

V O L V O

A review of automotive history for developing the future

Leo Laine

Easter morning 1900 on 5th Aveny, New York

Where is the car?



Easter morning 1913 on 5th Aveny, New York

Where is the horse?



The momentum of the solar energy transition

Received: 25 August 2022

Femke J. M. M. Nijse^{1,2,3}, Jean-Francois Mercure^{1,2,3}, Nadia Ameli⁴,
Francesca Larosa^{4,5}, Sumit Kothari⁴, Jamie Rickman⁴, Pim Vercoulen^{1,6} &
Hector Pollitt^{2,3}

Accepted: 25 September 2023

Published online: 17 October 2023

Introduction – Renewable energy

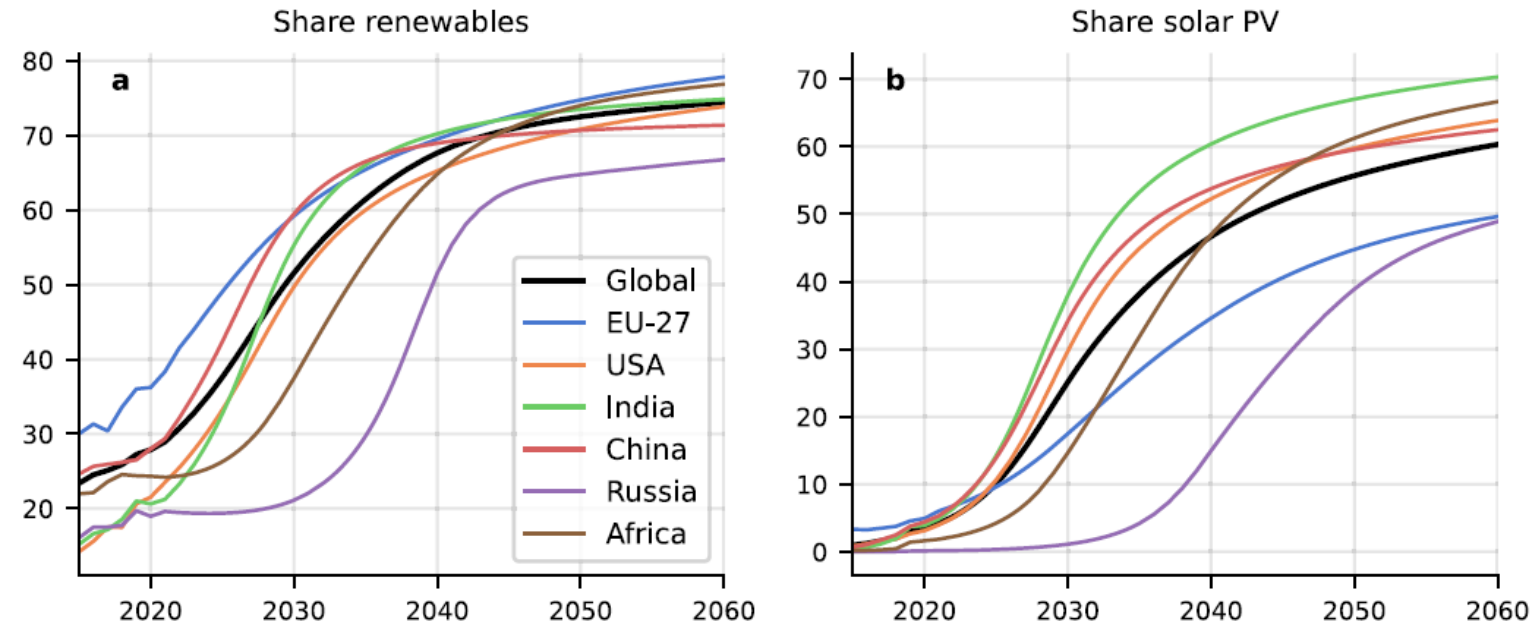


Fig. 2 | Renewable share of electricity. **a** total renewables (hydro + wind + solar + biomass) and **(b)** solar PV. Initially, renewables are dominated by hydropower and to a lesser extent wind. This is soon overtaken by solar, depending on regional factors.

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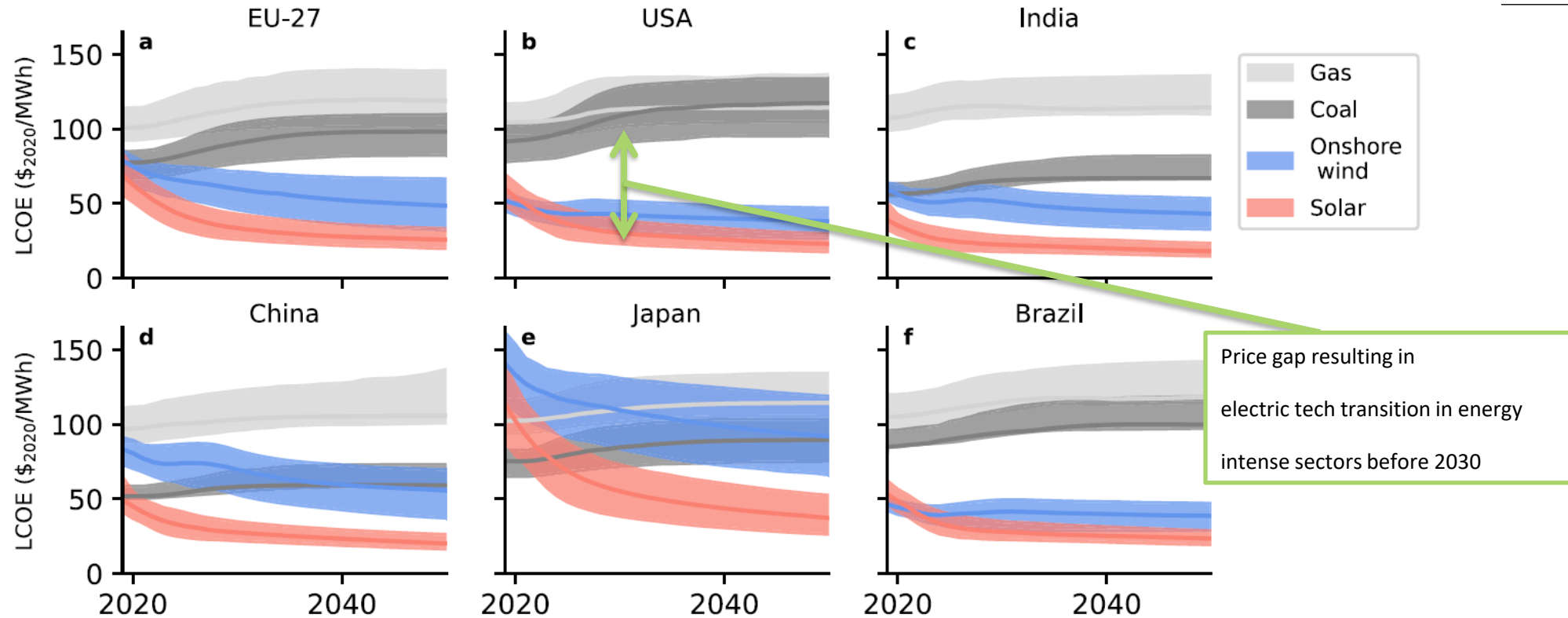


Fig. 3 | Regionally weighted average levelised cost of electricity (LCOE), including system storage costs and excluding policies. a EU-27 **(b)** United States **(c)** India **(d)** China **(e)** Japan and **(f)** Brazil. Shaded areas are the 10–90% confidence

interval. Solar PV + system storage is already among the cheapest forms of electricity. In some regions, wind and solar remain competitive, whereas solar becomes much cheaper in others. Without carbon taxation, coal is typically cheaper than gas.

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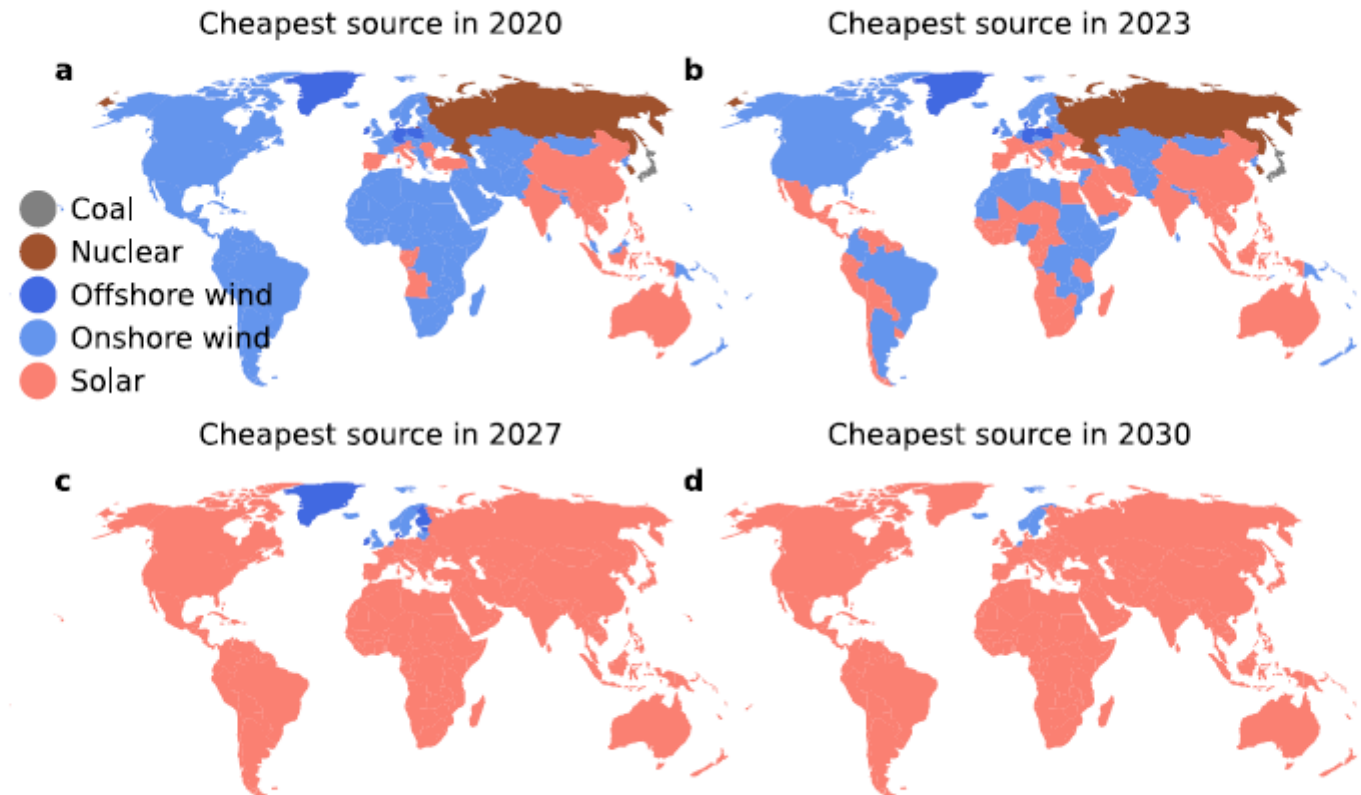
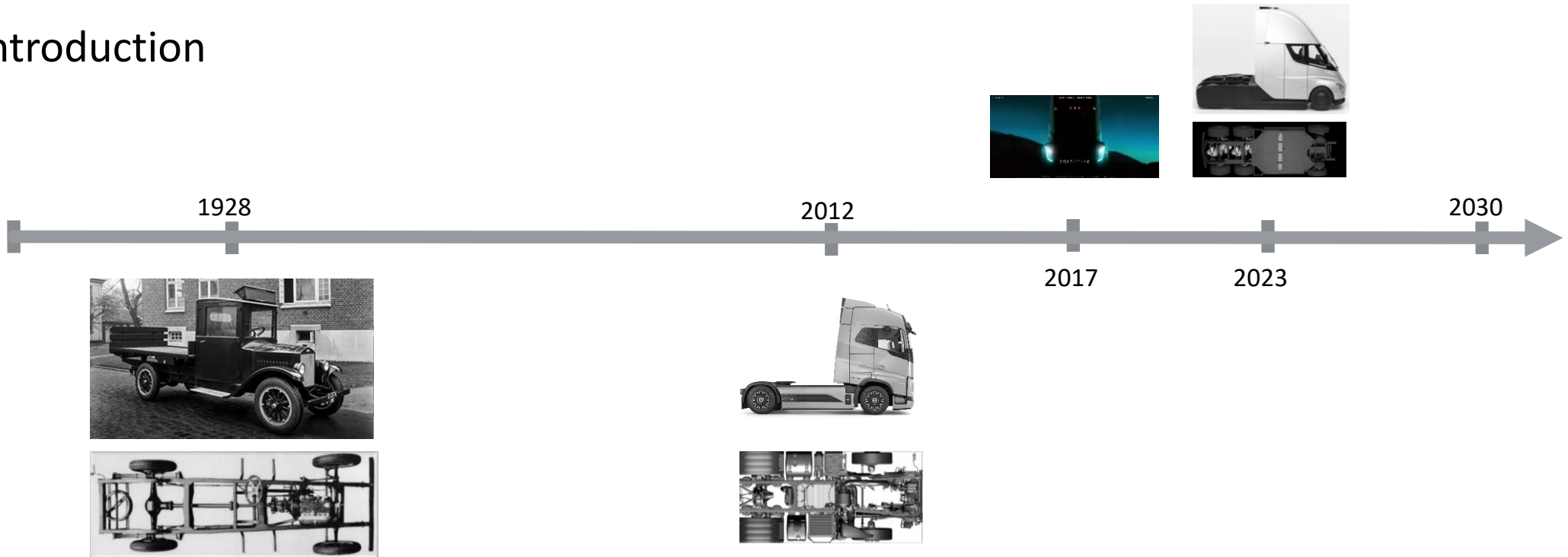
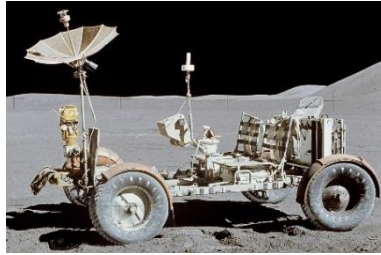
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Fig. 4 | Technology with the lowest LCOE_{ssc} by year and E3ME region. Each map shows the 70 E3ME regions: in 2020 (a), 2023 (b), 2027 (c) and 2030 (d). The biggest shift occurs between 2020 and 2027, which sees a range of technologies give way to solar PV as the cheapest source of electricity.

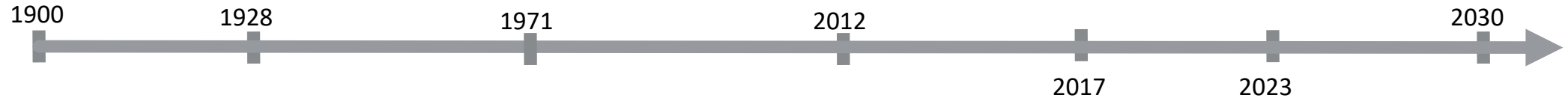
Introduction



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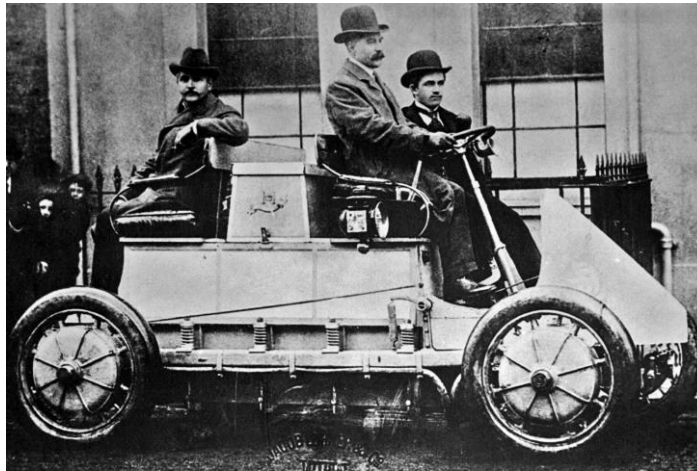
Apollo 15 Lunar Roving Vehicle
4x4 BEV / NASA



In-wheel
motors

battery chassis
structure

Minimize
resistance forces
(air / roll)



Lohner-Porsche Electromobile 1900
4x4 in wheel motors



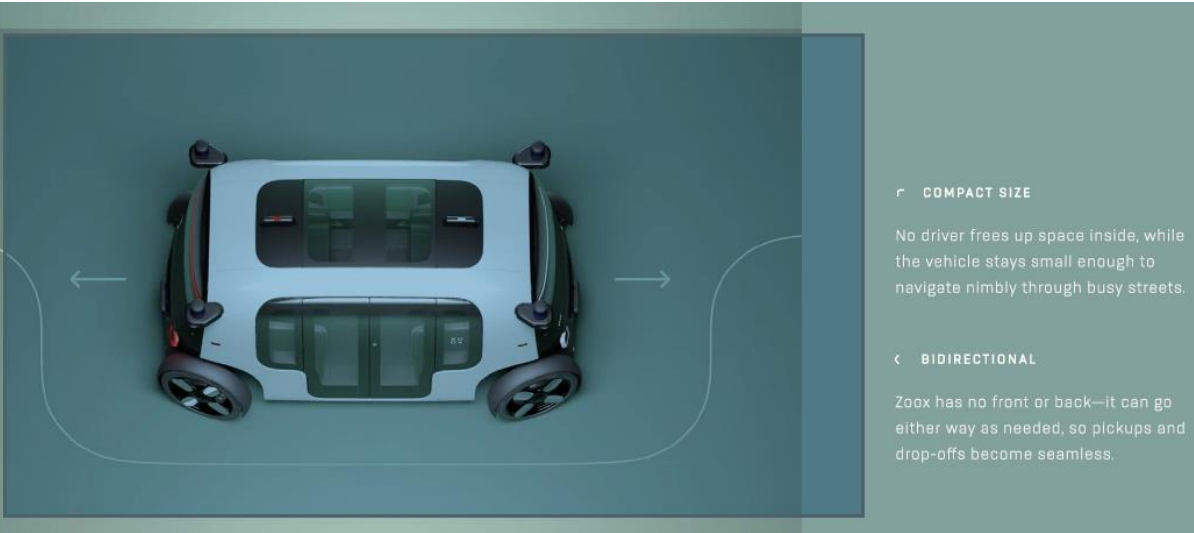
Series Hybrid Lohner Porsche 1900
4x2 in wheel motors

Range extender
with ICE (FC)

Modular e-axle
system

Less use of service
brakes

ZOOX: Electric self-driving car allowed on public road in California, between Zoon offices, driving Zoon employees, February 2023



COMPACT SIZE

No driver frees up space inside, while the vehicle stays small enough to navigate nimbly through busy streets.

BIDIRECTIONAL

Zoon has no front or back—it can go either way as needed, so pickups and drop-offs become seamless.



Amazon's Self-Driving Car Unit Shuttles People on Public Roads

<https://www.youtube.com/watch?v=-CuwF5PDXqo>

ZOOX

Zoon Robotaxi on Public Roads: A World's First

Built with no steering wheel or pedals, this is the first time in history a purpose-built autonomous robotaxi has carried passengers on public roads.

MILESTONE	First-time in history a purpose-built autonomous robotaxi has carried passengers on public roads.
LOCATION	Foster City, California
ABOUT THE ROUTE	One mile per direction, connecting between two main buildings at Zoon headquarters. Our vehicle can transport up to four people at a time on a public route between two Zoon office buildings, can travel up to 35 mph, and navigates left-hand and right-hand turns, bidirectional turns, traffic lights, bicyclists, pedestrians, vehicles, and other road agents on this route.
WHEN	On February 11, 2023, we conducted our maiden run of our employee shuttle service in our purpose-built robotaxi, built without a steering wheel or pedals.
WHO IS ELIGIBLE	This initial service is exclusive to Zoon employees.
COST	This service is provided exclusively to Zoon employees, and we will not charge a fare.
SAFETY DRIVERS	This is the first-time in history that an autonomous, purpose-built, FMVSS-compliant robotaxi is on public roads without a safety driver.
PERMITS	Zoon secured an extension to its California Driverless permit to give us the proper regulatory authorization to test drive our purpose-built vehicles on public roads.
WHAT'S NEXT	This marks the first test run of our employee shuttle service in our headquarters of Foster City, California, with our employee shuttle service to launch soon.

ZOOX.COM

PRESS@ZOOX.COM



Source: 2023-02-28 mail from Dr Carl-Johan Hoel at Zoon, former Volvo group i-PhD student on tactical decision-making using reinforcement learning with uncertainty awarness

Electric Vehicles and their Impact on Tyres

July 2021

Requirements and influences of EVs



- › Increasing registrations of electric vehicles and hybrids with higher **vehicle weights (2.0-3.0T)** than combustion engines.
- › Higher demand for bigger rim sizes / load capacities leads to tyres with lower aspect ratios, **ca. 53% of OE development sizes have aspect ratios ≤50%**
- › Range extension by low rolling resistance required, current **average RR level 6.0kg/T at Robust B.**
- › NVH requirements of electric vehicles are increasing due to dominance of rolling noise in driver cabin, **pass by noise level 66dbA and cavity noise requirements.**

Difference between an electric vehicle and a conventional combustion engine?

Service and maintenance potential

Electric vehicle*

Comparatively high acquisition costs

Lower maintenance potential

Combustion vehicle**

Comparatively lower acquisition costs

Higher maintenance potential

Service and Maintenance only for:

- › Air filter
- › Brake fluid
- › A/C- liquid
- › Tyres
- › **Brake pads**
(last at least twice as long as conventional vehicle)



ICE:

- › No oil change
- › No spark plugs
- › No fuel filter
- › No exhaust system
- › No catalyst
- › No silencer
- › No clutch



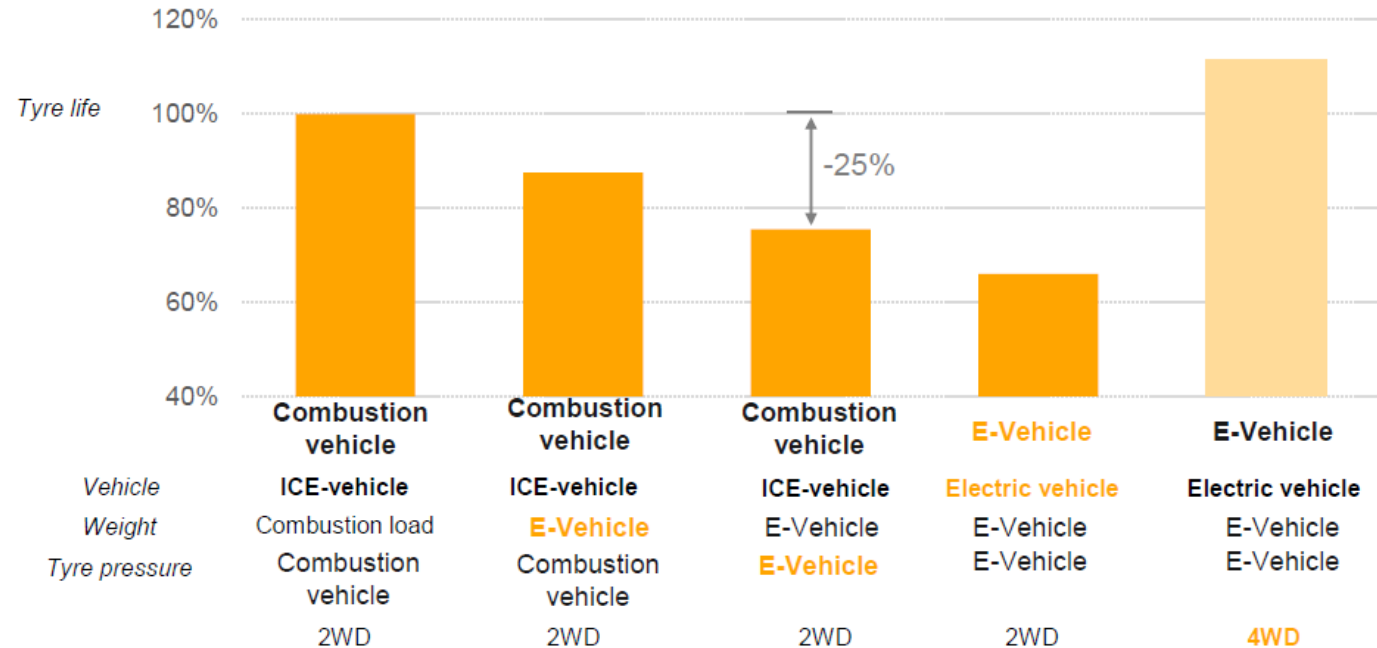
Tyres are preserved and are gaining in importance. The relevance of the business areas in the dealerships will shift.

What influence do Electric Vehicles have on tyre wear?

Tyre wear: A tyre characteristic approach*

Examined Parameters

- › Vehicle weight
- › Tyre pressure
- › Torque (driving profile)
- › Powertrain



*Vgl. Bäuning – Continental Reifen Deutschland, Electromobility and Tyres, VDI Wissensforum, 16.10.2019.

Fundamental differences between EV vehicle platforms
Key mechanical component comparison examples

ContiAcademy 



In wheel EV drivetrain



Conventional EV drivetrain

27/07/2021
ContiAcademy © Continental AG

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TESLA

MODEL S MODEL X MODEL 3 ENERGI

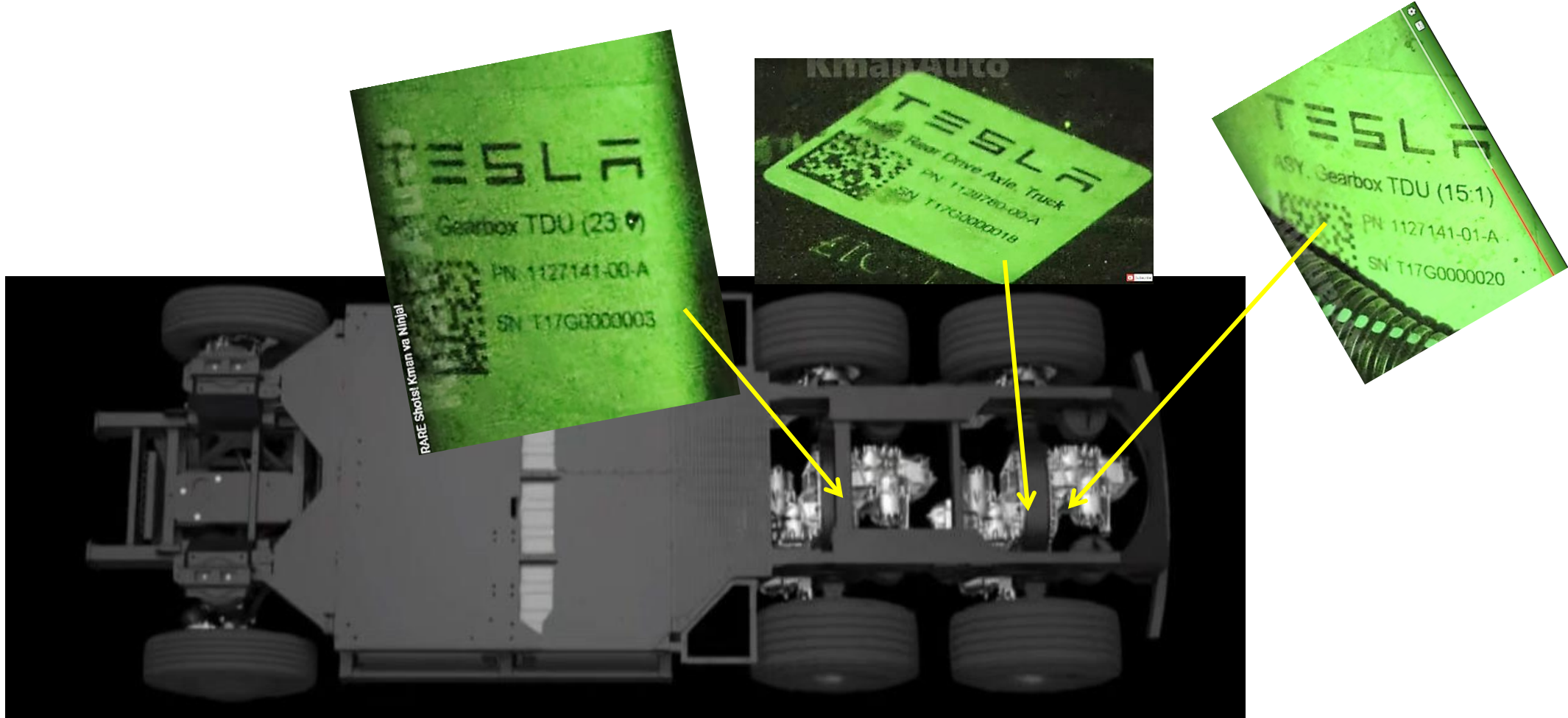
LOGGA IN 



2017-11-16

Tesla © 2017 • Integritet & juridisk information • Kontakt • Jobb • Platser • 

1 Motor (cruise axle) & 2 Motors (power axle) from TESLA model 3



1 speed transmission
torque vectoring

Ratio 23/1
Startability
Propulsion axle

Ratio 15/1
Cruise
Propulsion axle



Initial insights from the launch of the Tesla Semi

Discussion document

February 2023

Tesla leverages its passenger car battery technology for its massive 900 kWh batteries and reaches the lowest energy consumption within the industry

Vehicle concept: Battery pack

Battery packs



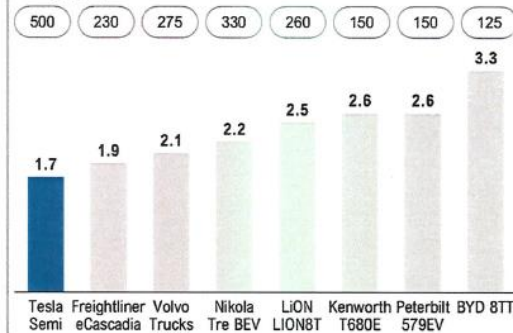
- Batteries are between 800-900 kWh, 1,000 V
- Packs in trucks deliveries so far are 21,700 cells – 4,680 structural packs come later (likely for large volume production)
- Will be offered as 6- and 9-packs (for 300- and 500-mile ranges, respectively)
- In 9-pack battery version, 3 rows in parallel of 3 packs in series

1) Test conditions (e.g., speed) likely differs between vehicles

Source: Tesla Semi Delivery Event (YouTube), Desk research, Roland Berger

Heavy-duty truck performance [kWh/mi]¹⁾

Range [mi]



- Lowest energy consumption of all electric trucks
- Target of 1.6 – 1.5 kWh/mi in Tesla roadmap

RB evaluation

- Best-in-class energy consumption allows Tesla to optimize range
- Aerodynamic design of the purpose-built cab (versus repurposed diesel truck cabs of competitor trucks)
- Drag coefficient of 0.36 (based on Tesla data) vs ~0.6 for traditional semi trucks
- Leveraging passenger car battery technology allows for significant scale effects

0.99-0.93 kWh/km



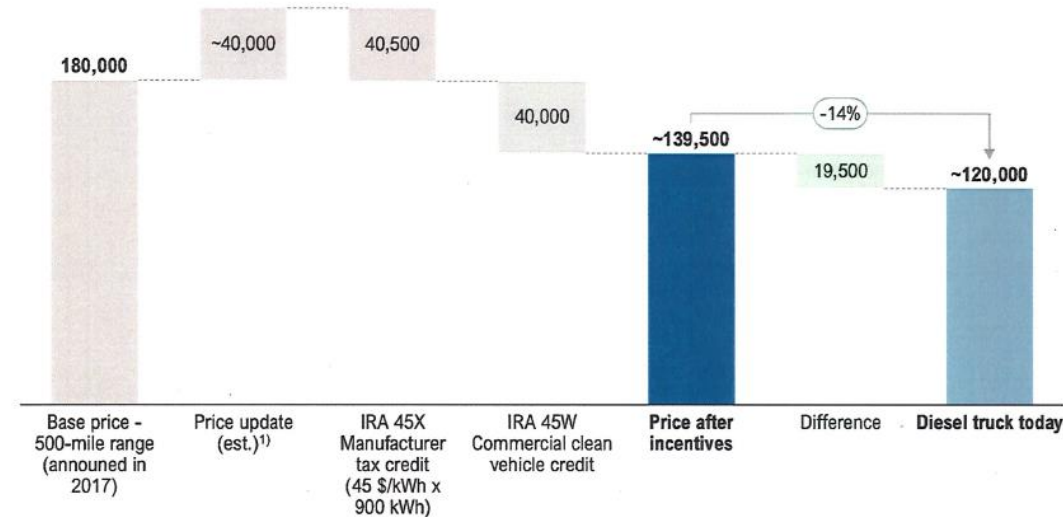
Initial insights from the launch of the Tesla Semi

Discussion document

February 2023

IRA incentives will narrow the gap between a Tesla Semi and a typical diesel truck – Lack of own service network less critical as e-trucks requires less maintenance

Tesla Semi pricing and incentives [USD per vehicle]



RB evaluation

- Tesla Semi pricing is expected to be higher than announced in 2017, though exact figures have not been made public
- After incentives, estimated price comes to ~USD 140k for 500-mile range, which is not far from typical diesel truck
- Tesla is able to be aggressive on pricing because of the wide margins of their car business compared to established OEMs, especially as vehicle volumes increase²⁾
- High durability – Tesla claims 1 m miles – would eliminate residual value issue
- Lack of own service network less critical
 - E-trucks with only limited maintenance need (e.g., no fluid changes required)
 - Routine maintenance (tire changes) already done inhouse by large fleets
 - Tesla successfully sold > 1 m cars without having an own service network

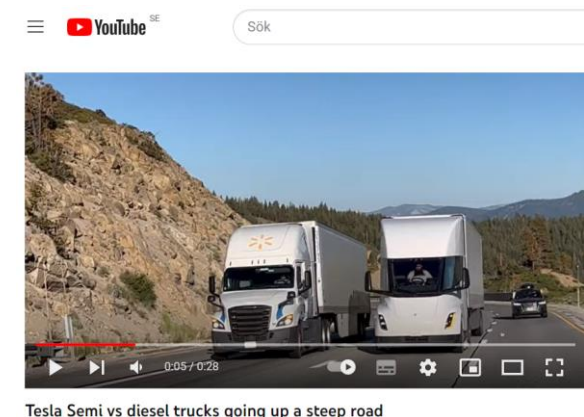
1) Estimate based on previous price increases from Tesla; Model 3 prices have been increased by 10% in 2021 vs the announced base price in 2017; additional 20% price increase in 2022
 2) Profit per vehicle, Q3 2022: tesla 9,570 USD versus Toyota 1,200 USD

Source: Desk research, Roland Berger

Summary: TESLA Semi's TCO and Spec will be minimum target baseline values for any OEM developing heavy vehicle products for long haul and regional road transports.

i.e., which OEMs (new or old), will deliver real competition to TESLA Semi?

https://www.youtube.com/watch?v=i0Rv0_Nnwdo



Tesla semi documented performance - RunOnLess

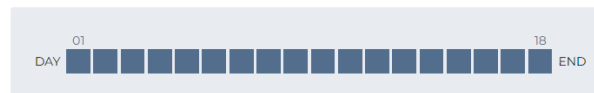


Total Kilometers **1732**

Average Kilometers/Day **1732**

Estimated Deliveries **1**

Average Deliveries/Day **1**



SELECT DAY:

Day 17

SELECT DEPOT:

PepsiCo (Sacramento)

SELECT TRUCK:

Tesla 3

SELECT UNITS:

Metric

UPDATE

Key takeaways:

1. Product cost 2023 1.9 MSEK

2. Performance in 2023 as a diesel truck:

20hr *85 km/h = 1700 km..

(It is maximised performance with 2 drivers a 10 hrs within 24hrs)

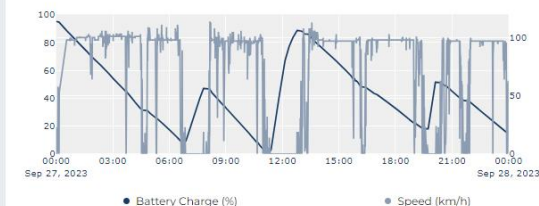
3. High uptime, cruise axle design is key total time*0.82*0.93 where driven in cruise speed.

81.8% driving whereof 92.6% where driven with +50 mph / +80 km/h (11% charging time and 17% inactive)

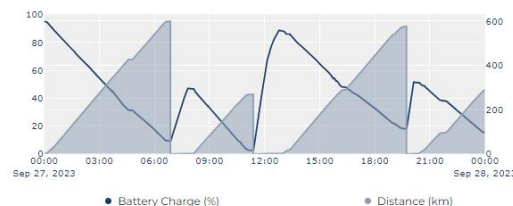
Run On Less Results

(take a look at the data yourself 3 Tesla Semi 18 days...)

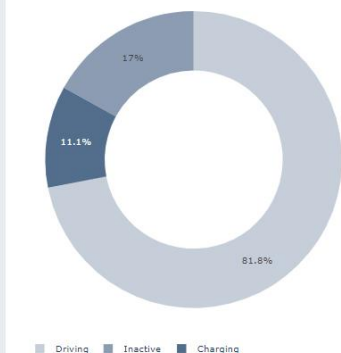
Battery Charge (%) & Speed (kmh)



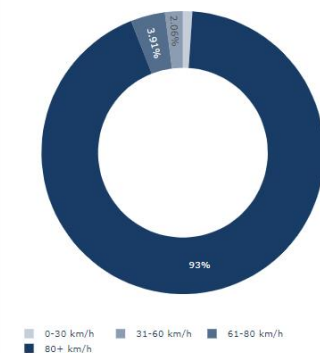
Battery Charge (%) & Distance (km)



Truck Activity



Distance By Speed



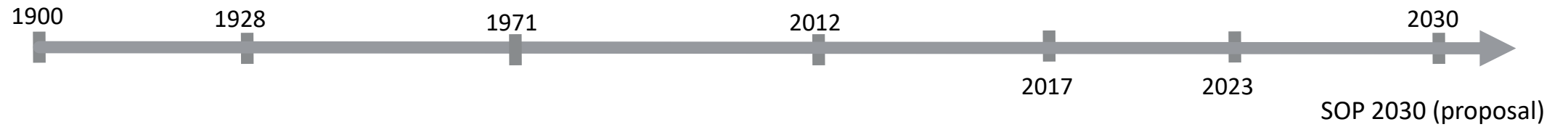
Energy In



Energy Out



Introduction



SOP 2030 (proposal)

BEV 40 ton

Range 900 km

Product cost X MSEK

