MASSIVE ELECTRICITY STORAGE

An AIChE White Paper

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Summary

The United States is embarking on a number of routes to develop an electric power generation system that depends less on fossil fuels in order to conserve oil and natural gas and have a lower impact on the generation of greenhouse gases. Our nation, along with the rest of the world, is turning to renewable energy sources to hopefully

power to eventually replace fossil/nucl

To meet a 100 MW of firm demand with wind power, 286 MW of nameplate wind power capacity must be installed because the capacity factor for wind is at best 35 percent today. Only 35 percent of a wind farm's nameplate capacity can be considered firm for reliable and economic load dispatch due to the inherent variable and intermittent nature of wind power, and even then storage is required. Current design calls for installing storage capacity equal to about 20 percent of the nameplate capacity, or 57 MW, to achieve a 95 percent assurance that the 286 MW of wind farm capacity can deliver 100 MW baseload power. The amount of storage needed is 6-8 hours, or 342-456 MWh (2).

With solar power, a typical annual average of 10 hours per day is available for power generation, immediately cutting the capacity factor to 40 percent. Add to this the variable nature of solar power due to seasonal changes and cloud cover and the overall capacity factor drops to around 20 percent. Fortunately, power consumption at night is typically much lower than during the day, so that with sufficient storage capacity it is possible to cover the demand during off-peak hours without generation.

As a basis for our "upper bound" analysis, solar and wind generation are both treated with a 35 percent capacity factor. So, to meet a 100 MW firm demand, 286 MW of nameplate generation capacity must be installed, plus 57 MW of storage power for 8 hours of storage, or 456 MWh of storage capacity.

Knowing what each 100 MW of firm demand would require in terms of wind power installed capacity and the MES required to deliver 100 MW of dispatchable power supply, we can complete the calculations for the three scenarios above to produce Table 1 below. For example, Scenario (a) of 20 percent renewable power grid penetration means 200 GW of firm capacity. This would require the installation of 572 GW of nameplate capacity of solar/wind, plus 114 GW of MES storage power with 912 GWh of storage capacity. Similar calculations are made for Scenarios (b) and (c).

For capital cost calculations, best current estimate shows installed wind capacity at $1500/kW (3) and solar at $3600/kW (4). For MES, American Electric Power estimates $3000/kW for a NaS battery system (5).

Table 1 summarizes the current "upper bound" conservative estimates for the needed MES capacity under the 3 scenarios of grid penetration.

Table 1. “Upper Bound” Estimate of U.S. MES Size and Cost

Grid Penetration By Renewable Power, %	20	50	75
Firm Renewable Demand, GW	200	500	750
Nameplate Renewable Installed Capacity, GW	570	1430	2150
Capital Investment for Installed Capacity, $ billion	860	2150	3220
MES Power Capacity, GW	114	285	428
MES Storage Capacity, GWh	912	2280	3424
MES Capital Investment, $ billion	342	855	1284

4. **Action Needed**

To make a renewable energy electric power system a reliable reality it will be necessary to ensure that MES options are developed. This is the critical path to harnessing renewable energy. To achieve this goal in the time required, the following actions must be undertaken:

a. Inform the public of critical MES need through papers, meetings, briefings, media, and conferences. Decision makers must be informed that without MES, r

b. DOE is the logical agency to stimulate MES development, from basic science to R&D and the subsequent demonstration stages. By recognizing the vital role of MES, DOE should place top priority on MES R&D for the transition to renewable power. With DOE's interest and support, Congress then has a solid bas

References:

(1) BP, “Statistical Review of World Energy 2007”; EIA Electric Power Annual wit