

European Coal Gasification Projects

FutureGen Workshop
Tokyo, 25th February, 2008

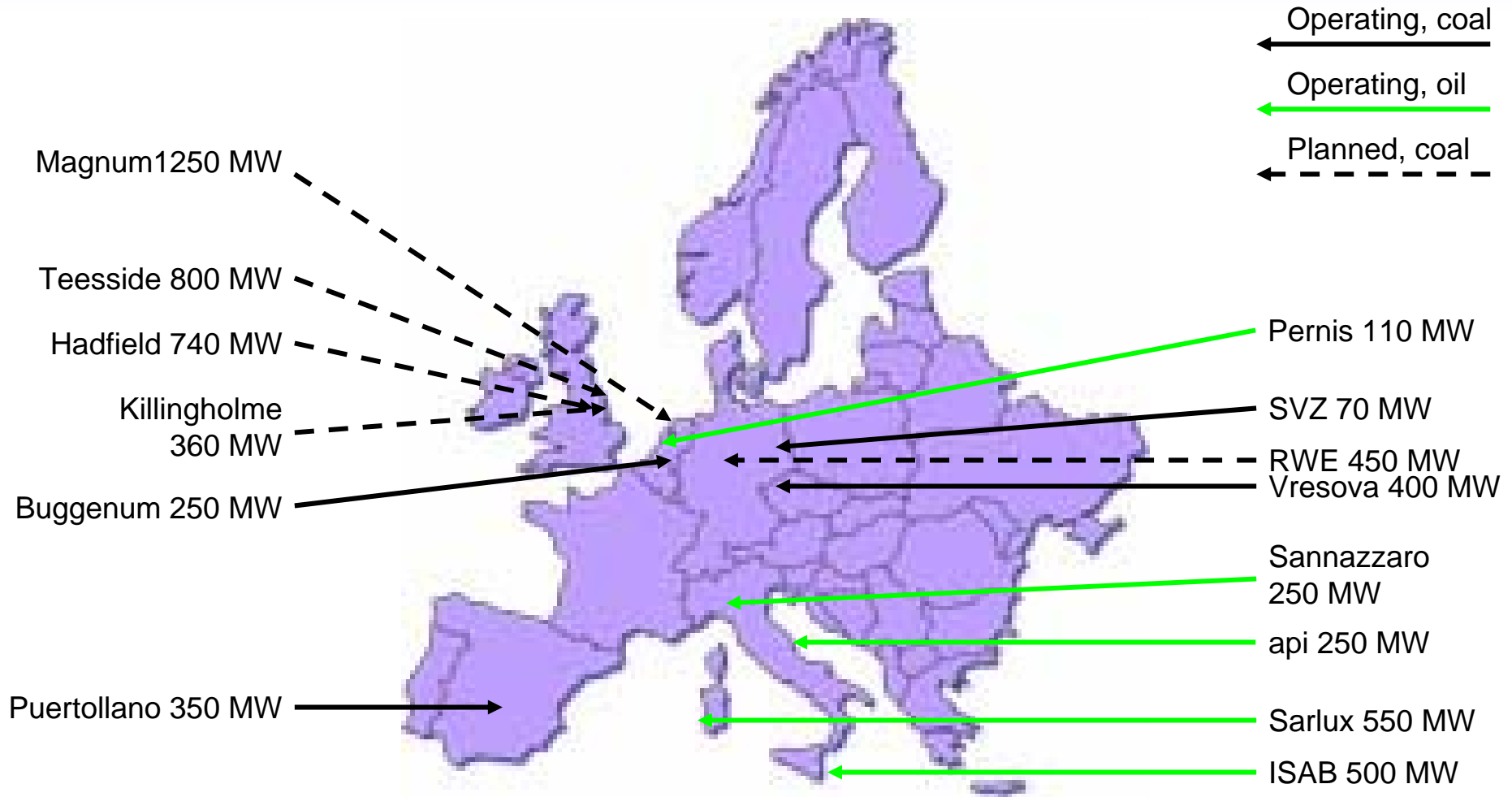
Chris Higman

SYNGAS CONSULTANTS LTD

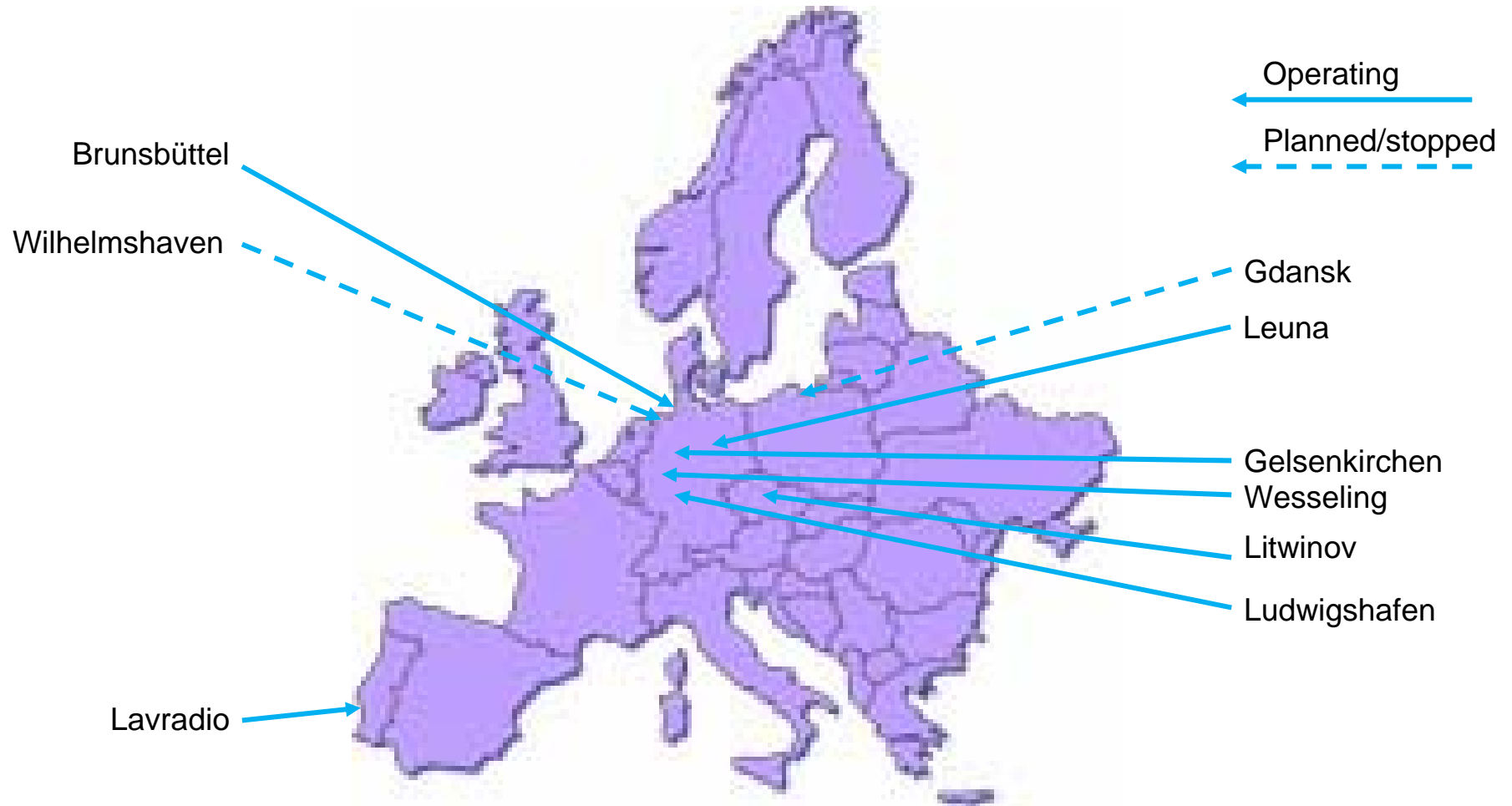
Overview

- Operating IGCCs in Europe
 - Coal-based
 - Refinery-based
- Planned IGCCs in Europe
 - The Netherlands (Magnum)
 - Germany (RWE)
 - United Kingdom (Teesside, Hatfield, Killingholme)
- Issues requiring resolution
- Conclusions

IGCC Activity in Europe



Other Large Gasification Plants



Buggenum, Netherlands

- IGCC: 253 MWe
- Feed: 2000 t/d coal
- Gasifier: Shell
- GT: Siemens V94.2
- Start up: 1994
- Owner: Nuon Power



Source: Nuon

- Up to 30% (mass) biomass feed
- Demo CO₂ capture plant in planning (30 000 t/a)

Puertollano, Spain

- IGCC: 350 MWe
- Feed: 2600 t/d
Coal, Petcoke
- Gasifier: Prenflo
- GT: Siemens V94.3
- Start up: 1998
- Owner : Elcogas



Source: Elcogas

- Demo CO₂ capture plant in planning
- Co-gasification of biomass planned
- Biofuel planned

Vresova, Czech Republic

- IGCC: 400 MWe
- Feed: Lignite
- Gasifiers: Lurgi type
- GT: 2x GE 9E
- Start up: 1968/1996
- Owner: Sokolovska Uhelna



Source: Sokolovská uhelna AS

Siemens tar gasifier recently started up

Schwarze Pumpe, Germany

- IGCC: 75 MWe
360 t/d MeOH
- Feed: Lignite, Waste
- Gasifiers: Lurgi type,
Siemens, BGL
- GT: GE 6B
- Start up: 1956/1984/2000
GT:1997
- Owner: Sustec SVZ



Source: SVZ

- 2007: waste to methanol stopped for economic reasons
- Additional project to return Siemens gasifier to lignite feed

Sarlux, Italy

- IGCC: 550 MWe
40000 Nm³/ H₂
- Feed: 3560 t/d VVR
- Gasifier: 3xGE
- GT 3x GE 9E
- Start up: 2000
- Owner: Sarlux



Source: Sarlux

ISAB, Italy

- IGCC: 512 MWe
- Feed: 3168 t/d
Asphalt
- Gasifier: 2 x GE
- GT 2 x V94.2K
- Start up: 2000
- Owner: ISAB



Source: Preston

- Additional gasifier for H₂ in planning

Falconara, Italy

- IGCC: 250 MWe
- Feed: 1560 t/d VVR
- Gasifer: 2 x GE
- GT Alstom 13E
- Start up: 2001
- Owner: api



Source: Spence

Sanazzaro, Italy

- IGCC: 250 MWe
40 000 Nm³/h H₂
- Feed: 1200 t/d VVR
- Gasifier: 2 x Shell
- GT: V94.2K
- Start up: 2006
- Owner: Eni R&M



Source: Camozzi et al.

Pernis, The Netherlands

- IGCC. 110 MWe
285 t/d H₂
- Feed: 1650 t/d VVR
- Gasifier: 3 x Shell SGP
- GT: 2 x GE 6B
- Start up: 1997
- Owner: Shell

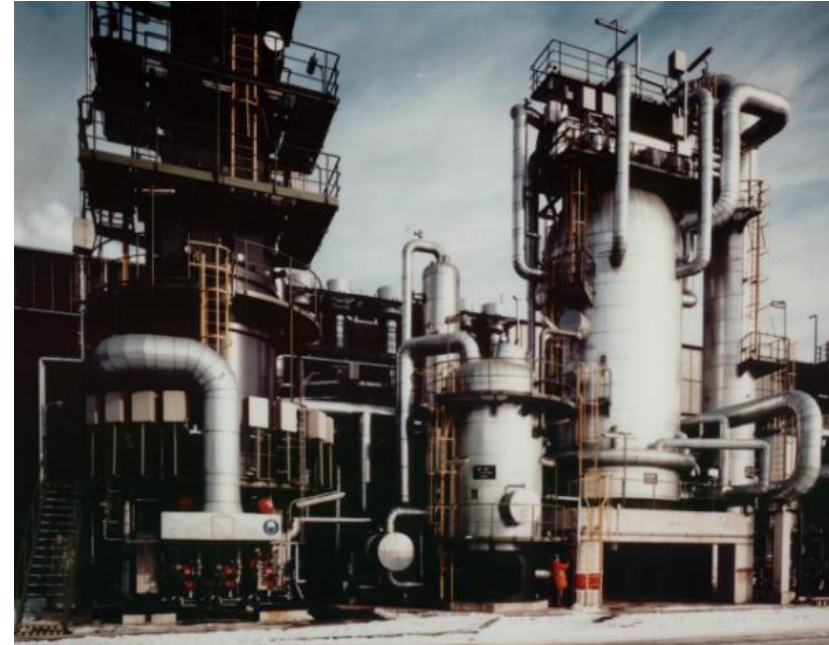


Source: Shell

- ~ 1.1 MMt/a CO₂ in hydrogen trains captured
- 325 000 t/a used for greenhouses via 85 km pipeline

Wesseling, Germany

- MeOH: 1000 t/d
- Feed: 800 t/d VVR
- Gasifier: Shell + GE
- Start up: 1969/1980
- Owner: Shell



Source: Lurgi

- was using gas from Berrenrath
660 t/d HTW coal gasifier

Gelsenkirchen, Germany

- NH_3 1200 t/d
- MeOH 900 t/d
- H_2 40000 Nm^3/h
- Feed: 1560 t/d VVR
- Gasifier: 4 x Shell
- Start up: 1972
- Owner: BP



Source: Lurgi

- Classic poly-generation with swing between NH_3 and MeOH to suit markets

Brunsbüttel, Germany

- Ammonia: ~2050 t/d
Urea: 1600 t/d
- Feed: ~1900 t/d resid
- Gasifier: 4 x SGP
- Start up: 1978
- Owner: Yara



Source: Lurgi

- 1.85 MMt/a CO₂ captured in ammonia plant (equivalent to 300 MWe IGCC)
- ~ 400 000 CO₂ used in urea plant. with compression to ~150 bar

Lavrado, Portugal

- Ammonia: 900 t/d
Urea: 300 t/d
- Feed: 800 t/d VR
- Gasifier: 2 x Shell
- Start up: 1984
- Owner: CUF



Source: Lurgi

- 80 000 t/a CO₂ to urea plant
- 64 000 t/a CO₂ sold to food industry

Leuna, Germany

- MeOH: 2090 t/d
H₂ ~70000 Nm³/h
- Feed: 2400 t/d VVR
- Gasifier: 6 x SGP
- Start up: 1985
- Owner: Total



Source: Leuna

- ~1.6 MM t/a CO₂ captured
- 12 000 t/a CO₂ supplied to EU CO₂-SINK demo sequestration project at Ketzin

Nuon Magnum, The Netherlands

- IGCC: 750 MWe
- NGCC: 450 MWe
- Feed: Coal, Biomass, Nat. Gas
- Location: Eemshaven, NL
- Gasifiers: 3 x Shell
- Start up: 2011
- Limit changes from Buggenum to lessons learned



Source: Nuon

New, phased approach:

- CCU for 2011
 - GT order already placed
- IGCC for 2012
- Partial CO₂ capture to start 2013

RWE, Germany

- IGCC: 360 MWe
- Feed: Lignite
- Location: N/A
- Start up: 2014
- CCS: from start
- CO₂: 2.3 MMt/a
- Efficiency: Target 40% LHV
- Storage: depleted gas reservoirs or saline aquifers
- Cost: €1bn (Q1/2006)



Source: RWE

- Efficiency 35-38.5%, working to improve
- Storage site approval planned for 2010

Centrica, Teesside, UK

- IGCC: 800 MWe
- Feed: Coal
- Location: Teesside
- Start up: 2012
- CCS: from start
- CO₂: 5 MM t/a
- Storage: EOR
- Cost: £1.5 bn (7/2007)



Source: Roddy

- 85% CO₂ capture

Powerfuel, Hatfield, UK

- IGCC: 740 MWe
- Feed: Local coal
- Location: Hatfield, Yorks.
- Start up:
- CCS: from start
- CO₂: ~90% capture
- Storage: EOR



Source: Powerfuel

- 2 x Shell water quench gasifiers
- Permitting partially in place
- FEED contract awarded

E.ON, Killingholme, UK

- IGCC: 360 MWe
- Feed: Coal
- Location: Killingholme
- Start up: 2012/2013
- CCS: from start
- CO₂: 2.5 MM t/a
- Efficiency: >35% (LHV)
- Storage: EOR



Source: E.ON

- Project stopped after details of UK "CCS competition" announced.

Issues requiring resolution

- Costs
 - Rapid CAPEX increases affecting projects in many sectors
 - Who pays for CCS in a competitive power market?
- Legislation
 - Permitting storage
 - Permitting CO₂ pipelines (standards)

Some Legislation Issues

- Political climate is generally favorable, but concrete steps are required, e.g.
 - European Trading Scheme phase 3 rules not yet known
 - London Protocol and OSPAR treaties amended to facilitate CCS, but OSPAR still needs ratification
 - HSE rules (including CO₂ specification) for land transport
 - Long-term liability issues
 - Monitoring and verification requirements need defining

Conclusions

- Gasification well established in Europe – particularly in the refining sector
- There is already 2745 MWe IGCC capacity in Europe, of which 1075 MWe is coal-based
- New projects all aim for early CCS
- BUT, uncertainties in
 - Carbon pricing
 - Legislative frameworkcausing delays, project phasing and even stops

Questions?