Overview and Progress of United States Advanced Battery Consortium (USABC) Activity

Project ID: ES097

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USABC
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USABC
UNITED STATES ADVANCED BATTERY CONSORTIUM LLC

OVERVIEW (DE-EE0006250)

Timeline:

- Start: Oct. 01, 2013
- End: Oct. 01, 2018

Barriers:

Batteries addressed:

- Development of Technology goals
- Development of RFPIs
- Review and acceptance of Developer responses to RFPIs

Budget:

Total Budget: $125M

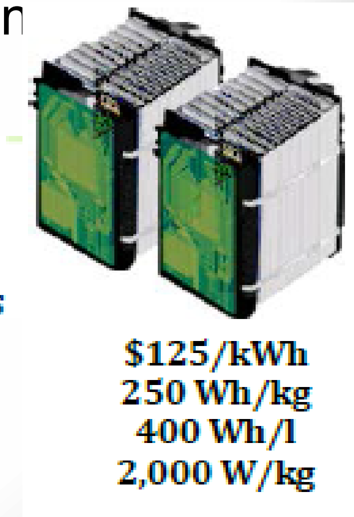
DOE Cost Share: $62.5M
DOE Funding in 2013 - $0
DOE Funding in 2014 -0.4M
DOE Funding in 2015-3.9M
DOE Funding in 2016- 3.0M

Partners:

Developers;
FCA, Ford, GM;
INL, ANL, NREL, SNL;
DOE
Project Lead: USABC

Objective: Mission of USABC

- Foster the development of electrochemical energy storage technologies within the US, that support commercialization of electrified vehicle powertrains



Cell Targets
350 Wh/kg
750 Wh/l
1,000 "C/3" cycles

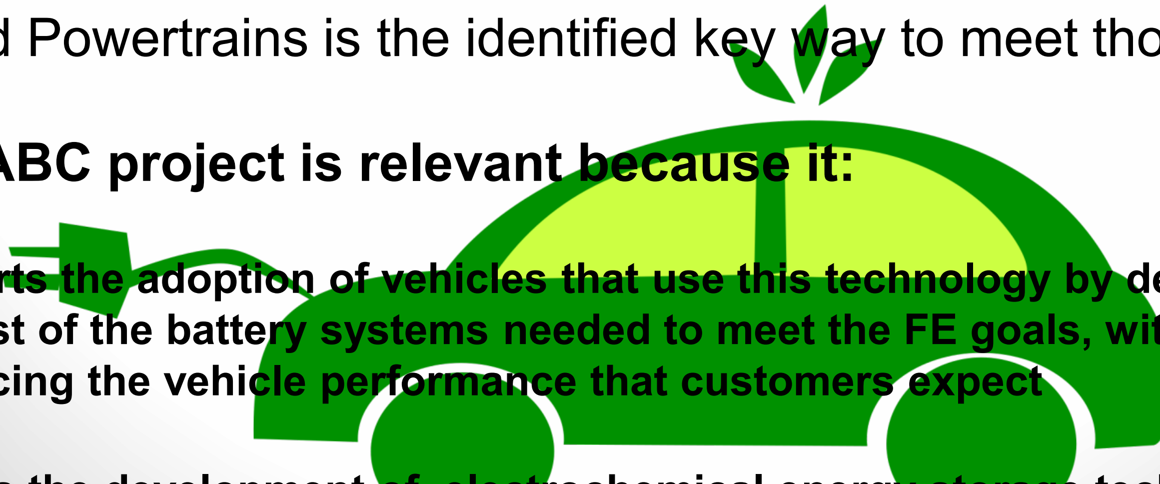
- Advance the development of battery technologies to meet the DOE system cost, energy and power goals

- Maintain consortium to allow for the combined technical and financial resources of the DOE, automotive OEMs (FCA US, Ford, General Motors), technology development partners, and U.S. National Laboratories to jointly conduct advanced battery research and development on a cost shared basis

Cooperation has resulted in the successful commercialization of various electrical energy storage technologies and increased presence of developers of these technologies within the US

Relevance

- Federally mandated Fuel Economy goals require automotive manufacturers to make significant FE improvements
- Electrified Powertrains is the identified key way to meet those goals.
- **This USABC project is relevant because it:**



  - **Supports the adoption of vehicles that use this technology by decreasing the cost of the battery systems needed to meet the FE goals, without sacrificing the vehicle performance that customers expect**
  - **Fosters the development of electrochemical energy storage technologies within the US that support commercialization of electrified vehicle powertrains**
  - **Provides input from automotive OEMs in the establishment of performance goals needed to meet real world vehicle performance requirements,**
  - **Drives development of Test Manuals and Test Methods for battery systems**

Approach: Cooperative Group Effort

Automotive OEMs
Technical Expertise
Funding Coordination
Program Management
Test Method Development
Industry Experience & Input
Development Partner Assistance
Real World Requirement Perspective

DOE
Funding Coordination
National Lab Management
Governmental Perspective
R&D Plan Development
Progress Tracking and Reporting
Performance & Cost Targets Analysis

National Labs
Life Prediction
Abuse Testing
Development Partner Assistance
Long Term Fundamental Research
Performance & Benchmark Testing
Thermal Analysis & Design Support
Battery Simulation and Model Development

Development Partners
Technical Expertise
Tangible Cost Data
Applied Research Capability
Manufacturing Capability
Hardware Deliverables
Cost-Shared Funding

Strategy: Program SOW Development Process

RFPI Workgroup

- Establishes Technology Goals Technical
- Generates Request For Proposal Information
- RFPI Posted on USCAR Website and Industry Notified
- Responses Received/Reviewed/Ranked
- USABC TAC and MC Final Selection

Program Workgroup

- Develop SOW with identified Developer
- Address Technical and Business Concerns
- Agree on final SOW with Development Partner
- USABC TAC and MC agree on SOW

Developer

- Develops/Agrees on SOW
- Performs to SOW
- Provides Hardware Deliverables
- Reports as Required

Strategy: RFPI Program Descriptions

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Technology Assessment Program

- Test/evaluate developer's existing or slightly modified technology
- Typical Total Program Budget - $0.4M
- Typical TAP Timeline Description below

Jan '15	March '15	June '15	June '16
Program Kickoff	Developer Internal Testing to SOW >18 test units	Deliverables to USABC/NL ≥18 test Units	Final Report

Technology Development Program

- Provide technical and funding support to strong developer with a demonstrated technology capable of meeting/surpassing USABC technology goals.
- Typical Total Program Budget - $1.0 to $Multi-millions
- Typical TDP Timeline Description below

Jan '15	Dec '15	March '16	June '17	Jan '18
Program Kickoff	Developer's First Technology Internal Testing	First Deliverables to USABC/NL ≥18	Final Deliverables to USABC/NL <40	Final Report

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Strategy: USABC Technology RFPIs

USABC RFPIs – Common Areas

- Responses from single developers or a collaborative team of developers
- The responses must meet a strict 75% US content for the funded part of the program
- Maximum 50% cost share provided from USABC/DOE
- Technology must meet or have the capability of meeting or approaching identified USABC goals for that technology.
- Key development areas are: Cost, Calendar Life, and Cycle Life
- Supports development efforts of electrified powertrains technology to be cost/performance competitive with ICE technology.
- Final program deliverables must include cells and/or modules

Results: USABC Technology RFPI Opportunities

USABC RFPIs – Descriptions

- **EV** - High energy-to-power ratio batteries, which utilize an advanced material as the negative electrode active material for a Li-Ion cathode chemistry.
- **PHEV** – One of several options of energy-to-power ratio batteries, which utilize an advanced material as the negative and/or positive electrode active material; or, incorporate some novel approach to significantly reduce technology cost.
- **48V** - Long cycle/calendar life, high power-energy ratio batteries or battery systems which utilize advanced materials for the electrode active materials.
- **12V Start/Stop** - Long cycle/calendar life, high power to energy ratio batteries (under hood or, not under hood), to meet start-stop and traditional 12V demands.
- **Separator** - Improvement in High Voltage Stability (~5V) and Internal Short protection capability of enhanced Separator material as demonstrated in high energy-to-power ratio cells.
- **Electrolyte** - Improvement in High Voltage Stability (~5V) and Abuse Tolerant Electrolytes as demonstrated in various energy-to-power ratio cells

Results: USABC Technology RFPI Opportunities

USABC RFPIs – Descriptions

- **Cell Active Material** - Active cell materials development to meet USABC cost targets, while making significant progress towards USABC performance goals.
- **Recycled Material** – Recovery/reuse of active battery materials from end of life electric vehicle batteries back into new battery systems to 1) Lower total life cycle costs of battery systems, 2) Increase the residual value of end of life battery systems, and/or 3) reduce recycling costs.
- **Manufacturing Processes** - Improvement in the manufacturing processes for Cell and/or active materials as demonstrated in high energy-to-power ratio cells, which utilize an advanced material as the negative and/or positive electrode active material for a Li-Ion chemistry.
- **System Component** - Encourage development activity for improvement in the areas of Thermal Management for Li Ion battery systems for EV, PHEV, or 48V vehicles, as demonstrated with intended high volume automotive usage.
- **Benchmarking** - Aimed at companies with the capability to perform comprehensive pack and vehicle level benchmark tests on specific vehicles with electrified powertrains; and, on vehicle battery systems per USABC guidelines.

Results: USABC Technology GAP Charts

EV Technology

USABC Goals for Advanced Batteries for EVs - CY 2020 Commercialization

End of Life Characteristics at 30°C	Units	System Level	Cell Level
Peak Discharge Power Density, 30 s Pulse	W/L	1000	1500
Peak Specific Discharge Power , 30 s Pulse	W/kg	470	700
Peak Specific Regen Power , 10 s Pulse	W/kg	200	300
Useable Energy Density @ C/3 Discharge Rate	Wh/L	500	750
Useable Specific Energy @ C/3 Discharge Rate	Wh/kg	235	350
Useable Energy @ C/3 Discharge Rate	kWh	45	N/A
Calendar Life	Years	15	15
DST Cycle Life	Cycles	1000	1000
Cost @ 100K units	$/kWh	125	100
Operating Environment	°C	-30 to +52	-30 to +52
Normal Recharge Time	Hours	< 7 Hours, J1772	< 7 Hours, J1772
High Rate Charge	Minutes	80% ΔSOC in 15 min	80% ΔSOC in 15 min
Maximum Operating Voltage	V	420	N/A
Minimum Operating Voltage	V	220	N/A
Peak Current, 30 s	A	400	400
Unassisted Operating at Low Temperature	%	> 70% Useable Energy @ C/3 Discharge rate at -20 °C	> 70% Useable Energy @ C/3 Discharge rate at -20 °C
Survival Temperature Range, 24 Hr	°C	-40 to+ 66	-40 to+ 66
Maximum Self-discharge	%/month	< 1	< 1

PHEV Technology

APPENDIX A - USABC Goals for Advanced Batteries for PHEVs for FY 2018 to 2020 Commercialization

Characteristics	Units	PHEV-20 Mile	PHEV-40 Mile	xEV-50 Mile
Commercialization Timeframe		2018	2018	2020
All Electric Range (AER)	Miles	20	40	50
Peak Discharge Pulse Power (10 sec)	kW	37	38	110
Peak Discharge Pulse Power (2 sec)	kW	45	46	120
Peak Regen Pulse Power (10 sec)	kW	25	25	65
Available Energy for CD (Charge Depleting) Mode	kWh	5.8	11.6	14.5
Available Energy for CS (Charge Sustaining) Mode	kWh	0.3	0.3	0.3
Minimum Round-trip Energy Efficiency	%	90	90	90
Cold cranking power at -30°C, 2 sec - 3 Pulses	kW	7	7	7
CD Life / Discharge Throughput	Cycles/ MWh	5000/29	5000/58	5000/72.5
CS HEV Cycle Life	Cycles	300,000	300,000	300,000
Calendar Life, 30°C	year	15	15	15
Maximum System Weight	kg	70	120	150
Maximum System Volume	Liter	47	80	100
Maximum Operating Voltage	Vdc	420	420	420
Minimum Operating Voltage	Vdc	150	153	300
Maximum Self-discharge	%/month	<1	<1	<1
System Recharge Rate at 30°C	kW	3.3 (240V/16A)	3.3 (240V/16A)	6.6 (240V/32A)
Maximum Discharge Pulse Current (≤10s)	A	300	300	400
Unassisted Operating Temp Range (10s)	°C	-30 to +52	-30 to +52	-30 to +52
30°-52°	% Power	100	100	100
0°	% Power	50	50	50
-10°	% Power	30	30	30
-20°	% Power	15	15	15
-30°	% Power	10	10	10
Survival Temperature Range	°C	-46 to +66	-46 to +66	-46 to +66
Max System Production Cost @ 100k units/yr	$	$2,200	$3,400	$4,250

48V Technology

USABC Requirements of Energy Storage Systems for 48V HEV's at EOL

Characteristics	Units	Target
Peak Pulse Discharge Power (10 sec)	kW	9
Peak Pulse Discharge Power (1 sec)	kW	11
Peak Regen Pulse Power (5 sec)	kW	11
Available Energy for Cycling[1]	Wh	105
Minimum Round-trip Energy Efficiency	%	95
Cold cranking power at -30 °C (three 4.5-s pulses, 10s rests between pulses at min SOC)	kW	6 kW for 0.5s followed by 4 kW for 4s
Accessory Load (2.5 minute duration)[1]	kW	5
CS 48V HEV Cycle Life[2]	Cycles /MWh	75,000 / 21
Calendar Life, 30°C	year	15
Maximum System Weight	kg	≤8
Maximum System Volume	Liter	≤8
Maximum Operating Voltage	Vdc	52
Minimum Operating Voltage	Vdc	38
Minimum Voltage during Cold Crank	Vdc	26
Maximum Self-discharge	Wh/day	1
Unassisted Operating Temp Range (Power available to allow 5s charge and 1s discharge pulse) at min. and max. operating SOC and Voltage	°C	-30 to +52
30 °C - 52 °C	kW	11
0 °C	kW	5.5
-10 °C	kW	3.3
-20 °C	kW	1.7
-30 °C	kW	1.1
Survival Temperature Range	°C	-46 to +66
Max System Production Price @ 250k units/yr	$	$275

12V Technology

End of Life Characteristics	Units	Target: Under hood	Target: Not under hood
Discharge Pulse, 1s	kW	6	
Max discharge current, 0.5s	A	900	
Cold cranking power at -30 °C (three 4.5-s pulses, 10s rests between pulses at min SOC)	kW	6 kW for 0.5s followed by 4 kW for 4s	
Min voltage under cold crank	Vdc	8.0	
Available energy (750W accessory load power)	Wh	360	
Peak Recharge Rate, 10s	kW	2.2	
Sustained Recharge Rate	W	750	
Cycle life, every 10% life RPT with cold crank at min SOC	Engine starts/miles	450k/150k	
Calendar Life at 30°C, 45°C if under hood	Years	15 at 45°C	15 at 30°C
Minimum round trip energy efficiency	%	95	
Maximum allowable self-discharge rate	Wh/day	2	
Peak Operating Voltage, 10s	Vdc	15.0	
Sustained Operating Voltage – Max.	Vdc	14.6	
Minimum Operating Voltage under Autostart	Vdc	10.5	
Operating Temperature Range (available energy to allow 6 kW (1s) pulse)	°C	-30 to + 75	-30 to +52
30 °C – 52 °C	Wh	360 (to 75°C)	360
0 °C	Wh	180	
-10 °C	Wh	108	
-20 °C	Wh	54	
-30 °C	Wh	36	
Survival Temperature Range (24 hours)	°C	-46 to +100	-46 to +66
Maximum System Weight	kg	10	
Maximum System Volume	L	7	
Maximum System Cost (@250k units/year)	$	$220	$180

Results: USABC Technology GAP Charts

Table 2. USABC Li-ion battery separator goals and recommended test methods.

Parameter		Units	USABC Goal		Test Method
Thickness		µm	< 25 ± 1		ASTM D5947-96, D2103
Permeability	Gurley #	s /10 cm^3	< 11 (power)	25 (energy)	Pat. US 4,464,238
	MacMullin #	non-dimensional	< 4 (power)	8 (energy)	electrolyte resistance ratio
Wettability		non-dimensional	wet-out in electrolytes[1]		relative wicking speed
Functional Life		years	capable of supporting cell performance for 15 years[2]		long-term cell testing
Average Pore size		µm	< 0.2		ASTM E128-99
Shear Strength[3]		gf / 25.4 µm film	300		ASTM F1306-90
Thermal Stability[4]		% shrinkage/90°C (1 h)[5]	< 5		ASTM D1204
Uniformity (Defects)[6]		pinholes/roll	zero throughout roll length		cell manufacturer confirmation
Tensile Strength		N/A	<2% offset at 1000 psi		ASTM D882-00
Cost		$\$/m^2$	0.60 @ 10M sqm/yr		N/A
Shutdown Temperature (See Section 6.2)		°C	(105 ± 5) °C		hot ER
High Voltage Resistance (See Section 6.2)		V	5.0 V		glassy carbon electrode & cell performance

Separator Technology

APPENDIX C. USABC Gap Chart for Advanced Electrolytes[1,2]

Parameter		Unit	USABC Goal	Present Status
Electrochemical Stability (100 $\mu A/cm^2$ threshold)	Upper Voltage	V vs. Li/Li^+	5	
	Lower Voltage		0	
Specific Conductivity	at 30°C	mS / cm	>12	
	at -30°C		>4	
Lithium Transference Number		nondimensional	>0.35	
Viscosity	at 30°C	cP	5	
	at -30°C		20	
Impurities	H_2O	ppm	<20	
	HF		<50	
Purity of Each Component		%	≥99.99	
Vapor Pressure (25°C)		mm Hg	<1	
Flashpoint		°C	>100	
Lithium Salt Solubility		M	1	
Cost @ a yearly production volume no more than 20,000 ton/year		$/kg	<10	

Electrolyte Technology

Proposed Cell Attributes

Cell Level Attributes (supplied by developer)	Units	Current State (baseline)	End of Program Target
List Target USABC HEV/EV/PHEV Program			
Cell Capacity (1-C discharge)	Ah		
Cell Volume (without terminals/tabs)	Liter		
Cell Mass	g		
Vmin continuous, V max continuous (0 and 100% SOC)	V, V		
Vmin pulse - V max pulse	V, V		
Vnominal	V		
Cost: Energy (basis: usable energy)	$/Wh		
Cell format	can/pouch		
Cell dimensions: (height x width x thickness)	mmxmmxmm		
Recovered active materials in cathode	%		
Total recovered materials in cell	%		
Proposed Architecture to Achieve System Targets			
Battery Size Factor (BSF)	#		
Parallel-Series Configuration	__p__s		

Recycling Technology

Results: USABCTechnology GAP Chart/Test Manuals

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Thermal Management Technology

Table 1. USABC Li-ion battery thermal management system gap chart

Program Targets		Units	USABC Goals*					Program Target
			EV	PHEV			48V	
Key Parameters	Parameter Details			PHEV-20	PHEV-40	xEV-50		
Operational Life @30°C		[years]	15					
Operating Environment		[°C]	-30 to +52					
Pack Temperature Uniformity	ΔT: Cell-to-Cell	[°C]	< 3					
Cell Temperature Uniformity	ΔT: Cell Surface	[°C]	< 3					
System Efficiency	Ambient (unconditioned)	[ratio] Q/P**	> 15					
	Active		> 4					
Weight	In Pack Components Only	[kg]	< 5.3	< 5.6	< 9.6	< 12	< 1	
	Pack + Vehicle Connections		< 11.5	< 8.4	< 14.4	< 18	< 1.2	
Volume	In Pack Components Only	[L]	< 13.5	< 11.75	< 20	< 25	< 2	
	Pack + Vehicle Connections		< 22.5	< 16.5	< 28	< 35	< 2.8	
System Cost		$	< 112 @100k units	< 44 @100k units	< 68 @100k units	< 85 @100k units	< 6 @250k units	

**Developer to select one system application (48V, PHEV, or EV) for the proposal and align with existing RFPI battery performance targets as listed on the USABC website: (http://www.uscar.org/guest/article_view.php?articles_id=85)*

Major Revisions to USABC:

- ❑EV Test Manual
- ❑PHEV Test Manual
- ❑12V Start/Stop Test Manual
- ❑Battery Cost Model

Cell Material Technology

Table 1. USABC Cell active material gap chart – CY 2025 Commercialization.

Level	End of Life Parameter at 30°C	Unit	USABC Positive Electrode Goal	USABC Negative Electrode Goal	Program Goal	Test Method
Material	Available Specific Capacity	mAh/g	250	1000		C/3 CC-CV Charge, C/3 CC Discharge
	Available Capacity Density	mAh/cc	675	1800		
	Nominal Voltage	V vs Li/Li^+	4.5	< 1.0		
	Available Specific Energy	Wh/kg	1125	1000		
	Available Energy Density	Wh/L	3000	1800		
	Peak Specific Discharge Power	W/kg	2250	2000		30 Second Pulse
	Tap Density	g/cc	2.7	1.8		ASTM D4781
	Cost	$/kg	10	5		500 MT/yr
	Active Material Fraction	%	90	90		Weight Fraction
Cell	Calendar Life	Years	15	15		-
	Cycle Life	Cycles	1000	1000		DST

Results: Technology Development Programs

TECHNOLOGY	DEVELOPER	$US, M	TIME, MON	DESCRIPTION
EV	AMPRIUS	5.5	36	Focused development of an EV cell using sourced NMC cathodes against an optimized Silicon Nanowire anode to meet capacity and life; 30, 40Ah cells
	ENVIA	7.7	36	Focused development of an EV cell with an optimized High Capacity Manganese Rich layered-layered cathode against an optimized Si/SiO/C composite anode for capacity and life; 27, 50Ah cells
	LG CHEM	4.2	36	Focused development of an EV cell with an optimized Manganese or Nickel rich cathode against an optimized SI based anode for capacity and life; 20 20-65Ah cells; 3-12 to 16 cell modules
	SEEO	0.4	18	Evaluation of SEEO $LiFePO_4$ solid cathode against Lithium foil, at 80^0C temp. against USABC EV goals; 3 modules
PHEV	XERION	0.7	18	Focused development of a PHEV cell design based on active material electrodeposited onto a conductive (StructurePore™) foam as a conformal thin film to obtain ultra-cap like power and battery-like energy density; 36, >1Ah cells

Results: Technology Development Programs

TECHNOLOGY	DEVELOPER	$US, M	TIME, MON	DESCRIPTION
12V START/STOP	LG CHEM	2.2	24	Focused development of a 12V cell and module design based on LTO/LMO chemistry to meet the cold crank and cycle and 15-year life performance needed for underhood applications; 46 cells, 6 12V modules
	MAXWELL	2.7	19	Focused on development of a capacitor for a battery-capacitor parallel design, and a proof of concept 12V NOT-underhood system applications; 18, 12V modules; 15, 1200F UCs
	SAFT	5.8	30	Focused development of LTO/LMO (or blend) 12V module in an injection molded thermoplastic monoblock container for underhood system applications; 4, 12V modules, 20, 46Ah cells
MATERIALS				
	SiNode	4.0	30	Focused development of a Silicon/graphene anode material that meets the USABC Material performance metrics for Anodes. 18, 10Ah cells

Results: Technology Development Programs

TECHNOLOGY	DEVELOPER	$US, M	TIME, MON	DESCRIPTION
ELECTROLYTE	NOHMS	1.6	18	Develop functional IL based electrolyte combinations with appropriate co-solvent combinations that exhibit high ionic conductivity, excellent cathodic and anodic stability and high thermal stability for applications in 5V Li-ion batteries; 60, 10Ah cells
	soubrain	2.1	24	Focused development of an abuse tolerant, 5V electrolyte, that nearly meets the USABC cost goals, while exhibiting performance metrics that meet the USABC targets for electric vehicle applications; 30, 10Ah cells
SEPARATOR	ENTEK	2.1	24	Focused development of a inorganic filled separator, with improved mechanical properties and stability in a 5V system; 36, 25Ah cells

Results: Technology Development Programs

TECHNOLOGY	DEVELOPER	$US, M	TIME, MON	DESCRIPTION
RECYCLING	FARASIS	1.5	24	Demonstrate Direct Recycling approach with a focus on scaling up a process that allows for the recovery and reuse of the anode and cathode active materials to make new Li Ion cells with same chemistry ‘direct’ from recovery, with minimum processing; 24, 25Ah cells
	WPI	1.0	24	Demonstrate recycling process that requires little or no sorting to recover the cathode material from Li Ion cells with a focus on scaling up the process to make new Li Ion cells with NMC 111 tuned chemistry from incoming streams of mixed chemistry; 30, 25Ah cells
BENCH-MARKING	FEV	0.4	12	Perform multiple Benchmarking activities as identified by USABC and USCAR Transmission WG on the eGolf vehicle and electrified Powertrain system, as well as a cost analysis on the powertrain components

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Future Plans

- **Improve RFPI Response and SOW Development Process**
- **Continue Update/Revision of: Test Manuals; Test Methods; and Battery Cost Model**
- **Post other technology cost reduction development opportunities**
  - **Manufacturing Process - RFPI**
  - **Battery System Component - RFPI**
- **Increase scale up opportunities for successful/promising technologies, from appropriate DOE programs**
- **Encourage formation of development collaboration teams**

Summary

- Developed and published 11 different RFPIs (with GAP charts) to support technology development.
- Provided funding to 14 different companies in support of 15 different programs.
- Supported eight different technology development programs: EV, 12V, PHEV, Anode, Electrolyte, Separator , Recycling, and Benchmarking.
- Completed revisions of EV, PHEV, and 12V test manuals; initiated revisions of Abuse and 48V test manuals & nearing completion; and, updated USABC Battery Cost Model.
- USABC Home page, on the USCAR.org website below.

http://www.uscar.org/guest/view_team.php?teams_id=12

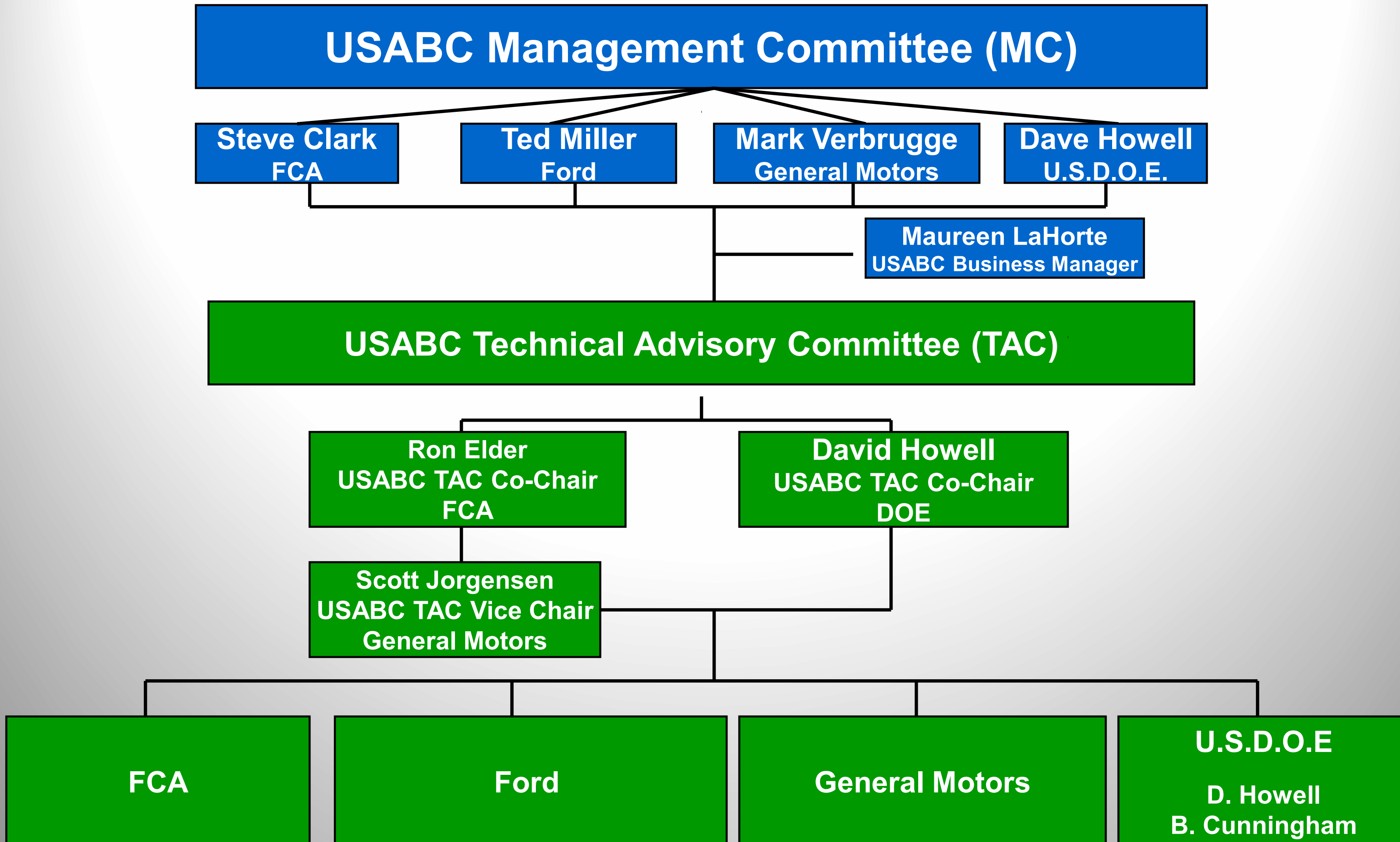
On behalf of the USABC , I thank you!!

Acknowledgements

- DOE
  - Dave Howell
  - Brian Cunningham
  - Jack Deppe
- National Labs
  - Argonne National Labs; Idaho National Labs
  - National Renewable Energy Lab; Sandia National Lab
- USCAR
- Numerous Industry Partners

Backup Slides

USABC Organization



FCA - Ford - General Motors

Overview of Posted RFPIs

Vehicle Technology Application: Key Specific Goals

EV

- 1000 DST
- 15-year
- $125/kWh
- 45kWh
- 500 Wh/L Sys.
- 750 Wh/L cell
- FY 2018-2020

PHEV

- Three P/E, PHEV Sys.
- EV range
- 5000 CD
- 300k HEV
- 15-year
- $2k to $4k
- FY 2018-2020

48V Mild

- Sys. <$300.00
- 75k HEV
- 15-year
- Cold crank
- FY 2020

12V S/S

- 450k S/S
- 15-year
- Cold crank
- Under-hood/Not UH
- System ~$200.00
- Enhance traditional Lead-Acid 12V S/S applications

Overview of Posted RFPIs

Technology Application: Key Specific Goals

Separator Material

Improvement over current separators in one or more of the following areas:

- **15-year calendar life**
- **Thermal stability with <5% shrinkage/90^{0}C**
- **High-voltage (5.0 V) stability**
- **Cost \$0.60/m^2 @ 10M sq. m/year**

Electrolyte Material

Improvement over existing electrolytes in one or more of the following areas:

- **Cost <\$10/kg**
- **-30°C conductivity >4 mS/cm**
- **5V stability**
- **Flashpoint, >100^{0}C**
- **Vapor pressure at 30°C <1mm Hg**
- **Components purity >99.99%**

Development of Cell with Recycled Content

- **Incorporate >15% recovered active materials into a Lithium-ion cell from end-of-life hybrid/electric vehicle cells**
- **When tested cells meet or approach the goals of one of the USABC vehicle technology applications**

Technology Application: Key Specific Goals

System Component Development

Technology goal: Assist developers focused on development of energy storage system components internal to or supportive of pack designs that:

- Reduce overall system cost
- Help system to meet USABC long-term vehicle performance/ life goals
  - Efficient Thermal Management
  - Integrated Structural Solutions

Cell Manufacturing Development

Technology goal: Assist developers focused on development of Manufacturing processes, techniques, etc. of cells that will:

- Reduce cell manufacturing cost
- Significantly improve cell performance.

Typical Program Evaluation Procedure

The process evaluates each proposal against four major topics:

- Merit of selected chemistry as reflected in its Gap Chart Analysis & other basics.
  - 30% Weight Factor
- Technical approach to address gaps: Completeness, risks, timeliness, etc.
  - 30% Weight Factor
- Appropriateness of program cost & cost share
  - 20% Weight Factor
- Developer's past performance , manufacturing experience & facilities
  - 20% Weight Factor