The impact of Hydrogen-fired Gas Turbines on HRSGs

IGTC 2023 Technical Session 2: Product sustainability, performance & reliability

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NEM Energy B.V.
History and current locations

Established
in **1929**

Various acquisitions
1996 – 2001

2014 NEM opens
new HQ in the
Netherlands

2022 Siemens Energy HTT
becomes NEM Energy B.V.

Boilers since
1936

HRSGs since
1960s

2010 NEM
Germany opens
new office

2011 Siemens
Acquires NEM
(name change in 2018)

2015 Largest CCPP
contract ever (14.4 GW)

2023 NEM acquires
Balcke Duerr

OUR ENERGY, YOUR POWER

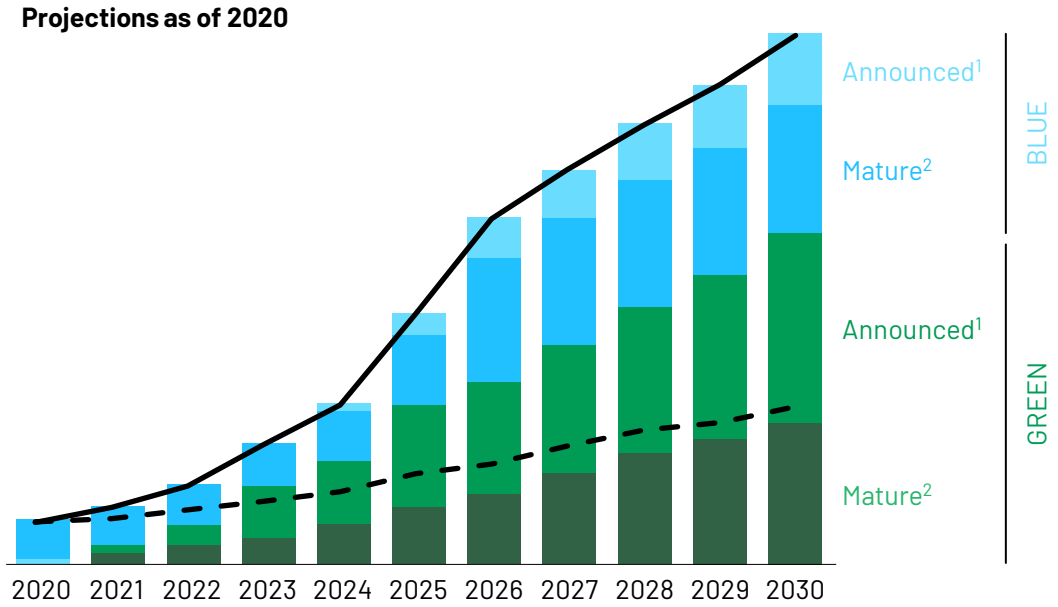
SIEMENS

BALCKE
DÜRR

Strong growth expected in Hydrogen production

Announced clean Hydrogen capacity through 2030

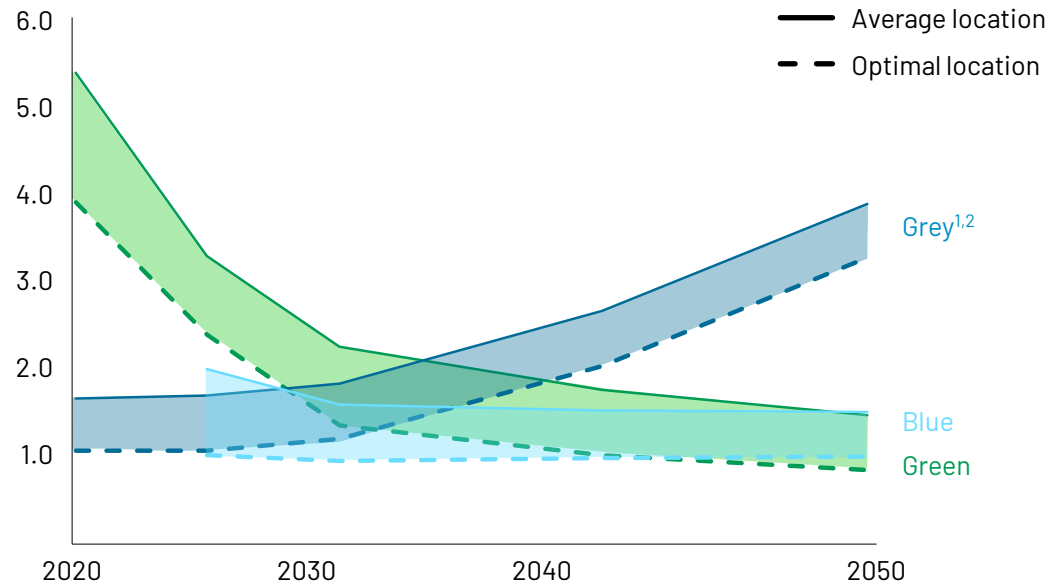
Production capacity
Mt p.a.



1. Includes projects at preliminary studies or at press announcement stage; 2. Includes projects that are at the feasibility study or front-end engineering and design stage or where a final investment decision (FID) has been taken, under construction, commissioned or operational

Hydrogen production pathways, including carbon costs

Production cost of hydrogen
USD/kg

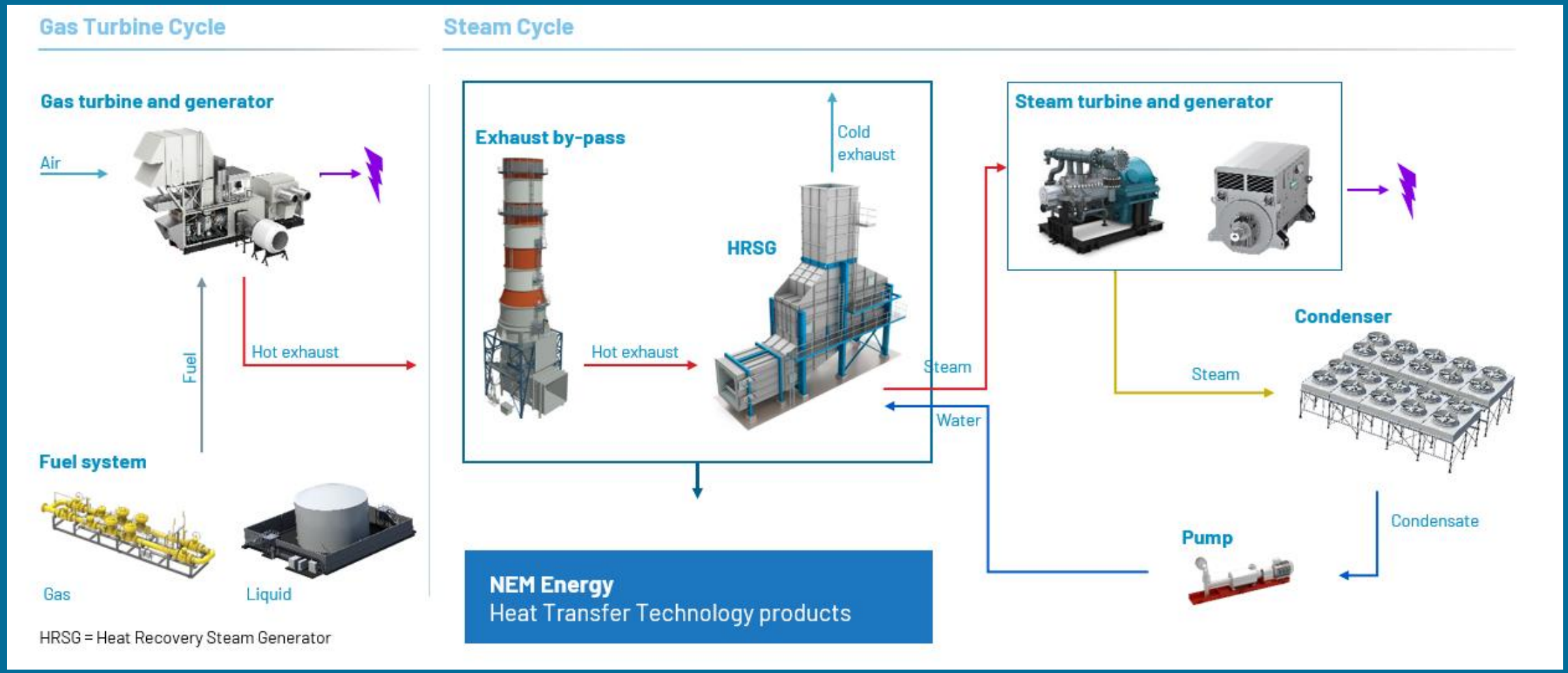


Key assumptions:
Gas price 2.6–6.8 USD/Mmbtu
Cost USD/Ton CO_2 30 (2020), 50 (2030), 150 (2040) and 300 (2050)
LCOE USD/MWh 25 – 73 (2020), 13 – 37 (2030) and 7 – 25 (2050)

Source: Hydrogen Council, McKinsey "Hydrogen insights report 2021"

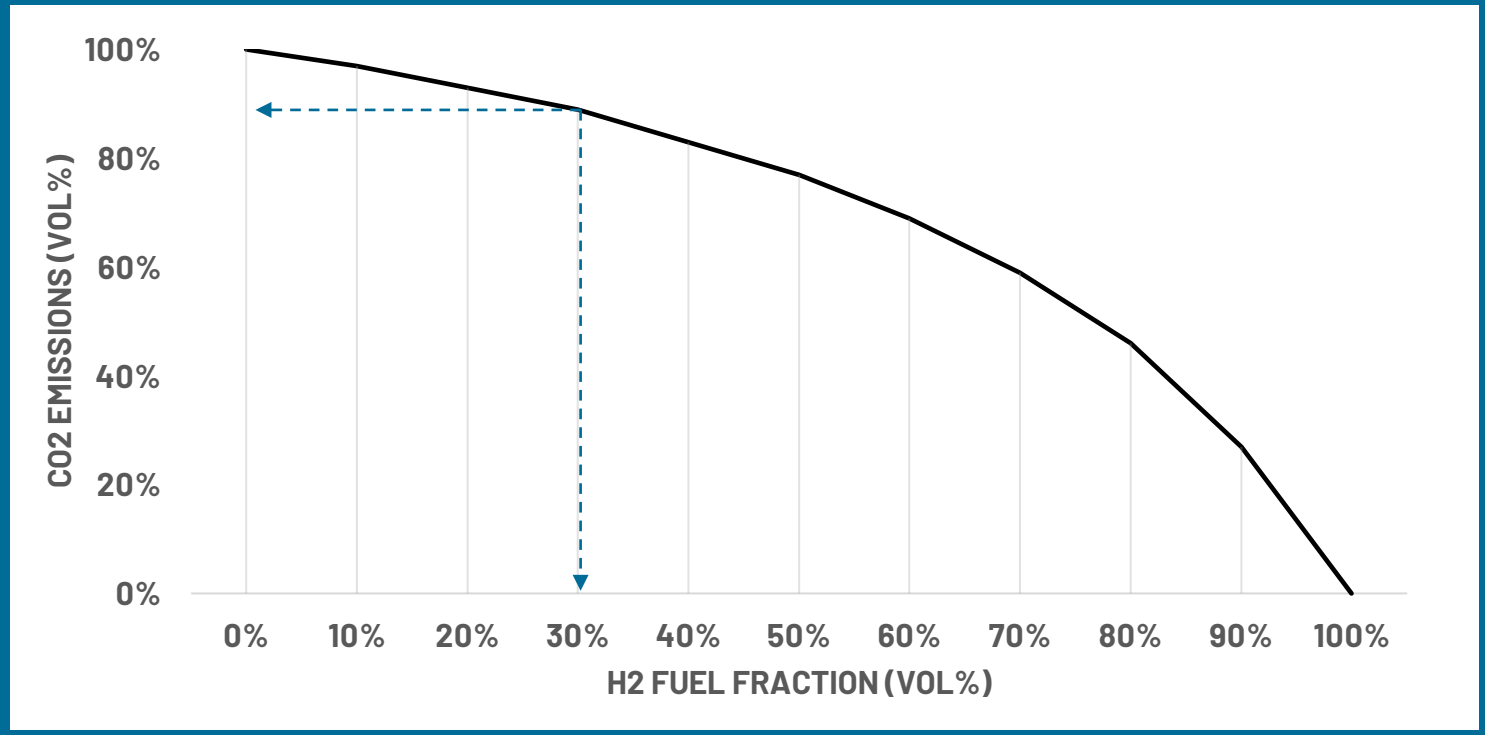
Hydrogen in CCPP's

The Gas Turbines are being made 'Hydrogen-Ready', but what does it mean for the HRSGs?



Physics of Hydrogen

- Expressed as volume percent (%) in the industry
- High mass-related heating value (LHV) of 120MJ/kg (2.4 times higher than Methane).
- Very low density, 8 times lower than Methane.
- Tendency to reduce ductility in carbon or low-grade steel – hydrogen embrittlement
- A blend of Natural Gas (NG) with 30% H_2 delivers about 11% CO_2 reduction



Hydrogen use in GTs impacts 5 HRSG aspects

1

Safety

Hydrogen has a wider explosion range and lower ignition energy compared to natural gas

2

Exhaust

Exhaust gas volume and temperature

3

Emissions

Potentially dealing with higher NOx content

4

Condensation

Higher water content and varying dew point

5

Supplementary firing system

Fuel supply and flame behavior

Impact of Hydrogen usage on HRSGs

1 Safety

H2 has:

- *Wider explosion range and lower ignition energy compared to NG.*
- *Similar auto-ignition temperature as NG.*

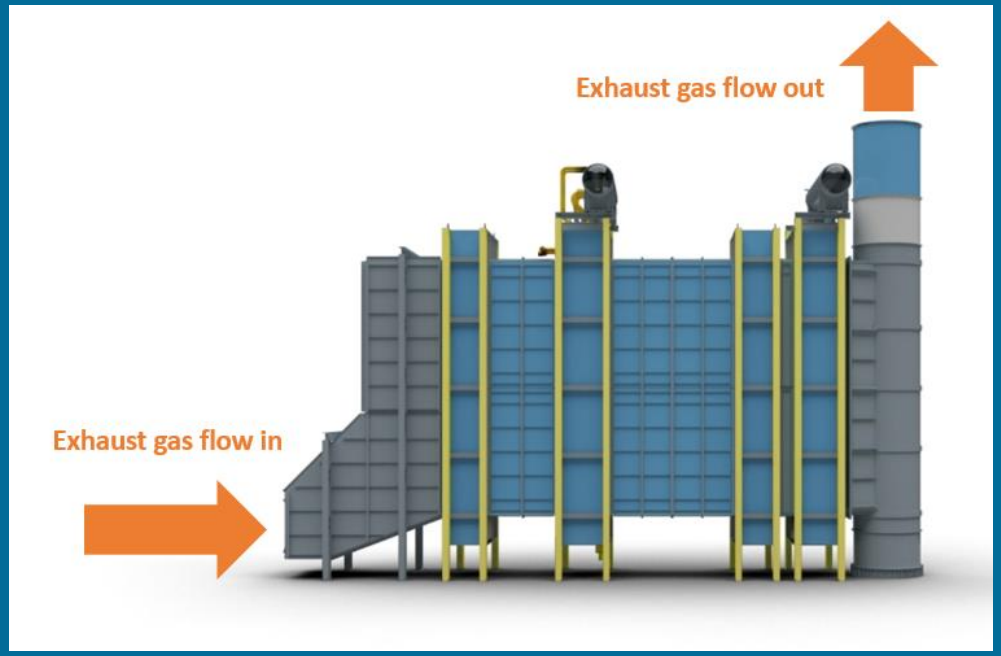
- Same accumulation pattern as for NG is expected, since the density of both gases is much lower than that of air.
- For NG, explosion protection measures such as purging (according to recognized standards such as NFPA 85) are implemented.
- For H2 co-firing, explosion protection measures to be evaluated on a case-by-case basis, depending on factors such as HRSG type (vertical/horizontal).

Impact of Hydrogen usage on HRSGs

2

Exhaust

- Increased exhaust gas volumetric flow and higher temperature compared to NG.
- HRSG design adaptation: avoid exceeding the max allowed GT backpressure and overheating of pressure parts.

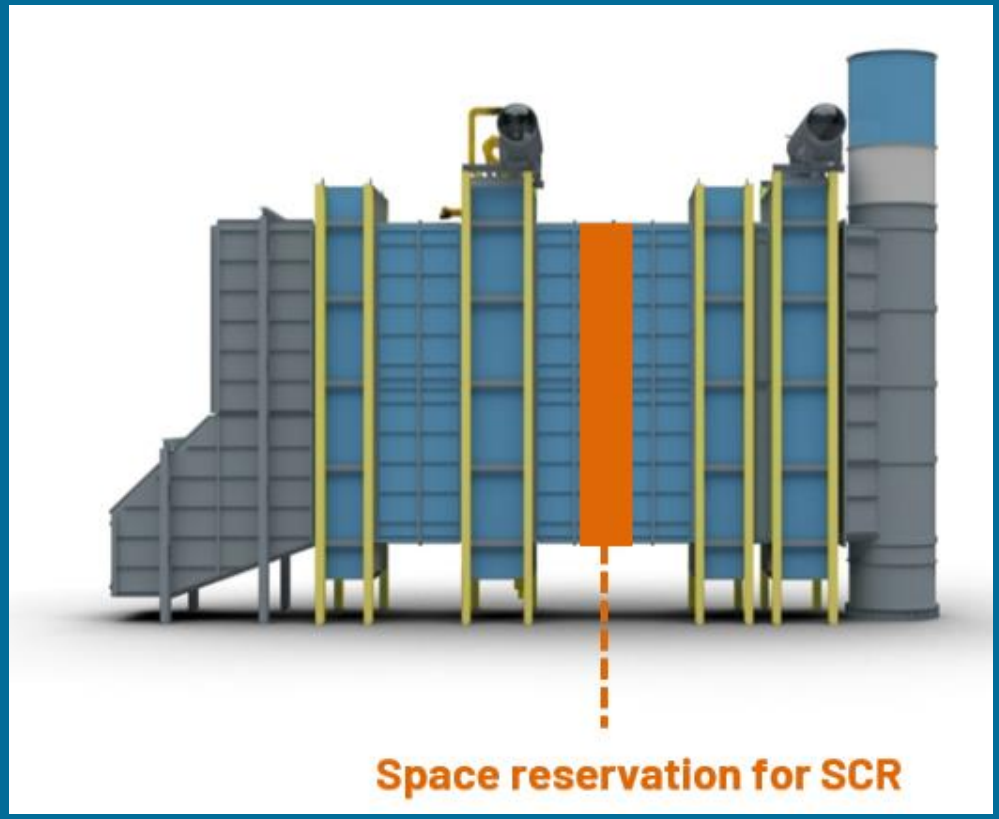


Impact of Hydrogen usage on HRSGs

3

Emissions

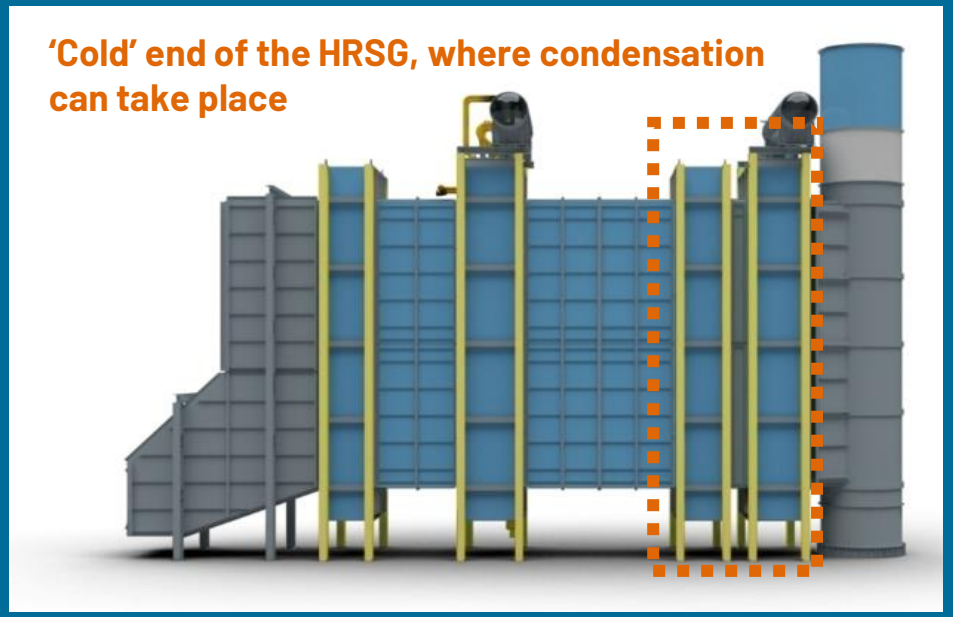
- Like to result in higher NOx (Nitrogen oxides) emissions compared to NG.
- When no SCR system is installed, an empty spool duct could reserve space for installation at a later stage.
- When a SCR system is installed, potentially more space needs to be considered to fit a future H_2 -Ready SCR system.



Impact of Hydrogen usage on HRSGs

4 Condensation

- Higher water content in the exhaust.
- Water dew point increases as a function of H_2 content in the blend, especially above 50%.
- In most cases it can be handled with FW recirculation by increasing the MWT setpoint.
- For of a fuel blend with a significant sulfur content, also the acid dew point plays a role.

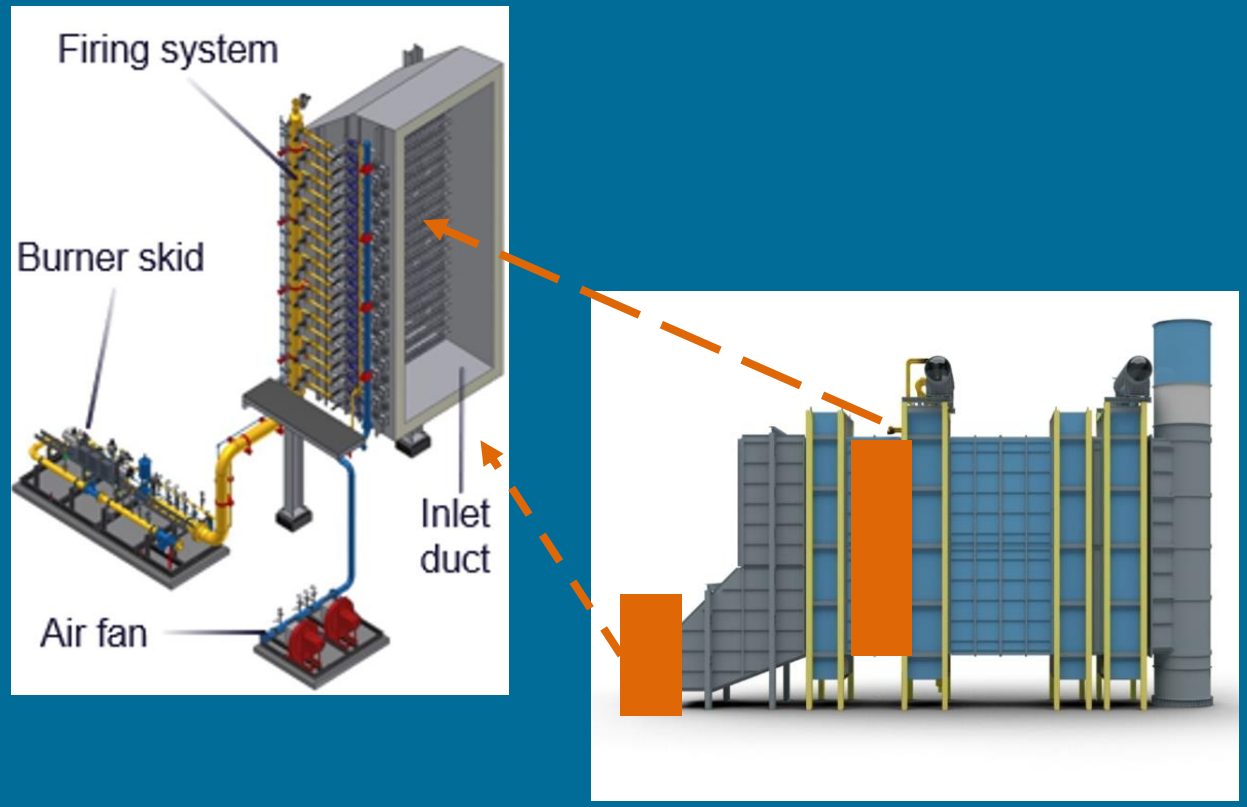


		NG	30% H_2	100% H_2
H_2O content	Vol%	10.3	10.7	16.7
Dew point	°C	47	48	57
HRSG MWT	°C	x	x+1	X+10

Impact of Hydrogen usage on HRSGs

5 Supplementary firing

- Possible in supplementary firing (burner) systems.
- For new installations, burner design shall consider the difference in LHV and supply pressure between H_2 and NG.
- Special provisions may be required to make an existing burner H_2-Ready.

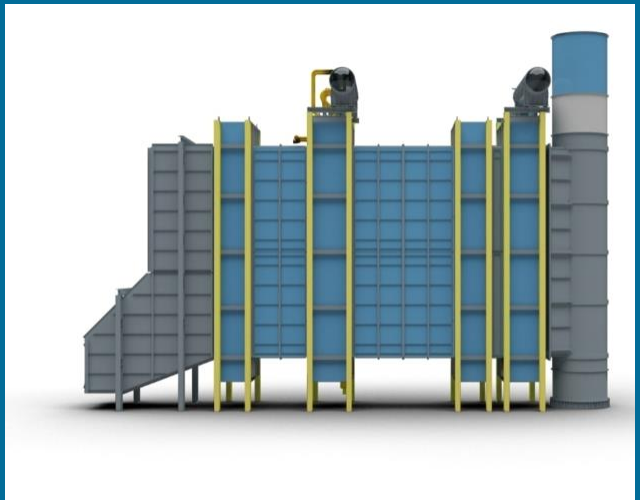


Typical duct burner locations

"H_2-Ready" HRSGs can reduce future H_2 retrofit costs

Hydrogen readiness is key to new combined cycle power plants (CCPPs) and **HRSGs**

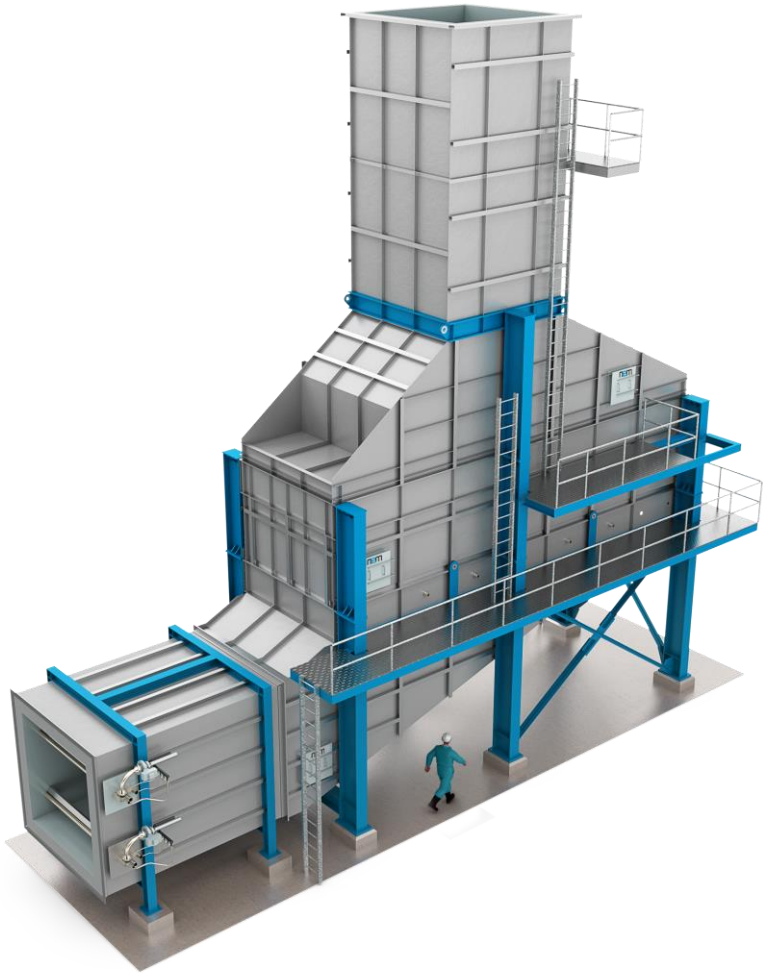
- While keeping front-end investments low, the installation can already be prepared to be able to cope with H_2 operations at a later stage
- Depending on H_2 co-firing time roadmap and requirements, optimized equipment configurations will be offered
- NEM Energy BV is awarded the 'H2- readiness concept certificate' by TÜV SÜD.



Areas:	**Components considered:**
Fuel Supply:	Materials, sizing, aux. fuel, metering, additional systems…
Fire/Ex Protection:	Fire/Ex protection concepts, sizing of systems
HRSG:	**Materials, temperatures, Emission control**
I&C & Electrical:	Design acc. to IIC
Safety:	Safety Integrity Levels definition and design
Certification:	**Certification by independent third-party**

HRSG as part of a plant certification or as independent component

NEM Energy is ready for Hydrogen



1 **Hydrogen will be an important part of the future power generation industry.**

2 The **HRSG is impacted** by firing hydrogen in the gas turbine and there are **various challenges to be considered.**

3 The HRSG can be made **Hydrogen-Ready** in the design phase to **minimize impacts** when shifting to Hydrogen in a later stage.

4 **NEM Energy offers Heat Recovery** products behind GTs to **support the Hydrogen roadmap** for both existing and new build applications.

Thank you for your interest and attention! Let's keep in contact.

Together, we make energy more efficient!

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