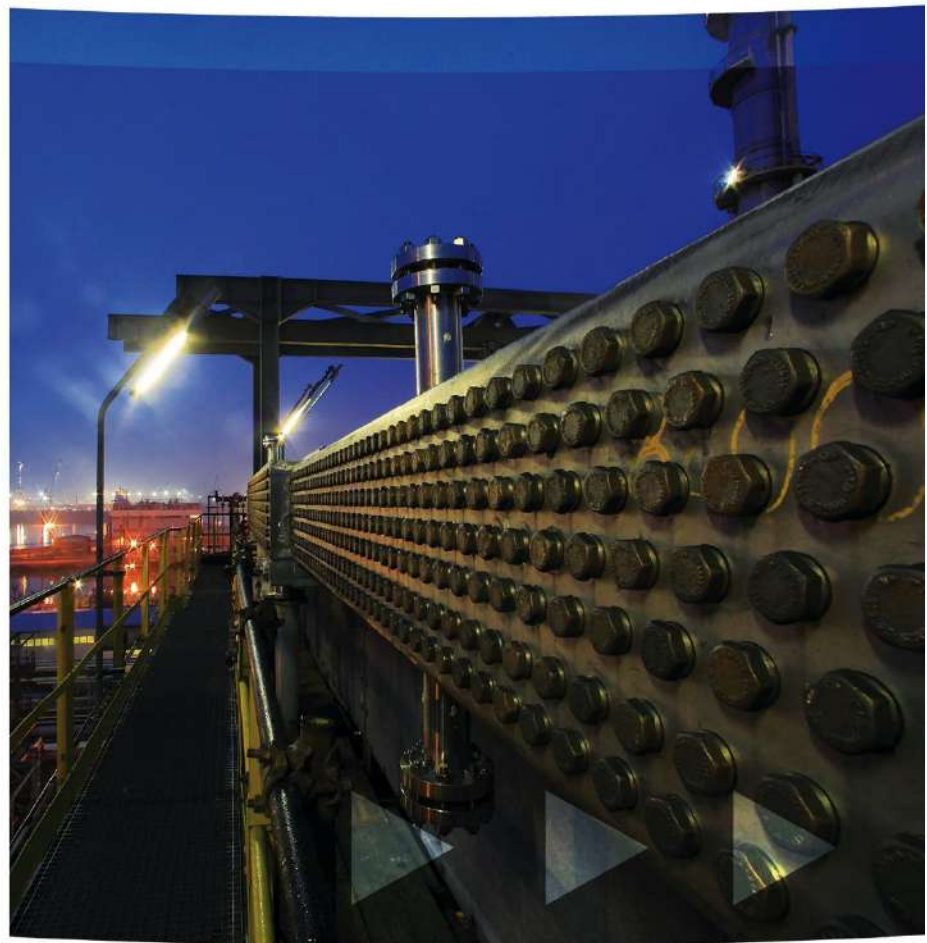




HYDROCARBON PROCESSING

IRPC 2015

1-3 June 2015 | Jumeirah at Etihad Towers | Abu Dhabi, UAE



HELIUM AS A DRIVER FOR GAS FIELD DEVELOPMENT

Duncan Seddon*, Michael Clarke
and Greg Ambrose

- DUNCAN SEDDON & ASSOCIATES PTY. LTD
116 KOORNALLA CR.
MOUNT ELIZA
VICTORIA 3930
AUSTRALIA
Email: seddon@ozemail.com.au

HELIUM

- NOBLE GAS ----- INERT GAS BLANKETING
- VERY LOW DENSITY (0.1786g/L)-----BALLOONS & AIRSHIPS
- VERY LOW BOILING POINT (4.2K)----- SUPERCONDUCTING MAGNETS (MRI)
 - HIGH THERMAL CONDUCTIVITY (0.1513W/m/K)----- WELDING – Al, Cu
- Estimated US 2013 use:
 - Cryogenics 23%
 - Pressurizing and purging 18%
 - Welding 13%
 - Controlled atmospheres 18%
 - Leak detection 4%
 - Breathing mixtures 2%
 - Other 13%

HELIUM

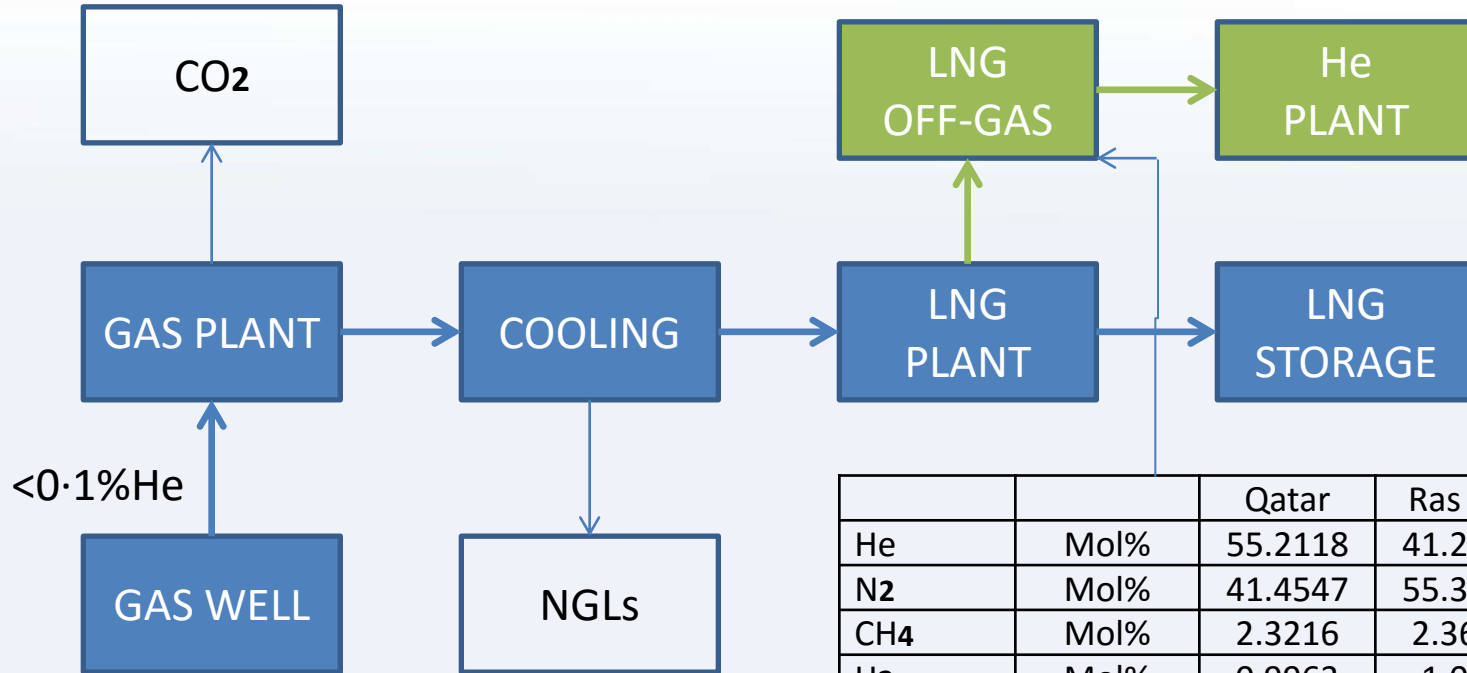
- **SECOND MOST ABUNDANT ELEMENT IN THE UNIVERSE**
- produced by hydrogen fusion within seconds of the Big Bang
 - RARE ON EARTH
 - 5.2ppm of the atmosphere
- MAINLY PRODUCED BY RADIO-ACTIVE DECAY OF URANIUM AND THORIUM MINERALS
- estimated 3000t/y are produced most of which escapes to space
 - MAIN SOURCES – Natural gas
- Concentration ranges from ppm levels to several percent

HELIUM BY EXHASUTIVE SEPARATION OF AIR

	MW	MOL%	WT%
NITROGEN	32	78.084	75.47
OXYGEN	28.02	20.947	23.2
ARGON	39.94	0.934	1.28
CARBON DIOXIDE	44.01	0.035	0.046
NEON	20.18	0.001818	0.0012
HELIUM	4	0.000524	0.00007
METHANE	16	0.00017	
KRYPTON	83.8	0.000114	0.0003
HYDROGEN	2.02	0.000053	
NITROUS OXIDE	44	0.000031	
XENON	131.29	8.7E-06	0.00004
		100.00	100.00

HELIUM RECOVERY FROM NATURAL GAS (1)

LNG OPERATIONS

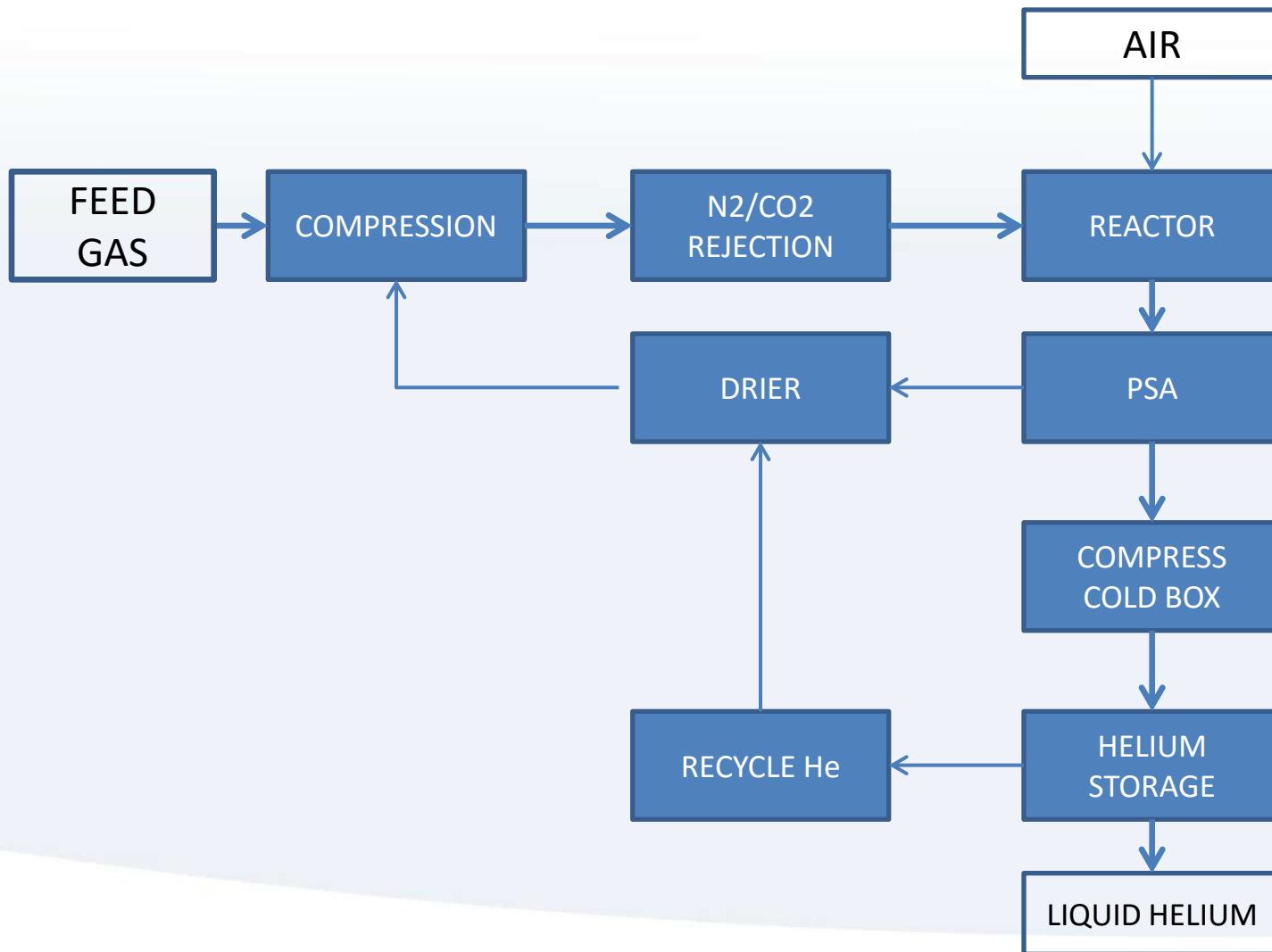


		Qatar	Ras gas
He	Mol%	55.2118	41.2501
N2	Mol%	41.4547	55.3319
CH4	Mol%	2.3216	2.3686
H2	Mol%	0.9963	1.032
CO	Mol%	0.0026	0.0038
Ne	Mol%	0.0017	0.0013
P	bar	2	2
T	C	ambient	ambient
Flow	Ncm/h	1.28	0.91

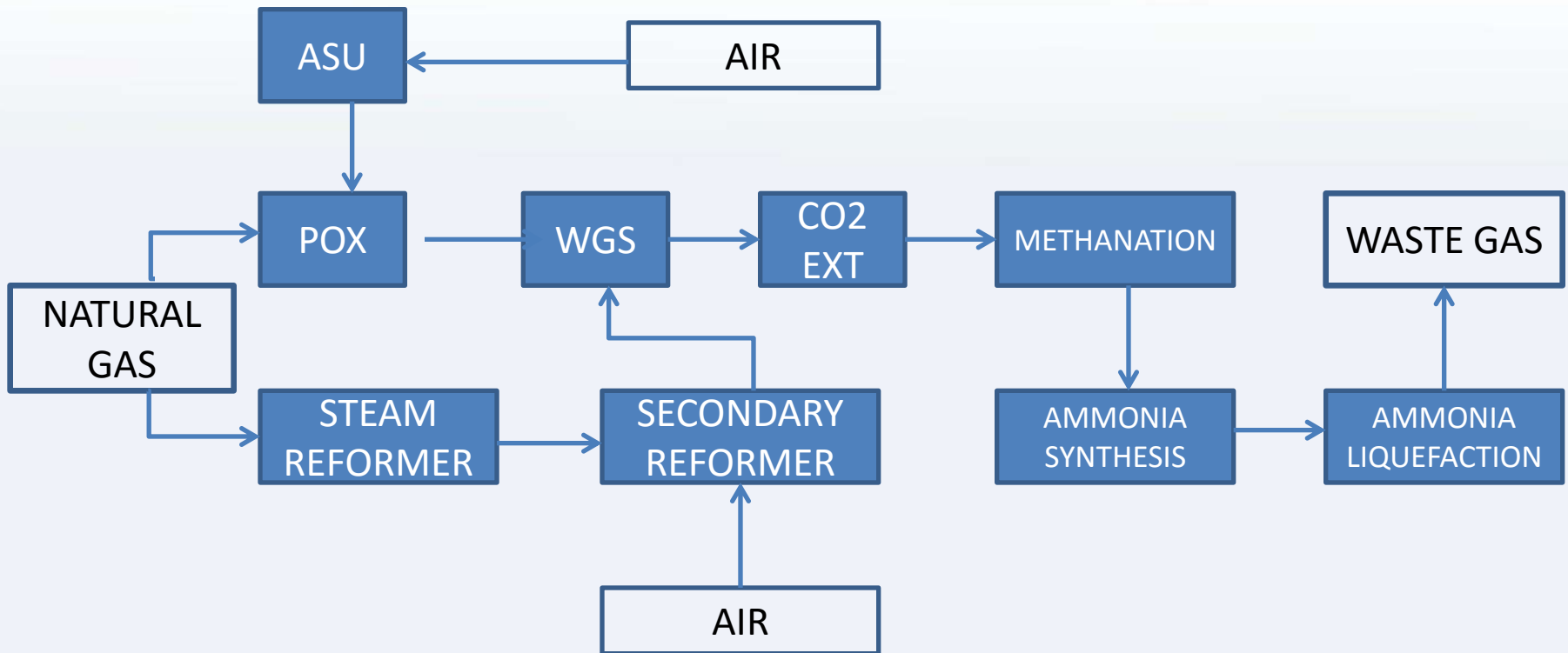
Vaclav Chrz, Int Cong Cryogenics (part 2), CERN Geneva, 31 Aug 2010

HELIUM RECOVERY FROM LNG OFF-GAS

(AFTER Vaclav Chrz, Int Cong Cryogenics (part 2), CERN Geneva, 31 Aug 2010)

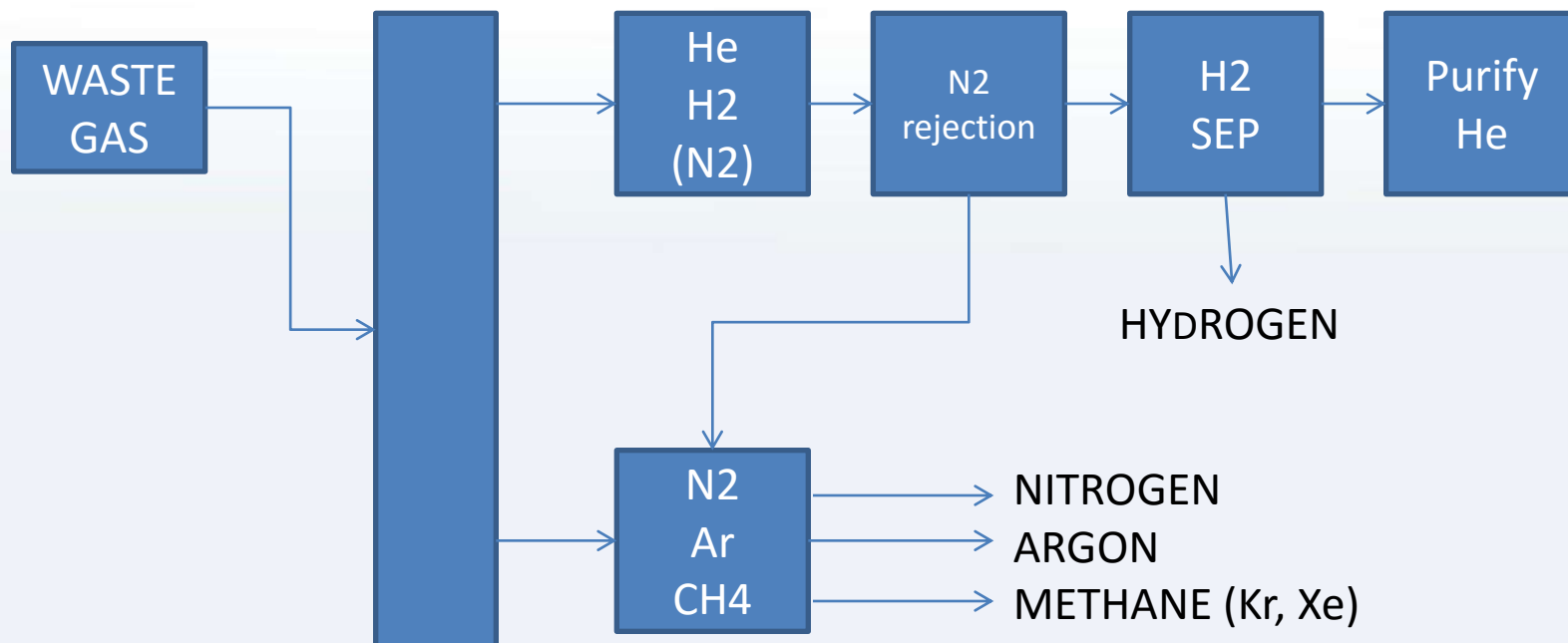


HELIUM RECOVERY FROM AIR/NATURAL GAS AFTER AMMONIA SYNTHESIS



SEPARATION OF AMMONIA OFF-GAS

(AFTER Vaclav Chrz, Int Cong Cryogenics (part 2), CERN Geneva, 31 Aug 2010)



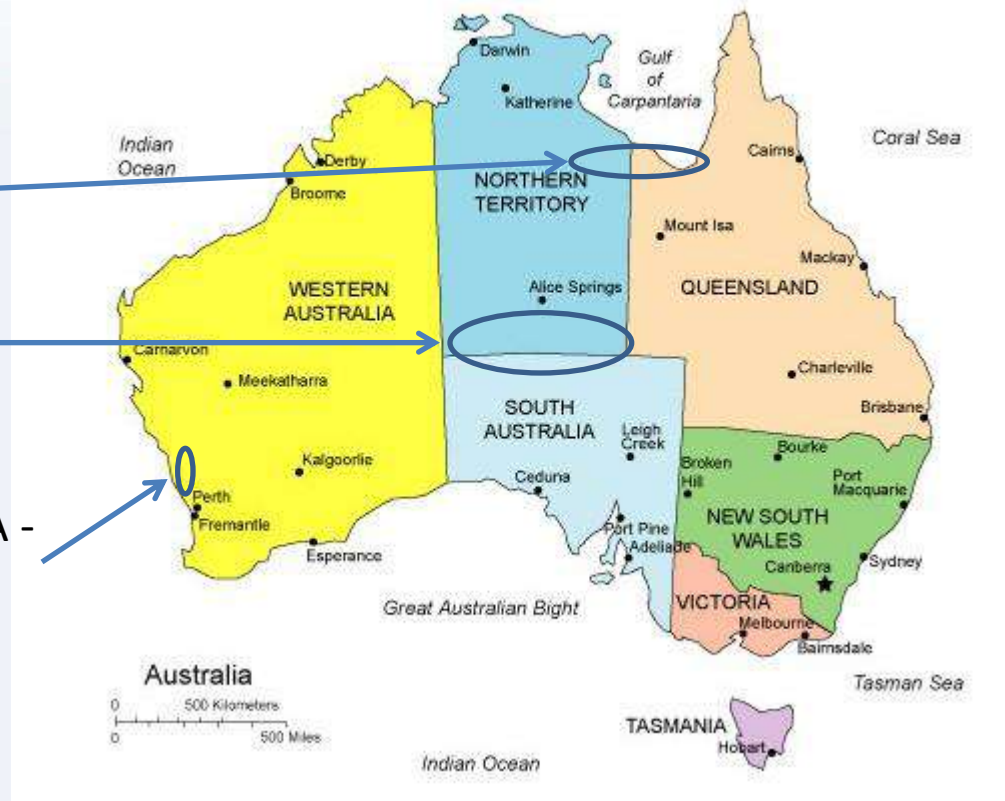
OFF-GAS FROM UKRAINE AMMONIA PLANTS

		Azot	Priportovy
NH3	vol%	1.70	2.00
Kr + Xe	vol%	<0.001	<0.001
CH4	vol%	13.00	8.60
Ar	vol%	5.30	5.60
N2	vol%	20.70	19.00
Ne	vol%	0.01	0.01
H2	vol%	59.00	64.40
He	vol%	0.30	0.40
		100.01	100.01

DEVELOPMENT OF REMOTE HELIUM PROSPECTS

Areas of interest:

1. The 'Gulf Country', NT & Qld, - sea access,
2. SOUTH AMADEOUS BASIN
- Remote but with N/S rail and road links and some gas pipelines
No other facilities, and
3. The North Perth Basin, WA -
Excellent logistics

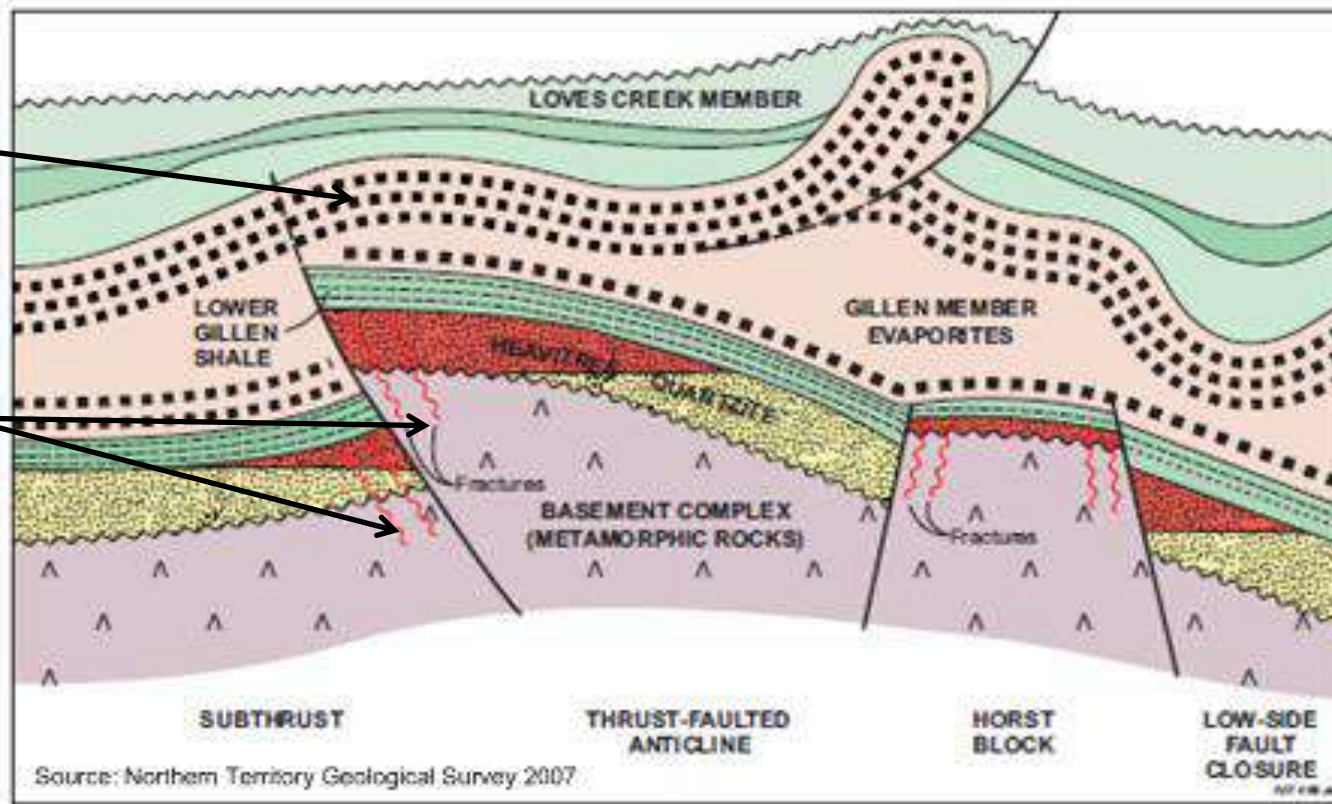


DEVELOPMENT OF REMOTE HELIUM PROSPECTS

Helium Structural Geology

SALT TRAPS

He SOURCE
ROCKS



TWO WELLS DRILLED SHOW HIGH HELIUM LEVELS

	Mt Kitty	Magee-1
HELIUM	9	6.2
HYDROGEN	11	0.03
CARBON DIOXIDE		0.82
NITROGEN	61	43.61
METHANE	13	39.26
ETHANE	4	6.1
PROPANE		1.91
BUTANE		0.93
PENTANE		0.38
HEXANE +		0.17
	98	99.41

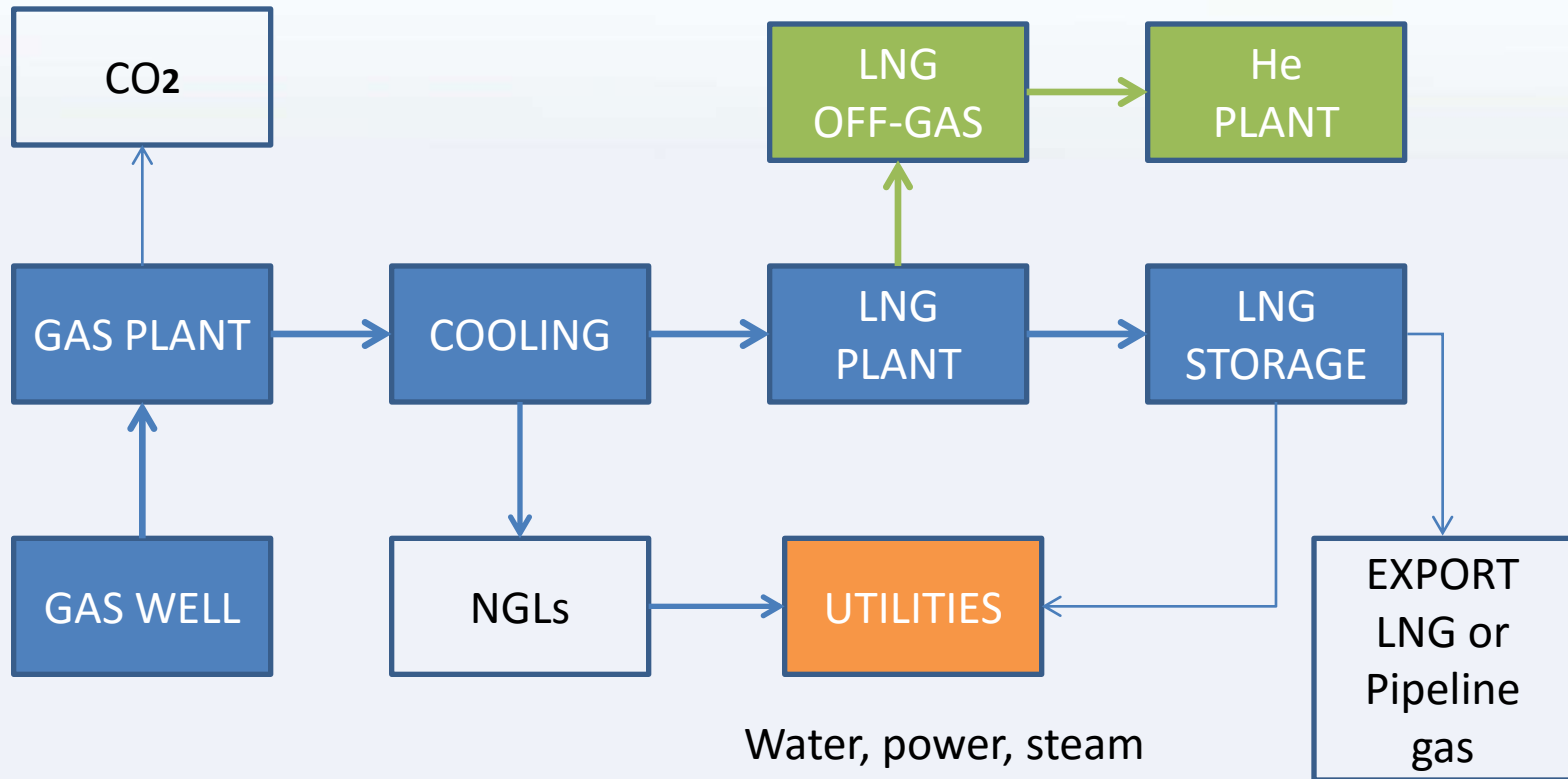
HIGH NITROGEN CONTENT OFTEN ASSOCIATED WITH HELIUM

HIGH HYDOGEN CONTENT AT MT KITTY MAY BE ANOMALOUS

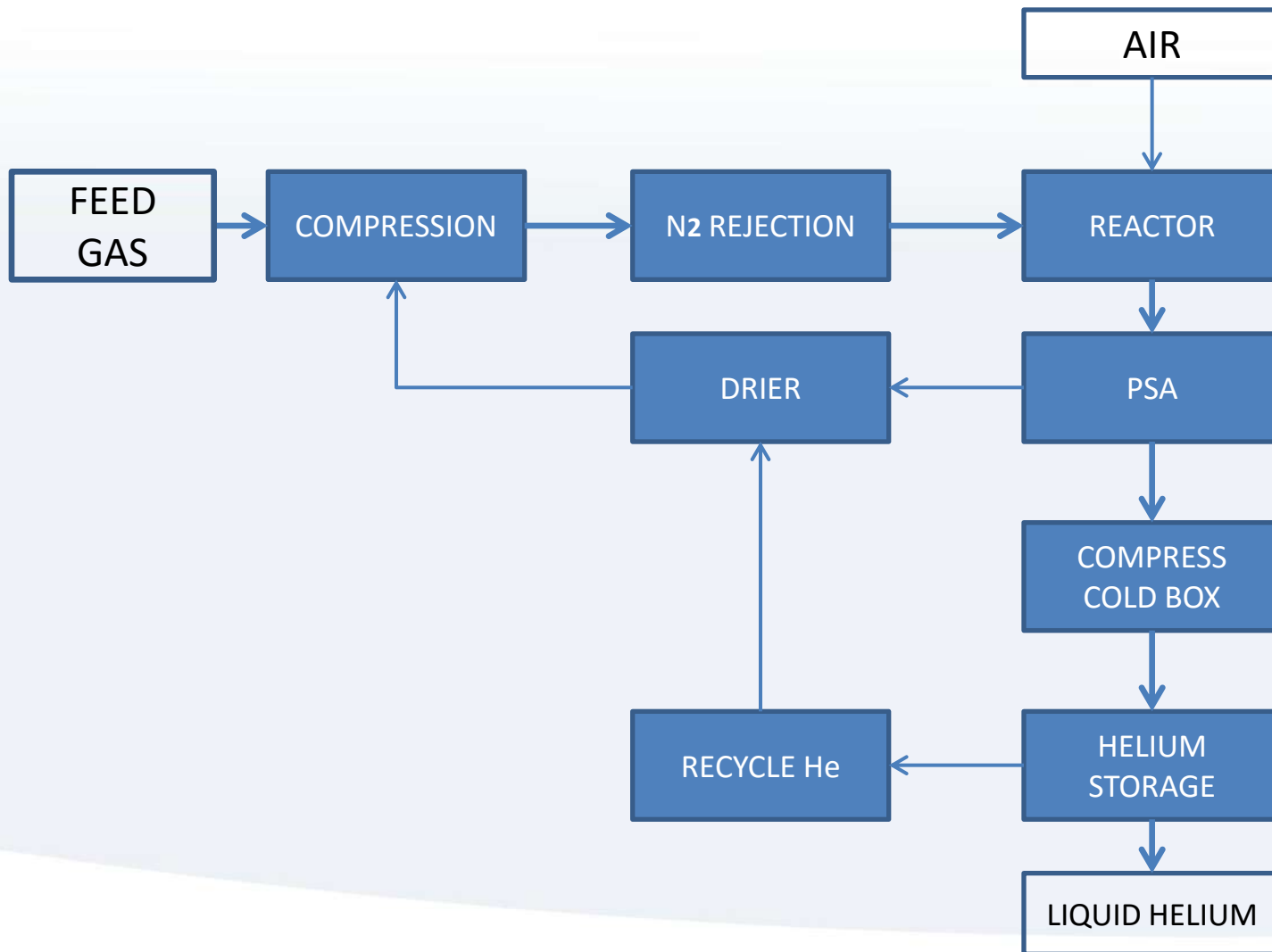
POSSIBLE USES OF PRODUCTS

HELIUM	Main product – either sold as crude He/N ₂ or pure (99.95%)
HYDROGEN	Oxidized when in low concentration; high concentration used for ore processing. External sales if logistics available
CARBON DIOXIDE	Possible sales a refrigerant
NITROGEN	As liquid used to help transport He; sales as coolant; use in well-drilling and well stimulation
METHANE	Sold as LNG, compressed gas or pipeline gas; used to run facility utilities
ETHANE	Sold in LNG etc.
PROPANE	Large volumes sold as LPG; sold in LNG etc (boosting calorific value); used to run facility utilities
BUTANE	Large volumes sold as LPG; used to run facility utilities
PENTANE	Large volumes sold as condensate; used to run facility utilities
HEXANE +	Large volumes sold as condensate; used to run facility utilities

HELIUM RECOVERY FROM MAGEE NATURAL GAS (1)



POSSIBLE HELIUM RECOVERY FROM MAGEE (2)



PROSPECTIVE FLOWS (Mcm/d) Magee

MMscfd	10	50	100	200
Mcm/d	0.283	1.413	2.826	5.652
He	0.018	0.088	0.176	0.353
H ₂	0.000	0.000	0.001	0.002
CO	0.000	0.000	0.000	0.000
CO ₂	0.002	0.012	0.023	0.047
N ₂	0.124	0.620	1.240	2.480
CH ₄	0.112	0.558	1.116	2.232
C ₂ H ₆	0.017	0.087	0.173	0.347
C ₃ H ₈	0.005	0.027	0.054	0.109
C ₄ H ₁₀	0.003	0.013	0.026	0.053
C ₅ H ₁₂	0.001	0.005	0.011	0.022
C ₆ +	0.000	0.002	0.005	0.010

ENERGY FLOWS PJ/y		Magee		
MMscfd	10	50	100	200
Mcm/d	0.28	1.41	2.83	5.65
He	0.00	0.00	0.00	0.00
H ₂	0.00	0.00	0.00	0.01
CO	0.00	0.00	0.00	0.00
CO ₂	0.00	0.00	0.00	0.00
N ₂	0.00	0.00	0.00	0.00
CH ₄	1.44	7.18	14.35	28.70
C ₂ H ₆	0.39	1.97	3.94	7.89
C ₃ H ₈	0.18	0.89	1.79	3.57
C ₄ H ₁₀	0.11	0.57	1.13	2.26
C ₅ H ₁₂	0.06	0.28	0.55	1.10
C ₆ +	0.03	0.14	0.28	0.57

HELIUM CASH FLOW DRIVES PROJECT

Gas sales	\$/GJ	5
He (crude)	\$/cm	3.03
He recovery efficiency		70%
Thermal efficiency		75%

	CASH FLOW (\$M/y)				
	10	50	100	200	
MMscfd	10	50	100	200	
Mcm/d	0.28	1.41	2.83	5.65	
He	12.71	63.56	127.11	254.22	
H ₂					} Oxidised and removed
CO					
CO ₂					
N ₂					} Assumed no value
CH ₄	8.27	41.34	82.69	165.37	
C ₂ H ₆					} Used for utilities
C ₃ H ₈					
C ₄ H ₁₀					
C ₅ H ₁₂					
C ₆ +					

OUTLINE ECONOMICS FOR 50MMscfd INPUT

MMscfd		50
Capital cost	\$M	\$ 300.00
Return on capital (14%)	\$M/y	\$ 42.00
Working capital	\$M	\$ 5.61
Return on working capital (10%)	\$M/y	\$ 0.56
Operating cost		
Labour (3.5% capex)	\$M/y	\$ 10.50
Maintenance (3.5% capex)	\$M/y	\$ 10.50
Chemicals (1.5% capex)	\$M/y	\$ 4.50
Others (1.5% capex)	\$M/y	\$ 4.50
	\$M/y	\$ 30.00
GAS COSTS		
\$3/Mcf	\$M/y	\$ 51.00
TOTAL COST	\$MM/y	\$ 123.56
Gas by-product credit (\$5/GJ)	\$MM/y	\$ 41.34
He production cost	\$MM/y	\$ 82.22
	\$/cm	\$ 2.74

QUESTIONS for YOU

Do you have gas discoveries that are:

1. Undeveloped,
2. With high nitrogen, and that:
3. Could contain HELIUM?

If so, seriously consider investigating those discoveries.

QUESTIONS PLEASE

and

THANK YOU

Duncan Seddon

Email: seddon@ozemail.com.au