The Transition towards Zero Emission Power Generation - Technology Implications

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Contents of Presentation

- A BIT OF A SCENE SET FROM AN INDUSTRY POINT OF VIEW

- SOME VIEWS ON A CARBON ABATEMENT STRATEGY FOR FOSSIL FUELS - THE TRANSITION ISSUE

- AN ILLUSTRATION ON HOW SUCH A STRATEGY IS BEING IMPLEMENTED IN INDUSTRY
  ..........using some ALSTOM activities as an example
**Viewpoint**

- **Energy Equipment/Systems Supply Company**
  - ALSTOM Power: world-wide supplier of power generation plant, components and services

- **Advanced Power Generation Sector**
  - UK Advanced Power Generation Technology Forum (APGTF)
  - European Industry: EPPSA/ EUnitedTurbines

- **EC Networks**
  - Thematic network on CO2NET, CAME-GT, POWERCLEAN
  - Representative of European industry and researchers
  - EU-25 wide

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UNECE Zero Emission Power OTTER Geneva 7Dec04
AN OVERALL PERSPECTIVE
Near Term Global Position

50 Years Market Development
Order Volumes by Regions

2 major growth cycles in the past led by NAM.

Future growth
- importance of developing countries
- upsurge in China and Asia

Significant impact of increased liberalisation,
de-regulation and privatisation
Long Term Energy Market

- Different needs world-wide
  - uneven access to modern energy

- Growth of Renewable Energy but ....

Continuing reliance on fossil fuels
  - especially likes of China and India

IEA projections of global power station build to 2030

IEA World Energy Outlook 2003

Reinforced by IEA WEO 2004
Installed Base Capacity - Aging Fleet

- Over 1/4 of world-wide capacity is more than 30 years old
  ..... a lot in the developed world

 Tot. Installed 2002 : 3791 GW

 GW Volume of plants reaching 40 years of age, by year:

- LAM
- MEA
- China
- Asia
- North America
- Europe

 Source: UDI, BD/MI

 Average 35 GW / a

 ALSTOM
Security of Supply

Power rationing threatens UK industry

Power rationing threatens UK industry

Increasing concerns regarding supply

The Sunday Times 24/August/03

The Sunday Times

Security of Supply

Alstom

Power rationing threatens UK industry

Luidmea Kenteen and Dominic O’Connell

UK Coal challenges Drax bidder

The Sunday Times 24/August/03

Security of Supply

Alstom
Environmental Implications

- **Environment**
  - Short term: Kyoto 2008-12 proving hard to meet?
  - Boost from Russian approval
  - Tighter regulation: EC Large Combustion Plant Directive
  - Impact of Emission Trading: launch Jan/05

**Importance of environment as a driver**
Environmental Implications

Kyoto Burden Share and EU-25 Trade under EU Emissions Trading Scheme

Effectively a zero net gain in CO₂ reduction for EU-25

Percentage points below (-) or above (+) linear target path

-70 -60 -50 -40 -30 -20 -10 0 +10 +20 +30 +40

DTI 2002

DTI 2002 with use of Kyoto mechanisms

Courtesy of EC
Environmental Implications

- Environment
  - Longer term: 60% GHG reductions by 2050?
  - Importance of engaging Emerging Market Economies?

Forecasted CO₂ Increases
Source: EC/EEA, 2004

importance of environment as a driver
All measures will be required
– different solutions in different parts of the world

No one single winning technology
– complementary actions

Broad portfolio approach necessary
– energy efficiency, REN, fossil, nuclear

Development of energy technology will be essential

Clean use of fossil fuels: a critical transition for decades yet in getting to a sustainable energy future
STRATEGY FOR CLEAN FOSSIL FUELS

A full Carbon Abatement Technology approach
Flexible strategy to cover uncertain future

High efficiency combined with `Capture ready` concept?

Value of CO₂? Geography?

`Zero Emissions` Trajectory

`Increased Efficiency` Trajectory

Carbon Reduction

Near-term | Mid-term | Long-term

Time
Carbon Management Strategy for Fossil Fuels

- Must be developed with the following in mind
  - Long term time frame: out to 2030 and beyond
  - Technology needs to be `in-tune` with market to engage investors
  - Needs of different markets and countries

- Must contain the overall approach of
  - Increased efficiency, fuel flexibility and re-powering
  - Near-zero emission with CO₂ capture and storage
  - Link to Hydrogen issues or long term sustainable `vision`

- Must include aspects of
  - Research and technology development
  - Component and system validation
  - Demonstration/`Lighthouse` Projects
  - Deployment mechanism

Must embrace non-technical issues as well as technical
Clean Fossil Fuel Technologies firmly established as key component of carbon reduction strategy
- 18% reduction in Carbon Intensity by 2012, backed by RTD and D initiatives in fossil fuels
- Clean Coal Plant Improvement programme : 2b US$ over next decade
- `Futuregen` Project launched with 1b US$, 80% from USDOE : electricity and hydrogen plant with CO$_2$ sequestration
- CO$_2$ Capture and Storage budget for 2004 requested at ~50m US$ from a `zero` position less than 5 years ago with US regional networks established

US Co-operative Initiatives
- Carbon Sequestration Leadership Forum [CSLF] : started in June/03 involving now 16 countries plus EC
- complementary to International Partnership for an Hydrogen Economy [IPHE]

Strong competition from USA on world markets
**European Countries**
- Germany: new COORETEC action addressing fossil fuels
- UK: CAT strategy for fossil fuels planned for early 2005
- Other Member States addressing CAT issues

**European Commission/EU**
- EC Framework 6 (2003-2006) Theme of “CO₂ Capture and Storage associated with Clean Power Generation from Fossil Fuels”
  
  ……..importantly FP7 now being addressed

**Increasingly strong EU interest in Carbon Abatement**
• **Some other Country Actions outside Europe**
  - **Australia**: CO$_2$ Capture and Storage TRM, COAL21
  - **Canada**: Canadian Clean Power Coalition, Coal TRM

• **Other relevant International Initiatives**
  - **IEA**: GHG RTD and Clean Coal Centre
  - **IEA**: Working party on Fossil Fuels
  - **CCP**: Carbon Capture Project of `Oil Majors`; continuation phase into most likely cost-effective capture technologies
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Backed by new Australian Energy fund
~500m A$ launched in Jun/04 out to 2020
Part of an overall strategic framework addressing clean fossil fuels as a key element of a sustainable energy portfolio.
AN INDUSTRY TECHNOLOGY POSITION

What is happening in industry?
An illustration of some of ALSTOM Power activities

• efficiency improvements
• fuel switch/retrofitting/repowering
  • zero emission
Cost Remains Important

Structure of the Cost of Electricity

<table>
<thead>
<tr>
<th></th>
<th>Natural gas CC</th>
<th>Coal-fired</th>
<th>Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>O &amp; M costs</td>
<td>12%</td>
<td>27%</td>
<td>34%</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>76%</td>
<td>41%</td>
<td>16%</td>
</tr>
<tr>
<td>Capital costs</td>
<td>12%</td>
<td>32%</td>
<td>50%</td>
</tr>
</tbody>
</table>

- Coal: Balanced cost structure
- Natural Gas: Dependence on the fuel price
- Nuclear: High capital costs share

Different situations exist in different countries
Impact of Efficiency Improvement on CO₂ Reduction
Retrofit Technology

Sustained increase in plant output/efficiency improvement

Figure 8
Test results of earlier retrofit to modernise 660MW units (HHH sister units at Hinkley, Hartlepool and Hh)

Performance test results from 4 x 660MW HP retrofits in the UK

SUSTAINED
Brown Coal fired
Supercritical Boilers

PS Schwarze Pumpe 2 x 800 MW

PS Niederaußem 1,000 MW
## Gas Turbine Technology

**Requirements, Key Buying Criteria**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>2003</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest Cost of Electricity</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>First Cost</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Reliability &amp; Availability</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Operating &amp; Maintenance Cost</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NOX Emissions</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>CO2 Emissions</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>High Operating Flexibility</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>High Fuel Flexibility</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Power Augmentation</td>
<td>Yellow</td>
<td>Red</td>
</tr>
</tbody>
</table>

Gas Turbine will be a key prime mover for 21st Century
CO₂ Capture Options

• “Tail-end” CO₂ capture
  adsorption/stripping process
  using MEA, physical absorbents, ....

• Oxygen combustion
  internal (membrane) or external
  (ASU) oxygen supply

• Novel/Pre-combustion
  IGCC based systems
  carbonate capture
  chemical looping

Towards Zero Emissions at the right price
Environmental Control

- Low risk & proven key technologies & products

- Largest installed base in air pollution control:
  - Over 60,000 MW in FGD (Flue Gas Desulferization)
  - Over 28,000 MW in SCR (Selective Catalytic Reduction)
  - Over 168,000 MW in Particulate Control

- Active RTD programmes in all areas

Not just Carbon Dioxide - also SOx, NOx, Particulates .......
Some Concluding Remarks
Final Concluding Thoughts

- `Uncertainty and Change` will continue
  - difficult to forecast future; no one single winning technology; broad balanced portfolio approach
  - fossil fuels will continue to play a major role for decades yet
  - clean use of fossil will be a key transitional issue
  - impact of a real value for CO₂ - Emission Trading/Tax implications; market could change dramatically

- **2005 - a Year of Opportunity**
  - UK will have leadership of G8 and the EU
  - real chance to influence on the European and world arena
  - importance of Global Climate Change
  - engagement of Emerging Market Economies

Innovation and continued technology development will be essential to meet complex demands of the future