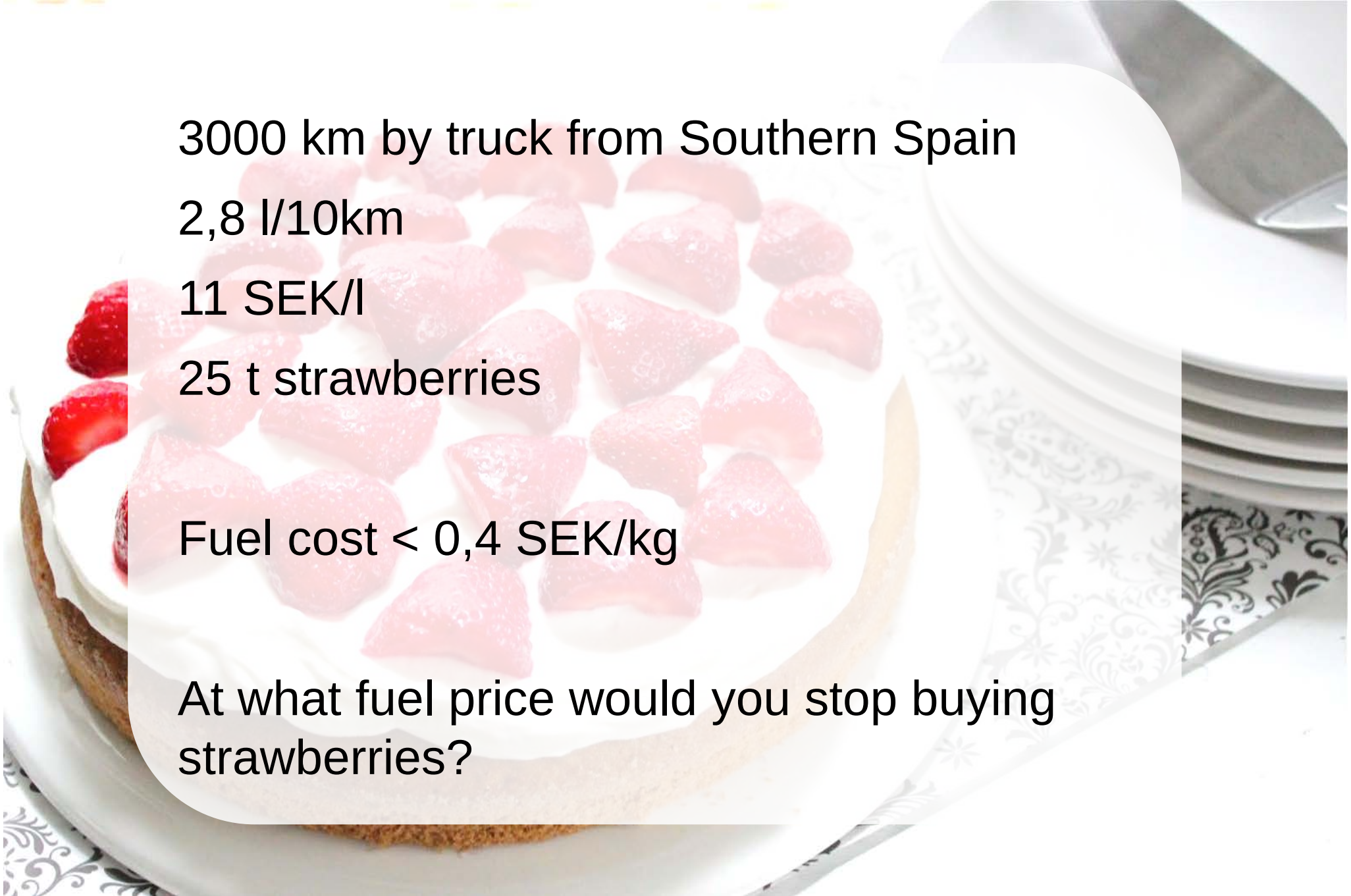
Elektrifiering av tunga fordon – Vart är vi på väg?

Niklas Thulin



3000 km by truck from Southern Spain

2,8 l/10km

11 SEK/l

25 t strawberries

Fuel cost < 0,4 SEK/kg

At what fuel price would you stop buying strawberries?

Swedish climate law

- Newly signed Swedish climate law requires significant CO2 reduction from all sectors by 2030. 70% reduction transport, 63% reduction all other sectors (1990 ref).
- Rapidly build bio-fuel production capacity from waste in forestry and agriculture, and use for air, sea and most difficult commercial vehicles/machines.
- Electrify everything possible, on- and off-road.
- Only allow new sales of zero emission for all cars, truck, buses from 2025.
- Phase out ‘all’ fossil all fuel vehicles by 2030 (by taxation or legislation) (with possibility exemptions).
- At least double wind energy capacity.
- Steady and significant increase of fossil fuel taxes from now.

Why Electromobility?

(It’s all about charging and batteries)

- **Pro**
  - Reduce fuel/energy cost
  - Significant increase energy efficiency
  - Reduced noise
  - Reduced CO2 emissions (grid mix dep.)
  - Zero tail-pipe emissions
  - Electricity global ”fuel” with secure local supply
  - Prepares for future GHG and emission legislation
- **Con**
  - Vehicle/machine price (battery cost)
  - Driving range/ operation time (battery capacity)
  - Load capacity (battery weight)
  - Missing standardization & infrastructure for charging
  - Raw material supply and recycling

Hybrid definition

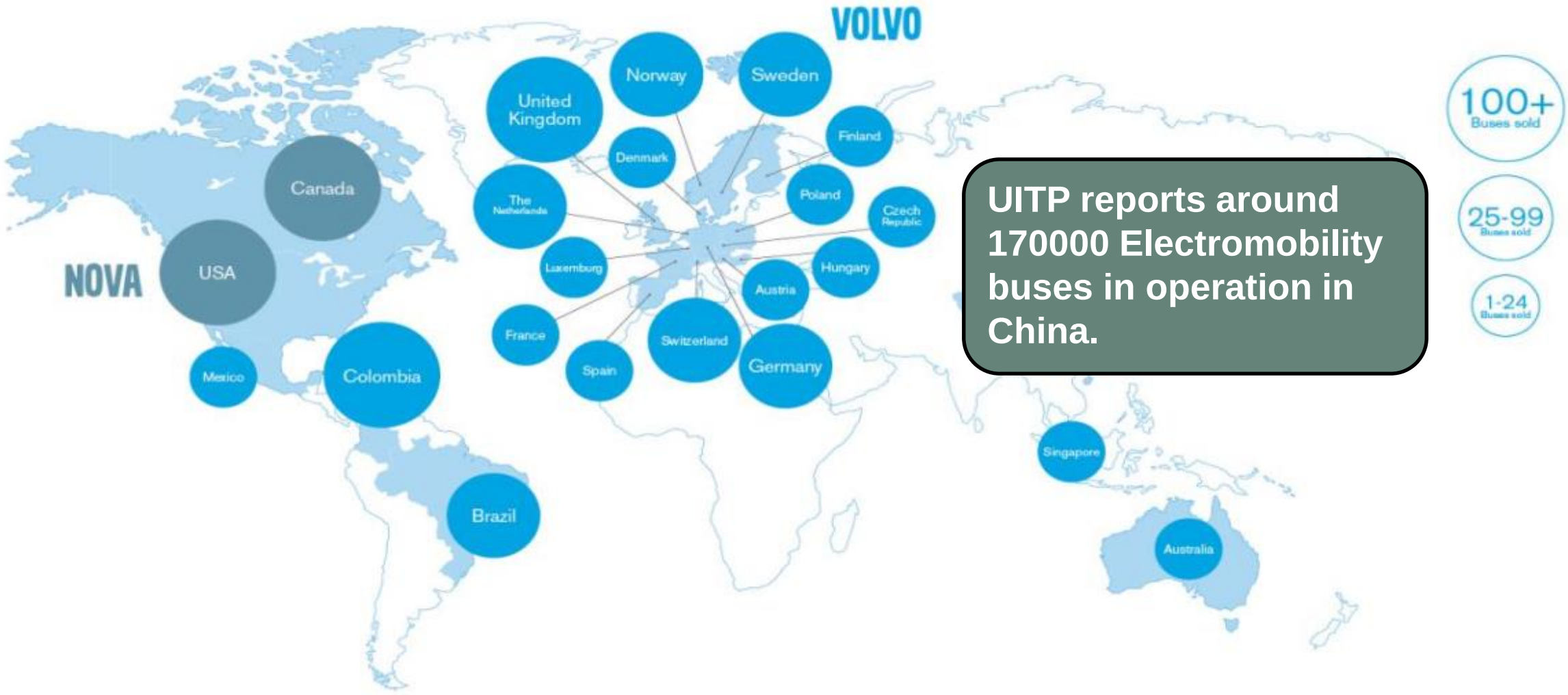
- A hybrid vehicle has two energy sources to be used for traction or other work (like digging with excavators).
  - One is usually a combustion engine supplied with fuel from a tank.
  - In electric hybrids, one is an electric machine supplied from a battery.
- Primary drive for hybridization in storing and re-using energy otherwise lost (e.g. during braking or going downhill). Up to 40% fuel reduction.
- Hybridization also offers potential for
  - Idling elimination
  - Zero-emission features
  - Engine operation point optimization

Powertrain types

- By adding one or several electric machines in the powertrain very many different powertrain configurations are possible.
- The most common are:
  - Parallel hybrid
    - Combustion engine and electric motor drive on same prop-shaft
  - Series hybrid
    - Combustion engine + electric motor works as a generator and charges battery. A second electric motor drives the wheels.
- Plug-in hybrid
  - A hybrid powertrain (of any configuration) with an external charging interface. Grid energy can be used for propulsion.
- Electric
  - No combustion engine. One or several electric motors driving wheel of through prop-shaft.


Buses
GLOBAL
OUR OFFERING
Volvo re
order of
for Tron
MON, SEP 18, 2017 13:00 CET
Volvo Buses has secured its la
7900 Electric buses for the city
Public transportation administra
technologies. In 2010 they were
from Volvo will run on four route
Press release
Volvo will bring autonomous electric buses to Singapore
1/11/18
AB Volvo
Volvo Buses and Nanyang Technological University (NTU) in Singapore have signed a cooperation agreement on a research and development program for autonomous electric 12-metre buses. The program is part of the Land Transport Authority of Singapore's drive to create new solutions for tomorrow's sustainable public transport.
EOG 627
västtrafik

>8 000 Electromobility buses all over the world



UITP reports around 170000 Electromobility buses in operation in China.

Electromobility truck demos

Volvo Trucks will start selling electric trucks 2019

1/23/18

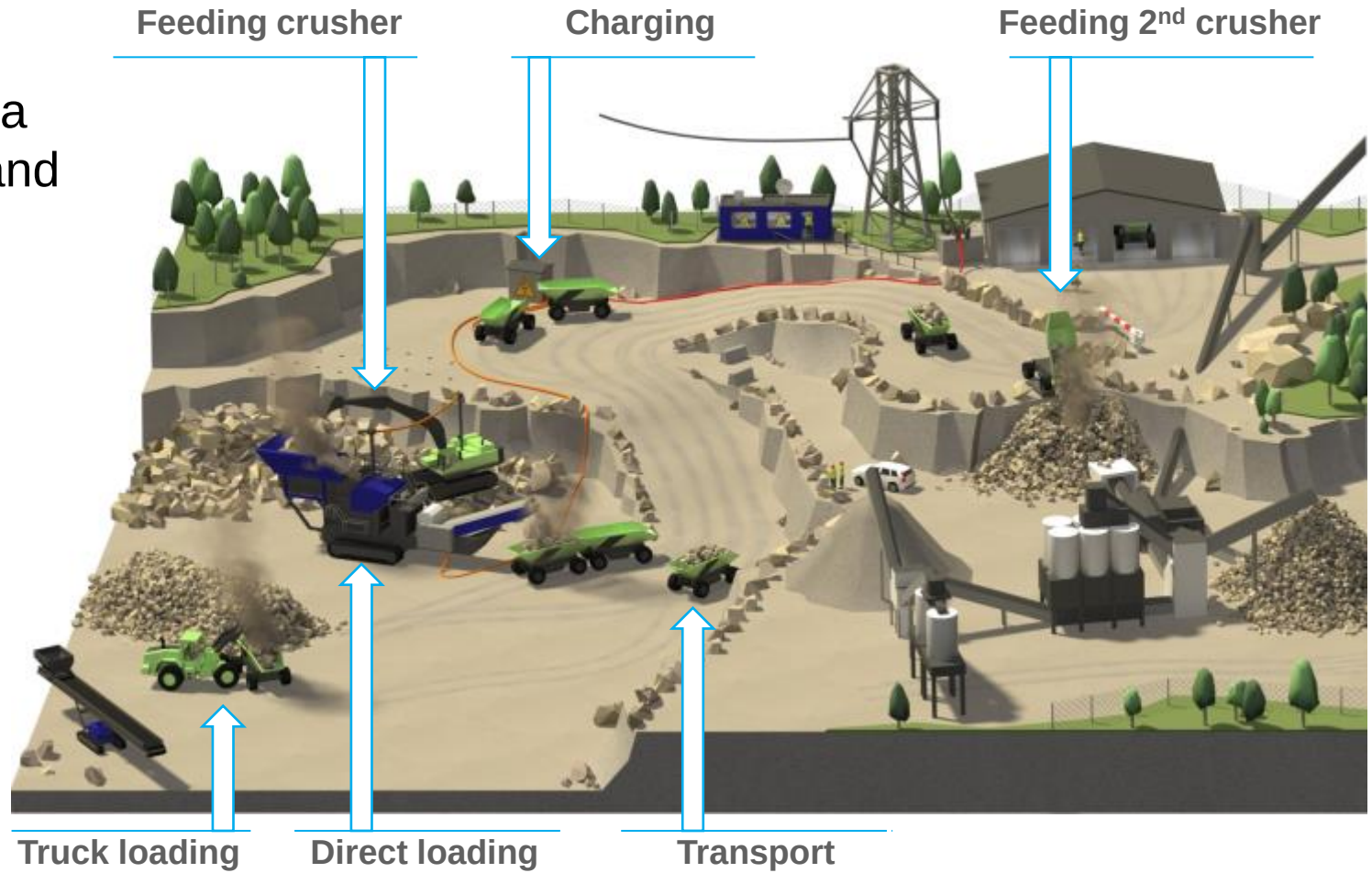
AB Volvo

In 2019 Volvo Trucks will start selling electric medium-duty trucks in Europe, and the first units will be put into operation together with a few selected reference customers already this year. “Electromobility is fully in line with Volvo Truck’s long term commitment for sustainable urban development and zero emissions”, says Claes Nilsson, President Volvo Trucks.


VOLVO
HYBRID
L.X01
PROTOTYPE
AUTONOMOUS ELECTRIC

Work site electrification

- Volvo CE will together with construction company Skanska and two universities develop and demonstrate (in 2018) an electrified quarry operation.
- Potential for significant reduction in cost of operation
- New machines, charging & automation concepts will be demonstrated.

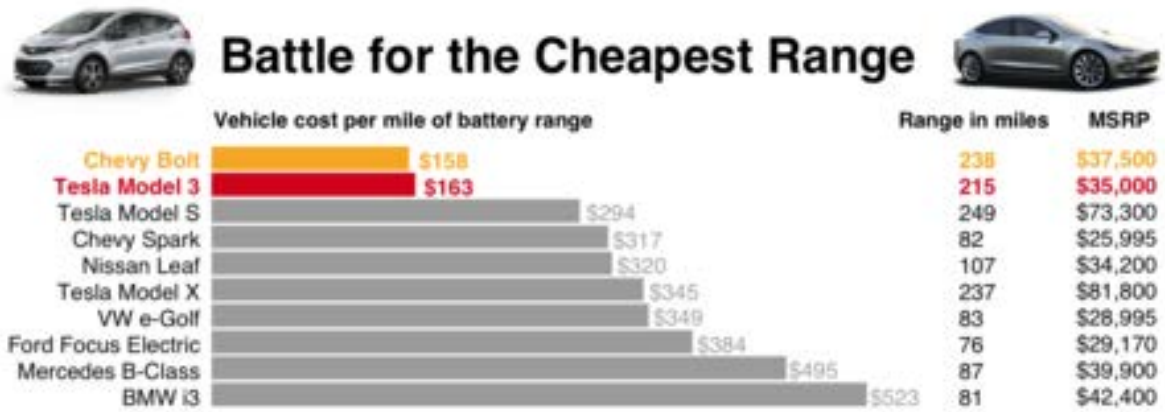


Global drivers for Electrification

Growing anti-diesel momentum.

- ”Diesel Gate” and implementation of Paris Climate Agreement shifting focus in automotive industry.
  - Major cities (e.g. London, Paris, Mexico City) are communicating ”diesel bans” in 2025 time frame.
- India, France, UK and others plan to only allow sales of electric cars in 2030-2040 time frame.
  - Hybrid and electric cars now >50% of new sales in Norway.
- EU CO_2 limits driving electrification
  - E.g. all new cars models from Volvo Cars will be electrified from 2019.

- 1/3 of Toyota sales in Europe are hybrids.
- Toyota Prius now similar price as diesel Golf in Germany.
- Cost-per-range for electric cars has reduced 50% in one vehicle generation.



Global drivers for Electrification

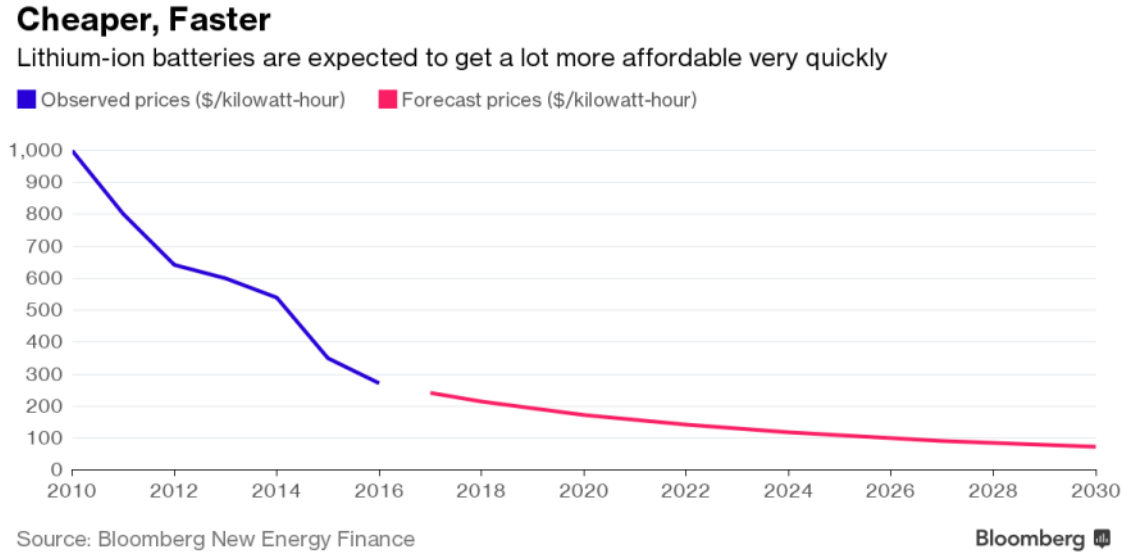
High ambitions in leading regions.

- Mayors of Los Angeles and Long Beach in June re-confirmed ambition to have fully zero emission ports by 2030.
  - All new mobile port equipment sold from ≈2023 need to be zero emission.
  - Vast majority of new machines sold in Sweden from ≈2023 need to be zero emission.
- Airports commit to carbon neutrality, e.g. Munich 2030.
  - Zero emission ground equipment and climate compensation for in/out bound air traffic.

Economical drivers

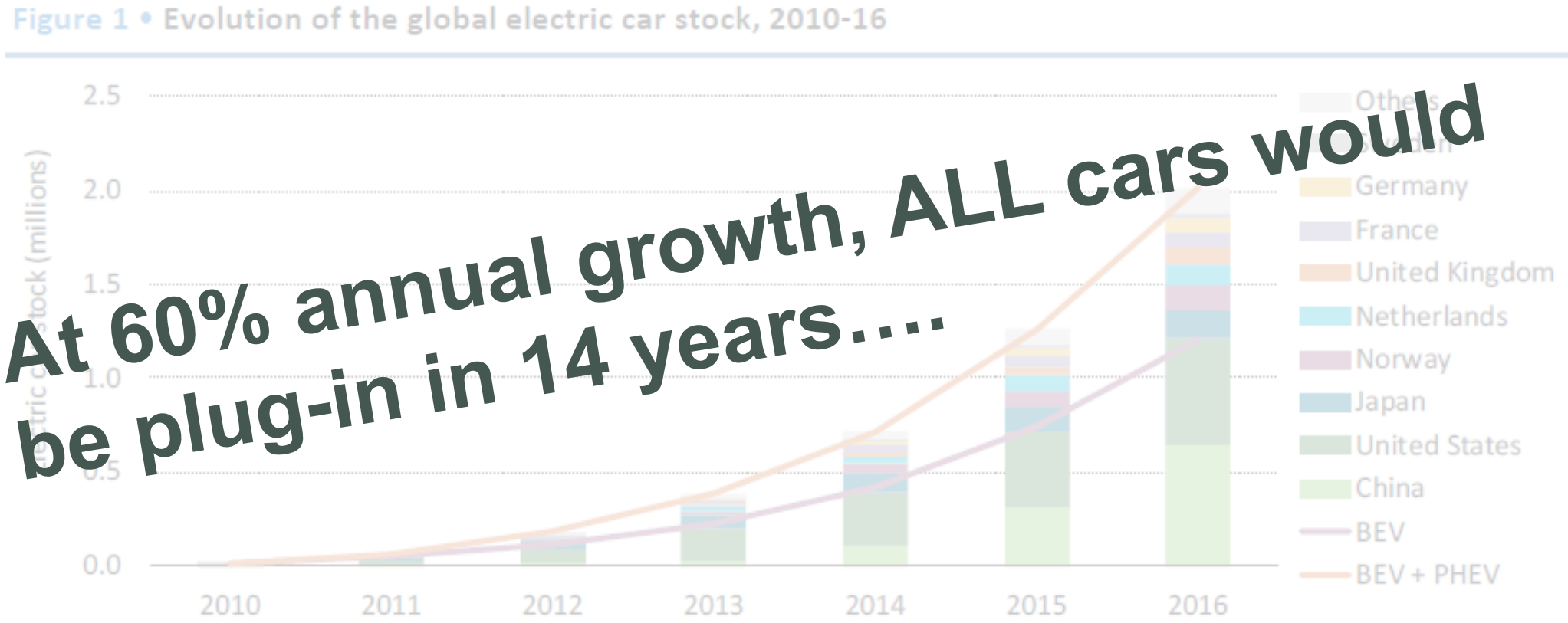
Cost of ownership competitiveness increasing rapidly.

- Close to tipping point when full electric is total-cost-of-ownership competitive with diesel vehicles for best electrification cases, e.g. urban trucks and buses.
  - › Good industrial cases in short term
- Battery price reduction expected to continue



Plug-in car sales

Steady growth in China, US and Northern Europe.



At 60% annual growth, ALL cars would be plug-in in 14 years….

Source: International Energy Agency - Global EV outlook 2017

Trucks

- Market for electric trucks comparable to where electric buses were a few years ago.
- Several emerging offers from new entrants or special vehicle manufacturers.
- E.g. EMOSS (NL), Charge (UK), E-FORCE (CH), Ginaf (NL), PVI (FR), TEVVA (UK), Wrightspeed (US), Motiv Power Systems (US), VIA Motors (US), BYD (CN), ZEROTRUCK (US), Nohm (US), Efficient Drivetrains (US),….
- Concept vehicles end emerging field tests from more established manufacturers.
- Focus on China, California & progressive European cities.

Buses

- More or less all bus makers now have an electric bus offer for all types of bus products.

Industrial

Many have already developed a first generation Electromobility offer.

Terberg YT202-EV electric terminal tractor

Sandvik DD422iE electric drilling

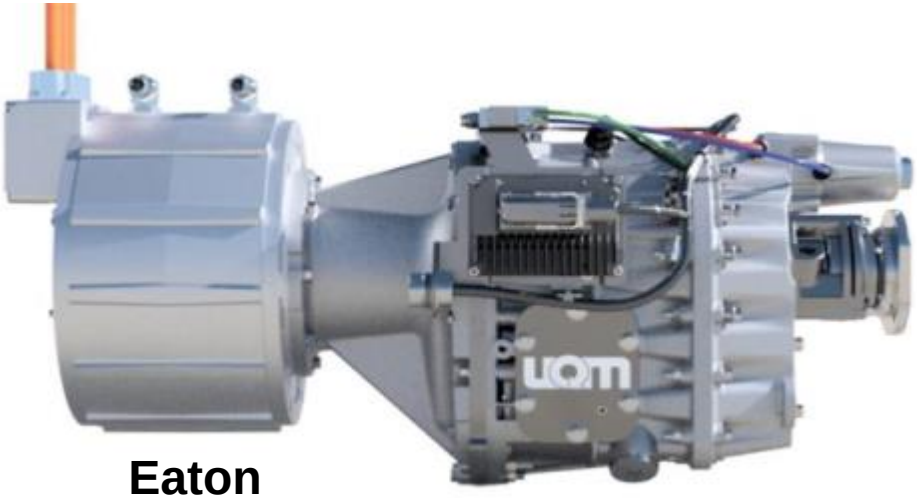
Konecranes SMV 4531 TB5 HLT series hybrid reach stacker

Kalmar Ottawa T2 electric tractor

Atlas Copco Scooptram ST7 electric loader

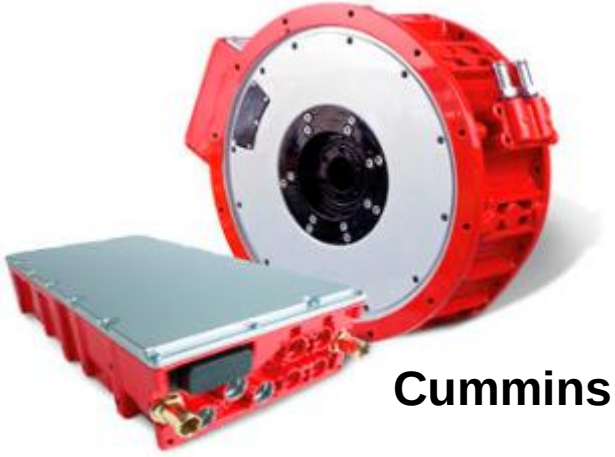
CVS Ferrari series hybrid empty container handler

Major Tier 1 suppliers entering market



Eaton

Bosch



Cummins

ZF

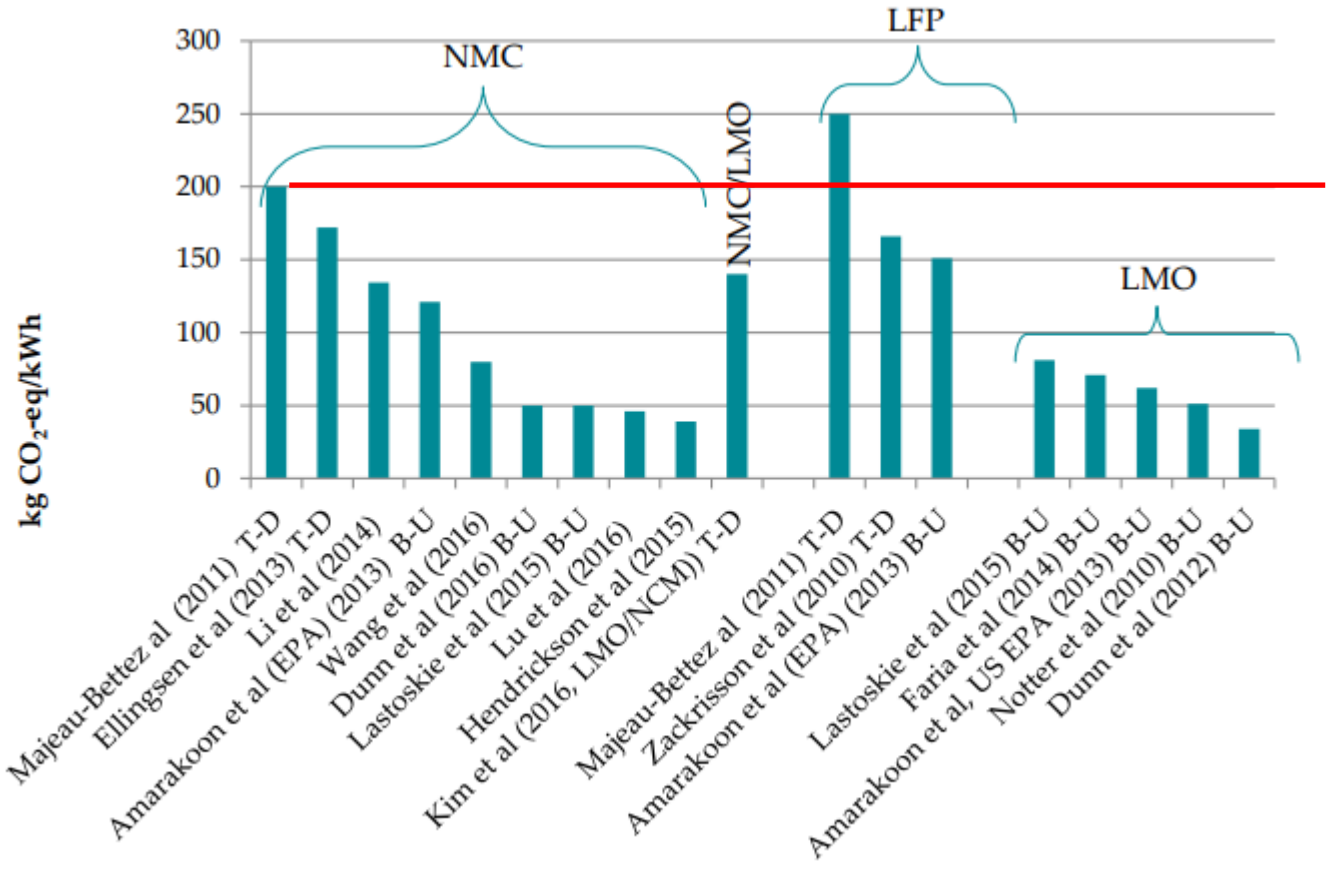
Disruptors?

- Proterra - California based bus maker. Dedicated electric bus design. Light weight design and batteries in floor. Now offers bus with typical range >500 km, proven close to 1700 km range in testing. US market leader.
- Nikola - California based truck maker. Will offer fuel cell semi trucks. Business model includes vehicle leasing, maintenance and fuel (produced by Nikola using own solar farms).

Tesla Semi

- 500 miles range full load highway speed (≈800-1000 kWh?)
- 30 min charging for 400 miles range (>1 MW charging?)
- Individual wheel motors, 0-60 mph in 20s
- Autopilot features
- Production start end 2019
- Prices 150-200 kUSD

Impact of battery production



200 kWh battery
40 t CO2
15 000 l diesel

City bus: 70 000km @0,45 = 31 500 l/year
Urban truck: 35 000km @0,3 = 10 500 l/year
Terminal tractor 5 000h @10 = 50 000 l/year

The plug-in hybrid long haul case

- Assuming operation 300 days per year x 600 km/day and 3 l/10 km the annual diesel use is 54 000 liters.
- Assuming hybridization will save 5 % fuel and adding plug-in, allowing for 5 % of daily km in all electric mode (≈ useable energy of 50 kWh).
  - Annual diesel fuel saving is ≈ 5 300 l
  - Annual electricity use is ≈ 15 000 kWh
  - Charging twice a day (night & lunch), annual saving is ≈ 7 800 l

The electric city truck case

- Assuming 300 days per year x 150 km per day
  = 45 000 km/year, and average fuel consumption 3 l/10 km.
  - Annual diesel fuel saving ≈ 13 500 l
  - Annual electricity use 45 000 km x 1.1 kWh/km ≈ 50 000 kWh
- GM has communicated a battery cell price of 145 USD/kWh for the 2016 Bolt.
  - At this cell price, realistic to achieve zero emission at lower life time cost.
- Additionally maintenance costs expected to be reduced.

Charging vs. battery capacity

Over-night

300-400 kWh
2-3 tonnes of battery
Depot charging only
1 charger per bus

Opportunity

100-150 kWh
1-1.5 t of battery
Charging infra needed
Increased passenger capacity

Electric road

50-100 kWh
0.5 t of battery
Electric road infra needed
Increased passenger capacity

Electric Road Systems

- Vehicles with pick-up systems enabling continuous power supply from an electrified road.
  - › Significant energy saving potential in longer distance road transport
- Several options (catenary, inductive, or conductive) are currently being investigated in Sweden.
- Greatest societal benefit if infrastructure shared with cars.

Battery vs. Fuel cells




≈75% Well-to-wheel

H_2




≈25% Well-to-wheel

Challenges

- Rapid technology development
  - Time-to-market critical
- Competences different from traditional engine and powertrain development
- Optimal electric vehicle design different from current platforms
- Different sales tools & processes, esp. when in combination with infrastructure
- Affordability for vehicle companies (new technology vs. initially low volume products)
- Affordability for vehicle customers (capital expenses vs. operating expenses)

Societal benefits

- Two reports evaluate the societal benefit of reduced noise and emission levels from electric commercial vehicles in urban environments.
  - Both reports calculate the value to about 4 SEK/km.
- How can the vehicle buyers benefit from this?
  - E.g. an incentive of 1 SEK/km would immediately make full electric urban trucks much more cost effective than diesel trucks.


DTC 508