Project: Efficient Use of Renewable Energy

Brief Description: $1 million is requested to develop technologies such as hybrid batteries and smart control systems for rural applications allowing more efficient use of renewable power.

Executive Summary: Renewable energy is an increasingly important component of our state and national energy portfolio. Rural states with favorable resources and land-use, such as Montana, will likely see considerable development of wind and solar. However, the full benefit of this development will not be realized without addressing several technical hurdles. Of particular concern is that renewable energy sources such as wind and solar are inherently variable in their power output and typically produce a small fraction of their full rated power. This "capacity factor" is typically around 35% for wind (for example, a 1 MW wind turbine typically delivers an average power of 350kW) and 21% for solar. This means that transmission either must be significantly overbuilt to deliver power long distances or power must be discarded during better that average operating conditions. In addition, since renewable sources can vary unpredictably, utility companies must have spinning reserve or readily "dispatchable" sources available to pick up load which are typically inefficient and fossil energy based reducing the "green" benefit of renewables. We address this challenge with two complementary technologies that MSU-Bozeman is uniquely suited to develop.

Project Description:
Dispatch of Rural Loads. The composition of rural loads including de-watering, refrigeration, irrigation, heating, and material handling differ considerably from urban areas. For example, in Montana, a significant fraction of the load, in some cases up to 40%, is related to irrigation. In principle, irrigation and similar rural loads can be controlled in real-time to reflect the availability of a renewable resources and grid requirements. These local loads would allow the utilization of peak power from wind and solar while mitigating transmission requirements. The proposed project would demonstrate the feasibility of this technology on an experimental scale by producing a specially modified irrigation controller. This controller would combine real-time wind energy production data with information about the crop to produce an irrigation schedule that preferentially draws power during periods of high wind productivity. In principle, this kind of system could allow enhanced development of wind and solar, ease transmission infrastructure requirements, and help farmers contain energy costs.

Advanced Hybrid Battery Development. The most desirable solution for renewable sources is to store the power they produce so that it can be accessed on demand. The challenge is that an energy storage system must provide very high round-trip efficiency to be worth the investment. One promising technology being developed at MSU is a novel high-temperature hybrid battery combining energy storage in a liquid metal anode and through an electrolysis process which combines both fast- and slow-response capabilities increasing efficiency. The proposed device will capture liquid metal in a tailored pore micro-structure, which addresses fabrication problems seen with other liquid-metal anode designs and allows the potential for electrolysis on the same material scaffold. By nature, direct conversion devices of this kind have tight couplings between the material, electrical, and structural domains. Therefore, we will co-design the materials, hybrid battery, and controls while optimizing the liquid metal / ceramic interface regions which will help ensure successful system-level performance during scale-up and implementation.

Congressional Action Needed: Funding of $1 million dollars in FY11 is requested.

Importance to Montana: The proposed technologies would allow increased development of alternative energy sources and efficient utilization of the energy produced. This would reduce greenhouse gas emissions and enhance the energy independence of the United States.

Contacts at MSU: Tom McCoy, Vice President for Research, (406) 994-2891
Lee Spangler, Associate Vice President for Research, (406) 994-1658