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Equilibrium supply security in a multinational electricity market with renewable production

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Support schemes to increase the production of energy from renewable sources now are common in many parts of the world as part of a policy to reduce greenhouse gas emissions and the dependence on energy imports. Subsidization of renewable electricity often has sparked investments predominantly in solar and wind power.

Output fluctuations inherent to solar and wind power have subsequently raised concern about the ability to continuously satisfy demand in a system relying on such intermittent electricity production. In circumstances of a substantial shortfall of renewable output, the system operator may be forced to disconnect consumers from the grid in order to maintain system stability.

An alternative to curtailing consumers is to ensure sufficient thermal capacity to replace renewable electricity in situations of scarcity. Some of this capacity will necessarily be deployed very infrequently. Electricity prices must then be very high in such events to ensure that the required investments to achieve supply security are profitable at market-based prices.

Capacity reserves are a means to ensuring supply security while avoiding price spikes by reducing the need for market-based thermal investment. Another solution is to increase network capacity. Improved market integration allows local variations in renewable production to off-set each other with a reduced likelihood of supply shortage as a result.

This paper develops an economic model to examine factors that underlie country decisions to acquire capacity reserves and invest in network improvement. A purpose is to analyze the welfare-economic consequences of decentralized policy making about security of supply in a multinational electricity market.

A larger capacity reserve improves the security of supply, but distorts the price of electricity, which causes overconsumption and insufficient investment in thermal-based capacity. Both effects spill over to neighboring countries in an integrated market. As these foreign externalities go in opposite directions, nationally decided capacity reserves can be too large or too small from a social welfare viewpoint.

Network investments benefit the entire market because improved market integration reduces the risk of supply shortage and ensures that the existing production capacity is used in a more cost-efficient manner. Nationally decided network investment therefore is insufficient. A policy conclusion is that domestic regulation of electricity networks provides too weak incentives for network expansion and should be complemented by a supranational support system.

Competitive and well-functioning financial markets substantially reduce the need for, and the incentive to introduce, capacity mechanisms because capacity reserves then distort long-run prices without providing any substantial hedging benefits.

Maintaining supply security is more costly when countries define supply shortage at the national level and procure capacity reserves to solve domestic resource problems. A more efficient solution would be to consider integrated targets and coordinate the activation of capacity reserves across national borders.

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