Chartwell

Manufacturing Leader's Guide to Energy Reduction

Transforming Manufacturing Through Strategic Energy Reduction

Table of Contents

Overview

In today's rapidly evolving industrial landscape, the imperative to adopt sustainable practices has become increasingly apparent. Energy efficiency stands at the forefront of these efforts, promising environmental benefits, economic advantages and an enhanced public image.

While sustainability efforts are oftentimes framed as oppositional to financial growth, Chartwell is dispelling those myths. In this eBook, we’ll dive into how Chartwell’s methodology, developed to increase capacity and reduce raw material waste, can be applied to reduce energy consumption and improve sustainability - without capital expenditure.

Dispelling myths: Energy reduction ≠ expensive equipment upgrades

Amid the push for sustainability, there are many misunderstandings surrounding the practicalities of adopting energy-efficient strategies. Common misconceptions include the belief that energy-efficiency improvements:

- Require substantial capital investment
- Compromise the quality or features of the product
- Impact customer experience
- Disrupt operations
- Take too much employee resource

Use these insights to understand the three most common misconceptions of reducing energy in manufacturing operations and what simple steps can be taken to make big strides in energy savings.

Myth 1: Achieving energy efficiency requires capital expenditure

When manufacturers think of energy efficiency one of the first things that comes to mind is how expensive it will be to implement sustainable practices into manufacturing processes.

In fact, significant reductions of 5-20% in energy usage can be achieved through minimal capital expenditure (CapEx) strategies. Despite concerns about lengthy payback times and perceived expenses, manufacturers often fail to realize the multitude of opportunities for energy savings without large capital investment. These opportunities can be uncovered by leveraging Chartwell techniques honed through years of process improvement.

Myth 2: Enhancing energy efficiency may harm product quality

Another prevalent misconception is that altering manufacturing processes to enhance energy efficiency may compromise the quality or characteristics of the product. The reality, however, is that the majority of manufacturing processes can be executed more energy-efficiently without changing the core process or end-product.

Myth 3: Customer experience and operational efficiency will be impacted

The impact on customer experience and overall operational efficiency is another common myth surrounding energy reduction. On the contrary, many energy-efficient options lead to operational improvements, such as reduced maintenance requirements. Additionally, consumers and potential employees are increasingly drawn to companies that embrace sustainable practices, making energy efficiency an attractive aspect.

To address these misconceptions, it's critical to adopt strong energy management practices as a fundamental part of operations improvement.

Shifting Perspectives

> "For industrial energy users, I see a lot of companies approaching the task of reducing their emissions as a purely technological or optimization problem. This assumes away the often significant potential there is to reduce the overall amount of energy used in the process, irrespective of the energy source. The benefits of efforts to bring this abosolute energy usage down stretch far beyond simple bottom line savings- regulators are demanding action, employees are engaged and excited by these initiatives and the savings made can be reinvested to get ahead of the competition on price and on the increasingly important product carbon footprint."
>
> **Miriam Hall**
> Partner, Chartwell

Energy efficiency is fundamental to operations

In today's dynamic manufacturing landscape, the traditional metrics of efficiency, such as time, material, and yield, must expand to incorporate energy consumption as a vital measure. Shifting perspectives to recognize energy efficiency as fundamental to operations improvement not only aligns with sustainability goals but also holds significant potential for enhancing profitability and competitive advantages such as enhanced brand value, a greater ability to deliver service to stakeholders or even a continuing license to operate.

Although energy prices stabilized in 2023 compared to high volatility in 2022, this doesn't mean they have reduced. They are still double the level they were in 2021. Due to these recent increases to energy costs, manufacturers can significantly enhance their bottom line and gain a competitive advantage in the market by reducing energy consumption, thus lowering expenses.

Adhering to regulatory requirements and setting and achieving sustainability goals enhances Corporate Social Responsibility (CSR) efforts and improves brand reputation opening doors to top talent and financial incentives such as grants and tax relief.

In the EU, energy makes up between 5.7% and 8.4% of the production costs of sectors such as basic chemicals, man-made fibres, iron and steel, and paper.

Source: Frontier Economics. "How Energy Prices Drive Industry's Competitiveness." Accessed April 9, 2024. https://www.frontier-economics.com/uk/en/news-and-insights/articles/article-i6479-how-energy-prices-drive-industry-s-competitiveness/.

Energy Reduction in Practice

Achieving energy savings is easier than you might think. The following Chartwell success stories demonstrate how implementing energy-efficient measures can yield tangible benefits. These real-world examples debunk some of the common misconceptions and provide inspiration to manufacturing leaders to pursue similar initiatives.

Saving natural gas consumption

Industry: Food manufacturing

Results: 190 tons of CO_2 saved annually in natural gas consumption

By breaking down the energy consumption of a food manufacturer Chartwell were able to identify that the main boiler was operating 40% below the expected efficiency. Fixing the root cause (a worn burner plate and broken controller) saved an estimated 190 tons of CO_2 annually in natural gas consumption.

Increasing plant efficiency

Industry: Continuous polymer manufacturing

Results: 10% reduction in energy per ton of finished product

At a continuous running polymer plant losses in efficiency arose from slow running compared with the bottleneck's potential capacity and downtime due to blockages. In driving up the plant efficiency by reducing variation in key quality parameters and root cause problem solving, the client could produce the same output in 30% less time. This reduced the energy per ton of finished product by 10%.

Optimizing processes

Industry: Chemicals manufacturing

Results: +100 tons of CO_2 saved annually

At a resin manufacturer, understanding technical constraints uncovered that excess solvent was built into the process recipe to compensate for temperature spikes in the reactor. Optimizing this process saved over 100 tons of CO_2 annually.

Making a big impact

Industry: Ethanol manufacturing

Results: Saved +10% of the site energy bill

At an ethanol manufacturer, a detailed energy balance uncovered wet insulation on the main distillation column, saving 2,600 tons of CO_2 annually (over 10% of the site energy bill) once replaced – with an ROI of 50 days.

Energy Scans: Identifying Opportunities

> "You can't improve what you don't measure"
>
> **Peter Drucker**

Identifying opportunities and priorities

In the pursuit of identifying energy efficiency opportunities, a crucial starting point is conducting a comprehensive energy scan.

One powerful Chartwell methodology employed for this purpose is our Zero-Loss Analysis. This methodology seeks to answer the question, "In an ideal scenario, what would be the minimal energy required to complete a given process?"*. By comparing the ideal energy consumption to the actual consumption of the process, we can uncover inefficiencies and areas for targeted improvement.

This understanding encompasses conducting a mass balance, which considers factors like water, waste, and input materials, and an energy balance, which encompasses various energy streams such as gas, electricity, and steam. These balances are conducted around both the actual process and an ideal theoretical process based on engineering and physics principles.

Conducting detailed mass and energy balances for complex processes is no easy task, but there are several key stages.

Key Energy Scan Stages:

1. The scan typically begins with baseline data collection, meticulously quantifying resource inputs and their associated costs throughout the organization. This process extends to assessing the volume and costs of resource outflows and wastes and is as granular as possible (half-hourly, hourly, daily, weekly, or monthly).

2. The team examines historical efforts to improve resource efficiency, evaluates previous studies and recommendations (if relevant).

3. To understand drivers of energy consumption, data related to activity, operating hours, weather, production, and square footage is gathered to better understand current performance levels. In cases where plant data capture is lacking, direct measurements, trials, line studies, or observations may be employed.

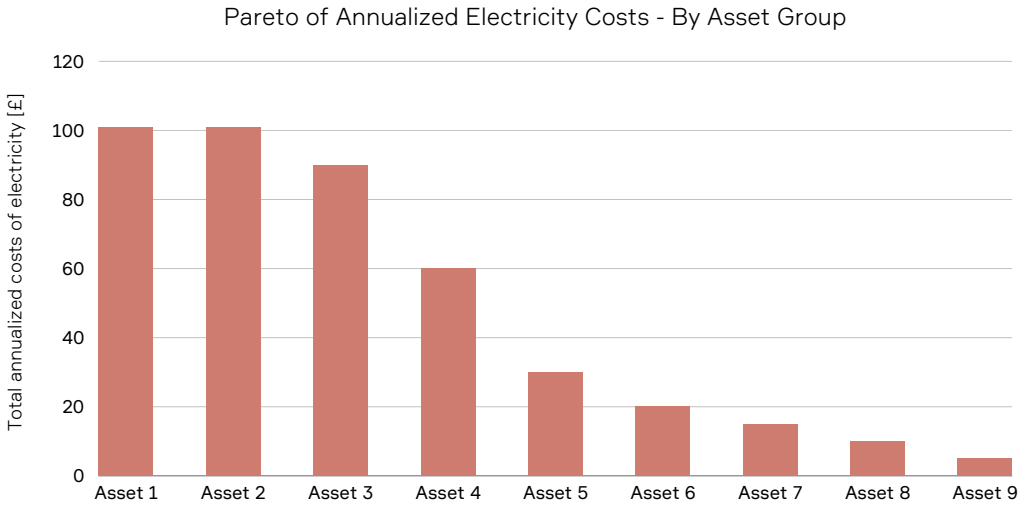
*Per unit of product output. This is to ensure we're measuring an efficiency, and not simply reducing the output of the product to save energy.

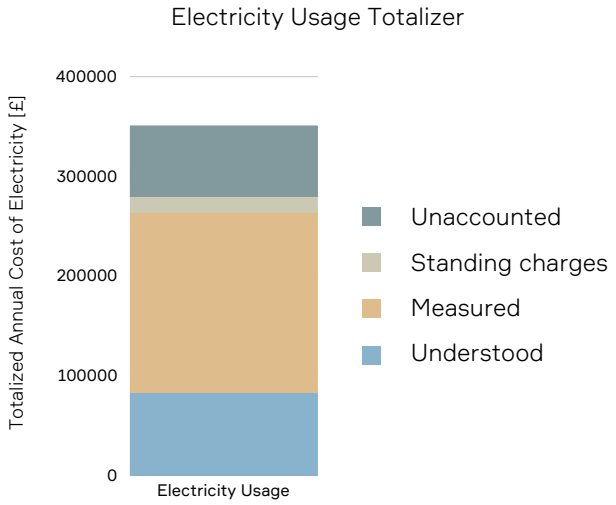
Mapping energy consumption: Identifying key areas for optimization

By comparing the difference between the ideal and actual balances we can begin to identify unknown or previously misunderstood losses. These discrepancies guide our research focus before undertaking more thorough analysis, or kicking off projects.

Building upon the insights gained from the comprehensive Energy Scan, we can now delve into researching the identified losses. Data needs to be organized into easy-to-understand visual tools. This helps analyze the data effectively to uncover the reasons behind any losses.

Tools like paretos, totalizers and impact maps can quickly pinpoint the biggest energy losses and consumers to help prioritize areas for targeted investigation.





High-value, low complexity opportunities

Drawing insights from the aforementioned analysis and tools, allows the development of a plan starting with high-value, low-complexity opportunities. This guarantees that capital expenditure is directed towards areas where it will have the greatest impact.

It's important that this stage of the Energy Scan places an emphasis on collaboration with involvement from a wide-range of site team members. Challenging constraints and understanding the "why" behind losses is essential. Insights stemming from experience and strong process understanding and its resource usage are invaluable for identifying opportunities and understanding the underlying causes of variance. Furthermore, involving personnel in this process ensures ownership and commitment to the results, increasing the likelihood of successful implementation.

Points to note:

1. While small and repeatable savings are often overlooked, they contribute significantly to overall improvements and should not be discounted.

2. Processes with a heavy resource consumer usually manage that asset relatively efficiently (e.g. a polymer plant containing a large extruder accounting for >50% of the sites electricity consumption), but may have blind spots regarding other forms of energy and resource use.

3. Many opportunities may entail capital expenditure and have a lengthy lead time for implementation. Establishing a solid baseline and a plan for valuing the impact of changes in plant operating or ambient conditions is crucial for accurately assessing the impact of these opportunities.

The Value of Energy Scans

The power of systematically deploying these Chartwell methodologies uncovered major energy saving opportunities.

$2.8m

A one week Energy Scan at a US concrete producer identified energy reduction opportunities of 10-20% by using current clamps to capture energy utilization data. This is worth $2.8m per annum.

$0.7m

A two week Energy Scan at a major US chemical manufacturer identified $0.7m energy savings per annum by combining strong process understanding gained through observation and energy utility bills.

$2-4m

A three-day Energy Scan at a global specialty chemicals company uncovered potential savings of 10% starting from a high-level energy consumption map. This is worth $2m to $4m per annum, without CapEx.

$2.2m

A two week Energy Scan at a US-based manufacturer of food ingredients, ethanol and biofuels identified recoverable energy savings by analyzing steam and chemical mass balances around the process assets. This is worth $2.2m per annum.

Optimizing Energy Consumption

Strategies beyond equipment upgrades

Enhancing planning and utilization

Reducing overutilization through improved planning

Machinery and equipment often require a significant surge of power during startup and shutdown:

- During startup assets may require sustained energy draw to heat assets or stabilize control systems
- During shutdown processes need to be safely powered down, which can also consume considerable energy

These phases often involve activating or deactivating various systems, heating or cooling equipment, and ensuring proper functioning of all components. Running a manufacturing plant involves fixed energy costs that stay consistent regardless of production levels. These costs include baseline energy needs for essential operations like lighting, climate control, or idling assets. These systems continue drawing power even during production downtime or when operating at reduced capacity.

Through enhanced planning we can:

1. Minimize startup/shutdown frequency by scheduling longer production runs

2. Plan startup/shutdown during off-peak hours to take advantage of cheaper energy costs

3. Gain better control over the usage of specific assets, enabling us to identify times when they are not needed and switch them off to save energy
   - Installing automatic control systems can help by automatically switching off unrequired assets

A concrete example

Industry: Concrete manufacturing

Results: Cut electricity usage by 15-20% without affecting plant capacity or flexibility

A concrete ready-mix business uses electricity in the preparation and mixing of aggregate, sand, cement and water. A comprehensive energy scan revealed that less than half of the electricity was used by the key manufacturing assets. A base load of electricity was being consumed day and night regardless of the plant throughput. Comparing energy usage across sites revealed best practices, for example, using automated switches to stop heavy conveyors when not in use. Implementing these insights cut electricity usage by 15-20% without affecting plant capacity or flexibility.

Enhancing planning and utilization

Reducing overutilization through problem solving

Energy Scans can highlight inefficient equipment. Targeted maintenance can address issues such as worn-out components, leaks, or malfunctions promptly to prevent energy wastage, and a proactive maintenance schedule ensures that equipment is regularly inspected, serviced, and repaired to maintain optimal performance.

Thorough scans also Identify bottleneck assets within the production process that limit throughput and efficiency. We should Implement solutions to optimize the performance of bottleneck assets to ensure that they are running at maximum speed to maximize throughput and minimize idle energy waste. This way we will minimize idle energy waste and our fixed energy utilization will be split over a higher throughput, increasing the energy efficiency of our processes.

Scans identify areas of waste, including material, energy, and time. We can optimize process parameters, workflows, and resource allocation to minimize waste generation and maximize resource efficiency. Furthermore, we can implement recycling and reuse initiatives to minimize the consumption of raw materials and reduce waste generation.

Specialty polymer

Industry: Specialty chemicals manufacturing

Results: 10% reduction in energy intensity per tonne of finished product.

A continuous polymer plant produces two tonnes of specialty polymer per hour with a current efficiency of 45%. Efficiency losses stem from slow operations and downtime due to handling and sieving blockages, especially in fluidized bed driers and air handling equipment. By improving efficiency to 60%, unlocking speed enhancements, and solving material handling blockages, the plant can produce the same output in 30% less time. This results in two immediate benefits: a reduction in energy intensity by 10% per tonne of finished product and spare plant capacity for increased sales.

From grain to gas

Industry: Ethanol manufacturing

Results: +50% of every unit of energy consumed was wasted

An ethanol plant ferments corn and wheat waste to produce automotive grade ethanol. The key fermentation stage is heated using direct injection of steam. The client wanted to reduce their costs and carried out a Chartwell 'Zero Loss Analysis' of the minimum theoretical energy required to produce ethanol. What they found surprised everyone. For every unit of energy consumed, more than half was wasted in the form of directly adding steam in the fermentation stage and subsequently evaporating this added water in the driers .

A breath of fresh air

Industry: Resin manufacturing

Results: +100 tonnes of CO_2 saved annually

Challenge technical constraints to improve existing processes – at a resin manufacturer, understanding technical constraints enabled Chartwell to identify the key energy-using (and cycle time-limiting) steps as boiling and drying solvent. Excess solvent was built into the process recipe to compensate for temperature spikes in the reactor. Improving how the mix tank was refilled enabled a more consistent resin concentration, standardizing the reactor temperature and allowing for reduced solvent per product. In addition to enabling an additional 15% output, this process change saved over 100 tonnes of CO_2 annually.

Conclusion

Producing the same or additional product with less energy consumption and waste is a double-win for the environment as well as the bottom line.

Applying Chartwell's Zero-Loss Approach to energy can expose opportunities which may not already be evident:

- **Clearly visualize losses** – the first step is understanding where energy is being consumed. A rigorous mass and energy balance can reveal surprising focus areas
    - Common key challenge: availability of data is often low, which is why Chartwell developed a playbook of techniques to get the necessary data
- **Prioritize high-value, low-complexity opportunities** – small but repeatable opportunities can add up, especially if they can be immediately implemented. This allows capex investments to be focused on highest-impact losses
    - Common key challenge: prioritization of projects can be unclear, which is why Chartwell uses opportunity matrices and work with engineering teams to communicate the value of all priority projects
- **Improve planning and utilization** – Some energy-heavy steps in a process may not need to be conducted in the first place. Minimizing startups and optimizing processes to use as little material as possible can have major energy benefits in addition to raw material savings.
    - Common key challenge: change management can make it hard for improvements to stick, which is why Chartwell has a suite of results sustainability structures which we embed with our clients

Chartwell helps clients overcome these common key challenges. Contact our team of operations improvement experts today to help guide your team through reducing energy in your organization.

Chartwell

Get in Touch

Get rapid, remarkable and sustainable productivity gains for your organization. Contact us to become a client:

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www.chartwell-consulting.com