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EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Project session 3: "Flexible Generation"

flexturbine
powerplant technologies

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

Alexander Wiedermann
MAN Energy Solutions SE

Short presentation of the project

Structure and Budget

- 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**

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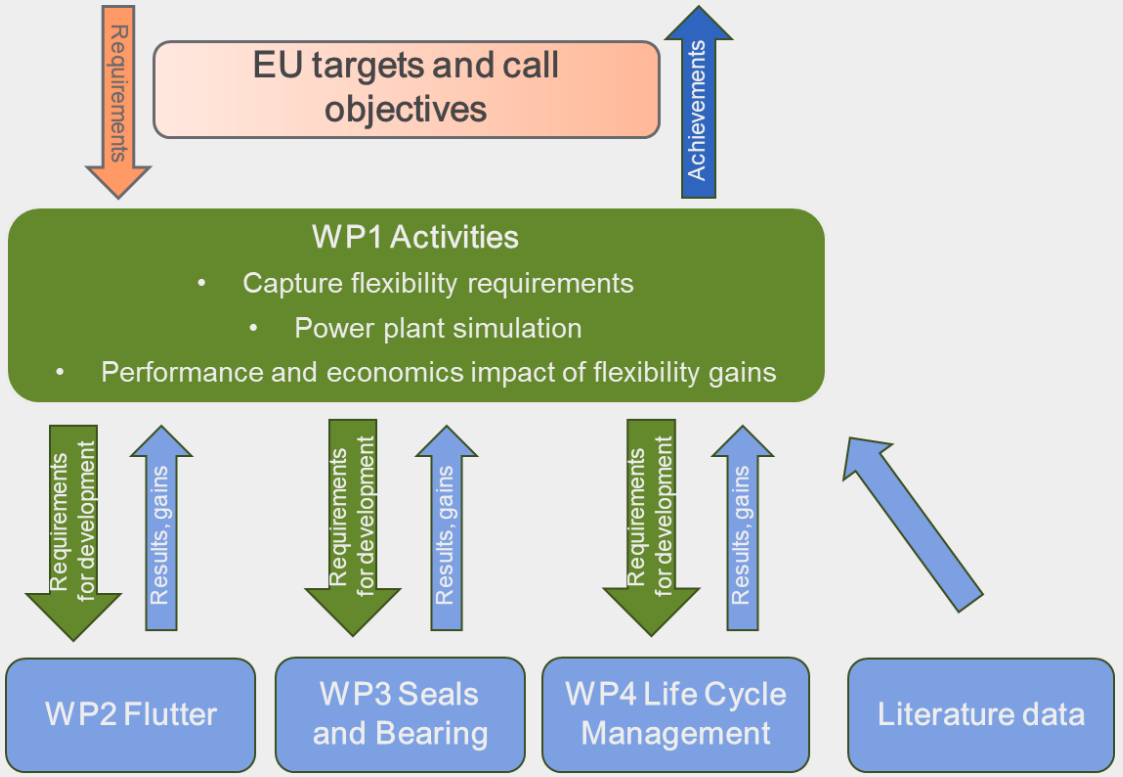
- Project web site: http://www.flexturbine.eu

Programme structure



Short presentation of the project

Consortium Map & Partner Details

Coordinator:

Doosan Škoda Power

SIEMENS

GE Oil & Gas

MAN Energy Solutions

ARTTIC
INTERNATIONAL MANAGEMENT SERVICES

ANSALDO ENERGIA

Università degli Studi Firenze

Linköping University

KIT Karlsruher Institut für Technologie

TECHNISCHE UNIVERSITÄT DRESDEN

ZÁPADOČESKÁ UNIVERZITA V PLZNI

University of Belgrade

Politecnico di Milano

TECHNISCHE UNIVERSITÄT DARMSTADT

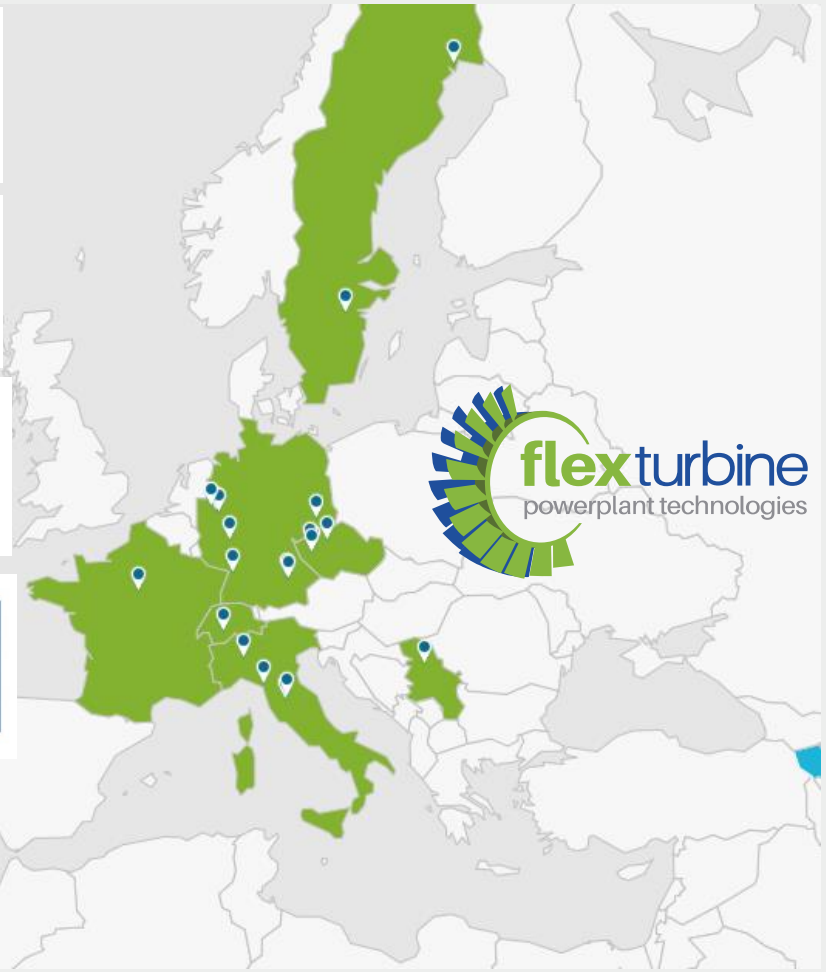
CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

TECHNISCHE UNIVERSITÄT MÜNCHEN

LULEÅ UNIVERSITY OF TECHNOLOGY

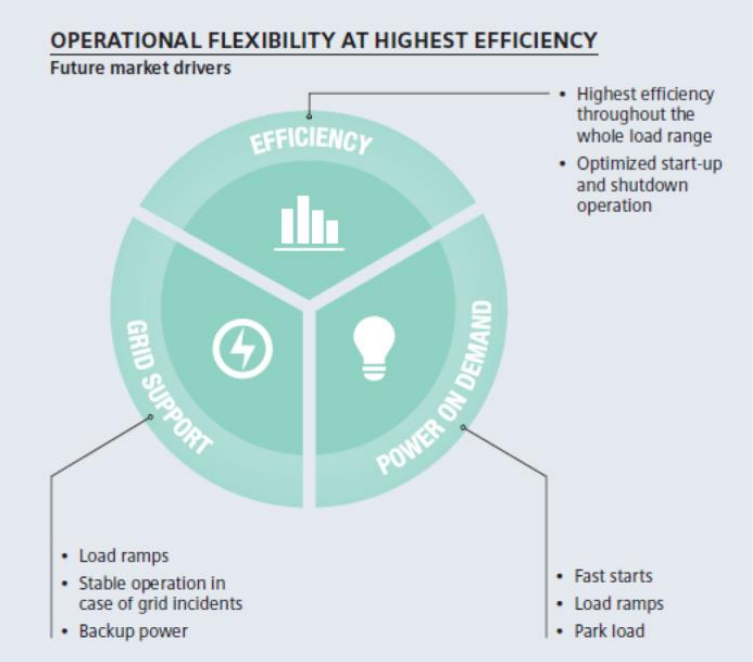
COMTES FHT

RUHR UNIVERSITÄT BOCHUM RUB



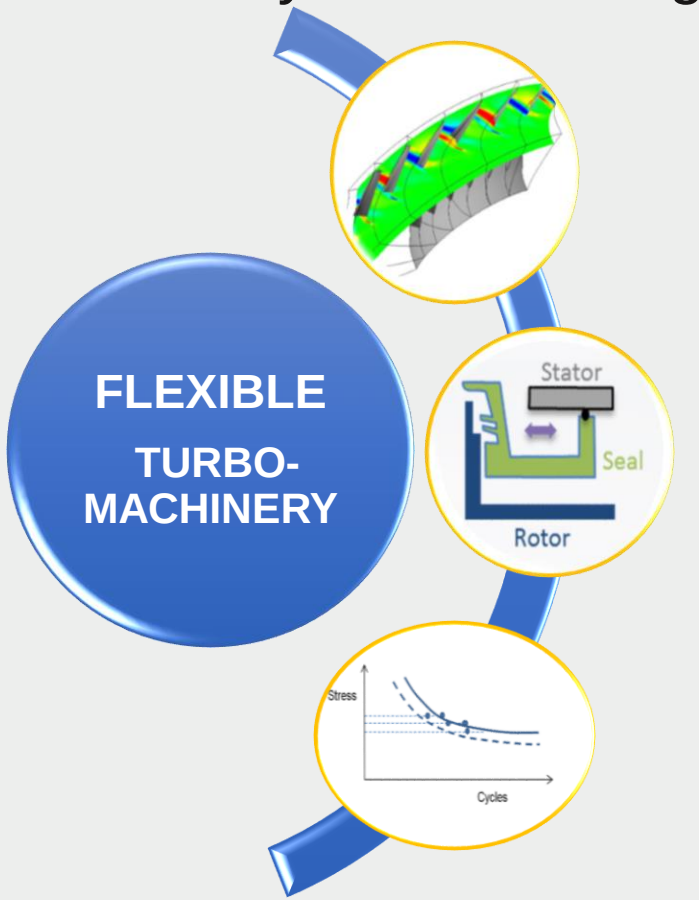
Short presentation of the project:
Objectives

- 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 CO_2, NO_x 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

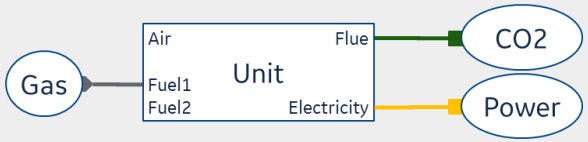
Key exploitable results addressing energy system

Parameter	Gas Turbine (GT)						Steam Turbine (ST)		
	< 50 MW			> 200 MW			> 200 MW		
	State of Art 2016	Expected	Achieved	State of Art 2016	Expected	Achieved	State of Art 2016	Expected	Achieved
Ramp-up time: Cold [min]	8 – 10	< 5		~ 20	~ 15		180	130	
Warm [min]	3 – 5	< 3		10 – 20	~ 10		60	40	
Hot [min]	3 - 5	< 3		10 - 20	~ 10		20		
Startings (through lifetime): Cold [-]	2,000	> 5,000		1,300	2,000		150	200	
Warm [-]	4,000	> 10,000					1,000	1,500	
Hot [-]	4,000	> 10,000		3,700	5,000		4,000	6,000	
Load changes > 10 % (per day)	~ 10	> 50		> 20	> 50		unlimited		
Efficiency variation (at 50 % of full power load)	82 % of full load	> 85 % of full load		> 86 % of full load	> 90 % of full load		97 % of full load	> 98 % of full load	

Deployment prospects of the most promising solutions

WP1 - Whole engine modelling

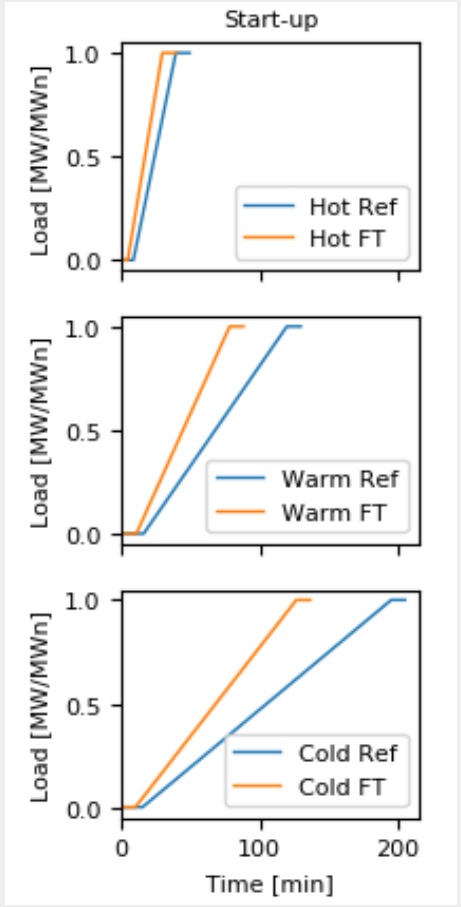
- The results show the benefits of each of the technology
  - Plant configuration, considering markets and jurisdictions



State & Transition	Parameter	Unit	Current
Steady state	Nominal efficiency	%	57.4
	Efficiency MinLoad	%	51.8
Cold start	Fuel consumption	MWh	1912.61
	O&M costs	€	15’444
Warm start	Fuel consumption	MWh	1171.87
	O&M costs	€	8’316
Idle to full load	Idle to Full load	min	8.5
	Fuel consumption	MWh	385.07
	O&M costs	€	6’177.6

WP2 + WP3 + WP4

FlexTurbine
58.55
53.48
1239.37
14’553
766.06
7’425
4.34
288.75
5’286.6



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% H_2, 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?

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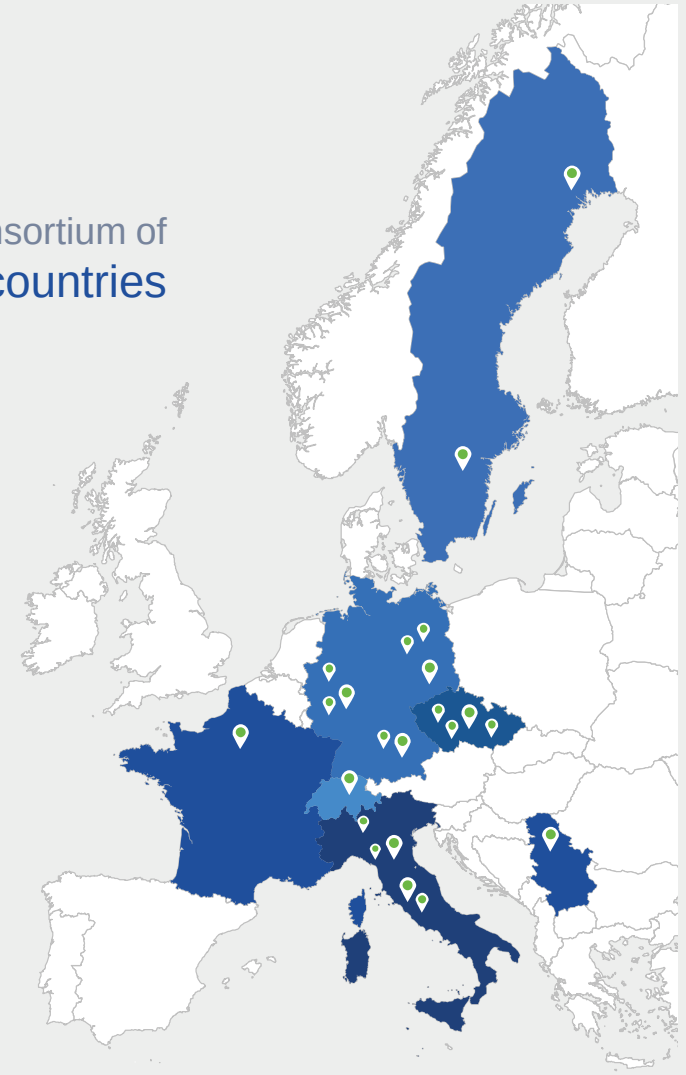
An OEM Consortium of
21 partners in 7 countries



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