Decarbonization Roadmap of Krakatau Steel Toward Net Zero Carbon by 2060

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SYNOPSIS:

Indonesia has set ambitious national determined contributions (NDC) target to reach 29% CO_2 emissions reduction by 2030 in order to achieve net zero carbon by 2060. This target makes all sectors especially iron and steel industry, setting their strategy to zeroize CO_2 whose intensive energy user consumes 8% of global energy as well as produces 7% of emissions (Almost 2,6 $GTCO_2$) from total global emissions.

Krakatau Steel has had two routes for ironmaking process which are natural gas based (Direct Reduction Plant) and coal based (Blast Furnace Complex) that implicates flexibility in determining product competitiveness. Upon this flexibility, resulting more challenges to control emissions and achieve net zero carbon by 2060. From the internal study, Blast Furnace (BF) – Basic Oxygen Furnace (BOF) route contributes high specific emission than DR-EAF route, from direct emission contributes 2.29-tons CO_2/ton slab and from Direct Reduction (DR) – Electric Arc Furnace (EAF) route contributes 0.51-tons CO_2/ton slab.

Going forward, Krakatau Steel has been evaluating, assessing and deciding in the perspective of technology and economically viable way to reduce CO_2 in all routes, by short-long-term strategy. For the short-term strategy, KS has implemented the following initiatives e.g., utilization of coke oven gas for energy source in RHF, installing solar cell (embedded and floating) at plants, offices, warehouses and water reservoir which are able to potentially reduce ~24 kTon CO_2 p.a. Whereas for the long term strategy, KS has planned optimizing DR-EAF that potentially reduce ~1600 kTon CO_2 p.a, shifting natural gas based to hydrogen based Direct Reduction (~1800 kTon CO_2 p.a) and installing Carbon Capture for Blast Furnace (~975 kTon CO_2 p.a).

Keywords: Roadmap; Net-Zero Carbon; Iron & Steel; Blast Furnace; Direct Reduction; Renewable Energy

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I. Introduction

In line with the Paris Agreement, Indonesia is set the emission reduction target (law no. 16 of 2016, Confirmation of Paris Agreement UNFCCC) in Nationally Determined Contribution (NDC) by 29% (unconditional) and conditional target up to 41% of the business-as-usual scenario by 2030. The nationally determined contribution is included the mitigation aspect, adaptation and resources support (financial, ability to enhancement, and transformation of climate change technology) to prevent 2^{o}C increase in global average temperature and to pursue efforts to limit the temperature increase to 1.5^{o}C.

The government of Indonesia (GOI) also promulgated presidential regulation No. 22 of 2017 on National Energy Grand Plan which mandates the target of 23% New Renewable Energy (NRE) in national energy mix by 2025 and 1% reduction in energy intensity per year. As part of emission reduction and green economy, the GOI has officially promulgated Law No. 07 of 2021 on Harmonization of Tax Regulation which mandates carbon tax will be imposed on individuals or entities that buy good containing carbon and/or carry out activities that produce carbon emission.

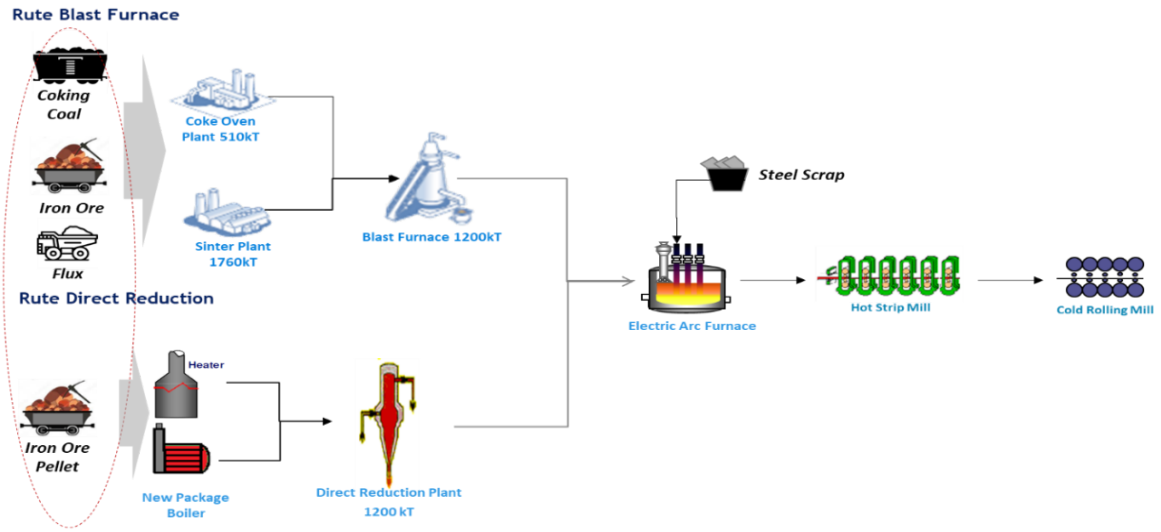
The industry sector contributed 26,81% of direct emissions and 11,85% of emissions from indirect electricity. To achieve the 1,5^{o}C target, the industry sector should reduce emission by 65% to 90%. The implementation of energy efficiency is the key to reaching Indonesia's NDC target. Policy for energy efficiency in industrial sector is focusing on government regulation that require industries with energy consumption greater than or equal 6,000 tons of oil equivalent (TOE) per year to implement energy conservation.

Steel production is energy intensive and produce a lot of emission, every year steel industries are consumed around 8% global energy and emit around 7% emission (2,6 GT CO_2). The carbon intensity from steel production in Indonesia at 2016 is reported around 1.656 kgCO_2/ton production. To facing these global issues and achieve the sustainability of business process, Krakatau Steel is set the strategy mitigation to reduce CO_2 emissions by carbon avoidance and/or carbon removal.

I. Production process and energy utilization

Krakatau Steel is an energy intensive user and emits a lot of CO_2 emissions from the utilization of fossil fuels, which also makes the cost of energy occupy the second rank in the cost structure. Realizing these issues, the GOI's policies and renewable energy sources is important to implement diversification of energy to anticipate the increasing cost of energy, raw materials, and production costs.

As an integrated steelmaker, Krakatau Steel has had 2 routes of ironmaking which are natural gas based (Direct Reduction Plant) and coal based (Blast Furnace



Complex), steelmaking plant, and rolling mill (Hot Strip Mill and Cold Rolling). The overview process is shown by this figure below.

Figure 1. Business process of Krakatau Steel

In normal operation (business as usual), the energy consumption was dominated by iron & steelmaking plant. But currently these plants (Blast Furnace Complex, DR Plant, Steelmaking Plant) are temporary stop, so energy consumption is dominated by rolling process (HSM & CRM) both for fuel and electricity. current energy consumption of Krakatau Steel shown by figure 2.

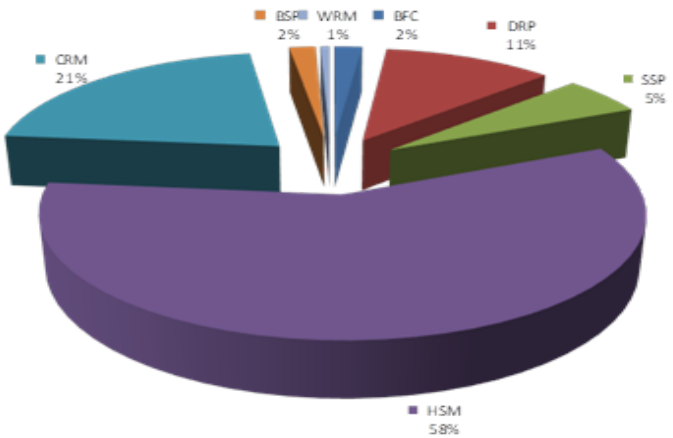
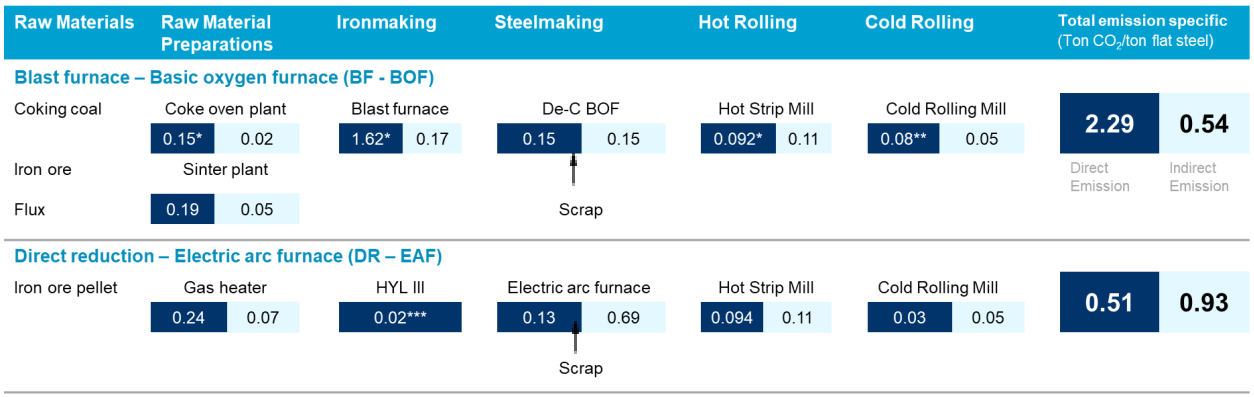


Figure 2. Structure of Energy Consumption 2021

(Source: Report of Audit Energy Krakatau Steel, 2021)

II. Emission figure of Krakatau Steel

In business as usual, CO_2 emissions are mostly produced by the Blast Furnace process because of the utilization of coal as the main fuel (2,29 tCO_2/ t flat steel and 0,56 tCO_2/ t flat steel) for direct emission. Compared to Blast Furnace process, the DR Plant process produced lower emissions for direct emission 0,51 tCO_2/t flat steel and indirect emission around 0,95 tCO_2/t flat steel.



Source: Internal study of Krakatau Steel, 2021

Figure 3. Emission figure by route of ironmaking

As mention before, the iron and steelmaking plant are temporary stop and emission is produced by rolling process. Sample calculation from flat product at hot strip mill number 1 and 2 by considering scope 1, 2, and 3 the emission mostly contributed by scope 3 which are coming from slab purchasing. To reduce scope 3 emission, Krakatau Steel needs to work closely with its supplier. The emission figure is shown by figure 4.

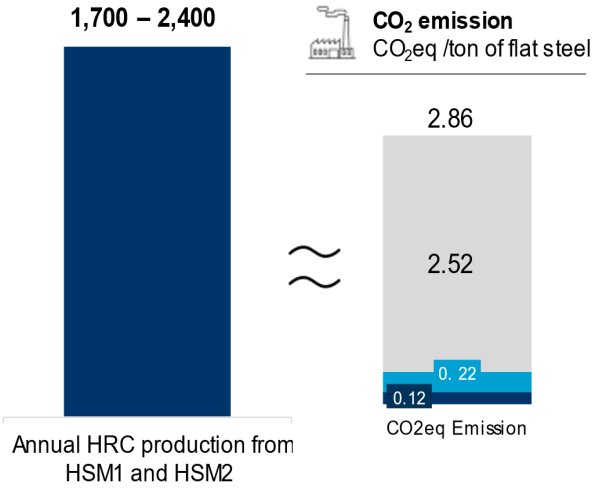


Figure 4. CO_2 emission per ton of flat steel

III. Benchmarking of Net-Zero Emission Technology

As the core pillar of today's society, steel industry needs to meet the effective and economically viable way to cope with pressure to reduce its carbon emission. Currently the steel industry is among the three biggest producers of carbon dioxide, steel plants are therefore a good candidate for decarbonization.

For short term transition, improving the performance of technology by conventional routes and reducing demand through efficient use of materials play an important role with the contribution of 90% of the emission reduction by 2030 in the Sustainable Development Scenario. For the medium and long term, Carbon Capture Utilization and Storage (CCUS) technology and the fuel shift from coal to natural gas, hydrogen, and bioenergy play a more dominant role.

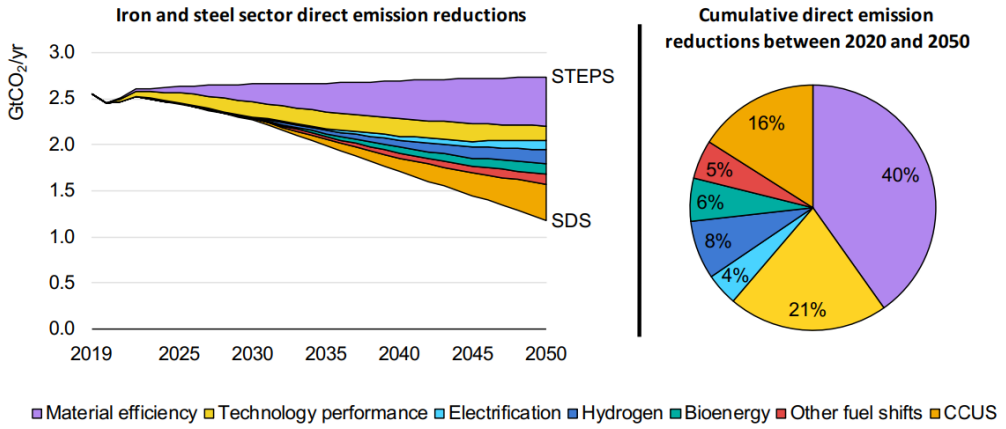


Figure 5. Direct Emission CO_2 reduction in Sustainable Development Scenario (EIA, Iron and Steel Technology Roadmap)

Indeed, almost all global producers are currently developing decarbonization strategies and running pilot plants to assess different production technologies. The technology comparison for future steelmaking is shown by figure 5.

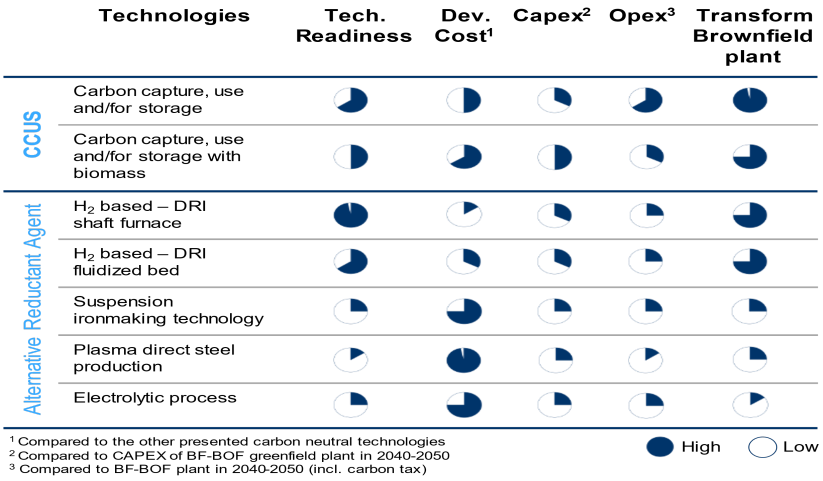


Figure 5. **Technologies compared for future steelmaking**

(The future of steelmaking, Roland Berger | 2020)

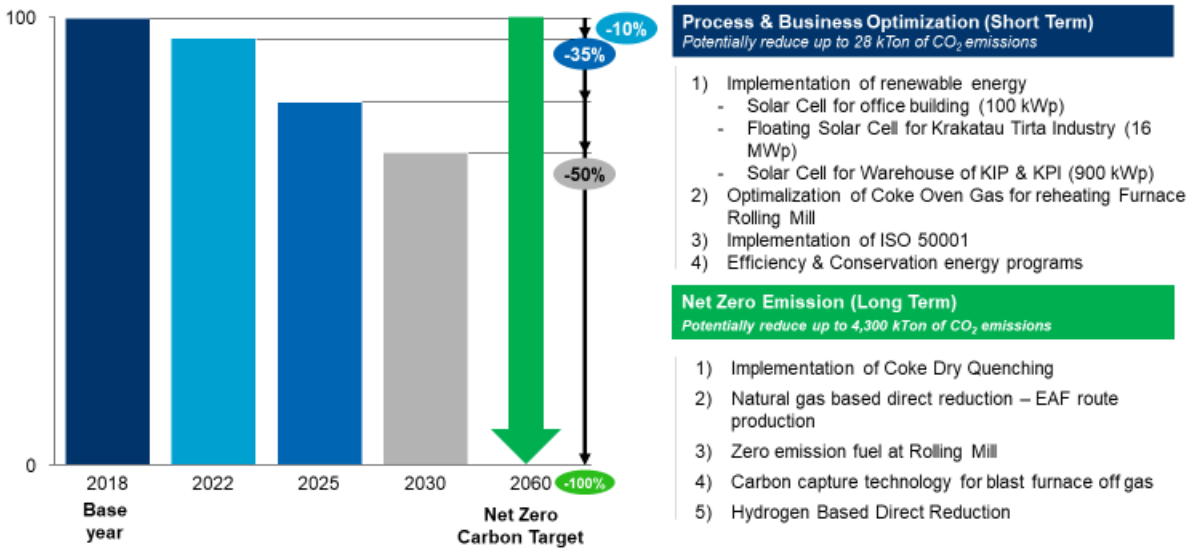
In figure 5 shown that independently CCUS is not sufficient to achieve carbon neutrality by 2050. The next option is to adopt alternative reduction technologies. However, new problems arise related to the requirement for green electricity in large quantities and at affordable prices. Energy sources that can meet these criteria still need time to be developed.

IV. Strategic Roadmap of Krakatau Steel

In order to support the government's efforts to achieve GHG emission reduction targets and to create an environmentally friendly and sustainable industry, Krakatau Steel has determined decarbonization roadmap. This roadmap is intended as an initial step that can be used as a reference in efforts to achieve emission reduction targets at Krakatau Steel.

All strategies based on business as usual of Krakatau Steel which are all plant were running and coupled with the future development of carbon technology. Able to be subdivided into 2 schemes by the duration of action:

- Scheme 1 (Short term mitigation): Energy Efficiency Programs & Implement of Renewable Technology
- Scheme 2 (Long term mitigation): Implement of green fuel and/or technology for long term plan



V. Conclusion

Referring to the latest technological developments, there are several alternative steel-making technologies that have low CO_2 emissions and potentially to be applied at the Krakatau Steel production facilities e.g. carbon capture and H_2-based DR instead of energy efficiency and conservation programs. Government policies and support are very important to the success of this roadmap, especially as they relate

to the provision of renewable fuel and energy. To ensure this roadmap, Krakatau Steel continues to conduct internal studies together with relevant stakeholders.

VI. List of citation

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