Executive Summary

The Philippines consists of many small, medium-sized, and large islands and there is large potential to increase electricity demand in future. The country's main power source is coal, followed by domestic natural gas produced by the Malampaya gas field. Imports of liquefied natural gas (LNG) will increase due to depletion of this gas field and a shift in power generation from coal to gas. Consequently, it is essential to devise an economic system for delivery of small and medium-scale LNG from primary to subordinate (secondary and tertiary) terminals located near the islands' gas-fired power plants (GPPs). The following approaches are applied to determine the optimal small- and medium-scale LNG delivery solutions.

1. Estimation of electricity demand at the provincial level in 2040 based on the Philippines' Power Development Plan
2. Estimation of LNG consumption and location of GPPs
3. Optimal (minimum-cost) LNG delivery from a primary terminal to a subordinate terminal near GPPs using the linear programming model
4. Based on the delivery results from the linear programming model, computerised simulation of LNG delivery using a dynamic simulation model under assumptions including LNG barge operation, tank size of the subordinate terminals, and in the case of typhoon strike

The three major regions in the Philippines are Luzon, Visayas, and Mindanao. Our assumptions were as follows.

(i) A transmission line will be completed in the Luzon region by 2040. By then it will no longer be necessary to deliver LNG to GPPs in this region.

(ii) Cebu and Zamboanga are the two primary terminals in the Visayas and Mindanao regions; and Tacloban, Tagbilaran, Surigao, Bislig, Iligan, and General Santos are the six ports with subordinate terminals near GPPs.

The results of the optimisation model suggest the following points.

(i) Having two primary ports (Cebu and Zamboanga) is a lower-cost solution than having one primary port.

(ii) The hub-and-spoke delivery method is a lower-cost solution than the milk-run method.

The results of the dynamic simulation model yielded the following points on the size of LNG barges and LNG tanks at subordinate terminals.

(i) Large LNG barges are recommended to reduce number of vessels, especially small barges (capital cost), as well as running costs (operation cost) due to scale merits. But barge size depends on water depth in the ports.

(ii) Large tank size increases capital costs, but should be a key parameter to mitigate the influence of typhoons by avoiding a tank shortage.

The simulations recommend the following scenario as a minimum-cost solution for delivering LNG for small- and medium-scale power generation in the Visayas and Mindanao regions.

(i) Choosing Cebu and Zamboanga as the primary terminals;

(ii) using three large (30,000-cubic metre) LNG barges;

(iii) using a large (27-kilotonne) tank at each subordinate terminal; and

(iv) in case of a typhoon, six large LNG barges are required.

However, the assumptions for the two simulation studies are preliminary. It is recommended that when the Department of Energy undertakes feasibility studies it applies these simulation approaches to obtain optimal and feasible solutions for small-scale LNG delivery using appropriate and reasonable assumptions.

This study was successful, but several issues remain.

(i) Due to data limitations, electricity demand and LNG demand for each GPP and secondary port were estimated to be the same.

(ii) Assumptions for the optimisation approach using the linear programming model, especially capital costs for LNG ship (or barges) could be optimistic. We assumed lower capital costs for LNG ships applying simple structures that are just LNG tanks on barges.

(iii) Assumptions for the dynamic simulation were also simplified. The speed of LNG ships and the time taken for loading and unloading was assumed to be the same, whether they were large or small.

When the Department of Energy decides to increase the number of GPPs in the country, appropriate assumptions can be applied for both approaches to obtain more realistic solutions.