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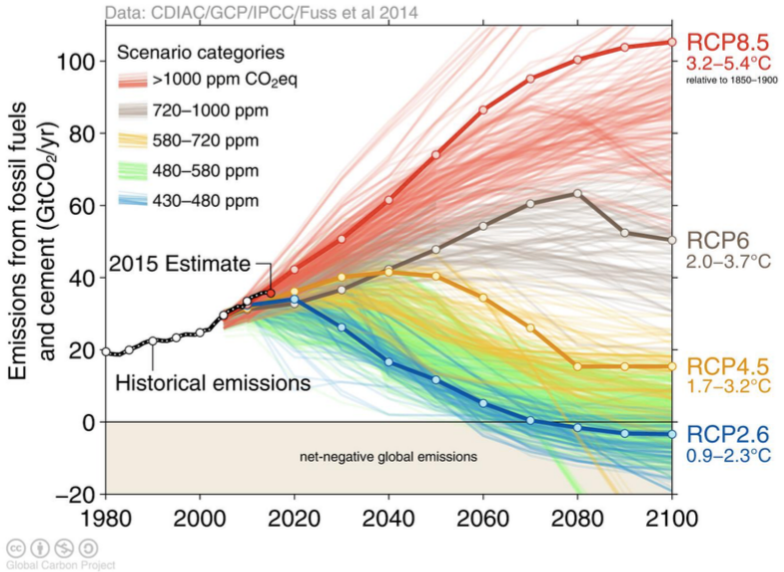
The European Association for Electromobility

COP21: Electric Vehicles (transition) and Renewable Energy

Bert Witkamp, AVERE

IRENA Innovation Week, May 12, 2016

The COP21 challenge



Over 1000 scenarios from the IPCC Fifth Assessment Report are shown
Source: Fuss et al 2014; CDIAC; Global Carbon Budget 2015

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

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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

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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.

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WHERE ARE WE WITH EV'S?

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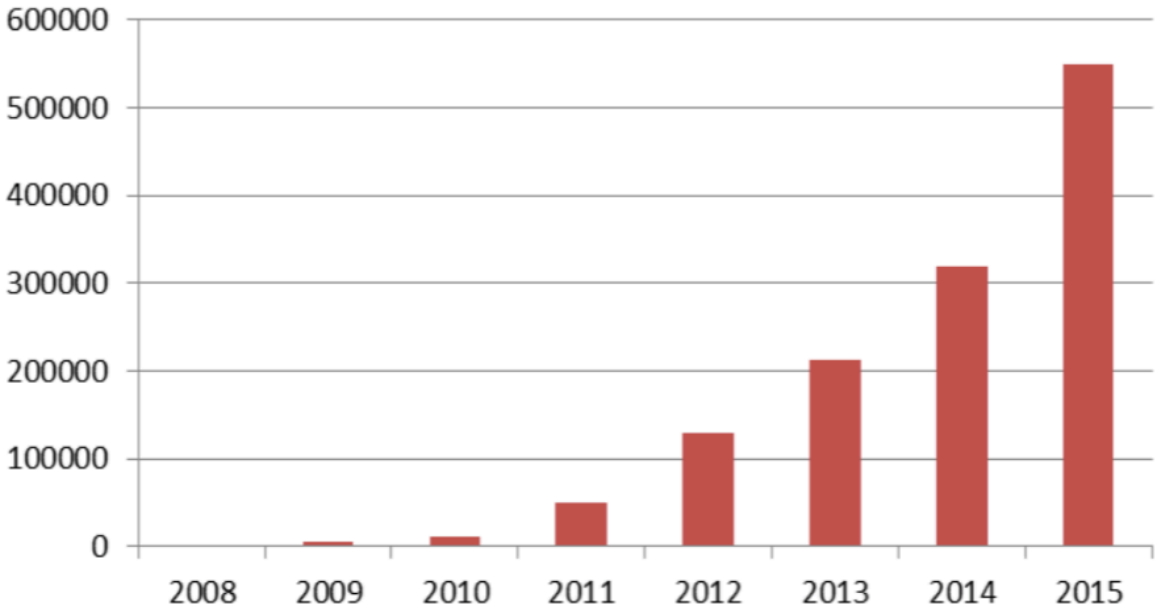
Global EV sales 2015 > 0.5 million



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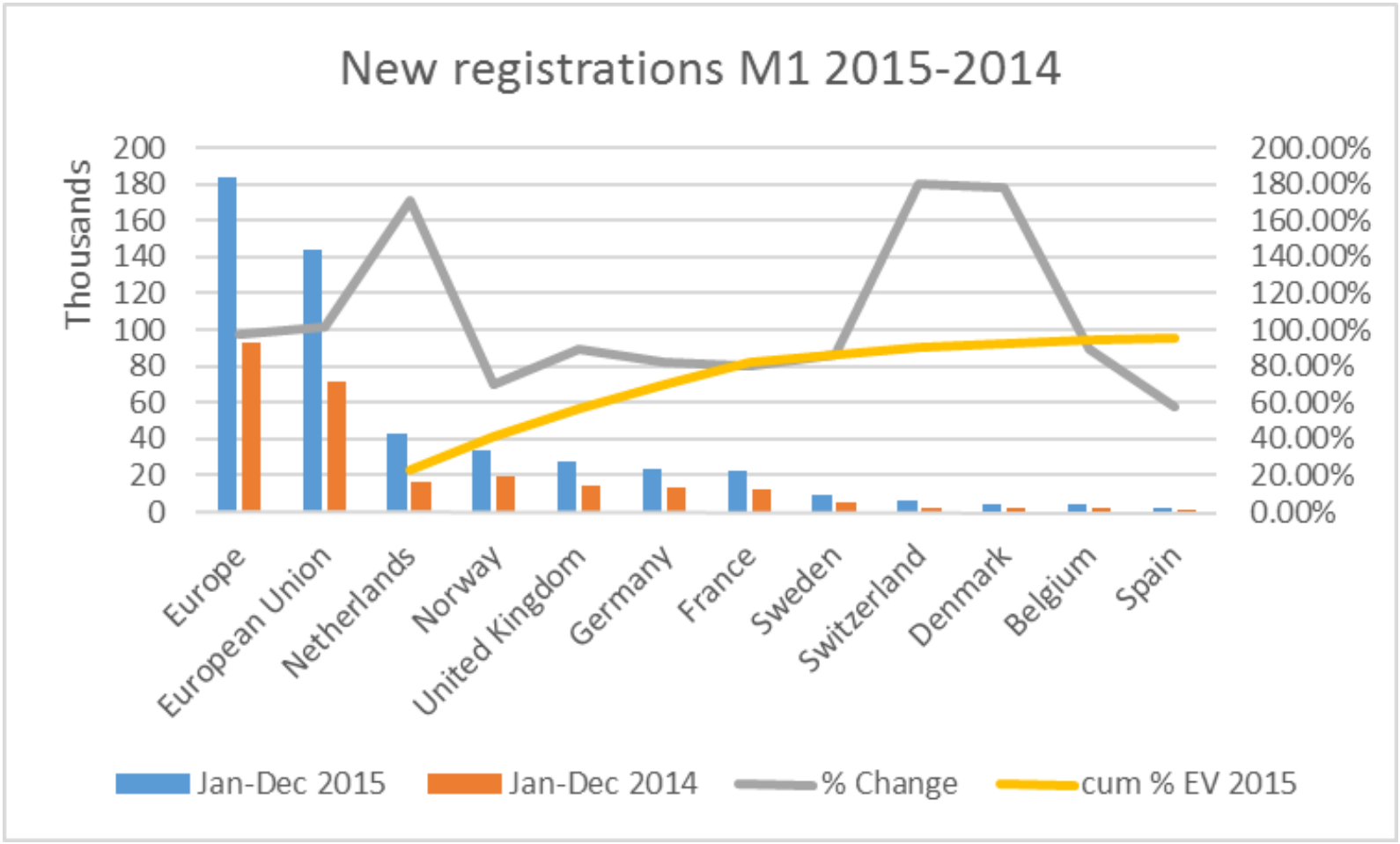

At continued
2015 growth rate:

All cars EV
In 2023

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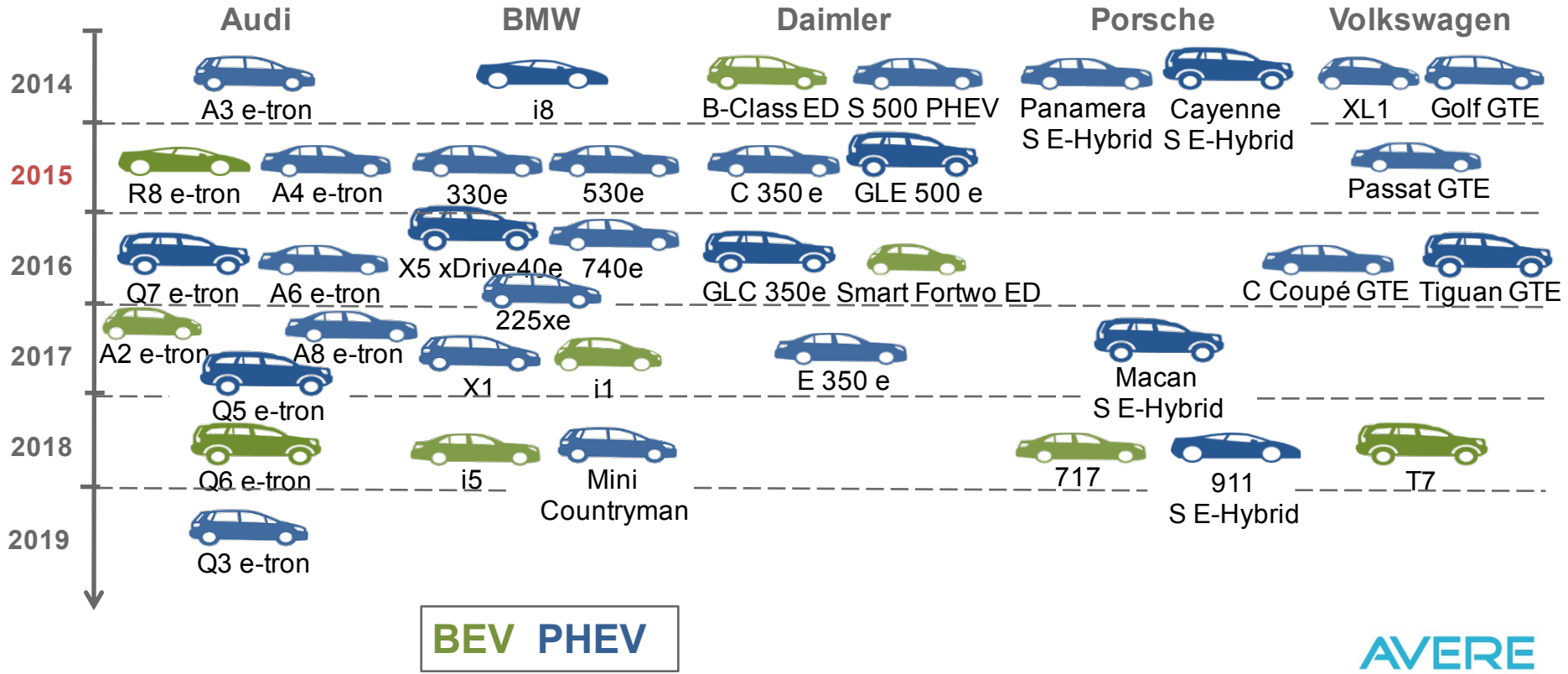
EV's in German OEM product portfolios: 2014 - 2020



Source: DLR

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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”

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2015: The outlook has never been so positive

- ✓ **People love there 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

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2025: Will EV’s become economical?

TRANSITION TO 21-ST CENTURY TECHNOLOGIES

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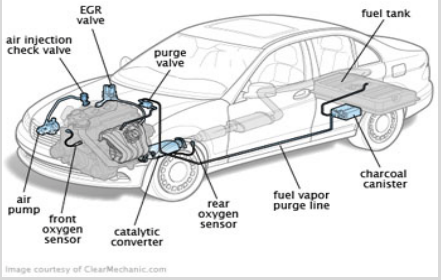
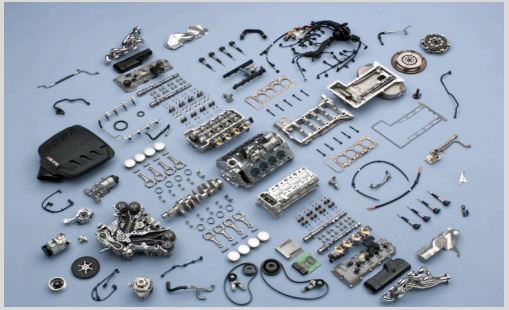
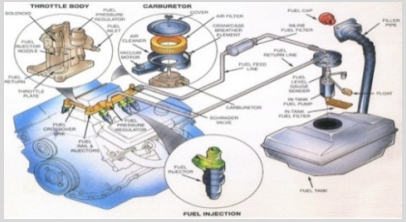
The transition to 21st century technology

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

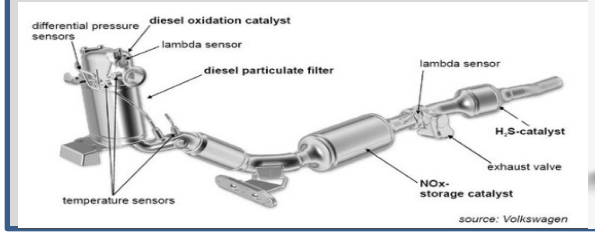
20th century best in class technology: NOT fit for 21st!



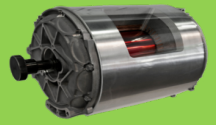




Precision mechanical engineered parts and complex emission control system



21st century best in class technology



Off-the-shelve electronics and electrical parts

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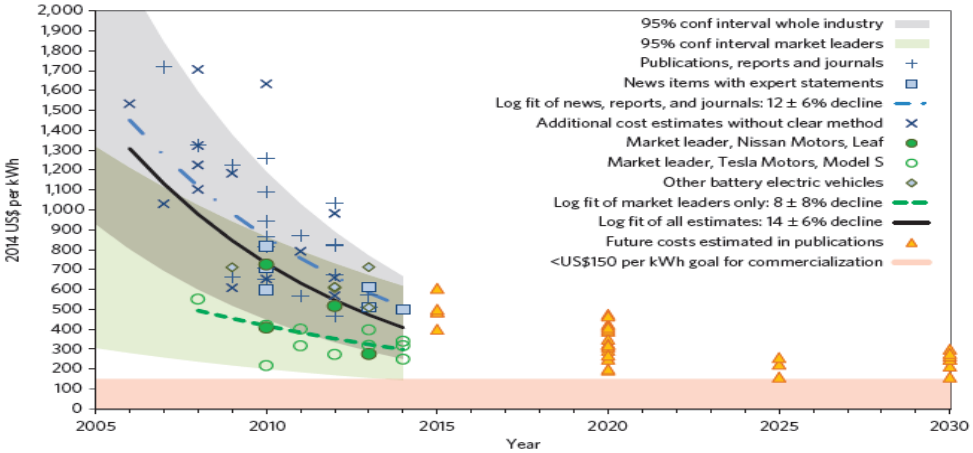
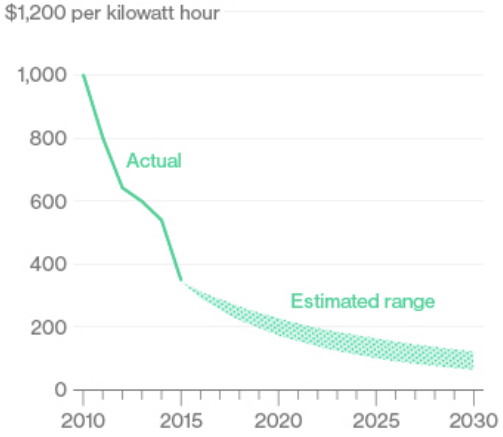
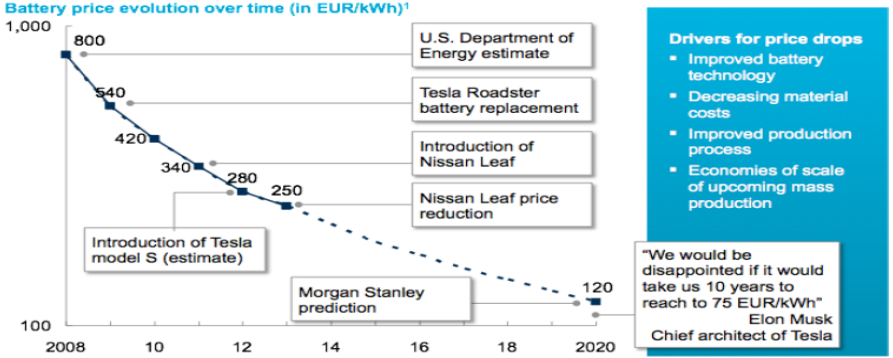
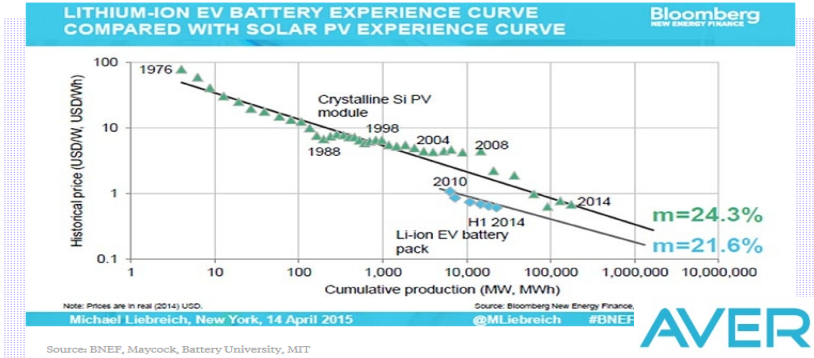
Electric Cars To Cost Same As, Or Less Than ICE Within A Decade







Electric Car Battery Costs Are Falling as Fast as Solar Panel Costs

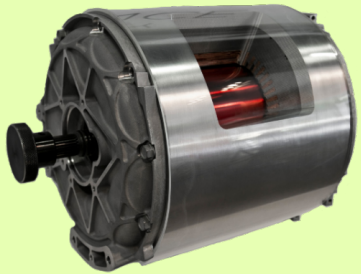


Source: BNEF, Maycock, Battery University, MIT

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



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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 ☺**

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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!

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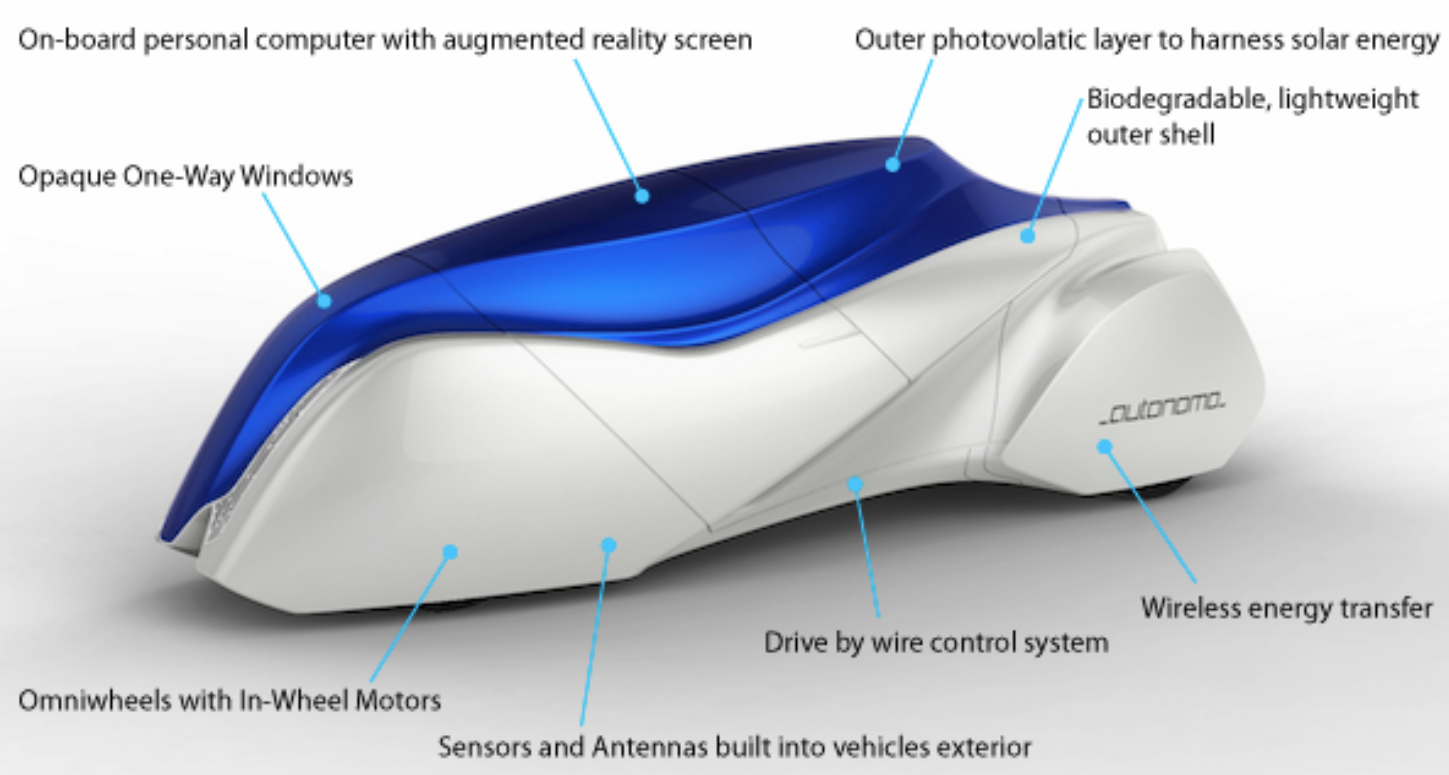
Electric vehicle innovation has only just started….



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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

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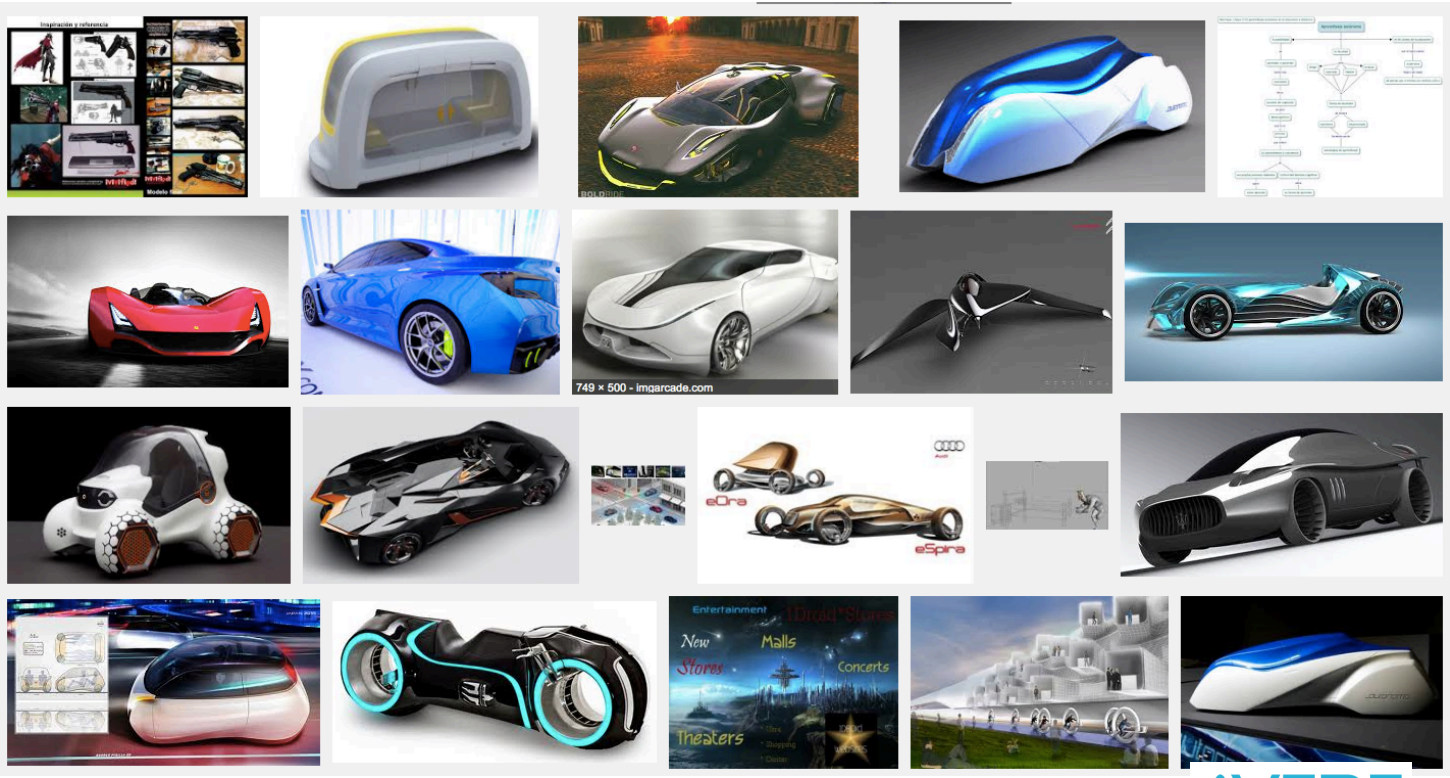
A wide choice in type of high performance EV's can be expected



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EV: HEAVEN SEND GIFT TO UTILITY INDUSTRY

Renewable energy and electric drive: the perfect fit

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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**

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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

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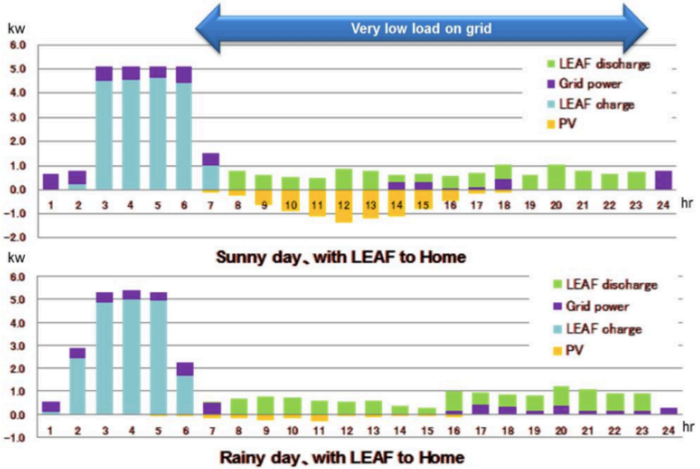
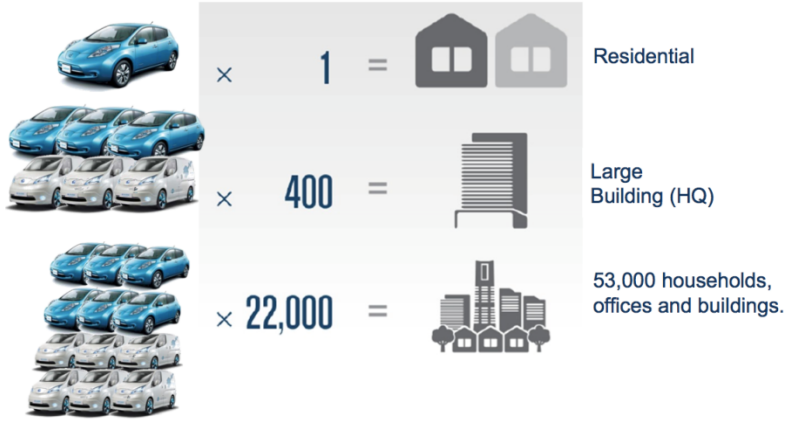
EV (battery) as part of buildings: can be scaled up!



■ EV storage capacity is scalable to actual local usage scenario



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

Graphics provided by Nissan

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Keep the oil in the ground !

Renewable energy + electric drive

Gobal oil consumption 2014	**91 mio barrel/day**
Oil used for Road Transport	**39 mio barrel/day**
Gasoline	**22 mio barrel/day**
Diesel	**17 mio barrel/day**
Road transport energy use per day	**62,037 GWh**
Road transport energy use per year	**22,644 TWh**

Energy efficiency ICE vehicle:	**17% (-83%)**
Refining efficiency (US data)	**85% (-15%)**
Energy efficiency Electric Vehicle	**85% (+15%)**
Electricity required to replace	**3,849 TWh**
Global electricity consumption 2012	**19700 TWh**
Extra electricity requirement	**20 %**

- Excluding lubricants/motor oils
- Sources: EIA, DOE, Statistica, IEA, OPEC, wikipedia

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

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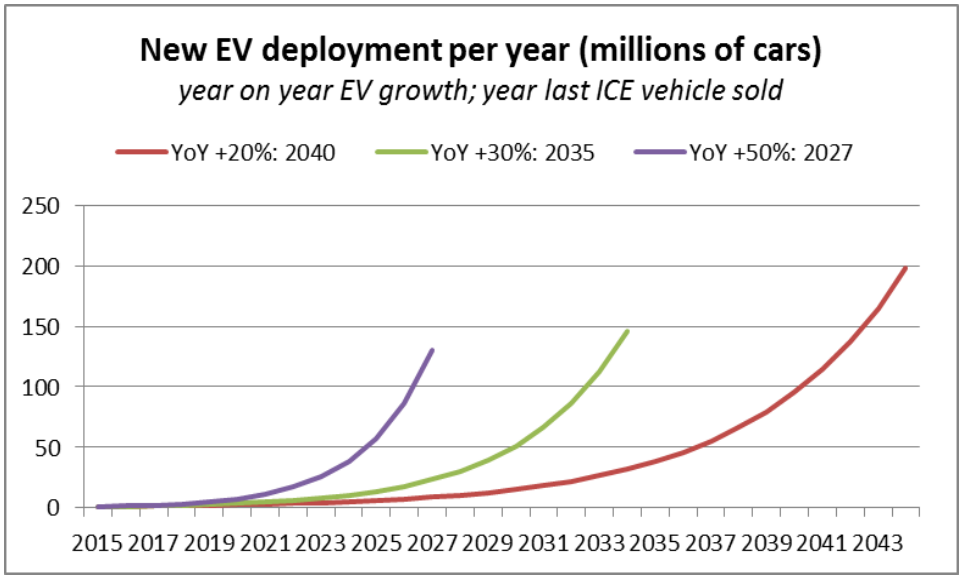
Transition to Electric drive: speed of transition essential



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

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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…

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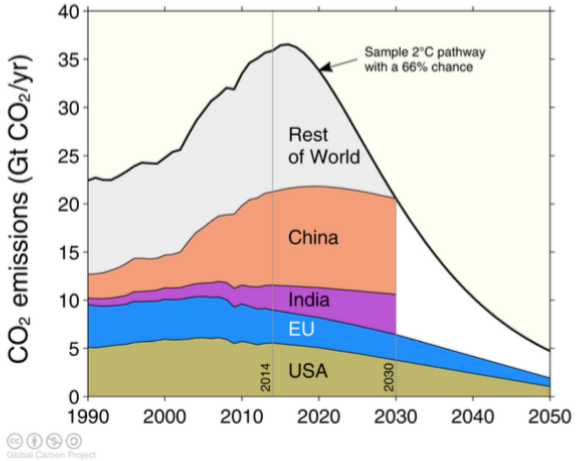
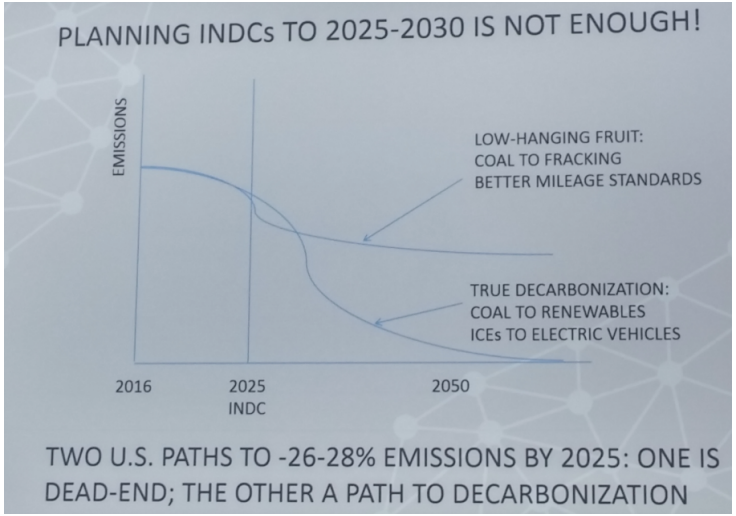
BACKUP SLIDES

Committed sofar @ COP21

The emission pledges from the US, EU, China, and India leave little room for other countries to emit in a 2°C emission budget (66% chance)



What we need to do for 1.5C



There is no time for detours or exploring dead-end roads

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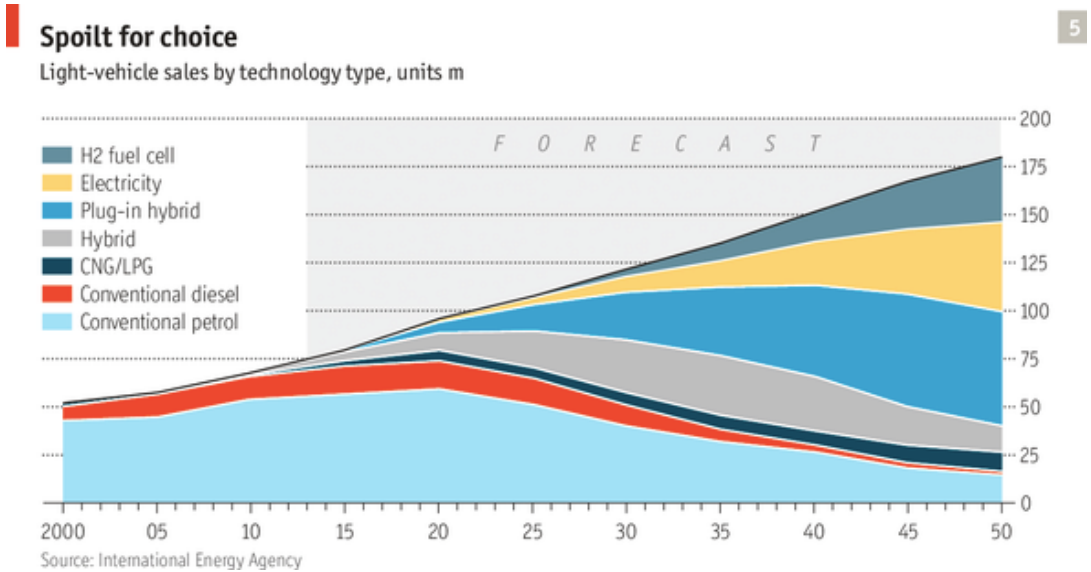
A common view on the 2050 car sales

result of linear or whisful thinking?



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 !

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EV's on the road in Europe have NEDC footprint of 30 g CO2/km

factor 4 to 5 lower than ICE

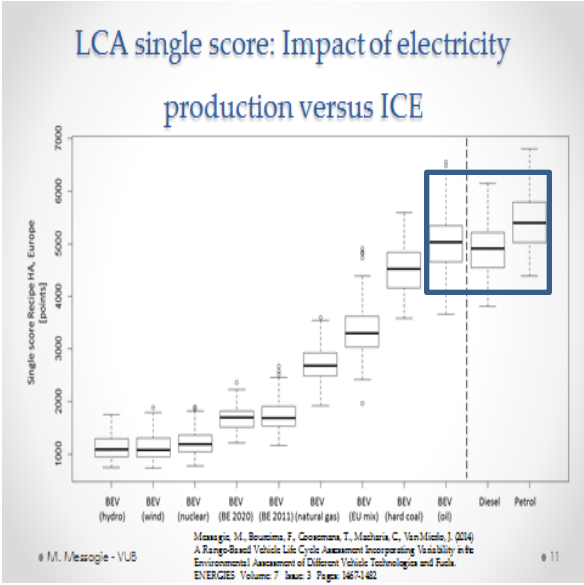
The weighted average gCO2/kWh of all EV's on the road in Europe:

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



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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*

OEM's little to gain and a lot to loose?

- ✓ 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

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!

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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 trasnport: several hundred Giga factories: *cost reduction per kWh ?? !!!*

- Europe: all cars electric = + 15 – 20 % electricity consumption
- Europe: all road transport = + 20 – 25 %

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BEV or FCEV efficiency using renewable energy

Fuel cell technology requires 3 x more REN then batteries

100%

Transport & charging
86%

BEV
69%

100%

electrolysis
70% remaining

Compression

distribution
50%

fuel cel
27%

FCEV
22%

Source: TU Eindhoven, The Netherlands

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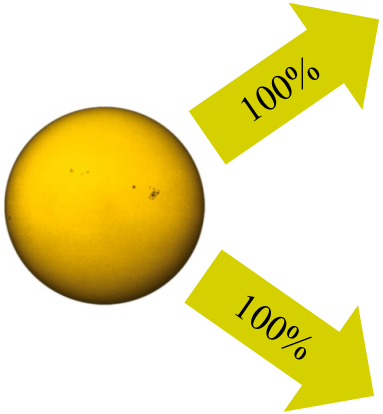
Solar energy and transport: land use EV's versus Biofuel ICE

200 – 400 x more land needed for biofuel crops



PV **20%**

Transmission & charging **17%**

EV **14%**

Photosynthese **0,38%**

Refining & transport **0,16%**

ICE **0,03%**

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