HEV, P-HEV & EV MARKET 2010 – 2020
IMPACT ON THE BATTERY BUSINESS

Christophe PILLOT

c.pillot@avicenne.com

4TH International Congress on Automotive Battery Technology

Dorint Pallas Wiesbaden, Germany
9th – 11th May 2011
Information for Growth

Powering your company’s market strategy with in-depth research

- Creation: 1992
- Headquarter: Paris
- Liaison Office: Japan, USA
- Director: M. Madani
- AVICENNE Energy Director: C. Pillot
- 4 consultants in Paris

AVICENNE ENERGY

The Rechargeable Battery market 2010-2020
April 2011, 20th Edition

Customized Client Projects

AVICENNE MEDICAL
METHODOLOGY: EXTENSIVE FIELD RESEARCH TO RETRIEVE & CROSS CHECK INFORMATION

- Top management contact network
- Conferences & Exhibitions

In Depth analysis Of applications

Cross Check Analysis
- Battery Makers
- Battery Users, OEM
- Raw materials suppliers
- Environment & recycling
- Safety
- Substitution technologies: SuperCap, Fuel cells

HEV, P-HEV & EV MARKET 2010 - 2020 ; IMPACT ON THE BATTERY BUSINESS - May 2011
MORE THAN 100 REFERENCES WORLDWIDE

- A123
- Air Liquide
- Air Product
- Alcatel
- Amperex (ATL)
- Aros Securities
- ARC
- Atofina - Arkema
- AT Kearney
- Axeon
- Bain
- Battery R&D Association of Korea
- B&D
- BHP Billiton
- Brand Licencing Parners (BLP)
- Bourns
- Bosch
- BYD
- Cap X
- Catella
- Carbone Lorraine
- CDN Cobalt
- CEA/LITEN
- Celgard
- Chemetall
- CIAPS
- CIBA
- CNRS
- Cogema
- CRU Group
- CSC Challenge Strategy Change
- DELTA
- DGA
- Dialog Semiconductor
- Dow Chemical
- Dupont
- Duracell
- EDF
- Electro Energy
- Ener 1
- Energizer
- ETC AB
- Facom
- Falcon Bridge
- Fairshild semiconductor
- Fameart
- FIST
- Floridienne de Chimie
- FMC Lithium
- Fortu Power Cell
- France Telecom
- Fulton Innovation
- GAIA
- GIL Import Batteries Ltd.
- GS Melcotec
- HC Starck (Bayer)
- HILT1
- Hitachi Maxell
- Hollingsworth & Vose Cie
- Honeywell
- HPL (High Power Lithium)
- Hutchinson
- IER
- IGL Export.
- International Component
- Inco
- Intersil
- ITRI
- ITS
- Johnson Controls
- JBC
- Kodak
- Kruger
- Lazar
- Leclanché
- Legrand
- LG Chemical
- Lion cells
- Little Fuse
- Lilipucian
- Lynas Corp
- Matsushita
- Microsoft
- MTI Micro Fuel Cells
- Mindbranch
- Moltech
- Molycorp
- Motorola
- NCCP - Russia
- Nitech
- NKKPC – Brett Nelson
- Norilsk Nickel
- NTK Powerdex
- OMG Inc
- Panasonic
- Philips
- PK & Wise
- PRAYON
- PSA
- Rayovac
- Renault
- Rhodia
- Saft
- Samsung SDI
- Sanik
- Schroder Venture
- Scotent Entreprise
- Shenzhen High Power Technology
- Schott AG
- SKC
- SVE - Dassault
- Solvay
- Sony
- Stibat
- Storck
- Toda Kogyo
- TOTAL
- Total Wireless Solution
- Toyota
- Tyco
- Umicore
- Uniross
- Varta
- Warburgpincus
- World Industrial Information Center
- WR Grace & Cie
- Zebra
- ZPower
OUTLINE

1. THE RECHARGEABLE BATTERY MARKET IN 2010
2. ELECTRIC VEHICLE SEGMENTATION
3. HEV MARKET BY COMPETITOR AND BY AREA
4. FORECASTS BY 2020
5. IMPACT ON THE BATTERY BUSINESS
MAIN QUESTIONS

- Impact of the financial & economic crisis on the HEV market & the PHEV or EV developments?
- Will the HEV penetration continue ? Where is the limit?
- Car suppliers strategy for HEV, PHEV & EV? Do they believe in those markets?
- What are the main market drivers & limiters?
- When will Li-ion appeared massively in HEV? NiMH Vs. Li-ion for HEV?
- Which Li-ion batteries for the future HEV, PHEV & EV?
- Cobalt, Lithium, Nickel or Phosphate future needs?
- Market for EV, PHEV & HEV batteries in 2015 & 2020 ?
- Who will be the main battery suppliers?
- Will high level investment result in a significant overcapacity in the future?
WHY HEV?

Petroleum consumption worldwide 1960-2009

Price of the WTI barrel of oil, US $

CO$_2$ density in the atmosphere increase

Source: Energy Information Administration, US Government
Source: http://www.eia.doe.gov/emeu/steo/pub/contents.html
(1) Estimations

IPCC, Intergovernmental Panel on Climate Change, Climate Change 2007, Synthesis Report p38
HEV, P-HEV & EV MARKET 2010 - 2020; IMPACT ON THE BATTERY BUSINESS - MAY 2011

HEV, P-HEV & EV DEFINITION & SEGMENTATION

HYBRID LEVELS:
- Micro HEV: up to 144 V
- Mild HEV: 14 - 42 V
- Medium HEV: 42 - 144 V
- Full HEV: > 144 V

Fuel saving Vs. Cost

- EV: 100%
- P-HEV: 80%
- HEV: 60%

*Note: Micro HEV are not in the HEV statistics & HEV forecast

- CITROEN C3
- TOYOTA VITZ
- GM Saturn Vue
- GM AURA
- GM MALIBU
- HONDA ACCORD
- HONDA CIVIC INSIGHT
- MERCEDES S400
- TOYOTA PRIUS
- TOYOTA CAMRY
- FORD ESCAPE
- FORD FUSION
- MILAN
- GM YUKON
- GM TAHOE
- NISSAN ALTIMA

Tel.: +33 1 47 78 46 00
c.pilot@avicenne.com

Information for growth
Battery for Automotive market in 2010: 11% of the battery market in value

Battery sales, M US$, Worldwide, 1995-2010

Battery sales, M US$, Worldwide, by application 2000-2010

Source: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
THE RECHARGEABLE BATTERY MARKET IN 2009
VOLUME IN MWH

Battery for Automotive market in 2010: <5% of the battery market in Volume

The worldwide rechargeable battery market, MWh, 1995-2010

The worldwide rechargeable battery market, MWh, 1995-2010

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
NIMH IN 2010
MAIN APPLICATION: HEV

1 200 M NiMH cells – 3 500 MWh
1.65 B$

NiMH battery market worldwide in value
% for HEV application

NiMH battery by applications, worldwide, % in value, 2010

HEV 65%
Cordless Phones 9%
Retail: RC cars, Toys, Household, DSC, 18%
Others 8%

CAGR 2005/2010
+14% per year in Volume
+10% per year in value

SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011

HEV, P-HEV & EV MARKET 2010 - 2020 ; IMPACT ON THE BATTERY BUSINESS - MAY 2011

Tel.: + 33 1 47 78 46 00
c.pilot@avicenne.com
1,3% of vehicle sold worldwide in 2010 was Hybrid

HEV sold per year, M units, worldwide, 2000 - 2010

Penetration of hybrids in the global sales, 2000-2010

Note: Micro HEV are not in the HEV statistics & HEV forecast

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
HEV WORLDMIDE IN 2010

Total HEV Vehicles:
≈ 900,000 units in 2010

HEV sold per year, M units per car manufacturers, 2000-2010

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
Total HEV Vehicles: ≈ 900 000 units in 2010

Note: Micro HEV are not in the HEV statistics & HEV forecast

HEV sold per year, M units per country, 2000-2010

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
HEV FORECASTS UP TO 2015

HEV MARKET IN 2015 : 2,2 Million units (1)

Penetration of hybrids (2) in the global sales, 2000-2015

Penetration of hybrids (2) in the global sales, 2000-2015

(1) Assumptions:
- >75 M vehicle sold WW in 2015
- 3% Hybrids

Source: The Rechargeable Battery Market 2010-2020, Avicenne, March 2011
NIMH BATTERY DEVELOPMENTS

NiMH Capacity is increasing
Exemple of AA NiMH
(index 100 in 1996)

<table>
<thead>
<tr>
<th></th>
<th>PRIUS II</th>
<th>PRIUS III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>6.5 Ah</td>
<td>6.5 Ah</td>
</tr>
<tr>
<td>Cells</td>
<td>228 (38 * 6)</td>
<td>168 (28 * 6)</td>
</tr>
<tr>
<td>Voltage</td>
<td>273.6 v</td>
<td>201.6 v</td>
</tr>
<tr>
<td>Specific power</td>
<td>1000 W/kg</td>
<td>1300 W/kg</td>
</tr>
<tr>
<td>Specific energy</td>
<td>46 Wh/kg</td>
<td>46 Wh/kg</td>
</tr>
<tr>
<td>Total power/HEV</td>
<td>36 kW</td>
<td>37.8 kW</td>
</tr>
<tr>
<td>Total energy/HEV</td>
<td>1778 Wh</td>
<td>1310 Wh</td>
</tr>
</tbody>
</table>

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
Thanks to TOYOTA, Panasonic EV, got more than 75% of the HEV battery market and a large know-how.
Li-ion is **THE** solution for the future

- **BUT, SAFETY, LIFE TIME & COST issues**
- Lot of technical solutions (NMC, NCA, LFP, LCO...)
- Lot of EXPENSIVE Developments...

So,
- Lot of JV, partnerships etc...

## JOINT VENTURE & STRONG PARTNERSHIP

<table>
<thead>
<tr>
<th>TOYOTA</th>
<th>NISSAN</th>
<th>HONDA</th>
<th>FORD</th>
<th>MITSUBISHI</th>
<th>DAIMLER</th>
<th>BYD AUTO</th>
<th>BOSCH</th>
<th>CONTINENTAL</th>
<th>JC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANASONIC</td>
<td>PEVE</td>
<td>NEC</td>
<td>AESC</td>
<td>GSY</td>
<td>JV (HEV)</td>
<td>LEJ (EV)</td>
<td>SB LiMotive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAFI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BYD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENAX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRIUS III NiMH</th>
<th>PRIUS x - Li-ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>201.6</td>
</tr>
<tr>
<td>Cells</td>
<td>168 (28*6)</td>
</tr>
<tr>
<td>Capacity</td>
<td>6.5 Ah</td>
</tr>
<tr>
<td>Energy</td>
<td>1310 Wh</td>
</tr>
<tr>
<td>Weight</td>
<td>38 kg</td>
</tr>
<tr>
<td>T°C Range</td>
<td>+</td>
</tr>
<tr>
<td>Cyclability</td>
<td>+</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td></td>
</tr>
</tbody>
</table>
# LI-ION BATTERIES DEVELOPMENTS

## HEV, P-HEV & EV MARKET 2010 - 2020 ; IMPACT ON THE BATTERY BUSINESS - MAY 2011

<table>
<thead>
<tr>
<th>Li-ion</th>
<th>TOYOTA</th>
<th>NISSAN</th>
<th>HYUNDAI</th>
<th>MITSUBISHI</th>
<th>BYD Auto</th>
<th>SUBARU</th>
<th>MAZDA</th>
<th>SUZUKI</th>
<th>SAEC</th>
<th>GM</th>
<th>FORD</th>
<th>CHRYSLER</th>
<th>TESLA</th>
<th>BAE</th>
<th>FISHER</th>
<th>KODIA (Meta Electric)</th>
<th>DAIMLER</th>
<th>VW</th>
<th>AUDI</th>
<th>BMW</th>
<th>PSA</th>
<th>RENAUT</th>
<th>FIAT</th>
<th>VOLVO</th>
<th>TRKK</th>
<th>TATA</th>
<th>PANTHERINE</th>
<th>MAGNA</th>
<th>CONTINENTAL</th>
<th>DELPHI</th>
<th>TATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanyo</td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C Smart</td>
<td></td>
<td></td>
<td></td>
<td>C &amp; P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEVE</td>
<td>c &amp; P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AESC (Nec-Nissan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C &amp; P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC SAFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEJ - Blue Energy Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS - HONDA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C Pack</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A123</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LiTec - Evonik</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEI (GSY-Mitsubishi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB LiMotive (SDI-BOSCH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C &amp; P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENAX - CONTI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAGNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P Pack</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOUSHIBA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>China 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BYD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HITACHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BATSCAP (BOLLORE-EDF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SK Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HEV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TESLA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTINENTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C Smart</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUP/E-One</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emerdel (Delphi 28.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>mini</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RENAUT/AESC/CEA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panasonic/Tesla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sony</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HITACHI/MAXELL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAXELL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EIG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19
LI-ION PENETRATION IN VARIOUS DEVICES
AVICENNE & OTHER ANALYSTS FORECAST

1. AVICENNE HEV Forecasts, March 09, Relevant scenario
2. AVICENNE HEV Forecasts, March 09, Li-ion Optimistic scenario
3. IIT, Takeshita, March 08, The 25th International Battery Seminar & Exhibit, Slide 8 & March 2009, 26th Battery Seminar, Slide 5
4. AAB, Menahem Anderman, Ph.D., Tampa, Florida, May 2009

SOURCE: AVICENNE COMPILATION, MARCH 2011
LONG TERM HEV FORECAST FROM 3 TO 8 M HEV IN 2020

HEV FORECASTS (Million)

SOURCE: AVICENNE COMPILATION, MARCH 2011
LONG TERM
HEV BATTERY FORECASTS

HEV market, million units, worldwide, 2005-2020

HEV battery market worldwide, million $ 2000-2020

Note: Micro HEV are not in the HEV statistics & HEV forecast

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
HEV, P-HEV & EV LONG TERM FORECASTS
EV ENERGY NEED: 25 MORE THAN HEV!

Average Wh per device

EV  25000
P-HEV  10000
HEV  1000
E-bikes  400
Power Tools  45
Portable PC  50
Mobile Phone  4

EV(1) sold, in million units, worldwide, 2010 - 2020

Number of EV sold worldwide ( Million)

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011

HEV, P-HEV & EV MARKET 2010 - 2020; IMPACT ON THE BATTERY BUSINESS - MAY 2011
Long Term
EV, PHEV & HEV Battery Forecasts

Assumptions
- 100,000 EV in 2015
- 400,000 in 2020
- 100% Li-ion
- 0.1 M P-HEV in 2015
- 0.4 M in 2020
- 100% Li-ion
- 2.2 M HEV in 2015
- 3.5 M in 2020
- 35% Li-ion in 2020

EV, HEV & P-HEV Battery needs (M Wh)
2005 - 2020

(Pack level)

Source: The Rechargeable Battery Market 2010-2020, Avicenne, March 2011
Assumptions

- 200,000 EV in 2015
  - 1M in 2020
  - 100% Li-ion

- 0.1 M P-HEV in 2015
  - 0.4 M in 2020
  - 100% Li-ion

- 2.2 M HEV in 2015
  - 3.5 M in 2020
  - 35% Li-ion in 2020

**EV, HEV & P-HEV Battery needs (M Wh)**
2005 – 2020 (Scenario 2)

**Total battery demand (M Wh)**
2005 – 2020

**SOURCE:** THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011

---

Tel.: + 33 1 47 78 46 00
c.pilot@avicenne.com

**HEV, P-HEV & EV MARKET 2010 - 2020 ; IMPACT ON THE BATTERY BUSINESS - MAY 2011**

26
LIB MANUFACTURING INVESTMENT 2009-2015
10-12 B$ WORLDWIDE / >50 GWH IN 2015

Total Investment (M$) made for LIB manufacturing

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
ANNOUNCED INVESTMENT WILL RESULT IN SIGNIFICANT OVERCAPACITY

**Assumptions**

- 200,000 EV in 2015
  - 1M in 2020
  - 100% Li-ion
- 0.1 M P-HEV in 2015
  - 0.4 M in 2020
  - 100% Li-ion
- 2.2 M HEV in 2015
  - 3.5 M in 2020
  - 35% Li-ion in 2020

**EV, HEV & P-HEV Battery needs (M Wh)**

2005 – 2020 (Scenario 2)

**SOURCE**: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
The Hybrid vehicle is the only mass market choice for electric traction cars today.

Toyota opened this market and earn money with HEV models.

The hybrid vehicles is now a niche market: in 2015 we believe more than 2,1 million Hybrid cars will be sold worldwide.

The battery technology is today the NiMH, we don’t expect the Li-ion to be significant on the HEV mass market.

P-HEV & EV will be powered by Li-ion.

1 M EV represent roughly 20 000 MWh, or 40 000 tones of cathode materials!

HEV, P-HEV & EV will change the gasoline dogma in the car Industry. In the next decade, we are expecting one of the world most important disruption in the car industry.

Then, EV could change totally the battery market on a long term basis.

**SOURCE:** THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
Christophe Pillot

Phone + 33 -1 - 47 78 46 00
Fax + 33 - 1 - 47 78 46 01

c.pilot@avicenne.com
On our Web Site : www.avicenne.com