



TRI HITA
CONSULTING



Report

2023 GHG INVENTORY

PT Indonesia Steel Tube Works

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2023 GHG Inventory Report

This report was developed by Tri Hita Consulting for ISTW. The purpose of the report is to document ISTW's 2023 GHG inventory, providing a detailed analysis of the company's emissions across Scope 1, 2, and 3 categories. The report includes an evaluation of emissions sources, intensity, and data management practices. Recommendations for emissions reductions and improved reporting are also provided, based on the assessment of ISTW's current performance. The findings aim to support ISTW's sustainability strategy and future ESG initiatives.

For more information, please visit:

<https://www.istw.co.id/>

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GLOSSARY & ABBREVIATIONS

Carbon dioxide	CO ₂
Electric vehicles	EVs
Greenhouse gas	GHG
Independent Power Producer	IPP
Indonesia Steel Tube Works	ISTW
Internal rate of return	IRR
Kilowatt-hour	kWh
Methane	CH ₄
Nationally Determined Contribution	NDC
Nitrous oxide	N ₂ O
<i>Perusahaan Listrik Negara</i>	PLN
Tonnes of CO ₂ equivalent	tCO ₂ -e

EXECUTIVE SUMMARY

In 2023, PT Indonesia Steel Tube Works (ISTW) undertook its inaugural greenhouse gas (GHG) inventory to establish a comprehensive baseline for its emissions across all operational facilities. ISTW is a leading manufacturer of steel pipes and tubes for diverse applications. This GHG inventory serves as a critical step in ISTW's commitment to environmental sustainability in the manufacturing industry.

Tri Hita Consulting was engaged to conduct a GHG inventory for all ISTW plants. This inventory establishes a baseline for future GHG calculations and reduction strategies, while also familiarising employees with the inventory process and identifying initial mitigation options.

The GHG emissions were calculated following the GHG Protocol and ISO 14064-1:2018 standards. Scope 1, 2, and selected Scope 3 emissions (with a focus on upstream transportation and business travel) were measured. **Figure 1** shows the total GHG emissions reported in 2023.

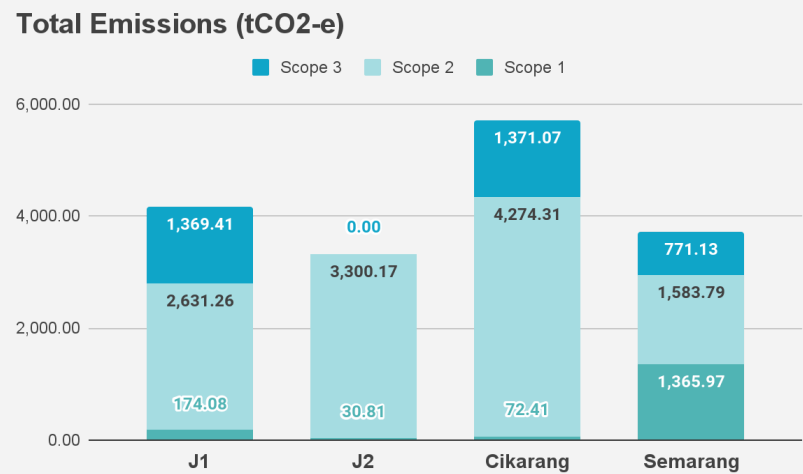


Figure 1. Distribution of the reported emissions by plants per category

ISTW reported total emissions of **16,944.41 tCO₂-e** from its four plants in 2023. The **Cikarang** plant was the largest contributor at **5,717.79 tCO₂-e (33.7%)**, followed by **J1** at **4,174.75 tCO₂-e (24.6%)**, **J2** at **3,330.98 tCO₂-e**

(19.7%), and **Semarang** at **3,720.89 tCO₂-e (22%)**. J1 and J2 had high Scope 2 emissions due to reliance on PLN electricity, while Semarang's high Scope 1 emissions stemmed from machinery and fuel use.

In 2023, ISTW's **energy intensity (Figure 2)** was **0.86 GJ/tonne**, with **J1 and J2** plants at **1.14 GJ/tonne** due to high energy use, while **Cikarang** excelled at **0.38 GJ/tonne**, showing more efficiency. **Semarang** had a higher intensity at **1.74 GJ/tonne**, influenced by old machinery and energy-intensive galvanisation.

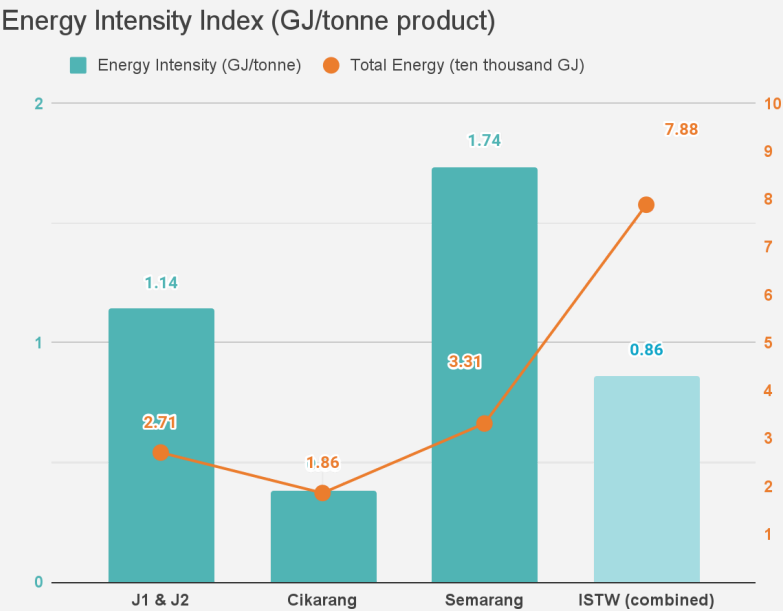


Figure 2. Energy intensity index of ISTW in 2023

The reported **emissions intensity (Figure 3)** was **146.79 kgCO₂-e/tonne**, with **J1 and J2** at **258.84 kgCO₂-e/tonne**, primarily from electricity use, while **Cikarang** achieved **89.21 kgCO₂-e/tonne**, indicating better efficiency despite high total emissions. Compared to competitors, ISTW's performance reveals significant opportunities for improving energy management and reducing emissions intensity.

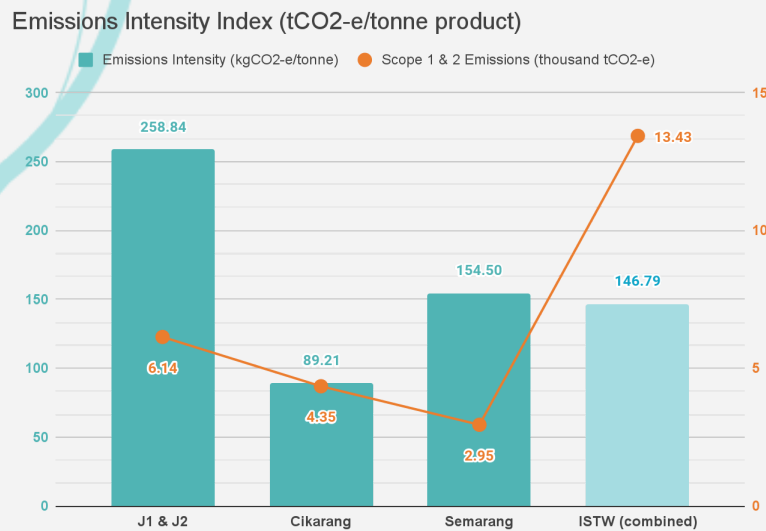


Figure 3. Emissions intensity index of ISTW in 2023

To align ISTW's energy and emissions performance with local competitors, a reduction of approximately 55% in energy intensity and 39% in emissions intensity would be required to match its current levels (0.39 GJ/tonne and 89.6 kgCO₂-e/tonne). Therefore, ISTW should consider:

1. **Energy Efficiency:** Optimising production processes and machinery to reduce energy consumption (e.g., sensor to monitor real-time energy use in machinery and industrial chiller at the production line to prevent overheating).
2. **Fuel Switching:** Transitioning to biodiesel and exploring electric vehicle options for logistics.
3. **Renewable Energy Expansion:** Installing solar panels at J1, J2, and Semarang plants.

The 2023 GHG Inventory shows ISTW's operational efficiencies across plants, with Cikarang identified as the most effective due to its relatively newer machinery, given the plant's construction in 2013. However, the J1, J2, and Semarang facilities show potential for improvement in energy and emissions management. Adopting best practices from Cikarang, investing in new technologies and cleaner energy sources, will be essential for enhancing sustainability and maintaining ISTW's competitive edge.

INTRODUCTION

PT Indonesia Steel Tube Works (ISTW) has been manufacturing steel tubes and pipes since 1971 with various kinds of types and sizes. As a manufacturing industry, ISTW is aware of its greenhouse gas (GHG) emissions produced in its operational activities. ISTW recognises the importance of understanding its carbon footprint and is committed to accurately calculating its GHG emissions. Therefore, ISTW aims to identify key emission sources with a thorough GHG inventory. This activity also intends to develop strategies to reduce them in alignment with Indonesia's Nationally Determined Contribution (NDC) targets, which strives to reduce greenhouse gas emissions by 29% under a business-as-usual scenario and up to 41% with international support by 2030.

Tri Hita Consulting has been hired to conduct a GHG inventory for the operations of ISTW across all plants, including the J1, J2, Cikarang, and Semarang plants. The result of this GHG inventory should serve as a baseline for ISTW in future calculations and reduction strategies. Tri Hita Consulting also visited ISTW plants in Jakarta, Cikarang (West Java), and Semarang (Central Java) to familiarise employees with the GHG inventory, identify initial potential mitigation options, and collect data with higher accuracy from every operational activity.

This 2023 GHG Inventory Report outlines the organisational and operational boundaries of the GHG inventory and calculates the emissions produced by ISTW's four plants, as well as associated facilities and services. The report includes GHG emissions for Scope 1, Scope 2, and two categories of Scope 3 (Categories 4 and 6).

The content of this report follows the requirements of ISO 14064-1:2018. GHG emissions were determined in accordance with ISO 14064-1:2018 and the GHG Protocol to be consistent with international standards and protocols.

CHAPTER 1: GENERAL DESCRIPTION OF THE ORGANISATION GOALS AND GHG INVENTORY OBJECTIVES

1.1 Organisation Description

PT Indonesia Steel Tube Works (ISTW) is a steel tube manufacturer established in 1971, with over 50 years of experience in producing high-quality steel tubes and pipes. The company manufactures a variety of mechanical tubes and pipes for use in industries such as automotive, construction, and general piping. ISTW operates using advanced pipe-producing mills with a production capacity of approximately 140,000 metric tonnes per year and 10 million pieces per month.

The primary shareholders of ISTW include Metal One Corporation, Maruichi Steel Tube Ltd., and PT Respati Djaja, all of whom contribute to ISTW’s operational and strategic direction. A visual representation of ISTW’s primary shareholders is illustrated in **Figure 4**.

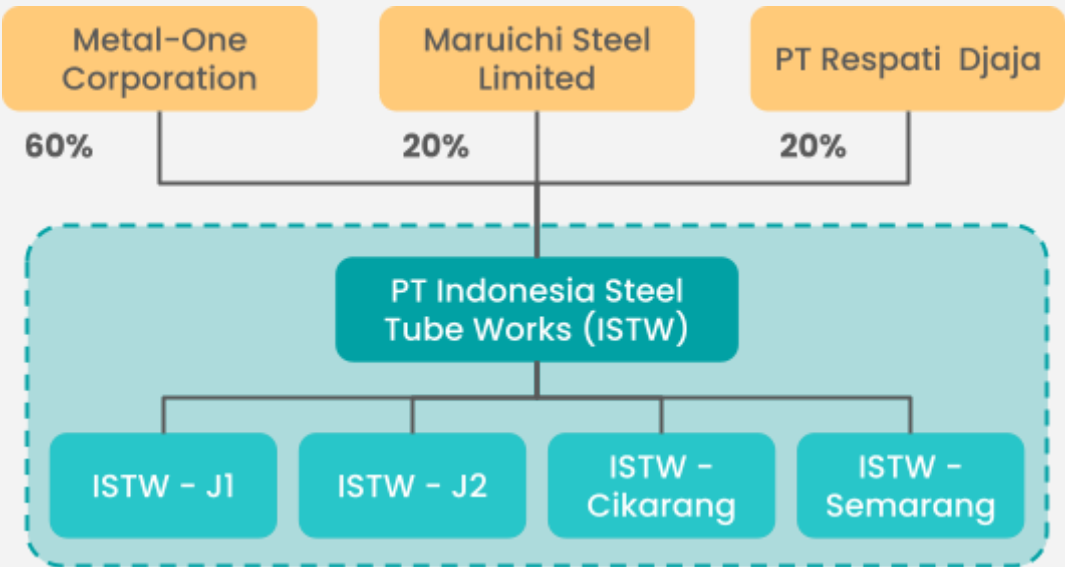


Figure 4. ISTW primary shareholders

ISTW operates from multiple locations, including its headquarters and main facility, the “J1” plant, in the Pulogadung Industrial Area in Jakarta, a recutting facility, the “J2”, also in Pulogadung. ISTW also has operational facilities in Cikarang (West Java) and Semarang (Central Java). The geographic distribution of ISTW’s facilities is illustrated in **Figure 5**.



Figure 5. Location of ISTW facilities in Jakarta, Bekasi, and Central Java

ISTW is committed to maintaining high production standards, holding certifications such as IATF 16949, ISO 45001, and ISO 14001. The company serves customers throughout Indonesia, with ambitions to further increase its output in response to growing demand across various industries.

1.2 People Responsible and Intended Users

This report was created by Tri Hita Consulting on behalf of ISTW. The 2023 GHG Inventory project was managed by Marya Tisnandya, with Verena Streitferdt overseeing Quality Assurance. The consultants involved in this inventory include Rio Inggit Dharmawangsa, Divine Ifransca Wijaya, and Karensa Nanda Putri Krisworo.

The GHG inventory was conducted under Ronny Siagian as General Manager, Asep Aswandi as Team Leader of QHSE, and Masayoshi Sawada as the President Director of ISTW.

The intended users for this GHG inventory are ISTW and its shareholders. This report is not intended for publication.

1.3 Reporting Period

The GHG inventory includes emissions from activities undertaken from 1st of January 2023 until 31st of December 2023. Details are included in the boundary and scope.

1.4 Methodology

1.4.1 Standards and Methodologies Used for This Inventory

The GHG emissions were determined in accordance with The GHG Protocol: A Corporate Accounting and Reporting Standard (GHG Protocol, 2004) to be consistent with international protocols and standards. The content of this report has been compiled in line with the requirements of ISO 14064-1:2018.

The calculation methodologies and determination of the emission factors follow the IPCC standard (2006, 2019). GHG emissions have been calculated by multiplying the collected activity data by its relevant emission factor:

$$\text{Proposed Activity Data} \times \text{GHG Emissions Factor} = \text{GHG Emissions}$$

Activity data was collected and recorded by ISTW as a quantifiable measure of activity (e.g., litres of fuel consumed). The emission factor is a conversion of the activity data into GHG emissions. Where specific data was not available, assumptions, benchmarks and standard

recommendations have been used to fill the gaps. Finally, in the case this was not possible, a qualitative approach was followed to assess GHG impacts, in line with the second edition of the Institute of Environmental Management and Assessment (IEMA) guidance (2022).

For Scope 3, Category 4 (Upstream Transportation and Distribution) and Category 6 (Business Travel), the **distance-based approach** was used to estimate emissions, accounting for the distance travelled in the transportation of mother coils and business travel activities. Scope 3 accounting is based on the Technical Guidance for Calculating Scope 3 Emissions (GHG Protocol, 2013). This approach uses the following formula:

$$\text{Distance Travelled} \times \text{GHG Emissions Factor} = \text{GHG Emissions}$$

1.4.2 List of GHGs Taken into Account

The GHGs reported by ISTW include CO₂, CH₄, and N₂O (mainly from fuel combustion and electricity consumption), as well as HFCs (from fugitive emissions, e.g. air conditioning refrigerant leaks and fire extinguishers). There is no indication that emissions from PFCs, NF₃ or SF₆ occurred through ISTW's operations.

1.5 Statements by the Organisation About Verification

ISTW has no current plans to verify the results of the 2023 GHG Inventory using the GHG Protocol Standard or ISO 14064-1:2018. However, this step may be considered in future reporting periods.

CHAPTER 2: ORGANISATIONAL BOUNDARIES

This chapter includes the description and explanation of boundaries and consolidation methodologies. It describes ISTW's current activities and plans for the upcoming year.

2.1 Overview of PT Indonesia Steel Tube Works (ISTW)

PT Indonesia Steel Tube Works (ISTW) specialises in the production of steel pipes and tubes for a variety of applications, including general construction, as well as the manufacturing of round, galvanised, oval, square, and rectangular pipes and tubes. ISTW's products are widely used in infrastructure projects, industrial applications, and building constructions.

ISTW's operational process is divided into two main stages: slitting and milling. In the slitting stage, the mother coil is uncoiled, slit into narrower strips, and then recoiled. In the milling stage, these strips are uncoiled, formed into the desired shapes, welded, sized, cut to length, and packed for distribution. This production process allows ISTW to manufacture steel pipes of varying dimensions and specifications to meet the diverse requirements of their customers across multiple industries.

2.2 Organisational Boundaries Included for this Reporting Period

As of 2023, ISTW has four operational facilities, commonly referred to as "plants", that are included in the scope of this GHG inventory. These facilities are detailed as follows:

- Jakarta Office and Factory (J1 plant), located in Pulogadung Industrial Area, Jakarta.
- Jakarta Recutting Factory (J2 plant), also situated in Pulogadung Industrial Area, Jakarta.

- Cikarang Factory (**Cikarang** plant), located in Greenland International Industrial Center, Cikarang, Bekasi.
- Semarang Office and Factory (**Semarang** plant), located in Semarang, Central Java.

The GHG emissions reporting for 2023 focuses on Scope 1, Scope 2, and selected Scope 3 emissions from all ISTW plants. The activities considered for inclusion in the inventory include fuel combustion and fugitive emissions (**Scope 1**), electricity usage (**Scope 2**), and the following **Scope 3** emissions: Upstream Transportation and Distribution (**Category 4**) and Business Travel (**Category 6**).

2.3 Organisational Business Units Excluded from This Inventory

All of ISTW's plants have been included in the 2023 GHG inventory, for activities related to Scope 1 and 2 emissions, and selected Scope 3 emissions, as detailed above.

2.4 Chosen Organisational Boundary Approach

ISTW has full operational control of its offices and plants. For that reason, the operational control approach was used to consolidate emissions of the company.

CHAPTER 3: REPORTING BOUNDARIES

This chapter includes the description and explanation of emissions categories that are considered. As of 2024, ISTW has never calculated a thorough GHG emissions across all plants. In the Semarang plant, preliminary emissions calculations had been conducted but the scopes were limited. Therefore, the result of this 2023 GHG inventory will serve as ISTW's baseline for future calculations.

3.1 Scope Definition

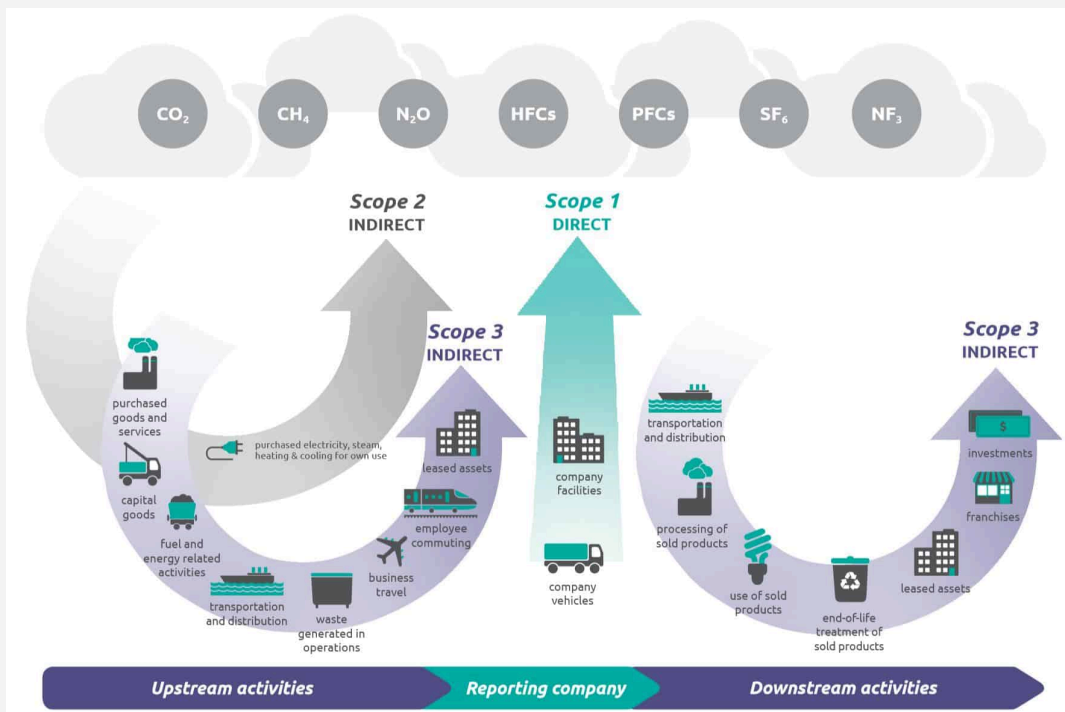


Figure 6. Scope definition according to the GHG Protocol

The GHG Protocol categorises emissions into three scopes (Figure 6), namely Scope 1, Scope 2, and Scope 3:

Scope 1: All direct emissions from the activities of an organisation or through sources under its control e.g. on-site fuel combustion such as gas boilers, fleet vehicles, and air-conditioning leaks.

Scope 2: Indirect emissions from electricity and communal energy (for example communal cooling or heating) purchased and used by the organisation. Emissions are created during the production of the energy and eventually used by the organisation.

Scope 3: All other indirect emissions from activities of the organisation, occurring from sources that they do not own or control. Scope 3 emissions are usually the largest share of an organisation's carbon footprint and include emissions associated with the entire supply chain.

- **Category 4 Upstream Transportation and Distribution:** Emissions from the transportation of goods purchased by the organisation. In this report, only the transportation of mother coils (both local and imported) by sea freight was included in the calculation.
- **Category 6 Business Travel:** Emissions from employee travel for work-related purposes. In this report, the modes of transportation included in the calculations are flights, trains, and cars.

Following the GHG Protocol standard, all biogenic emissions and removals, such as combustion of biofuels, are not attributed to any scope. Instead, biogenic emissions and removals are reported separately in Section 4.1.4.

3.2 GHG Emission Source Inclusions

All main emissions for ISTW are listed in **Table 1** below. The direct GHGs relevant to the company include CO₂, CH₄, N₂O, and HFCs. There is no indication that emissions from PFCs, NF₃ or SF₆ occurred through ISTW's operations.

The calculation includes carbon sequestration from tree planting and nursery activities at its Cikarang and Semarang plants. Selected high-carbon-sequestration species are counted, while those with low quantities or minimal impact are excluded.

Table 1. GHG emissions and reduction sources included in the 2023 GHG Inventory.

Business Unit	GHG Emission Source	GHG Emissions Scope	Data Source	Data Collection Unit	Uncertainty (Description)
All business units	Fuel for emergency generators	Scope 1	Consumption data from each business unit	L, type of fuel	It is assumed that the consumption values and the type of fuel are reported correctly.
All business units	Fuel for own vehicles	Scope 1	Consumption data from each business unit	L, type of fuel	It is assumed that the consumption values and the type of fuel are reported correctly.
All business units	Fugitive emissions from refrigerant leaks	Scope 1	Consumption data from each business unit	kg, type of refrigerant	It is assumed that the quantity of refrigerant is reported correctly.
Semarang Plant	Biodiesel B35	Scope 1	65% diesel: Scope 1 35% biogenic: Scope 1 (CH ₄ and N ₂ O) Out of Scope (CO ₂)	L, type of fuel	It is assumed that the consumption values and the type of fuel are reported correctly.
All business units	Grid electricity	Scope 2	Consumption data from each business	kWh	It is assumed that the consumption values are reported correctly.

			unit		
All business units	Business travel	Scope 3, Cat 6	List of all business travels	multiple	It is assumed that the data source is complete and accurate. The computation of the direct flight and road distances have been done with dedicated online platforms and the ones from train and ferry distances are based on databases; it is assumed that the values are accurate.
All business unit	Upstream Transportation	Scope 3, Cat 4	Transportation supplier list of mother coil import and local	multiple	It is assumed that the data source is complete and accurate. The computation of the direct flight and road distances have been done with dedicated online platforms and the ones from train and ferry distances are based on databases; it is assumed that the values are accurate.
Cikarang Plant	Tree planting and nursery	Out of Scope	Data from the HRGA Department of Cikarang Plant	multiple	It is assumed the tree planting and nursery records are complete and accurate.
Semarang Plant	Tree planting and nursery	Out of Scope	Data from the HRGA Department of Semarang Plant	multiple	It is assumed the tree planting and nursery records are complete and accurate.

3.3 GHG Emission Source Exclusions

While this inventory captures a comprehensive range of GHG emissions, certain sources have been excluded from the 2023 GHG Inventory. **Table 2** summarises the specific GHG emissions and reduction sources that have been excluded from this inventory.

Table 2. GHG emissions and reduction sources excluded in the 2023 GHG Inventory

Business Unit	GHG Emission Source	GHG Emissions Scope	Data Source	Data Collection Unit	Uncertainty (Description)
All business units	Upstream transportation	Scope 3 Cat 4	Transportation supplier list of spare part machine import and local	multiple	Data deficiency
Cikarang Plant	Tree planting and nursery	Out of Scope	Tree species with quantities fewer than five (5)	multiple	It is assumed that trees with quantities fewer than five (5) do not contribute significantly to carbon sequestration.
Semarang Plant	Tree planting and nursery	Out of Scope	Tree species with quantities fewer than five (5)	multiple	It is assumed that trees with quantities fewer than five (5) do not contribute significantly to carbon sequestration.

CHAPTER 4: QUANTIFIED GHG INVENTORY OF EMISSIONS

4.1 Emissions Calculation and Result

4.1.1 Emissions by Category

As detailed in **Figure 7** below, in 2023, ISTW emitted a total of **16,944.41 tCO₂-e** (tonnes of CO₂ equivalent). This total does not include biogenic emissions or emission removals, which are discussed in Section 4.1.4 Biogenic Emissions and Removals.

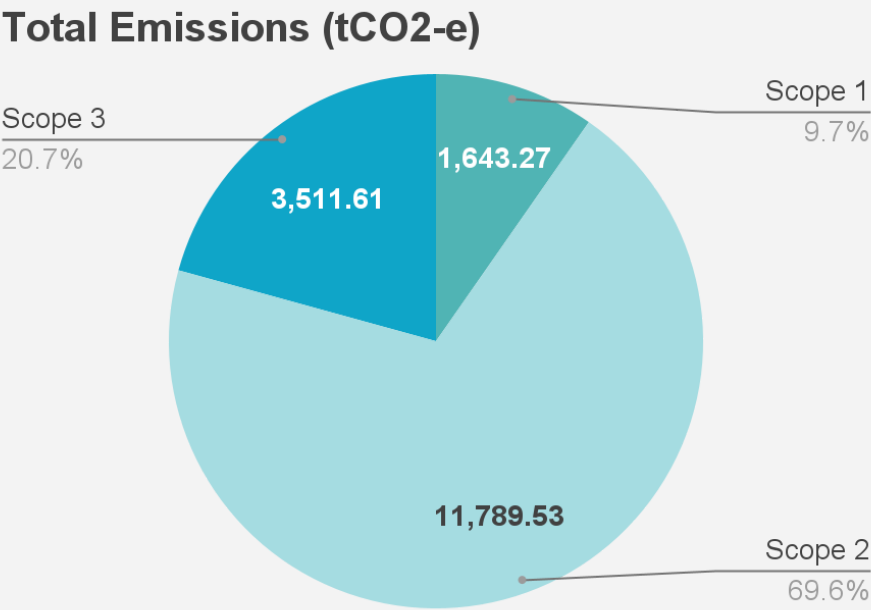


Figure 7. Distribution of the reported emissions by category

Scope 1 emissions, which arise from direct fuel combustion activities (e.g., vehicles), amount to **1,643.27 tCO₂-e**, representing **9.7%** of total emissions. Stationary fuel combustion contributes to emissions from the use of LPG, diesel, Pertamina, and B35 in various equipment and generators. Mobile combustion sources, such as company vehicles, also release emissions from diesel, Pertamina, and B35 usage. In addition to fuel combustion, fugitive emissions occur from the release of refrigerants (R22, R32, R407C).

The majority of emissions at ISTW arise from **Scope 2** emissions, which totals **11,789.53 tCO₂-e**, representing **69.6%** of total emissions. These emissions are primarily associated with electricity consumption during the operational processes, sourced from PLN (*Perusahaan Listrik Negara*). Since PLN's electricity generation is largely based on fossil fuels, it significantly contributes to ISTW's overall emissions profile. Therefore, the result shows that electricity consumption is the most critical source of emissions for ISTW, which necessitates greater efforts to reduce or switch to renewable energy sources.

For **Scope 3** emissions, ISTW emitted **3,511.61 tCO₂-e (20.7%)**, which includes **Cat. 4** emissions of **3,239.33 tCO₂-e** from the transportation of mother coils (both local and imported) by sea freight. If machine parts transportation were included in this calculation, the total would increase significantly, as most of these parts come from overseas and are transported by air freight. Additionally, **Cat. 6** emissions, covering business travel from flights, trains, and cars, contributed **272.38 tCO₂-e** to the total reported Scope 3 emissions. Therefore, from the calculated Scope 3 emissions, transportation of mother coils is the most significant contributor to ISTW's reported Scope 3 emissions.

It is important to note that Scope 3 emissions usually represent the major part of a company's total emissions; in the case of ISTW, the reporting of these two categories should be considered as a first step in view of reporting all indirect emissions in the future. The GHG Protocol defines 15 categories, with some that could potentially be significant for ISTW, such as *Purchased Goods and Services* (Cat. 1), *Downstream Transportation and Distribution* (Cat. 9), and *Processing, Use and End-of-Life Treatment of Sold Products* (respectively Cat. 10, 11 and 12).

A detailed breakdown of emissions and removals of ISTW in 2023 is presented in Table 3.

Table 3. Emissions and removals of ISTW by plants and category (tCO₂-e)

Emissions Category	ISTW-J1 (tCO ₂ -e)	ISTW-J2 (tCO ₂ -e)	ISTW-CKR (tCO ₂ -e)	ISTW-SMR (tCO ₂ -e)	Total (tCO ₂ -e)	% emissions
<i>Direct Emissions from Stationary Fuel Combustion – Scope 1</i>						
LPG	0.23	0.00	0.16	7.03	7.42	<1%
Diesel	8.63	5.77	3.69	0.00	18.09	<1%
Pertamax	0.00	0.00	0.00	0.37	0.37	<1%
Biodiesel (B35)	0.00	0.00	0.00	911.69	911.69	5%
Subtotal	8.87	5.77	3.85	919.09	937.57	5%
<i>Direct Emissions from Mobile Fuel Combustion – Scope 1</i>						
Diesel	6.14	12.70	30.83	0.00	49.68	<1%
Biodiesel (B35)	0.00	0.00	0.00	375.24	375.24	2%
Pertamax	123.58	12.33	31.06	38.39	205.37	1%
Subtotal (tCO₂-e)	129.73	25.03	61.90	413.63	630.29	4%
<i>Direct Fugitive Emissions from Release of Greenhouse Gases – Scope 1</i>						
R22	0.00	0.00	0.00	23.78	23.78	<1%
R32	0.00	0.00	0.00	9.45	9.45	<1%
R407C	35.48	0.00	6.65	0.00	42.13	<1%
Fire extinguisher CO ₂	0.01	0.01	0.02	0.00	0.04	<1%
Subtotal	35.49	0.01	6.67	33.24	75.41	<1%
Total Scope 1	174.08	30.81	72.41	1,365.97	1,643.27	10%

Emissions Category	ISTW-J1 (tCO ₂ -e)	ISTW-J2 (tCO ₂ -e)	ISTW-CKR (tCO ₂ -e)	ISTW-SMR (tCO ₂ -e)	Total (tCO ₂ -e)	% emissions
<i>Indirect Emissions and Removals from Imported Energy - Scope 2</i>						
Electricity from PLN grid	2,631.26	3,300.17	4,274.31	1,583.79	11,789.53	68%
Subtotal	2,631.26	3,300.17	4,274.31	1,583.79	11,789.53	68%
Total Scope 2	2,631.26	3,300.17	4,274.31	1,583.79	11,789.53	68%
<i>Cat 4. Upstream Transportation - Scope 3</i>						
Emissions from expeditions and transportation	1,252.63	0.00	1,368.77	617.93	3,239.33	19%
Subtotal (tCO₂-e)	1,252.63	0.00	1,368.77	617.93	3,239.33	19%
<i>Cat 6. Indirect Emissions from Business Travel - Scope 3</i>						
Economy flights	96.54	0.00	0.00	0.78	97.32	<1%
Business flights	0.78	0.00	0.00	0.00	0.78	<1%
Train trips	0.00	0.00	0.00	0.16	0.16	<1%
Car and taxi trips	19.45	0.00	2.31	152.26	174.02	1%
Subtotal	116.78	0.00	2.31	153.20	272.28	2%
Total Scope 3	1,369.41	0.00	1,371.07	771.13	3,511.62	20%
Total Emissions	4,174.76	3,330.98	5,699.93	4,081.92	17,287.59	100%
	24.15%	19.27%	32.97%	23.61%	100.00%	
Total Scope 1 and 2 Emissions	2,805.35	3,330.98	4,328.86	2,864.15	13,329.33	100%
	21.05%	24.99%	32.48%	21.49%	100.00%	

Note: the values presented in this table are rounded from calculations with a precision of 10⁻⁶ tCO₂-e. Therefore, apparent sum errors can appear in some cases.

4.1.2 Emissions Distribution by Plant

In 2023, ISTW's total emissions amounted to **16,944.41 tCO₂-e**, with the emissions distributed among its four plants (**Figure 8**). The **Cikarang plant** was the largest contributor, emitting **5,717.79 tCO₂-e**, accounting for approximately **33.7%** of the total emissions. The **J1 plant** followed closely, with emissions of **4,174.75 tCO₂-e (24.6%)**, while the **J2 plant** produced **3,330.98 tCO₂-e (19.7%)**. The **Semarang plant** emitted **3,720.89 tCO₂-e**, representing roughly **22%** of the total emissions.

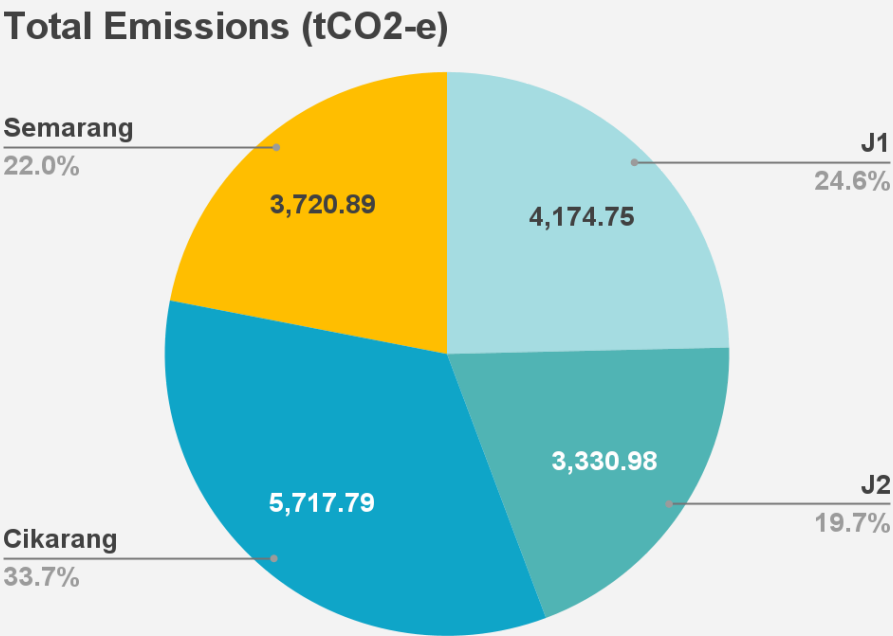


Figure 8. Distribution of the reported emissions by plants

A comprehensive summary of the emissions by plant and category for 2023 is outlined in **Figure 9**, offering a detailed account of each plant's contributions across various emissions categories.

Total Emissions (tCO₂-e)

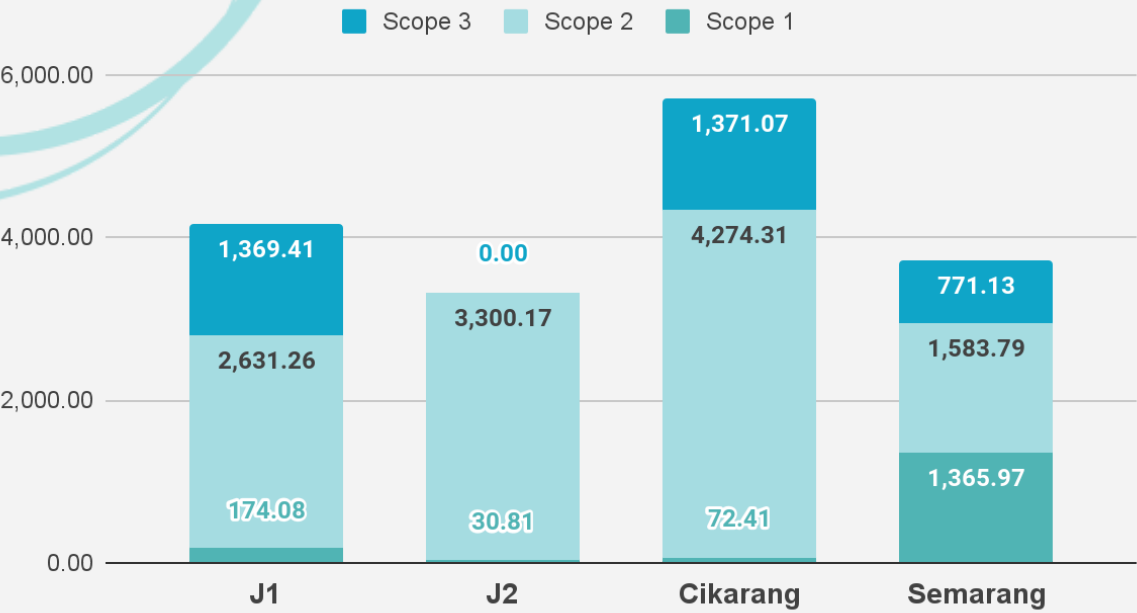


Figure 9. Distribution of the reported emissions by plants per category

This distribution indicates that the **Cikarang** plant, as the newest plant with highest production output, is a significant contributor to ISTW's overall carbon emissions. However, if **J1 and J2** are considered together as part of the same production process, their combined emissions of both plants (**7,505.73 tCO₂-e**) would represent a substantial **44.3%** of the total emissions, surpassing the Cikarang plant. This consolidation emphasises the critical importance of implementing effective emissions management initiatives at these interconnected facilities to drive reductions in ISTW's overall carbon emissions.

The **J1** plant, also the headquarter of ISTW, emitted **4,174.75 tCO₂-e** in total, with Scope 1 emissions accounting for **174.08 tCO₂-e** and Scope 2 emissions at **2,631.26 tCO₂-e**. The relatively low Scope 1 emissions indicate that direct fuel combustion is not a major contributor to overall emissions, aligning with its operational model focused on processing mother coils. However, the high Scope 2 emissions suggest a significant reliance on

electricity sourced from PLN. Additionally, J1's Scope 3 emissions of **1,369.41 tCO₂-e**, are largely from the transportation of imported mother coils from South Korea, China, and other countries.

Emitting a total of **3,330.98 tCO₂-e**, the J2 plant has minimal Scope 1 emissions at **30.81 tCO₂-e** which reflects limited direct fuel usage. The Scope 2 emissions are noteworthy at **3,300.17 tCO₂-e**, revealing a similar dependency on fossil fuel-based electricity as J1. As J2 is directly linked to J1 as it continues with the recutting process in the production line, it inherits the same challenges regarding energy consumption. The absence of reported Scope 3 emissions shows the plant's operational context within the J1 facility, where logistics activities occur mainly at J1.

The **Cikarang** plant is the largest emitter, producing **5,717.79 tCO₂-e**, with Scope 1 emissions at **72.41 tCO₂-e** and Scope 2 emissions at **4,274.3 tCO₂-e**. This plant benefits from newer machinery, contributing to its high production output despite its significant energy consumption. The substantial Scope 2 emissions point to a considerable dependence on electricity, which drives the plant's overall emissions profile. Furthermore, Cikarang's Scope 3 emissions of **1,371.07 tCO₂-e** reveal the importance of transport logistics in its carbon footprint, similar to J1.

The Semarang plant emitted **3,720.89 tCO₂-e**, with a significant Scope 1 contribution of **1,365.97 tCO₂-e**, primarily due to relatively old machinery and fuel usage related to the galvanising process. Its Scope 2 emissions are relatively lower at **1,583.79 tCO₂-e**, indicating less reliance on electricity compared to the other plants. The Scope 3 emissions stand at **771.13 tCO₂-e** which indicates some contribution from logistics but significantly lower than Cikarang and J1. This difference arises because Semarang mostly sources mother coils locally from West Java, while imported coils are primarily transported to J1 and Cikarang, resulting in higher transport emissions.

4.1.3 Emissions by Type of GHG

Table 4 below presents the results of the 2023 GHG Inventory by type of GHG. No PFCs, SF₆, or NF₃ emissions have been reported.

Table 4. ISTW 2023 emissions by GHG (tCO₂-e)

Emissions per GHG (t CO ₂ -e)	TOTAL GHG (CO ₂ -e)	Carbon dioxide (CO ₂)	Methane (CH ₄)	Nitrous oxide (N ₂ O)	HFCs (wavg)	PFCs (wavg)	Sulfur hexafluoride (SF ₆)	Nitrogen trifluoride (NF ₃)
Emissions Category	GWP-100	1	27.9	273	1,499	4,000	25,200	17,400
Scope 1 – Direct Emissions								
Direct Emissions from Stationary Fuel Combustion	1,255.11	1,250.60	1.53	2.97	0.00	0.00	0.00	0.00
Direct Emissions from Mobile Fuel Combustion	759.39	765.38	1.04	7.99	0.00	0.00	0.00	0.00
Direct Fugitive Emissions from Release of Greenhouse Gases	75.41	0.04	0.00	0.00	75.37	0.00	0.00	0.00
Total Scope 1 (tCO₂-e)	2,089.91	2,016.0	2.58	10.97	75.37	0.00	0.00	0.00
Scope 2 – Indirect Emissions from Imported Energy								
Indirect Emissions from Imported Electricity *	11,789.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Scope 2 (tCO₂-e)	11,789.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emissions per GHG (t CO ₂ -e)	TOTAL GHG (CO ₂ -e)	Carbon dioxide (CO ₂)	Methane (CH ₄)	Nitrous oxide (N ₂ O)	HFCs (wavg)	PFCs (wavg)	Sulfur hexafluoride (SF ₆)	Nitrogen trifluoride (NF ₃)
Scope 3 – Other Indirect Emissions								
Cat 4. Indirect Emissions from Upstream Transportation *	3,239.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cat 6. Indirect Emissions from Business Travel *	272.28	189.12	1.81	5.66	0.00	0.00	0.00	0.00
Total Scope 3 (tCO₂-e)	3,511.62	189.12	1.81	5.66	0.00	0.00	0.00	0.00
Total Emissions (tCO₂-e)	17,734.2	2,548.3	4.38	16.62	75.37	0.00	0.00	0.00
Total Scope 1 & 2 Emissions (tCO₂-e)	13,775.9	1,912.6	2.58	10.97	75.37	0.00	0.00	0.00

*The emission factor per type of GHG is not known for the electricity purchased on the PLN power grids.

With no emissions from high-impact gases, ISTW can concentrate its reduction efforts on more prevalent greenhouse gases, such as CO₂, CH₄, and N₂O, which are directly linked to its operational activities. While no emissions of PFCs, SF₆, or NF₃ have been reported, the use of R22 in Semarang signifies a potential area for emissions improvement, as R22 can significantly contribute to GHG emissions due to its high GWP.

4.1.4 Biogenic Emissions and Removals

At ISTW, the use of biodiesel B35 at the Semarang plant resulted in **446.64 tCO₂-e** of biogenic emissions attributed to its 35% biofuel content. Although biogenic emissions are generated from B35 biodiesel, this level is significantly lower than it would be if ISTW used conventional diesel. In addition, ISTW's tree planting and nursery programme sequestered approximately **103.47 tCO₂-e** from the atmosphere through trees planted in Cikarang and Semarang plants. A detailed account of biogenic emissions and removals from ISTW is shown in **Table 5**.

Table 5. Emissions from the combustion of biofuels and removals

Emissions Category	ISTW-CKR (tCO ₂ -e)	ISTW-SMR (tCO ₂ -e)	Total (tCO ₂ -e)
<i>Emissions from Biofuel Combustion</i>			
Biodiesel (B35) – Stationary Fuel Combustion	0.00	317.54	317.54
Biodiesel (B35) – Mobile Fuel Combustion	0.00	129.10	129.10
<i>Subtotal (tCO₂-e)</i>	<i>0.00</i>	<i>446.64</i>	446.64
Total Biogenic Emissions	0.00	446.64	446.64
<i>Emissions Removal</i>			
Carbon sequestration from tree planting and nursery	-17.87	-85.60	-103.47
<i>Subtotal (tCO₂-e)</i>	<i>-17.87</i>	<i>-85.60</i>	-103.47
Total Emissions Removal	-17.87	-85.60	-103.47
Total Biogenic Emissions and Removal	-17.87	361.04	343.17

4.2 Internal Performance Tracking

Two main indexes can be used to track the performances of the ISTW—the energy intensity and the emissions intensity. For this calculation, only Scope 1 and Scope 2 emissions were considered to align with industry practices and facilitate a fair comparison across companies. When comparing energy intensity and emissions intensity, ISTW's role as a steel pipe and tube manufacturer is particularly significant. Unlike general steel

production, which often involves steelmaking in a furnace, **ISTW focuses on transforming mother coils into finished products**. This operational distinction is important, as emissions can vary greatly depending on the production method. Companies engaged in full steelmaking processes typically have higher energy intensity and emissions intensity due to the energy-intensive nature of primary production. Therefore, while industry averages are informative, it is crucial to consider ISTW's specific operations, which may result in **lower energy intensity and emissions intensity** owing to its current manufacturing approach.

Total production output per plant and all plants combined were used to calculate energy intensity, emissions intensity, and CO2 intensity, as seen in Table 6.

Table 6. Total production output of ISTW in 2023

Plant	Total Production Output (tonnes)
J1 & J2	23,706.93
Cikarang	48,723.18
Semarang	19,092.88
ISTW (combined)	91,523.00

4.2.1 Energy Intensity Index

The energy intensity index (**Figure 10**) is an important metric for evaluating ISTW's operational efficiency, indicating the amount of energy consumed per tonne of steel produced. This index was calculated using total energy consumption across all plants. For 2023, ISTW's overall energy intensity stood at **0.86 GJ/tonne**. A breakdown of energy intensity per plant is detailed below.

Energy Intensity Index (GJ/tonne product)

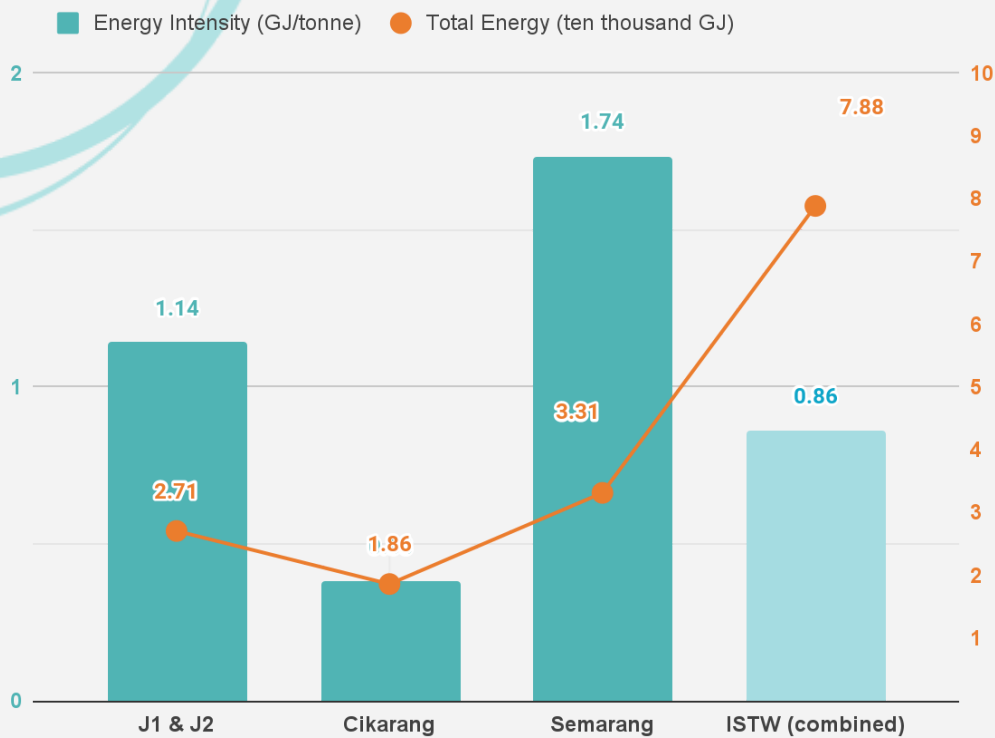


Figure 10. Energy intensity index of ISTW in 2023

J1 and J2 plants exhibited the highest energy intensity at **1.14 GJ/tonne**, which can be attributed to their energy-intensive production processes. These facilities together consumed **27,073 GJ** while producing **23,706 tonnes** of steel pipes. The higher energy intensity suggests inefficiencies likely stemming from the reliance on electricity for initial production and the logistical processes involved in transporting mother coils for recutting.

Conversely, Cikarang demonstrated a significantly lower energy intensity of **0.38 GJ/tonne**, consuming **18,622 GJ** and producing **48,723 tonnes** of steel pipes. This lower figure shows the plant's more advanced energy-efficient technologies and processes that maximise production while minimising energy consumption. Cikarang's superior performance in this regard indicates its role as the most efficient plant in ISTW's operations.

The Semarang plant has an energy intensity of **1.74 GJ/tonne**, consuming **33,138 GJ** for a production output of **19,092 tonnes**. The higher energy intensity reflects the limitations of older machinery and potential areas for enhancing operational efficiency. The plant's galvanisation process, which involves hot-dip galvanising to create corrosion-resistant steel, also contributes to its elevated energy intensity. This process is energy-intensive (World Steel Association, 2023) and adds to the plant's operational demands, further impacting the energy use. **Table 7** below compares ISTW's energy intensity with similar industries.

Table 7. Comparison of energy intensity between ISTW and similar industries

Company	Report Year	Energy Intensity (GJ/tonne)	Remarks	Source
ISTW	2023	0.86	Lower energy efficiency compared to SPINDO and Maruichi Steel Tube Ltd.	2023 GHG Inventory Report
SPINDO*	2023	0.39	Higher energy intensity, indicating less efficient or higher energy use.	Sustainability Report 2023
Maruichi Steel Tube Ltd.*	2022	Insufficient data	Production outputs in the ESG report are stated in various units, preventing direct comparison.	ESG Report 2022
APL Apollo*	2022-2023	0.41	Lower energy intensity, suggesting advanced efficiencies and innovative energy efficiency practices.	ESG Report 2022-2023

**The energy intensity values are approximate figures derived from the energy and production output data presented in each company's sustainability reports; actual values may vary significantly.*

The differences in energy intensity among steel manufacturers can be attributed to the boundaries of their production processes. ISTW's operations begin with mother coils acquired from suppliers, while other companies may start from earlier stages, such as raw materials.

Additionally, some companies produce a broader range of steel pipes, contributing to disparities in energy intensity values.

While ISTW demonstrates a comparatively lower energy intensity, reflecting operational effectiveness, the higher energy intensity observed in the **J1 and J2 plants (1.14 GJ/tonne)** and the **Semarang plant (1.74 GJ/tonne)** highlights areas for improvement. In contrast, the **Cikarang plant** showcases superior energy efficiency (**0.38 GJ/tonne**), suggesting that J1, J2, and Semarang could benefit from adopting best practices in energy management, upgrading machinery, and optimising production processes to enhance their performance.

4.2.2 Emissions Intensity Index

The GHG emission intensity index is a key performance indicator for ISTW's operations, measuring how much GHG is emitted per tonne of steel pipe produced. ISTW's emissions intensity, with combined emission and output from all plants in 2023, was **146.79 kgCO₂-e/tonne (Figure 11)**. Emissions at the J1 and J2 plants reached **258.84 kgCO₂-e/tonne**, while Cikarang and Semarang had lower intensities of **89.21 kgCO₂-e/tonne** and **154.50 kgCO₂-e/tonne**, respectively.

Emissions Intensity Index (tCO₂-e/tonne product)

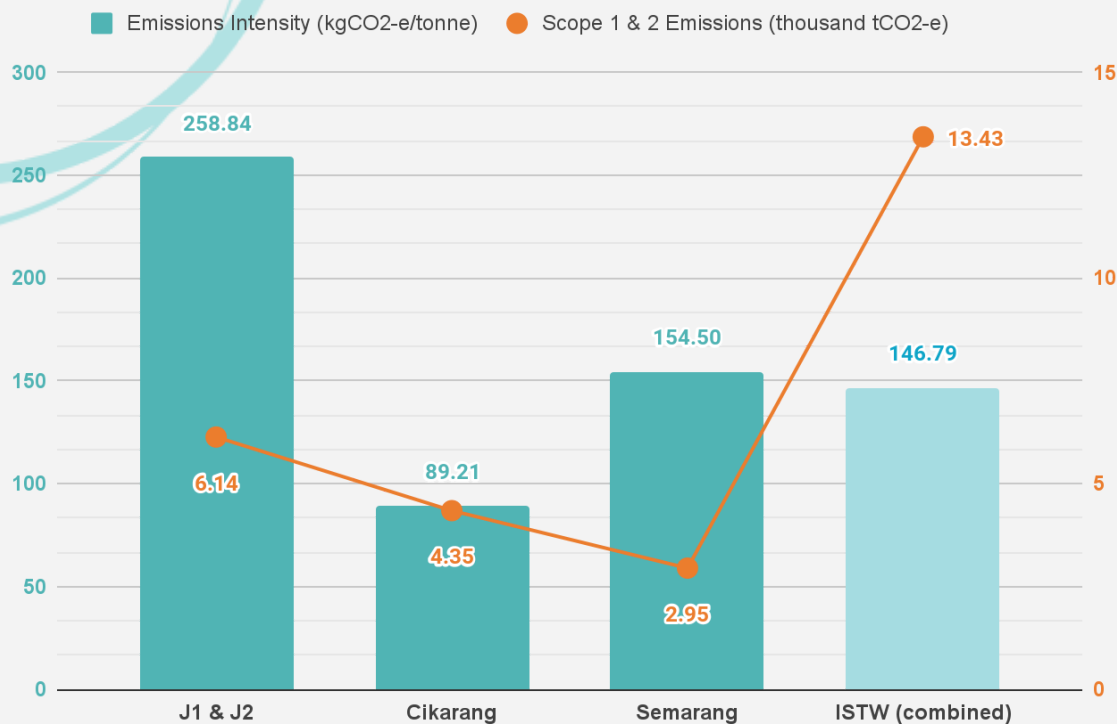


Figure 11. Emissions intensity index of ISTW in 2023

The 2023 emissions intensity data for **Cikarang**, despite having the highest total emissions (4.35 thousand tCO₂-e), also exhibits the lowest emissions intensity at **89.21 kgCO₂-e/tonne**, which reflects its superior energy efficiency. This plant handles the bulk of ISTW's production, outputting **48,723 tonnes** of steel pipes, yet its advanced technology and efficient processes contribute to lower emissions per tonne produced. Therefore, Cikarang's advanced energy-efficient systems make it the most sustainable plant on a per-tonne basis, despite its large production output.

With a combined emission intensity of **258.84 kgCO₂-e/tonne**, **J1 and J2** are the highest emitters per tonne of steel pipe produced. This is likely driven by the energy-intensive production processes, particularly electricity consumption (Scope 2) in J1 for the initial production pipes and tubes from mother coils and in J2 for recutting. However, J1 and J2 produce

a much lower volume of steel products (**23,706 thousand tonnes**). This higher emissions intensity indicates that these plants are less energy-efficient, which could be attributed to various operational factors, including their production methods and possibly less optimised energy systems.

The **Semarang** plant has an emissions intensity of **154.42 kgCO₂-e/tonne**. The plant produces **19,092 tonnes** of steel products, including galvanised steel, which often requires additional energy-intensive processes that increase emissions. This galvanisation, done through the hot-dip method, aims at producing higher-quality, corrosion-resistant steel, contributing further to the plant's Scope 1 emissions through fuel use in machinery and emissions generated from the galvanisation process itself (World Steel Association, 2023). Furthermore, Semarang's Scope 3 emissions are high because of the distance from raw material suppliers, with both overseas and local transport emissions significantly impacting its total GHG intensity. Therefore, the combination of older machinery, transportation-related emissions, and galvanisation processes, despite the plant's lower production output, contributes to its comparatively higher emissions intensity. A closer look at ISTW's emissions intensity against similar industries is showcased in **Table 8**.

Table 8. Comparison of emissions intensity between ISTW and similar industries

Company	Report Year	Emissions Intensity (kgCO ₂ -e/tonne)	Remarks	Source
ISTW	2023	146.79	Higher emissions intensity compared to similar industries.	2023 GHG Inventory Report
SPINDO*	2023	89.6	Lower emissions intensity, indicating more efficient production or usage of cleaner energy sources.	Sustainability Report 2023

Company	Report Year	Emissions Intensity (kgCO ₂ -e/tonne)	Remarks	Source
Maruichi Steel Tube Group Ltd.*	2021	104.58	Lower emissions intensity, indicating more efficient production or usage of cleaner energy sources.	ESG Report 2022
Borusan Mannesmann*	2022	76.76	Lower emissions intensity, indicating more efficient production or usage of cleaner energy sources.	Sustainability Executive Summary 2022 Report
APL Apollo*	2022–2023	38.9	Significantly low emissions intensity, suggesting high operational efficiencies and usage of cleaner energy sources.	ESG Report 2022–2023

*The emissions intensity values are approximate figures derived from the emissions and production output data presented in each company's sustainability reports; actual values may vary significantly.

ISTW's low energy intensity, paired with a relatively high emissions intensity, can be attributed to several factors:

- It may be attributed to reliance on energy sources with high emissions factors that impact its overall carbon footprint.
- The production techniques used at ISTW may lead to significant GHG emissions due to the types of steel products manufactured, which could be more carbon-intensive than those produced by similar industries.
- The differences in operational reporting practices may contribute to these discrepancies, including variations in energy use and emissions across companies.

ISTW's relatively higher emissions intensity, particularly with the **J1 and J2** facilities at **258.84 kgCO₂-e/tonne**, indicates a need for targeted

operational improvements to address the inefficiencies associated with energy-intensive processes. The **Cikarang** plant, with a more efficient emissions intensity of **89.21 kgCO₂-e/tonne**, highlights best practices that could be adopted by other plants to enhance their performance. Therefore, ISTW should consider conducting an assessment of its production processes across all plants to identify and implement energy-saving measures, upgrade equipment, and explore cleaner energy sources to align its emissions intensity with industry standards.

4.2.3 CO₂ Emissions Intensity Index

The CO₂ emissions intensity index provides a specific overview of the carbon dioxide emissions generated per tonne of steel pipe across ISTW's facilities, as shown in **Figure 12**.

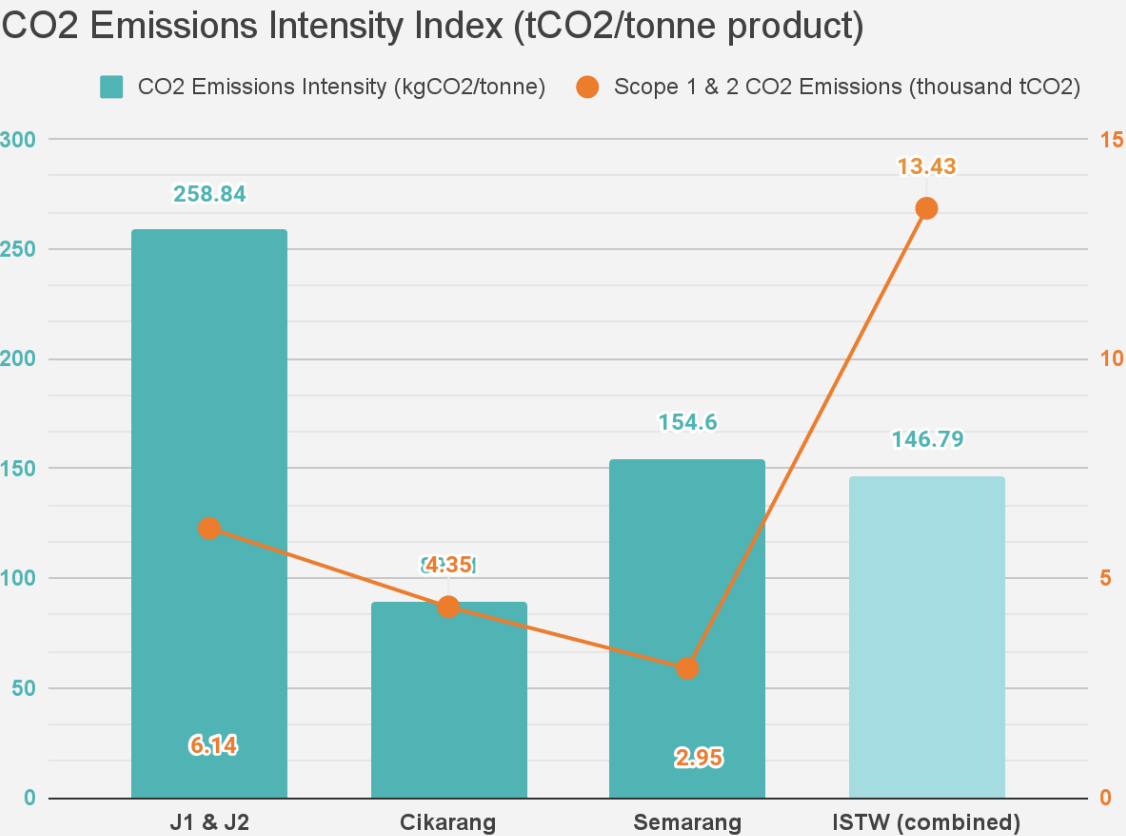


Figure 12. CO₂ emissions intensity index of ISTW in 2023

The separation of CO₂ emissions from total GHG emissions does not significantly alter overall trends, as the CO₂ emissions intensity closely mirrors the emissions intensity previously described in Section 4.2.2. The only notable distinction is the CO₂ emissions intensity of the Semarang plant, which is **154.60 tCO₂/tonne**. This finding indicates that CO₂ emissions, when evaluated independently, correlate closely with the overall GHG intensity patterns across ISTW's plants.

4.3 Emission Factors Considered for This Inventory

The emission factors (EF) have been determined according to IPCC standards. Tier 2 EFs (national/regional data) have been used whenever available, while Tier 1 EFs (IPCC standard data and methods) have been applied for the remaining EFs. These are listed in **Table 9** below.

Table 9. Emission factors used for the computation of the 2023 GHG Inventory

Emission type	Emission source	Overall CO ₂ -e	Unit	Reference
Combustion emissions	Emission gas type	Emission factor		Reference
Stationary combustion	Diesel	2,6975	kg CO ₂ -e/L	Tier 2—ESDM (Indonesia)
	Gasoline	2,4001	kg CO ₂ -e/L	Tier 2—ESDM (Indonesia)
	LPG	2,9925	kg CO ₂ -e/TJ	IPCC 2006 Methodology
	B35	1,7533	kg CO ₂ -e/L	Pertamina Patra Niaga
	Pertamax	2,3073	TJ/Gg	IPCC 2006 Methodology
	B100	2,2261	kg CO ₂ -e/L	IPCC 2006 Methodology
Mobile combustion	Diesel	2,7309	kg CO ₂ -e/L	Tier 2—ESDM (Indonesia)
	Pertamax	2,1500	kg CO ₂ -e/L	Tier 2—ESDM (Indonesia)
	B35	1,7779	kg CO ₂ -e/L	Pertamina Patra Niaga
	B100	2,2261	kg CO ₂ -e/L	IPCC 2006 Methodology
Fugitive emissions	Emission gas type	Emission factor		Reference
Refrigerant leaks	R134a	1530,0	kg CO ₂ -e/kg	IPCC AR6
	R407C	1773,9	kg CO ₂ -e/kg	IPCC 2019 Vol 3. Chapter 7
	R22	1960,0	kg CO ₂ -e/kg	IPCC 2006
	R32	771,0	kg CO ₂ -e/kg	IPCC 2006
Fugitive emission	Apar CO ₂	1,000	kg CO ₂ -e/kg	GHG Protocol

Emission type	Emission source	Overall CO ₂ -e	Unit	Reference
Grid electricity	Emission source	Emission factors		Reference
Grid electricity from PLN	Electricity	0,870	kg CO ₂ -e/kWh	Tier 2—2019 emission factors per grid (Jamali) published by ESDM
Transportation	Emission source	Emission factors		Reference
Emissions due to flight transport	Economy - short haul	0,09245	kg CO ₂ -e/pkm	GHG Protocol Cross-Sector tool
	Business - short haul	0,13867	kg CO ₂ -e/pkm	GHG Protocol Cross-Sector tool
Emissions due to communal transport	Train or MRT	0,1013	kg CO ₂ -e/pkm	GHG Protocol Cross-Sector tool
Emissions due to private or service transport	Gasoline car	0,2984	kg CO ₂ -e/pkm	Assumption based on Tier 2 values

4.3.1 Carbon Sequestration Emission Factors for Planted Trees

To determine the amount of carbon sequestered by a tree over a specific period, various methods are available. The simplest approach involves measuring the diameter of the tree at breast height (DBH) at a height of 1.30 metres at both the beginning and end of the measurement period. Scientific literature provides allometric equations tailored to different tree species and climatic regions, which define the correlation between DBH and tree biomass. Using these equations, one can derive formulas and ratios that facilitate the calculation of carbon sequestered by the tree during its growth phase, as well as the corresponding CO₂ absorbed to achieve this carbon storage. Examples of tree sequestration values can be found in **Table 10**.

Table 10. Example of tree sequestration values

Tree species	Latin Name	Base DBH (cm)	MAI DBH (cm)	MAI biomass (kg/year/tree)	Yearly Carbon Sequestration (kgCO ₂ /year/tree)	Source
Sengon	<i>Paraserianthes falcataria</i>	8	4	24.80	42.75	Munawar & Wiryono (2014)
Albasia	<i>Albizia falcataria</i>	8	4	17.91	30.87	Marak & Khare (2017)
Cengkeh	<i>Syzygium aromaticum</i>	7	2	14.29	24.62	Karyati <i>et al.</i> (2019)

In the 2023 GHG Inventory of ISTW, 1,255 trees were included in the carbon sequestration calculations. Trees of species with fewer than five individuals were excluded. ISTW's tree planting and nursery program in 2023 sequestered approximately **103.47 tCO₂-e** from the atmosphere. Specifically, trees planted in the Cikarang plant accounted for **17.87 tCO₂-e**, while those in the Semarang plant contributed **85.60 tCO₂-e** in carbon sequestration. This variation is due to differences in tree numbers and age across sites. However, the overall impact of ISTW's trees on carbon reduction remains minimal relative to the company's total emissions, indicating a limited role in offsetting its broader GHG footprint.

4.4 Data Uncertainties

As indicated in **Table 1** in Section 3.2, certain datasets exhibit varying levels of uncertainty, which could affect the overall accuracy of the GHG inventory.

4.4.1 Scope 1

For the emissions calculations related to diesel generators, it is assumed that they are operated for a duration of 60 minutes. This assumption may introduce variability in emissions estimates, as actual usage times can differ.

4.4.2 Scope 2

Discrepancies have been observed between the electricity bills received by ISTW staff and the total electricity consumption recorded by kilowatt-hour (kWh) metres. This may result from differences in the electricity cut-off dates between ISTW and PLN, leading to uncertainties in the recorded Scope 2 emissions.

4.4.3 Scope 3

- **Category 4:** The emissions associated with the transport of machine parts by air freight have not been calculated due to unrecorded weight data. Additionally, there is a lack of data on the transport of mother coils from the warehouse to the initial port of shipment. Details regarding the type of vessel used (fuel type, etc.) are also absent. Therefore, standard assumptions were applied in the distance-based calculations between ports and from the arrival port to ISTW's plants.
- **Category 6:** For business travel, the distances flown by staff on planes were calculated using the direct distance between airports. A similar approach was applied for journeys made by train and car, which may not fully capture the actual distance travelled due to varying routes taken.

4.5 Recommendations to Improve Future Reportings

4.5.1 Enhance Energy Consumption Recording

ISTW's energy data system currently records monthly electricity, fuel consumption, and associated costs in electronic formats. However, certain energy bills are inconsistent with actual usage, some production areas lack kWh metres, and are scattered across various records. To address these gaps, ISTW's energy data management system will require redevelopment to encompass all major GHG emission sources and reductions effectively. Digitalisation and improvements in data collection would be valuable steps. A streamlined, digitalised energy management

system could address current inconsistencies and discrepancies in data. Redeveloping ISTW's energy data system to consolidate all major GHG emission sources and reductions into a centralised platform would support these efforts.

Appointing a dedicated energy manager will facilitate compliance with ISO 50001 standards and streamline the process of recording energy consumption. This will enable ISTW to improve the reliability of emissions data and identify potential areas for energy and GHG reductions.

4.5.2 Improve Data Recording for Transport of Purchased Items

To comprehensively assess Scope 3 Category 4 emissions, it is essential to implement systematic data recording for the transport of machine parts and other purchased items. For an effective data recording for Scope 3 Category 4 emissions from the transport of purchased items, ISTW should collect the following data:

- **Weight of Transported Goods:** Accurate weight measurement for each item being transported in kilograms or tonnes.
- **Transportation Mode:** Type of transport used (e.g., truck, ship, air).
- **Distance Travelled:** The distance from the supplier location to port/airport, and to ISTW facilities.
- **Frequency of Shipments:** Number of trips for each item or order.

4.5.3 Standardise Business Travel Data Recording

For consistent and accurate tracking of emissions from business travel (Scope 3, Category 6), ISTW's department managing travel should adopt a standardised template across all plants. This template should capture key data points needed for emission calculations, including:

- **Travel Mode:** Air, rail, or road (specify class for air travel).
- **Travel Distance:** Actual kilometres for each trip leg.
- **Travel Frequency:** Number of trips per month/quarter.

- **Accommodation Data** (optional): Hotel type and duration of stay, which can enhance emissions accuracy.

4.5.4 Verification of the Future Inventories

This first GHG Inventory is a significant step towards understanding ISTW's environmental impact. To enhance the credibility of future inventories, obtaining third-party verification of reported figures should be considered. Engaging an independent auditor will bolster transparency and stakeholder confidence. As noted in **Table 2** in Section 3.3, the inclusion of any previously missing GHG sources is essential before formal verification can take place.

CHAPTER 5: PRELIMINARY RECOMMENDATIONS FOR EMISSIONS REDUCTIONS

5.1 Emissions Reduction Initiatives

5.1.1 Current Actions

ISTW is already taking several steps to reduce its GHG emissions and improve overall environmental performance. ISTW has installed solar panels at the Cikarang plant in 2024, marking a significant move towards renewable energy adoption. This project, in collaboration with SUN Energy & Sojitz through Surya Nippon Nusantara (SNN), is expected to produce approximately 510,622 kWh of renewable energy per year, potentially reducing emissions by around 397 tCO₂e annually. While this initiative is a start toward renewable energy integration, its impact is relatively small in comparison to ISTW’s total Scope 2 emissions in 2023, as presented in Table 11.

Table 11. Summary of ISTW’s Scope 2 Emissions in 2023

	J1	J2	Cikarang	Semarang	Total
Scope 2 Emissions (tCO ₂ e)	2,631.26	3,300.17	4,274.31	1,583.79	11,789.53

In comparison to ISTW’s Scope 2 emissions, the solar panel’s contribution to reducing Scope 2 emissions remains modest. However, for the next GHG inventory for 2024, it will quantify the actual generated energy and annual reduction of the Cikarang solar panels. Nevertheless, this solar panels initiative in Cikarang will serve as a model for other ISTW plants, where similar renewable energy projects are being planned.

ISTW’s energy efficiency initiatives, such as upgrading to LED lighting and replacing R22 air conditioners, mark a step towards sustainability.

However, these actions alone are unlikely to yield substantial GHG reductions. Focusing on operational efficiency for process machinery, where energy demands are highest, could achieve more impactful emissions reductions. For instance, implementing sensor technology to monitor real-time energy use and potentially lower emissions. Additionally, installing a chiller system for cooling during high-heat processes, could further improve efficiency and decrease the energy use of core manufacturing operations.

5.1.2 Recommended Future Initiatives

Building on its current progress, ISTW should consider the following initiatives to further reduce emissions and enhance its environmental performance:



Recommendation 1: Energy Efficiency and Process Optimisation

ISTW should focus on enhancing efficiency gains in its production processes by assigning dedicated personnel to optimise existing machinery and evaluate the cost-effectiveness of replacing inefficient technology, particularly in the Semarang plant. This approach would help ISTW align with ISO 50001 standards for energy management. Potential energy efficiency measures include:

- Installing sensors to identify and rectify inefficiencies in the production process.
- Transitioning to energy-efficient lighting systems across all facilities.
- Replacing older machinery with more efficient alternatives, including conducting lifecycle cost analyses to assess the internal rate of return (IRR) of potential energy-efficient technologies.

- Increase machine productivity and efficiency to reduce energy consumption (e.g., enhancing galvanising output, raising mill speeds, and using welding machines that consume less energy).
- Maintain machines and equipment according to standard procedures to ensure they operate efficiently and consume less energy.



Recommendation 2: Continue Fuel Switching Activities

ISTW should encourage a transition to biodiesel and biofuels across all its plants. Specifically, the J1, J2, and Cikarang plants should switch from diesel to biodiesel, as this can significantly reduce their overall carbon emissions while providing a more sustainable fuel source. Meanwhile, the Semarang plant should continue using biofuel options, such as B35 biodiesel, but also consider phasing out R22 refrigerant to further minimise its environmental impact.

Introducing electric vehicles (EVs) at all plants, particularly for transportation and internal logistics could enhance fuel efficiency and reduce emissions, albeit with the recognition that EVs may entail higher upfront costs. To complement this effort, ISTW could also consider implementing optional fuel-saving driving training for drivers to improve fuel efficiency, especially for vehicles that will continue to operate on biodiesel.



Recommendation 3: Renewable Energy Expansion

ISTW should focus on expanding its renewable energy initiatives by installing solar panels at Semarang, J1, and J2 plants, which together

consume a significant portion of electricity and contribute notably to operational emissions. Potentially, ISTW could explore a leasing arrangement with an Independent Power Producer (IPP), which could provide the capital to install solar panels on ISTW's facility rooftops.

In light of the recent regulatory changes under Minister of Energy and Mineral Resources Regulation No. 2/2024, which allows for greater flexibility in the installation of rooftop solar systems, ISTW has an opportunity to scale up its renewable energy efforts. The updated regulations remove the previous 100% limit on the capacity of solar installations, enabling ISTW to utilise available PLN quotas for larger installations.

Currently, ISTW's Cikarang plant uses a direct purchase model for solar energy, while other plants could consider a leasing arrangement to save costs. For instance, companies like SUN Energy offer lease systems where users pay a monthly rate based on kWh usage, typically 6% – 11% lower than PLN rates. This model is popular among companies in Indonesia as it requires zero capital expenditure (capex), making it a more cost-effective option decided at the tender stage for solar panel installations.

ISTW can benefit from reviewing energy efficiency and emissions reduction initiatives implemented by similar industries, as shown in **Table 12**. In summary, similar industries are adopting diverse energy efficiency and emissions reduction measures, including upgrading equipment, implementing renewable energy sources, and transitioning to electric and hybrid vehicles. These initiatives demonstrate practical pathways for ISTW to enhance its environmental performance through technology upgrades and renewable energy adoption. Therefore, ISTW can identify effective strategies that align with its sustainability goals and operational needs by leveraging these examples.

Table 12. Industry examples of energy efficiency and emissions reduction efforts

Company Name	Energy Efficiency Efforts	Emissions Reduction Efforts
SPINDO	<ol style="list-style-type: none"> 1. Enhance operational effectiveness through machine and equipment maintenance. 2. Maintain vehicles and operational tools as per procedure. 3. Utilise solar cells as alternative electric energy. 4. Replace lamps with energy-saving alternatives. 5. Conduct energy conservation awareness sessions for employees. 	<ol style="list-style-type: none"> 1. Implement solar cells as alternative energy in Unit 4 and Unit 6. 2. Improve productivity in Galvanized 302 to reduce gas usage. 3. Use electric conveyances for Plate Cutting Machines to limit forklift usage. 4. Plant trees to offset operational carbon emissions.
Maruichi Steel Tube Ltd.	<ol style="list-style-type: none"> 1. Upgrade boilers and hydraulic units with high-efficiency systems. 2. Switch plant equipment, like pumps, to inverter technology. 3. Transition lighting to LEDs across all plants, completing by 2023. 	<ol style="list-style-type: none"> 1. Promote energy conservation, switch from kerosene to LNG, and install solar panels. 2. Upgrade company cars to electric vehicles. 3. Use high-tensile steel in Maruichi Handy Pipe STK700 to reduce CO₂ emissions in production and transport.

Company Name	Energy Efficiency Efforts	Emissions Reduction Efforts
Borusan Mannesmann	<ol style="list-style-type: none"> 1. Use RS30-2 welding machines, which consume 15% less energy. 2. Optimise SRM Cooling Tower to achieve 30% energy savings. 3. Replace exterior lighting with LEDs in all factories. 4. Optimise annealing furnaces and boilers. 5. Monitor energy efficiency with ISO 50001. 	<ol style="list-style-type: none"> 1. Use renewable energy with IREC-certified electricity and plan a Wind Power Plant. 2. Incorporate electric vehicles in logistics to reduce emissions. 3. Turn off SRM panel room fans to achieve a 9-ton CO₂ reduction annually.
APL Apollo	<ol style="list-style-type: none"> 1. Increase mill speed from 20 to 34 MPM to reduce energy and boost production by 70%. 2. Install programmable logic controllers for speed control on motors. 3. Replace conventional lighting with LED in all locations. 	<ol style="list-style-type: none"> 1. Establish an independent 8.3MW wind power plant and install 16.5MW solar power. 2. Switch from furnace oil to KOG as a more sustainable energy source.
Tenaris	<ol style="list-style-type: none"> 1. Replace natural gas-fired furnaces with induction-based options. 2. Modernise equipment and revamp furnaces. 3. Upgrade heat treatment furnace with hydrogen-ready burners at Dalmine mill. 4. Install Consteel® technology at Siderca mill for efficient raw material charging. 	<ol style="list-style-type: none"> 1. Operate a 103 MW wind farm and plan a new 94 MW wind farm. 2. Develop 11-MW onsite solar projects at Arcore and Sabbio. 3. Use recycled steel scrap in electric arc furnaces, reducing emissions by 37% compared to the global steel industry average.

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