Welcome to this week's presentation and conversation
hosted by the
Canadian Association for the Club of Rome,
a Club dedicated to intelligent debate and action on global issues.

Vehicle to Grid Integration—
A Great Solution to Store Renewable Energy.

Our speaker today is Raymond Leury has been an electric vehicle (EV) owner for 9 years & is President of the Electric Vehicle Council of Ottawa. Since retirement from IT strategy consulting, he has been researching & advocating for EVs of all sizes. This led to a successful campaign to get OC Transpo to transition to e-buses. As the number of EVs increases, they represent a unique challenge to integrate them into the grid in a way that avoids costly upgrades. Although wind & solar are the cheapest sources of electricity production, they are intermittent & require a storage solution that will allow the grid to store energy for use during peak demand periods. Could EV batteries fill the gap & turns a challenge into an opportunity?

Mr. Leury's presentation will be followed by a conversation, questions, and observations from the participants.

CACOR acknowledges that we all benefit from sharing the traditional territories of local Indigenous peoples (First Nations, Métis, and Inuit in Canada) and their descendants.

2022 June 29

Zoom #105

Agenda

- The (Power) Grid
- Speed of change
  - AT&T cellular
  - Solar cost
    - IEA changing numbers
  - Wind cost
  - Battery cost
- Ontario
  - Demand
  - EV effect
- Policy implications

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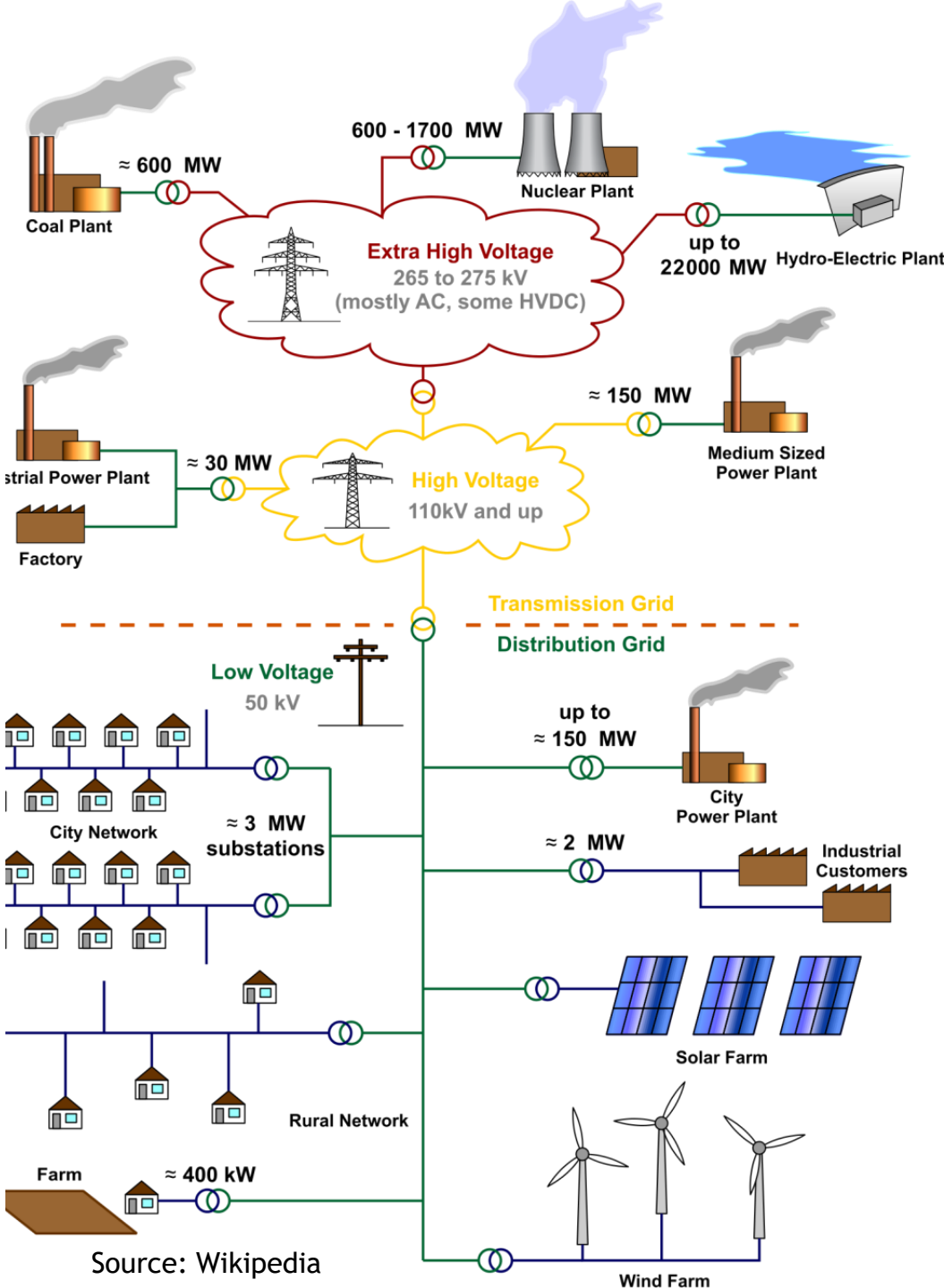
The (Power) Grid

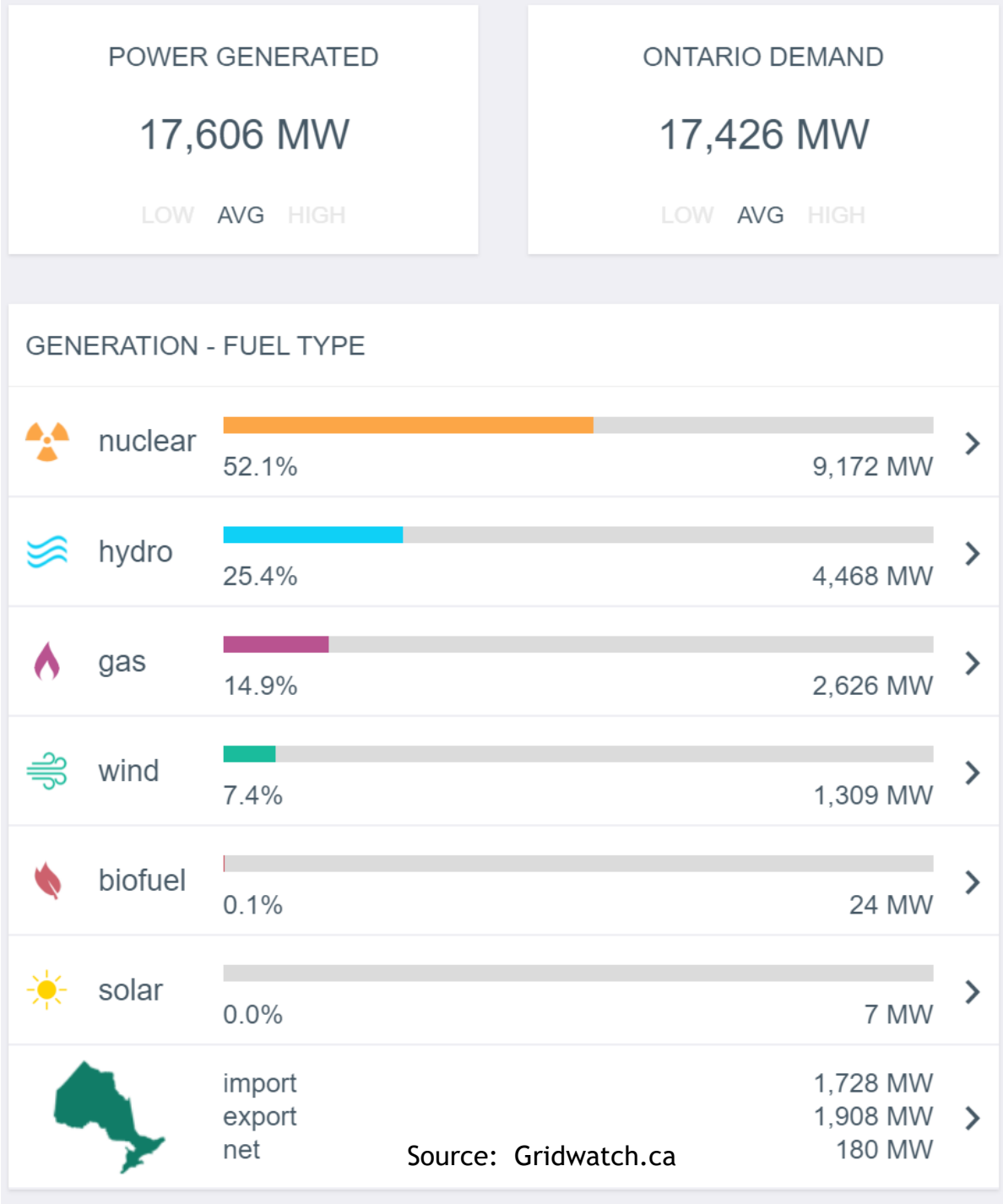
- Akin to a water distribution system
  - Electricity flows from high pressure to low pressure
  - “Storage” is used to regulate the flow
- “Legacy” model
  - Large centralized production facilities
  - Expensive distribution network – NIMBY
  - Limited storage – hydro reservoirs
- Demand and Supply
  - IESO (Independent Electricity System Operator)
  - Must be balanced 100% of the time
  - Frequency must be maintained at 60 Hz
- Pricing – how do you make money?
  - Power supply
  - Standby dispatchable power
  - Frequency regulation



Source: Wikipedia

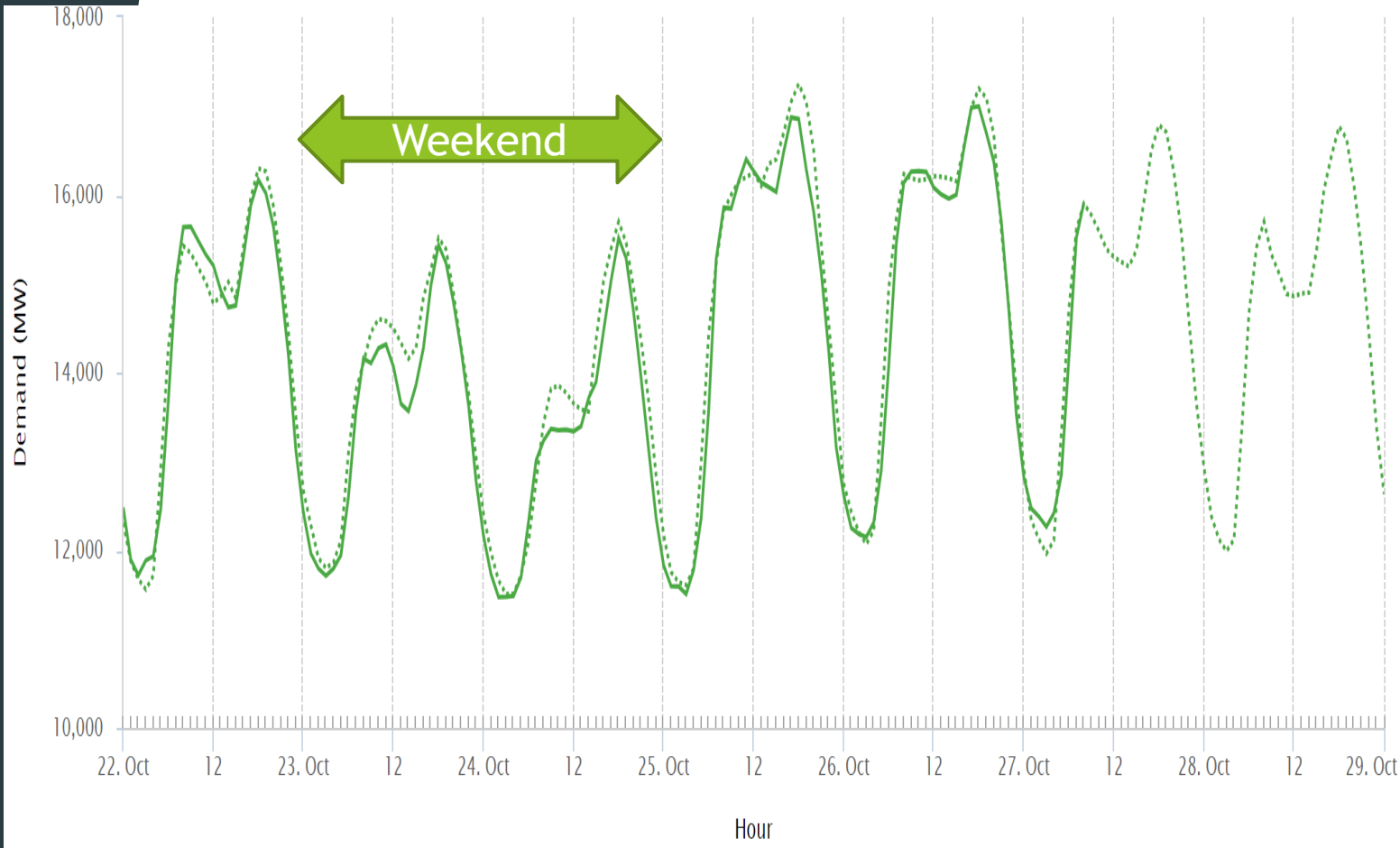
The (Power) Grid

- Base load
  - Nuclear is on or off
    - Takes days to cycle on/off
  - Coal takes hours
  - Hydro takes minutes
- Peaker plants
  - Gas takes minutes
- Solar
  - Generates when there is sun
- Wind
  - Generates when it's windy
  - Can be curtailed
- Batteries (lithium-ion)
  - **Sub-second response**
  - Expensive if purpose built



Myth: EVs Will Cause Grid Collapse

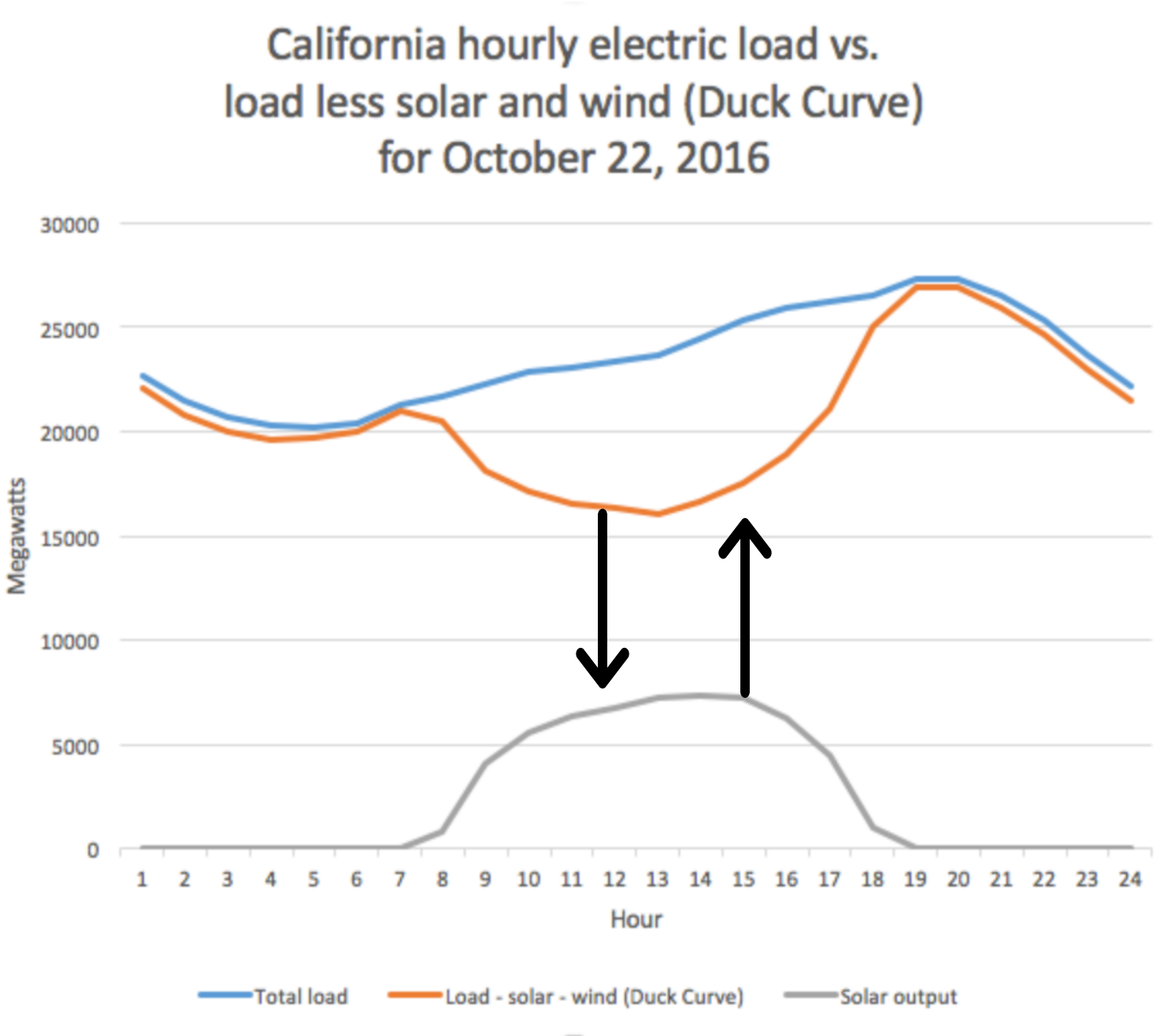
- Current unchanged grid can support 30% of fleet being electrified
- Lots of spare capacity at night
  - 5% of water in Ontario wasted at night
  - Wind energy is curtailed
- Smart Charging
- Smart Grids
  - Use (car) batteries to store intermittent excess supply
- Distributed Energy Resources (DER)
  - Avoid upgrading transmission
  - More resilient system



Demand for Ontario in Oct 2021

The Duck Curve

- As solar production share increases, we face an overproduction risk
- Storing overproduction is a challenge
- Purpose built storage is expensive
- Example from California on a Saturday
- www.vox.com/2016/2/10/10960848/solar-energy-duck-curve



Money drives investment decisions

- Technology improvements change what is the most cost-effective technology at any point in time
  - My father shoveled coal to heat government buildings in the 1940's
  - We heated our home with oil in the 60's
  - We switched to gas in the 80's
  - Heat pumps are now most cost effective
- "Don't ask a barber if you need a haircut" – Warren Buffett
  - Nuclear industry – of course the grid will collapse without nuclear as the base load
  - Oil industry – gas is a great transition energy source
  - Oil industry – (gray) hydrogen is the future
  - Oil industry – we will always need oil
- The stone age did not end because we ran out of stones…

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Speed of Change

"We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten."

– **Bill Gates**

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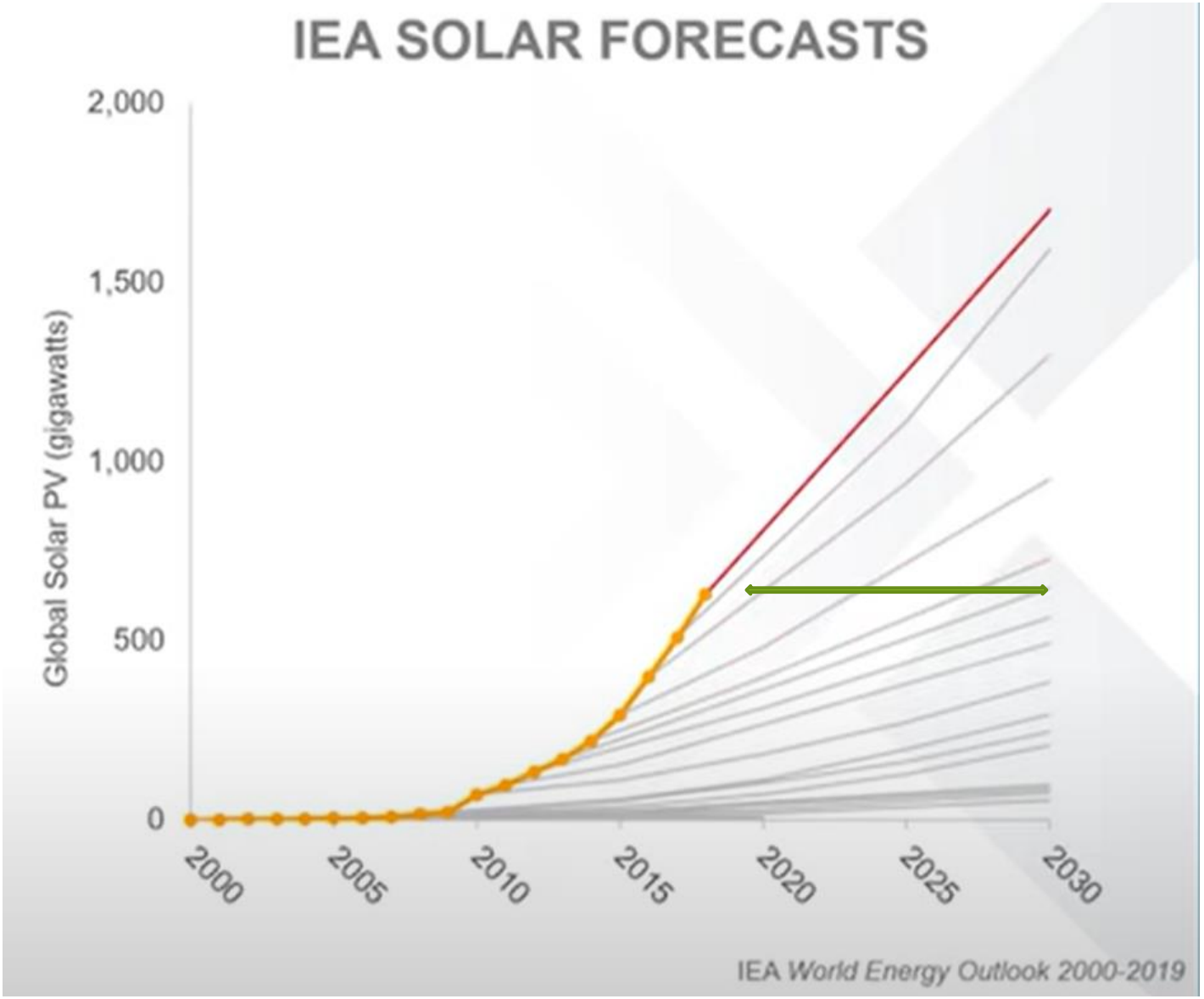
International Energy Agency

- Consistently underestimate growth of solar
- Projections linear when they should be exponential
- Forecasting the future is hard!
- 2014 forecast for 2030 reached by 2018



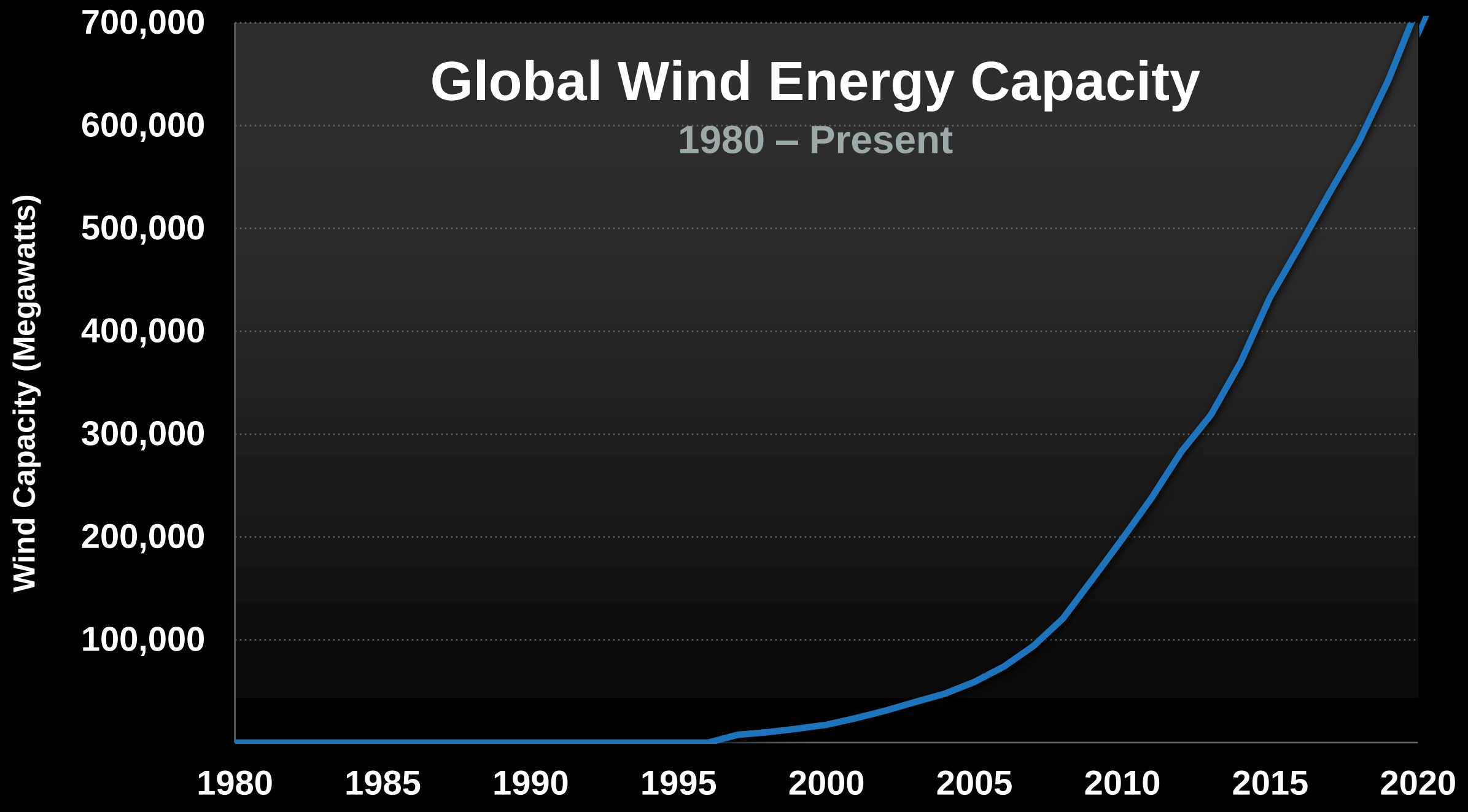
In 1980 AT&T commissioned a study to forecast cell phone use by the year 2000

They projected 900,000 users

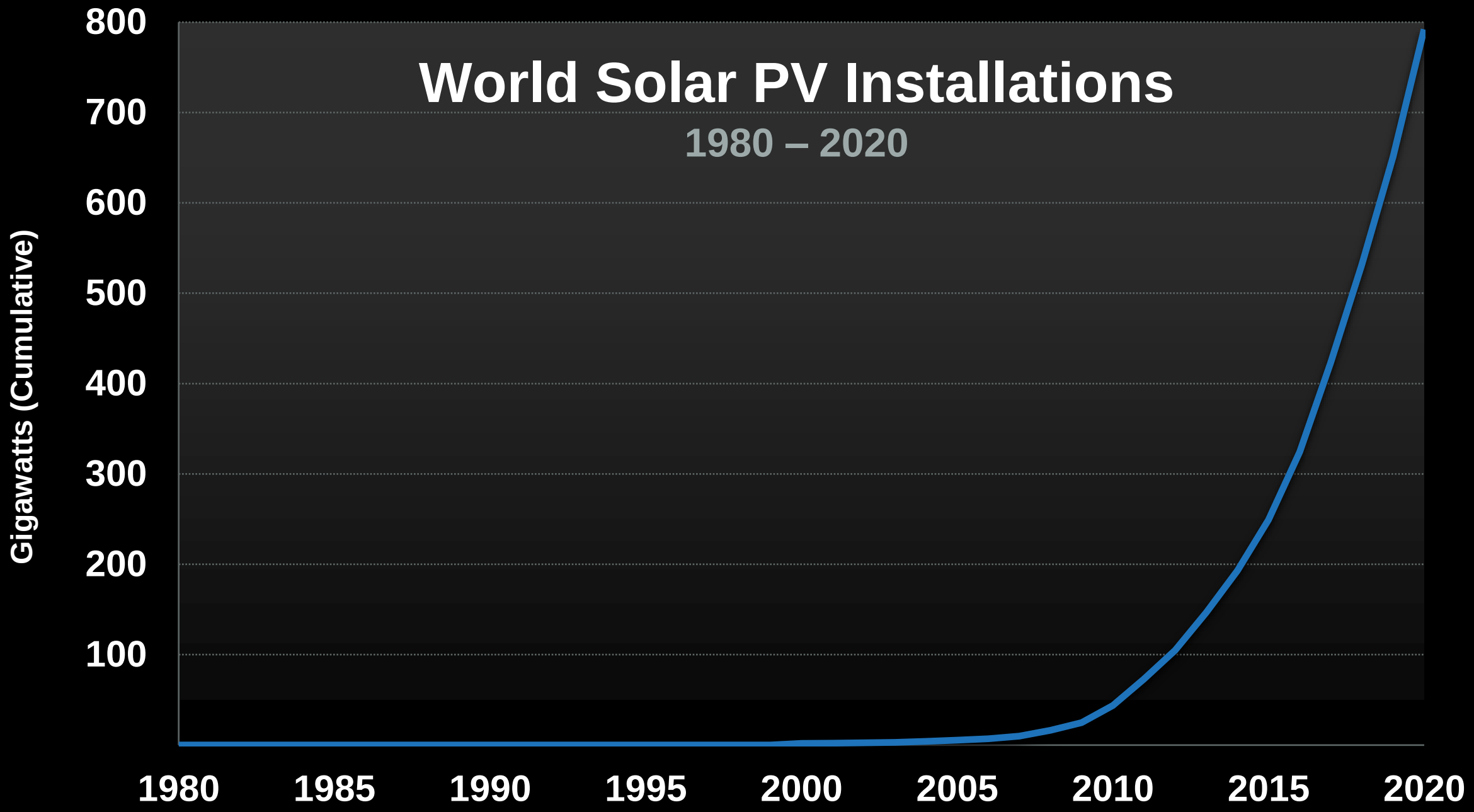
The actual figure was

109 million

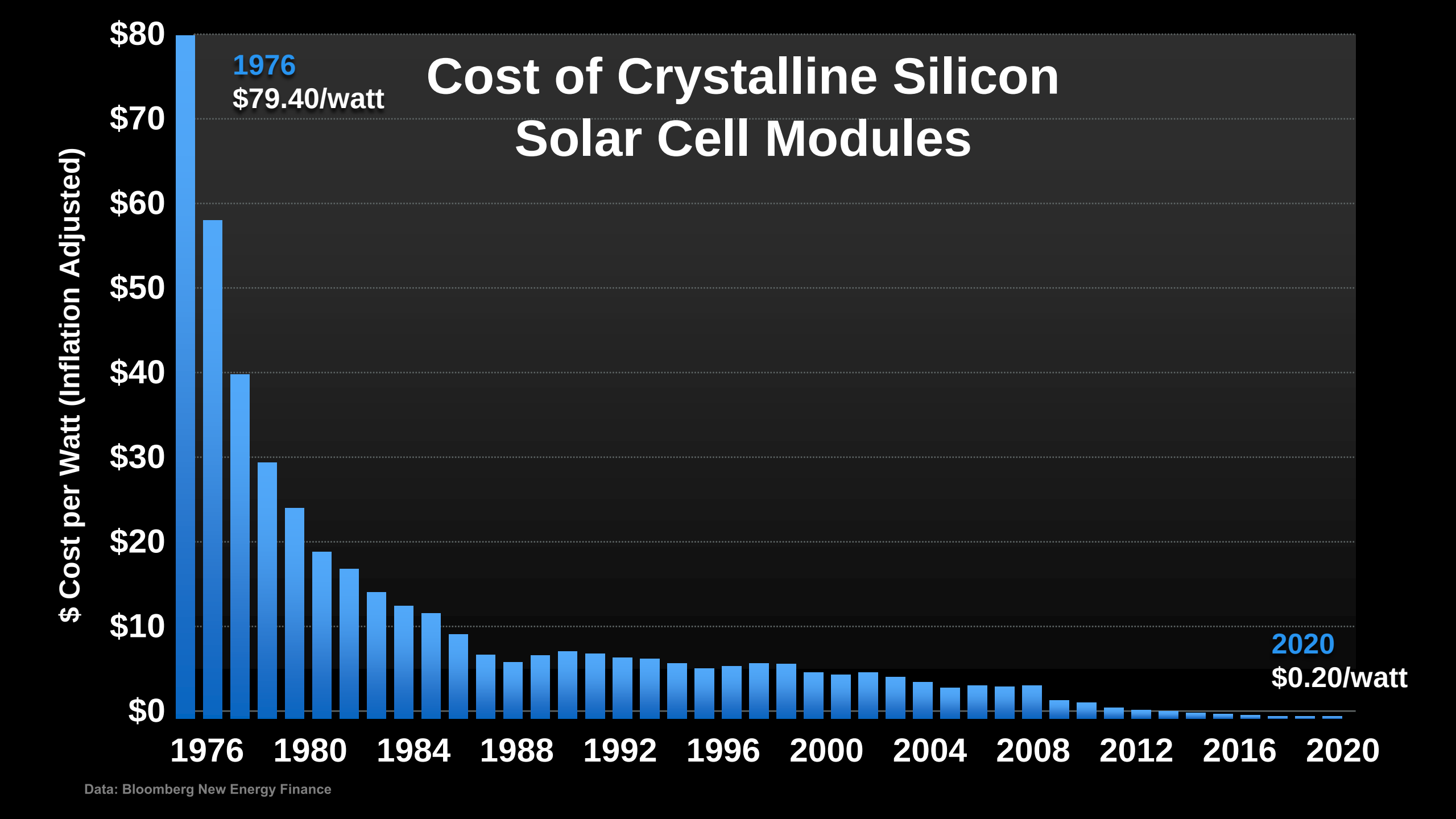
120 x higher



Data: Earth Policy Institute/Bloomberg New Energy Finance



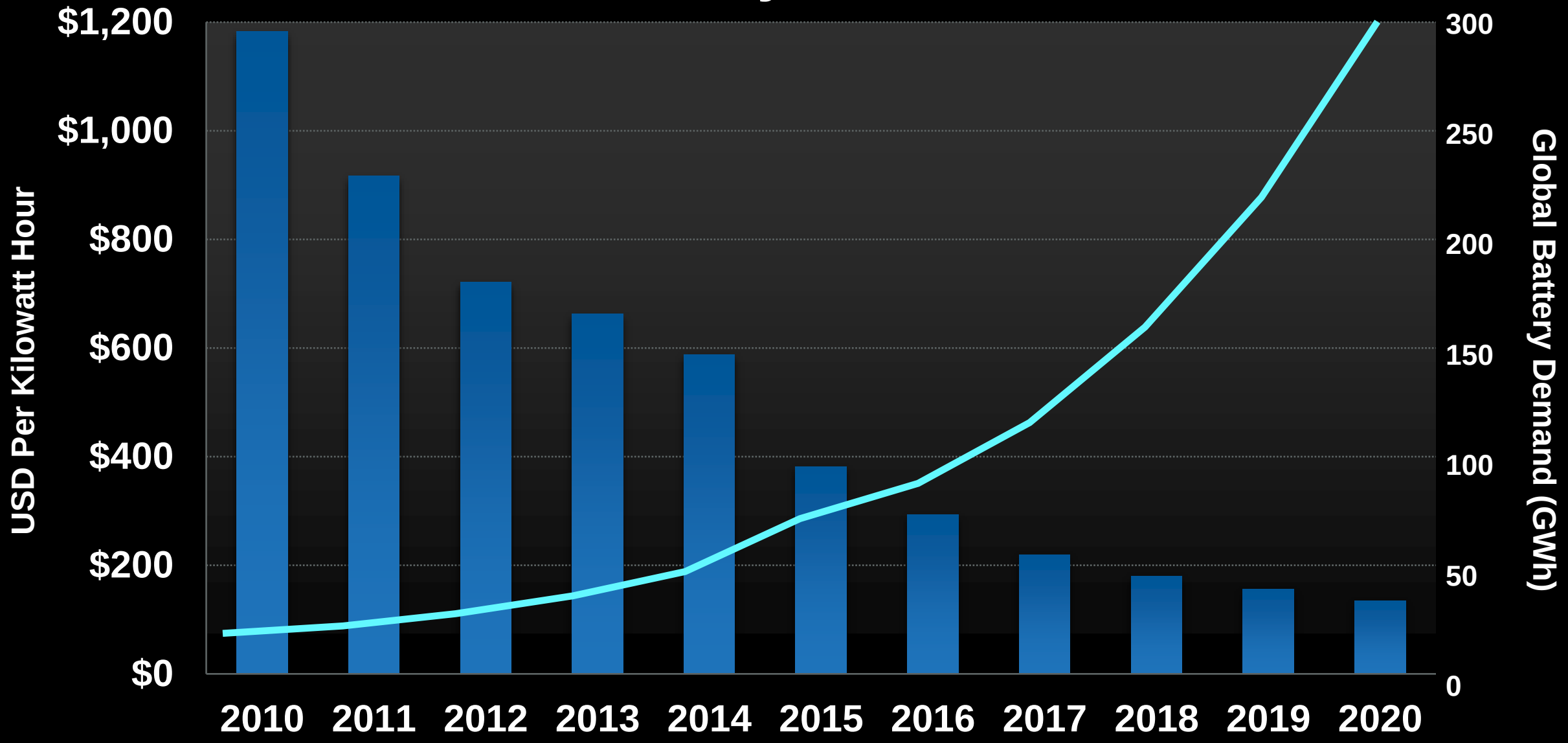
Data: Earth Policy Institute/BP, Statistical Review of World Energy June 2014 (London: 2014); Bloomberg New Energy Finance


Cost of Crystalline Silicon Solar Cell Modules
1976
$79.40/watt
2020
$0.20/watt
$ Cost per Watt (Inflation Adjusted)
$80
$70
$60
$50
$40
$30
$20
$10
$0
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
Data: Bloomberg New Energy Finance

Bluewaters Power Plant, Western Australia

This $1.2 billion coal-fired power plant, Australia's newest, has been written off as worthless by its owners due to cheaper competition from renewables.

Lithium-ion Battery Prices and Demand



Volume-weighted averages
Data: Bloomberg New Energy Finance

Bottom Line

- Solar and wind
  - Cheapest sources of electricity almost everywhere on the planet
  - Continue to drop in price
  - Outcompeting all other sources
- But: they are intermittent!
  - We need storage!
- (Note that EV market share is also growing exponentially)
- The only barriers to adoption are non-monetary

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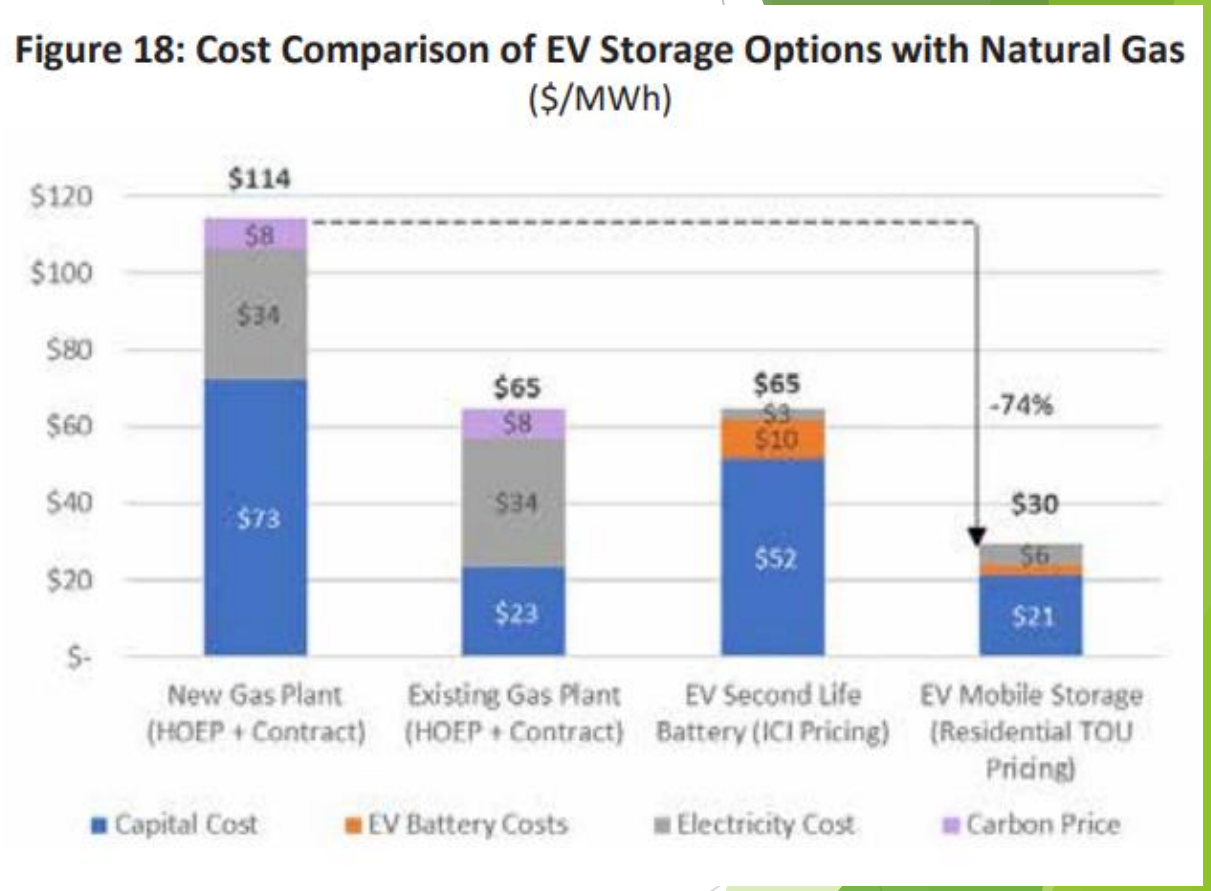
EV Batteries: very inexpensive storage

- Typical EV 60kWh capacity
- Small incremental investment
  - Bi-directional charging
- Much cheaper than natural gas
- V1X – demand shifting
  - Possible with all EVs today
- V2X – offset other loads
  - EV *and* charging station must support
- V2G – vehicles to grid



Strategic Policy Economics, EV Batteries Value Proposition for Ontario's Electricity Grid and EV Owners A Preliminary Cost and Benefit Assessment, July 2020 (link)

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The Math for EVs in Ontario

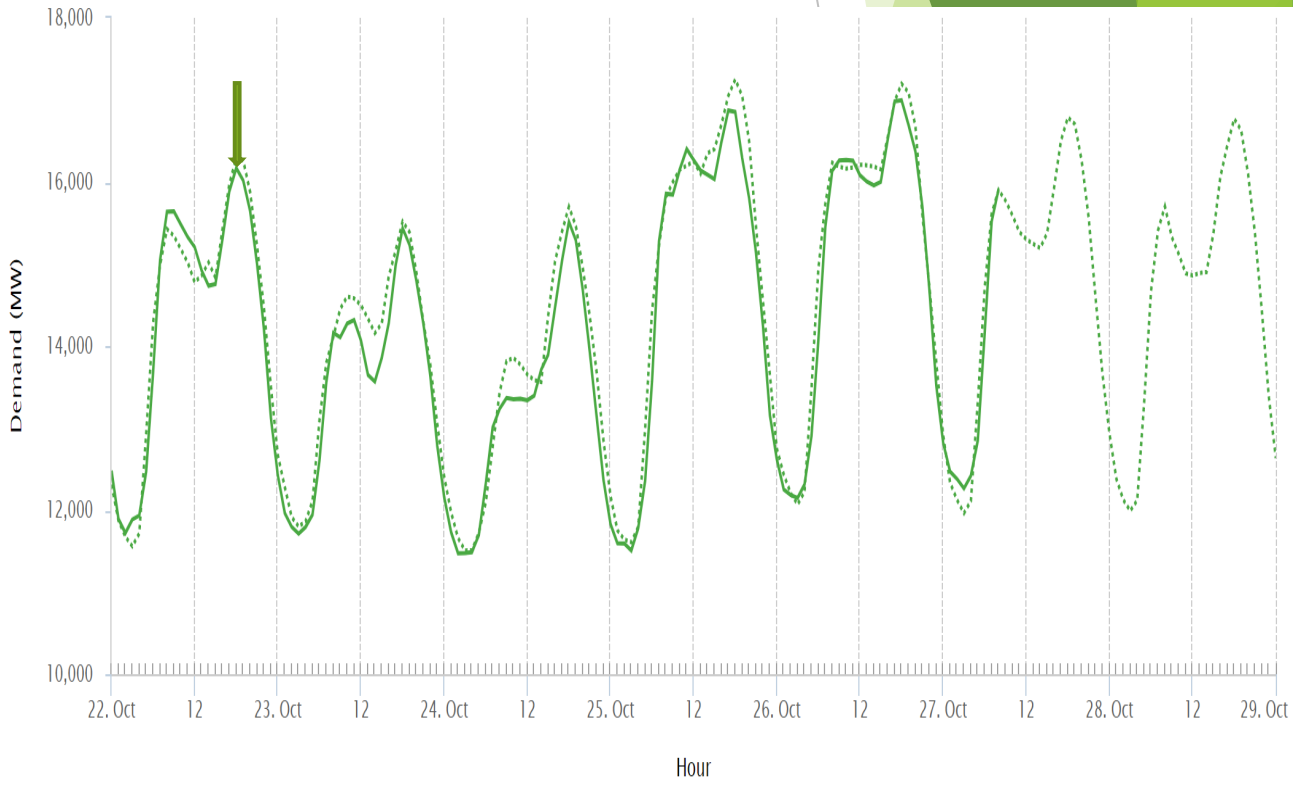
- Naïve users will plug their car in when they get home from work
  - Why should they do anything else…
- Assuming charging at 30A 240v which is 7.2kW
- Assuming one million EVs charging during the evening peak

  -> 7,200MW

  50% higher evening peak!

  -> we need smart charging!

  -> we need incentives to charge at night
- 10M light duty vehicles in Ontario (2040)
  - 72,000MW if all charge at the same time
  - Without considering heavy duty
- Alternatively…



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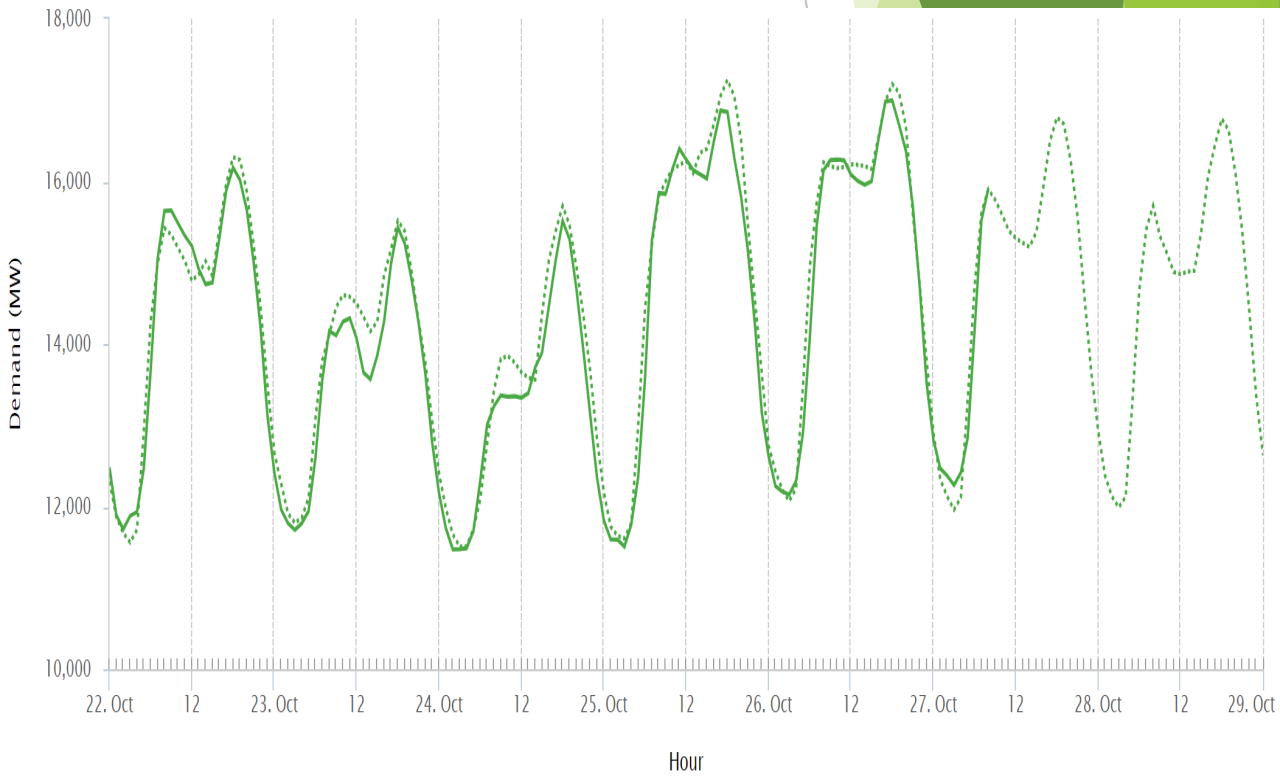
The Math for EVs in Ontario

- Alternatively…
- Average commute is 30km/day
  - Takes less than 60 min to charge for 30km – assume 60 min
- Spread the load overnight from 7PM to 7AM
- -> 600MW (from 7,200MW)
- EVCO forecast
  - 4-6M light duty EVs by 2030 (Ontario)
- Total of approx. 10M light duty in Ontario
  - 6,000MW



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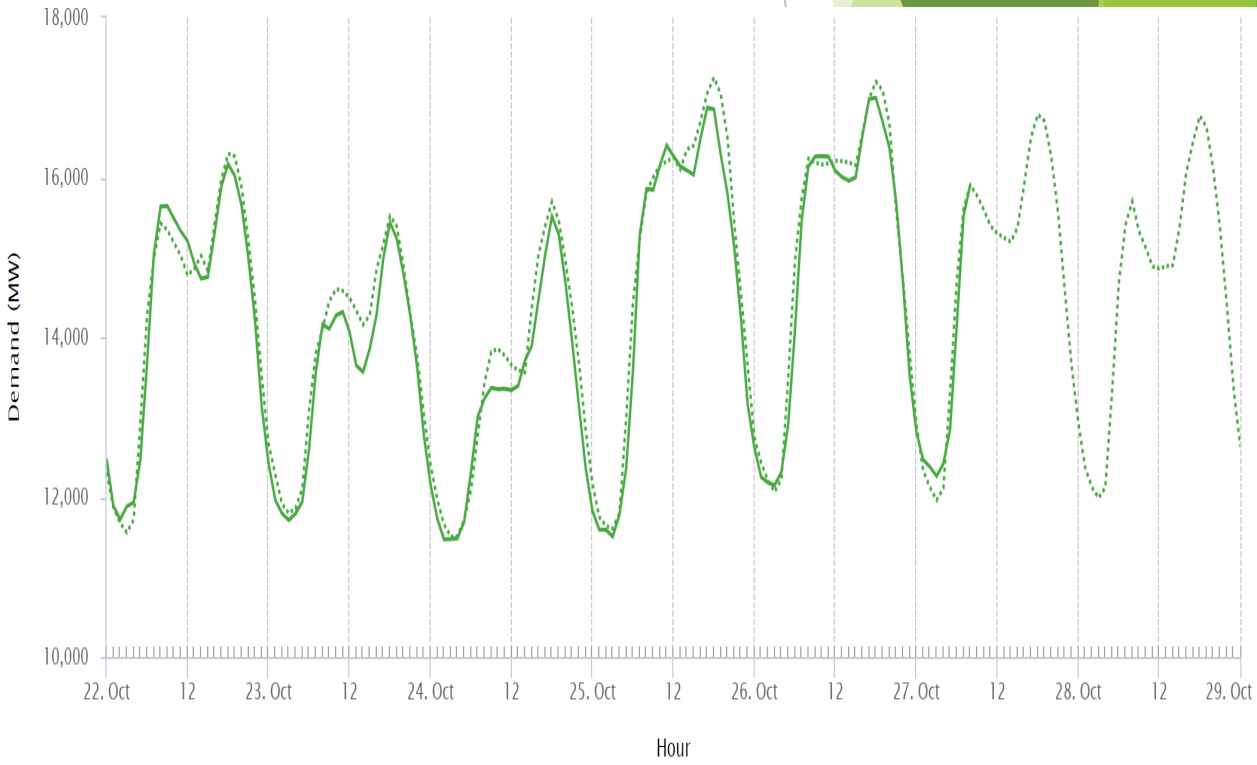
The Math for EVs in Ontario

- V2G (Vehicle to Grid) for peak shaving
- Assuming:
  - One million EVs plugged in at peak
  - Draw up to 2kW each for 2 hours (evening peak)
  - Adds 2,000MW of capacity
- F150 Lightning supports 11kW
  - Assuming all EVs match that
  - 110GW EV discharge capacity by 2040
  - **4 times forecast peak in 2040 (27.3GW)!!**
- No need for massive grid upgrades
  - DER



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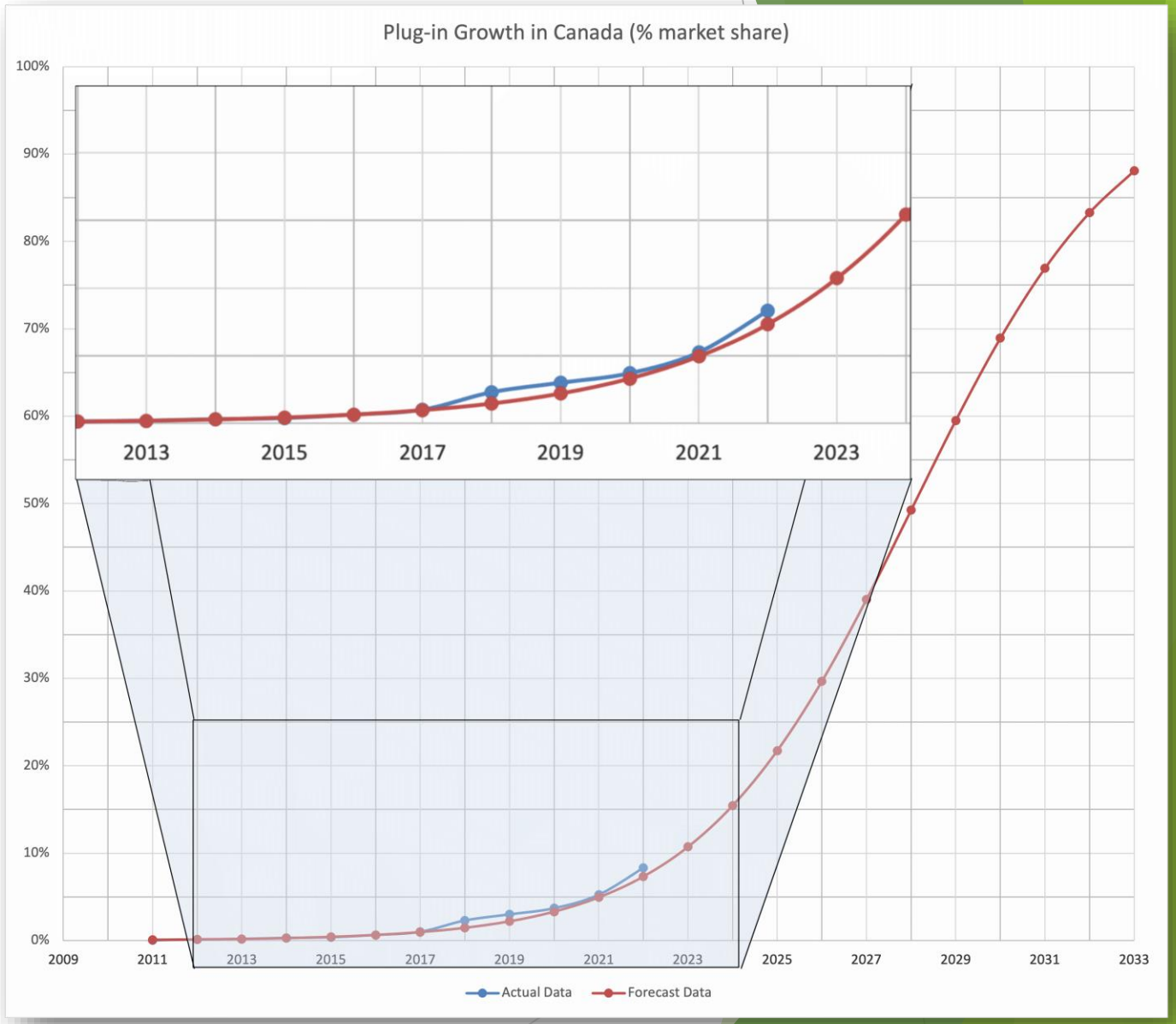
The rEVolution is Happening Sooner Than You Might Expect!

- EV market share is following a standard adoption curve despite the ongoing supply shortages and COVID-19 impacts.
- Real life sales data are plotted in blue on the adoption curve model. The projection from 2017 has proven accurate (if somewhat conservative) and shows nearly all new cars sold will be plug-ins by the end of the decade.
- The bulk of the sales growth will happen in the next few years & many automakers and dealers will be caught by surprise.



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Policy Implications

- OEB (Ontario Energy Board)
  - Need regulatory support for V2X
    - Aggregation of EVs into virtual batteries
    - Pricing
  - Pilots including Hydro Ottawa
    - BluWave-ai
- IESO (Independent Electricity System Operator)
  - Coordination of supply to meet demand
- EVs must support bi-directional charging
  - No impact on warranty
- Charging stations must support bi-directional charging
  - At a reasonable cost

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June 29, 2022
10:34 AM EDT
Last Updated an hour ago

Climate Change

EU countries reach deal on climate laws after late-night talks

By Kate Abnett

Summary

- EU countries reach deals on package of green policies
- Countries agree to support 2035 fossil fuel car ban
- Compromise on fund to shield citizens from CO2 costs
- EU countries and Parliament will now negotiate final laws

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