



# Application of $\epsilon$ UCG™ Technology in International Commercial Projects

*Ergo Exergy Technologies Inc.*

*Montréal, Québec, CANADA*

High Commission for Pakistan, Montreal, August 03, 2016

# The Essence

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## The Exergy UCG™ (εUCG) –

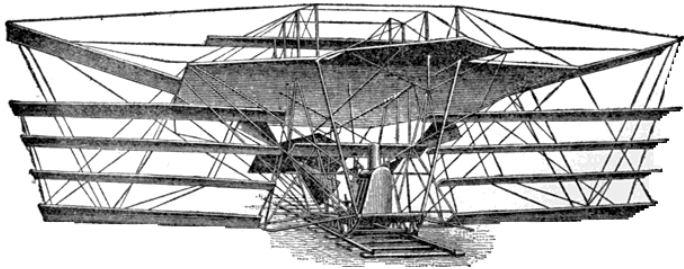
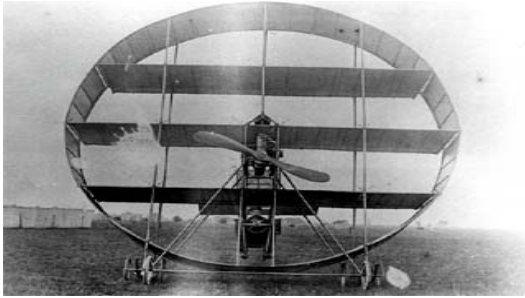
the Source of Hydrocarbons from Unminable Coal:

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

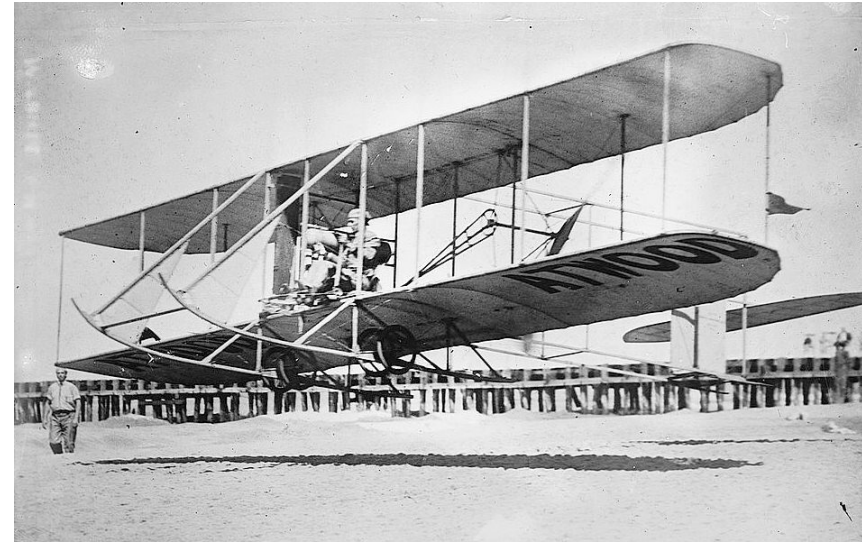
# εUCG Technology

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## Runners-Up



## The Winner

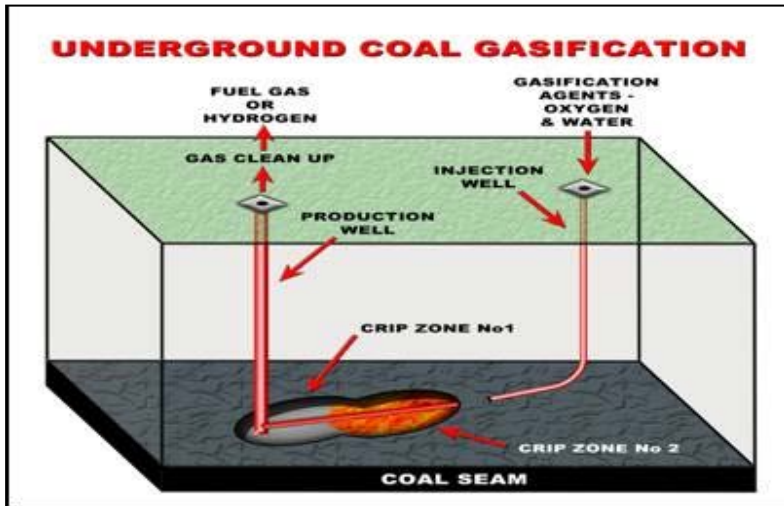


Wright Brothers

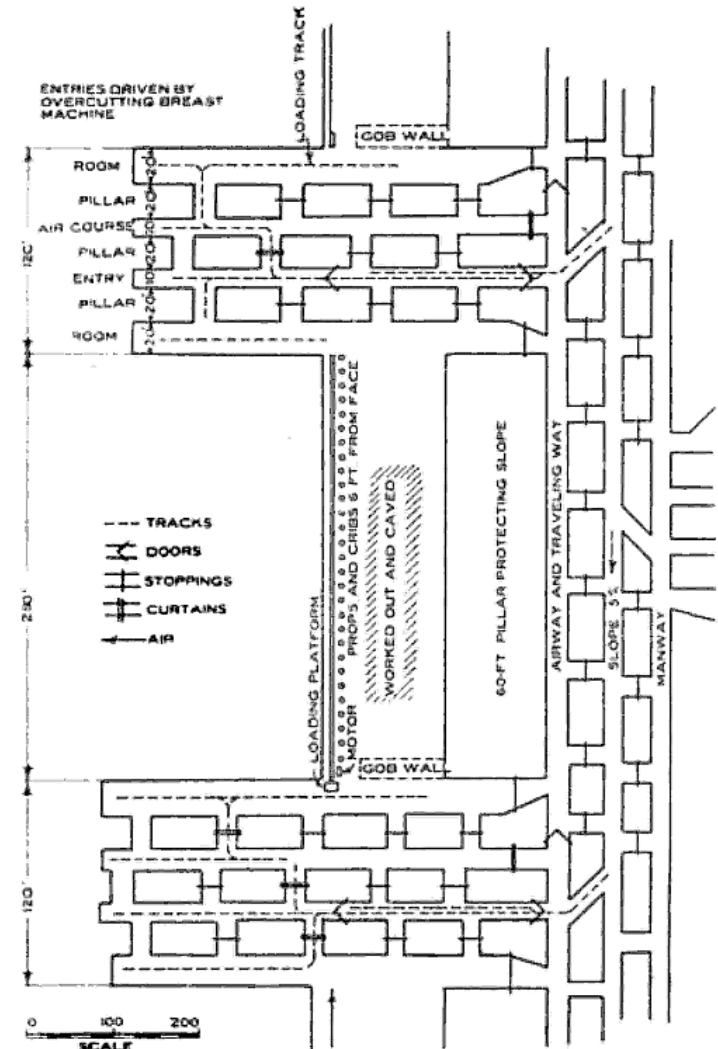
# εUCG: Coal Mining Technology

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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, H<sub>2</sub>O, CO<sub>2</sub> 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



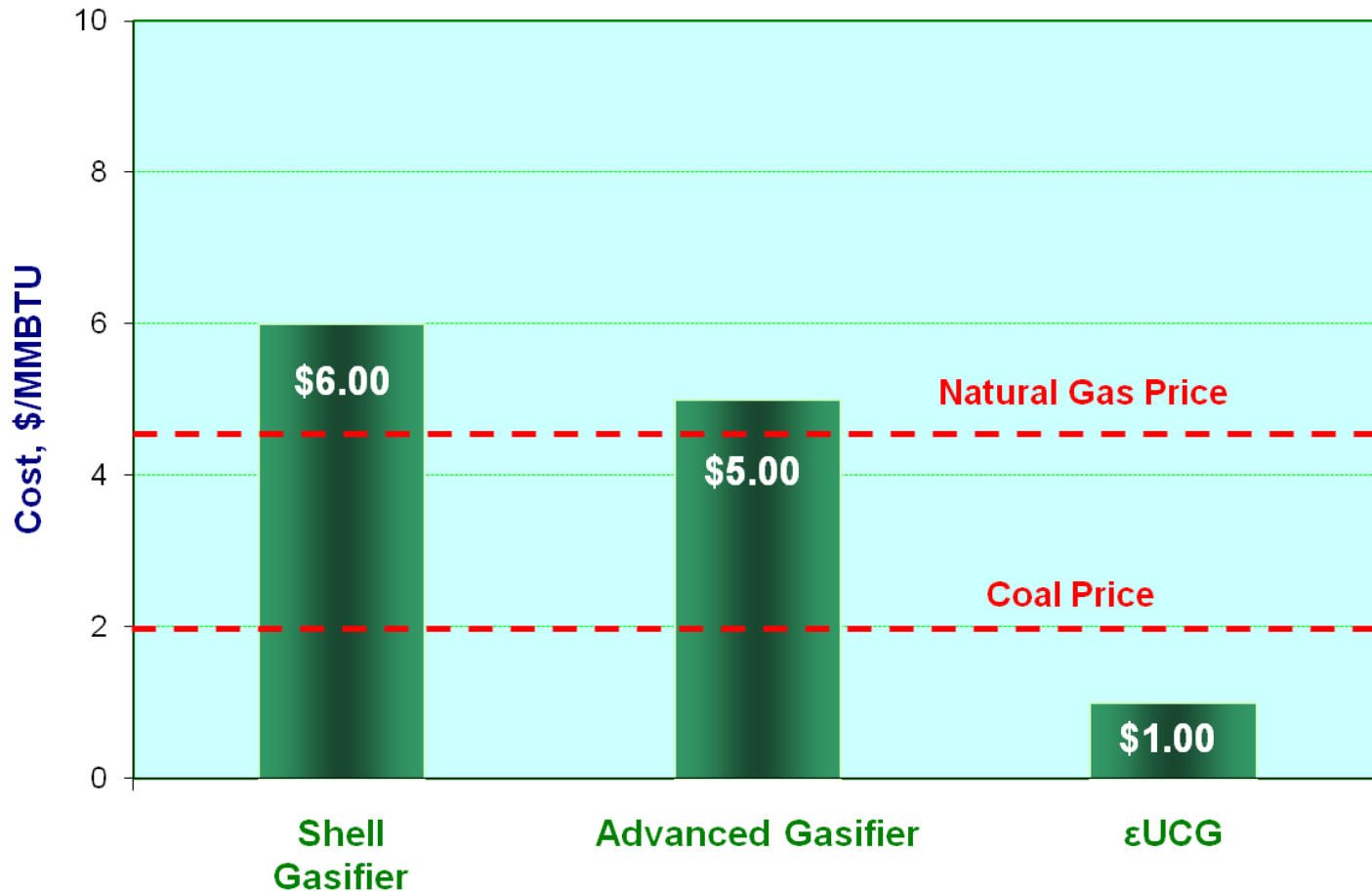
vs.



# εUCG Syngas

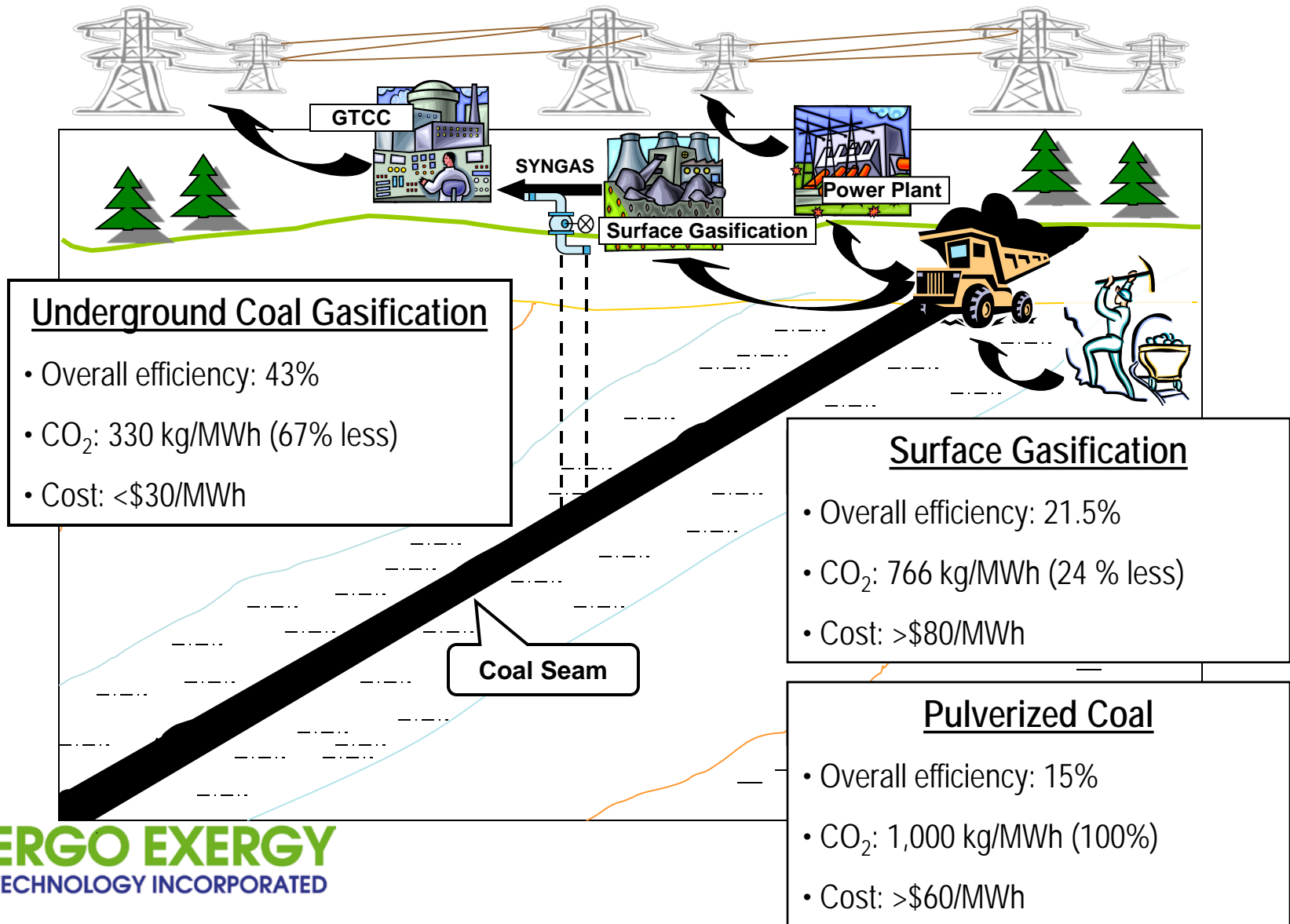
*Low Cost product*

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# εUCG vs. Conventional Coal

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# 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

# Chinchilla I and II

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## Chinchilla I and Chinchilla II:

Two completely different operators



Two completely different results.



# Chinchilla I (Ergo 1997-2006)

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Status Nov. 2006 : fully quenched, shut down.

- 1 panel - 9 process wells; capacity 80,000 Nm<sup>3</sup>/h, 30 months
- 35,000 t of coal extracted, over 80 million Nm<sup>3</sup> of gas, stable gas quality LHV=5.0 MJ/Nm<sup>3</sup>, p = 1100 kPa, t = 120<sup>o</sup> 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.



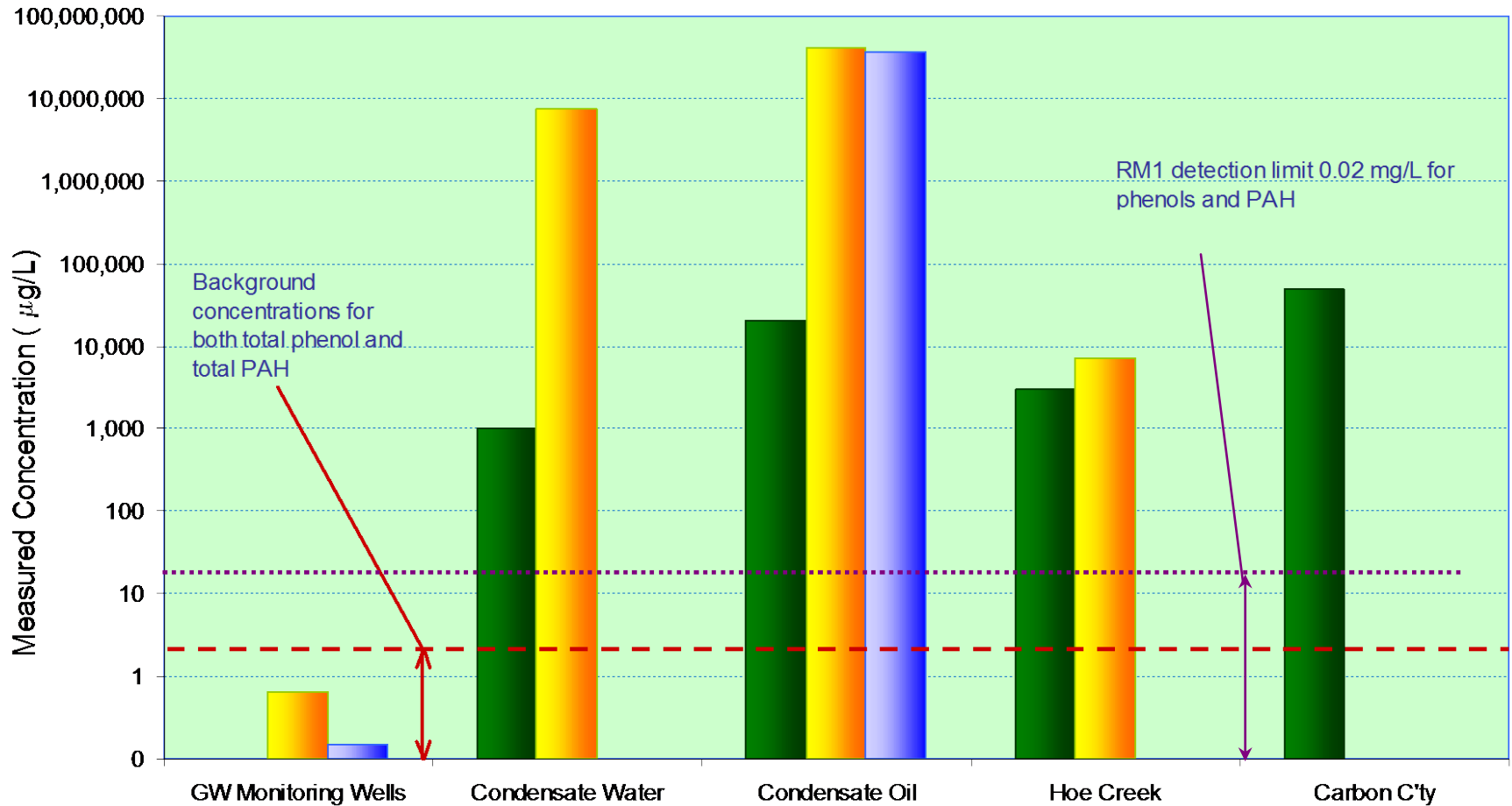
- Environmental monitoring during operation, shutdown and post shutdown complied with rigorous EPA requirements; quarterly environmental performance reports prepared by Golder Associates have been submitted to Queensland EPA.
- Annual environmental audits by independent company Sinclair Knight Merz – 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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# Chinchilla II (Linc 2007-2015)

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*No Involvement of Ergo Exergy Technologies Inc.*

In operation : 2007 – 2013, four consecutive trials, total extraction under 10,000t; shutdown underway

Major environmental investigation by Department of Environmental and Heritage Protection (QEHP) :

- More than 230 bores were drilled; water and soil samples were collected from 13 farms.
- Lab tests confirmed presence of carbon monoxide, hydrogen, hydrogen sulphide, BTEX and other chemicals.
- Allegedly found “scientific evidence of operation above hydrostatic pressure, fracturing the landform, and excursion of contaminants.”

QEHP alleges that plant owner failed to report numerous plant incidents:

- Fire that caused site evacuation in 2007
- Persistent leaks of toxic gas into air and groundwater from 2007 till 2011
- Worker’s claims about their ill health as result of “uncontrolled releases” of gas at site in 2007-2013.

QEHP Charges:

- Irreversible damage “to more than one environmental receptor [the atmosphere, vegetation, water and soil].”
- A 320 km<sup>2</sup> exclusion zone around 1 km<sup>2</sup> plant.
- EHP has laid 5 criminal charges against the plant owner

# Majuba $\epsilon$ UCG Project

*PC Co-Firing* → *IGCC*

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Majuba Power Plant:

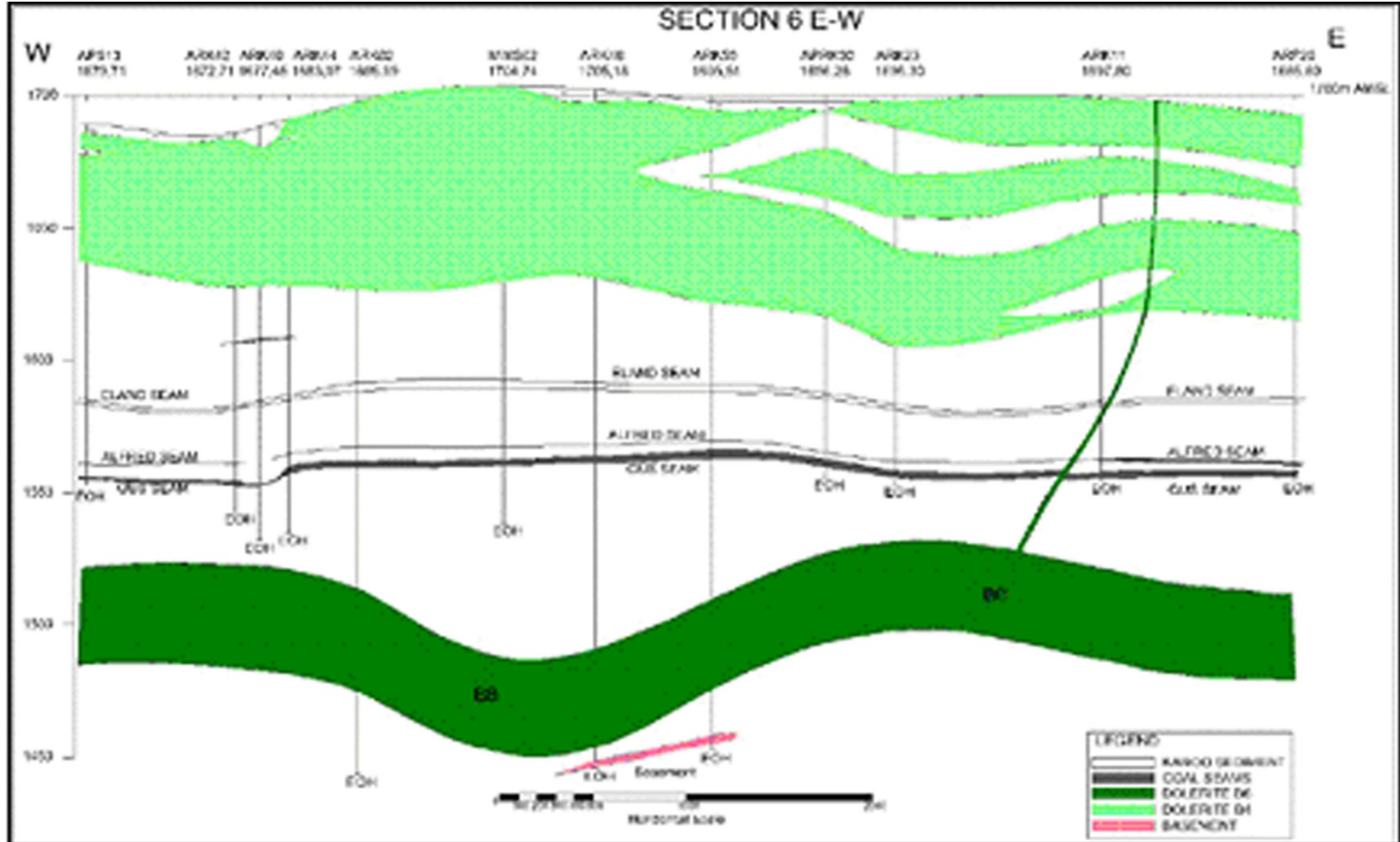
4,200 MW<sub>e</sub>



# Majuba $\epsilon$ UCG Project

PC Co-Firing  $\rightarrow$  IGCC

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# Majuba $\epsilon$ UCG Project

*First  $\epsilon$ UCG Gas in Africa*

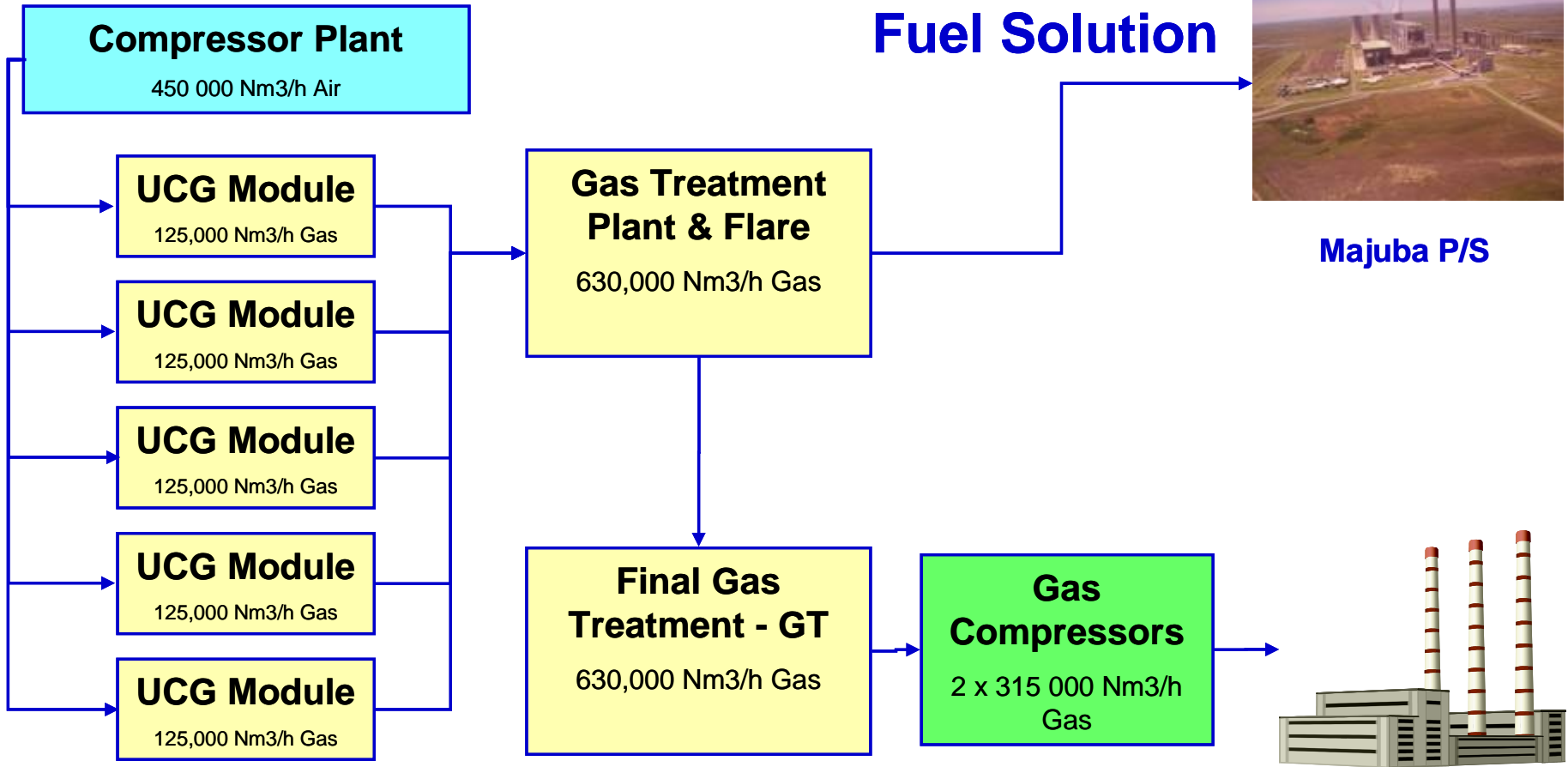
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# Majuba $\epsilon$ UCG Project

PC Co-Firing  $\rightarrow$  IGCC

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**Capacity Solution**

**350 MWe IGCC**

# Majuba $\epsilon$ UCG Project

*PC Co-Firing → IGCC*

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New Gas  
Treatment Plant



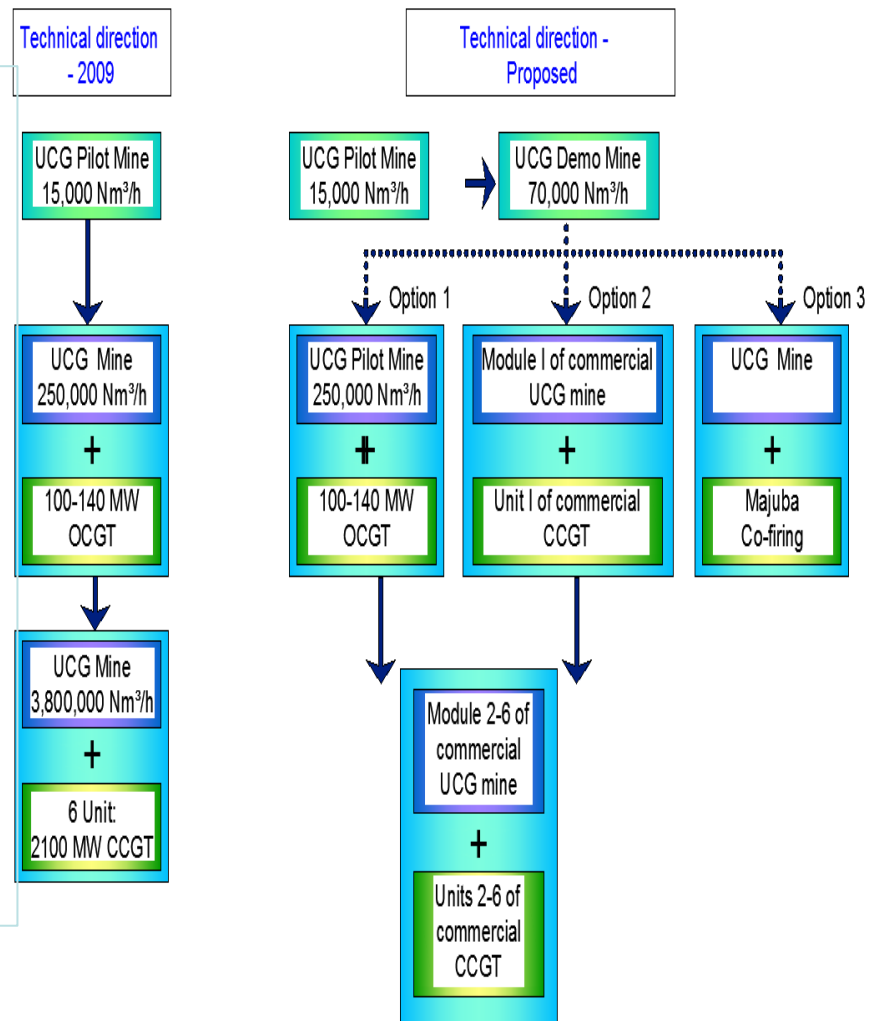


# Majuba $\epsilon$ UCG Project:

- PC Co-Firing  $\rightarrow$  IGCC

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- Multiple unresolved small faults and dykes
- Very low permeability, low moisture coal
- Record RCL rates
- 7 years of continuous  $\epsilon$ UCG operation
- Successful environmental management
- Co-firing syngas in commercial boilers
- Controlled Shutdown of panel 1 underway
- FEED for 140MWe Gas Turbine Plant
- Commissioning of 6MWe  $\epsilon$ UCG co-firing plant
- Developing 70,000 m<sup>3</sup>/h commercial-scale panel
- Pathway to 2,100MWe  $\epsilon$ UCG-IGCC plant



Source: Eskom Holding Ltd.

# Kingaroy eUCG 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

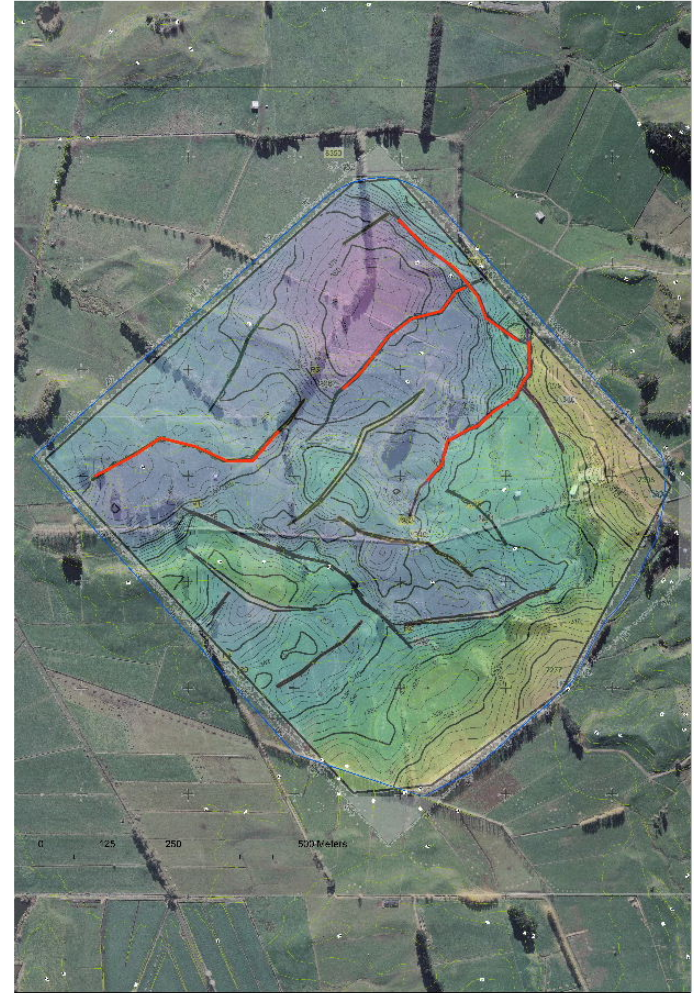
- Commissioned March 15, 2010
- Shut down due to laboratory error
- 17,000 analyses of GW have been undertaken on and around the site and no contamination of ground water has been detected
- Plant moth-balled



# Huntly West $\epsilon$ UCG Project (SENZ)

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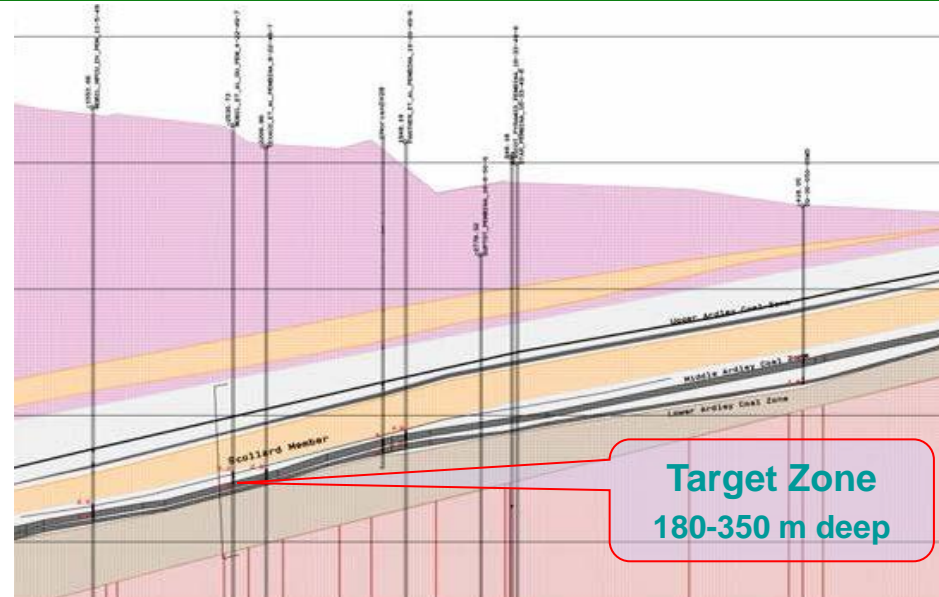
- Depth 240 – 540 m, very complex geology
- Two target coal seams gasified together
- Coal thickness >17m
- Partial (top 30%) coal seam extraction
- Over 35 bar hydrostatic pressure
- Very weak coal, overburden – multiple casings
- Sponcom Management
- Vertical wells, Aquasplitt™ & RCL
- Pilot Plant 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)

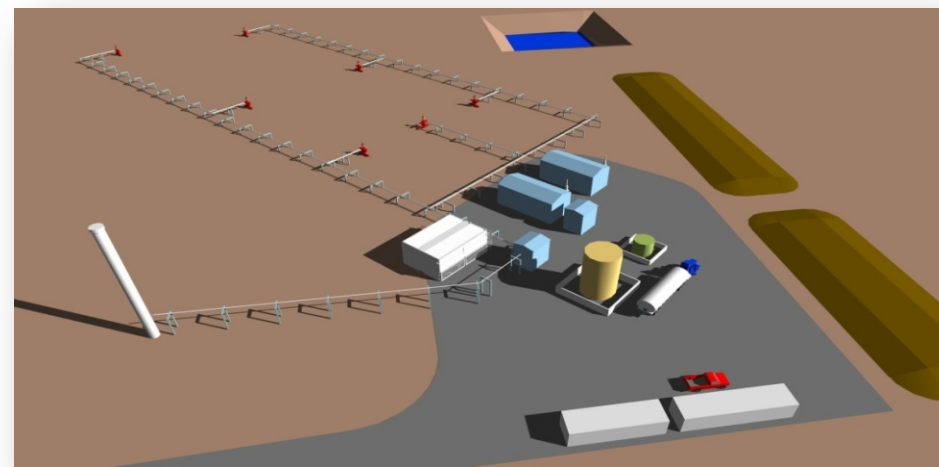
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- Consistent 7m coal seam
- Depth 180 -350m
- High quality subbituminous coal
- No known faults or geological complications
- Low permeability coal
- Poor coal aquifer
- Protection of sub-surface aquifers

## Status

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

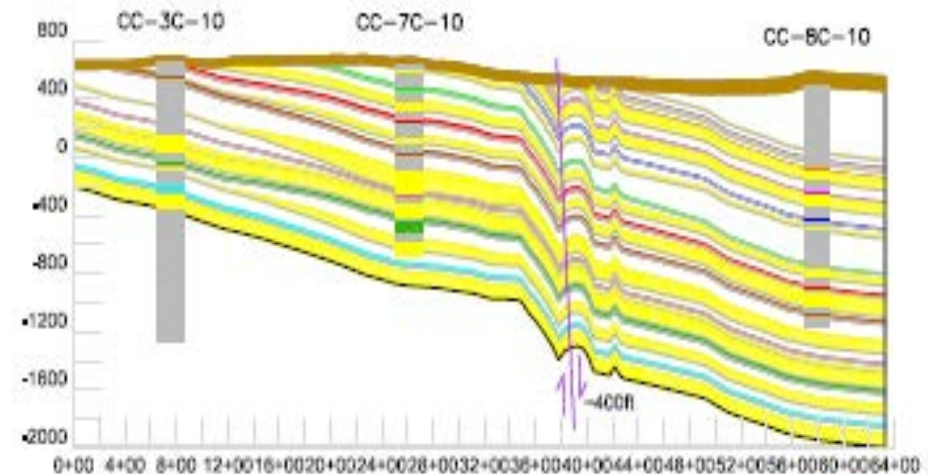
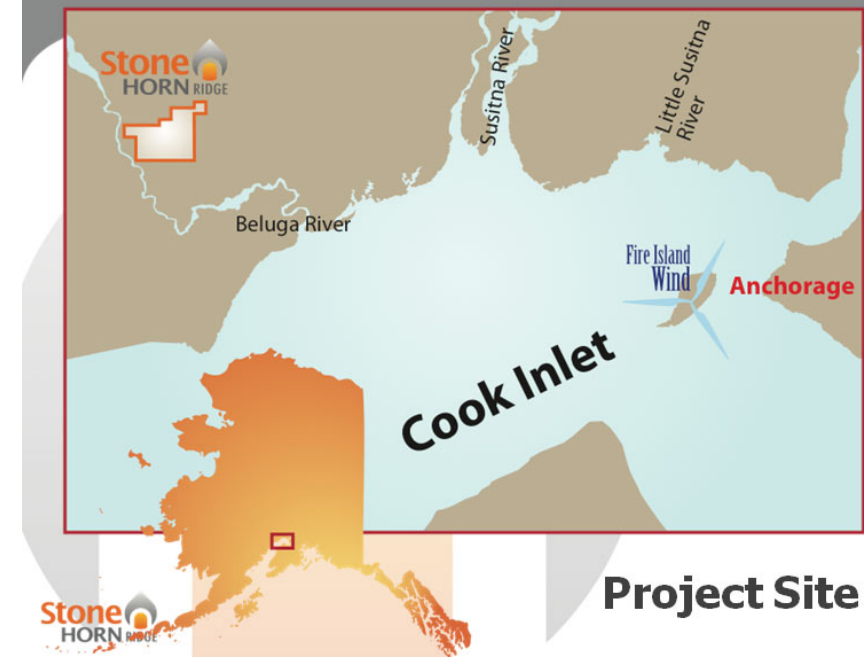


# SHR & UCG Project (Laurus Energy)

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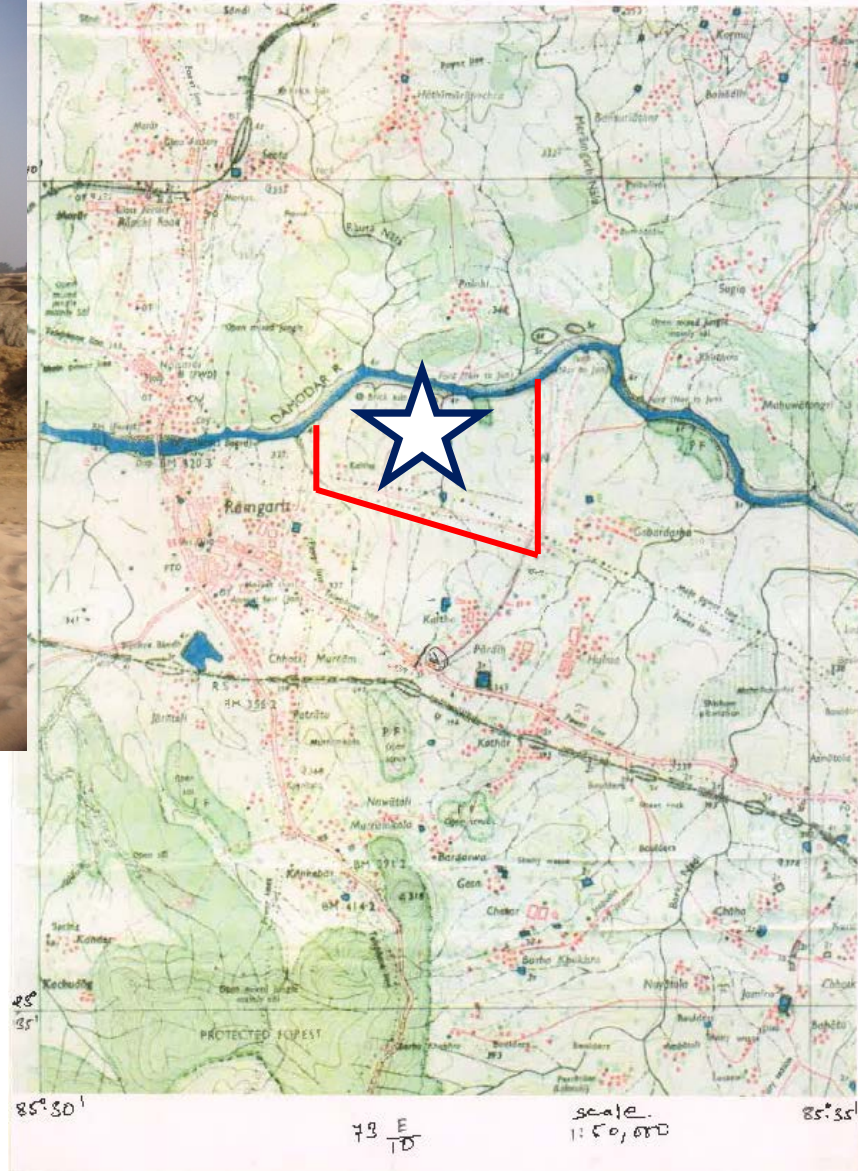
- Depth 200-1650m
- Weak, partly unconsolidated surrounding rock
- Sequence of 14 coal seams, 2 – 7m thick
- Remote location, limited site access
- Rank varies from lignite to subbituminous within project area
- Multiple major faults
- Multiple sand bands in the formation
- Completed Exploration & Site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

[Images: StoneHorneRidge Project](#)



# India εUCG Projects

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- Coal seam 3 – 16 m      [Images: AE Coal Technologies India Ltd.](#)
- Resource 166 MT
- High volatile bituminous coal

# NFS eUCG 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



# Products from εUCG™

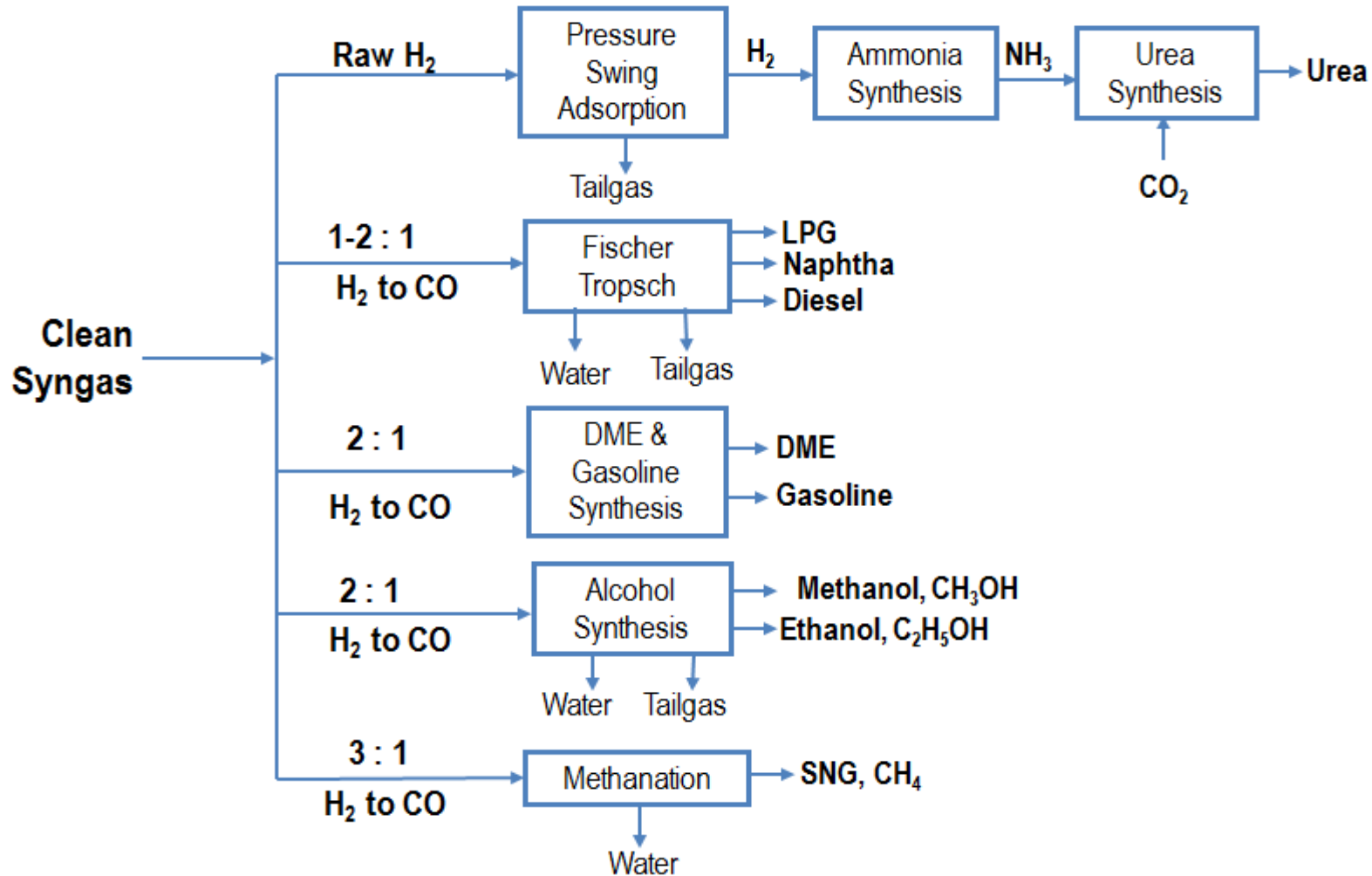
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## Economics of products from εUCG™ (India 2014)



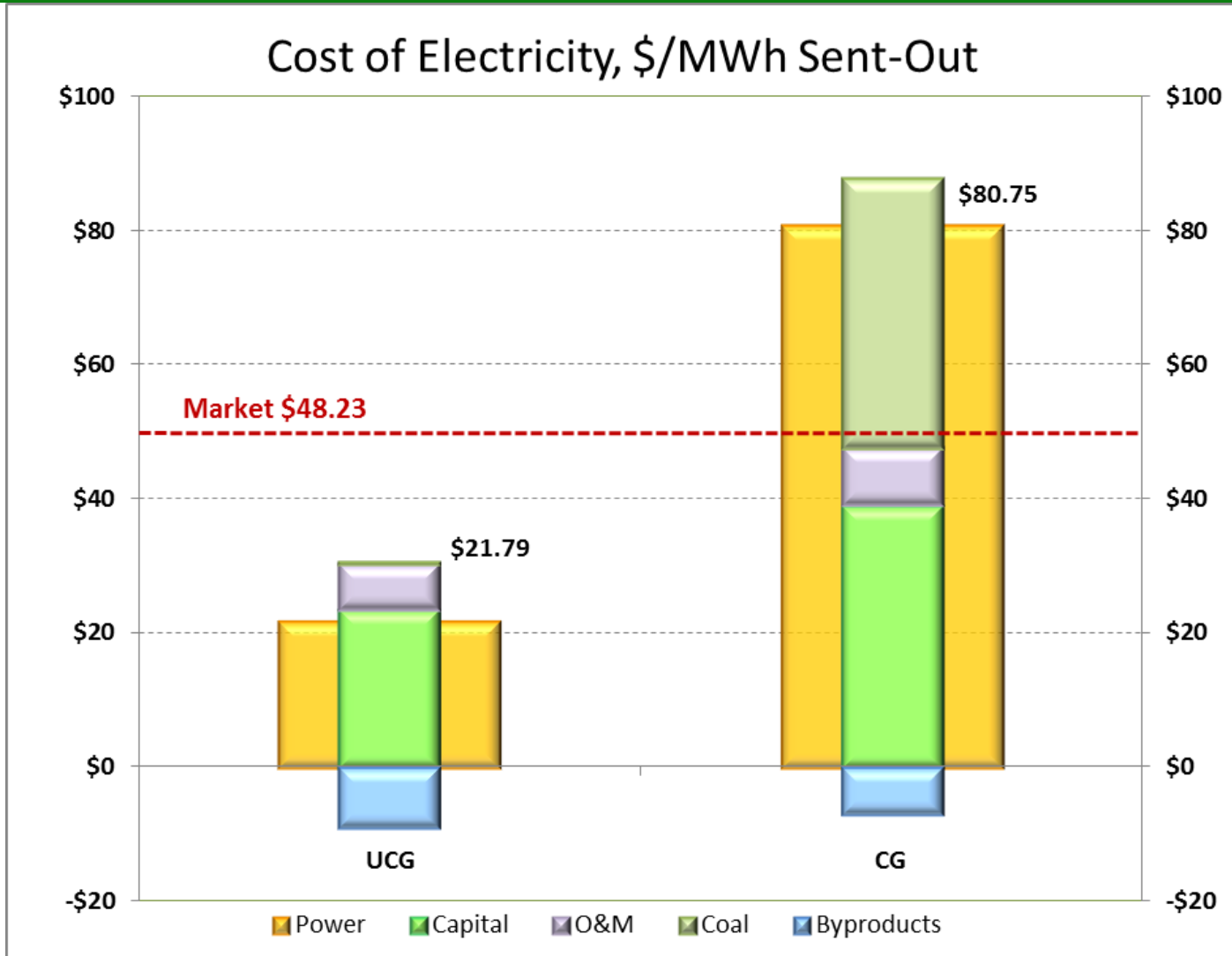
# Synthesis Products (India 2014)

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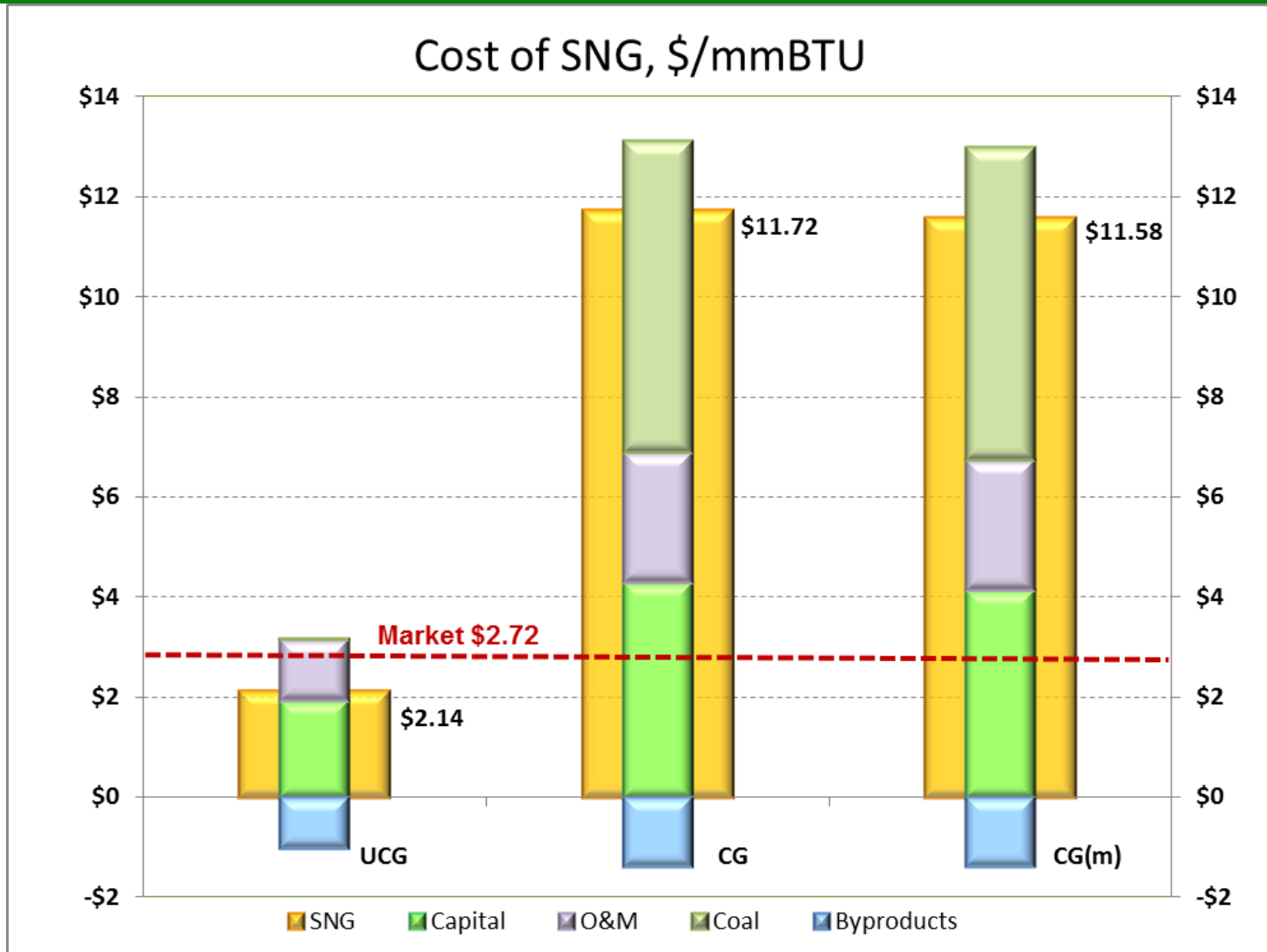
# εUCG vs. CG – Electricity (India 2014)

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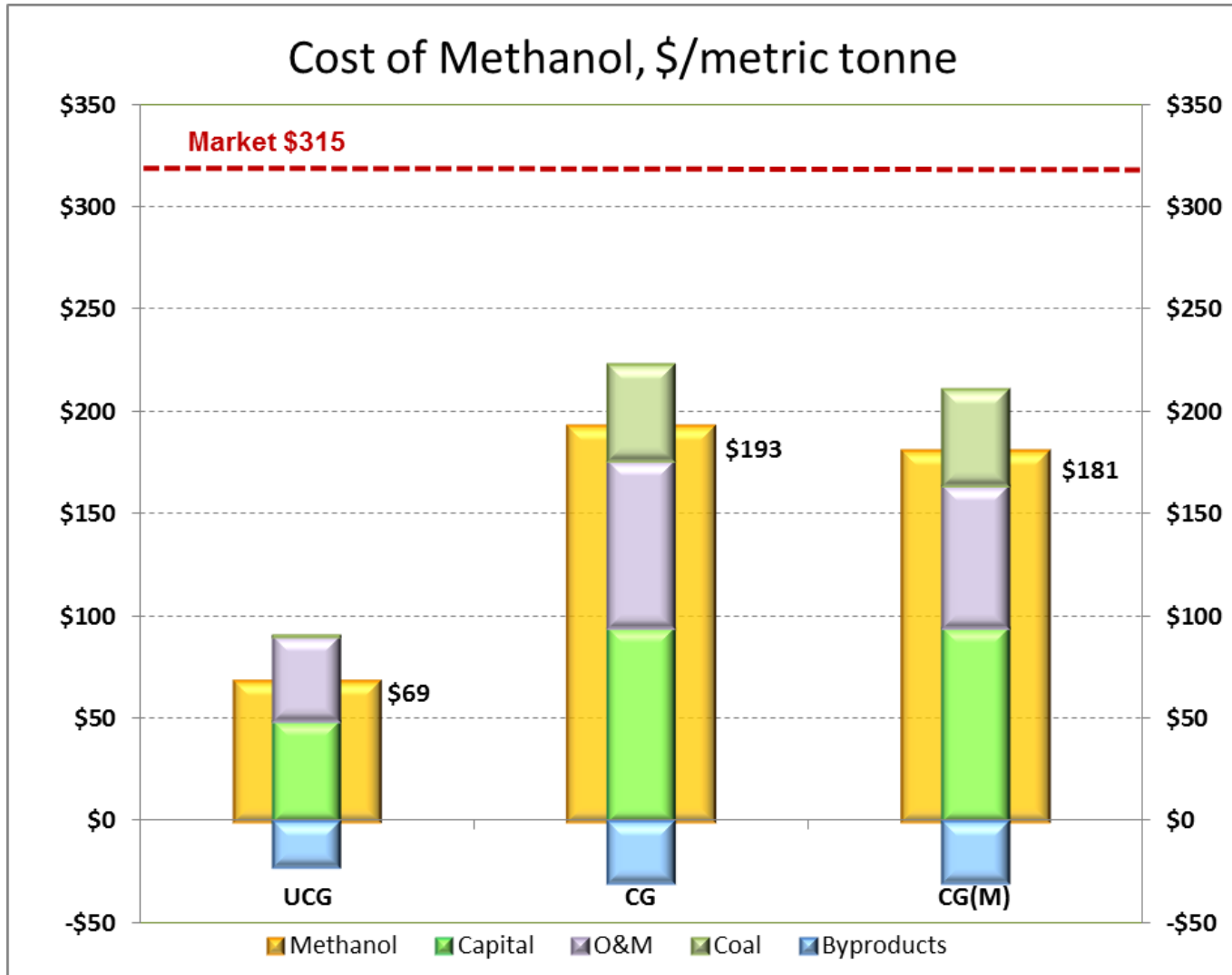
# εUCG vs. CG – SNG (India 2014)

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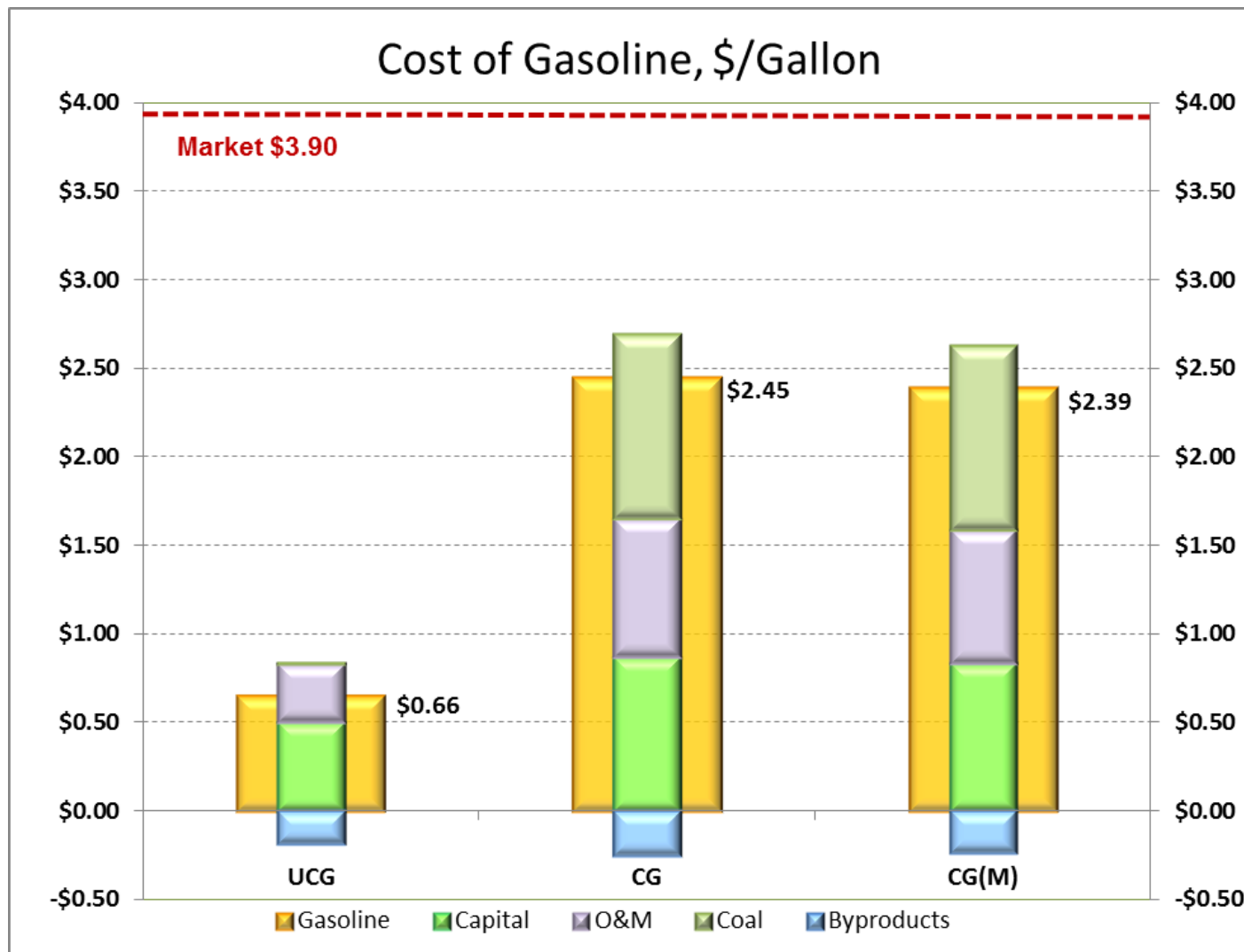
# εUCG vs. CG – Methanol (India 2014)

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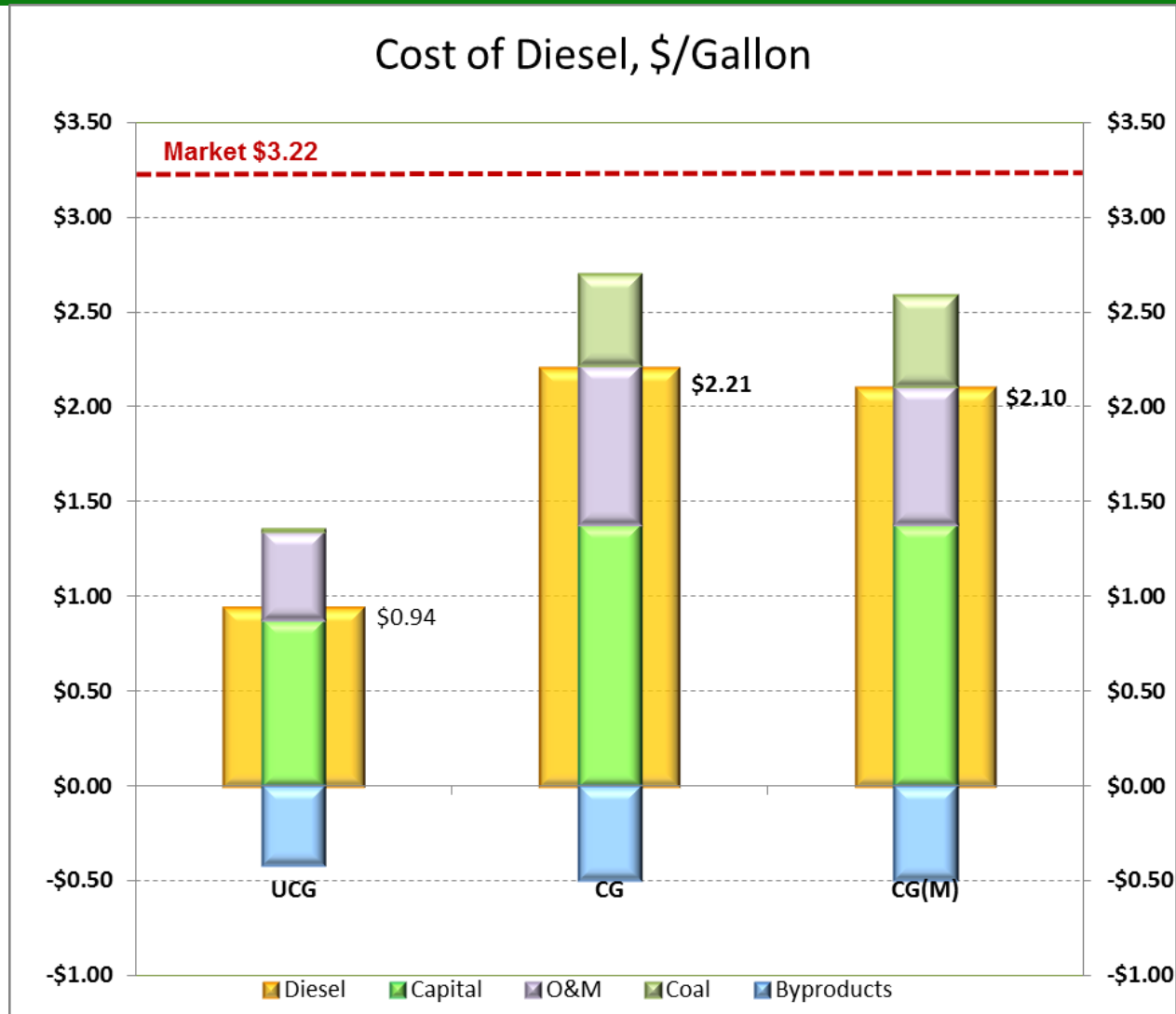
# εUCG vs. CG – Gasoline (India 2014)

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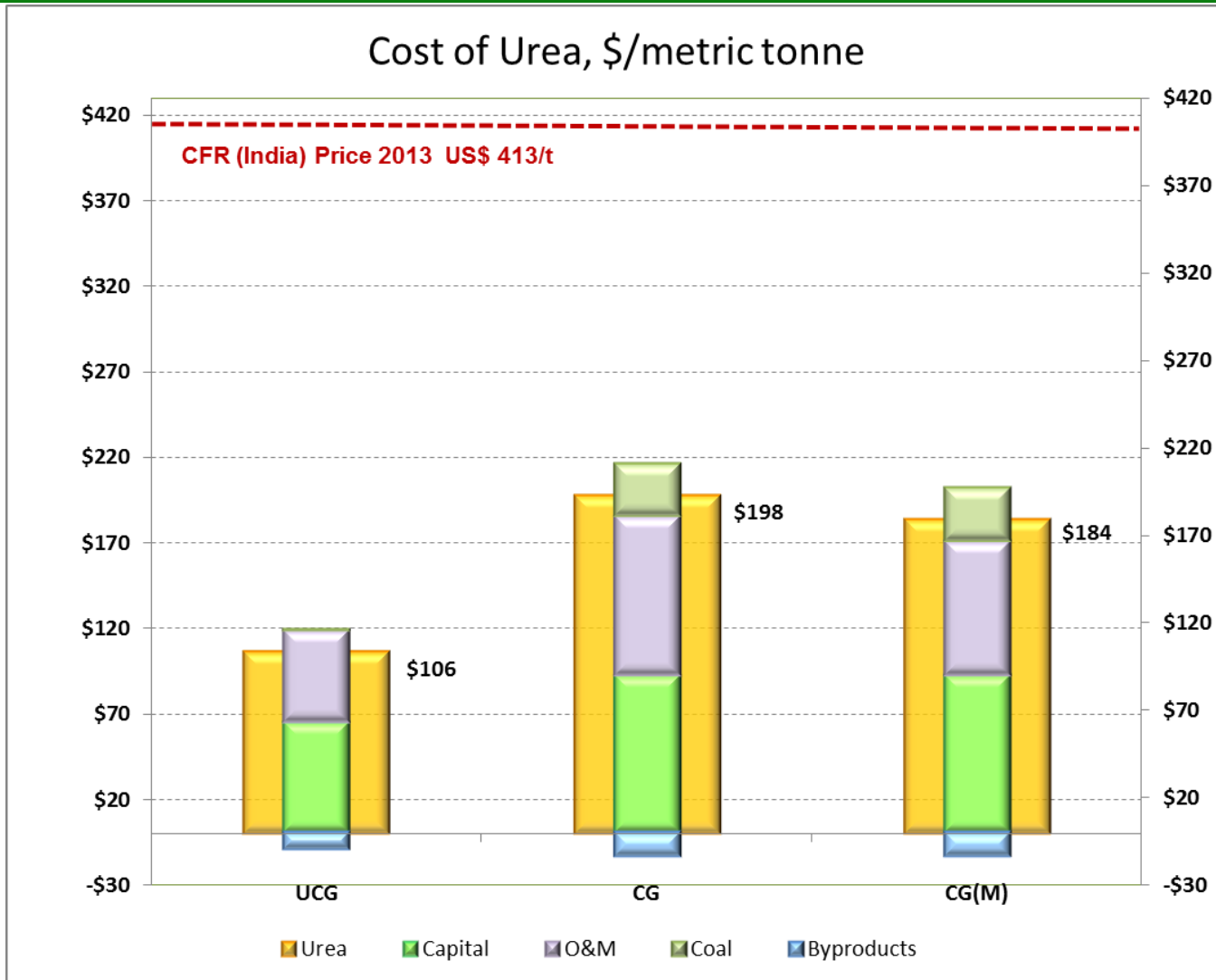
# εUCG vs. CG – Diesel (India 2014)

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# εUCG vs. CG – Urea (India 2014)

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# εUCG Thar Lignite Report 2003


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## Conclusions

- Conducted in 2002 – 2003 for the Block III
- It is concluded that...the Block III of the Thar coalfield is likely to support a UCG operation with an output to sustain a power station in the range 120 MW to 1,200 MW.

Reserve Category	GSP estimate, Mt	UCG reserves, Mt
Measured reserves	412.75	274.17
Indicated reserves	1337.01	888.12
Inferred reserves	258.28	171.58
<b>Total reserves</b>	<b>2008.04</b>	<b>1333.87</b>

One Block of Thar Lignite would support generation of **8,000MW<sub>e</sub>** for 30 years

 **ergo** Exergy Technologies, Inc.



**Power Generation Project Based on  
Underground Coal Gasification of Block III  
of Thar Coalfield, Pakistan**

Phase 0.1: Screening Study

Final Report (Excerpt)

February 2003

Côte Saint Luc · Quebec · Canada



# The Exergy UCG Technology

## Score Card...

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- ✓ Clean Energy from Unminable Coal
- ✓ Energy- and Carbon-Efficient
- ✓ Cost Competitive
- ✓ Geopolitical and market security

# Thank you!

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