Sustainable goals

The United Nations developed their 2030 Sustainable Development Goals to enhance everyone's quality of life; they range from Poverty to Climate action, care of the Environment both on land and below water to education. These things concern us all and make good sense. They make even more sense when they can also help us improve and achieve even better monozukuri, the art of manufacturing.

As you know Mitsubishi Electric originates from Japan, and one of the interesting but relatively unknown points about Japan is it has had to develop a culture of self-sufficiency as it no longer has any natural resources.

- No oil
- No gas
- No coal

In numbers it is only 6% self-sufficient in energy. That means energy has to be imported and that is expensive, so saving energy is embedded in to every aspect of our daily lives.

Taking care

Mitsubishi Electric is just about to start its ninth environmental plan which will run from 2019-2021 which will coincide with the 100th anniversary of the company. Among its goals is to create and popularize energy saving products, and reduce CO_2 emissions to create a low-carbon society. Today, Japan is a very difficult country to manufacture in and still compete aggressively on the global stage, as nearly all resources are expensive; from energy to labor, so in order to survive we have developed and adapted until energy saving is part of our DNA and that has also been recognized by CDP awards for Climate and Water. So our mission is to share our experience and know-how to achieve this important goal.

3 R's of Sustainability

Many people have never heard of this but it is as important as Kaizen. The three R's refer to:

Reduce
use of unnecessary things

Reuse
items whenever possible

Recycle
items when their useful life is over.

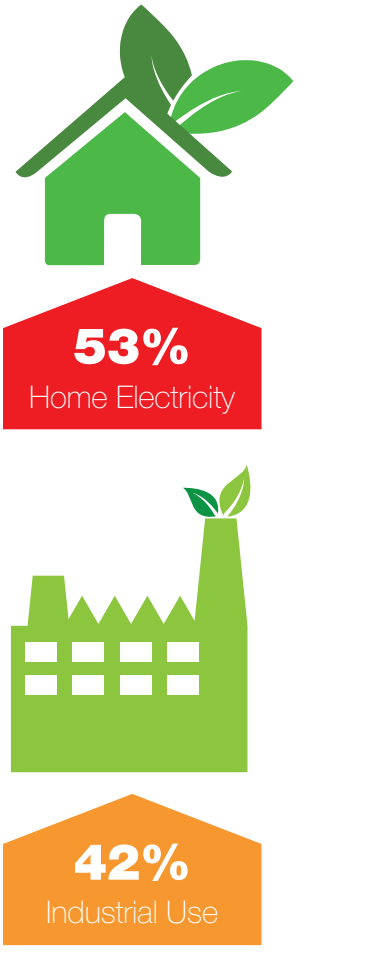
And in the case of energy, especially from a corporate or manufacturers standpoint, it's even tougher. If you use it you have two choices:

Reduce it or Pay for it!

It's totally unavoidable… like paying taxes!

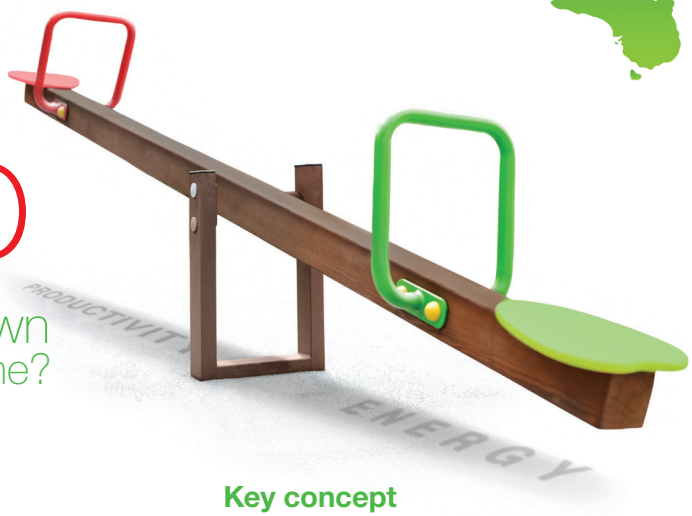
And to make things worse, energy prices have been going up steadily over the past years. In fact the US Energy Information Administration have demonstrated that the average retail price of electricity has increased 53% for home users and 42% for industrial users… so it makes sense to treat energy as a precious resource and in some way use it 'Just In Time'.

So understanding when, where and how much energy is used is the first step to managing its consumption.



According to the US Energy Information Administration the average retail price of electricity has increased over the past 15 years.

What goes up and down at the same time?



The challenge

Ok, it's a small joke, we can see that it's a see-saw, but in a manufacturing context actually this is a bit more serious because it hits the bottom line; the actual answer is Energy and Productivity.

Energy saving could be simply executed by turning all your machines off… but how does that help because you are unable to produce. Therefore, if you focus on improving productivity, i.e. making more saleable products with less energy you have solved the real puzzle.

And that's why Mitsubishi Electric energy saving is not about cutting costs but about improving productivity.

Key concept

There is one key concept which is fundamental to changing the perception of energy usage. We call this:

EPU

It represents the amount of Energy consumed to produce one product (Energy Per Unit produced).

$$\text{EPU} = \frac{\text{Energy consumption (in kWh)}}{\text{Production (in Units)}}$$

EPU has two powerful attributes; it allows the direct association of the energy cost to the manufacturing activity; it is also variable/dynamic. That does not sound so important until you have a line stoppage and the EPU starts to rapidly increase as energy is consumed but product is no longer being produced.

The second attribute is that it makes it easy to compare production performance between lines, or even factories because the EPU is entirely driven by the efficiency of production, i.e. productivity. And this is why we use it to benchmark ourselves but also to drive our energy saving activities.

Typically manufacturers have a very clear idea of the material costs, direct and indirect labor costs, logistics, depreciation etc related to their manufacturing processes. But very rarely do they actually know anything other than the headline energy consumption.

By applying the e-F@ctory 'concept of connect everything' and measure what's important we are able to derive the EPU. The great thing is energy monitoring can be applied retrospectively to any existing site or machinery. Modules can be added to existing breakers directly or distributed measurement points can be installed without disrupting the existing production or cabling – simply clamp over the appropriate CT modules.

Connecting these to local meters and monitoring stations makes it easy to pull all that data back to a central management point. The more visibility you give to that data the more change effect you can create. In the next few paragraphs we will highlight this in action with some real use cases.

Environmentally sensitive cabling?

With Anywire you can.

Did you ever think about how environmentally friendly it would be to reuse existing cabling as new network cables?

Anywire's flexible 'Topology Free' concept enables efficient wiring paths that reduce cabling and time. It features high noise resistance and compatibility with general purpose cabling, even allowing the reuse of existing electrical wiring. You can also take advantage of its innovative diagnostic options to monitor both sensor performance over time and connection status, and pre-empt costly work stoppages. Saving time and money and reducing the impact of your manufacturing infrastructure on the environment.

Anywire is another great example of the e-F@ctory Alliance in action.

For almost 100 years Mitsubishi Electric has chosen to conduct its business under seven guiding principles:

1. **Trust.** Establish relationships with society, customers, shareholders, employees, and business partners based on strong mutual trust and respect.
2. **Quality.** Provide the best products and services with unsurpassed quality.
3. **Technology.** Pioneer new markets by promoting research and development, and fostering technological innovation.
4. **Citizenship.** As a global player, contribute to the development of communities and society as a whole.
5. **Ethics and Compliance.** In all endeavors, conduct ourselves in compliance with applicable laws and high ethical standards.
6. **Environment.** Respect nature, and strive to protect and improve the global environment.
7. **Growth.** Assure fair earnings to build a foundation for future growth.

Being a leading green company is in our DNA, it helps the environment, is a social duty but it also makes good business sense.

Case #1: The circuit breaker line

As noted ,energy costs have been rising but in Japan this was compounded by the consequences of the Fukushima earthquake which meant all nuclear power plants were also shut down, leading to even more expensive energy and in some areas additional usage regulations.

Problem:

- Rapidly rising energy costs
- Strict government regulation

e-F@ctory solution

- Introduction of energy efficient components
- Energy management system
- Production improvement using FA-IT connectivity

Firstly, the energy consumption needed to be visualized, that meant energy data needed to be collected from every part of the process. The result was a very clear picture which could be drilled down from production hall, to line to individual machine. The other key aspect was the time base of the measurement frequency – this is also critical to catch the real root cause of problems. Looking for correlation between events even on different processes and machines quickly reveals where the real problems are.

The last major learning point was that sadly technology does not solve everything. There has to be a strong commitment as a company, which filters down to every employee working towards the same goal and that's why sharing the data on a wide basis makes everyone aware of the scale of the problem.

Then it's a case of going through the simple steps of visualize the issue, find the cause, take action – its pure PDCA!

For a low margin product like a breaker, coupled with fierce global competition, every cent saved counts.

Case #2: The circuit board line

In this example, the direct impact of EPU analysis will be demonstrated.

Problem:

- Multiple machinery and production lines
- Frequent line stoppages made it hard to grasp the real energy usage

e-F@ctory solution

- Energy data visualized per machine
- EPU KPI applied

As in Case #1 the first step was to collect the data, but collection was not limited to energy only. Additional information such as the production schedule, equipment data, quality data and process error data were also collected. The critical point was this was collected in 'real time'. That meant extensive line side data processing, time date stamping and filtering, so Edge Computing was an important element to make that possible.

Initially we were flooded with data, graphs and analysis – we could not see what was happening so we applied EPU. Then we could pinpoint when production dropped and energy peaked and cross reference that with error and quality information.

We noticed several things;

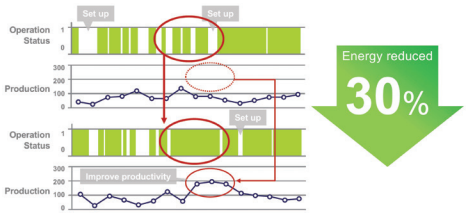
- We were setting up/starting the machines too early in the morning before main production commenced.
- We saw frequent stops due to material shortages.
- Equipment trouble and extended downtime occurred because maintenance members all took their break at the same time.

Sometimes the problem is a combination of events or things that happen infrequently, so capturing and analyzing the data are important steps to get right.

We also saw our biggest energy consumer was naturally the curing oven, but we could not continuously turn it on and off as there needed to be a constant temperature and there was a lag in taking action and its effect. So from the EPU analysis we had identified that the utilization of the oven was the single most important issue; we needed to keep it as busy as possible.

What to do?

To minimize non-productive time when we changed production between product lines (when we are consuming energy but producing nothing) we implemented a 'Change Over' support system to reduce the downtime and number of changes needed – so it was fundamentally linked with the production planning system. The result was worth it, we reduced energy by 30%.



Small incremental improvements are better than no improvements at all. Every solution does not have to be 100% correct but will move you closer to the goal.

Case #3: Energy predictive maintenance

The title of this example is quite a heavy hint to what we did. When a machine fails it is no longer productive but may still be consuming resources, so understanding in advance when a machine is likely to fail can be a big help – and energy consumption can be a great indicator of when something is going wrong. A simple example is when a motor bearing is running dry or is damaged it encounters more friction and hence consumes more energy.

So now the energy consumed can be an indicator of the health of the motor.

In this case it really was a motor which was failing a vacuum pump which was part of an electronics production line.

Problem:

- Sudden breakdown of vacuum pump (even though it had an expected life of 3-5 years)

e-F@ctory solution

- Improved OEE; monitoring the motors power consumption for predictive maintenance
- Simple solution without any additional sensors – just using the existing data

Case #4: Small changes, big results (Fukuyama Works)

In the last example we can see elements of the three previous examples deployed alongside the efforts to change 'human' behavior. Over 10,000 visitors per year come to Fukuyama Works to hear how we managed to save around 1,700kW off of peak contract demand – that's equivalent of a small solar station covering 3.4 hectares or 100m JPY; for simplicity let's call that 1m USD per year…every year. The all-important EPU reduced from 14.3 JPY/unit to just 5.5JPY/unit… that's 62% down.

The video below gives you a bit more insight in to this amazing story:

It's important to start on small projects where you can check you are getting the ROI you expect, then work up to bigger projects 'experience is the best teacher'.

And remember, a lot of the activities were simply to remind people to turn lights off, adjusting the air conditioning temperature by 1 or 2 degrees, checking for worn motors, identifying root causes.

The way forward

Not everyone is an energy expert so we have packaged up a lot of know-how in to smart components, ready to use templates and solution packs.

We are also happy to receive fact finding visits to the factories to see what has been achieved. ■