An industrial energy efficiency case study in the steel industry

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ABB’s global consulting business was able to help a global steel producer to find circa R150-million in annual energy savings at one of its integrated steel mills, through the application of a structured industrial energy efficiency program.

The integrated steel mill has the capacity to produce up to 5-million tonnes of steel per year, with over 4000 employees based at the site. The mill produces black coil, pickled and oiled coil sheet, and cut-to-length sheet and slit coils.

The vast site is a fully integrated steel mill, with quay facilities, sintering plant, casting over-plant, two blast furnaces, two basic oxygen converters, two continuous casters, in-ladle vacuum degassing, hot strip mill and multiple finishing lines. The plant management had already made significant investment in energy efficient core process technologies and on-site waste gas integration. To complement the successful energy efficiency initiatives, the plant challenged ABB to identify and develop energy efficiency opportunities on the site. A structured, collaborative approach helped to identify 53 energy savings opportunities covering a wide range of systems. After these opportunities were identified, the joint team collaborated to confirm the most attractive opportunities and develop them into a prioritised portfolio of fully specified projects capable of rapid and successful implementation.

The ABB industrial energy efficiency programme

The industrial energy efficiency (IEE) program consists of three stages: Opportunity Identification; Master plan; and Implementation (Fig. 1).

Opportunity identification

The opportunity identification phase is the first step in delivering a comprehensive energy reduction and optimisation programme. The study identifies specific opportunities to deliver improvements, by understanding how and where energy is used. Three areas of assessment are considered across each aspect of the industrial site; namely technology and control, monitoring and targeting, and behaviours and practices (Fig. 2).

The three areas of assessment may be considered separately or together as part of a complete programme.

Industrial process expertise

ABB’s in-house engineering teams have successfully delivered energy improvements with process energy optimisation in: metals, mining and minerals processing; power generation; chemicals; pulp and paper; oil and gas processing; life sciences, and food and beverage industries.

Benefits

Opportunity Identification is the proven methodology for identifying savings of 5 to 20% of the total site energy bill, through identification of energy saving opportunities in site utilities and processes, assessment of behaviours and practices, and monitoring and targeting strategies.

Scope of assessment

Technology and control:

This aspect of the opportunity identification study assesses the efficiency of existing utility systems and identifies improvements through process control, equipment modification or alternative energy efficient technologies, typically covering the following energy systems:

- Fired equipment (heaters, furnaces etc.)
- Steam boilers and steam systems
- Industrial refrigeration and chillers
- Compressed air and industrial gases
- Cooling water and water treatment facilities of electrical systems
- High voltage and site users
- Heating, ventilation and air conditioning (HVAC)

Monitoring and targeting: This is a key element of an effective energy management programme, so this aspect of the study assesses how well the site is able to measure key parameters of process operation and utility use versus best practice. The study considers:

- The presence and extent of energy metering and recording.
- Data collection and storage system.
- Data analysis techniques used to extract information from the data.
- How well the information is presented to key users.
- Whether KPIs are in place for ongoing performance assessment.
- How well M&T is integrated into the site’s energy management practices.

Behaviours and practices:

This aspect of the study identifies and assesses behaviours and practices which are influencing energy efficiency across site process and utility operations. The assessment also provides a comprehensive review versus best practice, covering:

- Energy strategy and policy
- Capital investment
- Information technology
- Operational management
- Operational planning and performance
- Energy management
- Training and development
- Staff motivation
- Maintenance

Assessment process

The opportunity identification methodology follows a well-established process, which can be tailored to specific client and site requirements. The study starts with a request for information, to collect...
opportunities, with:
portfolio of attractive energy saving identification phase is to produce a The objective of this opportunity to identify and confirm energy saving information acquired from the site visit to analyse and review the additional site assessment, the team will continue management on the site. Following the site visit is to identify practical opportunities with key site personnel. The objective of the information through interviews with key site personnel. The objective of the site visit is to identify practical opportunities to improve energy efficiency and energy management on the site. Following the site assessment, the team will continue to analyse and review the additional information acquired from the site visit to identify and confirm energy saving opportunities.
The objective of this opportunity identification phase is to produce a portfolio of attractive energy saving opportunities, with:
• A description of the energy saving opportunity by plant area or system
• An estimate of the range of energy savings
• An assessment of the likely level of investment which will be required for implementation of the energy saving recommendations
• An understanding of the likely payback times of the portfolio.
Master plan
The master plan is the second phase of the IEE programme. In this phase we develop an existing portfolio of energy saving opportunities into a comprehensive implementation plan, in conjunction with our clients, with consideration and assessment of the key aspects of each project.
The master plan is a continuous process, almost concurrent with the implementation of energy saving projects and is overseen by an appointed programme manager who liaises throughout this phase with the client’s organisation, the team and third party vendors where applicable.
Methodology:
The master plan is tailored to meet requirements; however the process flow diagram in Fig. 4 depicts the main elements of a typical Master Plan.
Alignment workshops:
A series of alignment workshops are conducted with the client at the beginning of the master plan phase, considering the key aspects of each energy saving opportunity within the portfolio, including:
• Agreement upon the magnitude of energy savings and likely investment range.
• Removal or reduction of assumptions.
• Identification of potential constraints.
• Availability of data to confirm opportunity.
Prioritisation process:
The prioritisation process is typically conducted in conjunction with the alignment workshop(s) with the objective of prioritising the energy saving opportunities portfolio, according to our project evaluation criteria. Our methodology’s evaluation parameters are often combined with the customer’s own criteria to score the projects for feasibility and ease of implementation. Examples of criteria used in the prioritisation process include payback period and business impact.
Deliverables – project portfolio:
At the close of the alignment workshop(s) and prioritisation process, an agreed project portfolio is developed with energy saving projects prioritised into three categories:
• Quick win projects for immediate implementation.
• Tier 1: Projects selected for immediate development towards implementation.
• Tier 2: Projects that require further information prior to selection and development.
For each project selected in tier 1 of the project portfolio, a project specification is developed to enable implementation, covering:
• Identification of technical, environmental and health and safety risks.
• Benchmarking of current performance, confirmation of savings and payback estimates.
• Estimation of the implementation costs of the selected project solutions.
• Development of benefits verification and measurement methodology.
• Compilation of comprehensive implementation schemes and key assumptions.
For each project in tier 2 of the project portfolio, an opportunity summary is developed to enable confirmation of the energy saving project, covering:
• Opportunity description
• Further information required
• Project confirmation schedule
• Likely timescale & resources
Tier 2 projects can then later be promoted to tier 1 and project specifications developed in accordance with the confirmation schedule and consolidation process.
Enabling programme:
The enabling programme is the mechanism used to drive rapid implementation of energy saving projects and to maximise the cash flow from the Industrial Energy Efficiency (IEE) programme. It is overseen
by the programme manager and includes the development, specification and implementation of projects along with the confirmation of selected tier 2 opportunities.

Consolidation:

The consolidation component of the enabling programme is a series of periodic workshops designed to:

- Review and validate the value of the programme with savings verification for implemented projects.
- Review and prioritise tier 2 opportunities, promoting to tier 1 for project specification.
- Identify constraints, confirm budget cycles and optimise the ongoing implementation schedule.

For multi-site and strategic IEE programmes, the consolidation process is often conducted at a regional level, in addition to site-based coordination activities.

Implementation:

Implementation of energy saving projects is the third phase of the IEE programme, driven as a continuous process by the Programme Manager using the Master Plan as a road map.

Organisation to deliver:

The implementation team and resource requirements are specific to individual energy saving projects, ranging from:

- Quick win projects requiring little resourcing.
- Large capital investment projects requiring significant project feasibility, design, execution and procurement of equipment and/or technology from third party vendors.

An IEE programme typically develops a portfolio of projects with a mixture of resource and competency requirements and as such, requires dynamic access to a diverse range of expertise.

The flexibility of the IEE programme approach means that resources can be provided by any of ABB, the client’s organisation, third party organisations, or a combination of these, to maximise the value of the programme to the customer.

The programme manager retains overall responsibility for the successful implementation of the programme, utilising resources from the best available source for each project task.

Implementation project examples:

A portfolio of energy saving projects ranges from simple through to complex implementations; examples, in ascending order of complexity include:

- Optimisation of process set-points and parameters (e.g. flue gas oxygen concentration control for fired equipment).
- Optimisation of control loop or equipment sequencing (e.g. fan system control for ventilation systems).
- Additional instrumentation for improved control or monitoring and targeting (e.g. compressed air system demand and consumption).
- Replacement/switch-out of auxiliary/balance of plant equipment for efficiency (e.g. correct sizing of cooling water system pumps).
- Improvements in behaviours and practices (e.g. incorporation of energy efficiency requirements within standard procurement cycles).
- Upgrade or replacement of key equipment and/or site processes (e.g. upgrading to variable speed drives for major equipment)
- Design and installation of new sub-processes and equipment to improve energy efficiency (e.g. installation of economisers for improved heat recovery on steam boilers).
- Feasibility, design and installation of major processes and equipment to improve energy efficiency (e.g. installation of gas turbine cogeneration unit for on-site generation of energy efficient electricity and heat).

Implementation team and resources:

For a typical IEE programme, the resource mix of the team for individual projects will be driven by the nature of the projects themselves and the in-house capabilities of the client’s organisation.

Five key aspects of resource requirements and their source are considered project-by-project, as depicted in Fig. 5.

Management:

Successful implementation of the IEE portfolio is driven by close collaboration between the programme manager and the client sponsor.

Expertise:

On an individual project basis, the mix of client and the team expertise can be selected according to the project requirements. For some simple projects, further expertise may not be required.

- Engineering:
  On an individual project basis, project design can be provided by ABB, or where the client organisation has in-house capability, the client project team. For some simple projects, project design may not be required.

- Execution:
  On an individual project basis, installation and commissioning can be provided by ABB, or the client organisation where in-house capability or preferred contractor resources exist. For some simple projects, project execution may be conducted without significant resource.

- Technology:
  ABB is a world leader in the supply of energy efficient power and automation technologies and is also able to identify and acquire appropriate technologies from specialist third party vendors, in order to support rapid implementation of the IEE programme.

Industrial energy efficiency at integrated steel mill

This section focuses on the IEE process as completed at the leading global steel producer’s integrated steel-mill in France. The following sub-sections present, for each of the phases of the IEE programme, the highlights of the initiative with the steel mill that is the subject of this paper.

Opportunity identification:

A wide range of plant areas were considered during the opportunity identification phase, these included:

- Blast furnaces
- Cowper stoves
- Basic oxygen steelmaking (BOS) plant
- Power plant
- Hot rolling mill
Due to the highly effective management of thermal energy usage that is in place at the plant, the opportunity identification phase at the mill was uniquely focused upon only electrical energy savings. This phase was conducted over a total of six weeks by the ABB Global Consulting team, supported by local expertise within the organisation. Following the review of initial data supplied by plant personnel, the site assessment was conducted during a single, concentrated week on site. Key to the success of the site-based assessment was the support of the mill personnel, collaborating in a single assessment team throughout, with further support from site personnel during the subsequent analysis phase. The combined assessment team, in two groups, assessed each of the above areas to determine the major energy consumption and generation areas, modes of operation, and identification of opportunities to reduce energy consumption without compromising operating schedules, quality, or health, safety and environmental considerations. In total, 53 opportunities to reduce energy consumption were identified, ranging from simple, zero capital, “quick-wins” through to minor and major projects with significant capital investment. Examples of the identified opportunities include:

- MV variable speed drive opportunities
- LV variable speed drive opportunities
- Process control changes to optimise energy consumption
- Cooling tower optimal operation – for pressure and temperature
- Power plant boiler air-to-fuel ratio optimisation
- Equipment selection for reduced energy consumption
- Evaluation of existing process parameters to optimise energy consumption

**Master plan**

Following the conclusion of the opportunity identification phase, prioritisation of the 53 projects identified was conducted at the mill together with site personnel. A combination of ABB Energy Consultants, plant management and technical resources were accessed during a series of alignment workshop meetings to identify constraints, reduce assumptions and decide upon the most attractive set of projects for development. The team confirmed three zero capital investment opportunities for immediate implementation with energy savings of R1.2-million/year, with an averaged payback of less than one year. In addition, four of the identified opportunities were selected and developed for implementation with energy savings of R19-million/year, and an average payback of one year. For each of these projects, ABB developed project specification documentation as an enabler for capital expenditure application, in conjunction with the site’s own project-acceleration process, including:

- Estimated benefits and likely project costs
- Benefits verification models
- Implementation schedules

**Conclusions**

- Quick payback opportunities are often still available
- Identifying the potential requires understanding of technology and operation and constraints
- Need to consider both thermal and electrical energy
- Benefits from sharing experiences across industry sectors
- Objective prioritisation of Opportunity Portfolio by joint team yields real benefits

**References**

[1] ABB Review, “Iron & Steel Case Study”, Contact Edith Kikonyogo, ABB South Africa, Tel 010 202-5000, edith.kikonyogo@za.abb.com