Dependency of Wind Power on Water Resources

Response to TES Co-editors Article: Inseparability of water and energy, in vol. 10 no. 1, 2011

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The paper Inseparability of Water and Power (Thorn et al. 2011) states that "Wind and wave based energy sources are the only two energy sources that do not have an impact on our freshwater resources (not including construction materials)." There are many places where wind power is related to hydroelectric and pumped storage projects to store the wind produced energy when the wind is blowing for generation when demand is high but with no wind blowing, and is a subject for further discussion. Background information on the different ways intermittency of wind power is dealt with in many countries, derived from source material in Wikipedia, is presented here for additional consideration. It shows that wind generation is often related to water projects and also solar energy projects which the authors indicate has a big impact on water use and water development as well as water quality.

Wind power can be replaced by other power stations during low wind periods. Transmission networks must already cope with outages of generation plant and daily changes in electrical demand. Systems with large wind capacity wind power components may need more spinning reserve (plants operating at less than full load). Pumped-storage hydroelectricity or other forms of grid energy storage can store energy developed by high-wind periods and release it when needed (International Power 2012). Stored energy increases the economic value of wind energy since it can be shifted to displace higher cost generation during peak demand periods. The potential revenue from this arbitrage can offset the cost and losses of storage; the cost of storage may add 25% to the cost of any wind energy stored, but it is not envisaged that this would apply to a large proportion of wind energy generated. For example, in the UK, the 2 GW Dinorwig pumped storage plant evens out electrical demand peaks, and allows base-load suppliers to run their plant more efficiently.

Although pumped storage power systems are only about 75% efficient, and have high installation costs, their low running costs and ability to reduce the required electrical base-load can save both fuel and total electrical generation costs (Capital Electric 2012). In particular geographic regions, peak wind speeds may not coincide with peak demand for electrical power. In the US states of California and Texas, for example, hot days in summer may have low wind speed and high electrical demand due to air conditioning. Some utilities subsidize the purchase of geothermal heat pumps by their customers, to reduce electricity demand during the summer months by making air conditioning up to 70% more efficient (Wald 2008); widespread adoption of this technology would better match electricity demand to wind availability in areas with hot summers and low summer winds.

Another option is to interconnect widely dispersed geographic areas with an HVDC "Super grid". In the US it is estimated that to upgrade the transmission system to take in planned or potential renewables would cost at least $60 billion (Dixon 2009). In the UK, demand for electricity is higher in winter than in summer, and so are wind speeds (Sindon 2005). Solar power tends to be complementary to wind (Hill 2008). On daily to weekly timescales, high pressure areas tend to bring clear skies and low surface winds, whereas low pressure areas tend to be windier and cloudier. On seasonal timescales, solar energy typically peaks in summer, whereas in many areas wind energy is lower in summer and higher in winter (SECO 2010; Dykes 2008). Thus the intermittencies of wind and solar power tend to cancel each other somewhat. The Institute for Solar Energy Supply Technology of the University of Kassel pilot-tested a combined power plant linking solar, wind, biogas and hydrostorage to provide load-following power around the clock, entirely from renewable sources (Solar Server 2008). A report on Denmark's wind power noted that their wind power network provided less than 1% of average demand 54 days during the year 2002 (Sharman 2005). Wind power advocates argue that these periods of low wind can be dealt with by simply restarting existing power stations that have been held in readiness or interlinking with HVDC. Electrical grids with slow-responding thermal power plants and without ties to networks with hydroelectric generation may have to limit the use of wind power (Czisch 2007).

Wind power and pumped storage have a long history. Most farming wind mills are used to pump groundwater up to a storage tank when the wind is blowing, and water is withdrawn from the storage tank at whatever rate and pressure when needed with or without the wind blowing. There were usually wind mills refilling the water tanks along railways in the days of steam powered railway locomotives. Steam engine dependent mining and manufacturing facilities had wind mills pumping water to keep their water supplies filled. The water dependency of wind power in the past, present and future and in relation to other present and new energy sources is quite clear.

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