



***“LA COMBUSTIONE DI IDROGENO
IN AMBITO INDUSTRIALE”***

Le sfide da affrontare e le opportunità per la filiera

***Tenova Hydrogen SmartBurner
per forni riscaldamento e trattamento del settore metalli***

Enrico Malfa – R&D Director

tenova[®]

The challenge for the Hydrogen

Adaptation to a new era? Or to the transition?

IT IS NOT THE STRONGEST OF THE SPECIES THAT SURVIVES, NOR THE MOST INTELLIGENT THAT SURVIVES. IT IS THE ONE THAT IS THE MOST ADAPTABLE TO CHANGE.

LEON C. MEGGINSON
PARAPHRASING CHARLES DARWIN



A 20-year-long transition means many changes to be dealt with. Companies can thrive or die in the meantime.



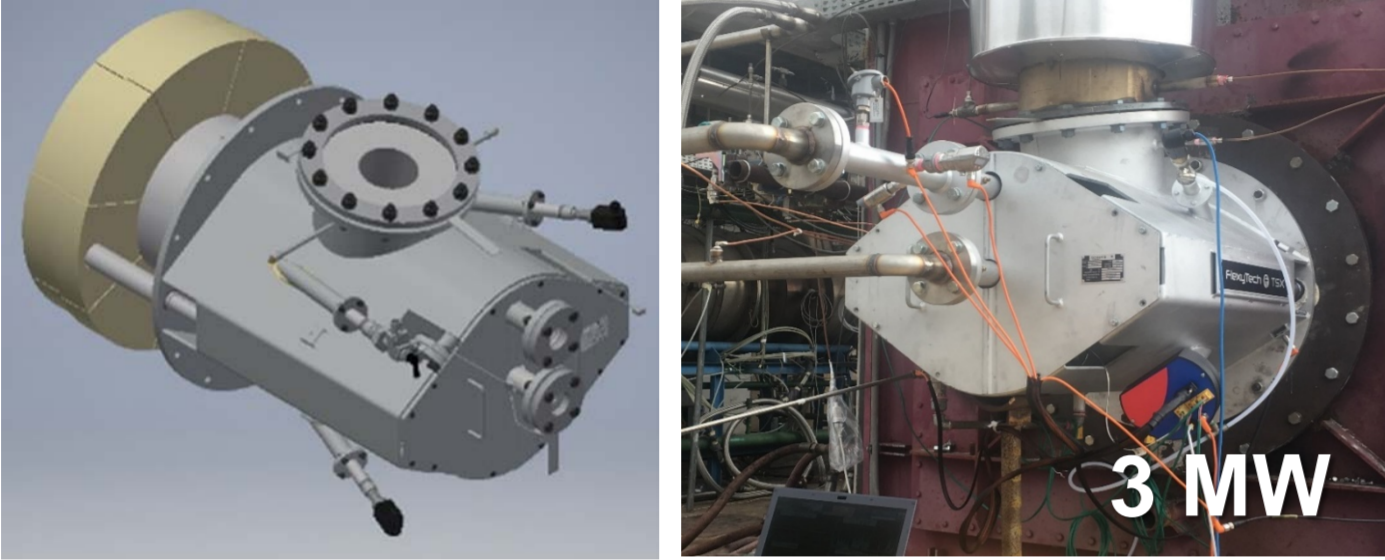
Hard to abate sector need flexible solutions to preserve the investment



Hydrogen Ready Burners

TENOVA HYDROGEN ROADMAP DEVELOPMENT

2020



3 MW

TSX - Lateral Flameless burner for Reheating Furnaces

2021



200 kW

TRKSX - Flameless Self-recuperative burner for Treatment Furnaces



Burners are able to work with any mixtures of NG/H₂ up to 100% H₂

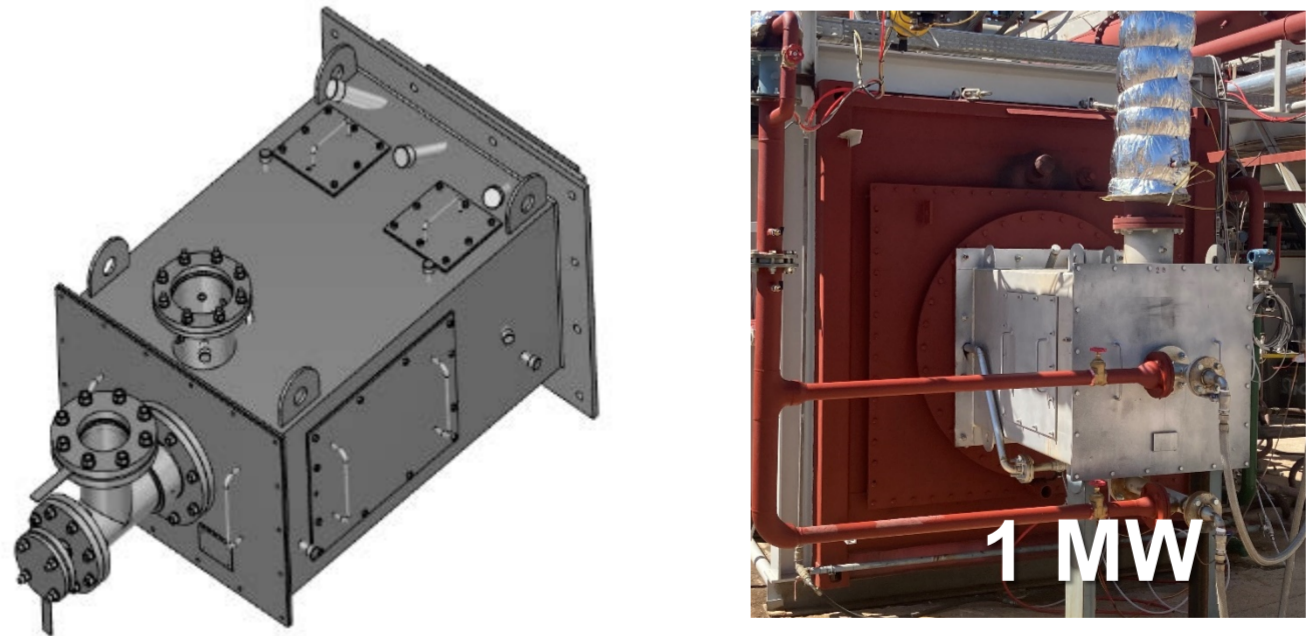
2022 - in progress



100 kW

THSQ - Lateral Preheated Air burner for Bell Annealing Furnaces

2022 - in progress



1 MW

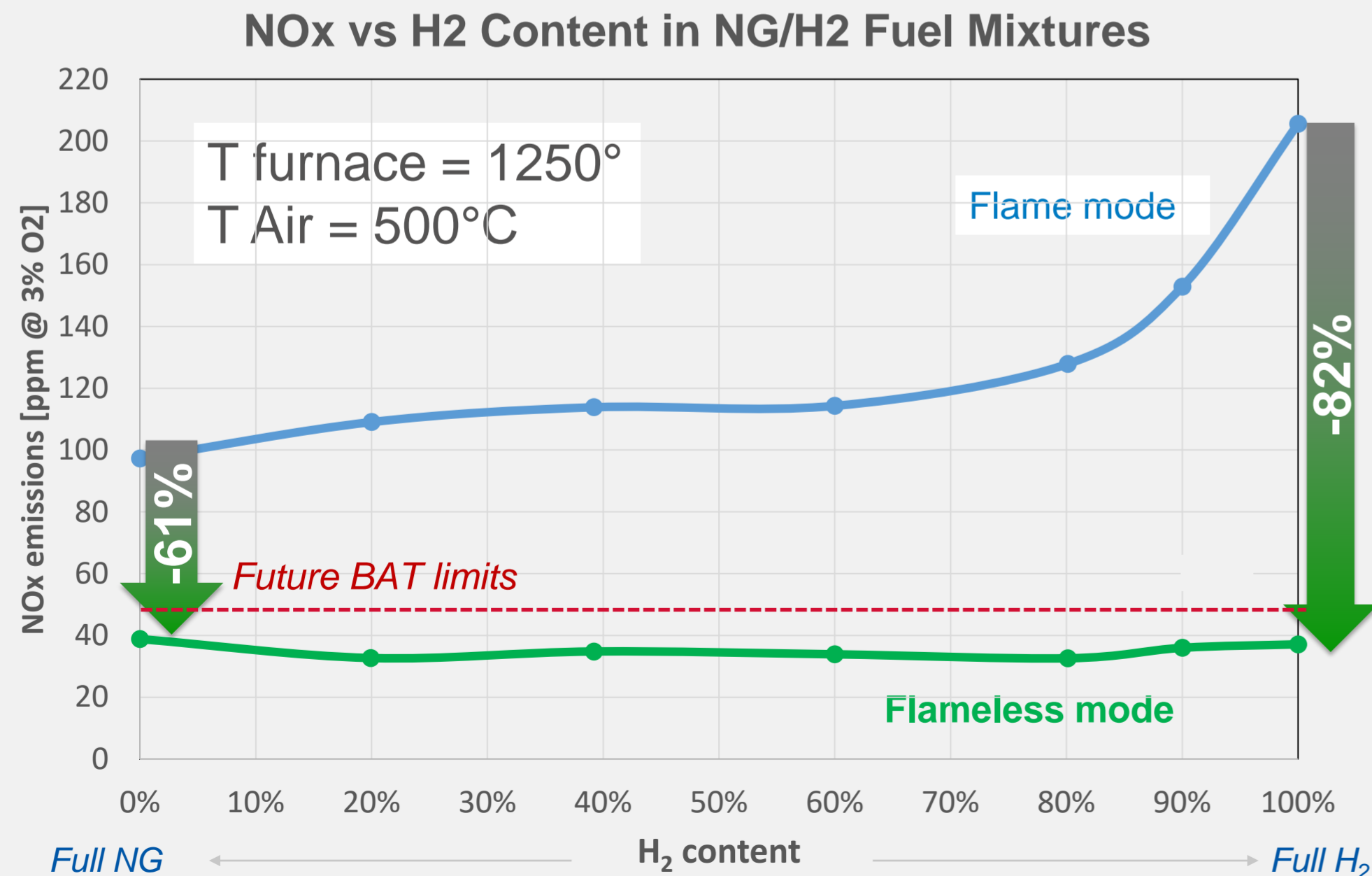
TRGX – Flameless Regenerative burner for Reheating Furnaces



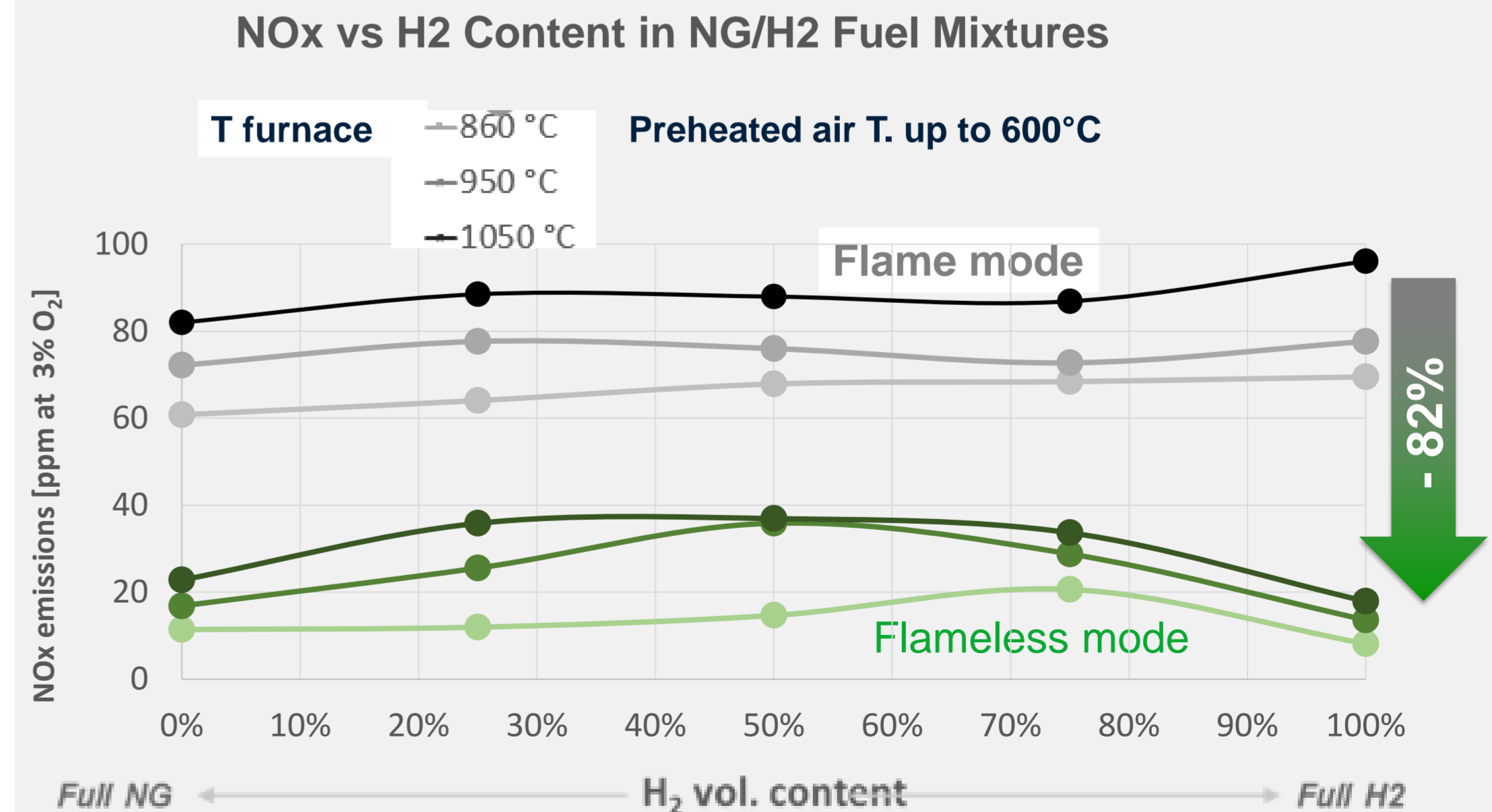
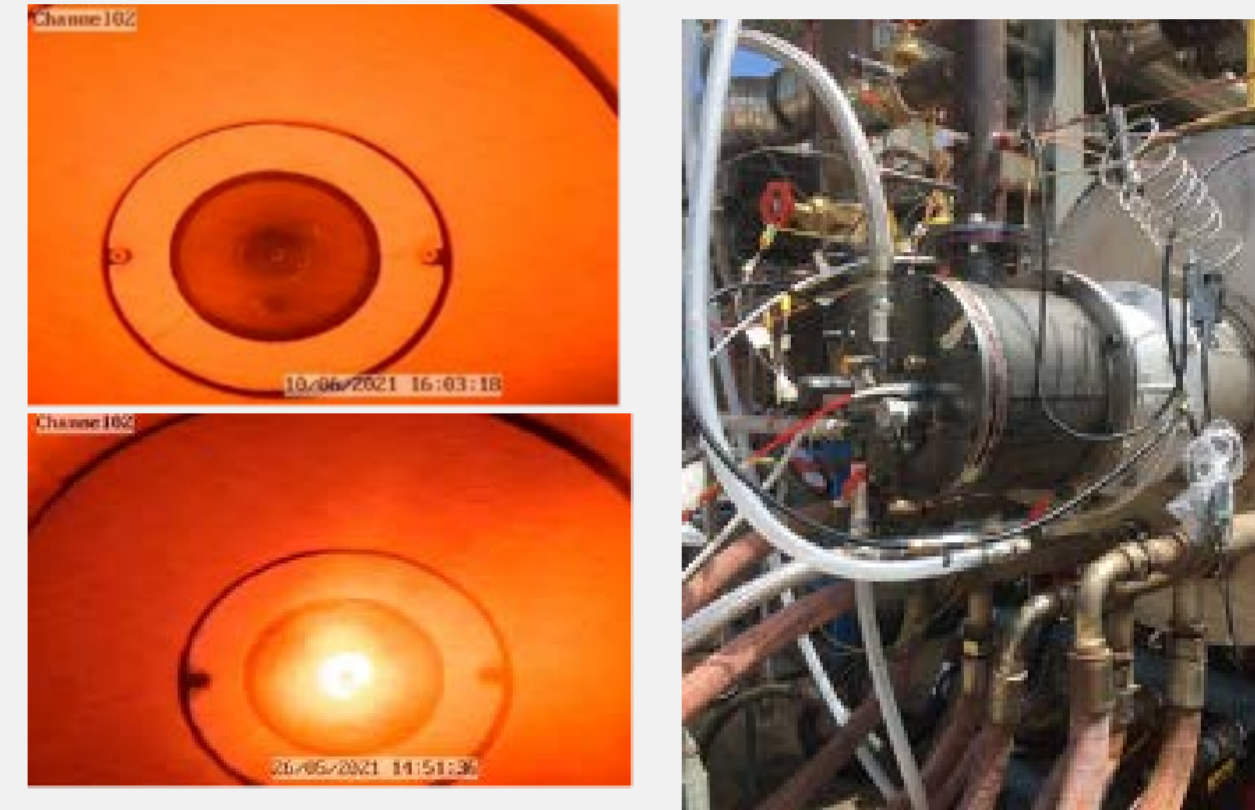
- **Flat Flame burners**
- **Self-recuperative burners for radiant tubes**

Hydrogen ready combustion systems

Re-heating / Lateral / TSX



Treatment / Lateral / TRKSX



Tenova SmartBurner platform

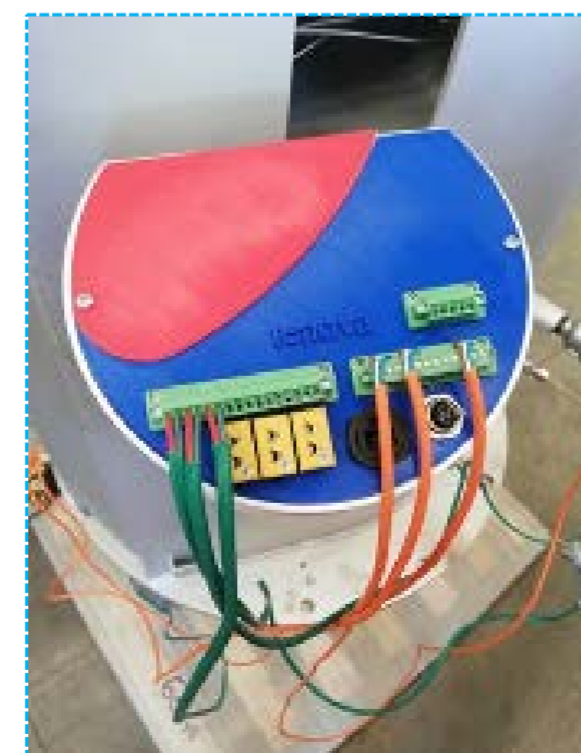


AN INTEGRATED IIOT APPROACH TO PROCESS & EQUIPMENT MONITORING

- Embedded sensors in each single SmartBurner
 - Proprietary optical sensor for combustion quality monitoring
 - **AlphaEdge** extracts statistics from signals
 - **TenovaEdge** streams burner data to Tenova Cloud.
- **Overview:** KPIs and KHIs for monitoring from plant operators.
 - **Monitoring:** real-time signals from embedded sensors on critical parts for remote troubleshooting.
 - **Trend Manager:** for investigating correlations and long-term trends.



TenovaEdge
connection to
Tenova Cloud

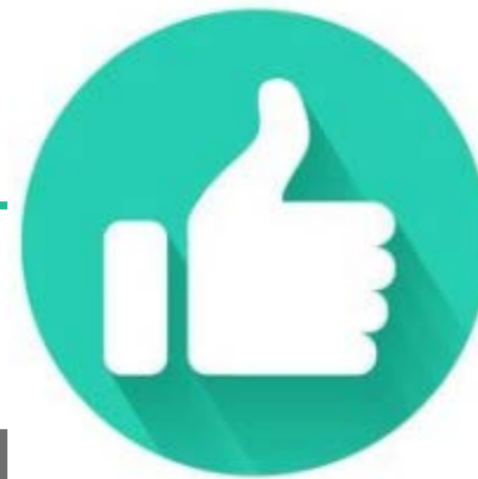


AlphaEdge
Tenova IoT
device

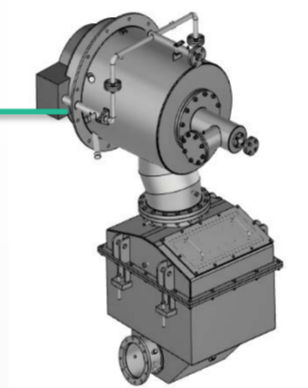


What's the NEXT STEPs

Hydrogen combustion allows an instant and direct reduction of CO₂ emissions:

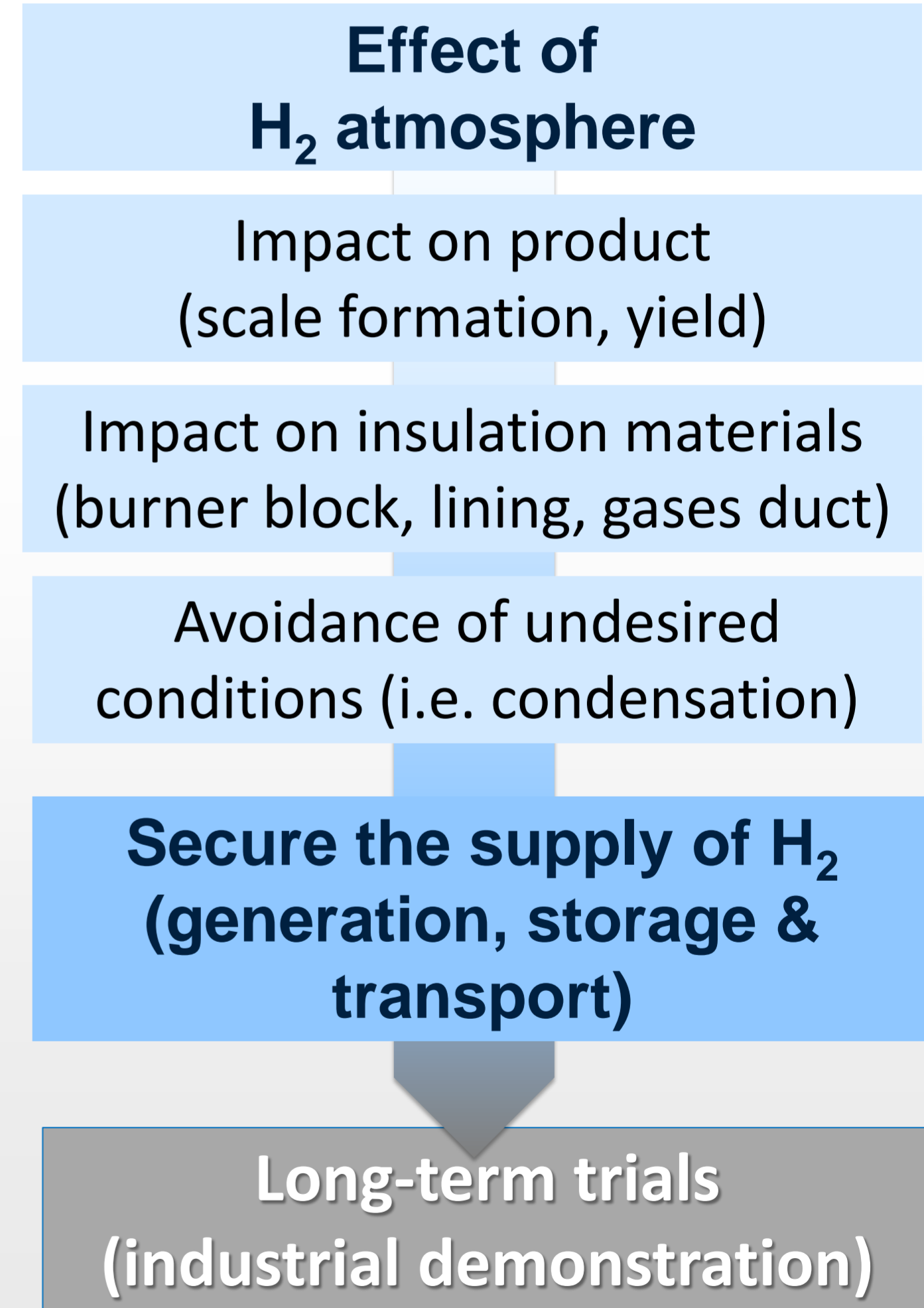


NG [%]	H ₂ [%]	LHV [kcal/N m ₃]	Waste Gases Composition				reduc. [%]
			O ₂ [%]	N ₂ [%]	CO ₂ [%]	H ₂ O [%]	
100%	0%	8590	0.91%	71.83%	9,1%	18,17%	-
90%	10%	7989	0.90%	71.66%	8.82%	18.62%	-3,2%
80%	20%	7389	0.90%	71.44%	8.51%	19.15%	-7,0%
50%	50%	5589	0.89%	70.65%	7.14%	21.42%	-23,1%
31%	69%	4448	0.88%	69.57%	5.66%	23.90%	-40%
23%	77%	3968	0.87%	68.97%	4.75%	25.41%	-50%
0%	100%	2590	0.83%	65.28%	0%	33.34%	-100%



Natural gas Regenerative burners VS Conventional

Hydrogen combustion still poses some issues



Flameless Combustion is the technology:

- NOx reduction
- Coupling with high air temperature
- Increment of temperature uniformity
- Thermal stress reduction on burner parts

ROLLING MILL DEMO PROJECT

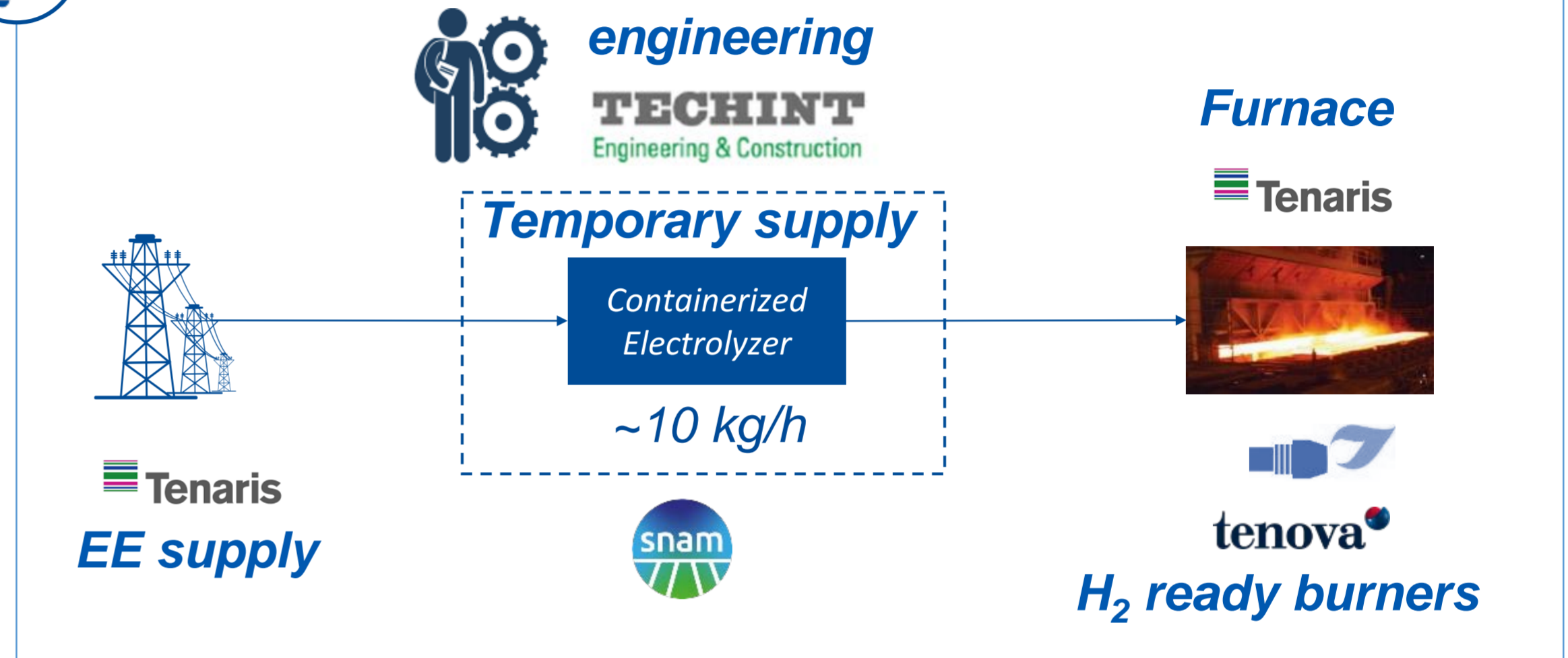


The project

Objectives	<ul style="list-style-type: none"> Industrial field test of a H₂-ready burner installed in a industrial furnace in Tenaris steel shop, with 100% H₂ fuel
Performed activities	<ul style="list-style-type: none"> Burner design and construction Sizing of the electrolyser
Next steps	<ul style="list-style-type: none"> Supply of the electrolyser Installation in Tenaris Long term test



Project scheme

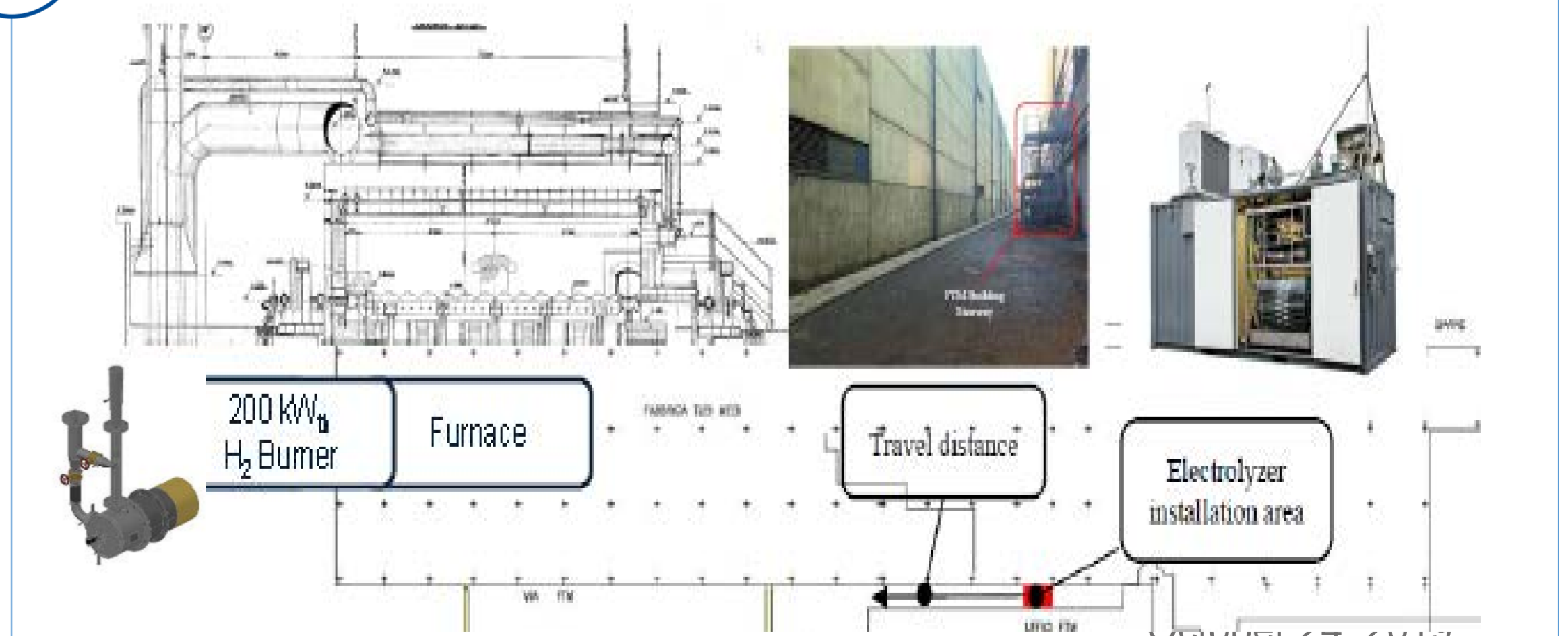


The roles of partners

 	<ul style="list-style-type: none"> Temporary supply & operation of the containerized electrolyser engineering for integration of electrolysis and buffering system assistance with permits
	<ul style="list-style-type: none"> H₂ ready burners supplier
	<ul style="list-style-type: none"> Equipment installation Furnace operation Electricity supply



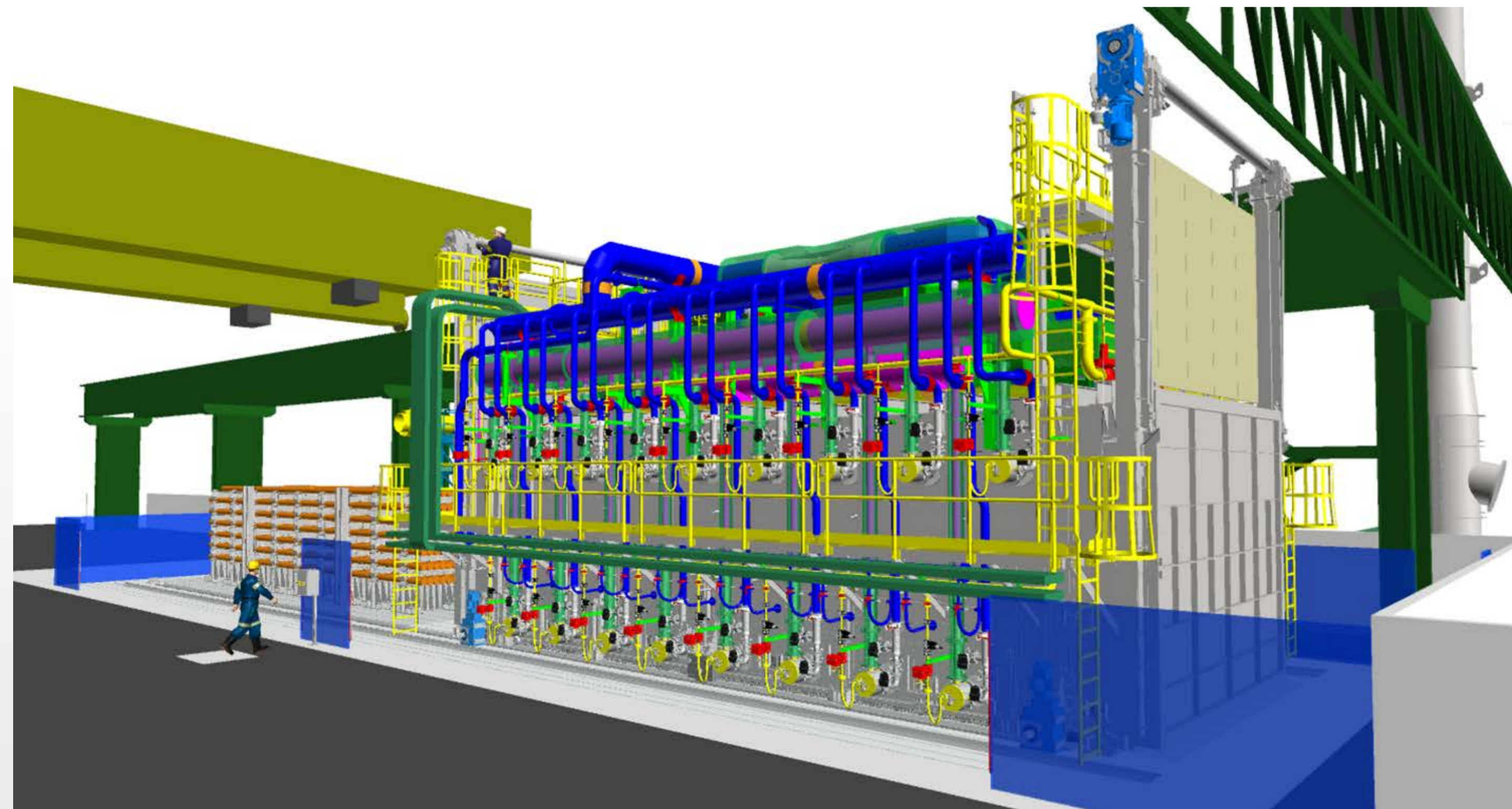
Industrial set-up



Tenova first industrial reference

HYDROGEN / NATURAL GAS FIRING IN A HEAT TREATMENT FURNACE

Tenova's first industrial furnace for **full H₂ firing** using our **TRKSX H₂/NG SmartBurners** is currently under construction: erection started on March 16th – furnace light up scheduled by the end of June 2022

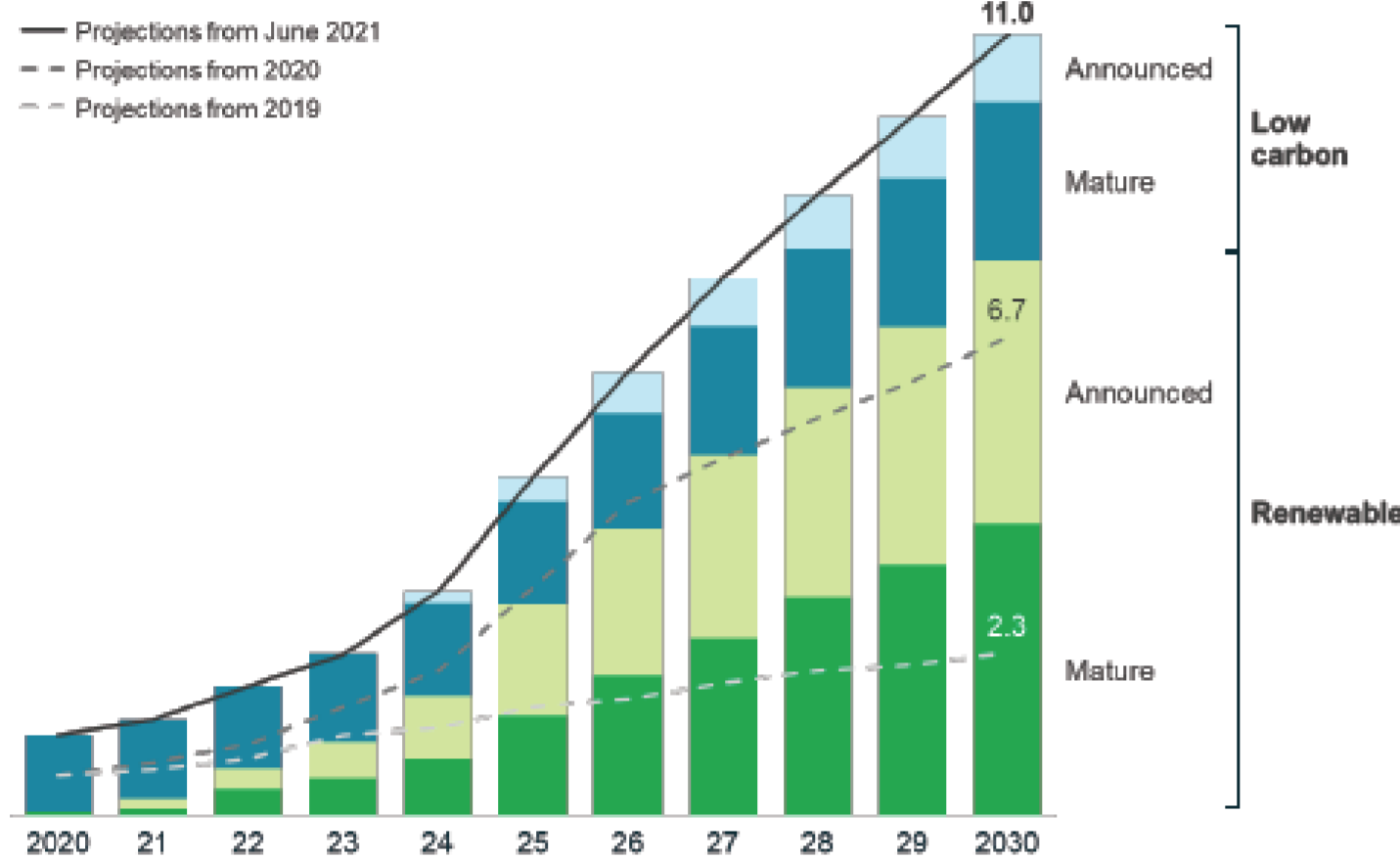


H₂ combustion in steelmaking

ENABLER FACTORS

H₂ availability
quantities and cost

Cumulative production capacity, Million tons p.a.

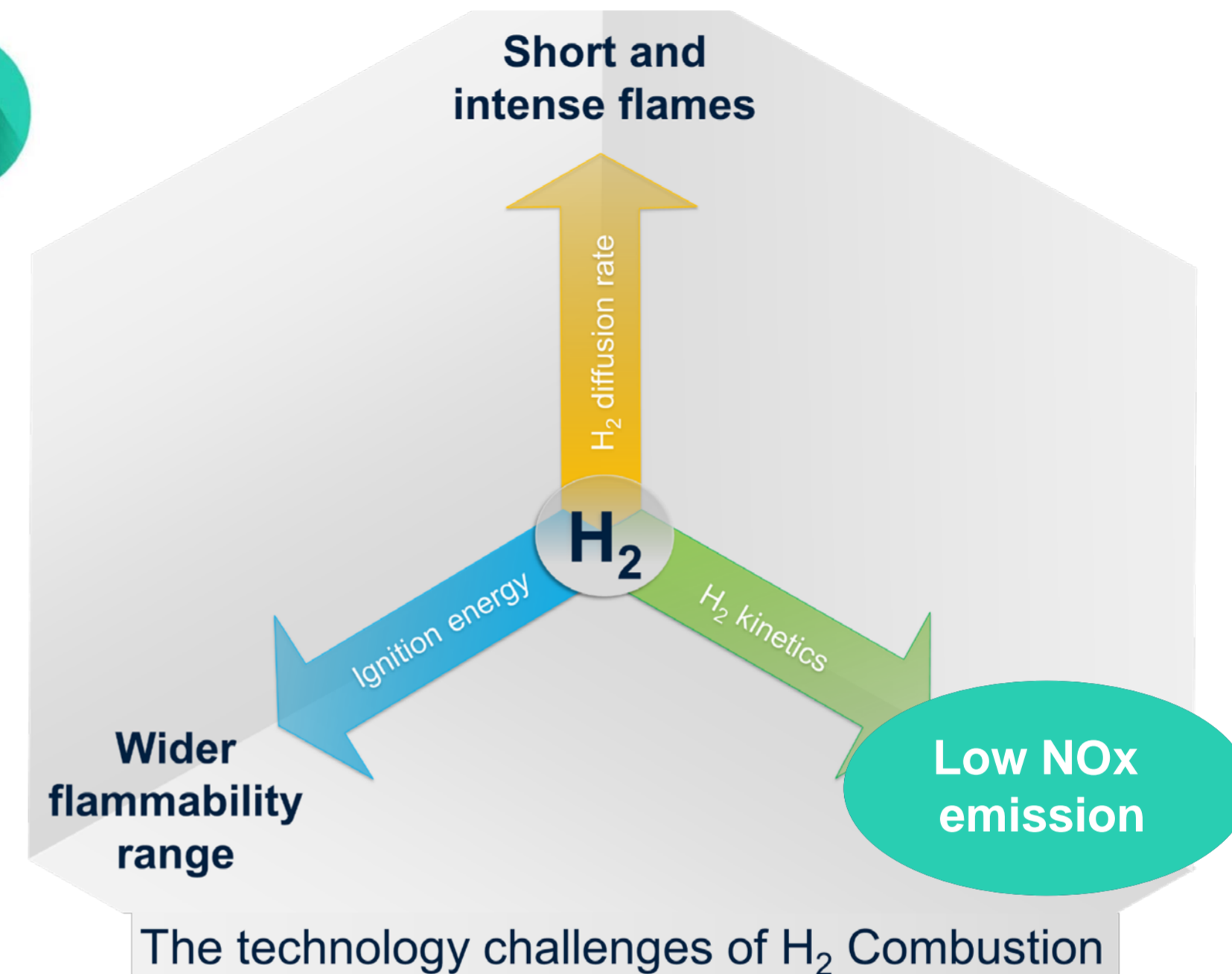


>60%
increase in capacity
announced in the past 5 months

69 GW
clean hydrogen capacity
by 2030 announced

+7.7 Mt
additional capacity
(low carbon and renewable)
announced for post-2030

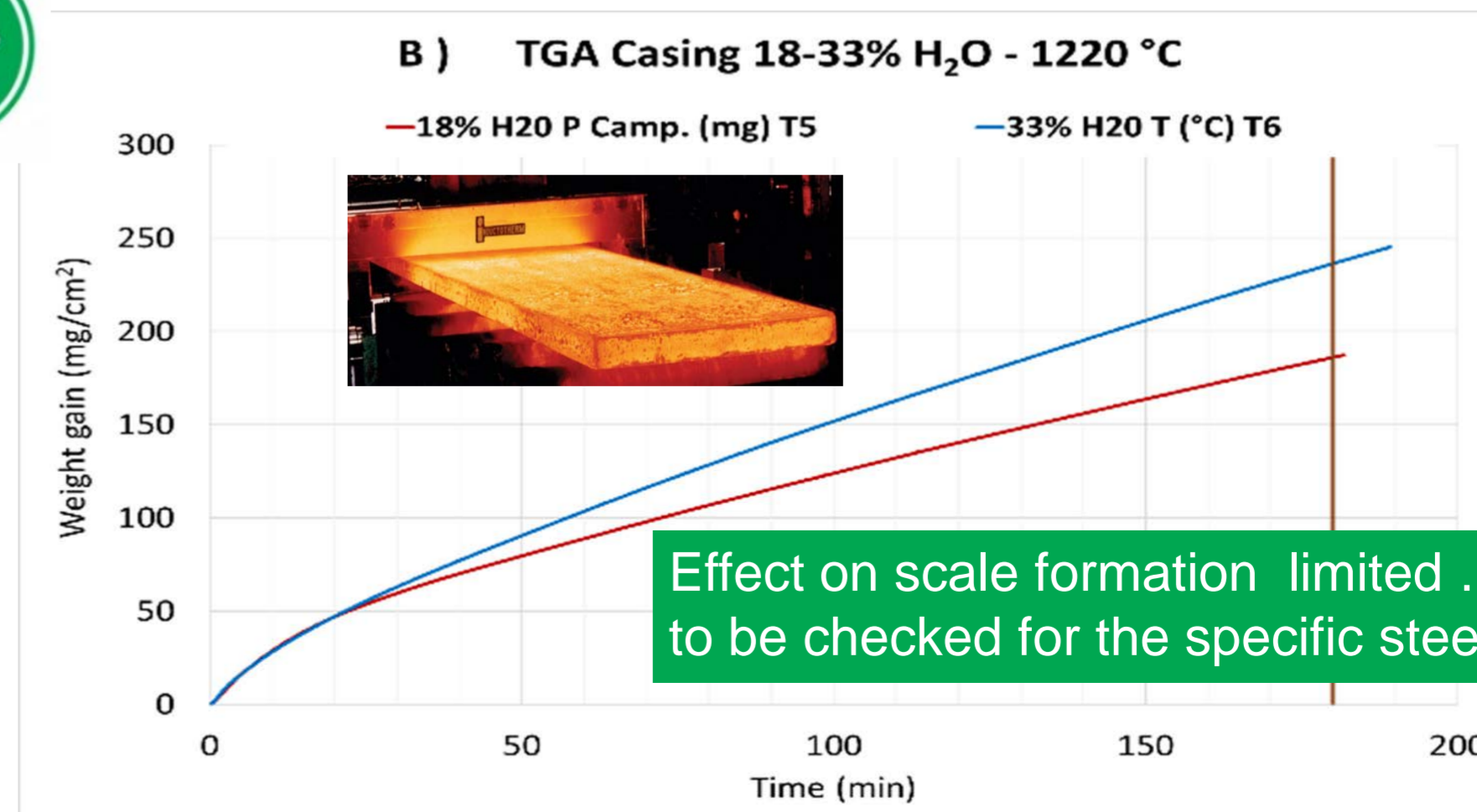
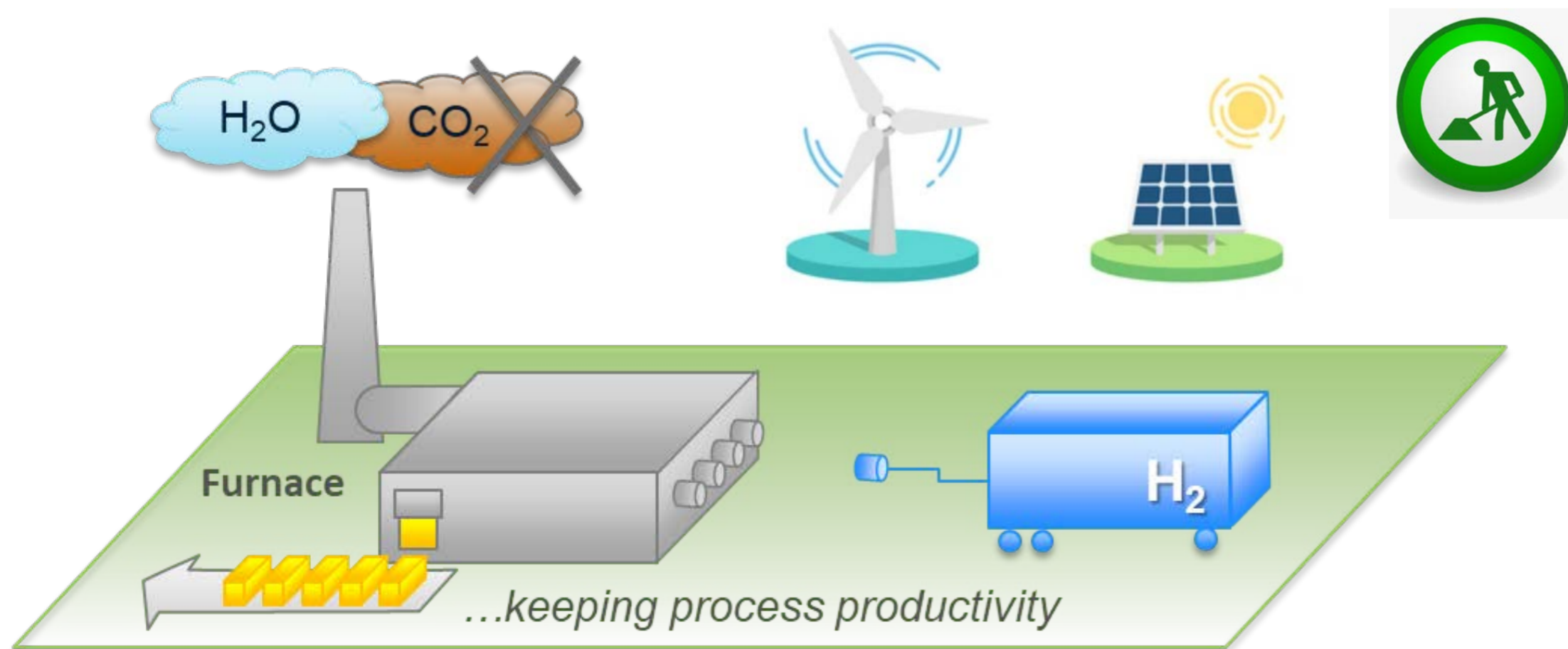
McKinsey Hydrogen Insights – July 2021



H₂ ready
Combustion System

The technology challenges of H₂ Combustion

System integration
permitting and revamping



Effects on the
product quality



***Tenova Hydrogen
SmartBurner
per forni riscaldamento e
trattamento del settore
metalli***

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