of fossil fuels and associated emissions. |
| Attribution of Impacts | The carbon savings detailed in this case study are a result of ChargePoint's charging stations, combined with the use of AT&T's IoT technology, which together overcome barriers to EV charging station installation by enabling the development of technology platforms and new financing programs that help address the costs of installing charging stations. Both AT&T and ChargePoint play a fundamental role in enabling the environmental benefits that are delivered. |
| | |
| Primary Effects | AT&T connected charging stations lead to carbon savings by enabling the use of EV's rather than fossil fuel vehicles. |

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| Secondary Effects | <p>An improvement in the implementation and usability of EV charging stations can increase the proportion of drivers using electric vehicles, reducing emissions derived from vehicle fossil fuel consumption.</p> <p>This increase in demand can subsequently lead to greater investment into efficient electric vehicles and batteries, having knock-on effects for decarbonization in other industries in the long term.</p> |
| Rebound Effects | <p>In the short term, a large shift from fossil fuel powered to electric vehicles might lead to a greater overall quantity of manufactured cars than would have otherwise been made. This may create a disuse of petrol/diesel vehicles before their end of life and increases emissions in manufacturing and resource use.</p> |
| Trade-Offs or Negative Effects | <p>This technology does not appear to create other outsized or irreparable environmental or social impacts.</p> |
| Carbon Burden from the Enabling | <p>The embodied carbon emissions of the sensors and IoT devices, which will be minimal compared with the emissions reductions.</p> |
| Carbon Abatement Calculation | |
| Scope | <p>The scope of the case study covers all AT&T enabled ChargePoint charging stations in the US.</p> |
| Timeframe | <p>The data in this case study covers AT&T enabled charging stations in 2019.</p> |
| Functional Unit | <p>The functional unit for the avoided GHG emissions is expressed as metric tons of CO₂e per charging station.</p> |

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| Methodology | <p>The total electricity dispensed across ChargePoint's AT&T enabled charging stations, the top 3 charged vehicle models, and number of AT&T enabled charging stations was collected for the calendar year 2019.</p> <ul style="list-style-type: none"> • To calculate the kg CO₂e per charging point from the electricity used by EVs, the kWh dispensed per charging point was multiplied by the eGrid 2018 US average electricity EF. • Average kWh/mile was calculated using specific data for the top 3 vehicle models and information derived from various studies. This factor was then converted into miles/kWh. • Total distance travelled by cars recharged, per charging point was calculated by multiplying the 'kWh dispensed per charging point' by the 'miles per kWh' factor. This distance was subsequently used to calculate the kg CO₂e from the average car (using average car EF) per charging point. • The difference between the two calculated values gives tons of CO₂e savings per charging station. |
| Key Assumptions | <ul style="list-style-type: none"> • Assume the top 3 vehicle models are representative for all EVs using ChargePoint's AT&T enabled charging stations. • If the kWh/mile figure provided for each vehicle model did not include charging losses, an average charging loss factor of 23% was assumed. These charging losses account for the energy lost during the AC to DC conversion and energy consumed in surpassing battery resistance to charging. |
| Exclusions | <ul style="list-style-type: none"> • Embodied carbon emissions of the IoT connections. • Rebound effects related to an increase in the overall electricity demand and an increase in emissions from EV manufacturing. |

| | |
|---------------------------------------|--|
| <p>Data Sources</p> | <ul style="list-style-type: none"> • Electricity emission factors (eGrid – https://www.epa.gov/energy/egrid) • Greenhouse Gas Emissions from a Typical Passenger Vehicle – Tailpipe (EPA – https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle) • Greenhouse gas reporting: conversion factors 2019 (WTT) (DEFRA – https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019) • kWh/mile figures for top 3 vehicles (https://www.Ev-database.uk; https://www.insideevs.com; https://www.fueleconomy.gov) • Average charging losses (https://www.fueleconomy.gov/feg/atv-ev.shtml; https://www.researchgate.net/publication/314301528_Measurement_of_power_loss_during_electric_vehicle_charging_and_discharging; https://ev-database.uk/car/1106/Nissan-Leaf) • Top 3 electric vehicles using A&T enables charging stations, kWh dispensed in 2019 from AT&T enabled ChargePoint charging stations, total number of AT&T enabled stations (provided by ChargePoint) |
| <p>Results</p> | |
| <p>Carbon Abatement Factor</p> | <p>3,725 kg CO₂e / charging point</p> |

Endnotes

1. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> (Note, average eGRID electricity factors have been used rather than marginal AVERT electricity factors, this being a more conservative savings estimate).
2. Note that these estimated benefits are from AT&T-connected stations only. ChargePoint uses a variety of other network partners.
3. "Reducing Pollution with Electric Vehicles," U.S. Department of Energy, April 14, 2020, <https://www.energy.gov/eere/electricvehicles/reducing-pollution-electric-vehicles>
4. "Electric Vehicle Sales: Facts & Figures," Edison Electric Institute, April 2019, https://www.eei.org/issuesandpolicy/electrictransportation/Documents/FINAL_EV_Sales_Update_April2019.pdf
5. "Will Autonomous Vehicles be Electric?" Boston University Institute for Sustainable Energy, April 14, 2020, <https://www.bu.edu/ise/2018/08/27/will-autonomous-vehicles-be-electric/>
6. Professor Debbie Haski-Leventhal and Julian Concat, "The State of CSR and RME in Business Schools and the Attitudes of their Students," Macquarie University Graduate School of Management, 2016, <https://www.unprme.org/resource-docs/MGSMPRMEReport2016.pdf>
7. "Report shows a third of consumers prefer sustainable brands," Unilever, May 1, 2017, <https://www.unilever.com/news/press-releases/2017/report-shows-a-third-of-consumers-prefer-sustainable-brands.html>
8. "A Fundamental Reshaping of Finance," BlackRock, April 14, 2020, <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter>
9. "2018 State of Green Business," GreenBiz Group, April 15, 2020, <https://bit.ly/2VvxSHY>
10. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> (Note, average eGRID electricity factors have been used rather than marginal AVERT electricity factors, this being a more conservative savings estimate).



AT&T 10x Case Study:

Lowe's Uses HydroPoint and AT&T to Reduce Water Consumption and Carbon Footprint

AT&T 10x Case Study:

Lowe's Uses HydroPoint and AT&T to Reduce Water Consumption and Carbon Footprint

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:

Lowe's is focused on reducing its environmental impact while also increasing efficiency of its operations. To address these areas, Lowe's has installed HydroPoint® smart irrigation controllers that use AT&T Internet of Things (IoT) to optimize landscape irrigation outside 939 of its stores. Each year, the controllers reduce water use at these facilities by about 650 million gallons, saving Lowe's an estimated \$5 million in total water costs.¹ Because water treatment and pumping uses so much energy, saving 650 million gallons of water also effectively reduces community greenhouse gas (GHG) emissions by an amount equal to burning 84 thousand gallons of gasoline.

Annual Savings using HydroPoint at 939 Lowe's stores:



\$5 million



650 million gallons



**84 thousand
gallons of gasoline
(GHG equivalent)**

¹ Water-related cost savings estimated using average cost of .00776/gallon

The Challenge: Reduce retail store environmental footprint and operational costs.

Lowe's opened its first hardware store in North Carolina in 1946. It's now a Fortune® 50 home improvement company with thousands of home improvement and hardware stores in the United States, Canada and Mexico. In 2017, Lowe's employees helped over 18 million customers a week find the right equipment and materials for their projects.²

As experts in home improvement, including lawn and garden care, Lowe's understands the environmental impact of landscape irrigation. It also recognizes that being more efficient in its irrigation can lead to cost reductions. Lowe's is focused on projects that drive cost and environmental benefits, especially GHG emission and water use.



Lowe's recognized highly efficient landscape irrigation would address those goals effectively. Not only does efficient irrigation optimize water use, but it also has a hidden GHG benefit because most water is cleaned and pumped before it is used, a process that can be energy intensive. As a result, reducing water usage by using a more efficient irrigation system also reduces energy and associated GHG emissions.

"In 2014, we worked with our sustainability team to identify smart investments that would increase our efficiency while also reducing our environmental impact."

– Jay Clement, Lowe's director of facilities



 *up to*
half **of water used
for irrigation is
wasted**

The EPA WaterSense program estimates that as much as 50 percent of water used for irrigation is wasted because of evaporation, wind or runoff caused by inefficient irrigation methods and systems.³ Recognizing this, Lowe's evaluated several options before making its decision to invest in efficient landscape irrigation.

² Lowe's 2017 Social Responsibility Report

³ <https://www.epa.gov/sites/production/files/2017-03/documents/ws-factsheet-outdoor-water-use-in-the-us.pdf>

The Solution: HydroPoint and AT&T IoT use data to drive efficiency.

HydroPoint stood out as a premier solution based on the results of more than 25 public and private studies.⁴ HydroPoint uses AT&T Internet of Things (IoT) technology that couples the reliable and secure AT&T network with SIM technology and the AT&T Control Center, an automated connectivity management platform that helps deploy and manage connected devices. In business since 2002, HydroPoint solutions have proven to achieve 95 percent⁵ of conservation potential while reducing water use between 16 percent and 59 percent. They accomplish these results by leveraging detailed weather data transmitted using AT&T IoT connectivity to identify the optimal time and amount of water needed for irrigation, while keeping landscapes and plants healthy.

Each day, the HydroPoint Climate Center analyzes over 8 million weather data points from around the world, including over 50,000 U.S. weather stations and hundreds of thousands of other data sources, from aircraft to radio buoys and weather sensors (see Figure 1). This data is used to develop a model that calculates temperature, wind, humidity and solar radiation for every square kilometer of the continental U.S. and every 100 meters for Hawaii.

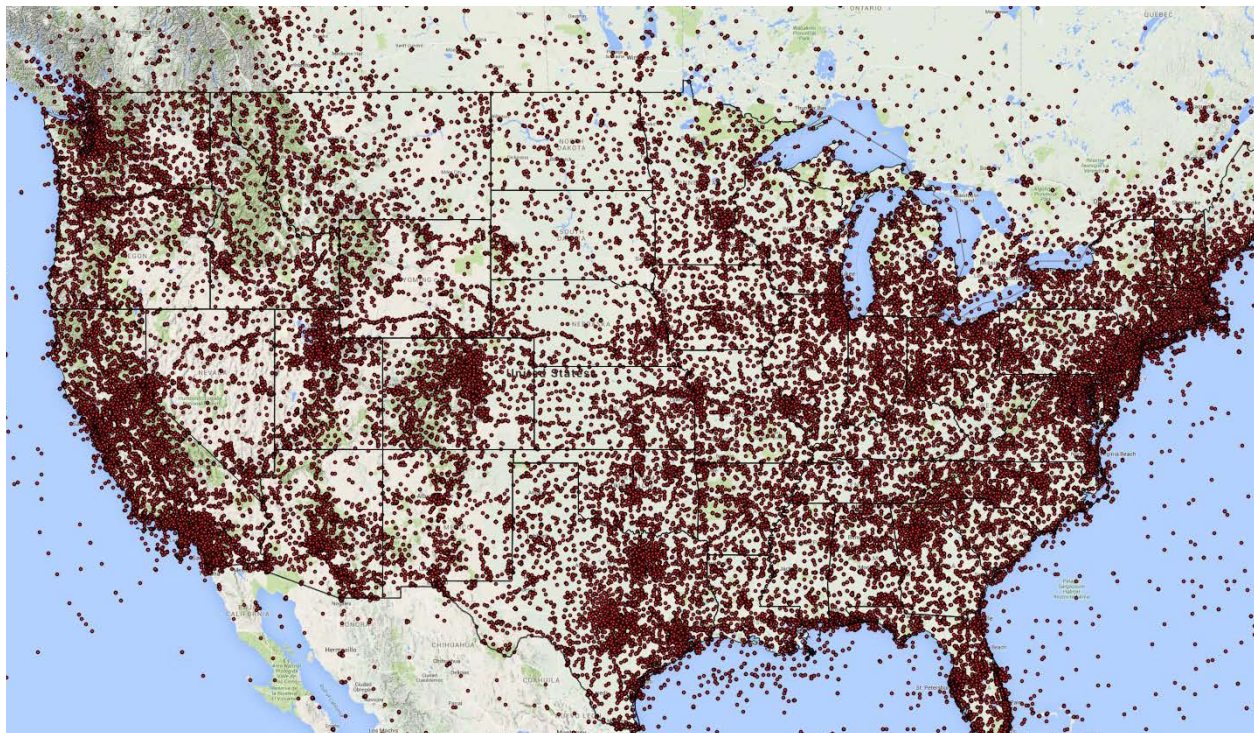


Figure 1

This analysis provides the system with superior weather data, specifically evapotranspiration (ET). A combination of four weather parameters – temperature, wind, solar radiation and humidity – ET is a highly accurate way to calculate landscape water needs and the primary indicator that HydroPoint uses to control irrigation.

4 <https://www.HydroPoint.com/resources/research-studies/>

5 Ibid

Unfortunately, many irrigation controllers only use temperature to determine irrigation patterns, which can overwater the landscape by as much as 43 percent (see Figure 2).⁶ Using AT&T IoT connectivity to collect and distribute rich ET data, HydroPoint can analyze more complete weather data and communicate with irrigation controllers to use water in a very efficient manner. Plus, it provides timely information to system managers.

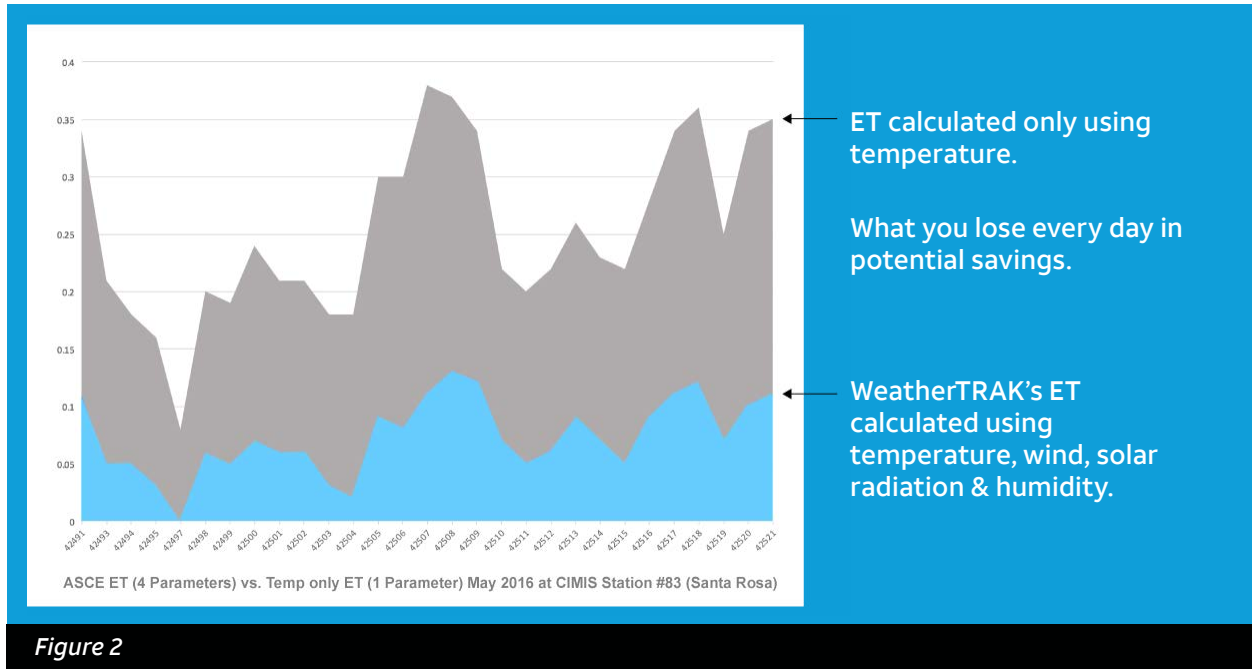


Figure 2

Implementation: Lowe's utilizes HydroPoint and AT&T to reduce building operation costs, water consumption and emissions.

Lowe's pilot of HydroPoint began in 2008 and quickly grew to a few hundred stores by the end of 2010. Lowe's realized the robust savings it could generate with the system and have since expanded the program to **939 retail facilities**. The results of the program are impressive for the environment and the bottom line. Annual water bills are lower by an estimated **\$5 million** and the associated annual water savings have swelled to about **650 million gallons**. And because most Lowe's stores use water from their local municipality, the company created annual downstream **GHG savings of about 750 metric tons CO₂e**, which is comparable to avoiding the use of over **84,000 gallons of gasoline**.⁷

"This is an example of a project that provides multiple layers of benefits. By expanding our use of HydroPoint, we save money while reducing water usage and greenhouse gas emissions in our community."

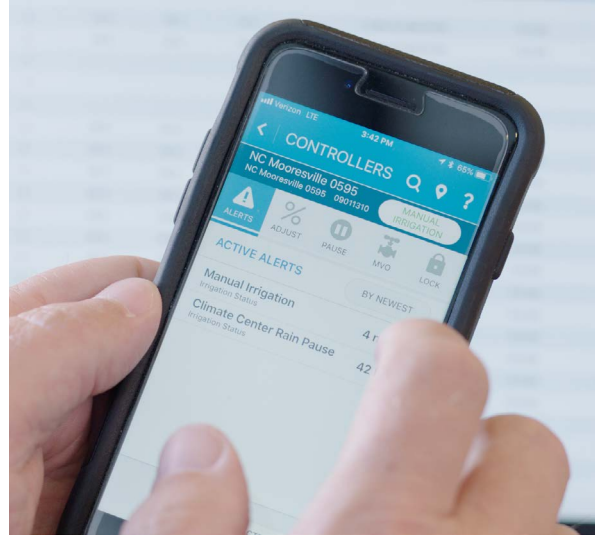
– Colleen Penhall, Lowe's vice president of corporate social responsibility

⁶ Allen, Rick G. The ASCE Standardized Reference Evapotranspiration Equation. American Society of Civil Engineers, 2005. Table F-2: Statistical summary of the comparisons between various reference ET methods, using growing-season results from 82 site-years of daily and 76 site-years of hourly data.

⁷ EPA GHG Equivalencies Calculator - <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

Sustainability Impact: Recognizing the HydroPoint solution's impact, AT&T has expanded the relationship beyond IoT connectivity.

Through a collaboration with HydroPoint, AT&T now offers [AT&T Smart Irrigation](#) as a part of its [Smart Cities suite of solutions](#) available to AT&T Business customers. AT&T has also installed the Smart Irrigation solution at many of its facilities and achieved [millions of gallons](#) of water savings in its own operations. Together, AT&T and HydroPoint hope to stimulate the adoption of this effective and easy solution that can help customers save money while reducing water usage and associated carbon emissions.



The motivation is clear: wide adoption of this smart irrigation solution could have substantial environmental benefits. If 2,000 retail stores with irrigation needs similar to Lowe's (e.g. 20 stores like Lowe's in the largest 100 U.S. cities) used HydroPoint or AT&T Smart Irrigation to increase the efficiency of their landscape irrigation, water use could be reduced by almost **1.4 billion gallons** and GHG emissions **1,590 metric tons**. This is equivalent to:



Water Savings

Almost 80 million US citizens skipping showers⁸ (All of Los Angeles doesn't shower for 20 days!)



Carbon Emissions Reduction

Not burning 179,000 gallons of gasoline⁹

Combining HydroPoint Irrigation with AT&T Connectivity Has the Potential to:

1. Create an effective and easy-to-use smart irrigation system that leverages comprehensive weather data to reduce water usage and costs; and
2. Reduce the GHG emissions associated with the cleaning and pumping of water used in our communities.

⁸ <https://www.home-water-works.org/indoor-use/showers> 1.362 billion gallons/17.2 gallons per shower = 79.2 million showers

⁹ EPA Greenhouse Gas Equivalencies Calculator. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

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 enables real-time, 24/7 leak notification and communication of more complete weather data to irrigation controllers. This lets customers track and manage their water usage with greater speed, precision and simplicity using cloud-based water management systems. |
| Impact Category | This case study focuses on water savings resulting from the implementation of the HydroPoint cloud-based water management system that utilizes AT&T Internet of Things connectivity and the greenhouse gas (GHG) impact associated with these savings. |
| Materiality | The impact of installing HydroPoint cloud-based water management systems to monitor irrigated land results in reductions in water usage and GHG emissions. The GHG emissions savings arise from energy reductions in the processing and pumping of the water. |
| Attribution of Impacts | The water and carbon savings described in this case study are a result of the design and manufacture of the HydroPoint smart irrigation controller, combined with the use of AT&T's IoT technology. Both AT&T and HydroPoint are fundamental in enabling the environmental benefits of the HydroPoint smart irrigation controller. |
| Relationship to Systems | <p>Many irrigation management systems solely use temperature to determine irrigation patterns. Using AT&T IoT connectivity, HydroPoint can analyze more complete weather data and communicate this data to irrigation controllers. This enables them to use water in a more efficient manner. AT&T connectivity also empowers the provision of granular and timely information to system managers. Increased visibility of water usage can boost potential to drive greater efficiency.</p> <p>The financial and environmental benefits arising from superior water savings enabled by AT&T connectivity, coupled with the ease of implementation, could encourage widespread adoption of smart water management systems, thus delivering scalable environmental benefits.</p> |
| Enabling and Rebound Effects | |
| Primary Effects | The implementation of HydroPoint technology delivers significant water savings. It also avoids the energy usage associated with processing and pumping wasted water. GHG savings follow energy savings and are dependent on the electricity grid mix in the state of interest. There are also direct cost savings associated with reducing water consumption. |

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| Secondary Effects | Depending on the size of a site, installing smart water management technology may reduce emissions from site vehicles as the automation removes the need to physically visit control valves and controllers within the irrigation system. This was not included in the study. |
| 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 | Burdens included the embodied carbon emissions of the electronic equipment (i.e., manager and member controllers within the irrigation system) and electricity usage of these devices. These emissions are considered negligible compared to the energy savings from water savings and were not included because of lack of sufficient data. |
| Carbon Abatement Calculation | |
| Scope | The scope of the carbon abatement calculation included the 939 Lowe's sites at which HydroPoint technology was installed. |
| Timeframe | <p>The calculations of carbon savings considered pre-and post-installation annual consumption data of the water management technology.</p> <p>The data reviewed by the Carbon Trust was made up of 2 data sets which included 542 of the 939 sites:</p> <ul style="list-style-type: none"> The first data set concerned 141 sites that installed HydroPoint technology starting in 2008 with most installing in 2010. Baseline year water consumption for each site (before HydroPoint installation) was compared to water consumption in 2013 (after installation of HydroPoint smart irrigation controllers). The second data set concerned 401 sites that installed HydroPoint smart irrigation controllers in 2016. Baseline consumption in this case was calculated using an average across the years 2013-2015 and was compared to 2017 consumption to determine water savings. <p>Water savings for the remaining 397 sites were estimated using conservative percentage savings figures, since these were either newly built sites, lacking full baseline data, or had not been in place for a full year in order to have annual savings figures. See the "Key Assumptions" section for the assumptions used to calculate the water savings at these sites.</p> |
| Functional Unit | The functional unit for the GHG emissions reduction is metric tons of CO ₂ e (tCO ₂ e) per site. This was calculated by multiplying water savings per site in millions of gallons (MG) by the carbon emission factor (tCO ₂ e/MG) of the water used at each site. |

| | |
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| Methodology | <p>To calculate carbon emissions savings as a result of water savings, it was necessary to determine the life cycle emissions intensity of the water used at each site. The emissions intensity of a public water supply varies depending on the source of the water (i.e., ground source vs. surface), the topography of the land over which it is distributed (e.g., steep terrain requires more electricity to pump the water), the level of the water and wastewater treatment and the carbon intensity of the electricity grid that powers the water processing and pumping. State level data covering grid emissions factors (including transmission and distribution (T&D) losses)¹⁰ and water source breakdowns for public supply¹¹ was used with assumptions of water levels and wastewater treatment which were based upon the standard practice of public water utilities in the U.S.¹² Energy usage figures for water distribution¹³ and Well to Tank (WTT) emissions¹⁴ were included in the calculation.</p> |
| Key Assumptions | <p>The following assumptions were made on the levels of water and wastewater treatment to determine the embodied emissions of the water at each site:</p> <ul style="list-style-type: none"> • The energy intensity of water treatment included coagulation, flocculation, filtration, microfiltration and disinfection. All of these processes are considered standard for a public water supply.³ • Tertiary wastewater treatment was assumed, as it is the most common degree of wastewater treatment.¹⁵ <p>Figures for the energy intensity (EI) of total water supply and wastewater treatment (including treatment and distribution) were calculated using data (given in kWh/MG) taken from a California Public Utilities Commission study.¹³ Figures were given in this study for the EI of supply and conveyance from various sources, different degrees of water and wastewater treatment and water distribution. Although data from the study is state specific, we believe it is reasonable to assume that water supply and wastewater treatment practices are largely consistent across the United States. In order to be conservative, where ranges in energy intensity of water treatment, wastewater treatment, conveyance, etc., were given, lower bounds of these ranges were taken.</p> <p>All energy required to process the water used at each site was assumed to come from the local electricity grid. Some utilities may use fuel-powered pumps or systems, which are more carbon intensive than the grid. Likewise, they could also use electricity with a renewable energy guaranteed source of origin for all their operations, which would nullify the carbon intensity of the water. Having reviewed the energy usage of water utilities in the UK (which can be found in annual reports), it was apparent that using electricity from the grid is normal practice in water processing. Therefore, this assumption is reasonable and a more granular approach is not necessary.</p> |

10 EPA. (2016). Emissions & Generation Resource Integrated Database (eGrid). Retrieved from <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>

11 Molly A. Maupin, J. F. (2014). Estimated Use of Water in the United States in 2010. Virginia. Retrieved from <https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf>

12 Centers for Disease Control and Prevention. (2015, January 20). Retrieved from https://www.cdc.gov/healthywater/drinking/public/water_treatment.html

13 California Public Utilities Commission. (2010). Embedded Energy in Water Studies, Study 2: Water Agency and Function Component Study and Embedded Energy - Water Load Profiles. GEI Consultants/Navigant Consulting. Retrieved from <ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%202/Study%20%20-%20FINAL.pdf>

14 DEFRA. (2017). Greenhouse gas reporting: conversion factors 2017. Retrieved from <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017>

15 Stanford Woods Institute, B. L. (2013). Water and Energy Nexus: A Literature Review. Water in the West. Retrieved from http://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review.pdf

| | |
|---------------------|---|
| | <p>The amount of water consumed (i.e., deferred from treatment) was calculated using FAO data,¹⁶ which published figures for the total municipal water withdrawal in the United States and the amount of treated municipal wastewater. This figure was used to determine the percentage of water supplied that was treated after use in municipal wastewater facilities. According to the Compendium of Sanitation Systems and Technologies, 2nd revised edition by eawag¹⁷, wastewater includes used water from agricultural activities, surface runoff or storm water.</p> <p>As mentioned under the "Timeframe" section, water savings were estimated for 397 sites since some installations were at new sites and others had not been in place long enough to have annual savings data. The newest 282 sites were installed by HydroPoint in early 2018. Estimations were calculated using the following assumptions for percentage savings, together with historic billing information to establish baseline consumption:</p> <ul style="list-style-type: none"> • It was assumed that the 282 new sites would exhibit 25 percent savings. This is lower than the average savings from the rest of the portfolio (30 percent to 45 percent) because these sites are last to be installed and it is assumed the savings potential is less. The average emissions intensity factor across these sites was taken to be the weighted average of the emissions intensity factors of two data sets provided by Lowe's (these data sets covered consumption for 2009 and 2013 for 141 sites and for 2013-2015 (average) and 2017 for 401 sites). • An additional 30 sites have no baseline as they were installed as a new installation during store construction. These were also conservatively assumed to have a 25 percent water saving. • The remaining 85 sites were installed before 2013, but did not have accurate baseline data. It was assumed that the savings for these sites were consistent with the first data set (45 percent). |
| Exclusions | <ul style="list-style-type: none"> • The embodied carbon emissions of the electronic equipment (i.e., manager and member controllers within the irrigation system) and electricity usage of these devices. • Reductions in the emissions from site vehicles that are no longer required to physically visit control valves and controllers used by the irrigation system. |
| Data Sources | <ul style="list-style-type: none"> • California Public Utilities Commission. (2010). Embedded Energy in Water Studies, Study 2: Water Agency and Function Component Study and Embedded Energy - Water Load Profiles. GEI Consultants/Navigant Consulting. Retrieved from ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%202/Study%202%20-%20FINAL.pdf • DEFRA. (2017). Greenhouse gas reporting: conversion factors 2017. Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017 • EPA. (2016). Emissions & Generation Resource Integrated Database (eGrid). Retrieved from https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid • Food and Agriculture Organization of the United Nations. (2012). AQUASTAT. Retrieved from http://www.fao.org/nr/water/aquastat/wastewater/index.stm |

¹⁶ Food and Agriculture Organization of the United Nations. (2012). AQUASTAT. Retrieved from <http://www.fao.org/nr/water/aquastat/wastewater/index.stm>

¹⁷ Elizabeth Tilley, L. U. (n.d.). Compendium of Sanitation Systems and Technologies. eawag. Retrieved from <http://www.iwa-network.org/wp-content/uploads/2016/06/Compendium-Sanitation-Systems-and-Technologies.pdf>

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| | <ul style="list-style-type: none"> • Molly A. Maupin, J. F. (2014). Estimated Use of Water in the United States in 2010. Virginia. Retrieved from https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf • Elizabeth Tilley, L. U. (n.d.). Compendium of Sanitation Systems and Technologies. eawag. Retrieved from http://www.iwa-network.org/wp-content/uploads/2016/06/Compendium-Sanitation-Systems-and-Technologies.pdf • Stanford Woods Institute, B. L. (2013). Water and Energy Nexus: A Literature Review. Water in the West. Retrieved from http://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review.pdf • Centers for Disease Control and Prevention. (2015, January 20). Retrieved from https://www.cdc.gov/healthywater/drinking/public/water_treatment.html • Lowe's water consumption data for 2009 and 2013 for 141 sites. • Lowe's water consumption data for 2013-2015 (average) and 2017 for 401 sites. |
| Results | |
| Carbon Abatement Factor | Calculations concluded that installation of the HydroPoint solution produces annual emission savings of 0.80 metric tons of CO ₂ e (t CO ₂ e) per site annually. The average emissions intensity factor of the water equated to 1.14 tCO ₂ e/ million gallons. |
| Water Savings Factor | <p>Annual water savings from implementation of HydroPoint technology is approximately 680,000 U.S. gallons per site.</p> <p>Water savings were calculated using Lowe's water usage data before and after installation of HydroPoint Smart Controllers.</p> |
| Insights | <ul style="list-style-type: none"> • Although this case study provides a good estimate of the carbon savings produced by the installation of HydroPoint, the carbon abatement factors do not take into account the size of each site. Including site acreage in subsequent studies, the result would produce an area-dependent carbon abatement factor and would improve comparability of the results. • The emissions intensity factor was cross-checked against emissions intensity figures posted by U.K. water utilities in their annual reports. Although the U.S. factors used in this study are smaller (as expected because of the conservative nature of the calculations), it was of the same order of magnitude. The average emissions intensity factor from selected U.K. water utilities was 1.94 tCO₂e/MG. • It must be noted that calculating the GHG emissions associated with the processing of water is subject to significant variability. For example, the relative mix of water sources (e.g., surface, ground, desalination) will vary throughout the year and between years, depending on changing meteorological conditions. Different regions within each state may also be affected differently by the same changes in meteorological conditions. • The energy required for the processing of the water could be examined at a utility rather than at a state level using assumptions on the levels of treatment pre- and post-installation, to increase the accuracy of the results. The data required to carry out this assessment was not available during this study. |



AT&T 10x Case Study:

AT&T Video Optimizer helps developers improve viewers' mobile app and video experience while lowering energy usage and emissions



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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 goal to enable carbon savings for our customers 10x the footprint of our operations by the end of 2025.

To meet this, we're working to make our operations more efficient across the company. 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.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

With the rise of high-speed mobile connectivity, people are changing the way they watch their favorite show, news program, movie or short videos. It's becoming all about the mobile device, as in the second quarter of 2019, more than half of global video views started on smartphones or tablets.¹

AT&T Video Optimizer is a free tool that helps app developers improve the performance of their apps, creating a better viewing experience for the end user. The tool also helps developers optimize mobile apps so that they use the mobile network efficiently. Not only does this make for a better user experience, but it also helps app providers save money on data center equipment that they don't have to use because they're serving content more efficiently.

AT&T Video Optimizer also has a less obvious benefit: optimized video reduces the energy needed to run the network equipment that transmits the videos. This results in lower greenhouse gas (GHG) emissions associated with the entertainment we watch from our mobile devices. Since the AT&T Video Optimizer was introduced in 2012 and used by mobile apps around the world, it is estimated that it has helped lower global electricity usage by more than **42,000 kilowatt hours a year**, reducing GHG emissions equivalent to not using over **2.7 million gallons of gasoline annually**.²

Estimated annual global environmental benefits of AT&T Video Optimizer



More than
42,000 kilowatt hours of electricity savings equivalent to:



More than **2.7 million gallons** of gasoline avoided

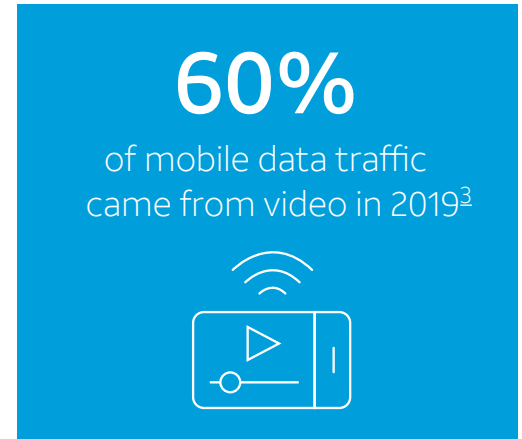
or



More than
25,000 metric tons of CO₂e avoided

Background: Mobile video usage is growing rapidly

As more mobile apps use embedded video and streaming becomes more popular, video streaming services in terms of both subscribers and viewing time per subscriber have grown.³ Stimulating the growth even more is the advancements in higher screen resolutions on mobile devices.⁴ This is already impacting the makeup of communications network traffic as more than 60% of traffic came from video in 2019.⁵ This trend is expected to continue. In fact, a 2019 report by Ericsson forecasted that video traffic on mobile networks will grow by around 30% annually.⁵

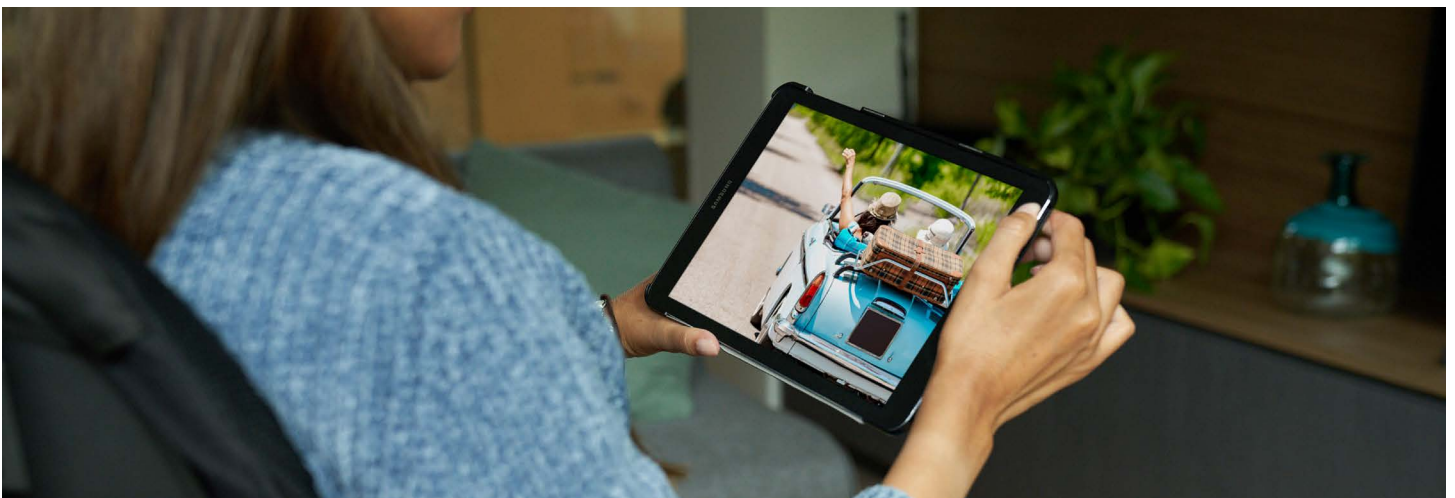


The Challenge: As more video goes mobile, efficient use of the wireless network becomes critical

Video is popping up across different types of mobile apps. From video streaming platforms to news and sports outlets, video is becoming a fundamental piece of our mobile user experience. However, making this experience enjoyable can be very challenging, and app developers are looking for ways to address several common issues such as:

- Startup delays
- Video stalls
- Poor video quality
- Slow responsiveness
- Excessive data usage
- Battery drain

These video performance challenges can be addressed by optimizing how video is distributed across the wireless network.

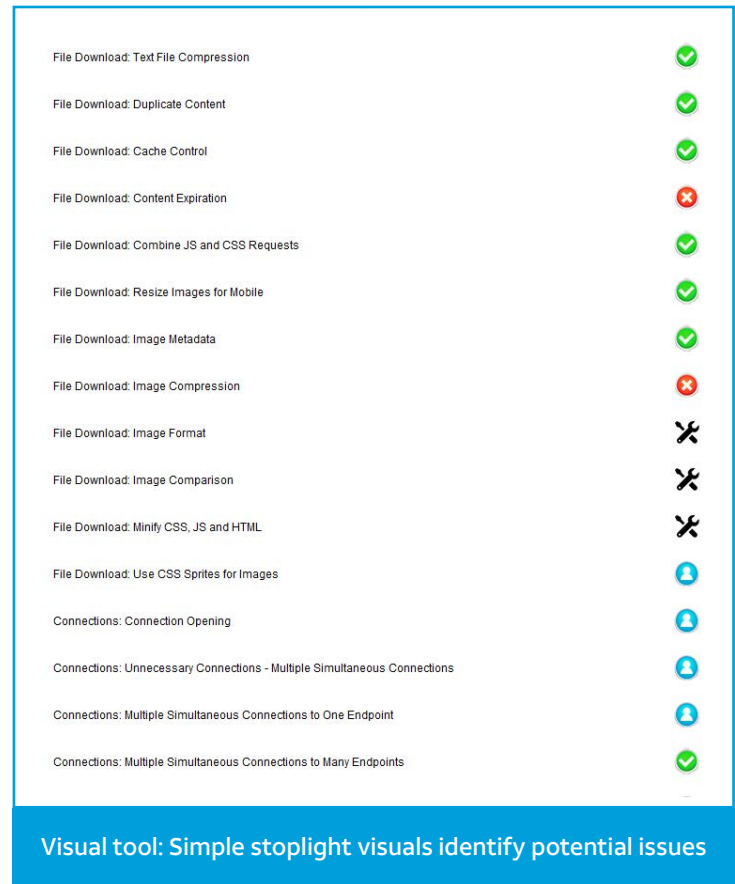


The Solution: AT&T Video Optimizer helps video content distributors use less bandwidth, improving customer experience while reducing costs, energy and emissions

The [AT&T Video Optimizer](#) is a tool AT&T created to help developers optimize the performance of their apps on a mobile network. The tool identifies 47 different best practices for app development and analyzes the app against all of them. And best of all, AT&T provides this tool for free.

The tool works on iOS and Android and it can be used for any application. The tool is particularly helpful to apps that require persistent network connection, such as social media, video and audio streaming, but since video is such a big traffic driver, video optimization has become a critical reason for a developer to use it.

AT&T Video Optimizer uses powerful analytics to detect critical issues such as wasted data traffic and excessive “chattiness” as a result of opening and closing connections inefficiently. It presents the findings in an easy-to-understand visual tool, making it is easy for the developer to identify and execute needed adjustments.



Benefits for the viewers

For the people using a video streaming app, the benefit is straightforward: the video starts quickly and plays smoothly.

By optimizing the video with AT&T Video Optimizer, the app simply works better and is more responsive. Because the app only downloads the needed data – and equally important, doesn’t download data it doesn’t need – the user can enjoy a smoother experience.

Further, because the AT&T Video Optimizer helps content providers catch errors to reduce the amount of data that is transmitted, the end user needs less data, which is an additional benefit for users with a limited data plan.

This also means that the AT&T Video Optimizer can help extend device battery life and reduce charging needs, which can result in lower electricity usage by an estimated **2.5 million kilowatt hours globally** each year, which is like avoiding the associated GHGs of more than **57,000 gallons of gasoline annually**.

Benefits for the app developer

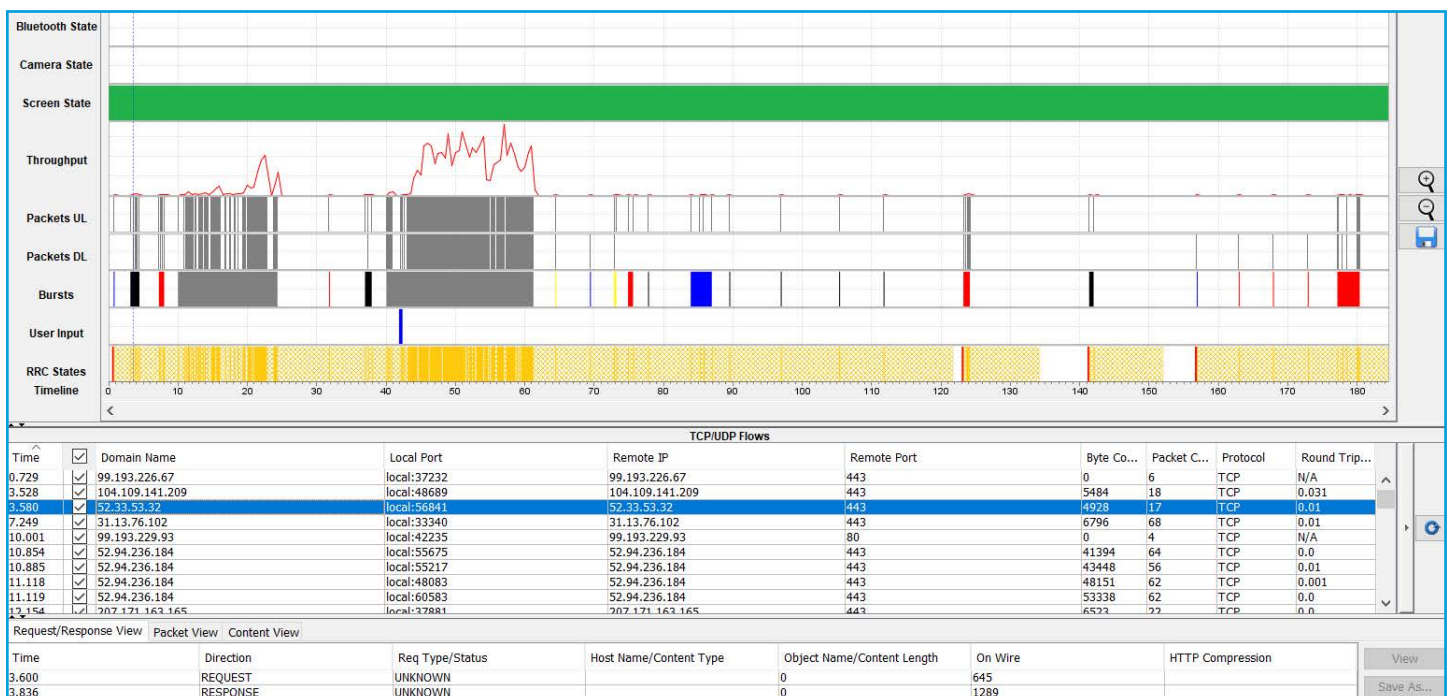
The AT&T Video Optimizer has been used by many of the leading video content providers, including WarnerMedia and HBO Max. By using this tool, developers can easily identify data-gobbling issues and fine-tune the app to eliminate waste. This helps the developers by providing a great customer experience, which is critical to success in the marketplace, while also helping to reduce costs.

By reducing unnecessary data transmitted by their apps, developers reduce their costs for network access and server load. For instance, a developer using the AT&T Video Optimizer to reduce data needs can also reduce data center costs such as investment in additional servers and the electricity needed to power them. Because much of this financial information is proprietary, this case study doesn't attempt to quantify these cost savings. However, based on AT&T's data center savings as a result of video optimization, we estimate that the cost savings are substantial.



AT&T Video Optimizer in action

A leading video app developer used the AT&T Video Optimizer to review an upcoming update to their platform and found that they weren't using text compression for subtitles. AT&T worked with the developer to identify the problem and a simple fix to reduce the amount of data transmitted during the video stream. That simple fix alone resulted in estimated data reductions of approximately **10%**.



Detailed data helps app developers identify opportunities to refine code.

Benefits for network providers like AT&T

For AT&T and other mobile network providers, the benefit of app developers using the AT&T Video Optimizer is simple: less video data traffic on the mobile network improves performance and congestion while reducing infrastructure and operating costs, including the costs and environmental impacts of electricity usage. In addition to a fundamental reduction of data transmission needs, the AT&T Video Optimizer also helps reduce the “chattiness” of apps, which streamlines the number of times data is requested and enhances network performance further.

For AT&T, this efficiency has helped the company avoid millions of dollars of unneeded server costs and hundreds of thousands of dollars in electricity costs since it started using the tool in 2012.

And because the tool is open-source, free, and used by developers with apps used around the world, the benefits apply to global communications networks, not just AT&T.

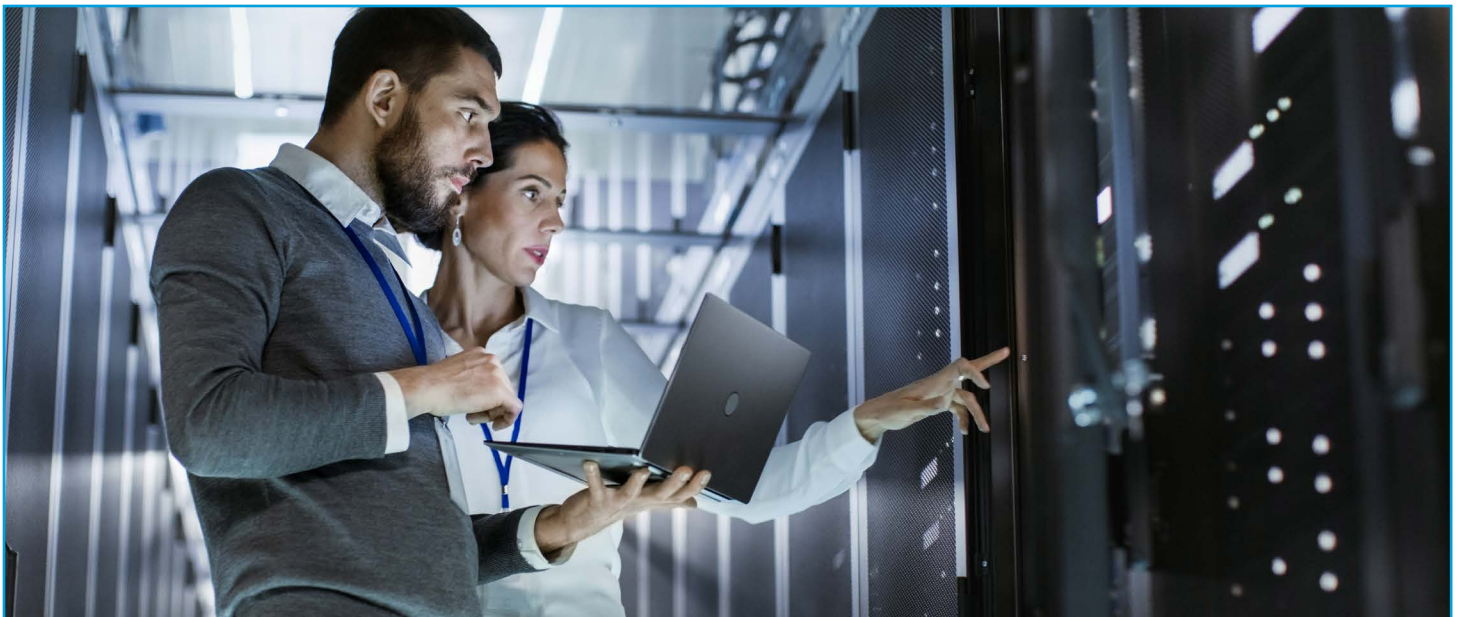
What's next? 5G optimization

Building on its success, the team behind the AT&T Video Optimizer is turning its attention to similar benefits that can be applied to 5G applications.

As 5G and edge computing gain momentum and content is pushed to the edge of the data network, it will be more important than ever to monitor data flow to drive traffic efficiency so that data isn't needlessly transmitted.

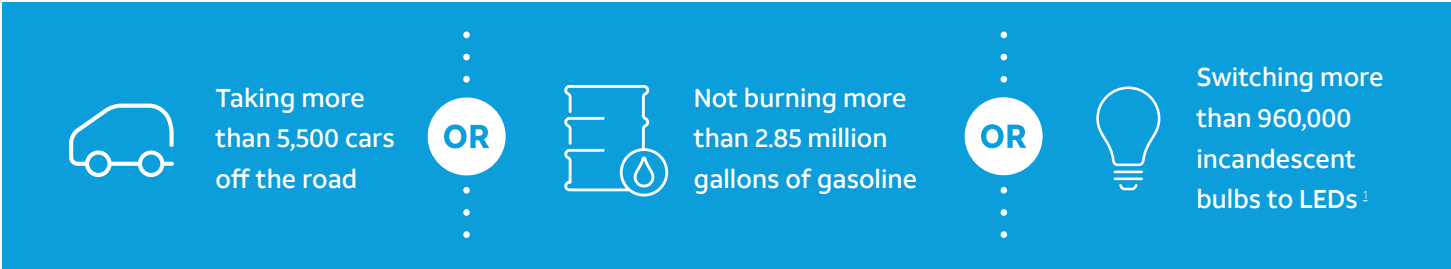
Using the same methodology developed for the AT&T Video Optimizer, the AT&T team hopes to drive similar data transmission efficiency into the next generation of 5G networks.

This work has the potential to create a better user experience and save money and energy for even more applications like gaming that will demand high capacity and low latency. And as mobile gaming becomes more popular, these benefits could really stack up.



Sustainability Impact: Efficient apps result in network and battery savings

It's no secret that mobile video is a big deal. If a picture is worth a thousand words, then mobile video is worth a chapter. That's why app developers are turning to tools like the AT&T Video Optimizer to improve the video watching experience for mobile users. In addition to the improved experience for the viewer, the Video Optimizer can also help save electricity. Because the benefits from AT&T Video Optimizer have global scale, even small adjustments to app code can result in an environmental benefit. When an app is optimized, the network energy efficiency benefits extend to wherever in the world the app is used. And smaller file size extends device battery life and reduces battery charging needs, reducing energy usage further. Together, these benefits add up to more than **42,000 kWh in electricity savings a year** across the globe, which is equivalent to more than **25,000 metric tons of CO₂e each year**, which is equivalent to:



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 Video Optimizer technology. The 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 Video Optimizer helps app developers optimize apps with video by catching errors and identifying areas consuming both unnecessary amounts of data and airtime. By reducing the amount of data consumed and airtime, AT&T Video Optimizer decreases the energy needed to run the network equipment that transmits the videos and can help extend battery life of the mobile devices using the app. This results in lower electricity usage and lower associated GHG emissions. |
| Impact Category | This case study focuses on the carbon impact of energy savings from network and battery savings of mobile devices enabled by the AT&T Video Optimizer tool. |
| Materiality | Video apps that have been optimized using AT&T Video Optimizer consume both less battery on a mobile phone and decrease the energy consumed on the network, thereby reducing electricity usage and associated GHG emissions. |
| Attribution of Impacts | The carbon savings detailed in this case study are a result of using AT&T Video Optimizer tool to optimize the use of video apps. |
| | |
| Primary Effects | AT&T Video Optimizer tool helps optimize video apps, decreasing data usage and device battery drainage, which in turn leads to lower electricity consumption and lower associated GHG emissions. |
| Secondary Effects | No secondary effects were identified. |

| | |
|---|--|
| Rebound Effects | Increased use of video apps due to improved user experience. |
| Trade-Offs or Negative Effects | This tool does not appear to create other outsized or irreparable environmental or social impacts. |
| Carbon Burden from the Enabling Technology | There are no embodied carbon emissions from this tool. |
| | |
| Scope | The network savings across the AT&T network and the battery savings from users of video apps on AT&T's network from a selected number of apps. |
| Timeframe | The data in this case study covers data and airtime reductions and the associated energy and carbon savings from 2012 to 2019. |
| Functional Unit | The functional unit for the avoided GHG emissions is expressed as metric tons of CO ₂ e per mobile phone subscriber. |

Methodology

The total data savings and airtime savings on AT&T's network from the use of AT&T's Video Optimizer on a select number of apps were collated between 2012 and 2019 and used to calculate network and battery energy savings, respectively.

Network Savings:

- To calculate Network Savings, annual data savings on AT&T's network was multiplied by the respective year's energy intensity, to produce kWh savings between 2012 and 2019. The cumulative annual energy savings was then divided by AT&T's total mobility subscribers, to provide the energy savings per connection for 2019.
- Using ITU data, this factor was multiplied by the number of mobile broadband connections in the US and globally, to provide total kWh saved for both the US and globally. The ITU figures were adjusted using an assumed adoption rate of 100% in the US and 50% globally to reflect the use of the apps in the respective areas.
- kWh savings were converted into carbon savings by multiplying the US and global figures by the US eGRID electricity emissions factor and the IEA & BEIS global electricity emission factor respectively. These values were subsequently converted into gallons of gasoline using the EPA equivalency factors.

Battery Savings:

- To calculate device battery savings, 2019 cumulative annual airtime savings on AT&T's network was multiplied by the average power consumption of the GSM radio module of a mobile phone to produce the annual kWh savings. This kWh savings figure was subsequently divided by AT&T's total mobility subscribers, to calculate the kWh savings per mobile subscriber for 2019.
- Using ITU data, this factor was multiplied by the number of mobile broadband connections in US and globally, to provide total kWh saved for both the US and globally. The ITU figures were adjusted using an assumed adoption rate of 100% in the US and 50% globally to reflect the use of the apps in the respective areas.
- kWh savings were converted into carbon savings by multiplying the US and global figures by the US eGRID electricity emissions factor and the IEA & BEIS global electricity emission factor respectively. These values were subsequently converted into gallons of gasoline using the EPA equivalency factors.

| | |
|--------------------------------|--|
| Key Assumptions | <ul style="list-style-type: none"> • Assume 100% adoption rate for US and a 50% adoption rate for global subscriptions (based on subscriptions/number of users of the selected apps in both the US and globally). • Assume apps will be used on smartphones while using mobile or fixed broadband. |
| Exclusions | <p>No exclusions</p> |
| Data Sources | <ul style="list-style-type: none"> • AT&T Data Savings data from selected apps (2012-2019) • AT&T Airtime Savings data from selected apps (2012-2015, 2017) • EPA Equivalences (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references) • Electricity emission factors (eGrid – https://www.epa.gov/energy/egrid) • IEA 2019 World Electricity Emission Factors • BEIS 2019 World Upstream Electricity Upstream Emission Factors (https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019) • ITU Statistics: Number of Fixed and Mobile Broadband Subscriptions (https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx) • Power Consumption of GSM radio module of a mobile phone (https://www.usenix.org/legacy/event/atc10/tech/full_papers/Carroll.pdf, https://arxiv.org/ftp/arxiv/papers/1312/1312.6740.pdf) • AT&T Domestic Broadband Connections and Mobility Subscribers (https://investors.att.com/~media/Files/A/ATT-IR/financial-reports/annual-reports/2019/complete-2019-annual-report.pdf) |
| Results | |
| Carbon Abatement Factor | <p>6.65 g CO₂e per mobile phone subscriber per year based on cumulative energy savings between 2012 and 2019.</p> |

Endnotes

1. "Q2 2019 Global Video Index," Brightcove, June 10, 2020, <https://www.brightcove.com/en/video-index?cid=701100000038RrX&pid=70114000002Qtgh>
2. "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> (Note, average eGRID electricity factors have been used rather than marginal AVERT electricity factors, this being a more conservative savings estimate)
3. "Mobile traffic by application category," Ericsson, November, 2019, <https://www.ericsson.com/en/mobility-report/reports/november-2019/mobile-traffic-by-application-category>
4. Ibid.
5. Ibid.
6. Ibid.



AT&T 10x Case Study:

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

AT&T 10x Case Study:

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

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 year¹



420 tons of fertilizer²



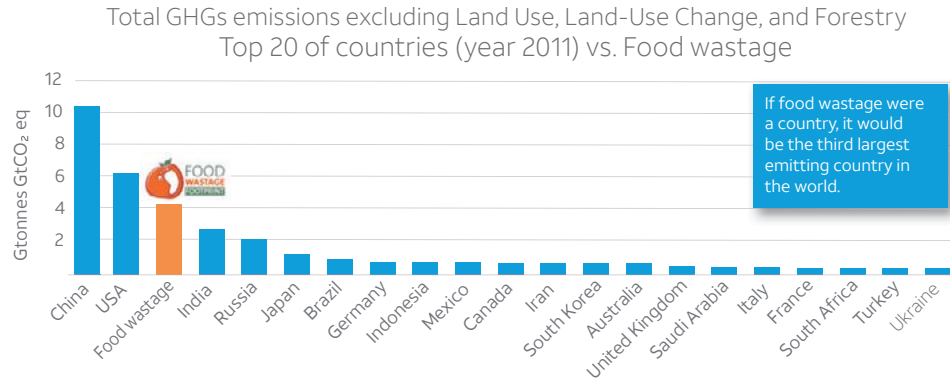
Around 5,000 metric tons CO₂e avoided, equivalent to not consuming 570,000 gallons of gas³

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 year¹ and 420 tons² of fertilizer. Doing so has reduced greenhouse gas emissions from the landfill by about 5,000 metric tons of CO₂e, which is like not consuming 570,000 gallons of gasoline³, 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 CO₂ 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 2010–17¹⁰ 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.

New Method:

As-Needed
Slurry Hauled
to Digester



**Energy
Fertilizer**

Old Method:

Scheduled
Waste Hauled
to Landfill



Methane (GHG)

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

11 James Thompson, “No End in Sight to US Landfill Cost Increases — Pacific Region to Experience Highest Growth,” NRRANet.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:

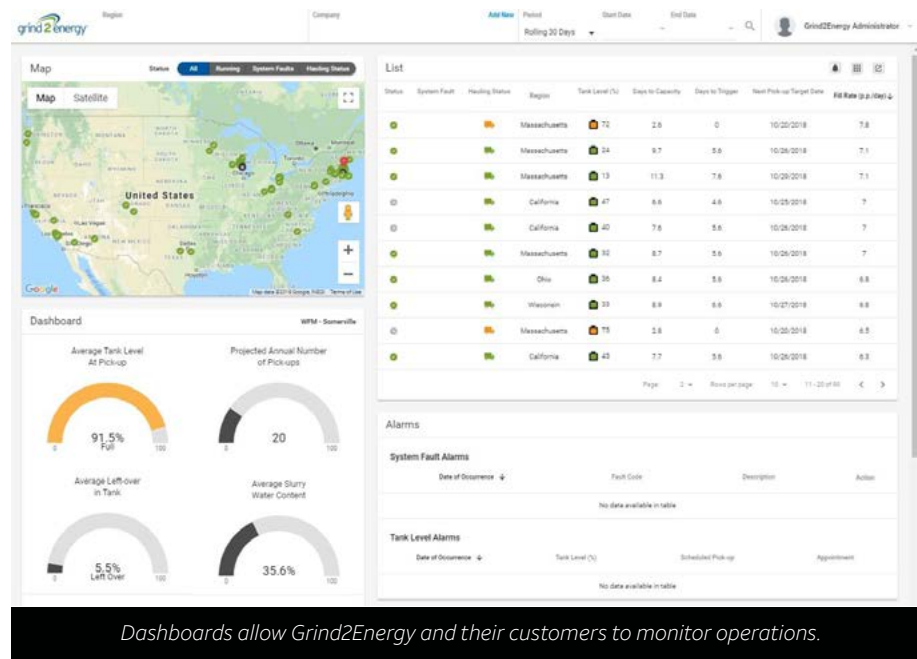
- **Maintenance:** The ability to remotely monitor systems across the country can reduce costs and emissions from technician trips. In addition, the systems alert Grind2Energy if key components aren't working properly or are broken. Having this information can prevent waste from piling up due to a broken 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.



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 year¹⁴ and **420 tons**¹⁵ of fertilizer. Doing so has reduced greenhouse gas emissions from the landfill by about **5,000 metric tons** of CO₂e, 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 road¹⁹ or



Not consuming over 36 million gallons of gasoline²⁰ or



Switching over 11 million incandescent light bulbs to LEDs²¹

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](https://www.statista.com), April 2018.

¹⁸ 38,000 (U.S. Grocery Stores) * 0.1 (10% adoption rate) * 84 (CO₂e avoidance per store)

¹⁹ U.S. Energy Information Administration [Greenhouse Gas Equivalency Calculator](https://www.eia.gov).

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 | <p>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.</p> <p>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.</p> |
| 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 | <p>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).</p> <p>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.</p> |
| 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 ₂ e) per site using the Grind2Energy service. |
| Methodology | <p>The GHG emission reductions are the sum of the emissions reduction from:</p> <ul style="list-style-type: none"> • Reduced methane emissions from diverting food waste from landfill. • Replacing grid electricity with lower carbon electricity generated from the captured methane. • Reduced pick-ups. <p>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.</p> <p>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.</p> |
| Key Assumptions | <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • 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 | <p>84 Metric Tons CO₂e per site</p> <p>or 0.7 Metric Tons CO₂e per short ton of food waste.</p> |
| Lessons Learned | <p>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.</p> |

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



AT&T 10x Case Study:

Rice Farmers Use Internet of Things to Enable Water and Emissions Reductions

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Rice Farmers Use Internet of Things to Enable Water and Emissions Reductions

AT&T has a goal – our “10x” goal – to enable carbon savings for our customers that are 10 times the footprint of our own operations by 2025. To meet this goal, we are engaging with customers and technology partners to implement and scale up carbon-saving solutions. Through this process, we are publishing a series of case studies and concepts to share our progress and learning. 10x case studies will discuss and quantify the carbon benefits of using AT&T technology to improve efficiency. In order to be included in the evaluation of progress toward our 10x goal, AT&T technology must play a fundamental role. To discover more about our goals, understand how we’ll track our progress, and see status updates and case studies like this, visit AT&T’s Connect to Good [website](#).

Rice: A Resource- and Emissions-Intensive Food Staple

Around the world and in the United States, rice is critically important to our food supply. While China and India are by far the largest rice-growing countries, the U.S. produces over 6 million metric tons of rice every month.¹ Across the US, more than 2.5 million acres of land are used to grow rice in seven different states,² and nearly 85% of the rice we eat in the United States is grown and harvested by farmers in Arkansas, California, Louisiana, Mississippi, Missouri and Texas.³

Traditional rice-farming methods are water-intensive, requiring that four inches of water be maintained across the entire field. All told, rice production uses up to 40% of the world’s irrigation water every year.⁴ But water use isn’t the only environmental concern related to rice growing: flooding rice fields creates an anaerobic environment — one without oxygen — that generates methane gas, a greenhouse gas



RICE: A RESOURCE-INTENSIVE CROP

- **2.5 million acres of land in US**
- **40% of global irrigation water**
- **1.5% of global GHG emissions**

¹ <https://www.worldriceproduction.com/>

² <https://www.edf.org/ecosystems/new-crop-rice-farmers-carbon-offsets>

³ <http://www.thinkrice.com/on-the-farm/where-is-rice-grown/>

⁴ <http://www.iflscience.com/environment/rice-and-wheat-production-use-more-water-than-all-other-crops-put-together/>

(GHG) that is 28 to 36 times as potent as CO₂ over 100 years.⁵ The methane produced by rice farming constitutes around 1.5% of global GHG emissions.⁶

The Challenge: Addressing environmental concerns by increasing adoption of “Alternate Wetting and Drying (AWD)” rice-farming methods

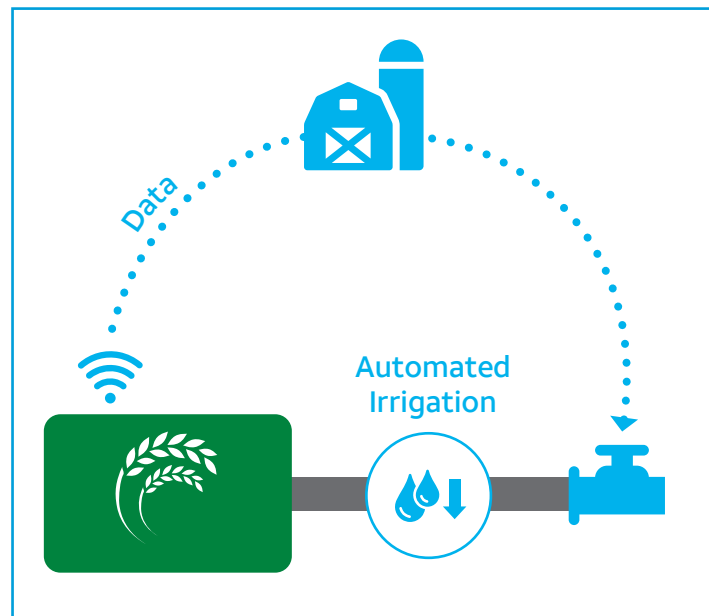
Given the potentially significant environmental impacts of rice production, innovative farmers have recognized the need to increase efficiency so they can grow more rice with fewer resources. “Alternate Wetting and Drying” (AWD)⁷ is a method of rice farming that addresses many of these environmental challenges. Instead of keeping a constant four-inch flood, AWD allows fields to dry down between floods after establishing the initial flood. By decreasing the amount of time fields remain flooded, AWD reduces water use, fuel and electricity use for running irrigation pumps, and the need for nitrogen fertilizers, while also slowing down the anaerobic activity that creates methane gas. Farmers and researchers are working together to optimize AWD and have found that when implemented properly, the practice can potentially increase yields while reducing fertilizer and water inputs as well as GHG emissions.

However, AWD can be challenging. It requires farmers to control water levels carefully across large tracts of land. It also introduces risk to the rice crops, as it can be difficult to assess depth accurately with only a few measurements at various points in the fields. Together, these barriers have slowed adoption of AWD.

The Solution: AT&T Internet of Things (IoT) creates visibility and control, making AWD a more attractive option

Using AT&T’s IoT solutions to connect water-level sensors and pumps can increase the control farmers have over their operations, helping to drive efficiencies and overcome some of the barriers to AWD adoption. As described below, PrecisionKing is an innovative technology company that is collaborating with AT&T to do just that.

PrecisionKing’s RiceKing sensors are placed across farmers’ rice fields, where they read water levels once an hour, allowing for 24-hour monitoring, while the PumpKing remote monitors allow farmers to set customized parameters for remotely turning pumps on and off. AT&T wireless connections between these pieces of equipment enable the transmission of water-level data collected from the RiceKing sensors to a management system that can be programmed to automatically signal AT&T-connected PumpKing monitors to turn



⁵ <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>

⁶ <http://www.wri.org/blog/2014/12/more-rice-less-methane>

⁷ <https://www.uaex.edu/farm-ranch/crops-commercial-horticulture/rice/2017%20Alternate%20Wetting%20and%20Drying%20Rice%20Management.pdf>

pumps on and off as needed. This reduces water use and prevents over-flooding or excessive drying — all without requiring anyone to physically be in the field.

This system also creates a historical record of the water depth over time. With more high-quality data available, farmers are better able to optimize management and reap the direct and indirect benefits of AWD. For instance, because the sensors can generate such accurate information about water depth, farmers can more easily collect the data required for verification of AWD-enabled GHG emissions reductions. Using AT&T's wireless network to connect these sensors and pumps greatly simplifies the collection of data and avoids the need for farmers to install wired or complex mesh network solutions. The addition of AT&T IoT connectivity to AWD can enable more efficient and reliable AWD processes, increase its ease of use and help drive financial savings from water reduction.

Implementation: PrecisionKing and AT&T help Whitaker Farms save water and reduce emissions

Jim and Sam Whitaker started farming in Arkansas in the early '90s, and they quickly recognized that running a successful farm would require resource efficiency. Seeing drought conditions across the country and recognizing the threat that climate change could pose to their business, the Whitaker brothers became early adopters of technology-enabled AWD.

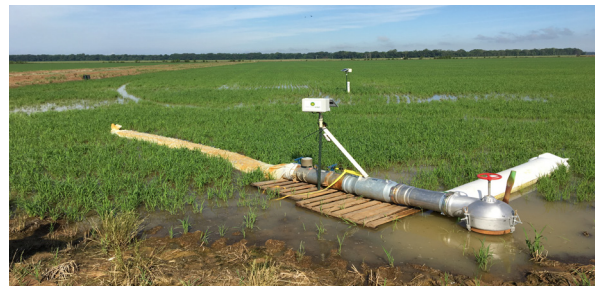
For the past five years, Jim and Sam have collaborated with PrecisionKing to optimize their rice fields. By using PrecisionKing technology and AT&T IoT connectivity, the brothers aren't gauging water levels by eye anymore. Instead, the technology increases the accuracy of water-depth monitoring and saves time and water. And remote pump-control technology turns pumps on and off as needed, helping to maintain optimal water levels without having to drive to the pump and make the change manually.

This operational insight and control is driving real operational efficiencies for Whitaker Farms. According to information collected by Jim, **connected RiceKing water-level sensors have reduced Whitaker Farms' water usage by up to 60%, while the connected PumpKing controls have reduced pump energy usage by 20-30%.**

Reduced Whitaker Farms' water usage by up to 60% and reduced pump energy usage by 20-30%.



Jim Whitaker, Whitaker Farms | Photo courtesy of Adam Jahiel



"We were learning the ropes, and it became clear to us that we needed to make more with less, and being an early adopter of innovative techniques and technology would be critical."

- Jim Whitaker, Whitaker Farms

Sustainability Impact Overview

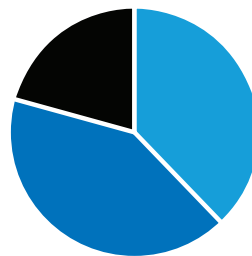
Measuring water savings from AWD is a relatively straightforward comparison of how much water was pumped into a field before and after implementing AWD. The measurement of the GHG reductions is a bit more complicated.

A substantial portion of the GHG reductions comes from the lower methane emissions, while additional reductions come from reduced fuel and/or electricity used to pump water, reduced use of nitrogen-based fertilizer due to more efficient management practices,⁸ and reduced truck fuel.

"There are several important pieces of data that go into the calculation, but the most critical factor is water depth. Using connectivity to collect that data and control water levels is a game-changer."

- Dr. Michele Reba, USDA-ARS-Delta Water Management Research Unit

Potential Environmental Benefits of AWD:



Sources of GHG Savings

- Pumps, 0.06 mtons CO2e
- Fertilizer, 0.11 mtons CO2e
- Methane, 0.11 mtons CO2e

Annual Water savings:
80,000 US gallons per acre

Annual GHG savings:
0.28 metric tons CO2e per acre

Several experts have developed technology and measurement protocols to estimate the amount of methane gas emissions generated by anaerobic activity in rice fields. For example, Dr. Michele Reba from the USDA-ARS-Delta Water Management Research Unit and her team of researchers and local farmers have collected extensive data to analyze and calculate the methane impacts of AWD. Using a variety of scientific methods, Dr. Reba and team have developed a good understanding of the methane reduction enabled by AWD.

Dr. Reba and her team continue to tune the process to better understand when and how much to flood rice fields, and data from connected sensors is helping to improve the process even more.

In addition to the environmental benefits, using an IoT-enabled solution has lowered water expenses and reduced the physical labor needed to manually survey the field conditions and flood or drain fields. This allows rice farmers like Jim and Sam to focus on other tasks, while receiving consistent data about field conditions. These financial, time, water and fertilizer savings mean farmers can produce an environmentally-superior product more efficiently.

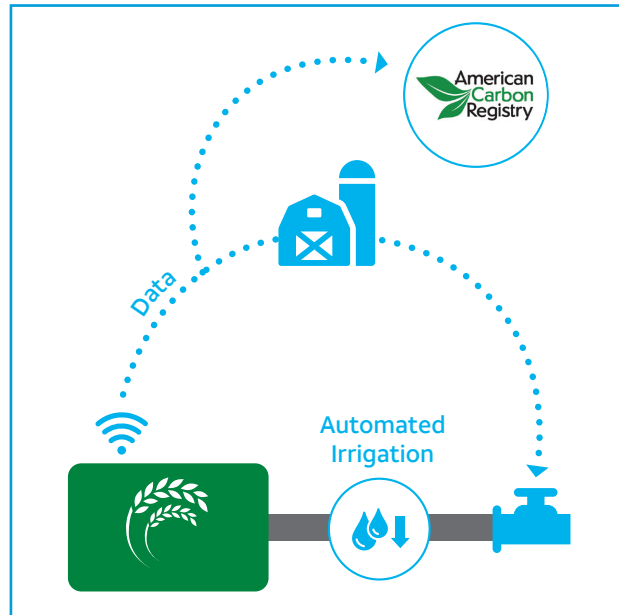
⁸ Nitrogen fertilizer usage information from Jim Whitaker. Note that fertilizer reduction is enabled by AWD as well as other management methods.

Turning farming efficiency into carbon credits

The Whitakers and a group of enterprising farmers began to pursue the idea of using methane savings from AWD to join the carbon credit market and create incremental revenue from efficient rice farming.

Together with sustainability and carbon market experts, including Terra Global Capital, American Carbon Registry (ACR), USDA Natural Resources Conservation Service (NRCS), California Rice Commission, White River Irrigation District and the Environmental Defense Fund (EDF), the group developed a carbon credit protocol called the “Voluntary Emission Reductions in Rice Management Systems” that quantifies the GHG reductions that result from efficient rice-growing techniques, including AWD.¹⁰ Using this program, rice growers in California and the Mid-South (Texas, Arkansas, Mississippi and Louisiana) can earn carbon credits for using conservation management practices to reduce methane. These carbon credits can then be sold on the carbon markets as an incremental form of revenue for the farmer.

The carbon credits generated through these projects represent quantifiable emissions reductions. In 2017, seven rice growers took part in the first rice-generated carbon credit trade, using techniques like AWD on 2,000 acres of farmland to eliminate 600 tons of carbon dioxide equivalent from 2013 to 2015.¹¹ Microsoft became the first company to buy these offsets in June 2017.¹² And while this carbon credit sale represents an exciting new potential revenue stream for the farmers, data collection for the carbon credits is a barrier to the success of this nascent market. Using IoT to collect accurate water-level data can greatly ease the data collection burden and overcome some of those barriers.



Voluntary Emission Reductions in Rice Management Systems

In 2014, a group of farmers and carbon experts worked with the American Carbon Registry to publish a protocol to quantify emissions avoided by using efficient rice-growing techniques, including AWD.⁹ The ability to integrate IoT into that measurement process has the potential to increase the efficiency and ease of data collection.

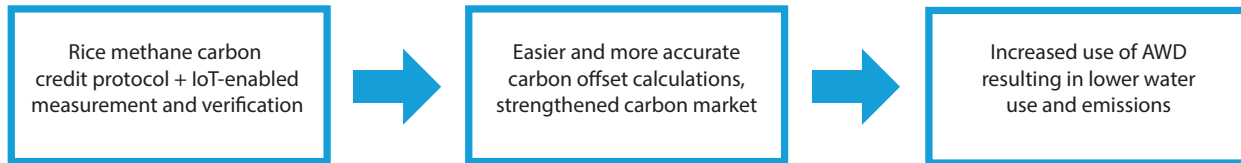
⁹ <http://americancarbonregistry.org/carbon-accounting/standards-methodologies/emission-reductions-in-rice-management-systems>

Note that there are other practices, such as rice straw removal (baling) and dry seeding, that also deliver GHG reductions, but are not included in this case study, as they are not enabled in the same way by connectivity and automation technologies.

¹⁰ <http://agfax.com/2017/06/15/rice-7-farmers-generate-carbon-credits-purchased-by-microsoft/>

¹¹ <https://insideclimatenews.org/news/26062017/agriculture-rice-methane-emissions-carbon-trading-microsoft-climate-change>

¹² <https://www.agweb.com/article/first-ever-rice-farming-carbon-credits-sold-to-microsoft-naa-ben-potter/>



This financial benefit is yet another incentive for rice farmers to move to AWD. While there are many variables that enter into a farmer's decision to use AWD, IoT-enabled water systems and data collection have the potential to help increase adoption.

“Capitalism moves the needle. If my peers see that IoT and AWD are helping me make money and build my business by driving down my water, gas and fertilizer bills while making it easier for me to collect the data needed to make more money from the carbon credit process, they’ll be more inclined to use it, too. And that’s better for our businesses and our environment.”

-Jim Whitaker, Whitaker Farms

If adoption of IoT-enabled AWD were to expand to all the rice farmers in Arkansas, Louisiana, Mississippi, Missouri and Texas, GHG emissions could be reduced by an estimated 325,805 metric tons CO₂e each year.¹³ That is equivalent to these annual savings:



Switching almost 11M incandescent lightbulbs to LEDs¹⁴

or



Not consuming over 36.5M gallons of gasoline

or



Taking almost 70k cars off the road

COMBINING PRECISIONKING WITH AT&T CONNECTIVITY HAS THE POTENTIAL TO:

1. Help overcome barriers to AWD adoption and create higher use among farmers, resulting in measurable methane reductions and water and fertilizer savings.
2. Become an important input for measurement and verification of carbon savings, which could help propel the nascent rice carbon offset market.

¹³ Analysis of the Scale-up Potential for Carbon Credits from Changing Rice Cultivation Practices, EDF, July 2015, funded by NRCS Conservation Innovation Grant 69-3A75-11-133

¹⁴ EPA Greenhouse Gas Equivalencies Calculator. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

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. The 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 enables water-level data to be remotely collected and connected to pumping systems to automatically control the water level in the rice fields. This helps both with the implementation of the AWD process and with the data collection required for verification of the carbon credits. Thus the technology helps to overcome barriers to implementation and increases the AWD adoption rate. |
| Impact Category | This case study focuses on carbon and water impacts from implementing the "Alternate Wetting and Drying" (AWD) process on rice farms. |
| Materiality | The impact of implementing AWD and other farming practices on rice farms results in reductions of both water usage and greenhouse gas emissions. |
| Attribution of Impacts | The emissions and water savings described in this case study are a result of changes in farming practices supported by PrecisionKing technology and AT&T IoT connectivity. AWD with technology integration makes the process easier and enables the collection of data that is necessary to quantify the GHG reduction benefits. |
| Relationship to Systems | AT&T connectivity and PrecisionKing technology reduce barriers to the implementation of the AWD practice by automating the process, helping reduce risk and providing both financial and environmental benefits. This can encourage widespread adoption of the practice, thus delivering scalable environmental benefits. |
| Enabling and Rebound Effects | |
| Primary Effects | <p>AWD is a process in which the rice field is allowed to dry to a wet mud for a period before re-flooding. Carbon savings associated with AWD come from three areas:</p> <ul style="list-style-type: none"> • Reduced methane emissions, due to reduced anaerobic digestion • Reduced fertilizer usage, resulting in reduced N2O emissions, and fewer GHG emissions from fertilizer production • Reduced use of irrigation water, resulting in less pump energy used and therefore fewer GHG emissions <p>Water savings are a result of less water used for irrigation of the rice fields.</p> |
| Secondary Effects | There are also reduced emissions from farm vehicles, as the automation reduces the need to physically visit the field to check water levels. No data was available to calculate this effect so it is not included in the case study results, and it is likely to be much less significant than the emissions reductions from the primary effects. |
| Rebound Effects | No rebound effects were identified. Some academic studies have previously reported a decrease in rice yield from the implementation of AWD. However, Whitaker Farms report an increase in yield using AWD, and they regularly run variety trials to test yield impact. |
| 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 embodied carbon emissions of the sensors and IoT devices, which will be minimal compared with the emissions reductions. |

| Carbon Abatement Calculation | |
|------------------------------|--|
| Scope | The scope are GHG emissions from rice production, including emissions from plant decomposition, fertilizer usage and energy for pumping water. |
| Timeframe | The American Carbon Registry (ACR) carbon credits relate to the period 2013-2015. The water usage data relates to a trial at Whitaker Farms in 2017. |
| Functional Unit | <p>The functional unit for the GHG emissions reduction is metric tons CO₂e per acre per year (which is also converted into metric tons CO₂e per connection).</p> <p>The functional unit for water reduction is US gallons of water used per acre per year.</p> |
| Methodology | <p>The GHG emissions reductions are the sum of the emissions reduction from:</p> <ul style="list-style-type: none"> • reduced methane emissions; • reduced fertilizer usage; and • reduced energy for pumping water. <p>The reduced methane emissions are calculated from the total verified carbon credits, as reported in the ACR verification report for project ACR230,¹⁵ and by dividing these by the acreage of the participating farm fields. This project encompasses 5 participating farmers, with 41 unique fields, and 2,877.2 acres in the Mid-South, in Arkansas and Mississippi. Receiving verified carbon credits requires following the Voluntary Emission Reductions in Rice Management Systems.¹⁶ This requires collecting data prior to the change to AWD, and collecting data throughout the implementation of the AWD process. The data includes: daily meteorological data; timing of specific events such as planting, tilling and harvesting; fertilizer application; crop residue harvesting, baling and stubble height; flooding and drainage dates; and use of baled straw and date of straw burning. The data is then entered into a DNDC (DeNitrification-DeComposition) model. The DNDC model has to be calibrated for the relevant geographical region. The DNDC model calculates the GHG reductions based on previously validated research and studies. The verification process then verifies the data that was collected, checking data records and photographs as evidence.</p> <p>The GHG savings from reduced fertilizer application are calculated from fertilizer savings figures provided by Whitaker Farms. The reduced N₂O emissions and reduced GHG emissions from fertilizer manufacture were calculated using the Carbon Trust crop calculator model.¹⁷ Note that the reduced fertilizer usage is not only due to the AWD practice, but also due to other new farm management methods.</p> |

¹⁵ <https://acr2.apx.com/mymodule/reg/prjView.asp?id1=230>

¹⁶ <http://americancarbonregistry.org/carbon-accounting/standards-methodologies/emission-reductions-in-rice-management-systems>

¹⁷ The Crop Calculator is part of the Carbon Trust Footprint Expert tool (<https://www.carbontrust.com/client-services/advice/footprinting/carbon-footprint-software/#footprintexpert>) and uses base data from the UK Government Department BEIS, Ecoinvent (version 2.0) and the Intergovernmental Panel on Climate Change (2016 IPCC Guidelines for National Greenhouse Gas Inventories).

¹⁸ <http://www.mississippi-crops.com/2017/01/20/three-years-of-awd-water-savings-in-rice/>

¹⁹ Analysis of the Scale-up Potential for Carbon Credits from Changing Rice Cultivation Practices, EDF, July 2015, funded by NRCS Conservation Innovation Grant 69-3A75-11-133

²⁰ <http://www.mississippi-crops.com/2017/01/20/three-years-of-awd-water-savings-in-rice/>

| | |
|--------------------------------|--|
| | <p>The GHG savings from water usage are calculated using data from a trial run on two similar fields at Whitaker Farms in 2017. The trial used PrecisionKing monitoring and pump control systems on both fields. One field was continuously flooded and the other was flooded using AWD. 16% water savings were achieved using AWD. Note that due to rainfall, only one complete dry-down was achieved. Other studies have shown 30% water savings with multiple dry-downs.¹⁸ GHG savings are calculated based on pump power and run times, and using a grid emission factor relevant to Arkansas.</p> <p>The water savings are calculated from the same trial, and use the flow readings from the pumps.</p> |
| Key Assumptions | <ul style="list-style-type: none"> • Use of ACR Rice Protocol and DNDC model for calculation of GHG emissions reductions from rice growing using AWD process • Assume that data provided by Whitaker Farms is representative for other similar implementations |
| Exclusions | <ul style="list-style-type: none"> • Embodied carbon emissions of the sensors and IoT devices • Emissions reductions from reduced farm vehicle journeys |
| Data Sources | <ul style="list-style-type: none"> • ACR registry verification report • Reduced fertilizer usage (Whitaker Farms) • Water flow, Pump power and pump run time (PrecisionKing monitoring reports) • Electricity emissions factor (from eGrid) |
| Results | |
| Carbon Abatement Factor | <p>Annual GHG savings of 0.28 metric tons CO₂e per acre from implementation of AWD process.</p> <p>This comprises:</p> <ul style="list-style-type: none"> • 0.11 metric tons CO₂e/acre from reduced methane emissions • 0.11 metric tons CO₂e/acre from reduced fertilizer use • 0.06 metric tons CO₂e/acre from water pumping savings <p>Note that calculating GHG emissions associated with agricultural processes is subject to significant variability. This can be due to differing meteorological conditions (such as temperature and rain fall), differing soil conditions and other variations from farm to farm and field to field.</p> <p>The results used here have been compared to other sources and are all considered to be conservative. For example, the EDF¹⁹ report calculates a carbon abatement from AWD of up to 0.4 tCO₂e per acre (which does not include abatement from reduced fertilizer use).</p> <p>Assuming one sensor per field and an average field size of 60 acres, this equates to an annual GHG reduction of 16.9 metric tons CO₂e per connection.</p> |
| Water Savings Factor | <p>Annual water savings from implementation of AWD is 80,000 US gallons per acre.</p> <p>This is based on the trial at Whitaker Farms in 2017, which achieved a 16% reduction with a single dry-down compared to continuous flooding (while other studies have achieved a 30% reduction with multiple dry-downs²⁰). Note that Whitaker Farms has achieved total savings of about 60%, or 600,000 gallons saved per acre, compared to the state average figure. This includes benefits from both zero-grade fields and AWD. (Zero-grade involves levelling the field and is a prerequisite for implementing AWD).</p> |
| Lessons Learned | <p>There is considerable variability in agricultural processes, therefore it is useful to compare results across different studies to test the representativeness of the results.</p> |



AT&T IoT for Good Case Study:

Asparagus has a lower water footprint thanks to Devine Organics, WaterBit and AT&T

AT&T IoT for Good Case Study:

Asparagus has a lower water footprint thanks to Devine Organics, WaterBit and AT&T

The Challenge: Making high-volume organic farming more efficient

You could probably guess that asparagus is good for you. Full of antioxidants, minerals and amino acids but void of fat and cholesterol,¹ asparagus is a great part of any healthy diet.

When talking with Elvia Devine, the co-founder and driving force behind Devine Organics, about this vegetable, it's clear she's become a leader in organic farming with an eye to the future.

"It's about our kids and grandkids. If we eat well – including lots of clean fruits and vegetables grown without pesticides and other stuff – it can open doors for the next generation."

Elvia Devine, CEO and co-founder, Devine Organics



And this simple mission has propelled her to be a successful organic farmer for decades. Starting in the early 1990s, Elvia has been driven to grow the finest fruits and vegetables at Devine Organics, a family, woman and minority-owned business with operations in California and Mexico. With rising wages, water limitations and pricing pressures from conventional farmers, Elvia and team are compelled to be more efficient and innovative in order to compete.

Agriculture is key to California's economy, it employs about 3% of the state's workforce and accounts for about 2% of the state's gross domestic product.² It's also a major water user: roughly 9 million acres of farmland in California are irrigated; this represents about 80% of all water used for businesses and homes.³ While the rains of 2017 brought relief from historic California droughts, more than 90% of the state was in some form of drought in 2016.⁴ So when thinking about resource efficiency, water is a logical place to focus, especially in the water-tight central valley of California.

As Jose Garcia, the Devine Organics farm manager and Elvia's son-in-law, explains, he and his crew traditionally walked the rows of asparagus and manually probed the ground to check moisture. This process was a valiant attempt to understand when and how much to water, but it was inefficient and time-consuming, oftentimes resulting in higher costs due to overtime work.

¹ <http://www.allasparagus.com/asparagus-facts/>

² <https://www.wired.com/2015/06/farming-and-drought/>

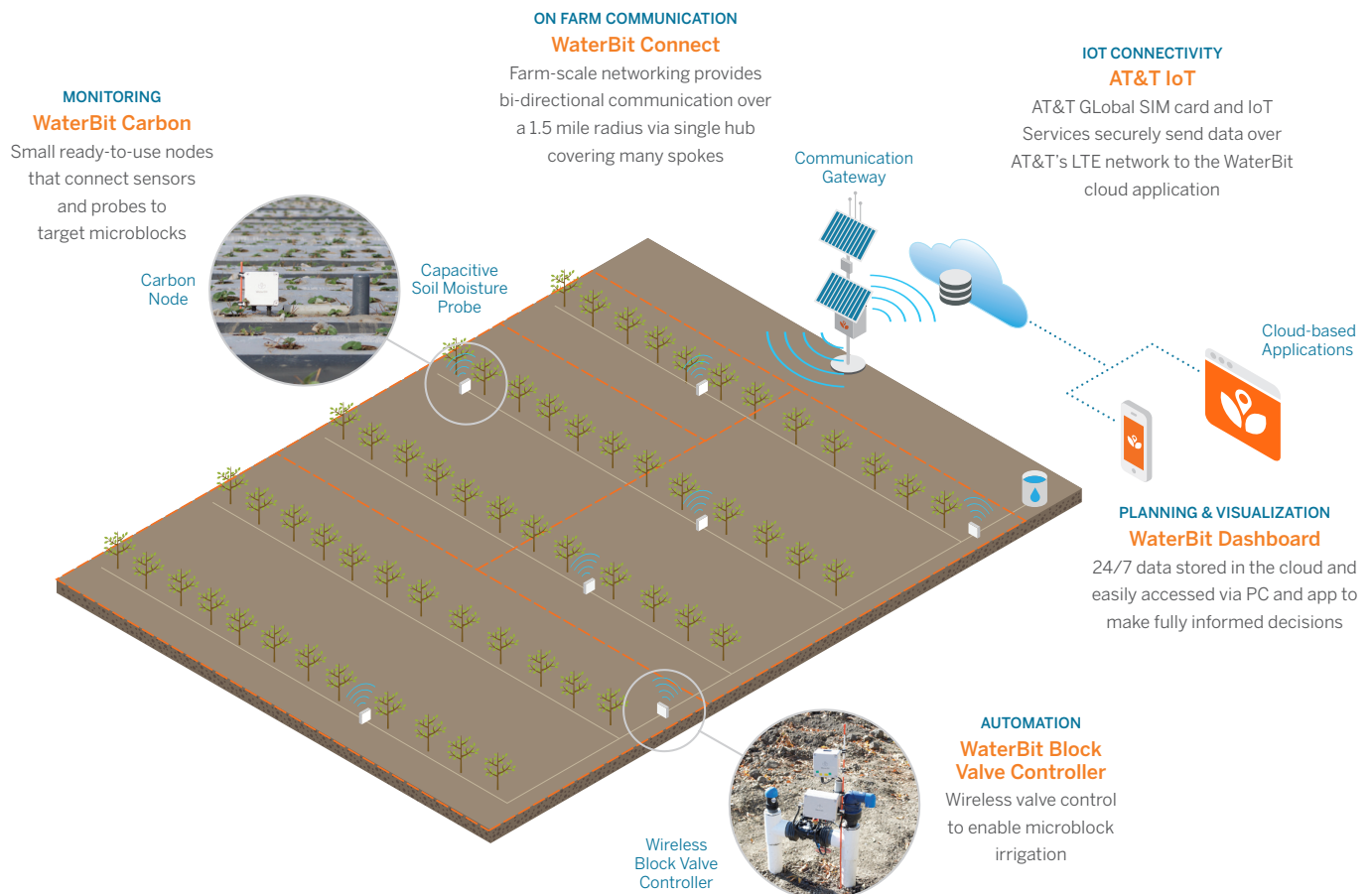
³ <http://www.ppic.org/publication/water-use-in-california/>

⁴ <http://www.latimes.com/local/lanow/la-me-drought-gone-20170223-story.html>

The Solution: WaterBit and AT&T Internet of Things (IoT) create control and drive efficiency

Elvia and Jose knew that the manual moisture-sensing process wasn't the most efficient or effective process, so Elvia started looking for a robust solution to help her improve soil moisture levels. In order to address this issue, Elvia and Jose turned to a comprehensive solution from WaterBit and AT&T.

WaterBit distributes small, solar-powered sensors across farmers' fields, collecting information on soil moisture and field conditions. The sensors require no maintenance and are placed under the foliage so they won't interfere with field operations and harvests. Data from the sensors is sent to a communications gateway hub that can be thousands of feet away. The gateway uses an AT&T Global SIM card and Internet of Things (IoT) Services to send highly secure data over the AT&T LTE network to the WaterBit cloud application where it is analyzed to determine if a section of the field needs more or less water. Farmers can also easily access analysis and scheduling tools through a user-friendly mobile app, allowing them to control irrigation timing and duration, fine-tuning as the soil's needs vary.



For Jose, what differentiates WaterBit from other solutions is reliability and ease. The WaterBit Dashboard provides a comprehensive overview of his field's moisture and irrigation status. Since it's connected via the AT&T network, he can easily access it 24/7 via computer or smartphone. This means he can make fully-informed decisions about when, where and how much to water.

“WaterBit’s soil probes tell us exactly where the crops need more or less water, all from the WaterBit Dashboard app. It helps us monitor the soil and control the valves in the field, helping us apply the right amount of water at the right time and place. It’s amazing to have such control, even on a Sunday morning when I’m rolling out of bed.”

Jose Garcia, farm manager, Devine Organics

Implementation: Less water yields more asparagus.

The Devine team first installed WaterBit on 40 acres of asparagus crops in December of 2017. In their first season to use it – on only a relatively small portion of their farm – they’re already able to estimate enough savings to make a difference. The Devine team estimates a 6% water reduction, equivalent to over 750K gallons in water savings during their first season of use.⁵ To put it in perspective, that’s like over 43,000 Americans skipping a shower for a day!⁶ And there are additional benefits including an estimated:

- 5% reduction in greenhouse gas emissions from fuel used for pumping water and truck trips to manually check the fields
- 5% drop in labor hours and cost
- decreased nutrient use because of a reduction in leaching

All of this adds up to the potential for real savings, and that’s especially important for Kevin Dees, controller at Devine.

First Season Estimated Results:

Field Size: 40 acres

Water: 750K gallons reduction

Production: Almost 2x increase

“The benefits start to add up to substantial savings. Reducing water usage is a huge benefit, especially considering the volatility of water prices in California. Labor and fuel cost reductions also contribute to bottom line benefits, especially as we look to expand to more crops.”

- Kevin Dees, controller, Devine Organics

⁵ Devine Organics, Estimated water savings in spring 2018 growing season.

⁶ 750,000 / 17.2 = 43,605, <https://www.home-water-works.org/indoor-use/showers>



Other benefits that aren't as easy to quantify are helping the Devine crew do more with less. Without WaterBit, Devine oftentimes wouldn't realize they had problems with the irrigation of their crops until the end of the season – when it was too late. Now they're much more likely to see and address problems as they arise, helping to improve crop yield.

In fact, Jose reports that crop **production jumped from 800 to 1500 pounds/acre** across the asparagus field using the WaterBit/AT&T solution. The system is also helping to eliminate human error. An automated and dashboard- driven irrigation helps prevent a well-intentioned employee from forgetting to turn off sprinkler at the correct time.

“It's amazing to have the visibility and control that WaterBit and AT&T enable. The crew that works those fields really likes it, and it has eliminated overtime costs.”

- Jose Garcia, farm manager, Devine Organics

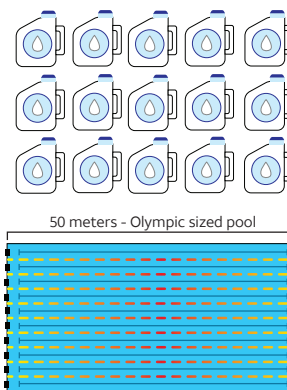
Expanding the Water Savings and Efficiency Benefits

After their initial installation in the asparagus fields, the Devine team is looking to expand into other crops like pistachios and melons. These crops have dynamic water needs, so Elvia and Jose are optimistic they'll benefit from the WaterBit system. She's also looking to expand their use of WaterBit into Mexico, where they operate other large organic farms. And beyond her own crops, she's hoping to share the lessons she's learned with other farmers trying to increase their efficiency. Elvia's enthusiasm is understandable.

"We can't do what we do now without technology; it's a must to stay in business. That's why we've been investing in new technology like WaterBit and AT&T. People depend on us for work; kids deserve the food we grow. We've got to look at ways to grow more with less in a healthy way."

Elvia Devine, CEO and co-founder, Devine Organics

Especially when you consider the savings Devine realized from their first experience on a relatively small farm plot. Imagine the beneficial impact of this technology if it were utilized more broadly. If Elvia's success inspires 100 farmers to use the WaterBit/ AT&T solution on just 40 acres, they could collectively save about **300M gallons** of water a year. That amount would fill over **450 Olympic-sized swimming pools**.⁷



Imagine the potential savings when more farmers like Elvia Devine realize the efficiencies and cost benefits of the technology and expand beyond 40 acre plots...

⁷ 3M gallons annual savings * 100 farmers / 660,000 gallons in an Olympic-sized pool.

<https://www.livestrong.com/article/350103-measurements-for-an-olympic-size-swimming-pool>



AT&T 10x Case Study:

Using the Internet of Things to reduce facility costs and emissions



AT&T 10x Case Study:

Using the Internet of Things to reduce facility costs and emissions

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.

Learn about our goals, our progress, and more case studies like this at att.com/10x.

Summary

To reduce energy costs and greenhouse gas emissions (GHG), AT&T has incorporated Internet of Things (IoT) connectivity with legacy building information to identify when facility equipment is operating inefficiently. The AT&T IoT Professional Services group, experts in the design, testing, and implementation of IoT projects, has worked with the AT&T Energy team to use IoT sensors to gather data on previously unmonitored equipment and merge it with data from existing building management systems (BMS). Bringing equipment performance information together has led AT&T to optimize maintenance and address problems in a timely manner via dashboards, reports and alerts. This has reduced electricity use and the associated emissions. At the end of 2017, 27,000 pieces of AT&T building equipment across 250 cities were on the system, reducing electricity expense by about \$925,000 and GHG emissions by 5,150 metric tons in 2017. **Based on the success of the program, the AT&T IoT Professional Services team is offering Consulting Services for the IoT-Enabled Building Energy Management system to AT&T customers.**

2017 Estimated Annual Savings:

\$925K Electricity Expense
5,150 metric tons of CO₂e

The Challenge: Many buildings are not energy efficient, but identifying the causes can be difficult.

In 2010, buildings accounted for 32% of total global final energy use and 19% of energy-related GHG emissions.¹ On top of that, an average of 30% of the energy consumed in commercial buildings is wasted.² This waste results in higher costs and energy usage, contributing to higher GHG emissions.

Building Environmental Impacts

32% of global energy use
19% of energy-related GHG
30% energy waste

¹ https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter9.pdf

² <https://www.energystar.gov/buildings/about-us/how-can-we-help-you/improve-building-and-plant-performance/improve-energy-use-commercial>



Understanding building equipment performance is a critical first step to boosting efficiency. Being able to identify inefficient equipment sooner means we can address the issue more quickly. But because facility managers are typically faced with a complex and disparate set of legacy BMS, especially among older buildings, getting an accurate view can be challenging. Even if a building has a BMS, managers don't always get all the information they need in a timely and usable format. And in some cases, equipment is not monitored, requiring a technician do an in-person inspection.

Many proactive facility managers are searching for ways to gain accurate and timely equipment performance data to help them identify waste, reduce emissions and reduce total building costs from maintenance and new capital equipment.

AT&T is committed to efficiency, but its wide-ranging building portfolio presents challenges.

As part of our commitment to energy efficiency, AT&T established a goal in 2008 to reduce our electricity consumption relative to data growth on our network by 60%. By 2013, we met that goal by implementing thousands of building and network energy efficiency projects. So, we extended the goal to generate an additional 60% of improved energy intensity by 2020.³

Our size presents both opportunities and challenges in meeting this goal. AT&T manages a complex real estate portfolio covering over 250,000,000 square feet and comprised of approximately 247,000 locations, more than 2,500 of which are occupied buildings. Many of the buildings utilize a BMS, but because those systems have been installed over decades, there are many different platforms across the portfolio, making it difficult to compare sites to identify poorly performing facilities.

Many pieces of equipment were not monitored at all for a number of reasons, including the costs to install a wired system and the difficulty managing a Wi-Fi network dedicated to building equipment. As a result, AT&T found it difficult to identify when equipment was running inefficiently and needed to be adjusted. Unable to consistently get equipment performance data, facility managers normally perform maintenance on a scheduled basis or reactively when a problem is reported. It became clear to John Schinter, assistant vice president of Energy at AT&T, that we lacked visibility. And it was creating unidentified inefficiencies and waste.

“After years of energy efficiency projects, we had addressed many of the obvious opportunities to reduce energy waste. But it was clear that we weren't seeing the whole picture. We needed a tool to increase the visibility of building equipment across the portfolio and identify new opportunities to save money and reduce our energy and carbon footprint.”

–John Schinter, assistant vice president, Energy, AT&T

3 <http://about.att.com/csr/goals>

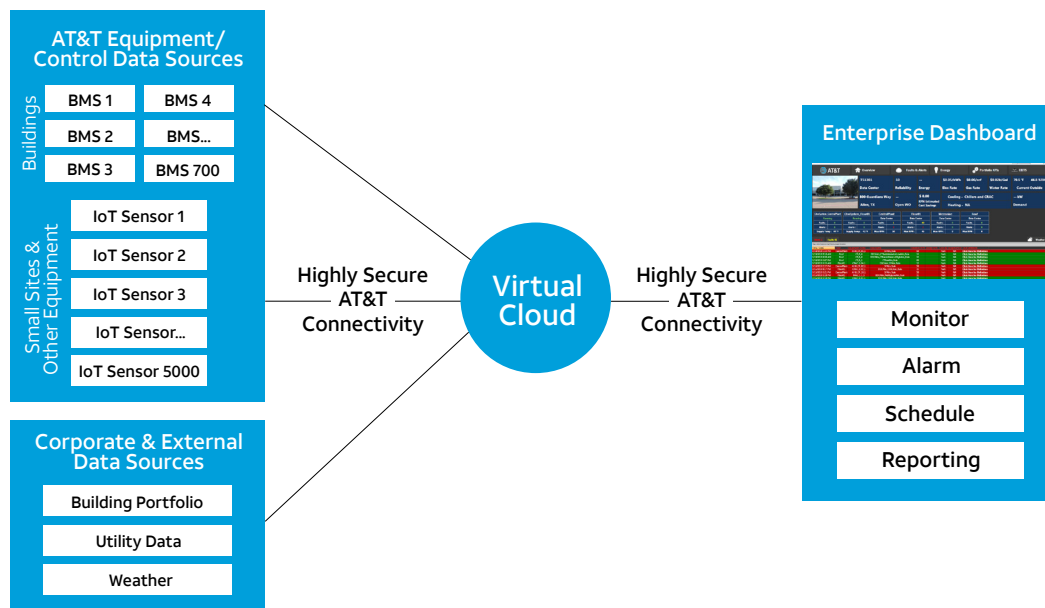


The Solution: AT&T IoT gathers and analyzes building data in near real-time.

To address this problem, AT&T set out to create a single platform to track facility equipment data. AT&T IoT Professional Services worked closely with the AT&T Energy team and other technology collaborators to develop reporting platforms comprised of two primary internal data sources:

- **Building Management Systems (BMS)** – Legacy BMS collect basic equipment information at many large AT&T facilities, but the data was inconsistent as many of these systems had been installed over decades. Because many of these systems used slow dial-up modems with no security, they were updated to secure, cellular gateways.
- **IoT Sensors** – AT&T operates many small facilities for which it was too difficult or expensive to gather data. AT&T added IoT sensors and connectivity to gather information about equipment performance at these sites, detecting a range of information including electricity usage, air and water flow, temperature, humidity and more. Some also include a push-button that can be used to confirm when a technician inspects a piece of equipment.

The IoT-Enabled Building Energy Management system not only collects information from the IoT sensors and BMS, but also integrates other data that aids in analyzing building efficiency such as the building portfolio details, utility data and weather details.



The data from all of these sources is transported over the AT&T network into a virtual cloud. It then is analyzed and presented to managers and technicians via a dashboard equipped with easy-to-read reports. The IoT-Enabled Building Energy Management system also provides AT&T with tools to create customized data visualization, analytics and fault detection. The AT&T network allows the system to share this information with the facility management team much faster and more securely than before.



Implementation: 105 Million data points every day

AT&T began using the IoT-Enabled Building Energy Management system in late 2015. By the end of 2017, we were collecting more than 1.2 million pieces of information associated with 27,000 pieces of equipment at over 350 facilities. Collecting data throughout the day, the system generates about 105 million data points daily. As a result, AT&T has a connected real estate portfolio across a range of facility types and geographies.

Perhaps most important, the system transformed AT&T’s facility management capabilities from primarily reactive to proactive. The AT&T IoT Professional Services and Energy teams have developed over 420 unique rules that generate alerts when a “fault” occurs, indicating that a piece of equipment isn’t running efficiently. The system has identified almost 7 million faults since 2015, creating centralized dashboards and reports that facility managers can access to better understand how their facilities are performing. In the past, the vast majority of building maintenance events were scheduled activities, with only a small percentage handled as needed. Now, an increasing amount of maintenance is proactively prioritized based on information from the IoT-Enabled Building Energy Management system.

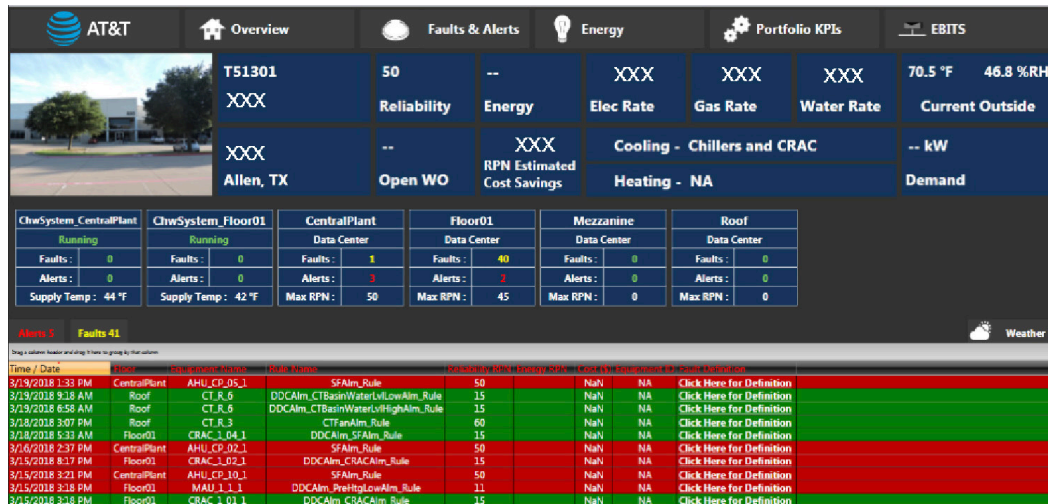
Comprehensive and timely visibility:

| | |
|----------|------------|
| Pumps | Fans |
| Motors | Generators |
| Lighting | Boilers |
| Fans | Chillers |

| BEFORE | | NOW |
|----------------------------|-----|--|
| Scheduled & Reactive | >>> | Informed & Prioritized |
| Human Equipment Inspection | >>> | Sensor-driven Fault Detection & Diagnostic |



The AT&T IoT Professional Services team worked with the AT&T Energy team and leading real estate analytics organizations to develop customized dashboards to provide a comprehensive view of energy efficiency across the portfolio.



When an alert occurs, the system generates a Facility Improvement Measure (FIM) to address the issue.

Common Alerts:

- Climate Control not in Automatic mode
- Leaking Valve
- Overcooling
- Damper stuck
- High Fan Speed
- Overheating
- Dirty Filter

Common FIMs:

- Reprogramming equipment such as chillers, economizers, fans and variable frequency drives (VFDs), etc.
- Replace broken sensors.
- Return controls to automatic mode to improve operations and energy efficiency.
- Repair outside air dampers reducing the need for mechanical cooling.



Sustainability Impact Overview

AT&T reduced energy consumption and associated GHG emissions by using the IoT-Enabled Building Energy Management system to actively monitor equipment performance across a large portion of the portfolio. In 2017, AT&T managers evaluated 2,900 Facility Improvement Measures (FIMs) at over 350 facilities, with heating and cooling efficiency representing much of the work. Examples include:

- 1,000 fan system FIMs resetting discharge air set points or adjusting VFDs, economizers and other miscellaneous equipment.
- 115 chiller plants FIMs saving 41,000 hours of run time, reducing capital and avoiding premature equipment replacement.

In sum, the system enabled **\$925,000 in annualized electricity savings** and a **9 million kWh energy reduction** in 2017. The effort is ramping up in 2018, and we expect to see significant incremental energy savings over time.

This electricity savings equals almost **5,150 metric tons of CO₂e**, which is the same as:



Taking over **1,100 cars off the road**
or



Not using over **580K gallons of gas**
or



Switching over **170,000 incandescent lamps to LEDs⁴**

This has been so successful that AT&T IoT Professional Services team is offering Consulting Services for the IoT-Enabled Building Energy Management service to customers looking to reduce energy costs and associated GHG emissions.

We believe this savings estimate is conservative because it doesn't include all accounts of time, fuel and electricity savings from technicians in the field. The following are anecdotal evidence of savings that are not included in these estimates.



Detailed fault information makes it easier to find and address a specific issue that may not have been found until routine maintenance

“The IoT-Enabled Building Energy Management system alerted me when the space temperature and supply air temperature at one of my remote sites was way too low. I traveled to the site to investigate and learned someone had the temperature set points way down, so I changed the settings. I only visit this site once a month at most, so this setting would have remained in effect for who knows how long.”

- Facility technician, AT&T, Washington

“After getting an alert from the IoT-Enabled Building Energy Management system, I found debris and dust from the construction of another facility located next to the building blocking the intake. This issue may not have been discovered until the regular maintenance routine was to be performed, which was scheduled for a couple of months later. Because it was discovered early using fault detection, the issue was corrected before the dampers and unit could fail.”

- Facility technician, AT&T, East region

Alerts help avoid early equipment failure and replacement

Constant equipment information at remote sites reduces lengthy truck rolls

“Before the IoT-Enabled Building Energy Management system, I would spend hours traveling to remote sites to perform routine maintenance. Now, getting real-time information about those remote sites, I only make those trips when needed, saving me time and fuel.”

- Facility technician, AT&T, Central region

“This innovation is at the heart of how we think about environmental sustainability at AT&T. It tackles an important issue for our business and our environment by leveraging the technical and operational expertise that AT&T has developed over the decades.”

- Charles Herget, assistant vice president, Sustainability Integration, AT&T

USING AT&T CONNECTIVITY TO AGGREGATE DISPARATE BUILDING SYSTEMS HAS THE POTENTIAL TO:

1. Give facility managers the timely information they need to correct energy efficiency problems.
2. Reduce energy use and associated emissions from building operations.
3. Reduce facility equipment maintenance and repair costs.
4. Reduce capital costs by extending the life of existing equipment.



Applying the 10x Carbon Impact Methodology

Carbon Trust and Business for Social Responsibility (BSR) collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's technology. The 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 | Using IoT connectivity for data aggregation and data management of Building Management Systems (BMS) enables AT&T to proactively monitor energy use and equipment performance. This allows preventative maintenance and more timely responses to equipment malfunctions that results in improved energy use of building infrastructure equipment. |
| Impact Category | This case study focuses on electricity use and GHG emission impacts. |
| Materiality | IoT-Enabled Building Management system leads to reductions in electricity use and corresponding reductions in GHG emissions. |
| Attribution of Impacts | The reductions in GHG emissions are a direct result of coordinated monitoring and maintenance of the building equipment, which is possible due to the collation of the disparate data by the deployment of the IoT connectivity and cloud technologies. |
| | |
| Primary Effects | The monitoring, IoT connectivity, cloud, and enterprise dashboard system enables improved maintenance resulting in reduced electricity consumption and reduced GHG emissions. |
| Secondary Effects | There are no secondary effects. |
| 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 emissions related to the enabling technology is the embodied and in-use emissions associated with the system. That includes the embodied emissions and electricity use of the monitoring devices, IoT devices, the cloud and dashboard systems. We expect these will be minimal compared to the overall emissions reductions. |
| | |
| Scope | The scope of the case study covered 378 of AT&T's larger facilities, by analyzing improvement measures identified by the IoT enabled building management system. |
| Timeframe | The timeframe was for the calendar year 2017. |
| Functional Unit | The functional unit was the electricity and GHG emissions savings per site. |



| | |
|-----------------------------------|--|
| Methodology | <p>The system identifies a number of 'facility improvement measures' (FIMs), which engineers can respond to, and which may result in electricity and GHG emission savings.</p> <p>The FIMs for 2017 were analyzed and classified into the following categories: chiller setpoints, economizers, fans and VFDs, air reset controls, water reset controls, and freeze protection. The system also automatically monitors run-hours for the different equipment, thus allowing an estimate of electricity savings; additionally the system can capture estimate kWh and savings against each FIM. The total savings are summed up for all the categories. This method will likely underestimate the savings, as not all of the savings are captured using this approach. (For example, savings outside of the above categories would not have been captured).</p> |
| Key Assumptions | <ul style="list-style-type: none">• Detailed saving figures were derived based on expert opinion, and then aggregated by system reports. |
| Exclusions | <ul style="list-style-type: none">• Smaller sites were not included as they are on a different system with less accessible data.• Reduced engineer trips to site were not included due to the difficulty of reliably capturing the required information. |
| Data Sources | <ul style="list-style-type: none">• FIM and site data provided from the system by AT&T• EPA eGRID 2016 electricity emission factors |
| | |
| Carbon Abatement Factor | 13.6 metric tons CO ₂ e per site for the year |
| Electricity Savings Factor | 24,500 kWh per site for the year |
| Lessons Learned | The estimates in this study are conservative because of the distributed nature of the AT&T real estate portfolio. Additional data capture and reporting of savings could identify additional savings and benefits from the system, however the data input requirements and analysis may be onerous. |



AT&T 10x Case Study:

"Efficiency-as-a-Service" Enables AT&T to Reduce Lighting Bills and Emissions

AT&T 10x Case Study:

"Efficiency-as-a-Service" Enables AT&T to Reduce Lighting Bills and Emissions

AT&T believes technology plays a critical role in reducing carbon emissions and we are using the power of our network to create a better, more sustainable world. We've set a 10x carbon reduction goal to enable carbon savings 10 times the footprint of our operations by the end of 2025. To meet this goal, we're working companywide to make our own 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 improve efficiency, and is one in a series sharing our learning as we make progress toward our 10x goal. For more information about our goals, our progress, and to view more case studies like this, visit AT&T's [10x website](#).

The Challenge:

Overcoming the Upfront Costs of Energy Efficiency. Companies are increasingly focused on energy efficiency for a variety of good reasons. Using energy more efficiently can help businesses reduce costs and address stakeholder expectations to decrease emissions and associated climate impacts. Improving energy efficiency typically requires replacing aging equipment with more energy-efficient technologies – often requiring significant upfront capital expenditure that can make it difficult to justify the required investment. Organizations need a model to overcome that challenge and boost energy efficiency.

"Since 2008, the AT&T Energy Program has aggressively pursued energy efficiency projects at our facilities. There came a point in time when the readily-fundable projects – those with high return on investment – were gone. We needed a way to continue the momentum, and EaaS helped us overcome funding hurdles and expand our portfolio of projects tremendously."

– John Schinter, Assistant Vice President, Energy, AT&T

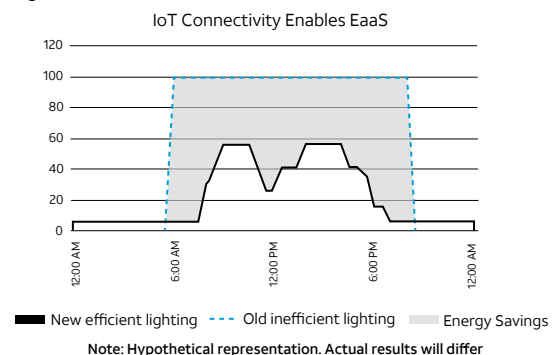
The Solution:

Efficiency-as-a-Service (EaaS) can create immediate electricity and cost savings without upfront capital investment. Using AT&T Internet of Things (IoT) connectivity, EaaS providers can accurately measure and model the energy savings that companies can realize through implementation of energy-efficient technologies. That information helps EaaS providers generate immediate electricity cost savings for their users, while also allowing them to pay for the installation of the technology over time.

How does the EaaS model work?

Consider the electricity usage pattern for lighting in a typical office building in which the lights are usually on during working hours, and low at night. As you can see in Figure 1, more efficient smart lighting can help reduce the electricity needed to power the lights, and sensors can help ensure they are only turned on when needed. Although these equipment upgrades can produce significant savings on utility bills, upfront investment costs can be prohibitive. EaaS providers help companies

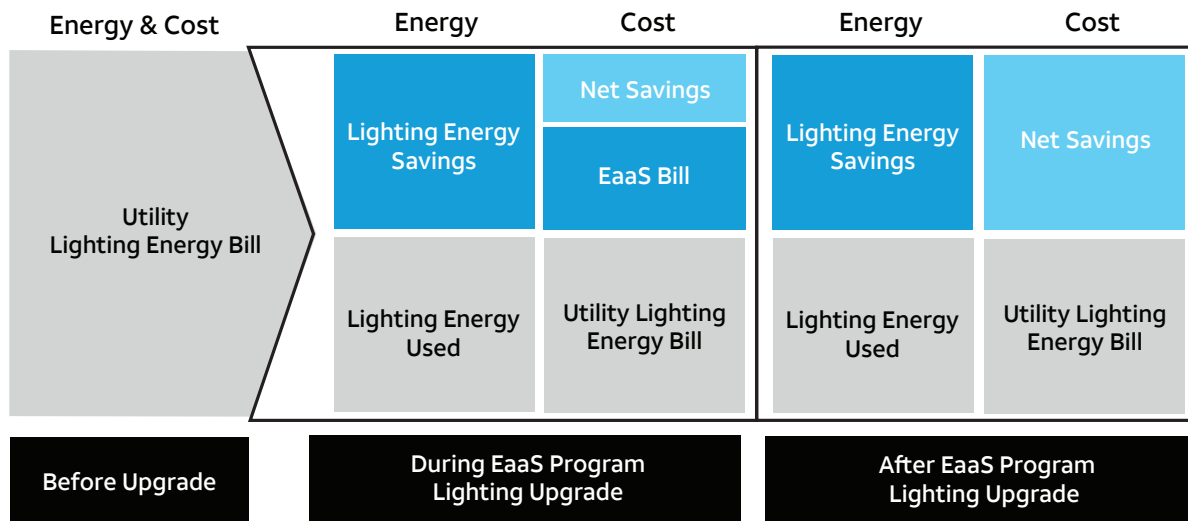
Figure 1:



overcome that barrier by using cost models to accurately demonstrate energy savings that could be realized by installing energy-efficient smart lighting technologies. Based on that information, the company and the EaaS provider may enter into an agreement under which the EaaS provider agrees to fund installation and maintenance of the energy efficiency technology, including IoT connectivity. This system sends almost real-time lighting usage information to a centralized system that measures and validates electricity savings for their customer.

As depicted in Figure 2, when engaged in a typical EaaS program, the company pays two electricity-related bills – one a significantly decreased bill to its electric utility, and one to the EaaS provider based on the amount of energy cost savings enabled by the energy-efficient technology. While there are two bills, the total cost on those bills is typically only 75-90% of the bill before the efficiency upgrade, thereby producing an immediate utility savings for the company. These payments continue until the EaaS provider has been compensated (typically 5-10 years), after which the company retains the energy-efficient equipment and enjoys the full financial benefits of the reduced energy usage – an energy budget reduction windfall.

Figure 2:



AT&T IoT connectivity makes the invisible visible by helping EaaS providers accurately quantify the energy efficiency of the new equipment, allowing customers to see and get the benefit of those savings without incurring large upfront costs and waiting months or years for savings to prove out.

"A key component to this program is the ability to meter the savings and collect the data in near real-time. Metering allows us to see how much energy was saved in a given month, which in turn allows us to accurately make the EaaS payment for the energy savings that were delivered in that month."

– Robert Butrico, Senior Energy Manager, AT&T

AT&T's Implementation: An EaaS solution using AT&T IoT connectivity has been used to deploy efficient lighting systems at hundreds of AT&T facilities, including administrative buildings, data centers, retail stores, work centers and telecommunications equipment buildings across the United States. We expect this program to continue to expand in the coming years as we look at ways to use this model for different applications and in more buildings. We are also working with technology and business collaborators to leverage AT&T IoT technology to create EaaS programs that enable similar benefits for companies that are having trouble funding energy efficiency projects in administrative and retail buildings.

Sustainability Impact Overview: By overcoming investment hurdles, the EaaS model allows AT&T to install more energy-efficient equipment, reducing emissions from purchased electricity. The new equipment also typically has lower maintenance requirements, thus reducing fuel use from truck trips. As of the end of 2017, the EaaS program enabled AT&T to reduce electricity consumption in **647 facilities** that produced almost **\$20M** of annual avoided electricity utility payments, and reduced electricity usage by **183 million kilowatt hours**. That's the equivalent of over **97,500 metric tons** of CO₂e. These greenhouse gas emissions are equivalent to:



Not consuming almost 11M gallons of gasoline¹ or



Taking almost 21K cars off the road² or



33 wind turbines running for a year³

"Our corporate sustainability initiatives at AT&T are built on the fundamentals of the triple bottom line. As such, financial responsibility is critical to our continued success, and the EaaS program has been a tremendous asset in helping us grow our environmental programs in a financially responsible manner."


– Charles Herget, AVP Sustainability Integration, AT&T

¹ <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>


² Ibid.

³ Ibid. (however, using the electricity kWh saving figures rather than the conversion with marginal national US factors used in the EPA equivalencies calculator)

Our typical office building⁴ achieved energy savings of over 500,000 kWh each year with EaaS. If this solution were deployed at **1,000** similar office buildings across the US, it could contribute to annual carbon savings of almost **280,000 metric tons** CO₂e, equivalent to:

 Not consuming over 30M gallons of gasoline⁵ or

 Taking almost 60K cars off the road⁶ or

 89 wind turbines running for a year⁷

Using the EaaS program, AT&T:

1. Realizes the electricity and carbon-saving benefits of more efficient equipment without up-front investment,
2. Reduces recurring electricity expense slightly from the beginning of the program term,
3. Reduces electricity expense dramatically and retains the use of the high-efficiency equipment after the term of the program, typically 5 – 10 years.

4 Average for AT&T administration buildings (excluding non-office buildings and data centers).

5 <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>

6 Ibid.

7 Ibid. (however, using the electricity kWh saving figures rather than the conversion with marginal national US factors used in the EPA equivalencies calculator)

Carbon Impact Methodology

Carbon Trust and BSR (Business for Social Responsibility) collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's technology. The details of the methodology can be found on the [AT&T 10x](#) website. Here is a brief summary of the analysis for this case study:

| | |
|---|--|
| Description of the Enabling Technology | AT&T connectivity enables Efficiency-as-a-Service (EaaS) providers to track energy and cost savings resulting from an upgrade in energy-efficient equipment. The AT&T EaaS case study focuses on lighting equipment (e.g. LED lightbulbs, sensors and control systems). AT&T connectivity plays a fundamental role in enabling the EaaS model, as without the connectivity the third party funding partner would not be able to track energy savings and the lack in certainty would prevent the initial investment. |
| Impact Category | This case study focuses on carbon impacts |
| Materiality | In facilities where renewable energy is unavailable, electricity use produces greenhouse gas emissions that contribute to climate change. AT&T is developing solutions to reduce energy use and its resulting emissions and climate change impacts. |
| Attribution of Impacts | The carbon savings in this solution are attributed to AT&T, as its connectivity technology plays a fundamental role in enabling the solution. These savings will result in a reduction in AT&T's Scope 2 carbon emissions. |
| Enabling and Rebound Effects | |
| Primary Effects | New energy-efficient lighting equipment allows AT&T to save energy and reduce their carbon emissions. |
| Secondary Effects | Using LEDs rather than heat-intensive fluorescent bulbs lowers cooling (HVAC) requirements. LEDs also have higher life expectancy, reducing the number of maintenance trips required to change lightbulbs. |
| Rebound Effects | None |
| 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 burden from the enabling technology is the embodied carbon emissions associated with the new equipment and the trips (referred to as truck rolls) required for installation. |
| Carbon Abatement Calculation | |
| Scope | The carbon abatement calculation provides the total carbon saved by AT&T in 2017 through the EaaS program minus the additional carbon emissions from the truckrolls required for the installations of the new equipment. |
| Timeframe | Calculations in this case study were performed using data from 2016 and 2017. Savings data for 630 facilities was collected in 2016 and assumed to be consistent in 2017. Savings data from 17 additional facilities were collected in 2017 and added to the original set from 2016. |
| Functional Unit | The carbon abatement factor calculates the carbon savings (metric tons CO ₂ e) per facility using more energy-efficient lighting equipment. |

| | |
|--------------------------------|--|
| Methodology | Energy savings are calculated using metered energy consumption. The metered energy savings are then converted into carbon savings using Environmental Protection Agency (EPA) emission factors. Savings from decreased cooling requirements are assumed to be 40% of metered energy savings. The total number of truck roll miles is calculated using the average number of truck rolls and the average distance per truck roll. The number of total truck roll miles is converted into carbon emissions using EPA emission factors. |
| Key Assumptions | For sites with no truck roll data we assumed 2 truck rolls per year driving a distance of 56 mile one-way trip based on average truck roll data. In total, the carbon emissions from truck rolls are equivalent to only 0.002% of the total avoided carbon from reduced energy use in lighting. |
| Exclusions | <ul style="list-style-type: none"> • Embodied carbon emissions associated with equipment (e.g. LED lights; sensors; etc.) • Carbon savings associated with reduced maintenance trips to site (due to longer lifetime of LED lights) |
| Data Sources | <ul style="list-style-type: none"> • Metered savings from EaaS for 2016 and 2017 • EPA emission factors eGRID 2016 combined with Defra 2016 Well-to-Tank emission factors • Number of truck rolls per installation by site |
| Results | |
| Carbon Abatement Factor | <ul style="list-style-type: none"> • 151 metric tons of CO₂e per facility for all facilities included in this case study, including administrative buildings, data centers, retail stores, work centers and telecommunications equipment buildings across the United States. • 280 metric tons of CO₂e per facility for administrative buildings in the United States. |



AT&T 10x Case Study:

Connected drones reduce cost and environmental impact of water tank inspections



AT&T 10x Case Study:

Connected drones reduce cost and environmental impact of water tank

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 goal to enable carbon savings 10x the GHG footprint of our operations by the end of 2025.

To meet this objective, we're working to make our operations more efficient across the company. 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.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

In order to maintain a clean and safe water supply for their communities, water utilities take water storage tanks out of service every 3-5 years to conduct inspections. If water utilities joined drones and remotely operated vehicles (ROVs) with secure AT&T Internet of Things (IoT) connectivity and a video analysis platform, they could keep their tanks in service, reduce inspection time, and avoid unnecessary risk of injury. If utilities used this method to inspect 10% of the water tanks in the U.S., they could save about **1 billion gallons** of wasted water, reduce greenhouse gas (GHG) emissions by roughly **2,000 metric tons of CO₂e**, and lower inspection costs by approximately **\$12 million** every year.

Background

Where does our water come from? When we turn on the faucet, we take for granted that we will receive clean, safe water. Water utilities in the U.S. are responsible for providing 322 billion gallons per day¹ of potable water to their customers. The primary function of water tanks is to ensure a continuous and reliable supply of water to local communities. Amidst a background of aging infrastructure, inspecting and maintaining the structural integrity, sanitary conditions, and security of water storage tanks is increasingly important. In the U.S. alone, there are over 115,000 water tanks across over 146,000 public water systems.²

Estimated annual benefits if used on 10% of water tanks in the U.S.



1B Gal
of water saved



2,000
metric tons CO₂e
avoided



\$12M
in inspection
costs saved



300,000
out-of-service
hours saved

1 "Total Water Use in the United States," U.S. Geological Survey, August 16, 2019, https://www.usgs.gov/special-topic/water-science-school/science/total-water-use-united-states?qt-science_center_objects=0#qt-science_center_objects.

2 "SDWIS Federal Reports Advanced Search," U.S. Environmental Protection Agency, August 16, 2019, <https://ofmpub.epa.gov/apex/sfdw/f?p=108:1::NO:1::>



The American Water Works Association (AWWA) recommends comprehensive inspections are conducted on water tanks every 3 years,³ but a report by the Environmental Protection Agency (EPA) found that most facilities inspect every 6 to 8 years, which could prevent significant structural and sanitary issues from being detected.⁴ In addition, the AWWA recommends routine visual inspections are conducted externally daily or weekly and periodic inspections are conducted monthly or quarterly to check for deterioration of coatings or obvious signs of water quality problems.

Drones are increasingly being used for 'intelligent inspections,' which includes the inspection service and analytics on the collected data. This type of information is a value-add to businesses and utilities, with Boston Consulting Group estimating that the services and data from drones will represent \$23 million of the \$50 million total drone market by 2050.⁵ In addition to drones, which provide aerial inspections, ROVs provide underwater inspections. Special accessories, such as thickness gauges and rotating arms, can enhance inspection capabilities and allow ROV-based inspections to deliver similar accuracy to that of people-based inspections with lower cost, time and risk of injury.

The Challenge: Reduce environmental impact, safety risks and operational costs of comprehensive water storage tank inspections

Typically, utilities hire third parties to conduct a comprehensive external and internal inspection to look at structural, sanitary, coating, safety and security conditions of its water storage tanks.

For internal inspections, most utilities conduct a washout inspection in which they take the tank out of service and drain the water into a nearby ditch or creek. Utilities have to plan inspection logistics carefully to ensure they can still meet customer demand and drain the tank slowly enough to avoid flooding areas downstream. Some utilities simply can't afford to take a tank out of service due to customer demand, which often leads to infrequent or incomplete inspections.

This method wastes millions of gallons of potable water, and can be expensive and time consuming, with costs ranging from \$10,000 to \$20,000 per tank and taking up to two weeks to drain, inspect, test, and refill the tank before putting it back into service.

For external inspections, inspectors use a cherry picker, scaffolding or climb the tank. These methods, while relatively inexpensive, require extensive logistics and coordination, waste energy to use heavy machinery, and create safety concerns for inspectors climbing the tanks. In addition, it's hard for inspectors to get a full view of the tank, limiting their ability to find issues with corrosion or coating on top of the tanks.

Once the inspections are complete, the utility receives a final inspection report, typically about a week later, which includes pictures and notes from the inspection company. Utilities then use the report to create maintenance requests or submit proposals for larger capital works projects. Sometimes they will input this data into an asset management system, but typically the report is simply archived. Limited data management and analysis prevent utilities from executing further data analysis that would help them more easily and efficiently manage issues over the life of the tank.

Challenges of typical water tank inspections:

- Wastes treated water
- Takes tank out of service
- Uses excess energy for scaffolding, machinery, and multiple trips to the site
- Prevents inspection of hard to reach areas of the tanks
- Creates safety concerns for inspectors

3 American Water Works Association Manual M42, 1998

4 "Finished Water Storage Facilities," U.S. Environmental Protection Agency, August 15, 2002, https://www.epa.gov/sites/production/files/2015-09/documents/2007_05_18_disinfection_tcr_whitepaper_tcr_storage.pdf

5 Alexandre Amoukته, Joel Janda, and Justin Vincent, "Drones Go To Work," Boston Consulting Group, April 10, 2017, <https://www.bcg.com/publications/2017/engineered-products-infrastructure-machinery-components-drones-go-work.aspx>



The Solution: Pairing drones and ROVs with a drone video platform saves water, energy, time, and money and creates valuable data for asset maintenance



By using drones and ROVs, utilities can keep their tanks in service, avoid dumping millions of gallons of potable water on the ground and reduce cost and safety concerns. This method also enables utilities to collect and analyze better, real-time data.

Outside the tank, the drone operator flies the drone around the storage tank and takes video of the tank from all angles. The drone communicates with an AT&T IoT-enabled drone video platform developed by AT&T's business partner, KSI Data Sciences, which uses AT&T's network to deliver high quality video where it can be quickly analyzed. By providing higher levels of security, an ability to scale, and faster data processing, the network also enables data analytics.

On the ground, the inspector and water utility staff watch streaming video of the inspection. The video is streamed in near real-time to the cloud for inspectors or utility staff to collaborate with the drone operator. This feature allows both onsite and offsite staff to zoom in on areas of interest and instruct the operator to investigate areas that need closer examination.

Inside the tank, a sanitized ROV navigates the rafters and other obstacles in the tank to measure coating thickness, detect cracks and corrosion, and clean sediment out of the tank. Similarly, the drone video platform uses the AT&T network to stream video to the cloud and help identify areas that need closer inspection. The platform can also integrate a utility's existing sensors or cameras to monitor the overall health of the tank, plan for risks, and accurately predict future maintenance.

Collecting accurate data and applying analytics are crucial to identifying predictive maintenance opportunities. According to Deloitte, predictive maintenance can increase equipment uptime by 10 to 20% and reduce maintenance planning time by 20 to 50%.⁶ The streaming video can be combined with analytics software to help utilities quickly and clearly identify areas that need maintenance, such as:

- Identifying precise GIS locations of cracks, leaks, or other structural weaknesses and determine the severity and urgency of repair required
- Running change detection analysis to compare footage from past inspections and identify any major variations, including corrosion, vegetation, or effects of natural disasters
- Determining whether there is sediment in the tank, and use special ROV accessories to remove unwanted debris or check coating thickness
- Developing a 3D photogrammetry model of the site, which can be used for monitoring and surveying changes in the site, for example after a storm or natural disaster

⁶ "Predictive Maintenance," Deloitte Analytics Institute, Issue 7/2017, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/deloitte-analytics/Deloitte_Predictive-Maintenance_PositionPaper.pdf



Technology in action at local water utilities



To understand the potential benefits of this type of solution, consider a local water utility with 12 water storage facilities delivering 7 million gallons of water every day to 85,000 customers. By using drones and ROVs, this utility could reduce its wasted water annually by **1.3 million gallons** while reducing water costs by around **\$5,000 and \$20,000** in inspection costs, not including potential savings from avoided energy and operational costs. In addition, they could save almost **500 hours** of out-of-service time by conducting an inspection in **1 day instead of 1-2 weeks**, reducing risk of injury and contamination. Finally, they could reduce GHG emissions by up to **3 metric tons of CO₂e** per year due to avoided travel and avoided electricity for treating and pumping water that was previously dumped.

Synergistic Solutions International (SSI), an AT&T drone business partner, has used the system to help solve another type of problem: lost equipment. While conducting maintenance on a pipe running from the water treatment plant to

the ground storage tank 600 feet away, a hose inflating a plug in a point of entry to the pipe snapped, deflating the plug and sending it into the pipe. If the plug created a blockage in the pipe, it would have disrupted service to the utility's customers. Typically, the utility would have had to dig up the ground around the pipe and drill a hole every 10-20 feet until they were able to find and rescue the plug. This would have required an immense amount of fuel, time, and money to dig up and replace the pipes.

By using an ROV, the SSI team was able to find and remove the plug in 3 days, saving the utility around \$340,000. While explicitly measuring other benefits is challenging, it's safe to say that the utility saved significant amounts of water, energy, and time with the ROV and prevented costly service interruption to their customers.

“Drones collect data that other sensors can't access, which, combined with the drone video platform, allows customers apply analytics in real-time and uncover trends they weren't aware of before.”

Chris Keon,
CEO, Synergistic Solutions International

“Combining AT&T's secure IoT connectivity with drone-provided data enables us to provide a video analysis platform that can save our customers time, money, and water.”

Jon Gaster, CEO, KSI Data Sciences



Sustainability Impact: Taken for granted, water tanks offer opportunity for tech-enabled efficiency

We see them in rural towns and in our suburban neighborhoods: water tanks are so commonplace and taken for granted that they almost become invisible. Combined with the pipes connecting them, they are the backbone of the of the U.S. water infrastructure, with over 115,000 dotted across the country.⁷

Water tanks are critical infrastructure, but their maintenance and upkeep can be expensive, dangerous and environmentally wasteful. Drones and ROVs, paired with secure connectivity, create an effective alternative to the traditional way of doing inspections. If just 10% of water tank inspections transitioned to this method, 2,300 inspections each year would achieve water savings of **over 1 billion gallons** of water and GHG emissions reductions of nearly **2,000⁸ metric tons of CO₂e** annually. Utilities could also save around **\$12 million** and nearly **300,000 hours** of out-of-service time per year. This is equivalent to:



Taking almost **430**
cars off the road



Not burning almost **225,000**
gallons of gasoline



Switching almost **67,000**
incandescent bulbs to LEDs⁹

⁷ "SDWIS Federal Reports Advanced Search," U.S. Environmental Protection Agency, August 16, 2019, <https://ofmpub.epa.gov/apex/sfdw/f?p=108:1::NO:1::>

⁸ 115,818 sites* 10% * per site emission reduction calculation of 0.17 metric tons of CO₂e = 1,993

⁹ "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> (Note, the average eGRID electricity factors have been used rather than the marginal AVERT electricity factors, this being a more conservative estimate of the savings).



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. The 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 | <p>AT&T connectivity enables the inspection of water tanks using drones and ROVs. This provides a more energy and time efficient method to inspect the tanks by avoiding the need to drain and refill the water tank for each inspection. It also reduces the number of times the inspection team has to travel to the water tank and it avoids the need to transport heavy equipment (i.e. scaffolding or cherry pickers) to the site. Similarly, using drones and ROVs enables water tank maintenance operators to fix issues, such as a lost plug in a pipe, in a quick and less disruptive manner.</p> <p>Real-time scanning data and live video is sent via AT&T's network to enable faster inspection.</p> |
| Impact Category | <p>This case study focuses on the cost, water and energy savings resulting from the implementation of drone and ROV inspection methods at water tank sites, and the GHG impact associated with these savings.</p> |
| Materiality | <p>Using drones and ROVs to inspect water tanks reduces the cost, emissions, time and water loss associated with the traditional method of inspecting water tanks.</p> <p>The environmental and financial benefits arising from this approach enabled by AT&T connectivity could encourage widespread adoption of improved water tank maintenance and management, thus delivering scalable environmental benefits.</p> |
| Attribution of Impacts | <p>The cost, emissions, time, and water savings described in this case study are a result of changes to the water tank inspection and maintenance practices supported by drone and ROV technology and AT&T IoT connectivity.</p> |
| Primary Effects | <p>The drone monitoring and scanning system enables more efficient inspection of water tanks, avoids the need to drain and refill the water tank, and thus reduces the energy, water, and time used for inspecting and maintaining the water tanks.</p> |
| Secondary Effects | <p>There are also reduced emissions from delivery and water supply infrastructure as smaller vehicles and less pumping equipment is required.</p> <p>The inspection company may also have lower insurance costs.</p> |



| | |
|---|---|
| Rebound Effects | There are also reduced emissions from delivery and water supply infrastructure as smaller vehicles and less pumping equipment is required. |
| 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 embodied and in-use carbon emissions of the drones and ROVs, which will be minimal compared with the emissions reductions. |
| Scope | The scope for this case study covers the comparison between the use of drones and ROVs to inspect a water tank and the traditional water tank inspection method, which involves draining the tank. The case study also assesses the impacts of using drones to fix specific water tank issues compared to traditional repair methods. |
| Timeframe | Savings were calculated on a yearly basis, even though inspections only occur every 3 to 5 years. |
| Functional Unit | The functional unit for the carbon emissions reduction is metric tons CO ₂ e per tank per year. The functional unit for water reduction is U.S. gallons of water used per tank per year. The functional unit for cost savings is U.S. dollars per tank per year. |
| Methodology | <p>The GHG emissions reductions were calculated by comparing the emissions associated with the traditional water tank inspection method and the drone-enabled inspection method.</p> <p>For the traditional method of inspection, the carbon emissions were calculated for the transportation of equipment and staff to and from the water tank site and the draining and re-supplying of water to the water tank. This was then compared to the emissions associated with the drone/ROV inspection method, which involved less transportation of staff to the water tank sites and no requirement to drain or re-supply the tank with water but included the emissions from the use of the drones and ROVs during the time of inspection.</p> <p>The GHG emission reductions were also calculated for comparing the use of an ROV against a traditional method of finding a lost plug. For the traditional method of solving a lost plug, the carbon emissions are calculated by estimating the emissions from the heavy equipment used to dig to the pipe, as well as create and weld a hole in the pipe. This was then compared to the emissions associated with using an ROV to fix the issue, which required only digging one hole and welding it back together.</p> |



Key Assumptions

- Average capacity of a water tank: 500,000 gallons of water
- Time to refill water tank: 6 hours
- Height of water tank: 300 feet or 100 meters
- Price of water: \$3.70 per 1,000 gallons
- Cost of traditional inspection method per tank: \$10,000
- Cost of drone inspection method per tank: \$5,000
- Frequency of water tank inspections: between 3 and 5 years. Assumptions for example utility were 3 years based on county data. Extrapolated assumptions used 5 years for most conservative calculation.
- Average distance from nearest town to water tanks: 31.4 miles
- Approximate power rating of water pump: 120kW
- Approximate power consumption of ROV: 0.18kW
- Use of ROV for inspection: 11.5 hours
- Approximate power consumption of drone: 3kW
- Use of drone for inspection: 1 hour
- Number of holes required to find lost plug using traditional method: 56
- Number of holes required to find lost plug using ROV: 1

Exclusions

- The embodied emissions of the drone and ROV devices, as well as emissions related to data communication processing.

Data Sources

- Water tank data during interviews with several water utilities across the U.S.
- Pump data. Example data retrieved from <https://product-selection.grundfos.com>
- Drone data. Example data retrieved from <https://www.dji.com/uk/matrice-200-series/info>
- ROV data. Example data retrieved from http://download.videoray.com/documentation/mss/html_defender/equip_connections.html
- EPA. Emissions & Generation Resource Integrated Database (eGrid 2016). Retrieved from <https://www.epa.gov/energy/emissions-generation-resource-integrateddatabase-egrid>
- DEFRA. Greenhouse gas reporting: conversion factors 2019.
- Retrieved from <https://www.gov.uk/government/publications/greenhouse-gas-reportingconversion-factors-2019>



| | |
|--------------------------------|--|
| Carbon Abatement Factor | The result of using drones and ROVs leads to carbon savings of 0.17 tCO ₂ e per year for a 500,000 US gallon tank, inspected every 5 years. Extrapolating this to 10% of water tanks in the US would lead to savings of 1,993 tCO ₂ e. |
| Water Savings Factor | Avoiding the need to drain a water tank every 5 years for inspection leads to savings of 100,000 gallons per year for every 500,000 US gallon tank. |
| Lessons Learned | The carbon savings are relatively low, although there are other environmental savings (reduced water wastage) and cost savings. Most of the carbon savings are from avoiding the re-supply and pumping of water to refill the tanks. |



AT&T 10x Case Study:

AT&T FlexWareSM puts common network functions on one device, reducing space, electricity usage, and emissions



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AT&T FlexWareSM puts common network functions on one device, reducing space, electricity usage, and emissions

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 goal to enable carbon savings 10x the GHG footprint of our operations by the end of 2025.

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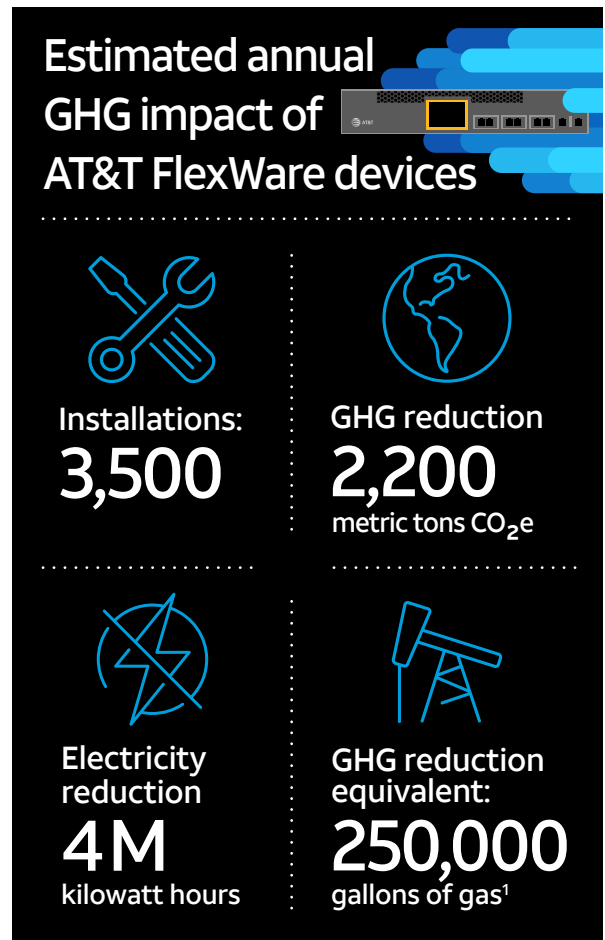
Summary

As companies create their next generation networks based on cloud computing and server virtualization, the ability to dynamically control network capacity becomes increasingly important. In traditional networks, specific functions require specialized hardware, typically proprietary, and usually from different vendors. Routers, firewalls, and wide area network (WAN) accelerators each require electricity to run and be cooled, and when updates are needed, technicians usually must make manual changes, box by box, often across many locations. AT&T FlexWare allows companies to deploy a variety of these functions on one general-purpose piece of hardware. Built on the concept of Network Function Virtualization (NFV), AT&T FlexWare enables users to:

- run multiple applications on a single device
- mix and match applications based on location needs
- logically connect applications together.

This not only simplifies and streamlines network deployment and management, but it can also help lower capital expenses, reduce power and cooling requirements, and increase operational efficiency.

Based on average electricity savings achieved from moving three applications to one FlexWare device, it is estimated that each FlexWare device can reduce electricity by 130 watts. If 3,500 of these devices were to be installed and perform the functions previously performed by a router, firewall, and WAN accelerator, the annual energy savings would be an estimated **4 million kWh**, reducing greenhouse gas (GHG) emissions by over **2,200 metric tons of CO₂e**. This is equivalent to the emissions from more than **250,000 gallons of gasoline**.¹





The Challenge: Managing distributed network equipment requires power and cooling, generating GHG emissions

As companies become more focused on reducing GHG emissions through energy efficiency, business leaders are looking for ways to reduce electricity usage and costs. For many companies, a hidden energy cost is in their network equipment, frequently with a wide collection of different types of equipment performing unique critical functions. In addition to the costs associated with running these pieces of hardware, there is also the cost and emissions associated with the electricity used to keep the equipment cool. So, in addition to the inherent challenges of managing this diverse set of equipment, this traditional setup also adds to the energy usage — and GHG emissions — of a company.

Challenges of a traditional network:

- Different platforms increase complexity
- Updates can be slow and costly
- Hidden energy usage

The Solution: AT&T FlexWare consolidates equipment, helping reduce electricity demand and emissions

AT&T FlexWare allows businesses to deploy multiple network functions on a single device while replacing traditional purpose-built hardware. The solution uses a single software-controlled device to perform multiple virtual functions that would otherwise require separate traditional hardware devices. Traditional services manage many individual appliances, each with its own software, and they perform a specific function like a router does. In contrast, the standard AT&T FlexWare device replaces the traditional appliance and supports up to three virtual services, which would normally require several individual hardware devices.

These virtual managed services streamline the service assurance and availability process by performing multiple virtual functions — such as routing, firewall protection, and WAN acceleration — on the device. Because the service reduces the number of physical proprietary appliances, it can help customers reduce data center and equipment space, which helps reduce maintenance and energy costs as well as the carbon footprint. In addition to the energy savings potential from AT&T FlexWare, businesses can also recognize other critical benefits:

Speed — Quickly deploy and configure

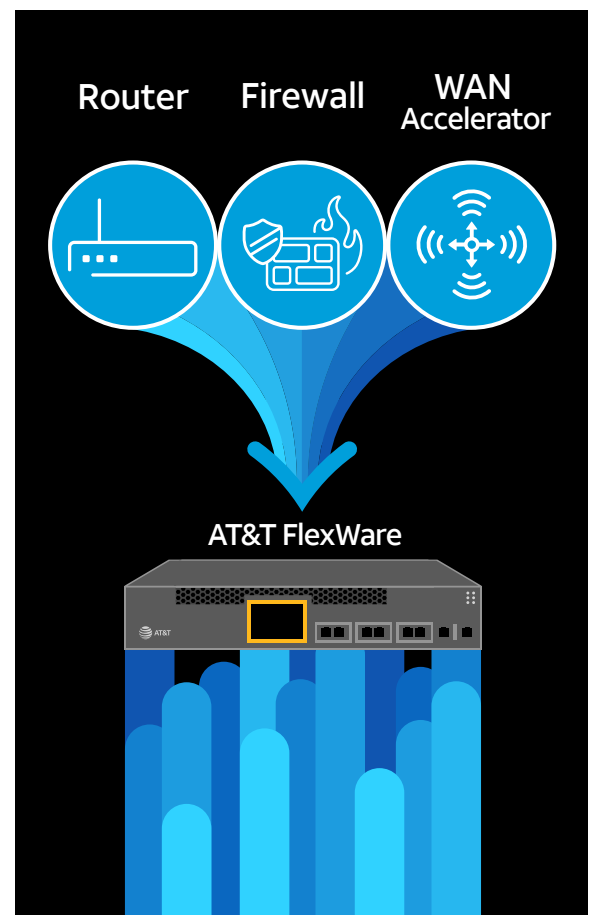
Simplicity — Network infrastructure and management

Cost efficiencies — Competitive total cost of ownership

Reliability — Redundancy and security options

Customizable — Mix and match locations with solutions, platforms, and devices

Scalable — Future ready your investment as your business evolves





Customer Impact: AT&T FlexWare provides benefits across industries

Many Fortune 500 companies are beginning to expand their use of the FlexWare equipment as they begin to realize the benefits. From insurance and apparel companies to manufacturers and municipalities, AT&T customers are beginning to adopt FlexWare to modernize their networks. FlexWare is now available in over 200 countries and territories, and as AT&T FlexWare evolves to accommodate more types of services, we expect demand for the solution to grow.

Sustainability Impact: As AT&T FlexWare use becomes more common, energy savings mount

The benefits of the system also translate into reduction of environmental impact. Working with Carbon Trust, a leading non-government organization with extensive experience in GHG measurement, we've used average electricity usage of traditional network equipment — routers, firewalls, and WAN accelerators — and compared them to the electricity usage of the AT&T FlexWare device.

It is estimated that each AT&T FlexWare device can reduce electricity by **130 watts**. As an example, if AT&T customers were to use 3,500 FlexWare devices to perform the functions previously performed by a router, firewall, and WAN accelerator, annual energy savings would be an estimated **4 million kWh**, generating over **2,200 metric tons** of greenhouse gas (GHG) emissions. This is equivalent to:



Taking almost **475**
cars off the road



Not burning more than
250,000 gallons of gasoline



Switching almost **85,000**
incandescent bulbs to LEDs



Applying the 10x Carbon Impact Methodology

Carbon Trust and Business for Social Responsibility (BSR), two leading non-government organizations with extensive experience in GHG measurement, collaborated with AT&T in the development of a methodology to measure the carbon benefits of this AT&T technology. The details of the methodology can be found on the AT&T [10x website](#). The following table summarizes how the 10x methodology was applied to estimate the environmental impacts described in this case study:

| | |
|---|--|
| Description of the Enabling Technology | The AT&T FlexWare device enables the replacement of multiple purpose-built hardware devices with a single hardware device capable of delivering several network functions. |
| Impact Category | This case study focuses on the net electricity savings resulting from powering and cooling fewer hardware devices and the greenhouse gas (GHG) impact associated with these savings. |
| Materiality | Performing multiple network functions in a single device reduces the electricity consumption required compared to a traditional network. The GHG emissions reductions relate to the production of grid-supplied electricity. |
| Attribution of Impacts | The carbon savings described in this case study are a result of the AT&T software-controlled FlexWare device offering the same functionality as multiple purpose-built hardware devices. |
| Primary Effects | The AT&T FlexWare device allows customers to save electricity and reduce their carbon emissions. |
| Secondary Effects | Using one device rather than multiple devices to perform the same functions lowers cooling requirements and also reduces the demand for the production of multiple purpose-built devices and the associated embodied carbon emissions. |
| Rebound Effects | None identified. |
| Trade-Offs or Negative Effects | Server virtualization relies on cloud computing to update/install software, which has its own electricity demands that are difficult to attribute to individual users. |
| Carbon Burden from the Enabling Technology | The carbon from the enabling technology is the embodied and in-use phase carbon associated with the AT&T FlexWare device. |
| Scope | The scope of carbon abatement covers an example of 3,500 FlexWare devices. |
| Timeframe | Calculations estimated the savings for the calendar year 2018. |



| | |
|--------------------------------|--|
| Functional Unit | The functional unit for avoided GHG emissions is expressed as kg CO ₂ e per device. |
| Methodology | <p>Estimated savings per device were estimated based on the average power of a typical router, firewall, and WAN accelerator devices on the market at the time of research.</p> <p>Net savings were calculated by subtracting the FlexWare power requirements from the total power requirements of the devices listed above, before applying energy savings associated with avoided cooling requirement, estimated to be an additional 30% of the energy savings.</p> <p>The electricity saving was converted to a carbon saving using the EPA eGRID average emission factor for the US plus upstream and transmission and distribution (T&D) losses from DEFRA.</p> |
| Key Assumptions | <ul style="list-style-type: none"> • Implementation of FlexWare will always result in the replacement of three devices (router, firewall, and WAN accelerator) with a single FlexWare device. • Devices are in operation 24 hours, 365 days per annum. • Savings from decreased cooling requirements are assumed to be 30% of calculated energy savings. The 30% HVAC energy saving figure is based on the ASHRAE² guidelines that 30 to 35 watts of cooling is required to offset the heat output for every 100 watts used. • We have assumed that the majority of FlexWare devices are installed in the U.S. |
| Exclusions | We excluded the embodied emissions of the AT&T FlexWare device and the replaced devices, as well as the power required to run cloud computing services. |
| Data Sources | <ul style="list-style-type: none"> • Replaced device specifications available on respective vendor's websites. • EPA — Emissions & Generation Resource Integrated Database (eGrid 2016). Retrieved from https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid • DEFRA — Greenhouse gas reporting: conversion factors 2018. Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018 |
| Carbon Abatement Factor | 638 kg CO ₂ e per device per year |

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²[American Society of Heating, Refrigerating and Air-Conditioning Engineers](https://www.ashrae.org)