Climate Change – the Nuclear Solution

1. Australia's Climate Change Record
2. Nuclear Energy and Low Carbon Electricity Generation
3. The Trouble with Intermittent Renewables
4. Nuclear Downsides and Upsides
5. Australian Plan for Extremely Low Carbon Generation

Questions

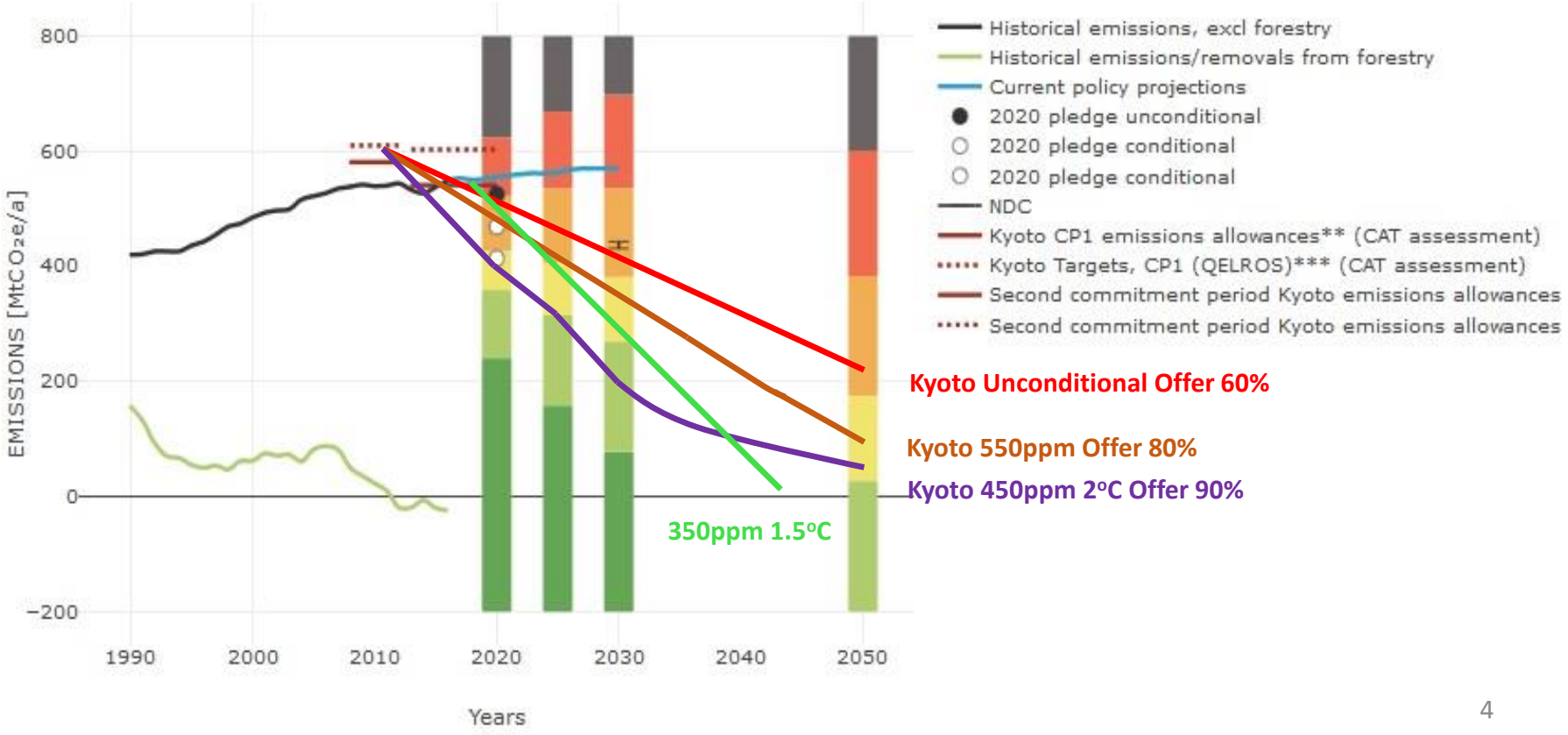
Dr James Hansen – Grandfather of Climate Change Science

Section 1

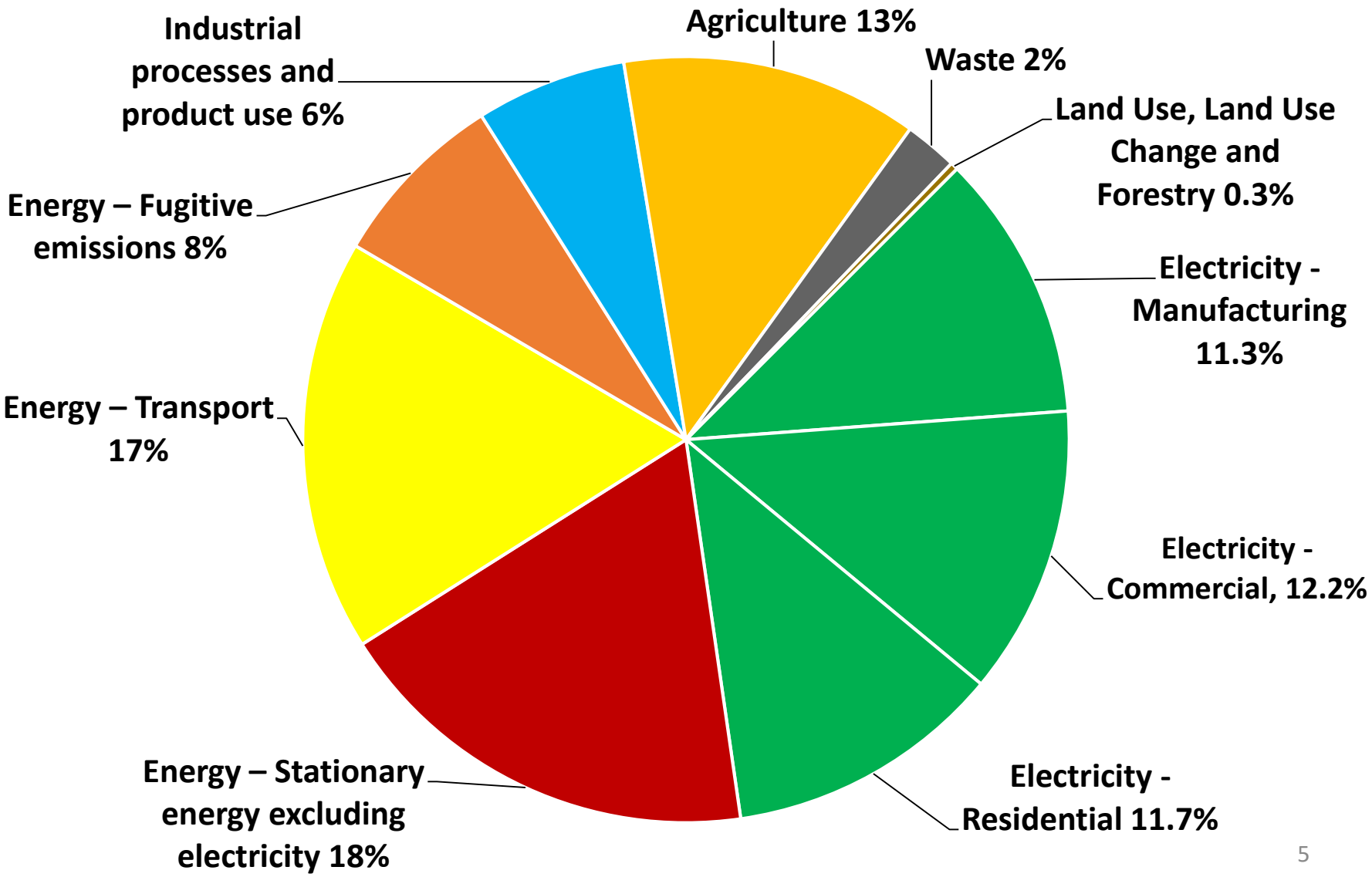
Australia's Climate Change Record

Australia's Emissions Progress according to Climate Action Tracker

CRITICALLY INSUFFICIENT	HIGHLY INSUFFICIENT	INSUFFICIENT	2°C COMPATIBLE	1.5°C PARIS AGREEMENT COMPATIBLE	ROLE MODEL
4°C+ WORLD	< 4°C WORLD	< 3°C WORLD	< 2°C WORLD	< 1.5°C WORLD	<< 1.5°C WORLD



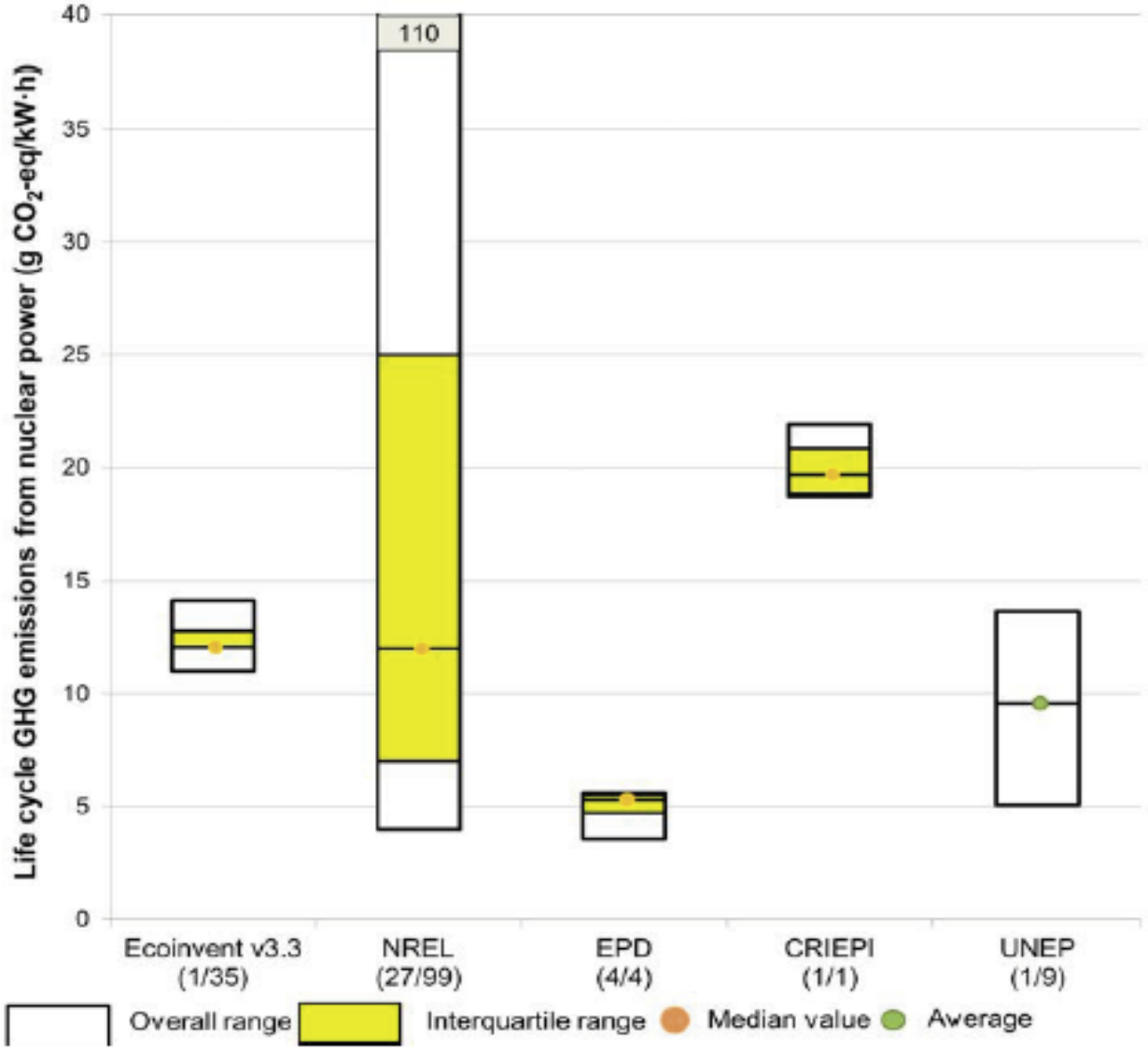
Australia's carbon emissions sources



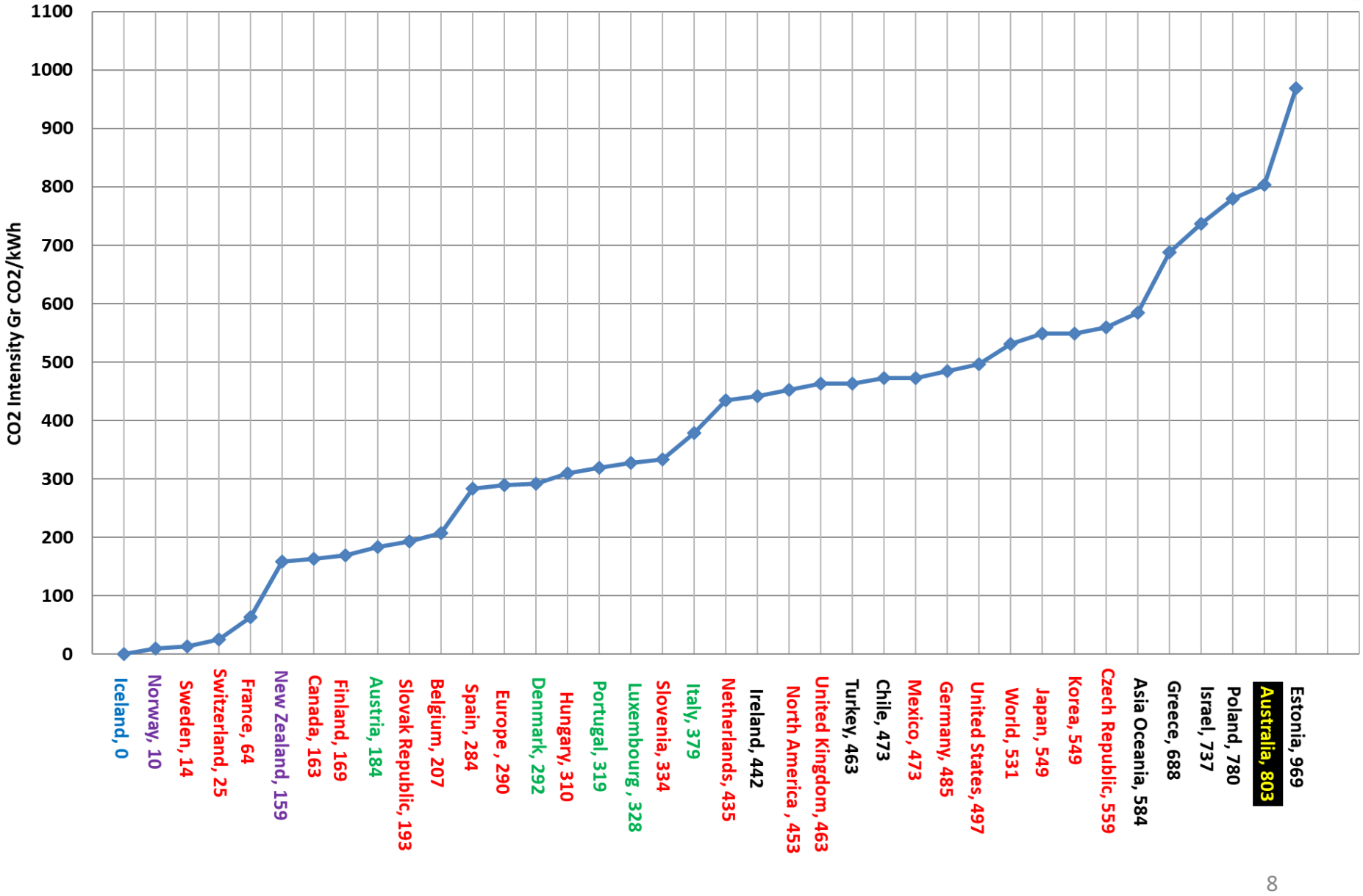
Section 2

Nuclear Energy and Low Carbon Electricity Generation

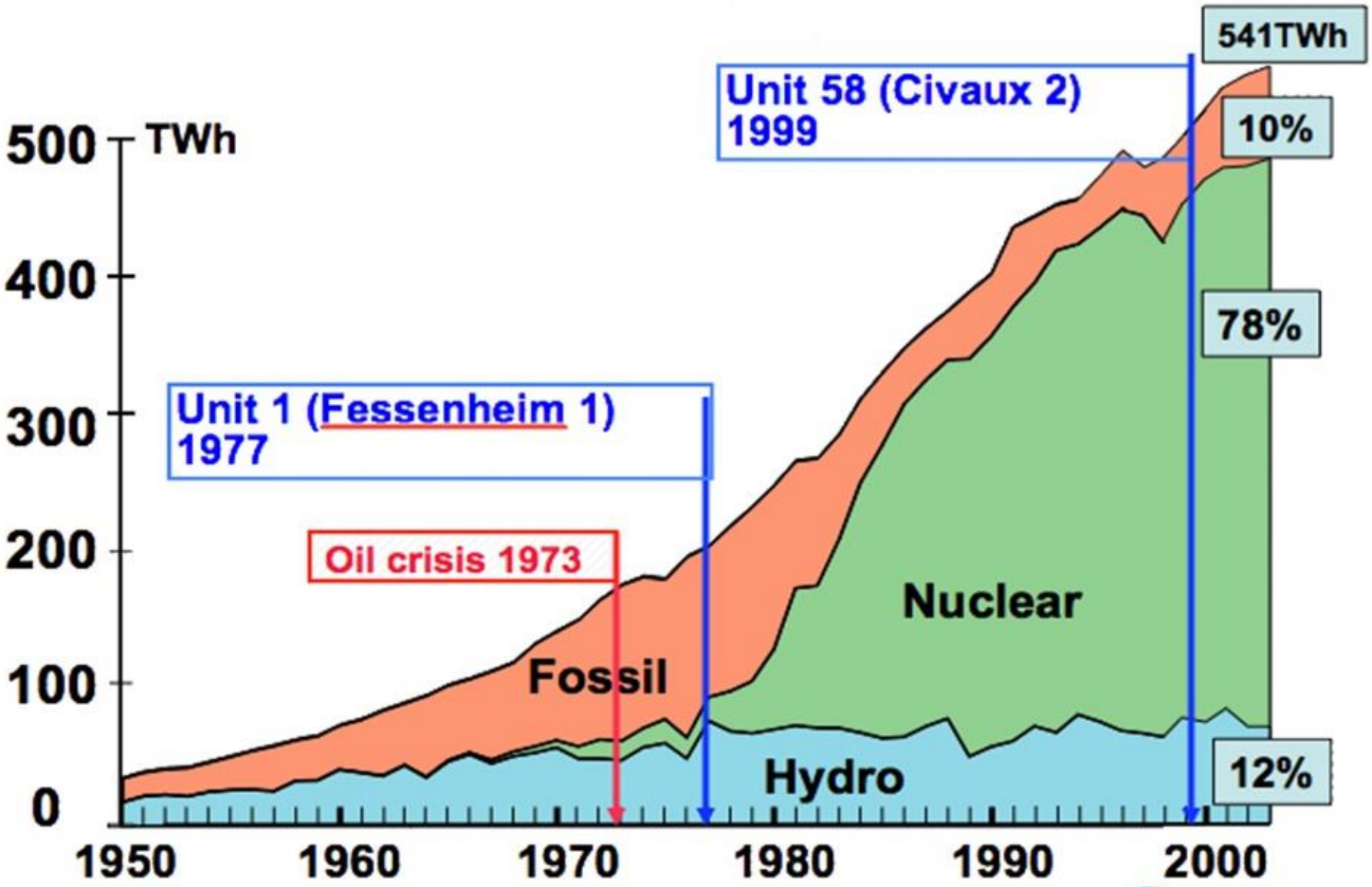
Life Cycle GHG's from Nuclear Energy



CO2 Intensity of Electricity Production OECD 2011 to 2013



French nuclear programme.
58 nuclear power plants in 22 years

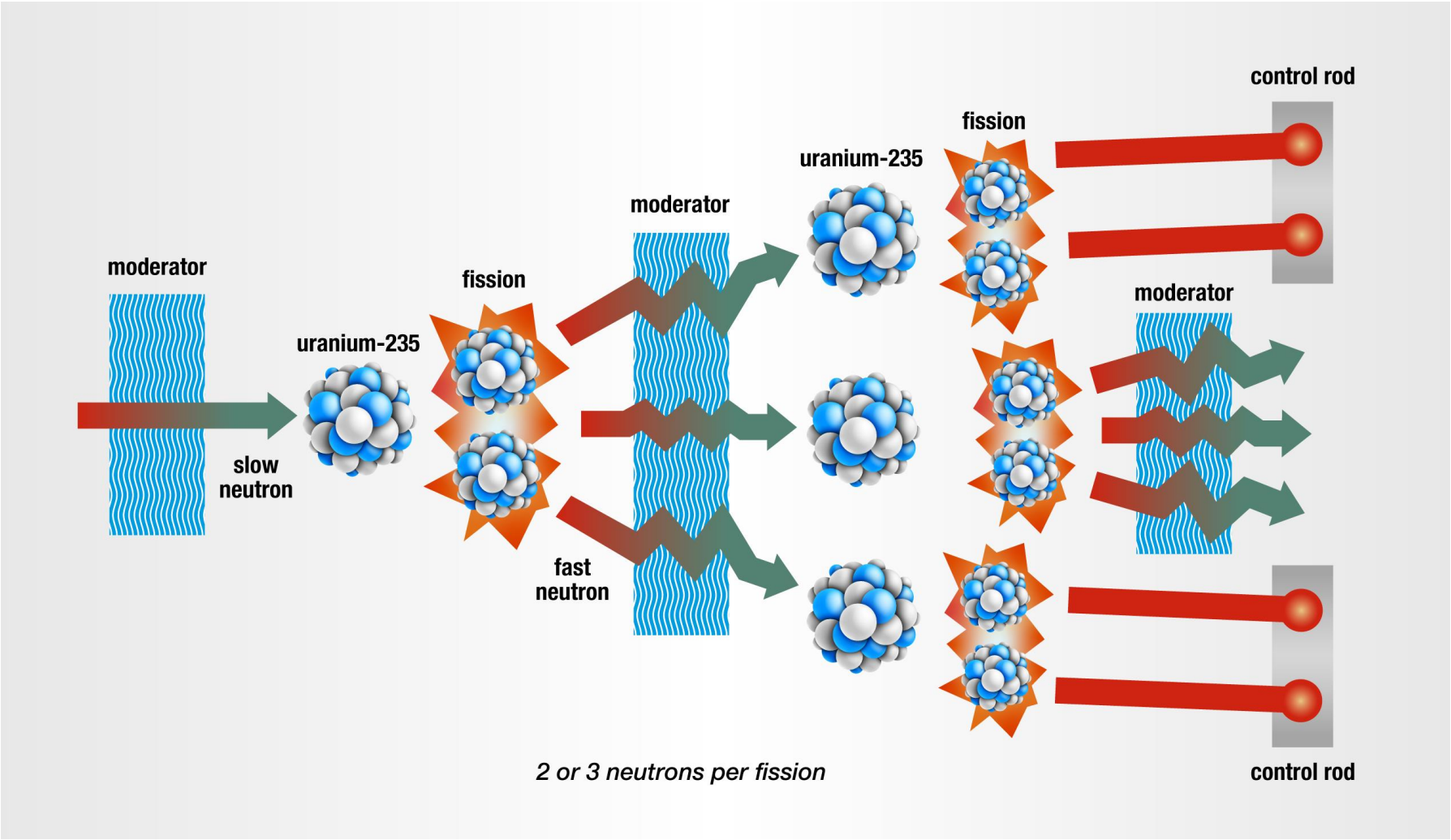


Very high Power intensity for Nuclear Reactors

A 1000 MW(e) plant requires the following number of tonnes (t) of fuel annually:

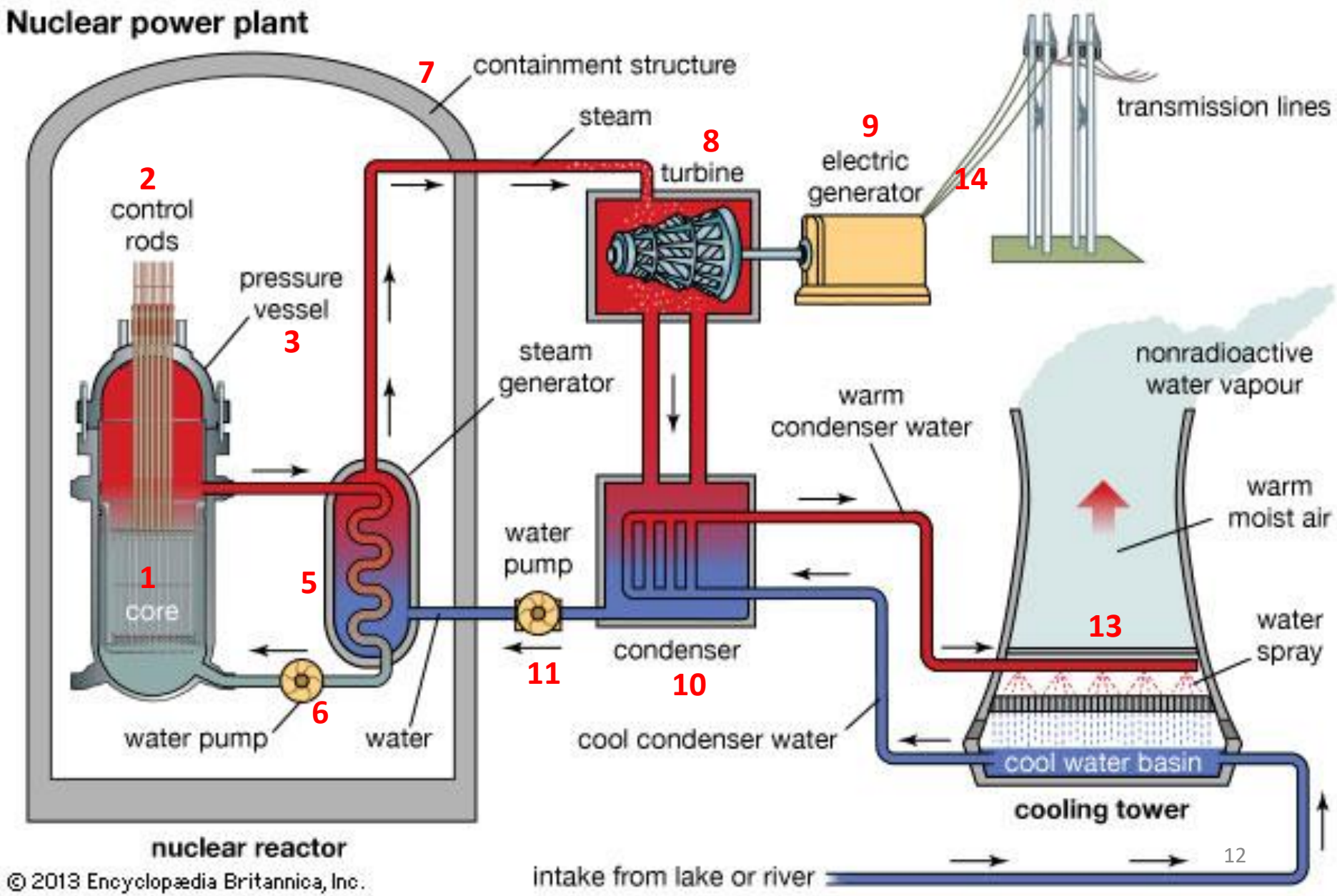
- **2,600,000 t coal: 813 trains (3200 t each)**
- **2,000,000 t oil: 10 super tankers**
- **30 t uranium: reactor core (10 cubic metres)**

236.053 amu in → 235.867 amu out
0.186 x C^2= 172.57 MeV + 26 MeV delayed



e.g. 1n+ ^{235}U→ ^{137}Cs+ ^{96}Rb+ 3neutrons

Fission Power Reactor - PWR



Shin Kori Units 1 and 2

near Busan in South Korea

2 x 997MW OPR1000 Nuclear Power Plants

Section 3

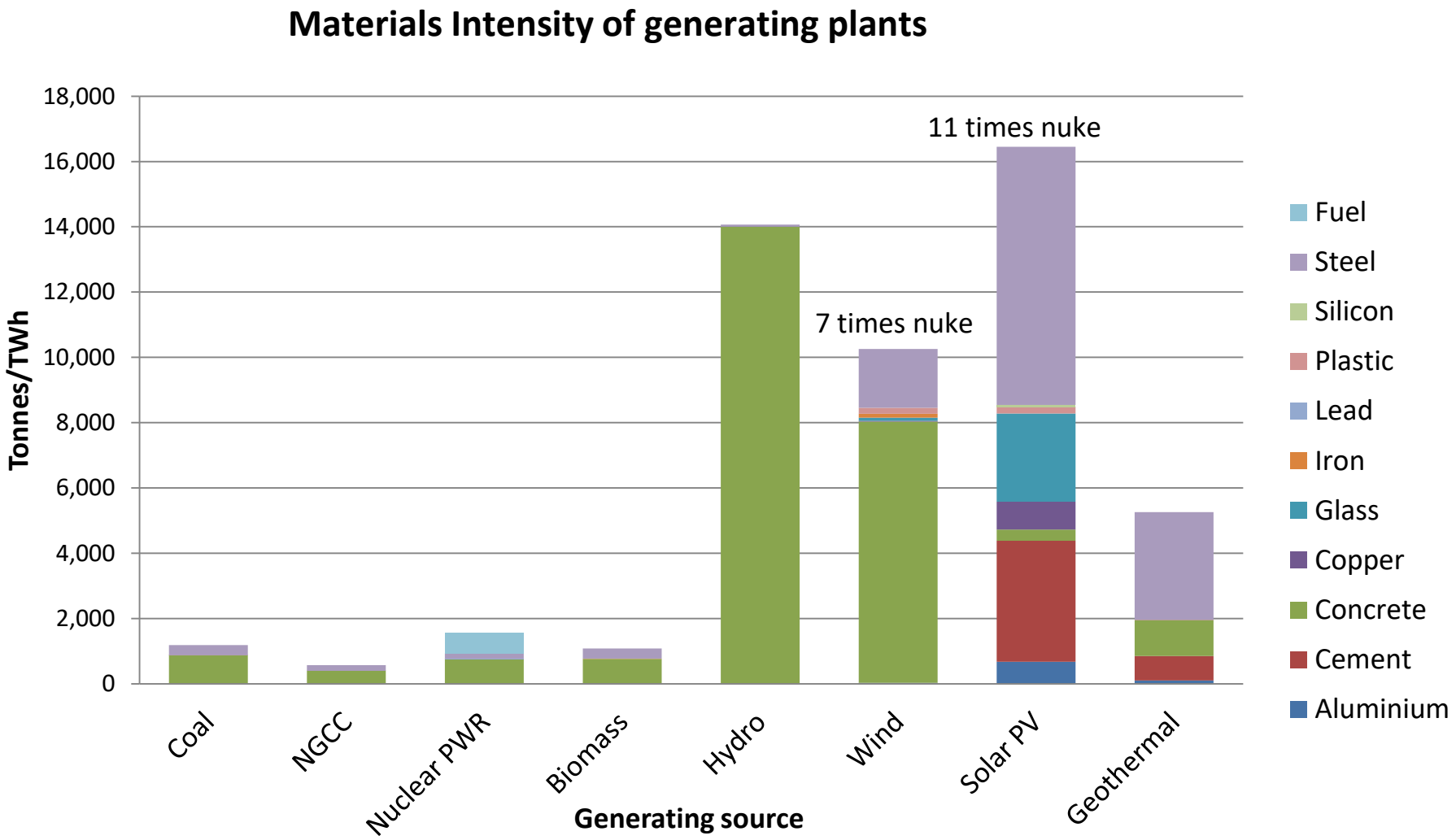
The Trouble with Dispatchable and Intermittent Renewables

Son La Dam, Vietnam.
2.4 GW and 10,246 GWh/yr

Total Reservoir capacity	**3.1 km^3**
Surface area	**440 km^2**

Loss of visual and environmental amenity

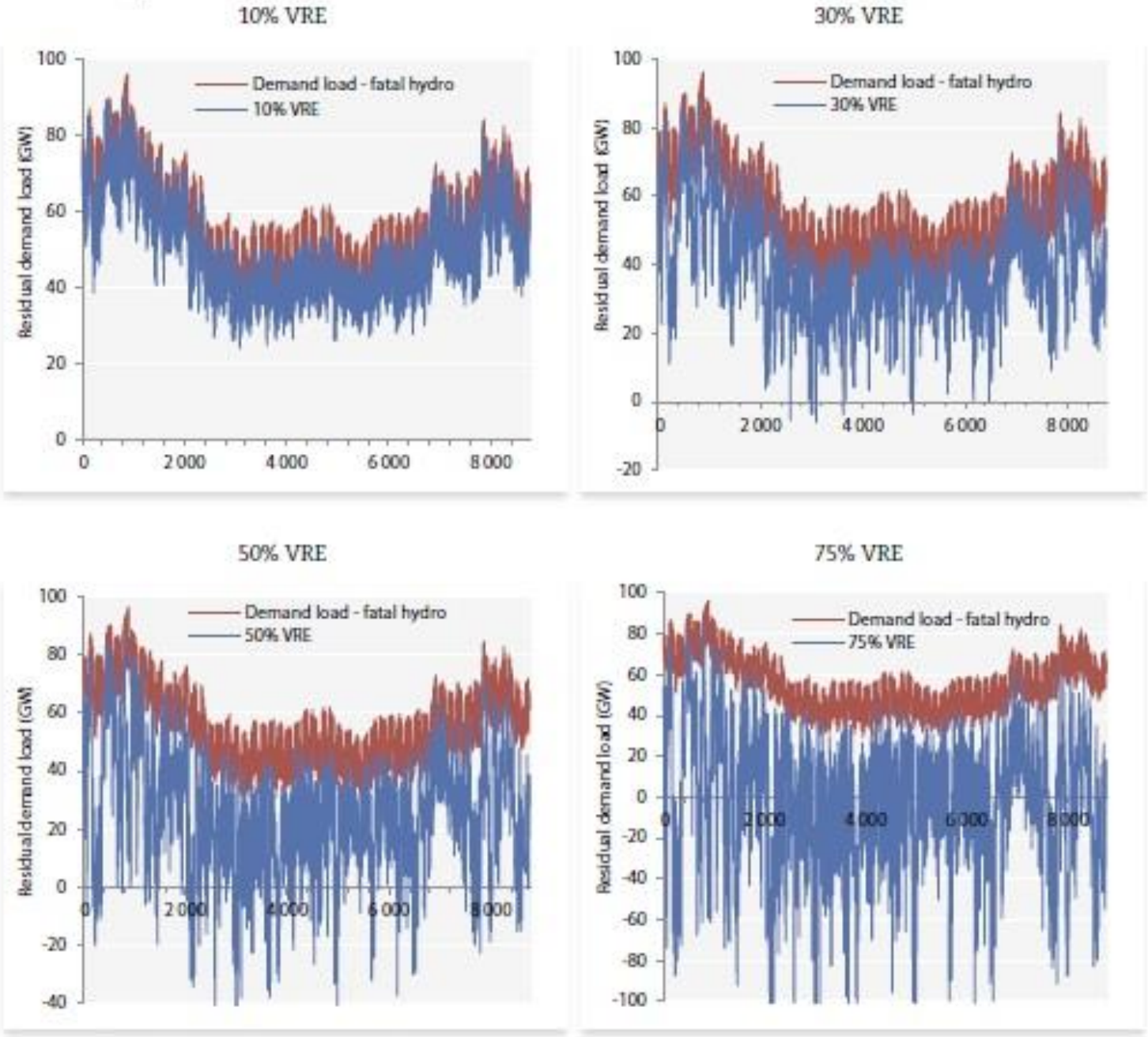
What does renewable really mean?



Data from IAEA 2010
Electricity generation and health
Anil Markandya, Paul Wilkinson, Lancet 2007; 370: 979–90

Impact of Variable Energy on System Reliability

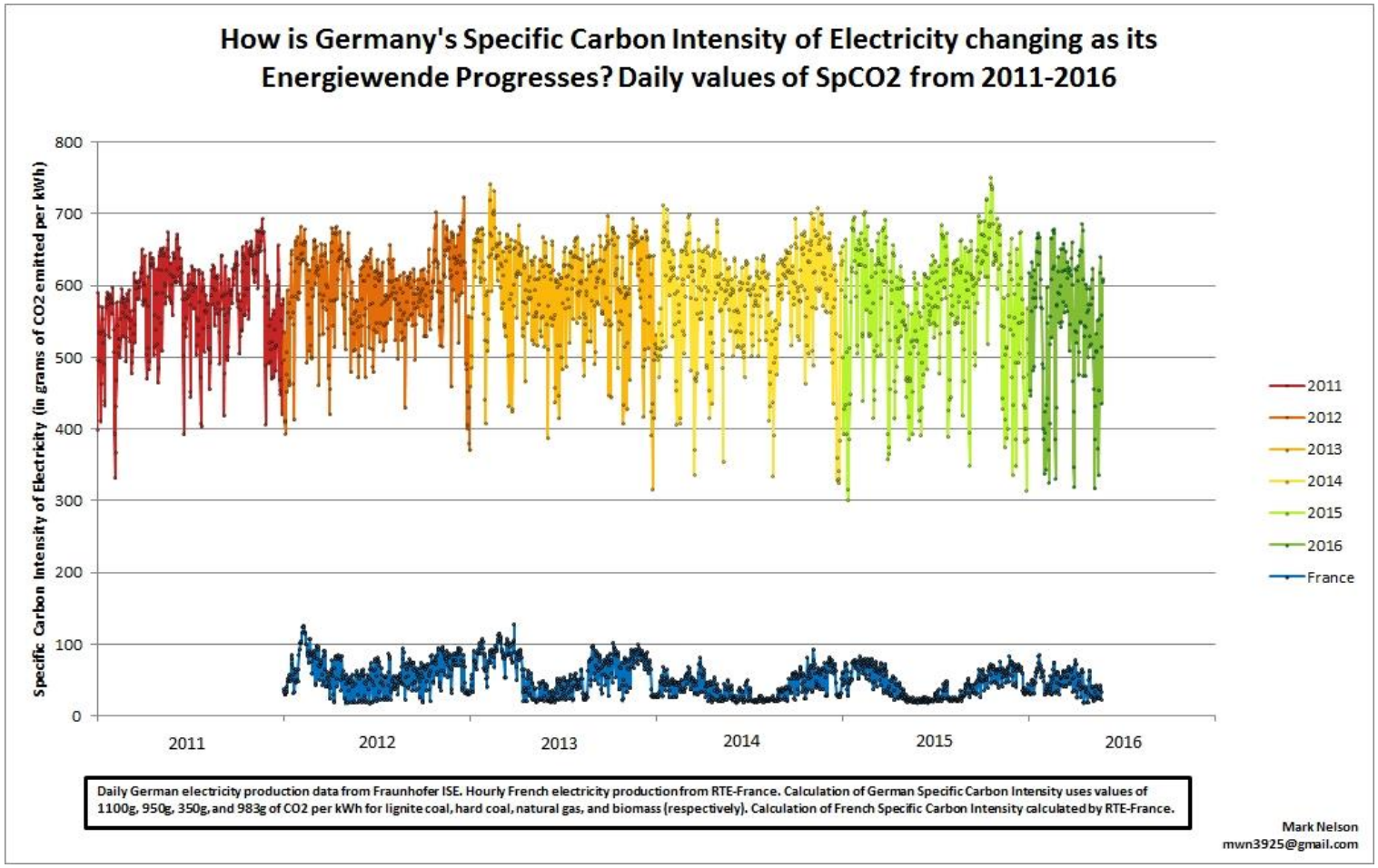
Figure 23. **Comparison of the residual load at different VRE generation shares**



Note that the figures have a different vertical scale.

The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables OECD

German vs French Emissions

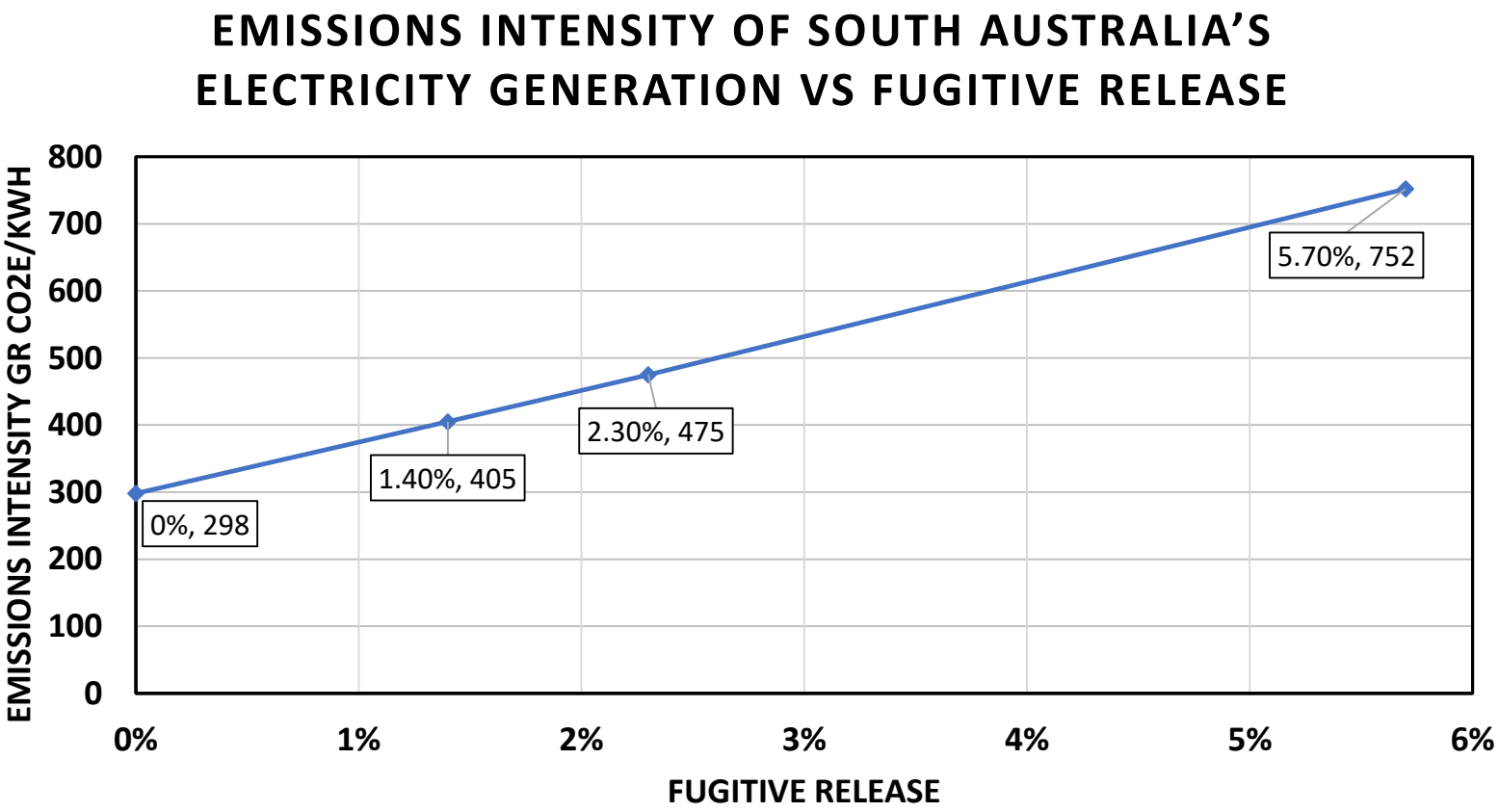


Angela Merkel, 22 January 2019 : " When we participate in conferences on the climate, Emmanuel Macron has a small advantage over me because he has so many nuclear power plants that he emits very little CO2 "

Profound Impact of Fugitive Gas Emissions

Example for South Australia with 48.5% of electricity coming from wind and solar in 2016

42.8% comes from gas and 8.2% comes from Victorian imports



A magnitude-5.4 earthquake that struck the city of Pohang on 15 November 2017 was probably caused by an experimental geothermal power plant.

The quake was the nation's second strongest and its most destructive on modern record — it injured 135 people and caused an estimated 300 billion won (US$290 million) in damage.

Section 4

Nuclear Downsides and Upsides

Radiation Exposure

Radiation Worker 10 µSv hr^{-1} x 40 hr/wk x 50 wk/yr ⇒ 20 mSv yr^{-1}
Public 0.08 µSv hr^{-1} x 24 hr/day x 365 day/yr ⇒ 1 mSv yr^{-1}
Background 2.6 mSv yr^{-1} ⇒ Public limit is only just above background.

Sleeping next to someone

Eating one banana

Living within 80 km of a nuclear power plant for a year

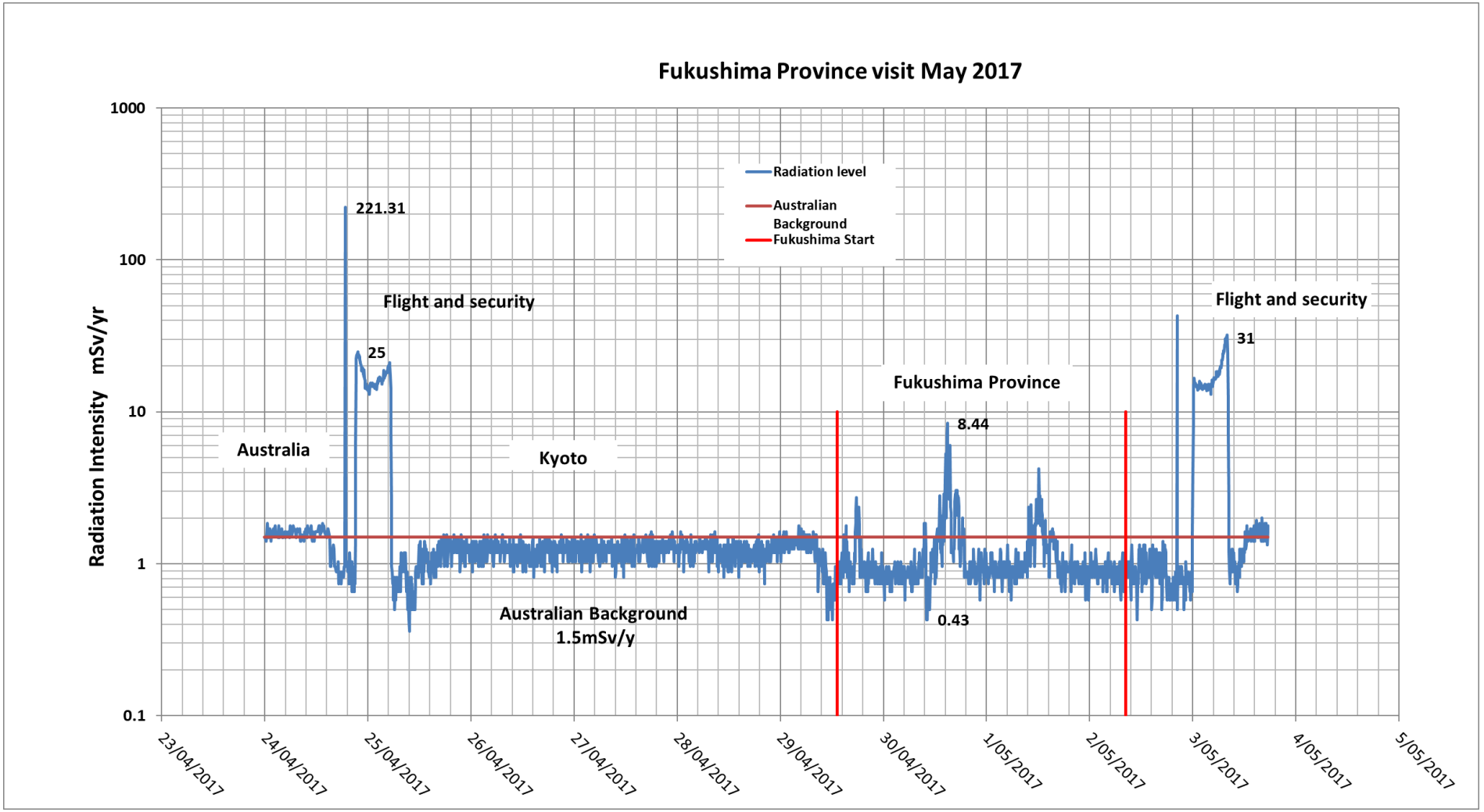
Living within 80 km of a coal power plant for a year

Background dose received by an average person over one normal day (10 µSv)

= 0.05 micro Sv (Sievert) µSv

Fukushima Province Radiation

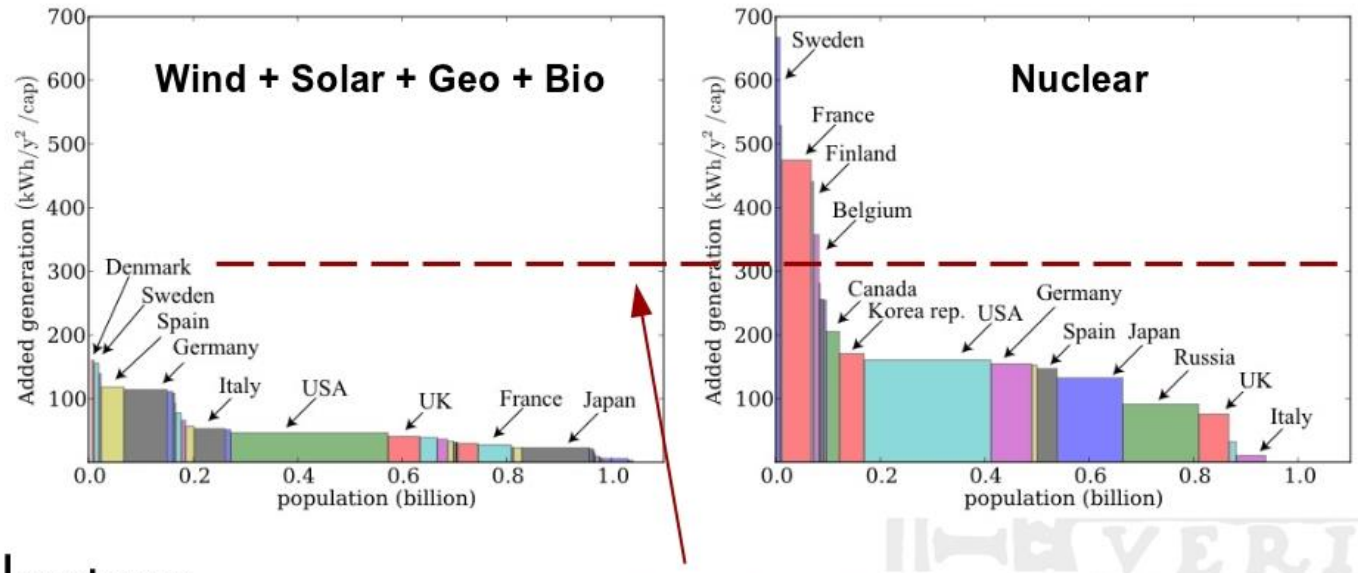
Measurements I took in 2017



Nuclear Power has proven to be Humanity's Fastest Tool for Decarbonisation

How fast is fast enough?

Fastest added generation of electricity per person and year



analys.se

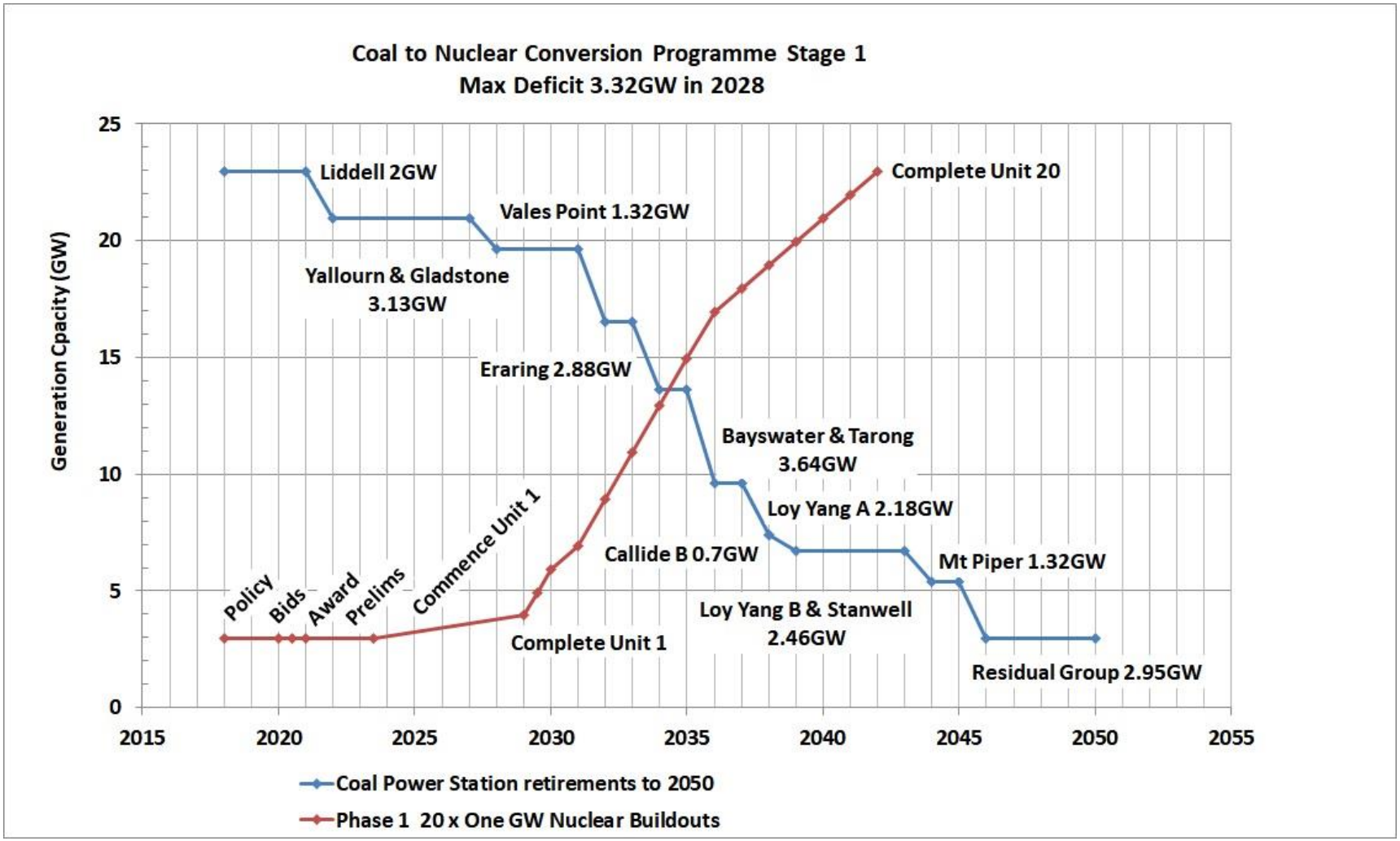
Required rate for 2 degree target

Source: World Bank & BP Statistical Review, picture by Carl Hellesen

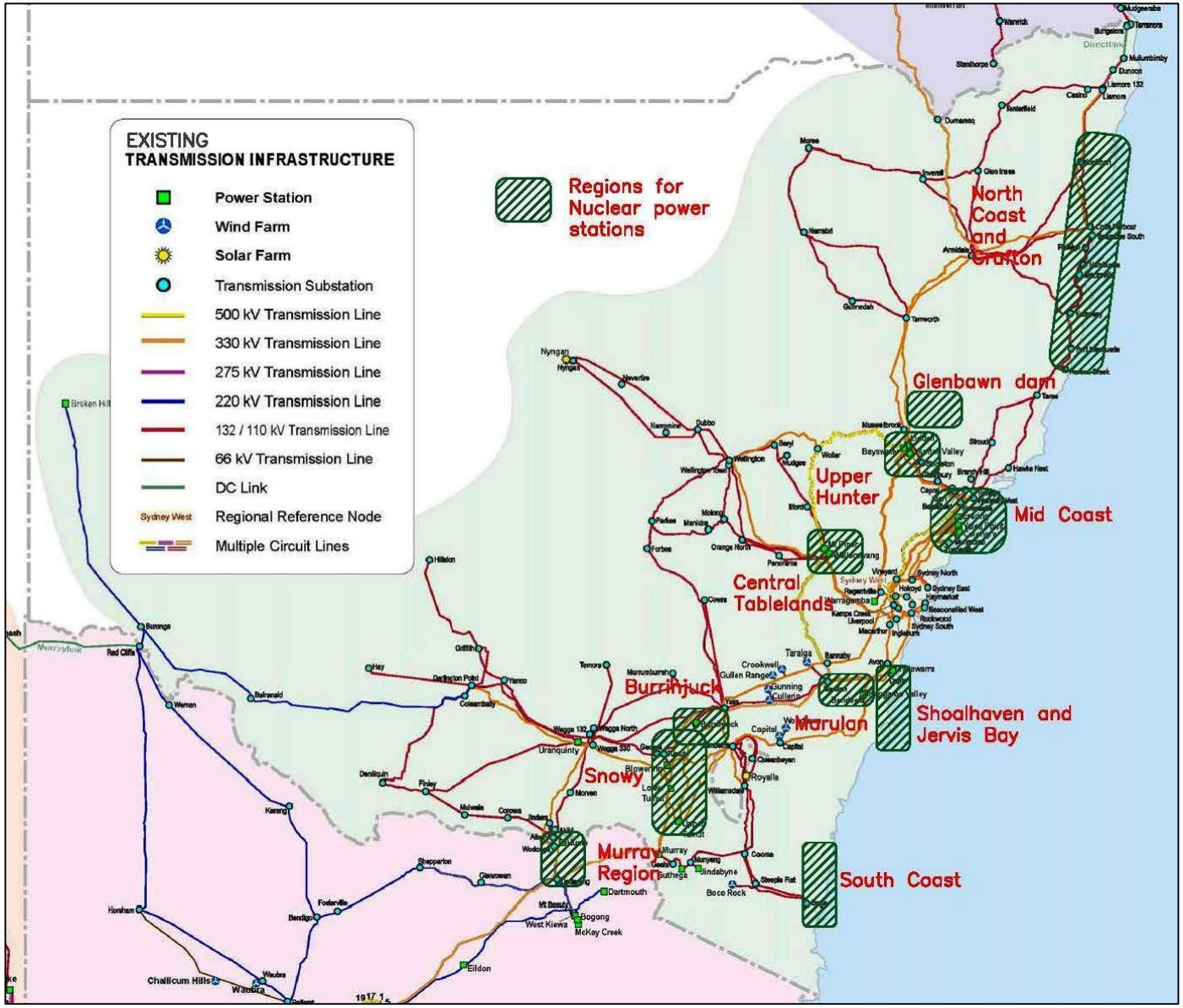
Section 5

Australian Plan for Extremely Low Carbon Generation

Nuclear Replaces Coal with 20 Nuclear Power Plants



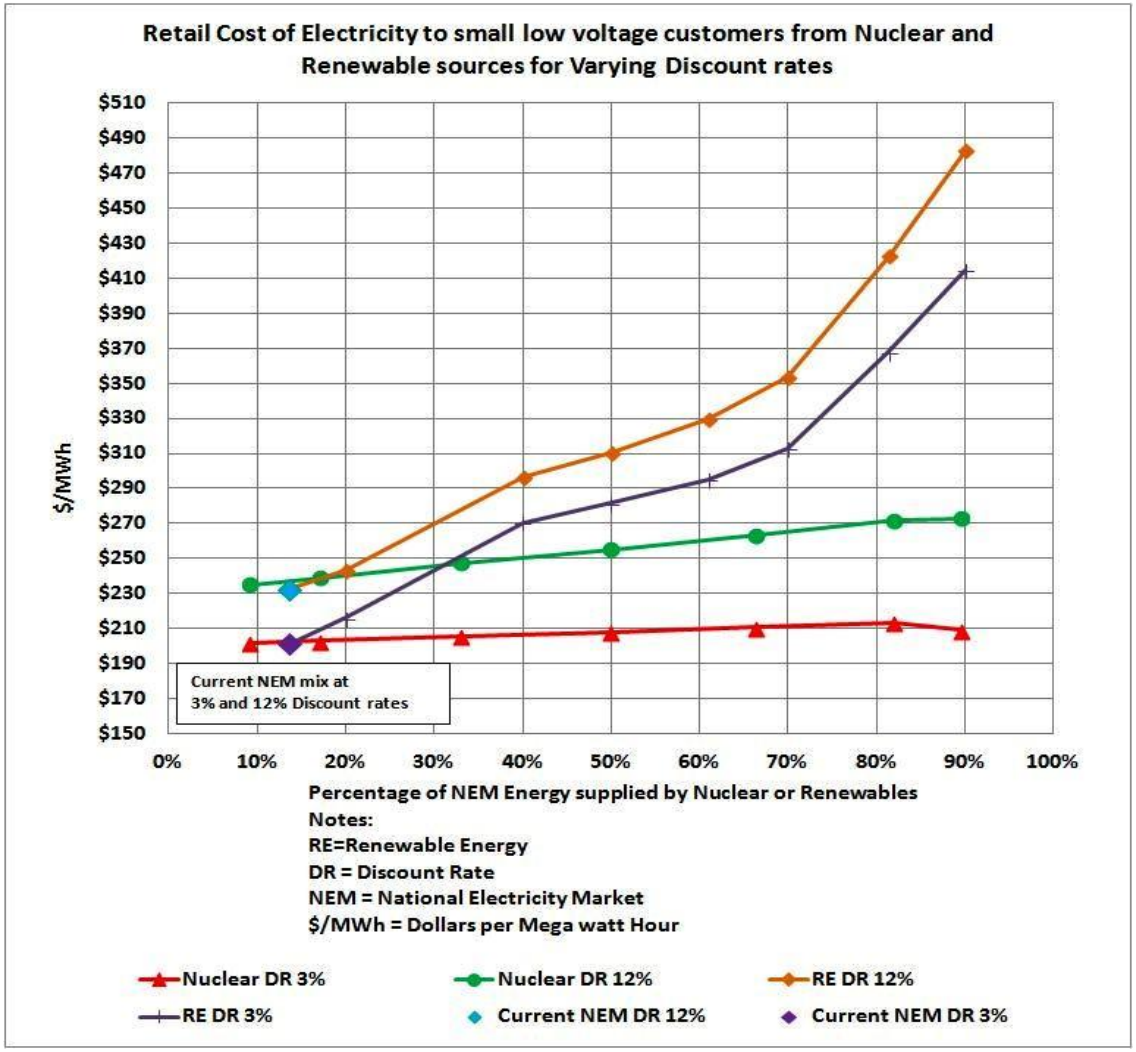
Regions within NSW



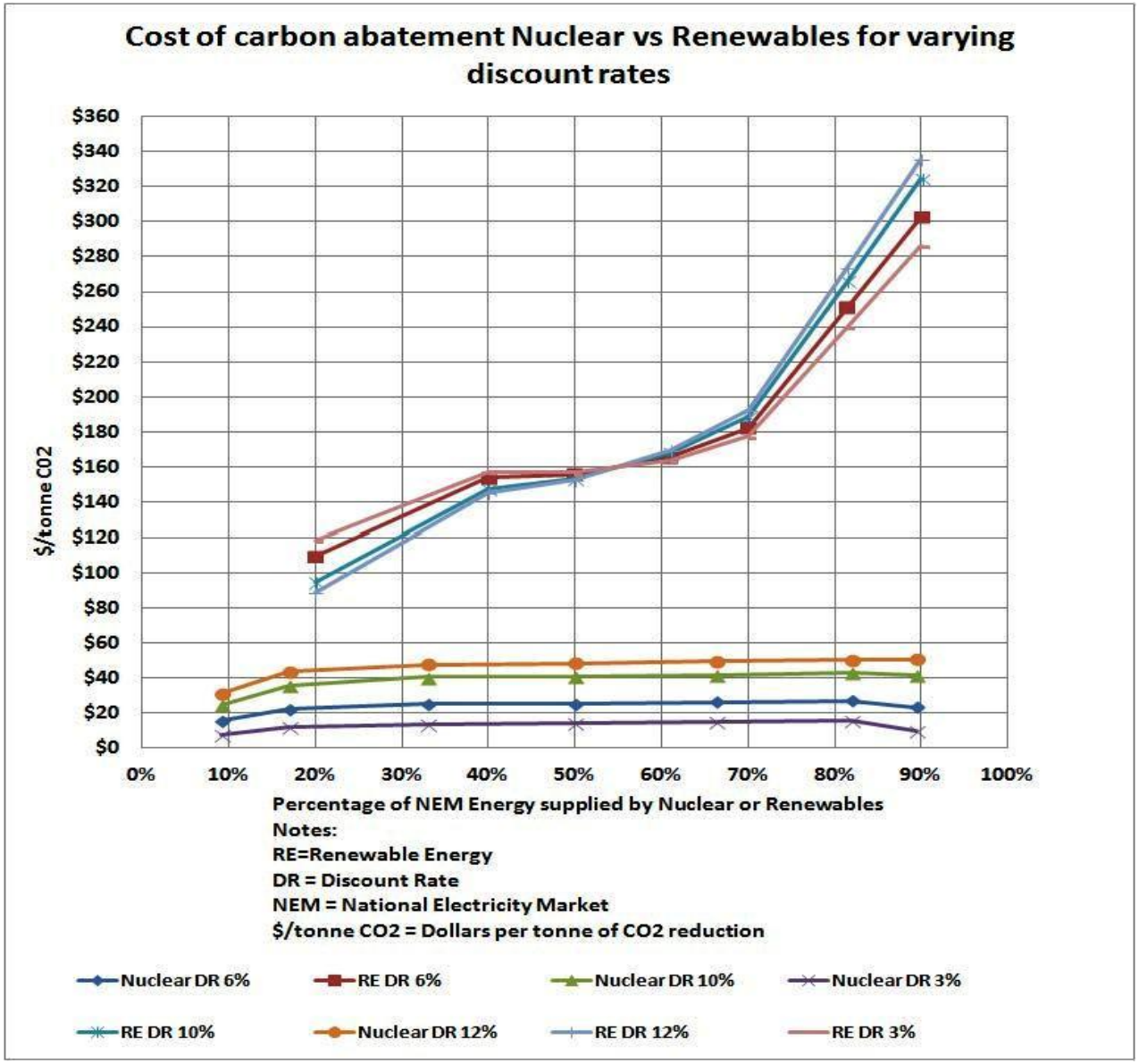
Generating Mix for 50 gr CO2/kWh & 81% nuclear energy

Generator	Capacity	% delivery	Delivery	Capacity Factor	Emissions
Type	MW		MWh		T/MWh or gr/kWhx1000
Pumped Storage	5,000				
Solar PV	4,000	0.050	9,502,598	0.27	0.00
Hydro	4,200	0.082	15,584,260	0.42	0.00
Nuclear	20,000	0.812	154,322,186	0.88	0.02
Open Cycle Gas	6,548	0.050	9,502,598	0.17	0.03
		Total	190,051,953		0.05

60% Lower Retail Electricity Prices with Nuclear Energy



Much Lower Carbon Abatement Costs with Nuclear Energy



Nuclear for CLIMATE AUSTRALIA

https://nuclearforclimate.com.au/

The Australian Nuclear Association
http://www.nuclearaustralia.org.au/