Spring 4-11-2016

The good, the bad and the ugly

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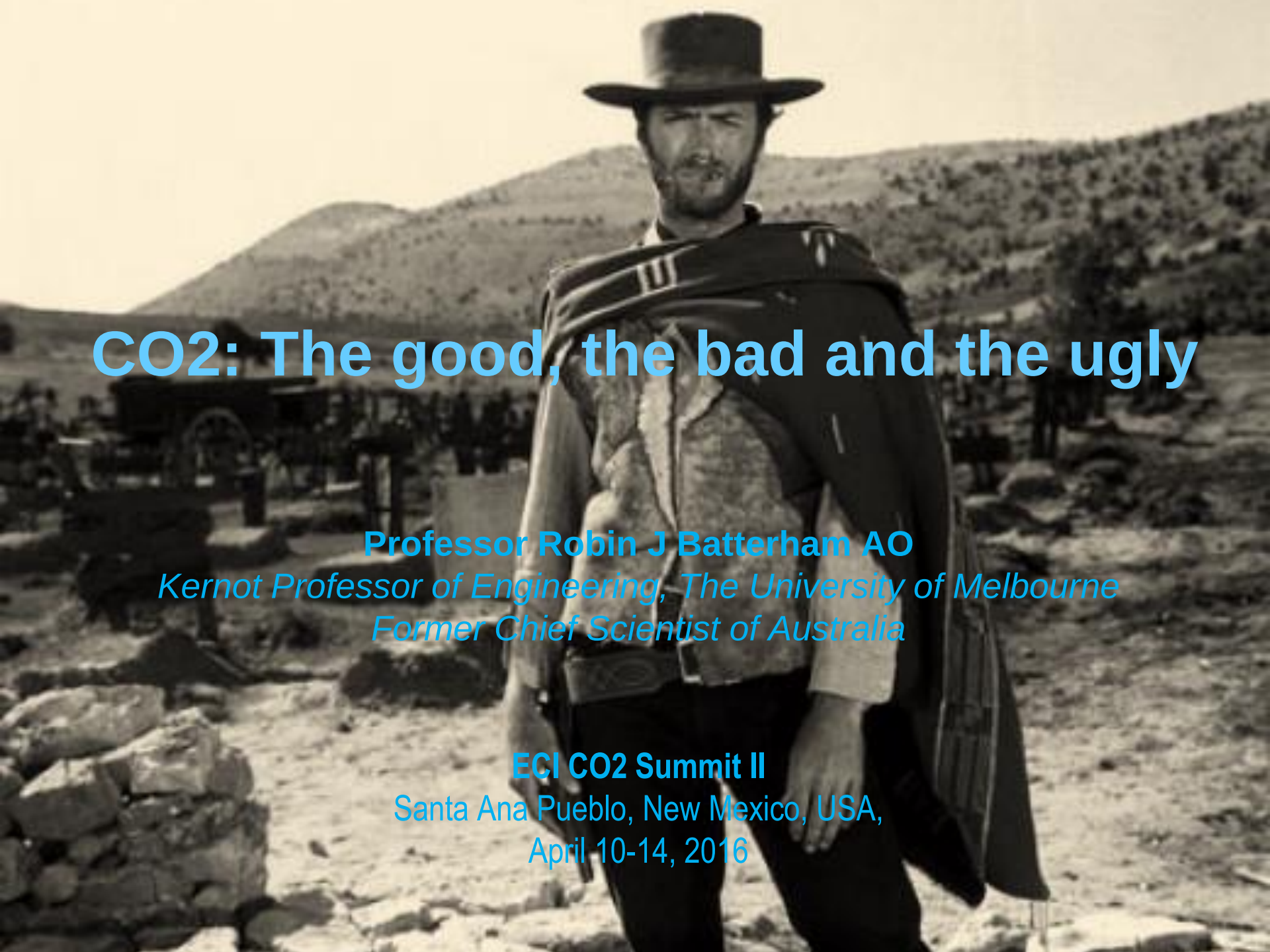


CO2: The good, the bad and the ugly

Professor Robin J Batterham AO
Kernot Professor of Engineering, The University of Melbourne
Former Chief Scientist of Australia

ECI CO2 Summit II
Santa Ana Pueblo, New Mexico, USA,
April 10-14, 2016

We know all the answers, why do we need this conference?

Source: http://reneweconomy.com.au/2015/solar-energy-costs-continue-to-plunge-across-the-world-17972

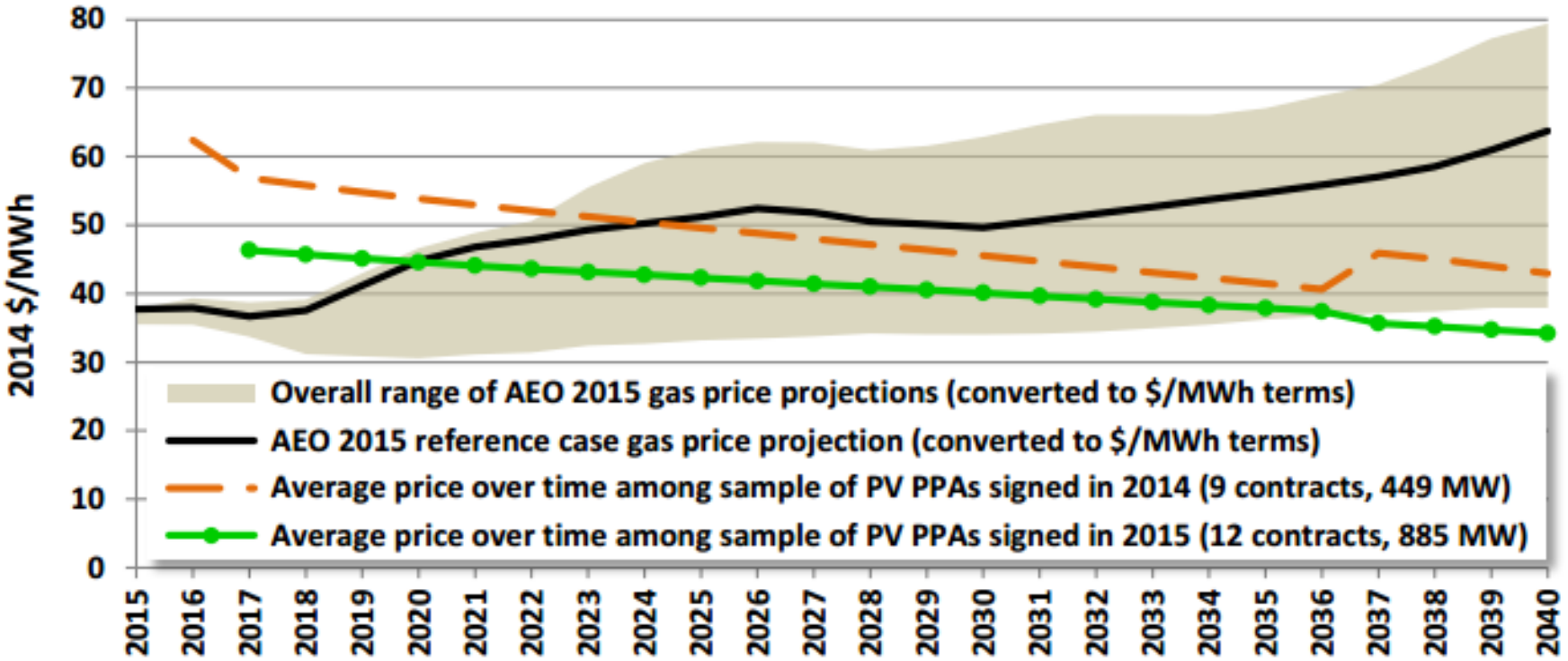
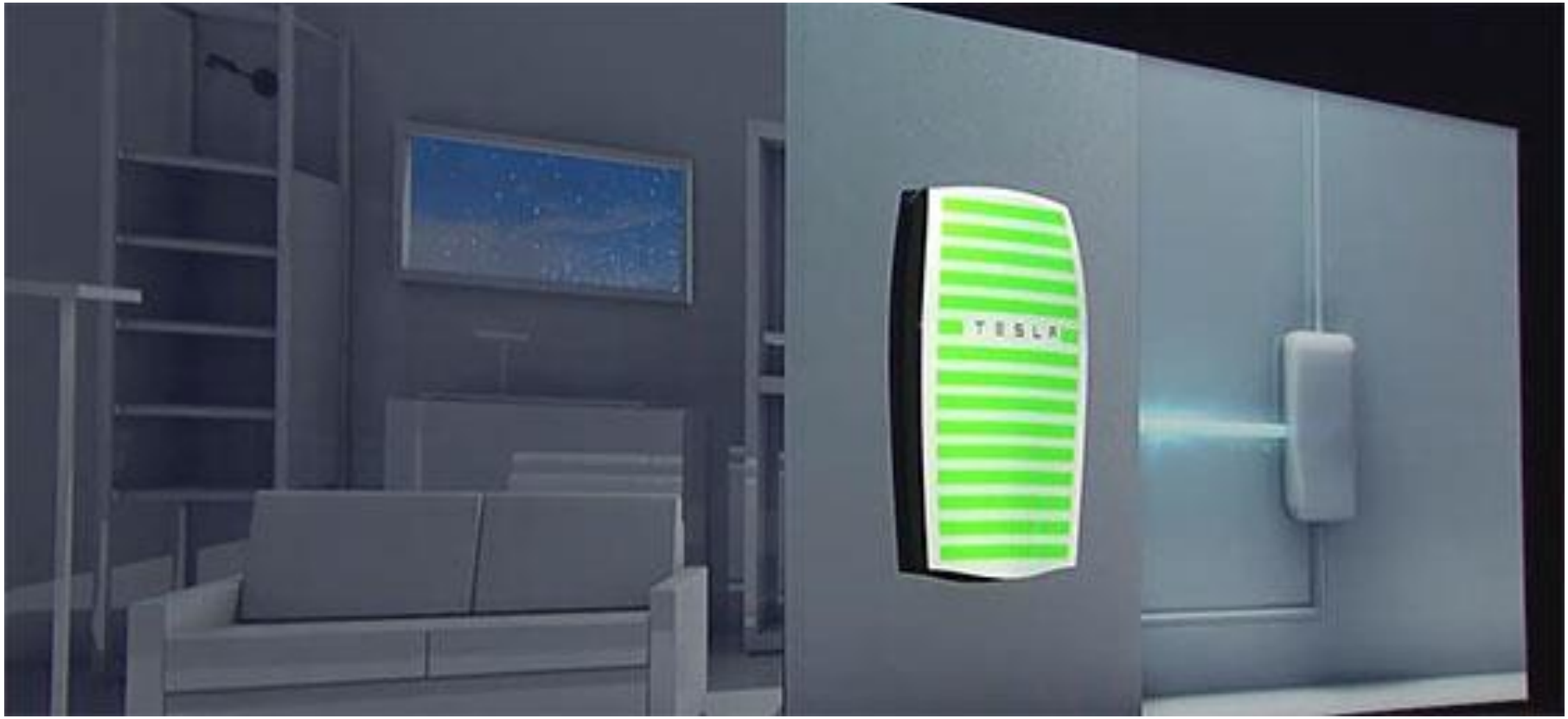


Figure 18. Average PV PPA Prices and Natural Gas Fuel Cost Projections Over Time

Source: https://emp.lbl.gov/sites/all/files/lbnl-1000917.pdf


TESLA

The Sydney Morning Herald

Lithium prices are soaring and Rio Tinto says it may start mining the commodity

Peter Ker
Published: December 17, 2015 - 10:23AM

- The bad
- The ugly
- The good
  - Technology will always surprise
  - And so to emissions reductions
  - Balancing step change and incremental initiatives

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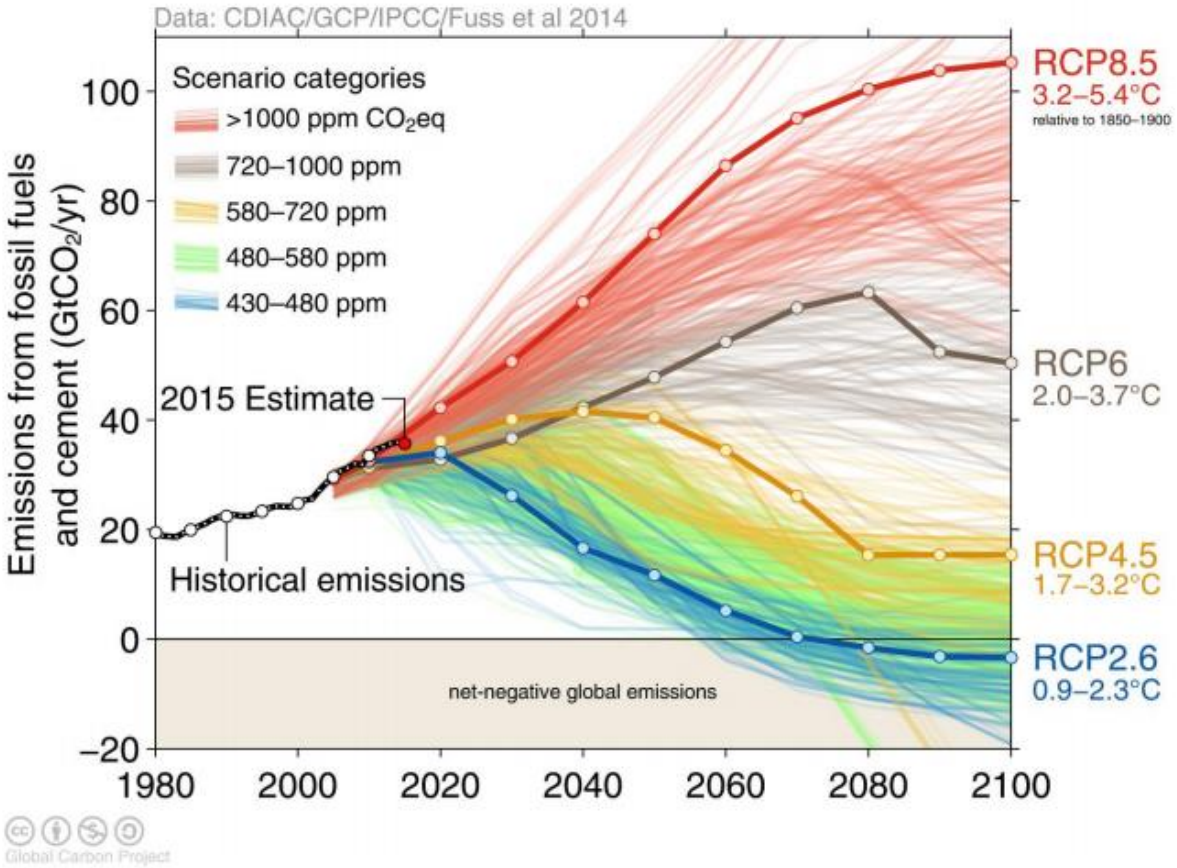
Global Carbon Project 2015

The emission pledges submitted to the Paris climate summit avoid the worst effects of climate change (red), most studies suggest a likely temperature increase of about 3°C (brown)



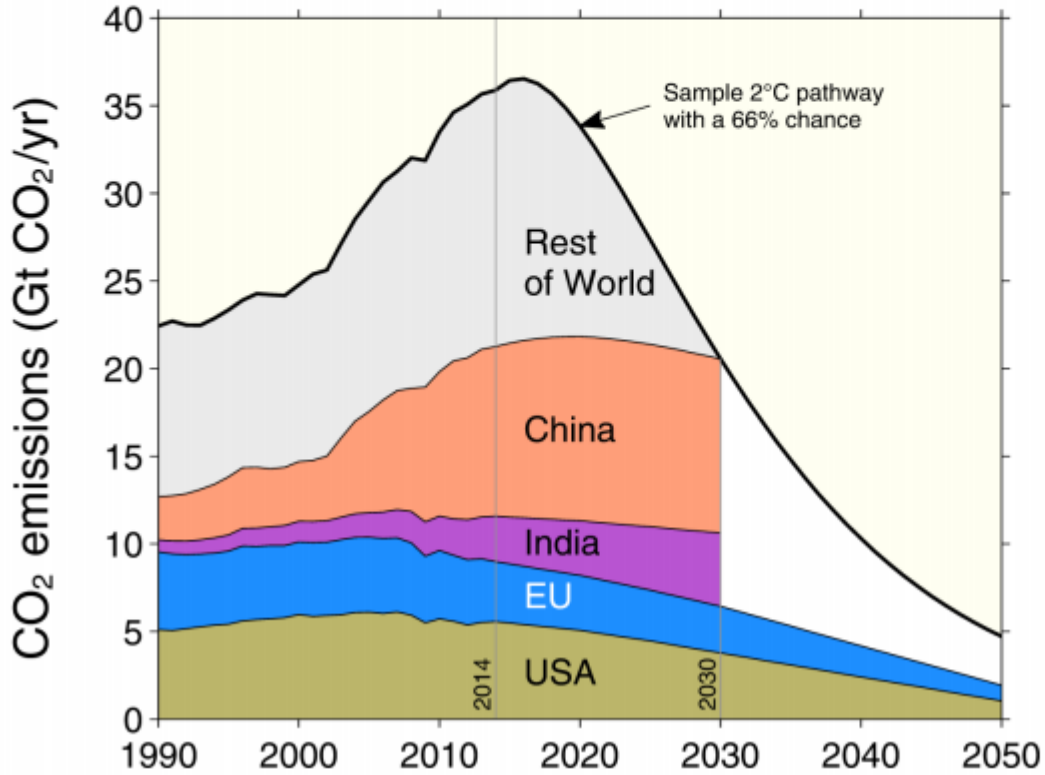
Over 1000 scenarios from the IPCC Fifth Assessment Report are shown

Source: Fuss et al 2014; CDIAC; Global Carbon Budget 2015

Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf

The emission pledges (INDCs) of the top-4 emitters

The emission pledges from the US, EU, China, and India leave little room for other countries to emit in a 2°C emission budget (66% chance)



Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf

There is a strong lesson here:

- We believe – but apparently not enough

- The bad
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CSIRO Publicity

ClimateWire

SUSTAINABILITY

Australia Cuts 110 Climate Scientist Jobs

Because the science is settled there is no need for more basic research, the government says

Source: http://www.scientificamerican.com/article/australia-cuts-110-climate-scientist-jobs/

Really ugly

- Another strong message – don't question the science or the scientists.

- And what might engineers contribute?

- The bad
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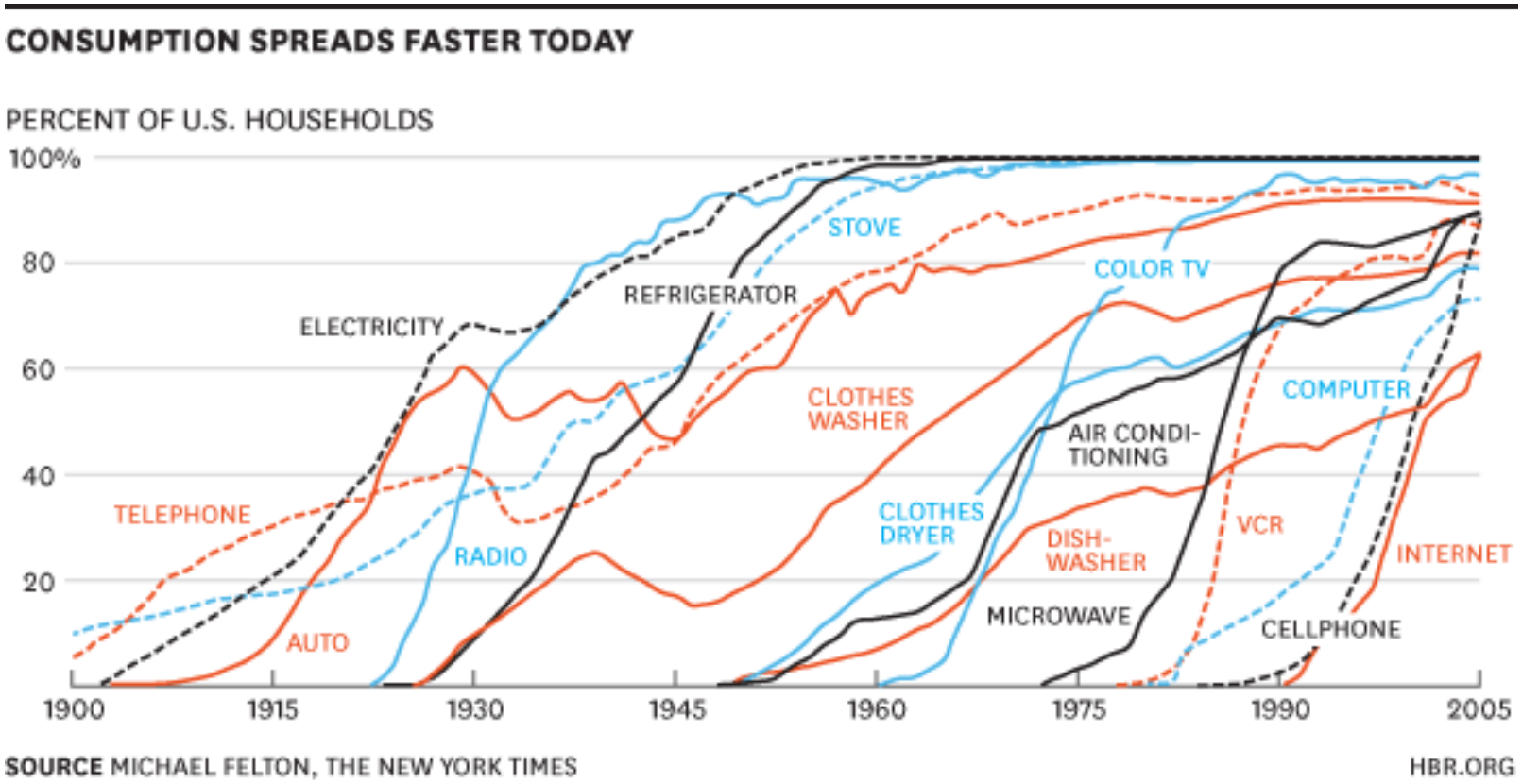
Technology is never settled



Source: https://hbr.org/2013/11/the-pace-of-technology-adoption-is-speeding-up/ /

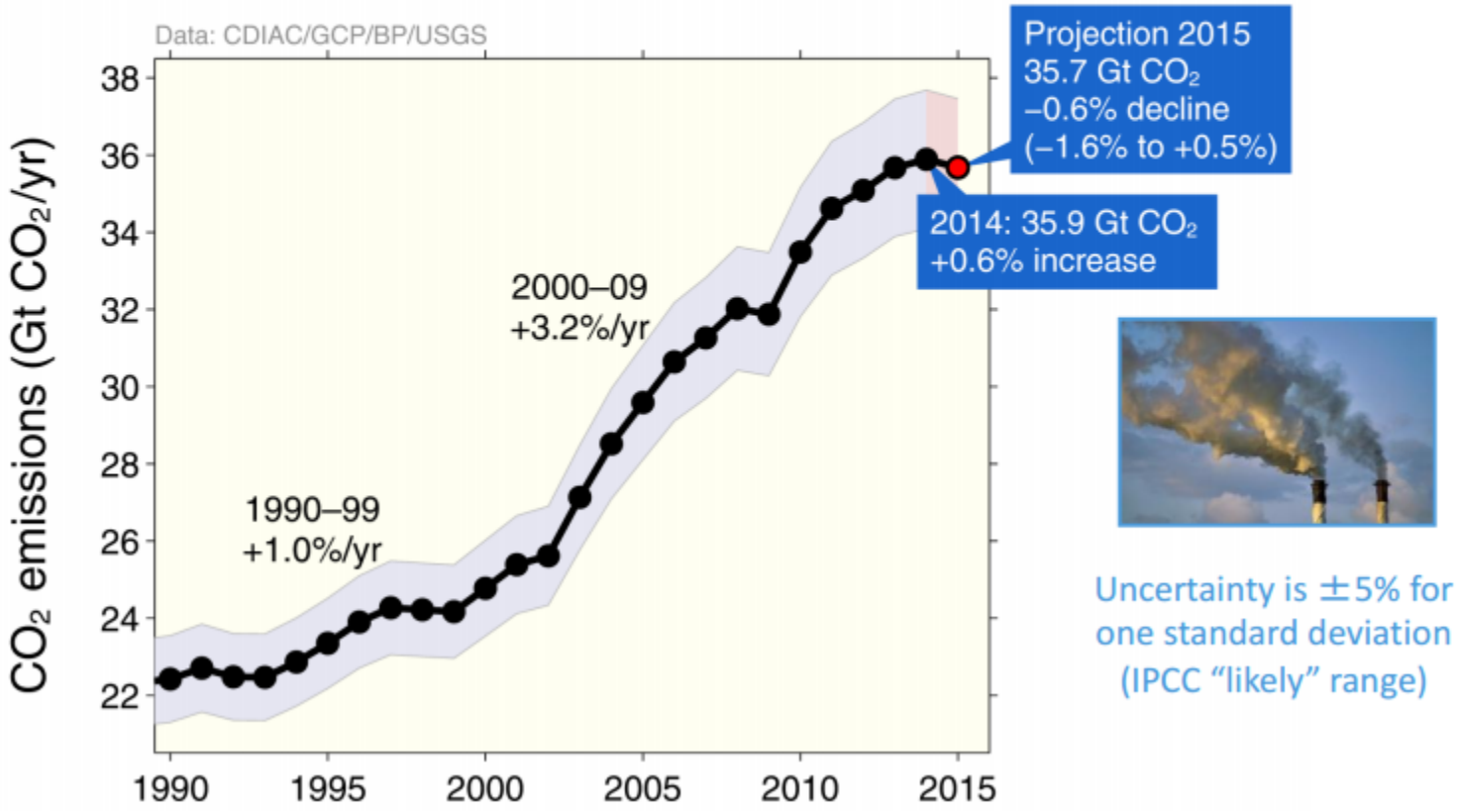
Who predicted the fall off?

GLOBAL CARBON PROJECT

Emissions from fossil fuel use and industry

Global emissions from fossil fuel and industry: ~~35.9~~ ± 1.8 $GtCO_2$ in 2014, 60% over 1990

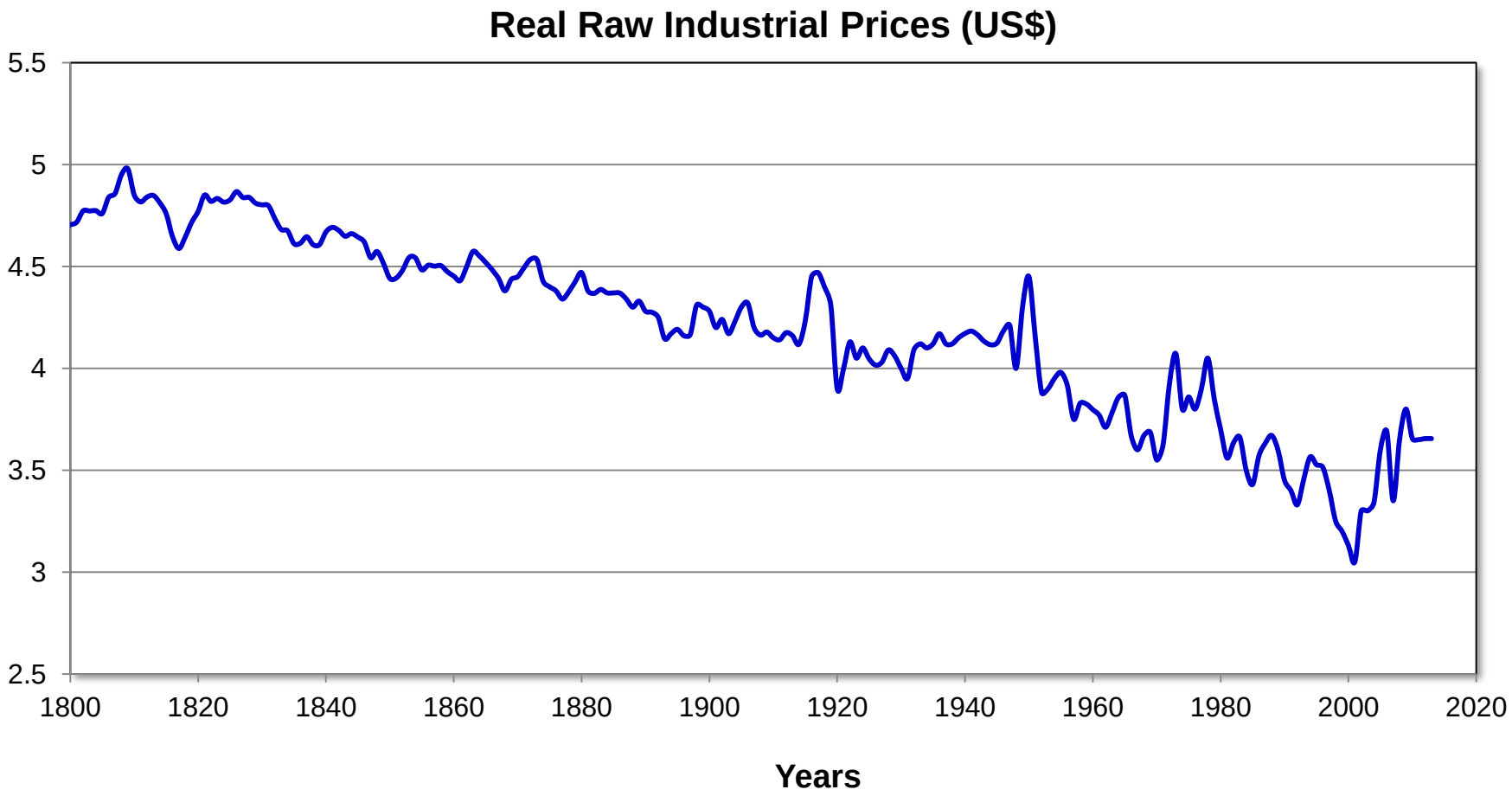
Projection for 2015: 35.7 ± 1.8 $GtCO_2$, 59% over 1990



Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf

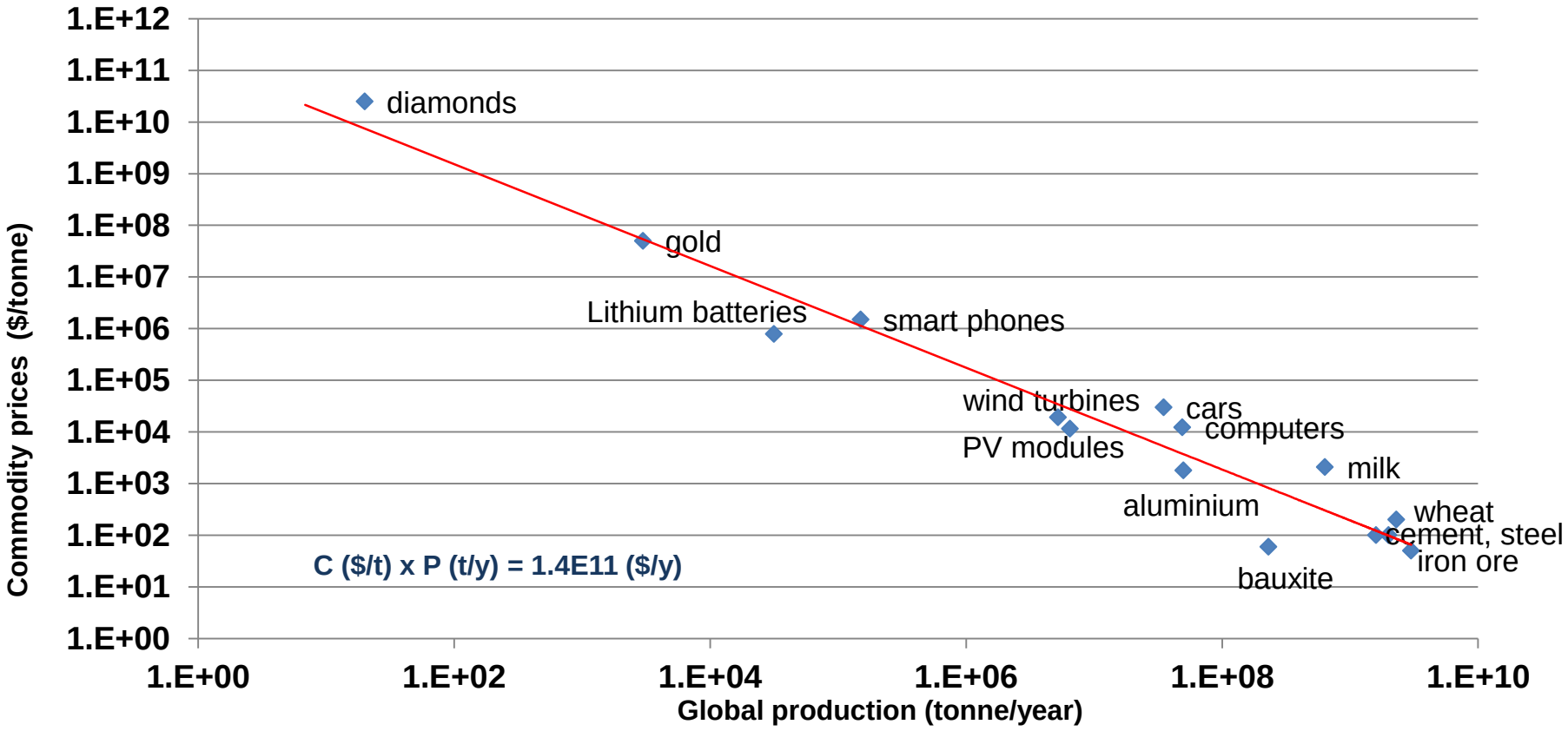
Costs keep falling in real terms:



Adjusted by U.S. GDP deflator; shown as a natural logarithm

Source: BCA Research

Economic impact at national and international levels comes from driving down the cost curve



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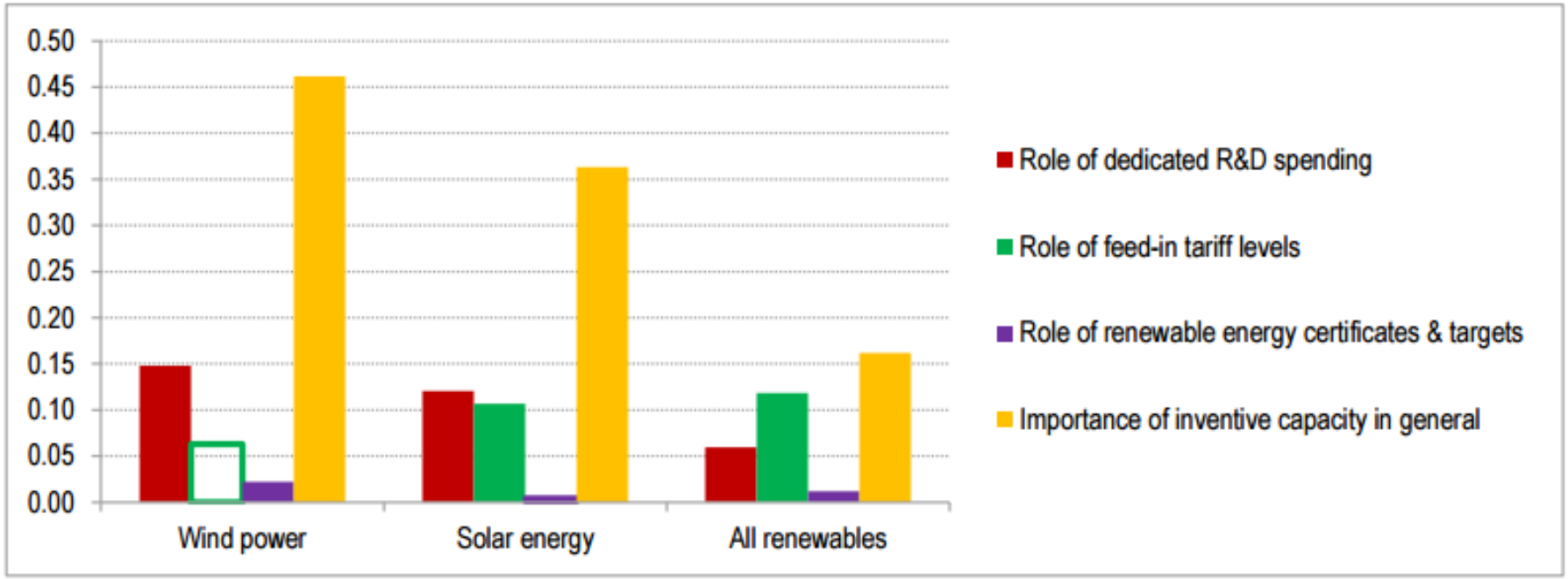
Technology and the future

Quotes from the report:

- “It is technology that is central to human existence and is important, both now and in the future”.
- “Uncertainty, innovation and risk are all tightly linked and all command or demand intervention”.

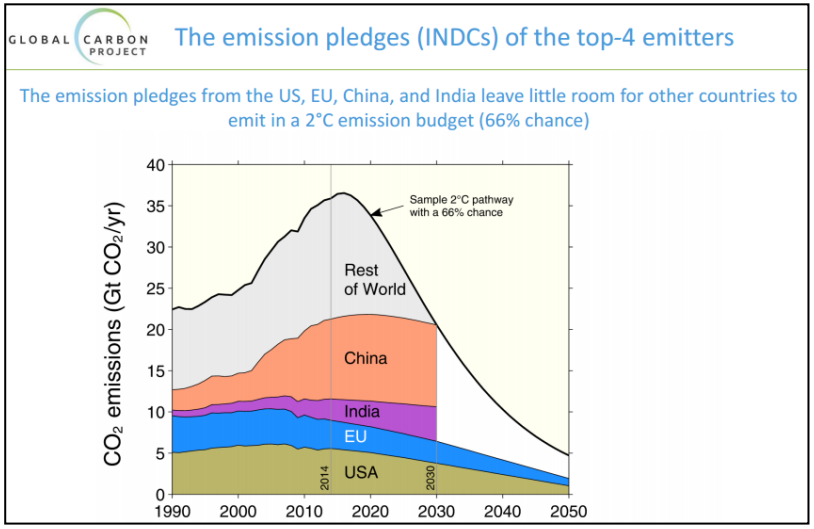
“Just because we are uncertain of the future doesn’t mean that it is not clear that action is required” but what action?”

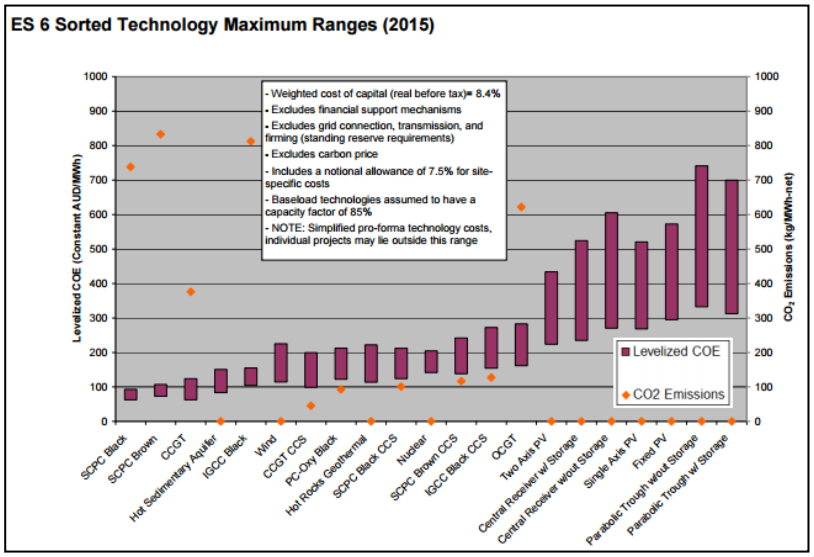
Estimated effect on inventive activity

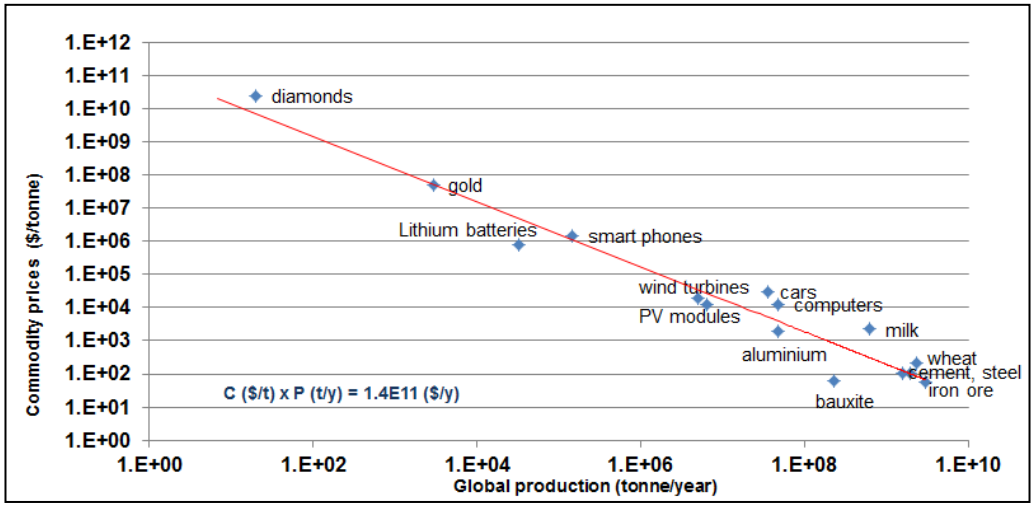


Source: https://www.wto.org/english/tratop_e/envir_e/wksp_envir_nov12_e/1ivanhascic_oecd_e.pdf

But in summary, there is no single best strategy…







Source: http://www.industry.gov.au/Energy/Documents/facts-stats-pubs/AEGTC%202010.pdf

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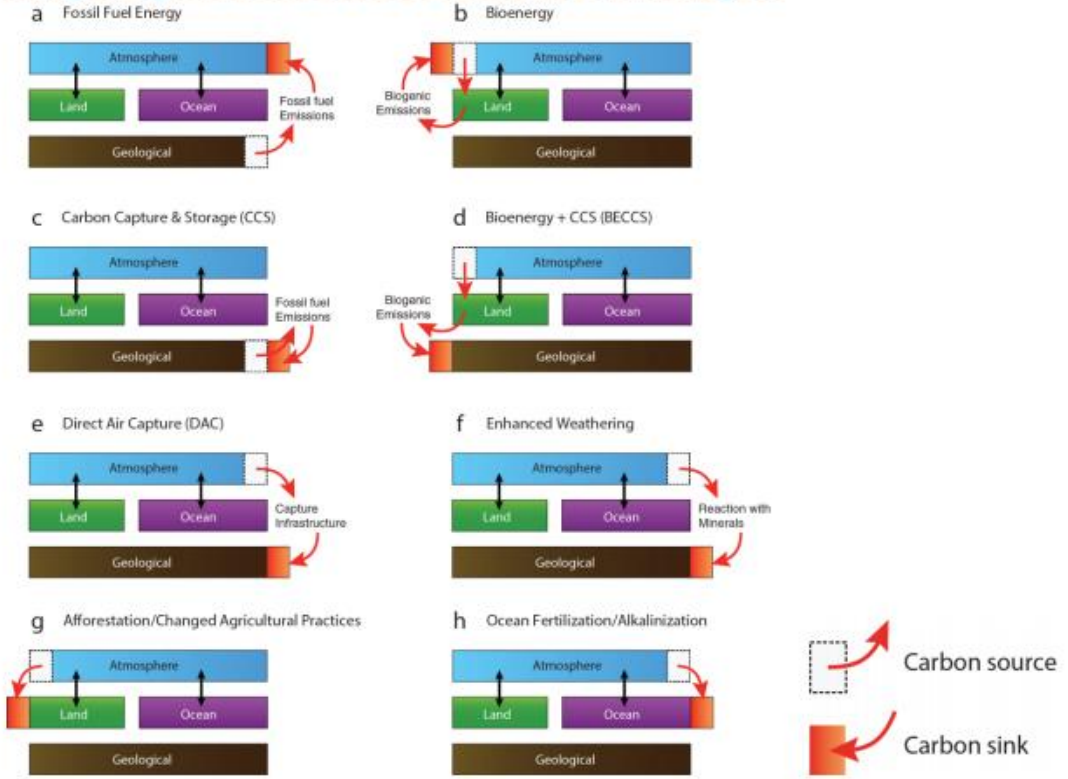
There are many paths to choose from:

GLOBAL CARBON PROJECT

Different Negative Emission Technologies

Schematic representation of carbon flows among atmospheric, land, ocean and geological reservoirs for different technologies



Source: Smith et al 2015; Global Carbon Budget 2015

Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf

Batterham's bets

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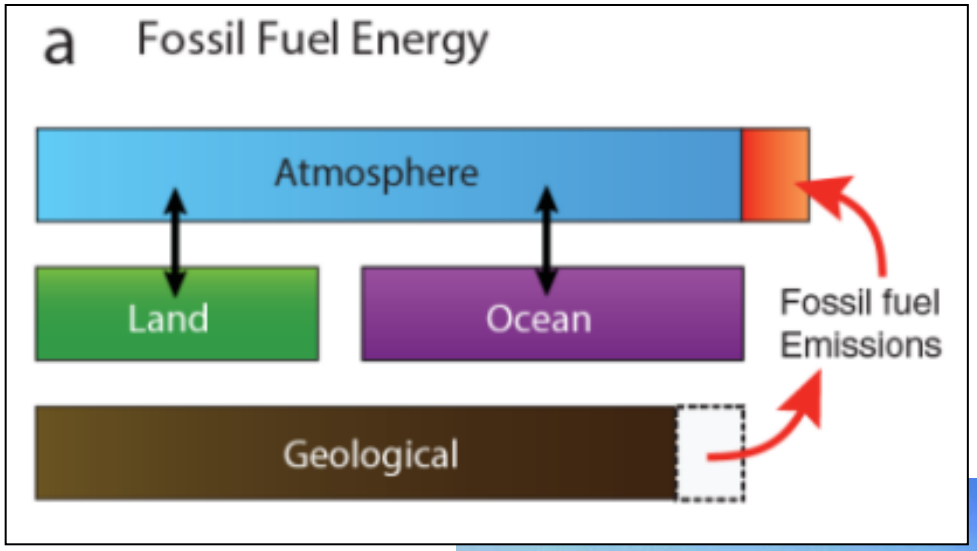
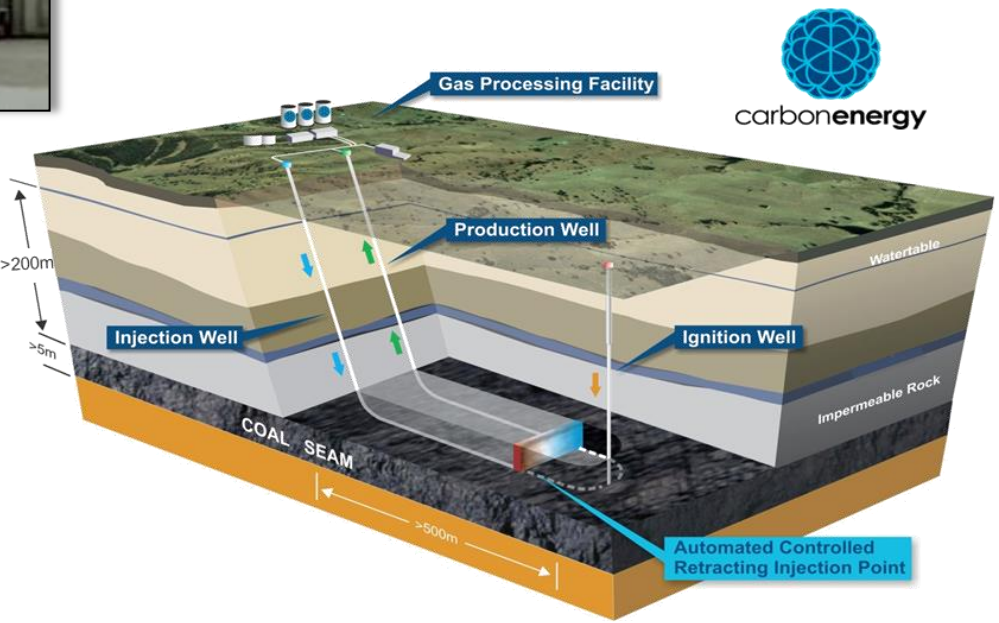
Reduce fossil emissions: coal lives for many years



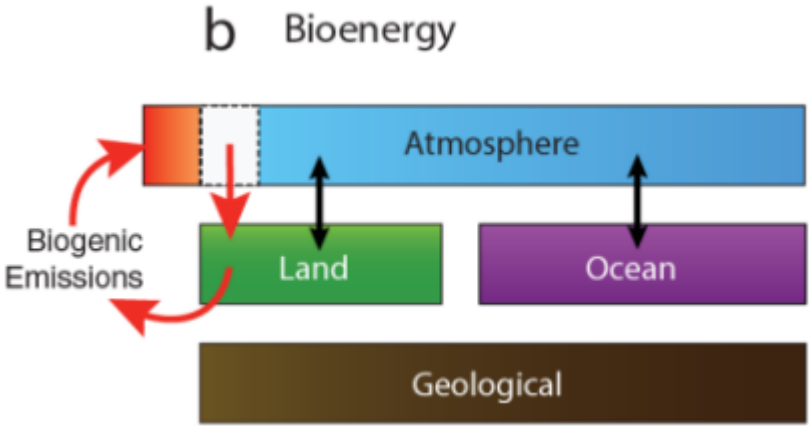
Direct Injection Carbon Engine (DICE)
only 122 years old

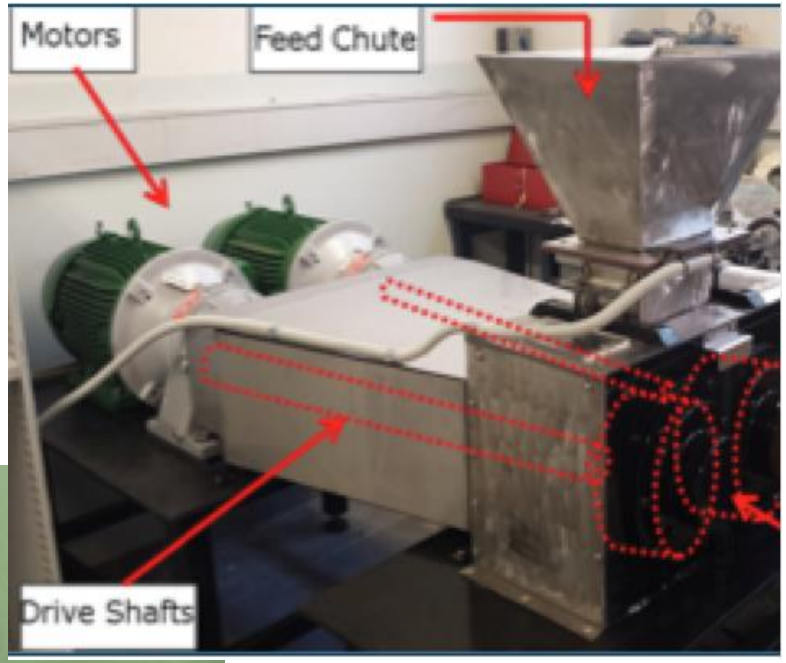
Carbon Energy's UCG Design

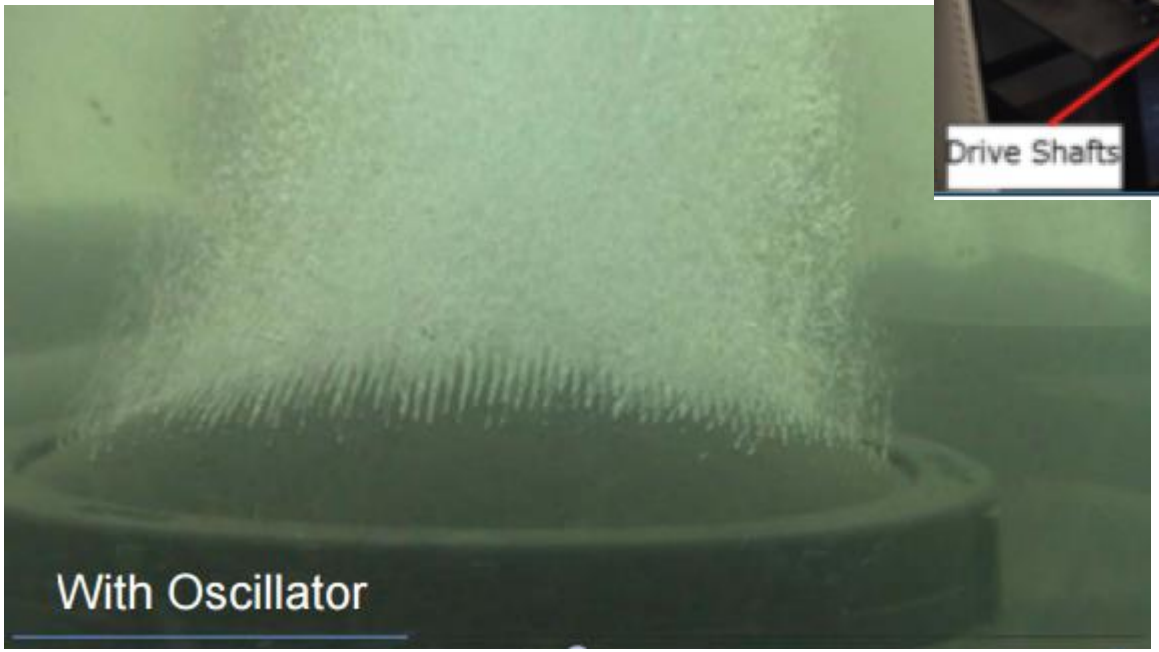
Underground Coal Gasification (UCG) also ancient but now much improved – a competitor to the flight to gas



Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf

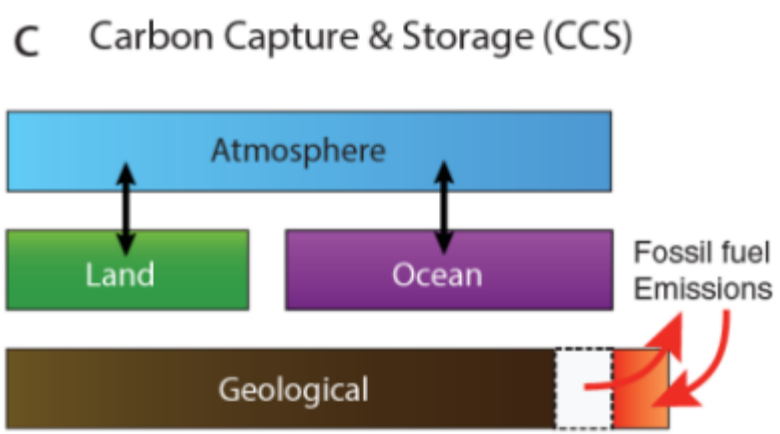






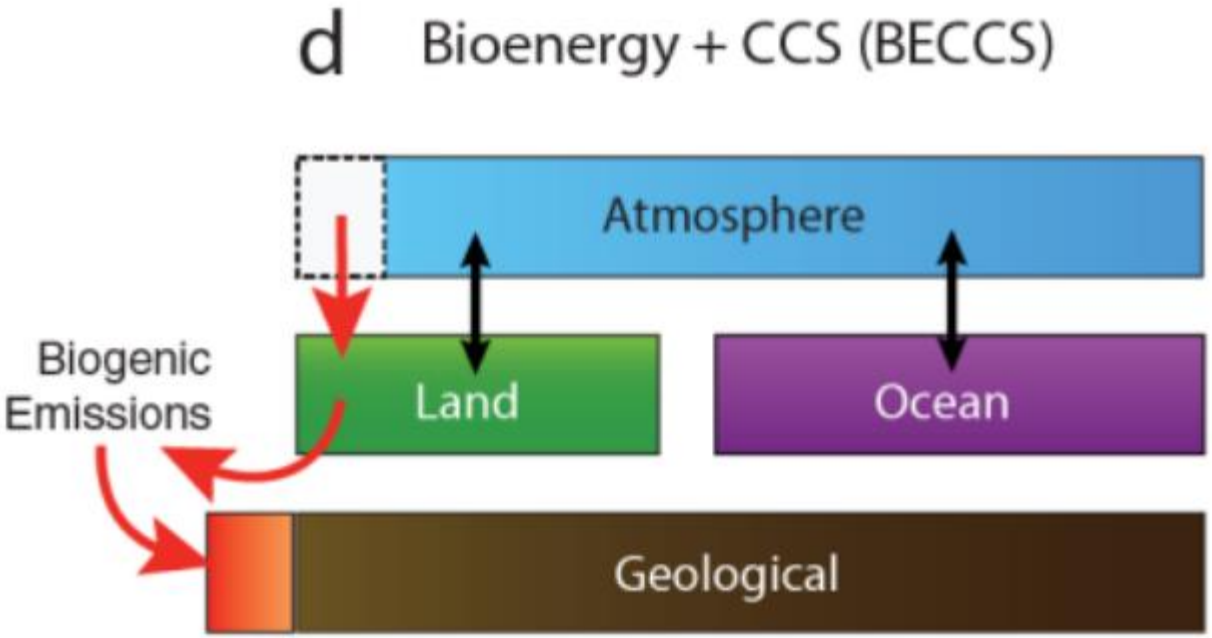
Source: http://www.waterindustryforum.com/documents/uploads/documents-library/4%20Will%20Zimmerman.pdf

CCS – the perpetual infant?

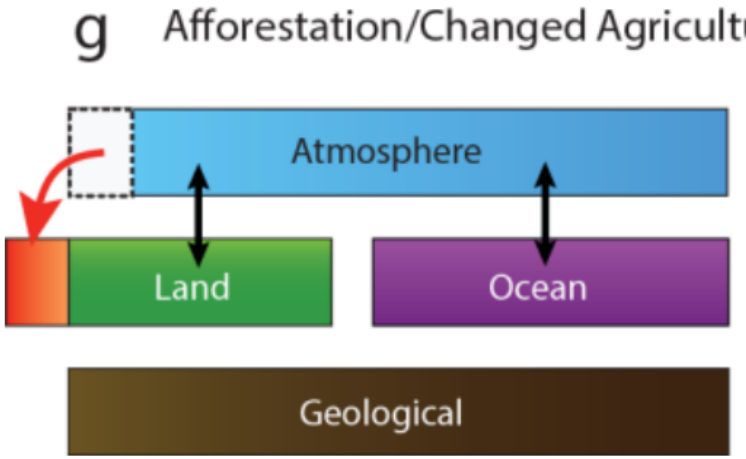


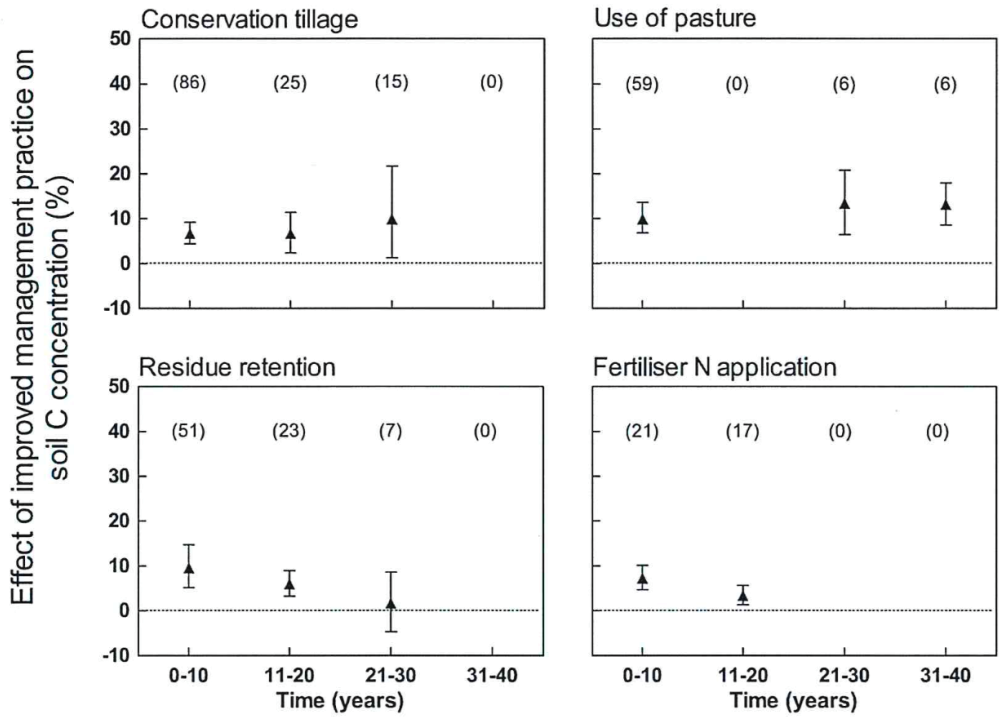
Source: http://saskpowerccs.com/ccs-projects/boundary-dam-carbon-capture-project/; https://hub.globalccsinstitute.com/publications/assessment-sub-sea-ecosystem-impacts/61-behaviour-fate-released-co2-ocean

An obvious combination, also suited to DICE



And not to mention soil carbon…





Conclusion: farming practices help, but not much

Source: Nature Scientific Reports | 3:2179|DOI: 10.1038/srep02179

And now for a different story:

- For $14/t of CO_2 sequestered (per hectare)
- Could be 30% of Australia's emissions
- Plus better water retention

ATMOSPHERIC CO2 ABSORPTION INTO FARMLAND SOILS
MEASURING PERIOD 1997 – 2010

COAL TO CARBON FERTILISER & BIO-SEQUESTERING OF CARBON

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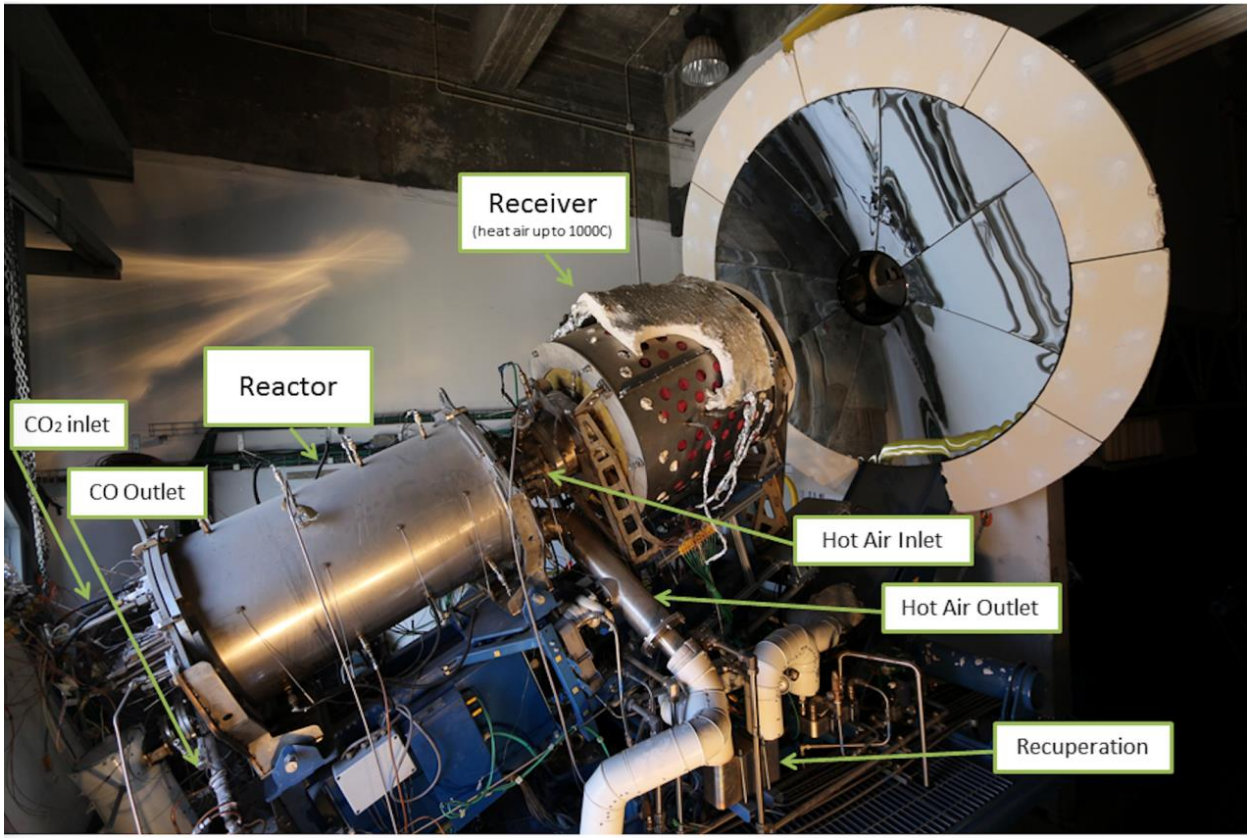
There are many brave alternatives:

- Some deserve attention



Source: http://www.newco2fuels.co.il/

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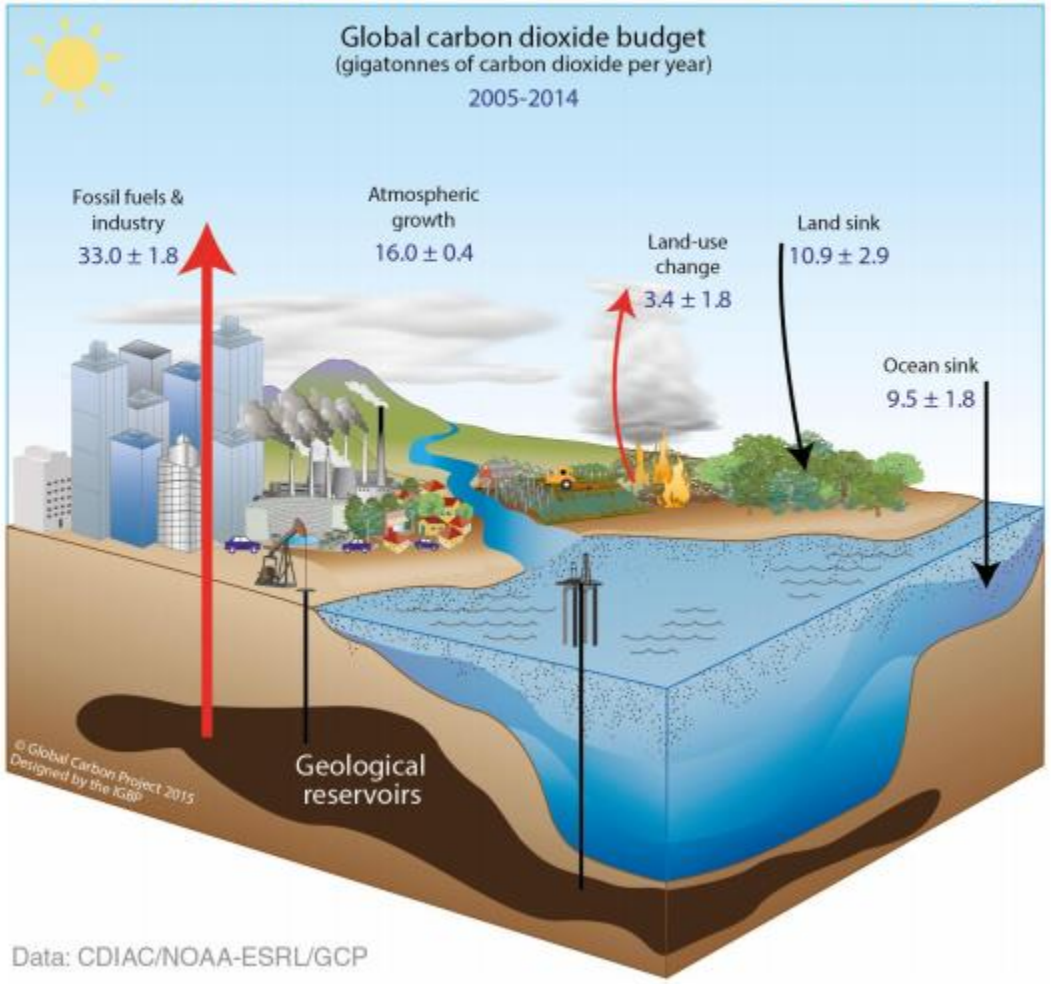
In closing:

- It’s not just renewables
- Fossil fuels will be around for a while
- As Engineers, we can make it happen

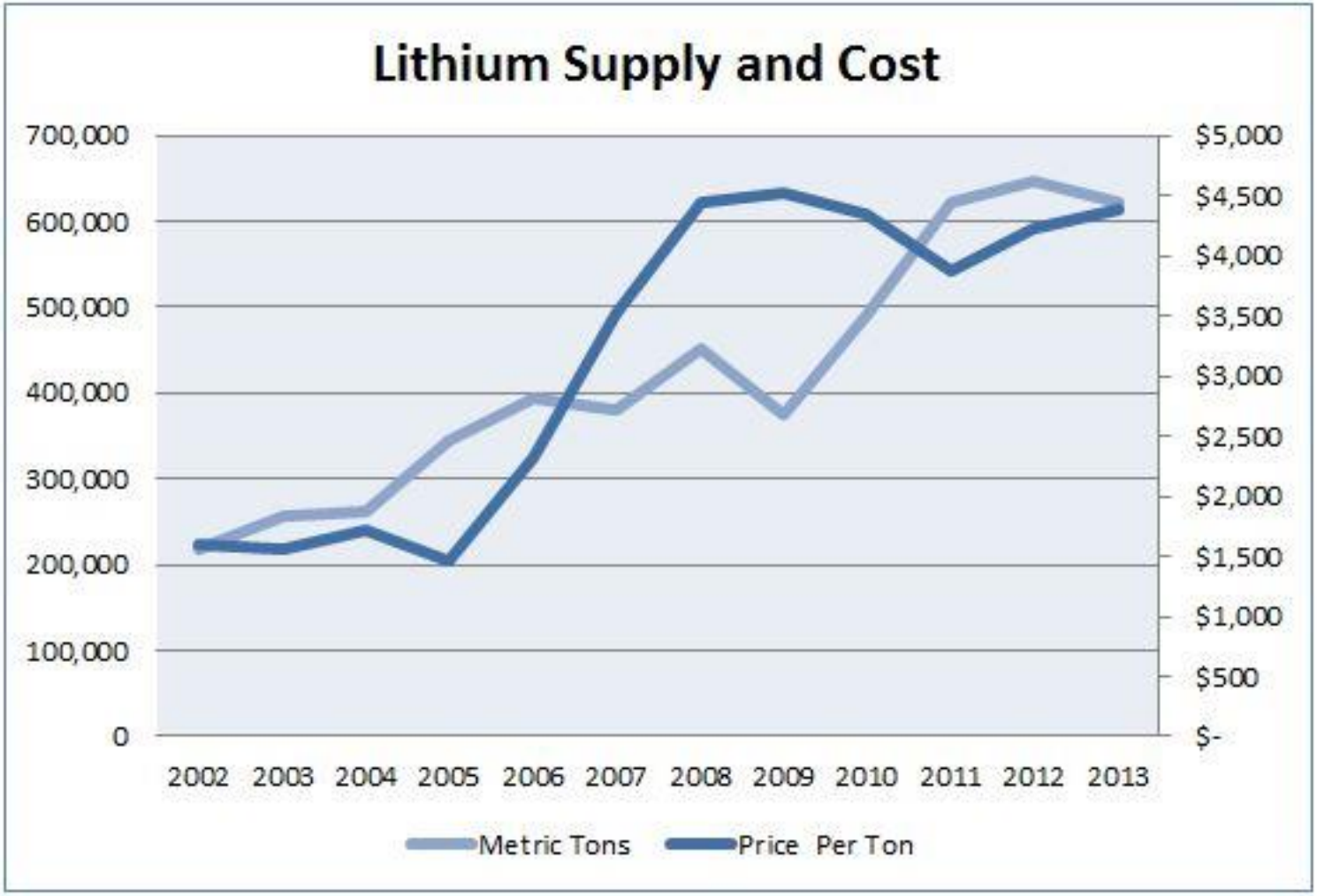
EXTRA SLIDES

In closing:

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2005–2014 ($GtCO_2$/yr)



Source: http://www.globalcarbonproject.org/carbonbudget/15/files/GCP_budget_2015_v1.02.pdf



Source: http://www.nanalyze.com/2015/08/dont-invest-in-lithium-mining-companies/

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