Status of Coal–fired Power Generation & Export Potential for Europe’s Re–industrialisation

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11th EC–EURACOAL COAL DIALOGUE on the future role of coal in Europe and current challenges
Agenda

I. EPPSA
II. European Excellence
III. Thermal Power Outlook
IV. High Efficiency & Flexibility
V. Exports Situation
VI. Investments
VII. Carbon Lock–in
VIII. Conclusions
The European Power Plant Suppliers Association

is the voice, at European level, of companies supplying power plants, components and services.

EPPSA members, located throughout Europe, represent a leading sector of technology with more than 100 000 employees.

Virtually all thermal power plants in the EU are built by members of EPPSA or equipped with their components, and provide around 50% of Europe’s electricity.

EPPSA members provide the most advanced thermal power technologies in the world.
In the EU, we support
➢ >40% GHG reduction by 2030

At global level, we support
➢ 40 – 70% GHG reduction by 2050
European Excellence

Industry
➢ Many global industry leaders have their hub and expertise in the EU

Research
➢ Universities and Research Institutes are developing European excellence in the field of Thermal Power (e.g. UK, DE, FR and ES)

EU Funding
➢ The EU is heavily investing in Research and Projects Programmes through various funds (e.g.: Horizon2020) for highly efficient, flexible and clean thermal power plants

Environment
➢ Europe is at the forefront of environmental legislation (e.g.: IED and its Large Combustion Plant BREF)
Thermal power is vilified in the current push for RES.

- Fossil Fuels are dirty
- Fossil Fuels are limited
- Fossil Fuels are imported
- The threat of Carbon lock-in

Thermal power is a fundamental part of the energy mix.

- There are ample, indigenous reserves of Fossil Fuels
- Thermal Power is increasingly clean and efficient due to technological advances
- Thermal Power Electricity Generation is cost competitive under market conditions
- Flexible Power Plants are necessary to compensate the residual load and to provide back-up when RES are not available
European Market

Generation mix in 2030

Source: EPPSA study on 2030 Role of Thermal Power in Europe, January 2015
European Market

Capacity investments necessary by 2030

Source: EPPSA study on 2030 Role of Thermal Power in Europe, January 2015
The reality shows that there is almost an investment stop on all fossil power plant technologies in the EU28, even if these investments can reduce the GHG footprint significantly.

Source: European Commission
Global & European energy mix towards 2030–2050

World electric generation by fuel

OECD Europe electric generation by fuel

Status of Coal–fired Power Generation & Export Potential for Europe’s Re–industrialisation
I. Thermal power generation will remain the backbone of the electricity generation mix on a global level. 

\[ \text{CO}_2 \text{ intensity from fossil fueled power is the predominant reduction target} \]

II. Affordability of electricity production is as important as it is linked with employment and growth. 

\[ \text{Competitive Energy Pricing and Security of Supply are global targets.} \]
What type of Thermal Power is needed?

Industrial Emissions Directive \(\rightarrow\) LCP BREF

Performance Standards from European experience in thermal power generation technologies are being defined.

Countries (Korea, China, etc.) are requesting to have these technologies and Associated Emission Limits translated for own use.
What is a high efficient power plants

State of the art efficiencies for clean, new build power plants

- Natural gas power plant: $>60\%^*$
- Ultra SuperCritical hard coal power plant: $>43\%^*$
- SuperCritical coal power plant: $>39\%^*$
- SubCritical hard coal power plant: $\leq 39\%^*$

- Ultra Supercritical lignite coal power plant: $>43\%^*$

in addition, CCS can be used for further GHG avoidance

*indictative efficiencies
Balancing necessities today (Germany, as an example):

- High renewable generation, wind and sun;
- Minimum thermal;
- Often reality: very low renewable generation, wind and sun; thermal fills the gap.

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Flexibility is also key

- Reduction of minimum load
- Reduction of startup cost and startup time
- Increase of load change speed
- Maximum load extension

**Minimum load reduction**

(-) Lower efficiency = higher specific cost
(+) Continuous sales of grid services
(+ Savings in auxiliary fuels
(+ Avoiding start-up and additional thermal fatigue

**Non regret strategy for flexibility!**

**Improvement of startup**

(-) Loss of operational hours and income
(+ auxiliary fuel savings
(+ faster startup
## Flexibility is also key

<table>
<thead>
<tr>
<th>Parameters / characteristics</th>
<th>Currently operating PP fleet (PPs erected in the 20. century)</th>
<th>Current BAT (PPs erected in the 21 century)</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum load for continuous operation [%]</td>
<td>15–20 for hard coal &gt;50 for lignite 4)</td>
<td>15–20 for hard coal 2) 35–40 for lignite 3) 4)</td>
<td>~15 (considering alternative &amp; low carbon solid support fuels and their blends)</td>
</tr>
<tr>
<td>Ramping rate [%/min]</td>
<td>2–3</td>
<td>5</td>
<td>~10</td>
</tr>
<tr>
<td>Frequent start–up and shut down ability (cold/warm/hot)</td>
<td>Specific nr. of start–ups /shut downs foreseen per year (limited to few cold start–ups)</td>
<td>Possible daily start–up for hard coal PP (usually hot/warm daily, cold over the weekend)</td>
<td>Possible daily variations between 15–100% to avoid daily start ups</td>
</tr>
</tbody>
</table>

1) Best possible known, and documented  
2) Usual min load operation for recent new built plants still is only around 30–40% due to lowest marginal cost of all hard coal units  
3) Oil/gas may be required as supporting fuel for lignite  
4) Plants are existing in Germany or are being retrofitted with dry lignite firing to operate in the range of 20%–30% load
Developments in firing systems (hard coal and lignite)

State-of-the-art examples

Tangential firing systems based on tilting jet burners located in the corners

Opposed wall firing systems with low NOx swirl burners installed

Furnace design with opposed burner arrangement

Source: MHPSE

Source: Alstom
Developments in firing systems (hard coal and lignite)

Concepts for low load operation (short term measure)

**Hard coal boilers**
- Reduction of nr. of hard coal mills in operation down to “one mill” operation
- Minimum load 15–20% with “one mill” operation

**Lignite boilers**
- Reduction of nr. of fan beater mills down to a “three mill” operation
- Minimum load 35–40% with a “three mill” operation

Source: Alstom
Exports of steam or other vapor generating boilers
What is happening?

Source: US Comtrade Database, November 2014
Comparison of public financing for foreign coal-fired PP

2007 – 2013

Source: Quantifying Chinese Public Financing for Foreign Coal Power Plants, University of Tokyo, November 2014
Comparison of public financing for foreign coal–fired PP

<table>
<thead>
<tr>
<th></th>
<th>Asia (except China, Japan, and South Korea)</th>
<th>India (as a part of the left column)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcritical (MW)</td>
<td>55,192</td>
<td>36,983</td>
</tr>
<tr>
<td>SC/USC (MW)</td>
<td>29,940</td>
<td>28,080</td>
</tr>
<tr>
<td>Share of supercritical</td>
<td>35.17%</td>
<td>43.16%</td>
</tr>
</tbody>
</table>

Types of boiler technology supplied by Chinese manufacturers to Asian overseas markets after 2007

Concrete example in Europe

Stanari Power Plant, Bosnia:
- New rules set by EIB, etc.
  - financially backed by China Development Bank
  - own imposed supplier: Dongfang Electric Corporation

Results:
- EIA was changed in 2010 and 2013 and not compliant with EU legislation
- 410MWel to 300MWel
- from 43% supercritical to subritical with 34.1% efficiency

Sources: Quantifying Chinese Public Financing for Foreign Coal Power Plants, University of Tokyo, November 2014 and Bankwatch Network, 2015
<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Owner</th>
<th>Country</th>
<th>Start of commercial operation</th>
<th>el. Power net [MW]</th>
<th>Fuel</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datteln 4</td>
<td>E.ON</td>
<td>Germany</td>
<td>2016</td>
<td>1050</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Eemshaven</td>
<td>RWE</td>
<td>Netherlands</td>
<td>2014</td>
<td>1530</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>EnBW</td>
<td>Germany</td>
<td>2014</td>
<td>870</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Lünen</td>
<td>Trianel</td>
<td>Germany</td>
<td>2012</td>
<td>746.6</td>
<td>Bit. Coal</td>
<td>45.95%</td>
</tr>
<tr>
<td>Maasvlakte</td>
<td>E.ON</td>
<td>Netherlands</td>
<td>2015</td>
<td>1050</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Mannheim</td>
<td>GKM</td>
<td>Germany</td>
<td>2015</td>
<td>870</td>
<td>Bit. Coal</td>
<td>46.40%</td>
</tr>
<tr>
<td>Moorburg</td>
<td>Vattenfall</td>
<td>Germany</td>
<td>2015</td>
<td>1520</td>
<td>Bit. Coal</td>
<td>46.50%</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>GDF</td>
<td>Netherlands</td>
<td>2014</td>
<td>725</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Walsum 10</td>
<td>Steag</td>
<td>Germany</td>
<td>2012</td>
<td>725</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Westfalen D/E</td>
<td>RWE</td>
<td>Germany</td>
<td>2014</td>
<td>1530</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Wilhelmshaven</td>
<td>GDF</td>
<td>Germany</td>
<td>2014</td>
<td>725</td>
<td>Bit. Coal</td>
<td>46.00%</td>
</tr>
<tr>
<td>Gent</td>
<td>GDF</td>
<td>Belgium</td>
<td>2010</td>
<td>305</td>
<td>COG / BFG</td>
<td>43.00%</td>
</tr>
<tr>
<td>Hamborn</td>
<td>RWE</td>
<td>Germany</td>
<td>2003</td>
<td>228</td>
<td>COG / BFG</td>
<td>42.70%</td>
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<tr>
<td>Boxberg R</td>
<td>Vattenfall</td>
<td>Germany</td>
<td>2012</td>
<td>630</td>
<td>Lignite</td>
<td>43.70%</td>
</tr>
<tr>
<td>Boxberg Q</td>
<td>Vattenfall</td>
<td>Germany</td>
<td>2010</td>
<td>855</td>
<td>Lignite</td>
<td>42.40%</td>
</tr>
<tr>
<td>Neurath F/G</td>
<td>RWE</td>
<td>Germany</td>
<td>2012</td>
<td>2160</td>
<td>Lignite</td>
<td>43.00%</td>
</tr>
<tr>
<td>Niederaußem K</td>
<td>RWE</td>
<td>Germany</td>
<td>2003</td>
<td>390</td>
<td>Lignite</td>
<td>41.60%</td>
</tr>
<tr>
<td>Lippendorf</td>
<td>Vattenfall</td>
<td>Germany</td>
<td>2002</td>
<td>1724.6</td>
<td>Lignite</td>
<td>42.90%</td>
</tr>
<tr>
<td>Belchatow block #14 ELB</td>
<td>PGE</td>
<td>Poland</td>
<td>2011</td>
<td>858</td>
<td>Lignite</td>
<td>42.00%</td>
</tr>
<tr>
<td>Oresundsverket</td>
<td>E.ON</td>
<td>Sweden</td>
<td>2009</td>
<td>420</td>
<td>Natural Gas</td>
<td>58.00%</td>
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<tr>
<td>Avedoreverket 2</td>
<td>DONG</td>
<td>Denmark</td>
<td>2001</td>
<td>548</td>
<td>Wood, Biomass</td>
<td>45.00%</td>
</tr>
<tr>
<td>Amagerværket 1</td>
<td>HøFor</td>
<td>Denmark</td>
<td>2009</td>
<td>71</td>
<td>Wood, Biomass</td>
<td>20.00%</td>
</tr>
<tr>
<td>Emlichheim</td>
<td>BEKW</td>
<td>Germany</td>
<td>2015</td>
<td>13</td>
<td>Wood, Biomass</td>
<td>30.00%</td>
</tr>
<tr>
<td>Sleaford</td>
<td>ECO2 North Links</td>
<td>England</td>
<td>2014</td>
<td>38.5</td>
<td>Wood, Biomass</td>
<td>34.00%</td>
</tr>
<tr>
<td>Brigg</td>
<td>BWSC North Links</td>
<td>England</td>
<td>2016</td>
<td>40</td>
<td>Wood, Biomass</td>
<td>34.00%</td>
</tr>
<tr>
<td>Torrevaldaliga Nord</td>
<td>Enel</td>
<td>Italy</td>
<td>2009</td>
<td>1830</td>
<td>Bit. Coal</td>
<td>43.70%</td>
</tr>
</tbody>
</table>

EPPSA and its members have been assembling a database, covering the efficiency and emissions of thermal power plants before and after retrofitting/refurbishing.
High Efficiency Thermal Power

- Fuel savings, Reduction of CO₂ emissions, More affordable electricity

Total Net capacity replaced: 22,0 GW
Investments from 2000 to 2015: 27,4 billion €
Saved fuel cost until 2030: 29,1 billion €
Saved CO₂ emissions per year: 57,37 million t/a
Saved CO₂ emissions until 2030: 1,25 billion t
Average saved fuel (meaning saved CO₂ emissions): 32 %

CO₂ avoidance cost over 20 years: 23,92 €/t
Real Cost / saved ton of CO₂ (Capex, Opex, saved fuel, saved allowances): -19,58 €/t

Lowest Ever Recorded CO₂ avoidance costs

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International comparison of fossil power efficiency and CO₂ intensity

20% more CO₂ reduction achieved only by replacement!

**Absolute** CO₂ emission reduction potential for fossil power generation by energy efficiency improvement by replacing all fossil public power production by BAT for the corresponding fuel type.
What about Carbon Lock-in?

What is the carbon lock-in effect?

- Different definitions exist.

Very often used to indicate that when we build plants today, they will still be in operation in 2050, making a decarbonisation of the Electricity System impossible by 2050.
What about Carbon Lock-in?

- We have seen that the needed thermal power capacity plays a “servicing” role:

  ![Graph showing load and demand with residual load and I-RES as 'baseload'.]

Question: Is there really a lock-in or a necessary contributor?

It is indeed a clear choice: Necessity to balance the system.

Response from modern thermal power is necessary as they are the only able to render the full fledge services of:

- Variable energy resources balancing; System security; and Grid services even if no dispatchable RES are available.

Political choice to achieve this with older, more costly or with modern, cleaner, more flexible and cost effective plants.
Added Value of High-Efficient Thermal Power Generation

- Indispensable
- State-of-the-Art
- European Excellence
- Low hanging fruit

If not European suppliers, who?
Thank you for your attention

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