MARKET REPORT

SUSTAINABLE STEEL IN THAILAND

REUSE & RECYCLE

RECYGLO THAILAND

RECYGLO 's mission is to process materials in a safe, non-hazardous manner with an aim to keep the world environmentally clean; promoting sustainable development and implementing circular economy in order to create a more resilient future for all; helping businesses and individuals minimize their environmental impact through effective solutions.

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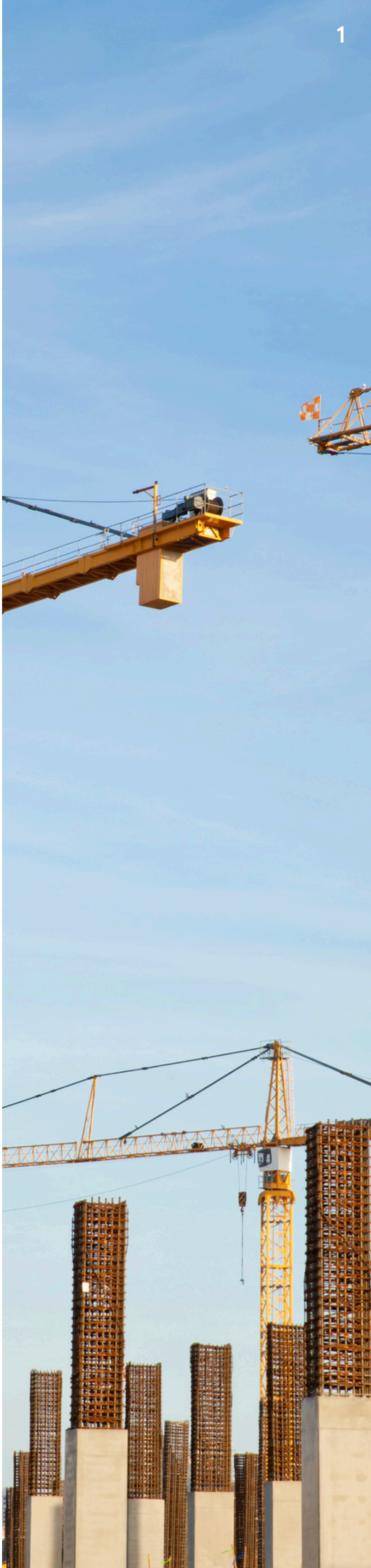
EXECUTIVE SUMMARY

The global steel market is experiencing significant trends that are shaping the future of various industries, including construction. In recent years, the steel industry has faced negative trends due to challenges stemming from the pandemic recovery, geopolitical tensions, and the global push for sustainable development. In **Thailand**, the **construction market** is a major consumer of steel, heavily influencing the country's steel market dynamics. As Thailand continues to develop its infrastructure, demand for steel remains high despite challenges related to resource dependency and environmental impact.

One promising approach to addressing these challenges is the adoption of the **Circular Economy (CE)** concept. Unlike the traditional linear economy, which follows a "take-make-waste" pattern, CE aims to ***reduce waste and maximize resource efficiency.*** This can be achieved by keeping products, materials, and resources in use for as long as possible through **reuse and recycling.**

This market report explores the steel industry with a particular focus on the reuse and recycling of steel in Thailand. By exploring these practices, **RecyGlo Thailand** aims to provide insights into how Thailand can enhance its steel industry sustainability, reduce environmental impact, and promote economic growth within the framework of CE. Through this report, we will define the benefits, challenges, and opportunities associated with the reuse and recycling of steel, ultimately supporting Thailand's national sustainability objectives and reinforcing its global competitiveness in the steel industry.



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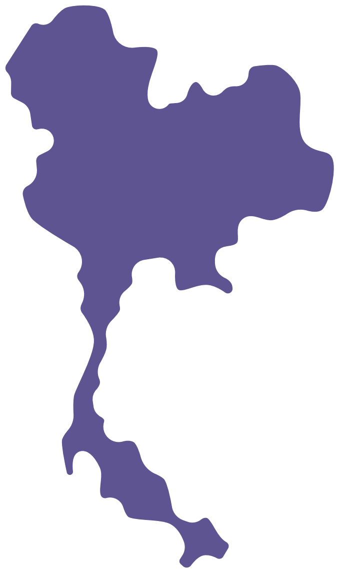
INTRODUCTION

2.1 OVERVIEW



Steel has historically been a foundational material for modern society, serving as a critical input in the production of numerous consumer goods essential to economic growth and health, including the **construction, automotive, electrical appliances, and packaging sectors** (Mahattanalai, 2019). Thailand, possessing limited raw material resources, produces minimal iron ore and predominantly depends on imports. In recent years, **more than 60% of Thailand's steel consumption has been reliant on imported steel.** In 2022, the nation consumed approximately 16.39 million tons (Mt) of steel. However, domestic steel production accounted for only 7.1 Mt, necessitating imports amounting to 10.78 Mt. Within Thailand, flat steel products are the most consumed, with domestic demand for flat steel largely met through imports, which constitute 70-75% of the total imported steel (*Thailand Steel Industry Research Report 2023-2032*, 2023).

2.2 CONCEPT OF CIRCULAR ECONOMY

A circular economy (CE) is an economic system designed to reduce waste and maximize resource efficiency. Unlike the conventional linear economy, which follows a "take-make-dispose" pattern, CE strives to keep products, materials, and resources in use for as long as possible through methods such as reuse, remanufacturing, and recycling. The aim is to **establish a closed-loop system** where **waste is minimized, and resources are continually circulated within the economy.**

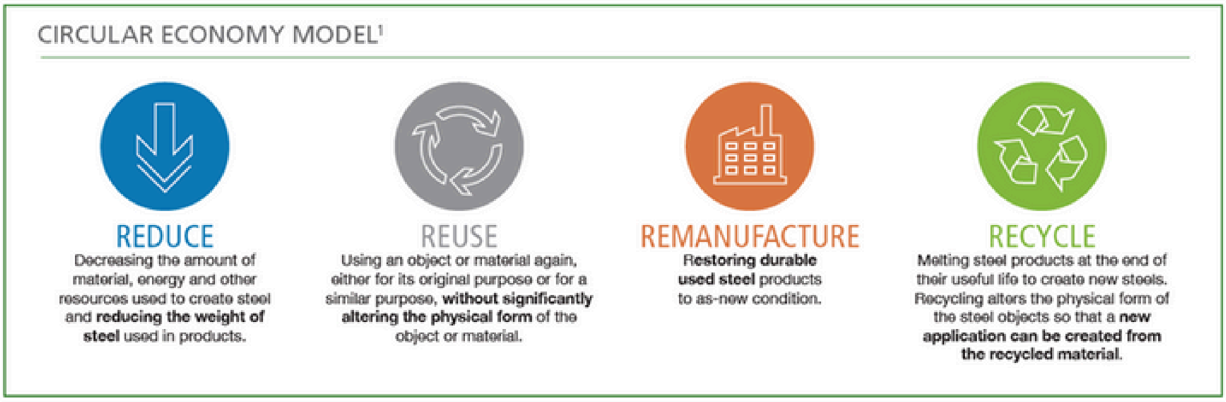


Fig. 1. Circular economy model in the steel industry

In **Thailand**, the steel industry plays a crucial role in supporting the construction, manufacturing, and infrastructure sectors. However, it is a resource-intensive industry that contributes significantly to environmental challenges, particularly in terms of carbon dioxide emissions, resource consumption, and waste production. By adopting CE principles, Thailand's steel industry can lessen its environmental impact, promote sustainable economic growth, and aid in global climate change mitigation efforts. This strategy not only supports Thailand's national sustainability objectives but also strengthens the steel industry's competitiveness and resilience in the global market

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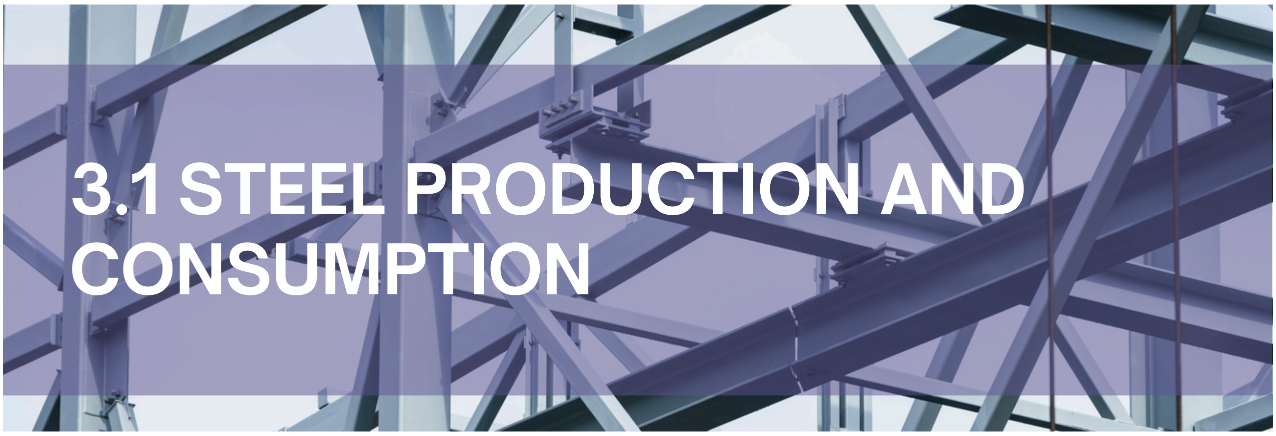
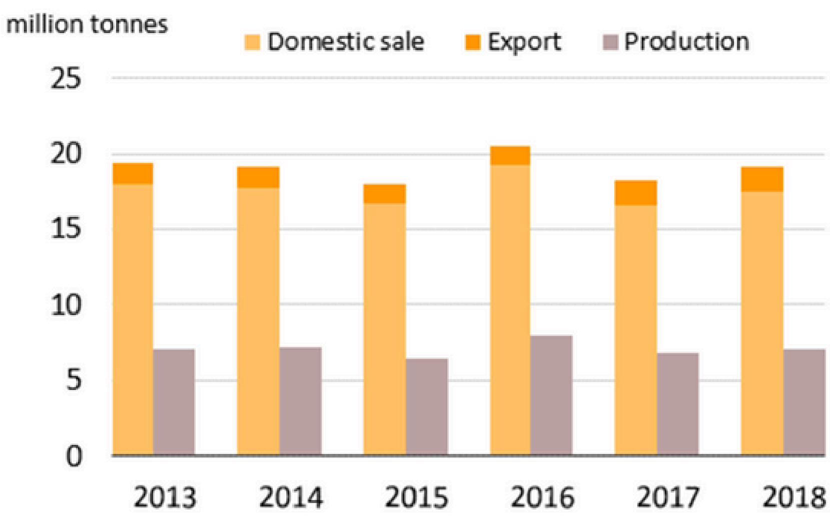
CURRENT STATE OF STEEL INDUSTRY IN THAILAND



3.1 STEEL PRODUCTION AND CONSUMPTION

Steel production comprises three essential stages: raw material extraction and processing (upstream), steelmaking and casting (midstream), and the finishing and distribution of steel products (downstream). In these processes, raw materials such as iron ore and coal are processed, converted into steel, shaped into semi-finished forms, and ultimately rolled and fabricated into finished products for use across various industries. In **Thailand**, **there is no domestic upstream steel production due to environmental and health concerns** for nearby communities, coupled with the **high investment costs** that make achieving profitability challenging. Therefore, most of the iron and steel productions are midstream and downstream industries which import semi-finished steel products such as slabs, blooms and billets etc. from foreign countries (Juntueng et al., 2016). Thailand's steel production, which primarily employs **the electric arc furnace (EAF)** process, has an annual capacity of approximately 10 million tons (*Thailand Steel Industry Research Report 2023-2032*, 2023). The majority of Thai steel products are consumed domestically rather than exported, with the domestic market and export ratio standing at 91:9 (Fig. 2).



Source: ISIT (as of December2018)

Fig. 2. Steel sale, export and production of Thailand

The **construction sector** dominates steel consumption in Thailand, accounting for 57% of nationwide usage, particularly in products like rebar, structural steel, and fasteners. Other significant sectors include automotive manufacturing (18%), electronic appliances (9.2%), and machinery (11.1%) (Mahattanalai, 2019). The rising demand for steel was **primarily driven by the development of various infrastructure projects**, particularly those in the real estate sector (Juntueng et al., 2016).

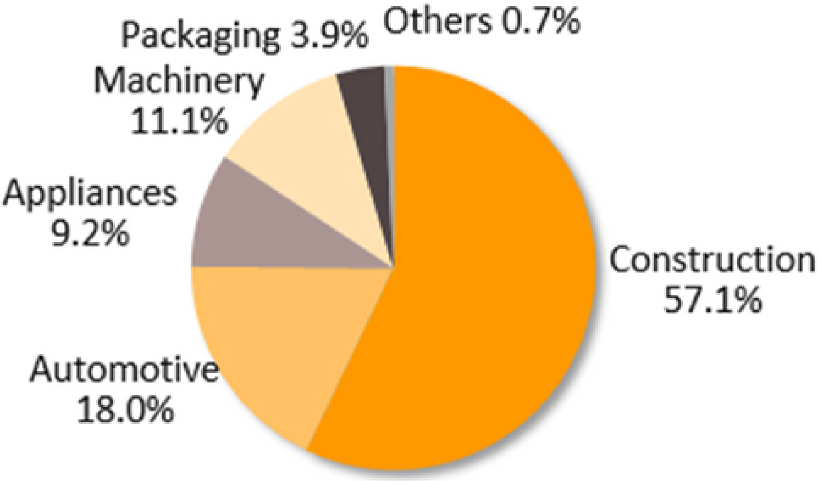


Fig. 3. Steel consumption in Thailand by sector
Source: Iron and Steel Institute of Thailand (ISIT)

However, Thailand's steel consumption is **increasingly reliant on imports**, with over 60% of steel needs being met by foreign sources. This dependence has risen from 62.3% in 2018 to nearly 66% by 2022, primarily due to the high costs of locally produced steel and an inadequate product range (*Thailand Steel Industry Research Report 2023-2032*, 2023). **China and Japan** are the leading exporters of steel products to Thailand. Chinese exports mainly consist of long products such as **rebar**, which are more cost-effective than their Thai counterparts. On the other hand, flat steel products, including **hot and cold rolled steel**, are predominantly imported from Japan. These high-grade products are specified by Japanese-owned vehicle and parts manufacturers in Thailand, as local manufacturers often cannot meet the stringent quality standards required (Mahattanalai, 2019).

3.2 USAGE OF STEEL IN CONSTRUCTION

In Thailand, the construction sector is the **largest consumer of steel**, which is extensively utilized across a range of construction projects, including high-rise buildings, bridges, stadiums, industrial facilities, and other infrastructure endeavors. Steel is one of the important materials of the construction sector and according to the Office of Industrial Economics (OIE), the amount of steel usage in the construction sector can be seen in Fig. 4 (Lunkam, 2021).

The material's versatility, strength, durability, and cost-effectiveness render it an optimal choice for various construction applications. A principal factor contributing to the widespread use of steel is its remarkable **strength**, which enables structures to support significant loads and endure challenging weather conditions. Additionally, steel's **resilience to natural disasters**, such as earthquakes and floods, further enhances the safety and longevity of constructions in Thailand. This attribute is particularly valuable in a country vulnerable to seismic and flood risks, ensuring that steel structures **maintain their integrity and functionality over time.**

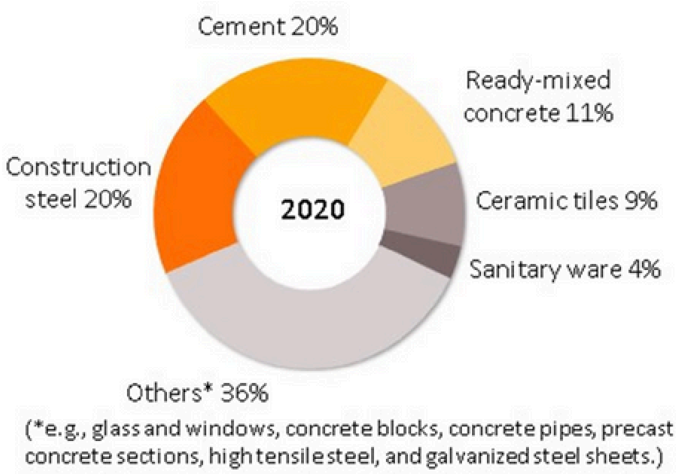


Fig. 4. Steel consumption in construction
Source: Office of Industrial Economics (OIE)

3.3 CHALLENGES OF LINEAR ECONOMY PRACTICES

The **linear economy model**, often summarized as "take-make-dispose," refers to a traditional approach where raw materials are extracted, processed into products, and eventually discarded as waste after their useful life (*Steel and the circular economy*, n.d.).

Linear Economy

Several significant challenges arise from the usage of this model in steel industry such as: **resource extraction, production, and waste.**

Resource Extraction

The raw material needed in production of steel is **iron ore** and it is obtained by **mining and quarrying** which creates several impacts to the surroundings as mentioned below:

<table>
<tr><td>Site clearing</td><td rowspan="2">• Deforestation due to cutting of trees and bushes within the site area
• Impact on the fauna and flora species such as affecting their habitat
• Gaseous emissions from use of machineries and vehicles during the whole extraction process
• Visual impact and surface disturbance due to excavating earth surface (land degradation)
• Noise pollution around the area
• Groundwater pollution
• Temporary surface water pollution due to extraction process</td></tr>
<tr><td>Mineral exploration</td></tr>
<tr><td>High demand for raw materials</td><td>The depletion of natural resources leads to habitat destruction and biodiversity loss.</td></tr>
</table>

Production

High energy consumption	• The entire steelmaking process is energy-intensive and **requires a large amount of fossil fuels** • Although most Thai steel manufacturers use EAF (electric arc furnaces), the electricity generated from fossil fuels **contributes to greenhouse gas (GHGs) emissions**
Noise pollution	Machinery and equipment operation such as metal smelting, welding, cutting can generate significant **noise** pollution.
Air pollution	The production process emits particulate matter (PM), sulfur dioxide (SO2), nitrogen oxides (NOx), and volatile organic compounds (VOCs) and GHGs that contribute to **air pollution, climate change** and have **adverse health effects**.
Water pollution	As steelmaking requires high quantities of water, wastewater contains heavy metals, chemicals, and other pollutants, which, if not treated properly, can **contaminate local water bodies, harming aquatic life and human health**.
Waste generation	The steel industry generates waste like slag, dust, sludges, used refractories, and oil residues. When these cannot be recycled or sold, they are **dumped in landfills**. Improper waste management at disposal sites risk **leaching harmful substances** like hydrocarbons, salts, sulfur compounds, and toxic heavy metals.

Waste

In a linear economy, the focus is on the production and disposal of steel products, with limited emphasis on recycling and reuse. This leads to a **loss of valuable materials** that could otherwise be repurposed, resulting in inefficiency and a higher environmental burden. Disposing of steel products in landfills not only wastes the embodied energy and resources used in their production but also **occupies land that could be used for other purposes**, leading to environmental degradation and potential contamination of soil and groundwater.

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REUSE OF STEEL IN THAILAND

4.1 BENEFITS OF STEEL REUSE

As cost rises and resources are exhausted for steel production, an emerging sector of steel reuse and recycling emerges to supplement the market. In general, steel reuse can be defined as **steel products and materials that are taken from the waste stream and reused in their original form with minimal reprocessing** such as **steel beams** (BioRegional, 2008). Fig. 5 provides a visual understanding of the process of how steel can be reused upon deconstruction or demolition (C1) to supplement the fabrication of steelworks (A3). In this way, reusing it can definitely avoid the steel from returning to the steel mill which risks higher carbon emissions associated with producing new steel.

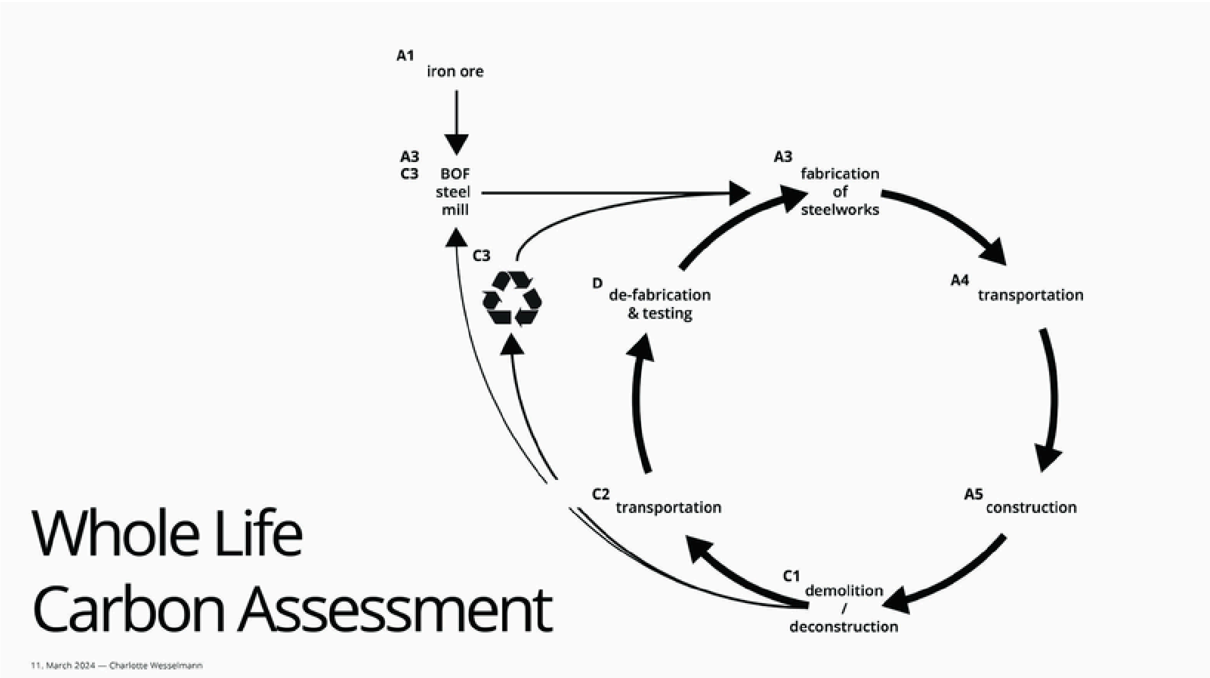


Fig. 5. Whole life carbon assessment of steel reuse
Source: ...

As portrayed by Fig. 6, BRE Environmental Profiling shows a **96% environmental impact saving** by reclaiming and reusing 99 tonnes of structural steel. Although new steel sections typically contain 60% recycled content, the environmental impact is reduced 25 times in comparison to reclaimed and reused steels.

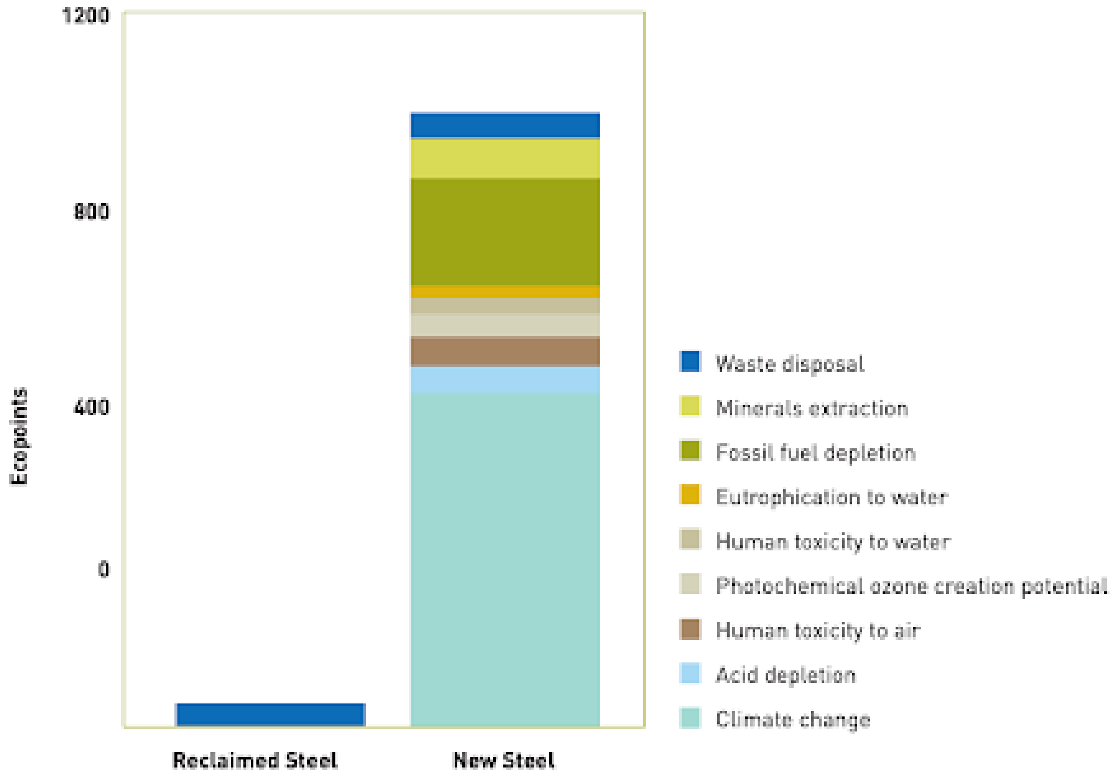


Fig. 6. Environmental impact saving of using reclaimed (reused steel) against new steel
Source: BioRegional

One primary benefit of reusing steel is that it can **significantly reduce environmental impact.** In comparison with producing a new steel, reusing parts of steel can **protect the environment by up to 96% from damages** (BioRegional, 2008). The primary motivation for engineers and clients considering steel reuse is the environmental benefits, including energy savings and reduced carbon impact. While these environmental advantages are substantial, they may not be enough to overcome the challenges, particularly the increased project costs (BioRegional, 2008).

For instance, **1 tonne of reused steel saves the same amount of carbon dioxide as 2 m² of photovoltaic panels over their typical 20-year design life**.

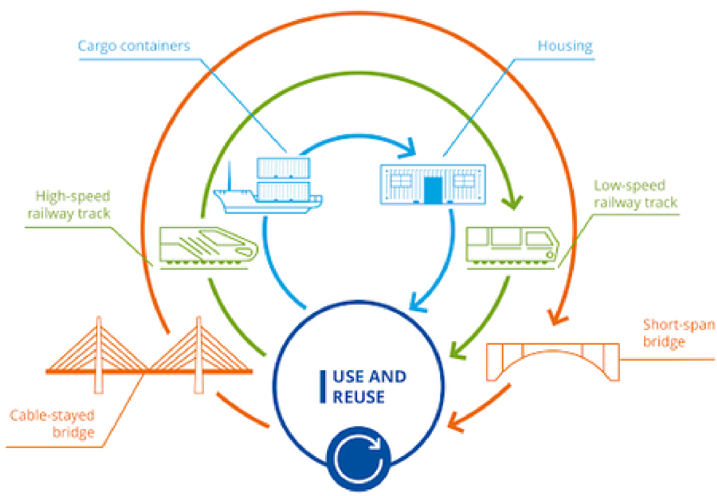


Fig. 7. Reuse cycle of steel
Source: World Steel Association

However, this comes with significantly different upfront costs. ***1 tonne of reused steel saves 1.8 tonnes of carbon dioxide emissions*** and is usually cheaper than new steel. Even with a 20% premium cost, the extra cost is about £140 per tonne. In contrast, 2 m² of photovoltaic panels, operating at optimal performance for 20 years, also saves 1.8 tonnes of carbon dioxide but costs between £500 and £1,000 per m².

In addition, reusing steel has been proven to also **reduce embodied carbon by 80%** compared to traditional procurement methods (Symmetrys, 2022). This reduction is greater than what can be achieved when recycling steel, as reusing steel does not require the energy-intensive process of re-melting and re-forming in electric arc furnaces. Although 98% of steel is being recycled, 63% of that steel is still using virgin steel (Symmetrys, 2022).

Therefore, reusing steel helps reduce demand for new steel. Current **estimates suggest that reused steel is cheaper than new steel,** though more research needs to be done to confirm the assumption of its cost saving benefits.

Nonetheless, the reuse of old steel from previous or abandoned projects should be implemented since it would help mitigate **unnecessary energy consumption required to mine, melt, and produce new steel,** and would help to minimize harmful air and water emissions as well. The lifespan of existing steels can be extended and small- and large-scale steel products can be repurposed for other secondary uses; for example, steel cargo containers can be repurposed to form homes or shelters, whereas high-speed railway tracks can be reused to path low-speed railways instead (World Steel Association, n.d.).

4.2 SECOND-HAND CONSTRUCTION MARKET

According to Arizton Advisory and Intelligence (2023), the **Southeast Asia second-hand construction material market was valued at USD 1.01 billion in 2022** and is **projected to reach USD 1.47 billion by 2029**, growing at an annual rate of 5.48%.

Second-hand construction materials, which include leftover materials, items sold after bankruptcies, and old materials from past constructions, are often **cheaper** and can be of **good quality**. However, the COVID-19 pandemic has disrupted the supply chain, reducing the use of these materials. Most used building materials come from decommissioned commercial buildings, not homes, and their prices vary based on condition, purchase time, and use, making them harder to price accurately.

THAILAND'S SECOND-HAND CONSTRUCTION MARKET

In **Thailand**, the second-hand building construction market is *close to non-existent*. Most **foundations** and organizations in Thailand that accept and donate second-hand items often accept daily necessities to help individuals and families who are less fortunate and do not have access to financial institutions.

The Habitat for Humanity Thailand foundation that was established in 1998 helps homeowners to build, repair, or renovate houses with new or second-hand construction materials that are **donated from the government or the public.**

The process is not free-of-charge, nonetheless, homeowners are able to donate and return how much they can to pass on the opportunity to others in need. Additionally, the ***construction materials cannot be hand-picked or selected*** as the foundation focuses primarily on the reparation of homes instead (Poaulai, 2022).

On the other hand, the Suan Kaew Foundation (established by Suan Kaew Temple in 1993) located in Nonthaburi province exclusively **focuses on the collection and donation of second-hand construction materials in Thailand**. It was reported that the foundation has adopted a policy of accepting donations of second-hand construction items or collecting leftover items that donors across the country have discarded.

Subsequently, the foundation then **sells the items at a cheaper price** to help reduce expenses for those with low incomes while effectively reducing waste. The foundation has found that second-hand construction materials are another channel for low-income earners in that they are able to use the materials for the construction, renovation, or repair of their own residences at an affordable price.

Furthermore, the collected second-hand construction materials cannot be reserved in advance since each donated material pile differs daily based on the source.

The foundation collects and sells second-hand materials that include **wood, windows and doors, aluminium windows, accessories, floor tiles, roofing tiles, sanitary ware, and miscellaneous items.** Certain **doors, roofing tiles, poles, and structural frames contain steel.**

However, several challenges were faced by homeowners who purchased the second-hand construction materials, which include poor material fitting and subsequent deterioration over time. For instance, second-hand roofing tiles were reported to fit incorrectly which led to unequal tile stacking and required further repair 2-3 years after installation (Poaulai, 2022).

Additionally, second-hand construction materials can also be purchased via **online business-to-consumer (B2C) marketplaces** such as Facebook.

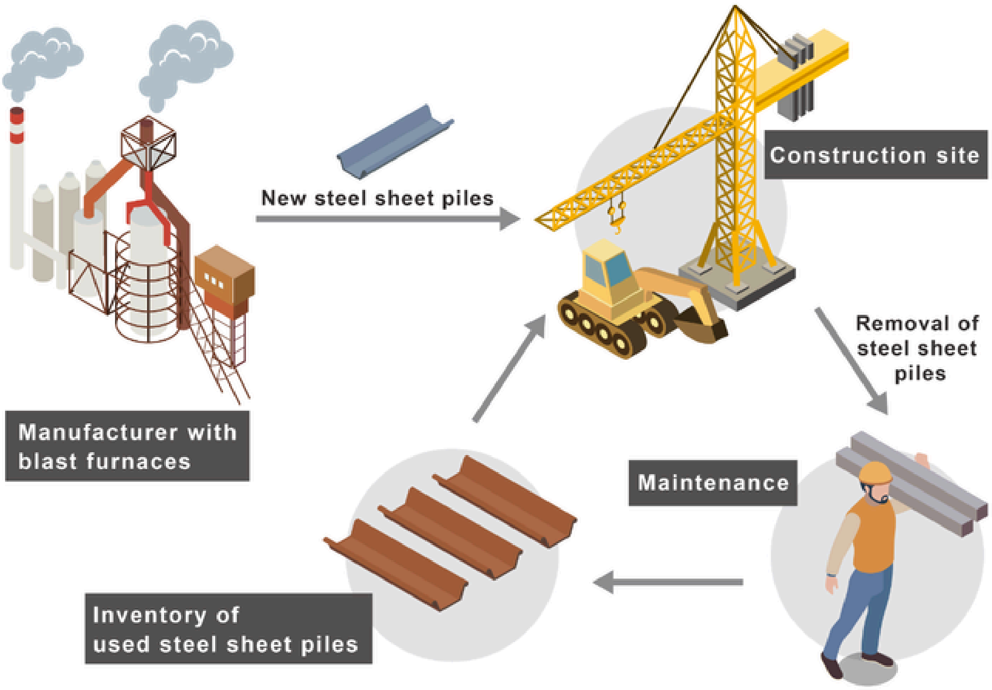


Fig. 8. Cycle of steel sheet production for construction
Source: Hanwa Japan

4.3 CHALLENGES AND OPPORTUNITIES

Tingley and Davison (2011) identify several barriers to steel reuse and building deconstruction, including **health and safety concerns and time constraints** when deconstructing existing buildings. Placing more value on existing structures could allow for earlier identification of reuse potential, giving more time for deconstruction. Technical challenges arise from traditional welded shear studs, which make salvaging beams difficult, but using bolted connections could help, though it would be **labor-intensive and costly.** Automating the deconstruction process could alleviate this. Additionally, ***sourcing steel, the cost of reuse, and re-certification are practical challenges*** noted from discussions with design teams and literature reviews (Tingley and Davison, 2011).

There is **uncertainty about the costs** of reusing steel, partly due to lack of experience in specifying reused steel. Perceived risks of project delays also add to the cost. Deconstruction of existing structures takes slightly more time than demolition, which, if planned early, should not impact the project schedule but will incur additional labor costs.

For instance, in the Smith and Wallwork Engineering project, deconstruction is estimated to take 10 days, with extra time for re-fabricating elements into new trusses. Deconstruction labor costs are quoted at £2,000 more than demolition, with additional costs for shot blasting the salvaged steel. This makes the reuse option about 25% more expensive, posing a significant barrier. Nonetheless, it was estimated that the **reuse of steel is only at 6% as compared to 93% of being recycled as the industry prioritizes recycling over reusing the steel materials.**

EXPLORING OPPORTUNITIES IN THE REUSED STEEL INDUSTRY

The risks and uncertainties of reusing structural elements from end-of-life buildings can be mitigated by **adopting advanced digital technologies** (Çetin et al., 2021).

However, the *construction industry faces a bottleneck due to its low level of digitalization*, being the least digitized sector (McKinsey & Company, 2016).

Addressing some of these barriers requires a multi-criteria decision-making framework to evaluate the reuse potential of structural elements, considering **logistics, structural performance, life cycle, economic assessment, and safety.**

Advanced digital technologies can facilitate reuse by automating parts of the pre-demolition audit and reuse assessment procedures, reducing costs, and increasing reliability.

Another significant potential to support and achieve circular economy goals is the adoption of Artificial Intelligence (AI) in reusing steel. The Ellen MacArthur Foundation (2021) highlights several opportunities for AI to enhance material circulation within the economy, particularly through the use of AI algorithms that recognize and identify objects with cameras and sensors. AI can impact the circular economy of the steel industry in three main ways:

Automated Assessment

AI can conduct automated condition assessments of used steel and provide recommendations on whether they can be reused, resold, repaired, or recycled to maximize value preservation.

Automated Disassembly

AI can manage the automated disassembly of used steel, adjusting disassembly equipment settings based on the steel's condition and position.

Sorting

AI can sort post-consumer mixed material streams using visual recognition techniques combined with robotics.

Additionally, reusing steel can offer a plethora of **job opportunities** for the working-age population in Thailand, such as metal scrap collection, separation, and logistics jobs. This is because long-lasting and high quality steel products can be reused repeatedly while raw steel materials are conserved for future use. 1 tonne of recycled steel can save up to 1,400 kg of iron ore, 740 kg of coal, and 120 kg of limestone on average, which indicates that the reuse and repurpose of existing steel products can help to reduce the excessive usage of limited natural resources (World Steel Association, n.d.). Hence, steel is a material that can be implemented in the **Circular Economy (CE) model** which will be discussed in the following section.

05

STEEL RECYCLING IN THAILAND

5.1 OVERVIEW OF STEEL RECYCLING PRACTICE

Steel is a crucial raw material that is widely used in the production of many consumer goods and items (Mahattanalai, 2019). In Thailand, the steel industry includes three levels of categorization: namely **crude steel, semi-finished steel, and finished steel products** (Fig. 7). Slabs produced from **semi-finished steels** are often used to create flat products which include hot-rolled, cold-rolled, and galvanized steels (Tongpool et al., 2010).

Although the demand for steel is high in Thailand due to its prosperous industrial sectors and practices, the **problem of steel waste and recycling is on the rise.** The production of new steel is energy-intensive and involves the emission of greenhouse gasses that are harmful to the environment and human health (Tongpool et al., 2010).

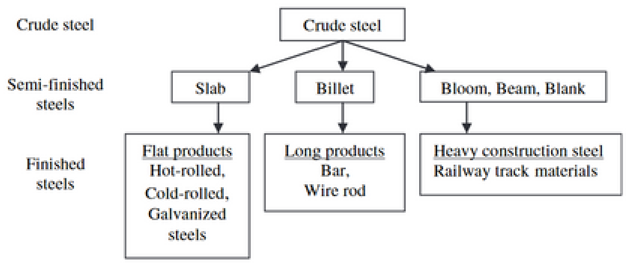


Fig. 9. Steel industry categorization
Source: Tongpool et al.

Since the early 2000's, the production, consumption, and recycling of steel and scrap metal has been on an upwards trend, however, the **limited amount and supply of scrap metal cannot meet its demand worldwide** (*Recycling and reuse*, n.d.). Additionally, the global consumption of scrap steel in key regions such as China, Europe, and Japan has been on a downwards trend (Willeke, 2024). **Steel demand is the greatest in developing economies in order to supply the creation of infrastructure and buildings, such as in Thailand.** Thus, **steelmaking from iron ore remains a necessary step due to the lack of scrap metal** (*Recycling and reuse*, n.d.).

Examples of steel products that are recycled include but are not limited to **vehicles, rails, turnings, and cast iron** (Norstar, n.d.). Currently, **there are few to none initiatives that recycle or reuse old steel in Thailand** aside from the waste management of scrap metal for import and export. **Steel recycling** requires the **melting of old steel or scrap metal** through the use of furnaces, which is an **energy-demanding process** similar to the production of new steel. Hence, the **reuse of old steel from previous or abandoned construction projects should be considered** in order to minimize the impact on the environment, especially if the quality of old steels are well-maintained and are in good condition.

5.2 ENVIRONMENTAL AND ECONOMIC BENEFITS

The drawbacks of **new steel production** via the steelmaking process includes **high energy input and costs**, as well as the **negative impact on the environment**. For instance, many Thai steel mills or melt shops incorporate **scrap metal** as the primary source of steel, and manufacturers without a furnace must purchase steel which incurs greater material costs. Alloys are often combined during steelmaking to help minimize raw material expenses that make up 47.1% of total costs (Taghipour & Akkalatham, 2021).

Moreover, the **environmental impact and waste generation from steelmaking is severe**, and it is without a doubt that waste management generation and disposal requires better upstream management and behavioral change from its people. Only 53% of the total solid waste collected is properly handled via waste disposal facilities or incineration by the local government, whereas the remaining **47% of total waste (6.93 million tons) is disposed of by open dumping**, and approximately **13.5 million tons of waste is disposed of illegally each year** (Taghipour & Akkalatham, 2021). Notably, in **Nonthaburi** province, only 22% of solid waste was reported to be recycled, whereas the remaining **78% of waste was disposed of in landfills and open dumps** in 2006. This further increased to nearly 25% in 2010 due to community participation in the Kitakyushu Initiative Network Program that helped to increase recycling awareness and reduce solid waste (Menikpura et al., 2011).

Steel waste is handled by steel recycling which involves the **remelting of end-of-life scrap steel** to generate new steel. This can be achieved since steel is a **durable** material that can be recycled and remelted multiple times **without losing its integral properties**. Additionally, steel is **magnetic** which allows it to be **easily separated and recovered** from other waste. The new steel retains the physical properties of the original steel, however, the purpose of the **new steel is more specific and aligned to its new task**. In general, all available steel is sourced from recycled steel in a closed material loop cycle (World Steel Association, n.d.).

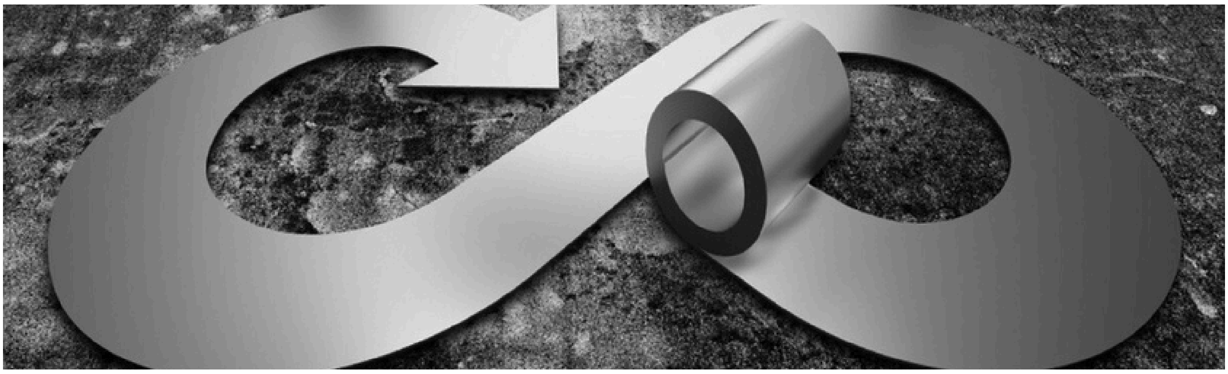
Although steel recycling requires the use of energy-intensive furnaces to remelt scrap steel, it should not be ignored that **steel recycling avoids or limits the use of iron ores and virgin steel**, which is **beneficial for the environment** and helps to **preserve natural resources** for future generations. In **2021**, 680 million tonnes (Mt) of steel was recycled – this helped to **mitigate the production of more than 1 billion tonnes of carbon dioxide emissions into the atmosphere** (World Steel Association, n.d.). Likewise, similar statistics were reported in **2023** where 630 Mt of recycled steel **prevented the generation of almost 950 Mt of carbon dioxide emissions** (Willeke, 2024).

Additionally, the **creation of new jobs** in the steel recycling sector can help to **drive economic growth** since steel recycling companies require workers and employees to run operations. In turn, this also allows for the generation of related jobs in other sectors, such as scrap collection, transportation, and management. The establishment of steel recycling ventures can **positively contribute to the gross domestic product (GDP)** of a country. In **2023**, **24,507 new jobs were created in the recycling industry** which reflected a 0.5% increase in employment growth rate in the U.S. (Pritchard, 2023).

5.3 INTEGRATION WITH CIRCULAR ECONOMY

Circular Economy (CE) is a business model that can be applied to many consumer products and services, which can therefore **create opportunities for change and sustainable business growth** (Taghipour & Akkalatham, 2021). CE can be accomplished through **resource management** and the **recycling of materials for reuse**, resulting in **minimized waste generation that can eventually lead to zero-waste**. The CE model can be applied in the steelmaking industry through the reuse and recycling of old steel if there is no need to produce new steels.

In **Thailand**, **waste management is the main CE practice** where scrap metal is collected, shredded, and **sold by exporters and importers** to and from other neighboring Asian countries. However, the steel shredding step is not regulated as it is not the responsibility of scrap metal producers, therefore, **scrap metal often ends up mixed together with solid waste** for disposal (Taghipour & Akkalatham, 2021).



A series of interviews with **67 Thai steel companies** showed that approximately **50% of companies found it difficult to sort scrap metal for recycling**, whereas 22% of interviewees did not have enough company finances to manage scrap metal. Meanwhile, **94% of the interviewed steel companies thought that CE was a worthwhile practice to implement**, while about 87% of participants were concerned about the environment. Lastly, approximately **93% of interviewed companies believed that the CE model would allow their companies to participate in the production of recycled steels** (Taghipour & Akkalatham, 2021).

5.4 ENVIRONMENTAL CHALLENGES ARISING FROM STEEL RECYCLING

Steel recycling faces many **environmental challenges** and **health hazards** which are presented in the table below. Although steel recycling has severe environmental concerns and drawbacks, the method should still be taken into account in order to **minimize the mining of new steel**. The **reuse of old steel is a zero-waste process**, however, remains mostly **situational** since reused steel cannot be repurposed for secondary usages in every sector. On the other hand, **steel recycling allows for scrap metal to be remelted and remolded to create more purposeful steel products**. Thus, both methods should be considered when venturing into new building and construction projects.

Environmental challenges	Causes
High impact on **fossil fuel use, global warming, ecotoxicity,** as well as the generation and leaching of minerals, carcinogens, and respiratory inorganics	Steel and **zinc** incorporation, especially in the downstream production of **hot-dipped galvanized steel** (Tongpool et al., 2010)
High energy and resource consumption, and **emissions** to the air, soil, and water	Use of traditional **blast furnaces, basic oxygen furnaces (BOF), or electric arc furnaces (EAF)** to melt scrap metal and old steel (Recycling and reuse, n.d.; Tongpool et al., 2010)
Human health hazard due to **dioxin and dust exposure** containing lead, cadmium, and chromium	Use of EAF to recycle scrap metal (Tongpool et al., 2010)

INSIGHTS FROM THAI INDUSTRY PLAYERS

"Recycling these scraps is beneficial not only because it reduces waste, but also because disposal can be challenging. By recycling, we can mitigate global warming and decrease our carbon footprint. It also cuts costs and conserves energy. There's no need to worry about using steel, as smelters have effective methods for separating and smelting it."

A LOCAL METAL RECYCLING COMPANY

"The price of steel has remained relatively stable after COVID-19, so the impact on the company has been minimal. While we haven't adopted any specific sustainability practices, we recycle steel by sending leftover materials back to the supplier after completing a project, where it is melted down and reused in other projects."

CONSTRUCTION COMPANY WITH 60 YEARS OF OPERATIONAL EXPERIENCE.

"We prioritize reusing any parts that can be reused, and recycle the rest. Our recycling supply chain involves various stages, such as disassembling, smelting, adding chemicals, and logistics, managed by different providers. We operate under strict compliance, holding all necessary licenses, ensuring zero landfill usage, proper reporting, and no burning of waste. With Thai new regulations, no new factories are allowed to dump waste from developing countries, and only a limited amount of hazardous materials can be disposed of, as most facilities are already at capacity."

ELECTRONIC WASTE RECYCLING PLANT

CONCLUSION

In conclusion, the **recycling of steel emerges as a more advantageous option than reuse in Thailand**, due to the inherent sustainability and scalability it offers. Even though reusing steel plays a valuable role in extending the lifespan of steel and is more energy efficient compared to steel recycling, it is often constrained by limitations such as the availability of sustainable materials, the integrity and safety of reused steel, and the necessity of meeting specific design standards in construction. On the other hand, steel recycling offers a more reliable solution by enabling the recovery of valuable materials from end-of-life products, reducing the demand for the resources, and significantly lowering environmental impacts associated with steel production.

Given Thailand's growing industrial and construction sectors, enhancing steel recycling practices is essential for sustainable development. Therefore, by prioritizing recycling, Thailand can mitigate the environmental impact of its steel industry, promote resource efficiency, and contribute to global efforts in combating climate change.

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