Role of Flexibility Mechanisms in Japan, Analysis using GIS and Grid Featured Technology Model

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Overview

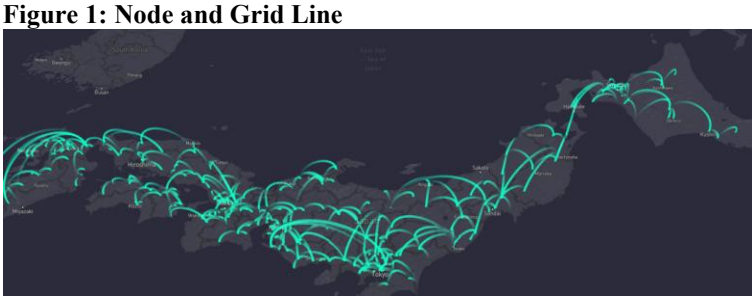
Japanese government officially announced 80% GHGs resdulction towards 2050, but there is no concrete policy and technology measures to meet the target. To meet the national mitigation target, renewable energy, especially Variable Renewable Energy (VRE), will be major electricity generators. The high shre of VRE increases the instability of energy system, to keep the stability of energystme need flexiciblity mechanism. As IEA points out, differenc stage of VRE propotion require difference level of flexibility mechanisms (IEA, 2017).

To identify the roles of each flexible mechanism at the each level of VRE share, newly built TIMES-based model is employed.

Methods

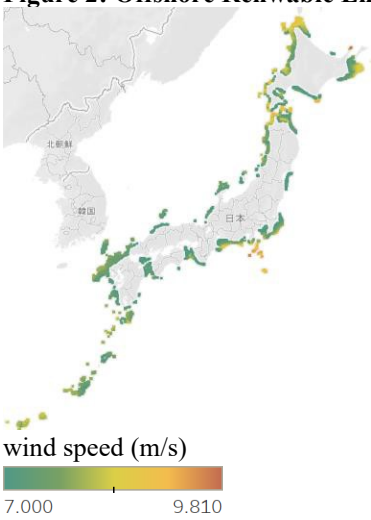
The TIMES-based JMRT (Japan Multi-regional Transmission) model is a 47 sub-regional model which only includes inter-grid connections between 10 grids. As a result, the model cannot reflect the weak grid infrastructure within grid regions, although the model uses 1km^2 mesh renewable energy potential data. To reflect grid capacity constraints, we disaggregated Japan into 351 nodes, or sub-stations.

Figure 1: Node and Grid Line



The model use GIS-based renewable energy potensital data and renewbale energy potential is assumed to connect to the closest node. As a result, the model is able to simulate grid capacity constraint and regional specific character of renewbale energy.

Figure 2: Offshore Renwable Energy Potential Map



Results

Figure 3 shows relationship between VRE share and each fexible mechanisms in each grid region.

Figure 3: Relationship between VRE Share and Each Flexibility Mechanism in Major Grid Regions

*Chub (Chubu), Chug (Chugoku), Hokk (Hokkaido), Kans (Kansai), Kyus (Kyushu), Toho (Tohoku), Toky (Tokyo)
** Grid Expansion (Newly Built Grid Capacity), AF_LNG (Availability Factor of LNG PowerStation), AF_PumpedStg (Availability of Pumped Storage), Grid Storage (Grid Storage Capacity), Waster Electorolysis (Hydrogen Porduced by Waster Electorlysis)

Conclusions

All flexibles machnsims are not employed at the same time. In Japan, there is a huge regional gap between renewable erny potential and energy consumption. In Japan, very first step is to build new grids to connect between energy consumption regions and renewable potential-rich regions. LNG PowerStation is used to fill a gap between electricity demand and electricity supply by VRE beyond 20% VRE share. Grid storage and water electrocysis will be employed beyond 60-80% VRE share. VRE share has a significant impacts on the desigh of energy system.

References

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Lehtila, Antti and George Giannakidis (2013), TIMES Grid Modeling Features, TIMES Version 3.4 User Note.