An assessment of the role of synthetic fuels in mitigating the rapid end-use technology transition in net-zero emissions scenarios

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1. Background

- Emissions reduction to achieve the 1.5C target will necessitate rapid energy system change.
  - ✓ It may lead to the premature retirement of fossil fuel-based technologies, so-called **stranded assets**.
- Studies suggested that **synthetic fuels** is one of potential decarbonization measures for hard-to-abate sectors.
  - ✓ Due to their **high production cost**, the role of synthetic fuels may be restricted to specific sectors.
  - ✓ Their compatibility with fossil fuel-based technologies could allow for decarbonization while remaining them → **Yet to be quantitively assessed**

2. Methodology

- We performed a scenario analysis using **AIM/Technology** which is **global energy system model.**
  - ✓ The impact of synthetic fuel penetration was assessed using two mitigation scenarios.
- Two indicators were selected to assess the impact on fossil fuel-based end-use technologies:
  - ✓ **1) The shares of electricity and hydrogen** in final energy consumption and **2) stranded investment**

Table 1 Scenario descriptions. * Corresponding to the emission pathway shown in **Fig. 2a**

Scenario	Emission pathway*	Synthetic fuels availability
Baseline	Baseline	available
1.5C w/ Synfuel	1.5C	available
1.5C w/o Synfuel	1.5C	unavailable

Region: World
Year: 2005-2050
Socio-economic assumption: SSP2

3. Results

3.1 Final energy consumption

- Synthetic fuels led to 9% of TFC in 1.5 w/ Synfuel.
  - ✓ Synthetic fuel penetration was most evident in the transport sector, accounting for 30% of final energy.

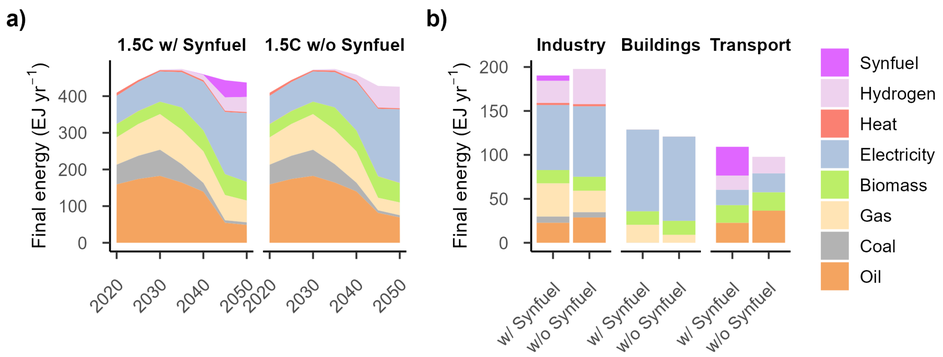

Fig.1
Final energy consumption.
a) Time series of final energy consumption.
b) Sectoral final energy consumption in 2050.

3.2 CO_2 emissions and carbon prices

- Residual emissions distribution varied between scenarios.
  - ✓ In 1.5C w/ Synfuel, the residual emissions from transport were **reduced**, while those from industry and buildings **remained**.

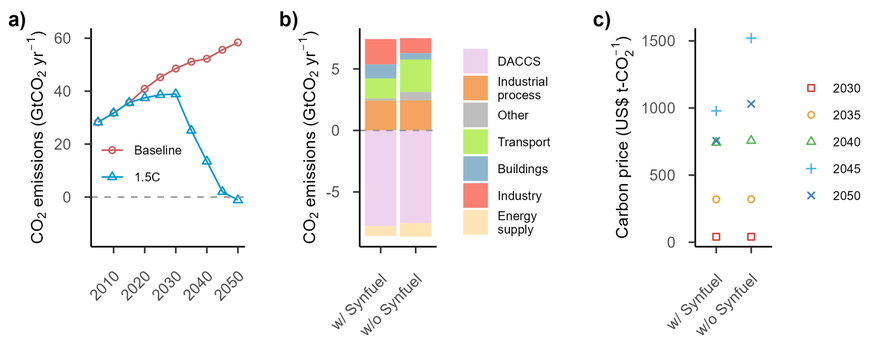

Fig.2
a) CO_2–FFI emission pathways.
b) Sectoral CO_2 emissions in 2050.
c) Time series of carbon prices in each mitigation scenario.

3.3 Shares of electricity & hydrogen in final energy

- The penetration of synthetic fuels shifted the distribution of emission reduction efforts among sectors
  - ✓ From **Deep electrification and hydrogen use** in industry and buildings to **synthetic fuel use** in transport

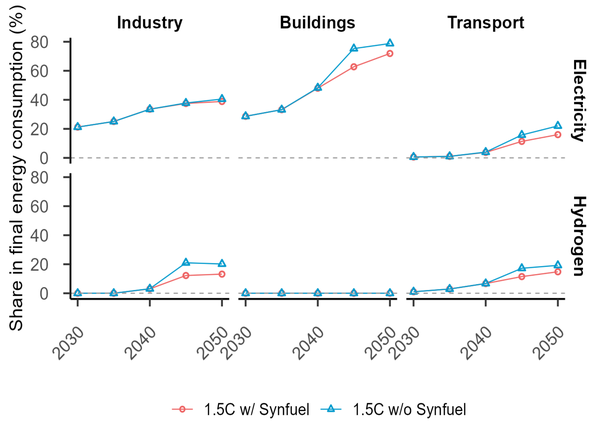

Fig.2 a) CO_2–FFI emission pathways. **b)** Sectoral CO_2 emissions in 2050. **c)** Time series of carbon prices in each mitigation scenario.

3.4 Stranded investment

- Synthetic fuel penetration reduced stranded investment
  - ✓ Approximately three quarters in industry and about 40% in the buildings and transport compared to 1.5 w/o Synfuel

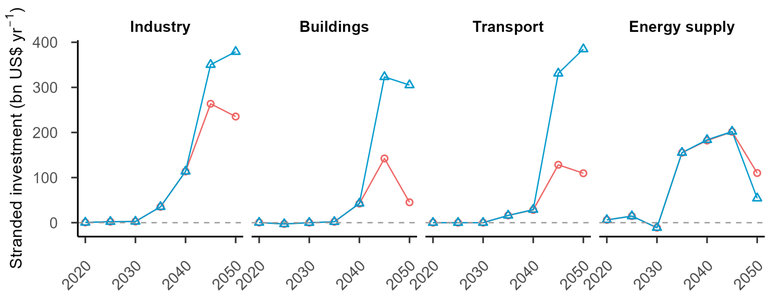

Fig.4 Stranded investment (additional values compared to baseline). Stranded investment is defined as the amount of technology stock not in operation in each period multiplied by the annualized initial investment.

4. Discussion

- Our findings suggest that the efficacy of synthetic fuels as a measure to remain fossil fuel-based end-use technologies.
  - ➢ The pursuit of emission reductions in transport and the continuation of fossil fuel use in other sectors using fossil fuel-based technologies.
- Potential decarbonization pathway that prioritize remaining fossil fuel-based technologies over total system cost is suggested
  - ➢ The benefits of remain fossil fuel-based technologies must be weighed against the losses incurred by the irrationality of using synthetic fuels in favor of cheaper options.

Acknowledgements: This research was supported by the Environment Research and Technology Development Fund (grant JPMEERF20211001) of the Environmental Restoration and Conservation Agency provided by the Ministry of Environment of Japan, JSPS KAKENHI Grant Number JP23K04087, the Sumitomo Electric Industries Group CSR Foundation, and the JSPS Research Fellow (grant JP22J15734).