ESTIMATED COSTS AND BENEFITS OF POWER GRID INTERCONNECTIONS IN NORTHEAST ASIA

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The objective of this paper was to prepare a rough estimate of the costs and benefits of connecting the power grids of four of the neighboring countries of Northeast Asia, namely the Republic of Korea (ROK), the Democratic Peoples' Republic of Korea (DPRK), Russia--specifically the Russian Far East (RFE), and China (Northeast China). The paper seeks to approximately establish what the order-of-magnitude capital costs of interconnections of two different types will be, as well as to estimate whether the potential benefits—including economic, environmental, and other benefits—of interconnection are sufficiently high to justify the investment costs. Investment costs are compared with other energy sector investments designed to reduce environmental impacts.

The paper draws on previous Nautilus work on future energy "paths" for the countries of Northeast Asia, as well as the work of colleagues in the region. This work is drawn upon to identify major areas in the region with significant electricity demand growth. The overall electricity supply situation in neighboring countries (current and projected) is then reviewed, and estimated costs of interconnection for two specific scenarios are prepared by using capital and operating cost estimates obtained for key transmission line and power generation components. The two scenarios studied are:

- **Scenario 1**, which assumes a transmission line from the Northeast ROK along the east coast of the DPRK and into China, connecting at Simpo (site of the nuclear reactors built by KEDO). This transmission line would allow power from the Simpo plants to flow to the ROK or China, and would allows any available baseload nuclear power from the ROK to be routed to China.
- **Scenario 2**, which posits a line connecting the Russian Far East, the ROK, the DPRK and Northeast China. The assumption is that power from the RFE hydroelectric plants flows to the ROK in the summer to meet peak demand there, and to China in the spring and fall. The linkage also allows power from ROK and./or Simpo nuclear power plants to flow to China in the spring and fall, and to the RFE to meet peak demand there in the winter.

The estimated benefits of interconnection are computed by estimating the economic benefits of transmission links (avoided fuel, capacity costs), estimating the environmental benefits of interconnections in terms of avoided emissions and related impacts, evaluate qualitative benefits for regional security, computing cost-effectiveness indices, and comparing cost-effectiveness with other options for reducing pollutant emissions.

Overall, the Scenario 1 interconnection scheme is estimated to have an annualized net cost (including all nuclear capacity costs) of approximately $190 million per year, or somewhat less than $0.02 per kWh transferred. This value computes to about $13 per tonne of carbon dioxide (CO_2) avoided. Costs are significantly lower if a portion of the nuclear capacity costs are considered "sunk" costs and not recovered in energy sold via the transmission line. Scenario 1 provides CO_2 savings of 15 million tonnes per year, as well as sulfur dioxide emissions reduction of just under 300 thousand tonne. When compared with the positive cost CO_2 emissions reduction measures included in the ROK's compilation of greenhouse gas reduction strategies (the "ALGAS" report), the transmission line concept considered in Scenario 1 provides similar emissions reduction at a lower average cost per tonne of CO_2 saved.

The Scenario 2 interconnection as modeled is estimated to have an annualized net cost (including all nuclear and hydro capacity costs, but only half of the costs of maximum avoided capacity in China, the RFE, and the ROK) of approximately $50 million per year, about $0.0033 per kWh transferred, or about $2.50 per tonne of CO_2. Annual savings of CO_2 using scenario 2 are estimated at about 20 million tonnes, along with 360 thousand tonnes of sulfur dioxides. Scenario 2 thus may be an economic proposition on economic grounds even if environmental benefits are not accounted for, and would likely be quite favorable if significant value were attached to the emissions reduction achieved through the project.

A number of areas for further regional collaborative study and analysis are suggested in the last section of the paper.