End-Use Model for Indonesia Low-Carbon Development Pathways in Energy Sector

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INSTITUT TEKNOLOGI BANDUNG

OUTLINE

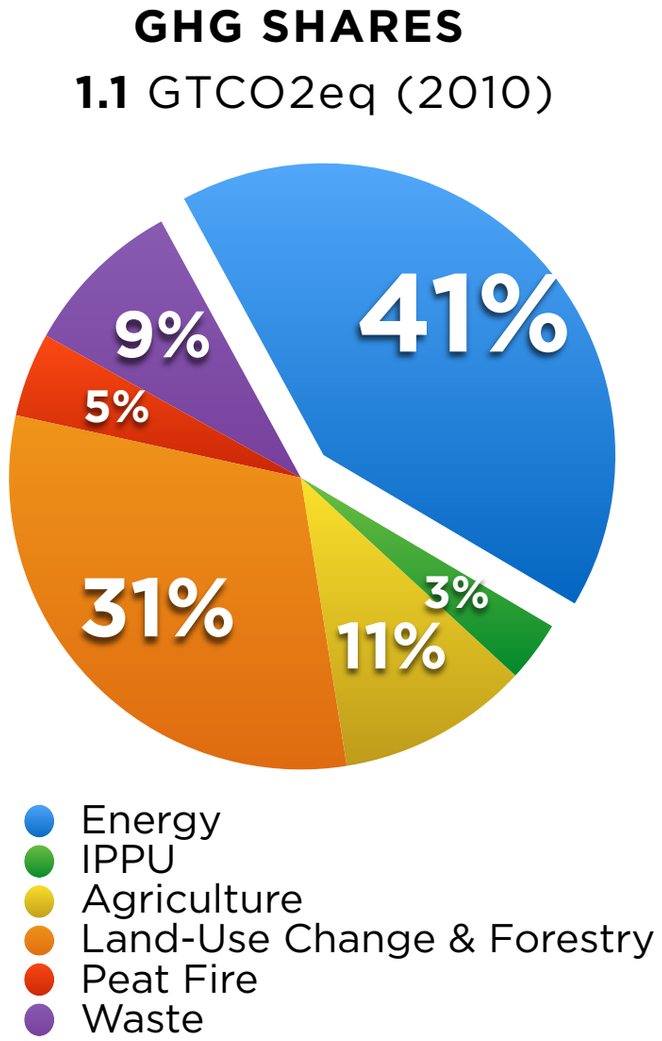
1. Introduction
2. Current Energy Situation in Indonesia
3. Energy and GHG Emission Model Using **End-Use GAMS**
4. Socio Economic Condition and Projection
5. **Low Carbon Development Path** of Energy Sector and **GHG Emission Reduction**

LCD is long term vision (2050) of economic development in a low-carbon way

Challenge for achieving LCD is now in a global mainstream. Particular emphasis in short-term (2020) is to address options for achieving GHG reduction target (National Action Plan) up to 26% below the baseline using domestic budget and further up to 41% if there is international support.

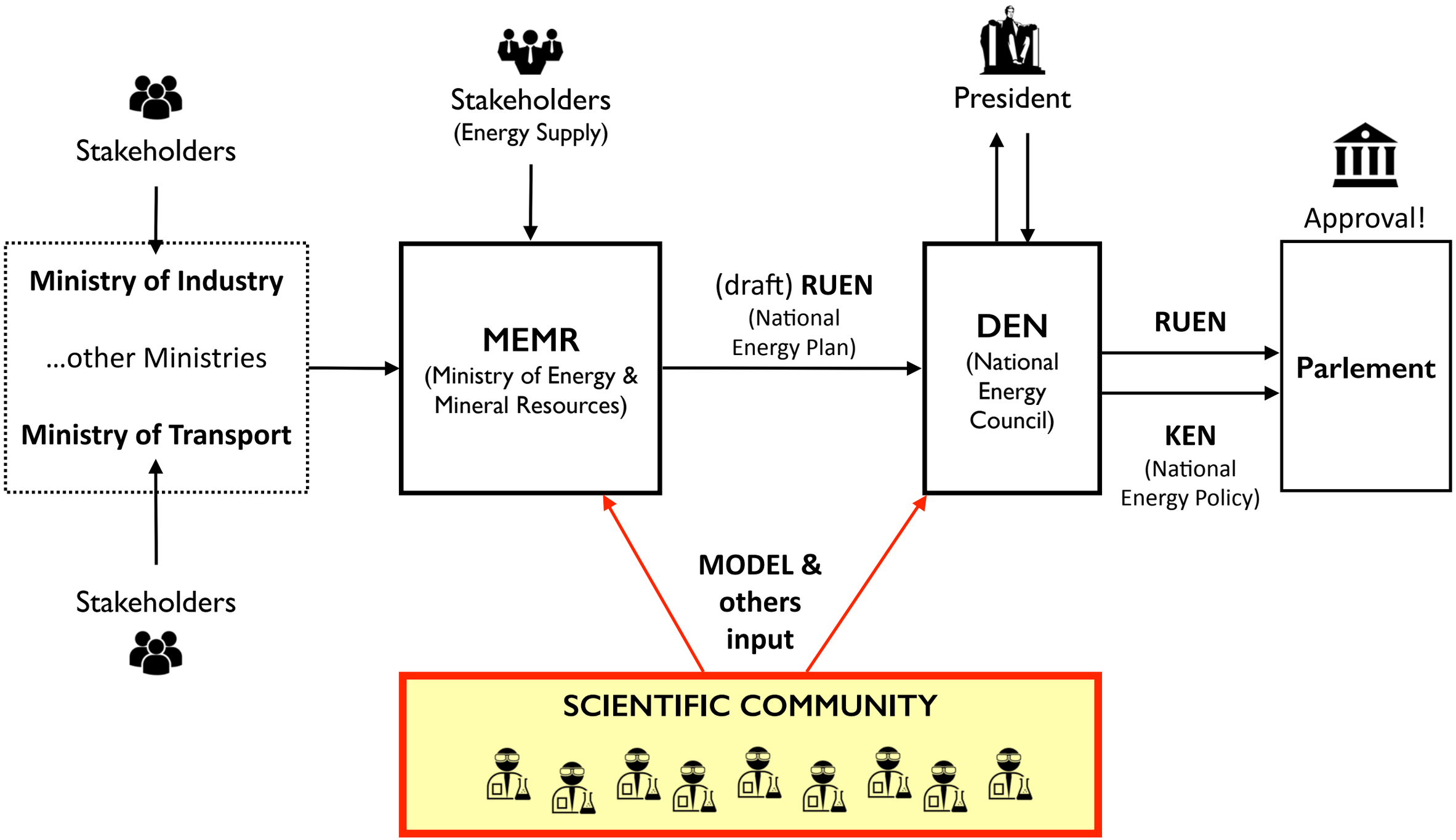
Activities in achieving this reduction target are supported by PerPres 61/2011 (National Action Plan for GHGs Mitigation Action) and PerPres 71/2011 (GHGs Inventory).

LCD strategy is not to achieve world's target on carbon intensity level; it is more to explore possibilities of the future development in a low-carbon way.

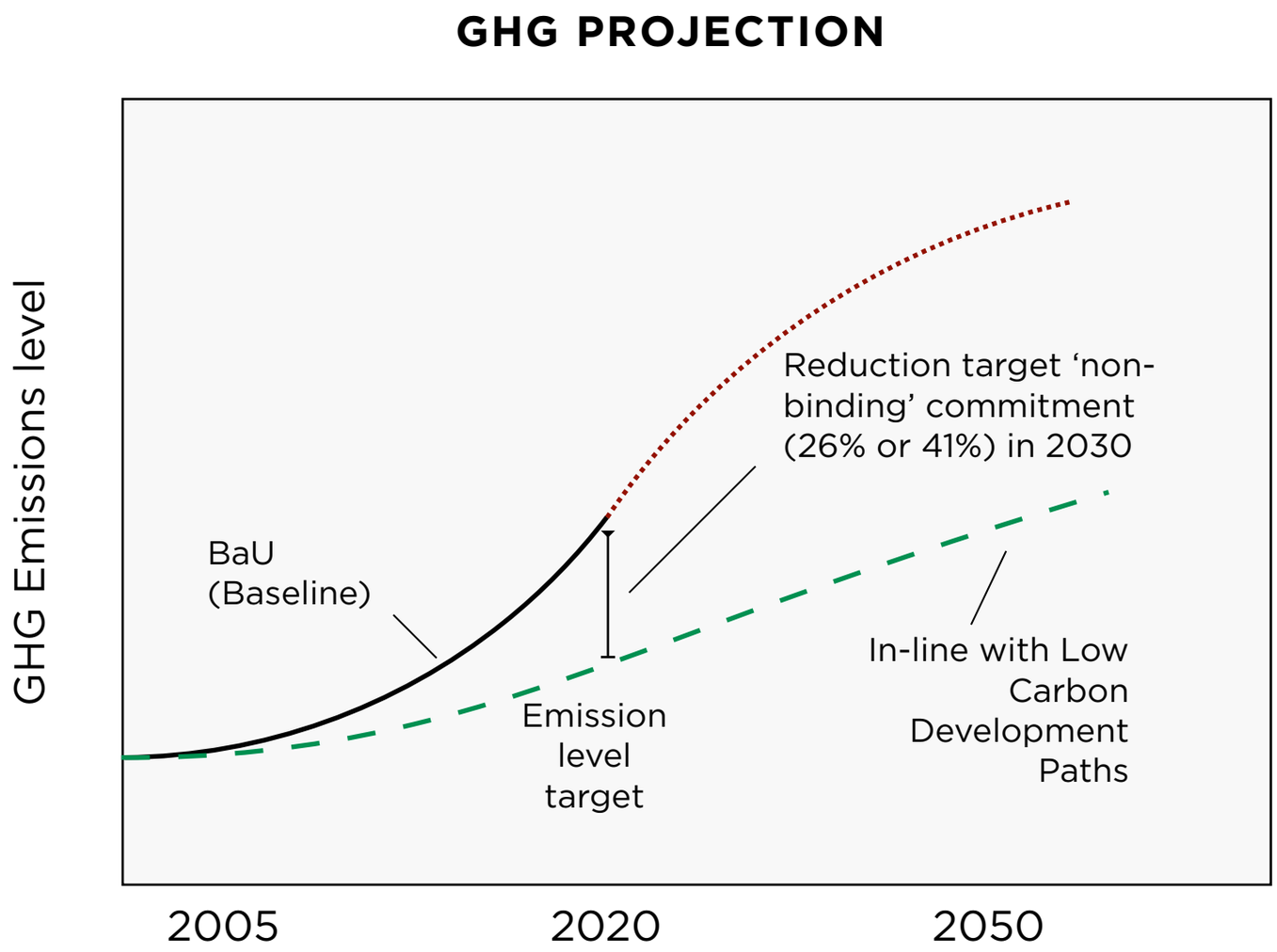


This publication presents 'End-Use Model for Indonesia Low-Carbon Development Pathways in Energy Sector' that is used for identifying development paths of energy sector and cost of development, GHG reduction potential if the development paths Toward to Low Carbon and costs of actions for reducing GHG in 2020 and 2050.

Inputs for Government of Indonesia in developing energy policy



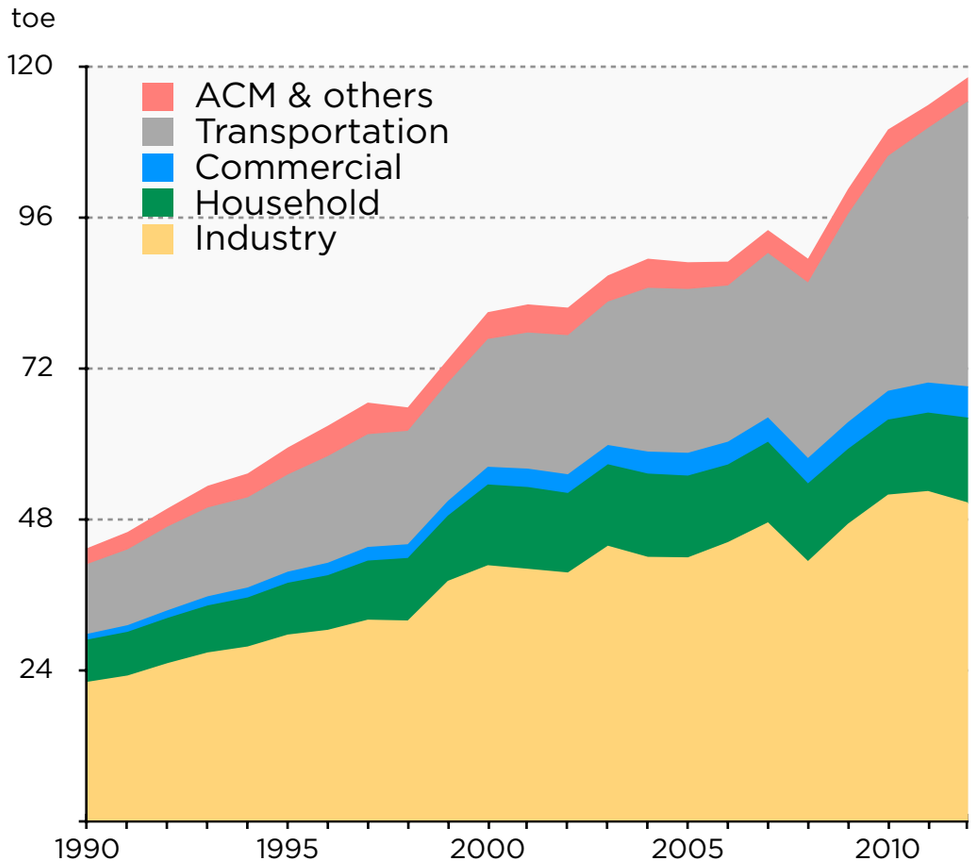
In response to climate change issues, GoI in 2010 announced 'non binding commitment' to reduce GHG emissions 26% below the baseline by 2020 with domestic budget and further up to 41% with international support.



To achieve the target, the government developed mitigation actions plan that is published as National GHG Mitigation Action Plan (RAN GRK).

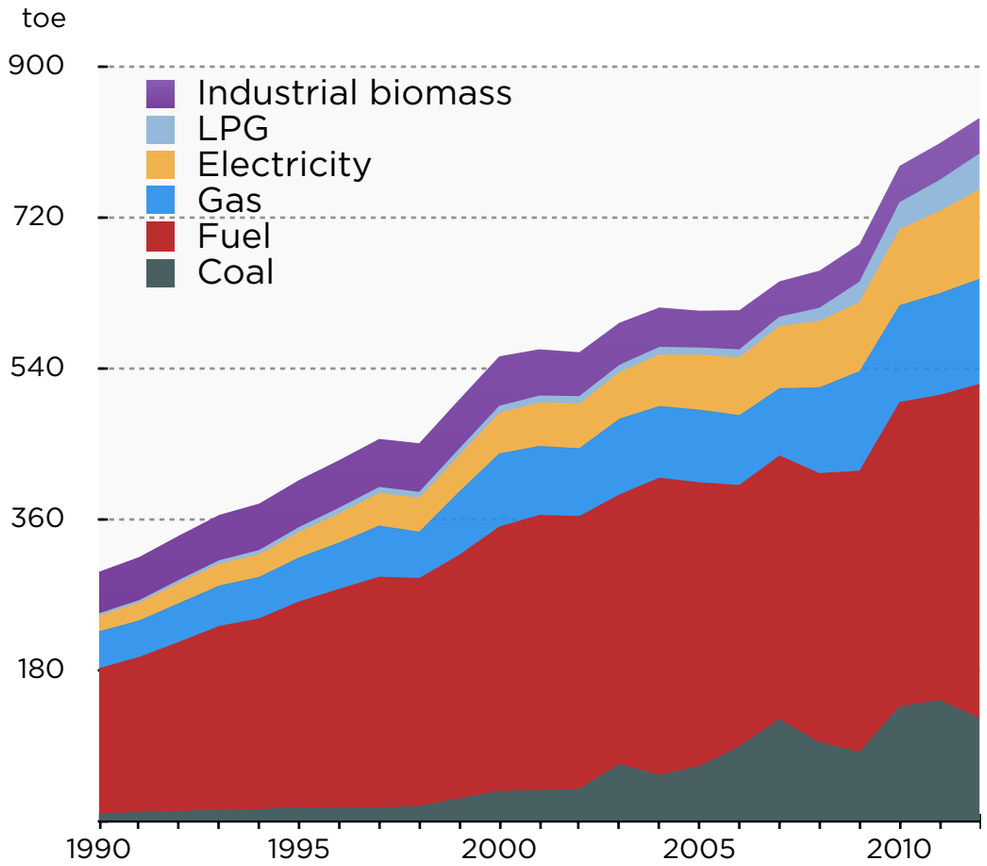
Significant increased in energy demand over transportation and industrial sector.

SECTORAL ENERGY DEMAND (“90-“12)



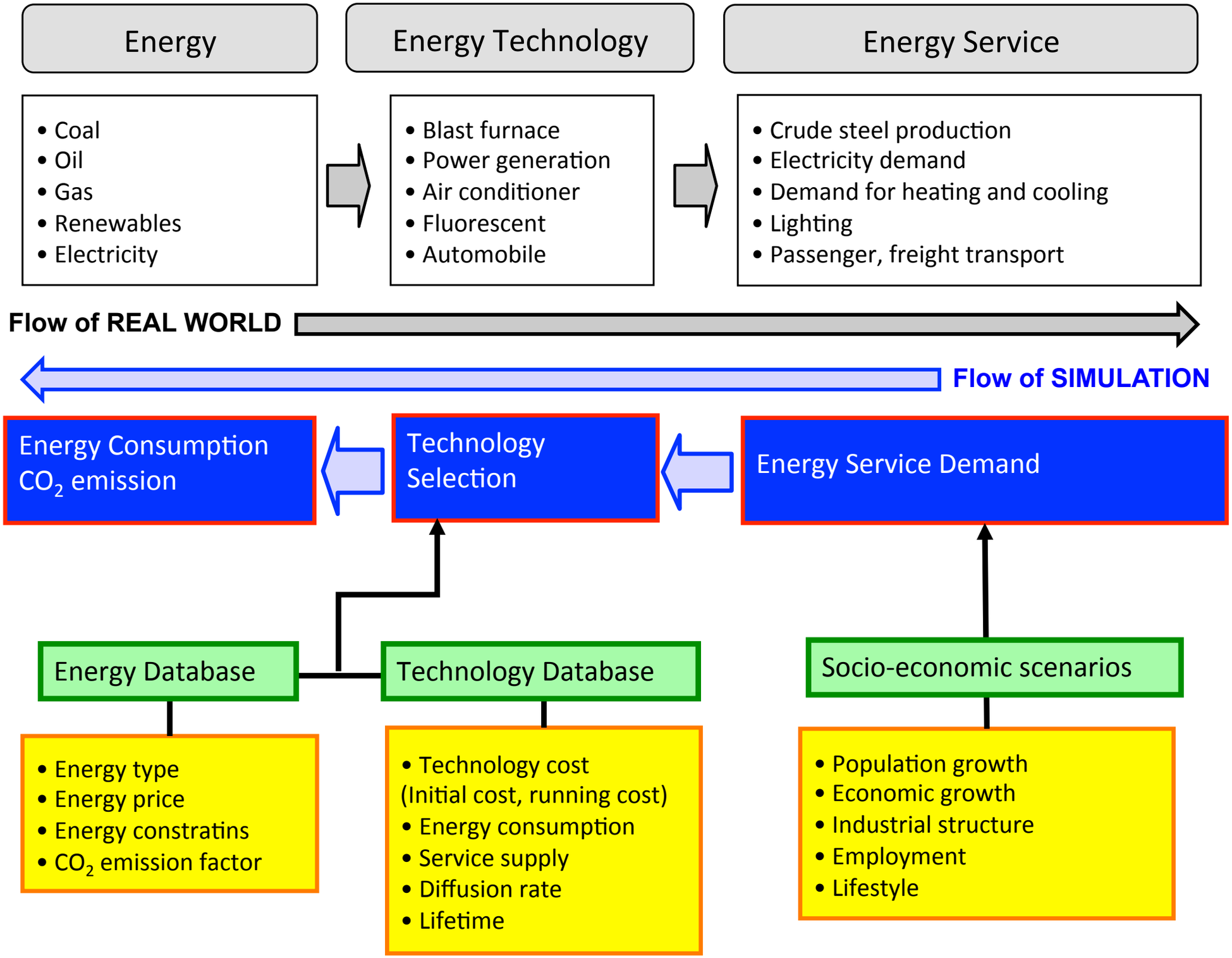
source: Pusdatin—ESDM

FINAL ENERGY DEMAND (“90-“12)



source: Pusdatin—ESDM

Implicating to increase in demand on energy, noticing that GoI is planning to transform their energy mix in increasing energy security and achieving climate targets.


Energy
Energy Technology
Energy Service
• Coal
• Oil
• Gas
• Renewables
• Electricity
• Blast furnace
• Power generation
• Air conditioner
• Fluorescent
• Automobile
• Crude steel production
• Electricity demand
• Demand for heating and cooling
• Lighting
• Passenger, freight transport
Flow of REAL WORLD
Flow of SIMULATION
Energy Consumption
CO_2 emission
Technology
Selection
Energy Service Demand
Energy Database
Technology Database
Socio-economic scenarios
• Energy type
• Energy price
• Energy constratins
• CO_2 emission factor
• Technology cost
(Initial cost, running cost)
• Energy consumption
• Service supply
• Diffusion rate
• Lifetime
• Population growth
• Economic growth
• Industrial structure
• Employment
• Lifestyle

Non-linear programming (GAMs End-Use & Extended Snap Shot) is used as a tool for developing energy development paths and estimating associated GHGs.

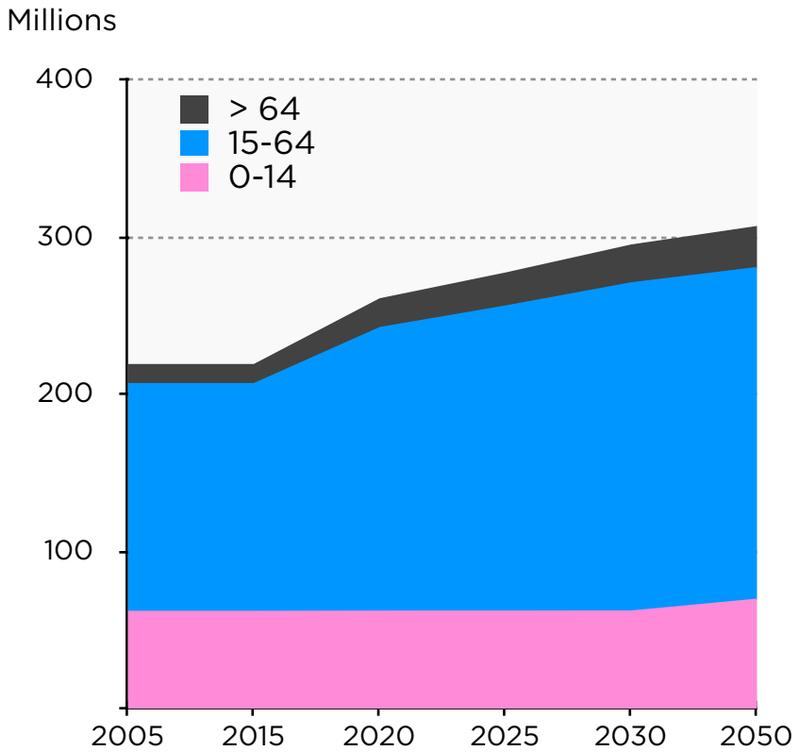
Two projection scenarios are developed:

BaU	Mitigation (CM1&2)
envisions development paths of energy sector and the associated GHG emission without considering mitigation efforts	development paths to achieve low carbon through: • **efficiency & conservation;** • **advance technologies;** • **renewables;** • **CCS**
Base year for projection scenarios is 2005 and target year is 2020 and 2050	

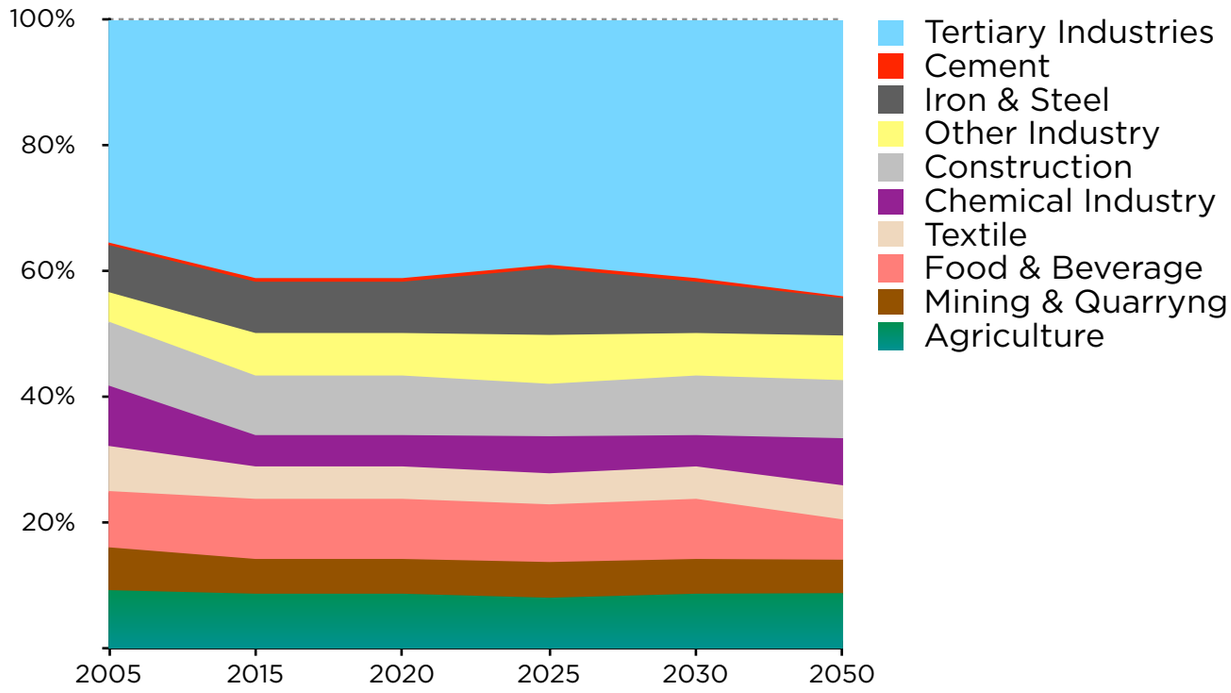
Energy demand projection is gathered from ExSS results. Analysis of socio-economic data (driving forces) projects the final energy demand.

(Driving Forces) Input Parameters to ExSS Modelling.

POPULATION



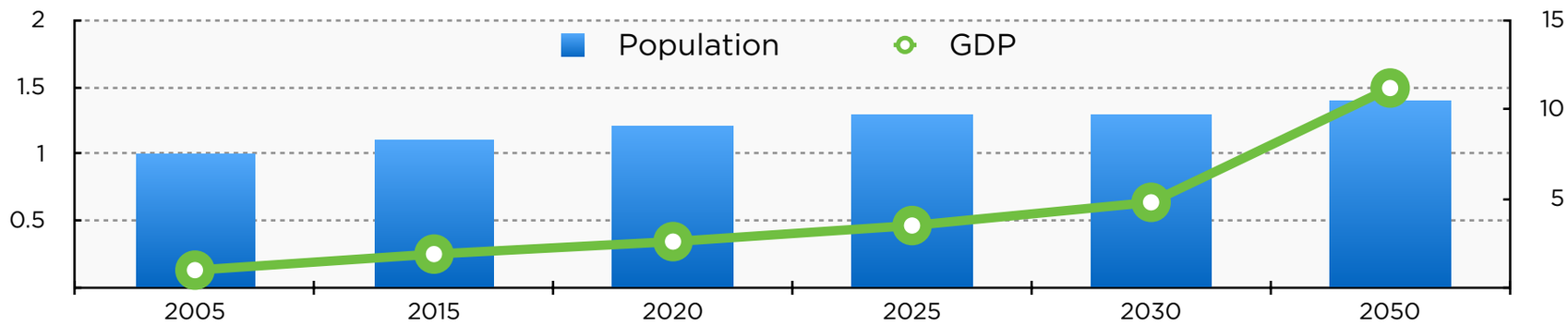
INDUSTRIAL OUTPUT



	2005	2015	2020	2025	2030	2050
Trillions IDR	3.53	6.67	9.10	14.11	16.92	38.99

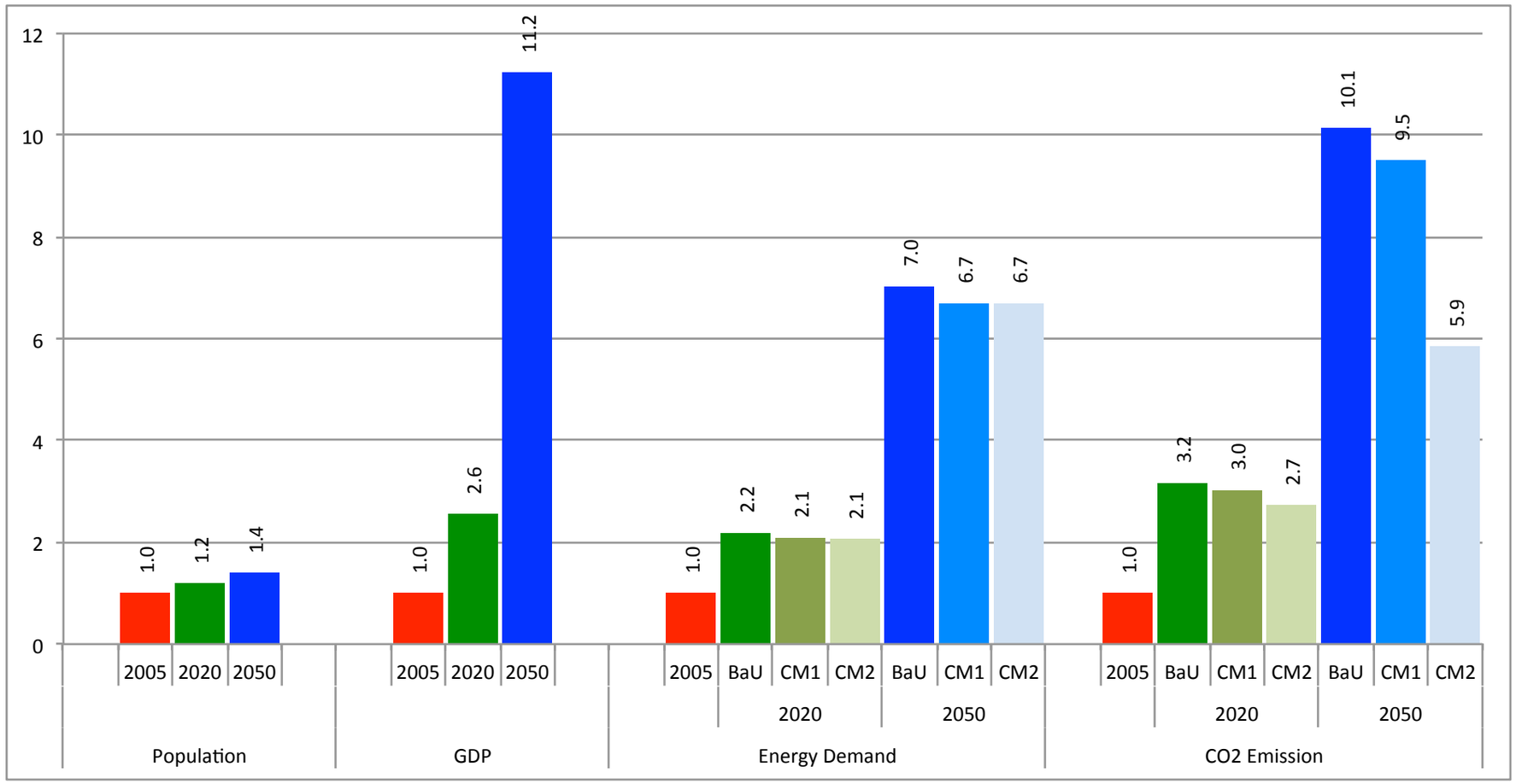
POPULATION GROWTH

GDP GROWTH



source: BPS

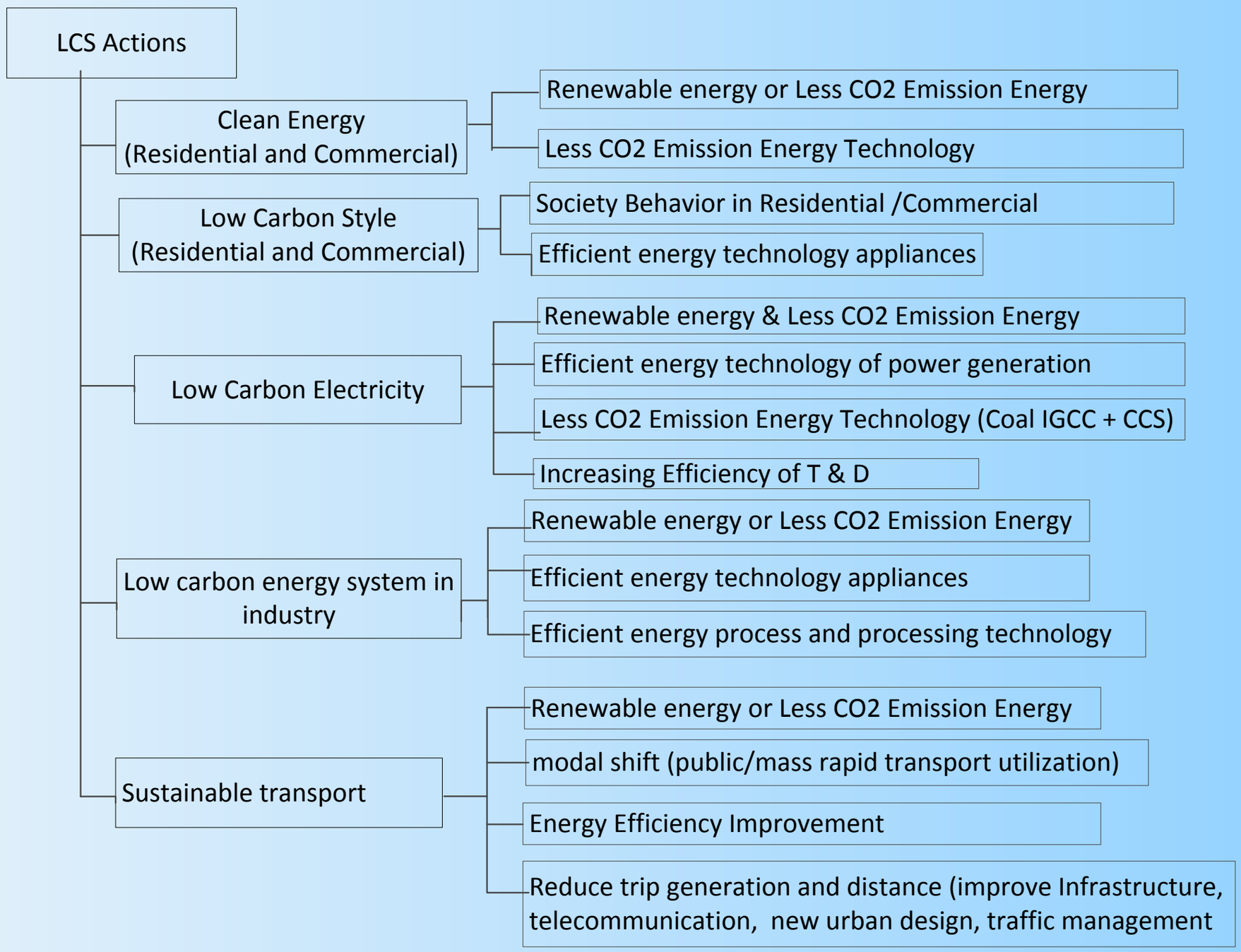
Baseline scenario:
Projection of GHG emission under expected socio-economic development in Indonesia without additional countermeasures to reduce GHG from energy.



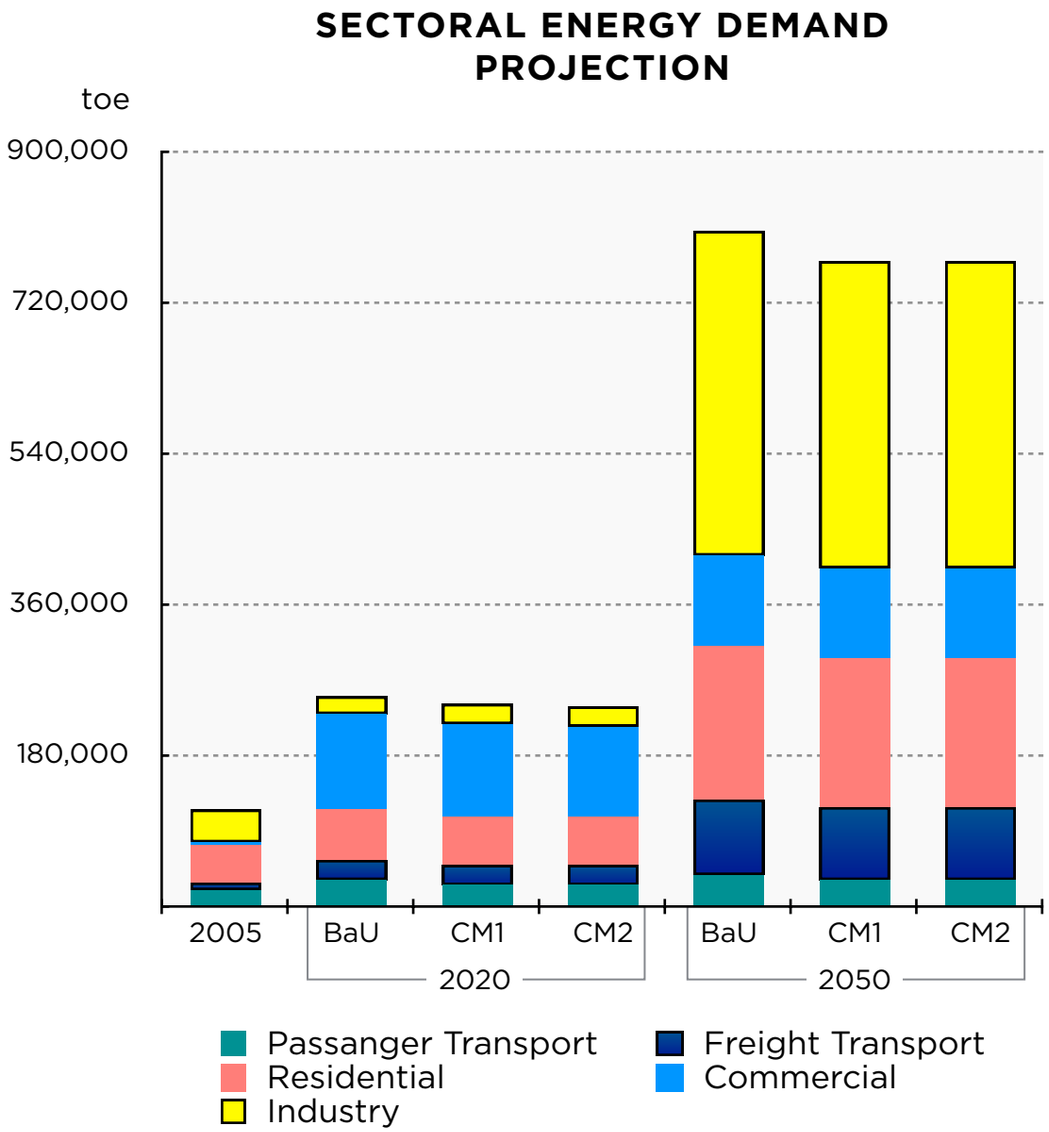
Counter Measure (CM) scenario:
Introduction of low-carbon measures which are already available. Assumptions are based on the official target (RAN-GRK, reduce 38 $MtCO_2$ in energy sector).

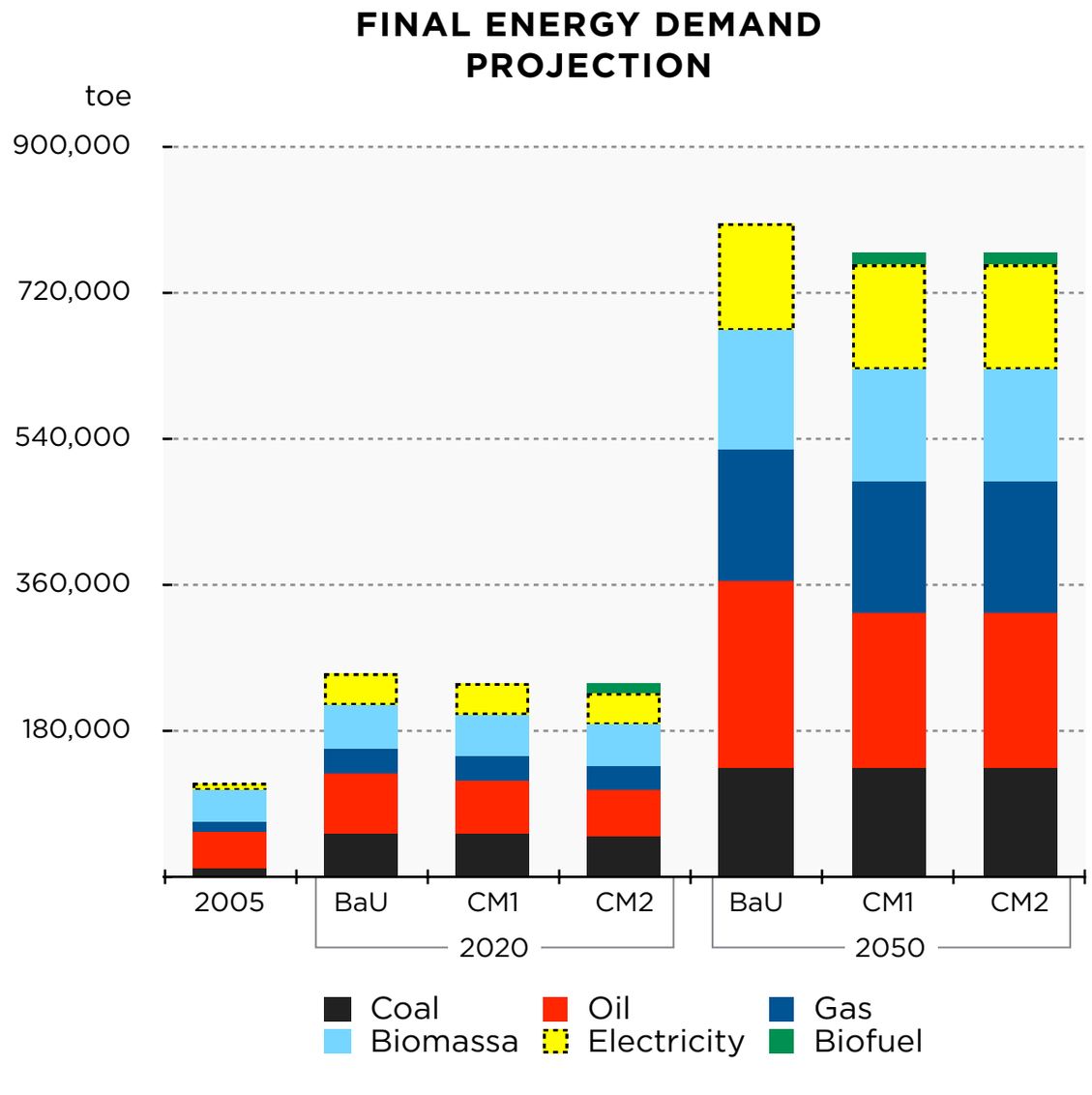
This model assess the impacts of different measures in LCS Actions.

LOW CARBON DEVELOPMENT
STRATEGY



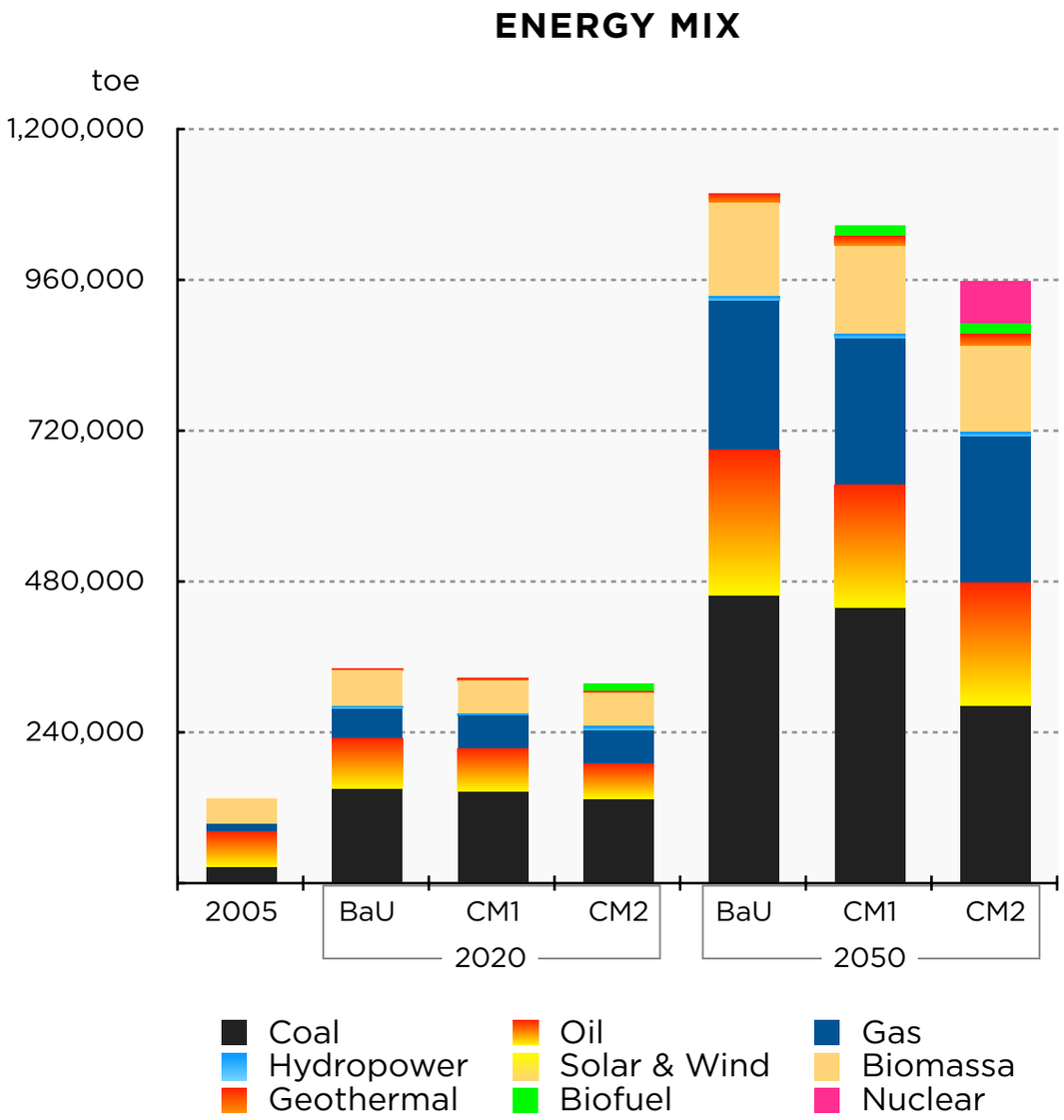
Difficult to move away from Oil — large share of oil in energy demand by type

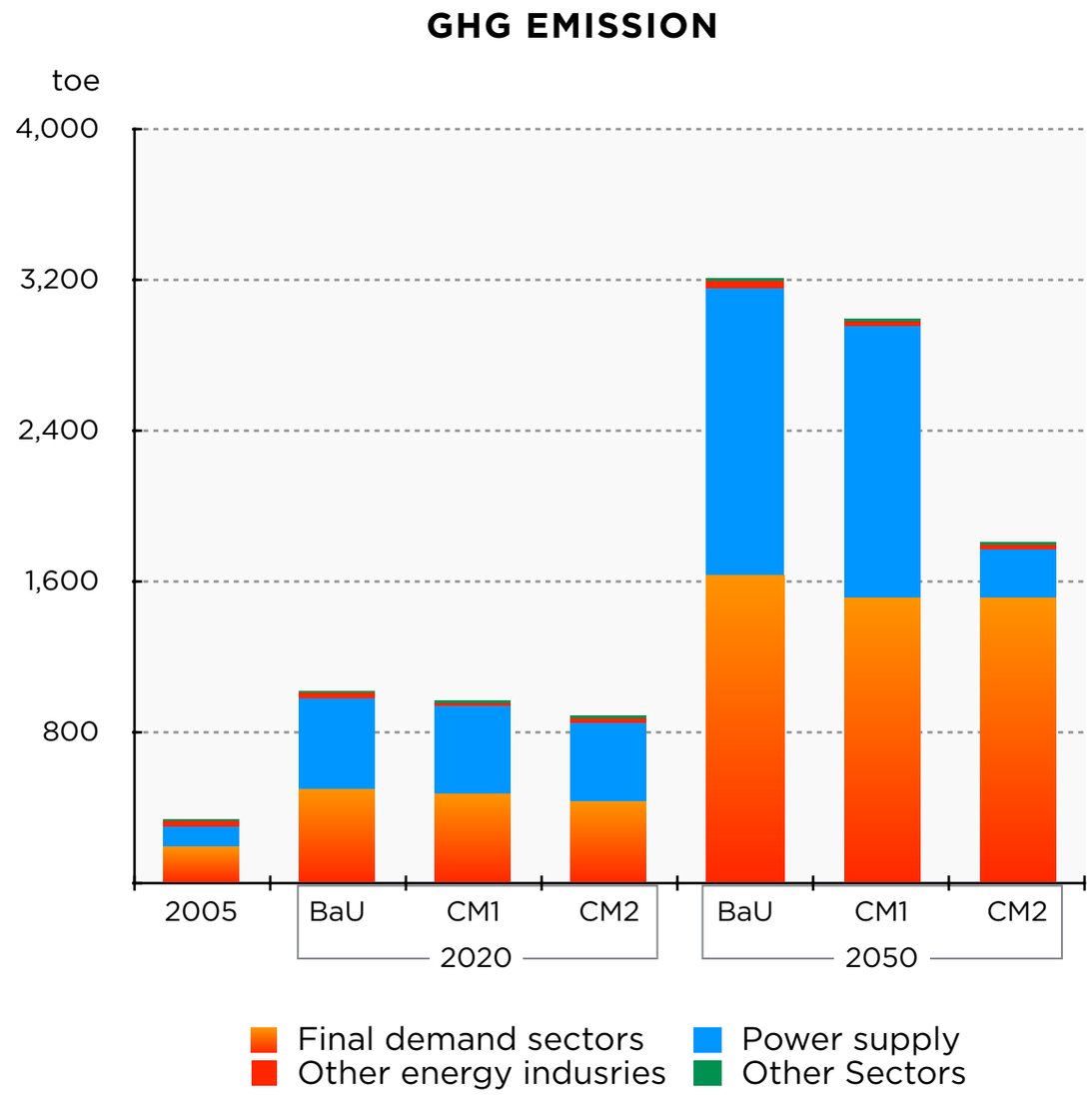




High increase in energy demand portion from industrial sector and freight whilst decrease in commercial sector

In CM2 there are nuclear and Coal-CCS being introduced.



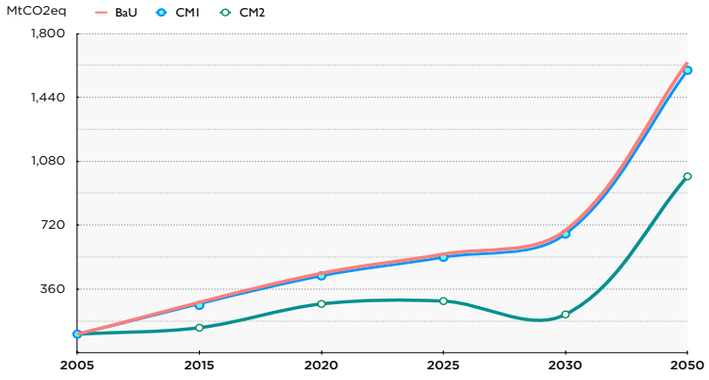


Significant decrease of power sector GHG Emission are mainly contributed by Nuclear (16%) and Coal CCS (42%).

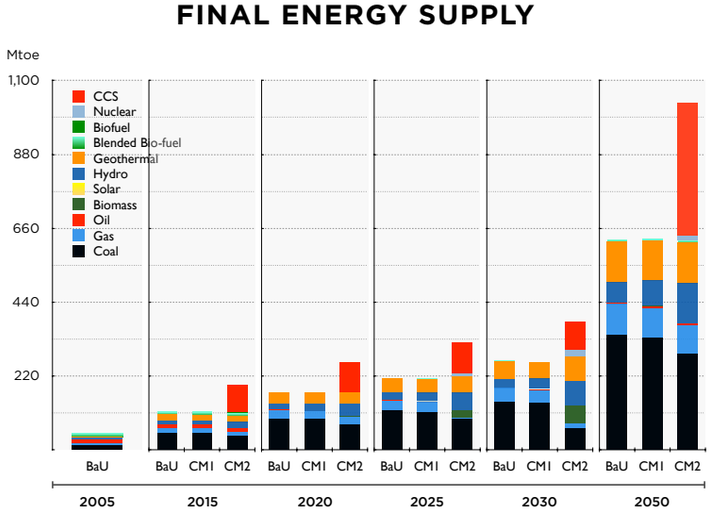
POWER SECTOR — LOW CARBON ENERGY SYSTEM

Counter Measure 1 follows the RAN-GRK plan in increasing the utilization of new and renewable technologies and energies **(Solar, Hydro, Geothermal, Biomass)**, in this scenario there are a decrease in electricity demand due to lower activities in other sectors due to efficiency and conservation programs activated. **There are changes in share of Coal, Oil, and Gas in the energy mix.**

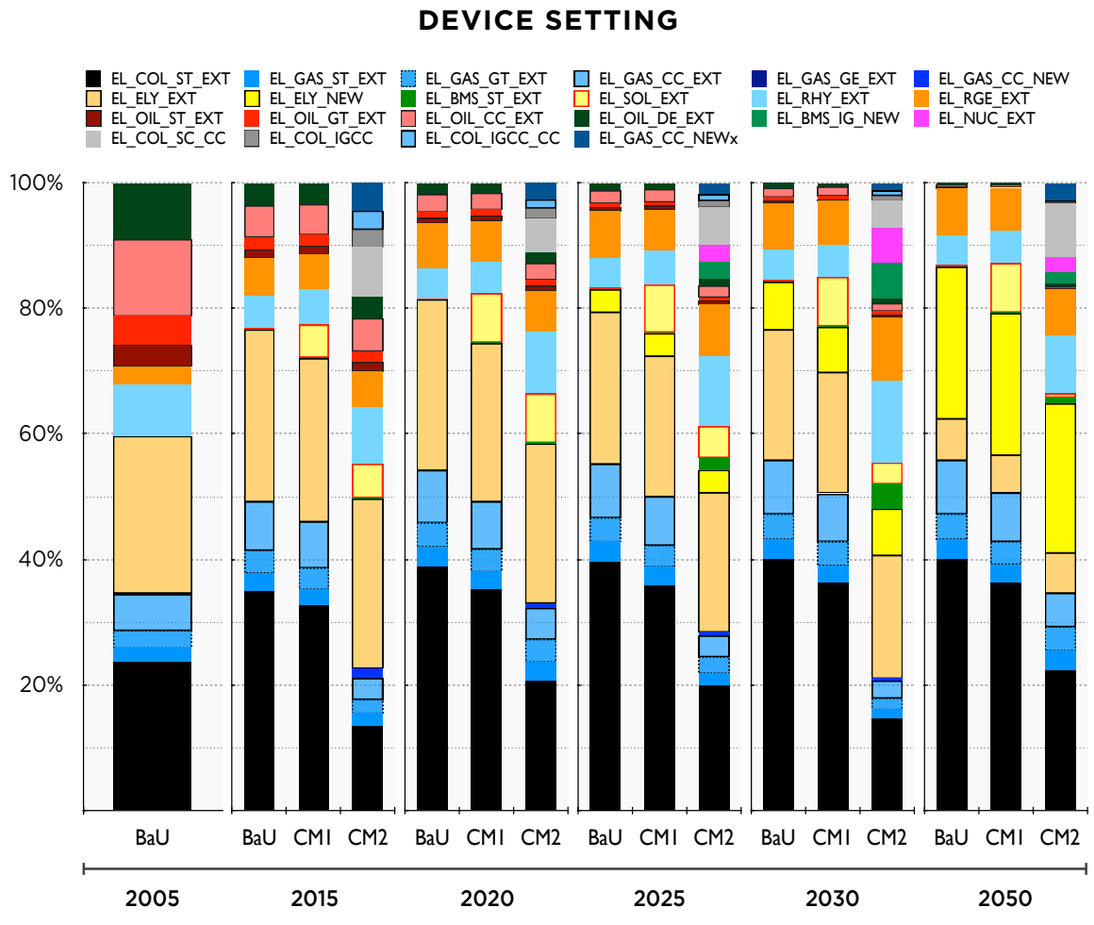
GHG EMISSIONS



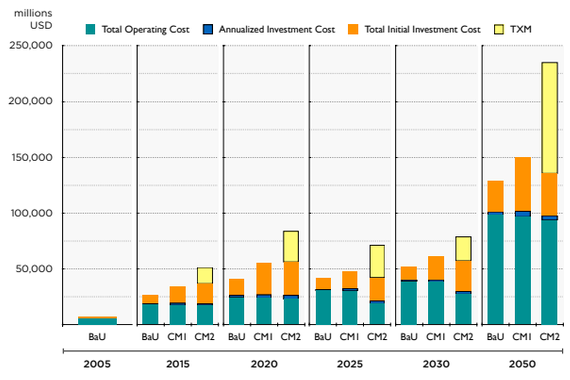
FINAL ENERGY SUPPLY



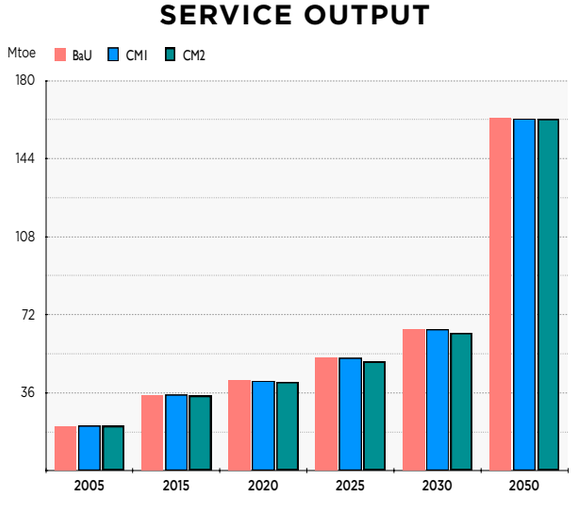
DEVICE SETTING



MITIGATION COST

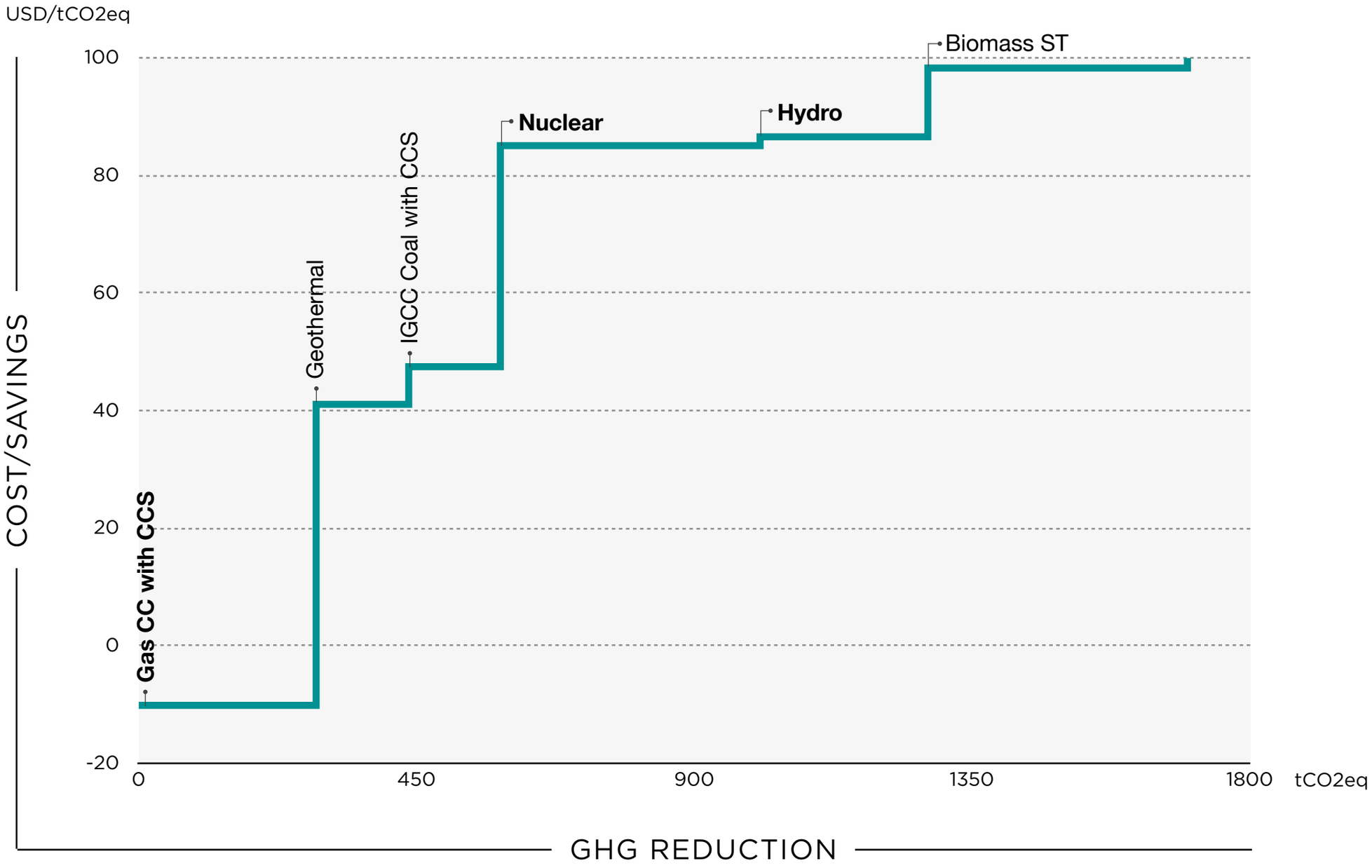


SERVICE OUTPUT



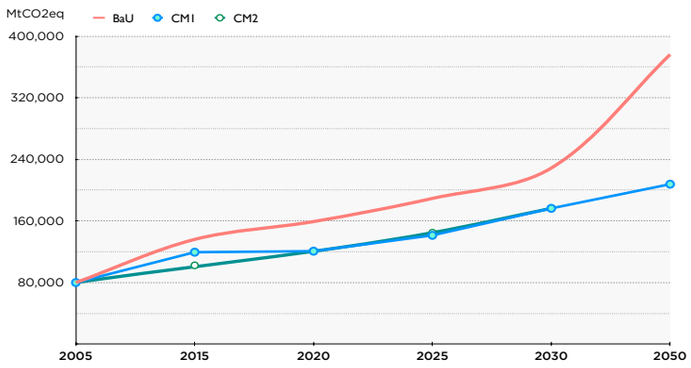
Counter Measure 2 maximizes the potency of CM1 through **extensification in the use of Carbon Capture Technologies, Nuclear Power, and especially the introduction of Biofuel in power sector.** Further decrease in electricity demand than CM1. With a **specified share of Coal in the energy mix (66%),** the rest of energy share are competed, as well as the technology selection. Advance technologies are introduced and competed with existing technologies, and Biofuel is introduced promptly in the power sector.

ABATEMENT COST CURVE

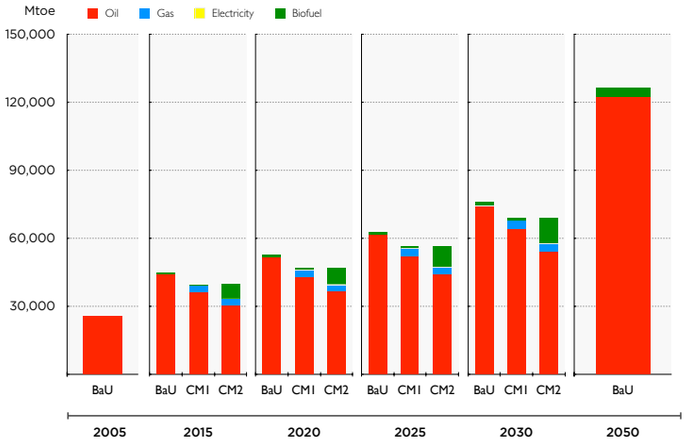


Business as Usual scenario projects the growth of output service with no change in share of transportation modes (data: National Statistics, Directorate General of Transportation).

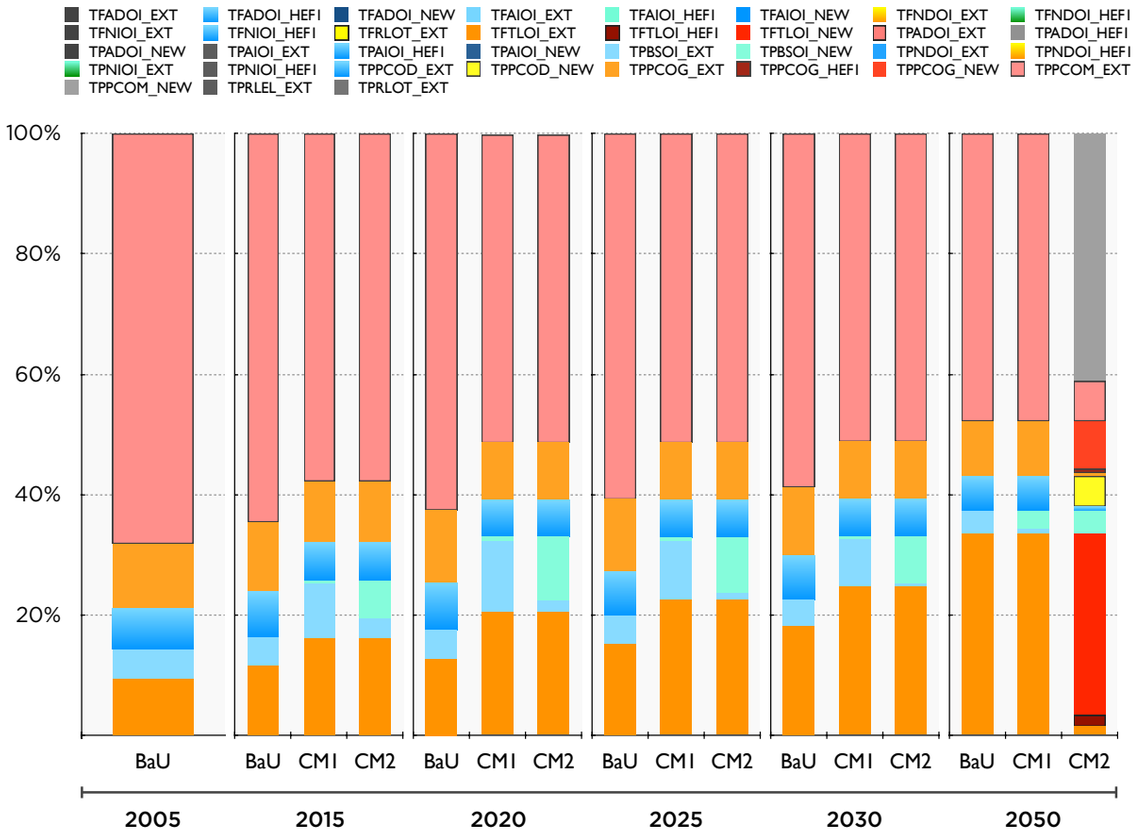
GHG EMISSIONS



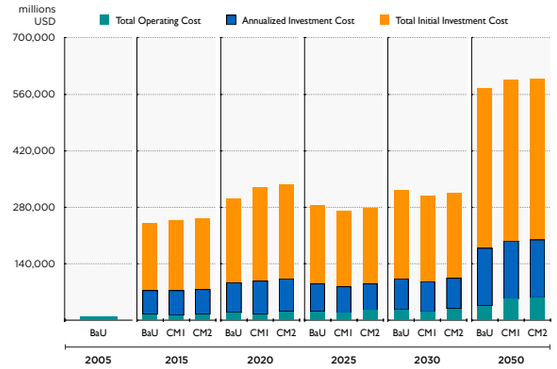
FINAL ENERGY SUPPLY



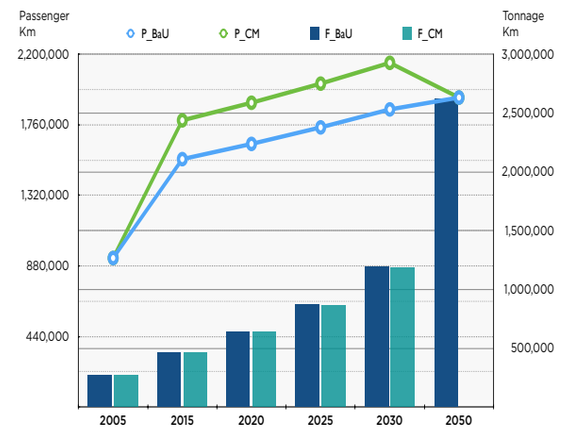
DEVICE SETTING



MITIGATION COST



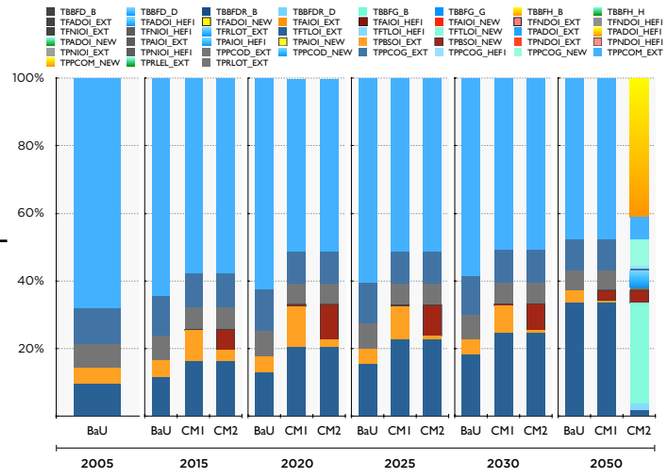
SERVICE OUTPUT



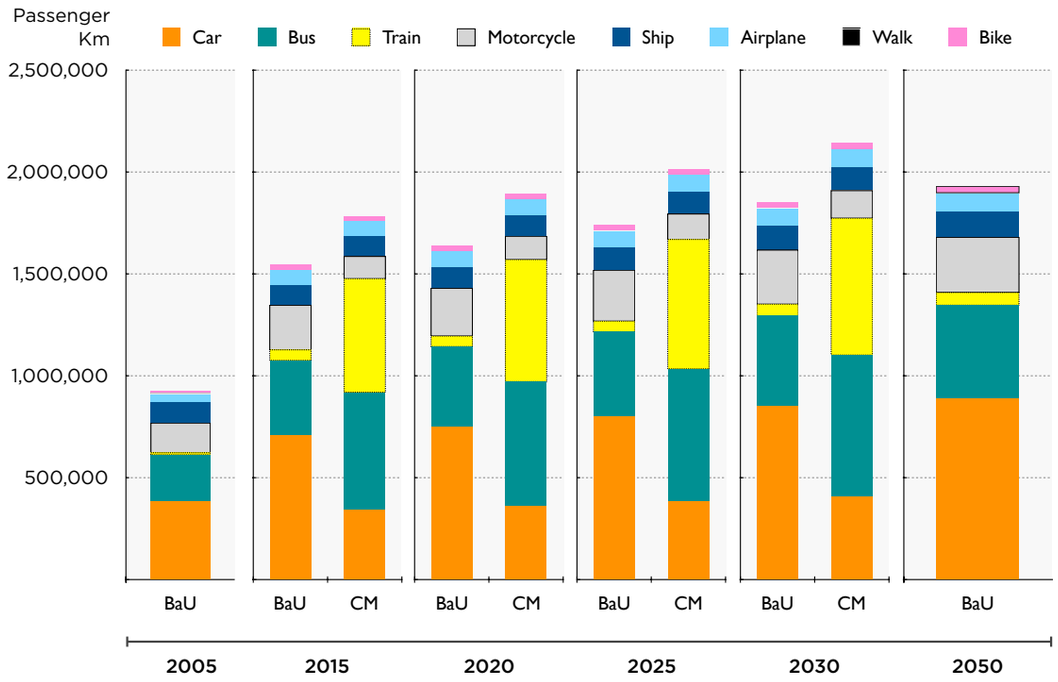
Efficiency and Conservations program through RAN-GRK reduce the service demand of transportation in passenger km as well as tonnage-freight km. In **Counter Measure Scenario** there are introduction of advanced technologies in transportation that enables lower emission as well as lower energy consumption.

TRANSPORTATION SECTOR — LOW CARBON ENERGY SYSTEM

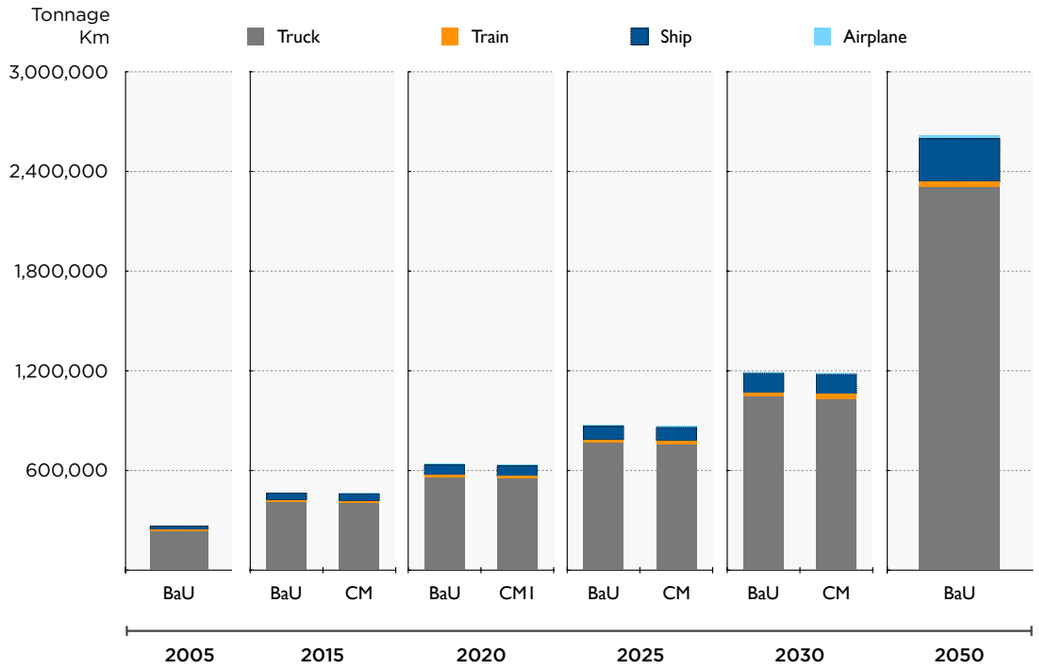
DEVICE SETTING



PASSENGER

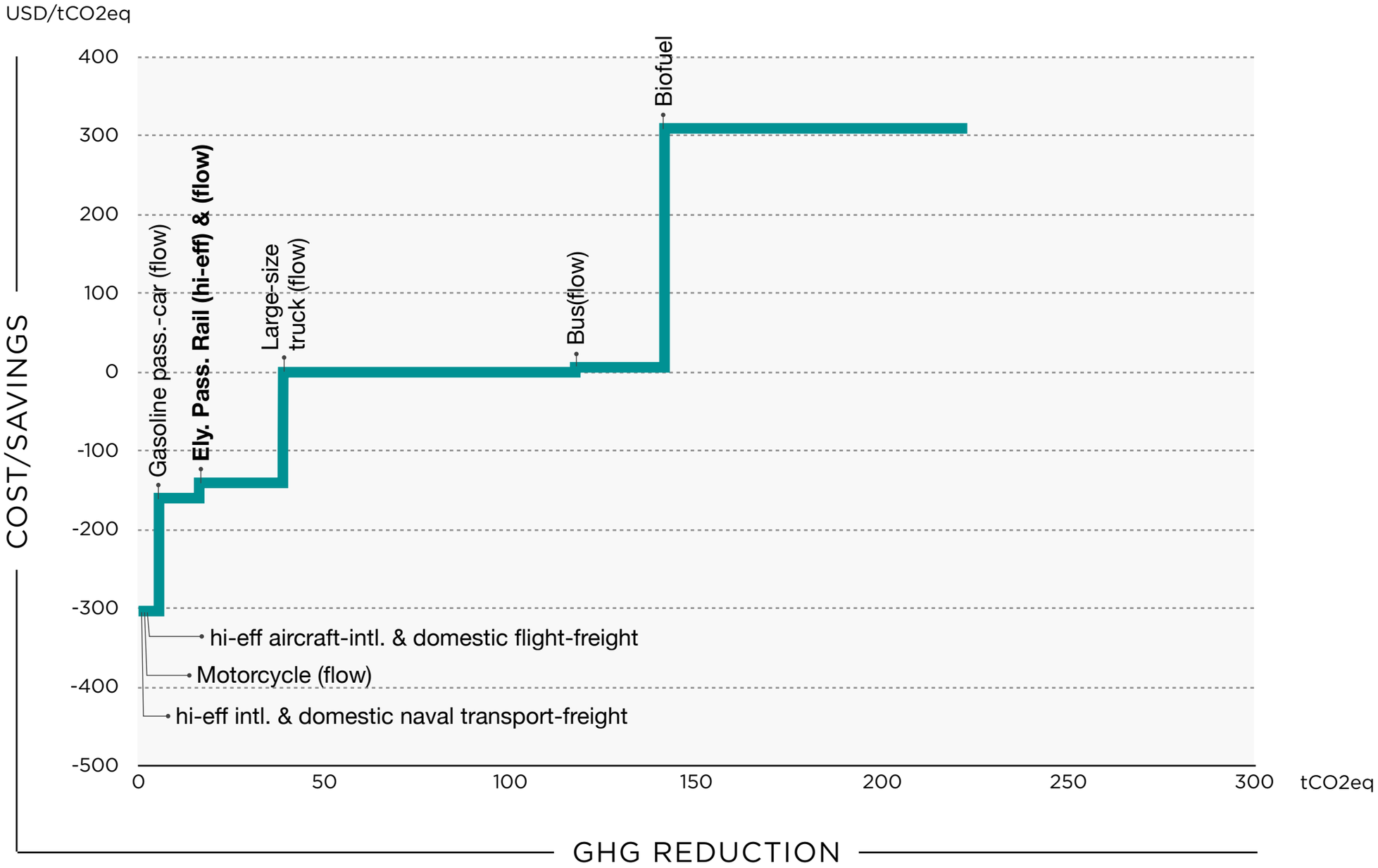


FREIGHT



The high **increase of passenger train usage** has a significance impact in reducing GHG emission in transportation sector, the use of train takes a great portion of private cars and motorcyclists in the mode share. Shifting to a mass and centralized transportation system has a great impact in reducing GHG emission as well as increasing the efficiency of transporting activity.

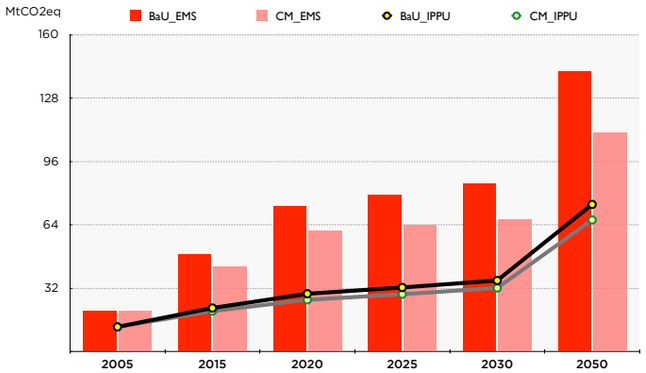
ABATEMENT COST CURVE



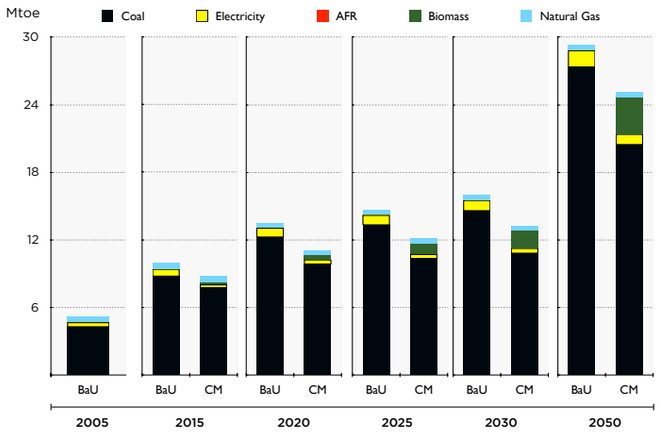
CEMENT + IRON & STEEL INDUSTRY — LOW CARBON ENERGY SYSTEM

In Business as Usual scenario there are a limited introduction of alternative material in the production process of cement industry. **In Counter Measure Scenario there are extensive use of alternative fuel and material (AFR),** such as Biomass for clinker substitute material and Biomass for fuel combustion process (waste, husk, hazardous waste, etc.). The reuse of waste and use of renewables as fuel and materials reduces the GHG emissions. Advanced technologies increases efficiency in energy usage.

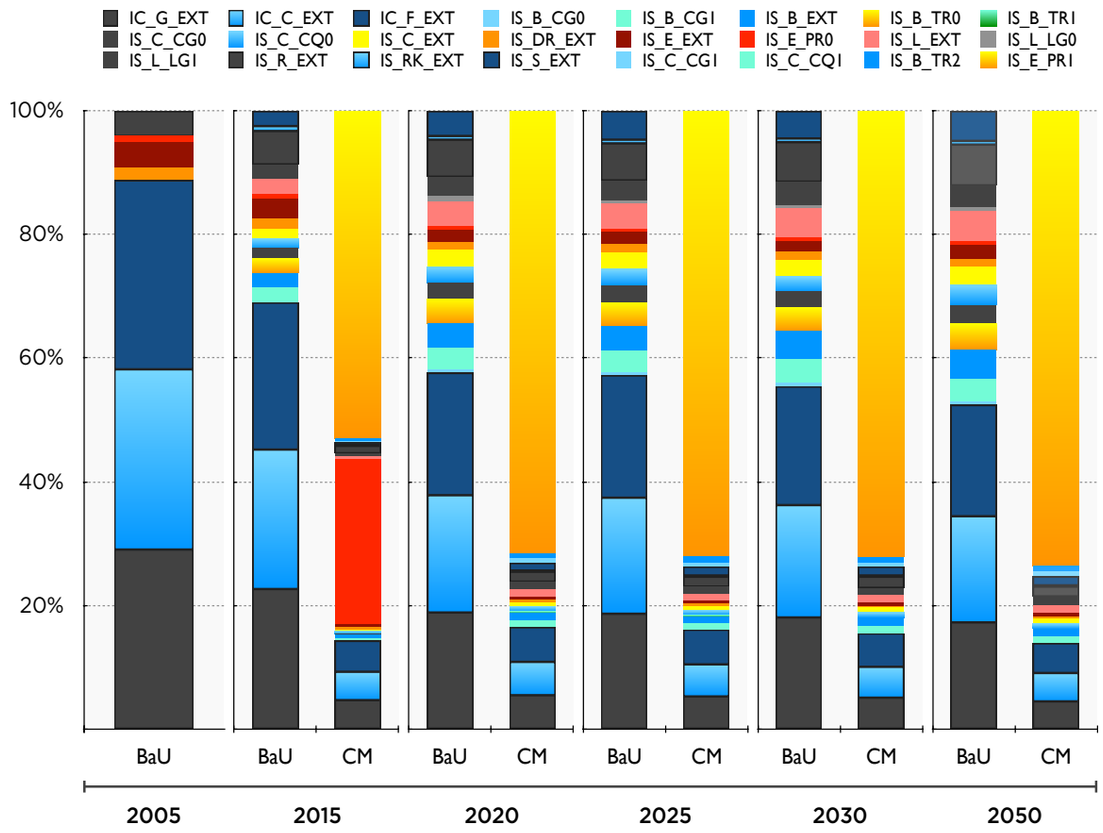
GHG EMISSIONS



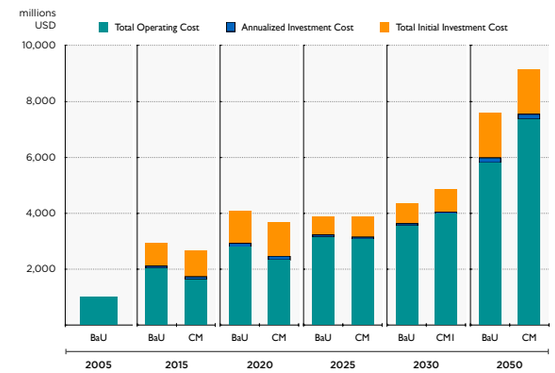
FINAL ENERGY SUPPLY



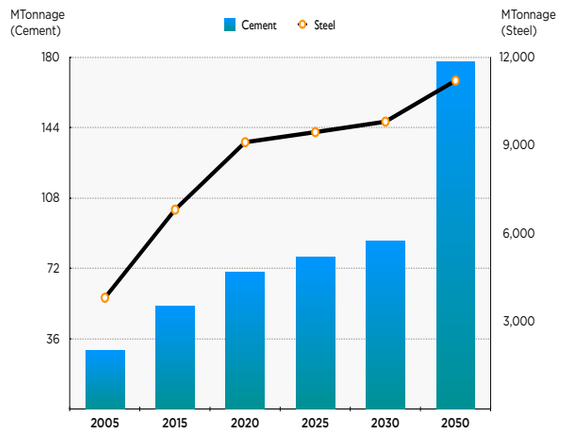
DEVICE SETTING



MITIGATION COST



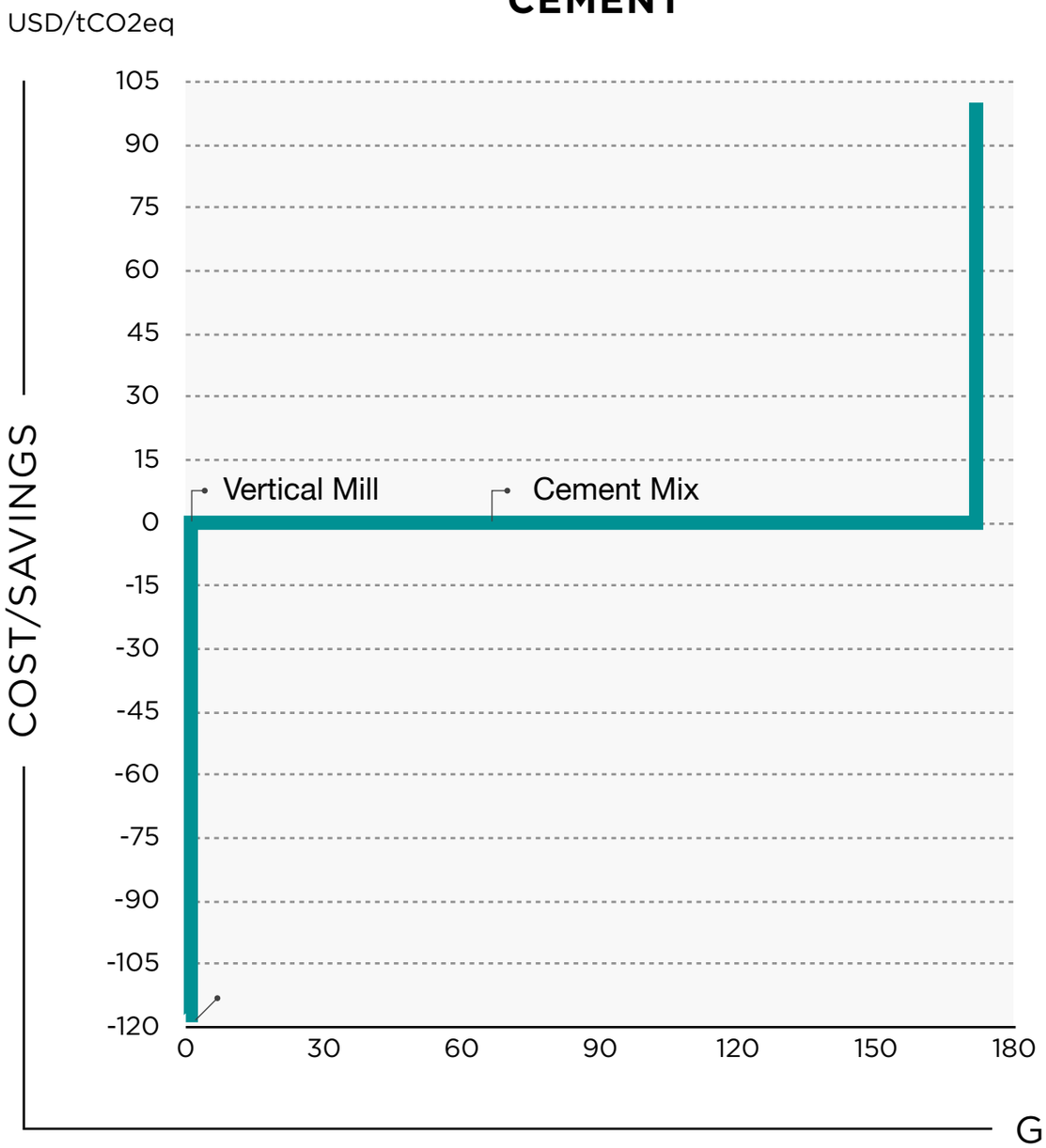
SERVICE OUTPUT



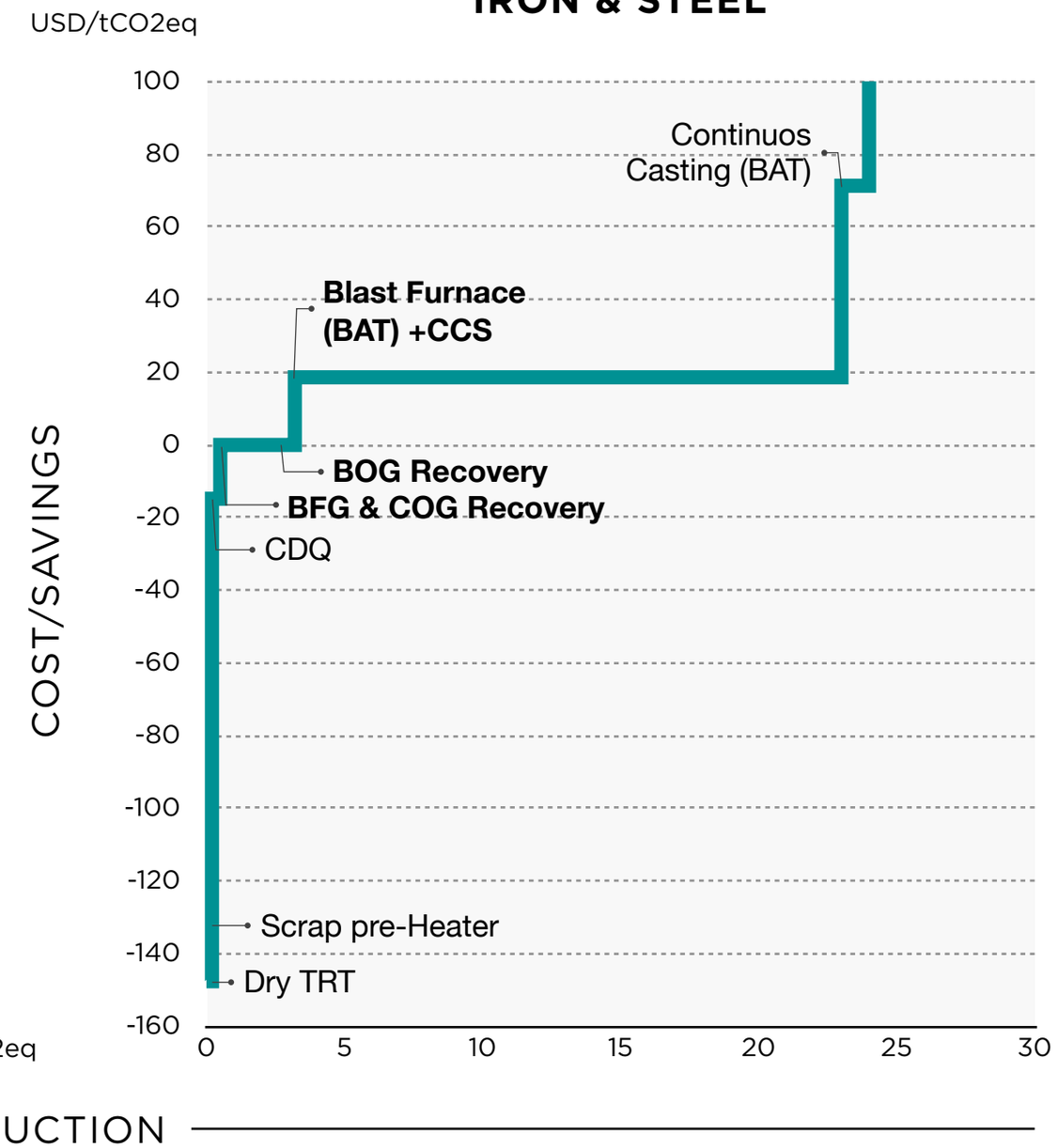
Business as Usual scenario has limited domestic (local) process and activities. There are imports in the middle production chain through foreign process (e.g. Pelletization process and most Pig Iron Process). **In 2020, Blast Furnace process will be running under PT. Krakatau Steel and POSCO Steel Ltd..** CM scenario in iron & steel industry introduces the competition of advanced technologies in the production process. Advanced technologies have significant impact to higher efficiency in energy use and further reduce GHG emissions, noticing that Iron & Steel industry is an energy intensive industry.

ABATEMENT COST CURVE

CEMENT



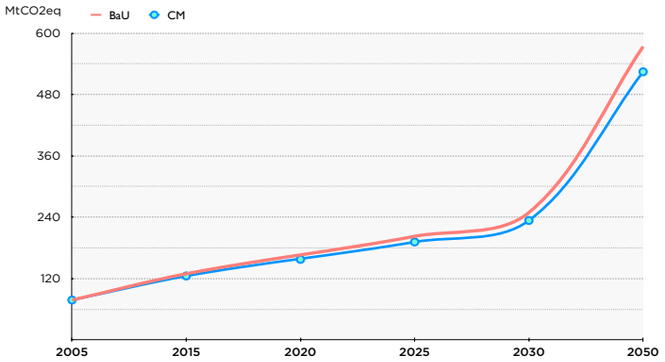
IRON & STEEL



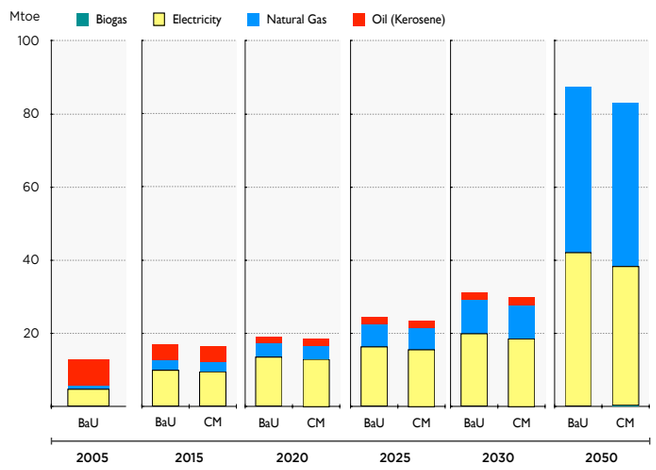
RESIDENTIAL SECTOR — LOW CARBON ENERGY SYSTEM

Efficiency and Conservations program through RAN-GRK reduce the service demand of residential sector. In CM1 there are **introduction of advanced technologies** in home appliances and fixtures enables lower emission as well as lower energy consumption. **Biogas is introduced in CM1 with a limited penetration to the market.** There are also shift in technologies, into technologies that use electricity as energy source (e.g. electric stove, electric heater, etc.).

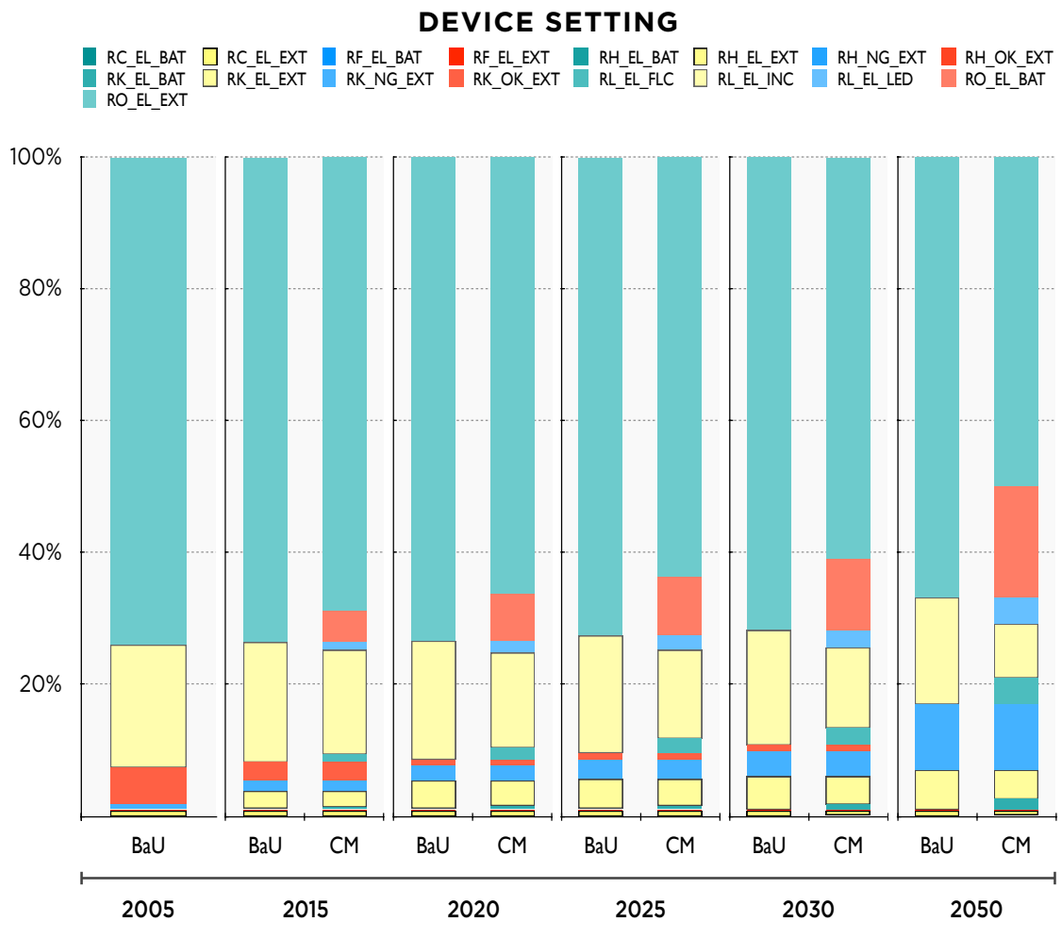
GHG EMISSIONS



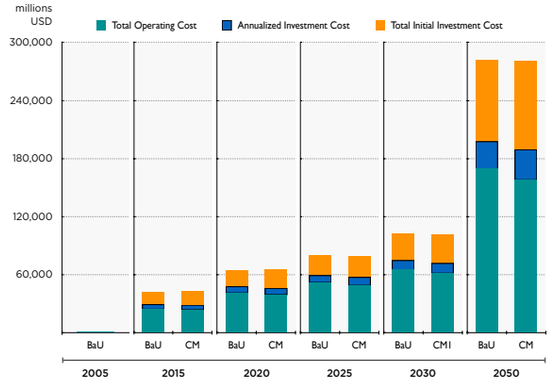
FINAL ENERGY SUPPLY



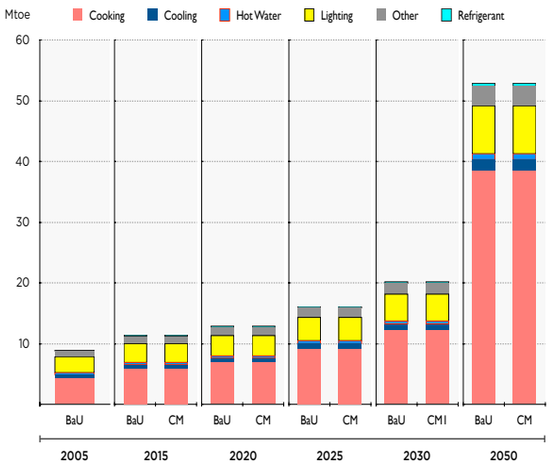
DEVICE SETTING



MITIGATION COST

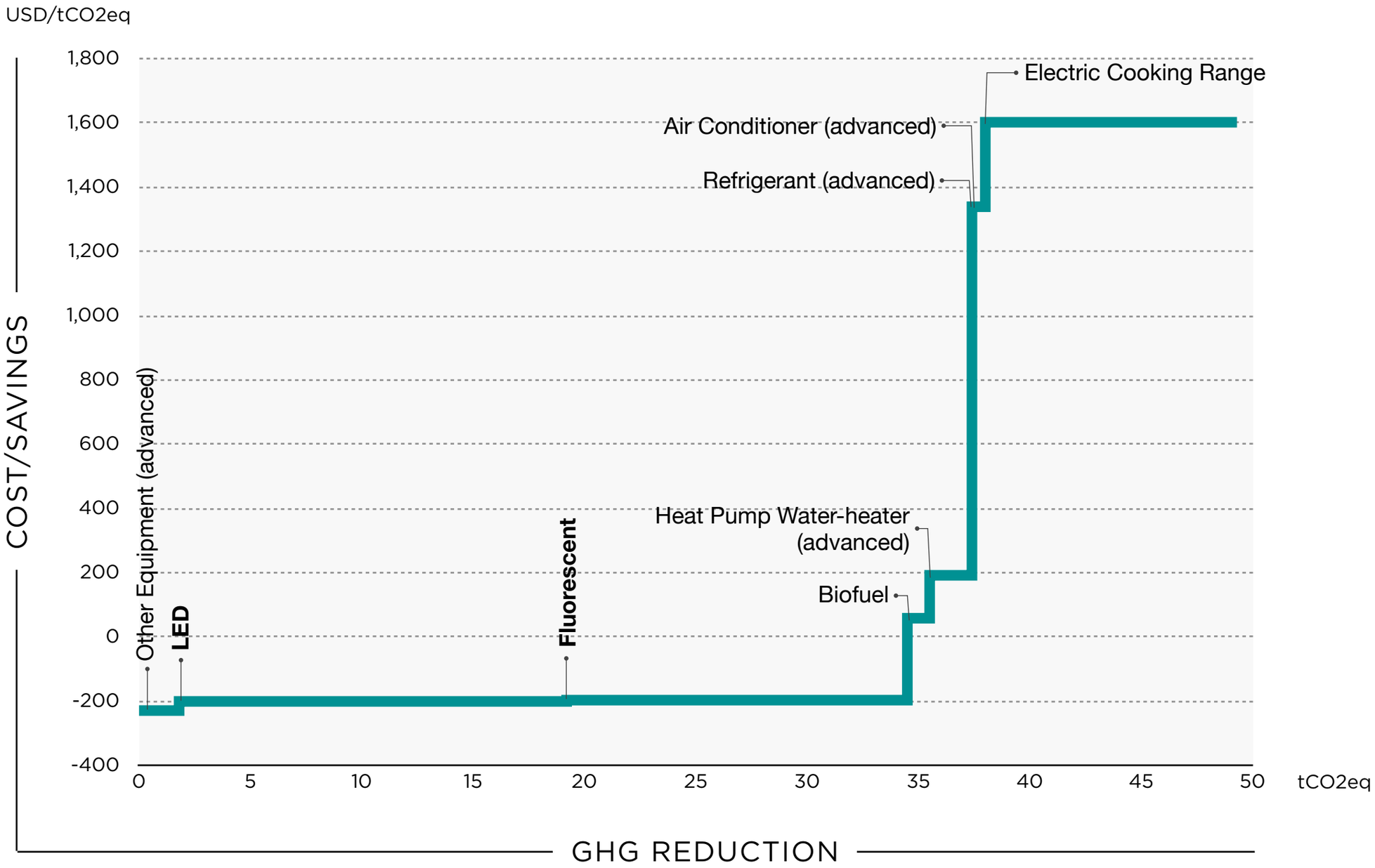


SERVICE OUTPUT



The CM scenario has a mere small impact of GHG reduction due to high intensity of energy usage. In average households in Indonesia are urban sprawl, with less population density implicating to more energy usage per square meter of land-capita.

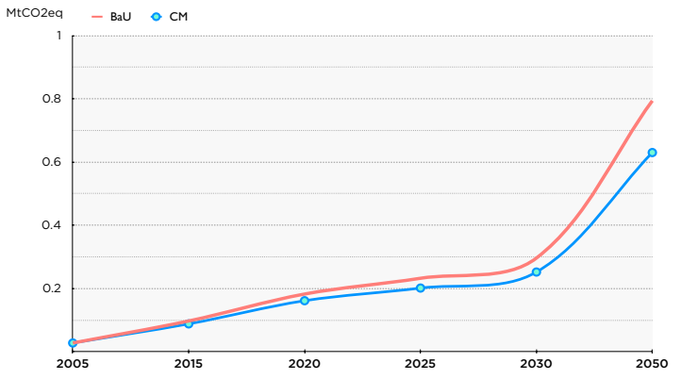
ABATEMENT COST CURVE



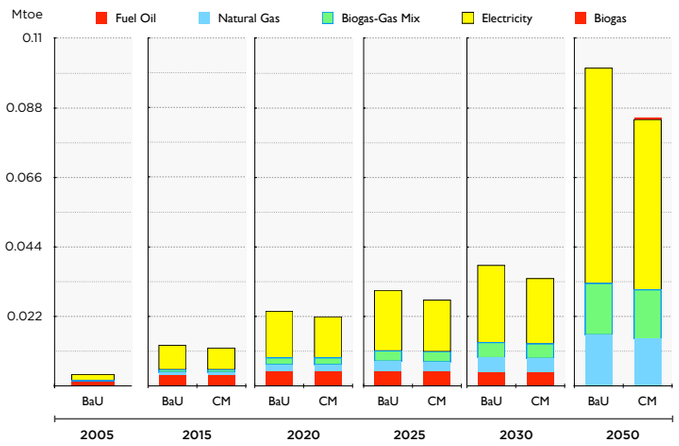
COMMERCIAL SECTOR — LOW CARBON ENERGY SYSTEM

Commercial sector consists of buildings operating as office, market place, restaurant, and hotel and leisure services. **Commercial sector in Indonesia has about 4% share of total energy consumption.** Most of the energy consumption is on other electrical equipment (i.e. elevators, escalators, etc.). **Space cooling is the largest energy consuming specified equipment,** acknowledge that Indonesia is a tropical country with an average temperature of 28˚c and over in the cities.

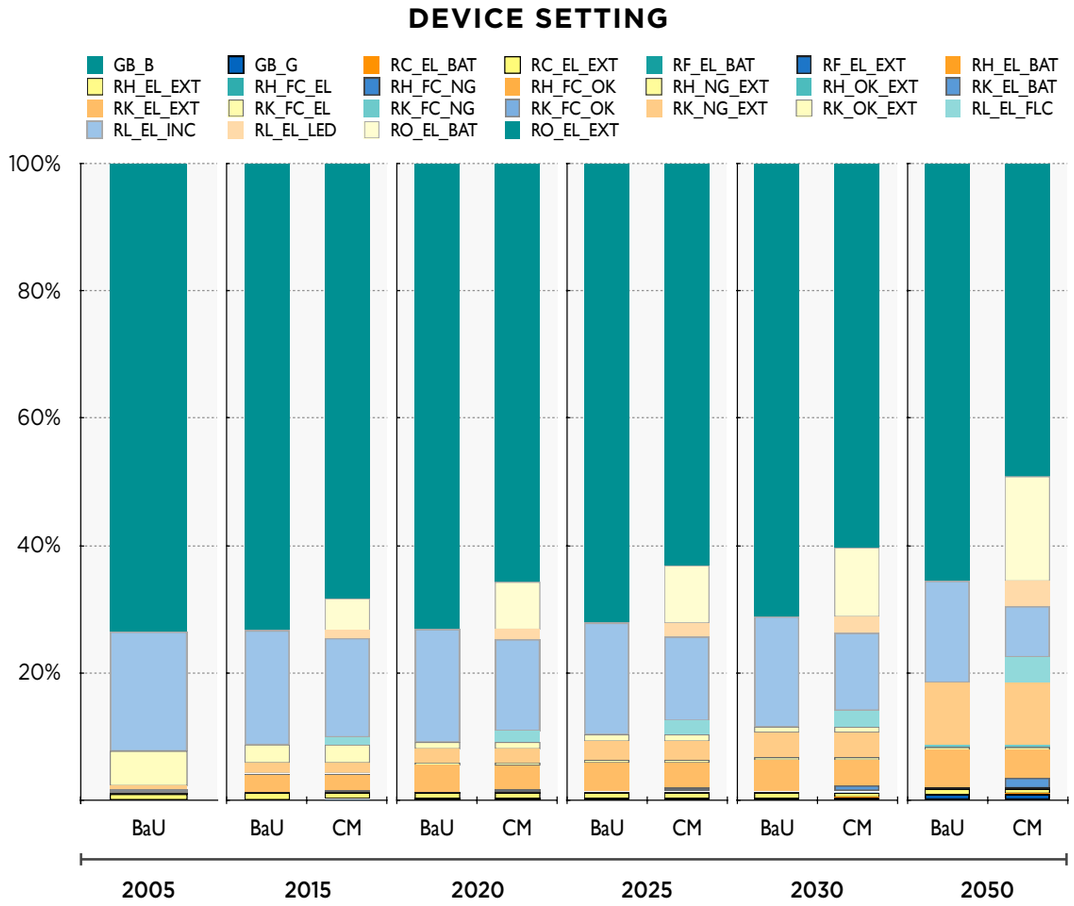
GHG EMISSIONS



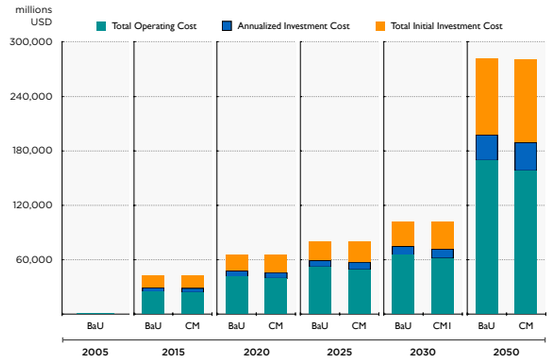
FINAL ENERGY SUPPLY



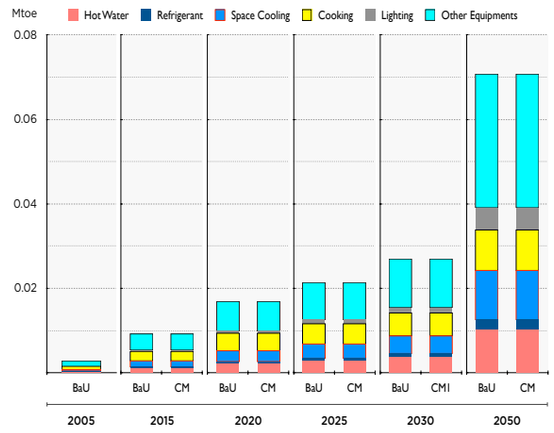
DEVICE SETTING



MITIGATION COST



SERVICE OUTPUT



Efficiency and Conservations program through RAN-GRK reduce the service demand of commercial sector. In Counter Measure Scenario there are introduction of advanced technologies in commercial equipments and fixtures enables lower emission as well as lower energy consumption. **Biogas is introduced in CM Scenario with a limited penetration to the market.**

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End-Use Model for Indonesia Low-Carbon Development Pathways in Energy Sector

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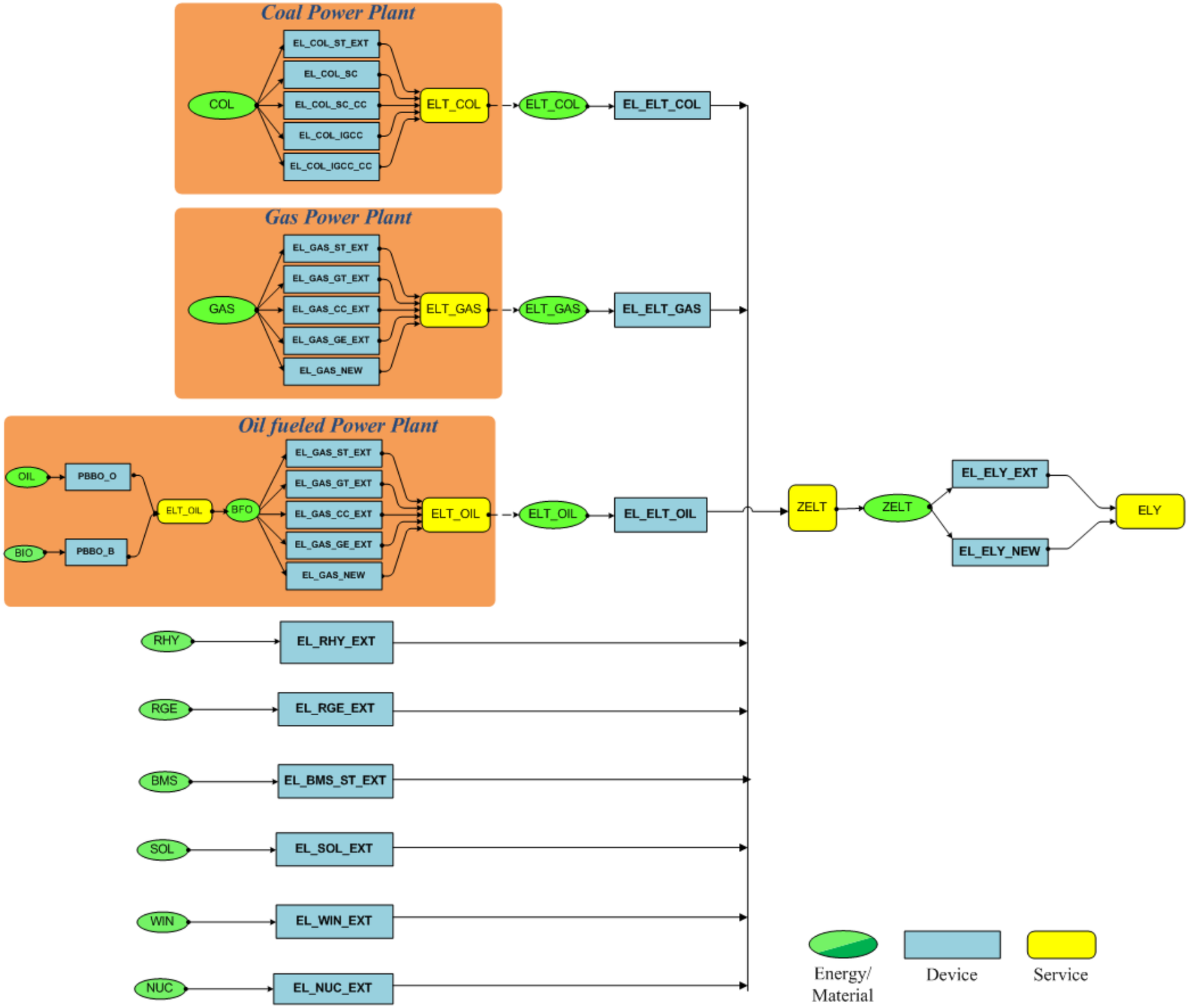
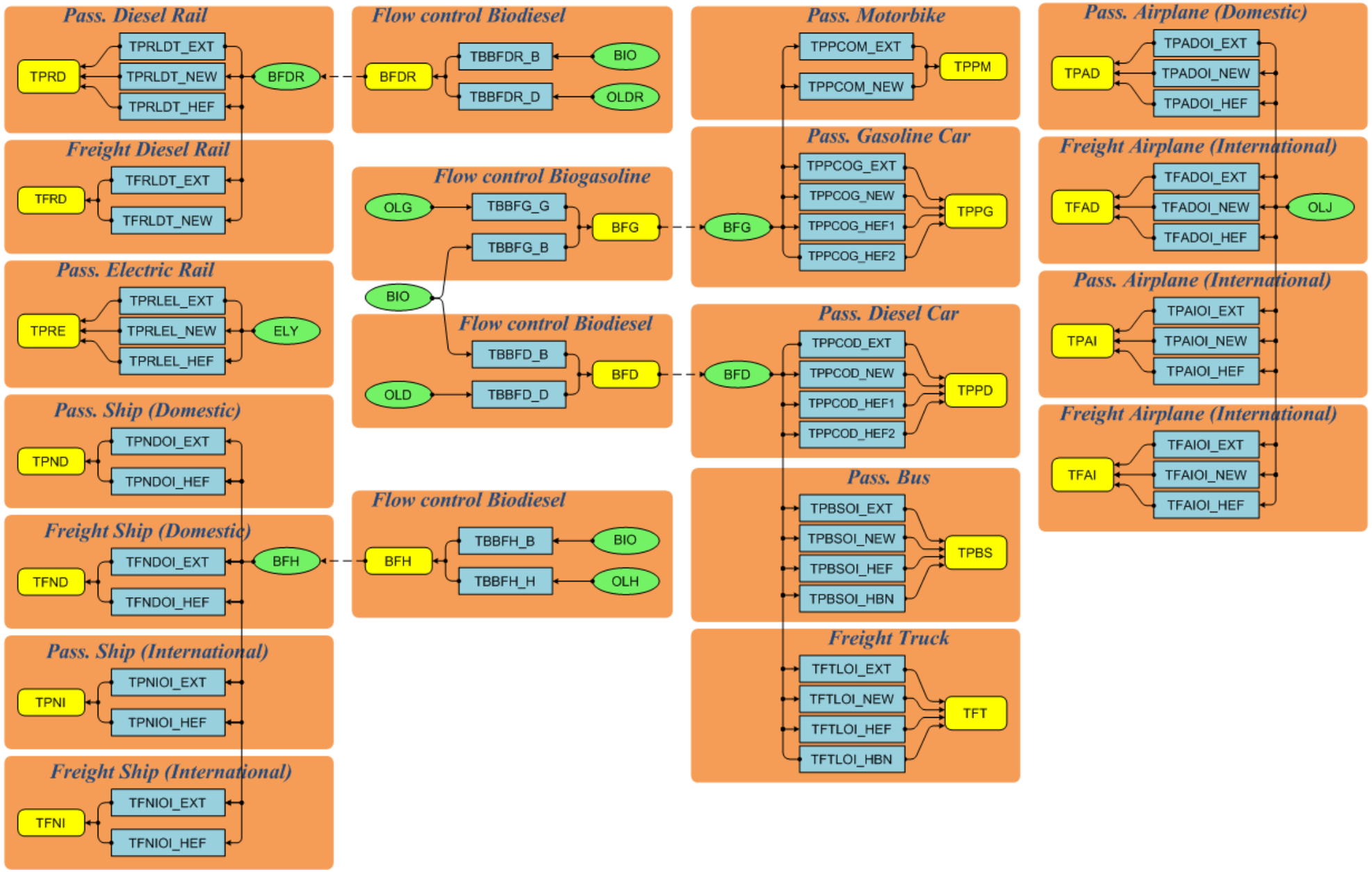
Tsukuba, 23 January 2015

Center for Research on Energy Policy
INSTITUT TEKNOLOGI BANDUNG

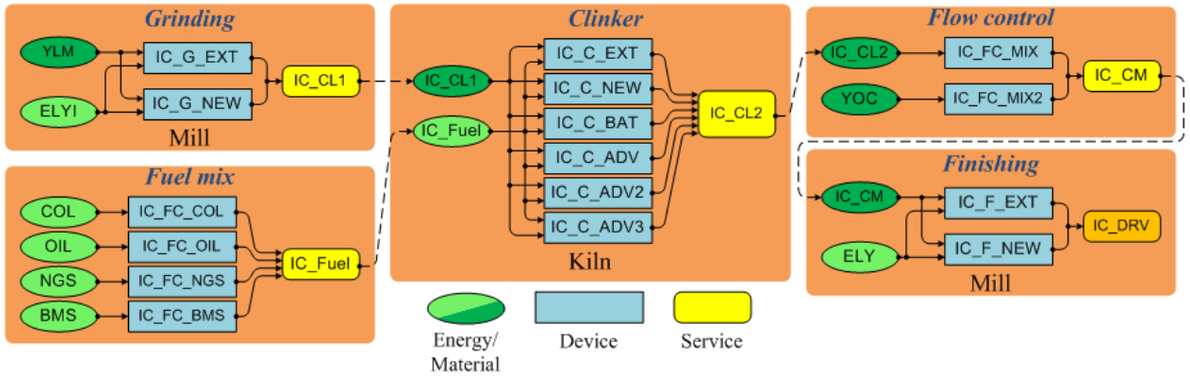
POWER SECTOR — LOW CARBON ENERGY SYSTEM



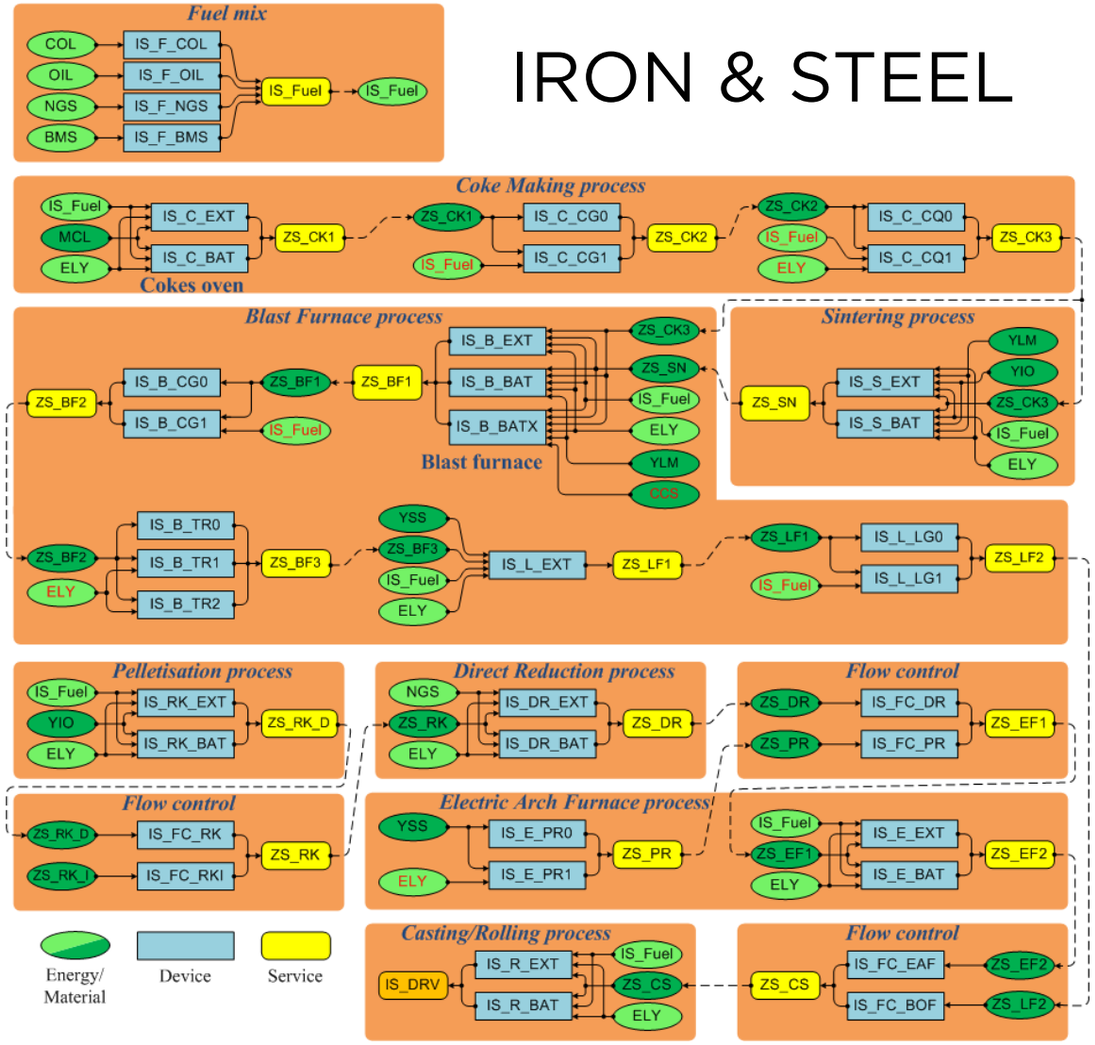
TRANSPORTATION SECTOR — LOW CARBON ENERGY SYSTEM



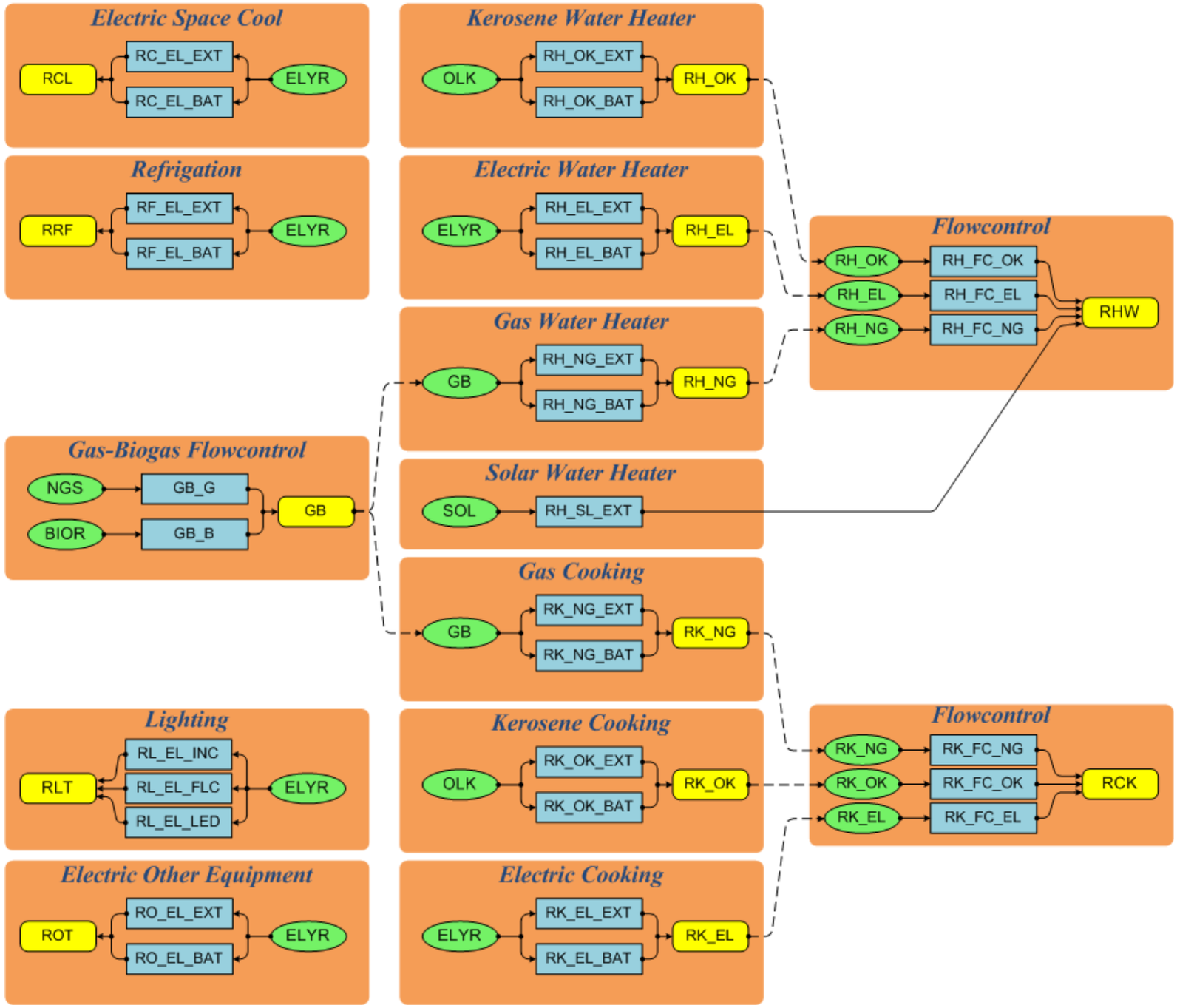
CEMENT INDUSTRY



IRON & STEEL



RESIDENTIAL SECTOR — LOW CARBON ENERGY SYSTEM



COMMERCIAL SECTOR — LOW CARBON ENERGY SYSTEM