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
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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

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. (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).

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 higher than that of their fresh counterparts.”

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. 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


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.

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 industrial.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 industrial.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 industrial.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, industrial.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 industrial.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, industrial.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.

![Temperature (F) vs. Energy Consumption](image)

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 industrial.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 industrial.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, industrial.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 industrial.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 industrial.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 industrial.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 | 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. 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. |
| Impact Category | 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. |
| Materiality | 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. |
| Attribution of Impacts | 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. |
| Relationship to Systems | 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. 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. |
| Primary Effects | 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. |
### Secondary Effects

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.

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.

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.

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.

### 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 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 CO₂e per facility, or as kg CO₂e per ton of produce frozen (inbound + outbound).

#### Methodology

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.

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.

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.

#### 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

- Electricity data provided by Lineage Logistics
- Production data provided by Lineage Logistics

## Results

### Carbon Abatement Factor

Annual carbon savings were calculated as an average for the three years 2015, 2016 and 2017 as: 1,400 tCO₂e per cold storage facility, or 9.4 tCO₂e 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.