Institute for New Economic Thinking AT THE OXFORD MARTIN SCHOOL

Smith School of Enterprise and the Environment

UNIVERSITY OF OXFORD

A new perspective on decarbonising the global energy system

COP26 Global Alliance of Universities on Climate

12th November 2021

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with thanks to Prof J. Doyne Farmer & Dr Rupert Way

CHATHAM HOUSE

Foreign, Commonwealth & Development Office

Overview

What are decision-makers being told about climate mitigation pathways?

What is wrong with this story?

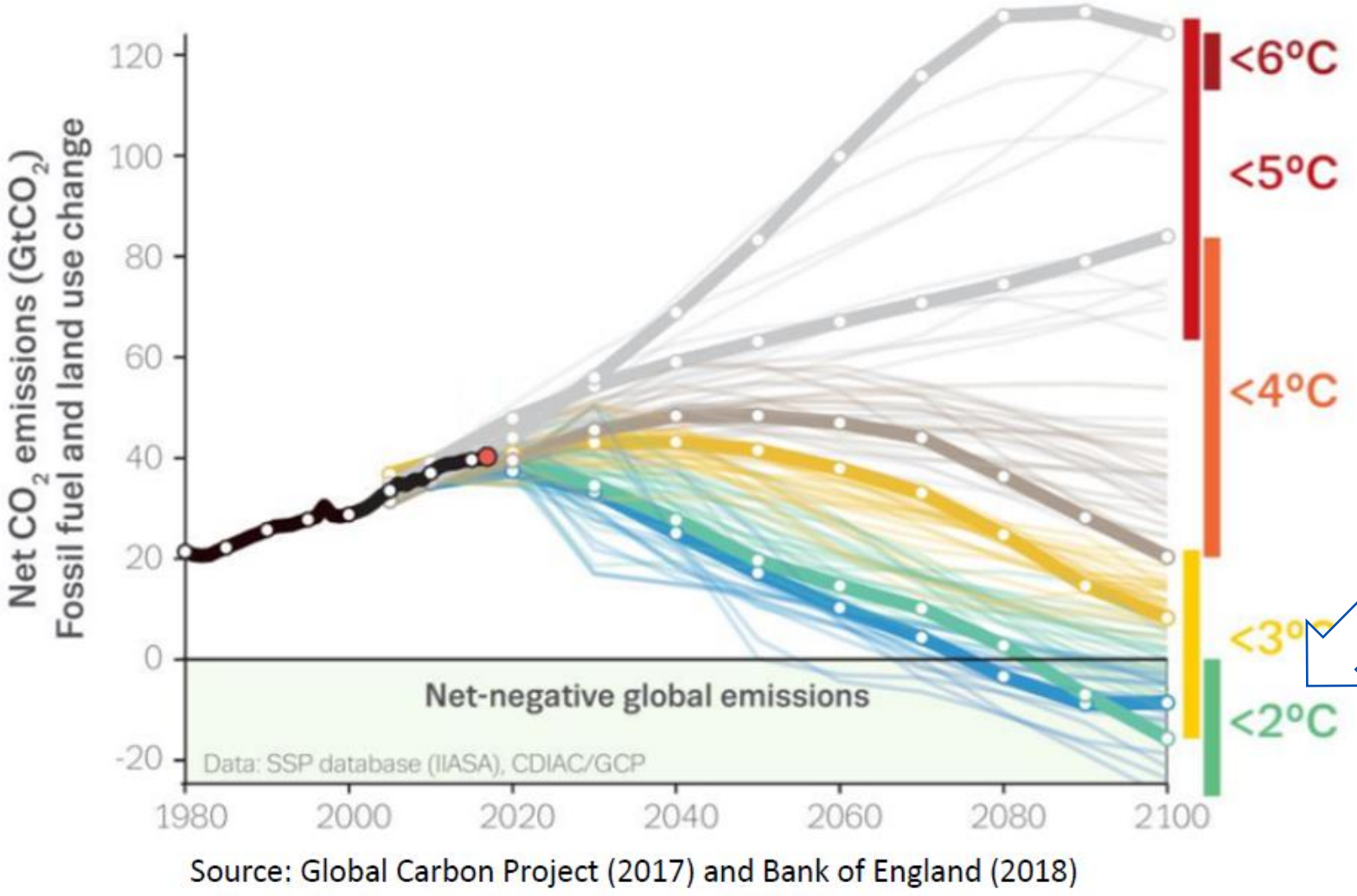
Is there a better perspective?

What is the cost of decarbonising the global energy system?

What does this mean for China?

Conclusions

“Stopping climate change will be slow or very expensive”



Source: Global Carbon Project (2017) and Bank of England (2018)

To achieve < 2 degrees:

- Economic growth must suffer
- We may need to reduce our energy usage
- We need to build 13Gt or more of Carbon Capture and Storage plants by 2100
- Electricity prices are likely to be higher

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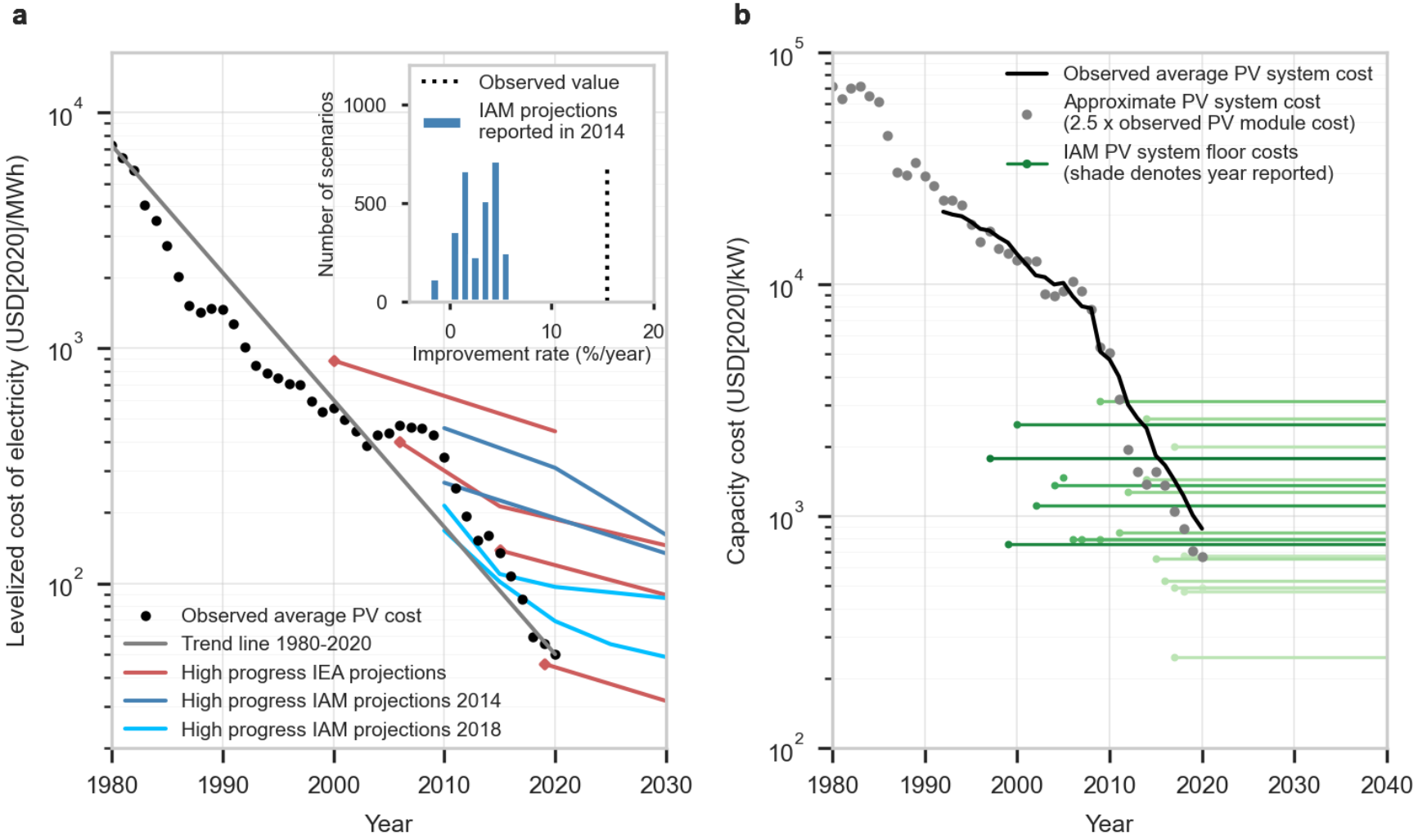
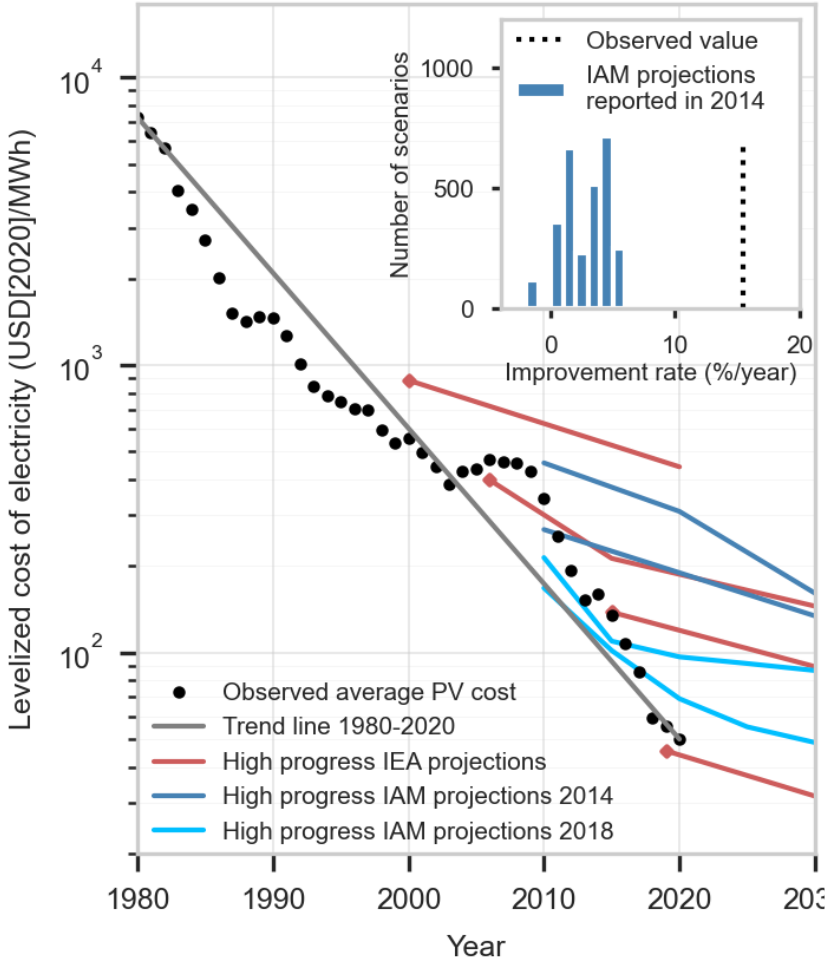
The performance of the IEA and IAM projections are poor



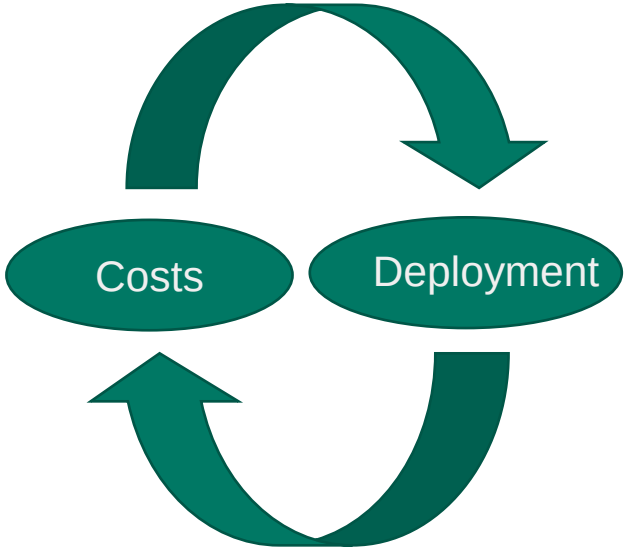
(Way et al., 2021)

…and not entirely based on the latest empirical evidence

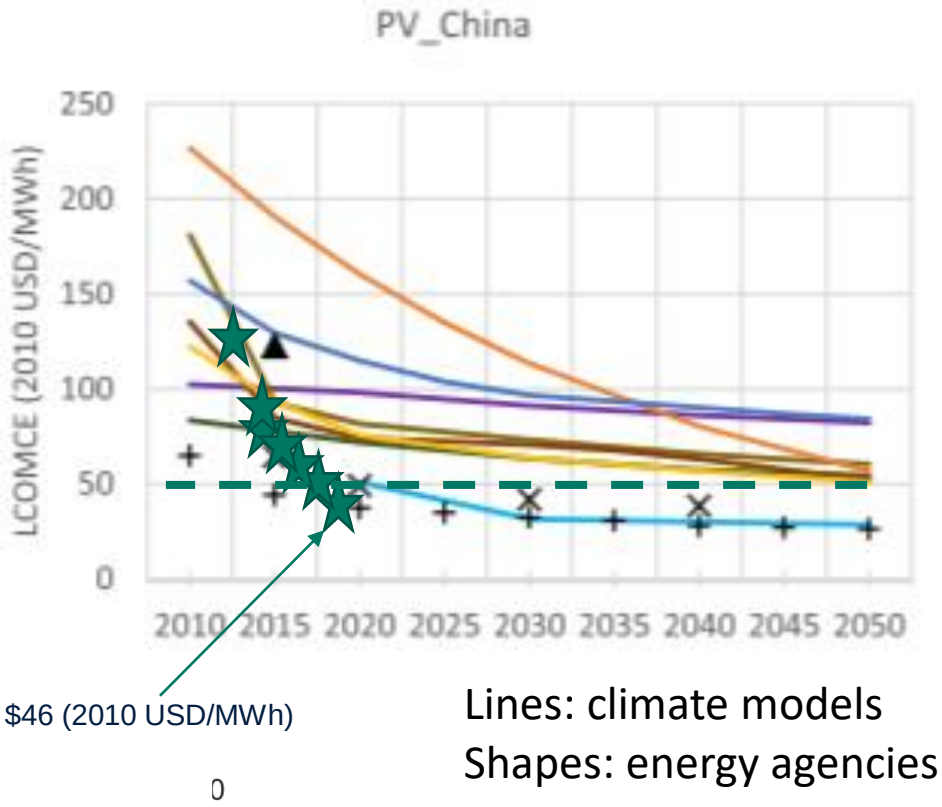
a PV cost projections are consistently too high



Learning-by-doing



Models become quickly out of date



Lines: climate models
Shapes: energy agencies
(Krey et al., 2019)

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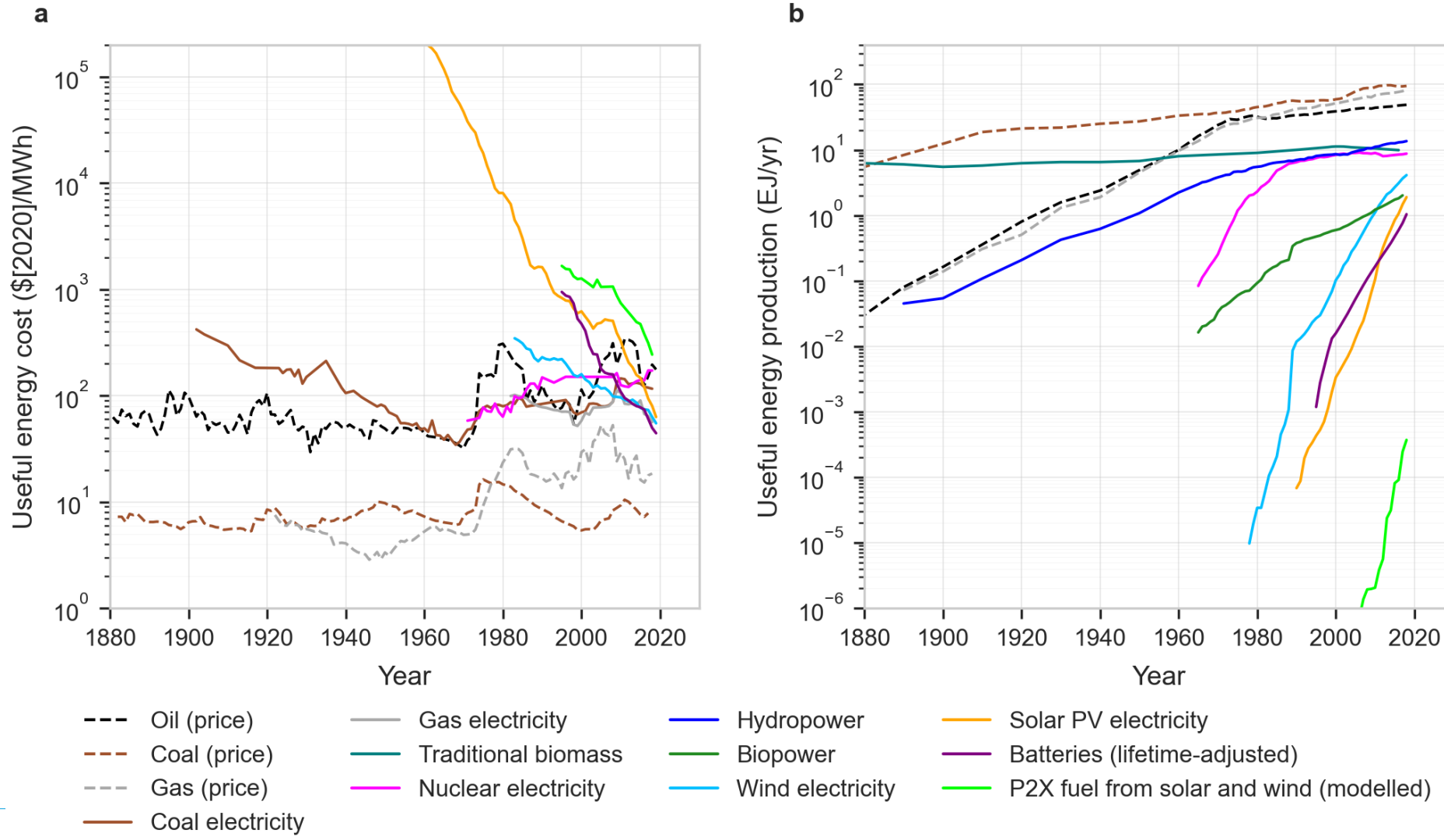
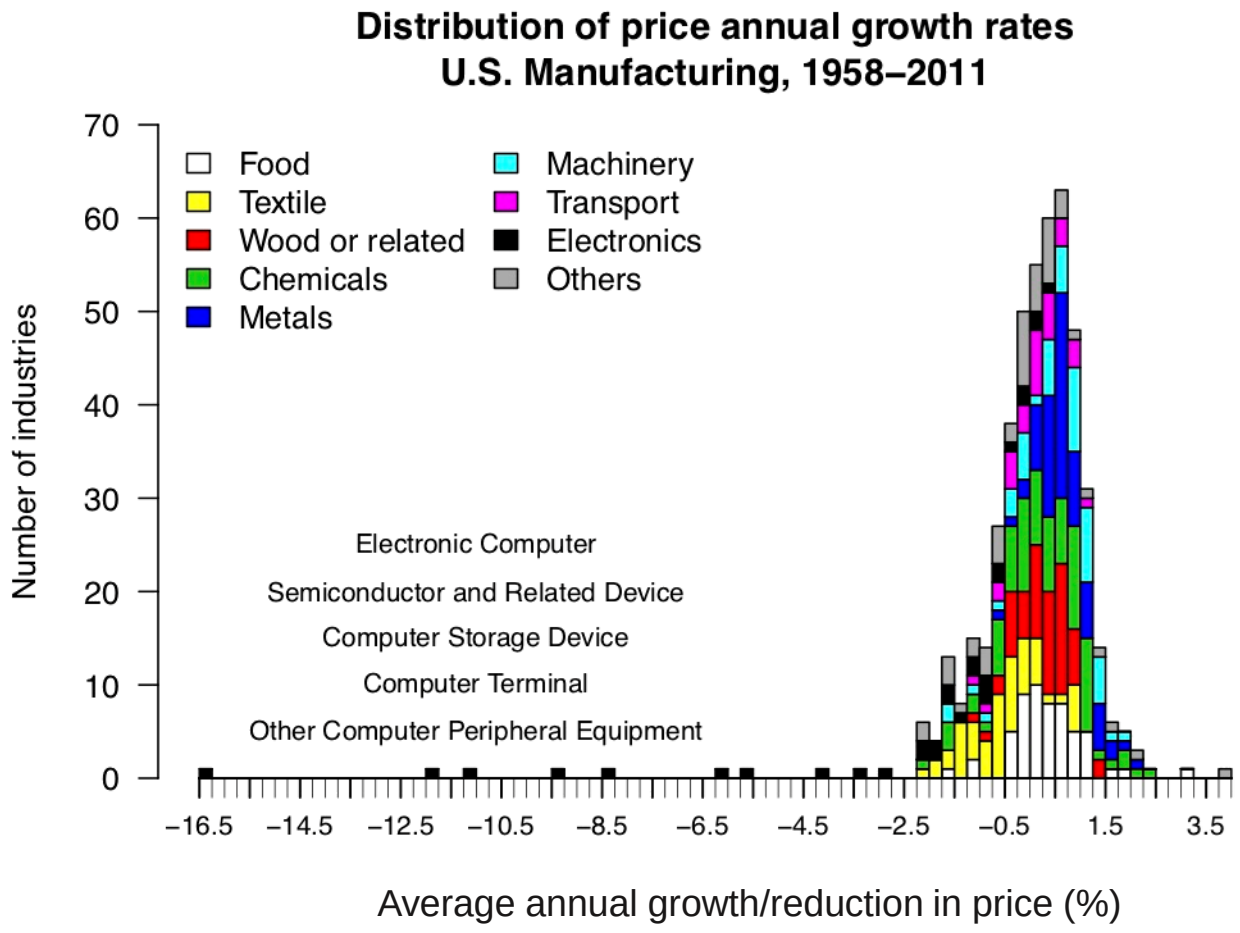
Evolution of the global energy landscape

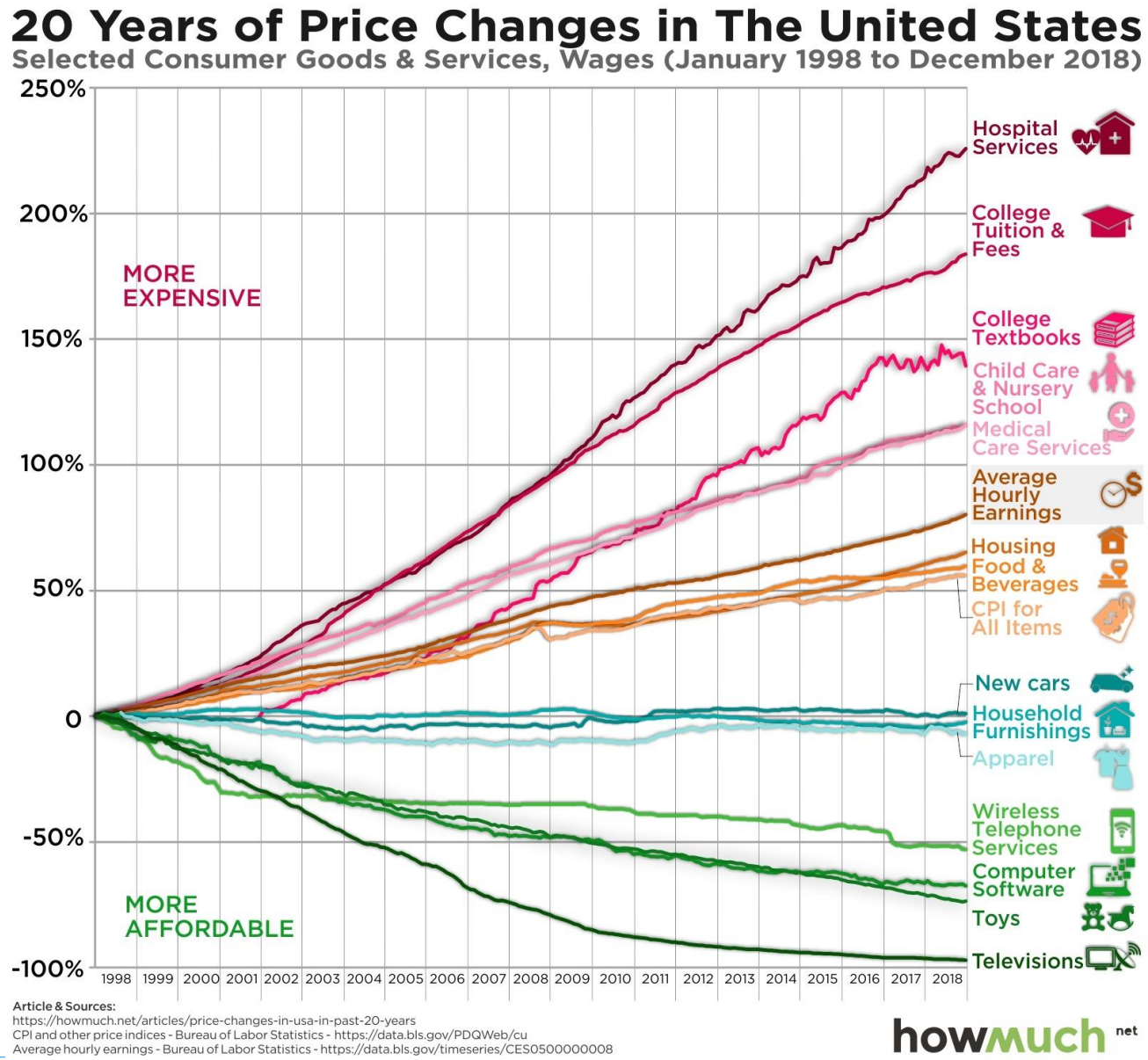


Heterogeneity of Technological progress



Thanks to François Lafond and Jangho Yang

Consumer goods

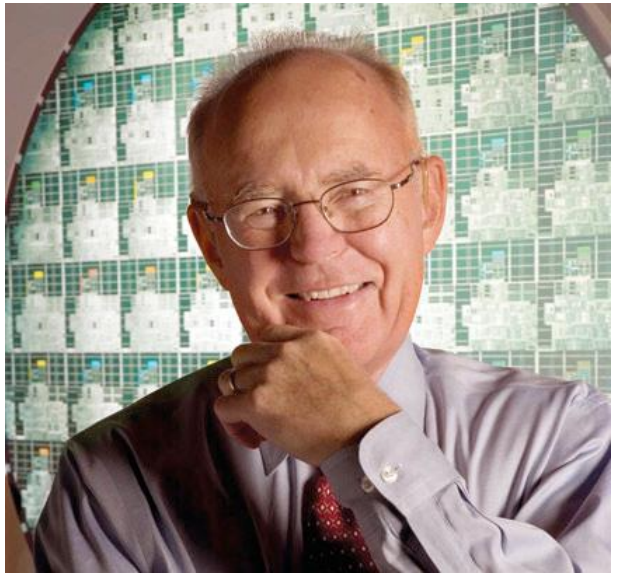


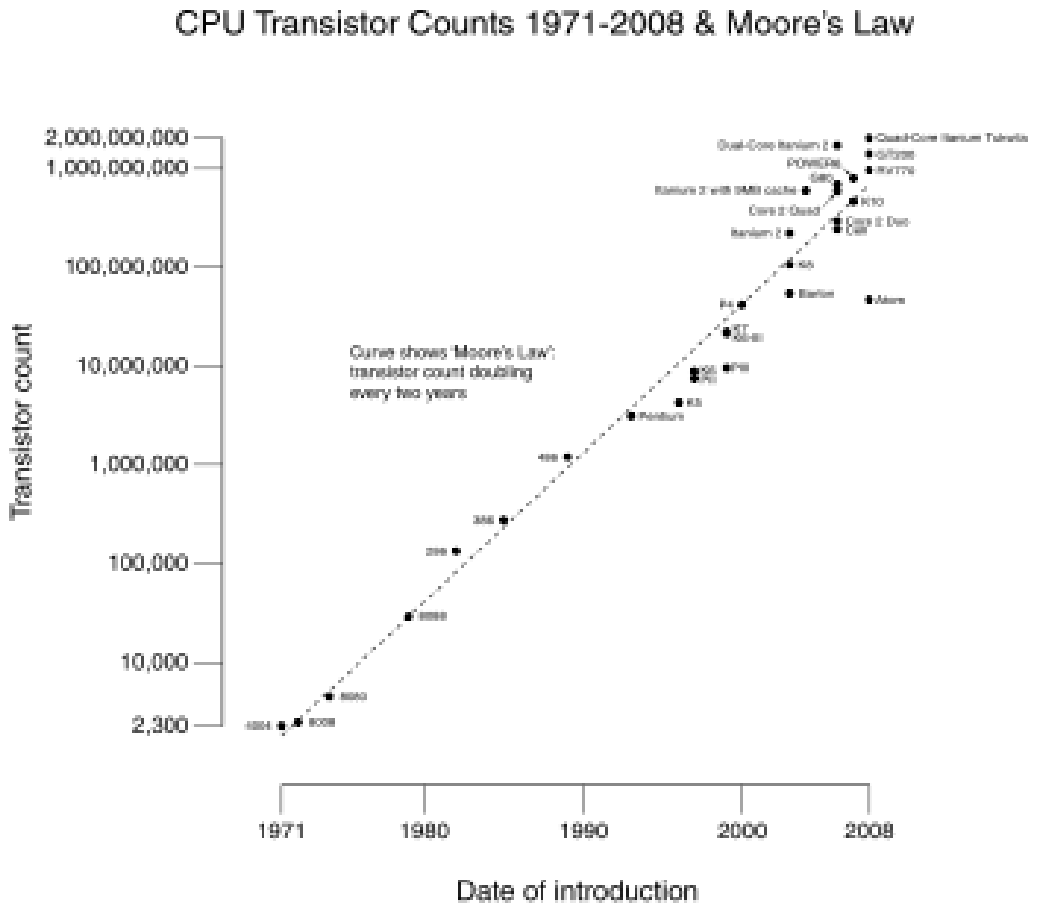
Thanks to Jangho Yang

How to take advantage of persistence and heterogeneity of technological change?

Make use of empirical laws.

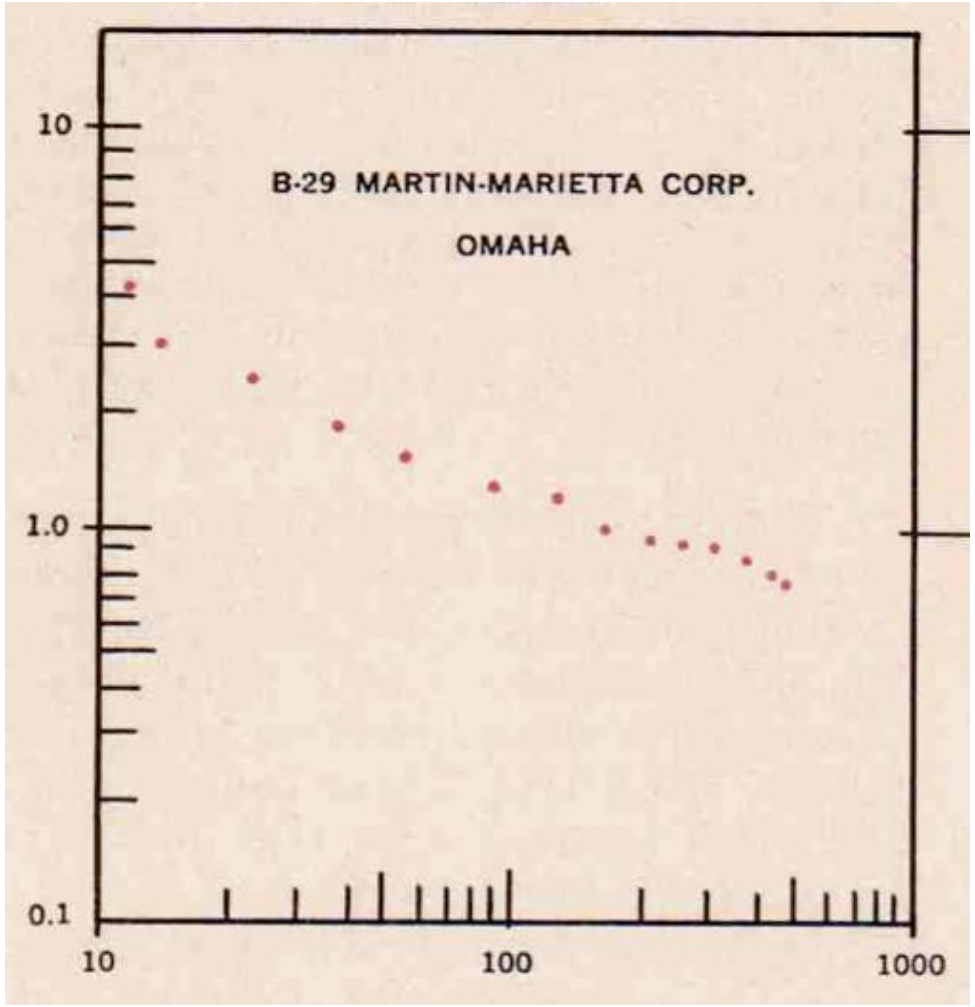
Moore's Law (1965)





Originally a statement about density of transistors. We will use to refer to the hypothesis that **technological performance improves exponentially with time.**

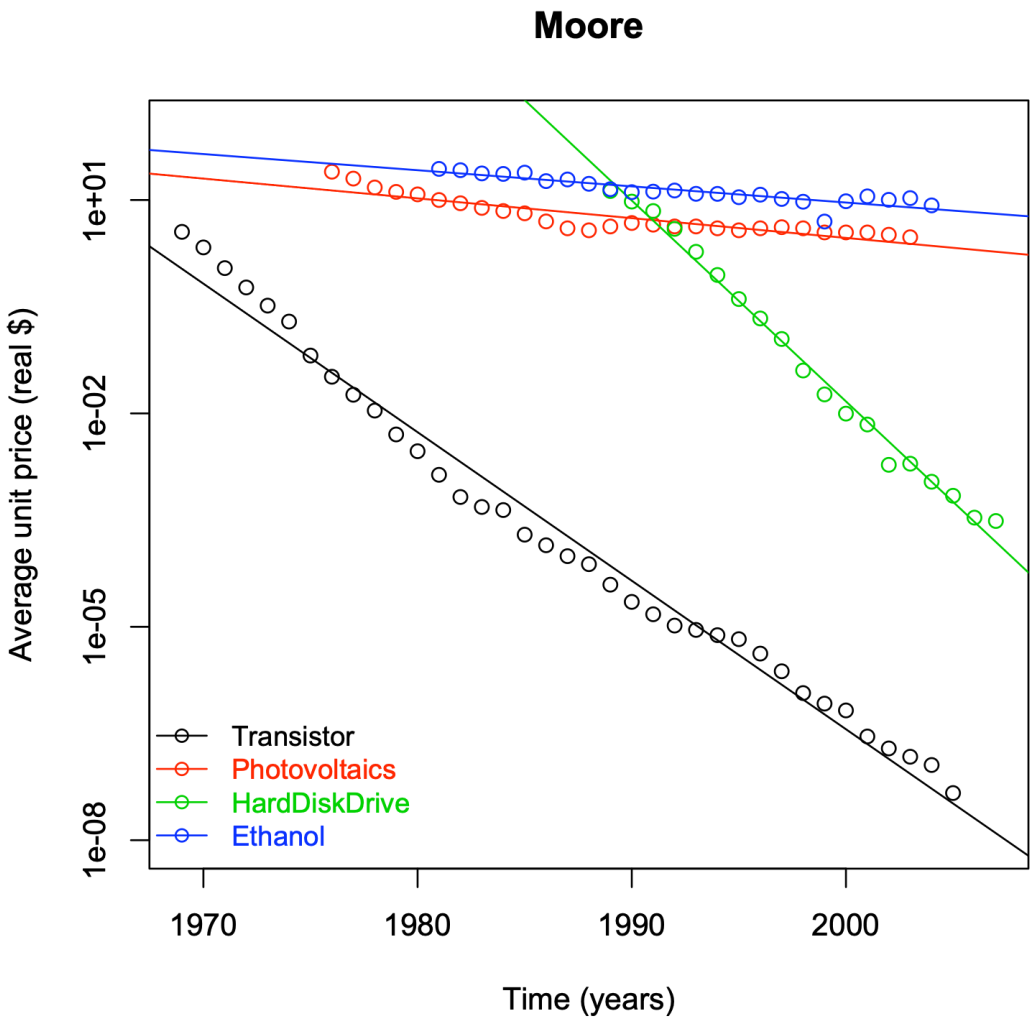
Wright's Law (1936)

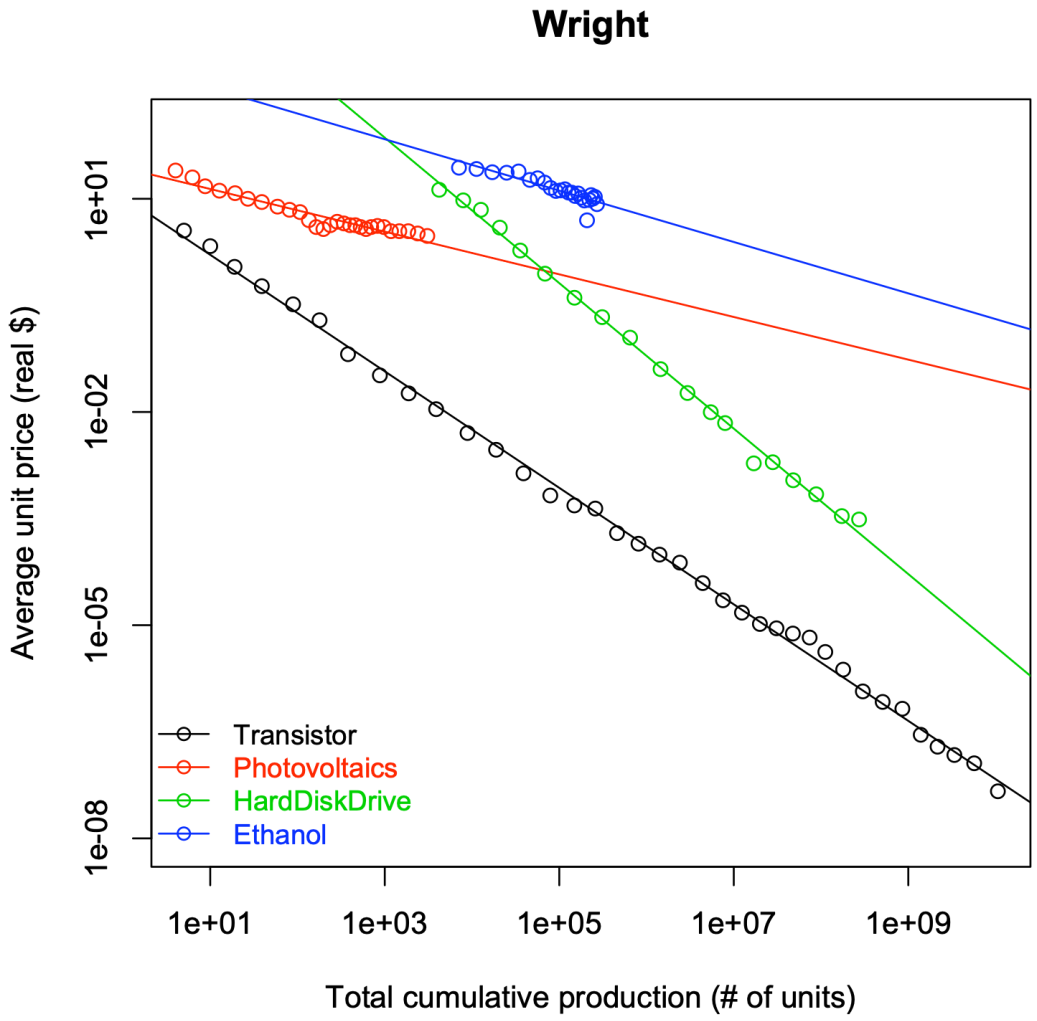


Cost vs. cumulative production follows a power law: $y = x^{-\alpha}$

Cumulative production a proxy for *experience*

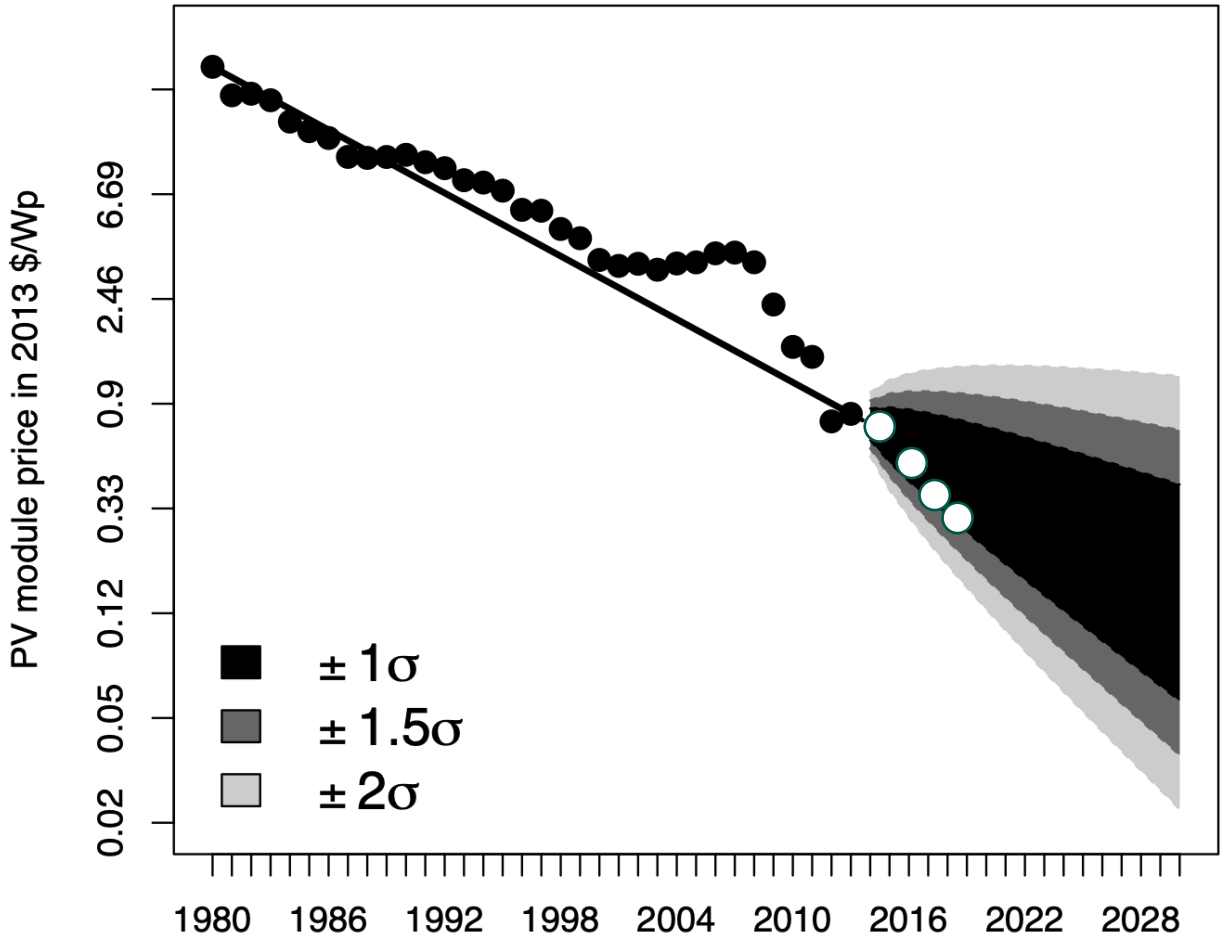
Both laws work well for many technologies





Distributional forecast of solar PV assuming business as usual

- Reformulate Wright's law as a time series model (Lafond et al, 2018)
- Validated on over 50 technologies
- Provides experience curve forecasts with reliable error bars
- Forecasts are scenario-dependent: the more we produce, the higher our probability of moving down the experience curve

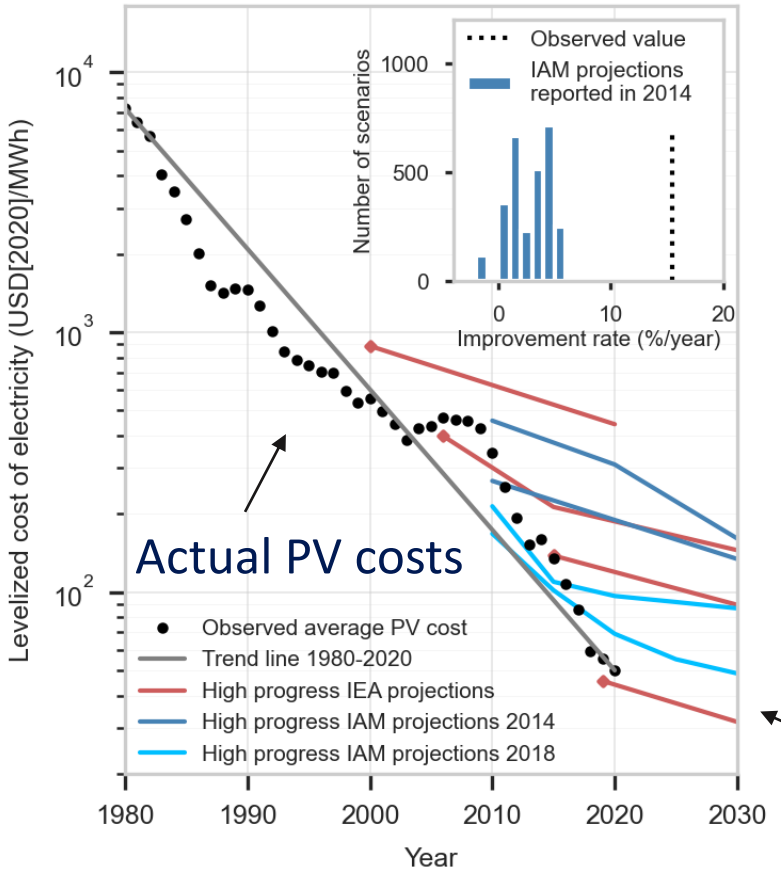


Farmer and Lafond (2016)

IEA scenario only achieves 30% emission reductions by 2040

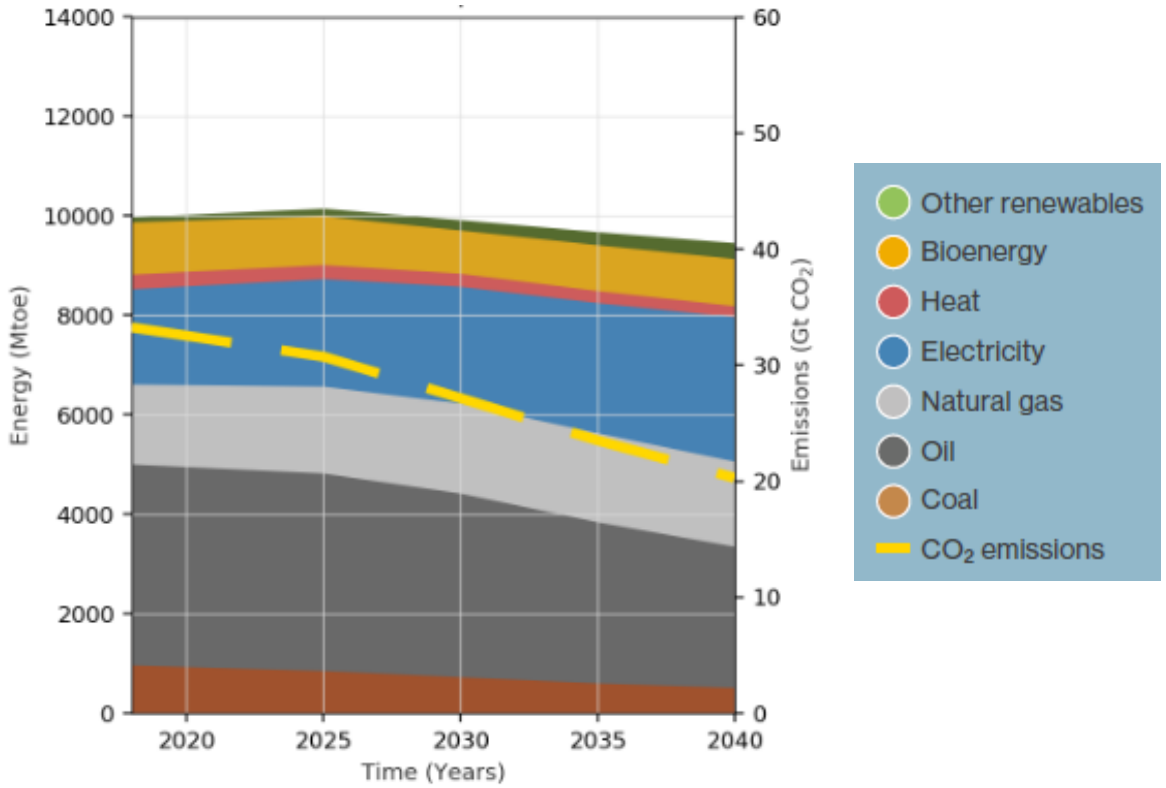
a

Average global solar PV costs



IEA Projections

Global final energy mix

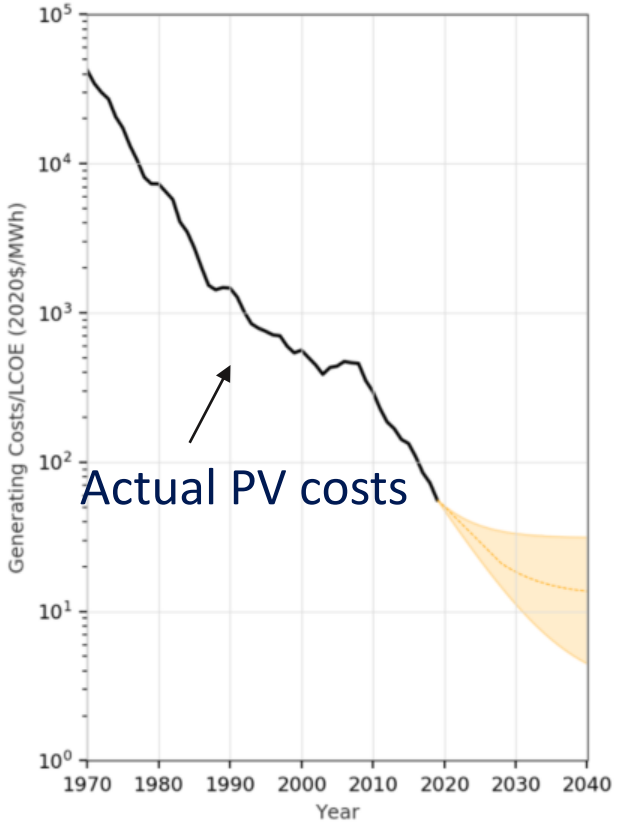


IEA's Sustainable Development Scenario

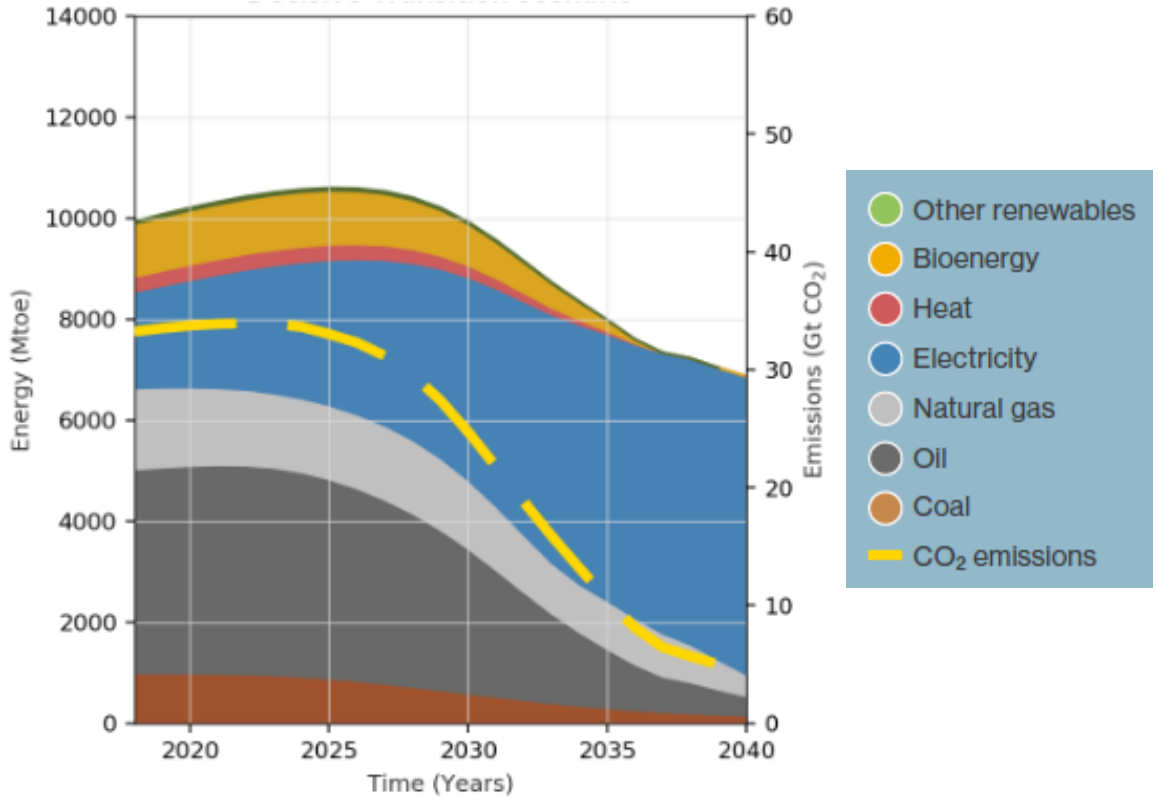
(Ives et al., 2021)

Strong support for clean tech achieves >80% emission reductions by 2040

Average global solar PV costs



Global final energy mix



Our Decisive Transition Scenario

(Ives et al., 2021)

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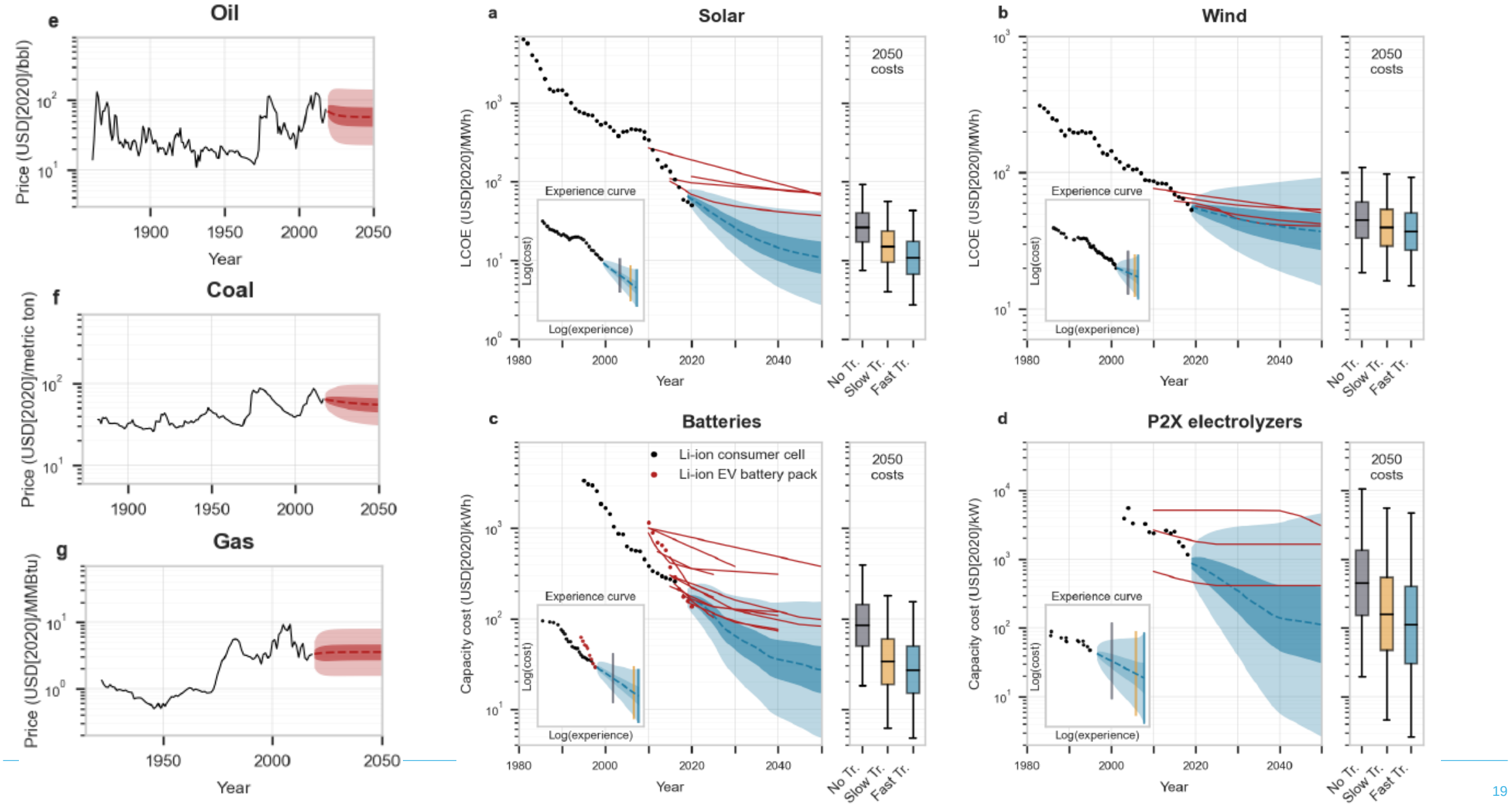
Empirically grounded technology forecasts for key technologies



(Way et al., 2021)

We built a simple, transparent model of the global energy system

Dispatchable, baseload energy

Liquid fuels

Entire fossil fuels energy system

Renewables plus batteries

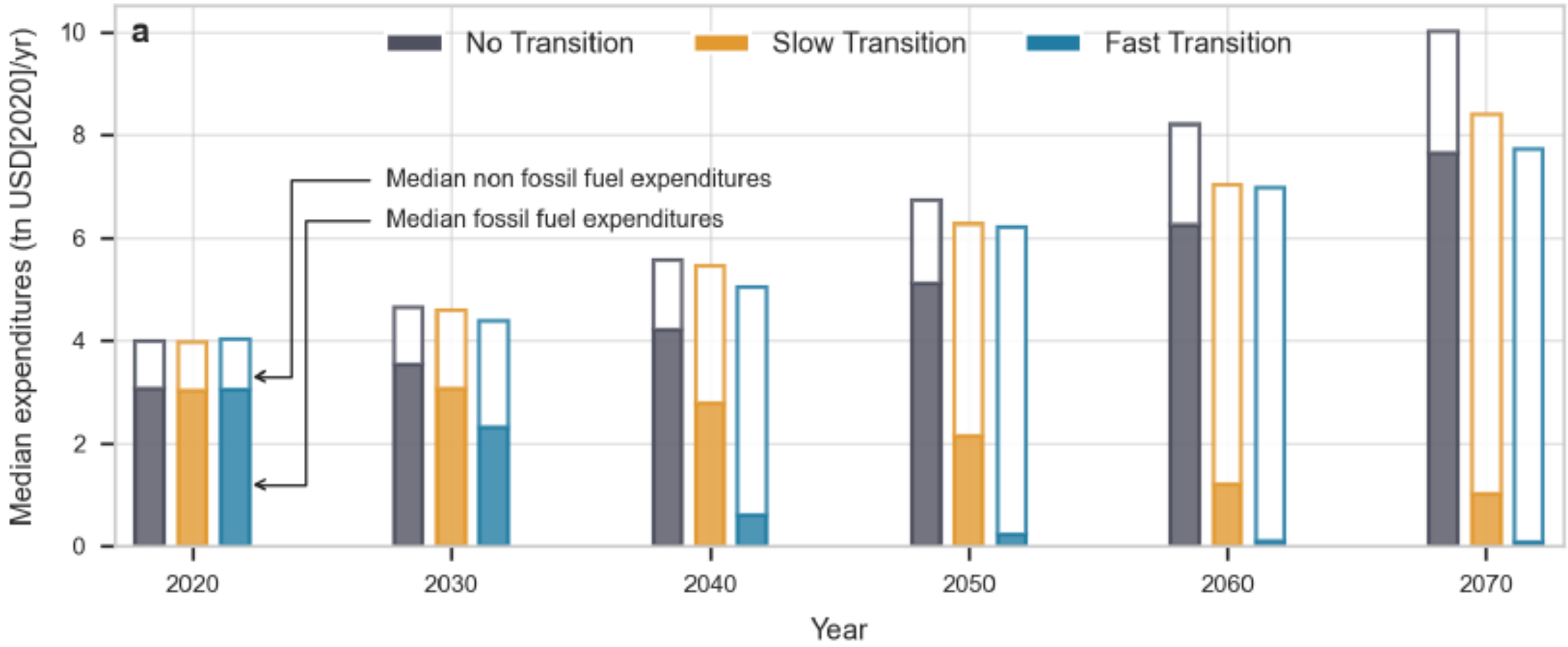
Renewables plus hydrogen

Renewables plus batteries plus hydrogen

(Way et al., 2021)

…and found we will save trillions with a Fast Transition!

Median total savings of Fast Transition over No Transition = $26 trillion by 2070



Median annual expenditures on fossil fuel and non fossil fuel technologies in each scenario (USD$tn) at a 2% discount rate

(Way et al., 2021)

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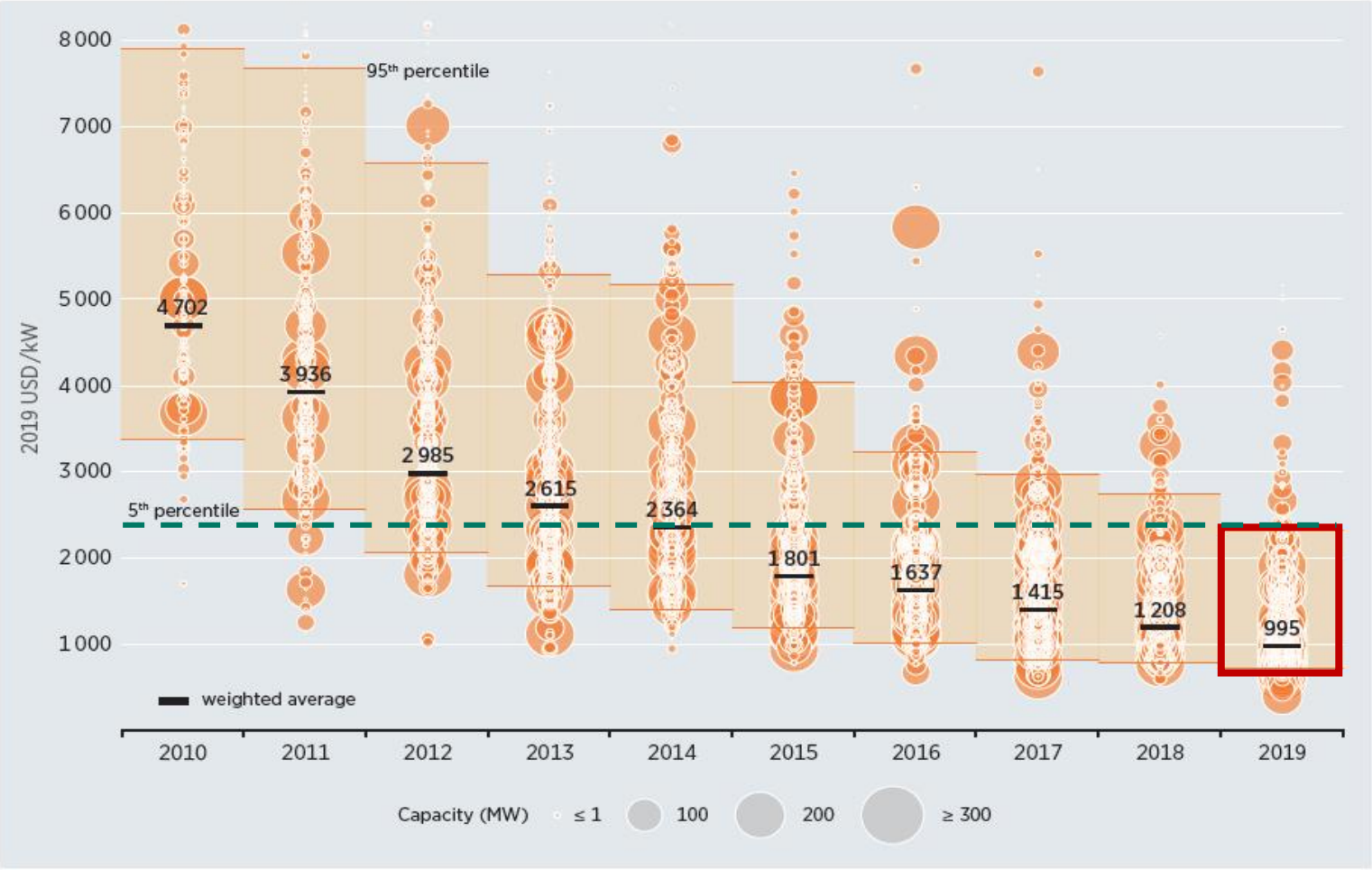
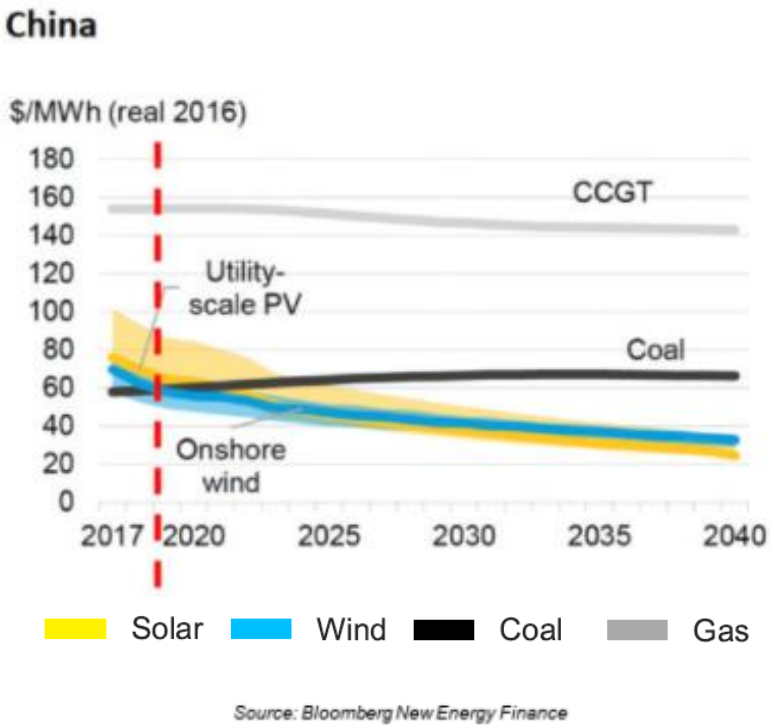
Renewables cheaper than fossil fuels for most of China in 5 years

Figure 3.5 Detailed breakdown of utility-scale solar PV total installed costs by country, 2019

Figure 3.3 Total installed PV system cost and weighted averages for utility-scale systems, 2010-2019

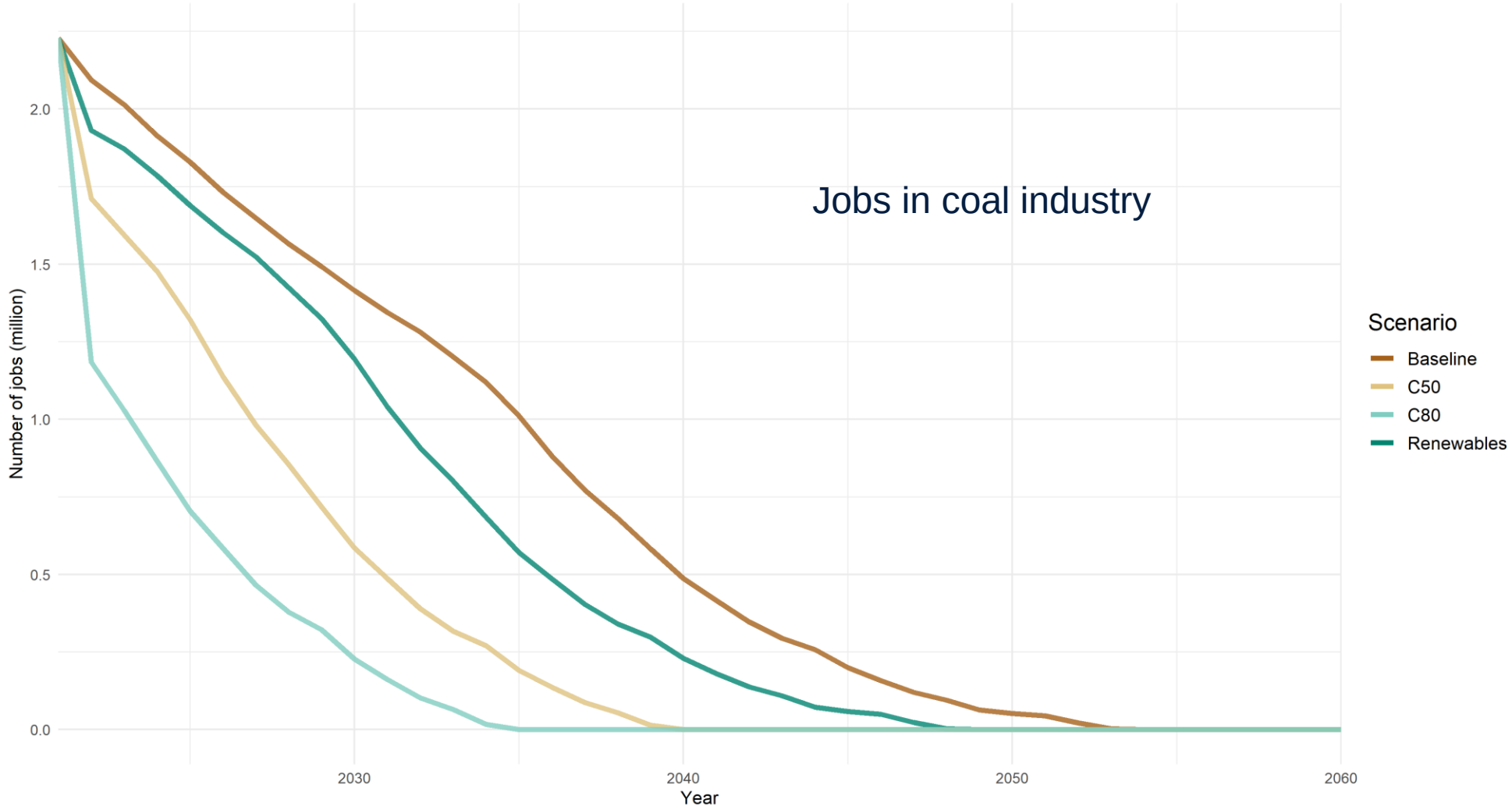




Source: Bloomberg New Energy Finance

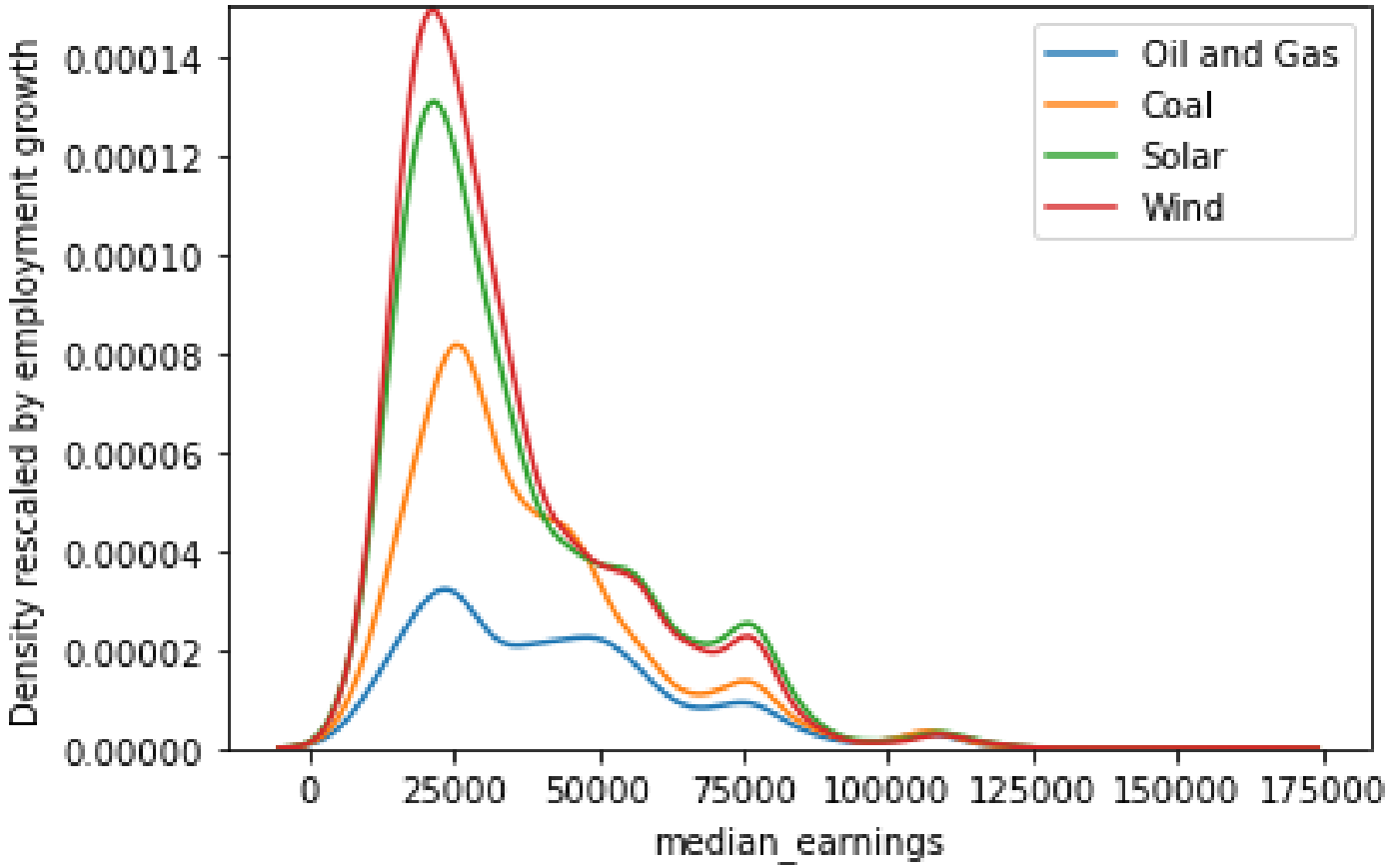
Source: IRENA Renewable Cost Database.

Enormous structural change likely in China – potential for further job losses in coal



Thanks to Alex Clark - adapted from (He et al., 2020)

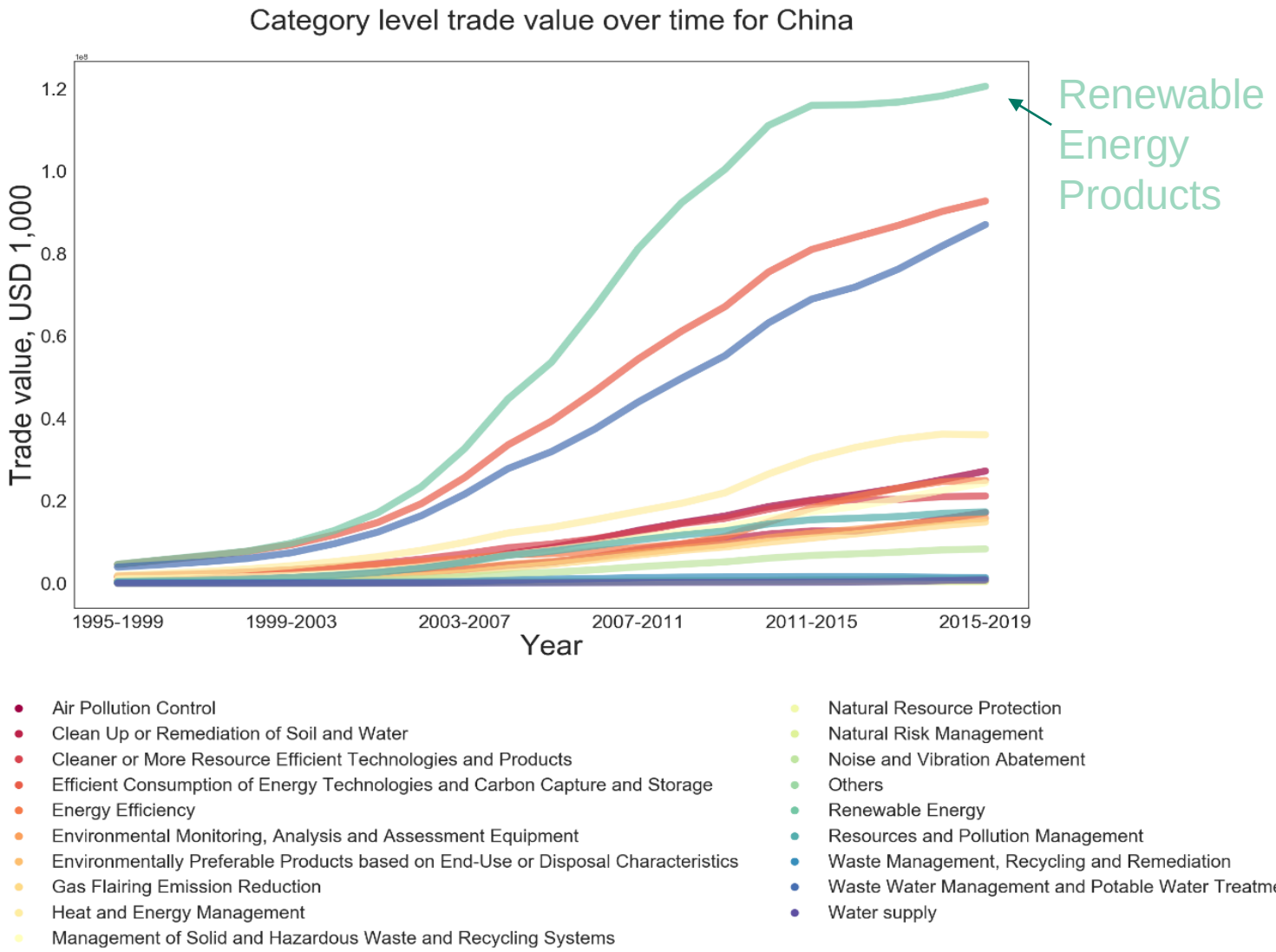
More green jobs expected but strategies needed to manage the transition risks



- More jobs in renewables but coal wages are higher on average
- There will be significant regional and skill shortages – **stranded locations**

Thanks to Joris Bucker

China has enormous growth potential in green products



Thanks to Penny Mealy & Pia Andres

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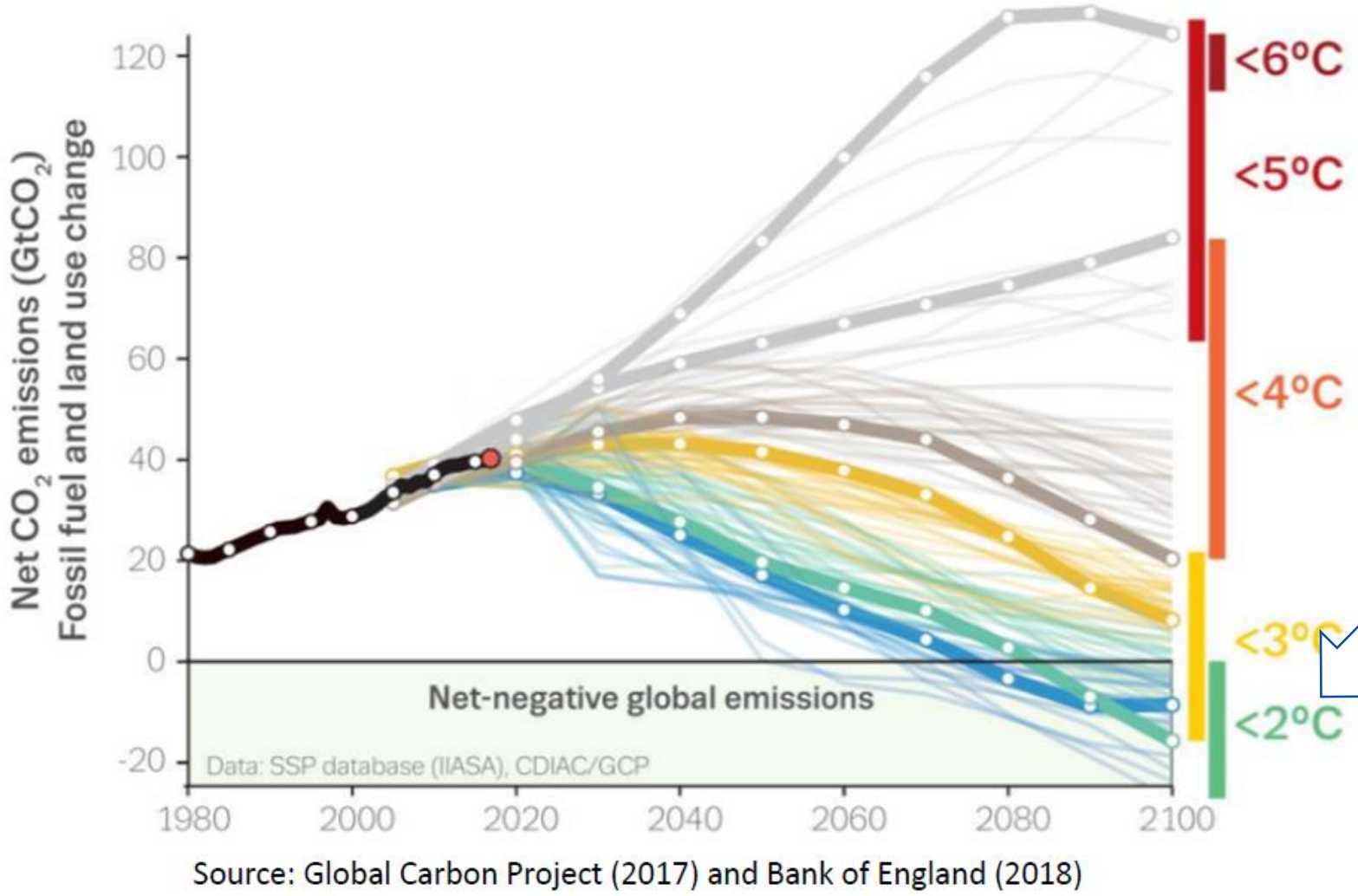
The IPCC story of meeting the Paris goals seems unachievable

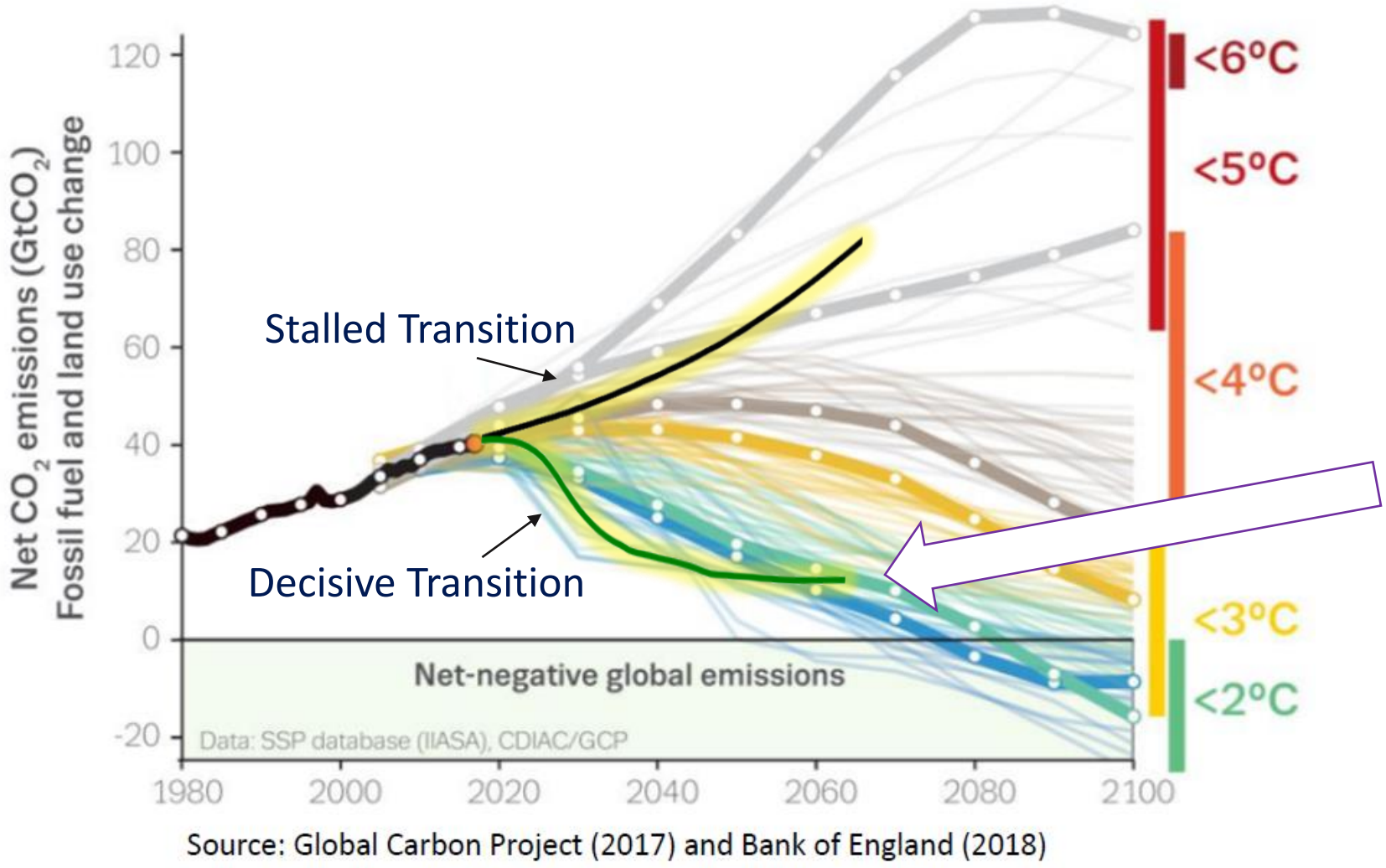


Source: Global Carbon Project (2017) and Bank of England (2018)

To achieve < 2 degrees:

- Economic growth will suffer
- We may need to reduce our energy usage
- We need to build a Carbon Capture and Storage plant every 3 days to 2100
- Electricity prices are likely to be higher

Aligns the energy system with the Paris goals for much less cost



Source: Global Carbon Project (2017) and Bank of England (2018)

The Fast Transition has:

- No reduction in economic growth required
- No reduction in energy use applied (but could be)
- No Carbon Capture and Storage used (yet)
- Electricity prices ~ *one third* of "business-as-usual"

SUSTAINABLE DEVELOPMENT GOALS

Conclusions

- There is an opportunity to change the “mood music” being played to decision makers
- Continued strong growth in investment in key renewable and storage technologies over the next decade will:
  - Put us on track to meet the Paris emission reduction goals
  - Cost trillions less than business as usual
  - Need not reduce economic prosperity
  - And could make electricity much cheaper for everyone
- China faces a considerable challenge but has much to gain from the clean energy transition including huge growth in clean energy and storage exports

Thank you

EnergyChallenge.info

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