IMPLEMENTATION ENERGY RECOVERY AND RENEWABLE ENERGY PLAN OF PT KRAKATAU POSCO

BY

RYAN AGUSTIAN*

SYNOPSIS

PT. KRAKATAU POSCO (PTKP) with Blast Furnace Technology basis use coal as much as 2.1 million ton per year for raw material (reduction agent) and energy (energy recovery from waste). Implementation of energy recovery from waste is an important way to reduce energy consumption, because of energy price increase continuously due to the limited source. Energy recovery from waste in general is the conversion of non-recyclable waste materials into usable heat, electricity, or fuel through a variety of processes. This process is often called waste to energy. The efforts of PTKP to utilize and maximize energy recovery from waste to reduce energy consumption are implementation of high innovative technique, managing energy supply–demand and conduct energy saving campaign. High innovative technology installation such as Top Recovery Turbine (TRT), Waste Heat Boilers (WHB) and utilizing by-productes (BFG, COG and LDG) as fuel in production process and Power Plant. Almost 50% of generated by-productes are used for producing electricity in Steam Power Plant. Total energy recovery is 0.72 MTOE per year (48% of energy consumption). PTKP has a plan to install solar panel with capacity 500 KW in roof top of new coil yard for the project of renewable energy in 2023.

Keywords : Energy Recovery, Waste to Energy, Energy Supply – Demand, Innovative Technique.

*****Energy Technology Engineer and Certified Energy Manager, PT Krakatau POSCO, Cilegon, Indonesia.

1. Introduction

PT. KRAKATAU POSCO (PTKP) was established on 26th August 2010 as a joint venture Integrated Steel Mill company between PT. Krakatau Steel, an Indonesia State-Owned Steel Maker and world's most competitive Steel Maker from South Korea, POSCO. PTKP are the most reliable and competitive Integrated Steel Mill (ISM) in Indonesia which officially operating since early of 2014. Using the best steel industry technology with three million ton a year of capacity in the first phase, PTKP is ready to provide the best slab and plate products.

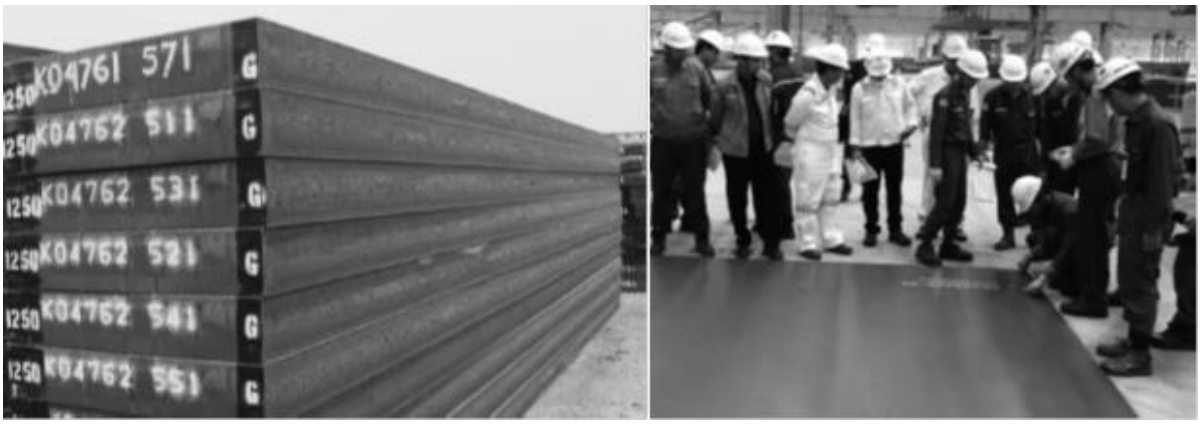


Figure 1.1 PTKP Slab and Plate Product

To produce steel slab and plate from raw materials, PTKP needs many energy sources with total energy consumption up to 1.49 million tons of oil equivalent (MTOE) or equal to 1.1% of Indonesia's energy consumption per year. Understanding how energy used and managed such a necessity is particularly perceived in the steelworks, not only because of the increasing costs of energy, but also as a consequence of the global steel competition, which reduce the cost of production without losing steel quality.

ISM PTKP is the Steel Maker plant which consume large of energy, therefore many kinds of opportunities to reduce energy consumption while maintaining plant productivity. Our steelworks implement energy saving improvements to reduce energy wastes. Based on best practice of the both parent companies, managing energy supply demand, implement high innovative technique to utilize energy recovery, and conduct energy saving campaign to reduce energy wastes and optimize energy usage.

For the long term plan PTKP production capacity will increase in term of upstream and downstream facilities in purposely towards the most competitive steel producer in the world. Nowadays by having fully support from Indonesia Government, PTKP together with the shareholders, POSCO and PT Krakatau Steel will conduct business expansion into 10 million steel cluster in Cilegon which divided into second and third phase. In this November 2022 PTKP formally operates Hot Rolling Plant as one of company expansion plan for the upstream facility. Therefore, the energy usage obviously will increase up to more than three times to support the production operation. The way how to manage energy supply and demand for the long term become crucial, especially through maintaining and maximize the usage of energy recovery. PTKP also had planned to use renewable energy started on 2023.

2. Energy Supply and Demand Management

PTKP, in relation with Good Corporate Governance compliance, PTKP create a specific unit for managing company energy supply and demand, which is belongs to Energy Department. The main focus of this department is to support ISM production processes through maintaining reliable energy and utility supply without disrupting operation process at the most effective and efficient both in usage and cost side. PTKP established energy policy in order to make sure the energy supply and demand management activity is sustainable and synergy to all PTKP facilities, business units, employees and other service contractors.

In order to achieve company objective, Energy department divided into four teams. Energy Technology team as supervising unit which responsible for managing energy supply and demand. Utility Supply team and Electric Supply team responsible for support ISM operation by control supplying reliable energy/utility without interruption. The last, Energy Analysis team which responsible to perform energy saving/efficiency in ISM process, through energy audit by internal certified energy auditor and CO_2 reduction management.

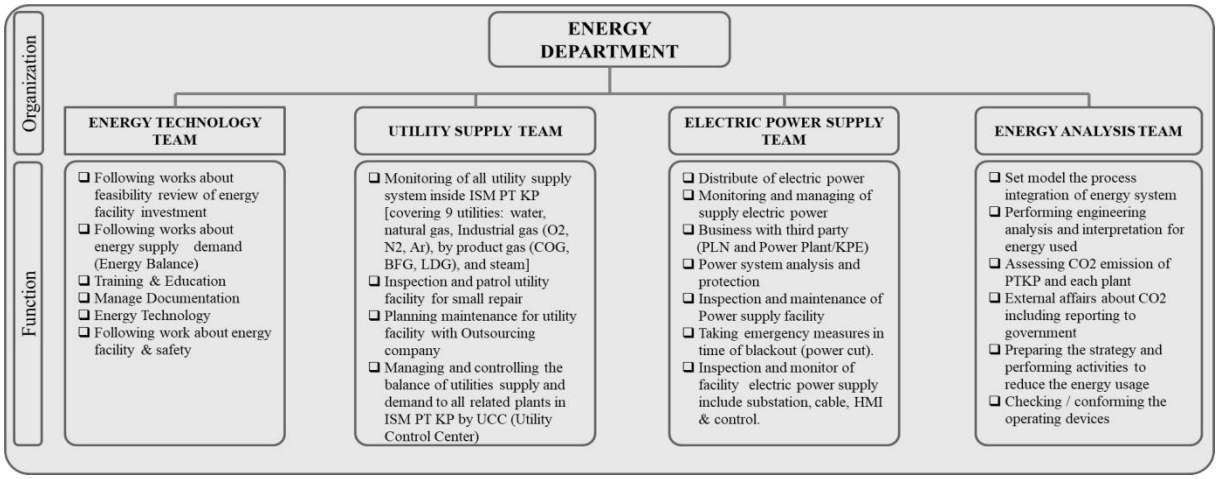


Figure 2.2 Energy Department Organization

PTKP for producing slab and plate for one year operation requires purchasing energy (import energy) as much 1.94 MTOE of energy. This imported energy consists of coal, anthracite, electricity, steam & high speed diesel. By utilizing those imported energy, it can generates energy recovery as much 0.72 MTOE through the production process. Moreover, ISM PTKP also providing energy sales (export energy) to outsourcing company around ISM area as much 0.45 MTOE consists of by-product gas, steam and electricity.

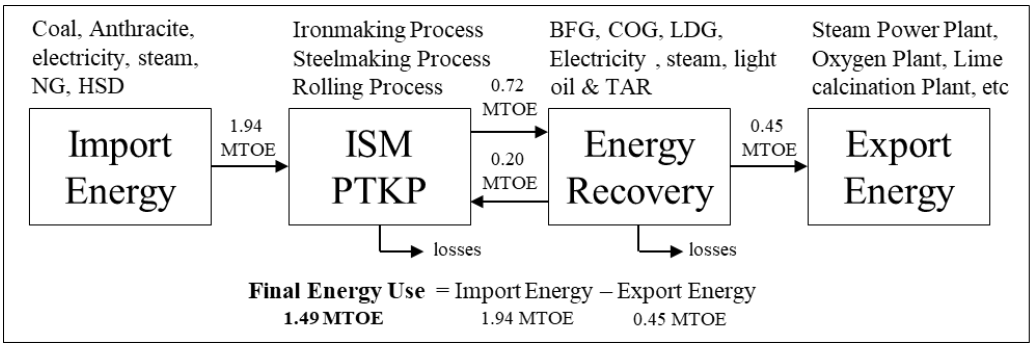
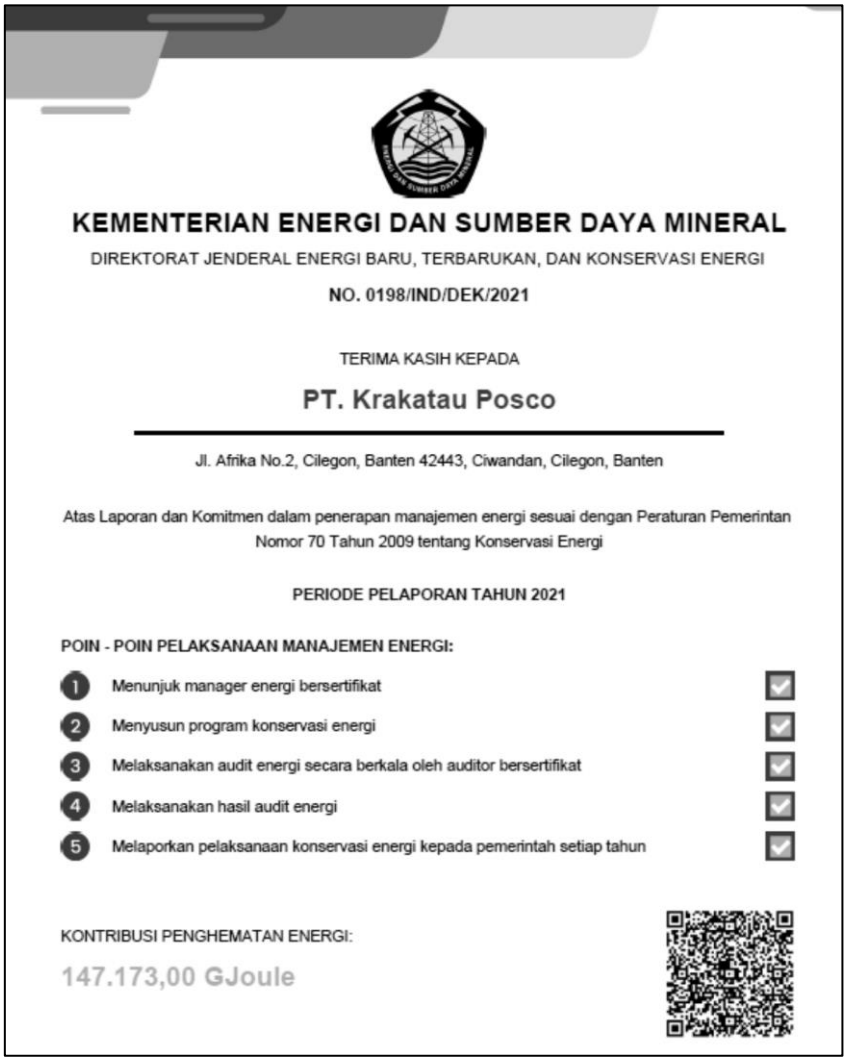


Figure 2.3 ISM PTKP Energy Flow Diagram

In Indonesia there are some rules governing regarding energy management. It regulated in Government regulation PP. No 70 year 2009 about Conservation Energy. There is statement that an Organization which consumes energy more than 6000 TOE should implement energy efficiency and conservation by energy manager personnel. Every year the organization should report the energy efficiency activity to ministry of energy and mineral resources of Indonesia through energy manager within each organization. In this case, PTKP annual energy consumption achieved more than 6000 TOE.



KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL

DIREKTORAT JENDERAL ENERGI BARU, TERBARUKAN, DAN KONSERVASI ENERGI

NO. 0198/IND/DEK/2021

TERIMA KASIH KEPADA

PT. Krakatau Posco

Jl. Afrika No.2, Cilegon, Banten 42443, Ciwandan, Cilegon, Banten

Atas Laporan dan Komitmen dalam penerapan manajemen energi sesuai dengan Peraturan Pemerintan Nomor 70 Tahun 2009 tentang Konservasi Energi

PERIODE PELAPORAN TAHUN 2021

POIN - POIN PELAKSANAAN MANAJEMEN ENERGI:

1. Menunjuk manager energi bersertifikat
2. Menyusun program konservasi energi
3. Melaksanakan audit energi secara berkala oleh auditor bersertifikat
4. Melaksanakan hasil audit energi
5. Melaporkan pelaksanaan konservasi energi kepada pemerintah setiap tahun

KONTRIBUSI PENGHEMATAN ENERGI:

147.173,00 GJoule

Figure 2.4 Energy Management of 2021 Certificate from Ministry of Energy and Mineral Resources Indonesia

The certificate explains that PTKP has implemented Energy Management and fulfilled the following points:

1. Appoint a certified energy manager
2. Develop energy conservation programs
3. Execution regular energy audits by certified auditors
4. Implementation of energy audit results
5. Report the implementation of energy conservation to the government annually

PTKP implemented cost reduction in its operational process to achieve the determined standard operation, and also to gradually reduce energy cost in order to achieve operational efficiency, so that the cost can be minimized and profit can be maximized to improve the effectiveness and continuity of PTKP operational activity.

The energy efficiency activities are carried out routinely in every year, for reducing energy losses and minimizing fixed energy consumption, PTKP have been doing energy conservation activities to reduce energy cost, improve Thermal, Mechanical / Electric equipment efficiency, etc. The list of improvement activities and result:

Tabel 2.1 List of PTKP Energy Saving & Conservation Activities

Activities	Improvement	Result
Reduce PLN cost during Steam Power Plant overhaul	Adjust overhaul schedule, electricity, fuel saving, maximize P/P operation	Reduce cost about 1.5 MUSD
Increase Steam Recovery from Waste heat boiler	Adjust parameter operation	Steam Recovery increase 7 ton/hour
Reduce lighting tax cost by control Steam Power Plant Operation	Control electricity generation to reduce excess power to Grid	Reduce cost about 1 MUSD/Year
Increase Reverse Osmosis (RO) water production	Restoration RO membrane and install new #4 rain water pit	Increase RO water production 600 m^3/Day
Converting LPG to Natural Gas as gas fueled at PTKP Workshop	Make a new NG pipeline to Workshop	Reduce LPG saving 514 Gcal/yrs (51.4 TOE/Year)
Fuel Consumption Reduction in Coke Oven Battery	Adjust excess air and leakage repair	Reduce fuel consumption, about 29,786 Gcal/Year
Electricity Saving in Air Compressor system - All PTKP Plant	Installment of additional windows in compressor room – Plate Mill ultrasonic inspection to find and repair the leakage point.	Achieve electricity saving 49.000 kWh/ month (147 TOE / Year)
Tundish Preheating Optimization	Reduce operation burner from 3 into 2 burners	Reduce fuel consumption from Tundish. Saving COG 1,016 Gcal/Year
Steam Saving in Distribution Pipeline	Perform steam audit to find and repair leakage point	Achieve steam saving 4,462 ton / month (339 TOE / Year)
Reducing the operational energy cost of Cooling Tower facility	Turning off 1 Cooling Tower Fan for 6 Hours, starts in : 00.00 AM	Achieve electricity saving 13.000 kWh / month (39 TOE / Year)
Air Ratio Improvement RF plate Mill zone 1 & zone 2	Air ratio parameter adjustment	Achieve COG saving 4,220 Gcal/yrs (422 TOE/Year)
Cooling load analysis in office Building and electrical	Turning off 70 unit of unnecessary AC, from total 160 AC installed	Achieve electricity saving 300,000 kWh / month (900 TOE / Year)

PTKP also conducted energy audit in its operational activity to efficiency on the usage of energy, water and others, because PTKP realizes that the efficiency of energy has contributed to cost efficiency and also reducing the GHG (scope 1) emission, in this case, the usage of fuels, and GHG (scope 2) indirectly in this case, electricity usage.

3. Implementation of Energy Recovery

ISM PTKP during the production process generating a lot of energy recovery such as usable heat, electricity and fuel through a variety of processes. Energy recovery that utilized by PTKP are such as fuel (BFG, COG & LDG), electricity and steam.

3.1 Blast Furnace Gas (BFG)

BFG is an emission gas produced from Blast Furnace. Blast Furnace (BF) is the main facility that processes the solid raw material (ferrous/ore, coke & some additives (Silica-CaO) to be converted into hot metal. Hot Metal is the result of a reaction between the solid raw material with the gas reductor (CO). During the process on the Blast Furnace, The Gas Reductor is produced through chemical reaction of hot blast & PCI (in the raceway, $C+O_2 \rightarrow CO_2$ or $C+\frac{1}{2}O_2 \rightarrow CO$), afterward CO_2 reacts with the Coke ($CO_2+C \rightarrow 2CO$) and finally produced $CO_{(g)}$. The reduction process between gas reductor $CO_{(g)}$ with solid ferrous/ore will produce $CO_{2(g)}$. All the gas out from top BF called BFG and it is weight is 1.03, which is slightly heavier than the air and it's major component is nitrogen. Annual BFG production up to 0.38 MTOE (25% of energy consumption). BFG use as fuel for ISM operation as much 46% for Blast furnace and Coke Oven Plant. Then as fuel for Steam Power Plant 50% (export energy).

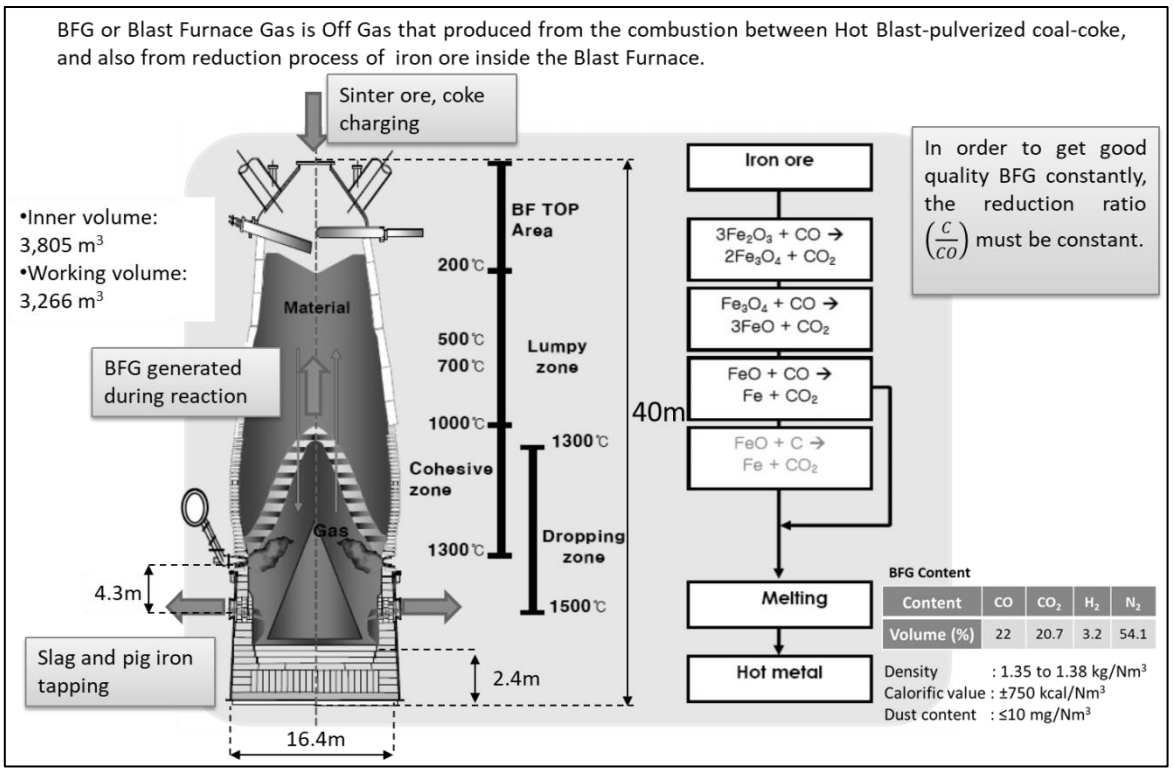


Figure 3.1.1 BFG generation process

3.2 COG (Coke Oven Gas)

Raw COG is generated during coking coal carbonization process which taking place in oxygen-less ovens of Coke Oven Plant (COP). The raw COG is further processed in the By-Product Plant to remove ammonia liquor, tar, and light oil prior to utilization as fuel. In the

Gas treatment Plant, crude COG is cooled down in primary coolers. Hydrogen sulfide (H_2S) and ammonia (NH_3) in crude COG are scrubbed while BTX is removed and recovered for further utilization. After removing all the impurities, clean COG will supply to other steelworks consumers. From gas treatment Plant process there are energy recovery generated beside clean COG, such as TAR and BTX which be sold to outsourcing company (export energy) as much 0.04 MTOE (3% of energy consumption). Annual COG production up to 0.22 MTOE (15% of energy consumption). COG use as fuel for ISM operation as much 64% for Sinter, Blast furnace, Coke Oven and Plate Plant. Then 36% as fuel (export energy) for Steam Power Plant 28% and 8% for other outsourcing companies.

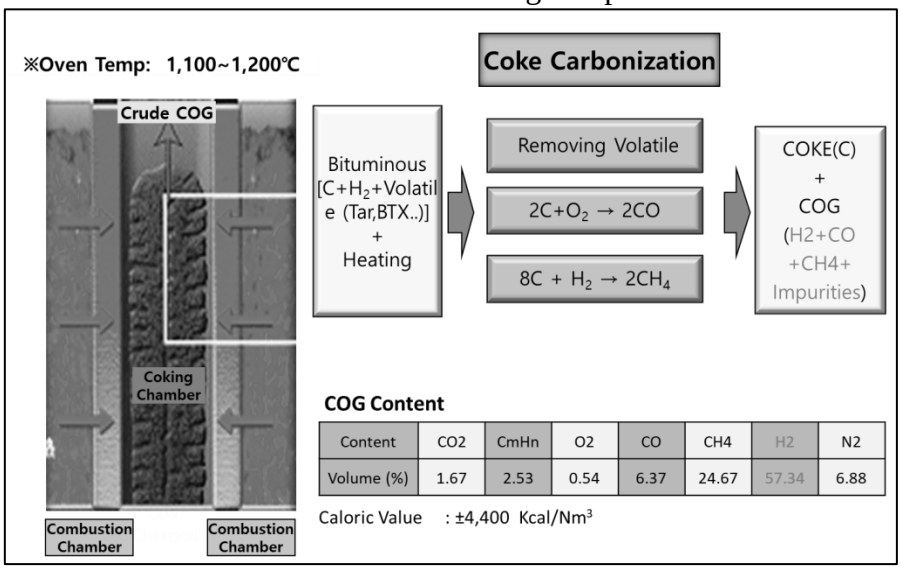


Figure 3.2.1 COG generation process

3.2 LDG (Linz Donawitz Gas)

Linz Donawitz Gas is the gas that produces from the oxidation process of molten iron (C contain 4~4.5%) into melted steel (C Contain 0.04%) in a Basic Oxygen Furnace (BOF). LD gas composition is mainly from Carbon Monoxide gas, because of the reaction: C + ½ O2 = CO (gas). From this reaction, high amount Carbon monoxide gas will produce. CO gas is a colorless, odorless, and tasteless gas that is slightly lighter than air. Annual LDG production up to 0.04 MTOE (3% of energy consumption). LDG use as fuel 100% for Steam Power Plant (export energy).

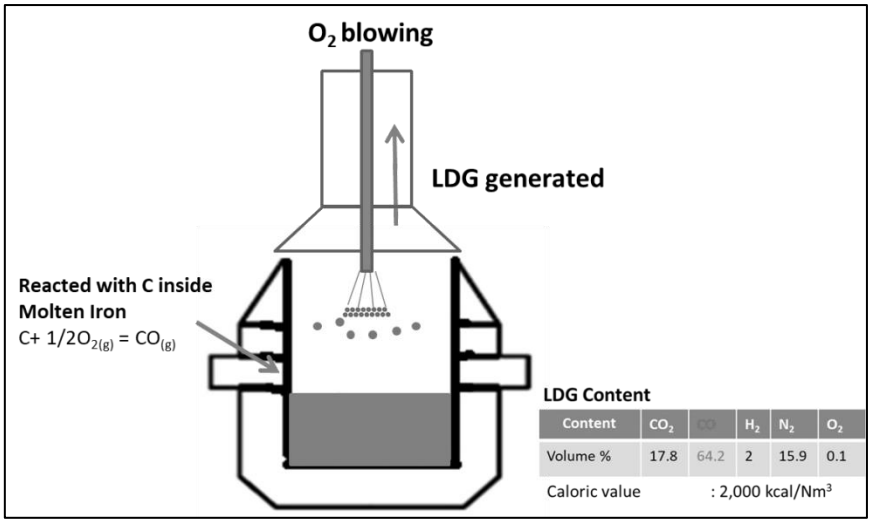


Figure 3.3.1 LDG generation process

3.4 Top Pressure Recovery Turbine (TRT)

Top gas pressure inlet is approximately 0.95 kg/cm^2 and outlet 0.1 kg/cm^2. The average annual electricity production is 14 MW. TRT can generate electricity during the blast furnace process by utilizing pressure gas out of top blast furnace to rotate a turbine-generator. With installation TRT in Blast Furnace, ISM PTKP can generate electricity and can annually save 0.03 MTOE (2% of energy consumption).

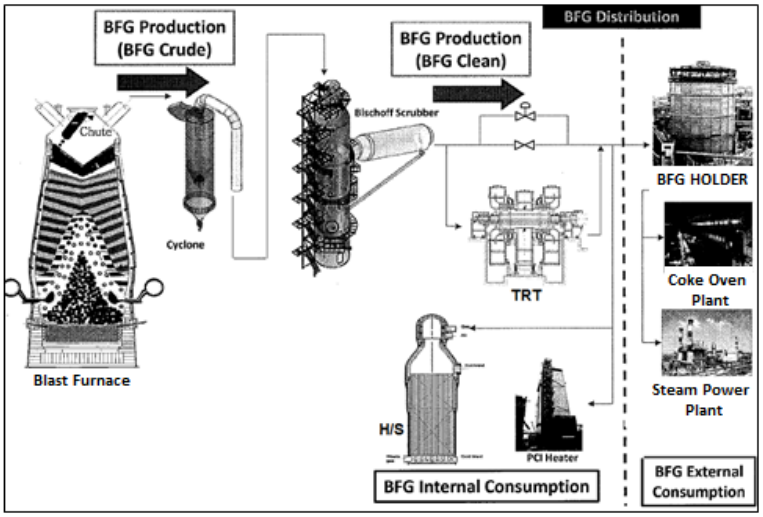


Figure 3.4.1 Schematic Top-Pressure Recovery Turbine

There are several activities to improve and maintain electricity generation from TRT:

- TRT overhaul scheduling
- Improve gas cleaning process to reduce dust contain

3.5 Waste Heat Boiler

With installation of heat recovery from Lurgi Thyssen (LT) system in steel making plant, our ISM can reduce energy consumption up to 0.005 MTOE per year (0.3% of energy consumption). Steam is produce from circulating the de-mineralized water into cooling stack to cooling the Linz Donawitz Gas (LDG). This is the system that produces high-pressure process steam by using waste gas generating from converter in Steel Making Plant (SMP). The circulating water can reduce the LDG temperature from $1,400^{0}$C to be $1,000^{0}$C. In the result, the steam with temperature 210^{O}C ~ 248^{O}C and pressure 1.40 ~ 3.80 Mpag will be produced. Before sending to steam network, steam will be a treatment in pressure reducing station to reduce the steam pressure become 1.40 ~ 3.80 Mpag to 1.20 ~ 1.40 Mpag and to separate water molecule from the steam. After treatment, steam will delivery to steam network for another purpose in ISM.

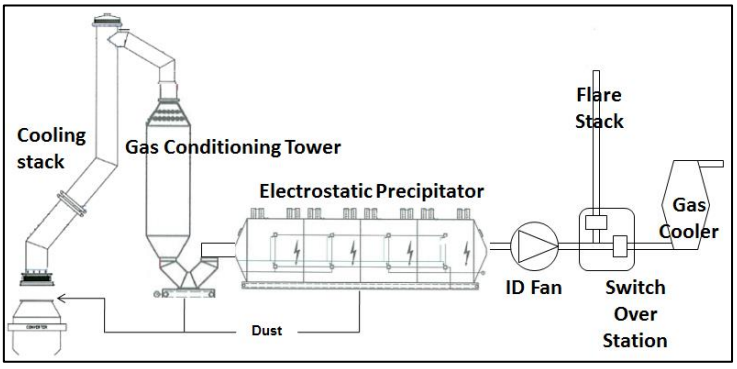
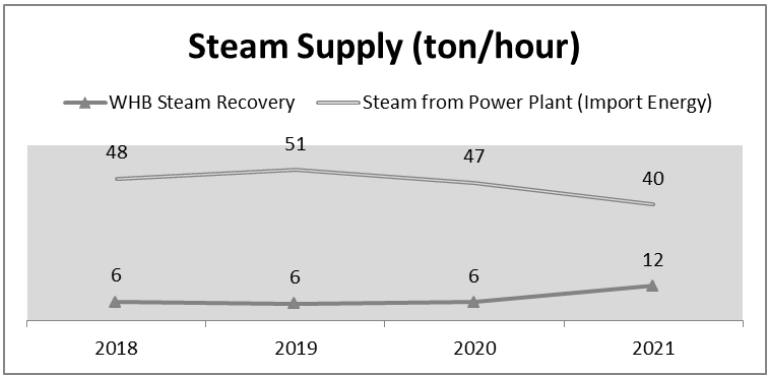


Figure 3.5.1 Schematic Heat Recovery By Lurgi Thyssen (LT) System

There are several activities to improve and maintain steam recovery from waste heat boiler:

- replace and maintain steam trap & steam insulation
- steam leakage inspection & repair
- adjust parameter operation



Graph 3.5.1 Waste heat boiler steam recovery increase after improvement

3.6 Steam Power Plant

In order to maximize utilization of by-product gas that generated by our ISM, PTKP conduct such a work collaboration with other investment to build a Steam Power Plant. Steam Power Plant has 2 x 100 MW capacity with main fuel by-product gas consist of BFG, COG and

LDG which supplied by ISM PTKP. The designed to fire BFG as main fuel and COG/LDG used as ignition fuel and auxiliary fuel for flame stabilizer.

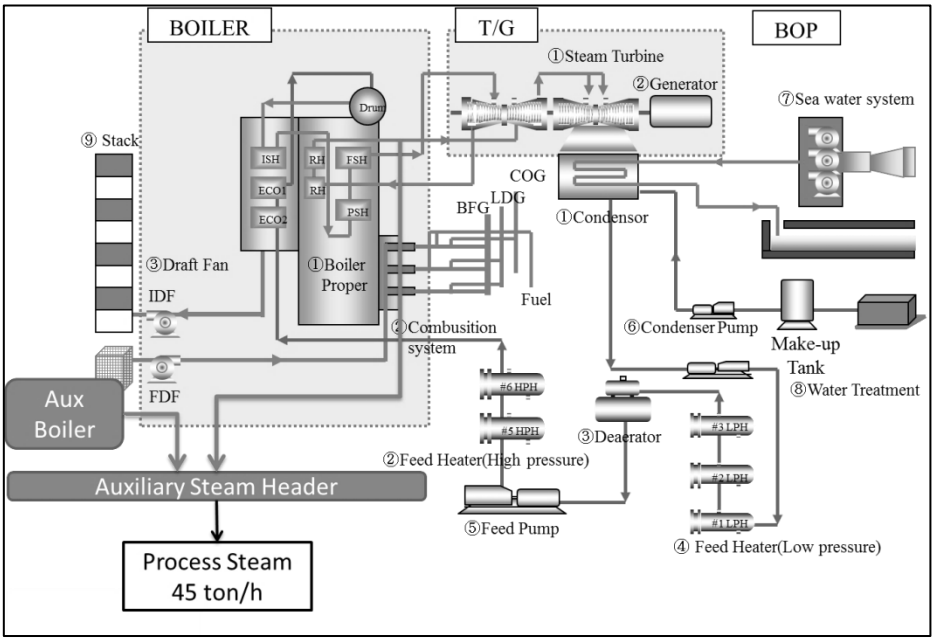


Figure 3.6.1 Schematic Steam Power Plant System

As a result, about 0.29 MTOE of the surplus waste by-product came from ISM PTKP are recovered and utilized as fuel of the gas-fire boiler. Therefore about 138 MW of electricity and 46 ton/hr of steam which is at 260 C, 12.75 bar generated. In summary, the estimated amount of emission reduction is about 1,000,000 tCO_2eq per year by replacing the fossil fuel for generating the electricity and steam.

Figure 3.6.2 Bird's eye view of the Steam Power Plant

4. Renewable Energy and Green Industry Road Map

The following action plan has been designed to enable PTKP to meet our objective and continue for CO_2 emission reduction and environmental compliance.

4.1 Solar Panel Installation

PTKP will commence the development of solar photovoltaic (PV) project in new Hot Rolling Plant factory with capacity 0.53 Mega Watt Peak in 2023. Investment Plan: Solar Power

(Panel, Inverter, Cable, Power Monitoring System and etc.) Total available area for solar system on coil yard rooftop 4,569 m² with potential installed capacity 0.92 MW. The Solar investment cost estimation about 1.39 Million USD.

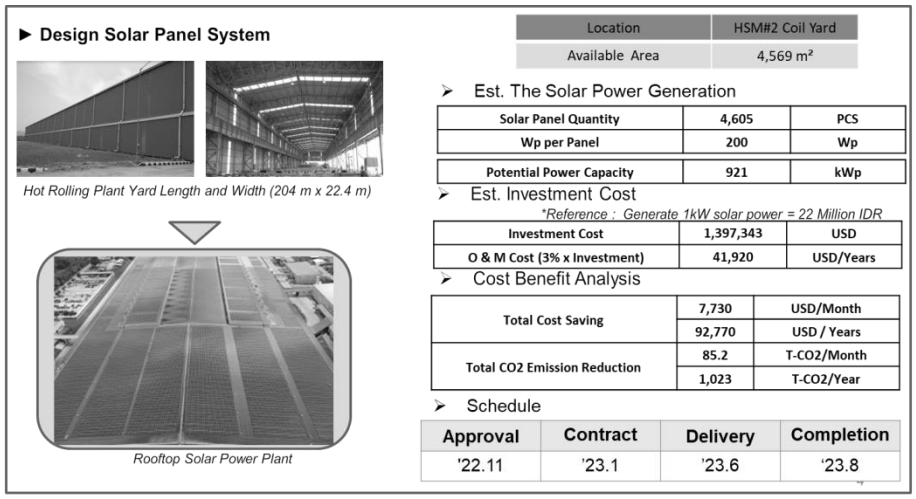


Figure 4.1.1 Design Solar Panel System

4.2 POSCO Eco-Friendly Technology Application (Hydrogen Reduction)

In the future steel industry will face big challenge of the era of net-zero carbon. As one of the country that signed Paris Agreement, Indonesia give Nationally Determined Contribution (NDC) to UNFCCC that stated its conditional target to reduce emissions by up to 41% with international cooperation support. PTKP had planned to install Fluidized Bed Reduction Reactor (HyREX) for the 3rd phase on 2030 with capacity 3 million tons of crude steel. This technology will adopt POSCO technology as our parent company. Low carbon product demand will increase every year due to the crisis of global warming.

Hydrogen reduction steelmaking is an innovative technology that produces iron using hydrogen (H_2) as a substitute of fossil fuel. When fossil fuels such as natural gas and coal react chemically with iron ore, they generate carbon dioxide (CO_2), while hydrogen only generates water (H_2O). It will result hydrogen reduction steelmaking can dramatically reduce carbon emissions in the steelmaking process.

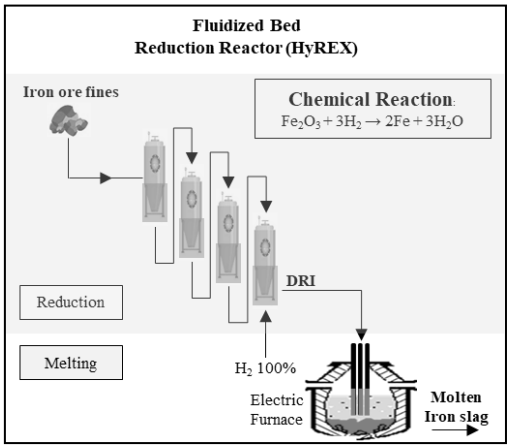


Figure 4.2.1 HyREX of steelmaking process

5. Conclusion

In terms of PTKP as an integrated steel mill as emphasizes to use energy in the most efficient, cost-effective and environmentally responsible manner possible. PTKP will keep on efforts of energy reduction improvement. Several activities is conducted such as energy supply & demand management, implementing high innovative technique to utilizing energy recovery and continuous improvement activities. These efforts reduce the energy consumption as much as 0.72 MTOE or equal 48% of energy consumption per year. Its consist of 43% from utilizing by-product gas as fuel for ISM PTKP operation and export energy, by selling BTX and TAR 3 %. The remaining 2% from Top Pressure Recovery Turbine electricity generation and steam recovery of waste heat boiler.

6. Reference

[1] Press Release. 2021. *Ancang-Ancang Baja 10 Juta Ton dari Cilegon.* Retrieved from https://indonesia.go.id/kategori/indonesia-dalam-angka/3255/ancang-ancang-baja-10-juta-ton-dari-cilegon?lang=1

[2] *Handbook of Energy & Economic Statistics of Indonesia*. Ministry of Energy and Mineral Resources Republic of Indonesia: 2021

[3] Government regulation PP. No 70 year 2009 about *Conservation Energy*

[4] *Great Conversion to Low-carbon Eco-friendly Steelmaking Process HyREX*. POSCO-TODAY Global Communication Channel: 2022