Indonesia NZE 2060 of Energy Sector

How to Accelerate Decarbonization in Power Sector

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Current Situation of Indonesia Energy Transition

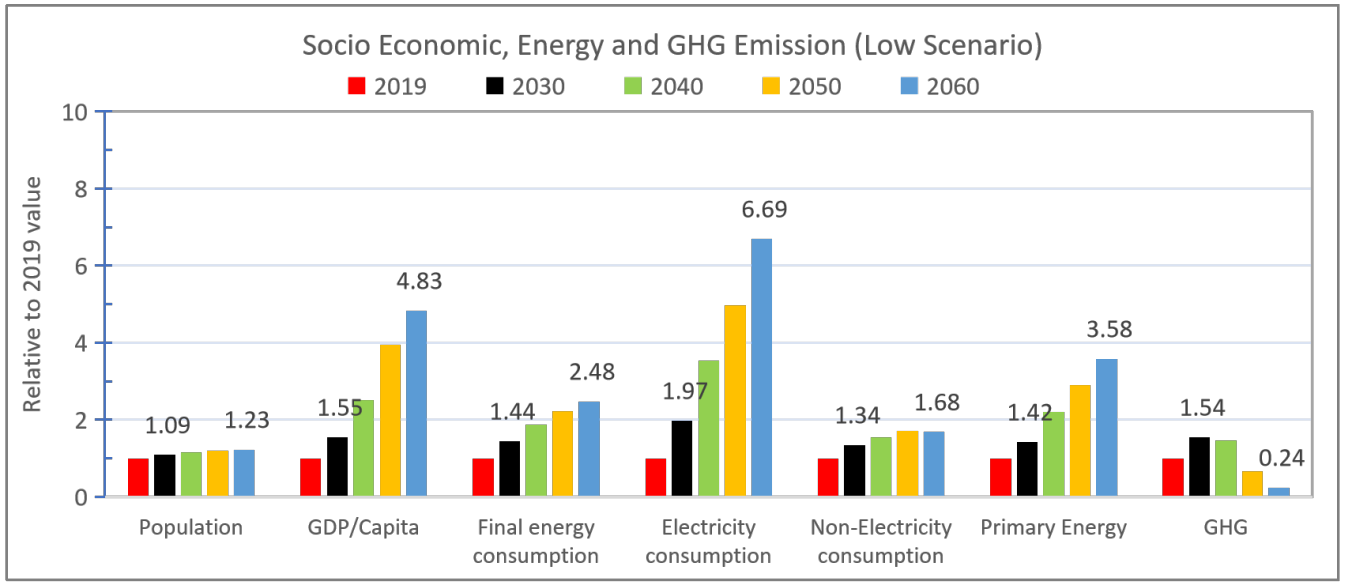
a. Indonesia is updating **National Energy Policy (KEN)** with the main objective is **energy security**, in which energy will be supplied for **modern society and rational demand** (high growth but considered efficient and characterized by high demand for electricy) with clean, green, and sustainable energy supply.

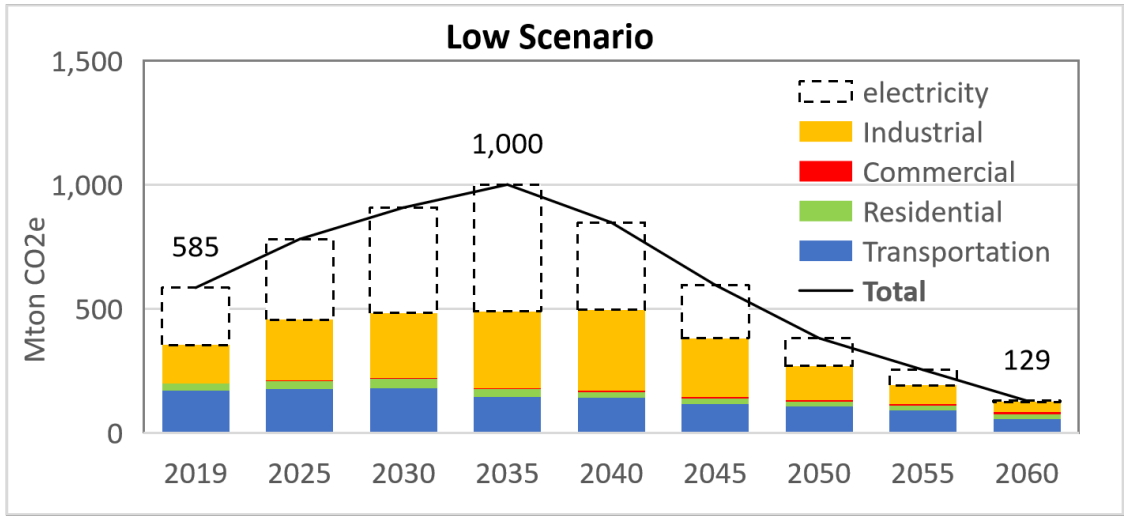
b. The update considers current situation development related to high population growth, economic growth target, environment and global climate change considerations, Paris Agreement, etc. Indonesia is targeting to escape from 'midle income trapped' to become developed countries in 2045, in which **energy needs and the associated GHG emissions will increase significantly as a consequence**.

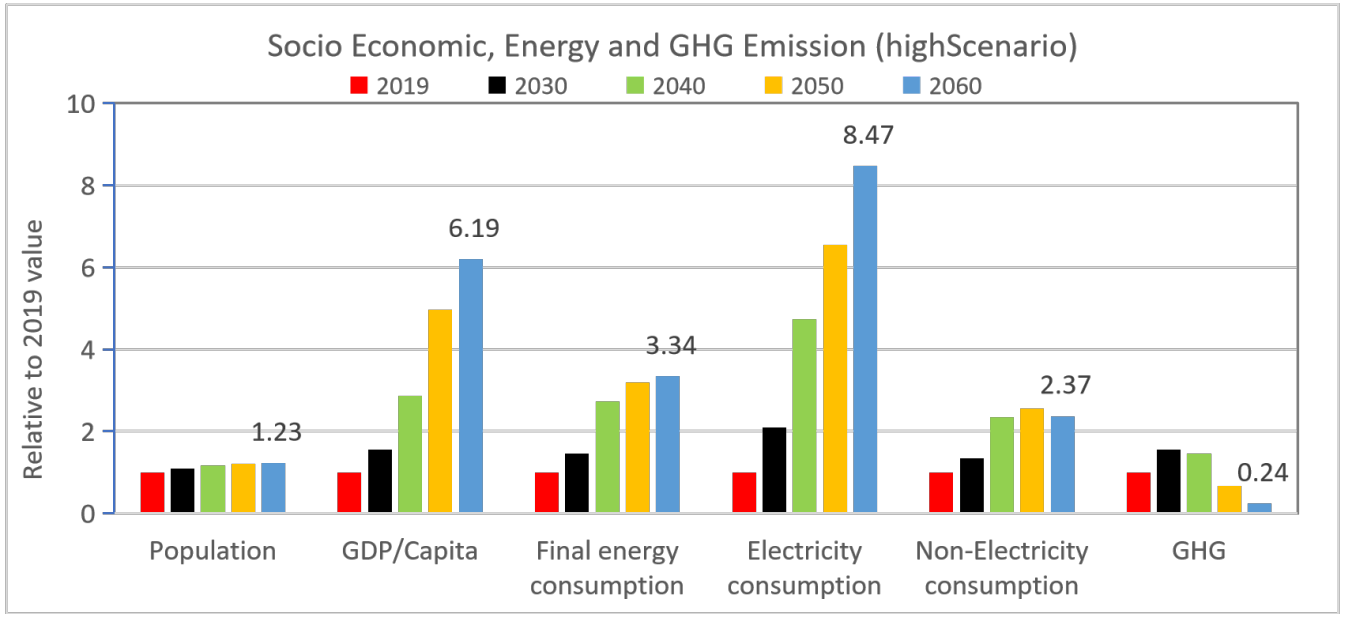
c. Indonesia is preparing **decarbonization roadmap of energy transition to achive NZE 2060, i**n which Second NDC is temporary target to meet Paris Agreement through deep decarbonization while keep high economic growth is also prioritize important (not lower than 5.2% - 6% per year).

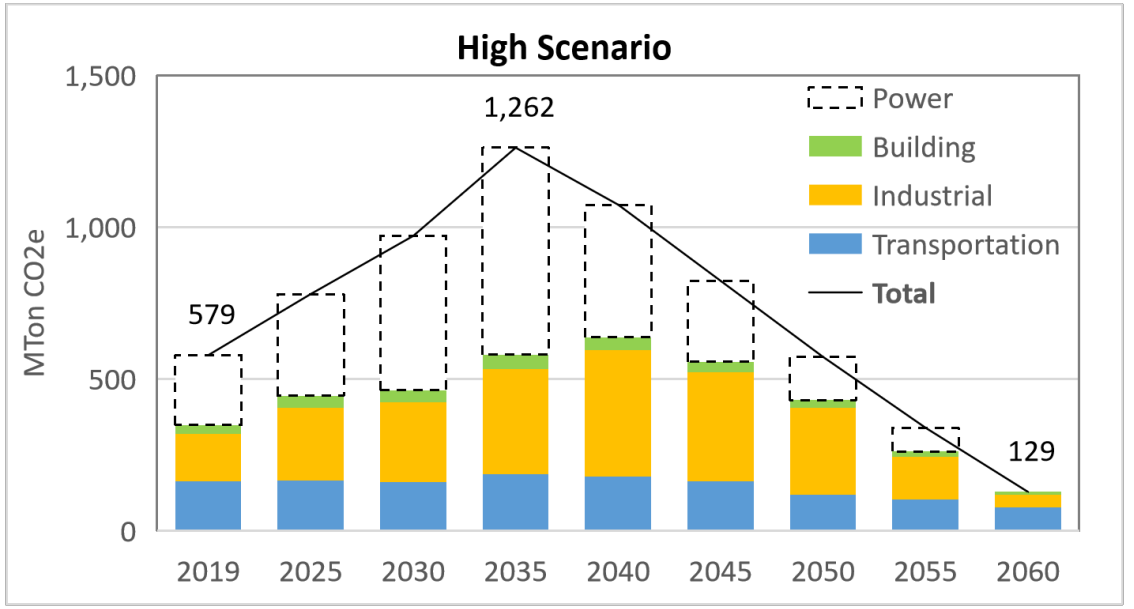
d. In the energy transition, the key of decarbonization for reducing of GHG emissions comprises the processes of **downshifting fossil fuels** and **re-developing** whole energy systems to be operated on low (zero) carbon and efficient energy and technology. One of the options is replacing coal to NRE, where **repower** is also considered as one the options.

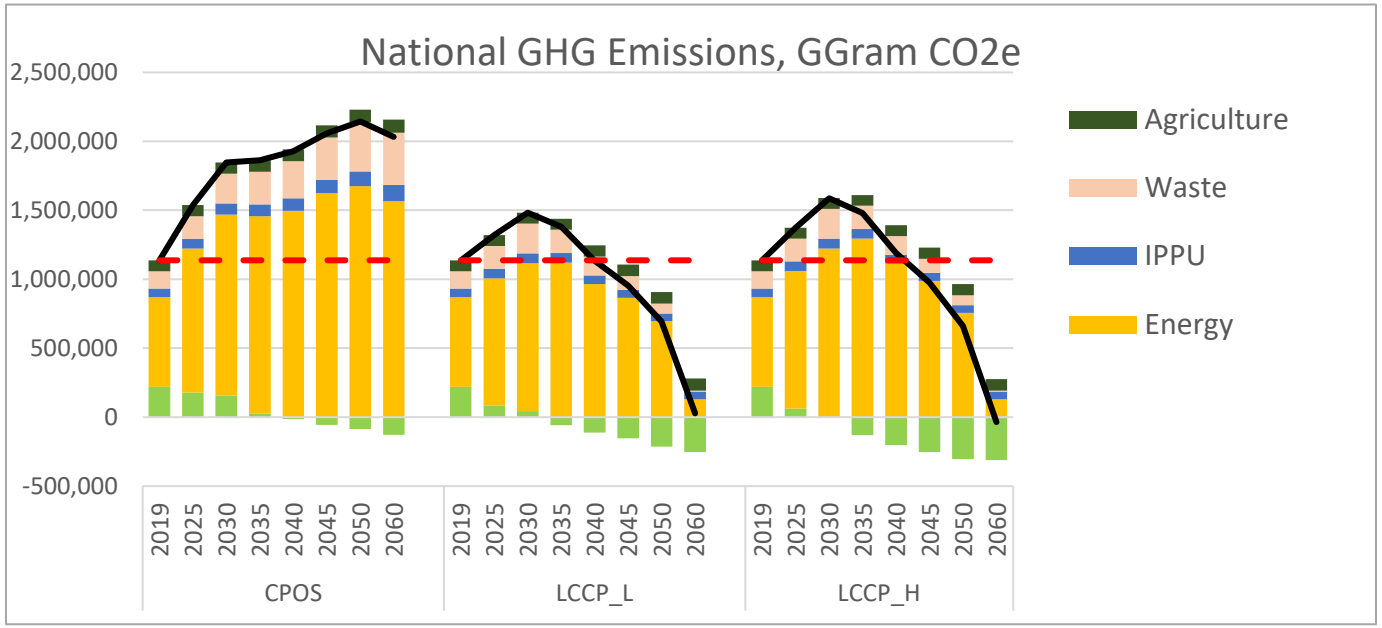
Energy Consumption and the Associated GHG Emissions

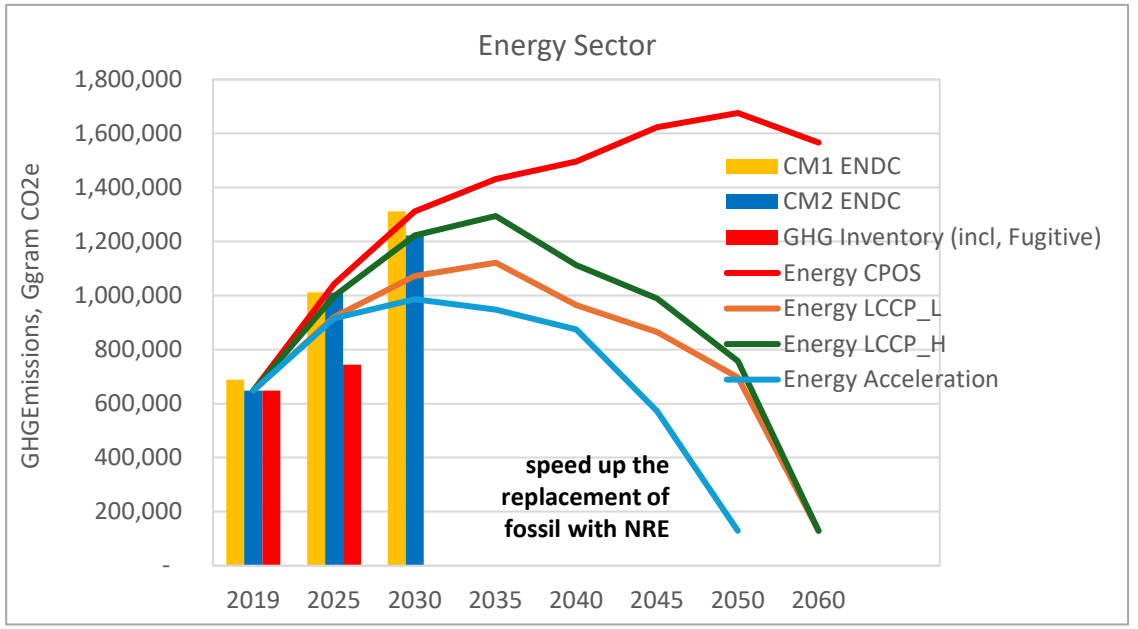


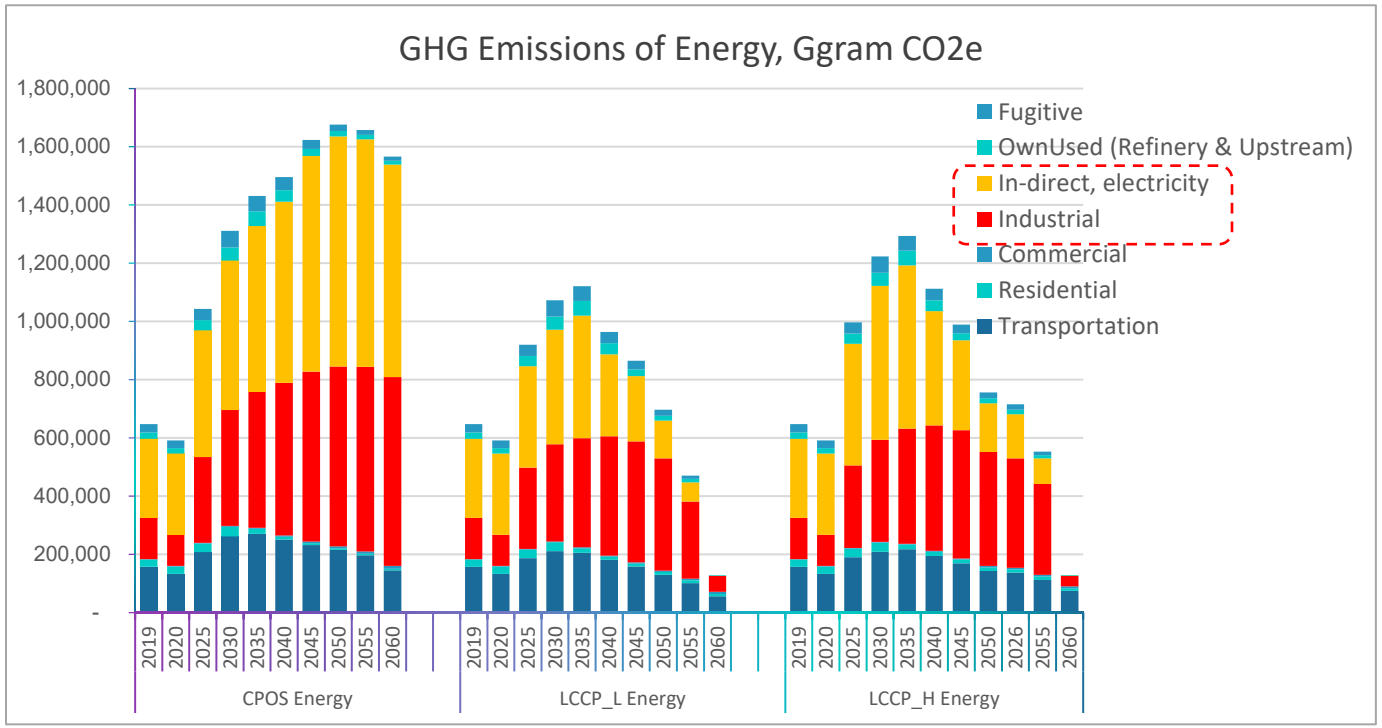


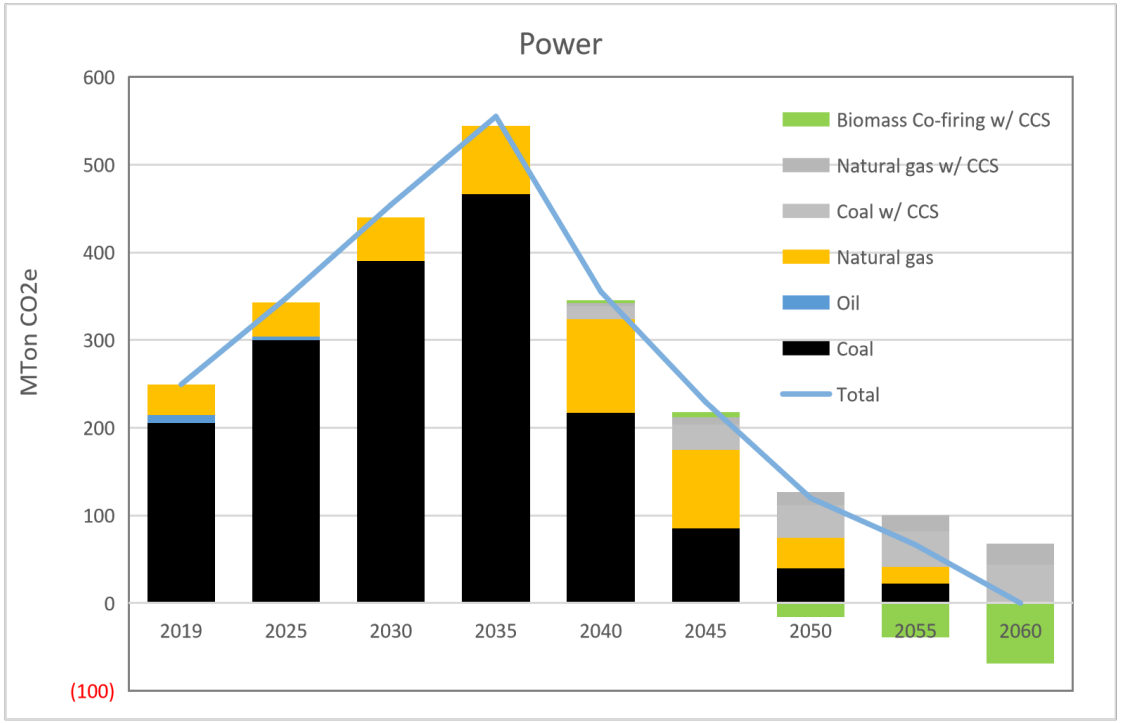




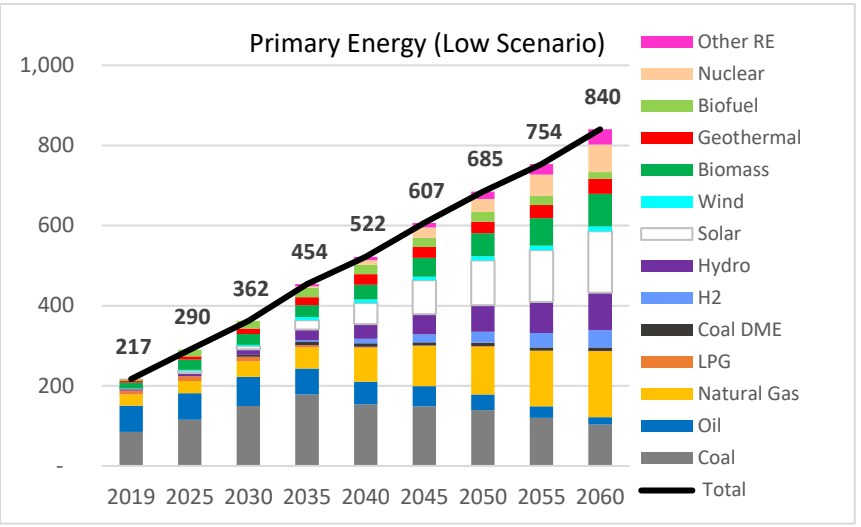

National GHG Emissions, GGram CO2e
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
Agriculture
Waste
IPPU
Energy
2019 2025 2030 2035 2040 2045 2050 2060
CPOS
LCCP_L
LCCP_H

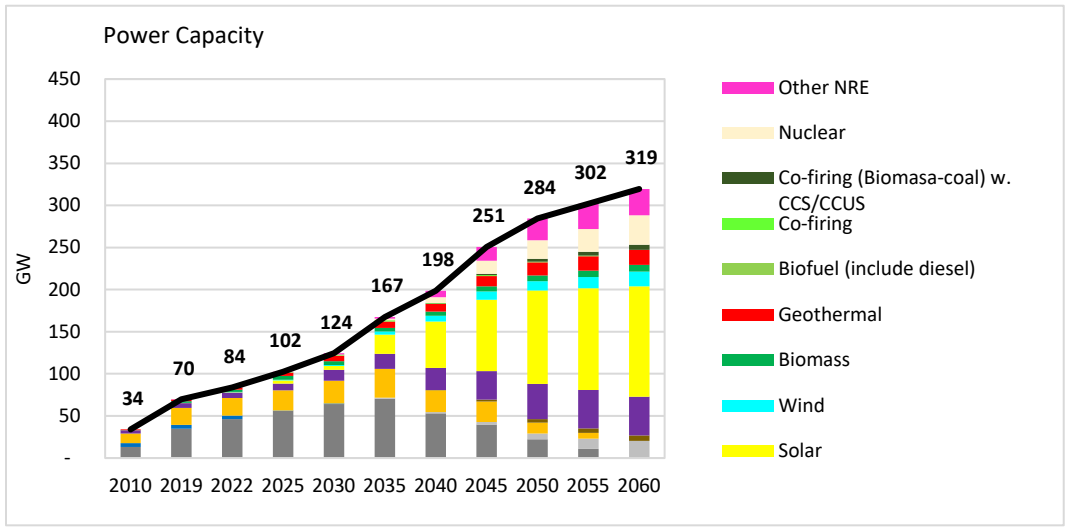

Energy Sector
GHGEmissions, Ggram CO2e
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
CM1 ENDC
CM2 ENDC
GHG Inventory (incl, Fugitive)
Energy CPOS
Energy LCCP_L
Energy LCCP_H
Energy Acceleration
speed up the replacement of fossil with NRE
2019 2025 2030 2035 2040 2045 2050 2060

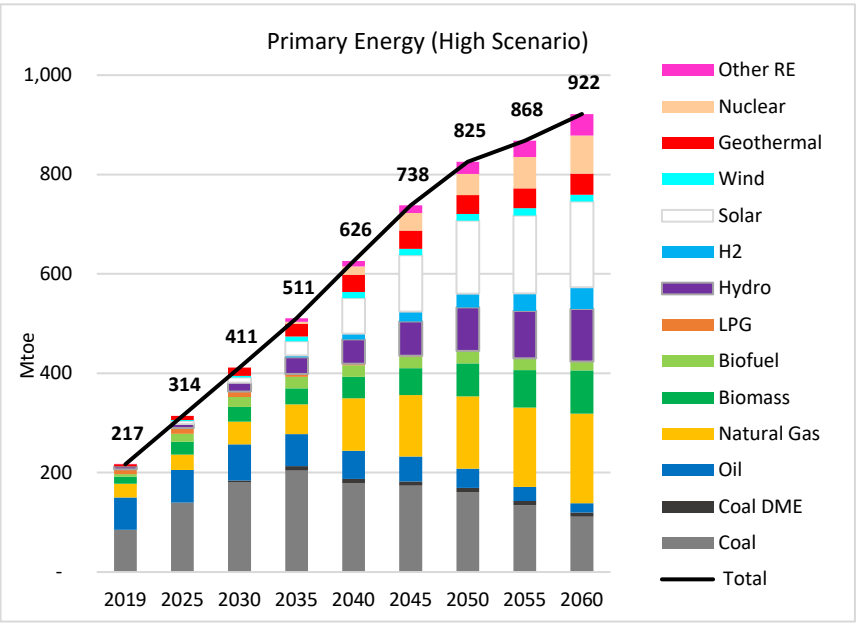

GHG Emissions of Energy, Ggram CO2e
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
Fugitive
OwnUsed (Refinery & Upstream)
In-direct, electricity
Industrial
Commercial
Residential
Transportation
2019 2020 2025 2030 2035 2040 2045 2050 2055 2060
CPOS Energy
LCCP_L Energy
LCCP_H Energy

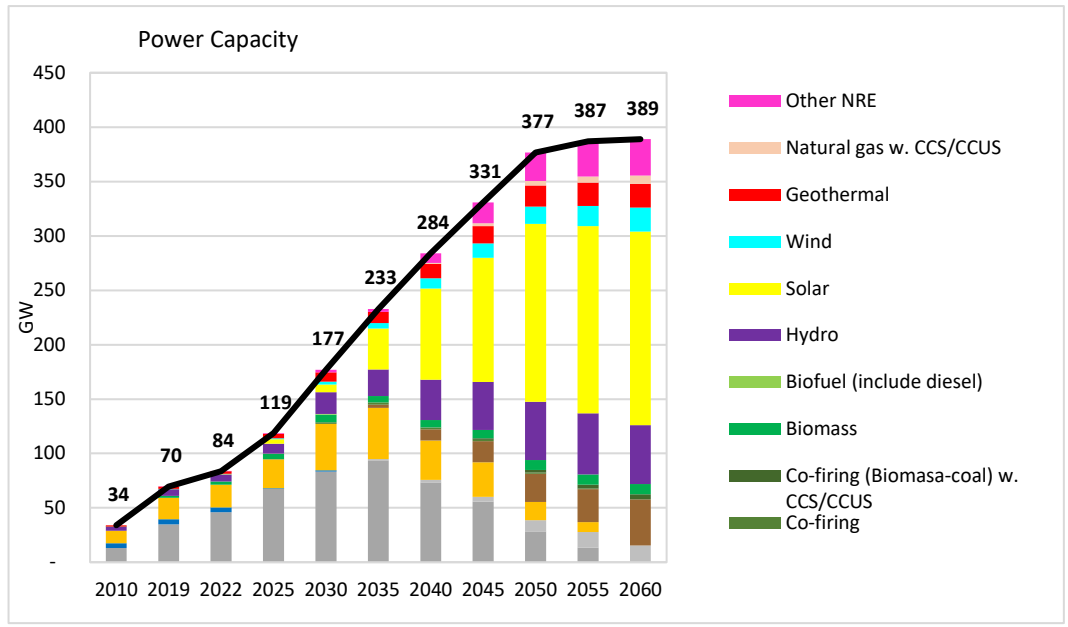

Power
MTon CO2e
600
500
400
300
200
100
0
(100)
Biomass Co-firing w/ CCS
Natural gas w/ CCS
Coal w/ CCS
Natural gas
Oil
Coal
Total
2019 2025 2030 2035 2040 2045 2050 2055 2060

DECARBONISATION PATHWAY









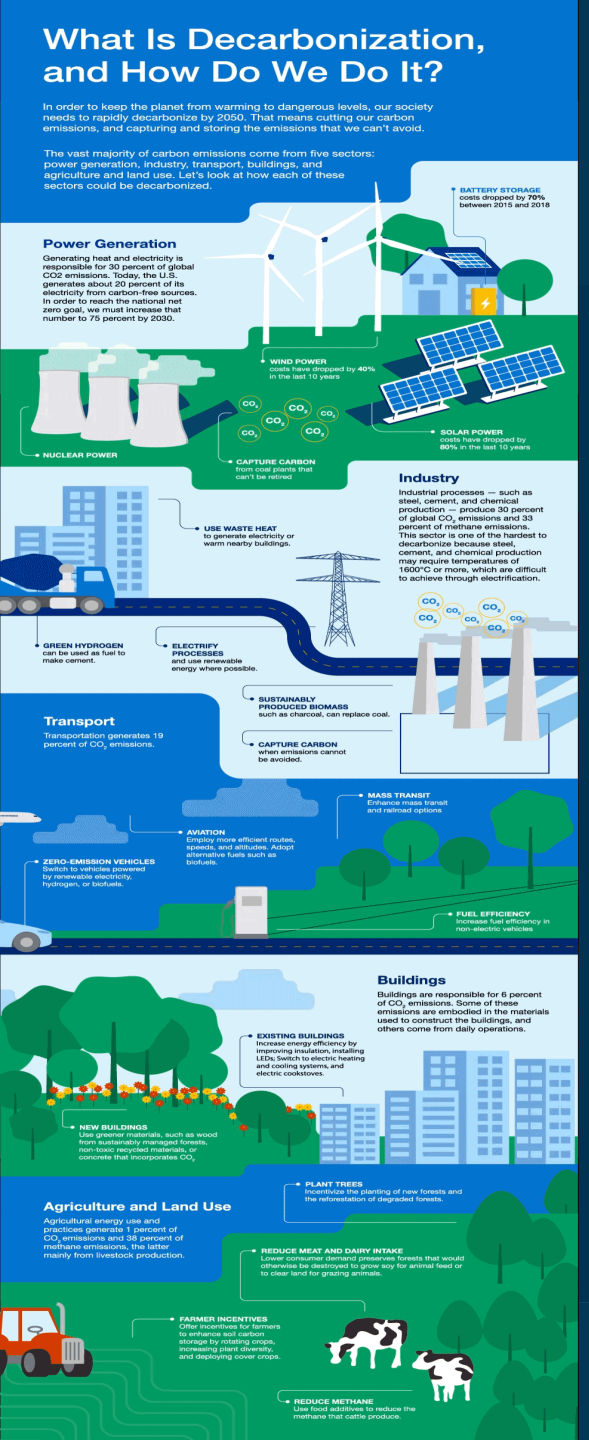
Capacity, GW (2060)	LOW	HIGH
Coal, including (co-firing) w/ CCS	**23**	**18**
Biomasa, including (co-firing) w/ CCS	11	12
Solar	131	178
Wind	18	22
Hydro	46	54
Geothermal	18	22
Nuclear	**35**	**42**
Other NRE (Amonia, H_2,OTEC, etc)	31	33
Natural gas w/ CCS	6	8
Total	**319**	**389**

Green H2 & NH3 Production

Capacity, GW (2060)	LOW	HIGH
Solar	113	131
Hydro	23	30
Nuclear	**10**	**12**
Total	**144**	**172**

Source: Draft academic paper for Indonesia National Energy Policy, Institut Teknologi Bandung (March, 2024)

The Best Decarbonization and How to do it



a. Increasing initiatives to achieve peak carbon emissions in a planned & gradual manner, in line with the principle of getting new before throwing away the old.

b. Replacing the entire coal-fired power generation system with new RE facilities will result not only in a loss of **state asset value** for facilities that are still operating and stranded assets in coal power sector (power plants and related infrastructure) but also value of coal at mining locations as state and regional income) and increase cost of energy production and lowering reliability (if existing plants will still use)

c. To be able to continue to utilize the stranded assets while decarbonize of coal-fired power plants by continuing use of the remaining coal plants + CCS/CCUS with BECCS technology, co-firing (biomass, H2, NH3), and **repowering (nuclear reactors and advanced geothermal)**

d. Energy density & ability to use existing equipment will direct the use of cofiring (biomass, H2, NH3), repowering (nuclear, advanced high temp. geothermal) as the main path for the down shifting of coal power plant

WHY REPOWER ?

- Potentially saving stranded asset in coal power plant – where a lot of equipment, infrastructure can be still used except the coal boiler.
- Provide benefits in saving of the investment costs, potential to avoid penalty in the power bussiness, **may move the peak emissions of energy sector is earlier than 2035** and the NZE is sooner (before 2060), in which repowering with nuclear reactor will also reduce the obstacle in collection biomass in the cofiring power system
- In the Government Regulations on National Energy Policy (RPP KEN) article 16 par (f), it states that the use of new energy sources from nuclear energy is directed at **generating electricity (incl. re-powering, co-generation, and also produce hydrogen and ammonia)**;
- Most options decarbonization in power are expensive if the entire coal-fired power system are totally replaced with new RE facilities or other low carbon emitting energy technology

Low Scenario

Power	2025	2030	2035	2040	2045	2050	2055	2060
Coal	**56**	**64**	**71**	**53**	**40**	**22**	**11**	**0**
Coal w. CCS/CCUS	0	0	1	2	3	7	12	20
Co-firing (Biomasa-coal) w. CCS/CCUS	0	0	0	0	2	4	5	6
Natural gas	24	27	34	26	24	13	7	0
Natural gas w. CCS/CCUS	0	0	0	1	2	4	5	6
Nuclear	0	0	**2**	**7**	16	24	33	45

High Scenario

Power	2025	2030	2035	2040	2045	2050	2055	2060
Coal	**68**	**83**	**94**	**73**	**56**	**28**	**13**	**0**
Coal w. CCS/CCUS	0	0	1,2	2	4	10	14	15
Co-firing (Biomasa-coal) w. CCS/CCUS	0	0	0	0	1	3	4	5
Natural gas	26	43	47	36	32	17	9	0
Natural gas w. CCS/CCUS	0	0	0	1	3	4	6	8
Nuclear	0	0	**3**	**10**	20	29	37	54

Related Terminology in Indonesia National Energy Policy for Supporting the Implementation Repowering (Draft)

Article 55

Perubahan opsi terakhir pemanfaatan Tenaga Nuklir menjadi salah satu jenis energi baru yang akan dimanfaatkan untuk pembangkitan tenaga listrik dan/atau dalam bentuk panas untuk co-generation.

Changes the terminology of 'final option of using Nuclear Energy' to become 'a new type of energy that will be used to generate electricity and/or in the form of heat for co-generation

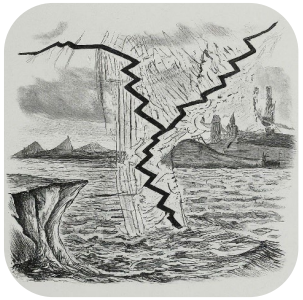
Article 64 - 69

Harga energi berdasarkan nilai ekonomi berkeadilan dan dukungan pemerintah untuk sektor energi dengan pendanaan ketahanan energi dan pendanaan dekarbonisasi sektor energi.

Energy prices are based on fair economic values and government support for the energy sector with energy security funding and energy sector decarbonization funding.

In natural phase down of coal power (2035 - 2030), nuclear power can be used as new build for the replacement of coal plant or repowering (replacing 'coal power boiler' with 'nuclear reactor'). Acceleration program (JETP) in Indonesia would be directed towards repowering instead of earlier replacing coal plant with renewable energy.

Criteria of Repowering Score (Adopted from QCL Methodology)



Seismic Risk

Tsunami Risk

Flood Risk

Population Density

Cooling Type

Water Stress Index

Emission Intensity

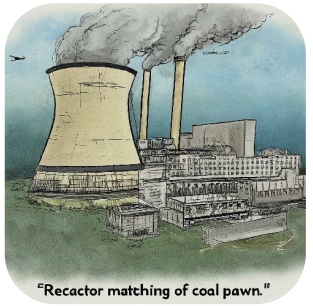
Production Cost

↓

reduce LCOE

Effective Age

Retirement Date



Reactor Matching

Power Delivery Type