### Current Operating IGCC Plants (Coal Feedstock)

<table>
<thead>
<tr>
<th>Commercial Operating Date</th>
<th>Net Output</th>
<th>Gas Turbine</th>
<th>Gasifier</th>
<th>Gasifier Details</th>
<th>Gasifier Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buggenum (Netherlands)</td>
<td>253 MW</td>
<td>Siemens V94.2 (SGT5-2000E)</td>
<td>Shell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wabash (USA)</td>
<td>262 MW</td>
<td>GE 7FA</td>
<td>ConocoPhillips</td>
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<tr>
<td>Vresova (Czech Rep.)</td>
<td>398 MW</td>
<td>GE 9E (2 off)</td>
<td>Lurgi (26 off)</td>
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</tr>
<tr>
<td>Polk (USA)</td>
<td>250 MW</td>
<td>GE 7FA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puertollano (Spain)</td>
<td>330 MW</td>
<td>Siemens V94.3</td>
<td>Uhde</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nakoso (Japan)</td>
<td>250 MW</td>
<td>MHI M701DA</td>
<td>MHI</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1,743 MW</strong></td>
<td></td>
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</tr>
</tbody>
</table>

Source: [www.gasification.org](http://www.gasification.org) and other public websites.
IGCC – Current Projects

Only three showing any significant progress:

- Edwardsport (Duke Energy), Indiana, USA
  - $2.9B ($4,700/kW) – 618 MW
  - COD 2012

- Kemper County (Mississippi Power), Mississippi, USA
  - $2.2B ($3,800/kW) – 582 MW (with 65% CO₂ capture)
  - COD 2014

- GreenGen, Tianjin, China
  - $1B ($4,000/kW) – 250 MW
  - COD 2011
European Energy Programme for Recovery (EEPR)

- €180M to each project
  (except Porto Tolle, which has €100M)
- "Rules"
  - >80% CO₂ capture
  - Transport and store underground
  - 250 MWₑ or greater
  - Knowledge share
- Reserves in grey

1 – Hatfield (IGCC) - Powerfuel
2 – Jaenschwalde (Oxy-Fuel) – Vattenfall
3 – Porto Tolle (Post-Comb) - Enel
4 – Maasvlakte (Post-Comb) – E.ON
5 – Belchatow (Post-Comb) – PGE EBSA
6 – Compostilla (Post-Comb) - Endesa
New Entrants’ Reserve (NER300)

- 300M CO₂ credits from NER to be made available to CCS and Renewable installations.
- Total value unknown
  - Depends on price of a CO₂ credit
  - Depends on split between CCS and Renewables
  - €3B for CCS may not be unreasonable guess.
- Up to eight CCS plants to be demonstrated by end of 2020 (more possibly at a later date, subject to funding being available).
  - Announcements made at end of 2011 and end of 2013
  - 50% of CAPEX paid up front
- Shortlist of projects to be announced end-2010.
- 250 MW minimum, to be in service by 2015. 85% CO₂ capture.
New Entrants’ Reserve (NER300) – UK CCS Projects

- Partial list released
- This slide represents author’s best guess
- All three main CCS routes shown
  - Five pre-combustion capture
  - Three post-combustion capture
  - One oxy-fired plant

1 – Blyth (Pre) – Progressive Energy
2 – Teesside (Pre) – Progressive Energy
3 – Hatfield (Pre) – Powerfuel
4 – Endex (Pre/Gas) – Powerfuel
5 – Killingholme (Pre) – C.GEN
6 – Peterhead (Post/Gas) – SSE/Shell (Retrofit)
7 – Longannet (Post) – Scottish Power (Retrofit)
8 – Hunterston (Post) – Ayrshire Power
9 – Drax (Oxy) – Drax Power/Alstom
European IGCC Projects

- None has final sanction
- Uncertainty over storage holding them back?
  - Highlights importance of storage sites shown on map

- 1 – Hatfield (IGCC) – Powerfuel – Phase 1 (CCGT)
- 2 – Magnum (Nuon/Vattenfall) – Phase 1 (CCGT)
- 3 – Rotterdam (Essent) – Postponed
- 4 - Rotterdam (C.GEN) – Polygen (S/U 2015) – In feasibility
- 5 – Hürth (RWE) – 450 MW IGCC – Postponed
- 6 – Kedzierzyn (ZAK/PKE) – Polygen (S/U 2015?) - Unknown
- 7 - Ketzin (EU Project) – CO₂ injection into aquifer
- 8 – Sleipner (Statoil) – CO₂ injection into gas field
- 9 – Snøhvit (Statoil) – CO₂ injection into gas field
Technology Updates

• Many types of gasifier available
  • ConocoPhillips, GE, MHI, KBR, Shell, Siemens, TPRI.
  • These are either proven, or starting to enter service.
  • Other novel designs being developed, but are not yet commercially available.

• Warm gas clean up
  • Potential efficiency and CAPEX benefit

• Gas turbine technology
  • H-class turbines – now available for natural gas
  • 60% CCGT efficiency, cf. 55% for older F-class GTs.
Summary

- Costs are still very high
  - Only makes sense if carbon is restricted
  - However, then IGCC with CCS could be competitive.

- Technology slowly moving forward to drive costs down.

- Many projects moving forward slowly/not at all
  - Uncertainty over future for coal and CCS
  - Financial constraints