Project session 3: “Flexible Generation”

Flexible Fossil Power Plants for the Future Energy Market through new and advanced Turbine Technologies

Alexander Wiedermann
MAN Energy Solutions SE

ETIP SNET – Regional Workshop Petten 19-20 September 2019
H2020 LCE-17-2015 - **Highly flexible and efficient fossil fuel power plants**

- Grant agreement reference: 653941 — FLEXTURBINE
- Project duration: **39 months**, January 2016 – March 2019
- Budget: **9.5 Mio€** (EC funding 6.5 Mio€)
- Partners: **21 partners** from 7 countries
- Coordinator: **Doosan Škoda Power**

  Luboš Prchlík
  Doosan Škoda Power
  Tylova 1/57 301 28 Plzen, Czech Republic
  Tel.: +420 (0)37 818 5082
  lubos.prchlik@doosan.com

- Project web site: [http://www.flexturbine.eu](http://www.flexturbine.eu)
Short presentation of the project

Consortium Map & Partner Details

Coordinator:

Doosan Škoda Power

MAN Energy Solutions

ANSALDO ENERGIA

SIEMENS

GE Oil & Gas

FLORENTIA STUDIORUM

IN SUPREMIA DIGNITATE

UNIVERSITAS

University of Belgrade

Linköping University

KIT

University of Technology Dresden

České vysoké učení technické v Praze

CTU

Západoslovenská univerzita

V Prešove

Technische Universität München

Luleå University of Technology

RUHR Universität Bochum

Comtes FHT
Short presentation of the project: Objectives

• Project aims to strongly **advance state-of-the-art thermal power plant engine technology**

• **Major global challenges**
  • **Stability** of the energy grid
  • **Flexibility** - uncertainties related to the supply of energy from wind, solar and also varying demand
  • **Efficiency - environmental**, in terms of minimizing and reducing CO₂, NOₓ and also **economical**, in terms of the cost and affordability of electricity

• **Specific requirements**
  • Safe permanent operation in off-design operation
  • High number of start-ups, short start-up times
  • High part load efficiency
  • Lifetime extension of the existing fleet
  • Maintenance cost – longer service intervals
  • Applicability for retrofitting
Short presentation of the project: Workpackages

• Challenges
  • Key areas limiting ST and GT flexibility

Flutter
- Aero-elastic instability
- Potential immediate blade destruction
- Limitations on off-design and low load operation

Seals and Bearings
- Increased wear due to flexible operation
- Consequent undesirable leakage flow
- Mechanical losses
- Rotor-stability concerns for low clearances

Life Cycle Management
- Increased thermo-mechanical loading due to flexible operation
- Limitations on number of start-ups
- Limitations on start-up times
- Maintenance scheduling – shorter service intervals

OB1
Improved flutter-resistant turbine blade design

OB2
Improved seal and bearing designs

OB3
Improved life cycle management
## Key exploitable results addressing energy system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Gas Turbine (GT)</th>
<th>Steam Turbine (ST)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 50 MW</td>
<td>&gt; 200 MW</td>
</tr>
<tr>
<td>Ramp-up time: Cold [min]</td>
<td>8 – 10</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Warm [min]</td>
<td>3 – 5</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>Hot [min]</td>
<td>3 - 5</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>Startings (through lifetime): Cold [-]</td>
<td>2,000</td>
<td>&gt; 5,000</td>
</tr>
<tr>
<td>Warm [-]</td>
<td>4,000</td>
<td>&gt; 10,000</td>
</tr>
<tr>
<td>Hot [-]</td>
<td>4,000</td>
<td>&gt; 10,000</td>
</tr>
<tr>
<td>Load changes &gt; 10 % (per day)</td>
<td>~ 10</td>
<td>&gt; 50</td>
</tr>
<tr>
<td>Efficiency variation (at 50 % of full power load)</td>
<td>82 % of full load</td>
<td>&gt; 85 % of full load</td>
</tr>
</tbody>
</table>
Deployment prospects of the most promising solutions

WP1 - Whole engine modelling

• The results show the benefits of each of the technology
  • Plant configuration, considering markets and jurisdictions

<table>
<thead>
<tr>
<th>State &amp; Transition</th>
<th>Parameter</th>
<th>Unit</th>
<th>Current</th>
<th>FlexTurbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady state</td>
<td>Nominal efficiency</td>
<td>%</td>
<td>57.4</td>
<td>58.55</td>
</tr>
<tr>
<td></td>
<td>Efficiency MinLoad</td>
<td>%</td>
<td>51.8</td>
<td>53.48</td>
</tr>
<tr>
<td>Cold start</td>
<td>Fuel consumption</td>
<td>MWh</td>
<td>1912.61</td>
<td>1239.37</td>
</tr>
<tr>
<td></td>
<td>O&amp;M costs</td>
<td>€</td>
<td>15’444</td>
<td>14’553</td>
</tr>
<tr>
<td>Warm start</td>
<td>Fuel consumption</td>
<td>MWh</td>
<td>1171.87</td>
<td>766.06</td>
</tr>
<tr>
<td></td>
<td>O&amp;M costs</td>
<td>€</td>
<td>8’316</td>
<td>7’425</td>
</tr>
<tr>
<td>Idle to full load</td>
<td>Idle to Full load</td>
<td>min</td>
<td>8.5</td>
<td>4.34</td>
</tr>
<tr>
<td></td>
<td>Fuel consumption</td>
<td>MWh</td>
<td>385.07</td>
<td>288.75</td>
</tr>
<tr>
<td></td>
<td>O&amp;M costs</td>
<td>€</td>
<td>6’177.6</td>
<td>5’286.6</td>
</tr>
</tbody>
</table>
Needs for future R&I activities coming out of the project (1)

Existing conventional power plants

Not designed for flexible operation, would cause increased wear, shorter lifetimes of the components and, increase in operation and maintenance cost

FLEXTURBINE aims to strongly advance state-of-the-art fossil fuel power plant engine technology to provide the technology basis for the next generation of flexible turbomachinery essential to enable transition to low carbon-emission power generation

The mission of TURBO-REFLEX is the development and optimisation of technologies, applicable to a selected set of turbomachinery engine components, which can be used to retrofit existing power plants
Needs for future R&I activities coming out of the project (2)

- **Research needs covered in** Turbo-Reflex
  - **On component level:**
    - Combustor and Compressor Technology Upgrades
    - Storage-ready Component Adjustments
    - Mechanical integrity
  - **On plant level:**
    - Control and maintenance
    - Condition based monitoring

- **Research needs to be addressed**
  - Stable combustion systems for ultra-low emissions down to very low minimum load
  - Fuel flexibility: Hydrogen - gas mixtures, up to 100% H₂, synthetic fuel
  - Sector coupling: plants for efficient heat and power
  - Integration of storage in power generation

Gas turbine powered plants are the backbone of decarbonization in Europe
Lessons learned and barriers to innovation deployment

- **Technical level**
  - Further turbomachinery components to be investigated and optimised to enable more flexible operation of state-of-the-art and new thermal power plants

- **Industry level**
  - Deal with a changing and highly volatile market
  - Harsh competition with Eastern Asia OEM’s
  - Industry reorganisation

- **European / political level**
  - Reputation of fossil fuel power generation in Europe: what is its future role? How to achieve future investments in research?
  - Acknowledge the differences between countries in Europe, which makes standardisation challenging
  - Ensure that products created as part of the TURBO-REFLEX project achieve the maximum impact

**Convince that modern plants are enabler for RES increase**
Questions?

An OEM Consortium of 21 partners in 7 countries

Alexander Wiedermann
Phone: +49 208 692 2238 / +49 151 58235592
Email: alexander.wiedermann@man-es.com