Cost Leadership and Plant Efficiency Enhancement in Indonesia Cement Industry to support Decarbonization Initiatives

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Chairman of Indonesia Cement Association

30 April 2024

16 Members of the Indonesian Cement Association, with 23 integrated plant consist of 50 production line

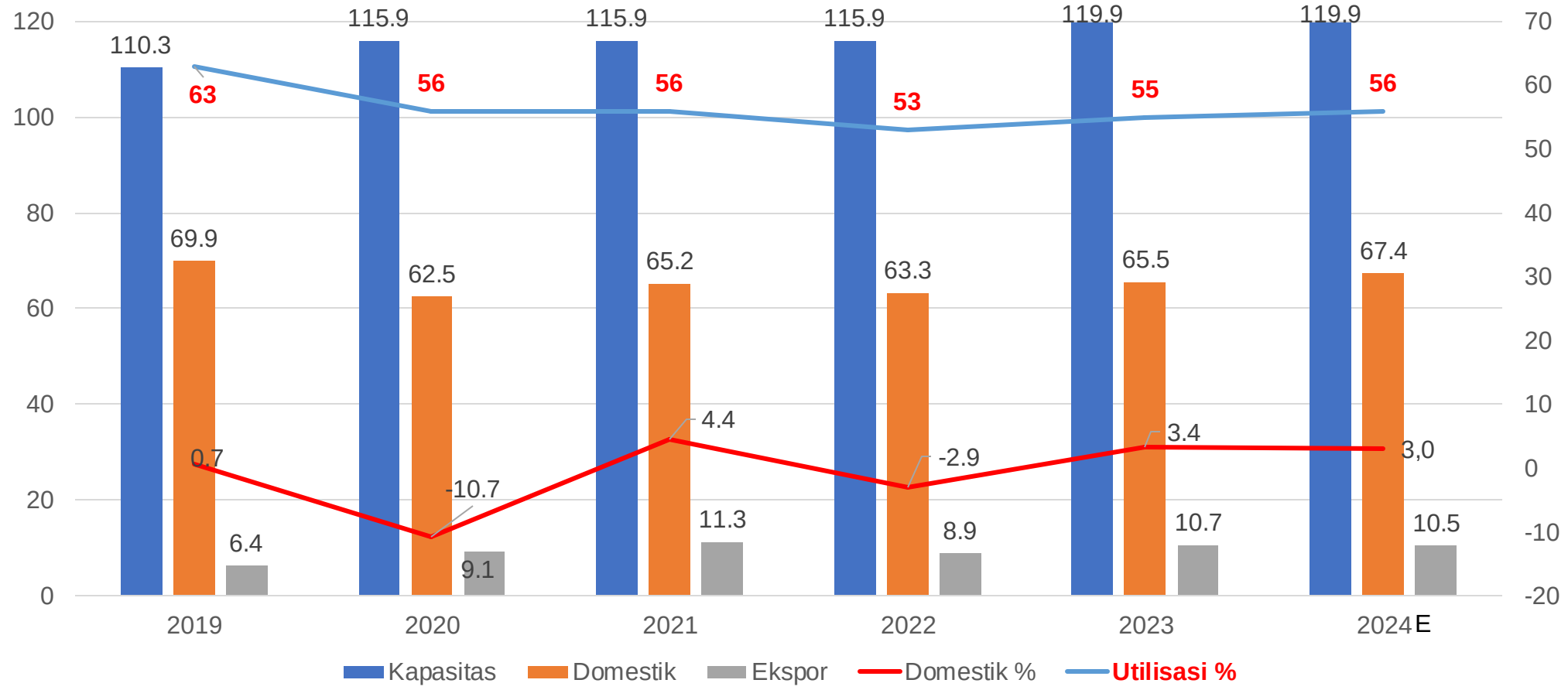
ASI Members:

1.PT Semen Indonesia (Persero) Tbk
2.PT Semen Padang
3.PT Semen Gresik Tbk
4.PT Semen Tonasa
5.PT Solusi Bangun Indonesia Tbk
6.PT Indocement Tunggal Prakarsa Tbk
7.PT Semen Baturaja Tbk
8.PT Semen Kupang
9.PT Semen Bosowa Maros
10.PT Cemindo Gemilang Tbk
11.PT Jui Shin Indonesia
12.PT Sinar Tambang Arthalestari
13.PT Semen Jawa
14.PT Conch Cement Indonesia
15.PT Semen Imasco Asiatic
16. PT Kobexindo Cement

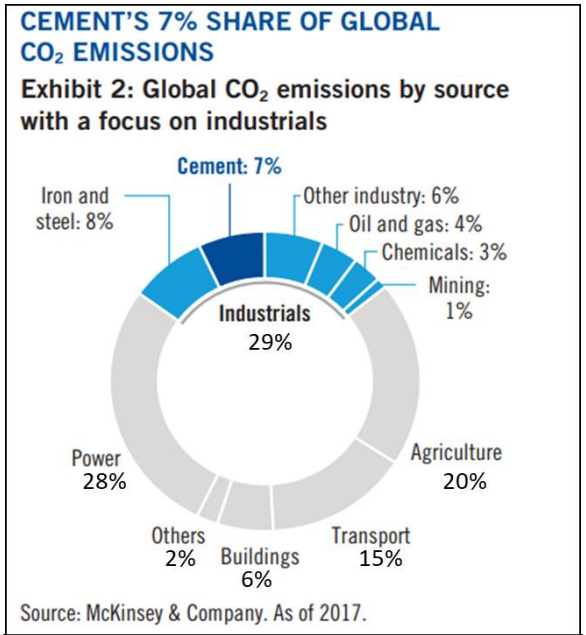
Domestic Market Update 2023 and Growth Potential in 2024

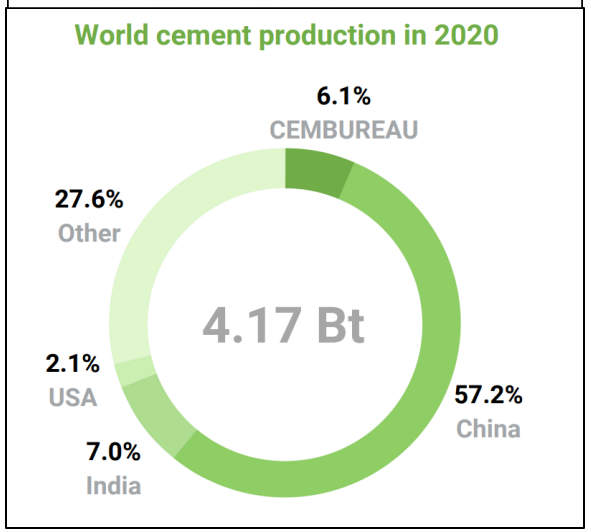
- Compared to 2022, 2023 Demand Growth is +3.4% vs LY. Higher demand occurred, lower inflation (2.56% vs LY) and infrastructure construction acceleration (which also contributed by IKN construction)

- **In 2024**, cement **demand** projected to **grow up to 3%** compared to 2023, resulting in industry **utilization to 56% (which still lower than 2019 utilization level)**



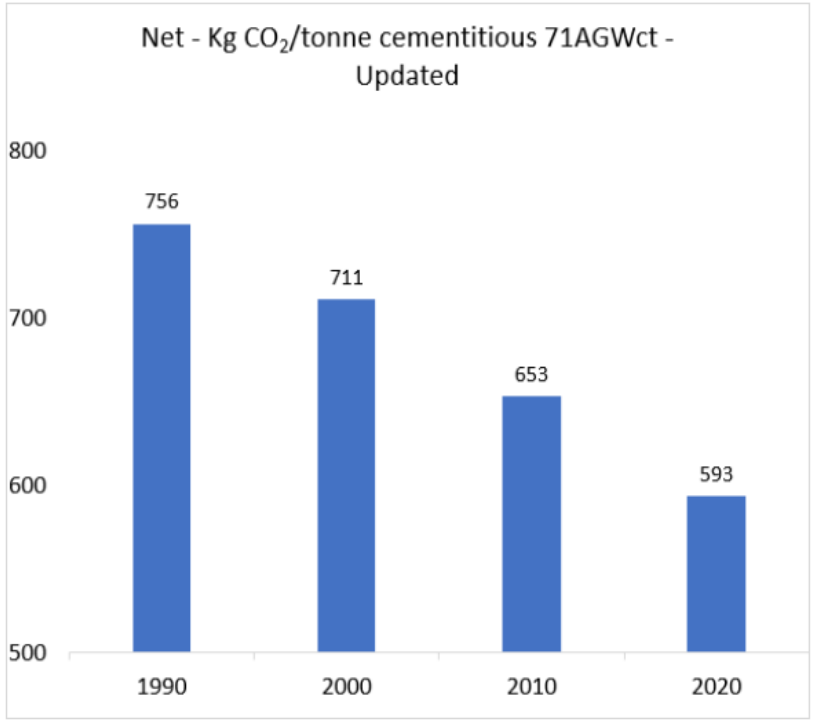
Overview on World Cement Production and Net CO_2 Emission





Source: cembureau 2021-activity-report

Net CO_2 emissions in 2020 (global cement*)



22 %
Reduction in Net CO_2 emissions per tonne cementitious (1990 baseline)

17 %
Reduction in fossil fuel consumption (1990 baseline)

19 %
energy efficiency improvement (1990 baseline)

Source: GCCA – GNR report 2021
* Data coverage : Austria, Brazil, Canada, Czech Republic, Egypt, France, Germany, India, Italy Morocco + Argentina + Tunisia, Philippines, Poland, Spain, Thailand, United Kingdom, United States

71AGWct = Net CO2 emissions – Weighted average excluding CO2 from on-site power generation – Grey and white cementitious products

Estimated Global CO_2 Emission is 2,47 bio Tonnes of CO_2,while Indonesia around 40 Mio Tonnes

Future Cement Industries Overview and Its Connectivity With SDG

Climate neutral – Cement factories reduces carbon dioxide emissions, while also conducting climate preserving measures.

Producing innovative products and services which provides sustainable solutions.

Circular by using materials and energies, to process and reuse by-products and wastes accordingly.

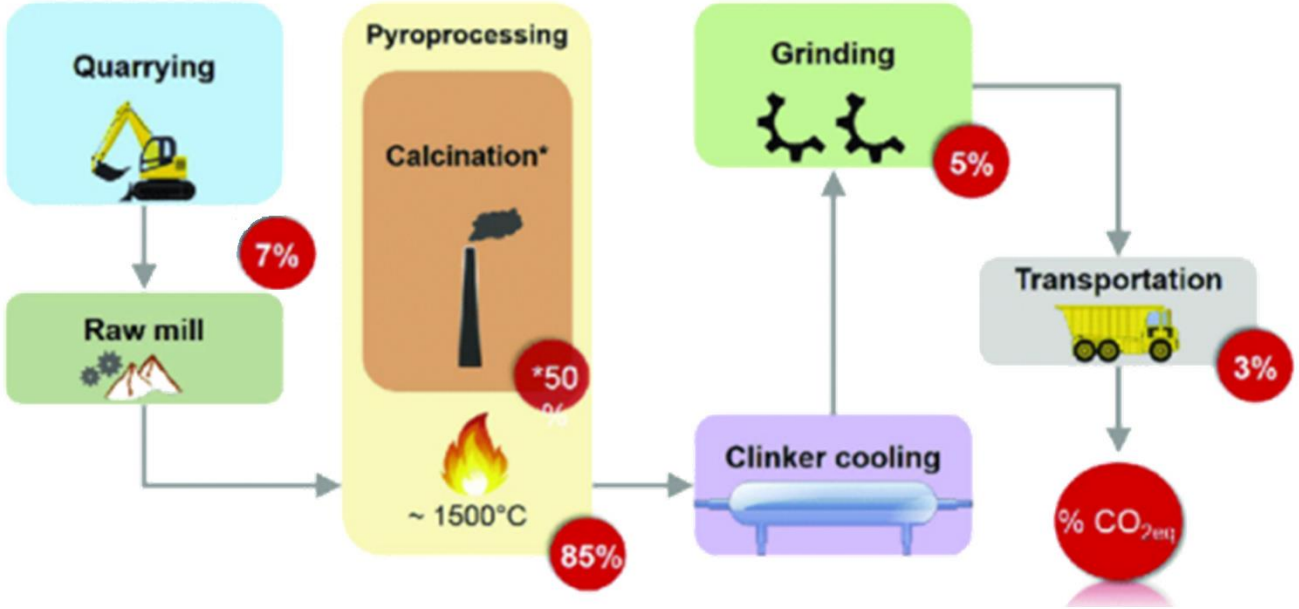
Provides sustainability for nature.

Provides benefits to stakeholder.

"Green economy, green technology and green product harus diperkuat agar Indonesia bisa bersaing di pasar global. Kita memiliki kesempatan yang besar masuk ke produk hijau dan ekonomi hijau ini baik dari sisi produksi, distribusi, dan konsumsi" **~ Presiden Joko Widodo (2021)**

UN Sustainable Development Goals adopted by Indonesian Government

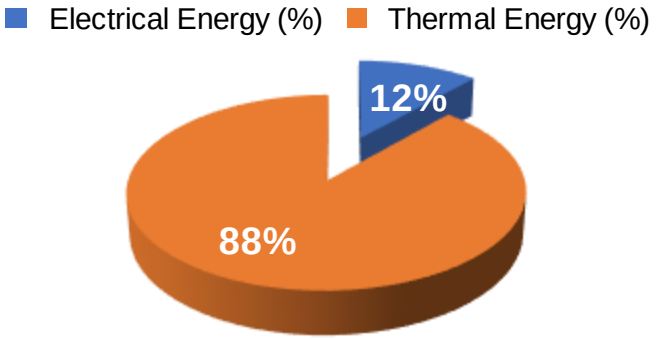
Overview of Energy Demand in the Cement Industry



Red circles indicate the percentage of CO_2 eq emissions associated with manufacturing. (*) 50% of the emissions associated with pyroprocessing arise from direct release of CO_2 from calcination and the remaining 35% from fuel and energy consumption.

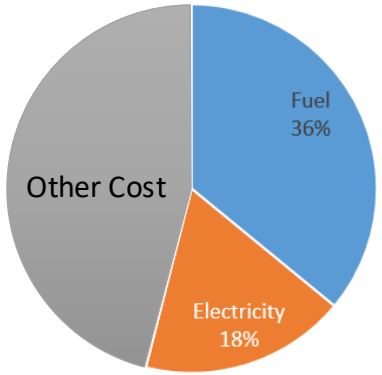
Source : Imbabi et al., 2012

Energy Demand in Cement Industry
(Thermal and Electrical Energy in Joule Proportion)



Thermal energy and electrical energy Management is closely related to CO_2 Emissions reduction from companies, therefore **Energy Efficiency and Conservation are required**

Energy Cost Estimation in Cement Production (COGM)



Fuel contributing 35% of Cement Production cost (or 53% from Variable Cost), while Electricity contributing 18 % of Cement Production cost (or 26% from Variable Cost)

Indonesia is committed to reduce its carbon emissions as stipulated in its Enhanced NDC, which will be aligned with the Long-Term Low Carbon and Climate Resilience Strategy (LTS-LCCR) 2050 with a vision to achieve net-zero emission by 2060 or sooner

Indonesia's NDC outlines the country's transition to a low-emissions and climate-resilient future

Targeted Sectors

New commitment in Adaptation

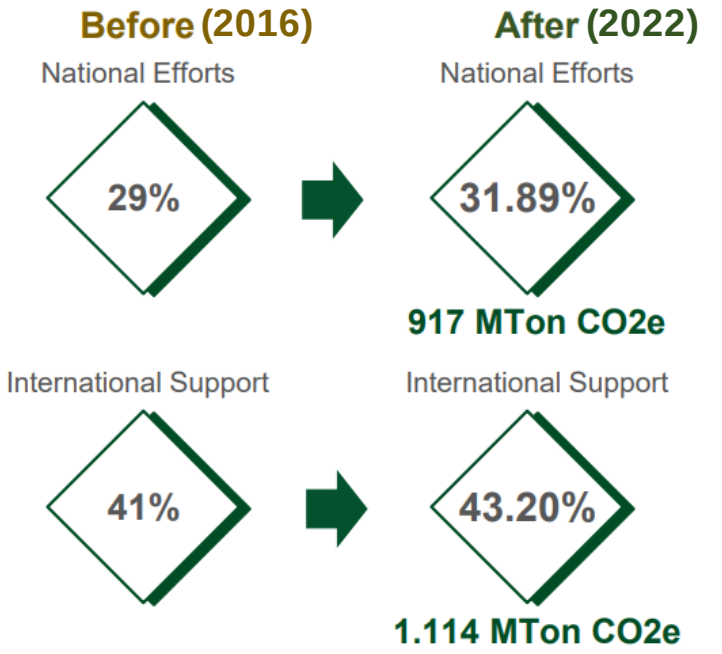
Related with Oceans, wetlands, human settlement.

2nd NDC 2024

UN CLIMATE CHANGE CONFERENCE UK 2021

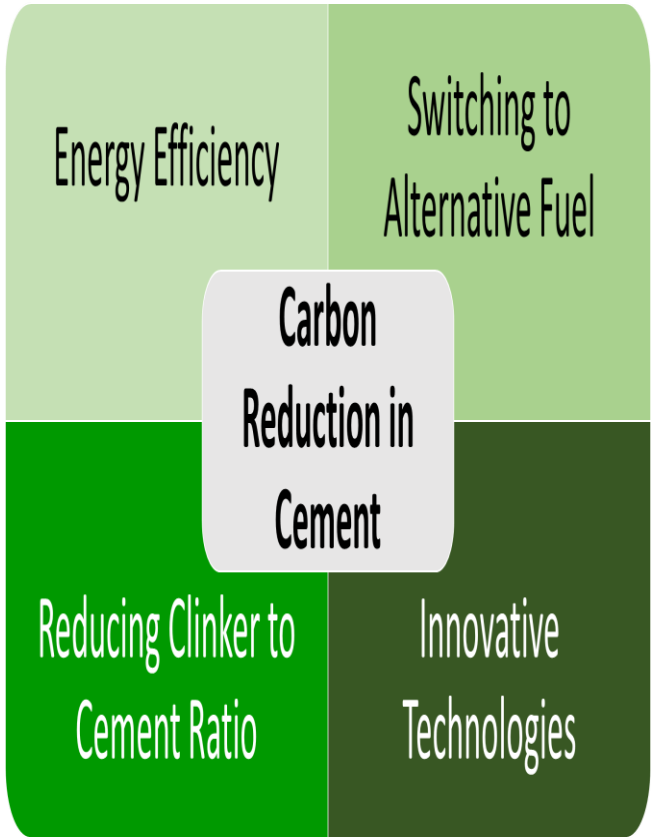
1. **Coal phase down** with the framework of energy transition,
2. **Blue carbon** resources, and
3. Reduction of **HCFs**

Enhanced NDC



Long Term Strategy on Low Carbon and Climate Resilience 2050 (LTS - LCCR 2050)

CO_2 Emission Reduction (Scope 1 & 2) Initiative in Cement Industry



CO_2 Emission Scope 1 – From Internal Process

Increase Alternative Fuel (to replace Fossil Fuel) & Raw Material (AFR) Use

- AFR pre-processing & feeding facility optimization
- Optimizing the consumption of **Industrial waste and biomass**
- Anticipation in process/emission improvement
- **Refused Derived Fuel (RDF)** initiatives around plant operations
- Multi-stakeholder cooperation, permiting

Reduce fuel cost

Reduce Clinker Factor (CF) in Cement Production

Produce low carbon content cement

- Substitution of CO_2 intensive clinker in cement **with fly ash & bottom ash, Limestone, and other potential binder**
- Promotion/advocacy for performance-based cement standard with lower clinker factor

Reduce material and electrical energy cost

Optimize Specific Thermal Energy Consumption (STEC)

- Efficient plant thermal energy consumption
- **Advanced process control rollout**
- **Innovation technology such as Hydrogen injection**

Reduce fuel cost

CO_2 Emission Scope 2 – From Indirect Use of Electricity

SEEC Optimization

- **Digitalization & automation of production facility**
- **Equipment improvement**/replacement
- Clinker factor reduction

Reduce electrical energy cost

Renewable Energy Supply

- **Solar Panel installation** via Partnership with local provider
- Other renewable initiatives such as optimize use of existing **waste heat recovery power generator (WHRPG)**

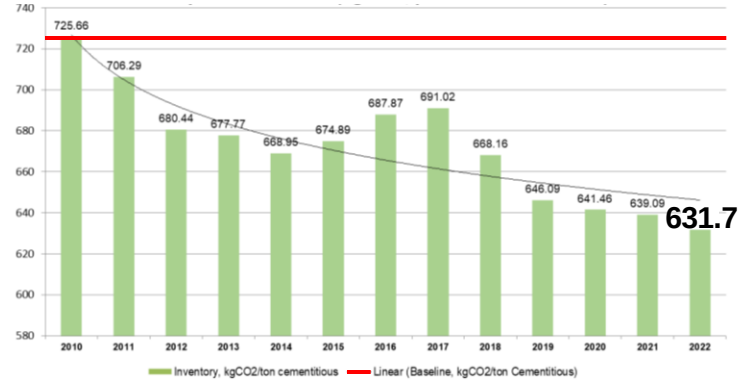
Reduce electrical energy cost

CO_2 Emission Reduction in Indonesia Cement Industry

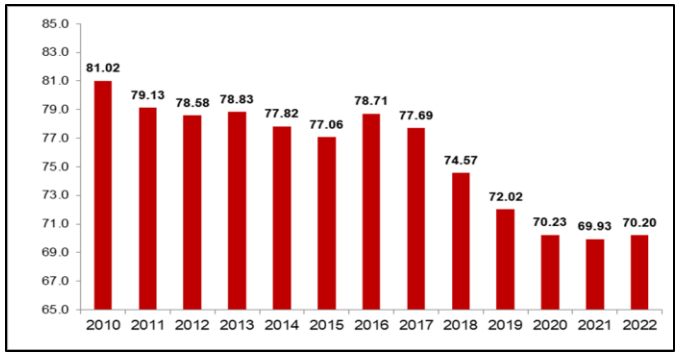
Indonesia cement industry implements a series of initiatives and appropriate technologies to lower GHG emissions and other conventional gas emissions, among others, by:

(1) reducing the clinker factor,
(2) using alternative fuel and renewable energy, as well as
(3) increasing the level of thermal substitution.

Net Specific Emission (kg CO_2/ton Cementitious)



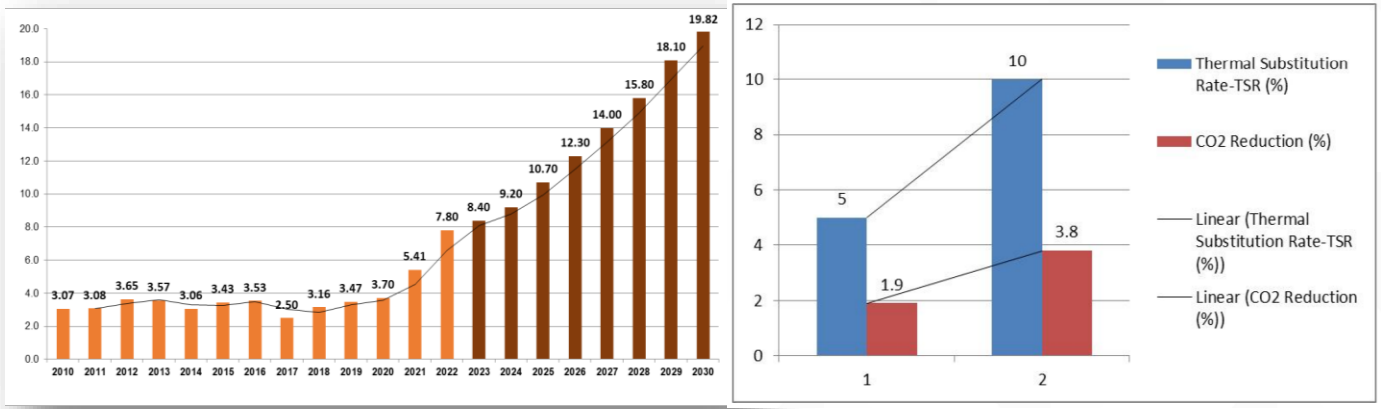
Trend Clinker Ratio (%)



CO_2 emissions reduction in non-OPC cement products
(Comparison to OPC cement with CO2 emissions of 782 kg/ton)

Hidraulic Cement – HE Type	29% Lower than OPC tipe I emission	PPC Cement	21% Lower than OPC tipe I emission
PCC Cement	32% Lower than OPC tipe I emission	Portland Slag Cement (PSC)	38% Lower than OPC tipe I emission

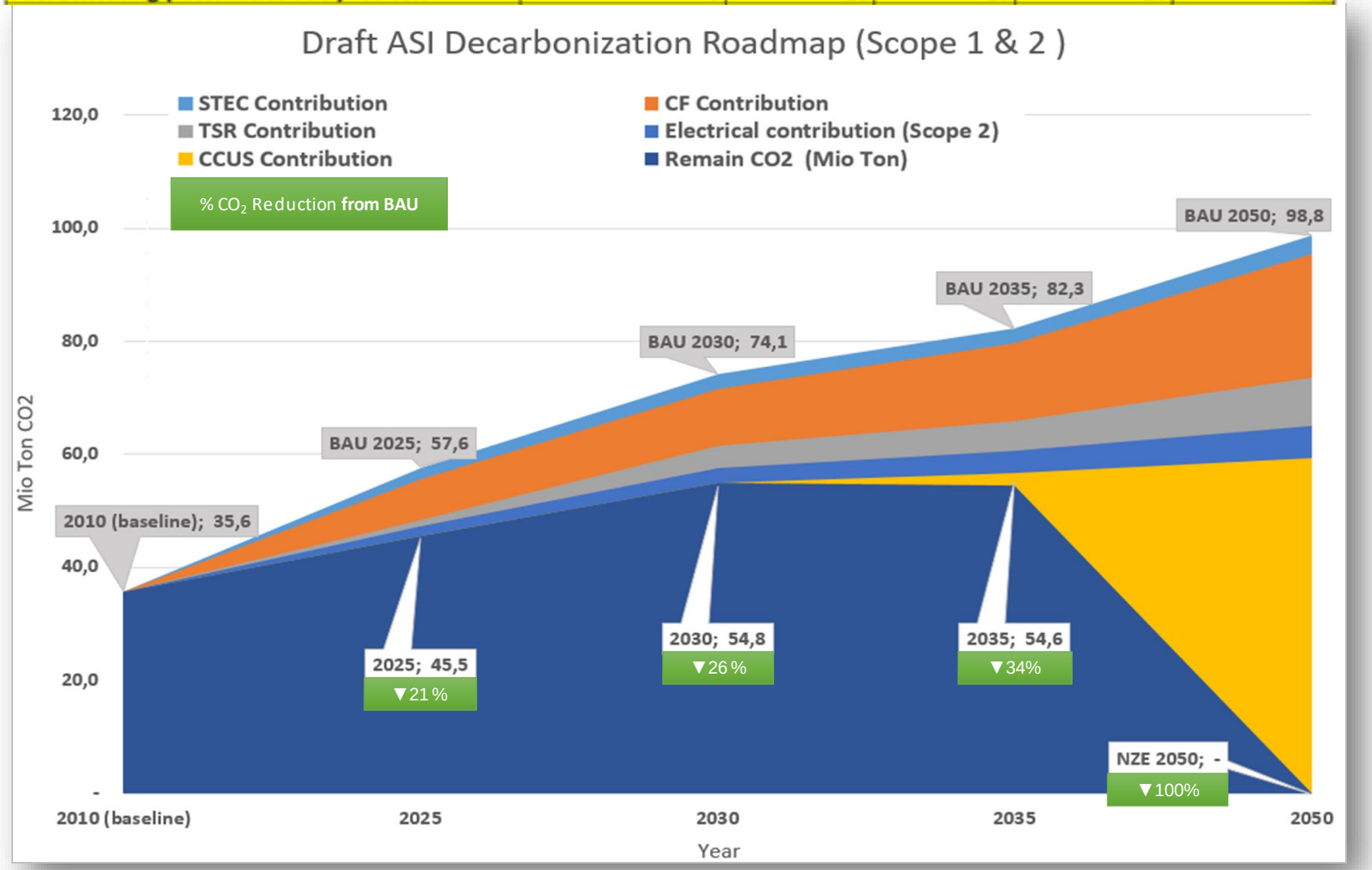
Trend and Projection of Thermal Substitution Rate (%)



Every 5 % Thermal Substitution Rate by using alternative fuel will reduce CO2 approx. 1.9 %

(ICA Draft) Decarbonization Road Map – Scope 1 and Scope 2

Parameter	2010 (baseline)	2025	2030	2035	2050
Produksi Semen (Ton)	43.200.000	70.000.000	90.000.000	100.000.000	120.000.000
Scope 1					
Reduction Clinker to cement ratio (%)	81	69	68	65	60
Fuel Switching (Alternative Fuel) - % TSR	3	11	23	28	40

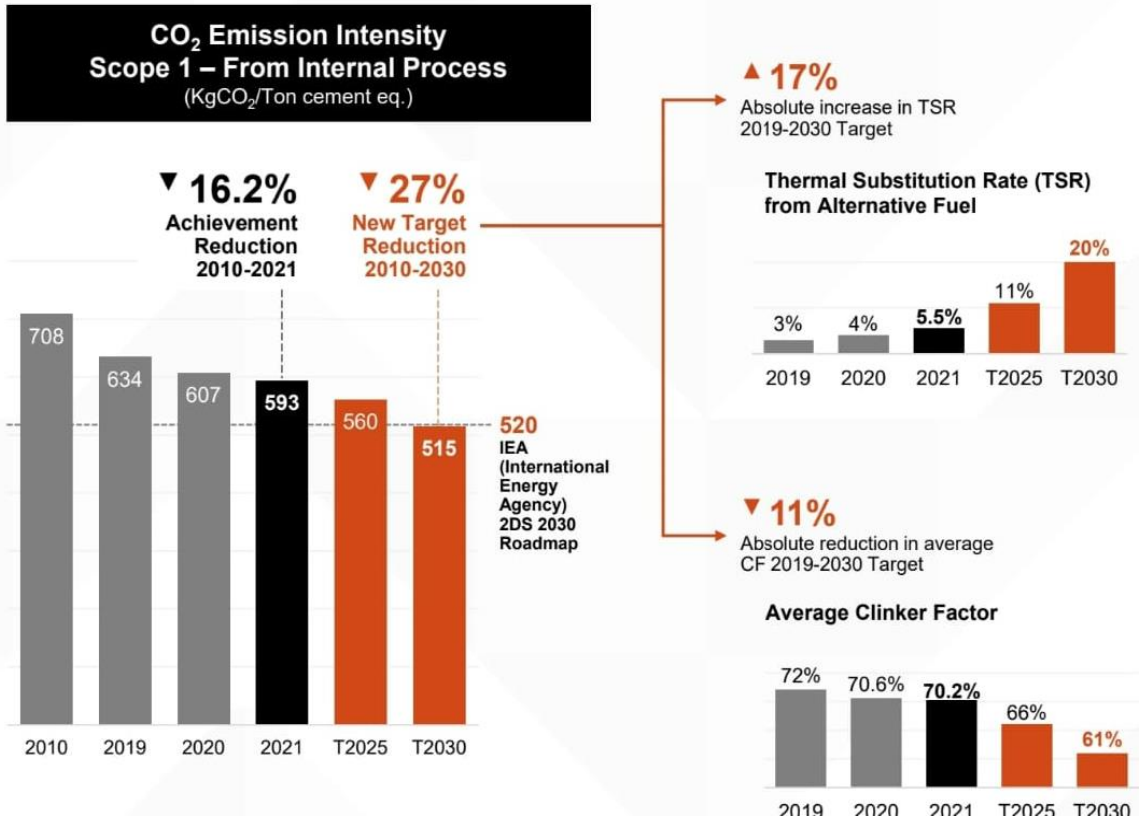


Initiatives contribution up to 2050	
STEC Contribution (%)	3,4
CF Contribution (%)	22,1
TSR Contribution (%)	8,7
Electric Scope 2 (%)	5,9
CCUs (%)	60,0
Total	100,0

- Decarbonization action till 2030 aim to reduce CO_2 emission by 19.3 mio tonnes (26% reduction from BAU), and directly affecting Green House Gas (which causing climate change)
- In the other hand, it gives growth opportunity for Technology Manufacturer and challenge for Cement Producer (due to additional cost)
- Therefore supports from regulator are required in accelerating the action as well (such as : incentive, carbon pricing mechanism)

Example of Company GHG Emission Reduction Roadmap & Initiative

Semen Indonesia Group



Initiative

Reduce Clinker Factor (CF) in Cement Production

- Substitution of CO_2 intensive clinker in cement with fly ash & bottom ash
- Promotion/advocacy for performance-based cement standard with lower clinker factor

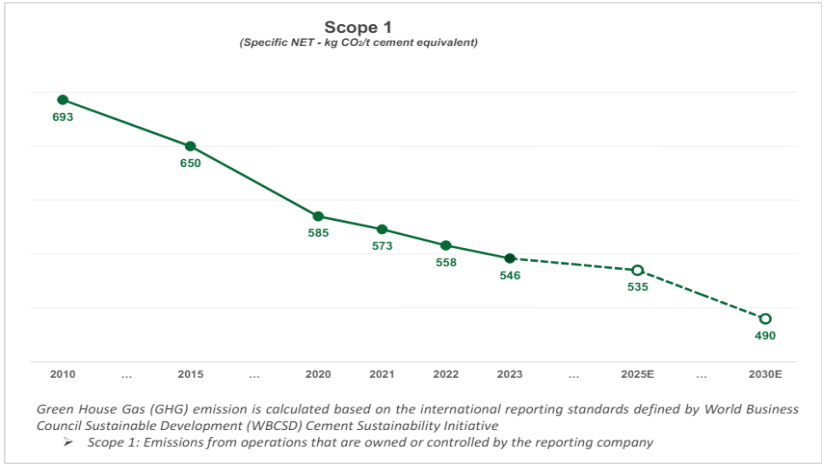
Optimize Specific Thermal Energy Consumption (STEC)

- Efficient plant thermal energy consumption
- Advanced process control rollout
- Innovation technology such as Hydrogen injection

Increase Alternative Fuel & Raw Material (AFR) Use

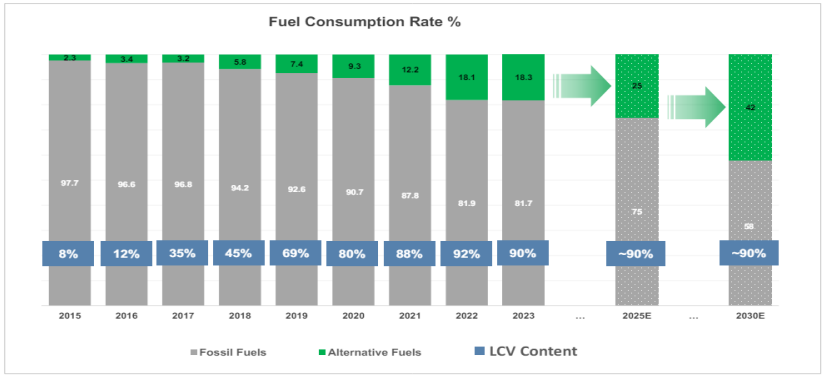
- AFR pre-processing & feeding facility improvement
- Anticipation in process/emission improvement
- Refused Derived Fuel (RDF) initiatives around plant operations
- Multi-stakeholder cooperation

Indocement Tunggal Prakarsa



Green House Gas (GHG) emission is calculated based on the international reporting standards defined by World Business Council Sustainable Development (WBCSD) Cement Sustainability Initiative

- *Scope 1: Emissions from operations that are owned or controlled by the reporting company*

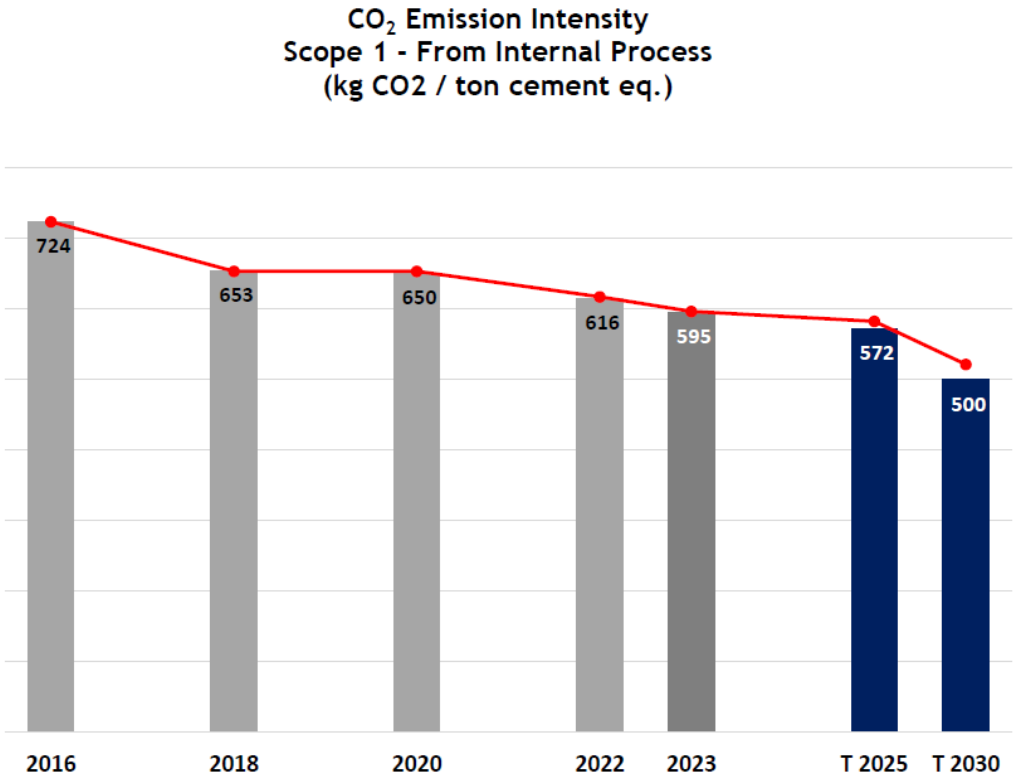


Initiative

1. Reducing clinker ratio by using alternative raw materials and additive substances to reduce carbon emissions.
2. Substituting fossil fuel with alternative fuels such as biomass, RDF and others.
3. Generate electricity from renewable energy sources, such as Solar Power and Waste Heat Recovery Power Generation.
4. Technology investment in carbon capture and utilization to reduce high CO2 emission volume

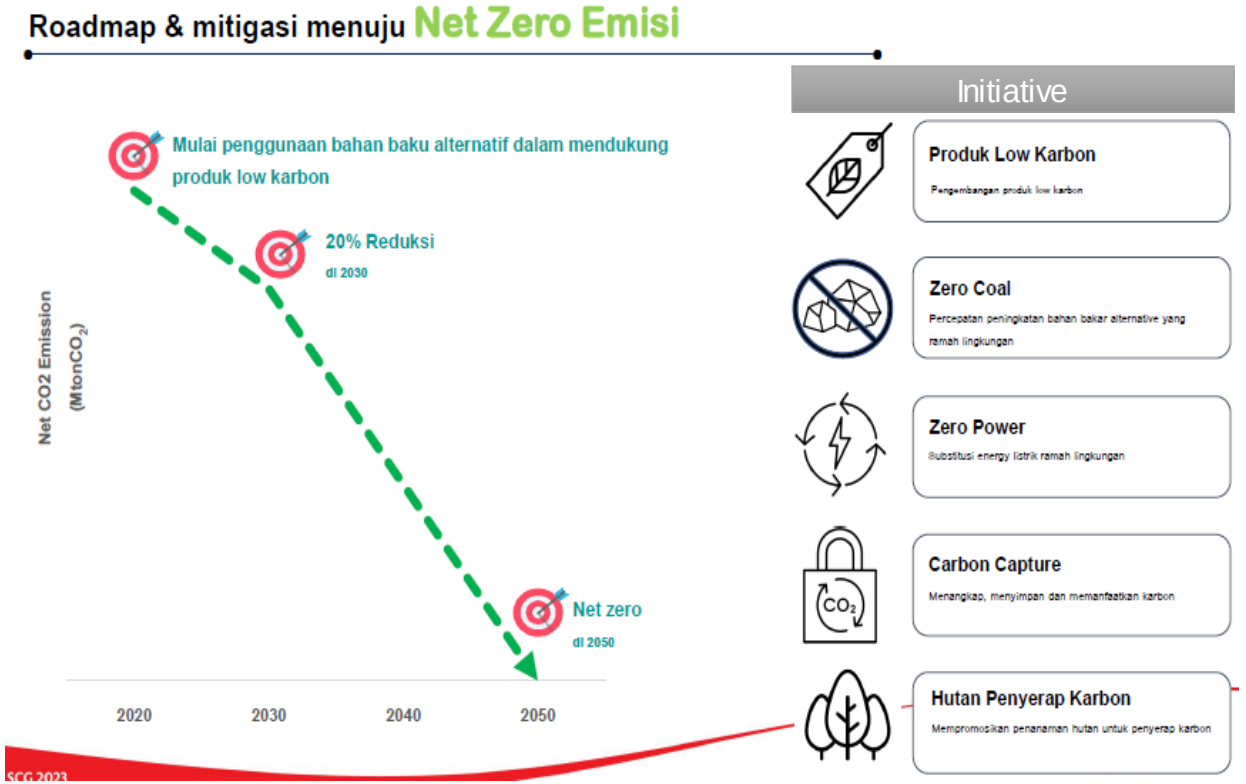
Example of Company GHG Emission Reduction Roadmap

Cemindo Gemilang

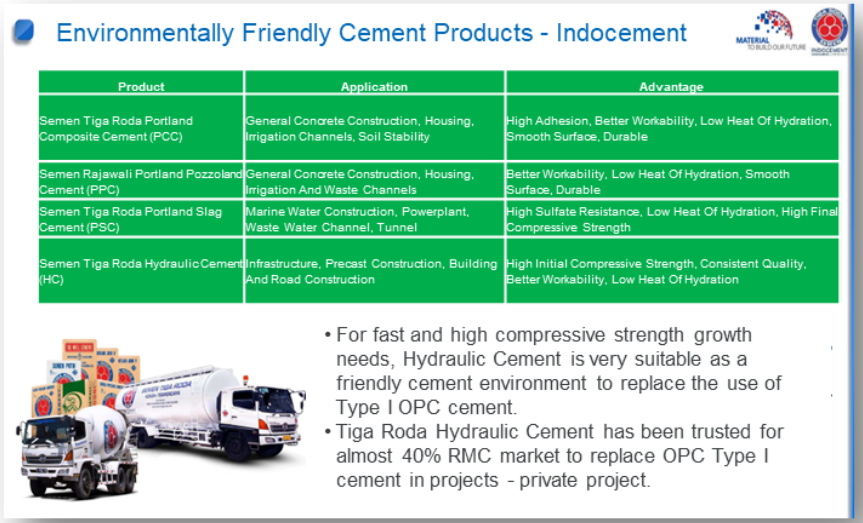


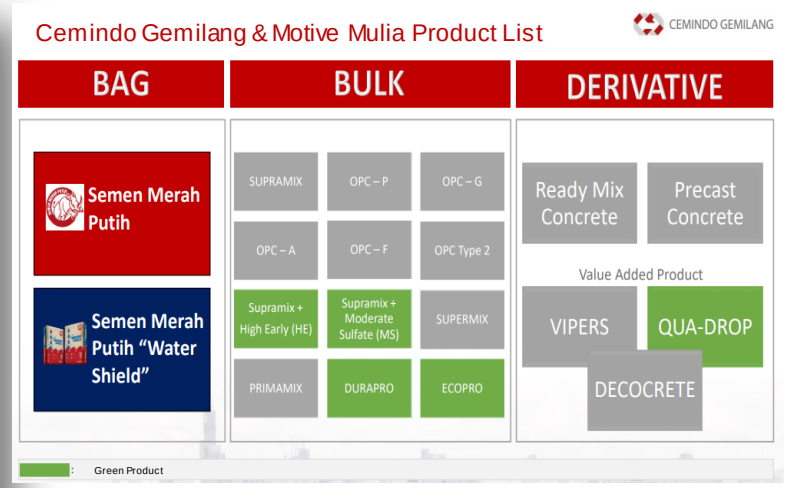
Initiative				
Reduce Clinker Factor in Cement Production	▪ New products development ▪ Optimizing product mix	Energy Efficiency	▪ Commissioning & maximizing utilization of Expert Optimizer (advanced process control) for Bayah Plant ▪ Improvements in preheater to reduce SHC ▪ Invested Electric Vehicles (EVs) to replace the use of internal combustion engine-based vehicles
Increase usage of alternative fuels and raw materials	▪ Installation of alternative fuel feeding facility on kiln # 2 ▪ Planting Kaliandra tree as alternative fuel at the Bayah Plant ▪ Starting of RDF projects in provinces near Bayah plant (Cilegon, Banten)		

Semen Jawa (SCG)



Initiative Examples: Clinker Factor Reduction For Environmental-Friendly Cement Products





Hidraulic Cement – HE Type → **29%** Lower than OPC tipe I emission

PPC Cement → **21%** Lower than OPC tipe I emission

PCC Cement → **32%** Lower than OPC tipe I emission

Portland Slag Cement (PSC) → **38%** Lower than OPC tipe I emission

▶ **Impact :**

- ❑ 1% CF reduces the specific electrical energy by approx. 0.8-0.9 kWh/t.cem
- ❑ 1% CF reduces the specific CO2 Emission by approx. 2-3 kg.CO2/t.cem
- ❑ 1% CF decrease will reduce around 0.96% in production cost

Initiative Examples of Switching to Alternative Fuel (1)

Industrial Waste

Type of wastes:
- Rubber waste
- Used rags
- Plastic waste
- Oil sludge
- Textile & garment waste
- Expired products
- etc

Biomass

Type of wastes:
- Rice husk, wood chip, saw dust, coffee husk

Municipal Solid Waste

Type of wastes:
- Municipal solid waste to RDF

▶ **Examples :**
- ❑ SIG Group (Industrial waste, Biomass, and RDF cooperation with local government
- ❑ Indocement (Investment on RDF feeding facilities and coop. with Jakarta for Bantar Gebang wast),
- ❑ Cemindo Gemilang (Planting Kaliandra as alternative fuel at Bayah Plant, investment on RDF feeding facilities and coop. with local government

▶ **Impact :**
- ❑ **5% Alt Fuel Increase will reduce 1 – 2% emission**
- ❑ **1% TSR increase will reduce around 0.6% fuel cost**

Initiative Examples of Switching to Alternative Fuel (2) MSW to RDF Development Project

SBI as The Pioneer in The Implementation of Refuse-Derived Fuel (RDF) Technology in Indonesia

The first trial of Biodrying technology at SBI Narogong Plant Geotainer facility in 2016 as a basis for the RDF facility design at the Cilacap Plant.

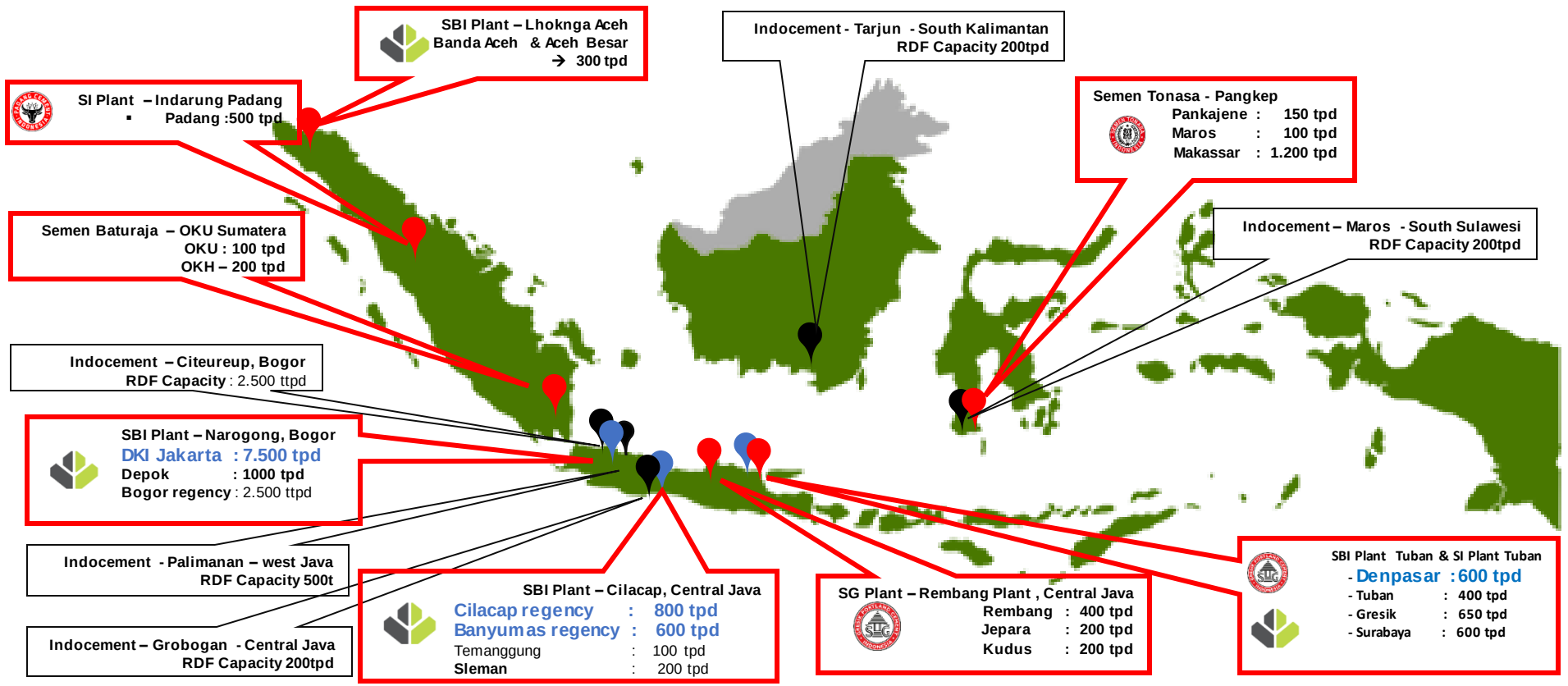
Together with Central Java Provincial Government & Cilacap Regency, MOEF, Ministry of Public Work and Danish Embassy, SBI involved as the pioneer of the first RDF facility in Indonesia with a capacity up to 160 tons/day of municipal waste, which will be proceed into RDF as an alternative fuel & substitute 40 tons of coal in SBI Cilacap Plant.

“RDF Utilization helps create an healthier environment for society

SBI utilized RDF processed in Bantargebang, through RDF facility managed by DKI Jakarta Provincial Government

Initiative Examples of Switching to Alternative Fuel (3) MSW to RDF Development Project

Map of potential future development of MSW business for Cement Industries in Indonesia



NOTE :
Cement Plant use RDF
- SIG
- ITP

Development Completed & Continue for Operation Phase :

1. Cilacap : 70 – 80 ton/day RDF from 160 ton/day fresh MSW
2. DKI Jakarta : RDF Bantargebang (700 ton/day RDF)
3. Banyumas : Residue from ITF (10 – 15 ton/day RDF)
4. Denpasar - Bali : 220 ton/day RDF

On Going & Next Project :

1. Aceh : 300 ton/day MSW
2. Padang : 300 ton/day MSW
3. Tuban : 150 ton/day MSW
4. Temanggung : 100 ton/day MSW
5. Sleman : 200 tpd MSW
6. Depok : 600 ton/day MSW
7. Purwakarta : 200 ton/day MSW
8. Magelang : 500 ton/day MSW
9. Rembang : 200 ton/day MSW
10. Citeureup – Bogor: 2,500 ton/day MSW
11. Palimanan-Cirebon : 500 ton/day MSW
12. Grobogan : 200 ton/day MSW
13. South Kalimantan : 200 ton/day MSW
14. South Sulawesi : 200 ton/day MSW

Cement Company	Clinker Capacity [ton per year]	TSR [%]	RDF Volume		MSW Equivalent Volume	
			Ton per year	Ton per day	Ton per year	Ton per day
Semen Indonesia Group	38,460,000	10	1,058,552	3,529	2,301,200	7,671
Other Cement Plant	35,820,432	10	933,247	3,111	2,028,799	6,762

Note : TSR = Thermal Substitution Rate

Initiative Examples of *Energy Efficiency*: Digitalization – Smart Plant

Energy Efficiency Improvements and Developments

- Maximize Production Rate and reduce unplanned stops
- Periodically Energy Audit and Programs, i.e. False Air Reduction and Idle Managements Programs
- Equipment Upgrade & Optimization
- Smooth operation with Low Grade Fuels. etc.

*However, it is not enough with continuous improvement and development, **digitalization** can increase energy efficiency through technology that collects and analyzes data to effect real-world changes in energy use….*

Contributions :

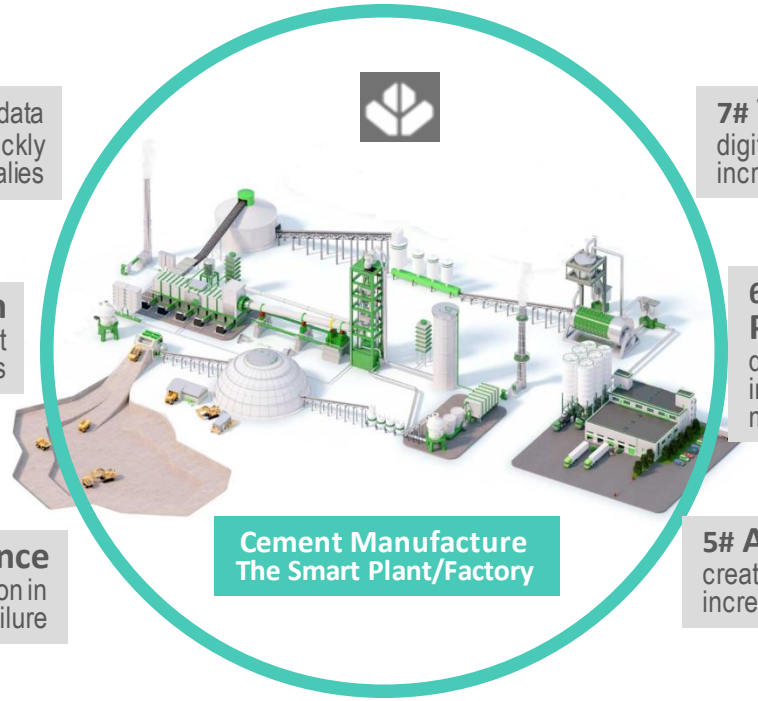
Impacted to KPI :
- Improve Performance of Plant scale
- Significantly lower cost
- Economic of scale
- Standardized & Simplification

PEOPLE & MANAGEMENT :
- Speed of Decision Making
- Empowering People
- New Skills & discipline
- New working culture
- Digital & innovation culture

1# Real time data monitoring data will be recorded in milliseconds to quickly detect and correct anomalies

2# Predictive Operation
Advanced control algorithm predict process behavior and anomalies

3# Predictive Maintenance
System detect abnormal condition in real time and predicts time to failure



7# Virtual Reality : create digital twins of cement plants to increase efficiency of sites

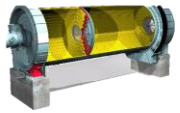
6# Maintenance & Production inspection
digital mobile device for report inspection instantly result to management system

5# Automation & Robotic
create digital twins of cement plants to increase efficiency of sites

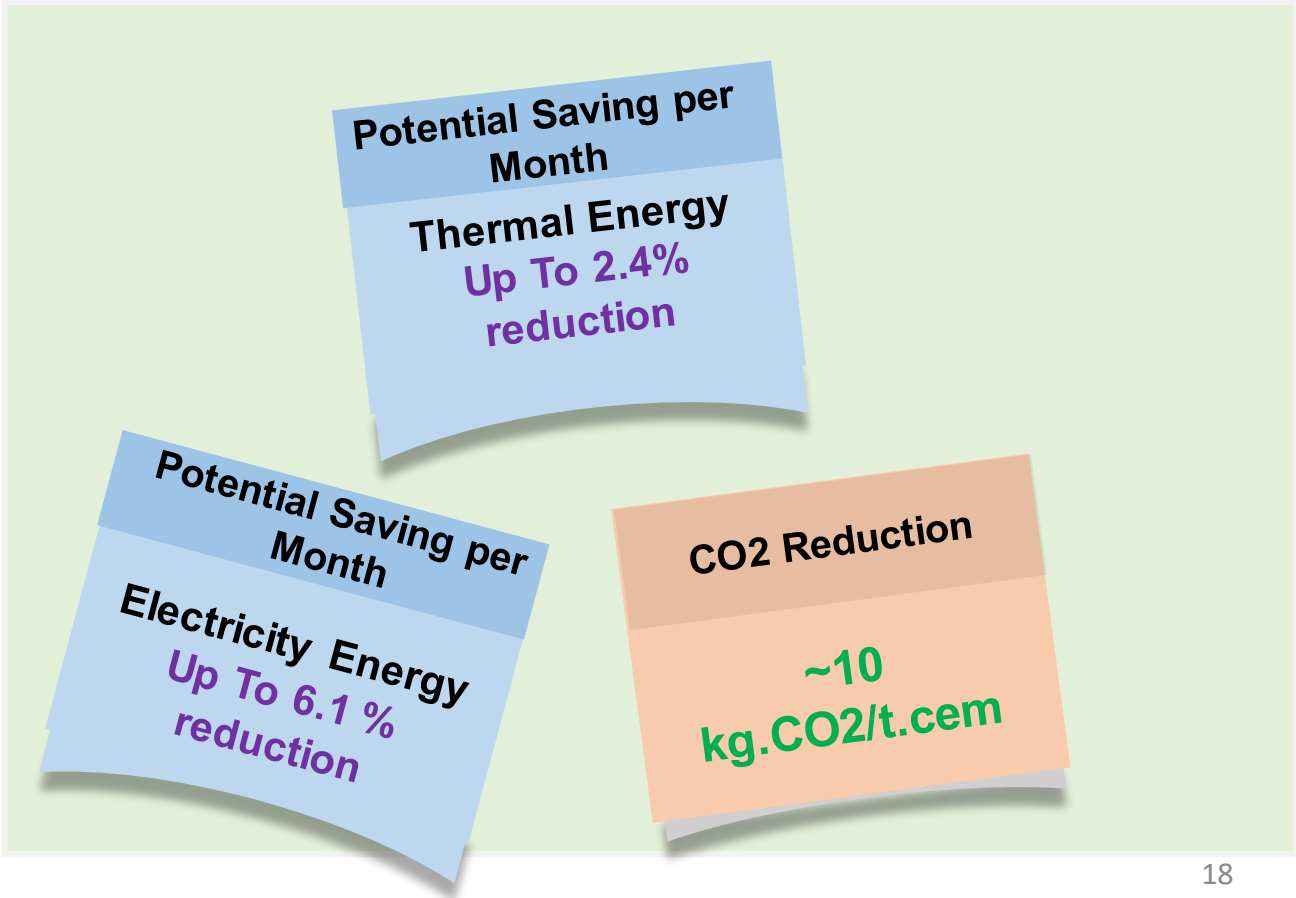
4# Performance & Collaboration Tool (PACT) :
Moves operational decision making from experience base **to data centric**. It combine data from various source and enable machine learning/AI application

Initiative Examples of *Energy Efficiency*: Digitalization – Smart Plant

Advanced Process Control (APC) Use Case

		Subject	Value (in %)
Raw Mill		Rate Index ↑	1.5 till 3.71 %
		Electricity ↓	2.85 till 5.97 %
Kiln		Rate Index ↑	1.06 – 2.5 %
		Thermal ↓	1.47 till 2.43 %
		Electricity ↓	0.1 till 6.12 %
Ball Mill		Rate Index ↑	2 till 5.1 %
		Electricity ↓	-2 till 4.8 %
VRM Cement		Rate Index ↑	2.32 till 3 %
		Electricity ↓	2.56 till 5.28 %

Potential Energy Savings

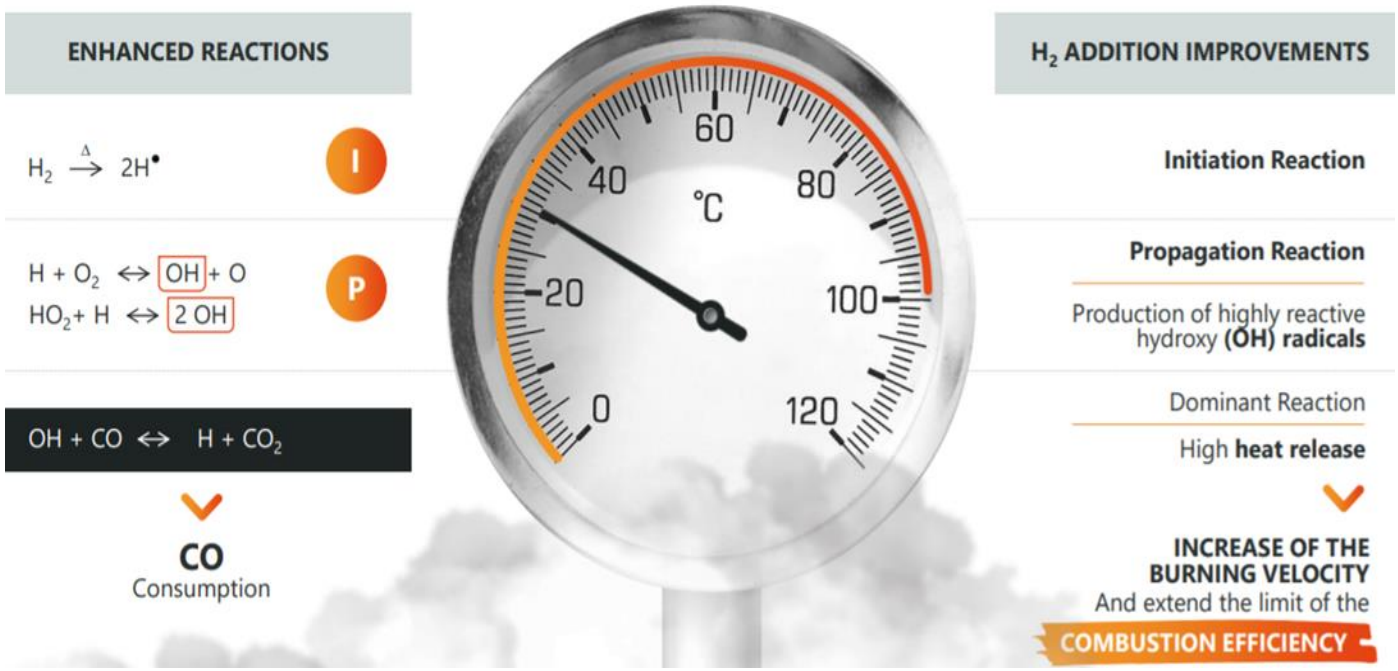


- ❑1% Thermal Energy Consumption decrease will reduce around 0.33% in production cost
- ❑1% Electrical Energy Consumption decrease will reduce around 0.21% in production cost

Initiative Examples of *Energy Efficiency*: *Hydrogen Injection Technology Use Case*

Optimize Specific Thermal Energy Consumption (STEC)

Technology implementation improve combustion quality, ensuring CO reduction, by increase combustion speed without any environmental impact



Implementation Result

- **Production rate increase** around **3.86 – 4.49%**
- **Thermal energy (STEC) reduction** around **1.7 – 2.2%**

TOTAL ENERGY REDUCTION in 5 Month (-45.2) Terra Joule (or -9.0 TJ/Month)

CO_2 Reduction ~11.752 ton per year

CO_2 Reduction ~5.4 kg.CO2/t.cem

SMALL AMOUNTS of H2 and O2, produced by PEM technology, are injected into the existent combustion system.

THE INCREASE IN SPEED OF THE COMBUSTION, promoted by H2 addition, is most likely a chemical effect rather than a thermal effect

Initiative Examples of *Energy Efficiency*: *WHRG Use Case*

Semen Indonesia

- **WHRPG (Waste Heat Recovery Power Generation)** plant has been installed at Semen Padang (Ind.5 Plant) & Ghopo-Tuban
- SP : 8.5 MW Capacity, Tuban : 21 MW Capacity
- ***Reduce CO_2 emission by ± 800 kg CO_2/MWh generated***
- Saving Estimation : 120 Bio IDR/Year

Cemindo Gemilang

- **WHRS (Waste Heat Recovery System)** plant has been installed at Bayah Cement Plant (Line 1 & Line 2)
- Capacity : 2 x 15 MW
- ***Reduce CO_2 emission by ± 877 kg CO_2/MWh generated***
- Saving Estimation : 27.82 Bio IDR/Year

Key Messages

1. From 2010 to 2022, the carbon intensity of Indonesia cement industry reduced from 725 kg CO2/ton cementitious to 631.70 kg CO2/ton cementitious, achieve an absolute emissions reduction of 6.54 Million ton CO2 or have reduced by 12.9 per cent. The cement industry plays a crucial role in reducing CO_2 emissions, and its commitment to implementing strategic initiatives is essential to achieving net-zero carbon emissions.

2. **Green Industry Cement**

   Ready to support Green Industry Program in reducing CO2 through the use of **Renewable Energy** including biomass, municipal waste such as RDF, and industrial waste. Besides that, cement manufacturers are currently producing a lot of environmentally friendly cement products, and however some of the **lower carbon products** need Indonesian Standard (SNI) acceleration, in addition, to supporting material specifications for infrastructure projects that accommodate environmentally friendly cement.

3. **Support from the Government on the regulation and policy is needed mainly to boost up the initiative of decarbonization**.

4. Decarbonization initiative best practice in Indonesia cement industry shows that initiative implementation not only **contributes to CO_2 emission reduction , but also increases cost competitiveness**

Thank You

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