Technology disruption & adoption

Economics of transport electrification & renewable energy

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18 December 2023

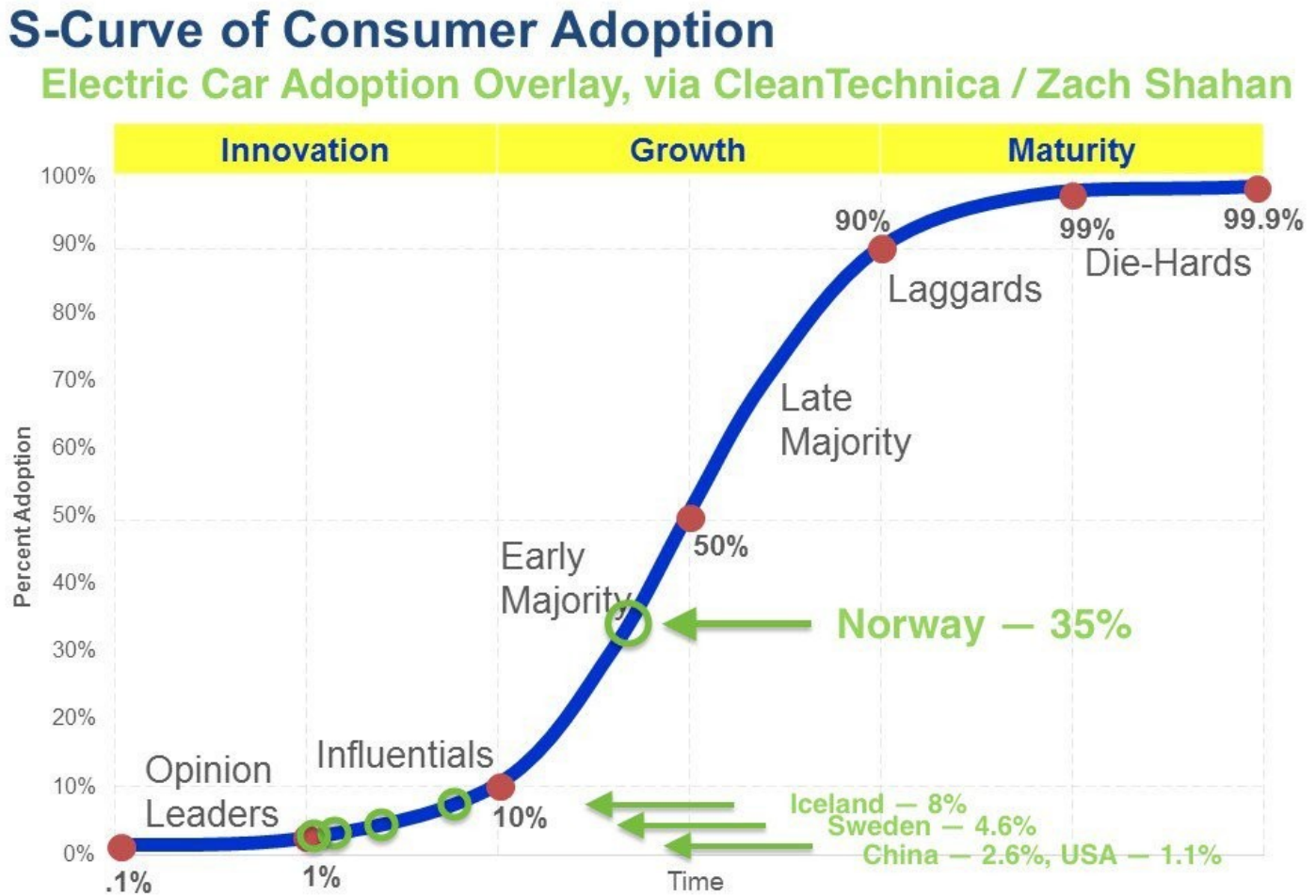
AEVA – ACT Branch

Technology adoption & disruption

The ‘S’ adoption curve

The learning cost curve (Wright’s Law)

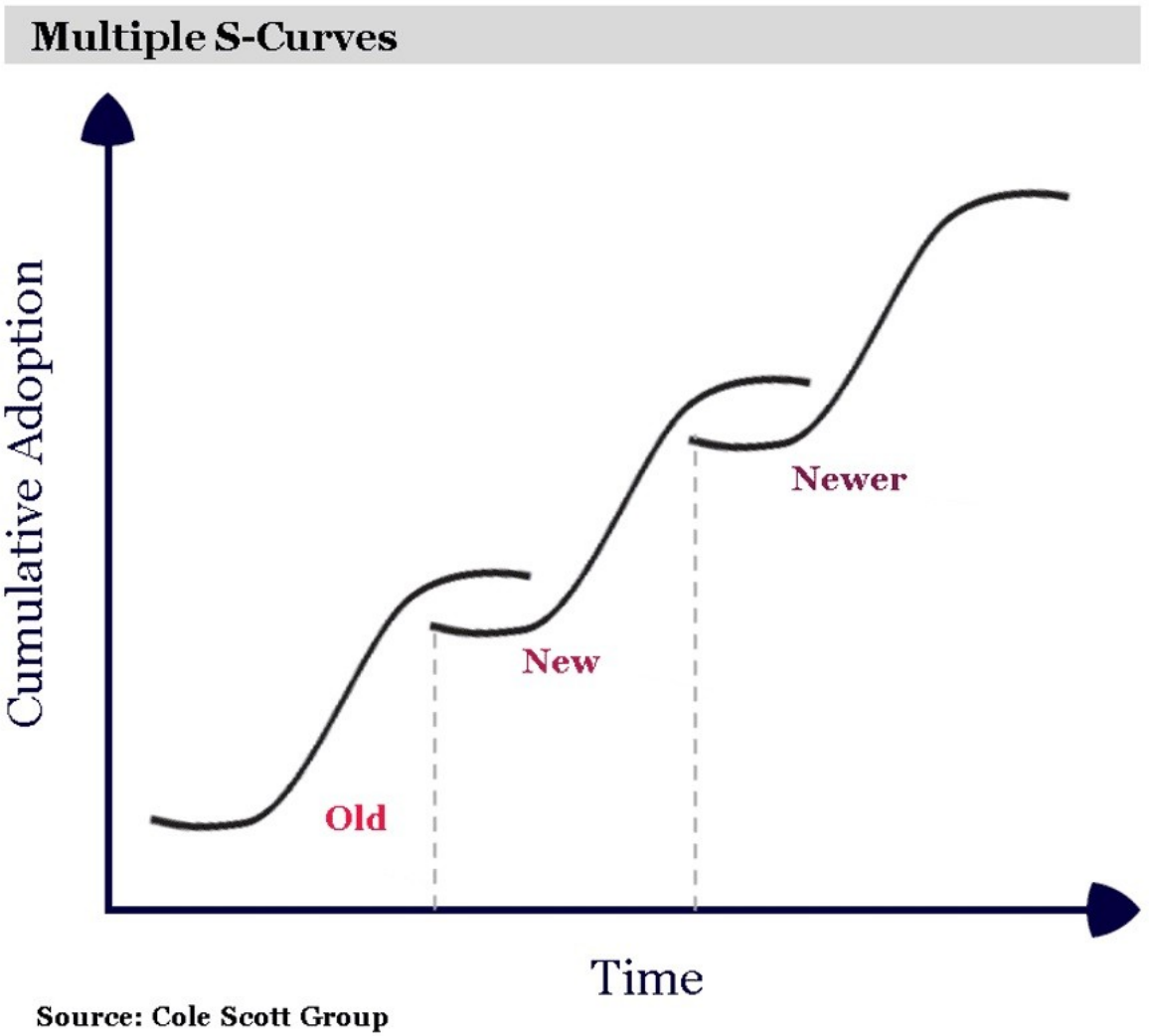
The ‘S’ adoption curve



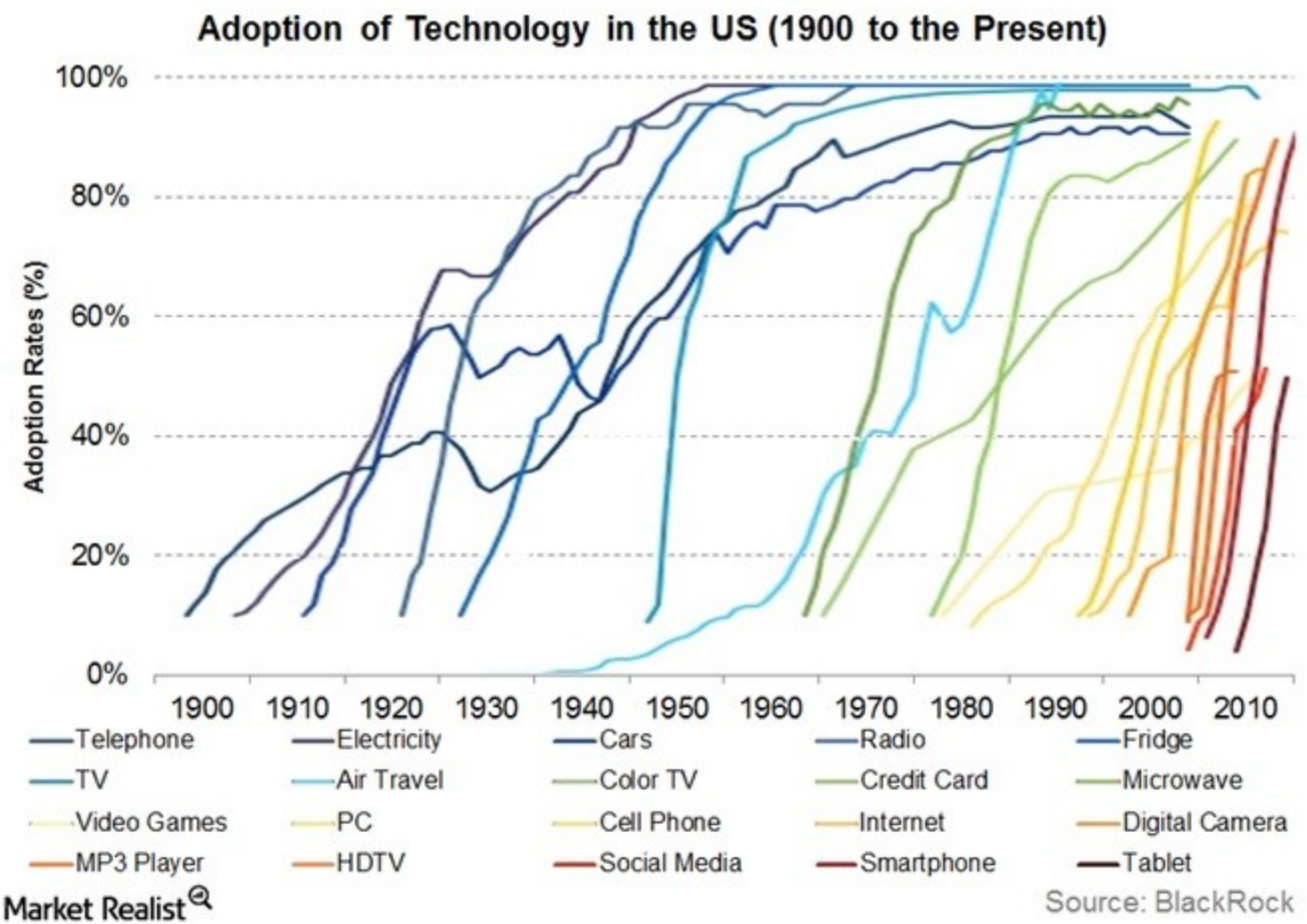
Source: Dent Research

www.dentresearch.com

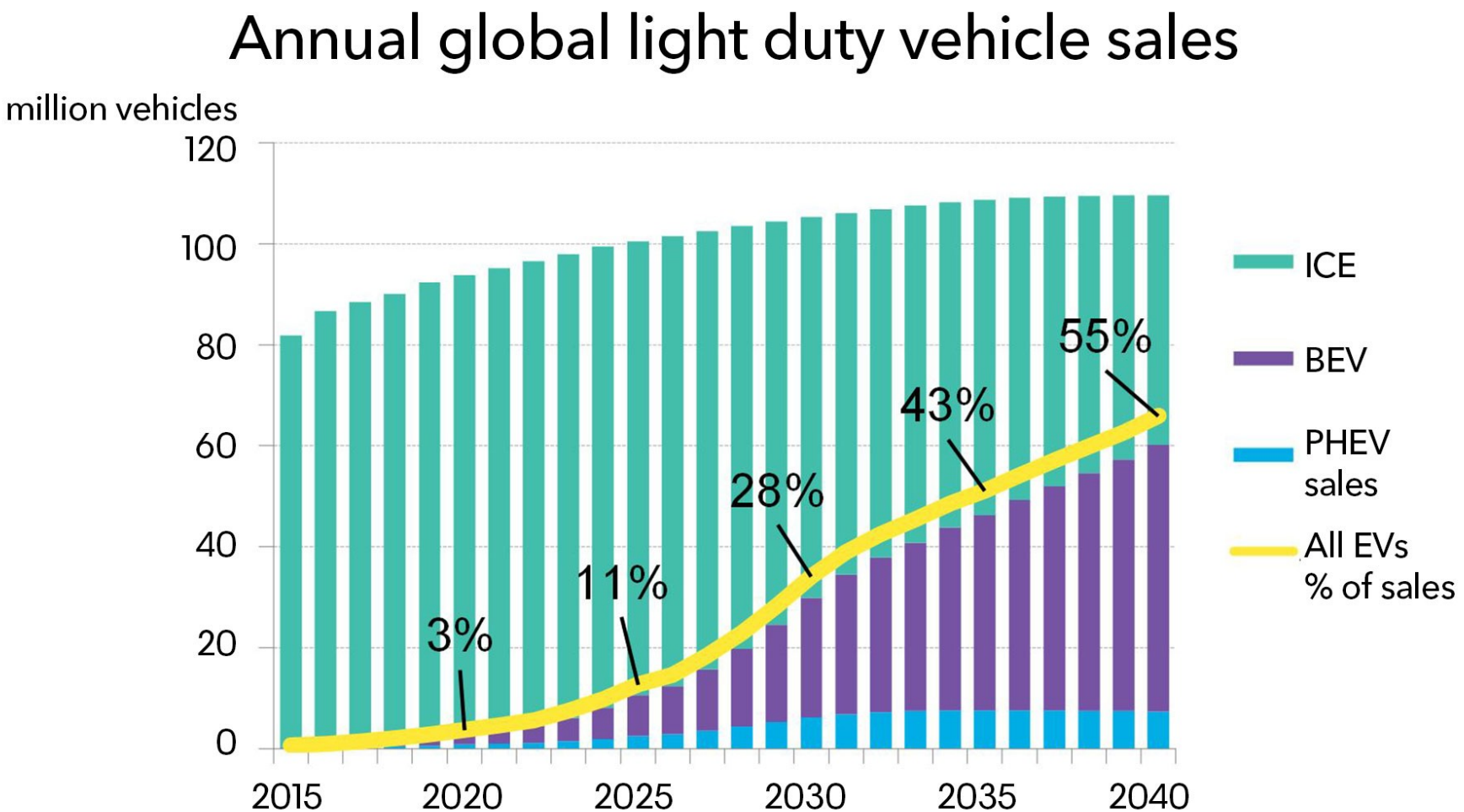
Multiple ‘S’ adoption curves



US technology adoption 1900-2010

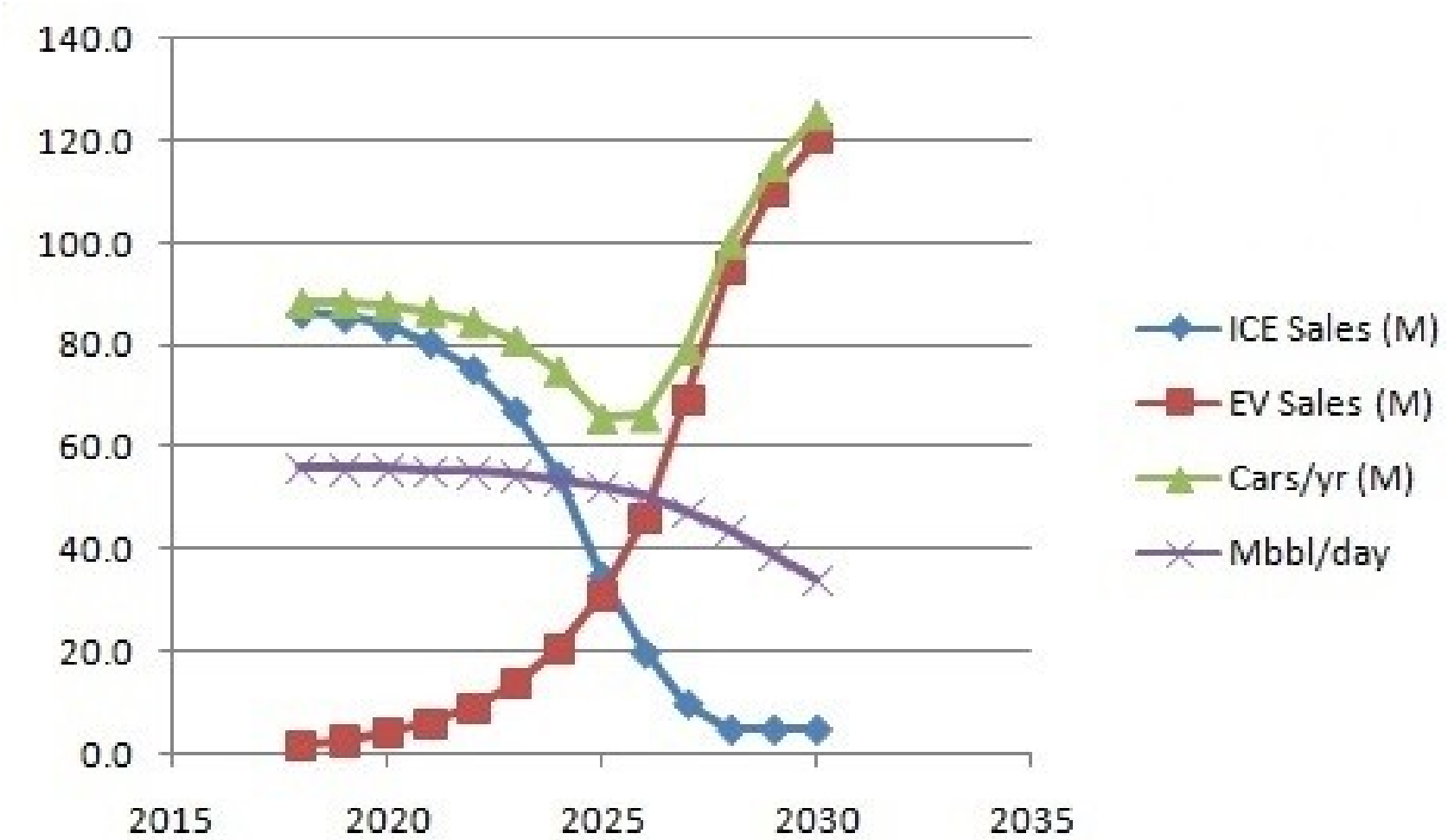


Evolutionary EV adoption curve



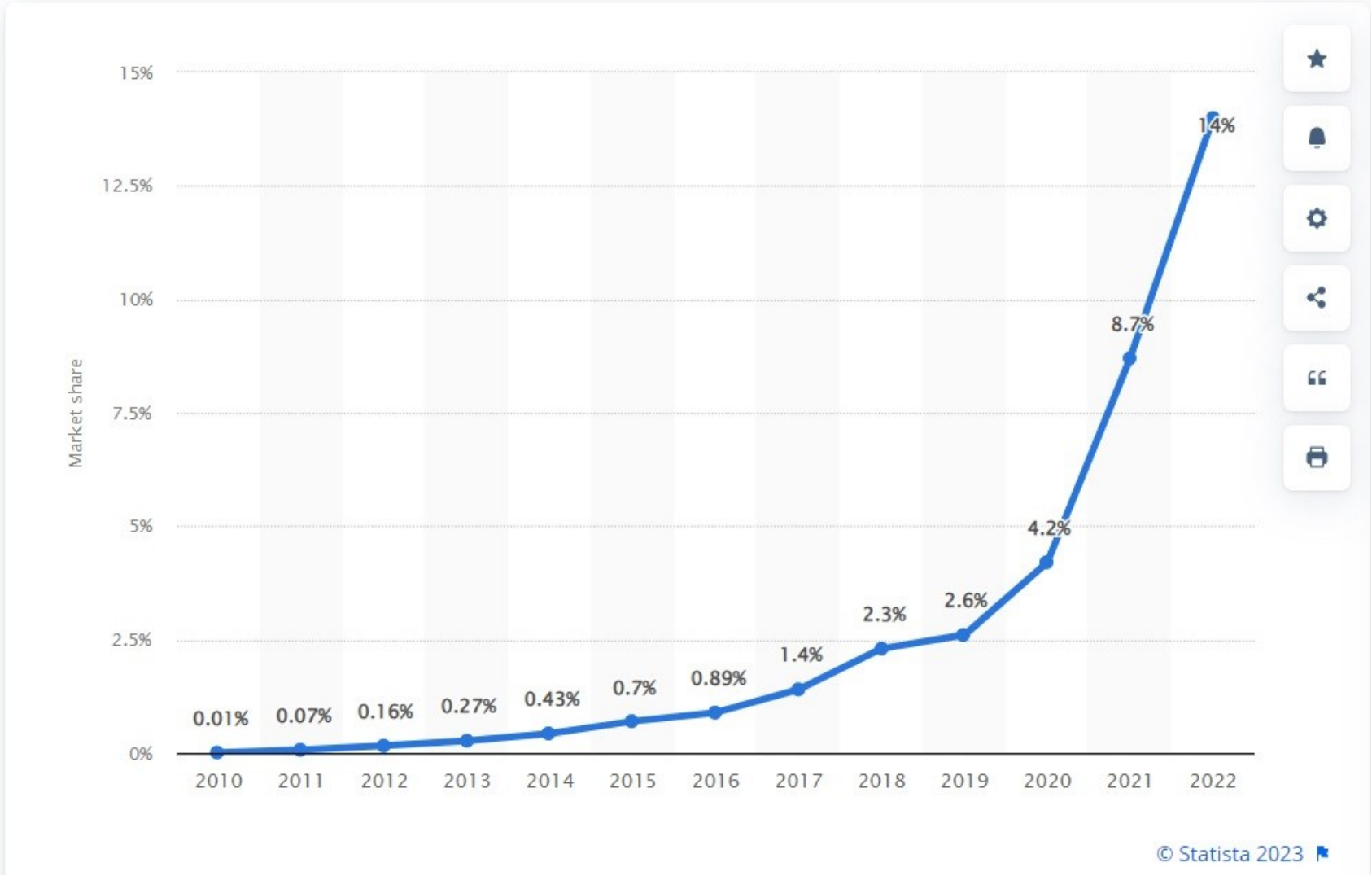
Source: Bloomberg New Energy Finance

Disruptive EV adoption curve

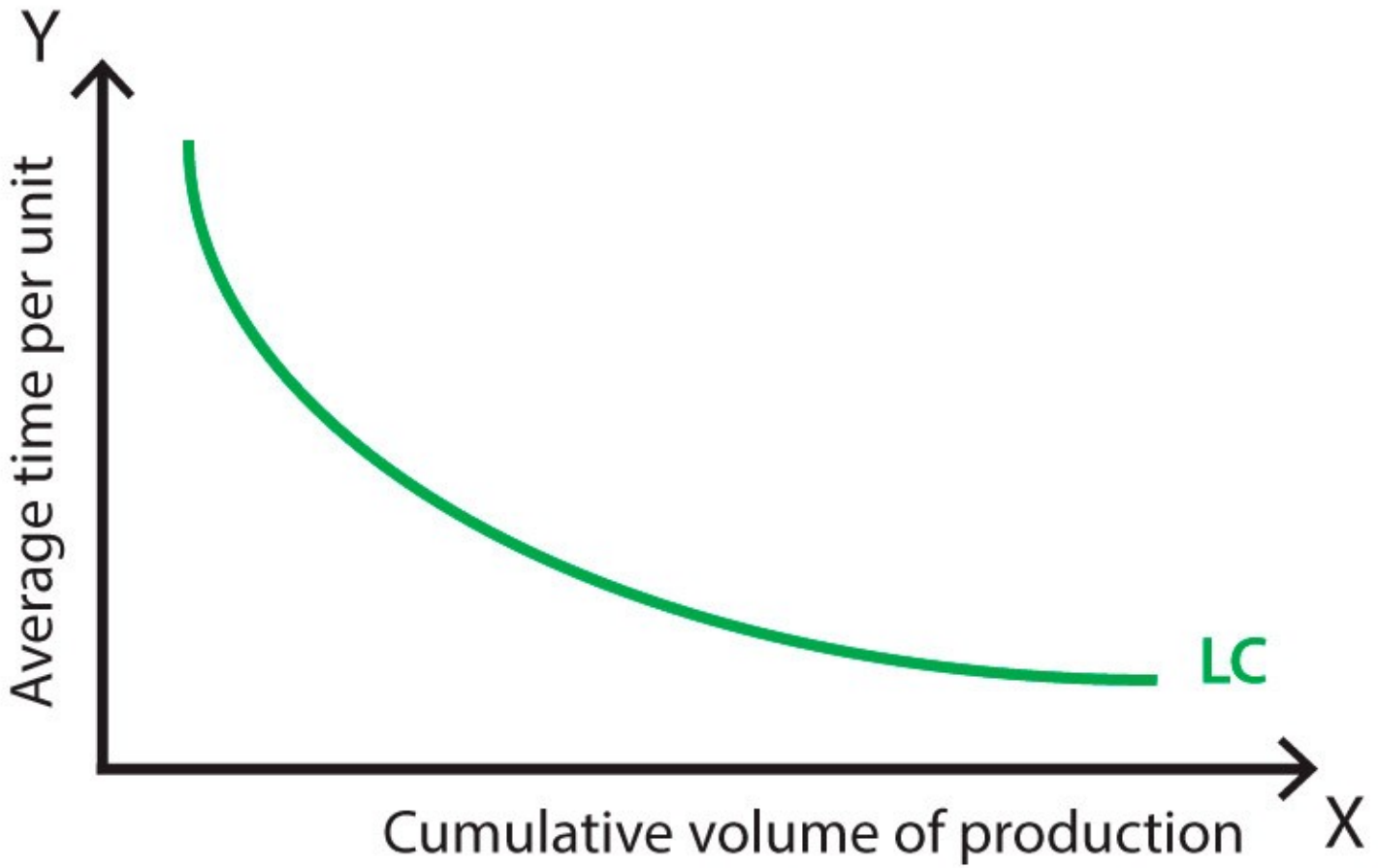


Ross Tessien: EVs, Oil, And ICE: Impact By 2023 And Beyond – Seeking Alpha Nov 2018

Actual EV adoption curve (2010-22)



The learning cost curve



Wright's Law

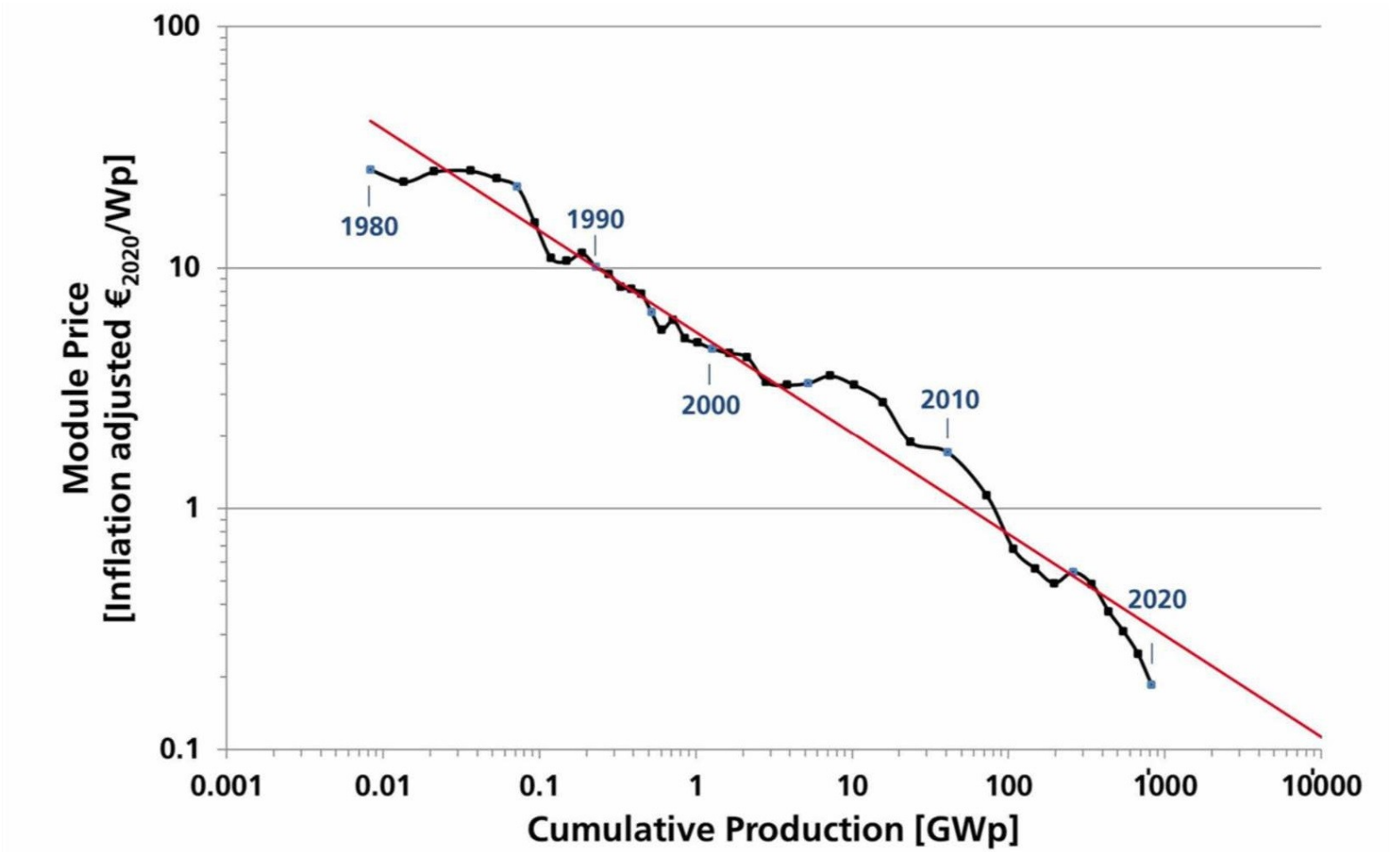
Theodore P Wright

Worked in US aero industry in the 1930s

Observed that unit labour costs declined by a constant percentage with each doubling of cumulative total production volume

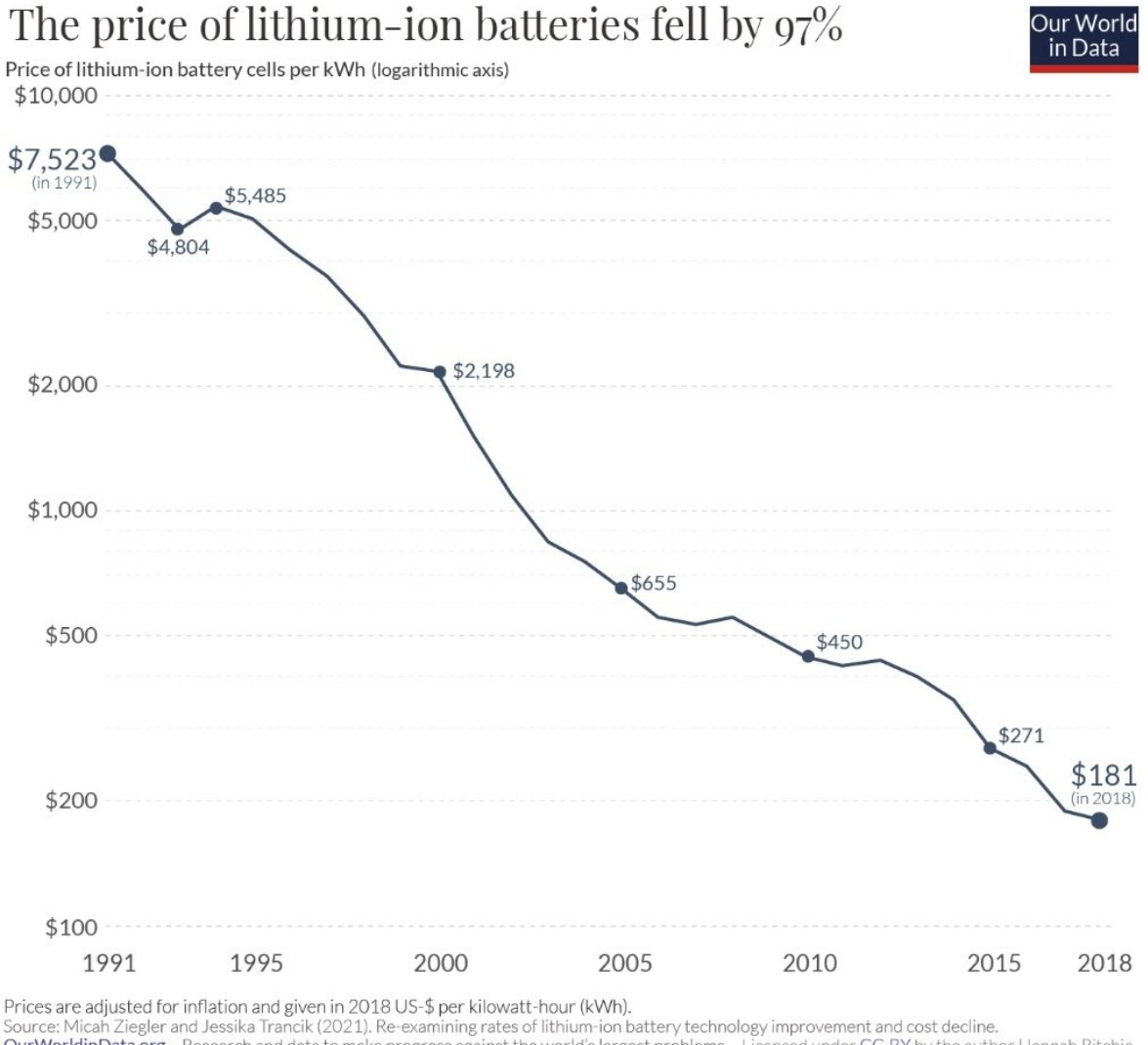
Confirmed that this relationship was generally applicable to technology production

The learning cost curve – solar PV



Photovoltaics report, Fraunhofer Institute, July 2021

The learning cost curve – batteries



Transport efficiency & economics

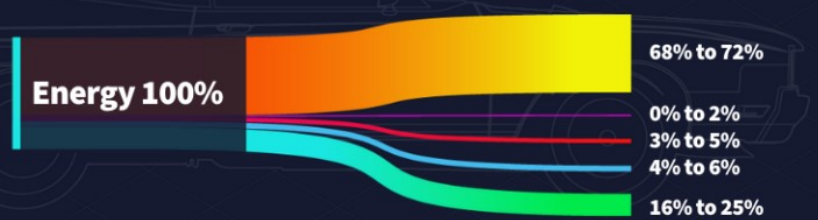
Electrification

Renewable energy

Transport

Gasoline Vehicle Efficiency

The majority of energy is lost to engine and driveline inefficiencies or used to power accessories, resulting in less than **20% efficiency.**

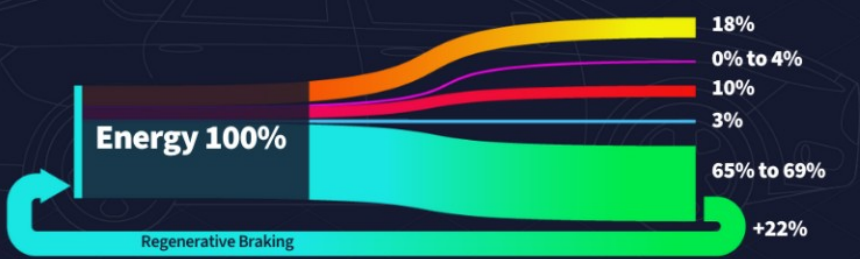


- Engine losses
- Auxiliary electrical losses
- Drivetrain losses
- Parasitic losses
  E.g. water, fuel and oil pumps, ignition systems, engine control systems, etc.
- Energy to wheels

Where the energy goes: Gasoline vehicles (2018) Fuel Economy.
Available at: https://www.fueleconomy.gov/feg/atv.shtml.

Electric Vehicle Efficiency

Approximately 31-35% of energy is lost to inefficiencies. However, 22% is recaptured by regenerative braking, resulting in over **90% efficiency**



- Electric Drive System losses
- Auxiliary electrical losses
- Energy lost in charging the battery
- Accessory losses
- Energy to wheels
  Plus net regenerative braking

Where the energy goes: Electric cars (2018) Fuel Economy.
Available at: https://www.fueleconomy.gov/feg/atv-ev.shtml.

TRITIUM

‘Tank-to-wheel’ efficiency

ICE powertrain	~ 15-30%
Electric powertrain	~ 80%

Wholesale energy costs

Diesel & petrol	A$110-120/MWh *
RE-generated electricity	A$50-100/MWh *

* excluding GST & excise

Energy cost ‘at the wheel’

Diesel & petrol	~ A$350-800/MWh
RE-generated electricity	~ A$65-130/MWh

Example – road freight

Sydney-Melbourne ~ 880 kilometres

Diesel semi ~ 600 litres => A$700 *

Electric semi ~ 1-1.5MWh => A$50-150 *

* wholesale energy costs excl. GST & excise

Example – rail freight

Sydney-Melbourne ~ 865 kilometres

5000 tonne container 'superfreighter'

Diesel traction ~ 15,000 litres => A$17,000 *

Electric traction ~ 50MWh => A$2.5-5,000 *

* wholesale energy costs excl. GST & excise

Macroeconomic benefits

Currently Australia imports ~ 32 gigalitres of petroleum products (~ 320TWh) to fuel its road fleet, at a wholesale cost of ~ A$35 billion/year.

=> ~ 1.4% of GDP (2022)

Electrification of the road fleet by mid-21C will reduce the energy requirement to ~ 100-120TWh of domestically generated RE electricity at a wholesale cost of ~ A$5-12 billion/year

=> ~ 0.2-0.5% of GDP (relative to 2022 baseline)

Questions & answers