SYSTSEMS ANALYSIS ON JAPANESE HYDROGEN MARKET USING DETAILED TIMES-BASED TECHNOLOGY MODEL

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Overview

Japanese governmnet unveiled the Japan Roadmap on Htdrogen on 23rd June, 2014. This research aims to identify key factors which affect hydorogen market, Japan's carbon emissions, energy independence, and system costs. Based on these factors, we will propose a new energy system for an alternative energy era, using a detailed sub-regional electricity technology model, the Japan Multi-regional Transmission (JMRT) model. Intermittency and geographical sensitivity are the two main factors that differentiate renewable electricity from conventional sources. Seasonal and diurnal variations in wind/solar electricity necessitate use of backup capacity and storage. Further, the most renewable sources in Japan – onshore wind, has better potential in regions with low electricity demand. This makes integrating the more or less isolated (10) grids of Japan a very important issue. The JMRT model employs 1 sq km grid GIS information on wind speeds, distances from the nearest road and from electricity grid for a very detailed description of wind potential. This project uses systems analysis approach, which is the dissection of a system into its component pieces to study how those pieces interact and work together.

Methods

The bottom-up model used for this research, the JMRT (Japan Multi-regional Trading) model, is a detailed disaggregate Japanese electricity generation system model based on TIMES to reflect factors which affect the popularisation of renewables. The TIMES objective is to minimize the total ccost of the system, properly augmented by the 'cost' of lost demand. All cost elements are appropriately discounted to a selected year
The Japanese electricity system comprises 10 grids that have very poor interconnections. Renewable potential is not sufficiently high on the grids that have high demands. In addition, due to seasonal and diurnal variation in demands, this is not possible and the actual utilisation turns out lower than the potential. To reflect above realities, we have included geological tastes. For example, onshore wind, each 1 km mesh data have unique information, wind speed which define availability factor, distances from the nearest road and electricity grid, capital cost, operational maintenance cost and lat/long. In addition, we have included the capacity of inter-grid connections.
In the research, we have picked up three types of unceratinties, 1) policy objectives carbon mitigation and energy independecy and 2) infrastructure, electricity grid expansiion, hydrogen trade and hydreogne station and employed systems analysis to indetify the impacts of undecertainties on hydrogen popularisations.

Results

Following figure shows a relationship between hydrogen generation and wind turbine generation and from the figure, hydrogen works as storage of intermittent hydrogen.

Figure 1 Relationship between Hydorgen and Intermittent

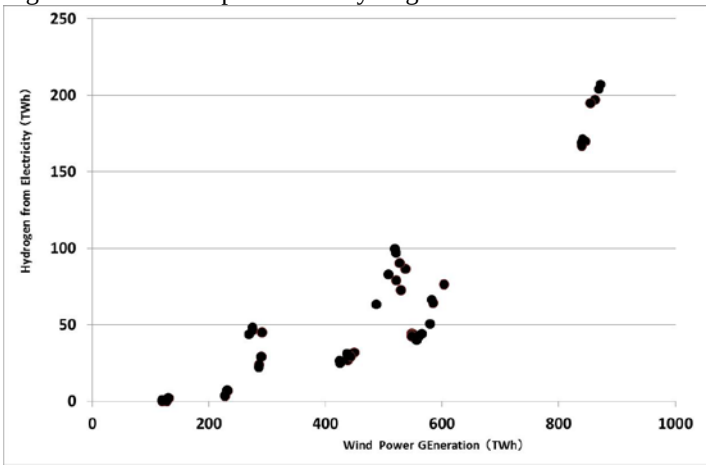
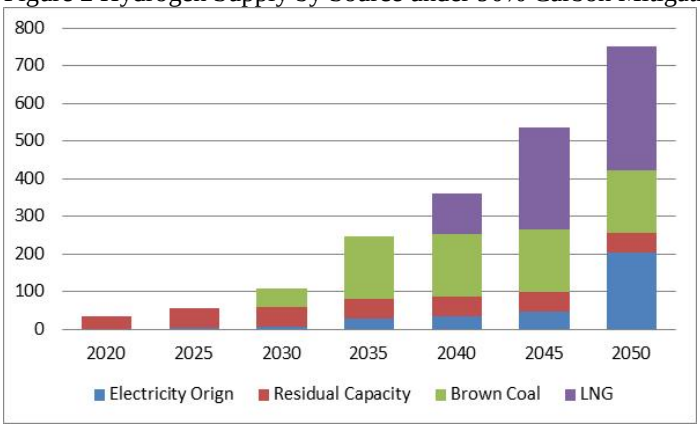


Figure 2 Hydrogen Supply by Source under 90% Carbon Mitigation Target[1] (TWh)



Conclusions

In the early stage of carbon mitigation, renewable energy, especailly PV and wind power, play a major role, but the increase the share increase of renebale energy make difficult to meet electriicty supply to demand due to the nature of instraibility load. To stabilise electricity system need electricity storage. Hydrogen will play a electricity storage role.

In addition, carbon mitigation also has huge impacts on hydrogen market. The maximu market of hydrogen in 2050 will be 149.3TWh under 30% mitigation target, 217.1TWh under 60% mitigation targe and 753.4TWh under 90% mitigation target, respectivelly.

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[1] Carbon mitigation target below 2008 by 2050