Session 2: Technological drivers of the energy transition

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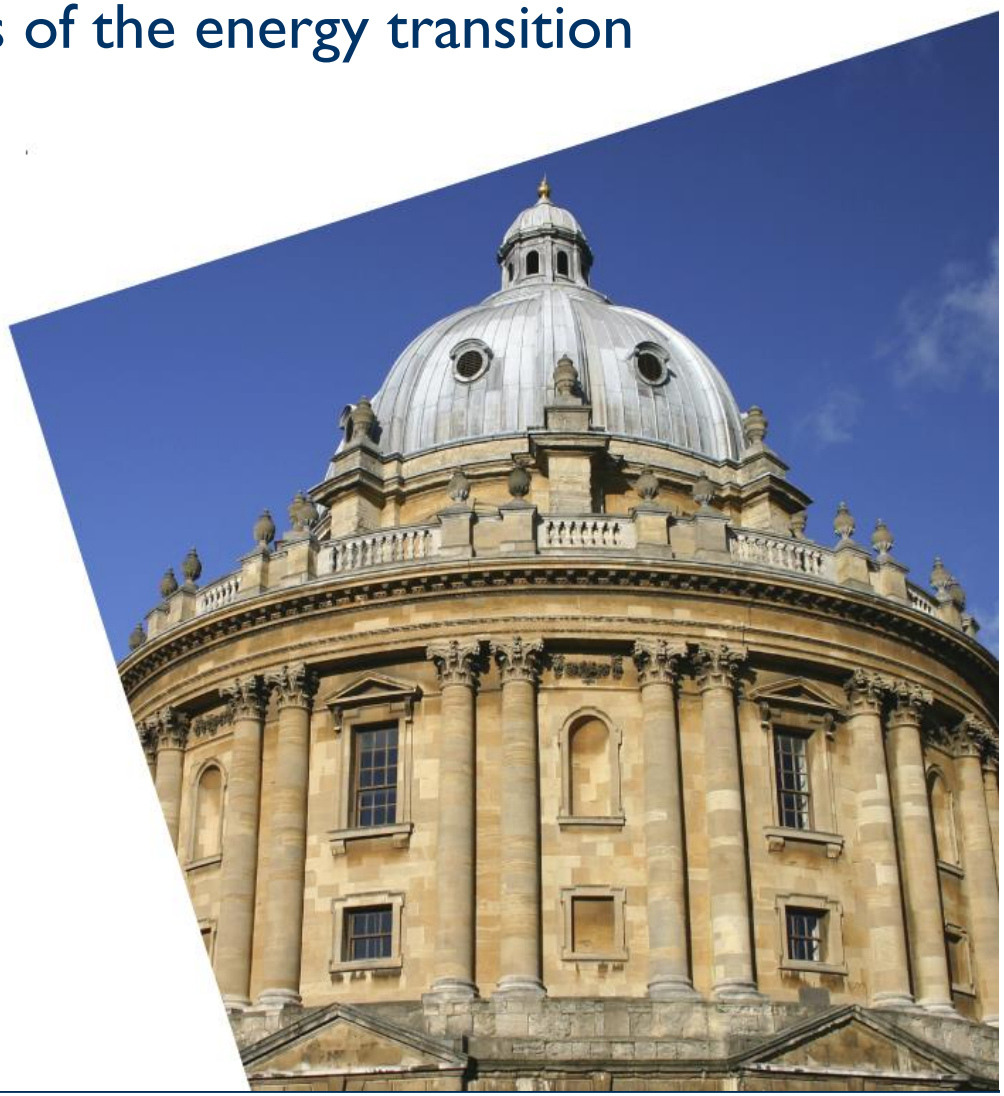


Tehran, Sunday 10 September 2017

Reminder of previous session

1. Paris
2. Policy responses thus far
3. Arguments to slow action
4. Some economics of climate policies
5. Corporate responses

Agenda for this session

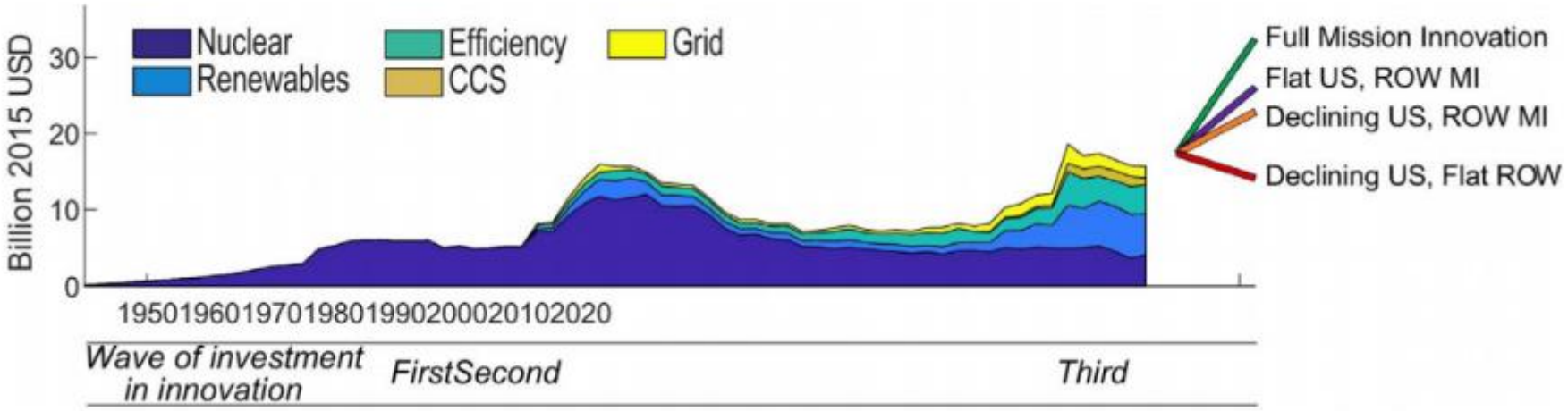
1. Technological progress
2. Will we get there in time?

"Mission Innovation" pledged to double clean energy R&D spend, although Trump is unlikely to do this

Each of the 20 participating countries will **seek to double** its governmental and/or state-directed clean energy research and development investment **over five years**.

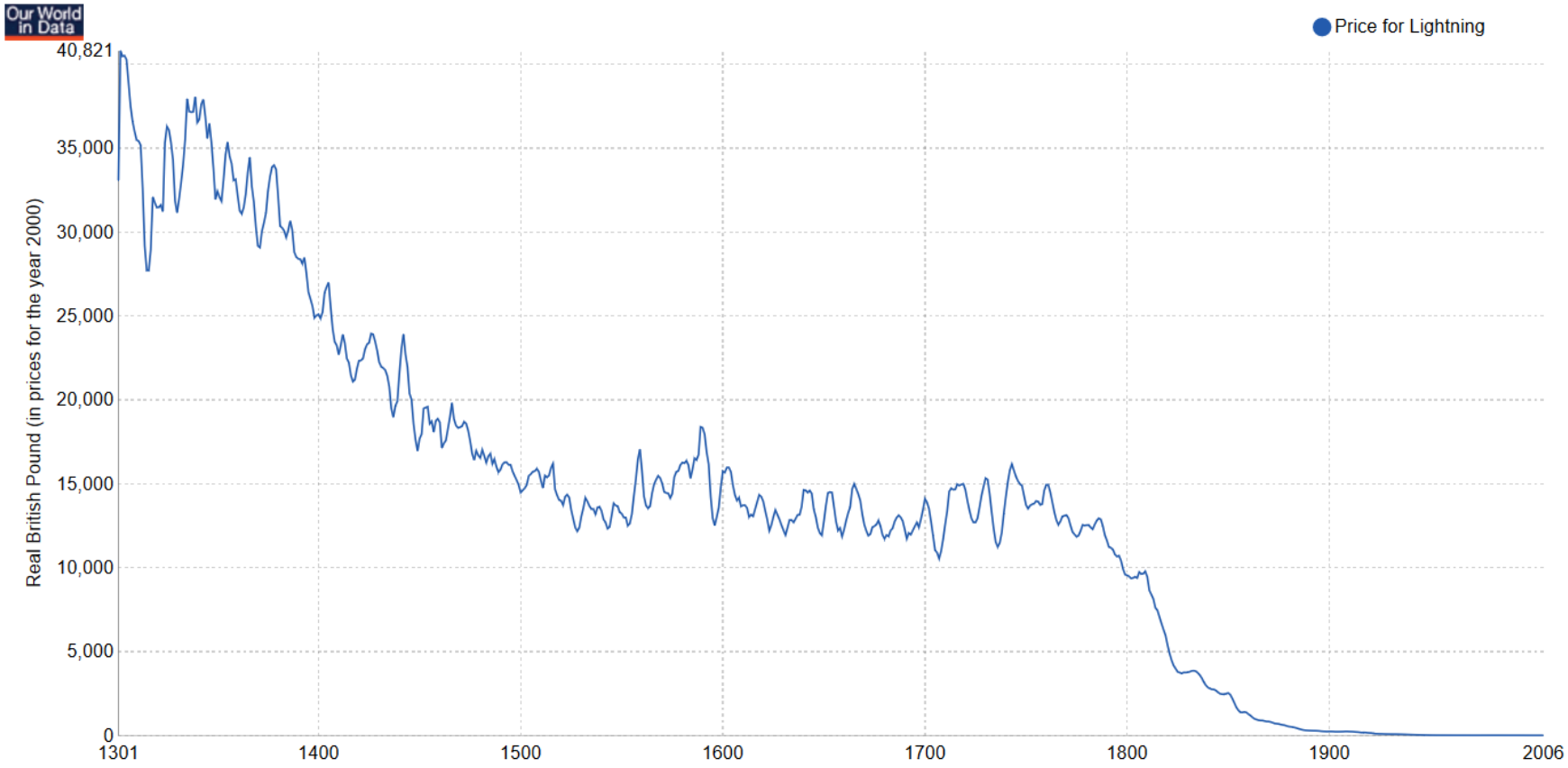
New investments will be focused on **transformational clean energy technology** innovations that can be scaled to varying economic and energy market conditions that exist in participating countries and in the broader world.

Overall, energy R&D has been relatively flat for a long time, but will rise with MI (even without US)



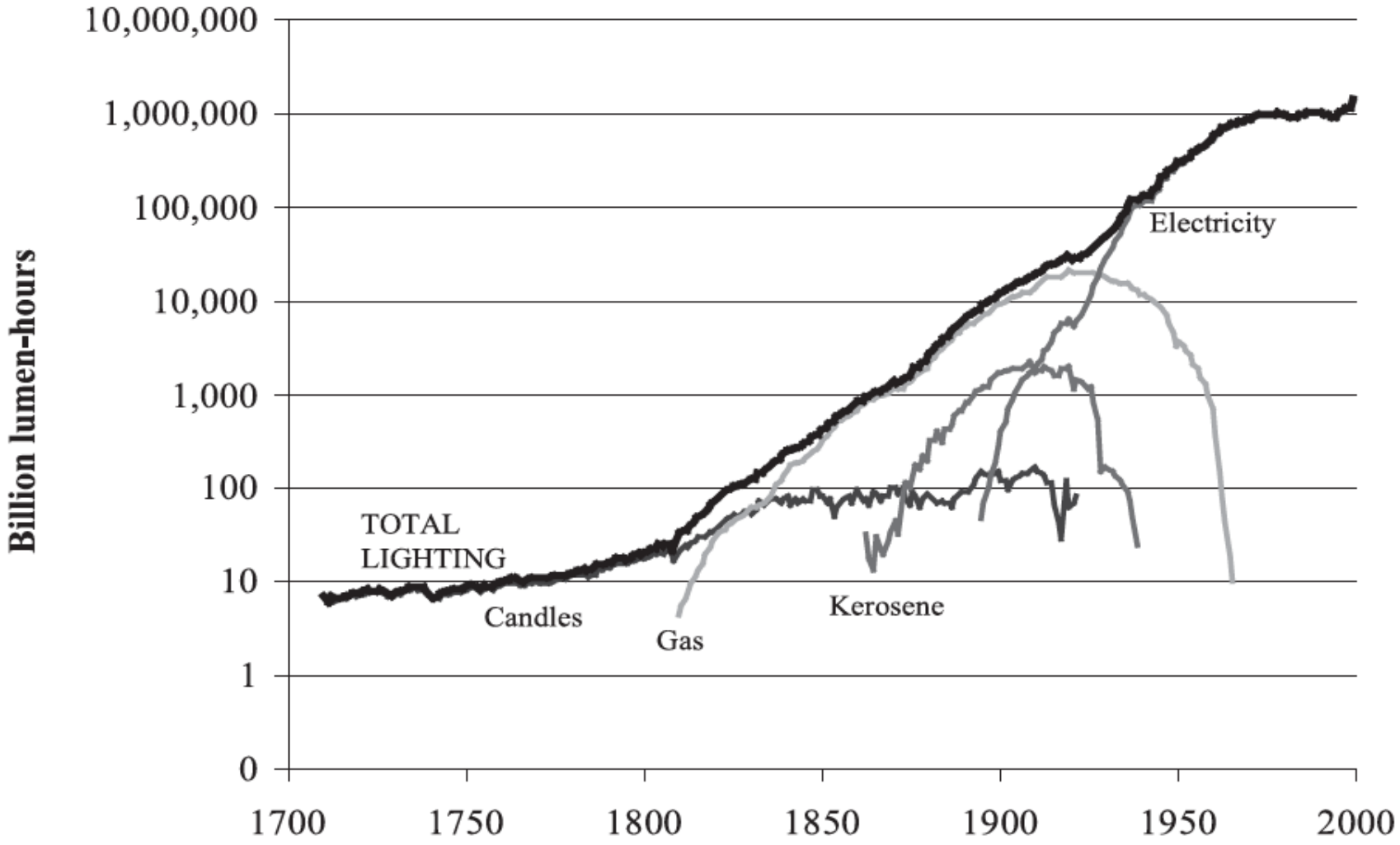
Efficiency and tech progress means the price for many energy services (e.g. lighting) has collapsed

Price for lighting in the UK from 1300 to today



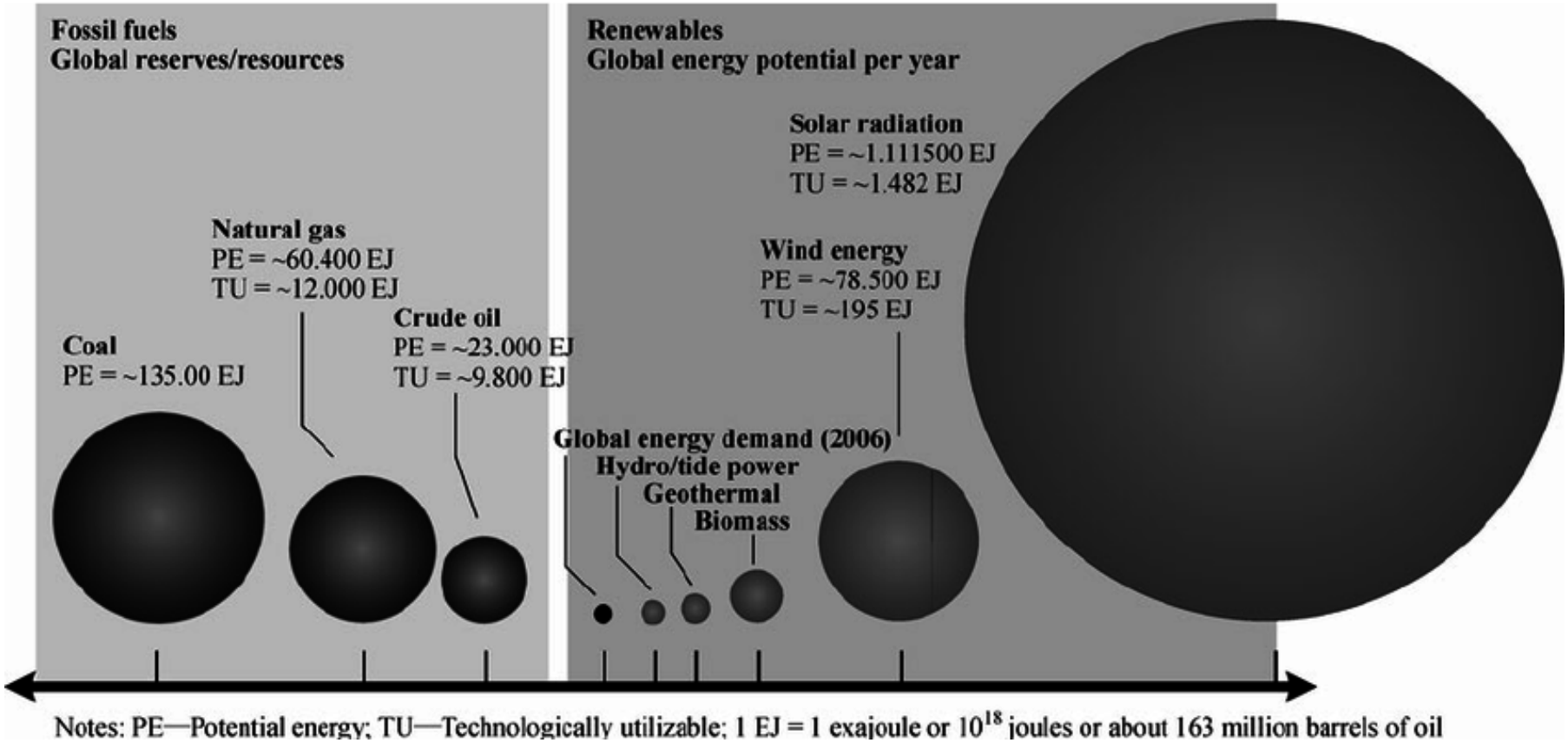
Source: Roser, M. Ourworldindata.org

Consumption of energy services (e.g. lighting) has rocketed since 1700. Satiation points?



Source: Fouquet and Pearson (2006)

De we have enough energy to go around, and to keep creating order from chaos?



Source: Ferric et al (2013)

Solar PV (unlike solar thermal) is an entirely new way of generating electricity – no turbines required

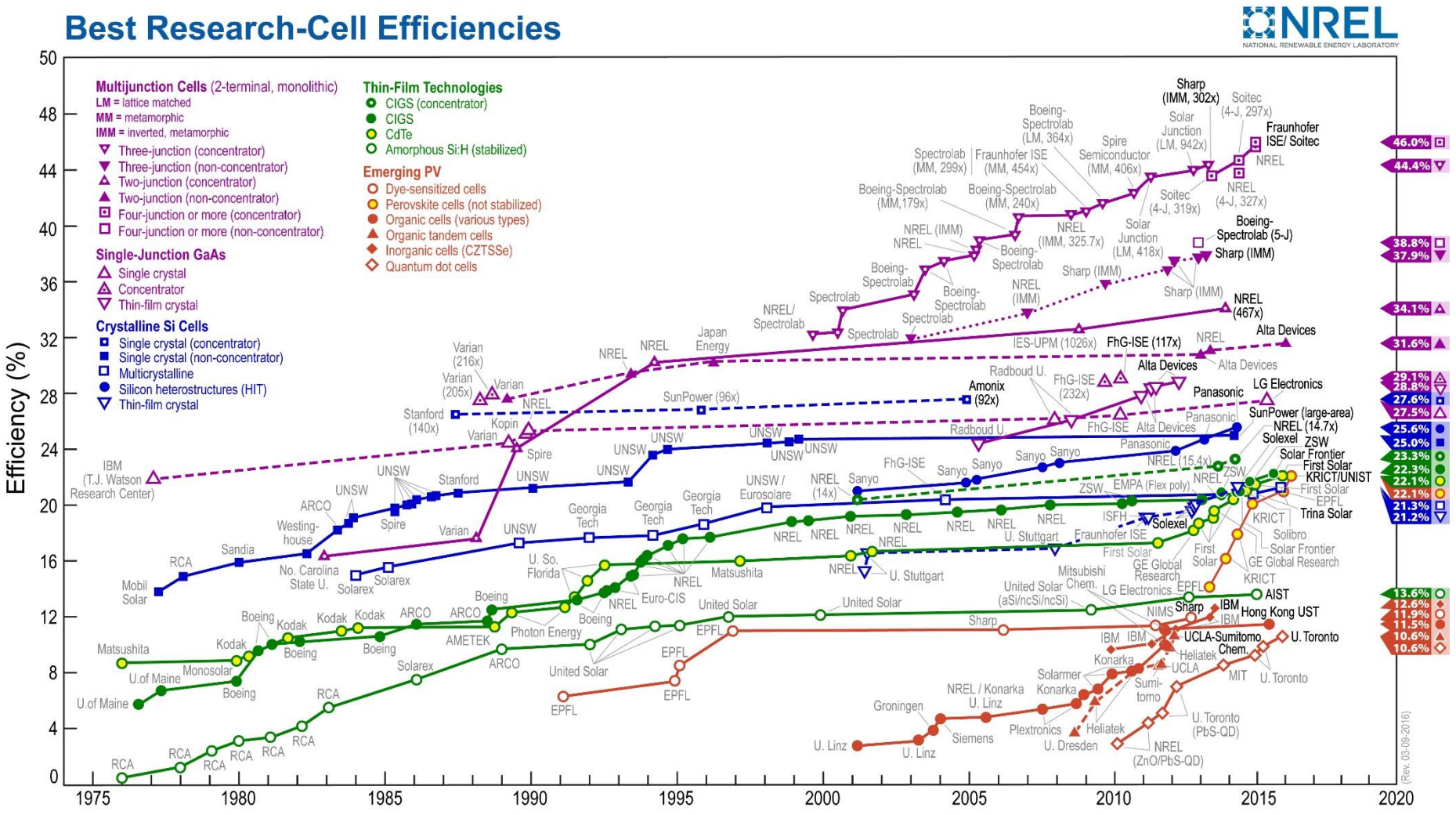
Smith School of Enterprise and the Environment

UNIVERSITY OF OXFORD

Solar PV

CSP

Solar efficiencies continue to rise, reducing costs (including balance of plant per Watt)



Source: https://energy.gov/sites/prod/files/2016/04/f30/efficiency_chart_0.jpg

The first floating solar farm in the UK was commissioned in 2014

Several different university teams are working on spray on solar (semiconductor nanocrystals)

Solar tiles may not be too far around the corner – costs are reputed to be falling…

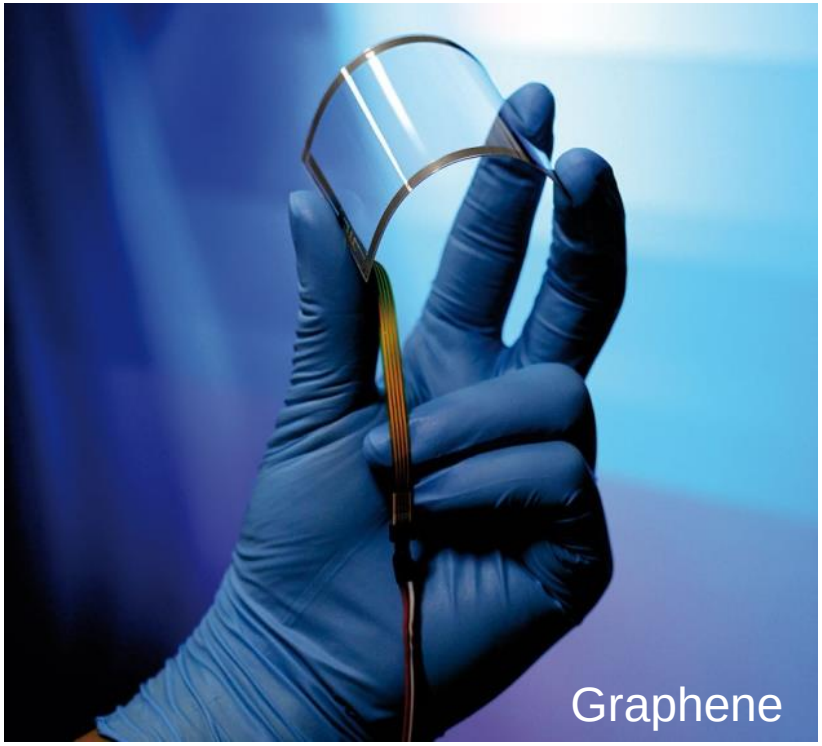
Innovations in solar are promising, including some out of Oxford labs

Source: Rob Lavinsky, iRocks.com

Credit: Oxford Martin School

Much of this is based around new materials science to make better practical use of solar physics

- Perovskites ($CaTiO_3$)
  - High conductivity
  - Increasing efficiency
  - Simple processing
- Graphene (C)
  - High conductivity
  - Very thin
  - Flexible



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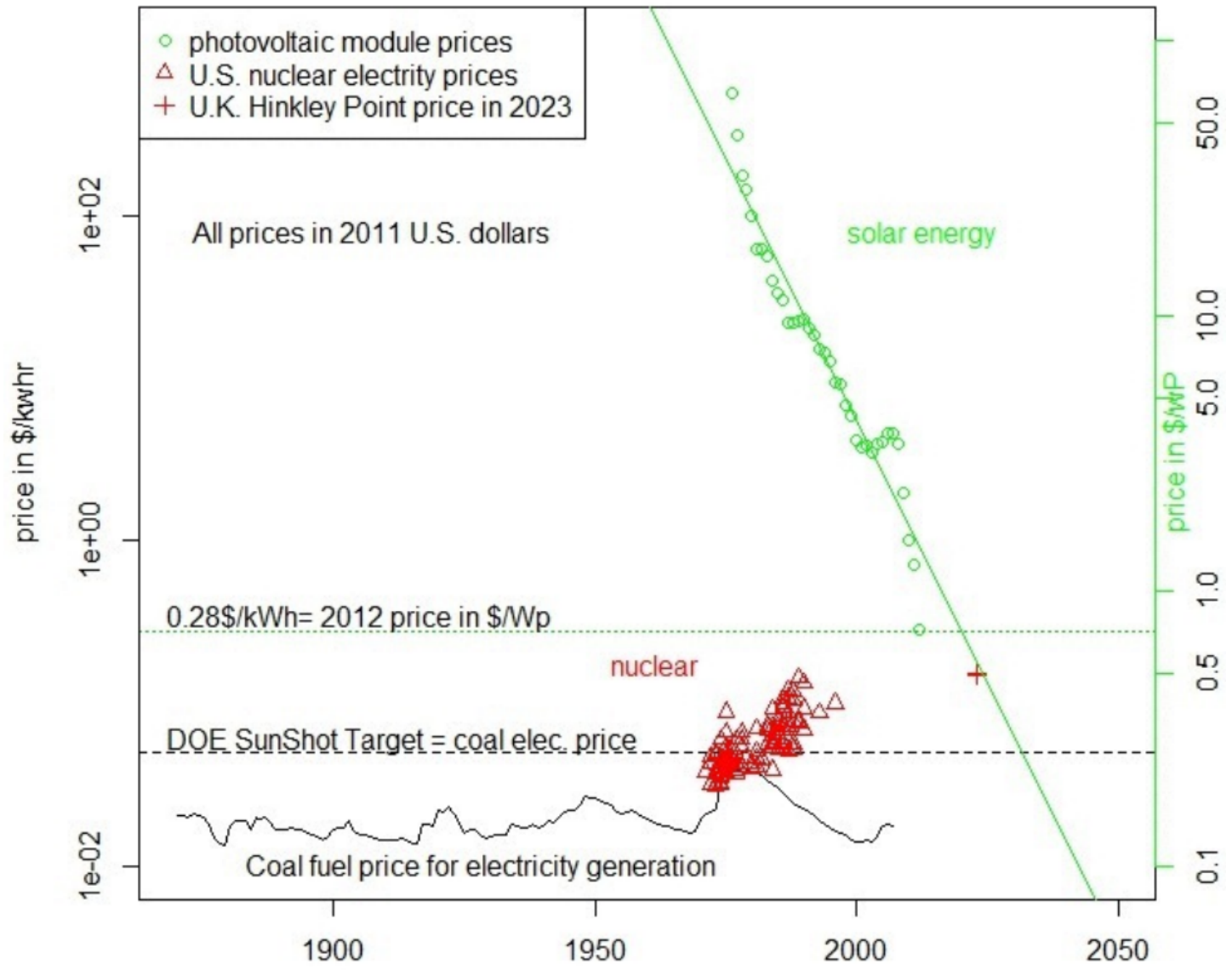
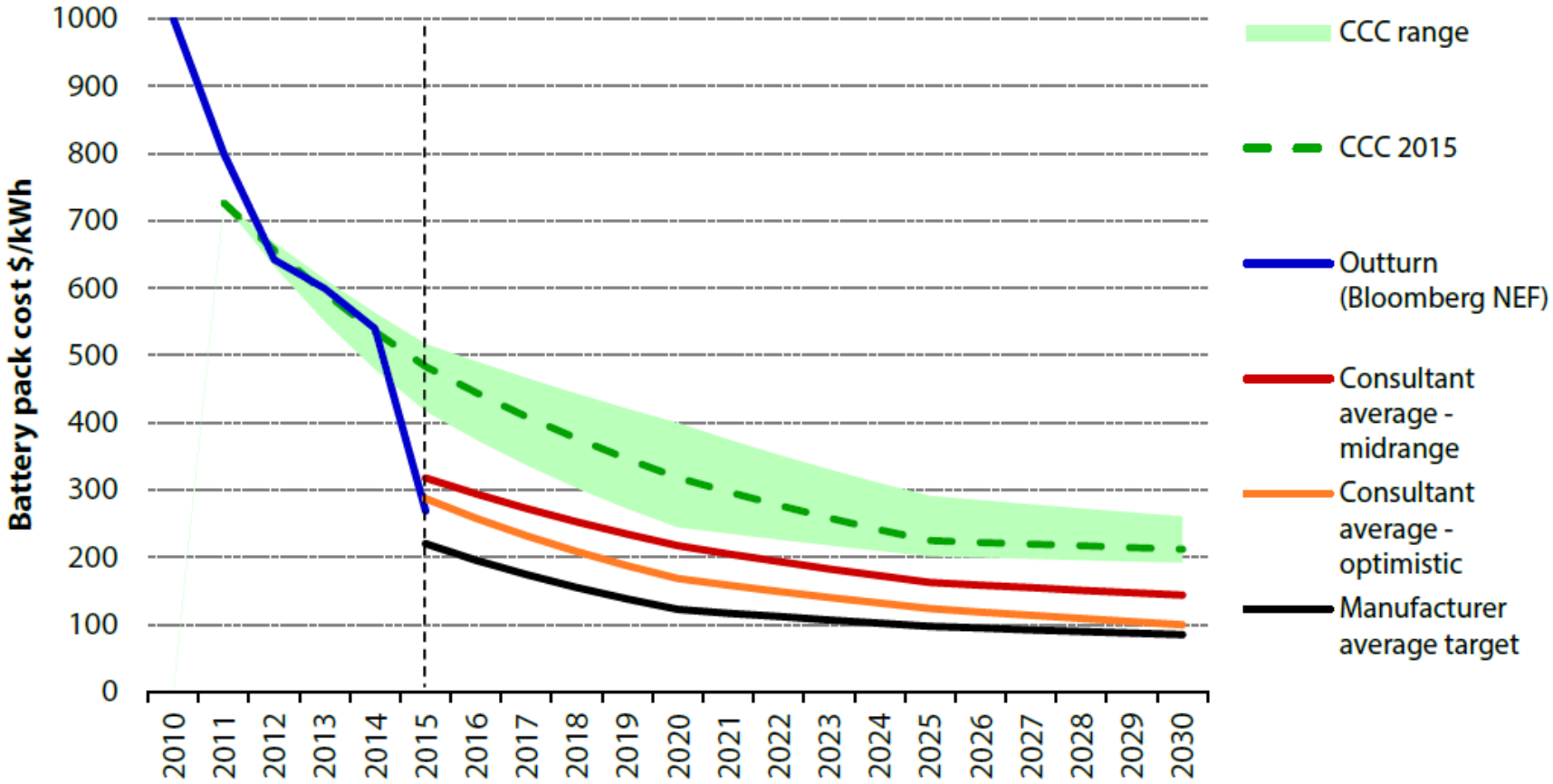
Viewed over the long run, the price collapse is genuinely remarkable compared to power from coal



A clean, cheap, and unlimited supply of energy is no longer entirely infeasible

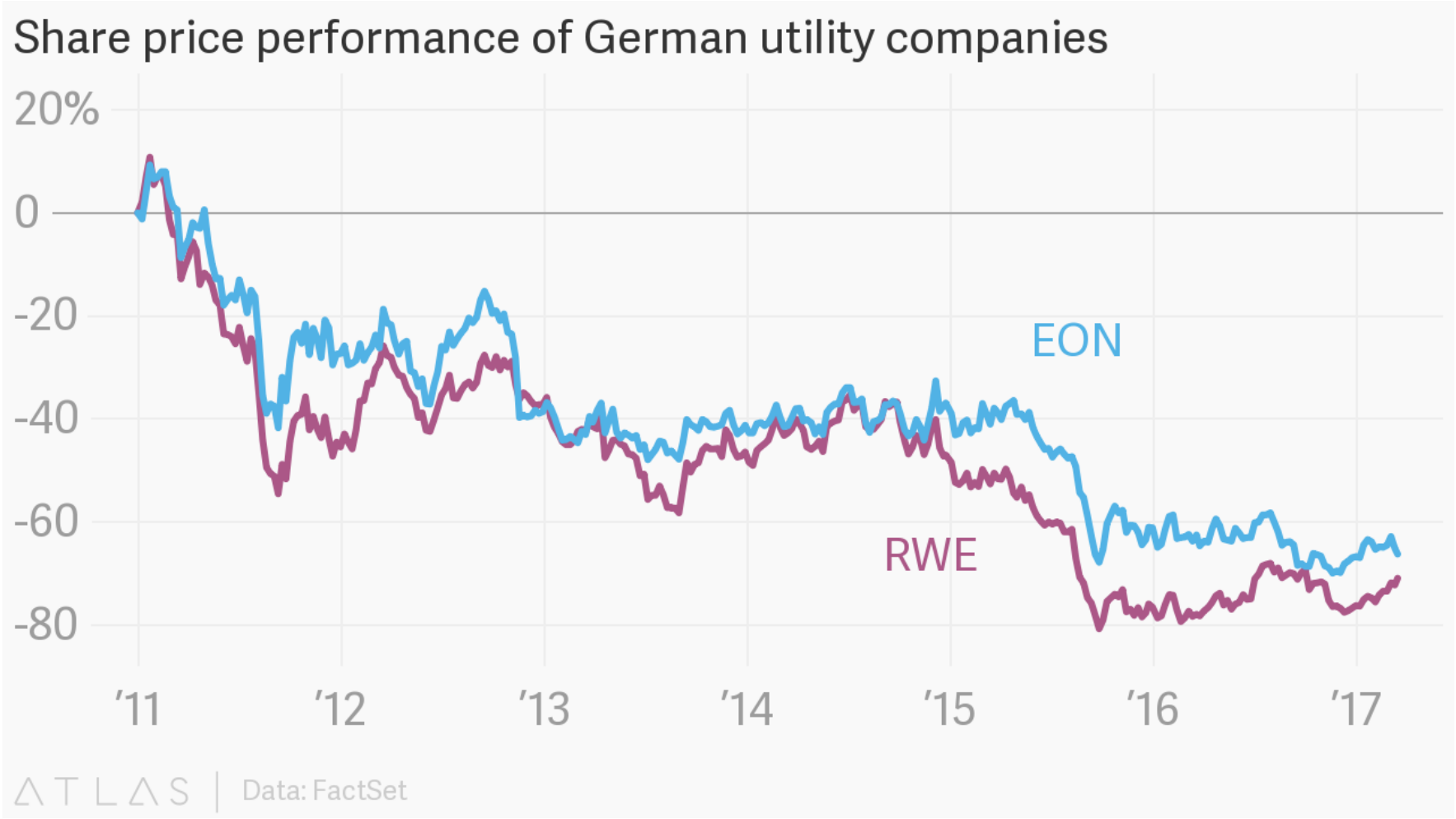
Source: Jaguar Plant in the United Kingdom

The rate of decline in battery costs has surprised official agencies such as the CCC

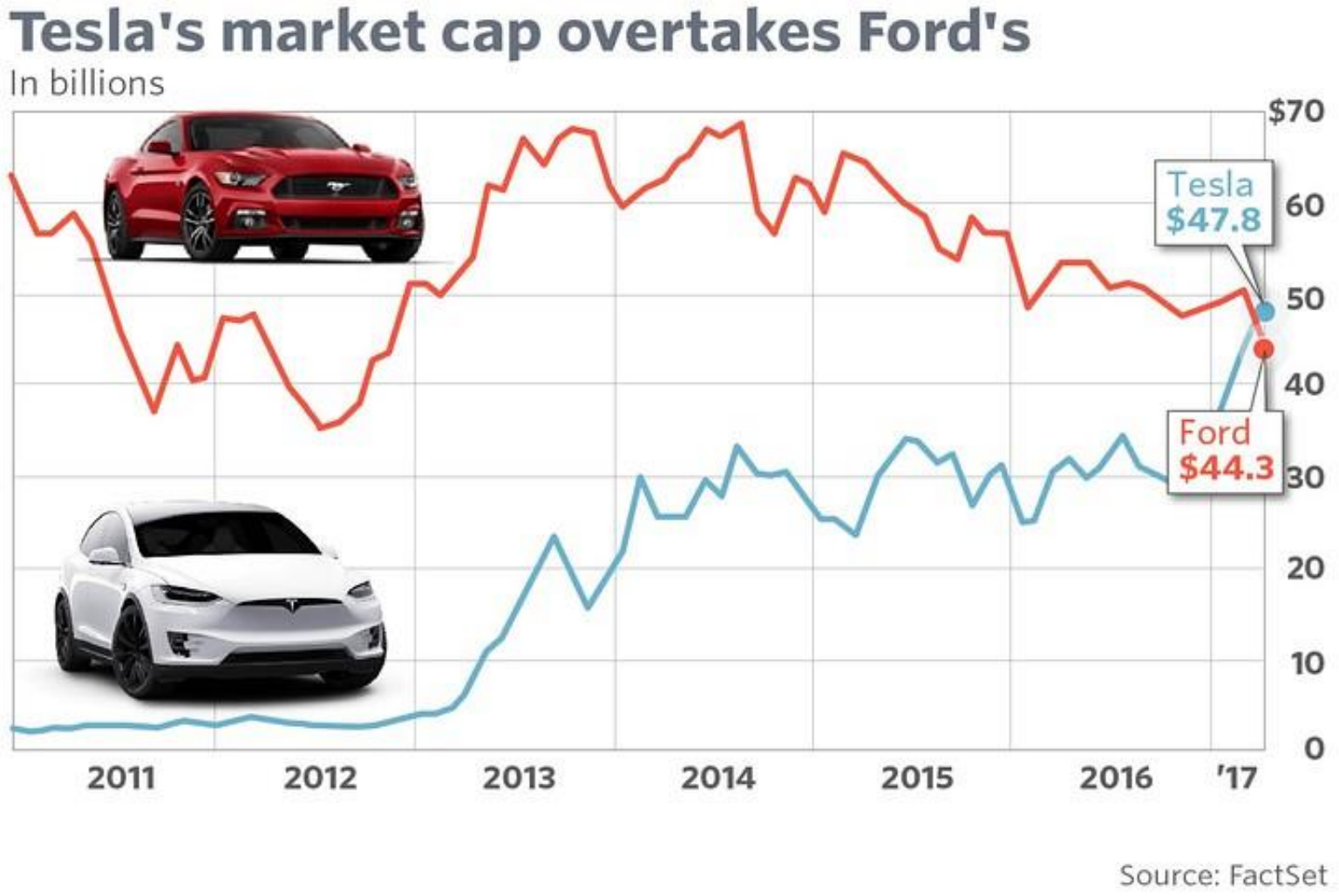


Source: CCC (2017) Meeting carbon budgets

Cheap renewables has thus far hammered incumbent utilities in Germany



Similarly, betting on incumbent car manufactures has not paid compared with backing the disruptive entrant



EVs and AVs represent a potential revolution in personal transport

- Cars currently parked > 90% of the time
- Could be driver > 90% of the time
- Some estimates 80% fewer car parking places required
- Cost of ownership 90% lower
- Impact on demand…?

Source:

And if they take off, electric vehicles could have serious implications for oil and power respectively

- Oil demand is heavily transport dependent
- Hybrids and gas as a transition
- Batteries, infrastructures and all-electric vehicles

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How quickly will the dominoes fall?

Jaguar Land Rover to make only electric or hybrid cars from 2020

Carmaker follows Volvo in spelling an end for petrol or diesel-only cars, despite not making any electric vehicles at present

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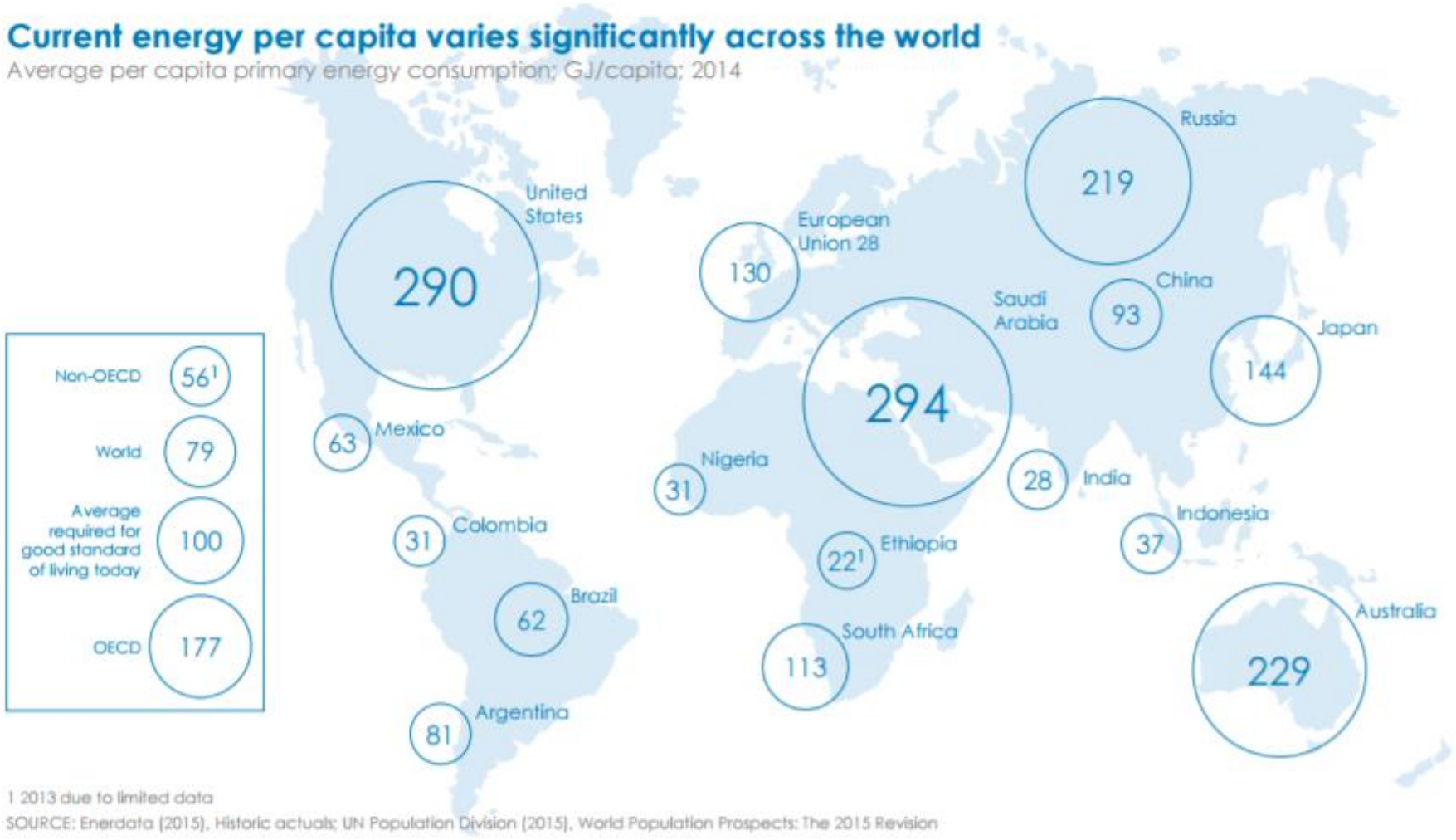
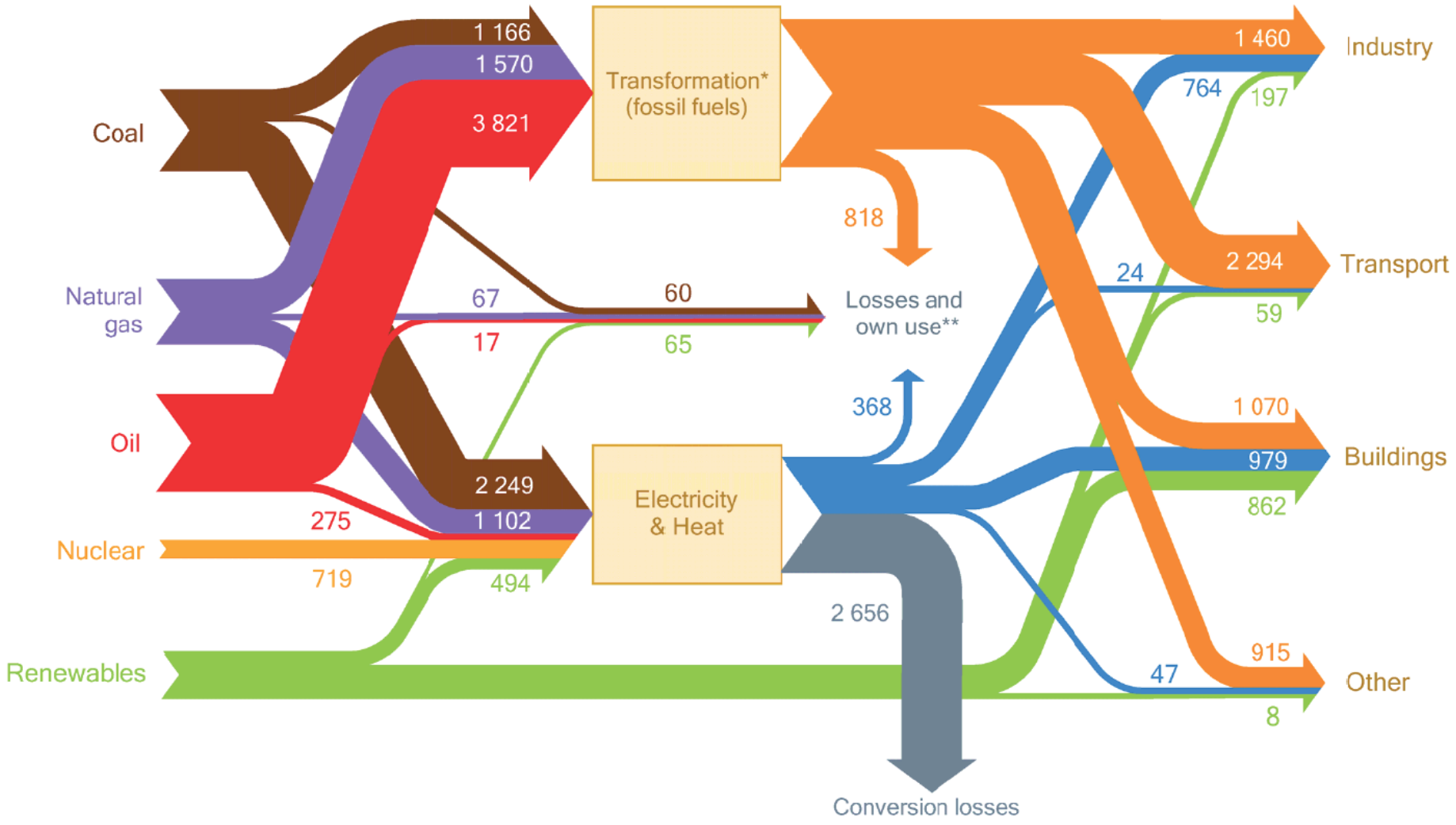
2. Will we get there in time?

Energy per capita varies from 20 GJ to > 200 GJ p. a. ETC argues that 100 GJ is needed for a good life



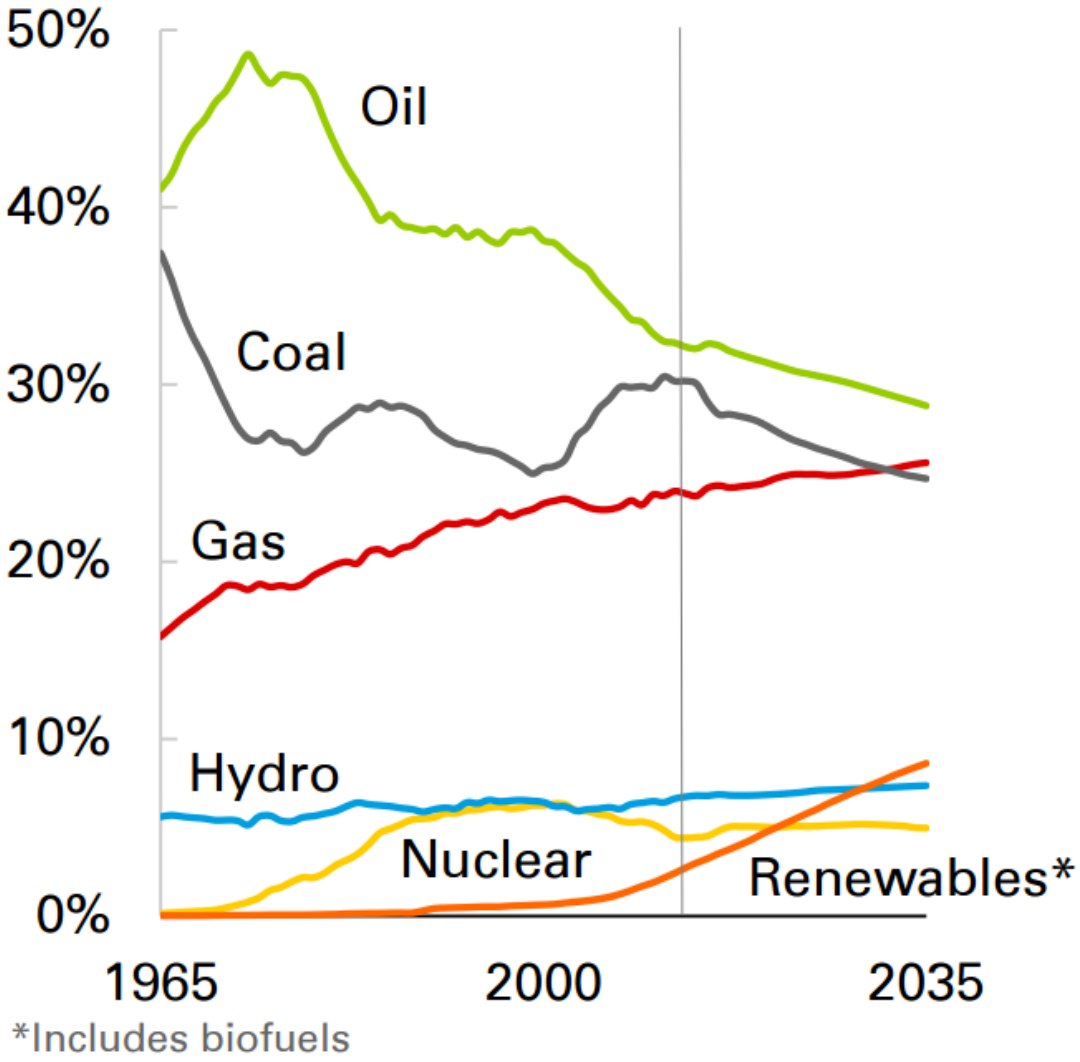
Source: Energy Transition Commission (2017) Better Energy, Greater Prosperity

Globally, energy is still primarily fossil fuels



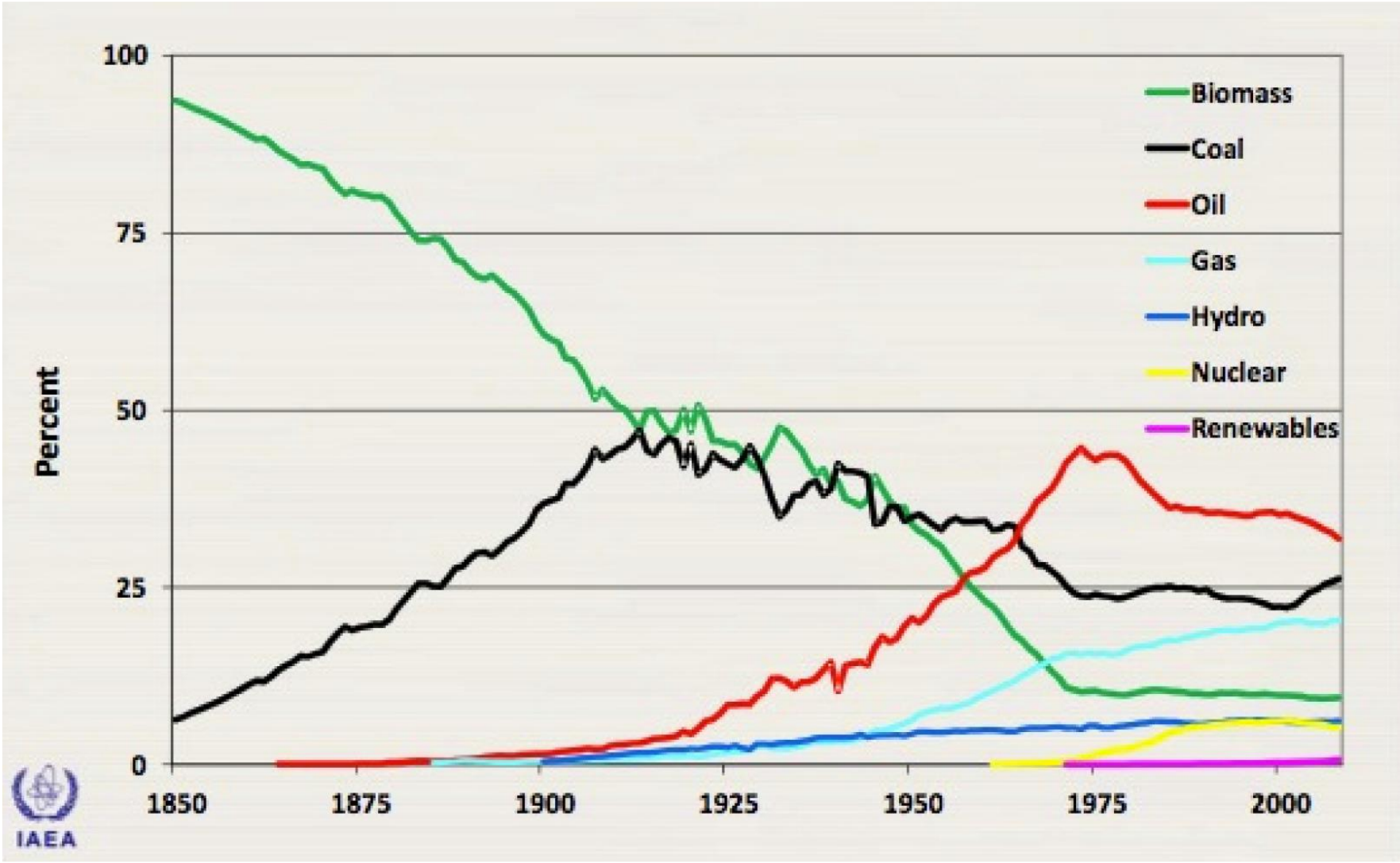
Source: IEA (2012) World Energy Outlook, Figure 2.8

The oil majors and the IEA suggest that change is unlikely to come quickly



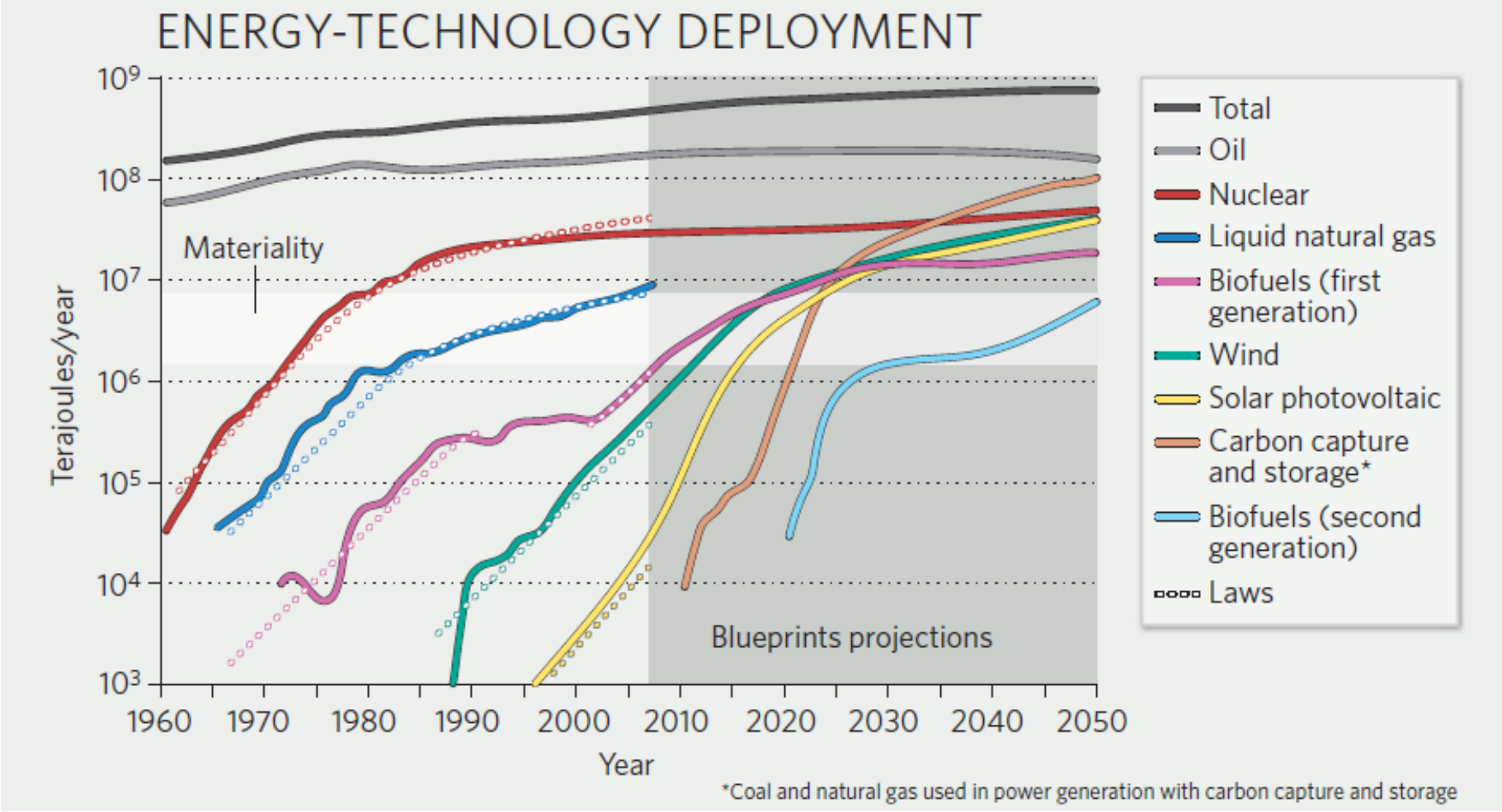
Source: BP (2016) World Energy Outlook, Figure 2.8

Historically, energy transitions have happened slowly, each one taking many decades



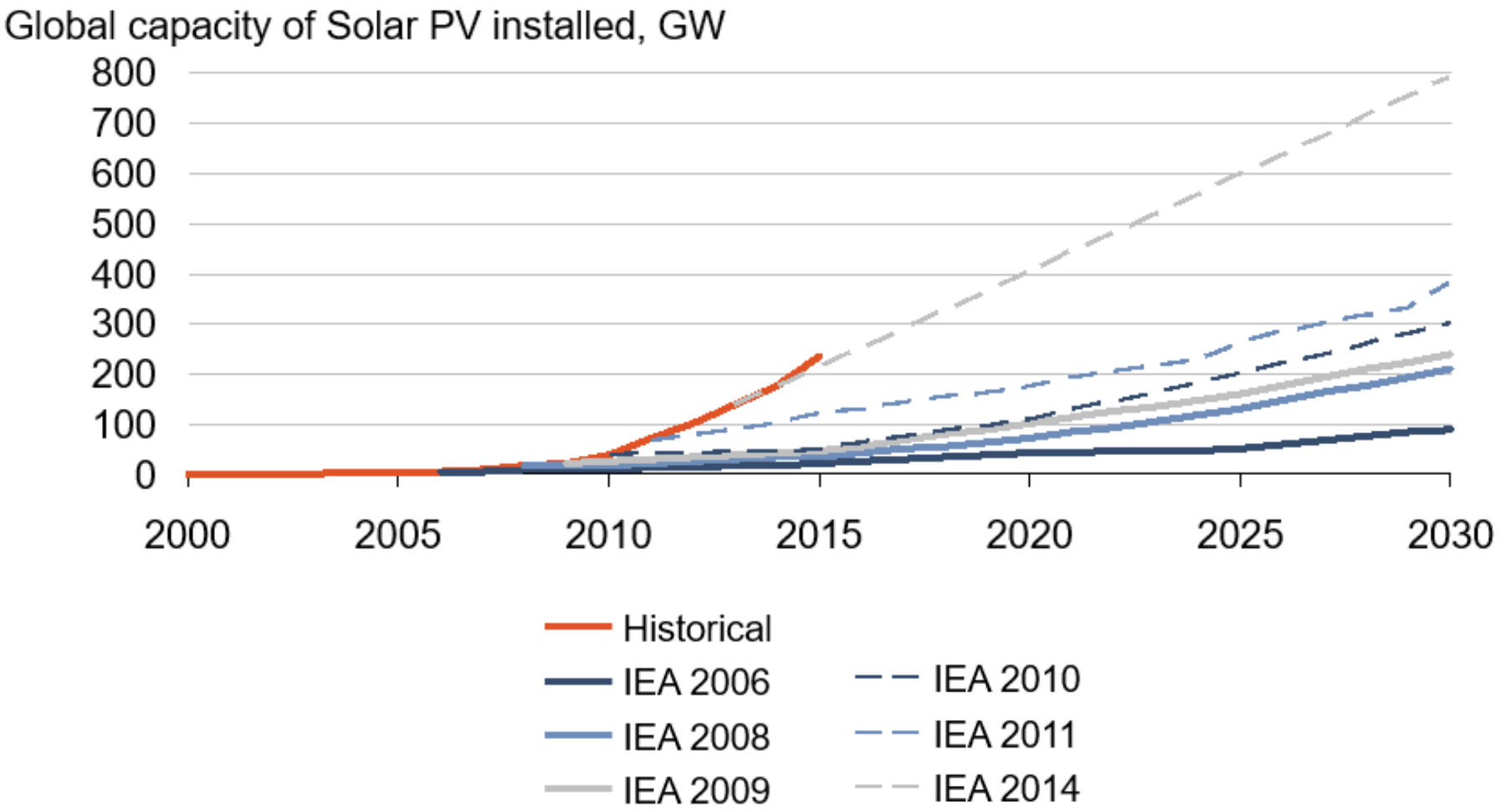
Source: IAEA

Past 'evidence' therefore appears to back up the view that such rapid change is very unlikely, but…



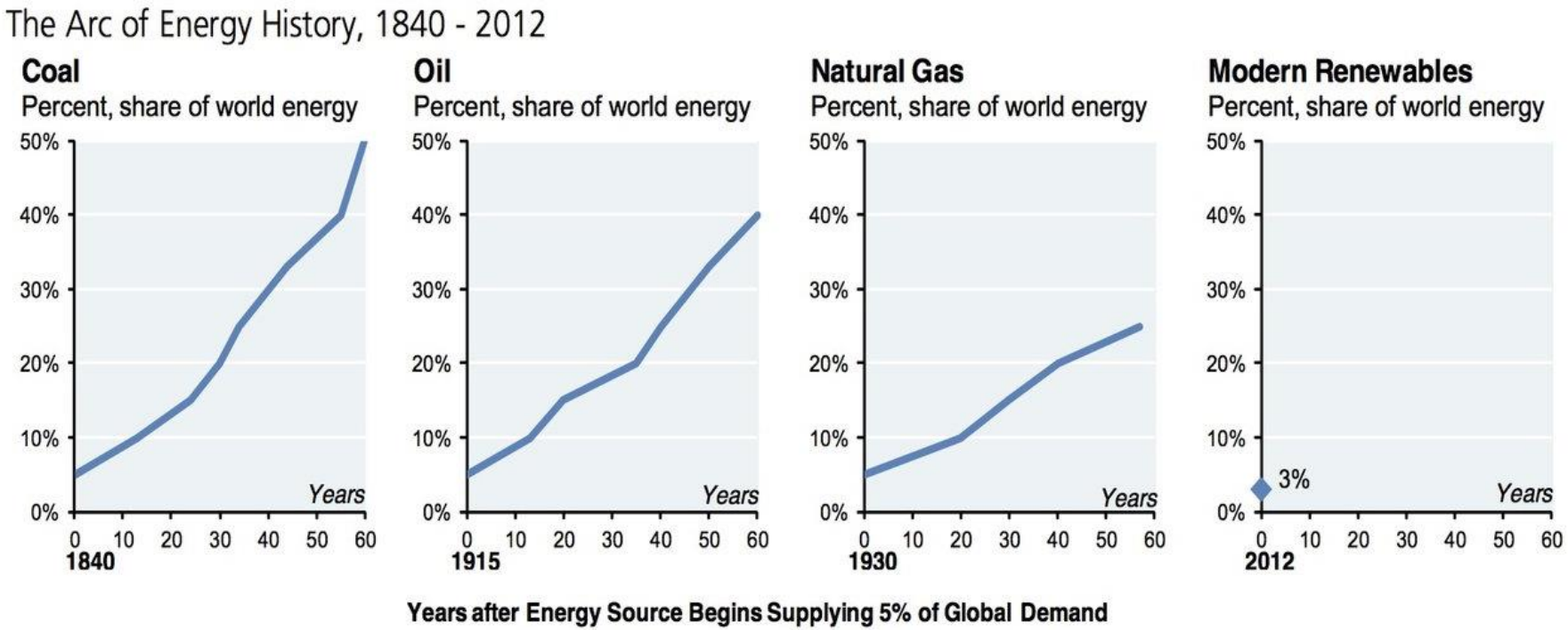
Source: Kramer and Haigh (2009, Nature) No quick switch to low-carbon energy

The big guys already have an impressive track record in getting it wrong on solar



Transitions can be fast: New York went rapidly from the horse (1900) to the car (1913)

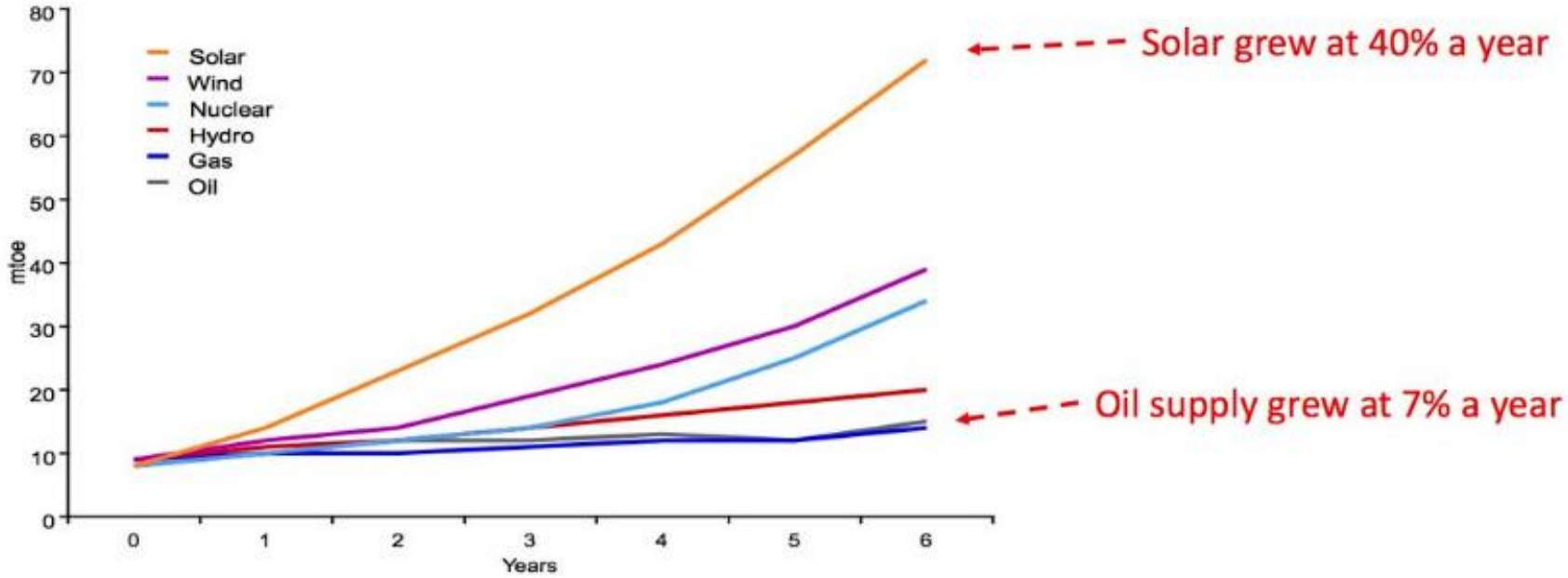
Others (e.g. Smil) note energy sector transitions are always slow, because of e.g. long lived capital



Source: JP Morgan Asset Management based on Smil (2014) Scientific American

Could this time be different?
Solar growth rates are historically unprecedented

Growth after a fuel reached 10 mtoe (million tonnes of oil equivalent)

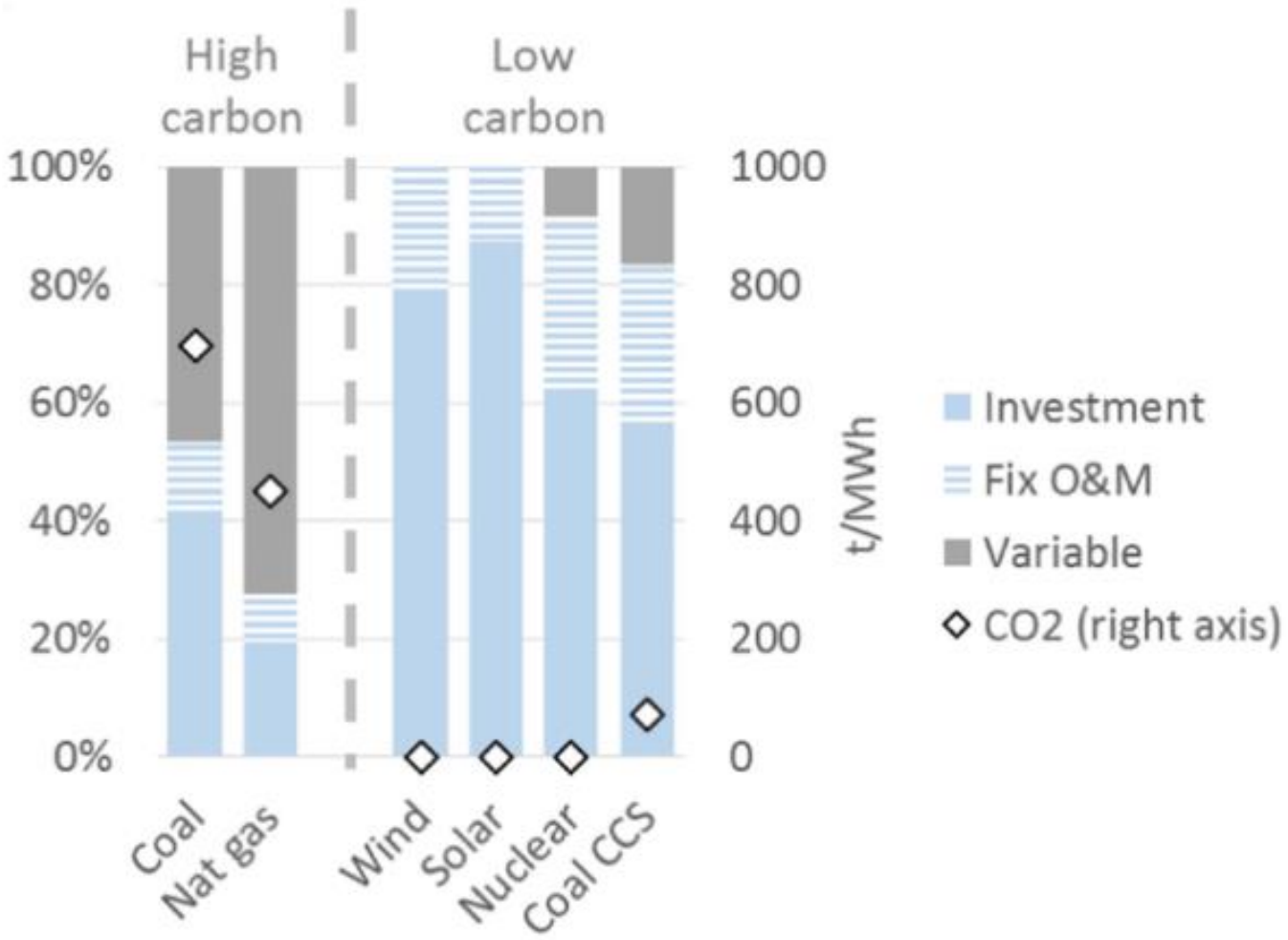


Sources: BP, Smil, TSRP estimates.

Source: Kingsmill Bond, see https://www.carboncommentary.com/blog/2016/11/17/the-time-needed-for-energy-transitions#_ftn15=

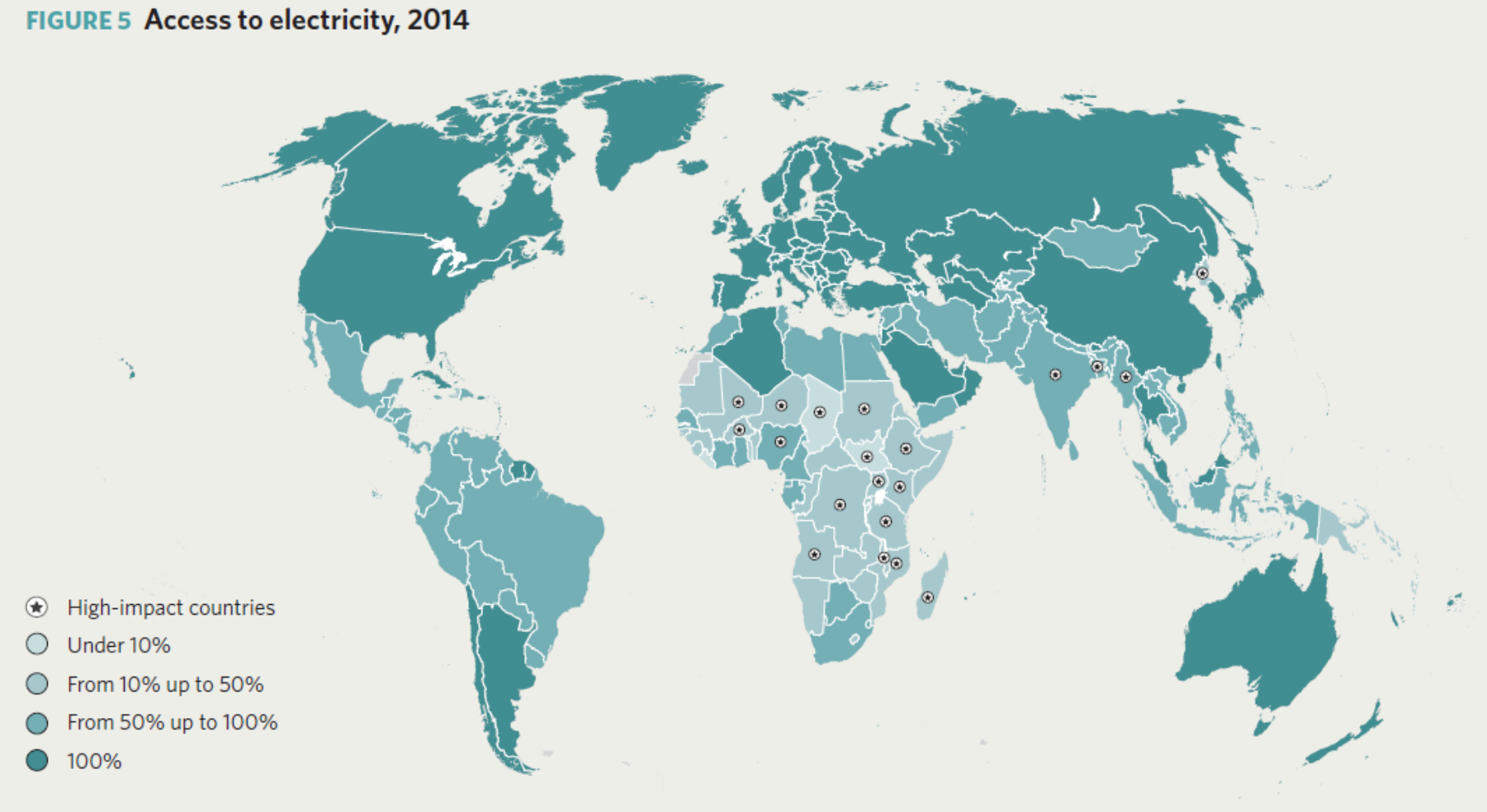
Finance will be important because the new energy world is more capital than fuel

So financing is more important than ever → next session!



Source: Hirth and Steckel (2016, ERL)

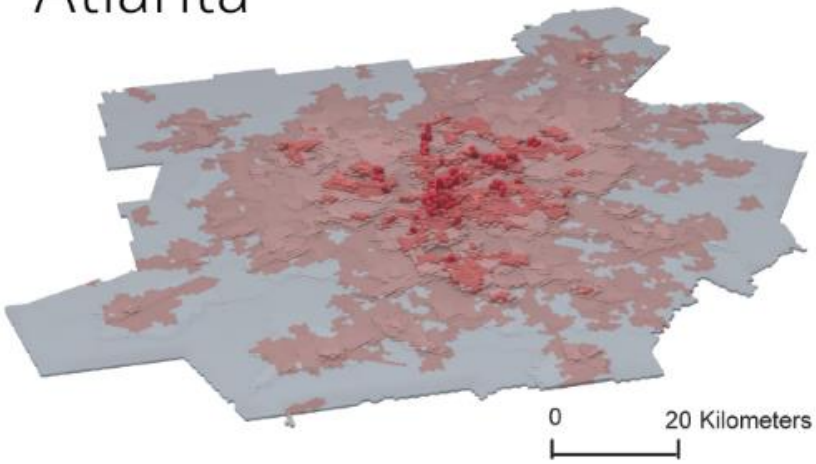
Much depends upon how rapidly, and how, countries electrify across Africa and South Asia



Source: SE4All (2017)

It also depends on urban design (emissions are 6x in Atlanta cf Barcelona)

Atlanta



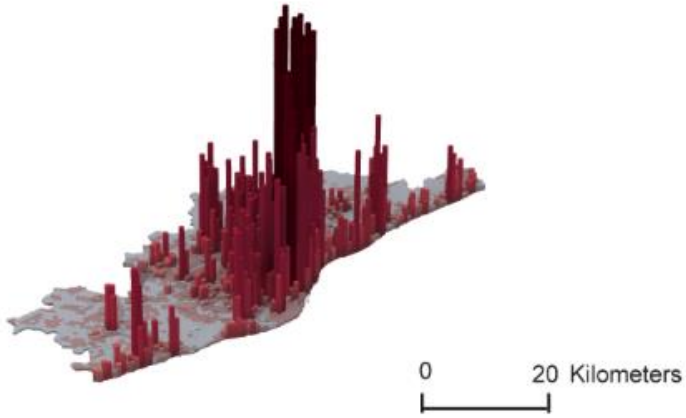
5.3 million
Population

16,605 sqkm
Total area

7,692 sqkm
Urban area

6.9 tonnes CO2
Transport carbon emissions per capita

Barcelona



5 million
Population

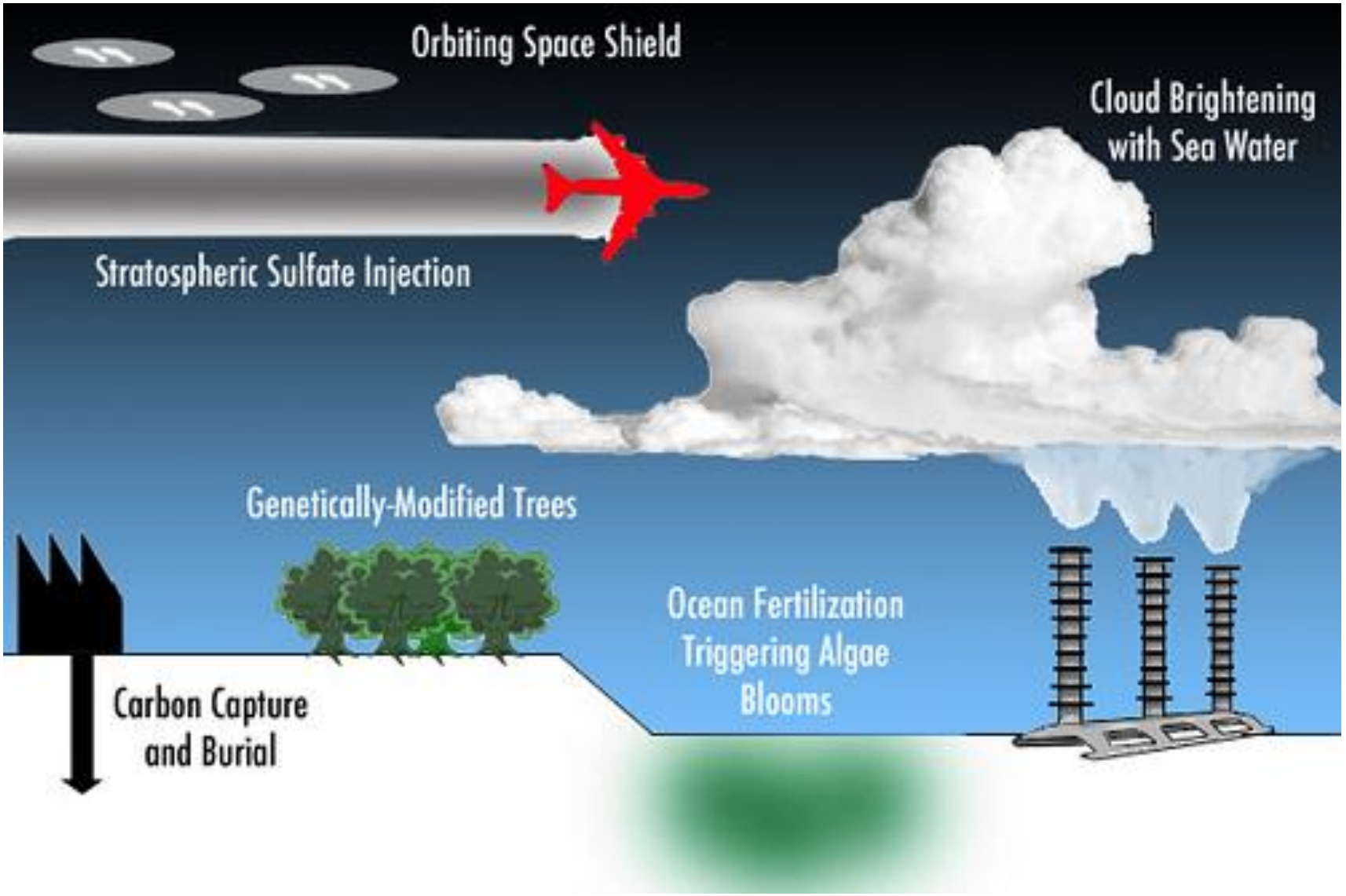
3,263 sqkm
Total area

648 sqkm
Urban area

1.2 tonnes CO2
Transport carbon emissions per capita

Source: LSE Cities, 2014

And if all else fails, we can try geoengineering



Summary

Whether we will transform our economy in time depends upon:

1. Can we accelerate the pace of technological change? (Very likely)
2. Can we integrate new tech into systems fast enough? (Likely)
3. Will we urbanise in a sensible way? (Maybe)
4. Will the finance be available? (Likely)
5. Will the climate be kind to us? (We are rolling the dice…)

Source: SE4All (2017)

Thank you