Clean Coal Technologies in South Africa

UN EWG CCS
10 & 11 Sep07
New York

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<table>
<thead>
<tr>
<th>SUPPLY</th>
<th>TRANSFORM</th>
<th>TRANSPORT</th>
<th>END USE</th>
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<tbody>
<tr>
<td>Oil</td>
<td>Oil Refineries</td>
<td>Rail</td>
<td>Liquid Fuels</td>
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<tr>
<td></td>
<td>PetroSA</td>
<td>Road</td>
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<td></td>
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<td>Pipeline</td>
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<td>Natural Gas</td>
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<tr>
<td></td>
<td>Sasol</td>
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<tr>
<td>Coal</td>
<td>“Washery”</td>
<td>Road/Rail</td>
<td>Export</td>
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<tr>
<td>Nuclear</td>
<td></td>
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<tr>
<td>Renewable</td>
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<td>Eskom and Others</td>
<td>Transmission</td>
<td>Electricity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wires</td>
<td></td>
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<tr>
<td></td>
<td>Koeberg</td>
<td>Person/Road</td>
<td>Wood</td>
</tr>
</tbody>
</table>
ELECTRICITY
Eskom [Electricity]

~40% Africa Generation Capacity

Coal Fired
Nuclear
Hydro
Gas Turbine [Liquid]
Potential New Coal
NEW ELECTRICITY GENERATION STATIONS I

- **Coal:**
  - Super Critical Coal-Fired: Medupi plus three others under consideration
  - Underground Gasification
  - Return to Service of Coal-Fired Mothballed Plant

- **Nuclear:**
  - Pebble Bed Modular Reactor
  - Pressure Water Reactor

- **Import:**
  - Botswana – Mmamabula – Coal [~200Bt resources?]  
  - Mozambique – Cahora Basa – hydro - current
  - Mozambique – Mepanda Uncua – hydro
  - DRC – Inga – possible
  - Namibia – Kudu Gas - possible
NEW ELECTRICITY GENERATION STATIONS II

Renewable Energy:
- Wind – Darling Wind Farm - ~13MW
- Mini Hydro – eg Bethlehem
- Mini Solar
- Electricity Displacement; Solar Hot Water, LPG

Gas:
- Gas Turbine;
  - LNG
  - Liquid
  - Coal Bed Methane
UNDERGROUND GASIFICATION
First Flaring

Eskom

20Jan07 First Flaring
Technology Provider: Ergo
Exergy Inc (Canada)
## Refinery Capacity

<table>
<thead>
<tr>
<th>Facility</th>
<th>Barrels/day (Crude or equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calref (Capetown: Caltex)</td>
<td>100 000</td>
</tr>
<tr>
<td>Sapref (Durban: BP/Shell)</td>
<td>180 000</td>
</tr>
<tr>
<td>Genref (Durban: Engen)</td>
<td>105 000</td>
</tr>
<tr>
<td>Natref (Sasolburg: Sasol/Total)</td>
<td>86 000</td>
</tr>
<tr>
<td>Sasol (Coal to Liquid)</td>
<td>150 000</td>
</tr>
<tr>
<td>PetroSA (Gas to Liquid)</td>
<td>45 000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>666 000</strong></td>
</tr>
</tbody>
</table>

Current liquid fuel supply: ~40% synfuel.
NEW LIQUID FUELS

- **New Synfuel Plant:**
  - Sasol considering synfuel plant on Waterberg Coalfield

- **Refinery Capacity:**
  - Green field
  - Brown field
  - No decision as yet

- **Bio-Fuels:**
  - Bio-Fuel Strategy currently before government.
CARBON CAPTURE & STORAGE
South Africa is a Member of the Carbon Sequestration Leadership Forum

Processing Membership for IEA GHG

First Step:

💰 Is there potential for CCS in South Africa
   - If YES – then Undertake Next Steps
   - If NO – then Discard CCS as a Greenhouse Gas Mitigation Tool

💰 First Step Indicated a Possible CCS Potential
CO₂ EMISSION CONCENTRATIONS

CO₂ EMISSIONS

Emissions in Gg/year Value
- 0 - 880
- 881 - 3,712
- 3,713 - 8,336
- 8,337 - 14,845
- 14,846 - 29,410
- 29,411 - 53,203
- 53,204 - 105,257
## CO₂ EMISSION QUANTIFICATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Mt</th>
<th>% Emission</th>
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</thead>
<tbody>
<tr>
<td><strong>SEQUESTRABLE</strong></td>
<td></td>
<td></td>
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<tr>
<td>Electricity</td>
<td>161</td>
<td>65</td>
</tr>
<tr>
<td>Industrial</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Other Energy</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>249</td>
<td>61 %</td>
</tr>
<tr>
<td><strong>NON-SEQUESTRABLE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Agriculture</td>
<td>48</td>
<td>27</td>
</tr>
<tr>
<td>Fugitive</td>
<td>42</td>
<td>24</td>
</tr>
<tr>
<td>Transport</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Heat Production</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>159</td>
<td>39 %</td>
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</tbody>
</table>

**Total** 408
## SYN-FUEL CO2 EMISSIONS

<table>
<thead>
<tr>
<th>Plant</th>
<th>Location</th>
<th>CO2 Source</th>
<th>CO2 Emitted (Mt/a)</th>
<th>CO2 Conc (%)</th>
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</thead>
<tbody>
<tr>
<td>Sasol1</td>
<td>Sasolburg</td>
<td>Boilers &amp; Heaters</td>
<td>7</td>
<td>10-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gasifiers Downstream</td>
<td>4</td>
<td>90-98</td>
</tr>
<tr>
<td>SSF Sasol 2</td>
<td>Secunda</td>
<td>Boilers &amp; Heaters</td>
<td>9</td>
<td>10-15</td>
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<tr>
<td></td>
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<td>Gasifiers Downstream</td>
<td>14</td>
<td>90-98</td>
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<tr>
<td>SSF Sasol 3</td>
<td>Secunda</td>
<td>Boilers &amp; Heaters</td>
<td>9</td>
<td>10-15</td>
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<tr>
<td></td>
<td></td>
<td>Gasifiers Downstream</td>
<td>14</td>
<td>90-98</td>
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<tr>
<td></td>
<td></td>
<td>Total ~32Mt/y</td>
<td></td>
<td>~95%</td>
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Sasol Investigating **Enhanced Coal Bed Methane Recovery**

**Country Readiness** [*Enablers in place that will facilitate the implementation of a carbon capture and storage project*]:

- Identification and Characterisation of Sources
- Identification and Characterisation of Storage Sites
  - Terms of Reference being compiled
  - International expertise
  - Technology make-or-break
- Regulatory System – still to be addressed
Country Readiness continued

Plant Ready [Stationary Sources]

Capacity Building:

- Technical Know-How;
  - Membership CSLF, IEAGHG?
  - Bi/Multi-Lateral Co-operation
- Human Capacity;
  - CSLF Training Programme 2007 [USA] ~4 attendees
  - IEA Training Programme [Germany] - [Bilal Patel]
- Public Outreach;
  - FFF Workshop Jun07
  - Journal/Newspaper Articles
OTHER CLEAN COAL ACTIVITIES

- Coal Fired Electricity:
  - Super-critical
  - TSP/SOX/NOX
- Efficiency Measures
- Coal/Gas to Liquids
- Gasification
- Fluidised Bed Gasification
- Coal Bed Methane
- Basa njengo Magogo
My fire works best, in 5 easy steps!

- gives less smoke
- burns longer
- Heats quicker
- is much safer

BASA NJENGO MAGOGO

Smoke Emissions
SOUTH AFRICAN NATIONAL ENERGY RESEARCH INSTITUTE
SANERI ORIGIN

- Establishment Directed by Cabinet
  - Increase energy research and development in South Africa
  - Increase human capacity in energy research
- Established Third Quarter 2006
- Established as a company in the CEF Group
  - CEF formed under the Central Energy Fund Act of 1977
- Senior Managers Appointed Dec06
- Priorities:
  - Develop human capacity
  - Undertake in-house research [main function]
THEMATIC AREAS

- Energy Infrastructure Optimisation
- Energy Efficiency and Demand Side Management
- Impact of Energy Use on the Environment
- Use of Energy to Stimulate Socio-Economic Development
- Cleaner Fossil Fuel Use (including clean coal)
- Renewable Energy
- Alternative Energy Sources (including fuel cells and hydrogen)
- Energy Planning and Modelling
- Energy Policy Research
ACHIEVEMENTS
Research Projects

Contract Research Funding

💰 Call for proposals issued during October 2006
💰 1st phase review (one pagers)
   - 148 projects proposed, totalling R4.5 billion
   - 78 projects, totalling R203 million identified as immediate projects
💰 2nd phase review
   - 72 projects reviewed with revised budget of R84.7 million
   - Only 41 projects, totalling ~R49 million supported, due to funding limitations only
ACHIEVEMENTS
Bursaries

- Call for applications 2006
- More than 50 applications received
- Awarded:
  - 10 Masters Studies Bursaries
  - 15 Doctoral Studies Bursaries
ACHIEVEMENTS
Research Chairs I

☢ Chairs

_currency_S Clean Coal Technologies – Wits
.Currency_NWU supported to develop Associate Chair
_currency_S Bio-Fuels – Stellenbosch

☢ Associate Chairs

_currency_S Bio-Fuels – Stellenbosch
_currency_S Bio-Fuels – NWU [Potch campus]
ACHIEVEMENTS

Research Chairs II

Future Chairs
- Call for Chairs in Progress
  - Energy Efficiency
  - Fuel Cells
  - Clean Household Energy
  - Hydrogen Economy

Finalisation expected soon

Hub & Spoke
- Renewable Energy - Stellenbosch
CO-OPERATION
POSSIBLE AREAS OF CO-OPERATION

- **Carbon Storage Atlas:**
  - Council for GeoScience has Southern Africa geological expertise.
  - Need expertise regarding the peculiarities of carbon storage.

- **Coal Road Map:**
  - Co-operative Initiative between;
    - Department of Minerals and Energy
    - Industry
    - Fossil Fuel Foundation
  - “Wrinkles” of persons who have done it before.

- **Methane to Markets Workshop [cFeb 2008]:**
  - Fossil Fuel Foundation workshop to address the regulatory issues and hurdles that inhibit the movement of methane to markets.
  - International speaker to address regulatory gaps and how they were overcome.

- **Identification of CCTs**
**SUMMARY**

- **South Africa has Coal Based Energy Economy**
  - Coal only current economic energy reserve

- **Undertaking Coal Energy Diversification:**
  - Renewables: 10,000 GWh by 2013
  - Bio-Fuels

- **Clean Coal Technologies:**
  - Super-Critical
  - Underground Gasification
  - Carbon Capture & Storage
  - Other
  - Efficiency Increases – 12% by 2014

- **Coal/Gas to Liquids**

- **South African National Energy Research Institute:**
  - Newly formed
  - Creating human capacity
  - Eventually in-house research
END

THANK YOU