



Application of ϵ UCG™ Technology in International Commercial Projects

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The Essence

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The Exergy UCG™ (εUCG) –

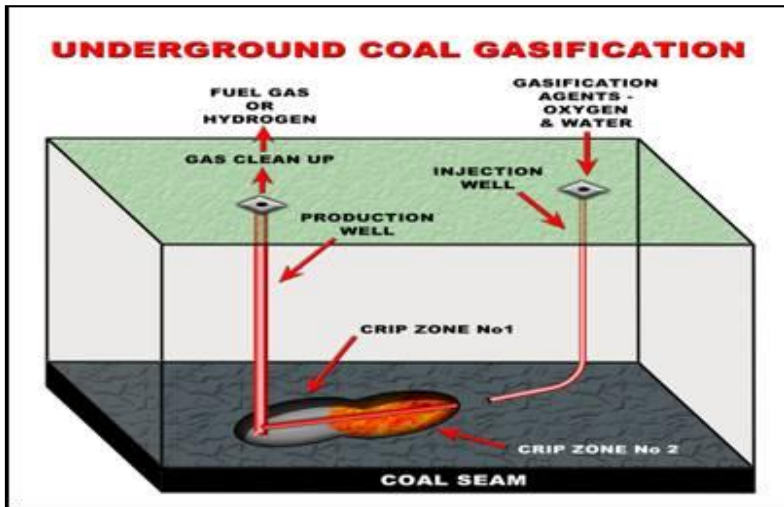
the Source of Hydrocarbons from Unminable Coal:

- Indigenous and safe
- Environmentally Clean and Carbon Efficient
- Cost Competitive
- for IGCC Power Generation
- for Synthesis of Clean Fuels & Chemicals

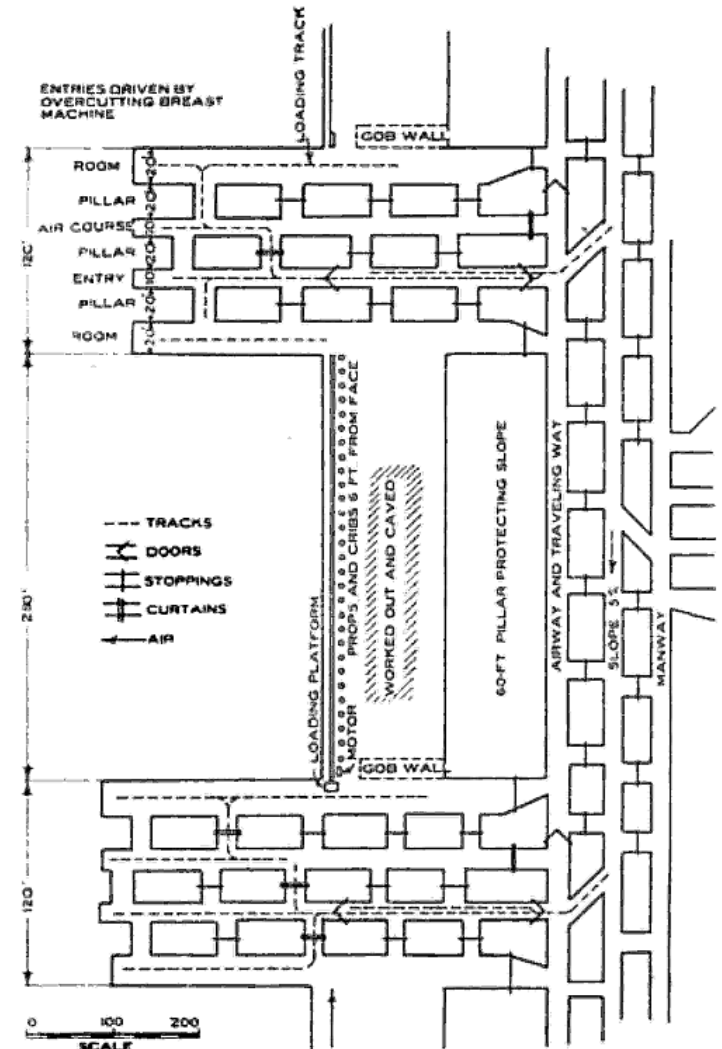
εUCG: Coal Mining Technology

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- εUCG is not a 2-well process, but large-scale mining method
- Rock deformation and ground water influx management
- Injects oxygen, air, H₂O, CO₂ etc.
- Drilling of directional, inclined, vertical and other wells
- Modern technology based on 70+ years of Soviet work
- Average panel capacity 5PJ/a (0.3 Mt/a), 2-5 years life
- Mine-average coal extraction rates of 95%
- Mine-average cold gas efficiency of 75-85%
- Issues: large-scale consumption of GW, subsidence



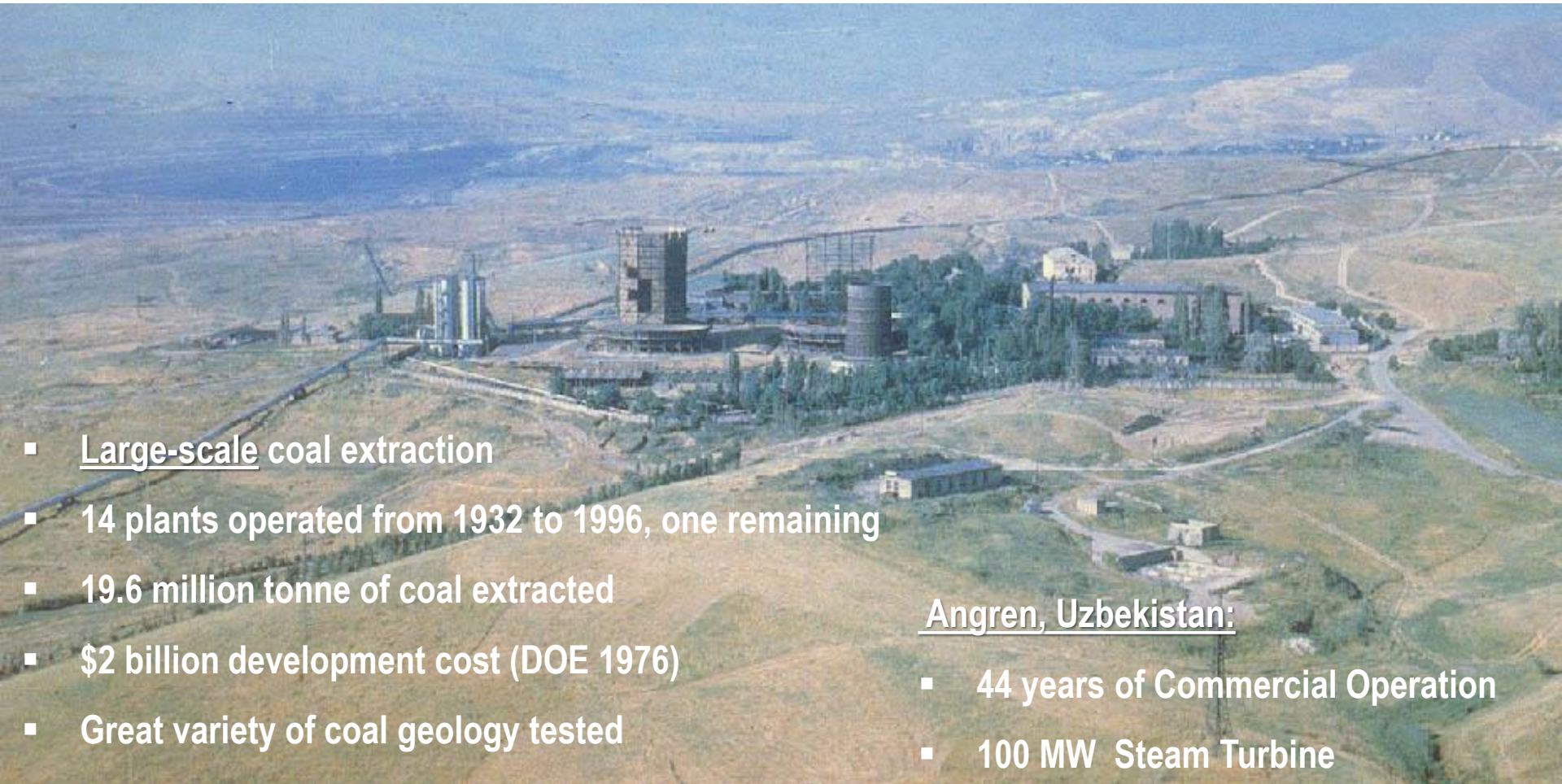
vs.



εUCG Technology

Soviet UCG Program

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- Large-scale coal extraction
- 14 plants operated from 1932 to 1996, one remaining
- 19.6 million tonne of coal extracted
- \$2 billion development cost (DOE 1976)
- Great variety of coal geology tested

Angren, Uzbekistan:

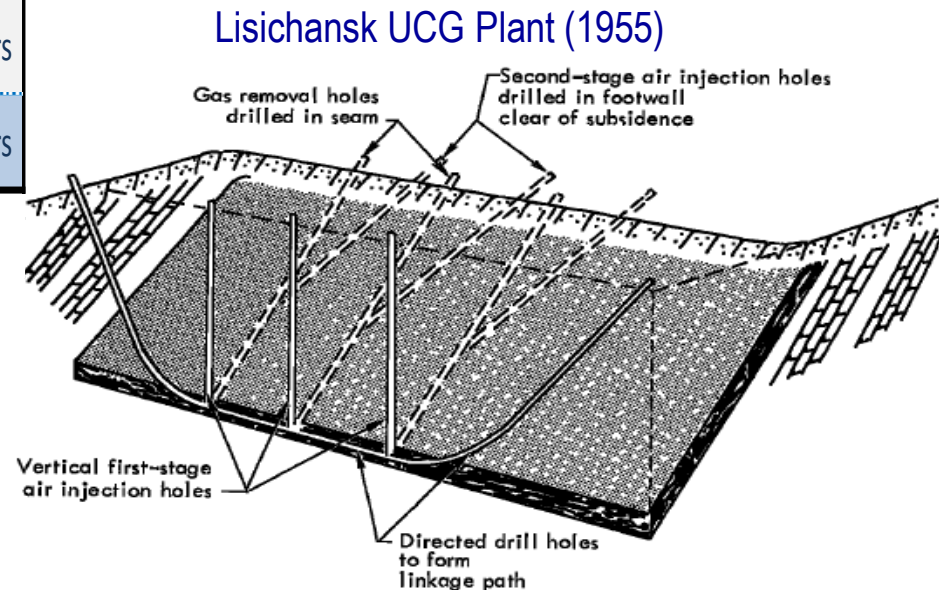
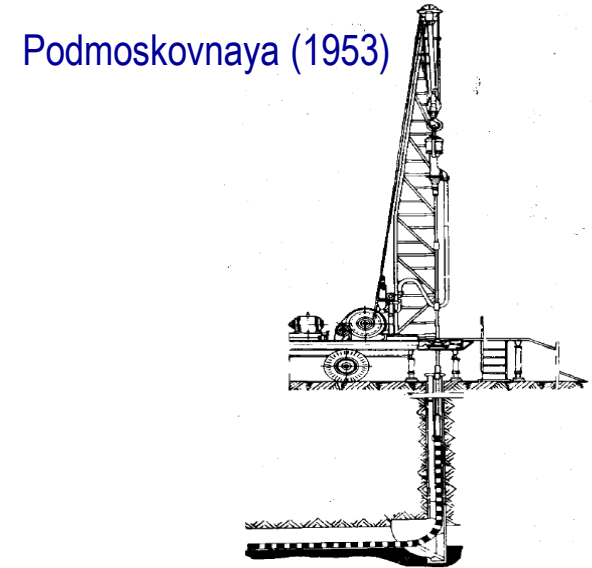
- 44 years of Commercial Operation
- 100 MW Steam Turbine

Directional Drilling in Soviet Plants

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UCG Plant	Life time	1 st Direct. hole	Total in-seam legth drilled, m	Note
Gorlovka	1935-41	1936	648	6 wells
Lisichansk	1936-77	1934	37,000	ID 200mm
Podmoskovnaya	1940-64	1948	1,260	90°, ID 140mm
Shatskaya	1959-76	1959	1,650	90°, ID 140mm
Yuzhno-Abinskaya	1955-96	1957	32,400	downhole motors
Angren*	1961 -	1963	24,800	downhole motors

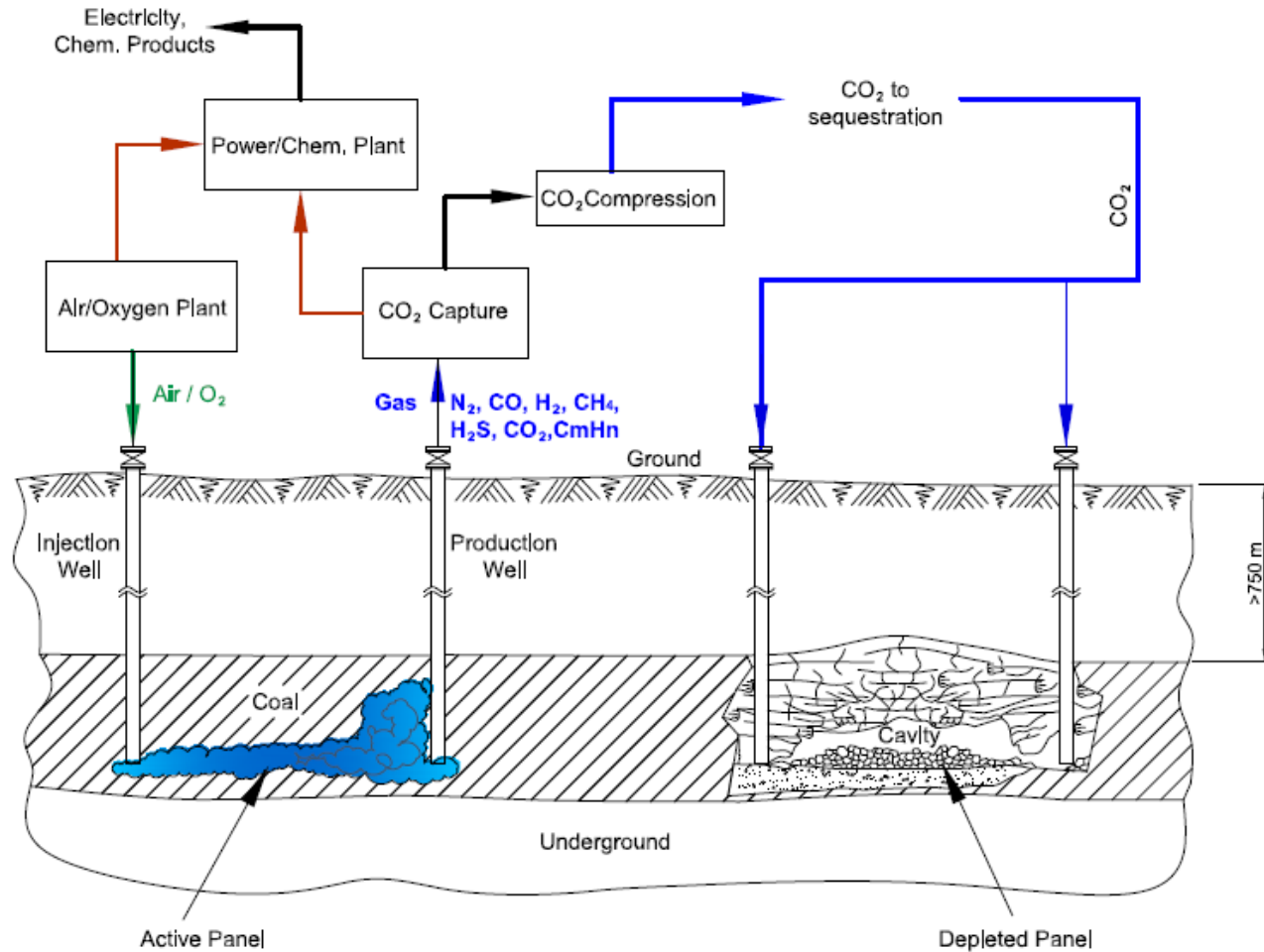
*Until 1999



εUCG & Global Warming

CO₂- Sequestration

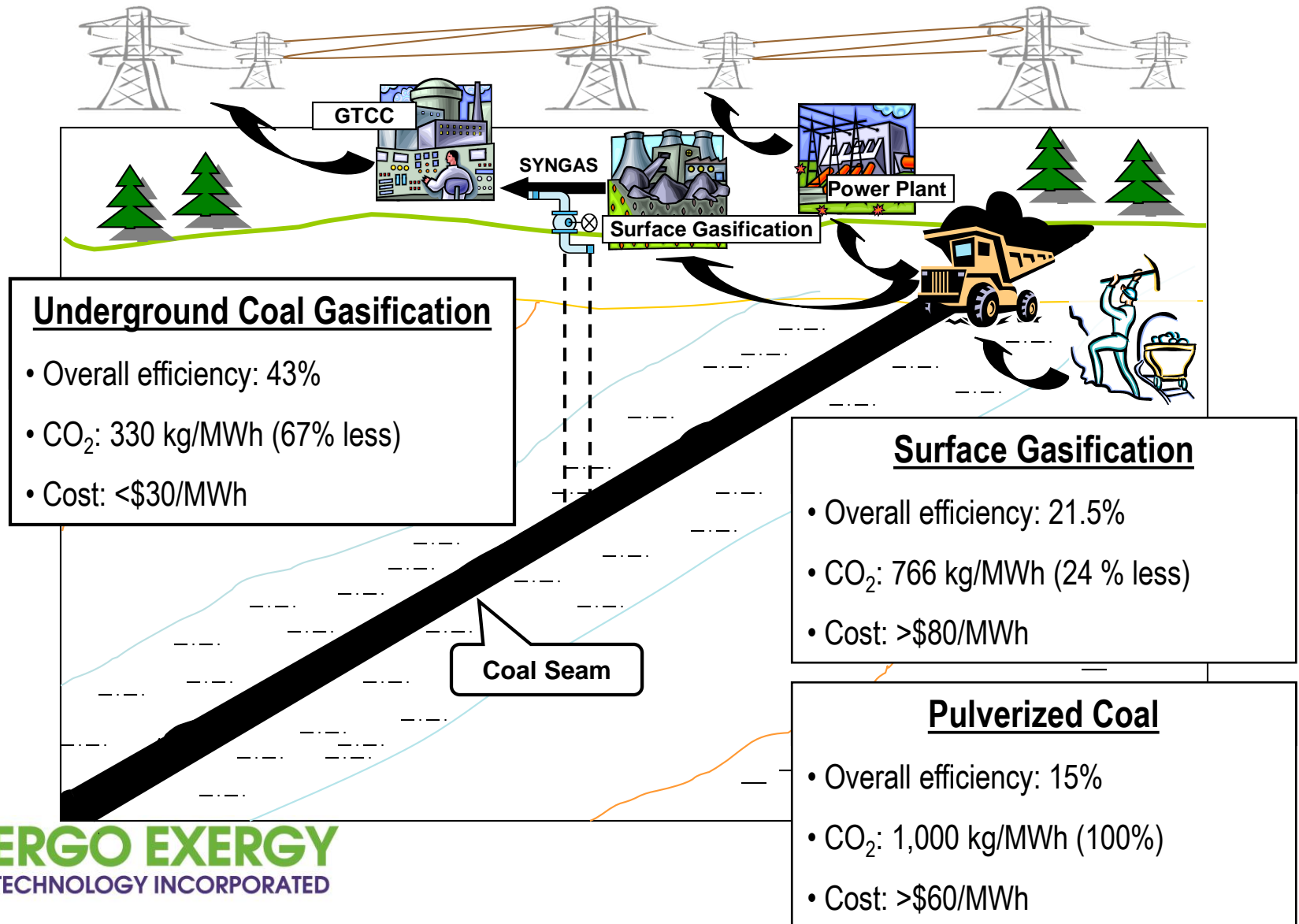
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ε UCG vs. Conventional Coal

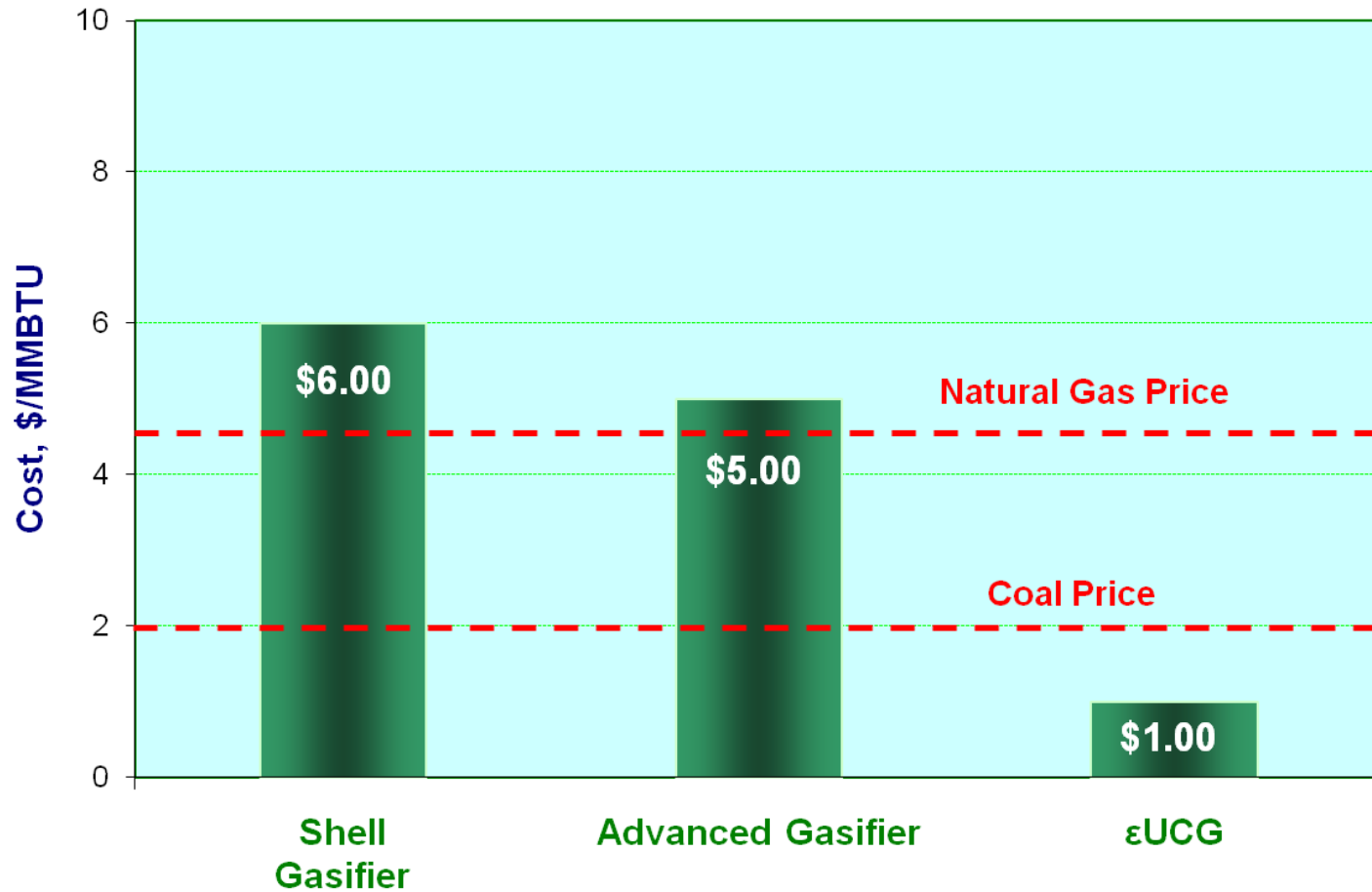
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εUCG Syngas

Low Cost product

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Texas: ϵ UCG vs. CG

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ϵ UCG vs. CG, Cost Reduction

	Capital	O&M	Coal	By-products Credit	Product
Electricity	39%	28%	98%	29%	56%
SNG/CH ₄	55%	43%	98%	-25%	66%
Methanol	52%	49%	98%	-25%	62%
Gasoline	42%	44%	98%	-24%	55%
Diesel	36%	44%	98%	-15%	54%
Urea	29%	42%	98%	-25%	44%

CO₂ Capture (% of total Carbon in coal)

	Electricity	SNG	Methanol	Gasoline	Diesel	Urea
ϵ UCG	57%	45%	43%	43%	48%	29%
CG	43%	56%	57%	57%	62%	39%

Texas: eUCG vs. CG

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With the same:

Feedstock, Project location, Labor cost, Financing conditions & Market

eUCG delivers the following advantages:

- 30-55% lower capital cost
- 30-50% lower O&M cost
- 98% lower lignite cost
- **45-65%** lower product costs

εUCG Technology

All Kinds of Coal

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UCG Plant	Rank	Thickness, m	Depth, m	Dip°	LHV,MJ/kg
<i>Lisichansk</i>	Bituminous	0.44 - 2.0	60 - 250	38 - 60	20.1 - 23.0
<i>Yuzhno-Abinsk</i>	Bituminous	2.2 - 9.0	130 - 380	35 - 58	28.9 - 30.7
<i>Podmoskovnaya</i>	Lignite	2.5	30 - 80	<1	11.8
<i>Angren</i>	Lignite	3.0 - 24.0	110 - 250	7	15.3
<i>Shatskaya</i>	Lignite	2.6	30 - 60	<1	11.0
<i>Sinelnikovo</i>	Lignite	3.5 - 6.0	80	<1	8.0
<i>Chinchilla</i>	Sub-bituminous	10.0	135	<1	21.7
<i>Majuba</i>	Bituminous	3.5-4.5	285	3	20.3
<i>Kingaroy</i>	Sub-bituminous	17.0	200	5	23.5
<i>Huntly West</i>	Bituminous	4.0-22.0	220-540	0-75	24.5
<i>CC Alberta</i>	Sub-bituminous	7.0	150-260	6	20.5-23.0
<i>Alaska SHR</i>	Lignite/ Sub-bituminous	1.0-12.0	50-650	0-75	11.0-16.5



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Chinchilla I (Ergo 1997-2006)

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Status Nov. 2006 : fully quenched, shut down.

- 1 panel - 9 process wells; capacity 80,000 Nm³/h, 30 months
- 35,000 t of coal extracted, over 80 million Nm³ of gas, stable gas quality LHV=5.0 MJ/Nm³, p = 1100 kPa, t = 120° C
- Demonstrated 95% recovery of the target coal resource and 75% total energy recover.
- Gasifier pressure was always lower than hydrostatic.
- Three-phase gradual shutdown procedure ended in 2003.
- Venting cavity at the time of shutdown operation.
- Cavity cooling by natural water influx.



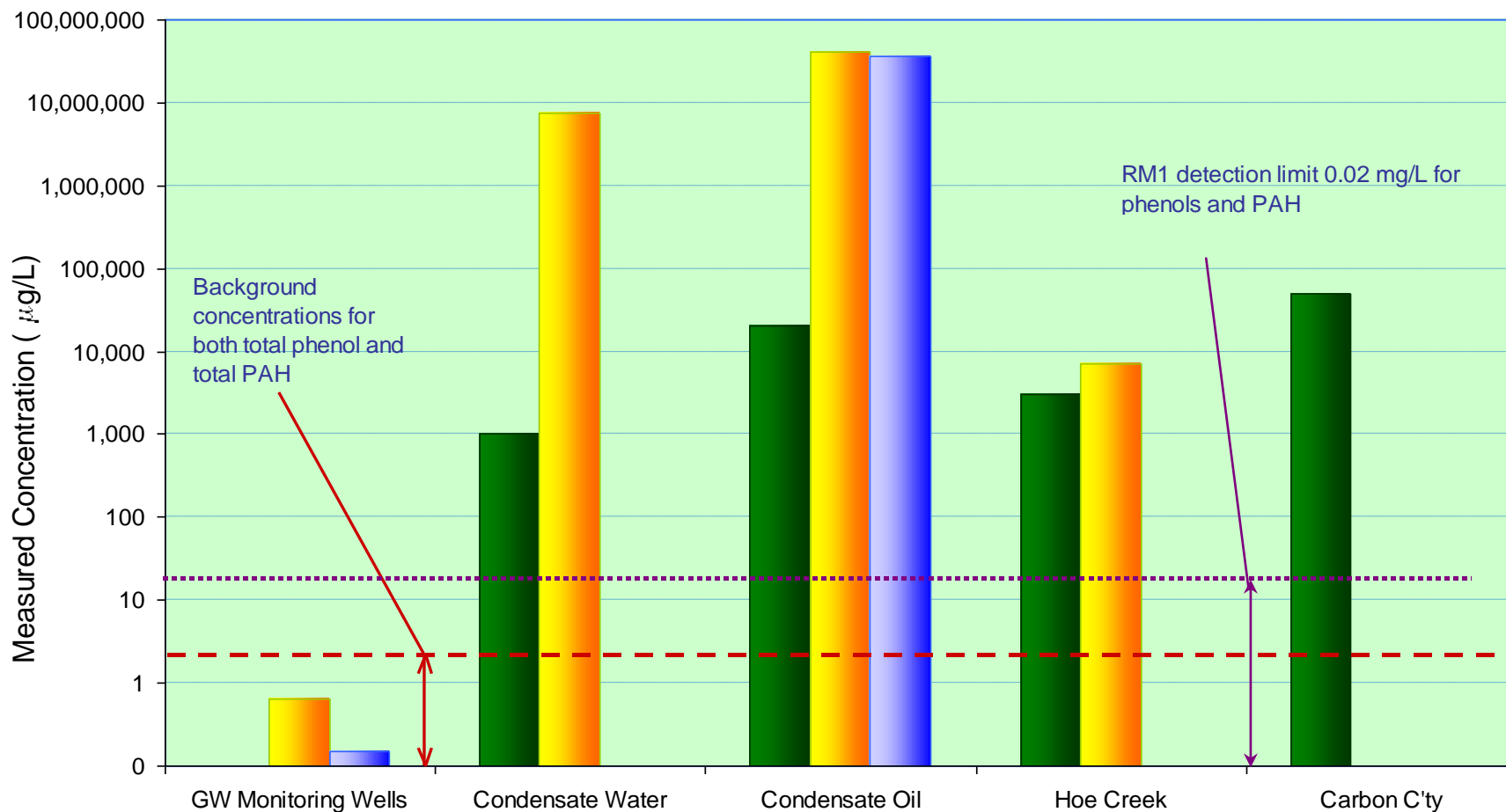
- Environmental monitoring during operation, shutdown and post shutdown complied with rigorous EPA requirements; quarterly environmental performance reports prepared by Golder Associates have been submitted to Queensland EPA.
- Annual environmental audits by independent company Sinclair Knight Merz – during all seven audits no environmental issues reported.

No environmental issues from 1997 to Nov. 2006

Chinchilla I (Ergo 1997-2006)

Groundwater Protection

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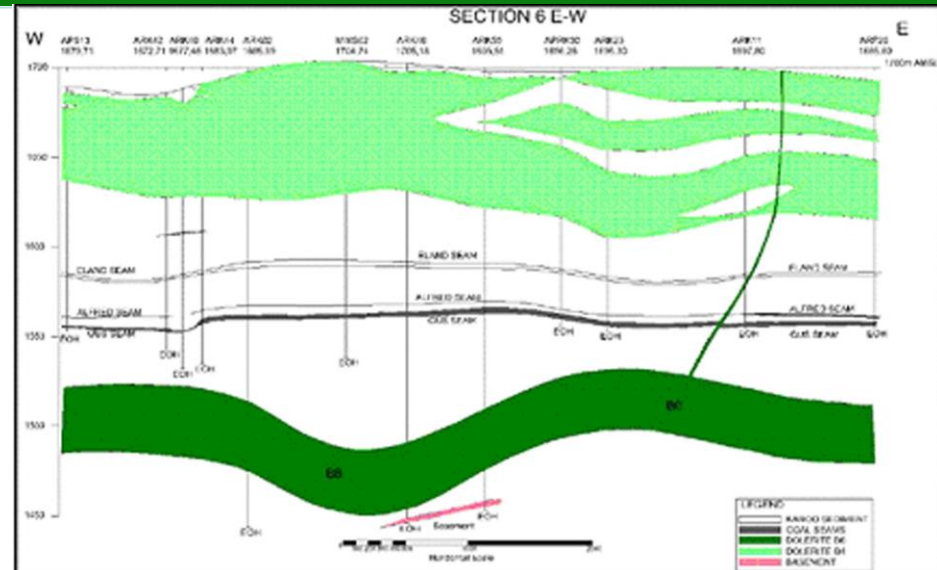
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■ Benzene ■ Total Phenol ■ Total PAH

Majuba ϵ UCG Project (Eskom)

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- Multiple unresolved small faults and dykes
- Very low: permeability, moisture, VM, reactivity
- Sponcom Hazard
- Overburden rock: negative angles of draw
- 7 years of ϵ UCG operation, over 60,000t
- 1 directional, 10 vertical wells
- Record RCL rates
- Successful environmental management
- Co-firing syngas in commercial boilers
- Controlled Shutdown of panel 1 underway
- FEED for 140MWe Gas Turbine Plant
- Commissioning of 6MWe ϵ UCG co-firing plant
- Developing 70,000 m³/h plant
- Pathway to 2,100MWe ϵ UCG-IGCC plant



Kingaroy ε UCG Project (Cougar)

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- 210m depth, 19m thick sub-bituminous coal seam
- Partial (top 50%) coal seam extraction
- Soft unconsolidated overburden with strong basalt layers – multiple casing completion
- High permeability coal seam: vertical wells with RCL (15.7m/day)
- Short operation – RCL only

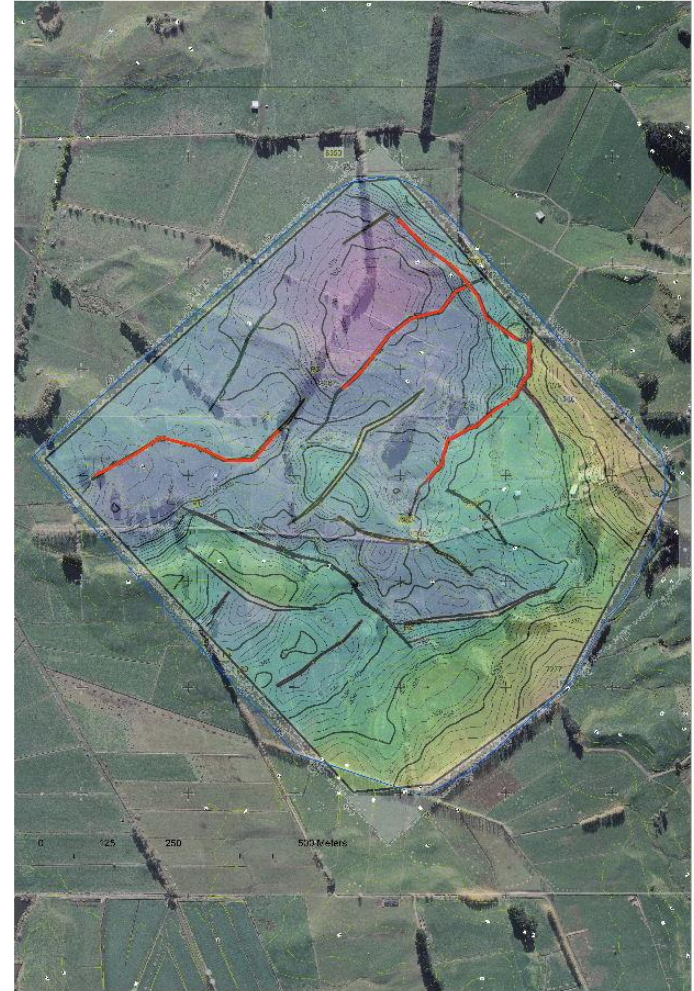
- Commissioned March 15, 2010
- Shut down due to laboratory error
- 17,000 analyses of GW have been undertaken on and around the site and no contamination of ground water has been detected
- Plant moth-balled



Huntly West ϵ UCG Project (SENZ)

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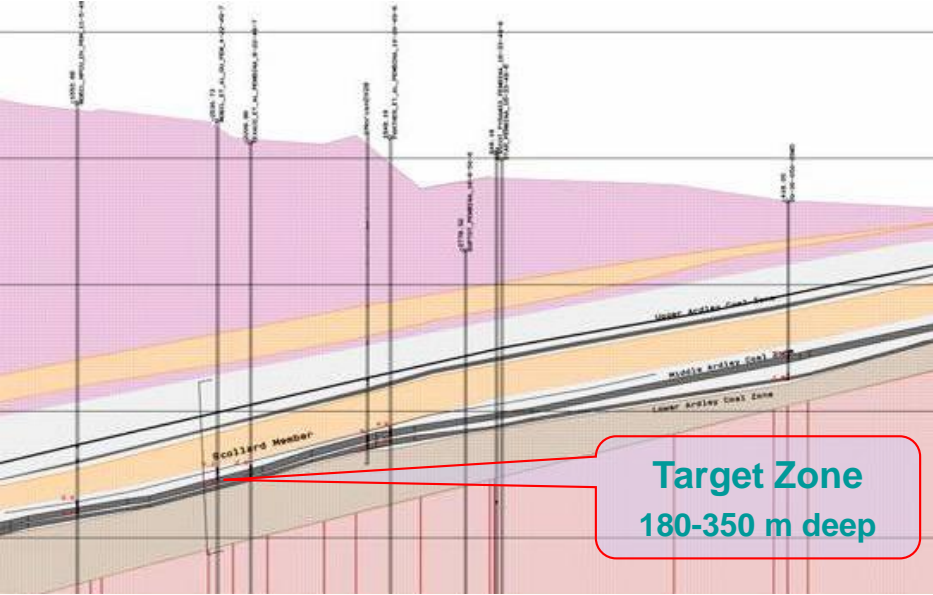
- Depth 240 – 540 m, very complex geology
- Two target coal seams gasified together
- Coal thickness >17m
- Partial (top 30%) coal seam extraction
- Over 35 bar hydrostatic pressure
- Very weak coal, overburden – multiple casings
- Sponcom Management
- Vertical wells, Aquasplitt™ & RCL
- Pilot Plant Started April 12, 2012
- 5 months operation, over 5,000t
- Controlled shut-down completed
- No environmental issues



[Image: Solid Energy New Zealand Ltd](#)

Alberta eUCG Project (Laurus Energy)

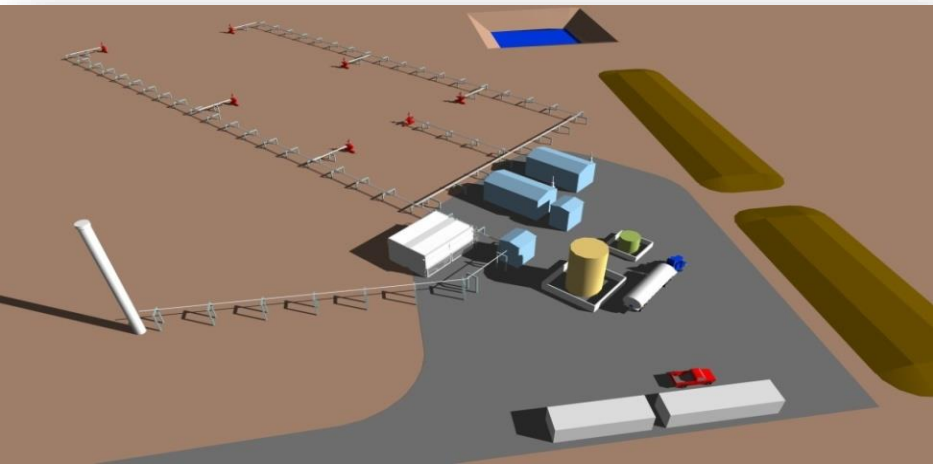
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- Consistent 7m coal seam
- Depth 180 -350m
- High quality subbituminous coal
- No known faults or geological complications
- Low permeability coal
- Poor coal aquifer
- Protection of sub-surface aquifers

Status

- P-F & Site characterization completed
- Demonstration Plant permits obtained
- Commenced EIA
- Built demonstration plant
- GW monitoring
- Calibration burn pending

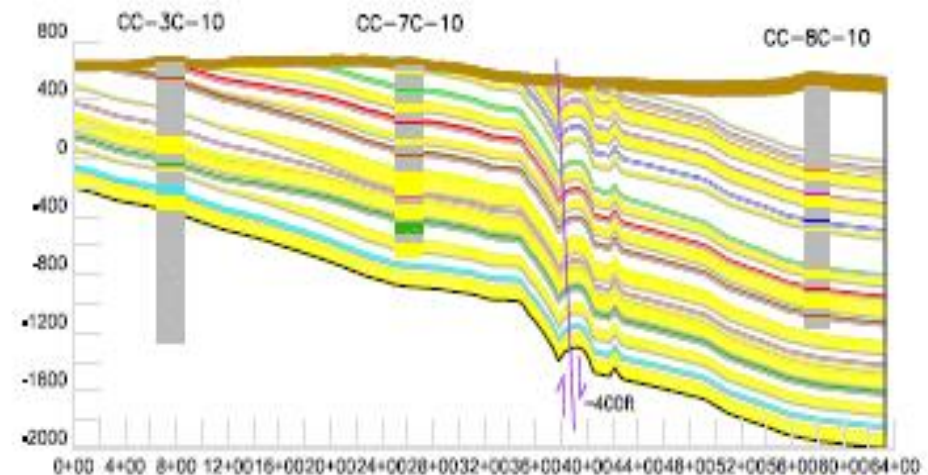


SHR & UCG Project (Laurus Energy)

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- Depth 200-1650m
- Weak, partly unconsolidated surrounding rock
- Sequence of 14 coal seams, 2 – 7m thick
- Remote location, limited site access
- Rank varies from lignite to subbituminous within project area
- Multiple major faults
- Multiple sand bands in the formation
- Completed Exploration & Site Selection
- Site Characterization starting

[Images: StoneHorneRidge Project](#)



NFS εUCG Project (Sasol)

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- 1.5 to 8m coal seams
- Depth 140 – 470m
- Strong stable overburden rock
- Piezopermeability effects
- Oxygen injection
- F-T syngas
- Site Selection and Pre-Feasibility completed



The Exergy UCG Technology

Score Card...

© Copyright Ergo Exergy Technologies Inc. 2015. All rights reserved.

- ✓ Clean Energy from Unminable Coal
- ✓ Exergy- and Carbon-Efficient
- ✓ Cost Competitive
- ✓ Worldwide Applications

Muchas Gracias!

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¿Tienes preguntas?