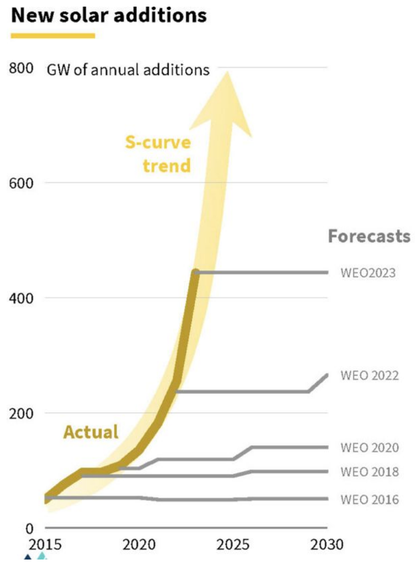
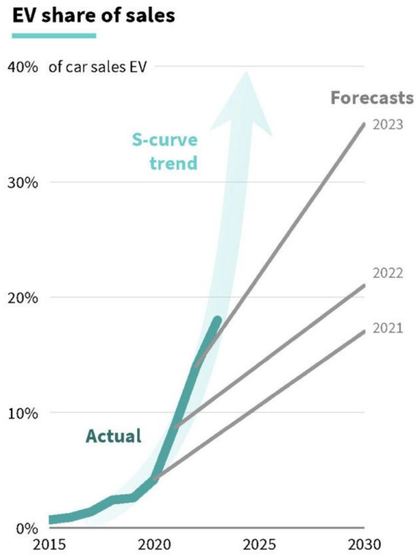
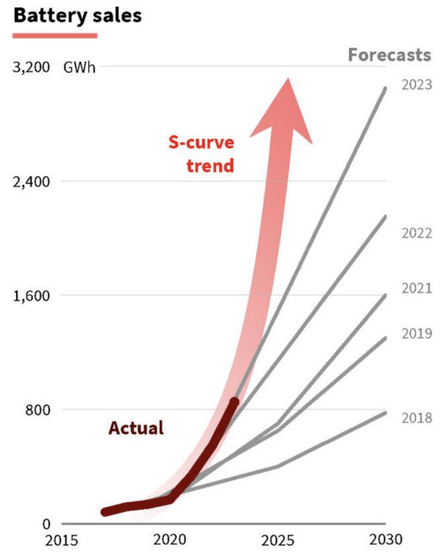








Climate Solutions

We are on the cusp of the fastest, deepest, most consequential
transformation of energy in 100 years

Ken Johnson PhD. Seniors for Climate Sept 11th 2024

Overview

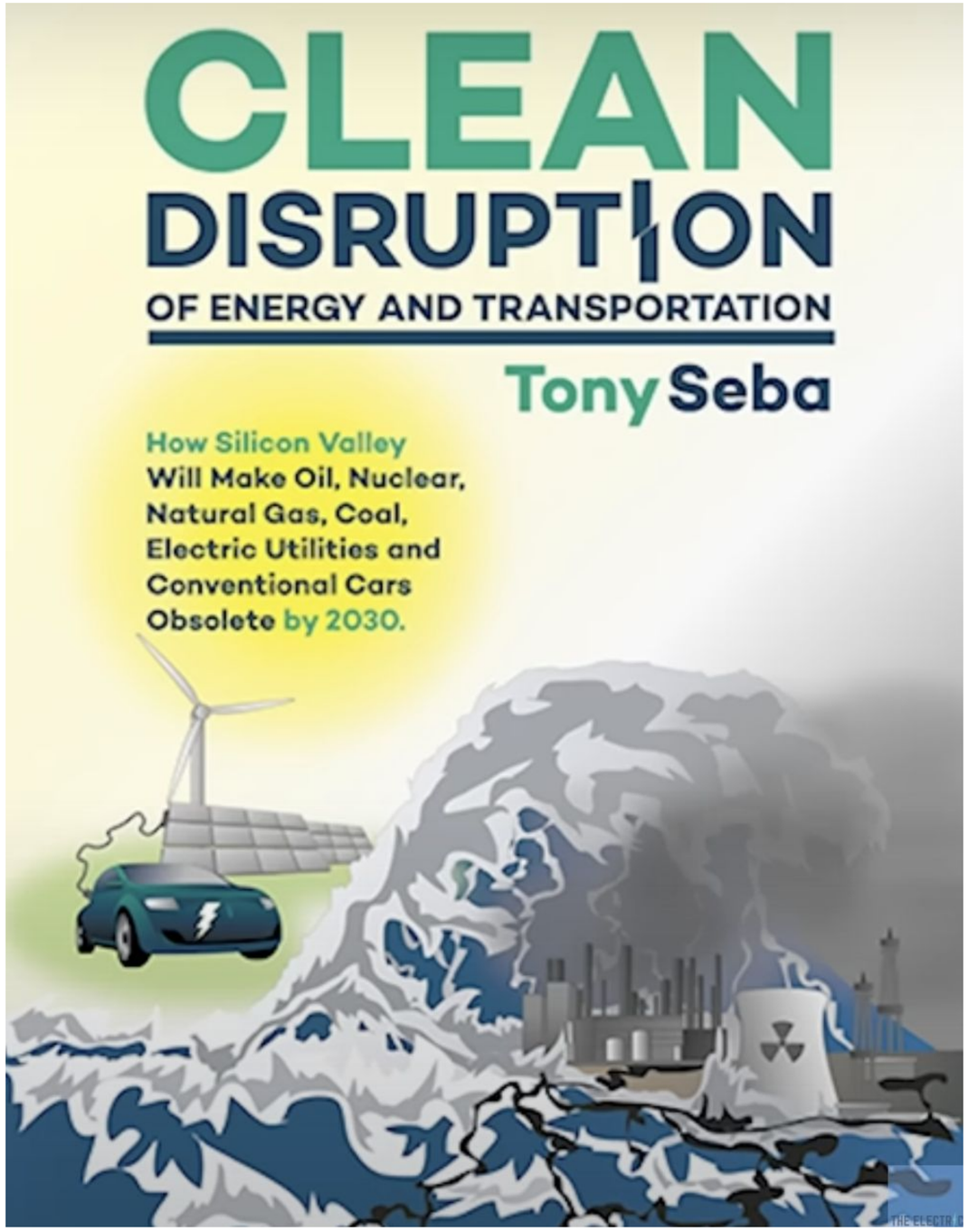
The disruptive decade

- Adoption of Wind, Solar, Batteries and EVs
- Exponential Growth
- Plummeting Costs

- Canada as an outlier

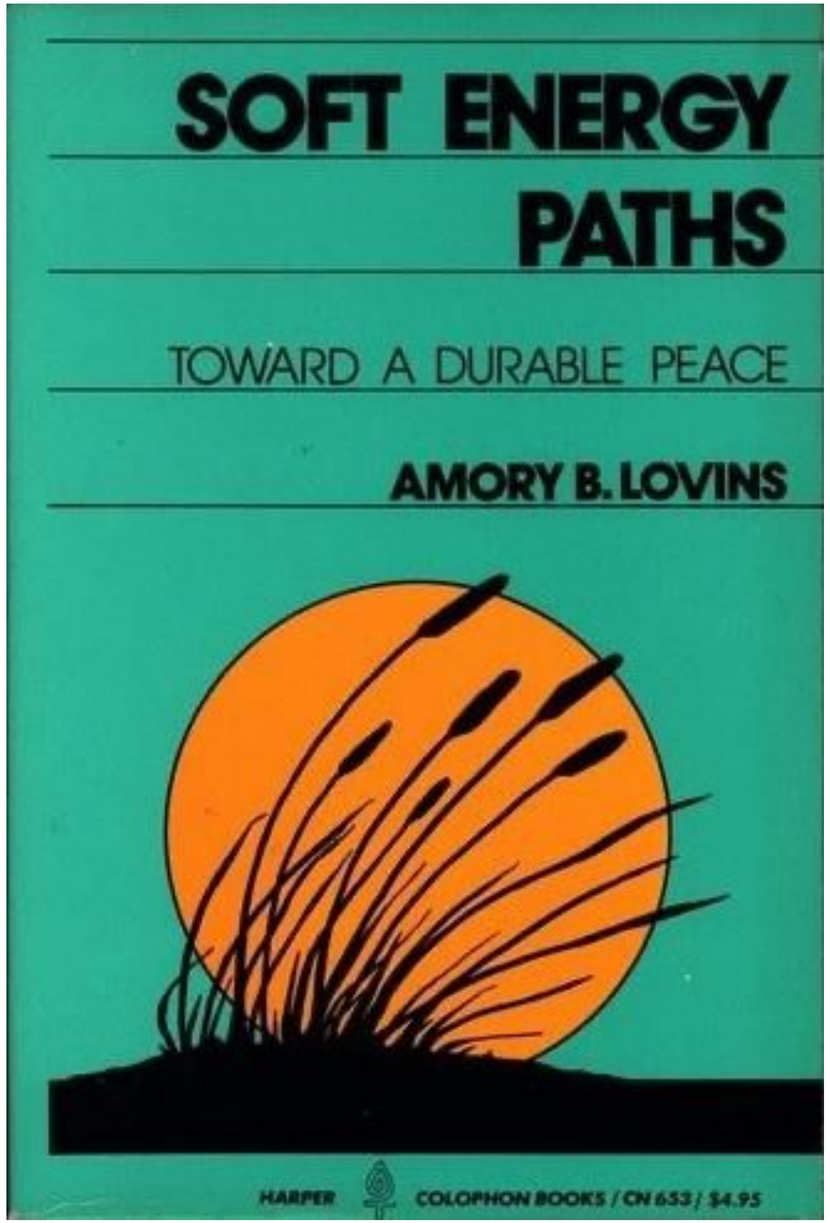


“We are on the cusp of the fastest, deepest, most consequential transformation of energy in 100 years”. Tony Seba, 2021



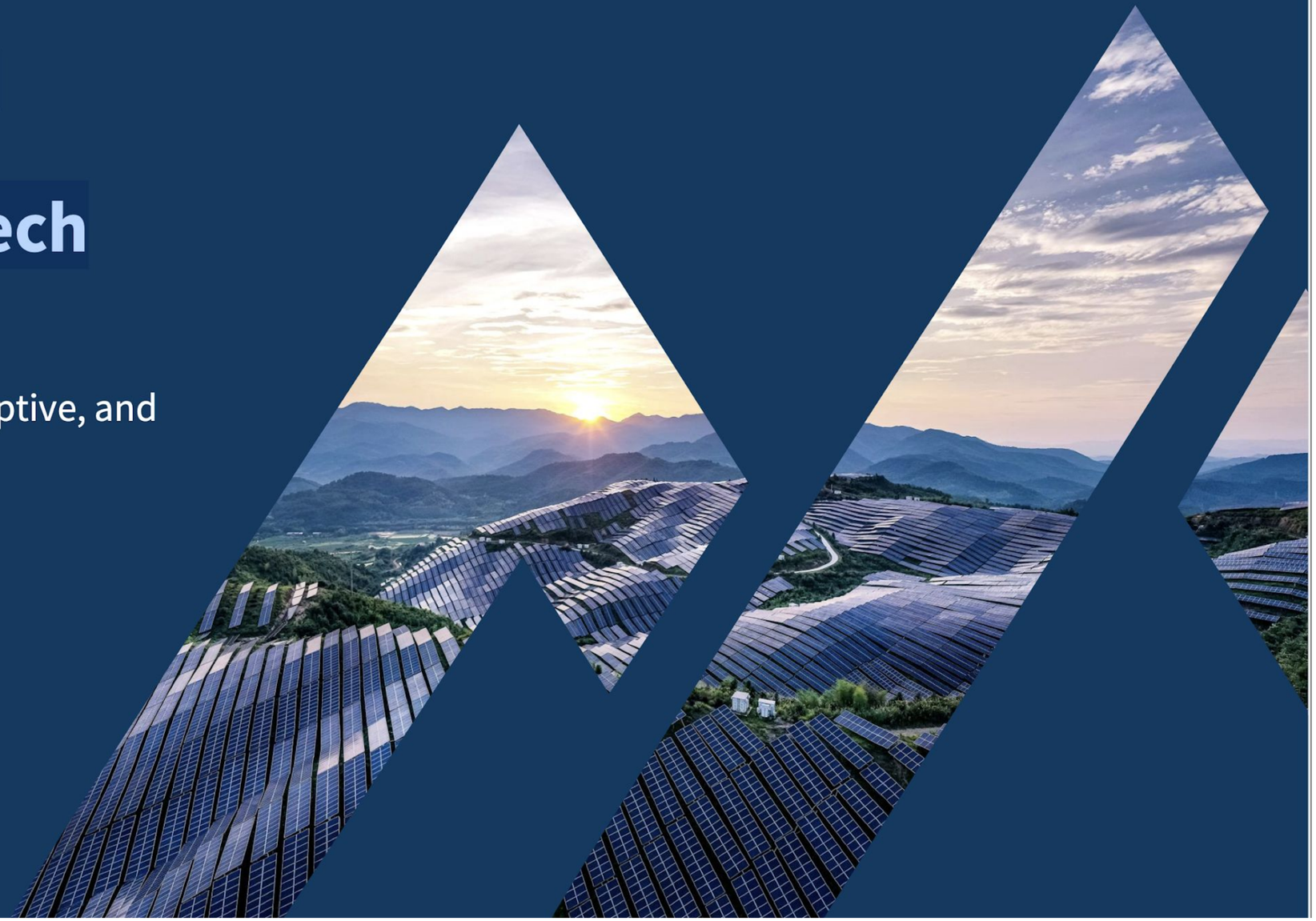
Amory B. Lovins





The Cleantech Revolution

It’s exponential, disruptive, and now

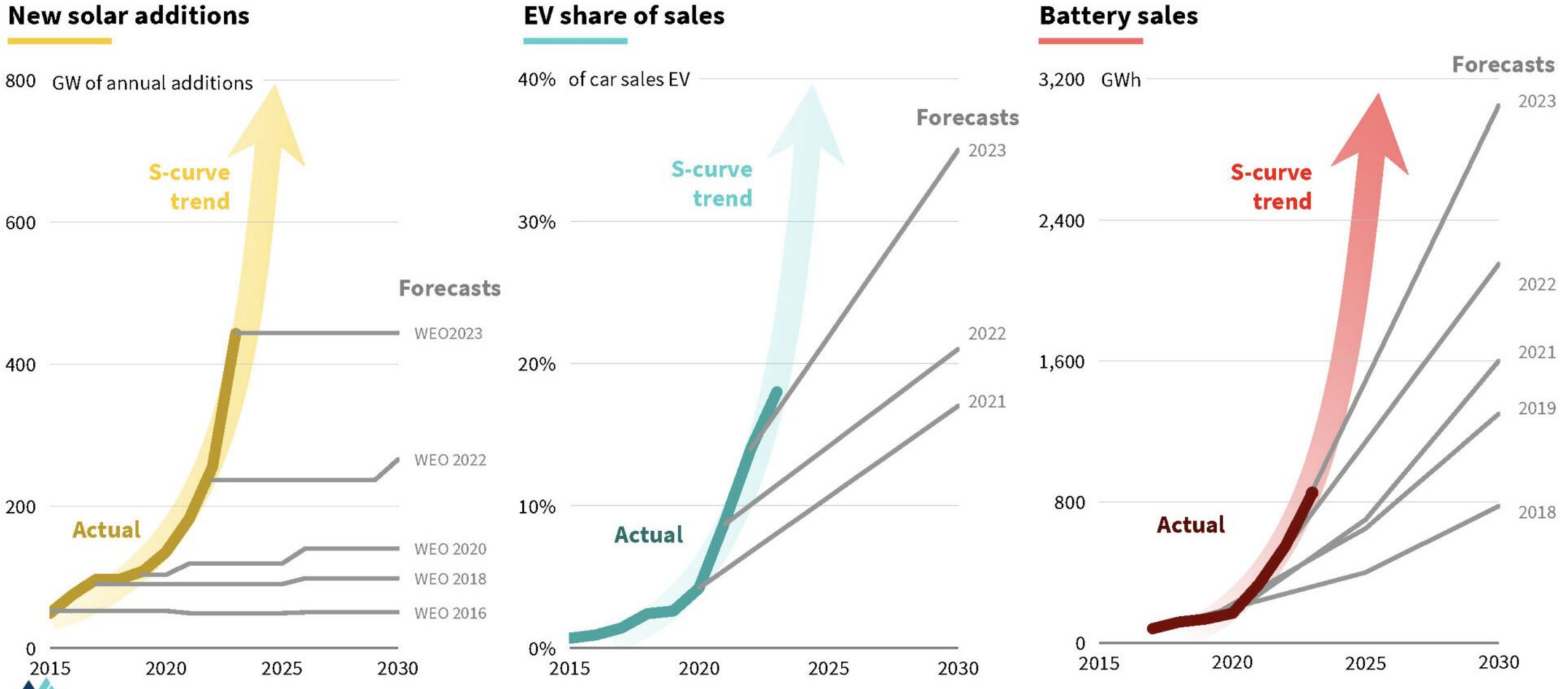


Kingsmill Bond,
Sam Butler-Sloss,
Daan Walter

June 2024

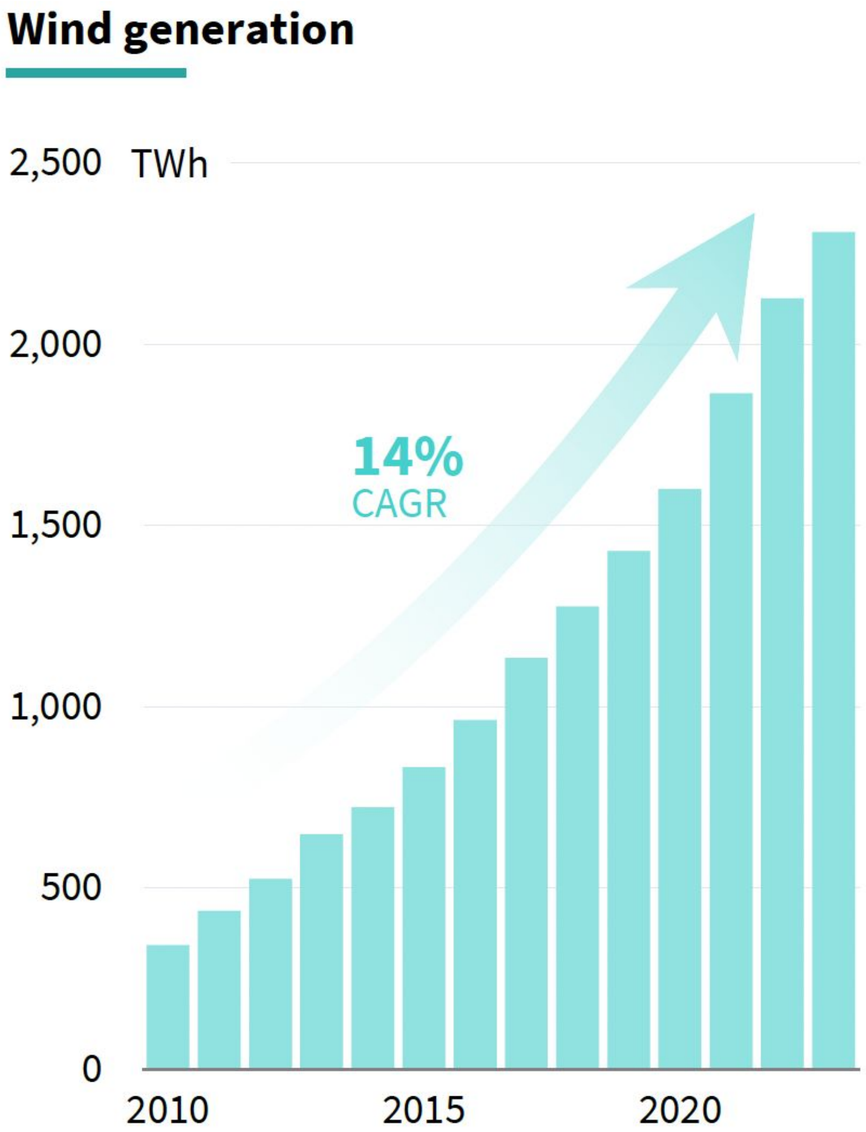
Incumbents have underestimated the speed of change

Even neutral actors modeled in **linear** terms. But change has been exponential



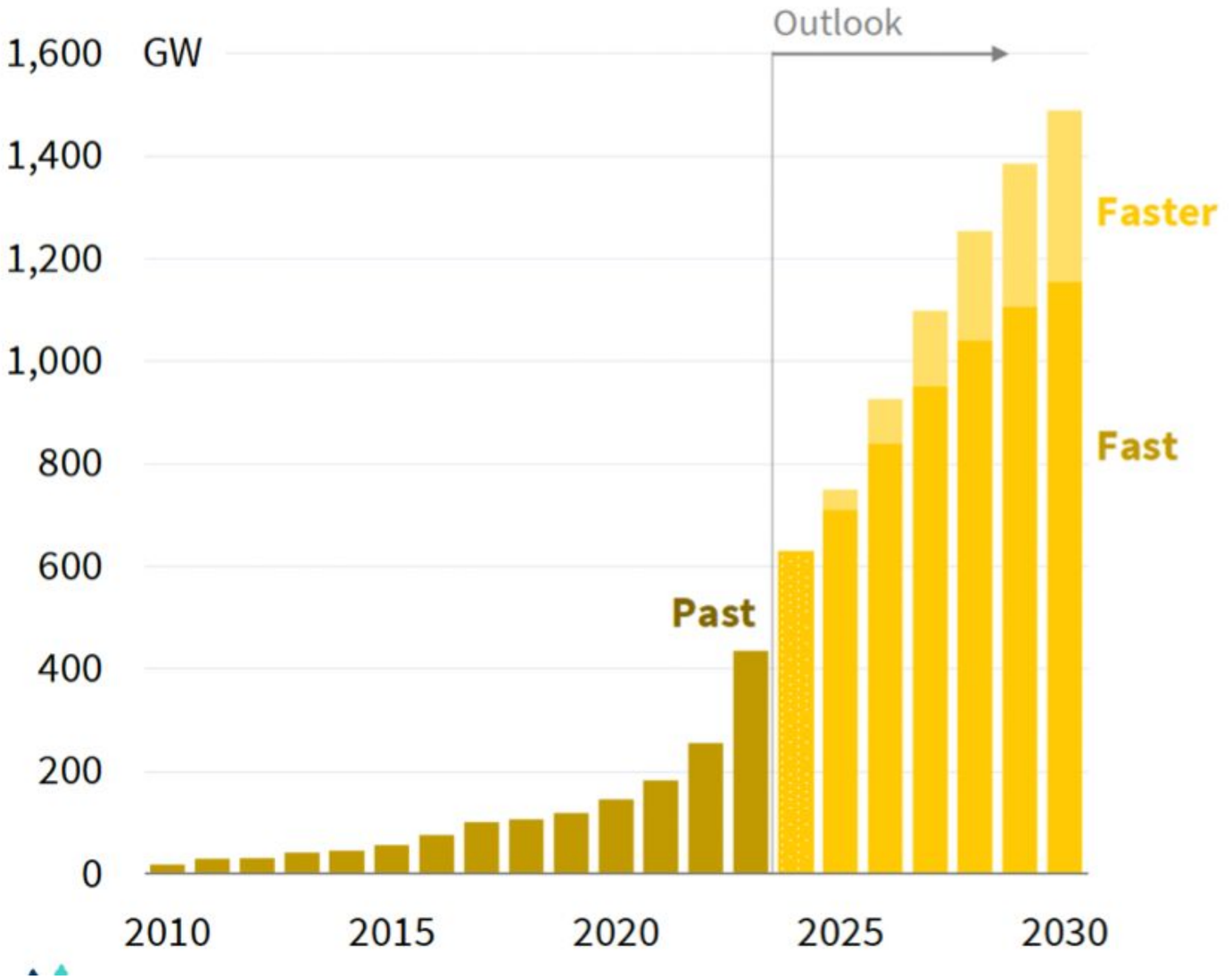
Source: BNEF (solar and battery actuals), IEA STEPS for WEO forecasts , RMI annotation.

Wind generation



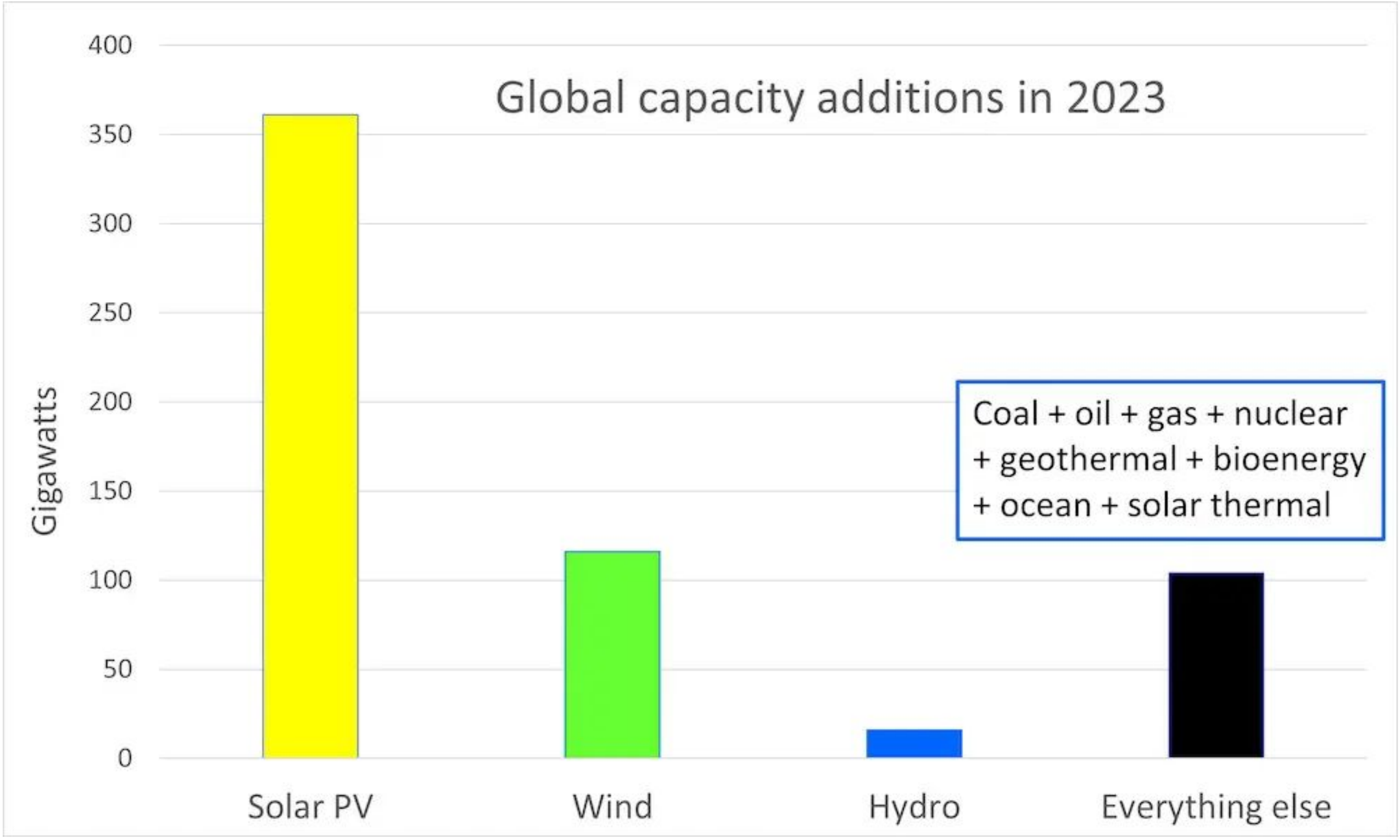
Solar sales are on track for over 1,000 GW per year by 2030

Global solar sales

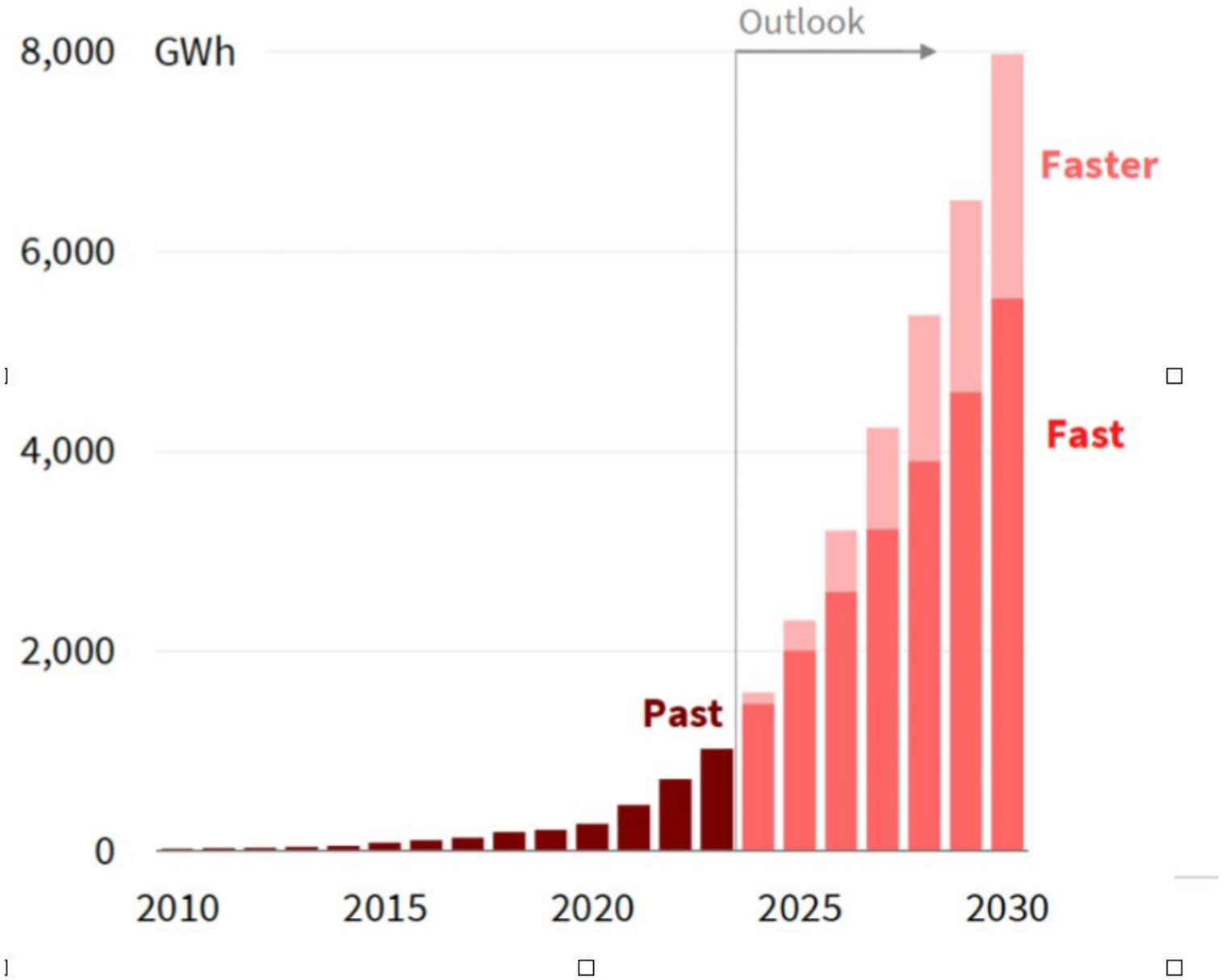


Solar is now being installed faster than any technology in history

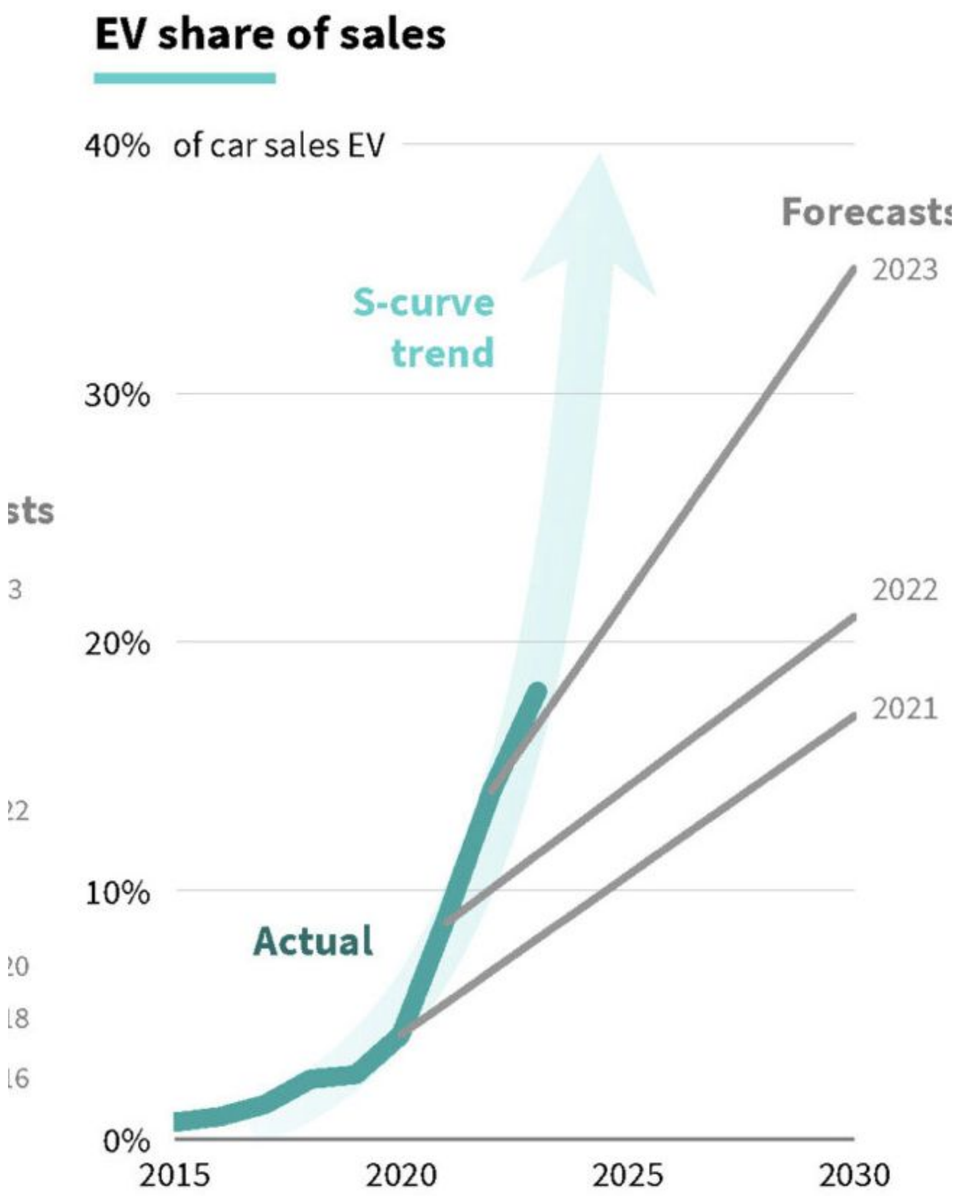



Global capacity additions in 2023
Gigawatts
400
350
300
250
200
150
100
50
0
Solar PV
Wind
Hydro
Everything else
Coal + oil + gas + nuclear
+ geothermal + bioenergy
+ ocean + solar thermal

Global battery sales



Electric Vehicle Marketshare

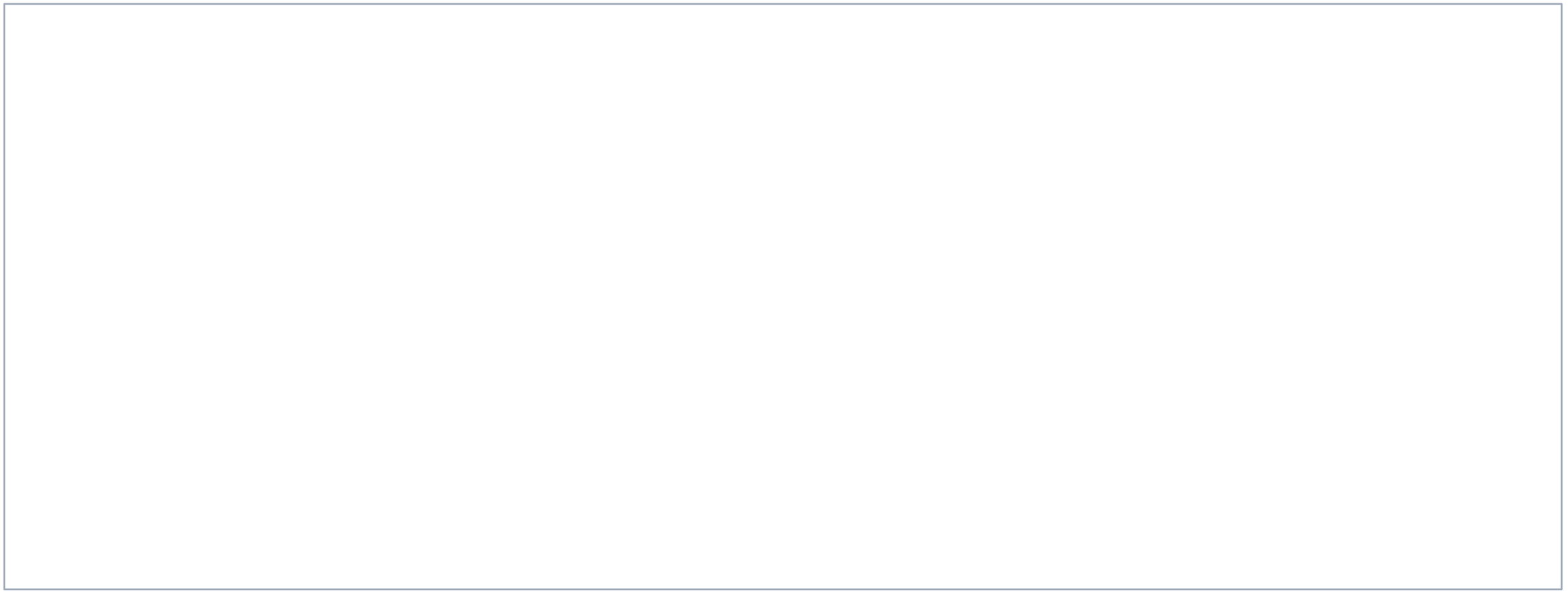


BYD Seagull – Price: ~$11,400+



- Range: 305-405 Km (~190-251 miles)

Plummeting Costs of Renewables

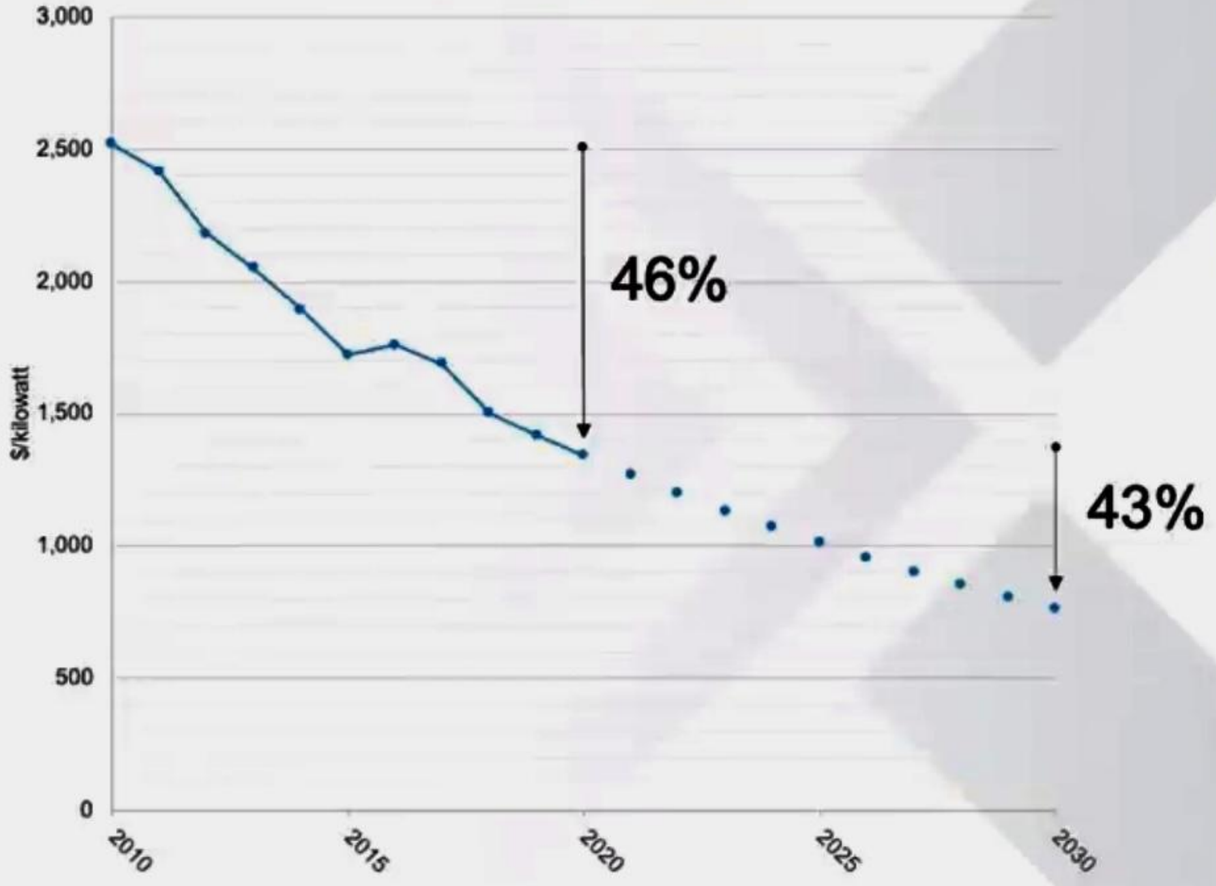


Cost Curves Track and Predict Technology Adoption





wind costs

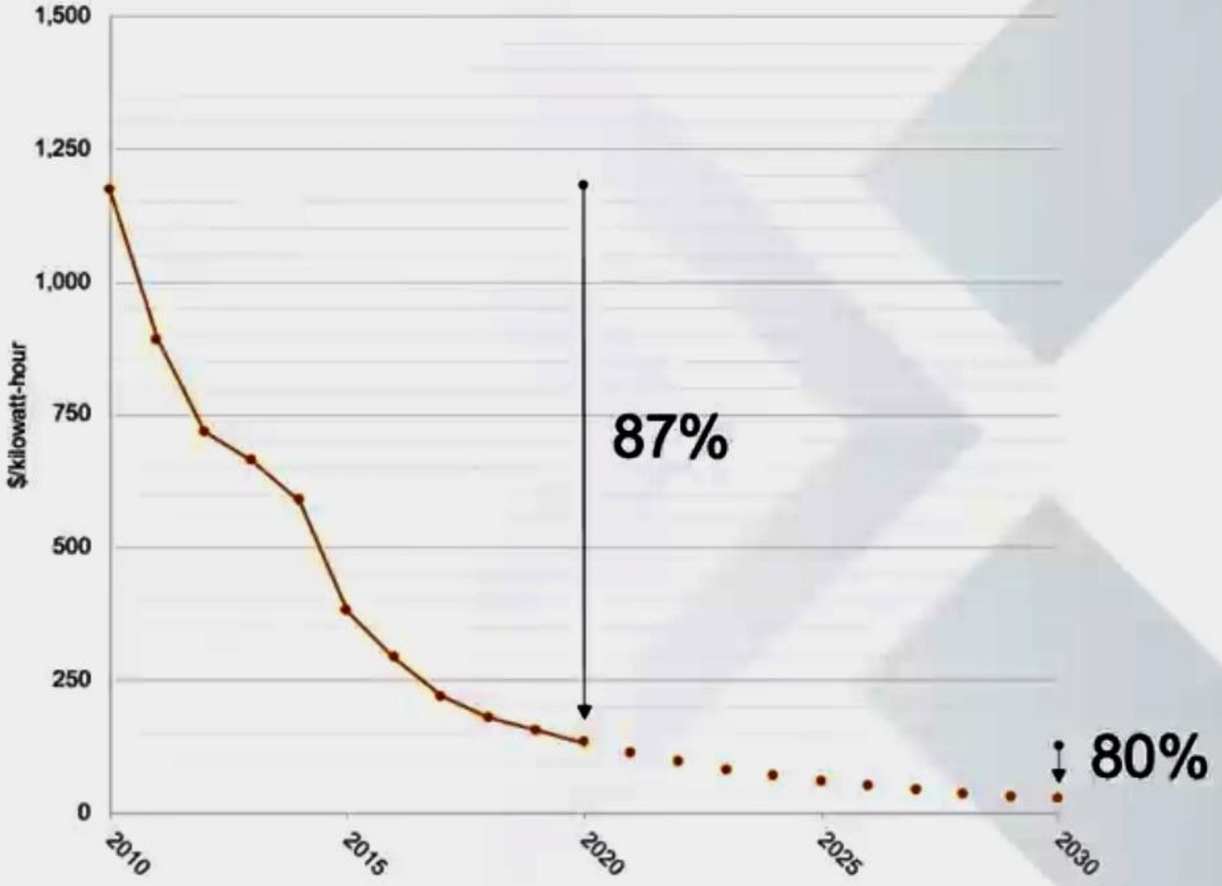




RethinkX



battery costs





RethinkX

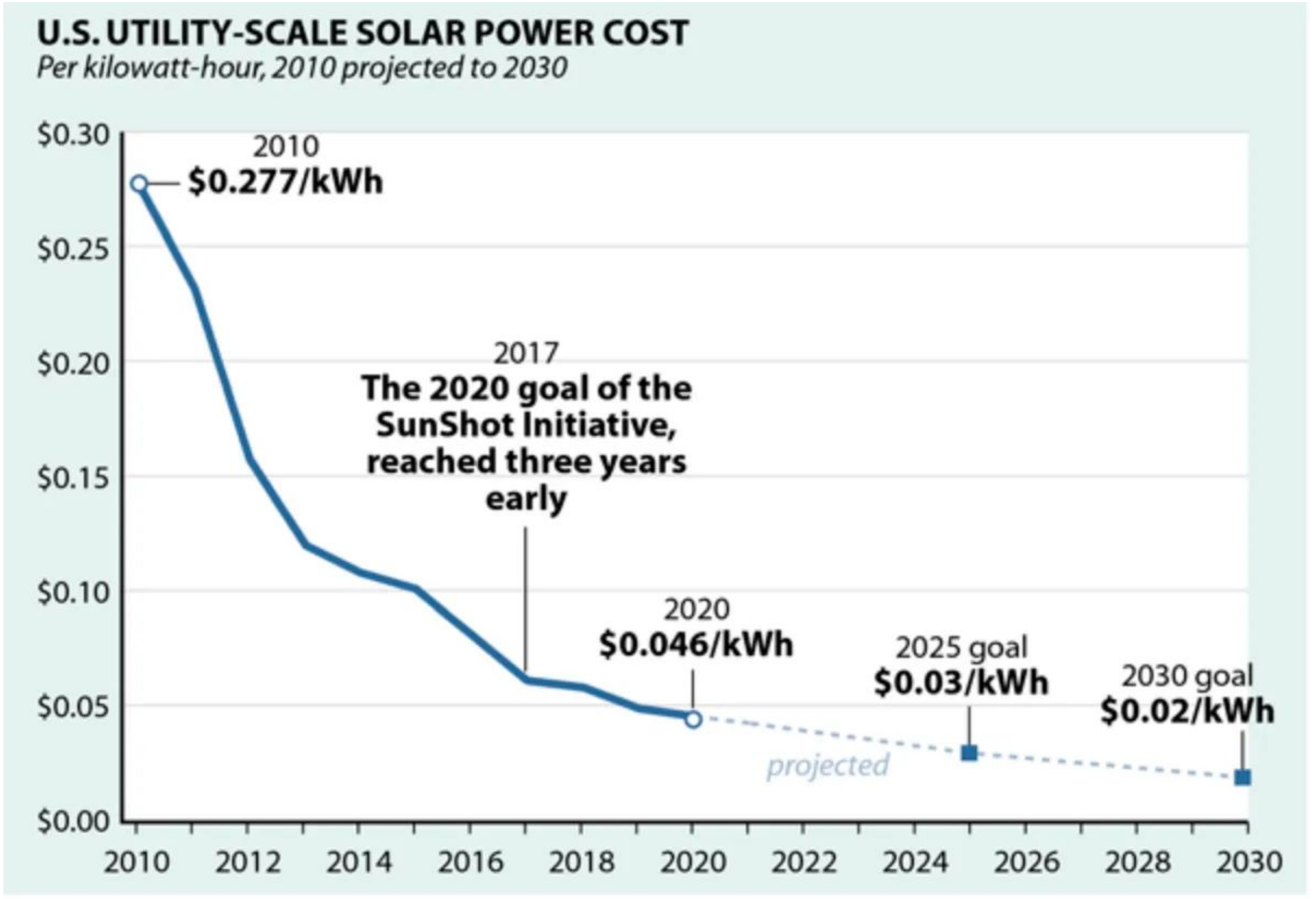


COST CURVES: IMPROVEMENTS IN COST AND CAPABILITY

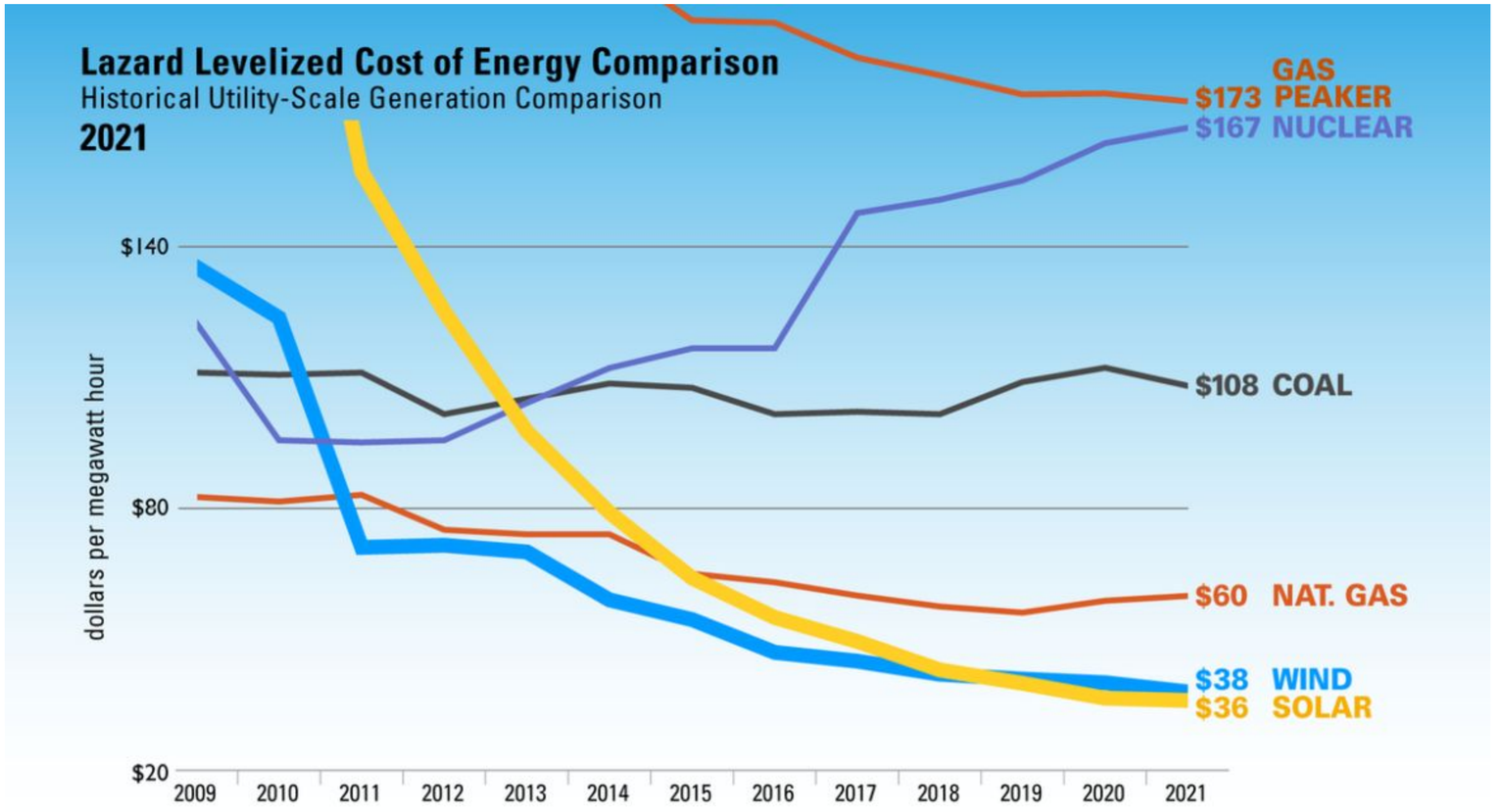




RethinkX


U.S. UTILITY-SCALE SOLAR POWER COST
Per kilowatt-hour, 2010 projected to 2030
$0.30
$0.25
$0.20
$0.15
$0.10
$0.05
$0.00
2010
$0.277/kWh
2017
The 2020 goal of the SunShot Initiative, reached three years early
2020
$0.046/kWh
2025 goal
$0.03/kWh
2030 goal
$0.02/kWh
projected
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
SOURCES: U.S. Department of Energy; NREL
PAUL HORN / Inside Climate News

Solar is now cheapest source of energy – ever!





Nearly firm generation [(S or W) + ~4hrs B] **cheaper** than the **operating cost** of **coal**, **nuclear**, **oil** & **gas** fired generation units. James Robos, CEO NextEra Energy (1)







Convergence:
Solar, Wind and Batteries (SWB)

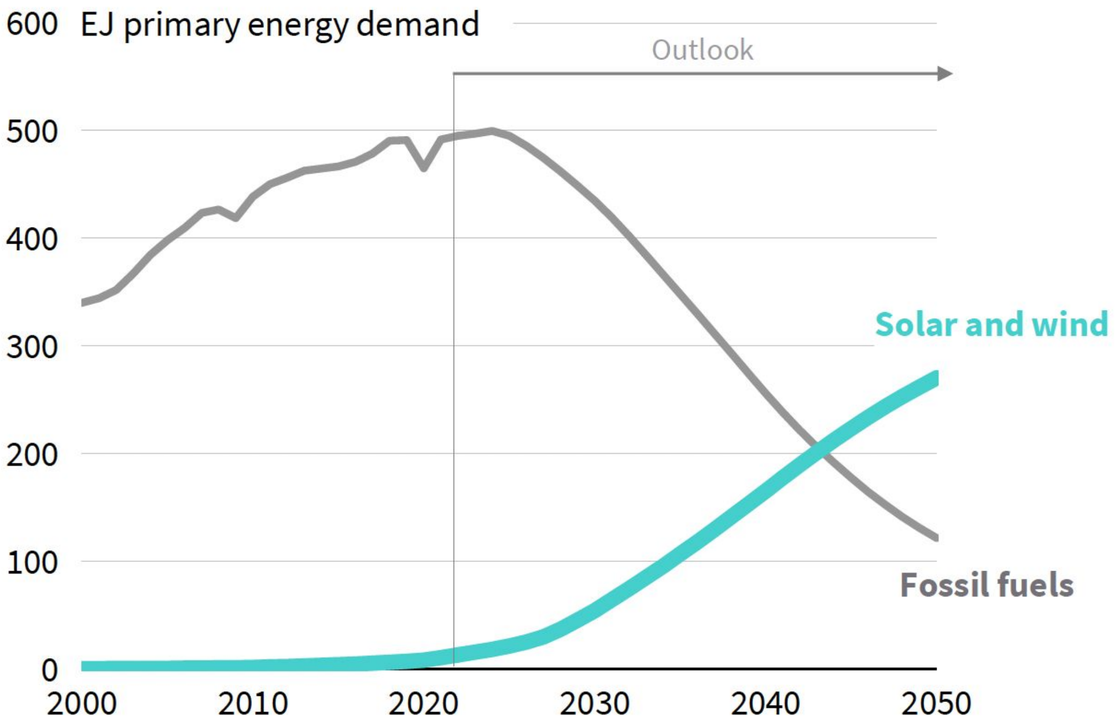
Cost Curve:
the cheapest sources of energy will become ~70% cheaper over the next decade!



RethinkX

The **new technology** narrative of exponential and beneficial change: a shift to a cheaper, faster, and distributed energy system

The new technology insurgent's energy outlook



Source: Rystad Energy 1.6°C Scenario.

The Economist

The solar age

The exponential growth of solar power will change the world

IT IS 70 YEARS since AT&T's Bell Labs unveiled a new technology for turning sunlight into power. The phone company hoped it could replace the batteries that run equipment in out-of-the-way places. It also realised that powering devices with light alone showed how science could make the future seem wonderful; hence a press event at which sunshine kept a toy Ferris wheel spinning round and round.

Today solar power is long past the toy phase. Panels now occupy an area around half that of Wales, and this year they will provide the world with about 6% of its electricity—which is almost three times as much electrical energy as America consumed back in 1954. Yet this historic growth is only the second-most-remarkable thing about the rise of solar power. The most remarkable is that it is nowhere near over.

To call solar power's rise exponential is not hyperbole, but a statement of fact. Installed solar capacity doubles roughly every three years, and so grows ten-fold each decade. Such sustained growth is seldom seen in anything that matters. That makes it hard for people to get their heads round what is going on. When it was a tenth of its current size ten years ago, solar power was still seen as marginal even by experts who knew how fast it had grown. The next ten-fold increase will be equivalent to multiplying the world's entire fleet of nuclear reactors by eight in less than the time it typically takes to build just a single one of them.



Solar cells will in all likelihood be the single biggest source of electrical power on the planet by the mid 2030s. By the 2040s they may be the largest source not just of electricity but of all energy. On current trends, the all-in cost of the electricity they produce promises to be less than half as expensive as the cheapest available today. This will not stop climate change, but could slow it a lot faster. Much of the world—including Africa, where 600m people still cannot light their homes (see Middle East & Africa section)—will begin to feel energy-rich. That feeling will be a new and transformational one for humankind.

To grasp that this is not some environmentalist fever dream, consider solar economics. As the cumulative production of a manufactured good increases, costs go down. As costs go down, demand goes up. As demand goes up, production increases—and costs go down further. This cannot go on for ever; production, demand or both always become constrained. In earlier energy transitions—from wood to coal, coal to oil or oil to gas—the efficiency of extraction grew, but it was eventually offset by the cost of finding ever more fuel.

As our essay this week explains, solar power faces no such constraint. The resources needed to produce solar cells and plant them on solar farms are silicon-rich sand, sunny places and human ingenuity, all three of which are abundant. Making cells also takes energy, but solar power is fast making that abundant, too. As for demand, it is both huge and elastic—if you make electricity cheaper, people will find uses for it. The result is that, in contrast to earlier energy sources, solar power has routinely become cheaper and will continue to do so.

Other constraints do exist. Given people's proclivity for living outside daylight hours, solar power needs to be complemented with storage and supplemented by other technologies. Heavy industry and aviation and freight have been hard to electrify. Fortunately, these problems may be solved as batteries and fuels created by electrolysis gradually become cheaper.

Another worry is that the vast majority of the world's solar panels, and almost all the purified silicon from which they are made, come from China. Its solar industry is highly competitive, heavily subsidised and is outstripping current demand—quite an achievement given all the solar capacity China is installing within its own borders (see Business section). This means that Chinese capacity is big enough to keep the expansion going for years to come, even if some of the companies involved go to the wall and some investment dries up.

In the long run, a world in which more energy is generated without the oil and gas that come from unstable or unfriendly parts of the world will be more dependable. Still, although the Chinese Communist Party cannot rig the price of sunlight as OPEC tries to rig that of oil, the fact that a vital industry resides in a single hostile country is worrying.

It is a concern that America feels keenly, which is why it has put tariffs on Chinese solar equipment. However, because almost all the demand for solar panels still lies in the future, the rest of the world will have plenty of scope to get into the market. America's adoption of solar energy could be frustrated by a pro-fossil-fuel Trump presidency, but only temporarily and painfully. It could equally be enhanced if America released pent up demand, by making it easier to install panels on homes and to join the grid—the country has a terawatt of new solar capacity waiting to be connected. Carbon prices would help, just as they did in the switch from coal to gas in the European Union.

The aim should be for the virtuous circle of solar-power production to turn as fast as possible. That is because it offers the prize of cheaper energy. The benefits start with a boost to productivity. Anything that people use energy for today will cost less—and that includes pretty much everything. Then come the things cheap energy will make possible. People who could never afford to will start lighting their houses or driving a car. Cheap energy can purify water, and even desalinate it. It can drive the hungry machinery of artificial intelligence. It can make billions of homes and offices more bearable in summers that will, for decades to come, be getting hotter.

But it is the things that nobody has yet thought of that will be most consequential. In its radical abundance, cheaper energy will free the imagination, setting tiny Ferris wheels of the mind spinning with excitement and new possibilities.

This week marks the summer solstice in the northern hemisphere. The sun rising to its highest point in the sky will in decades to come shine down on a world where nobody need go without the blessings of electricity and where the access to energy invigorates all those it touches. ■

remarkable is that it is nowhere near over.

To call solar power's rise exponential is not hyperbole, but a statement of fact. Installed solar capacity doubles roughly every three years, and so grows ten-fold each decade. Such sustained growth is seldom seen in anything that matters. That makes it hard for people to get their heads round what is going on. When it was a tenth of its current size ten years ago, solar power was still seen as marginal even by experts who knew how fast it had grown. The next ten-fold increase will be equivalent to multiplying the world's entire fleet of nuclear reactors by eight in less than the time it typically takes to build just a single one of them.



“To call solar power's rise exponential is not hyperbole, but a statement of fact. Installed solar capacity doubles roughly every three years, and so grows ten-fold each decade.

Such sustained growth is seldom seen in anything that matters. That makes it hard for people to get their heads round what is going on.”



“When it was a tenth of its current size ten years ago, solar power was still seen as marginal even by experts who knew how fast it had grown.

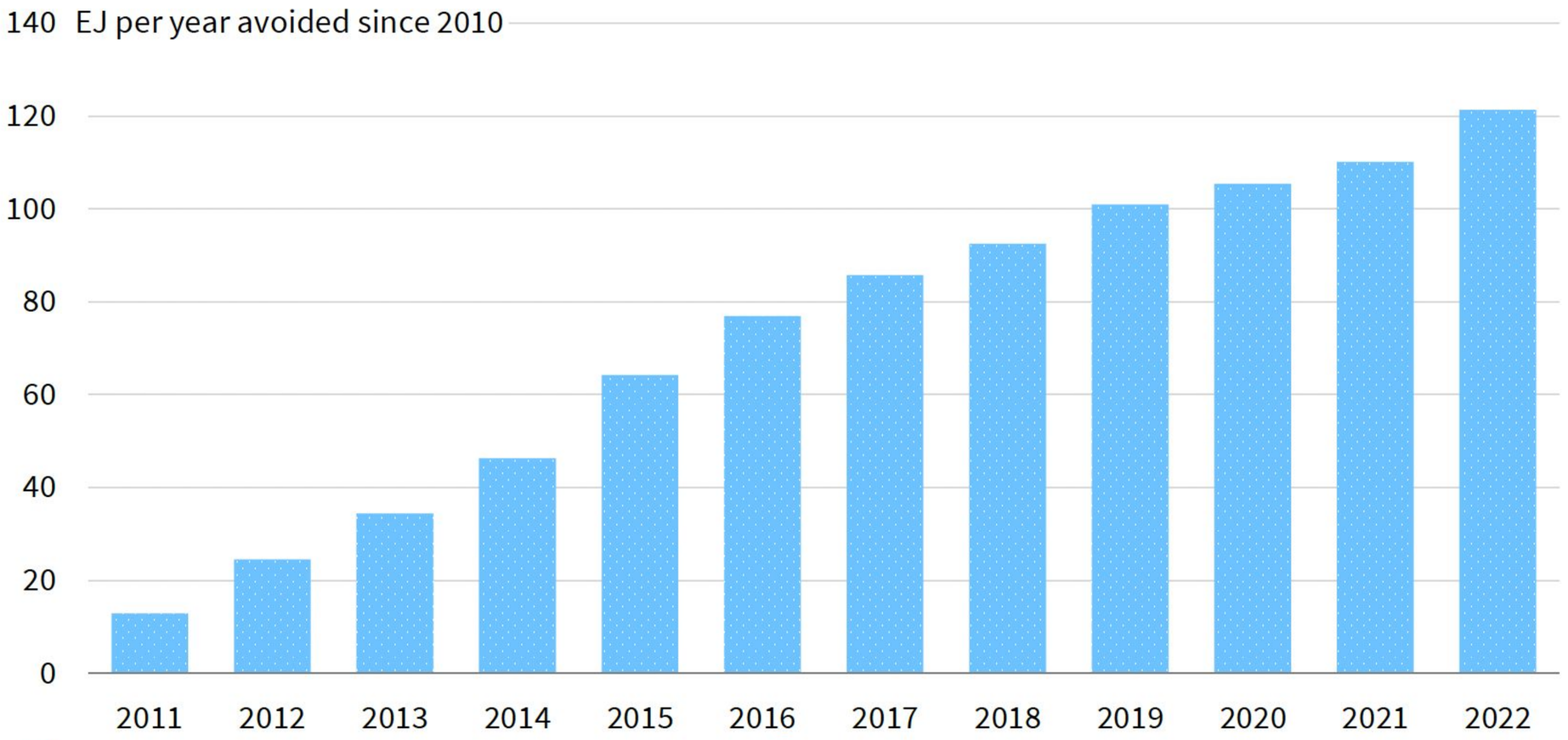
The next ten-fold increase will be equivalent to multiplying the world's entire fleet of nuclear reactors by eight in less than the time it typically takes to build just a single one of them.”

Improved Efficiency

Efficiency is the Deep Force of change

Efficiency gains since 2010 have reduced energy demand growth more than any other factor

Efficiency gains



Avoided energy

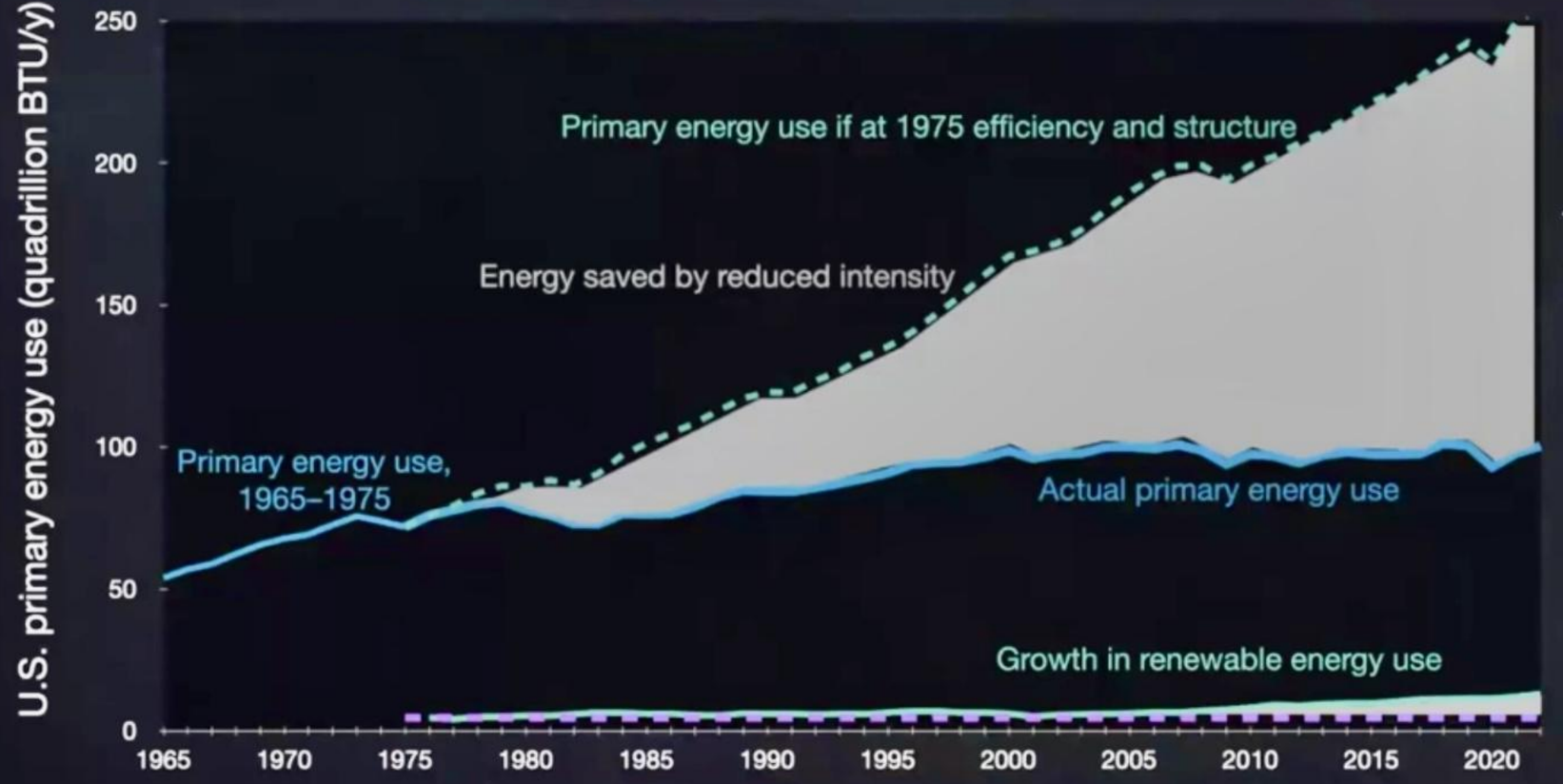
Efficiency gains over the last decade were one fifth of primary energy demand in 2022 of 632 EJ

Source: IEA WEB, IEA WEO, RMI calculations. Energy efficiency here is simply defined as the difference between GDP growth and energy demand growth.



Reduced energy intensity has had 27× the impact of renewable growth

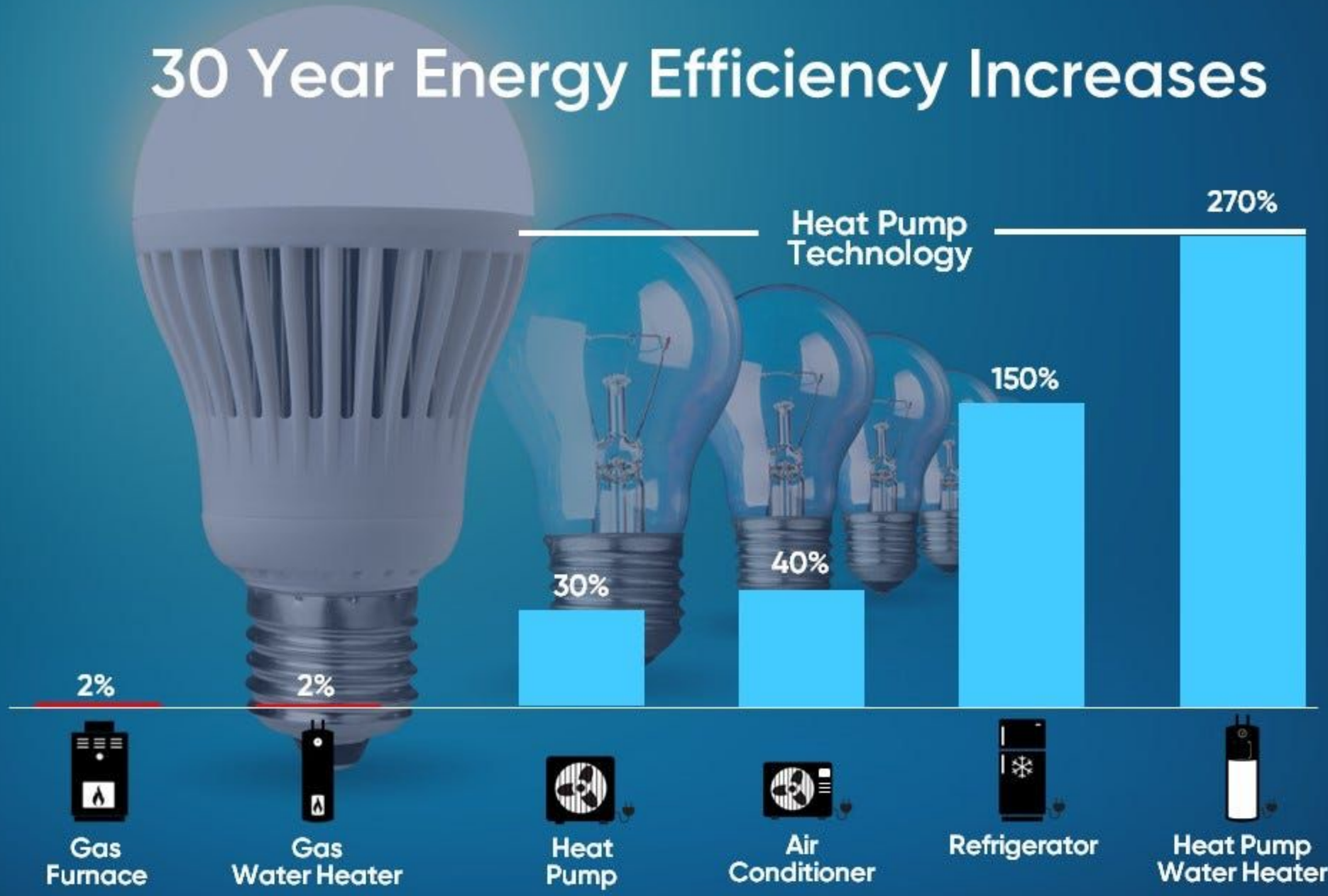
(United States, 1975–2022, not weather-normalized, USEIA data)



1975–2022 cumulative savings from reduced primary intensity: 3,208 qBTU

1975–2022 growth in total renewable output: 117 qBTU

30 Year Energy Efficiency Increases

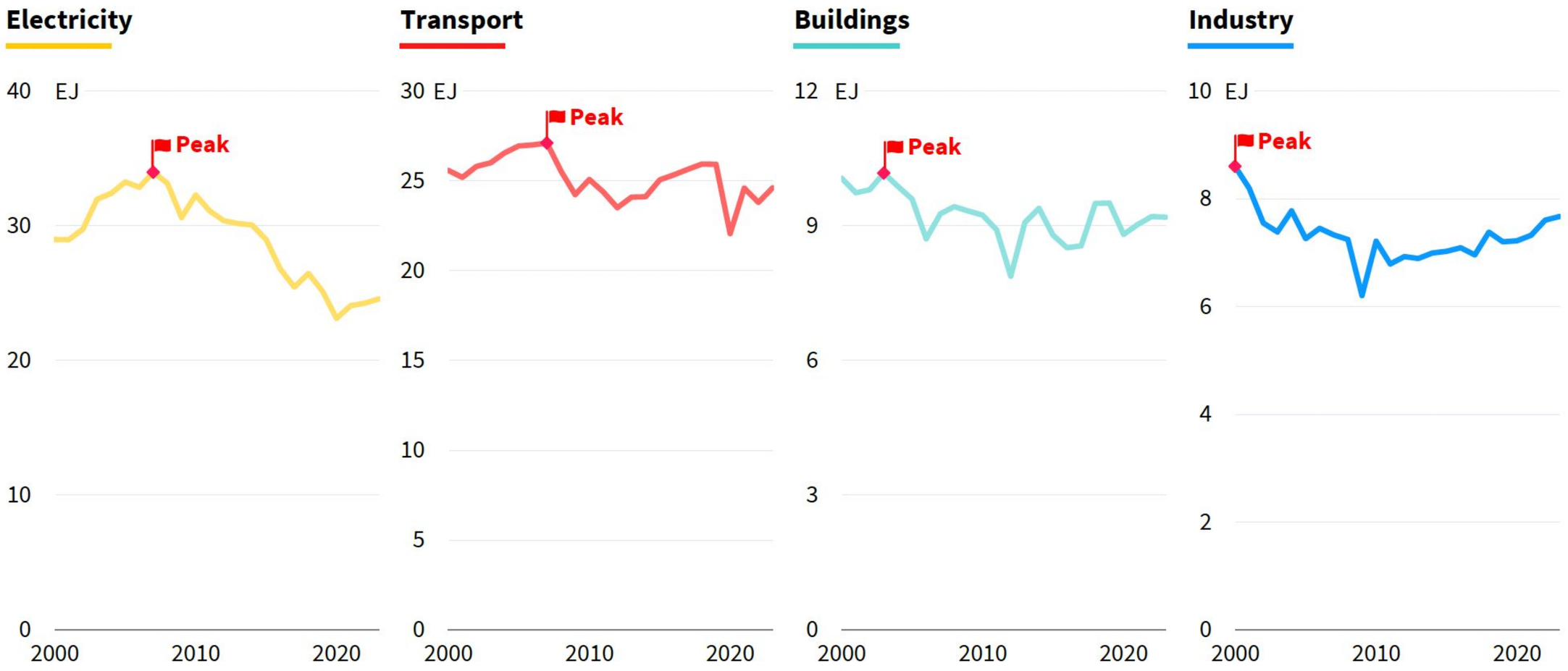


Minimum efficiency standards increases or energy factor increases from DOE - 1990 to 2020

electrify now

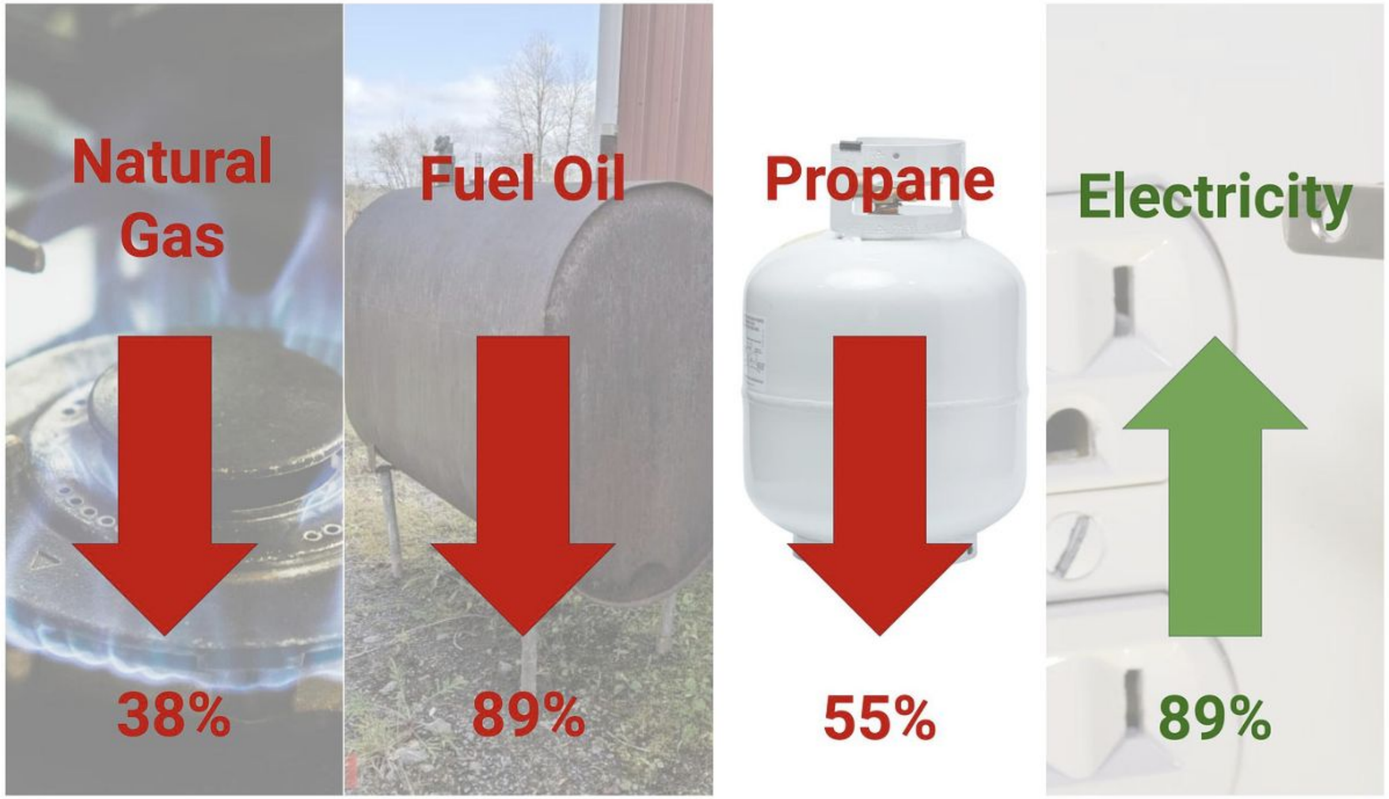
United States — every major sector is past peak fossil demand

Fossil fuel demand across sectors peaked more than 15 years ago



Source: BNEF NEO 2024.

Americans burn much less fossil fuel in their homes on average and use much more electricity compared to half a century ago. This good news means that even though the "Electrify Everything" movement became a leading decarbonization strategy a decade or so ago, American homes had actually been steadily electrifying long before that. An all-electric future is thus not only possible, we're well on our way to achieving it.

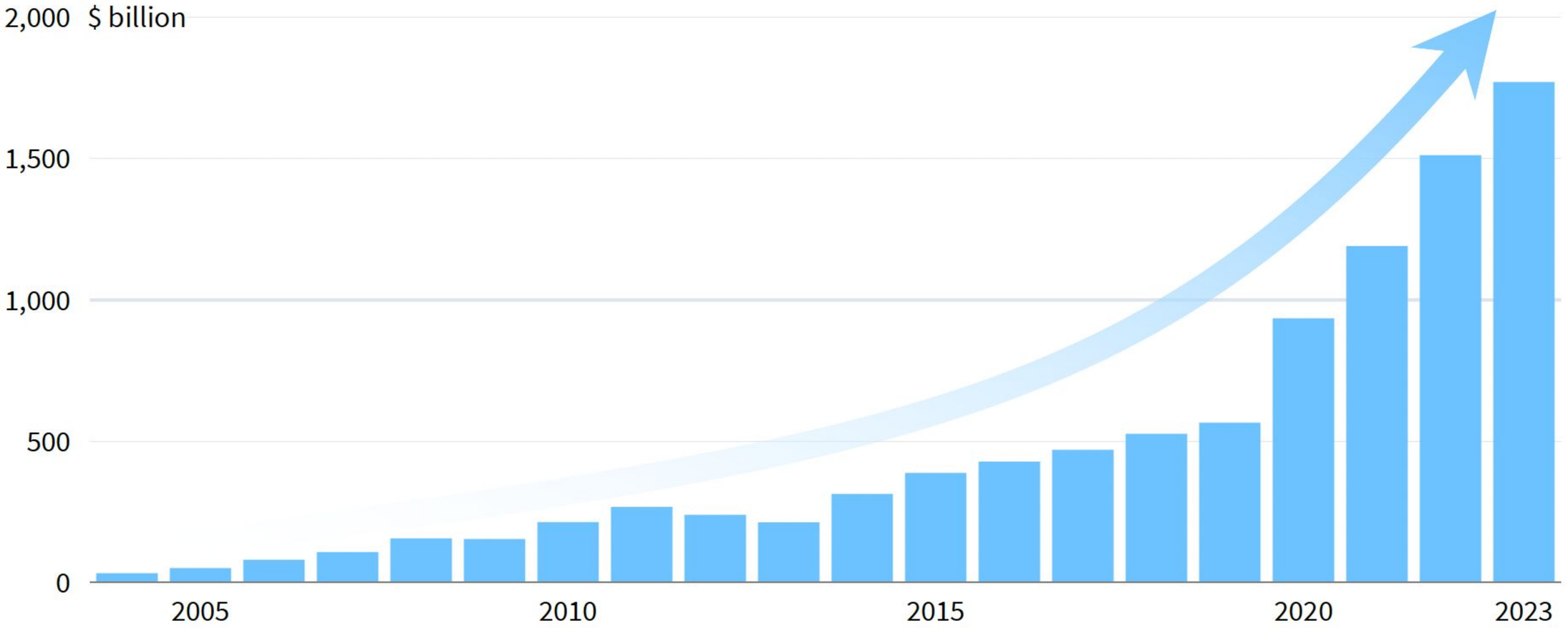


Per capita fuel consumption trends in American homes 1972-2022. Data from the Energy Information Administration.

Capital has poured into cleantech

The first cleantech trillion took decades; the second trillion will happen in four years

Cleantech investment

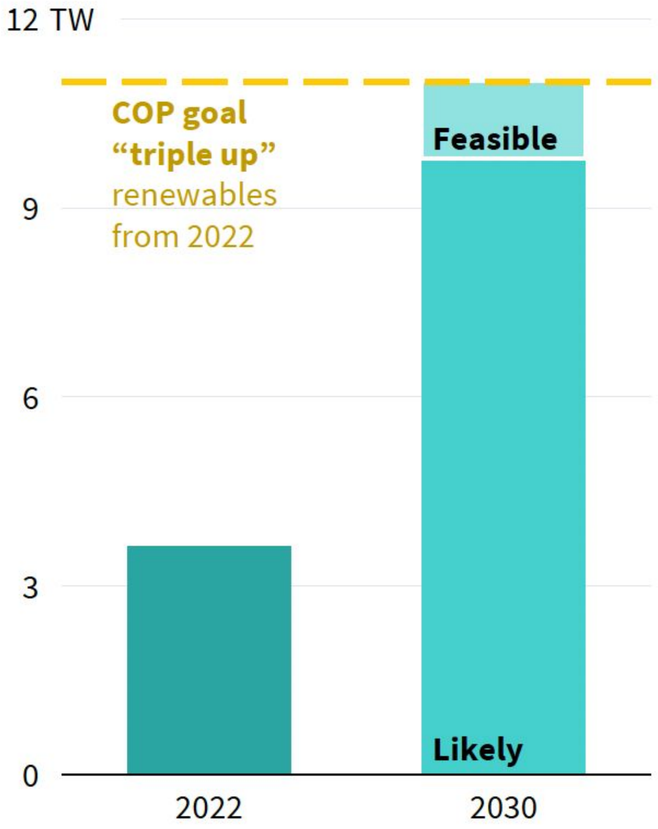


Source: BNEF.

Tripling renewables by 2030

S-curves suggest we will triple renewables

Renewable capacity

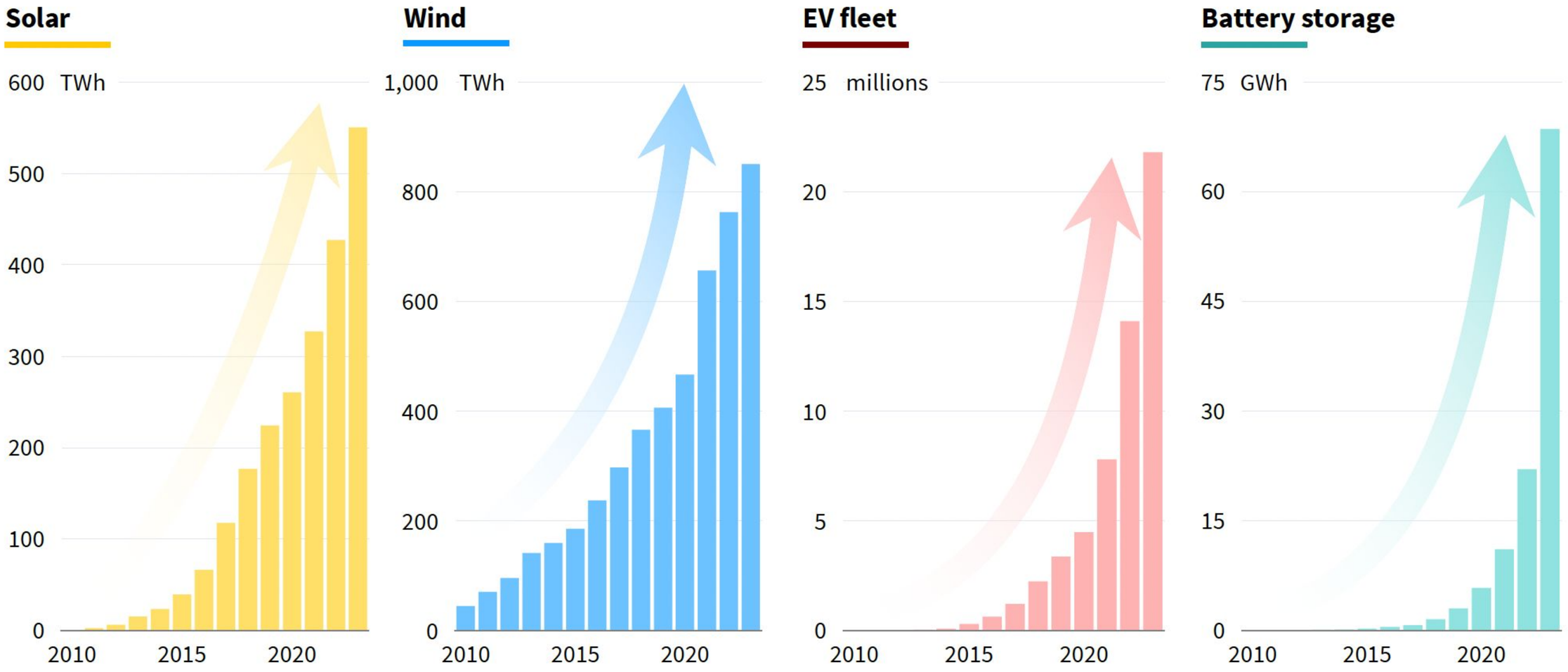


RMI

Source: IEA APS scenario as likely (Announced Pledges Scenario); NZE as feasible (net zero emissions).

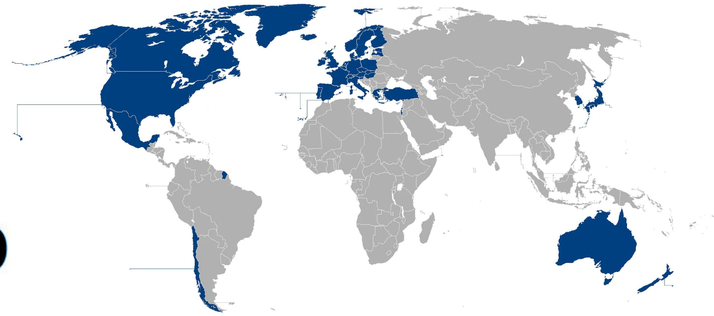
Super-fast growth in China drives change

In a decade, solar generation increased by 35 times, wind 9 times; EVs and batteries scaled even faster



Source: IEA, BNEF.

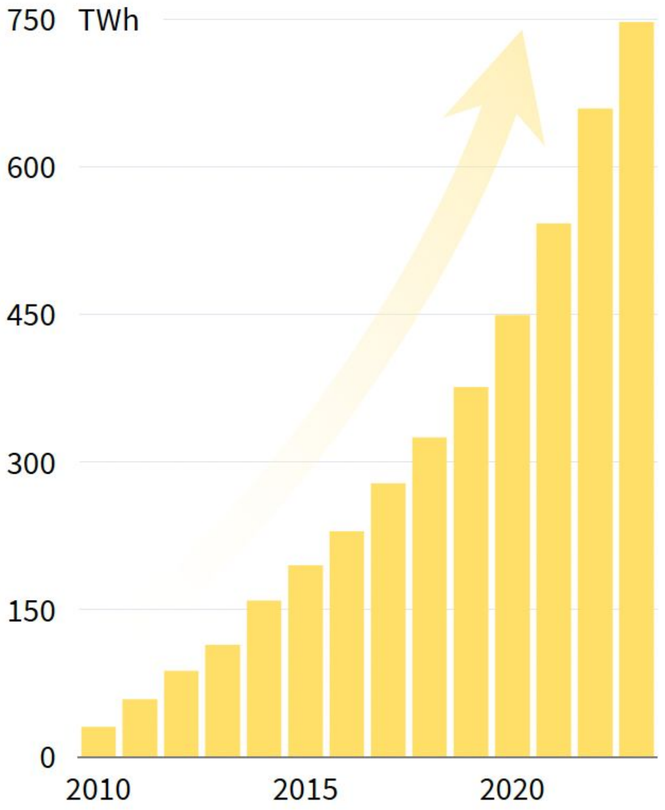




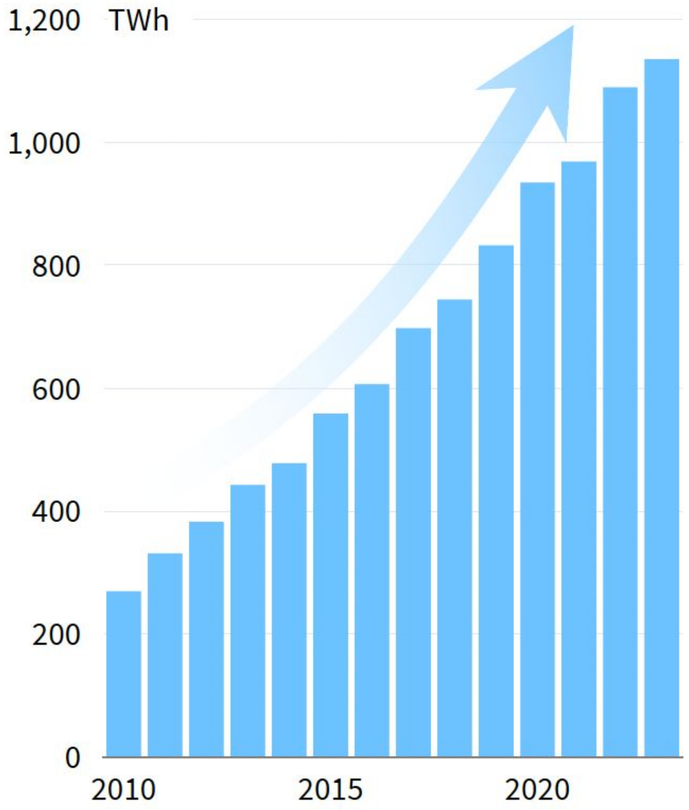
Exponential growth is also happening in the OECD

Over the past decade, solar generation went up 7 times, wind 3 times, and EVs sales up over 50 times

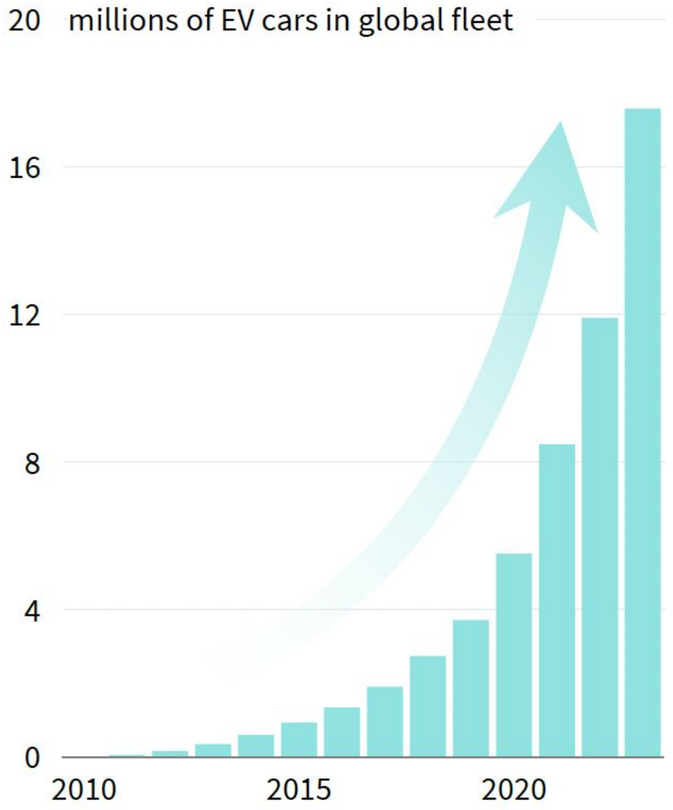
Solar



Wind



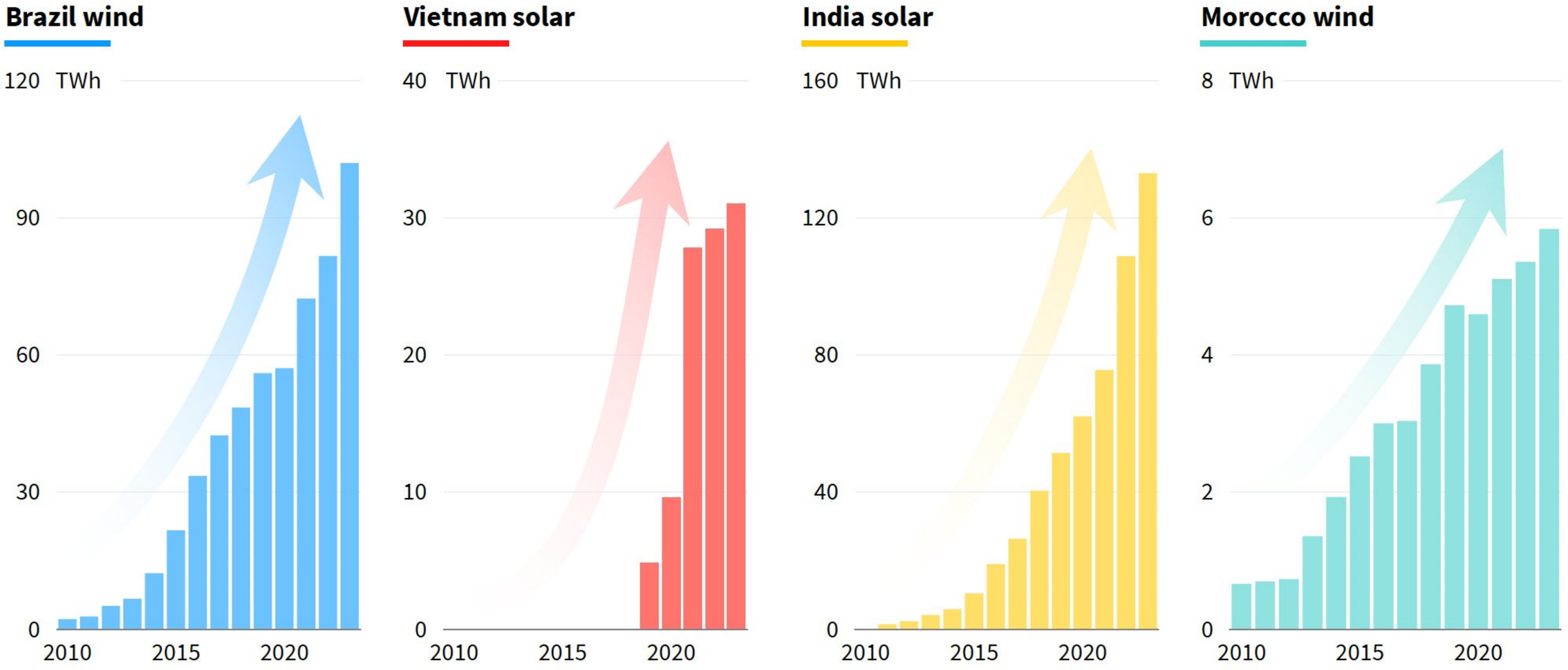
EVs



RMI *Source: Ember, IEA.*

Exponential growth in emerging economies

The adoption of superior technology is not confined to the Global North



RMI Source: IEA.

NORTH COUNTY CLIMATE CHANGE ALLIANCE

Our Changing Planet Series Event, August 13, 5:30 PM PT



Special Guest!

Mark Jacobson, PhD

Director, Atmosphere/Energy Program, Stanford University

100% Clean, Renewable Energy and Storage for Everything

Dr. Jacobson will present his groundbreaking work on the scientific basis of the energy portion of the U.S. Green New Deal and pathway to 100% renewable energy in cities, states, and countries worldwide.

NCCCA

Event Moderator



Karl Aldinger
President, NCCCA

100% IN 139 COUNTRIES

Transition to 100% wind, water, and solar (WWS) for all purposes
(electricity, transportation, heating/cooling, industry)



- Residential rooftop solar **14.89%**
- Solar plant **21.36%**
- Concentrated solar plant **9.72%**
- Onshore wind **23.52%**
- Offshore wind **13.62%**
- Commercial/govt rooftop solar **11.58%**
- Wave energy **0.58%**
- Geothermal energy **0.67%**
- Hydroelectric **4%**
- Tidal turbine **0.06%**

JOBS CREATED 52 MILLION

JOBS LOST 27.7 MILLION

100% Canada

A vision for the transition to 100% wind, water & solar energy



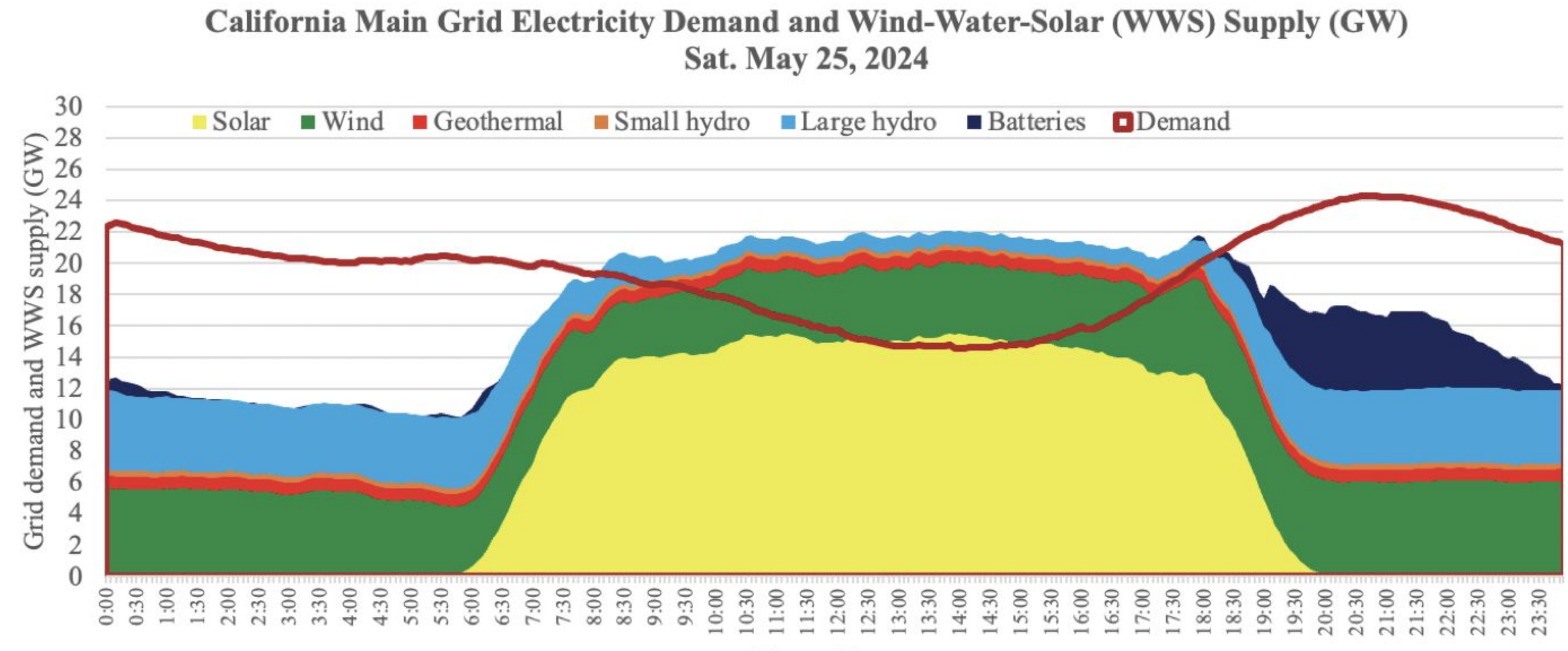
- Residential rooftop solar **7.6%**
- Solar plants **8.9%**
- Concentrating solar plants **0%**
- Onshore wind **32.7%**
- Offshore wind **8.9%**
- Commercial & government rooftop solar **14.7%**
- Wave devices **0.7%**
- Geothermal **2.6%**
- Hydroelectric **23.6%**
- Tidal turbines **0.3%**

40-Year Jobs Created

Number of jobs where a person is employed for 40 consecutive years.

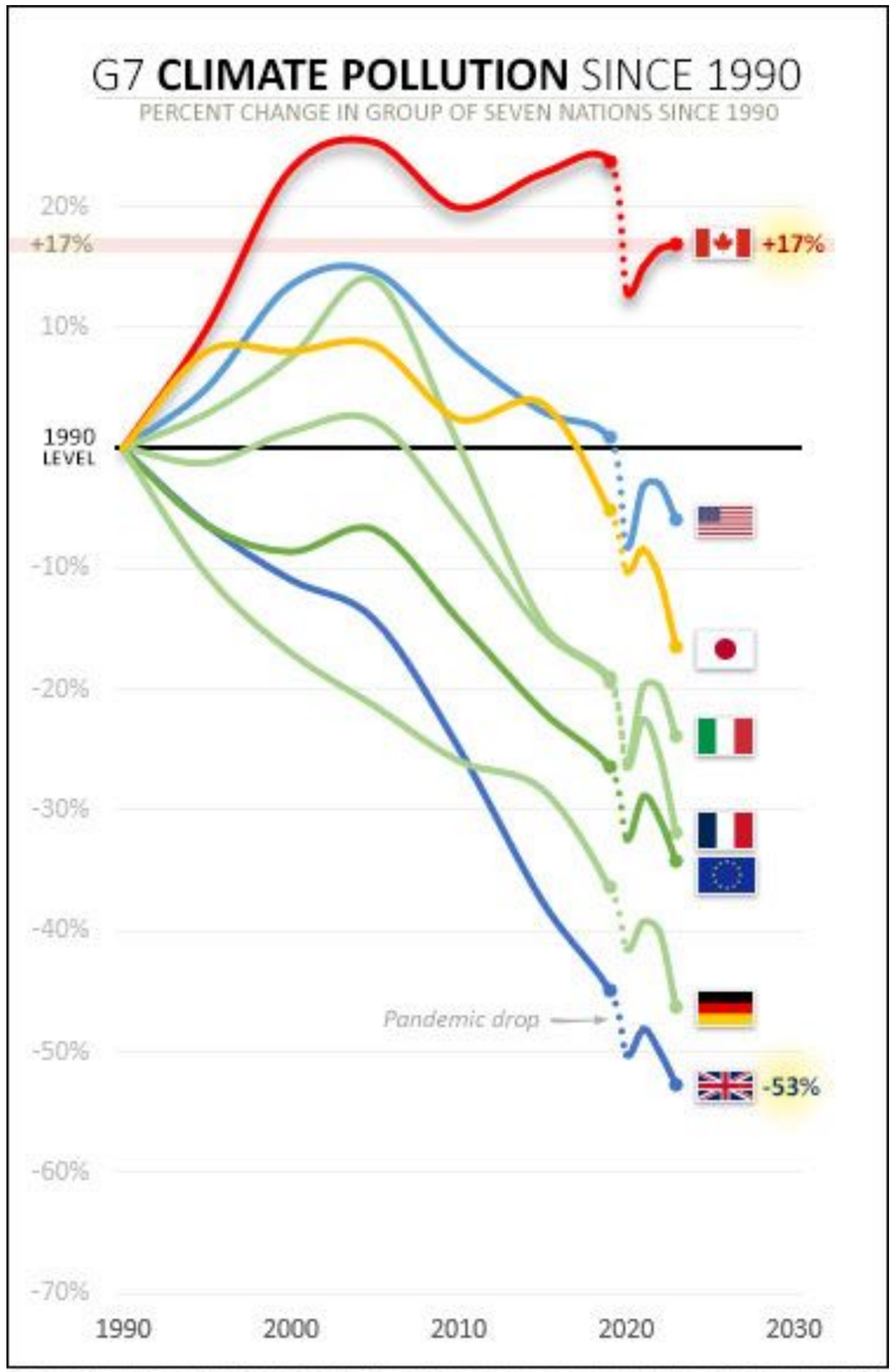
- Construction jobs: **234,505**
- Operation jobs: **215,360**

California May 25th 2024:
Cleantech meets all Electrical Demand all Day



Meanwhile …

Back in Canada



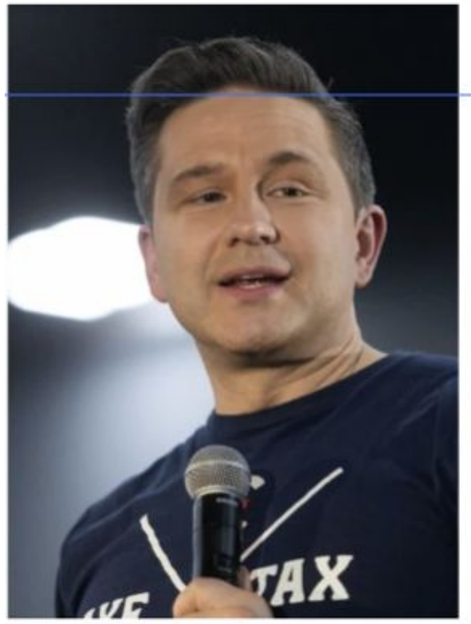
G7 CLIMATE POLLUTION CHANGES SINCE 1990. Historical emissions data thru 2022 from UNFCCC National Inventory Reports in 2024. Chart shows every fifth year from 1990-2015 and then each year

Sadly, Canadian priorities have been:

- Maintaining billions of dollars in subsidies each year for the fossil fuel industry
- Supporting renewables at 1/90th rate of that for fossil fuels (2020-2022: $150 million vs $13.5 billion/year)
- Providing major tax credits (subsidies) to O&G industry for the dubious floundering Carbon Capture Utilization and Storage technology
- Paying $32 billion to build the Transmountain oil pipeline
- Support for fracked natural gas pipelines in BC
- Federal proposals for regulating changes to: the building code, zero-emission vehicle sales, oil and gas emissions cap, (but the implementation timelines are anathema to the emergency)
- In Ontario, a commitment to spending 112 billion on nuclear power - too slow and too expensive to be a climate solution, not to mention a little risky.
- In Alberta, a 7 month pause on renewables recently - undermined investor confidence, etc.

Sadly, Canadian priorities have been:

- Billion in Fossil Fuel subsides -
- Major tax credits for the floundering false climate solution of Carbon Capture
- $32 billion for the Transmountain oil pipeline
- Support for fracked natural gas pipelines in BC
- Supporting renewables at 1/90th rate of that for fossil fuels (2020-2022: $150 million vs $13.5 billion/year)
- Federal proposals for regulating changes to: the building code, zero-emission vehicle sales, oil and gas emissions cap, (but the implementation timelines are anathema to the emergency)
- In Ontario, 112 billion on nuclear power - too slow and too expensive to be a climate solution, not to mention risky.
- In Alberta, a 7 month pause on renewables recently - undermining investor confidence, etc.



Today's Conservatives not fit to lead in an emergency

Today, as another existential and civilizational threat barrels down upon us, what would Conservative leadership look and sound like? Pierre Poilievre's Conservative Party is a far different beast than your grandparents' Conservatives, and Poilievre is no Winston Churchill.

Opinion



By Seth Klein | Opinion, Politics | April 19th 2024

CANADA'S NATIONAL OBSERVER

The climate movement must shift gears or it's done

By Seth Klein | Opinion | August 27th 2024



Seth Klein

Team Lead and Director of Strategy with the Climate Emergency Unit

A different type
of climate solution

COOPERATE FOR CANADA

With our present electoral system, too often the CPC wins seats – despite a progressive majority. We must act accordingly, and cooperate to prevent this.

We are focused on key ridings where a cooperative approach could prevent a Conservative win.

In Conclusion

- This is the decade of energy and transportation disruption
- Exponential growth of renewables driven by technological innovation and huge cost reductions
- Cautious optimist that the world could meet its 2030 COP goal of tripling renewables.
- Canada is out of step with developments around the world.