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UNITED STATES ADVANCED BATTERY CONSORTIUM LLC

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

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USABC
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ES097

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Overview

Timeline

- Start – July 2006 *(current CA)*
- Ongoing

Budget

- Total project funding (FY2011)
  - DOE share - $7.5M
  - Contractor share - $7.5M
- Funding for FY12
  - $21.6M

Barriers

- Barriers
  - Battery Cost
  - Battery Performance
  - Battery Life
- Targets

DOE Goals	HEV 2010	PHEV 2015	EV 2020
Cost $ / System	500-800	1700-3400	4000
Performance Discharge Power (kW) Available Energy (kWh)	 25-40 0.3-0.5	 38-50 3.5-11.6	 80 30-40
Life Cycles	300k *(shallow)*	3000-5000 *(deep discharge)*	750 *(deep discharge)*

Partners

- Chrysler, Ford, GM, DOE
- INL, ANL, SNL, NREL, LBNL, ORNL

Overview
(Mission)

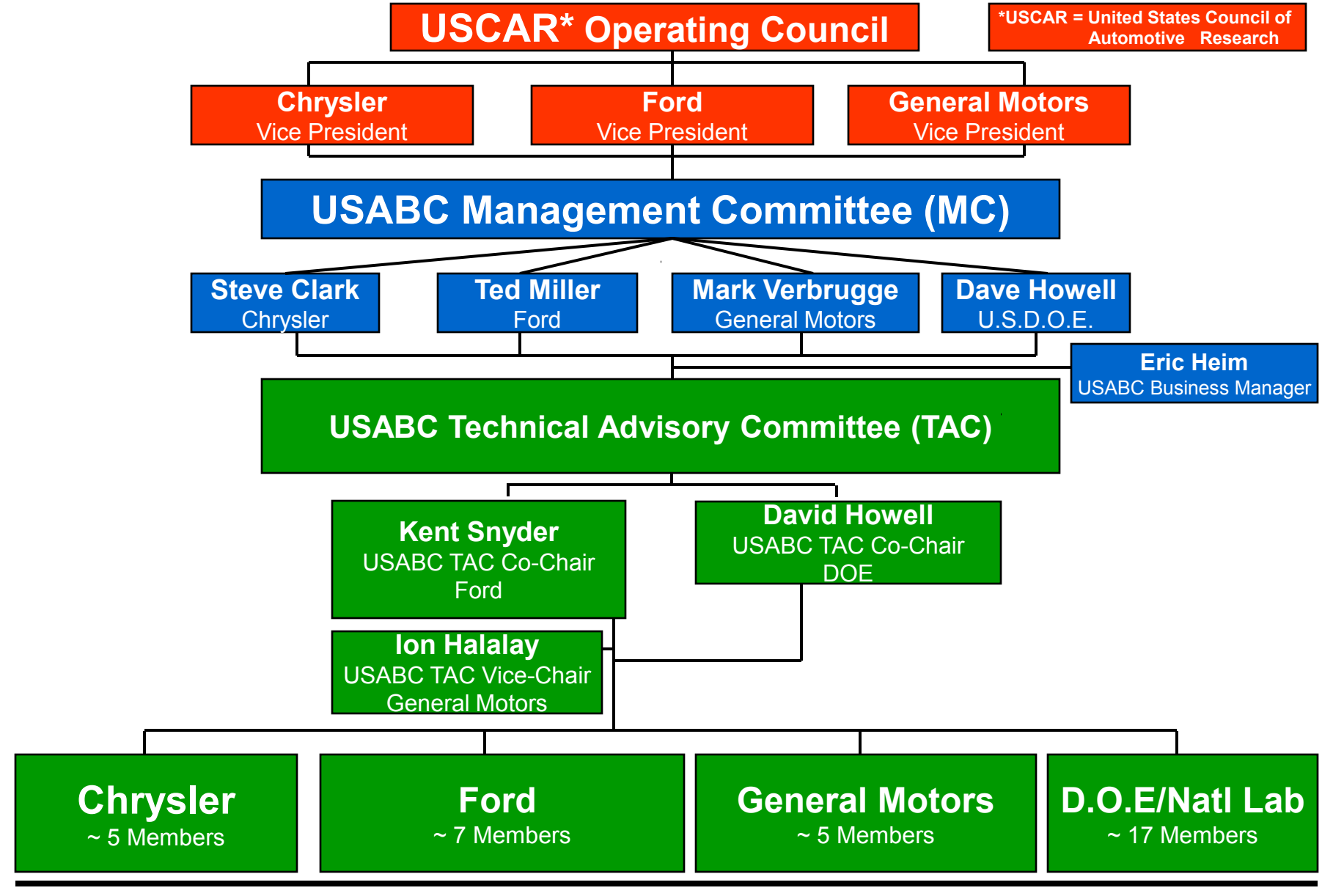
- **The United States Advanced Battery Consortium (USABC), comprised of Chrysler, Ford, and General Motors, funds pre-competitive electrochemical energy storage R&D**

- **Funding for development activity occurs through a cooperative agreement between USABC and DOE.**

- **This cooperation allows for the combined technical and financial resources of the DOE, OEM automakers, development partners, and U.S. National laboratories in jointly conducting advanced battery research and development.**

Overview

(organization)



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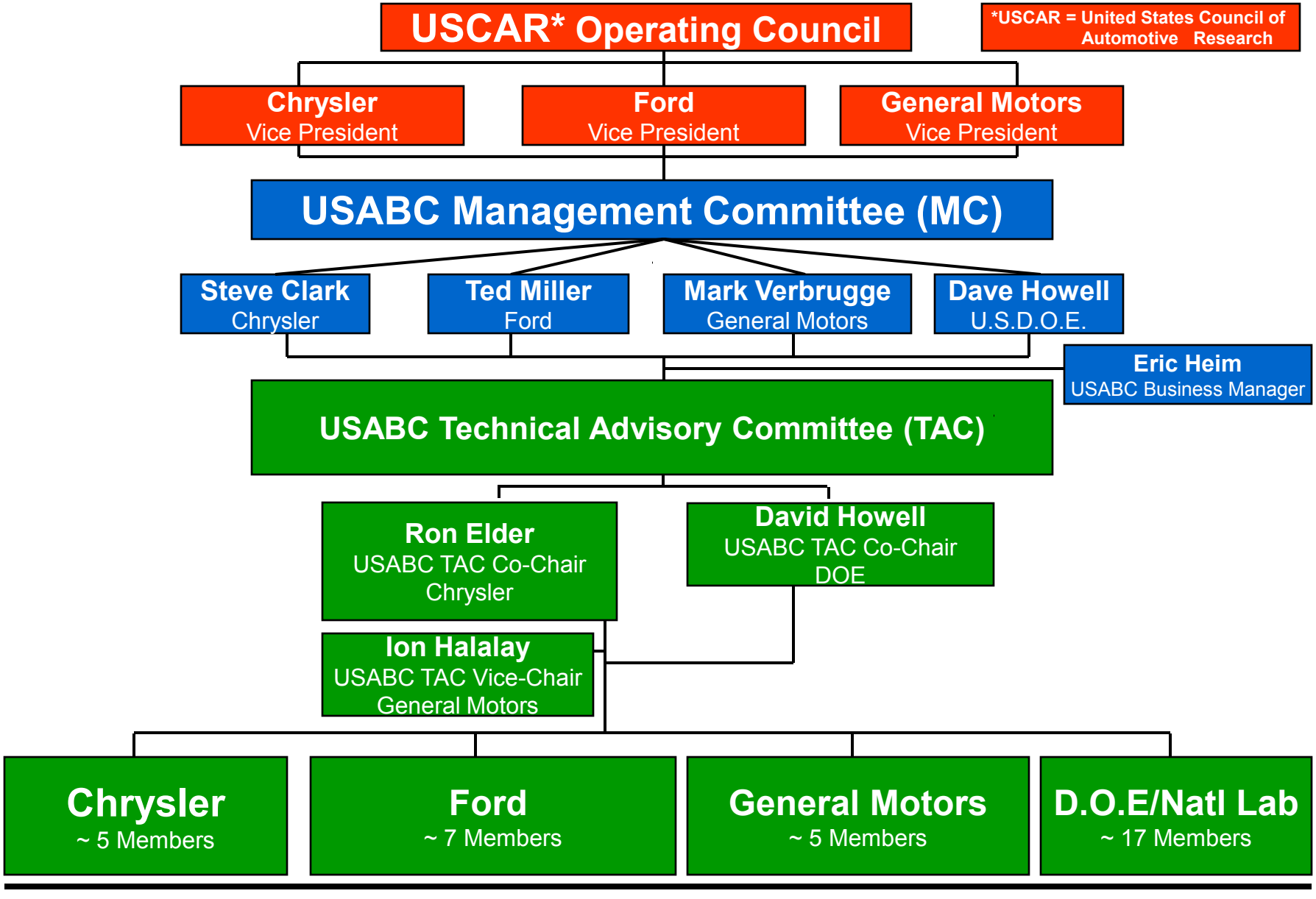

Collaborations

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

Automotive OEM's
Technical Expertise
Program Management
Test Method Development
Industry Experience & Input
Development Partner Assistance
Real World Requirement Perspective

COOPERATIVE GROUP EFFORT

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

DOE
Funding Coordination
National Lab Management
Governmental Perspective

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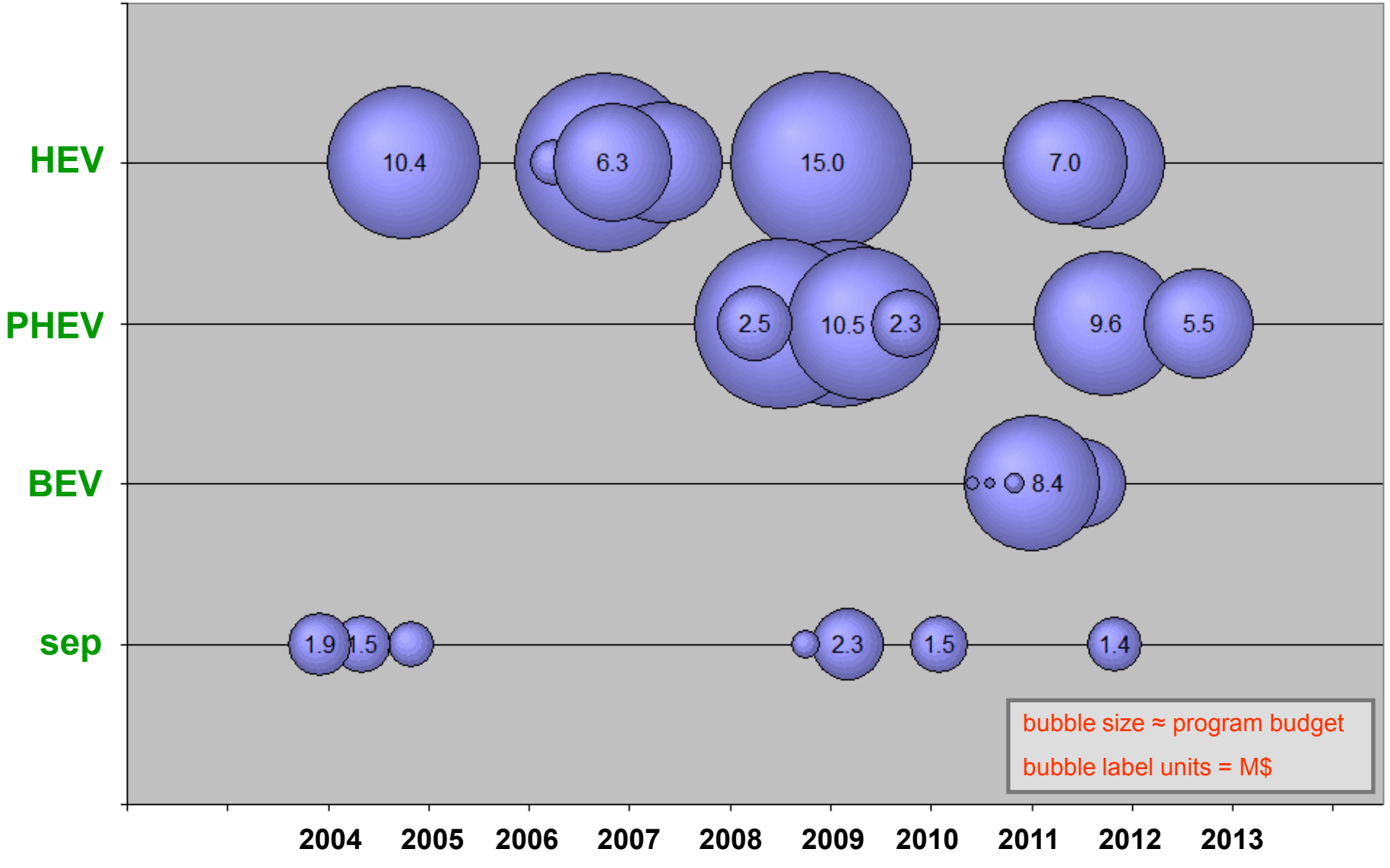
Overview

(Program Budget HIstory)



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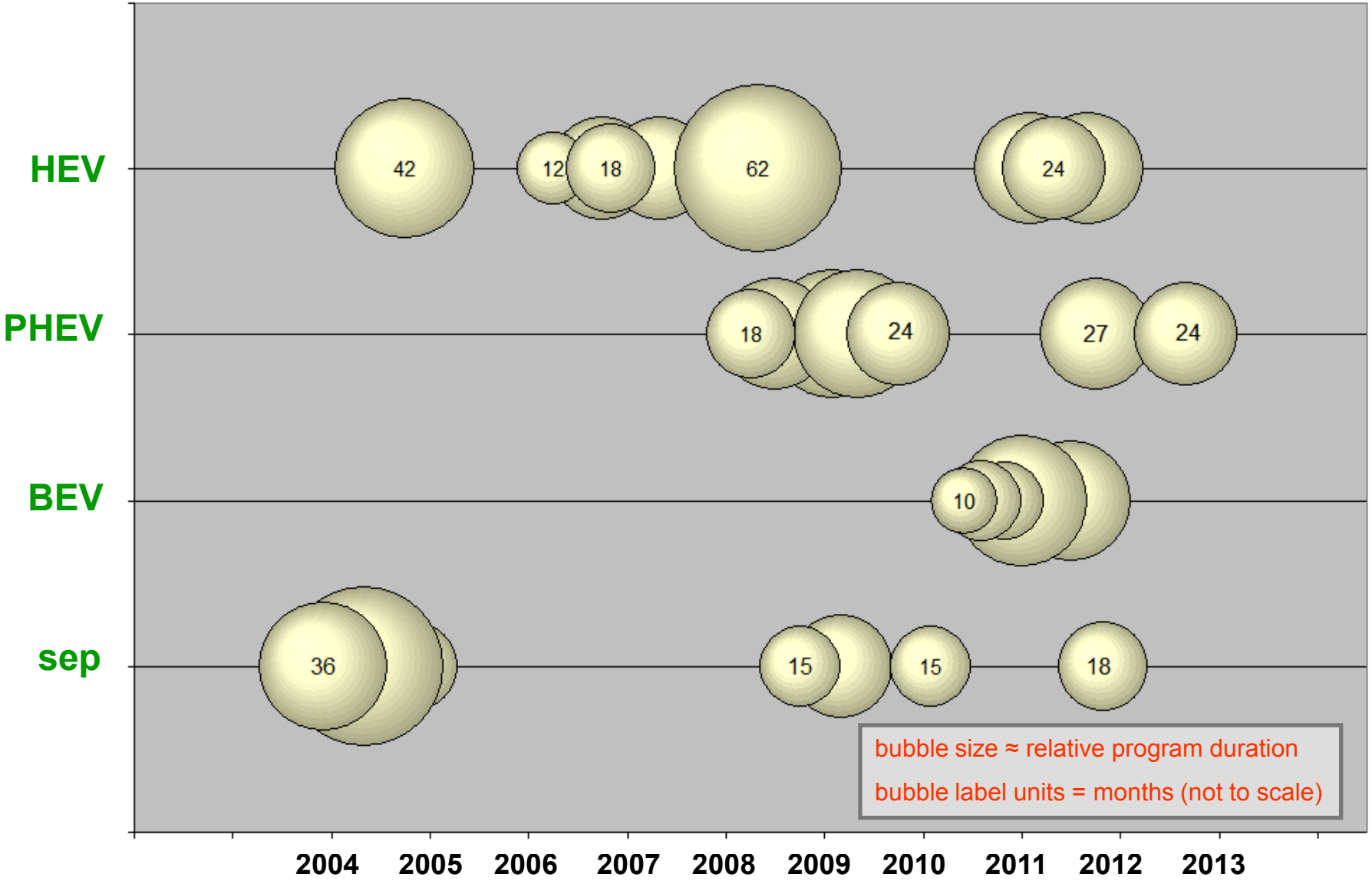
Overview

(Program Relative Duration History)



FY2011 Project

Initiate USABC Programs Towards 2010 RFPI Focus Areas and Begin New Requirements Development

Objectives:

- Initiate and manage new and follow-on programs targeting reduced cost via increased energy density in high-energy (PHEV & EV) systems, and reduced cost via lower total energy content in HEV systems
- Form workgroups and begin development of requirement sets for electrolytes and 12V stop-start applications, and revise existing EV goals

Key Focus Points In FY2011
Ongoing & New Program Examples

	App	Program Type	Increase Energy Density	Reduce Cost	Improve Calendar Life
Envia	EV	DEV	●	●	
Cobasys	EV	DEV	●	●	
Quallion	EV	DEV	●	●	
K2	EV	TAP	●	●	
SK	EV	TAP	●	●	
JCI	PHEV	DEV	●	●	●
A123	PHEV	DEV	●	●	●
LG-CPI	PHEV	DEV	●	●	●
Maxwell	LEESS	DEV	●	●	
A123	LEESS	DEV		●	
Actacell	LEESS	TAP			●
Entek	SEP	DEV		●	

TAP = Technology Assessment Program

DEV = Development Program

Approach *(HEV)*

For further HEV battery system cost reduction, projects initiated towards newly developed alternate HEV goals

- Reduce cost via total energy content reduction
- Maintain significant HEV power capability

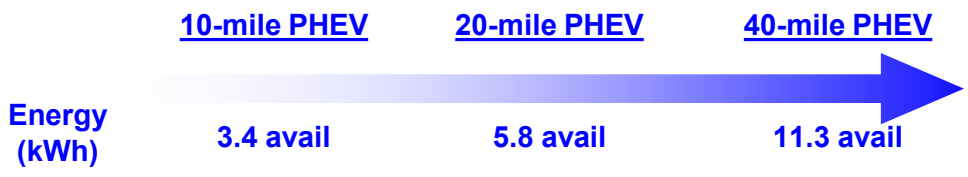
Low Energy - Energy Storage System (LEESS) Power Assist HEV Goals

End of Life Characteristics	Unit	PA (Lower Energy)	
2s / 10s Discharge Pulse Power	kW	55	20
2s / 10s Regen Pulse Power	kW	40	30
Discharge Requirement Energy	Wh	56	
Regen Requirement Energy	Wh	83	
Maximum current	A	300	
Energy over which both requirements are met	Wh	26	
Energy window for vehicle use	Wh	165	
Energy Efficiency	%	95	
Cycle-life	Cycles	300,000 (HEV)	
Cold-Cranking Power at -30ºC *(after 30 day stand @ 30 °C)*	kW	5	
Calendar Life	Years	15	
Maximum System Weight	kg	20	
Maximum System Volume	Liter	16	
Maximum Operating Voltage	Vdc	≤□□	
Minimum Operating Voltage	Vdc	³0.55 V_{max}	
Unassisted Operating Temperature Range	ºC	-30 to +52	
30 º -52º	%	100	
0º	%	50	
-10º	%	30	
-20º	%	15	
-30º	%	10	
Survival Temperature Range	ºC	-46 to +66	
Selling Price/System @ 100k/yr)	$	400	

Approach *(PHEV & EV)*

For further higher-energy battery system cost reduction on a $/kWh basis :

- projects initiated towards higher-mile-range PHEV goals and historical EV goals
- $ benefit of energy density increase maximized with higher energy content systems



USABC Requirements of End of Life Energy Storage Systems for PHEVs

Characteristics at EOL (End of Life)	units	High Power/Energy Ratio Battery	Moderate Energy/Power Ratio Battery	High Energy/Power Ratio Battery
Reference Equivalent Electric Range	miles	10	20	40
Peak Pulse Discharge Power - 2 Sec / 10 Sec	kW	50 / 45	45 / 37	46 / 38
Peak Regen Pulse Power (10 sec)	kW	30	25	25
Max. Current (10 sec pulse)	A	300	300	300
Available Energy for CD (Charge Depleting) Mode, 10 kW Rate	kWh	3.4	5.8	11.6
Available Energy for CS (Charge Sustaining) Mode	kWh	0.5	0.3	0.3
Minimum Round-trip Energy Efficiency (USABC HEV Cycle)	%	90	90	90
Cold cranking power at -30°C, 2 sec - 3 Pulses	kW	7	7	7
CD Life / Discharge Throughput	Cycles/MWh	5,000 / 17	5000 / 29	5,000 / 58
CS HEV Cycle Life, 50 Wh Profile	Cycles	300000	300000	300000
Calendar Life, 35°C	year	15	15	15
Maximum System Weight	kg	60	70	120
Maximum System Volume	Liter	40	46	80
Maximum Operating Voltage	Vdc	400	400	400
Minimum Operating Voltage	Vdc	>0.55 x Vmax	>0.55 x Vmax	>0.55 x Vmax
Maximum Self-discharge	Wh/day	50	50	50
System Recharge Rate at 30°C	kW	1.4 (120V/15A)	1.4 (120V/15A)	1.4 (120V/15A)
Unassisted Operating & Charging Temperature Range	°C	-30 to +52	-30 to +52	-30 to +52
30°-52°	%	100	100	100
0°	%	50	50	50
-10°	%	30	30	30
-20°	%	15	15	15
-30°	%	10	10	10
Survival Temperature Range	°C	-46 to +66	-46 to +66	-46 to +66
Maximum System Production Price @ 100k units/yr	$	$1,700	$2,200	$3,400

USABC Goals for Advanced Batteries for EVs

Parameter(Units) of fully burdened system	Minimum Goals for Long Term Commercialization	Long Term Goal
Power Density(W/L)	460	600
Specific Power – Discharge, 80% DOD/30 sec(W/kg)	300	400
Specific Power - Regen, 20% DOD/10 secW/kg	150	200
Energy Density - C/3 Discharge Rate(Wh/L)	230	300
Specific Energy - C/3 Discharge Rate(Wh/kg)	150	200
Specific Power/Specific Energy Ratio	2:1	2:1
Total Pack Size(kWh)	40	40
Life(Years)	10	10
Cycle Life - 80% DOD (Cycles)	1,000	1,000
Power & Capacity Degradation(% of rated spec)	20	20
Selling Price - 25,000 units @ 40 kWh($/kWh)	<150	100
Operating Environment(°C)	-40 to +50 20% Performance Loss (10% Desired)	-40 to +85
Normal Recharge Time	6 hours (4 hours Desired)	3 to 6 hours
High Rate Charge	20-70% SOC in <30 minutes @ 150W/kg (<20min @ 270W/kg Desired)	40-80% SOC in15 minutes
Continuous discharge in 1 hour - No Failure(% of rated energy capacity)	75	75

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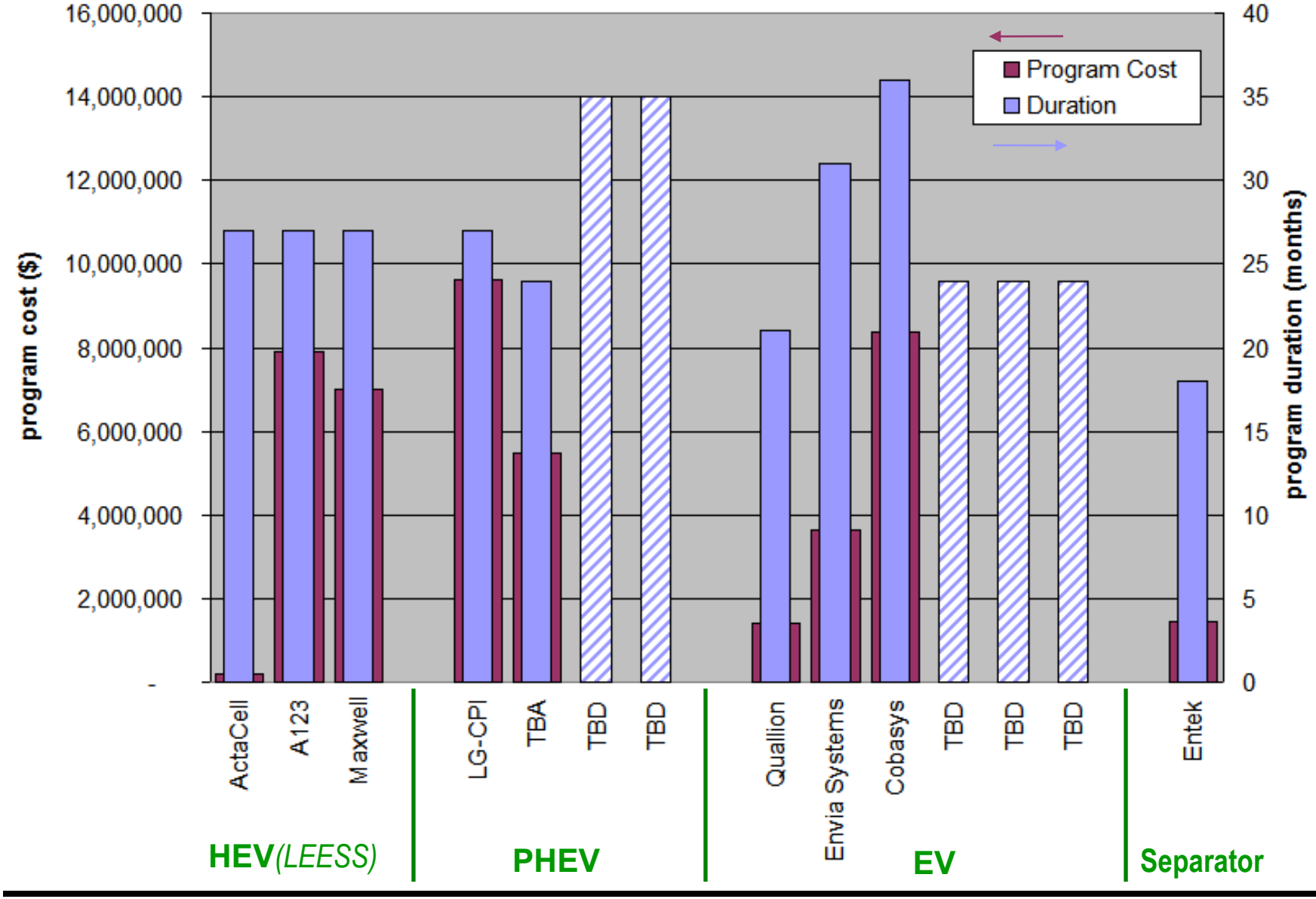
FY2011 Accomplishments

(*Program Negotiations & Initiations*)

Accomplishments

(Ongoing Programs in 2012 & Going Forward)



Accomplishments

(Electrolyte Goals Development Example)

Workshop Schedule

Focus on Key Topics
- High Voltage
- Low Cost
- Low Temperature

Breakout Session Format
- Allows all to contribute
- All will Discuss All Topics

Conversation Starters
- Draft Requirements
- Topic Specific Questions

Room Assignments
- Workshop – CR5
- Breakouts – CR1, CR2, CR3

Thursday, August 18, 2011	
9:00	Workshop Overview, Breakout Assignment
9:15	USABC Presentation (Masias)
9:45	BATT Presentation (Foure)
10:15	Break
10:30	ABR Presentation (Amine & Zhang)
11:00	ABR Presentation (Xu & Jow)
11:30	Lunch
12:30	High Voltage Breakout
1:30	High Voltage Joint Discussion
2:30	Break
2:45	Low Cost Breakout
3:45	Low Cost Joint Discussion
4:45	First Day Wrap-Up
Friday, August 19, 2011	
9:00	ABR Presentation (Smart)
9:30	Low Temperature Breakout
10:30	Low Temperature Joint Discussion
11:30	Wrap-Up Workshop Summary

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Accomplishments

(12V Stop-Start Goals Development Example)

12V Attribute/Characteristic	Units	Target
Discharge Pulse, 1s	kW	6
Max current, 1s	A	*800
Engine-off accessory load	kW	1.5
Cold cranking power at -30 °C (three 2-s pulses, 10 rests between)	kW	5
Min voltage under cold crank	Vdc	8
Available energy (@ 1.5 kW)	Wh	100
Recharge Rate	W	750
Cycle life miles/profiles (Engine starts)		150k/150k (450k)
Calendar Life	Years	15
Minimum round trip energy efficiency	%	95
Maximum allowable self-discharge rate	Wh/day	10
Maximum Operating Voltage	Vdc	14.6
Minimum Operating Voltage under load	Vdc	>10.5
Operating Temperature Range (available energy)	°C	-30 to + 52
30 °C - 52 °C	%	100
0 °C	%	50
-10 °C	%	30
-20 °C	%	15
-30 °C	%	10
Survival Temperature Range	°C	-46 to +66
Maximum System Weight	kg	10
Maximum System Volume	L	5
System Selling Price (@100k/year)	$	$180

Collaborations

- **Battery & Battery Material Development Partners !!!**
- Chrysler, Ford, GM
- DOE
- Idaho National Labs, Argonne National Labs, Sandia National Labs, National Renewable Energy Labs, Lawrence Berkely National Labs, Oak Ridge National Labs

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Future Work

- Finalize 12V Stop-Start requirements and develop and issue related RFPI for potential program initiations in 2013
- Finalize electrolyte requirements and develop and issue related RFPI for potential program initiations in 2013
- Finalize overhauled EV goals and requirements towards potential new future programs

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Summary

- Remaining down-selected programs from 2010 RFPI process contracted and initiated in 2011
- Key follow-on programs contracted and initiated in 2011
- Electrolyte workgroup and requirements development initiated
- 12V Stop-Start workgroup and requirements development initiated
- EV goals overhaul workgroup initiated