



ICAO

UNITING AVIATION

Safety Oversight of Lithium Batteries for Transport

Lima, Peru



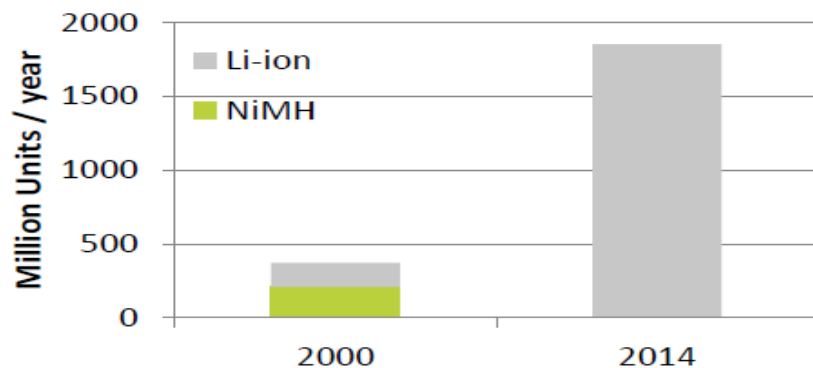
Lithium Battery Global Market

- What is the historic trend of lithium battery manufacturing?
- What are the future trends expected?
- What effect has this trend had on air transportation?
- How does an industry this size control quality, counterfeiting and noncompliance with the dangerous goods regulations today?

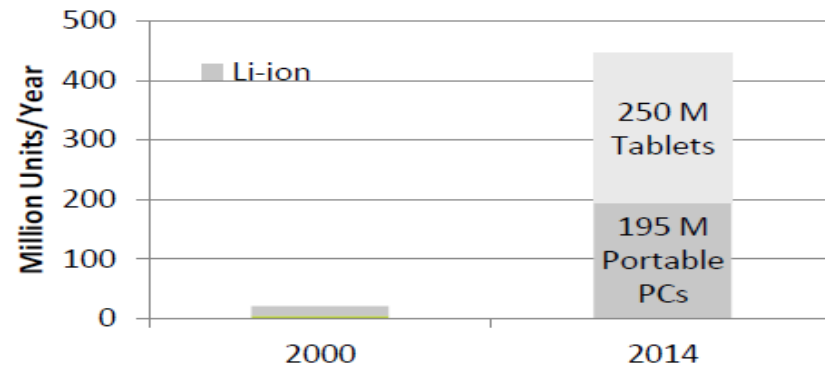


THE BATTERY MARKET IS REALLY DYNAMIC

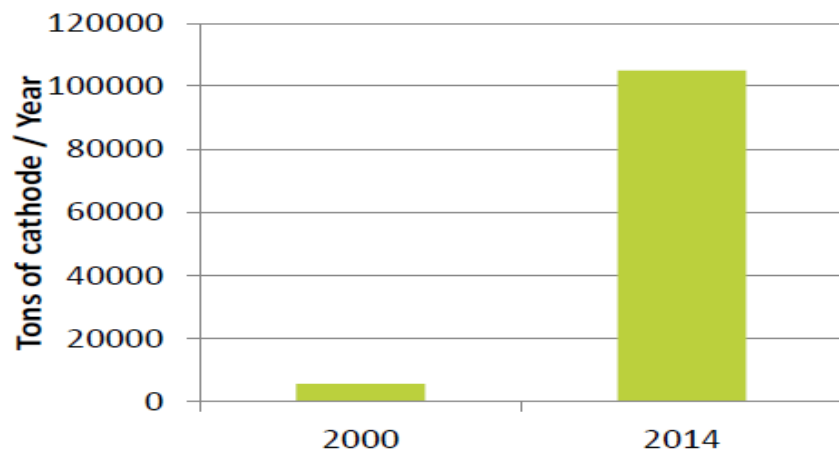
Cellular Phones sold per Year (Million)



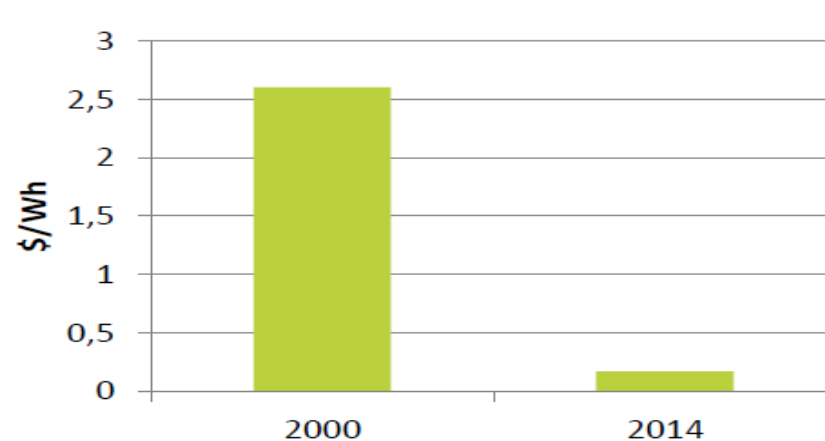
Portable PC sold per Year (Million)



Tons of Li-ion Cathode per year



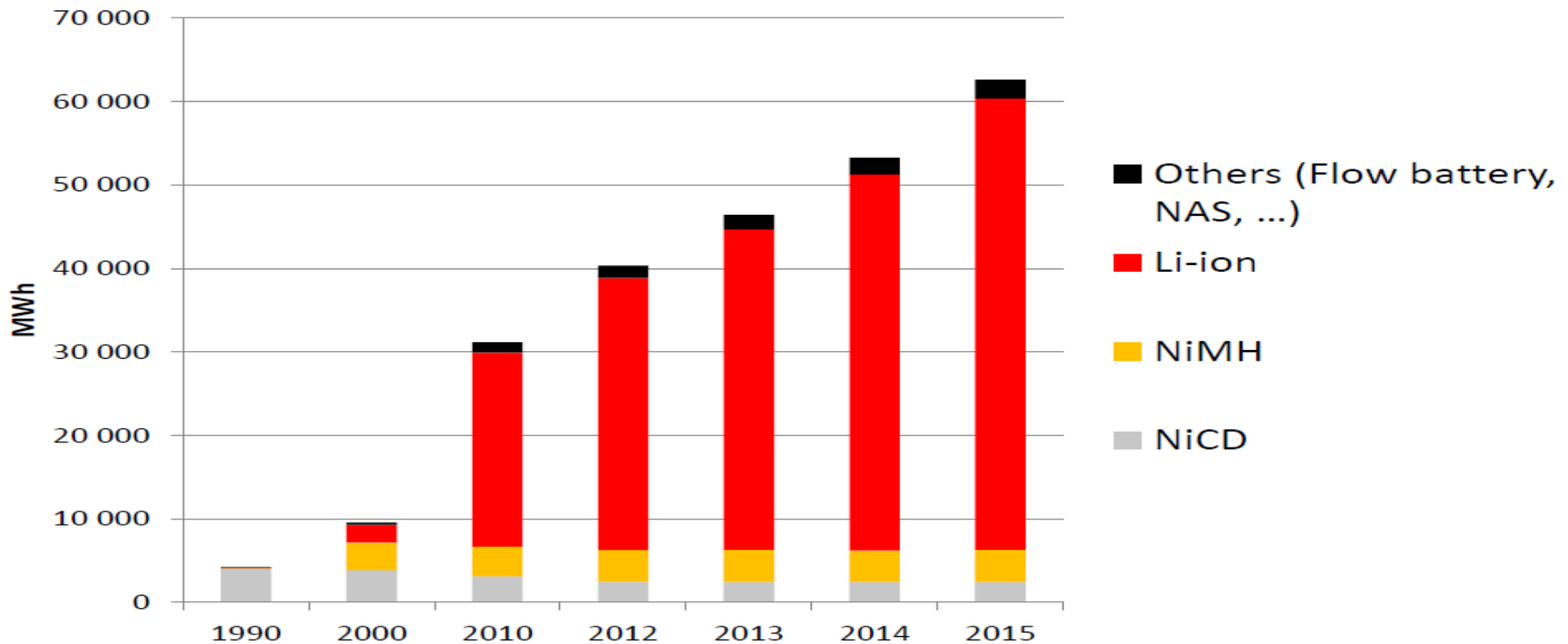
Li-ion 18650 cell price (\$/Wh)



Source: AVICENNE ENERGY Analyses 2015

THE WORLDWIDE BATTERY MARKET 1990-2015

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



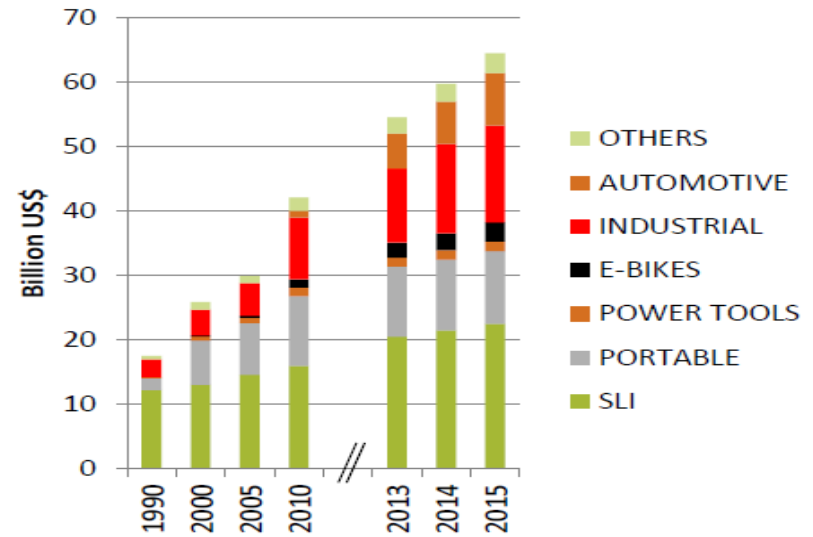
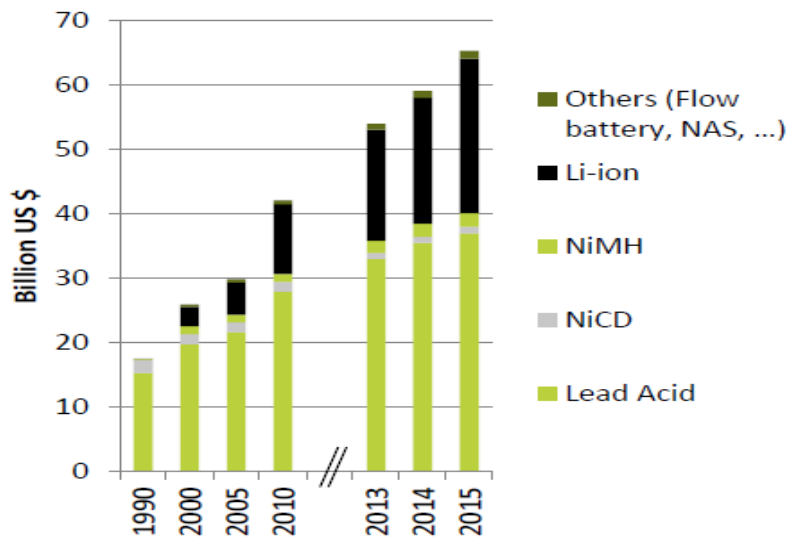
Source: AVICENNE ENERGY, 2015

2015: Estimations

THE WORLDWIDE BATTERY MARKET 1990-2015

60 BILLION US\$ in 2014 – Pack level¹

5% AVERAGE GROWTH PER YEAR (1990-2014)



SLI: Start light and ignition batteries for cars, truck, moto, boat etc...

PORTABLE: consumer electronics (cellular, portable PCs, tablets, Camera, ...), data collection & handy terminals,

POWER Tools: power tools but also gardening tools

INDUSTRIAL

- MOTIVE: Forklift (95%), others
- STATIONARY: Telecom, UPS, Energy Storage System, Medical, Others (Emergency Lighting, Security, Railroad Signaling,, Diesel Generator Starting, Control & Switchgear,

AUTOMOTIVE: HEV, P-HEV, EV

OTHERS: Medical: wheelchairs, medical carts, medical devices (surgical power tools, mobile instrumentation (x-ray, ultrasound, EKG/ECG, large oxygen concentrators

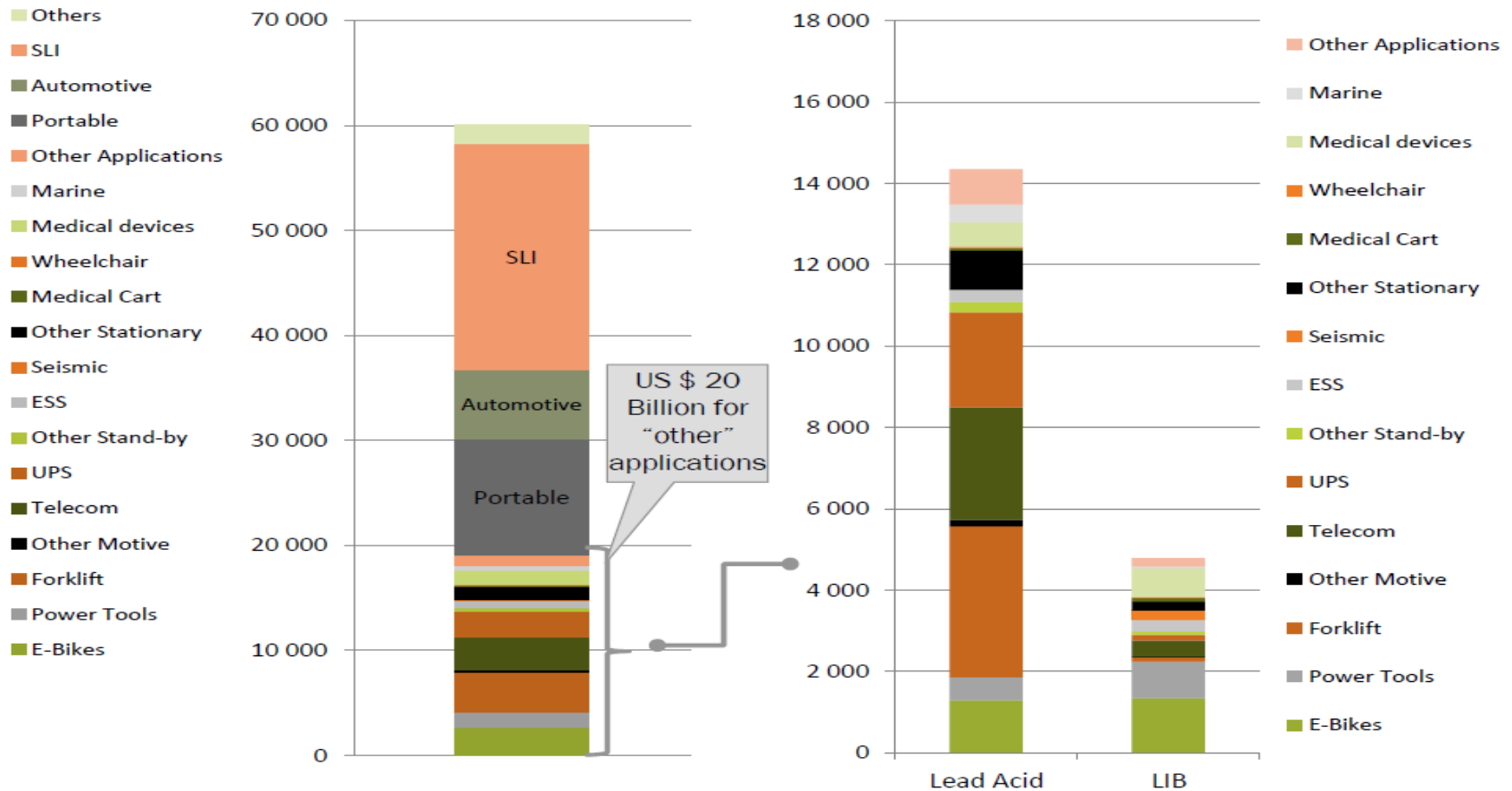
1- Pack: cell, cell assembly, BMS, connectors – Power electronics (DC DC converters, invertors...) not included

Source: AVICENNE ENERGY, 2015

2015: Estimations

THE WORLDWIDE BATTERY MARKET IN 2014: US \$ 60 BILLION

Battery market in 2014 (M\$)



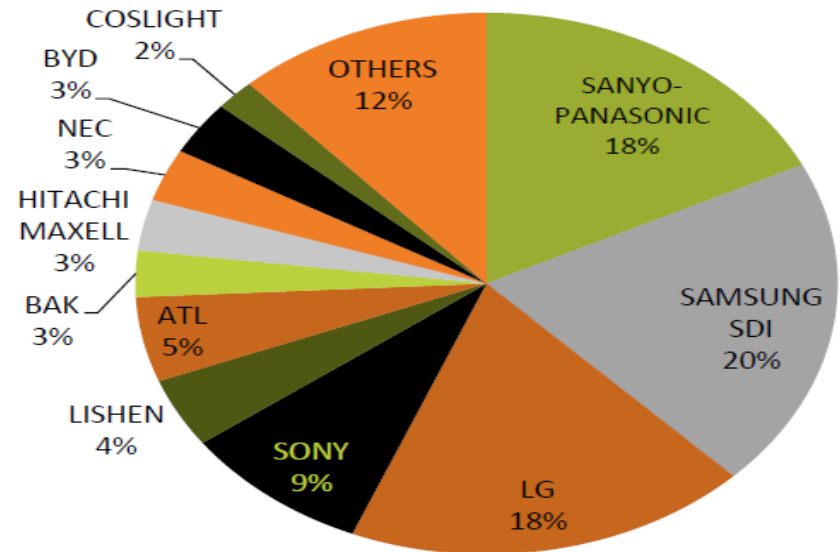
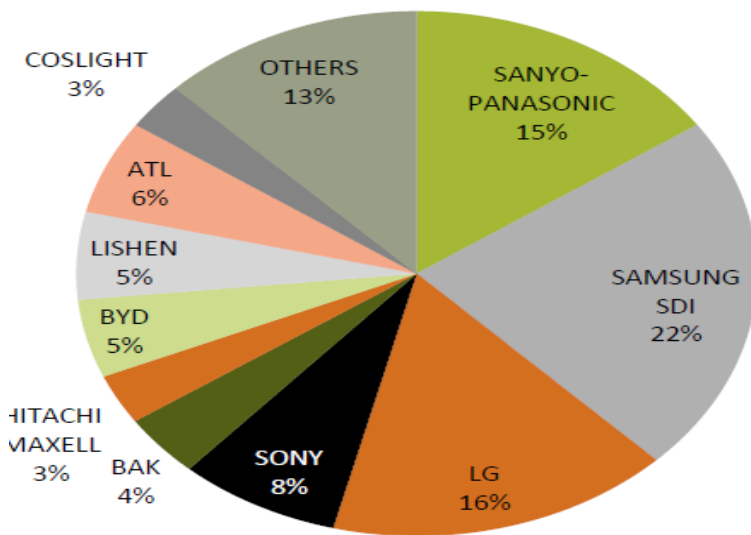
1- Pack level: Pack including cells, cells assembly, BMS, connectors – Power electronics (DC DC converters, invertors...) not included

Source: AVICENNE ENERGY, 2015

LI-ION BATTERY: MARKET SHARE IN 2014 WORLDWIDE

The worldwide Li-ion battery market Company market share in 2014 in volume: 5400 M cells

The worldwide Li-ion battery market Company market share in 2014 in value⁽¹⁾ – 13,6 B\$

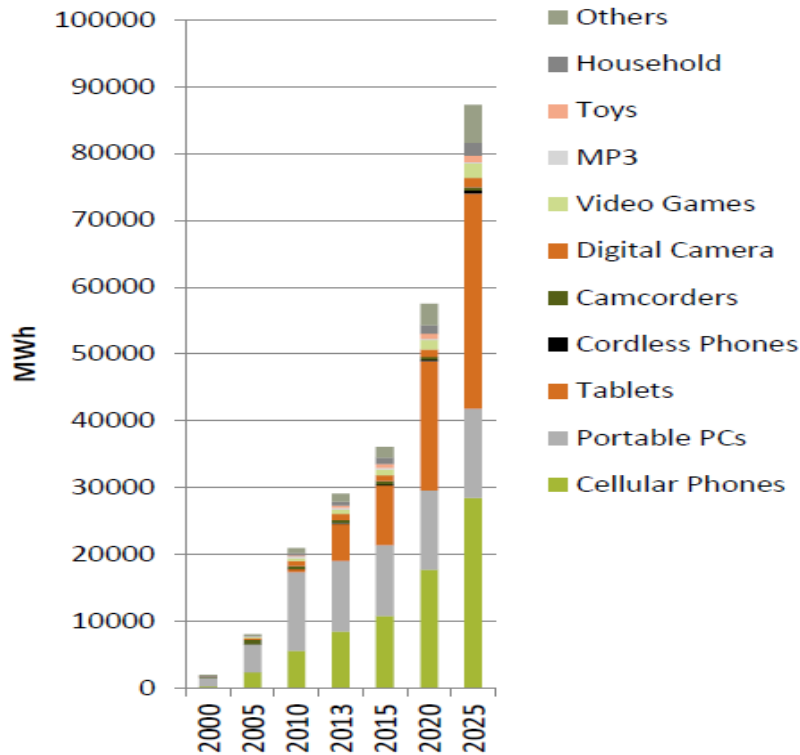


Source: AVICENNE ENERGY Analyses 2015

(1) Cell level. LIB battery pack market: >16,7 B\$

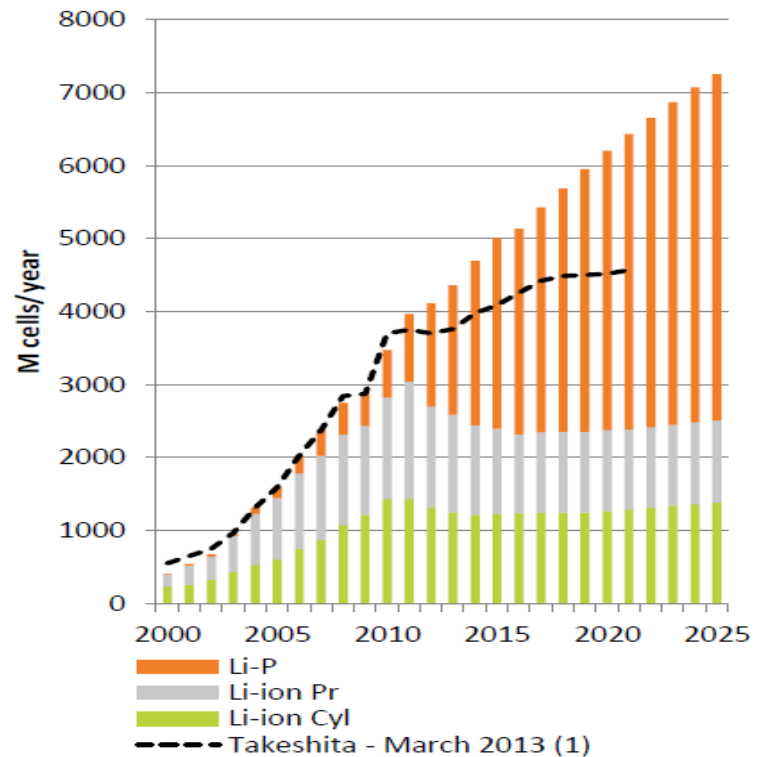
2025 LIB FORECASTS FOR PORTABLE ELECTRONIC DEVICES

2000-2025 LIB market, MWh, by application (3C)



Source: AVICENNE ENERGY Analyses

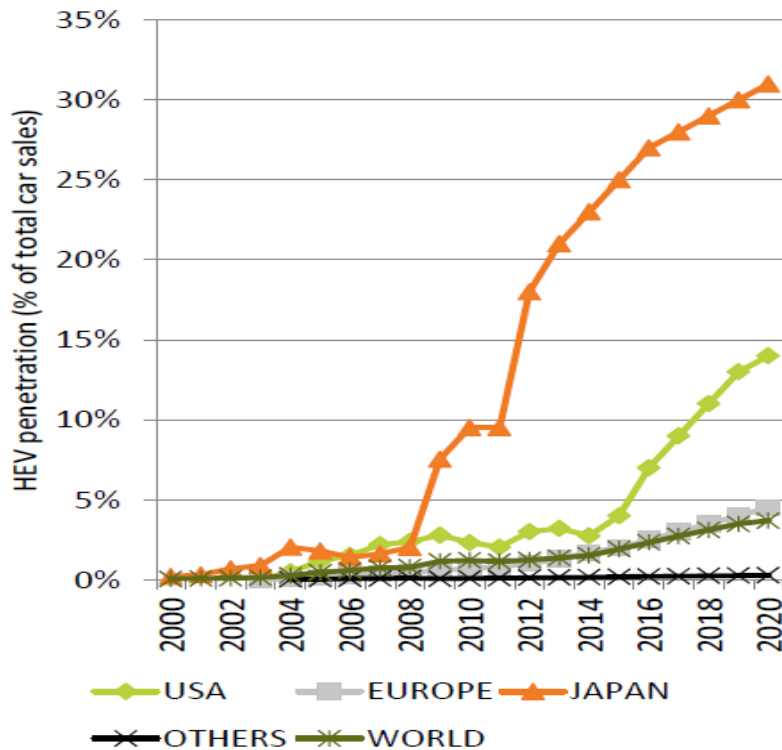
2000-2025 LIB market, M cells, by form factor (3C)



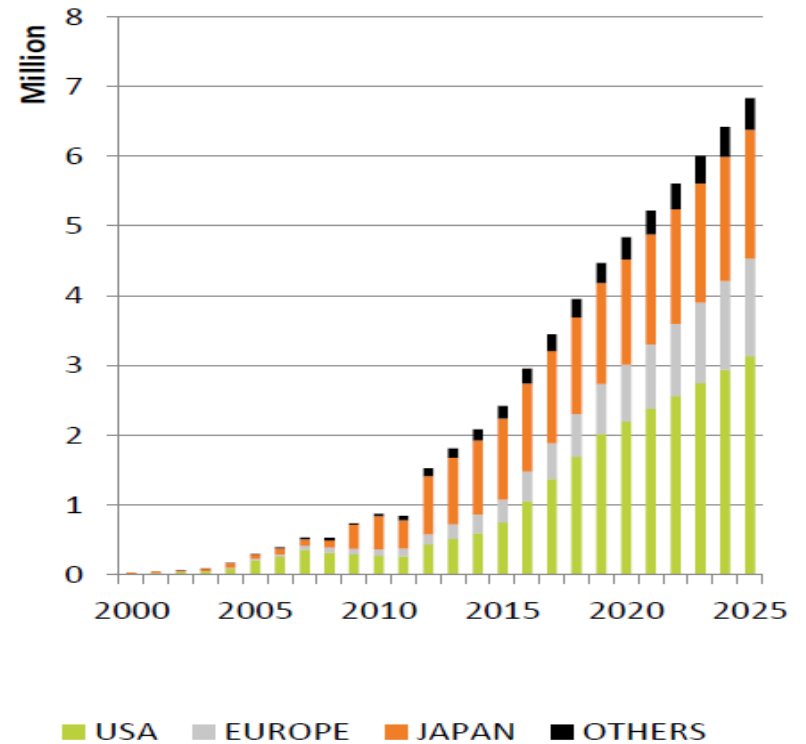
(1) Source: Takeshita, Battery Japan 2013 BJ-3 conference – Slide p 4

HEV FORECASTS 2000-2020

HEV MARKET: 2,5 Million units in 2015 – 5 M in 2020 – 7 M in 2025



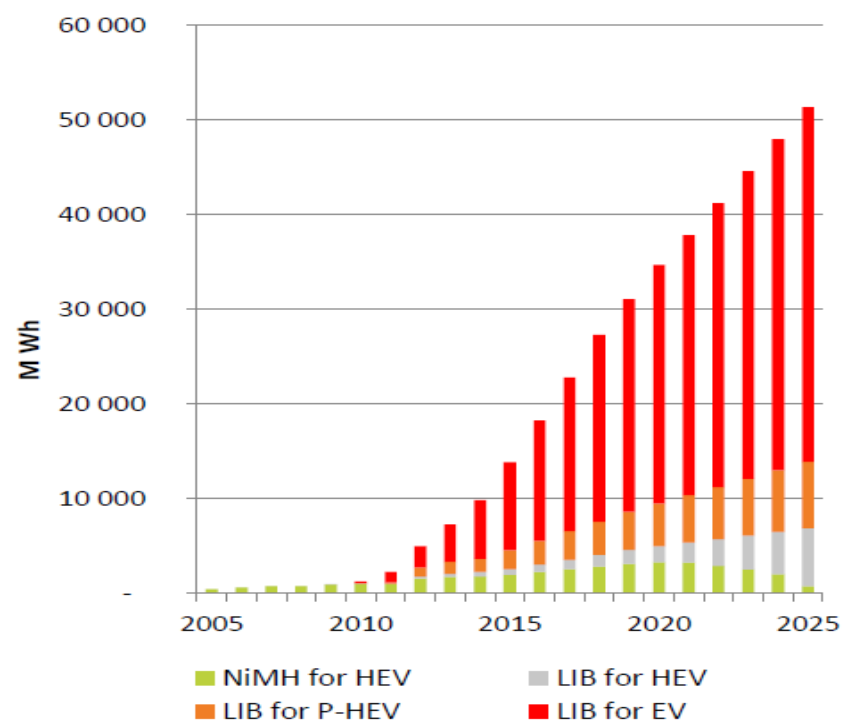
Micro hybrid not included



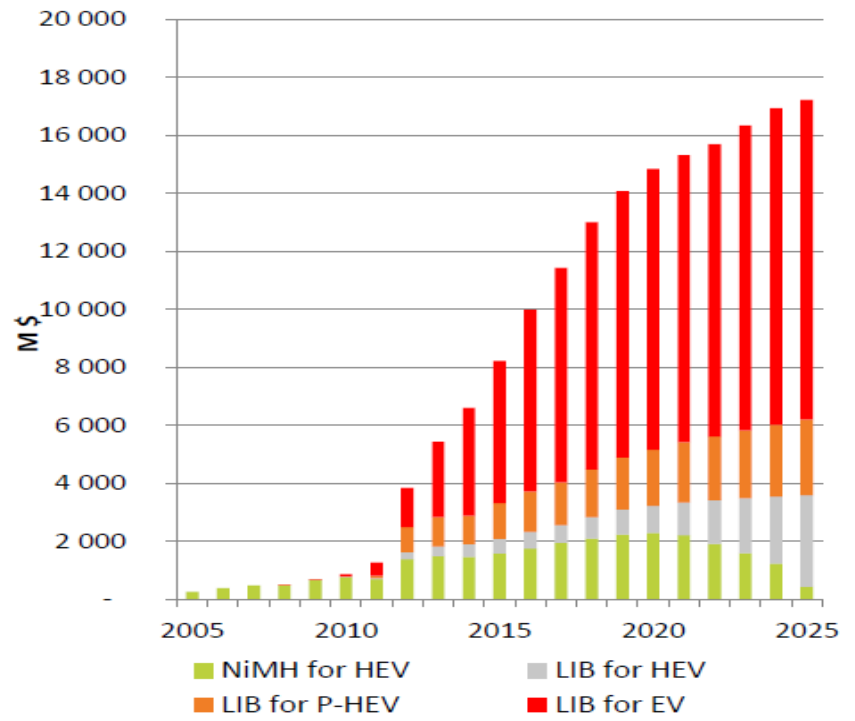
Source: AVICENNE ENERGY Analyses 2013

TOTAL BATTERY DEMAND FOR AUTO FORECASTS

EV, HEV & P-HEV Battery needs (MWh)
 CAGR 2013-2020: +23%



Rechargeable battery market for Auto⁽¹⁾, M\$ for x-EV 2000-2025
 CAGR 2014-2020: +14%



Source: AVICENNE ENERGY Analyses 2013

(1) Pack level



Noncompliant and Counterfeit Lithium Batteries

- There are standards and treaties that govern the manufacture of chemicals, however lithium batteries although dangerous goods for transportation are articles.
- Articles are not covered under the same standards and treaties as chemicals.
- Articles are also not covered by Globally Harmonized System (GHS) or required to have an Material Safety Data Sheet (MSDS).



Regulating Articles for Transportation

- The regulation and classification of solids, liquids and gases is a clear framework in the dangerous goods regulations.
- Articles are not as straight forward to regulate.
- Lithium batteries were viewed as an industrial article when first put into the regulations.
- Lithium batteries became a consumer products industry.
- Today we have a combination of industrial and consumer applications.

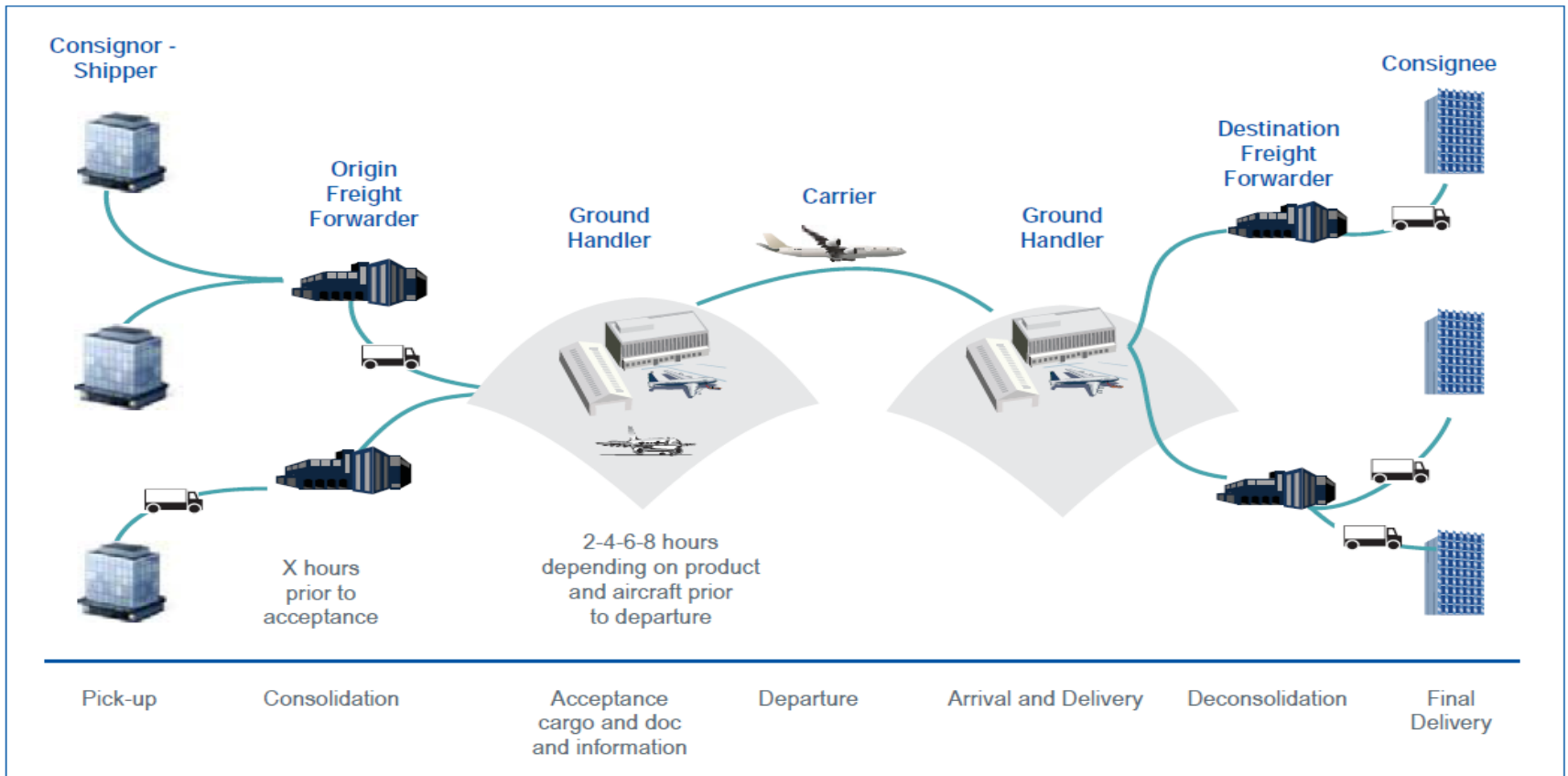


Noncompliant and Counterfeit Lithium Batteries

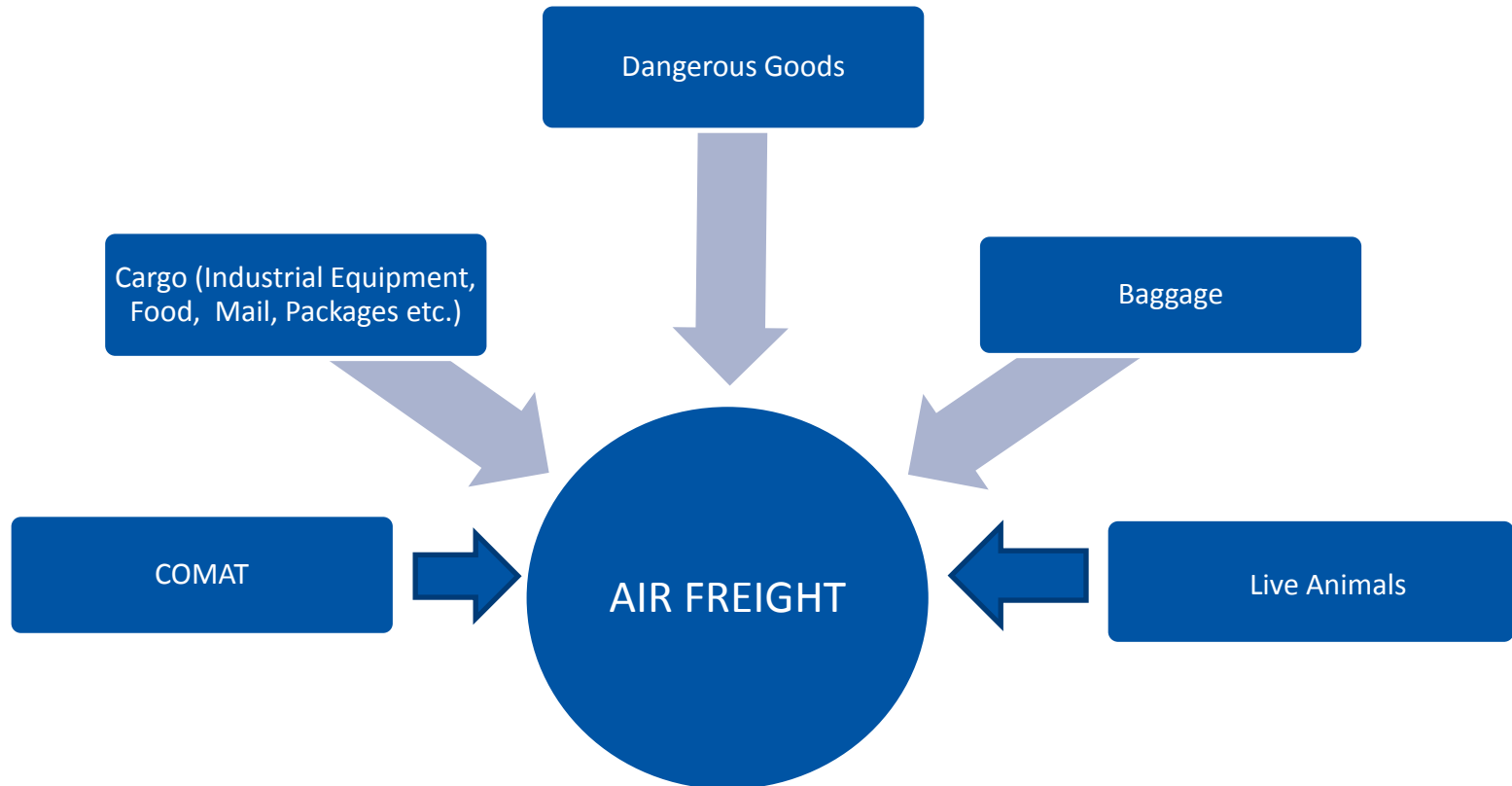
- It is very difficult for everyone to understand something they use everyday in many applications is a dangerous good in transport.
- It is also very difficult to oversee an industry that has growth in not only the quantities manufactured but the quantity of manufacturers involved in the process.
- The cargo system itself is very complex.

The BIG Picture

There is shared responsibility to ensure that air cargo moves safely and securely through this chain



What goes into air freight/cargo?





The Organizations that provide oversight and surveillance

Currently the Cargo Safety oversight is conducted in coordination by many organizations within ICAO

Annex 19 – Safety Management Systems

Annex 18 – The Safe Transport of Dangerous Goods

Annex 17 - Security

Annex 14 - Aerodromes

Annex 13 – Aircraft Accident and Incident Investigation

Annex 9 – Facilitation

Annex 8 – Airworthiness

Annex 6 – Operation of Aircraft

For States this means that the Cargo Safety Program may focus on compliance with the applicable requirements and standards often within separate lines of business within the Civil Aviation Authority or a completely different agency.



Noncompliant and Counterfeit Lithium Batteries

- As the market demand for lithium batteries increased, so did the number of manufacturers.
- With the increase in manufacturing came an increase in counterfeit and noncompliant batteries.
- Non compliance is very difficult to control as the requirements for testing and a quality manufacturing program are in the transportation regulations.
- Many believe that noncompliant batteries are the highest risk in transportation today and in the future.



Why is oversight so complex?

- **Authority**
 - The authorities that need to conduct oversight of the manufacturing are not clearly defined
- **Standards**
 - Other large industries develop industry standards to provide a quality and best practices reference for authorities to include in their oversight programs.
- **Number**
 - The number of manufacturers and manufacturing states means the authorities responsible can change state to state.



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Contact Information

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