COP21: Electric Vehicles (transition) and Renewable Energy

Bert Witkamp, AVERE
IRENA Innovation Week, May 12, 2016
The COP21 challenge

1.5 C implies:
- Emissions peak in 2020
- Zero carbon in 2070
- Developed countries zero carbon in 2060

We have a target!
- But no idea how to do it
- We need to have long term plans
- Plans need to lead to zero carbon
We have passed the tipping point

• COP-21 Paris: faster and further with decarbonisation
  – 1.5 C target
  – Realisation that we need to ACCELERATE decarbonisation
  – TRANSPORT more prominent than ever
  – Disruptive transition is needed and all stakeholders have to commit

• Coal to fracking and improved vehicle milage as alternative?
  – Dead end road which does NOT achieve COP21 targets
COP21: transition to renewable generation & storage, electric drive and smart grid is required and there is no alternative

**Electric drive:**
No emissions & low noise, right sized vehicles: liveable cities!

**Renewables + storage + smart grid & charging + electric drive:**
Decarbonizes our economy, improves energy efficiency, improves air quality in cities and stimulates economy.
WHERE ARE WE WITH EV’S?
Global EV sales 2015 > 0.5 million
At continued 2015 growth rate:

All cars EV

In 2023
EV’s in German OEM product portfolios: 2014 - 2020

Source: DLR
Future charging needs

• > 90% of charging @ home or workplace (will evolve to wireless)
  – 95% of daily need without need for charging

• Longer EV range = higher charging power for “fast charging”:
  – 2 hours drive = 240 km = 40-60 kWh @ 400 kW = 6 to 9 minutes

• Interoperability of charging stations accross operators & borders

• Smart charging and incentives to deal with “supply-demand”
2015: The outlook has never been so positive

- People love their EV’s!
- > 0.5 million EV sales 2015
- Norway EV > 30% new car sales in 2016 = mass market
- Electric city buses competitive 2015 - 2020
- 250+ km e-range mid sized models in 2016-2017
- 400-600 km e-range vehicles in 2016-2019
- Battery prices falling much more rapidly than predicted!

BUT:
- Maximum range too limited
- Fast charging rates are too low
- Electric vehicles too expensive
- Not enough models available
2025: Will EV’s become economical?

TRANSITION TO 21-ST CENTURY TECHNOLOGIES
The transition to 21st century technology

A new manufacturing paradigm: EV’s are easy to produce and the technology is widely available

20th century best in class technology: NOT fit for 21st!

Precision mechanical engineered parts and complex emission control system

21st century best in class technology

Off-the-shelf electronics and electrical parts
Electric Cars To Cost Same As, Or Less Than ICE Within A Decade

Battery price evolution over time (in EUR/kWh)

Drivers for price drops:
- Improved battery technology
- Decreasing material costs
- Improved production process
- Economies of scale of upcoming mass production

"We would be disappointed if it would take us 10 years to reach 76 EUR/kWh."
Elon Musk
Chief architect of Tesla

Lithium-ion EV battery experience curve compared with solar PV experience curve

Source: Bloomberg New Energy Finance

$1,200 per kilowatt hour

Actual
Estimated range

Electric Car Battery Costs Are Falling as Fast as Solar Panel Costs
Which horse (power) are we betting on?

- 3x more kW/kg
- 40x more kW/liter
- 4x more efficient
- ZERO emission
- LOW noise
- VERY low maintenance
Technology disruptions are rarely foreseen by industry insiders and experts

• Around or before 2025: EV’s likely to be the lowest cost vehicles

• Decarbonisation of transport is not a choice, it has to happen

• EV dominant passenger car technology within a decade?

• In 2030 or before all cars sold are electric?

At a certain moment, people will not buy old technology anymore, especially young people! People love EV’s 😊
Societal needs will shape mobility

*electric vehicles are only one aspect of a transforming mobility*

**Society & cities needs:**

- Better air quality
- Lower noise levels
- Carbon neutral
- Walking / cycling
- Public transport
- Car sharing
- Multimodal transport
- Zero-emission zones

**Vehicles will be:**

- Digital / Connected
- “Software on wheels”
- (Semi) Autonomous
- **Electric drive**
- Lighter weight
- Right-sized
- Shared (use/ownership)
- Part of a mobility system
- Less in number!
Electric vehicle innovation has only just started....
PARADIGM SHIFT IN ROAD TRANSPORT

The car as net energy producer!
- generation: 900 kWh in NL
- use: 500 kWh/year
- 13,500 km/year

Energy efficiency: 3.5 kWh / 100 km………………in 2012
A wide choice in type of high performance EV’s can be expected
EV: HEAVEN SEND GIFT TO UTILITY INDUSTRY

Renewable energy and electric drive: the perfect fit
EV’s and US electricity generators

Edison Electric Institute on Transportation Electrification:
• “Electrification Is Our Biggest Opportunity”
• “Electric Utilities Need Transportation Electrification”

Pacific Northwest National Laboratory:
• 160 million vehicles can be powered solely from existing off-peak generating capacity
EV: Impact on electricity production & generating capacity

Full scale transition to electric drive in Europe and USA:
- No investments in generating capacity
- In Europe: no investment in high voltage transmission / modest investments at distribution level
- Smart charging is needed (charge at right moment)
- Better asset utilisation = lower cost
- V2G technologies and business models will give additional benefits

Electrification of transport is a perfect fit with REN:
- Produces mostly electricity
- Produces intermittently and need storage & backup
EV (battery) as part of buildings: can be scaled up!

- The car is parked where people are
- Electricity is needed where people are
- Batteries can provide or store electricity

Graphics provided by Nissan
Keep the oil in the ground!

*Renewable energy + electric drive*

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tr>
<td>Global oil consumption 2014</td>
<td>91 mio barrel/day</td>
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<tr>
<td>Oil used for Road Transport</td>
<td>39 mio barrel/day</td>
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<td>Gasoline</td>
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<td>17 mio barrel/day</td>
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<td>Road transport energy use per day</td>
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<td>Road transport energy use per year</td>
<td>22,644 TWh</td>
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<td>Energy efficiency ICE vehicle</td>
<td>17% (-83%)</td>
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<tr>
<td>Refining efficiency (US data)</td>
<td>85% (-15%)</td>
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<tr>
<td>Energy efficiency Electric Vehicle</td>
<td>85% (+15%)</td>
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<td>Electricity required to replace</td>
<td>3,849 TWh</td>
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<td>Global electricity consumption 2012</td>
<td>19,700 TWh</td>
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<td>Extra electricity requirement</td>
<td>20%</td>
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</tbody>
</table>

- Based on current situation
- Excluding off-road vehicles
- Electricity from REN
- *Data to be checked!!*

- Excluding lubricants/motor oils
- Sources: EIA, DOE, Statistica, IEA, OPEC, wikipedia
Transition to Electric drive: speed of transition essential

Maintain 50% EV growth

- “Giga factories”: 2020: 10, 2027: 100
- Smart grid: renewable energy + EV’s + V2G
- Produce 100,000,000 electric cars in 2027
- Industrial opportunities
COP21: systems transformation

Innovations: technical, non-technical
- Drive costs down, increase speed of transition
- Leverage «Mission Innovation » and «Breakthrough Energy Coalition »

Which way: dead end road or the right way?
- «Moonshot » policy choice needed! Scenario’s needed!

COP21 is largest business opportunity the world has seen since...
BACKUP SLIDES
Committed sofar @ COP21

What we need to do for 1.5C

There is no time for detours or exploring dead-end roads
A common view on the 2050 car sales result of linear or wishful thinking?

Spoilt for choice
Light-vehicle sales by technology type, units m

Source: International Energy Agency

Technology is changing so fast that people have difficulties in understanding this and taking into account

History tells us that a Technology-Zoo scenario is not likely to last long time!
EV’s on the road in Europe have NEDC footprint of 30 g CO2/km

*factor 4 to 5 lower than ICE*

The weighted average gCO2/kWh of all EV’s on the road in Europe:

30 g CO2/km (NEDC cycle)

45 g CO2 / km (real driving) = 4 to 5 times less than ICE

*Based on the weighted average of 227 g CO2 / kWh (2013 data)*

Many EV drivers & station operators use renewable energy, increasing amounts of renewable energy used for EV’s never sees the grid
Who is going to manufacture the vehicles of the future? And where?

*Multi-trillion $ industries start investing: IT/Internet/Electronics, Chemical, Power, Automotive*

- OEM’s? *If they adapt fast enough*

✓ Tesla (like start ups):
✓ BYD, Geely, Foxconn,…
✓ Google
✓ Apple
✓ Tata, Mahindra
- Other “digital”, consumer goods or industrial goods manufacturers…?
- Combinations of any of these?
- Many, many small companies (Light Electric Vehicles!)
- **Demographics: volume goes to Asia**

**OEM’s little to gain and a lot to loose?**

*Future manufacturing of EV’s is “democratic”: very easy, low cost, small scale and open for many companies, industries and countries wanting to build up an automotive industry!***
Electric Vehicles and utilities: how big?

- **2015:** 300,000 EV’s in Europe, 3.5 GWh batteries 1 GW max power
- **2020:** 3 Mio EV’s? 40 GWh batteries 10 - 15 GW max power
- **2025:** 25 Mio EV’s: > 400 GWh batteries > 100 GW max power
- **2030:** 100 Mio EV’s?

- 1 Tesla Giga battery factory: 50 GWh batteries / year, net zero energy factory: -50% cost
- 10% cars EV’s: 10 Giga factories: cost reduction per kWh ?!!
- All road transport: several hundred Giga factories: cost reduction per kWh ?? !!!

- Europe: all cars electric = + 15 – 20 % electricity consumption
- Europe: all road transport = + 20 – 25 %
BEV or FCEV efficiency using renewable energy

*Fuel cell technology requires 3 x more REN than batteries*

Source: TU Eindhoven, The Netherlands
Solar energy and transport: land use EV’s versus Biofuel ICE

200 – 400 x more land needed for biofuel crops

Photosynthese 0,38%
Refining & transport 0,16%
ICE 0,03%

PV 20%
Transmission & charging 17%
EV 14%