

Global Developments in the UCG Industry

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The UCG Association

- The UCGA is the professional body for the Underground Coal Gasification Industry;
- Engages with Government, decision makers, environmental groups and the media;
- Promotes and assists to develop the highest standards of professional performance amongst all in UCG.
- Membership drawn from 28 countries.

www.ucgassociation.org

Riverside: UK, Indonesia, Australia

West Cumbria



Liverpool Bay



Firth of Forth



Amble



Thames Estuary

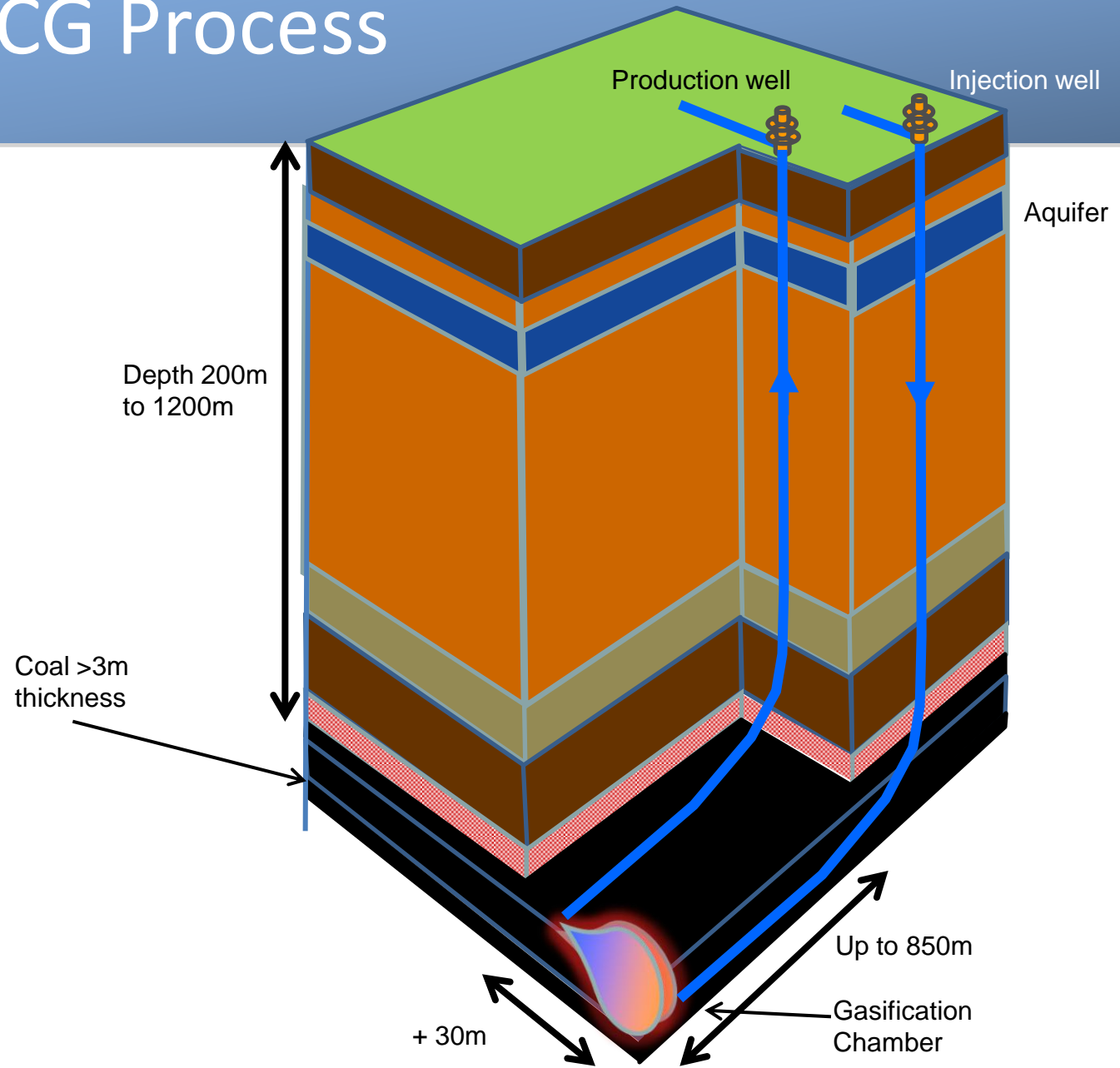


Six granted UCG licences in the UK,
Inserts show licence boundaries and
seismic coverage

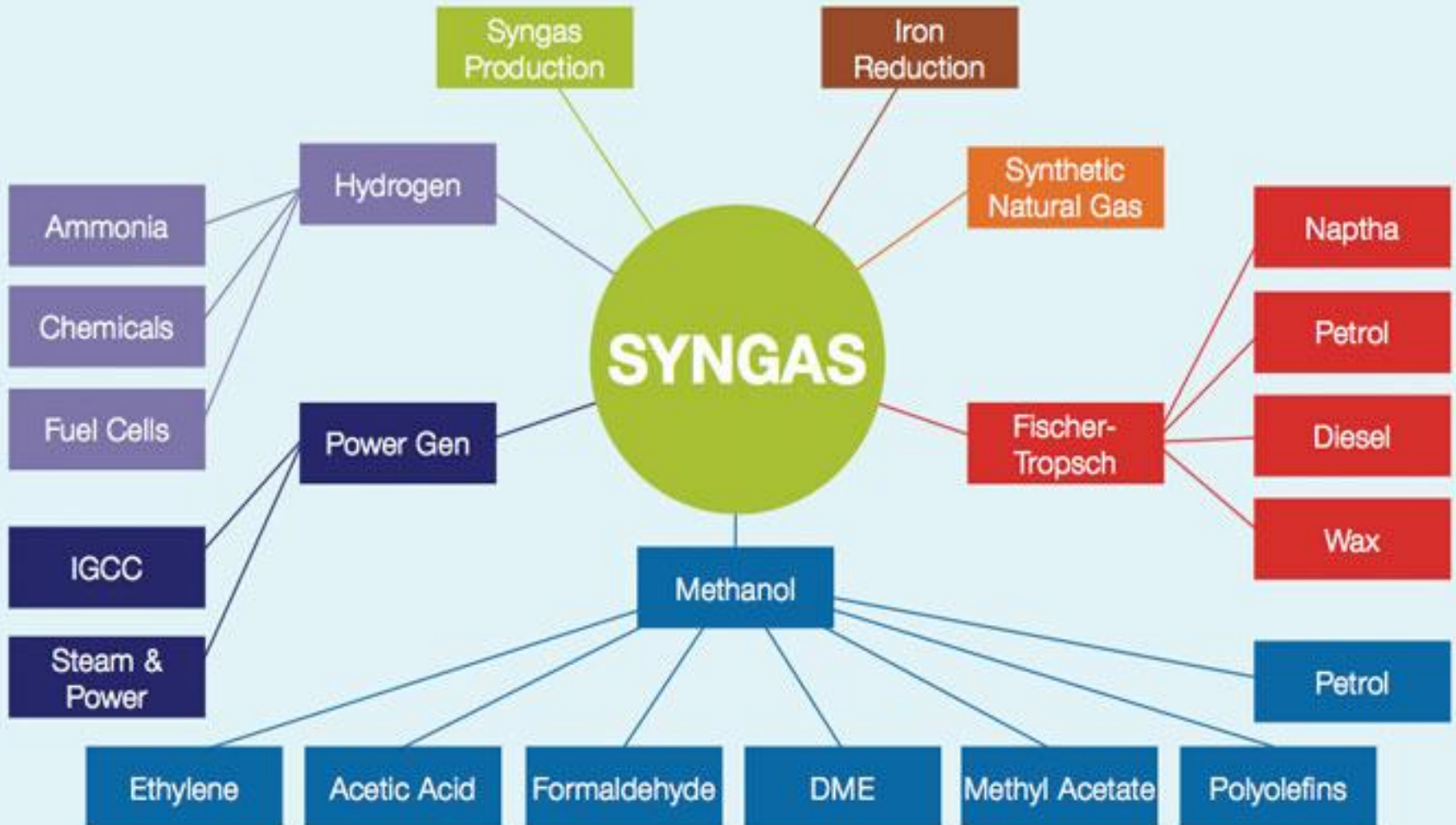
Benefits of UCG

- Massive increase in accessible coal, and therefore in coal reserves and resources.
- Low cost of production for a range of value products including power, fuel, and fertilizer.
- Reduced greenhouse gas emissions (GHG's).
- Reduced environmental impact – no mining, less water consumption, and reduced pollution emission (SO_x, NO_x, mercury, ash).

UCG Process



Output Options



Output Depends on Markets

- * Electricity remains a popular first choice for proposed projects due to simplicity of production.
- * Fischer Tropsch and methanol are technically challenging and have high capital costs; but the products are readily marketable & are transportable.
- * Synthetic Natural Gas (SNG) also produces an easily marketable product, is technically easier, and the economics are generally good.
- * Hydrogen has potential for the future, but not now.
- * Enhanced Oil Recovery and Enhanced CBM Recovery?

hydrogen

PRAXAIR
Hydrogen Systems

new

Honda Fuel Cell Power



FCX

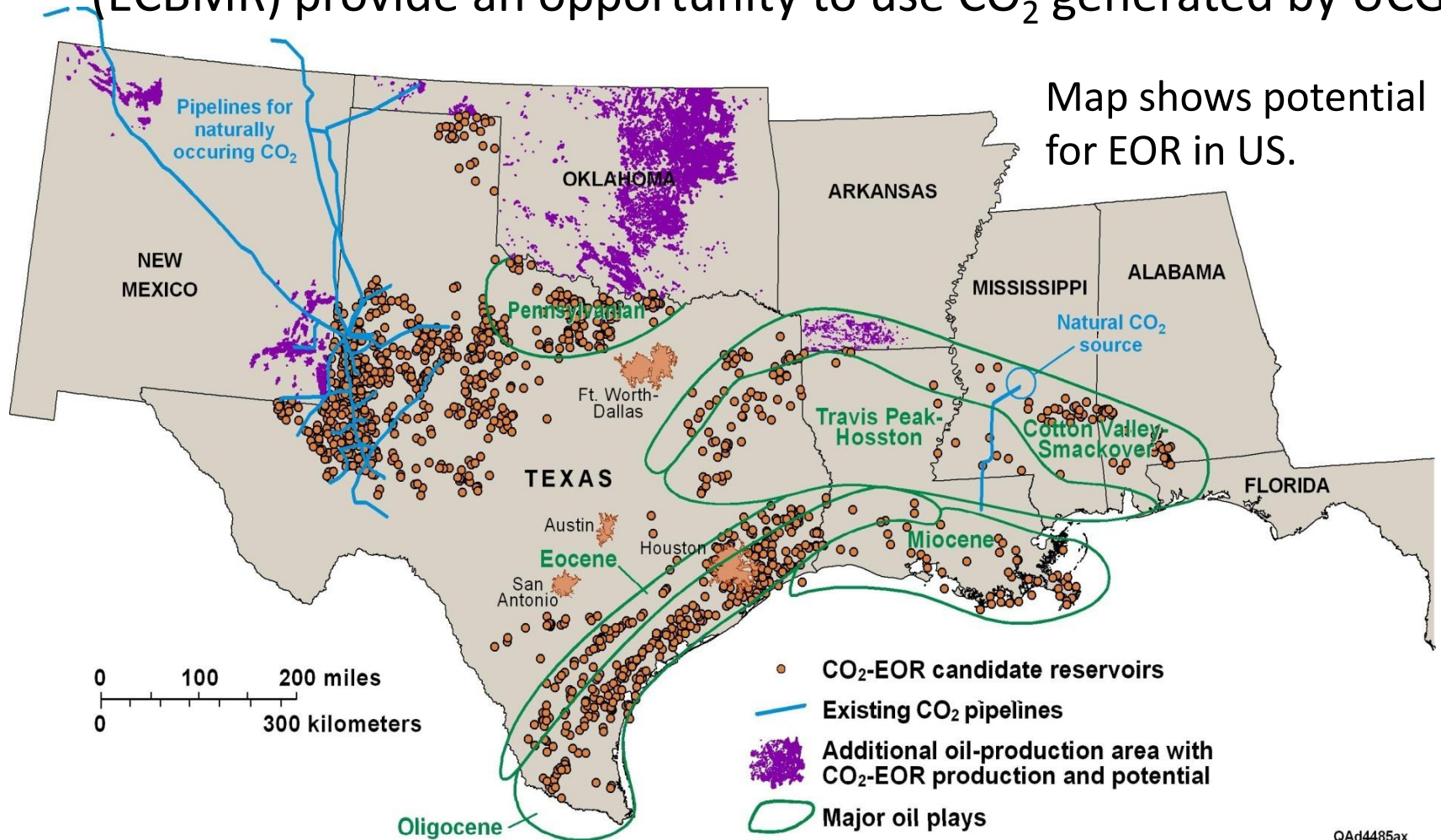
California
FCX 19



CO₂ for EOR

Enhanced Oil Recovery (EOR) and Enhanced CBM Recovery (ECBMR) provide an opportunity to use CO₂ generated by UCG.

Map shows potential for EOR in US.



Current International UCG Activity

China, Mongolia, Indonesia, Vietnam

Australia, New Zealand

United Kingdom, Poland, Hungary, European HUGE project, Poland, Czech Republic, Russia, Bulgaria

Canada, USA, Brazil, Chile

South Africa, Botswana

India, Pakistan, Bangladesh

Recent UCG Activity

- Yerostigaz UCG, Angren, Uzbekistan
50 years of continuing UCG production (110m-220m)
- Chinchilla UCG Pilot, Linc Energy, Australia
Extended piloting, plus UCG syngas to diesel (<200m)
- Kingaroy UCG Pilot, Cougar Energy, Australia
Pilot plant closed by Government (<200m)
- Gonggou Mine Wulanchabu, Ulanchap, etc.
ENN pilots directed toward commercial scale UCG.

Recent UCG Activity

- Bloodwood Creek, Carbon Energy, Australia
Extended dual lateral reactor. (<200m)
- Majuba Power Station, Eskom, South Africa
UCG syngas to co-fired 350 Mwe IGCC plant (<250m)
- Swan Hills Synfuels, Canada
Gasification at 1400 meters
- Hydrogen Underground Gasification Europe (HUGE) Project, Katowice, Poland
Multinational research project, phase 2 began 2011

Recent Chinese UCG Activity

- Important research work and innovations by, for example, China University of Mining and Technology and ENN, as well as new-comers like SinoUCG.
- Many innovations including huff & puff for hydrogen production, tunnel UCG developments, radon detection for chamber monitoring, laboratory testing, gasification modelling, and multi-directional streaming.
- The Chinese focus has unfortunately been mostly on shallow UCG – the Russian method and tunnel UCG.

Deep Coal

- While most UCG pilots have focused on shallow coal and lignite, the real goal must be to gasify deep coals.
- Deep coals create far less risk of contamination, of impact on valued aquifers, and of surface subsidence.
- In centres of industry and population shallow coal have often already been mined, especially in China, and it is the deeper coals which are still abundant.
- Deep UCG requires superior drilling technology and technical innovation, but it is feasible and at a properly selected sites will provide very good returns.

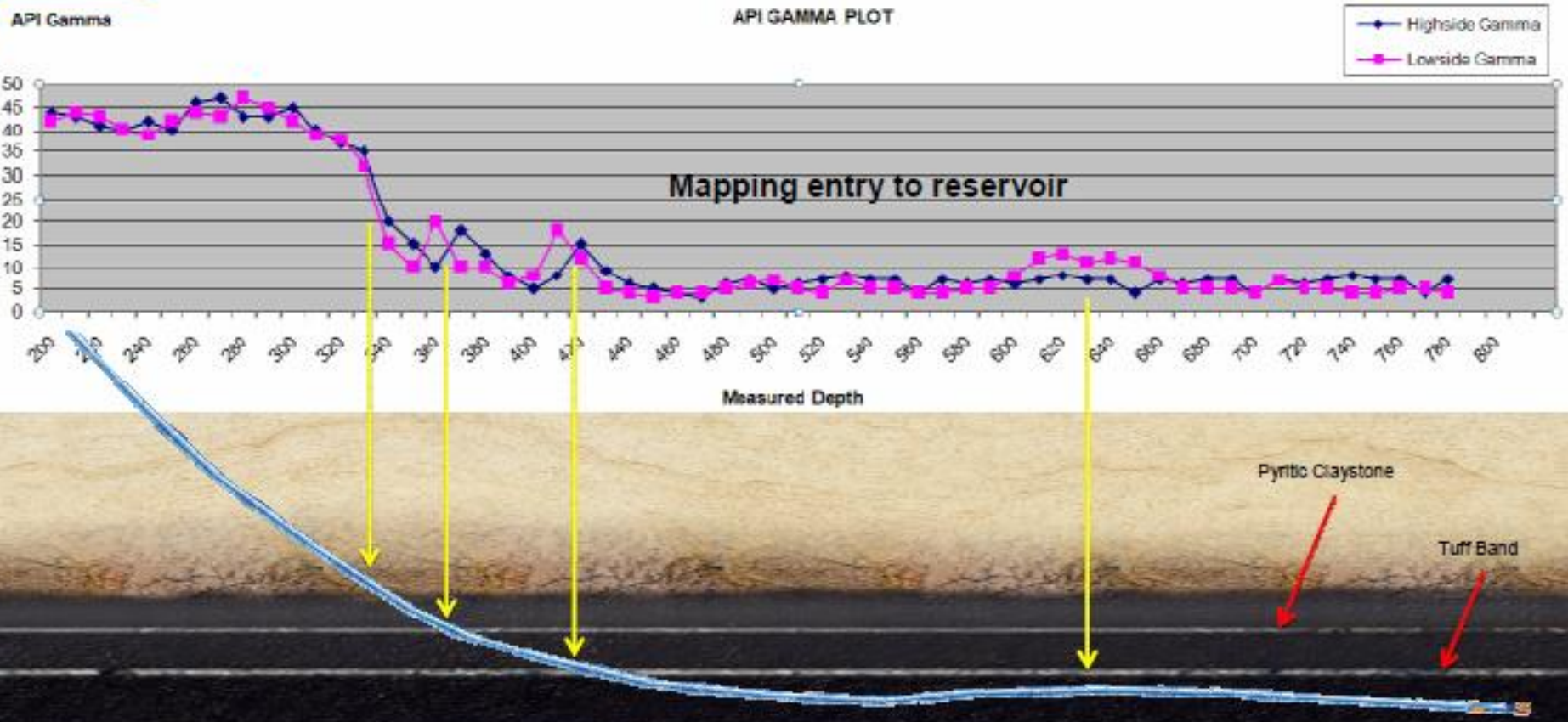
Deeper UCG

Deeper is better, but:

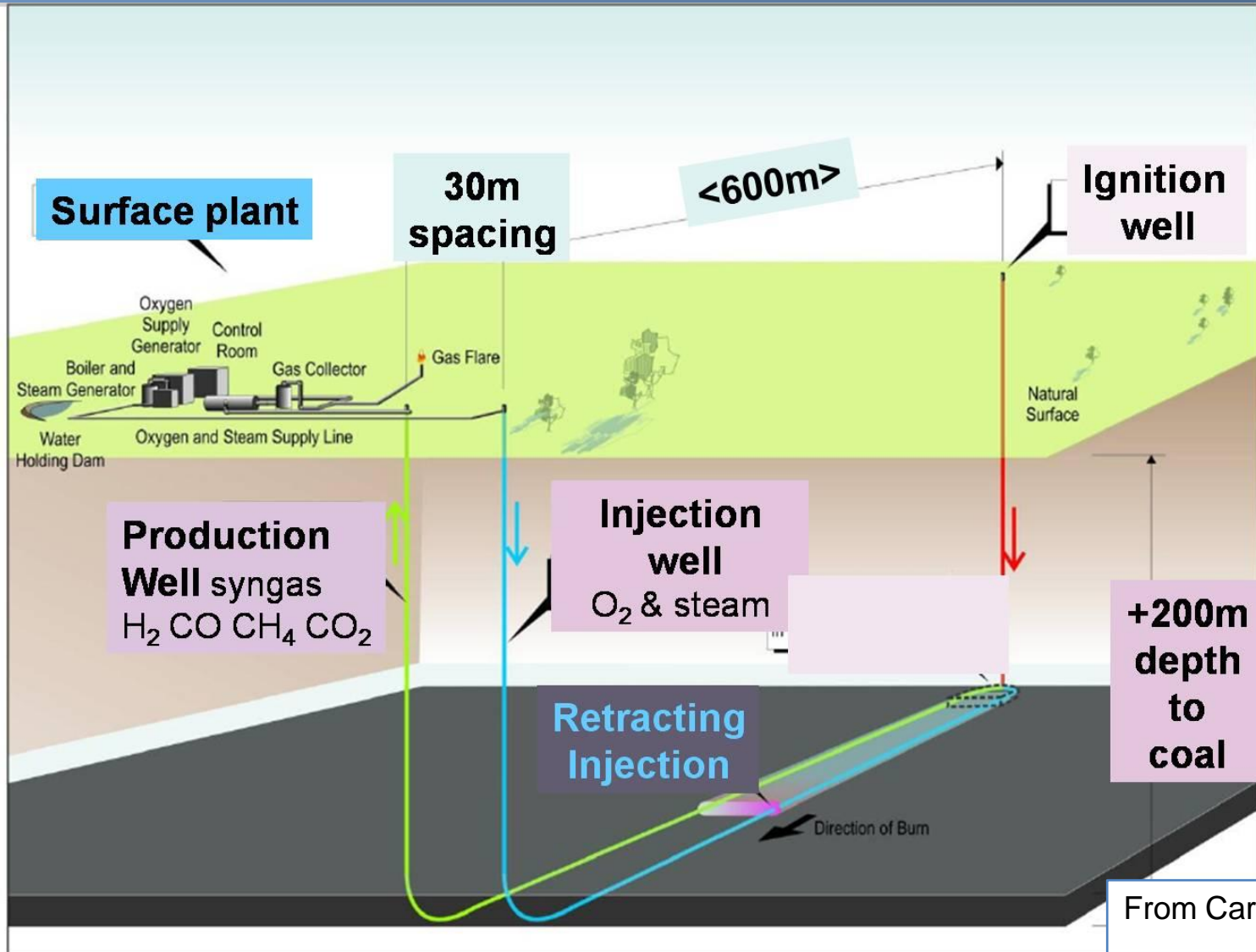
- Higher O₂/air ratio
- Higher pressure producing more CH₄
- Higher cost per well
- Requires efficient directional drilling
- More well control risk, more casing strings, larger surface footprint.



Directional Drilling

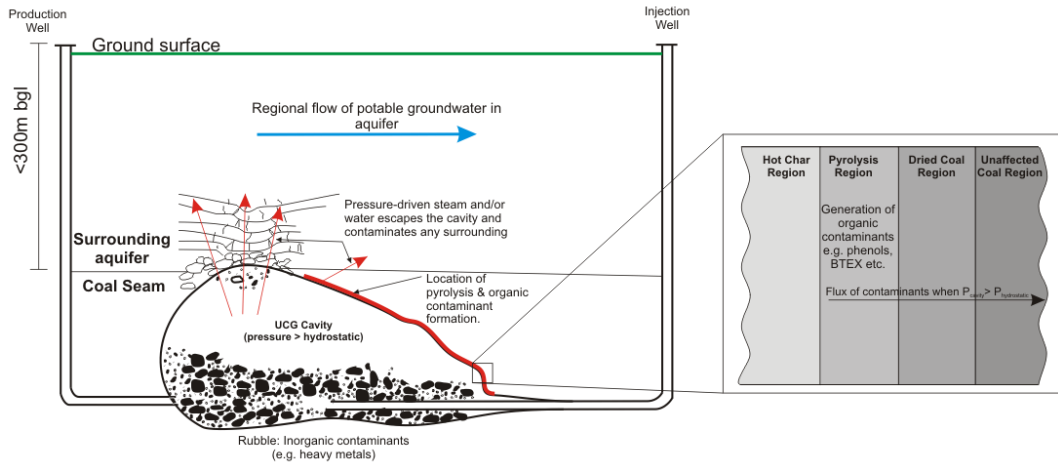


Dual Lateral Knife Edge Design

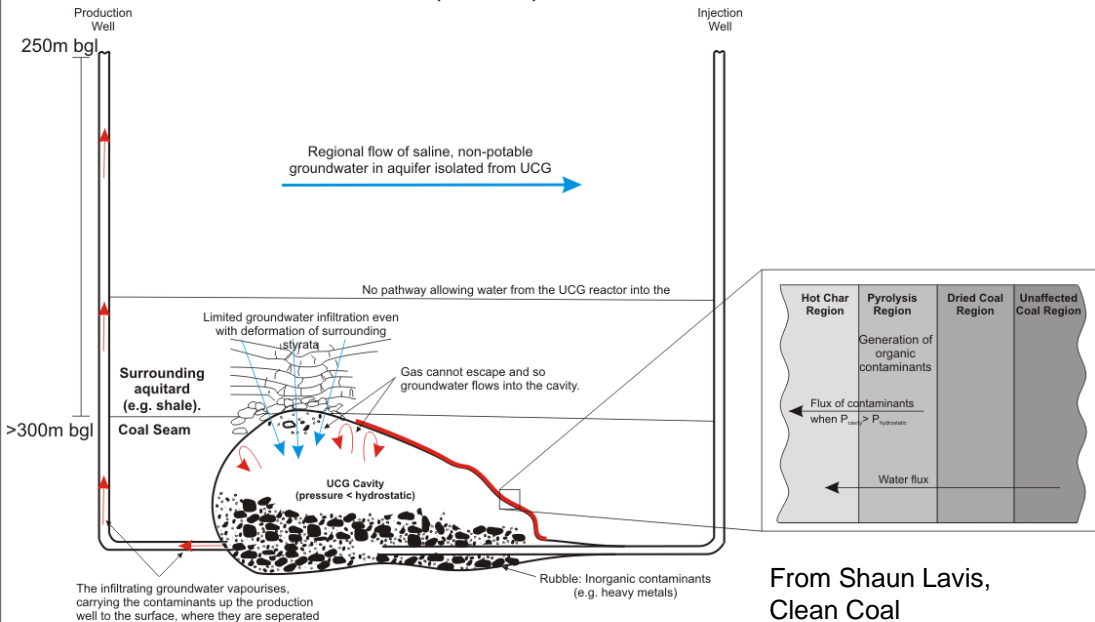


Reducing Environmental Risk

A: Poorly selected site with incorrect operation parameters.



B: Well selected site with correct operation parameters.



From Shaun Lavis,
Clean Coal

- Select deeper coals (>300m) as more likely to isolate contamination from valued aquifers.
- Isolate the source of contamination by avoiding faults, joints, old wells, or other unsealed pathways for contaminants.
- Preference for sites with effective aquitards above and below.
- Good geo-mechanical properties of the overburden (stiffness, yield strength), as well as coal fracture density and orientation.

Carbon Management

- Gasification reduces gross CO₂ production relative to energy produced from mined coal.
- UCG reduces fugitive CH₄ and CO₂ emissions caused by coal mining.
- UCG is well positioned to benefit from developing Carbon Capture and Storage (CCS) technology due to efficient capture of CO₂ and drilling technology.
- CCS has not progressed as quickly as hoped

Carbon Storage, Sleipner



- Commenced 1996 off Norway
- Approx 12 million metric tons of CO₂ injected
- No leakage to surface detected

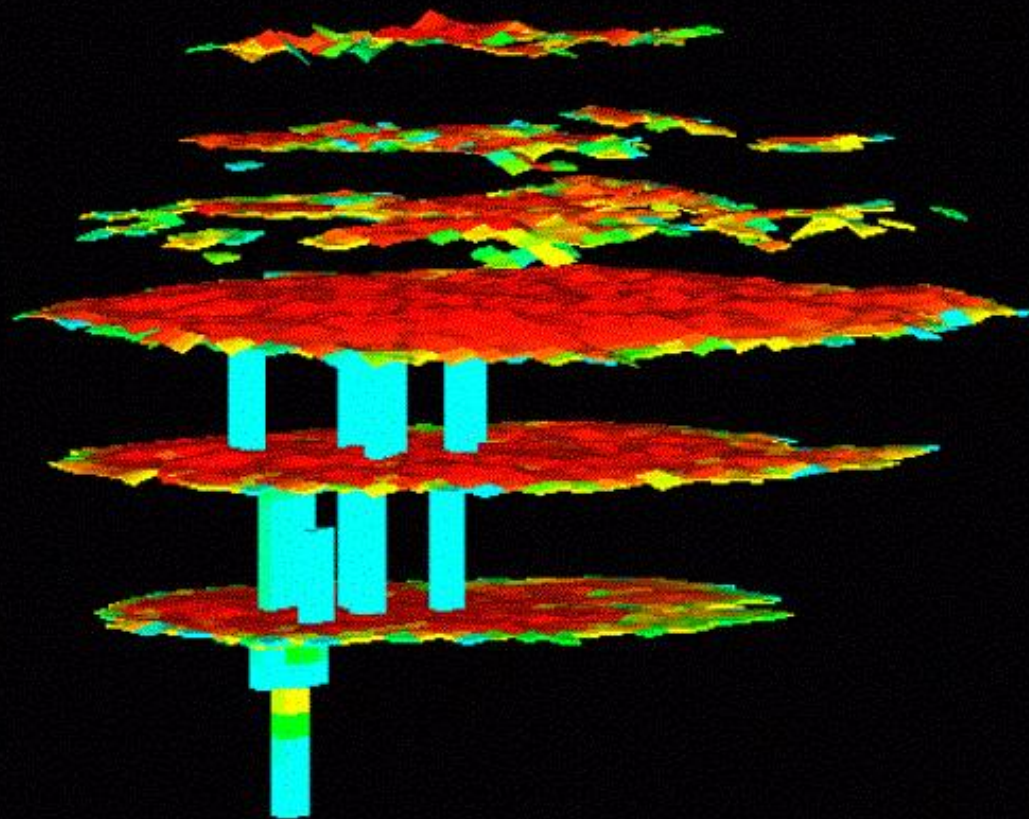


Source: World Coal Institute,

<http://www.worldcoal.org/carbon-capture-storage/>

3D Modelling, Sliepner

After three years of injection



GasSat



Parameters Affecting UCG Design

Coal

Permeability

Thickness

Dip

Depth

Rank

Chemical Composition

Operations

Well Layout & Design

Injection Composition

Flow Rate

Operating Pressure

Product Gas Volume

Gas Calorific Value & Flow
Rate

Environment

Strata Properties

Geology

Hydrology

Drilling Properties

Environment Subsidence

Water Contamination

Selection Criteria for UCG

Coal Type:	High Lignite, Sub-bituminous, bituminous
Ash :	< 50%, low swelling, low caking
Depth:	150 to 1500 metres
Thickness:	Minimum 2 metres per seam
Moisture:	< 40%
Inclination:	Up to 70 degrees from horizontal
Overburden:	Structurally stable, aquacludes preferred
Faulting:	No migration path to potable aquifers
Old Workings:	All boreholes and shafts known and plugged

THANK YOU

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