Boston-Power®

Delivering Advanced Lithium-ion Batteries for Electric Vehicles

August 5, 2010

Introducing Boston-Power

- Founded in 2005 to deliver world's safest and highest performance battery solutions
- Headquarters and R&D labs in Westborough, MA
- 6σ, 5S mass production in Asia
  - 10MWh/month today
  - expanding to 100MWh/month
- Serving portable power market leaders HP and Asus as well as portable medical electronics
- Several EV pilot programs; and powering the commercialization of Saab ZE 9-3 EV

Partnership with #1 notebook PC vendor - since 2008

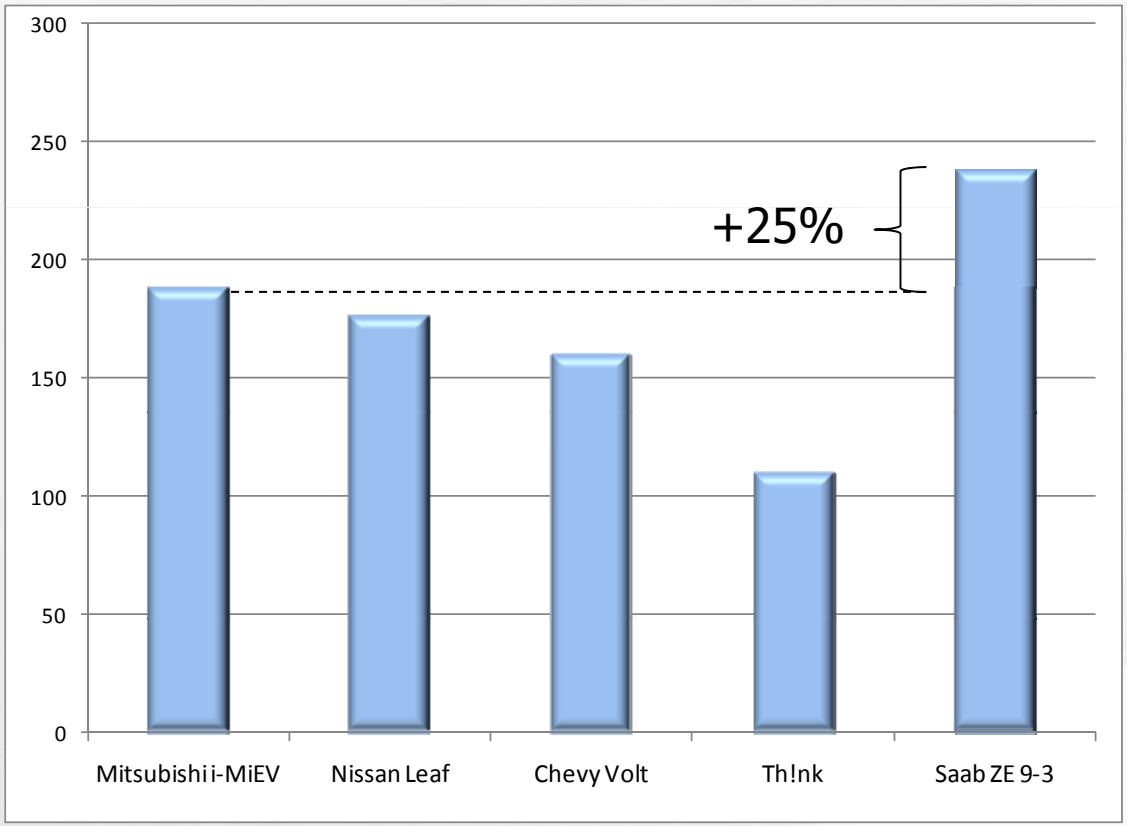
"Boston-Power Announces HP as First Customer ..." Dec 2008

- Boston-Power® Sonata® battery offers HP customers:
  - >3 years of "like new" battery runtime
  - Industry's first 3 year battery warranty
  - >40% improvement in TCO
  - >50% reduction in environmental impact
  - Zero field failures or returns

Boston-Power is the first and only non-Asian battery maker to win HP as a customer and first to be co-branded

Boston-Power battery delivers 25% more energy density for long driving range

Energy Density of Multiple EV Packs (Wh/L)



Cell Roadmap for 2012:

Swing® 5200 = +47%

Swing® 5600 = +56%

Significant market drivers for advanced energy storage fueling two revolutions

- Mobility revolution
  - Connect anywhere, anytime
  - Power within device
- Clean Tech revolution
  - Zero-emission transportation
  - Energy security
  - Grid efficiency

Opportunities in multiple markets for advanced Li-ion batteries

BEV/PHEV market reality today…

Tesla Roadster

Nissan Leaf

Chevy Volt

Th!nk City EV

Reva NXR

Coda EV

Smith Newton

Ford Transit Connect

…with significant growth planned

2011


Toyota Prius PHEV


Renault Fluence ZE


Citroen C-Zero


Renault Kangoo ZE


BMW Mini-e


ToBe


Fisker Karma


BYD F3DM


BYD E6


Tesla Model-S


Chrysler 200C


Detroit Electric E63


Detroit Electric E46

2012


Smart ForTwo


Renault Be Bop


Volvo PHEV


Ford Focus EV


Fiat 500


Luxgen MPV


Saab ZE 9-3


Toyota EV

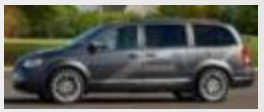
2013 & beyond


Bright Idea


BMW Active-e


Jeep Patriot


Jeep Liberty


Chrysler Town & Country


BMW Megacity

Economics from a TCO prospective will be critical to successful commercialization

ICE Energy Cost

Life yrs	Miles/Yr	Fuel Cost $/gal	Mileage mi/gal	$/mile	Simple Fuel Life Cycle Cost ($)
10	15,000	3	20	0.15	22500
10	15,000	6	30	0.20	30000
10	15,000	6.5	30	0.22	32500

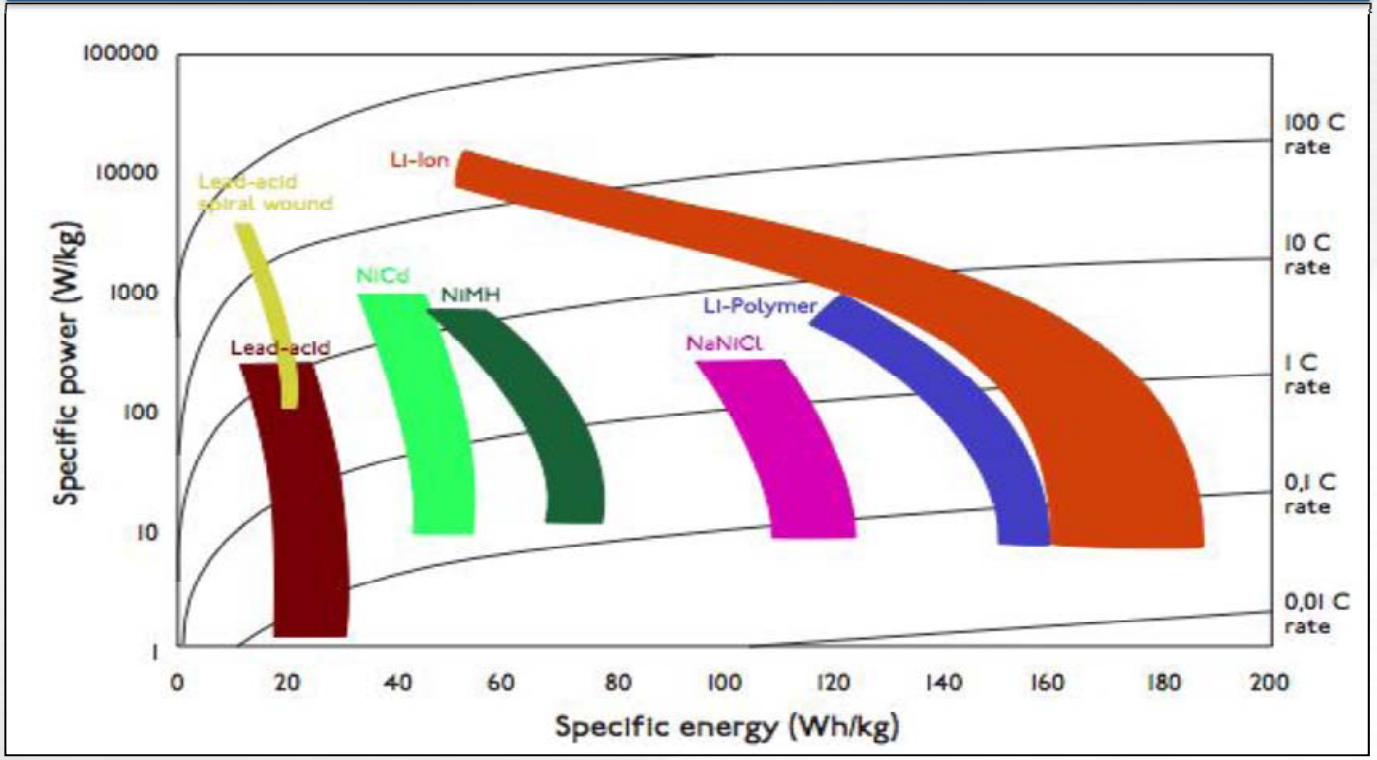
Electric Powertrain

Life yrs	Miles/Yr	Battery Size kWh	Battery Cost $/kWh	Electricity Cost $/kWh	Energy per mile (Wh/mile)	Simple CAPEX $/mile	Simple Energy Cost $/mile	Simple Life Cycle Cost ($)	with Residual Value
10	15000	50	300	0.01	300	0.10	0.003	15450	11950
10	15000	50	500	0.01	300	0.17	0.003	25450	21950
10	15000	50	700	0.01	300	0.23	0.003	35450	31950
10	15000	50	1000	0.01	300	0.33	0.003	50450	46950

- Change from distributed energy cost driven by the price of fuel to a capital intensive storage tank with low energy cost
- Government policy (price of fuel) will play a critical role

Battery technology has evolved to meet the needs of electric vehicles

Li-ion leads in energy density for BEV/PHEV due to best driving range



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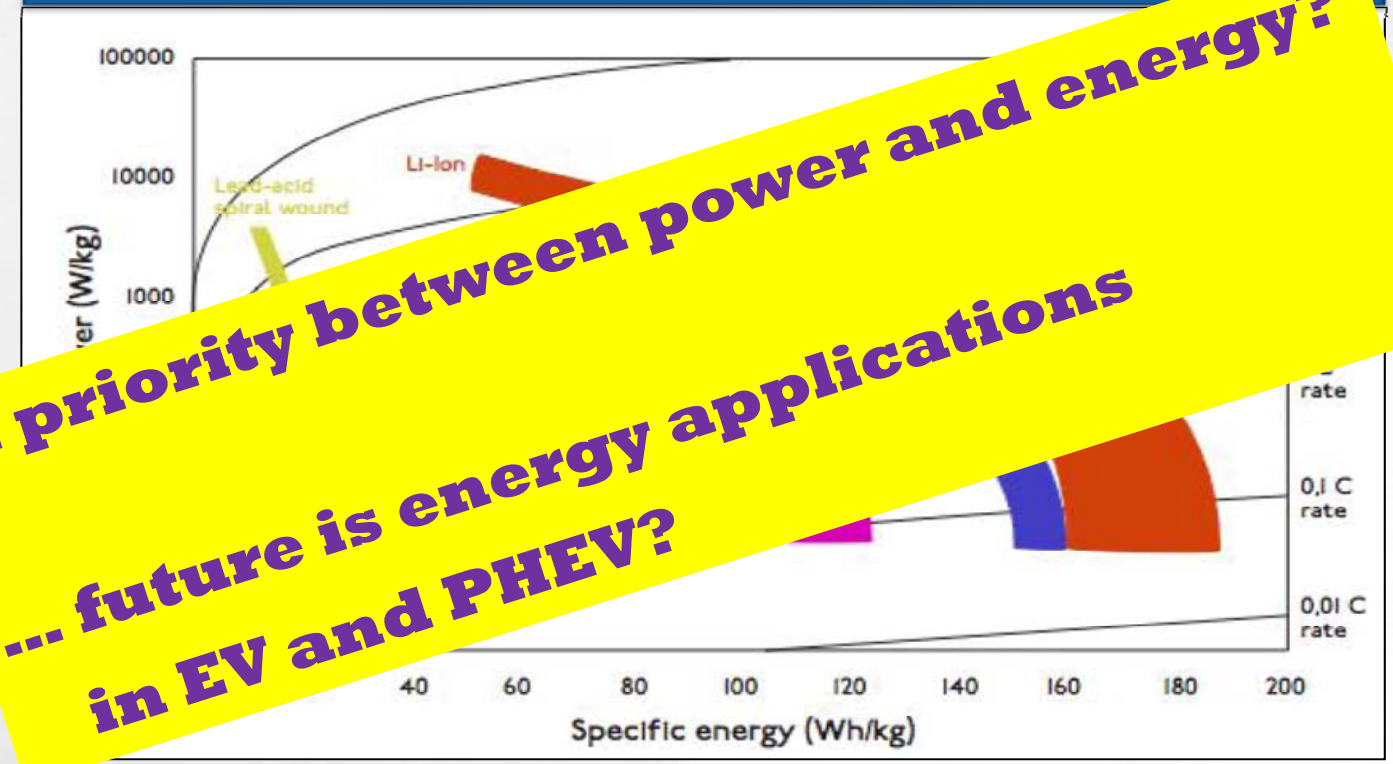


... priority between power and energy?

... future is energy applications in EV and PHEV?

Most electrified vehicles strive for less weight and volume and need energy batteries

Energy ⟵ ⟶ **Power**

	LCV	BEV	NEV	LEV	PHEV	E-Bus	HE-Bus	HEV
Wh/Kg	★ ★ ★	★ ★ ★	★ ★	★ ★	★ ★ ★	★ ★ ★	★	★
Wh/L	★ ★	★ ★ ★	★ ★ ★	★ ★ ★	★ ★ ★	★ ★	★	★ ★
W/Kg	★	★	★	★	★	★	★ ★	★ ★ ★
Battery Cap (kWh)	> 40	> 20	2~6	0.5~2	4~18	> 150	> 15	1~2
Battery Space (L)	>170	100	30~60	<5	40~80	>400		20~40
Nominal Voltage (V)	288	290-350	144	48	288	>400	>400	200
Motor	60kW	80kW	<20kW	1~3kW	45kW	120kW		50kW

Market is confused as power batteries are sometimes "force-fitted" into energy applications

- Most EV and PHEV have 1 hour or more electric drive time
- High power pulses are typically very short <1-2 minutes
  - Most high power pulses are delivered for 30s or less
  - These higher power pulses can be sustained by an energy battery
- Charging is mainly limited by the power of charging stations and very rarely <1 hour
- Power batteries used in energy situations will not be competitive
  - Weight diff. of 130kg for a 30 kWh battery comparing power (100Wh/kg) and energy (180Wh/kg) cells
  - Cost (balance-of-plant)

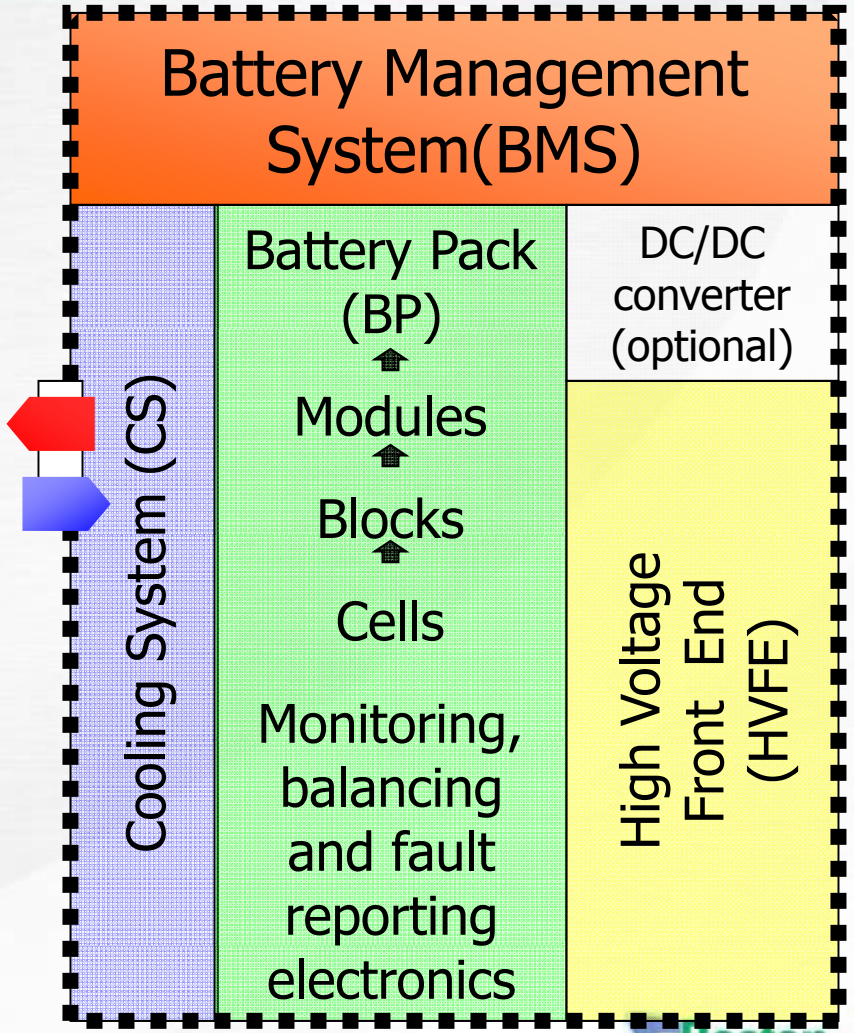
	HEV	PHEV	EV	LCV	EBUS
Typical Battery (kWh)	1-2	15-25	20-60	40-120	200
Electric Drive Time	1-10 min.	1 h	2-4h	2-4h	2-4h
Avg. C-rate	10C	1C	0.5-0.25C	0.5-0.25C	0.5-0.25C
Max Pulse C-rate	30C	5-6C	5-6C	5-6C	5-6C

How will supply chain prioritize between energy (EV) or power (HEV) batteries?

- A large Lithium-ion manufacturing facility can deliver about 1000 MWh of battery per year
  - Equals about 33,000 EVs (if 30kWh battery)
  - Or 1,000,000 HEVs (if 1kWh battery)
- Li-ion suppliers will need very big volumes to deliver value to a plant for HEVs, while relatively small EV volumes are needed to fill a plant
- A few EV fleets, stimulated by government, can kick-start Li-ion production

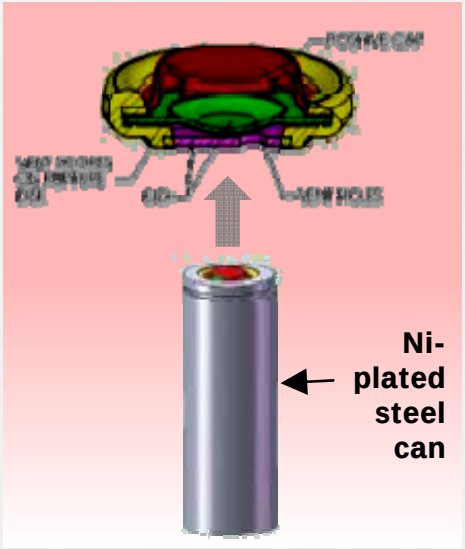
Electronics are an integral part of the battery design and management

- Battery management is critical to:
  - Calendar life
  - Fuel gauging and ease of integration
  - Safety and reliability
- Complexity of the electronics increases with battery size, but key requirements remain:
  - Charge and discharge controls
  - Monitoring voltages and temperatures



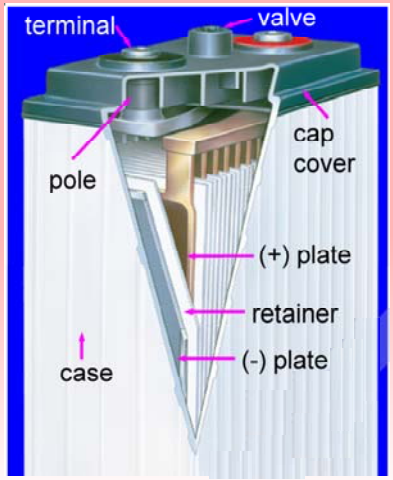
…and differ greatly across form factors

Cylindrical



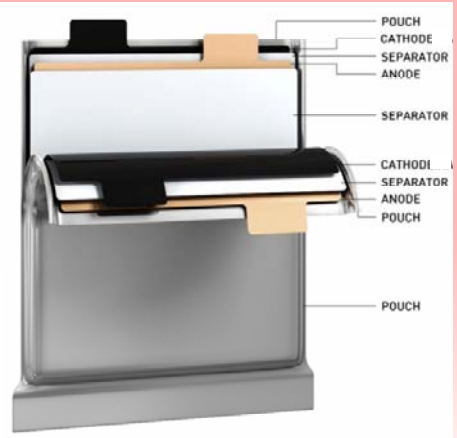
- Crimp sealed cap
- Nickel plated steel cans
- CID in lid
- Vents in lid
- All safety features in lid

Prismatic



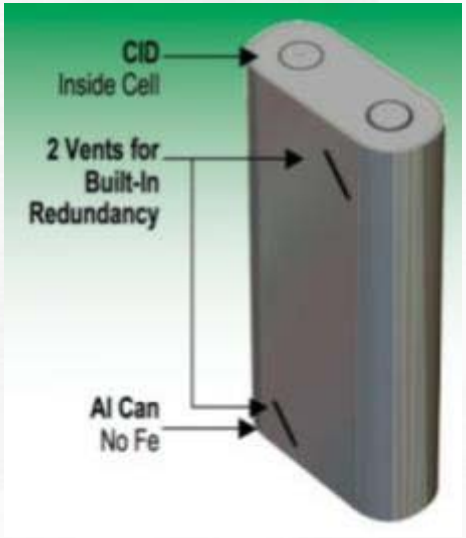
- Plastic or steel housing
- No CID
- Vent in lid
- Many internal connections
- Poor thermal dissipation

Polymer



- Soft packaging requires mechanical support
- Leakage risk
- Ballooning upon overcharge
- CID not possible
- Risk of "Dry out" due to uneven stack pressure
- Clean room assembly at the module level

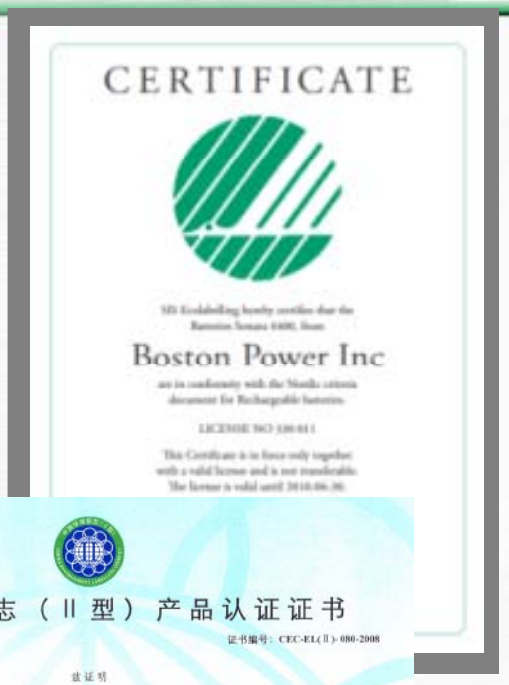
Advanced Li-ion



- Laser welded lid
- Aluminum can
- CID
- Vents on side of can

Consumers want environmentally sustainable solutions

- Green cars require green batteries!
- Rechargeable batteries provide efficient use of materials and energy – but more can be done
- Longer product life important – fewer batteries produced, purchased and consumed
- Achieving environmental accreditation is important
  - Nordic Ecolabel recognized as most stringent environmental certification
  - Also accredited by CEC in China


CERTIFICATE

Boston Power Inc


中国环境标志（II型）产品认证证书

BOSTON-POWER INC

自我环境声明符合 GB/T24021—2001 idt ISO14021: 1999
《环境管理 环境标志与声明 自我环境声明（II型环境标志）》的要求

Closing thoughts

- Energy batteries is the solution for range anxiety
  - Energy battery to be selected for driving range for more 1h vs
  - Power battery to be selected for 10-30 minutes
- Safety and high performance is a direct result of quality systems in manufacturing processes and battery design
- Embrace the track record and mass-production experience of the Li-ion industry from 20 years of portable power

Thank you!

Christina Lampe-Onnerud

Founder and CEO

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