PROJECT DATA

Heliocentric - 02GO12053

High Energy-Density Double-Layer Capacitor (HDLC) Energy Storage for Photovoltaic Systems

Recipient:	Heliocentric	Instrument Number:	DE-FG36-02GO12053
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Subcontractor(s):		B&R Number(s):	ED190602
		PES Number(s):	02-2008, 03-10157
EERE Program:	Solar Energy Technologies	State Congressional District	UT - 3

PROJECT SCOPE: The objective of this project is to scale-up and demonstrate commercial-scale HDLC prototypes above 1 kWh of packaged capacity. Key objectives include further development and improvements in electrode composite, trilaminate composite, the housing, and parameterization of the HDLC variables. HDLCs improve energy storage characteristics, reduce embodied energy by 6,110 kBtu/kWh C°, and lower photovoltaic system life-cycle cost per kilowatt-hour by 3–5 times. This would also improve in-system round-trip energy efficiency by 29–34%, and would have a 40–60% greater available capacity than lead-acid batteries.

FINANCIAL ASSISTANCE

Approved DOE Budget	$200,000	Approved DOE Share	$200,000
Obligated DOE Funds	$200,000	Cost Share	$194,600
Remaining Obligation	$0		
Unpaid Balance	$76,439	**TOTAL PROJECT**	**$394,600**

Project Period: 8/15/02-8/15/04

TECHNICAL PERFORMANCE
DE-FG36-02GO12053
Heliocentric
High Energy-Density Double-Layer Capacitor Energy Storage for Photovoltaic Systems

PROJECT SYNOPSIS

Heliocentric has developed a new energy storage technology, the High Energy-Density Double Layer Capacitor (HDLC) that addresses problems associated with energy storage in photovoltaic systems. The primary goal is to scale-up and demonstrate commercial-scale HDLC prototypes, above 1 kWh of packaged capacity, which meet the functional requirements in storage-moderated stand-alone, dispersed, and distributed energy systems. The key objectives include further development and improvements in: 1) The electrode composite, with focus on increasing scale, limiting and reducing impurities, and optimizing capacity; 2) The trilaminate composite, with focus on intralaminate bonding and bond conductivity; 3) The housing, with focus on sealing, cell balancing, permeability, and materials ratio; and 4) Parameterization of the HDLC variables, with focus on electrochemical, electro-photovoltaic, and economic assessments and their portability to cost-effective manufacture and commercial feasibility. The new double-layer capacitor achieves energy densities equivalent to lead-acid batteries while dramatically improving upon round-trip energy efficiency, cycle life, available capacity, autonomy, maintenance requirements, environmental life-cycle, and embodied energy.

The HDLC's improved energy storage characteristics promise to redefine photovoltaic system performance, reducing embodied energy by 6110 kBtu/kWh C^{o} and lowering photovoltaic system life-cycle cost per kilowatt-hour by 3–5 times. It also Improves in-system round-trip energy efficiency by 29–34%, and has a 40–60% greater available capacity than lead-acid batteries. The cycle-life is 1000 times greater than competitive technologies with no maintenance requirements, and is composed of environmentally safe carbon-based chemistry constructed from agricultural waste products that replaces lead-acid battery systems.

SUMMARY OF TECHNICAL PROGRESS

Heliocentric has progressed well focusing on refining manufacturing processes, building larger scale cells, and preparing to build larger-scale bipolar stacks. Accomplishments during the reporting period include:

- Built an automated prototype bipolar stack manufacturing machine
- Built scaled-up packaged cells
- Worked with manufacturer on volume cost estimates
- Initiated the development of lower-cost carbon electrodes materials and processing
- Conducted battery market research
- Submitted technology patents
- Screened more carbon electrode materials for performance and continued analysis of electrode performance test data
- Developed a new method of constructing test electrodes that is less expensive and less energy/time intensive

SUMMARY OF PLANNED WORK

During the next reporting period, Heliocentric plans to:

- Build bipolar stack prototypes using new automated machinery
- Further develop high energy density low cost carbons for electrodes
- Further develop their business plan and pursue (and secure) follow-on funding
- Perform thorough manufacturing cost analysis by working with suppliers and manufacturing partners

PROJECT ANALYSIS

Heliocentric is on track to complete the proposed tasks by 9/30/04. They have approximately 38% of DOE funds remaining, but will exceed their cost share by 4% (due mostly to the addition of a task not originally proposed in the SOO to develop electrolytes and funded by Heliocentric). The crux of the project is two-fold: 1) the efficacy of the new battery, and 2) the efficiency of the manufacturing process. These two issues will be addressed in Task 6 (test and parameterize) which is currently only 33% complete.

ACTION REQUIRED BY DOE HEADQUARTERS -

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK
02GO12053
Heliocentric
High Energy-Density Double-Layer Capacitor Energy Storage for Photovoltaic Systems

Detailed Task descriptions

Task 1. Complete Equipment Assembly

Procurement of higher power test equipment, a large furnace, and materials necessary for building and testing large-capacity HDLCs. New fabrication and test fixtures to accommodate high-capacity HDLCs and update process, data acquisition systems, and test software to integrate with new equipment will be built.

Task 2. Demonstrate Scaled-up Prototype Cells

Scale-up electrode composites, increasing scale while maintaining structural integrity, testing different precursors while integrating the large-scale electrode into functional monocells, testing different electrode/electrolyte pairs and performing electrochemical analysis.

Task 3. Develop Trilaminate Composite

Divider materials will be compounded and formed based on foundation experiments. Tests will be performed for different chemical, mold-in-place, and heat welding methods of lamination. Intralaminate bonding and bond conductivity will be tested.

Task 4. Develop Housing Assembly

Build and mold envelopes; experiment and test morphology, sealing, permeability, and materials ratio; integrate trilaminate into stacks, analyze electrochemical and mechanical performance. Improvements on the design based on tests results will be made, and they will implement appropriate passive or active cell balancing methods.

Task 5. Optimize Design

Optimization will be conducted for electrode compounding, processing, and materials, focusing on limiting impurities and optimizing capacity. Characterization of samples will be done using laboratory techniques such as x-ray spectroscopy, secondary ion mass spectrometry, thermogravimetric analysis, electron microscopy, and in-cell electrochemical analysis. Electrode improvements and results of the test plan will be folded into the design.

Task 6. Test and Parameterize

Results will be used to refine the test plan, adapt the test software using new data, and refine PV-HDLC interaction and economic models. Also the stacks will be tested, feeding back data into optimizing the design.

Task 7. Project Management and Reporting

Heliocentric will write semi-annual reports on milestone results and project progress, as well as a final report.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-02GO12053 Heliocentric

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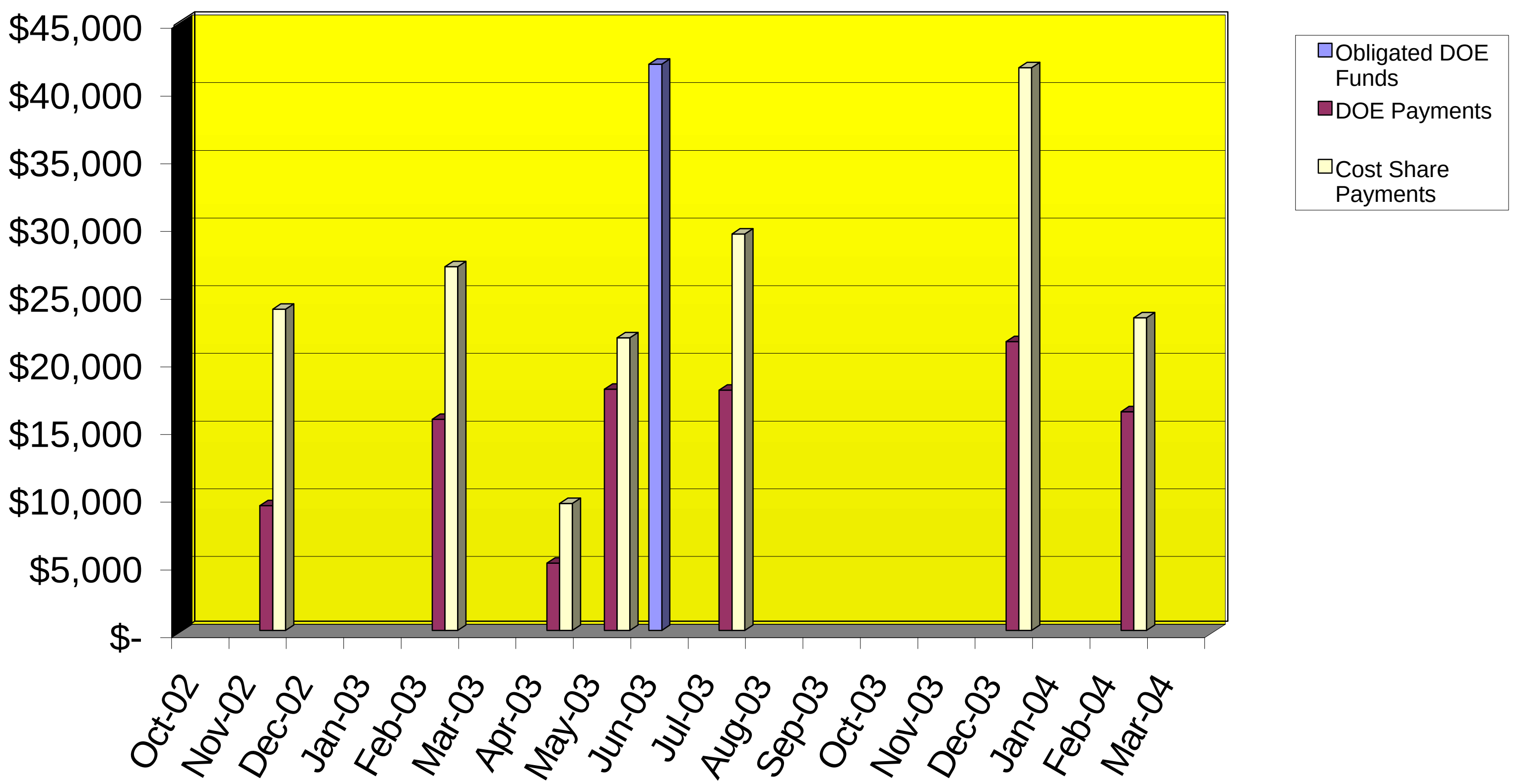

	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$41,834	$0	$0	$0
DOE Payment	$0	$9,215	$0	$0	$15,590	$0	$4,982	$17,815	$0	$17,754	$0	$0
Cost Share Payment	$0	$23,740	$0	$0	$26,875	$0	$9,377	$21,627	$0	$29,276	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$158,166	$200,000
DOE Payment	$0	$0	$21,352	$0	$16,160	$0	$20,694	$123,561
Cost Share Payment	$0	$0	$41,569	$0	$23,090	$0	$2,540	$178,094

Approved DOE Budget:	$200,000
Approved Cost Share Budget:	$194,600
Total Project Budget:	$394,600

* Prior Fiscal Years

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ID	Task Name	Start	Finish
1	Complete equipment assembly	Mon 9/30/02	Mon 3/24/03
2	Develop electrolytes	Mon 2/10/03	Mon 12/1/03
3	Demonstrate scaled-up prototype cells	Fri 7/4/03	Wed 2/4/04
4	Develop trilaminate composite	Fri 8/1/03	Mon 9/1/03
5	Develop housing assembly	Mon 12/2/02	Wed 6/30/04
6	Optimize design	Fri 3/5/04	Thu 8/5/04
7	Test and parameterize	Mon 7/5/04	Fri 9/3/04
8	Project complete - submit required reports	Mon 9/30/02	Thu 9/30/04