Tesla – Success Story or Hype

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BEV – Niche Market Only

High Battery Cost
Low Battery Performance – Limited Range
Lack of Charging Infrastructure
Slow Charging
Battery Safety
Battery Cycle and Calendar Life

Ford Focus EV

1.85M xEV’s sold in 2014
1.6M Hybrid EV’s sold in 2014
88M vehicles sold worldwide
at the same time
Tesla – New Electric Luxury Car

85 kWh Battery Pack, Optimal packaging

- Number 2, EV seller in the USA (Nissan Leaf 1st - But it is changed on Q2/2015 due to low Leaf cells)

- 30,000 cars already sold during 2014 - at a cost of ~$100K - not as promised in 2009 $45K

- Still consider as a small business in the global automotive business
Tesla Innovation

• New automotive OEM to penetrate the E-Mobility market

• 200 miles driving range EV - Not 100 miles only as all others

• Main luxury family car – Not the “second car/City car”

• Proved that customers will to pay more for luxury EV ~ $K100-130

• 7 Passengers: 5 adults + 2 child seats

Dual motor all wheel drive
Tesla Innovation

• Partner to a leading companies like Panasonic, Daimler and Toyota

• Super Chargers can fast charge the batteries when needed

• Battery Swap ready design (No plan to use that technology in near future)

• High safety NHTSA grades

• Most customers are satisfied

• Market cap (Q4 2014) ~$25B, ~50% of GM???
Tesla - 18650 Panasonic Cells

- High cell specific energy (NCR18650 ~250 Wh/kg)
- Low cell costs (per kWh) - $3.5 per cell now - $1 expected by Tesla at 2020
- Cell integrated safety features (SDS, Vent, CID)
- Robust cell housing (Steel)
- Mass market availability
- Optimized for high Cycle lifetime - 90% capacity after 3000 cycles
- Operating voltage range of 4.05-3.6V (Reduced D.O,D)
- ~$230/KWh current battery estimated cost – industry lowest
- Flexible choice of supplier (2nd source) and chemistry
Tesla Model S Battery

Official Vehicle Data
- Power: 270 kW
- Torque: 440 Nm
- Speed: 201 kph
- Acceleration: 0-100 kph 5.6 sec
- Range: 482 km (NEDC)
- Weight: 2108 kg

Official Battery Data
- Energy: 85kWh
- Voltage Nominal: 355V
- Voltage Max: 400V
- Cell number: 7104
- Configuration: 96s74p
- Cooling: Liquid
- Weight: 618 kg

Source: Official product and website information, Tesla
2020 Plans – The “Giga” Factory

• The target - 500k cars sales in 2020 - $35k cost (Model 3)

• “Giga” factory – Li-ion battery factory in Nevada to build Tesla cars cells & batteries - Start operation in 2017

• Project investment - $5 billion

• By 2020 project to achieve 35GWh/year of cells and 50GWh/year of battery packs
The “Giga” factory is necessary for supplying the battery needed for 500k cars – current world production can`t support it.

The “Giga” factory to double word li-ion production capacity…

Planned 2020 Gigafactory Production Exceeds 2013 Global Production

Global cell supply growing, but almost entirely in Asia

Battery pack cost/kWh reduced >30% by Gen III volume ramp in 2017

Source: IIT Takeshita 2013
2020 Plans – The “Giga” Factory

• 30% battery cost reduction with the “Giga” factory

• But the most expensive part in Li-Ion production is the raw materials – Without raw materials cost reduction it would be difficult to have significant battery cost reduction
Giga Factory Gamble

- 35GWh cell factory – 10 times than any existing factory
- Economy of scale only if the factory will work in full scale
- $5 billion investment – Where the money come from?
- Automotive OEM plans “tesla competing” 200 miles EV`s in 2017-2018 in a cost of $35k – What that will do to Tesla sales?
- Battery raw material manufacturers – Are they will to invest?
Giga Factory Gamble

• Tesla is the most important Panasonic customer – Failure of Tesla will strongly effect Panasonic- Is Panasonic will to invest?

• Subsidies and regulations – Are they enough to support strong EV`s sales when oil cost is low?

• Battery life, reliability and safety are not clear yet – AVL Report

• Charging infrastructure and especially high speed charging infrastructure is not ready

• The Giga factory project already experience mass production delays and price increases
Tesla Roadster 3.0 battery upgrade: $29,000 for ~78 kWh, 331 miles

- For a price of $29,000, with a $5,000 down payment, customers will receive a new battery pack.

- Stores roughly 40% more energy than the original battery, with an increase in total range of more than 35%.

- ~78 kWh with a resulting range of ~331 miles (533 km).

- The cost per kWh (~$372) is higher than a Model S battery due to the upgrades being almost entirely hand-built, and low-volume (only 2 or 3 per week).
Tesla – The Numbers

• But Tesla loses in 2014 are $238M !!! - Q1-2/2015 loses are $238M
• 21.5k vehicles delivered in Q1-2/2015, 11.58k cars delivered in Q3/2015.

• Most Automotive OEMS don’t believe they will make it – Are they wrong?
Tesla Residential Energy Storage (RES)

- Tesla projection of 500k car sales in 2020 seems not realistic

- Tesla announced the “Powerwall” 10KWh residential storage in a cost of $3500 as a way to generate profits and utilize the battery production capacity (7kWh in $3k)

- Is that Tesla core business? Is it possible to do profits from $350/KWh? Can Li-Ion batteries compete with the low cost Lead-Acid energy storage and the RES Li-Ion battery competitors?

- Grid Storage business grow slowly than any expectation

- New business needs new investments when Tesla is straggling to fund the Giga Factory
Tesla S Specifications - AVL Report

- General information
  - warranty battery: 8 years (unlimited mileage)
  - base price (Model S 85): 74,900€ (04/2014)
  - delivery time: 4 to 5 months (04/2014).
- Charger
  - 11kW on board, 3 phase 16A, 1 phase 40A.
  - optional: second 11kW on board
  - quick charge possible, but recommended is charging over night
- Propulsion
  - induction motor, rear axle driven
  - max speed: 203km/h.
- Safety:
  - excellent crash/passive safety: highest ranking in NHTSA
  - 8 airbags, traction control, ESP, ABS
- Others:
  - length: about 5m, weight: 2.1t.
  - 5+2 seats (last row for children only), 2 trunk areas
Tesla S – Vehicle Performance – AVL Report

- Performance
  + excellent acceleration and elasticity
  - long braking distance

- Drivability
  + overall excellent
  - only hill holding function is missing

- Energy management
  + good in all aspects
  + high efficiency, good recuperation
  + good balance between driving range and performance
  0 reasonable power derating
Cylindrical cell with very high gravimetric / volumetric energy density
High installed capacity leads to moderate P/E ratio
High safety level achieved, supported by vehicle structure
Overall poor production quality (gluing, welding, sealing, Kapton tape, etc.)

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<thead>
<tr>
<th></th>
<th>Public data</th>
<th>AVL data</th>
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<tbody>
<tr>
<td>Energy capacity [kWh]</td>
<td>85</td>
<td>73.2</td>
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<td>voltage nom. [V]</td>
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<td>voltage max. [V]</td>
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<td>cell type/ amount</td>
<td>Panasonic 18650 / 7104</td>
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<td>Cell capacity (inst.) [Ah]</td>
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<td>Weight, dry [kg]</td>
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<td>Volume [l]</td>
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<td>ca.370</td>
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<td>Main dimensions [mm]</td>
<td>2660/1460/115</td>
<td>2710/1547/200</td>
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<td>Pack energy density grav. [Wh/kg] / vol. [Wh/l]</td>
<td>137.5 / ---</td>
<td>125.6 / ca.198</td>
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<tr>
<td>Cooling system</td>
<td>liquid cooled</td>
<td>H2O/Gly = 43/57</td>
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Characterization tests
- Nominal capacity of cell not reached (@ 25°C), even not at C/5
- Moderate currents beneficial for capacity exploitation
- Higher currents (beyond C/3 discharge; corresponding to >23kW on pack level) significantly decrease exploitable capacity
- Cell resistance higher than anticipated
- Some cells investigated indicate early deterioration (significantly increased resistance as well as undetermined resistance characteristics)

Durability tests
- Cycle life test features by far stronger ageing at elevated current than initially anticipated
- 1C and 2C charging not feasible (charge transfer mainly via constant voltage mode)
  → limitation for quick charge function
- 1C currents lead to strong cell temperature increase
  → strong impact on ageing behavior
Tesla S – Cell Safety Test Results – AVL Report

- Overall conclusion
  - The cell is relatively safe
  - Only when penetrating the cell or overheating above 130°C, EUCAR hazard level 5 can be seen
  - The integrated CID is working and in the configuration with 74 cells in parallel, no problem of interrupting a high current is expected
  - Failure on a single cell (internal short) can be solved by opening CID or melting bonding wire to disconnect the cell but keep the battery active. Cells in parallel are not discharged as soon as CID or bonding wire open

- Cell safety
  - Overcharge → EUCAR hazard level 3
  - **Nail penetration** → **EUCAR hazard level 5**
  - Thermal stability
    - At 130 °C for 30 min → EUCAR hazard level 3
    - At 200 °C for 30 min → EUCAR hazard level 5
  - External short circuit → EUCAR hazard level 3

- Module safety
  - Overcharge one cell only → EUCAR hazard level 3
  - Overcharge one cell block (74p) → EUCAR hazard level 3
Summary

• E-Mobility market future is not clear – Seems that HEV and PHEV will be dominant and not the pure EV`s

• Tesla plans looks very risky – We can expect investment in small steps and not immediately in a full scale

• We can see a cost of $35K per vehicle as non realistic

• Tesla heavy losses continue

• Tesla will not survive without fast moving into profits

• Apple and Google are waiting in the corner for “Buy opportunity”
Thank You for Your Attention

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Information on this presentation was obtained by:

1. Public web sources.
2. Shmuel De-Leon Battery/Energy Sources Database ® (Includes 30,000 cell PDF data sheets).