Assessment of generation mix in 2030 using high resolution power dispatch model

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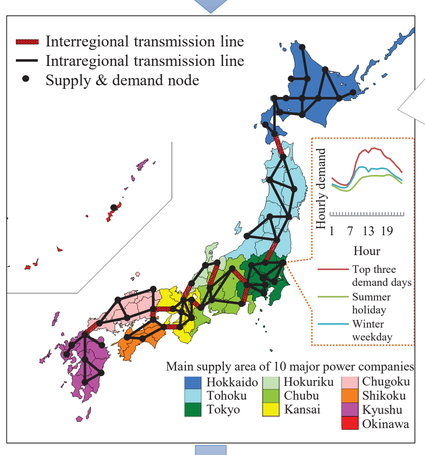
Introduction

- A draft of Japan's strategic energy plan was presented in July 2021.
- In response to an increase in the national greenhouse gas reduction goal, the target for the renewable energy ratio in power sector was nearly doubled (36-38%) and that for nuclear ratio left unchanged at 20-22%.
- Is there a more economically efficient power supply mix that can achieve the same reductions?
- If nuclear power is not available, can the same reductions be achieved by other generation mix? How?
- What kind of measures will be needed to manage high penetration of variable renewables (VERs)?

Methods

- AIM / Power [Japan] [1)]

Input: Electricity demand, fuel prices, capital costs, CO_2 targets…



Output: Generation mix, capacity mix, carbon price…

Spatial resolution: 60 prefectures
Time resolution: 8760 hours
Optimization: Single year, minimizing total system cost
Generators: Coal (boiler, IGCC, - w/CCS), Oil (boiler), Gas (boiler, NGCC, -w/CCS), Hydro (conventional, pumped), Nuclear, Solar PV, Wind (onshore, offshore), Biomass
Power system stabilization measures: Economic load dispatching control (EDC), Load frequency control (LFC), Interregional transmission, Pumped hydro, Battery for long-term fluctuation (sodium sodium-sulfur battery; NaS), Battery for short-term fluctuation (lithium-ion battery; LiB), Curtailment

- Data collection

Hourly electricity demand and hourly capacity factors for REs
Actual data was taken from website of former general electric utilities
Resource potentials of REs by prefectures
Data was taken from the REPOS by MOEJ[2)]
Capital costs, fuel prices
Data was taken from the SDS scenario in the IEA WEO 2020

- Scenario

Target region: Japan
Target year: 2030
CO_2 targets: 59% emission reduction from 2013 level (author's calculation based on a draft of the strategic energy plan)
Technological assumptions: no hydrogen, no CCS
Case setting: with nuclear, without nuclear

Results and discussion

More economically efficient power supply mix?

- It is economically efficient to **quite coal-fired power plants and build new NGCC** if only to achieve the same reduction.

Without nuclear case

- With the additional **NGCC**, combined with **VREs** at the same level as presented in the Strategic Energy Plan, **similar reductions could be achieved without nuclear power**.

Managing high penetration of VREs

- Most of seasonal and weekly fluctuations in demand and VREs were managed by **NGCC**.
- Both of **curtailment** and **VRE ratio** were high during the spring holidays (golden week).
- Excessive generation from **PV** would be stored in **pumped hydro** and used in the evening.

Future works

- Capacity mix in 2030 consistent with 2050 goal

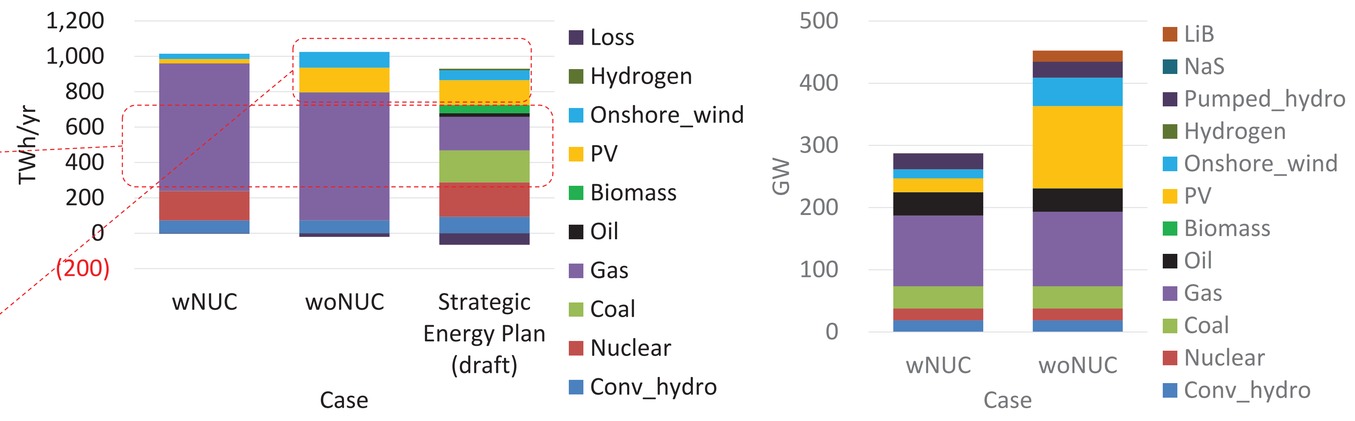


Figure 1. Generation mix and capacity mix in Japan in 2030

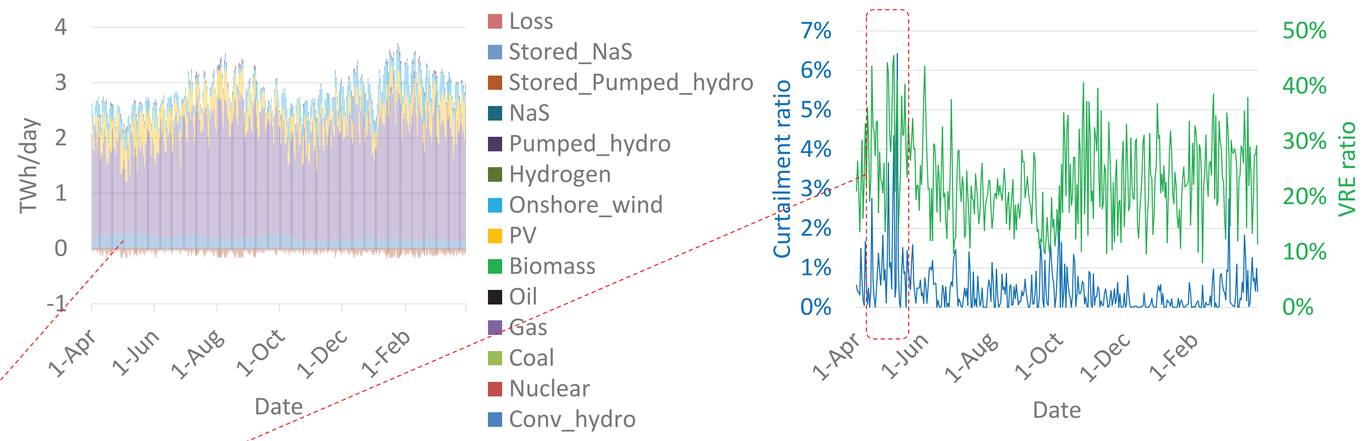


Figure 2. Daily generation mix (left) and curtailment and VRE ratio (right) in without nuclear case

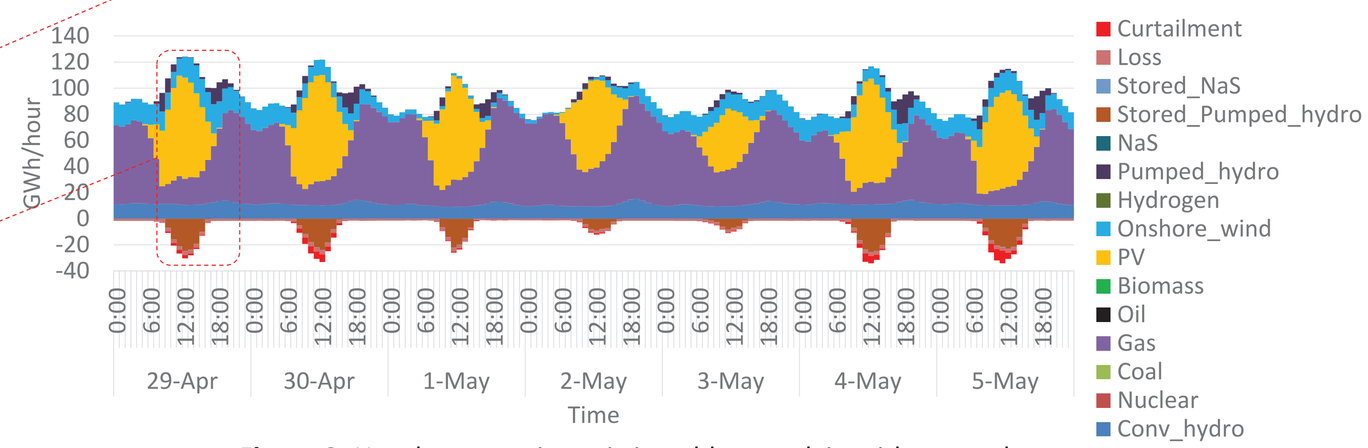


Figure 3. Hourly generation mix in golden week in without nuclear case

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AIM ASIA-PACIFIC INTEGRATED MODEL
Asia-Pacific Integrated Model
http://www-iam.nies.go.jp/aim

1) Shiraki, H. *et al., J. Clean. Prod.* **114**, 81–94 (2016), 2) MOEJ, Renewable Energy Potential System (REPOS) http://www.renewable-energy-potential.env.go.jp/RenewableEnergy/index.html (2020)

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