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Technip Energies

AIChE NL/B Company visit Burner Test Facility

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01 Technip Energies at a glance

Technip Energies at a glance

Listed on **Euronext Paris** Stock Exchange	Headquartered in Paris Registered in The Netherlands	60+ Years of operations
€6.1B[1] Revenue	A leading Engineering & Technology company for the Energy Transition	€13.2B[1] Backlog
~15,000 Employees in 34 countries	25+ Leading proprietary technologies	450 projects Under execution

[1]Revenue for 12-months ending June 30, 2020 and backlog position as of June 30, 2020.

Experienced, diverse and dynamic workforce

104
Nationalities

9y
Average seniority
(time spent at the Company)

28%
Women

46%
Millennials and Generation Z

~310
Technical experts
with industry leadership

~450
Project managers[1]

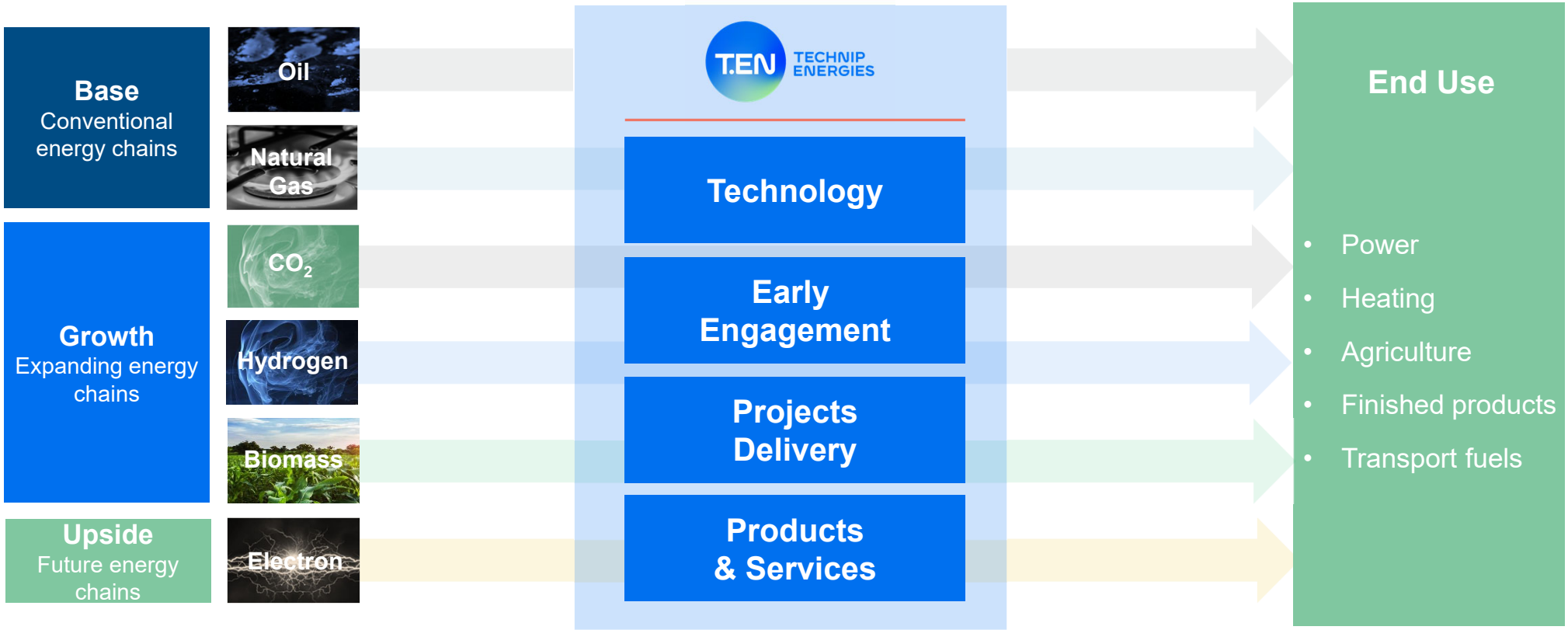
[1]From project manager level 1 up to fellow executive project director, including project engineering and control managers.

A global presence

Centers/ Representative Offices

RBU Headquarters

Central capabilities throughout the energy landscape



Technip Energies: Energy Transition is our business

Through extensive experience, technologies, project management, integrated expertise and EPC capabilities, we continue to break boundaries and **accelerate the journey to a low-carbon society**.

Our Four-Pillar Framework

LNG
Onshore and offshore liquefaction

Sustainable chemistry
Biofuels, biochemicals, circular economy

Decarbonization
Energy efficiency, Blue hydrogen, CCUS[1]

Carbon-free energy solutions
Green hydrogen, offshore wind, nuclear

[1]CCUS: Carbon Capture, Utilization and Storage.

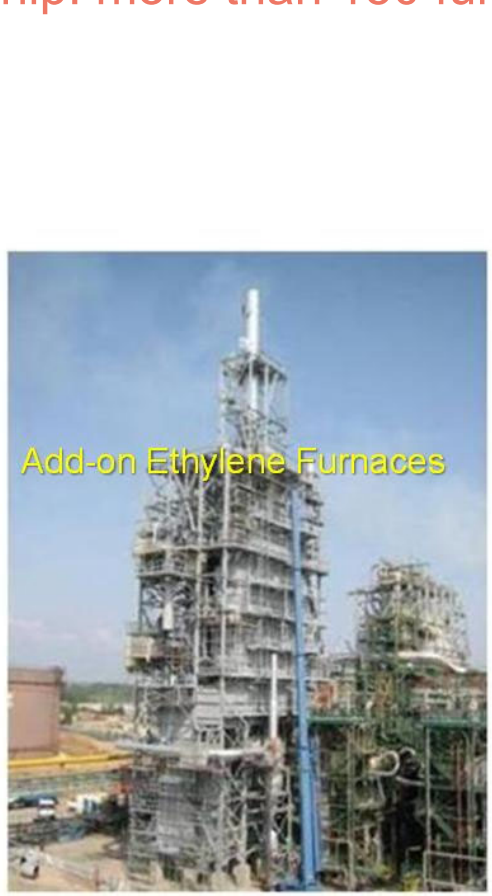
Technip Benelux B.V. – Furnace experience

Technip Energies' Leading Position in Furnace design

- Five decades of extensive furnace experience (Selas, KTI, Mannesmann, Technip)
- 1964 First hydrogen plant, 1966 First ethylene project
- Design of more than 2000 furnaces (EDC, process, refinery, DRI heaters)
- Global alliance with Air Products since 1992 (>40 plants)
- Total SMR plant references >275
- Exclusive partner of BTG Bioliquids B.V. for Fast Pyrolysis Bio-Oil Technology
- Merger between Technip and FMC Technologies → TechnipFMC
- Split of TechnipFMC and Technip Energies, Technip Benelux continues under Technip Energies brand

Technip Benelux B.V. – Ethylene Product Line

Market leadership: more than 150 furnaces modernized



Technip Benelux B.V. – Ethylene Product Line

Petrokemya, Saudi Arabia

Over 550 ethylene furnaces built

Technip Benelux B.V. – Hydrogen Product Line

Hydrogen / Syngas

- Hydrogen and Syngas Plants
- Steam Reformers
- Revamps / Capacity Increase

Capability Highlights

Technology Center & Service provider for:

- Ethylene Technology
- Hydrogen & Syngas Technology

EPC Company for:

- Our Ethylene and Hydrogen & Syngas Technologies
- Biomass to Oil (Fast Pyrolysis) with exclusive technology partner
- Revamps
- 3rd party technologies

TECHNIP ENERGIES

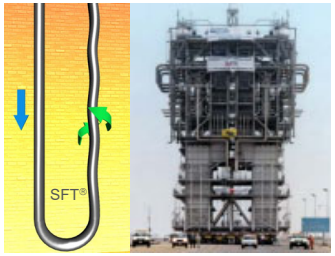
Our capabilities: from license to production support/services

Technip Benelux

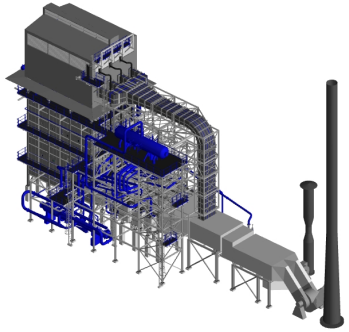
Licenses / Process Design/Engg

- Licensed proprietary technologies chosen at early stage of projects
- Process design packages / engineering to guarantee plant performance with proprietary supplies
- Assistance to plant start-up and follow-up during plant production

Proprietary Equipment



- Design, supply and installation of critical & proprietary equipment
- Fosters innovation



Complete Project Delivery

- Delivery of EPC(m) for plants based on Technip Energies' proprietary technology as well as third party technologies

Renewables

- Collaboration with BTL on FPBO technology
- FEED/EPC for third parties' technologies

Services

- Client support in day to day plant operation
- Furnace / Reformer surveys
- Spares

TECHNIP ENERGIES

02 Burner NOx reduction options

Requirements of Low NOx burners
Features of the Large Scale Vortex burner

Why Technip Energies manufactures burners

- More severe requirements force furnace designers to upgrade burner technology.
- New burners shall be cost effective and environmental friendly.
  → Manufacture burners under Technip Energies responsibility.

Advantages

- Avoidance risk of burner/firing problems on projects.
- Further optimization of firebox design.
- Low NOx emissions; avoidance expensive SCR Denox catalyst.
- Excellent flame pattern and uniform heat flux profile.
- Proven design, trouble free operation.
- Fabrication fully under Technip Energies quality control.

Process parameters influencing NOx formation

LSV burners have low flame temperature and NOx thanks to effective fuel staging

- Flame temperature
- Excess air
- Chemically bound nitrogen in the fuel (Fuel NOx)
- Residence time (at high temperatures)
- Degree of air pre-heat

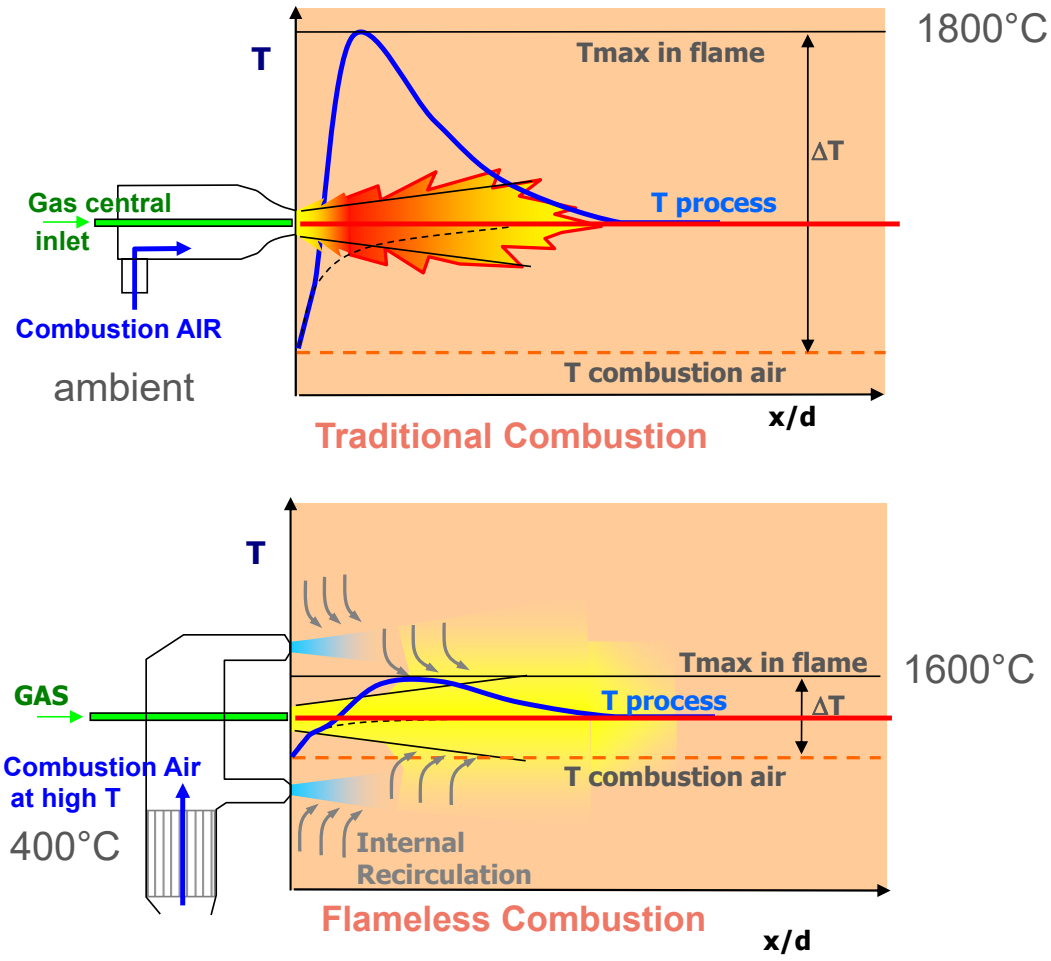
Fixed by the process

LSV® Burner overview

A furnace licensor is in the best position to optimize a burner / furnace combination

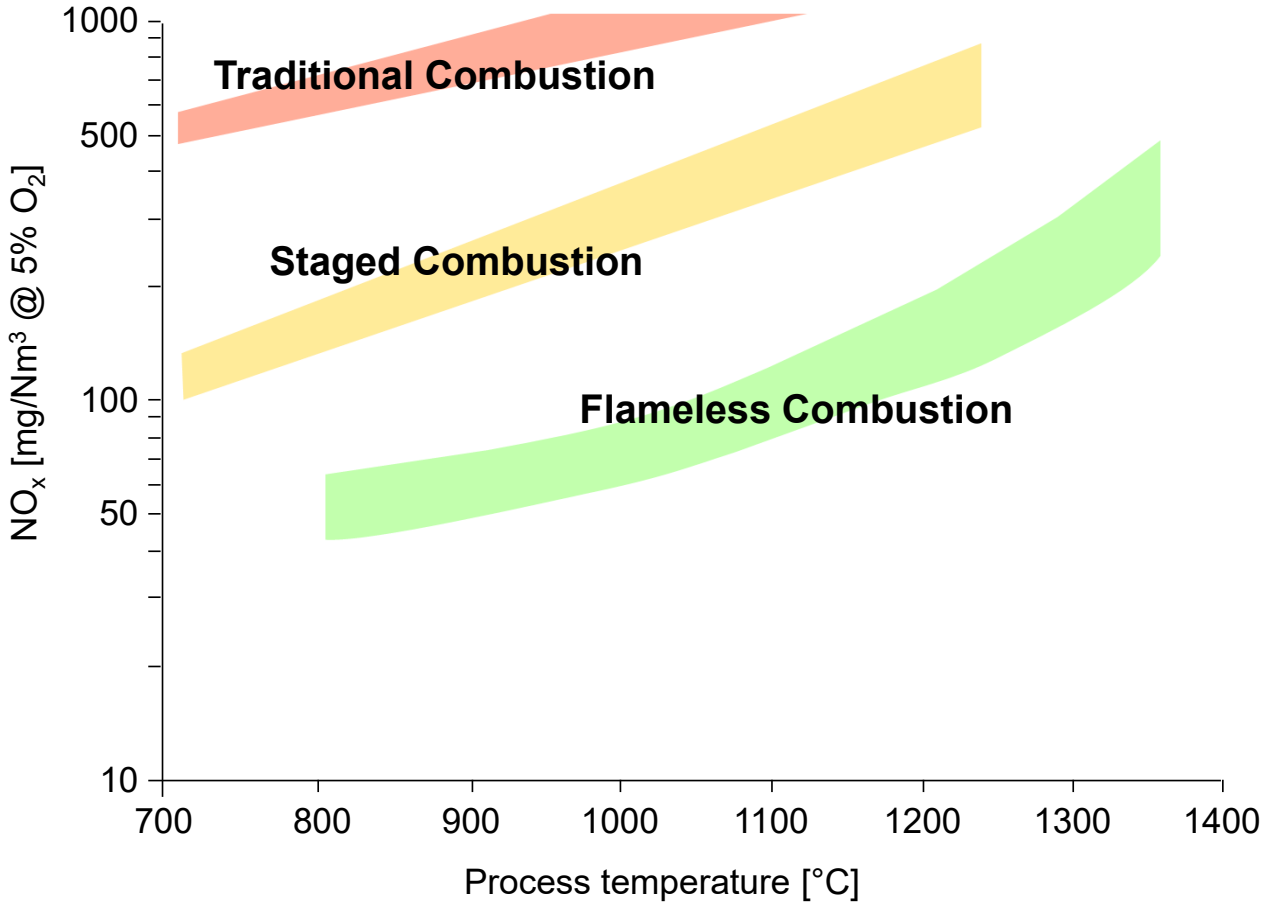
- LSV® = Large Scale Vortex burner.
- Developed by Air Products and Chemicals Inc. (APCI), a furnace owner and operator - not by a burner supplier.
- Design based on APCI experience with special burner designs (oxygen rich, high temperature applications).
- Operating plant references on several furnaces.
- Technip Energies continuous developing the LSV® burner.

Flameless Combustion



Source: Ing. Ambrogio Milani
IFRF Online Combustion
Handbook ISSN 1607-9116;2002

NOx Emissions



Source: V. Burkhardt, W. Roth, H. Tibbenham, J.Wuenning-Annealing and pickling lines: benefits from advanced combustion systems - Millenium; 2004

03 LSV® burner experience

Plant experience Westlake - AP (2005)

Hydrogen plant in operation from 2005 with LSV® burners

Operational Experience

Side lane LSV® burners

Operational Experience

Hydrogen Process Unit

at Preemraff Lysekil, Sweden

- Supplier: Air Products, USA
- Top fired Heater with 240 tubes (6 x 40)
- Numbers of Burners: 7 rows x 12 = total 84

Operational Experience

- Heat release per burner
  - Center burners — 1.92 MW
  - Side burners — 1.16 MW
- Fired heat in Steam Reformer — 144 MW
- Fuel gases
  - Refinery gas — (25 % by heat release)
    - Hydrogen — 65 vol%
    - Lower Heating Value — 44 MJ/Nm³
  - Pressure Swing Adsorber (PSA) offgas — (75 % by heat release)
    - Hydrogen — 19 vol%
    - Methane — 11 vol%
    - CO2 — 55 vol%
    - Lower Heating Value — 7.6 MJ/Nm³

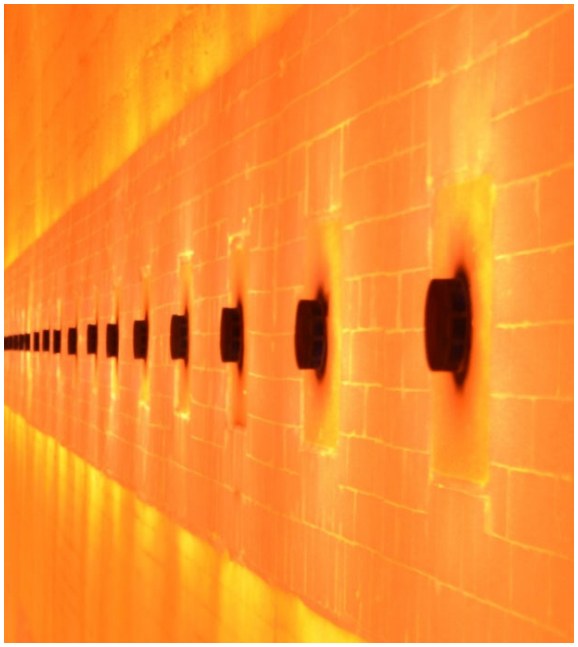
Operational Experience

- LSV Burner running in Low-NOx-mode
- Hydrogen Process Unit Preemraff Lysekil, Sweden

Technip Side Wall Burner (TSWB®)

Premix Radiant Wall Burner Firing Solution

- For steam cracking, refining and other processes, for new and revamp projects
- Optimized furnace performance by:
  - Flat flame radiant wall design
  - Secondary air staging
  - Robust design
  - Multi-fuel flexibility
  - Adjustable and uniform flame release profile
- Manufacturing through own production facility



A cost effective, low NOx product that is an outcome of Technip Energies' track record in design

Operational Experience

LSV® design data – Steam cracking furnaces		
Excess air	%	7.5 – 12.5
Flue Gas Temp (box temp)	°C	1200-1360
Combustion Air Temp	°C	ambient
Hydrogen in fuel gas	vol%	15 - 80
LSV® burner capacity	MW	2.4 – 3.6
TSWB® capacity	MW	0.3 – 0.5

Operational Experience

Summary Technip Energies proprietary burners

- Excellent flame patterns and flame stability
- Very good heat distribution on tubes and refractory
- No operational restrictions related to burner performance
- High firebox efficiency
- Low NOx emission
- Cost effective solution

04 Technip Energies burner fabrication

Fabrication Steps

Plate Rolling up to 100 mm thick

CNC Profile cutting

Technip Energies fabrication shop

Tube bending machine

Features

Testing

- Radiography Testing Enclosure (Capacity- 30 Ci Cobalt)
- Ultrasonic Testing
- Magnetic Particle Testing
- Universal testing machine –Tensile, Bend tests
- Charpy –V Notch Impact Test Machine
- Vickers hardness test
- Alloy analyzer

Capabilities

- Materials: Chrome Moly Steels, P91, Stainless Steels, Nickel Alloys
- ASME “U” Stamp for Pressure Equipment
- DNV Pre-assessment audit Completed in October 2016
- Audit by ASME team February 2016

CNC wirecut machine

Technip Energies Modular manufacturing yard

Location:

- Waterfront yard at Western Coast of India

Transportation:

- Up to 12.5 m W x 12.5 H from existing Jetty
- Own RORO Jetty in future
- 15,000 sq meters
- Covered Fabrication sheds with open Fab/Assembly areas

Modules:

- Up to 1000 MT weight

Pressure Equipment:

- Up to 150 MT weight, 100 mm thickness

TECHNIP ENERGIES

05 Burner Testing

Test facility
Hydrogen firing

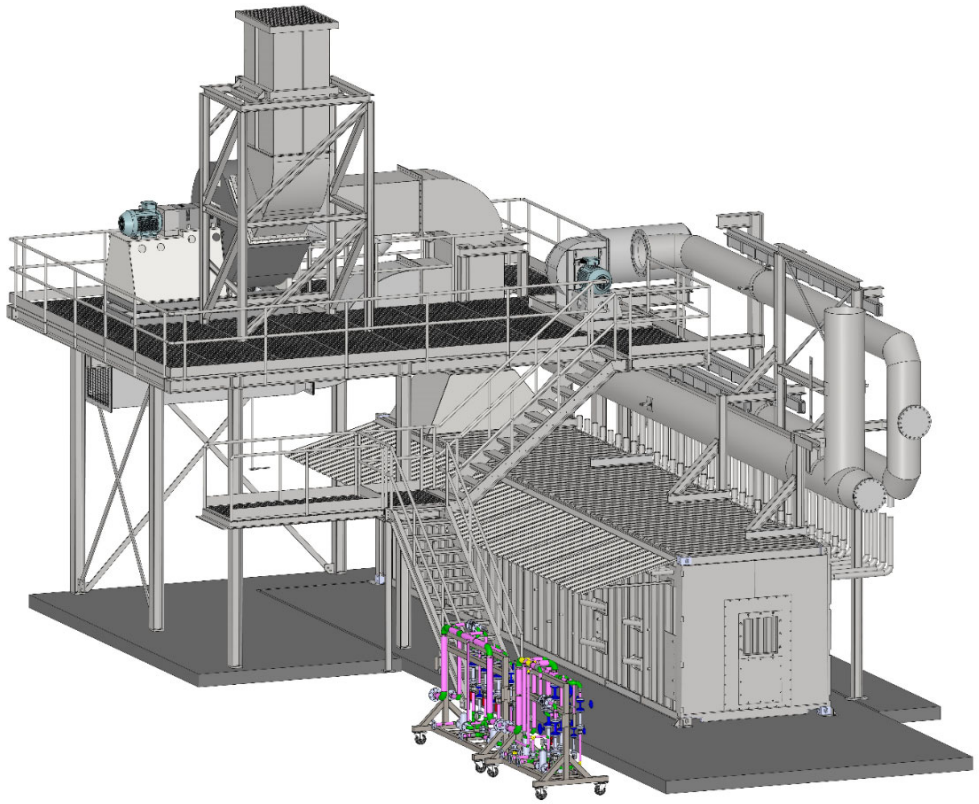
Burner Technology

Why Technip Energies operates a burner test facility

- Burners / combustion is an empirical technology.
- More severe requirements force furnace designers to continuously upgrade burner technology.
- Computational Fluid Dynamics (CFD) calculations are useful, but calculations alone cannot guarantee burner performance in the plant.
- To minimize burner failure risk in the plant, a furnace CFD in combination with a burner test is required.
- Measuring accurate heat flux profiles.

Burner Technology

T.EN Burner Test Facility - location Rotterdam



A small furnace is added to test sidewall burners

Burner Technology

100% Hydrogen firing development

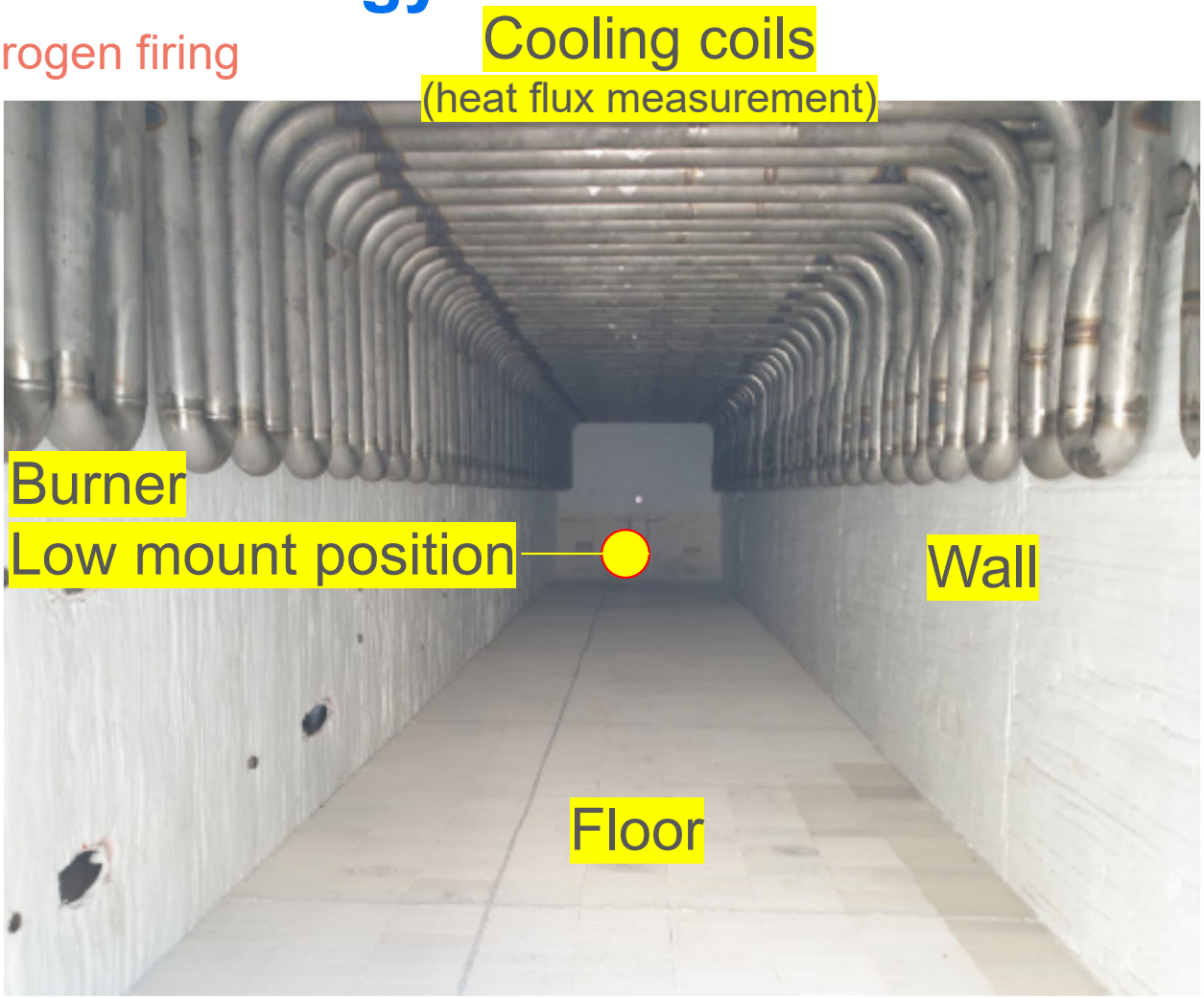
- Conventional fossil fuels add to carbon footprint.
- Carbon emission can be avoided when firing hydrogen fuel.
- Hydrogen fuel / natural gas fuel is fired with our Large Scale Vortex (LSV) burner and Technip Side Wall Burner (TSWB) to demonstrate the impact on flame shape.

Burner Technology

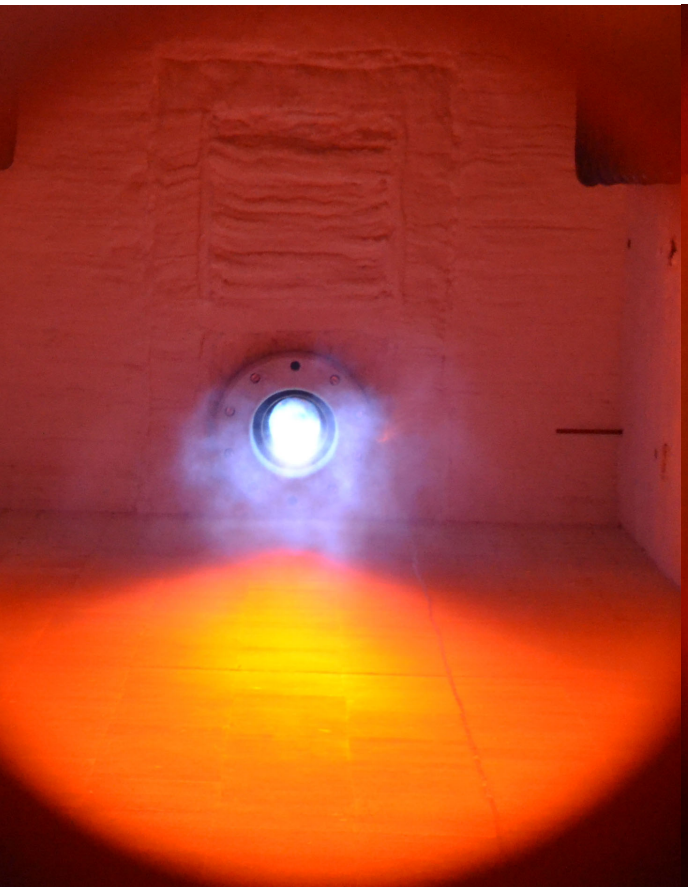
100% Hydrogen firing

Burner Technology

100% Hydrogen firing



Burner Technology



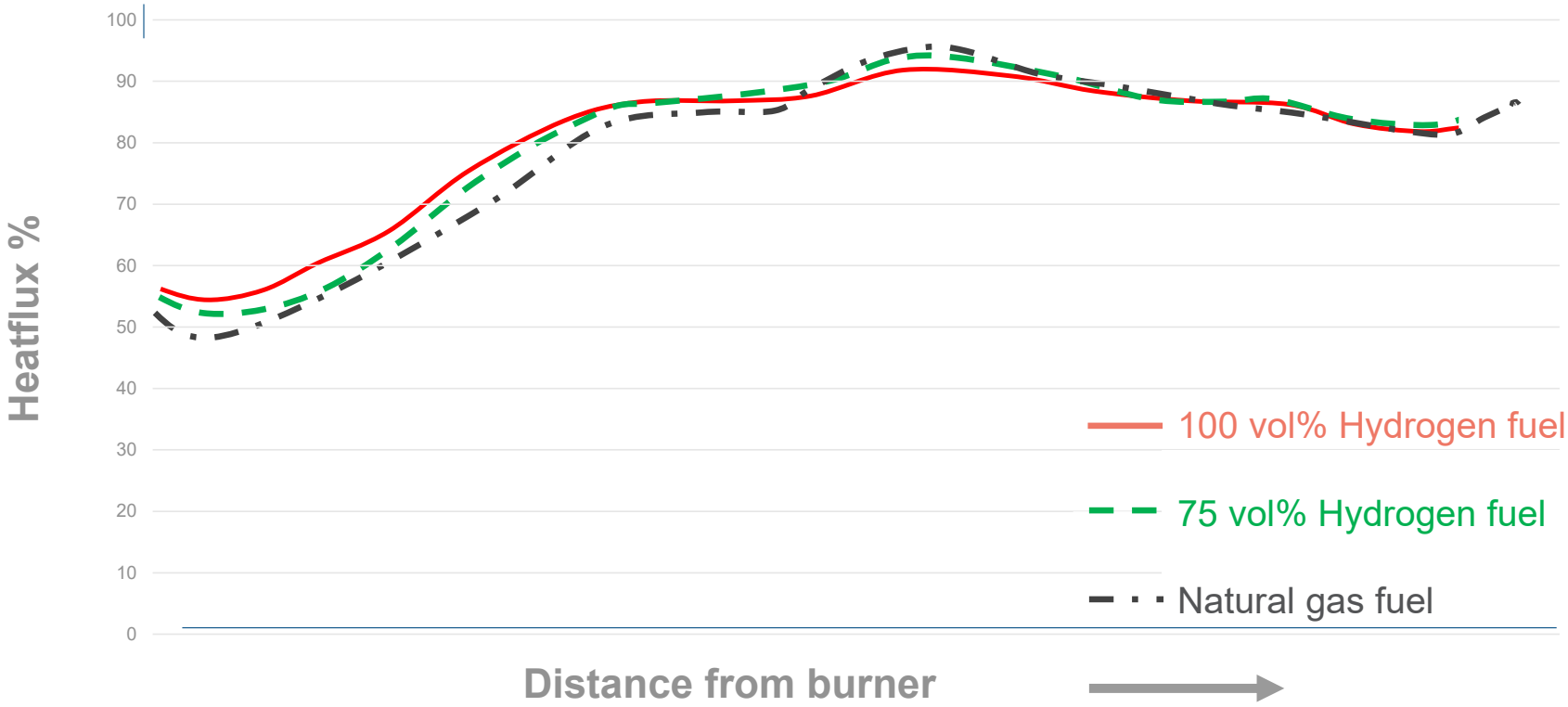
Natural gas fuel

75 vol% H2 fuel

100 vol% pure H2 fuel

Burner Technology

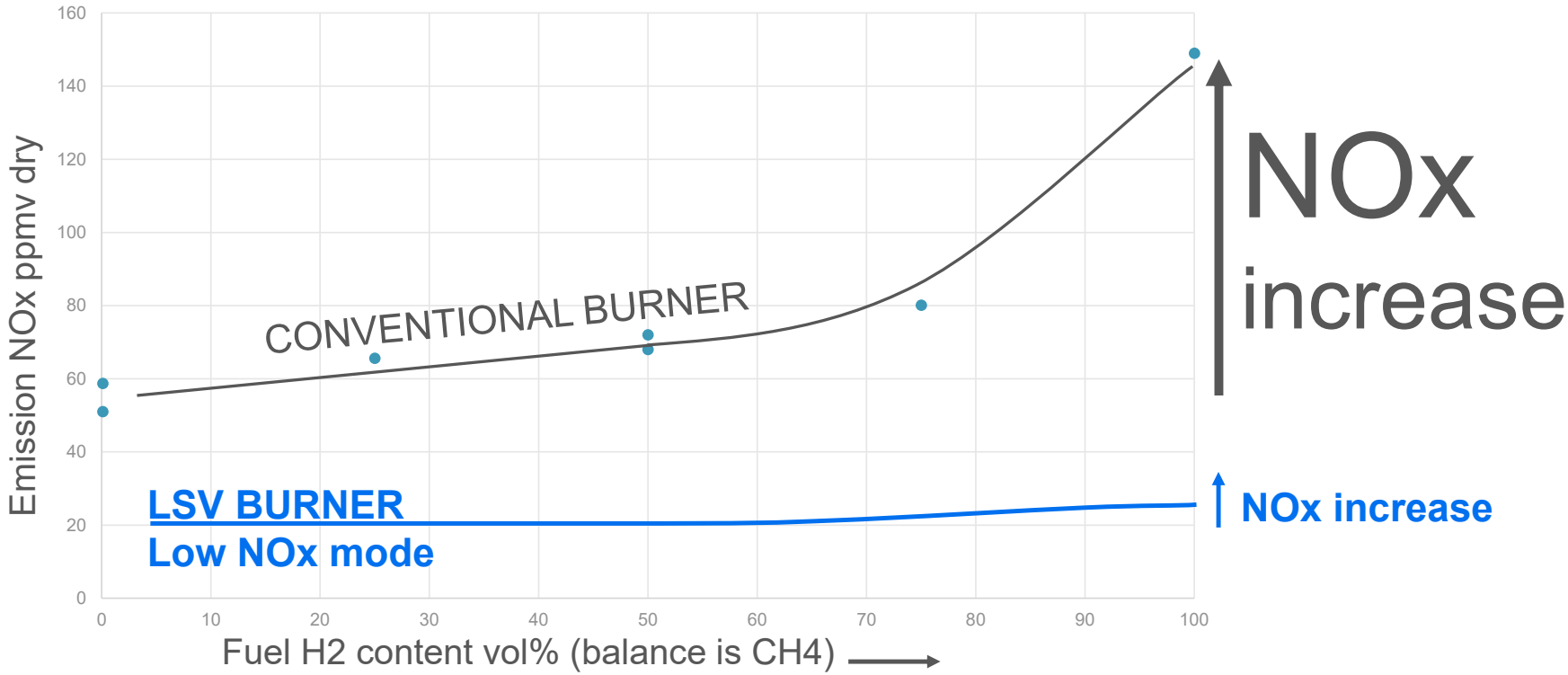
LSV burner heat flux profile versus distance from burner for: Natural gas fuel, 75 vol% H2 fuel and 100% H2 fuel



Heat flux profiles for 100 vol%, 75 vol% Hydrogen fuel are similar as for natural gas

Burner Technology

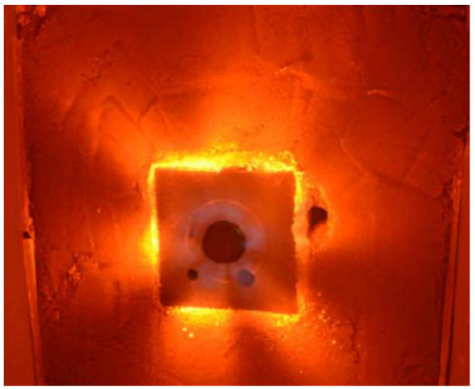
Conventional Burner and LSV® Burner NOx Emission vs Fuel Hydrogen Content



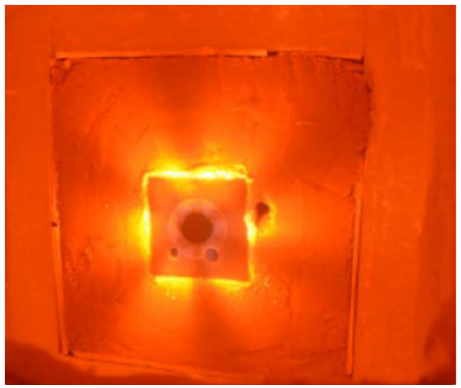
The LSV burner has a significant lower NOx emission than a conventional burner for H2 firing

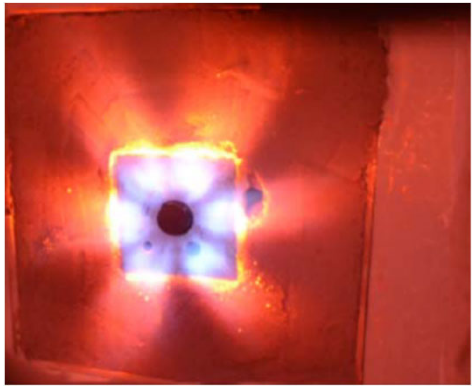
Burner Technology

Technip sidewall burner firing natural gas fuel up to pure hydrogen fuel



Maximum firing rate





Minimum firing rate

Natural gas fuel

100 vol% pure H2 fuel

Thank you