The Danish Energy Agency

Anonymous Audit Report
from a Steel company

ENERTEAM, 28/03/2025

Content

Introduction to the context

On March 13, 2019, the Decision No. 280/QD-TTg on approval of the National Energy Efficiency Programme (VNEEP) for the period of 2019-2030 was issued by the Prime Minister.

The VNEEP implements synchronously activities in the field of economical and efficient use of energy, showing commitments of all levels of government, associations, businesses, organizations, individuals to energy efficiency in particular and to climate change resilience and environmental protection in general.

The Vietnam-Denmark Energy Partnership Program Phase 3 (DEPP3) for the period 2020-2025 implement a number of activities, making substantial and effective contributions to help Vietnam's energy sector transition towards green growth, reduce carbon emissions through the development of a green energy system, operate a flexible power system, efficiently enforce policies and measures promoting energy efficiency and conservation.

One of the very important activities of promoting energy efficiency through Energy Audit in a broad variety of industrial sectors in Vietnam.

This document contains an anonymised summery of a specific energy audit report conducted as a part of the DEPP3 program. The audit has been conducted on a steel production plant, by Energy Conservation Research and Development Center (ENERTEAM), in collaboration with an international expert from Viegand Maagøe.

Summary

Through detailed energy mapping, auditors gained a clear understanding of the energy consumption structure, including the specific purposes of energy use in various production processes. The mapping provided an overview of heating, cooling, and electricity consumption distribution, facilitating the identification of main energy-consuming areas. Additionally, the analysis highlighted energy input/output flows and losses at each production stage, along with the current status of technological equipment used.

By examining the balance between raw material flows, energy consumption, and losses, auditors assessed the overall efficiency of energy use within the production process, identifying potential areas for improvement. As a result, nine Level B energy-saving projects were recommended. Among these, certain projects involving higher investment and technical complexity were classified as Level A. To ensure accurate realization of the energy and economic saving potentials of these Level A projects, it is recommended to conduct further evaluation through detailed pre-feasibility or feasibility studies.

Details of energy saving potentials are shown in the following table:

Figure 0.1. Summary of energy saving opportunities

Group of ECMs	**Electricity savings** *(kWh/year)*	**Cost savings** *(million VND/year)*	**CO_2 emission reduction** *(ton CO_2e/year)*
No investment cost or low investment cost[1]	178,629	309	120.9
Medium investment cost[2]	169,055	292	114.4
High investment cost[3]	2,666,813	10,457	4,089.1
Total	**3,014,497**	**11,058**	**4,324.9**
Percentage of savings	**3.5%**	**-**	**7.0%**

[1] No investment cost or low investment cost: Investment cost ≤ 500 million VND.

[2] Medium investment cost: 500 million VND < Investment cost ≤ 01 billion VND.

[3] High investment cost: Investment cost > 01 billion VND.

1 About the enterprise

The company is recognized as a leading company in the manufacturing and trading of construction steel products in Viet Nam. In early 2022, the company began to gradually expand its production and business scale. With a strong emphasis on quality as a core objective and user benefits as a fundamental principle, the steel products offered by this company have attracted significant investment from numerous stakeholders.

1.1 Description of the company

- Sector: Steel Industry
- Main raw materials: The main input materials are scrap metal purchased from various sources. Total raw materials input is 124,859 tons per year in 2023.
- Main products: The main production output are Steel Billet and Steel construction
  - Steel Billet: 57,362 (ton/year)
  - Steel Construction: 79,625 (ton/year)
- Annual energy total consumption:
  - Electricity:
    - Grid: 85,890,000 (kWh), equivalent to 7,385 (TOE), 85,890 (MWh)
  - CNG: 19,682,984 (kWh), equivalent to 1,692 (TOE), 19,683 (MWh)
  - LPG: 18,997,593 (kWh), equivalent to 1,633 (TOE), 18,998 (MWh)
  - Diesel oil: 3,169,941 (kWh), equivalent to 273 (TOE), 3,170 (MWh)
  - Gasoline: 244,444 (kWh), equivalent to 21 (TOE), 0.244 (MWh)
- Annual carbon footprint: 97,761 ton CO_2e

The share of energy consumption at the company in 2023 are as follows:

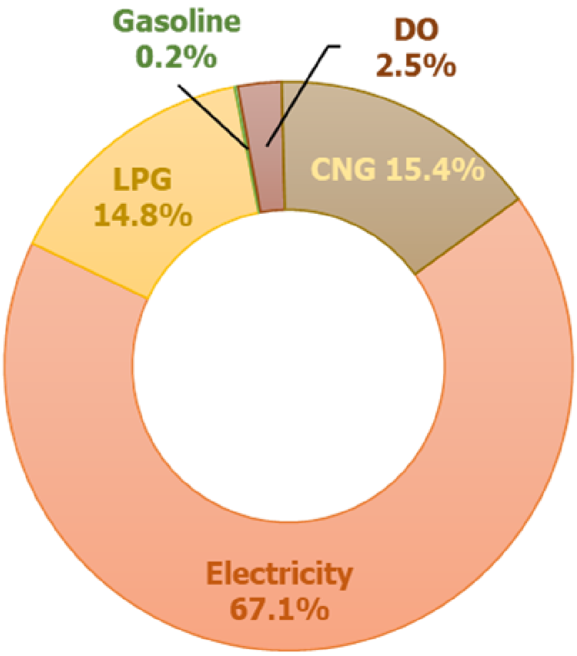


Figure 1.1. Share of energy consumption

The chart above shows that electricity is the most consumed energy in the company, accounting for about 67.1%, CNG accounting for about 15,4%, LPG accounting for about 14,8%. Other types of energy such as DO oil and gasoline account for 2.7%.

1.2 Description of the process

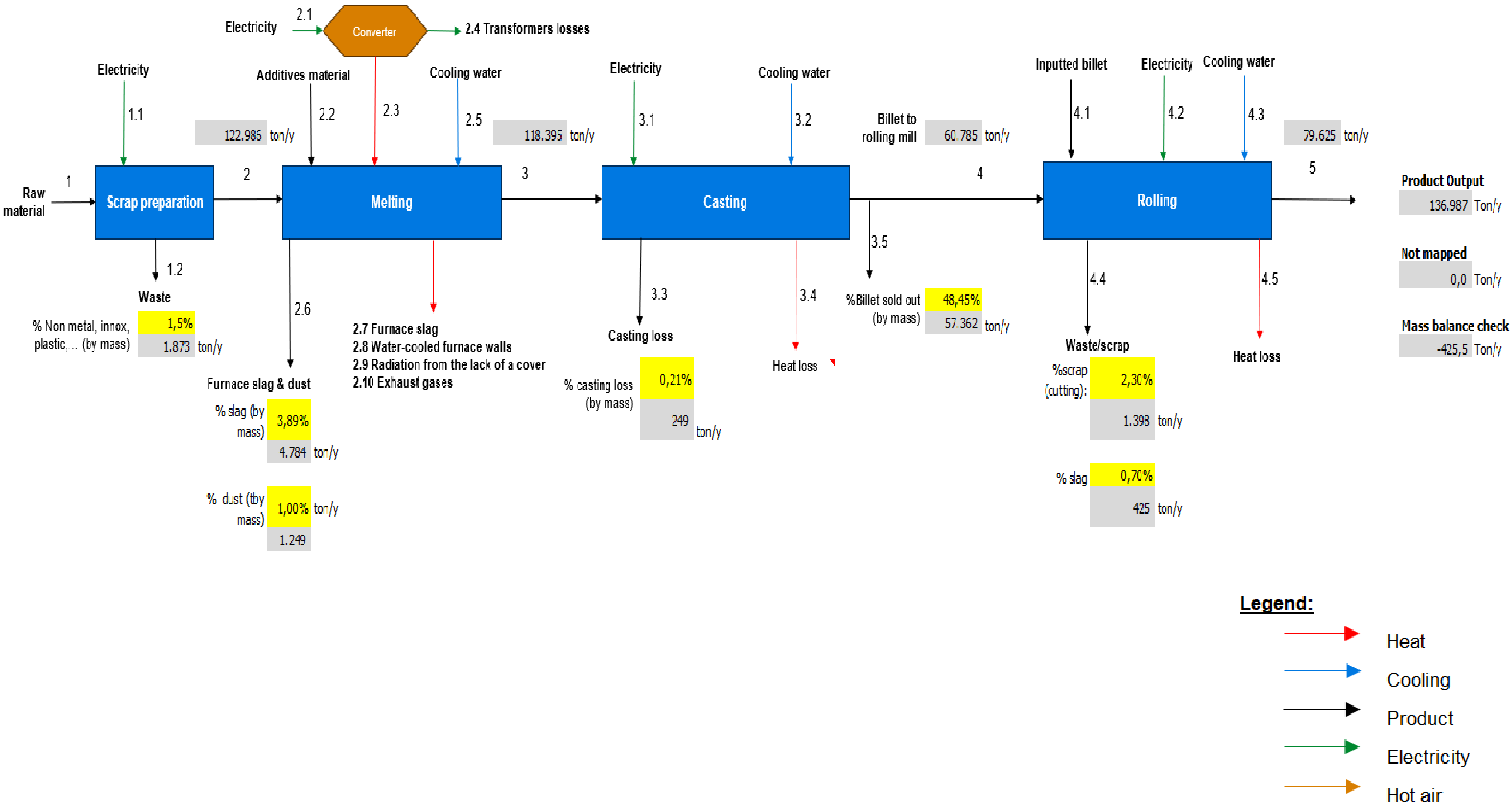
Steel melting process

Scrap steel is imported into the company's storage warehouse, after which the scrap steel is sorted and processed to meet the required specifications and quality standards of the technology. Once sorted and processed, the melting materials are transferred to the first production stage, which is steel melting in the medium-frequency induction furnace.

Steel rolling process

Steel billets from the casting workshop are transferred to the rolling process, passing through rough, intermediate, and fine rolling mills. The number of passes depends on product specifications. After fine rolling, the steel is cut, cooled on a cooling bed, then cut to length and bundled. Finally, the products are stored in the warehouse for dispatch..

The mass flow balance diagram of the company is shown below:



Scrap steel is received and prepared by cutting, crushing, and compressing it into blocks before being melted in a medium-frequency furnace with alloying materials. The resulting molten steel is cast into billets, some of which are sold, while the rest proceed to rolling mills. The billets pass through roughing and intermediate-finishing mills, with the number of passes depending on product specifications. After rolling, the steel is cooled, cut, bundled, and stored for shipment. The process involves thermal losses, especially during the energy-intensive Melting stage, due to furnace slag, water-cooled walls, radiation, and exhaust gases.

1.3 Description of the utility systems

1.3.1 Compressed air system

The company's compressed air system is divided into two areas: the Melting workshop and the Rolling workshop. Below is the list of the company's air compressors:

Table 1.2. List of air compressor at the company

No	Area	Brand	Rated power (kW)	Set pressure (BarG)	VSD (Yes/No)
1	Melting workshop	Kobelco	110	7.5	Yes
2		Kobelco	75	7.5	Yes
3		Hitachi	55	Standby	No
4		Hitachi	55	Standby	No
5	Rolling workshop	Kobelco	55	5.5 – 6.5	No
6		Kobelco	55	5.5 – 6.5	No

The air compressors in the Melting workshop have been equipped with inverters; however, the air compressors in the Rolling workshop have not yet been equipped with inverters and are operating in load/unload mode.

During the survey, the survey team also conducted measurements of the power consumption of the air compressors at the plant, and the results are as follows:

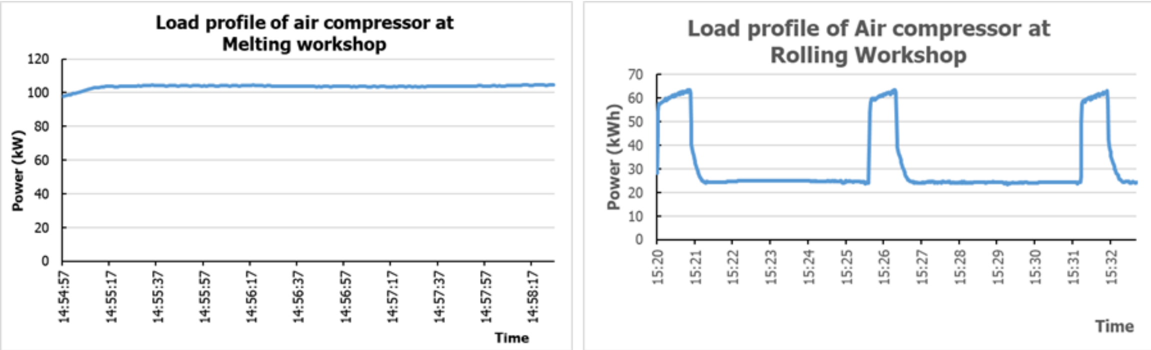


Figure 1.3. Load profile of air compressors at the company

1.3.2 Cooling system

The melting and rolling workshops use high-capacity water pumps for cooling purposes during the production process. The water pumps used in the cooling systems of the areas are listed as follows:

Table 1.4. Statistics of the water pumps used in the cooling systems

Cooling system	Quality *(pcs)*	Rated Power *(kW)*	Note
Water pump motor 75 kW	02	75	Cooling system in rolling workshop
Water pump motor 55 kW	06	55	
Water pump supplying IF	02	132	Cooling system in melting workshop
Circulating water pump	02	46	
Cooling tower fan	02	18.5	

The cooling water pump for the induction furnace is equipped with an automatic variable frequency drive controlled by pressure sensor signals (for supply water pumps) or water level sensor signals (for return water pumps). Efficiency of the water-cooling pump motors is 94,7%.

Table 1.5. Survey on the cooling efficiency of the cooling tower at the company

Water cooling tower for the melting furnace	Water cooling tower for the casting mold
– Temp of water into/out the cooling tower: 39°C / 30°C – Temp difference of water cooling: 9°C – Wet bulb temp: 28.5°C – Temperature difference between water after cooling and wet bulb temperature ranges from 2°C to 5°C	– Temp of water into/out of the tower: 37.3°C / 29.3°C – Temp difference of water cooling: 8°C

1.3.3 Exhaust fan system

The dust extraction fan for melting furnaces is equipped with a VSD controlled in steps (setting the operating frequency according to the number of operating furnaces)

Table 1.6. Parameters of exhaust fan at the company

	Rated power *(kW)*	Rated air flow *(m³/h)*	Actual power *(kW)*	Efficiency of the fan *(%)*
Exhaust fan	800	500,000	607	< 68

The simple illustration of the utility systems is shown below:

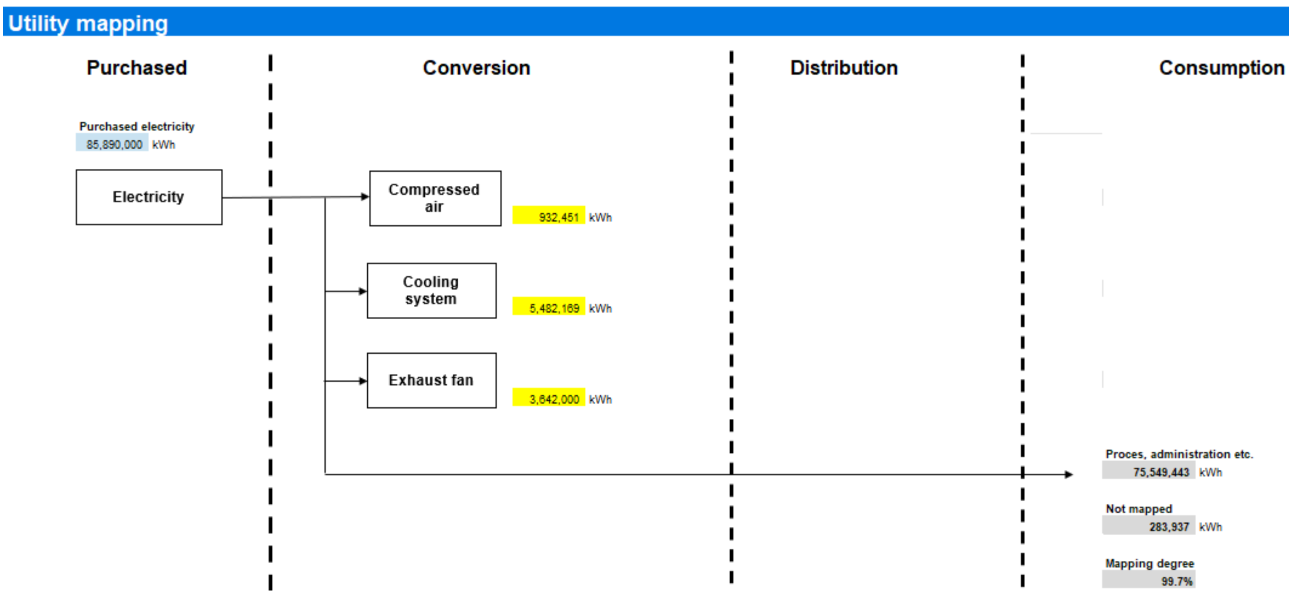


Figure 1.7. The simple illustration of the utility systems

The utility systems of the company include the compressed air system, the cooling system, and the exhaust fan system. Among these, the cooling system accounts for the largest share of energy consumption, representing 54.5% of the total electricity consumption for the auxiliary system. Next is the exhaust fan system, which accounts for 36.2%, and finally, the compressed air system, which accounts for 9.3%.

2 Methodology used to identify EE projects

2.1 How EE projects have been identified and developed

A throughout understanding of energy saving potentials in a specific company necessitates a good initial data collection and a seria of methodologies to apply in analysis of the energy consumption pattern.

- **Understanding the energy service**: An advanced understanding of the energy consumption in a company can often be described via the "onion diagram", which illustrates that for any significant energy user there is a reason for why significant amounts of energy is needed.

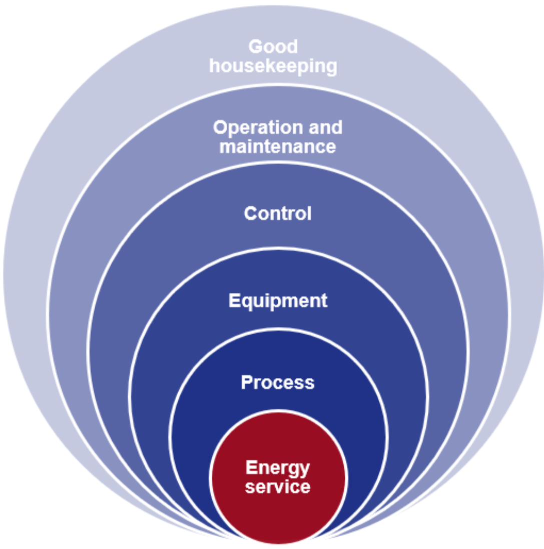


Figure 2.1. The "Onion diagram" for advanced understanding of energy consumption

- **Energy balances – Sankey diagrams:** For the most significant energy users, an energy balance should be established to illustrate the total energy balance and which losses that occur in the operation. Such an energy balance is often name a "Sankey diagram".

- **"Level-2"-mapping:** For companies with complex energy supply structures and multiple consumers of thermal energy (heating and cooling), a further assessment of design parameters for each consumer of cooling and heating must be carried out. It is important to understand that such large differences in delta-T, i.e. differences in process demand-temperature and delivered utility-temperature, can represent significant energy saving potentials. To enable such an understanding, companies with such energy supply patterns should carry out a “level-2”-mapping, where any thermal energy demand (heating and cooling) should be mapped by energy demand and temperatures.

- **Utility structures:** The understanding of hot/cool utility requirements with the Level-2-mapping should also be carried out.
- **Heat recovery schemes:** In most facilities heat recovery schemes represent significant energy saving potentials and overall, the following options are to be considered:
    - Improved efficiency of already existing heat recovery systems
    - Installation of new heat recovery systems internal at significant energy users
    - Heat recovery systems across multiple energy consumers
- **Large fan and pumping systems:** In certain sectors like cement, iron & steel, paper & pulp and chemical industry (fertilizers), comprehensive fan- and cooling water systems are operated. Such systems are often complex and with low efficiency, which shall be assessed carefully.
    - For large fans, the control strategy as well as the total fan efficiency must be assessed.
    - For large cooling water systems, a careful comparison of delivered cooling and consumed electricity for fans and pumps should be monitored continuously.
- BAT-assessments: A throughout understanding of Best Available Technology (BAT) can provide important information on potential energy savings in existing plants. It is important to stress that BAT-solution often will address the core unit operations in a facility and therefore is to be considered as a major and very expensive rehabilitation. Such changes are most often only possible if other benefits than energy savings can be achieved, by example increase production capacity, improved product quality, better flexibility of operation etc.

- **Maintenance procedures:** most industries have significant energy saving potentials simply via improving maintenance procedures for the most important energy users, by example:
    - Regular control of boiler efficiency (02-% and temperature in exhaust gas)
    - Repair or installation of missing insulation at all hot surfaces (piping, valves etc.)
    - Repair of leaks in compressed air piping systems
    - Cleaning of fouled heat exchangers
    - Monitoring of water content in ammonia in refrigeration systems
    - Removal/purging of air in condensers in freezing plants
    - Repair of steam traps in steam distribution systems
    - Etc.
- **Operational control and KPIs:** Most companies tend to monitor energy consumption on a regular basis (monitoring overall production output and overall energy consumption) – thus calculating a specific energy consumption-index (SEC) every week, month or year. Such a KPI (SEC) can only be used to monitor overall and long-term trends in energy usage and can't be used to improve energy efficiency as the SEC-KPI is influenced by many external factors. During the course of an energy audit, is shall therefore be identified if losses from inefficient operation of processes and utility systems occur and how such losses can be prevented.
- **Energy Management Systems:** Evaluation of the facility energy management status must be conducted through interviewing and onsite surveying (assessing metering infrastructure; reviewing document; etc.). Organization of energy management shall be proposed including identification of relevant staff requirements to cover the necessary positions (e.g. energy managers, boards for energy management).

2.1.1 Potential for energy savings through energy mapping

Several key findings based on the energy mapping is identified:

- Understanding of the energy consumption structure or purpose of using energy in the specific processes.

- Overview of the distribution of heating, cooling and electricity consumption for the entire process and make it easy to identify the main energy consumers at the site.
- Energy input/output and energy losses at each stage in the production process
- Current status of technology equipment used in the production process

Electricity Consumption:

- Induction Furnaces: The primary electricity consumption for production is predominantly utilized by induction furnaces in the melting process, which account for an impressive 90.3% of the total electricity used for production.
- Utility Systems: While utility systems (such as air compressors, pumps, and fans) consume a relatively minor portion of electricity, their indirect impact on overall energy efficiency is significant. Optimizing these systems can lead to reduced energy demand and enhanced operational efficiency.

Thermal Energy Utilization:

- Conversion Losses: The electric power supplied to the induction furnace through power electronic converters incurs a conversion loss of 5.8%. However, the output heat utilized for the melting process is substantial, accounting for 94.2% of the energy input.

Cooling Systems:

- Energy Consumption for Cooling: The melting process relies on water to cool the high-temperature furnace walls, which constitutes 41.9% of the company's total cooling energy consumption. The casting and rolling processes contribute 32.9% and 25.2%, respectively.
- Overall Impact: These cooling systems account for approximately 6% of the company's total electricity consumption in 2023 and are managed with considerable attention to ensure efficiency.

Heat Waste:

- Primary Energy Losses: The main energy losses in the processes from heat loss to the environment due to the high temperature of the output steel billets. The most significant measured heat loss occurs from the cooling water for the furnace walls during the melting process, representing 35.3% of total losses.
- Other Losses: Transformer losses and furnace slag losses follow, accounting for 17.6% and 12.8% of total losses, respectively. Additional losses arise from exhaust gases, radiation, and heat dissipation in the rolling and casting processes.
- Design and Operation Issues: The high level of heat losses is primarily attributed to the outdated design and operational status of the induction furnace.

Based on these finding, some focus areas for improvement are listed below:

Table 2.1. Screening of energy saving opportunities/projects based on the walkthrough assessment

No.	System	Energy saving opportunities
1.	Melting furnace	Furnace efficiency
2.		Raw-material handling
3.		Pre-heating
4.		Renewables
5.	Transformers	Transformer loss control
6.		Harmonic control
7.	Exhaust fan	Install VSD to control the exhaust fan
8.		Use high efficiency motor
9.	Cooling water systems	Flow controlled from feeding pressure
10.		Efficiency of pumps
11.		Efficiency of electric motors
12.		Efficiency of fans and cooling tower construction
13.	Air Compressor	Replace old air compressors with low efficiency
		Install VSD for air compressors
14.	Energy management	KPIs for Melting
15.	Others	Install solar rooftop PV system
16.		Control waste balance and melting quality
17.		Strategy for hydraulics and DC motors
18.		ORC from heat recovery (casting and rolling section)

After conducting an in-depth survey during the onsite assessment, data from the walkthrough assessment, the current situation, and the company's investment plans were reviewed. All potential energy-saving and efficiency projects were identified and agreed upon for further development and analysis.

2.1.2 Specific energy consumption

The energy consumption rate indicates the average energy consumed per product, used to compare the company's energy efficiency with the standard levels in order to assess the energy consumption status and propose savings for the following month and year.

For the steel industry, the Ministry of Industry and Trade has issued regulations on energy consumption standards in the steel sector for the period from 2021 to the end of 2025 (Circular No. 20/2016/TT-BCT).

Table 2.2. Compare the company's energy consumption rate for 2023 with the standards set by the Ministry of Industry and Trade.

Process	Unit	Standard	Specific energy consumption
Steel billet production using induction furnace	MJ/ton	2,500	**2,363**
Cold rolling of steel sheets and coils	MJ/ton	1,500	**1,242**

According to Circular No. 20/2016/TT-BCT issued by the Ministry of Industry and Trade regarding energy consumption standards for the steel industry, the company complies with the energy consumption rates for steel billet production using induction furnaces and the Cold rolling of steel sheets and coils, as per the regulations.

2.1.3 Classification of projects level A, B

During the energy audit process, many observations will be made which could have potential energy savings. All these observations should not be analysed in detail, but they should at a minimum be mentioned within the energy audit. At the beginning of the energy audit, it is advised to make a working document where all the observations will be noted throughout the audit. Thereby a large screening list can be created.

The observations within the list will be referred to as level B projects, where the potential energy savings and investment are evaluated based on estimates if possible.

The screening list of level B projects should be evaluated and up to 5 projects should be selected for further development. These projects will be called level A projects and should be developed enough for making a decision of whether to carry out a pre-feasibility study.

Examples of content in level A and B project development:

Level A:

- Project description
- Energy savings
- Financial savings
- Investment
- Payback time
- Simple system process flow diagram (PFD)
- Simple Risk analysis

Level B:

- Project description (one or two lines)
- Energy savings
- Financial savings
- Investment (based on experience)
- Payback time

There is a total of 9 recommended projects (level B) for energy saving. In these 9 projects, some are expected to have high investment and technical complexity, these are classified as project level A. To make sure that the energy and economic saving potentials of level A projects are properly realized, additional steps must be taken for further evaluation through deep dive pre-feasibility/feasibility studies.

Table 2.3. Groups of ECMs

ECM group	Scope
Group I: Projects level B	Including initial findings and general projects. Usually required low investment and are relatively simple to implement regarding the technical issues.
Group II: Projects level A	Screened projects from level B with high investment and technical complexity (potential to implement deep dive pre-feasibility/feasibility study).

2.2 EE Project evaluation

2.2.1 Data collection

The audit team has obtained information on:

- Characteristics of equipment/utilities system;
- The operating data of equipment/utilities system collected through recording notebooks;
- The operating data of the equipment/utilities system collected through on-site measurements;
- Operating conditions of equipment/utilities system are based on design documents or other relevant technical documents.

Based on collected data, the audit team screened and combined parameters with values, analyzing the trend of fluctuations with difference from the parameters of the equipment/utilities system that must be achieved or can be achieved. That is the potential for energy saving opportunities.

2.2.2 Identify energy saving opportunities

In order to identify the options to detected energy saving potential, the audit team has calculated to demonstrate quantitatively the energy savings for each proposed improvement option.

2.2.3 Identify investment costs

Most calculations can use a simple payback period approach through dividing the investment cost of energy saving opportunities by the energy saving value, resulting is a simple payback period in years.

In case there are significant differences between the trend of changing in energy prices and interest rates or if the investment costs of the energy saving opportunity is unreasonable in various stages compared to the energy saving capacity that can be achieved at different times, the audit team will perform a life cycle cost assessment to better recognize investment performance for energy saving opportunities

2.3 EE Project prioritisation

The main criteria select the energy efficiency projects for further evaluation through deep dive pre-feasibility/feasibility studies:

- High potential for energy saving and reducing carbon emission.
- High energy costs saving
- Technical complexity
- Consistent with the Company's future technology investment

The potential for future expansion or a model for other businesses to refer to and implement.

2.4 Enterprises feedback

After conducting the energy audit, the consulting unit reported the results to the Company within the framework of the project. The proposed energy saving solutions were received positive feedback. The company was interested in investment solutions at level A, including investment scrap shredding machines and investment rooftop solar photovoltaic (PV) system.

The Company has developed a working plan with ENERTEAM on feasibility studies for Level A solutions and has found suppliers of scrap shredding machines with a capacity of 25 tons/hour.

3 EE Projects identified

This section includes projects that cover all identified and agreed-upon potentials (Level B)[4].

Table 3.1. Gross list (level B mapping)

Gross list							
Project no.	Name of Project	Energy form (gas, electricity, oil, etc.)	Investment Cost [mil VND]	Saving			Simple Payback [Years]
				Energy [kWh]	CO_2 [ton]	Financial [mil VND]	
1	Install VSD for air compressors of rolling workshop	Electricity	112	32.636	22,1	63	1,8
2	Install VSD for the cooling water pump at the rolling workshop	Electricity	77	121.950	82,5	234	0,3
3	Install VSD for the hydraulic pump motor of the material press	Electricity	127	24.043	16,3	46	2,8

[4] Then project developed at level B is not described in a section for itself because it is included in gross list.

Gross list							
Project no.	Name of Project	Energy form (gas, electricity, oil, etc.)	Investment Cost [mil VND]	Saving			Simple Payback [Years]
				Energy [kWh]	CO_2 [ton]	Financial [mil VND]	
4	Use high efficiency motor	Electricity	552	169.055	114,4	325	1,7
5	Investing scrap shredding machines	Electricity	40,000	2,666,813	1,804.4	4,614	8.7
6	Install rooftop solar photovoltaic (PV) system	Electricity	48,045	3,377,582	2,285.3	5,843	8.2

4 EE Projects identified

This section includes projects that has been chosen to be developed further (Level A)[5].

4.1.1 Investing scrap shredding machines

The current input materials for the company are mainly scrap collected from various sources. Due to the diversity of components, the company focuses on the material processing stage. Currently, the materials are processed using shredding machines to cut them into smaller pieces and pressing machines to compress them into blocks. However, this equipment is outdated, and the processed materials do not meet the company's needs.

Project information		
Project: Investing scrap shredding machines	**Project no.1**	**Date:**
Enterprise:	**ENERTEAM**	**Lead Auditor:**
Project description		
Current situation: The company uses scrap steel as input material for induction furnaces. The scrap steel is processed through shredding and compacting into rectangular blocks of 0.5m x 0.5m x 1m.		

[5] Then project developed at level B is not described in a section for itself because it is included in gross list.

Figure 4.1. Shredding machine and processed scrap after shredding.

Figure 4.2. Hydraulic pressing machine and the scrap blocks after pressing.

Although the material preparation process has included steps to treat the input material for the furnace, the treatment efficiency remains low. Specifically, the material fed into the furnace is large in size, making it difficult to load into the furnace, affecting the steel melting time and increasing the energy consumption for each batch.

Observing the loading time of scrap blocks with different sizes shows that when the scrap blocks is large (about 0.63m x 0.63m x 1m), the loading time sometimes takes up to 1 minute per load. When the scrap blocks are compacted to a more suitable smaller size, the loading time is around 12 to 22 seconds.

Figure 4.3. Scrap material is fed into the furnace in various sizes.

Proposed project

Investing scrap shredding machines at the material preparation stage. The investment in the scrap shredders helps reduce the size of the materials fed into the furnaces, decreasing both the time and energy consumption for each batch.

The potential energy savings from the investment solution will help the company reduce furnace electricity consumption by 3-5% (based on the results achieved by other steel manufacturing companies that have implemented similar measures).

Project illustration (PFD)

Figure 4.4. Reference of Large output Scrap Steel Crusher Machine

Project Budget

Element	Units	Unit costs (VND)	Costs (VND)
Scarp shredding machines	2	20,000,000,000	40,000,000,000
Total (VND)	**40,000,000,000**		

TIME SCHEDULE (month)

Activity	1	2	3	4	5	6	7	8	9	10	11	12
Feasibility study												
Order Placement												
Equipment delivery												
Installation (depending on the production schedule, etc.)												
Testing, commissioning												
Trial run+ staff training												X

Saving

Electricity savings: 2,666,813 kWh/yr	**Financial savings:** 5,120 mil. VND
GHG reduction: 1,804 tCO_2e/yr	**Simple Payback:** 7.8 yrs

Risk Analysis

- **Equipment Failure:** The new scrap shredders may face operational issues or breakdowns, which could lead to production downtime and increased maintenance costs.
- **Operational Disruption:** The installation and integration of shredders into the existing production line might disrupt the current workflow, leading to a temporary reduction in productivity.
- **Cost Overrun:** Initial investment costs for purchasing and installing the shredders could exceed budget estimates, impacting the financial resources of the company.
- **Training Requirements:** Operators and staff may need additional training to effectively use and maintain the new shredders, leading to a learning curve and potential delays in full implementation.

- **Material Quality Control:** If the shredding process is not properly managed, it could lead to inconsistencies in the size and quality of the shredded scrap, affecting furnace efficiency and product quality.

Non-Energy benefits
– **Increased Production Efficiency:** Reducing loading time with smaller scrap sizes will streamline the process, potentially increasing overall furnace throughput. – **Improved Furnace Lifespan:** Smaller, well-prepared scrap may reduce the wear and tear on furnaces, extending their operational life. – **Enhanced Safety:** The improved material handling and reduction in loading times can lower the risk of accidents during furnace operation, contributing to a safer working environment. – **Cost Savings from Reduced Maintenance:** By optimizing the scrap size, the strain on the furnace and other equipment is reduced, which may lead to lower maintenance costs over time.

4.1.2 Install rooftop solar photovoltaic (PV) system

The main electricity used by the company comes from the grid. Currently, the emission factor of Vietnam's electricity grid is 0.6592 tCO_2/MWh (according to Official Letter No. 1726/BĐKH-PTCBT). In the goal of reducing greenhouse gas emissions, finding a clean energy source plays an important role and has garnered significant attention from the company.

Project information		
Project: Install rooftop solar photovoltaic (PV) system	**Project no. 2**	**Date:**
Enterprise:	**ENERTEAM**	**Lead Auditor:**

Project description

Current situation:

The workshops at the company have large rooftop, which are not shaded by surrounding buildings. Therefore, the facility has potential for installing a rooftop solar PV system on these roof areas to supply partial electricity demand of the company.

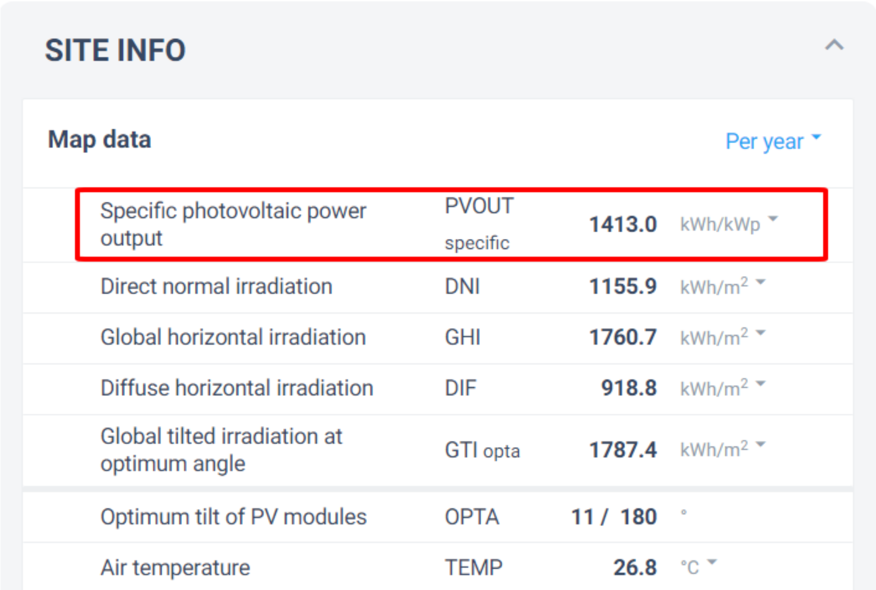


Figure 4.5. Average photovoltaic power output at the company

The total area of the available roof for installing solar PV is estimated at about 6,000 m^2. Average photovoltaic electricity output at company is about 1,413.0 kWh/kWp.year (*Reference:* *https://globalsolaratlas.info/map*).

Proposed project:

The electricity consumption in 2023 of the company is 90,748,715 kWh. An on-grid solar PV system with a proposed installed capacity of 1,0 MWp can meet 1.3% of the electricity consumption of the company.

The company can self-invest in the rooftop solar PV system (CapEx model) and own all the profits from the system or asks an Energy Service Company (ESCO) to invest in and operate the whole solar system (OpEx model). For ESCO investment, the service company will sell solar electricity back to the company at a price lower than the grid electricity price depending on the terms of the agreement between two parties.

To see the overall potential of the rooftop solar PV system, the calculation below will be based on the CapEx investment model.

Project illustration

A typical solar PV system is shown graphically below:

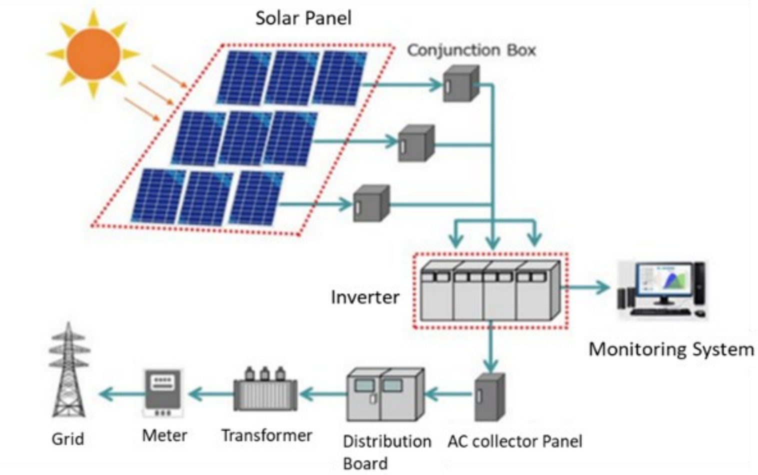


Figure 4.6. Average photovoltaic power output at the company

Project Budget

Element	Quantity (MWp)	Unit price (VND/MWp)	Costs (VND)
Install PV system	2,323	20,683,217,957	48,044,633,328
Total (VND)	**48,044,633,328**		

Time schedule (month)

Activity	1	2	3	4	5	6	7	8	9	10	11	12
Feasibility study												
Order Placement												
Equipment delivery												
Installation (depending on the production schedule, etc.)												
Testing, commissioning												
Trial run+ staff training												

Saving	
Electricity generated: **3,377,582 kWh/yr**	Financial savings: **5,843 mil. VND**
GHG reduction: **2,285.3 tCO_2e/yr**	Simple Payback: **8.2 yrs**
Risk Analysis	
– **Initial Investment Costs:** The upfront capital required for purchasing and installing the rooftop solar PV system may be high, which could strain the company's financial resources, especially if there are limited funds allocated for capital expenditures. – **System Maintenance and Performance:** The performance of the solar PV system could be affected by factors such as dust, dirt, or weather conditions, requiring regular maintenance to ensure optimal efficiency. Any unplanned maintenance costs could arise. – **Energy Storage:** Without an energy storage system, excess electricity generated during the day may be wasted, and the company may need to rely on grid electricity during nighttime or cloudy periods, which could reduce savings. – **Regulatory and Permitting Challenges:** There could be delays or complications in obtaining the necessary permits and approvals for installation, especially if local regulations or grid connection standards are not aligned with the company's plans. – **Return on Investment (ROI):** The expected ROI could be affected by fluctuations in electricity prices, changes in the government's renewable energy policies, or unforeseen operational issues, which might impact the financial feasibility of the project.	

Non-Energy benefits
– **Reduced Carbon Footprint:** The use of renewable energy will reduce the company's dependence on grid electricity, which is often generated from fossil fuels, leading to a decrease in greenhouse gas emissions. – **Energy Independence:** The rooftop solar PV system will reduce the company's reliance on external electricity suppliers, providing a more stable and predictable energy source. – **Improved Corporate Image:** Investing in renewable energy can enhance the company's reputation as an environmentally responsible company, which may lead to better customer loyalty and potential business opportunities with eco-conscious partners. – **Long-Term Cost Stability:** The company will benefit from a predictable electricity cost structure, avoiding future price volatility from the grid. This could be particularly valuable if electricity prices rise in the future. – **Potential for Future Expansion:** The installation of a solar PV system could serve as a model for future sustainability initiatives and open opportunities for scaling up renewable energy projects or integrating energy storage solutions. – **Enhanced Employee Morale and Engagement:** Employees may take pride in working for a company that is investing in clean, renewable energy, leading to higher job satisfaction and retention.