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A fast green energy transition is cheaper than business as usual

Presentation to California Energy Commission
December 14, 2022

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Institute for
New Economic Thinking
AT THE OXFORD MARTIN SCHOOL

Empirically grounded forecasts and the energy transition

Rupert Way, Matt Ives, Penny Mealy, JDF

- Energy makes about 75% of emissions
- We can make green energy transition quickly and at a purely economic profit
  - Need to continue to ramp up wind, solar, batteries, hydrogen (P2X) at existing rates for another decade or two
- Roadblocks to making this happen?
- This is a *sensitive intervention point*

Farmer et al, Science (2019)

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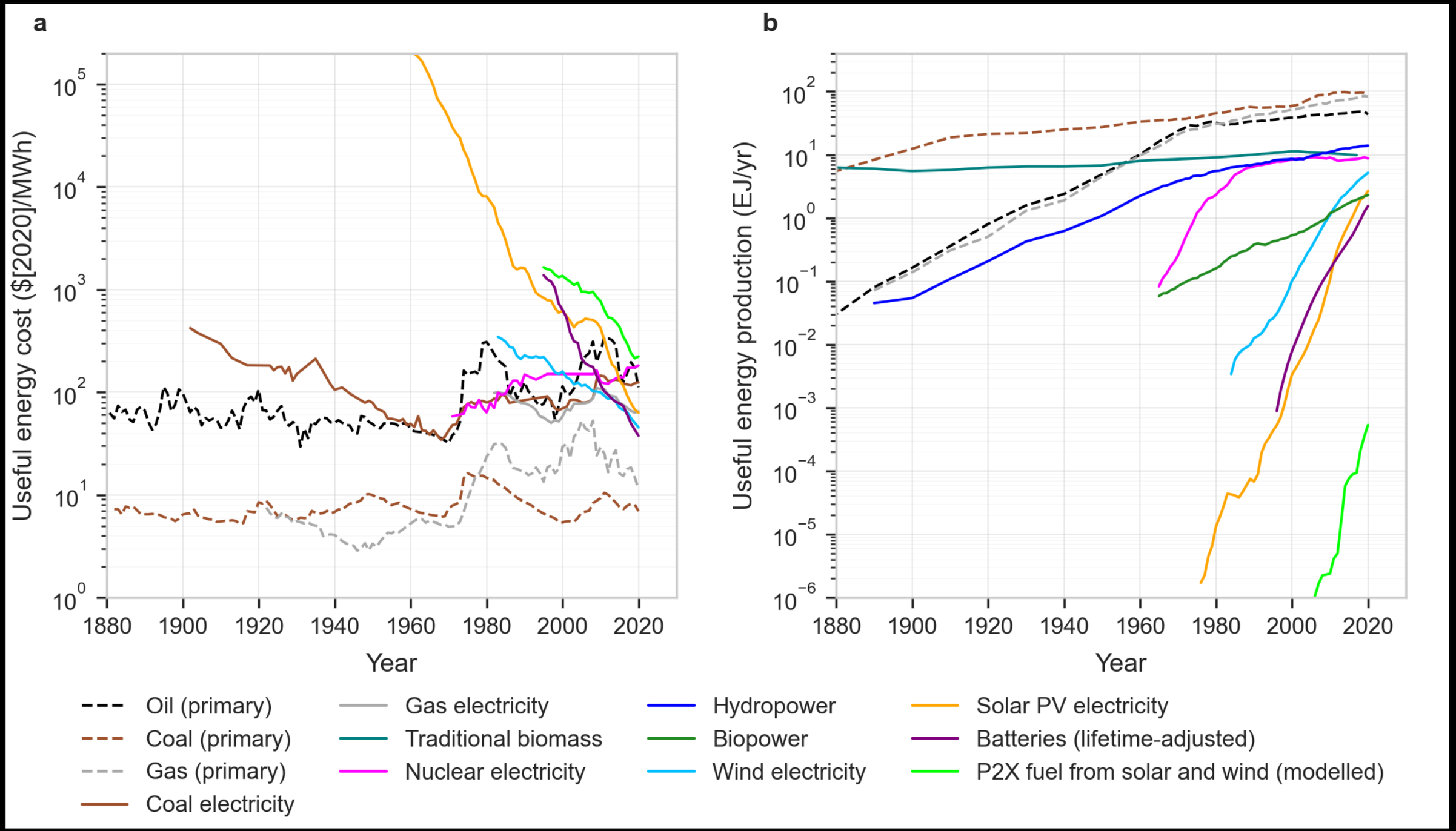
Evolution of global energy landscape



Cost

Production

What we did

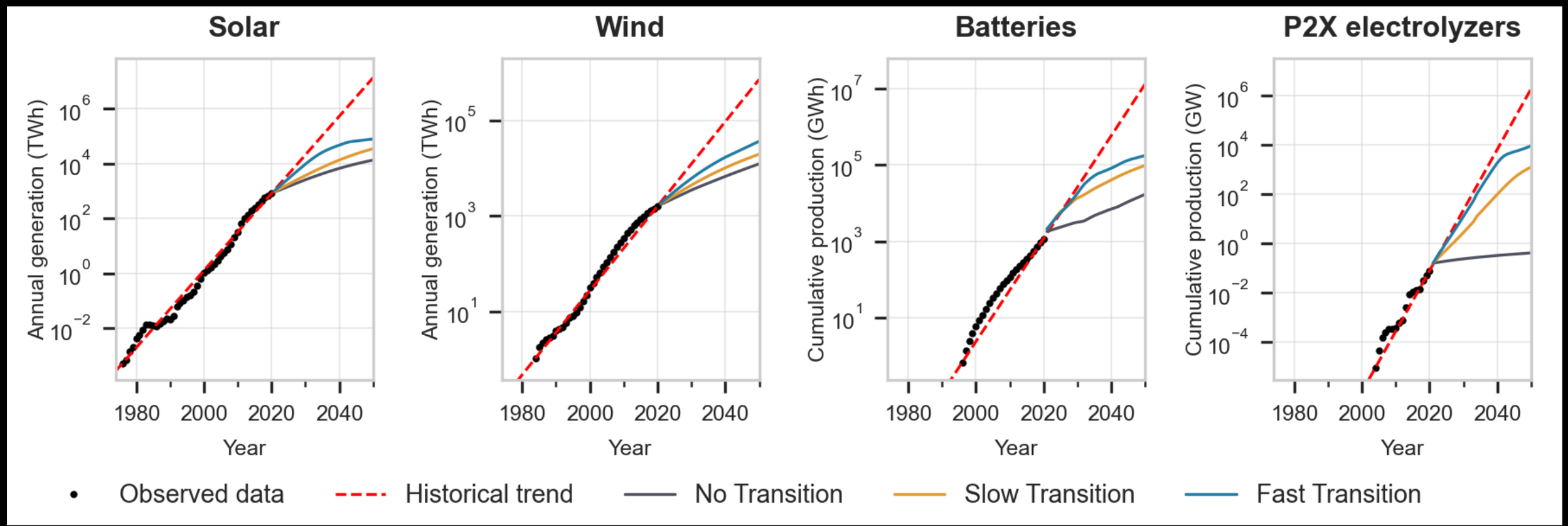
Rupert Way, Matt Ives, Penny Mealy, JDF

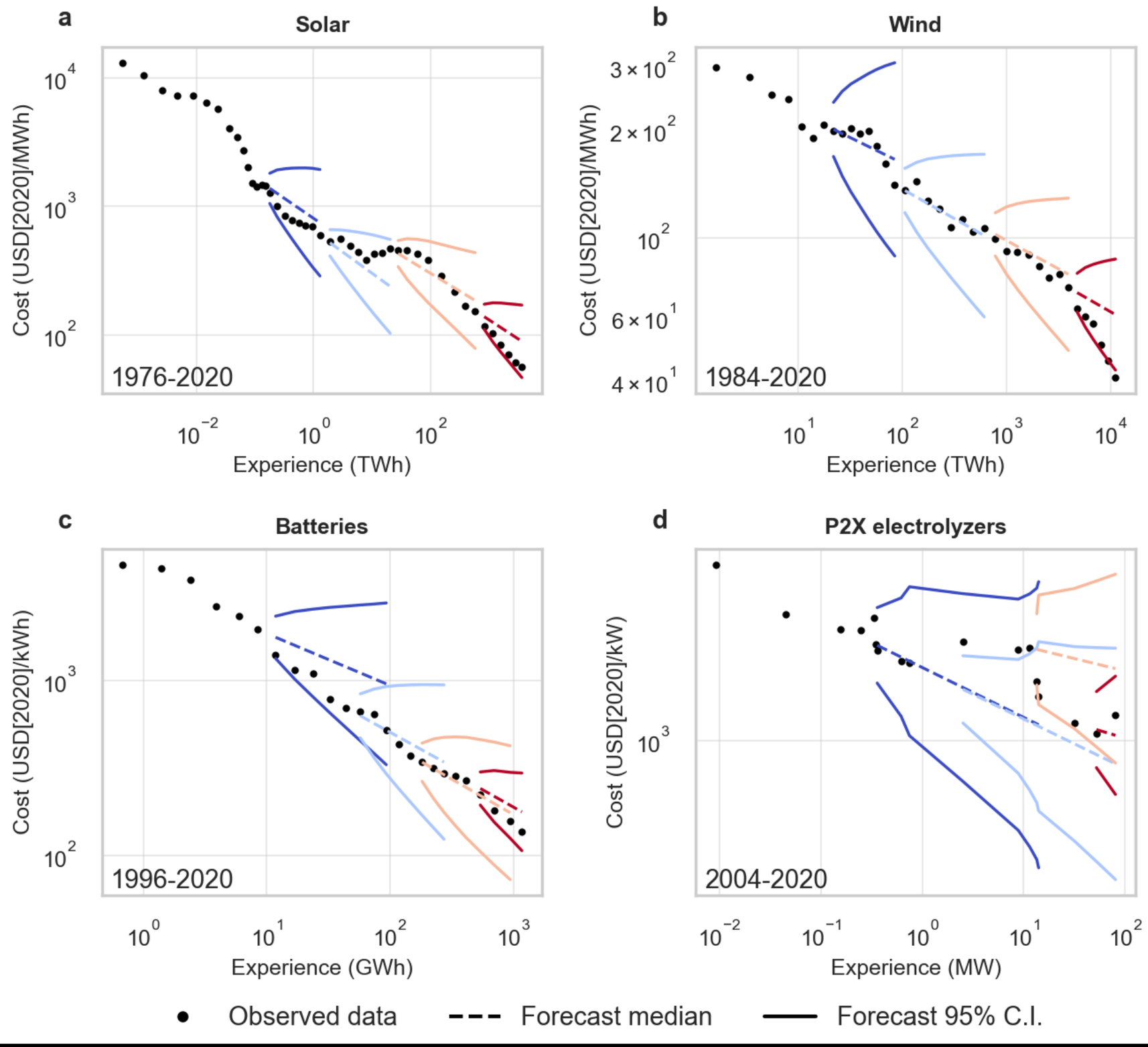
- Developed a probabilistic method for forecasting technology costs based on historical data
- Tested our method by pretending to be in the past and making 6000 forecasts for 50 different technologies – it worked well
- Applied this to 3 scenarios for the green energy transition (none, slow, fast)

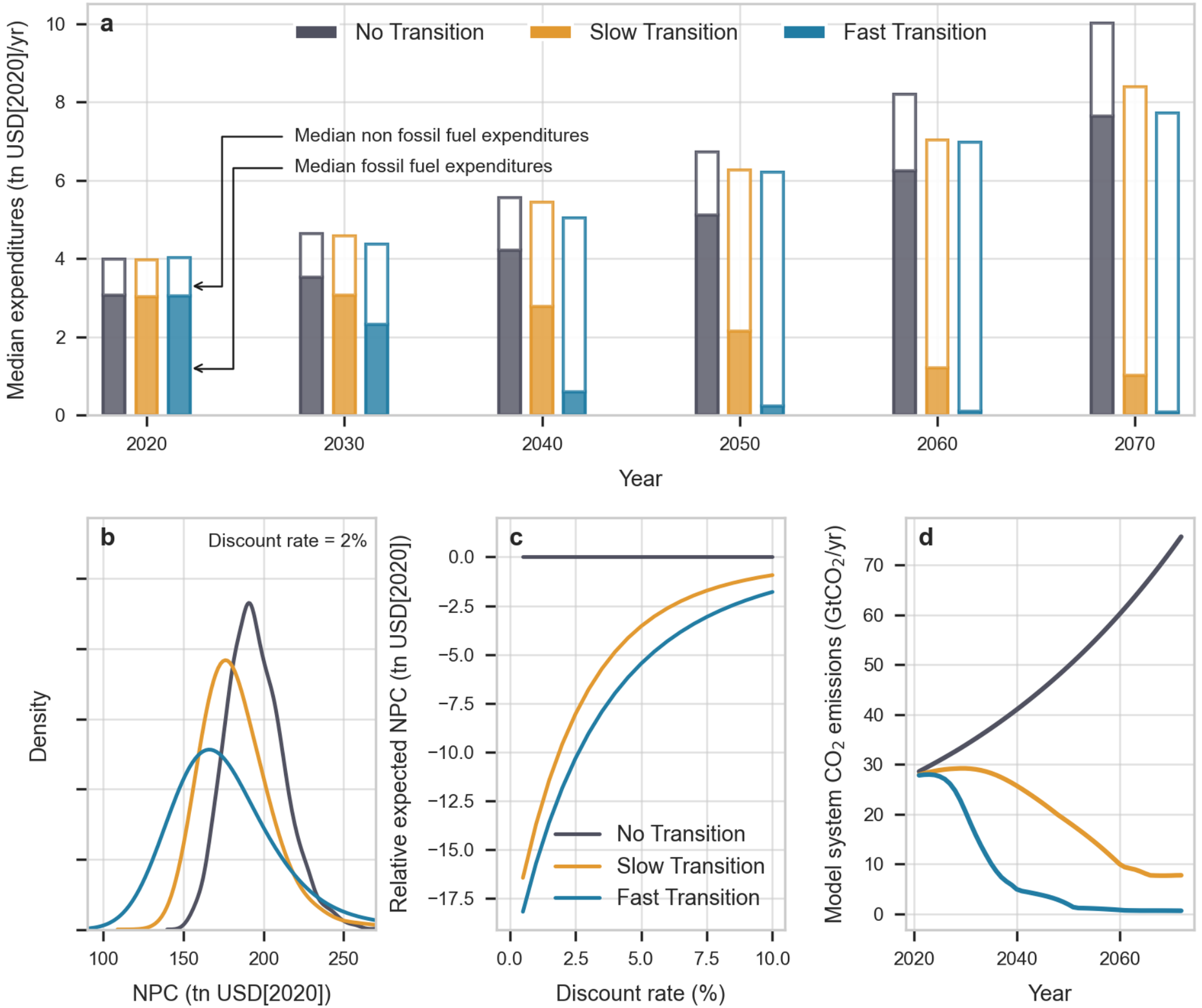
Fast transition scenario

- Key techs are solar PV, wind, batteries, P2X
- Extrapolate existing deployment trends
- Phase out fossil fuels over next 25 years
- Use P2X for energy storage (1 month) and liquid fuels (heat, shipping, air transport, …)

Three scenarios for key technologies

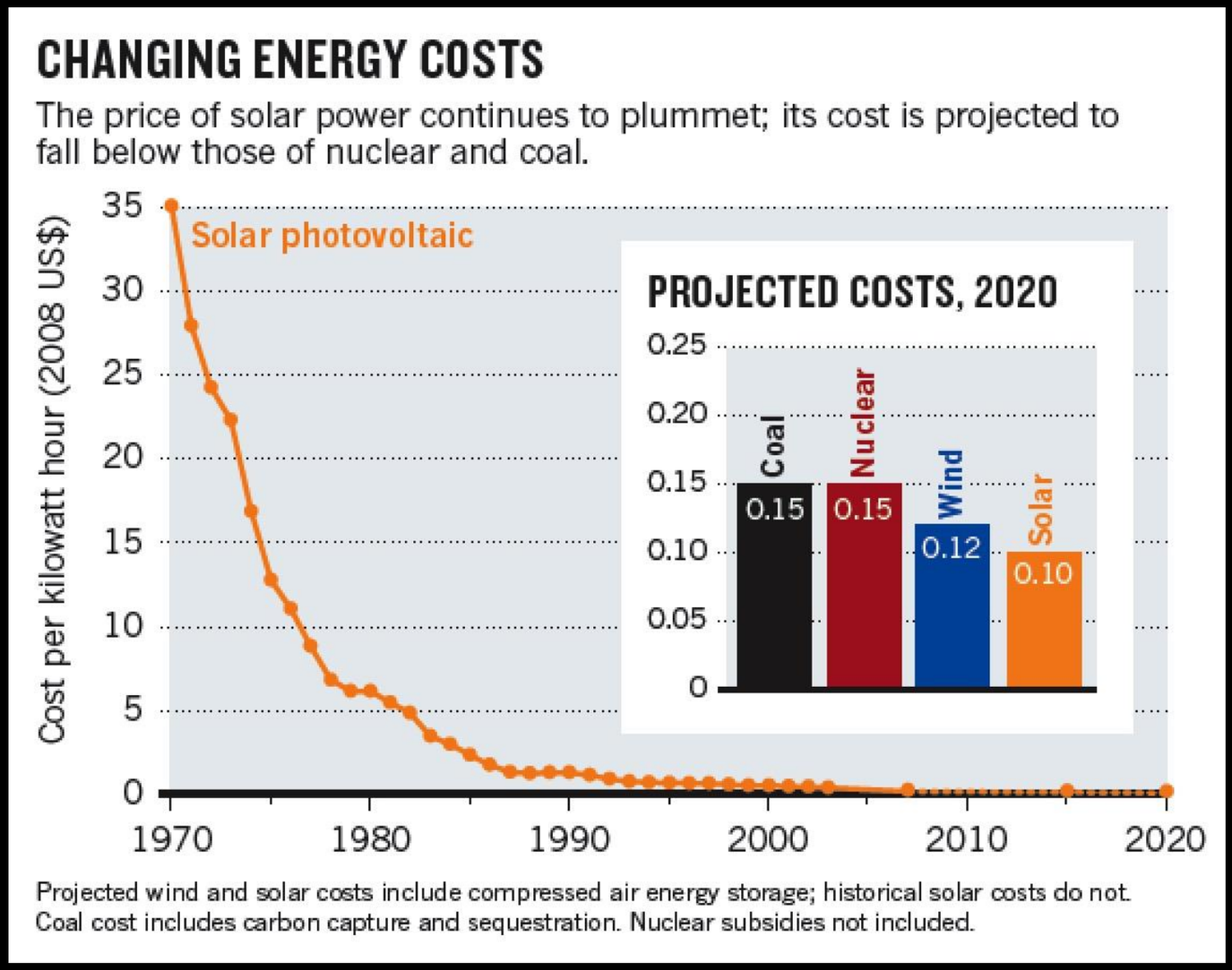



a
Solar
Cost (USD[2020]/MWh)
10^4
10^3
10^2
1976-2020
10^{-2}
10^0
10^2
Experience (TWh)
b
Wind
Cost (USD[2020]/MWh)
3×10^2
2×10^2
10^2
6×10^1
4×10^1
1984-2020
10^1
10^2
10^3
10^4
Experience (TWh)
c
Batteries
Cost (USD[2020]/kWh)
10^3
10^2
1996-2020
10^0
10^1
10^2
10^3
Experience (GWh)
d
P2X electrolyzers
Cost (USD[2020]/kW)
10^3
2004-2020
10^{-2}
10^{-1}
10^0
10^1
10^2
Experience (MW)
Observed data
Forecast median
Forecast 95% C.I.


a
No Transition
Slow Transition
Fast Transition
Median non fossil fuel expenditures
Median fossil fuel expenditures
Median expenditures (tn USD[2020]/yr)
10
8
6
4
2
0
2020
2030
2040
2050
2060
2070
Year
b
Discount rate = 2%
Density
100
150
200
250
NPC (tn USD[2020])
c
Relative expected NPC (tn USD[2020])
0.0
−2.5
−5.0
−7.5
−10.0
−12.5
−15.0
−17.5
No Transition
Slow Transition
Fast Transition
0.0
2.5
5.0
7.5
10.0
Discount rate (%)
d
Model system CO_2 emissions ($GtCO_2$/yr)
70
60
50
40
30
20
10
0
2020
2040
2060
Year

Contrasting forecasts of solar energy costs

Economist (2014):
Solar power is by far the most expensive way to reduce carbon emissions



Farmer and Makhijani, Nature, 2010

What about IAMs and IEA?