



**national planning
commission**

Department of Planning, Monitoring and Evaluation
REPUBLIC OF SOUTH AFRICA

NUCLEAR ENERGY AND THE ENVIRONMENT

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Background

- ▶ South Africa has a well-established and mature nuclear Industry experience
- ▶ Environmental sustainability through efforts to reduce pollution and mitigate the effects of climate change is non negotiable
- ▶ Always aiming at reduction of carbon emissions and releasing of pollution into the atmosphere and the environment

Nuclear Waste

- ▶ Radioactive waste includes any material that is either intrinsically radioactive, or has been contaminated by radioactivity
- ▶ Every radionuclide has a half-life - the time taken for half of its atoms to decay, and thus for it to lose half of its radioactivity.
- ▶ Radionuclides with long half-lives tend to be alpha and beta emitters - making their handling easier - while those with short half-lives tend to emit the more penetrating gamma rays. Eventually all radioactive waste decays into non-radioactive elements.
- ▶ The more radioactive an isotope is, the faster it decays.

Radioactive Waste

- ▶ Radioactive waste is typically classified as either low-level (LLW), intermediate-level (ILW), or high-level (HLW), dependent, primarily, on its level of radioactivity.
- ▶ LLW -generated from hospitals and industry, as well as the nuclear fuel cycle. It comprises paper, rags, tools, clothing, filters, etc
- ▶ ILW - comprises resins, chemical sludges, and metal fuel cladding, as well as contaminated materials from reactor decommissioning.
- ▶ HLW- from the 'burning' of uranium fuel in a nuclear reactor. HLW contains the fission products and transuranic elements generated in the reactor core. HLW accounts for just 3% of the volume, but 95% of the total radioactivity of produced waste. There are two distinct kinds of HLW:
 - Used fuel that has been designated as waste.
 - Separated waste from reprocessing of used fuel.

Radioactive Waste Handling

- ▶ Before disposal, nuclear waste needs to be in solid form and resistant to leaching.
- ▶ Packaging should be appropriate to the waste and its disposal.
- ▶ High-activity waste requires shielding.
- ▶ Treatment and conditioning processes are used to convert a wide variety of radioactive waste materials into forms that are suitable for their subsequent management, including transportation, storage and final disposal. The principal aims are to:
 - Minimize the volume of waste requiring management via treatment processes.
 - Reduce the potential hazard of the waste by conditioning it into a stable solid form that immobilises it and provides containment.

Radioactive Waste Handling

- ▶ It is important to note that, while treatment processes such as compaction and incineration reduce the volume of waste, the amount of radioactivity remains the same. As such, the radioactivity of the waste will become more concentrated as the volume is reduced.
- ▶ Conditioning processes such as cementation and vitrification are used to convert waste into a stable solid form that is insoluble and will prevent dispersion to the surrounding environment. A systematic approach typically incorporates:
 - ▶ Immobilising the waste through mixing with the matrix material.
 - ▶ Packaging the immobilised waste in, for example, metal drums, metal or concrete boxes or containers, or copper canisters.
- ▶ High-level waste (HLW) is the main focus of attention, though it comprises only about one percent of all radioactive waste by volume. The main scope for volume reduction is within low-level waste (LLW) and intermediate-level waste (ILW). Both ILW and HLW require shielding, so the handling and conditioning may be in hot cells of various kinds to provide that.

Koeberg Nuclear Power Station



Environmental Impact-Nuclear Waste

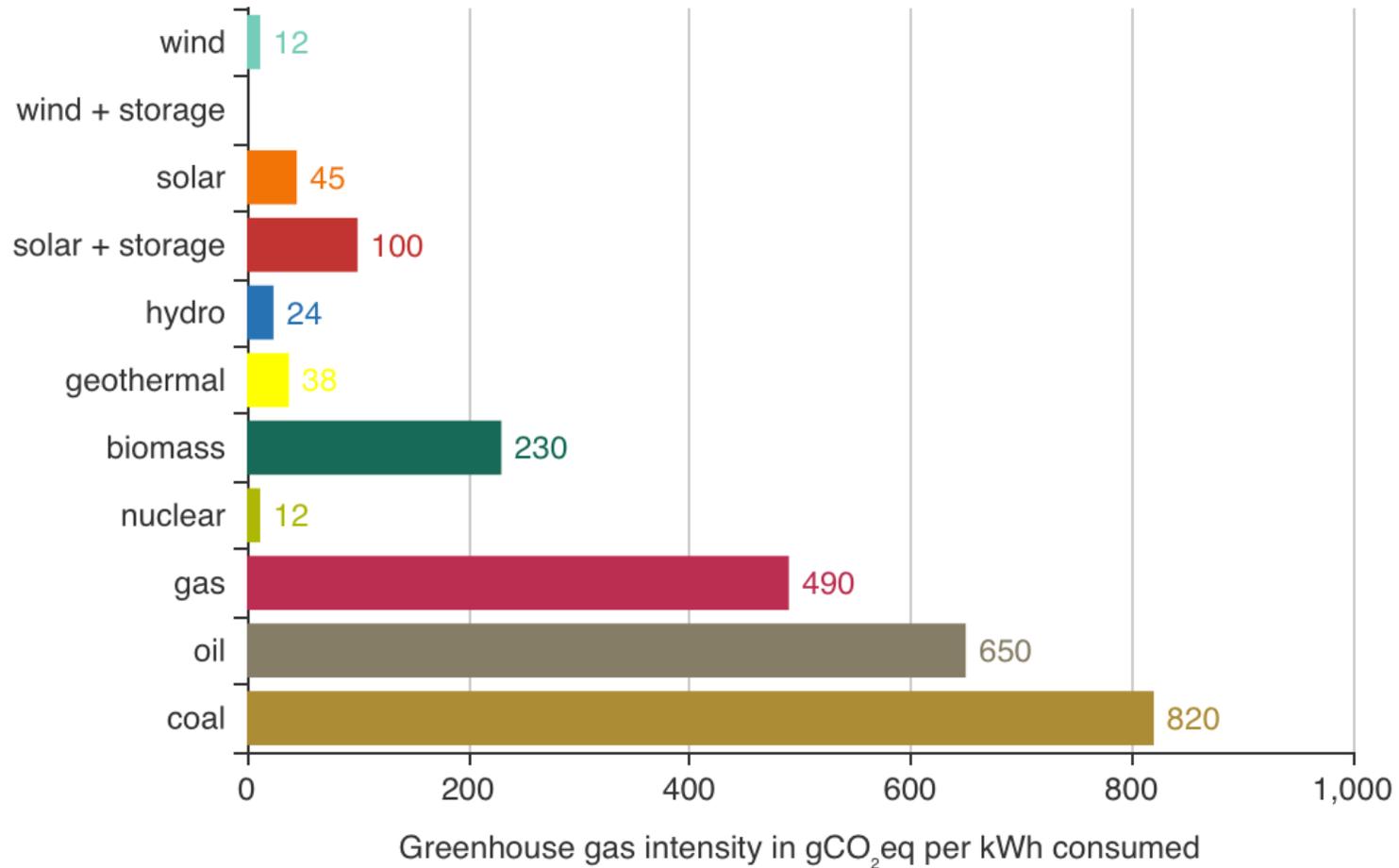
- ▶ The nuclear industry is a highly regulated industry with very stringent license and operational requirements
- ▶ Concerns about the safety of high-level and low-level nuclear waste are real
- ▶ 28 years of operations at Koeberg, the total spent fuel assemblies produced by the 1800MW power plant. Still on site remain on the Koeberg site as the volumes are still small.
- ▶ The waste could fit on less than half a tennis court(about 40%)
- ▶ South Africa should embark on waste minimization processes
- ▶ Reprocessing the spent fuel, most could be reused and further reduce the waste

Emission...

- ▶ Together with wind, nuclear is the lowest carbon emitter of all energy sources at 12gCO₂/kWh consumed

Greenhouse gas intensity of electricity production modes

in gCO₂eq / kWh consumed



Source: Live cycle emissions from [Electricity Map \(data\)](#) and [How Sustainable is Stored Sunlight?](#) for solar + storage intensity estimations.

- ▶ www.electricitymap.org real time, depicting live energy mix and CO2 emissions of various countries around the world

Nuclear Incidents

- ▶ The significant impact of historical events at nuclear facilities cannot be ignored
- ▶ Chernobyl and Three-Mile Island and Fukushima
- ▶ These accidents have resulted in minimal deaths or injuries

Energy Source	Mortality Rate (deaths per 10⁹ kWh)	
Coal – global average	161	(50% of global electricity)
Coal – China	278	(75% of China's electricity)
Coal – U.S.	15	(44% of U.S. electricity)
Oil	36	(36% of global energy, 8% of global electricity)
Natural Gas	4	(20% of global electricity)
Biofuel/Biomass	24	(21% of global energy)
Solar (rooftop)	0.44	(< 1% of global electricity)
Wind	0.15	(~ 1% of global electricity)
Hydro – global average	1.4	(15% of global electricity, 171,000 Banqiao dead)
Nuclear	0.04	(17% of global electricity w/Chernobyl&Fukushima)

Sources –World Health Organization; CDC; ICAP - significant coal use increases health care costs approximately 11%

Conclusion

- ▶ Nuclear energy has the lowest carbon footprint of all, it also has the lowest physical footprint - limiting the environmental impact to a smaller area even better with modular reactors
- ▶ Nuclear energy has the highest capacity factor (available electricity at all times)
- ▶ The lowest mortality rate of all energy sources.
- ▶ It also produces the least amount of waste of any energy source
- ▶ lasts up to 3 times longer than other power plant technologies.

Conclusion/Take home points

- ▶ Wind and Nuclear are smallest polluters of all energy sources.
- ▶ The mortality rate of nuclear energy is lower than any other energy source
- ▶ There is a need to educate all stakeholders and deal with the fear of nuclear



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Thank you

