

The global Growth of UCG - with specific reference to Europe

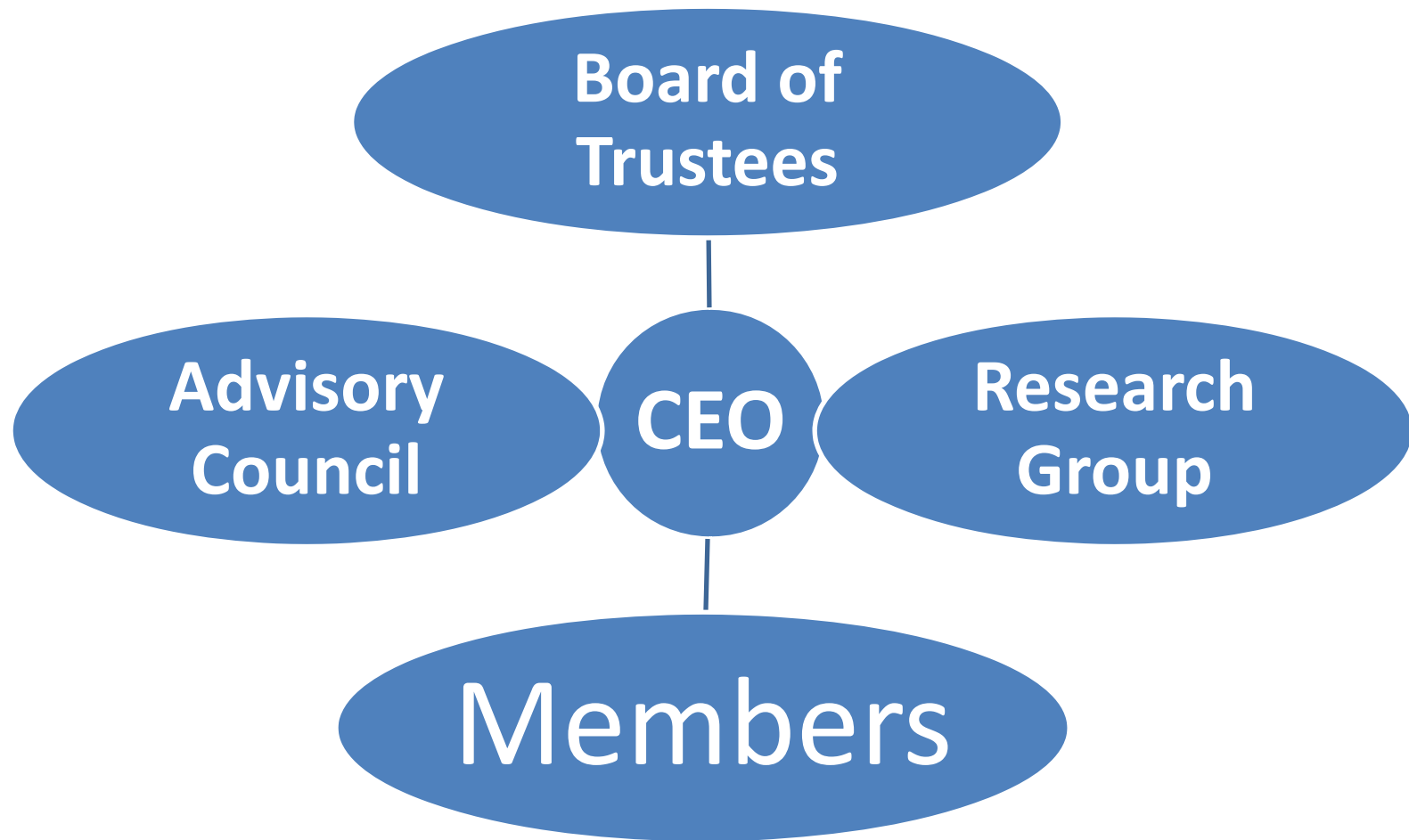
**Marc Mostade,
Technical Director Clean Coal Ltd**



Underground Coal Gasification Association (UCGA)

- UCG Association is the professional body for the UCG Industry;
- Represents the global UCG industry – all sectors;
- Promotes the commercial, social and environmental benefits of UCG technology;
- Creates a home for energy professionals and academics, and a scientific and technical base for industry – a conference is organised each year;
- Offers independence, professionalism and a wealth of expertise in UCG;
- UCGA is globally recognised as the centre of excellence and information for all – a training course is organised each year.

UCGA Management Structure



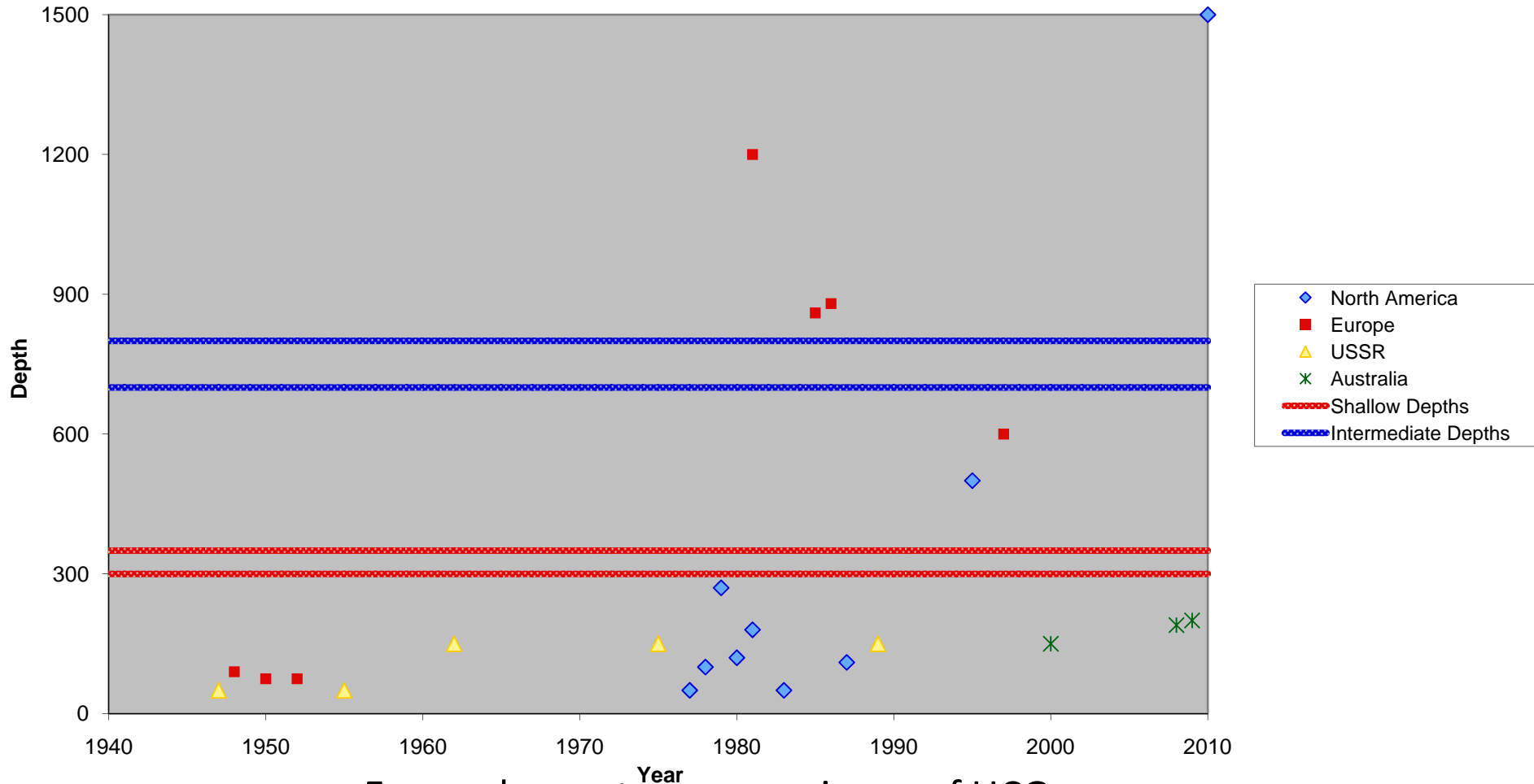
UCGA Membership

- Non-profit organisation;
- Membership by annual subscription;
- Over 280 members, representing more than 70 organisations: Oil & gas, national governments, regional agencies, banks accountants, lawyers, providers of UCG services, UCG operators universities, energy associations & advisors, coal association, utilities, and UCG specialists;
- 26 Countries represented:
Australia, Belgium, Botswana, Bulgaria, Brazil, Canada, China, Colombia, Germany, Hungary, India, Indonesia, Ireland, Italy, Japan, Kazakhstan, Netherlands, Norway, Poland, Russia, Slovakia, South Africa, Ukraine, UK, USA, Vietnam.

Some of the UCGA Members



UCG Projects related to depth



Europe has a strong experience of UCG
at intermediate/great depths

Summary of UCG past experience in Europe

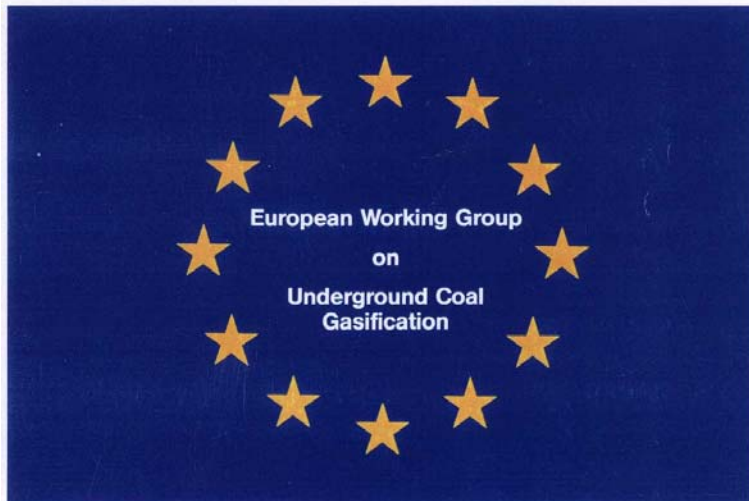
- Bois-la-Dame, Belgium, 1948, Anthracite, Shallow Depth;
- Newman Spinney, UK, 1949-1959, Sub-bituminous, Shallow Depth;
- Djérada (Morocco), France, 1950-1955, Anthracite, Shallow Depth;
- Bruay-en-Artois, France, 1981, Anthracite, Great Depth;
- Thulin, Belgium, 1981-1987, Anthracite, Great Depth;
- Haute-Deule, 1985-1986, Anthracite, Great Depth;

Summary of UCG past experience in Europe (cont.)

The Future Development of Underground Coal Gasification in Europe

A Comprehensive Report to CEC

Brussels, April 1989

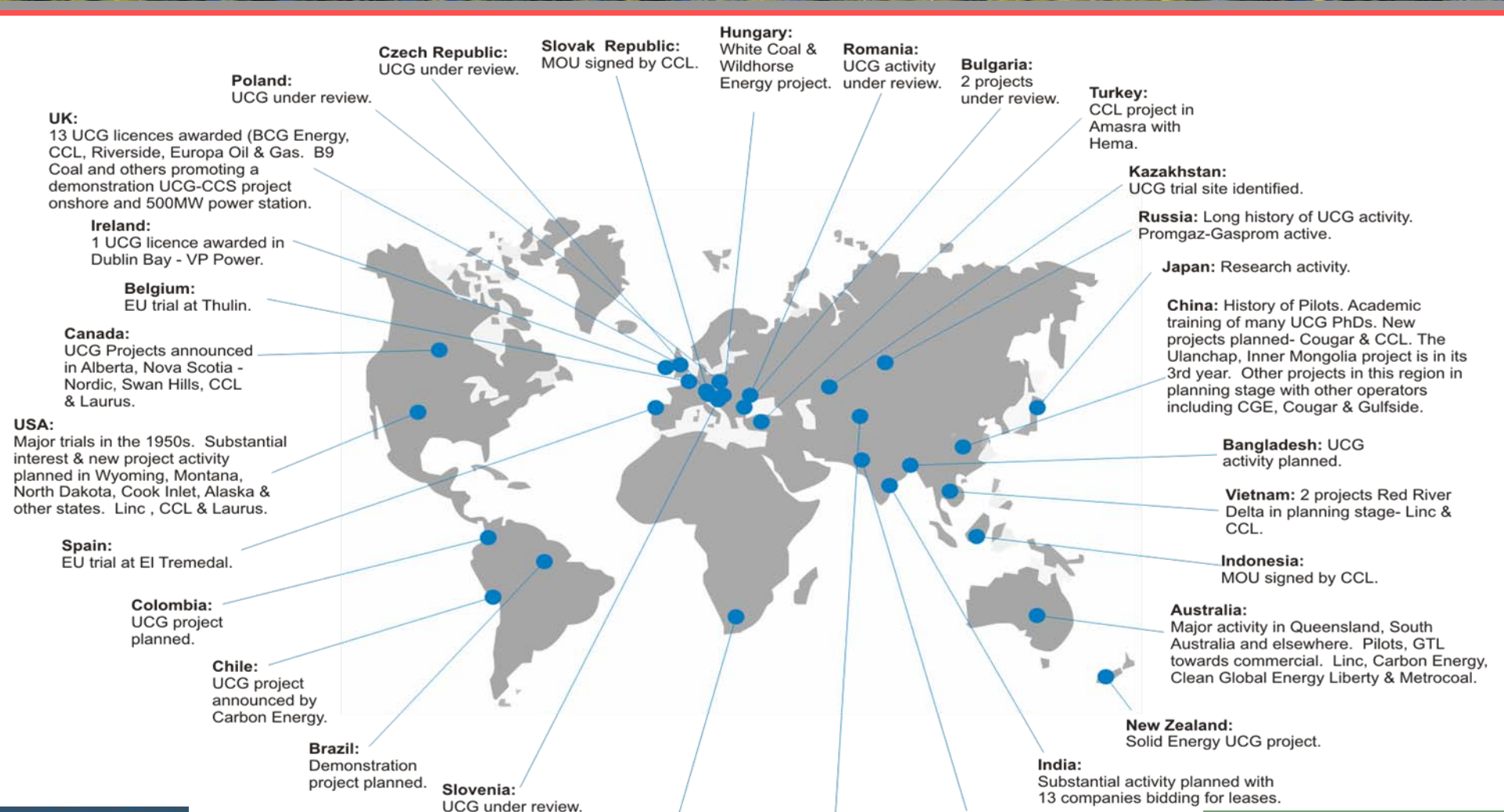


Participating Member States:

- Belgium (IDGS)
- Germany (K2G)
- France (Gaz de France)
- The Netherlands (TU Delft, ECN)
- Spain (IGME)
- UK (British Coal, British Gas)

- El Tremedal, Spain, 1991-1997, Sub-bituminous, Intermediate Depth.

How fast is the industry growing?



UK:
13 UCG licences awarded (BCG Energy, CCL, Riverside, Europa Oil & Gas. B9 Coal and others promoting a demonstration UCG-CCS project onshore and 500MW power station.

Ireland:
1 UCG licence awarded in Dublin Bay - VP Power.

Belgium:
EU trial at Thulin.

Canada:
UCG Projects announced in Alberta, Nova Scotia - Nordic, Swan Hills, CCL & Laurus.

USA:
Major trials in the 1950s. Substantial interest & new project activity planned in Wyoming, Montana, North Dakota, Cook Inlet, Alaska & other states. Linc, CCL & Laurus.

Spain:
EU trial at El Tremedal.

Colombia:
UCG project planned.

Chile:
UCG project announced by Carbon Energy.

Brazil:
Demonstration project planned.

Slovenia:
UCG under review.

South Africa:
Eskom in 2nd stage of UCG project. Others reviewing.

Uzbekistan:
Oldest UCG plant in the World (50yrs) in Angren.

Pakistan:
Substantial activity planned in Syndh Province.

India:
Substantial activity planned with 13 companies bidding for leases.

New Zealand:
Solid Energy UCG project.

Australia:
Major activity in Queensland, South Australia and elsewhere. Pilots, GTL towards commercial. Linc, Carbon Energy, Clean Global Energy Liberty & Metrocoal.

Indonesia:
MOU signed by CCL.

Vietnam: 2 projects Red River Delta in planning stage- Linc & CCL.

Bangladesh: UCG activity planned.

China: History of Pilots. Academic training of many UCG PhDs. New projects planned- Cougar & CCL. The Ulanchap, Inner Mongolia project is in its 3rd year. Other projects in this region in planning stage with other operators including CGE, Cougar & Gulfside.

Japan: Research activity.

Russia: Long history of UCG activity. Promgaz-Gasprom active.

Kazakhstan:
UCG trial site identified.

Turkey:
CCL project in Amasra with Hema.

Bulgaria:
2 projects under review.

Romania:
UCG activity under review.

Hungary:
White Coal & Wildhorse Energy project.

Slovak Republic:
MOU signed by CCL.

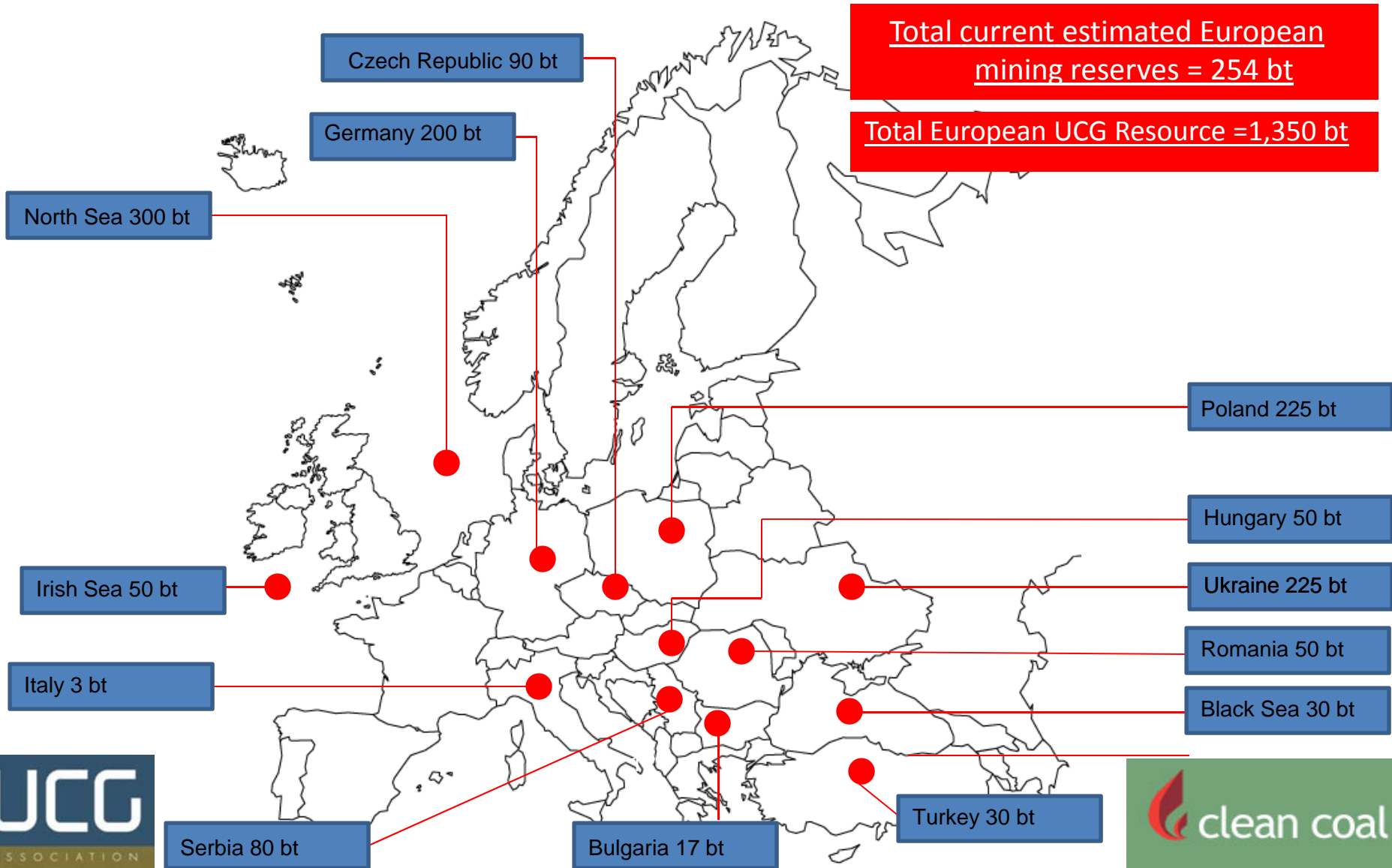
Czech Republic:
UCG under review.

Poland:
UCG under review.

Summary of new UCG projects in Europe

- UK – 13 off-shore UCG licences awarded;
- Ireland – 1 off-shore UCG licence awarded;
- Hungary – 2 main UCG projects, Synclean Energy in Mecsek & WildHorse in Varalja;
- Turkey – 1 UCG project, Hema in Asmara
- UCG under review in Poland, Czech & Slovak Republics, Romania, Bulgaria.

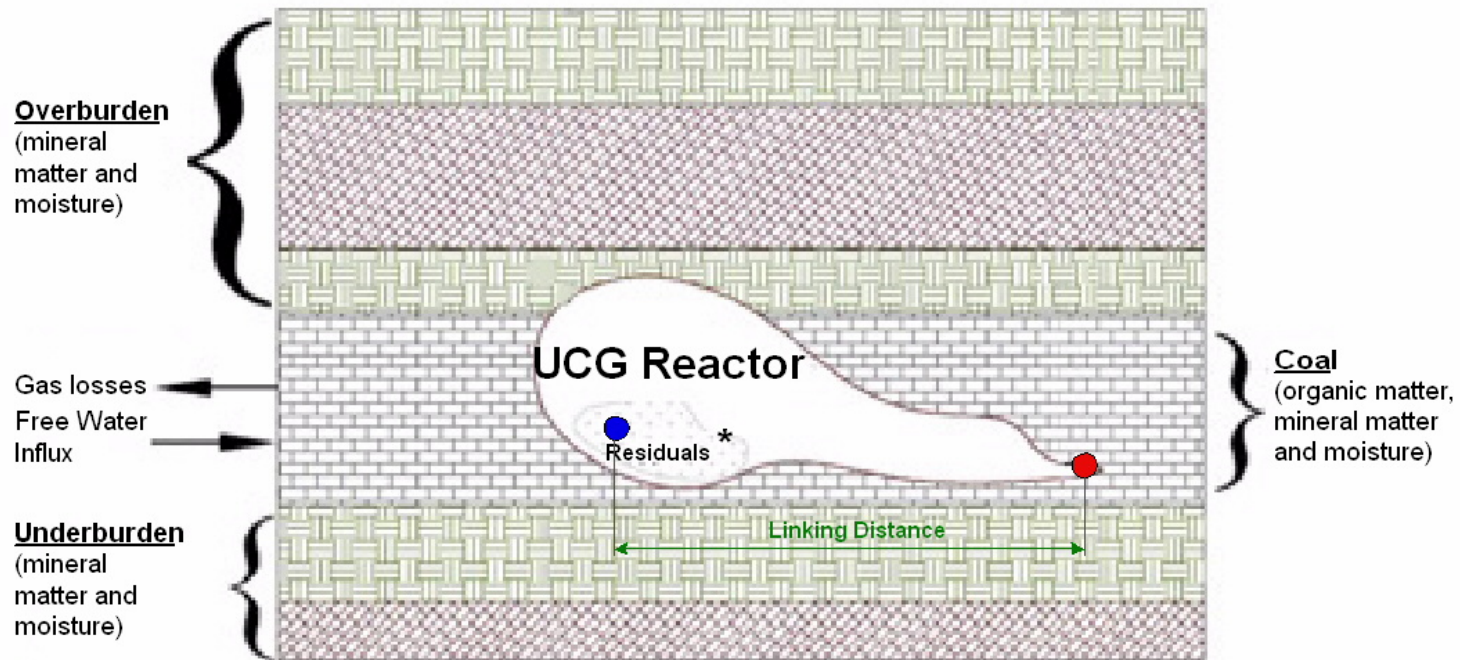
Coal available for UCG in Europe



UCG Reactor Schematic

● **Injection Point**
(oxidant: air, enriched air or oxygen, and water)

● **Production Point**
(raw syngas: H_2 , CO , CH_4 , H_2S , CO_2 , steam, coal liquids and particulates)



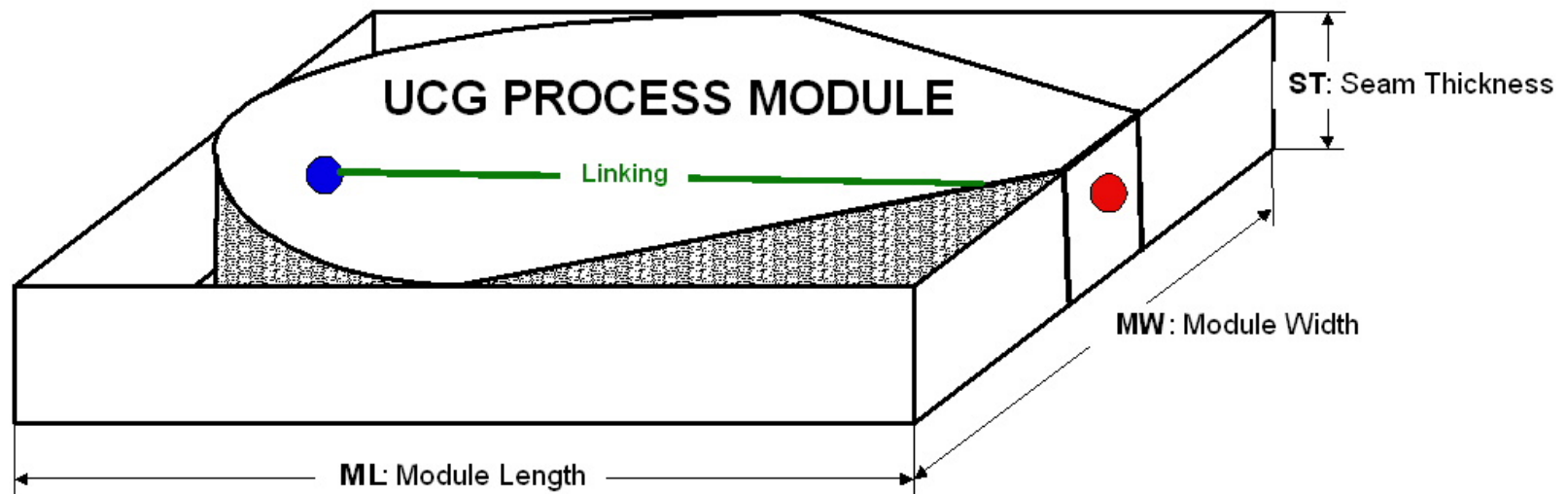
* Ash, char, organic residues, and collapsed overburden

All UCG processes are similar in that they require a minimum of **two process points linked in-seam**: (i) one to inject the gasifying agents and start ignition, (ii) the other to recover the syngas produced.

UCG Process Module Concept

● **Injection Point**
(oxidant: air, enriched air or oxygen, and water)

● **Production Point**
(raw syngas: H_2 , CO , CH_4 , H_2S , CO_2 , steam, coal liquids and particulates)

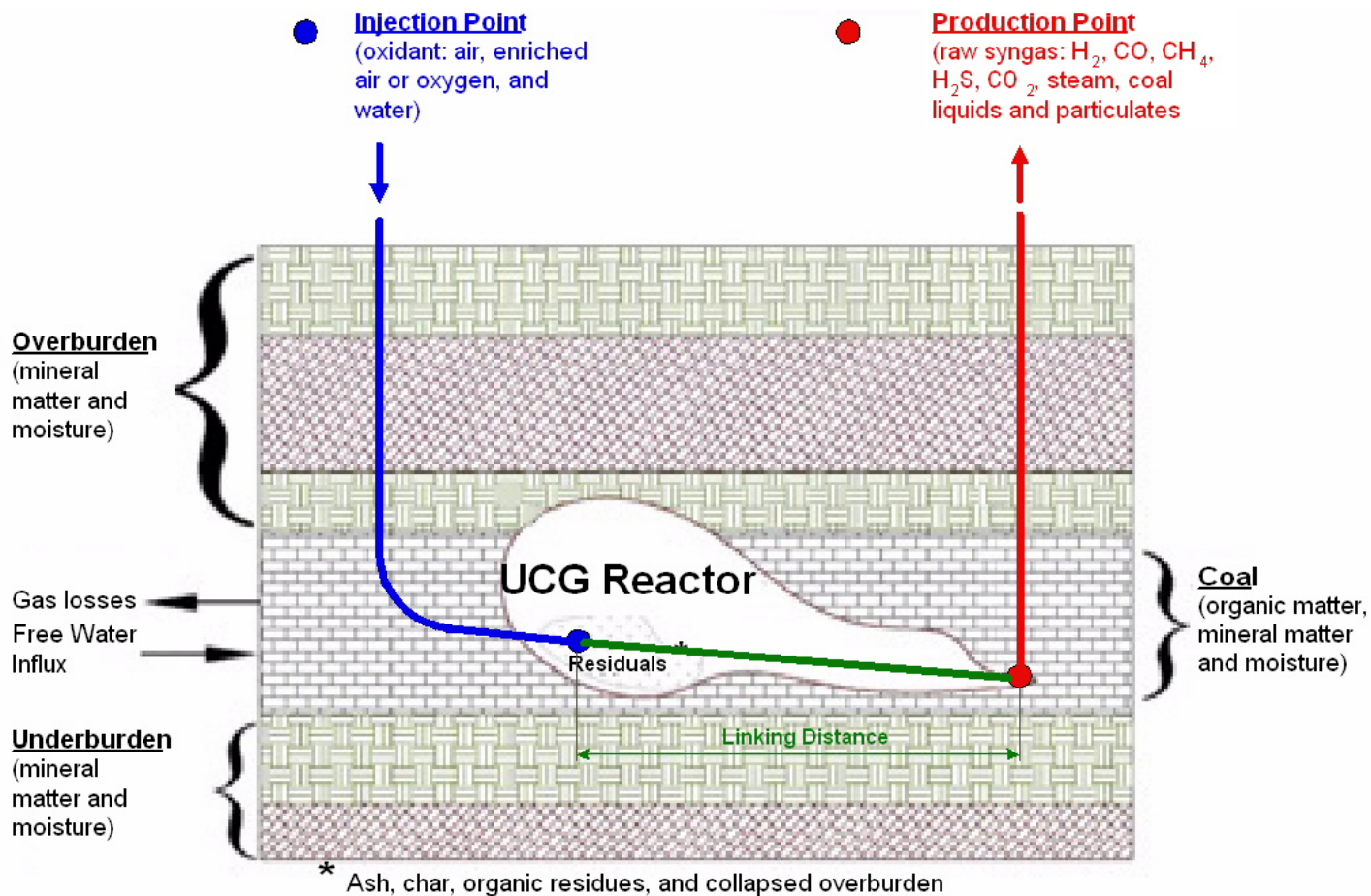


Main in-situ process parameters are:

- Geometrical (ST, ML, MW, Geometrical or "Sweep" efficiency)
- Chemical (Energy density in place, coal conversion efficiency)

The modern UCG technology -

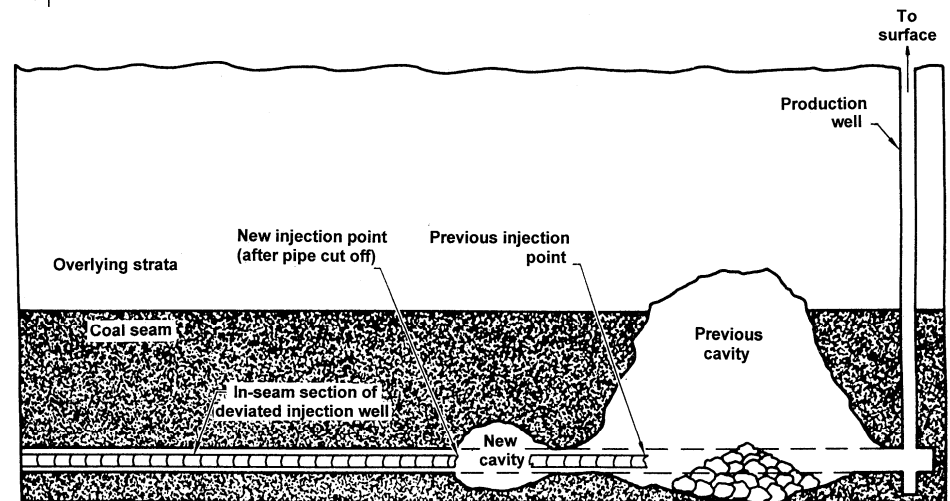
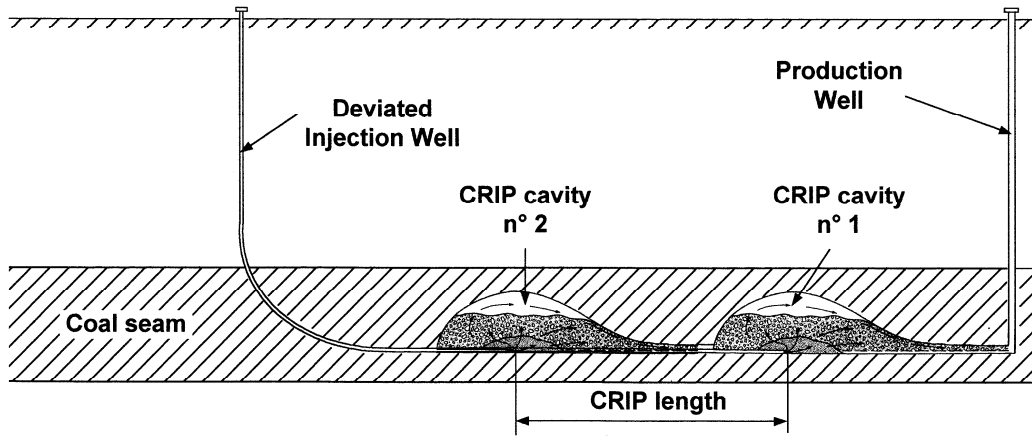
Controlled Retracting Injection Point (CRIP) Concept



Both wells are linked in-seam by one deviated in-seam drilling

- Enhanced linking distance
- Injection/ignition point is controllable from deviated in-seam injection well

CRIP: How it works



Technology Status for UCG at great depth

- **Deviated in-seam drilling, UCG module completion & linking**
 - Experience from oil, gas, CBM, CCS, and previous UCG trials at great depth
- **CRIP & remote control ignition design (pure oxygen)**
 - Coiled tubing, and experience from previous UCG trials at great depth
- **Production well design (corrosion, erosion & temperature)**
 - Experience from geothermal & highly corrosive gas/oil wells, and previous UCG trials at great depth
- **Monitoring of UCG**
 - Experience from oil, gas, CBM, CCS, mining: micro-seismicity, micro-gravity, cross-well seismic & electro-magnetic, and previous UCG trials at great depth: tracer tests, fibre optic TDR & DTM, mass & heat balances

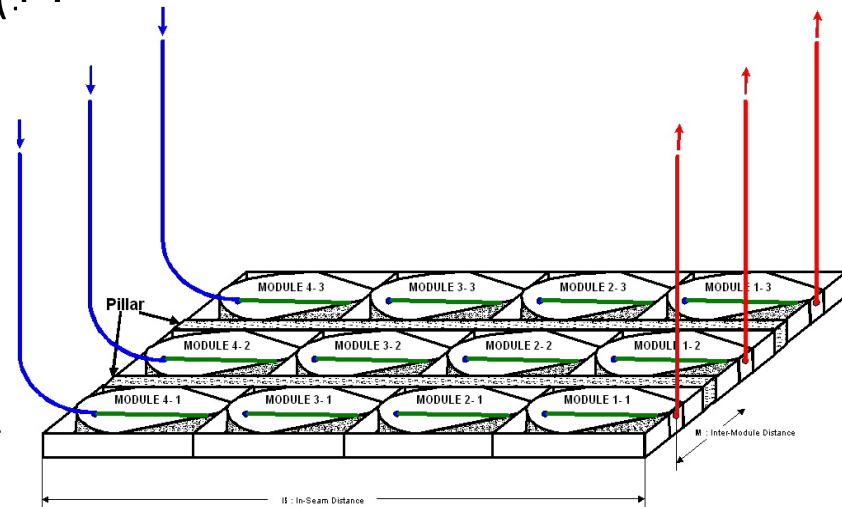
Study case: CRIP at 800 m depth, 500 MW thermal

■ Coal quality & geometrical parameters

- Bituminous: 28 GJ/t (38 GJ/m³)
- Depth: 800 m
- Thickness: 4-6 m (13 - 20 feet)
- Linking distance: 800 m
- Inter-module distance: 14-20 m
- Sweep efficiency (pillar included): 50-55 %

■ Chemical process parameters

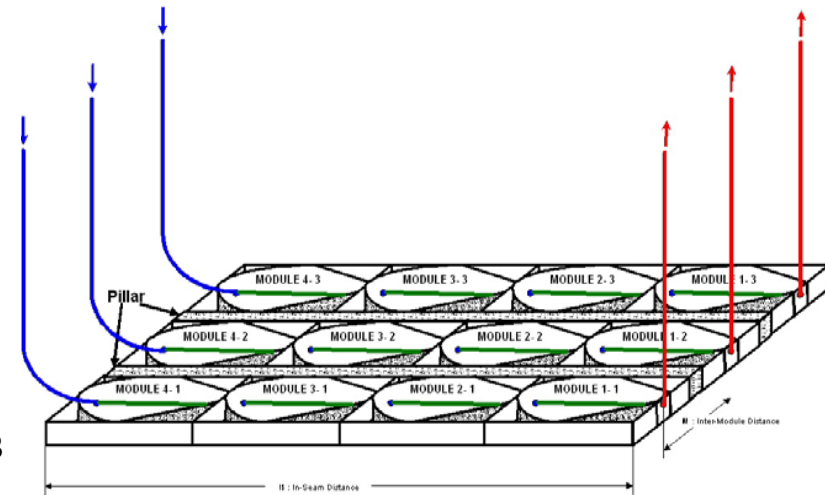
- Efficiency: 35-40 GJ/tO₂
- Module thermal power: 45-55 MW
- Pressure: 70-80 bar
- Module in //: 10
- Module life time: 0.5-1.1 year



Study case: CRIP at 800 m depth, 500 MW thermal

■ Raw Syngas Production at wellhead (per module)

- Hydrogen: 15.7 - 18.2 vol%
- Carbon Monoxide: 6.2 - 7.2 vol%
- Methane (plus C₂₊): 13.9 - 16.2 vol%
- Hydrogen Sulphide: 0.3 - 0.6 vol%
- Carbon Dioxide: 34.3 - 30.3 vol%
- Water Steam: 31.6 - 25.1 vol%
- Nitrogen: 0.5 - 0.2 vol%
- High Heating Value (HHV): 8.4 - 9.8 KJ/Nm³
- Flow Rate : 440,000 - 500,000 Nm³/day
480 – 590 tonne/day
- Gasification rate: 160 – 200 tonne/day



■ Estimated cost of Raw Syngas

= 1.7 – 3.1 €/GJ

Conclusions

- Modern UCG with CRIP concept is technically & economically available for Europe;
- The UCG Association supports the development of UCG at intermediate & great depth in Europe;
- The UCG Association proposes to form an European Chapter based on the past experience (European Working Group on UCG, Haute-Deule, Thulin & El Tremedal UCG trials).

**Thank you very much
for
your attention**