Revisiting Electrical Energy Saving Initiatives for Industrial Facilities

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Executive Summary

Energy saving initiatives can be used to reduce operating costs for industrial facilities. However, a careful assessment must be made before selecting proper solutions. In practice, there are no "one-size-fits-all" solutions to save on electricity costs. A proactive approach to energy management is often recommended since the electric power industry is constantly changing. Long-term energy management strategies should be reviewed yearly to identify new energy saving opportunities.

A good starting point is to have a strong understanding of how electricity is billed. From there, it is easier to determine what could be improved through on-site measurements and performance monitoring. After needs and constraints are properly identified, an appropriate energy management plan can be implemented.

Any selected approach can be reduced to one of two possibilities: improving how existing equipment is used (through process optimization) or installing new infrastructure. On the surface, it may seem that purchasing new equipment might not be the best solution because of expected upfront capital costs. However, it is worth considering, given that energy savings can quickly offset the cost of new equipment.

One cannot understate the benefit of revisiting electrical energy savings initiatives. Receiving an expert opinion on the topic can often lead to significant savings in annual operating costs. This white paper discusses a case study where a client saved over $1 million annually by implementing key energy saving measures

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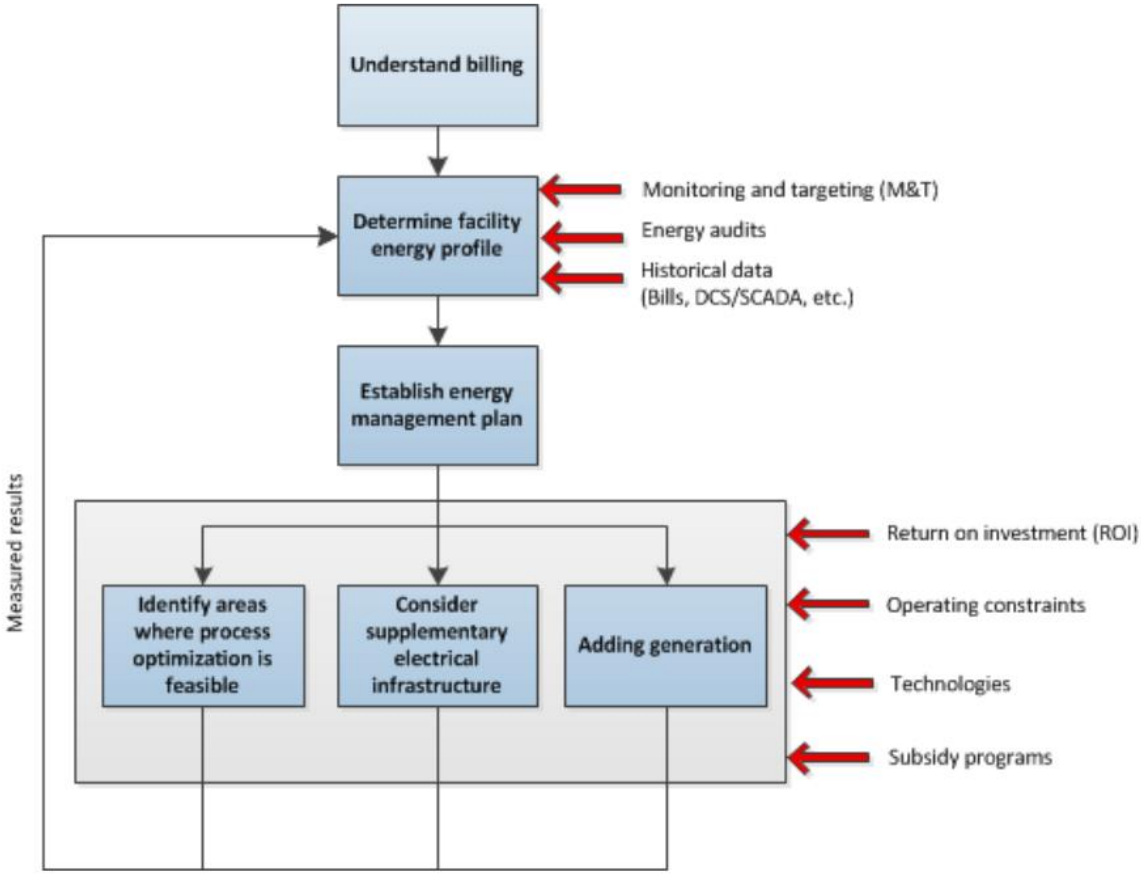
Business Challenge

Why has it become critical to refurbish generating stations?

The cost of energy, regulatory compliance and carbon emission reduction can seriously impact the operating costs of industrial facilities. As electricity rates continue to increase, some energy saving strategies that were not economically feasible in the past may now make more sense as experience, practices and technologies in energy management have matured. Consequently, it might be worthwhile revisiting energy saving strategies in the current economic climate.

A methodical approach to reduce electricity costs takes the following into account:

- Understanding what you are actually paying for in your electricity bill
- Identifying the major power consumers in your facility (structured monitoring and targeting)
- Developing options to reduce energy costs (by establishing an energy management plan)
- Implementing and monitoring performance


Understand billing
Determine facility energy profile
Monitoring and targeting (M&T)
Energy audits
Historical data (Bills, DCS/SCADA, etc.)
Establish energy management plan
Measured results
Identify areas where process optimization is feasible
Consider supplementary electrical infrastructure
Adding generation
Return on investment (ROI)
Operating constraints
Technologies
Subsidy programs

Description of the Solution

Understanding billing

Choosing appropriate electrical energy saving opportunities starts with a good understanding of how and where energy is used, especially how electricity is billed by your local utility.

The electricity bill for industrial customers normally includes the following:

1. Energy: Your total electricity consumption (in kW.h or MW.h) measured over a defined billing period (typically 1 month).

The energy billing rate is either fixed or variable. A variable electricity price can be based on the average market price of electricity during any given hour for example.

2. Power: Your maximum "peak" demand (in kW or MW) measured during a defined billing period. If a power factor at the connection point is lower than the target threshold (e.g., 0.9, 0.95), some utilities might impose penalties in their billing by using apparent power (kVA).

The peak demand billing rate is also fixed or variable based on, for example, the summer or winter billing period. In Ontario, for example, there is an additional cost based on peak demand for electricity during periods when overall power demand is at its highest (Global Adjustment).

Energy saving initiatives at a glance

You can achieve an overall reduction in your electricity costs by either reducing your energy consumption (kW.h) or by limiting your peak demand (kW) over the billing period. Determining which option is more appropriate depends on the energy profile, operating needs, condition of existing assets and other considerations specific to each facility.

One should be wary of "one-size-fits-all" solutions because industrial processes vary greatly and every facility is unique. The first step is to review existing processes and to understand the corresponding electrical load profile. The preferred approach is to provide an energy saving solution that optimizes the use of existing equipment. An energy saving solution does not always require capital expenditures on new equipment.

You can consider purchasing new equipment after all process optimization opportunities have been exhausted. Again, innovative solutions should be adapted for each industrial facility. Specific regulatory requirements, expected return on investment (ROI), the age of equipment and production schedules are all factors that need to be considered and tailored to client needs. As a starting point, reviewing historical billing data and completing on-site measurement campaigns are useful tools for energy management. By completing an energy audit, experts can determine the overall energy profile of a facility. This allows the facility owner to set targets for reducing power and energy consumption and to monitor the performance of future energy efficiency strategies.

Process optimization

Process optimization begins by identifying any areas that can be improved. Electrical performance of an industrial facility can then be improved by correcting or modifying the areas where equipment can be used more efficiently. Examples of strategies that can yield the highest reduction to electrical power consumption include reviewing the overall system control philosophy or the maintenance plan for large motors and any other equipment supporting physical processes at an industrial facility. To ensure that process optimization is most effective, operations and maintenance personnel need to be involved.

Optimizing processes and saving on electricity costs is possible by reducing overall energy or peak demand. It is worth noting that energy reduction normally also limits peak demand.

Examples of an energy savings initiative (kW.h reduction)

1. Increased efficiency through combined heating and power (CHP) design

- Recover compressor heat loss
- Optimize heat storage
- Make best use of energy loss to decrease heating loads

2. Load management

- Ventilation on demand (VOD) to decrease power demand in areas not being used

- Efficient cooling systems for infrastructure, including large motor air-flow cooling systems

Examples of peak demand initiatives (kW reduction)

1. Load shedding: Shifting power consumption to times of the day when energy costs are lower

- Modify production practices during peak demand periods by stockpiling materials for instance.

- Adjust heating and cooling philosophy during peak demand periods.

2. Peak reduction: Turn off or reduce loads when electricity is more expensive.

3. Adjust operating procedures.

Installing new electrical infrastructure

Energy saving initiatives related to installing new equipment aim to increase efficiency (reduce kW.h or kW.h/unit produced) and decrease peak demand (kW). Examining the viability of adding equipment should consider both energy savings and reductions to peak demand to establish the return on investment (ROI).

In particular, with the growing costs of grid-supplied electricity during peak demand periods, it may be worthwhile to consider adding on-site generation. Depending on the location of an industrial facility, the fuel costs to power electrical equipment can be much lower than using utility power (especially during periods of peak demand). When determining the feasibility of adding generation, one should consider expected future costs of electricity versus expected future costs of fuel.

Examples of energy savings initiatives (kW.h reduction)

1. Installing energy-efficient technologies (HVAC, variable speed drive, high-efficiency lighting, high-efficiency motors, etc.)

2. Implementing active power management solutions to provide real-time response to energy demand either through energy management systems (EMS) or by modifying operating practices

3. Integrating renewable energy power (hydro, wind, solar)

Examples of peak demand initiatives (kW reduction)

1. Providing stand-by power (diesel or natural gas generation, energy storage) for peak shaving
2. Optimizing supply voltage quality; installing reactive power compensation ensures an acceptable power factor is maintained at the point of interconnection (POI) and at equipment voltage level

Benefits of the Solution

Example project: Cogeneration plant for an off-grid gold mine

This off-grid diesel cogeneration plant for a confidential client has an installed capacity of 24 MW and supplies building heating (~10 MW) through a distributed thermal system. With a total investment of $400,000, BBA improved the reliability and efficiency of the cogeneration plant, by:

- Balancing over 310 heating systems
- Increasing energy recovery by over 50%, from 5.3 MW to 8.3 MW
- Reducing diesel fuel consumption by 2 million litres per year

This allows the facility owner to save $1.3 million per year (an annual return on investment of 225%).

Typically, stand-alone power plants operate conservatively (i.e., lower capacity) in case of sudden generator shutdowns. This was considered an appropriate strategy to prevent plant production losses, but it was not the optimal setup for overall efficiency, maintenance costs and fuel consumption.

To improve electrical efficiency and heat production through recovery, BBA implemented an entirely new and innovative plant operational philosophy, allowing generators to operate at higher capacity with greater efficiency. As a result, gains in plant efficiency and maintenance outweighed anticipated production loss expenses.

To apply this philosophy to daily operations, the BBA expert team developed a simple-to-use operating matrix, which leverages in-house simulation software based on:

- thermal and electrical loads
- cogeneration efficiency
- failure probability and associated mill production losses

The same underlying principles that led to the success of this project are also applicable to facilities that are connected to utility power. It follows that parallels exist between fuel consumption and total energy purchased from a utility company.

Example project: Energy optimization of an ammonia cooling network and air compressors

Molson Breweries introduced a corporate program to reduce energy consumption at its Canadian plants. All projects were identified during a detailed energy efficiency analysis and listed in a strategic energy management plan.

The program covered five Canadian plants. Projects were started in the following areas to improve energy consumption:

- Cold production (ammonia cooling system)
- Steam production, distribution and use
- Building heating and ventilation
- Pumping and compressed air
- Electricity consumption (comprehensive review of motors)

Thirty-five specialized energy audits in five Canadian breweries enabled Molson to establish strategies to improve energy efficiency and achieve a 20% overall reduction in electricity consumption along with a 15% reduction in natural gas consumption.

The total energy consumption at these facilities was reduced by 6,677 MWh/year, providing an annual cost savings of $267,000. In particular:

- There was a reduction in air compressor energy consumption of 750 MWh/year at the client's Montréal facility.
- There was a reduction in overall energy consumption of 4,835 MWh/year by optimizing control and pumping equipment for ammonia cooling systems.

A changing industry

The world of electric power utilities and governing legislations is constantly changing. A proactive approach to long-term energy management relies on periodic reviews of your energy saving initiatives, including performance monitoring, fine-tuning and lessons learned.

Ensuring that a system is properly commissioned and maintained is of paramount importance to achieve and sustain expected savings. It is a fact that equipment that is well maintained and properly commissioned will be more efficient. Recommissioning or tuning can improve the performance of aging equipment and increase operational efficiency.

Sudden rate changes, new legislation, financial incentives, efficient-energy subsidies or peak shaving programs can drastically modify the ROI for energy savings projects, as illustrated by the Global Adjustment (GA) Program, introduced in Ontario in 2009, discussed below.

Ontario Global Adjustment Program

The Ontario Global Adjustment (GA) Program aims to reduce overall energy consumption and power demand during high-market price periods. Similar programs exist in a few other Canadian provinces, where utilities apply higher rates during winter periods (or during summer periods in U.S. southern states). The GA Program has introduced an additional cost for all electricity consumers to cover the difference between the market variable price and the utility fixed rate.

On a positive note, substantial energy savings opportunities are now available to industrial customers in Ontario who are part of the Industrial Conservation Initiative (ICI). By participating, an industrial facility with over 1 MW of monthly average peak demand, designated as a Class A power consumer, has the opportunity to decrease its peak demand during the five coincident peak (5CP) and to reduce its GA contributions significantly.

For Class A power consumers, the GA cost is based on the contribution by the facility power demand on the five highest 1-hour periods of peak demand (5CP) over the year (during a base period from May 1 to April 30). This contribution to the 5CP, called the Peak Demand Factor, controls the GA cost for the next year. For example, a Peak Demand Factor of 1% means that a customer has contributed to 1% of Ontario's coincident peak demand for the five highest hours of the current base period. After the base period ends on April 30, the customer will be charged for 1% of the total monthly GA cost until April 30 of the following year.[1]

During the 2015–2016 base period, the GA total cost was $12.333 billion, which means that a 1 MW reduction for each of the 5CP (during the 2014–2015 base period) would have resulted in an annual savings of ~$400,000. The potential to have this level of cost savings is available to all large industrial power consumers (> 1MW during the previous base period).

If the customer decides not to participate in the ICI, it then becomes a Class B consumer and will be charged a fixed electricity rate, which includes its full share of the GA charge.

Conclusion

Energy saving initiatives can reduce operating costs of industrial facilities. However, a careful assessment is required to select the most economical solution. After needs and constraints are identified, appropriate energy saving solutions can be put into motion.

The first step is to look for process optimization opportunities on existing equipment. Making better use of equipment already in place can prevent capital costs for new equipment.

The second step is to consider replacing existing equipment or installing new equipment. After selecting technically feasible options, it is necessary to consider the return on investment (ROI). It is also necessary to consider whether installing on-site generation can be used to provide power at a lower cost than what is supplied by utility companies. Energy savings could quickly offset the cost of new equipment.

To achieve long-term success, you must monitor the performance of your system to make sure you are getting the most out of any investments. By making sure that all system components are properly maintained and commissioned, you will achieve the best long-term results for energy savings.

Remember, there is no "one-size-fits-all" solution for saving on electricity costs and the electric power industry is constantly changing. Long-term energy management strategies should be reviewed by experts on an annual basis to identify new savings opportunities.

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Mr. McLoughlan is part of the Electrical Engineering Department at the BBA Toronto Office with five years of experience in his field. After completing a bachelor`s degree in electrical engineering at Memorial University of Newfoundland, he has been involved in a variety of projects, which included designing electrical, instrumentation and telecom equipment.

The experience and knowledge that Mr. McLoughlan has acquired during the course of his education, combined with his involvement in various projects, make him a valuable resource within BBA's Electrical Engineering team.

Reference

1. "IESO," [Online]. Available: http://www.ieso.ca/sector-participants/settlements/global-adjustment-and-peak-demand-factor. [Accessed 24 03 2017].

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