

Field Performance of Hybrid Power Systems.

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Subject: Hybrid system field experience

Presentation: Oral Preferred

Abstract

The increasing costs of implementation for conventional approaches to rural electrification are leading to the deployment and evaluation of pilot-scale community-based hybrid power systems with the goals of cost-effective, sustainable solutions for rural electrification. Although there is a great amount of anecdotal information about wind-hybrid systems, there continues to be a lack of quality, well-documented, information about the operation of these types of systems. This hinders an accurate understanding of the true performance and cost of wind-hybrid systems, and in many cases prevents their further optimization. The National Renewable Energy Laboratory (NREL) has participated in the design, installation, instrumentation, and evaluation of more than 18 small hybrid power systems in Mexico, Chile, Russia, Brazil, Ghana and the United States. These systems are characterized by having the renewable energy connected to the DC bus, referred to herein as “DC-based” systems. An analysis of the performance of these systems, especially those for which detailed monitoring information is available, is resulting in a new understanding of how these systems operate.

Through the detailed monitoring and evaluation of pilot systems, a large discrepancy has been found between the power produced by small wind turbines in a hybrid application and energy production estimates based on the site’s climatic conditions and the turbine power curve. The reasons for this discrepancy, which can result in a 75% loss of total renewable energy generation, vary but largely fall into three general categories; short-term, but significant increases in battery voltage during wind turbine charging, gale wind patterns in which the battery is fully charged in the first hours of the storm and then control-system shortfalls resulting in poorly timed diesel battery charging. Each of these items will be discussed in detail and assessments completed for different mitigation strategies to improve the energy capture of wind based hybrid power systems.

The correct assessment of these issues may also impact the results of power system modeling, causing them to dramatically over predict system energy capture and overall performance. Some discussion will be given to the impact of these systems losses and how they can be assessed with different simulation tools.