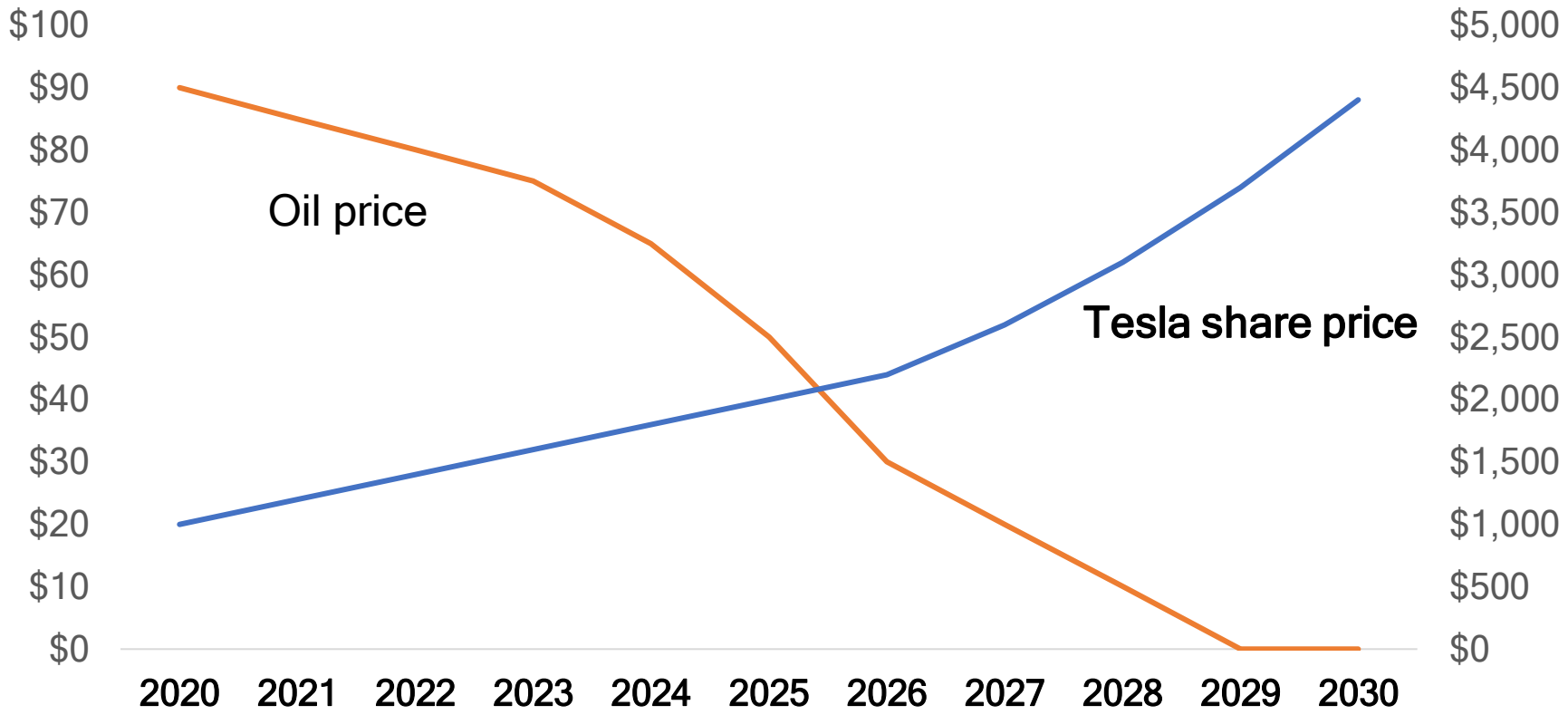
Energy Transition – Multi-$trillion Ponzi scheme or the biggest tech market ever?

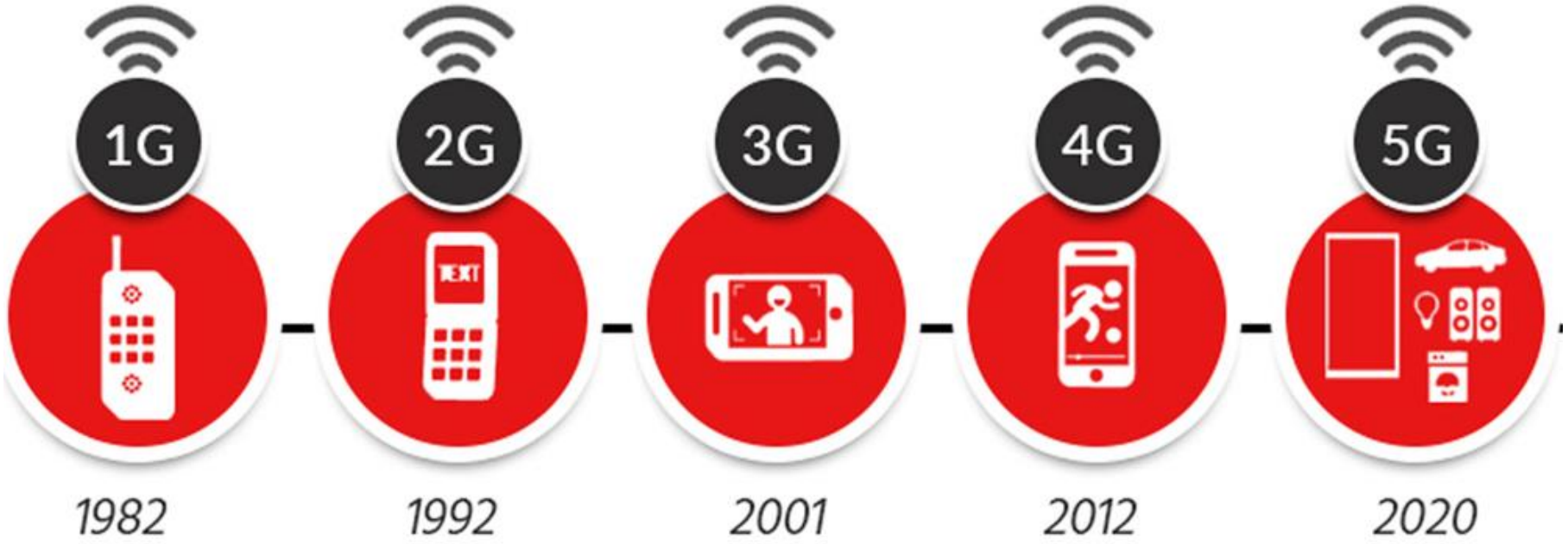
Institute for Sustainable Energy and the Environment (I-SEE) seminar

Who's right - Tesla or Exxon Mobil



Forecasts we've made successfully in other markets

2003 - Apple to become biggest consumer electronics supplier in the world
2004 – Wireless standards accelerating in their deployment



More Forecasts

2008 – Cellular largest format for video delivery
2010 – Wifi largest wireless network in the world, 20bn chips a year
2012 – 5G takes 15 years to deploy
2013 – Broadcast TV ad revenues switch online

WiFi Protocol	Year	Speed
WiFi6 (80211.ax)	2021	9.6 Gbps
802.11ac wave2	2016	1.73 Gbps
802.11ac wave1	2014	866.7 Mbps
802.11n	2009	450 Mbps
802.11g	2003	54 Mbps
802.11a,b	1999	11Mbps
First Gen WiFi	1997	2Mbps

WiFi has increased its performance by 5000X in 24 years

How much has natural gas improved its performance by in that time? Or coal, or oil?

More Forecasts

And many others relating to the Deployment strategies of 5G, the uptake of different video compression techniques, the emergence of Sports streaming at scale

If we had a super-power, it would be forecasting industry transformations that take only 10 to 20 years. But how long do transformations take now?

How long do you keep a TV, a car? a Tablet? a PC? a phone?

How long does an energy grid take to develop and what will make it develop? One thing – the Promise of extraordinary returns

Getting it right

When everyone in energy fails to forecast accurately - you need someone who is used to hypergrowth - that's Rethink

Is this just rising climate change awareness? Absolutely NOT
This is a least cost industry and with solar and wind parity, the brakes have been taken off spending

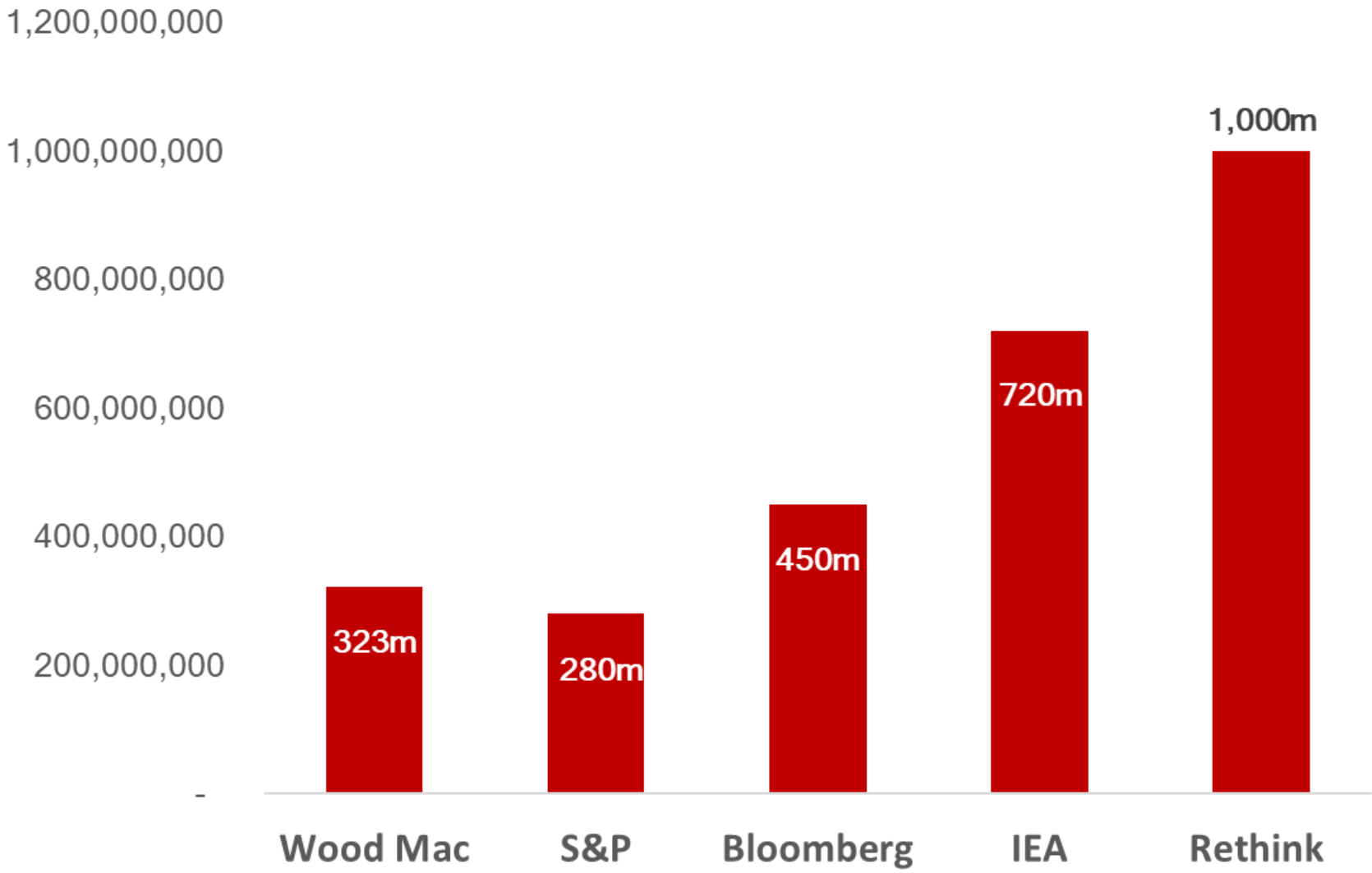
Rethink Energy 3.5 years old more accurate forecasts than anyone else in the industry – already the IEA is shifting its stance to copy us.

The IEA has been around for 46 years?

What's the secret? – predicting key inflexion points – moments of change

Cumulative Global EV forecast to 2040

How could we forecast this in early 2020?



Can anyone do mathematical series

What's the next number in the sequence

2017	2018	2019	2020	2021
1%	2.5%	10%	17%	24.5% ....
Differences	1.5%	7.5%	7%	7.5%

Inescapable conclusion in Europe, with numbers like this being typical is 32%, followed by 39%, followed by 46% - but it may in fact be faster

2019 was depressed because no EVs were used in adverts, in 2020 we had a pandemic, in 2021 – more pandemic

All while ICE car sales are 20% to 35% down on prior years

There are three rules…

The three rules we have used to predict growth in consumer markets

1)I want one
2)I can afford one
3)I know someone who has one

Who has seen a Tesla today – I have driven 12 miles and I have seen 6 and I live in a sleepy Cotswold village, looks 100 years old, and I saw 3 before I left it

All put a T in the chat box or N if you have not seen a Tesla while driving today.
We'll count them later

Here's how we calibrated our research

In Q2 2020 the world was full of headlines saying EV sales had collapsed

The truth was that EV sales in China had suffered from the withdrawal of subsidies

By Q3 they were back

This gave us two examples where all things were the same except subsidies

Q1 and Q2 2021 gave us a chance to test our forecasts and we had more or less forecast them perfectly

However, some things had changed

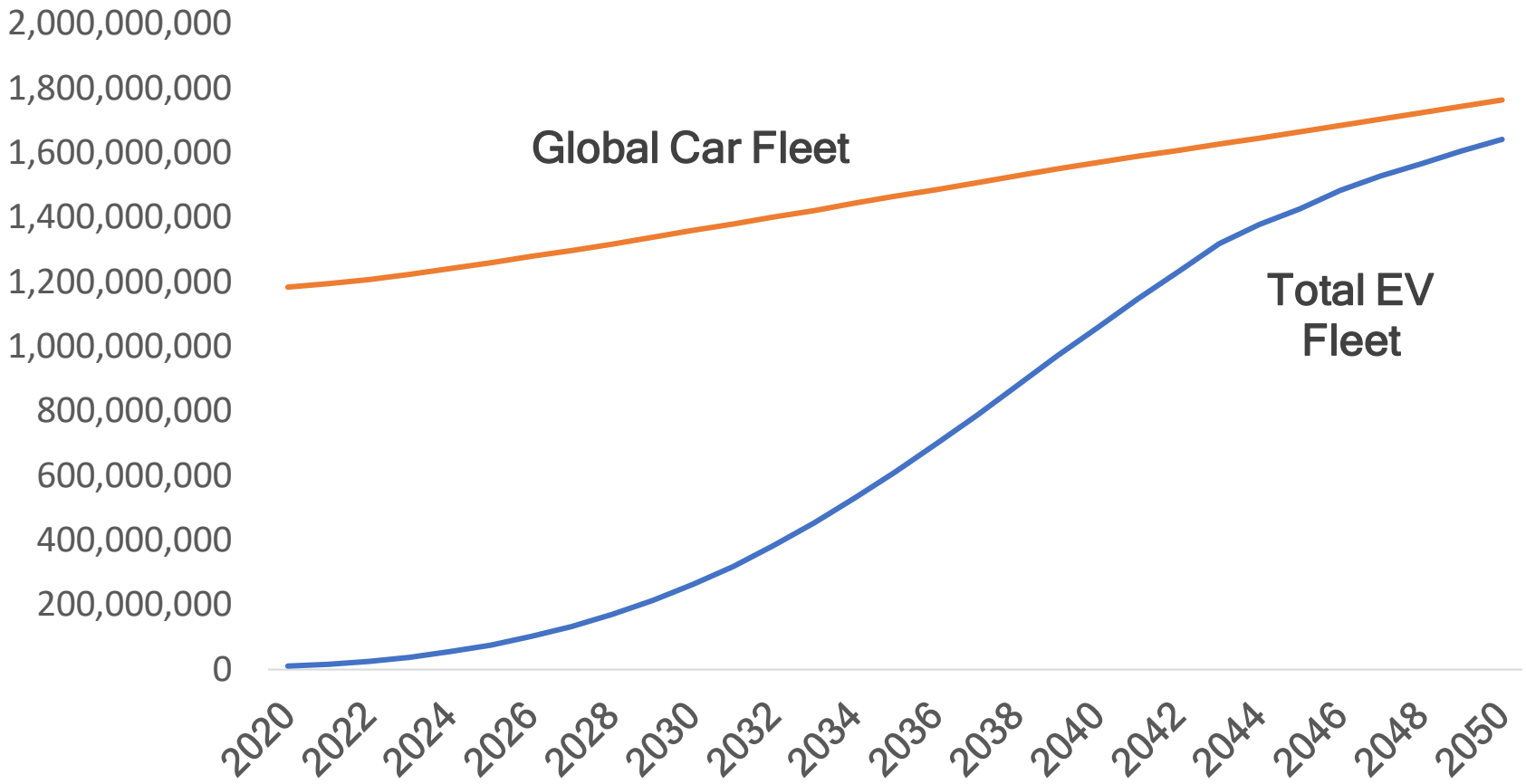
Biden came to power promising 500,000 extra charge points

All the major car makers in the world including GM, Ford, VW, BMW, Volvo, Mercedes, Toyota, Jaguar Land Rover, Stellantis, Honda and Nissan have made promises to transform to EVs. Can you imagine the effort of setting up those supply chains?

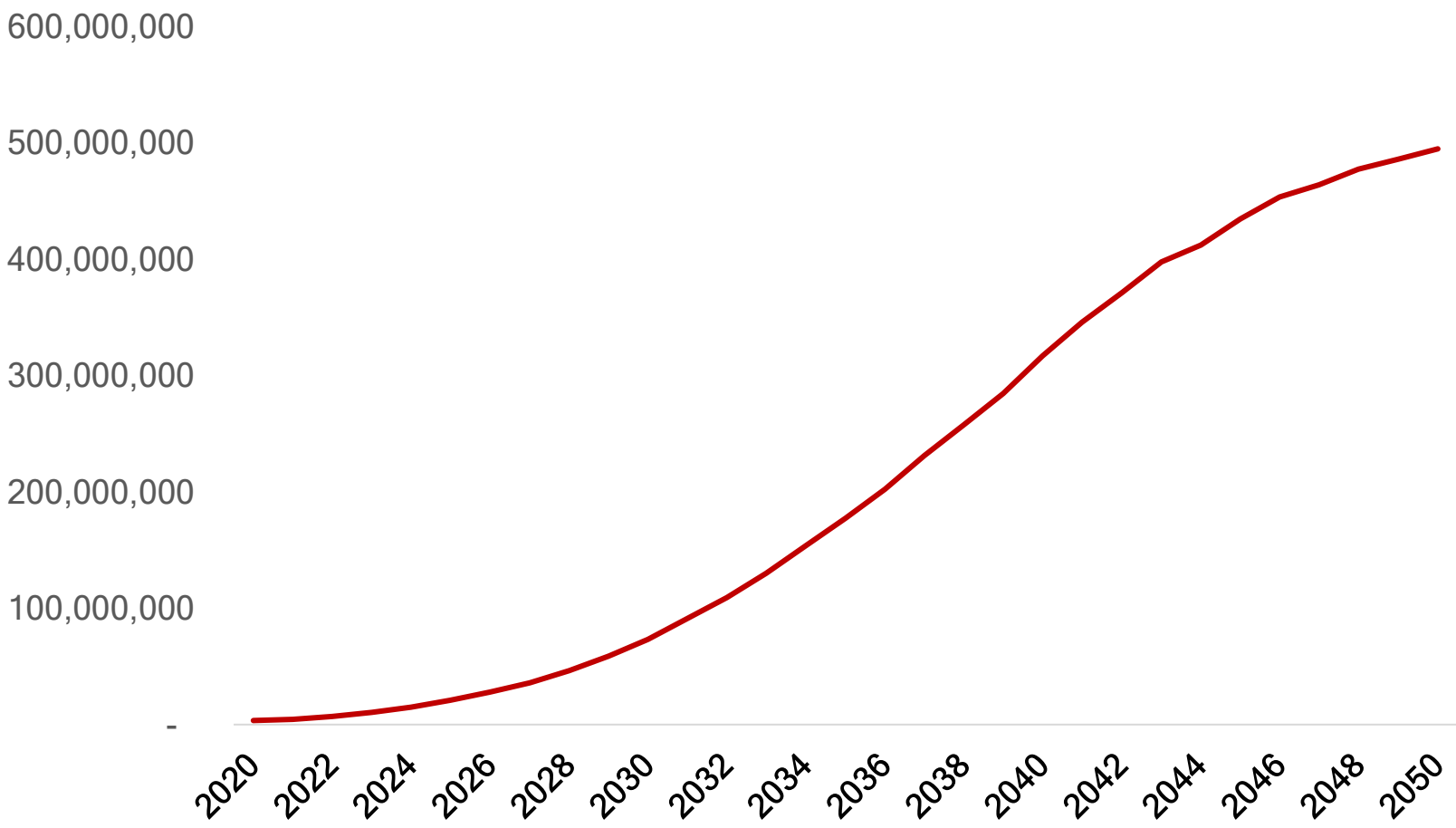
The European Commission issued directive to every EU country must no longer allow new ICE vehicles to be sold by 2035.

This sped things up slightly…

Global EV fleet penetration to 2050



Global Public and Private Charging points to 2050



Constructed from government spend promises, current rate of growth, ratio of installed charge points per EV, on a country-by-country basis

EVs in the UK

2022 over 1 million,
2030 10 million

	2020	2021	2022
EV additions	175,082	248,364	344,163
EV cumulative	439,882	688,246	1,032,409
Total cars in UK	32,700,000	32,219,734	31,746,187
% Evs installed	10.7%	15.0%	19.5%
Non EV Cars	32,260,118	31,531,488	30,713,778
Public Charge P	36,950	51,618	72,269
Private Charge I	139,003	194,184	271,868

Forecasting individual behaviours

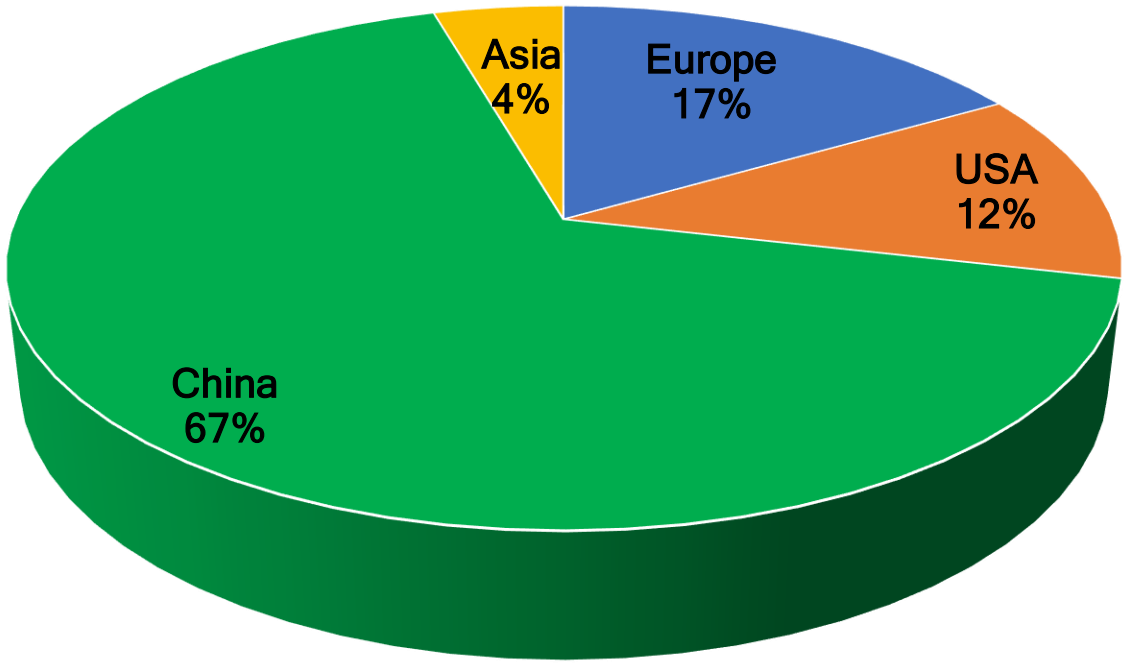
No ICE cars by 2035

$23.7 million in compensation with $16.8 million in share options when she saw the value that Tesla had.

How many lithium engineers does it take to launch a Gigafactory?

200 Gigafactories by 2030 - 3,000 GWh of battery - only enough to make 46.8m EVs

Lithium Ion factory capacity by 2030



It's only JUST enough – more Gigafactories will be needed – Gigafactories can sell everything they make

Output must double by 2040 – hit 6,000 GWh of production eventually

Source: Oxford Institute for Energy Studies

Which make it one of the fastest growing technology markets ever

Which kind of answers the question we set as the title for this presentation

What about Solar, Wind, Energy Storage and Hydrogen?

What changes most about fossil fuels?

Fossil fuels only change with supply and demand – all price changes are short-lived.

Solar, Wind, Energy Storage and hydrogen change because we are relatively inexperienced at doing them

Fall in costs governed by Wright's law which states price falls by X% whenever market doubles. You just have to find out what the X% is.

In solar the constant in Wright's law is about 23%

All gains are process and volume gains, breakthroughs are extra

We are modeling Hydrogen electrolyzers at 20%

Today solar panels cost roughly the same, but soft costs are lower, and some produce more electricity, so the cost per watt continues to fall

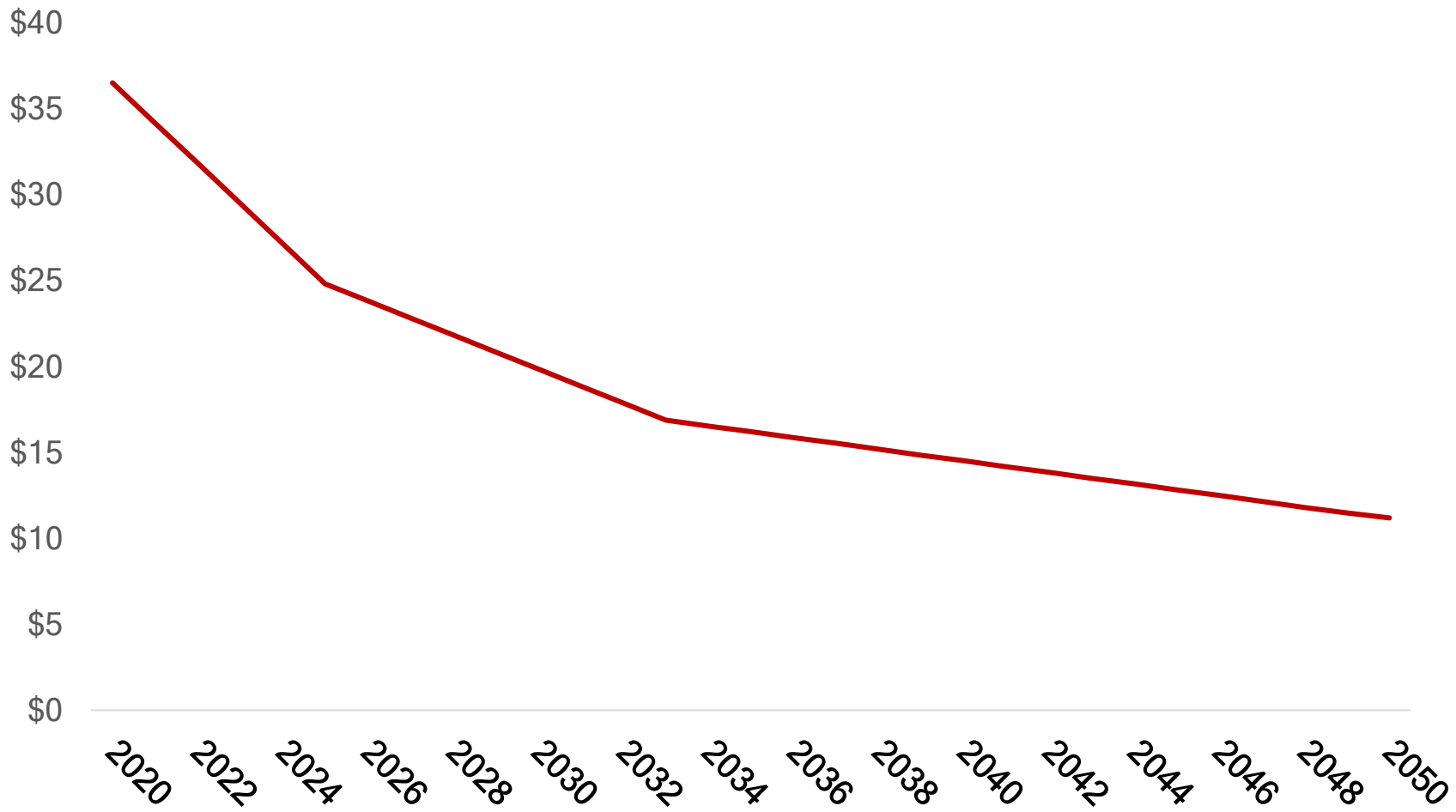
What about polysilicon pricing going up and import tariffs

NREL has calculated that for 2021 solar costs have fallen 12% in the US
Remember our constant is each time installations double, not each year

This is with high import tariffs, some parts of the market cut off due to Uyghurs oppression, with global shipping costs through the roof, with aluminum and steel up in costs, and polysilicon and glass up almost 50%.

The polysilicon shortage will go by 2023, the transport anomalies will be behind us in 2022, and metals costs will level out

Forecast LCOE per MWh of solar using Wright's law



Breakthroughs include Perovskite, and perovskite tandems 27% of energy to 40%.

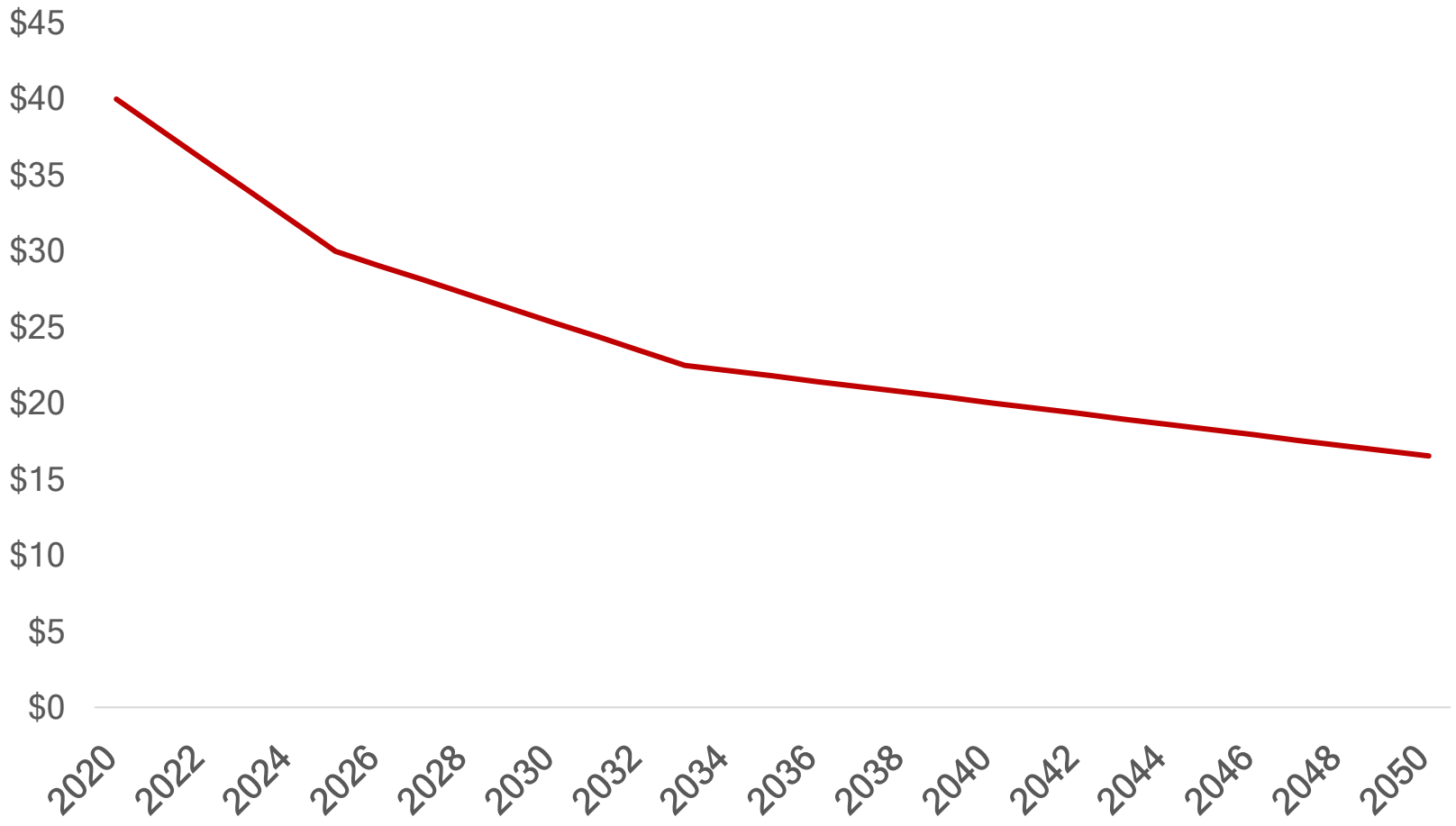
Cost down, output doubles

Transparent solar windows Commercial timeframe 2032.

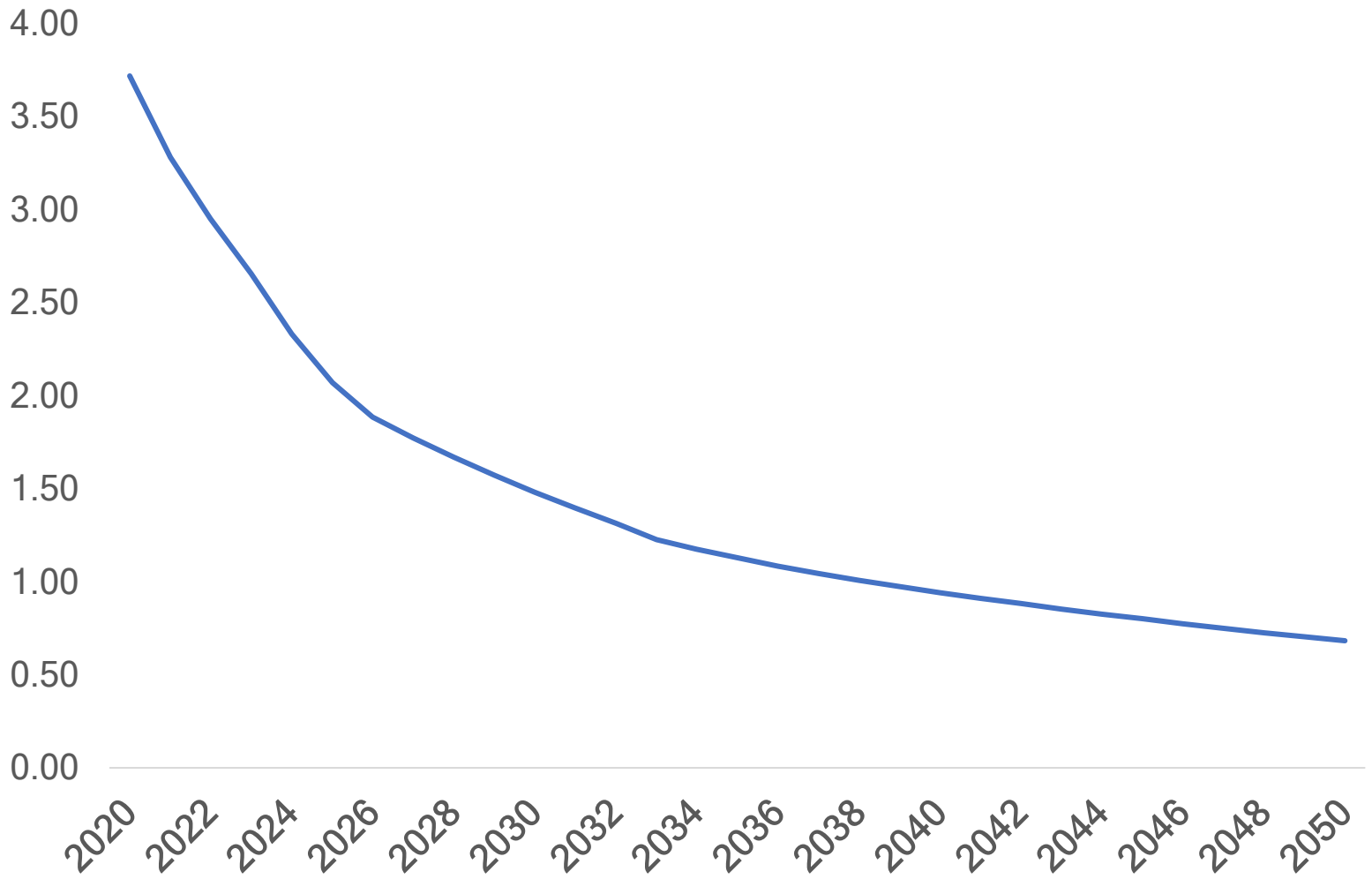
Carbon nanotubes turn heat to light and harvests it - electricity from 27% to 80%. Commercial timeframe 2035.

This curve is with Zero breakthroughs

Forecast LCOE per MWh of wind using Wright's law



Green Hydrogen Cost [$/kg]



A few worry that hydrogen is a product looking for a market…

Is hydrogen about distribution? Or making it where you need it? We think it is both.

Is it

Electrolyzer

Fuelling station

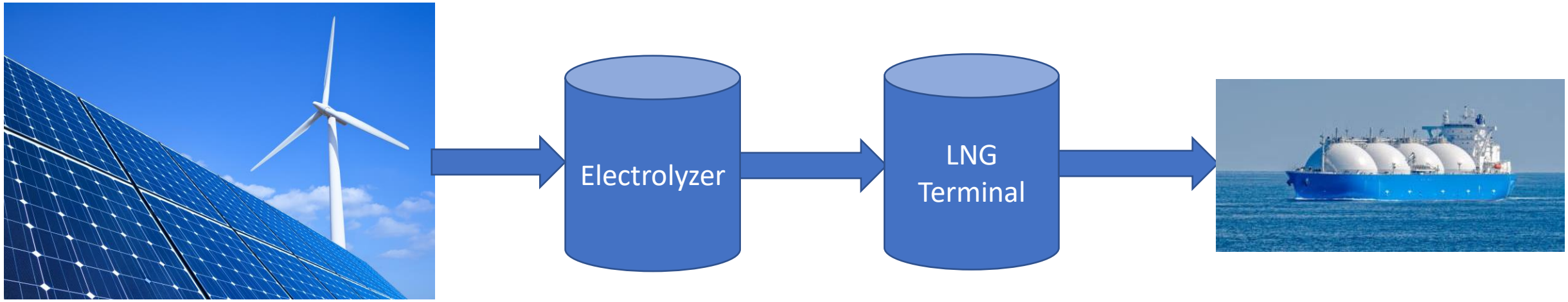
Or

Electrolyzer

Pipeline

Fuelling station

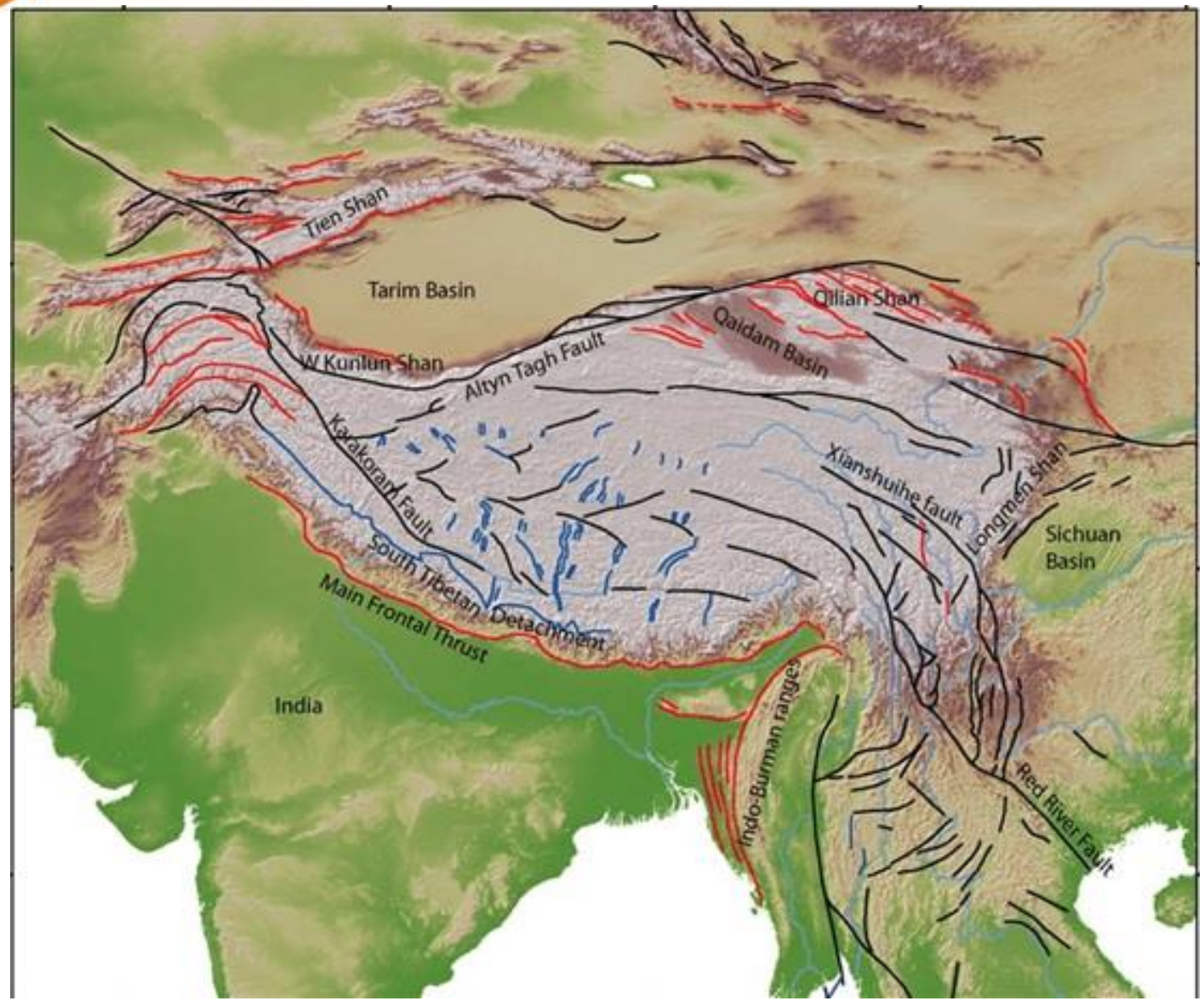
Or worse – could it be this?



Only countries with insufficient land space to have a serious renewables structure will import hydrogen

Only Japan and South Korea come to mind

Finally, a few world on climate change



Himalayan Mountains and the Tibetan Plateau

Yangtze, the Yellow River, the Ganges and the Indus – which supply water to 2.7 billion people

Yangtze alone home to 460 million people – falling in flow since 1980 – 1000 lakes dried up already

By 2050 over 40% of the glaciers will be gone, by 2100 all of them will be gone

Which results in millions of these…

Or worse still…

This…

So don't tell anyone that climate change is NOT dangerous

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