GREEN FLEET Conference2010

DRIVING ECO-FRIENDLY & AFFORDABLE FLEETS

Chris Pick

Manager, Global Electrification Business Strategy

Ford Motor Company

Vehicle Electrification Technologies and Industry Approaches

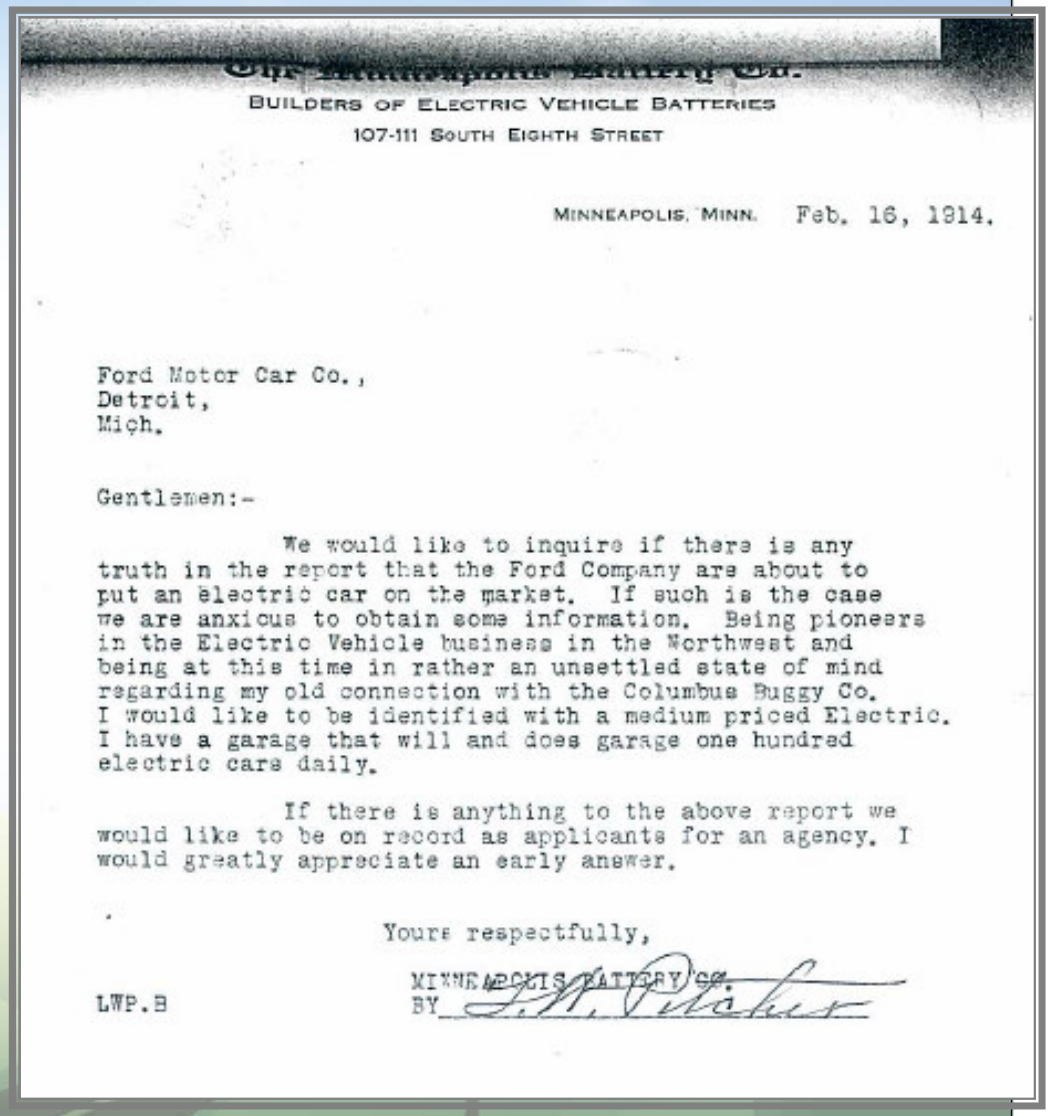
Agenda

- Drivers for Electrification and Technology Background
- Industry Volume and Mix Projections
- Infrastructure Development
- Opportunities and Challenges

Drivers for Electrification and Technology Background

Electrification of Vehicles: 100-year-old vision…

- In the early 1900's more than 27 companies were building electric cars, ~1/3 of the cars on the road were electric
- In 1912, an electric roadster sold for $1,750, while a gasoline car sold for $650.
- In 1914, Henry Ford and Thomas Edison experimented with an electric car using Edison Batteries
- In 1915 the Ward Motor Vehicle Company offered an electric wagon for $875 on an one-year installment plan for the vehicle and a $10.50 month rental fee for the Edison Storage battery



The Minneapolis Battery Co.
BUILDERS OF ELECTRIC VEHICLE BATTERIES
107-111 SOUTH EIGHTH STREET

MINNEAPOLIS, MINN. Feb. 16, 1914.

Ford Motor Car Co.,
Detroit,
Mich.

Gentlemen:-

We would like to inquire if there is any truth in the report that the Ford Company are about to put an electric car on the market. If such is the case we are anxious to obtain some information. Being pioneers in the Electric Vehicle business in the Northwest and being at this time in rather an unsettled state of mind regarding my old connection with the Columbus Buggy Co. I would like to be identified with a medium priced Electric. I have a garage that will and does garage one hundred electric cars daily.

If there is anything to the above report we would like to be on record as applicants for an agency. I would greatly appreciate an early answer.

Yours respectfully,

MINNEAPOLIS BATTERY CO.
BY L. W. Pitcher

LWP.B

Sustainability Strategy - Electrification

2007 — 2011 — 2020 — 2030

Near Term
Begin migration to advanced technology

Mid Term
Full implementation of known technology

Long Term
Continue leverage of hybrid technologies and deployment of alternative energy sources

Near Term

- Significant number of vehicles with EcoBoost engines
- Electric power steering – begin global migration
- Dual clutch and 6 speed transmissions replace 4 & 5 speeds
- Flex Fuel Vehicles
- Add Hybrid applications
- Increased unibody applications
- Introduction of additional small vehicles
- Battery management systems – begin global migration
- Aero improvements
- Stop/Start systems (micro hybrids) introduced
- CNG/LPG Prep Engines available where select markets demand

Mid Term

- EcoBoost engines available in nearly all vehicles
- Electric power steering - High volume
- Six speed transmissions - High volume
- Weight reduction of 250 – 750 lbs
- Engine displacement reduction aligned with weight save
- Additional Aero improvements
- Increased use of Hybrid Technologies
- Introduction of PHEV and BEV
- Vehicle capability to fully leverage available renewable fuels*
- Diesel use as market demands
- Increased application of Stop/Start

Long Term

- Percentage of Internal combustion engines dependent on renewable fuels
- Volume expansion of Hybrid technologies
- Continued leverage of PHEV, BEV
- Introduction of fuel cell vehicles
- Clean electric / hydrogen fuels
- Continued weight reduction actions via advanced materials

Electrification Technologies – Background

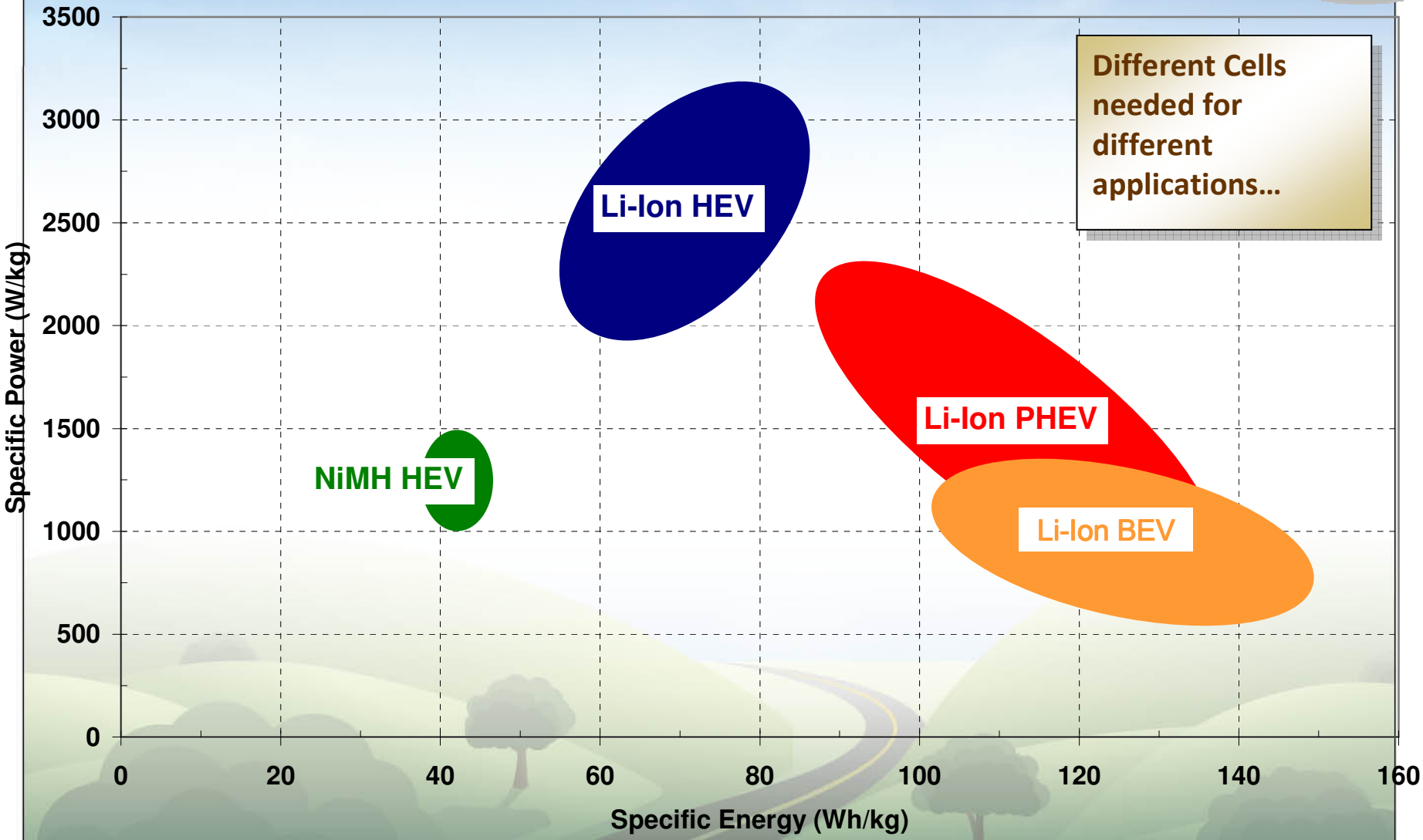
Function / System	Engine stop/start	Engine Assist (Downsize)	Regenerative Brake	Electric launch	All Electric Drive	Fuel Economy Improvement
Micro-hybrid (14V)	YES (> 0.3 sec)	Minimal (< 3 kW)	Minimal (< 3 kW)	NO	NO	3-6%
Mild Hybrid (42V)	YES	Modest (< 9 kW)	Modest (< 9 kW)	NO	NO	8%/12%
Medium Hybrid (100+V)	YES	YES	YES (full benefit)	NO	NO	40%
Full Hybrid (300V)	YES	YES	YES	YES	Yes	55%+
Plug In Hybrid (based on Blended Full)	YES	YES	YES	YES	Yes	80%+
Battery Electric Vehicle	YES	No Engine	YES	YES	YES	Infinite

Blended PHEV Hardware Commonality with HEV

Component	*HEV*	*PHEV*	
High Voltage Battery			Power vs. Energy
Traction Motor			Same
Generator			Same
Inverter(s)			Same
Electric AC			Same
DC/DC Converter			Same
Regen Brakes Hardware			Same
Transmission			Same
Engine			Same
Charger & Wiring			New
Electric Pumps/Cooling Circuits			Modified transaxle oil lubrication/cooling circuit

- Significant Re-use of HEV hardware to leverage scale

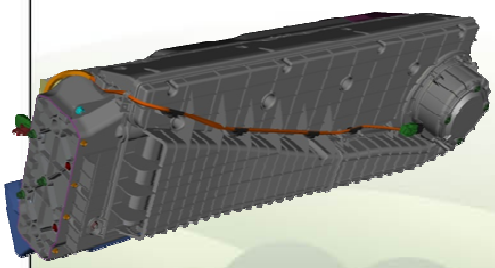
Battery Remains Key



Different Cells needed for different applications…

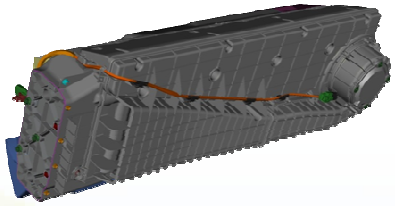
Necessary Battery Technology Evolution

EV Battery
- 23 kWh
- 225 kg
- 125 liters



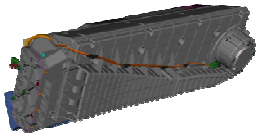
1st Gen

EV Battery
- 23 kWh
- 180 kg
- 100 liters



2nd Gen

EV Battery
- 23 kWh
- 110 kg
- 75 liters



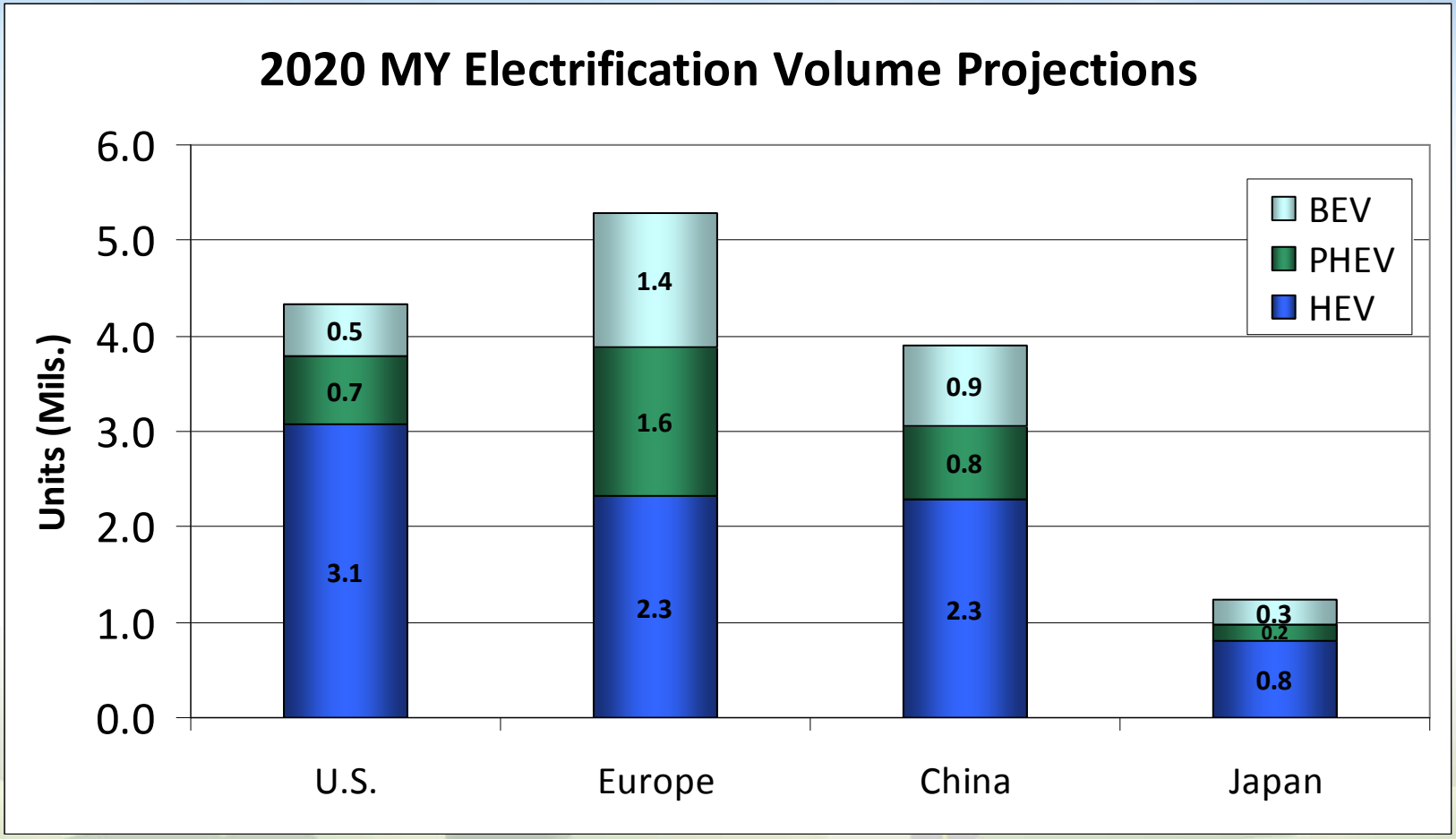
Future

Goal

Fuel Tank eq.
- 23 kWh
- 55 kg
- 60 liters

Industry Volume and Mix Projections

2020MY Global Electrification Volumes by Region



Note: Volume projections are based on forecast data from the following 3rd party studies:
- Roland Berger - Powertrain 2020: China's ambition to become market leader in E-Vehicles (April, 2009)
- Boston Consulting Group - The Comeback of the Electric Car? How Real, How Soon, and What Must Happen Next (December, 2008)
- J.P. Morgan - Global Environmental Series Volume 3 - HEVs Potential Reconsidered in Economic Crisis (May, 2009)
- A.T. Kearney - Retooling the Vehicle for 2020: How Advanced Technologies Will Radically Restructure the Automobile & Automobile Industry (March, 2010)
- Credit Suisse - Electric Vehicles - Global Equity Research (October, 2009)

Ford Announced Electrification Projects

2004 CY | 2010 CY | 2012 CY | 2018+ CY

BEV
Battery Electric Vehicles

- Transit Connect Electric (Global C-Platform)
- Focus Electric (Global C-Platform)

PHEV
Plug-in Hybrid Electric Vehicles

- New PHEV (Global C-Platform)

HEV
Hybrid Electric Vehicles

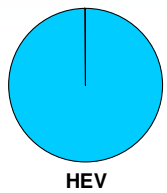
- Escape → Next Generation HEV (Global C-Platform)
- Fusion/Milan → Next Generation HEV (CD-Platform)

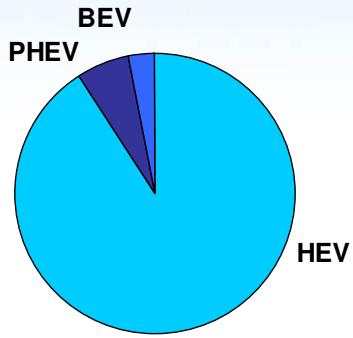
Ford Global Electrification Product Plan

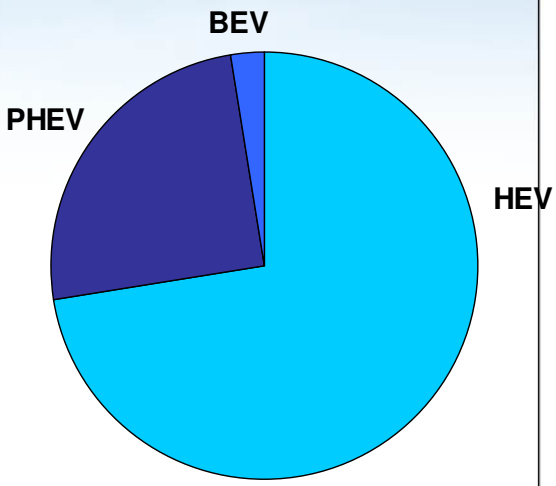
Ford Global Volume

% of total Ford volume

2010 CY	2015 CY	2020
1%	2-5%	10-25%



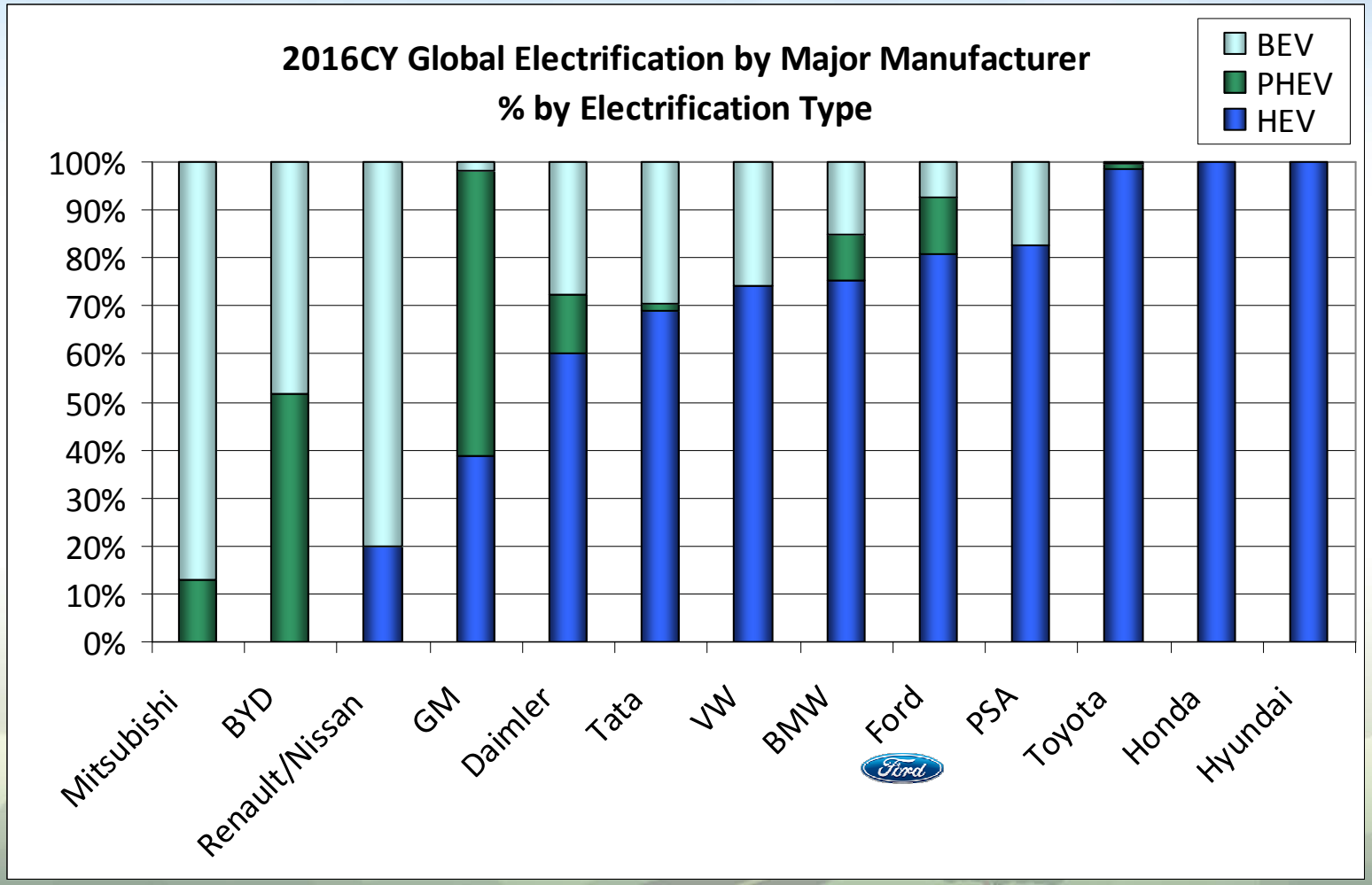




- Balanced Portfolio
- Global Flexibility
- Volume will be predominantly HEV
- Plug-ins gaining acceptance

Balanced growth also provides flexibility to react to volatile external factors

2016MY Global Electrification Volume Projections by Manufacturer (>40K)



Note:
- All data is from CSM Worldwide global comprehensive vehicle production and sales forecasts, 6/06/10.
- Major manufacturers are those with >40,000 electrified vehicle sales projected in 2016

Infrastructure Development

Infrastructure: Realizing the Power of Plugging-In

Charging Customer Segments

Priority

Most Frequent

Less Frequent

Charge at Home

Main charge spot located in garage or driveway of residence.

Charge at Depot

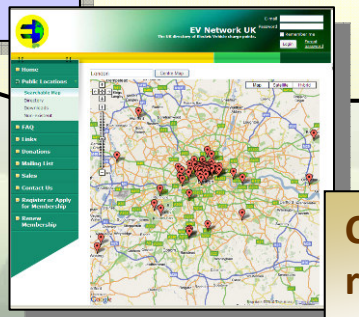
For fleets customers, main charge location is fleet depot where multiple chargers could be installed.

Charge at Work

Main charge location is work – allowing urban commuters/street parkers to have reliable charge. Also allows extended range for home chargers.

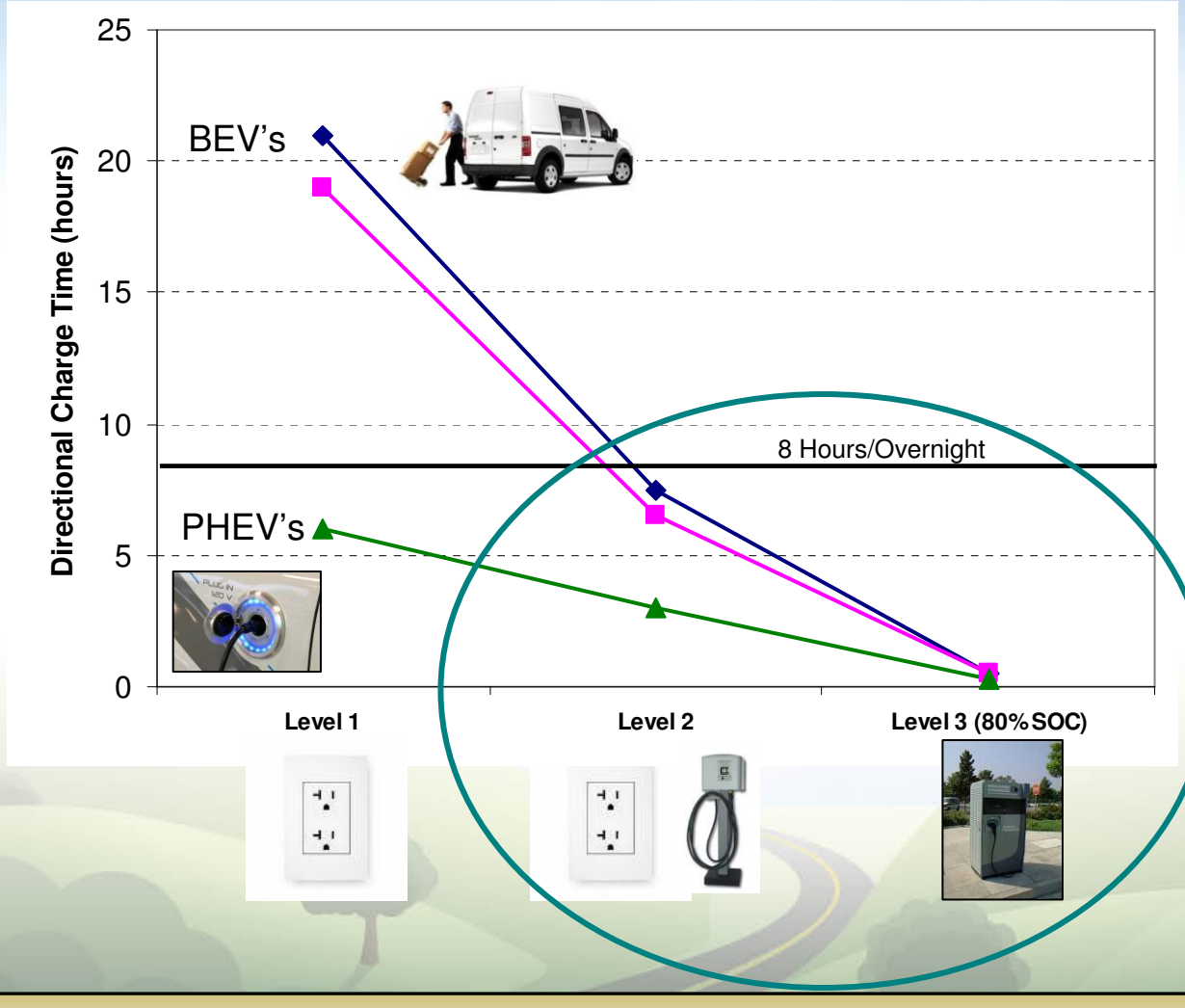
Charge at Public Space

For occasional trips, municipal charge locations could be viable option. If reservation system is implemented, could be used for main charge location.



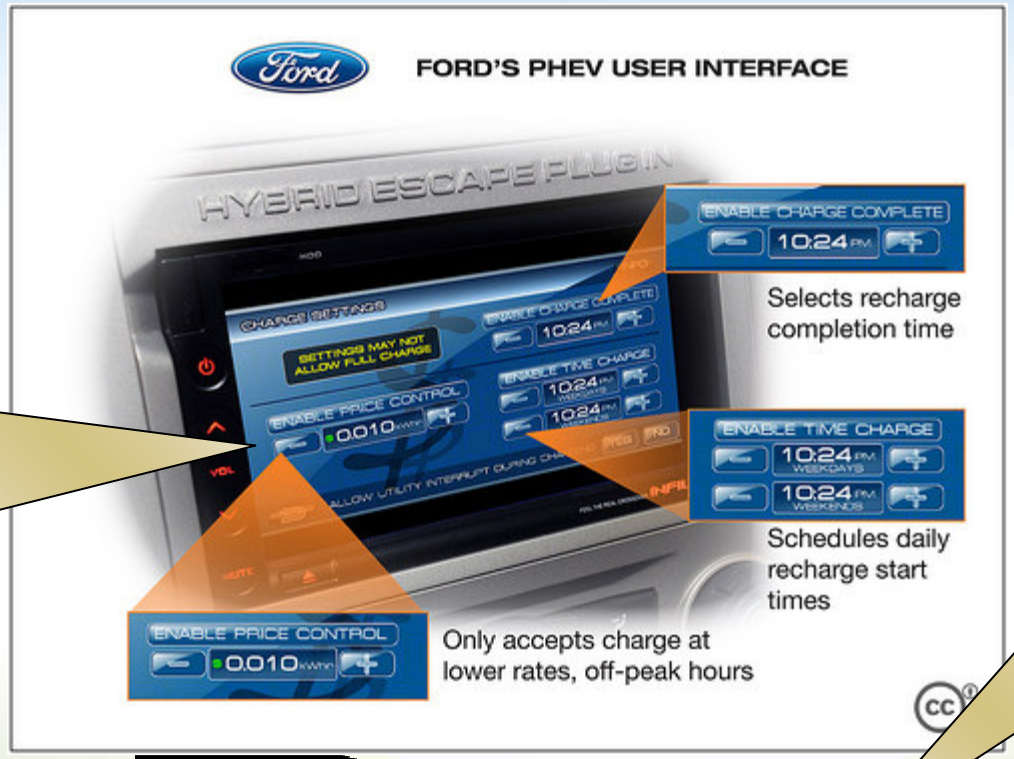
Charging Infrastructure is a key enabler to Plug-in Vehicles – regardless of where consumers end up charging their vehicles

Plug-In Vehicle Charging Options



Target overnight charging (less than 8 hours) - base assumption that Level 2 installation will be required for BEV's, and optional for PHEV

Driver-Vehicle Interaction – Improved Efficiency



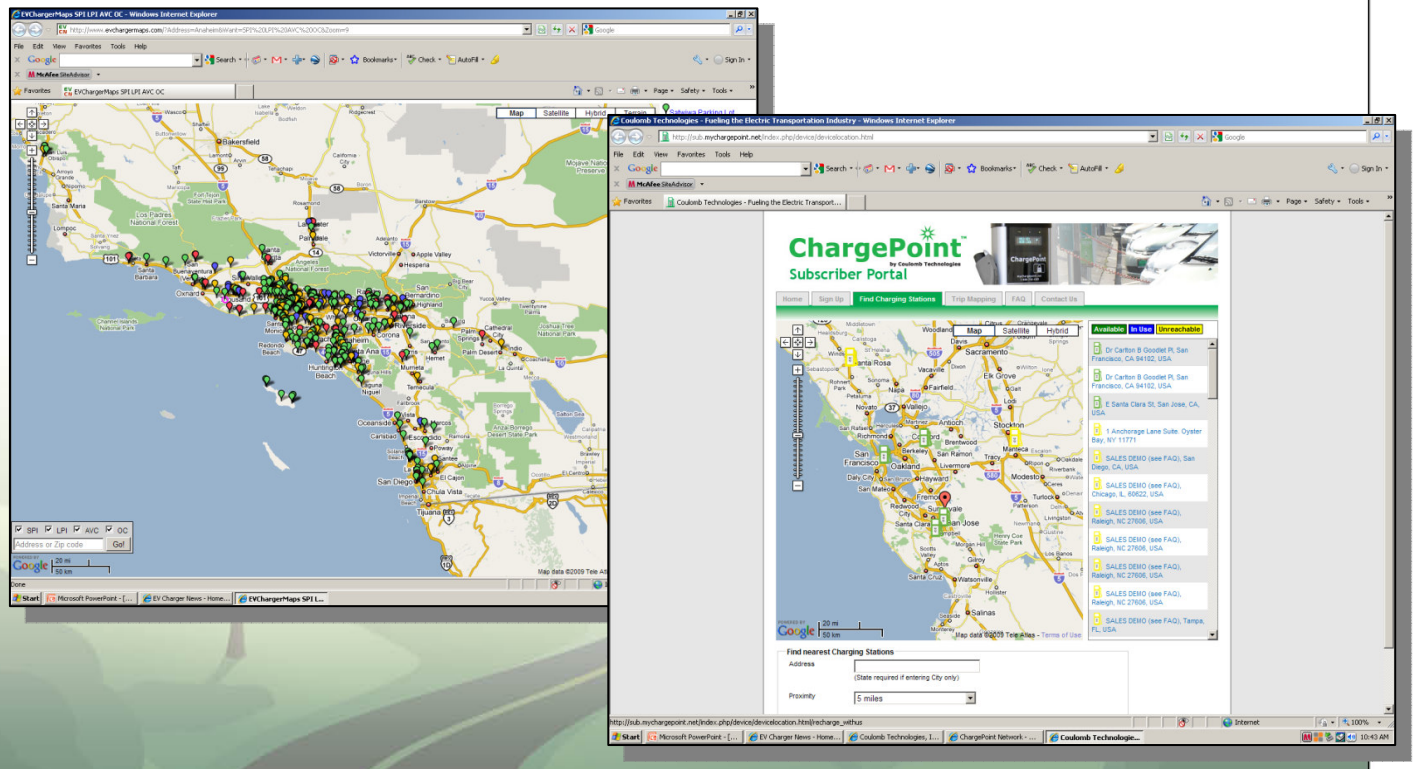
New Knowledge and Skills Needed: Customer and Engineer

New concepts required for Plug-In vehicles

Market Readiness

- Current plug-in owners on average charge at least two times per day[1]
- Charge point availability is cited as the key adoption barrier to electric vehicles[2]
- In an experiment, adding fast chargers at strategic city points increased electric fleet vehicle use – charge point usage did not increase but lessoned range anxiety[3]
- Based on announcements, current public and private Level 2 infrastructure installation rates will not keep pace with plug-in sales.

1,500 public chargers currently tracked in U.S. on www.evchargermaps.com and www.mychargepoint.net



Much to Learn! Customer Behavior and what is really valued…

[1] Reference UC-Davis Market Survey
[2] Reference EPRI Focus Group Findings May 2009
[3] Reference Tokyo Electric Power Company (TEPCO) experiment

Opportunities and Challenges

Opportunities & Challenges:

=

Significant New Load

Ford + Microsoft

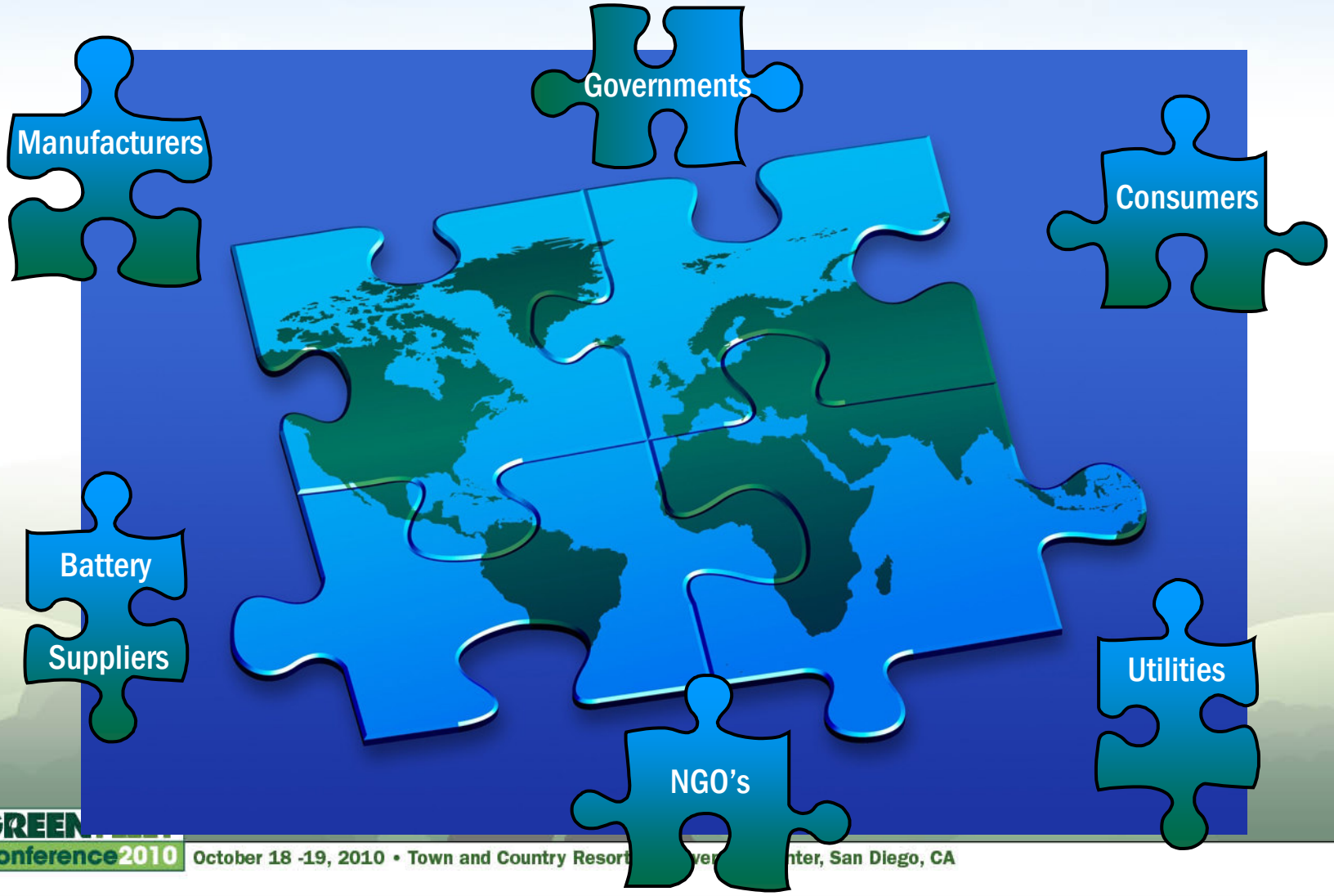
Information + Feedback → Change

Clustering

Communication with Utilities

Integrated Approach With Shared Responsibility

The development of a sustainable electrified market will be dependent on close cooperation between many key stakeholders




Ford