# **Turbomachinery International – ETN Global Joint Webinar**

The need for CO<sub>2</sub> neutral flexible dispatchable power in the energy transition An EU perspective

Webinar 29 June 2021



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# Global carbon emissions today and decarbonisation needs to reach Net-Zero by 2050



Global CO<sub>2</sub> emissions (33.7 gigatons)

Coal, oil and gas production in 2050 net-zero roadmap

Global production in exajoules



\*Decarbonization as used herein is intended to mean the reduction of carbon emissions on a kilogram per megawatt hour basis | Source: IEA WEO 2020

**ETN Global** 

### Many possible pathway towards net-zero GHG in 2050

- remaining emissions (industry, transport) compensated by storage
- power generation emissions down to zero (from 2040 in this example)



#### EU Commission Communication "A Clean Planet for All" (COM(2018)773 Final)



# European "Green Deal" Towards a net-zero EU by 2050

The **"European Green Deal"** is the EU's strategy for a European carbon-neutral society by 2050.



A European Green Deal Striving to be the first climate-neutral continent

Agreement reached European Climate Law legal obligations to:

- ✓ reduce GHG emissions by 55% by 2030 (vs. 1990)
- ✓ carbon-neutrality by 2050

# "Fit for 55%" Package

- ✓ Taxonomy: Sustainable Finance
- ✓ Revision of the EU Emission Trading Scheme
- ✓ Carbon Border Adjustment Mechanism
- ✓ Energy Efficiency Directive
- ✓ Renewable Energy Directive
- Hydrogen and System integration strategies
- Reducing methane emissions in the energy sector

### **The European Green Deal – Structure**



#### Not just energy and climate, but all the policies with an impact on emissions

### Powering a climate-neutral economy: An EU Strategy for Energy System Integration

#### The energy system today :

linear and wasteful flows of energy, in one direction only

#### Future EU integrated energy system : energy flows between users and producers, reducing wasted resources and money



Integration allows to store energy from intermittent renewables

Requires zero carbon fuels like hydrogen to decarbonise the hard to abate sector (like steel)

#### A mix of:

- Reinforced and smarter networks (from generation to appliances)
- Storage
- Dispatchable zero emission power generation

# **A Hydrogen Strategy for a Climate Neutral Europe**

The path towards a European hydrogen eco-system step by step :



From now to 2024, we will support the **installation of at least 6GW of renewable hydrogen electrolysers in the EU**, and the production of **up to 1 million tonnes** of renewable hydrogen. From 2025 to 2030, hydrogen needs to **become an intrinsic part of our integrated energy system**, with at least 40GW of renewable hydrogen electrolysers and the production of **up to 10 million tonnes** of renewable hydrogen in the EU. From 2030 onwards, renewable hydrogen will be deployed at a large scale across all hard-to-decarbonise sectors. To decarbonise the economy, the EU needs to promote clean hydrogen



# Many thanks for your attention !!!

# **Questions?**

→ DECHAMPS.PJT@GMAIL.COM

# Role of H<sub>2</sub> for Power and Heat Generation

Introduction to webinar "Is Hydrogen the Answer to Low-Emissions Turbomachinery?"

Geert Laagland Director of Engineering – BA Heat | OU Heat Projects Co-Chairman of ETN Global's Hydrogen Working Group



### About 20,000 employees

# This is Vattenfall We will help power our customers to live free from fossil fuels within one generation

## **Basic facts**

- One of Europe's largest producers of electricity and heat
- 100% owned by the Swedish state
- Main products: electricity, heat, gas and energy • services
- Main markets: Sweden, Germany, Netherlands, Denmark and the UK



#### Location of our operations and major plants



# CO<sub>2</sub>-neutral flexible dispatchable power needed



- Need to decarbonize flexible dispatchable power increases through time:
  - 2050 target: electricity sector needs to be CO<sub>2</sub> neutral (Climate Law)
  - Additional electricity demand due to electrification: increasing emissions in power sector
  - 2030 targets: decarbonization of flexible power generation can contribute to reaching 2030 targets
- Until 2030 insufficient incentives to decarbonise flexible dispatchable power generation (higher CO<sub>2</sub> price needed)

# **Options CO<sub>2</sub>-neutral flexible dispatchable power**





# **Decarbonizing district heating in Berlin**



# Role of H<sub>2</sub> in decarbonized energy system



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# H<sub>2</sub> is finding its way for electricity & heat

Example; Expected H<sub>2</sub> Demand Germany



Source; Agora 2020

European H<sub>2</sub> Backbone Development





# **Necessary conditions for H<sub>2</sub> developments**











# High Hydrogen Retrofits and Partnerships



#### Webinar:

Is Hydrogen the Answer to Low-Emission Turbomachinery?

Peter Stuttaford CEO, Thomassen Energy June 2021



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# Filling The Renewable Gap

- The Gas Turbine Advantage
- Flexible fast load coverage
- · Cleanest of the fossil fuels
- Ability to run on wide range of fuels, including green fuels such as hydrogen
- Excess <u>renewable energy can be harvested</u>, stored and released in gas turbines
- Existing gas turbine power plants available for retrofit with cost effective carbon free upgrades
- Ability to follow the transition to renewable World at a pace which is flexible and dependent on local & regional market drivers

### Gas Turbines can meet the flexibility need ... and go green









# Hydrogen solutions for low CO<sub>2</sub> Energy Transition





2 steps to full hydrogen operation (1st step already in commercial operation)

## Hydrogen Retrofit scope on the Gas Turbine





- Compressor and other engine components remain unchanged
- Fuel delivery manifolds and fuel lines may need to be re-sized if needed based on hydrogen content
- Control system and Fuel delivery skids upgraded as required

# 9E Hydrogen in Commercial Operation – Key Package Elements





3. Premix Combustion system (more than 100 natural gas E-class installations, 3 with H<sub>2</sub>)



3 years stable and flexible sub-9ppm NOx Operation from 0% to 35% H2

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# FlameSheet<sup>™</sup> Commercial Machine Experience

- 8 FlameSheet<sup>™</sup> (7 FlameTOP) enabled machines in operation, 6 years of experience
- Up to 20% additional load turndown and fuel flex with sub 9ppm NOx and CO
- Hardware in excellent condition after 28,000 hours and 400 starts
- Up to 60% by vol H2 F-class firing condition in test rig; up to 40% C2+'s\*

















## FlameSheet<sup>™</sup> Retrofit Enhances Operational and Fuel Flexibility

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1MW to 300MW with 0% to 100% Hydrogen with 1 Scalable Combustor Platform

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100% Natural Gas OP16 Full Load < 6 ppm NOx



100% Hydrogen OP16 Full Load < 10 ppm NOx



### Operations from 100% natural gas to 100% hydrogen with dry low emissions

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# Turnkey Clean Energy Package (Low/Zero Carbon) Demonstrator





#### Container Package1.8MW OPRA OP16 gas turbine

Container package Electrolyser

A turnkey package for clean energy – just supply water and power grid connection:

- 1. Electrolyser absorbs low cost electricity from grid AND/OR Solar/Wind
- 2. Hydrogen is made by electrolyser and accumulated in high pressure storage vessel (included)
- 3. Gas turbine releases energy back to the grid when electricity prices rise to fill gap in renewable generation

### Energy storage and flexible balancing package with zero carbon capability

# Solutions for the Energy Transition

- The gas turbine advantage:
  - Rapid flexibility for power grid balancing
  - Opportunity for clean energy storage with hydrogen
- Partnership advantage:
  - Shared expertise
  - Shared risk
  - Cost effective and commercially applicable solutions
- Package solutions:
  - Hydrogen supply, storage and safety
  - Fuel mixing/handling, controls, combustion, hot end assessment
- Planned 100% hydrogen flexible engine demonstrations:
  - Small engine  $\textbf{2022/23} \rightarrow \textbf{2MW}$
  - Medium engine  $\textbf{2023} \rightarrow \textbf{20}$  40MW
  - Large engine  $2024/25 \rightarrow 100 300MW$

## High hydrogen retrofits/partnerships for carbon free power generation and energy storage









# Thank You

# www.thomassen.energy

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