NIES International Forum 16 February 2023

An Analysis of Indonesia Energy Sector Development Pathway to Achieve Net Zero Emission 2060

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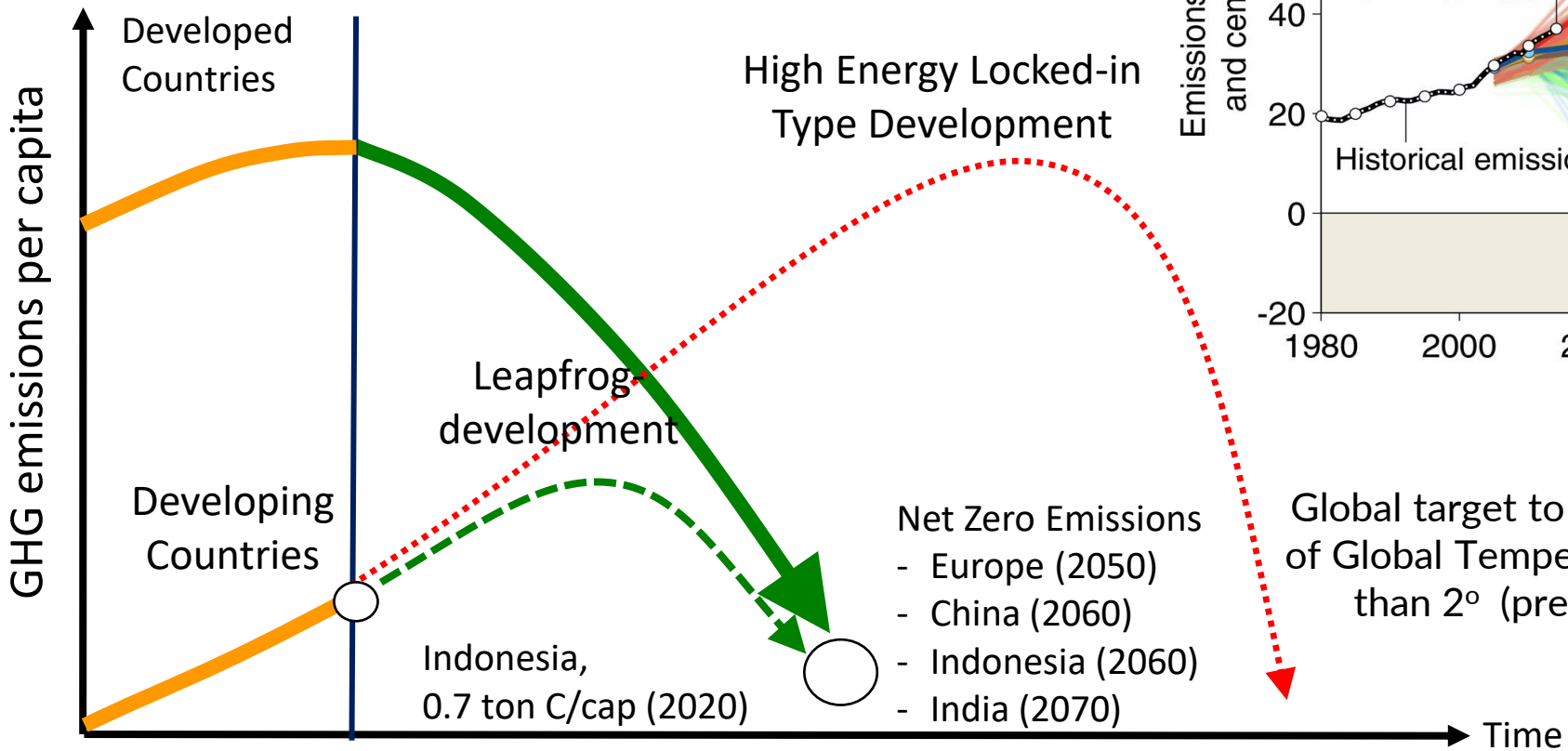
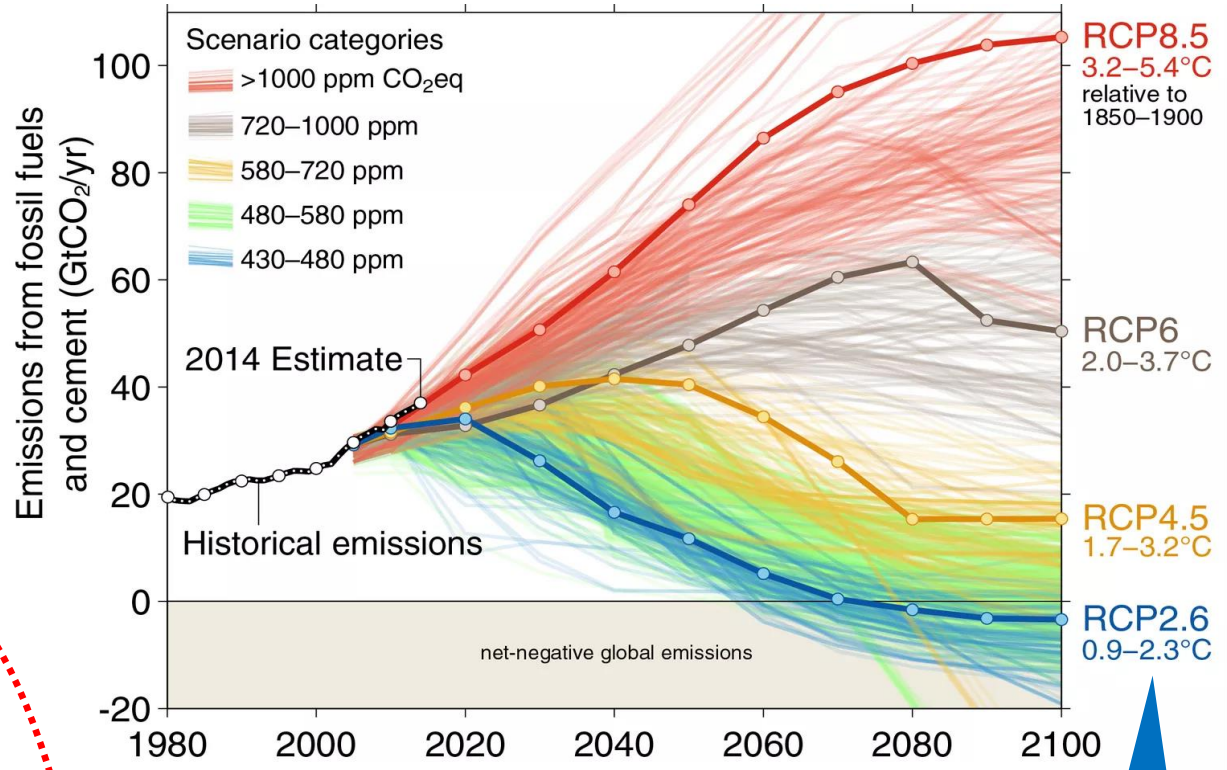
Low Carbon Development Strategies and CO_2 Emissions Reduction Challenges

International (2005), Ton C/capita
-Japan, UK, Germany 2.5
-US 5.5; Canada 4.2
-India 0.3; China 0,6
-World (average) 1.0 – 1.1





In-line +2˚C

Global target to keep increasing of Global Temperature not more than 2° (preferable 1.5°)

Increasing 1.5°C is considered as threshold limit for "*climate catastrophe*"

GHG Emission/capita [Source: AIM training WS Asian LCDS Study , 2010]

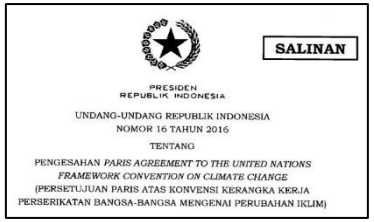
PARIS AGREEMENT AND INDONESIA COMMITMENT

Paris Agreement (PA) 2015

- Commitment to contribute in reducing GHG (NDC)
- Transparency Framework
- Means of Implementation (MoI)

Presented by **PRESIDENT RI** COP21/CMP11 in Paris - (Dec **2015).**

Signing of **Paris Agreement (PA) at** *High-level Signature Ceremony for the Paris Agreement in* United Nation, New York **(April 2016).**


SALINAN

PRESIDEN
REPUBLIK INDONESIA

UNDANG-UNDANG REPUBLIK INDONESIA
NOMOR 16 TAHUN 2016
TENTANG
PENGESAHAN *PARIS AGREEMENT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE*
(PERSETUJUAN PARIS ATAS KONVENSI KERANGKA KERJA PERSERIKATAN BANGSA-BANGSA MENGENAI PERUBAHAN IKLIM)


FIRST NATIONALLY DETERMINED CONTRIBUTION
REPUBLIC OF INDONESIA

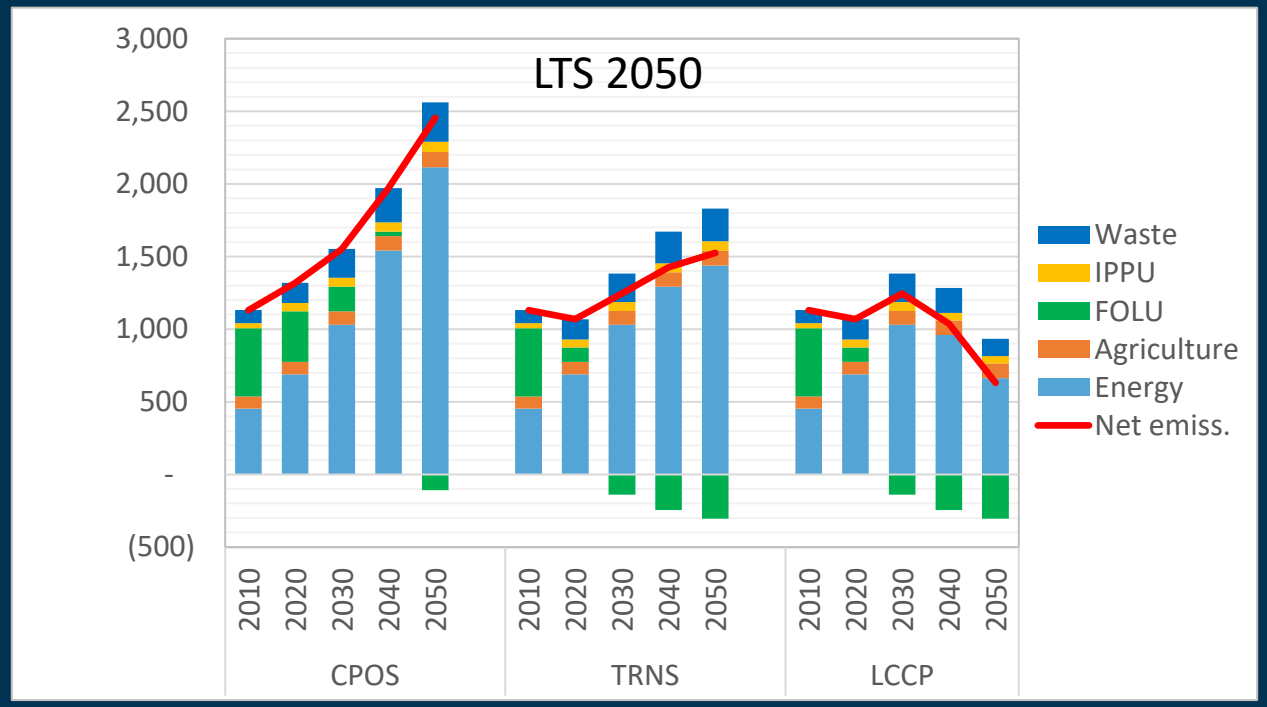
- Ratification **UU 16/2016 :** *Paris Agreement To The UNFCCC* **(Oct 2016)** including dokuments: **First NDC Indonesia to** UNFCCC
- ***Enhanced NDC*** *(September 2022)*
- ***Mainstreaming*** **NDC and** strategy to achieve NDC targets and Long Term Strategy (LTS LCCR)

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

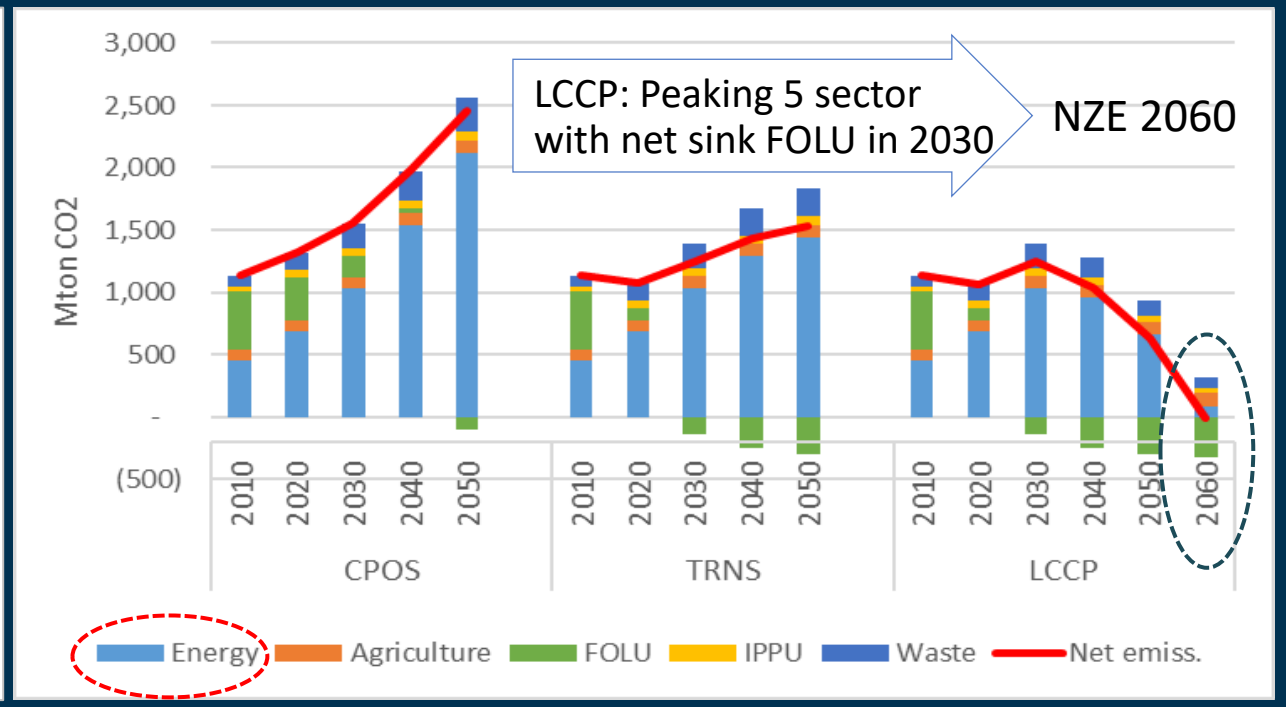
COUNTRY COMMITMENT

Indonesia
LTS LCCR and NZE

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



NZE 2060
(Net Zero Emissions)



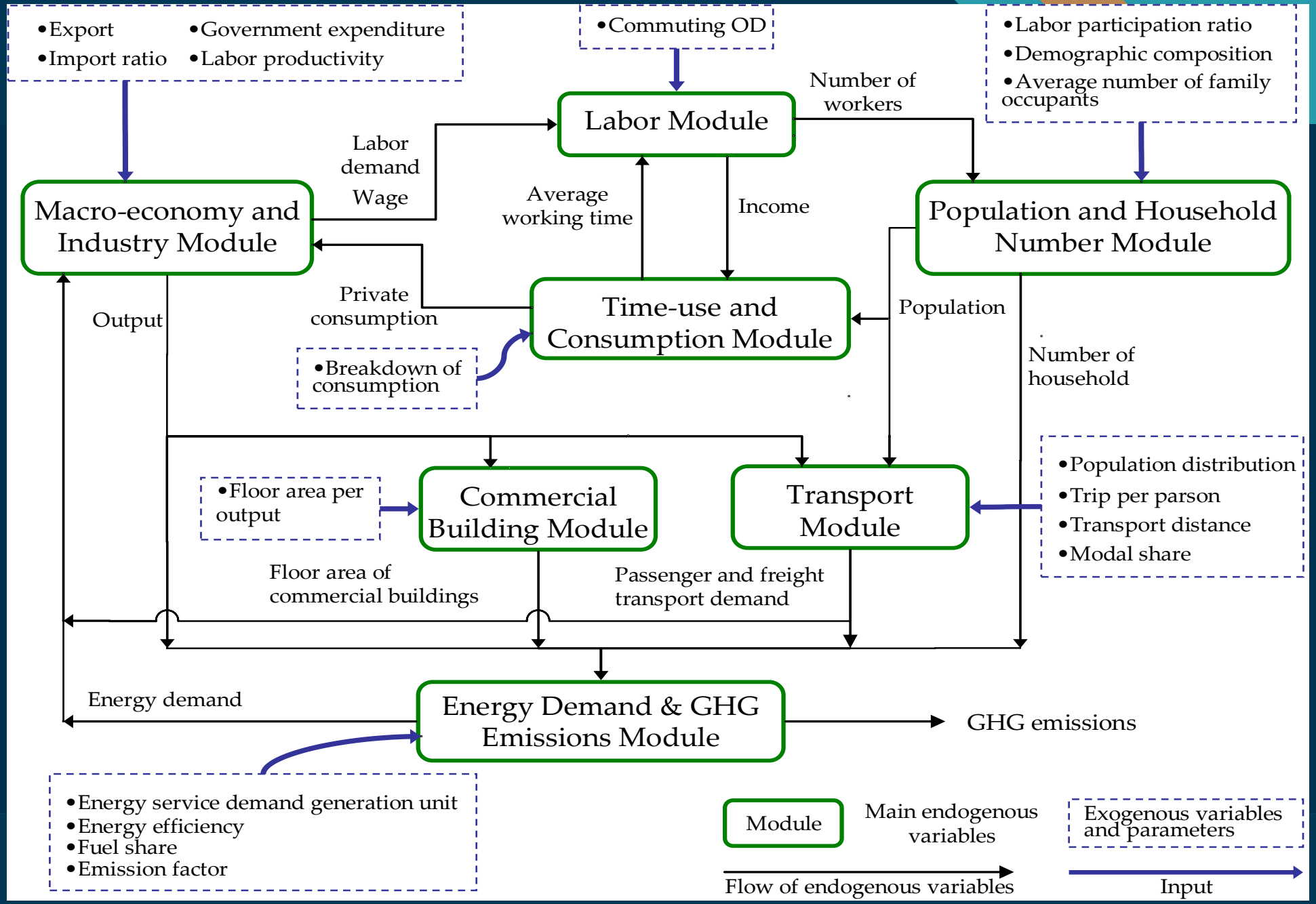
Sumber: LTS LCCR Indonesia, KLHK (2021)

- **CPOS** (Current Policy)
- **TRNS** (Transition)
- **LCCP** (Low Carbon Scenario Compatible with Paris Agreement Target)

Sector	2010	2020	2030	2040	2050	**2060**
Energy	453	638	1030	960	572	**129**
IPPU	35	55	62	55	50	**45**
Agriculture	84	88	94	98	102	**101**
FOLU	470	98	-140	-246	-304	**-362**
Waste	89	139	198	170	120	**87**
Net Emissions	1,131	1,018	1,244	1,037	540	**0**

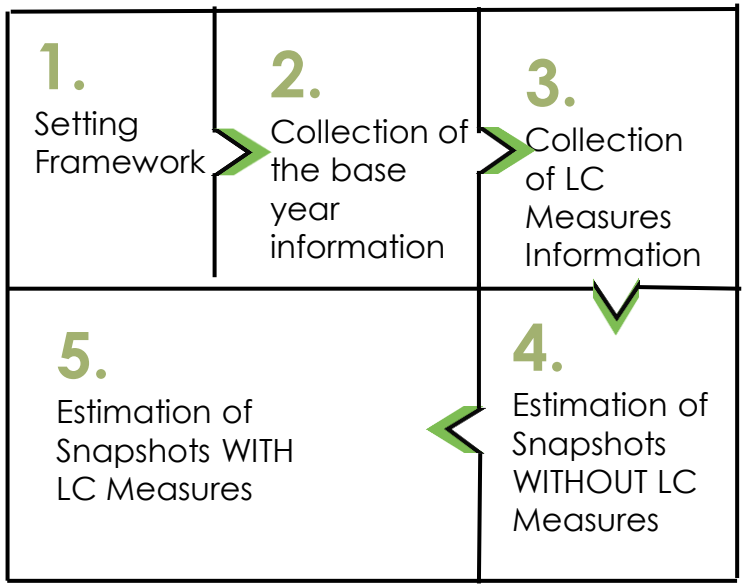
Development of NZE 2060 Scenario

Energy Economics Model

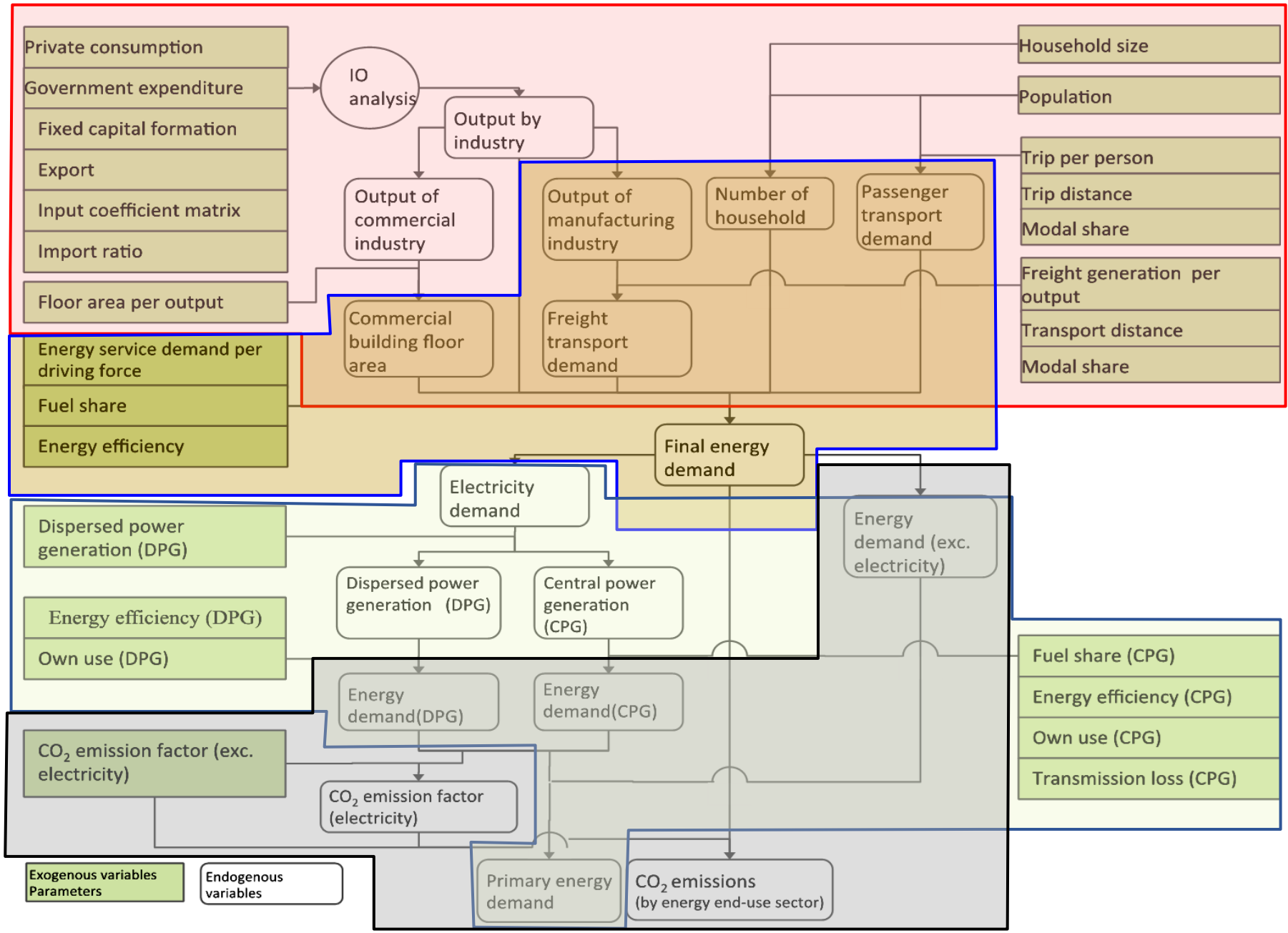


Methodology

Back casting Approaches



1. ***Driving Force Settings***
2. ***Final Energy Demand***
3. ***Primary Energy Demand***
4. ***GHGs emission***



METHODOLOGY
EndUSe Model

Service demand

- Electricity

Socioeconomic Scenario (BAU & CM scenario)

- Population growth
- Economic growth
- Life style
- Electricity demand

Technology selection focus on :

- Direct Coal Fired
- Supercritical
- Ultra Supercritical
- IGCC
- Combined cycle
- Coal w/ CCS
- Biomass w/ CCS (BECCS)
- Biomass
- Co-firing
- Geothermal power
- Hydro power
- Solar power
- Wind power
- Nuclear power

Energy Database

- Energy price
- Energy type
- Energy constrain
- Emission factor
- Fuel availability

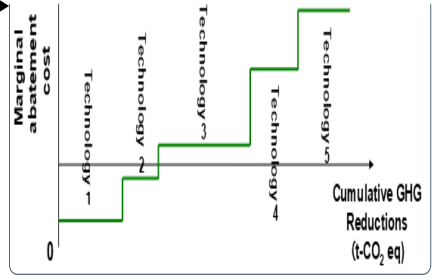
Technology Database

- Technology lifetime
- Energy consumption
- Efficiency
- Share
- Technology price
- Investment cost and OM cost
- Technological availability

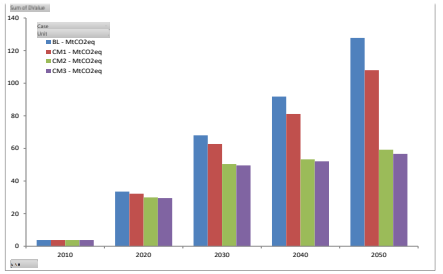
Energy Consumption

- Coal
- Natural gas
- Oil
- Biomass
- Geothermal
- Hydro
- Solar
- Wind
- Nuclear
- Other renewable

Abatement cost curve (ACC)



Pivot diagram (EndUse result)

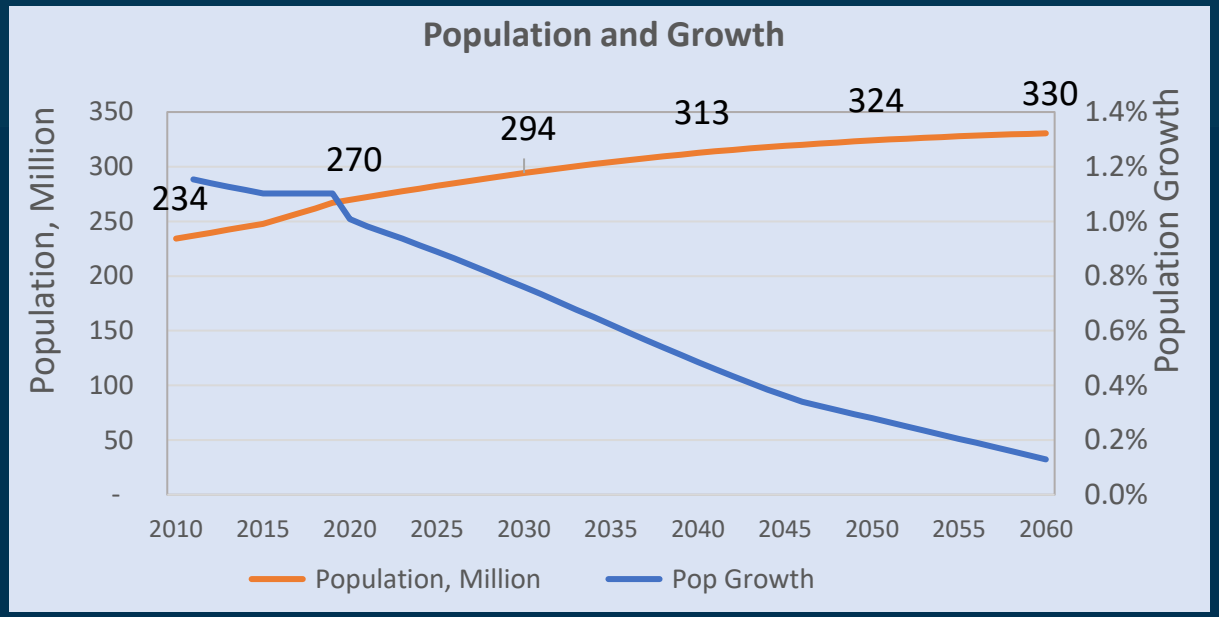


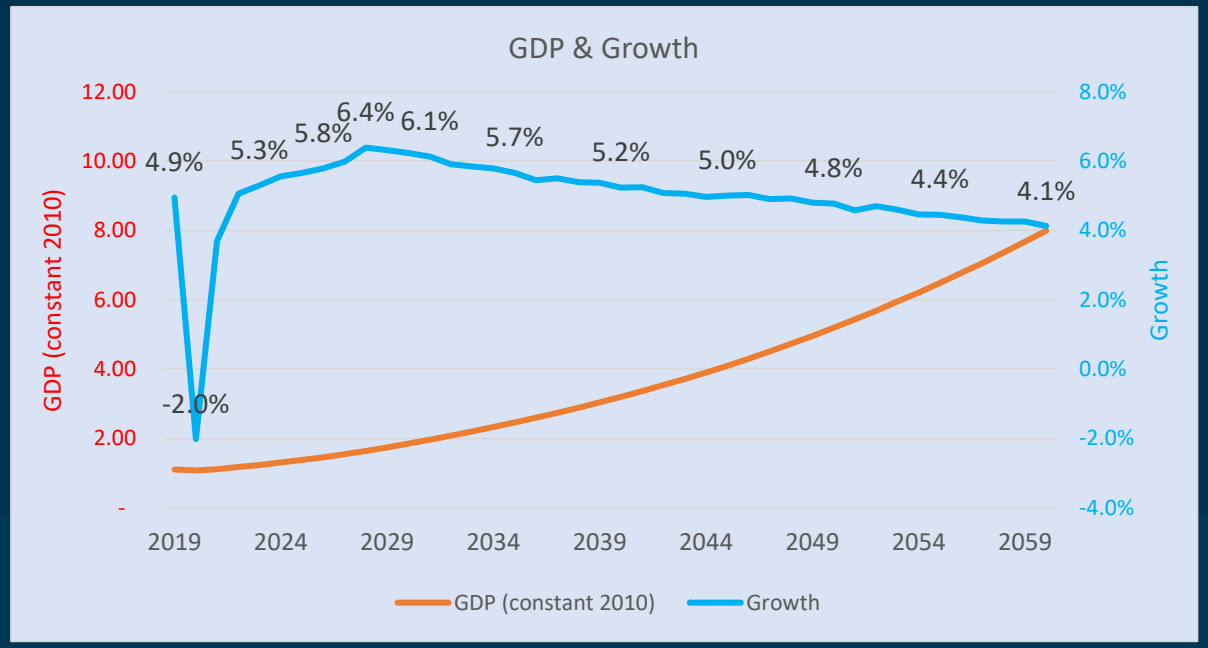
- CAPEX
- OPEX

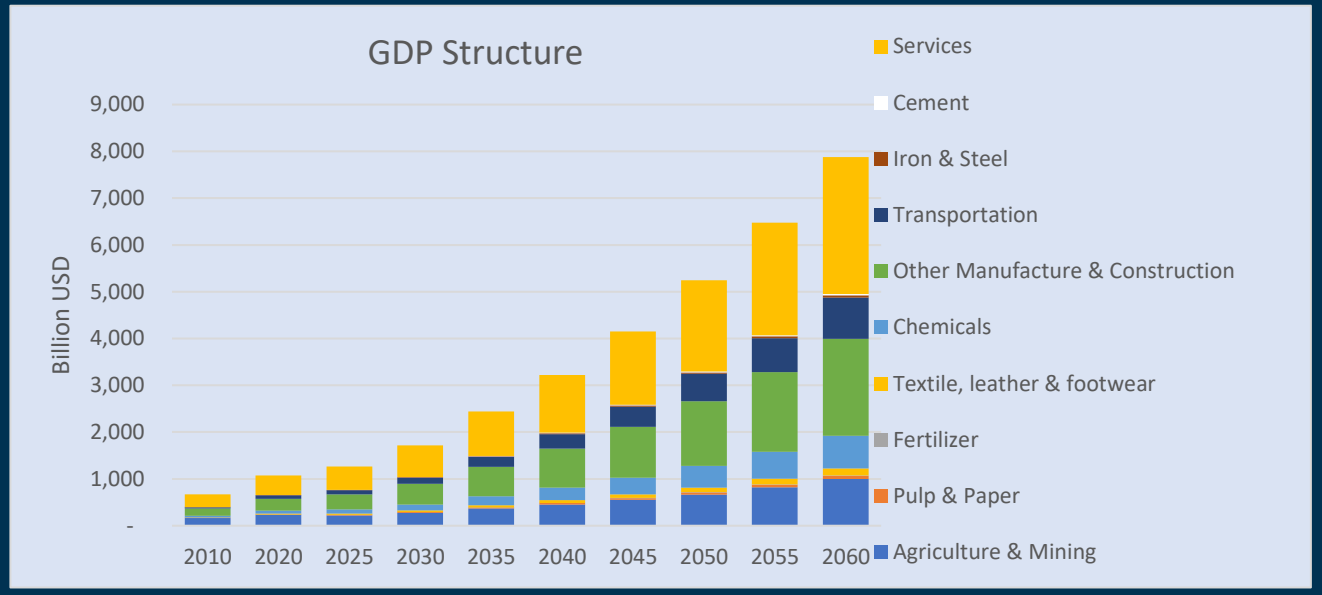
Selection of technology and estimation of power generation capacity need to be done to meet service demand (Hibino et al., 1996) and estimate the energy demands and the associated GHG emissions released from the operation of the selected technology (Mikiko et al., 2000).

Assumptions for Socio-Economic Development & Energy Demand Target

Future Economic and Population Developments







The major contributors of Indonesia economy are manufacturing, service sector, agriculture and transportation

BASIC ASSUMPTION IN MODELING

MODELING TOOLS

Backcasting Approach:

- ***Asia Pacific Integrated Model-Extended Snapshoot* (AIM-ExSS)** for estimating rational energy demand projections of different consuming sectors
- **End Use Model** for energy technology selection through optimization based on cost of energy, cost of technology (Capex/ Opex) and GHG emission reduction

DEMOGRAPHY & MACRO ECONOMIC

Parameter	Unit	Avg	2019	2025	2030	2040	2050	2060
Population	Million		268	282	294	314	325	330
Population growth	% p.a.	0.51%		0.89%	0.76%	0.49%	0.28%	0.13%
GDP	billion USD		1,095	1,372	1,847	3,193	5,189	7,985
GDP growth	%	5.2%		5.7%	6.2%	5.2%	4.8%	4.1%
GDP per capita	USD/cap		4,087	4,857	6,281	10,218	16,017	24,169

Source: BPS, 2021

Note:

Economic development is expected to continue with average an growth of 5.2%/year. Post covid pandemic, Indonesia has to have economic growth of 5%-6% (2022-2025) and 6.3%-7.1% (2026-2030) to be able to escape from 'middle income trap' to become developed country in 2045. This development will require high but rational energy growth.

BASIC ASSUMPTION IN MODELING (cont'd)

ENERGY USE

Energy Indicator	Indonesia (2060)	*Benchmark*
Final Energy Consumption/Capita (TOE/capita)	~1.35	World (2020) : 1.32 OECD (2020) : 2.68
Electricity consumption/capita (kWh/kapita)	~5,500	World (2021) : 3,513 OECD (2020) : 7,085
Primary Energy Consumption/Capita (TOE/capita)	~2.5	World (2020) : 1.7 Japan (2020): 3.2

Sourcer: IEA (2021), Our World in Data (2022)

Note:Energy use per capita is one of the assumption in modeling to indicate that Indonesia would have become developed country in 2060.

RE RESOURCES

Energi	Potential (GW)	Utilization (GW)
Solar	3,295	0.217
Hydro	95	6.637
Bioenergy	57	2.284
Wind	155	0.154
Geothermal	24	2.293
Ocean	60	-
Total	**3,686**	**11.585**

Sumber: Ditjen EBTKE, KESDM

Energy Transition in NZE

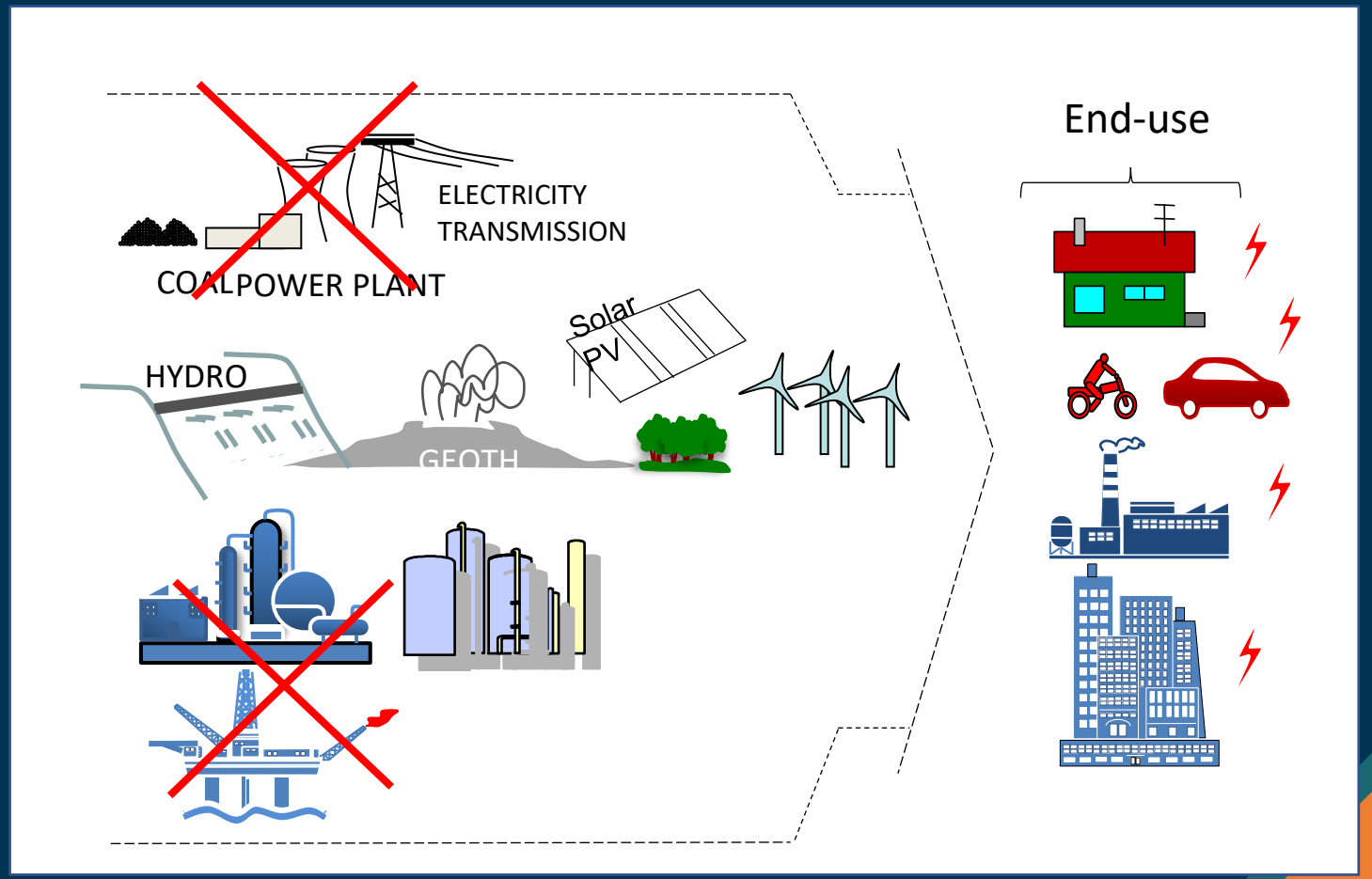
The **energy transition** is a significant structural change in energy system through deep decarbonization so that the increase in earth's temperature does not exceed 1.5°C (Paris Agreement).

The ultimate target is NZE (Net Zero Emissions)

Energy transition implementation should not hamper socio-economic development.

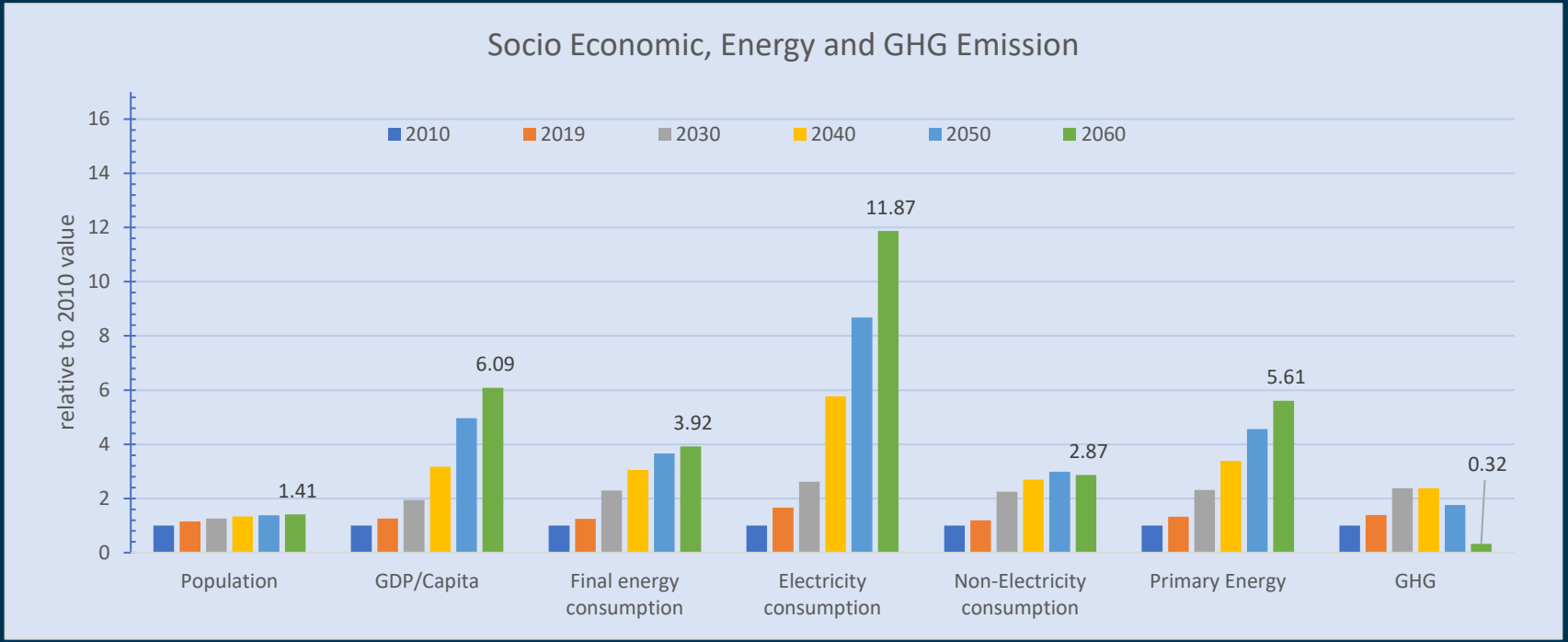
The main components:

- Maximizing renewables,
- Electrification of end user (including EV),
- Deep decarbonization of power sector
- CCS/CCUS for remaining fossil energy,
- New energy (hydrogen, ammonia, nuclear)



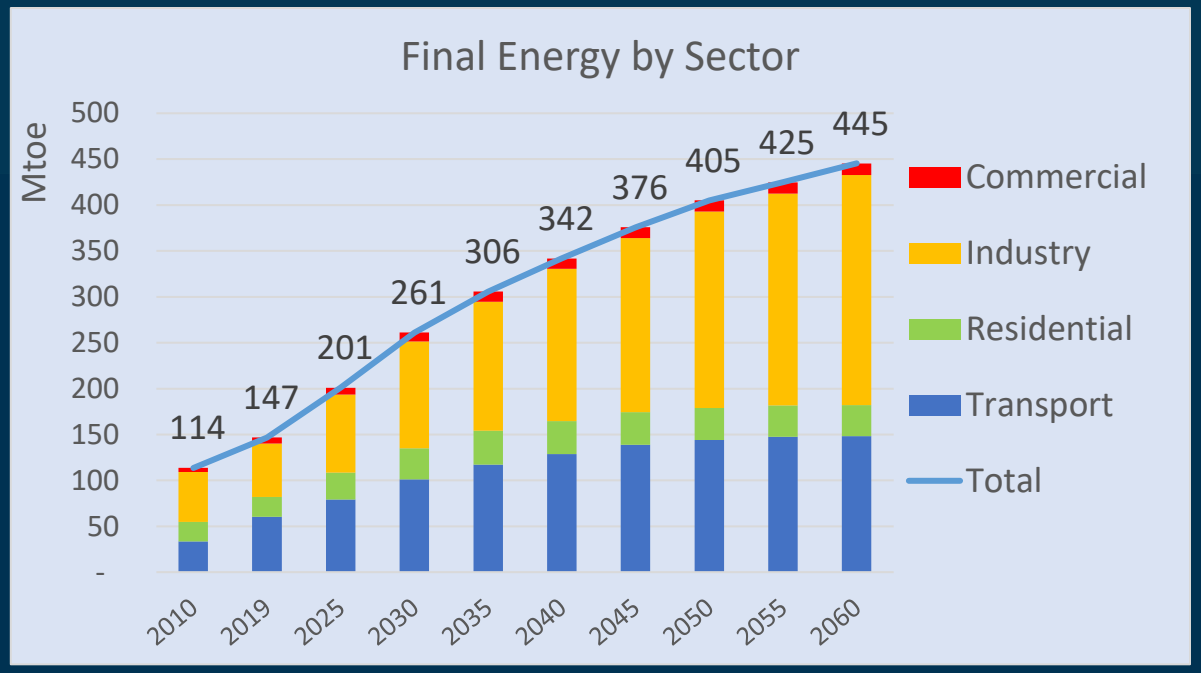
Projection of Energy Demand and Supply and The Associated GHG Emissions

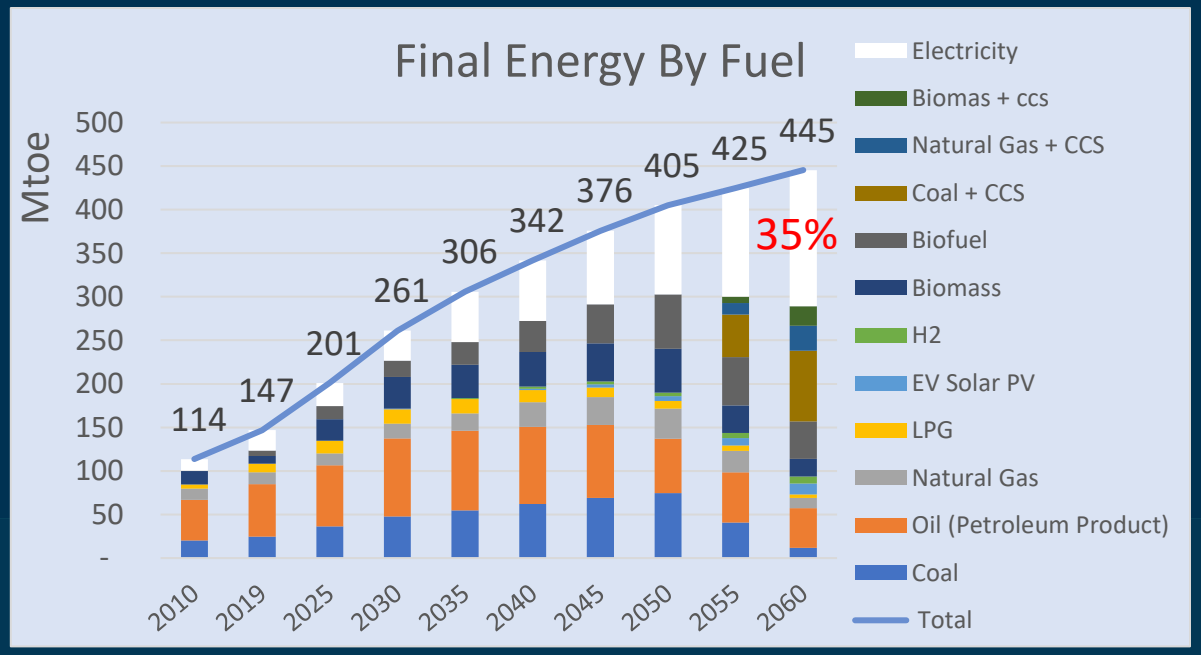
Socio-economic Assumption, Energy Target and the Associated GHG Emissions



- World average of final energy demand in 2020 (IEA 2022) was 1,32 toe/capita/year, in OECD countries it was 2,68 toe/capita/year, while world average primary energy supply was 3 toe/capita/year.
- In 2060, Indonesia energy consumption is targeted to exceed world average in 2020, i.e 1.45 toe/capita/year, which has considered more efficient energy technology trajectory.
- In 2060, electricity consumption level would reach 5000 kWh/capita/year, which is about the same level with developed country consumption level (7000-8000 kWh/cap/year in 2020.

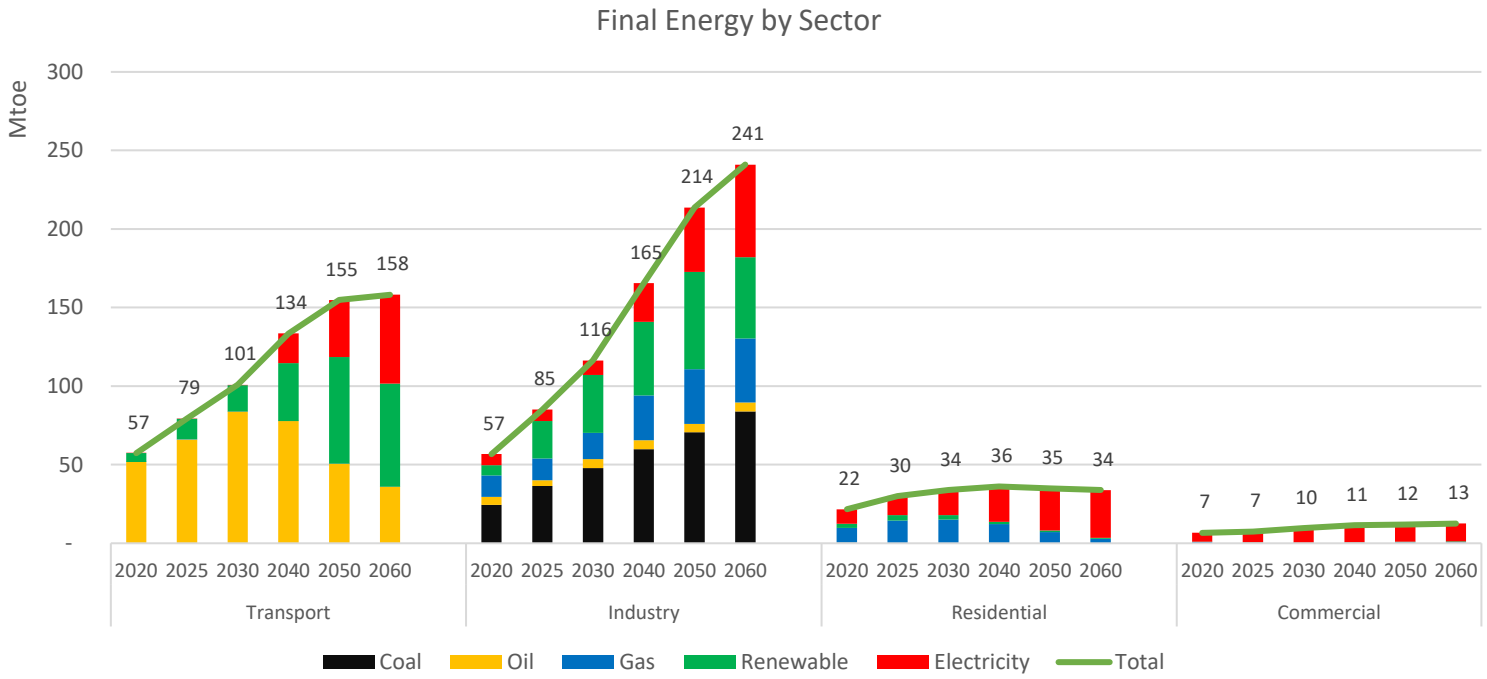
Energy Sector Development Challenges in Indonesia

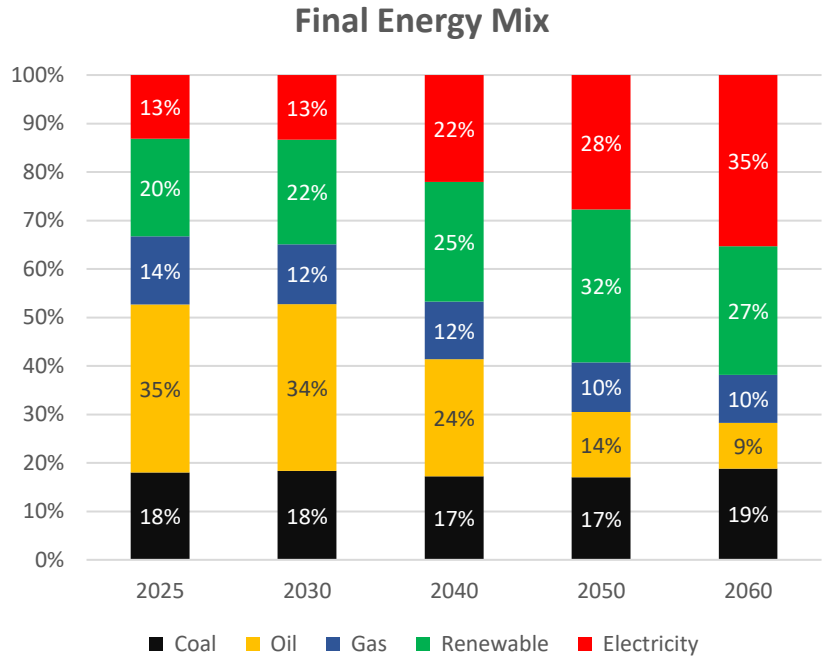




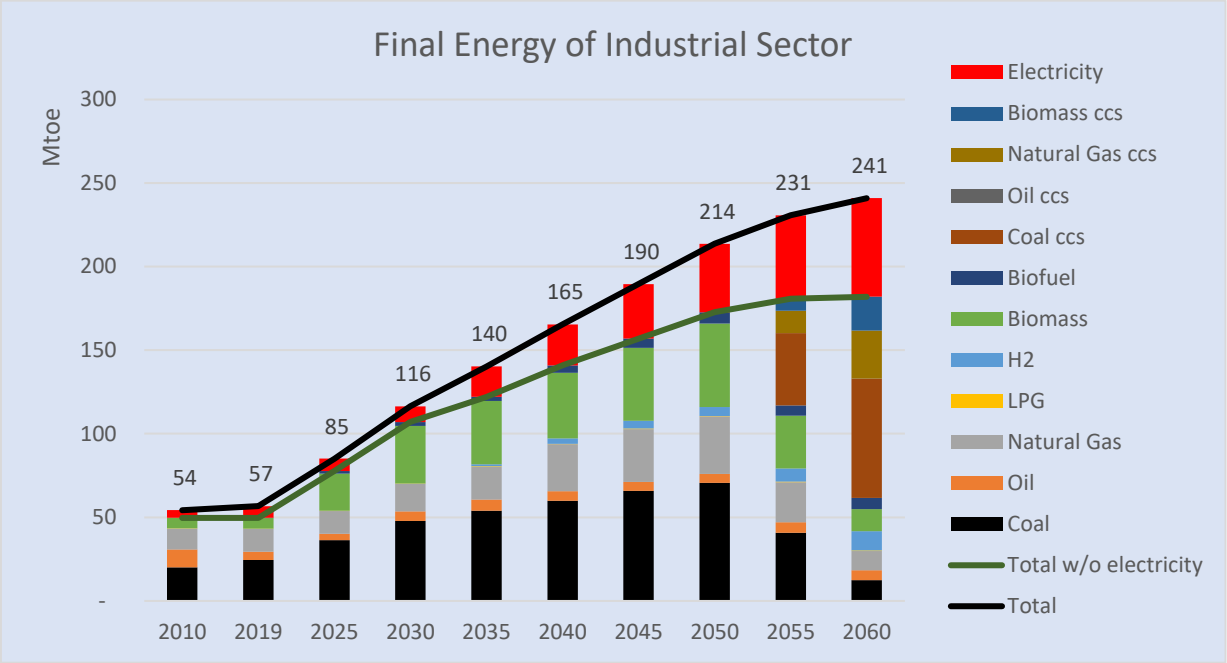
- **High economic growth**: increasing energy demand, with current technology lead to high GHG emission
- **Ensure Energy Security & Resilience**
- **National Energy Policy:**
  - Moving away from Oil (depleted & import dependency)
  - Strategic assets (gas, coal) – need to save stranded assets
  - Improved energy efficiency and conservation
  - Development of new energy (nuclear, H_2, ammonia, CBM, shale gas) and renewable energy (green H_2, wind, hydro, geothermal, solar PV, biomass-biofuels)
- Current development: increasing energy consumption and GHG emission while we have global commitment to achieve the targets of Paris Agreement
- Need for 'pollution-free' air quality (esp. in urban areas)
- Energy infrastructure challenges of archipelagic country

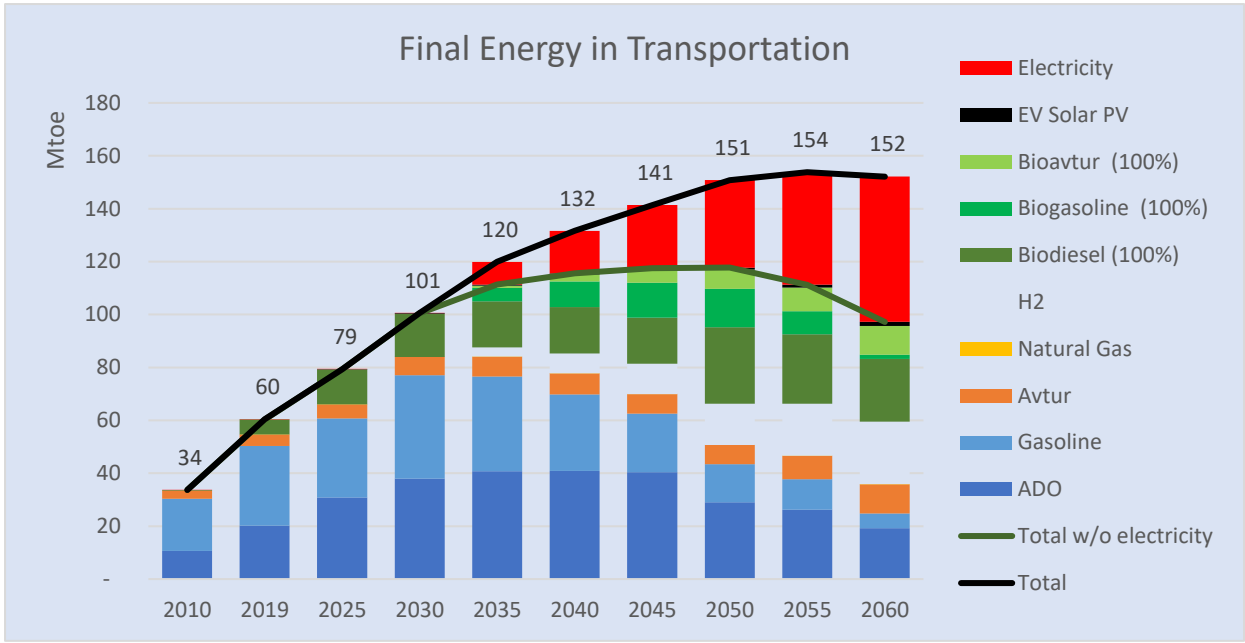
Final Energy Demand Projection by Sector and by Fuel

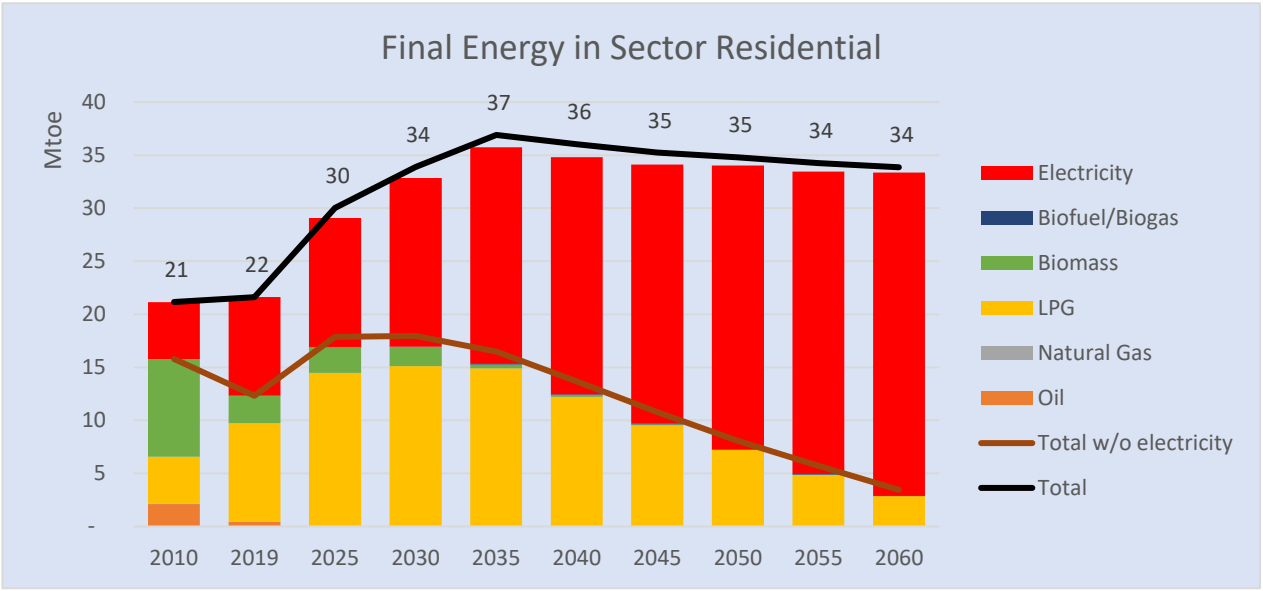


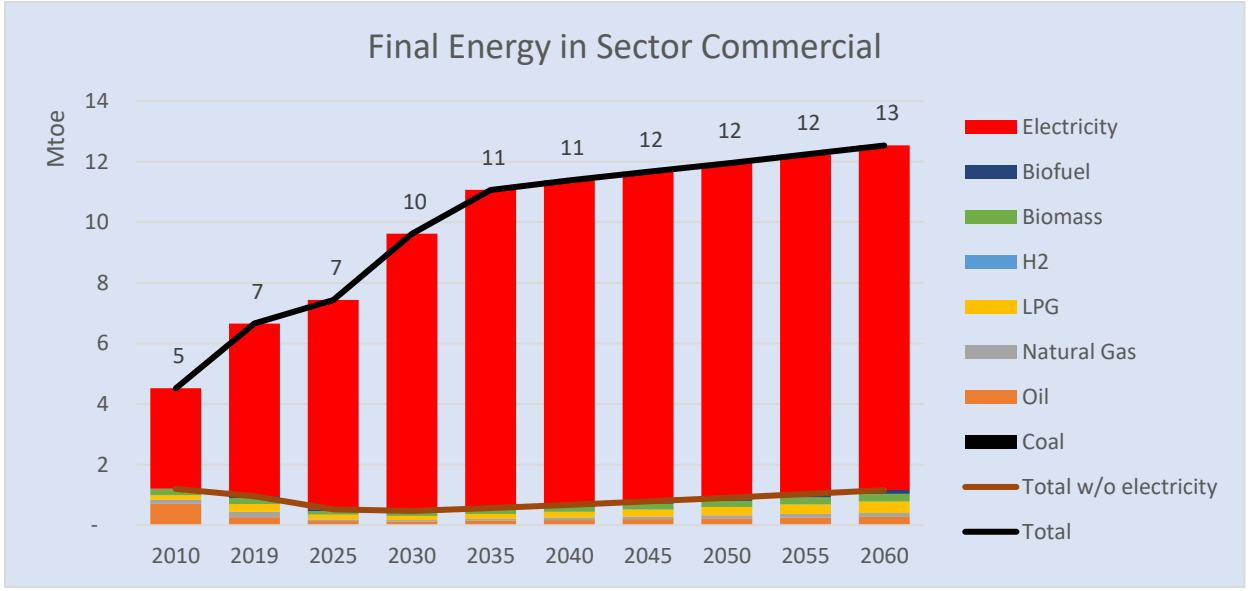


- Industry and transport demand are expected to continuously to grow on average of 3.6% and 2.6% per year, respectively. Energy demand of other sectors will slightly increase but tend to slow down around 2050.
- Electrification of end uses in all sectors including transport (EV) is one of main programs to support energy transition. In total, electricity demand will grow 4.9% per year, on average. In order to result in climate change mitigation, end-use electrification must be accompanied with decarbonization of electricity.
- Use of renewable in transport (biodiesel, biavtur, biogasoline) and in industry (biomass and biofuel) are expected to continue to grow.

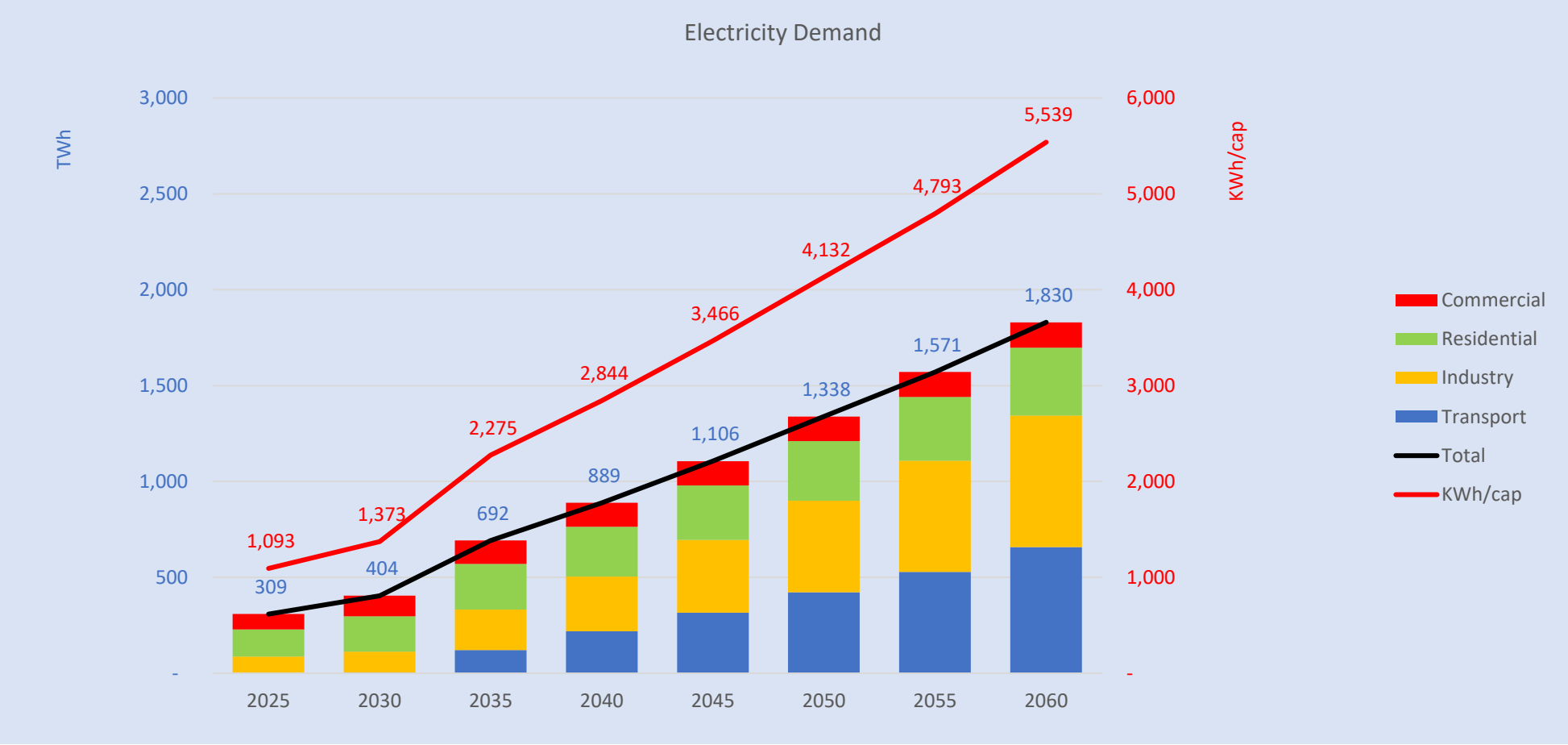

Final Energy of Industrial Sector
Mtoe
300
250
200
150
100
50
-
54
57
85
116
140
165
190
214
231
241
2010
2019
2025
2030
2035
2040
2045
2050
2055
2060
Electricity
Biomass ccs
Natural Gas ccs
Oil ccs
Coal ccs
Biofuel
Biomass
H2
LPG
Natural Gas
Oil
Coal
Total w/o electricity
Total


Final Energy in Transportation
Mtoe
180
160
140
120
100
80
60
40
20
-
34
60
79
101
120
132
141
151
154
152
2010
2019
2025
2030
2035
2040
2045
2050
2055
2060
Electricity
EV Solar PV
Bioavtur (100%)
Biogasoline (100%)
Biodiesel (100%)
H2
Natural Gas
Avtur
Gasoline
ADO
Total w/o electricity
Total


Final Energy in Sector Residential
Mtoe
40
35
30
25
20
15
10
5
-
21
22
30
34
37
36
35
35
34
34
2010
2019
2025
2030
2035
2040
2045
2050
2055
2060
Electricity
Biofuel/Biogas
Biomass
LPG
Natural Gas
Oil
Total w/o electricity
Total

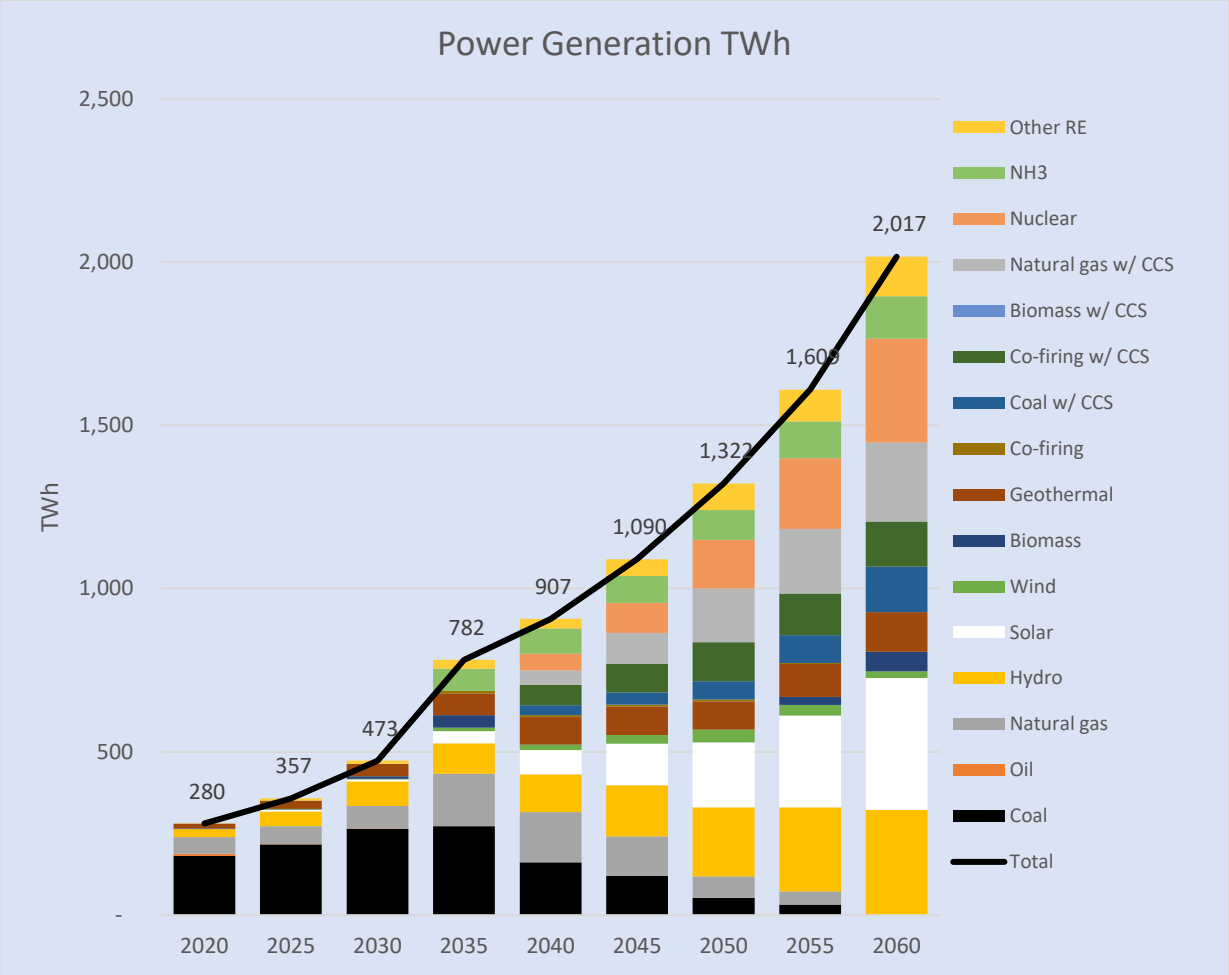

Final Energy in Sector Commercial
Mtoe
14
12
10
8
6
4
2
-
5
7
7
10
11
11
12
12
12
13
2010
2019
2025
2030
2035
2040
2045
2050
2055
2060
Electricity
Biofuel
Biomass
H2
LPG
Natural Gas
Oil
Coal
Total w/o electricity
Total

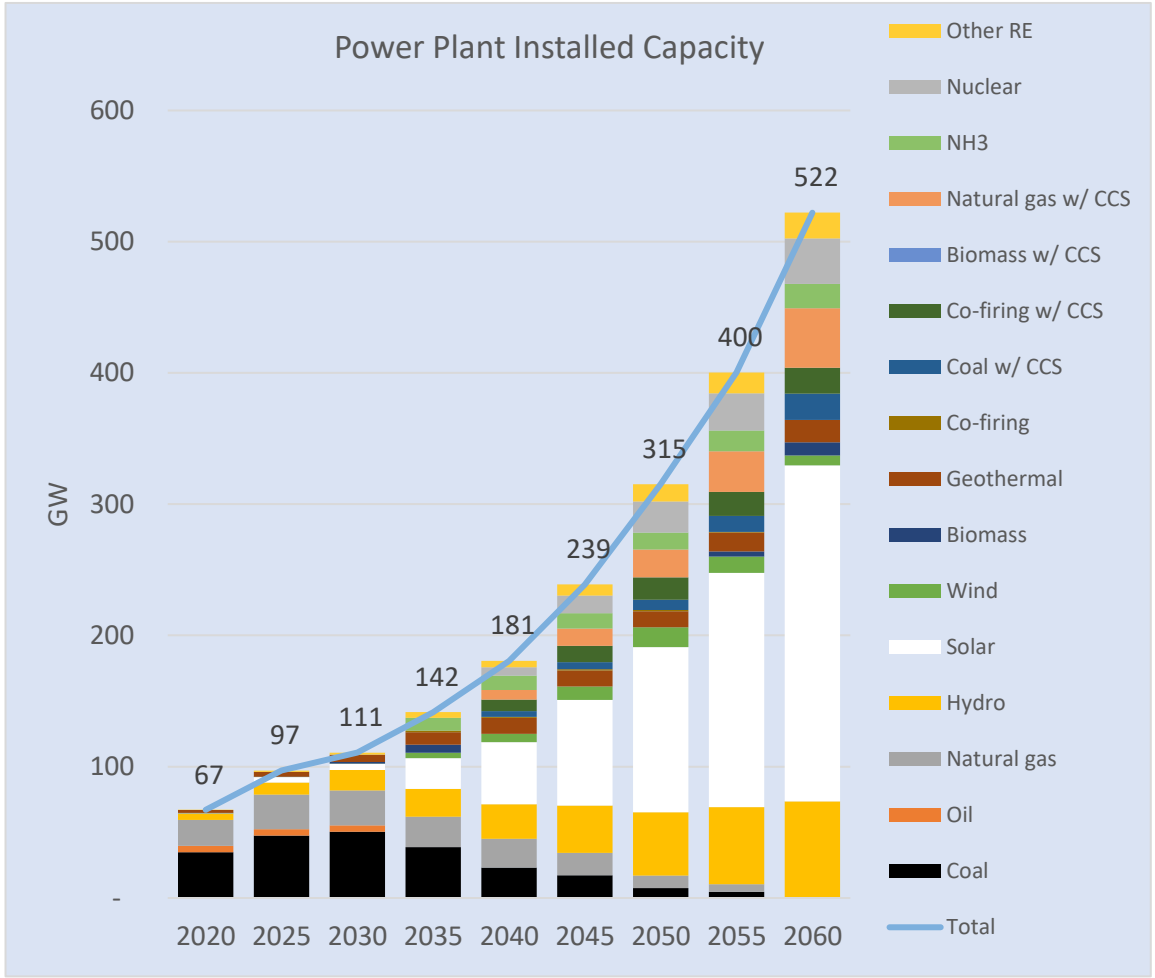
Electricity Demand Projection



- Electricity demand will reach 1,830 TWh in 2060. High growth will occur in industry and transportation.
- The per capita consumption will reach around 5,500 kWh/year

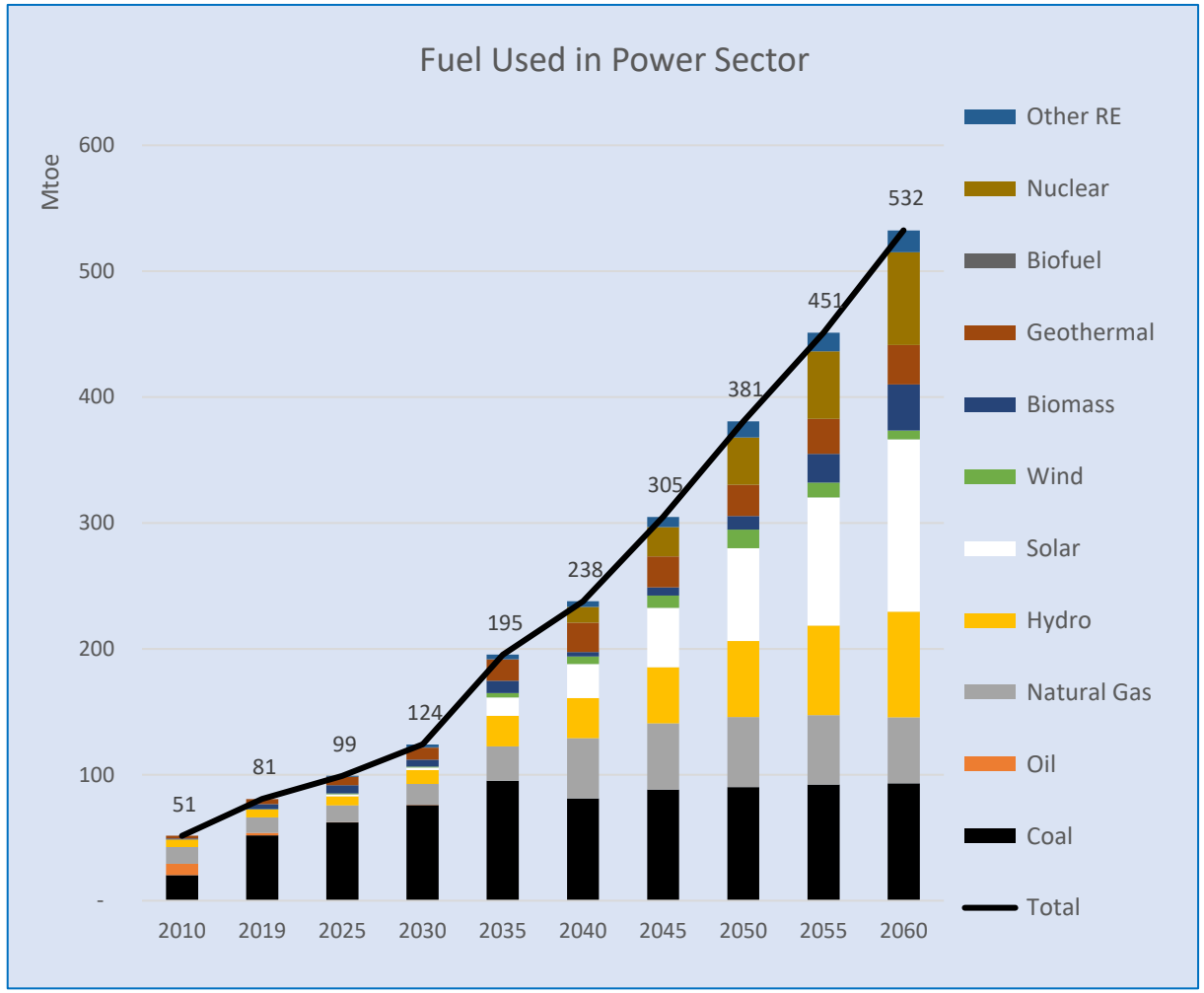
Electricity Generation Projection

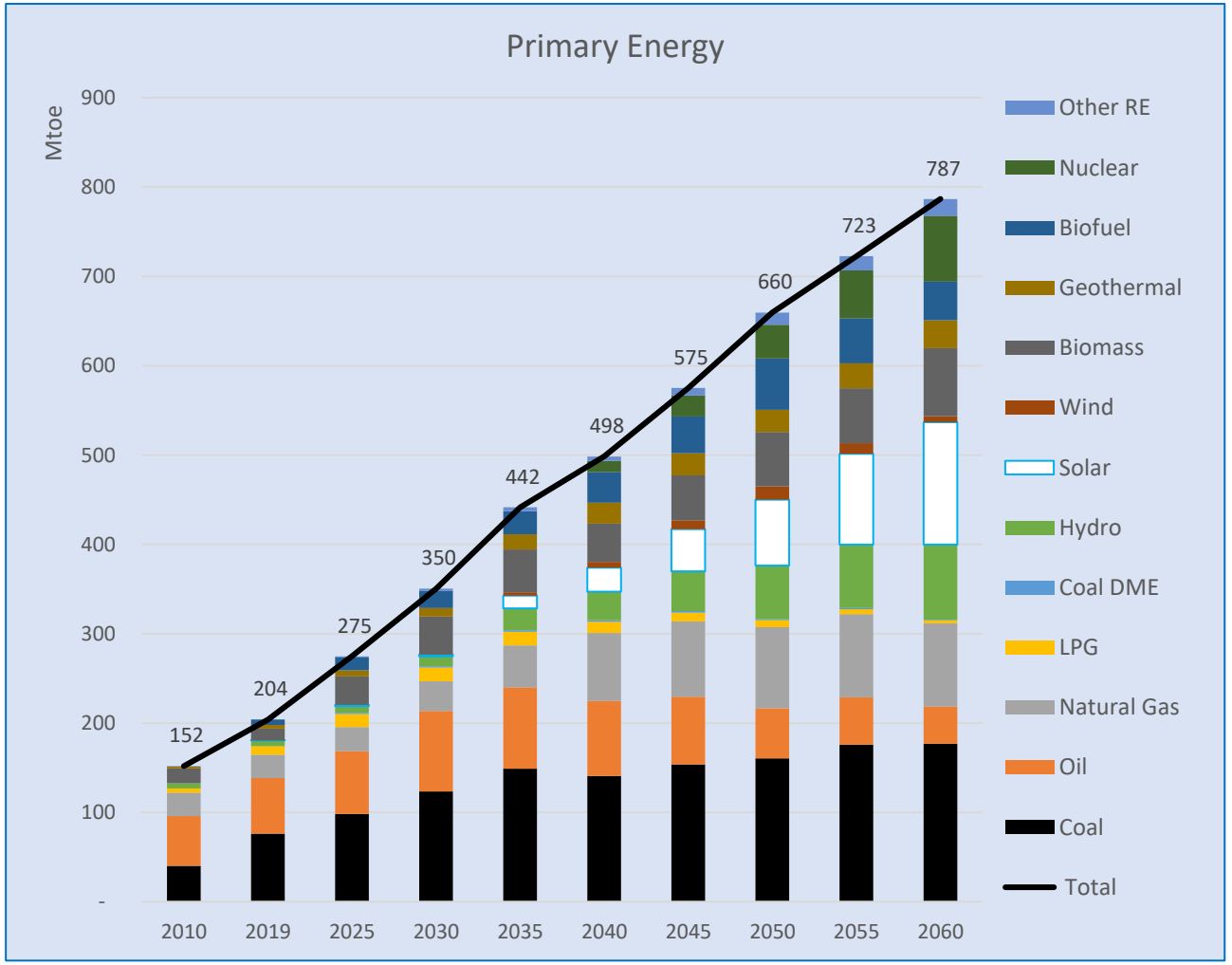




- Power supply will be dominated by renewable (60% in 2060). The major renewable will be solar power, hydro and geothermal.
- Remaining fossil energy power plants will be equipped with CCS/CCUS. Other decarbonization technologies: nuclear (begin in 2035) and NH3.

Role of Renewables

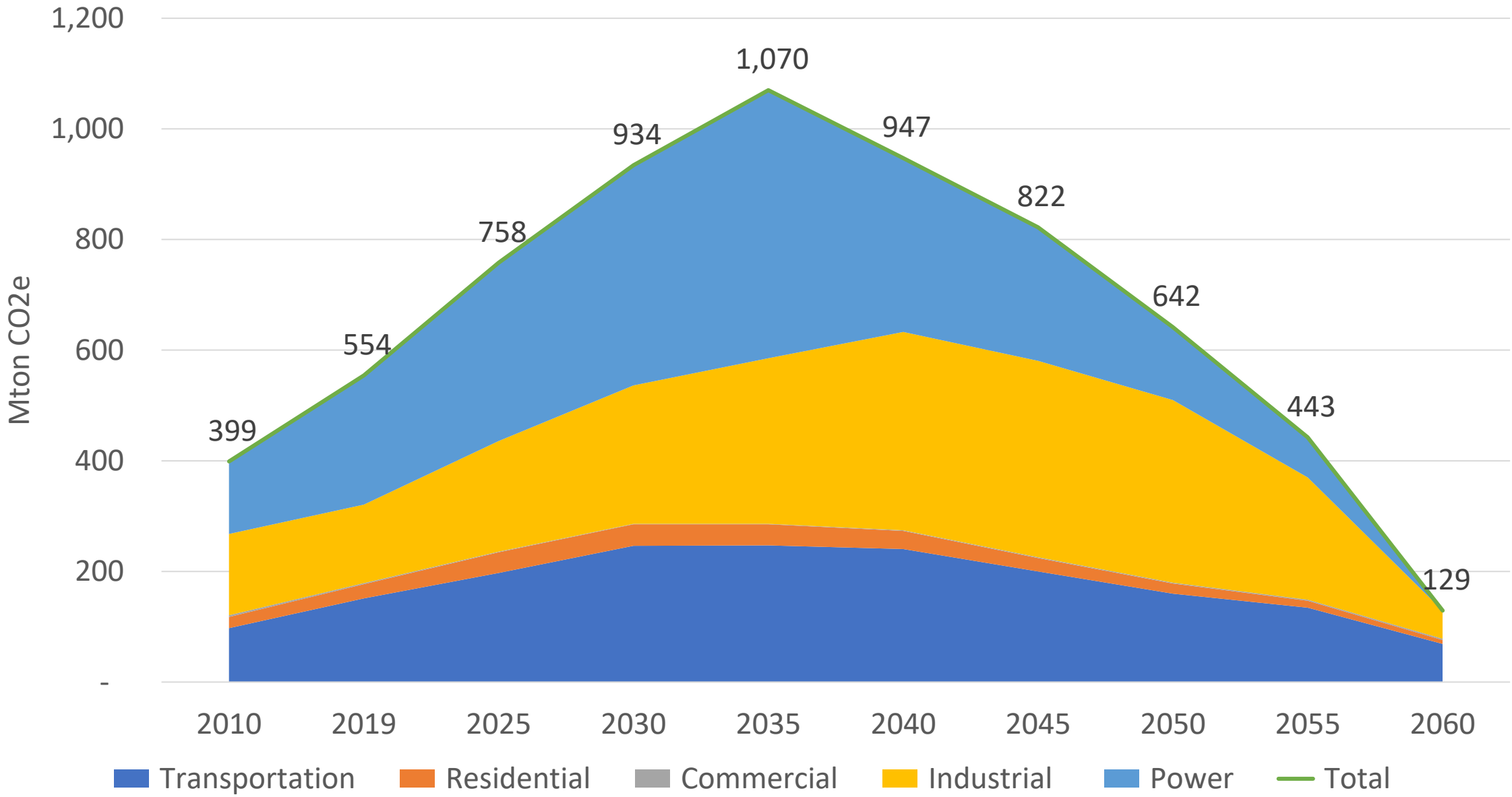




Share of RE	2019	2025	2030	2035	2040	2045	2050	2055	2060
In power	17%	24%	26%	36%	43%	46%	54%	57%	60%

Share of RE	2019	2025	2030	2035	2040	2045	2050	2055	2060
In primary	14%	23%	25%	31%	38%	44%	54%	58%	63%

GHG Emission



NZE Endeavor Challenges

- High economic growth - increasing energy demand, with current technology lead to high GHG emission, while we have commitment to achieve NZE
- National Energy Policy - optimization of Energy Security, Resiliency, Independence, and NZE endeavors.
- Decisions for short term development must avoid “locked-in” phenomena of fossil energy infrastructure investment.
- Have to deal with issues of stranded assets of coal resources and early retired infrastructure
- Energy infrastructure challenges of archipelagic country (optimization of inter island grid and distributed system).
- Must find solutions for hard-to-decarbonize industry sector (high temperature and pressure systems) – continue fossil but plus CCS.
- Employment - need to prepare work forces to move from fossil industry to RE industry (not easy)

NZE Endeavor Challenges (ctd.)

- Development of bioenergy must consider the availability of land area, which is also needed by FOLU sector to achieve carbon net sink target. Need to develop 2nd gen biofuels (from agriculture wastes)
- Large share of renewable in power system must consider grid stability due to supply intermittency of RE. May need large size battery systems and other type of storage such as pump storage for hydropower.
- Since many of NZE technologies are new, to reduce dependence on import, we need to develop local capacity in the manufacturing those technologies (EV, solar PV including batteries etc.) through R&D, field trial, joint venture, etc.
- CCS is a new technology, the fate of NZE will depend on the success of CCS technology development and the matching between CO2 source and storage location.
- Last but not least, NZE endeavor will need very large investment, while in the meantime capitals are needed by various development agenda. Therefore, Indonesia have to seek for international cooperation for NZE financing. For short term (NDC), need to explore opportunity offered by JETP (Just Energy Transition Partnership)

Policy Needed for NZE

Transport Sector

Increase biofuel in transport fuel mix:

- Allocate land area for growing feedstock,
- Incentives for R&D to produce advanced (2nd gen.) biofuels

Increase Electric Vehicle in transport energy mix:

- Provide incentives for early stage promotion of EV (soft loan/subsidy for EV purchase)
- Develop EV charging stations (provide financing for state own or private companies)
- Provide incentives for developing local capacity in EV manufacturing (including through joint venture), including battery

Promote the use of public transport (develop infrastructure, ticket price subsidy for passenger)

Develop railway systems to promote passenger and freight transport

Policy Needed for NZE (ctd.)

Building sector

- Increase efficiency of appliance (establish minimum performance standards) and promote and facilitate energy-efficient culture/habit (education, campaign etc.)
- Promote the use of electric stoves (subsidy for stove purchase)

Industry sector

- Develop natural gas infrastructure (government investment)
- Facilitate the development of biomass energy resource base (energy plantations ang agriculture wastes)
- Incentives for investment needed for efficiency improvement (soft loan)

Power sector

- Incentives to promote the development of solar PV (utility scale, residential scale). Investment and incentives to develop local capacity in solar PV system manufacturing.

Policy Needed for NZE (ctd.)

Power sector (ctd.)

- Financing for hydropower development including micro hydro. Increase investment for exploration and exploitation of geothermal and wind
- Investment for the development of local capacity in new energy (hydrogen, ammonia, nuclear) and CCS/CCUS systems (R&D, field trial etc).

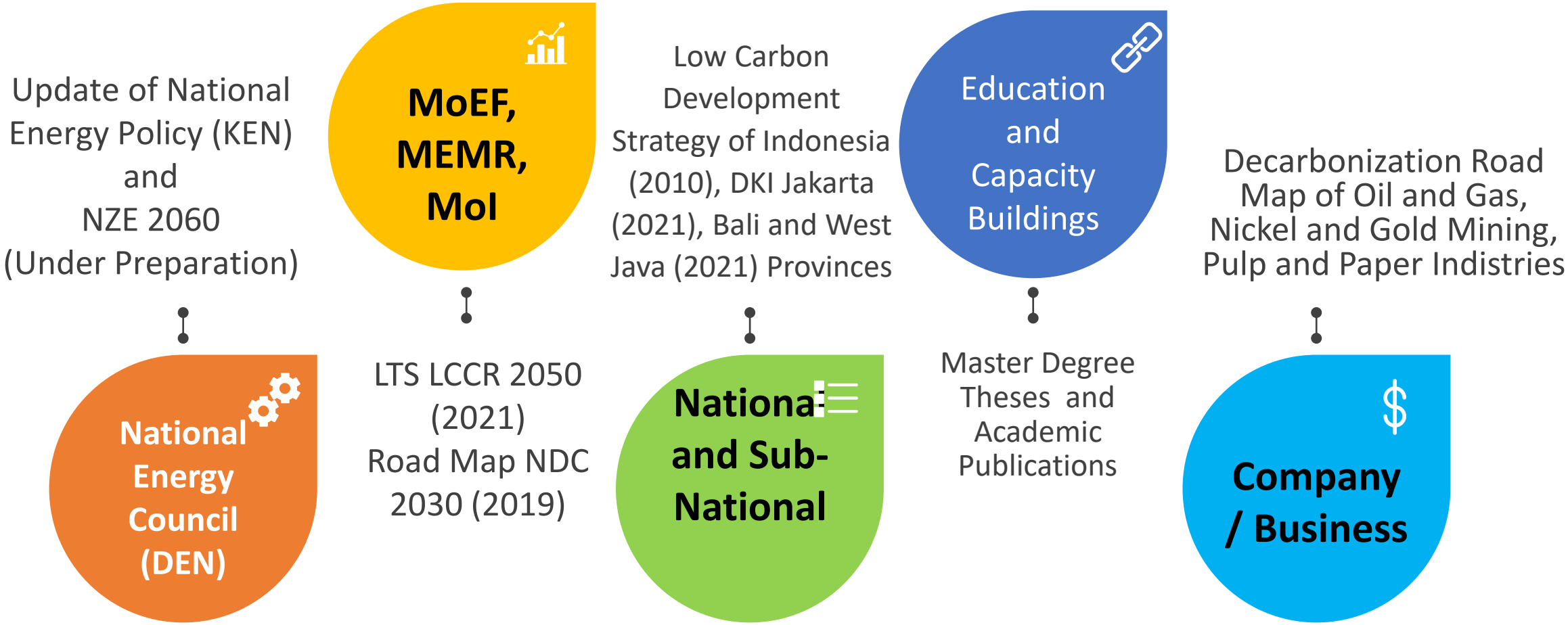
General policies for promoting mitigation action.

Establish **carbon pricing** mechanism (**cap and trade, cap and tax, result based payment**)

STAKEHOLDER ENGAGEMENT ACTIVITIES

Contribution to the development of mid-/long-term GHG emissions reduction scenario analyses in Indonesia Energy Sector

AIM ExSS, AIM End Use, AIM CGE (in progress)



INDONESIA
Long-Term Strategy for Low Carbon and Climate Resilience 2050

- 2021 -

FOREWORD

Climate change is recognised as one of the most complex, multi-faceted, and severe threats to humanity. Guided by the common but differentiated responsibilities and respective capability principle of the UNFCC Convention, the actual response to the climate challenge is determined by the ability of individual countries to adapt or build resilience to a changing climate, while contributing to the global greenhouse gas mitigation effort as indicated through Parties' NDCs. As mandated by the Paris Agreement, Parties are invited to envisage a long-term climate vision under a half century of strategy on low GHG emission.

Responding to this mandate, Indonesia submits Long-Term Strategy for Low Carbon and Climate Resilience 2050, which aims to contribute to global goal and to achieve national development objectives, taking into consideration the balance between emission reduction, economic growth, justice and climate resilience development. The LTS-LCCR 2050 also reflects the mandate Indonesian Constitution (UUD 45) Article 28 H on the state obligation to guarantee decent life and healthy environment for all citizens.

Under the LTS-LCCR 2050, Indonesia seeks opportunities for international partnerships to support sustainable transition towards low carbon economy and green recovery post COVID-19 pandemic as well as global justice. We believe this would be an opportunity to start a transition phase which will lead to transformation of our whole economy, social and environmental development.

The implementation of a low carbon and climate resilience strategy requires a balanced focus on the process of government coordination and stakeholders engagement as well as considering the issues on just transition, gender, inter-generation, the needs of vulnerable groups, adat communities (*Masyarakat Hukum Adat*) and local community.

JOKO WIDODO
President of the Republic of Indonesia

PETA JALAN IMPLEMENTASI

NATIONALLY DETERMINED CONTRIBUTION

MITIGASI

2019

AIM

Low Carbon Society Scenario Toward 2050

INDONESIA

Energy Sector

February, 2010

Institut Teknologi Bandung (ITB) - Indonesia
Institute for Global Environmental Strategies (IGES) - Japan
Kyoto University - Japan
National Institute for Environmental Studies (NIES) - Japan
Mizuho Information & Research Institute - Japan

INDONESIA
NDC 2030 & LTS LCCR 2050

INDONESIA NZE
(NET ZERO EMISSION)
2060

Sedang dalam proses penyusunan

Enhanced NDC RI 2030
(September 2022)

Jakarta, 27 February 2020

Challenges and Opportunities in Enhancing Power Sector Contribution to Achieve NDC Target and Paris Agreement (Long-Term Strategy)

Retno Gumilang Dewi, Gissa, Sarah, Iwan, and Bintang
Center for Research on Energy Policy
INSTITUT TEKNOLOGI BANDUNG

This Study is Supported by :

Preliminary Study

LONG-TERM STRATEGY To ACHIEVE

DKI JAKARTA's LOW CARBON SOCIETY 2050

This Study is Supported by :

LONG-TERM STRATEGY:

West Java's
Low Carbon Society **2050**

By **Retno Gumilang Dewi & Ucok Siagian**
Gissa N Sevie, Iwan Hendrawan, Rias Parinderati, Rien Rakhmana, Sarah

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The Potential of Renewable Based Power Plant Development Towards Bali Green and Independent Electricity Supply

RG Dewi[1,2], UWR Siagian[1,3], GN Sevie[1], I Hendrawan[1], R Parinderati[1] and R Rakhmana[1]

[1] Center for Research on Energy Policy, Institut Teknnologi Bandung, Indonesia
[2] Chemical Engineering Department, Institut Teknologi Bandung, Indonesia
[3] Petroleum Engineering Department, Institut Teknnologi Bandung, Indonesia

27-28th October 2020

Medan International Conference on Energy and Sustainability - MICES 2020

"Energy, Covid-19, and The Changing World"

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Messages to Youth Generation to Support NZE Endeavors

- Climate change is real and has begun to show its effect, everywhere. Youth generation of today who will face climate change and its impacts.
- We (seniors) are the last generation that can change the course of climate change. We can and we will. For this, we need more involvement of youth generation. We are committed to helping youth generation take action to protect the future of our planet. We encourage youth generation to raise youth voices on the climate crisis, increase youth activism and to increase youth participation to address climate change.
- We believe that youth generation have the potential and energy to be involved in lNZE endeavors. All they need is the opportunity to be included and have their voices and perspectives heard.
- We understand that youth generation need support from us, the government and society in general, in the forms of various resources and enabling environment .
- We understand that the government need to promote meaningful engagements and programes to train young people on NZE endeavors.
- Youth participation and activism could be done through education, advocacy, campaign and also through research activities.

Thank you

gelangdewi@gmail.com and ucokwrs@gmail.com