Energy and Green Growth

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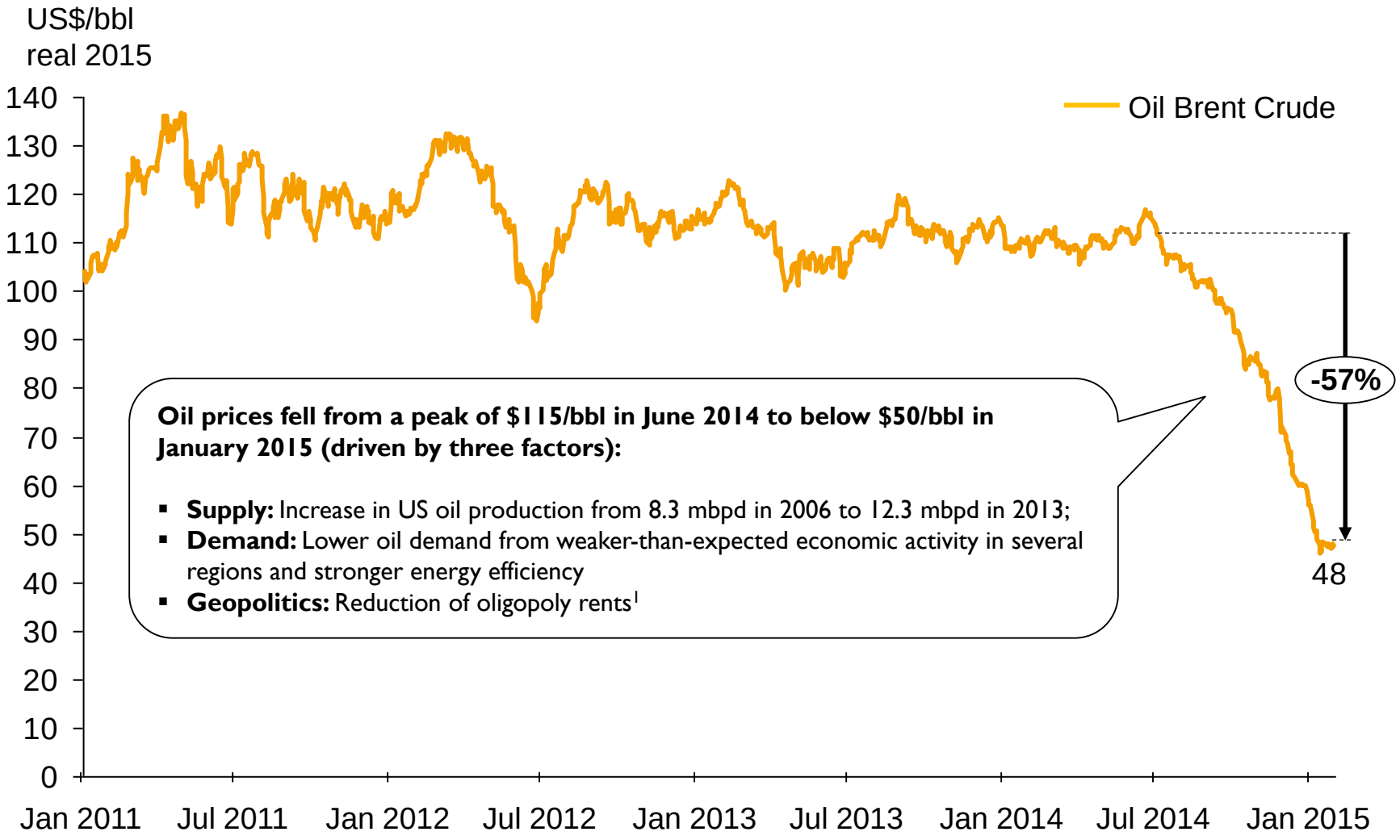
Suppose that there were a clean, cheap, and unlimited supply of energy…

Source: Jaguar Plant in the United Kingdom

Agenda

1. What is the relationship between energy and economic growth?
2. Is "green growth" useful or vacuous?
3. Is green growth even possible?
4. What are the policy implications?
5. Conclusion

During the second half of 2014 we saw a collapse of oil price…how does this affect economic growth?



Oil prices fell from a peak of $115/bbl in June 2014 to below $50/bbl in January 2015 (driven by three factors):

- **Supply:** Increase in US oil production from 8.3 mbpd in 2006 to 12.3 mbpd in 2013;
- **Demand:** Lower oil demand from weaker-than-expected economic activity in several regions and stronger energy efficiency
- **Geopolitics:** Reduction of oligopoly rents[1]

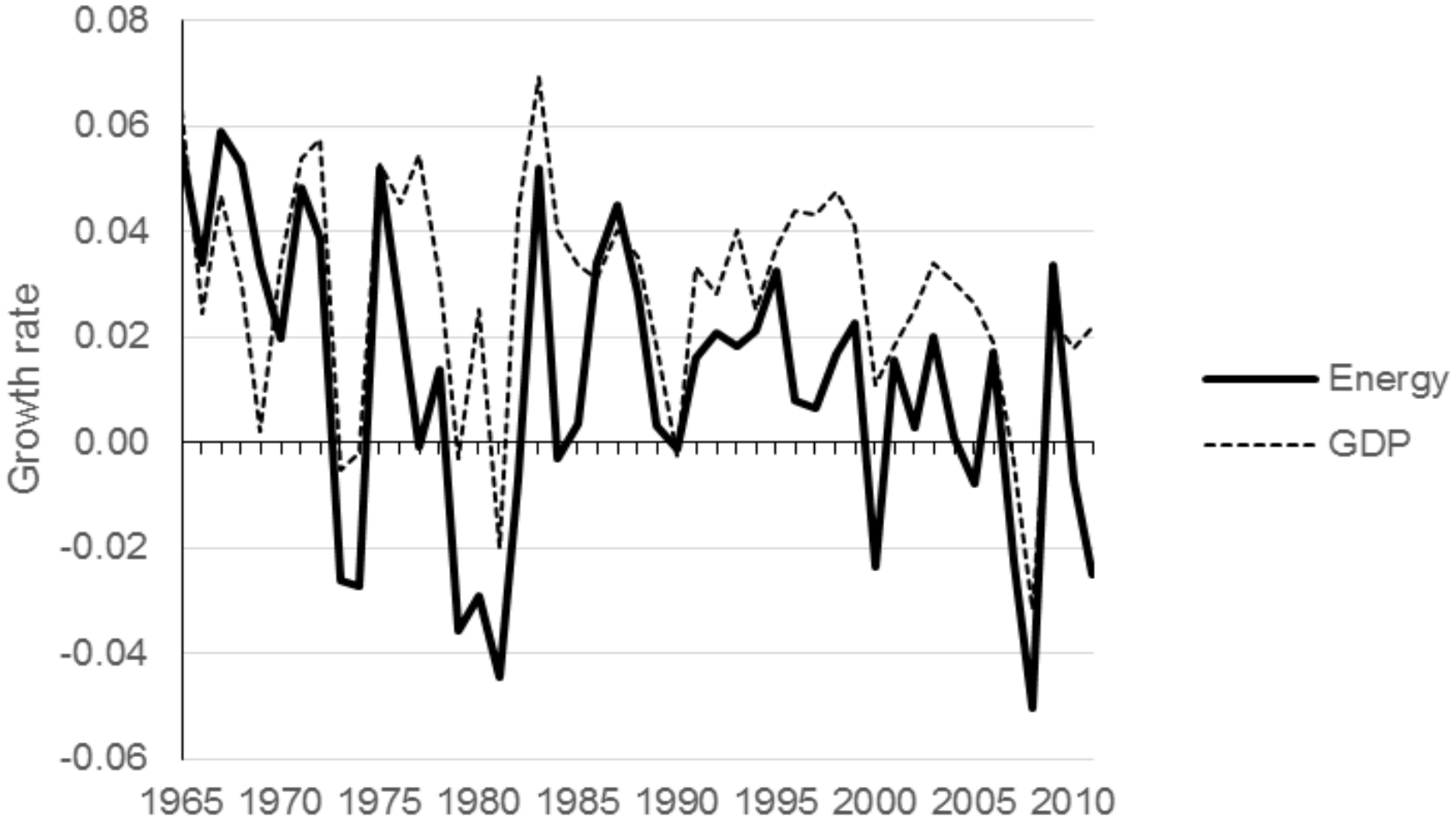
1 OPEC announced that it would maintain current production levels (Nov. 27th, 2015)

Source: Aurora Energy Research; Thomson Reuters; EIA; IMF; OPEC

The oil price crash has re-opened questions on the relationship between energy and economic growth

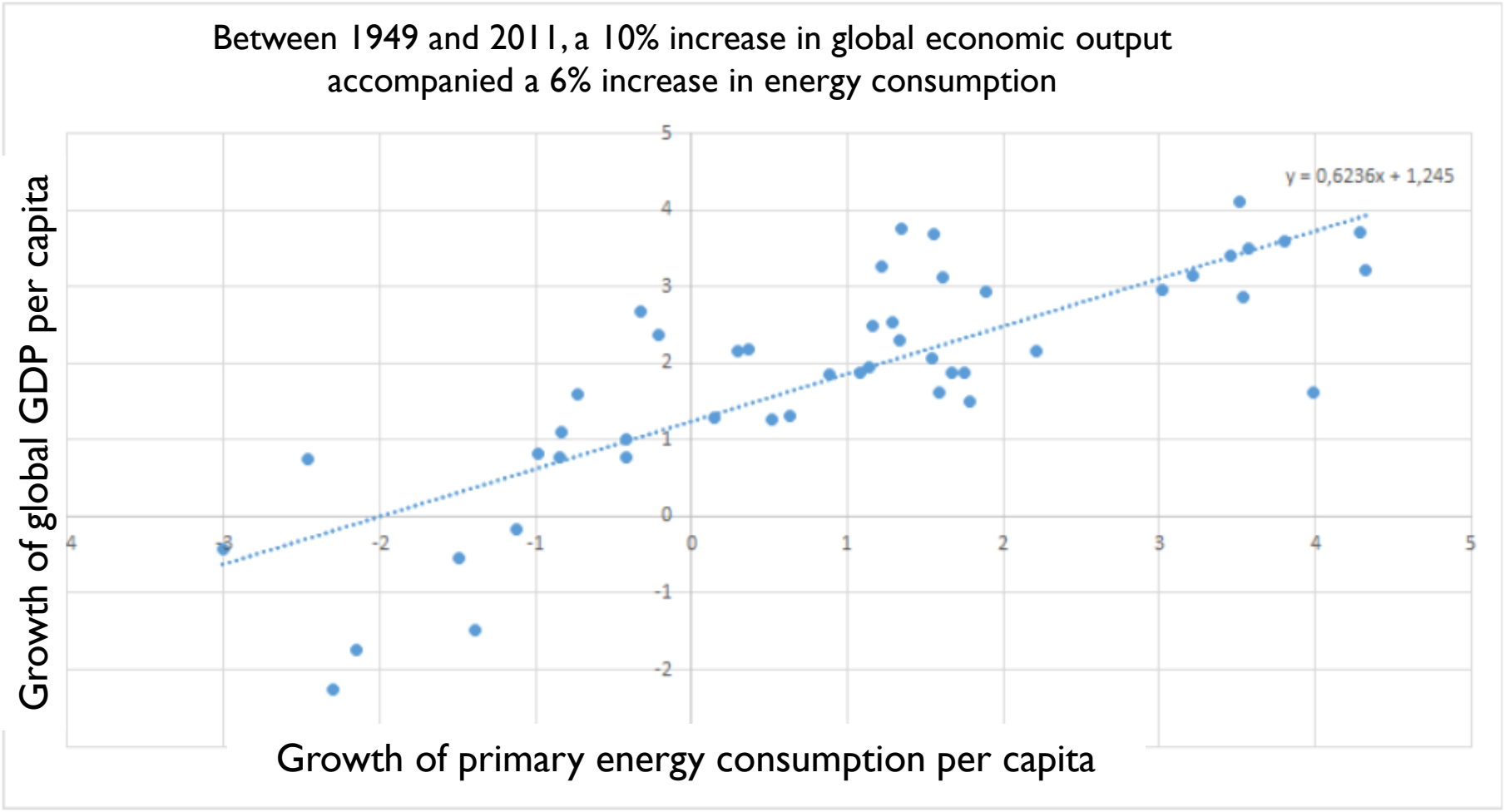
As oil *prices* fall, we can expect oil *consumption* to increase.

The link between energy consumption and GDP is clear in the USA and globally



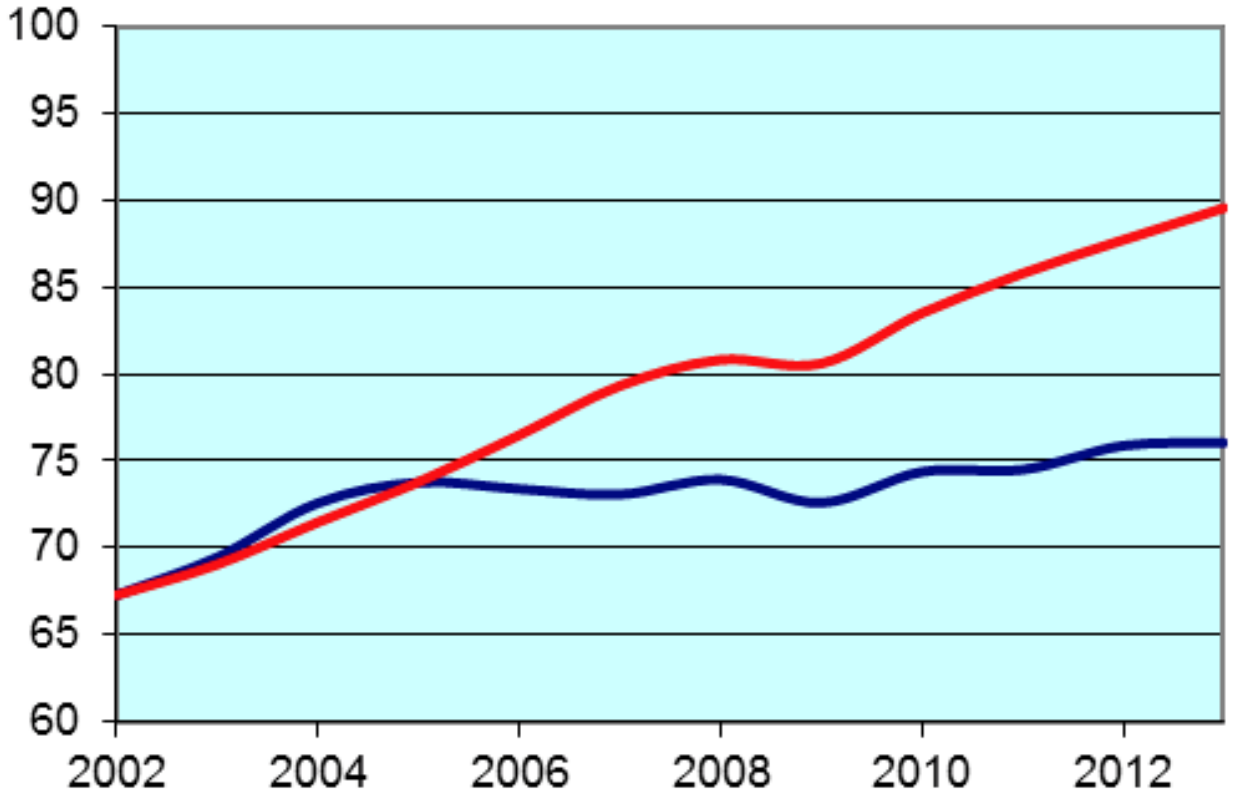
Source: Hannesson (2014), Energy use and Economic Growth, 1965 – 2012ç

A 10% increase in global economic output has accompanied a 6% increase in energy consumption



Source: EIA in Giraud & Kahrman (2014)

But very recently (2006-2013), oil has not correlated with economic growth as predicted…



Red line: Predicted oil demand based on GDP data from IMF and an assumed oil consumption growth / GDP growth elasticity of 0.7

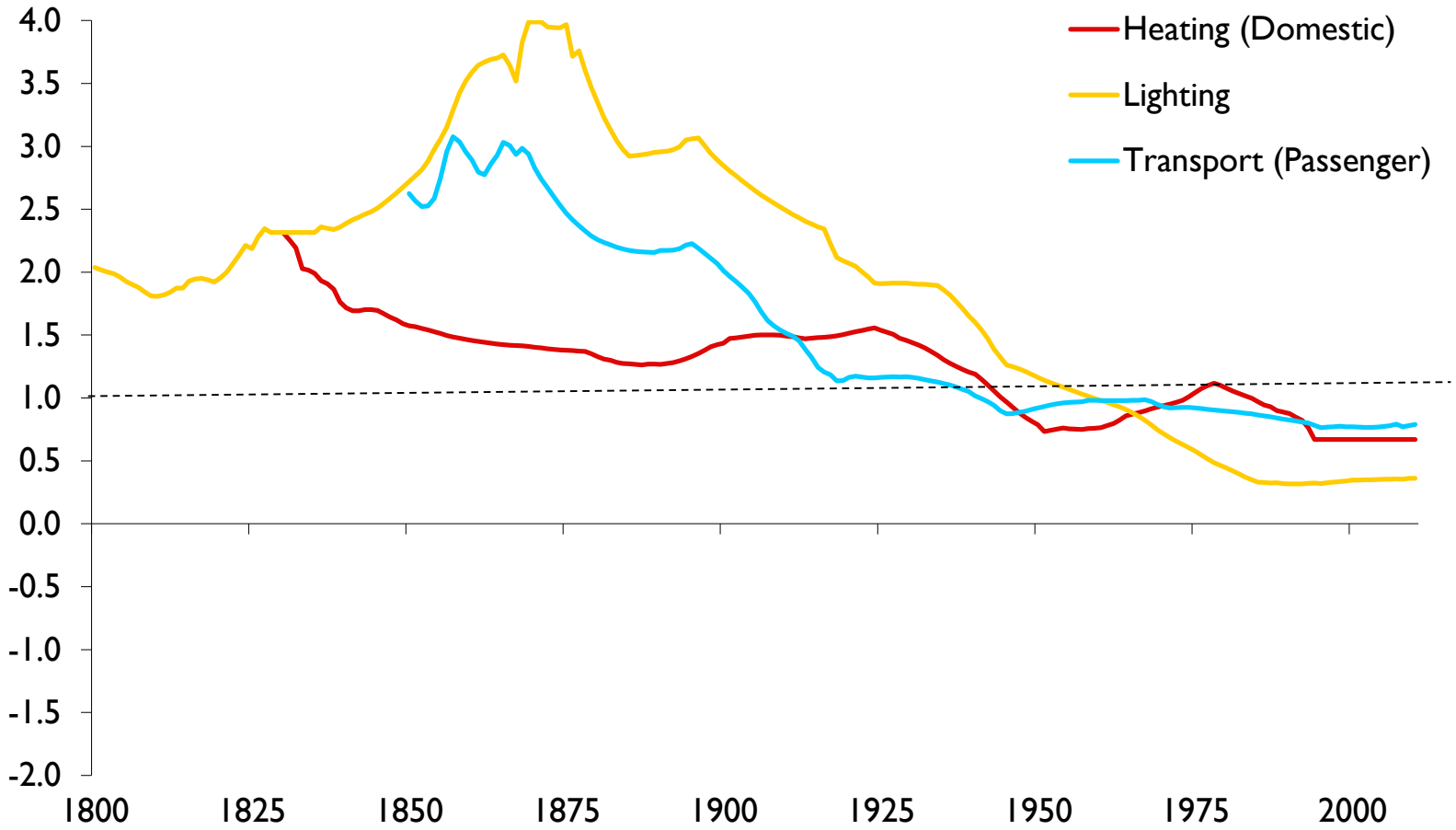
Blue line: Actual world field production of crude oil and condensate

2002-2013, in millions of barrels per day, from EIA

Source: http://econbrowser.com/archives/2014/06/energy-demand-and-gdp

But while there is long-run decoupling, increasing incomes still correlate with increasing energy

Income elasticity of demand for energy services in the UK (1800-2010)



Source: Fouquet (2014)

Agenda

Institute for New Economic Thinking AT THE OXFORD MARTIN SCHOOL

1. What is the relationship between energy and economic growth?
   - What is the impact of the oil price fall on clean technology development?
2. Is "green growth" useful or vacuous?
3. Is green growth even possible?
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Impacts of the low oil price on clean technologies is unsurprisingly likely to be negative

- The expected boost to the global economy driven by the current lower oil prices will be more than neutralised by other negative factors, including "investment weakness" and "adjustment to lower medium-term growth" according to the IMF
- In the medium and long run, low oil prices will halt development of some (high cost) oil projects (e.g. in the Antarctic or oil sands in Canada) and price will likely edge back up
- Expect low oil prices to have a (mild) negative effect on **clean technologies**
  - **Electric vehicles:** A low oil (and pump) price has a negative effect on cost advantage
  - **Clean energies:** Adverse effect via the correlation of oil and gas prices and the impact on electricity prices

Tesla stock prices have fallen, but only once markets saw the oil price falls as not temporary

Development of Brent oil price (red line) and Tesla Motors stock price (blue line)

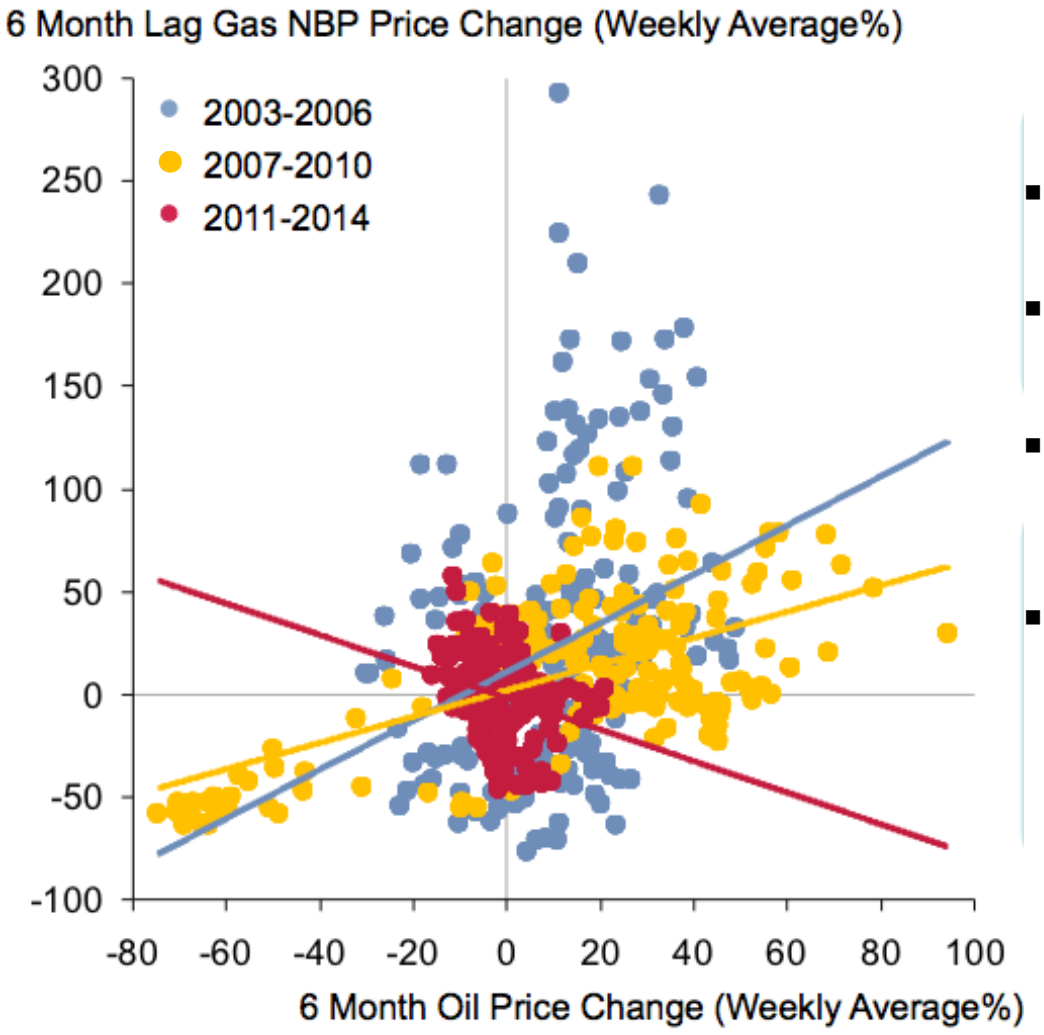
Last 3 months (indexed on Nov. 13th 2014)

Last 12 months (indexed on Feb. 13th 2014)

- Over the last 3 months Tesla stock price has declined with the oil price
- But in the longer run (1 year), Tesla stock price appears less affected by oil price collapse

Source: Google Finance

And recently the relationship between oil & gas prices has weakened, muting the impact on renewables



- Oil and gas were historically highly substitutable
- Oil-linkage acted as a buffer against gas price shocks
- Now, there is much lower substitutability across most end-use sectors
- And gas contracts are not as frequently linked to oil prices

Source: Aurora Energy Research; Thomson Reuters

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Various somewhat fuzzy concepts have preceded the emergence of "green growth"

Sustainable development

- Sustainable – can be maintained for a relatively long period of time (along many dimensions such as resources, culture, institutions, etc.)
- Development – broad focus (includes wealth as well as health, education, security, inequality, justice, livelihood, maybe even 'happiness', etc.)

Sustainable prosperity

- Prosperity – economic well-being, not always measured by GDP, for rich countries

Low-carbon growth

- Low-carbon (as opposed to carbon-intensive) implies (significantly) reducing the carbon emissions of the economy while increasing economic output
- This is a subset of green growth

Sustainable, resilient, inclusive growth

- Resilient – less vulnerable to external shocks and faster recovery after shocks, i.e. more stable
- Inclusive – halting (and reversing) the increase in inequality within nations
- Growth – narrow focus on economic growth, as measured by GDP increases

Source: Hepburn, Teytelboym & Pfeiffer (2015, forthcoming)

Green growth may be defined as growth that does not reduce aggregate natural capital

Green

- Reflects concern about climate change but also broader environment
- Might be captured by non-decreasing natural capital
- Broader issues such as inequality, culture and institutions, are given lower priority

Growth

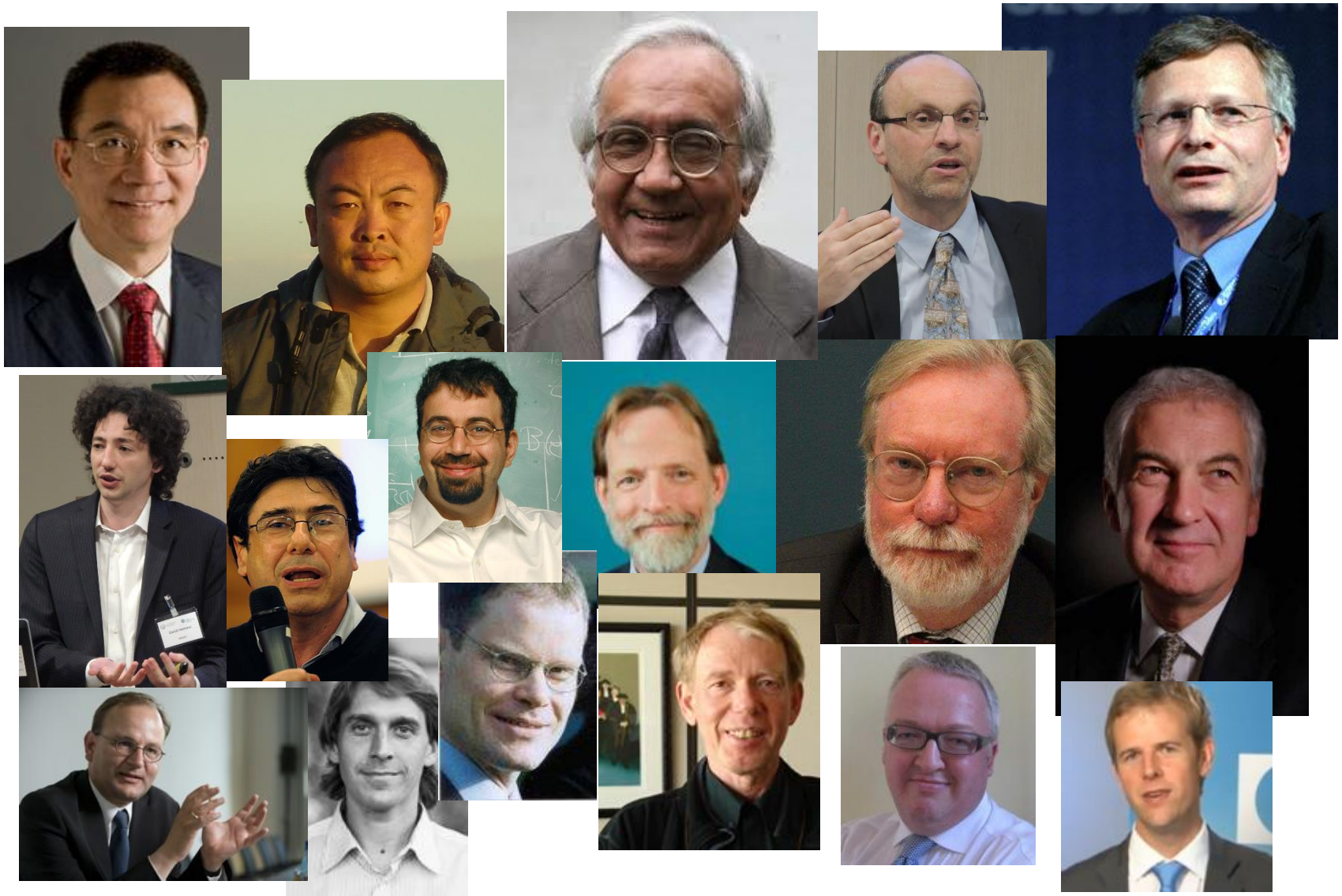
- Refers specifically to old-fashioned growth in per capita GDP
- Wide reach of "development" that includes health and education is boiled down to convenient and politically appealing short-term metric

- This combination is attractive to policymakers because it suggests that there may be no trade-off between environmental protection and economic growth
- Often strong emphasis on assumption that "green growth" does not mean slowing down growth at all

"We are not sacrificing our economies to deal with climate change. Quite the opposite – going green means going for growth." – UK Energy and Climate Change Minister at the "Green Growth Summit" in October 2014

Bowen and Hepburn (2014); Hallegatte, Heal, Fay, and Treguer (2012)

Current issue of *Oxford Review* is on Green Growth papers from (male) economists around the world



Source: Various

Why worry about growth? 1 billion still in poverty, another 3 billion middle class people by 2050

Human population in 2050:

- 9-10 billion people
- 4 billion middle class consumers

Demand by 2030:

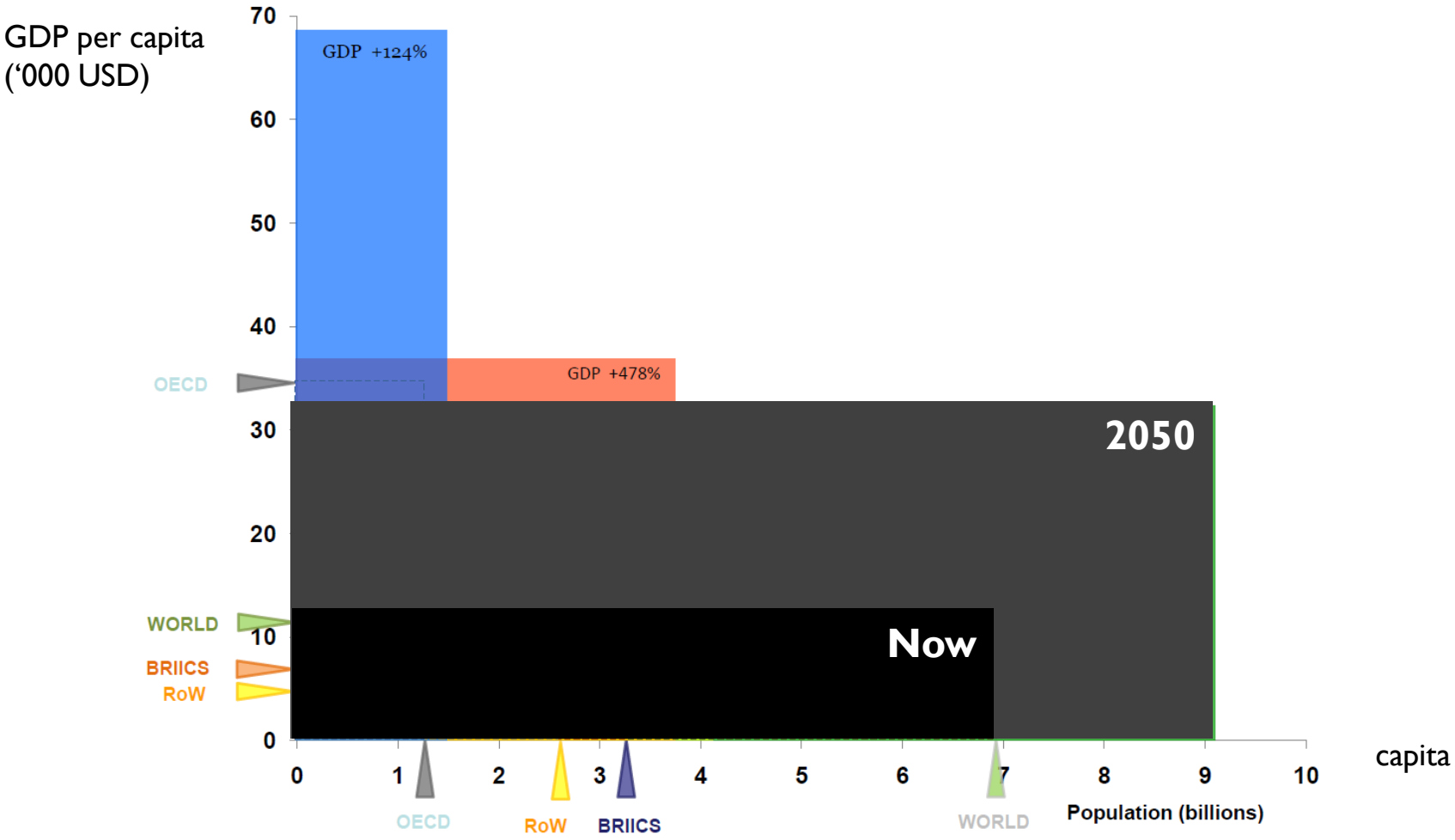
% increase in demand*

- **Food:** up to 50% increase
- **Phosphorus:** up to 70% increase
- **Water:** up to 50% increase
- **Energy:** up to 60% increase

'Prosperity without growth' simply not an option

Source: Vivid Economics (2012): Modelling for 2012 World Economic Forum at Davos

Why worry about natural capital? We haven't seen anything like the pressure that is coming at it



Source: OECD (2012): OECD Environmental Outlook to 2050

So achieving 'green growth' has become a central objective of various international organisations

THE WORLD BANK
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European Bank
for Reconstruction and Development

Asian Development Bank

Source: Hepburn, Teytelboym & Pfeiffer (2015, forthcoming)

Green growth focussed on protecting **renewable** natural capital

Forests, ecosystems, etc are **"renewable"** natural capital

Coal, oil, gas is **"exhaustible"** natural capital

Source: Forest of Dean in Gloucestershire; Photo: CORBIS

Strong green growth

Time horizon

Economic growth	Short term	Long term
Absolute: Is the economic growth rate positive?	✓	✓
Relative: Is the growth stronger than non-green growth?	✓	✓

- Green growth as utopian growth: In the short- and long-run positive economic growth that is even higher than traditional 'dirty' and environmental degrading growth
- **Less likely**

Source: Hepburn, Teytelboym & Pfeiffer (2015, forthcoming)

Weak green growth

Time horizon

Economic growth	Short term	Long term
Absolute: Is the economic growth rate positive?	✓	✓
Relative: Is the growth stronger than non-green growth?		✓

- In the short run investments in transition to green growth will likely lead to a sacrifice of growth (as compared to traditional growth) but growth probably still positive in absolute terms
- In the long run, however, stronger growth (e.g. because of less environmental degradation)
- **More likely**

Source: Hepburn, Teytelboym & Pfeiffer (2015, forthcoming)

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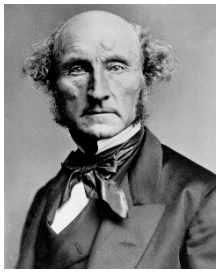
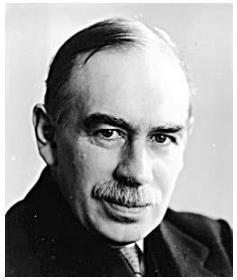
Throughout history, distinguished economists have asked whether we may need to stop growing



1. **John Stuart Mill:** if we do not deliberately guide the economy towards such a stationary state, an environmental collapse will result.

2. **Sir John Hicks:** that once population is controlled, the 'Stationary State is no longer a horror. It becomes an objective at which to aim.



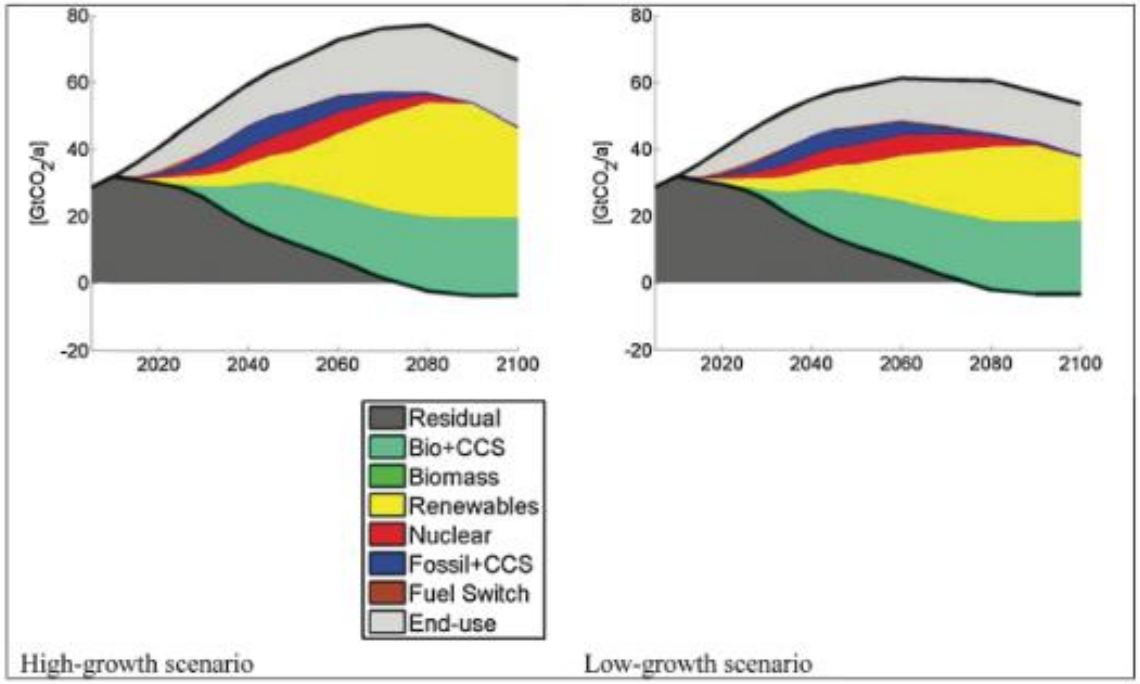
3. **John Maynard Keynes:** Economic Possibilities for Our Grandchildren

4. **Tinbergen:** Saving the environment will check production growth, and lead to lower levels of national income

Source: Various, see Hepburn and Bowen (2013) for a list of primary references

Do we have to sacrifice economic growth to achieve our climate targets?

Technology portfolios to achieve a 450ppm CO2 target under scenarios assuming high (2.8% p.a., left) and low (1.7% p.a., right) rates of economic growth, respectively[1]

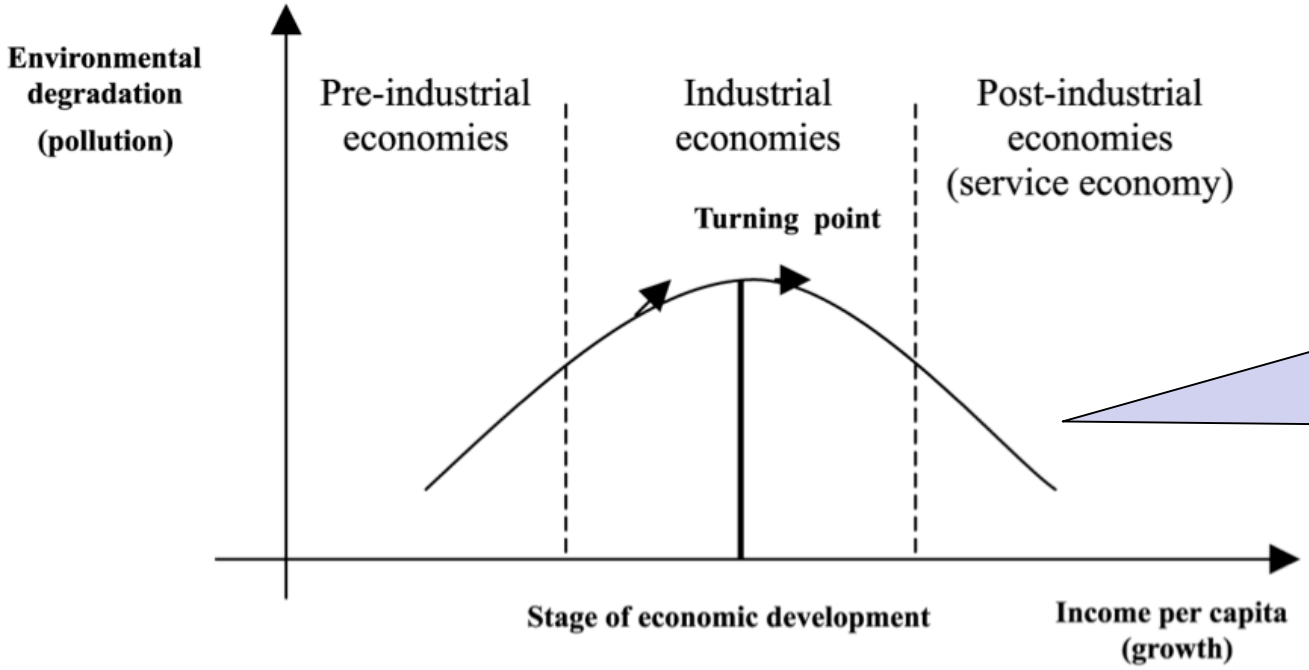


- A low-growth strategy does address the undeniable technological risks
- **But instead of reducing economic growth, tackling these risks directly via well-tailored policy instruments would be more efficient**

Source: Jakob & Edenhofer (2014, Oxford Review of Economic Policy)

Do we have to sacrifice economic growth to achieve our climate targets?

The Environmental Kuznets Curve (EKC):[1] Is there a robust relationship between the evolution of a country's per capita GDP and its level of environmental degradation?



For example, it may be possible that a richer country improves the management of its fisheries and lakes, but neglects to control sulphur dioxide emissions or the nitrogen cycle

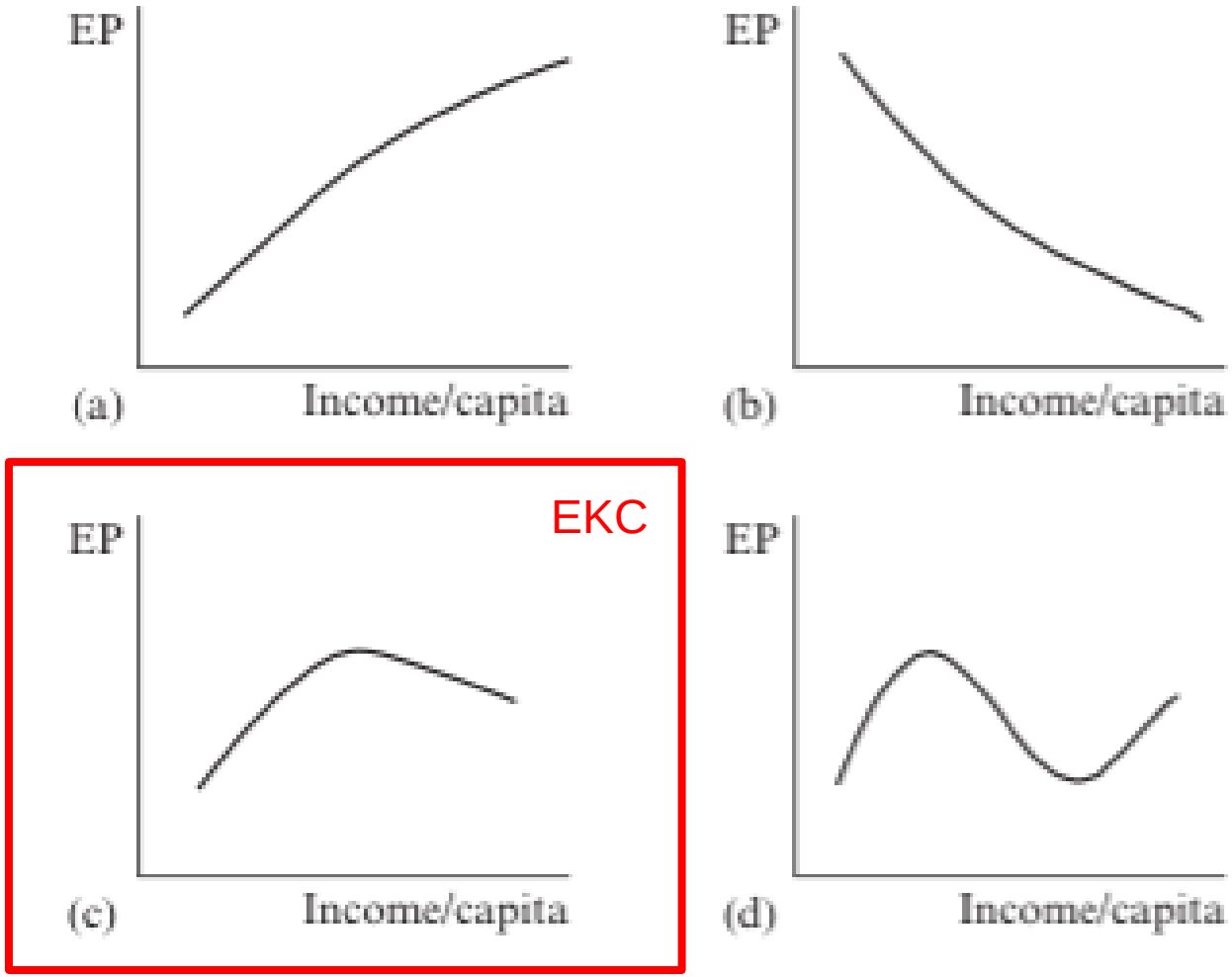
But

- Definition: Environmental degradation very multi-faceted
- Spill-over effects: Some degradation effects are global problems (e.g. climate change)

1 E.g. Panayotou (1993), Brock & Taylor (2010), Stokey (1998)

Can we just rely on economic growth to solve our environmental problems?

Relationships between environmental pressure (EP) and per capita income:



- Vast amount of empirical work done on the EKC hypothesis
- Evidence supporting the hypothesis is at best specific to local pollutants

Source: Hepburn & Bowen (2013)

But is zero economic growth the answer?

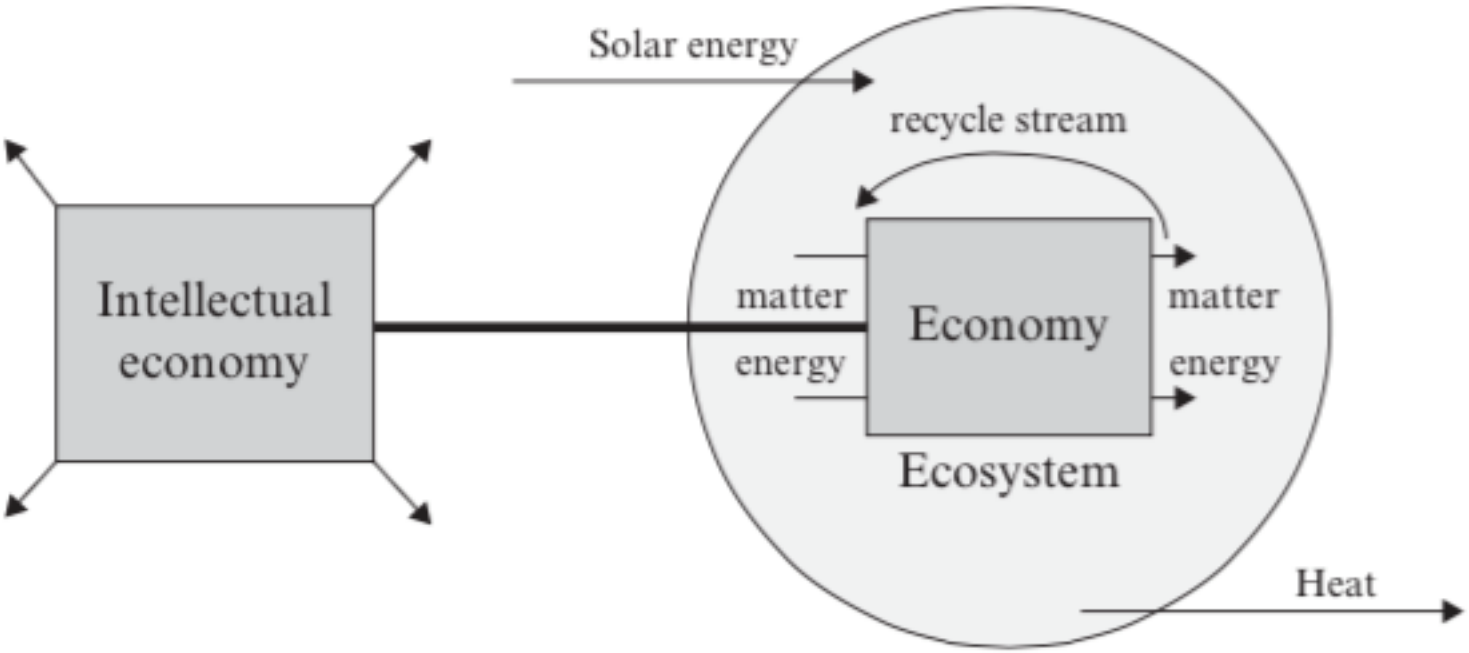
- Delivering long-term technological progress necessary to decouple emissions from GDP *while forcing growth to be at zero* is extremely unlikely
- Simply cutting emissions by reducing GDP is probably the most expensive technology to cut emissions
- Sustainable economic growth over the next century is necessary to improve alleviate poverty and to deliver innovation

Zero or negative growth is not the solution to protect the environment

Source: Hepburn, Teytelboym & Pfeiffer (2015, forthcoming)

The material economy is bounded by the ecosystem; the intellectual economy is not

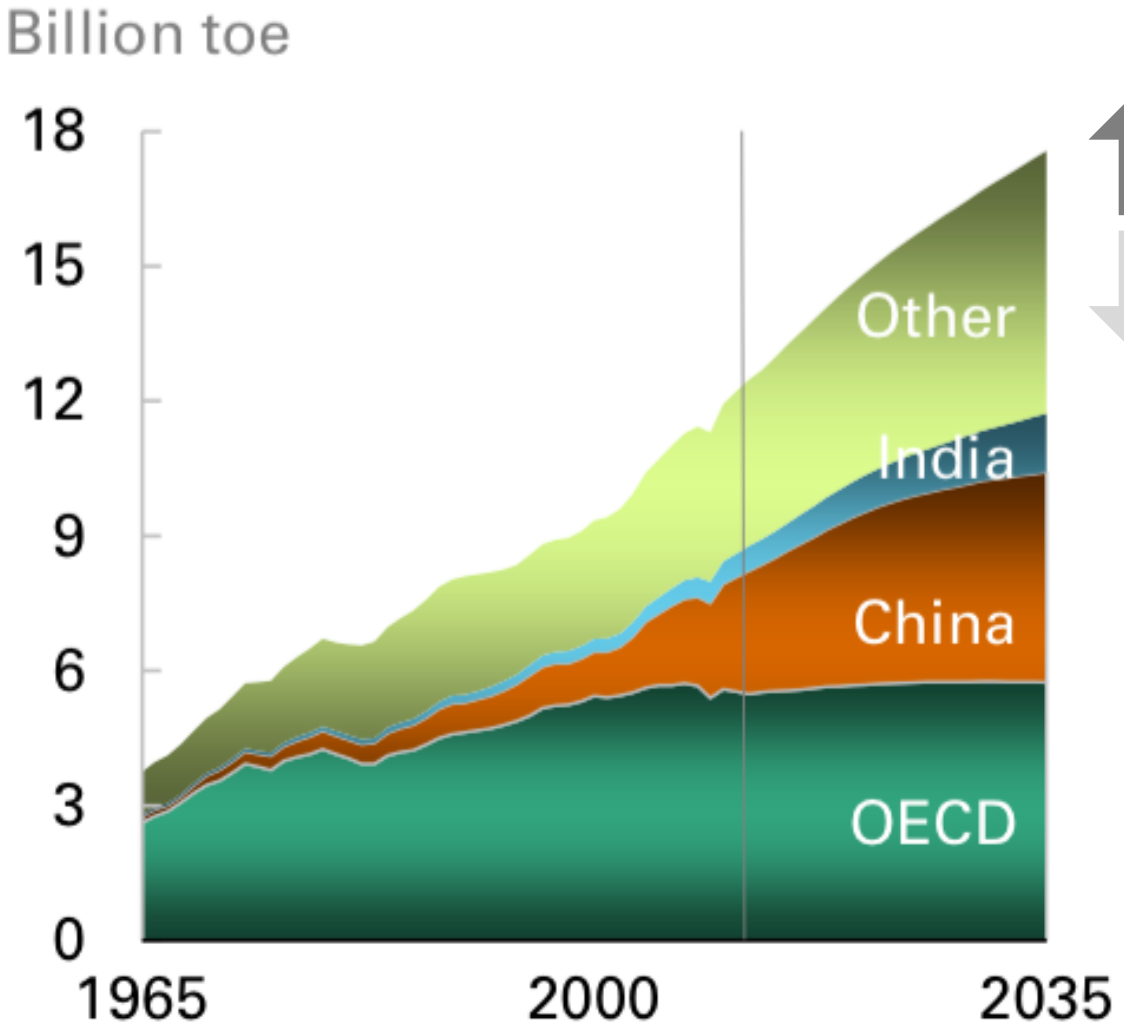
Simplistic relationship between the economy and the environment



Source: Hepburn & Bowen (2013)

How will green growth affect future energy demand?

Primary energy consumption forecast until 2035



Increase: E.g. by increased agricultural intensity?

Decrease: E.g. by energy efficiency measures?

Whatever the impact – green growth implies that a high share of future energy supply is clean

Source: BP (2014): BP Energy Outlook 2035

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The policy implications for energy are large

1. **Stop subsidising** fossil energy use (around $500 billion p.a.)

2. **Stop exploring** for more fossil fuels (around $600 billion p.a.)

3. **Stop spending** so little on clean energy R&D (around $4 billion p.a.)

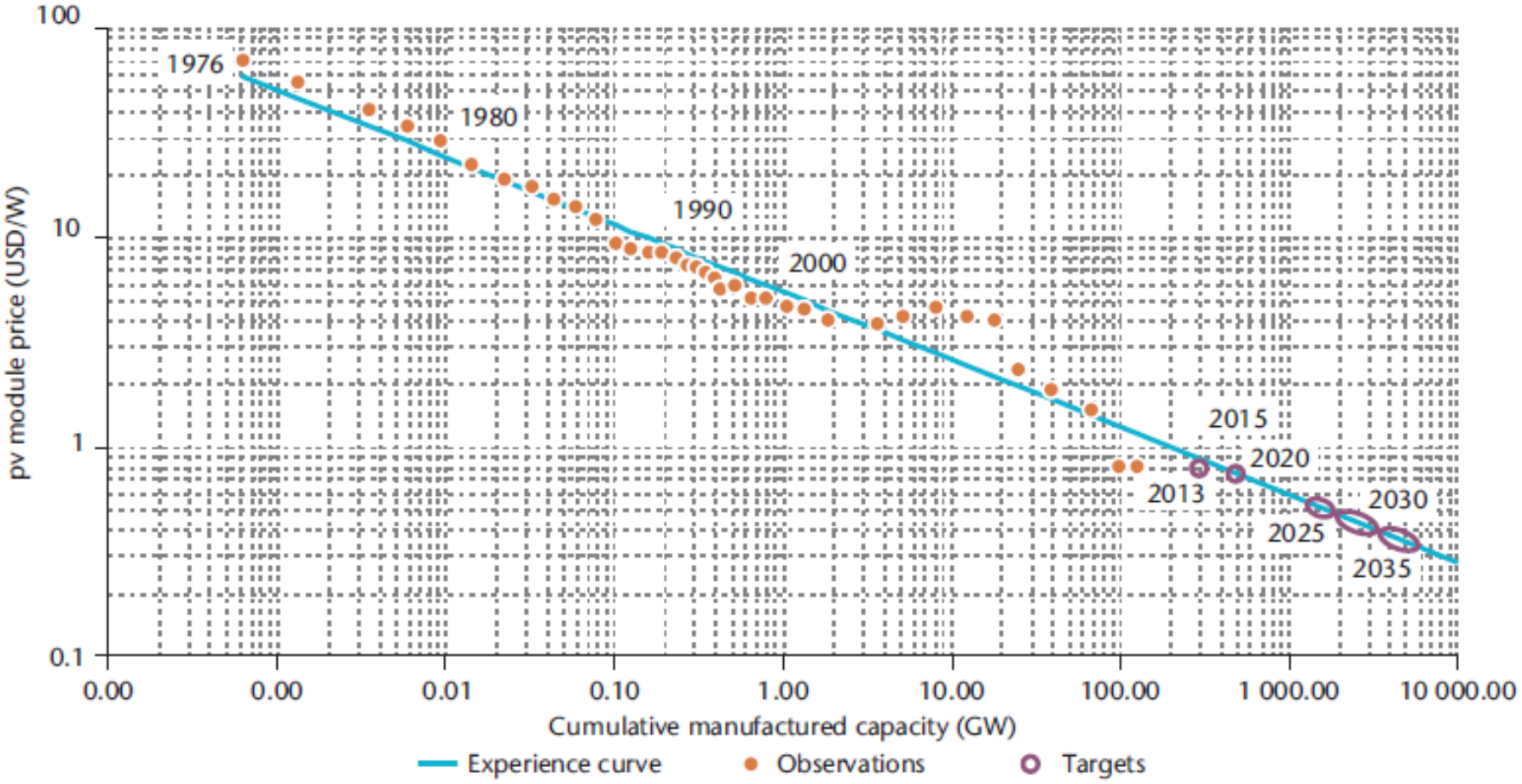
4. **Stop mispricing natural capital** — around US $6 trillion of natural capital may be mispriced (ecosystems, biodiversity, climate stability)

It is vital to understand the drivers of cost reductions in renewable energy – INET teams are on the case

Smith School of Enterprise and the Environment

University of Oxford

Past module prices and IEA projections to 2035



Notes: Orange dots indicate past module prices; purple dots are expectations. The oval dots correspond to the deployment starting in 2025, comparing the 2DS (left end of oval) and 2DS hi-Ren (right end).

Source: IEA (2014) Technology Roadmap for Solar Photovoltaic (p23)

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Conclusions

1. Energy and economic growth remain closely related, despite recent reduction in interdependence
2. Energy use will continue to climb and is needed for green growth
3. The natural capital under pressure is that which isn't (explicitly or implicitly) priced.
4. Reducing emissions by reducing economic output is the most expensive form of abatement – clean technology is much better
5. The key to clean technology deployment is reducing costs
6. The key to reducing costs is…likely more brainpower.

Thank you!