2. Energy Storage Technologies

Energy storage technologies, especially batteries, are critical enabling technologies for the development of advanced, fuel-efficient, light- and heavy-duty vehicles, which are critical components of the U.S. Department of Energy's (DOE's) Energy Strategic Goal: "to protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy." The program's vision supports the development of durable and affordable advanced batteries covering the full range of vehicle applications, from start/stop to full-power hybrid electric, electric, and fuel cell vehicles. Much of this work will transfer to energy storage for heavy hybrid vehicles as well. Energy storage research aims to overcome specific technical barriers that have been identified by the automotive industry together with the Vehicle Technologies Program. These include cost, performance, life, and abuse tolerance. These barriers are being addressed collaboratively by the DOE's technical research teams and battery manufacturers.

In August 2009, the Department announced the selection of 26 projects totaling $1.5 billion for developing the manufacturing capacity of advanced batteries and advanced battery components. ARRA-funded energy storage technology activities support the establishment of a domestic capacity for batteries, which will help develop the market for advanced electric drive vehicles. Twenty ARRA activities are for developing the manufacturing capacity for advanced batteries and battery components, including the production of lithium-ion cells and polymers; production of polymer separators and other components; and battery recycling. Six additional activities are for the creation of new battery facilities, or the upgrading of existing facilities, that will enable researchers to test batteries, improve battery safety, and increase the throughput of specialized thermal testing. For this merit review, these 26 ARRA-funded projects were not evaluated during the 2011 Annual Merit Review.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1 to 4)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A summary table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
PHEV and LEESS Battery Cost Assessment	Barnett, Brian (TIAX LLC)	2-6	2.88	3.13	2.00	2.63	2.86
A High-Performance PHEV Battery Pack	*Alamgir, Mohamed (LG Chem, Michigan)*	*2-10*	*3.33*	*3.17*	*2.50*	*3.00*	*3.10*
USABC HEV and PHEV Programs	*Yoon, Steven (A123Systems)*	*2-13*	*3.17*	*3.17*	*2.00*	*2.83*	*2.98*
JCS PHEV System Development-USABC	*Engstrom, Scott (Johnson Controls-Saft)*	*2-15*	*3.17*	*3.33*	*3.33*	*3.00*	*3.25*
Advanced Cathode Material Development for PHEV Lithium Ion Batteries	*Gardner, Jamie (3M)*	*2-18*	*3.67*	*3.83*	*3.67*	*3.33*	*3.71*
USABC Battery Separator Development	*Smith, Ron (Celgard)*	*2-20*	*3.00*	*2.83*	*2.83*	*2.80*	*2.87*
Multifunctional, Inorganic-Filled Separators for Large Format, Li-ion Batteries	*Pekala, Richard (Entek)*	*2-23*	*3.67*	*3.50*	*3.83*	*3.50*	*3.58*
Hybrid Nano Carbon Fiber/Graphene Platelet-Based High-Capacity Anodes for Lithium Ion Batteries	*Jang, Bor (Angstron Materials)*	*2-25*	*3.80*	*3.20*	*2.80*	*3.20*	*3.30*
New High-Energy Nanofiber Anode Materials	*Zhang, Xiangwu (NC State/NLE)*	*2-27*	*3.33*	*3.83*	*3.50*	*3.33*	*3.60*
Stabilized Lithium Metal Powder, Enabling Material and Revolutionary Technology for High Energy Li-ion Batteries	*Yakovleva, Marina (FMC)*	*2-29*	*3.29*	*3.43*	*2.00*	*2.86*	*3.14*
Protection of Li Anodes Using Dual Phase Electrolytes	*Mikhaylik, Yuriy (Sion Power)*	*2-32*	*3.43*	*3.29*	*2.86*	*2.71*	*3.20*
Process for Low Cost Domestic Production of LIB Cathode Materials	*Thurston, Anthony (BASF)*	*2-35*	*3.00*	*2.83*	*2.67*	*2.67*	*2.83*

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Engineering of High Energy Cathode Materials	*Amine, Khalil (Argonne National Laboratory)*	*2-38*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
New High Energy Gradient Concentration Cathode Material	*Amine, Khalil (Argonne National Laboratory)*	*2-40*	*2.00*	*3.00*	*3.00*	*3.00*	*2.75*
Design and Evaluation of Novel High Capacity Cathode Materials	*Johnson, Christopher (Argonne National Laboratory)*	*2-42*	*3.00*	*3.00*	*2.00*	*3.00*	*2.88*
Evaluation of Li2MnSiO4 Cathode	*Belharouak, Ilias (Argonne National Laboratory)*	*2-43*	*2.00*	*2.00*	*2.00*	*2.00*	*2.00*
Development of High-Capacity Cathode Materials with Integrated Structures	*Kang, Sun-Ho (Argonne National Laboratory)*	*2-44*	*4.00*	*3.00*	*3.00*	*4.00*	*3.38*
Developing High Capacity, Long Life Anodes	*Amine, Khalil (Argonne National Laboratory)*	*2-46*	*2.00*	*2.00*	*3.00*	*2.00*	*2.13*
Develop Improved Methods for Making Intermetallic Anodes	*Jansen, Andrew (Argonne National Laboratory)*	*2-48*	*2.00*	*2.00*	*3.00*	*2.00*	*2.13*
Novel Electrolytes and Additives for PHEV Applications	*Abraham, Dan (Argonne National Laboratory)*	*2-49*	--	--	--	--	--
High Voltage Electrolytes for Li-ion Batteries	*Jow, Richard (Army Research Laboratory)*	*2-50*	--	--	--	--	--
Development of Advanced Electrolytes and Electrolyte Additives	*Zhang, Zhengcheng (Argonne National Laboratory)*	*2-51*	--	--	--	--	--
Development of Novel Electrolytes for Use in High Energy Lithium-Ion Batteries with Wide Operating Temperature Range	*Smart, Marshall (Jet Propulsion Laboratory)*	*2-52*	--	--	--	--	--
Novel Phosphazene-based Compounds for Enhancing Electrolyte Stability and Safety of Lithium-ion Cells	*Gering, Kevin (Idaho National Laboratory)*	*2-53*	--	--	--	--	--
Screening of Electrode Materials & Cell Chemistries and Streamlining Optimization of Electrodes	*Lu, Wenquan (Argonne National Laboratory)*	*2-54*	*3.50*	*3.00*	*3.50*	*3.00*	*3.19*
Scale-up and Testing of Advanced Materials from the BATT Program	*Battaglia, Vince (Lawrence Berkeley National Laboratory)*	*2-56*	*3.00*	*2.00*	*3.00*	*3.00*	*2.50*
Fabricate PHEV Cells for Testing & Diagnostics	*Jansen, Andrew (Argonne National Laboratory)*	*2-57*	*3.33*	*3.67*	*3.67*	*3.00*	*3.50*
Electrochemistry Cell Model	*Dees, Dennis (Argonne National Laboratory)*	*2-59*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Diagnostic Studies on Li-Battery Cells and Cell Components	*Abraham, Dan (Argonne National Laboratory)*	*2-61*	*3.67*	*3.33*	*3.33*	*3.00*	*3.38*
Electrochemistry Diagnostics of Baseline and New Materials	*Kostecki, Robert (Lawrence Berkeley National Laboratory)*	*2-63*	*3.33*	*3.33*	*3.33*	*2.67*	*3.25*
Diagnostic Studies to Improve Abuse Tolerance and Life of Li-ion Batteries	*Yang, Xiao-Qing (Brookhaven National Laboratory)*	*2-65*	*3.50*	*3.50*	*3.50*	*3.50*	*3.50*
Develop and Evaluate Materials and Additives that Enhance Thermal and Overcharge Abuse	*Amine, Khalil (Argonne National Laboratory)*	*2-67*	*3.50*	*3.00*	*3.00*	*3.00*	*3.13*
Evaluation of Abuse Tolerance Improvements	*Orendorff, Chris (Sandia National Laboratories)*	*2-69*	*3.00*	*3.00*	*3.50*	*3.00*	*3.06*
Overcharge Protection for PHEV Batteries	*Chen, Guoying (Lawrence Berkeley National Laboratory)*	*2-71*	*3.00*	*2.50*	*3.00*	*3.00*	*2.75*

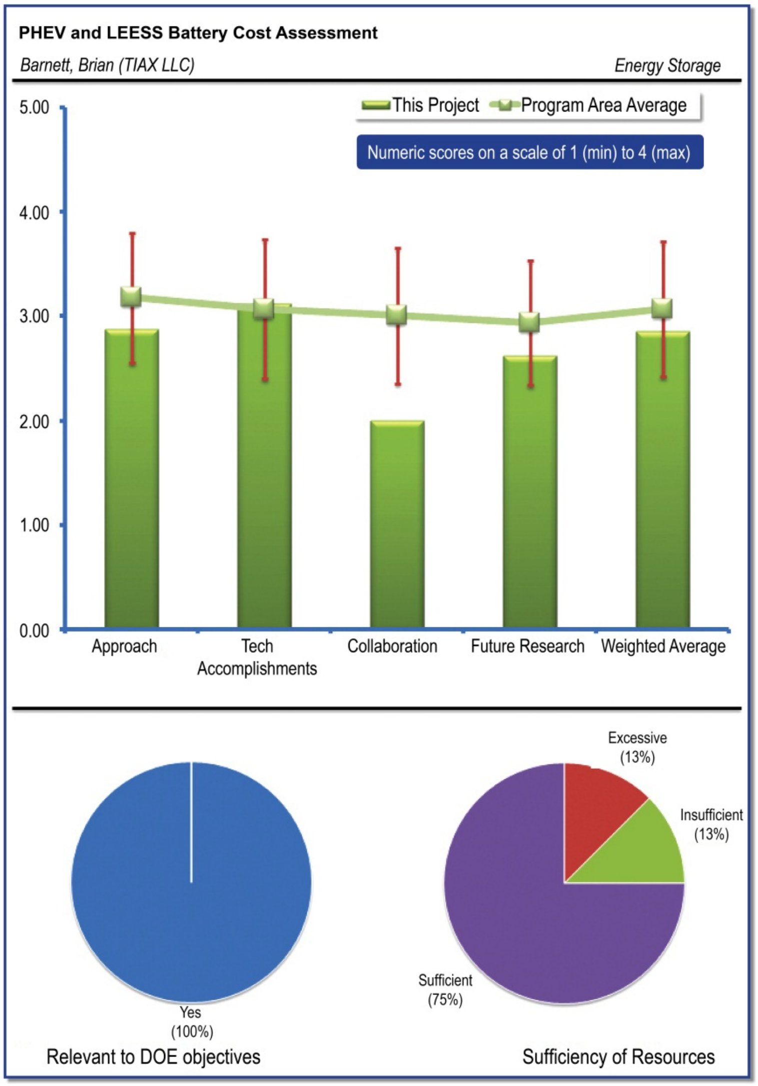
Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
High Energy Density Ultracapacitors	*Smith, Patricia (Naval Surface Warfare Center)*	*2-73*	*3.43*	*3.00*	*3.29*	*3.00*	*3.14*
In-situ characterization and diagnostics of mechanical degradation in electrodes	*Daniel, Claus (Oak Ridge National Laboratory)*	*2-75*	*2.67*	*2.67*	*3.33*	*2.33*	*2.71*
Low Cost SiOx-Graphite and High Voltage Spinel Cathode	Zaghib, Karim (Hydro-Quebec)	2-77	3.00	3.00	3.00	2.75	2.97
Design and Evaluation of Novel High Capacity Cathode Materials	Thackeray, Michael (Argonne National Laboratory)	2-79	3.75	3.25	3.50	3.25	3.41
The Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides	Whittingham, M. Stanley (SUNY-Binghamton)	2-81	3.00	3.00	3.33	3.00	3.04
STABILIZED SPINEL AND POLYANION CATHODES	Manthiram, Arumugam (University of Texas at Austin)	2-83	3.00	2.67	2.33	3.00	2.75
Olivines and Substituted Layered Materials	Doeff, Marca (Lawrence Berkeley National Laboratory)	2-85	4.00	3.50	3.00	3.00	3.50
First Principles Calculations and NMR Spectroscopy of Electrode Materials	Ceder, Gerbrand (University of Cambridge)	2-86	4.00	3.00	4.00	3.50	3.44
Development of High Energy Cathode Materials	Zhang, Jason (Pacific Northwest National Laboratory)	2-87	2.80	3.00	2.60	3.20	2.93
Inexpensive, Nonfluorinated (or Partially Fluorinated) Anions for Lithium Salts and Ionic Liquids for Lithium Battery Electrolytes	Henderson, Wesley (North Carolina State University)	2-89	2.75	2.75	2.00	2.25	2.59
Molecular dynamics simulation and ab intio studies of electrolytes and electrolyte/electrode interfaces	Smith, Grant (University of Utah)	2-91	3.00	3.33	3.67	3.00	3.25
In situ Characterizations of New Battery Materials and the Studies of High Energy Density Li-Air Batteries	Yang, Xiao-Qing (Brookhaven National Laboratory)	2-93	4.00	4.00	4.00	3.67	3.96
Search for New Anode Materials	Goodenough, John (University of Texas at Austin)	2-95	3.33	3.33	2.67	3.33	3.25
Electrolytes - Advanced Electrolyte and Electrolyte Additives	Amine, Khalil (Argonne National Laboratory)	2-96	4.00	4.00	3.00	3.00	3.75
Development of Electrolytes for Lithium-ion Batteries	Lucht, Brett (University of Rhode Island)	2-97	3.00	3.00	3.33	3.00	3.04
Bifunctional Electrolytes for Lithium-ion Batteries	Scherson, Daniel (Case Westerm Reserve University)	2-99	3.00	3.00	2.67	2.67	2.92
Studies on Oxide Cathode Crystals	Chen, Guoying (Lawrence Berkeley National Laboratory)	2-101	3.00	3.33	3.33	2.67	3.17
Investigation of critical parameters in Li-ion battery electrodes	Cabana, Jordi (Lawrence Berkeley National Laboratory)	2-103	3.00	3.50	3.25	2.75	3.25
New Electrode Designs for Ultrahigh Energy Density	Chiang, Yet-Ming (Massachusetts Institute of Technology)	2-105	3.00	3.00	3.33	3.33	3.08
Fundamental Approach to Electrode Fabrication and Failure Analysis	Battaglia, Vince (Lawrence Berkeley National Laboratory)	2-107	2.50	2.00	3.50	2.50	2.38
Modeling-Thermo-electrochemistry, Capacity Degradation and Mechanics with SEI Layer	Sastry, Ann Marie (University of Michigan)	2-109	3.50	3.50	1.50	3.00	3.19

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
The Role of Surface Chemistry and Bulk Properties on the Cycling and Rate Capability of Lithium Positive Electrode Materials	Shao-Horn, Yang (Massachusetts Institute of Technology)	2-110	3.50	4.00	3.50	3.50	3.75
Interfacial Processes - Diagnostics	Kostecki, Robert (Lawrence Berkeley National Laboratory)	2-112	3.25	3.75	3.25	3.50	3.53
Performance and Degradation Modeling of Batteries	Srinivasan, Venkat (Lawrence Berkeley National Laboratory)	2-114	3.00	3.00	2.67	3.00	2.96
Polymers For Advanced Lithium Batteries	Balsara, Nitash (Lawrence Berkeley National Laboratory)	2-116	2.50	3.00	1.50	2.50	2.63
Electrolytes - R&D for Advanced Lithium Batteries. Interfacial Behavior of Electrolytes	Kerr, John (Lawrence Berkeley National Laboratory)	2-117	3.00	3.00	3.00	3.00	3.00
Advanced Binder for Electrode Materials	Liu, Gao (Lawrence Berkeley National Laboratory)	2-119	3.50	2.50	3.50	2.50	2.88
ATOMISTIC MODELING OF ELECTRODE MATERIALS	Persson, Kristin (Lawrence Berkeley National Laboratory)	2-121	2.33	2.00	2.33	2.33	2.17
Intercalation Kinetics and Ion Mobility in Electrode Materials	Daniel, Claus (Oak Ridge National Laboratory)	2-123	3.33	2.67	2.33	2.33	2.75
In-Situ Electron Microscopy of Electrical Energy Storage Materials	Unocic, Ray (Oak Ridge National Laboratory)	2-125	3.67	3.33	3.33	3.00	3.38
Diagnostic Testing and Analysis Toward Understanding Aging Mechanisms and Related Path Dependence	*Gering, Kevin (Idaho National Laboratory)*	*2-127*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Overview and Progress of United States Advanced Battery Research (USABC) Activity	Snyder, Kent (Ford Motor Company)	2-129	3.33	3.17	3.83	3.00	3.27
Progress of DOE Materials and Manufacturing Process R&D Grants	Johnson, Chris (National Energy Technology Laboratory)	2-132	3.29	3.43	3.43	3.29	3.38
Computer-Aided Engineering for Electric Drive Vehicle Batteries (CAEBAT)	*Pesaran, Ahmad (National Renewable Energy Laboratory)*	*2-135*	*4.00*	*3.60*	*3.80*	*3.60*	*3.73*
Electrolytes and Separators for High Voltage Li Ion Cells	Angell, Austen (Arizona State University)	2-137	2.80	2.60	2.60	2.20	2.60
Integrated Lab/Industry Research Project at LBNL	Cabana, Jordi (Lawrence Berkeley National Laboratory)	2-139	3.25	3.00	3.75	2.75	3.13
Integrated Lab/Industry Research Project	Vaughey, Jack (Argonne National Laboratory)	2-141	3.75	2.75	3.75	3.25	3.19
Hard Carbon Materials for High-Capacity Li-ion Battery Anodes	Dai, Sheng (Oak Ridge National Laboratory)	2-143	2.40	2.00	1.20	2.00	2.00
Carbon/Sulfur Nanocomposites and Additives for Li/Sulfur Batteries	Liang, Chengdu (Oak Ridge National Laboratory)	2-146	2.75	2.75	1.50	2.75	2.59
Studies on the Local State of Charge (SOC) and Underlying Structures in Lithium Battery Electrodes	Nanda, Jagjit (Oak Ridge National Laboratory)	2-148	3.00	2.67	2.67	2.00	2.67
Perfluoro Aryl Boronic Esters as Chemical Shuttle Additives	*Hunt, Adam (Enerdel)*	*2-150*	*3.29*	*3.00*	*3.29*	*3.29*	*3.14*
Numerical and Experimental Investigation of Internal Short Circuit in a Li-ion Cell	*Kim, Ge-Heon (National Renewable Energy Laboratory)*	*2-153*	*3.60*	*3.60*	*3.80*	*3.40*	*3.60*

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Battery Thermal Modeling and Testing	*Smith, Kandler (National Renewable Energy Laboratory)*	*2-155*	*4.00*	*4.00*	*4.00*	*3.75*	*3.97*
PHEV Battery Cost Assessment	Gallagher, Kevin (Argonne National Laboratory)	2-157	3.38	3.00	3.00	3.38	3.14
Novel Composite Cathode Structures	*Johnson, Christopher (Argonne National Laboratory)*	*2-160*	*3.00*	*3.50*	*3.00*	*3.00*	*3.25*
Overall Average			3.18	3.07	3.01	2.94	3.07

Note: Italics denote poster presentations.

PHEV and LEESS Battery Cost Assessment: Barnett, Brian (TIAX LLC) – es001



Reviewer Sample Size

This project had a total of eight reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive, but with a few suggestions for improvement. One reviewer commented that the project provides battery cost comparisons and observations which may be useful on a relative basis. Another person had similar comments about the importance of cost, stating that the cost analysis of the batteries for profitability is very important. Another reviewer reinforced that cost is a key issue in the commercialization of new technology for EV, HEV and PHEV. They added that to be successful, a business must be profitable. This careful study provides the basic business information needed to construct a business plan for success in building lithium (Li)-ion batteries for transportation. Another person had detailed comments, affirming that this project is quite relevant to the overall DOE goal of partly replacing the conventional vehicles with hybrid or electric vehicles to minimize the national dependence on petroleum resources. The (high) cost of batteries for PHEVs is a serious issue from the manufacturers' perspective and thus requires considerable attention. The overall objective is to develop cost assessments based on appropriate models, for various chemistries and designs to identify the specific technology areas that need to be improved to mitigate the high costs. These studies, if successful, will assist in overcoming the cost barrier for Li-ion batteries for vehicular applications. The reviewer concluded by observing that successful implementation of the battery technologies in vehicular applications would in turn reduce the petroleum consumption, and pave the way towards petroleum replacement. One commenter explained that cost is the biggest barrier to the introduction of hybrid vehicle technology capable of providing substantial reduction in vehicular petroleum consumption. The reviewer felt that this work provides useful information on the impact of recent lithium ion battery technology on cost; both the absolute and relative information is useful. Another reviewer felt that the project will provide the appropriate information showing the cost benefits of using electrochemical electrical energy storage systems to replace petroleum for use in vehicle transportation. The reviewer also agreed that the project as outlined will also provide helpful directional information for choosing the optimum type and size system for automotive OEMs to significantly improve fuel economy. Another person stated that the cost models, if realistic, provide some forward business planning necessary for product development and marketing. It would be great to see a detailed comparison of variables between the TIAX model and the Santini/Gallager/Nelson model. The final person emphasized that the cost assessment is crucial in adequately addressing the DOE objectives and identifying clear limitations and challenges of Li- ion technology to fully exploit their potentialities in real applications. The reviewer added that on the other hand, the specific project objectives are not well described and commented with few information about budget and effective efforts.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reactions to this question were mixed, with most being positive. One person stated that the approach is realistic and complete. Another person pointed out that the approach involves the comparison of LEESS requirements with cell count of Prius IV nickel-metal hydride (NiMH) cells required to meet requirements is a useful observation and metric on a relative basis. One reviewer applauded the carefully thought approach which includes all of the elements and the parameters involved in commercial production. The reviewer added that the results can be trusted; Dr. Barnett has significant experience in this area (20 years or more) and understands the nuances of building a cost structure for a new product. Another person had very detailed comments, stating that in the past, TIAX performed the cost assessment for different chemistries in PHEV applications, which led to the expected conclusions that materials with high power and long life, electrodes with less surface area and methods facilitating rapid electrode coating help the cost. In the present work, a similar assessment has been made for LEESS applications, which have higher power needs, with three different approaches: i) parametric analysis of different Li-ion systems; ii) experimental characterization of different chemistries; and iii) extrapolation from the performance data of commercial systems. The reviewer added that the results indicate that, unlike for PHEVs, the majority of the cost comes not from cell materials, but from materials in the battery components (pack electronics) and cell casing, and the cell formation and aging processes, such that reducing the number of cells can lead to lower overall pack cost. Though not entirely unexpected from the increased power needs of the LEESS, the present analysis clearly provides some insight into the cost components. The reviewer concluded by asserting that the project is well-designed and integrated with other developments in materials and cell fabrication. One person commented that the selected approach is adequate in the definition and development of cost models and cell design determination, but it is questionable in including an internal coin cell preparation and testing for model validation. The reviewer felt that this approach strongly reduces the general applicability of the developed model to the rest of the Subprogram, because apparently there is no connection with the chemistries, cells, modules, and battery designs largely investigated in other projects. Another reviewer said that the cost analysis work seems logical and well organized and based on sound assumptions and methods. The reviewer pointed out that the assumed production volume is not indicated clearly. The reviewer also noted that the effect of production volume and the dependence of cost on production maturity are not explicitly addressed. The reviewer concluded by stating that it would be useful to estimate when these costs would be achieved. Another reviewer felt that the amount of material presented within the time restraints was excellent and that the work seems to be proceeding in a way that would provide useful information to the various automotive OEMs. The reviewer stated that they would like to see a summary slide showing how the different cell/system parameters clearly drive the system toward meeting the performance requirements relative to the cost implications. The reviewer also remarked that system voltages and current limitations should be included as they can/will drive chemistry selections, system size, cell count, and consequently system cost. Another reviewer offered that for high power-to-energy ratio the supercapacitors are more important and may meet the U.S. Advanced Battery Consortium (USABC) cost goals. The reviewer added that even though the approach is well thought out, it lacks the analysis for LEESS based on high power to energy ratio. The reviewer concluded by offering that supercapacitor may meet the USABC cost goals for the system. The final reviewer cautioned that specific use of coin cells for power estimation and area-specific impedance (ASI) determination may lead to significant inaccuracies in values.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments to this question were mixed. One person commented that the work shows good progress in state of the art Li-ion batteries towards cost goals and shows design approaches to reduce costs. The reviewer thought that there was very good insight on how design effects cost for PHEV and LEESS cases. The reviewer also thought that good credible tools developed both for estimates and relationships of variables effecting costs for complicated applications. Another person offered that this is the first time a study has been conducted with this scope. They added that the study is based on facts and not wishful hope that all will be okay. The reviewer added that this study is one of the basic needs for a viable business plan. The reviewer stated that the other need is a business model with markets, penetration path and profit-loss calculations. The reviewer concluded by remarking that once the costs are known, the credible business plan can be constructed. Another reviewer had detailed comments, stating that reasonably good progress has been achieved in carrying out the cost analysis for the batteries for LEES applications and the results are not contrary to the expectations, for a power-based application. In short, a chemistry that can support high power loads will have less electrode area and less number of cells, and thus is a preferred option. The project is well designed, but the approach is not as relevant and robust. It is based on in-house test data from the coin cells (far from reality) and the values for the electrode loadings, fade rates and SOC ranges are rather arbitrary and may not relate to those adopted in the industry. The loading, for example, may not be uniform across different chemistries, differing in tap densities. The coin cell data are particularly suspect, especially with the impact electrolyte conductivity had on the power characteristics, and it is hard to predict the behavior of large capacity cells form the coin cell data. Also, there may be several variations from the materials and the electrode design parameters that TIAX used for these cells. The reviewer concluded by suggesting that a more direct collaboration with the manufacturers of one or two representative chemistries in terms of using their electrodes/cells data will add credibility to these analyses and to the conclusions from this study. Another reviewer had similar comments, stating that the technical achievements are interesting and valuable, but only of limited acceptability because they are strongly conditioned by the approach restricted to the in-house cells. The final reviewer felt that a great deal of work was done in the selected areas. However, the reviewer mentioned that they would like to have seen more costing information on the electrolyte and separator costs as they may contribute more significantly to the cell cost depending on the chemistry. It was not clear to the reviewer that this issue was fully addressed. The reviewer concluded by hoping that the final program outcome will provide a clear "overall" system cost range for the various current cell technologies, with respect to the different cathode material.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments to this question revealed that there was limited, if any, collaboration. One person stated that the presenter did not elaborate upon this in the PowerPoint presentation. Another person noted that in order to get the information for the study, Dr. Barnett has had to establish a trust in the investigator to present the results carefully and protect proprietary information. One commenter stated that there are no collaborations mentioned in the presentation, though they would presume that the principle investigator (PI) would have had some discussions/interactions with the battery manufacturers or other researchers on the material properties, electrode design aspects, etc. Another reviewer agreed, stating that the collaboration is not clearly addressed and is considered extremely important with need for some coordination with other projects for improving expected results. Another reviewer mentioned that there was no indication of collaboration or coordination with other institutions. This reviewer suggested that particularly, there could have been some outside measurements for verification of power vs. electrode loading from national labs and/or battery developers. Another reviewer had similar comments that they did not see any significant collaboration with other partners. The reviewer emphasized that they would like to have seen some collaboration with others to support larger format cell builds. The final reviewer commented that it was not obvious who is validating the database and models because the process is held confidential.

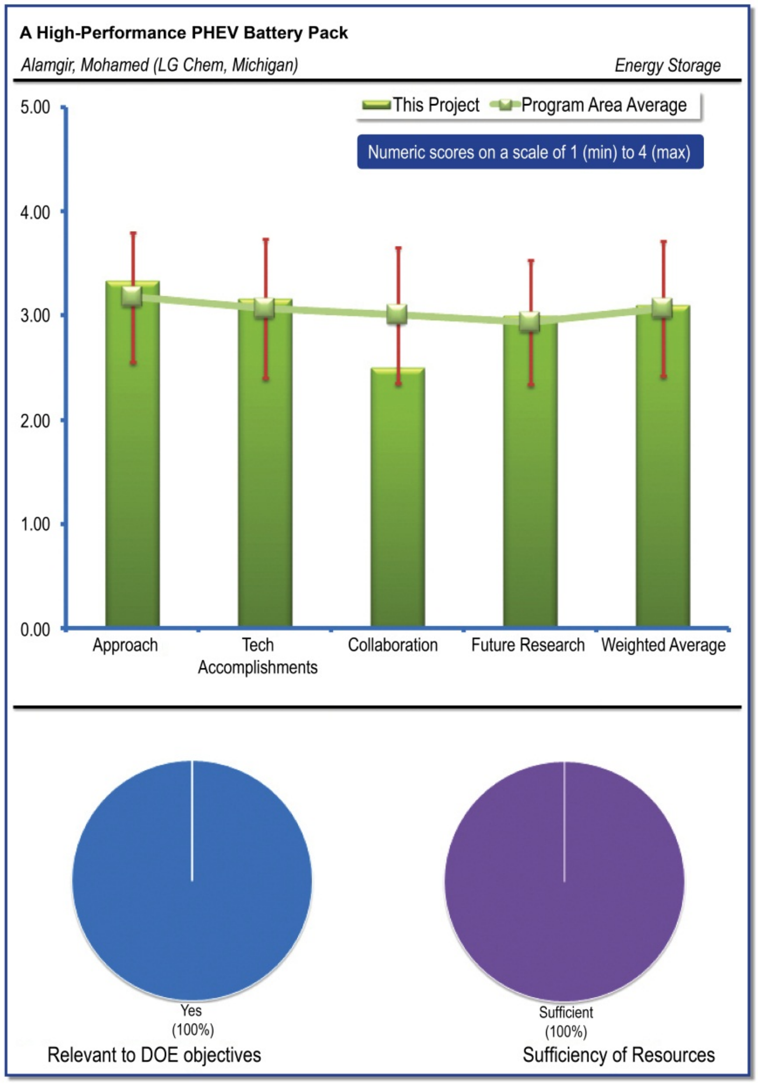
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer comments state that the future plans are not clear. One person observed that the proposed research for Fiscal Year (FY) 11 is to update the models and databases to place all assessments in a common basis and to investigate the tradeoffs between HEV performance, fuel economy, and battery cost. Another reviewer commented that each new material and process for making materials and cell assembly will require a new calculation on cost. The reviewer felt that this model should be able to accomplish updated costing with a minimum of effort, provided only minor changes in cell assembly processes are made; once constructed, the model can be updated on a regular basis. One reviewer commented that the program outlines future work for the LEESS program in extremely broad terms; more definition is needed. The reviewer added that the program does not say anything about the future PHEV effort. The reviewer concluded by stating that it was felt that one future plan for the PHEV program should be similar to the very broad future plan for the LEESS program - investigate the tradeoffs for the various PHEV systems, with respect to fuel economy and battery cost. Another person asserted that it was not clear if the running activities are the final ones, or there is a lack of information about prosecution of work, which is not adequately analyzed with extension to lithium commercial systems. Another commenter stated that the future work description was minimal and vague. This reviewer also felt that information on the project start and end date timeline was missing, to the point that they were unclear whether the contract had ended or not. The reviewer concluded by requesting that if there will be new projects, that more info on future work would be useful. One person asked whether the 2014/2015 timeframe assesses a time far enough forward for OEM projections (should be focused 5-10 year forward). The final person commented that the future research continue based on the perception of the successful last two years; however, the validation of success is lacking.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Comments all pointed to the fact that the presenter did not provide sufficient information. One reviewer commented that the lack of information made it hard to give clear justification to this criterion. Another person agreed with this assessment, stating that resources and funding for the project were not disclosed in the presentation. One commenter indicated that the budget information is not provided here, but recalled from discussions at the meeting that it is approximately $150,000; if so, the resources are adequate for the planned effort. Another reviewer also had similar comments, explaining that budget and cost information is missing. The reviewer criticized that omitting this for only this project makes it look like there is some special relationship or favoritism to this contractor. The reviewer concluded by stating that verbally it was stated the cost was $150,000 per year; if so, this was actually a great value for the investment. Another reviewer commented that based on the scope of the study the resources provided by DOE are marginal; therefore, the reviewer was sure that TIAX provided considerable support in the gathering of the data. The final person commented that TIAX appears to have the needed expertise and financial support to accomplish stated and recommended goals in the program’s time frame.

A High-Performance PHEV Battery Pack: Alamgir, Mohamed (LG Chem, Michigan) – es002



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive. One person stated that the project clearly addresses key elements for Li batteries functional to the DOE objectives. Another person agreed that the project is aimed at improvements in performance and cost of batteries for PHEVs that can substantially reduce petroleum usage for passenger vehicles. The reviewer added that the work spanned battery cells, modules, and packs addressing energy, power, life, and safety performance. Another person had detailed comments, describing that this is a project, ongoing for the last few years, initially aimed at developing a PHEV-10 mile battery pack system based on Li-ion cells with 5,000 cycle-life and 15-year life, as targeted by USABC, and accompanied by a highly efficient thermal management system. The reviewer explained that the current objectives are to develop cells for a PHEV with a 40-mile range on a single charge (PHEV-40), using next generation high capacity cathode materials, to develop battery packs and to further optimize the thermal management system. The reviewer's comments concluded by affirming that the project objectives are quite in tune with the DOE goals of reduced greenhouse gas (GHG) emissions and petroleum consumption through the use of hybrid and electric vehicles. One commenter noted that LG Chem (LG) is a large company that supplies Li-ion batteries for use in powering EV, HEV and PHEV now under development. The reviewer stressed that successful deployment of the vehicles hinges on a viable source of high energy batteries. The final reviewer commented that battery and component development are necessary enablers to successful deployment. The separator advancements by LG have been essential for safety and tolerance abuse.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reactions to this question were mixed. One person was not clear on the approach or even what program was under review. The reviewer noted that three are covered included two that appear complete and one that just started this month, so they were not clear what we are supposed to be reviewing. The remaining reviewers did not hold this opinion. One person described that the design, construction, and production of flat, prismatic cells for incorporation into battery packs is essential for powering these PHEV vehicles. The reviewer concluded by stating that the design has been carefully qualified for performance as well as safety. Another commenter reported that the project has been well prepared and organized with focus on various key components of the Li battery. The reviewer felt that the project is well based on previous projects results and open issues. Another person observed that the approach is believed to be driven by the current production environment (GM); LG has shown significant gains in battery development in a short timeframe. The final reviewer had detailed comments, explaining that the approach is based on improving the cell performance characteristics by optimizing the composite cathode (spinel/layered), carbonaceous anode material, electrolyte composition, and more importantly a proprietary ceramic–reinforced separator in a laminated package cell deign. The spinel manganese oxide is a good choice to meet the life and cost target and the laminated packaging helps in improving the specific energy and reducing the cost, while the use of ceramic-reinforced separator will provide additional safety to the battery during any abuse. Thermal control of the battery pack through the circulation of chilled air is easy to implement and may be cost-effective as well. The reviewer concluded by stating that the overall project is well designed and well integrated with the materials developments, under the other DOE projects related to lithium batteries.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reactions to this question were mixed. One reviewer commented that they were unsure what was supposed to be reviewed. This reviewer added that however, in all cases, progress is not clearly presented. The reviewer concluded by suggesting that a USABC gap analysis would be a useful way of showing progress. One person reported that the results of previous projects are very good and the progress of the last project is still too limited. Another reviewer mentioned that LG provides batteries that are reliable, have high performance characteristics that are essential for the success of the PHEV in the U.S. market. One person had detailed comments, acknowledging that considerable improvements have been made from Gen 1 to Gen 3 cells in all the desired characteristics (i.e., cycle life, high temperature resilience and the low-temperature cranking) to meet the targets of the USABC program. It was difficult, however, to quantify in the absence of units on the graphs; possibly the relative improvements could have been mentioned in the charts. Likewise, it was difficult to gauge how well the specific energy (40 mile range) requirements have been met, in the absence of actual numbers for Watt hour (Wh)/kilogram (kg). The packs designed and delivered appear to meet the performance targets and are equipped with efficient thermal, and probably compatible, design based on circulating chilled air inside the battery. The reviewer added that the developed results in performance thus achieved here look quite promising and it is possible that further improvements in the specific energy and reduction in the cost of the thermal management will emerge from this effort that can benefit PHEV-40. The final reviewer remarked about the interesting comparison of air- vs. liquid-cooling; and asked how this refrigeration system is going to help meet the cost targets of <$200/kilowatt hour (kWh).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reactions to this question were mixed, with some reviewers stating there was no collaboration, while others felt the collaboration was good. One reviewer commented that the design, qualification and performance have been carried out in-house at LG. The suppliers of critical parts have worked alongside LG to arrive at the final design and the suppliers of critical electrode, electrolyte, and packaging assure a high quality product. Another person indicated that there is good ongoing collaboration with the National Laboratories in terms of testing and verifying the performance of the cells and packs emerging from this project, as well as the thermal management scheme developed here. Another reviewer, however, felt that the collaborations of the research community are well selected and appropriate. Probably, the type of effort with significant activities on materials, system engineering and cost reduction would require the involvement of materials producers and thermodynamic modeling & engineering contributions. The final reviewer stated that the work occurred all inside LG, but even though they are capable, this lacks the rationale of collaboration.

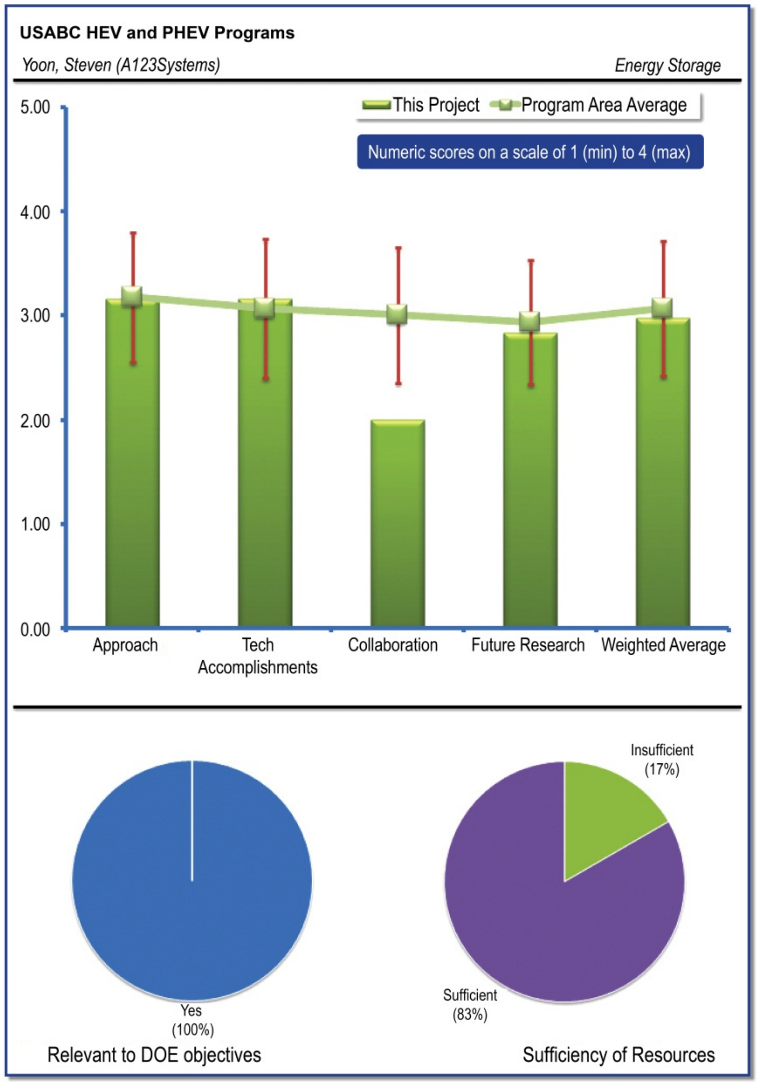
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reactions to this question were again mixed. One person stated that they were unclear about the future plans. Another reviewer reported that no future research plans were requested to the best of their knowledge. One commenter stated that future work is part of the presented project just started and it is relevant in terms of planning. The final person commented that the future plans include developing cathodes of higher specific energy to meet the needs of the PHEV-40 in terms of energy density and optimizing the thermal management system to reduce the overall cost of the battery packs. The reviewer concluded by stating that future work is thus planned in a logical manner and not many serious barriers are expected in this improvement for PHEV-40.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

All three reviewers to comment indicated the resources were sufficient. One person stated that the budget seems adequate. Another person explained that sufficient resources were provided to carry out the project. The final reviewer commented that the resources are adequate for this project to achieve the objectives.

USABC HEV and PHEV Programs: Yoon, Steven (A123Systems) – es003



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive. One person stated that the project provides the cells for 10- and 40 mile PHEV vehicles. Another person explained that the project is aimed at improvements in performance and cost of batteries for PHEVs that can substantially reduce petroleum usage for passenger vehicles. Specifically, the work aimed at development of pouch cells with potential for higher energy density and lower cost. Another reviewer agreed that the project is focused on advanced Li battery for EVs, well supporting DOE objectives. The final reviewer had detailed comments, asserting that the project is consistent with the DOE goals of reducing petroleum consumption and GHG emissions by using battery-powered hybrid and electric vehicles. This project is aimed at: i) developing Li-ion battery packs comprising prismatic pouch cells using A123 Systems (A123) doped nanophosphate chemistry for PHEV (10 and 40 mile); and ii) developing low-cost battery modules for HEV hybrid battery systems. These programs thus align with the goals by addressing the relevant technical barriers such as life, safety and cost. Owing to the higher power and enhanced safety characteristics of this battery chemistry (using lithium phosphate), this system would be an excellent candidate for the HEVs and PHEV-10, though, it may be challenging to meet the 40-mile range, due to its lower specific energy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments to this question were generally positive. One reviewer noted that a traditional approach was taken in the design of the cells for battery packs. Another person commented that the project is well organized with clear objectives, milestones, and deliverables conveniently related to the identified technical barriers. However, the proposed solutions are described in a generic manner making hard to evaluate the effective level of innovation introduced. Another commenter mentioned that two complex and comprehensive programs were included with a reasonable organized approach, but the reviewer thought the presenter could have provided more detail. The final reviewer had detailed comments, stating that the approach is based on addressing the key technical barriers for this technology for its applicability in PHEVs and HEV. The approach thus consists of: i) developing high energy materials, optimize electrode and pouch technology in new cell designs (20 ampere-hour [Ah] prismatic) with long cycle life; ii) optimizing thermal management through cell and module design for good calendar life; iii) improving energy density through efficient module / pack design; and iv) reducing cost through high energy materials and improved deigns. Similar goals for the HEV are being achieved through improved electrode and hardware design. The overall project is well designed, looks feasible and well integrated with the materials developments, under the other DOE projects related to lithium batteries. The only barrier that this technology may find it difficult to meet is the high-energy specific energy requirement for PHEV-40; these cathodes (either iron [Fe] or Mn phosphates) are unlikely to meet the energy needs and no additional information was provided in support of the high energy density characteristics from these materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer indicated that the results are very interesting with good progress with respect to the objectives. Another reviewer commented that high-performance battery packs based on a pouch cell configuration were designed and fabricated but performance fell short. Another reviewer had similar comments, stating that though aggressive, the USABC targets of cost and calendar life were not reached (very important). The next reviewer acknowledged that the project included comprehensive and complex programs with challenging hardware and testing tasks. The reviewer felt that the gap analyses showed excellent progress to USABC goals and also mentioned that the programs will be completed late with no-cost extensions. The final reviewer commented that the technical accomplishments and progress achieved in the two parts of this project, i.e., for the PHEVs and HEVS, are impressive, though there must be considerable leverage from the other in-house efforts. Specific accomplishments for the PHEV program include setting up the production facility for 20 Ah (pouch) prismatic cell for PHEV and completing the fabrication and testing of two generations of cells, with the latter meeting the energy and power needs, and likely to meet the life target, but still falling short in the cost goal. In the HEV category, the accomplishments include development and delivery of 10-cell module, comprising 32113 cells, which meet HEV power and energy targets and are to comply with the life requirements. In addition, a 6Ah HEV Prismatic cell was developed and delivered with expected improvements in cost, energy, and power targets. The reviewer criticized that once again, as with other USABC–sponsored developments, it is hard to know how well this project is pacing towards the PHEV or HEV goals, in the absence of any quantitative data. This project has delivered several forms of hardware (cell and packs) at various stages for testing at the national laboratories.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers all stated that there was no collaborations, but the reactions to this were mixed. One person commented that the work occurred all inside A123, so it does not meet the goals of collaboration. Another person commented that coordination and collaboration was as would be expected. Another reviewer mentioned that no partners or collaborations were included in the project, though they surmised that this does not seem to negatively impact the program. One commenter expressed that there is no formal collaboration in the development of these technologies, but there is ongoing collaboration with the National Laboratories in terms of testing and verifying the performance of the cells and packs emerging from this project. The final reviewer had similar comments, stating that there are no collaborations planned and used; it should be better to have at least the contribution of National Laboratories for at least optimizing and clearly confirming the results.

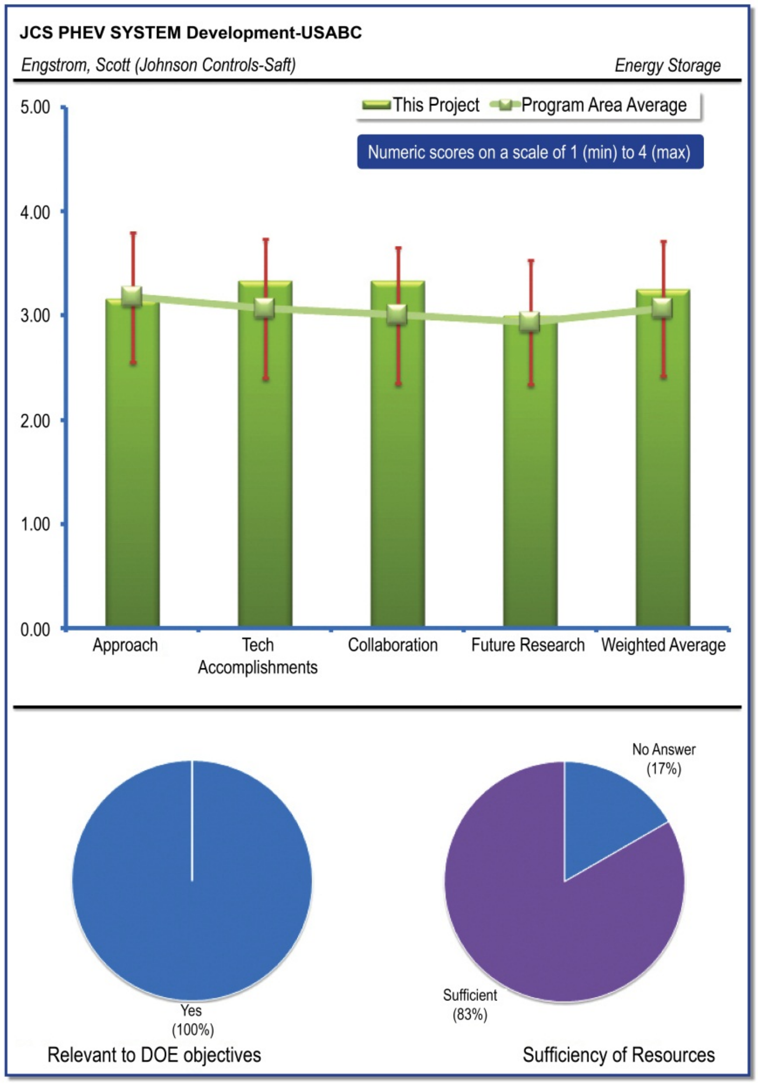
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reactions to this question were mixed, with some believing that the project is completed while other felt that there is work remaining. One reviewer commented that the limited work left is correctly related to the previous results. Another reviewer offered that the future plans are to continue the testing of Gen 2 1.5 Ah prismatic cells and packs for the cycle life and calendar life and cold cranking requirements and to deliver a pack based on these cells. Therefore, the future work appears logical with no anticipated risks. Another person stated that there was no extension to the contract. One reviewer reiterated that this is a no-cost project extension, but added that the project is essentially over. The final reviewer commented that the project is essentially complete and seems generally successful with exception of cost, which is challenging and may be addressed through manufacturing development activities.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the resources are adequate for this project to achieve the objectives. Another person stated that the budget seems okay. The final reviewer expanded on this, stating that the cost extension required to complete the project was denied.

JCS PHEV System Development-USABC: Engstrom, Scott (Johnson Controls-Saft) – es005



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive. One person pointed out that the project is aimed at improvements in performance and cost of batteries for PHEVs that can substantially reduce petroleum usage for passenger vehicles. The reviewer added that the work spanned battery cells, modules, and packs addressing energy, power, life, and safety performance. Another person affirmed that the design and construction of experimental cells is an essential part of arriving at the best cell design for a particular purpose. One reviewer remarked that all advances to progressing cell materials in the technology are important. Another reviewer acknowledged that the project is well in line with DOE objectives. The final reviewer had detailed comments, agreeing that the project is consistent with the DOE goals of reducing petroleum consumption as well as GHG emissions by using battery-powered hybrid and electric vehicles. The reviewer explained that this project is aimed at developing, fabricating and qualifying 20 Ah prismatic cells for PHEVs for 20-mile (PHEV-20) and 40-mile all-electric range applications, and optimizing the battery system designs meet the USABC performance goals. The reviewer concluded by explaining that this project is thus attempting to overcome the technical barriers of energy density, cycle life and cost of the present cells for the PHEV applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviews to this question were mixed, with some reviewer providing criticisms, while others described the approach. One reviewer stated that the project is organized to improve existing Li technology with a detailed, but generic, approach with limited indication of the real innovations. Another person commented that the researcher’s presentation of the approach was disorganized and confusing, but the reviewer acknowledged that the project is a comprehensive and a large body of work. One reviewer explained that the project approach included that cells were constructed and built with specific applications in mind, e.g., PHEV-20 or PHEV-40. The reviewer highlighted that the choice for cathode is a critical part of the activity. The commenter also noted that all the constructions need to be cycled, and tested according to a pre-prescribed regime. Thermal management and other safety features are incorporated into the cell packs. A thermal model was developed and testing for performance and abuse tolerance was carried out. The reviewer concluded by mentioning that a cost model was developed for experimental purposes. The final reviewer described that the project approach is based on: i) utilizing the existing Saft prismatic cell manufacturing equipment and technology for the wound or stacked cell design; ii) evaluating advanced cathode materials (nickel manganese cobalt [NMC]) for improved energy densities [compared to nickel cobalt aluminum oxide (NCA)-based systems]); iii) redesigning the cell mechanics to meet the targeted 30 Ah capacity; and iv) developing and delivering a battery system with series/parallel combinations of these prismatic cells. The reviewer concluded by explaining that in addition to performing tests to assess the improvements in capacity, cycle life and calendar life, detailed tests were conducted to demonstrate the safety tolerance of these cells to various abuse test conditions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reactions to this question were mixed. One person stated that the researchers met all goals and targets. Another reviewer noted that the cells and packs were assembled and tested according to prescribed regimes to confirm the cell design and that several iterations on the design are made to respond to the testing results. The reviewer concluded by mentioning that a final design was established and further testing of performance, safety, etc. was carried out. One reviewer had detailed comments, acknowledging that good progress has been achieved in improving the specific energy in the 20 Ah prismatic cells for PHEVs with 20-40 miles range. The reviewer described that other project accomplishments include: i) optimization of cell fabrication methods for improved robustness and manufacturability; ii) optimization of NMC chemistry to improve cell performance; iii) development of prismatic cell building capability for both wound and stacked prismatic cells; iii) fabrication, testing and delivery of a prototype system; iv) development of a thermal simulation model, which was later verified through experiments; and v) carrying out various abuse tests to demonstrate the safety. The reviewer observed that once again, as with other USABC–sponsored developments, it is hard to know how well this project is pacing towards the PHEV goals, in the absence of any quantitative data, though it is clear that there is notable improvement from Gen 0-Gen2 versions. This reviewer concluded by mentioning that the project has delivered several forms of hardware (cell and packs) at various stages for testing at the National Laboratories. Other reviewers had similar comments about the difficulty in gauging the progress. One reviewer noted that the results achieved seem interesting, but are substantially incomplete to give a clear evaluation of the progress. The reviewer also criticized that most graphs had numerical indication of the involved quantities. The final reviewer agreed with others that there seems to be significant progress in development of prismatic cell hardware with NMC chemistry. The reviewer explained that it is evident that a lot of work was done, but that it was difficult to judge the status with respect to USABC goals. The reviewer suggested that a gap analysis chart would have been helpful. The reviewer concluded by mentioning that the program is complete but at least three deliverables are past due.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reactions to this question were generally positive. One reviewer commented that the use of National Laboratories is a plus. Another reviewer noted that the presenter mentioned the collaboration with Saft and Entek. Another reviewer noted that Johnson Controls Inc. (JCI) worked closely with Entek for separators and BASF for NMC materials and USABC for contract issues. Another reviewer had similar comments, indicating that there was some collaboration with the separator developer, but this is ongoing collaboration with the National Laboratories in terms of testing and verifying the performance of the cells and packs emerging from this project. The final commenter felt that the collaborations are reasonable, but that there is no collaboration with other subprogram participants. Particularly, there is no clear indication of the possible role and contribution of independent testing laboratories.

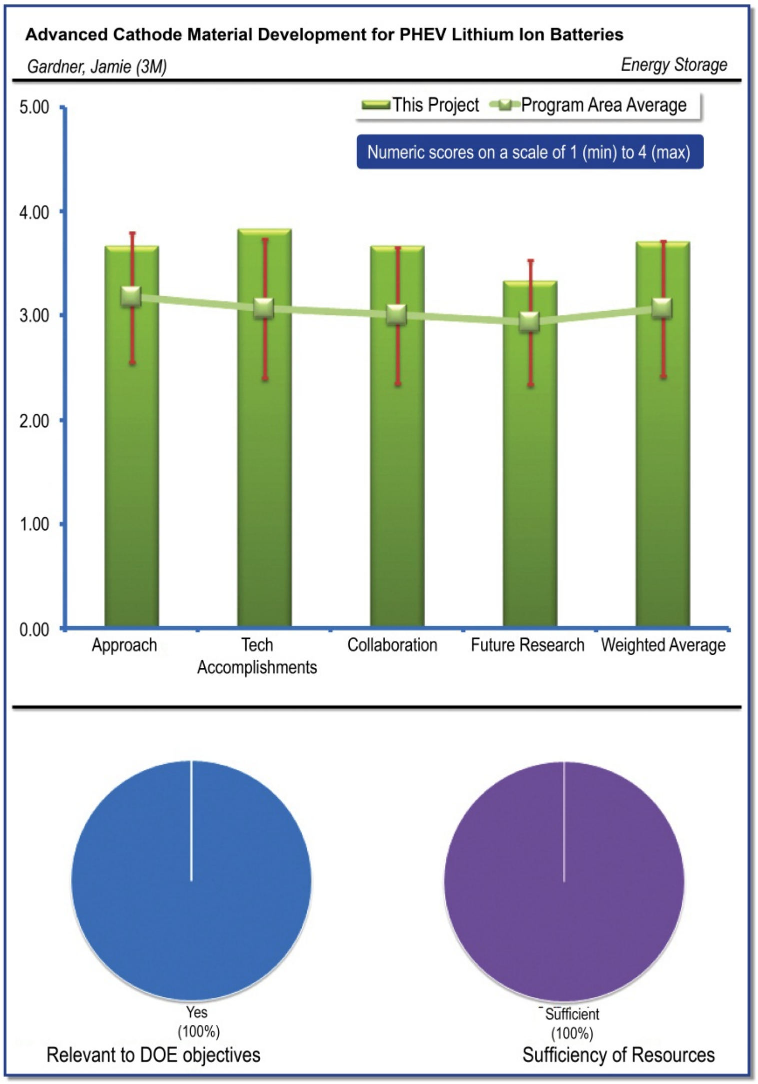
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments to this question were mixed, with some reviewers describing the future plans and others stating there were no future plans since the project is over. One person felt that the next steps are appropriate and well related to the previous work. Another reviewer commented that the future planned studies are logical, look feasible and include fabricating and delivering improved prismatic cells and the 20-mile battery systems for multiple lab evaluations, and develop designs for low-cost 40-mile battery system. One reviewer indicated that the program path was established and followed and that the contract is almost finished. Another reviewer, however, stated that the future plans presented are sketchy and not quantitative. Another commenter reported that additional work was not discussed, while the final reviewer stated that the question was not applicable.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reactions to this question were mixed. One person stated that the financial resources were adequate for the contract requirements. Another person agreed, commenting that the resources are adequate for this project to achieve the objectives. The last reviewer expressed that it was very hard to make revision on a so large budget with limited information.

Advanced Cathode Material Development for PHEV Lithium Ion Batteries: Gardner, Jamie (3M) – es006



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive, although only two reviewers out of four specifically mentioned the project's support of DOE objectives. One person described that the project provides new high-energy cathode materials for use in cells and battery packs for transportation applications. Another person explained that the project provides for lighter weight and lower cost cathode materials providing higher specific energy and lower cost batteries particularly for EV and PHEV applications. Another reviewer emphasized that the project absolutely supports DOE's petroleum reduction goals; advanced cathode and other cell core components will be essential for technology success. The final reviewer commented that this project is aimed at developing advanced cathode materials with enhanced capacity (10%) and reduced cost (15%), with no loss in cycle life or thermal stability compared to the state-of-art metal-nitrogen-carbon (MNC) (111) cathodes. Low specific energy and high-cost are the two deterrent factors for the PHEV-40 batteries and new electrode materials are required to overcome these barriers, so successful development of these materials will increase the viability of Li-ion batteries powering the PHEVs and electric vehicles, which, in turn, will reduce the petroleum consumption as well as decrease the GHG emissions, as desired by DOE.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers provided various summaries on the researcher approach. One person mentioned that the approach followed traditional approach to identify materials, scale-up pilot plant and construct 18650 cells to verify performance. Another reviewer explained that the project is based on a combined approach using statistical models to identify and select cathode materials, followed by experimental work. The reviewer felt that the selection of technical issues with quantitative targets is a sign of good planning. Another reviewer also felt that the project utilized a good, well-organized, and detailed approach to target both compositional modification and process improvement to achieve cost reduction. Another reviewer had similar comments, stating that the approach utilized known methods the project scope was well defined with an achievable target. The final reviewer had detailed comments, stating that the approach is based on developing new cathode materials from the layered-layered composites of Li_2MnO_3 and $LiMO_2$, where M=Mn, Ni or Co. The reviewer agreed that this approach is the most likely solution to increasing specific capacity of the cathode materials beyond 170 mAh/g, as is also being attempted by several other laboratories. The range of compositions (Mn-rich) being focused here will duly address both the technical barriers of energy and cost, without compromising with the thermal stability or cycle life. Further, the efforts to scale up the cathode synthesis and validate its performance and abuse tolerance in sealed cells are consistent with the project goals. The reviewer concluded that the project is thus well-designed, looks feasible, and well-integrated with the other material development efforts under DOE.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Responses to this question were all positive. The first reviewer commented that the results are close to the defined targets with an excellent progress. Another reviewer remarked about the excellent noted achievement on all defined barrier goals. The reviewer added that noteworthy is "cost" which seems difficult in most projects and is essential if not the key to market success. One commenter highlighted that the researchers achieved increased specific capacity and lowered material costs in accordance with goals. Detailed characterization confirmed comparable, or better, performance across all gap analysis criteria. Another reviewer had similar comments, acknowledging that the project was completed, including developed cathode materials with lower cost and higher performance, and sent cells for evaluation in DOE labs. The final reviewer described that the project progress achieved in developing new material, i.e., optimizing the cathode material composition (from about 50 samples), is quite reasonable. The improvements in capacity meet the initial targets, even though these improvements are not as significant as the reviewer expected. Subsequently, however, the material has been successfully scaled up to 25 kg and assessed in detail for its electrical performance and abuse tolerance in 18650 cells. These tests indicate that the 18650 cells containing this advanced cathode materials have met the performance targets, from the “gap analysis”. Further confirmation of the benefits for this material will, of course, have to come from the cells fabricated by a battery manufacturer. The reviewer concluded by affirming that this project has delivered a few cells to the DOE laboratories for the assessment of performance and safety.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All reviewers noted the good collaboration with National Laboratories. One person acknowledged the good collaboration with ANL and Sandia. Another reviewer mentioned that the researchers collaborated with Sandia and Argonne and supplied cells for testing. One reviewer commented that the project is well-integrated in the subprogram with good collaboration with National Laboratories. Another reviewer applauded that Sandia is an excellent test partner for independent abuse testing. The final reviewer affirmed that there is good collaboration with the National Laboratories in terms of testing and verifying the performance, and demonstrating the abuse tolerance of the 18650 cells with the advanced cathode material.

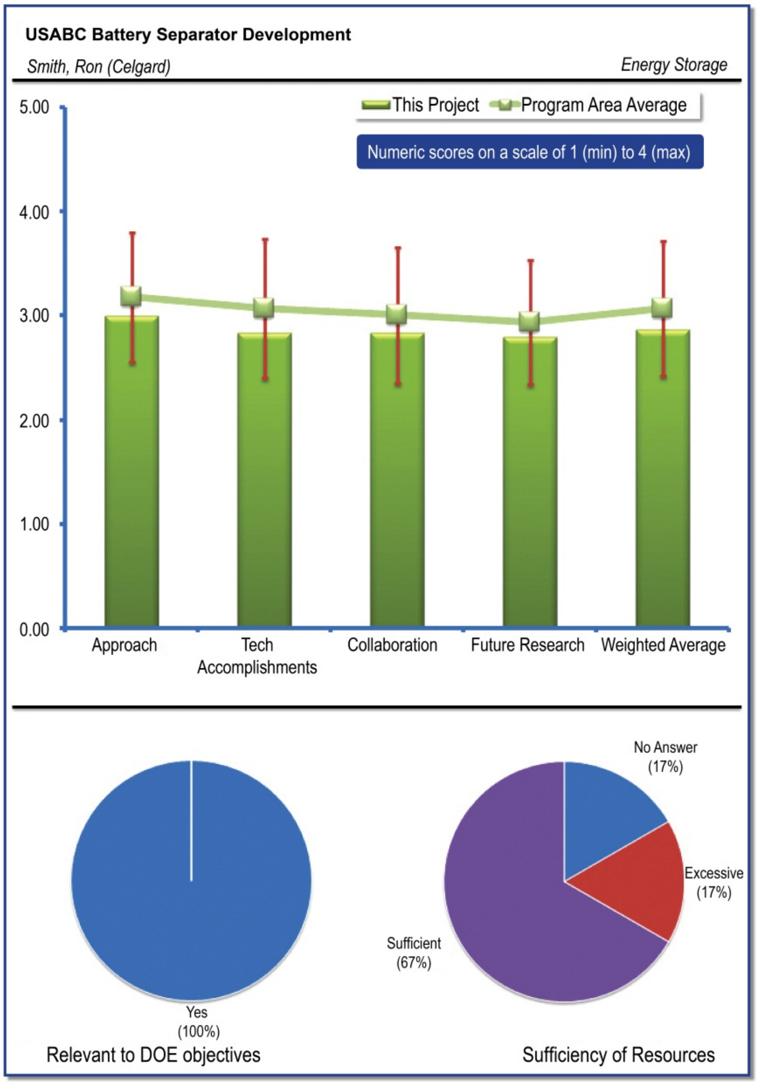
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reactions to this question were mixed, with some people stating that the project was completed with no proposed work, while others described future work plans. One reviewer commented that as the project is winding down this year, the plans for the rest of the year are to continue the life tests on the cells in-house and to collaborate with the National Laboratories to complete performance verification in 18650 cells. Another person commented that the project was successfully completed, but would be nice to share plans to utilize new materials in products. Another reviewer, however, felt that the future plans were well-connected to the running and previous work. Another reviewer had similar, but brief comments, stating that the work proposed is reasonable. The final reviewer requested that DOE keep this project going into large cell format.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All reviewers felt that the resources were adequate. One person stated that there was no mention of resources issued, while another reviewer felt the resources are okay. The final reviewer to comment stated that the resources are adequate for this project to achieve the objectives.

USABC Battery Separator Development: Smith, Ron (Celgard) – es007



REVIEWER SAMPLE SIZE

This project had a total of six reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

Responses to this question were all positive. One reviewer commented that the work on separators can give support to DOE objectives, even if these objectives are not clearly described in the presentation. One commenter affirmed that the robust separator is essential for long life and high performance. The reviewer also pointed out that Celgard supplies a high percentage of separator materials for the Li-ion industry. Another person explained that the project's goal is to develop procedures for battery separators for improved safety for lithium ion batteries for EV, HEV, and PHEV applications. One reviewer highlighted that separator development is a key safety enabler in the automotive market. The final reviewer commented that this project is aimed at developing a standard testing protocol for evaluating high temperature melt integrity (HTMI) properties of lithium-ion battery separators and to design and develop a separator product that demonstrates HTMI criteria. Mechanical failure of separators through shrinkage at high temperatures is a known failure that ultimately leads to cell thermal runaway, should there be any thermal abuse condition within the cell. The shrink-resistant separator being developed here will greatly improve the safety of Li-ion batteries, which is a major technical barrier for the viability of Li-ion batteries powering the PHEVs and electric vehicles to reduce petroleum consumption as well as decrease GHG emissions.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

One person explained that a test method was developed to confirm the performance of a new separator material; the project then developed a new material with improved performance. Another reviewer commented that the overall research plan is reasonable; however, approach details are missing. One reviewer had detailed comments, explaining that the approach is based on developing test standards for the HTMI properties of the separators, both on the films as well as on the cells containing these separators. The film tests include dimensional rigidity (stability) under hot conditions of 150-200° Celsius (C) as well as shutdown properties (increased resistance with temperature) of the polymer. The reviewer criticized that the shutdown requirement was not part of the current project. New separators being developed in this project include polymeric component as well as ceramic filler for improving the mechanical properties. The reviewer concluded by indicating that the project is well-designed and looks feasible to develop new mechanically robust and thermally resilient separators for Li-ion cells. One person remarked that the approach includes an interesting metric of separator "withdrawal" from the hot tip. The final reviewer commented that there is an acceptable understanding on technical barriers of Li cell separators with the development of specific testing procedures; however, it is not fully understandable why a novel separator must be developed to validate the procedure: other commercial separators should be used. The reviewer added that work on novel separator development cannot be simply focused on preparation of materials for testing validation, but it should have more practical and technical objectives.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Responses to this question were mixed. One person reported that the researchers met the goals of developing a new material that meets to goal and a method to test the separator materials to conform performance. Another reviewer expressed that any advancement which at least minimally delays the onset of runaway is a success, perhaps however if the delay or initial internal short can be detectable by the BAS. If detectable, the system may have a small amount of reaction options to the rest of the pack so as to avoid catastrophic failure. One reviewer had detailed comments, describing that new test standards have been developed in this project for the separator materials, based on: i) hot-tip test for the melt integrity; ii) temperature-dependent resistance for the shut-down property; and iii) dimensional stability under load at high temperatures. In addition, the hot-box tests on the cells provide correlations with the dimensional stability and shut-down property of the separator. New separators were developed based on impregnating the polymeric separators with ceramic fillers, as is being done in the other laboratories. Three versions of such composite separators were developed and demonstrated to have improved dimensional stability at high temperatures. The reviewer added that interestingly, the HTMI coating did not prevent cell failure in the nail penetration test, but would delay exotherm onset. The reviewer concluded by indicating that this project has delivered two rolls of the new separators to DOE laboratories for further assessment. Other reviewers had more critical comments, with one stating that the results are only partially addressing the targeted objectives. The final reviewer criticized that the results are not impressive. Additionally, this reviewer observed that the procedures developed were not clearly identified or explained. The reviewer felt that none of the separators appear to pass Z-direction strength test. Further, this reviewer continued that the work also does not appear comprehensive or creative. The reviewer concluded by cautioning that neither the test procedures, nor the separator research and development (R&D) work, appear to provide much value towards new separator products.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments all point to fact that the only collaboration is with a National Laboratory (Sandia). One reviewer stated that Celgard is the sole contractor. Another person indicated that Celgard had delivered samples for National Lab testing. Another reviewer indicated that there is ongoing collaboration with the National Laboratories in terms of providing external validation of the developed HTMI materials. A reviewer felt that the collaboration has been improved with Sandia National Laboratories' involvement, but it has not fully investigated the possibility to validate the test procedure in other organizations and on other separators. The final reviewer reinforced that they always encourage including Sandia as an abuse partner, since their core abuse knowledge is superior and growing.

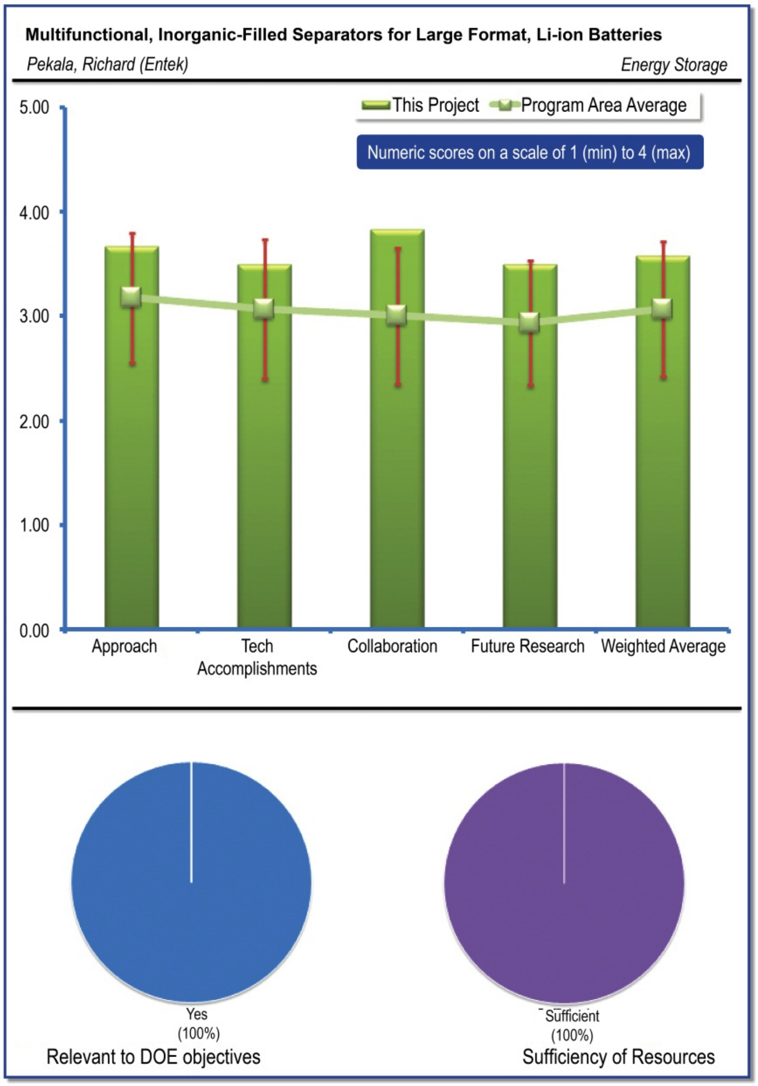
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reactions to this question were mixed. One person pointed out that the plans include developing manufacturing methods for the new separator. Another person indicated that the proposed future research is focused on continuing the evaluation of ceramic-based coatings for HTMI battery separators in terms of cost-benefit ratio and examining alternative, long-term technologies. Others did not share these opinions, with one reviewer stating that the proposed future plan is very limited with a generic focus on barriers. Another reviewer commented that future plans are vague and indefinite, so the reviewer was left to believe there may be no outcome other than to consider this as a future R&D direction. One reviewer stated that this question does not apply since the work had been completed. The final reviewer commented that the presenter's response to this question was not totally understood, but for lack of any other place for the reviewer to comment, this reviewer questioned the inclusion of the defensive posture from the 2010 AMR comments in the presentation.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reactions to this question were mixed. One reviewer stated that the researchers had sufficient resources available. Another person agreed, commenting that the resources are adequate for this project to achieve the objectives. Others were more critical. One reviewer commented that the presented activities are not really consistent with the planned budget. The final reviewer explained that it does not look like this project was worth the money spent. The reviewer found it hard to believe that $2M was spent on this project.

Multifunctional, Inorganic-Filled Separators for Large Format, Li-ion Batteries: Pekala, Richard (Entek) – es008



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reactions to this question were all positive. One reviewer commented that the project focused on developing procedures for battery separators for improved safety for lithium ion batteries for EV, HEV, and PHEV applications. Another person stated that separators are essential for good cell operation. One reviewer had detailed comments, stating that high temperature mechanical and dimensional stability of the separator, with or without shutdown, is the key to ensure adequate safety of Li-ion cells and batteries. Safety is indeed a major technical barrier for the viability of Li-ion batteries powering the PHEVs and electric vehicles, which would reduce the petroleum consumption as well as decrease the GHG emissions from automobiles. The reviewer remarked that this project is aimed at developing multifunctional, inorganic-filled separators and demonstrating their performance in 18650 cells. One person reinforced that anything which improves fade rate characteristics of cells is a plus for the economics of EVs. The final reviewer agreed that the project addresses key objectives functional to DOE needs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reactions to this question were all positive. One reviewer commented that the approach is based on developing freestanding, dimensionally-stable, separators filled with silica and/or alumina to achieve less than 5% shrinkage at 200°C, low impedance and also with no adverse effects on the electrical performance. The latter is being verified in 18650 cells fabricated by the collaborator, American Lithium Energy Corporation. The tests performed thus far address only the electrical performance but not the improvement in safety, which is primarily the expected benefit with these ceramic-reinforced separators. These separators do not have the shutdown properties, which, though not listed in the current USABC goals, is a desired property. The reviewer concluded by stating that overall, the project is well designed and looks feasible to develop new mechanically robust and thermally resilient separators for Li-ion cells. Another reviewer pointed out that the approach addressed abuse tolerance, high temperature, life and cost drivers using silica filled polymer separator material with biaxial orientation with good high temperature stability. One person commented that the approach is good with clear indications of the technical issues and objectives and the project is rationally organized to meet the targets. Another reviewer explained that the researchers have developed a comprehensive and well-organized approach with adequate detail. The reviewer added that the approach includes a good plan for matrix design or samples and excellent step wise test plan. The final commenting reviewer stated that the approach is a very good comparison between control sample and test.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer described that the researchers developed a process to produce inorganic filled separators with improved performance and abuse tolerance. Another person had detailed comments, describing that several separators filled with inorganic materials (e.g., silica and/or alumina) were developed, which met the USABC goal in terms of high temperature stability (i.e., less than 5% shrinkage at 200°C). The reviewer added, these separators also have excellent electrolyte wetting property and show low impedance even at low temperatures. In order to verify the compatibility of these separators with the electrode materials, several 18650 cells were fabricated with different inorganic fillers and tested for different characteristics (i.e., cycle life, self-discharge at 60°C and low temperature performance). It was clear to the reviewer from these tests that there is no evidence that inorganic-filled separators have adverse effects. Cell performance is generally better than for controls: longer cycle life, less self-discharge, and higher rate capability. The reviewer concluded by stating that the project progress accomplished towards the project goals and the overall DOE goals is quite satisfactory. Another reviewer commented that the results are interesting with good progress with respect to the technical barriers. The reviewer felt that the comparison with target is very promising and also the insurance about the cost targets. The final reviewer remarked about the good comprehensive results with multiple samples meeting targets. This reviewer added that the separator seems to provide other improved properties beyond improved safety and that the program is on track for very successful conclusion in June.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments to this question were very positive. One reviewer acknowledged the good cooperation with American Lithium and JCI and the overall good responsiveness to needs. Another reviewer had related comments, stating that there was good collaboration with appropriate partners including suppliers, testing, and customers. Another reviewer agreed, emphasizing that there is an integrated network of collaborations, well selected, and really needed to have a complete view and evaluation of the technical results, combining private and public bodies. One reviewer described that there is ongoing collaboration with American Lithium Corporation for the fabrication of 18650 cells with inorganic filled separators and also with a few other non-DOE collaborators for separators characterization and raw materials. The final reviewer commented that they were pleased to see such a wide-ranged cell build up in process with different cell manufacturers.

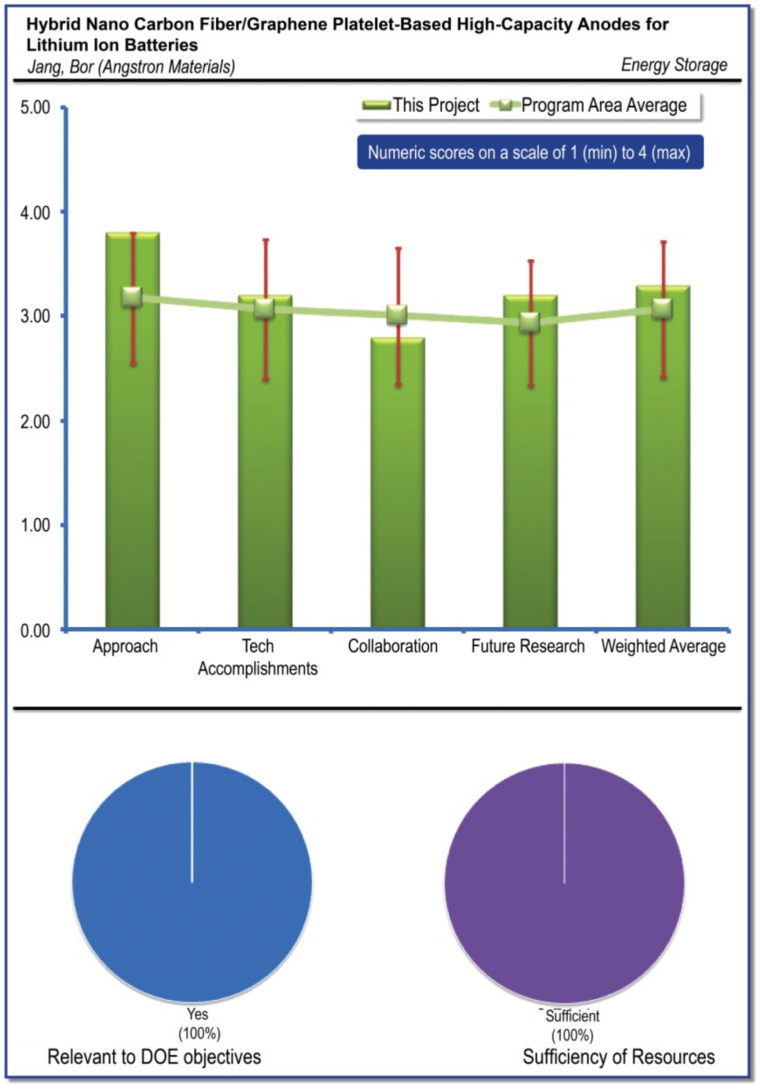
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Responses to this question were all positive. One reviewer commented that the project is proposing a logical prosecution with clearly identified and explained tasks. Another evaluator pointed out the good detailed list of future plans, most of which are in progress, with excellent prognosis of successful completion. Another reviewer remarked that abuse testing is essential and scheduled and that test samples have been distributed to other cell assemblers including JCI, Dow-Kokam, and A123. The final reviewer reported that there are clear plans for future research to: i) continue 18650 cell performance testing for cycle life and 60°C storage; ii) conduct abuse tests on cells; iii) continue pilot production of silica-filled separators; and iv) send separator samples for large format cell builds, e.g., A123, Dow-Kokam™, and JCI-Saft.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The responses to this question were mixed. One person commented that the resources are adequate for proposed/ongoing effort. Another reviewer agreed that the resources are adequate even considering the established collaborations. One reviewer expressed that the project was a great value to DOE for minimal investment. The final reviewer commented that the contract looks to be completed with present funding.

Hybrid Nano Carbon Fiber/Graphene Platelet-Based High-Capacity Anodes for Lithium Ion Batteries: Jang, Bor (Angstron Materials) – es009



Reviewer Sample Size

This project had a total of five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive. One person stated that the project is relevant to DOE objectives. Another reviewer noted that the energy density and specific energy will be improved with a high energy anode. One commenter explained that this project offers an approach to higher specific capacity anode materials that could increase the specific energy of lithium ion batteries for electric vehicles and/or plug-in electric vehicles. Another reviewer commented that like other core materials of the battery, the anode development to increase range or reduce cost for equivalent range is essential. The final reviewer indicated that the result of the project is a new silicon based anode system. The technical feasibility of the material has been demonstrated. The nano-graphene base surrounds the silicon spheres and limits/minimizes the volume changes on charge and discharge. Significantly higher cell energy density is possible.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer stated that the approach is challenging and innovative with proposed breakthrough on Si-anode preparation. The project is well organized and feasible with typical risk of advanced research. Another person agreed that this is certainly a leading edge application of carbon nano-fibers (CNF) technology, but the reviewer questioned how durable this is. One reviewer applauded that the use of conductive carbon nanofibers onto the copper foil to produce a laminated electrode structure was very creative. The reviewer added that the graphene sheets prevent aggregation of the nanoparticles during the charge-discharge process. Another reviewer agreed that using nano-graphene and nano-silicone is a good match for conductivity and prevention of fracturing active material. Other reviewers offered criticisms and suggestions. One evaluator commented that the technical barriers are provided, but not in priority order. It was not clear to this reviewer how this project will address high production cost. Pulverization is not a barrier itself but contributing to low cycle life barrier. The reviewer concluded by surmising that by low capacity the reviewers mean low specific capacity and really the barrier is low specific energy. The final reviewer indicated that it would be useful to have an estimate of what pack of at least cell level specific energy and energy density improvement could be achieved by using this material in an optimally designed cell. The reviewer warned that doubling the specific capacity of the anode material does not double the cell specific energy. Similarly, estimates of the effect of implementation of this material on cell and pack cost would be useful to fully assess the value.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person commented that a chemical vapor deposition (CVD) apparatus has been installed to mass produce the silicon coated conductive web. Small lab cells have given excellent stability and steady capacity on charge-discharge regimes. The remaining comments suggest that approach improvements are needed to improve the project results. One commenter stated that the results are very promising and some cost analysis should be included to the experimental work to estimate final cost. Another reviewer commented that the cycle life at 70% SOC window may not be sufficient. The reviewer also suggested that the cost goals do not match the automotive industry expectations for profitability. The final reviewer commented that there is evidence that a lot of fancy materials work has been done; however, quantitative progress towards 2011 targets of 1000 mAh/g capacity with 750 cycles, about 70% SOC swing, and less than 20% of capacity fade is lacking. The summary value proposition with the optimistically favorable cost prognostication is not convincing. The reviewer felt that actually it is doubtful with two expensive materials this anode approach can be cost acceptable.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Only two reviewers responded to this question. One acknowledged that the researcher’s work with Angstron, Nanotek, K@, E-one Moli, Honda, and Nissan should lead to rapid incorporation of the invention into the commercial world. The other reviewer indicated that there is appropriate collaboration from outside the subprogram. The reviewer suggested that some collaboration inside the subprogram (e.g., National Labs for validation in various lab cells and different cathodes) is recommended.

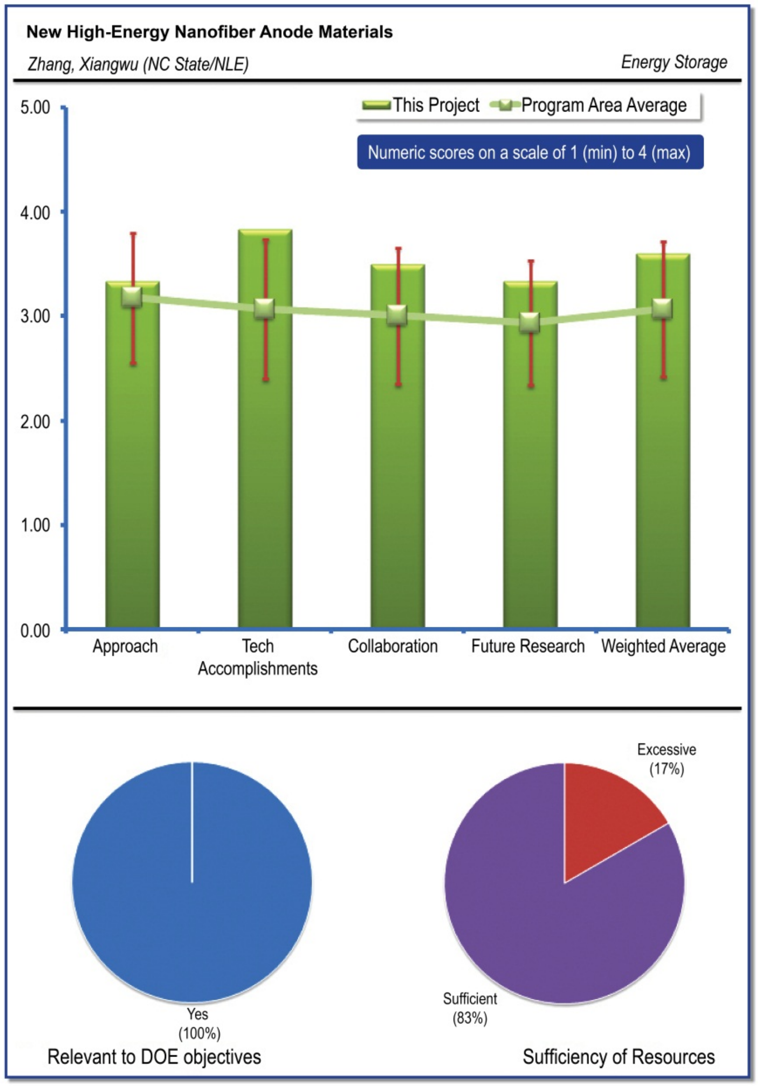
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person noted that the future plans include expansion of the processes into larger electrode sizes as well as improving the process steps are in order. A reviewer commented that the proposed plan for the prosecution of the activities is reasonable and well based on the previous results. The proposed cell testing does not clearly specify the selection of cathodes and electrolyte components. Another reviewer stated that they are interested to see results on a larger format application. Two reviewers had suggestions for the future research direction. One reviewer suggested that future work should focus on meeting specific capacity and cycle life targets and showing acceptable cost is achievable. The final reviewer indicated that the proposed research should be focused on developing low-cost anode about $10 - 15 per kg. The cycle life testing window should be widened to 80%.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers provided comments, both positive. One person stated that the funding level seems adequate. The other person commented that the funding was consistent with the progress and speed of development.

New High-Energy Nanofiber Anode Materials: Zhang, Xiangwu (North Carolina State University/NLE) – es010



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Responses to this question were all positive. One reviewer remarked that the project is useful to support DOE objectives, even if it only partially addresses key needs. Another reviewer stated that the project involves new high-performance anode silicon materials. A reviewer asserted that all core cell material development is essential to reaching battery objectives. One commenter explained that the carbon anode in Li-ion batteries has limited specific energy and this advanced nano-fiber will increase the battery energy density. The final reviewer described that this project offers an approach to higher specific capacity anode materials that could increase the specific energy of lithium ion batteries for electric vehicles and/or plug-in electric vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

All reviewers had positive comments to this question, with some reviewers providing suggestion for project improvements. One reviewer had detailed comments, indicating that the project is well focused on increasing the specific capacity over graphite materials while developing high cycle life relative to silicon anode materials. The targets have been adjusted appropriately upward to be relevant for both EV and PHEV applications. Aggressive materials cost targets have also been set. However, according to this reviewer, it would be useful to have an estimate of what pack of at least cell level specific energy and energy density improvement could be achieved by using this material in an optimally designed cell. Further, this reviewer added, doubling the specific capacity of the anode material does not double the cell specific energy. Similarly, estimates of the effect of implementation of this material on cell and pack cost would be useful to fully assess the value. Another reviewer agreed that the project uses a sound approach. The reviewer offered an additional improvement to the current program would be to investigate and report on initial and ensuing irreversible capacity loss with the anode materials. The reviewer concluded by emphasizing that further improvement to the current program or potential future program should include some focus on optimizing/minimizing initial and ensuing irreversible capacity loss. Another reviewer mentioned that the approach included developing a new method to produce anode materials using an electrospun process to combine lithium and carbon into nano-fiber materials for Li-ion cell anodes. One commenter indicated that the project is interesting and well-organized with clear tasks and milestones. The reviewer also thought that the electrospinning preparation of Si-anode was promising. The final evaluator noted that combining Si and carbon (C) will significantly improve anode specific energy.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All reviewers had positive comments to this question, with some reviewers providing suggestion for project improvements. One reviewer expressed that the progress is excellent with very promising results in terms of stability and specific capacity. Another reviewer reported that the researcher developed a Si/C nanofiber with a capacity of over 650 mAh/g. Established a base performance for the new material with a capacity of over 600 mAh/g. Another evaluator emphasized that the simultaneous progress towards specific capacities approaching 1,000 mAh/g and 750 cycles is impressive. The reviewer also thought that the progress towards process development resulting in a start-up company with promising cost projections was also very impressive. One reviewer indicated that the obvious thermal expansion life-cycle barrier will be challenging. The final reviewer explained that the automotive cycling depth of discharge (DoD) should be 80% or higher.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers had positive comments, with one posing a question. One person acknowledged that the researchers are working with several companies including American Lithium, Ted-Cel, ANL, and Indiana-Purdue universities. Another reviewer explained that the collaborations have been satisfactorily improved with respect to last year. One evaluator stated that the project includes outstanding collaborations with several organizations. The last reviewer noted that they were curious as to collaborative partners versus supplier status of the groups included in the project.

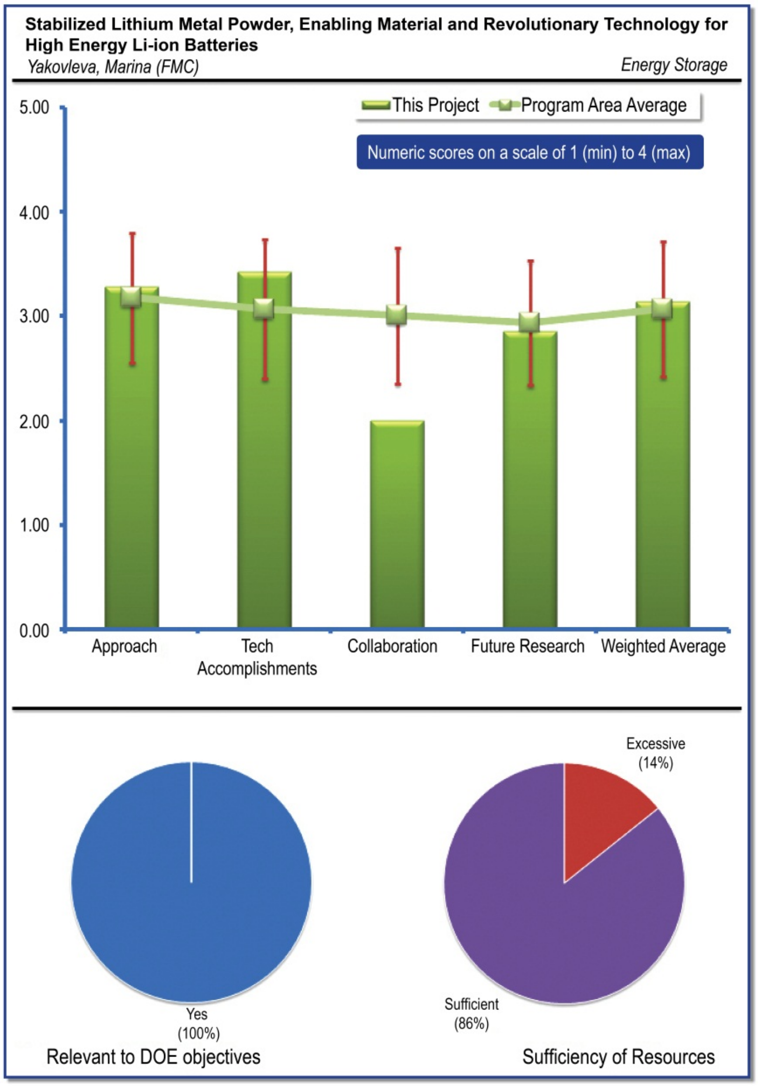
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers all had positive comments, with some offering suggestions to be included in the future plans. One reviewer stated that the researcher presented excellent and aggressive future plans. Another person commented that the plans include further improvements to the capacity by adjusting process parameters and that the project will deliver 18650 cells to potential customers. One reviewer indicated that the work planned for the next period is well-focused on the barriers even if there is no good indication of the effective progress awaited with the proposed innovations. Several reviewers provided suggestions for improving the work plan. One evaluator suggested that some focus on irreversible capacity loss characterization, reporting, and optimization should be included. Another person asserted that collaboration with an existing high-volume consumer electronics cell producer should be strongly pursued. The final reviewer offered that the work plan should include the cost justification of the advanced anode by comparing with the conventional anode material and should meet USABC cost goals.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reactions to this question were mixed. One person commented that there was no mention of money problems. Another person stated that the budget seems adequate. The final evaluator, however, expressed that without further expansion of the scope, the funding level seems excessive compared to other similar programs.

Stabilized Lithium Metal Powder, Enabling Material and Revolutionary Technology for High Energy Li-ion Batteries: Yakovleva, Marina (FMC) – es011



Reviewer Sample Size

This project had a total of seven reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reactions to this question were generally positive. One reviewer commented that the project addresses a key element of Li battery with relevant impact on DOE objectives. Another person pointed out that there is potential for cost reduction with the novel method of intercalating carbon anode. Another reviewer had similar cost reduction potential comments, stating that the lithium metal in powder form may be a lower cost anode for EV applications. One person indicated that the project provides new material for design and manufacturing flexibility providing potentially for improved specific energy and cost reduction for batteries EV, HEV, and PHEV applications. One reviewer had detailed comments, stating that lithiated metal oxides or phosphates serve as cathodes and also as lithium source in Li-ion cells. These cathode materials, however, have low specific capacities, compared to the anode counterparts, and thus limit the specific energies for the cells. In addition, some of the non-lithium cathodes, which may have better specific energies and safety, cannot be used in the present form, unless there is another form of lithium source that could be added in conjunction with such cathodes. The objective of this project is to develop cost-effective manufacturing processes for stabilized lithium metal powder (SLMP), which will function as an independent source of lithium. The overall objective is to integrate the SLMP Technology into the Li-ion cell for PHEV application, and support high volume production of Li-ion batteries and to make available commercial quantities of SLMP that will enable higher energy, safer, environmentally friendlier and lower cost lithium batteries. Such batteries will contribute to the success of PHEVs, which would in turn reduce the petroleum consumption and the GHG emissions in automobiles, and pave the way towards petroleum replacement. The final reviewer had a slight hesitation on answering "yes" without understanding DOE’s expectations of a material supplier of lithium. Any improvements in efficiencies and or customer needs in this area could logically take place in the competitive marketplace. However, the reviewer indicated that they have certainly learned a few things from the PI and encourage DOE’s objective pursuit.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer explained that meeting DOE goals will require higher-energy anode material, so the powdered lithium metal may be the best solution. The "slump" powdered lithium metal has the potential to lower production cost and yield higher performance than the present carbon anode materials. Another reviewer had detailed comments, stating that the approach is to develop a process and design a commercial unit to scale-up the production of SLMP dispersion. The reviewer explained that there are two approaches for integrating SLMP into the Li-ion chemistry. First, SLMP may be added to the anode to compensate for its irreversible capacity, such that the lithiated cathode efficiency might be improved. Alternately, SLMP might be used even to lithiate the carbon anode such that it may be combined with non-lithiated cathodes, which may have better safety compared to lithiated cathodes. In either approach, the amount of SLMP required to be added is considerably less, due to its high Li content, approximately 98%. The approach involves the development of a process and prototype unit for the commercial production of dry SLMP and the integration of SLMP Technology into a Li-ion system [e.g., mesocarbon microbeads (MCMB)/$LiMn_2O_4$ system] to demonstrate the improvements both in the capacity as well as cycle life upon SLMP addition. The reviewer concluded by remarking that the approach is well-designed and feasible and addresses the technical barriers of performance and cost targets of Li-ion batteries for PHEVs. Another evaluator commented that the project is well structured with clear objectives and well- identified barriers; however, there is a lack of clarity due to the absence of quantitative technical and economic targets. The final reviewer commented that coated lithium metal powder provides additional flexibility for the design and processing for lithium-ion batteries, greatly reducing some detrimental effects of irreversible capacity. The reviewer added the suggestion that the potential effect on specific energy and cost should be quantitatively estimated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reactions to the question were mixed, some positive and some providing work plan suggestions. One reviewer stated that the project seems to be tracking the timeline defined two years ago. Another reviewer reported that the vendor delivered equipment for fabricating "slump" anode and the site has been prepared. The reviewer added that Kureha was selected to supply anode material, Toda the manganese spinel materials, and that the project is still on the original schedule. One reviewer had detailed comments, stating that the progress achieved within last two years is consistent with the project plans as well as with the DOE goals. The reviewer indicated that the researchers had completed the design, purchase, installation and commissioning of a commercial-scale unit for the production of SLMP dispersion. Also, the research team completed the experimental runs with the new commercial-scale and the optimum dispersion conditions were determined. SLMP can be applied uniformly using micro-gravure method onto the pre-fabricated electrode or transferred to electrode surface through a carrier film. The benefits of the SLMP Technology have been successfully demonstrated in a Li-ion cell with Kureha hard carbon and Toda $LiMn_2O_4$. Improvement in the capacity with comparable cycle life was demonstrated with SLMP additions to the anode. The reviewer felt that it is, however, surprising that the use of SLMP has not been accepted yet by industry, even after years of its development, and the associated problems (e.g., potentially electrolyte stability) need to be understood and resolved. Another commenter acknowledged the good progress towards goals, including testing material in real cells showing beneficial effects on capacity as well as no detrimental effects on power and cycle life. The reviewer concluded by adding that the presentation was not well organized and could be more clear and concise. One reviewer stated that the results are very promising with very good progress; however, the reviewer still has some concerns about the cost impact. One evaluator indicated that an evaluation in a graphitic carbon based system should be, or should have been, included. The final reviewer explained that the accomplishment should track cost of the material and should be analyzed for a business case.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reactions to this question were mixed. One reviewer indicated that the researchers are working closely with equipment and materials vendors to meet program goals. Another reviewer had a conflicting view, stating that there are no partners on this project; however, FMC Corporation (FMC) has been involved in collaborations outside this project in support of material development for Li-ion cells. Another reviewer suggested that collaborators from inside the subprogram should be identified. The commenting reviewer stated that it was not obvious if the Li-ion cell developers are benefiting from the developed material, and if so, how the cost of the batteries is improving.

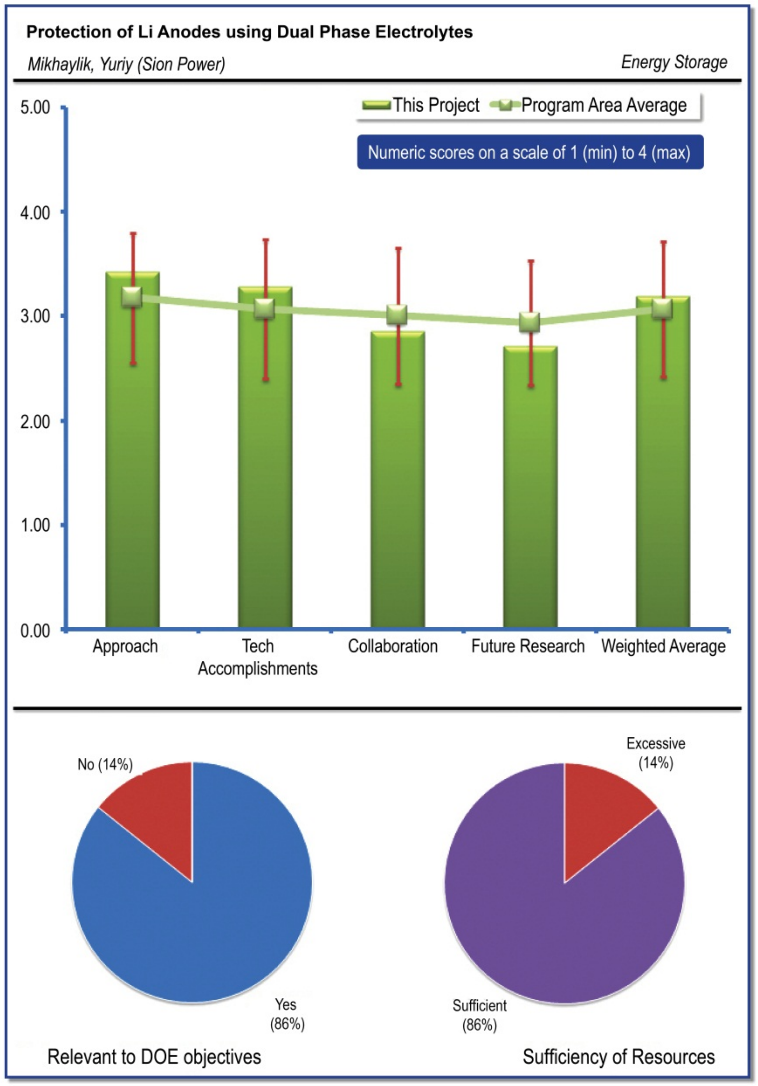
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reactions to this question were mixed. One reviewer indicated that the project is mainly equipment-oriented to produce new anode construction in Li-ion cells. Another person felt that there are clear plans for future research to: i) explore the use of pilot scale alternative unit to produce dry SLMP powder directly from battery quality lithium metal, which will be cost-effective; and ii) integrate SLMP Technology into the Li-ion cell using SiO/$LiCoO_2$ system. Another reviewer, however, stated that no future research plans were shared. Another evaluator, however, felt that the future work is very poorly described, but it seems adequate and consistent with the previous work. One reviewer suggested that an evaluation in a graphitic carbon based system should be included. Another person mentioned that a collaboration with an existing high-volume consumer electronics cell producer as a direct and included element of this project should be strongly pursued. The final reviewer commented that the future work should include cost study and life testing.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Responses to this question were mixed. One person commented that funding is adequate. Another reviewer agreed, remarking that the resources seem adequate. A reviewer commented that the resources are adequate for this project to achieve the objectives. The final reviewer, however, asserted that the resources for the project are excessive for a program within this category.

Protection of Li Anodes Using Dual Phase Electrolytes: Mikhaylik, Yuriy (Sion Power) – es012



Reviewer Sample Size

This project had a total of seven reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer stated that the project is relevant to DOE objectives. Another reviewer provided detailed comments, describing that the lithium-sulfur (LiS) system offers high gravimetric and volumetric energy densities, due to the high specific capacity of the sulfur (S) cathode. However, its advantages have not been realized yet due to the solubility of polysulfides from the cathode in the electrolyte migrating to the anode and affecting its cycle life. The objective of this project is to develop an electrolyte system with two immiscible electrolyte solutions for the anode and cathode compartments, each with adequate chemical/electrochemical stability and impermeability for the polysulfides towards the anode and finally, stabilization of the Li anode. The overall objective is to incorporate such an electrolyte system in large format cells and demonstrate the improvements in anode and cathode function, cycle life, and increase in thermal runaway temperature. These studies, if successful, will lead to high specific energy Li batteries for PHEVs, which would in turn reduce the petroleum consumption and GHG emissions in automobiles, and pave the way towards petroleum replacement. Another person had similar comments, describing that the development of a new electrolyte that provides two separate liquid phases would open new opportunities to develop unique constructions where each electrode chemistry has its own unique electrolyte yet functions as a normal cell construction. The reviewer added that the system has good potential as a rechargeable, metallic lithium system. Another person expanded on the previous comment, noting that the electrolyte, like all core battery materials, requires development for long-term success. One reviewer mentioned that the lithium-sulfur chemistry has one of the highest energy densities. Another reviewer commented that the project involves the development of high specific energy batteries for EV applications. The final reviewer commented that there is no evidence that LiS systems can ever provide appropriate performance for automotive applications, although the reviewer felt that they may have potential for other applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer expressed that the project is challenging with a well-organized structure and clear approach to technical solution to innovative Li/sulfur cells with novel dual-phase electrolyte and cell design. Another reviewer had detailed comments, explaining that the approach is based on a dual-electrolyte system with different electrolytes immiscible into each other and tailor-made to anode and cathode environments. The anode electrolyte is immobilized in a polymeric gel, which is stable towards Li preventing the Li dendrites and also functioning as separator. More importantly, it does not dissolve polysulfides from the cathode. The catholyte, on the other hand, is tailored to improve the sulfur cathode performance with high polysulfide solubility. The demonstration of this LiS system with dual-phase electrolytes will be further demonstrated in large format 2.5 Ah cells after optimizing the cell design in terms of electrode sizes, substrate thickness, active material loading and depth of discharge and developing the production of larger gel-polymer coated anodes and cathodes. Even though the approach looks feasible from the improvement in cycle life, the reviewer felt that it is not realistic to assume that the anode will be free of dendrites with the proposed gel electrolytes in ether solutions, based on the vast number of studies with Li metal rechargeable systems in the past. The reviewer concluded by highlighting that the safety issues associated with this system are still to be answered, and offering uncertainty as to how increasing the thermal runaway temperature to 165°C would help with the Li metal anode. Another reviewer commented that for the development of the new construction, a LiS battery system is proposed. A Phase 1 gel electrolyte for the lithium side (where Li_2S_2 is insoluble) and a different composition Phase 2 electrolyte (where it dissolves polysulfides for the sulfur side of the cell) is used in a large format prismatic cell construction. The reviewer also mentioned that the concept has been demonstrated in small 0.25 Ah cells where 140 cycles have been demonstrated. One evaluator commented that the approach seems reasonable, but might rely too much on modeling. The reviewer suggested that stepwise experiments for cell size scale-up might be beneficial in view of many variables involved with this complex and challenging technology. The final reviewer noted that the use of LiS as a base technology for this development (acknowledging that Sion Power uses this technology) is aggressive, but is probably key to getting the high energy LiS into automotive sized batteries. The reviewer concluded by stating that there are still questions around the safety and cycle life goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reactions to this question were mixed. One evaluator stated that there is a really good progress with promising results. Another reviewer described that the 2.5 Ah cell has been cycled over 100 times with only a slight decrease in capacity on each cycle. The gel polymer is mixed with a silica filler. The mixture could be coated with slot die techniques in the 2 to 10 micron thickness. The Li anode did not show mossy lithium deposits after cycling. It is expected that 500 to 1,000 cycles can be obtained with the new construction using a uniform pressure on the cell, the dual-phase electrolyte, and solid-electrode interface formation on the lithium from the Advanced Research Projects Agency-Energy (ARPA-e) project. The reviewer concluded by mentioning that the dual-phase electrolyte eliminated thermal runaway on 50% of the cells tested at end-of-life. One commenter felt that reasonably good progress has been achieved within the last couple of years, consistent with the project plans as well as with the DOE goals. The reviewer mentioned that improvements in both cycle life, beyond the modest target of 50 cycles to about 140 cycles without Li dendrites, with twice the anode capacity, and a marginal improvement in thermal safety have been demonstrated in small pouch cells with the proposed two-component electrolyte system. The researchers completed the design of large-format 2.5 Ah cells and developed the hardware system for the production of gel-polymer coated anodes and initiated the production of cells. The reviewer concluded by stating that surprisingly, there were no cell level data presented here to support the claims of improvements in cycle life and rate capability in full cells. The final reviewer highlighted that last year's impressive results were presented again this year, perhaps from poster slides, but progress since then seems slow. Some modeling results were shown but may or may not represent reality in physical cells. The poster discussion indicated that the first 2.5 Ah cell was built and 250 Wh/kg specific energy was achieved with other testing underway. The reviewer stated that from discussions, the program seems to be on track and that this is very challenging work with breakthrough potential.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reactions to this question were mixed. One person mentioned that collaboration with BASF has significantly increased the effort on the project. Another reviewer indicated that the collaborations are limited, but seem adequate in this Phase. A reviewer suggested that it could be beneficial to collaborate with National Labs and others. One evaluator pointed out that there are no partners on this project; however, Sion Power has been involved in collaboration outside this project with BASF for the development of materials for Li-S cells. The last reviewer commented that the project needs to include additional collaboration with ionically conductive anode coating developers.

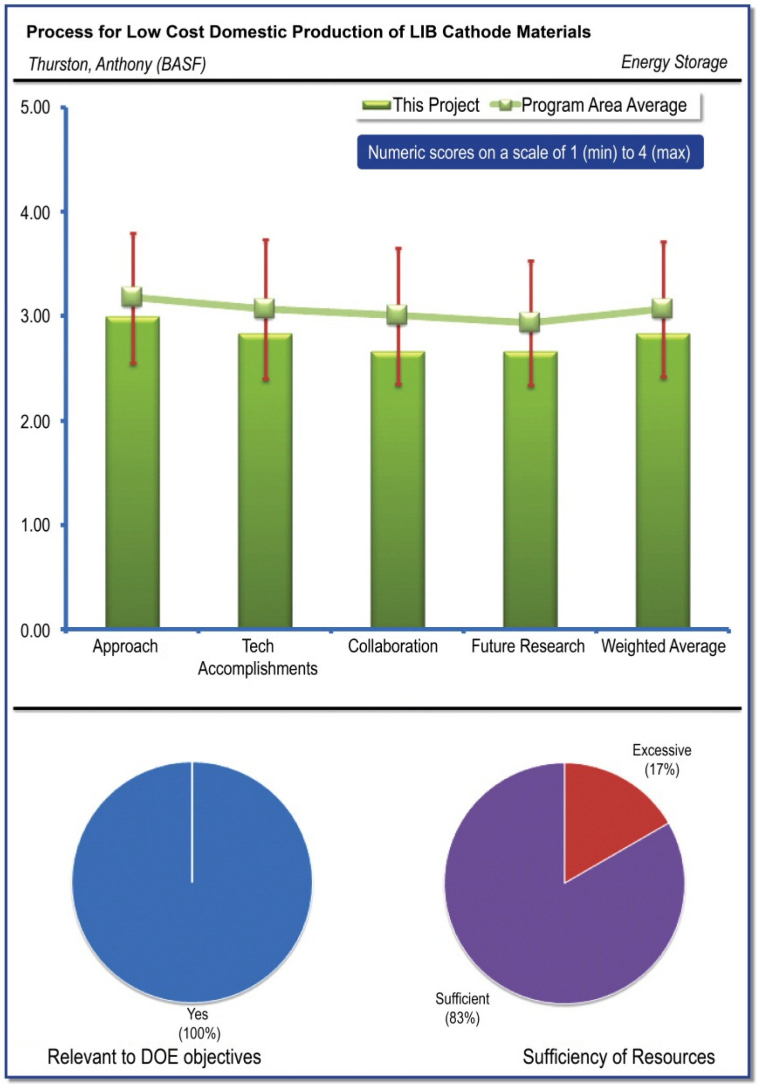
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Responses to this question were mixed. One person commented that there are clear plans for future research to: i) finalize the design of 2.5 Ah cells, fabricate them and test under USABC test conditions; and ii) demonstrate their high energy, improved cycle life, and safety. The reviewer felt that these plans are consistent with project objectives. Another reviewer commented that the demonstration of good cycle life of the 2.5 Ah cells by August 2011 will be a key to the viability of the system. One reviewer commented that the proposed work is consistent with the achieved results, but cautioned that the researchers need the cell testing results to be fully validated and fixed for future work. The reviewer also observed that additional collaboration on anode and electrolyte structural characterization inside the subprogram would better verify materials characteristics. Another evaluator felt that there were not much details or explanation of how the results were used to adjust development path. One reviewer cautioned that the program should not move to large format cell stage, but should focus on advancements at a more fundamental (small or lab-cell) scale, if the program is continued. The final person asserted that the cycle life goal of 1,000 cycles for an EV application should not be compromised.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All reviewers agreed that the financial resources are adequate. One person stated that they are okay. Another reviewer expanded somewhat, indicating that the resources are adequate for an exploratory project. The final reviewer commented that the resources are adequate for this project to achieve the objectives.

Process for Low Cost Domestic Production of LIB Cathode Materials: Thurston, Anthony (BASF) – es013



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All reviewers had positive responses to this question. One person provided detailed comments, stating that this project is quite relevant to the overall DOE goals. It is important to develop low-cost production methods for cathode materials being developed under the Batteries for Advanced Transportation Technologies (BATT) and Advanced Battery Research (ABR) programs, and BASF is well positioned to undertake these studies. The objective is to produce two cathode materials, suitable for electric vehicle application, using BASF's existing assets and low-cost production process and to validate their performance in cells and battery packs. Also, there are plans to work with auto OEMs to ensure that the cathode materials being produced meet the standards. Specific objectives for this year include: i) reduction of processing time by 25%; ii) increase in production capacity by 25%; iii) increase energy density of cathode material (Ah/kg) by 25%; and iv) initiate pilot plant production of NCM materials at a greater than 100kg level. The reviewer felt that these studies, if successful, will lead to the incorporation of high-energy and low-cost cathodes in Li-ion cells for enhancing the PHEVs, which would in turn reduce the petroleum consumption, and pave the way towards petroleum replacement. Another reviewer remarked that the availability of a high performance, low-cost cathode material produced in the U.S. is essential for a viable EV, PHEV and HEV domestic production. One commenter affirmed that the project properly addresses economical and technical aspects of Li cathode material production functional to DOE objectives. Another person commented that the low-cost cathode materials from domestic and global suppliers are needed to meet the battery cost goals. Another reviewer pointed out that the project provides for the development of materials and processes to provide higher specific capacity and lower cost cathode materials. The final reviewer reported that the project is an excellent example of technical progression of manufacturing efficiencies.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Responses to this question were mostly positive, with one reviewer providing criticisms. One reviewer provided detailed comments, describing that the approach is to utilize BASF's production and R&D facilities in U.S. to develop low-cost production process for the cathode materials developed in DOE laboratories and to ultimately produce them at a few ton levels. This approach also involves the selection of proper starting materials and adopting suitable blending methods and calcing schedules. In addition, BASF will work with Farasis Energy, Inc. (Hayward, California) to evaluate these materials in 18650 cells and with commercial partners such as automotive OEMs and Tier I suppliers to validate BASF's cathode materials and finally test a Li-ion battery pack containing BASF's cathode materials. Typically, manganese-rich mixed metal (NCM) oxides are being developed which provide considerable cost savings together with enhanced specific capacities. The reviewer concluded by remarking that the project looks feasible and well designed and integrated with the material development efforts in the DOE laboratories, especially with the licensing of ANL cathode material technology. Another reviewer expressed that the project is clearly designed with well selected production steps. The reviewer added that the preparatory cost analysis gives also quantitative savings. One reviewer commented that the researchers had developed a good approach to target both compositional modification and process improvement to achieve cost reduction. One reviewer explained that the project will develop production capability to produce two cathode materials for electric vehicle applications. The reviewer added that the project will identify and qualify starting materials as well as evaluate new materials for performance in small test cells. The final reviewer stated that the approach does not evaluate the process cost of the conventional cathode production material and does not have any process cost targets, which are important for the success of meeting battery cost goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reactions to this question were mixed. One reviewer provided detailed comments, stating that impressive progress has been achieved within the last two years, consistent with the project plans as well as with the DOE goals. Cathode materials of various formulations were synthesized in the NCM category, some with high rate capability (10ºC) and some with high capacity (approximately 170 mAh/g). Significant improvements were made in the synthesis of NMC-111 cathode, with the process changes resulting in reduced processing time and increased potential production capacity, while maintaining product performance. Several of these cathode materials showed performance comparable to the state of art materials. Among these several formulations successfully synthesized and evaluated, there is the class of high-energy cathode materials (with low Co and Ni) that shows impressive performance characteristics of about 280 mAh/g and good rate capability. The reviewer highlighted that this is indeed a notable accomplishment, considering their inherently poor power characteristics. Another person commented that there had been good coupled improvements in specific capacity and materials cost $/kg. The reviewer suggested that the researcher should also report $/mAh and estimated effect on specific energy and battery $/kWh cost. The reviewer felt that the project seems to be on target with milestones and plans and that there was good progress and credible that objectives will be met at end of program. One reviewer offered the opinion that NCM 226 is the lowest cost NCM with the highest specific capacity. The reviewer added the suggestion that the cathode should be characterized for the cycle life, calendar life, energy density, low temperature performance, safety, etc. to focus on the low-cost material. Other reviewers were more critical, with one evaluator commenting that there is more evidence with respect to the previous year about the progress achieved on cathode materials. The reviewer added that the progress is more appreciable, but with no clear evidence of a substantial breakthrough in material research and in preparation process. However, still some concern remains about the real transferability of the process to other cathode materials. The final reviewer simply stated that the progress to develop process and production capability has been slow.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments to this question were generally positive, but with some criticisms. One evaluator indicated there was good collaboration with Farasis and plans for further collaboration with others in future. Another reviewer, however, stated that the collaboration was more of a supplier arrangement than as a collaborator. One reviewer acknowledged the collaboration with Farasis to evaluate the BASF shows reasonable performance in cylindrical and pouch cells. The reviewer was concerned that the appearance of the pouch cells is less than satisfactory; any bubbles in the outer packaging material is not good and indicated non-uniform pressure on the electrode stack. Another reviewer acknowledged that there is ongoing collaboration with Farasis energy to assist in the assembly and testing of 18650 cells and packs from BASF-produced NCM cathode materials and to provide guidance for design modifications in order to meet customer requirements. The reviewer also mentioned that there is collaboration with ANL via technology transfer. One person criticized that the collaborations are still limited to cell preparator while other collaborations were announced, but were not disclosed and not even justified in term of needs. The final reviewer commented that the collaborations should include a mature cell producer to assess the acceptance of the low-cost cathode material.

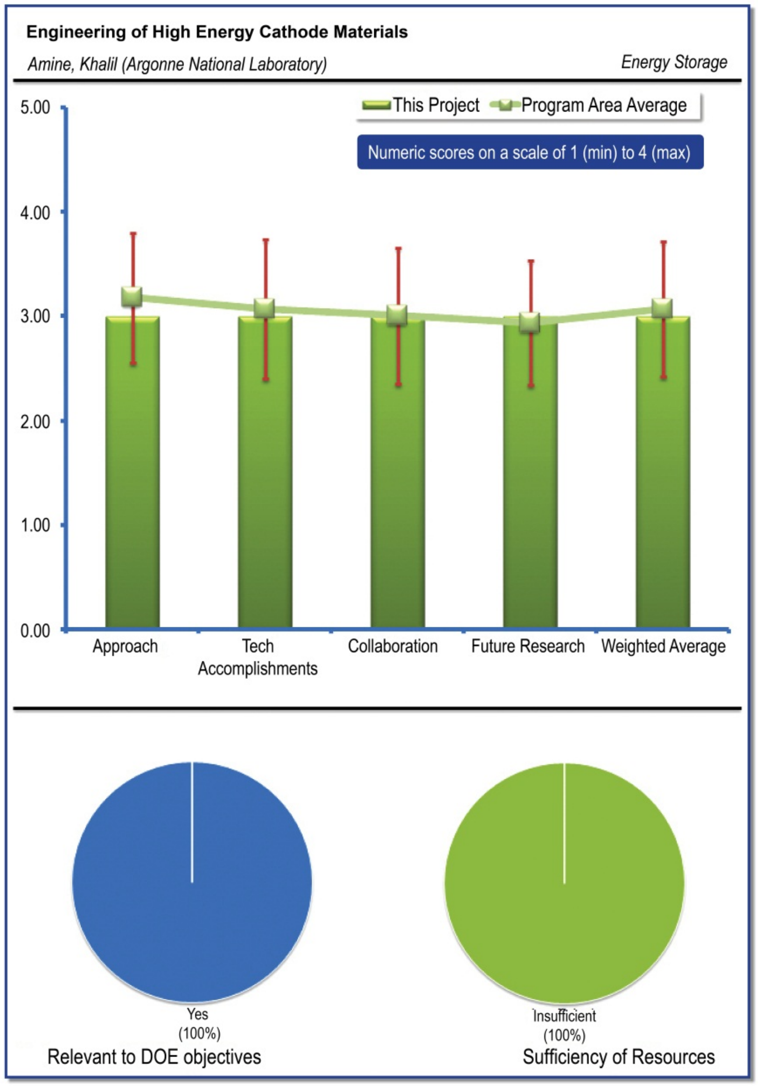
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Responses to this question were mixed. One reviewer stated that the proposed future research is well planned and the future plans are consistent with the overall goals and include: i) pilot production of 1 MT of NCM in pilot plant; ii) pilot production of 100 kg of high energy NCM in pilot plant; iii) verify the quality of the HE NCM materials;, and iv) evaluation of Li-ion battery pack with the cathode materials produced here. Another person agreed that researchers have a good plan, but suggested that it should be flexible about whether goal should be 2, 1, or 4 new materials since even one significantly improved material with substantial cost reduction would be a success. One reviewer commented that the fact that the researchers have a 25% improvement objective for processing time and production capacity as well as a 25% improvement in energy density is an indication that the process still needs definition. The reviewer added that the cost estimations should have been clear by this time in the project. Another reviewer expressed that the proposed work is generically consistent with the achieved results, but remarked that there is no indication on the way the next steps and improvements will be reached. The final reviewer asserted that the future research should focus on the cost analysis as soon as possible to assess the success of the development work and DOE's support.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reactions to this question were mixed. One evaluator commented that the resources of about $5 M with approximately 50% cost-share over three years are consistent with the project scope in terms of developing low-cost production methods for the next generation cathode materials for their incorporation in Li-ion batteries. The remaining reviewers were more critical. One evaluator commented that BASF has had sufficient resources to accomplish their goals, but the reviewer was disappointed in the progress made by this international company that should be a leader in this field. The last reviewer expressed that they are significant efforts and resources in relation to the product improvement effort that hardly justifies a 50% cost sharing.

Engineering of High Energy Cathode Materials: Amine, Khalil (Argonne National Laboratory) – es015



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer affirmed that the project has a strong emphasis on the cathode capacity, the bottleneck for a higher energy range battery.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer remarked that the researchers had developed an innovative approach and that it was interesting to see the graphene approach applied on these materials. The use of graphene is interesting, it seems it provides higher conductivity as well as a lower reactivity towards the electrolyte. It is hard to see how the tap density is affected after using graphene. In the future, the reviewer suggested that it should be important to report some of the capacity data in mAh/g total electrode weight. Some of the powders maybe excellent at the active material level, but require too much conductive additive or may not load well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer cautioned that at some point, before the authors go too deep into one particular approach (such as carbon coating), they should test their material in a more industrial oriented battery. The reviewer felt that is also important to study how stable is Mn in these structures, in particular towards Mn dissolution.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer expressed their understanding of the difficulties in finding collaborators from industry based in the U.S.; however, the authors should go an extra mile toward that goal.

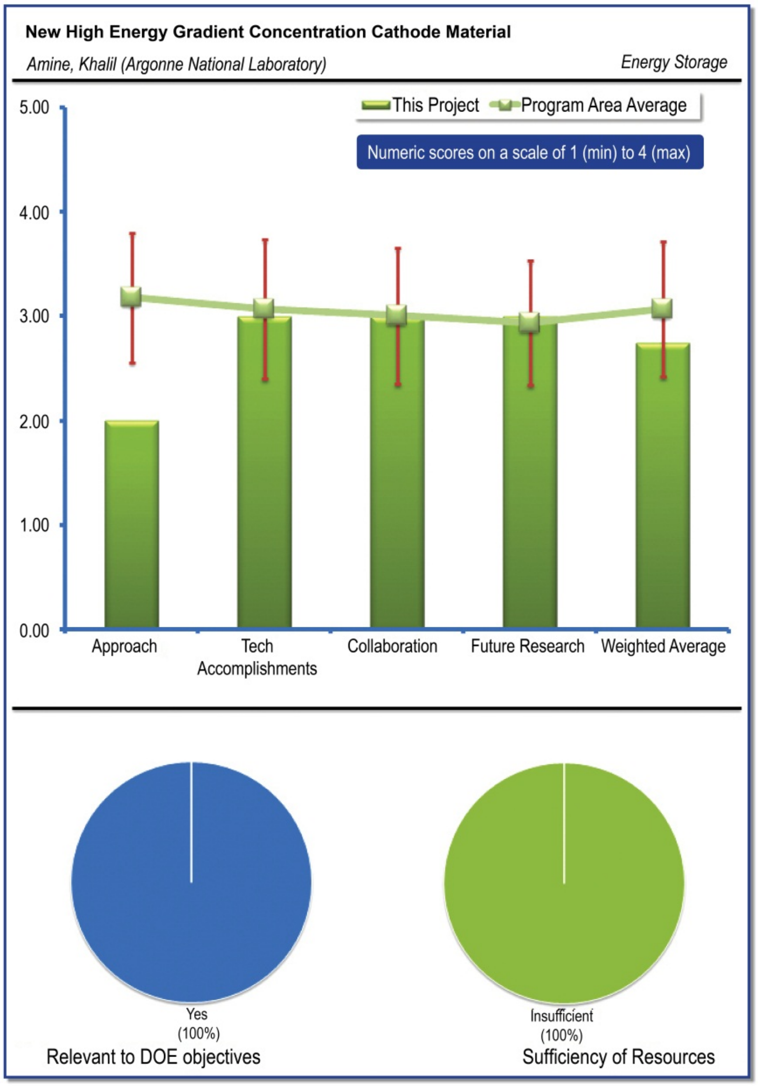
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer stated that they would like to see more full battery data of the commercial type. The reviewer acknowledges that this is difficult, and there is a lot of intellectual property involved, but collaborations with the U.S. industry are badly needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer commented that the financial resources are sufficient at the moment; however, if the authors move into industrial battery testing they may need additional resources.

New High Energy Gradient Concentration Cathode Material: Amine, Khalil (Argonne National Laboratory) – es016



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer agreed that the project is very relevant as the authors concentrate their efforts on cathode capacities.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer provided detailed comments that the gradient approach is a very creative idea; however, the reviewer had the impression that the practical feasibility of the process is not yet certain. The precipitation process is continuous but only for a few hours. After a few hours the precipitation process has to stop. Furthermore, since the metal cations concentration is varying over time, the precipitation process never reaches steady state. This lack of steady-state produces a variety of different materials, and unfortunately too much powder out of specifications, or with powder that shows lower performance. The powder that the authors have shown yield high capacity, but the reviewer had the impression that other powders, coming from the same lab, may have higher potential in the practical arena.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer observed that based on the cross-section analysis, it seems that some of the particles are not very dense at the center. At some point it would be important to disclose the mAh/g unit in terms of total electrode weight. At the moment, it seems that the authors are considering only the weight of the active powder.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer acknowledged that participants in this field of study know that is difficult, but additional efforts with industrial partners based in the U.S. should be pursued.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

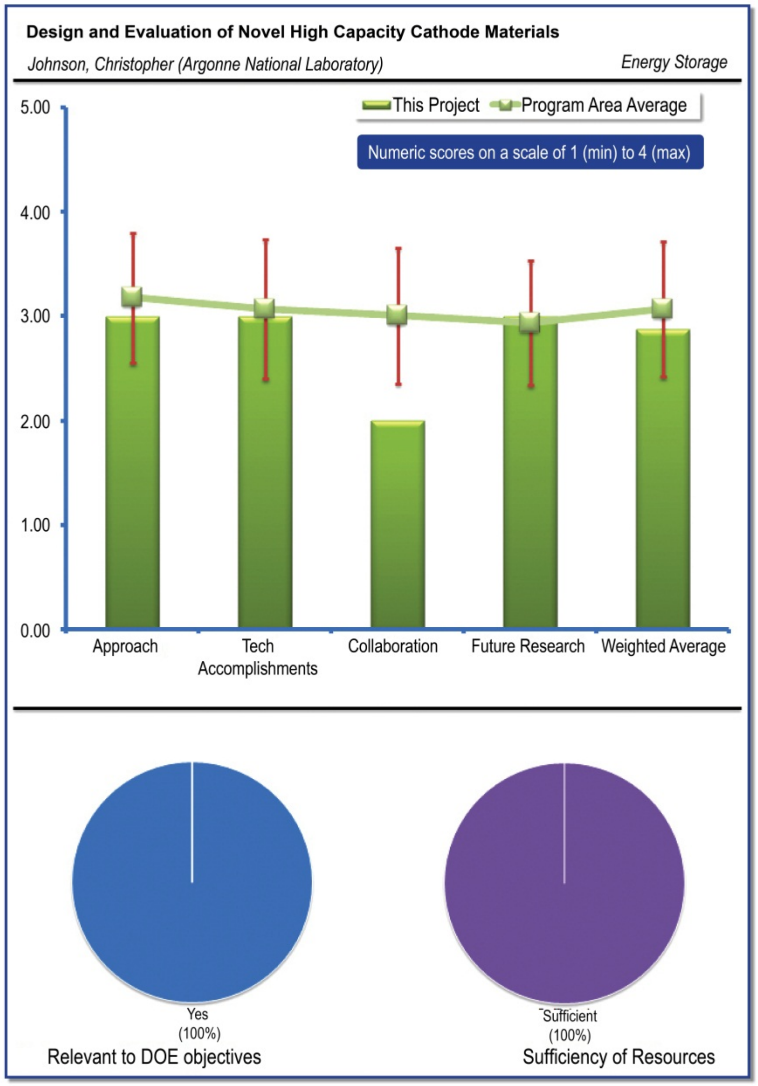
The reviewer suggested that in the future the authors may try to concentrate in the industrial synthesis of these gradient powders. The researchers should try to mimic the very successful gradient approach but with a method that generate a more uniform powder quality.

The reviewer acknowledged that this can be very challenging and require additional creative efforts. However, if the powders are showing very promising results in industrial battery, it may be worth trying.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer stated that the resources may be insufficient if the authors explore the performance of their powders in industrial batteries.

Design and Evaluation of Novel High Capacity Cathode Materials: Johnson, Christopher (Argonne National Laboratory) – es017



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer observed that it concentrates the efforts on high-energy cathodes which are critical if we want to increase the battery range.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer offered that it is an interesting approach in an area that is risky and that it seems that there is a lot of chemistry at the electrode level. However, the reviewer added, if the authors managed to resolve some of the issues (such as reforming the Li_2O to form nanoscopic Li_5FeO_4) we may have a very high payoff in terms of cathode capacity.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer explained that it is a difficult system, an area of research that involves a lot of synthetic efforts. The reviewer added that in order to judge better the potential of these materials, the capacity should be reported also in terms of mAh/g total electrode. The reviewer felt that maybe the capacity values may decrease substantially, but improvements in this area are very important.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer commented that the project seems to be in a development phase, more concentrated in basic research, the collaboration with industry may not be strong at the moment.

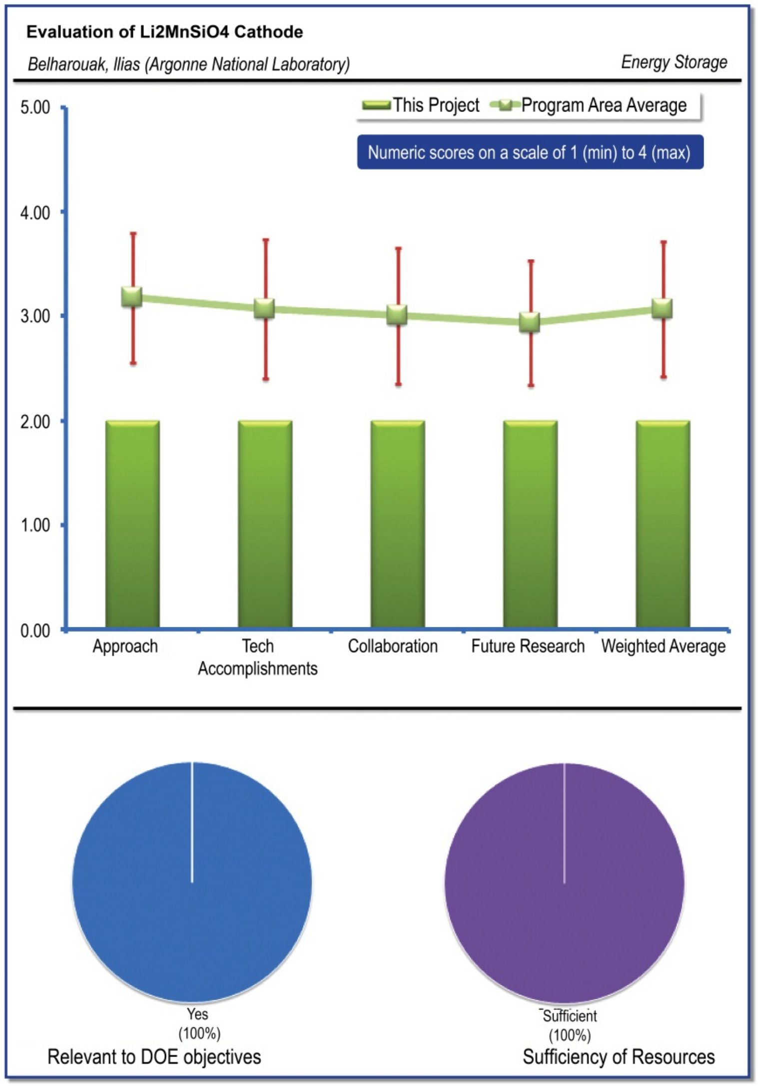
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer suggested that in the future, the authors should also study the possibility of Fe being lost into the electrolyte. The reviewer had the impression that iron dissolution (from the electrode or from iron impurities) will have a very negative impact on cell performance.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer did not provide a comment to this question.

Evaluation of Li_2MnSiO_4 Cathode: Belharouak, Ilias (Argonne National Laboratory) – es018



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer stated that this research is supportive of the DOE overall objective as it concentrates the efforts on a high-capacity cathode.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer stated that the approach was an interesting attempt to improve the Li_2MnSiO_4 performance; however, it seems, the authors were confronted with too big of a challenge. The reviewer mentioned the discovery of crystallinity on a charged electrode was important and interesting.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer observed that it seems it was hard to move this study forward.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer explained that apparently the collaboration with other institutions was not strongly pursued.

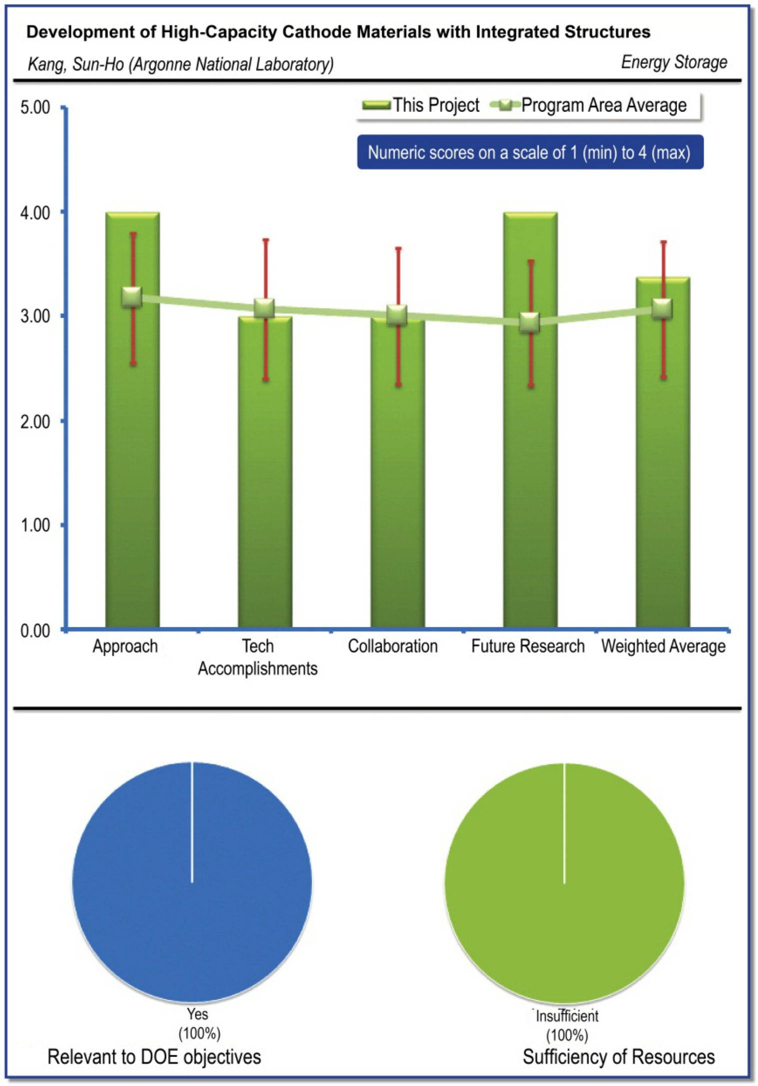
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer noted that it seems that the project is being discontinued.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer did not provide a comment to this question.

Development of High-Capacity Cathode Materials with Integrated Structures: Kang, Sun-Ho (Argonne National Laboratory) – es019



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer stated that the work is very related to the overall DOE objective; the electrode capacity is critical in this case.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer agreed that the approach is very focused on technical barriers, mainly Mn dissolution and the voltage shape change. The reviewer suggested that maybe the authors should also indicate the electrode capacity in terms of mAh/g total electrode weight. The reviewer also explained that if the powders require large amounts of conductive additives, or if they do not load well (low tap density), that should be an area where the authors should strongly focus their effort also.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer stated that the authors have shown good progress and they seem to be trying to build a strong bridge with industrial partners. The reviewer also agreed that the researchers are also downselecting the best two most promising cathode chemistries to be tried in full batteries.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer felt that the collaboration with other institutions seems to be moving in the right direction.

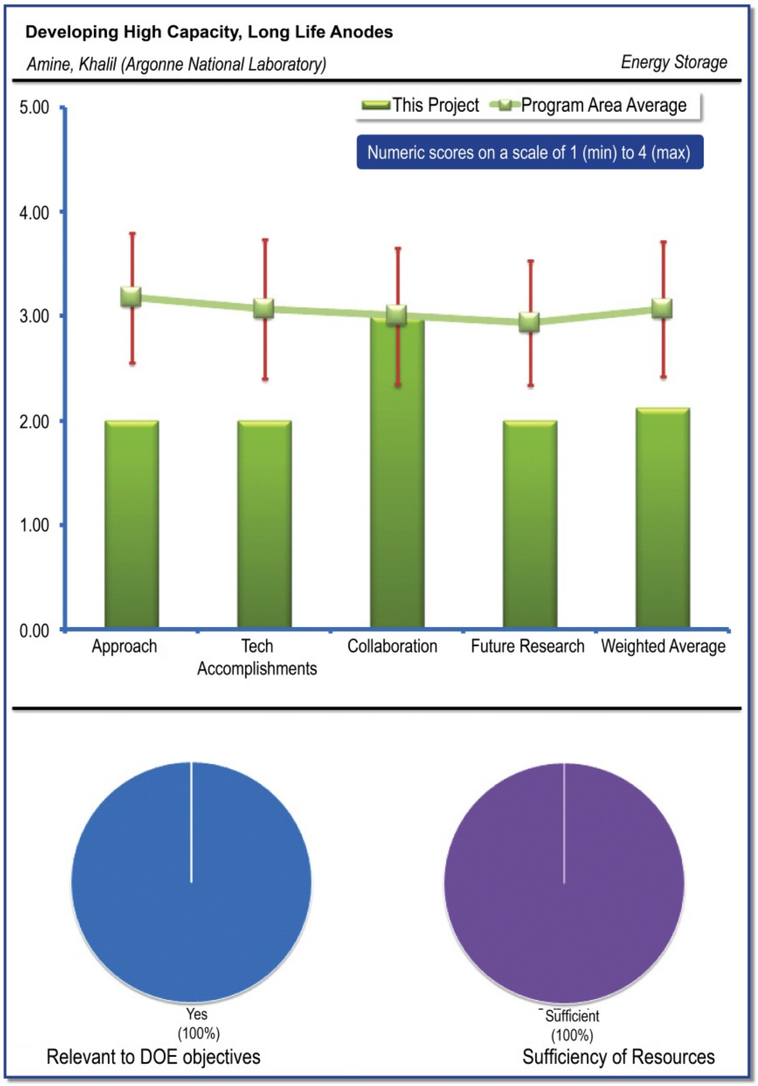
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer stated that it seems that the authors are focused in building a bridge between their basic research findings and industrial batteries. They have clearly indicated their commitment to additional efforts with U.S. companies. It may not be easy to overcome barriers such as intellectual property, but that type of collaboration is badly needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer felt that the researchers had insufficient funding if the authors strongly pursue industrial collaborators.

Developing High Capacity, Long Life Anodes: Amine, Khalil (Argonne National Laboratory) – es020



REVIEWER SAMPLE SIZE

This project had a total of one reviewer.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

The reviewer stated that anodes with improved performance over current graphite anodes are desirable. The reviewer continued, noting that considering that very little progress has been made on increasing the reversible capacity of cathode over one electron per cation, the next large performance improvement of Li-ion cells may come from using anodes beyond graphite.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

The reviewer observed that the project focuses on using mostly engineering approaches. The reviewer felt that shifting away from the old titanate anodes is a step in the right direction, but the researchers still need to consider revolutionary approaches to solving the reversible capacity and low cycle life of the new anodes with large volume changes during cycling.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

The reviewer observed that all of the materials shown in the presentation are still far away to be competitive against current graphites in actual cells in many aspects even though they may have some advantages here and there.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

No comments were received in response to this question.

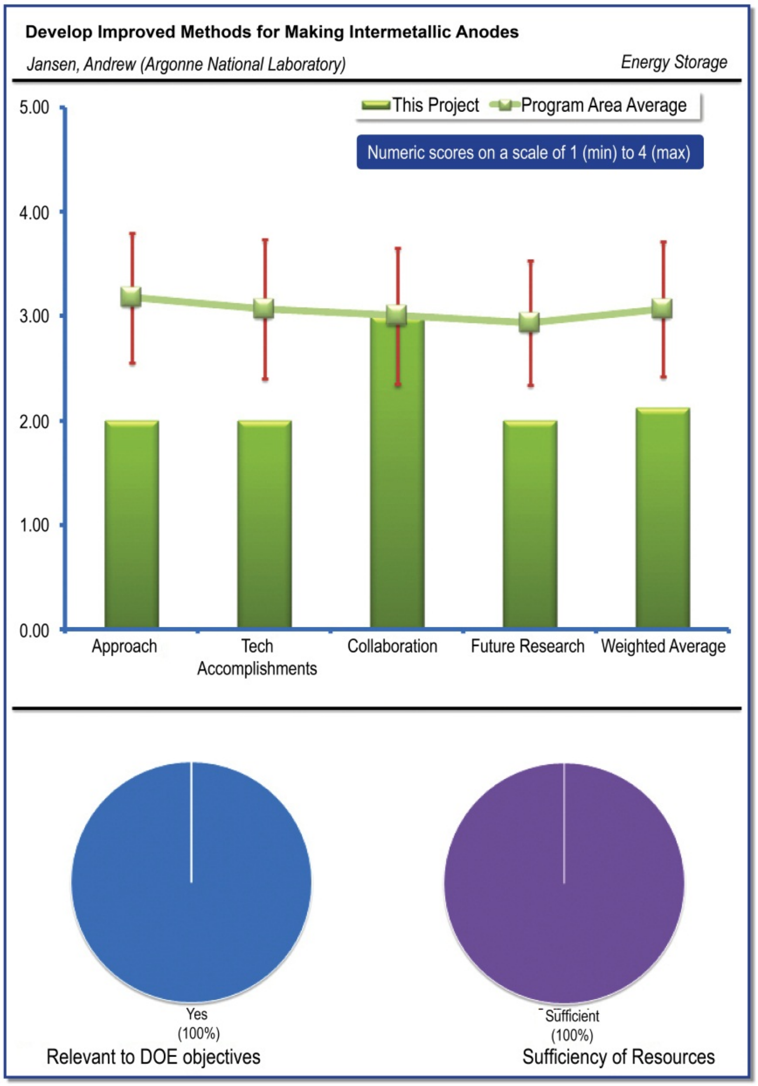
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The reviewer indicated that the failure mechanisms for this type of anodes have been well studied in the past. The reviewer emphasized that the researchers need new ideas to overcome the large irreversible capacity during first cycle and low cycle life of these new anodes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Develop Improved Methods for Making Intermetallic Anodes: Jansen, Andrew (Argonne National Laboratory) – es022



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

No comments were received in response to this question.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer stated that the researchers need new ideas to make the Cu_6Sn_5 type anode with large volume expansion work. The reviewer felt that the current approach in controlling particle size and using new binders did not seem to work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer remarked that it was good to expand the exploratory type work beyond Cu_6Sn_5. The reviewer felt that some results from WildCat seemed to show some promise.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in response to this question.

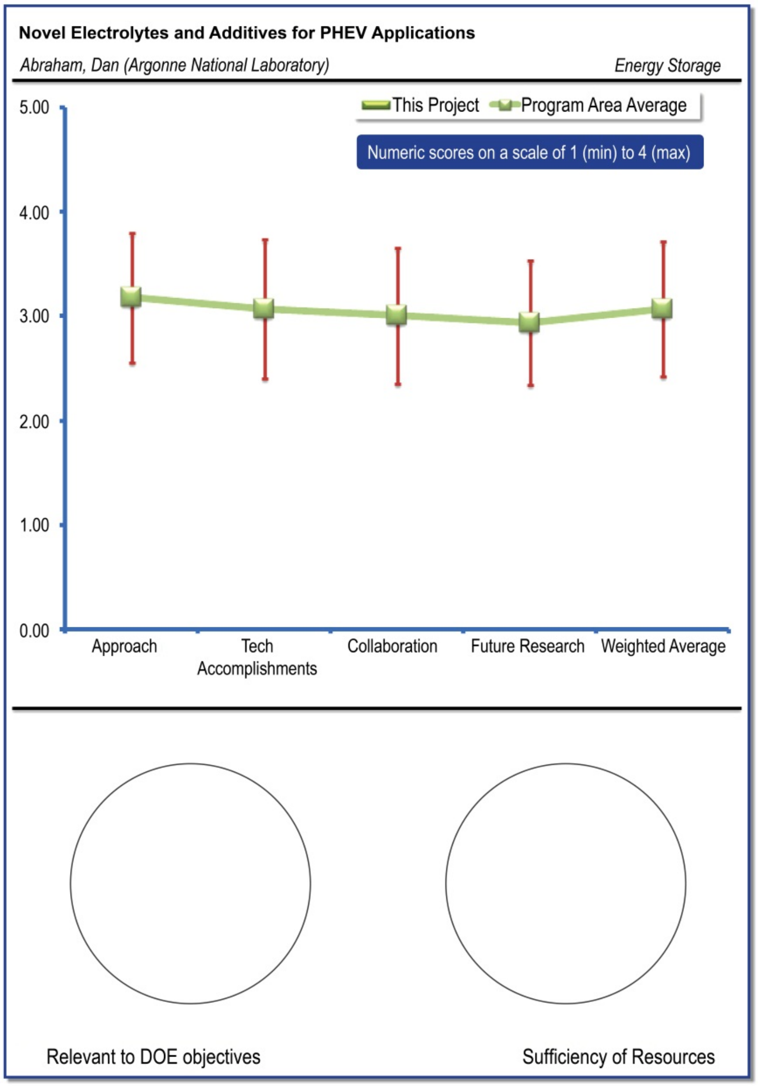
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer suggested that more binder does not seem to be able to control the expansion of the anode. The evaluator added that the researchers need to confirm that the metal oxides like $Fe_2O_3$and Li_5FeO_4 are promising before doing much. They concluded by offering that these materials will need pre-lithiation first to overcome the irreversible capacity first.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Novel Electrolytes and Additives for PHEV Applications: Abraham, Dan (Argonne National Laboratory) – es023



Reviewer Sample Size

This project had a total of zero reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

No comments were received in this section.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments were received in this section.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

No comments were received in this section.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in this section.

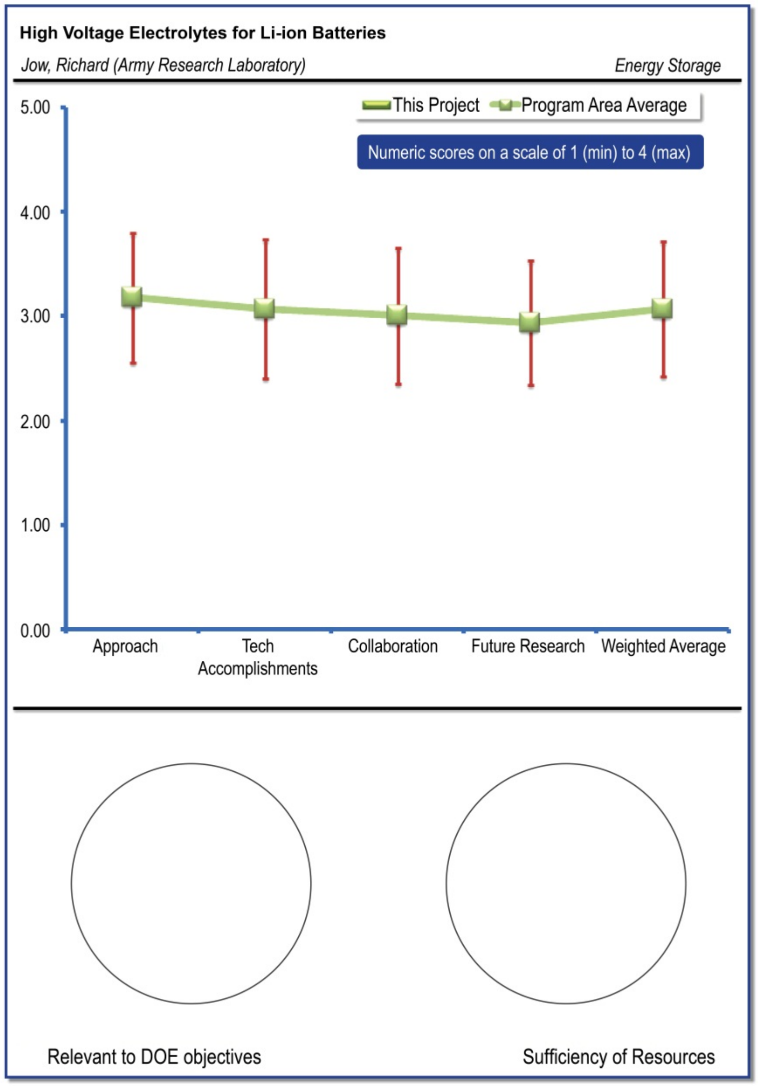
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

No comments were received in this section.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in this section.

High Voltage Electrolytes for Li-ion Batteries: Jow, Richard (Army Research Laboratory) – es024



REVIEWER SAMPLE SIZE

This project had a total of zero reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

No comments were received in this section.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

No comments were received in this section.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

No comments were received in this section.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

No comments were received in this section.

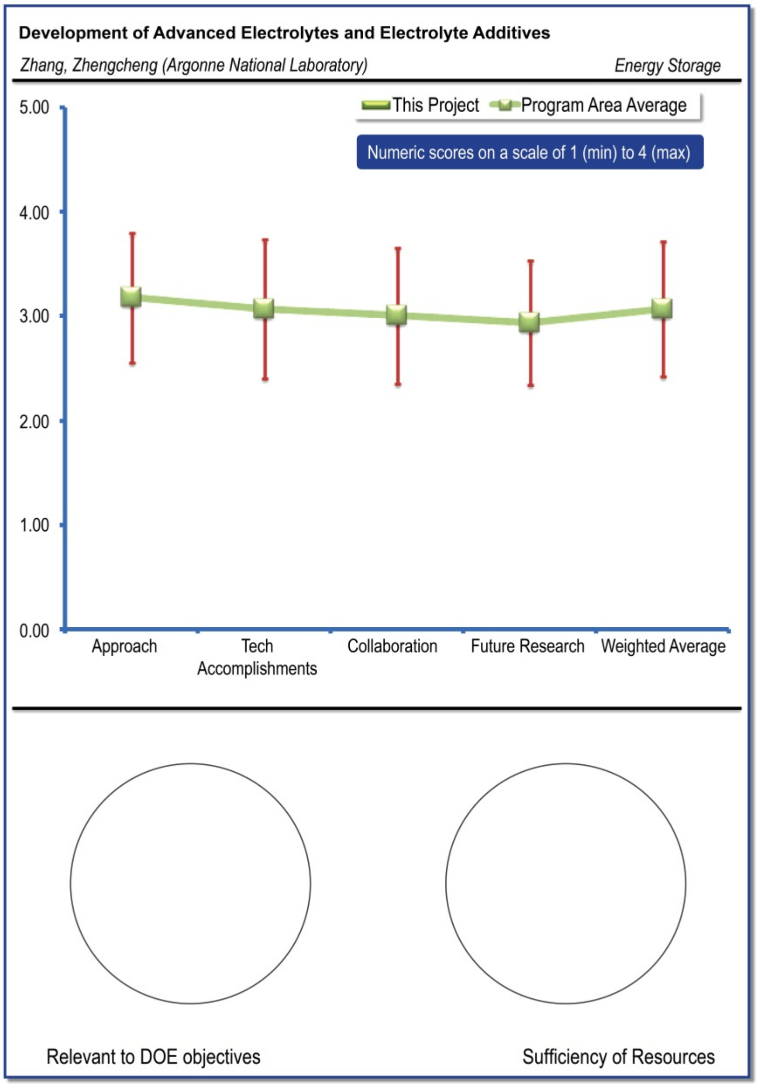
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

No comments were received in this section.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

No comments were received in this section.

Development of Advanced Electrolytes and Electrolyte Additives: Zhang, Zhengcheng (Argonne National Laboratory) – es025



Reviewer Sample Size

This project had a total of zero reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

No comments were received in this section.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments were received in this section.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

No comments were received in this section.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in this section.

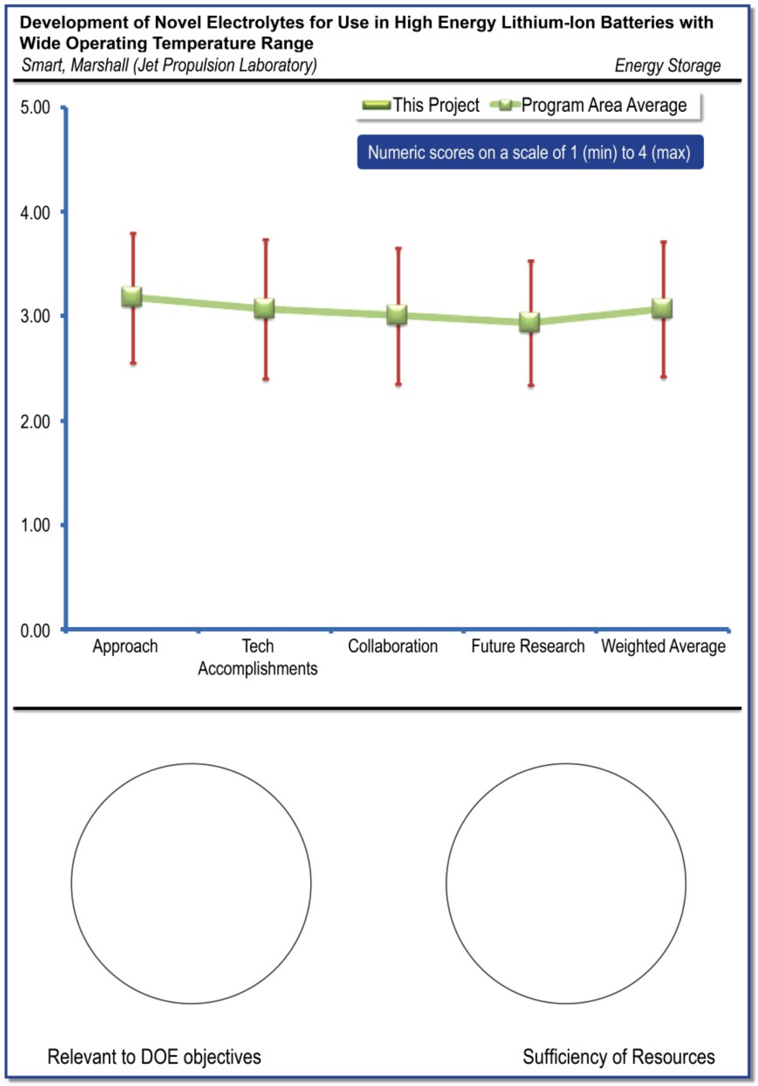
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

No comments were received in this section.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in this section.

Development of Novel Electrolytes for Use in High Energy Lithium-Ion Batteries with Wide Operating Temperature Range: Smart, Marshall (Jet Propulsion Laboratory) – es026



Reviewer Sample Size

This project had a total of zero reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

No comments were received in this section.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments were received in this section.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

No comments were received in this section.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in this section.

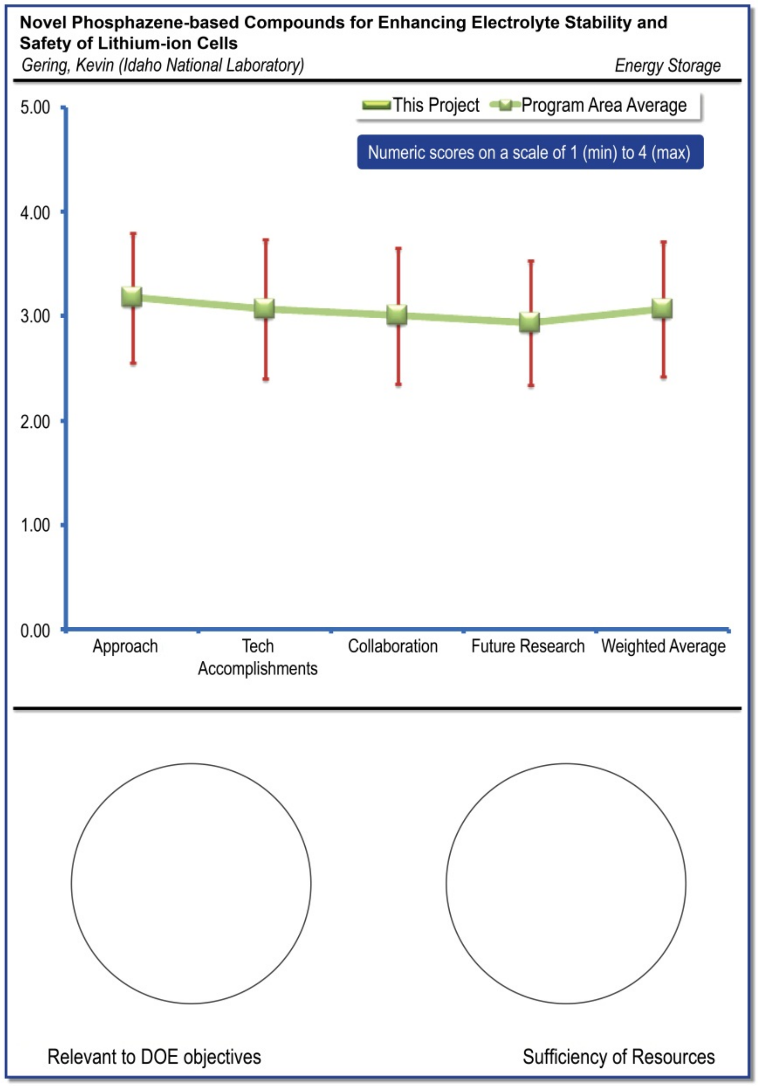
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

No comments were received in this section.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in this section.

Novel Phosphazene-based Compounds for Enhancing Electrolyte Stability and Safety of Lithium-ion Cells: Gering, Kevin (Idaho National Laboratory) – es027



Reviewer Sample Size

This project had a total of zero reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

No comments were received in this section.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments were received in this section.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

No comments were received in this section.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in this section.

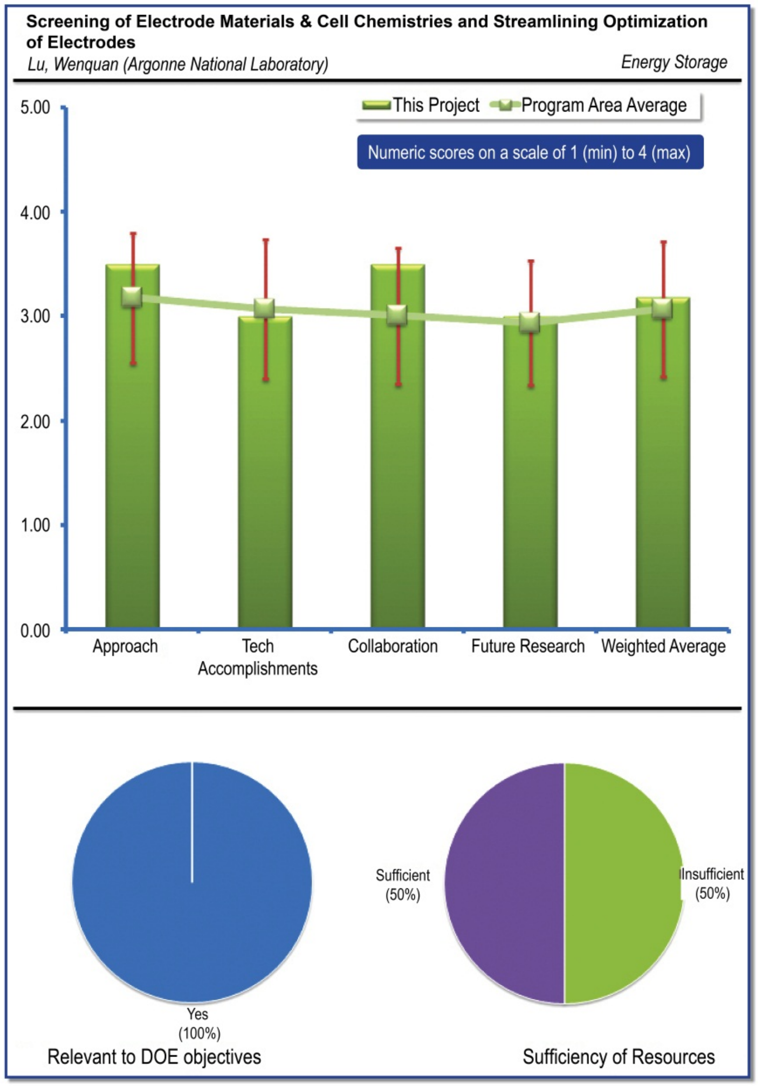
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

No comments were received in this section.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in this section.

Screening of Electrode Materials & Cell Chemistries and Streamlining Optimization of Electrodes: Lu, Wenquan (Argonne National Laboratory) – es028



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer observed that this is sort of advance screening of materials in many ways similar to what battery manufacturers do routinely. The reviewer suggested that it may be helpful to have some strict guidelines to show what are the parameters for screening and what filters are used to screen the materials ahead of time; in other words, the reviewer asked what the minimum pass criteria was for the screening. Another reviewer felt that the work is very relevant to DOE objectives and that the high energy cathode materials, electrode fabrication, and new electrolytes are extremely important when we try to increase the range of an HEV.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reactions to this question were mixed. One reviewer was critical of the approach, stating that, by and large, general industry practice has been employed to screen materials; more is expected from a National Lab. The other reviewer felt that the approach was very focused on technical barriers and that it seems that the authors are focusing in very practical issues. This person mentioned several high points of the approach, including: i) that voltage depression of the composite cathode material seems to be a critical component; ii) the work on fluorinated electrolytes is also very important; and iii) optimization of the electrodes is also critical.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to one reviewer, some of the technical findings tend to sound trivial and fully expected [e.g., poor particle connectivity in the electrode can be improved by increasing carbon black (CB)]. For such matters to become of value, the optimal composition and trade-offs are to be discussed and explained. Another reviewer remarked that it is important to move to the more realistic unit of mAh/g total electrode weight as opposed to mAh/g active material weight. This is important because the study suggest that carbon coating of the cathode powder increases the electronic conductivity; however, tap density may go down.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated that the authors should try a stronger collaboration with industrial partners. This person offered that their techniques may help improve the life of the battery.

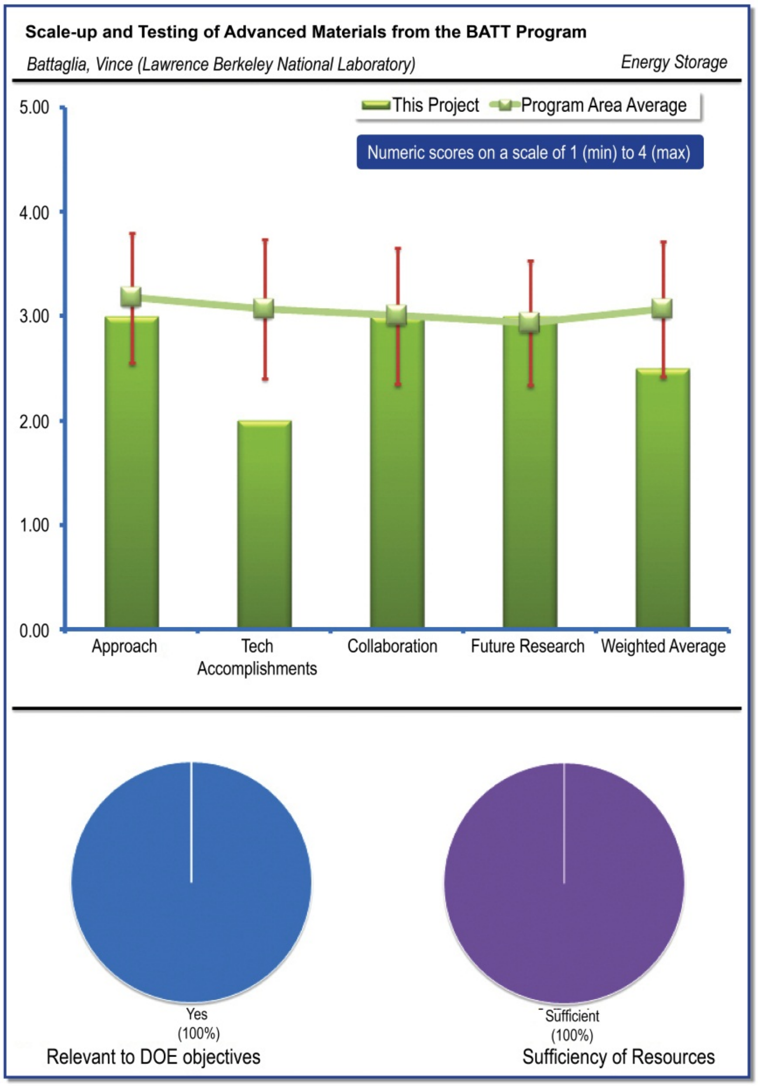
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer suggested that the authors should also focus on the analysis of failed batteries. The reviewer asked whether the researchers could a) measure the conductivity of electrodes taken at the end-of-life and b) use the nanoelectrical imaging of electrodes as a toll for predicting cycle life. This evaluator also thought that it could be of great interest to put together a model, using their variety of measuring techniques, that could explain certain failure mechanisms in commercial batteries. The reviewer concluded by asking whether the failure mechanisms are being addressed by the new materials or electrode compositions.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the project should be expanded towards a stronger interaction with American companies (the reviewer acknowledged that this is not an easy task) and study commercial Li-ion batteries.

Scale-up and Testing of Advanced Materials from the BATT Program: Battaglia, Vince (Lawrence Berkeley National Laboratory) – es029



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer stated that it is important to have a third-party as a central place for evaluations of various new materials at bench scale so that the performance can be compared on the same basis. The reviewer also asserted that it is also important that the central place can recommend materials for the next phase (e.g., scale up) if the same types of materials are supplied by various labs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

No comments were received in response to this question.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

No comments were received in response to this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments were received in response to this question.

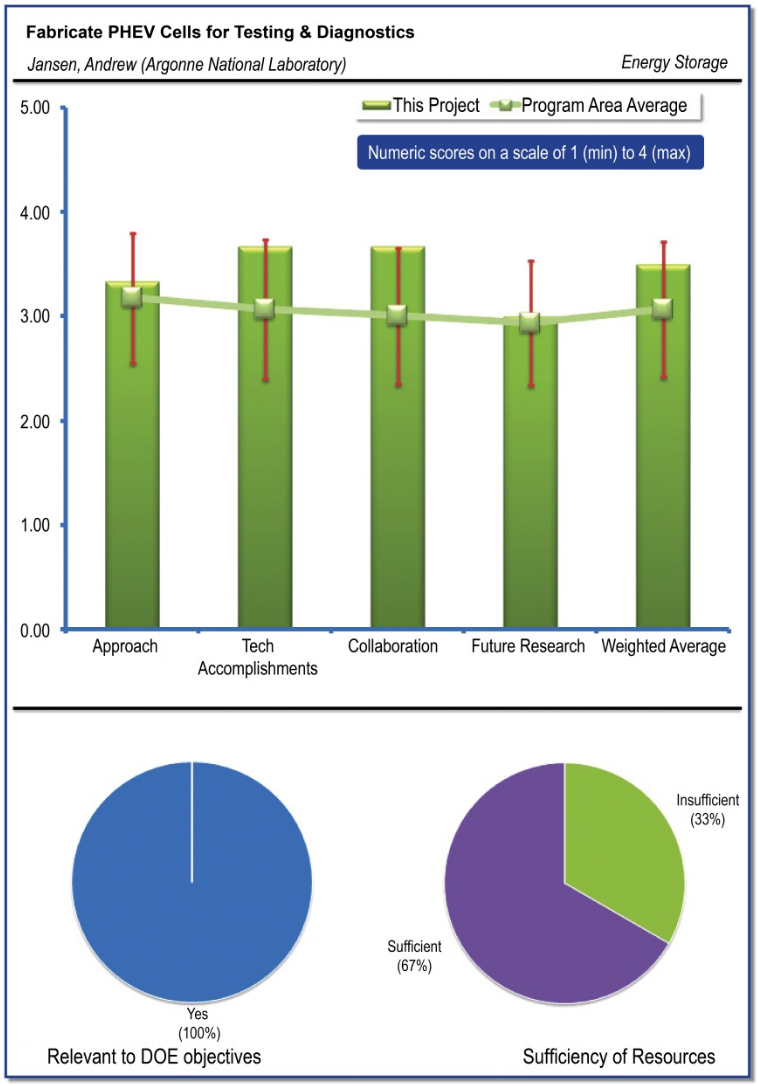
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer stated that besides testing the intrinsic capacity and rate capability of the new electrode materials, the performance of electrode (not the active material) using optimized formations is important from practical applications and should be evaluated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Fabricate PHEV Cells for Testing & Diagnostics: Jansen, Andrew (Argonne National Laboratory) – es030



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reactions to this question were all positive. One evaluator asserted that it is very good for one key DOE lab working Li-ion cells to have the adequate capability on making full cells (at least the 18650 size) at a pilot line scale. Another reviewer expressed that electrode and cell fabrication play a big role in performance and life. The reviewer also pointed out that scale up is a critical step in transitioning R&D into pilot/production processes. The final reviewer agreed that the project is very relevant, particularly if the authors direct their efforts toward the understanding of the failure mechanisms of commercial batteries. The reviewer indicated that data should be compared with the results obtained on batteries assembled using new materials and electrode compositions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer noted that using industry and experts to guide the fabrication processes is a smart approach. Another reviewer felt that the project is very relevant and that it will bridge basic research and industrial batteries. The reviewer emphasized that the cell fabrication facility is critical; there are not too many places where batteries, similar to commercial cells, can be assembled in the U.S., so this is very important. The reviewer concluded by acknowledging that the installation of the cell making equipment, for cylindrical cells, was an important milestone.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person commented that the PI reported excellent progress with a clear execution path. The reviewer suggested that as far as test results go, the researcher should consider other parameters that might impact results (e.g., in measuring material capacity, tap density is a critical parameter that could change the results, sometimes dramatically). Another reviewer highlighted that this is a very important facility that should help bridge the gap between research and development work, as well as industrial cells. For this reason, the reviewer thought that it is important to report some of the capacity data in mAh/g total "electrode" weight and not only mAh/g total "active" weight. Another person remarked that the equipment and machines seem to be adequate for ANL’s plans to produce full cells from scratch. It was not clear to the final reviewer how many tools and means that ANL has for property measurements and controls for cell making. The reviewer suggested that the areas needed to control and measure are mix uniformity, slurry rheology, electrode thickness and variations, electrode integrity, tension of the webs during winding, electrode alignments, dust, separator properties, and so on. The reviewer added that having a standard operating procedure (SOP) for all key steps is critical.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reactions to this question were positive. One reviewer commented that it is very good for newcomers to learn the know-hows from industrial companies. The other reviewer to comment noted that it seems the authors have strongly emphasized interaction with industry. The reviewer acknowledged that this is difficult, and not too many U.S. companies are available; however, the authors should keep working toward that goal.

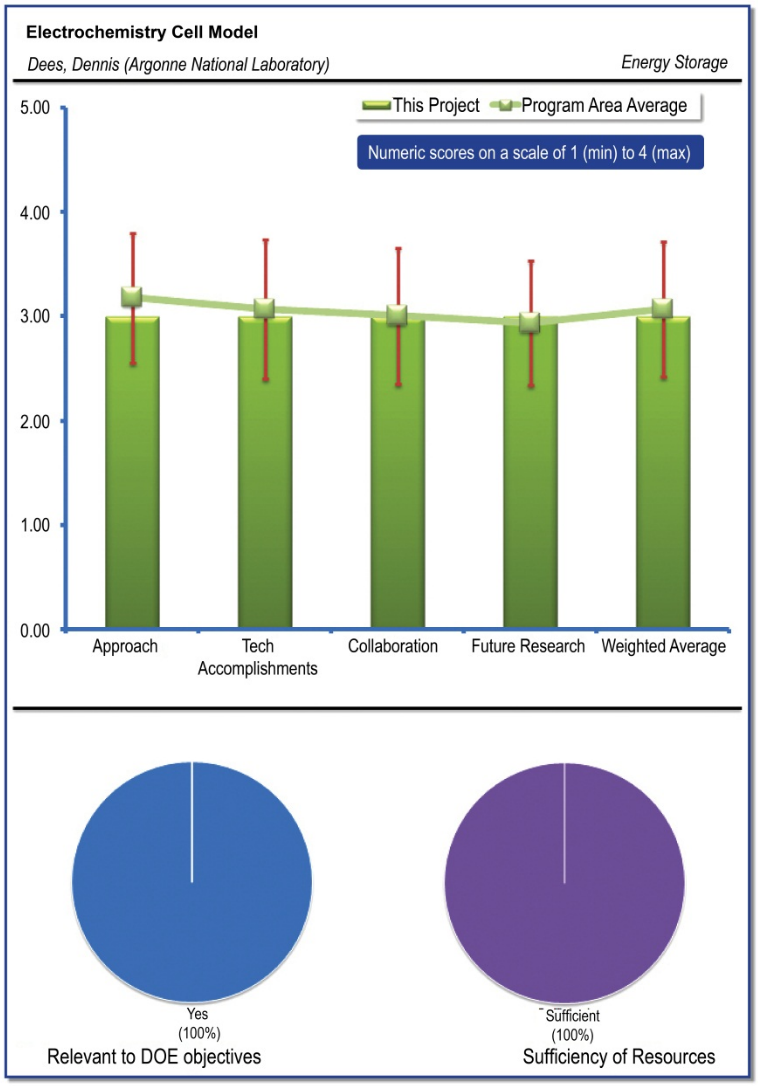
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered suggestions for improving the future work. One reviewer suggested that the researchers need to consider the impact of extraneous factors (e.g., the stack pressure in the case of pouch cells, since they may also impact performance/life data). Another person noted that failure analysis can give important hints on cycle life performance and active material issues that may not show up in standard tests. The reviewer added that the breaking-in of the batteries (formation) is also very important; there is too much "black art" in this area so the reviewer was glad to see efforts in that direction and referenced Slide 15 in the author’s presentation. The final reviewer suggested that the researchers need to keep in mind that there are still some differences between the cells made on pilot scale and production scale. So at some point, this project needs to demonstrate that cells made on the pilot scale can match the cells made on production by a reputable battery company.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The only reviewer to comment stated that maybe the project needs more funding depending on a stronger interaction with industrial partners.

Electrochemistry Cell Model: Dees, Dennis (Argonne National Laboratory) – es031



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer commented that electrochemical modeling work is useful for providing insights and detailed information on cell performance that are difficult or impractical to obtain experimentally.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The respondent stated that, in the past 10 to 20 years, a significant amount of work on Li-ion cell modeling has been published by several groups (e.g., Newman, While, Wang, and many others). The use of new differential equation solver software seems very helpful for solving the complex models (coupled partial differential equations). However, this reviewer wonders if the PI has examined many other commercial solvers and compared the pros and cons of using Process Systems Enterprise Limited (PSE) advanced process modeling (gPROMS). This reviewer added it is a good approach to develop a model based on experimental observations (solid electrolyte interface [SEI] and micropores inside the particles).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer felt many parametric studies provided useful information.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer said it appears that this group is capable of doing sophisticated modeling work all by themselves. Therefore, there is little need to collaborate with other modelers working on the DOE projects. However, some kind of coordination with the Lawrence Berkeley National Laboratory (LBNL) group is recommended to ensure that they will compare results if these two groups are modeling the same phenomena. This reviewer added that some overlap is good to double check the results.

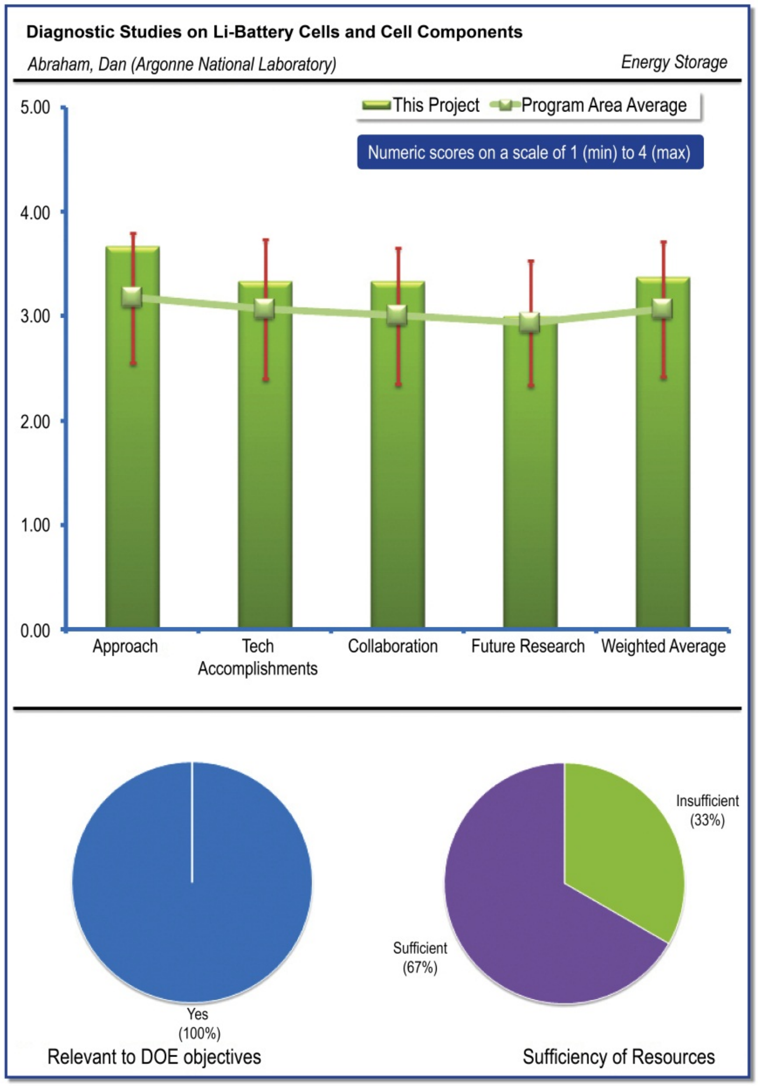
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer commented that, at some point, the PI needs to verify experimentally the key modeling results and new discoveries. This reviewer refers to the verification part to be carried out by other groups and done at the end of project. After the model is ready for distribution, this reviewer added, the PI should try to promote the usage of the model by select cell designers and material developers.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer said the resources were sufficient. There were no additional comments.

Diagnostic Studies on Li-Battery Cells and Cell Components: Abraham, Dan (Argonne National Laboratory) – es032



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments were generally positive in this section. One reviewer said effective diagnostic tools are always useful. A second reviewer commented that understanding aging and failure mechanisms will eventually lead to longer life and economically viable solutions. The final reviewer commented the project was very relevant, adding that diagnostic studies and aging of the electrodes are critical if we want to increase the range and the life of a Li-ion battery.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section, with reviewers offering a few further suggestions. The first respondent noted that the approach of using multiple techniques like X-ray diffraction (XRD) (long range structure), X-ray absorption fine structure (XAFS) (local structure), X-ray photoelectron spectroscopy (XPS) (surface film oxidation), and referenced cell (individual electrode effect) by the PI and co-workers is very effective on diagnosing the failure mechanisms. Another reviewer noted a nice combination of pure and applied research, and added that the latter should be emphasized further. The voltage profile observed in layered-layered oxide seems to be an important issue that should be studied further. The final reviewer stated that good insights were gained on aging mechanisms. This reviewer also observed a well-organized and systematic approach to problem solving, and a very good and clear analysis. Some questions remain on the interpretation of data (e.g., it is suggested that capacity loss is mainly due to Li-consuming reactions in the anode but in fact the anode's impedance suffers a lot less than the cathode). This reviewer went on to note that the evidence provided shows that the cathode capacity is by and large maintained. Finally, this reviewer questioned where the consumed Li came from and the evidence for supporting that.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers offered a number of suggestions in this section. The first reviewer said progress has been excellent, and added that maybe additional work to include the role of electrolyte and separator will strengthen the work. A second respondent, as mentioned earlier, would like to see more capacity data focused in mAh/g total electrode weight; in particular, when the authors try to bridge the gap between pure and applied research. The final reviewer commented that the diagnostic tools used by the PI and co-workers have indeed provided some insights into the failure modes. The authors indicated that the capacity fade of the baseline cell appears to result from

Li loss during graphite SEI dissolution/reformation. This might be true, but it needs to be confirmed by checking the cycled anode and cathode separately. This can be done by pairing the cycled anode with a fresh cathode and the cycled cathode with a fresh anode and then cycling the cells again.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The lone respondent commented the authors have shown strong collaboration with other institutions. This reviewer stated that although difficult; the group should keep trying for a stronger interaction with the U.S. battery industry.

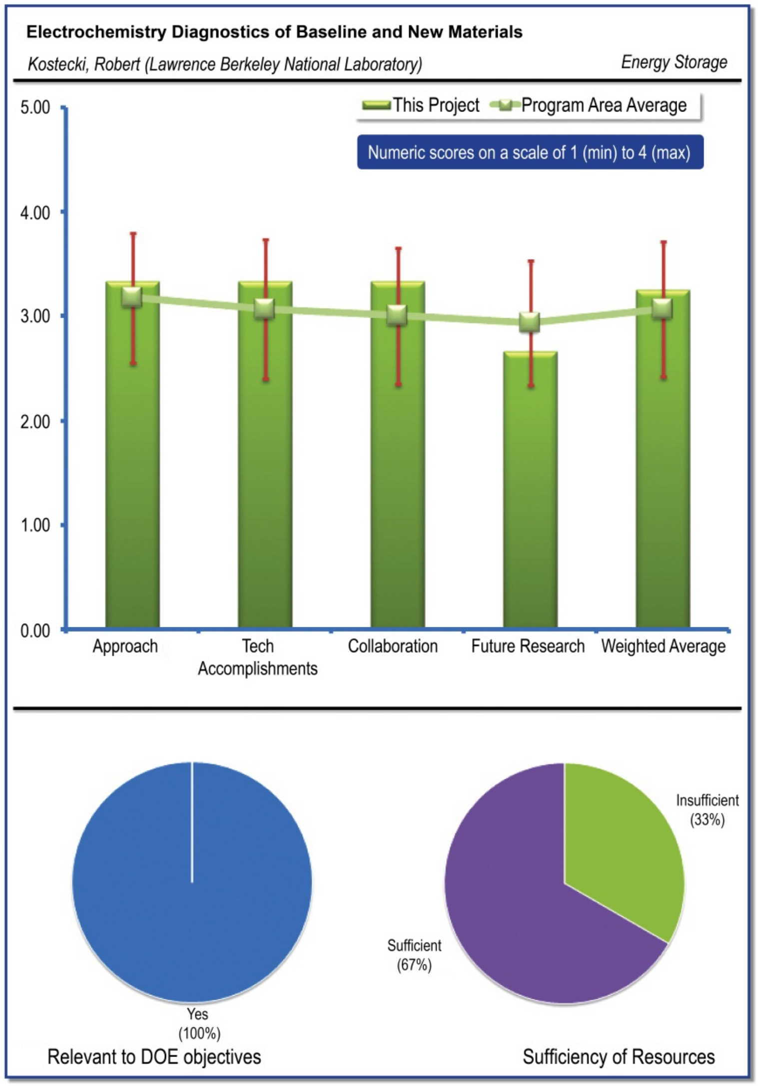
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered a number of suggestions in this section. The first said include the role of electrolyte and separator, and added that the solid-electrolyte interface changes during aging are critical. A second reviewer commented the aging experiments are very important; they should probably emphasize the analysis of failed batteries (autopsy), of commercial and more advanced cells. The final reviewer noted that, in addition to the proposed future research, one electrochemical diagnostic tool that the PI and co-workers can consider is to develop a referenced cell for the 18650 size, as ANL has the capability of making 18650 cells as the testing vehicle for many applied researches.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The lone respondent commented that resources may not be sufficient, depending on the strength of collaboration with U.S. companies (battery or chemical companies).

Electrochemistry Diagnostics of Baseline and New Materials: Kostecki, Robert (Lawrence Berkeley National Laboratory) – es033



REVIEWER SAMPLE SIZE

This project had a total of three reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

One reviewer stated high-voltage cells are presenting one of the few viable options to reach high energy and low cost. The other respondent commented it was very relevant, adding that the study towards understanding the degradation mode of active materials is critical if we want to lower the cost and increase the range of a battery.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

The first respondent commented the PI has clearly demonstrated an obstacle (i.e., oxidation of electrolyte and PF_6- intercalation into conductive carbon additives) and presented a feasible solution to overcome the problem with evidence. The other reviewer commented that, now that the authors have identified some of the problems associated with degradation and failure of carbon, for example, they should try to identify which of these degradation mechanisms is playing an important role in commercial batteries, or even advanced batteries that are still under consideration.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

One reviewer stated important progress has been demonstrated, adding that more data related to full batteries are also necessary. The other respondent liked the citation of the previous work on PF_6- interaction into carbon materials. This reviewer has seen in some cases the researchers do not refer to previous work performed by others. This reviewer added that the amount of work presented seems to be insufficient to justify a $600,000 project. Only three carbon materials and the effects of heat treatment and surface treatment were investigated using cyclic voltammetry (CV) and Raman. Finally, this reviewer queried whether there were any other major accomplishments in the past years that did not get reported in this postal presentation.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

One reviewer stated that the authors have shown strong collaboration with other institutions, and added that a stronger interaction with U.S. companies, which is not easy, should be strongly pursued. The other reviewer commented a proof of concepts presented at the full cell level would have strongly reinforced the findings.

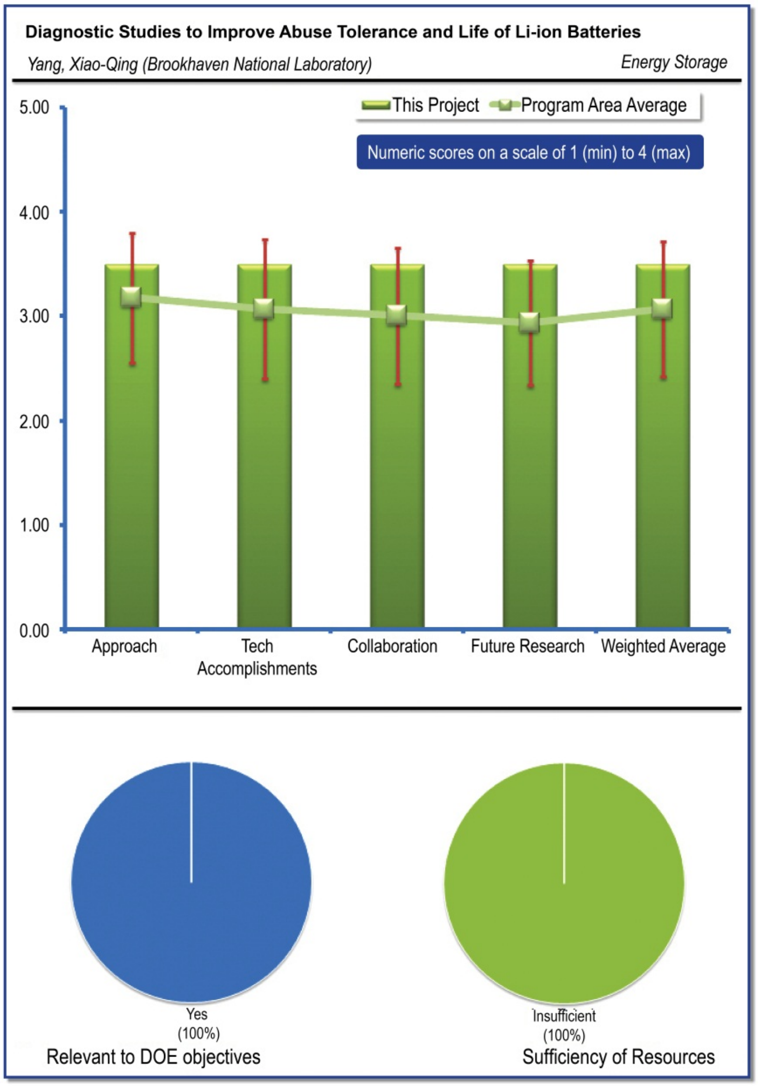
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered a number of suggestions in this section. The first respondent said to extend the study to include electrolyte oxidation on the high voltage (HV) oxide particles, adding that it seems more intuitive if electrolyte oxidation occurs primarily on the oxide particles rather than conductive carbon particles. Extend the study to use HV solvents (e.g., sulfones). That would be more relevant than carbonaceous solvents. A second reviewer stated, as mentioned earlier, diagnosis and the analysis of the failure mechanism associated with these batteries is strongly recommended. The authors may try to analyze commercial batteries in an effort to identify key issues that may need particular attention now. The final respondent commented the group needs to be more specific on the areas to focus on. Because the project is on electrochemistry diagnostics, this reviewer would like the PI to focus on a specific area and provide in-depth scientific understanding of a few key items.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers said the resources were sufficient, while one said the resources were insufficient. The lone commenter said the authors may need additional resources depending on how strong their collaboration is with U.S. companies.

Diagnostic Studies to Improve Abuse Tolerance and Life of Li-ion Batteries: Yang, Xiao-Qing (Brookhaven National Laboratory) – es034



REVIEWER SAMPLE SIZE

This project had a total of two reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

One reviewer said safety is an absolute must-have, especially in the transportation sector. This reviewer added that insights into what might lead to thermal runaway are invaluable. A second reviewer said the work is very relevant, adding that abuse tolerance, cell capacity and power fading are critical issues that, if improved, will translate into a higher battery range.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

The first respondent said the PI has mastered the art of advanced imaging techniques and attacks the problem directly and with authority. The other reviewer stated the in-situ transmission electron microscope (TEM) studies are clearly important and have produced a better understanding on degradation issues. In-situ studies are very close to real life conditions. It should be important to study the Al_2O_3-coated electrode in a full cell to see if additional issues (good or bad) show up.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

One reviewer noted excellent insights with clear explanation of the underlying phenomena, while the other respondent commented interesting work. This reviewer added that safety-related issues are critical in Li batteries. The coating of an electrode with Al_2O_3 has to be tested also in cylindrical cells. The in-situ XRD measurement in collaboration with Proctor & Gamble was very interesting. It would be important to know the tradeoff of a coated electrode or powder. This reviewer added the thermal decomposition mechanism of Gen2 and Gen3 powders was an important achievement.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

The lone respondent stated that the respondent understands that is not easy to find U.S. companies ready for collaboration, but added that the interaction with Duracell, Dow chemical, and GM R&D Center should be strongly pursued.

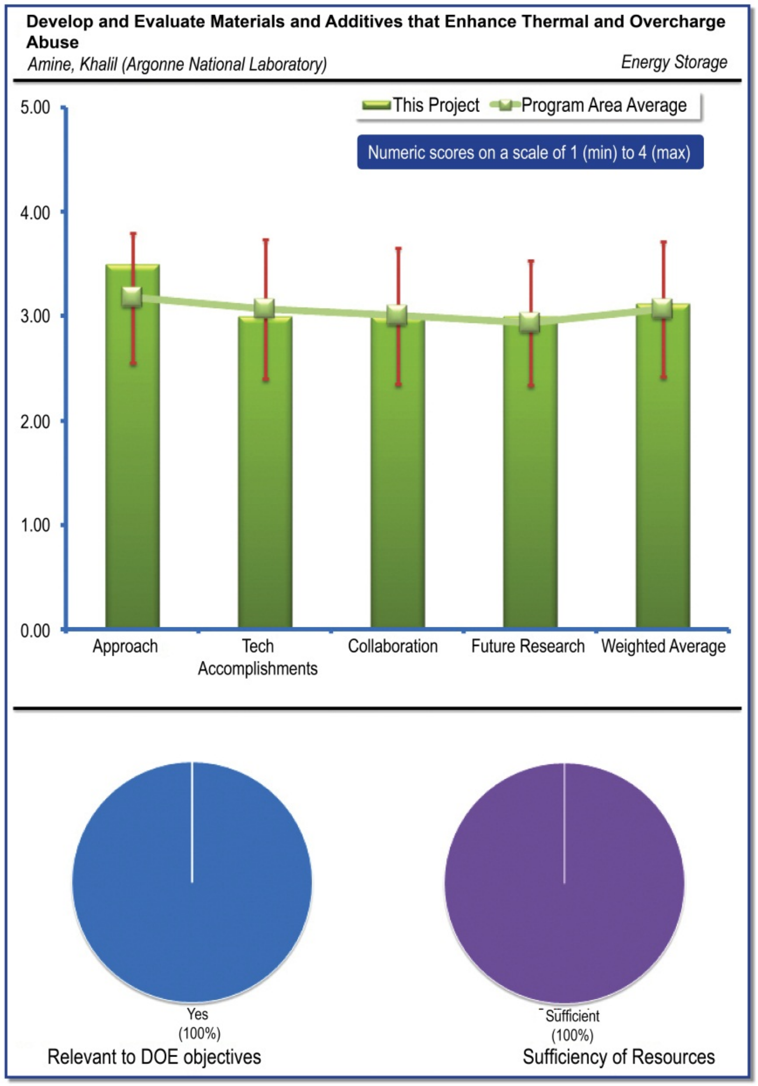
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer would like to see these studies extended to newer cathode materials (e.g., Li-rich layered-layered) and compared to more established cathodes (NCA, NMC, etc.). The other respondent said, as mentioned earlier, further experiments with commercial batteries should be tried. This reviewer added so far the results are promising; therefore, tests performed on commercial batteries seem to be a natural avenue to explore.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said more emphasis on using advanced imaging techniques will produce richer output, while the other reviewer said the resources are insufficient if a stronger interaction with U.S. companies is pursued.

Develop and Evaluate Materials and Additives that Enhance Thermal and Overcharge Abuse: Amine, Khalil (Argonne National Laboratory) – es035



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer commented that batteries are the viable near-term option for vehicles. Safety is a critical issue in adopting the lithium-ion technology for vehicles, and this project focuses on it. The other respondent noted the 3.9V redox shuttle (ANL-2) could potentially be useful as a redundant safety feature and capacity regulator for a $LiFePO_4$-type cathode that has an upper charging cut-off voltage at or below 3.9V.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent indicated the researchers focused on identifying and solving the problem. The other reviewer commented this project focuses on developing and evaluating electrolyte additives and materials that can enhance the thermal stability and abuse tolerance of lithium-ion batteries. This reviewer added that electrolyte additives and redox shuttles can help to improve safety, so the approaches and direction are reasonable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer noted electrolyte additives to form better SEI layers on graphite have been developed. Two redox shuttles have been identified. Also, scale-up of the materials developed is being pursued. This type of work has been occurring with the PI with a large amount of resources for quite some time now, and it is not clear what is new this time. This reviewer questioned whether any of these materials can make a breakthrough or game change in the industry. The other respondent indicated the performance of the ANL-2 as a redox shuttle is good. However, this reviewer added, ANL-2 by itself as the sole protection method for overcharge is not likely to be sufficient for the cathode with excess capacity over 3.9V. Issues that still need to be addressed include variation of the cut-off voltage as a function of discharge rate and temperatures. Additionally, this reviewer commented, the high-rate capability at room temperature, and especially at low temperature, may be decreased substantially if the concentration of ANL in the electrolyte is 0.2 or 0.4M.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The lone respondent in this section noted the collaborations are with Sandia National Laboratories and EnerDel: the usual people the PI has been interacting with in the past.

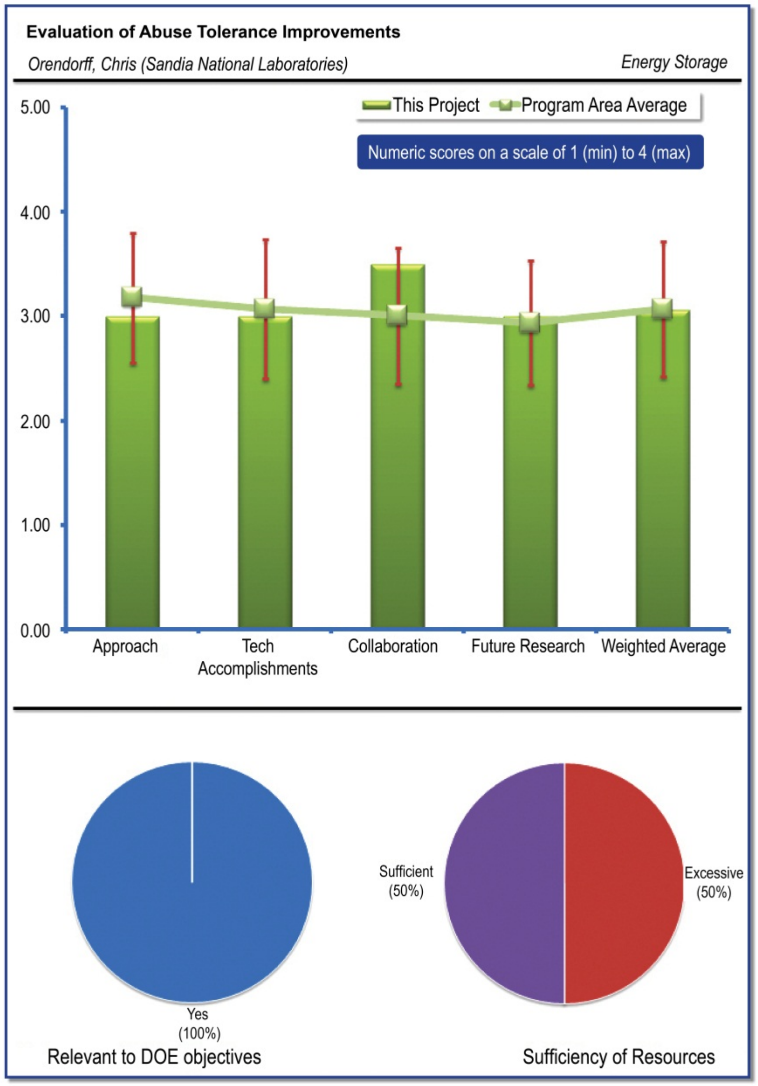
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer acknowledged that the future work is focused on carrying out more characterization and exploring new redox shuttles, which are natural extensions. The other reviewer would like the group to thoroughly investigate the potential drawbacks of the ANL-2 in the following areas: (1) effect of ANL on high rate capability at room and low temperatures; and (2) effect of ANL on cycle life (need to test to 60-70% of the initial capacity for the control) at room and elevated temperatures. This reviewer added that, after sufficient work is done to characterize ANL-2, then the group can expand their research effort into other items outlined by the PI and co-workers. They need to focus the effort on something that shows promise rather than doing general research work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented the resources were sufficient for fundamental and applied research work, while the other agreed the resources are sufficient for the level of effort on the project.

Evaluation of Abuse Tolerance Improvements: Orendorff, Chris (Sandia National Laboratories) – ess036



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer wrote battery safety is a critical area for consumer and EV Li-ion cells. The other respondent commented that safety and abuse tolerance are critical issues in successfully adopting the lithium-ion technology for vehicle applications. This project addresses these important issues.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

This first reviewer said the project focuses on identifying the mechanisms of heat and gas production in lithium ion cells during charge-discharge. Such an understanding can help to develop appropriate materials systems for safer lithium-ion cells. The project also focuses on developing materials that will minimize gas and heat generation. The second respondent noted the author certainly has successfully applied a key technique (Accelerated Rate Calorimetry [ARC]) for characterization of several materials and a few full cells in the past year. As long as the equipment is available, the testing itself is straightforward. This reviewer added that characterizing commercial cells is important for baseline establishment. For full cell thermal testing, this reviewer added, the PI needs to collaborate with the groups in other DOE labs (e.g., NREL) on modeling using the thermal parameters generated from the PI's work. This will help understand the failure mode of the full cells on thermal abuse.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer indicated good results and good correlation between component testing and real cell testing have been obtained. The other person noted that software and hardware have been upgraded for accelerated calorimetry tests. This reviewer added that a few cathode materials with chemical coatings have been assessed. Chemical coating with AlF_3 has been found to enhance the thermal stability. This is as one would expect since the highly reactive cathode surface is not in direct contact with the electrolyte when the cathode is coated with inert AlF_3. Attempts to develop thermally stable electrolytes seem to cause other problems such as decreases in conductivity and capacity. It may be a tough problem to tackle to have all the parameters in a favorable position.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer indicated the work involves extensive collaboration with several people: other national labs, universities, and industry. This is a big plus for the project. The other respondent indicated a need for some modeling work to understand the causes of thermal runaway of cells using the improved materials under select key abuse tests.

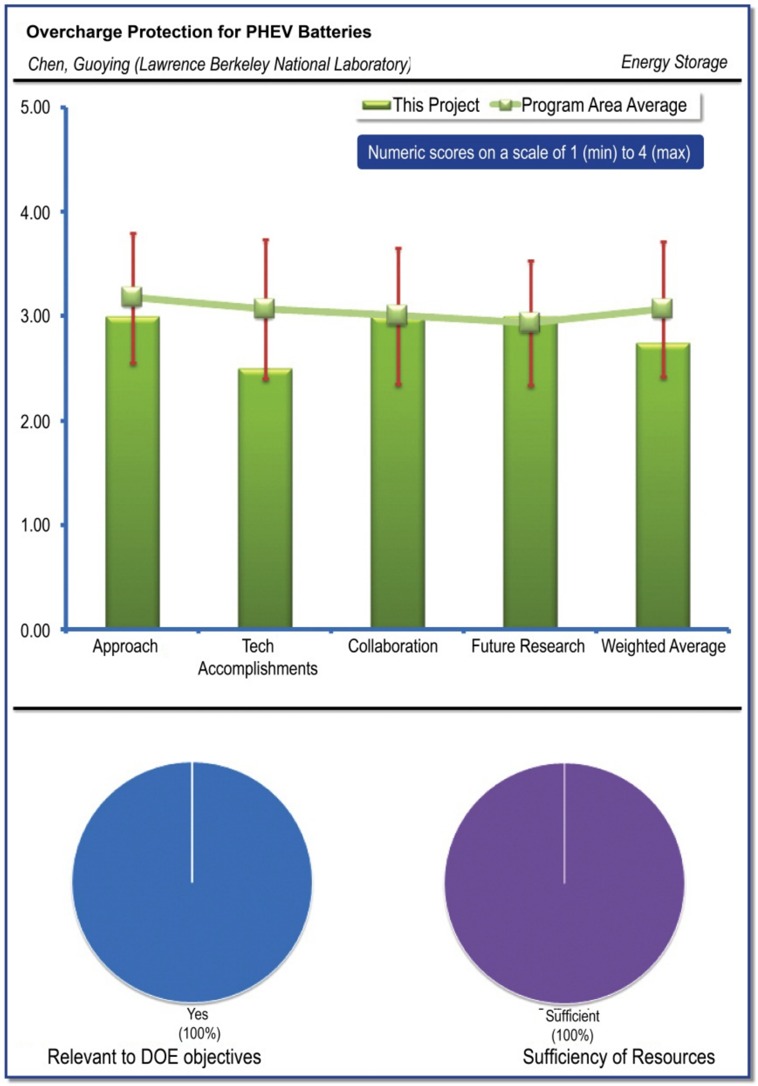
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer said the future work focuses on an extension of the ongoing work to develop both better understanding and to develop better materials. The other reviewer made a few individual comments: (1) Understand the interactions of individual components on cell safety on thermal abuse for a few select key designs; (2) Establish the baseline of the safety characteristics of a few select commercial batteries (e.g., 18650 and large format PHEV or HEV batteries from a few large companies) on thermal abuse; and (3) besides thermal abuse, how does the new/improved material perform in cells on a few select mechanical and overcharging abuse tests?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said the resources were sufficient while the other said they are excessive. One reviewer stated the current funding for this project is on the high side, and added that $1.3M per year is a large amount of funding.

Overcharge Protection for PHEV Batteries: Chen, Guoying (Lawrence Berkeley National Laboratory) – es037



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer commented PHEVs and EVs are attractive options to displace petroleum use in the U.S. This project focuses on developing over-charge protection for lithium-ion batteries so that the technology could be successfully applied to vehicle technologies. The other respondent acknowledged it is relevant fundamental research work for the SE program. However, this reviewer added, the importance of developing an internal overcharge protection for improving Li-ion safety is low because current electronic circuits can provide adequate overcharge protection for individual Li-ion batteries. In terms of cost reduction, the PIs need to compare the cost for the integrated circuit with the estimated cost for the internal overcharge protection system (material and production cost) for several assumed volumes to determine if the cost reduction assumption is valid.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The lone respondent indicated this project focuses on the development of electroactive polymers for internal self-actuating protection. It is a viable approach. It has the primary goal of increasing the cycle life and rate while lowering the cost.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer noted a high-voltage polymer has been found to provide improved stability at low voltages. This reviewer added that it could be applied to various battery chemistries. It has been found to carry large currents. The PI may want to increase the activities to accelerate the developments. The other respondent noted the technical barriers related to (1) the onset voltage, (2) the effect of the charging rate on the onset voltage, (3) the temperature on the onset voltage, and (4) cycle life, have been addressed to certain degrees in the project progress report. However, this reviewer would like the PIs to expand the tests to include (1) capacity retention on charged cells (i.e., capacity loss at room and elevated temperatures) and (2) overcharge protection capability for the best-bet system measured at different rates/temperatures and at different voltage cuts for the gen-2 cathode $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ or another cathode that will have excess capacity on overcharge.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first respondent commented that developing an internal overcharge protection system that will be able to be implemented requires a significant amount of resources and funds. This reviewer suggested the work be done just within the fundamental stage. Unless a material/separator system can resolve all the concerns related to cell performance and safety, the PI's should not attempt to do any scale-up work. This is because the likelihood of success on replacing the current external integrated circuit by an internal method for overcharge protection is really low. If there is anything, one may consider using both for the cases where the cathode has extra capacity available during overcharge. The other reviewer noted the collaborations are mostly with the scientists/engineers at Lawrence Berkeley National Lab, and added the PI could extend the collaboration outside LBNL to get a better perspective and enhance the productivity.

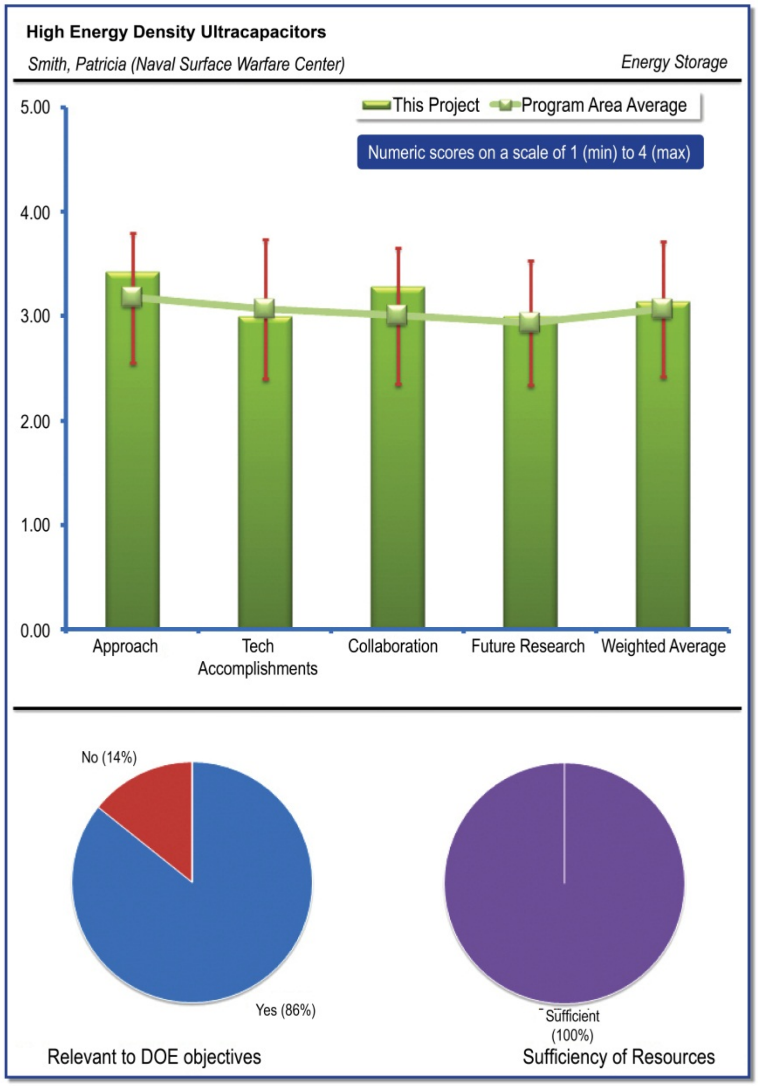
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer remarked the future work is exploratory with an aim to identify other polymers, characterize them, and explore in different cell configurations. This reviewer added it could be broadened in collaboration with others at universities. The other respondent made a number of comments. This reviewer said that in general, this is really fundamental research work. If there is any intention that the PIs plan to move the project into a next phase for scale-up, then the PIs need to develop specific goals for this project. For example, the onset voltage is x.xx volts with certain standard deviations on various discharge rates and temperatures for a given material developed and construction used. If not, just concentrate on the fundamental side of the project and identify any potential pitfalls of the best-bet systems and the means to overcome them. This reviewer added that, besides looking for new materials with the onset voltage higher than 4.4 (vs. Li), the PIs need to provide additional data on the best-bet system to address the following questions: (1) How precisely can the internal overcharge protection control the onset voltage and the capacity removed from the cathode for gen-2 cathode (or a cathode with excess capacity on overcharge) on different rates and at different temperatures when the best-bet internal overcharge protection system is used? (2) What is the capacity retention of a fully charged cell at room and elevated temperatures after one, three, and six months for the best-bet system? (3) What is the effect of the best-bet internal overcharge protection method on cell rate capability and long term cycle life?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Both reviewers said the resources were sufficient. One reviewer commented that the resources were sufficient for fundamental work, while the other reviewer stated the current funding level is adequate for the level of activities.

High Energy Density Ultracapacitors: Smith, Patricia (Naval Surface Warfare Center) – es038



Reviewer Sample Size

This project had a total of seven reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments were generally positive in this section. One reviewer commented the project well integrates technical aspects useful for the achievement of DOE objectives. A second respondent stated ultracapacitors with high energy density could become a viable approach for vehicles, and thus the project is relevant with respect to the objective of displacing petroleum use in the U.S. Another reviewer noted the ultracapacitor may replace the batteries for power-assist automotive applications because they have the potential to be cheaper than the batteries. A fourth respondent indicated that, though capacitors are not generally viewed as a high potential long term solution to EVs, they have a genuine place in HEVs and in an electrically hybrid application with a battery. They can bring certain safety solutions as well as other safety risks. This is a good project for the goals of DOE. Another reviewer said ultracapacitors have the ability to absorb and release large amounts of energy almost instantly. For instance, this reviewer added, in regenerative braking, huge energy bursts are created and a battery has trouble handling the bursts while ultracapacitors by their nature have a very fast response time. One person commented that supercapacitors offer advantages over batteries for power assist HEV applications in terms of cycle life, safety, and low temperature performance. Modest improvements in specific energy might enable supercapacitors to meet HEV energy storage application requirements with a superior solution to batteries. In contrast, the final reviewer indicated that, with the recent advance of high rate lithium-ion batteries, the need for a hybrid system using regular Li-ion batteries combined with ultracapacitors to run HEVs and PHEVs is questionable. That being said, this reviewer added, for fundamental research, the project still has some value in terms of understanding the limits of the Li-ion capacity and discovering new systems.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section. The first reviewer remarked the approach is the correct one: identify the high capacity/capacitance electrode materials and the appropriate electrolyte composition then select the best combination for further qualification. This reviewer added the pouch cell construction is best for screening. The lithium negative gives a significantly higher voltage system than the usual carbon-carbon capacitor construction. Another respondent said this project is probably the only one looking at hybrid supercapacitors (or battery-like supercapacitors) by combining the best of Li technology with the best of electric double-layer capacitor (EDLC) technology. The project is well organized with good prospects of feasibility, because of the clear technical targets. A third reviewer commented the project is focused on developing high energy density electrodes and compatible electrolytes for lithium-ion ultracapacitors. This reviewer added that identifying electrode materials with high energy density is the bottleneck for ultracapacitors, and this project focuses on it. Another person felt characterizing the newly developed capacitors for energy is a good start. However, it needs to be balanced with the conventional power available at all temperatures. This reviewer added there is a need for increasing energy density without reducing power density and cost. If we do not meet the power, cost, and energy goals, it will be difficult to compete with batteries. One final commenter said good focus on specific energy, but it was not clear where 15 Wh/kg came from as a goal. It was not quite clear to this reviewer why this particular asymmetric supercapacitor approach was chosen since comparison to other approaches is not discussed. Cost is key barrier to supercapacitors for this application and was not discussed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments tended to be positive in this section. One reviewer stated the best combination was identified and a more intense evaluation on the characteristics of carbon and positive electrode was carried out to qualify the selection of carbon positive electrode and electrolyte. This reviewer added that safety issues were addressed. A second reviewer said the results are very encouraging and well-focused towards the objectives, and added the investigation will have been better integrated with structural analysis to better understand material modifications. Another respondent noted good progress in demonstrating specific energy and characterizing performance including safety testing results. This respondent also observed an interesting, favorable result about improved charge retention over the symmetric supercapacitor. One final respondent noted carbon-based materials are pursued. However, this reviewer added, carbon-based capacitors have been widely investigated. It is not clear what the significance of the work is compared to what is already known. The PI may want to focus on other materials that promise to increase the energy density.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first respondent stated the collaborations are appropriate and well-selected. A second reviewer said the collaborations involve other universities and companies. This reviewer added that the interaction with companies like Maxwell is very beneficial to the project. The final reviewer noted the group has collaboration with Cabot, the University of Massachusetts, and Ener2 for the next generation evaluations, as well as Hunter College for nuclear magnetic resonance (NMR) evaluation to identify lithium in the SEI layer.

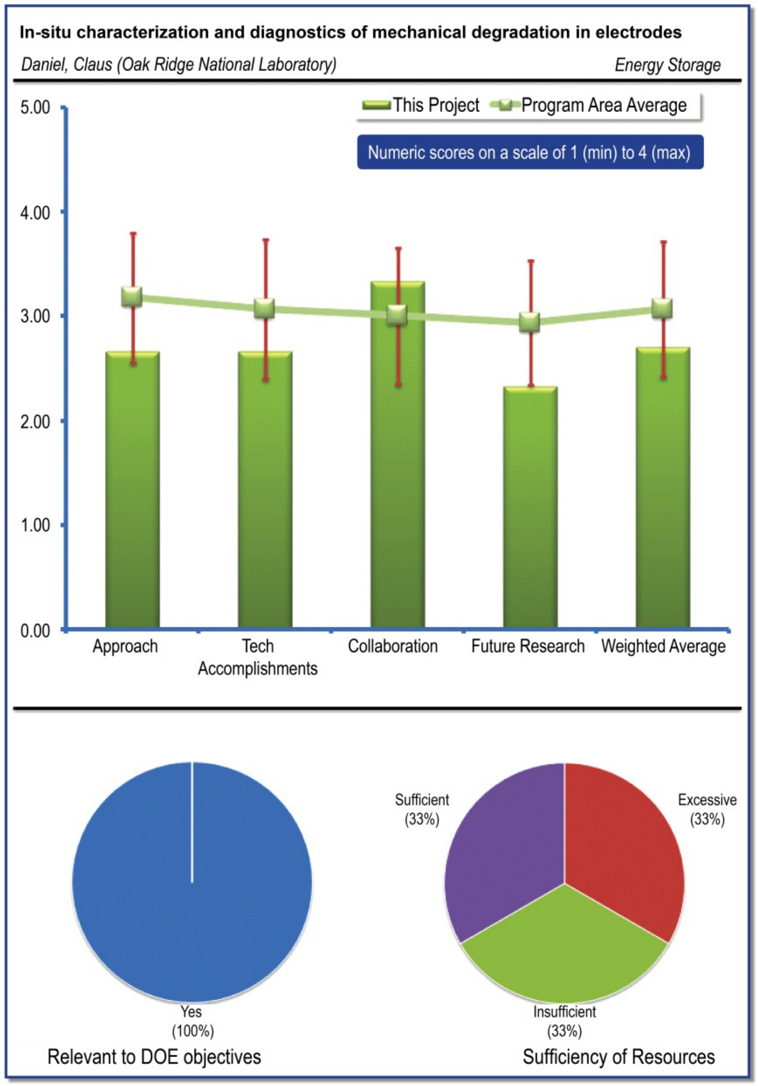
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered a number of suggestions in this section. The first commenter stated the plans for continued study have been clearly identified for new electrolyte system studies and performance evaluations. Another reviewer commented the planned activities are very well-connected to the previous work with clear steps. A third respondent was not sure about the need for further solvent investigation, but thinks cycle life measurements are critical for application. Another reviewer said future research should not compromise in the -30°C power capability of the conventional ultracapacitors and the cost should be half of the cost of the batteries per kW power. Another said future work is focused on a continuation of electrolyte investigation and their characterization with NMR, differential scanning calorimetry (DSC) analysis, and stability measurements. The PI may want to focus on other electrode materials systems since carbon capacitors are already being developed by industry. One person emphasized the need to talk to car manufacturers that have developed HEVs, PHEVs, and EVs to determine the voice of customers first for the actual need of the hybrid system and understand its technology pitfalls. This is because the premise of the project is established on the conceptual advantages of the hybrid system. One final reviewer questioned whether any car companies would plan to use the technology considering the additional cost associated with making the UCs and integrating them with the batteries, if the performance goals are achieved at the end of the project. Additionally, this reviewer offered a query regarding the energy efficiency of charging the UCs after they are depleted by the batteries.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All seven reviewers said the resources were sufficient. One reviewer commented they have adequate resources for the study, while another agreed the resources seem adequate. One final reviewer said the funding level is adequate for the efforts.

In-situ characterization and diagnostics of mechanical degradation in electrodes: Daniel, Claus (Oak Ridge National Laboratory) – es039



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments were mixed in this section. One reviewer commented that the project is very relevant, and added that the study of mechanical/chemical degradation of the electrodes and the active materials should help prolong the battery life. Another person indicated the project should help shed some light on determining the mechanical cracking and phase-change induced stress on particle fracturing during cycling. The final reviewer is not sure about the relevance, nor could this reviewer see how this technique could shed light on the underlying mechanisms of mechanical failure.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were mixed in this section. One reviewer said the integration of acoustic emission with x-ray diffraction is accomplished well in this project. Another reviewer commented that it was a very novel technique, and added it would be interesting to try the in-situ X-ray measurement on industrial batteries. In contrast, a third reviewer stated the acoustic emission for detecting particle cracking has been used many years before; it is not a new method as suggested by one reviewer in 2010. A final reviewer did not see the results supporting the benefits of acoustic measurements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer noted page 13 of the presentation shows a very important plot where anode and cathode are analyzed in-situ and at the same time. This reviewer acknowledged that it is difficult to establish collaboration with industry; however, the authors should try to analyze, using their technique, commercial batteries. It should be of great interest to understand the failure mechanism of commercial batteries using this technique. The second reviewer requested the results to help this reviewer better understand how mechanical failures occur, where or when it happens, how to prevent it, or shed light on the mechanisms of failure. One final reviewer indicated the acoustic emission (AE) method has been shown to be effective in identifying the key particle cracking steps for Si-based anode by the PI. However, this reviewer added, for the common cathodes and graphite anodes used in Li-ion cells, the particle cracking does not seem to be the key failure mechanisms for cycle life.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The lone respondent acknowledged how difficult the interaction with industrial partners is. IP issues and confidential information are important barriers; however, this reviewer added, the authors should try hard towards that goal.

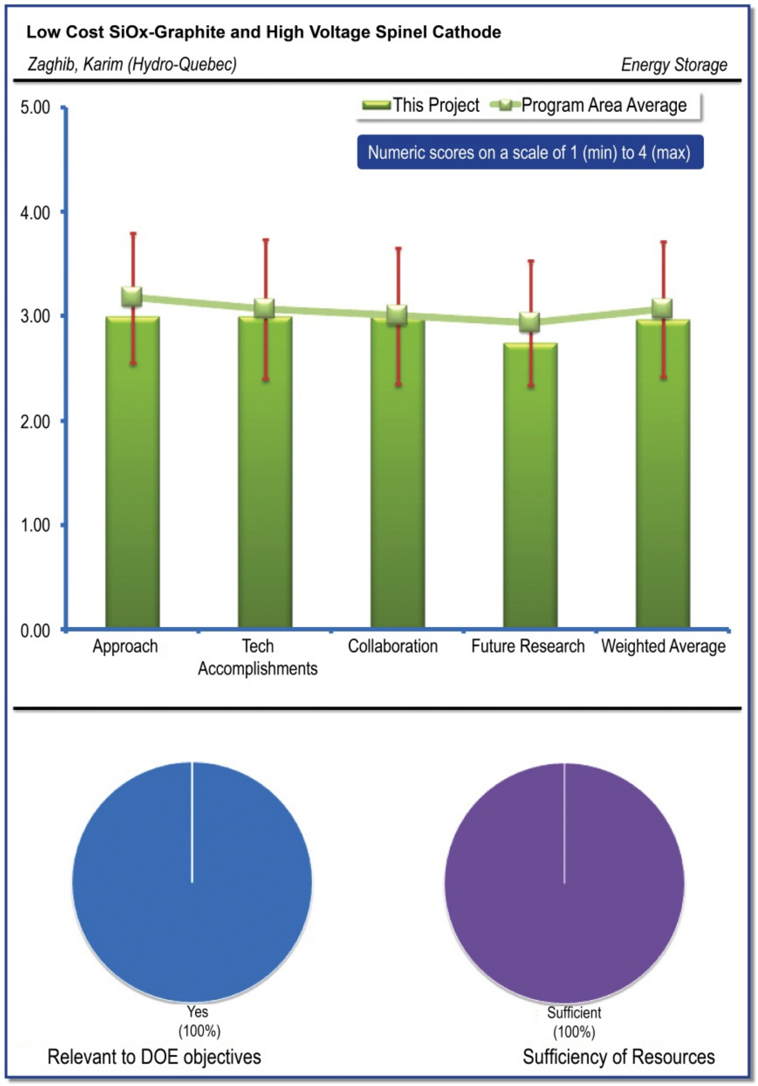
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered a number of suggestions in this section. One reviewer commented the authors should explore creative ways to bridge the gap with industry, particularly with the U.S. industry. A second respondent emphasized the need to include a model cathode that has almost zero strain on cycling and different particle size in the study for assisting data interpretation. Another person commented understand the relationship between particle cracking with other physical properties of the electrode beyond the particle size. One final reviewer commented that the future work sounds like doing more of the same. The reviewer further questioned what the expected findings and benefit would be from this technique.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said the resources were sufficient, one said the resources were insufficient, and one said they were excessive. One respondent said insufficient if the authors strongly pursue further interactions with U.S. companies.

Low Cost SiOx-Graphite and High Voltage Spinel Cathode: Zaghib, Karim (Hydro-Quebec) – es048



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments were generally positive in this section. One reviewer said improvements in cathode and anode materials will increase the extent of fleet electrification. Another person indicated those materials are considered for the next generation for Li ion batteries. A third reviewer noted that two aspects limiting Li-ion technology are clearly identified and functional in addressing DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were mixed in this section. The first respondent indicated the technical barriers are well analyzed and approached in a convincing manner with acceptable development on anode and cathode materials. This reviewer added the investigation on the defined material is complete and acceptable. Another reviewer commented the passivation approach of lithium nickel manganese oxide (LNMO) and silicon anode work is promising and being approached logically. A third reviewer noted it might be good to see how the feedback from the collaborators under the BATT program influences the material development and helps to focus on the objectives to improve poor cycle/calendar life. One final reviewer stated it is not clear how the PI could achieve the low-cost SiOx. These materials were studied for more than ten years.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were mixed in this section. One reviewer felt the achievements are excellent with clear indications of the next steps and the technical limitations of the selected materials with good prospects for improvements. Another reviewer has not seen the SEI layer analysis that was addressed in the approach slide, and added the idea for carbon-coated silicon is very old and, also, the results are not new. A third reviewer made two separate comments: (1) Regarding Si anodes, the work shows results comparing different binders and the effect on 1st cycle efficiency and reversible capacity, but does not address cycling life and calendar life. In-situ studies of the Si anodes confirmed the literature data. (2) The coating of the high voltage spinel material results in not only better cyclability, but also in higher capacity. This reviewer asked what the amount was of the coating component. The final reviewer made a number of specific comments. Regarding the Silicon anode material, is it possible to benchmark compare their performance against 3M or Mitsui Mining? Regarding Slide 9, it seems predictable that a 13um material would crack. What is the particle size distribution (PSD) of the Si nanomaterial? The in-situ anode scanning electron microscope (SEM) movie was very impressive. This reviewer added, in general, polyimides are considered an expensive resin family. Has there been any comparison with what sort of cost impact there would be versus the existing polyvinylidene fluoride (PVdF) or styrene butadiene rubber (SBR) /carboxymethyl cellulose (CMC) costs? Continued this reviewer, regarding the lithium iron phosphate (LFP)-coated LNMO, is the process based on mechanical milling? The SEM doesn't show a smooth coat. Regarding Slide 14, after about 4C (i.e., 8C or greater), the LFP doesn't seem to contribute any capacity based on the LFP voltage plateau region; the slopes of the coated and uncoated seem similar at these rates. Instead the 8C rate with LFP starts its discharge around 4.5, while the non-coated starts around 4.1 and yet still provides slightly greater capacity due to a shallower curve. LFP is not electrochemically active in this region, so is it the prevention of resistive film build-up on the cathode or some other mechanism? The AC impedence (ACI) results on Slide 15 suggest the same, but why is the LFP inactive at above the 8C rate? From the SEM, the particle sizes seem rather small; what is the extent of carbon coating on the LFP? What are the electrode/cell details of these rate tests (loadings, thickness, porosity, additives, etc.)? This reviewer added, regarding Slide 29, low temperature oxide (LTO)/LFP work was only mentioned in the technical back-up slides; is this being continued? Ozuku-sensei proposed this system years ago for sealed lead acid (SLA) replacements; is this being pursued by Hydro-Quebec? Regarding Slide 30, why was a different amount of adiponitrile (22%) used than the other two nitrile (50%) attempts?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments were mixed in this section. One commenter remarked the project is well integrated with BATT activities, with good support and collaborations in place with other project participants and external institutions. A second reviewer noted it will be beneficial to see the effect of the collaborative effort on the design of the future work. Another respondent noted the presentation mentioned collaborations with Vince and Venkat on silicon, and added it would benefit from a collaborators slide. One final reviewer commented that the PI did not use new materials and thus needs to collaborate more to investigate the material from different aspects.

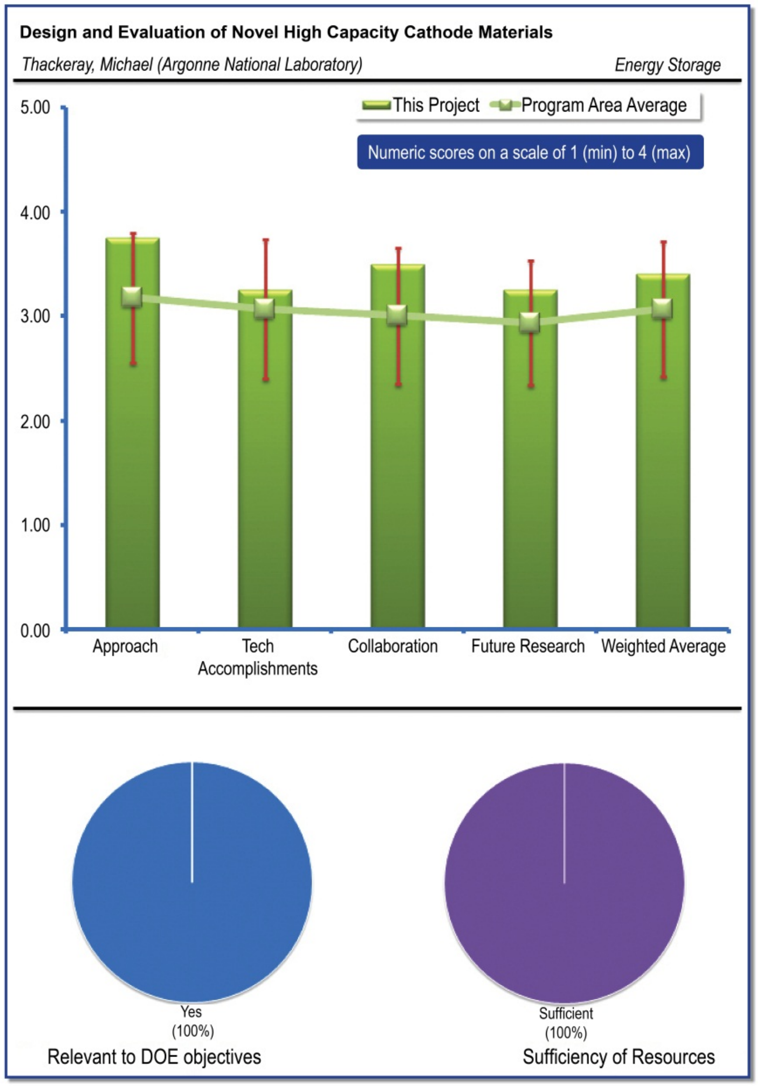
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments were mixed in this section. One reviewer stated the planned future steps are well justified by the achieved results and by the aim to solve the identified problems. A second reviewer indicated the proposed future work seems reasonable, and would encourage Hydro-Quebec to share more of its future collaboration plans. Another person noted the future activities are planned well. More focus should be on the understanding of the effect of the binder on the performance of the Si anodes vs. mere comparison. One final reviewer commented that the PI needs to review the approach and results. This reviewer does not see they are aligned.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All four reviewers said the resources were sufficient. One reviewer commented that there was great progress on the 18650 facility development and utilization. A second reviewer stated it seems that there are sufficient resources. One final reviewer said the consistent budget is considered adequate to the work presented and the achieved results.

Design and Evaluation of Novel High Capacity Cathode Materials: Thackeray, Michael (Argonne National Laboratory) – es049



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer indicated the project is clearly in line with DOE objectives, while a second respondent noted that high-capacity cathode material is considered one of next generation materials. The final respondent commented that the two materials highlighted within this research show either appreciable specific capacity, increased operating voltage, or both. The focus extends to rate capability and durability. The reason for the selection of these materials is due to the relatively low cost of the metal oxide formulations selected. All of these aspects of the project are directly in line with the PHEV-40 battery goals which, in turn, is directly in line with the DOE objective for petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section. One person said the approach is defined well to solve the issues, while another commented the project is well addressing clearly identified barriers on the materials under investigation. This second reviewer added that the combination of experimental and theoretical is well combined. A third reviewer stated the approaches are systematic, adding that, while selection of some routes over others were not comprehensively covered, the selected approaches were well communicated and could be aligned with each technical barrier that needed to be addressed. This reviewer added that rate capability was addressed verbally, but this is one of the themes for the balance of the program. The final reviewer indicated there is a very clear understanding of the technical issues and a very methodical approach in addressing them. This reviewer noted the constant search for new ways of doing things.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer stated the results are excellent, with clear progress that is well related to the planned work and expectations. A second respondent noted good progress on a new family of the composite materials and new sonication technique to improve the stability of the surfaces of the electrodes. This reviewer asked if the effect of the impurities that could be brought with the coating reagents, such as SO_4, were considered on the calendar life of the electrode in the full cell. Another reviewer commented the barriers of specific capacity and high voltage appear to have been overcome. Durability/cyclability shows significant improvement, and shows promise that this can be addressed, at least to a minimal goal. This reviewer added that rate capability still needs to be addressed; processability and cost issues have been addressed, and show significant promise in meeting goals. One final reviewer commented that there are more experimental data. However, this reviewer added that the presenter needs to provide more information about the test methods.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer noted excellent coordination between all collaborators. Another person commented some collaboration exists, while the final respondent said the collaborations are reasonable and adequate to the need of the project.

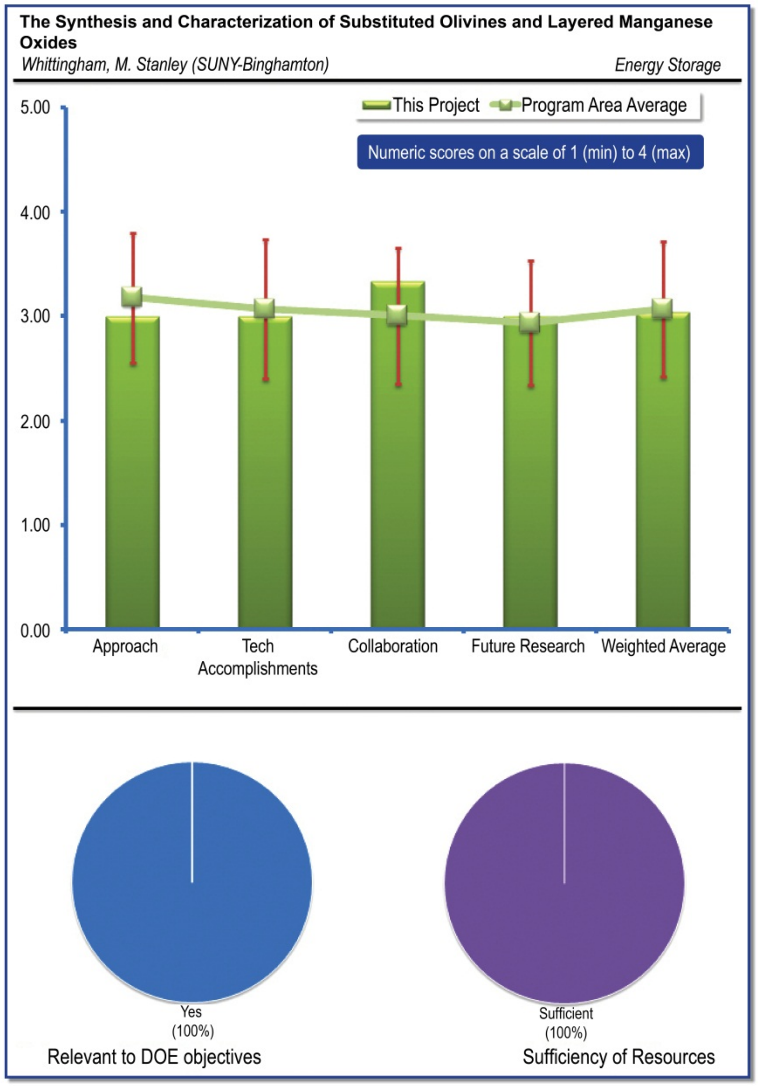
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments were generally positive in this section. The first respondent said the plan is well-defined and this reviewer looks forward to seeing the results for the surface design next year. Another reviewer indicated the proposed plan for the next-period activities is reasonable, with well-identified steps to solve the open issues. A third person acknowledged that the focus is on improving upon the work done to date and on developing fundamental tools. The final respondent highlighted the group’s very clear understanding of the high capacity composite material challenges and clear path forward to address them.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All four respondents said the resources were sufficient. Two reviewers indicated the resources seem to be sufficient, while a third commented the project has been very successful to date. This third reviewer added it appears likely that all barriers will be addressed, although some may require additional future work in order to be adequately overcome (specifically durability and rate).

The Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides: Whittingham, M. Stanley (SUNY-Binghamton) – es050



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One person indicated the relevance of this study is clear, while another stated cathode developments will enable further fleet electrification. The final respondent said the project well addresses key aspects of Li-ion cells for meeting DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were mixed in this section. One reviewer indicated there is a clear view and comprehension of the barriers with a very good approach to try to solve the identified problems; the main questions are efficiently answered proposing and verifying scientific and technological solutions. A second commenter felt that the structural characterization, including defects and morphology, is good but was not addressed in this study. The final reviewer made a number of comments. This reviewer noted the comment was made during the presentation that this project is targeting moderate PHEV rates of 1 to 3C. These rates are more appropriate for EVs, not PHEVs. The USABC targets for PHEV High P/E and High E/P designs target between 3 to 13C. The PI was requested to clarify which battery type is the target of this program. Regarding Slide 3, if the goal is 200 Ah/kg, some of the materials currently pursued seemed surprising. Stoichiometric NMC cycled at low voltage due to self-identified electrolyte limits and olvine and its derivatives seem unlikely to achieve this goal. Since higher voltage NMC cycling would be needed, it seems that this program would benefit from more electrolyte work. The iron pyrophosphate has a theoretical value of 220 mAh/g and is interesting work that should be continued; however, if the researchers do not feel they could access this capacity without higher voltage electrolytes, then they should work on this or collaborate with someone who does. Regarding Slide 13, researchers should not worry about targeting more than one lithium materials. This reviewer added that, although a system with multiple plateaus is more complicated to engineer around at the vehicle level, the potential benefit to energy far outweighs this concern, especially at the research stage.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were mixed in this section. One reviewer commented that the results are outstanding, even the negative ones, because they allow us to better clarify the behavior and performance limitations of some of the materials. The modifications and innovations proposed have resulted in excellent progress with respect to the starting points. Another reviewer stated that Al substitution is not new, so they expected different analysis from the previous work. One final reviewer made comments on individual slides. Regarding Slide 4, the statement that NMC 442 is the optimum stoichiometric $LiMO_2$ is a bold statement that could use some more qualifications. Depending on the application and use, other versions hold benefits. Regarding Slide 9, good comparison of materials power capability, but more detail on each (e.g., particle size, loading, carbon additives, tap densities, etc.) would help judge the true power capability. The same information should be shared for Slide 12 to help understand whether power increase comes from the material itself or the test conditions. Regarding Slides 13 to 15, they show interesting and promising work on pyrophosphates.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer indicated the collaborations are effective and well-motivated with good coordination and integration, while the second respondent can see good collaboration from industry as well. The final reviewer said there was good collaboration with other program members and engagement with commercial entities through work with Primet. This reviewer added that LBNL Kostecki mentioned some existing work on pyrophosphates, which is also one of the topics of this program; if appropriate, discussions between these two groups would seem helpful. Additionally, collaboration with a high-voltage electrolyte group seems highly useful in achieving this program's goal of 200 Ah/kg.

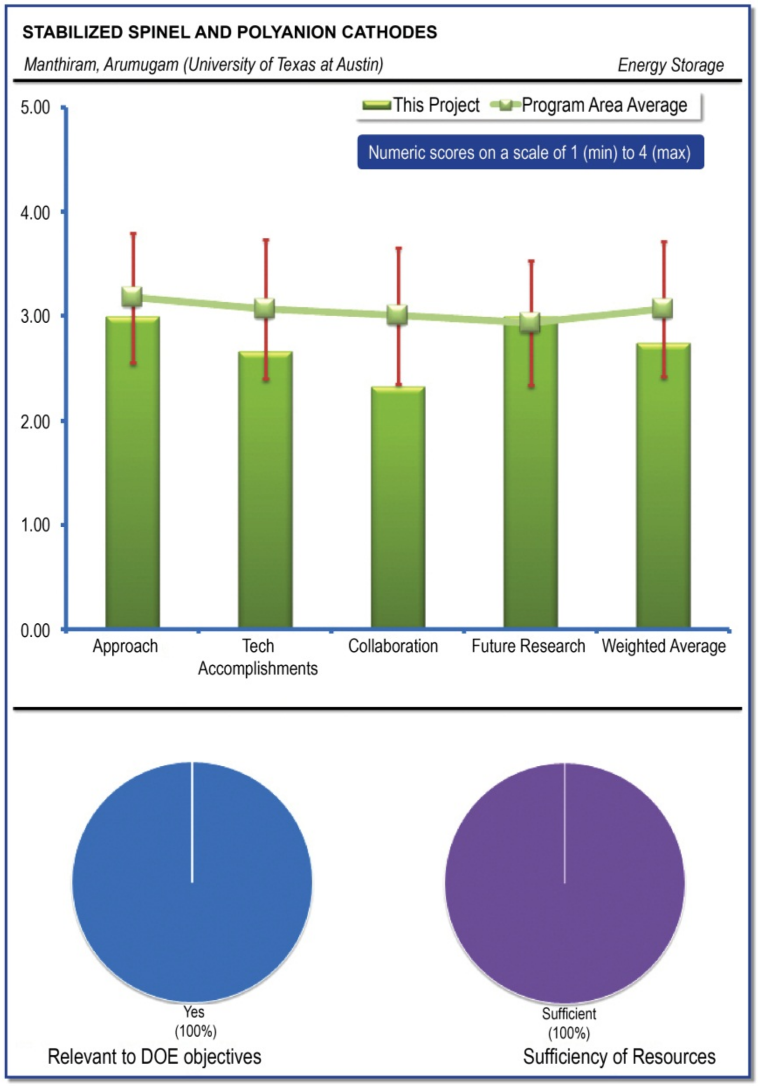
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer commented the remaining work is well-consistent with the already achieved results and are finalized to improve and finally reach the proposed objectives. Another reviewer noted the future work will look at non-lithiated cathodes, though no information was provided as to how lithiation will be addressed. Although many possibilities exist, this reviewer added, they all have issues and tradeoffs so it is important to understand the approach of this individual program. The final commenter remarked the proposed future research can focus more fundamental analysis for the materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All three reviewers said the resources were sufficient. One person said the overall resources are considered adequate, while the other respondent in this section commented it seemed resources were sufficient.

STABILIZED SPINEL AND POLYANION CATHODES: Manthiram, Arumugam (University of Texas at Austin) – es051



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer commented the scientific and technological aspects investigated in the project are functional to the DOE objectives, while another noted cathode developments will enable further fleet electrification. One final reviewer indicated stabilized spinel is one of the big issues to use.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent stated the project clearly identifies materials improvements of spinel cathodes by applying a variety of interesting solutions. This reviewer added the approach of combining structural and electrochemical characterization to analyze material changes is valuable and appropriate. A second reviewer noted a good balance of approaches to achieving improved cathodes. Another reviewer commented it is fine to use fluorinated cathode to stabilize as the PI tried for other materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person felt the results are really interesting and well-supported and evaluated with good experimental evidence. This reviewer added the progress is good and can be further improved with more emphasis on stability: more focus on an acceptable number of cycles well above the values demonstrated. Another reviewer commented the fluorinated cathode was used previously by the PI, and this reviewer does not think this was used in the industry yet. This reviewer needs to know what the issue is that still remains. One final reviewer commented on a number of individual slides. Regarding Slide 7, Coulumbic efficiency was stated to be around 98%. Are the 2% of electrons going to electrolyte breakdown? If power/resistance is tested after cycling, is an impact of a growing SEI layer detected? Do the different substituted species perform differently? This reviewer added that, given the scale of the image, it is hard to tell any impact on coulombic efficiency (CE) from the different substitutions. Rate data without more information regarding the cell/electrode design (e.g., loadings, additives, thicknesses) and material properties (e.g., particle size, surface area, etc.) is difficult to judge. Regarding Slide 8, what is the particle size and penetration depth through the 10 seconds or so during which self-segregation is seen? Is the same seen with Ga and Cr? Regarding Slide 9, tap densities and the procedure to determine all of the morphologies should be shared to properly appreciate the microcubic's 2.0g/cc value. Regarding Slide 10, the commercial reference used to show the improved cycling of the microcubic is inappropriate. The researcher mentioned that the commercial example has a different valence distribution than his microcubic, which is why the cycling is poor. An apples-to-apples comparison reference should be shown in the future to better show the impact of the microcubic morphology on cycling. Regarding Slide 13, the six formulations in the upper left corner have multiple data points for each. How was the range of non-stoichiometric non-oxygen/fluorine addition determined for each? The valence range tested for the Ti and Cr species seems smaller than that for the Fe or Al, for example.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer commented it seems that most of the work is done in their lab. Another respondent stated the collaboration framework is consistent with the needs of the project. One final reviewer noted a good amount of collaboration is summarized in Slide 18. However, this reviewer added, the electrolyte work with University of Rhode Island is never discussed in the presentation except in Slide 18. What work was carried out?

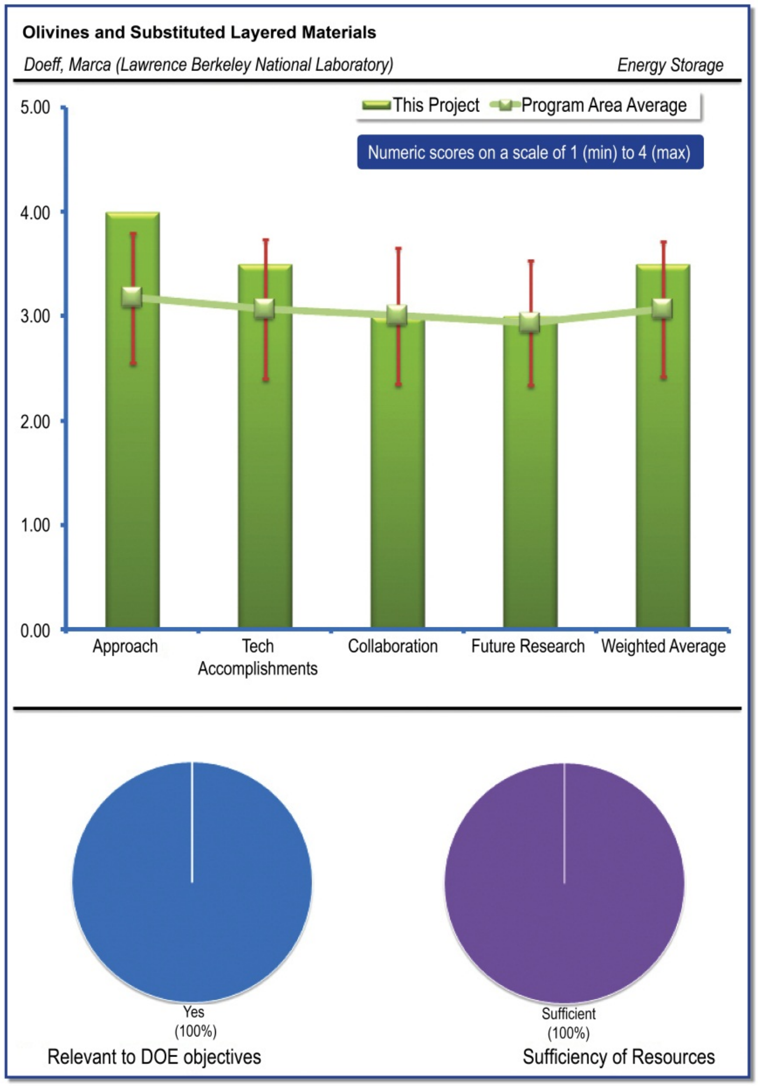
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person remarked the subsequent plan is reasonable even if after material selection and composition optimization more attention to the project objective is recommended with attention to higher capacity and longer cycle life (adequate stability work). Another person felt the future work is well-defined. The third reviewer commented the future work on silicates, vanadium, and high-voltage phosphates looks more likely to make progress towards the energy cost barriers and should be encouraged. This reviewer added that stabilization of the 4V spinel and an alternative for traditional $LiFePO_4$ are interesting, but the higher risk, higher reward work on the silicates, vandium, and high-voltage phosphates is more appealing.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All three reviewers said the resources were sufficient. One reviewer commented the project seems adequately supported, while the other respondent said there seemed to be sufficient resources.

Olivines and Substituted Layered Materials: Doeff, Marca (Lawrence Berkeley National Laboratory) – es052



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The lone respondent indicated the project addresses key aspects of Li-ion cells for better supporting DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer commented the structure of presentation is good, while the other indicated the project is very well organized and structured to give answers to the identified material problems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first respondent stated the technical results show a significant progress with respect to the planned objectives, and added that the extension of structural investigation on a limited number of samples gives more proof about the feasibility of the preparation processes. The other reviewer commented that the performance of the original material is not good, so the group may need to review the synthesis method, but the analysis is detailed and good.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said some collaboration exists, while the other remarked the collaborations are all functional to the specific needs of the projects and are very complete with limited involvement from potential interested industries.

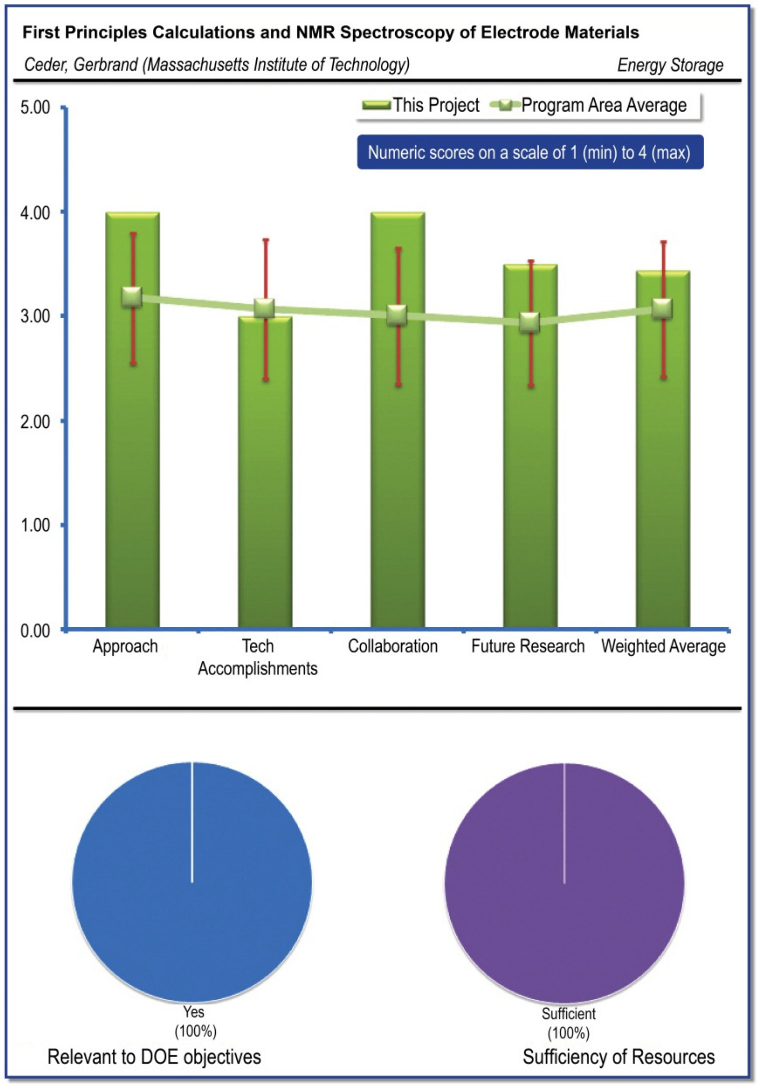
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer indicated the future work is well organized and prepared according to the results of the previous period, while the other stated the future plan is well-defined.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Both reviewers said the resources were sufficient. One reviewer remarked they seem appropriate. The other respondent said it seems resources are sufficient.

First Principles Calculations and NMR Spectroscopy of Electrode Materials: Ceder, Gerbrand (Massachusetts Institute of Technology) – es054



REVIEWER SAMPLE SIZE

This project had a total of two reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

One reviewer said the project is well-aligned to support DOE objectives, while the other respondent said it is a good screening method for new cathode materials.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

One reviewer commented the approach for work was well-defined, while the other person noted the technical barriers are well-addressed with consistent work that well integrates theoretical and experimental work with frontier research on novel materials.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

The first respondent stated the results are highly promising, with outstanding progress opening the road to activities on new materials for the cathode and anode. The other person said it seems very effective to analyze using NMR, especially for alloy materials.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

One person commented the experimental and simulation study was assigned well, while the other reviewer indicated there is a well-organized and efficient network of collaborations inside and outside the subprogram.

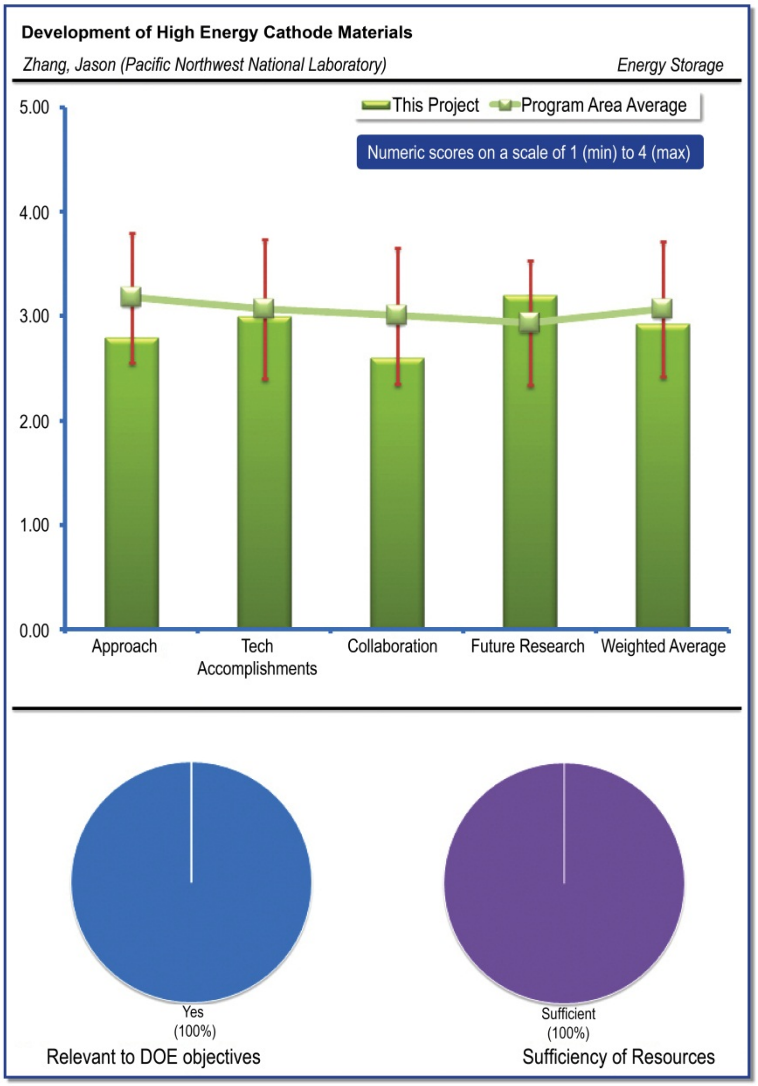
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

One person commented the future work is well organized, strongly based on previous results, and adequately integrated in the rest of the subprogram. The other respondent agreed, stating the future work is well-defined.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Both reviewers said the resources were sufficient. One reviewer indicated there are no specific comments on the level of resources, while the other respondent commented that resources do not seem to be sufficient.

Development of High Energy Cathode Materials: Zhang, Jason (Pacific Northwest National Laboratory) – es056



REVIEWER SAMPLE SIZE

This project had a total of five reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

One reviewer stated the project adequately considers aspects related to DOE objectives, while another noted cathode developments will enable further fleet electrification. One final reviewer remarked high-energy cathode development is one of the critical barriers for the next generation of high-energy batteries.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

Reviewers offered a number of suggestions in this section. This first commenter said the approach for the work is well-defined. Another person indicated the technical barriers are well identified and conveniently addressed with a project clearly focused on technological improvements of well-defined cathode materials. This reviewer added that the V-oxides are not new and, even if they are correctly analyzed, there should be more specific reference or diversification, in the approach description, with respect to the large research activity spent in the past on these intercalation compounds for Li metal cells. A third reviewer said good approach to look at higher energy materials such as $LiMnPO_4$ and $LiNi_{0.5}Mn_{1.5}O_4$. $LiMnPO_4$ thermal work is interesting, but improving the power/energy available is more important to the overall DOE goals. The $LiNi_{0.5}Mn_{1.5}O_4$ work should be more coordinated with other DOE work; the choice of one dopant (0.05 Cr) and one additive (0.25% LiBOB) seems more scattershot and less systematic than some other DOE work. The final reviewer commented the approach chosen for the preparation of the high voltage spinel material to make it easy to adopt by the industry is indeed practical. The PI might want to consider doping elements other than Cr; Cr is becoming more and more regulated.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

Comments were mixed in this section. The first respondent commented the achievements are interesting, with good progress on LNM cathodes and on nanostructuring V-cathodes. Another person noted the PI included a lot of data for the audience to understand, and added they want to see the issue more clearly, especially for the vanadium materials. A third reviewer commented good cycling performance is a must for the cathode to be used by the industry, and very good results are demonstrated. However, this reviewer added, high irreversible capacity on the first cycle, and thus reduced reversible capacity, cannot make this material high-energy material. The reviewer added that this material limitation is very serious in the full cell format. One final reviewer made a number of comments on individual slides. Regarding Slide 6, a loading level of $35 mg/cm^2$ is very heavy, especially for a power-challenged material like $LiMnPO_4$. 22% KB is added to help get some capacity; could one trade down on the KB by reducing the loading level? Has any tradeoff of loading/KB/porosity been done to arrive at the current electrode? The 2009 goals were for 150mAh/g; that was dropped this year. Is 150mAh/g not achievable with $LiMnPO_4$? What sorts of anode and current collectors are used? If using copper, cycling to 2.0V vs. Lithium seems difficult. Regarding slides 13 and 14, comparing the two sets of cycling data, why does the charge/discharge capacity inverse? In Slide 13, $LNMO_4$, the charge capacity is lower than the discharge capacity. Is this a typo or is there decomposition occurring such that Coulombic efficiency is greater than 100%? In slides 14 to 16, what is the Coulombic efficiency over the long term? Does one see the LIBOB boost beyond the initial formation? Was the impact of other additives/levels considered or was this the only attempt? This reviewer added that 50% CE will be very difficult to use at lower temperatures. Regarding Slide 14, comparing the $LNMO_4$ and Cr-doped $LNMO_4$ is difficult without additional cell/electrode design information; are all parameters (loading, thickness, particle sizes, etc.) the same? Regarding Slide 17, what sort of carbon loadings/particle sizes are required to achieve the power depicted? Why is there so much emphasis on power at this early stage instead of energy improvement?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated some collaboration exists, while another indicated the collaborations are considered sufficiently adequate even if more collaboration with other organizations working on the same subjects would be advisable. A third respondent acknowledged good collaborations with other groups; however, more integration into other $LiNi_{0.5}Mn_{1.5}O_4$ work seems useful, especially in the area of electrolytes. The final reviewer noted it might be beneficial to have a summary slide of the results provided by the partners and how it had influenced the PNNL research.

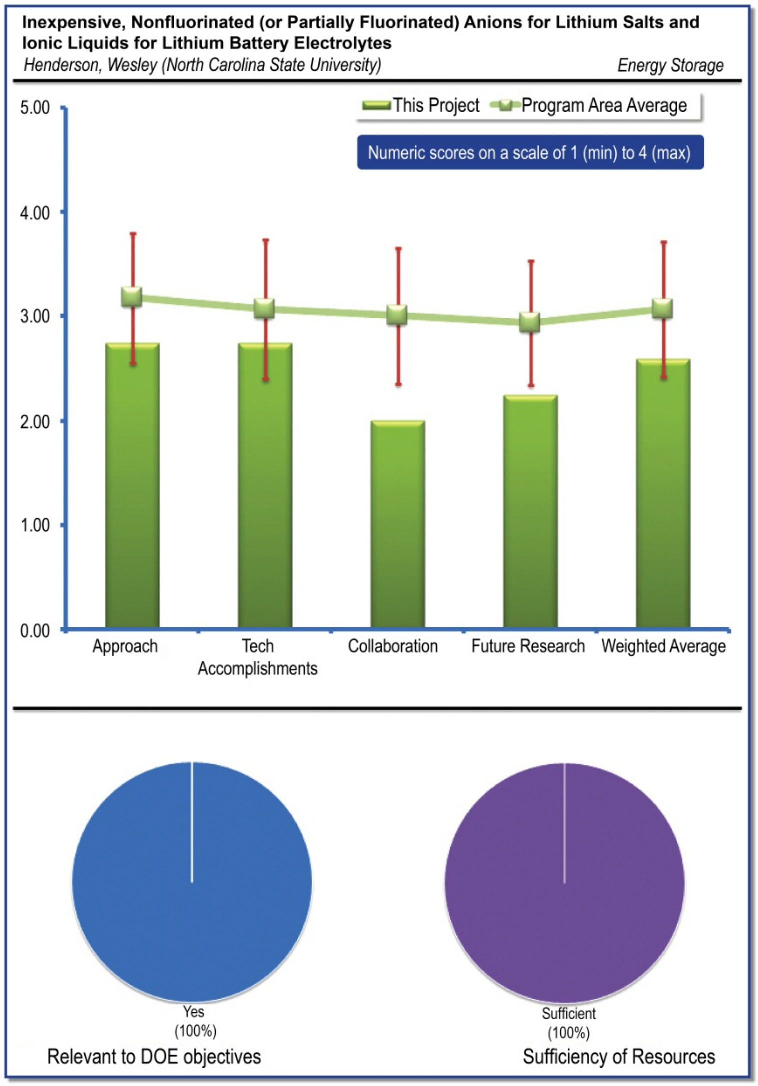
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer felt the future plan is reasonably correlated to the achieved results, adding that more work on the standard cell design based on the LBNL proposal is recommended. A second person commented that the future work on $LiNi_{0.5}Mn_{1.5}O_4$ seems reasonable, but added it was unclear what the future work on the vanadium compounds is. Another person noted a clear path forward to address the limitations of the high voltage spinel material and asked if there are any plans to continue work on vanadium cathodes. The final reviewer noted it seems there are no further research plans for the vanadium materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All five respondents in this section said the resources were sufficient. One person stated the budget seemed adequate, while another agreed there seems to be sufficient resources.

Inexpensive, Nonfluorinated (or Partially Fluorinated) Anions for Lithium Salts and Ionic Liquids for Lithium Battery Electrolytes: Henderson, Wesley (North Carolina State University) – es057



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer stated the characterization and discovery of new electrolytes is important for getting DOE objectives, while another added that improvements in electrolytes will enable greater fleet electrification. The third reviewer commented that the electrolyte work should be done more in DOE projects.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers offered a number of suggestions in this section. One commented that the project is well-organized and focused on technical barriers. The characterization of anions for Li battery electrolytes is an important means for selecting novel and optimized materials, even if it is not clear how the low-cost target is effectively addressed. A second reviewer commented on individual slides. Regarding Slide 3: it was unclear how the PI will address the last two objectives without any anode and cathode related work; collaboration with another group in this area is very strongly needed to leverage the work. Regarding Slide 5: the reviewer felt it was unclear how this approach will address the barriers of low temperature power. The materials considered that are borate-based are known to have lower Li+ dissociation than $LiPF_6$, so it is unclear how they have a chance of beating the incumbent. Another person suggested that a more narrow focus of work on a specifically targeted range of electrolyte constituents may be beneficial. One final respondent commented that it is fine to study the detailed structure of the old materials by Raman techniques, but the PI could try newer material as well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer remarked the characterization of the various electrolyte formulations is very complete and promising, with clear indication for the prosecution of the work. The progress is well in line with the projected objectives. Another person commented that the gassing is well-known issue for LiFOB and LiBOB, and added that the PI should extend the work to electrochemical study as well. The final reviewer made a number of comments, indicating the LiDFOB Phase Behavior seems reasonable on its own, but it is difficult to see how it will be applied. Central Glass and Army Research Laboratory (ARL) have previously synthesized this material and done some preliminary studies. It is difficult to see how the current work improves the likelihood that LiDFOB will be used. This reviewer noted that sulfones are used in the sulfur lithium literature, and asked if there has there been any attempt to examine that usage for LiDFOB. Lastly, given how the high-voltage nitrile properties of material reported by the National Research Council (NRC) have been difficult for some to reproduce, this reviewer asked if the PI confirmed the voltage stability of his materials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer commented the collaborations still remain at a very good level for the scientific aspects, but the required involvement of industry still remains unclear and open with no explanations yet. Another person indicated collaboration with a partner skilled in electrode/cell assembly is urgently needed. In Slide 35 the PI mentions a couple of partners he is considering; why not a national lab? This reviewer adds that other groups/companies have sent John Kerr electrolytes for his evaluation before, and asks if that has that been considered. The final reviewer stated the group can do more electrochemical study with some institutions.

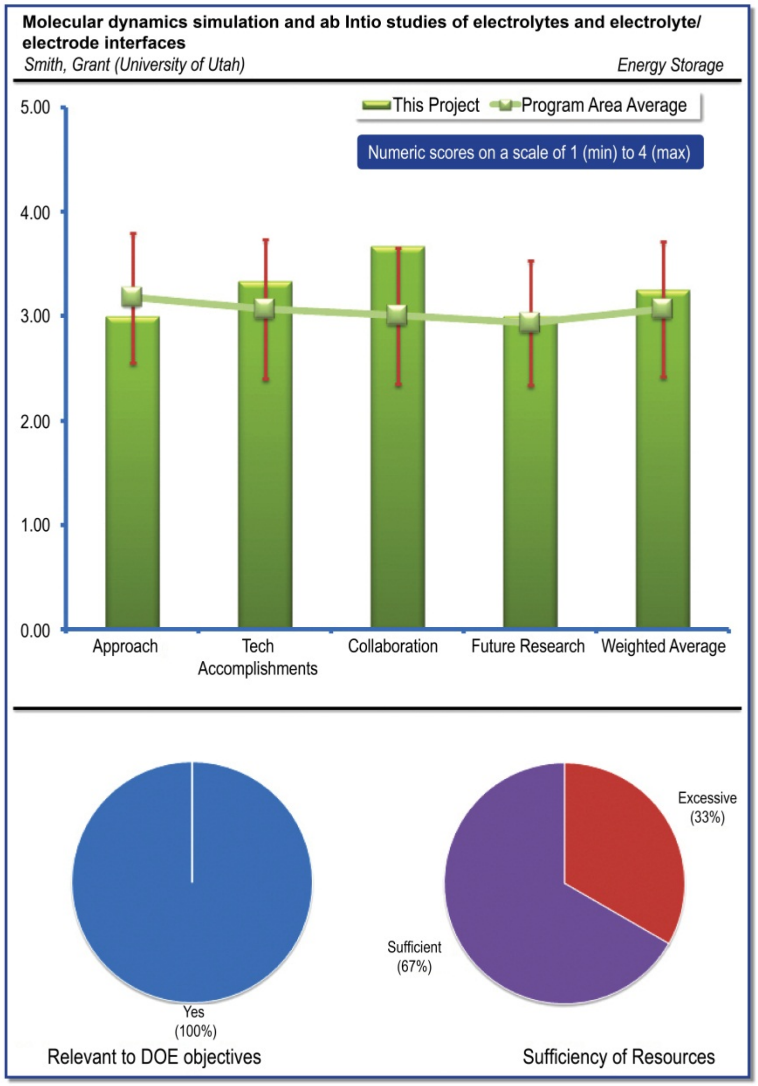
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewers offered a number of suggestions in this section. One reviewer commented the prosecution of activities is consistent with the previous results even if a better involvement of industry is not planned. Another reviewer felt a narrower focus may be beneficial. A third person suggested that high-voltage validation of electrolytes and some electrode/cell work should be added. The final respondent remarked that the PI should extend the work to electrochemical study as well.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All four respondents said the resources were sufficient. One reviewer said there seems to be sufficient resources, while another had no specific comment.

Molecular dynamics simulation and ab intio studies of electrolytes and electrolyte/electrode interfaces: Smith, Grant (University of Utah) – es058



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One person stated the electrolyte and SEI characterizations are functional to meet DOE objectives. The other respondent commented that modeling would be a good method to understand the phenomena inside the cell.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer indicated the approach based on simulations is complementary to the experimental one and is well-organized and feasible. This reviewer added the technical barriers are well addressed with simulations on two aspects: the electrolyte and the SEI. Another reviewer commented that the approach is good, but the apparent absence of any experimental confirmation activity to validate the modeling results, and/or the absence of an explanation regarding connection with any planned external model validation activity, seems to be a shortcoming. The final respondent indicated that, if the PI can find new materials based on the modeling results and extend the study, it would be good.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer said it is quite significant progress for the last three months, while another said the results are interesting and show good progress with respect to the selected barriers.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer noted several collaborations exist with other institutions. The other commenting reviewer said that the PI has reached a central position as reference for simulation in the subprogram with a well-organized and integrated network of collaborations that are very effective in progressing in the specific field of electrolytes and SEI.

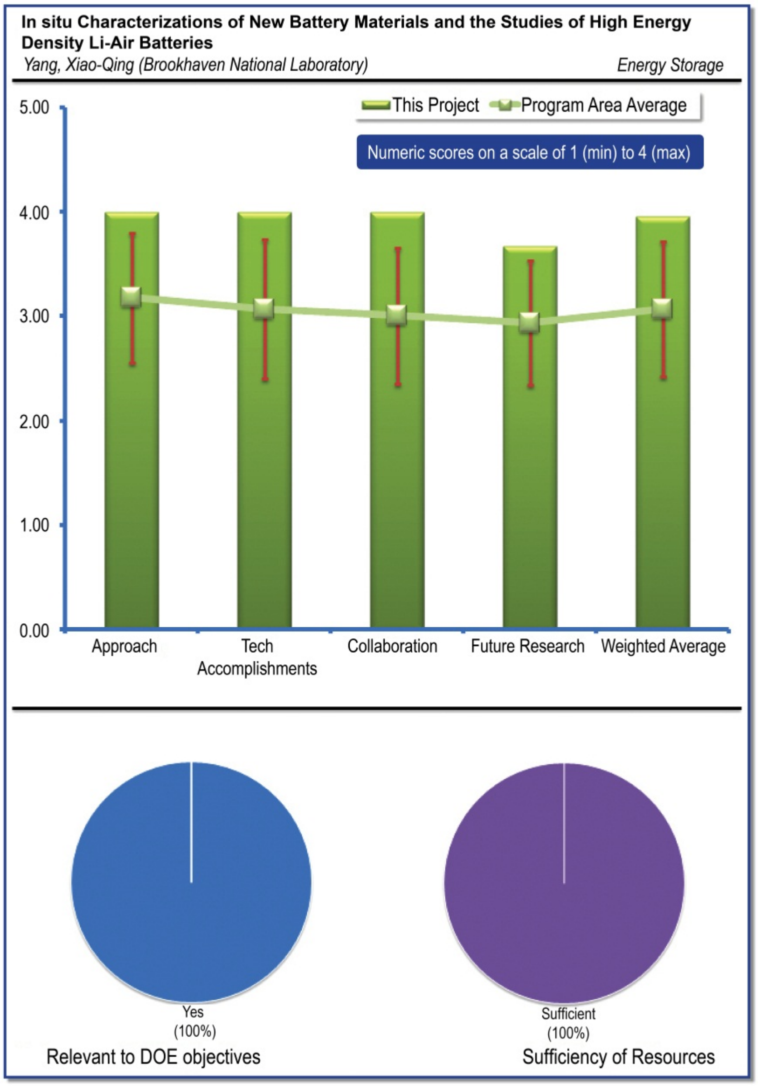
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer indicated the planned work is well aligned with already achieved results and the requests from other institutions involved in the subprogram, adding that the main recommendation is to explicitly include model validation and conclusion in the work. Another reviewer felt that work to validate the modeling results should be included, and/or reference to planned external validation work. The final respondent commented that, if the PI can do some electrochemical study to compare with the modeling, it would be good.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers said the resources were sufficient, while one felt the resources are excessive. One reviewer said there seems to be sufficient resources, while another indicated no specific comment.

In situ Characterizations of New Battery Materials and the Studies of High Energy Density Li-Air Batteries: Yang, Xiao-Qing (Brookhaven National Laboratory) – es059



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first respondent said the work done in this project is of general value and fundamental value in comparing and characterizing Li materials for DOE objectives. The other person commented that new material characterization is one of the proper roles of a national lab.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One person commented that the approach for the work was well-defined and also focused on new systems such as Li-Air. The other respondent said the technical barriers identified are addressed in a complete manner with an innovative approach aimed at analyzing the behavior of components and materials during operations. This reviewer added the applied techniques and the focus on key aspects of various Li chemistries show a well-organized project with a very good vision of the investigation and problems to be solved.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first reviewer said that the data analysis is very detailed and understandable, while another felt that the development of new in-situ techniques (such as in-situ XRD during chemical delithiation) is excellent and should be furthered, and additional new alternate approaches should be explored. The final respondent indicated the progress is relevant, with important results on the possible chemical modifications of cathode materials to improve their usability in various Li cells. This reviewer added that some studies on aged cells would be beneficial in completing the analysis on the degradation mechanisms of positive electrode materials. The project is a powerful scientific and technological tool for assisting the entire BATT subprogram. The work on Li-air is giving interesting results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer noted a well-structured and appropriate group of collaborations in and outside the BATT, with good coordination and rationale behind each individual collaboration. The other respondent commented that the group has a significant amount of collaboration with both other institutes and industry.

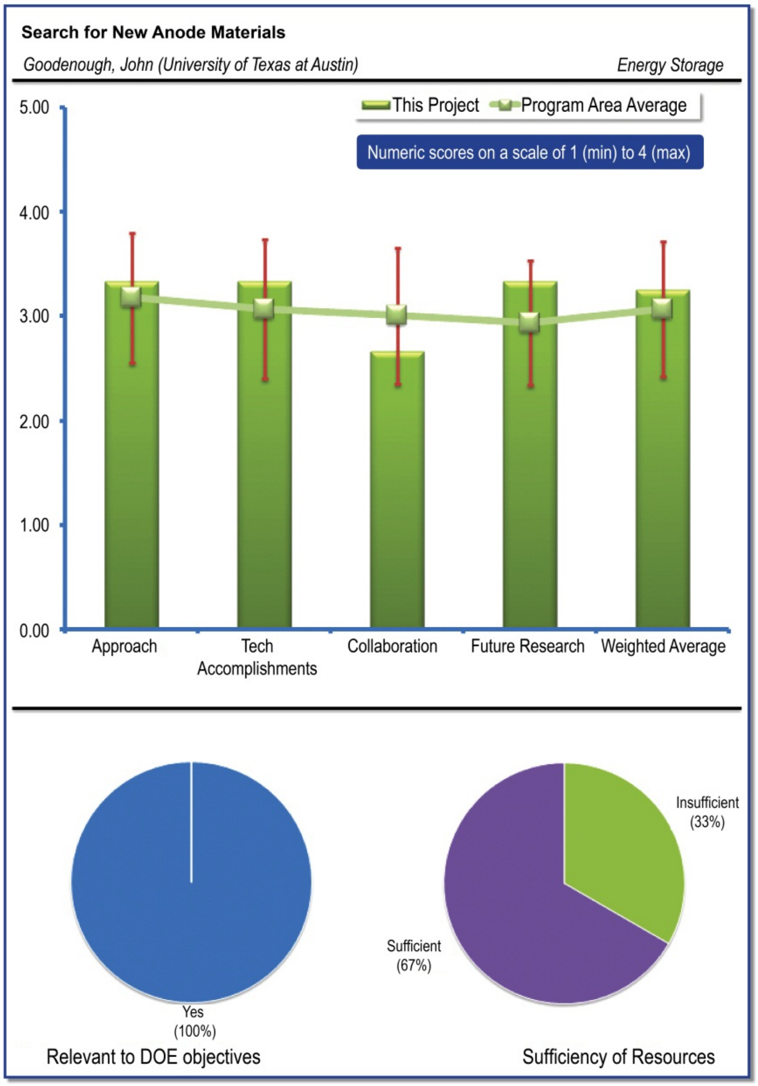
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first respondent commented that the future work is well-defined, while another said the work planned is consistent with the interesting results already achieved. This reviewer added that, due to the high level and quality of the expertise and equipment available, it is highly recommended that the group include a vis-à-vis comparison with other materials developed in other BATT projects to have a complete view of the potential need for further R&D on these materials. The final commenter said the proposed future work is generally excellent, but any focus on Li-Air (in the context of the potential for future automotive applications) should be very minimal (at most). In the place of Li-Air activity, additional focus and activity on Li-ion electrolytes would be of considerably greater value. This reviewer added the development of new in-situ techniques (such as in-situ XRD during chemical delithiation) should be furthered and additional new alternate in-situ approaches should be explored.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All three respondents said the resources were sufficient. One reviewer said there seemed to be sufficient resources, while the other commented the extension of work to other materials and chemistries may require more efforts.

Search for New Anode Materials: Goodenough, John (University of Texas at Austin) – es060



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer stated the exploration of a new electrochemical storage system is functional in achieving DOE objectives, while the other respondent emphasized a need to look for new materials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter said the project is well structured with the identification of clear technical barriers to be overcome. The basic concept and the cell design are developed and experimentally characterized. The other reviewer noted a good and reasonable explanation for choosing the materials for the flow battery.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer stated the results are promising and well in line with the planned objectives, while the other reviewer noted there are no electrochemical test conditions clearly indicated in the slides.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The first reviewer remarked the collaborations are very limited and not even motivated; it is recommended the group analyze and propose contributions from other institutions. The other respondent also noted that there seems to be little collaboration, but added that the group may not need so much collaboration for this project.

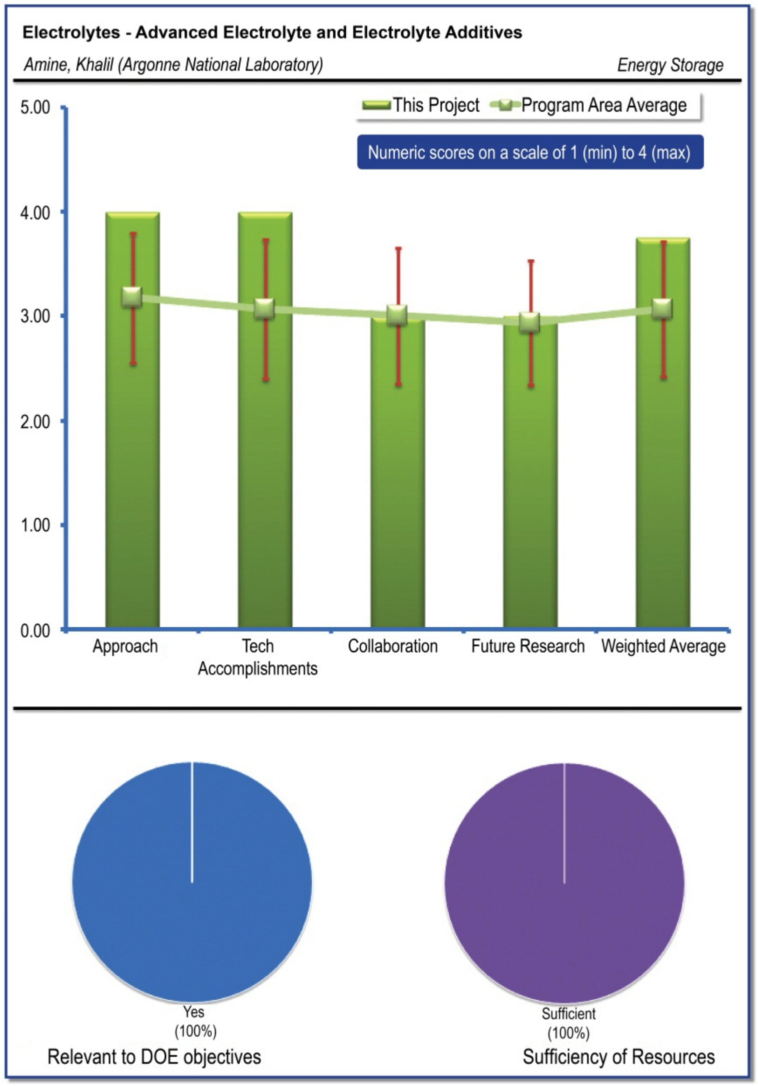
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person said the future work is reasonable, while the second respondent indicated the future work is well built on the achieved results.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers said the resources were sufficient, while one said they were insufficient. One person said the efforts are judged to be adequate, and another respondent said there seems to be sufficient resources.

Electrolytes - Advanced Electrolyte and Electrolyte Additives: Amine, Khalil (Argonne National Laboratory) – es066



Reviewer Sample Size

This project had a total of one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer said the work on electrolyte is useful for DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer commented that the project combines in an appropriate manner theoretical and experimental studies to select promising electrolyte materials and related additives able to meet the well-identified barriers of high stability during life and in severe conditions (abuse). The approach is reasonable starting from the survey of materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer indicated the achievements are very promising and complete, with an excellent integrated progress on the theoretical as well as the experimental part, with good indication in the selection of novel electrolytes and additives.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer said the network of collaborations is very good and appropriate even if a major involvement of other institutions of BATT, mostly focused in cell design, construction, and testing, may be useful experimental support in validating results.

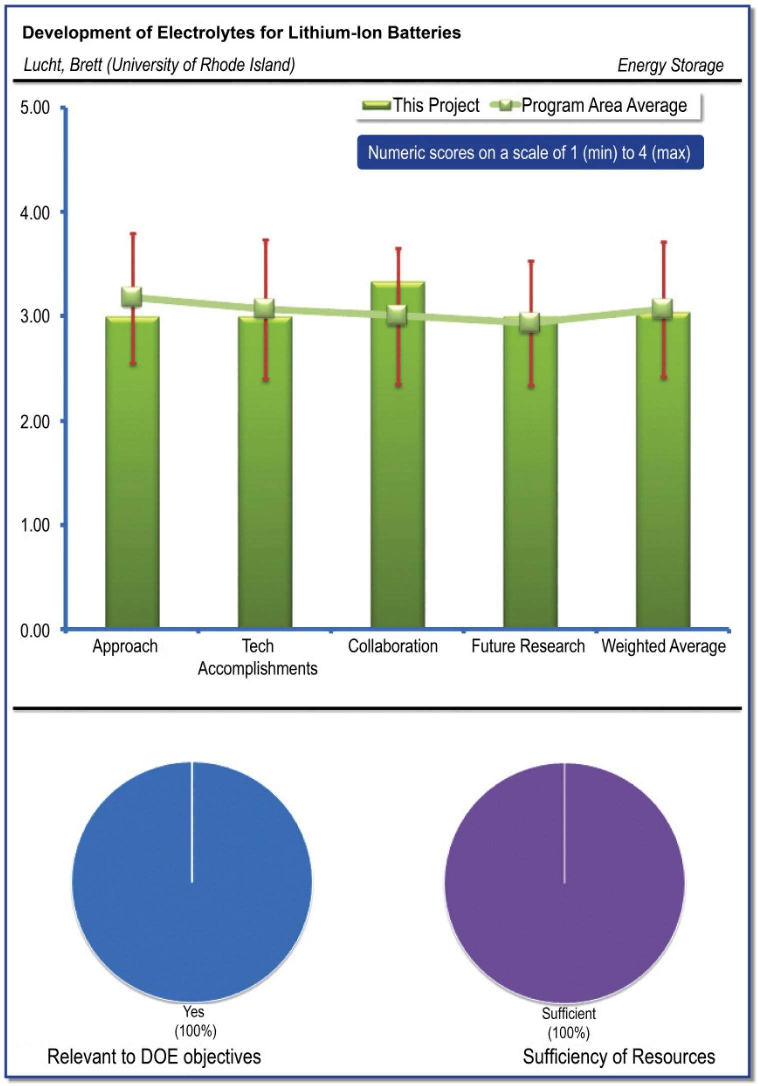
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The lone respondent said the proposed prosecution is consistent with the results already achieved. However, more collaboration with other institutions in BATT is recommended.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The lone reviewer said the resources were sufficient. The reviewer indicated the resources are considered adequate even in consideration of the possibility of having some feedback from other projects.

Development of Electrolytes for Lithium-ion Batteries: Lucht, Brett (University of Rhode Island) – es067



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer noted the electrolyte development is critical for reaching DOE objectives, while another stated improvements in electrolytes will enable greater fleet electrification. One final reviewer commented electrolyte work should be done more in DOE projects.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first respondent felt the approach is reasonable and logical throughout, while another reviewer noted clear objectives are related to technical barriers. This reviewer added the project is well focused on improved electrolyte materials and additives able to be used in thin film formation. One final reviewer commented the PI just focuses on one material so he can extend the research more to other materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer stated the results are interesting and of general value, and added the progress is appreciable and well-positioned with respect to practical improvements of electrolyte behavior. A second respondent noted one of the famous issues for LiBOB is gas generation, and this reviewer wondered if this material could have the same issue. The final reviewer made a number of comments on individual slides. Regarding Slide 8, the PI mentioned that the current yield of 60% is significantly improved; what was the original yield? Regarding Slide 9, the PI should share details of several batches of various purity levels; otherwise it's hard to appreciate the scope of work done. The image on Slide 9 is hard to read just due to formatting. The increase of c-rate at the 4th cycle causes a dip in CE. Is the same seen in an identical setup (cell/electrode) of $LiPF_6$? Regarding slides 9 to 11, what are the solvents used? Regarding Slide 12, what is carboxymethyl starch (CMS) and is it supposed to be comparable to NG? Regarding Slide 14, what is the capacity of your LNMO electrode? The presenter mentioned C/20 charging, but what current does that translate to? A 5mV/s rate would take at max ~18 minutes to sweep from 0 to 5.3V, whereas a C/20 rate would take 20 hours to fully charge. These are rather different time rates, so it would be helpful to know the currents as well as to understand how comparable things are. Regarding Slide 15, the image on the right is hard to interpret with its peaks off-chart. How were the relative intensities evaluated? Was there any degradation in that peak intensity and/or other F peaks created outside of the 70 to -60ppm range? Regarding Slide 17, how were these additives determined? In opening, the approach states that computational methods will be used, but they are not mentioned anywhere else in the presentation.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said the network of collaborations is judged appropriate, with a claimed involvement of an industry partner for commercialization verification. The second reviewer noted a large degree of collaboration, which seems to be coordinated well. This reviewer added it is unclear what the role of S. China University Tech is since the computational activity was not discussed. One final reviewer commented that some collaboration exists.

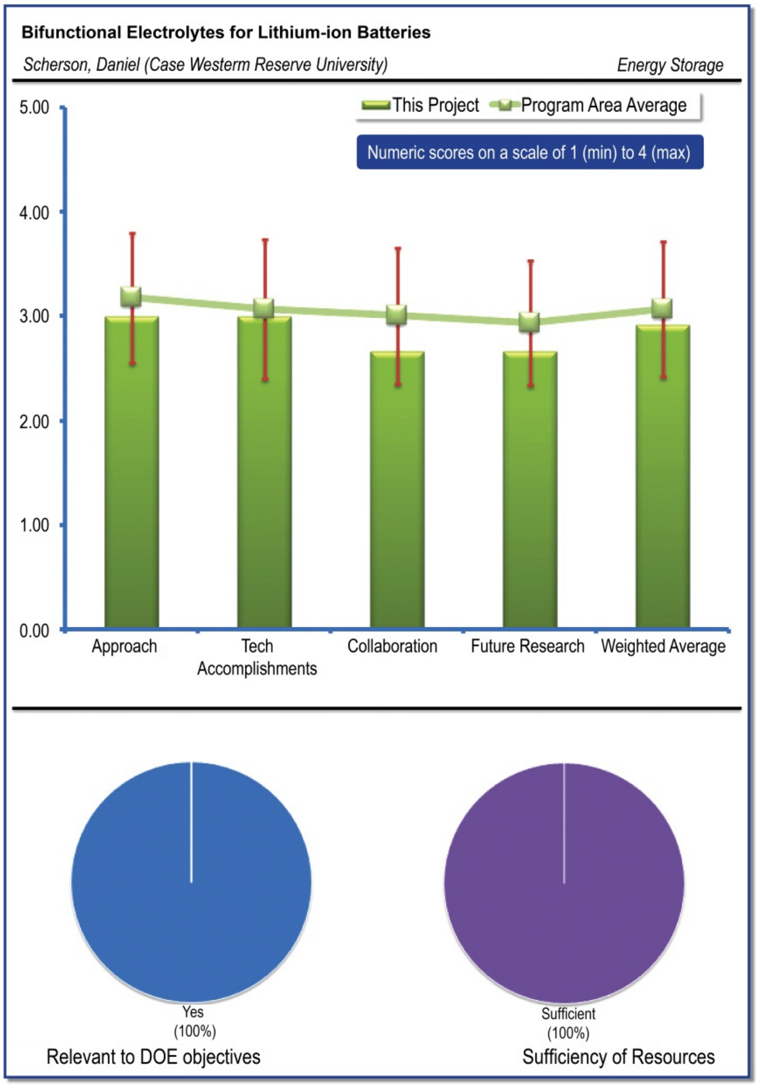
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers offered a number of suggestions in this section. The first respondent stated the proposed prosecution of work is consistent with the achievements and with the objectives of the project. It is recommended by this reviewer to complete the characterization of the developed materials including transfer number and other electrochemical measurements to fully characterize the materials with potential practical applications. A second respondent felt the future work seems reasonable, and added the silicon work should be emphasized to help benefit the other DOE groups working on this area. The final reviewer would like to see the mechanism for SEI and any gas formation.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All three reviewers said the resources were sufficient. One reviewer said the resources are appropriate, while another commented there seems to be sufficient resources.

Bifunctional Electrolytes for Lithium-ion Batteries: Scherson, Daniel (Case Western Reserve University) – es068



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer stated the development of improved electrolyte is an essential support to DOE objectives. Another commenter stated improvements in the electrolyte will enable greater fleet electrification. A third reviewer felt electrolyte work should be done more in DOE projects.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section. One respondent said the project is well structured with an acceptable approach, while another commented the approach seems reasonable and logically thought out. One final reviewer stated the in-situ attenuated total reflectance - Fourier transform infrared spectroscopy (ATR-FTIR) seems to be an interesting method.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer noted the results are interesting with a good progress. A second reviewer felt there could be very high concentrations of oxygen in the cells at abnormal conditions; if the PI can show how the electrolyte reacts under different conditions, it would be good. The final reviewer commented on individual slides. Regarding Slide 7, the CASE salt is a modified LiBOB structure. How do the changes impact the delocalization of charge and the lithium dissociation capability of the new salt? Regarding Slide 8, does the CASE salt always form a dimer as depicted in here? Regarding Slide 11, why are only 2-3 cycles of the experimental shown, when the reference is run to at least 5? What happens on the first discharge of cell 3 of the experimental; the voltage curve seems rather erratic? Why is the voltage curve used if only taken to less than five cycles? This confounds the results further, unless the voltage curve is needed for some reason for the experimental? What is the CE of the experimental? Why was $LiCoO_2$ chosen as the cathode? No one intends to use $LiCoO_2$ moving forward, so a more BATT-relevant cathode seems appropriate. Regarding Slide 12, what is the advantage of using this method instead of the thermogravimetric analysis (TGA) method more common in the literature? Regarding Slide 13, is the middle row supposed to be the 2-MePh species? It is labeled with the generic Ar side groups. Regarding slides 4 and 16, the milestones list the completion of the in-situ ATR-FTIR cell on April 10, yet very little data was shared using this tool.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

One reviewer noted some collaboration exists, while another person commented there are limited collaborations but they are well integrated. The final reviewer noted all of the collaborations are outside of the Vehicle Technologies (VT) program and based locally in Ohio. This reviewer added the researchers should consider if there are other partners that already exist in DOE and throughout the country that could assist their work.

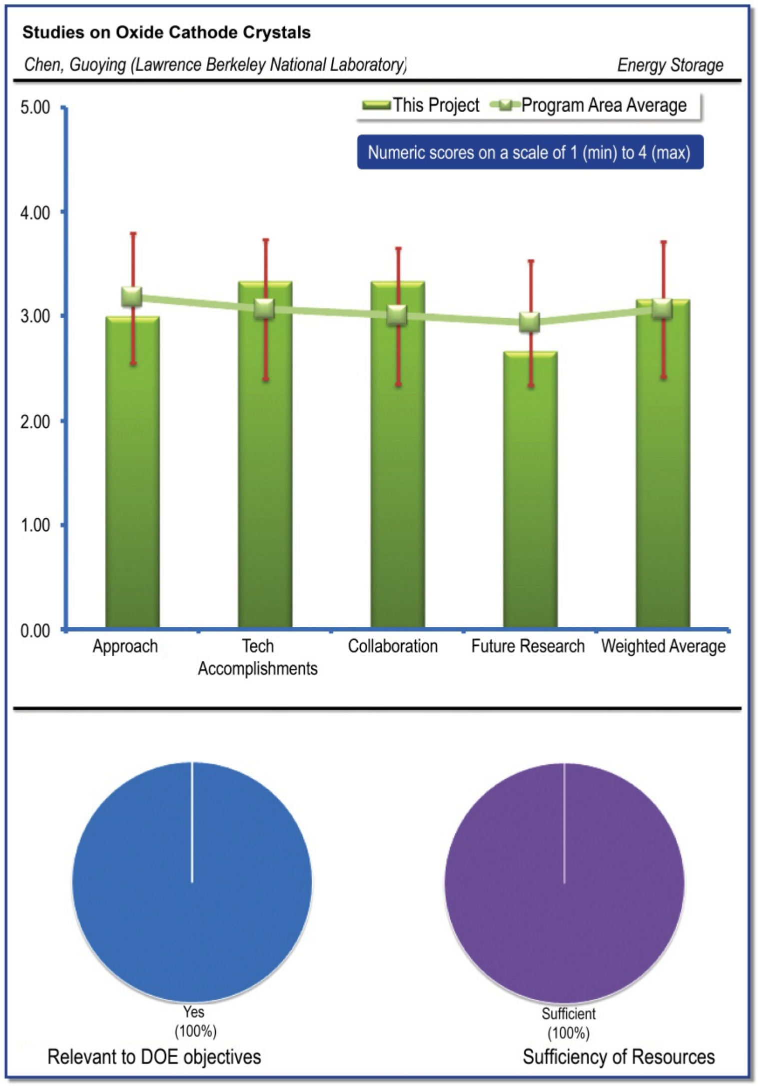
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

One respondent indicated the future planning is consistent with previous work. Another reviewer said additional in-cell testing is recommended, while a third would like to see some results for the in-situ ATR-FTIR; it seems to be an interesting method.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

All three reviewers said the resources were sufficient. One reviewer stated the resources are adequate, while the other respondent in this section said there seems to be sufficient resources.

Studies on Oxide Cathode Crystals: Chen, Guoying (Lawrence Berkeley National Laboratory) – es069



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first respondent said the project is functional to DOE objectives, while another stated improvements in cathodes will enable greater fleet electrification. The last respondent commented the relevance is fine but it can also be more specific.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One person felt the approach for the objectives is well-defined. A second reviewer stated the selected technical barriers are reasonably approached with the material analysis even if limited to oxide cathodes. This reviewer added some improvements would be possible with more cell test work. The final reviewer commented the approach seems reasonable; however, the $LiMMnPO_4$ and thermal work alluded to in the milestones/objectives don't show up in the work presented.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer indicated the results are valuable and well-directed towards the defined objectives with a clear identification of barriers. Another reviewer commented the analysis for the crystal was well done and the results were organized well. The final reviewer made a number of comments on individual slides. Regarding Slide 3, the last objective puts an emphasis on thermal stability for this project but no thermal data were shared. Regarding Slide 4, no work on $LiMMnPO_4$ was reported despite being an upcoming milestone. Regarding Slide 11, if this work is on single crystals, is that how the data on Slide 11 was created? What sort of experimental setup was created to test these materials for capacity and rate? Regarding Slide 12, this appears to be a comparison of one overlithiated sample (Seimi) versus two stoichiometric samples. To compare the size impact of the three, one should control for the other factors such as over-lithiation. The 1 um and 100nm crystals have LiOH and Li_2CO_3 labels in the SEM. Were the synthesis conditions the same for each and could that explain the capacity difference seen in the C/D data rather than size? What is the size domain of the Seimi samples? Regarding slides 10 and 16, SEM was used to look at high voltage LNMO and TEM was used to look at layered-layered morphology; were the converse studies done to examine morphology (i.e., SEM on layered-layered and TEM on high voltage LNMO crystals)? Regarding Slide 17, layered-layered work seems repetitive of Thackeray's previous work; one should clarify what is novel.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated the network of collaborations is outstanding and well integrated, while another said it seems to be appropriate collaboration with other institutions. The third reviewer indicated, regarding Slide 26, a large amount of collaborators were listed, and the work done by the authors should be clarified because most of the technical data reported appear to be of a type that was outsourced.

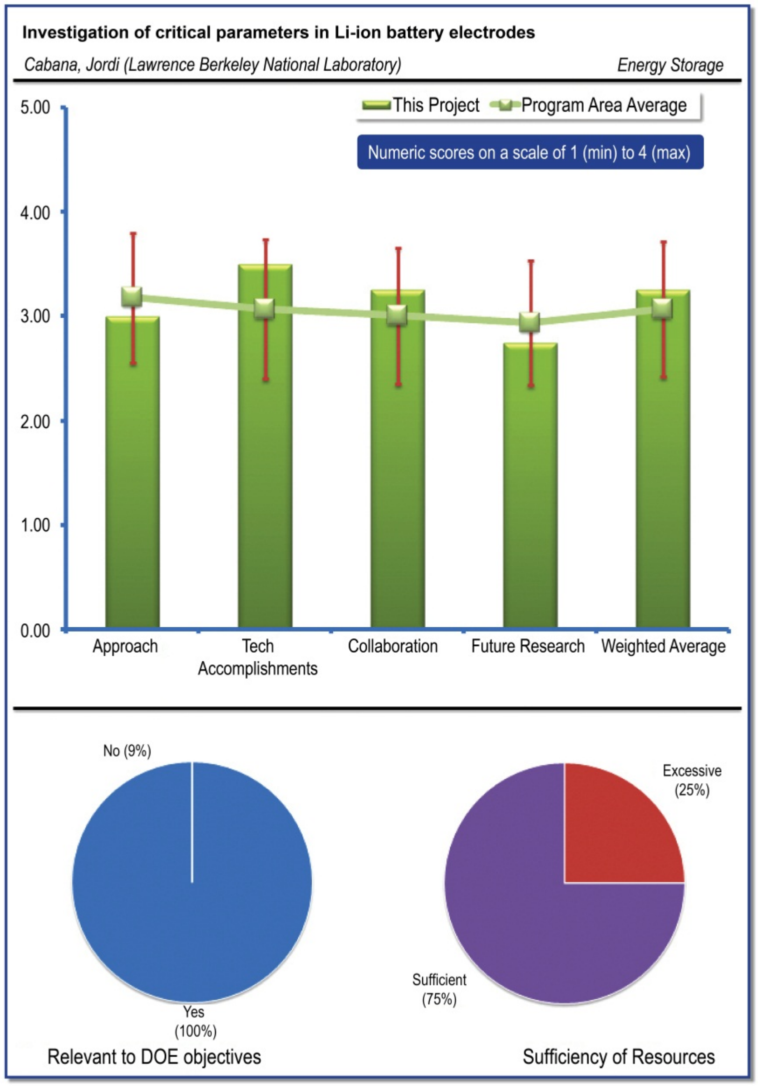
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer felt the future work is well-defined. A second respondent commented the plans for the future are adequately connected to the achieved results. One final reviewer noted larger integration and context to the work of the Ni/Mn spinel working group would be helpful.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All three reviewers said sufficient. One person stated the resources seem appropriate, while another commented there seems to be sufficient resources.

Investigation of critical parameters in Li-ion battery electrodes: Cabana, Jordi (Lawrence Berkeley National Laboratory) – es070



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first reviewer said the project clearly addresses scientific and technological aspects functional to the achievement of DOE objectives. Another reviewer commented that improved cathodes and anodes will increase fleet electrification. One final reviewer felt that the relevance is fine, but the presentation title did not express the contents well.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers offered a number of suggestions in this section. One reviewer said the approach is fine, adding that the title indicated the critical electrode parameter and yet this study focused on the materials. Another reviewer said the project has a focused approach on analyzing the behavior of defined classes of cathode materials with advanced techniques. The main improvement that may be suggested is to systematically analyze other cathode materials to try to give substantial inputs to improve cathode behavior. A third reviewer said better integration with other participants in the Ni/Mn spinel work is recommended, and added that little overall context/impact of this work to other activity is communicated. The final commenter stated that the first cycle inefficiency is common for all Ni-containing cathodes and, for the layered structures, is known to be reduced with the incorporation of cobalt. This reviewer added that NCA-type materials have been used in commercial applications and have demonstrated excellent cycling performance in the full cells. It might be helpful to take a broader view to assess the reasons for the irreversible capacity losses on the first cycle in the Ni-containing materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Remarks in this section are generally positive. One reviewer said the results are of relevant value with positive impact on material optimization, while another said very good progress towards the objectives, and selection of the techniques is commendable. A third person said the synthesized material was analyzed very well. One respondent posed a number of questions. Regarding Slide 5: how was the CE goal of 99.99% chosen? This efficiency will lead to 80% capacity after 2,231 cycles – what target does that meet? How was the ultimate goal rate set to C/2? Regarding Slide 12: what is the capacity performance of the material as a half cell, and what is the CE of the full cell? This reviewer also asked, more generally, what electrolyte was used and what was the voltage range swept for all of the group’s work? Further, regarding Slide 17: how is the theoretical capacity of $LiCoO_2$ reported as less than 200 mAh/g? What is the particle size/morphology of the NiO? One final reviewer asked, regarding Slide 15: is Li completely removed upon charge? If not, how does the investigator think it might affect the Coulombic efficiency?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said there are appropriate collaborations and good coordination among them, while another commented that collaboration with other institutions seems appropriate. A third reviewer said it is good to state how the collaboration impacts the progress and helps with the design of experimental work. One final reviewer noted a lot of collaboration, but commented that the integration into other high voltage Ni/Mn spinel work is not made as clear as it could be.

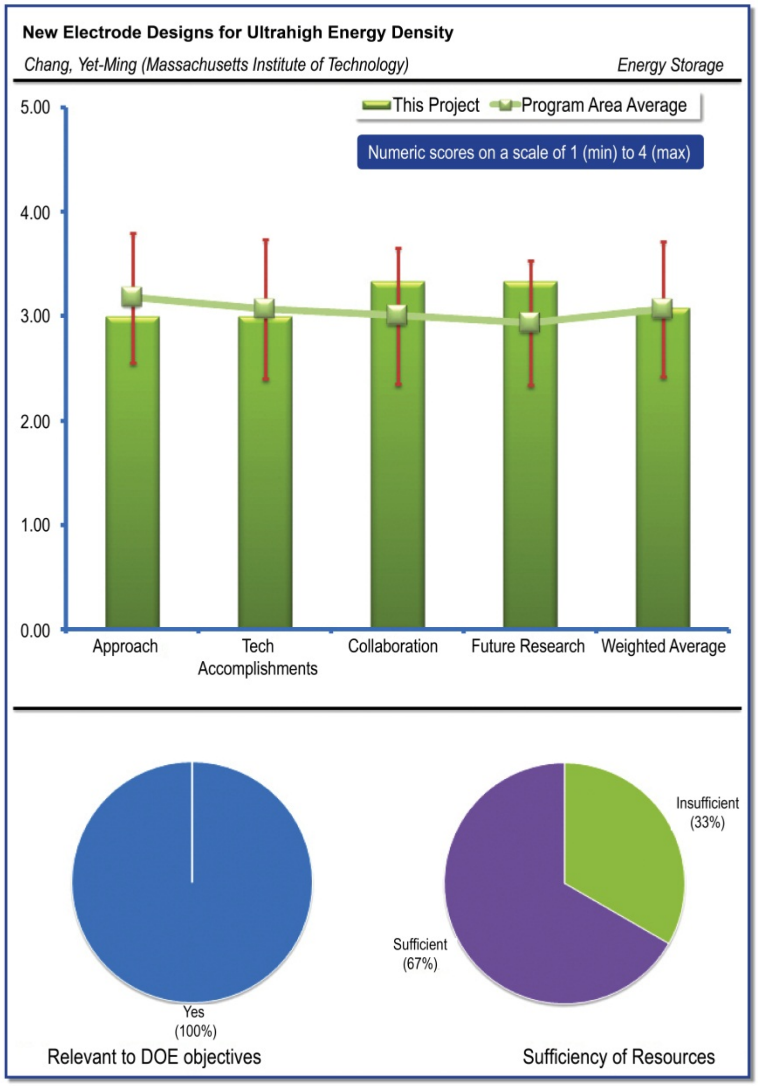
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments were generally positive in this section. One reviewer said the future work was well-defined, while another commented that the plan for future work is consistent with the achieved results. One person noted future work should clarify the connection to overall Ni/Mn spinel work. The final respondent indicated that the future work plan demonstrates an understanding of the material challenges and offers a good path forward. This reviewer added that it might be useful to look at the first cycle inefficiencies for the layered No-containing systems as well as the choice of the precursors. It is known, for example, that using lithium hydroxide for manufacturing of the Ni-based systems results in good-performing cathode materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Comments were mixed in this section. One reviewer said it seems to have sufficient resources, while another indicated there are no specific comments. The final respondent felt that the integration and contribution to other programs is unclear, particularly for a program that received twice the funding of many other programs in FY11.

New Electrode Designs for Ultrahigh Energy Density: Chiang, Yet-Ming (Massachusetts Institute of Technology) – es071



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer said the project looks at novel designs for improving Li batteries and better meeting DOE objectives. Another commented that electrode design is important for performance improvement and cost reduction of the battery. One final reviewer stated that electrode design is important but was not sure if this is suitable for university work.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer remarked that the project's objective of applying a novel cell design with an innovative preparation approach is very interesting, with a gradual approach starting from a conventional cathode material to arrive at a more innovative and applicable cathode material (such as Mn-based). Another person said very interesting approach, but added that the investigator might want to consider things other than water solvents to make sure Li/M stoichiometry is not affected during the procedure used to produce electrodes, which might result in a reduction of the delivered capacity. This reviewer added cathodes other than $LiCoO_2$ could be even more moisture sensitive. The final reviewer felt the pore design would be very important for thicker electrodes, but wondered if this non-uniform electrode can cause other issues.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were generally positive in this section. The first commenter stated the results are promising even in consideration of the large number of samples and the need to optimize the novel preparation approach. Another commented that there were excellent initial results for electrodes fabricated without any additives; very good understanding of the parameters controlling the electrode properties. This reviewer added good correlation of the results to the targeted applications. The final respondent would like to see how the non-uniform electrode affects the performance, and asked the investigator to please compare the result of energy density by volume also.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said the collaborations are adequate to the needs of the project, with good integration and coordination. The other respondent noted there are some collaborations.

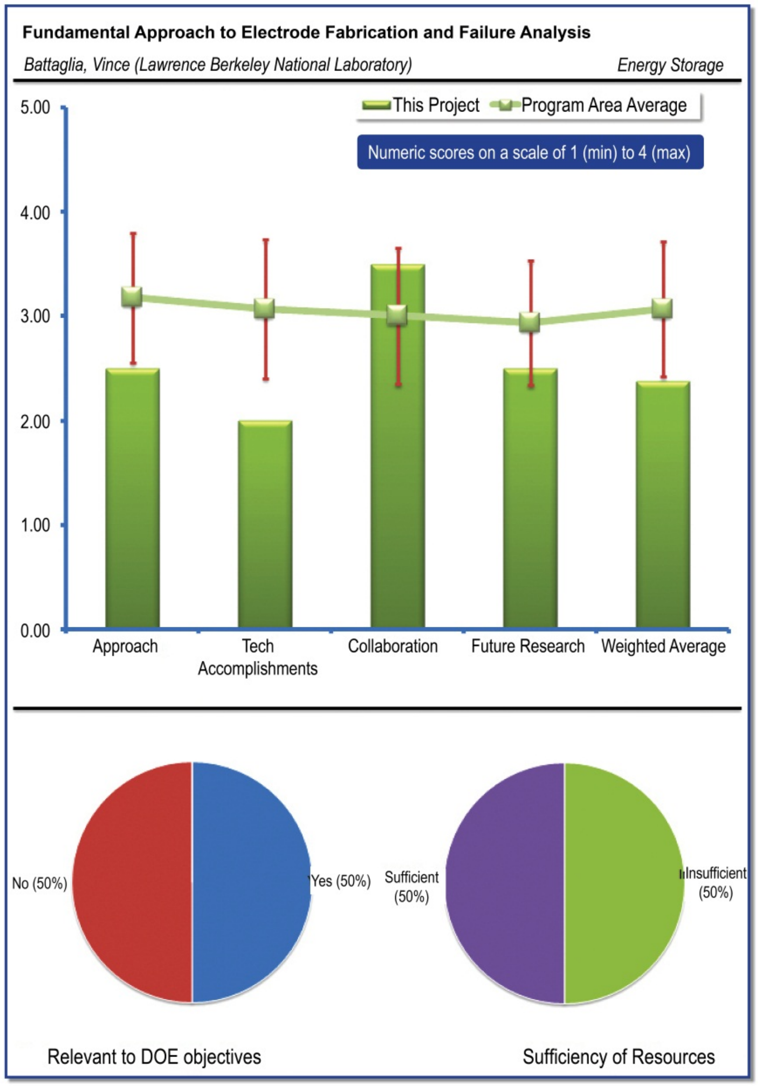
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The first reviewer said the future work is well-defined. The other respondent commented that the planned work for the next period is considered consistent with the results already achieved, and recommends accelerating the extension to other materials (not only one).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers said the resources were sufficient, while one said they were insufficient. One commenter said it seems more resources need to be added, and another reviewer asserted that the resources seem appropriate.

Fundamental Approach to Electrode Fabrication and Failure Analysis: Battaglia, Vince (Lawrence Berkeley National Laboratory) – es081



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer said the project is good towards DOE objectives. The other commenter said, as one reviewer mentioned last year, it is not national lab work.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer indicated the project has clearly identified key barriers and created a feasible and well organized project with significant contributions to reach the proposed objectives. The other reviewer commented it is not clear if the PI wants to focus on the process or materials to improve the electrode. This reviewer does not see the fundamental approach as the title described.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person commented that the results are of high quality, with an additional must that is the creation of a common electrode preparation procedure: a way to standardize and make comparable the activities in other groups in BATT. However, the results on capacity fade and related material changes are valuable. The other respondent expressed a need for more fundamental electrode analysis.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated there is some collaboration with other institutions, while the other respondent commented there is an appropriate network of collaborations that may act as the skeleton of the overall exploratory research work in BATT.

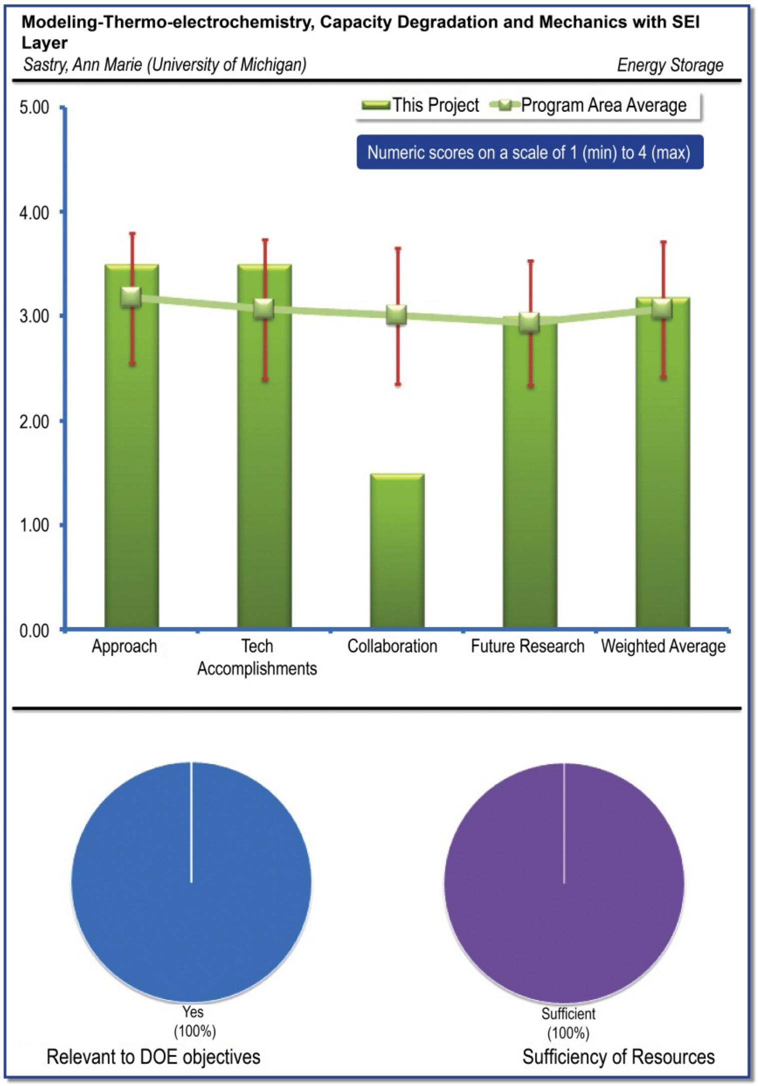
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person indicated that the planned future work is consistent with the already achieved results but apparently does not cover all the real needs of BATT in which a variety of other materials are developed and analyzed; a more structured coordination role of this project should be better planned and proposed. The other reviewer stated it is not clear why the PI focused on $LiNi_{0.5}Mn_{1.5}O_4$. This reviewer added that the PI could use more conventional materials to focus on the electrode failure mechanism.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said the resources were sufficient, while the other said they were insufficient. One reviewer stated that there seems to be insufficient resources. The second commenter felt that the resources are judged to be adequate even in the case of an increased role in harmonizing material selection in BATT.

Modeling-Thermo-electrochemistry, Capacity Degradation and Mechanics with SEI Layer: Sastry, Ann Marie (University of Michigan) – es082



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The first respondent said the project is addressing aspects functional to DOE objectives, while the other commented the modeling is one of the good methods to analyze the failure mechanism.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer said the project is perfectly structured and organized with a clear focus on key technical aspects. The other respondent would like to see if the dissolution is actually the critical issue for the degradation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The first commenter said the results are relevant with an excellent progress towards the objectives. The other person noted SEI formation modeling is challenging, and would like to see the results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer did not see so much collaboration, while the other commented that the lack of collaboration is not a positive aspect with limited involvement of other related projects.

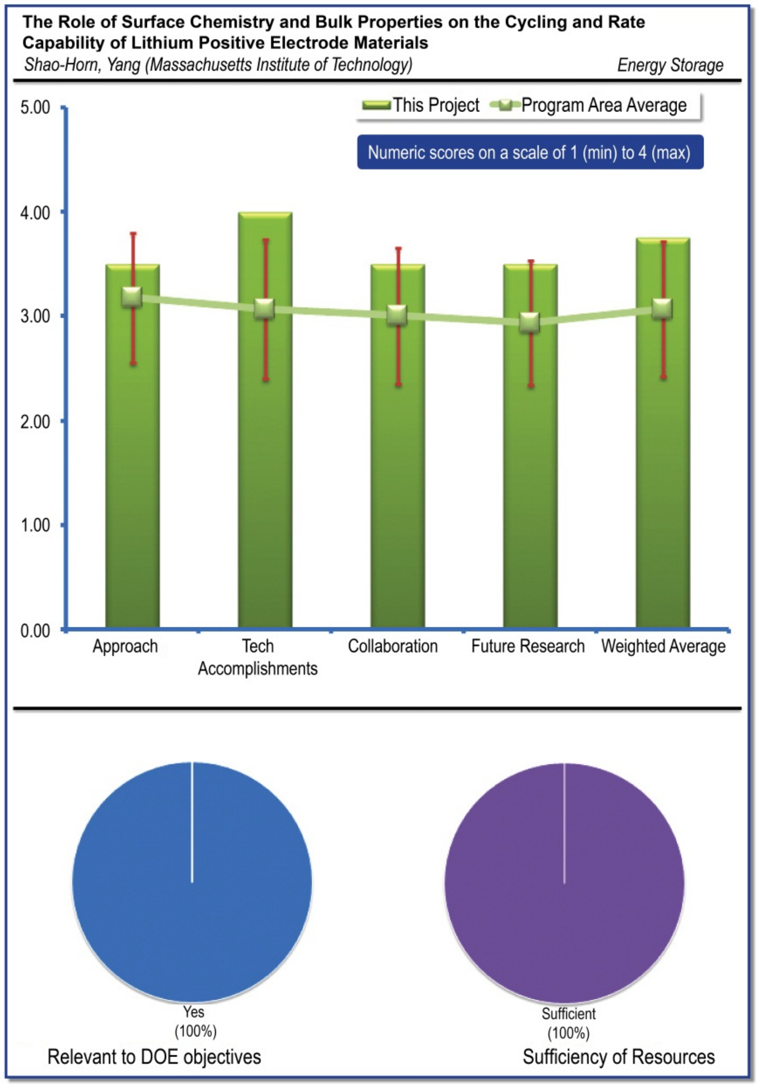
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person said the future work is well-defined. The other reviewer agreed, commenting the prosecution of the work is properly organized and based on previous results.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Both reviewers said the resources were sufficient. One reviewer said the resources are appropriate, and the other said the project seemed to have sufficient resources.

The Role of Surface Chemistry and Bulk Properties on the Cycling and Rate Capability of Lithium Positive Electrode Materials: Shao-Horn, Yang (Massachusetts Institute of Technology) – es084



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer said the surface chemistry is very important and difficult to analyze, while the other reviewer commented there is evident feedback to DOE objectives even considering the basic research approach.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first commenter said this kind of approach is common and reasonable. The other noted the project has a unique, systematic and feasible approach addressing surface analysis with cell behavior; in addition, the potentialities of Li-air cells are also clearly addressed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person commented that the results are very promising and excellent. This reviewer suggested the group increase the connection to practical behavior with extended life testing, and added that the activities on Li-air must be further developed. The other reviewer said it is an interesting finding about the cathode SEI. This person added that, if the group can support it with something other than XPS, it would be better.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer said the collaborations are appropriate, while the other felt that some collaboration exists. This second reviewer believes it is enough based on the achievement.

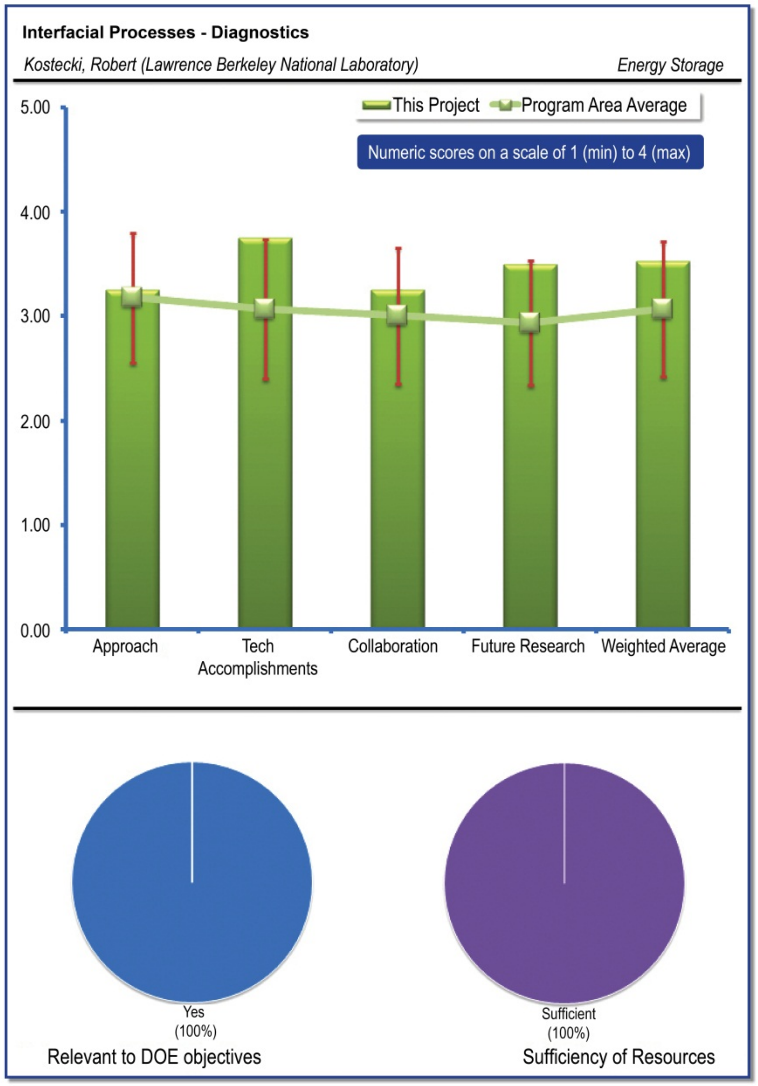
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One person commented the future work is planned well, while the other respondent said the future work description is poorly described but seems reasonable.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Both respondents said the resources were sufficient. One reviewer said the resources are adequate, while the other noted that there seems to be sufficient resources.

Interfacial Processes - Diagnostics: Kostecki, Robert (Lawrence Berkeley National Laboratory) – es085



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Feedback was positive in this section. The first reviewer indicated that surface characterization is a fundamental tool in improving Li cell performances, and then get DOE objectives. A second reviewer remarked that interfacial behavior is critical to improve Li ion batteries further. Finally, a third reviewer noted that improved diagnostic and analysis techniques will help improve lithium ion battery materials, which will increase fleet electrification over the long term.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section. One reviewer commented that the project is well organized and integrated within BATT activities with the scope to support with a common surface characterization platform the development of novel materials. The next reviewer acknowledged good use of diagnostic and analysis techniques. A third reviewer noted that there are several good in-situ techniques used. The fourth reviewer remarked that while the approach is excellent, absence of any activity within this project related to carbon-based anode materials is unfortunate.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewer feedback was generally positive in this section. The first commenter stated that progress has been excellent and well described with experimental results. Additionally, the quality and excellence of the investigation techniques are a powerful tool for the fundamental and applied research. The second commenter remarked that $LiNi_{0.5}Ni_{1.5}O_4$ diagnostic results and conclusions are of great value and have excellent focus. A third commenter indicated that there are good in-situ and ex-situ data and that they were analyzed well. The fourth commenter offered comments and questions specific to presentation slides. This commenter specified that on Slide 6, the spectra band-assignments showed up well in the slides presented, but appeared differently in the slides shared with reviewers. The same commenter questioned whether a change was made to Slide 6 in this regard, and offered another query about whether the non-stable layer on the cathode is also seen with other cathodes with this voltage/electrolyte combination. Further, this commenter inquired whether there is something about the $LiMnPO_4$ that increases this decomposition, and if the same result would be seen if fluorinated solvents that were more stable were used. This fourth commenter also provided feedback on Slide 9, inquiring whether the electrolyte was studied after aging with something like inductively-coupled plasma (ICP). Further, this commenter noted that it would be interesting to know if the Ni or Mn was solubilized into the electrolyte, and that it would be interesting to see the suspected surface enrichment if the particles could be sputtered to study the concentration as a function of depth. Finally, and in reference to the bottom of Slide 18, this same commenter offered that it would have been helpful to show the results of testing other electrolyte systems besides ethylene carbonate (EC)/ diethyl carbonate (DEC).

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

The comments received in this section were generally positive. The first reviewer offered that there is a good amount of collaboration with other institutions, while the second reviewer stated that the collaborations are adequate. The third reviewer acknowledged Slide 2, stated that high power lithium (HPL) was acquired by DOW, and questioned how this has affected the relationship/collaboration over time. This same reviewer also referenced Slide 20 and stated that future collaboration with 3M's alloy systems should be particularly encouraged.

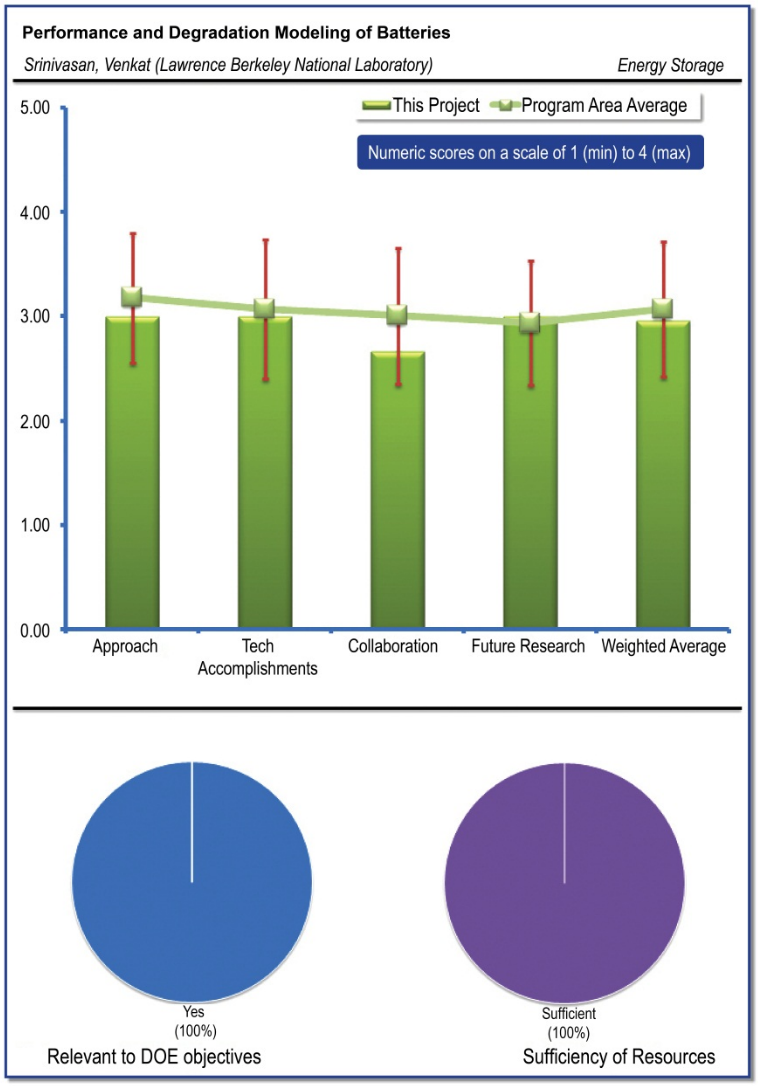
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Feedback from reviewers in this section was generally positive. One reviewer commented that the plan for future work is better than previous year on achieved results and BATT advanced investigation needs. A second reviewer indicated that proposed future work seems reasonable and logically thought out, and added that future alloy work with 3M should be particularly encouraged. The third reviewer noted that proposed future work is excellent, but absence of any planned activity related to carbon-based anode materials is again unfortunate. A fourth reviewer said to keep working on the in-situ method for other materials and analyze surface process.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The reviewers agreed that project resources were sufficient. A second reviewer added that the resources should be finally related to the number of materials to be investigated as a horizontal analytical tool for BATT.

Performance and Degradation Modeling of Batteries: Srinivasan, Venkat (Lawrence Berkeley National Laboratory) – es086



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments in this section were positive. One reviewer offered that the modeling is a good method to analyze the phenomena in the cells, and a second reviewer stated that the modeling work is assisting the progress in Li batteries relevant to DOE objectives. The third commenter indicated that improved cathode and anode material modeling and understanding will help improve fleet electrification over the long term.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Feedback from reviewers in this section was generally positive. The first reviewer remarked that the approach is well focused to the objectives with a good combination of models with experimental results. The second reviewer noted that while there is a good modeling approach, more reinforcement with experiments would strengthen the results. The third reviewer stated a desire to see more experimental data to support the modeling.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments in this section were generally positive. The first reviewer offered that progress is appreciable and well related to the identified barriers with modeling calculation and experimental validation. The second reviewer indicated that it was interesting to see the difference of SOC between the different particle size, as well as how fast Li can diffuse between the powder if there are good electron paths with carbon. This reviewer further inquired about the situation in the case of the layered materials or spinel materials. A third reviewer offered comments and questions specific to presentation slides. Specific to Slide 7, this reviewer noted that the right chart is labeled 5C rate, but each of the sizes has a different effective c-rate as their extent of superoxide dismutase (SOD) varies. This reviewer also stated that the 50nm c-rate has achieved 50% SOD after approximately 260 seconds, a rate of about 6.9C. This reviewer described that the examples of two particle sizes have a wide range of relative c-rates and it is a non-linear plot, so the c-rate changes during the experiment. Further, this reviewer noted that some commentary on what was kept equal beyond a c-rate label would be helpful. This third reviewer also acknowledged that the path dependence work discussed on Slide 10 is interesting, though correlation to more experimental data and commercial grade sample/size distributions would increase its relevance. This reviewer commented that Slides 14 and 15 point out that Silicon used in the manner depicted holds rather little Wh/L advantage over graphite, particularly at moderate rates, and questioned whether the loading trends' impact on power reverse themselves. Specific to Slide 14, this third reviewer stated that higher loading (red) has slightly better power than the middle (blue) and lower loading (pink). However, this reviewer points out that, in Slide 15, the best power retention comes from the lowest loading (red). Finally, this third reviewer highlights Slide 18, which should clarify the vehicle system (e.g., EV, PHEV, HEV) on which the researcher is focused. This reviewer indicates that it was mentioned that 2C rate was high power and that is only appropriate for an EV application. This reviewer also explains that Slide 18 references PHEVs, which have FreedomCAR targets of 3 to 13C rates.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewer feedback was somewhat positive in this section. The first commenter stated that the collaborations are part of the activities because the feedback from experimental groups is necessary to validate simulations and models. A second commenter acknowledged that some collaboration exists, while a third commenter noted more collaboration with experimental partners. This third commenter also added that the presentation does not make it clear what was collaborated on with those mentioned in Slide 2.

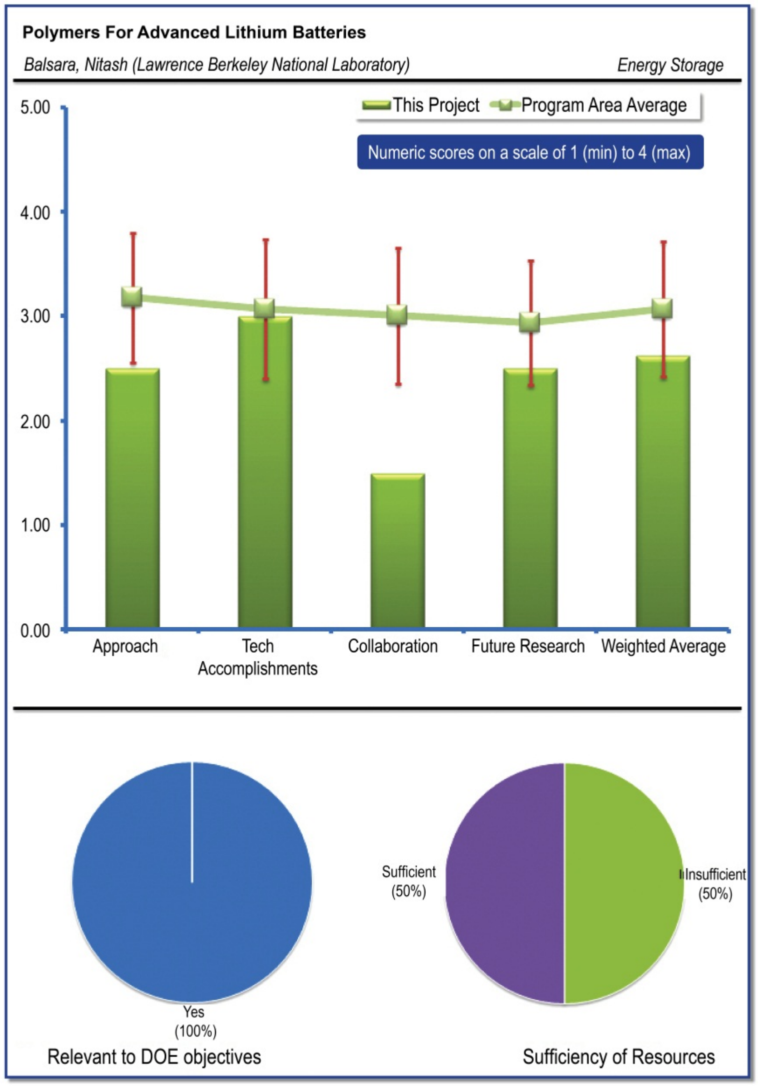
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The comments received in this section were generally positive. One reviewer noted that the future work is well-defined, and a second reviewer acknowledged good future direction. A third reviewer explained that planned work is consistent with the already achieved results, even if some other parameters or phenomena should be considered to further improve the simulation results and usability. Further, this commenter stated that the aging of cells should also be correlated somehow to the behavior of cathode and anode materials as it is recommended to consider the effect of temperature, which surely is a degradation factor.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewers agreed that project resources are sufficient. One reviewer noted that the resources seem adequate to the work, and a second reviewer commented that resources seem sufficient.

Polymers For Advanced Lithium Batteries: Balsara, Nitash (Lawrence Berkeley National Laboratory) – es088



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The comments received in this section were positive. One reviewer noted that the project aims well at DOE objectives, and a second states that the hybrid polymer is an interesting idea.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Feedback from reviewers in this section was generally positive. The first reviewer offered that the approach is adequate with a good definition of technical barriers. A second reviewer explained that block copolymer would create uneven current distribution on the electrode and may cause some life issues.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments from reviewers were generally positive in this section. One reviewer commented that the results are promising, showing good progress. The second indicated that it would be good if the Principal Investigator can demonstrate the actual rate capability and identify the gap from the practical target performance.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewer feedback in this section was generally negative. The first reviewer stated that there is no evidence of collaboration out of LBNL, and a second offered that collaboration with other institutions could not be seen.

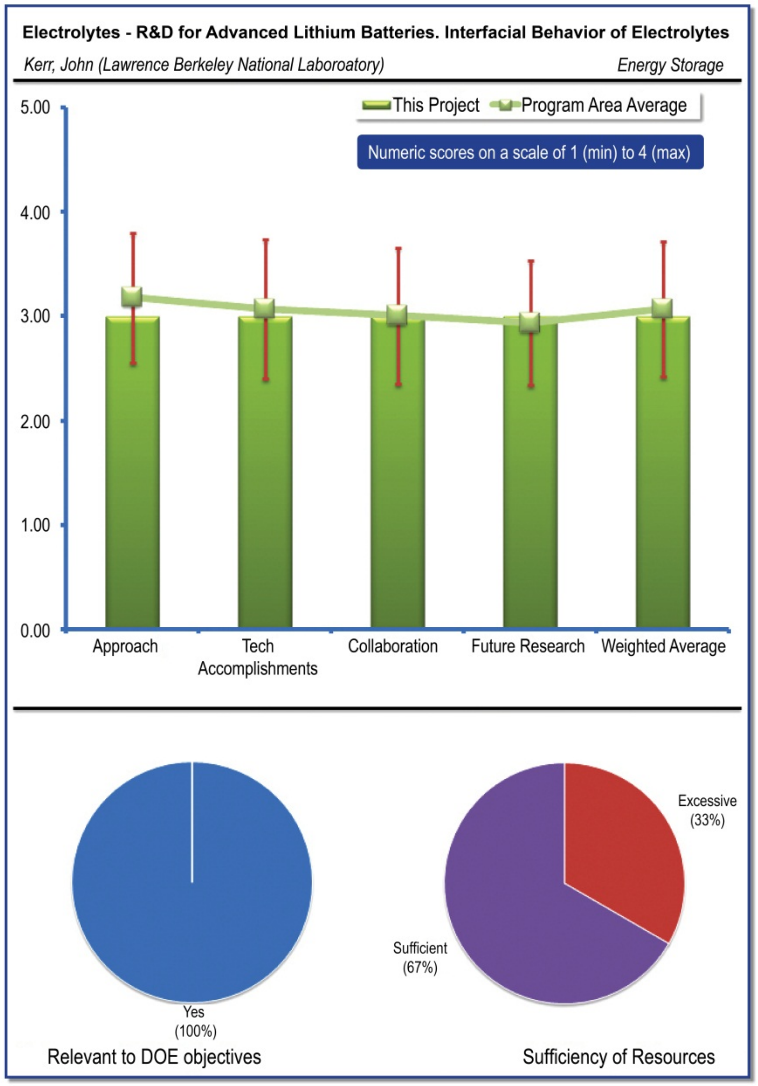
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were generally positive. One commenter described future plans as appropriate, while a second commenter stated there may need to be more work with industry to see the feasibility of the technology.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer feedback in this section was mixed. The first reviewer indicated that resources seem okay, while the second reviewer stated that it seems the resources are insufficient.

Electrolytes - R&D for Advanced Lithium Batteries. Interfacial Behavior of Electrolytes: Kerr, John (Lawrence Berkeley National Laboratory) – es089



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Overall feedback in this section was positive. The first commenter indicated that the project supports DOE objectives. A second respondent stated that the interfacial behavior is one of the biggest hurdles for the polymer electrolyte.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer comments were generally positive in this section. One reviewer remarked that the project has good organization with clear objectives to overcome selected barriers in the field of electrolyte materials. The second reviewer said good approach, and added that there are several polymer batteries in the market. Further, this reviewer offered that it would be good, as a benchmark, if the PI can investigate how interfacial issues are overcome. The third reviewer noted that activity with conductive additives in particular is excellent, solid work, but that work on Li-metal-based systems should be either eliminated or minimized.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments in this section were generally negative. The first reviewer explained that the results are interesting but not clearly presented, and added that the role of various solutions needs to be better described and analyzed. A second reviewer noted that the font for the graph is too small to see.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Feedback in this section was mixed. One commenter stated that there are several collaborations with other institutions. The second commenter acknowledged that while the collaborations are adequate and large, to some extent it is advisable to have more evident integration with other groups working on electrolyte materials.

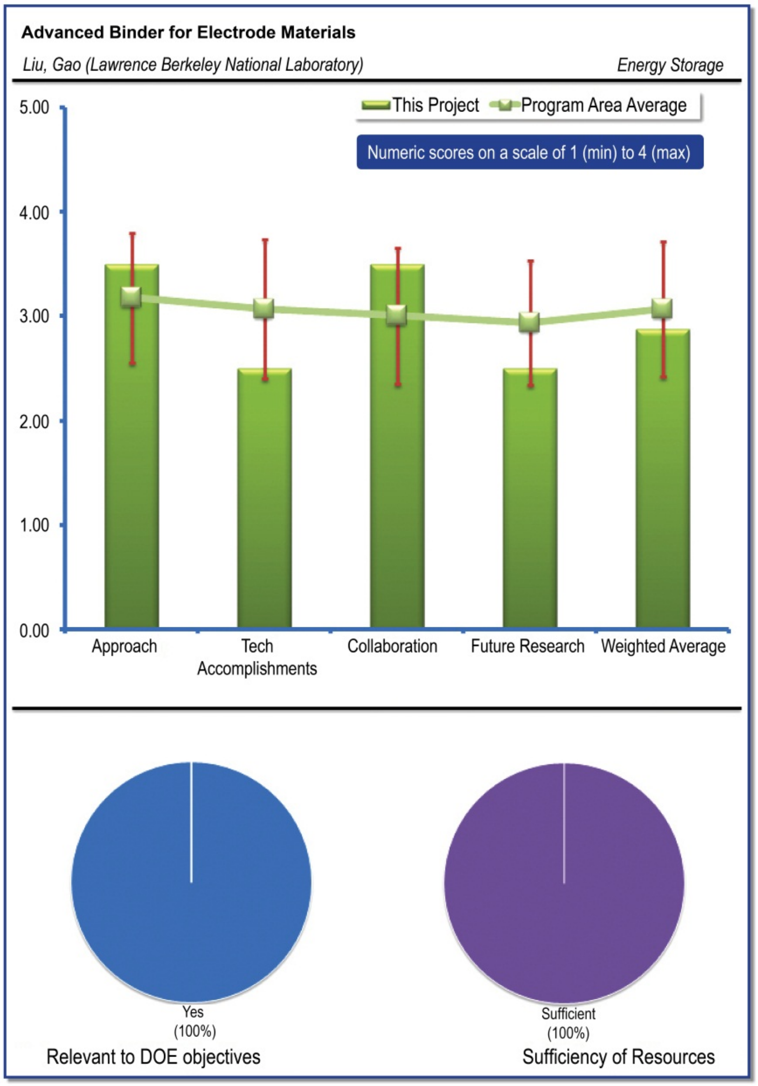
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer comments were generally mixed in this section. One reviewer indicated that graphite anode should also be investigated. A second reviewer explained that the future plan is substantially related to the results already achieved even if there are concerns about the way ionic liquids and new materials have been proposed for the next period without effectively completing the work on the ongoing materials. The third reviewer offered that work on Li-metal-based systems should be either eliminated or minimized. Further, this reviewer added that activity with composite electrodes, specifically with conductive additives in particular, should be expanded accordingly.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer indicated that resources seem sufficient, while a second reviewer stated that the declared leverage with the DOE Fuel Cell Technologies (FC) subprogram does not clarify the effective use of resources.

Advanced Binder for Electrode Materials: Liu, Gao (Lawrence Berkeley National Laboratory) – es090



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments were positive in this section. One reviewer explained that the binder research is relevant in introducing new materials and new Li cells with improved performances relevant to DOE objectives. The second reviewer noted that a conductive polymer for the binder is an interesting idea.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer feedback in this section was positive. The first commenter offered that the project is clearly organized with feasible milestones and deliverables aimed at addressing specific technical barriers in using Si anode materials, as well as integrating other BATT projects. A second commenter noted that, according to another presentation, the conductivity between the particle could be the issue not only for Si, and added that the PI may be able to extend the scope to other materials such as graphite.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were mixed in this section. The first reviewer acknowledged that progress is evident with very interesting results on new Si anode compositions using a polymer binder. This reviewer also said the variability of commercial Si has required additional work; it is not clear why improved Si, investigated in BATT, is not considered. This project could stay in the binder development. That SiO_2 is not good for SiOx was known in the industry ten years ago.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewer comments in this section were positive. One reviewer stated that the network of collaborations is complete and appropriate with a balanced contribution of research and industry. A second reviewer indicated that there are several collaborations with material companies.

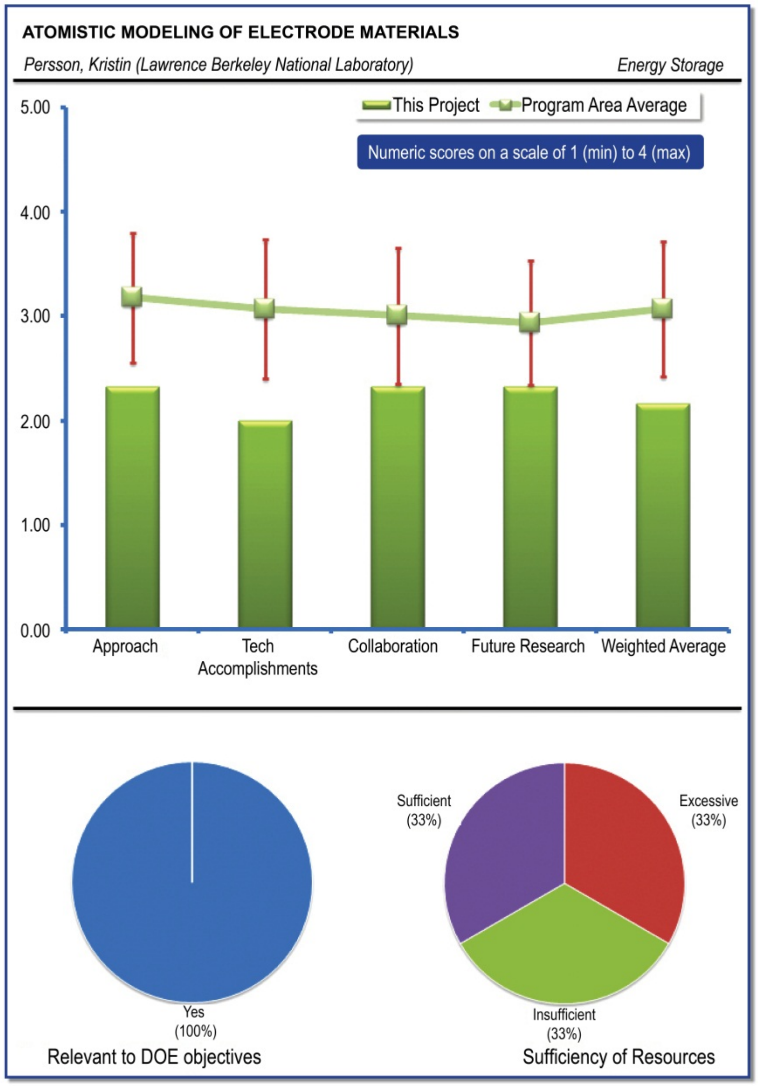
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Feedback was generally positive in this section. The first commenter remarked that the future work is well organized in relation to the previous results. The same reviewer also explained that it is not fully clear how the problem of commercial Si variability will be solved or faced, and that it may be recommended to use commercial and BATT Si powders to generalize the applicability of the proposed binder. The second commenter offered that closing the pore seems a critical issue for the current system and needs to be addressed. Furthermore, this respondent added that 70% porosity does not seem like a practical solution.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The first reviewer stated that the resources were considered adequate, and a second reviewer noted that resources seem sufficient.

ATOMISTIC MODELING OF ELECTRODE MATERIALS: Persson, Kristin (Lawrence Berkeley National Laboratory) – es091



REVIEWER SAMPLE SIZE

This project had a total of three reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

Comments in this section were generally positive. The first respondent explained that the project is aimed at solving problems functional to DOE objectives. The second respondent offered that electrode materials modeling will help improve the understanding of lithium ion batteries and enable greater fleet electrification over time. The third respondent indicated that the modeling by itself is fine to understand the phenomena well.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

Feedback from reviewers in this section was mixed. While one reviewer stated that the approach is appropriate with the use of ab initio modeling to investigate key Li barriers, a second reviewer indicated uncertainty as to whether Li diffusion modeling in graphite is useful. The third reviewer remarked that the modeling approach seems reasonable, although no clear connection to experiment to confirm and to the overall context of the BATT program.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

Reviewer comments were mixed in this section. The first reviewer stated that the results are promising, adding that the focus on a few and well defined materials has been appropriate. This reviewer further noted that the progress is of value and must be completed with more experimental results. The second reviewer commented it seems obvious that Li intercalation would not happen from basal plane, and added that more experimental data to support modeling results would like to be seen. A third reviewer offered comments specific to presentation slides. Regarding Slide 2, this reviewer explained that the barriers of cost, cycle life, and rate are not addressed directly at all in this approach. Further, this reviewer commented that while there are indirect implications from material design, the connections are not made by the researcher. The third reviewer also noted, in reference to Slide 4, that no information on $LiCoO_2$ or $LiMnO_2$ was shared, and added that it would be interesting to understand why layered $LiMnO_2$ is to be studied. Regarding Slides 6 and 7, this reviewer opined that the information shown for lithium graphite bottleneck work is very limited. This reviewer further added that while there are references provided for the other work, very little of those articles made it into the review slides. This third reviewer expressed, in reference to the Slide 7 conclusion that the basal plan is more stable but does not allow for lithium absorption and that the edge plans would enable faster transport, does not add to the field. Regarding Slides 8 and 11, this same reviewer commented that more information was shared for the $LiFePO_4$ synthesis condition optimizing, but no original experimental confirmation was provided to support the modeling. Finally, and in reference to Slide 12, this reviewer stated that no clear results for the Public Materials Database activity were shared.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer feedback in this section was generally positive. One reviewer said increased collaboration with experimentalists, and a second reviewer indicated that there is a little collaboration in LBNL. The third reviewer offered that the collaborations seemed appropriate but were not sufficiently emphasized and described in the presentation.

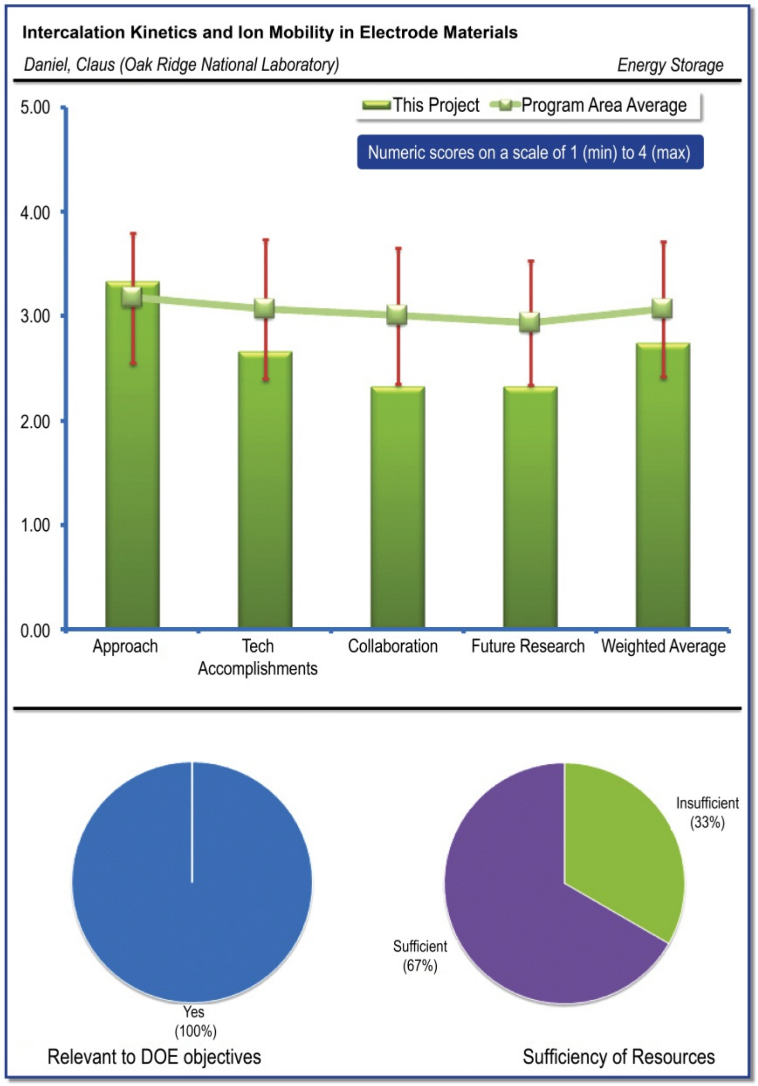
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were positive, in general. The first respondent stated that the work planned for next period is consistent with the results already achieved, and highly recommended an increased connection and validation with experimental results of the modeled materials and mechanisms. A second respondent asserted that more experimental data to support modeling results would like to be seen. The third respondent commented that future work should have a clearer connection to the overall BATT program goals and purpose. Additionally, this reviewer pointed out that work results should be presented at the AMR, rather than just included in referenced citations. This respondent further remarked that plans to work on layered $LiMnO_2$ or spinel $LiMn_2O_4$ should be clarified.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Comments in this section were mixed. While one reviewer indicated that resources do not seem sufficient, a second reviewer stated that the budget appears excessive given the increasing budget of this program and the limited results shared. The third commenter stated no specific suggestions.

Intercalation Kinetics and Ion Mobility in Electrode Materials: Daniel, Claus (Oak Ridge National Laboratory) – es093



REVIEWER SAMPLE SIZE

This project had a total of three reviewers.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

Comments in this section were positive. One reviewer observed basic studies that are functional to DOE objectives. A second reviewer offered that improved analysis of material properties of lithium ion batteries will enable greater fleet electrification over the long term.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

Reviewer feedback was generally positive in this section. The first commenter acknowledged a well-focused and combined approach with a clear plan and well defined objectives. The second commenter observed an interesting analysis approach to stress/strain behavior or materials. A third commenter remarked that in-situ methodology could be useful but the PI needs another methodology to support the results.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

Feedback in this section was mixed. One respondent stated that while the results are promising, more analysis and comparison with experimental results is needed. A second respondent explained that the grain boundary could be seen, but how it influences the electrochemical performance quantitatively could not be seen. The third responded provided feedback specific to presentation slides. This respondent, in reference to Slide 8, noted microindentation work seems very interesting, but inquired about the tip dimensions and indentation time, as well as whether or not that was the image shown on Slide 10. Further, regarding Slide 8, this reviewer questioned whether there is any expectation of what would happen to the mechanical behavior after cycling or heavy use. The third reviewer also queried, in reference to Slide 9, whether it is possible or practical to examine material for any cracking or other damage due to the indenting. Additionally, this respondent pointed out that Slide 10 images and scale bars were difficult to read, and that data should be more clearly communicated to support conclusions. Regarding Slide 11, this third respondent inquired as to what electrolyte was used. Finally, and in reference to Slide 12, the third reviewer suggested that more background on electrochmical strain microscopy (ESM) amplitude maps would help communicate the conclusions more clearly.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Mixed comments were received in this section. The first reviewer opined that a little collaboration exists, and a second reviewer encouraged collaborations with additional lithium ion battery material specialists. A third reviewer remarked that while the collaborations have been increased, they still seem inadequate and poorly integrated with the rest of the program.

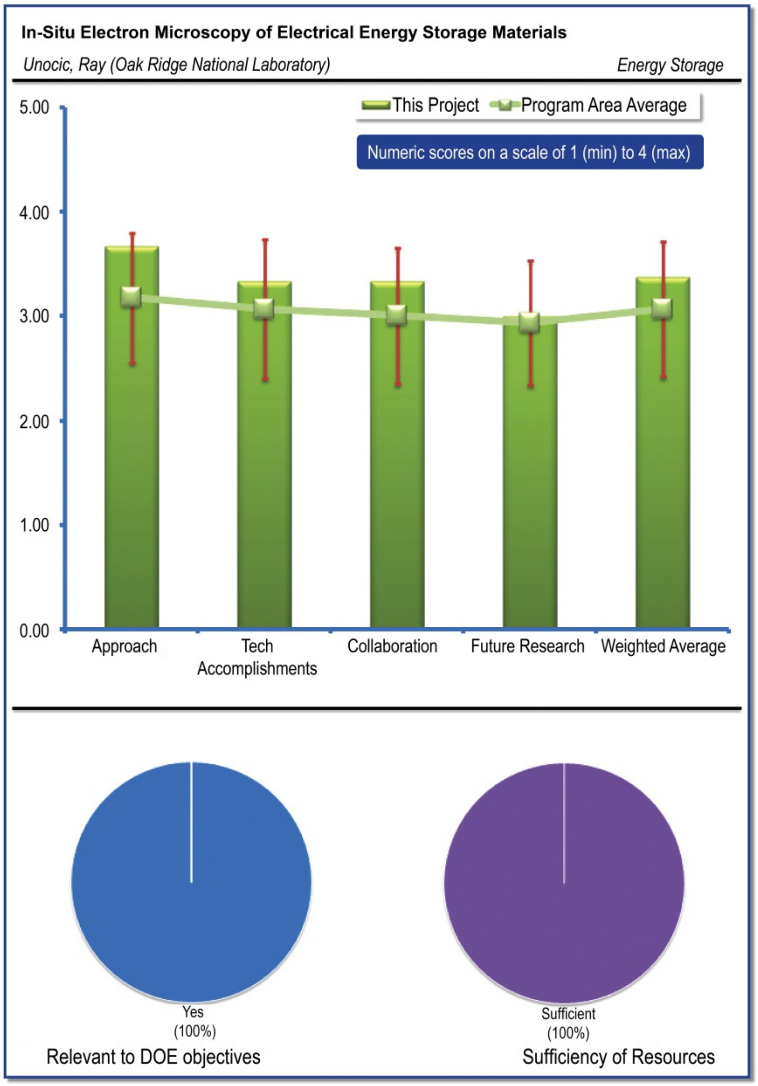
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Respondent feedback in this section was mixed. While one respondent noted that expansion of work to aged cathodes and/or various SOCs would be interesting, a second respondent requested that more electrochemical tests be conducted. Finally, a third respondent indicated that the future work is not clearly related to the technical barriers and the project objectives, and that a better description and major specifications are necessary to explain and justify the work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Mixed comments were received in this section. Although one reviewer observed that resources seem insufficient, a second reviewer said judged okay.

In-Situ Electron Microscopy of Electrical Energy Storage Materials: Unocic, Ray (Oak Ridge National Laboratory) – es095



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Feedback in this section was positive. One reviewer observed that diagnostic techniques are aimed at investigating basic mechanisms and improving materials selection for Li cell, which is functional to DOE objectives. A second reviewer commented that the direct observation is very interesting and useful with in-situ methodology.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, reviewer comments were positive in this section. The first respondent noted the excellent focus on developing and implementing a very valuable, new tool for the advancement of fundamental Li-ion electrochemistry understanding, and further remarked to keep going. The second respondent acknowledged that a lot of people have tried to do this and it is first time this respondent has seen the actual results. A third respondent explained that the idea to develop a brand new device for dynamically investigating the various processes is very challenging and stimulating. Additionally, this respondent commented that the barriers are well identified with some concern related to the description of the novel equipment, which is not clearly connected to the effective operation of the cells.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Feedback in this section was generally positive. One commenter stated that results are very interesting, and a lot of things can be done with this new technique. While the second reviewer agreed that the results are interesting, this person added that there is substantial work to be done to reach a complete view of the investigated processes.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Positive comments were received in this section. The first reviewer observed a good network of collaborations, and the second reviewer pointed out good collaboration based on the results.

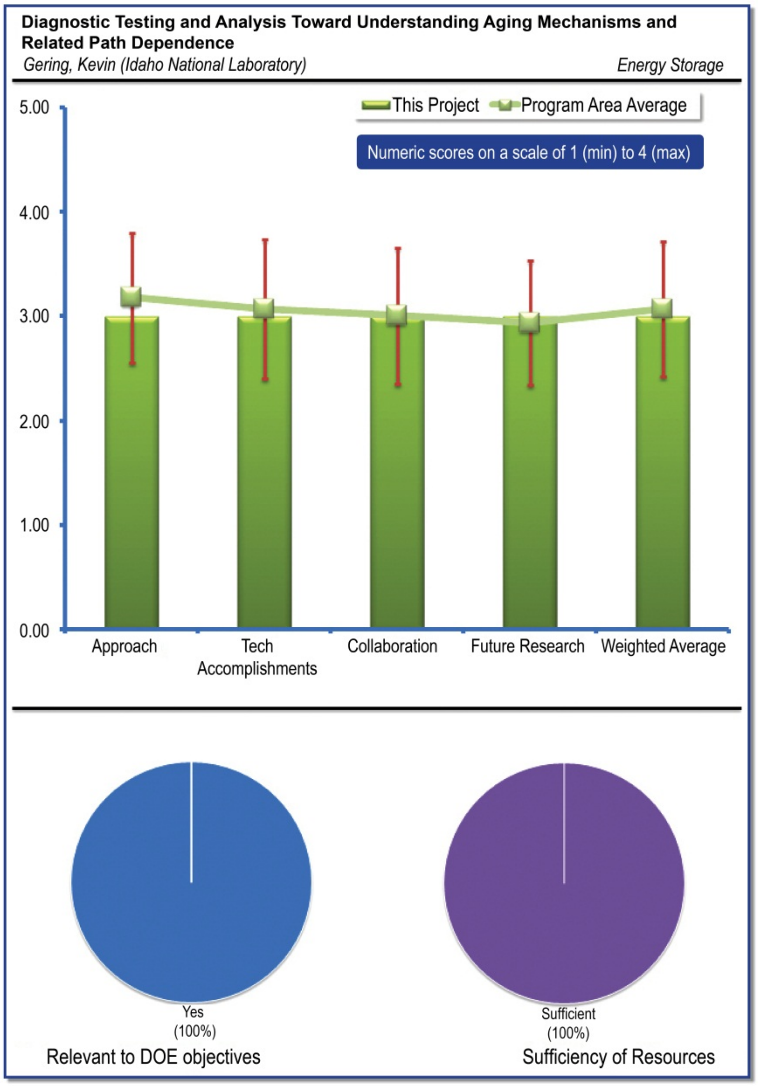
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer feedback in this section was mixed. One respondent acknowledged very good initial results, and added that, hopefully, the PI could find out new things with this technique. A second respondent indicated that the future work is very generic and not well correlated to the technical barriers and project objectives.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Responses in this section are positive. The first commenter noted that resources seem adequate, while the second commenter stated that resources seem sufficient.

Diagnostic Testing and Analysis Toward Understanding Aging Mechanisms and Related Path Dependence: Gering, Kevin (Idaho National Laboratory) – es096



REVIEWER SAMPLE SIZE

This project had a total of one reviewer.

QUESTION 1: DOES THIS PROJECT SUPPORT THE OVERALL DOE OBJECTIVES? WHY OR WHY NOT?

Feedback in this section was positive. A respondent indicated that this project is focused on understanding the aging process and path dependence in lithium-ion cells, and further added that safety and cycle life are important criteria for the ultimate success of lithium-ion technology for vehicles and to displace petroleum use. As a result, according to this respondent, the project is relevant.

QUESTION 2: WHAT IS YOUR ASSESSMENT OF THE APPROACH TO PERFORMING THE WORK? TO WHAT DEGREE ARE TECHNICAL BARRIERS ADDRESSED? IS THE PROJECT WELL-DESIGNED, FEASIBLE, AND INTEGRATED WITH OTHER EFFORTS?

Reviewer comments were generally positive in this section. One reviewer explained that this project aims to bridge the gap between laboratory evaluation of batteries and the real-world use conditions of lithium-ion batteries. Additionally, this reviewer observed that it focuses on understanding the nature and frequency of duty cycles and thermal cycles. Finally, this reviewer asserted that these are critical issues and need to be fully understood.

QUESTION 3: CHARACTERIZE YOUR UNDERSTANDING OF THE TECHNICAL ACCOMPLISHMENTS AND PROGRESS TOWARD OVERALL PROJECT AND DOE GOALS.

Overall, positive feedback in this section was received. The reviewer described that path dependence studies have provided data that could help develop a better understanding of the aging processes, and that computational methods have been developed to facilitate the diagnosis. Further, this reviewer expressed that the development of interactive battery management system currently underway could become valuable.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Remarks in this section were generally positive. One commenter acknowledged that the project involves collaboration with Hawaii Natural Energy Institute, Argonne National Lab, and the University of California-Pomona, and that it provides a broad perspective involving universities and national labs. Additionally, this reviewer suggested that the PI should consider involving industries, particularly automotive companies, because the work is critical to the automotive industry and the investigators could get good, valuable feedback from the automotive industry.

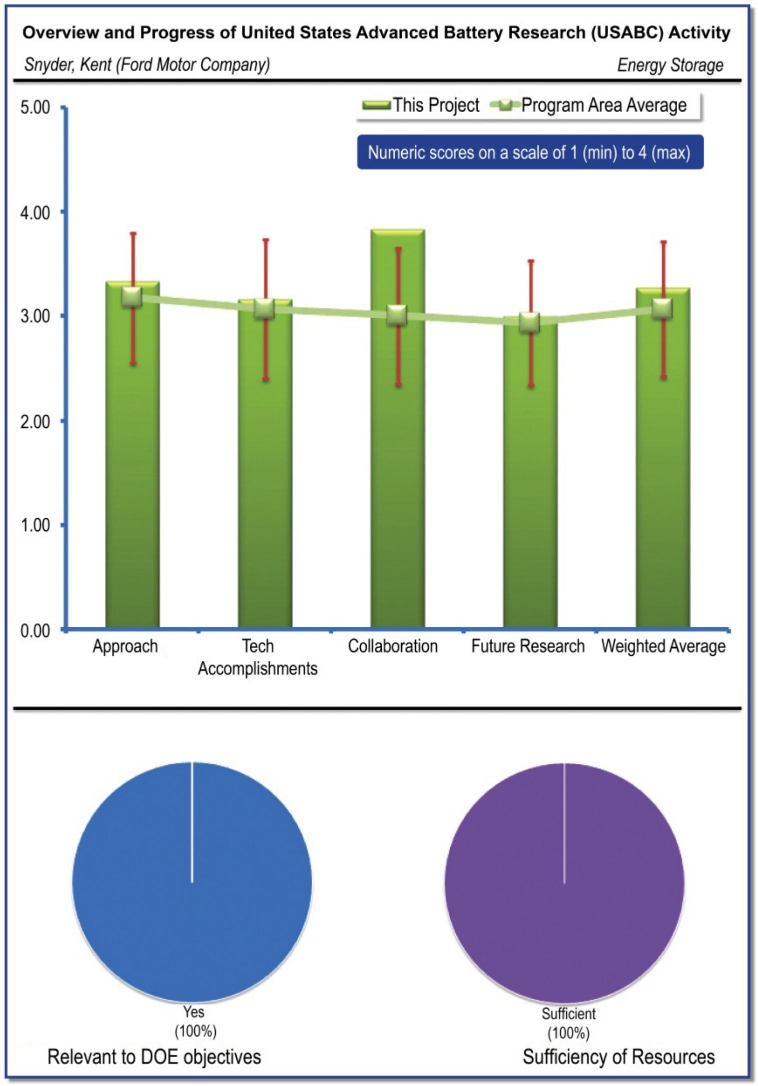
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer statements were positive, overall, in this section. The reviewer indicated that future work is aimed at a continuation of the current strategies, and that it also involves examining other path dependencies. This reviewer further offered that interaction with the automotive industry could help to define the future work more crisply.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Remarks in this section were generally negative, with one reviewer observing that funding is on the high side.

Overview and Progress of United States Advanced Battery Research (USABC) Activity: Snyder, Kent (Ford Motor Company) – es097



Reviewer Sample Size

This project had a total of six reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback in this section was very positive. One reviewer remarked that the USABC is absolutely essential toward bringing in the perspective of the OEMs, and added that this partnership should remain intact until batteries are commodities, and cost structure is reduced to acceptable market levels. Another reviewer stated that the project is a well-structured public-private initiative aimed at practically addressing DOE objectives, with selection of industry needs and requirements. The third reviewer expressed that the project is a direct co-operation of DOE activity with the auto companies to advance battery technology for use in propulsion of electric and hybrid vehicles. A fourth reviewer explained that battery technology and hardware are critical to development of the EV, HEV, and PHEV industry. This reviewer further mentioned that this program directly links battery developers with vehicle customers to guide R&D that directly meets vehicle manufacturer needs and benefits all parties involved. The fifth reviewer offered that this project is very relevant to the overall DOE goal of (partial) replacement of conventional vehicles with hybrid (HEV or PHEV) or electric vehicles, both to minimize GHG emissions as well as national dependence on petroleum resources. Additionally, this reviewer indicated that this USABC project is a collaborative effort between the leading U.S. auto manufacturers (i.e., Chrysler, Ford, and General Motors) and the National laboratories in conducting advanced battery research and development with joint funding from DOE and the contractors. Further, this person indicated that the objective of this consortium is to reduce the cost of batteries via increased energy density in high-energy (PHEV and EV) systems, and lower total energy content in HEV systems. Finally, this reviewer added that successful implementation of this project will result in widespread infusion of battery technologies in vehicular applications, which would in turn reduce petroleum consumption, and pave the way towards petroleum replacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments in this section were generally positive. The first respondent observed that the organizational and administrative approach is very well dimensioned to the significant level of efforts with clear approach for selecting priorities and key partners in developing results. A second respondent stated that the group combines the auto companies with the technology development activities in national laboratories, independent technology development partners with DOE resources, resulting in an efficient mechanism to further the development of electrified vehicle propulsion. The third respondent explained that the approach being adopted by USABC is sound, duly addressing the technical barriers with well-timed and appropriate milestones and deliverables that are consistent with developmental efforts elsewhere. This respondent further specified that several new projects are being initiated towards the following:

(i) newly developed alternate HEV goals of reduced cost via total energy content reduction, while maintaining significant HEV power capability; and (ii) higher-mile-range PHEV goals and historical EV goals. Additionally, this third respondent described that both the ongoing programs and the programs being initiated under USABC are well-directed towards meeting the objectives of reducing the cost for HEVs with high power and low energy systems, such as capacitors and high power batteries, and for the PHEVs with improved energy densities from the batteries. A fourth respondent pointed out that it is good that the focus of research is beginning to be reoriented towards PHEV and battery electric vehicle (BEV) applications, and also added that historic EV goals are long overdue for updating. The fifth respondent said generally focused on goals and good to see LEESS goals revised. This respondent added that EV battery goals are now 20 years old and need revision, and also pointed out that all goals are not consistent with each other for various applications. Furthermore, this fifth respondent suggested that it would be better to see more USABC reasoning and strategy shared in this forum. Finally, this respondent commented that the presentation was rather generic.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Overall, feedback in this section was positive. The first commenter asserted that the achievements are very consistent with the level of effort, and indicate valuable progress. A second commenter offered that significant progress has been made through the cooperation and development of standards, new battery systems, testing capability to identify problem areas, and funding solutions to them. The third commenter expressed that good progress has been achieved in initiating several technology development programs relevant to the program objectives, and pointed out that notable progress has been made in developing hardware (i.e., suitable prototype cells and modules from SAFT, A123 and LG Chem), and the thermal management systems for the LG. Additionally, this commenter noted that some of these cells, packs, and battery systems have been delivered to the national laboratories for evaluation. Further, this commenter shared that good developmental work has been initiated on the advanced (shrink-resistant) separators, which are perceived as a key component in improving the safety of Li-ion batteries. Finally, this third commenter stated that, based on these accomplishments, it is clear that tangible products will emerge from this effort that can benefit HEVs and PHEVs. A fourth commenter explained that the USABC and DOE sponsorship have provided the ideal example of government-led efforts to reduce the country’s dependence on foreign oil, and observed that the transportation segment is critical in this endeavor. The fifth commenter remarked that while some and/or most of the work is good or excellent, the presentation is so generic that the value of the recent projects to the USABC and Big 3 cannot be determined.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments received in this section were generally positive. One reviewer highlighted the project as an excellent example of how cooperation between the various parties can advance the technology. A second reviewer acknowledged very good collaboration with battery manufacturers, battery component suppliers, and national labs. A third reviewer indicated that the framework created with the public-private partnership has a complete network of collaborations involving research organizations and industry. The fourth reviewer pointed out that there is, by nature, prolific collaboration. The fifth reviewer explained that although there are useful collaborations with various national laboratories, particularly in the testing of prototype cells, packs, and battery modules, it is surprising that there has not been any collaboration in terms of getting advanced materials from these partnering laboratories. Further, this reviewer added that even though considerable materials development effort is ongoing at the national laboratories, it is not being fed into the USABC program. As a result, continued this reviewer, there is some disconnect, especially relative to material development. A sixth reviewer highlighted that working collaboratively with the major OEMs at the 50/50% level and utilizing/leveraging our national labs is a challenging accomplishment. This reviewer added that as market feasibility and product completion draw closer, this USABC effort should now be phased into greater contribution from the OEMs with the government assuming, perhaps, a minor 15-25% financial stake.

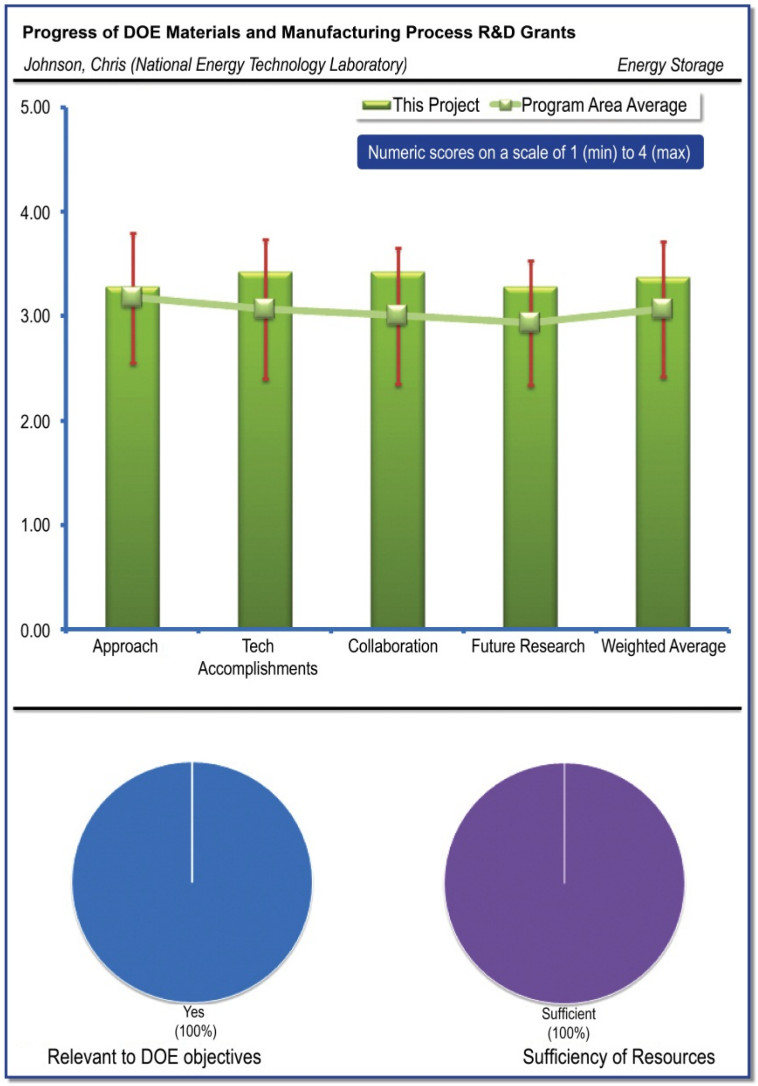
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer feedback was mixed in this section. The first commenter stated that future needs have been identified and contracts are being placed. A second commenter observed that plans for future research are as follows: (i) initiate new programs for material development (e.g., cathodes, anodes, electrolyte and separator) as well as for technology assessment; and (ii) demonstrate advancements in deliverable hardware in terms of high energy density and reduced cost (e.g., for high power systems). The third commenter indicated that the proposed future work is limitedly stressed even if USABC/FreedomCar has already established clear targets, but they are now in some cases outdated (not for PHEVs) and need to be revised in consideration of the present state of the art. The fourth reviewer expressed that there is no real roadmap other than a generic outline that says new projects will be evaluated and funded, and further requested that the vision, if any, be shared.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Overall, comments were positive in this section. The first respondent stated the funding is responsive to the needs, and the second respondent agreed that the resources are adequate for the planned effort. The third respondent explained that this is a huge funding effort with resources that are considered adequate in consideration of the other funding schemes made available by DOE. A fourth reviewer suggested that more insight be provided in this on-going project to show 1991-2011 spending with some projection on what might be needed for the next two to three years.

Progress of DOE Materials and Manufacturing Process R&D Grants: Johnson, Chris (National Energy Technology Laboratory) – es098



Reviewer Sample Size

This project had a total of seven reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback was positive in this section. The first respondent stated that the program supports the needs of the energy storage program to develop new technologies for transportation. A second respondent agreed, indicating that the project is obviously based on DOE objectives with relevant commitment on material R&D and manufacturing. The third respondent observed that this project provides the money to the various areas that support the electrification of vehicle industry, and further noted that all aspects of the industry appear to benefit from the funds in sufficient amounts to make a difference. A fourth respondent acknowledged that this project is very relevant to the mission of the Vehicle Technologies Program, which is to develop more energy-efficient and environmentally friendly vehicular technologies that result in significantly less petroleum consumption and GHG emissions. Further, this respondent offered, this project supports these goals by providing grants for developing various materials and manufacturing processes, as well as ARRA funding for developing battery manufacturing facilities within the United States, with the objective of accelerating transition to the next generation of hybrid vehicle transportation. Finally, this fourth respondent asserted that successful implementation of this project will result in widespread infusion of battery technologies in vehicular applications, which would in turn reduce the petroleum consumption and pave the way towards petroleum replacement. The fifth respondent explained that battery manufacturing capacity and low-cost manufacturing processes are key to availability and affordability of batteries for EV, HEV, and PHEV applications for petroleum displacement. The sixth respondent described an excellent summary of projects that certainly brings everything together.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments received in this section were generally positive. The first evaluator indicated that the overall project is well designed and well integrated with materials developments under other DOE projects related to lithium batteries. Further, this evaluator added, the approach is sound, feasible, and addresses the technical barriers (e.g., manufacturability). Additionally, this evaluator described the two-fold approach being adopted by the National Energy Technology Laboratory (NETL): (i) institute several technology developmental projects, with approximately 50% cost share from the developers, on various components of Li-ion cells for the next generation lithium batteries; and (ii) assist in setting up manufacturing facilities within the United States for Li-ion batteries of various chemistries as well as capacitors, and the associated raw materials. The second evaluator observed a progressive approach taken in a broad area of important subject areas, particularly considering that much of the work was initiated three years ago. The third evaluator expressed that this project has proportioned the monies to the various companies that appear to be viable businesses in the industry and willing to invest in the U.S. market. This approach, the third evaluator stated, increases the United States' ability to become less dependent on vehicle transportation energy sources outside of the United States, either petroleum or through support of vehicle electrification. A fourth evaluator reported that projects include the development of high energy batteries and related technologies as well as establishing battery manufacturing facilities to support the shift to electrified transportation to reduce dependence on foreign oil. The fifth evaluator pointed out that the approach is limitedly described, but substantially based on the selection of key research organizations and industry with breakthrough R&D proposals. A sixth evaluator mentioned that it was difficult to capture this in the overview presentation, but fast cycle manufacturing grants under ARRA was a direct approach to increasing battery manufacturing capacity. Furthermore, this evaluator suggested that the manufacturing process development is probably less effective.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewer statements in this section were mixed. One commenter shared that presented results are excellent in terms of progress and substantial innovation in various sectors from material R&D up to manufacturing processes. The second commenter observed that assistance in the establishment of battery manufacturing facilities supports the development of new, high energy battery systems and production of new, high energy battery materials. A third commenter explained that the progress achieved in initiating several technology development programs based on cost-share related to the Materials and Manufacturing of Li-ion cells on different materials is encouraging. Additionally, this commenter remarked that reasonable progress has been accomplished in many of these individual programs. This third commenter goes on to state that two of the programs initiated (i.e., EnerDel and Tiax) stand out in terms of their inappropriate funding levels. Specifically, a funding of about $3.5M for redox shuttle development and about $2.4M for understanding the internal short are not as justifiable by their relevance and accomplishments. Further, this third commenter adds, the programs under the ARRA Battery Manufacturing grants have, appropriately, a broader portfolio covering different technologies beyond Li-ion batteries. Some of them have already demonstrated production capability and it looks quite promising that tangible products will emerge from this effort that can benefit HEVs and PHEVs. A fourth commenter said difficult to capture in the presentation, but acknowledged that the fast track RFP and review process getting $2B on contract very quickly and competently was very effective in getting on track for adequate battery manufacturing capacity. This commenter added that there may even be overcapacity, which will effectively reduce costs for vehicle manufacturing in the beginning. The fifth commenter described that this project had two portions. The first portion (i.e., Manufacturing Process R&D), as observed by this commenter, seemed to have some metrics included, but the progress against those metrics appeared to be modest even when the metrics were clear. This commenter went on to discuss the second portion (i.e., ARRA Manufacturing Grants) of this project, which appears to have progress, but performance indicators were not clear enough to rate the progress. Finally, this fifth commenter highlighted that most of the progress to which this commenter refers is based on industry knowledge and the GM Volt build progress.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Feedback from reviewers was mixed in this section. The first respondent described a large and consistent network of collaborations with transparent and timely selection process. This respondent expressed that it is very impressive how fast and accurately selections were made, and observed that $1.5B was granted in a short time and with valuable results. A second respondent observed that a wide range of technologies and industries with direct impact on reducing foreign oil are supported while establishing a production capability in U.S. territories. The third reviewer offered that there is not much collaboration across these individual programs and acknowledged that there is substantial cost-share from the developing organizations, which need to protect their intellectual property. A fourth respondent remarked that there is no clear coordination between partner(s), as well as a lack of clear NETL input to the institutions after the monies are allocated. This respondent added that reporting on the programs seems to be the only collaboration.

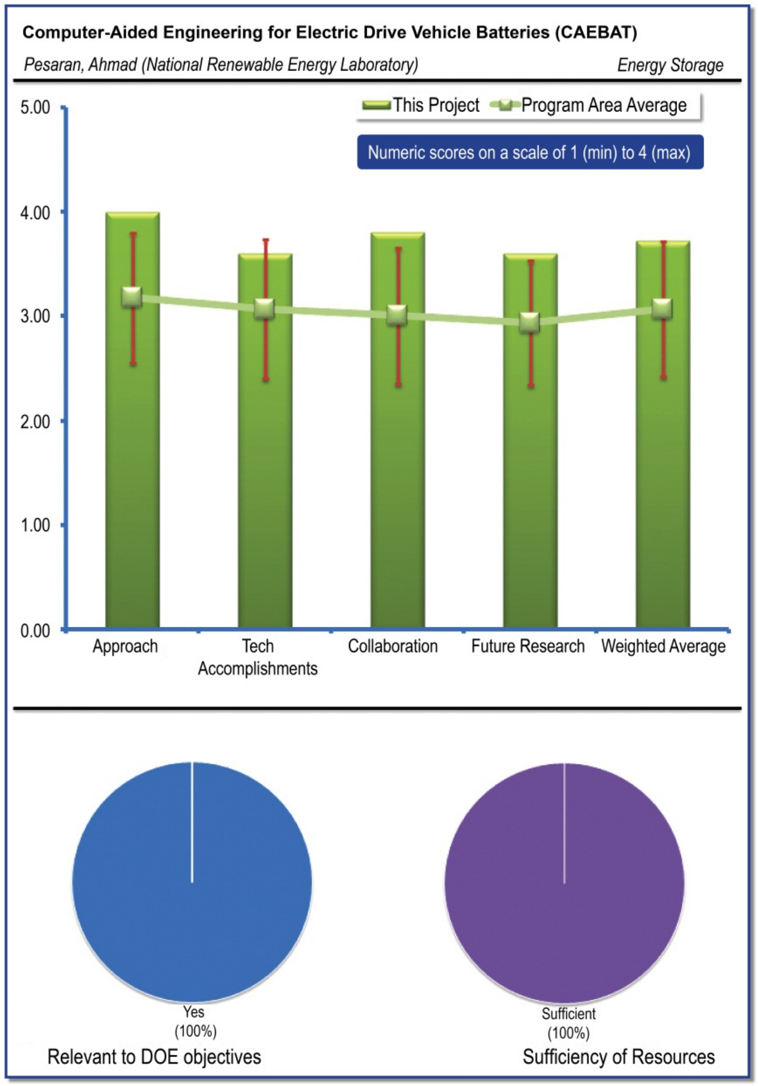
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were mixed. One evaluator reported on future plans, which include supporting the R&D programs on materials and manufacturing processes as well as supporting the battery manufacturing facilities. This evaluator added that the focus on multiple technologies, as is being done here, will mitigate the risk considerably. The second evaluator described that the way is well tracked on the work, which is clearly planned, accurately reviewed, and revised yearly. A third evaluator offered that work is related to lowering the cost of batteries while improving their performance. The fourth evaluator asserted that future plans were very unclear, and that given progress and desired goals, future plans could be assumed, but they need to be clearly spelled out.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Mixed reviews were received in this section. One commenter acknowledged that this is surely the hugest effort ever in the field. A second commenter indicated that funding is sufficient and will support the developments of new technologies in an orderly manner to avoid wasteful spending. Similarly, the third commenter expressed that the resources are adequate for the overall projects and most of individual projects, although two (i.e., EnrDel and Tiax) have resources that are not commensurate with their relevance and accomplishments. A fourth commenter cautioned on the possibility of overspending. This commenter also pointed out that one disturbing aspect is the very small number of jobs created per million dollars, which appears to be a common concern across all ARRA programs.

Computer-Aided Engineering for Electric Drive Vehicle Batteries (CAEBAT): Pesaran, Ahmad (National Renewable Energy Laboratory) – es099



Reviewer Sample Size

This project had a total of five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Feedback in this section was positive. One reviewer stated that the project is well directed towards DOE objectives. The second reviewer noted the need for a computerized tool to evaluate new chemistry, batteries, and systems for robustness for non-experts. This reviewer added that this will help with estimating life, cost, etc. The third reviewer explained that CAE tools can have extreme economic impact on battery performance and design as the CAE tools for vehicle structures have impacted the OEM design and economics of vehicles. A fourth reviewer remarked that commercially available and user-friendly computer modeling design tools for batteries will advance the sophistication and capability of battery manufacturers just as similar tools revolutionized the auto industry. Additionally, this reviewer mentioned that this will provide for better products optimized for lower cost. The fifth reviewer commented that computer aided design is an engineering tool that can reduce the time and effort to realize the best possible solution to a problem. This reviewer further added that this project is directly related to the reports of Smith and Kandler.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, remarks in this section were positive. The first evaluator indicated that this is a brand new, integrated approach to support engineering and analysis of Li batteries. This evaluator added that the project is ambitious and challenging, but well-structured and adequately ambitious because it is aimed at clear problem solving. The second evaluator described it as a very challenging but achievable project and noted a very ambitious approach to something that should well be worth it if successful. A third evaluator offered that the approach, when it results in a CAEBAT, will shorten the cycle of cell and system development. The fourth evaluator explained that a comprehensive program has been developed to speed the development of higher energy batteries for transportation. This reviewer added that this over-reaching program is designed to enhance NREL's existing electrochemical activities and speed the development of advanced reliable and safe battery systems. A fifth evaluator expressed that incorporating all of the modeling disciplines (e.g., CFD, thermal efficiency, lump mass, and structures) is a good way of starting. Further, this evaluator said that being able to model cell response to abuse is critical then progress this failure and cascade to propagation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewer feedback was positive in this section. One commenter acknowledged a good start in setting up for real work to start this year. A second commenter offered that the results achieved so far are mostly preparatory, but very promising with good prospect for success. The third commenter explained that modeling and computer-aided engineering tools have been developed to understand and predict performance, and added that two other programs in the review by Kandler and Smith are the result of this over-reaching program.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments in this section were generally positive. The first reviewer noted that the network of collaborations is well organized and complete. A second reviewer observed that the results are being published and shared with other national laboratories and auto companies to assist in speeding the development of new, safe, high-performance battery systems. The third reviewer acknowledged a good start with national labs and many complicated relationships to management. This reviewer pointed out that IP and other issues may slow down and/or otherwise make successful execution difficult. Further, this reviewer highlighted a tracking need because collaboration is more necessary in this project than most.

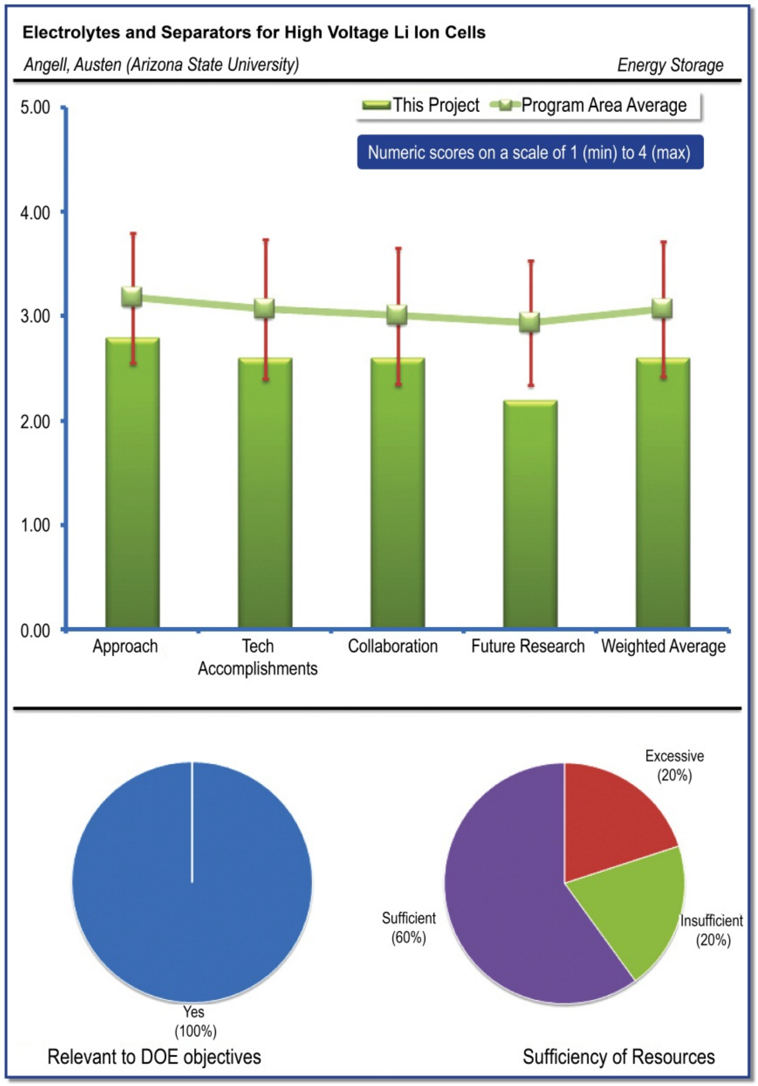
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Feedback in this section was positive. One respondent observed a good plan for an ambitious and challenging new project, while a second further described that future work addresses clear activities and an extension of collaborations. A third respondent said finalize the programs, transmit them to other laboratories, and share them with developers of battery systems. This respondent further noted that a key element has been the continued adequate funding of the program.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Comments received regarding this section were positive. The first evaluator offered that the effort is relevant and the resources necessary. The second evaluator stated that funding is adequate.

Electrolytes and Separators for High Voltage Li Ion Cells: Angell, Austen (Arizona State University) – es100



Reviewer Sample Size

This project had a total of five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback was generally positive in this section. One reviewer offered that there are clear targets aiming at DOE objectives. The second reviewer noted that improved electrolytes for lithium ion batteries will increase fleet electrification over time. A third reviewer indicated that high voltage electrolyte is the bottle neck for high voltage cathode. The fourth reviewer stated only if we believe that industry will go with high voltage cathodes and safety will not be compromised.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, comments in this section are generally positive. The first respondent stated that the work seems to be inspired by the work of others and is built on the best achievements in industry. The second respondent pointed out a need to set the target property for the compromised solution, such as the mixture with the conventional carbonate. A third respondent opined that the approach to sulfone-based solvents is interesting, and further offered that greater leveraging of BATT resources beyond the University of Utah would be constructive. The fourth respondent observed that while the approach is good, there is some confusion in the presentation that raises doubts about objectives and feasibility.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Feedback from reviewers in this section was mixed overall. The first commenter observed good review of field work and improvements made, and a second commenter noted that the results are promising. The third commenter expressed that it is almost obvious that the mixture would increase the conductivity. As a result, this commenter adds, the PI needs to understand the negative impact of adding the conventional electrolyte. Furthermore, this third commenter asserted that fluorinated sulfone also needs to be investigated regarding the reduction side. A fourth commenter offered a combination of general statements in this area, as well as remarks specific to presentation slides. In general, this commenter discussed, overall results should be more clearly structured as data shared show select, mixed results but do not present an overall picture of the new work performed. Additionally, this person suggested that it would be useful to have more slides like Slide 8, but with more results. This commenter also observed that slides appear with low resolution, which makes reading difficult. Uncertainty was expressed by the fourth commenter as to whether the low resolution is the result of the conversion to a PDF or some other root cause, but requested that it be addressed for the future. The fourth reviewer reported, in reference to Slide 3, that the "Relevance" tag states that only conductivity and high voltage are needed to improve energy density and power density, but many other components are needed as well. Specific to Slide 5, this commenter queried the significance of a visit by Toyota. Further referencing Slide 5, and noting the three different combinations of salt/solvent shown, this commenter questioned why there was no $LiPF_6$ paired with a sulfone or LiTFSI with EC/DMC to make it a more side by side comparison. Finally, for Slide 5, this person pointed out that the image shown is for methoxyethyl methyl sulfone (MEMS), but the chart data is for Trifluoroethylmethylsulfone (FEMS) and ethylmethylsulfone (EMS). Regarding Slide 6, the fourth commenter inquired about the trigger point for solvent decomposition to this group, and expressed that 0.1 mA/cm^2 seems rather large. Additionally, this commenter explained that it is difficult to judge whether it forms a good SEI or not without cycling data. Referencing Slide 12, the fourth commenter questioned the concentration of LiPF that is meant by saturated in methanesulfoneyl fluoride (MSF) and methanesulfoneyl chloride (MSCl). This commenter acknowledged the voltage stability shown for LiTFSI mixtures and conductivity for $LiPF_6$ on Slide 13, and expressed curiosity about what the converse of each looks like (i.e., voltage stability of $LiPF_6$ and conductivity of LiTFSI). Further, this commenter asked how the voltage stability of the EMS-MSF $LiPF_6$ mixture compares, and noted that it is shown on Slide 12, but at a different scale bar range that makes it difficult to do a side-by-side comparison. The fourth commenter, in reference to Slides 14 and 15, inquired about the C.E. of these CV, and observed that it is difficult to determine if lithium deposition and stripping are efficient. Finally, and in regard to Slide 16, the fourth commenter questioned whether the fluorination improved any experimentally measured property.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewer comments in this section were mixed. While one respondent noted that the work of the collaborators is well referenced, the second respondent observed that the collaborations are limitedly described. A third respondent offered that work beyond the modeling at University of Utah should be encouraged, and that pairing with experimentalists should help get these electrolytes into cells sooner rather than later. Specific to Slide 2/17, this respondent pointed out that the work with Chen at LBNL is mentioned, but no detail given. This respondent added that Slide 2 also lists the University of Rhode Island and PNNL as partners, but their contributions are not described. The fourth respondent said the collaboration was not clear.

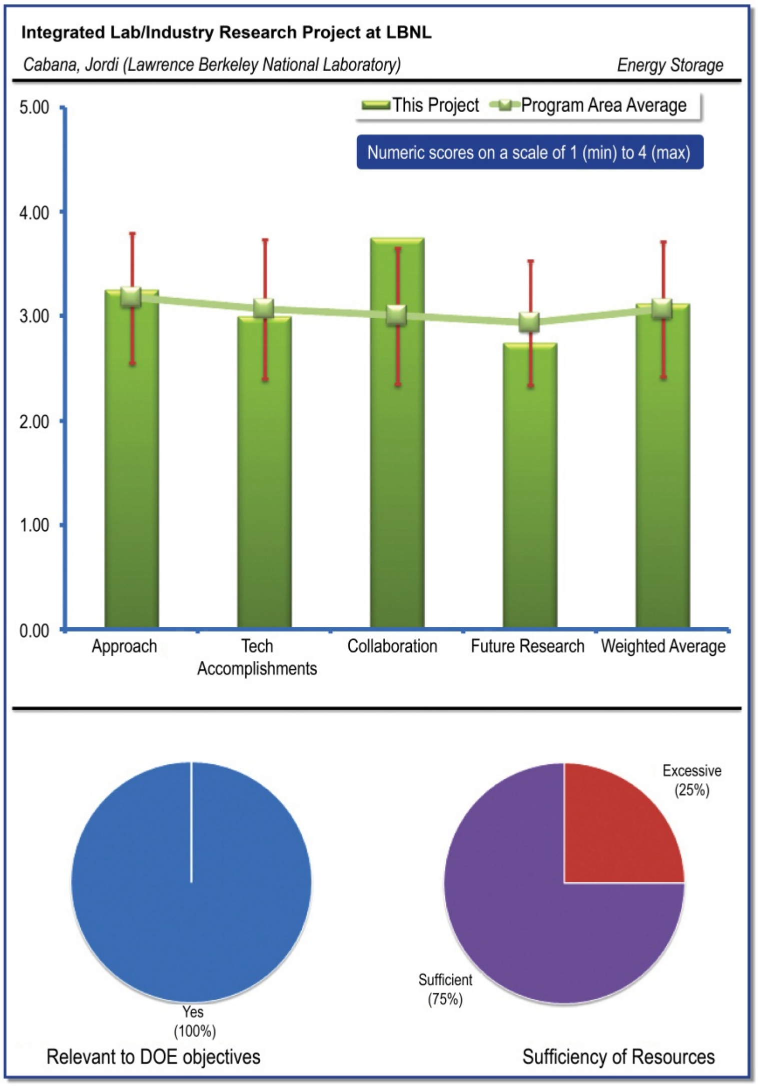
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Remarks in this section were generally negative. One reviewer stated that future work is not clearly described. The second reviewer discussed that content of future separator work, including intended materials or approach, does not seem to be defined. A third reviewer suggested that proposed future work should include cell based evaluations, and that separators are another large area of work. This reviewer also explained that it would be helpful to evaluate the performance of the sulfone in existing systems before advancing to a joint electrolyte/separator project. The fourth reviewer pointed out that more electrochemical study is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Feedback from the reviewers was mixed for this section. Although one reviewer indicated that funding for completed work seems appropriate, the sufficiency of resources is unknown because proposed future work content is unclear. The second reviewer opined that resources do not seem sufficient, and a third reviewer said no specific comments.

Integrated Lab/Industry Research Project at Lawrence Berkeley National Laboratory: Cabana, Jordi (Lawrence Berkeley National Laboratory) – es102



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer comments in this section were positive. One reviewer indicated that the project is relevant to DOE objectives. Another reviewer explained that use of Li metal is a big step to improve the energy, and the third reviewer offered that improvements in lithium metal anodes for lithium ion batteries can increase the level of fleet electrification over time.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Feedback in this section was generally positive. The first respondent indicated excellent progress towards developing qualitative tools to observe Li anode upon cycling and understand the current options of the lithium anode stabilization. A second respondent observed a novel approach of leveraging a large group of researchers on one task, and added that it was interesting to compare the results of this group to the Ni/Mn spinel work group. The third respondent stated that although the project is very well integrated with contributions from ANL and LLBL, the industry part is not well specified. A fourth respondent remarked that the integrated lab work seems interesting, but the scope seems too wide.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewer statements in this section were mixed. One reviewer commented that the results are interesting, but only preliminary due to the recent start of the project. This reviewer added that the results are mostly related to conventional dendrite formation and do not apparently cover the planned activities. A second reviewer noted good progress towards developing the necessary techniques to conduct future experimental work, but also identified a need to focus on the quantitative methods. The third reviewer observed that there is not a lot of data yet. A fourth reviewer offered comments specific to presentation slides. This reviewer expressed that setup, experiment, and results are poorly explained on Slide 7. Additionally, this reviewer remarked that the use of Kostecki's 4 electrode jig for lithium ceramic evaluation on Slide 8 looks promising. In reference to Slides 9 through 11, the fourth reviewer pointed out interesting work on the lithium glass, and suggested that more background on how and why these materials were chosen would be helpful.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments presented in this section were generally positive. One respondent noted an excellent selection of partners that should provide synergy in meeting the challenging objectives. The collaborations are adequate and well-coordinated, according to the second respondent, who also recommended that the participation of industry be enlarged due to the claimed lab/industry research approach. A third respondent observed that managing this large group and maintaining a sense of focus seems like it will be a challenge. This respondent also suggested to clearly mark out which group did what work in the future. The fourth respondent said this is supposed to be good.

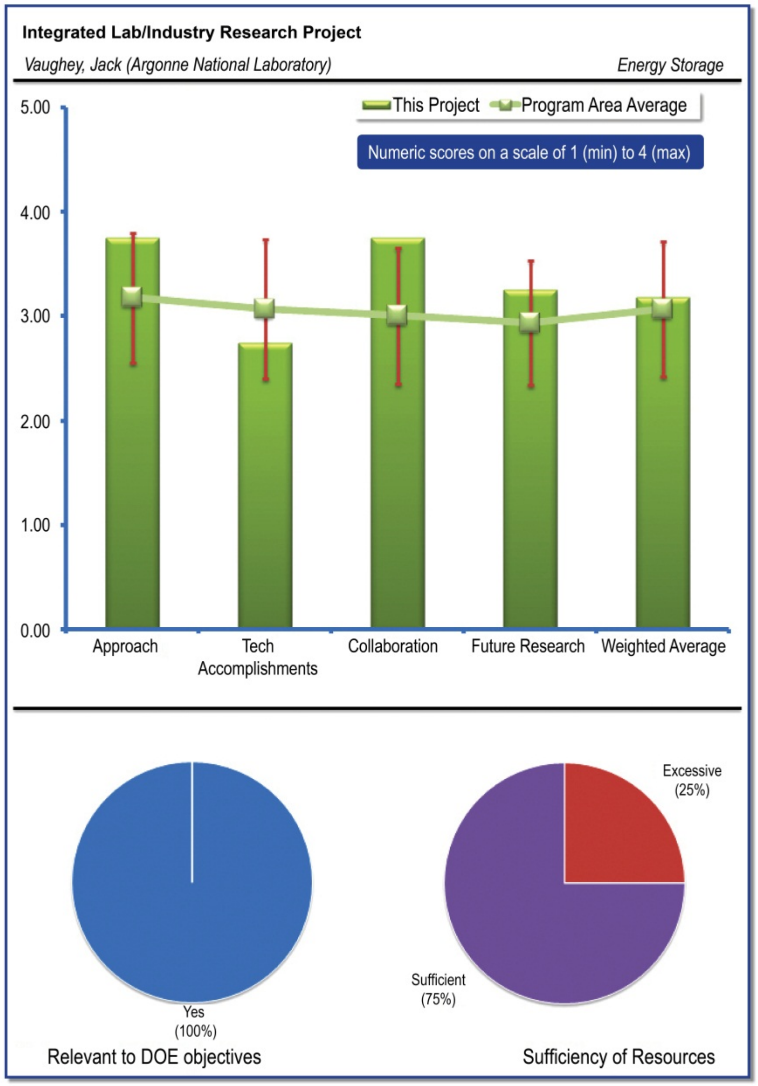
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Feedback was positive, overall, in this section. The first commenter remarked that future work looks thought-out and systematic. The second commenter acknowledged an excellent plan for periodic meetings between the partners and pointed out a great choice for the industry partner. According to the third commenter, the future work is well connected to the preliminary results even if it seems only partially connected to the overall project objectives. The fourth commenter explained that this is a long term project and suggested that the scope could probably be narrowed down more for each year.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer comments in this section were mixed. Although one evaluator stated that the resources seem adequate, a second evaluator indicated that resources seem excessive.

Integrated Lab/Industry Research Project: Vaughey, Jack (Argonne National Laboratory) – es103



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback in this section was positive. One reviewer asserted that the project is relevant. A second reviewer explained that many issues, including long-term historical limitations in cycle life capability of Li-metal systems, prohibit their potential for use in vehicle applications, and added that the program could be useful relative to the VTP program if it specifically serves to document the fundamental limitations. The third reviewer offered that use of Li metal is big step to improve the energy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were generally positive in this section. The first respondent noted an excellent understanding of the challenges of the lithium metal anode rechargeability and thus, excellent selection of the techniques for the studies. The second respondent observed an adequate approach with excellent integration between ANL and LBNL expertise. A third respondent stated it is reasonable that the PI wants to improve the interfacial behavior on the Li for long life. The fourth respondent explained that the silane-based coating activity is of interest as it may apply to and enhance applications other than vehicle applications where lower cycle life capability may be acceptable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Overall, reviewer statements were positive in this section. The first reviewer acknowledged that the project has demonstrated progress in the area of Li-metal coatings. According to the second reviewer, results are promising even if they are still preliminary because of the recent project start. The third reviewer agreed that initial results look very promising, and further offered that, in the area of coatings, attention should be given to cost of the coating reagents and coating procedures to make them scalable and thus acceptable by industry. A fourth reviewer pointed out that the silane coating is an interesting idea.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments in this section were positive. The first evaluator observed that the best in the field among companies/academia are working on this very challenging program. A second evaluator described the collaboration and coordination as high level with very good integration between ANL and LBNL. The third evaluator stated that this is supposed to be a good collaboration project.

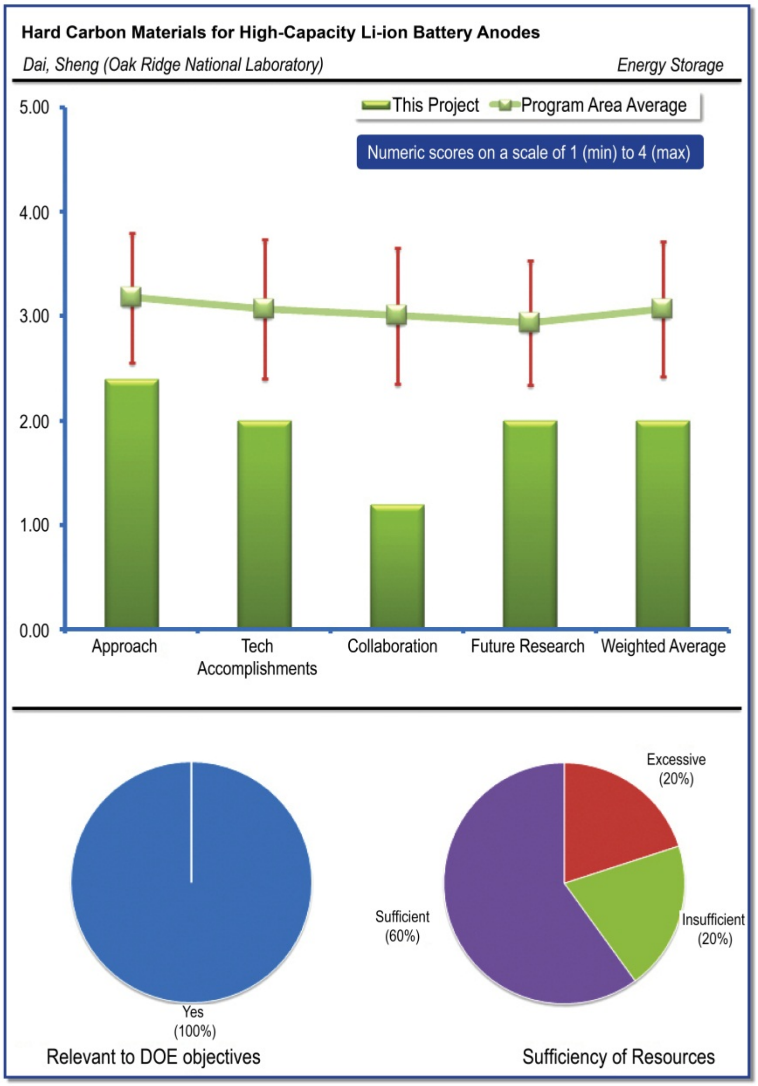
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Statements from reviewers were positive in this section. One respondent remarked that future work is defined well, and a second respondent observed that future work clearly shows the deep understanding of the challenges to be addressed. A third reviewer explained that further work with silane coatings and interfacial additives may be useful to better understand fundamental limitations. This respondent further noted that work to understand the fundamental beneficial mechanism(s) of silane coatings on Li may be useful, particularly as an alternative to further activity on ceramic lithium conductors. The fourth respondent stated it is appropriate.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Reviewer feedback in this section was generally positive. A reviewer indicated that resources seem sufficient, and a second reviewer offered no comments.

Hard Carbon Materials for High-Capacity Li-ion Battery Anodes: Dai, Sheng (Oak Ridge National Laboratory) – es104



Reviewer Sample Size

This project had a total of five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments in this section were generally positive. The first respondent indicated that the work on hard carbon is functional to meet DOE objectives of low cost and higher performances of Li batteries. A second reviewer offered that improvements in anodes for lithium ion batteries will improve fleet electrification over time. According to the third respondent, hard carbon is very old material but can be investigated again for a new market.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer feedback, overall, was mixed in this section. One reviewer acknowledged that the project addresses the technical barriers well with clear objectives, and that the solutions proposed are well described in terms of impact on the technical performances. However, this reviewer pointed out, it is unclear how the low cost target will be pursued. The second reviewer observed that approaches to improve cycling performance and volumetric capacities were good and provided good results. This reviewer further suggested that an approach to improve first cycle irreversible capacity should consider methods beyond the surface coating that cannot help with 40% loss. A third reviewer opined that an approach to optimizing one specific type of carbon without first surveying the existing is unlikely to lead to the barriers of cost, cycling, and energy being overcome. The fourth reviewer indicated that the PI should understand more about previous work for hard carbon because it is very old material commercialized by Sony in 1992, and it is well-known that the cycle life of hard carbon is good.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Statements in this section were generally mixed. One respondent stated that the results achieved so far are promising and well in line with the expected improvement to overcome technical barriers. This respondent observed that the cost issues are not considered and further recommended more vis-à-vis comparison with graphite. A second respondent acknowledged good results for cyclability and volumetric density improvement, and indicated that different approaches are required for the first cycle efficiency improvements. The third respondent remarked that the impact on potential energy density of significant irreversible capacity losses in the anode materials, if deployed in full cells, must be realistically considered and described. Further, this respondent added, investigation and description of power capability over a wide SOC range may illustrate additional advantages or disadvantages of the investigated materials compared to graphites. The fourth respondent mentioned that the irreversible capacity is too high, and that commercialized hard carbon has considerably less irreversible capacity without any modifications the PI has tried in this project. The fifth respondent offered comments specific to presentation slides. Referring to Slide 4, this respondent noticed an unbalanced picture of the advantages and disadvantages of the hard carbon/graphite given. Regarding Slide 5, this respondent opined that projections of hydrocarbon (HC) suitability for vehicles based on the voltage steps are weak. Further, unless a flat profile cathode like $LiFePO_4$ is used, all cathode materials have sloped curves, as well, which must be dealt with regardless of anode voltage steps. This fifth respondent inquired about the source of the hysteresis seen in the absorption of mesoporous hard carbon (MC550) on Slide 6. Continuing to Slide 7, this respondent questioned why some tests are taken to 10C or 20C c-rates if the objective is EV batteries. In reference to Slide 10, this respondent queried how the initial carbon source was determined and optimized. Further on Slide 10, the fifth respondent noted that a great deal of the later work (e.g., Approach 1, 2 and 3) is based on this step and it seems odd to optimize so much downstream without first performing a wider survey. Additionally on Slide 10, this same respondent questioned what cathode will be used, what will be the resulting cell voltage, and how will increasing the voltage range increase C.E. if the anode will be run to 3.0V. Referring to Slide 11, the fifth respondent observed that the surface coating of ppy appears to reduce the rate capability of the standard and queried how cycle life was improved based on the chart shown. In regards to Slides 12 and 13, this respondent questioned whether the same boost in conductivity shown on Slide 12 can be derived from a cheaper alternative to CNT, such as carbon black, acetylene black, or vapor-grown carbon fiber (VGCF). Considering Slide 14, this respondent reported that the C.E. improved 3% through the coating, which seems within the margin of reproducibility of handmade cells, and inquired about the sort of reproducibility seen. This fifth respondent questioned how cycling was improved based on the chart shown on Slide 16 and further offered that it seems the untreated version had higher capacity values. Regarding Slide 18, this respondent inquired about the size and morphology of the commercial Cr_2O_3 and whether it matched the composite. Further on Slide 18, this respondent queried whether the loading of 57% Cr_2O_3 to the reminder carbon matched the composite in the electrode, and how much of the Cr_2O_3 is electrochemically active. This respondent noted that in Slide 16, the pure MC550 had a capacity of about 1,000 mAh/g, while the composite MC550-Cr2O3 on Slide 18 had a capacity of around 600 mAh/g with 43% MC550. Further, this fifth respondent suggested that a pure MC550 voltage curve next to the composite should be shown on Slide 18.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Overall, comments in this section were negative. One evaluator offered that interaction or collaboration with a significant international supplier of Li-ion anode materials and/or a significant international supplier of Li-ion battery cells would be extremely beneficial for this project. Further, this evaluator added that the current level of collaboration, if any, is unclear. A second evaluator remarked no evidence was presented for either academia or industry collaborations. The third evaluator asserted that no external collaboration was identified, and a fourth evaluator agreed that there were no collaborations indicated. This fourth evaluator further mentioned the involvement of other institutes working on anodes and the participation of selected industries would be beneficial in fully overcoming project objectives. A fifth evaluator stated that no collaborations were seen.

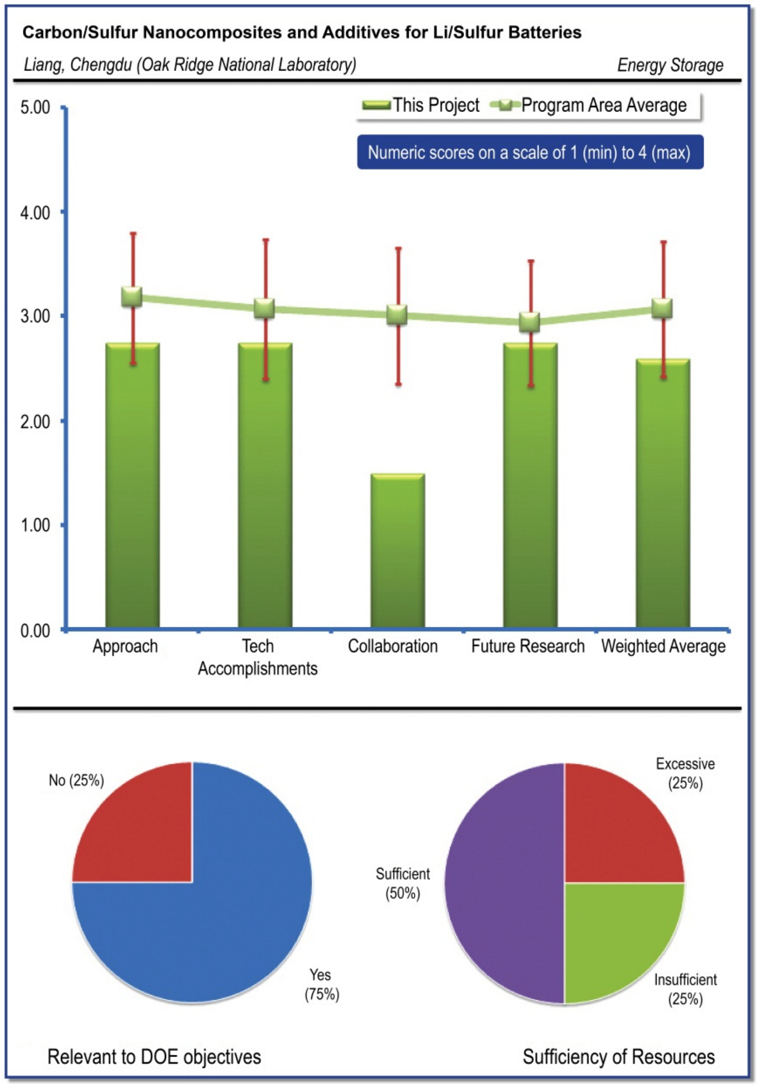
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Feedback was mixed in this section. The first respondent pointed out that further investigation into methods to reduce initial irreversible losses is planned and significant success in this area will be critical. The second respondent explained that the proposed prosecution of work is reasonable, but lacks some useful integration with well identified collaborations and inputs for introducing estimating cost aspects. Moreover, this respondent added, the proposed modification of carbon with CrO_2 seems limited and not sufficiently and clearly extended to alternative additives. A third respondent suggested that, before attempting to optimize one particular material, the researchers should survey the available materials to make sure an appropriate material to work on is selected. Further, this respondent added, existing commercial grade materials should be used as controls when comparing the results of their materials. The fourth respondent recommended that the PI should get the hard carbon that is commercially available for comparison. A fifth respondent said not clear and too general.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer comments were mixed in this section. Although one reviewer indicated that resources are judged appropriate for an enlarged effort with other materials and analysis, a second reviewer observed that resources seem insufficient.

Carbon/Sulfur Nanocomposites and Additives for Li/Sulfur Batteries: Liang, Chengdu (Oak Ridge National Laboratory) – es105



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback in this section was generally mixed. One reviewer described exploratory work on Li-S towards DOE objectives, and a second reviewer opined that Li-S has the potential to increase energy density. A third reviewer observed no evidence that Li-S systems as a sub-class of Li-metal systems can ever achieve sufficient cycle life for automotive applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments were mixed in this section. The first evaluator offered that the approach is holistic and targets all reactions in the Li/S cell, including corrosion issues of the cell parts. Although the second evaluator indicated that the project is properly addressing key technical barriers with reasonable objectives, this person pointed out that the integration with other efforts is limited to ORNL. The third evaluator said it was clear that the issue is S dissolution and Li_2S formation. A fourth evaluator identified that the primary focus of work appears to be on cathode side, when Li-metal anode issues may be the most fundamental problem.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The statements in this section were generally positive. The first respondent observed good results, specifically on the design of the sulfur electrodes and suggested catalytic process assisting with Li_2S reversibility. Results are promising and good in consideration of the start of the project, according to the second respondent. A third respondent explained that the cathode-side activity and accomplishments are valid and of value for non-automotive applications, after ignoring fundamental anode-side limitations and automotive applications. The fourth respondent remarked that it seems micro porous carbon could improve the S dissolution, but it is still far from the practical level. This respondent further noted that more significant breakthrough seems needed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Overall, feedback from reviewers in this section was negative. The first evaluator pointed out that the collaborations are limited to ORNL and no exploration has been done to identify other participants, particularly on the Li anode part, which seems to be a critical issue. No collaborations outside of ORNL were seen by the second evaluator. A third evaluator observed that there was not enough information on collaborative efforts.

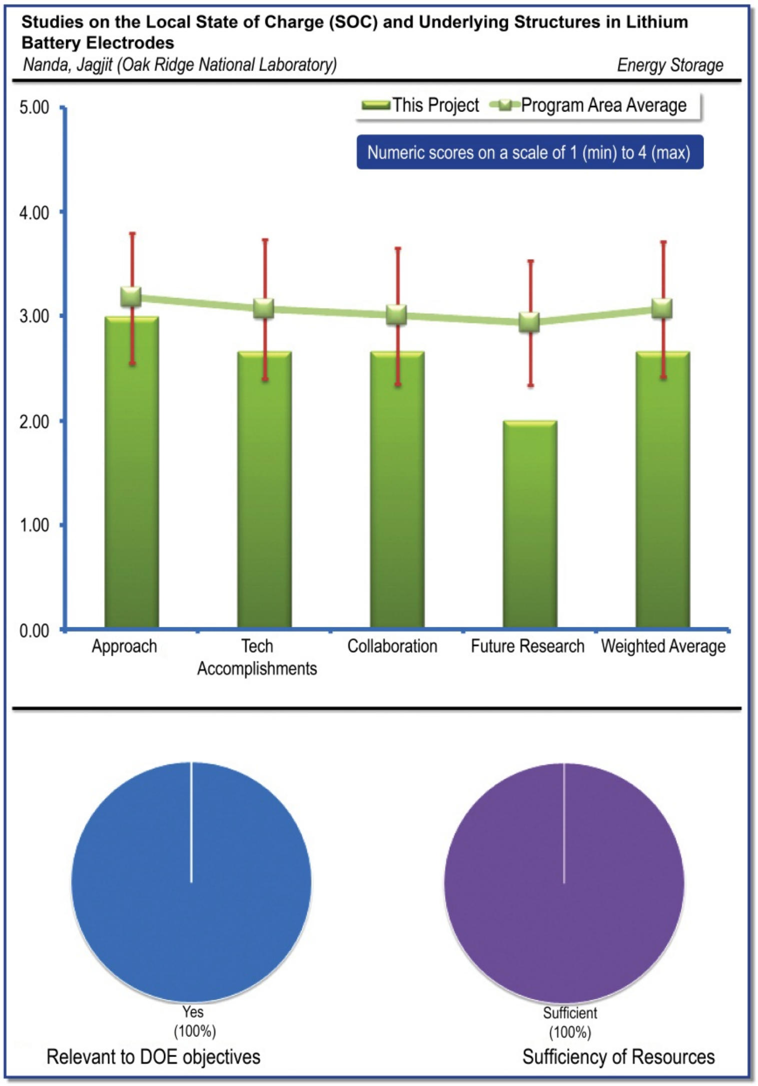
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were generally mixed. The first reviewer stated that the plan addresses the objectives well, and the second reviewer offered that the proposed plan is reasonably connected to the achieved results, even if more details are necessary to better understand the real work planned. This second reviewer further added that the focus on Li metal anode seems an open question that is not clearly addressed. A third reviewer remarked that significant breakthrough is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Feedback from reviewers was mixed in this section. Although one respondent considered the resources adequate, the second respondent suggested that resources seem insufficient.

Studies on the Local State of Charge (SOC) and Underlying Structures in Lithium Battery Electrodes: Nanda, Jagjit (Oak Ridge National Laboratory) – es106



Reviewer Sample Size

This project had a total of three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Overall, statements from reviewers were positive in this section. The first reviewer remarked that analysis of aging mechanisms is useful in improving Li cells towards DOE objectives. A second reviewer offered that an in-situ technique is a good method to understand the phenomena in the cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer feedback in this section was generally positive. One respondent expressed that it is interesting to understand local SOC in the electrode. A second respondent explained that the approach is good addressing limited, but well defined barriers, with limited integration with other activities. The third respondent highlighted that although the project has milestones and well defined tasks, the approach is not well defined.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were generally negative in this section. The first commenter requested to see how local SOC differences can be relaxed by time and by the electrode structure. The data presentation requires more clarity and reference to the objectives, according to the second commenter. A third commenter agreed that the results were limited and not clearly presented.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Feedback from reviewers was generally positive in this section. One reviewer indicated that some collaboration exists, while the second reviewer noted limited collaboration.

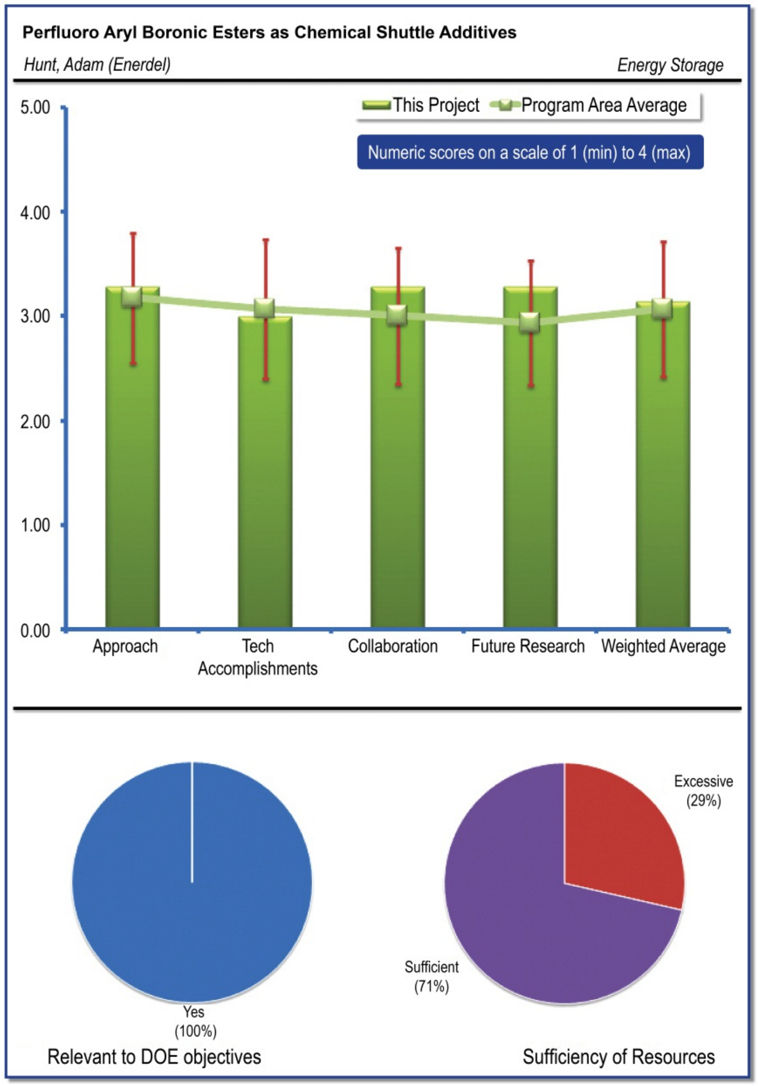
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were generally negative. The first evaluator stated that future research is not explicitly present, and it probably implies to be a work in progress. A second evaluator opined that the proposed plan needs to be redefined and better specified. The third evaluator agreed, and highlighted the need for more definition of future work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Overall, comments were generally positive in this section. One reviewer indicated that resources seem sufficient, while a second reviewer offered no specific comment.

Perfluoro Aryl Boronic Esters as Chemical Shuttle Additives: Hunt, Adam (Enerdel) – es107



Reviewer Sample Size

This project had a total of seven reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer statements in this section were positive. One reviewer asserted that the project sufficiently supports DOE objectives. A second reviewer described that this project is aimed at developing redox shuttles for Li-ion cells to improve their safety and reliability, which is consistent with DOE goals of reducing petroleum consumption and GHG gas emission by replacing conventional automobiles with battery-powered hybrid and electric vehicles. Unlike aqueous rechargeable batteries, this reviewer adds, Li-ion chemistry is not tolerant to overcharge; poor cyclability and safety are an ultimate result of the cathodes, anodes, and electrolytes undergoing degradation. Currently, this second reviewer explained, a bulky and costly solution to avoid overcharging Li-ion cells is using smart electronics. Further, according to this reviewer, redox shuttles undergo oxidation at the cathode at the potentials corresponding to the overcharge potentials of the cathode, and reduction at the anode during overcharge. Finally, the objective here, as described by this second reviewer, is to develop a redox shuttle compound and employ it in a large format Li ion cell. A third reviewer offered that these shuttle additives are "outstanding" development toward safe implementation of batteries. Overcharge of a cell in a battery can lead to a catastrophic event and must be avoided, warned the third reviewer. This reviewer added that chemical shuttles could provide a means to prevent the explosion of a unit cell. A fourth reviewer indicated that the success of the chemical shuttle will help with the reduction of cell monitoring and balancing in a battery pack, which may help with the overcharge protection. Finally, a fifth reviewer said provides simpler mechanism for cell balancing, improving safety and robustness for lithium ion batteries for EV, hybrid electric vehicle (HEV), and PHEV applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Feedback was generally positive in this section. One evaluator observed that results of molecular orbital modeling suggested that perfluoro Aryl Bodonic esters would be a good means to mitigate overcharge and control the cell voltage in a safe region. The second reviewer identified an interesting approach to improve Li cell safety. The third evaluator described that the approach is to test existing shuttles and not invent shuttles. Further, this evaluator noted, results could be available from the shuttle supplier. A good, general approach to test candidate redox couples for various requirements was acknowledged by the fourth evaluator. This evaluator pointed out that it seems cycle voltammetry or literature information can be quicker and more valuable than molecular orbital calculations. Furthermore, this fourth evaluator offered that in view of multiple requirements and narrow voltage range targeted, it may be necessary to screen test several dozen materials. This evaluator also suggested that there needs to be some additional thought into how to develop and acquire an ample selection of materials. A fifth evaluator reported that the approach in developing new redox compounds functioning in the desired voltages range included identifying new shuttles through molecular orbital (MO) calculations, verifying their electrochemical potentials, reversibility, and compatibility, and maximizing conditions for rapid diffusion of the oxidized species to the anode. This evaluator added that a new class of redox shuttle agents based on fluorinated 1,3,2-benzodioxaborole (BDB) was developed by ANL for NMC cathodes and is being evaluated in this project. Combined with the performance assessment, this fifth evaluator stated, the effects of redox additives on the anode SEI are also being addressed to ensure that the cell performance is not adversely affected by the addition of redox compound to the electrolyte. The fifth evaluator continued that even though the redox shuttle approach looks elegant, there are serious and insurmountable issues of kinetics (e.g., reversibility, solubility, diffusion between the two electrodes) and finally, its longevity for a good cycle life, etc., to make this approach feasible. This same evaluator highlighted that similar efforts on this approach have been ongoing for years for different cathode systems with little success.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments in this section were mixed. The first respondent observed promising results. The second respondent reported that a model of tech process was developed to understand interactions with the cell components, especially the surface of the anode SEI layer. This respondent added that the choice of additives to form the SEI layer had an influence on performance, and that work is continuing to evaluate other shuttle molecules with improved performance. A third respondent described interesting work and interesting results. This respondent also noted that the three candidate materials reported were studied somewhat extensively and maybe too extensively. All were unsuitable for various reasons, as reported by this respondent, because of voltage, chemical incompatibility, and/or stability issues. Although these extensive studies provide interesting information to write a scholarly paper, this third respondent opined that they will not lead directly to a solution to the problem. This respondent also pointed out a need to recover from being behind schedule and specified that finding a way to get more candidate materials to test and testing them quickly is needed. Finally, this third respondent questioned if it is possible to find a redox couple such that the redox voltage can be tuned by chemical adjustment. The fourth respondent opined that technical accomplishments and progress achieved in this project are only modest. Specifically, this respondent noted, three redox shuttle molecules were evaluated without any success. The redox additive BDB showed incompatibility with the anode, thickened its SEI, and required further adjustments to the electrolyte (LiF addition), as explained by this respondent. Yet, this respondent added, its stability was not adequate, losing the redox function after one cycle. This fourth respondent opined that this work has become more academic with papers than being of any value in the near future, and explained that a couple of other redox shuttle were examined with different voltages and for different cathodes, without any success yet. Finally, this respondent emphasized that these modest accomplishments only underline the difficulty associated with the approach of adding redox shuttles to the electrolyte for built-in overcharge for Li-ion cells.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewer statements were generally positive in this section. The first reviewer observed a good network of collaborations, and the second reviewer highlighted good collaboration with Purdue University and ANL. A third reviewer reported that Purdue University and ANL have collaborated in the work and contributed to the progress. The fourth reviewer explained that there is good, ongoing collaboration in the development of these redox additives with ANL and also with Purdue University in the assessment of and understanding the behavior of these redox compounds. The fifth reviewer suggested that 3M should be included in the list of collaborators because they have many years of experience with various chemical shuttles.

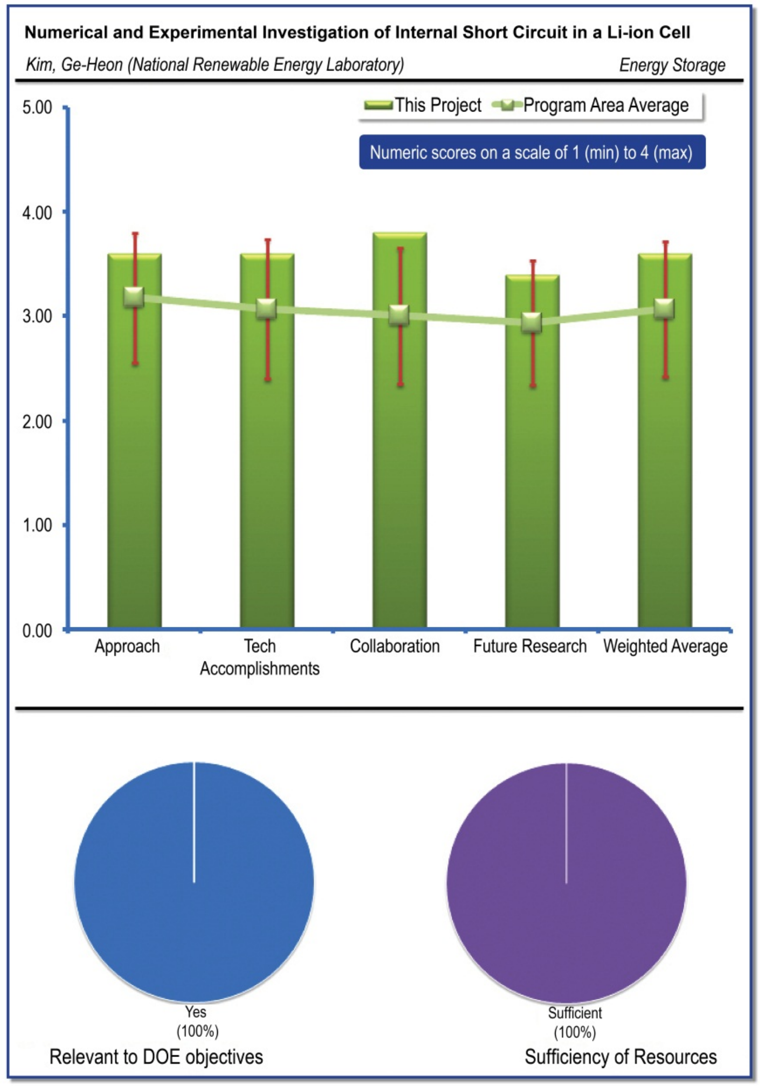
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Comments in this section were generally mixed. The first evaluator stated that there is an adequate plan for future work. The second evaluator asserted that the proposed work is right-on what is needed, and further added that more experimental information is needed to arrive at the best redox shuttle molecule. A third evaluator explained that future plans are to continue the development of new redox shuttle molecules being developed at ANL for different cathodes (NMC, NCA or LFP), characterize them, and demonstrate their efficacy in large full cells. This evaluator subsequently remarked that future work appears logical, and suggested that it is better to look at such redox additives being developed elsewhere in non-DOE laboratories. The fourth evaluator identified that the plan needs to be adjusted to recover from the missed FY2011 milestone.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Overall, feedback was mixed in this section. One commenter described the level of support as adequate, and a second commenter offered that resources are okay. The third commenter indicated that the program can be tailored to answer the fundamental questions of durability and effectiveness of the already known shuttles from 3M at a lower cost. A fourth reviewer expressed that resources are a little excessive for the project, which is still academic in nature.

Numerical and Experimental Investigation of Internal Short Circuit in a Li-ion Cell: Kim, Ge-Heon (National Renewable Energy Laboratory) – es109



Reviewer Sample Size

This project had a total of five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Positive remarks were received in this section. The first respondent asserted that the safety aspects are key to DOE objectives. A second reviewer explained that safety and reliability are key concerns regarding the introduction of high performance lithium ion batteries for HEV, EV, and PHEV applications, and have been a commercial barrier. Further, this reviewer highlighted that this work provides valuable insight on how to reduce serious safety risks for lithium ion batteries. According to the third reviewer, the internal short circuit is very difficult to sense and may have safety consequences. A fourth respondent emphasized that internal short circuits are the bane of Li-Ion batteries and every means must be used to identify the cause and prevent the internal shorting of a battery.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, reviewer feedback in this section was positive. One person indicated that the use of computer aided design speeds the solution to the problem and provides a fundamental base to identify and prevent internal shorting to occur. This person added that a means to induce an internal short has been developed and implemented in experimental cells to prove the calculations and provide a means to eliminate shorting in production cells. The second person reported that this addresses key barriers related to safety and reliability by modeling and quantifying the consequences of cell shorting. Additionally, the second person explained that it provides insight on how to design more safe cells and assess the shorting hazard based on cell design. Furthermore, according to the second person, both numerical modeling and experimental verification and testing are included in a creative and unique approach. A third reviewer observed a good project with a correct application of models. The reviewer said it may be helpful to model a scenario to simulate an internal short circuit which is seen in 18650 cells one out of multimillion times.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments in this section were generally positive. The first commenter stated that the results are very promising. A second commenter observed that unique insight has already been provided on how design affects shorting safety, and that this model can provide a tool to better develop specific batteries by manufacturers to evolve towards safer designs. This commenter acknowledged good, active collaboration with one or more battery companies, national labs, safety experts, and consulting. The third commenter explained that programs have been developed that are powerful in identifying the cause at an early stage such that individual problem cells can be eliminated and/or bypassed in a vehicle battery. The combination of a test method and modeling may help to validate the model, suggested the fourth commenter.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Statements from reviewers in this section were positive. The first evaluator observed good, active collaboration with one or more battery companies, as well as collaboration with national labs, safety experts, and consulting. A second evaluator noted a proper and well organized group of collaborations. The third reviewer reported that the experimental cells have been made by Dow Kokam. Furthermore, this evaluator indicated that the National Aeronautics and Space Administration (NASA) has tested the shorting device and an expert consultant in battery testing and safety has been used in the program.

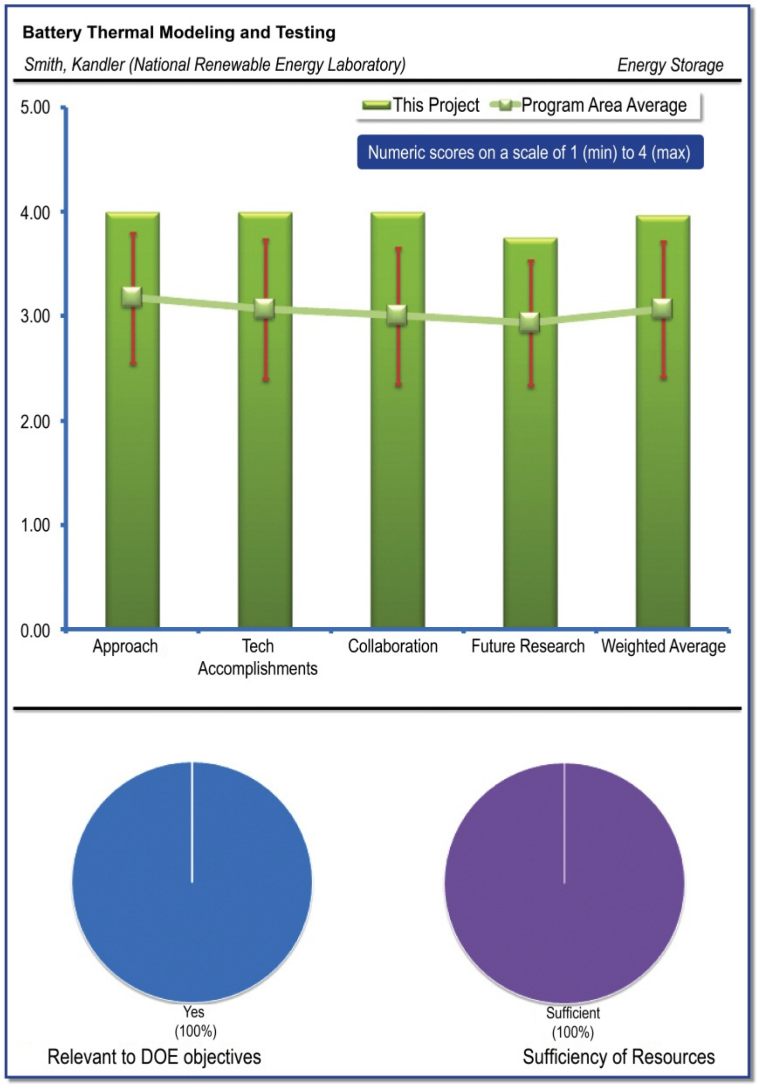
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Feedback was generally positive in this section. One reviewer acknowledged an appropriate and clear plan for future work that is correctly based on achieved results. The second reviewer asserted that this powerful methodology must be shared and adopted in DOE programs, especially those related to batteries for transportation and energy storage. A third reviewer suggested to compare the battery industry experience with the safety issues associated with the cell internal short to validate the model and simulation. Further, this reviewer continued, the results of this research should answer the frequency and intensity of internal shorts in the existing cell populations.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Comments in this section were generally positive. The first commenter asserted that money has been well spent, and the key has been the continued funding of the program to enable full project completion. A second commenter observed that resources are okay.

Battery Thermal Modeling and Testing: Smith, Kandler (National Renewable Energy Laboratory) – ess110



Reviewer Sample Size

This project had a total of four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewer feedback in this section was positive. One reviewer indicated that thermal testing is a necessary support to DOE objectives. A second reviewer explained that proper thermal management is required for battery systems for EV, HEV, and PHEV applications to enable safety, reliability, and life goals to be met. Further, this reviewer added, thermal modeling is an invaluable tool to the efficient development of effective thermal managements systems that enable battery pack system to still meet weight, packaging, and cost constraints. The third reviewer noted that thermal behavior of Li-Ion batteries in transportation is the key to safe operation and avoiding a catastrophic incident.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Statements in this section were positive. The first commenter offered that the ability to accurately characterize the thermal behavior battery system in order to avoid a catastrophic incident is essential to the success of electrification of energy storage and transportation. Additionally, this commenter pointed out, this project is one of the three programs that are essential to the overall, DOE electric vehicle program and go to the core of the technology. A second commenter observed a dual approach of world class thermal and calorimetric measurements capability coupled with numerical modeling, which is an excellent combination. The third commenter described a well-organized and focused project with a convincing approach combining various advanced tools to improve knowledge and extreme behavior of Li cells, modules, and batteries.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Positive feedback was received in this section. One evaluator noted an impressive and well-described amount of experimental and simulation results with a clear view and relevant progress. A second evaluator pointed out excellent work as has been historically true from this lab, and further acknowledged good, new measurements and modeling. This evaluator also remarked that the trade-off of studies with geographic effect is a practical problem that vehicle developers and manufacturers face. The third evaluator explained that accurate models of cells in a battery have been developed and should be used in all appropriate parts of the DOE program. Further, the evaluator said, this allows rapid characterization of thermal behavior as well as modeling of the overall performance of a battery system. Additionally, problems can be identified and removed before they occur in a particular cell and battery design. This third evaluator also indicated that implementation across the board will speed development of safe battery systems by all parties in the game.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments in this section were positive. The first reviewer observed a well-organized network, and a second reviewer asserted that the three posters from NREL were a highlight of the conference. The second reviewer added that implementing this capability in all DOE battery programs is essential and will seed the introduction of safe, powerful batteries for EV, PHEV, and HEV applications.

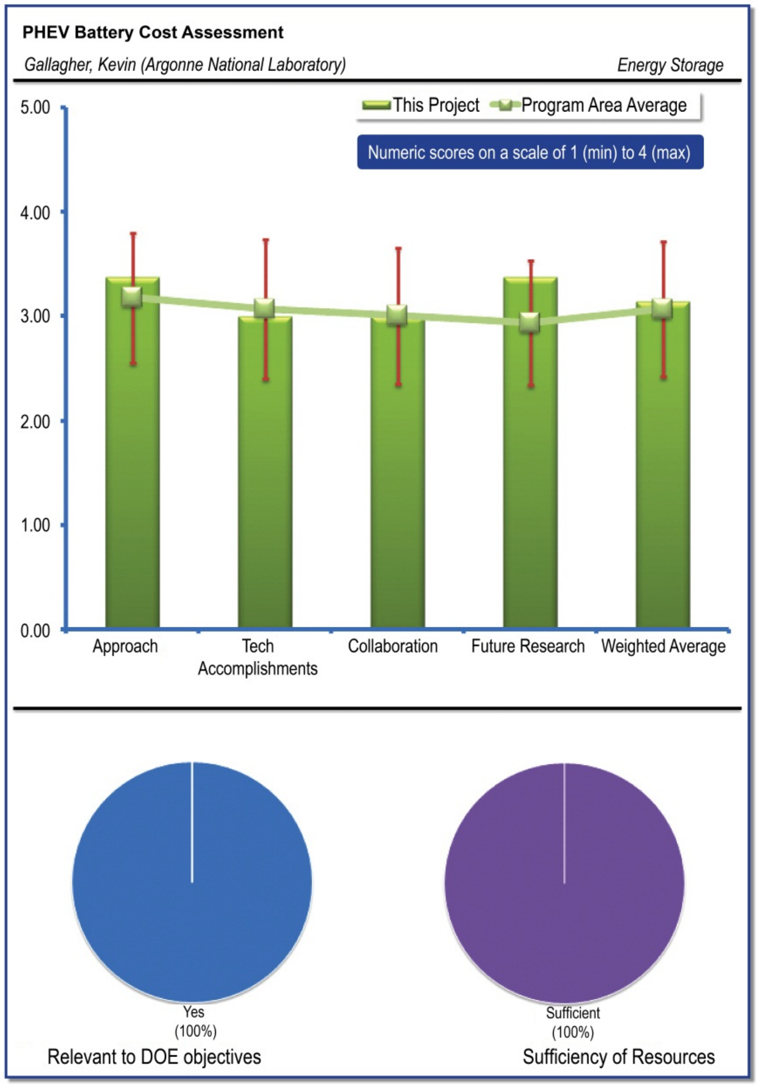
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Overall, reviewer feedback was positive in this section. One respondent stated that this work provides a good example of the benefits of computer modeling, and suggested this approach should be applied in other, appropriate situations. The ability to finish the model was a key element in success. Often, this respondent continued, management stops this type of program just when it is in a position to deliver the fruits of the effort. The second respondent noted clear and acceptable planning.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Remarks in this section were generally positive. The first evaluator expressed that resources are adequate for the mission. A second evaluator explained that the resources are strongly dependent on the number of chemistry and designs analyzed.

PHEV Battery Cost Assessment: Gallagher, Kevin (Argonne National Laboratory) – es111



Reviewer Sample Size

This project had a total of eight reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Comments in this section were positive. The first respondent offered that the project provides information that automotive OEMs can use to help determine the feasibility of using PHEV batteries and other hybrid battery approaches to help reach their 2020 fuel economy goals and reduce the use of petroleum, which is a DOE objective. A second respondent explained that this project is quite relevant to the overall DOE goal of partly replacing conventional vehicles with hybrid or electric vehicles to minimize national dependence on petroleum resources. Additionally, this respondent emphasized the high cost of batteries for PHEVs as a serious issue from the manufacturers' perspective that requires considerable attention. This respondent also remarked that the overall objective is to develop cost assessments, based on appropriate models, for predicting cost and performance characteristics for battery pack values from bench-scale results and for predicting methods and materials that enable the manufacturers to reach cost goals. Further, this second respondent stated, the objective is in support of an overall goal of developing a PHEV-40 with a price that is less than $3,400, a weight not exceeding 120 kg, and a volume within 80 liters. Finally, this respondent noted, these studies will assist in overcoming the cost barrier for Li-ion batteries for vehicular applications, if successful. A third respondent mentioned that the cost assessment is correctly prepared and relevant to DOE objectives. The fourth respondent stated that cost is always an issue, and a fifth respondent stressed that meeting cost goals are very critical to the success of electrification automotive vehicles. The sixth respondent agreed that cost is the biggest barrier to the introduction of hybrid vehicle technology capable of providing substantial reduction in vehicular petroleum consumption. This respondent further added that this work provides useful information on the impact of recent lithium-ion battery technology on cost, and specified that both the absolute and relative information are useful. Furthermore, this respondent opined that this work will provide software for cost estimation to the battery community at no cost so the industry can make use of tools developed here. A seventh respondent explained that cost projections are essential to battery evolution and market development of EVs. This respondent acknowledged that this project does follow a methodological approach for cell projections, but does need to include some control system and pack level cost projections to make it complete. This reviewer observed that it would also be interesting to do a detailed comparison between this model and Tiax.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, feedback in this section was generally positive. The first commenter reported that the approach adopted here was based on designing a battery and the required manufacturing facility in consideration of power area-specific impedance (ASI) and energy requirements. Thus, said this commenter, reach cost goals by obtaining performance and cost calculations for advanced Li-ion electrochemical couples (lithium- and manganese-rich [LMR]-NMC, LNMO, Gr-Si composite), and predicting the required materials and processes. This commenter acknowledged that the approach is based on similar models developed at ANL in the past and utilizes the likely production costs for OEM manufactures in 2020. The first commenter explained that both the design and cost are coupled in the model, which quantifies the impact of underlying properties on the total battery pack cost such as cell chemistry, parallel cells, electrode thickness limits, power-to-energy ratio, etc. Finally, this commenter indicated that the project is well designed and integrated with other developments in materials and cell fabrication. A second commenter remarked that the use of a single spreadsheet is an excellent idea and will be very useful for battery developers to estimate the cost of their batteries. The third reviewer commented that developing an accurate model is a key to creating valuable information on process and product cost. A fourth commenter observed that the technical and economic barriers are well identified with a convincing approach based on modeling cell performances, and cost and manufacturing needs for cell optimization and applicability. Because references are minimally made to complete battery systems, this commenter did caution that some conclusions and comparisons with DOE targets may be misleading. The fifth commenter indicated that cost analysis is important and it is good to see multiple programs funded in this area. Although the approach seems comprehensive from first principles, this commenter pointed out that the presentation was not clear on the full plan in this new program. Further, this commenter noted, the objective to provide this tool free to battery developers increases the value of this program for the U.S. battery and vehicle industries. A sixth commenter asserted that the approach met the project goals in providing a model that can be used by a battery supplier and an automotive OEM in determining the cost of a plant and the viability of using a PHEV battery system for a particular application. However, this commenter remarked, the approach does have limitations in that it is not clear that the model is flexible enough to support different cell designs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewer feedback in this section was positive, overall. The first person stated that accomplishments this year met expectations. A second reviewer described that a spreadsheet has been developed to simulate a realistic production line, and it can be adapted to other chemistries and production situations. Further, this person added, a performance model has also been developed to provide input to the cost model. The third reviewer observed that the project met the stated goals and delivered desired results on time, but did note that a suggestion is to see validation of the model based on an existing cell and how well the model projected the cost and manufacturing details for that cell. This reviewer felt, however, that the project more than met the stated project goals and the model will be a valuable tool for automotive OEMs. A fourth person offered that the progress is significant in the direction to solve addressed barriers. Availability of a public model may be effective in improving the tool with feedback from various users, remarked this reviewer, though it is unclear how use of the publicly available tool may be managed by the PI to improve its usability. The fifth person acknowledged that reasonably good progress has been achieved in carrying out the cost analysis for PHEV application batteries, and the results are not unexpected. Specific accomplishments, as reported by this person, include the following: (i) development of a fully integrated Li-ion design and cost model into a single spreadsheet; (ii) demonstration of potential cost reduction from increased electrode thicknesses and large-format pouch cells; and (iii) calculated cost reduction from advanced Li-ion cathode materials, including the high capacity layered-layered composites and the performance requirements necessary to realize savings. This fifth reviewer identified one difficulty associated with this model, which is that it is heavily based on area-specific impedance data from ANL. The person further noted that DC impedance data is a strong function of the test parameters (current step, pulse duration and the test-vehicle), and that the model will instead be robust if it is based on the real-time performance data from the manufacturer's prototype cells. Finally, this fifth reviewer suggested that a more direct collaboration with the manufacturers of one or two representative chemistries, in terms of using their electrodes/cells data, will add credibility to these analyses and to the conclusions from this study. A sixth person criticized that results were not well organized and results were not profound at this early stage in the project. Furthermore, this person asserted that more is expected in the future.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Remarks were mixed in this section. The first reviewer reported that a wide range of groups, companies and people provided input to the model. The project involved all of the partners needed to deliver a meaningful product, according to a second reviewer, but the third reviewer observed limited collaborations with other institutions and organizations. This third reviewer suggested that some contributions of manufacturers and other component developers may be beneficial in refining the model and extending its applicability to various cell designs and materials. A fourth reviewer remarked that there are no external collaborations here, and it is entirely an ANL in-house effort. This reviewer offered that a more direct collaboration with the battery manufacturers will be greatly beneficial. The fifth reviewer expressed that it was not clear how, in the future, this will evolve in relation with CAEBAT. A sixth reviewer said that it was good to hear about peer review and would like a follow-up on the recommendations of that next year.

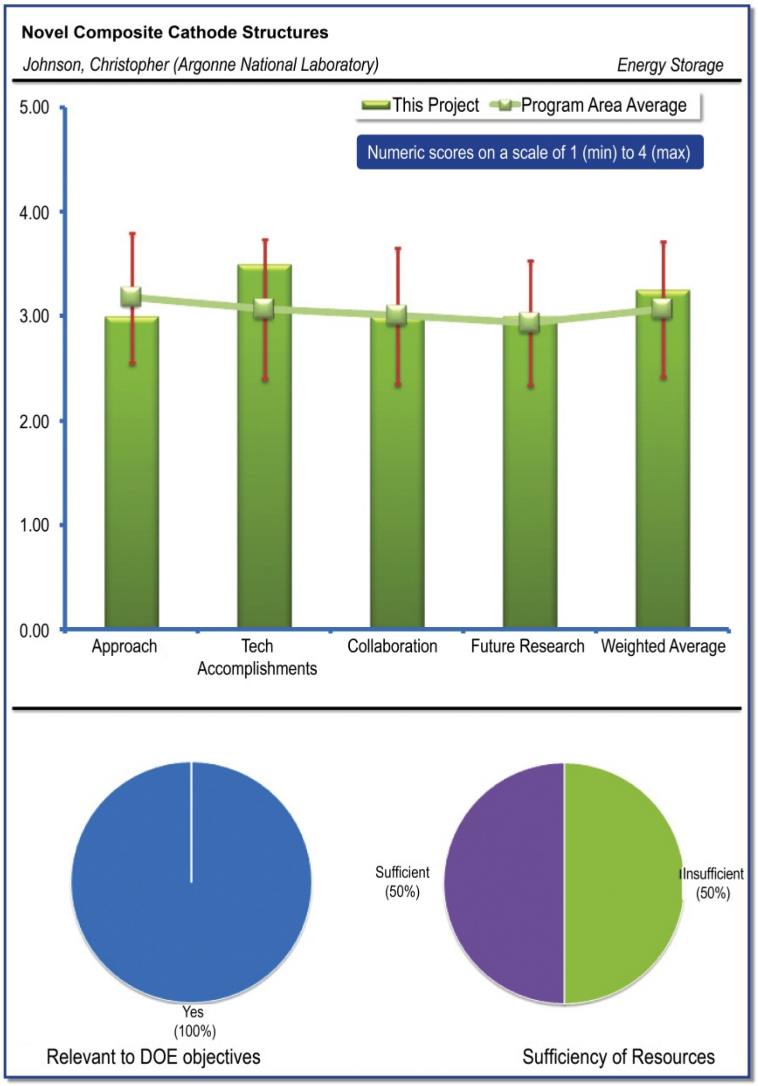
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewer feedback in this section was generally positive. One evaluator reported that the proposed future research includes the following: (i) advancing the thermal management portion of design and cost model; (ii) estimating cost reduction from advanced negative and positive electrode materials; (iii) further refining the model input parameters; and (iv) identifying battery pack integration component costs though collaboration. The second respondent observed that future project plans include adding a thermal management portion to model. This reviewer further suggested that different thermal management options be included in the model and that the model include self-contained cooling and heating systems. A third respondent indicated that planned activities for the coming year are appropriate and consistent with the work already done. However, this respondent opined that extension only to thermal management without considering the rest of electronics required (as the battery management system [BMS]) slows down completion of the model too much. The fourth respondent acknowledged that incorporating a thermal management model should be interesting, and the project at NREL can provide good input to this phase.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Overall, comments in this section were mixed. The first commenter stated that adequate resources are available, and the second commenter agreed that resources are adequate for the planned effort. The third commenter observed that the project involved multiple partners and accomplished the project goals at minimal cost. According to the description of the work and the proposed future work, the fourth commenter opined that the estimated budget is considered more than adequate.

Novel Composite Cathode Structures: Johnson, Christopher (Argonne National Laboratory) - es115



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Feedback was positive in this section. The first reviewer described that this project focuses on developing new cathode materials that can offer higher energy density, and noted that batteries are the prime candidates for HEVs and PHEVs, which are the viable, near-term solution to reducing petroleum consumption. The second reviewer indicated that cost and high thermal stability of cathode materials are central issues when trying to increase the battery range.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer comments in this section were generally positive. One commenter observed an interesting approach and that ion-exchange seems to be producing interesting powders. This commenter suggested that the authors later also focus on cost and possible steps to improve the synthesis of these materials. This first commenter also noted that the plausible mechanism of ion-exchange, where a shear of the crystal lattice seems to be taking place, was impressive. Further, according to this commenter, the TEM results shown in Slides 11 and 12 are very impressive and new. The results shown at different c rates are also impressive, asserted this first commenter. A second commenter reported that precursor materials based on sodium are ion exchanged with lithium. This commenter further added that they could become useful for sodium batteries even though the practical application of these materials is questionable because the ion exchange reactions for industrial production can increase the processing/manufacturing cost of the materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Remarks in this section were generally positive. The first evaluator pointed out that it is outstanding for a project that started only this year. A second evaluator offered that high capacities have been achieved with these materials and the cycle life is also good. However, this evaluator noted, they are not superior to some of the layered oxides already known to exhibit high capacity.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments were generally positive in this section. One respondent observed that most of the collaboration is with ANL, which is natural, and identified some collaboration on TEM with Michigan Technology University (MTU). The second respondent recommended that the authors should try to collaborate with U.S. companies in the future. Acknowledging that it is not easy, this respondent suggested that the authors should try to find a way of doing that.

QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Feedback from reviewers in this section was generally positive. The first reviewer indicated that future work is focused on doping, thermal stability, and transport measurements, which is a natural extension. A second reviewer offered that tests on full cells should be strongly pursued, and that diagnostic analysis on full cells should be attempted.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Overall, comments in this section were somewhat mixed. Although one commenter observed a level of funding that is adequate for the efforts being pursued, the second commenter remarked that resources are insufficient if the authors pursue a strong collaboration with U.S. companies.