

Mexico & the Clean Energy Revolution



Entrepreneur & Investor: Solar and Bitcoin



Max Webster

versionone

Bright

Yale

-
- I. Challenges of a Generation**
 - II. Exponential Technologies**
 - III. Solar Energy**
 - IV. Storage (Batteries)**
 - V. EVs (Autonomous Fleets)**
 - VI. What does this mean for me?**

I. Challenges of a Generation

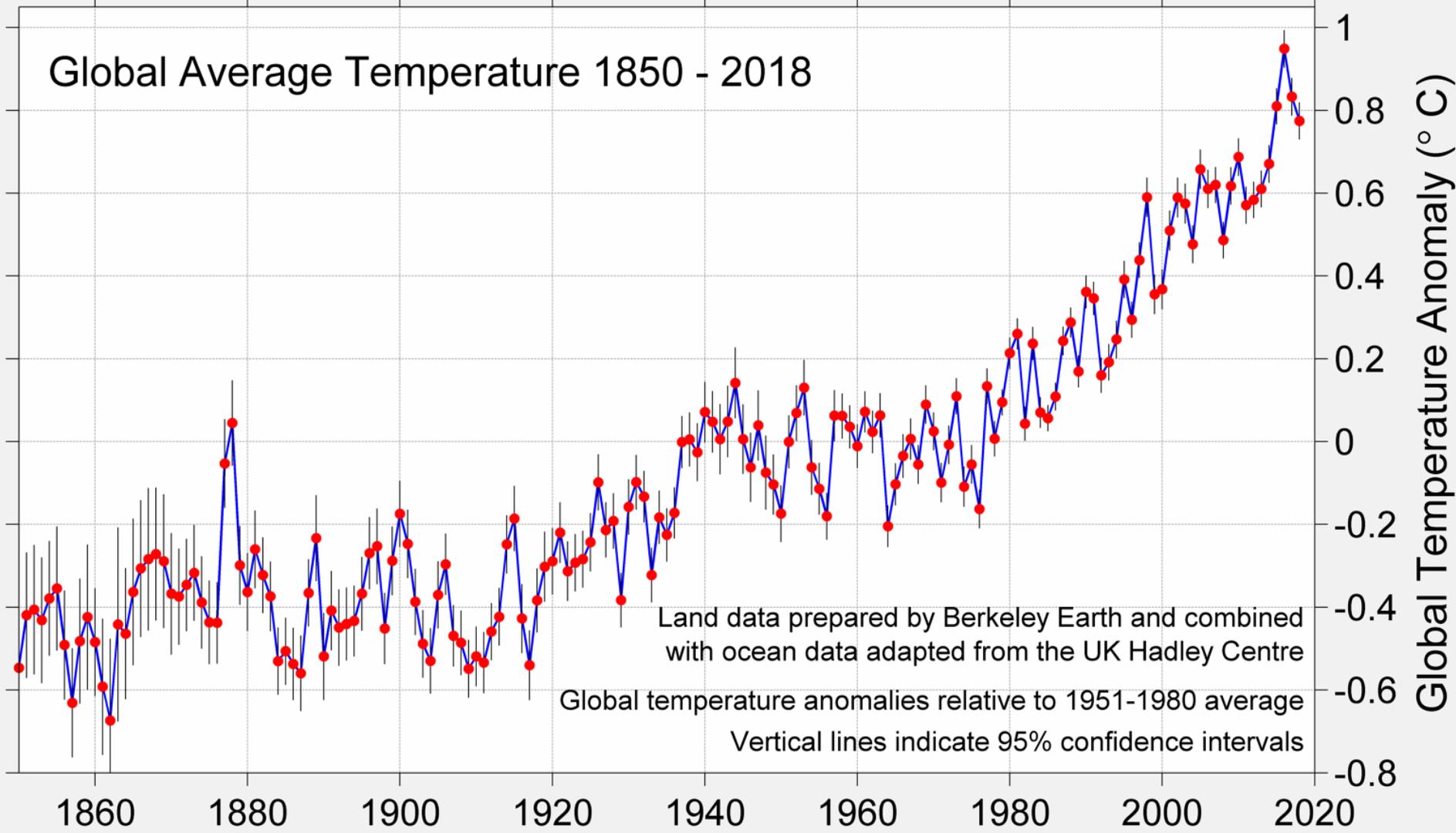
Climate Change



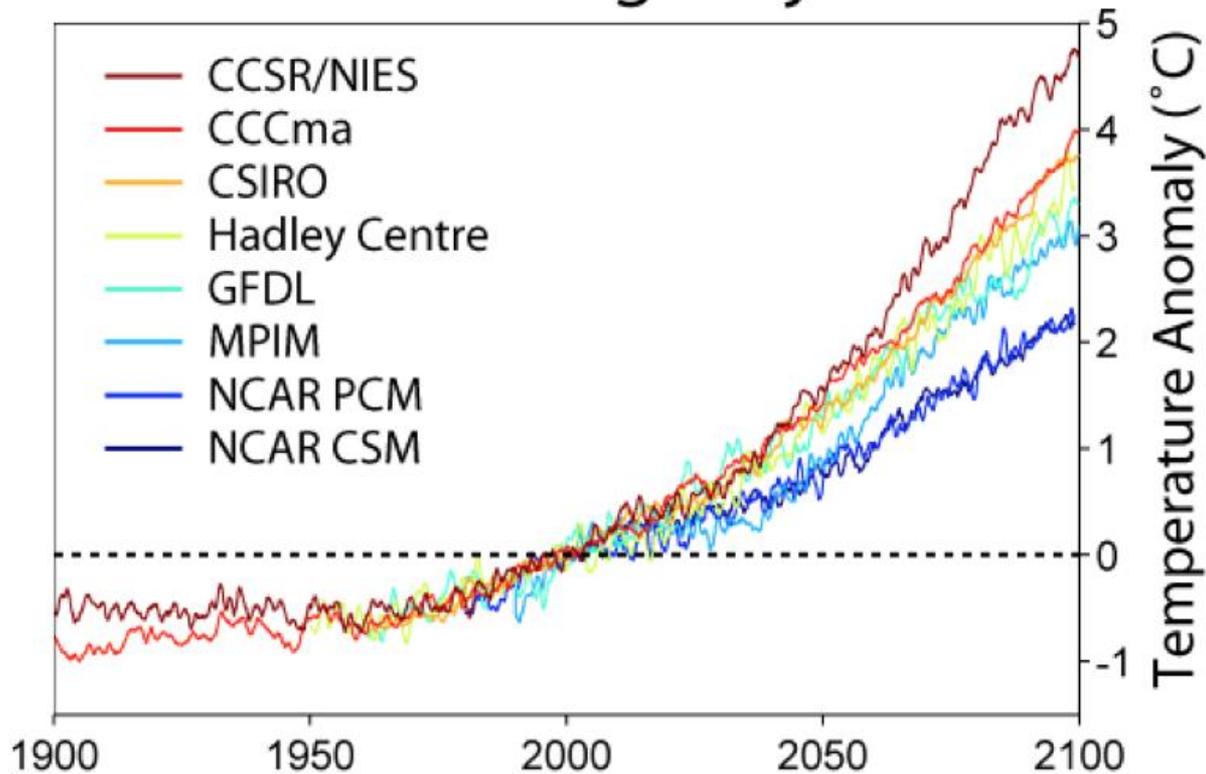




Global Average Temperature 1850 - 2018



Global Warming Projections



Energy Poverty



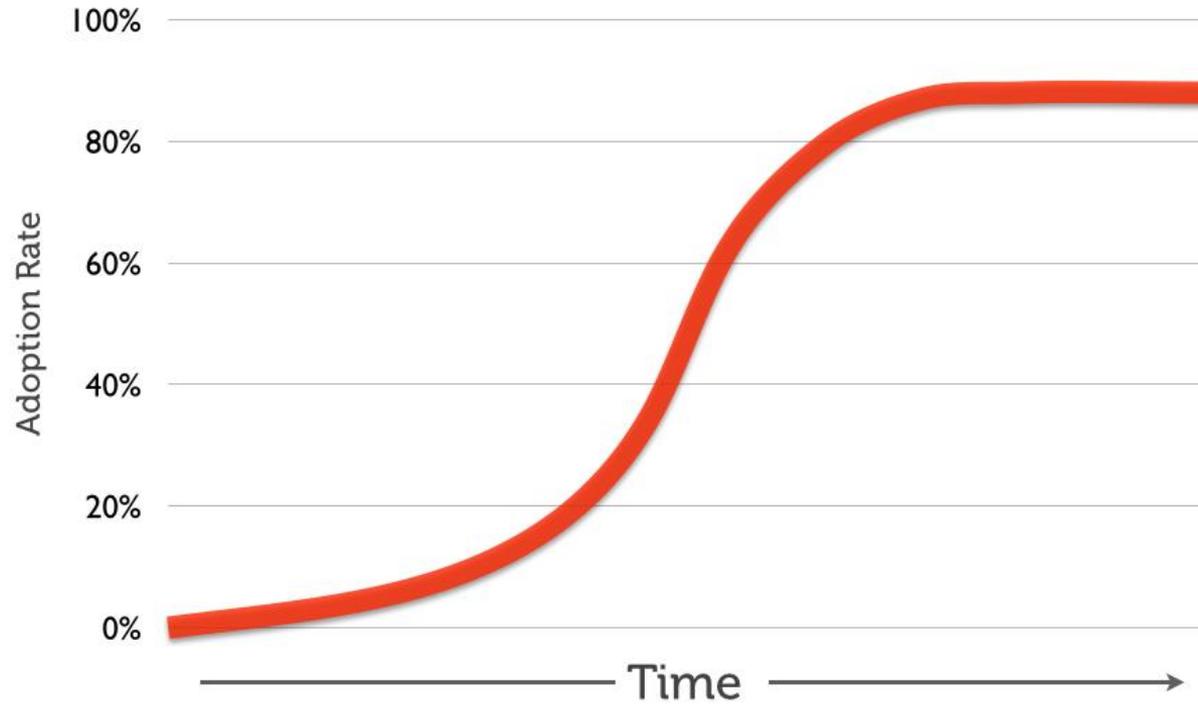
Air Pollution

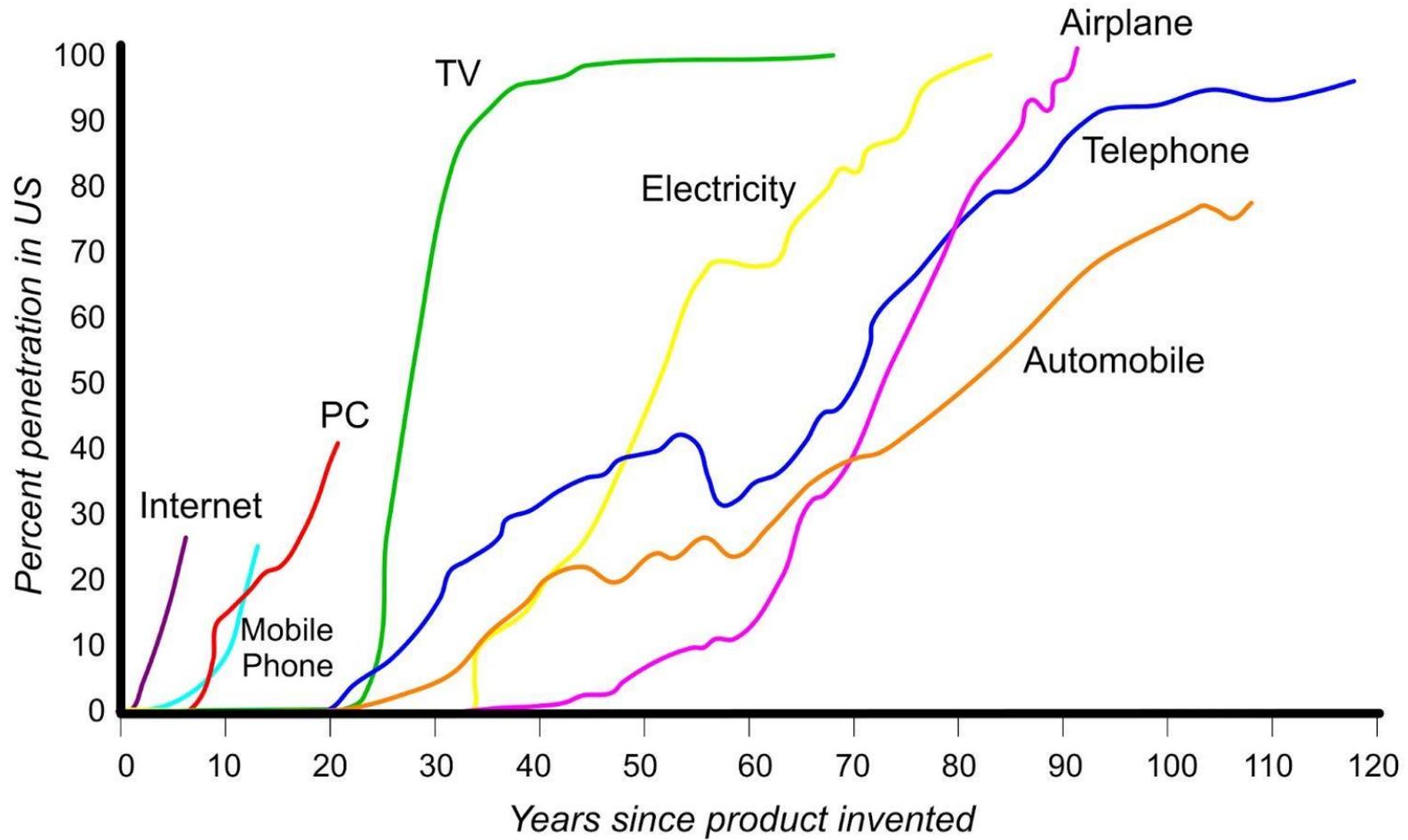




II. Exponential Technologies

— S-Curve Adoption Model





CIPA camera production 1933 - 2014

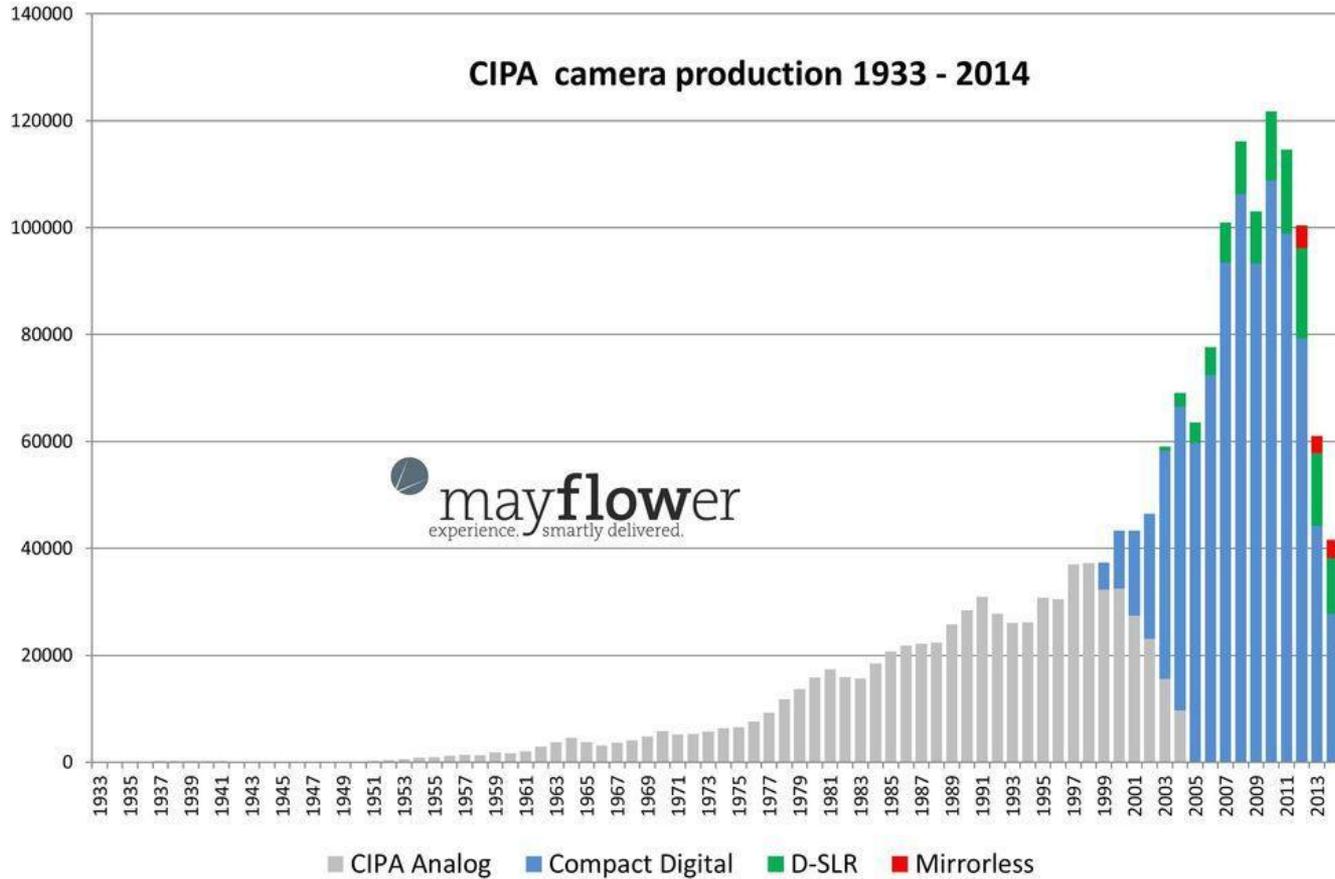


Exhibit I
Price of Model T, 1909-1923 (Average list price in 1958 dollars)

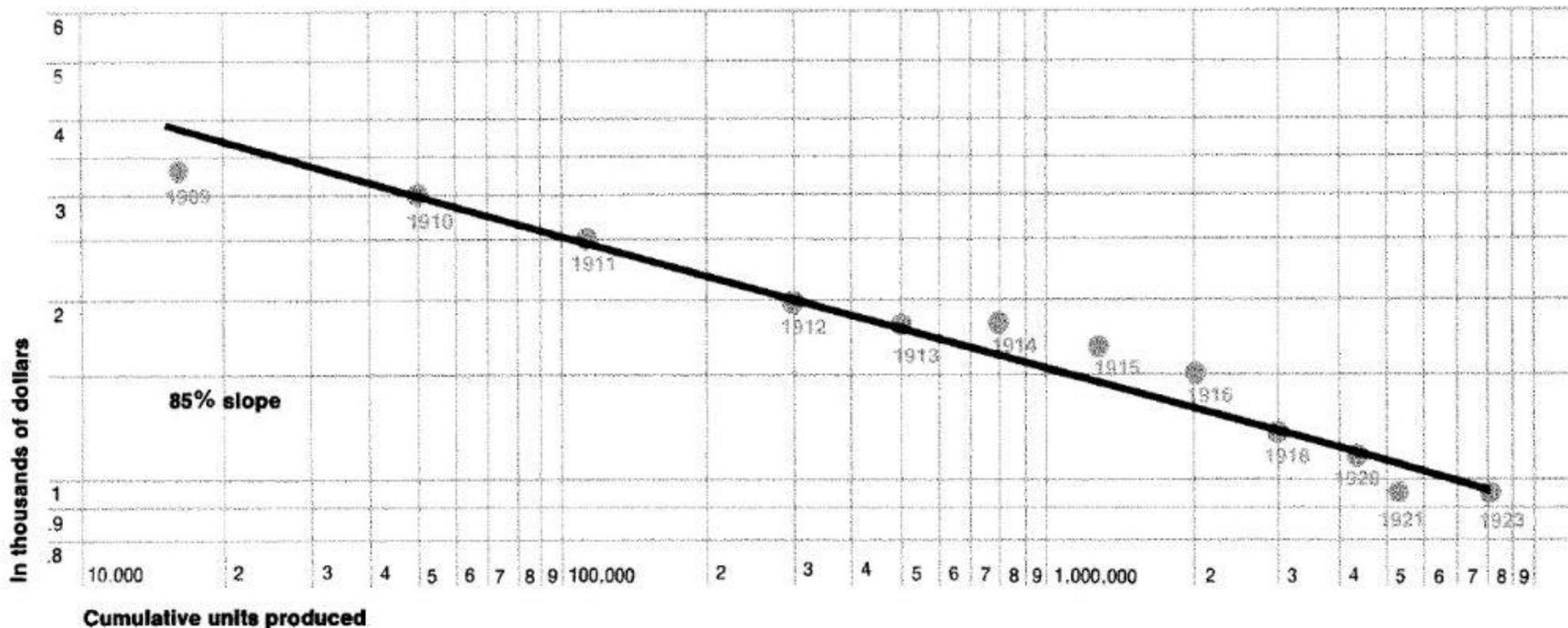
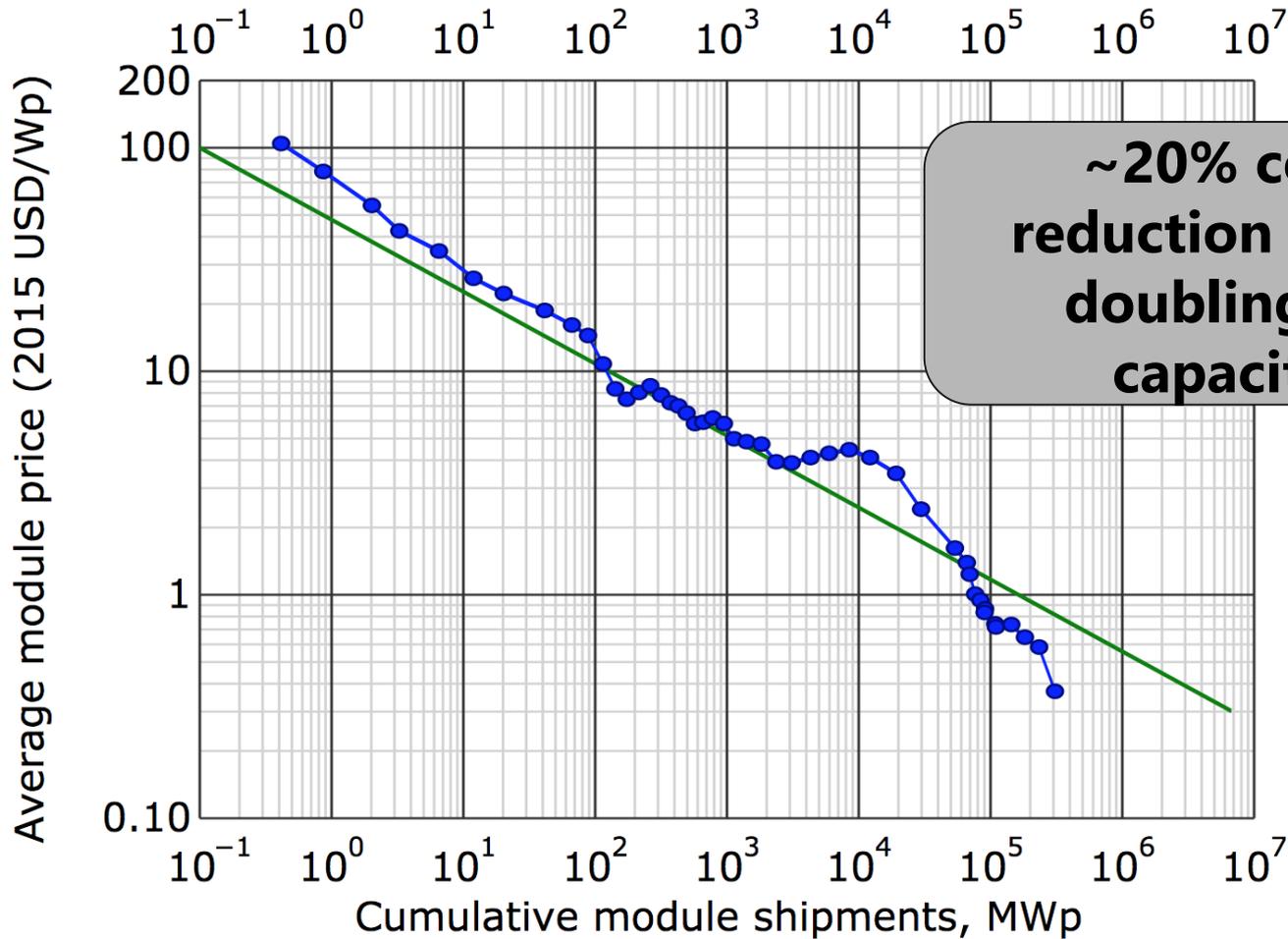


Figure 1. The price of the Ford Model T from 1909-1923[2].

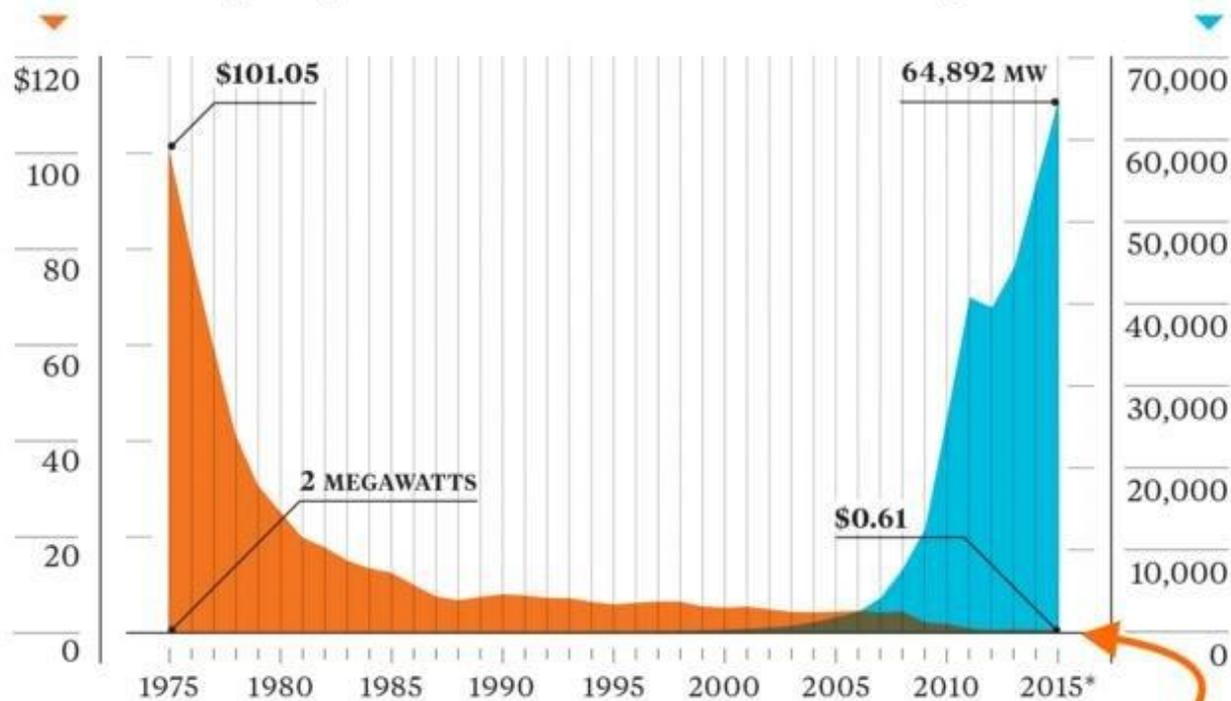
III. Solar Energy

Swanson's law



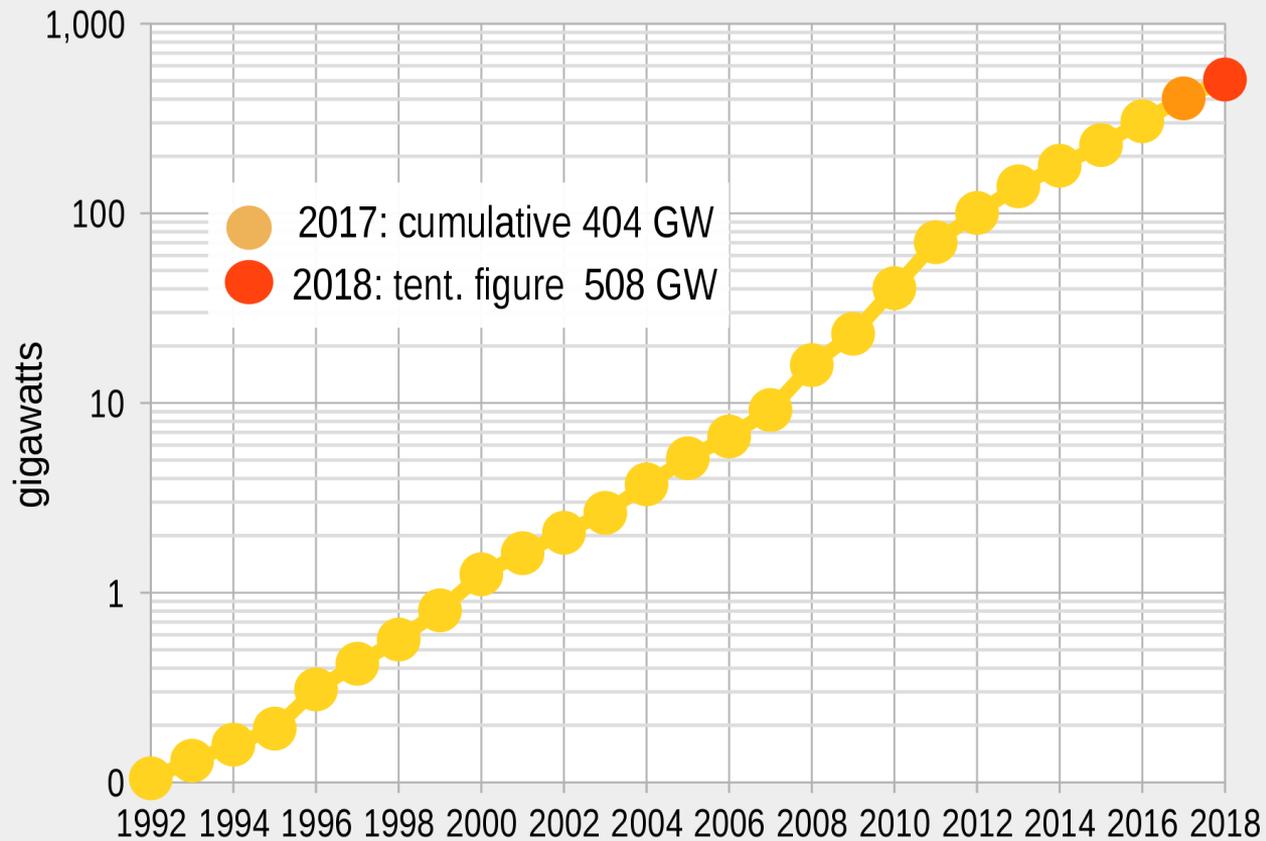
Price of a solar panel per watt

Global solar panel installations



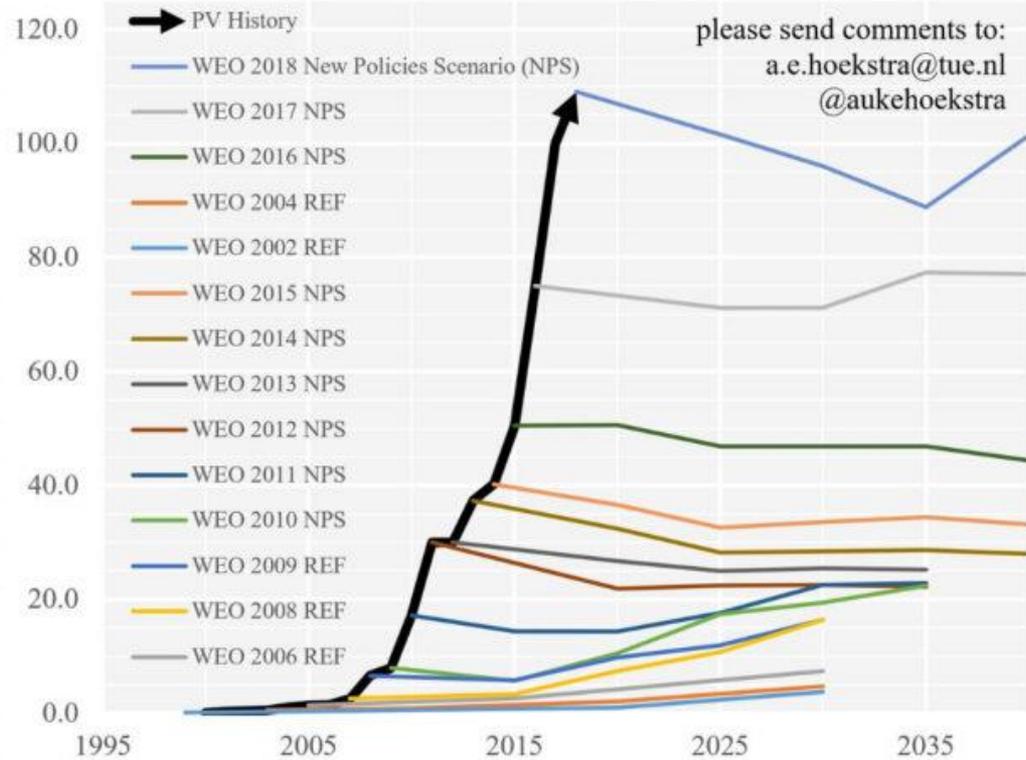
*Estimate. Sources: Bloomberg, Earth Policy Institute, www.earth-policy.org

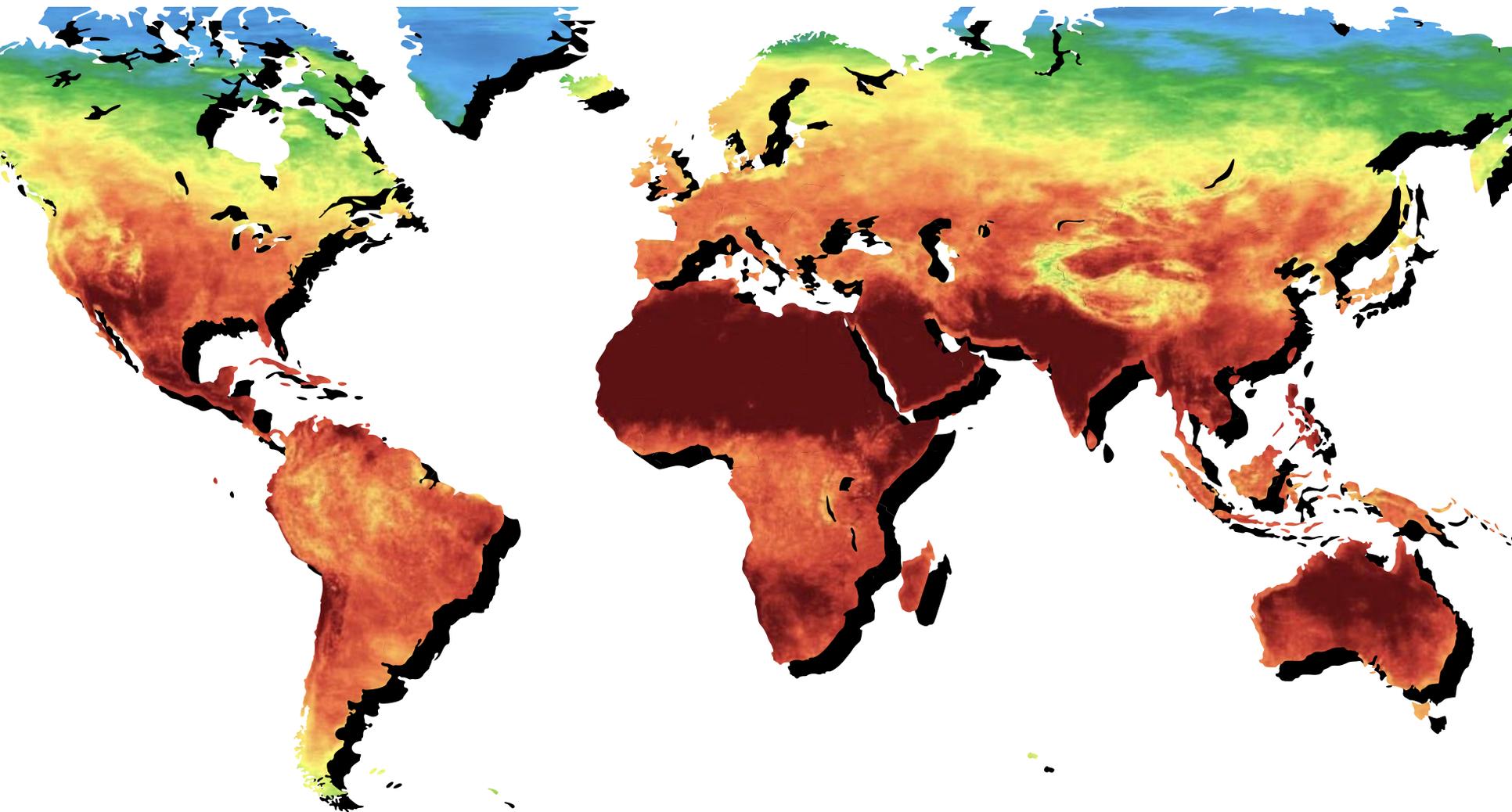
Exponential Growth of Solar PV (in GW)



Annual PV additions: historic data vs IEA WEO predictions

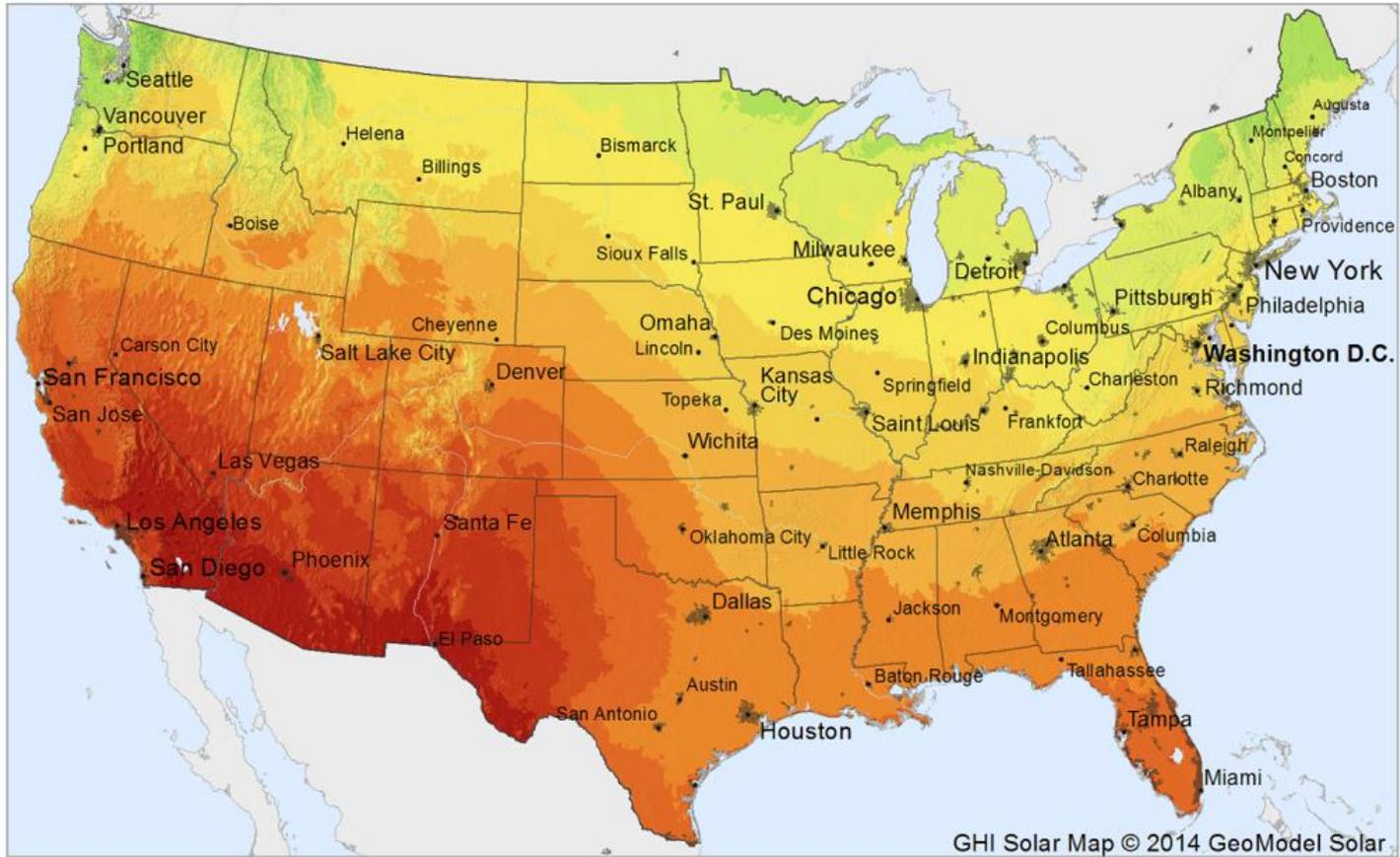
In GW of added capacity per year - source International Energy Agency - World Energy Outlook



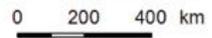
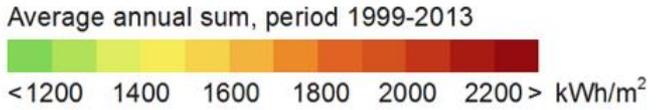


Global Horizontal Irradiation (GHI)

USA Mainlands



GHI Solar Map © 2014 GeoModel Solar



Global Horizontal Irradiation (GHI)

Mexico



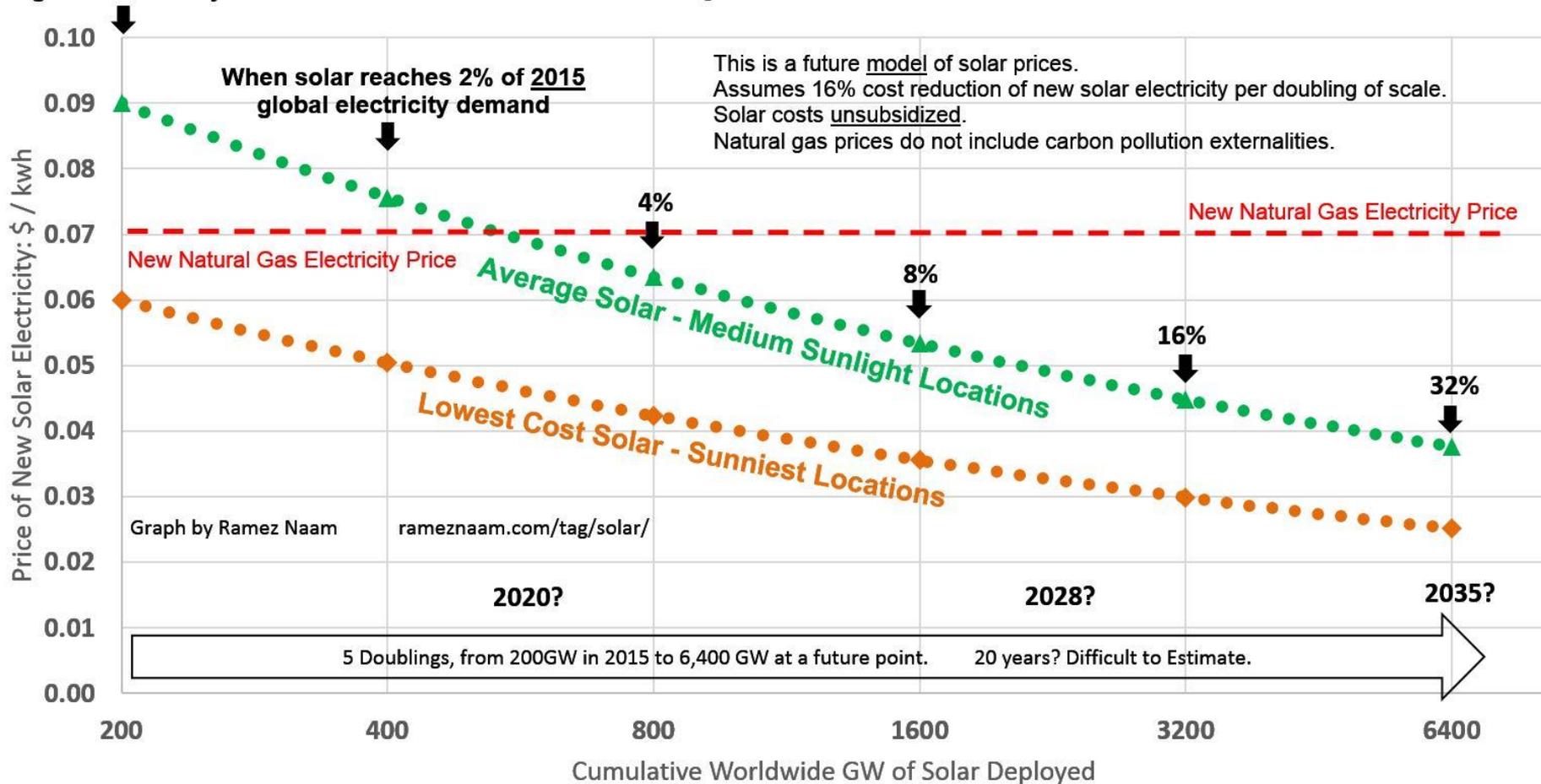
Average annual sum, period 1999-2013



0 200 km

How Cheap Can Solar Get?

2015: Solar is 1% of global electricity



Record Low Solar Prices

Abu Dhabi = 2.42 c/kWh

Chile = 2.1 c/kWh

Los Angeles = 2 c/kWh

Mexico = 1.92 c/kWh

Brazil = 1.75 c/kWh

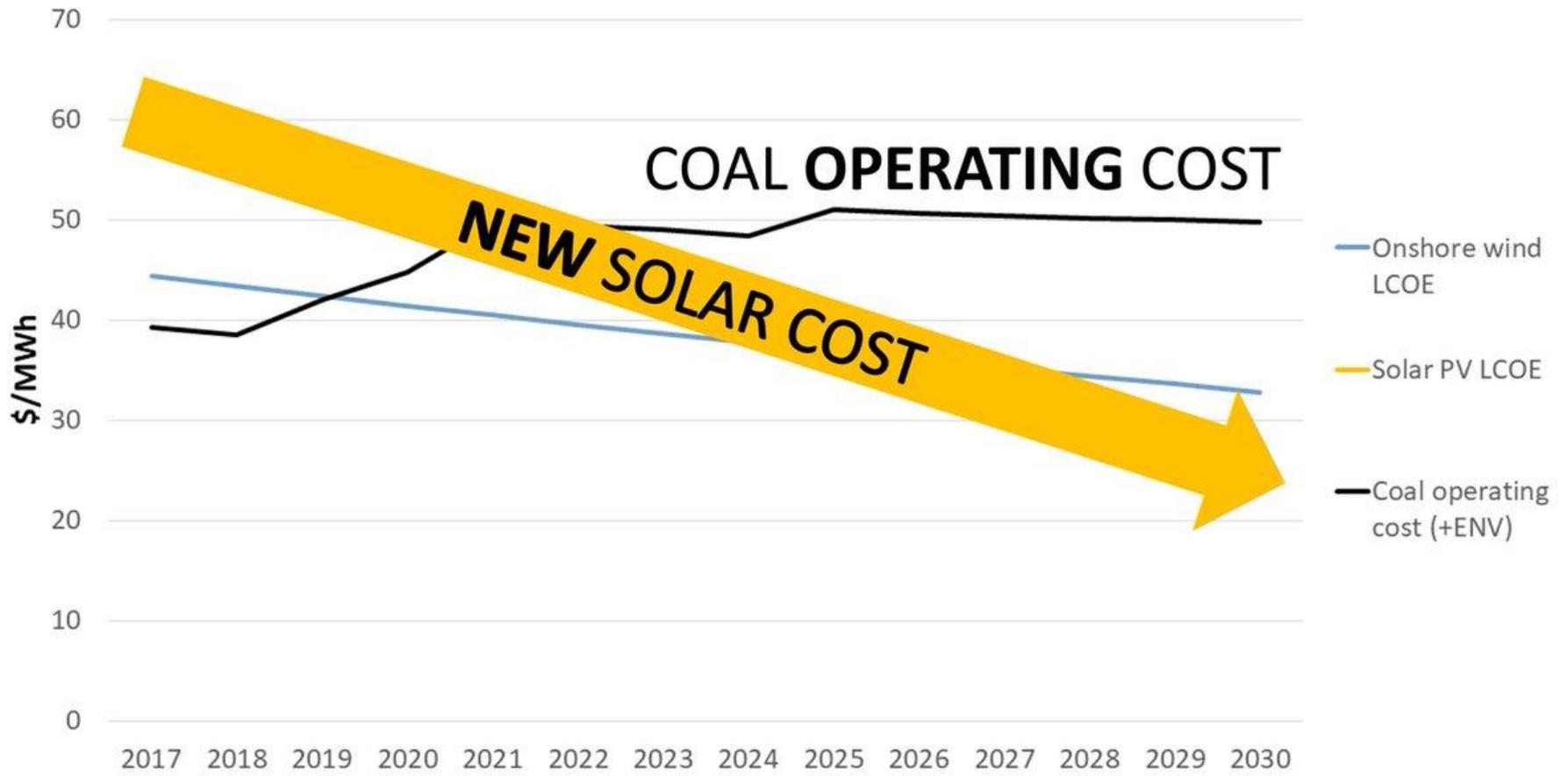
Saudi Arabia = 1.7 c/ kWh

Portugal = 1.65 c / kWh

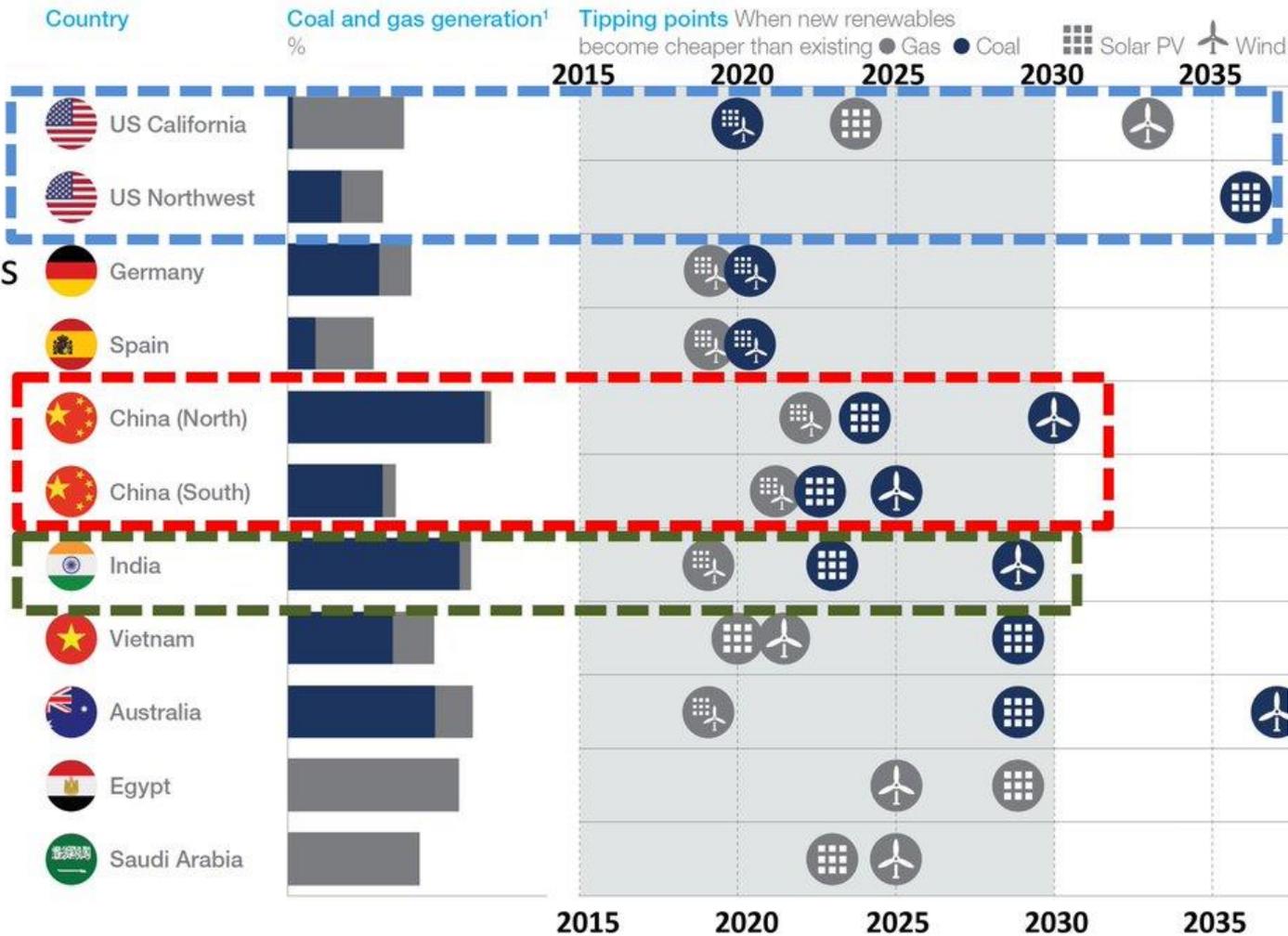
New wind and solar will be cheaper than existing coal and nuclear by the early 2020s

First, the headline numbers. Here are the costs Robo anticipates “early in the next decade”:

- Unsubsidized new wind: 2.0-2.5 cents per kilowatt-hour
- Unsubsidized new solar: 3.0-4.0 cents per kilowatt-hour
- Variable operating costs of existing coal or nuclear plants: 3.5-5.0 cents per kilowatt-hour



New renewables cheaper than existing coal and gas almost everywhere by 2030



CHARGE AHEAD —

Florida utility to close natural gas plants, build massive solar-powered battery

The battery bank will be significantly larger than the world's current biggest battery.

MEGAN GEUSS - 3/29/2019, 12:15 PM

Utility CEO: new renewables will be cheaper than existing coal plants by the early 2020s

Energy execs sound more like wild-eyed hippies every day.

By David Roberts | @drvox | david@vox.com | Jan 29, 2018, 3:00pm EST

Even in Indiana, new renewables are cheaper than existing coal plants



China Cancels 103 Coal Plants, Mindful of Smog and Wasted Capacity

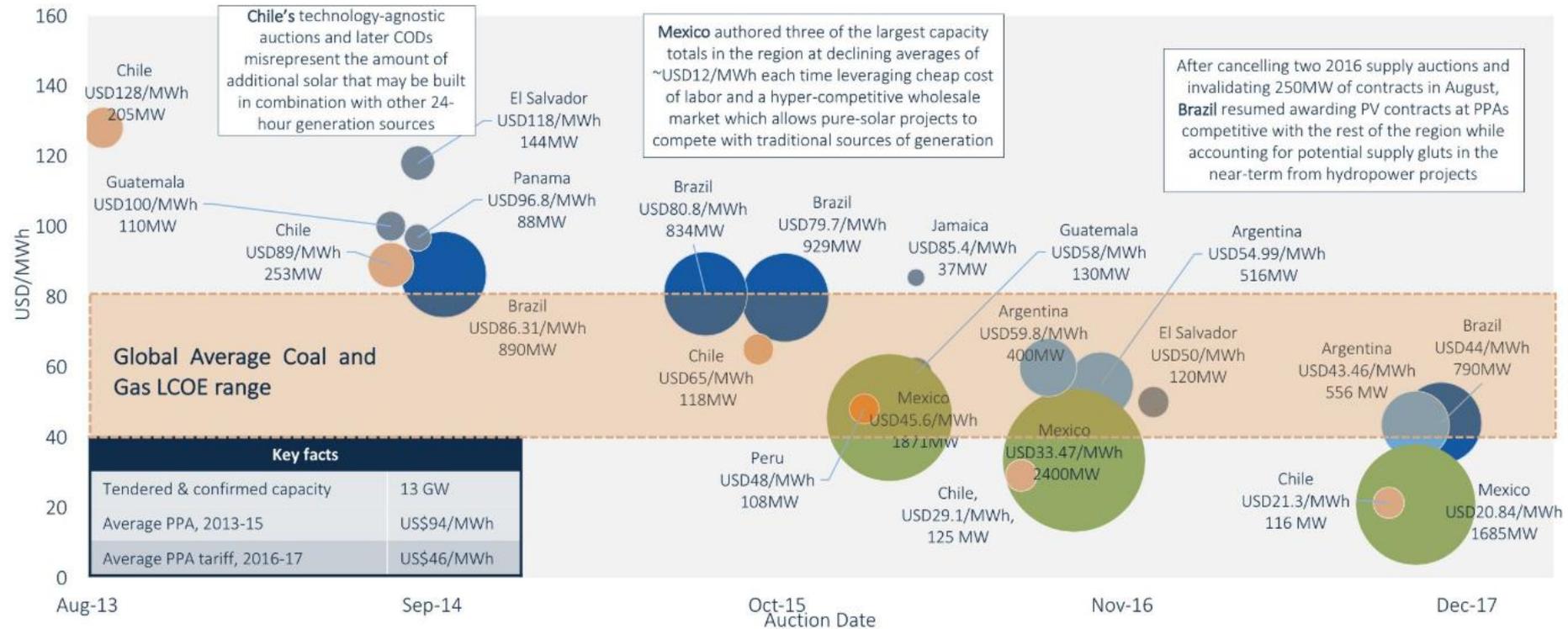
Mexico's Record Solar Prices Fall Below the Average Cost of Energy From Gas and Coal

India Cancels Plans For Huge Coal Power Stations Thanks To Record Low Solar Energy Prices

by Andrea D. Steffen  October 29, 2019

Mexico's Recent Average Bid Push PV Beyond Cost-Competitive Range with Coal and Gas

Latin America & Caribbean Tendered Projects by Bid Price and Capacity, 2013-2017



Source: GTM Research Global Solar Demand Monitor Q4 2017

**Can politics derail the
energy revolution?**

A photograph of Donald Trump at a campaign event. He is wearing a dark blue suit, a white shirt, and a blue and white striped tie. He is holding a black sign with white text that reads "TRUMP DIGS COAL". The background is a large, crowded arena with many people, some holding up phones to take pictures. There are blue signs with "TRUMP PENCE" visible in the crowd. The lighting is bright, typical of a large indoor event.

**TRUMP
DIGS
COAL**

Paid for by Donald J. Trump for President, Inc.

**TRUMP
PENCE**



IV. Storage (batteries)

A white rectangular box, possibly a product packaging, is shown against a plain white background. The box is oriented vertically and has the word "TESLA" printed on its front face in a simple, sans-serif font. The box has a dark green or black spine on the right side. The lighting is soft, creating a subtle shadow on the surface below the box.

TESLA

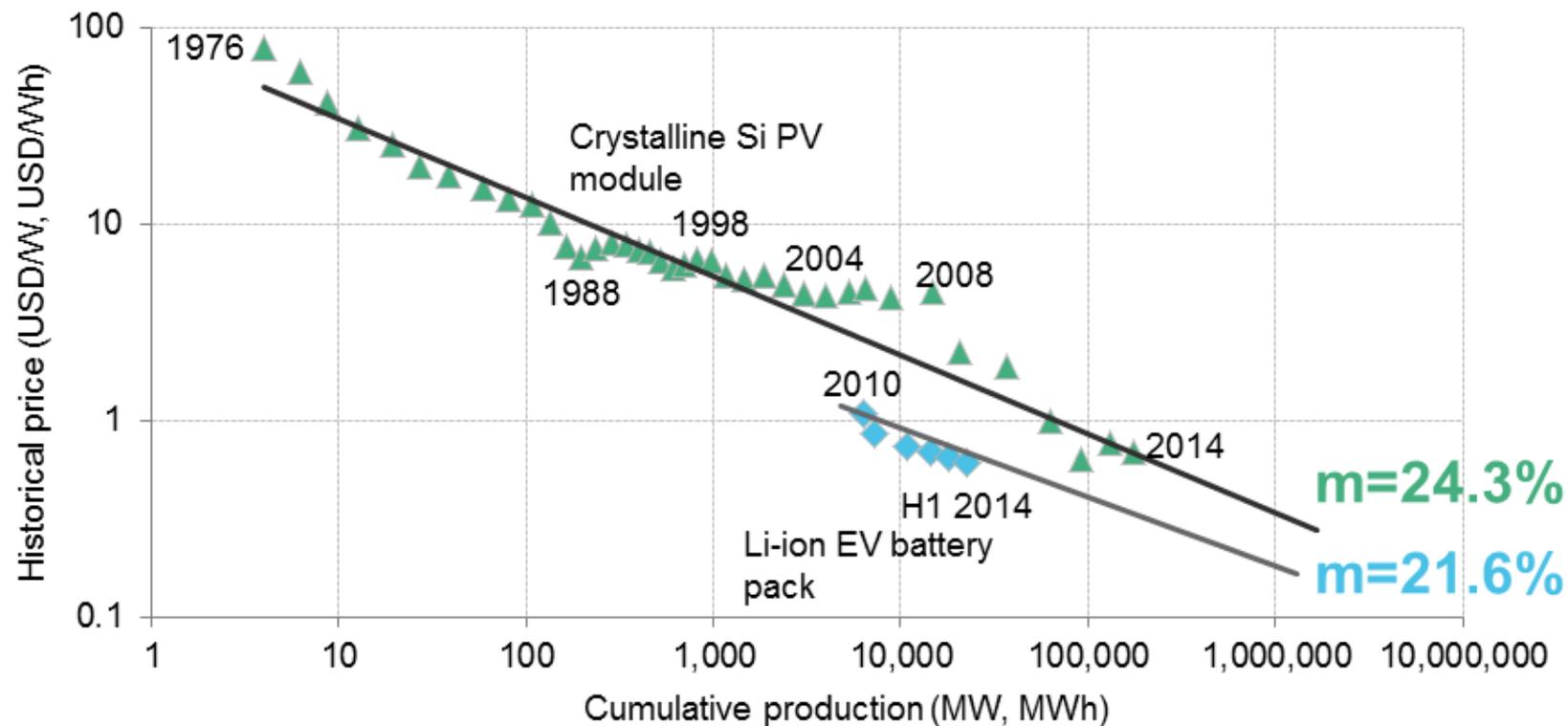
BATTERY
PRICES
FALL

TAP INTO
NEW
MARKETS

INCREASED
BATTERY
DEMAND



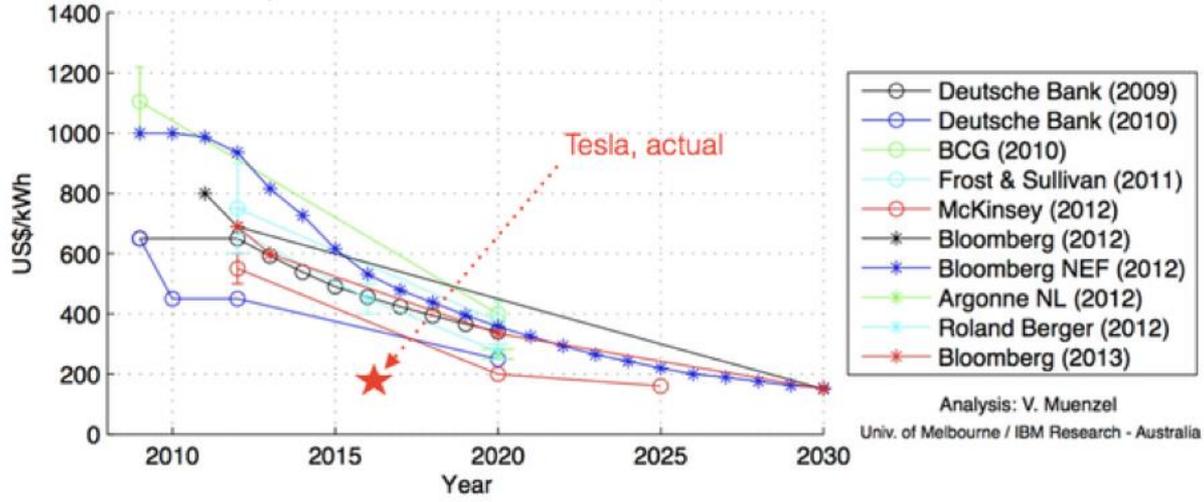
LITHIUM-ION EV BATTERY EXPERIENCE CURVE COMPARED WITH SOLAR PV EXPERIENCE CURVE



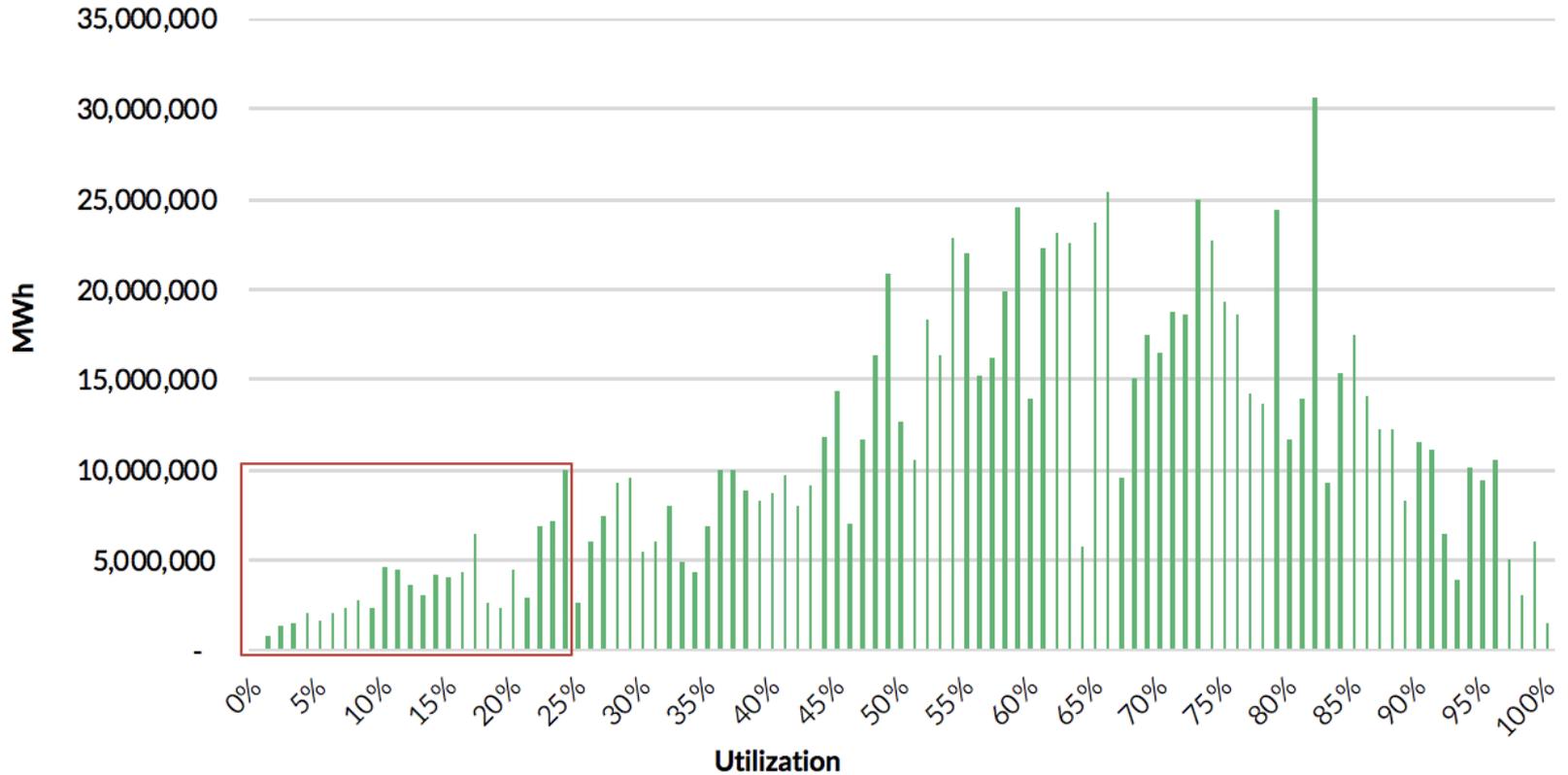
Note: Prices are in real (2014) USD.

Source: Bloomberg New Energy Finance, Maycock, Battery University, MIT

Cost predictions for full automotive Li-ion packs



Distribution of U.S. Natural Gas Generation by Utilization



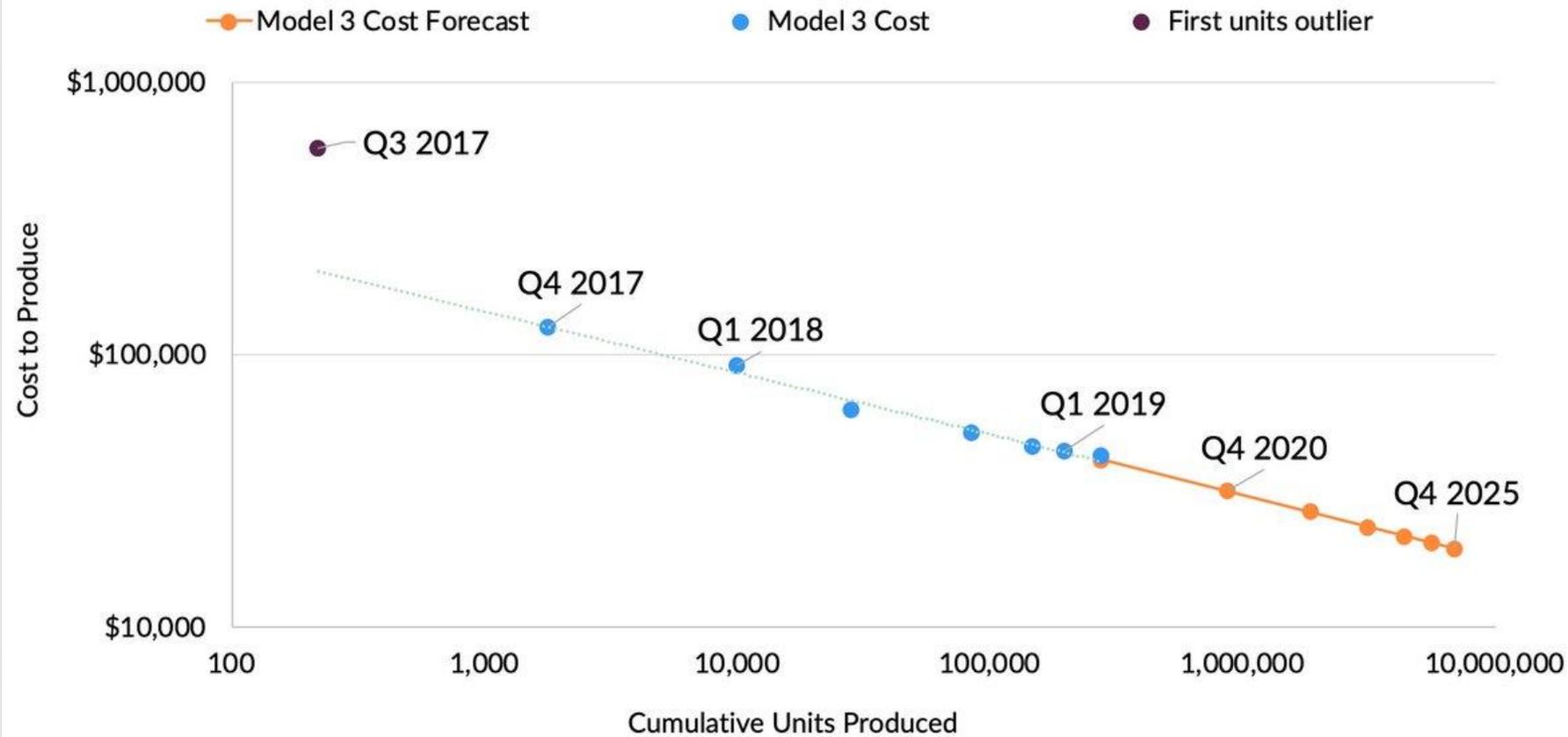
Source: ARK Investment Management LLC, 2019; Energy Information Administration (EIA)

V. EVs (Autonomous Fleets)

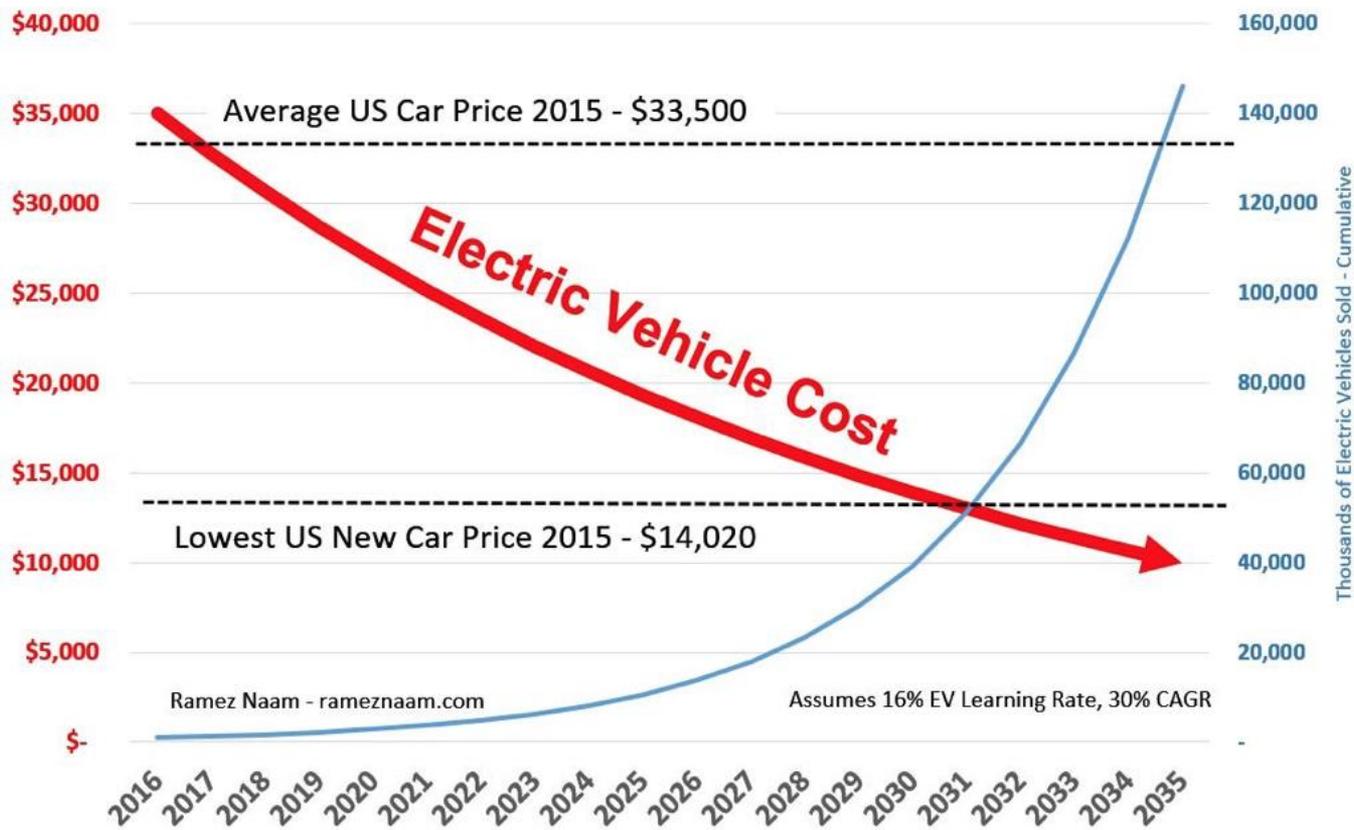
Convergence: Autonomous, EVs, Ridesharing



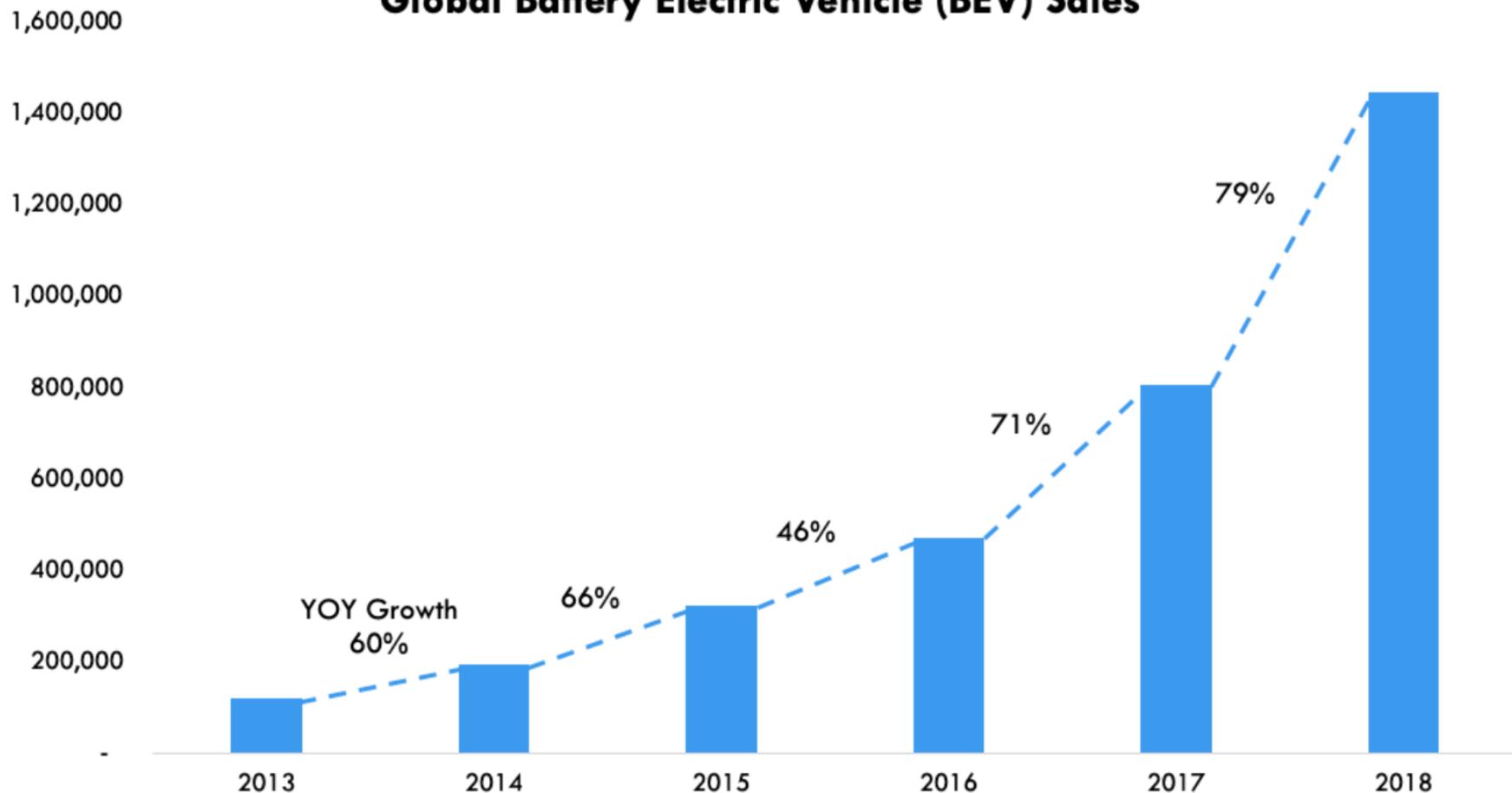
Model 3 Cost Decline Curve



Cost of 200 mile range EV

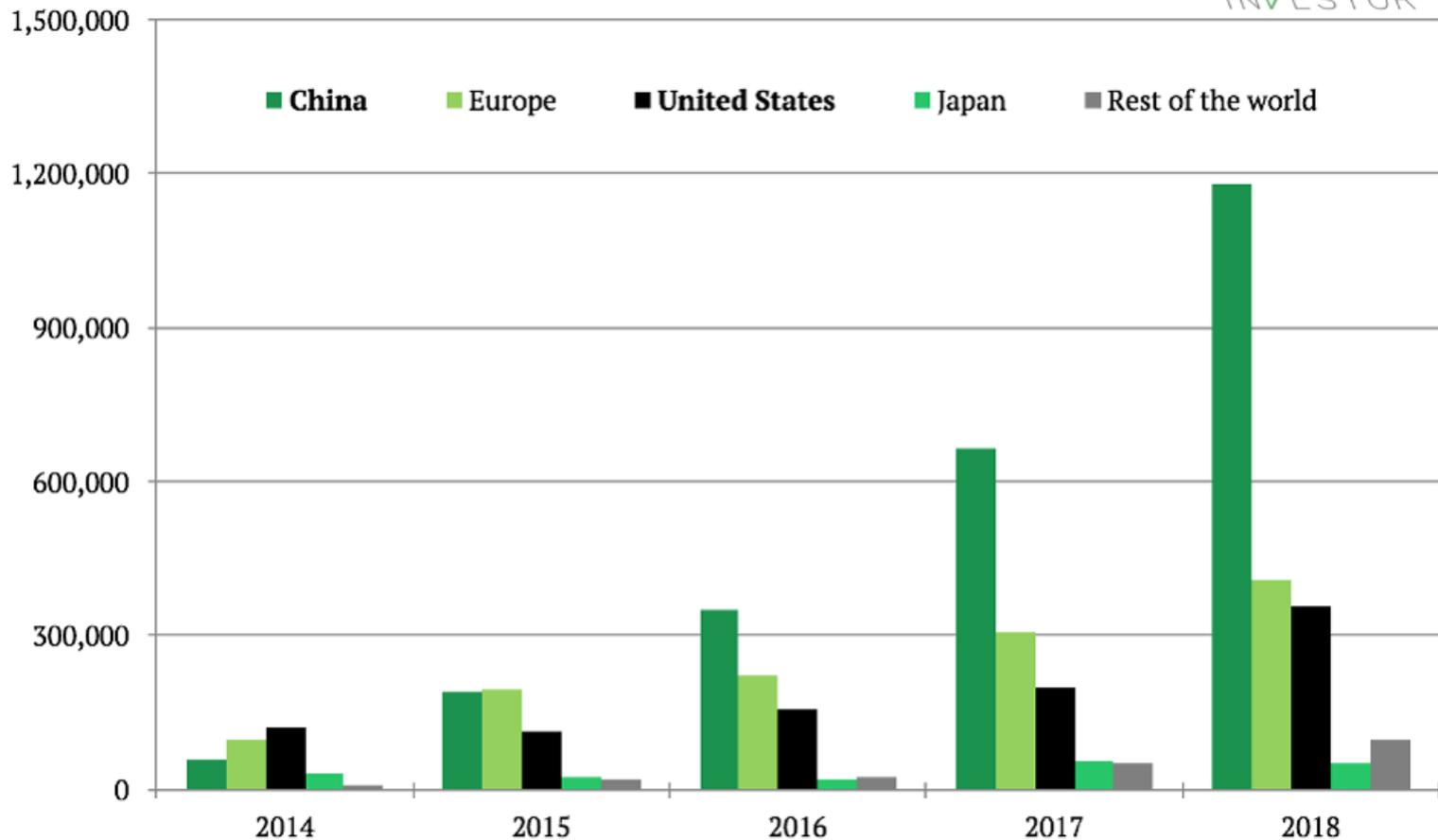


Global Battery Electric Vehicle (BEV) Sales



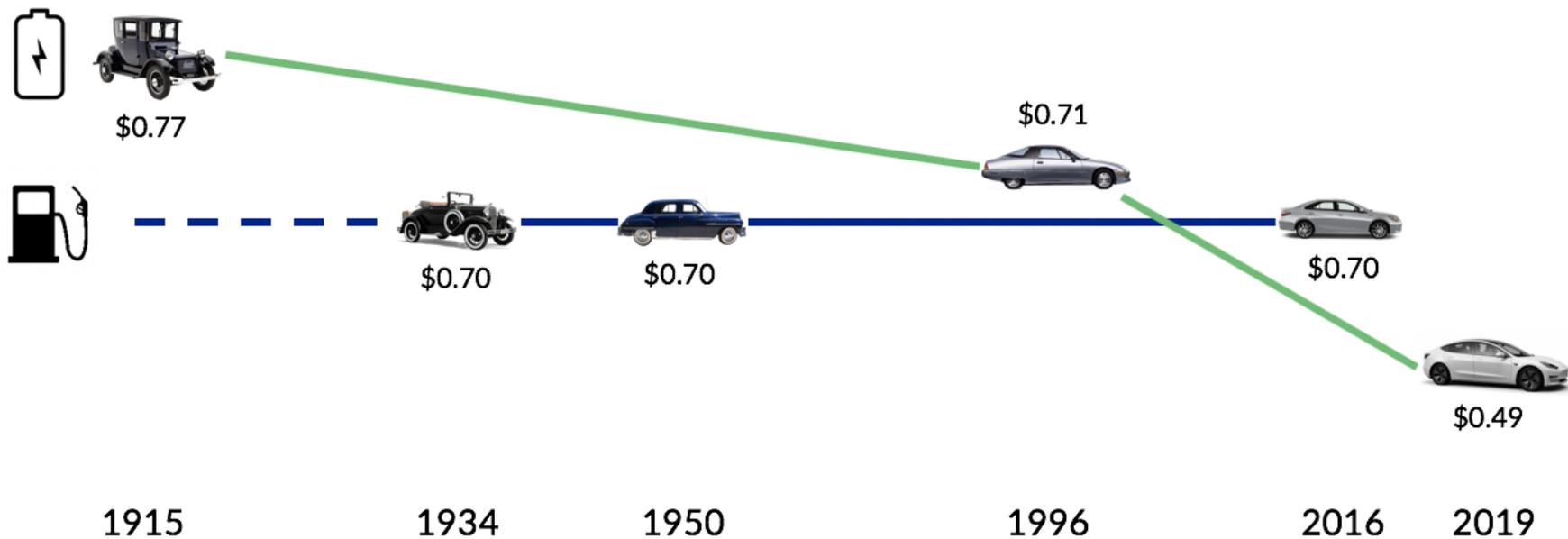
Source: ARK Investment Management LLC, 2019 | ark-invest.com; Data from: EVvolumes.com

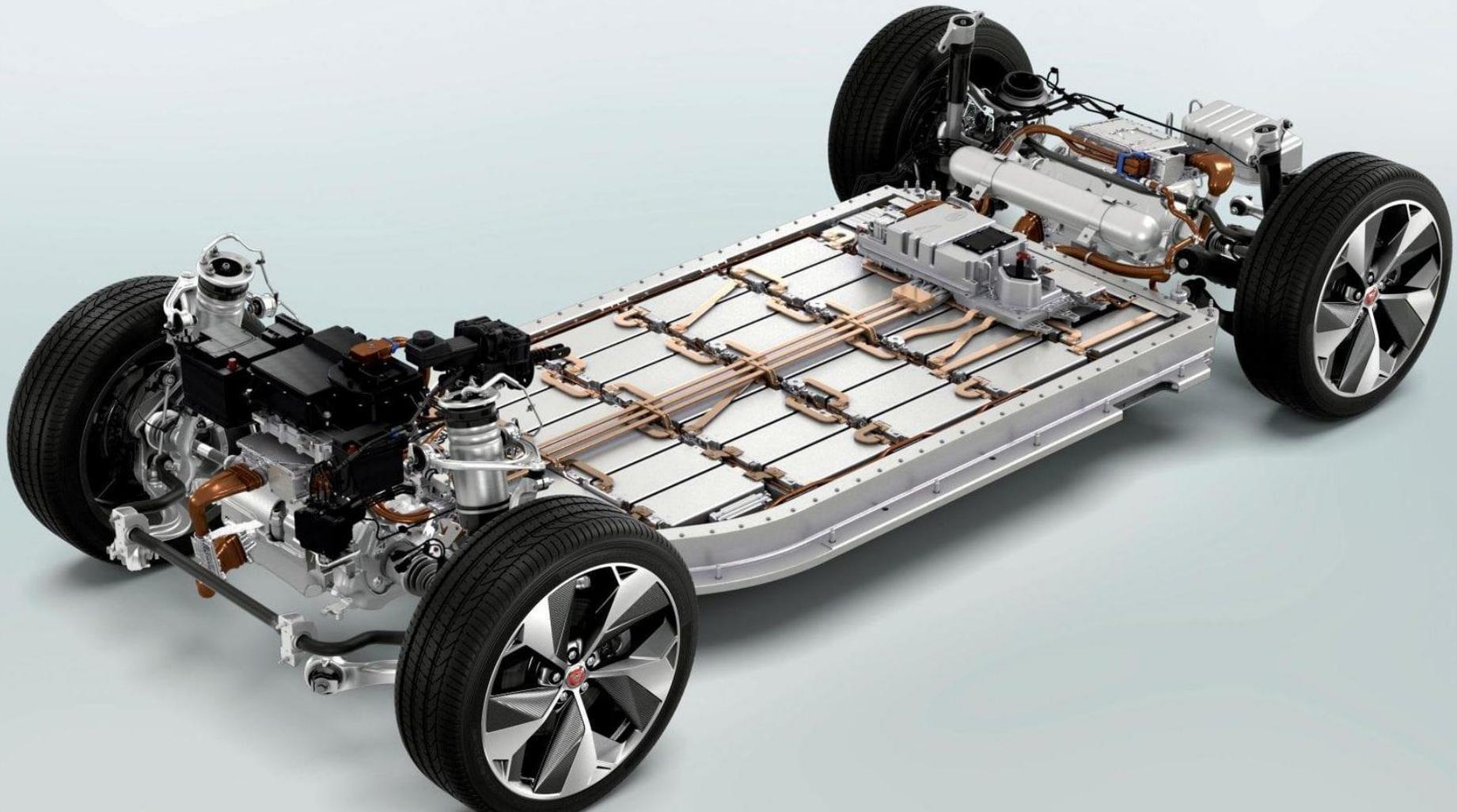
Global Electric Car Sales, 2014-2018



Cost Per Mile of a Personally Owned Vehicle

(2019 Dollars)





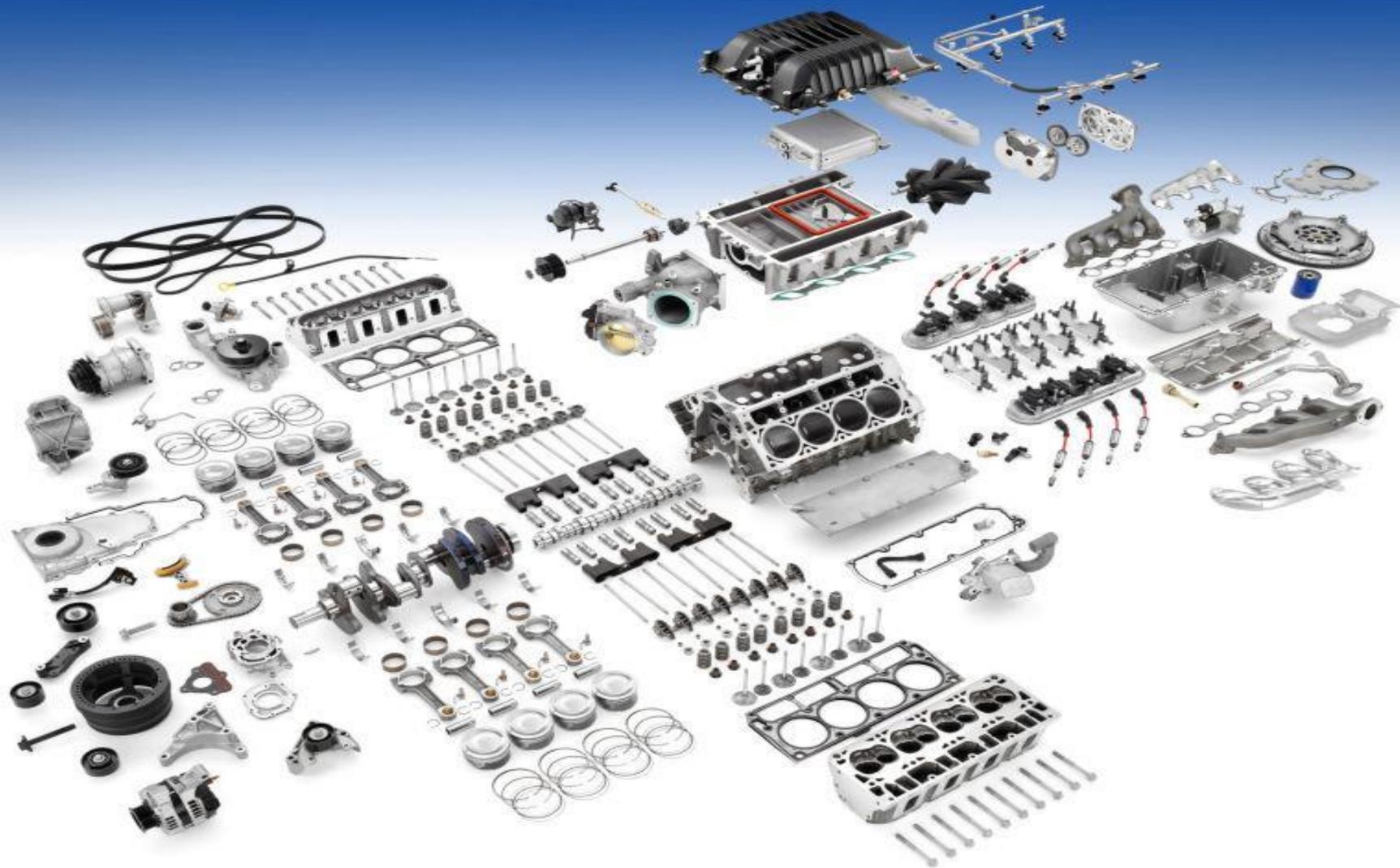
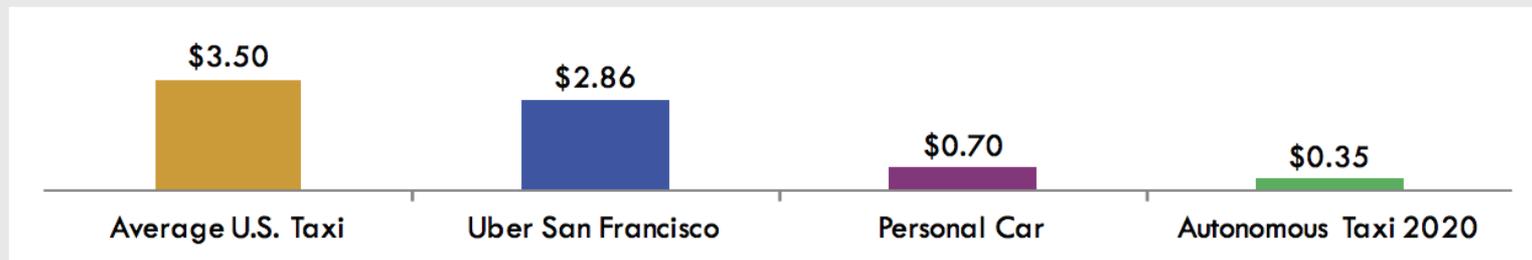




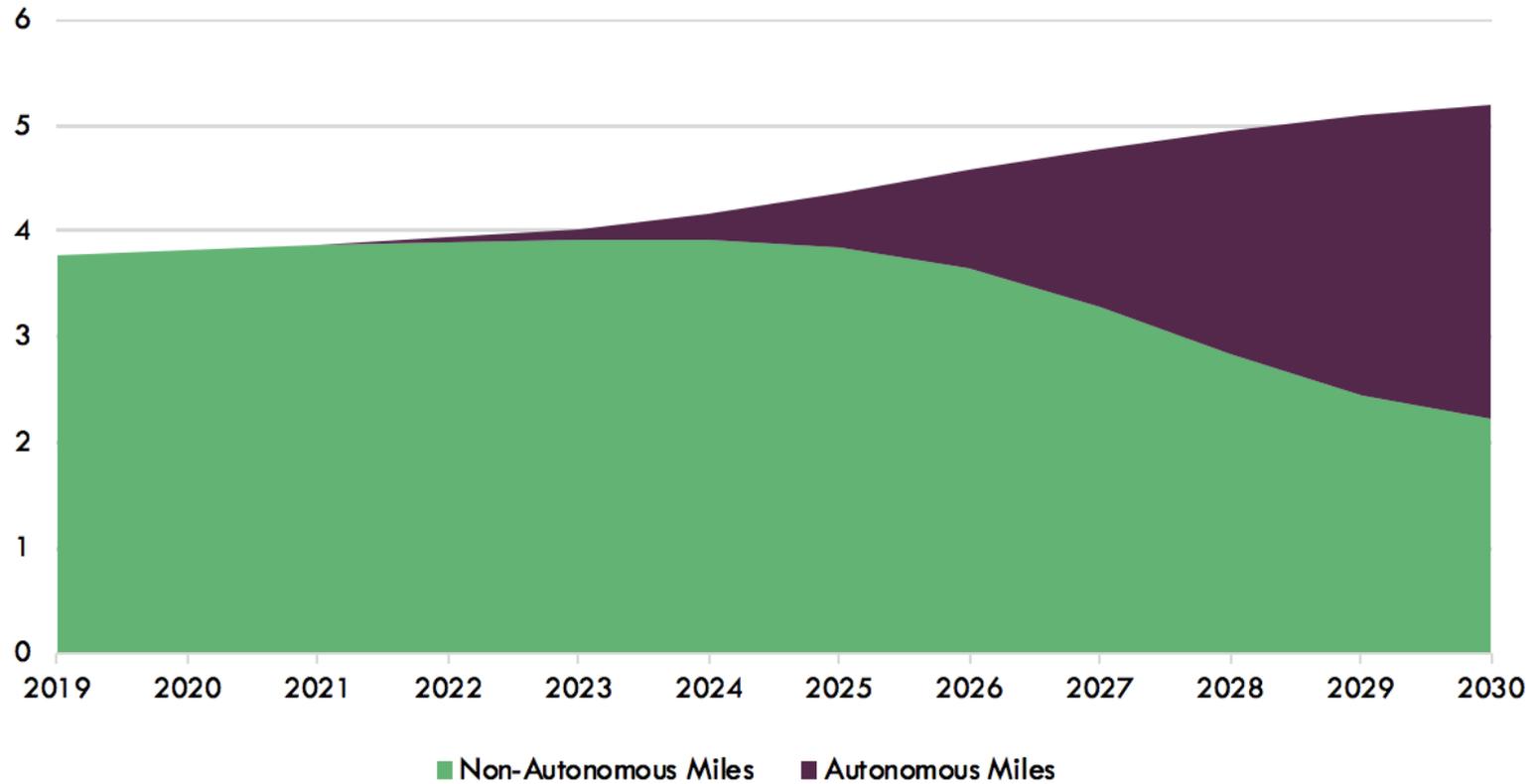


FIGURE 7
All-In Cost Per Mile of Vehicle Services



Source: ARK Investment Management LLC

US Vehicle Miles Traveled (Trillions)



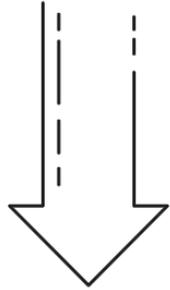
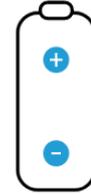
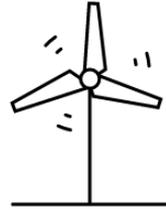
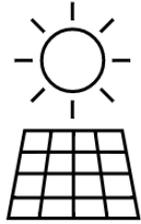


VI. What does this mean for me?

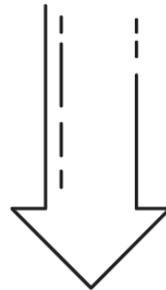
Solar + Efficiency + Storage =
Lowest cost
Biggest impact
Most autonomy / flexibility
(Prosumer)

Technology cost-declines since 2010

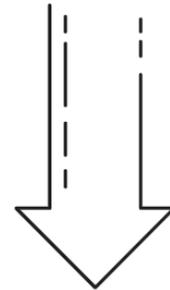
(Source: BloombergNEF)



85%

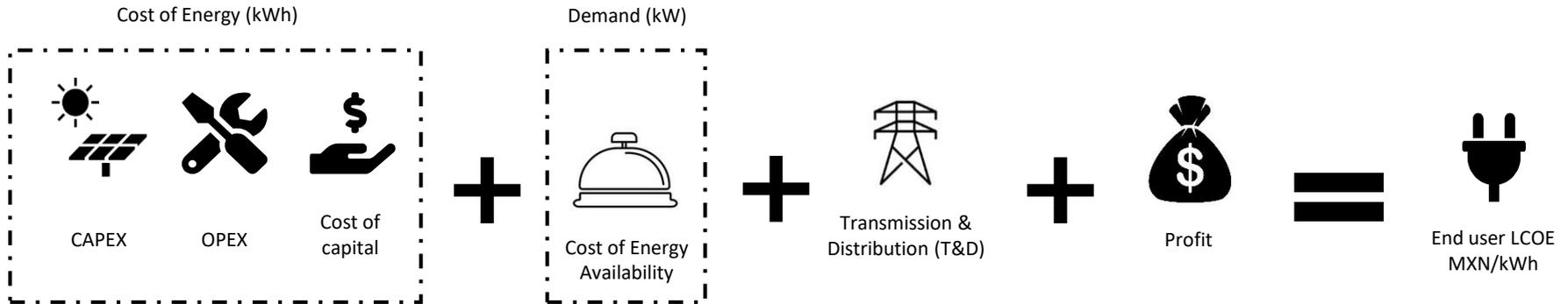


49%

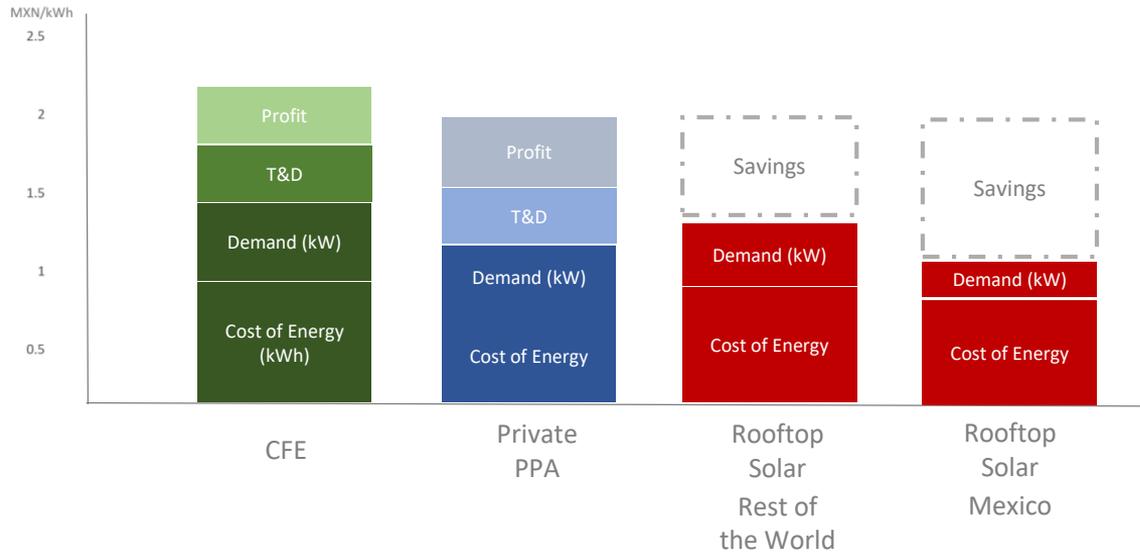


85%

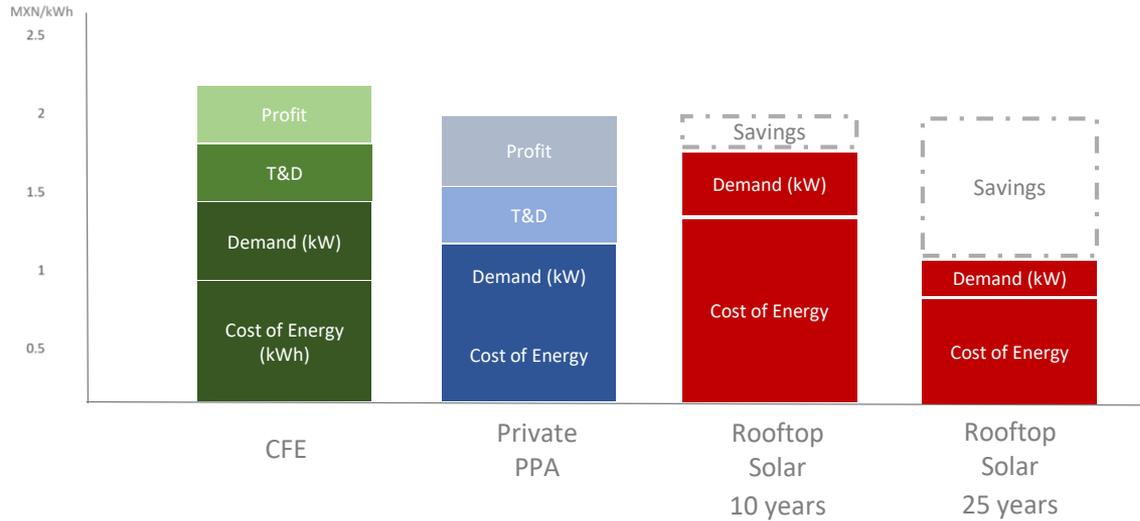
Levelized cost of electricity break down (LCOE)



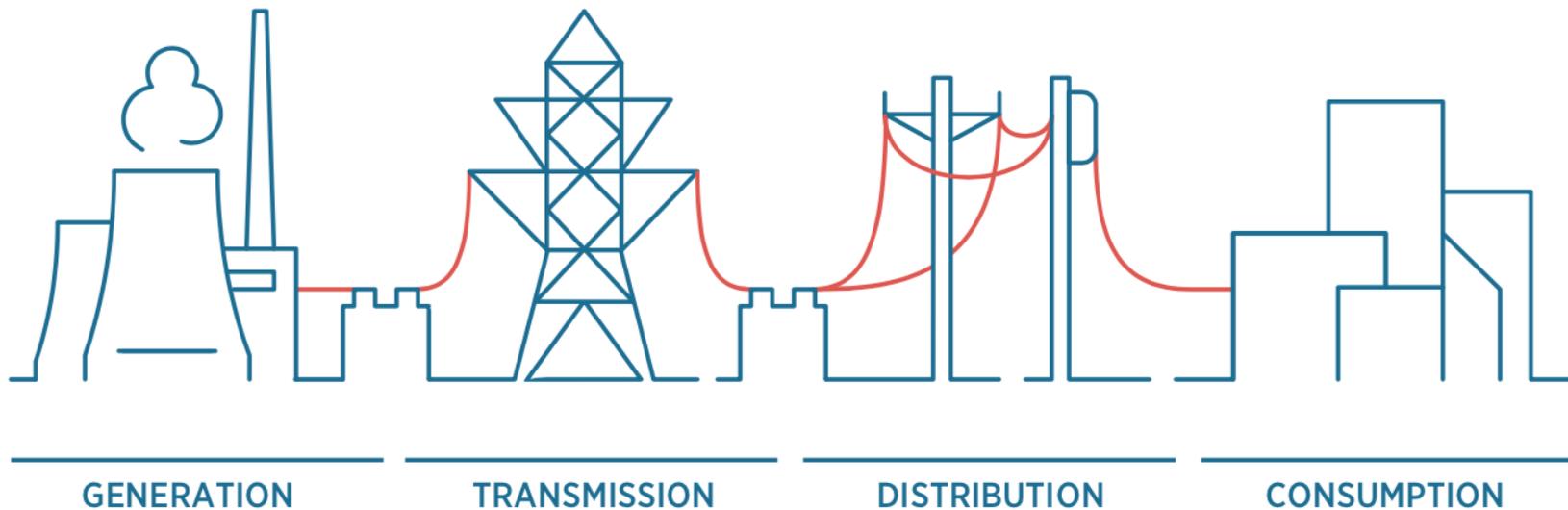
End user LCOE by source comparison



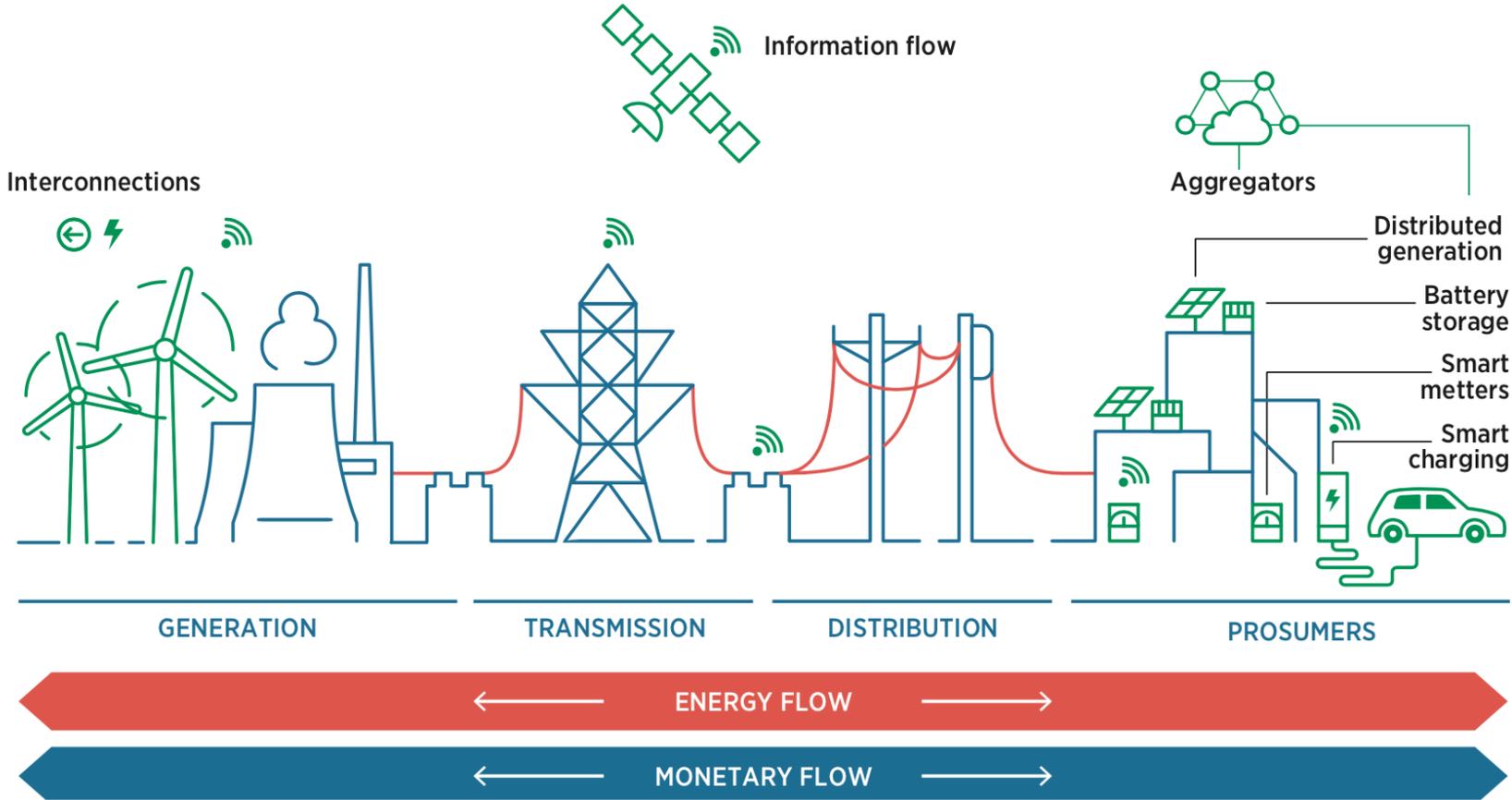
End user LCOE by source through time



TRADITIONAL ELECTRICITY SUPPLY CHAIN



NEW PARADIGM OF THE ENERGY SUPPLY CHAIN



Alvaro Migoya

amigoya@zolarity.com.mx

maximilian.webster@gmail.com

@MaxAWebster