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Emission Pathways towards Carbon Neutrality and Alternative Fuels Use in Asian Region

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Background

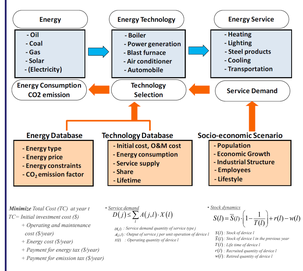
- The Paris Agreement requires to create GHGs emission strategies consistent with the 2 or 1.5 degrees target.
- **Developing countries in Asia**, where GHG emissions are expected to increase toward 2050, are required to achieve both economic development and emission reduction. Countries like Thailand and Indonesia are considering receiving international support in the future.
- **Japan** also expects a virtuous cycle of environment and economy involving Asian countries, especially by promoting energy-saving products, green infrastructure, and capacity building. Quantitative analysis of scenarios when low-carbon technologies are applied to developing countries will be helpful in providing important information for Japan to contribute to mitigation measures in Asia.

Purpose

- Preliminary Analysis of emission pathway towards carbon neutrality during the period of 2050 and 2060 for Indonesia and Thailand.
- Observe changes in the below parameters caused by **each scenario introducing hydrogen technologies, synthetic fuels and biomass**.
  1. Energy-related CO2 emission
  2. Electricity consumption
  3. Final energy consumption
  4. Fossil fuel reduction in total primary energy supply

Methodology

Model structure of AIM/Enduse



List of Assumptions in 2050 for RE_H2

- **Energy Service Demand :**
  Calculated based on "SSP2" from the Shared Socio-Economic Pathways.
- **Countermeasure for Supply side for RE_H2 case :**
  Gas fired power plant with CCS 5%, Biomass fired power plant with CCS 2.5%, Biomass fired power plant without CCS 2.5%, other renewables 90%.
- **Countermeasure for Demand side for RE_H2 case**:
  - Iron & Steel : Electric furnace 75%, DRI 25%
  - Cement : Kiln with CCS 100%
  - Other Industry : Industrial Furnace with Hydrogen 50%, Heat Pump Boiler 50%
  - Hot Water : Heat Pump 100%
  - Cooking : IH 75%
  - Passenger Transport : EV 100%
  - Freight Transport : EV 25%, FCV 50%, Biomass ratio in fuel oil 25%
  - Diesel Rail : Hydrogen 100%
  - Aviation/Ship : Hydrogen 50%

  ※No cap for CCS

  ※Colored measures vary depend on each case(see the table below)

- Scenario analysis for carbon neutrality in Indonesia and Thailand was made using AIM/Enduse. In particular, we focused on the difference in emissions due to the use of alternative fuels such as hydrogen and biomass.
- **As a preliminary study, the analysis was conducted assuming measurements on the demand side in Indonesia and on the supply side in Thailand**.

- Indonesia

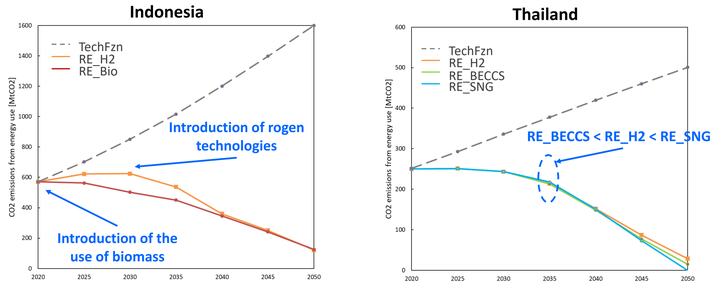
Case for Indonesia	Supply	Demand
Technology Frozen (TechFzn)	Technology Share Fixed from 2015	
Renewables & Hydrogen use (RE_H2)	(listed above)	(listed above)
Renewables & Biomass use (RE_Bio)	(listed above)	Industrial Furnace with Biomass 50% Freight Transport : EV 0%, FCV 0%, Biomass ratio in fuel oil 100% High efficiency diesel rail 100%

- Thailand

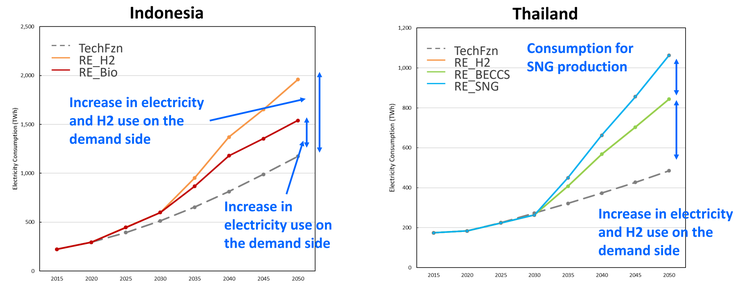
Case for Thailand	Supply	Demand
Technology Frozen (TechFzn)	Technology Share Fixed from 2019	
Renewables & Hydrogen use (RE_H2)	(listed above)	(listed above)
Renewables & BECCS use (RE_BECCS)	BECCS 5%, Biomass w/o CCS 0%	(listed above)
Renewables & Synthetic Natural Gas (RE_SNG)	SNG in City Gas 50%	(listed above)

Result

1. Energy-related CO2 emissions

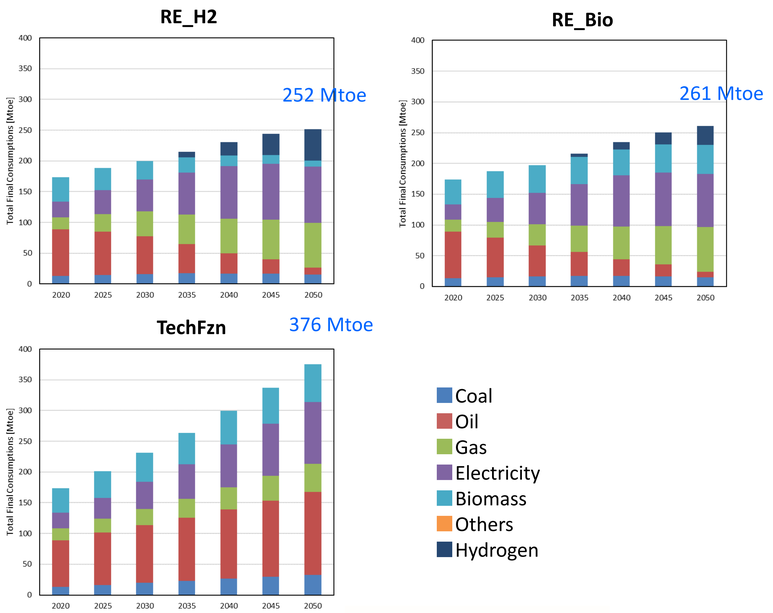


2.Electricity Consumption



※ RE_H2 has the same amount of electricity consumption as RE_BECCS

3. Final Energy Consumption (Indonesia)



- Final energy consumption of countermeasure case in 2050 decreased by around 30% compared to TechFzn case.
- Total amount in 2050 is roughly the same between RE_H2 and RE_Bio case. The ratio of hydrogen of RE_H2 case in 2050 was 25%, and that of fossil fuels like coal, oil, gas was 40%.

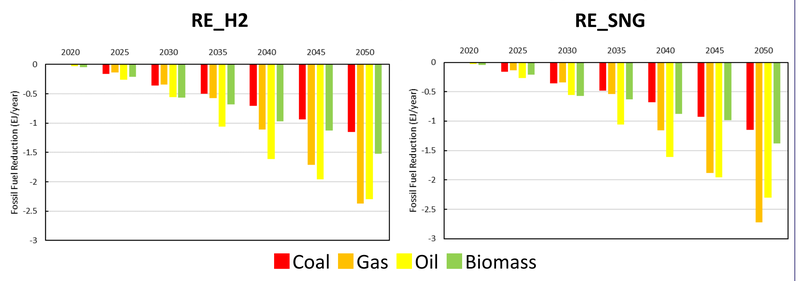
- **Indonesia**

  Since the analysis assumes neither mitigation measures of other industry sectors other than industrial furnaces and boilers nor complete decarbonization of iron & steel sector and cement sector, the CO2 emissions remain in 2050. The CO2 emissions in the 2 cases have almost the same trend after 2040 due to decarbonization in the other sectors (e.g. residential, service, transport sector).

- **Thailand**

  The emission factor for synthetic fuel is assumed to be 0 in the calculation. It indicates such a low emission factor for gas fuel and electricity in RE_SNG case that it can contribute to minimize the emission in 2050. On the contrary, in RE_H2 case, larger emissions can be observed from 2030 to 2035 as a result of the use of hydrogen technologies and thermal power generation.

4. Fossil Fuel Reduction in total primary energy supply(Thailand)



- The annual fossil fuel reduction of Thailand in RE_H2 case compared to TechFzn case was 7.3 EJ per year in 2050. In RE_SNG case, the reduction of natural gas is larger than that in RE_H2 case, but the amount of reduction of the other fossil fuels gets smaller due to the increase in power generation. Over all, there is no big difference in the reduction of total fossil fuels.

Next Step

- Continue to collect information on decarbonization technology, including ammonia technology, and try to apply it to models.
- Estimating SLCFs emissions in addition to CO2, and analyzing the synergistic effect of measures against air pollutants and mitigation need to be followed.
- Considering the policies of each country for scenario assumptions, analyze several cases for carbon neutral scenario towards 2050-2060.

Conclusion

- **When trying to use alternative fuels such as hydrogen and synthetic fuels, there is a concern about large electricity consumption due to the production of these fuels, and large CO2 emissions in the middle years if the emission factor for the power generation sector remains at a high level. The importance of decarbonizing the power generation sector was suggested, taking into account the trend of electrification on the demand side and the production method of alternative fuel.**
- **While the use of biomass on the demand side is unlikely to lead to negative emissions in 2050, it does not cause an increase in emissions in the middle years, suggesting that it is an effective mitigation measure to ensure commitment to achieve zero-emissions or close to zero.**

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