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Pathways to Deep Decarbonization in Indonesia Energy Sector

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INTRODUCTION

Deep Decarbonization Pathways Project (DDPP)

DDPP is an international research consortium, initiated by the Sustainable Development Solutions Network (SDSN) and the Institute for Sustainable Development and International Relations (IDDRI), consisting of 16 country research team. The aims of the research is to demonstrate how countries can transform their energy systems by 2050 in order to achieve a low-carbon economy and significantly reduce the global risk of catastrophic climate change.

Our objective is to explore potential development pathways by which the Republic of Indonesia could achieve the deep decarbonization of its economy, to the level where it would contribute to limiting global temperature increases to less than 2°C.

INTRODUCTION (Ctd)

The research addresses two main questions:

i. Is it technically feasible for Indonesia to take a pathway to the deep decarbonization of its energy system, taking into account the country's socioeconomic conditions, development aspirations, infrastructure stock, resource endowments, and other relevant factors?

ii. What investment would be required to achieve such a deep decarbonization?

http://deepdecarbonization.org/countries/#indonesia

Methodology

The energy and GHG emission scenarios of Indonesian Deep Decarbonization Pathway were calculated using the "Dashboard", a spreadsheet model developed by the DDPP team.

Future trajectories are obtained by applying energy-emissions related variables to the model by considering historical trend and national circumstances (country's development stage and targets, development priorities and resource endowment). One of the key success factors in the modeling is compilation of energy variables down to activity levels data. The pathway development require iterative process of extensive consultation with domestic stakeholders in the areas of energy and climate change mitigation.

The Scenarios

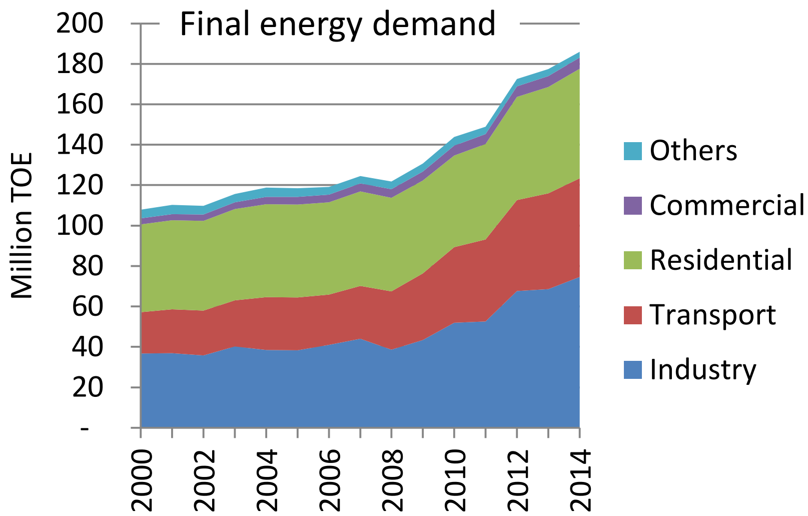
The "Renewable Scenario"
The "Renewable + CCS Scenario"
The "Economic Structural Change Scenario"

Indonesia Resource Endowment

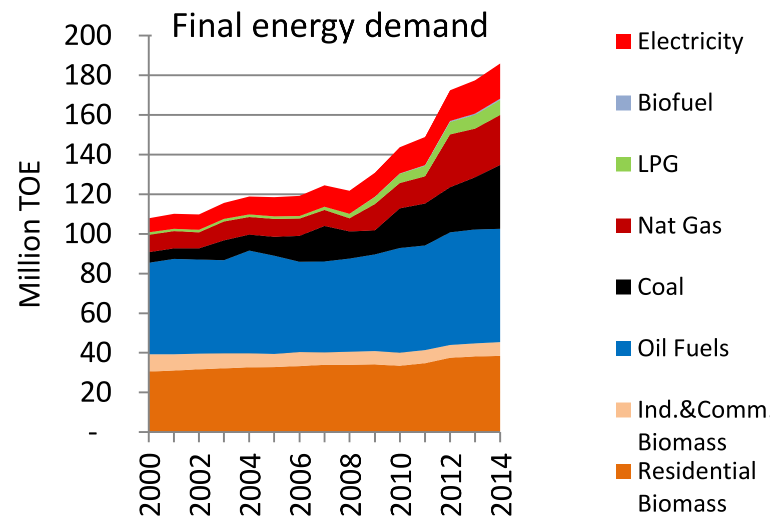
Status 2016

Energy Resource	Reserve	Resource
Oil, billion barrels	7.4	
Natural Gas, TSCF	150	
Coal, billion ton	29	119
CBM, TSCF		453
Shale Gas, TSCF		574
	Potential	
Hydro	75,000 MW	
Geothermal	29,000 MW	
Micro-hydro	750 MW	
Biomass	14,000 MWe	
Solar	4,80 kWh/m2 /day	
Wind	3 – 6 m/second	

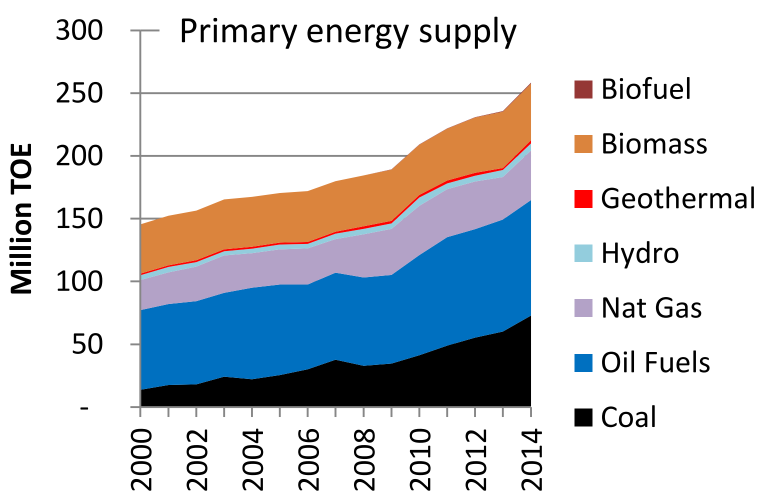
Past Energy Development



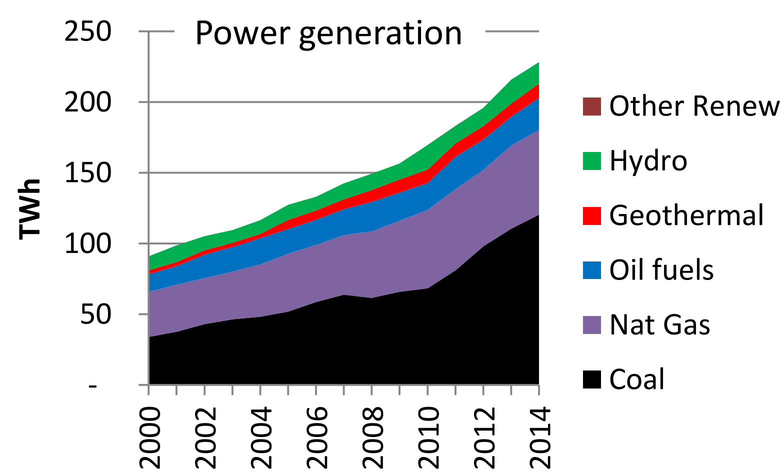
Transport growth 6.5% p.a. , Total growth: 4% p.a.



Coal growth 13.8% p.a.



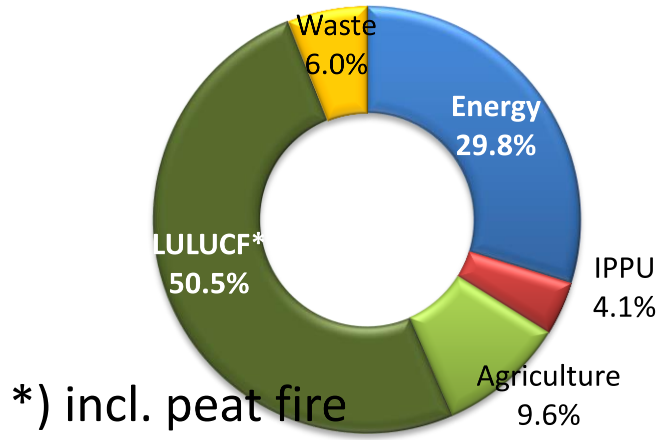
Coal growth 12.7% p.a.; Total growth 4.2 % p.a



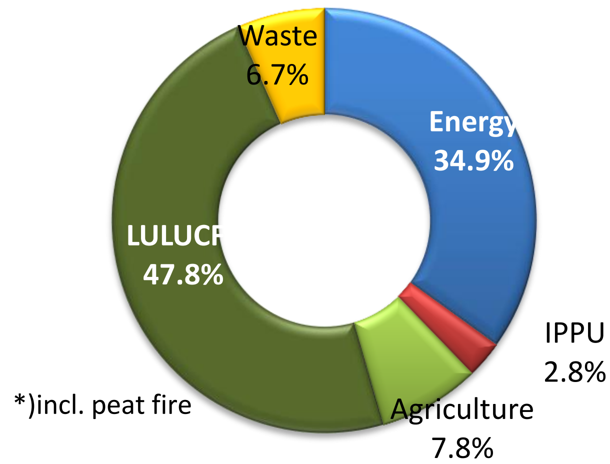
Coal growth 9.4% p.a.; Total growth 6.8 % p.a

GHG Emission Trends

2000 - 1,001 million ton



2012 - 1,454 million ton

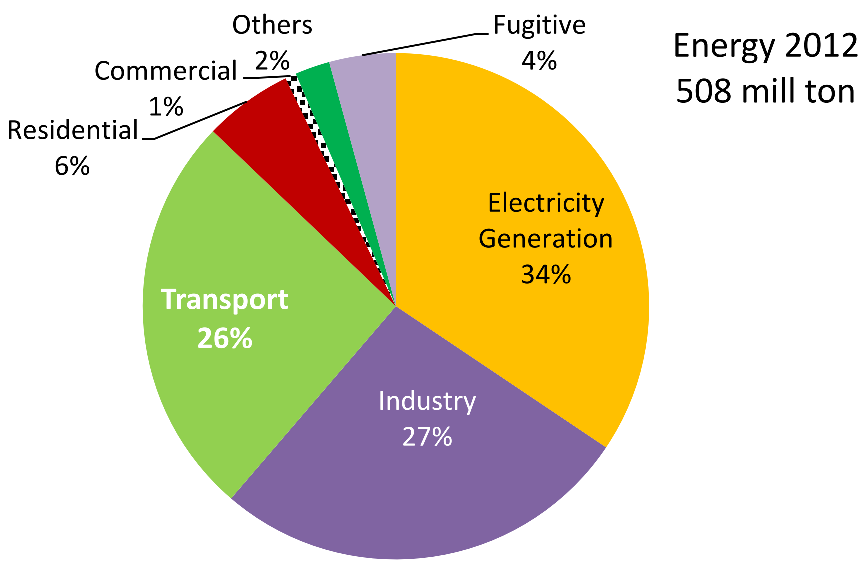


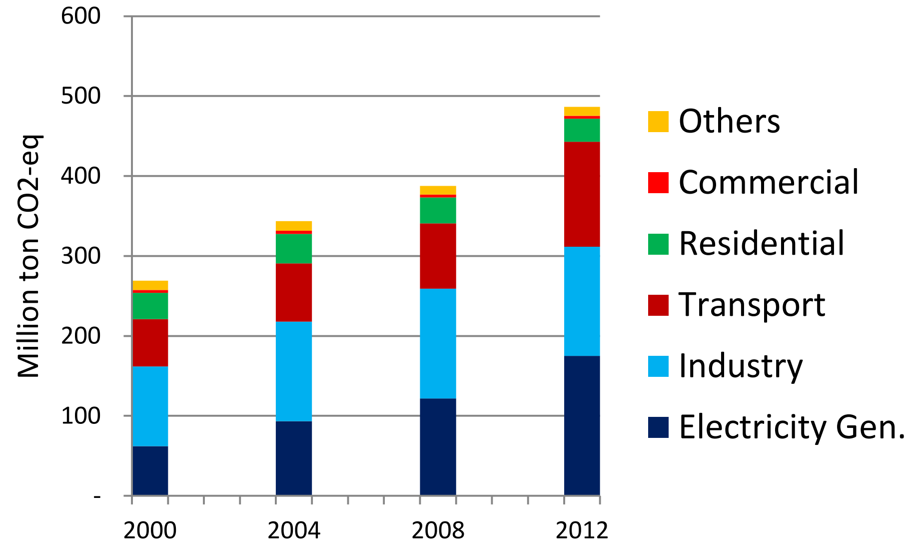
Sectors	Million ton CO2e		Percentage		Average annual growth
	2000	2012	2000	2012	
Energy	298	508	30	35	4.5% ⬅
IPPU	41	41	4	3	0.1%
Agriculture	96	113	10	8	1.3%
LULUCF *	505	695	51	48	2.7%
Waste	61	97	6	7	4.0%
Total	1,001	1,454			3.2%

**) including peat fire*

Source: Indonesia 1st BUR, 2016

Energy GHG Emissions Breakdown



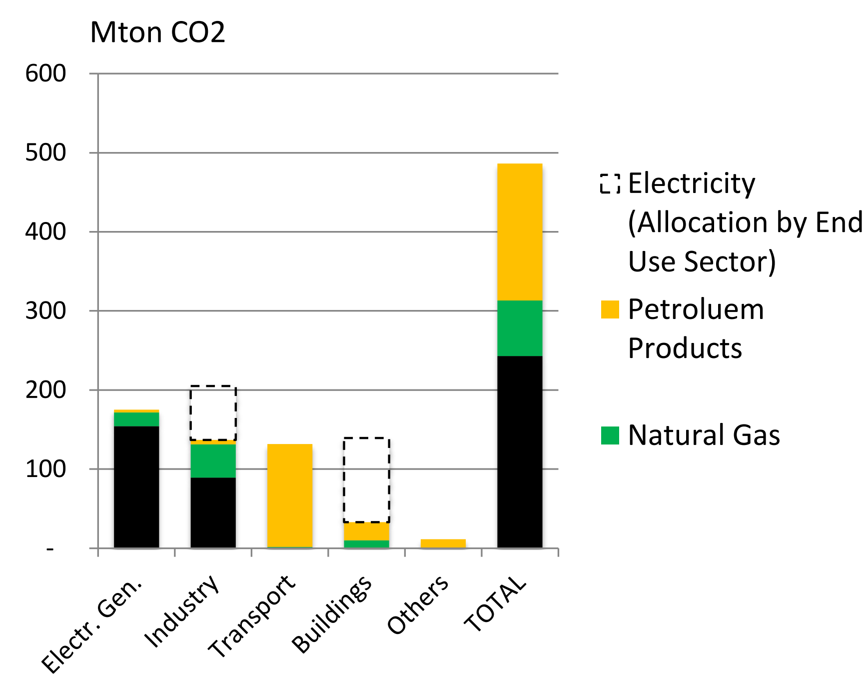


Combustion Emissions

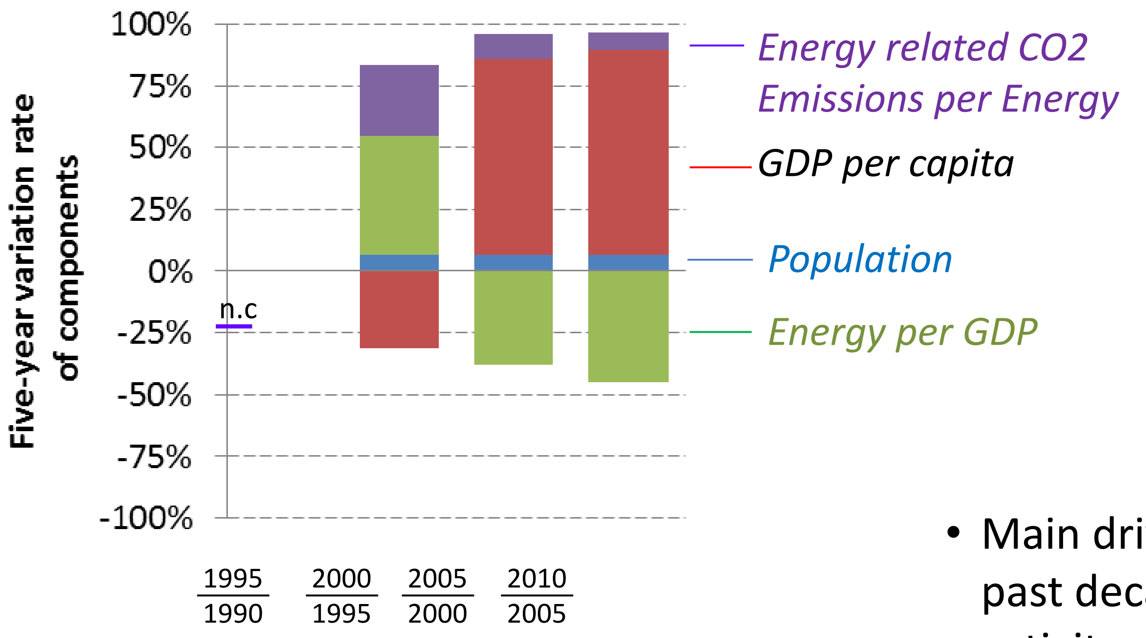
Major sources: coal & oil used in power gen., industry, transport.

End-use sector: 45% from fuel burning in industry.

Emissions from power generation is accounted by building (60%) and industry (40%) sectors.



Decomposition of energy related CO2 emissions, 1990-2010



- Main driver of GHG emissions over the past decade has been economic activity, which increased at a rate of 5% to 6% per year.
- Decreasing energy use per GDP indicate improvement of efficiency
- Carbon intensity is still increasing indicate more fossil energy use

Drivers of Growths

As a developing nation, the Indonesian economy and population are projected to grow significantly in the next four decades.

Development indicators and energy service demand drivers

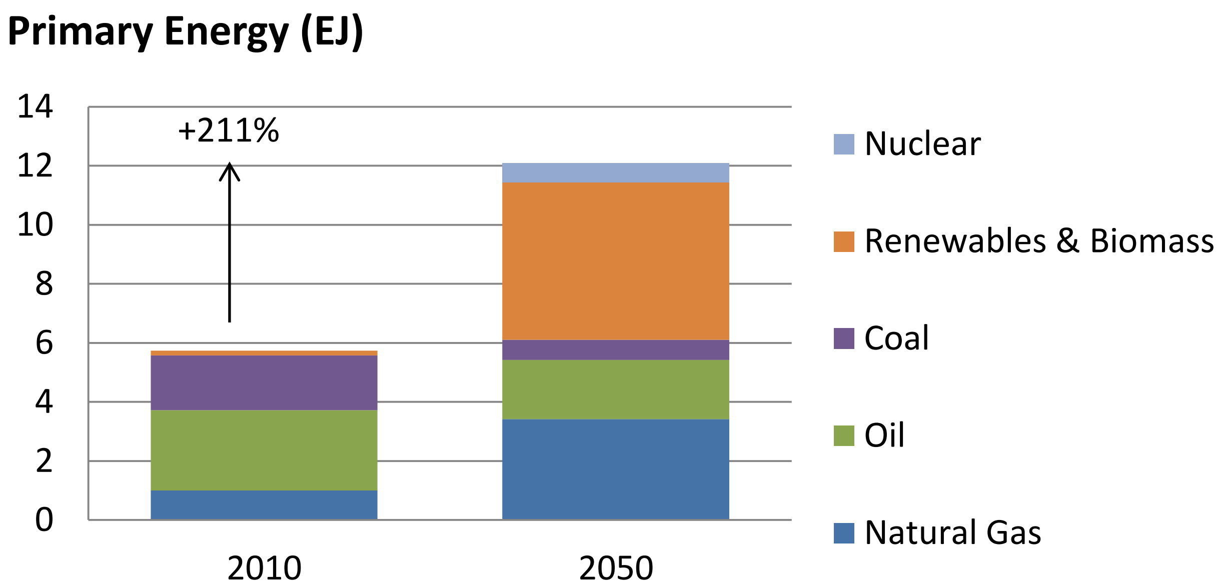
	2010	2020	2030	2040	2050
Population [Millions]	234	252	271	289	307
GDP per capita [$/capita]	2,306	3,655	5,823	9,319	14,974
Electrification rate	70%	85%	99%	99%	99%
Poverty indicator	12%	8%	3%	3%	2%

Assumptions

Sub-sector	Technology/fuel type	Unit	2010	2050
Commerce	Commercial floor space	Bm2	0.4	0.8
	Unit energy consumption	MJ/m2	460	650
Car (Personal and Taxi)	Share of EV in VKMT	%	0%	20%
	Share of Ethanol in PKM	%	0%	20%
Bus	Share of Electric in VKM	%	0%	5%
	Share of Biodiesel in VKM	%	0%	30%
Urban Rail	Share of Electric in PKM	%	0%	10%
	Share of Biodiesel in PKM	%	0%	20%
Air	Share of Biofuel in PKM	%	0%	20%
Freight Transport & Pipelines	Total Ton-kilometers (TTKM)	TTKM	0.45	1.2
	Share of Rail in TTKM	%	3%	10%
Freight Trucks	Share of TKM -Biodiesel	%	0%	30%
	Share of TKM - CNG	%	0%	20%
Freight Rail	Share of Electric in TKM	%	0%	20%
	Share of Biodiesel in TKM	%	0%	20%
Industry	Industry share of GDP	%	28%	18%
Iron and Steel Manufacturing	Physical Output	Million tons/yr	3.5	12
Cement Manufacturing	Physical Output	Million tons/yr	37	100
Small/Medium Manufacturing	Energy intensity	MJ/$	23	18
Power Sector	Share of Coal	%	49%	2.00%
	Share of Fuel Oil	%	12%	1.00%
	Share of Natural gas	%	30%	7%
	Share of Nuclear	%	0.00%	16%
	Share of Hydropower	%	6%	20%
	Share of Wind-Offshore	%	0.00%	2%
	Share of Solar PV	%	0.00%	20%
	Share of Biomass	%	0.05%	12%
	Share of Geothermal	%	3.00%	18%
	Share of Biofuel	%	0.00%	2%

Energy pathways by source

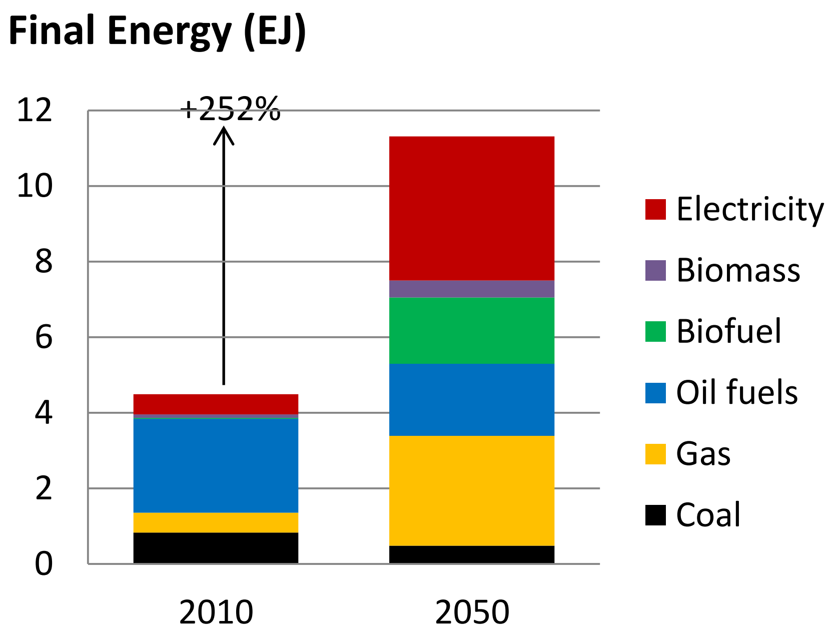
To achieve significant decarbonization, Indonesia has to drastically change its energy supply and demand mix.



Decarbonization in primary energy:

- Reduce oil consumption,
- Reduce coal consumption,
- Increase share of natural gas,
- Significantly increase the share of renewables, and
- Begin to use nuclear power.

Energy pathways by source

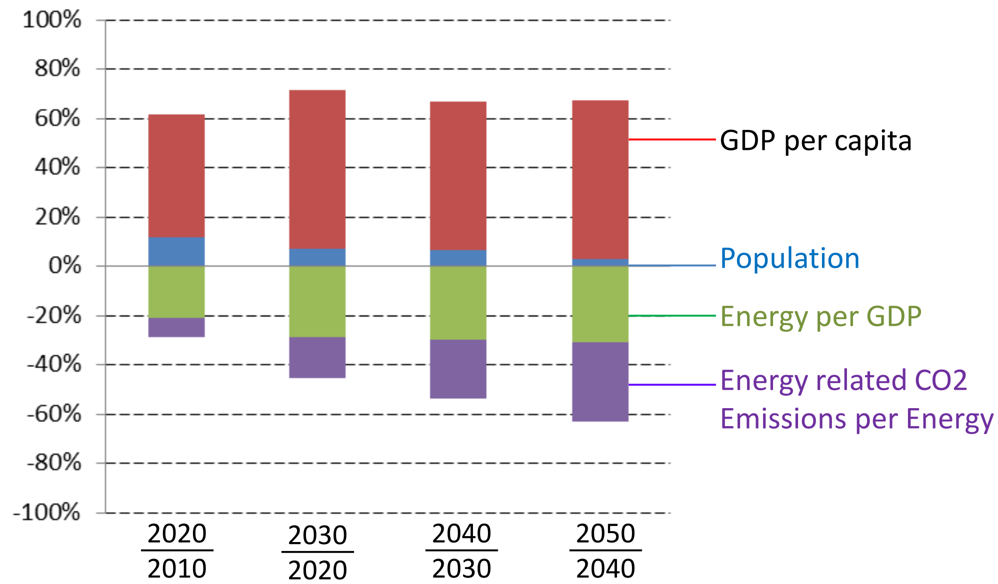


Decarbonization in final energy are:

- Significantly decrease use of coal use,
- Increase the share of natural gas,
- Significantly reduce oil consumption,
- Significantly increase share of electricity.

Element of Decarbonization Pathways

The drastic change of the primary as well as the final energy mix is a result of many measures.



The key elements of the pathway include:

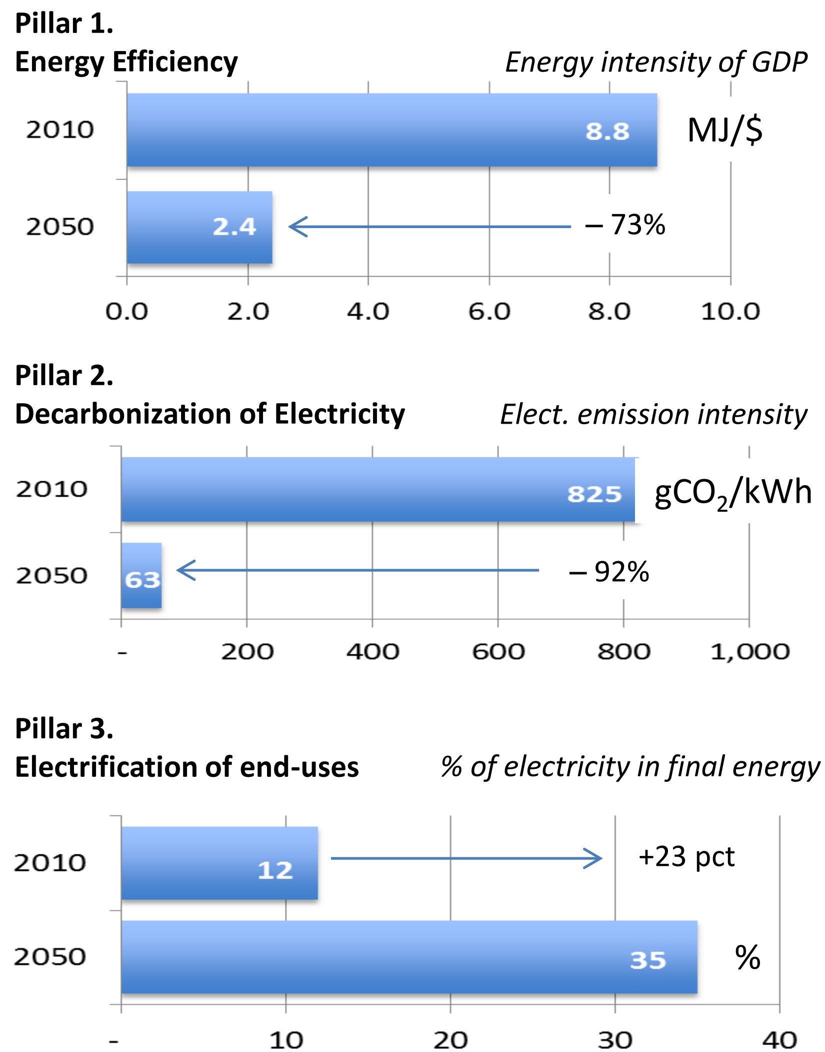
- Energy efficiency improvements would be deployed in all sectors.
- The deployment of lower-carbon emitting energy sources (fuel switching from coal to gas, oil to gas, and a switch from onsite fuel combustion to use of electricity).
- Further fuel switching to renewable resources: solar, hydro, and geothermal for power generation, biofuels in transport, and biomass, biofuels and biogas in industry.

The Pillars of Decarbonization

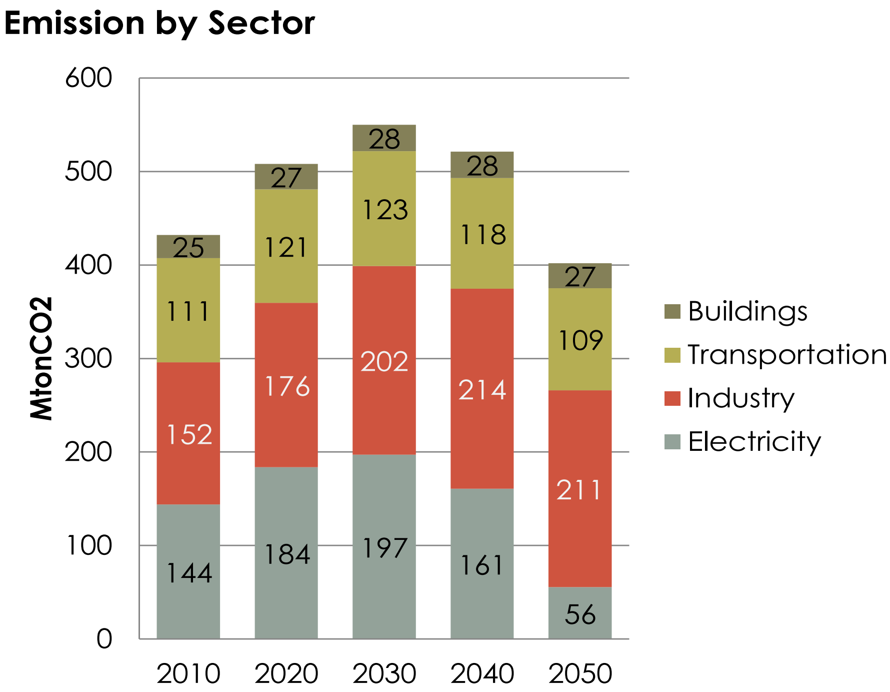
Pillar 1.
Energy efficiency measures would drastically decrease energy intensity of GDP (Energy per GDP)

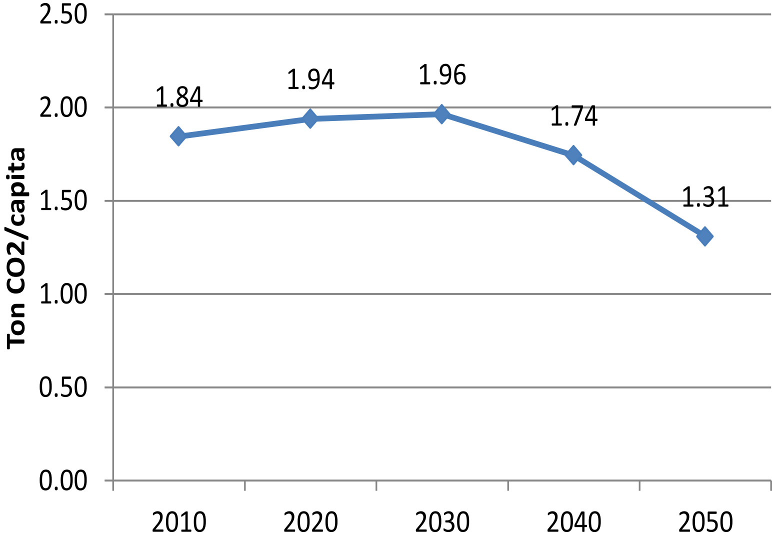
Pillar 2.
Decarbonization of electricity:
Use of low carbon emitting fuels and CCS would significantly electricity emission intensity (gCO2/kWh)

Pillar 3.
Electrification of end uses will reduce fossil fuel combustions and reduce emission (as long as the power generation is deeply decarbonized)



Results of decarbonization



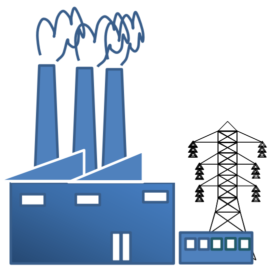


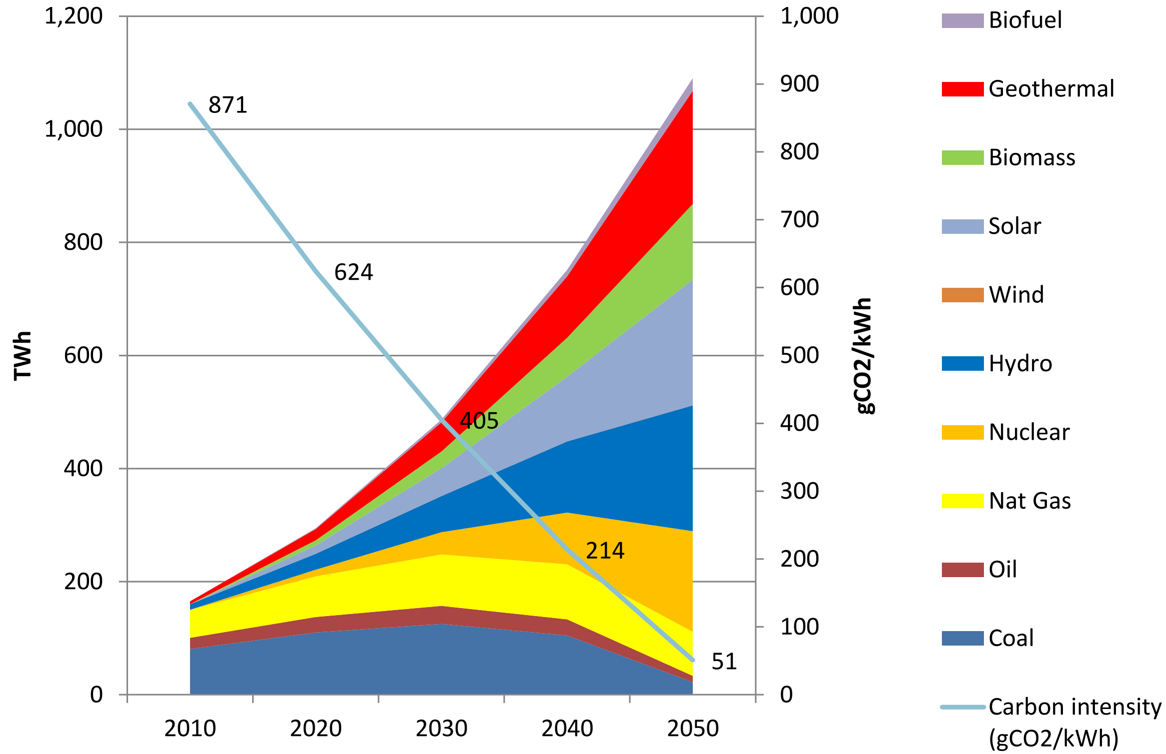
- Indonesian CO_2 emissions will first increase (due to economic development) and then decrease later (as a result of decarbonization measures).
- Industry and power generation remain the major emission sources in 2050.
- Significant decarbonization of electricity, 144 $MtCO_2$ (2010) to 56 $MtCO_2$ (2050).
- Emission from industry will increase from 152 $MtCO_2$ (2010) to 211 $MtCO_2$ (2050).
- Per capita emission will decrease from 1.84 ton CO2 to 1.31 ton CO2

Decarbonization by Sector

- Power generation
- Liquid fuels
- Industry
- Transport
- Building

Power generation





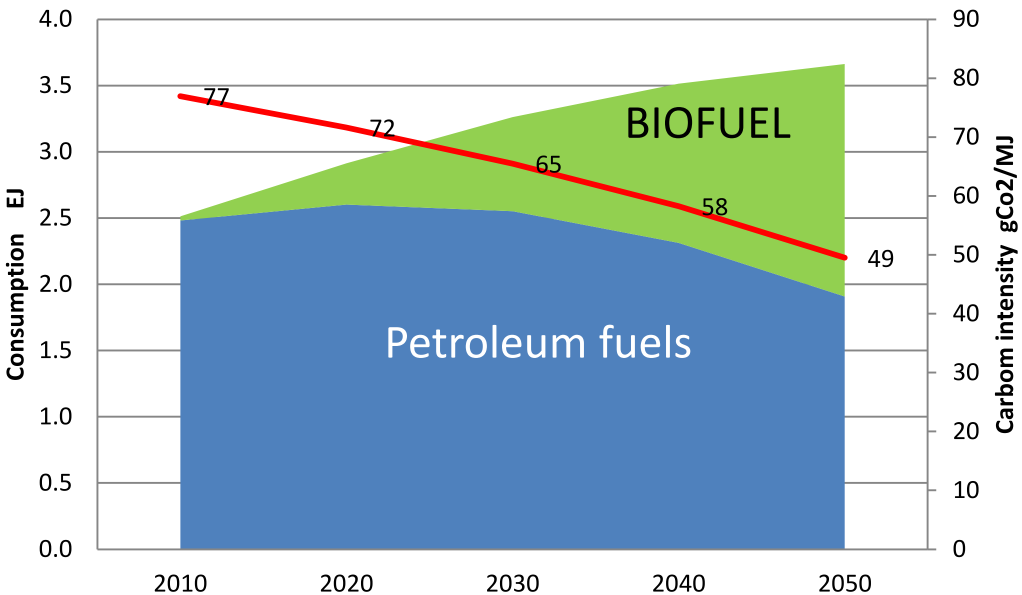
Electricity demand will continuously to increase with wealth and electrification in residential, industry and transport.

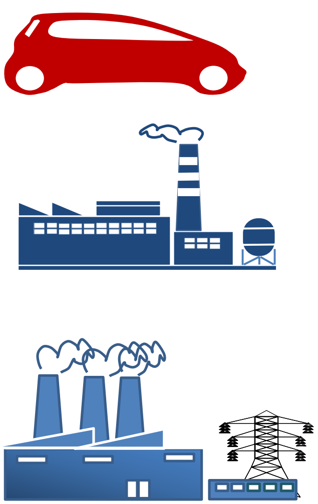
Decarbonization strategy:

- Fuel switching to less carbon-emitting fuels (coal to gas, oil to gas),
- Maximizing renewable (solar, geothermal, hydropower, biofuels)
- Energy efficiency improvement and use of nuclear power generation

Result: decrease of carbon intensity from 871 gCO_2/kWh to 51 gCO_2/kWh

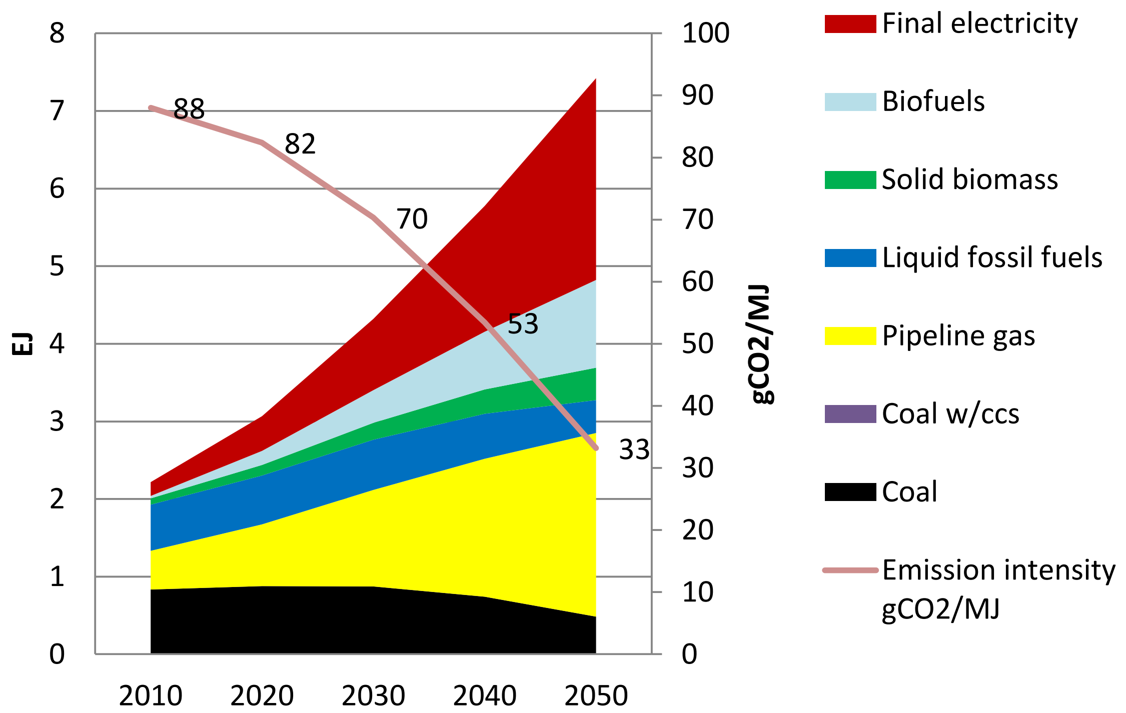
Liquid fuels

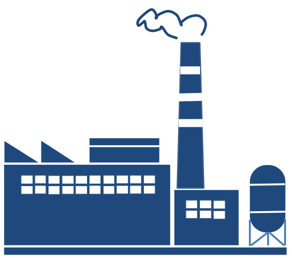




- Petroleum fuels will slightly increase and then decrease due to electrification of end uses (electric cooking, electric cars etc.) and substitutions by biofuels.
- For deep decarbonization significant switch from petroleum to biofuels is needed.
- Significant use of biofuels will decrease carbon intensity of liquid fuels.

Industry



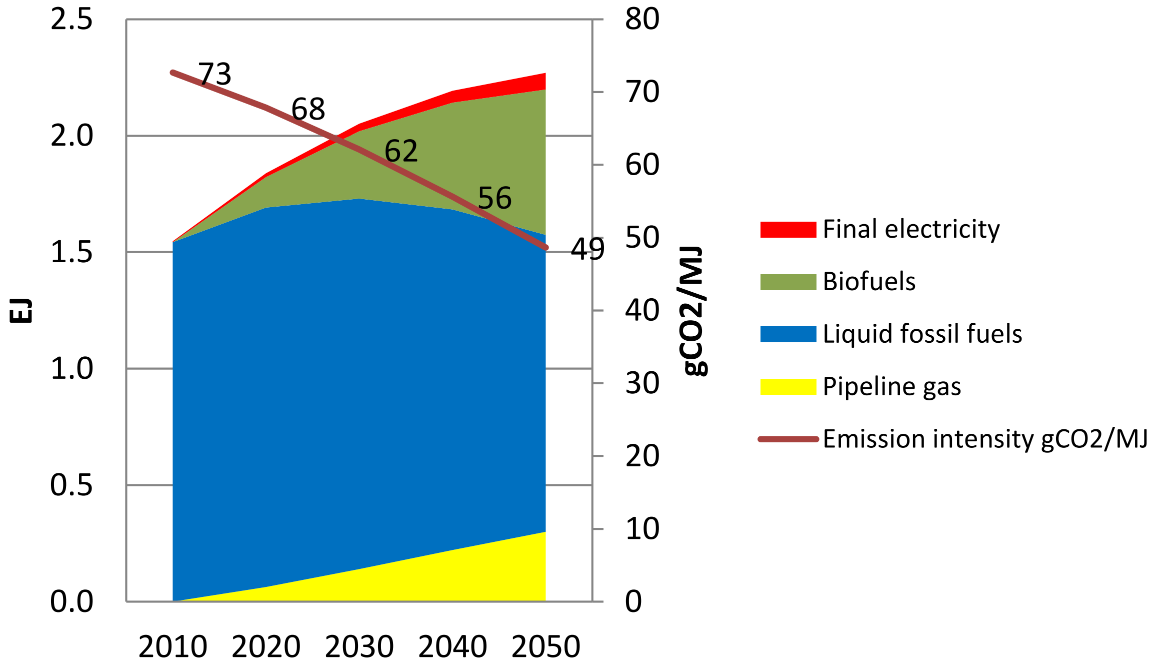


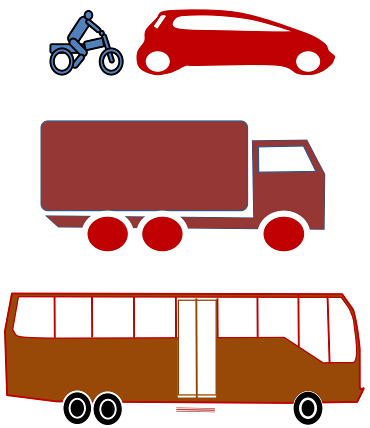
Component of decarbonization:

- Fuel switching to gas and bioenergy (solid biomass dan biofuel)
- Electrification of end uses in industry
- Reduce coal use

Results: decrease carbon intensity from 88 gCO2/MJ to 33 gCO2/MJ.

Transport



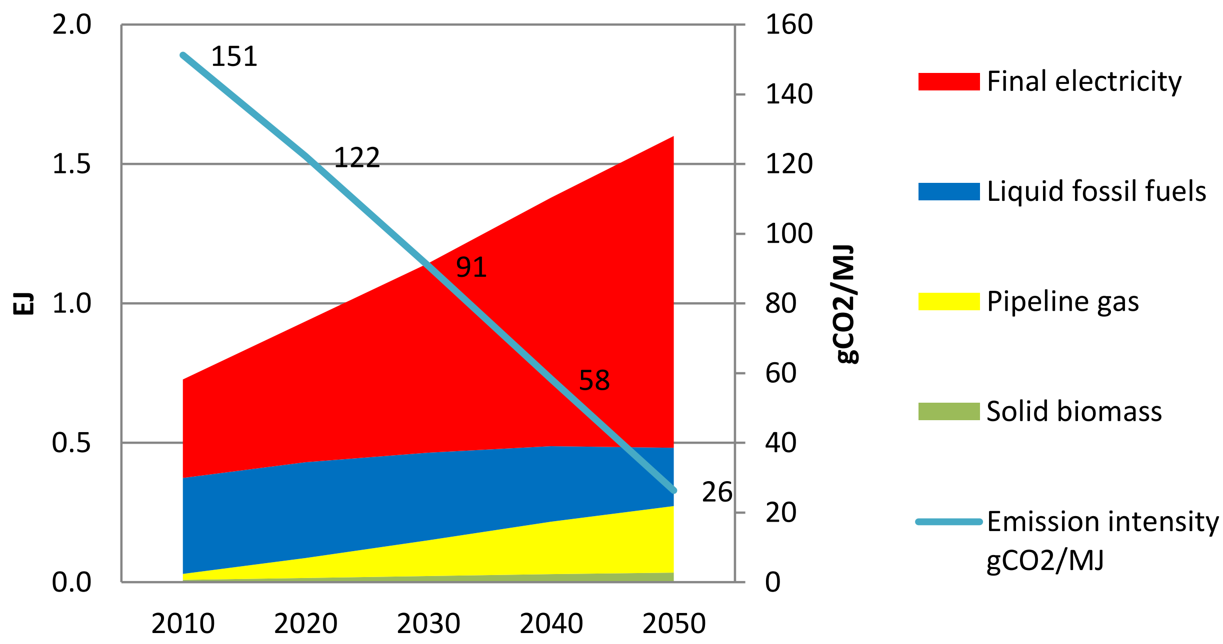


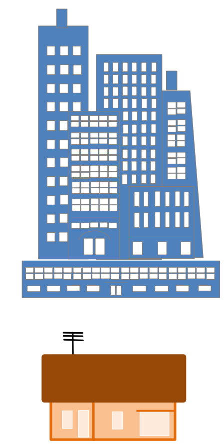
Component of Decarbonization:

- Modal shift to mass transport, electrification, fuel switching to gas and biofuels, more energy-efficient vehicles, shift of freight transport from road to railway.
- Personal vehicles decrease from 60% in 2010 to 40% in 2050.
- Share of electric cars reach 30% in 2050

Results: carbon intensity will decrease from 73 gCO_2/MJ to 49 gCO_2/MJ.

Building Sector (Commerce and Residential)



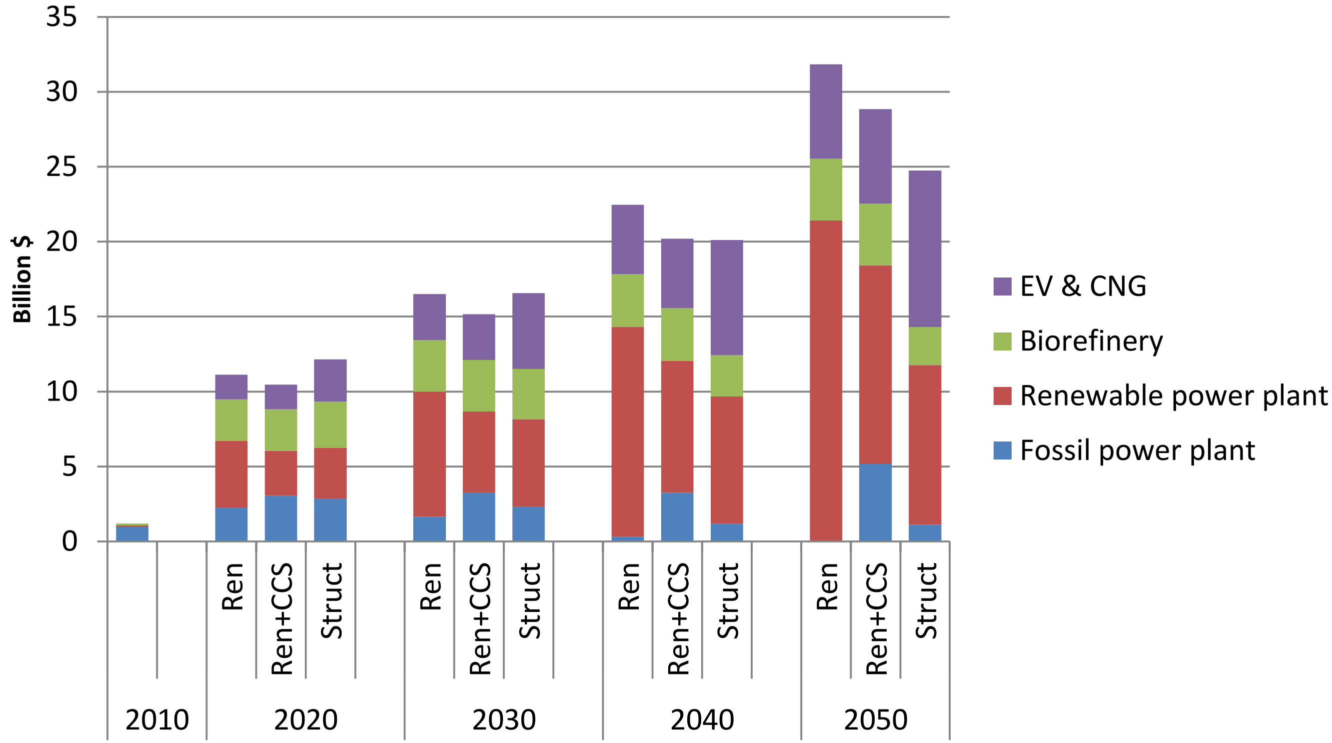


Component of Decarbonization :

- Fuel switching to gas/LPG and increase end use electrification
- Use of energy efficient equipment

Residential sector: increase in per capita income tend to increase energy consumption; however the increase is balanced by more efficient equipment

Investment Need for Decarbonization



**) Excluding additional infrastructure needed to support the operation of plants such as construction for gas pipelines, regasification plant (imported LNG), and to support the operation of electric vehicles or CNG such as recharging/ refueling stations; the costs associated with energy efficiency measures in buildings and industry have not been included*

Conclusions

1. The Indonesian deep decarbonization pathways combine strong action on the three pillars:
   (i) energy efficiency and conservation,
   (ii) decarbonization of energy carriers, especially deep decarbonization of electricity generation, and
   (iii) fuel switching to low-and zero-carbon emitting energies, including substituting combustion energy system with electricity energy system (electrification of end use).

2. The decarbonization scenario assumes the total deployment of renewable energy (solar PV, hydro, geothermal) to replace most, if not all, coal and oil power plants. In addition to renewables, some fraction of the power plants would be nuclear-powered. This scenario assumes that large size solar PV are deployable, and that large hydro resources in Papua (eastern Indonesia) is utilizable, to cater demand in the western part of Indonesia through sub-sea cables.

Conclusions (ctd.)

3. Deep decarbonization requires an enormous amount of investment to build infrastructure and deploy lower-carbon-emitting technologies which are, in general, more expensive than conventional technologies. For Indonesia, where climate-change mitigation does not yet greatly concern the government or society in general, this large investment required for decarbonization is a major challenge.

4. However, these investment needs still represent only a small fraction of total investments throughout the economy, especially in the context of the country's fast economic growth, which is assumed in our scenarios. The main challenge, therefore, is to develop adequate schemes and policy incentives to re-orient investments towards low-carbon options. This must include investing in infrastructure for deployment at scale, and in due time.

Thankyou

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