

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

Christophe PILLOT

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4TH International Congress on Automotive Battery Technology

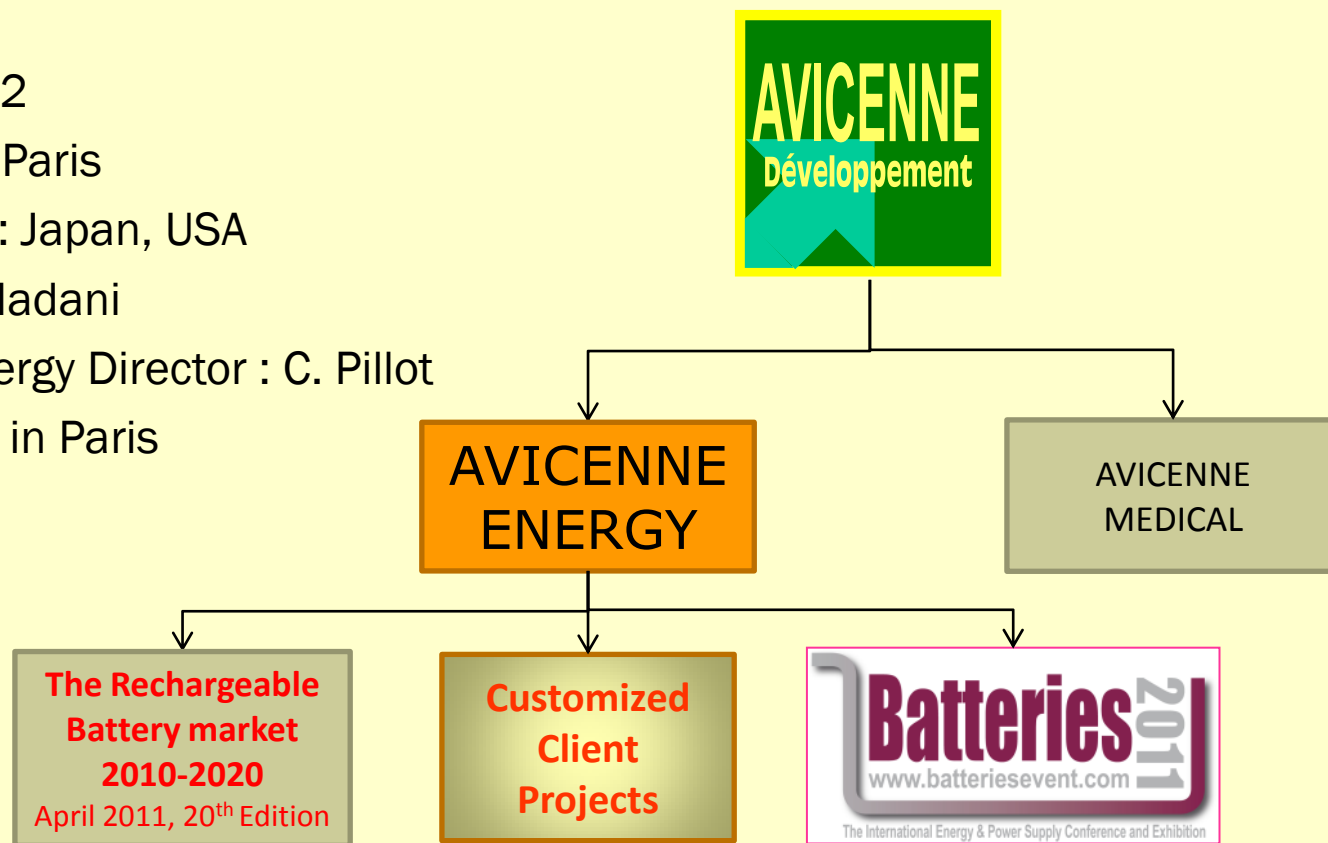
Dorint Pallas Wiesbaden, Germany

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



METHODOLOGY: EXTENSIVE FIELD RESEARCH TO RETRIEVE & CROSS CHECK INFORMATION

Top management contact network



Conferences & Exhibitions



2nd Int'l Rechargeable Battery Expo
BATTERY JAPAN



CIBF2010
9th China International Battery Fair

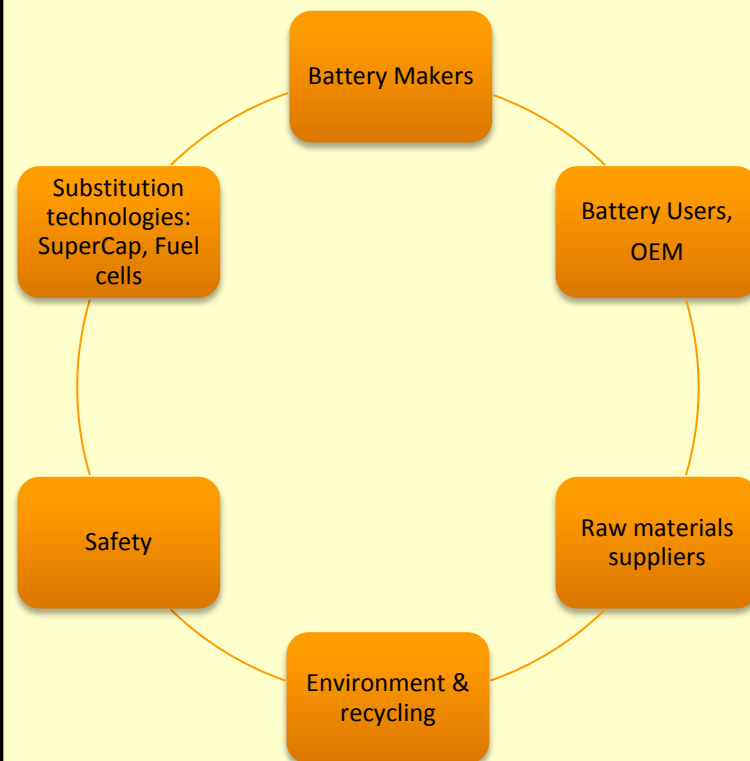
JAPAN ELECTRONICS SHOW

CeBIT

In Depth analysis Of applications



Cross Check Analysis



MORE THAN 100 REFERENCES WORLDWIDE

Information for growth

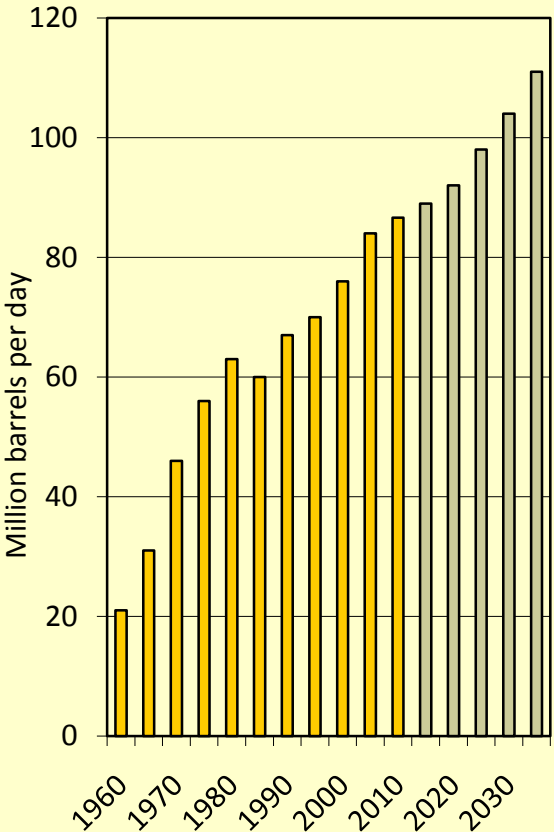
➤ A123	➤ Dialog Semiconductor	➤ ITRI	➤ Rhodia
➤ Air Liquide	➤ Dow Chemical	➤ ITS	➤ Saft
➤ Air Product	➤ Dupont	➤ Johnson Controls	➤ Samsung SDI
➤ Alcatel	➤ Duracell	➤ JBC	➤ Sanik
➤ Amperex (ATL)	➤ EDF	➤ Kodak	➤ Schroder Venture
➤ Aros Securities	➤ Electro Energy	➤ Kruger	➤ Scotent Enterprise
➤ ARC	➤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

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

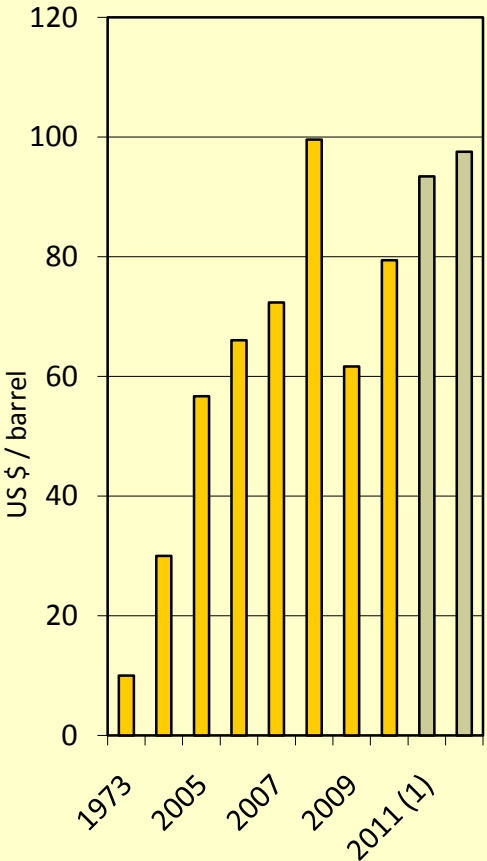
- Impact of the financial & economic crisis on the HEV market & the PHEV or EV developments?
- Will the HEV penetration continue ? Where is the limit?
- Car suppliers strategy for HEV, PHEV & EV? Do they believe in those markets?
- What are the main market drivers & limiters?
- When will Li-ion appeared 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?

Petroleum consumption worldwide 1960-2009



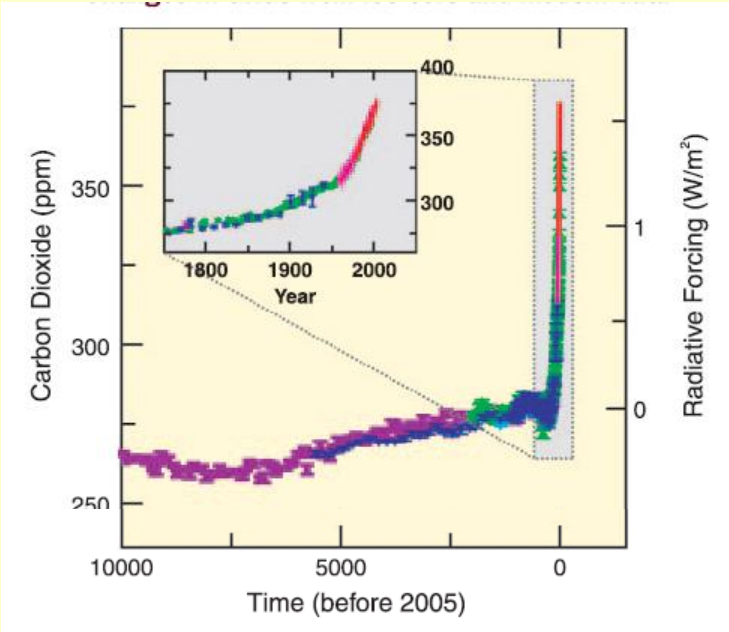
Source :Energy Information Administration, US Government

Price of the WTI barrel of oil, US \$



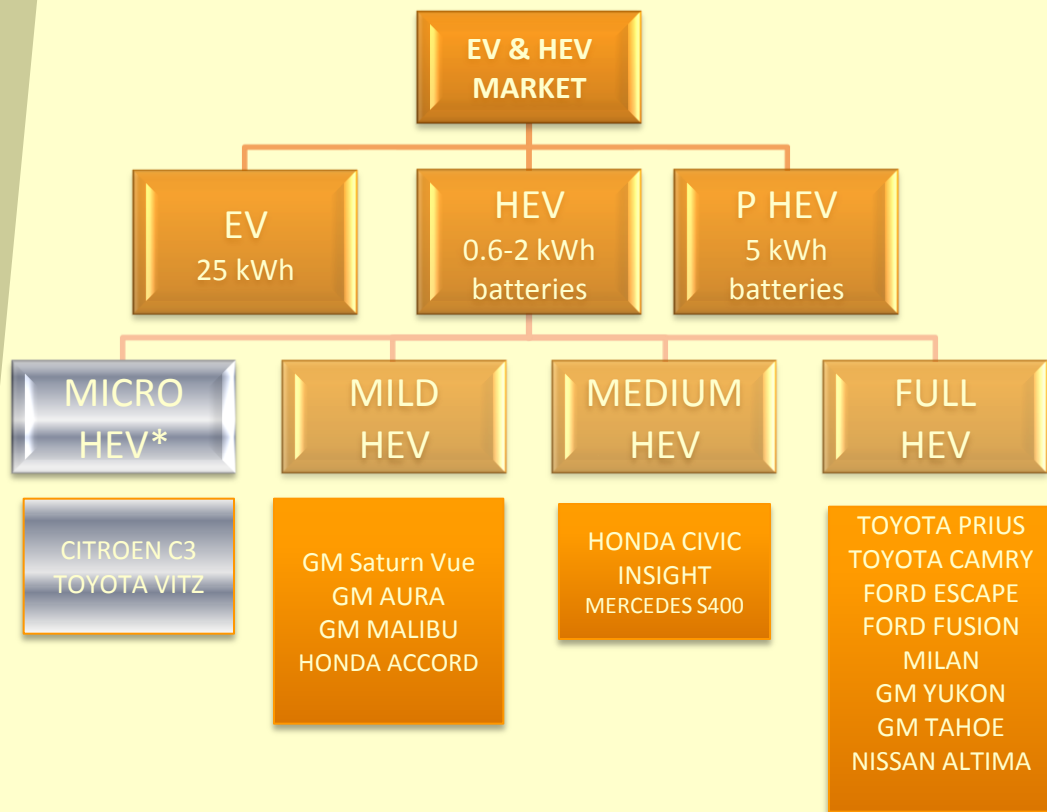
Source :<http://www.eia.doe.gov/emeu/steo/pub/contents.html>
(1) Estimations

CO₂ density in the atmosphere increase



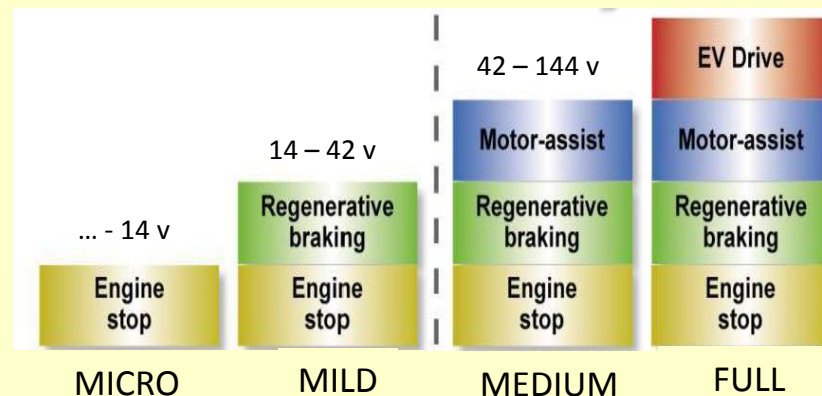
IPCC, Intergovernmental Panel on Climate Change, Climate Change 2007, Synthesis Report p38

HEV, P-HEV & EV DEFINITION & SEGMENTATION

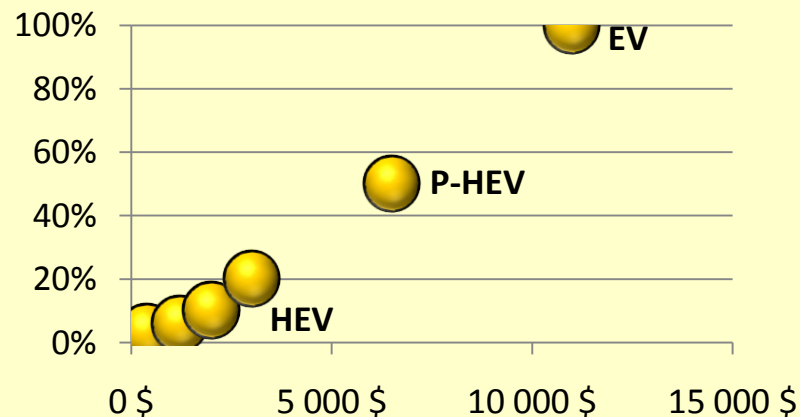


HYBRID LEVELS:

> 144 v



Fuel saving Vs. Cost



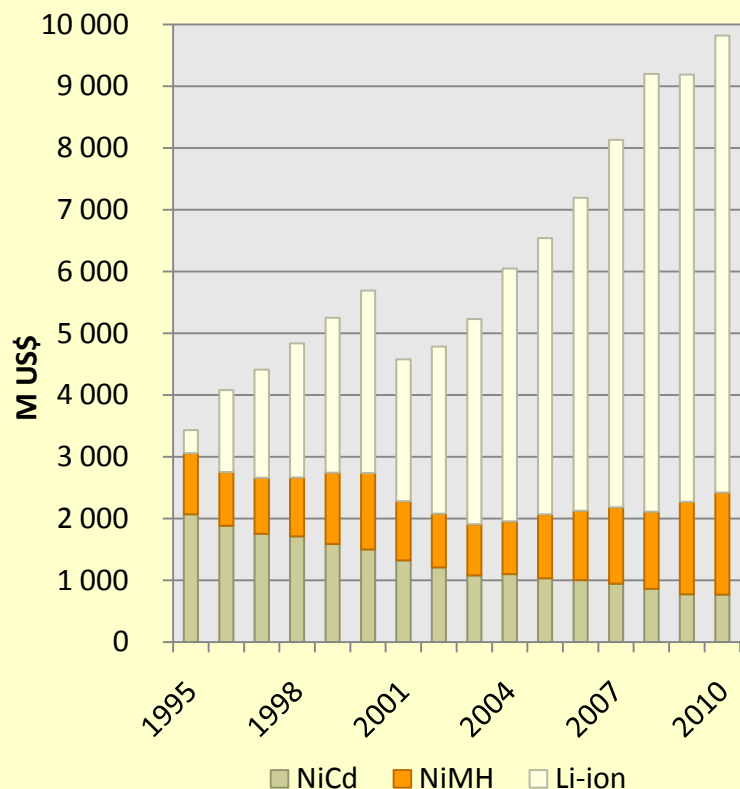
*Note: Micro HEV are not in the HEV statistics & HEV forecast

THE RECHARGEABLE BATTERY MARKET IN 2010

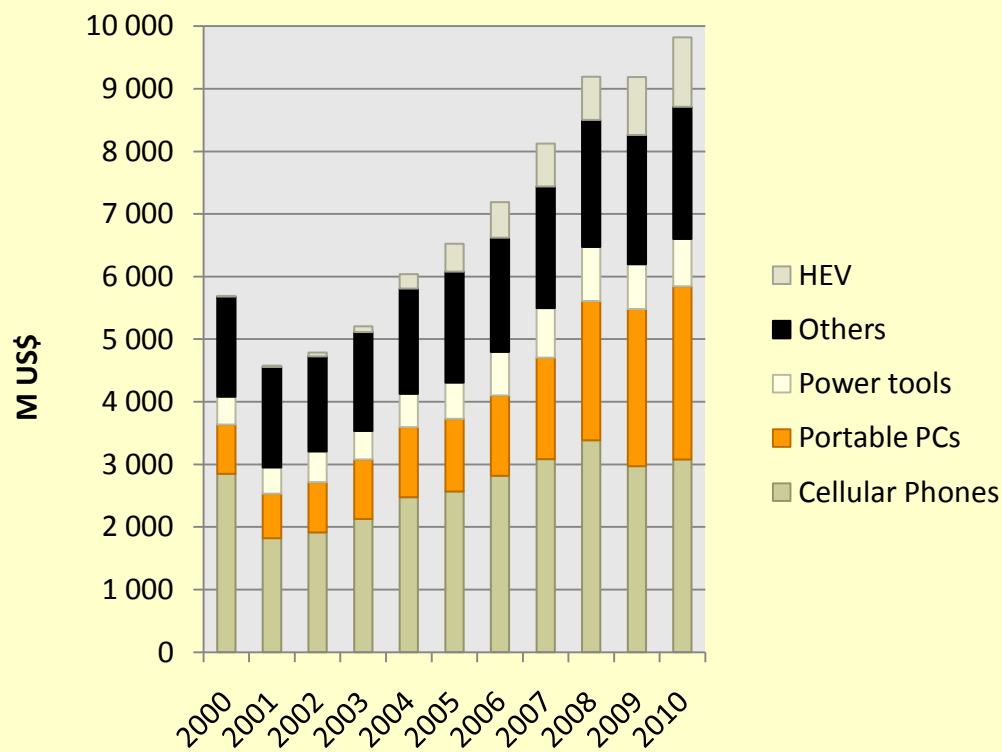
VALUE IN M\$

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

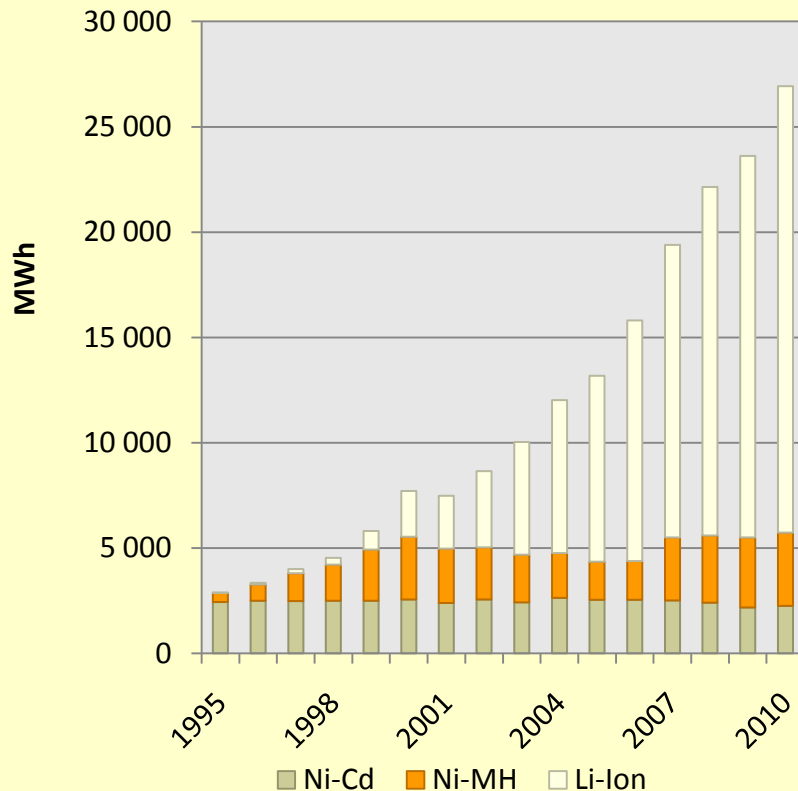
THE RECHARGEABLE BATTERY MARKET IN 2009

VOLUME IN MWh

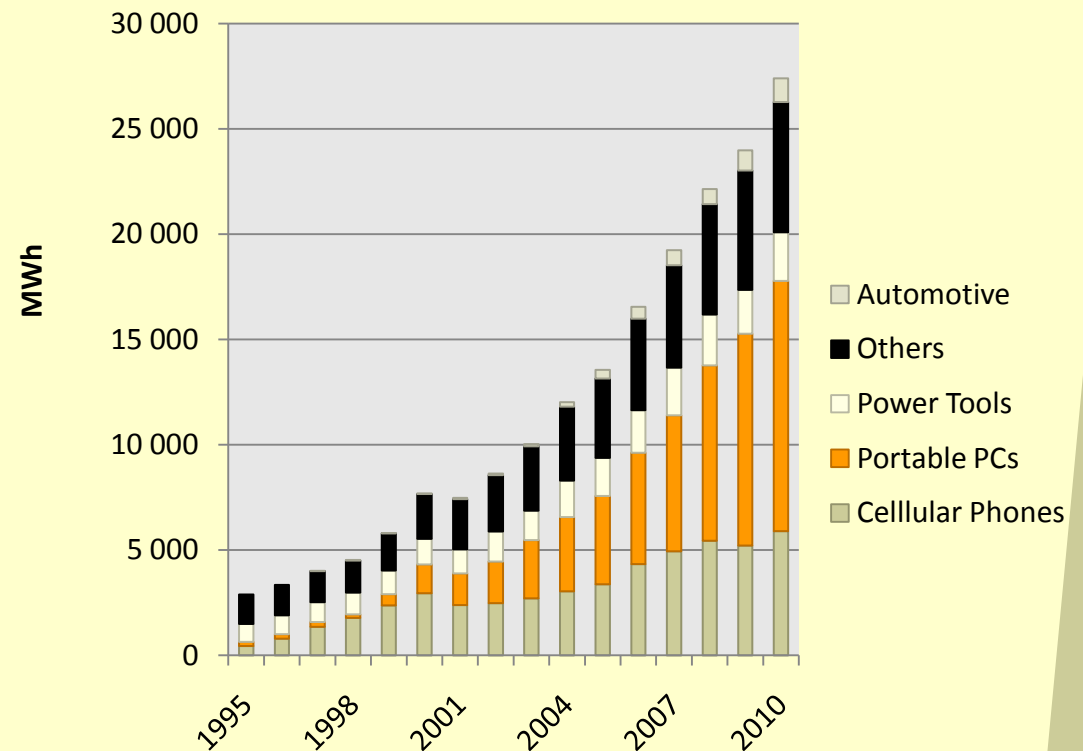
Information for growth

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

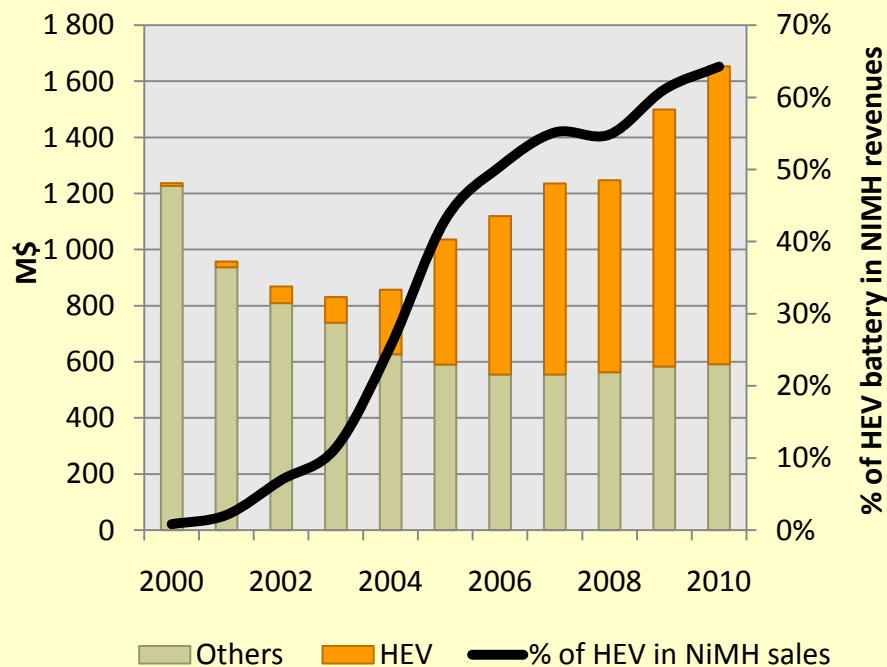
NIMH IN 2010

MAIN APPLICATION: HEV

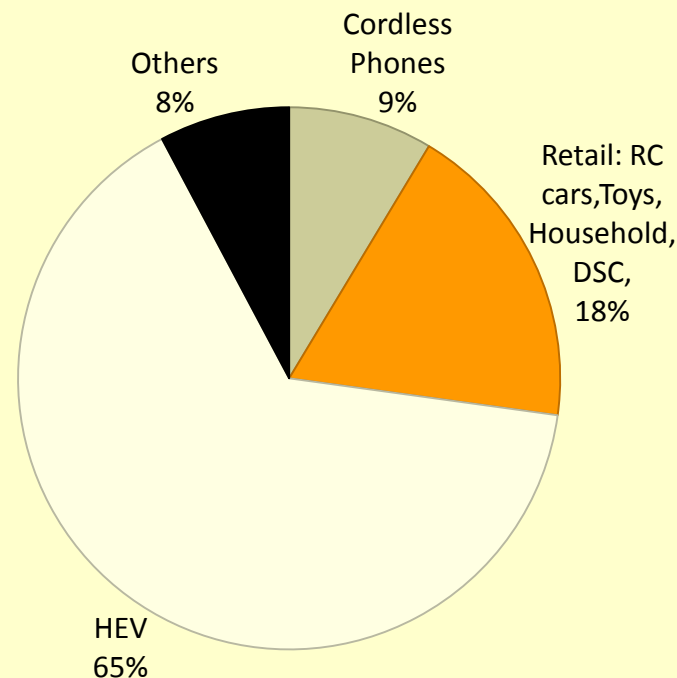
1 200 M NiMH cells – 3 500 MWh
1.65 B\$

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

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



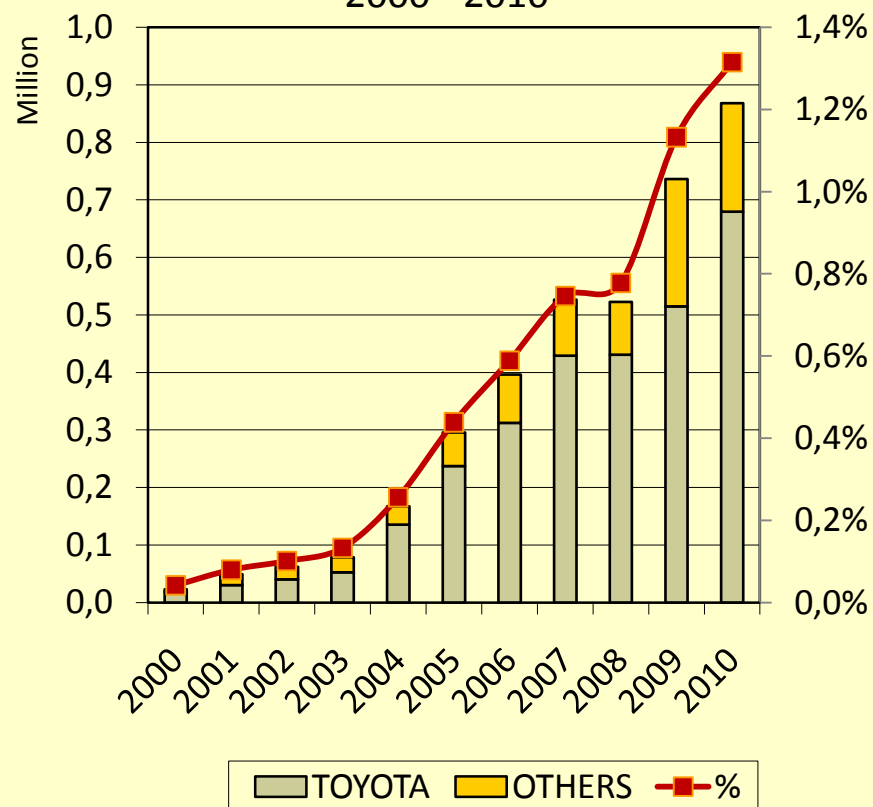
NiMH battery by applications, worldwide, % in value, 2010



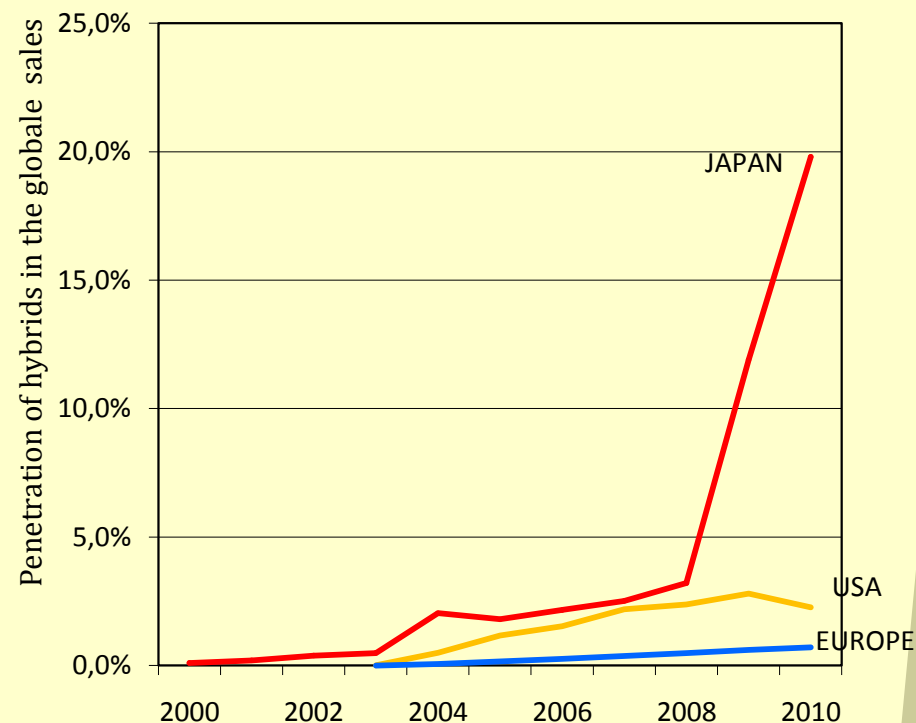
SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011

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

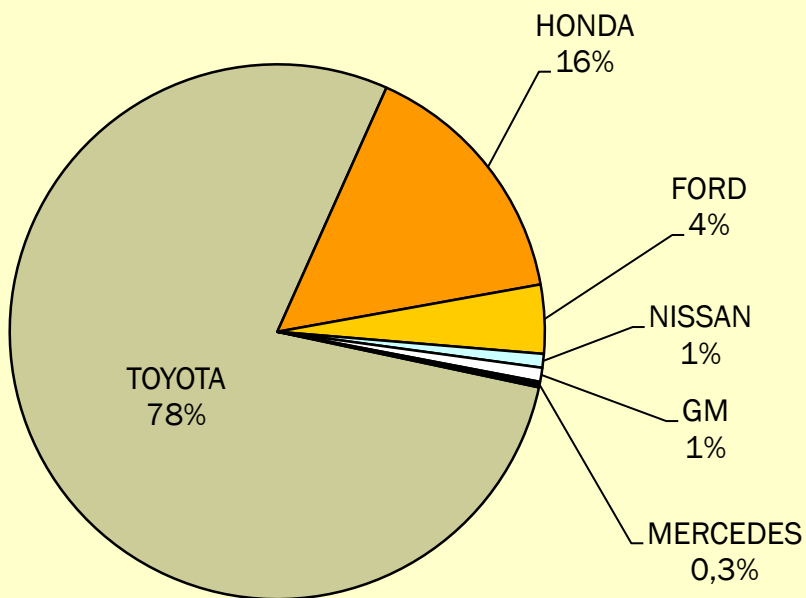


Note: Micro HEV are not in the HEV statistics & HEV forecast

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

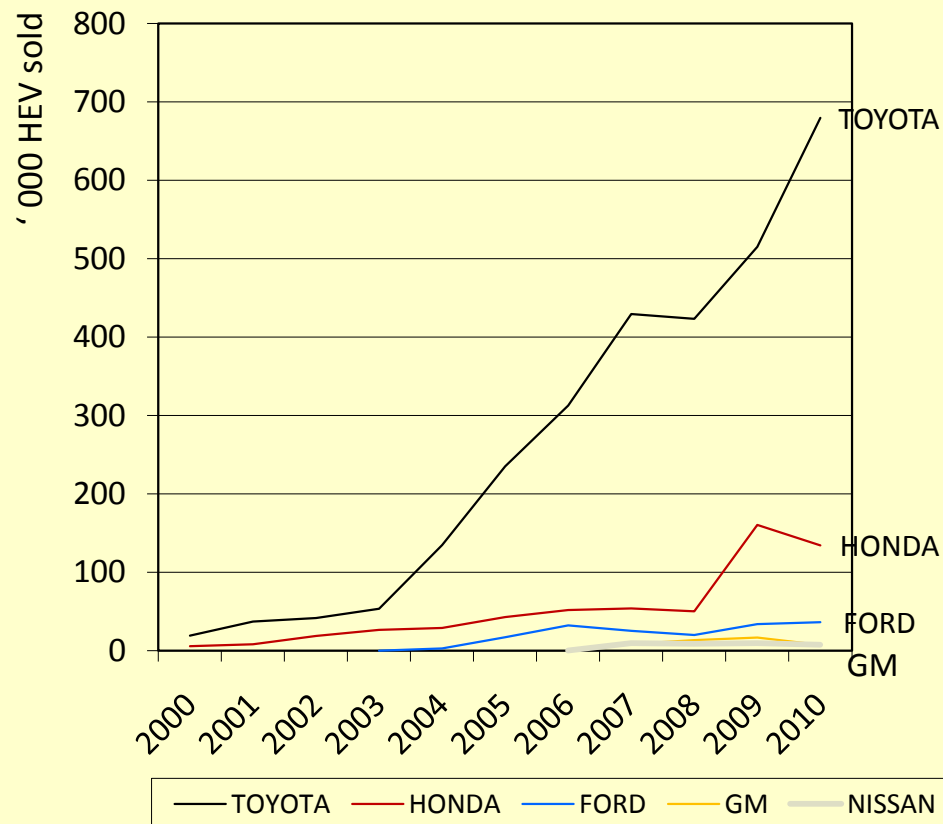
HEV WORLDWIDE IN 2010

Total HEV Vehicles:
≈ 900 000 units in 2010



SOURCE : TOYOTA, HONDA, GM, FORD, CHRYSLER

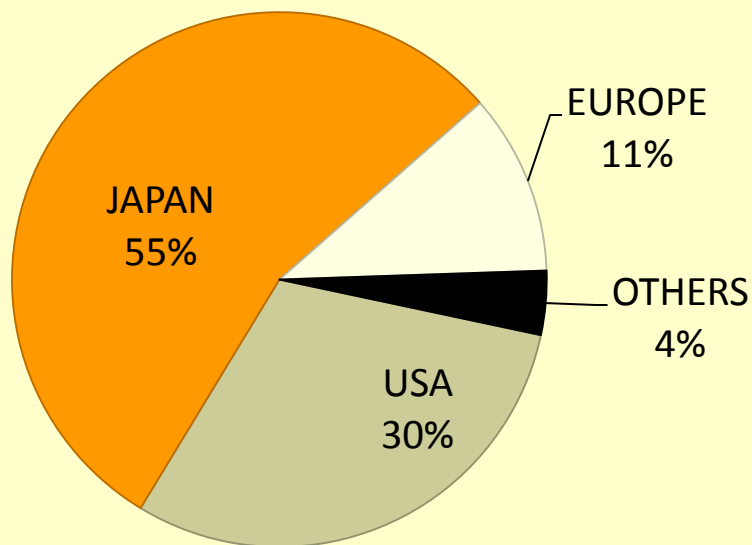
HEV sold per year, M units per car manufacturers, 2000-2010



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

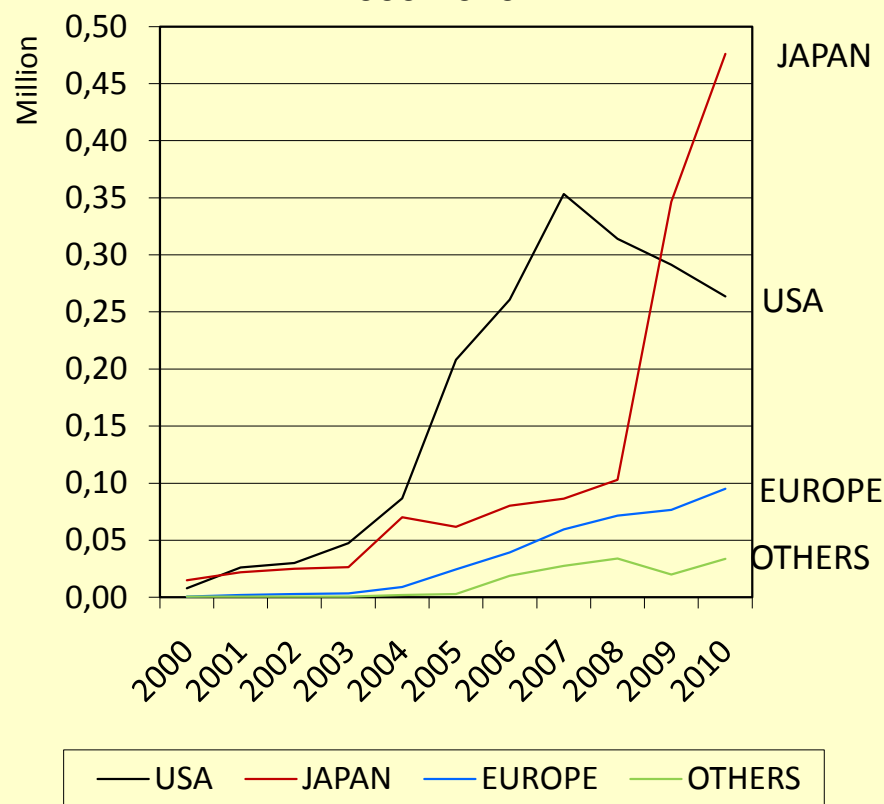
HEV WORLDWIDE IN 2010

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

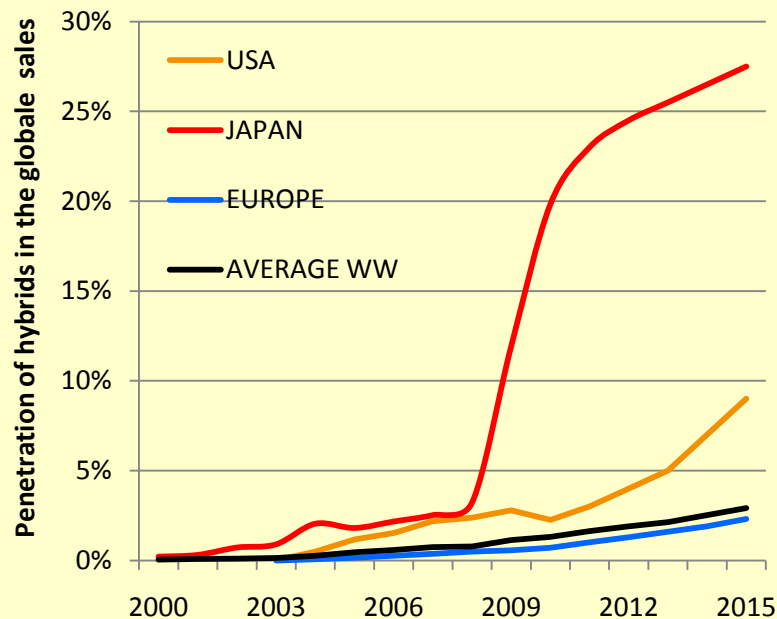


SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011

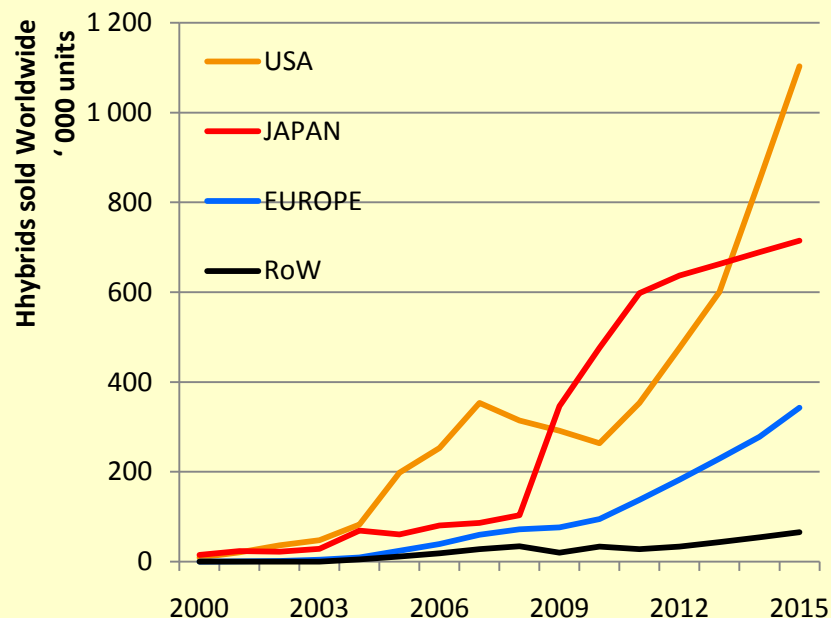
HEV FORECASTS UP TO 2015

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:

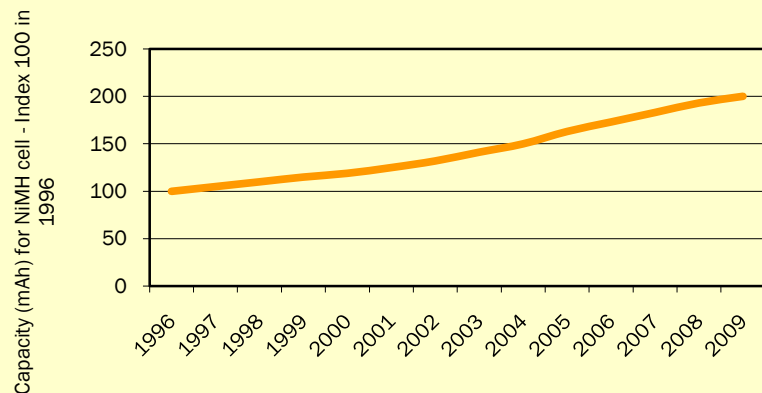
- >75 M vehicle sold WW in 2015
- 3% Hybrids

(2) HEV & hybrid excluding micro hybrids

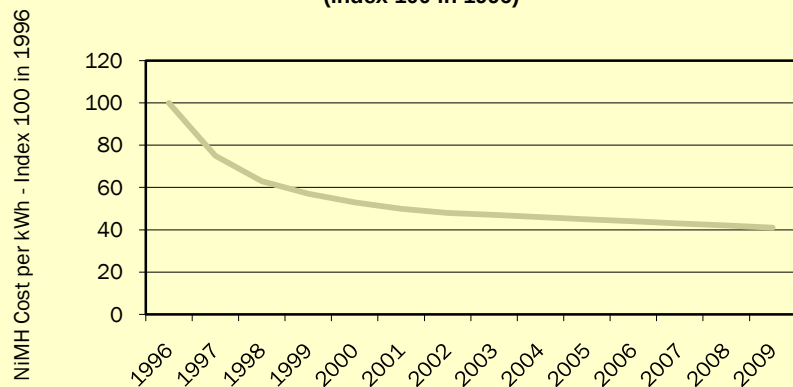
SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011

NIMH BATTERY DEVELOPMENTS

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



NiMH cost per kWh is decreasing
(index 100 in 1996)



	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

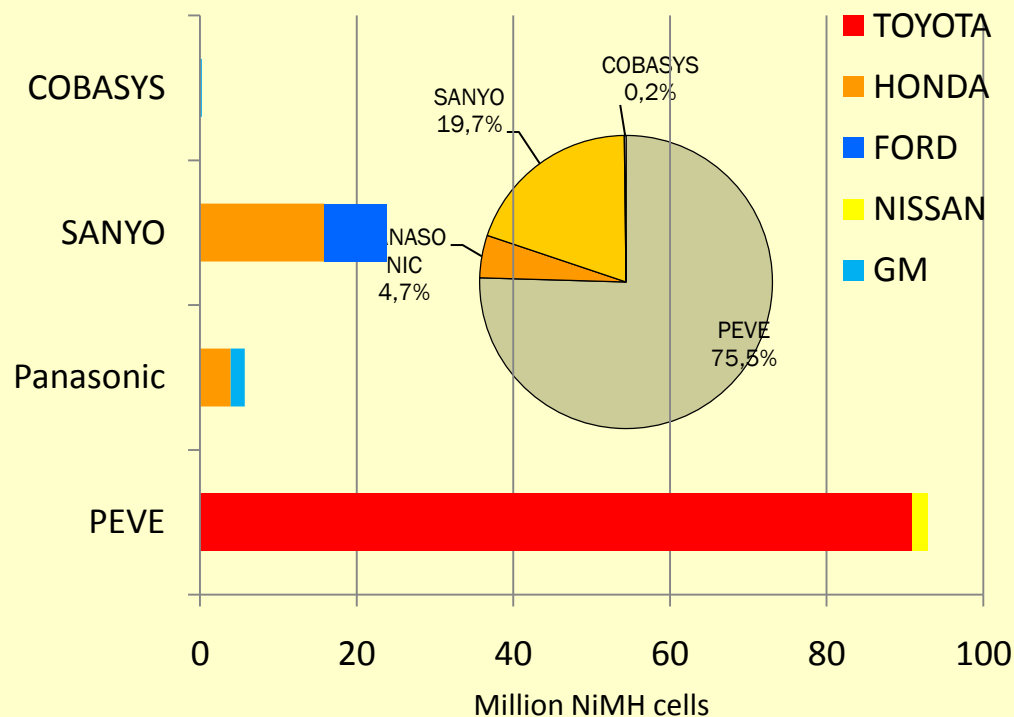
NIMH BATTERIES FOR HEV IN 2009/2010

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

LI-ION BATTERIES DEVELOPMENTS FOR HEV, P-HEV & EV

Information for growth

- 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						

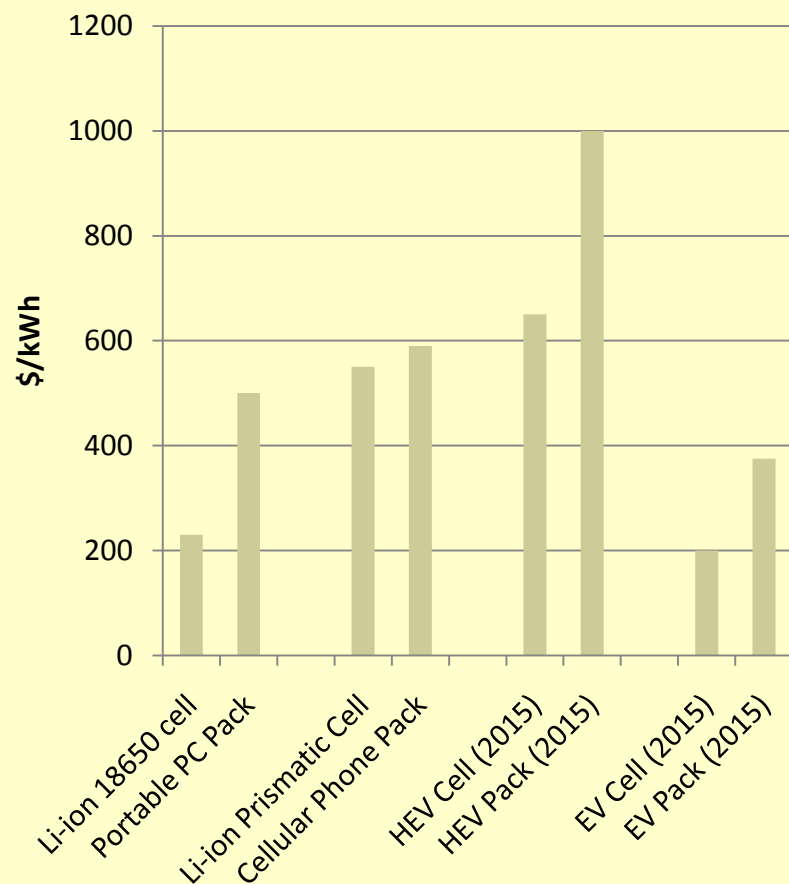
LI-ION BATTERIES DEVELOPMENTS

Information for growth

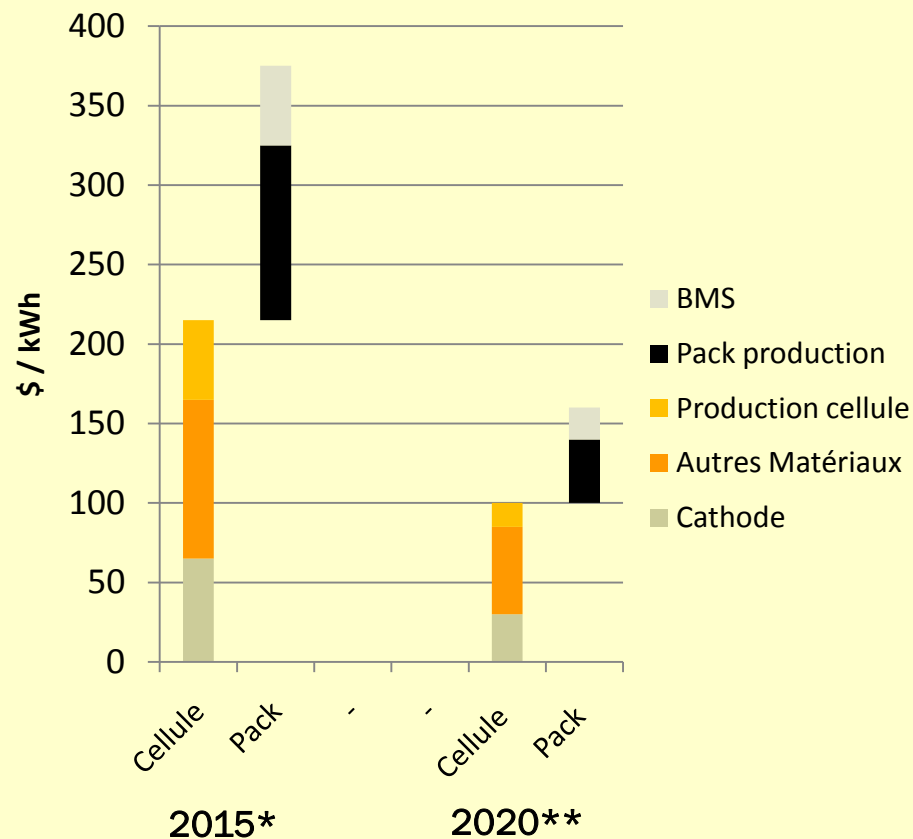
	ASIA										USA						EUROPE & AUTRES												TIERS 1			
Li-ion	TOYOTA	NISSAN	HONDA	HYUNDAI	mitsubishi	BYD Auto	SUBARU	MAZDA	SUZUKI	SAIC	GM	FORD	CHRYSLER	TESLA	BAE	FISKER	KODA (Miles Electric)	DAIMLER	VW	AUDI	BMW	PSA	RENAULT	FIAT	VOLVO	THINK	TATA	PININFARINA	MAGNA	CONTINENTAL	DELPHI	TATA
Sanyo																																
PEVE																																
AESC (Nec-Nissan)																																
JC-SAFT																																
BEJ -Blue Energy Japan GSY - HONDA																																
A123																																
LiTec - Evonik																																
LG																																
LEJ (GSY-Mitsubishi)																																
SB LiMotive (SDI-BOSCH)																																
ENAX - CONTINENTAL																																
MAGNA																																
GAIA																																
GSY																																
TOSHIBA																																
BYD																																
HITACHI																																
BATSCAP (BOLLORE-EDF)																																
SK Energy																																
TESLA																																
CONTINENTAL																																
ALP/E-One																																
Enerdel (Delphi 19,5%)																																
RENAULT/AESC/CEA																																
Panasonic/Tesla																																
Sony																																
Lishen																																
HITACHI MAXELL																																
MAXELL																																
EIG																																

LI-ION BATTERY COST

**LI-ION BATTERY COST
CELLS / PACK**



**LI-ION BATTERY PACK COST FOR EV
AVICENNE FORECASTS**

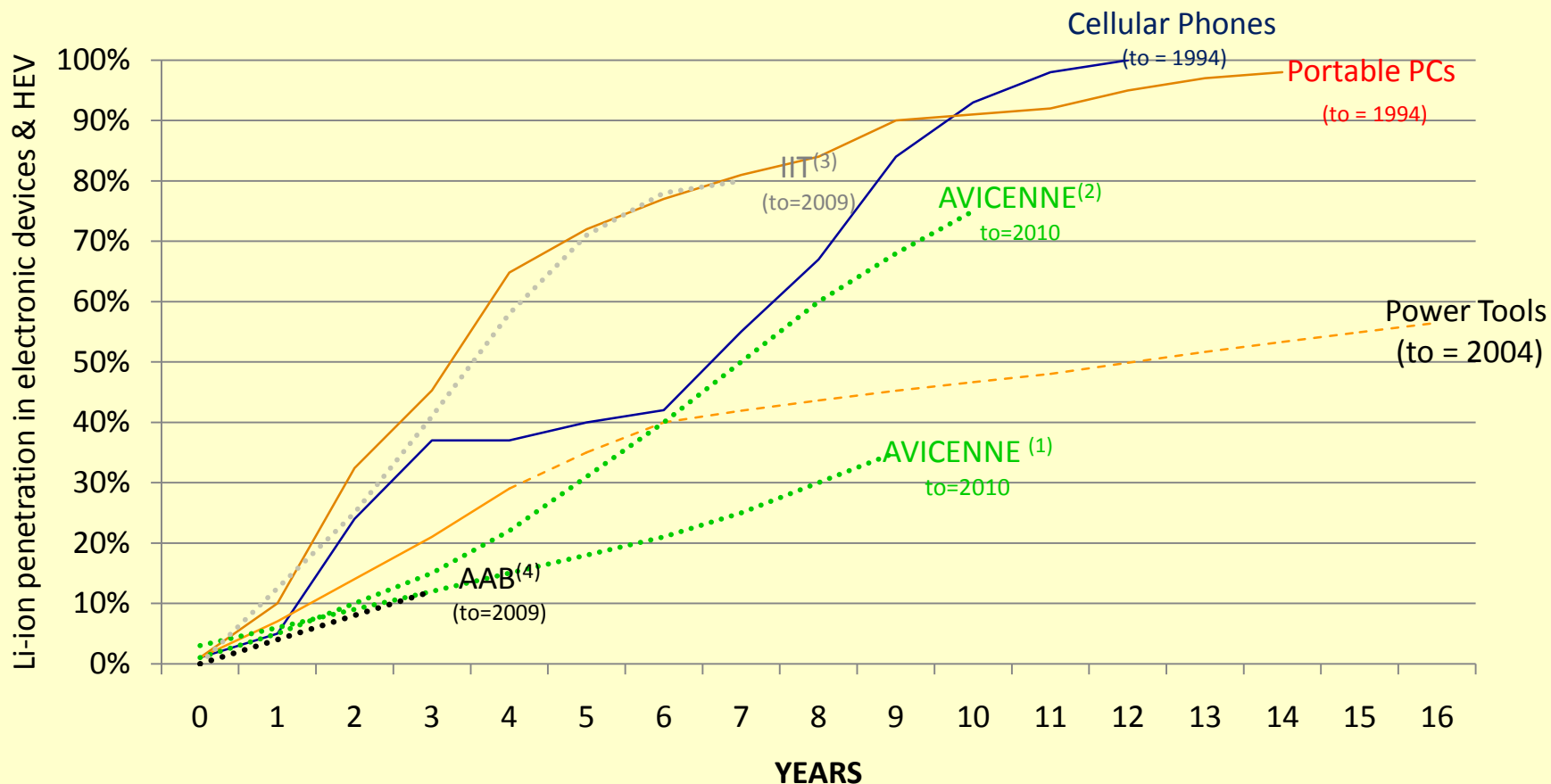


* For Production > 100 000 packs/year

** USBAC Goal in 2020

Source : AVICENNE Compilation, March 2011

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

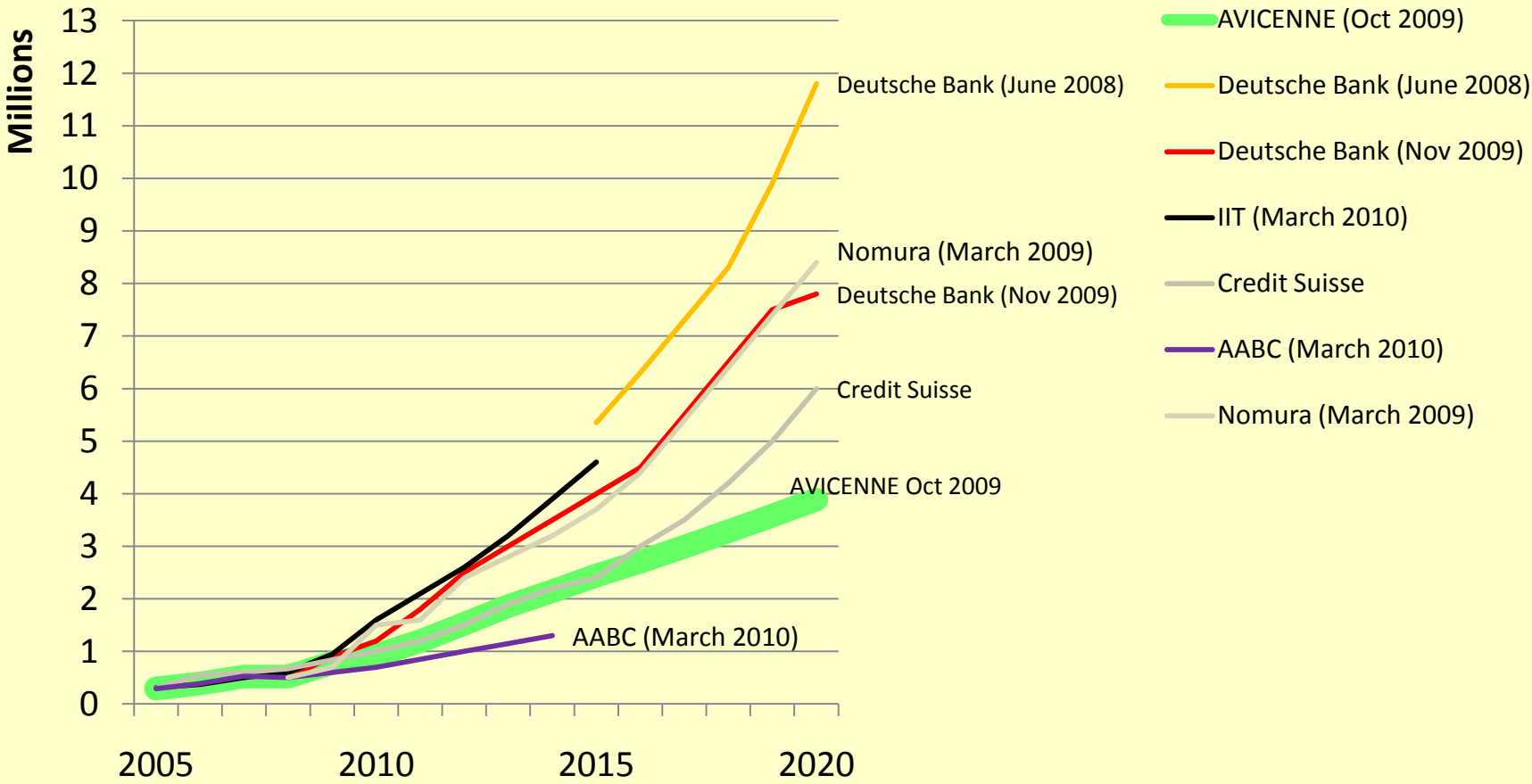


- (1) AVICENNE HEV Forecasts, march 09, Relevant scenario
- (2) AVICENNE HEV Forecasts, march 09, Li-ion Optimistic scenario
- (3) IIT, TAKESHITA, March 08, THE 25th INTERNATIONAL BATTERY SEMINAR & EXHIBIT, Slide 8 & March 2009, 26th Battery Seminar, Slide 5
- (4) AAB, Menahem ANDERMAN, Ph.D, Tampa, Florida, May 2009

SOURCE: AVICENNE COMPILATION, MARCH 2011

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

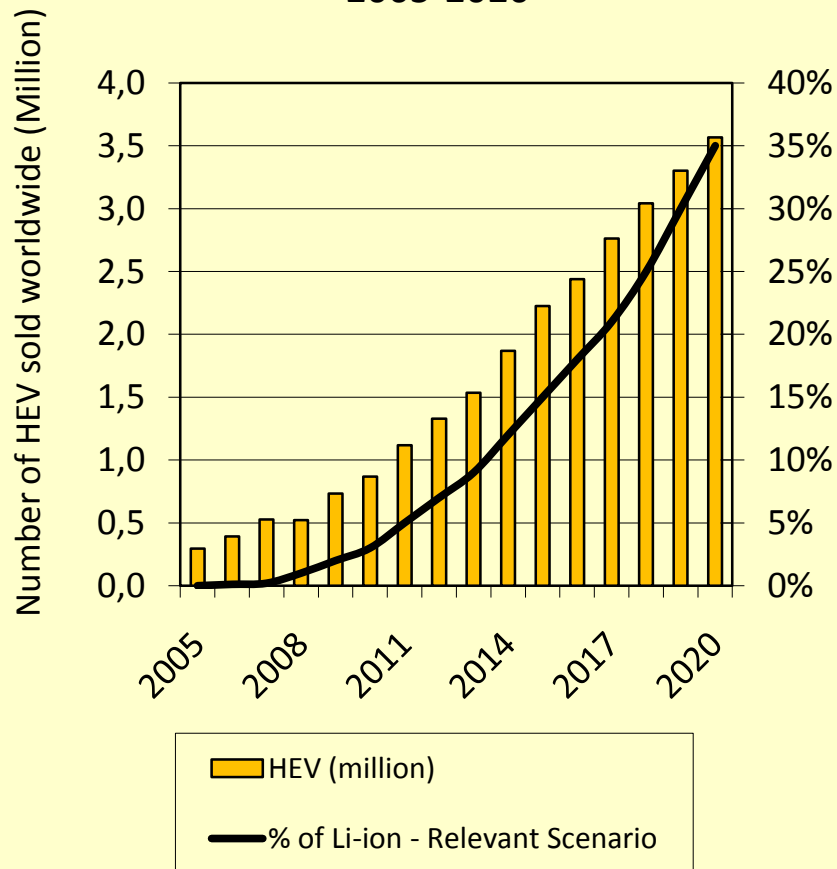
HEV FORECASTS (Million)



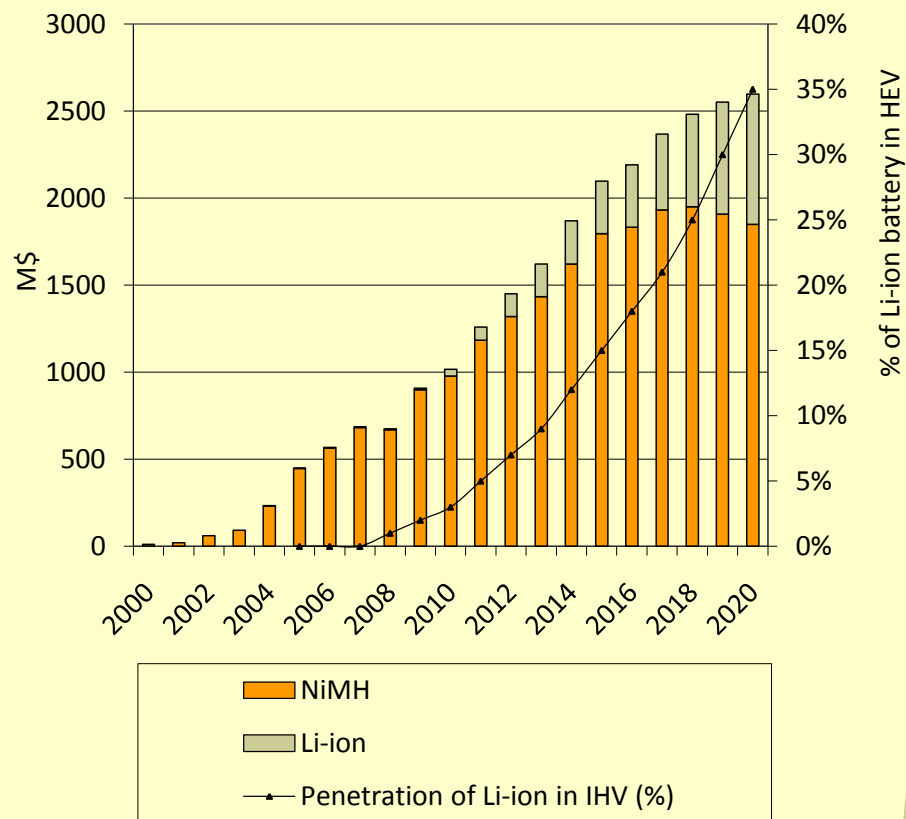
SOURCE: AVICENNE COMPILATION, MARCH 2011

LONG TERM HEV BATTERY FORECASTS

HEV market, million units, worldwide,
2005-2020



HEV battery market worldwide, million \$
2000-2020



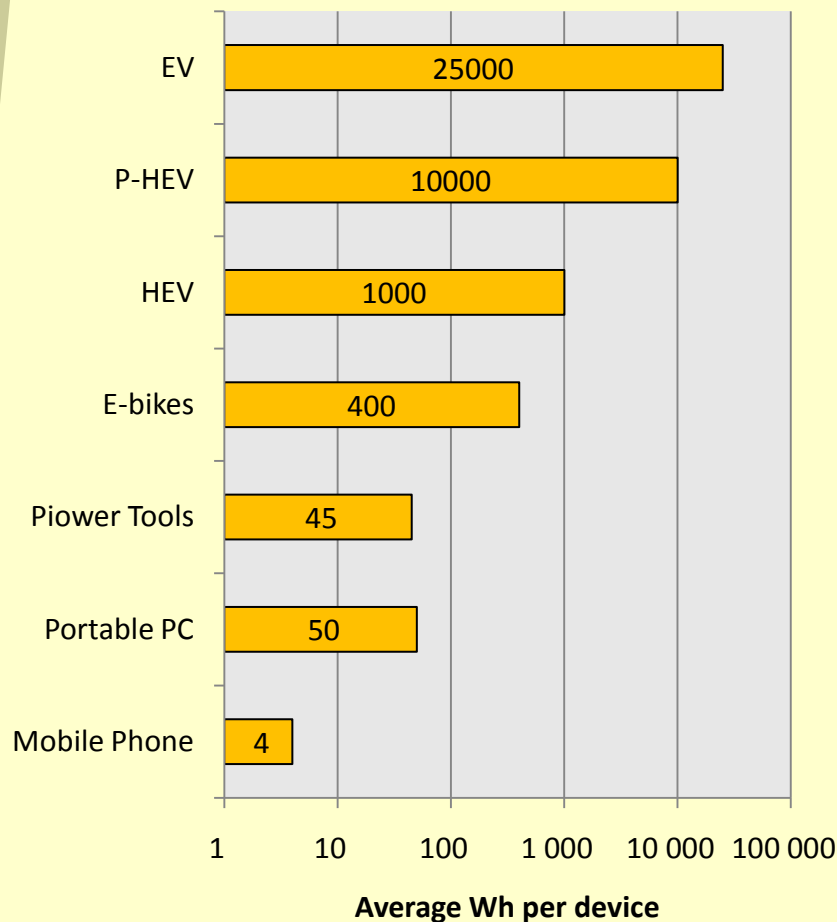
Note: Micro HEV are not in the HEV statistics & HEV forecast

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

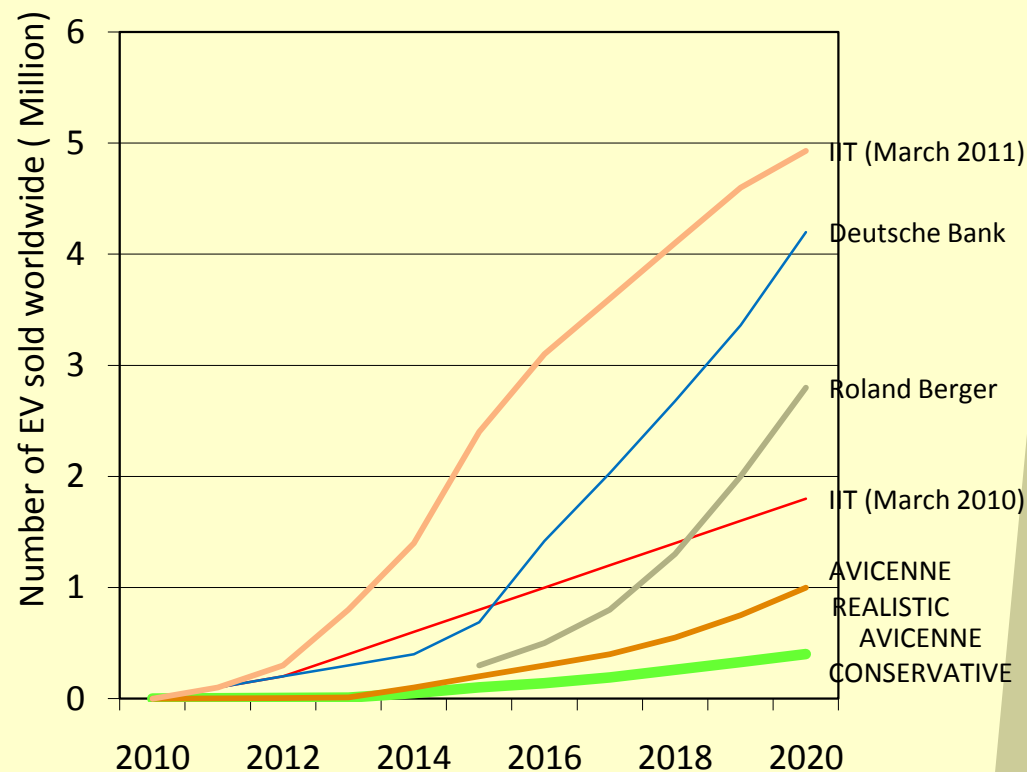
HEV, P-HEV & EV LONG TERM FORECASTS

EV ENERGY NEED: 25 MORE THAN HEV!

Information for growth



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



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

EV, PHEV & HEV BATTERY FORECASTS

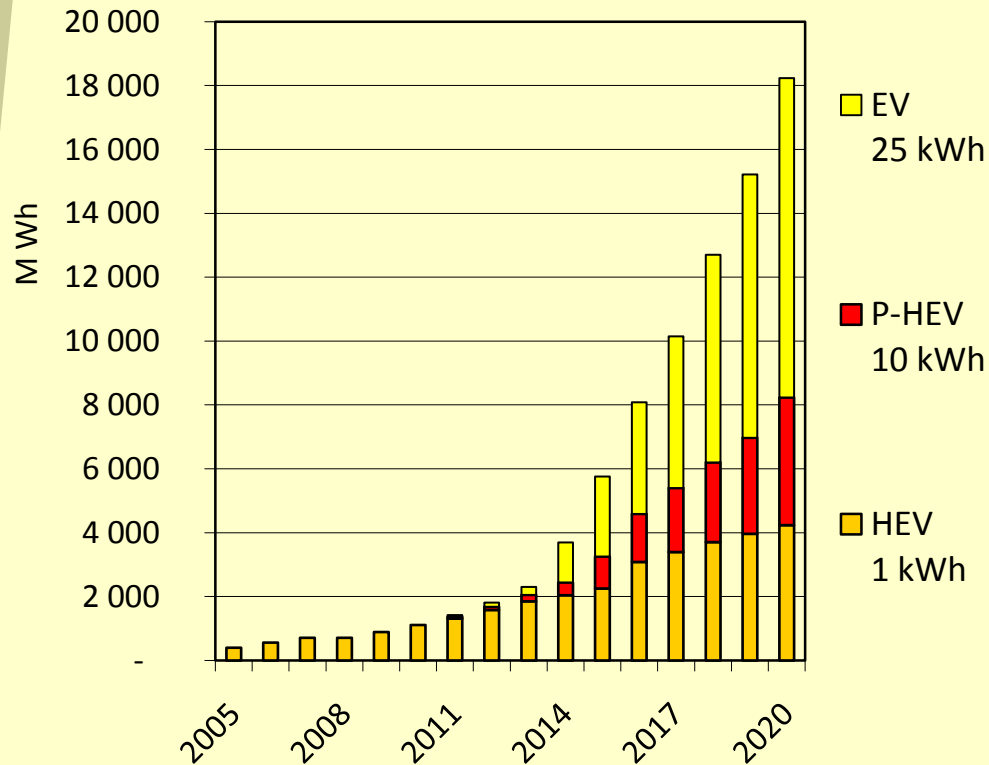
Assumptions

100 000 EV in 2015
400 000 in 2020
100% Li-ion

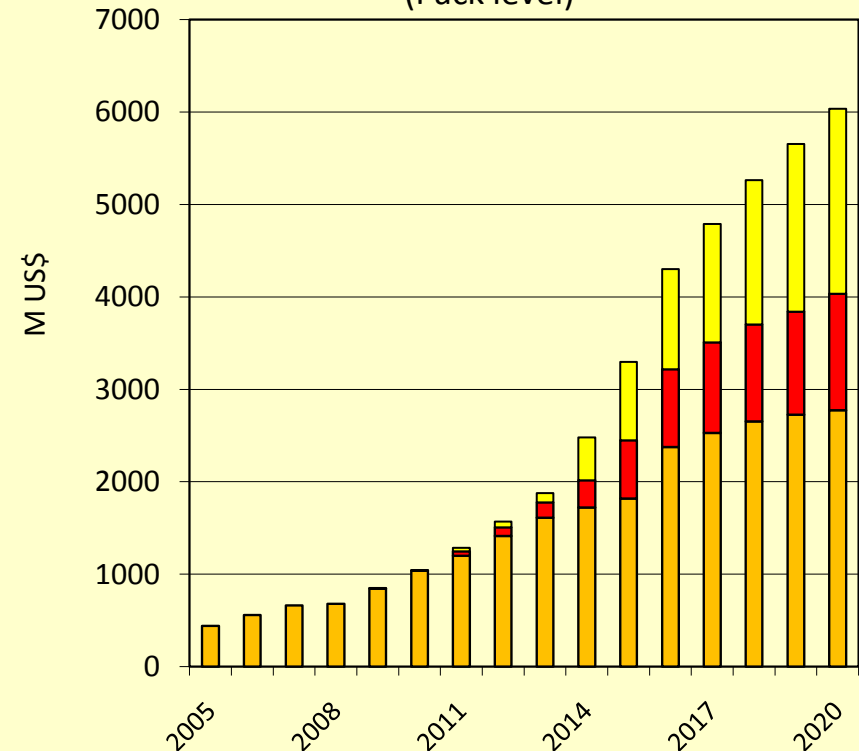
0.1 M P-HEV in 2015
0.4 M in 2020
100% Li-ion

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



AUTOMOTIVE RECHARGEABLE BATTERY
MARKET M US\$, Worldwide, 2005-2020
(Pack level)



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

TOTAL LIB DEMAND

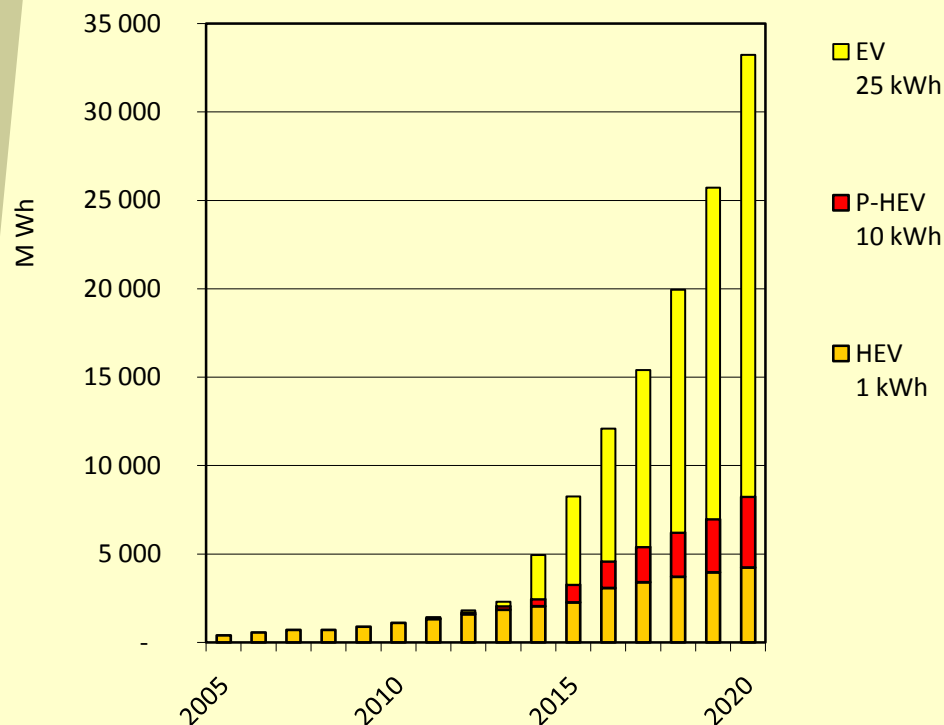
Assumptions

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

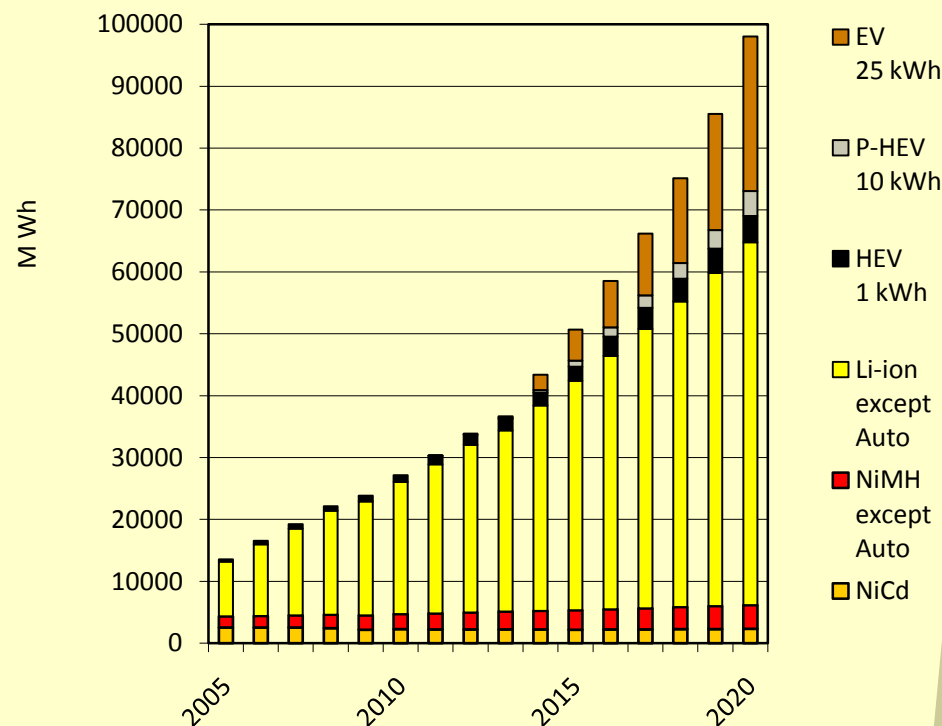
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0.4 M in 2020
100% Li-ion

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



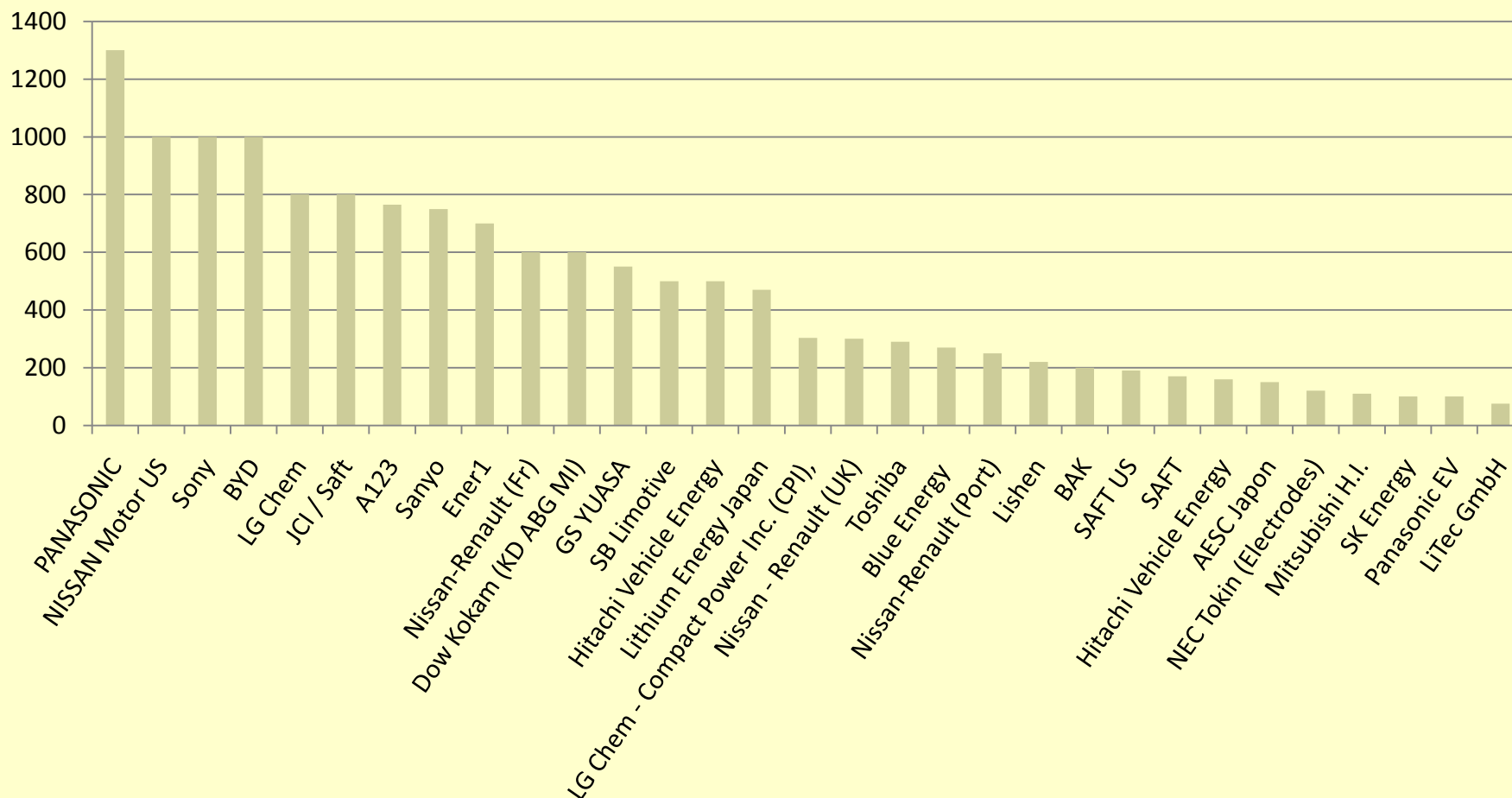
SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011

LIB MANUFACTURING INVESTMENT 2009-2015

10-12 B\$ WORLDWIDE / >50 GWH IN 2015

Information for growth

Total Investment (M\$) made for LIB manufacturing



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

ANNONCED INVESTMENT WILL RESULT IN SIGNIFICANT OVERCAPACITY

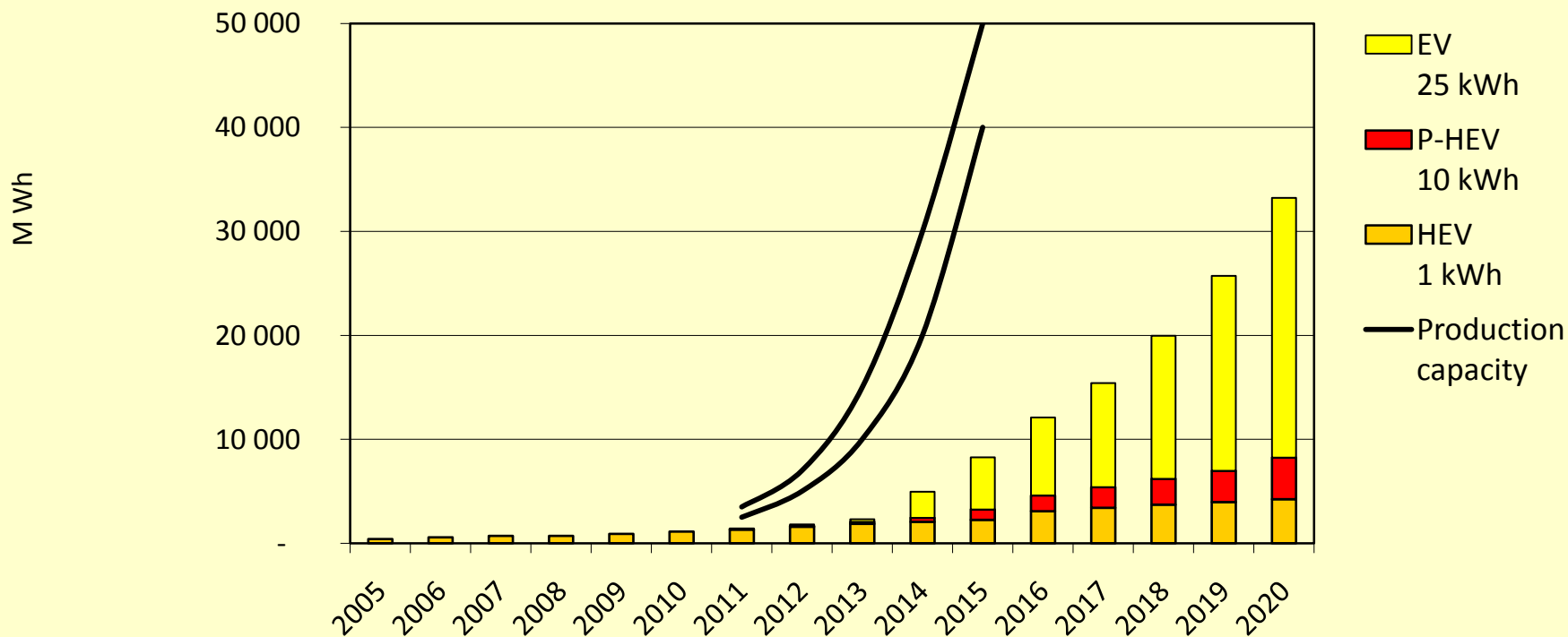
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EV, HEV & P-HEV Battery needs (M Wh)
2005 – 2020 (Scenario 2)

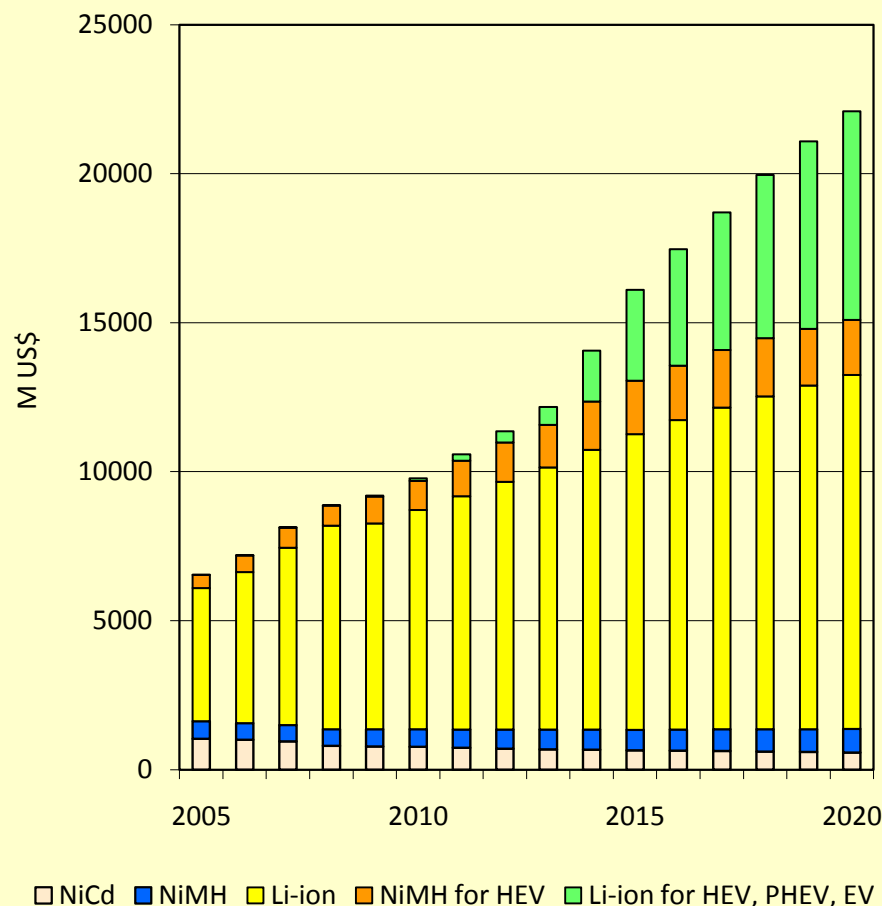


SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020 , AVICENNE, MARCH 2011

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 (\$2)



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

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Thank you!

