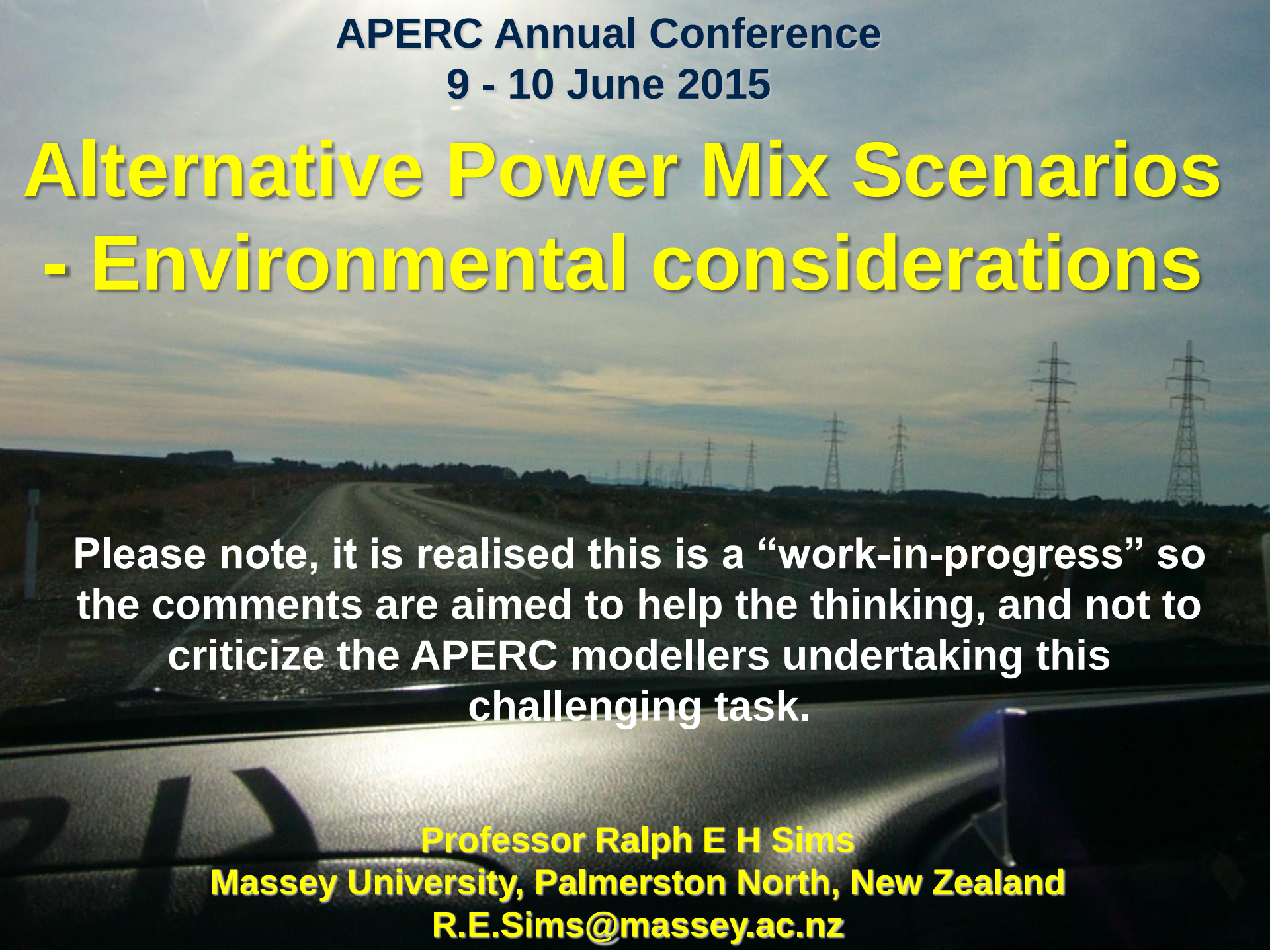
APERC Annual Conference
9 - 10 June 2015

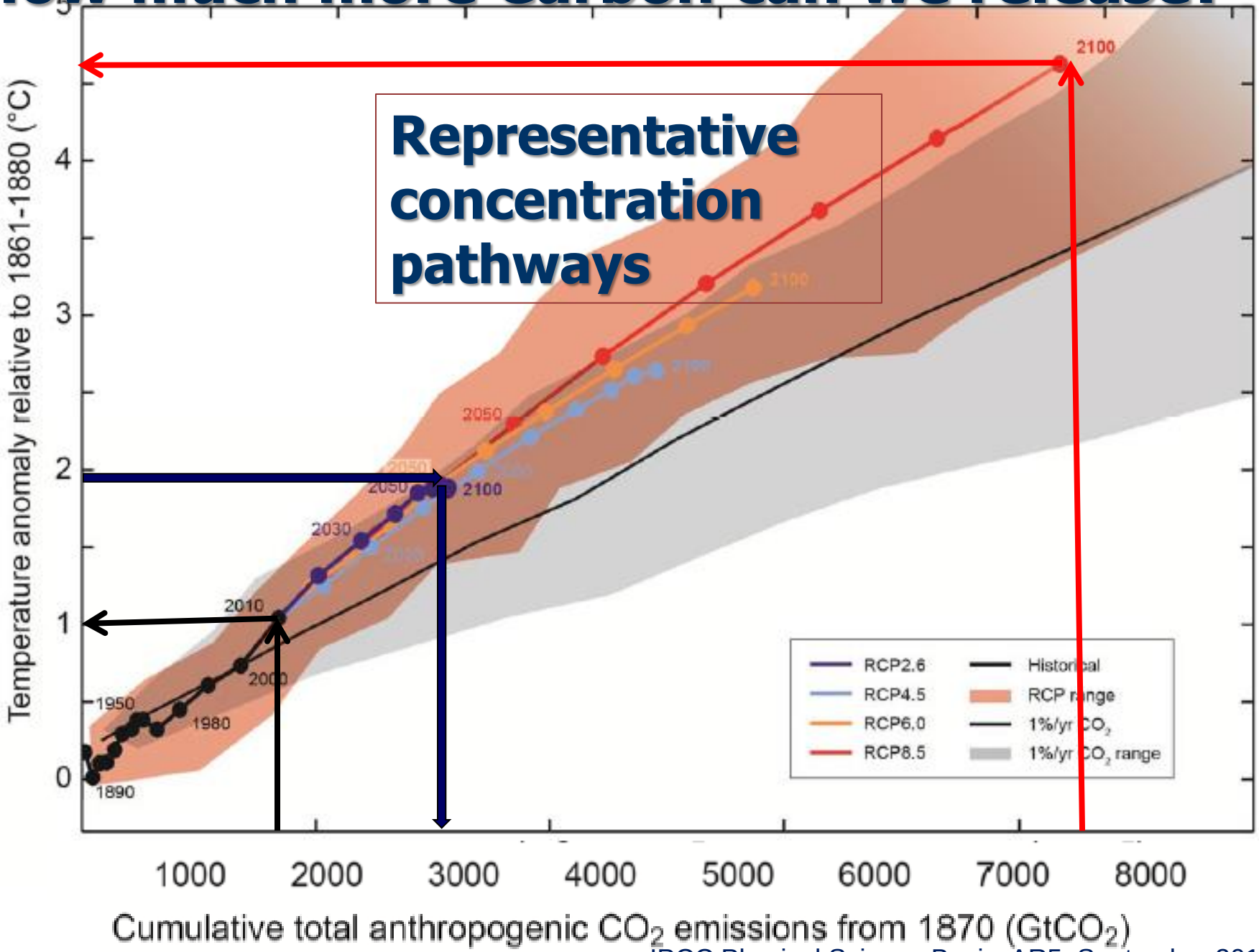
Alternative Power Mix Scenarios - Environmental considerations



Please note, it is realised this is a “work-in-progress” so the comments are aimed to help the thinking, and not to criticize the APERC modellers undertaking this challenging task.

Professor Ralph E H Sims
Massey University, Palmerston North, New Zealand
R.E.Sims@massey.ac.nz

How much more Carbon can we release?



IPCC Physical Science Basis, AR5, September 2013

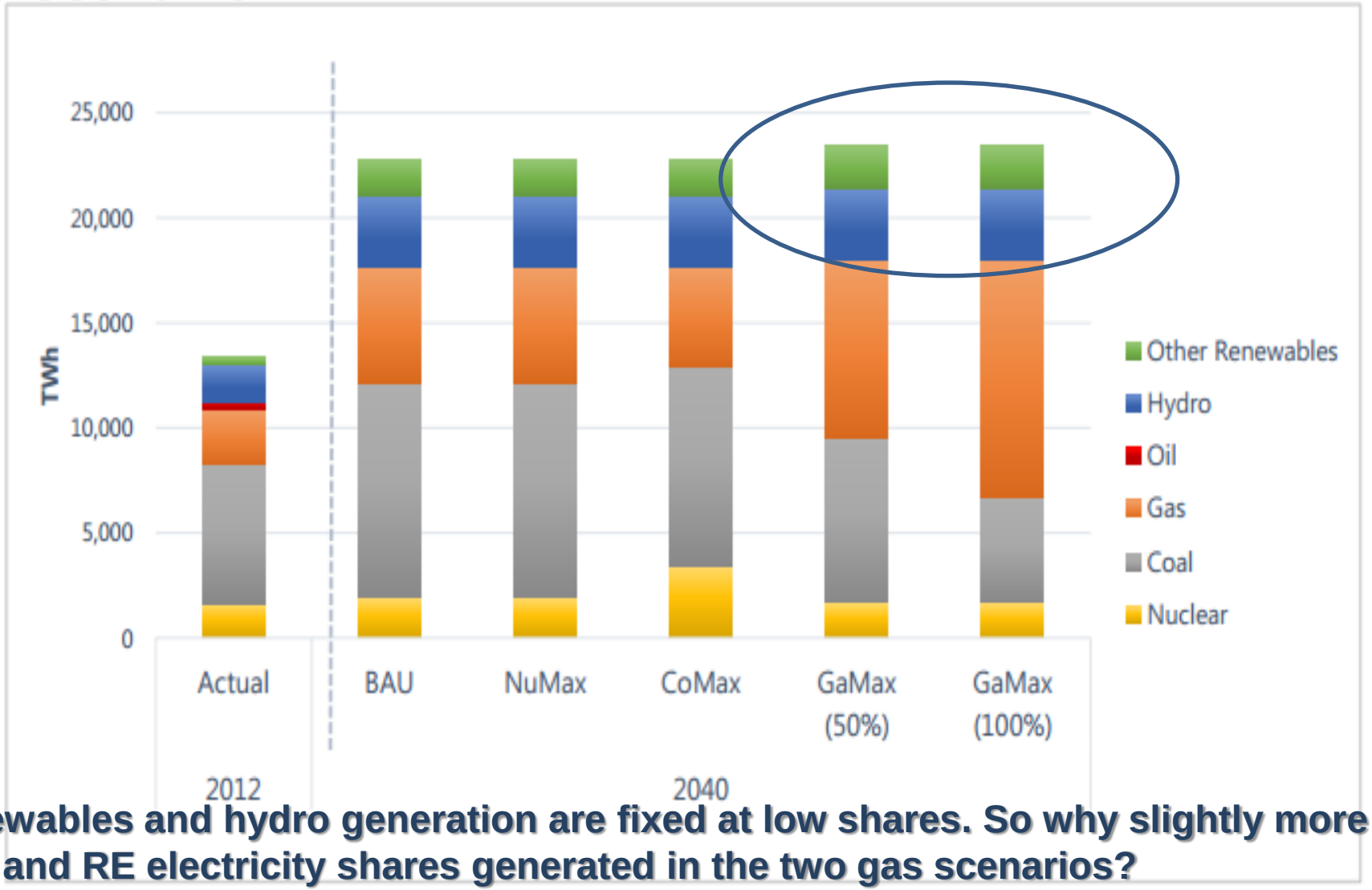
Alternative Power Mix Scenarios

“The scenarios strive to increase the use of cleaner coal, natural gas and nuclear in the electricity generation of APEC member countries”

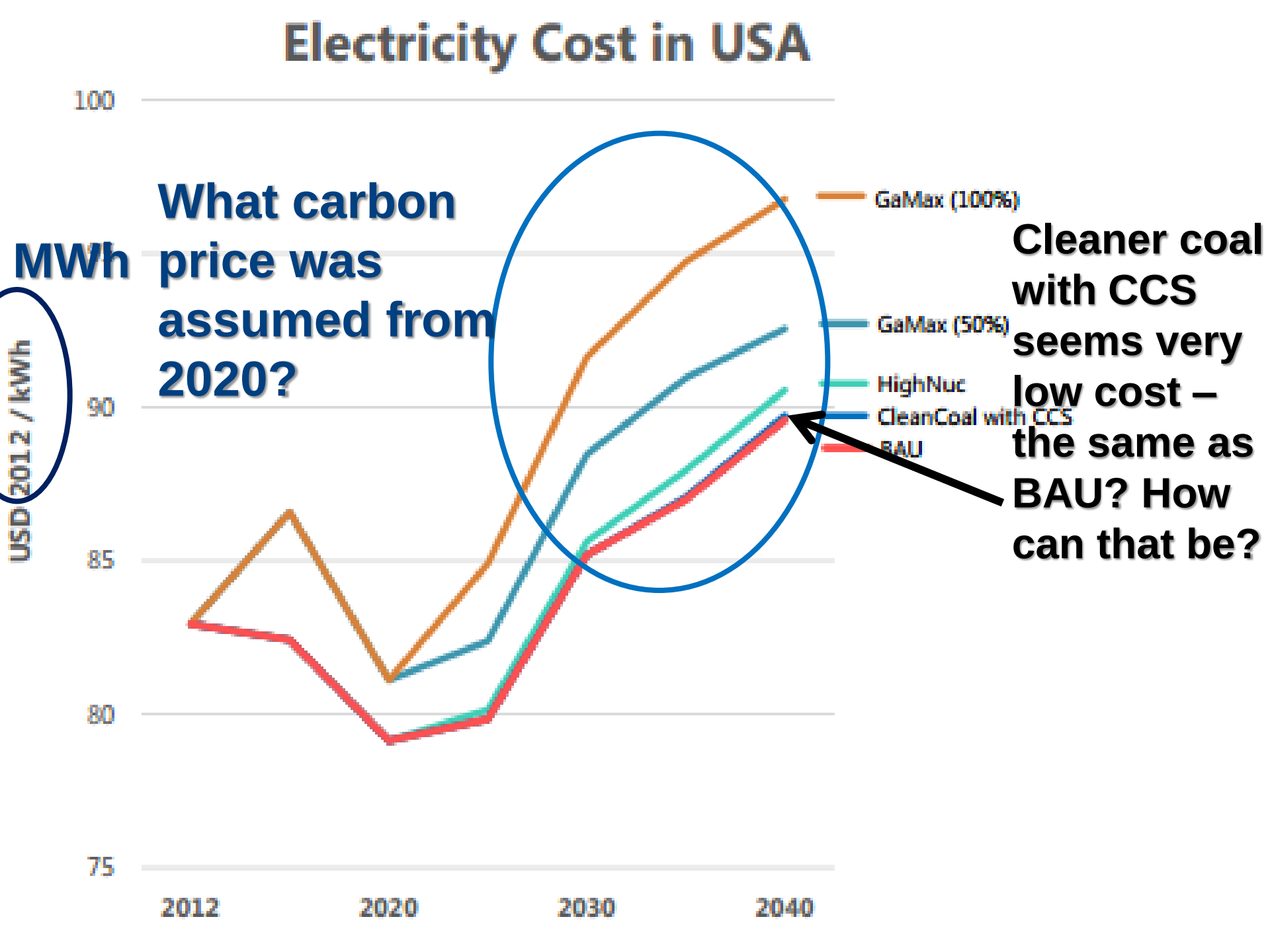
But is this a realistic outlook for an APEC country when renewable electricity is included in a different scenario?

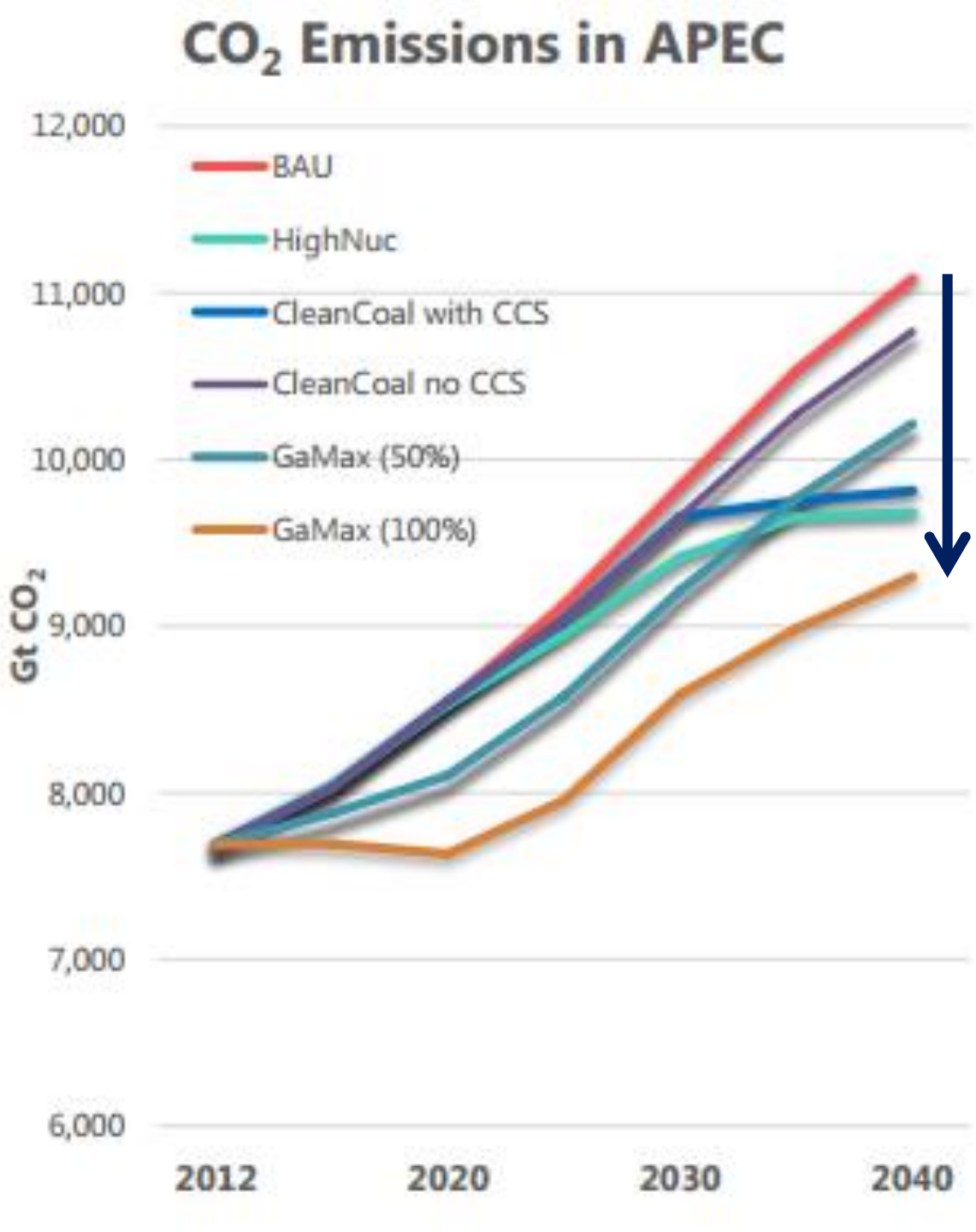
Some questions on Alternative Power Mix scenarios

APEC's electricity generation, 2012 and 2040: Results by sub-scenario



Renewables and hydro generation are fixed at low shares. So why slightly more total and RE electricity shares generated in the two gas scenarios?


Electricity Cost in USA
100
90
85
80
75
USD 2012 / kWh
2012
2020
2030
2040
GaMax (100%)
GaMax (50%)
HighNuc
CleanCoal with CCS
BAU
MWh
What carbon price was assumed from 2020?
Cleaner coal with CCS seems very low cost – the same as BAU? How can that be?

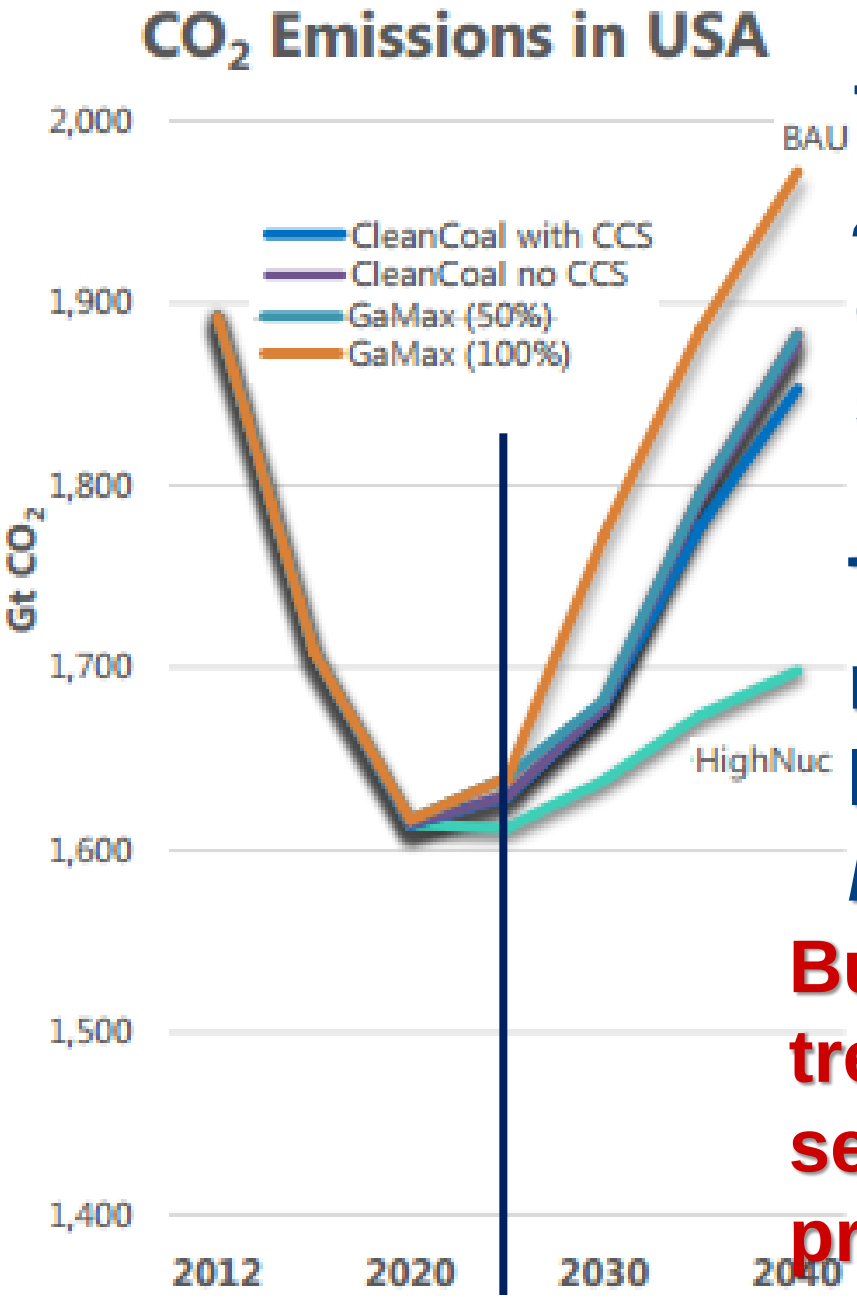


Only 15% reduction by 2040 for best case scenario.
This is unacceptable!

Even HiREN gave only 12.5% below BAU in 2040.

To show the full mitigation potential is one reason to consider merging the two scenarios into one.

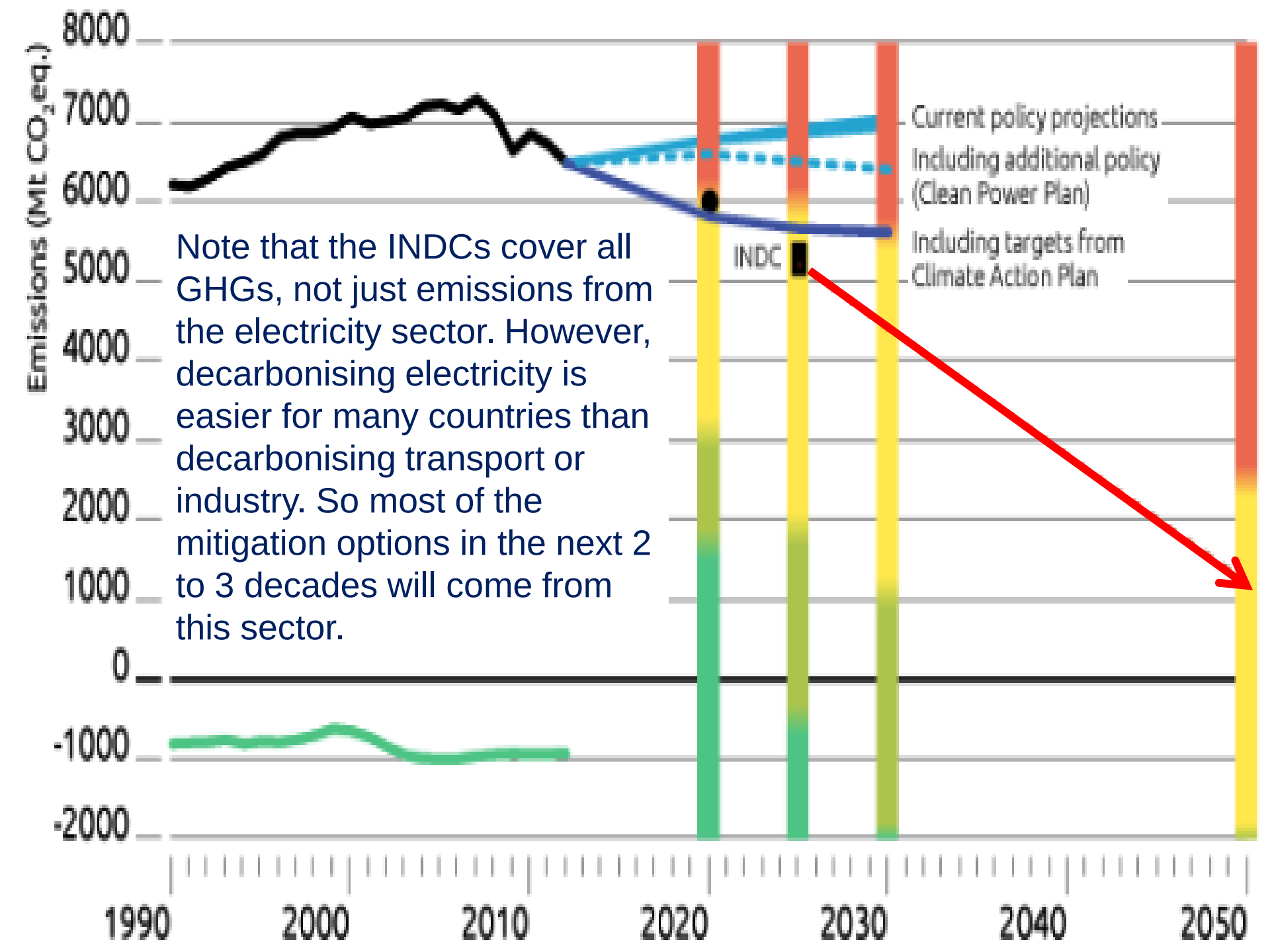
USA power generation emission projections



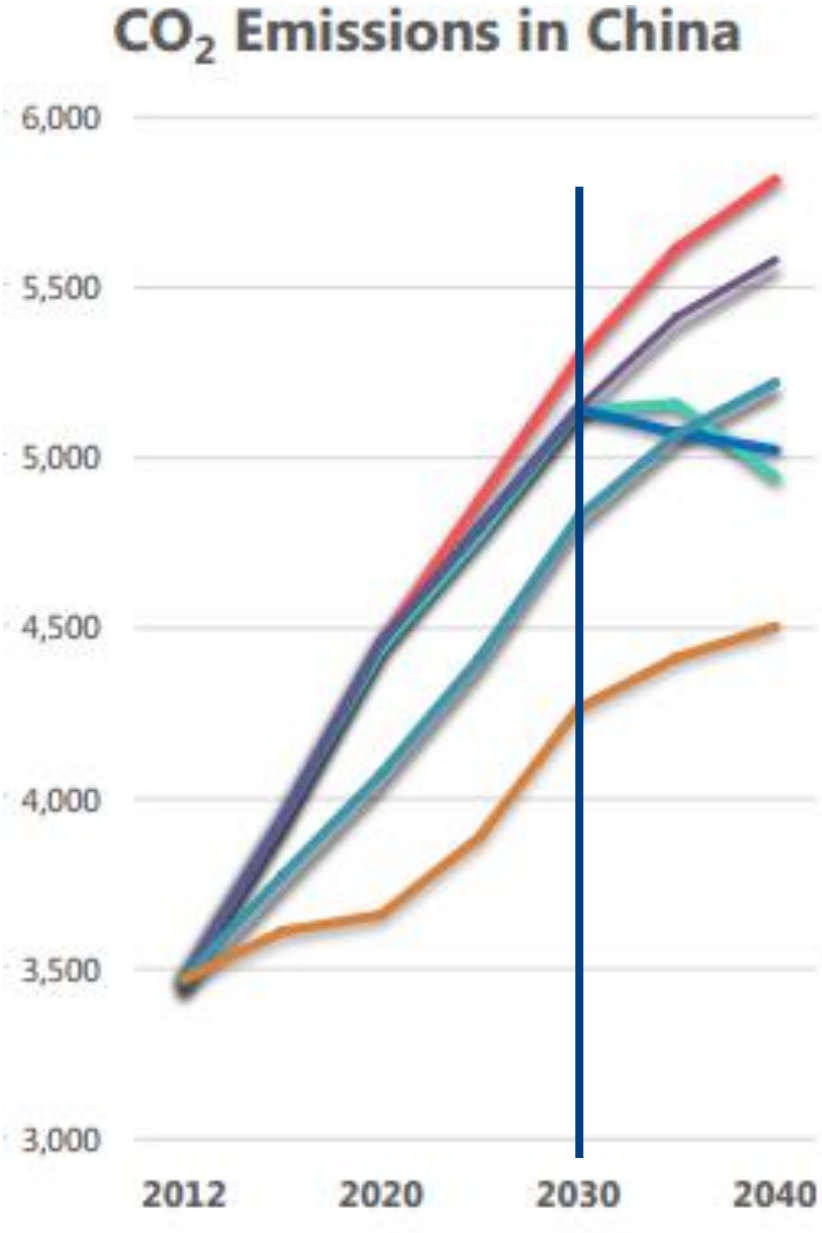
The *Clean Power Plan, 2014* aims to reduce emissions from the power sector by 30% below 2005 levels by 2025.

This projection appears to match that, and also the INDC target of *26-28% below 2005 by 2025*.

But why the later upward trend? Does it make logical sense, given the INDC and projected future pathways?


Emissions (Mt CO_2eq.)
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
1990
2000
2010
2020
2030
2040
2050
Current policy projections
Including additional policy (Clean Power Plan)
Including targets from Climate Action Plan
INDC
Note that the INDCs cover all GHGs, not just emissions from the electricity sector. However, decarbonising electricity is easier for many countries than decarbonising transport or industry. So most of the mitigation options in the next 2 to 3 decades will come from this sector.

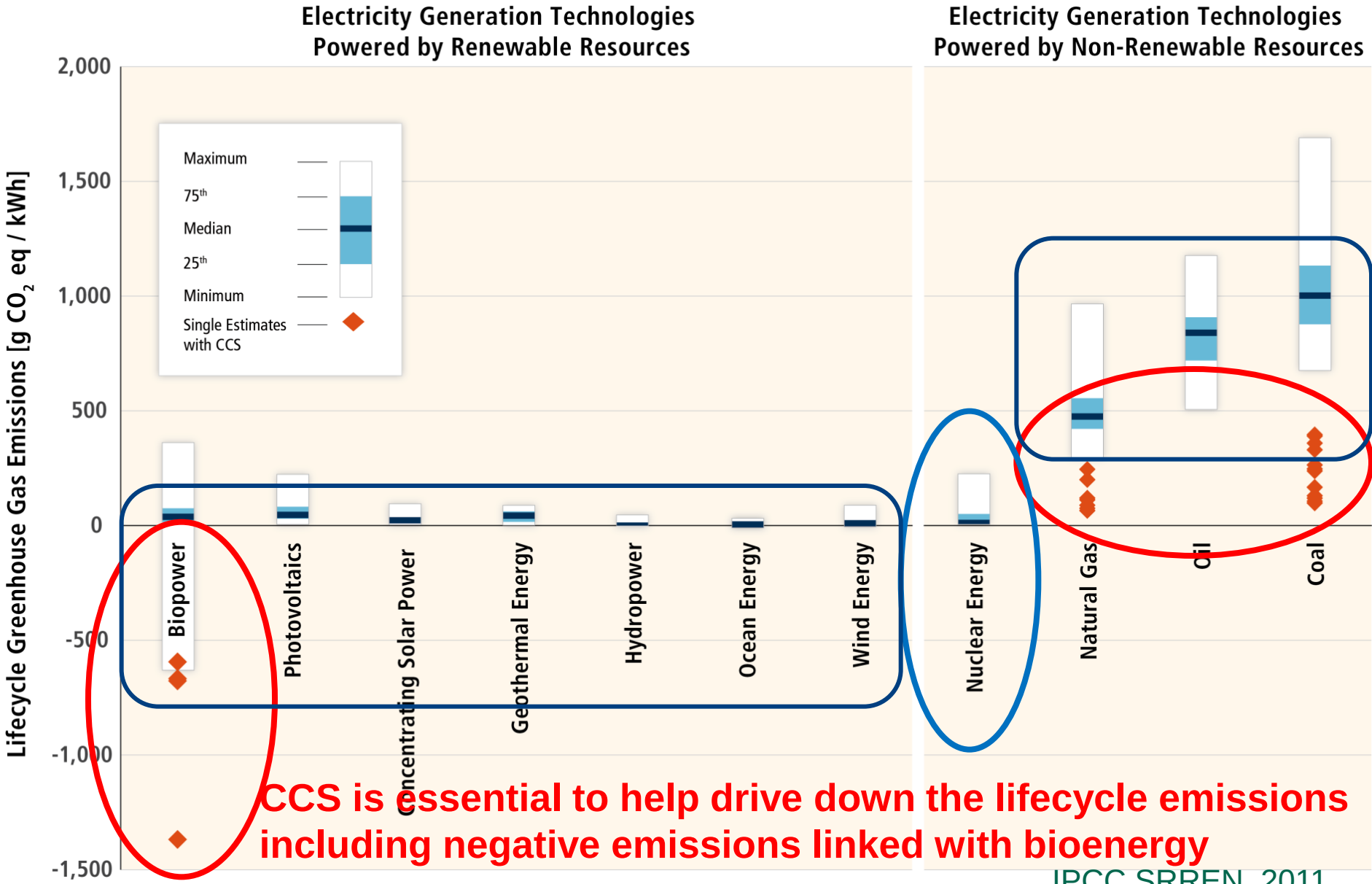
China's emission reduction projection



China has stated that its:
GHG emissions will peak before 2030 - when >20% primary energy will come from non-fossil fuels.

The APERC scenario shows a 2030 peak only for cleaner coal with CCS and I think, high nuclear – (with the shadows showing on some lines in the figure it is hard to tell which is which).

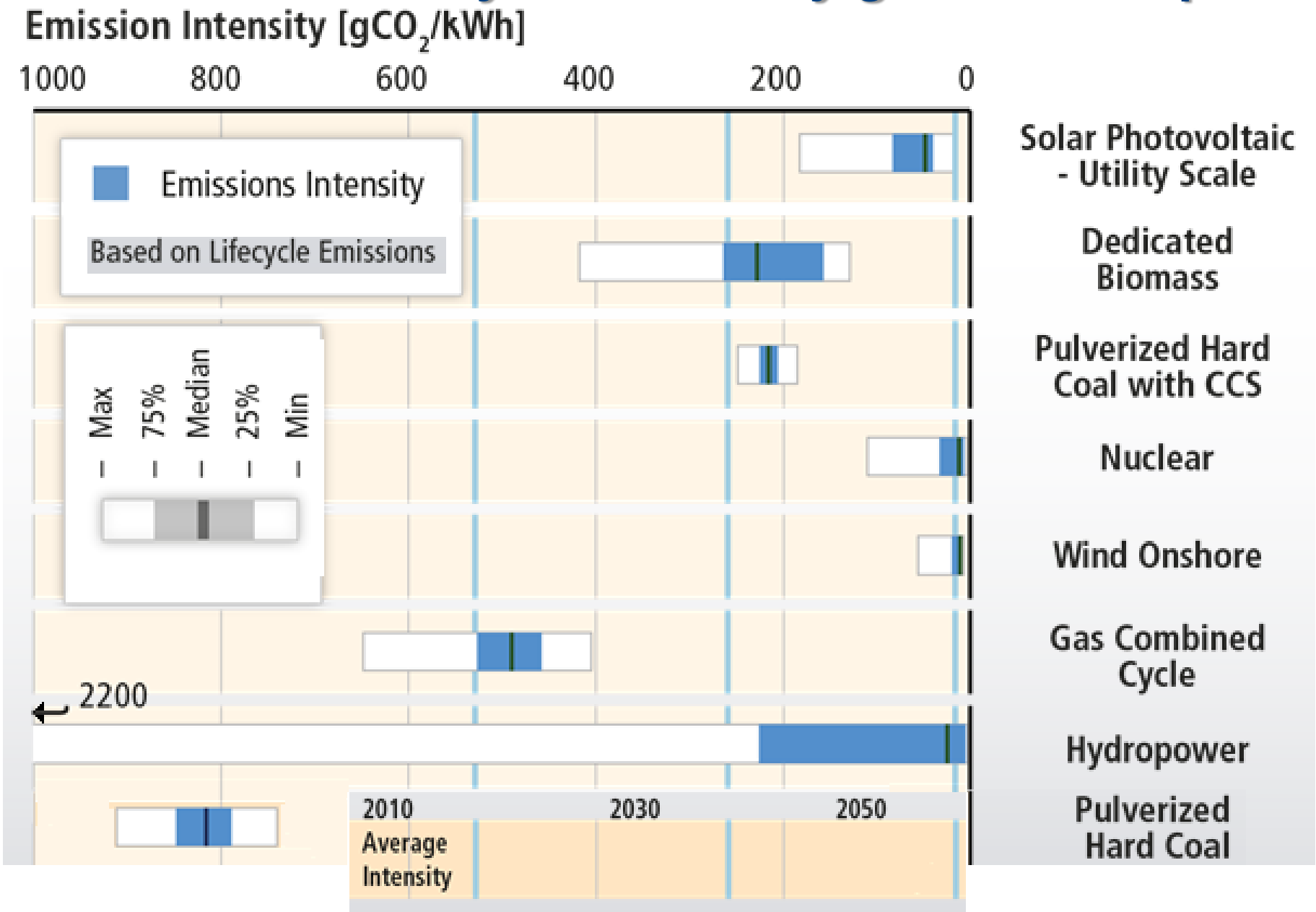
Life cycle GHG emissions of low-carbon technologies are considerably lower than those of fossil fuel options.



CCS is essential to help drive down the lifecycle emissions including negative emissions linked with bioenergy

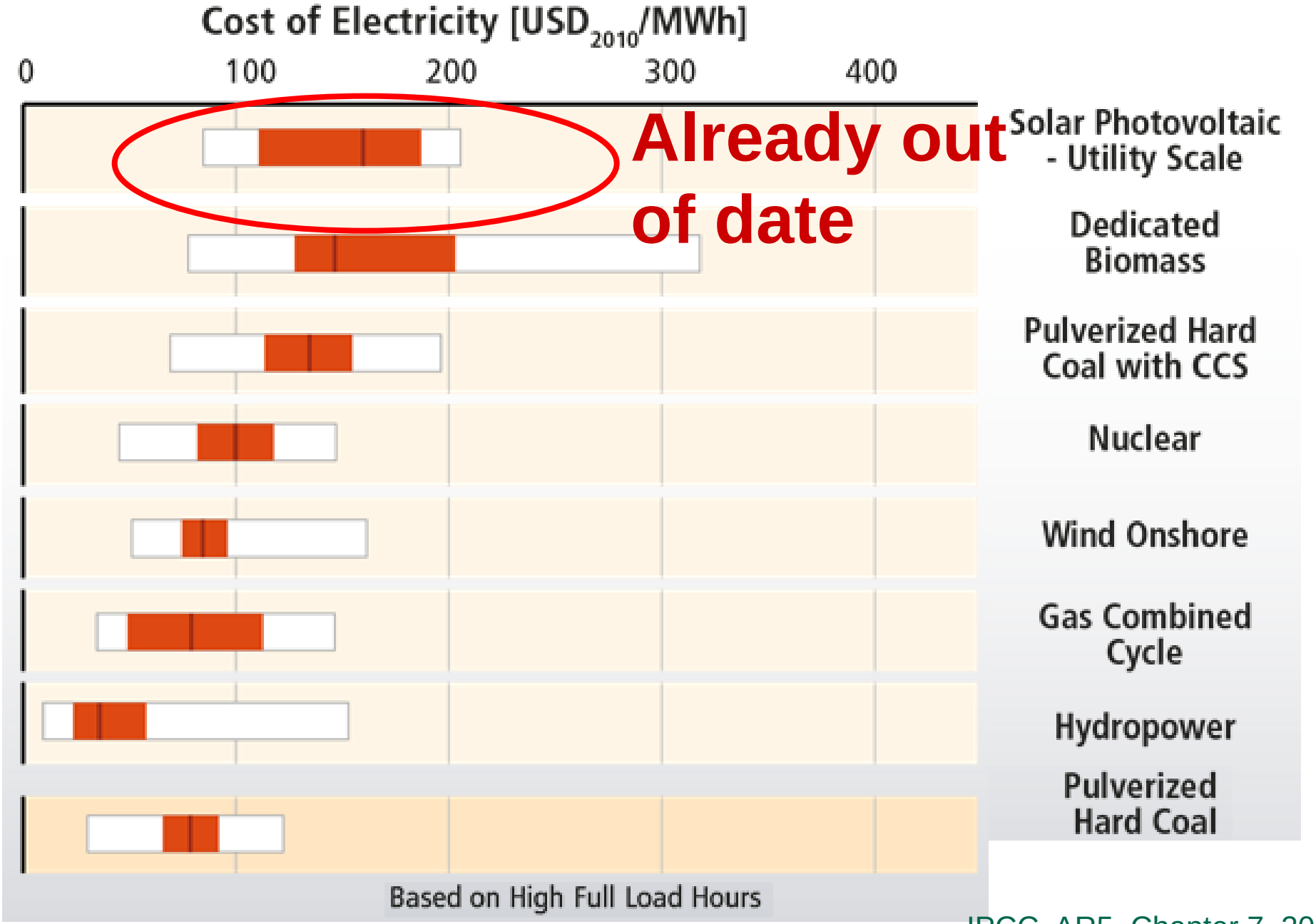
IPCC SRREN, 2011

Emission intensity of electricity generation options



IPCC, AR5, Chapter 7, 2014

Emission intensity of electricity generation options



IPCC, AR5, Chapter 7, 2014

Nuclear power is not easy:

- AREVA – EUR 4.9bn loss ($5.4bn) in 2014 after 3 previous years of losses.
- Merger planned with EDF to design, build and service reactors.
- EPR reactor in Finland is 10 years behind schedule with EUR 3.9bn impairment charges for AREVA and pending court hearings.
- Similar reactor at Hinkley in UK under construction, but now with some uncertainty.
- EPR reactor in Flammavile, France being built by EDF is 6 years behind schedule and EUR 6bn ($6.6 bn) over budget.
- Two EPR reactors in Taishan, China being built by China General Nuclear on time and within budget.

IPCC 4th Assessment Report, Mitigation 2007. Summary for Policy Makers

"Given costs relative to other supply options, nuclear power, which accounted for 16% of the electricity supply in 2005, can have an 18% share of the total electricity supply in 2030 at carbon prices up to 50 US$/tCO2-eq, but safety, weapons proliferation and waste remain as constraints."

This sentence took 6 hours to negotiate between the 160 countries at the IPCC SPM approval process in Bangkok, highlighting the sensitivity of nuclear power across countries and the public perceptions of it.

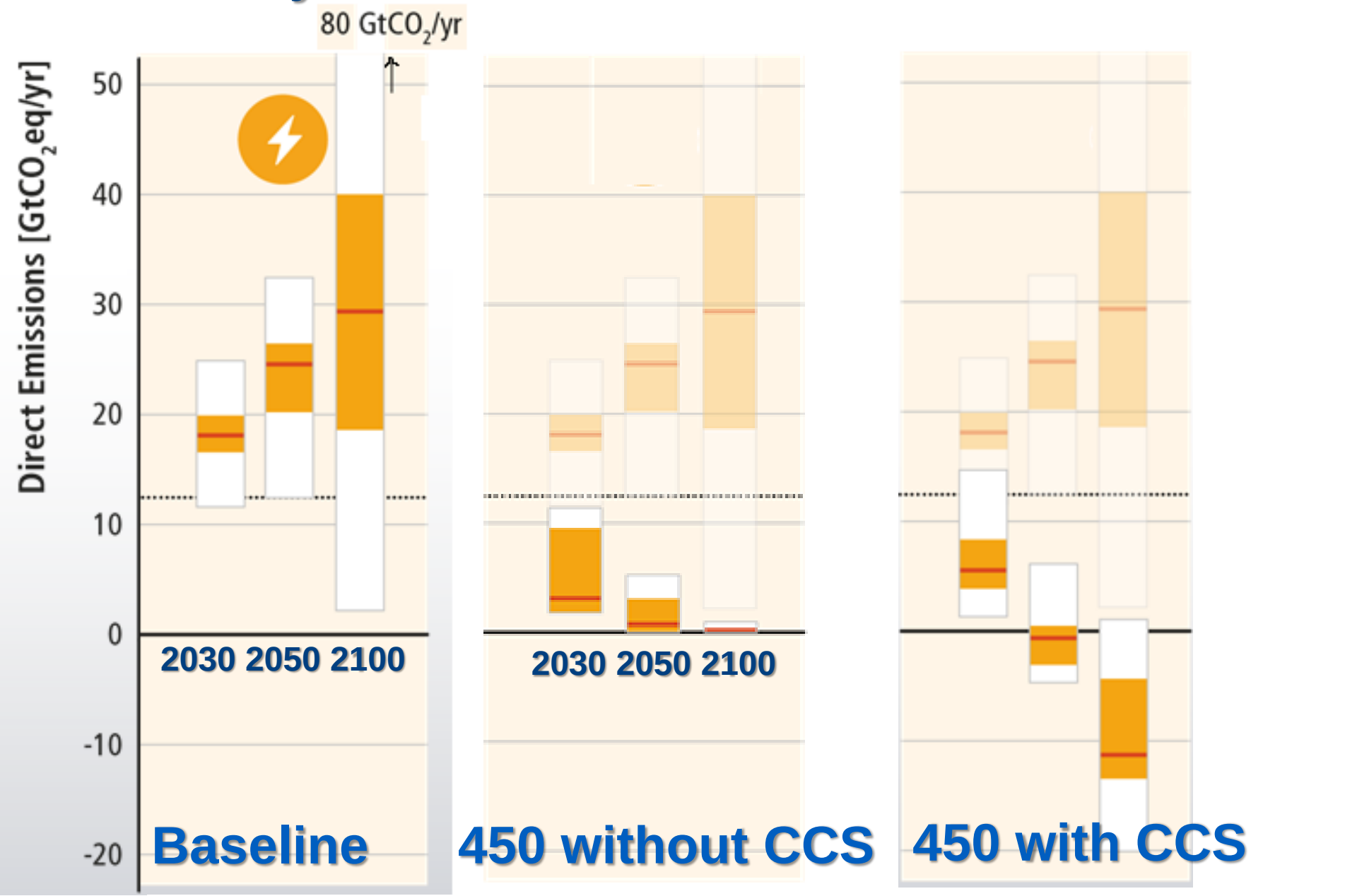
IPCC AR5-Mitigation 2014. Summary for policy makers

- Nuclear energy is a mature low-GHG emission source of baseload power, but its share of global electricity generation has been declining since 1993.
- Nuclear power could make an increasing contribution to low-carbon energy supply, but a variety of barriers exist.
- These include operational risks and the associated concerns, uranium mining risks, financial and regulatory risks, unresolved waste management issues, nuclear weapon proliferation concerns, and adverse public opinion.
- New fuel cycles and reactor technologies addressing some of these issues are being investigated and progress in research and development has been made concerning safety and waste disposal.

Linked with climate change mitigation are several co-benefits such as improved air pollution levels and their externalities.

- High levels of particulates have been recorded in many cities, and the health issues a growing concern.
- For example, Poland has 5,300 deaths per year from air pollution with related health costs estimated to range from $3.5 to 9 billion.
- Much of this comes from coal combusted for heating as well as that consumed in power plants.
- Black carbon, a short lived climate polluter emitted from diesel engines, cook-stoves etc, is a target for short-term climate mitigation, plus emission reduction can help improve health and crop growth.
- Deploying improved, high efficiency, power plant designs and filters is essential to reduce emissions.
- CCS shows promise, but what is its future?

Electricity sector emissions from 1200 scenarios



IPCC 5th Assessment Report – Mitigation, 2014

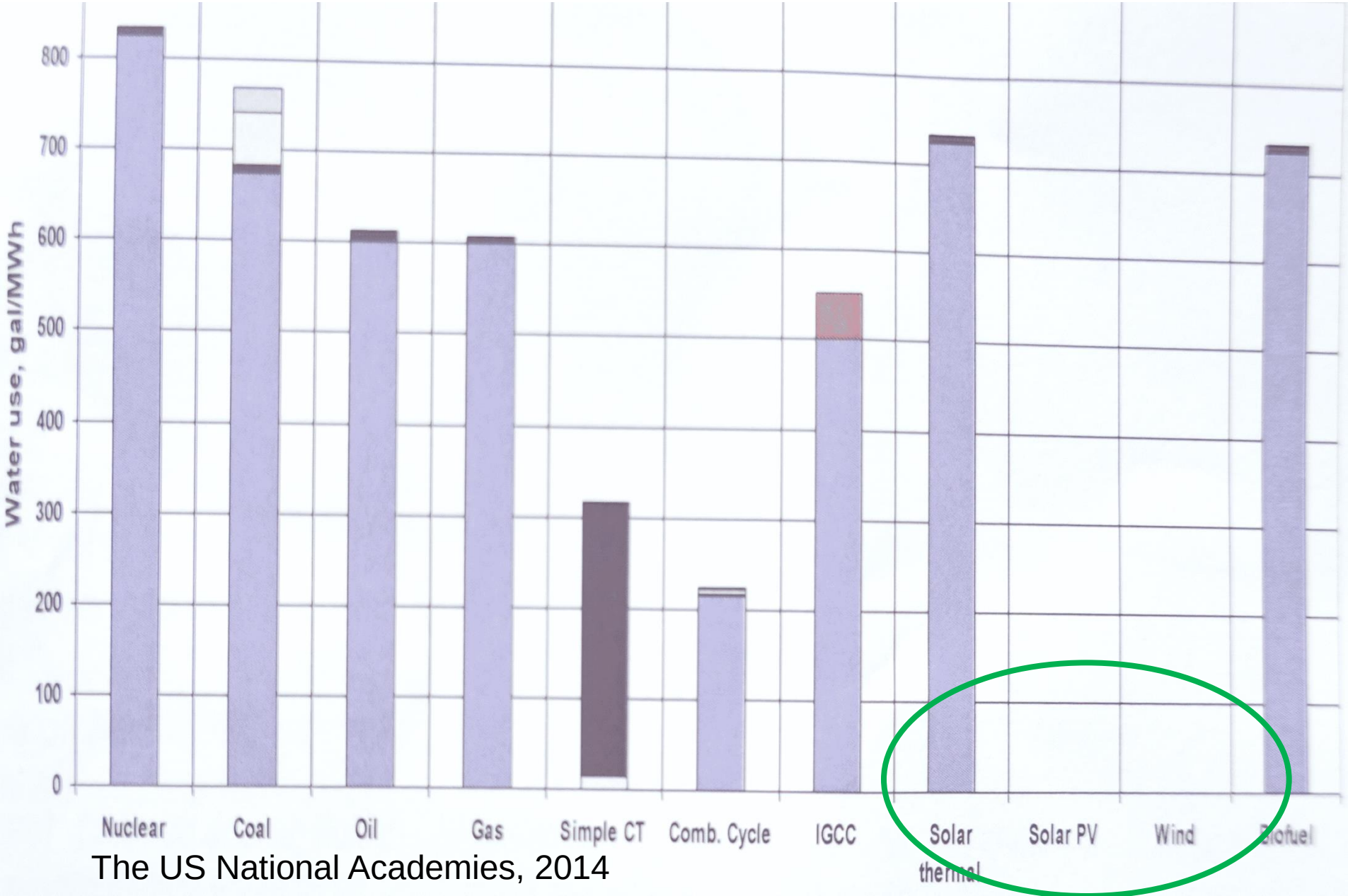
The future for CCS is not looking too bright.

- Future-Gen 2.0 CCS coal power project in Illinois, USA, rose to $1.62 bn, so USDOE pulled its $1.1bn share. Even for a demonstration plant, it was a high cost for only 166MW export capacity.
- The first commercial scale CCS project linked to a power-plant, the Boundary Dam plant in Canada, is exceeding expectations after 130 days operating, but the cost for this 110 MW export plant was $1.3bn.
- As for other technologies such as solar PV, cost reductions for CCS are likely over time from project experiences and learning.
- The Australian government has cut CCS RD&D funds.
- 4 major utilities quit *European Zero Emission Platform* – "We do not have the necessary economic framework conditions in Europe to make CCS an attractive technology to invest in."

IPCC AR5-Mitigation 2014. Summary for policy makers - CCS

- While all components of integrated CCS systems exist, CCS has not yet been applied at scale to a large, operational, commercial fossil fuel power plant.
- CCS power plants could be incentivized by regulation and/or if they become competitive with their unabated counterparts, for instance by sufficiently high carbon prices or direct financial support.
- For the large-scale future deployment of CCS, well-defined regulations concerning short- and long-term responsibilities for CO_2 storage are needed.
- Barriers to large-scale deployment include concerns about the operational safety and long-term integrity of CO_2 storage as well as transport risks.
- A growing body of literature covers how to ensure the integrity of CO_2 wells, the potential consequences of a pressure build-up within a geologic formation caused by CO_2 storage (such as induced seismicity), and the potential human health and environmental impacts from CO_2 that migrates out of the primary injection zone.

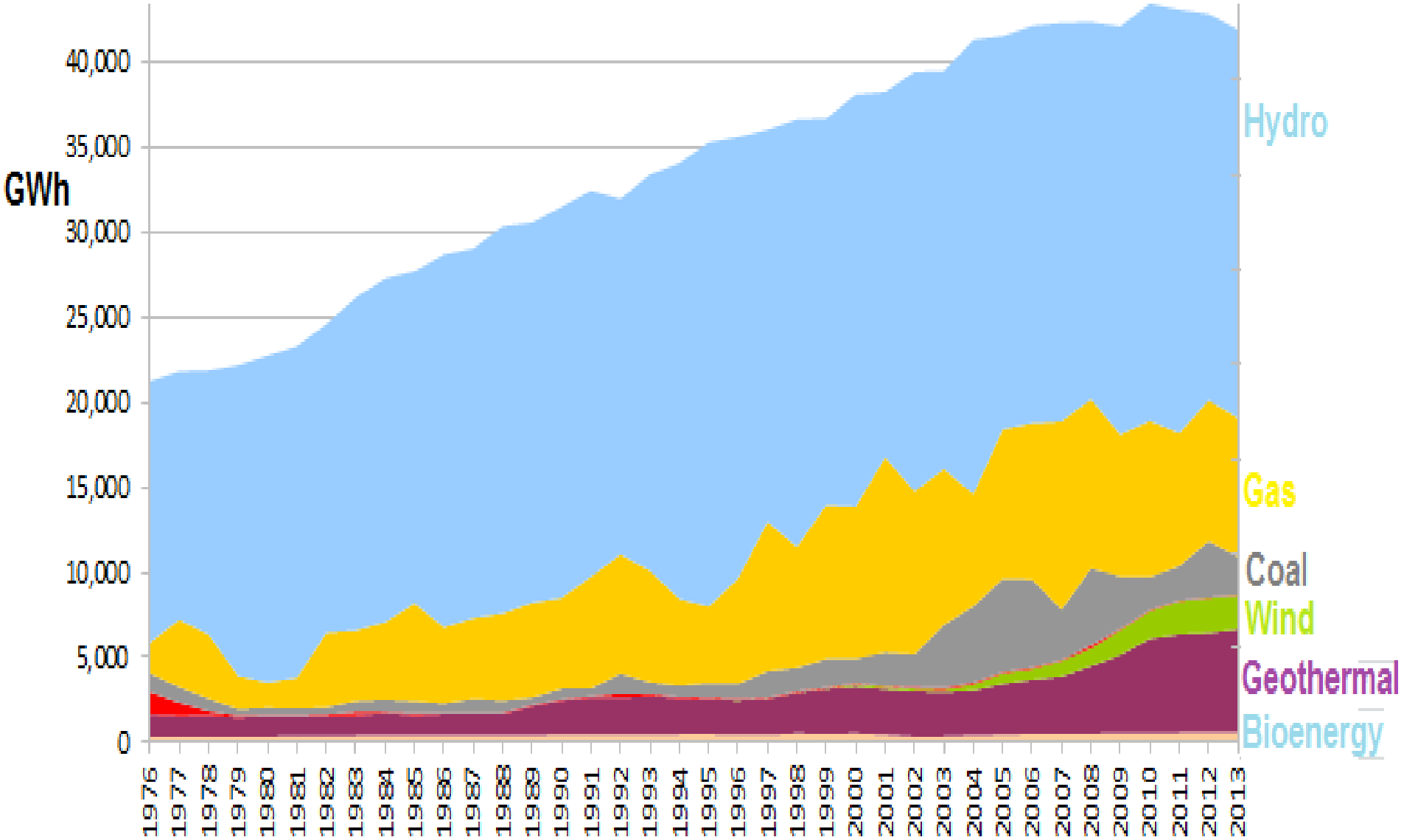
Power supply is not just costs and GHG emissions but also water demand that should also be taken into account.



The US National Academies, 2014

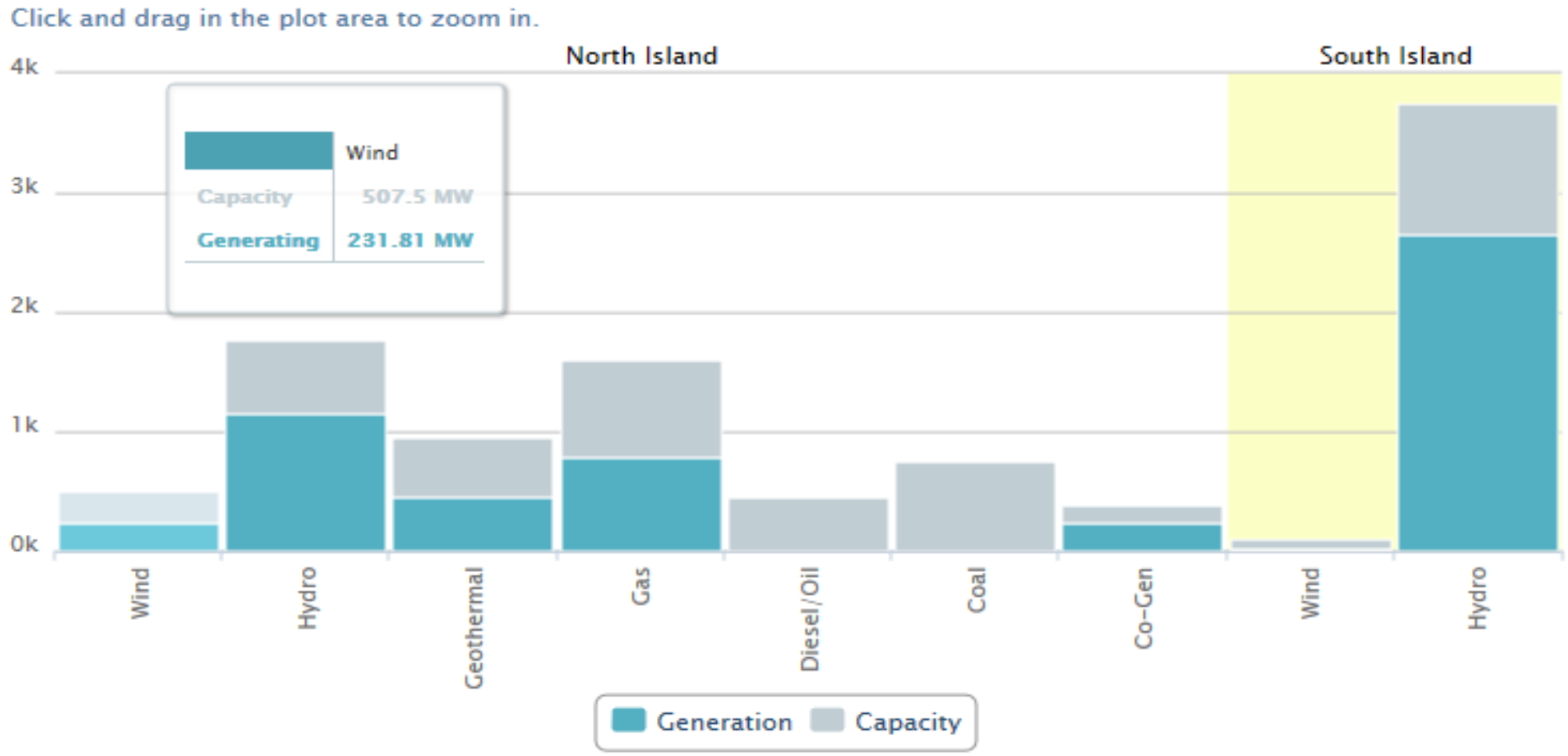
Can renewable energy resources be successfully integrated into existing and future energy supply and end-use systems?

Analysis should be more than just the fuel shares for electricity generation – this example for New Zealand.



Integration of renewable energy into the existing power system is critical. The NZ balance, to meet the ever changing demand, is a good example with 5 minute updates provided by the system operator in real time.

Current Generation (MW)



Total generation (as at) 08 Jun 2015 18:20

North Island 2,868.09 MW
South Island 2,667.65 MW

http://www.systemoperator.co.nz/system-operations/published-data/generation

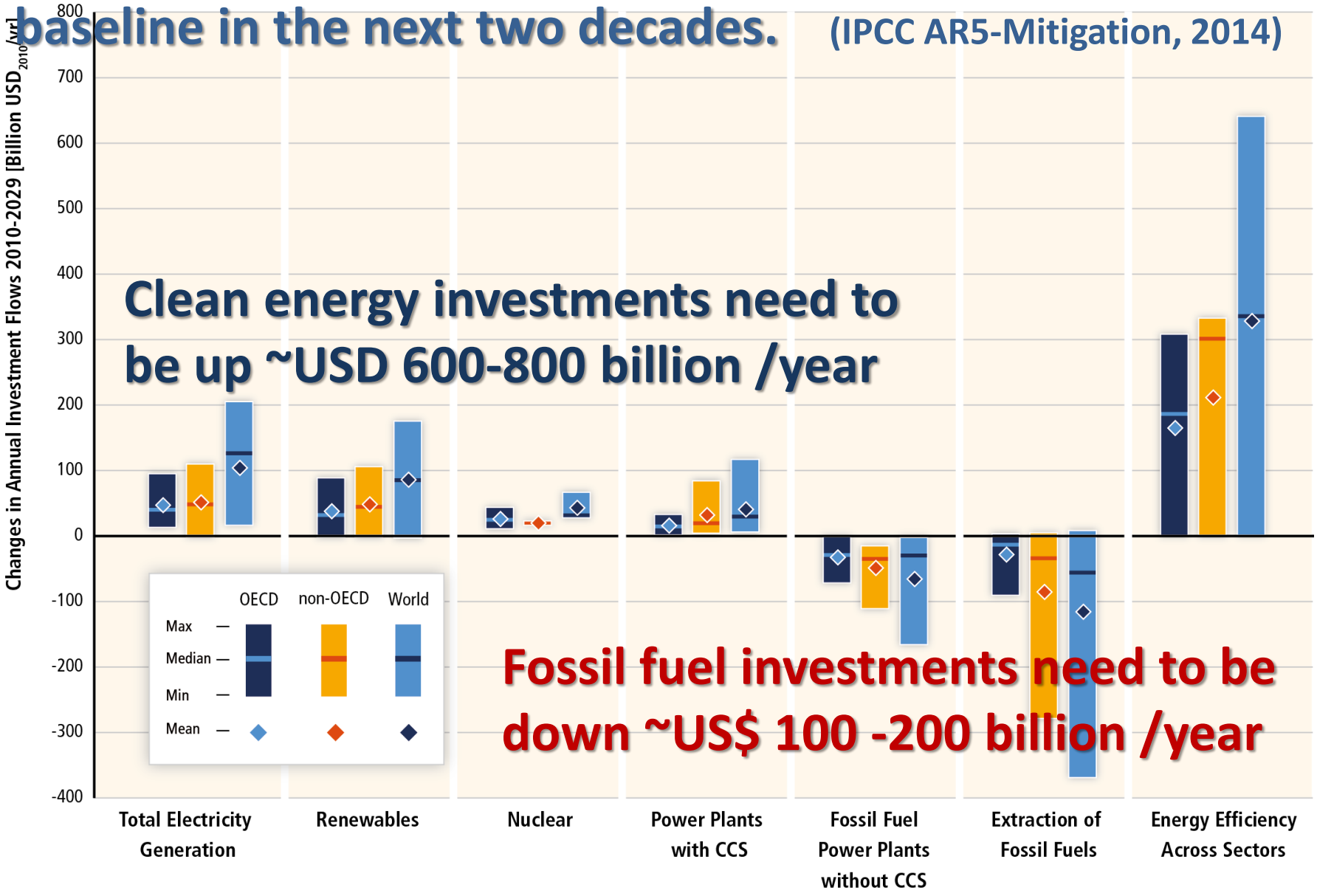
Renewable energy could shape future energy supply and end-use systems and should not be excluded from any scenario.

Electricity is expected to attain higher shares of RE earlier than either the heat or transport fuel sectors.

Parallel developments in electric vehicles, increased heating and cooling using electricity (including heat pumps), flexible demand response services (including the use of smart meters and smart-grids), energy storage and other technologies will help drive this trend faster than what many people can imagine. (The analogy is laptops versus main frame computers!).

Substantial reductions in emissions to stabilize at 2ºC will require large changes in energy investment compared to baseline in the next two decades.

(IPCC AR5-Mitigation, 2014)



In summary

A scenario without renewables is not a true reflection of the real world and the likely future energy supply mix in all countries.

Gas, nuclear and coal with CCS all have a role to play but there are technical and social barriers, especially for CCS and nuclear.

To constrain temperature rise to below 2°C we will need all the help we can get. The APERC Outlook scenarios show insufficient GHG mitigation potential from the APEC countries if this target is to be met.

They should be closer linked to the INDCs where feasible, be more ambitious, and consider water demand as well as costs and potentials.

The Paris COP in December 2015 will show whether or not the INDCs will be sufficient to constrain global temperature rise below 2°C - but it is not looking promising at this stage of the process.


For our future generations
(such as my grandchildren)
WE ARE RUNNING OUT OF TIME!