KTH VETENSKAP OCH KONST

Energy Storage for Electric Vehicles

Göran Lindbergh

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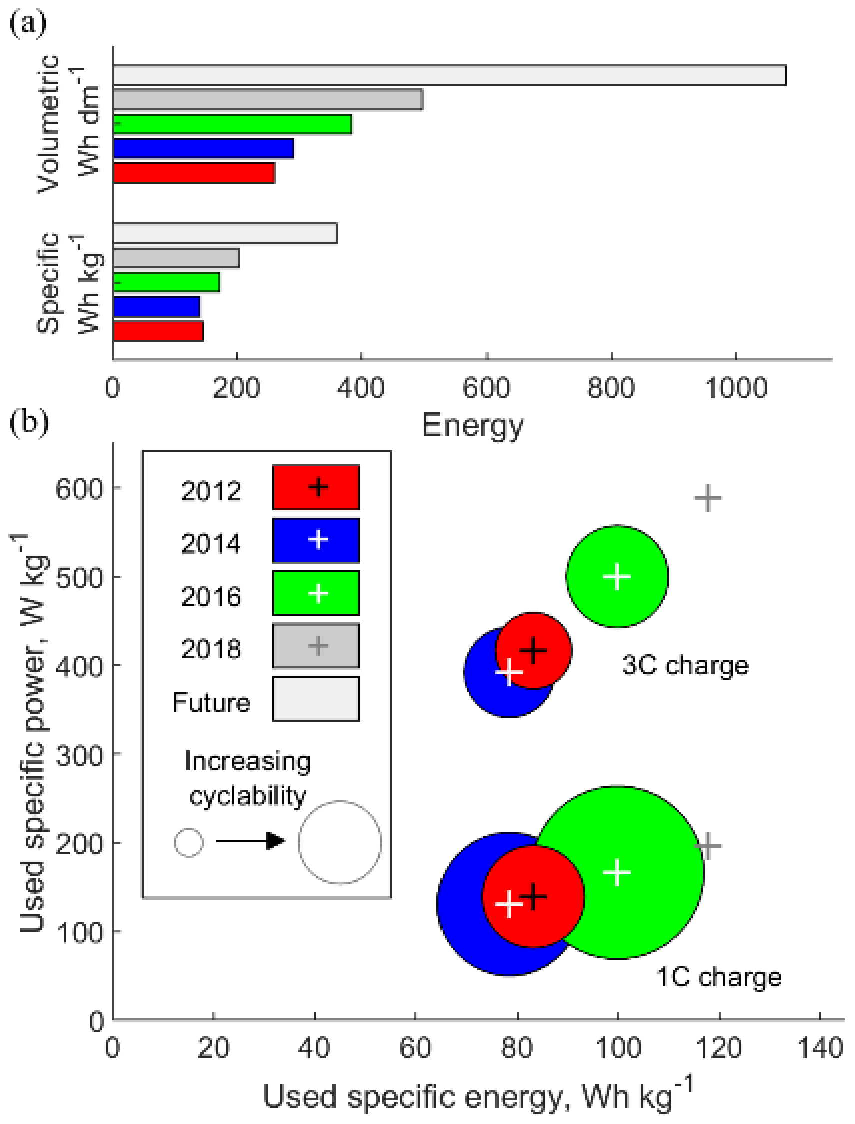
Electric vehicle battery demand

IEA Global EV Outlook 2024

Performance and Cycle Life Improvements of Prismatic Lithium-Ion Batteries

SUMMARIZED INFORMATION ABOUT CELL TYPES

Cell type	Market introduction	Capacity (Ah)	Voltage range (V)	Max. rated charge
A	2012	25	3.00 – 4.10	1C
B	2014	28	2.80 – 4.15	1C
C	2016	37	3.00 – 4.20	1C
D	2018	49	3.00 – 4.20	1.5C



a) Volumetric energy density and nominal specific energy and
b) ENPOLITE-style plot evaluating used specific power, used specific energy, and lifetime. Study of cell type 2018 and beyond is ongoing and their cyclability is not yet reported.

P. Svens, A.J. Smith, J. Groot, M.J. Lacey, G. Lindbergh, R. Wreland Lindström, *IEEE Transactions on Transportation Electrification*, 2022.

History of usable energy density in aviation

Viswanathan et al., Nature, Vol 601, 2022

Reflections on battery electric vehicles

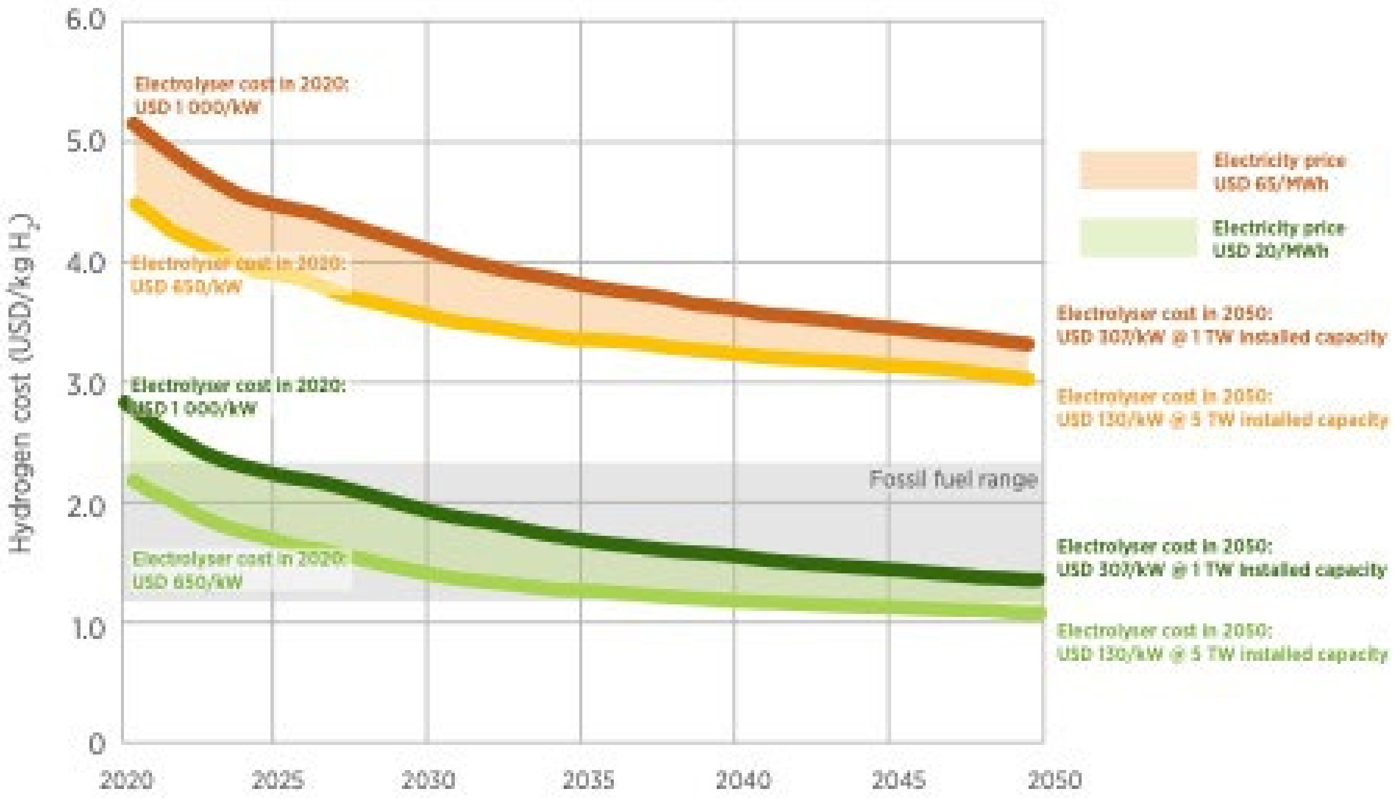
- Rapid global increase in the production of batteries for vehicles. Batteries that are getting better and cheaper.
- Dominated by lithium-ion batteries, but the rapid growth gives room for many different chemistries.
- Only about 4% of the world's road vehicles are electric today. For this share to grow, even cheaper batteries are needed.
- A growing share of electrification cannot be based on recycling today's batteries, but will require the supply of new raw materials.
- There are also many types of vehicles where batteries are insufficient, for example heavy-duty vehicles, in the marine sector and for aviation.

Conversion of hydrogen in fuel cells

Hydrogen and fuel cells are used for generation of electricity in applications that are:

- Portable
- Mobile
- Stationary

Hydrogen production cost



Note: Efficiency at nominal capacity is 65%, with a LHV of 51.2 kilowatt hour/kilogramme of hydrogen (kWh/kg H2) in 2020 and 76% (at an LHV of 43.8 kWh/kg H2) in 2050, a discount rate of 8% and a stack lifetime of 80 000 hours. The electrolyser investment cost for 2020 is USD 650-1000/kW. Electrolyser costs reach USD 130-307/kW as a result of 1-5 TW of capacity deployed by 2050.

Based on IRENA analysis.

Major technical and economical factors determining the cost of produced hydrogen:

- Electricity costs
- Capital expenses
- Conversion efficiency
- Annual operating hours

IRENA (2020), *Green Hydrogen Cost Reduction: Scaling up Electrolysers to Meet the 1.5°C Climate Goal.*

Reflections on fuel cell electric vehicles

- Hydrogen and fuel cells have the potential to electrify areas in the transport sector where batteries are insufficient.
- The area is more immature than the battery area.
- Large projects for fossil-free production of materials and chemicals driving large-scale production of hydrogen based on renewable electricity, and not the transport sector.
- A lot of research activities around water electrolysis for hydrogen production.
- A tough financing climate globally for the hydrogen area.