Introduction to the DRYLIG project

DRYLIG Final Workshop

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♦ Conclusions
Increasing RES penetration in the electricity system
- New market conditions for the electricity sector: emphasis on flexibility
- Lignite-fired units have to become more flexible, especially in countries where there is limited hard coal capacity to cover the flexibility needs
- Decreases in lignite quality and new operating regimes increase auxiliary fuel consumption
- State-of-the-art drying technologies may no longer be economically viable under new market conditions
- Several lignite units of older age / lower efficiencies, technical difficulties in integrating advanced dryer concepts
- Need to identify reliable, cost-effective lignite drying solutions taking into account the new operating regimes
- New and niche markets can support the economic viability of dry lignite production
Project data
- Duration: July 2014 – June 2017
- Budget: €2,207,633
- www.drylig.eu
- Funded by Research Fund for Coal and Steel, Grant agreement: RFCR-CT-2014-00009
- Coordinator: Centre for Research and Technology Hellas (CERTH)

Coloured by lignite installed capacity
Red > 2 GWe, Orange < 2 GWe
Source: booz&co., Understanding lignite generation costs in Europe, 2014
DRYLIG: Objectives

Main objective:
- Adoption of pre-dried lignite utilization towards increased flexibility, improved efficiency and environmental and economic performance

Target applications:
- Retrofits for existing lignite boilers: emphasis on partial load operation
- New market opportunities: start-up fuel in hard coal plants, DH systems, industrial applications, etc.
- Greenfield concept: Novel pre-dried lignite co-firing concept for the next generation of lignite boiler

Tools / Methods / Approaches:
- Technology overview and scoping studies
- Lab and industrial scale lignite drying and combustion experiments
- Modelling (1D boiler models, CFD modelling, steady and transient thermal cycle analysis) and engineering studies for large-scale plants
- Techno-economic evaluations
## Comparison of drying technologies

<table>
<thead>
<tr>
<th></th>
<th>Tubular dryer</th>
<th>Fluidized bed dryer</th>
<th>Drum dryer</th>
<th>Fan beater mills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating medium</td>
<td>steam</td>
<td>steam (flue gas)</td>
<td>flue gas</td>
<td>flue gas</td>
</tr>
<tr>
<td>direct/indirect</td>
<td>indirect</td>
<td>direct or indirect</td>
<td>direct</td>
<td>direct</td>
</tr>
<tr>
<td>Nominal steam</td>
<td>up to 25 t/h</td>
<td>up to 110 t/h</td>
<td>up to 50 t/h</td>
<td>up to 110 t/h</td>
</tr>
<tr>
<td>evaporating capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per dryer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>industrial scale</td>
<td>&gt; 50</td>
<td>4 1)</td>
<td>&gt; 50 2)</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>references</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Including industrial scale prototypes in Germany, Australia and US
2) only for other solid materials, like sewage sludge and peat

<table>
<thead>
<tr>
<th></th>
<th>Tubular dryer</th>
<th>Fluidized bed dryer</th>
<th>Drum dryer</th>
<th>Fan beater mills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements on coal</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>pre-treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary components</td>
<td>0</td>
<td>0</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>for pre-treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of heating medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(flue gas or steam)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirements on regular</td>
<td>+ +</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>maintenance due to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rotating parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology maturity</td>
<td>++</td>
<td>0</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Potential efficiency</td>
<td>+1)</td>
<td>++2)</td>
<td>0 3)</td>
<td>0 3)</td>
</tr>
<tr>
<td>increase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: "0" very small/modest, "+" medium, "++" high
1) When using bleed steam for heating, 2) when using bleed steam or steam compressor for heat supply
3) medium efficiency increase can be reached when flue gas waste heat or bleed steam is used
## Drying testing facilities (1/2)

<table>
<thead>
<tr>
<th>Fan beater mill (IFK)</th>
<th>TORBED fluidized bed scheme (WUT)</th>
<th>Multistage tape bed dryer (WUT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing with Greek, Polish and Australian lignites</td>
<td>Testing with Polish Earth (Sieniawa), xylitic (Belchatow) lignites, Greek and Romanian lignites</td>
<td></td>
</tr>
</tbody>
</table>
Drying testing facilities / Buettner (2/2)

<table>
<thead>
<tr>
<th>Lab scale fixed bed dryer</th>
<th>Pilot scale Rotating disc</th>
<th>Semi industrial scale rotating drum dryer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying curves of different lignite types (German, Greek, Romanian, Polish)</td>
<td>Installation, testing and optimization of drum intervals</td>
<td>Main tests under different operating set-ups (for Greek and Polish lignite)</td>
</tr>
</tbody>
</table>
Combustion testing facilities

<table>
<thead>
<tr>
<th>BTS: 20 kWth atmospheric drop tube furnace (IFK)</th>
<th>KSVA: 500 kWth pulverized fuel combustion rig (IFK)</th>
<th>20 kWth isothermal flow reactor (WUT)</th>
</tr>
</thead>
</table>

Scope of activities for the DRYLIG project

- Investigation of different co-firing configurations (DL + hard coal)
- Ignition and emission behavior at “simulated” low load operation
- Novel ignition systems (plasma burner for KSVA)
Agios Dimitrios Unit V activities

- Location: Kozani, Greece
- Operator: PPC S.A.
- Commissioning: 1997
- Operation: electricity / heat provision to DH network
- Capacity: 375 MWe / 358.5 MWe + 70 MWth
- El. efficiency: ~ 34% (net)
- Fuel: Greek lignite (5.0 – 5.4 MJ/kg LHV)

Furnace geometry for CFD modeling

Scope of activities for the DRYLIG project

- 1D and CFD modeling for DL co-firing with emphasis on partial load operation
- Thermodynamic integration of different dryer concepts in plant cycle
- Retrofits and balance of plant for dryer integration
WP120 boiler activities

- Location: Opole, Poland
- Operator: ECO S.A.
- Commissioning: 1988
- Operation: heat production for Opole DH network
- Gross/ net capacity: 140 MWth
- Fuel: Hard coal (19 – 25 MJ/kg LHV)

Scope of activities for the DRYLIG project

- Design and erection of new feeding system for dry lignite
- CFD modeling and thermal cycle analysis for dry lignite co-firing
- Co-firing tests with dry lignite pellets from Sieniawa mine in Winter 2016 – 2017
GKM Unit 9 activities

- Location: Mannheim, Germany
- Operator: Grosskraftwerk Mannheim AG
- Commissioning: 2015
- Operation: electricity / cogeneration
- Capacity: 911 MWe
- Design efficiency: > 46%
- Fuel: Hard coal

**Scope of activities for the DRYLIG project**
- Transient thermodynamic modeling for cold-start using dry lignite
- Study for retrofitting and balance of plant for dry lignite burners
Ptolemaida Unit V activities

- Location: Ptolemaida, Greece
- Operator: PPC S.A.
- Commissioning: 2020 (expected)
- Operation: electricity / heat provision to DH network
- Capacity: 660 MWe / 615 MWe + 140 MWth
- Design el. efficiency: ~ 41% (net)
- Fuel: Greek lignite-fired (4.4 – 6.9 MJ/kg LHV)

Scope of activities for the DRYLIG project
- Basic design for new-built, supporting up to 30% dry lignite co-firing
- Optimized for flexible operation
Techno-economic assessment: the Greek case for dry lignite production

1. Dry lignite production

2. Dry lignite handling (storage, transport, etc.)

3. Dry lignite utilization

Integration of lignite dryer at PPC lignite-fired power plant (Agios Dimitrios V)

Determination of demand and dimensioning of dryer

PPC self consumption (in more than one unit) for:
1. Reduction of technical minimum load
2. Maintaining low loads for various lignite quality
3. Unit start-up
4. Co-firing with raw lignite for efficiency increase

Fuel for heat / CHP boilers for local DH networks

Other industrial end-users (e.g. Ferronickel industry)

HFO / natural gas (support)
Biomass co-firing

Solid biofuels
Natural gas (if possible)

Depending on case (e.g. raw lignite use, hard coal imports, etc.)

4. Competitive /alternative solutions

DRYLIG: (RFCR-CT-2014-00009)
Conclusions

- Pre-drying in an upgrading technology that can bring added-value to an indigenous, low-cost fuel source
- The DRYLIG project has brought together research teams and industrial actors from most of the main lignite producing countries in the EU
- The emphasis of the DRYLIG project is not only on efficiency increase during full load operation but mostly for supporting partial load operation / allowing lignite boiler to operate at reduced technical minimums
- For economic operation of the pre-drying system, the identification of other potential end-users of lignite is important
- Potential end-users vary depending on the situation
- For Poland in particular:
  - Knowledge has been generated about drying properties of Polish lignite & co-combustion of Polish dry lignite with hard coal
  - The use of dry lignite as a supporting fuel in a district heating boiler has been demonstrated
  - An economic assessment of the cost of dry lignite production has been performed
Thank you for your attention!