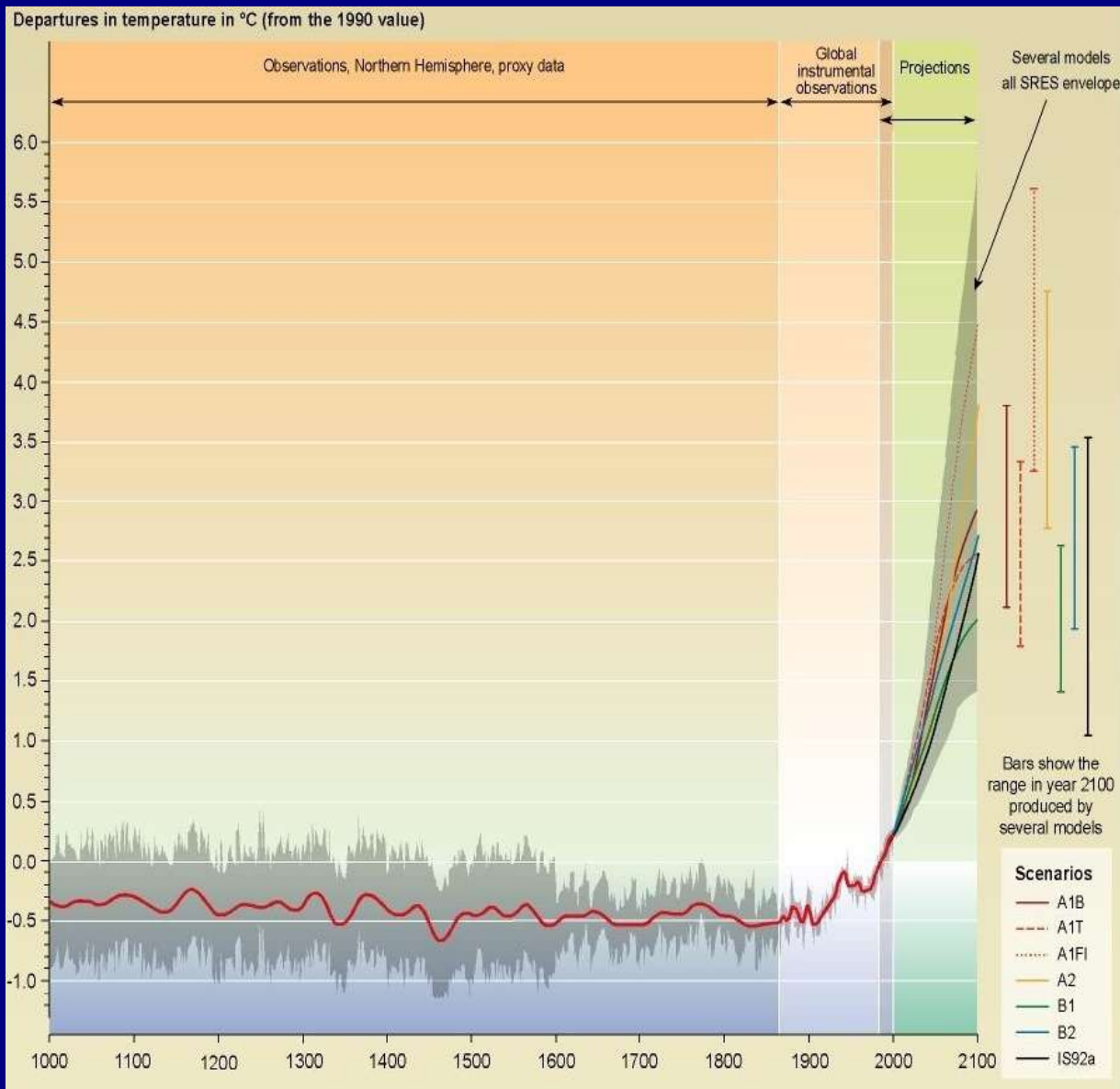


NUCLEAR POWER: OUR GREENHOUSE SOLUTION?

THE PROBLEM: CLIMATE CHANGE

PREDICTED SURFACE TEMPERATURE RISE BY 2100



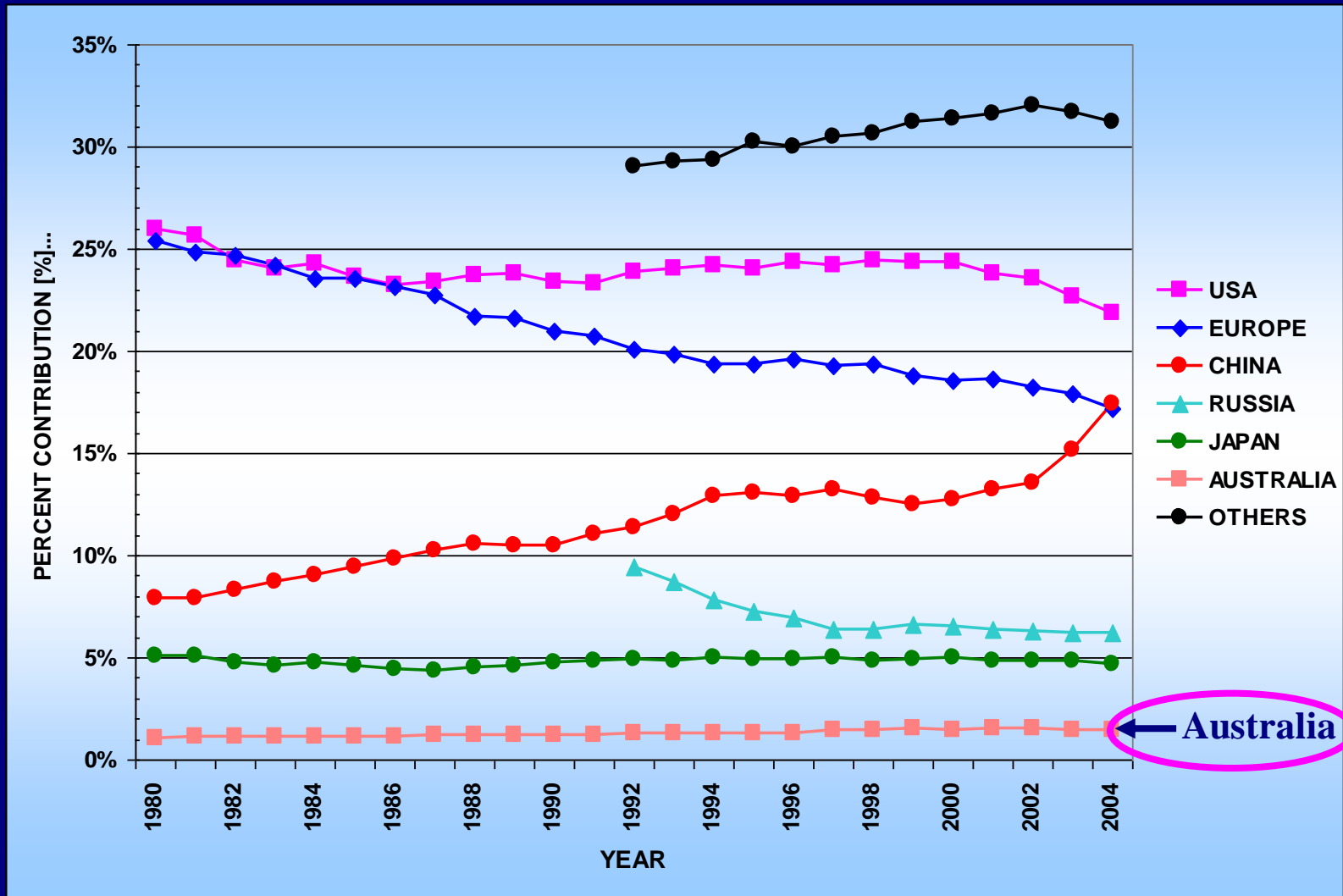
**THE SCARY SCENARIO :
1.5 – 5.5 °C
RISE BY
2100**

IPCC – International Panel for Climate Change

A MAJOR CAUSE: OUR GREENHOUSE GAS EMISSIONS

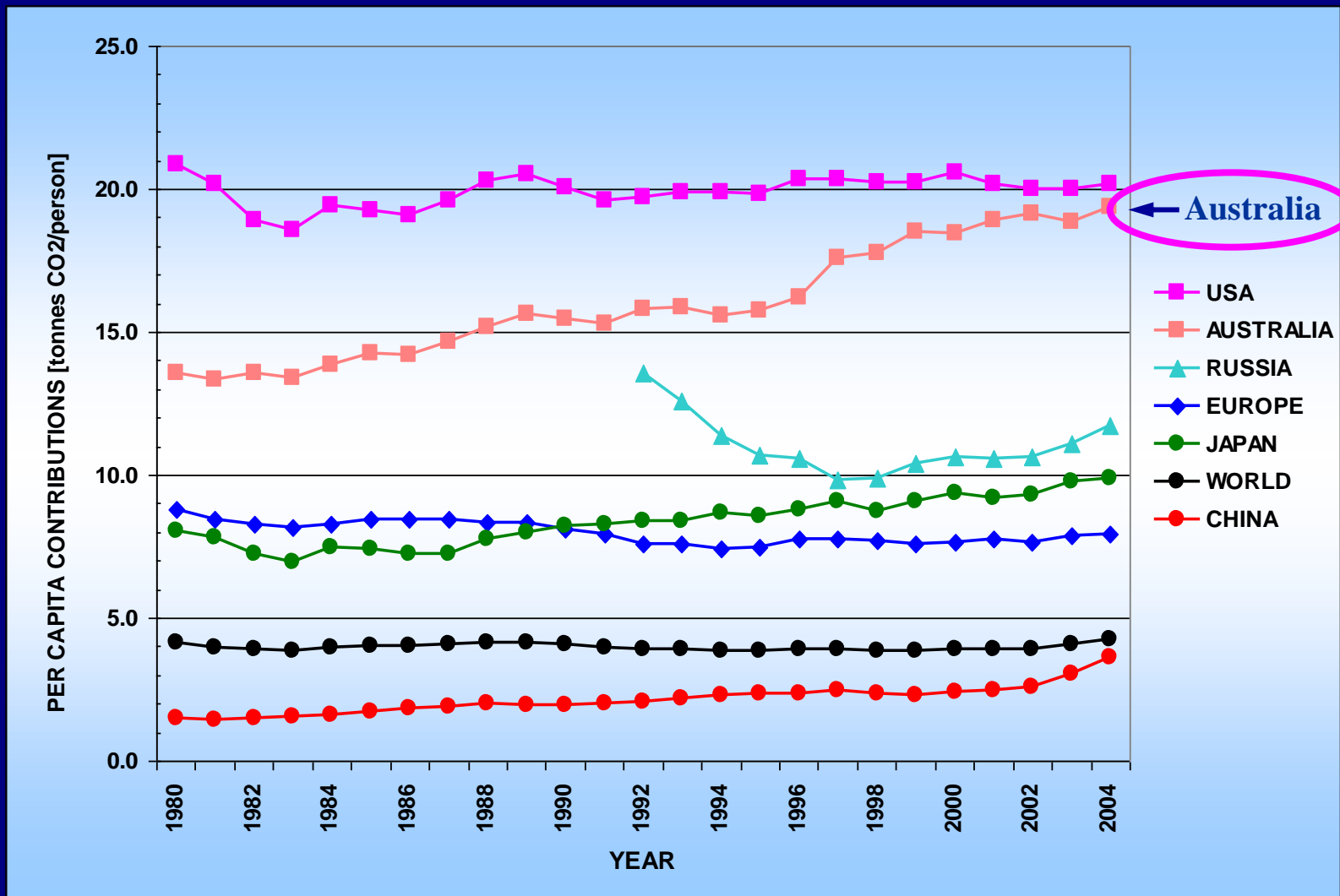
MAJOR GREENHOUSE GAS EMITTERS 1980 – 2004

[DEVELOPED COUNTRIES]



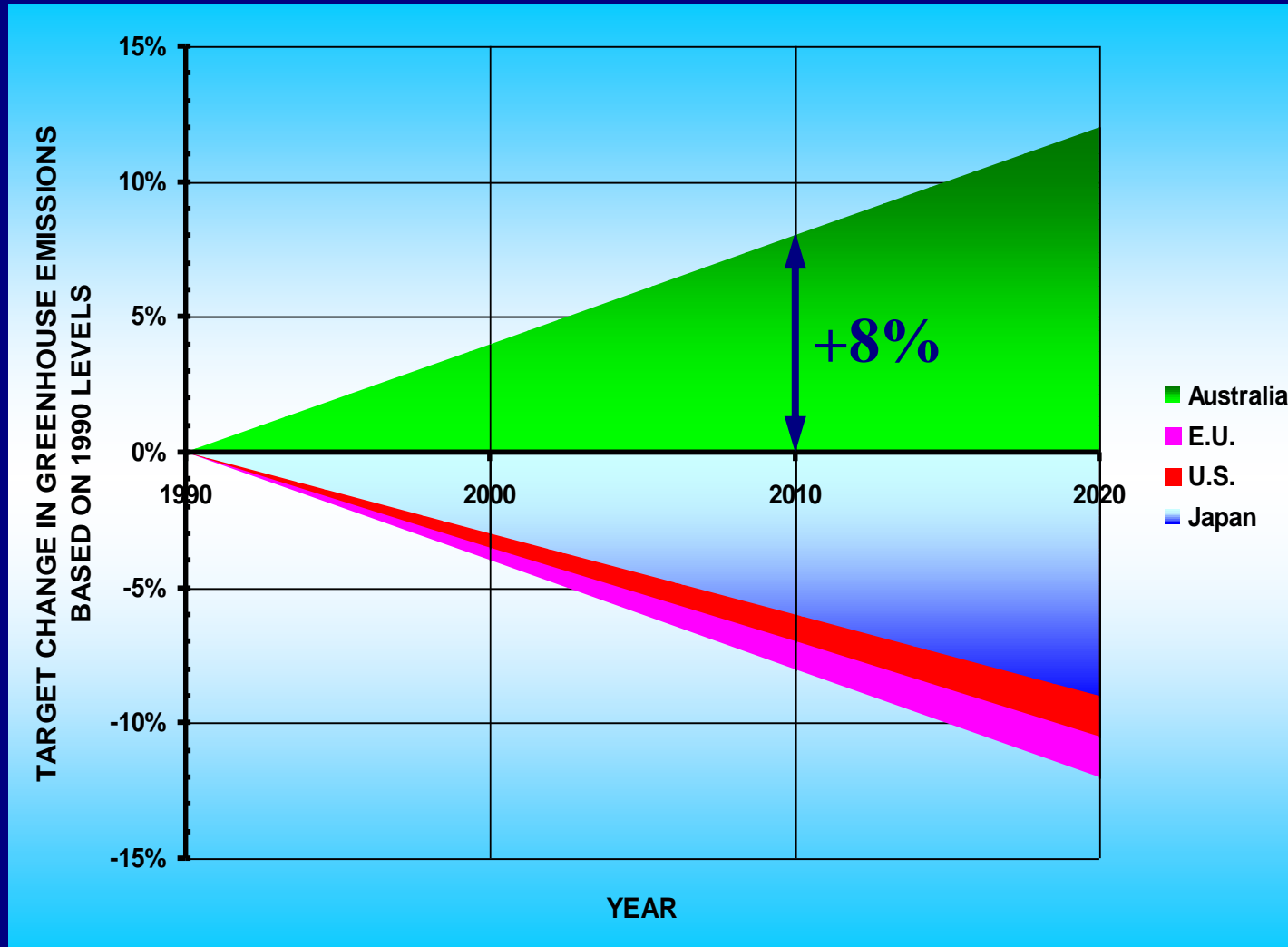
Source : IPCC

PER CAPITA GREENHOUSE GAS EMITTERS 1980 – 2004 [DEVELOPED COUNTRIES]



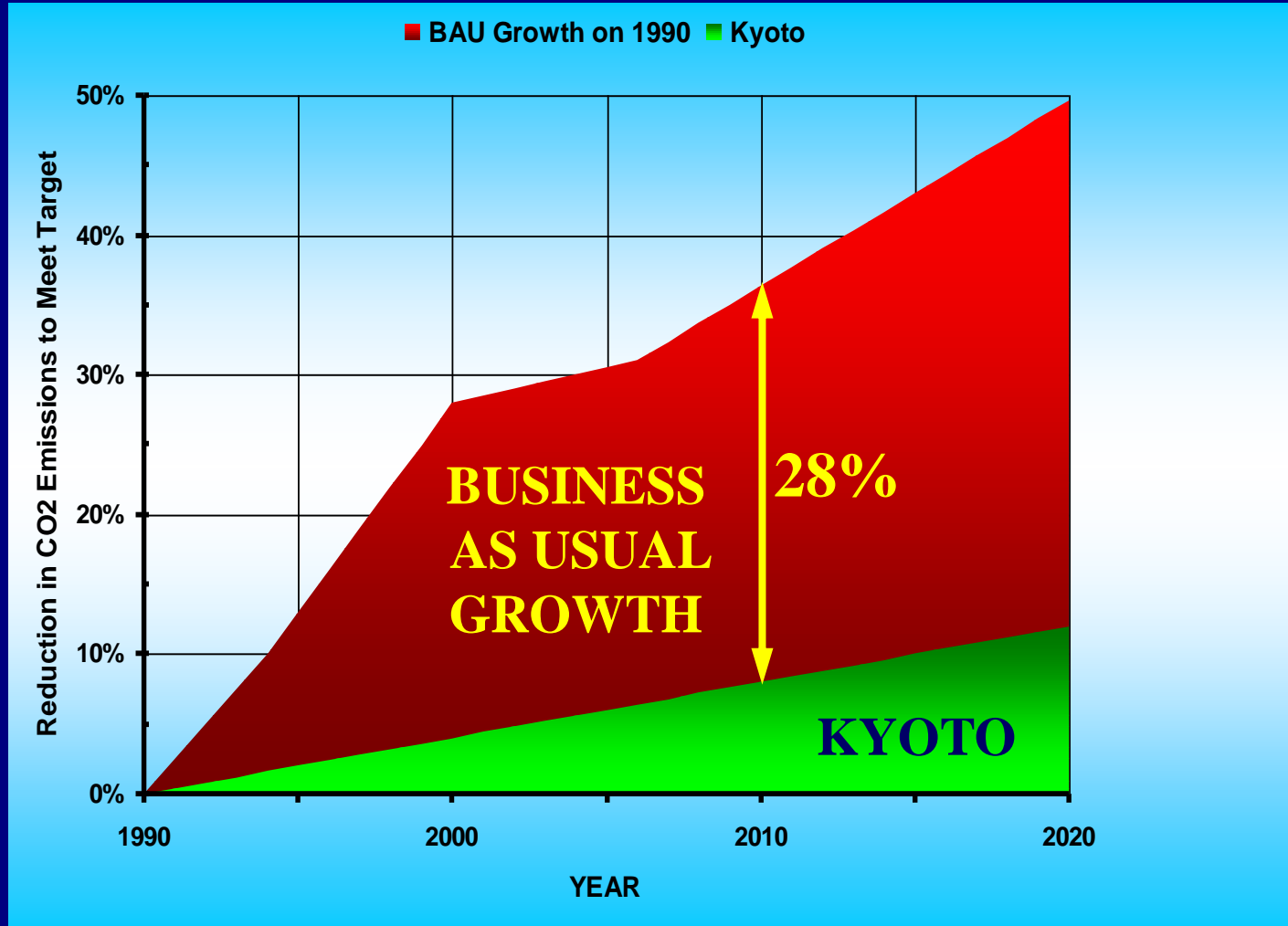
Source : IPCC

KYOTO ACCORD 1997 – GREENHOUSE EMISSION TARGETS FOR 2010–2012



NOTE: AUSTRALIA IS NOT A SIGNATORY OF THE KYOTO ACCORD.

WE HAVE A PROJECTED 28% GREENHOUSE EMISSION REDUCTION TO ACHIEVE BY 2010 –2012

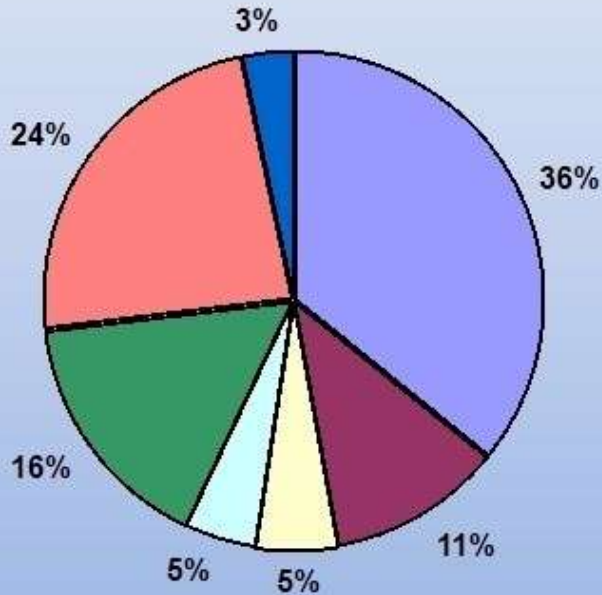


NOTE: AUSTRALIA IS NOT A SIGNATORY OF THE KYOTO ACCORD.

SECTOR GREENHOUSE EMISSIONS 1990 & 2005

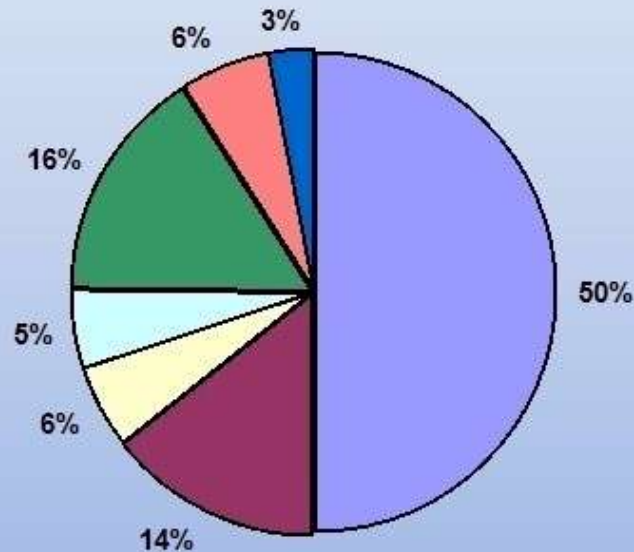
1990 SECTOR EMISSIONS (%)

[TOTAL = 547 Mega Tonnes CO₂ : 0%]



2005 SECTOR EMISSIONS (%)

[TOTAL = 559 Mega Tonnes CO₂ +2.2%



- Stationary Energy
- Transport
- Fugitive Emissions
- Industrial Processes
- Agriculture
- Land Use and Forestry
- Waste

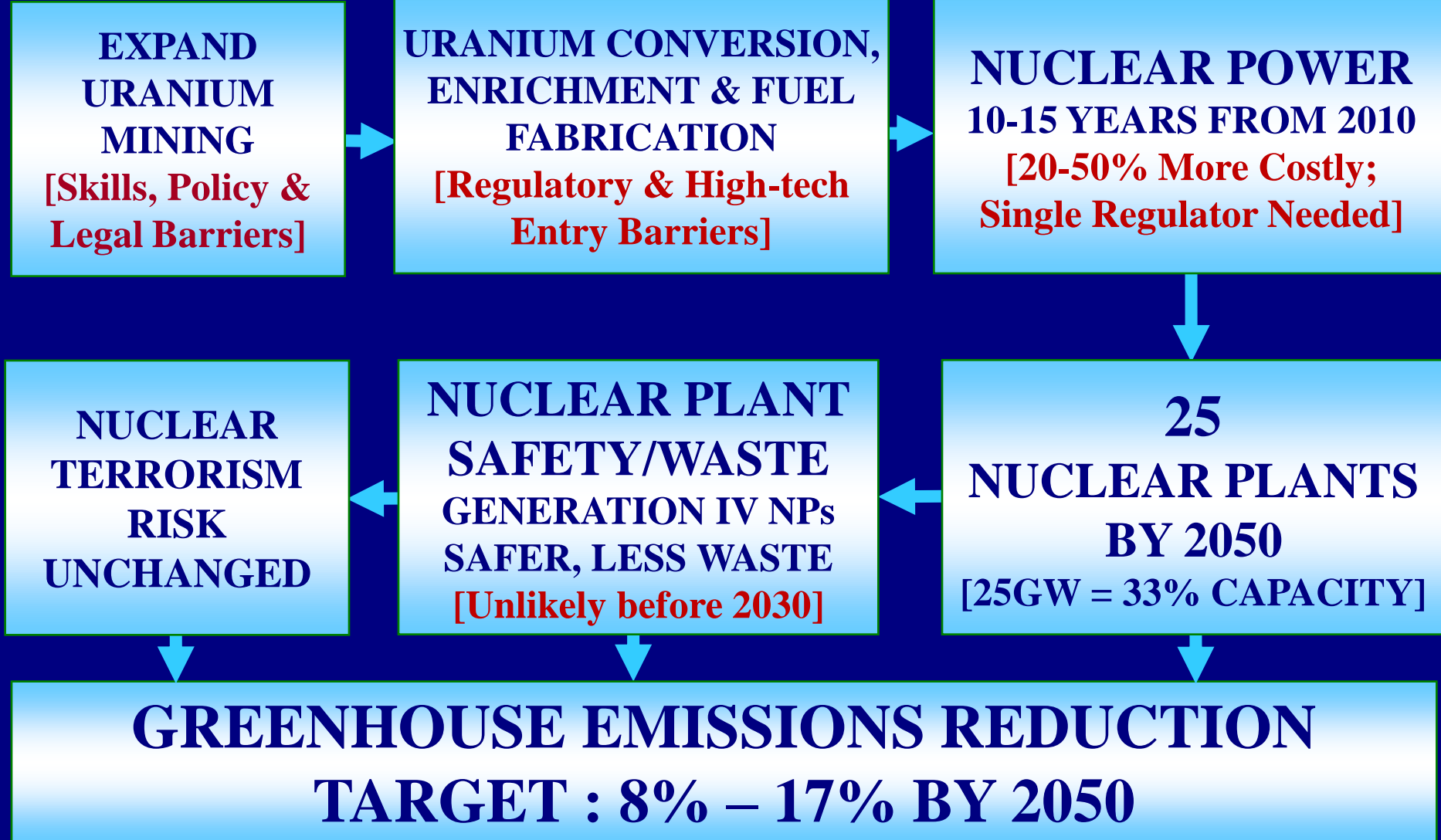
- ENERGY SECTOR EMISSIONS HAVE **INCREASED** BY **14%** FROM 1990 TO 2005
- REDUCED LAND USE/FORESTRY CLEARING HAS **DECREASED** EMISSIONS BY **18%** FROM 1990 TO 2005

**THE NUCLEAR POWER
OPTION
REVISITED
35 YEARS ON**

OZ NUCLEAR POWER – A SOBERING HISTORY LESSON



THE ZIGI SWITKOWSKI REPORT* – KEY FINDINGS



* Uranium Mining, Processing and Nuclear Energy Review – Department of Prime Minister and Cabinet

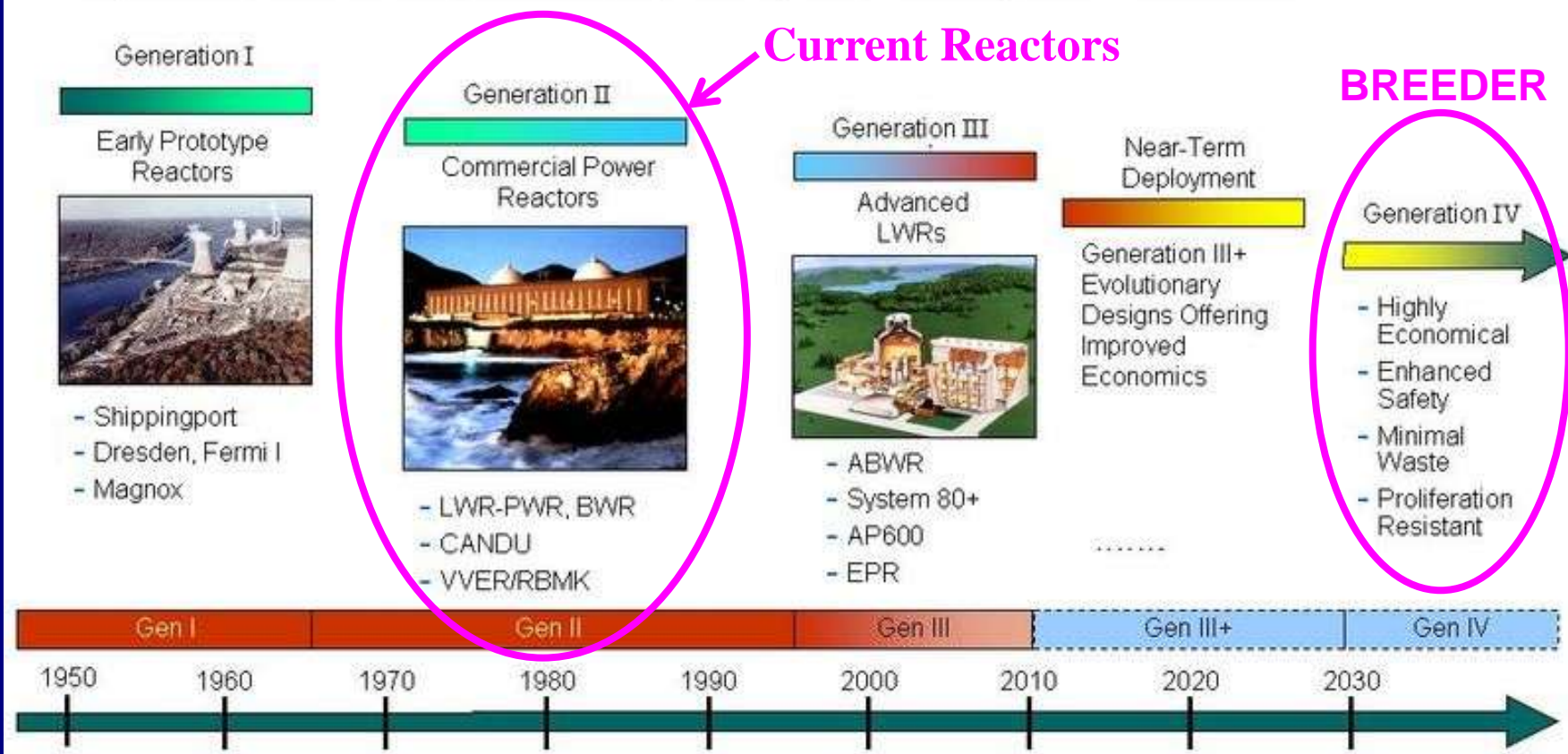
THE 'ZIGGY' NUCLEAR SCENARIO – 25 NUCLEAR POWER PLANTS LIKE THIS ONE ON OUR SHORELINE?



Diablo Canyon Nuclear Plant – California, USA

EVOLUTION OF NUCLEAR POWER – GENERATION IV REACTORS

Generation IV: Nuclear Energy Systems Deployable no later than 2030 and offering significant advances in sustainability, safety and reliability, and economics



Source: Wikipedia – Generation IV Reactors : http://en.wikipedia.org/wiki/Gen-IV_reactor

NUCLEAR POWER – KEY PUBLIC CONCERNS

- ❑ NUCLEAR POWER PLANT SAFETY**
- ❑ NUCLEAR POWER COSTS**
- ❑ NUCLEAR SKILLS & EXPERTISE NEEDED**
- ❑ RADIOACTIVE WASTE DISPOSAL – SYNROC**

OTHER

- ❑ NUCLEAR REGULATORY INFRASTRUCTURE NEEDED**
- ❑ CONSTRUCTION – ENGINEERING & TECHNOLOGY SKILLS & EXPERTISE.**
- ❑ OPERATION – SAFETY & PUBLIC HEALTH MONITORING**
- ❑ NUCLEAR PLANT DECOMMISSIONING & DISPOSAL**
- ❑ NUCLEAR PROLIFERATION & TERRORISM**

NUCLEAR POWER SAFETY

**THERE IS NO SUCH THING AS A
'RISK-FREE' WORLD**

EVERY human activity involves **RISKS**,
and the

RISKS are acceptable **only if** the **BENEFITS**
outweigh the **RISKS**.

SAFETY – NUCLEAR POWER INTERNATIONALLY

Currently 441 Nuclear Reactors operating worldwide
[PWRs 61%]

Nuclear Power generates 381GWe, equivalent to about
17% of the world's electricity

Nuclear Power has a high safety record compared
with other energy industries

- ❑ Accidents [1969 –2000] – Nuclear 1 (Chernobyl)
[Coal 1,221 (China 1,044); Hydro 11; Natural Gas 125].
- ❑ Fatalities – 47 workers+ 9 children (Chernobyl)*
[Coal 25,107 (China 7,090), Hydro 29,938 & Natural Gas 1,978].
- ❑ Nuclear Incidents (since 2000) – 5, NO deaths or injury
[2 workers received a small radiation dose].

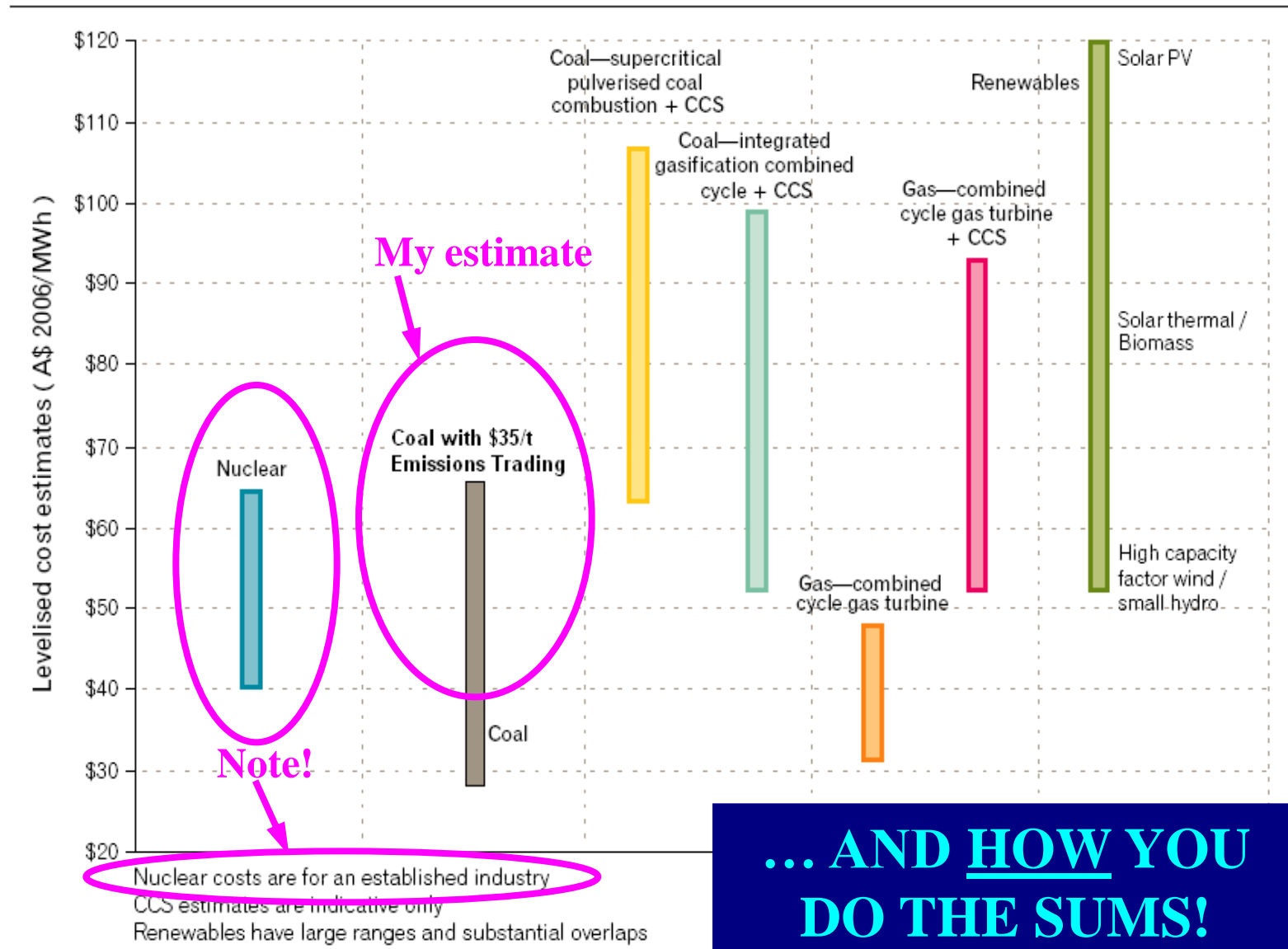
Sources: Uranium Mining, Processing & Nuclear Energy Review – Dept Prime Minister & Cabinet

* Wikipedia – Nuclear Fatalities

NUCLEAR POWER COSTS

THE NUCLEAR OPTION – IT'S ALL ABOUT COST ...

Figure 4.7 Levelised cost ranges for various technologies



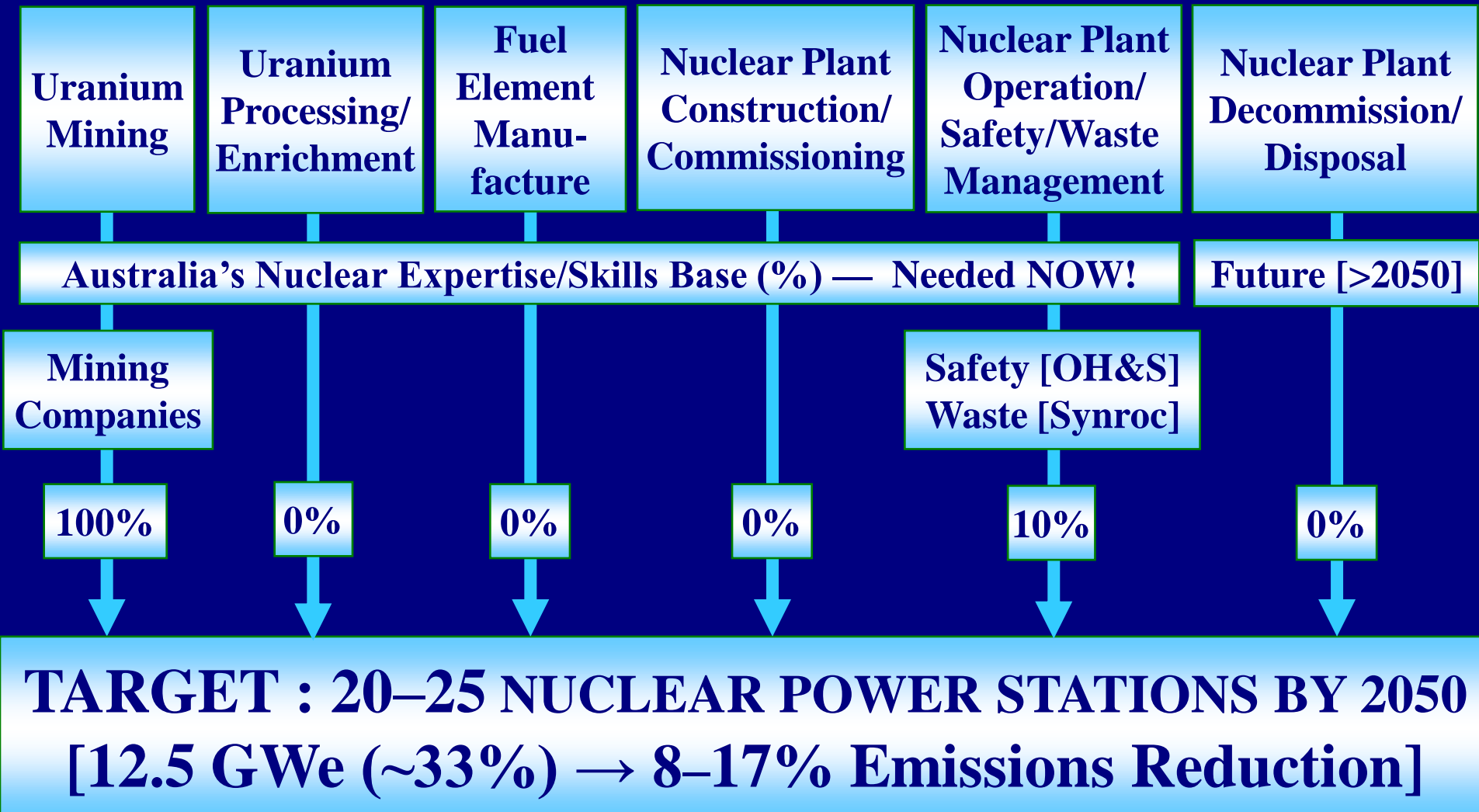
... AND HOW YOU DO THE SUMS!

Ziggy Switkowski Report – Nov 2006

NUCLEAR SKILLS/EXERTISE AUDIT

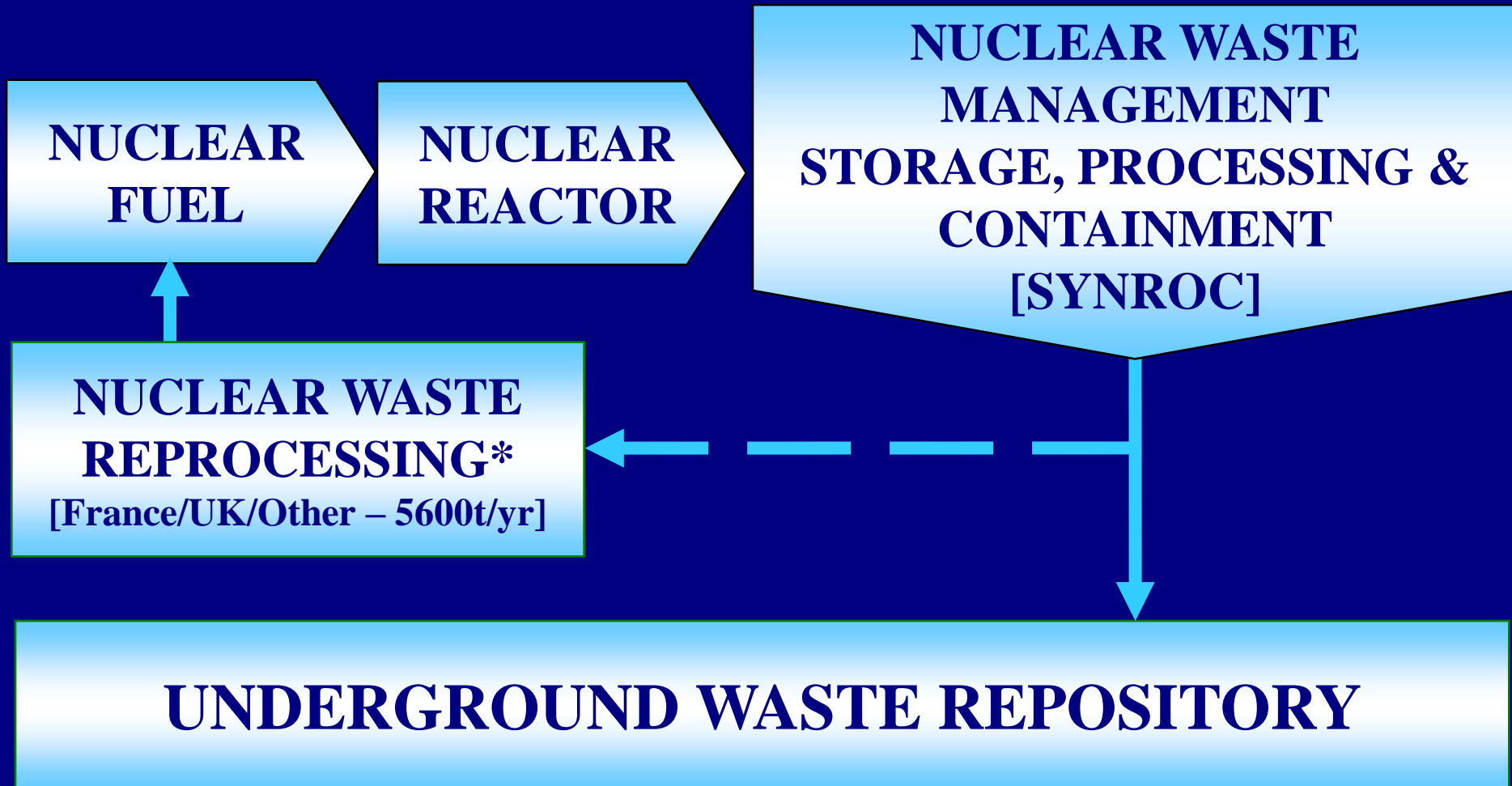
THE NUCLEAR FUEL CYCLE IS *VERY COMPLEX*

– OUR NUCLEAR EXPERTISE/SKILLS AUDIT



NUCLEAR WASTE MANAGEMENT

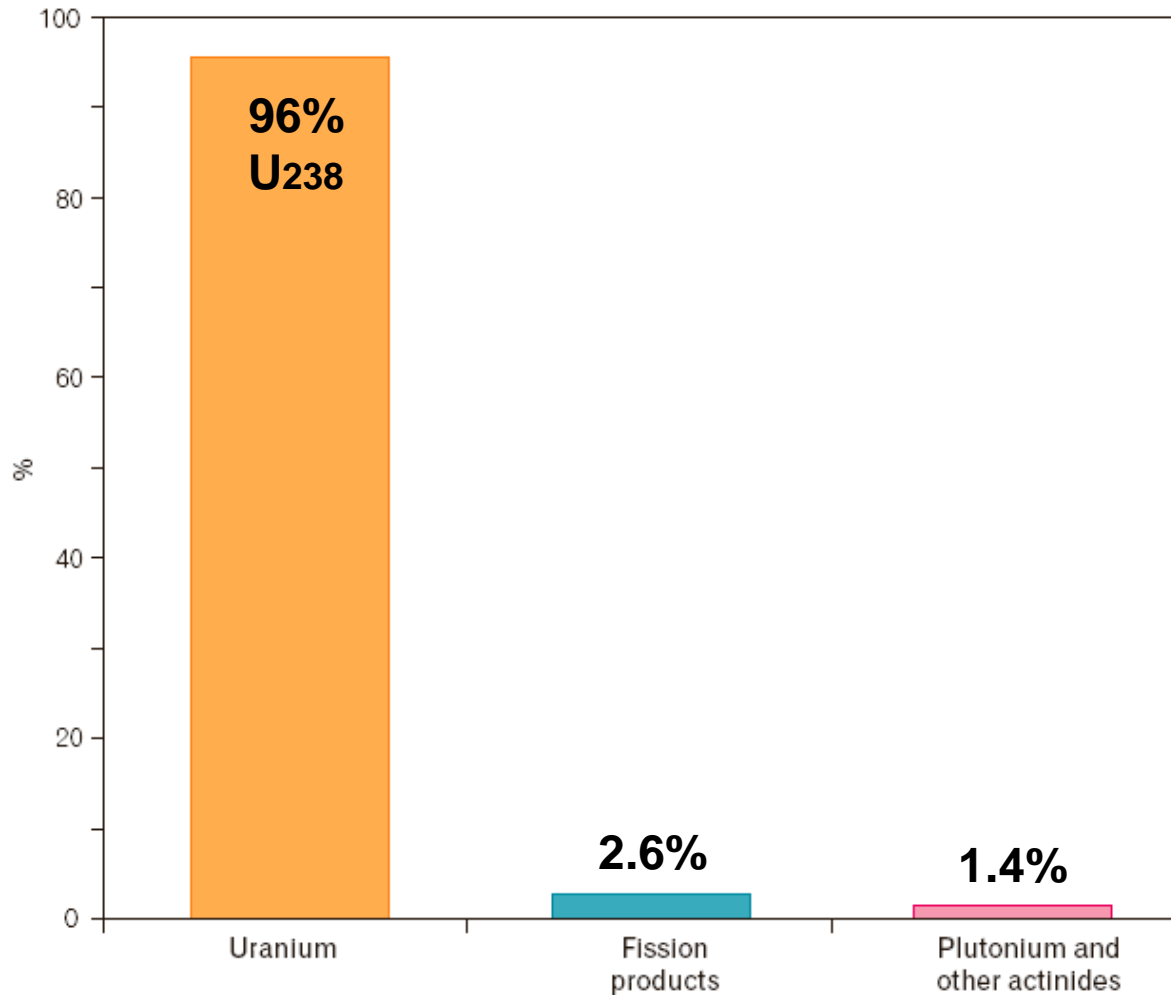
THE [OPEN LOOP] NUCLEAR FUEL CYCLE OF GENERATION II NUCLEAR REACTORS



* Wikipedia – Nuclear Reprocessing : http://en.wikipedia.org/wiki/Nuclear_reprocessing

WASTE FUEL OF GEN II NUCLEAR REACTORS

Figure 5.9 Constituents of spent nuclear fuel

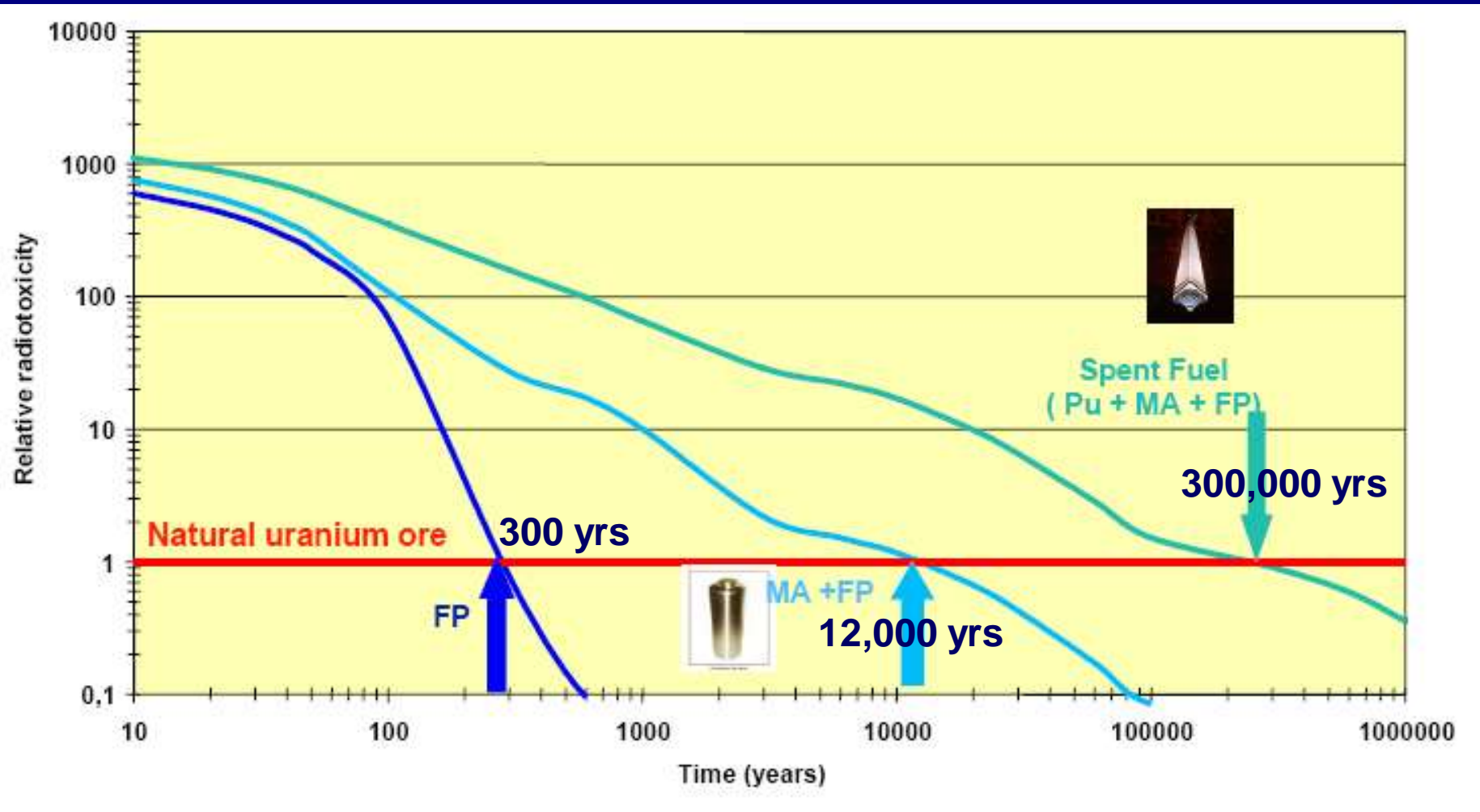


Note: Spent fuel is nearly 96 per cent U-238. Removal of uranium by reprocessing greatly reduces the volume of HLW requiring geological disposal.^[100]

Sources: Uranium Mining, Processing & Nuclear Energy Review – Dept Prime Minister & Cabinet

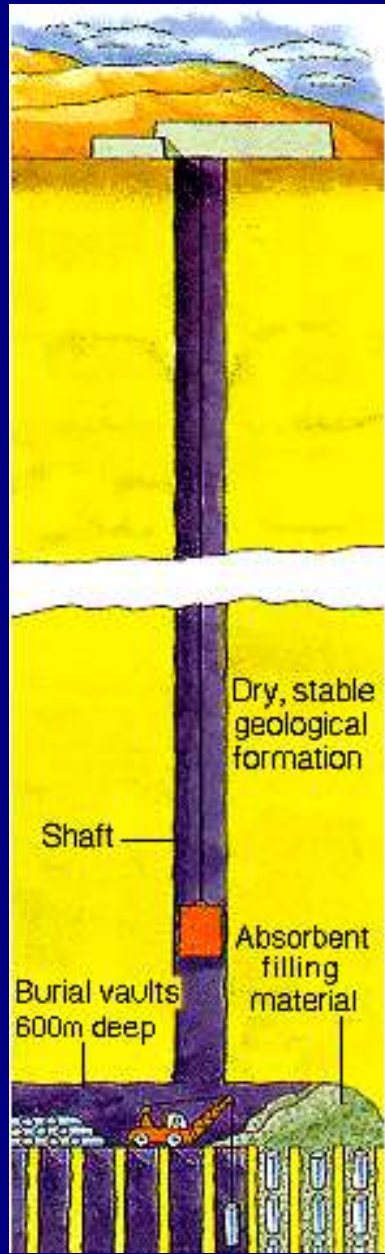
© Dr Tom Romberg – CANWIN NUCLEAR POWER FORUM – 2 June 2007

NUCLEAR WASTE RELATIVE TOXICITY*



* Source: IAEA 2004 – FP = Fission Products [^{90}Sr , ^{137}Cs , ^{99}Tc , ^{129}I] :
 MA = Minor Actinides [^{95}Am , ^{96}Cm , ^{97}Bk , ^{98}Cf , ^{99}Es] : Pu = Plutonium
 [Am =Americium, Cm = Curium, Bk = Berkelium, Cf = Californium, Es = Einsteinium]

NUCLEAR WASTE REPOSITORIES

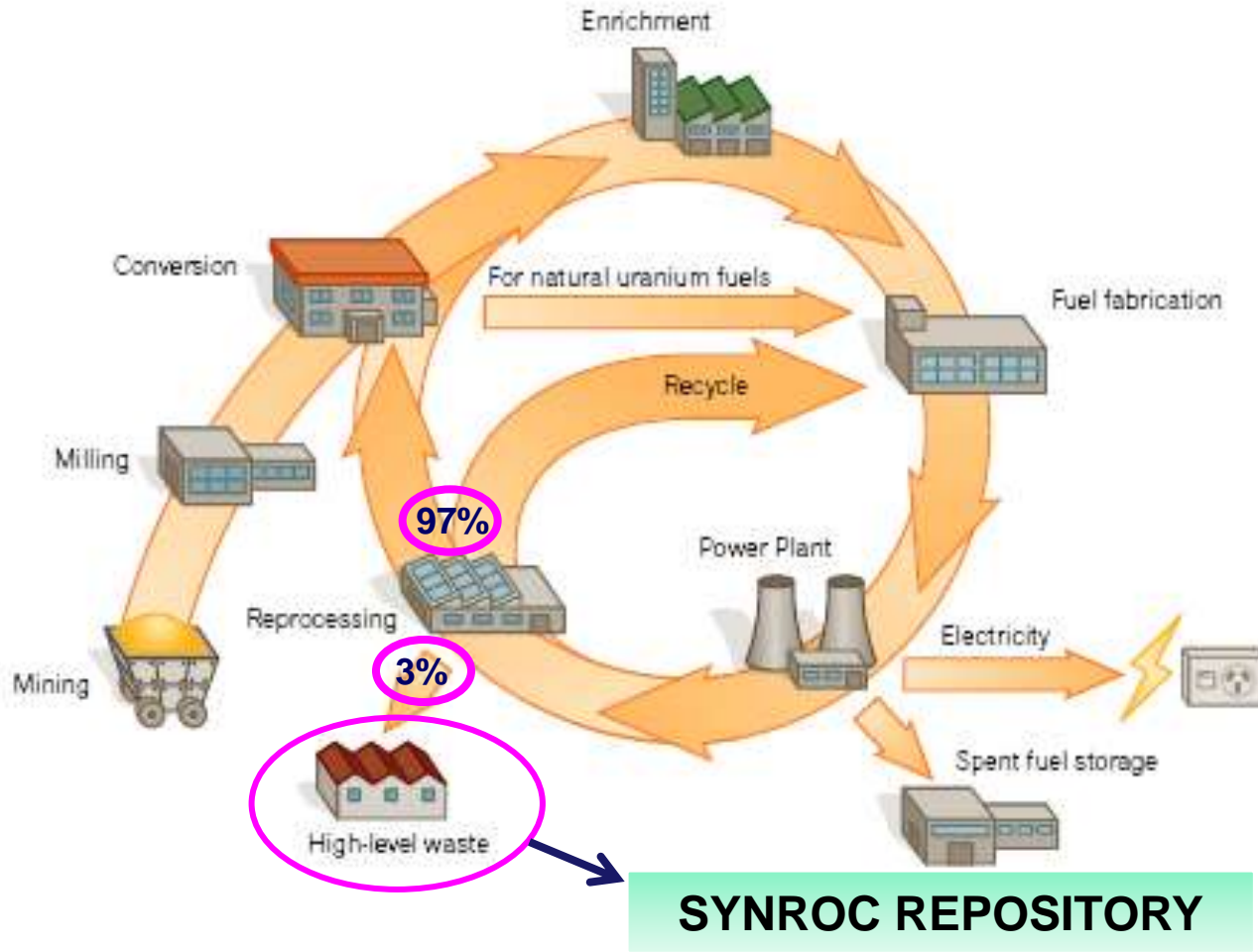


- ❑ **REPOSITORY** – Dry stable geological formations [OZ is well endowed]
- ❑ **WASTE** – Encapsulated processed nuclear waste [OZ – SYNROC process]
- ❑ **FILL** – Radioactive absorbent back-fill material
- ❑ **ENVIRONMENTAL** – Zero pollution, leaching, sub-terranean contamination, etc.
- ❑ **REGULATORY** – National authority to enforce IAEA Standards, safety inspections, inventory monitoring, etc.

Source: World Nuclear Association <http://www.world-nuclear.org/education/wast.htm>

THE NUCLEAR FUEL CYCLE OF GENERATION IV NUCLEAR REACTORS

Figure 1.1 Schematic of the nuclear fuel cycle

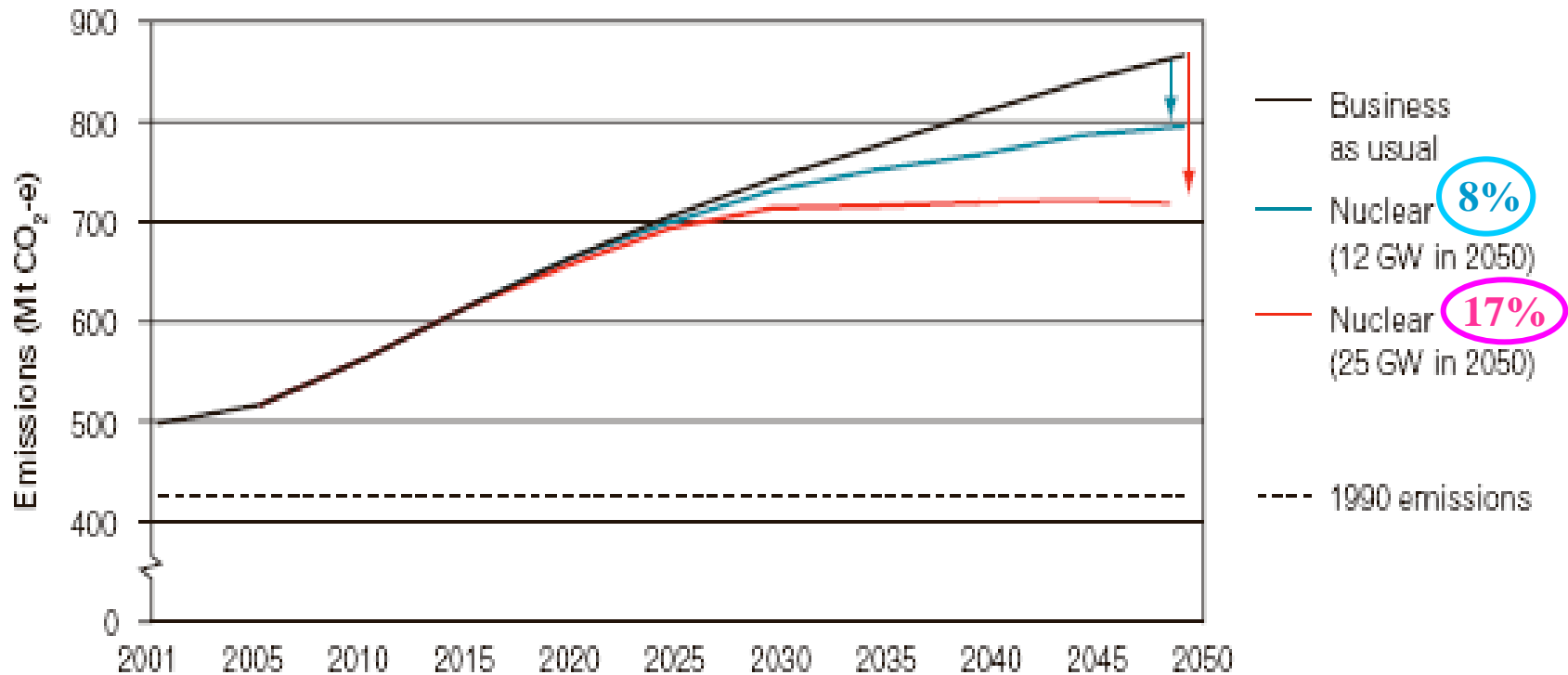


Source: Uranium Mining, Processing and Nuclear Energy Review – Dept Prime Minister & Cabinet

**...SO IS
NUCLEAR POWER
OUR GREENHOUSE
SOLUTION?**

SO... IS NUCLEAR POWER A GREENHOUSE SOLUTION FOR AUSTRALIA? [ZIGGY'S VIEW]

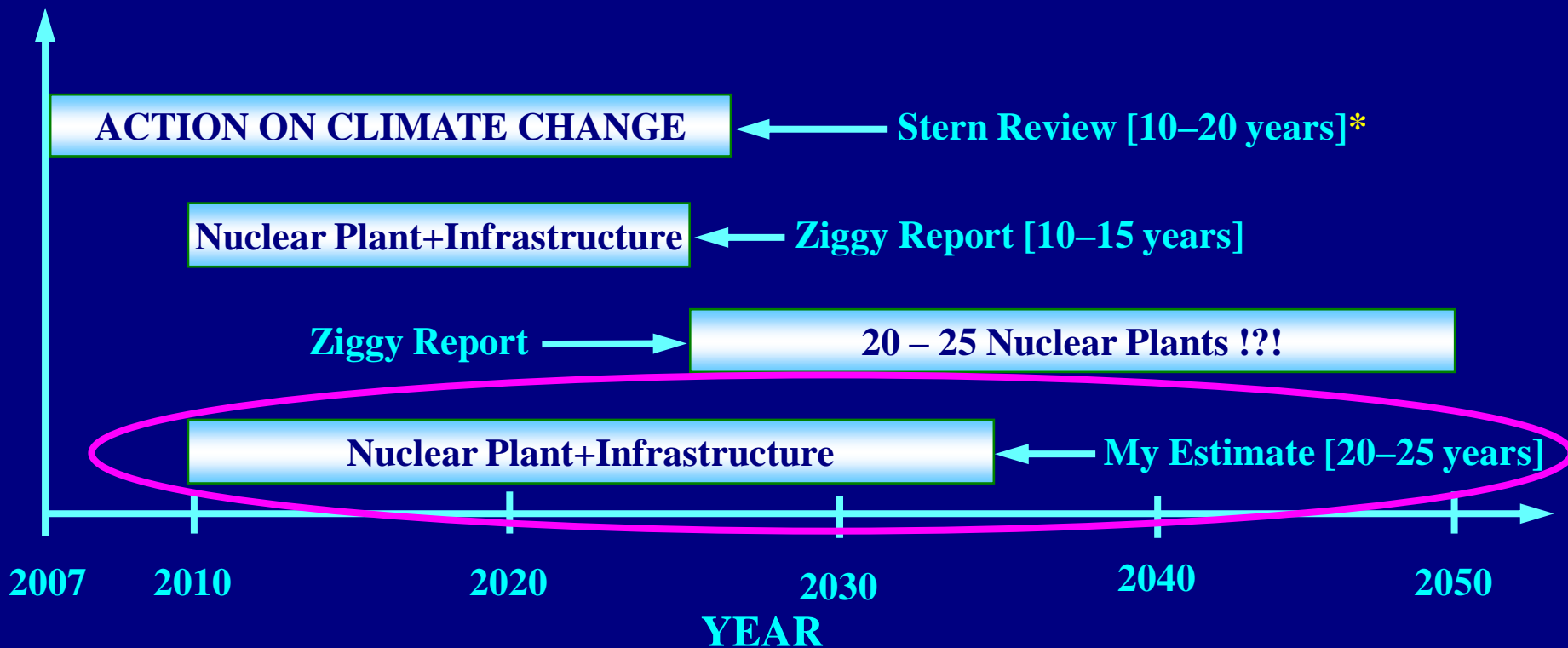
Figure 7.8 Potential to reduce Australia's emissions — illustrative scenarios to 2050



THE ZIGGY REPORT SAYS THIS SCENARIO SHOWS NUCLEAR POWER HAS THE POTENTIAL TO REDUCE EMISSIONS, BUT IN MY VIEW...

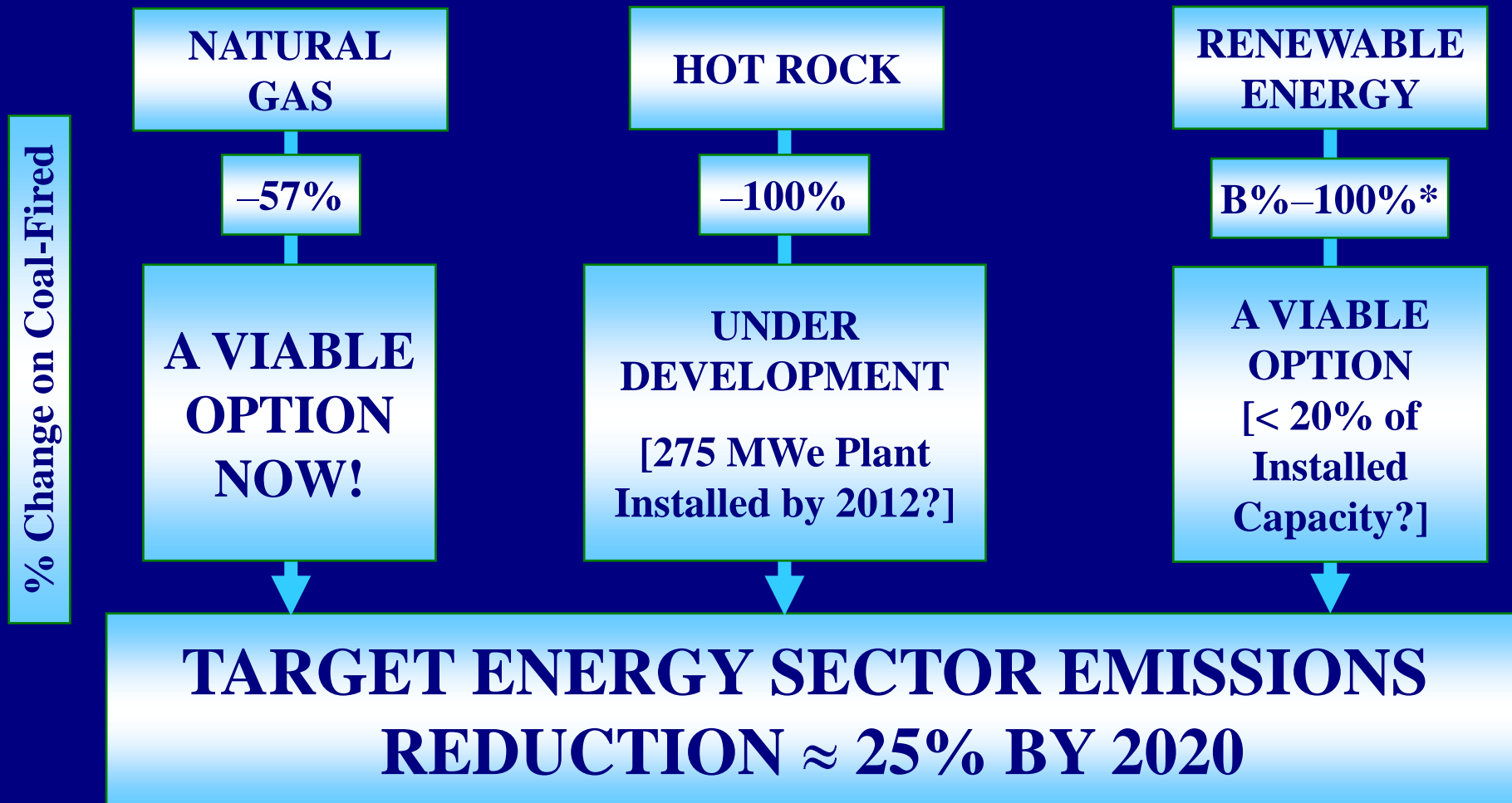
SO... IS NUCLEAR POWER A GREENHOUSE SOLUTION FOR AUSTRALIA? [MY VIEW]

...IN THE **MEDIUM TERM**, THE SHORT ANSWER IS **NO** BECAUSE OF THE **DISPARATE TIMESCALES INVOLVED FOR NUCLEAR POWER TO MAKE A SIGNIFICANT REDUCTION IN AUSTRALIA'S GREENHOUSE EMISSIONS WITHIN THE TARGET TIMEFRAME [10-20 YEARS], AND SO...**



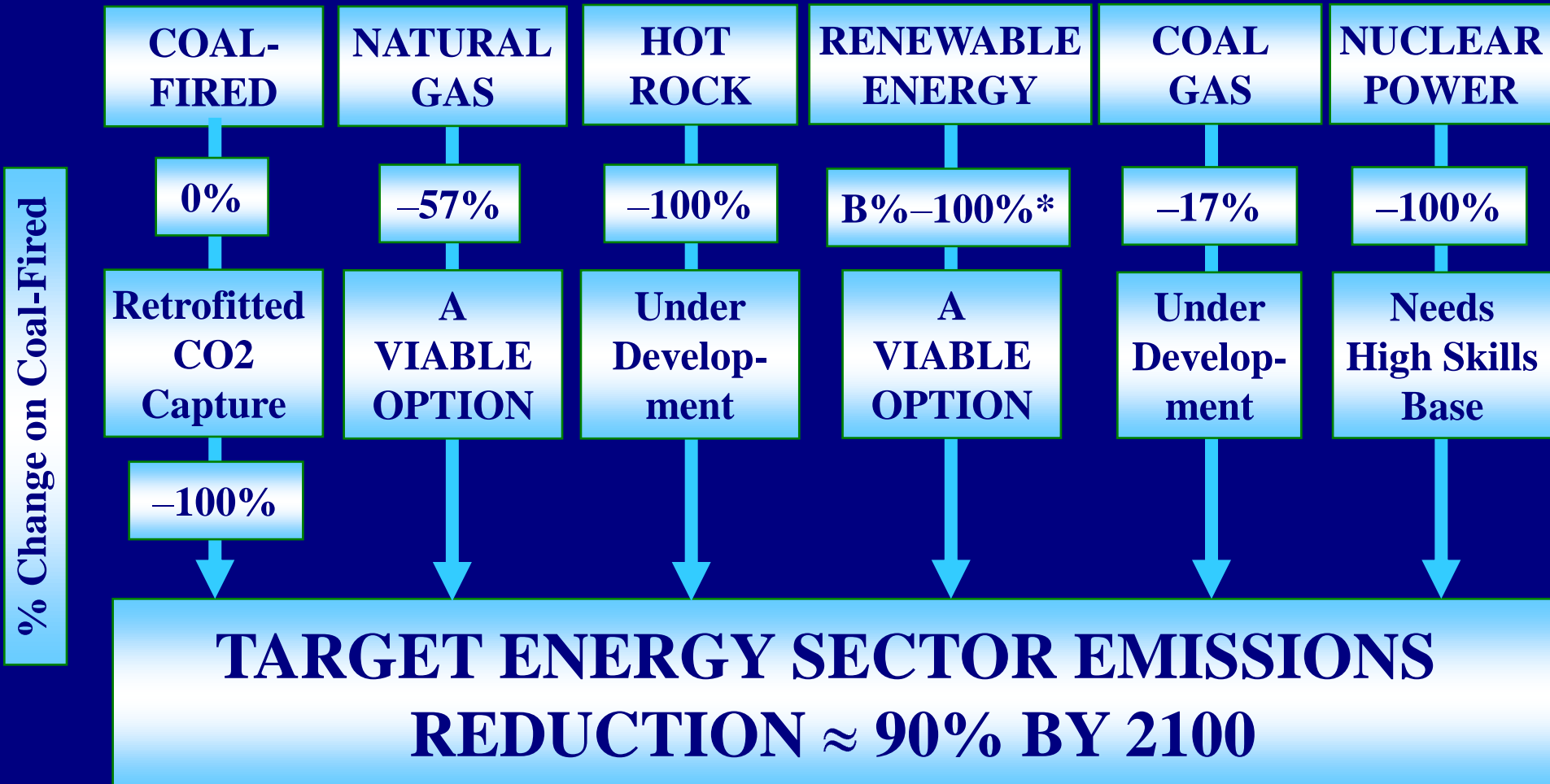
* Sir Nicholas Stern – “STERN REVIEW : The Economics of Climate Change”, H M Treasury, UK, 30 October 2006

...WHICH MEANS OUR IMMEDIATE ENERGY PRIORITIES SHOULD BE [My Scenario 1]...



❑ Renewable Energy backup generation [B%] utilised will determine the reduction achieved.

...AND OUR MIX OF LONGER-TERM ENERGY PRIORITIES COULD BE [My Scenario 2]...



❑ Renewable Energy backup generation [B%] utilised will determine the reduction achieved.

... AND A FINAL THOUGHT...

**“The Era of Procrastination, of Half-Measures,
of Soothing and Baffling Expedients, of Delays,
is Coming to its Close.**

**In its Place We are Entering a Period of
Consequences.”**

Sir Winston Churchill – November 12, 1936 : Al Gore – An Inconvenient Truth

THE END

THANK YOU FOR YOUR INVITATION

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SOUTHERN HIGHLANDS GROUP WEBSITE**

<http://www.engineersaustralia.org.au/shtrg>

**FOR “OZ SUSTAINABLE ENERGY” TALKS
BY GUEST EXPERTS ON:**

WIND ENERGY

SOLAR THERMAL ENERGY

HOT DRY ROCK ENERGY

SOLAR PHOTOVOLTAIC

NUCLEAR ENERGY

WAVE ENERGY

NATURAL GAS ENERGY

COAL GAS ENERGY

HYDROGEN ENERGY

FUEL CELLS