

Helium its occurrence, its uses and its future role in energy production

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Helium a noble gas, an element and a mineral

- Helium (He) is the second most common element in the Universe after hydrogen,
- It is only one of two elements that 'escape' from earth (the other being hydrogen),
- It is the product of the decay of radioactive elements, Uranium (U) and Thorium (Th), and
- Helium is an Alpha (α) particle, consisting of two protons and two neutrons, and liquefies @ 4K.

Helium is NOT a REE

- Scuttle-but has come that Helium is in short supply, and will be a long-term boom mineral,
- UNLIKELY, only possible if major producers such as Qatar and Algeria are in major strife, and potential producers such as Iran, Tanzania and South Africa do not go onto building Helium recovery infrastructure, and
- DENINATELY if we have a world war or other world-wide calamity.

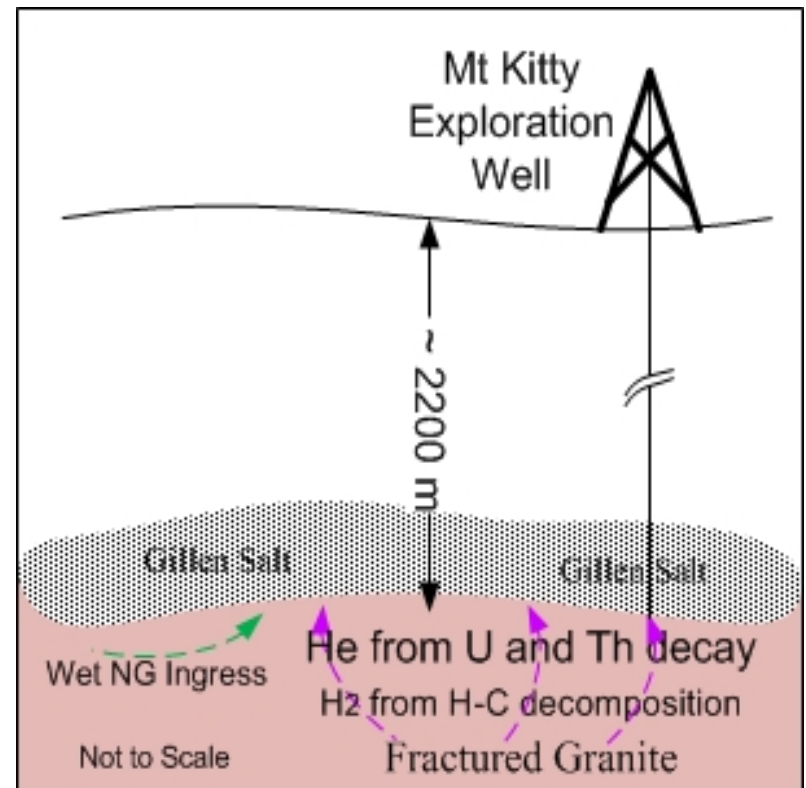
Helium Uses

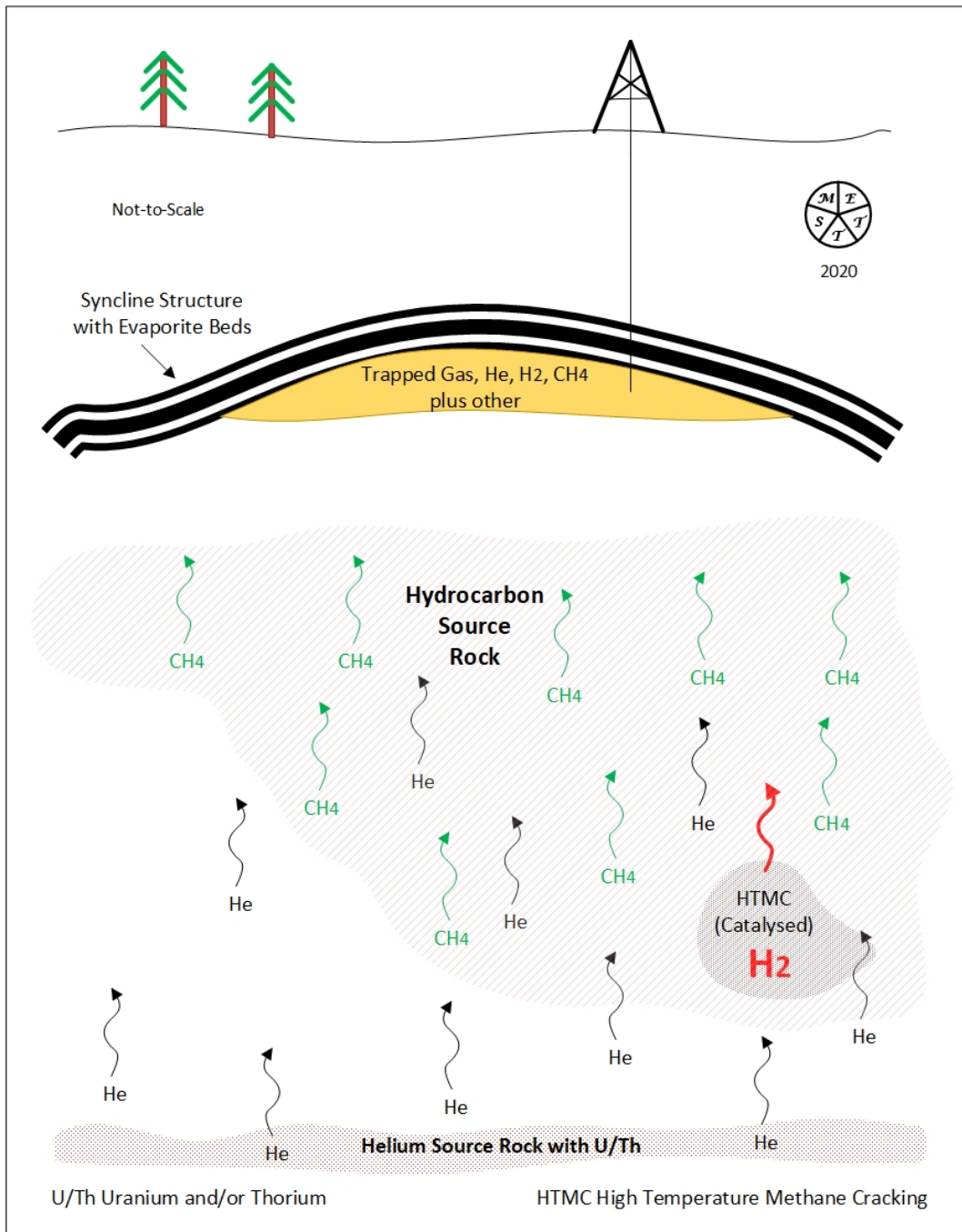
- MRI scans that use Super-Magnets,
- Specialist welding (tungsten arc),
- Controlled atmospheres for electronics manufacture,
- Industrial leak detection,
- Specialist deep diving gas mixtures, and
- Flight, space and balloons.

FUTURE: Clean Energy Sourcing

Finding Helium

- The U and Th are contained in GRANITOID rocks,
- The He is sealed in by salt layers, and
- He is often recovered as a component of natural gas.



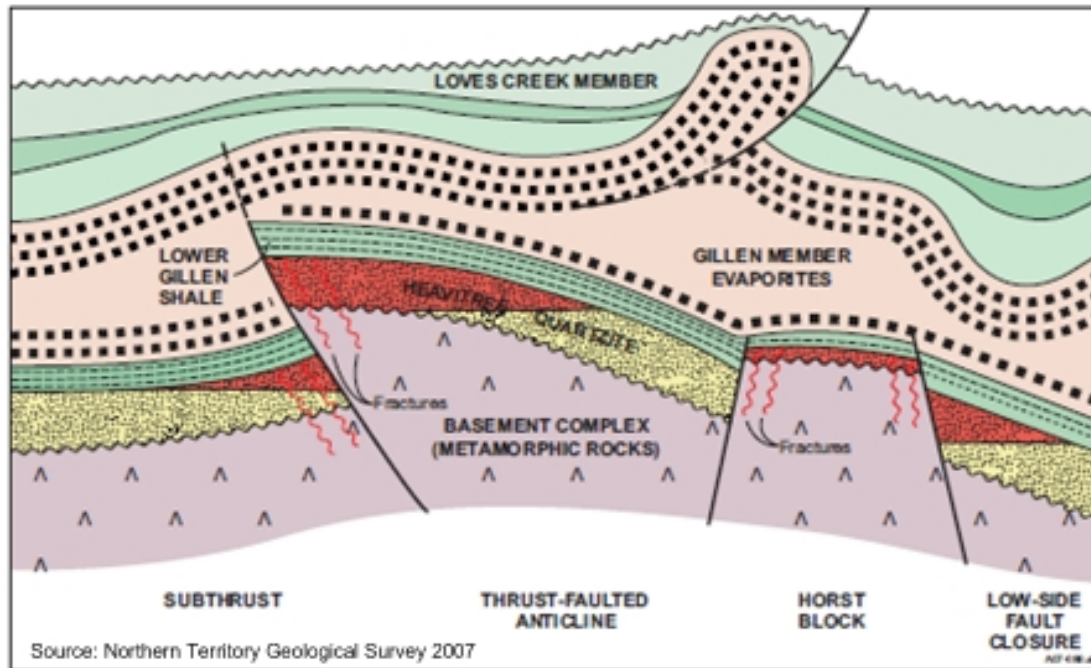


Type I Helium Plays

Note:

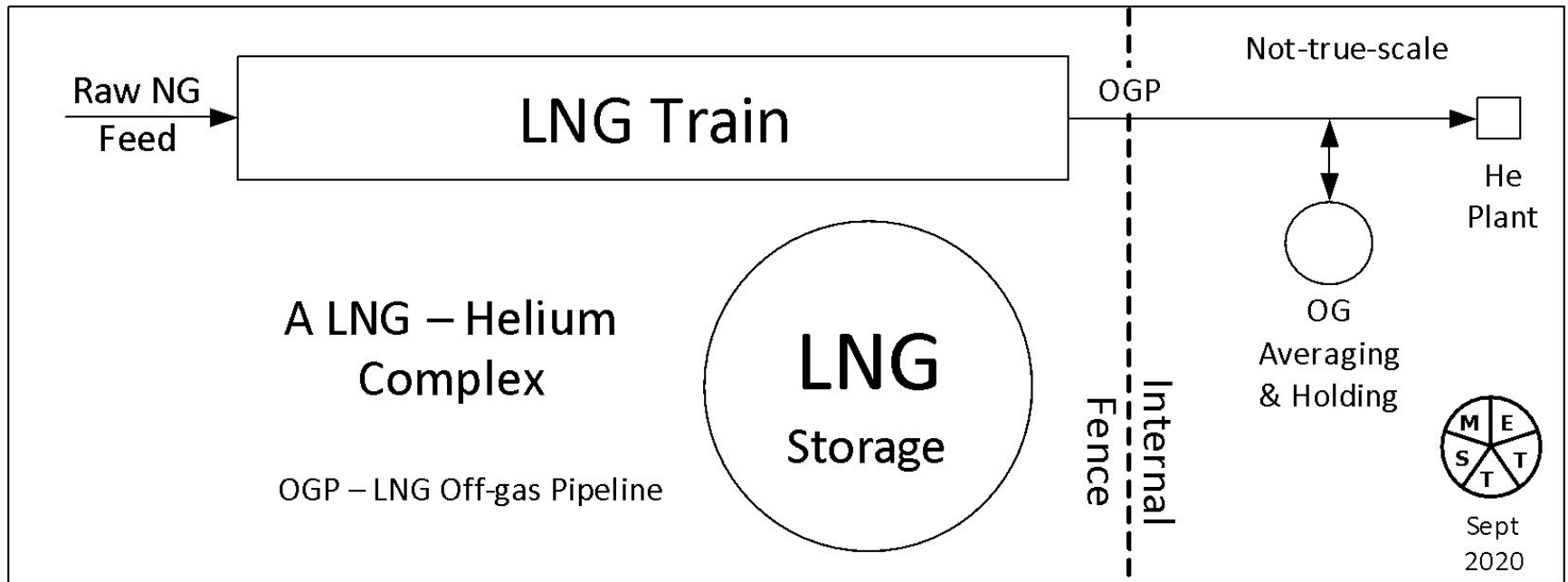
These plays can be:
kilometres in
dimensions, have
significant evaporite
sealing layers or not,
need very large
volumes of
hydrocarbon source
rock, and must have
some proximity to
U/TH containing rock.

Type II Helium Resources: where are the traps!



- The Three pre-cursors for Type II He resources:
 - A basement rock with Uranium and Thorium,
 - Sealing strata, evaporites (salt) and tight shales, and
 - Gas Reservoirs (porous rock and fractured rock).

Helium in LNG Production



An actual LHe plant: Linde Darwin



Photo: Linde/BOC Darwin LHe Plant – web sourced

This plant produces LHe from off-gas piped from the adjoining Wickham Point LNG plant; NG source Bayu-Undan Gasfield,

The raw NG that is fed to the LNG plant has a He concentration of 0.1% and produces an Off-gas with a He concentration of 3%, a 30:1 upgrading, and

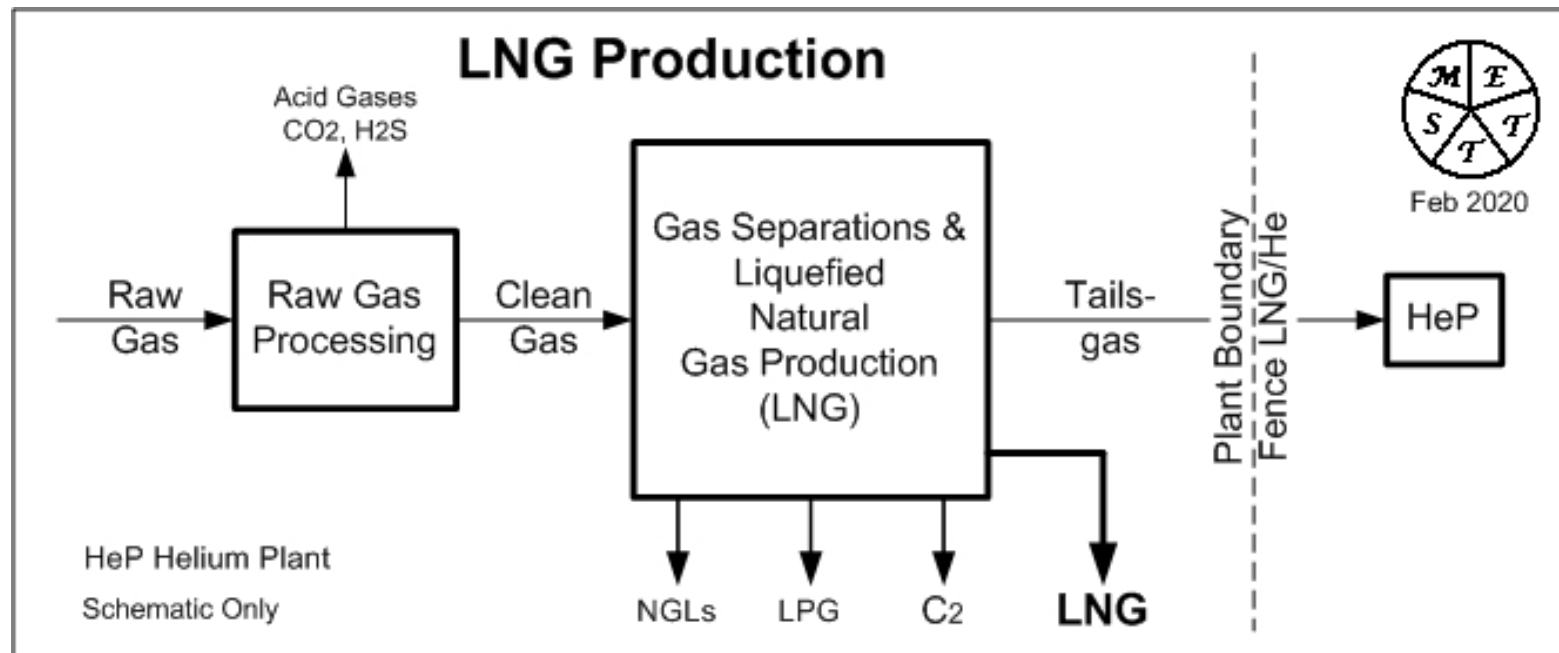
The Darwin He Plant produces around 2.5 tonnes of liquid helium per day $\approx$ 3% of the World's Helium demand.

Helium in Natural Gas

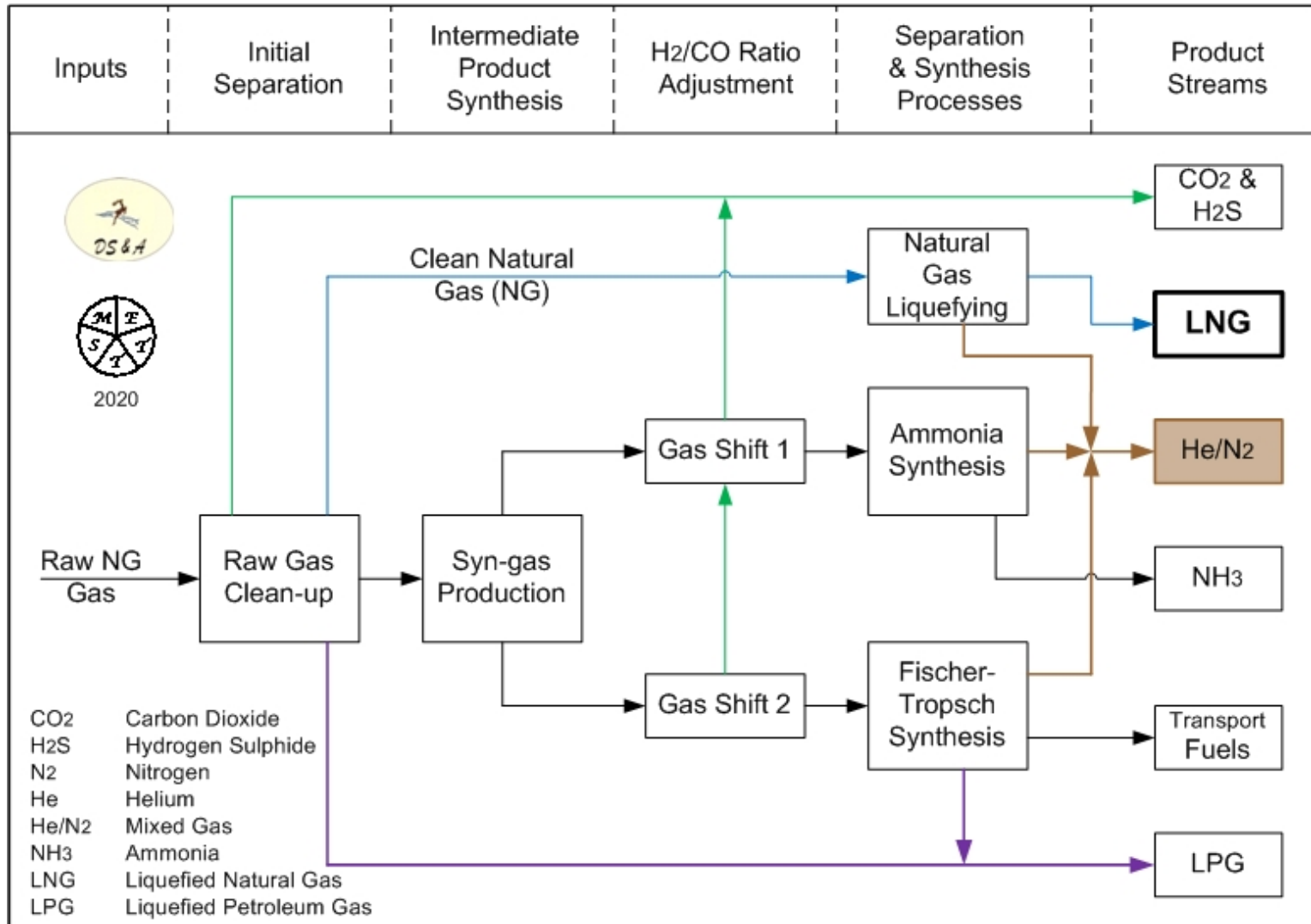
	Mt Kitty Australia	Magee-1 Australia	Qatar
HELIUM	>9%	6.2%	0.04%
HYDROGEN	11%	0.03%	
CARBON DIOXIDE		0.82%	
NITROGEN	61%	43.61%	Difference
METHANE	13%	39.26%	89.18%
ETHANE	4%	6.1%	7.07%
PROPANE		1.91%	2.50%
BUTANE		0.93%	1.16%
PENTANE		0.38%	
HEXANE +		0.17%	
	98%	99.41%	

Separating He from Natural Gas

- For plays that are essentially Natural Gas with LNG product (Type I), the secret is to produce a tails-gas that contains all the helium; the tails-gas is then stripped of He in the subsequent process.



The Possible Complete Story



Who has proven Helium

World Production and Reserves:⁸

	Production		Reserves ⁹
	<u>2018</u>	<u>2019^a</u>	
United States (extracted from natural gas)	64	68	3,900
United States (from Cliffside Field)	26	21	(¹⁰)
Algeria	14	14	1,800
Australia	4	4	NA
Canada	<1	<1	NA
China	NA	NA	NA
Poland	2	2	25
Qatar	45	51	NA
Russia	<u>3</u>	<u>2</u>	<u>1,700</u>
World total (rounded)	158	160	NA

Helium Prices: ‘The estimated price for private industry’s Grade-A helium was about \$7.57 per cubic meter (\$210 per thousand cubic feet), with some producers posting surcharges to this price.’

US Bureau of Land Management, Web Accessed February 2020

A Mysterious set of ‘figures’; Note: Helium is traded with a wink & a nod.

Please note Qatar: Big Resources, Big Production but a very low He in the NG

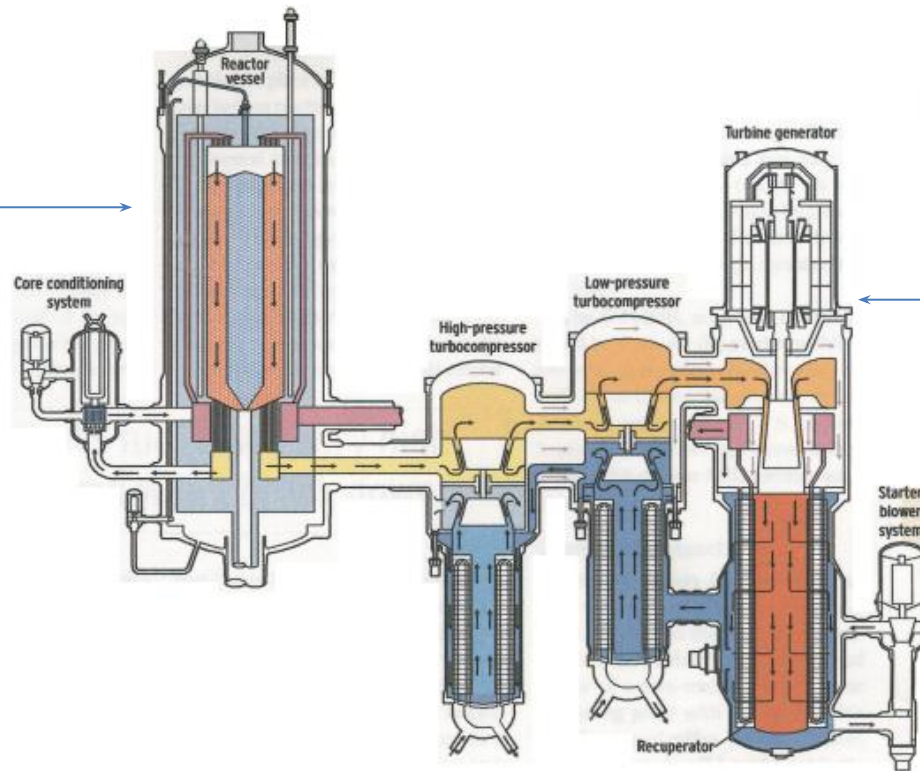
Power & Helium

- The most likely next generation nuclear power plants will be pebble-bed modular reactors using He in the Brayton cycle,
- In this cycle He replaces steam/water as the working fluid, and
- The systems will have a very high level of intrinsic safety and will be energy efficient.

Power & Helium – 2

PBMR

Reactor



Turbine-
Generator

Power and Helium – 3

- However advanced power generation machines will be Accelerator Driven Systems (ADS), where neutron beams are collided with Thorium and/or Uranium to produce heat thence generate electricity, and
- ADS units use super-magnets that require HELIUM to operate.

As an aside

- In Fusion Energy you 'make' helium:
- Deuterium (D) + Tritium (T) $\rightarrow$ Helium (He) + n,
D and T are isotopes of Hydrogen
- (1 Proton & 1 Neutron) + (1P & 2n) $\rightarrow$ (2P & 2n) + n + energy
- But will any of us be around to see Fusion Energy a working reality? Possibly the very young!
- Manufacturing He however will never be an economic activity.

Stop Press; Stop the World!

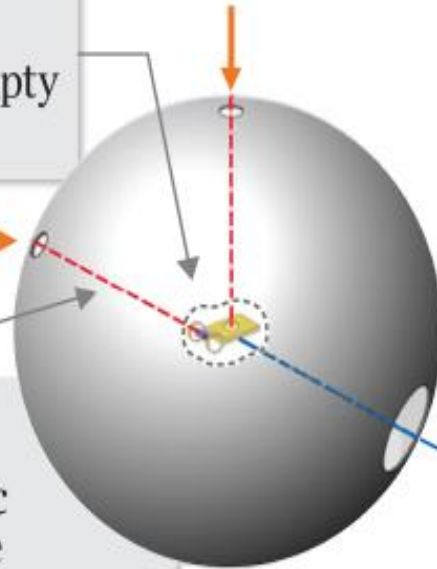
HOW IT WORKS

Hydrogen-boron fuel pellet is placed in the centre of a largely empty metal sphere

LASER 1

LASER 2

Two lasers are fired into the sphere: one establishes a magnetic containment field; the other triggers the 'avalanche' fusion chain reaction



The alpha particles generated by the reaction create an electrical flow that can be channelled into an existing power grid

The only waste product is helium

No radioactive waste, virtually no carbon dioxide emissions

Hydrogen + Boron + Laser Energy → Helium + MORE Energy = NUCLEAR FUSION

20th February, 2020, The Australian, Report on UNSW Fusion Energy Project

Thank You

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