World recoverable coal reserves

- USA: 267.6 billion short tons
  - Bituminous and anthracite: 126.2 billion short tons
  - Sub-bituminous: 101.9 billion short tons
  - Lignite: 39.5 billion short tons
- Russia: 173.1 billion short tons
- China: 126.2 billion short tons
- India: 101.9 billion short tons
- Other non-OECD: 100.1 billion short tons
- Europe and Eurasia: 87.2 billion short tons
- Australia and New Zealand: 55.5 billion short tons (lignite less than 0.05 billion short tons)
- Africa: 43.3 billion short tons
- OECD Europe: 11.5 billion short tons
- Other non-OECD Asia: 11.1 billion short tons
- Brazil: 10.8 billion short tons
- Other Central and South America: 7.3 billion short tons
- Canada: 2.3 billion short tons
- Others: 2.3 billion short tons

World total: 997.7 billion short tons

Data for the USA represents recoverable coal estimates as of 1 January 2006.

Includes Mexico, Middle East, Japan and South Korea.

Shell China coal gasification licences
Including its first equity investment

Covering a wide range of coals
- Lignite/sub-bituminous
- Bituminous
- High ash coals
- Wide range of Ash fusion T’s

Syngas production for:
- Methanol
- Fertiliser
- Hydrogen

1 – Yueyang Sinopec and Shell Coal Gasification Co. Ltd
2 – Hubei Shuanghuan Chemical Group Co. Ltd
3 – Liuzhou Chemical Industry Co. Ltd
4 – Sinopec Hubei Chemical Fertiliser Co.
5 – Sinopec Anqing Chemical Fertiliser Co.
6 – Yunnan Tianan Chemical Co. Ltd
7 – Yunnan Zhanhua Co. Ltd
8 – Dahua Group Ltd
9 – Yongcheng Coal and Power Group
10 – Shenhua Coal Liquefaction Corporation
11 – Zhongyuan Dahua Group
12 – Henan Yima Kaixiang
13 – A power company in Inner Mongolia
14 – Tianjin Soda Plant of Bohai Chemical Group
15 – A chemical company in Guizhou
Status of plants in China

Yueyang Sinopec and Shell coal gasification
Sinopec Anqing
Sinopec Hubei
Yunnan Zhanhua
Liuzhou
Hubei Shuanghuan
Yunnan Tianan
Giuzhou
Yongcheng
Inner Mongolia
Zhongyuan Dahua
Kaixiang
Dahua
Shenhua
Shell China’s achievements and challenges

- First year availability is confirmed.
- Technical availability increasing – run times of 60 days plus.
- High-ash coals proved to be process-able at commercial scale.
- Shell’s technical support capability in China has been built up in 2006/2007.
- Operational learning curve for SCGP.
- Numerous Chinese start-ups have added to Shell’s experience and competencies regarding local procurement, construction and operations.
- Thorough commissioning is a must for reliable operation later.
- Obtaining consistent coal quality continues to be a challenge.
Coal transportation in China
Enablers for the future

Technology:
- Water quench
- Carbon capture and storage
- Capital
- Reliability
- Learning capture

Market:
- Energy scenarios

Deployment capability:
- Organisation/people
- Vendors/sourcing
- EPC partners
Research and development in the 1970s/80s

Clean coal development

- SCGP pilot plant
  Amsterdam 6tpd

Residue gasification and Gas-to-liquids (GTL) development

- SCGP demonstration plant
  Harburg 150 tpd
- SCGP demonstration plant
  Houston 400 tpd
- GTL laboratory
  Amsterdam
- GTL pilot plant
  Amsterdam

30+ years of experience in R&D and Demonstration plants.
The design journey – Shell Gasification projects & licensed projects 1990 to today

- Buggenum – SCGP for power
- Up to 30% biomass co feed in SCGP
- Optim Canada
- Sannazzaro
- Pernis – Shell gasification process for hydrogen and power
- Dongting – SCGP for fertiliser
- Bintulu – GTL Shell middle distillate synthesis for specialties and transportation fuels

Chinese licences, including CO₂ carrier gas designs

20+ years of Design and Operating experience at commercial scale, 86 gasifiers in total.
SCGP is a proven technology at ever increasing scales

- 6 t/d  (1976) Pilot unit, Amsterdam, Netherlands
- 150 t/d  (1978) Demonstration unit, Harburg, Germany
- 250 t/d  (1987) SCGP-1, Houston, USA
- 2000 t/d  (1993) NUON IGCC, Buggenum, Netherlands
- 7500 t/d licensed, a further 7500 t/d considered (2006) Largest Chinese licence
SCGP water quench – a change for the better…

• Enable gasification of coals, which cannot be processed with a syngas cooler owing to fouling
  - High sodium/chlorine content

• Reduce capital expenditure
  - No syngas cooler
  - No candle filter
  - Simpler shift line-up

• Improve integration with a downstream shift for chemical applications
  - Water is added directly to the syngas, not via a saturator cycle in the shift section
...but stick to key advantages of SCGP

- **Membrane wall**, heat protection for the gasifier through water cooling and steam production
- Separate gas and slag outlets for processing high-ash coals
- Multiple burners enable large capacities and efficient slag removal with only a small amount of fines
- Proven scale-up rules for the gasifier
Enablers for the future

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Shell Global Solutions

Combining the operating experience of over 5000 staff with proven implementation skills and advanced technologies

- Diverse cultures and nationalities
- Over 50 years of implementing business and engineering solutions
- Project management
- Continued investment in innovation

- XTL and Gasification skills and Technologies
- Shell Global Solutions
Building XTL/CCE capabilities that prepare for the future

- 1990s: Buggenum asset management programmes
- 2000s: Larsen & Toubro as 2nd gasification authorised vendor
- 2000s: China sourcing CCE equipment
- 2010s: Appointed global manager XTL/CCE operations and global manager XTL/CCE engineering
- 2010s: Beijing CCE service centre
- 2010s: Detailed engineering through Chinese design institutes
- 2010s: Focus on CCE equity project development
- 2010s: 3P licensing

Shell Technology India

Focus on CCE equity project development
Integrated, large-scale projects for the future

Pearl – GTL with Shell gasification process and Fischer–Tropsch technology

Nuon Magnum – large-scale SCGP for power production with deferred carbon dioxide sequestration

Courtesy Nuon
**Pearl GTL Onshore: Huge Dimensions**

**Commissioning & Start-up:**
- Systems to commission: ~ 6,000
- ‘Flaws’ to be mitigated: ~ 3,300

**Construction:**
- Piping: ~ 100,000 tones
- Structural steel: ~ 100,000 tones
- Equipment: ~ 100,000 tones
- Peak manpower: 35,000+
- Total manhours: ~ 200 mln

**Process:**
- Number of P&IDs: ~ 1,000
- Shaft power consumption: ~ 1.2 GW
- Steam generation: ~ 8,000 tonnes/hr
- Catalysts: 5,630 tonnes

Pearl an example of Mega Project Management
Thank you

Shell Global Solutions is a network of independent technology companies in the Shell Group. In this presentation, the expressions ‘Shell’ and ‘Shell Global Solutions’ are sometimes used for convenience where reference is made to these companies in general, or where no useful purpose is served by identifying a particular company.