

## **CRADA Final Report**

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### **CRADA No. BG02-182**

### **LBNL Report Number\_\_\_\_\_**

**1. Parties:**

Lawrence Berkeley National Laboratory  
Empire Magnetics, Inc.  
Related Party  
Makeyev State Rocket Center (via LBNL Material Support Agreements)

**2. Title of the Project: Low-Maintenance Wind Power System**

**3. Summary of the specific research and project accomplishments:**

Generally the goals of the project were achieved. Several turbines of 1, 3 and 30 kW were designed, prototyped and evaluated. A 55 kW unit has been preliminarily designed. Two 1 kW alpha units and a 3 kW alpha unit were delivered to the US in 2005 and Empire

Magnetics provided custom alternators for the units. After evaluation, the 6 bladed, 3 kW unit was chosen for beta fabrication and 5 units were delivered to the US in December, 2009 while others remained for testing in Russia. The drawings sent by MSRC and SRCV did not match the hardware and several modifications were necessary on the delivered unit. Under the DOE Technology Commercialization Program, the modifications have been performed and testing is underway in the US. A satisfactory electronic controller was not delivered by the Russian or US partners.

4. Deliverables:

Deliverable Achieved	Party (LBNL, Participant, Both)	Delivered to Other Party?
Participant Business Plan	Participant	
System Constraints/Requirements	Both	MSRC
Review mechanical design	LBNL	MSRC
Alternator/Bearing Design, Test & Fab	Participant	MSRC
3 Alpha test units	Both w/ MSRC	MSRC
5 Beta 3 kW units	Both w/ MSRC	MSRC
Design and Project management reports	Both w/ MSRC	MSRC

5. Identify publications or presentations at conferences directly related to the CRADA?

6. List of Subject Inventions and software developed under the CRADA:

LBNL.024VEP (Improved Vertical Axis Wind Turbine and Aerodynamic Control Systems in the 1-10 kilowatt Power Range); CIB-2161(EP)

Empire Magnetics - 12/368,188, filed on 02/09/2009 for a “ AXIAL GAP DYNAMO ELECTRIC MACHINE WITH MAGNETIC BEARING”

Empire Magnetics - “Arcuate coil winding and assembly for axial gap Electro-Dynamo Machines (EDM)” US pat. No. 7,646,132 on Jan. 12, 2010

7. A final abstract suitable for public release:

Improved Darrieus Vertical Axis Wind Turbines and Aerodynamic Control Systems were designed, tested and prototyped with rated power levels of 1-30kW. The facilities and engineering expertise of the Makeyev State Rocket Center were used and the industrial participant invented an axial gap alternator for this specific application. The turbines market identified was in areas of Class 2 wind or better and near habitation since the units are very quiet, yet maintain aerodynamic efficiencies in the mid 30% range. Several Beta level units were delivered to the US and are undergoing test and verification.

8. Benefits to DOE, LBNL, Participant and/or the U.S. economy.

Wind energy is clearly the leading candidate for fossil fuel replacement in the next 20 years and ambitious goals are being considered at both the Federal and State levels. Congress recognizes this and has a tax credit incentive, as do many of the states. In California, the combined incentives can cover nearly 40% of the per installed unit price. This brings the payback period to less than 10 years in many sites that are near-coastal and on ridgelines in California. The country has suffered from the most recent oil price shock and energy security can be enhanced as well with widespread adoption of wind energy. The project has generated business opportunities in the Former Soviet Union and the United States and patents are filed in the major markets of the world. The University of California will benefit from the royalty streams derived from this IP.

9. Financial Contributions to the CRADA:

DOE Funding to LBNL	\$ 564,000
Participant Funding to LBNL	\$ 13,000
DOE Funding to MSRC	\$ 1,381,000
Participant In-Kind Contribution Value	\$ 1,995,000
Total of all Contributions	\$ 3,593,000