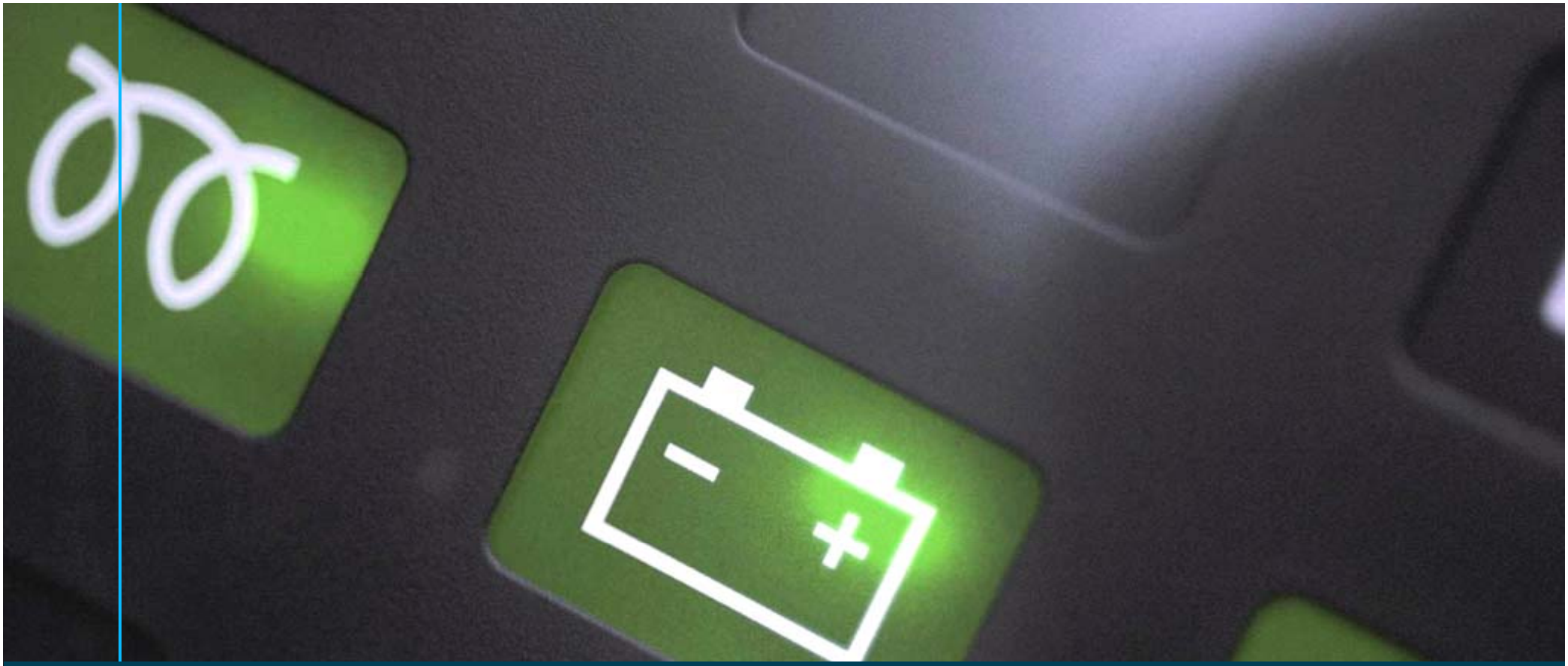

Powertrain 2020

Li-Ion batteries – the next bubble ahead?

Munich/Shanghai/Detroit – February 2010

Roland Berger
Strategy Consultants

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Roland Berger
Strategy Consultants

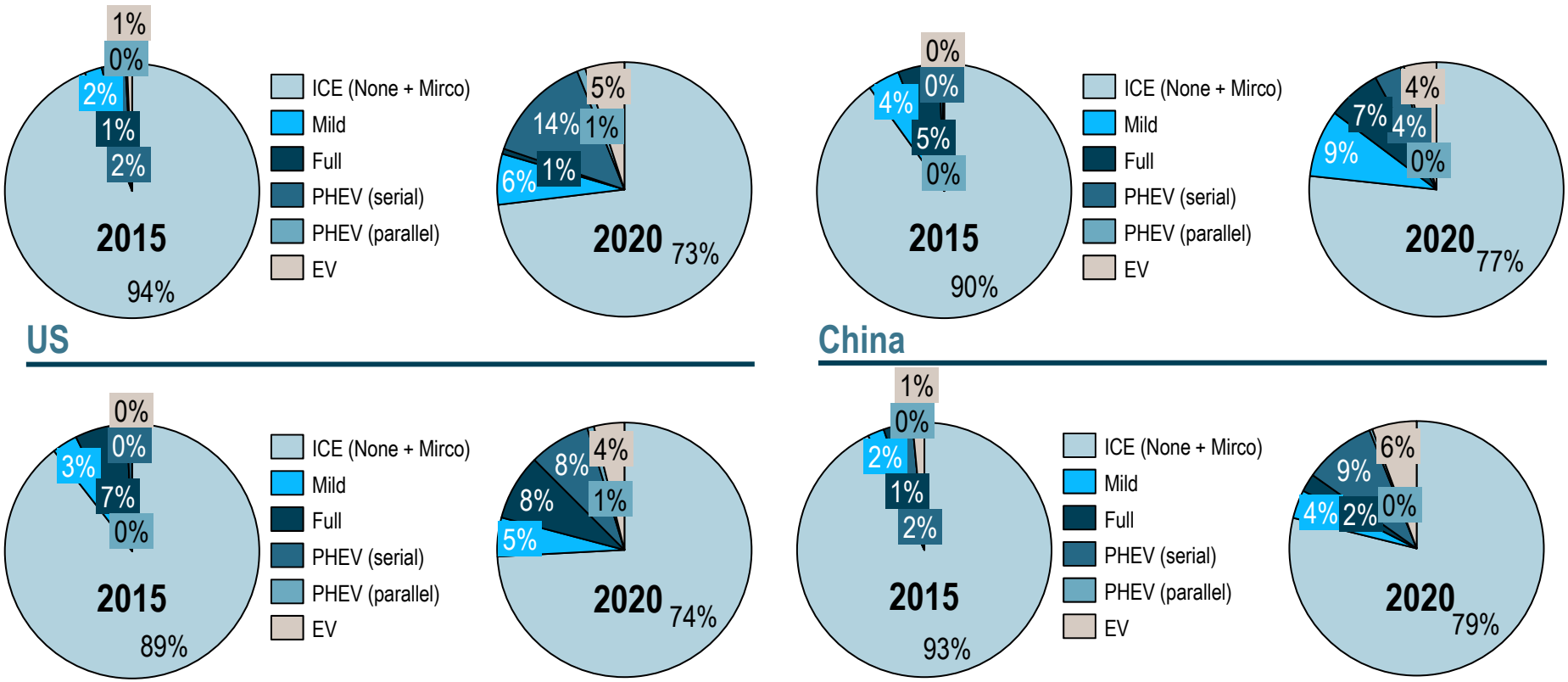
Manufacturers of LiIon batteries currently enjoy a business hype – but massive consolidation expected in next 5..7 years

- Share of electrified powertrains will increase in all major Automotive markets - driven by significant battery cost reductions in the next 10 years
- PHEV and EV in main regions account for not more than 1,2 mio vehicles in 2015 in an aggressive scenario – LiIon battery demand for HEV/PHEV and EV account for 0,82 mio "EV equivalents". Demand for LiIon batteries might further increase significantly until 2020, but 3 mio unit "EV equivalent" will not be reached before 2018
- Announced investments will result in significant overcapacity in the period between 2014 and 2017 (200% of 2016 demand already in 2015), especially in the US and Japan
- In addition, high levels of R&D and CAPEX will be required to drive down costs fast: EUR 50..100 m for new cell chemistry, EUR 350 m for 100k unit plant
- Therefore only six to eight global battery manufacturer will survive in the next five to seven years – critical size approx. EUR 600m revenues in 2015
- Western governments need to act in order to avoid loosing future technologies to Asia, battery suppliers need a well defined strategy to gain market shares fast to survive, investors should be aware of massive investment risks

Source: Roland Berger

Share of electrified powertrains will increase in all major Automotive markets

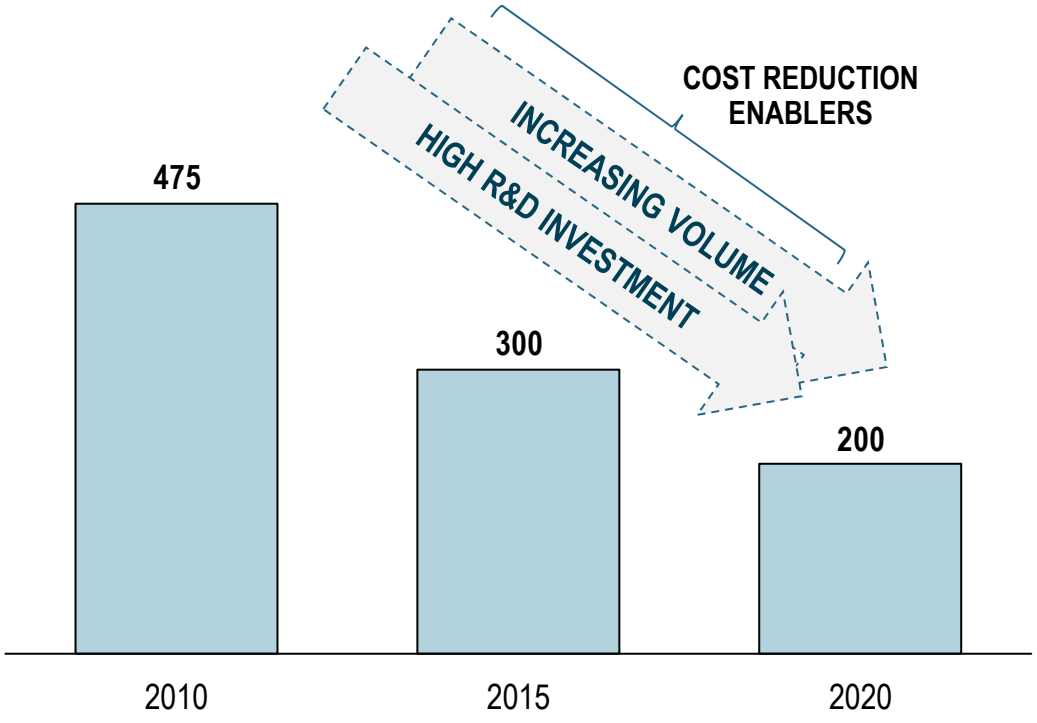
Share of powertrain technologies in major markets in 2015/2020 – High scenario



Source: Roland Berger

Increased share of HEV/PHEV and EV is driven by massive battery cost reductions in the next 10 years

Potential cost progression of high energy battery cells [EUR/kWh]



KEY POINTS

> Cost improvements will cause market volumes to rise substantially, further improving EV battery cost structure:
- Internal economies of scale
- Material supplier economies of scale/new entrants

> Significant advances in technology are required and are expected to be facilitated by substantial R&D investments:
- Design changes to remove components and increase energy density
- Chemistry changes – up to EUR 100 m invest for new chemistry

> Large capital investments into efficient, cutting edge manufacturing infrastructures is necessary: approx EUR 350 m for 100,000 unit EV equivalent plant

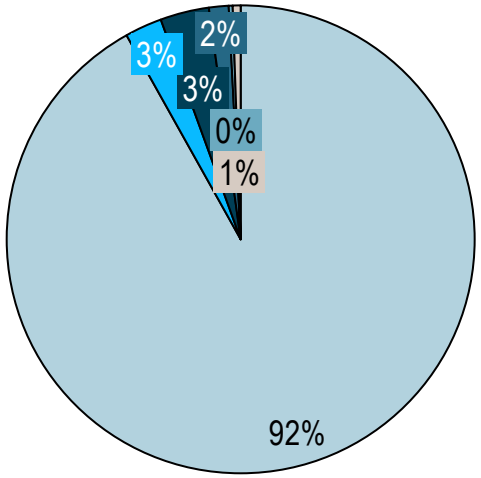
HIGH CAPITAL REQUIREMENTS DRIVE THE NEED FOR SCALE

Source: Interviews, Roland Berger

PHEV and EV in main regions account for 1,2 mio vehicles in 2015 – Lilon battery demand for 0,82 mio "EV equivalents"

xEV vehicles in major markets in 2015 (High scenario) and resulting LiIon battery demand

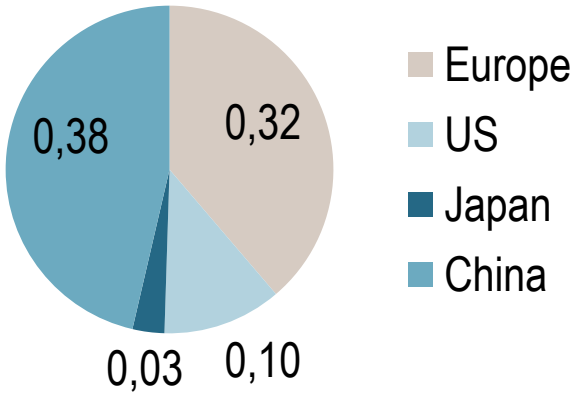
Vehicles in Western Europe, Japan, US, China



	Mio veh.
ICE (None + Mirco)	46,1
Mild	1,3
Full	1,6
PHEV (serial)	0,8
PHEV (parallel)	0,1
EV	0,3

LiIon battery demand

0,82 mio units EV equivalent



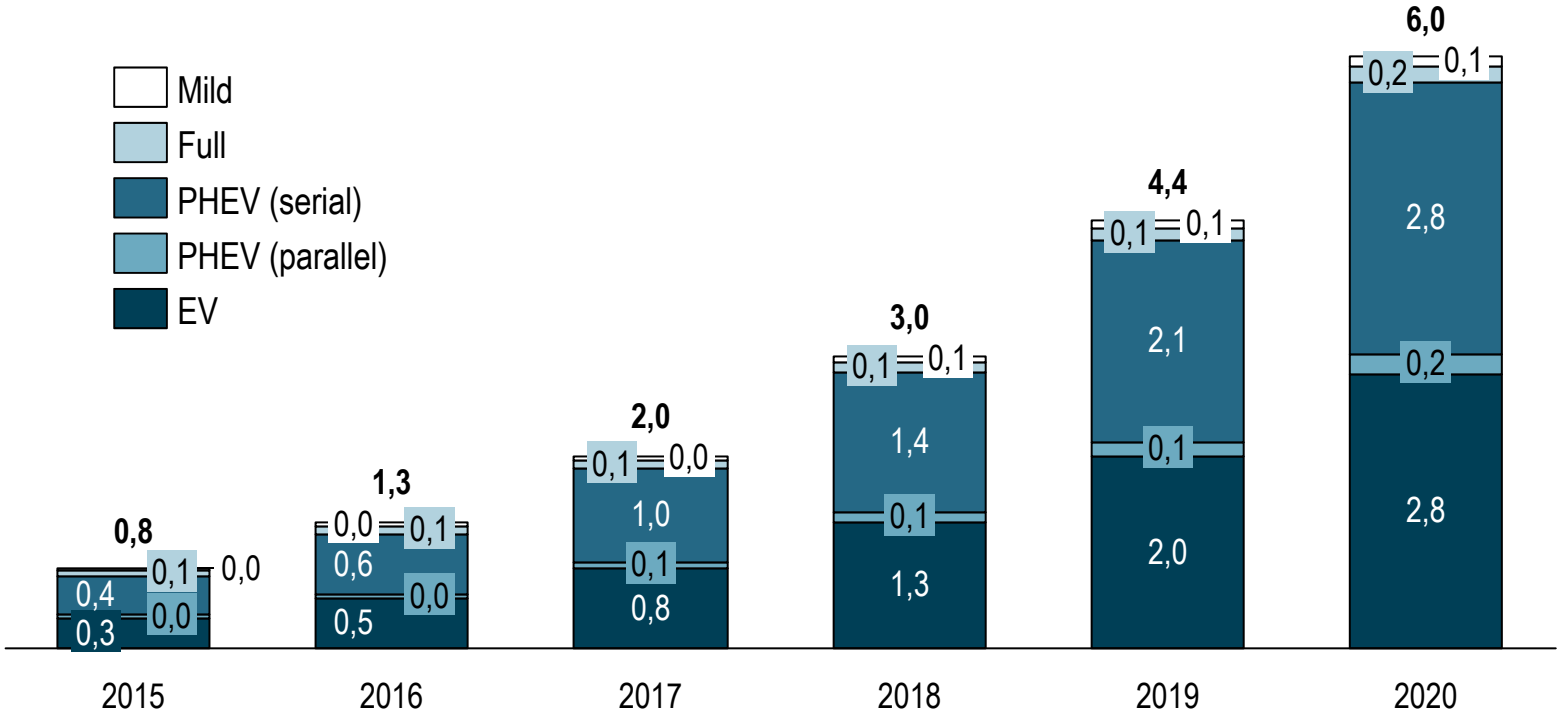
Assumptions:

EV:	25 kWh
PHEV:	12,5 kWh
Full Hybrid:	2,5 kWh
Mild Hybrid:	1,25 kWh
EV/PHEV:	LiIon batteries
Full/Mild Hybrid:	65% NiMh / 35% LiIon batteries in 2015

Source: Roland Berger

Demand for LiIon batteries will further increase significantly until 2020 - 3 mio unit "EV equivalent" not reached before 2018

LiIon battery demand in "EV equivalents" in major regions[1] 2015 – 2020 [units]



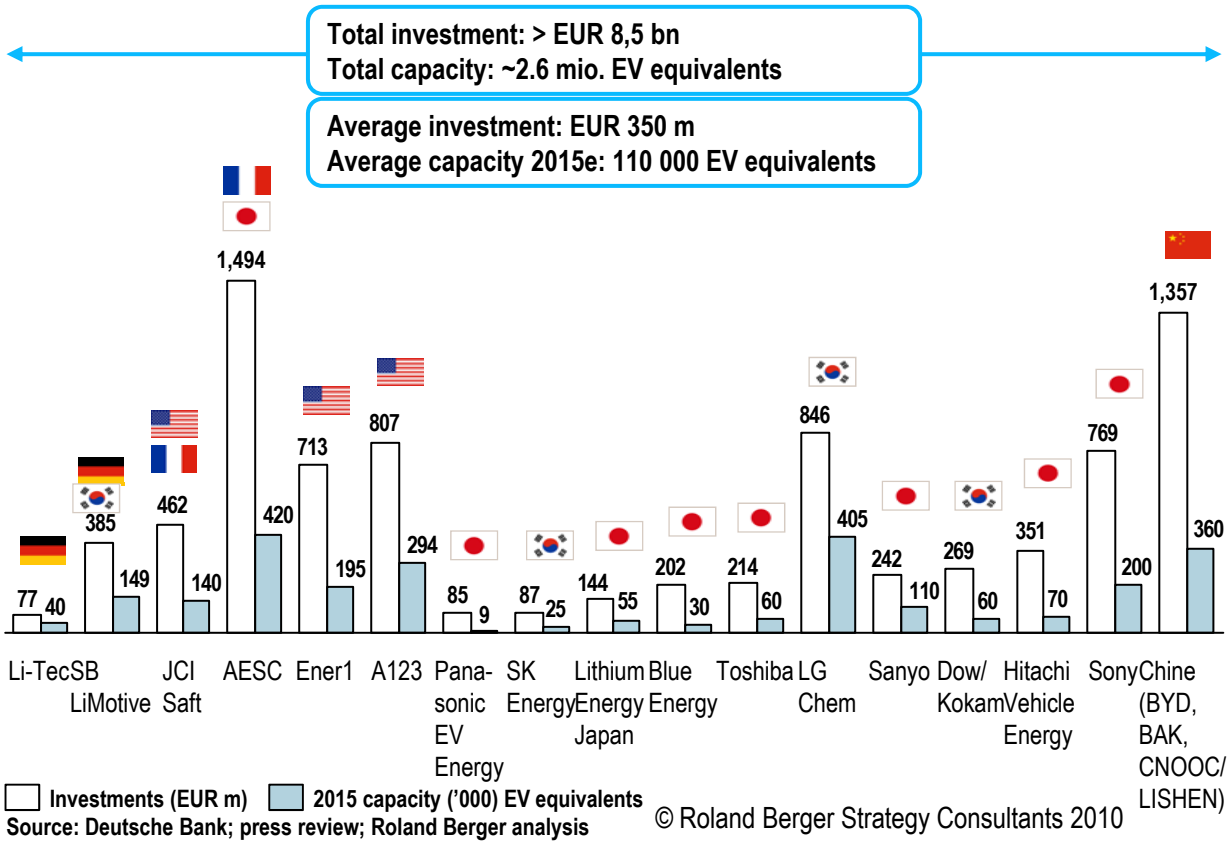
1) Europe, Japan, US, China

Source: Roland Berger

However, announced investments will result in significant overcapacity in the period between 2014 and 2017

Main investments 20 biggest players only for Li-Ion battery manufacturing – Automotive

Investments and estimated capacity in EV equiv. in 2015 [EUR m, '000]



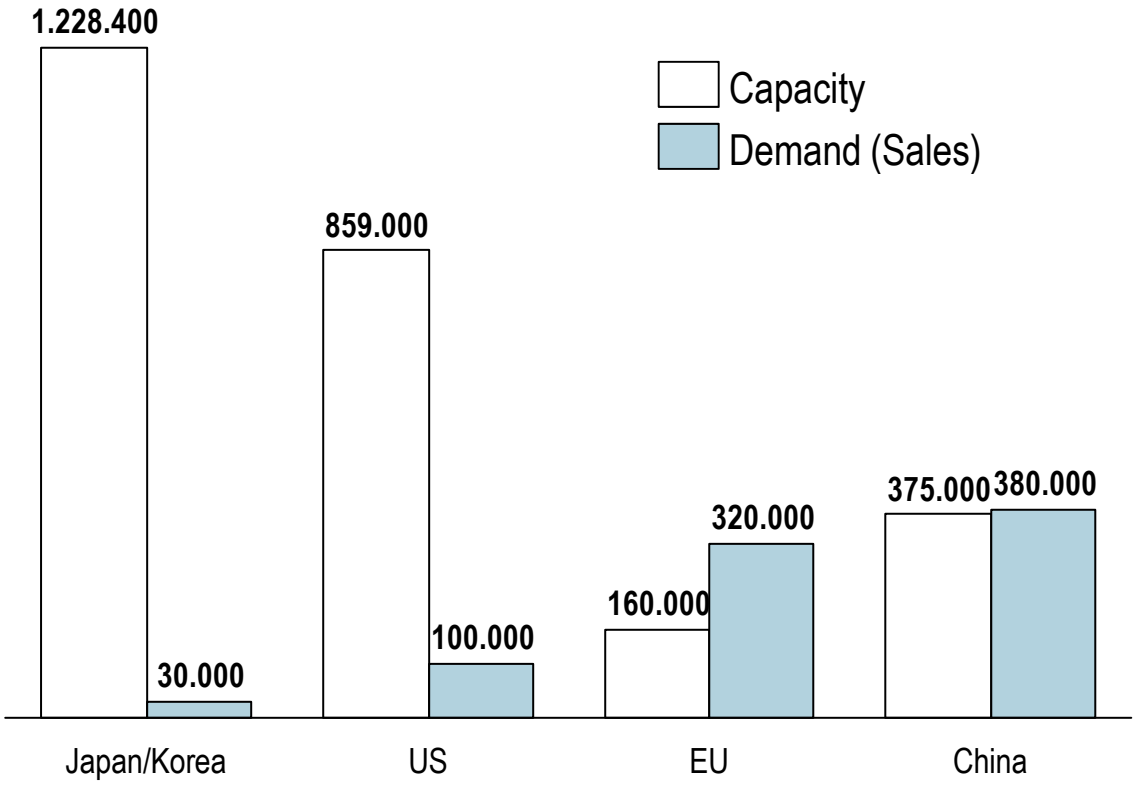
Source: Deutsche Bank; press review; Roland Berger analysis

Comments

- Declared capacity will be 200% of 2016 demand already in 2015
- Unannounced plans of key players and other companies further increase overcapacity
- National subsidies stimulate investment in excess capacity, e.g.:
  - USD 2.6 bn loans, steered by US DOE (e.g. USD 1.6 bn for Nissan, USD 148 m for JCI/ Saft)
  - EUR 125 m for the Renault-Nissan/NEC alliance (AESC) for battery manufacturing at Flins plant
  - Investments for BYD, BAK, CNOOC/Lishen strongly supported by the Chinese government
  - ...

Overcapacity is especially expected in the US and Japan

2015 demand and supply in major regions (units EV equivalents, high scenario)



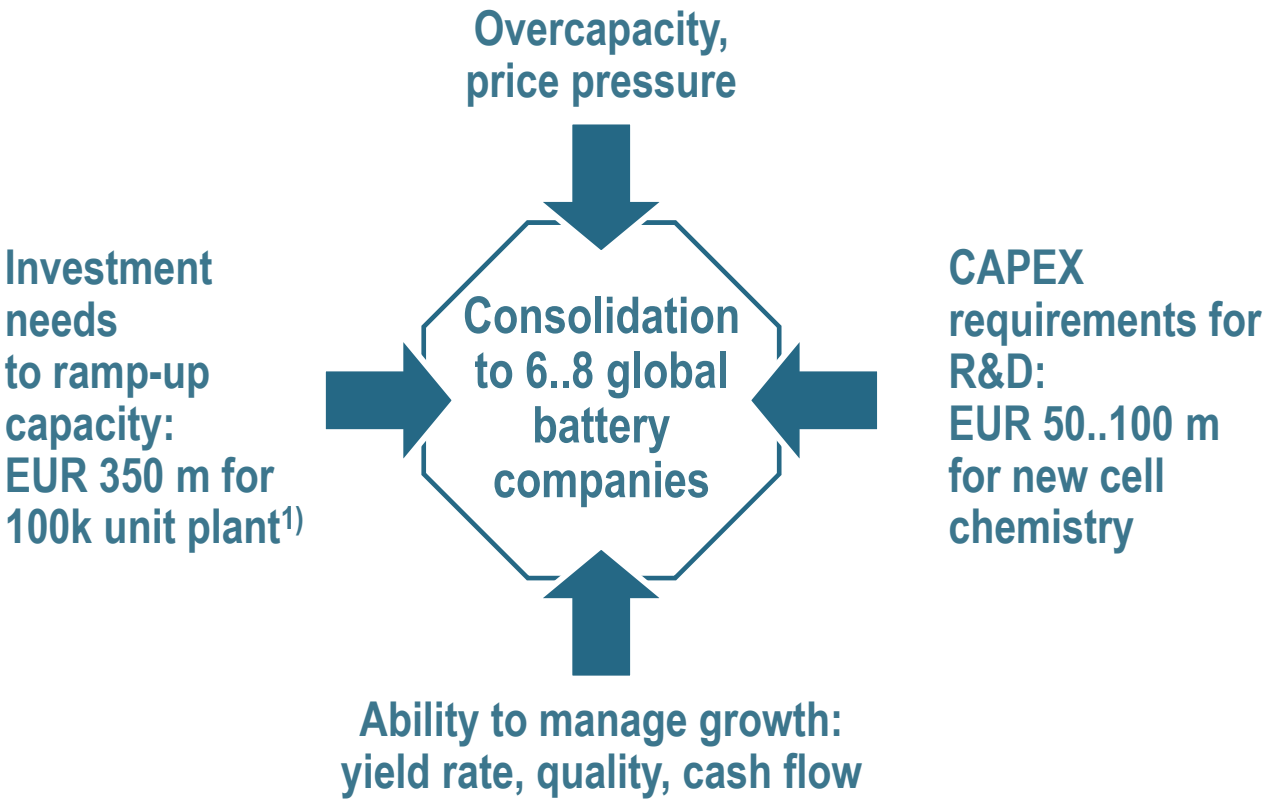
Comments

- EU:
  Not included: additional capacity planned but not officially announced for at least 100,000 "EV equivalent" units in Europe by Asian battery suppliers
  No coordinated approach so far
- Japan/Korea:
  Supply for exported cars (Toyota hybrids, EVs, Mitsubishi iMEV) accounts for some hundred thousand EV equivalents
  Massive support to drive technology leadership
- US:
  Overcapacity stimulated by massive subsidies, stimulation of demand side missing
- China:
  Announced invest in-line with expected demand
  Government wants China to become market leader in new energy vehicles

Source: Roland Berger analysis

Only 6 to 8 global battery manufacturer will survive in the next 5 to 7 years – critical size approx. EUR 600m revenues in 2015

Challenges for Automotive LiIon battery manufacturers will accelerate consolidation



1) EV equivalents

Source: Roland Berger analysis