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HEV, P-HEV, and EV market 2011-2020

Impact on the battery Business

Christophe PILLOT

Director, AVICENNE ENERGY

13 ELBC

PARIS

25 – 28 SEPTEMBRE 2012

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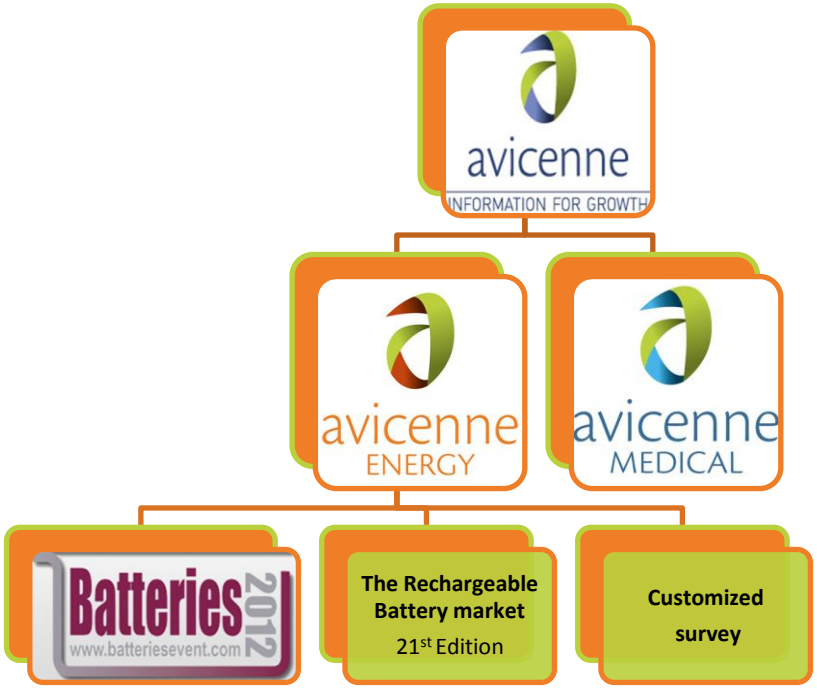
AVICENNE PROFILE

Information for Growth - Powering your company's market strategy with in-depth research

- Creation: 1992
- Headquarter: Paris
- Liaison Office: Japan, USA
- AVICENNE Energy Director: Christophe Pillot
- 4 consultants in Paris



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METHODOLOGY: EXTENSIVE FIELD RESEARCH TO RETRIEVE & CROSS CHECK INFORMATION

Top management contacts network > 17 000 contacts

Conferences & Exhibitions

Batteries 2012 – www.batteriesevent.com – The International Energy & Power Supply Conference and Exhibition

2nd Int'l Rechargeable Battery Expo BATTERY JAPAN

THE BATTERY SHOW

aabc

CIBF2010 – 9th China International Battery Fair

JAPAN ELECTRONICS SHOW

CeBIT

In Depth analysis Of applications

Cross Check Analysis

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MORE THAN 180 REFERENCES WORLDWIDE

- A123
- AIR LIQUIDE
- AIR PRODUCT
- AHLSTROM
- ALCATEL
- AMPEREX (ATL)
- APPLIED MATERIALS
- AROS SECURITIES
- ARC
- ASHLAND
- ATOFINA - ARKEMA
- AT KEARNEY
- AXEON
- BAIN
- BASF
- BATTERY R&D ASSOCIATION OF KOREA
- B&D
- BHP BILLITON
- BRAND LICENCING PARNERS (BLP)
- BOURNS
- BOSCH
- BUHLER GMBH
- BYD
- CAP X
- CATELLA
- CARBONE LORRAINE
- CARLYLE
- CATELLA
- CATERPILLAR INC.
- CDN COBALT
- CEA/LITEN
- CELGARD
- CHEMETALL
- CHEMISHE FABRIK BUDENHEIM
- CIBA
- CIAPS CHINA
- COGEMA
- CONOCO PHILIPS
- CRU GROUP
- CSC CHALLENGE STRATEGY CHANGE
- DCN
- DELTA
- DGA
- DIALOG SEMICONDUCTOR
- DOW CHEMICAL
- DOW CORNING
- DUPONT
- DURACELL
- EDF
- ELECTRO ENERGY
- ENER 1
- ENERGIZER
- EOLITE
- EPCOS OHG
- ERAMET
- ETC AB
- FACOM
- FALCON BRIDGE
- FAIRSHILD SEMICONDUCTOR
- FAMEART
- FIST
- FLORIDIENNE DE CHIMIE
- FMC
- FORTU POWER CELL
- FRANCE TELECOM
- FULTON INNOVATION
- GAIA
- GIL IMPORT BATTERIES LTD.
- GS MELCOTEC
- HC STARCK (BAYER)
- HILTI
- HITACHI MAXELL
- HOLLINGSWORTH & VOSE CIE
- HONEYWELL
- HPL (HIGH POWER LITHIUM)
- HUTCHINSON
- IER
- IGL EXPORT.
- INTERNATIONAL COMPONENT CORP.
- INTERNATIONAL RECTIFIER
- INTEK
- INTEL
- INTERSIL
- INCO
- ITRI
- ITS
- JBC
- JETRO
- JOHNSON CONTROLS
- KODAK
- KRUGER
- LAZARD
- LECLANCHÉ
- LEGRAND
- LG CHEMICAL
- LION CELLS
- LITTLE FUSE
- LILIPUCIAN
- LYNAS CORP
- MATSUSHITA
- MICROSOFT
- MTI MICRO FUEL CELLS
- MOLTECH
- MOLYCORP
- MOMENTIVE
- MOTOROLA
- MUNSTER UNIVERSITY
- NANOCYL
- NCCP - RUSSIA
- NITECH
- NKKPC
- NORILSK NICKEL
- NOVALED
- NTK POWERDEX
- OMG INC
- PANASONIC
- PHILIPS
- PHOTON
- PK & WISE
- POWER GENIX
- PRAYON
- PRISMARK
- PSA
- RAYOVAC
- RECHARGE
- RENAULT
- RHODIA
- ROLAND BERGER
- SAFT
- SAGENTIA
- SAINT GOBAIN
- SAKTI
- SAMSUNG SDI
- SANIK
- SCHRODER VENTURE
- SCOTENT ENTREPRISE
- SFPZ
- SHENZHEN HIGH POWER TECHNOLOGY
- SCHOTT AG
- SKC
- SVE - DASSAULT
- SOLVAY
- SONY
- STIBAT
- STORCK
- STRATEGY ANALYSIS
- TERRAROSSA CAPITAL
- TIGER GLOBAL
- TODA KOGYO
- TOTAL
- TOTAL WIRELESS SOLUTION
- TOYO
- TOYOTA
- TYCO
- UMICORE
- UNIROSS
- URALELEMENT
- US NAVY
- VARTA
- VOLTRACK
- WARBURGPINCUS
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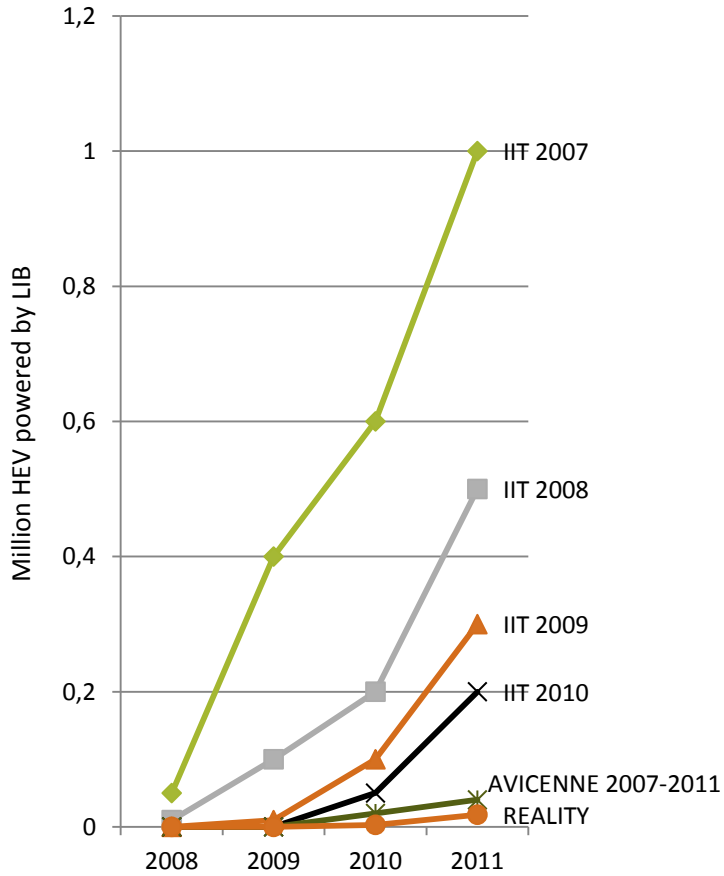
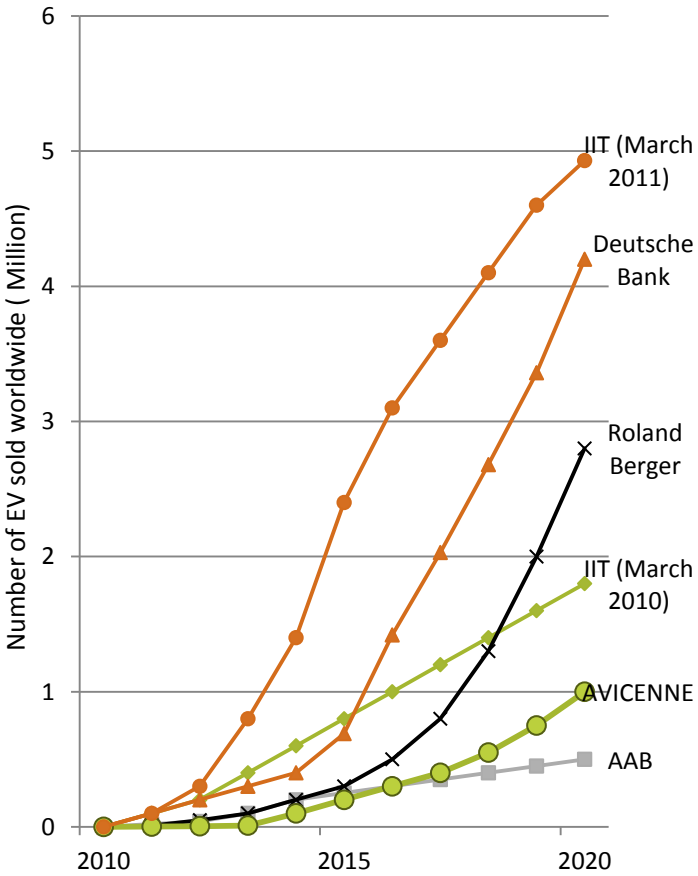
HEV powered by Lithium ion battery forecasts from 2008 to 2011



EV sold, in million units, worldwide, 2010 - 2020



Source : International Battery Conference, Fort Lauderdale 2007, 2008, 2009, 2010 & 2011

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OUTLINE

- THE RECHARGEABLE BATTERY MARKET IN 2011/2012
- THE HEV, P-HEV & EV MARKET IN 2011/2012
- 2020 FORECASTS
- IMPACT ON THE BATTERY BUSINESS
- IMPACT ON THE LED ACID BATTERY BUSINESS
- CONCLUSIONS

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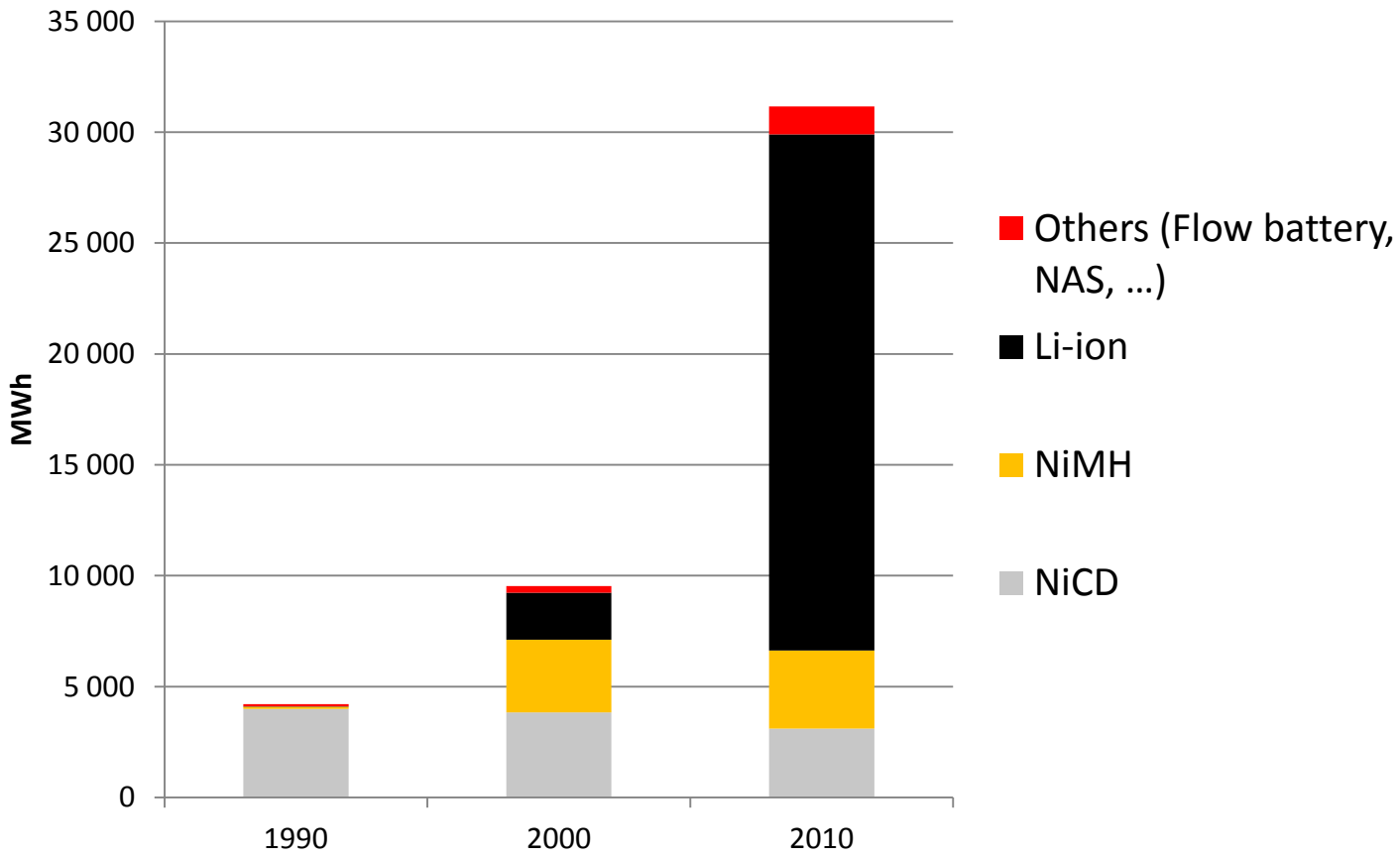
THE WORLDWIDE BATTERY MARKET 1990-2010

Lithium Ion Battery: Highest growth & major part of the investments



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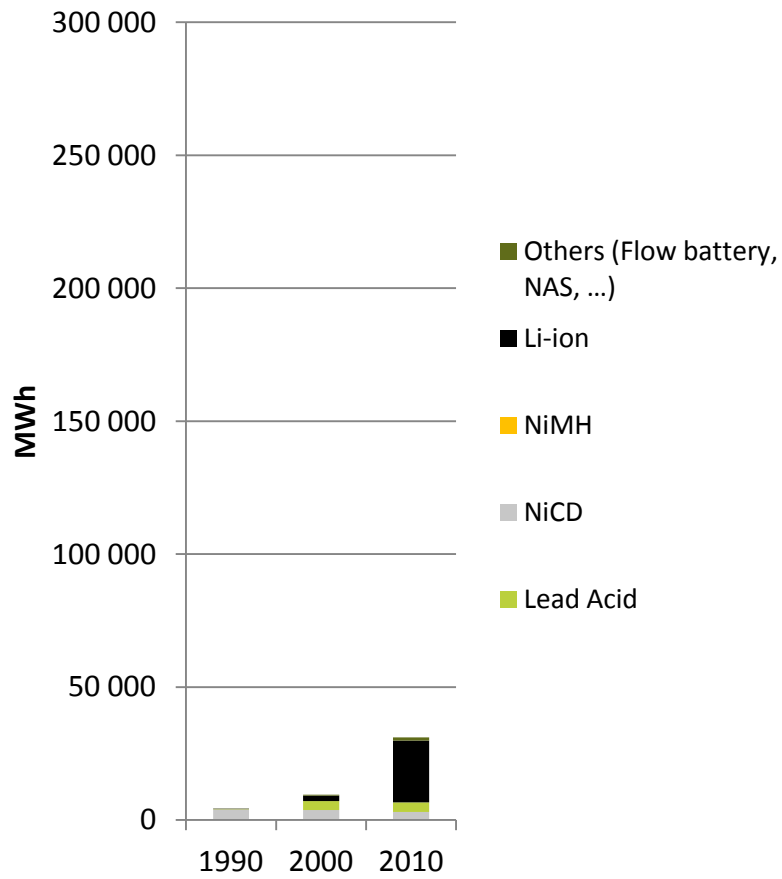
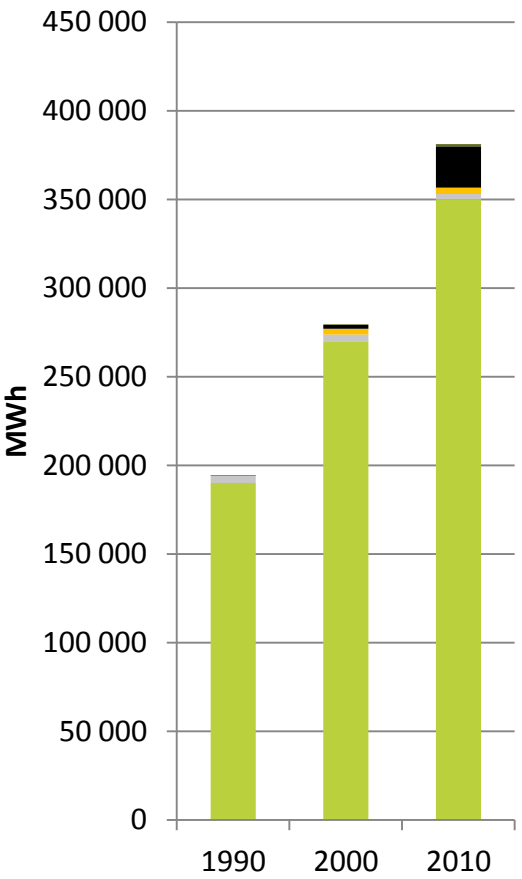
THE WORLDWIDE BATTERY MARKET 1990-2010

Lead acid: Major market





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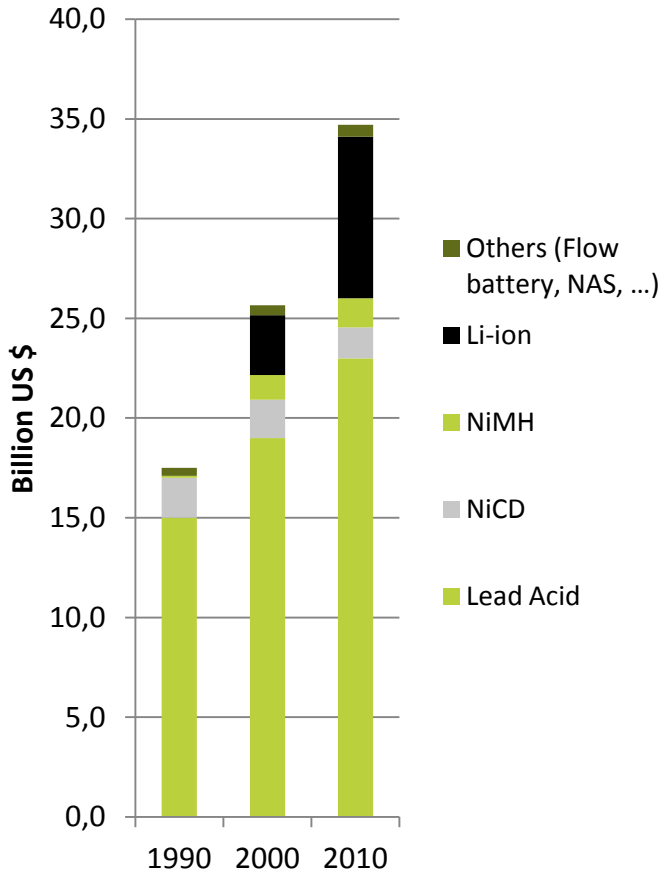
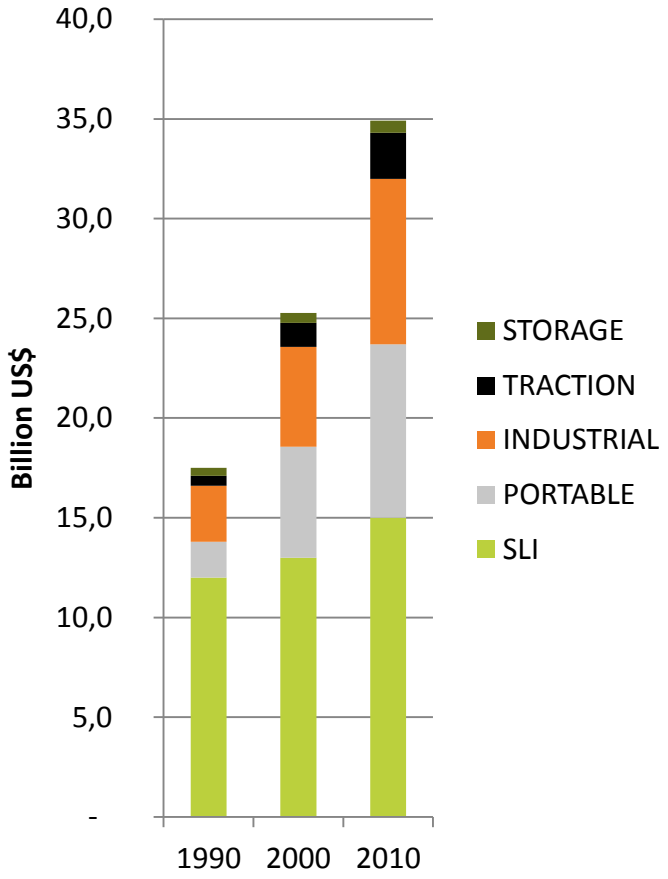
THE WORLDWIDE BATTERY MARKET 1990-2010

35 BILLION US$
5% AVERAGE GROWTH PER YEAR (1990-2010)





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EACH BATTERY TECHNOLOGY HAS ITS SPECIFIC ABSOLUTE ADVANTAGES

Advantage of ... / ...On		Lead Acid	Nickel Cadmium NiCd	Nickel Metal Hydride NiMH	Lithium-Ion	
					Conventional	Laminate
Lead Acid			• Gravimetric energy density • Volumetric energy density • Operating temperature range • Self discharge rate • Reliability (progressive extinction)	• Gravimetric energy density • Volumetric energy density • Self discharge rate	• Gravimetric energy density • Volumetric energy density • Voltage output • Self discharge rate	• Gravimetric energy density • Volumetric energy density • Self discharge rate • Design characteristics
Nickel Cadmium NiCd		• Higher cyclability • Voltage output • Price		• Gravimetric energy density • Volumetric energy density	• Gravimetric energy density • Volumetric energy density • Voltage output • Self discharge rate	• Gravimetric energy density • Volumetric energy density • Self discharge rate • Design characteristics
Nickel Metal Hydride NiMH		• Higher cyclability • Voltage output • Price	• Operating temperature range • Higher cyclability • Self discharge rate • Price		• Gravimetric energy density • Volumetric energy density • Operating temperature range • Higher cyclability • Voltage output • Self discharge rate	• Gravimetric energy density • Volumetric energy density • Operating temperature range • Self discharge rate • Design characteristics
Lithium-Ion	Conventional	• Higher cyclability • Price • Safety • Recyclability	• Operating temperature range • Higher cyclability • Price • Safety • Recyclability	• Price • Safety • Discharge rate • Recyclability		• Gravimetric energy density • Volumetric energy density (potentially) • Design characteristics • Safety • Price
Lithium-Ion	Laminate	• Higher cyclability • Price	• Operating temperature range • Higher cyclability • Price	• Volumetric energy density • Higher cyclability • Price	• Operating temperature range • Higher cyclability	
Absolute advantages		• Higher cyclability • Price	• Operating temperature range • Price	• Volumetric energy density	• Gravimetric energy density • Volumetric energy density • Self discharge rate • Voltage output	• Gravimetric energy density • Volumetric energy density • Self discharge rate • Voltage output • Design characteristics

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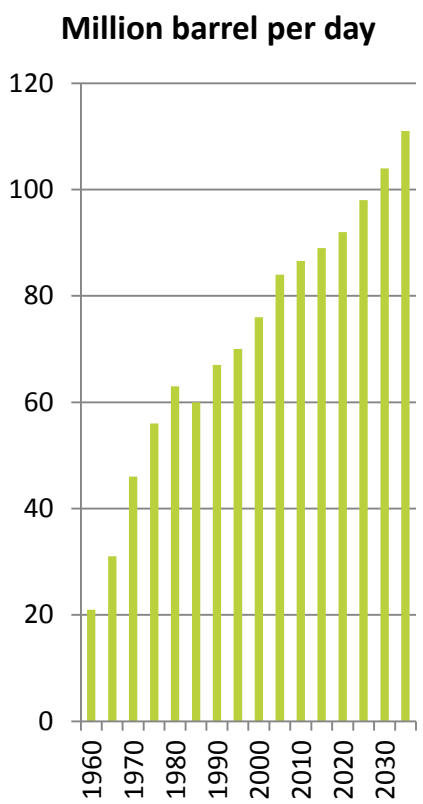
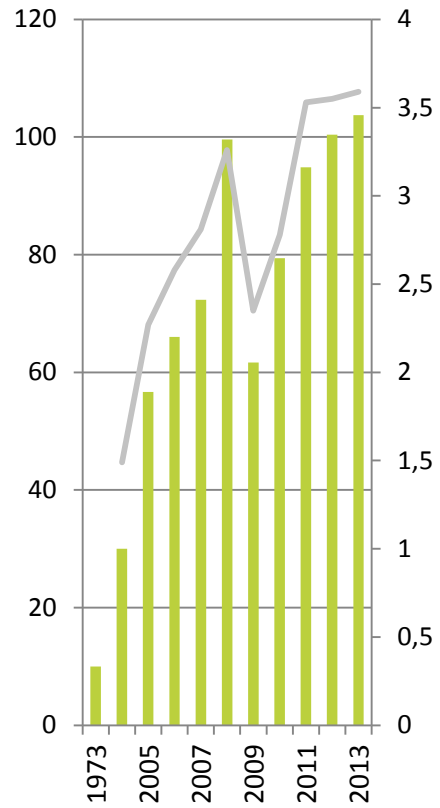
WHY X-EV ?

Petroleum consumption worldwide 1960-2030



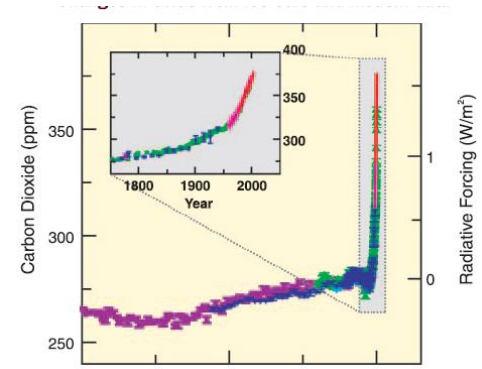
Source: Energy Information Administration, US Government

Price of the WTI barrel of oil, US $



Source: http://www.eia.doe.gov/emeu/steo/pub/contents.html

CO2 density in the atmosphere increase



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

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HEV, P-HEV & EV DEFINITION & SEGMENTATION

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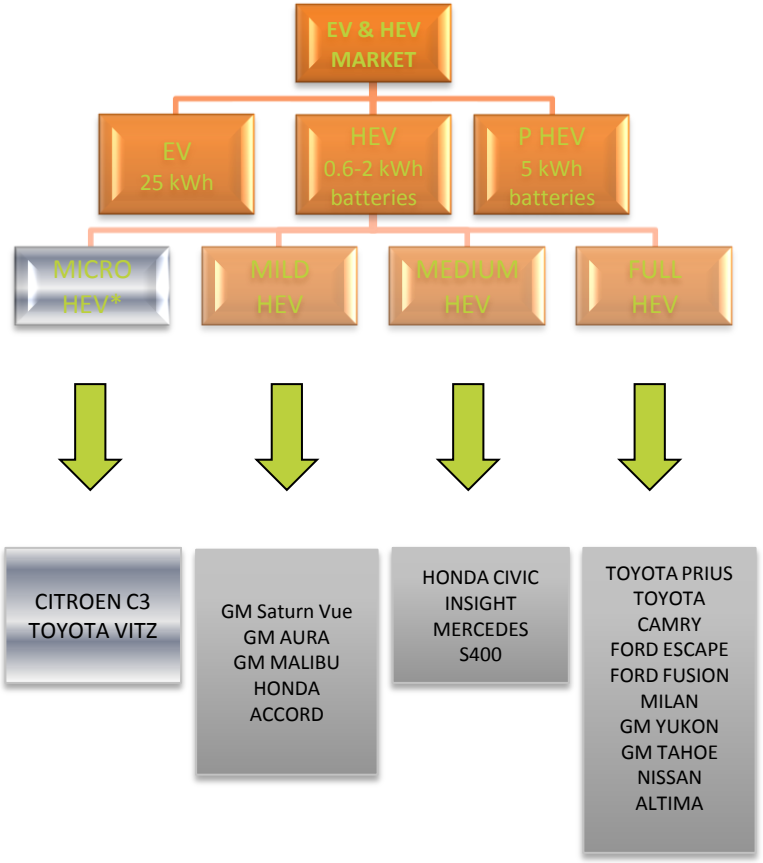

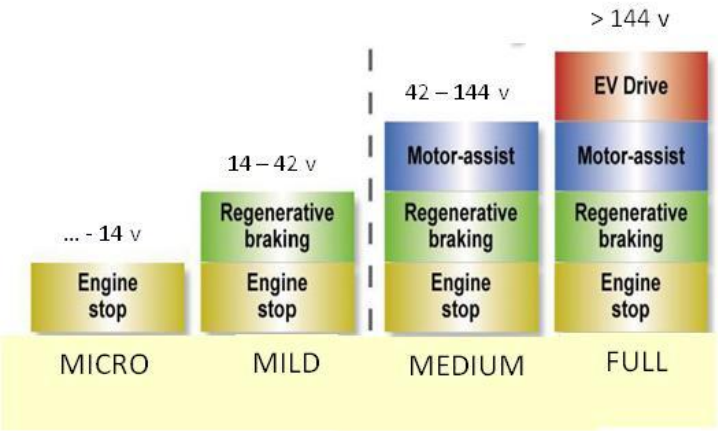

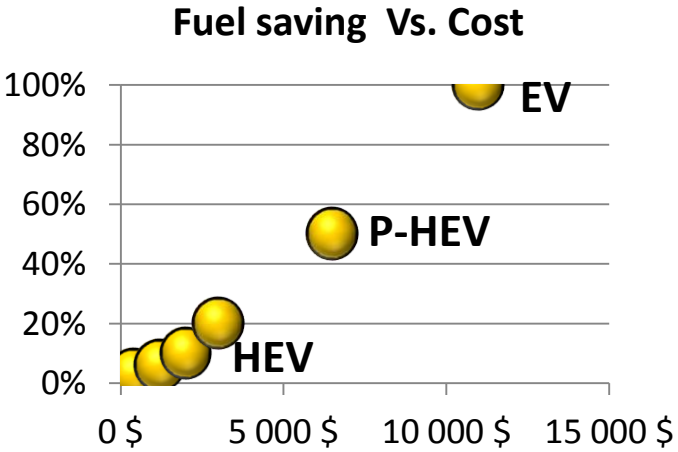

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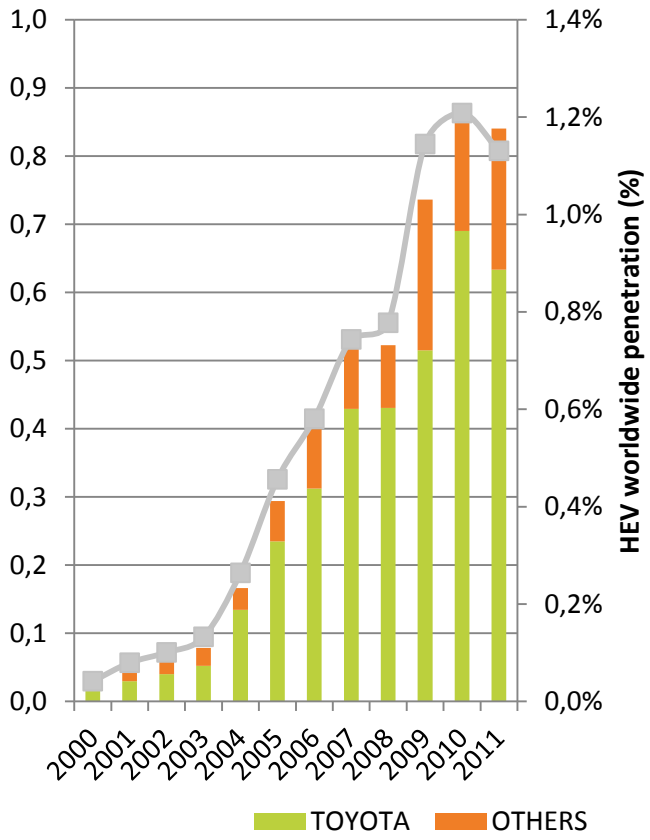
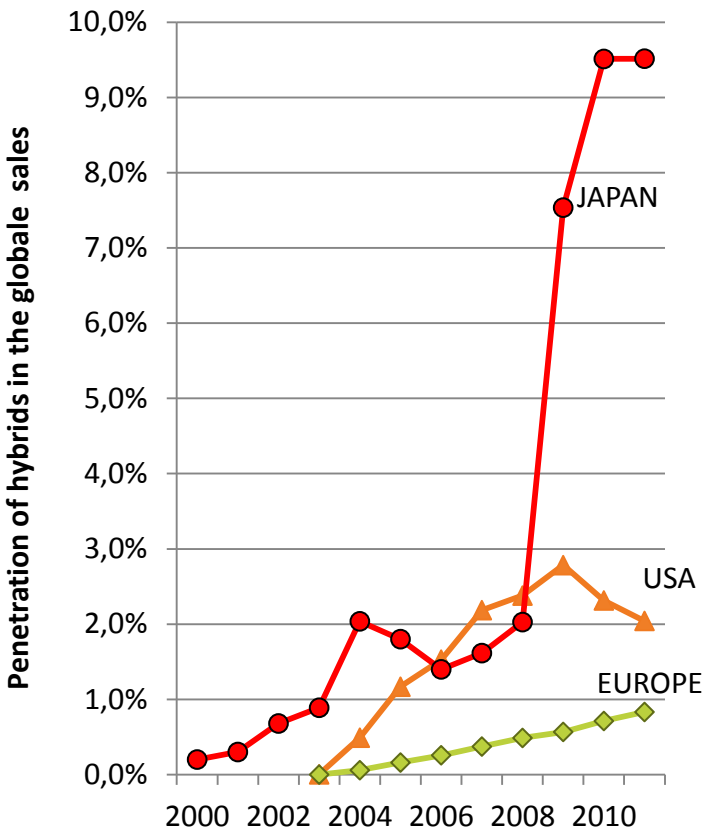
HEV WORLDWIDE IN 2011
LESS THAN 0.9M HEV SOLD

HEV sold per year, M units, worldwide, 2000 - 2011



Penetration of hybrids in the global sales, 2000-2011



Source: TOYOTA, HONDA, NISSAN, FORD, GM, HYUNDAI, MERCEDES, GM, BMW, VW, PORSCHE… Compilation AVICENNE ENERGY
Micro hybrid not included

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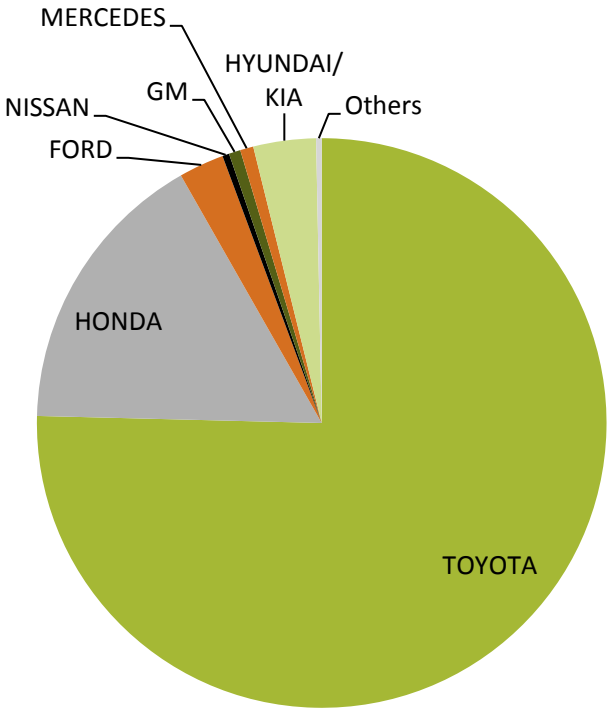
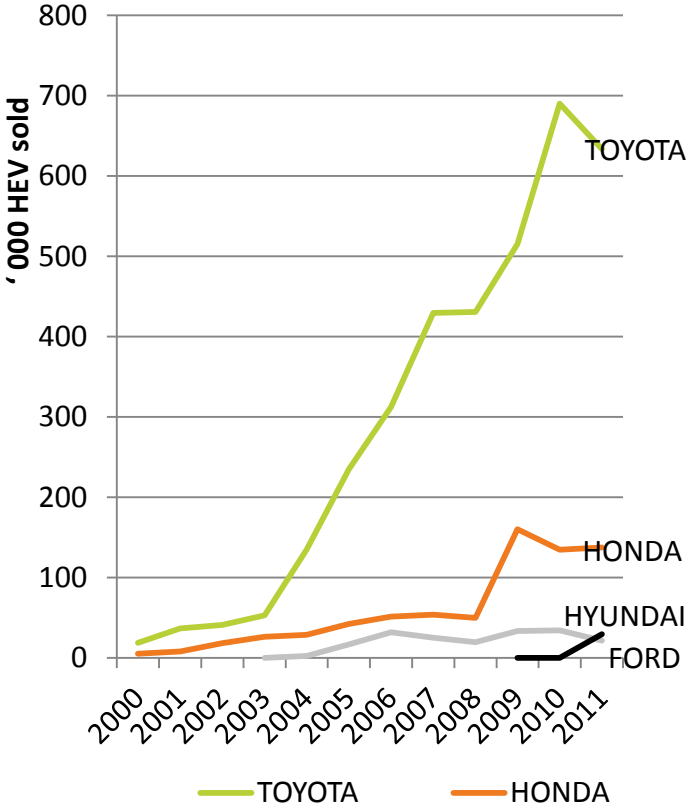
HEV WORLDWIDE IN 2011 BY CAR SUPPLIER

Total HEV Vehicles Less than 0.9 M in 2011



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



Source: TOYOTA, HONDA, NISSAN, FORD, GM, HYUNDAI, MERCEDES, GM, BMW, VW, PORSCHE… Compilation AVICENNE ENERGY
Micro hybrid not included

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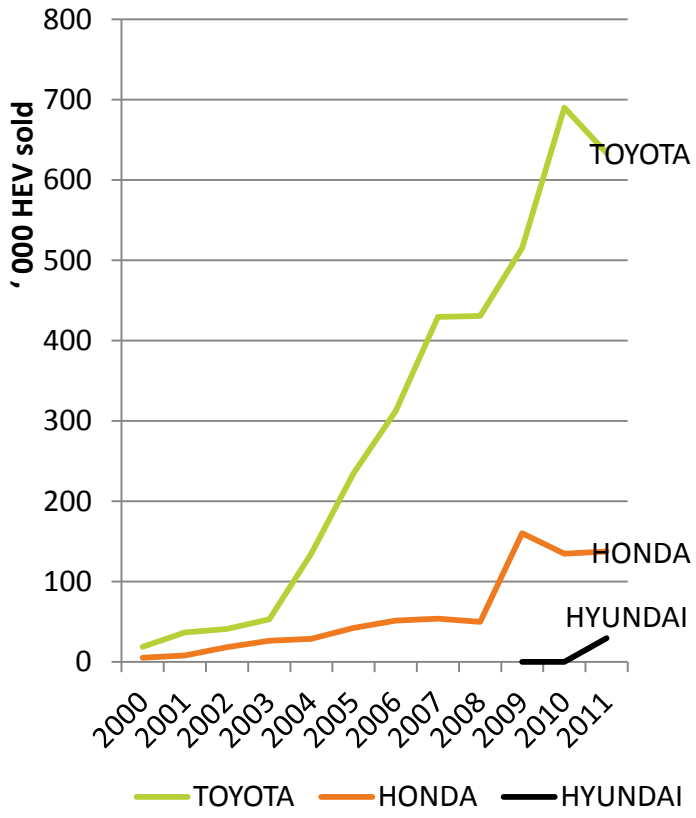
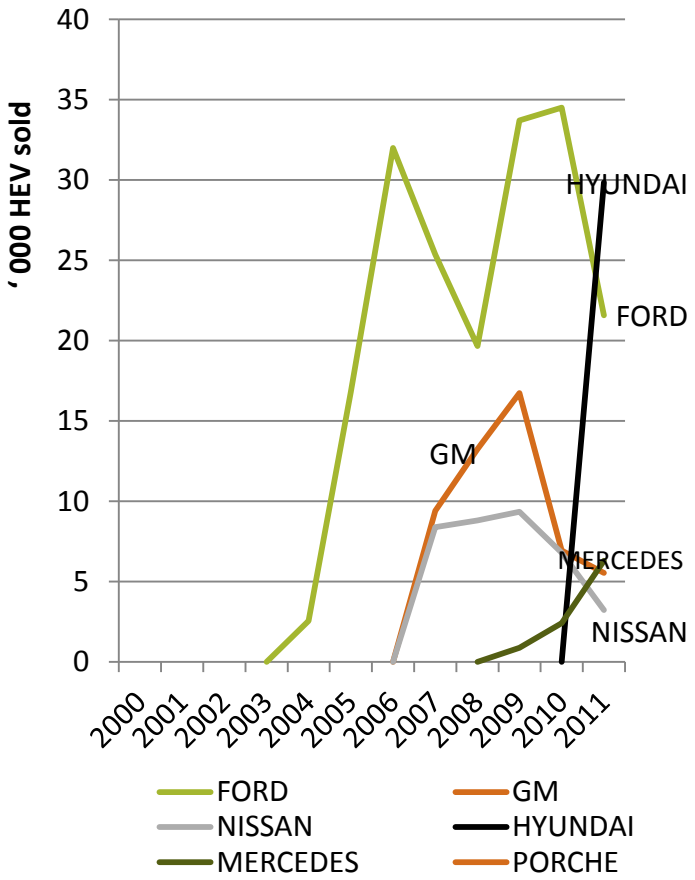
HEV WORLDWIDE IN 2011 BY CAR SUPPLIER

TOP 3: TOYOTA, HONDA, HYUNDAI



OTHERS: FORD, MERCEDES, GM, NISSAN…



Source: TOYOTA, HONDA, NISSAN, FORD, GM, HYUNDAI, MERCEDES, GM, BMW, VW, PORSCHE… Compilation AVICENNE ENERGY
Micro hybrid not included

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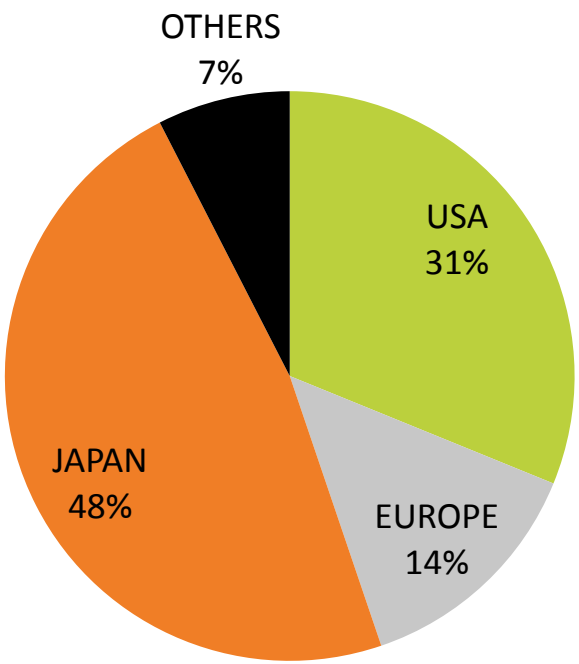
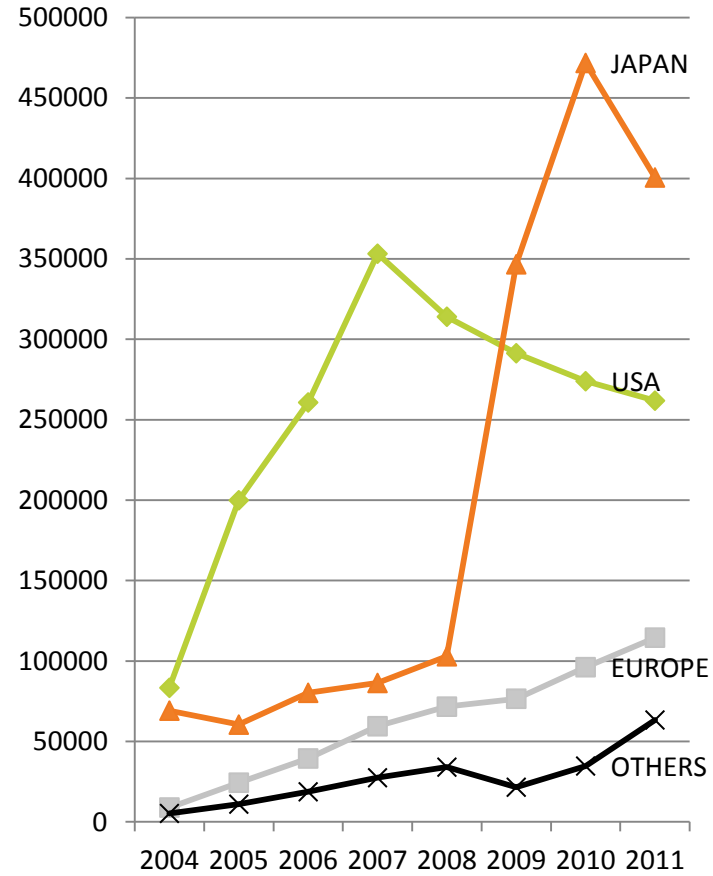
HEV WORLDWIDE IN 2011 BY COUNTRY

Total HEV Vehicles Less than 0.9 M in 2011



HEV sold per year, M units per country, 2004-2011



Micro hybrid not included

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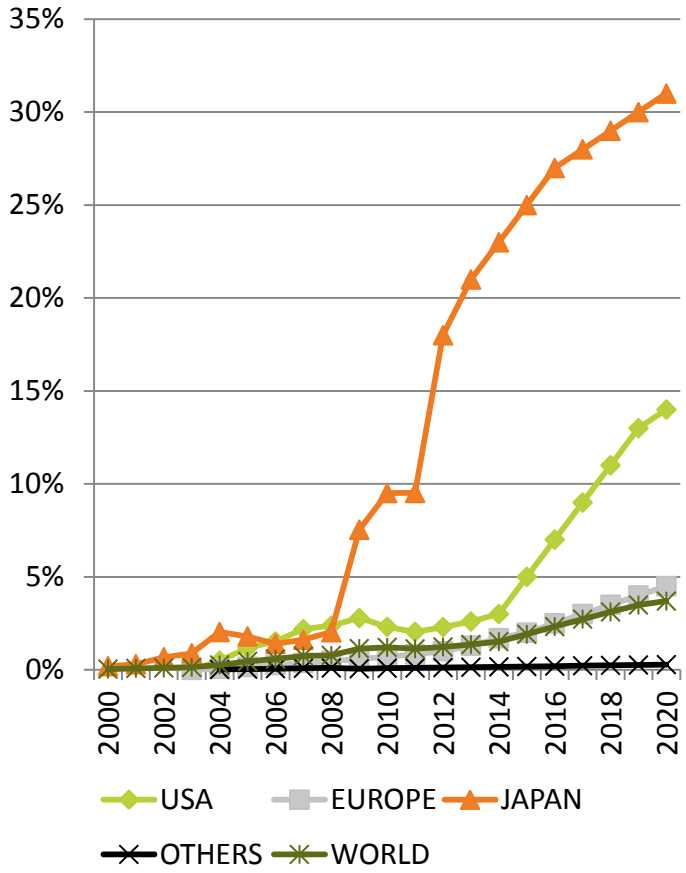
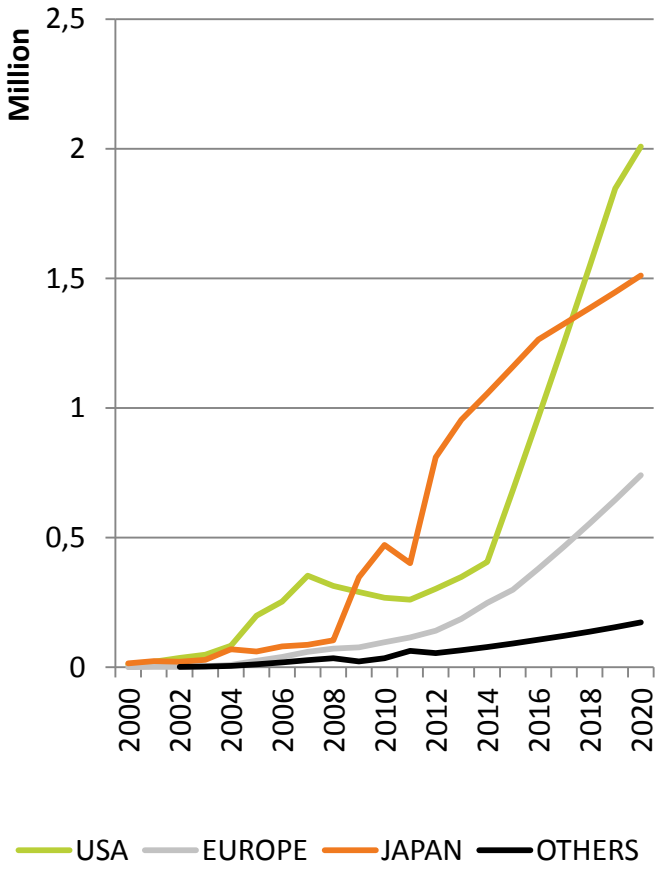
HEV FORECASTS 2011-2020

HEV MARKET: 2 Million units in 2015 & 4 M Units in 2020





Micro hybrid not included

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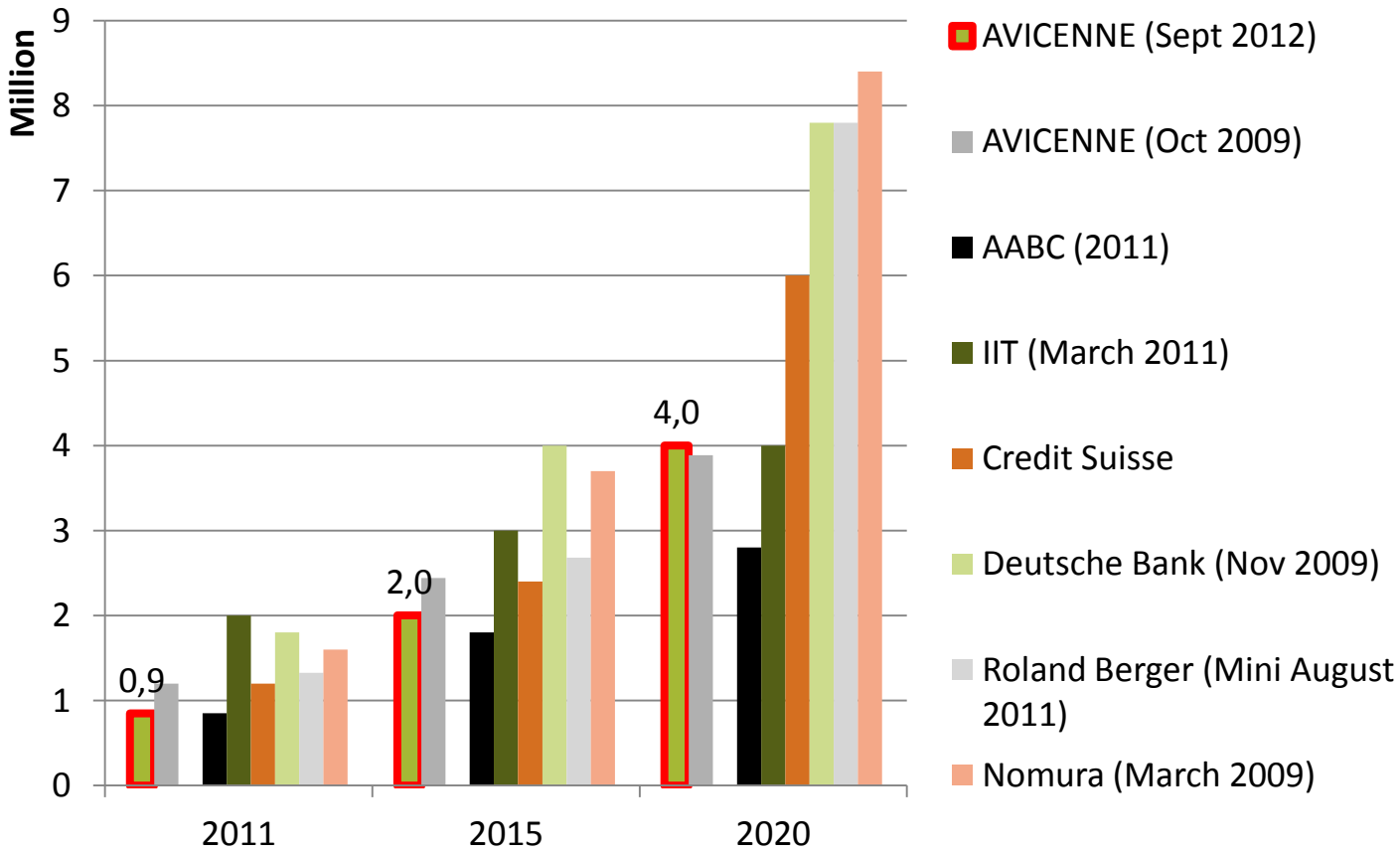
LONG TERM HEV FORECAST FROM 3 TO 8 M HEV IN 2020

AVICENNE ENERGY FORECASTS ARE REALISTIC COMPARE TO OTHER ANALYSTS



Source: AVICENNE ENERGY Compilation, February 2012
Micro hybrid not included

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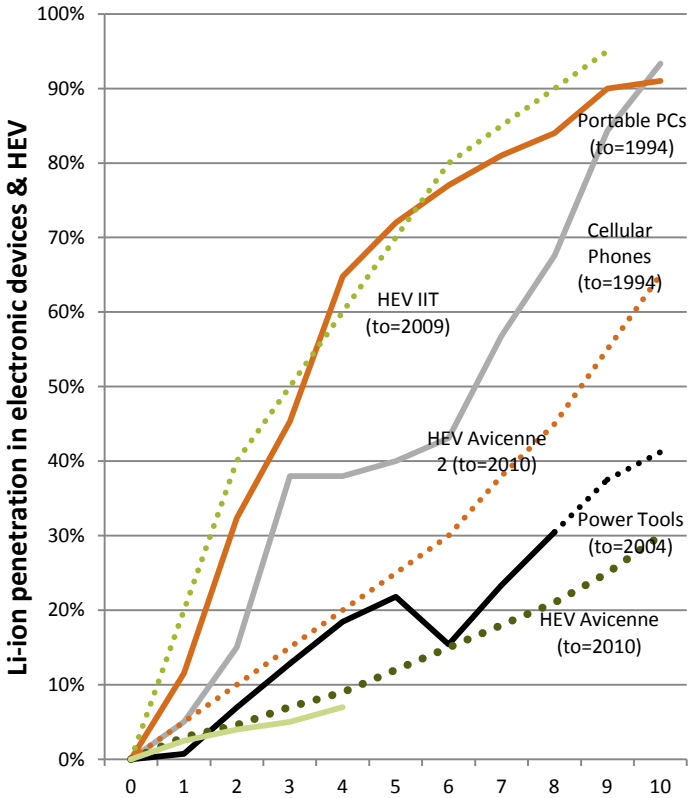
LI-ION PENETRATION IN VARIOUS DEVICES: AVICENNE & OTHER ANALYSTS FORECAST

Li-ion penetration in electronic devices & HEV



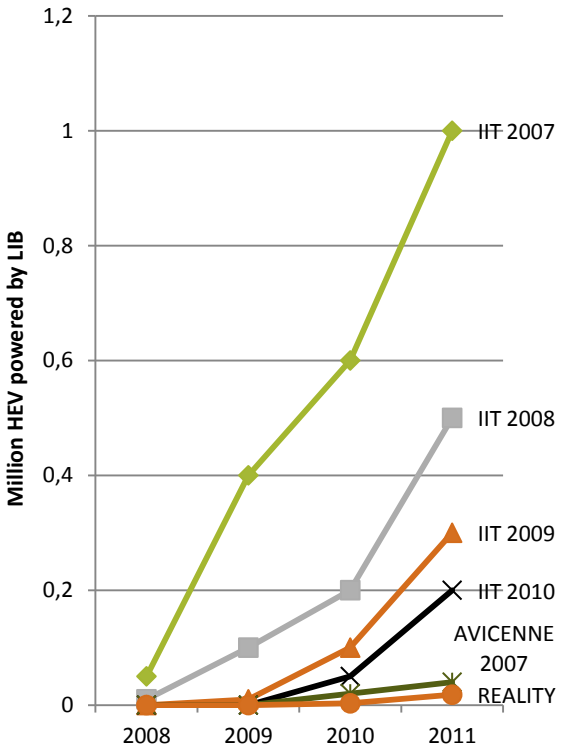
(1)AVICENNE HEV Forecasts, march 09, Relevant scenario

(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,

(4)AAB, Menahem ANDERMAN, Ph.D, Tampa, Florida, May 2009

HEV powered by LIB forecasts from 2008 to 2011



Source : International Battery Conference, Fort Lauderdale 2007, 2008, 2009, 2010 & 2011

Micro hybrid not included

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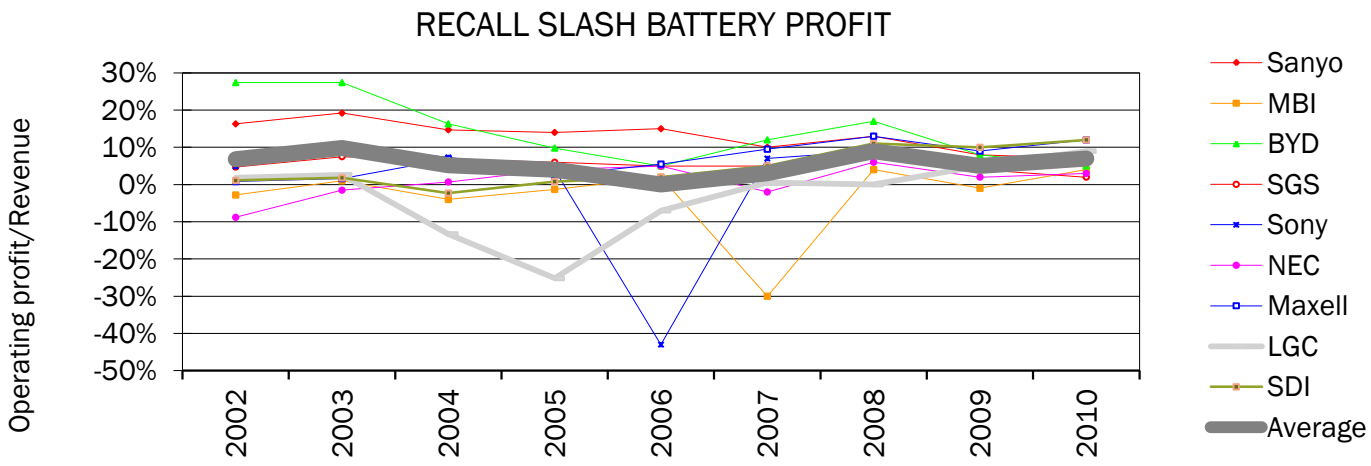
LIB BUSINESS
RECALL SLASH BATTERY PROFIT

- More & more incidents & accidents
- All the battery makers and the OEM are concerned
- Recall cost impact drastically the battery business and the profitability

Battery Makers	OEM	Battery recall	Date	Cost
Matsushita	Nokia	46 M cells	08/07	170 MUS$
Sanyo	Mitsubishi	1.3 M cells	12/06	35 MUS$
Sony	Dell, Apple, Toshiba, Lenovo,...	10 M Packs 65 M cells	2006	430 MUS$
Sony	HP, Toshiba, Dell	0.44 M	2009	



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TIME TO MARKET FOR NEW MATERIALS IN LIB INDUSTRY

1970ies 1980ies 1991 2004 2010

- The research and development in this industry is very long and time consuming.
- Time to market to commercialize a new material is long. Remember that the first Li-ion battery was launch by Sony in 1991 with LCO cathode, graphite, LiPF6 electrolyte & polyolefin membrane. It was 20 years ago.
- LTO was invented by Matsushita in 1993 (19 years ago)
- Lithium iron phosphate was invented in 1995 (15 years ago).
- So, it take between 10 & 20 years to commercialized a new material in the battery industry.

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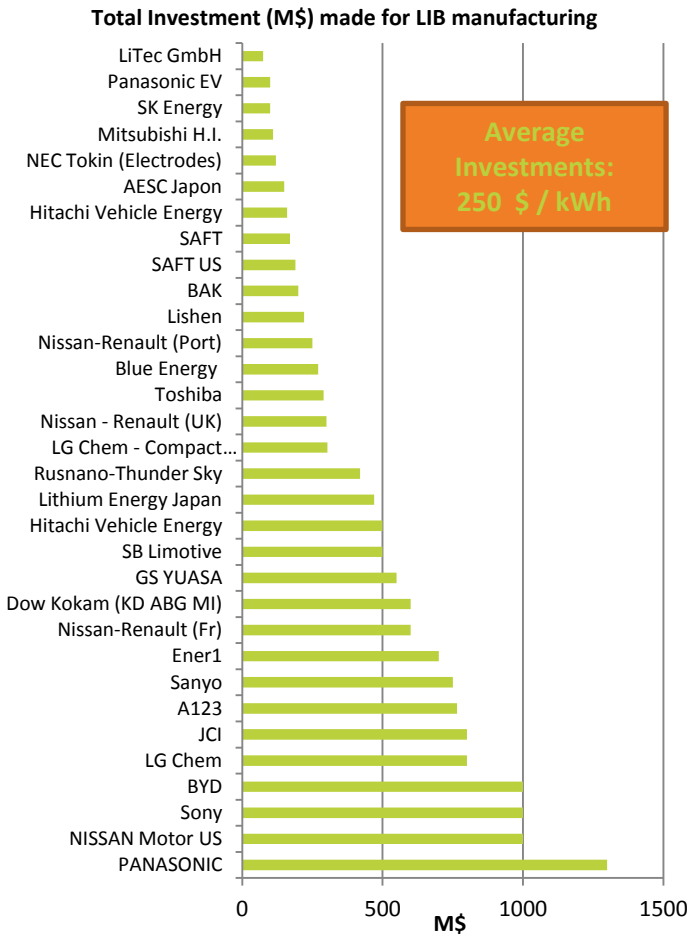
LIB MANUFACTURING INVESTMENTS 2009-2015

10-12 B$ WORLDWIDE

>50 GWh in 2015



A123 Michigan Plant - Photo courtesy of A123 Systems

Liotech Plant, Novosibirsk – 1,5 GWh production capacity

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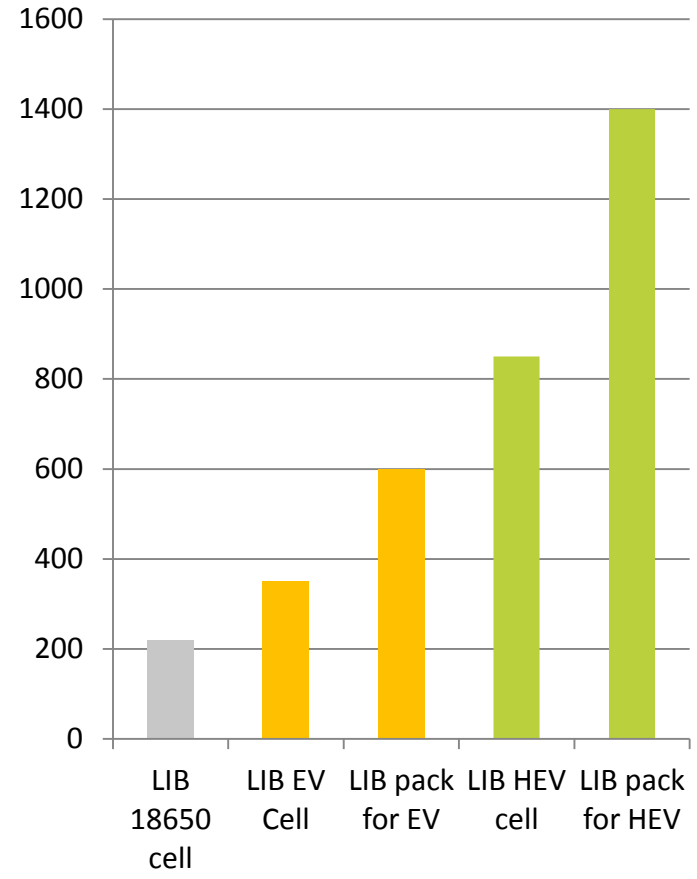
LIB BATTERY COST

Costs analysis

- Raw material cost (Co, Mn, Ni, Al, Cu, …)
- Anode, cathode, Electrolyte , separator, binders, Cu & Al foil, etc… cost structure :
  - CAPEX,
  - labor cost,
  - R&D
  - Marketing, Adm, Overhead, margin)
- Raw material needs / mAh
- Electrode process Yield
- Assembly Process Yield
- Cell manufacturing cost
- Module manufacturing cost
- Pack assembly cost
- …

Battery price in 2011 $/kWh



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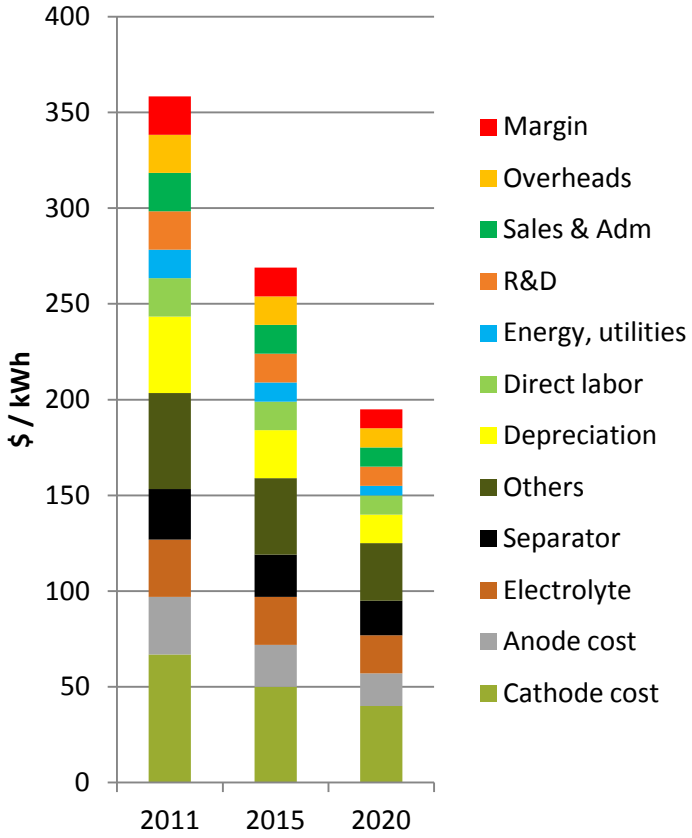
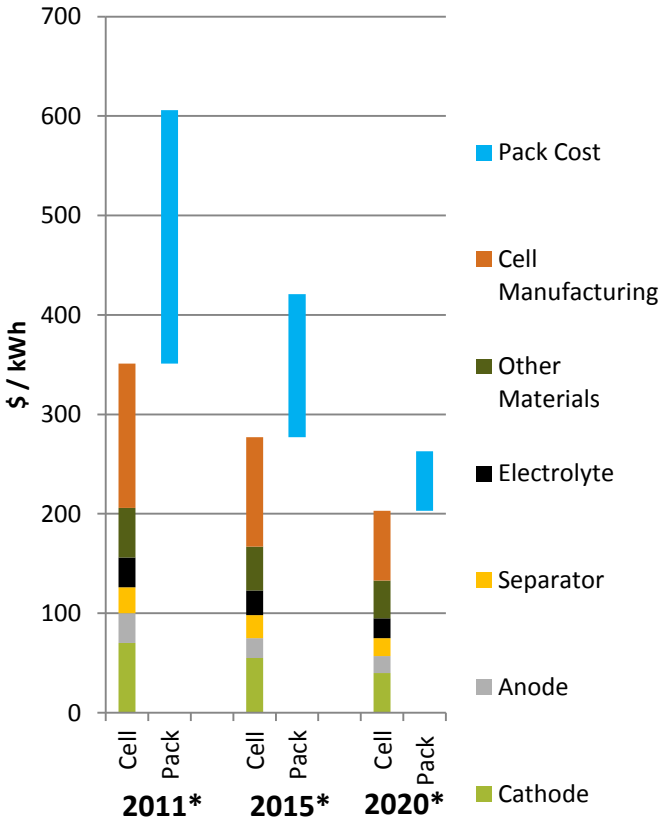
LI-ION BATTERY COST 2011-2020

LIB cell average cost (EV design ; NMC cathode)



LI-ION BATTERY PACK COST FOR EV



** For Production > 100 000 packs/year*

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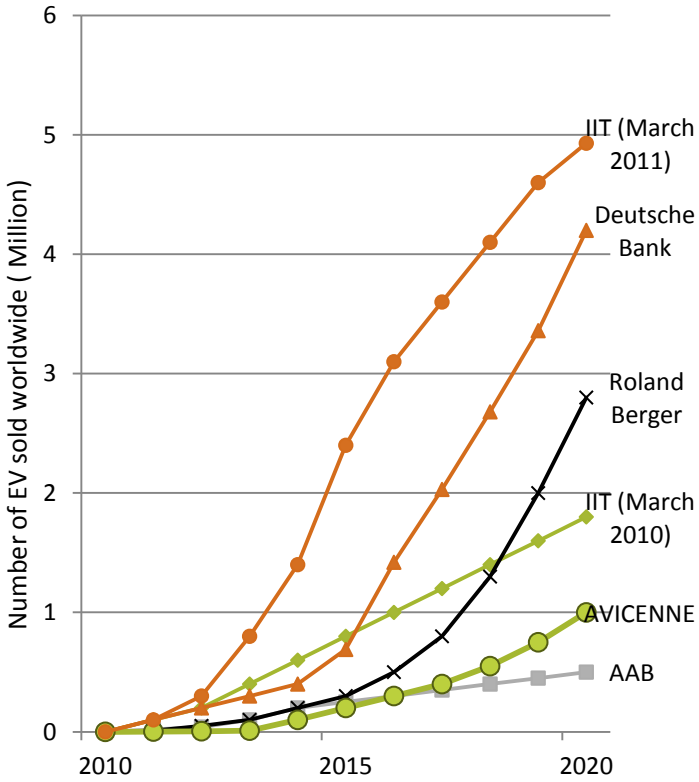
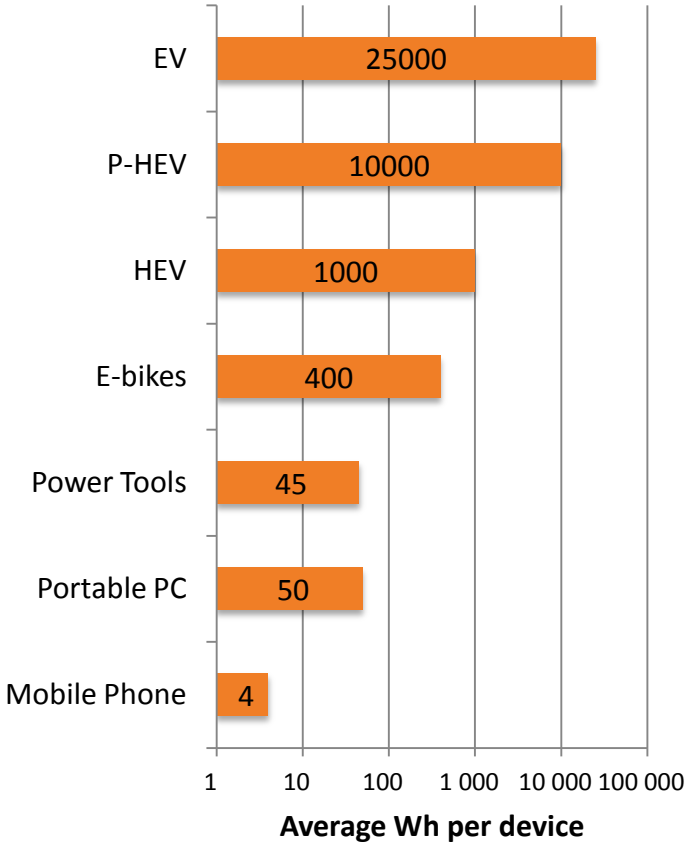
EV FORECASTS 2011-2020

EV sold, in million units, worldwide, 2010 - 2020



IIT, March 2011 Fort Lauderdale
IIT, March 2010 Fort Lauderdale
Deutsche Bank , Electric Cars: Plugged In 2 – Nov 2009
Roland BERGER, Oct 2011, Batteries 2011 Cannes
AAB, AABC Europe, Mainz, June 2011

EV impact on the LIB & raw material market is HUGE



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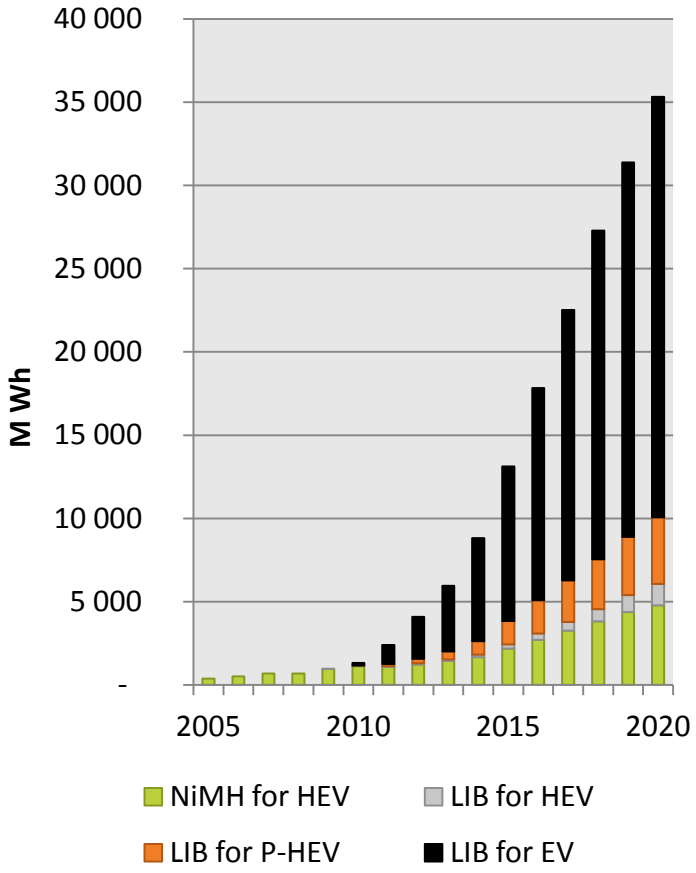
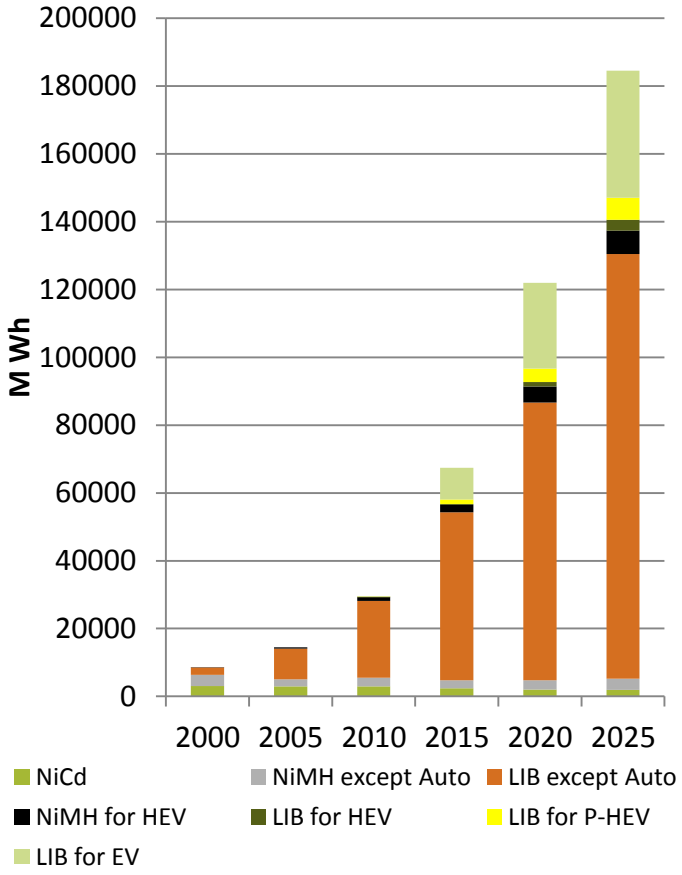
TOTAL BATTERY DEMAND 2011-2020

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



Total battery demand (MWh) 2000 – 2025



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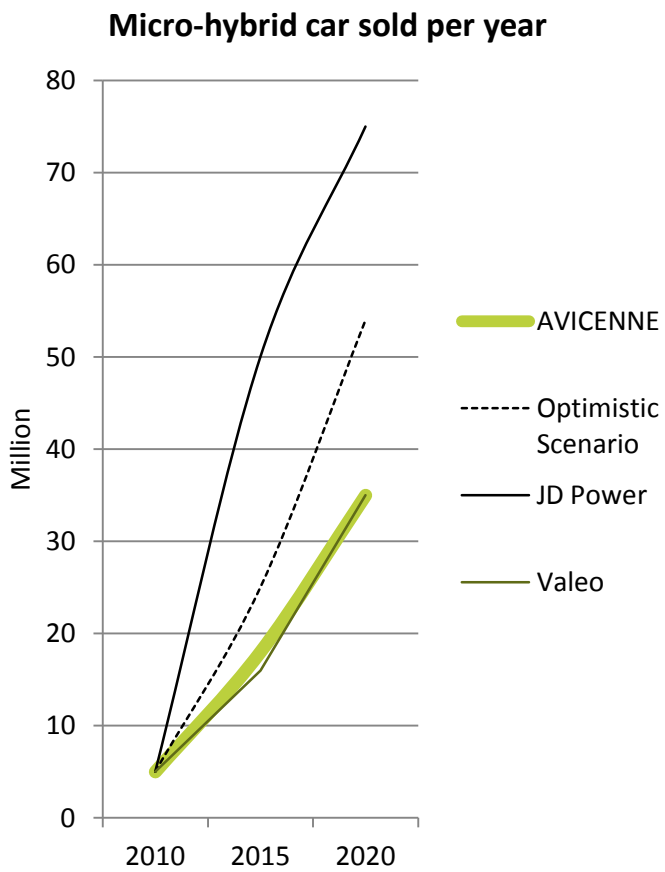
35 MILLION MICRO-HYBRIDS CAR IN 2020

Micro-hybrids car market 2010-2020



Advantages of micro-hybrid compare to HEV

- Powered by Advanced lead acid batteries
- Much more profitable than full HEV: 8 to 10 times less expensive than full HEV to save 5% gasoline instead of 20% (4 times less)
- Much more impact on CO2

	Micro-hybrid	Full HEV
Battery	Advanced lead acid	NiMH or LIB
Cost ($)	300	3000
Fuel saving	5%	20%
Million Vehicle sold per year in 2020	35	3.5

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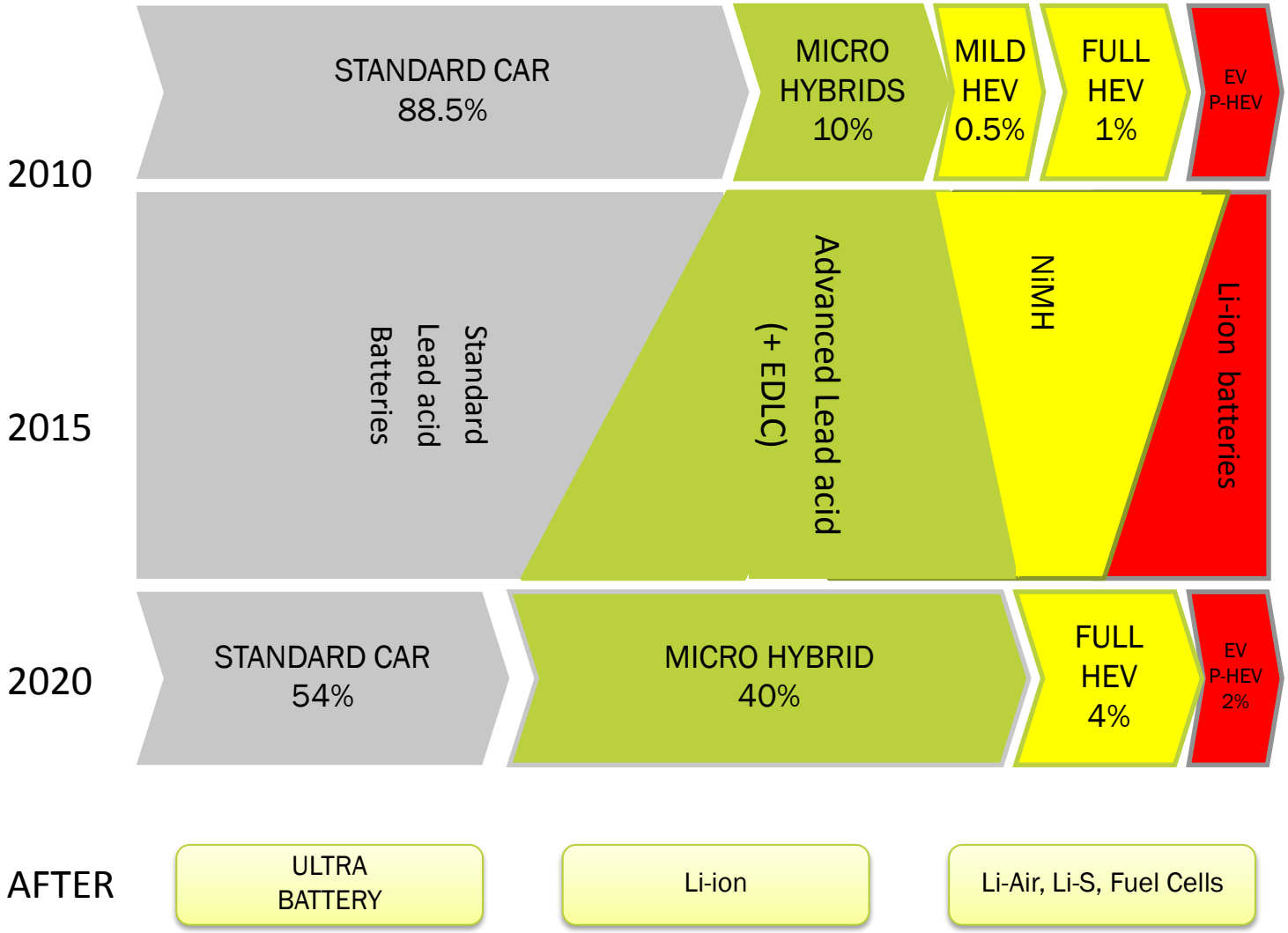
HEV, P-HEV AND EV REALITY OF THE MARKET WILL BOOST MICRO HYBRID AND ADVANCED LEAD ACID BATTERIES



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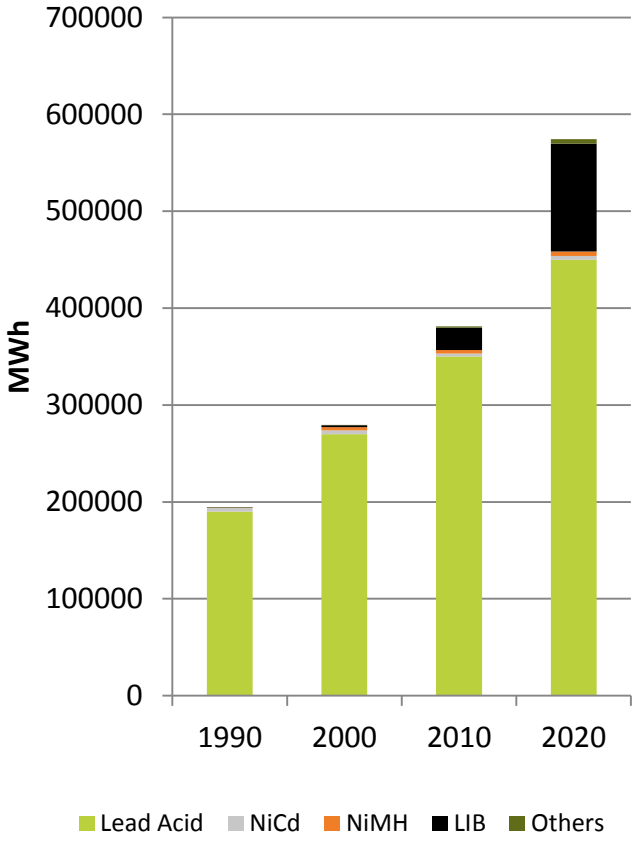
TAKEAWAYS

Battery Market 2010-2020

CAGR = +8%

- Li-ion battery is driven today by Portable PCs & electronic devices
- For HEV, the battery technology is today the NiMH
- LIB begin really to compete in 2012
- P-HEV & EV will be powered by Li-ion: 5 B$ market in 2015 & 9 B$ in 2020
- EV expectations attract large Chemical companies
- New materials are needed to meet Automotive standards
- HEV will account for less than 5% of the automotive sales in 2020
- P-HEV & EV < 2% by 2020
- Micro-hybrid will achieve 40%
- Lead acid battery will be the first market in 2020 in volume & value

RECHARGEABLE BATTERY MARKET WORLDWIDE 2000-2020



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THANK YOU

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