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Leanergy™: How Lean Manufacturing Can Improve Energy Efficiency

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Abstract: Energy efficiency has become a competitive issue for industrial companies. The evolution of energy prices and regulation will make this issue even more important in the future. For several years, the energy-intensive chemical industry has been implementing corrective actions. Helped by the absorption of base load energy consumption by larger production volumes, specific energy consumption (KWh per production unit) has been significantly reduced in recent years. However, most plants have reached the end of their first action plan based on improving the utilities performance. The Leanergy™ method developed by the consultancy company Okavango-energy, is a structured approach based on lean manufacturing which widens the scope of saving sources to process and operations. Starting from the analysis of actual production requirements, Okavango is able to adjust consumption to minimum requirements and so remove any energy consumption that does not contribute to the added value creation.

Keywords: Benchmarking · Competitiveness · Energy efficiency · Energy management system · Energy performance indicators · ISO 50001 · Kaizen Leanergy™ · Leanergy Index · Lean Manufacturing · Pinch method

Energy efficiency has become a competitive issue for industrial companies. Compared to their competitors, companies should not only prove to their stakeholders that they reduce their environmental impact but they must also control their energy cost.

In the coming years, one can expect increasing pressure on global warming issues as the average temperatures keep rising and weather disruptions are becoming more and more frequent and severe. This will probably lead to new taxes, new regulations, and more image-related aspects.

On the other hand, most studies show energy prices rising dramatically within the next 20 years, as the oil production cost increases, nuclear electricity companies invest in improving safety, and more expensive, but environmentally friendlier renewable energies' shares increase. This will obviously impact negatively on companies' margins particularly in the energy-intensive chemical industry.

In Switzerland, the energy consumption of the chemical and pharmaceutical industry represents approximately 15% of the total industrial energy consumption. It is therefore a major industrial consumer along with the cement, glass, paper and engineering industries.[1]

Energy consumption per production unit (specific energy) has dropped significantly (Fig. 1), however it doesn't mean that the energy efficiency has improved as fast as this ratio. As a matter of fact, the trend of the specific energy is partly due to the absorption of base load energy consumption by the additional production volumes. Investments in more energy efficient equipment and in some heat recovery projects explain most of the remaining progress.

Nowadays, most industrial companies are already investing time and money in energy-efficiency initiatives.

But how can they make the most of this new competitive challenge?

It's a Long Road to a Fully Energy Efficient Plant

Studies show that most industrial companies could lower their energy consumption by 20–30%. For example, the International Energy Agency (IEA) states that: "Manufacturing industry can improve its energy efficiency by an impressive 18 to 26%, while reducing the sector's CO_2 emissions by 19 to 32% …".[2]

So why are so many companies not obtaining such positive results? Although they take action, they don't have a structured, thorough and global approach on the current issue. Many opportunities of improvement, although acceptable from a return on investment point of view, are neither identified nor implemented.

First of all, energy is only one of the industrial performance issues. An approach to energy efficiency carried out by energy experts on their own, is quickly limited by production and productivity is-

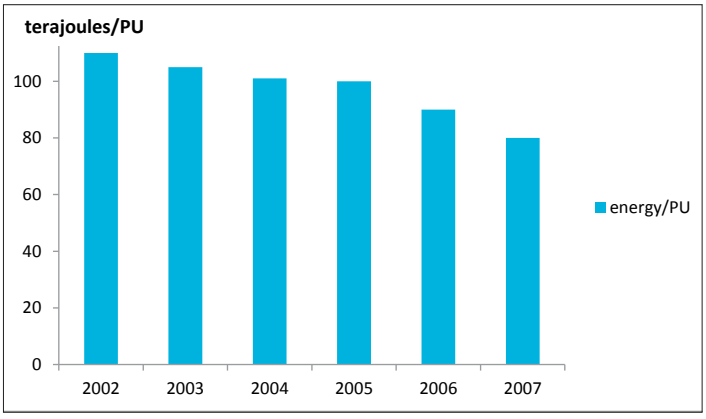

Fig. 1. Energy consumption in terajoules per production unit.[1] Source: SGCI Chemie Pharma Schweiz 2009

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sues. Industrials need the point of view of process specialists as well as energy experts to fully understand the issue, evaluate and define all possible opportunities for improvement.

This seems even more important when you consider that companies keep changing. New products are manufactured, processes are also redesigned or extended. As a consequence, the way energy is managed must also be continuously adapted to the new process. Again, it means that process and energy should be considered as one.

Energy consumption is the consequence of the decisions and actions made by many different actors within the company: maintenance team, production team, utility team, engineering team, supply chain manager, plant manager, financial manager… Different actors with different points of views and priorities. If nothing is done to coordinate all these actors, and if the energy issue isn't integrated with all other industrial performance issues at the top management level, it is difficult to reach long-term performance.

Finally, in order to set up a continuous improvement system, reliable performance indicators are paramount. Monitoring systems are often very limited, and energy consumption isn't easy to decrypt. Many influencing factors can usually be identified: production volumes, product mix, raw material quality, external temperature and humidity… Such factors are rarely integrated into a set of energy performance indicators. As a result, actions cannot be evaluated, objectives are difficult to set and waste is difficult to detect…

A Systemic Approach Inspired by Lean Manufacturing

Okavango-energy was created in 2009 by Jean-Pierre Riche, in response to these problems. His experience revealed that CEOs of European industrial companies were looking for a way to face this new competitive challenge, and were searching for support and expertise.

Okavango's team designed a whole new approach to energy, based on Lean Manufacturing methods, and aiming to maximize energy efficiency in the plant, as fast as possible.[3]

With Okavango's Leanergy™ method it takes approximately two months to build a short-, medium- and long-term strategy for energy efficiency. Potential actions are identified, evaluated, prioritized to build an action plan. Then implementation begins, with a Kaizen approach (Kaizen Leanergy™). First, the quick wins involving as much as possible operational people, in order to empower and get their commitment. Then the more complex initiatives involving management change or investments.

After one year, energy efficiency will have significantly improved, and the following year will be used to carry on with the action plan while setting up an energy management system in order to create a continuous improvement process.

Half of the Savings Don't Need Investment

Most specialists on energy efficiency focus on technology and equipment. But replacing a system by a more energy efficient one requires investment capacity. Okavango recommends beginning by questioning the process. How much energy does the product really require to be processed and manufactured? Have you challenged the cycle times, the temperature settings, the flows and pressures? Do you have a good reason or have you always done it this way? Have you? Really? What's the reason for it? Is the raw material, the plant layout, the process route still the same as when those production parameters were set? Are you aware of the energy cost and are you sure that you have no alternatives?

Significant energy consumption with no investment cost is saved by joining efforts of production specialists and energy experts to redesign the energy requirements of the process: heating temperature reduced in a storage tank, cycle length shortened in a reactor, dryer fan engine downsized…

Once the process is lean in terms of energy, and before improving equipment performances, it's time to think about investing in thermal integration.

Most products processes involve heating and cooling. Pinch is a very powerful method for modeling hot and cold flows in order to minimize external input of heat and cold. Pinch modeling will allow the ideal solution for thermal energy recovery to be defined, and challenge it according to economic constraints: investment in piping, pumps and heat exchangers, and return on investment.

It's only when the process has been brought to the minimum energy required and thermal integration has been studied, that one should consider evaluating how to upgrade the equipment. There is no point in investing in a high-performance burner for a steam boiler if the production of steam will be cut by 50% thanks to a better heat recovery and a reduced need. It may be time to buy a new boiler, as energy represents 90% of the cost of steam, and the efficiency of a boiler drops dramatically under 50% load!

Lastly industrial investment policy should integrate the long-term energy sourcing strategy. Future prices, environmental costs, regulation impacts may favor one energy rather than another as a source for parts of the process. Should tomorrow's dryers or ovens be operated on electricity, gas, fuel or coal? Today's investment will most probably limit tomorrow's choice…

Don't Forget the Impact of Operations

Any car designed to use 5 l/km of petrol, can be driven in a sporty way resulting in a 10 l/km consumption. Similarly, a lot of companies observe that the energy spending differs from one turn to another according to the team operating the production.

Working on organization, procedures and people's behavior allows companies to cut unnecessary wastes of energy. The solution can be found in Kaizen Leanergy by applying similar tools and systems to those used in improving machine productivity, raw material losses or intermediate stocks.

Classical examples include start and stop cycles on machines, open valves, manual settings, load/capacity ratio…

Maintenance procedures and the quality of their implementation impact significantly on the energy efficiency of equipment and leaking distribution networks.

Production planning also has an influence on energy demand and utility equipment. The synchronization of the operation directly impacts the utilization rate and therefore the capacity requested.

Remember that half of the energy savings can be made in an industrial plant without investment by working both on needs and operations.

Leanergy Index: A Qualitative Analysis to Improve Energy Benchmarking

It could be difficult for a multi-site company to compare the energy maturity of plants that manufacture different kind of products. It's even more complex to benchmark companies within the same sector. The specific energy ratio (energy consumption per unit produced) is not sufficient to compare plants or identify efficiency gaps because it depends on so many variables such as process technologies, product mix, raw materials, operations, age of the plant, *etc*. Hence a higher specific energy ratio is not equivalent to a more energy efficient plant.

Consequently, Okavango has developed a second type of performance indicator called Leanergy™ Index, in order to

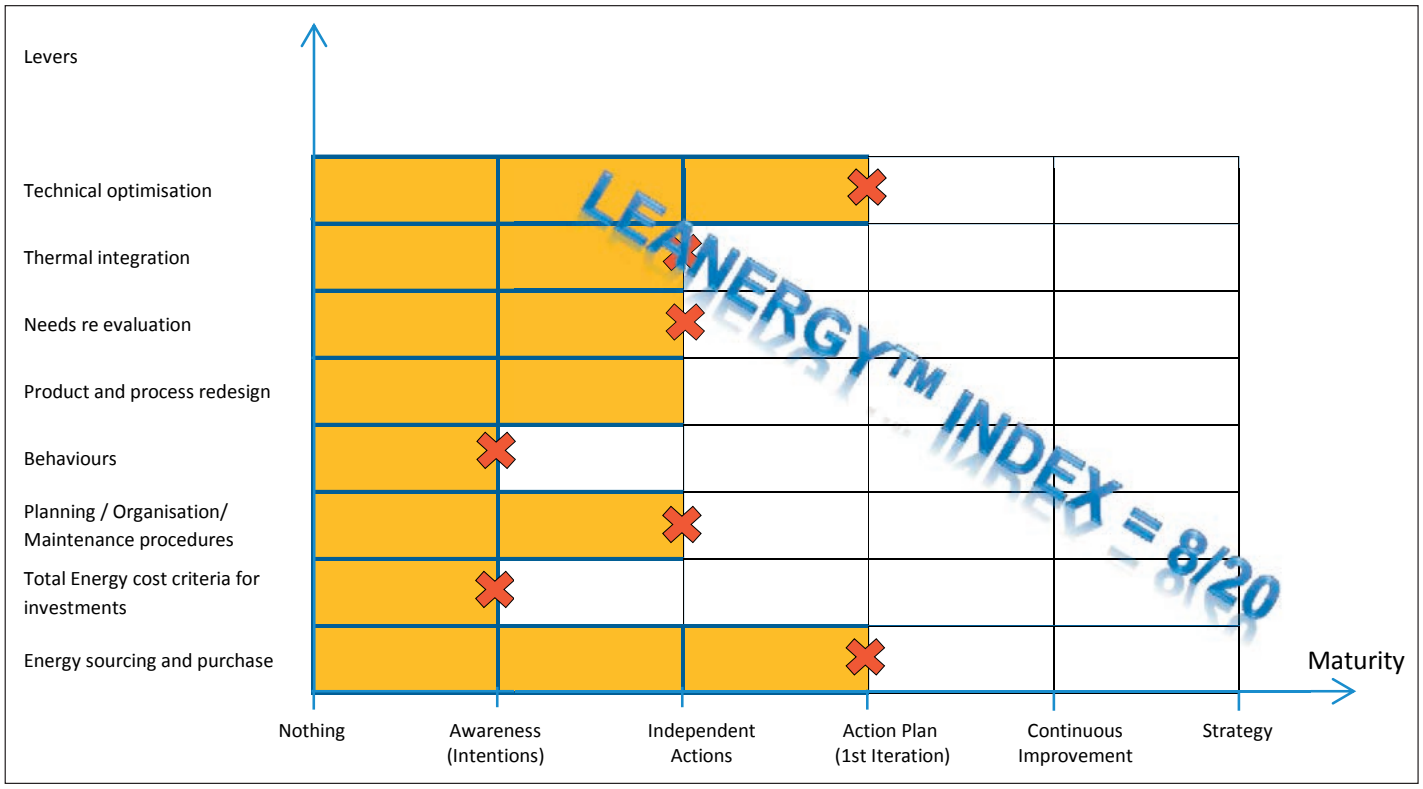

Fig. 2. An example of a Leanergy Index.

look at energy efficiency from a complementary angle.

Okavango's Leanergy™ Index, is a qualitative approach to evaluate companies' maturity in terms of energy efficiency. It provides a helicopter view of the principal improvement axes in a particular site, as well as a global maturity data to be benchmarked with other sites.

The analysis is based on a structured questionnaire often supported by a visit, covering all the levers influencing the energy consumption and final energy bill

Keep Improving by Integrating Energy Management to Industrial Performance System

Setting up an action plan based on a systemic approach and starting its implementation, has to be followed by the design of a continuous improvement program in order to guarantee long-term energy competitiveness.

The new ISO 50001 shows the way to an energy management system. The main rules are simple:[4]

- Initiated by the top management
- Led by an identified Energy Manager
- Communicated to all hierarchal levels
- Described in a detailed energy policy
- Followed up by a monitoring system
- Part of a continuous improvement process

Whether a production company decides to certify its system or not, they should insure its integration in the global scheme of industrial performance of the plant.

Conclusion

The Leanergy™ approach has demonstrated its relevance and efficiency in the industry. Because the stakes are high, many chemical companies have already been working on energy efficiency for several years. However, companies tend to limit their action to technical improvements of equipment and utilities production. They dare not challenge the process or the operations to consume less energy. From Okavango's experience, a structured and systemic approach, driven as a transformation program, is much more powerful than isolated and specific actions.[5]

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