Integration of Renewable Energy into Electricity Grids

G8 Project - Overview

Context

1. Many countries target an increase in the role of renewable energy sources (RES) in their energy portfolios. Consequently the efficient integration of RES sourced electricity into transmission and distribution systems is of high priority. To this end it is likely that transmission networks, the rules by which they operate, and markets will need to be modified to take into account the specific characteristics of renewables.

2. For example, existing electricity transmission systems were largely developed to link a relatively small number of large, centralised power stations. While centralised plant is likely to remain an essential part of energy portfolios (including some centralised RES plant such as hydro), some generation from RES (as well as conventional CHP plant) is connected to lower voltage distribution networks. The distributed nature of renewables is not the only difference from existing norms: variable output technologies[1], such as solar PV and wind energy, also represent a degree of departure from traditional "dispatchable" technology. These developments, and others, call for identification of the tasks along the road to integrating RES electricity.

3. While the related technological challenges may largely be seen as universal, they nonetheless vary from country to country according to a wide range of technical parameters governing the flexibility of a given system, such as the amount of dispatchable capacity in the generation portfolio, the storage capacity available, and the extent to which the system is interconnected to neighbouring systems. National disparities are more strongly apparent in terms of strategic energy policy, related legislation, and the regulatory environment, as well as the nature and size of electricity markets. These differences are the cause of much debate, and increase the difficulty in isolating the fundamental challenges from the cosmetic.

4. At the Gleneagles G8 Summit in 2005, the IEA was tasked with drawing together research into the challenges of integrating electricity from RES in an efficient manner.

The Project

5. The first task is to gather together the experts into a "knowledge bank" with sufficient intellectual weight and experience to establish what the key issues are, and to identify related tasks. However, a broad information base should not lead to the report becoming so long and convoluted that it can no longer serve the overall objective of shedding light on the debate.

6. A Kick-off Workshop was held in November 2006, for which a scoping paper was prepared by external consultants. The latter will update this paper, including the findings of the workshop, and submit it to the IEA in March / April this year. Further to the Kick-off Workshop, moderated discussions will be held in 2007, on technology issues, tentatively scheduled for May 29th; and on policy, market and regulatory issues, tentatively scheduled to take place in October in conjunction with REWP[2] 52 in Berlin. Prior to each, a concise discussion paper prepared by the IEA Secretariat, of not more than ten pages, will be circulated to the invitees.

7. The project will culminate in a Final Report to the Japan G8, in 2008, to be prepared by the IEA Secretariat.

[1] In 2005 the IEA produced a report "*Variability of Wind Power and Other Renewables: Management Options and Strategies*." The G8 project outlined here will address not only variable output technologies, and will focus on market and policy issues, within the bounds of technological feasibility.

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The Study

8. The Final Report, a concise document of no more then 80 pages, will aim to establish a degree of consensus on the priority issues and related tasks, based on the range of experiences to date. Its overall objective is to make short to medium term recommendations to countries that target or are considering targeting an increase in (or initiation of) the deployment of renewables. The development of a number of "electricity market paradigms" (see below), based on varying degrees of renewable energy penetration and overall system flexibility, will cast light on the associated challenges and benefits.

9. Variable output technologies, such as solar photovoltaic and wind energy, are of particular relevance to this study. Other renewable energy technologies, some of them dispatchable, with high capacity factors comparable to conventional sources of electricity - such as biomass, geothermal, hydropower and solar thermal technologies (with integrated thermal storage) - will also receive attention.

Final Report Outline. Part I: Market Paradigms

10. The study will filter the large body of research that has been developed in recent years, and attempt to establish a number of "electricity market paradigms." These will help distinguish among disparate national circumstances related to the deployment of renewables and the consequences for conventional electricity transmission and supply. The paradigms will feature a range of variables (see Para.3).

11. Their elaboration – based on national and regional experiences of RES integration to date – is intended to demonstrate to policy makers the specific issues and tasks associated with a given degree of penetration into existing generation portfolios. It is important to note at this point that a purely national approach in the elaboration of these paradigms will likely be misleading: national boundaries are decreasing in relevance to electricity systems as interconnection among neighbouring countries increases. With this in mind, the paradigms will be constructed in the context of supra-national electricity systems.

12. Mini-grids, particularly in a developing world context, need to be included. The status of mini-grids, on islands and elsewhere, will form the basis of a further market paradigm, and subsequent recommendations.

Part II: Key Technological, Regulatory, Policy and Market Issues

13. Following the main section of the report, a series of annexes will identify in a straightforward and concise manner the principal challenges ahead in terms of technology, policy, regulation and markets. Questions will be addressed such as: What are the essential characteristics of an electricity market which is "friendly" to RES, and in particular to variable output technologies? How should regulatory bodies go about ensuring fair access for new / small / distributed / variable output generators? What policies might be developed, alongside those that encourage generation from RES, to encourage transmission systems operators to integrate it?

14. Technology aspects will include, inter alia: system flexibility, predictability, variability (and intermittency), system balancing, interconnection, storage, optimising existing grid hardware, new grid capacity and design, overhead and underground cabling, power quality, challenges and benefits of distributed generation, intelligent grid control, demand side response and management, and priority R&D Tasks.

15. Market, policy and regulatory aspects will include: identification of electricity market types; unbundling of infrastructure, supply and generation; intelligent markets; incentivising grid development; existing and future regulatory practice; planning and approval procedures; grid codes and penalties; and the additional costs of RES integration.

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