Electric Vehicles: Market Opportunities and New Business Models for Industry Stakeholders

13tf Sept 2010
Agenda

360 Degree Vision of the Global Electric Vehicle Industry

- New Personal Mobility Business Models
- Electric Vehicles Market Overview, Technology Roadmap and Infrastructure Trends
- Global EV Market Size and Forecasts – PVs, LCVs and 2 Wheelers
- Business Model Analysis of Key Industry Stakeholders
- Opportunities in Electric Vehicles Market, Q&A
New Mobility Mode - Car Sharing: Over 9 mn members of Car Sharing schemes forecasted by 2015 in Europe and North America

<table>
<thead>
<tr>
<th>Car Sharing/Pooling models</th>
<th>Car Pooling or Ride Sharing</th>
<th>Car Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mutual Agreement</td>
<td>For Profit</td>
</tr>
<tr>
<td></td>
<td>Internet Based</td>
<td>Not For Profit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co-operative</td>
</tr>
</tbody>
</table>

- **Vehicle Segments**: Generally A, B and C
- **Engine Type**: Traditional Gasoline or Diesel. Alternative propulsion still niche but growing
- **Transmission Type**: Manual Transmission
- **Membership**: Mandatory
- **Travel Distance**: Usually Shorter Commutes
- **Booking System**: Telephone, Internet Based or Community Forums
- **Technology Adopted** (Vehicle access): Smart Card and Card Reader

**Car Sharing Allocation**

- **For Profit**
- **Not For Profit**
- **Co-operative**

**New Mobility Mode - Car Sharing**: Over 9 mn members of Car Sharing schemes forecasted by 2015 in Europe and North America.
State of NA Carsharing: Around 88% of NA Carsharing Members are in the United States across 26 Carsharing Programs

2016 Potential

- More than $3.3 billion in revenues
- More than 4.4 million members
- More than 72,000 vehicles in carsharing

U.S.

- 453,700
- 12.2%
- 2009

Canada

- 10,194
- 19.6%
- 2009

Potential

- More than $3.3 billion in revenues
- More than 4.4 million members
- More than 72,000 vehicles in carsharing
Case Study: Mu by Peugeot – Integrated Mobility On-demand Solutions Under One Roof

Market for Carsharing: Mu by Peugeot – Overview and Business Model (Europe), 2009

Working Concept

1. Create an account to use this scheme
2. Pay subscription charges to get charging units
3. Hire services or products based on balance in charging units
4. Earn mobility (reward) points that can be used for select services

Generate income from the stock of vehicles sitting at dealerships
Decrease spending by using the same infrastructure and staff

- Partnering with travel agencies, driving schools amongst others.
- Booking services on train, airplane travel and hotels.
- Discounts, prizes and member advantages.
- Micro-mobility solutions such as bicycles and scooters.
- Rental cars and vans.
- Vehicle accessories such as roof-boxes, cycle racks and child seats.

Current Points of Sale
- Brest: 2
- Nantes: 7
- Rennes: 4
- Lyon: 4
- Paris: 5

Expected to be expanded in key EU cities in 2010-2011

Source: Frost & Sullivan
Electric Vehicles Market Overview, Technology Roadmap and Infrastructure Trends
Electric Vehicle Industry Value Chain Provides Opportunity to Enter New Fields

Utilities

Integrators (e.g. Better Place)

OEMs

Government

Charging Station Manufacturers

System/Battery Manufacturers
Electric Vehicle Technology Roadmap (Global), 2008-2015
- Charging Times to Drop to <30 Minutes by 2015


- Driving Distance/charge-up to 55 Miles
- Charge Time – 6 to 8 hrs
- Battery Capacity – up to 16kWh
- Motor Power- Up to 70 kW

- Up to 125 Miles
- < 1 hour
- Up to 50 kWh
- 70 kW – 250 kW

- 190 + Miles
- < 15 minutes
- 75 kWh +

Infrastructure

- Slow charging - onboard
- Fast charging – mostly off board
- Battery Swapping

Market for Extended-Range Electric Vehicles: Technology Roadmap for Plug in Hybrid Electric Vehicles

- ELECTRIC RANGE
- BATTERY CAPACITY
- MOTOR POWER
- CHARGING TIME

- Up to 40 miles
- 7kWh – 15kWh
- 50kW – 70kW
- 2 – 6 hrs

- Up to 100 miles
- 16kWh – 25kWh
- 70kW – 140kW
- 15 mins – 2 hrs

Source: Frost & Sullivan
Electric Vehicle Technology Roadmap (Global), 2008-2015
- Iron Phosphate and Manganese Based Li-ion Preferred


**Batteries**
- Lead acid
- Nickel Metal Hydride
- Sodium Nickel Chloride
  - Phosphate based
  - Manganese based
  - Titanate based
  - Silica based
- Lithium Ion
- Zinc Air

**Electric Motors**
- Permanent Magnet
  - Asynchronous
  - Switched Reluctance
  - In wheel motors
- Motor Power- Up to 70 kW
- 70 kW – 250 kW

Source: Frost & Sullivan
Improved range extension will see charging points extend beyond city limits to urban and sub-urban areas with emphasis on both normal and fast charging stations.
Future Developments in Electric Charging Stations (2013 on) : Target Focus on Parking Lots With Over 30 Minute Journey Stops

Long Duration Stay
- Multiplexes, railway stations are strategic spots where consumer “Park & Pickup” intervals are ideal for 80% charge
- Conventional charging stations preferred over fast charging

Short-Medium Duration Stay
- Dining & Restaurants, Golf courses, movie theatres
- Fast charging stations attractive

Highway - Motels / Dining
- High potential of fast charging stations seen to extend range of EV’s
- Battery Swapping stations likely to gain ground as well

• EV Range extension will see the rise of urban/sub-urban consumers using EV
  • Fast charging stations seen across strategic locations on highways like motels, dining centres etc

Source: Frost & Sullivan
Diagnostic and Billing Services, And Value Added Services Will Attract Potential Investors To Expand Charging Stations Functionality

IN-BUILT SOLAR PANELS
- Generating proprietary electricity
- Will get energy from Utilities through groundwork

INTERACTIVE LCD DISPLAY
- Payment option - either manually through Debit/Credit Card or automatically through RFID
- Club with parking charges
- Opportunity to place orders in nearby coffee centres, restaurants or internet bays
- Vehicle Diagnostic Interface

CHARGING TYPE OPTIONS
- Compartments to provide charging capabilities for up to 4 vehicles at a time
- Option to provide both on-board and off-Board charging

DESIGN BLEND WITH ENVIRONMENT
- Charging posts are specifically designed to blend with a specific city's environment theme

EXTENDED FUNCTIONALITY
- Battery chemistry sensing
- Advertising
- Content delivery for on-board systems like MP3 stereos, TiVo systems and back-seat entertainment
- Gaming Options – coin fed for additional revenue generation
- Vehicle Tracking System

GARAGE SERVICES
- Future functionality of automotive diagnostics
- Communicate any or all (by law) or requested (by mfg) access to in-car diagnostic or fault tolerance modules in real time to a shared database
- Use unique IP address to store repair data for future access and compliance tracking

MANUFACTURER FOCUSED SERVICES
- Provide billing, roaming, and geo-location reporting and audit trails for reciprocal sharing and utility reconciliation
- Scaleable solution for charge-point installation upgrades
- Employ wireless networking capability and multi-carrier redundancy

FROST & SULLIVAN
Global Market Size and Forecasts
Mega-city, de-urbanization and ecological trends point toward a large market for electric vehicles. **EVs are likely to account more than 7% of the transportation market by 2020.**

Electric vehicles growth is supported by rapid development of the supporting EV infrastructure. Government attitude, demographics and customer willingness are the key OE market entry strategies.
EV Breakdown By Region - CEVs to Account for 70% Share In Europe; NA to Witness More PHEVs with a 20% Share

Battery Recycling and Second Life Market: EV Breakdown By Region – Sales Estimates (World), 2015

- Japan and China are the key markets for APAC => likely 80% market share. China expects major share from the local OEMs and potential for strong growth in India.

- eREV and PHEVs likely to account major share in the North American market driven by the virtue of demographics and customer driving characteristics => GM & Chrysler OEMs for eREVs. On the other hand, CEVs suit the demographics for the Europe.
Over 47 OEMs are Expected to Compete in the Global EV Market With Over 75 models by 2015

Battery Recycling and Second Life Market: EV Sales Breakdown by Vehicle Segments (APAC, Western Europe and North America), 2015

<table>
<thead>
<tr>
<th>Market Size in Major Regions (APAC, Western Europe and North America)</th>
<th>1.16 Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of EV OEMs</td>
<td>47</td>
</tr>
<tr>
<td>Total Number of EV Models</td>
<td>~79</td>
</tr>
</tbody>
</table>

(93%)
TRADITIONAL OEMS – (Sales Unit)

(7%)
NON – TRADITIONAL – (Sales Unit)

Note: All figures are rounded; the base year is 2009. Source: Frost & Sullivan

- IMEV
- BMW Mini
- Nissan Leaf
- GM Volt
- toyota 1Q
- Subaru - R1e/G4e
- VW UP
- Volvo C30
- Tata Indica
- Smart

- TH!NK
- City ZENN
- Pininfarina Blue
- Heuliez WILL
- ZAP
- BYD F6DM
- CODA
- OPTIMAL ENERGY

Note: All figures are rounded; the base year is 2009. Source: Frost & Sullivan
Chinese OEMs to launch 35 EV Models in Next 3 to 5 Years

<table>
<thead>
<tr>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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</thead>
<tbody>
<tr>
<td>A00</td>
<td>Beni EV</td>
<td>i-car</td>
<td>F0 EV</td>
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<td></td>
<td>Chana</td>
<td>Dongfeng</td>
<td>BYD</td>
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<td></td>
<td>QQ3 EV</td>
<td>M1e FAW</td>
<td>Mpe FAW</td>
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<td></td>
<td>Chery</td>
<td>Yueyue EV</td>
<td>A00 EV</td>
</tr>
<tr>
<td>A0</td>
<td>F3DM BYD</td>
<td>Haiya EV</td>
<td>Yuexiang EV</td>
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<td>FAW</td>
<td>Chana</td>
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<tr>
<td>A</td>
<td>F6DM BYD</td>
<td>Zhixiang plug-in</td>
<td>550 plug-in</td>
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<td>701 BAW</td>
<td>Chana</td>
<td>SAIC</td>
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<td>B</td>
<td>E6 BYD</td>
<td>Shuaikje EV</td>
<td>Saibao EV</td>
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<td>premacy EV</td>
<td>Dongfeng</td>
<td>Hafei</td>
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<td>FAW</td>
<td>Heyue plug-in</td>
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<td>MPV</td>
<td>Odin EV</td>
<td>Shuaikje EV</td>
<td>JAC</td>
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<td>Ruqi EV</td>
<td>BE 701 BAW</td>
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<td>Dongfeng</td>
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<td>2008 EV</td>
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<td>Zhongtai</td>
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<td>Midi EV</td>
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<td>BAW</td>
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<tr>
<td>SUV</td>
<td>Tiggo EV</td>
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<tr>
<td></td>
<td>Chery</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Source: Frost &amp; Sullivan</td>
</tr>
</tbody>
</table>

Sum 13 2 7 2 3 5 10 9 12 17
Electric 2 Wheelers – eBicycle, eScooter and eMotor Bike Market Worth Over 25M Units Worldwide

- Over 20 million electric 2 wheelers sold globally in 2008
- Modest growth expected globally with 22 million sales forecast by 2010

Sanyo Enacle
- Motor driven by torque sensor on pedal
- Regenerative Braking*
- Range – 35 km / 50 km*

XM 3000 Electric Moped
- Lead Acid / NiMH Battery
- 60 Volt lead acid battery
- Charging time – 7 hours
- Max speed – 70 kph
- Range – 80 km

Vectrix Electric Scooter
- Hub motor driven purely by throttle
- Regenerative functionality in high end models
- 125 Volt NiMH battery
- Charging time – 2 hours
- Acceleration (0 – 80 kph) – 6.8s
- Max speed – 100 kph
- Range – 110 km @ 40 kph
Business Model Analysis of Key Industry Stakeholders
## Business Models Analysis: Future Leasing Models To Sell 75% Of EVs; The Rest 25% Sold Traditionally

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Business Model 1</th>
<th>Business Model 2</th>
<th>Business Model 3</th>
<th>Business Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Package</td>
<td>Energy Package</td>
<td>Maintenance Package</td>
<td>Part Subsidy</td>
<td>Full Subsidy</td>
</tr>
<tr>
<td>COVER</td>
<td>Partial battery lease + Electricity</td>
<td>Energy Package+ Insurance+ Maintenance</td>
<td>Maintenance Package+ Discount</td>
<td>Maintenance Package+ 100% Discount</td>
</tr>
<tr>
<td>ENERGY</td>
<td>Monthly Bill</td>
<td>Flat: Max 1250 miles/month</td>
<td>Flat: 15,500 miles/year</td>
<td>Flat: ~18,500 miles/year</td>
</tr>
<tr>
<td>CONTRACT</td>
<td>NA</td>
<td>NA</td>
<td>4 years</td>
<td>7 years</td>
</tr>
<tr>
<td>SUBSIDY</td>
<td>NA</td>
<td>NA</td>
<td>50% car price</td>
<td>Free car</td>
</tr>
<tr>
<td>MONTHLY LEASE</td>
<td>Up to $225</td>
<td>Up to $500</td>
<td>$750- $1100</td>
<td>~ $1350- $2250</td>
</tr>
</tbody>
</table>

Other Possible Leasing models

<table>
<thead>
<tr>
<th>Flexible Mileage</th>
<th>Unlimited Miles</th>
<th>Max number of miles</th>
<th>Pay as you go</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible Contract</td>
<td>The customer opts for the number of years and flexible mileage- customized lease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Better Place, Frost & Sullivan

Note: Values that have been dealt here are an European perspective converted into US$ at today’s exchange rate.
Example of Products/Services Portfolio That Can be Offered by an Integrator in the E-Mobility Market

- **Charging Stations**
  - Manufacturing & Sales
  - Installation & Maintenance
  - Charge Payment Program / Subscription based services
  - Revenues from value added services
  - Premium revenues via Renewable Energy Vs Non Renewable Energy
  - Premium revenues via Peak Power Vs Off Peak Charging
  - Level 1 Vs Level 2 Vs Level 3 Charging

- **Batteries**
  - Battery Leasing Model
  - Refurbishing
  - Recycling
  - Battery 2nd life
  - Battery Swapping
  - Extend to other E-mobility solutions
  - Battery Integration

- **E-Mobility Vehicles**
  - Energy Subscription Packages
  - Extended E-mobility solution e.g. vehicle sharing
  - Offering After-Sales services – Market green solutions such as Solar panels to E-Mobility client base
  - Recycling and Refurbishing

- **Electricity**
  - Subscription based Energy service Scheme
  - Load Management
  - investment in renewable energy such as wind farms and gain carbon credits
  - Premium revenues via Peak Power Vs Off Peak Charging
  - Premium revenues via Renewable Energy Vs Non Renewable Energy

- **Telematics & other value added services**
  - Data Aggregator (working with other partners)
  - Battery management services
  - Advanced booking of charging stations
  - V2V and V2G Communication
  - Added value service (POIs, Diagnostics, etc)

**Possible Revenue Streams**

- Premium revenues via Renewable Energy Vs Non Renewable Energy
- Premium revenues via Peak Power Vs Off Peak Charging
- Level 1 Vs Level 2 Vs Level 3 Charging

**Source:** Frost & Sullivan
Opportunities in the Electric Vehicle Industry
Utilities Business Model – Revenue Generating Opportunities Are Mainly Outside Selling Energy

<table>
<thead>
<tr>
<th>Source Of Revenue Generation</th>
<th>Calculated over 5 years (based on certain assumptions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Revenues from Selling Electricity</td>
<td>€300Mn - €400Mn</td>
</tr>
<tr>
<td>2. Revenues from selling Charging Stations</td>
<td>€500Mn - €700Mn</td>
</tr>
<tr>
<td>3. Revenues from Installation &amp; Maintenance of Charging Stations</td>
<td>€300Mn - €500Mn</td>
</tr>
<tr>
<td>4. Revenues from Other Sources (Solar panels and other retailing, Advertising, Load Balancing, Garage Referrals, Data Downloads etc)</td>
<td>€450Mn - €650Mn</td>
</tr>
</tbody>
</table>

TOTAL: €1.5 bn - €2 bn

| Capital Investment (1st yr)                                                                 |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Includes: New Energy Capacity                                                               | €48Mn - €50Mn                                            |
| Command and control centre                                                                  |                                                          |

| Fixed & Operating Cost                                                                       |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Network Recurring Cost                                                                      | €640Mn - €650Mn                                          |
| Charging Station Purchase Cost                                                              |                                                          |
| Installation and Maintenance cost                                                            |                                                          |
| Logistics, Admin, Selling, general, rental, Marketing and Labour Cost                        |                                                          |
Controlling EV Charging – Opportunity for Utilities to Benefit from the Balancing Market by Managing the Energy Demands of EVs

European Utilities Views on Controllable Charging

- **Uncontrolled charging**
  - E-Mobility users can charge whenever they like to
  - Charging station is viewed as ‘sophisticated’ socket

- **Some degree of control**
  - Decision when to charge is left with customers
  - Certain degree of control is executed through ‘soft measures’ such as peak and off-peak tariffs

- **Fully controlled charging**
  - Utility is in full control of when charging takes place
  - Other parameters can be controlled as well, such as a type of energy goes into EV batteries
Automotive Li-ion Battery Recycling Market is Expected to be Worth More than 2 Billion $ by 2022


<table>
<thead>
<tr>
<th>Recycling Efficiency</th>
<th>Lead-acid Batteries</th>
<th>Aluminium Cans</th>
<th>Newspapers</th>
<th>Glass Bottles</th>
<th>Tires</th>
<th>Cellphones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling Efficiency</td>
<td>97%</td>
<td>55%</td>
<td>45%</td>
<td>26%</td>
<td>26%</td>
<td>10%</td>
</tr>
</tbody>
</table>

*Excluding batteries
*Others include Gold, Silver, Lead, Nickel, Zinc, Tin and so on

Plastics, 55%
Glass, 10%
Copper, 13%
Iron, 5%
Aluminium, 2%
Others, 15%

Note: All figures are rounded; the base year is 2009
Source: Battery Council, Umicore, Frost & Sullivan
Automotive Apps: From Car Sharing to Diagnostics to EV’s, Apps for Cars are becoming a Value Added Development
On Board Computers for Electric Vehicles – Developments like Nissan Leaf IT System, Better Place Autos Highlight the Importance V2G and V2I Communication

The electric car has an intelligent brain. An integrated IT support system constantly collects data from various electric vehicle parameters and ensures optimum vehicle performance. This brain is wirelessly connected to an IT Server. This backend server also interfaces with utilities to manage grid impact and also informs the user about the best time for recharge.

Nissan Leaf IT System

Better Place AutoOS

Intuitive and sophisticated software scan various vehicle parameters and ensure optimum vehicle performance.

An integrated IT support system constantly collects data from various electric car users.

A back-end service center provides information to users and also analyzes driving patterns among others.
Short List of New and Evolving Technologies (in-side Vehicle)

**Power Train**
- Engine
  - Electric Motors
    - PMM/Induction/SR/In-wheel, Hub Motors
  - E-Engine
- Gearbox
  - Integrated transmission with differential
  - In-wheel motors w/o transmission
- Batteries
  - Lithium Ion + Lead Acid for SLI (Optional)

**Power Systems**
- P-Electronics
  - Stepped DC/DC, DC/AC Converters, Inverters
  - Advanced BMS
  - 16-32-bit μ-controllers, IGBTs, MOSFETs
  - Charging unit/equipment
- Harness
  - 12V/300-440V
  - CAN/TT-CAN/Flex Ray

**Chassis**
- Steering
  - Active Front Steering
  - Steer By Wire
- Braking
  - HBS+EVP
  - Brake by Wire/EMB
- Others
  - Electric Axle and E-AWD
  - Electric Corner Module

**Interiors & Acoustics**
- Cockpit
  - Battery SOC, Temperature Indicator
  - Charging Systems Indicator-Locators
  - Motor Vehicle Speed, Distance Calculator
- NVH
  - High Frequency Isolators
  - Sound Generators
- Others
  - Telematics
  - Cooling systems

**Others**
- E-Systems
  - eHVAC Systems (Electric Compressors)
  - Electric Water Pump
  - Range Extender Module
  - Integrated Battery Modules
  - Telematics
  - LED Lighting
  - Cooling systems

Legend:
- Emerging (new) Technologies
- Evolving Technologies
Examples of Electrical Products Worth Considering

- MSD Plug Assembly
- MSD Base Assembly
- Travel Cord Set (CCID)
- Bulk head Battery Disconnect Units
- Charge Station
- Receptacle
- Specialist Plug and Inlets

**POWER ELECTRONICS**
- H.V. Battery Monitoring System
- Traction Inverter

**CHARGING SYSTEMS**
- Wall-Mount Cord Set
- On-Board Chargers
- Off-Board Chargers

**POWER DISTRIBUTION**
- Manual Disconnect
- Connection Systems
- Battery Disconnect unit

Source: Pictures Lear
Discussions