Geophysical Research Abstracts
Vol. 12, EGU2010-7349-1, 2010
EGU General Assembly 2010

On the integration of wind and solar energy to provide a total energy supply in the USA

Cristina Archer (1), David Mills (2), Weili Cheng (2), Matthew Sloggy (1), Edwin Liebig (1), and Alan Rhoades (1)

(1) California State University Chico, Chico, USA (carcher@csuchico.edu), (2) Ausra Inc., Mountain View, USA (david.mills@ausra.com)

This study examines the feasibility of using renewable energy – mostly wind and solar radiation - as the primary source of energy in the USA, under the assumption that a nationwide electric transmission grid is in place. Previous studies have shown that solar or wind alone can power the present U.S. grid on average. Other studies have shown that solar output from California and Texas using energy storage is well correlated with the state energy load on an hour by hour basis throughout the year and with the U.S. national load on a monthly basis. This study explores scenarios for use of wind and solar energy together at the national scale on an hour by hour basis to determine if such a combination is a better match to national seasonal load scenarios than either of the two alone on an hour-by-hour basis. Actual hour by hour national load data from the year 2006 are used as a basis, with some scenarios incorporating vehicle sector electrification and building heating and cooling using electric heat pumps.
Hourly wind speed data were calculated at the hub height of 80 m above the ground for the year 2006 at over 150 windy locations in the continental U.S. using an extrapolation technique based on 10-m wind speed measurements and vertical sounding profiles. Using a 1.5 MW wind turbine as benchmark, the hourly wind power production nationwide was determined at all suitable locations. Similarly, the hourly output from solar plants, with and without thermal storage, was calculated based on Ausra's model assuming that the solar production would occur in the Southwest, the area with the greatest solar radiation density in the U.S. Hourly electricity demand for the year 2006 was obtained nationwide from a variety of sources, including the Federal Energy Regulation Commission. Hourly residential heating and cooking, industrial heat processing, and future electrified transportation loads were calculated from monthly and yearly energy consumption data from the Energy Information Administration.
Using different scenarios of wind power penetration (between 10% and 120% of the average national electricity and/or energy demand), the remaining hourly electricity and/or energy load was covered by solar thermal electricity produced via the Ausra's innovative linear reflective system, with various amounts of storage. With a 20% redundancy (i.e., an average production of 120% of the demand), a match of $\sim$98% for electric load and $\sim$96% for total energy load were found for the 60%wind-60%solar combination and with 12-hr storage. Work is continuing on improving that match through more sophisticated storage usage strategies and by looking at other options for the few days in the year for which wind and solar might be insufficient.