Coal to chemicals challenges in developing countries

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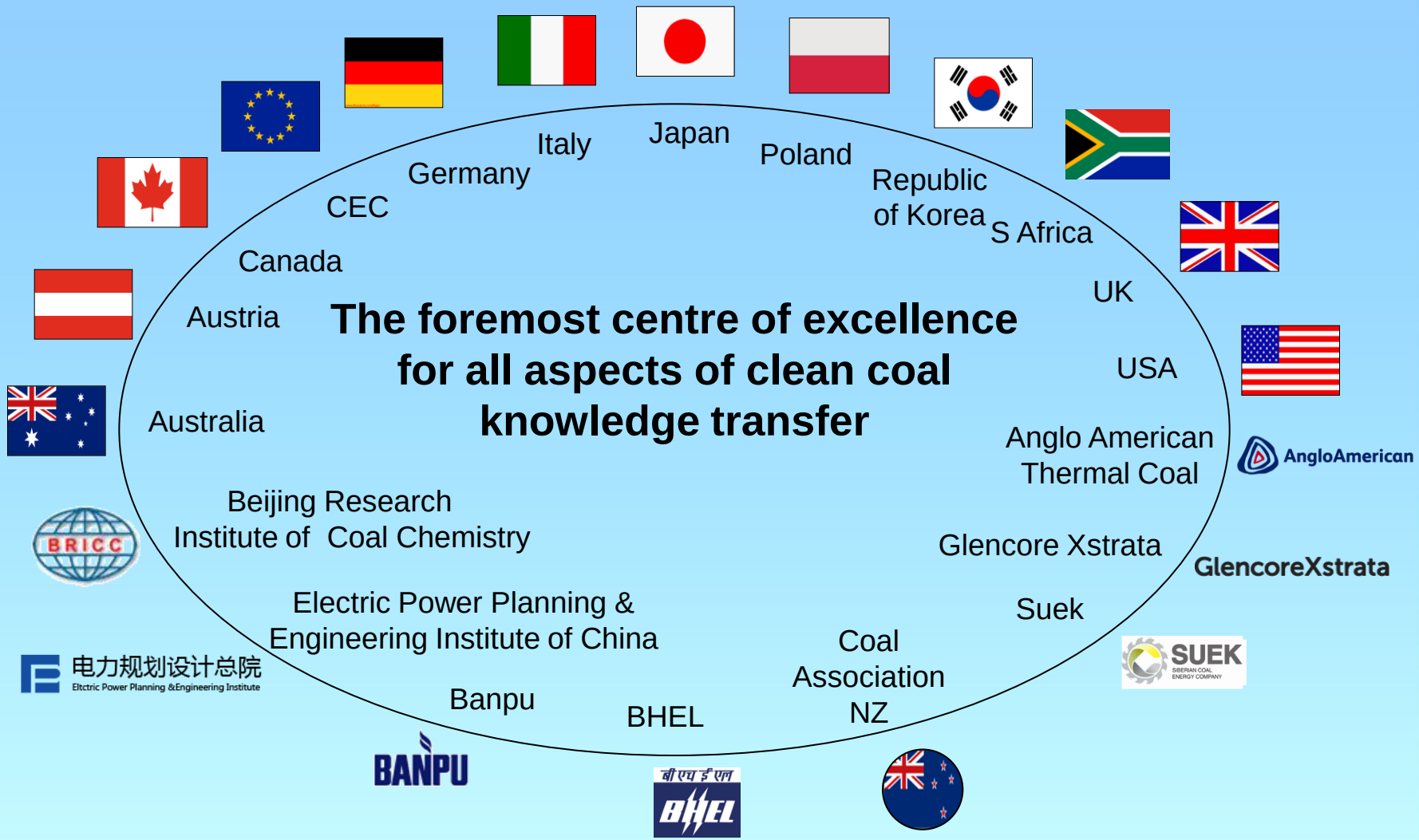
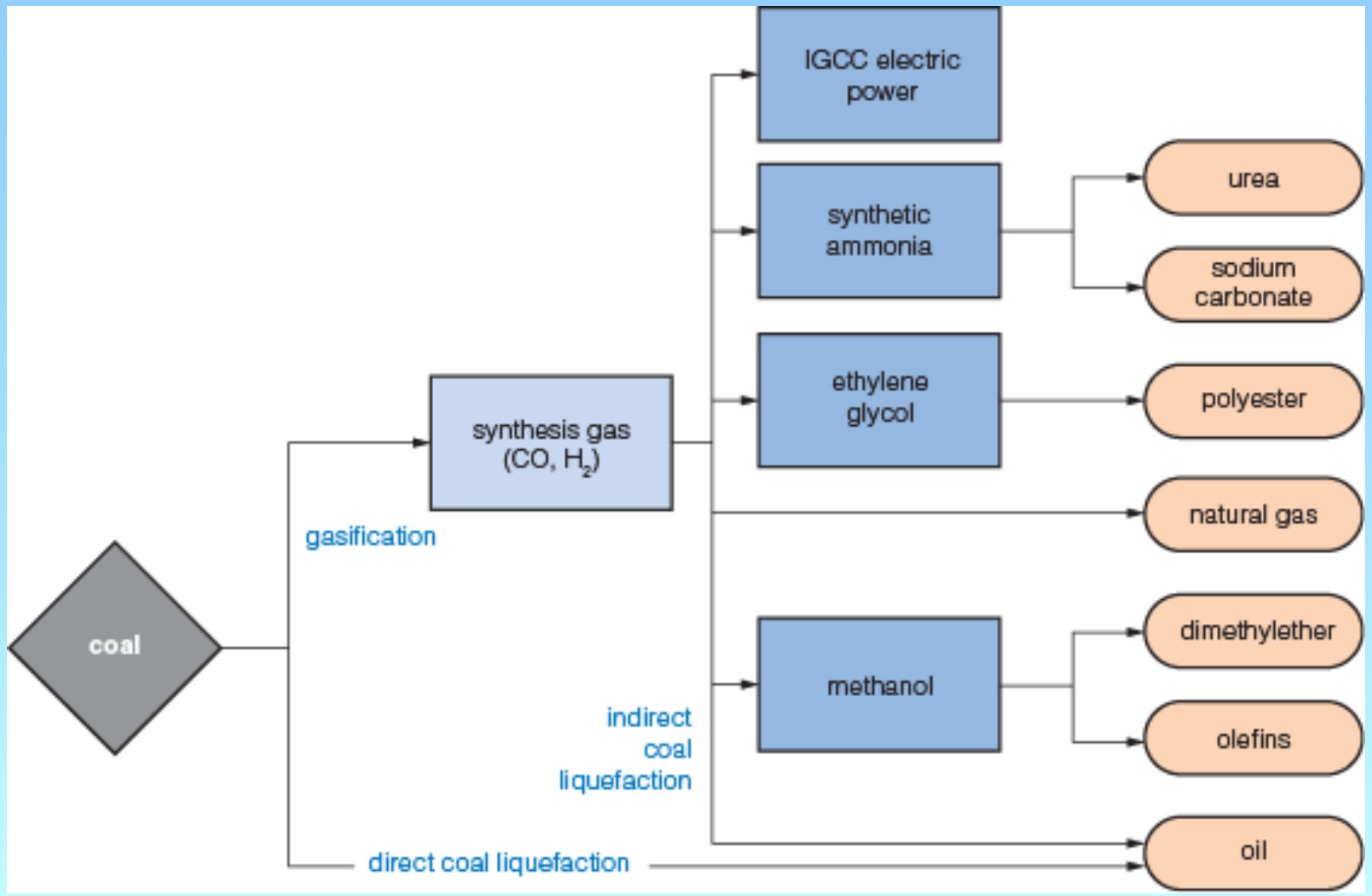


Scope of the presentation

- Rationale for coal to chemicals, gaseous and liquid fuels deployment
- Assessment of coal conversion opportunities
  - Basis for assessment
  - More promising developing countries
- Comparison with the Chinese experience
  - Energy & environmental issues
  - Economic considerations
  - Template for other countries
- Conclusions

New coal chemical industry supply chain is extensive



Prerequisites for assessing potential coal conversion projects

- Large reserves of low cost gasifiable coal required;
- Stranded coal, due to either its low-quality or location, can be attractive;
- Government ability and will to provide enabling support for the very large capital investments.

Further considerations

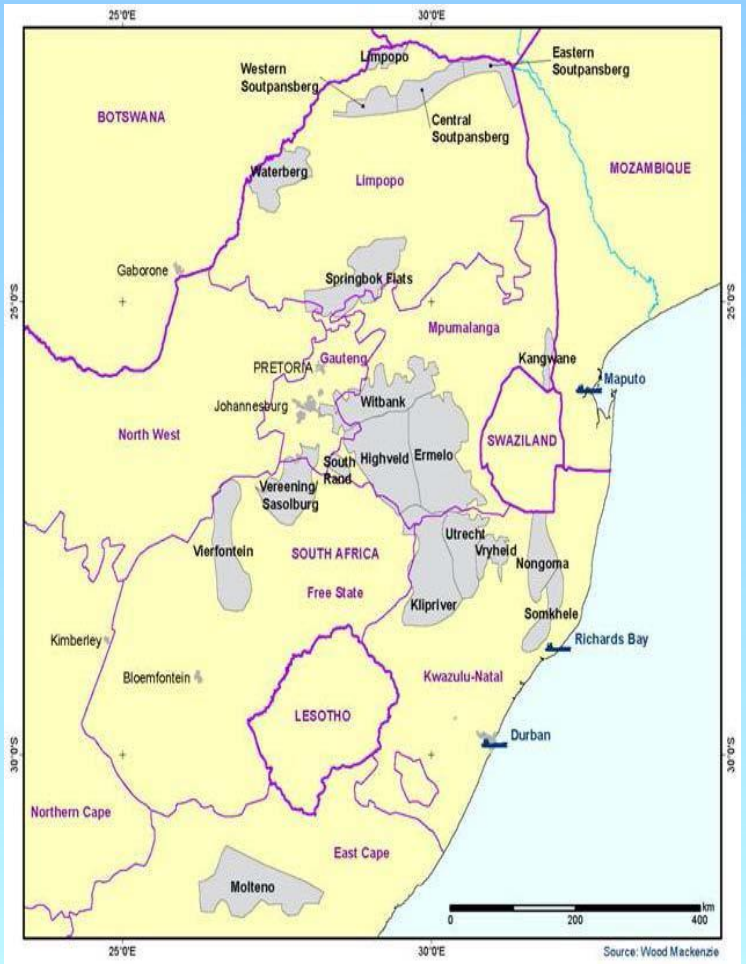
- Coal availability compared to either indigenous supplies or imports of oil and natural gas;
- Technical and economic issues must be attractive;
- Gasification products selection in terms of usage within the country itself and as exports;
- Infrastructure needs both for the supply of feedstocks and for transporting the end products;
- Institutional capacity requirements.

More promising developing countries for coal conversion development

Africa	Asia	Eurasia	Europe	South America
South Africa	China			
Mozambique	Mongolia	Ukraine	Turkey	
	Vietnam			
	India Indonesia	Uzbekistan		
Botswana		Russia		Brazil
Zimbabwe	Pakistan	Kazakhstan		

Commercial scale operations in South Africa

- Coal-based economy with significant domestic use and exports
- Sasol operates the world's only gasification-based commercial CTL facility at Secunda with an output capacity of 160,000 bbl/d of oil equivalent.
- Major Sasol petrochemicals production plant at Sasolburg, but in 2004 switched from coal to natural gas feedstock



Challenges and opportunities for Mongolia

- Very strong energy security driver to establish CTL and coal to chemicals
- Abundant, easily mineable lignite reserves and plenty of water in most of these regions
- Positive government support
- Cooperation underway between local companies and CTL technology suppliers
- Initial studies suggest an attractive price differential between CTL and imported oil products

- Limited technical and economic capacity
- Very limited infrastructure
- Small national GDP and need for external financing
- Mongolia seen as a risky investment in the mining sector

Challenges and opportunities for Mozambique

- Government support for exploitation of coal
- Very extensive coal reserves
- Market for CTL products both internally and for exports
- Active mining projects being developed by international companies for export purposes
- High ash rejects and coal preparation wastes can be used as gasification feedstock
- Studies underway to complement mining activities and results appear promising

- Lack of technical and economic capacity
- Small national GDP and need for external financing
- Lack of infrastructure
- Recent natural gas finds in region may make CTL an unattractive investment

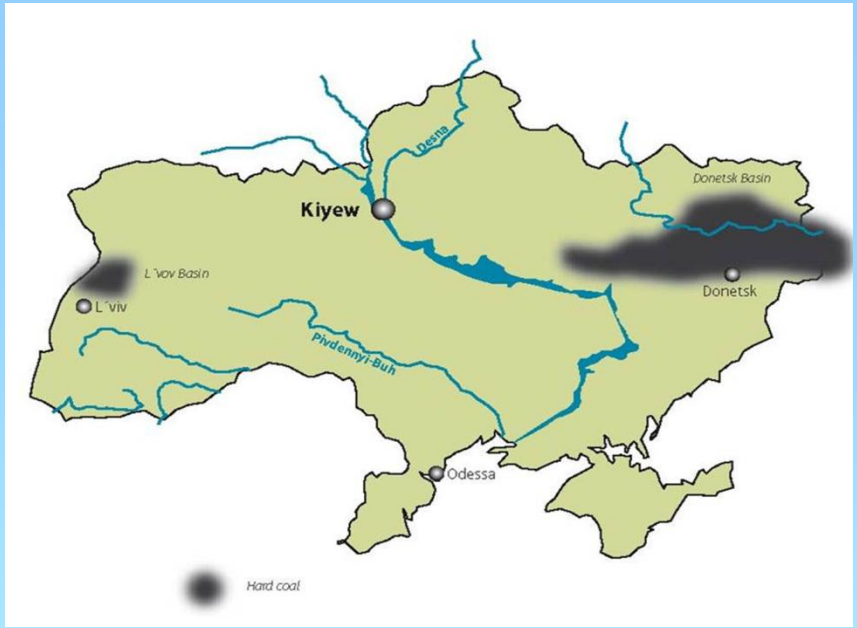
Activities in Vietnam

- Significant coal resources, in north of the country
- Joint ventures for exploitation proposed
- Interest in power and conversion projects
- One coal-to-chemicals project established at the Ninh Binh Nitrogenous Fertiliser Plant
- China Huadian Energy Development Company fulfilled EPC role

- Shell gasification technology used
- Full operation will produce 560,000 tonnes urea

Prospects for Ukraine

- Major coal reserves, much of which are lignite and subbituminous coal
- Economy is too highly dependent on imported natural gas and oil
- In principle, large-scale coal gasification to SNG could cut gas costs by 50%
- Ukraine to use domestic coal to produce a substitute for imported natural gas
- China will design and supply five coal to SNG plants in Luhansk, Donetsk and Odessa



- Shell will supply the gasification technology under license
- China Development Bank will provide a loan to cover the project's cost

Slow start in India

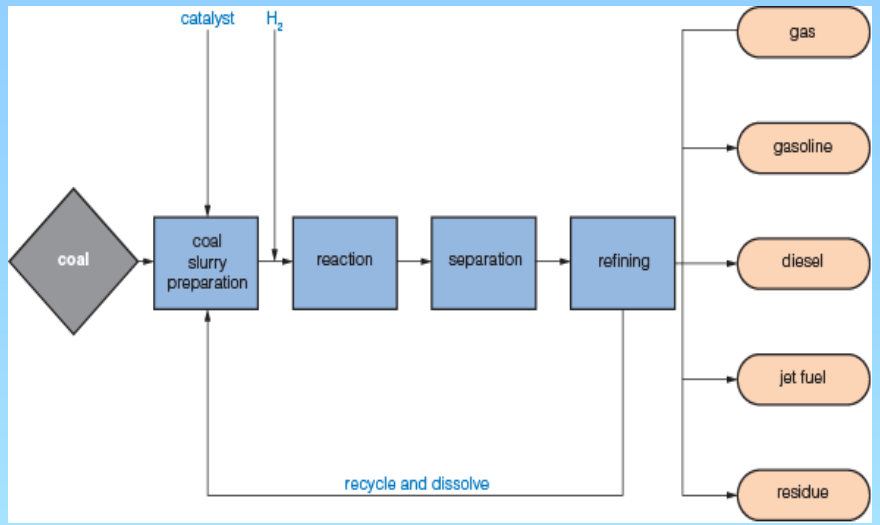
- Major user of coal and a rapidly growing economy
- Very large reserves of hard coal (60Gt) and lignite (38Gt)
- Hard coal far from industrial demand regions
- Major coal quality issues
- Government driven initiatives have been ineffective but some positive activities underway
- Jindal Steel and Power Ltd developing coal to chemicals project to produce a substitute reducing gas for the production of Direct Reduction Iron in a shaft furnace

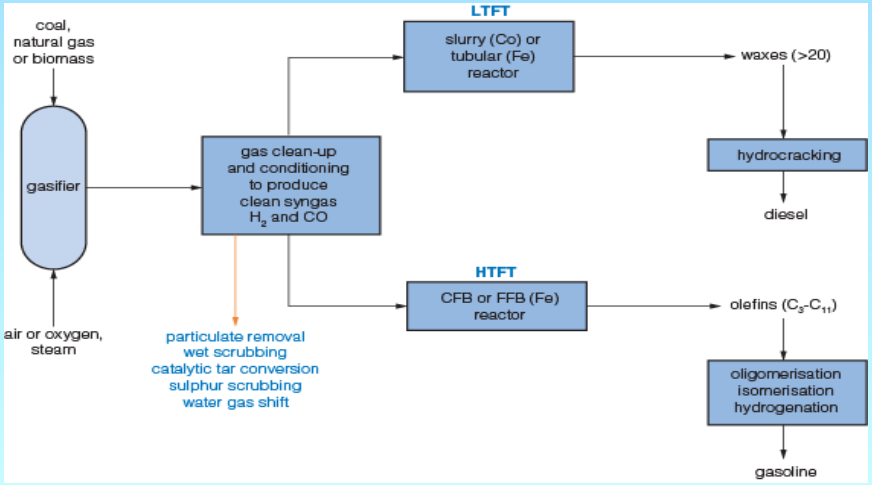
- Rashtriya Chemicals and Fertilisers Ltd, Coal India Ltd and the Fertiliser Corporation of India Ltd refurbishing several fertiliser production units

Comparison with China's coal to chemicals development and deployment programme

- Aim is to establish a modern coal chemical industry, to include the upgrade of those demonstration projects that offer the higher energy conversion efficiency, a suitable geographical location, with both adequate suitable coal supplies and sufficient water availability, as well as offering prospects for extending the industrial chain to promote local economic and social development.
- This will include a focus on the construction of projects for clean production, utilisation, processing and conversion of low-calorific-value coal

Indicative economic assessment for coal to oil products



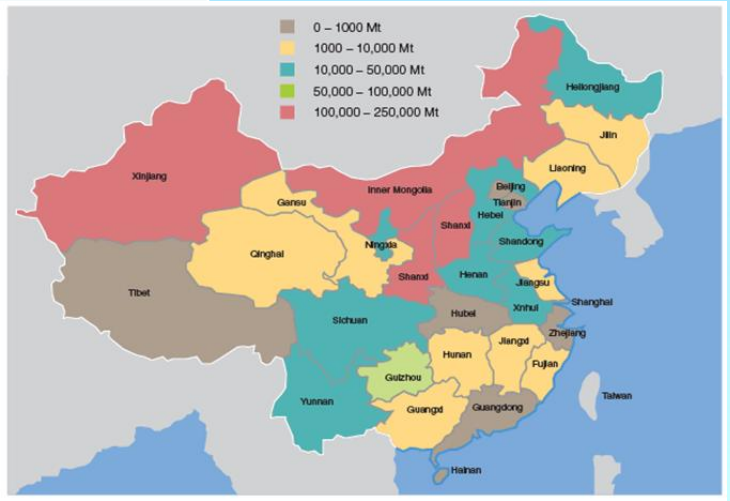


Indicative economic assessment

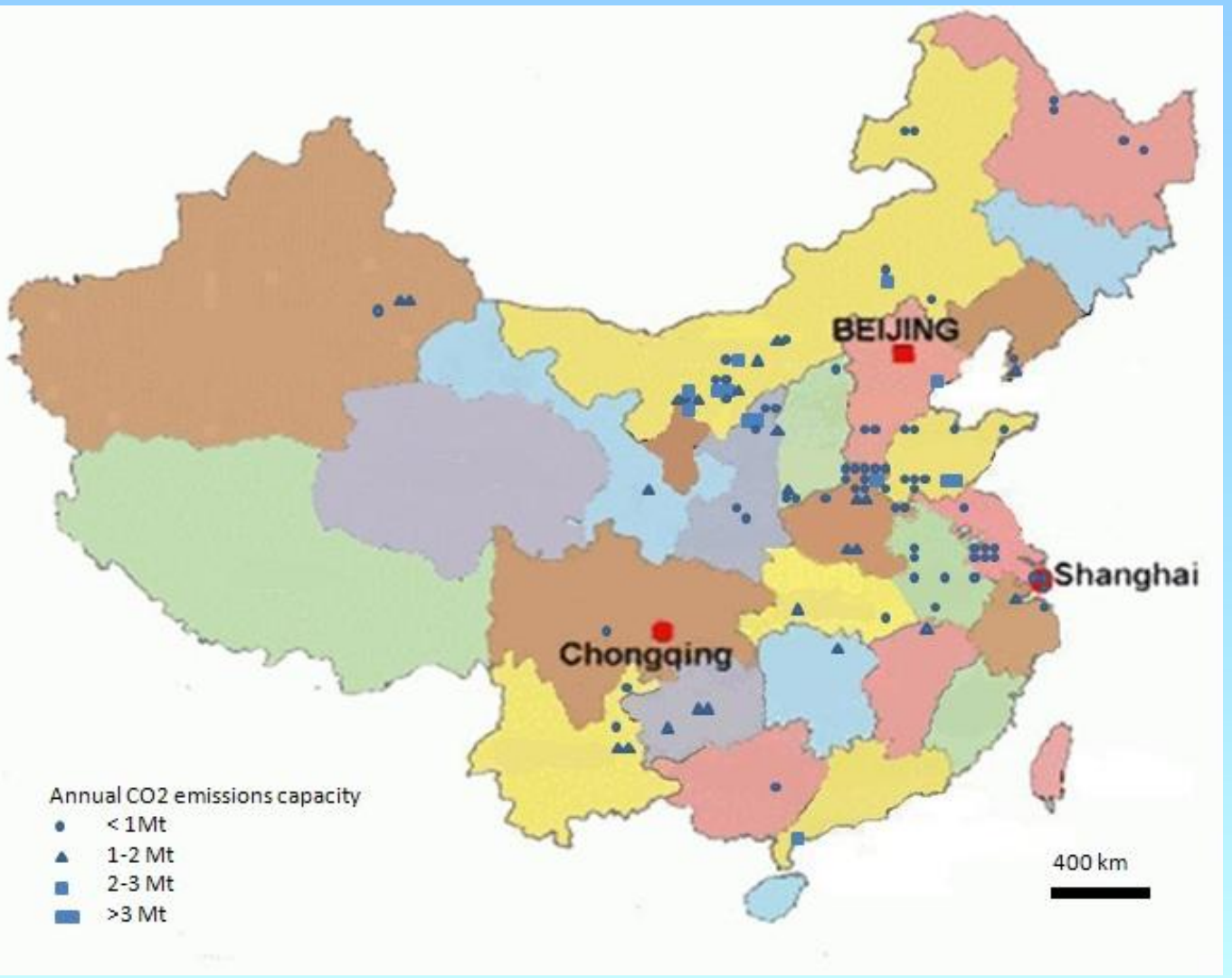
Input coal price (US$/tonne)	Crude oil production costs (US$/barrel)	
	ICL	DCL
15	35-45	25-30
125	80-90	49-59
155	110-120	65-75

Environmental considerations

Chinese applications	Standard coal consumption	Water consumption	CO2 emissions
	tonnes/tonnes		
ICL	4.39	13	5.0
Coal to olefins	6.68	33	5.5
Coal to ethylene glycol	2.55	14	2.0
tonnes/1000 Nm3			
Coal to SNG	2.83	6.58	2.5



Near term low cost CCUS opportunities



Conclusions

- Coal gasification for chemicals, gaseous and liquid fuels production can fulfil an important need, particularly in various developing countries where coal is the primary fuel source and oil and gas energy security is an issue.
- However, the establishment of projects in such countries can be problematical for a number of technical and economic reasons, although it is encouraging that some projects appear to be moving forward.
- For many, the role of China is likely to be critical in this regard as it can not only provide the technical expertise but also financially underpin such projects, including the associated infrastructure needs.
- China offers a template for large scale coal to chemicals, gaseous and liquid fuels deployment, for all stages of the industrial development cycle.
- Water availability and the need to limit CO2 emissions will need to be taken into account, if the global sector is to continue to grow