AVICENNE Développement

*Information for growth*

# THE BATTERY MARKET FOR HEV, P-HEV & EV 2010 - 2020

**Christophe PILLOT**

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THE 28TH INTERNATIONAL BATTERY SEMINAR & EXHIBIT

Fort Lauderdale, Florida
Wednesday, March 16th 2011

# 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


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# 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?


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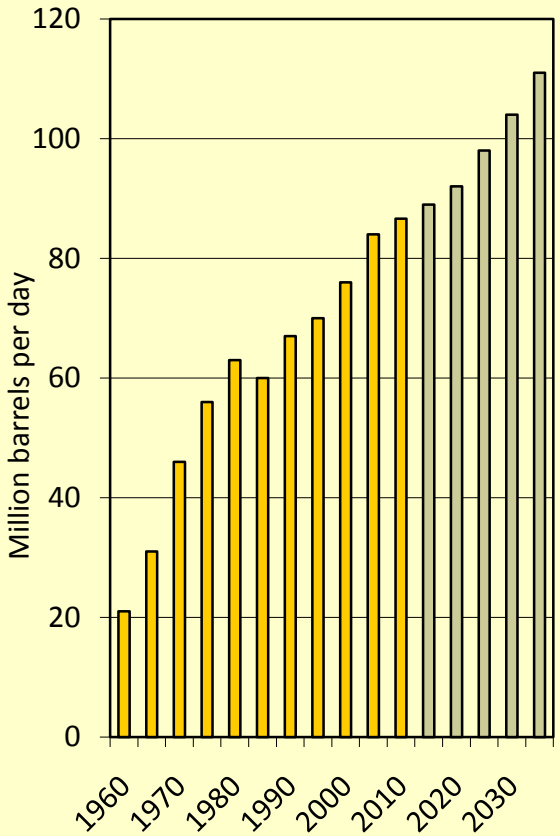
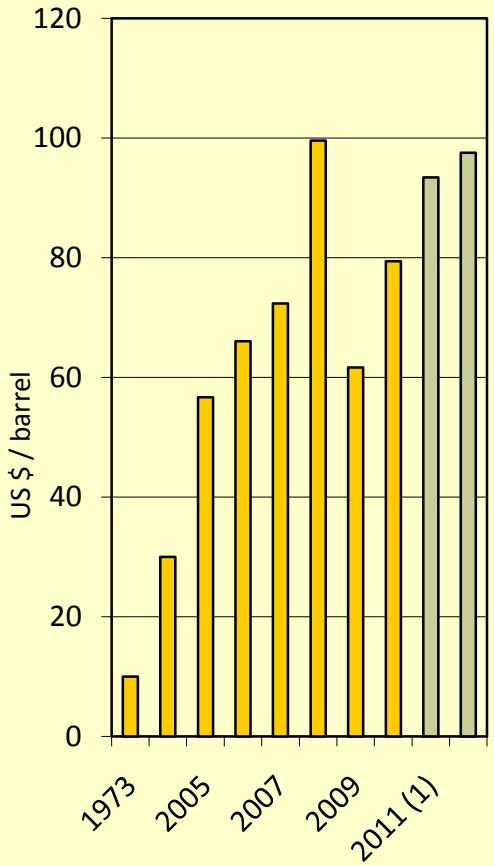
# WHY EV?

Petroleum consumption worldwide 1960-2009



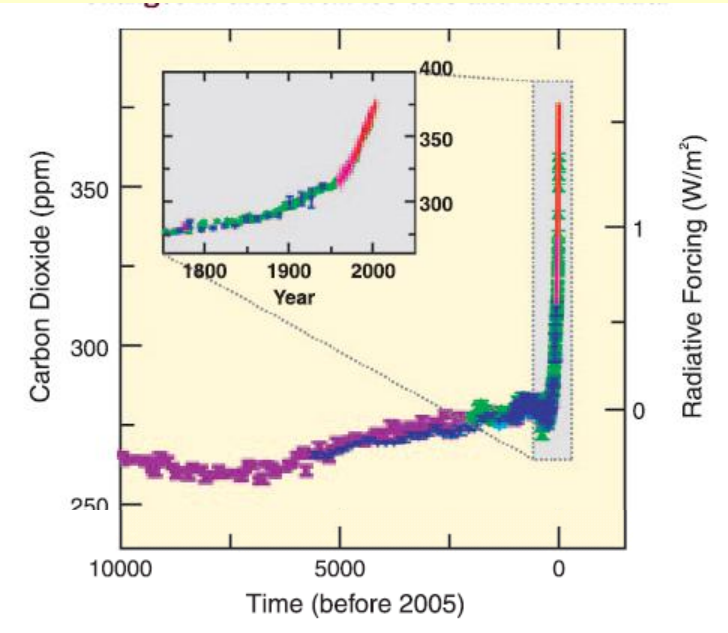

Source :Energy Information Administration, US Government

Price of the WTI barrel of oil, US $




Source :http://www.eia.doe.gov/emeu/steo/pub/contents.html
(1) Estimations

$CO_2$ density in the atmosphere increase




IPCC, Intergovernmental Panel on Climate Change, Climate Change 2007, Synthesis Report p38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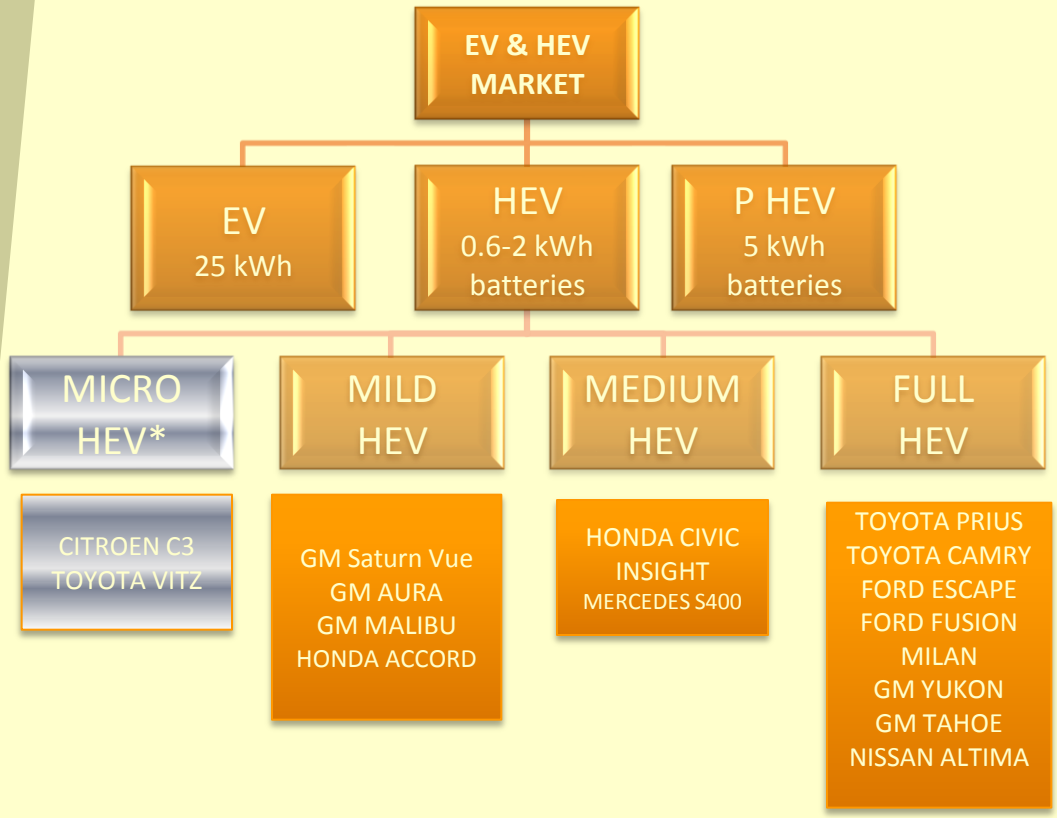
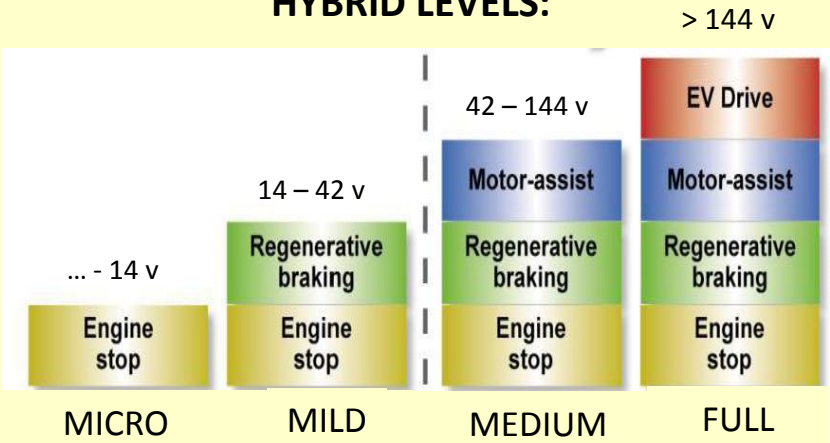
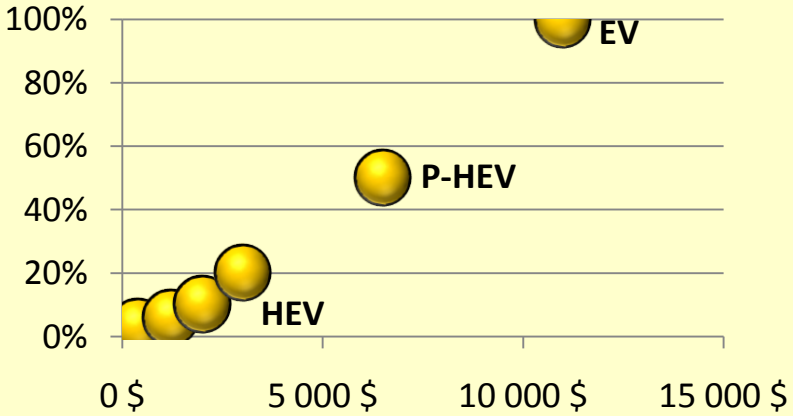
# HEV, P-HEV & EV DEFINITION & SEGMENTATION




**HYBRID LEVELS:**




**Fuel saving Vs. Cost**




*Note: Micro HEV are not in the HEV statistics & HEV forecast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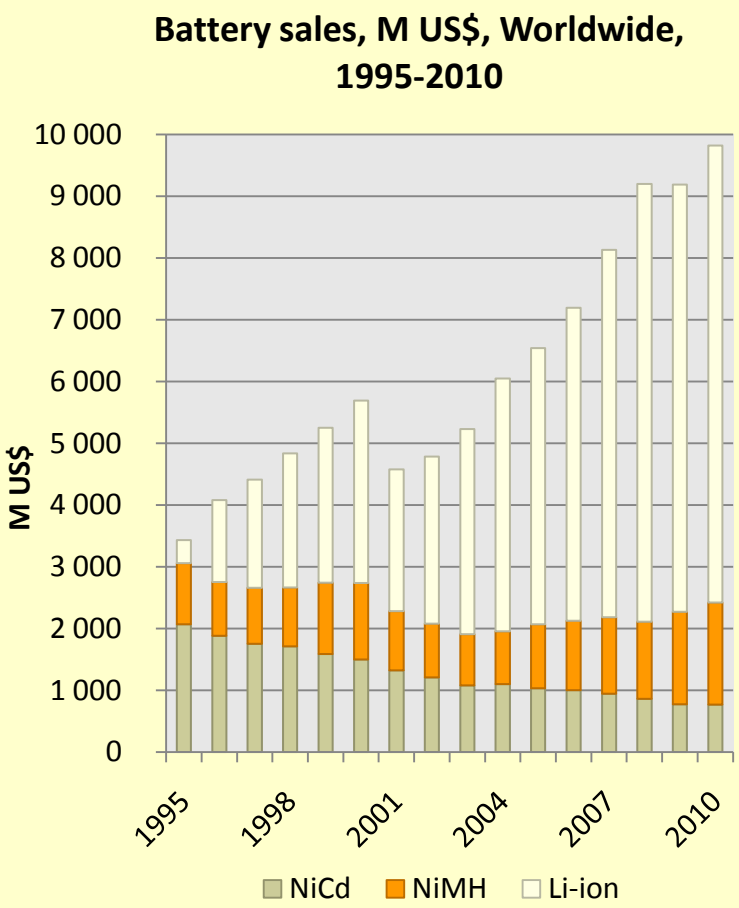
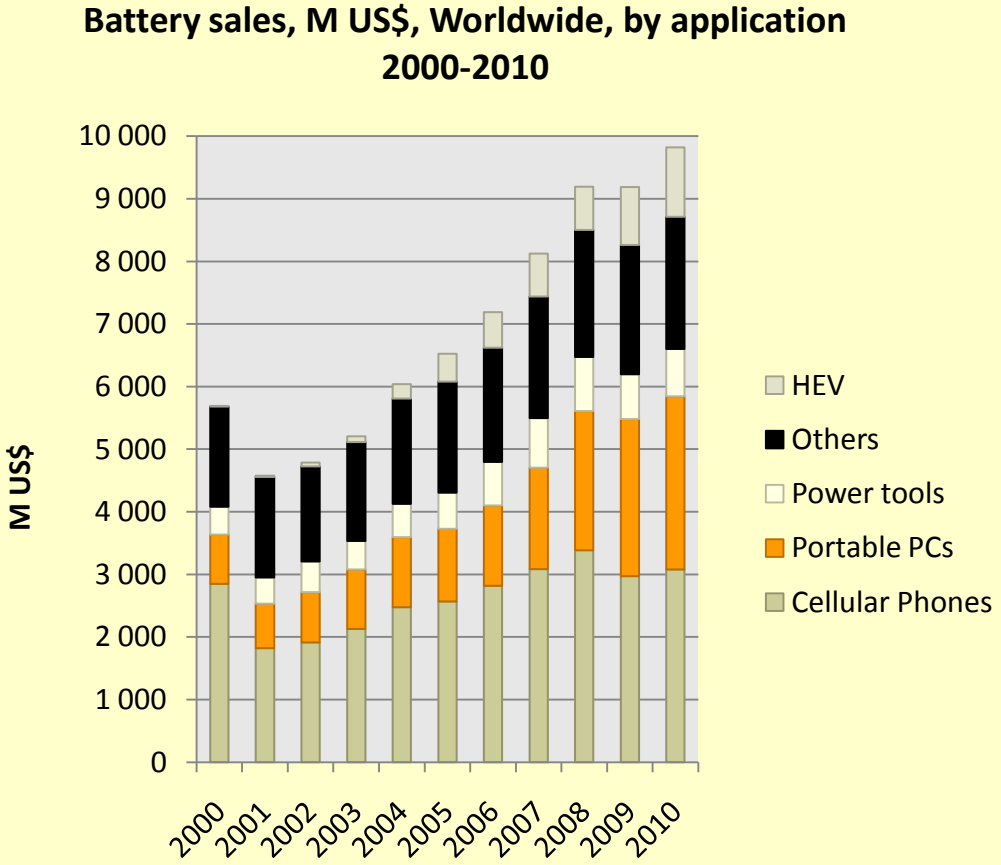
# THE RECHARGEABLE BATTERY MARKET IN 2010
# VALUE IN M$

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




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



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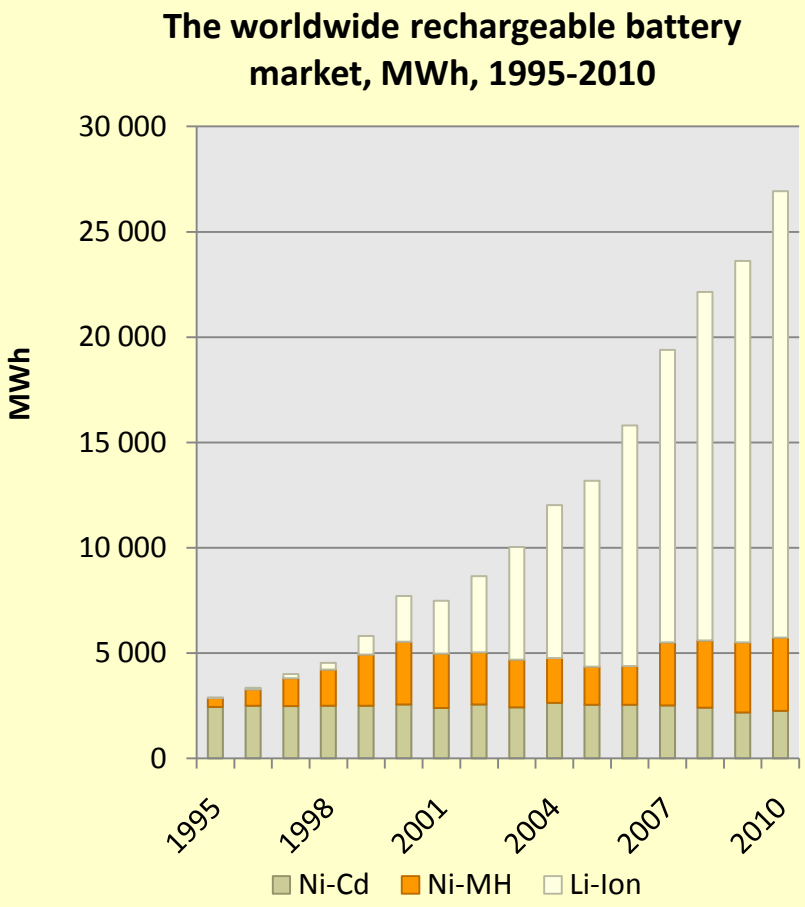
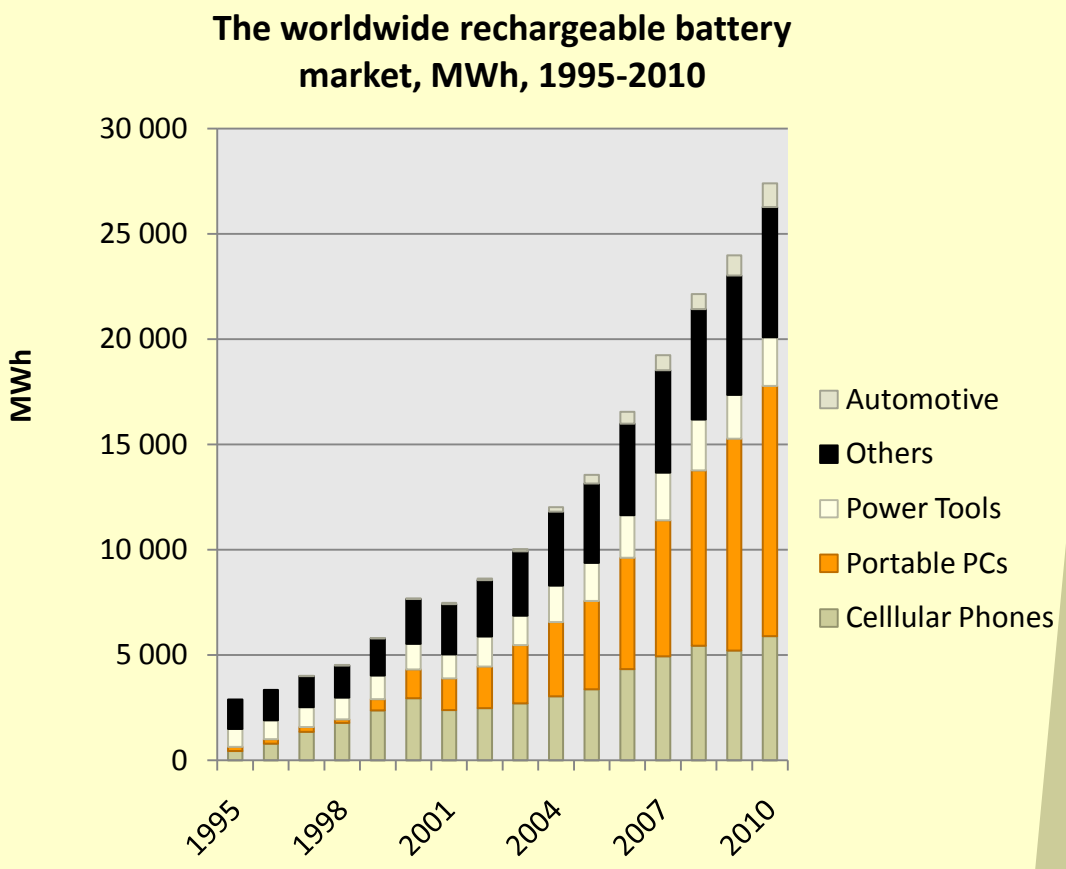
# THE RECHARGEABLE BATTERY MARKET IN 2009 VOLUME IN MWH

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




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



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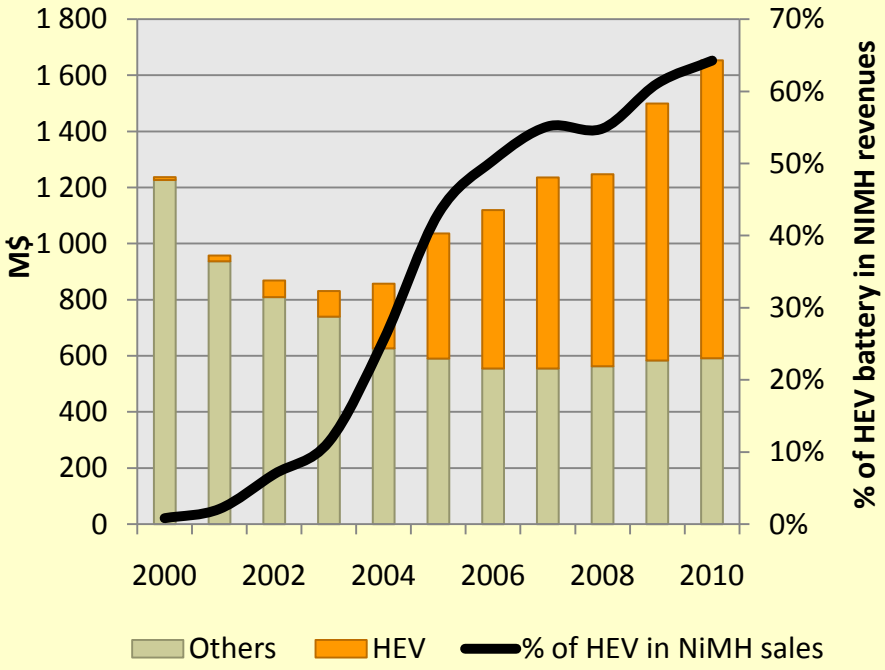
# NIMH IN 2010
# MAIN APPLICATION: HEV

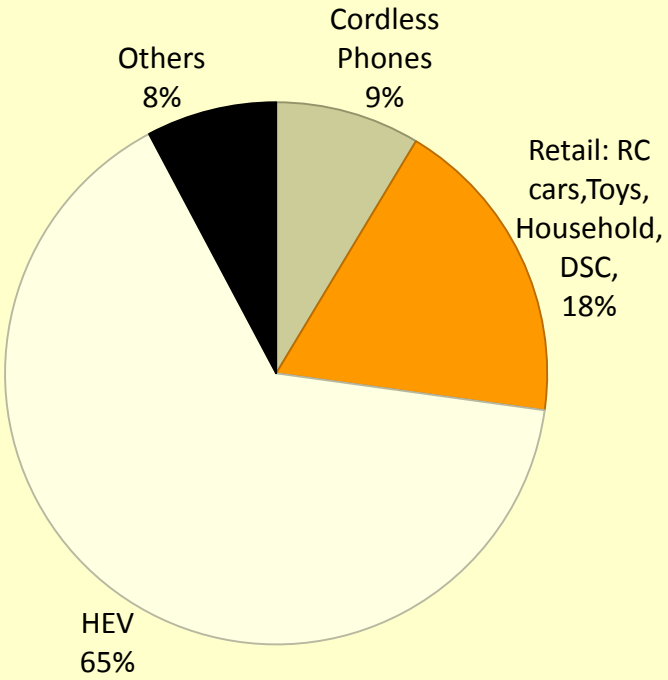
1 200 M NiMH cells – 3 500 MWh
1.65 B$

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

**NiMH battery market worldwide in value % for HEV application**




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




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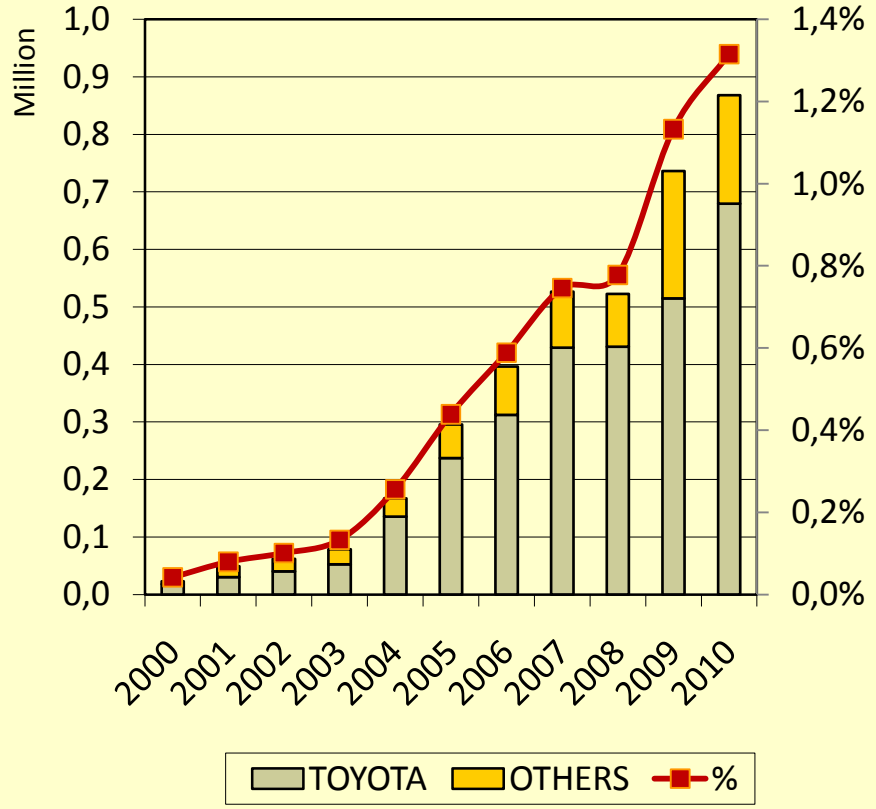
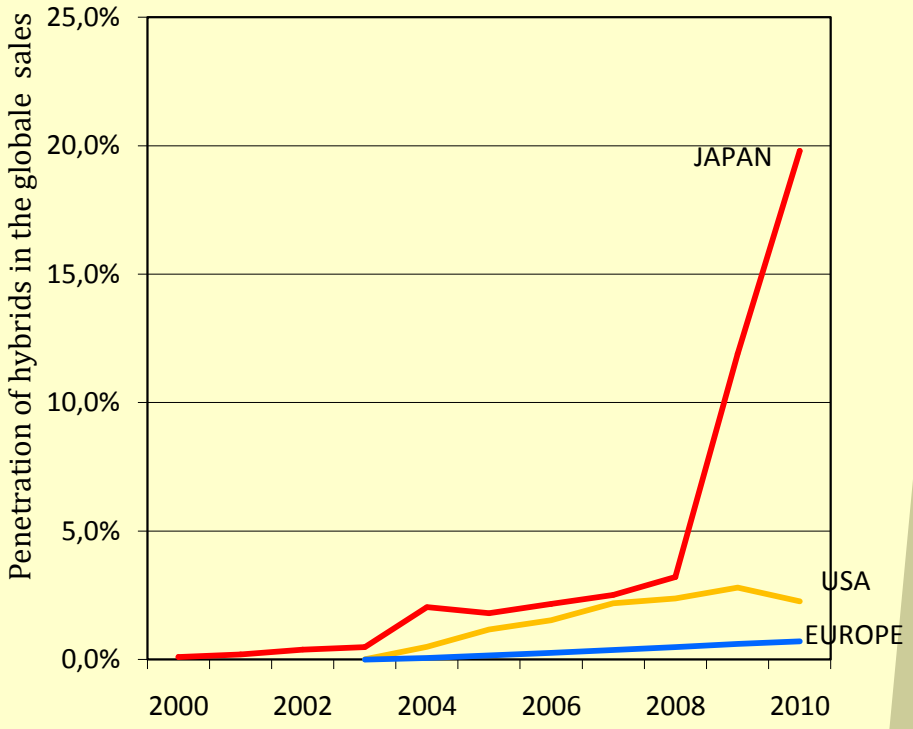
# HEV MARKET

## 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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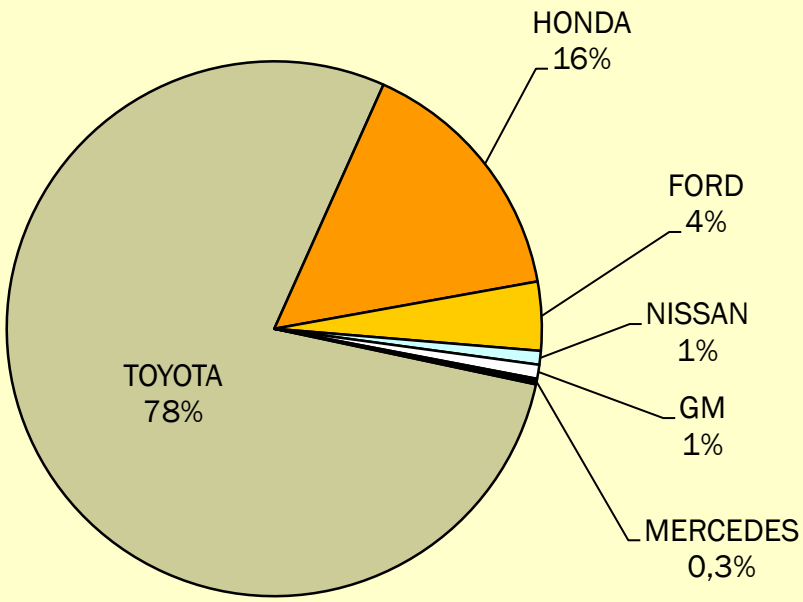
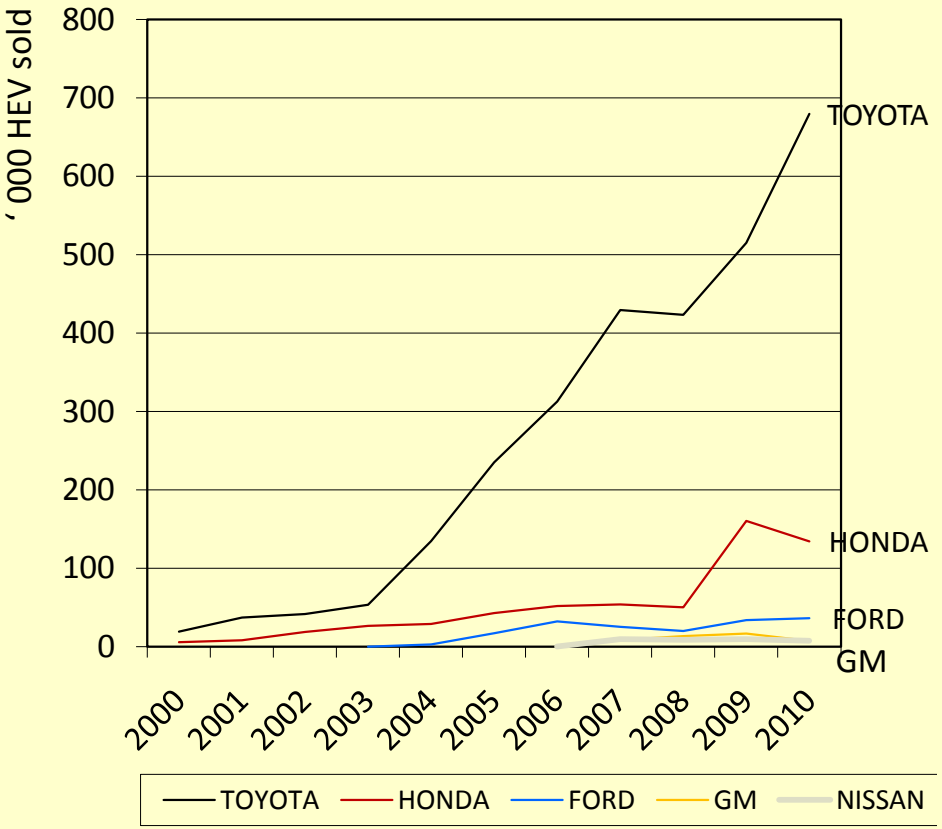
# HEV WORLDWIDE IN 2010

**Total HEV Vehicles:**
**≈ 900 000 units in 2010**




SOURCE : TOYOTA, HONDA, GM, FORD, CHRYSLER

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




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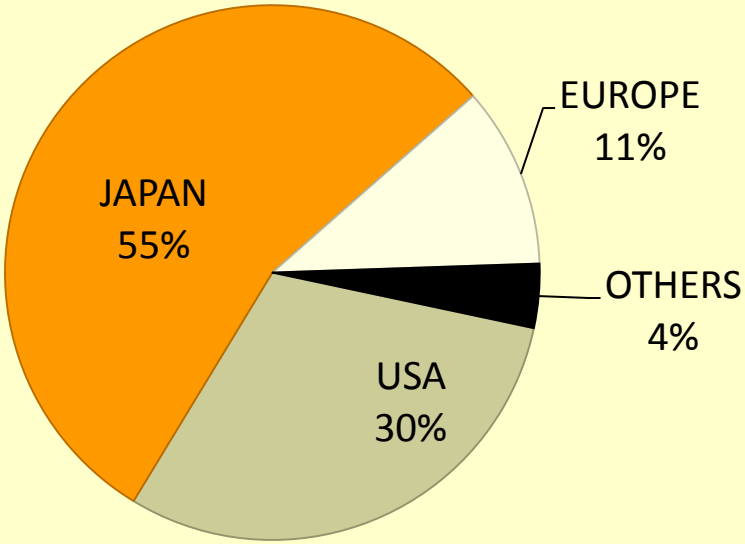


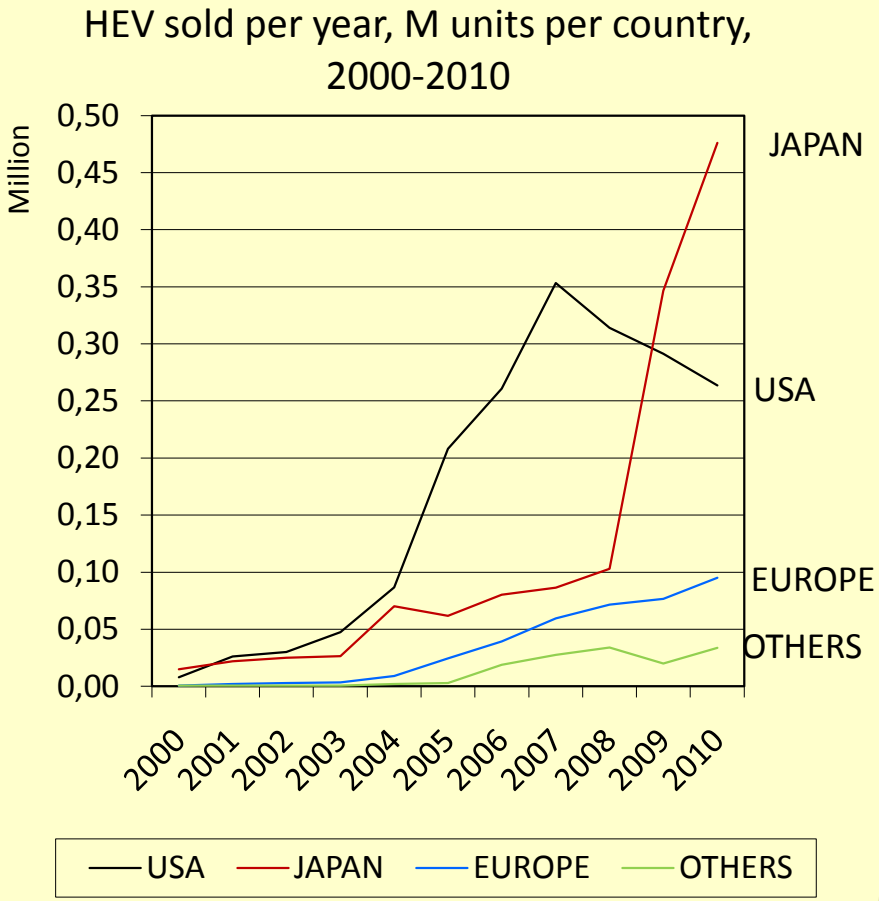


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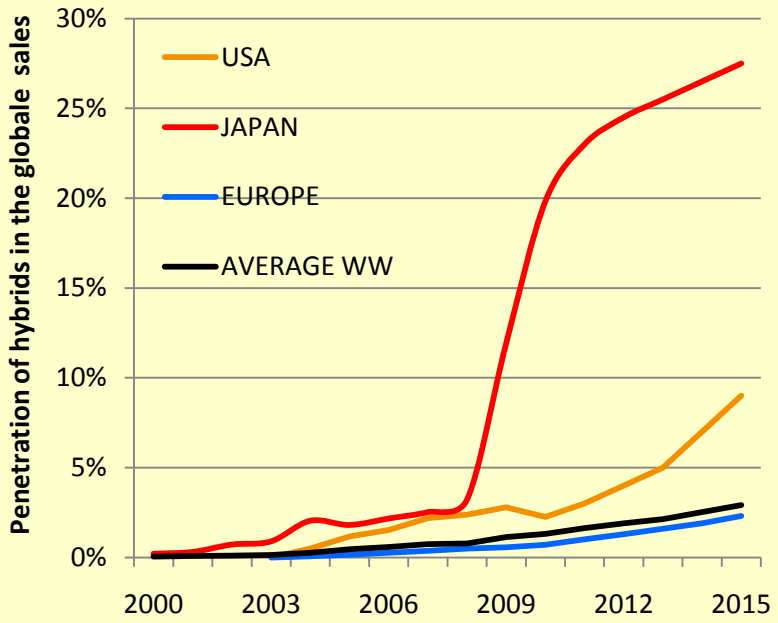
# HEV FORECASTS UP TO 2015

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

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

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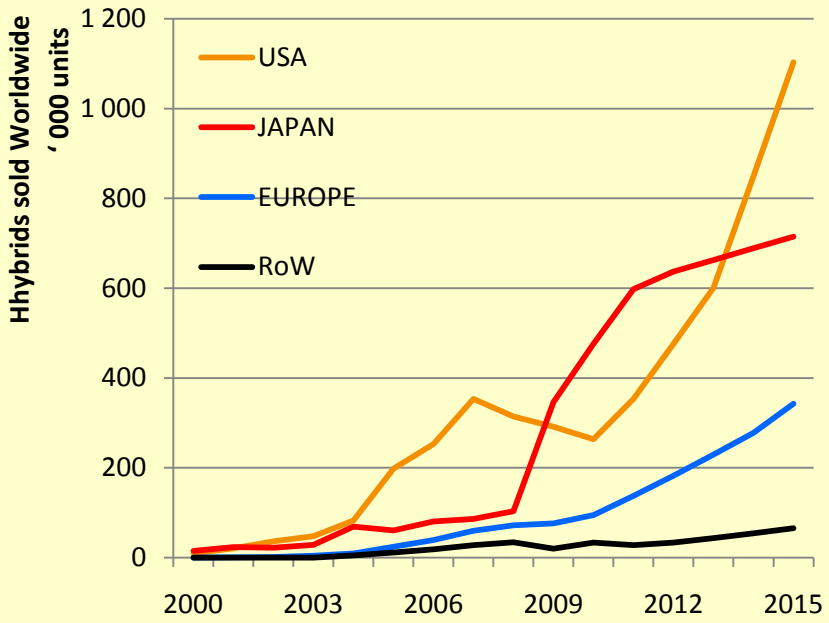


**(1) Assumptions:**
- >75 M vehicle sold WW in 2015
- 3% Hybrids

(2) HEV & hybrid excluding micro hybrids

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


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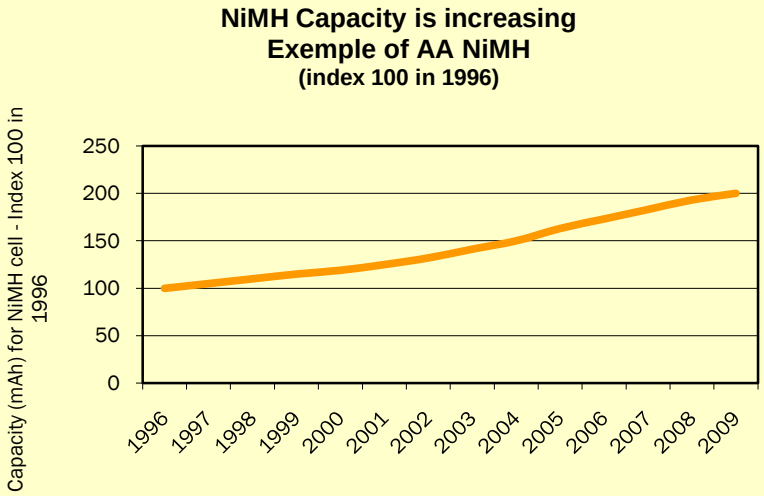
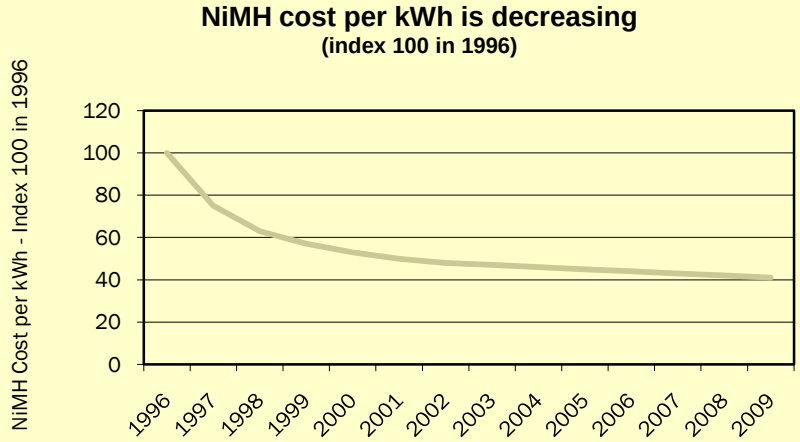
# NIMH BATTERY DEVELOPMENTS




| | PRIUS II | PRIUS III |
|---|---|---|
| Capacity | 6.5 Ah | 6.5 Ah |
| Cells | 228 (38 * 6) | 168 (28 * 6) |
| Voltage | 273.6 v | 201.6 v |
| Specific power | 1000 W/kg | 1300 W/kg |
| Specific energy | 46 Wh/kg | 46 Wh/kg |
| Total power/HEV | 36 kW | 37.8 kW |
| Total energy/HEV | 1778 Wh | 1310 Wh |

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



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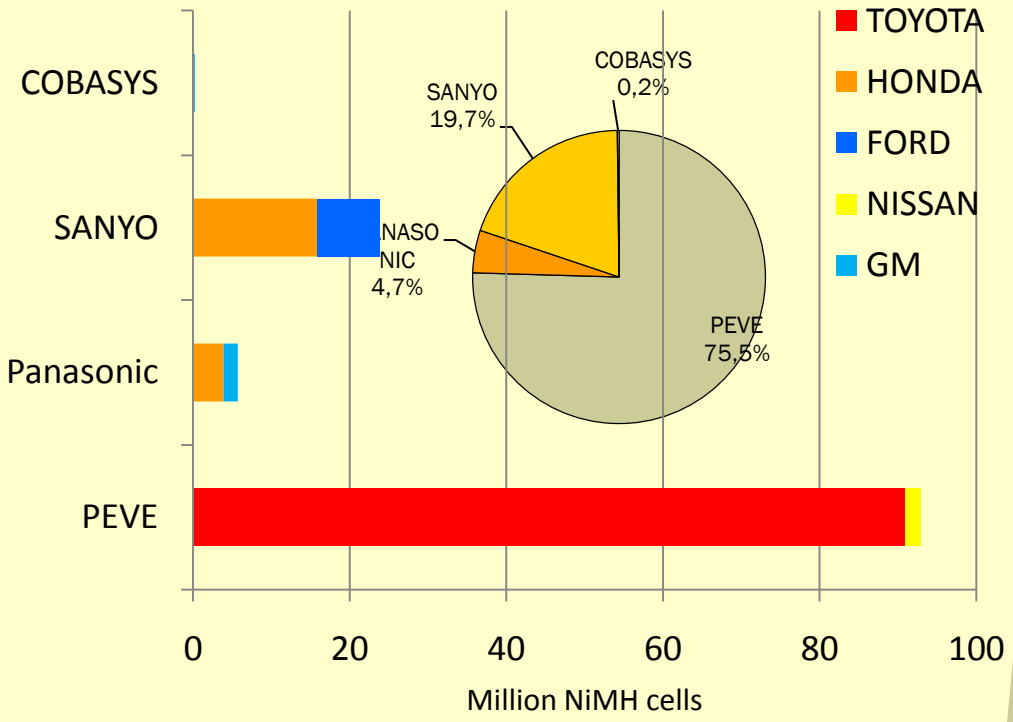
# NIMH BATTERIES FOR HEV IN 2009/2010

**Thanks to TOYOTA, Panasonic EV, got more than 75% of the HEV battery market and a large know-how**

| | | PEVE | SANYO | Panasonic | COBASYS | JCS |
|---|---|---|---|---|---|---|
| PRODUCTION | TOYOTA | ■ | | | | |
| | LEXUS | ■ | | | | |
| | HONDA | | ■ | ■ | | |
| | FORD | | ■ | | | |
| | NISSAN | ■ | | | | |
| | GM | | | ■ | ■ | |
| | BMW | | | | ■ | |
| | DAIMLER | | | | ■ | |
| | CHRYSLER | ■ | | | | |
| DEVELOPMENT | VW | | □ | | | |
| | DAIMLER | | | | | □ |
| | BMW | | □ | | | |
| | PSA | □ | | | | |
| | CHERY | | | | | □ |

■ Supply - □ Development

NiMH battery & Car makers relationships in 2009/2010




SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011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# LI-ION BATTERIES DEVELOPMENTS FOR HEV, P-HEV & EV

- 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...

| | PRIUS III NiMH | PRIUS x - Li-ion |
|---|---|---|
| Volts | 201.6 | 201.6 |
| Cells | 168 (28*6) | 56 |
| Capacity | 6.5 Ah | 3.8 Ah |
| Energy | 1310 Wh | 766 Wh |
| Weight | 38 kg | 25 kg |
| T°C Range | + | + |
| Cyclability | + | ++ |
| Safety | | |
| Cost | | |

## JOINT VENTURE & STRONG PARTNERSHIP

| | TOYOTA | NISSAN | HONDA | FORD | MITSUBISHI | DAIMLER | BYD AUTO | BOSCH | CONTINENTAL | JC |
|---|---|---|---|---|---|---|---|---|---|---|
| PANASONIC | PEVE | | | | | | | | | |
| NEC | | AESC | | | | | | | | |
| GSY | | | JV (HEV) | | LEJ (EV) | | | | | |
| SDI | | | | | | | | SB LiMotive | | |
| SAFT | | | | | | | | | | JV |
| BYD | | | | | | JV in China | HEV, EV | | | |
| ENAX | | | | | | | | | Partner | |
| MAGNA | | | | Partner | | | | | | |



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HEV
P-HEV
EV

# LI-ION BATTERIES DEVELOPMENTS

| | ASIA | | | | | | | | | | USA | | | | | | | EUROPE & AUTRES | | | | | | | | | | | TIERS 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Li-ion | TOYOTA | NISSAN | HONDA | HYUNDAI | MITSUBISHI | BYD Auto | SUBARU | MAZDA | SUZUKI | SAIC | GM | FORD | CHRYSLER | TESLA | BAE | FISKER | KODA (Miles Electric) | DAIMLER | VW | AUDI | BMW | PSA | RENAULT | FIAT | VOLVO | THINK | TATA | PININFARINA | MAGNA | CONTINENTAL | DELPHI | TATA |
| Sanyo | | | | | | | | | | | | C | | C Smart | | | | P | C<br>? | C & P | | | | | | | | | | | | |
| PEVE | C & P<br>C & P<br>Pack | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AESC (Nec-Nissan) | | C & P<br>C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| JC-SAFT | | | | | | | | | | | | | | | | | | C Pack Continental | | | | | | | | | | | | C | | |
| BEJ -Blue Energy Japan<br>GSY - HONDA | | | P<br>Cell<br>Yuasa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| A123 | | | | | | | | | | JV | | | | | c & p | | | ? | | | c & p | | | | | | | | C | | | |
| LiTec - Evonik | EV | | | | | | | | | | | | | | | | | ? | ? | | | | | | | | | | | | | |
| LG | | ? | | C & P | | | | | | | C<br>C | | | | | | | | | | ? | | | | | | | | | | | |
| LEJ (GSY-Mitsubishi) | | | | | C<br>? | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SB LiMotive (SDI-BOSCH) | | | ? | ? | | | | | | | | | | cells ? | | | | | ?<br>? | | Megac | ? | | | | | | | | | Cells | |
| ENAX - CONTINENTAL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MAGNA | | | | | | | | | | | | P | | | | | | | | | | Pack | | | | | | | | | | |
| GAIA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GSY | | | | | | | | | | | | | | | | | | | | | | Cells | | | | | | | | | | |
| TOSHIBA | | | Test | | | | | | | | | | | | | | | | C | | | | | ? | | | | | | | | |
| BYD | | | | | | | | | | | | | | | | | | China JV | | | | | | | | | | | | | | |
| HITACHI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BATSCAP (BOLLORE-EDF) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SK Energy | | | | ? | | | | | | | | | | | | | | HEV<br>EV | | | | | | | | | | | | | | |
| TESLA | | | | | | | | | | | | | | | | | | C Smart | | | | | | | | | | | | | | |
| CONTINENTAL | | | | | | | | | | | | | | | | | | P Mercedes S400 | | | | | | | | | | | | | | |
| ALP/E-One | | | | | | | | | | | | | | | | Cells | | | | | mini | | | | | | | | | | | |
| Enerdel (Delphi 19,5%) | | | | | | | | | | | | | | | | | | | | | ? | | | | | | | | | | | |
| RENAULT/AESC/CEA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Panasonic/Tesla | ? | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sony | | | | | | | | | | | | | | Cells ? | | | | | | | | | | | | | | | | | | |
| Lishen | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HITACHI MAXELL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MAXELL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EIG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | C & P |



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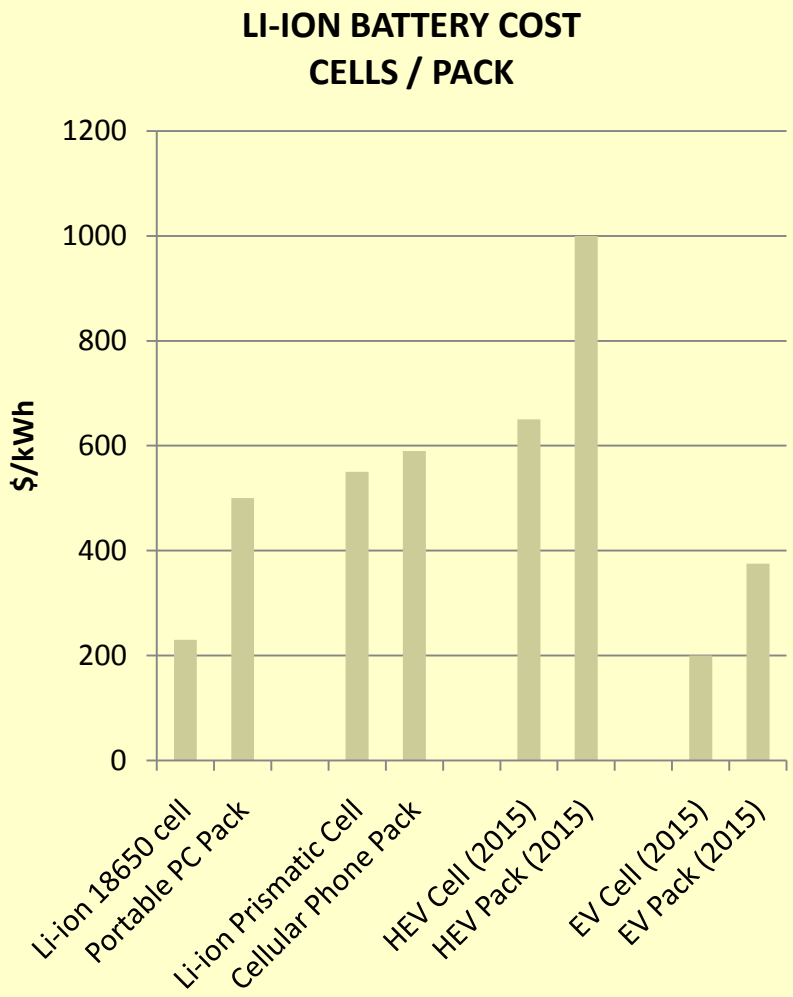
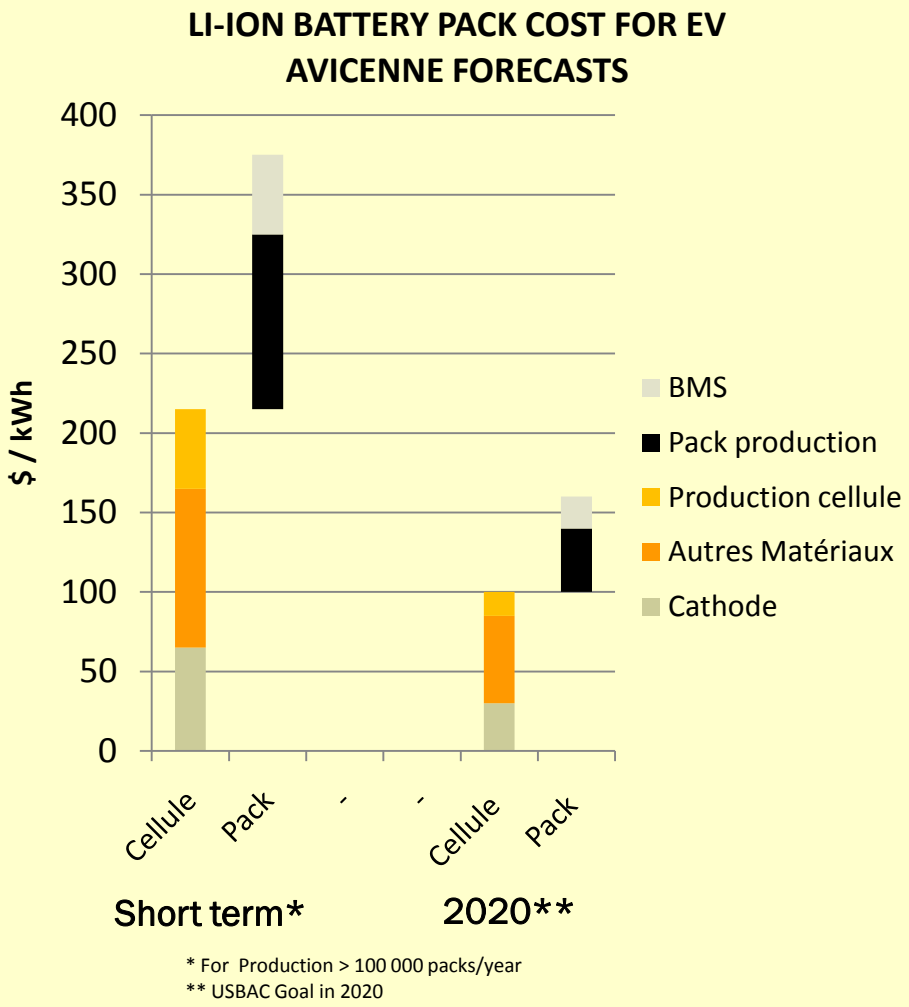
# LI-ION BATTERY COST




* For Production > 100 000 packs/year
** USBAC Goal in 2020

*Source : AVICENNE Compilation, March 2011*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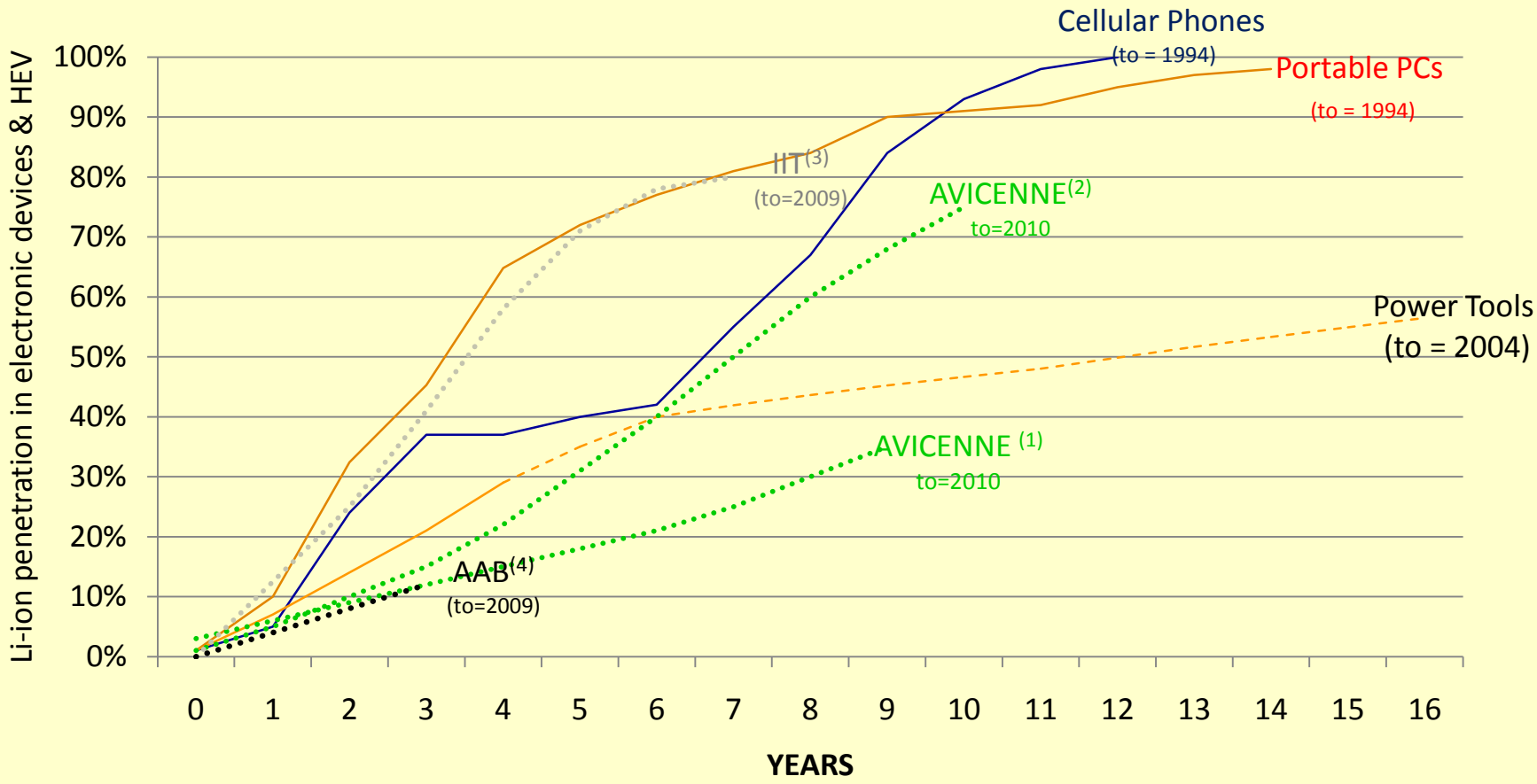
# LI-ION PENETRATION IN VARIOUS DEVICES AVICENNE & OTHER ANALYSTS FORECAST




(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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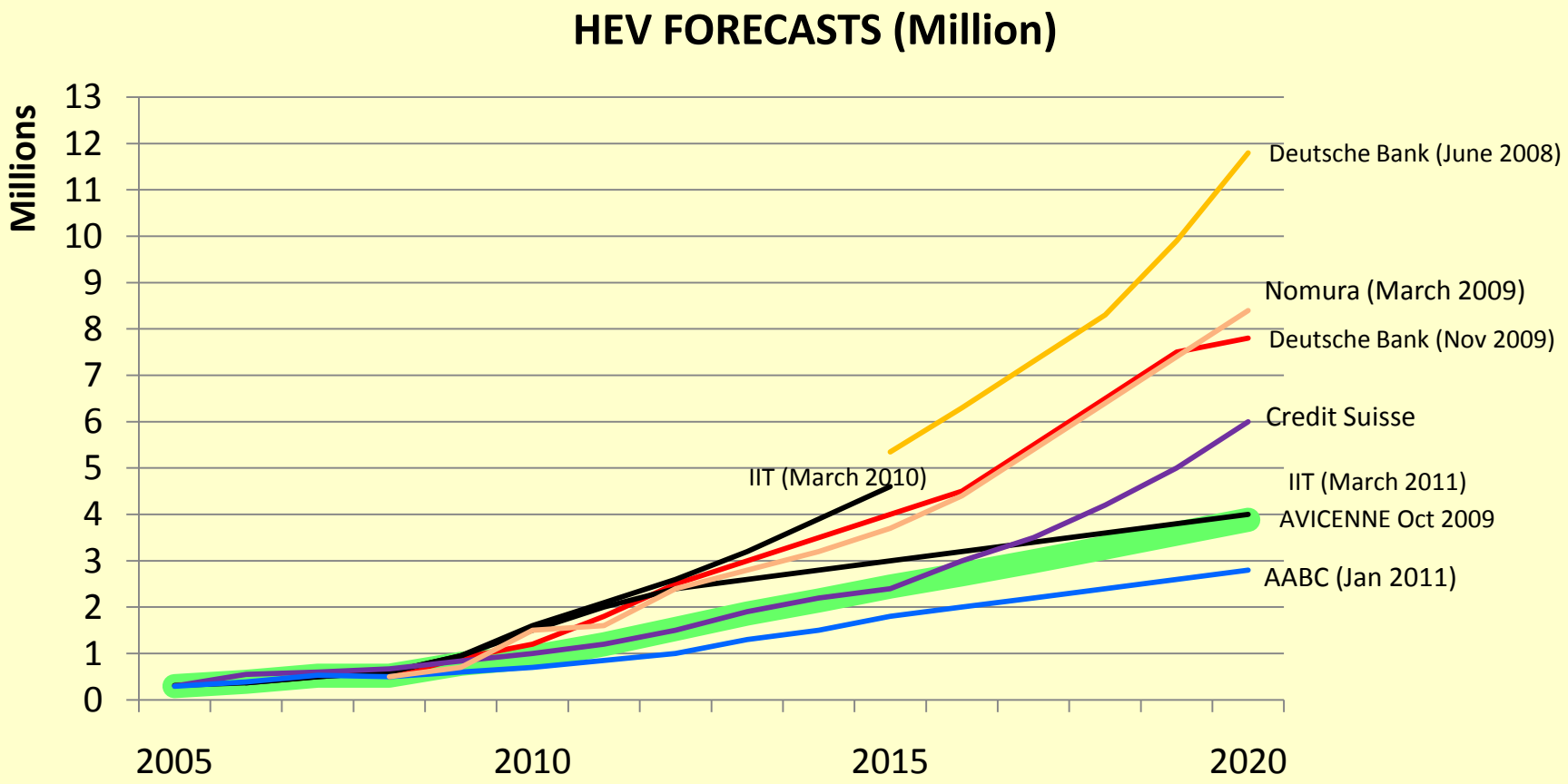
# LONG TERM HEV FORECAST FROM 3 TO 8 M HEV IN 2020




SOURCE: AVICENNE COMPILATION, MARCH 2011



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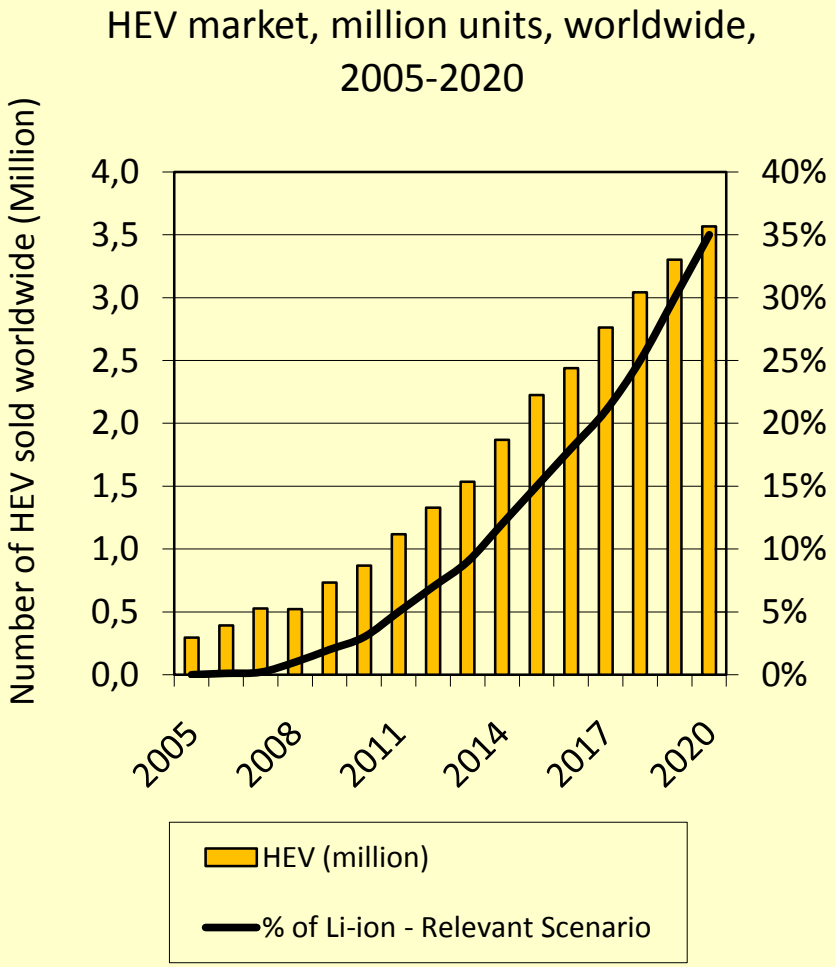
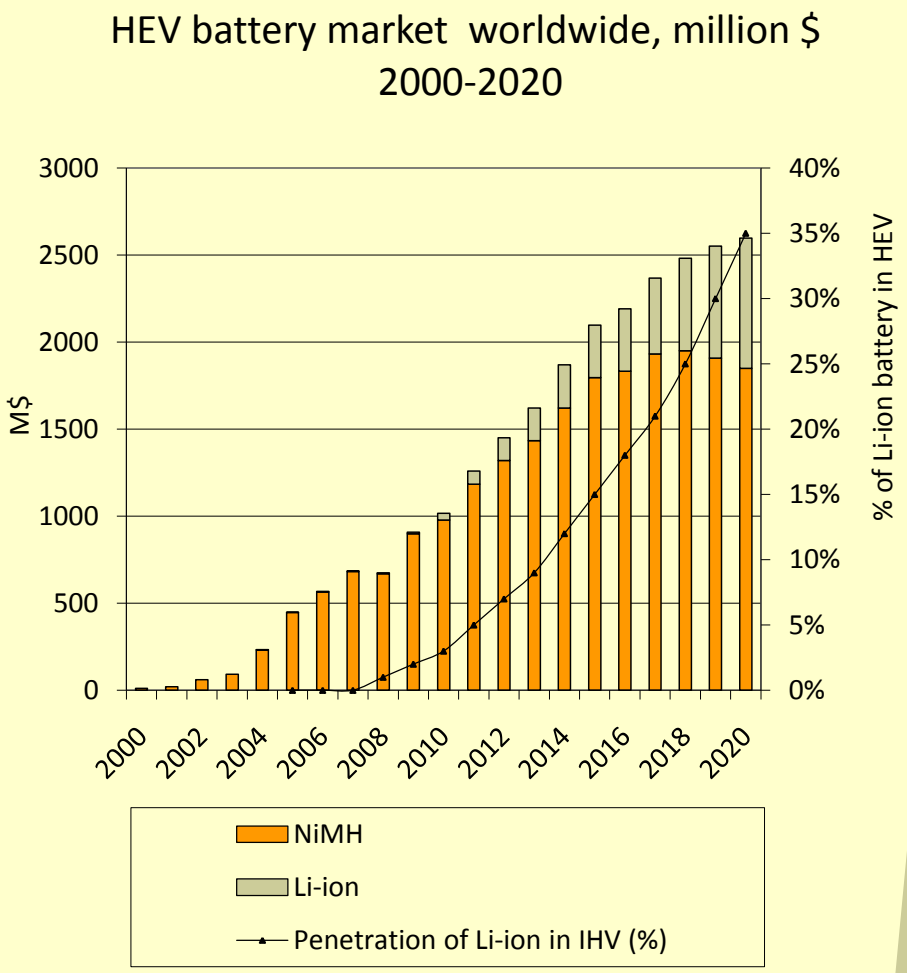
# LONG TERM HEV BATTERY FORECASTS




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

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



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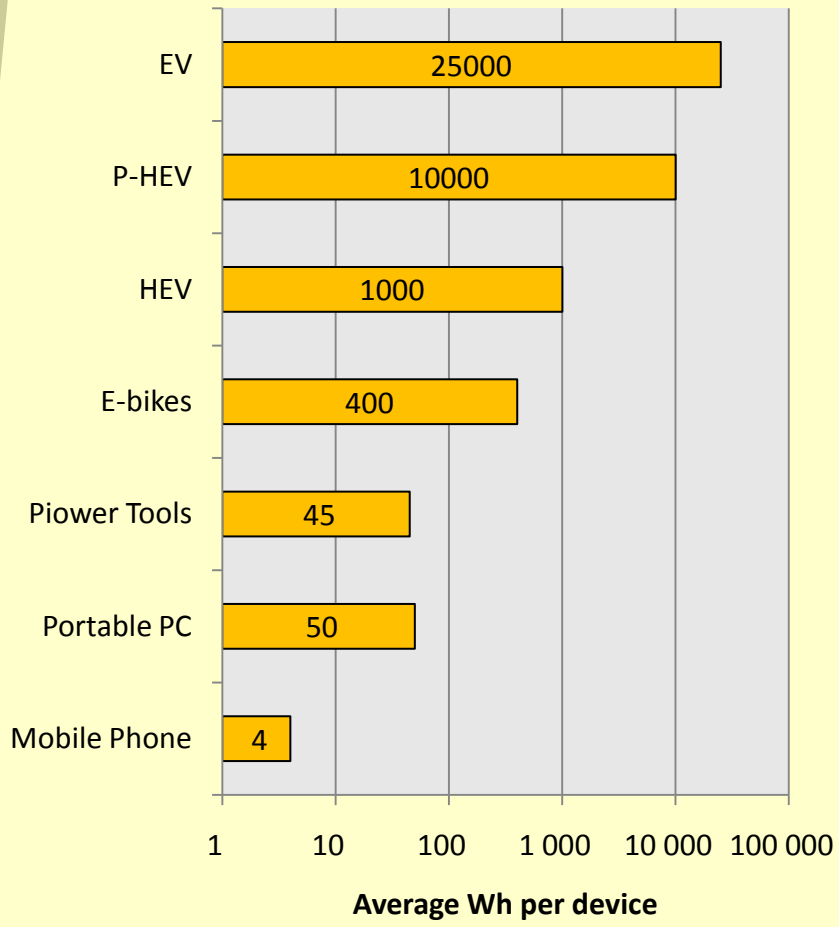
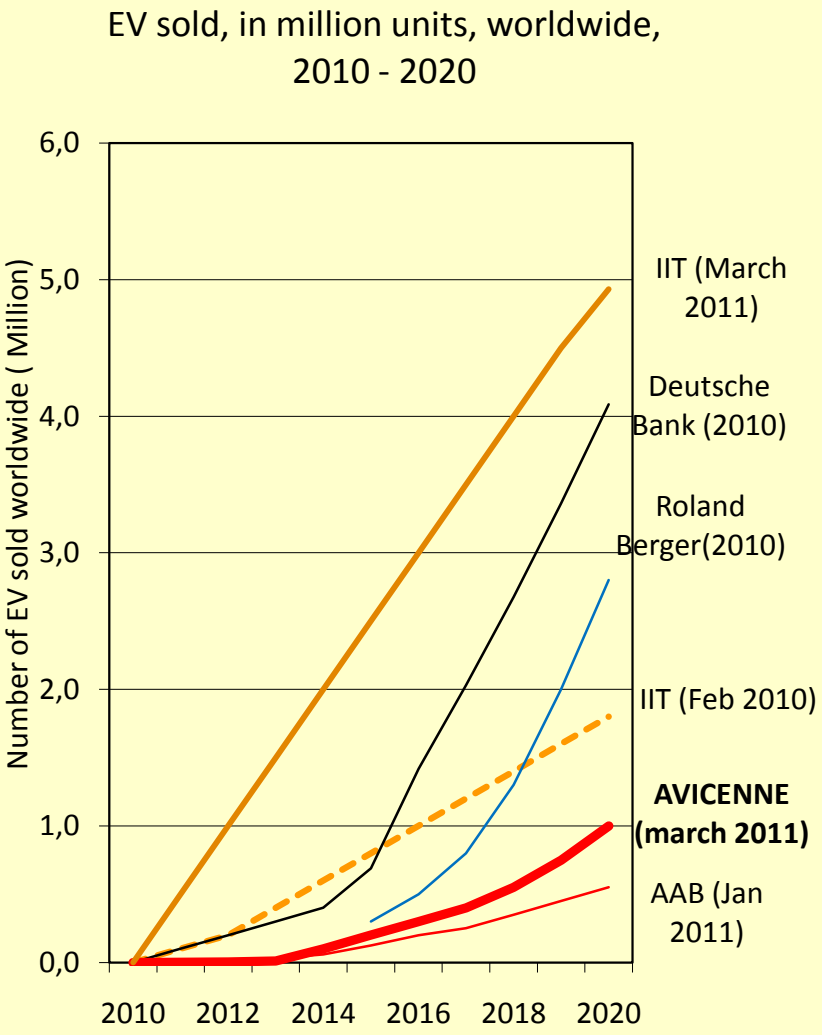
# HEV, P-HEV & EV LONG TERM FORECASTS
# EV ENERGY NEED: 25 MORE THAN HEV!




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



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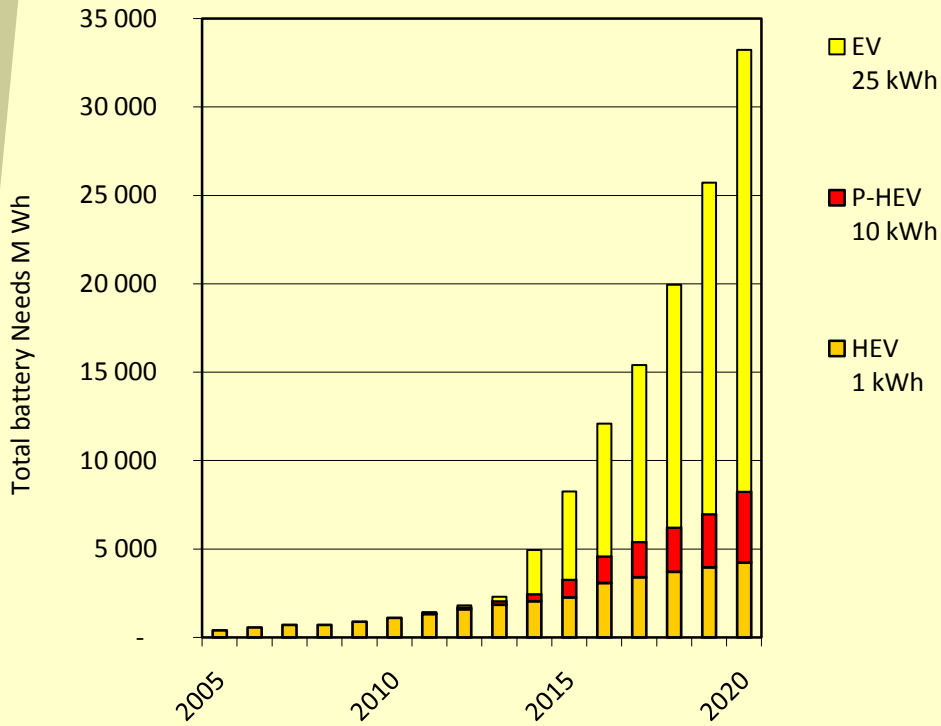
# TOTAL LIB DEMAND

Information for growth

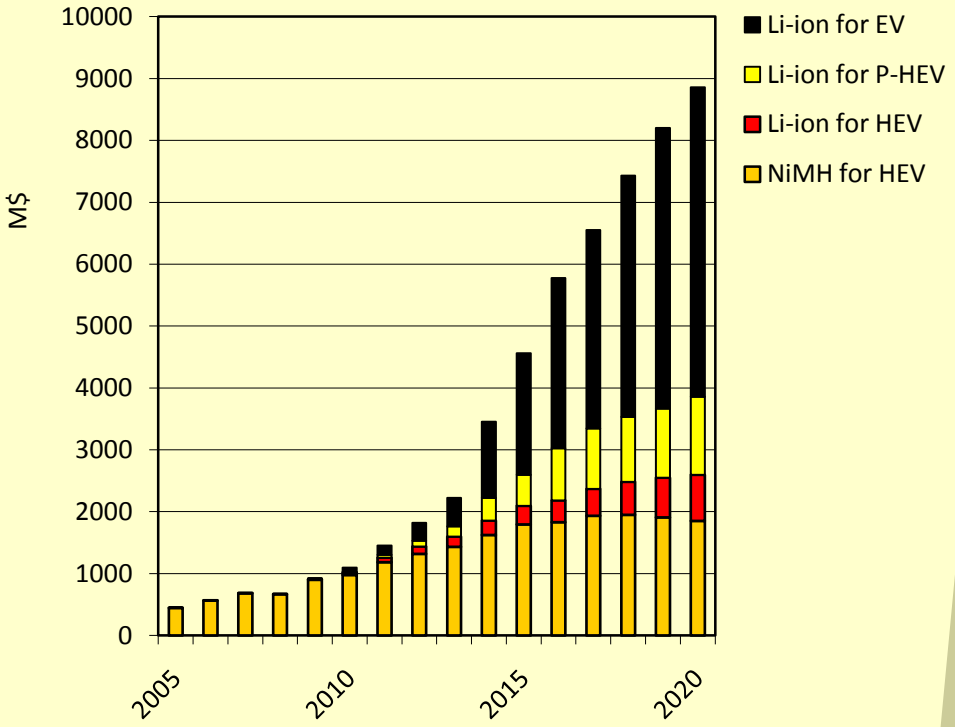
**Assumptions**

| 200 000 EV in 2015<br>1M in 2020<br>100% Li-ion | 0.1 M P-HEV in 2015<br>0.4 M in 2020<br>100% Li-ion | 2,2 M HEV in 2015<br>3,5 M in 2020<br>35% Li-ion in 2020 |
|---|---|---|

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




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




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



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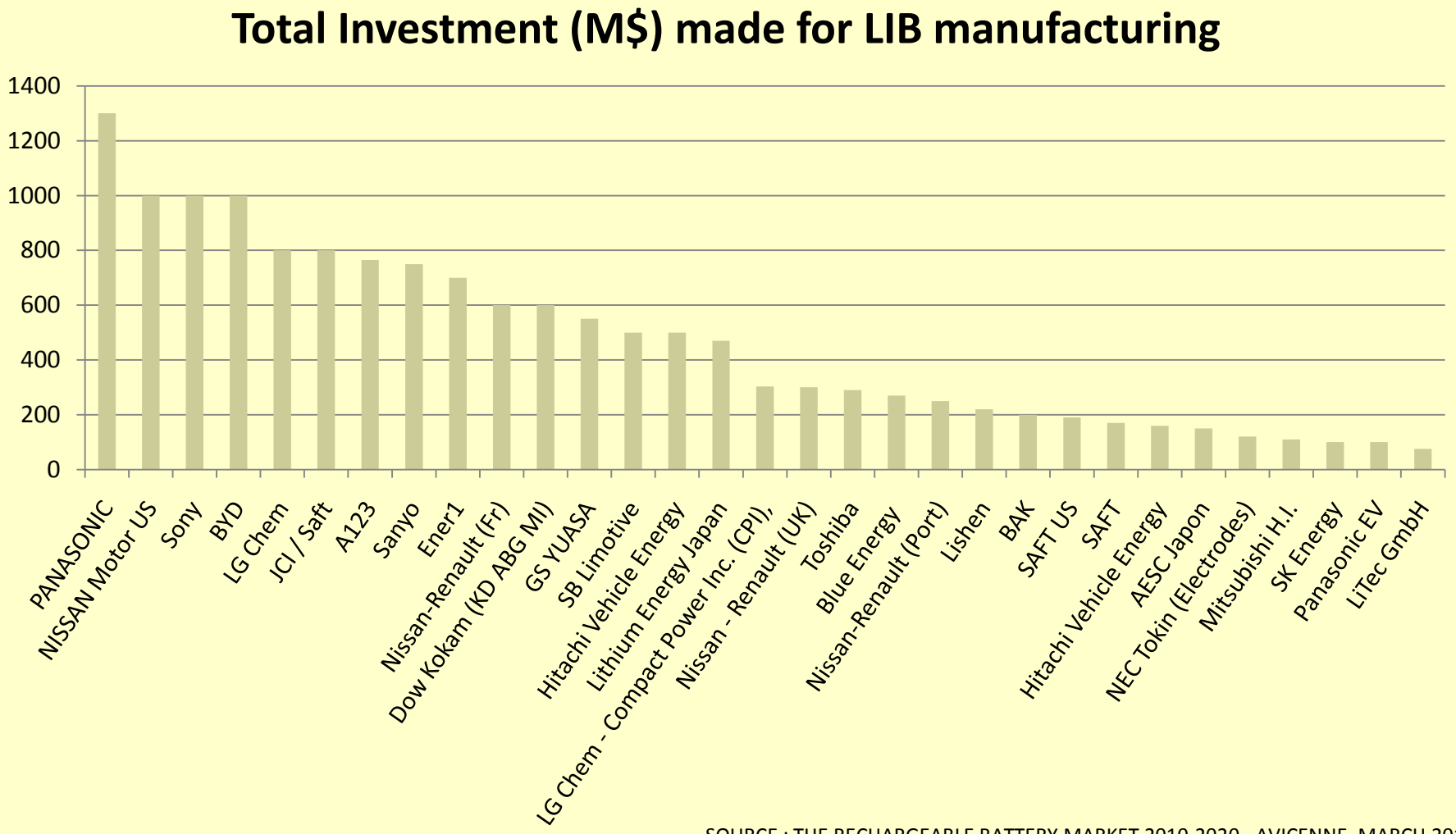
# LIB MANUFACTURING INVESTMENT 2009-2015
# 10-12 B$ WORLDWIDE / >50 GWH IN 2015




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



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# ANNOUNCED INVESTMENT WILL RESULT IN SIGNIFICANT OVERCAPACITY

Assumptions

| 200 000 EV in 2015<br>1M in 2020<br>100% Li-ion | 0.1 M P-HEV in 2015<br>0.4 M in 2020<br>100% Li-ion | 2,2 M HEV in 2015<br>3,5 M in 2020<br>35% Li-ion in 2020 |
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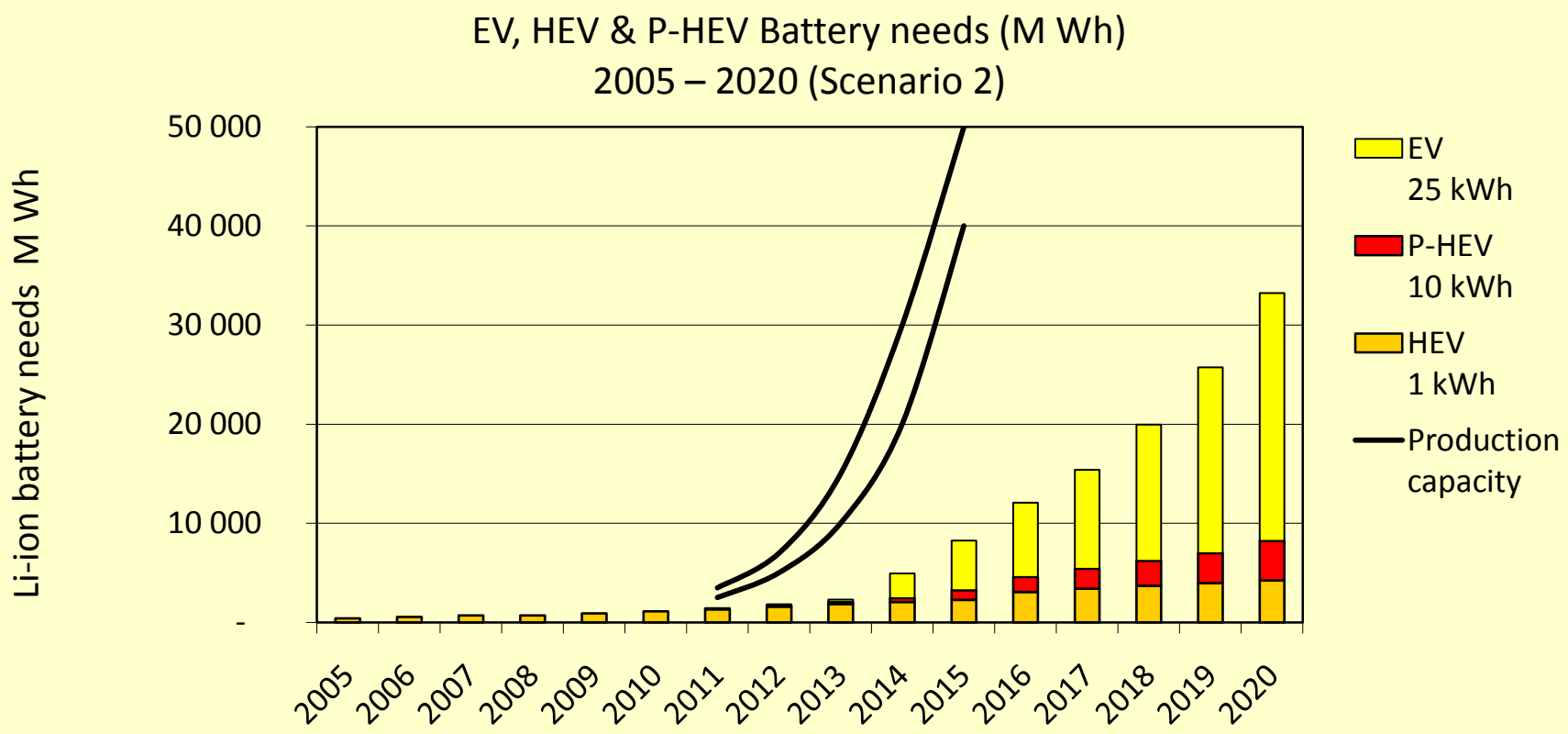


SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011



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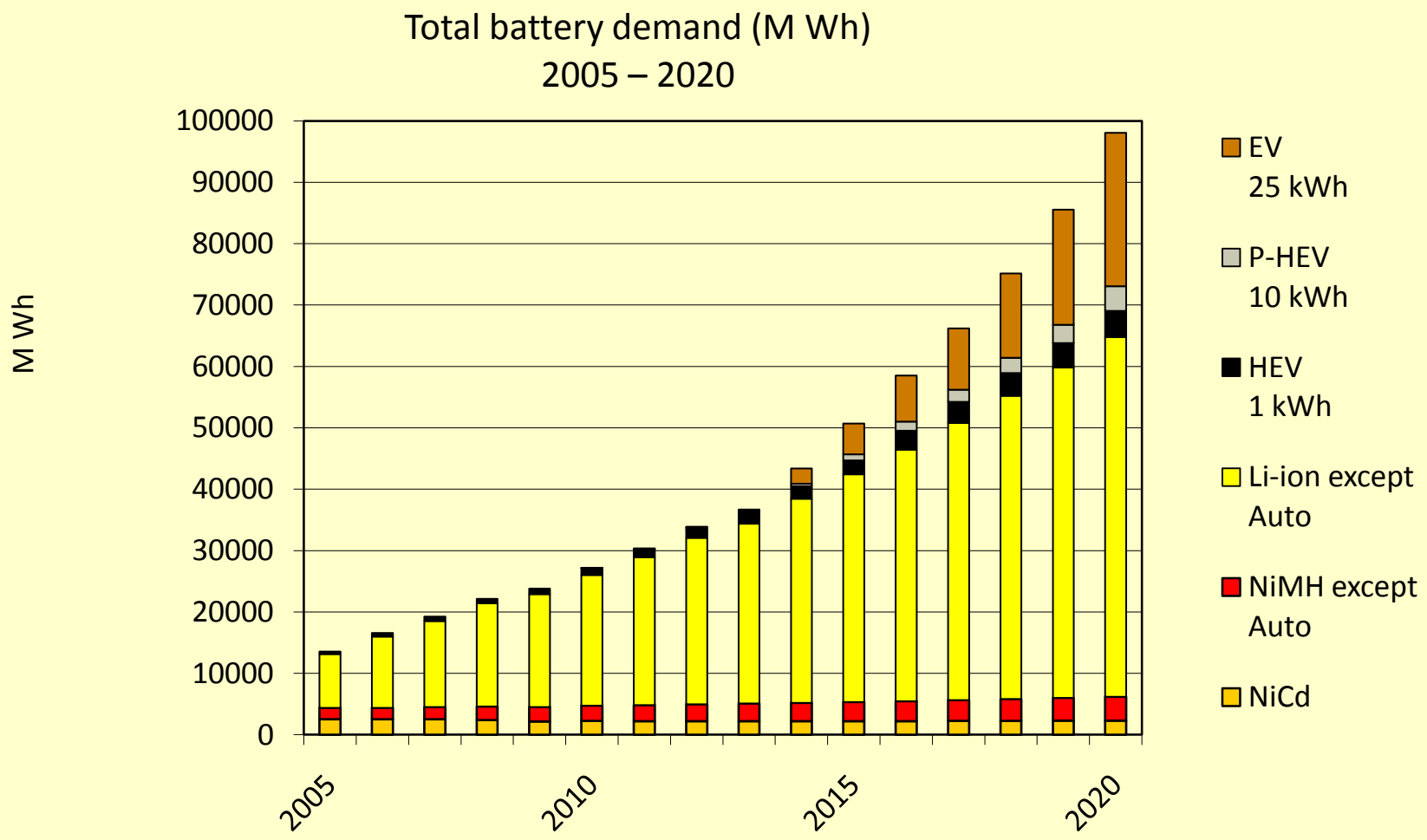
# TOTAL BATTERY DEMAND 2005-2020





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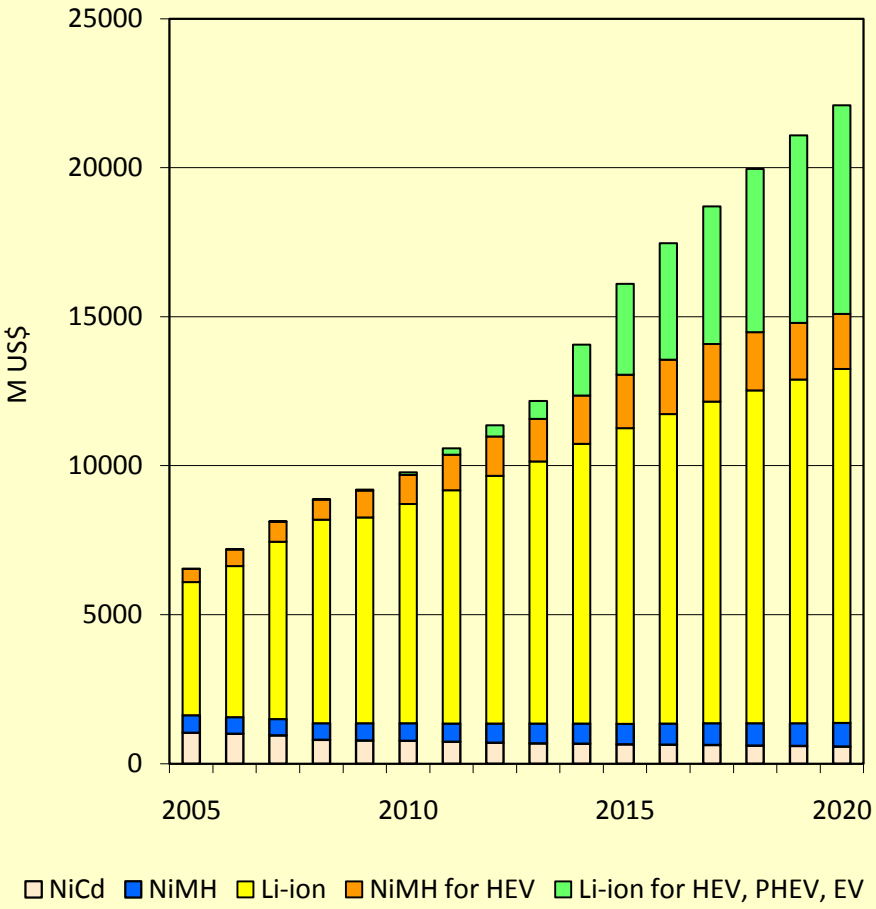
# TAKEAWAYS

- 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.

RECHARGEABLE BATTERY MARKET M US$, Worldwide, 2005-2020 - PACK LEVEL (S2)




SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011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# IMPACT OF A DISASTER

## LIB MATERIALS

**Cathode market share**

**Anode market share**

**Separator market share**

**Electrolyte market share**

## BATTERIES

**LIB market share**

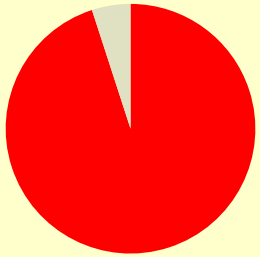
**NiMH market share**

**NiCd market share**

## APPLICATIONS

**Batteries for HEV, PHEV, EV market share**

**HEV, PHEV, EV market share**



JAPAN

OTHERS



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AVICENNE Développement

*Information for growth*

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Thank you !

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