自然エネルギー財団
RENEWABLE ENERGY INSTITUTE

Agora Energiewende

8 April 2022

Request for proposal by 30 April 2022

Modernization of the Grid for a Renewables-Driven Power System in Japan

Study on developing a vision of a future grid infrastructure for an fully renewable power supply.

1. Main Objective and Backgrounds

Main Objective

Support the planning of a flexible and resilient grid to accommodate high shares of renewables in Japan

Background

The successful and efficient integration of high shares of renewables in Japan for a decarbonized society by 2050 requires a modernized, flexible and resilient power grid that accommodates the different sizes, locations and supply patterns of decentralized generation systems. A previous Agora-Renewable Energy Institute (REI) study (2018)[1] showed that the currently planned grid can handle more than 40% of renewable electricity by 2030 from a stability perspective – even though it was designed to integrate large, conventional power plants.

For a larger expansion of renewables, however, major new investments will be required. REI's analysis of a decarbonized Japanese energy system by 2050[2], conducted with the support of Agora Energiewende, described two scenarios for Japan's transition to 100% renewables in a regional resolution. They provided a reference case and database for the regional distribution of new wind and solar power and a first order estimation of transmission grid development needs (NTCs between regional nodes) in upcoming decades.

On the other hand, the mid-term planning efforts of the Japanese government and the Organization for Cross-regional Coordination of Transmission Operators (OCCTO) for a master grid plan currently take into account a few scenarios, mostly considering the use of conventional generation. There is also a lack of analyses on the costs and benefits of different power infrastructure development scenarios, especially those accommodating nearly 100% shares of renewables.

Against this backdrop, REI seeks to develop a vision of a future grid infrastructure for an eventual fully renewable power supply. Based on this vision, we seek to foster discussions on the feasibility of such a power system, develop the outline of major interregional transmission infrastructure, and bring planning and assessment criteria developed in Europe into the Japanese discussions of power grid reinforcement. As a result, we contribute to widen the scope of the assessment performed by the government and OCCTO in their development of a master grid plan.

Objective

Taking into account the detailed hourly data provided by the 2050 decarbonization study[2], as well as the identified benefits of increasing net transfer capacities between major regions, this study will look at developing more concretely the transmission grid infrastructure-assessing the infrastructure requirement to reach carbon neutrality by 2050.

[1] https://www.renewable-ei.org/pdfdownload/activities/REI_Agora_Japan_grid_study_FullReport_EN_WEB.pdf
[2] https://www.renewable-ei.org/en/activities/reports/20210309.php

This study will be based on a load-flow analysis of the high voltage transmission system, by identifying concrete additional transmission lines and converter stations required to reduce congestions, curtailment and redispatch needs, while also satisfying the operational standards of the Japanese operators.

While not competing with the level of detail of grid planning conducted by TSOs themselves, this study will be sufficiently detailed to develop a tangible map of where transmission capacities will be increased, and provide an overview of associated investment needs. Storage and demand response options will be accounted for conceptually (and quantitatively to the extent practically feasible within the scope of such a study), as a means to reduce grid investment for infrastructure used at rare peak incidences, and in order to increase security of supply.

2. Scope and work packages

This study aims to evaluate in detail a future grid infrastructure vision for an fully renewable power supply in 2050. Two main scenarios should be analyzed, specifically the OCCTO base scenario – with a share of 50-60% renewables in 2050 - and the REI scenario – with a share of 100% renewables. For both scenarios, sensitivity analysis will be conducted. The framing condition and the parameter changes for the sensitivity analysis will be defined in accordance with the contractor. Those framing conditions could for example outline two very distinct systems, one relying mostly on transmission grid reinforcement (central scenario) while the other one would rely more on decentralized solutions (generation close to the load and battery roll-out). Parameter changes will include, for example, the amount of batteries installed, the localisation of renewables in-feed, electricity consumption for hydrogen and direct air capture and storage (DACCS), adjusted demand curves, etc.

Proposed work packages:

[WP1] The model set-up and data preparation

The consultant will develop a modelling framework whereby ABB PROMOD can analyze grid development plans throughout Japan. The reason for using ABB PROMOD is that it is the tool used by OCCTO and is consistent with OCCTO's analysis. Using a similar software will facilitate the exchange of information with OCCTO (including sharing input, output and network files) foreseen during this project.

Firstly, based on the current grid plan (2030), the consultant will calculate the amount of curtailment of renewable energy given exogenous electricity demand and renewable energy in 2050 as set in WP2. Then, the consultant will analyze how much renewables will be curtailed, under N-1 constraints, if (1) grid reinforcement measures are implemented and (2) "flexible demand" is introduced:

(1) For grid reinforcement, the analysis will focus mainly on the eastern Japan area, and parameters such as transmission line capacity between Hokkaido, Tohoku, and Tokyo will be used.

(2) For "flexible demand", batteries, charging electric vehicles, heat storage in heat pumps, hydrogen production, and DACCS are assumed. For storage batteries, the charge and discharge profiles should be given endogenously in PROMOD. Electric vehicle charging and heat storage in heat pumps should be provided exogenously by modified demand curve. Hydrogen production and DACCS should generate specific demand and be given endogenously in PROMOD.

So, for each scenario (and sensitivity analysis) the input parameters will be the level of grid (1) and "flexible demand" (2) and their combinations, and the output of the modelling is the amount of curtailed renewable energy.

For demand and renewable energy generation, data for the 8760 steps will be provided by REI for the 9 regions in Japan. The consultant will need to disaggregate those hourly profiles to each node of the grid model.

[WP2] Scenario Definition and sensitivity analysis

Two main scenarios should be implemented: the OCCTO base scenario and the REI scenario. The OCCTO base scenario is the scenario established by the OCCTO for the master plan study. Through this analysis, the validity and plausibility of OCCTO's assumptions and results will be replicated and potential insights will be gained for consideration by OCCTO and the Japanese government.

The REI scenario should be based on REI's analysis of a decarbonized Japanese energy system by 2050, conducted with the support of Agora Energiewende. The scenario describes Japan's transition to 100% renewables.

In both scenarios, several sensitivity analyses will be performed, with the parameter presented in WP1, grouped in two categories (1) transmission line reinforcement and (2) "flexible demand". In its offer, the consultant must price separately the costs of the two main scenarios and most important sensitivity analysis (core offer) and the additional costs for each additional sensitivity analysis.

[WP3] Analysis

ABB PROMOD's dispatch calculations to minimize operating costs should analyze a grid that achieves 100% renewable energy as of 2050, while minimising curtailment and respecting grid operation constraints (in particular N-1 constraints). For the two scenarios set in WP2 and the amount of transmission line reinforcement and flexible demand set as parameter, the following calculations should be provided for each 8760 hourly steps.

- Amount of RES curtailment in each area
- Amount of recharge/discharge of batteries
- Thermal power generation
- Nuclear power generation
- Renewable energy power generation
- Pumped storage power generation
- Transmission of electricity between areas and line ratings
- Hydrogen and DACCS demand
- Total operating costs (Fuel cost)

[WP4] Recommendation

Based on the analysis of WP3, the consultant should report preliminarily key recommendations taking into account the current situation in Japan and the results of the OCCTO official analysis. The process leading up to 2050 will also be considered, and results for mid-term policy recommendations along the way will also be extracted.

3. Deliverables and timeline

External research institutions, think tanks, and TSOs will be involved in this project both to facilitate the design of the study, as well as to contribute to the understanding, appropriation and dissemination of project results.

In conducting this analysis, the consultant is expected to:

- bring sound experience in power systems modelling,
- ensure data quality and reliability,
- have access to Japanese-specific data,
- have an in-depth understanding of the Japanese context and policies,
- have a proven record of achieving similar analysis in Japan, and
- be in close exchanges with the Study Group on Renewables Grid Integration for Decarbonization established by REI.

Bi-weekly calls will be set-up between the consultant and the clients in English.

The consultant shall provide a final report at the end of the project that will include

- An executive summary of 3-5 pages;
- A detailed description and justification of the model, methodology and input parameters;
- A description, quantification and adequate graphic representation of the results of the scenario analysis
- A discussion of the power system focused on grid reinforcement and flexibility options, making tangible recommendations.

The reports are to be written in English and bi-weekly meetings are to be conducted in English.

Main results will also be displayed in a power point presentation.

The indicative timeline of the project is as follows:

End of April 2022:	Project kick-off and start of WP1 and WP2
May 2022:	Start WP3
Mid of May 2022:	Presentation of first interim results on WP3
End of June 2022:	Presentation of second interim results on WP3
End of July 2022:	Discussion of interim results (WP3 and WP4)
End of August 2022:	Submission of final draft report and ppt presentation
End of October 2022:	Publication of final report in public event in Tokyo

The project proposal should;

- discuss the proposed time frame and identify potential risks for not meeting it.
- be presented within 20 slides pages (MS PPT format). However, the number of Appendix pages is not limited.

4. Offer submission and Contact person

Offers shall be submitted before the 30th of April. Contracting partner will be the Renewable Energy Institute:

Mika Ohbayashi, Director, m.ohbayashi@renewable-ei.org
Kaori Sakagami, Senior Manager, Administration, kaori.sakagami@renewable-ei.org

For any considerations or questions regarding the project, please refer to:

Renewable Energy Institute:
Seiichiro Kimura, Senior Researcher, s.kimura@renewable-ei.org

Agora Energiewende:
Dimitri Pescia, Program Lead, dimitri.pescia@agora-energiewende.de

Appendix: Weighting Criteria

[Appendix]

8 April 2022

BAFA programme: "Independent expertise for the global energy transition"

Weighting Criteria: Request for Proposal for Modernization of the Grid for a Renewables-Driven Power System in Japan

Submitted proposals shall be evaluated as follows;

A total of 100 points are achievable of which 30 points for price and 70 for quality.

Evaluation price calculation

- 30 points for the lowest price.
- 0 points for offers that are twice as expensive as the cheapest.

Quality 70 points to be evaluated as follows:

Concept	Minimum requirement	Max. Points
Description of the approach to the conception, preparation, implementation and follow-up of the tendered service.	• Preparation of Japanese-relevant data • A track record of similar analysis and consulting process in Japan	40
	• An understanding of the Japanese policy background.	20
Explanation of the planned work processes as well as the communication concept, especially if subcontractors or external experts are used.	• Cooperation with participating organizations, framework contract partners • General coordination • Description of internal substitution arrangements, knowledge management, and response and implementation work for requests	10