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# Methodologies and Solutions To Conserve Energy in Iron and Steel Industry


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**POINT OF VIEW**

## Conservation Mandates Require Profitable, Scalable Strategy for Sustainability

**From power generation to transport, industries and their machinery are built on steel, which gives it formidable influence over economies around the world. This prominence, however, brings added responsibility as governments and standards organizations are pressuring the iron and steel industry to reduce carbon emissions and energy intensity in the production process. Challenged with increases in production and degradation of raw material quality that have escalated energy requirements, steel producers now also face conservation mandates, some with severe financial penalties. The answer is to implement a strategy that balances economic, social and enviornmental sustainability goals with increased productivity and scalable profit.**

Steel production has grown over the years with current total crude steel production now at 1869.9 million tons and continued growth expected in the future. With 4 to 4.5[1] gigacalories per ton of crude steel (Gcal/tcs) energy intensity, the steel industry is responsible for 17% of world's total industrial energy consumption, which accounts for approximately 4 to 5% of total world CO2 emissions. An average of 1.9[2] tons of CO2 are emitted for every ton of steel.

Governments worldwide have taken notice of these levels and are advancing energy conservation initiatives. India's National Mission for Enhanced Energy Efficiency (NMEEE), for example, drives four programs to enhance energy efficiency in iron and steel as well as other energy-intensive industries. Beyond environmental benefits of new efficiencies, identifying new opportunities for energy conservation can help steel manufacturers, themselves, become more sustainable and gain benefits, such as:

- Cost savings through energy efficiency improvement.
- Energy intensity reduction.
- Effective management of energy resources.
- Process control driving quality and productivity.

## Optimize the Value Chain for Sustainable Supply and Demand

Steel producers understand the various processing stages that require energy in different forms (see Figures 1 and 2).[3,4] For example, upstream processes like refining raw material or making iron, show greater dependency toward thermal energy. Unfortunately, thermal energy damages water ecosystems and poses risk to animal populations. Organizations striving for an impact on the sustainability agenda must rotate to responsible and circular value in supply chains. By embedding sustainability into each stage of processing, producers can enable net-zero and responsible production lines.

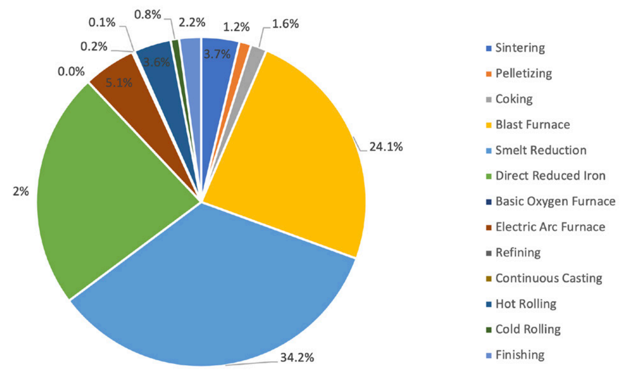


**Figure 1. Process-Wise Energy Consumption**

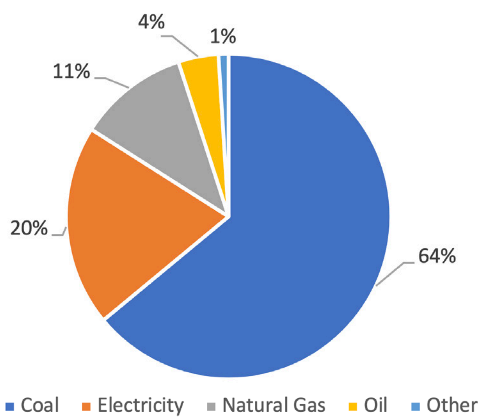


**Figure 2. Energy Structure of Steel Industry**

This "leaning in" to the circular economy means making adjustments that answer evolving sustainability standards, such as those being created by [International Organization for Standardization's technical committee 323 (ISO TC 323)].[5] To do so, steel producers first need to apply appropriate methodologies to assess energy consumption and identify where savings are feasible.

### Evaluate Consumption To Determine Conservation Best Practices

Energy use or energy requirement is governed by a simple equation:

*Energy Requirement =*
*Production Volume x Specific Energy Consumption*

As production volume is dictated by demand, steel producers recognize that the changeable variable in this equation is specific energy consumption. But adjustments to specific energy consumption that can reduce energy requirements can't be configured unless the theoretical limit and actual consumption of a process or system, as well as losses, can be determined.

To gain an understanding of the *theoretical limit or baselining*, administrators will want to monitor and compare energy consumption values with the baseline value determined through real-time monitoring. Then corrective action can be taken in case of deviations. Also, comparing energy performance of the process or system within the production unit over time and with peers in the industry allows benchmarking, which informs energy conservation best practices.

Administrators will also want to *identify energy losses* in terms of audit balance and management to identify potential opportunities for energy conservation. Perform mass or material and energy balance for critical and energy-intensive systems at regular intervals. An audit of systems and process in the production unit helps identify the most energy-intensive areas and chart out a focused approach towards energy conservation. And an energy management system (EMS) ensures a continual energy conservation process within the organization as it requires strong commitment from top management and proper employee training to create an energy savings culture.

Complete examination of the energy requirement equation for an organization is a substantial undertaking that would benefit from collaboration with a partner well versed in this analysis. With a full picture of specific energy consumption across the processes of the steel value chain, steel producers can move into the energy saving solutions that best support sustainability goals.

## How To Draw Energy Savings From Across the Steel Value Chain

Whether aiming for general energy savings or to answer the challenge of zero-carbon steel, a goal recently announced by the Japan Iron and Steel Federation,[6] steel producers will be looking at three categories of energy conservation solutions.

### Reduce Theoretical Limits With Waste Heat Recovery and Electric Energy Solutions

Recovering heat from waste gasses has long been an objective of steel manufacturers. Another look at the application of this strategy may be in order as heat exchangers can now preheat the combustion air and fuel in the reheating furnace and cold blast in stoves to reduce the fuel requirement of the process. Electric energy savings can be found from the production floor to the office to the yard via efficient electric lighting and systems. And implementing variable frequency devices (VFDs) can optimize motor operation for high-pressure pumps and industrial fans.

### Bridge the Gap Between Actual Consumption and Theoretical Limits: Direct Process

Digital tools and data analytics on historic operations data can help organizations understand, predict and optimize the energy consumption in the entire value chain and tap the energy losses. Consider the following "bridging" approaches and their direct applications to savings and sustainability:

- **Operations optimization.** Energy consumption in an electric arc furnace (EAF) can be optimized using an artificial intelligence and machine learning based mathematical model that predicts the electricity and oxygen requirements built on historic data.
- **Asset management.** Predictive analytics can provide insights into the electric overhead traveling (EOT) crane health, helping maintenance teams to improve performance, increase uptime and reduce energy consumption.
- **Predictive quality.** Direct reduced iron (DRI) quality can impact the energy consumption in EAF. Using mathematical models, the quality of DRI can be predicted, to optimize energy consumption in the downstream process.
- **Dynamic scheduling.** A dynamic scheduling program can build on the production forecast data and optimize reheating furnace operation to improve furnace efficiency and effective energy utilization.
- **IIoT Implementation.** Holistic views of energy consumption trends across the value chain can help the energy manager identify and prioritize energy conservation initiatives and meet regulatory requirements. In addition, specialized industrial IoT (IIoT) applications like application performance management can help automate and optimize these processes.
- **Digital Twins and Cyberphysical Systems.** These digital replicas of processes or systems can help optimize the process parameters through iterations on the input parameters, such as raw material quality, temperature and pressure. The blast furnace operator can perform better on the shop floor and optimize the hot metal production, quality and energy consumption by varying process and quality parameters on the digital twin.

### Use Byproducts or Alternate Fuels

These solutions replace traditional fuels with alternate or renewable ones to reduce the cost and dependency on the conventional fuels. For example, coke oven gas can be used in boilers to produce steam. Tire dust can be used as an alternative in the EAF and blast furnace to reduce cost, provided the quality is not compromised. Use these methods to help stabilize variations in traditional fuel availability and reduce production cost. Solar power offers tangible options for lighting across the process. Note that solar panels can be installed on rooftops, on open land or over water bodies to generate electricity, which can supplement power for lighting across the process, which is generated from captive power plants.

Amid these choices, a qualified partner can assist steel producers in identifying best choices and best practices for solutions that will enable energy conservation specific to their organizations.

> "We're keen to understand energy patterns in manufacturing facilities because our goal is to help utility companies embrace their responsibility for sustainability. By lowering emissions, reducing waste, and using less energy, we're all doing our part to create a better society, environment, and global economy."

**Sharad Nigam**
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## Hitachi Vantara Partners With the Steel Industry, Taking a Three-Step Approach to Energy Conservation

Based on our experience, we would note that the solutions above can vary in value potential and ease of implementation. Typically, they can be categorized as shown in Figure 3.

Hitachi Vantara can help you navigate through these solutions with our three-step approach. To ensure the use of best practices in developing your optimal strategy, Hitachi Vantara first aims to understand your current situation. Second, we work in close collaboration with the plant teams to understand today's process conditions and challenges in detail. We leverage our IT and OT expertise to reprioritize the above solution as per current requirements and visualize how that strategy can be enhanced. And finally, we present a clear road map for improvement to maximize the benefits both in short and long term (see Figure 4).

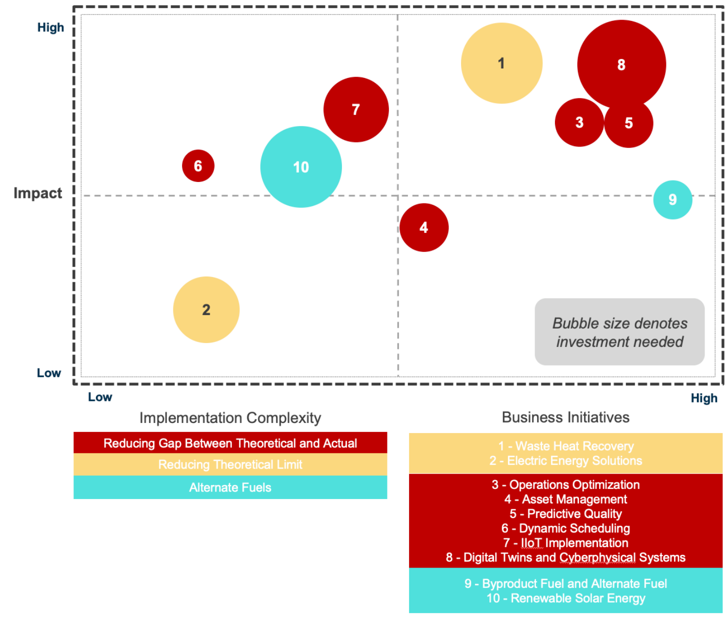


Figure 3. Actual value potential, ease of implementation and investment may vary as per the actual shop floor conditions.

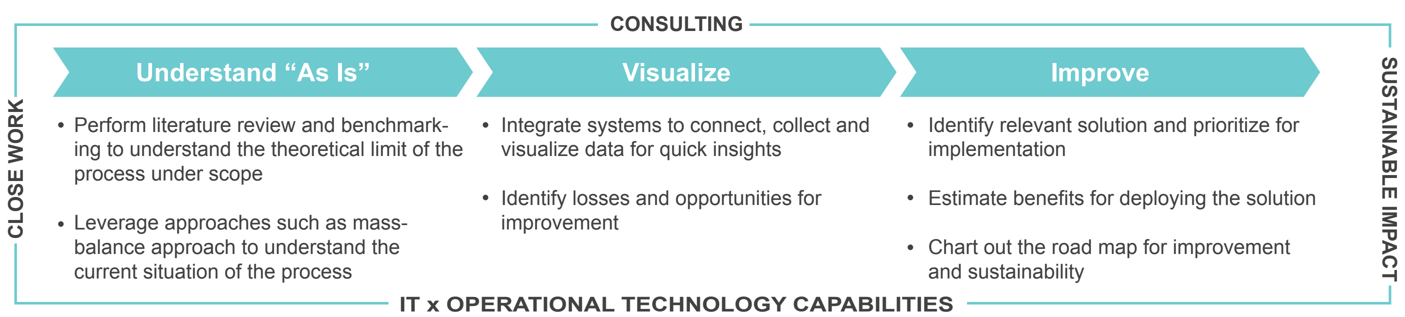


Figure 4. Hitachi Vantara's Three-Step Approach




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