Case Study 35 Energy Savings from Electric Motors

Objective: To reduce energy consumption from electric motors
Location: Australia
Website: http://www.isr.gov.au/motors/meps/index.html

Description:
From 1 October 2001, all three-phase electric motors from 0.73 kW to 185 kW supplied throughout Australia must meet minimum energy performance and 'high efficiency' standards. The new standards are set out in *Australian Standard AS/NZS 1359:2000*.

MEPS will remove from the market products deemed to be unacceptable because of the level of energy use required to deliver a given level of service.

The new uniform regulations will also set the Australian/New Zealand standard for minimum energy performance and for labelling of motors as 'high efficiency'. All products licensed for sale in Australia will have to be registered on a national database.

The data will be validated though targeted testing by independent laboratories, and significant penalties will apply for suppliers providing false or misleading information.
Saving the environment and saving money
The regulations will save four Mt CO_2 of greenhouse gas emissions through reduced power demands associated with more efficient motors—also saving motor users up to $165 million through lower energy bills over the next 15 years.

Consultative process
MEPS for motors were developed by the Australian Greenhouse Office Energy Efficiency Program, following a five-year Government/Industry/Stakeholder consultative process, and extensive economic and regulatory impact studies under the direction of the Australian and New Zealand Minerals and Energy Council.

The efficiency levels in the new regulations will be reviewed in four years, with a view to further raising the minimum efficiency levels.

Copies of the new Standard are available for purchase through Standards Australia http://www.standards.com.au.

Case Study 36 Variable Speed Drives Reduce Energy Consumption in HVAC Applications

Objective: To improve the ventilation systems energy efficiency
Location: California, USA
Website: http://www.oit.doe.gov/bestpractices/motors/mc-cs07.shtml

Description:
In an effort to improve ventilation system performance in its Fresno, California textile plant, Nisshinbo California, Inc. (NCI) working with ADI Control Techniques Drives (ADI-CT) of Hayward, retrofitted 15 of the system's fan motors with variable frequency drives (VFDs). This change enabled the fan control dampers to be fixed in a fully open position, and improved the system's air-flow control and energy efficiency.

Installation of the VFDs reduced the ventilation system's total electricity demand from approximately 322 kW to 133 kW, a 59 percent drop. The total annual energy consumption for the fans similarly fell 59 percent from approximately 2,700,000 kWh to 1,100,000 kWh. The energy-efficiency gains were possible because the VFDs enabled plant personnel to fully open the fan control dampers and reduced fan speed. This results in a large drop in motor power consumption and allows the system to operate efficiently.

These electricity savings translated to annual energy cost savings of about $101,000. When measured against the project's $130,000 gross cost which included the cost of the feasibility study; base case evaluation; system engineering and design; VFDs and associated equipment; and installation, startup, and commissioning, the simple payback for the project was 1.3 years.
It should be noted, however, that NCI did not pay for any of the costs that the project incurred.

In addition to the energy savings, NCI also realized additional benefits that were difficult to financially measure. First, installation of the VFDs gave plant personnel more control over the plant's air flow. NCI estimated that 48 hours of labor per year were saved because the dampers and ceiling diffusers no longer required modulating. Second, air quality is now easier to control, as responses to minor variations in the ventilation requirements are now possible. Third, the amount of airborne lint in the plant decreased, improving product quality and reducing the number of equipment breakdowns. Finally, the VFDs slightly increased the plant's power factor, thus reducing the power factor penalty costs.

Case Study 37 Using Correctly Sized Motors to Reduce Energy Consumption in Wastewater Facilities

Objective: To improve sewerage pump performance
Location: Trumbull, USA
Website: http://www.oit.doe.gov/bestpractices/motors/mc-cs08.shtml

Description:
Located just north of Bridgeport in southwestern Connecticut, the Town of Trumbull has a population of 32,000 and, with ten sewage pumping stations, a total raw sewage handling capacity of 3.3 million gallons per day. Each of the stations pump sewage to a main lift station where it is then pumped to a sewage treatment plant in Bridgeport.

The Town of Trumbull was looking for a way to increase the energy and operating efficiency of its Reservoir Avenue sewage pump station. With the help of ITT Flygt Corporation, the town altered the existing pump system by adding a smaller pump and modifying the system control scheme.

Under normal conditions, the operating point for the new pump is 450 GPM at 40.7 TDH, compared to 850 GPM at 50.3 TDH for the pumps in the original system. The specific energy of the optimized system was measured at 325 kWh/MG, a 255 kWh/MG decrease from the original system. In addition to the 17,643 kWh of energy savings achieved by modifying the pump unit, significant energy savings also resulted from changes made to other energy use sources in the station.
Annual energy consumption by the lighting system was reduced from 5,256 kWh to 78 kWh, while energy consumption of the bubbler level control (7,300 kWh/yr) and the cooling water pumps (1,752 kWh) was entirely eliminated. In all, 31,875 kWh was saved, a reduction of almost 44 percent, resulting in $2,614 in annual energy savings.

In addition to energy savings, the modifications reduced the system's cleaning and maintenance requirements as well as the control subsystem's maintenance requirements. Together, these reductions significantly decreased the labor needs of the station. Finally, the expected life of the operating equipment and electrical switch gear increased with the longer operating times and reduced power input of the new system.

Several lessons were learned from this Showcase Demonstration project which can be applied to other similar energy efficiency projects in the future: (1) rethinking the pump selection and operating methodology for pumping equipment can result in significant savings; (2) in systems with static head, stepping of pump sizes for variable flow rate applications can decrease energy consumption; (3) a "systems approach" can identify sources of energy consumption other than pumps that can be modified to save energy.

Case Study 38 Energy Savings in Compressed Air Systems

Objective: To reduce energy consumption in compressed air systems
Location: Various
Website: http://www.knowpressure.org/content/library/casestudies.cfm

Description:
The Compressed Air Challenge is a voluntary collaboration of industrial users; manufacturers, distributors and their associations; consultants; state research and development agencies; energy efficiency organizations; and utilities. The have a large number of case studies on their website including:

Michelin
In 1997, Michelin North America upgraded the compressed air system controls at its tire manufacturing plant in Spartanburg, South Carolina. In response to growing energy costs and the desire to remain competitive in the tire industry, Michelin performed an internal evaluation of its compressed air system to determine how it could improve the system's efficiency and energy use. The evaluation provided the basis for a project to install a new control system. The controls upgrade project at Michelin's plant enabled multiple compressor operation without blow-off during load swings. In addition, the plant has been able to stabilize and lower pressure levels, leading to estimated annual energy savings of $75,000 and 2,143,000 kWh.The project's total cost was $120,000, giving the plant a simple payback of approximately a year and a half.

Visteon
The energy team at Visteon's Monroe plant, formerly owned by Ford Motor Company, implemented an ongoing compressed air system leak management program. The team developed an approach that combined a traditional "find and fix" effort with an innovative implementation and marketing program. As a result of the leak management program, compressed air system consumption was reduced by more than 50% on a per production unit basis. This represents savings of over $560,000 per year and an 11.5% reduction in annual electricity costs.

Thomaston Mills
In 1997, a compressed air system improvement project was implemented at the Peerless Division of Thomaston Mills in Thomaston, Georgia. The compressed air system project was undertaken in conjunction with an effort aimed at modernizing some of the mill's production equipment. Once they were both completed, the mill was able to increase production by 2% per year while reducing annual compressed air energy costs by 4% (US$109,000) and maintenance costs by 35% (US$76,000). The project also improved the compressed air system's performance, resulting in a 90% reduction in compressor downtime and better product quality. Since the project's total cost was US$528,000 and the annual savings are US$185,000 per year, the simple payback is 2.9 years. The mill also avoided $55,000 in costs by installing a more optimal arrangement of compressors.

Case Study 39 Performance Contracting Leads to Energy Savings in Steam Production

Objective: To improve the energy efficiency of the steam production system in two hospitals
Location: Czech Republic
Website: http://www.weea.org/best/bulovka/

Description:
Energy Performance Services Czech Republic (EPS CR) has completed implementation of two performance contracting projects to provide energy efficiency services to two hospitals in the Czech Republic. These are the Bulovka Teaching Hospital in Prague and the Jilemnice District Hospital in northeast Bohemia. Both hospitals needed a significant upgrade in their central heating systems and were facing a situation of no available funding and operating expenditures that were rising more rapidly than incoming revenues or government subsidies would cover.

The performance contract with EPS CR provided long-term financing for the upgrade and generated savings that permitted the hospitals to reduce their operating costs without reducing the level of services. Both projects focused on modernizing heating systems, and did not include lighting renovations. Excluding construction time, the term of the performance contract for these projects is eight years.

There are four energy conservation measures in total project:
- switching the existing central steam system to district heating
- implementing a new energy management system
- installing a new air handler recovery system
- converting and upgrading to a new high efficiency natural gas boiler

Total installed cost of these measures was about US$2.7 million. All of the measures operating together will produce an annual savings of about US$700,000, resulting in a four-year simple payback. All four measures were put into operation in September 1995.

Case Study 40 Investment in Energy Efficient Equipment for Industrial Processes

Objective: Improving the energy performance in small scale glass production
Location: Firozabad, India
Website: http://www.teriin.org/case/glass.htm

Description:
It has been observed that small and medium enterprises in India are generally less efficient in material and energy use compared to larger enterprises and enterprises of similar scale in the developed countries. The poor energy and environmental performance is directly related to the lack of technical capacity in these enterprises to identify, access, and adopt better technologies and operating practices. Through detailed diagnostic studies carried out by TERI in various small and medium scale industrial clusters in 1995, it was found that there exists a tremendous scope for increasing energy efficiency in these units. Based on these studies, the small-scale glass industry cluster in Firozabad was identified for further intervention.The inadequacy of imported ready-made solutions for the small-scale glass making industry necessitated a dynamic design process in which the local industry played a central role. An important element of the intervention strategy to design and demonstrate an energy-efficient pot furnace was competence pooling, with synergies among the various actors resulting in an appropriate solution.

Though efficiencies of all furnaces were found to be low in general, it was decided to focus on pot and muffle furnaces in view of their low scale of operation, high share of coal use (48% for pot furnaces and 27% for muffle furnaces), very low operating efficiency and inability of the segment to mobilize support for technology upgradation. At this juncture, the Supreme Court of India passed a landmark judgement in response to a public interest litigation seeking protection of the Taj Mahal against pollution. Under this ruling, the apex court banned the use of coal /coke in the entire TTZ (Taj trapezium zone), an area of 10,400 sq. km. around the Taj. The court directed 292 specified industries located in the TTZ, which were using coke/coal as fuel, to switch over to natural gas, relocate outside the TTZ, or shut down. Gas Authority of India Limited (GAIL) was asked to supply gas to the industries in the TTZ. Since Firozabad also lies in the TTZ, it became mandatory for the industries in Firozabad to switch over to gas as a fuel. However, no off-the-shelf solutions were available to the industry to make this switch over.

The demonstration pot furnace, using natural gas as fuel, was commissioned in February 2000. There has been no deterioration in the plant performance, in terms of specific energy consumption. While specific energy consumption for the conventional furnaces was found to be about 5860 kcal/ kg of glass, for TERI furnace it was found to be 2460 kcal/kg of glass, a reduction of nearly 60 %.

Case Study 41 Investment in Energy Efficient Equipment for Industrial Processes

Objective: Improve the energy performance of small scale foundries
Location: Howrah and Nagpur, India
Website: http://www.teriin.org/case/foundry.htm

Description:
The Indian small-scale sector has over 6000 cupola-based foundry units, located mostly in clusters. The energy intensity of these units is quite high as shown by the charged coke percentage. Further, after the strict imposition of emission standards, most small-scale foundry units found it extremely difficult to comply, primarily due to the lack of availability of any ready-made gas cleaning systems. This presents an ideal situation where both energy saving and pollution reduction could be achieved through technological upgradation.

The Howrah belt of West Bengal has the largest concentration of foundry units in India and accounts for over 20% of the country's output production of grey cast iron. TERI's Action Research Programme in the Foundry Sector was initiated with the support of the SDC (Swiss Agency for Development and Cooperation) to improve the energy and environmental performance of small-scale foundry units.

Energy audits of representative conventional cupolas and DBCs (divided blast cupola) were conducted in both Agra and Howrah foundry clusters prior to the designing of the demonstration plant. These audits revealed a very low operating efficiency of the cupolas, characterized by a very high charged coke percentage. The emissions and the particle size were measured before designing the new pollution control system.

As against the conventional cupolas used in most foundries, the DBC is an attractive option for increasing profitability by reducing coke consumption from a modest investment. Further, the lack of availability of any ready-made gas cleaning systems made it very difficult for the foundries to meet the stringent particulate emission norm of 150 mg /Nm^3. Consequently, it was decided that a suitable flue gas cleaning system be designed along with a DBC. A DBC demonstration unit was set up, equipped with a flue gas cleaning system for controlling emissions. After optimization of control parameters, energy and environmental measurements were conducted to assess the copula's performance.

Results indicated that, as against the conventional-cupola-based foundry units, the demonstration cupola was at least 33% more energy efficient than the 'best' unit audited by TERI. The extent of coke saving is even higher (nearly 65%) compared to the 'worst' cupolas audited. The degree of abatement in stack emissions was also substantial, with the SPM (suspended particulate matter) emission being only one third of the stringent norm. The sulphur dioxide emission from the demonstration cupola was also well below emission standards.

Case Study 42 Co-generation and the Confectionary Industry in Nigeria

Objective: To produce the power and steam needs as part of the manufacturing operations
Location: Nigeria
Website: http://www.jxj.com/magsandj/cospp/2001_01/winwin.html

Description:
The productivity of many manufacturing entities in Nigeria is seriously constrained by an unreliable supply of energy, in the form of power and petroleum products, which are the major energy carriers in manufacturing. Over many years of manufacturing operations, the food company Cadbury Nigeria Plc. has taken this bull by the horns, by maintaining in-house responsibility for providing its facilities with a reliable, high-quality energy supply.

To manufacture these products, the company requires an adequate, cost-effective and reliable supply of power and steam. The company generates sufficient power to meet all its requirements from generators with a total installed capacity of about 7.3 MW. Its manufacturing facilities are currently not connected to the national grid. In 1998 the company generated an average of about 23,000 MWh of electrical energy with a peak power demand of about 5 MW, using diesel as the fuel.

Its steam supply in the same year was supplied by seven boilers with a total installed capacity of about 54 tons/hour. In 1998, a peak demand of about 35 tons/hour was achieved, using low pour fuel oil (LPFO) as fuel to produce dry steam at pressure of about 10 bar. During this year, LPFO consumption totalled about 6.3 million litres.

The result is that the company generates 100% of its power and steam needs within the factory. By so doing over a period of years, its major energy security consideration has been the adequate, timely and reliable supply of diesel and fuel oil. Even then, it has not been completely shielded from unreliable petroleum product supplies.

The need to increase energy security (and hence productivity), coupled with better environmental performance and superior economics, recently influenced the management's decision to shift from the use of diesel and fuel oil to natural gas.

The factory has been able to obtain a 39.7% reduction in fuel requirement compared with the existing system and resulting in a large financial saving for the organization, with system efficiency in the cogeneration system of 90%.

Case Study 43 Cogeneration and the Privatisation of the Electricity Industry

Objective: To develop cogeneration as a method of energy efficiency
Location: Brazil
Website: http://www.jxj.com/magsandj/cospp/2000_02/cogeneration_for_brazil.html

Description:
With 162 million inhabitants in an area of 8.5 million square kilometres, Brazil's population density in many areas is very low. Per capita income is also low, yet Brazil ranks amongst the ten largest economies in the world. Industrialization is fairly advanced – the country's automobile industry, for example, produces over 2 million vehicles per year. Demand for power, which was 320 TWh in 1999, is growing rapidly. Over the last decade GNP grew by 21%, but demand for power increased by 79%. There are two main reasons for the rapid growth: the first is the intensive urbanization and development of basic industry and infrastructure that took place throughout the 1980s to meet the needs of many regions in Brazil; the second is an increase in the informal economy.

Brazil relies on large-scale hydroelectric plants to produce 95% of electric load. These plants, including the world's largest, Itaipu, are located in five river basins and are linked to the market by an extensive system of transmission lines. Cogeneration accounts for approximately 3% of total generated energy, the majority of which is based on seasonal production by the sugar-cane industry. The relatively low contribution of cogeneration to total power production is a direct result of the old power sector model. This model favoured large hydropower projects, encouraging them to take advantage of economies of scale and favourable locations along Brazilian rivers.

While cogeneration was not prohibited, the model lacked clear mechanisms for the sale of excess electricity to the grid. Another major barrier was the low price for electricity. Natural gas availability was very limited, supplying less than 3% of Brazil's primary needs. For these reasons investment in the development of on-site generation was very slight. The barriers that have inhibited development of on-site generation are diminishing as Brazil's energy sector is reformed. Most of the electric distribution utilities have now been privatized, and distribution gas utilities with private control are being organized.

Cogeneration is currently being developed in Brazil. The World Bank has recently given a loan to the Programa de Combate ao despedicio de Energia Electrica (PROCEL) to focus on end-use energy conservation, and several industries are already using this technology (such as the President Vargas Steelworks with its 230 MW cogeneration thermoelectric power plant). Taking into account the existing power supplies and projected structures, the proportion of cogeneration in Brazil is likely to reach 10–15% by 2010. With demand expected to grow at a rate of 3–4% per year, demand for cogeneration could reach between 11 and 17 GW during the next decade, making Brazil one of the world's best markets for cogeneration and distributed generation.

Case Study 44 Cogeneration and District Heating

Objective: To replace coal fired cogeneration with natural gas
Location: China
Website: http://www.jxj.com/magsandj/cospp/2001_05/gas.html

Description:
China's energy needs are potentially enormous, and the challenge of supplying its vast population and rapidly growing economy is huge. Its environment is fragile in places, and the air quality in the larger cities already very poor. The country is also trying to find a balance between a centrally planned and a market economy. Greater use of natural gas is at the heart of the Chinese strategy for dealing with these potentially conflicting demands for energy supply.

Cogeneration has historically grown in step with other coal-fired plants, representing approximately 10-12% of coal-fired generating capacity since 1980. Large municipal steam systems and centralized cogeneration facilities in industrial parks are common. Nearly 45% of the cities in China have some form of centralized steam or hot water system. Population movements from rural areas to the cities and greater wealth have rapidly increased urban steam demand. State-run utilities and Chinese independent power producers have responded with the expansion of heating systems and new construction. The Beijing Municipal Heating Company, the largest in the country, increased its service area 15% in 2000.

After the capacity glut caused by the economic slowdown, the demand for electricity and steam in China is rebounding. The relatively steady pace of development in the country since the Asian financial collapse gives confidence in the stability of the country's financial system. In addition, many of the early problems, such as availability of foreign exchange and access to capital markets, have been worked out. However, there is still an uncertain regulatory environment which, while continually being reformed, also seems to have the potential for change on a continual basis.

For cogeneration developers, Chinese projects have almost solely involved coal-fired projects less than 100 MW, serving captive customers that were typically JV partners. Private power developer AES entered China with such a strategy, and more recently Alliant has announced it is taking a similar track.

Gas-fired projects have been less common, due to the extremely weak infrastructure. However, this infrastructure gap is being filled. Despite the many hurdles in the way of development, the high-profile West-East pipeline, the Guandong LNG terminal and further offshore gas production promise to provide substantial resources for gas-based cogeneration plants by 2008. The degree to which foreign participation will be realized in these projects will be due largely to the creativity in the financing and technology solutions offered to the Chinese market. While examples of early wins in the Chinese market are rare, there seems to be a consensus that the promise of the future will be worth the wait.