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## Thank You for Attending Our January Webinar

# Decarbonizing Thermal Applications for a Sustainable Future


**Your Host**

A.J. Piskor

Combustion and Advanced Controls

Business Development Manager

Lesman, a Kele Company

ajp@lesman.com



**Featured Speaker**

Brian Kelly

Applications Engineering Manager

Honeywell Thermal Solutions



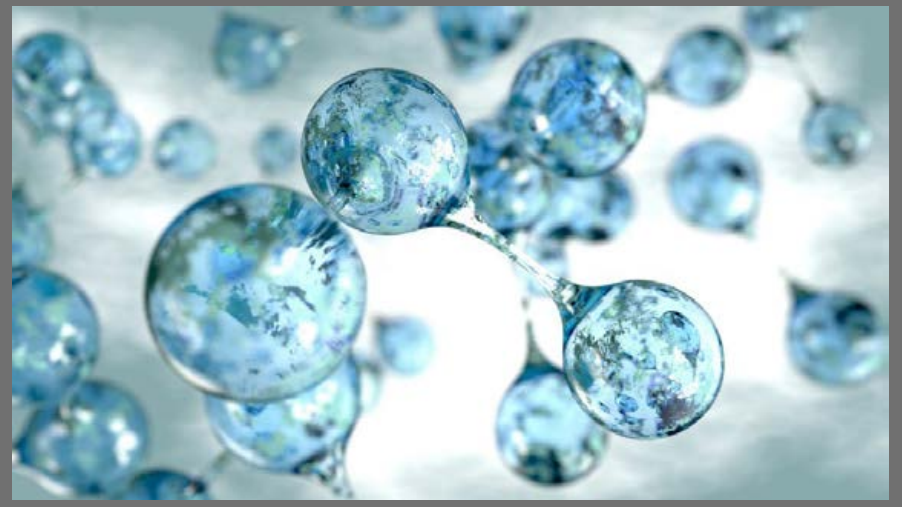
**Featured Speaker**

Todd Ellerton

Director of Business Development

Honeywell Thermal Solutions

# WHAT DOES SUSTAINABILITY MEAN TO YOU?



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# SUSTAINABILITY

sus·tain·a·bil·i·ty

/səˌstānəˈbilədē/

*noun*

the ability to be maintained at a certain rate or level.
"the sustainability of economic growth"

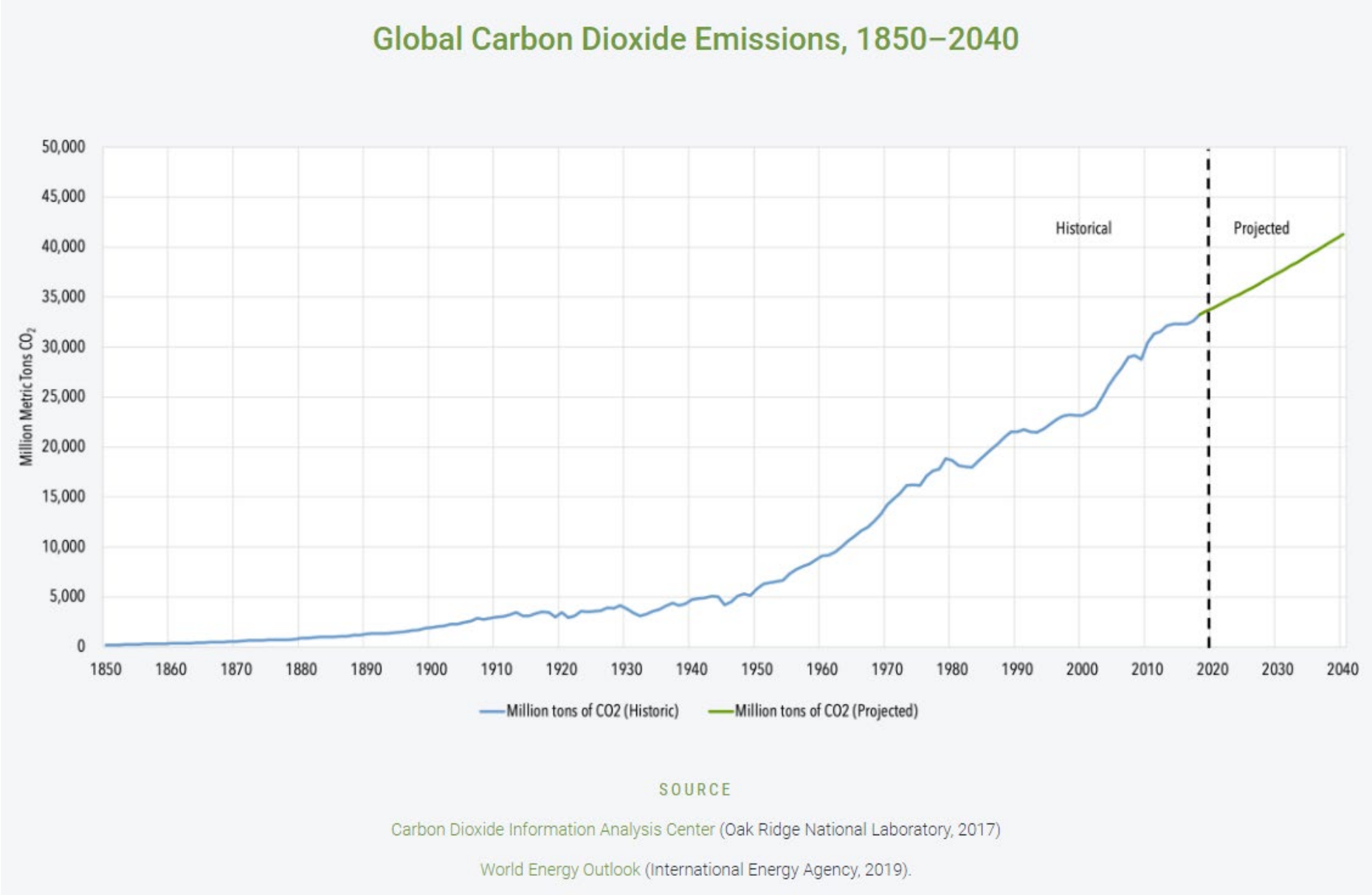
- avoidance of the depletion of natural resources in order to maintain an ecological balance.
  "the pursuit of global environmental sustainability"

What Are the 3 Principles of Sustainability?

The principles of sustainability refer to the three core concepts of environmental, social, and economic sustainability–sometimes broken down as "people, planet, and profits." This means that in order to be considered sustainable, a business must be able to conserve natural resources, support a healthy community and workforce, and earn enough revenue to remain financially viable for the long-term.

# GROWING FOCUS ON CARBON REDUCTION

# GLOBAL $CO_2$ EMISSIONS



# ENVIRONMENTAL FOCUS IS GROWING GLOBALLY

- **Governmental Actions**
  - Kyoto Protocol 2005
  - UN Paris Climate Accord 2015
  - UN COP28 Dubai, UAE 2023

  - Carbon Penalties
    - $CO_2$ taxes
    - Cap and trade systems

  - NOx Limits
    - Continued tightening of regulations

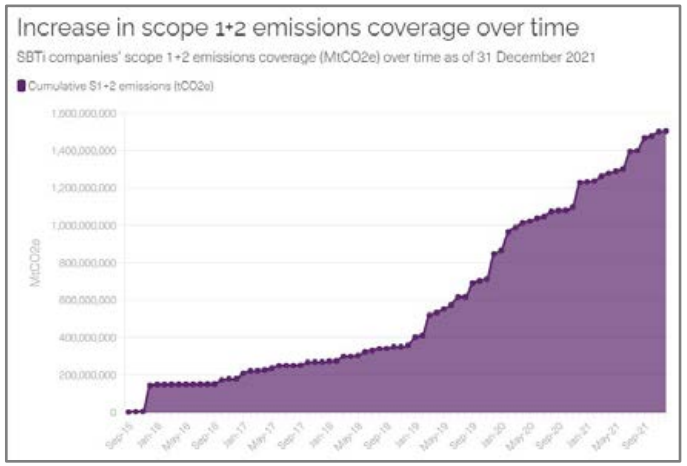
- **Corporate Actions**
  - Committing to reduce GHG emissions and become net zero

Legally binding goals to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

2°C / 1.5°C

197 Nations





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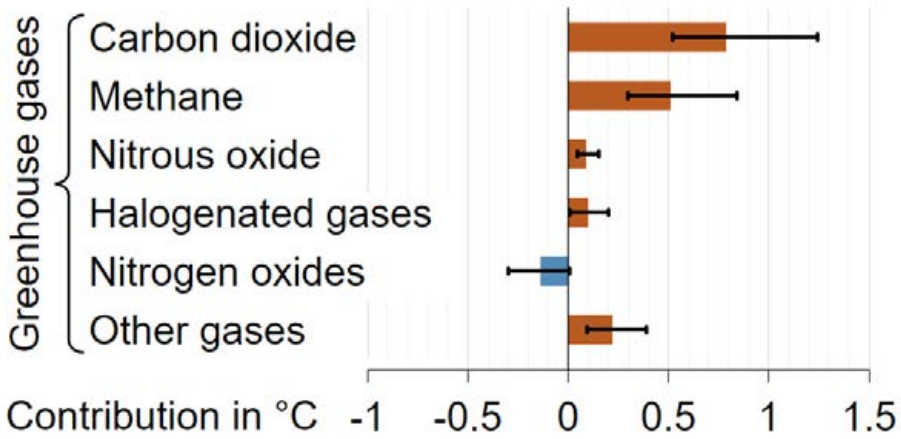
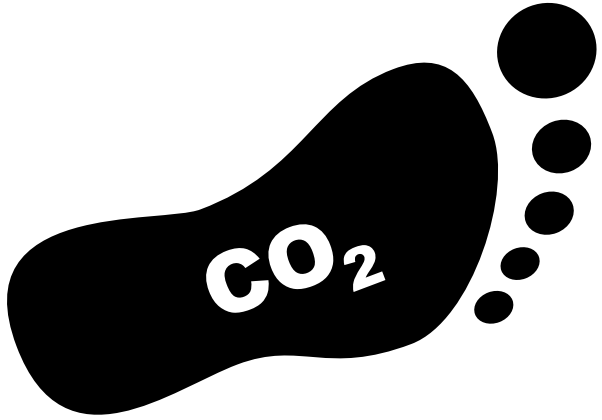
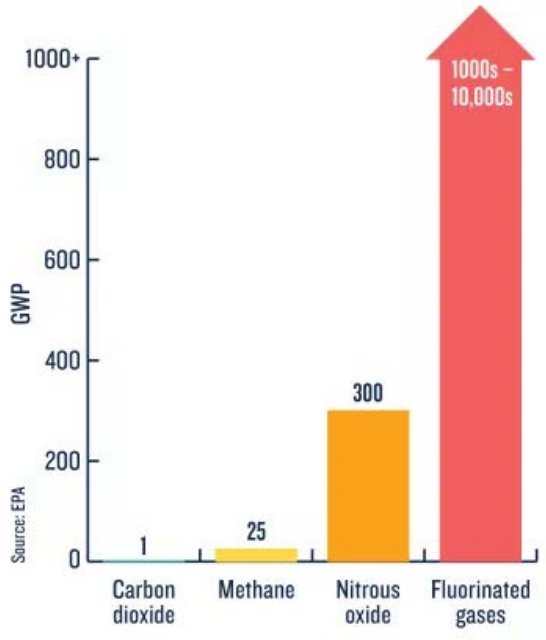
# WHAT IS CARBON FOOTPRINT?



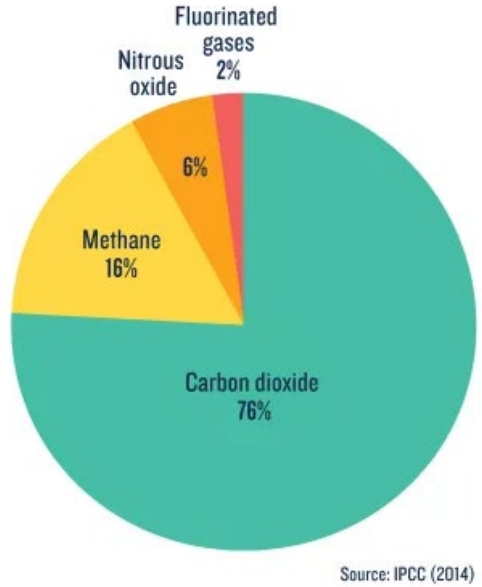

Source: Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report

It's more than just CO2




Global Warming Potential (GWP) is how much heat each gas traps relative to $CO_2$




Greenhouse Gases and their relative impact on climate change

## $CO_2e$ - Carbon Dioxide Equivalent

**A measure of total Greenhouse Gases emitted expressed in terms of the equivalent amount of $CO_2$**



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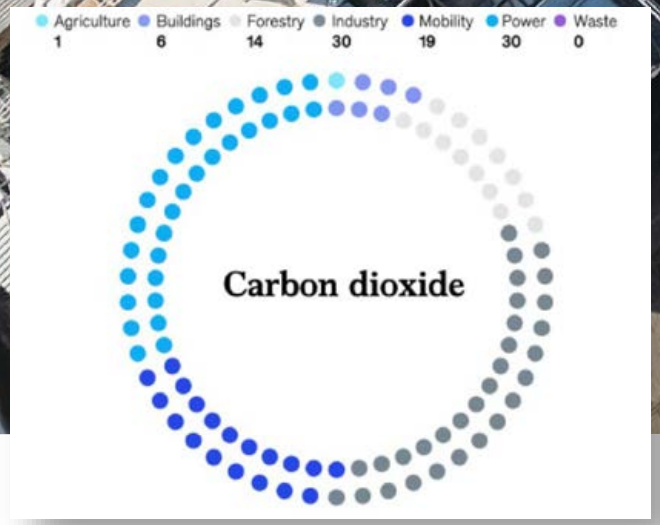
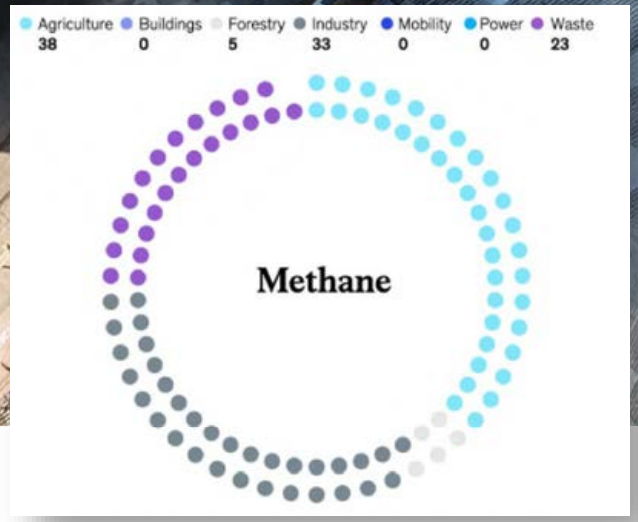
# Industry plays a big role in achieving climate neutrality.




**Industry** **30%** **33%**

Source: McKinsey Sustainability - Net Zero Challenge: Accelerating Decarbonization Worldwide. Emission Sources 2019.

# DECARBONIZATION

The term used for the process of removing or reducing the carbon dioxide ($CO_2$) output of a country's economy. This is usually done by decreasing the amount of $CO_2$ emitted across the active industries within that economy.

# $CO_2$ REDUCTION

**Means of reducing carbon emissions in industrial thermal processing**

- **Alternatives to fossil-based fuels**
  - Electric heating
  - Power-to-methane
  - Hydrogen
  - Bio-gases
- **Improved Efficiency**
  - Heat recovery
  - Tighter fuel-air ratio control

# RENEWABLE FUELS

**Renewable Fuels can help reduce or eliminate carbon emissions**

- **Ammonia**
- **Hydrogen**
- **Methanol**
- **Biogas**
- **Renewable Natural Gas (RNG)**


**Hydrogen expected to play a key role in reducing $CO_2$ from Industry**

# HYDROGEN AND CARBON REDUCTION

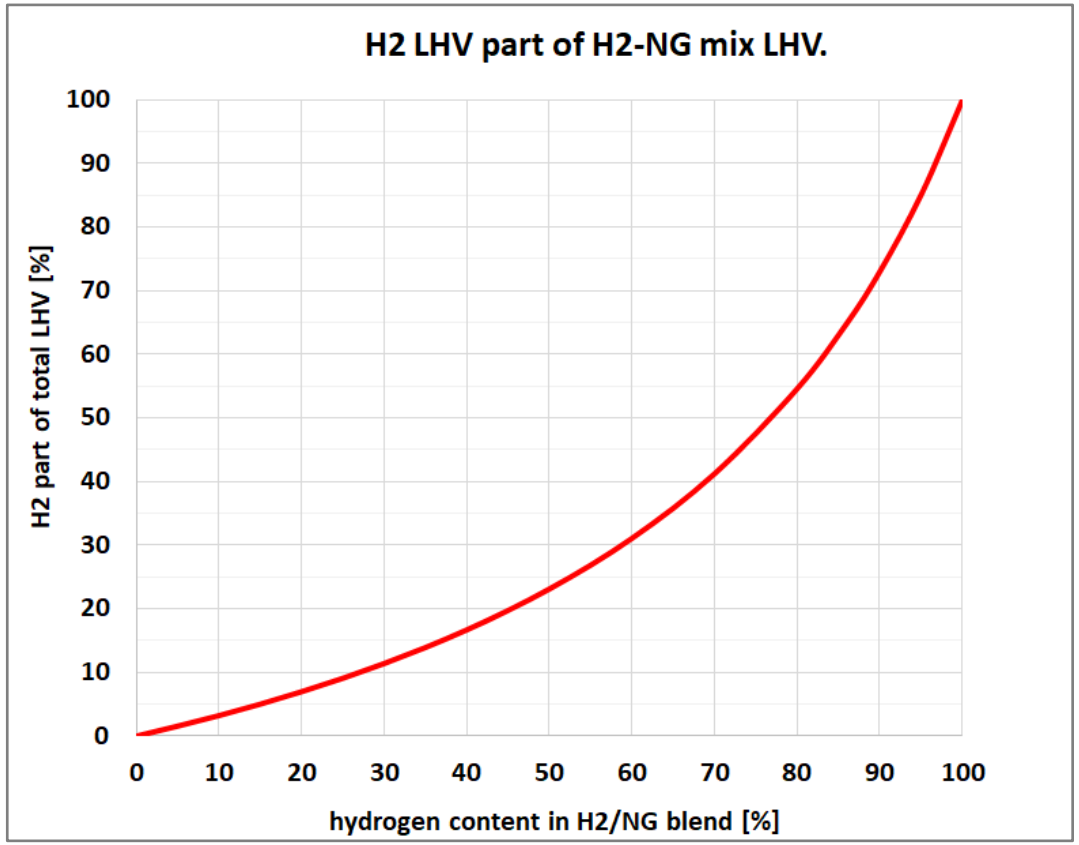

**Natural gas** $CH_4 + 2\ O_2 \longrightarrow CO_2 + 2\ H_2O + \text{energy}$

**Hydrogen** $2\ H_2 + O_2 \longrightarrow 2\ H_2O + \text{energy}$

**When produced with renewable energy, hydrogen as an energy carrier results in a CO2 neutral energy form**

## Hydrogen Combustion Characteristics

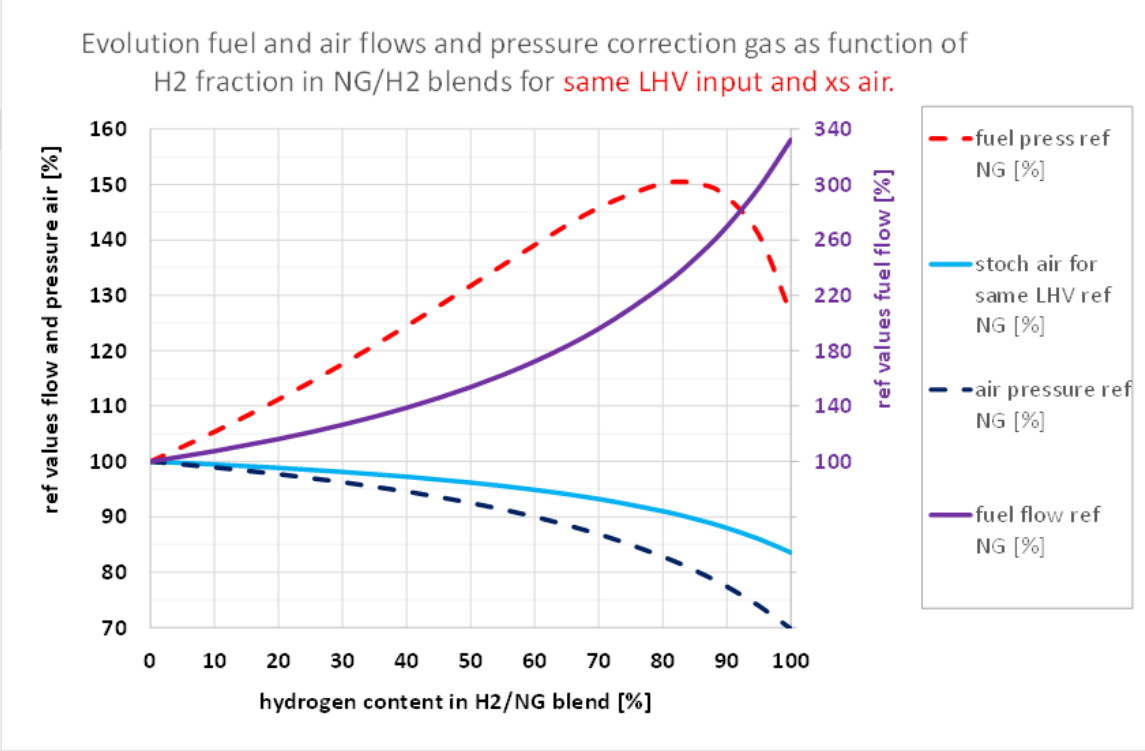
- H-atom is lightest and smallest element in the Periodic Table
  - Special attention for leakage rates (permeability)
- Hydrogen is colorless, odorless and tasteless
- 8 times lighter than natural gas (2 g/mol)
- 15 times lower spark energy required to ignite than natural gas (0.017 mJ)
- Flame burns +/- 8 times faster than natural gas (3.46 m/s)
- Hydrogen has a higher flame temperature than natural gas
- Extremely wide flammability range (LEL – UEL 4 – 77 vol%)
- Heating value factor 3 to 3.5 lower than most commerical natural gases (about 325 Btu/scf HHV)



# HYDROGEN KEY CONSIDERATIONS

## Pressure Requirements

- The required gas pressure at the burner will be higher with $H_2$ than for natural gas to achieve the same capacity (varies with $H_2$+NG Mix)




## More Info on NOx

- Burner mixing design influences $H_2$ impact on NOx
- Some burner mixing designs will not work with $H_2$
- Notable shift in NOx levels above ~70%  Hydrogen
- Volumetric NOx measurement/comparison (e.g. ppm) should be avoided.  Mass per unit energy is preferred to compare NOx from natural gas versus $H_2$.
  - **$CH_4$:  50 ppm @ 3% $O_2$ => 0.05983 #/MMBtu**
  - **$H_2$:  50 ppm @ 3% $O_2$ => 0.04118 #/MMBtu**
  - **$H_2$:  73 ppm @ 3% $O_2$ => 0.05983 #/MMBtu**

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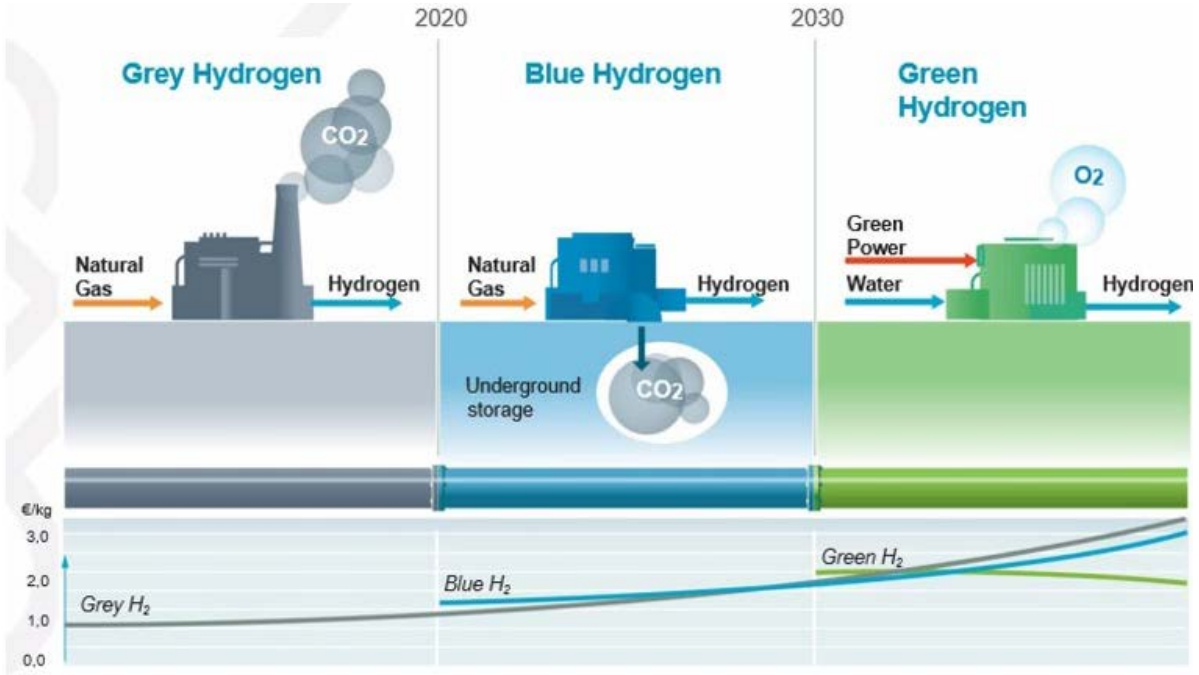
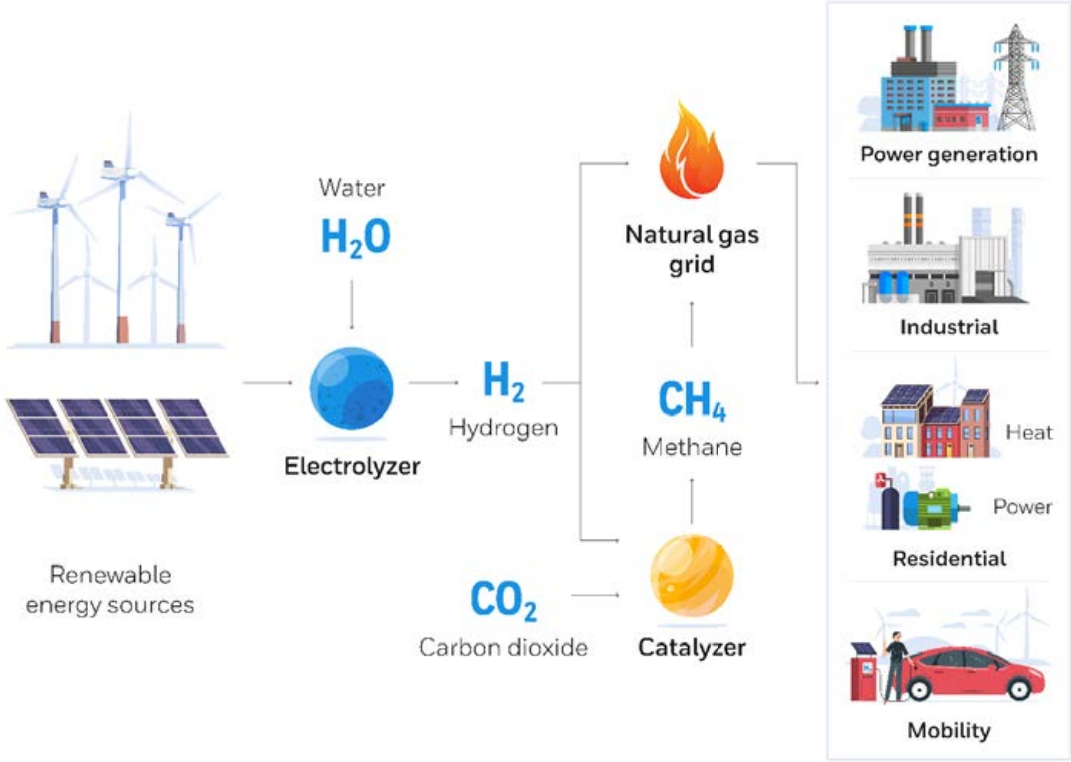
# HYDROGEN IN INDUSTRY – BENEFITS / OUTLOOK

**Benefit:** When produced with renewable energy, hydrogen as an energy carrier will result in a $CO_2$ neutral energy form (Green Hydrogen).




Source: tno.nl




**Outlook:** The most economic way to distribute hydrogen is to mix it in the existing natural gas grid.

- Blending up to 17% $H_2$ will be acceptable without changes to the distribution network and only minimum changes to most appliances (household furnaces, stoves, commercial boilers,…).
- Local small scale $H_2$ distribution can go up to 100%
- Long term, higher levels up to 100% $H_2$ will be targeted, although this will take time to achieve

**The promise of green hydrogen energy: zero carbon footprint**

# HTS PORTFOLIO – HYDROGEN VERIFICATION

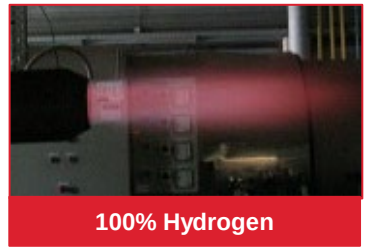
**R&D test program on HTS portfolio for up to 100% H2 operation**
**R&D labs in Lotte (DE), Vilvoorde (BE) and Muncie (USA)**

## Burner testing with fuel blends up to 100% hydrogen


100% Natural Gas


40% NG / 60% H2


20% NG / 80% H2


100% Hydrogen


## Fuel Delivery Components:

- Material suitability: construction materials compatible to 100% H2
- Functional behavior: validate flow rate characteristics, leakage rates

# HTS PORTFOLIO – HYDROGEN CAPABILITIES

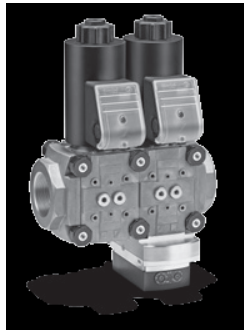
## Wide Range of Hydrogen Capable Burners





## Broad Offering of Hydrogen Capable Fuel Supply and Burner Management Equipment

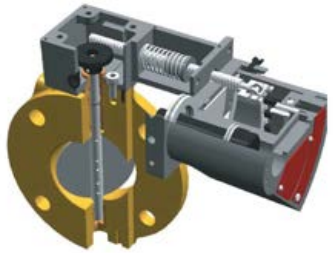
ValVario with ratio-control



Safety shut-off valves

SmartLink parallel positioning valves

A-Synchro control valves & Micro-Ratio valves



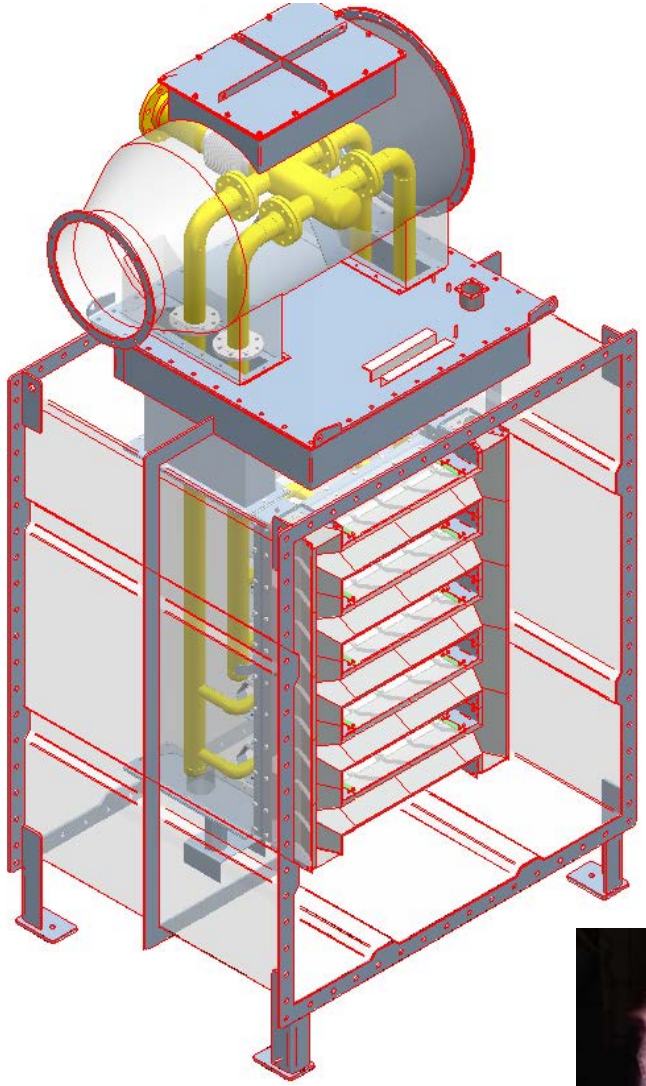
SLATE configurable safety & programmable logic controllers

BCU 570 burner controller

IFM flame monitoring for highest flame discrimination

# HYDROGEN CASE STUDY PAPER INDUSTRY

| | |
|---|---|
| Application: | Yankee hood dryer in Germany |
| Capacity: | 2 burners – 6500kW HHV each |
| Fuel: | Natural gas or hydrogen |
| Comb Air: | Preheated 200°C |
| Burner: | NP Airflo® with air box |
| Scope: | Combustion chamber with integrated burner, gas train, fuel/air ratio control, burner management system with Thermal IQ® (software for remote monitoring and optimization) |



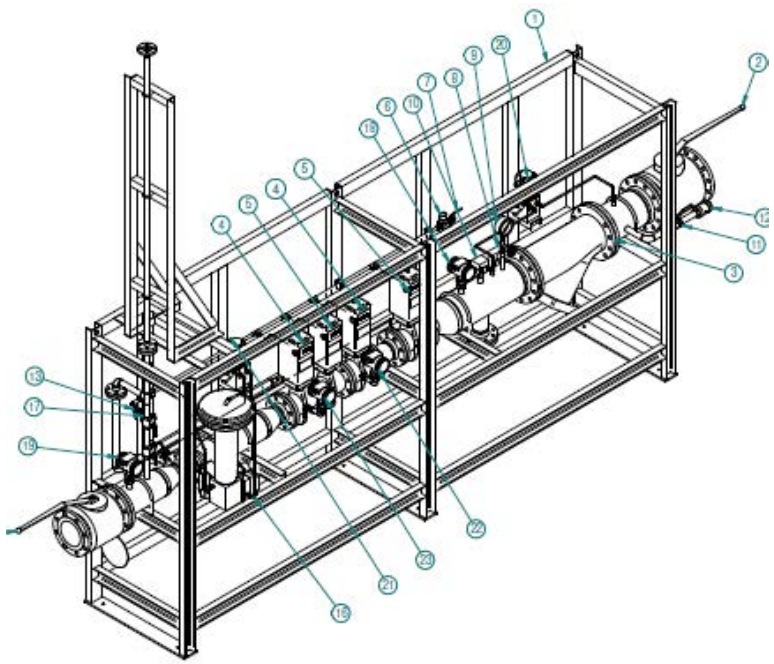
Natural Gas

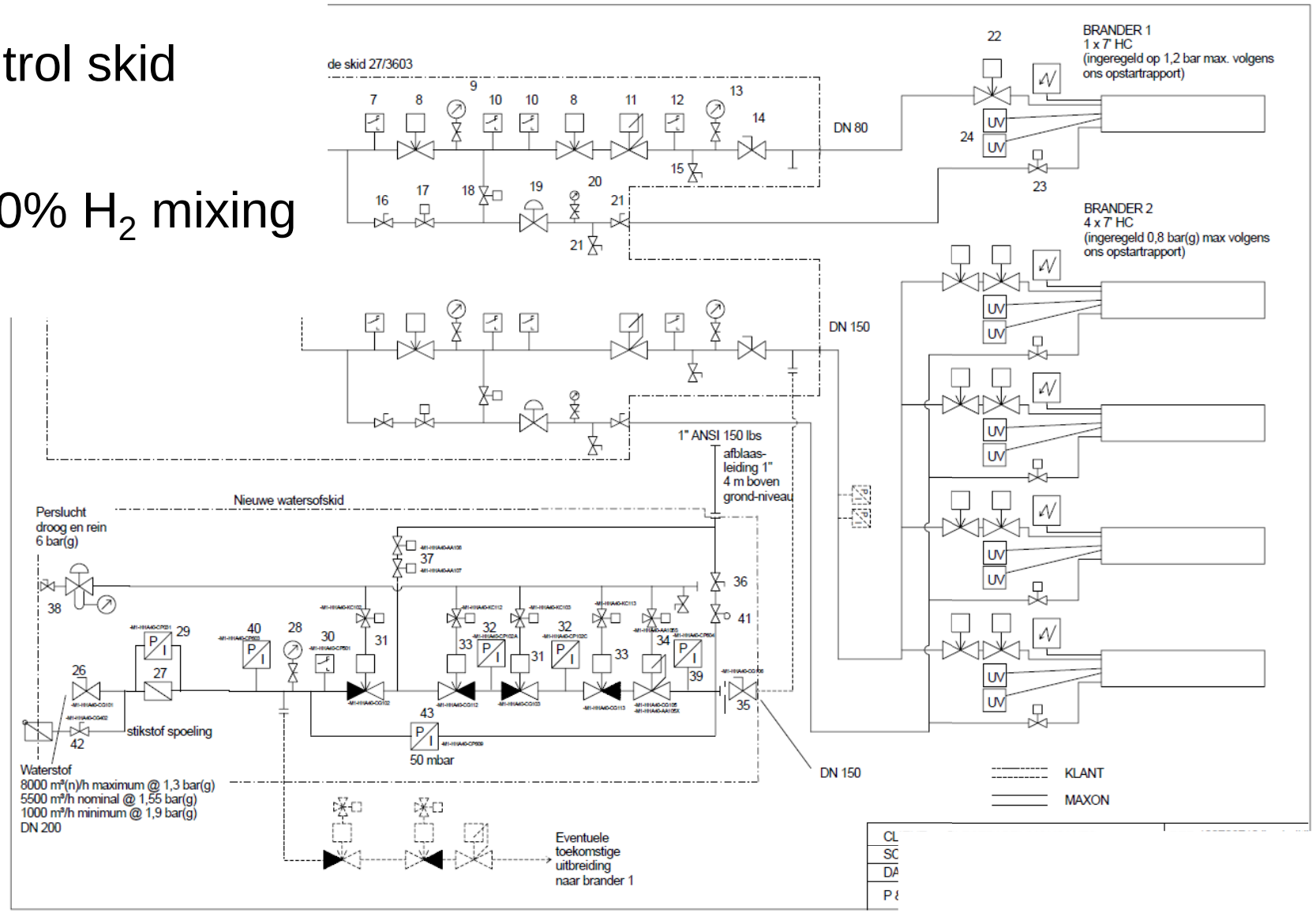
Hydrogen

# HYDROGEN – HTS CASE STUDY

HTS solution:

- Design & supply of $H_2$ control skid
- Mixing of NG & $H_2$
- Control system for 0 to 100% $H_2$ mixing



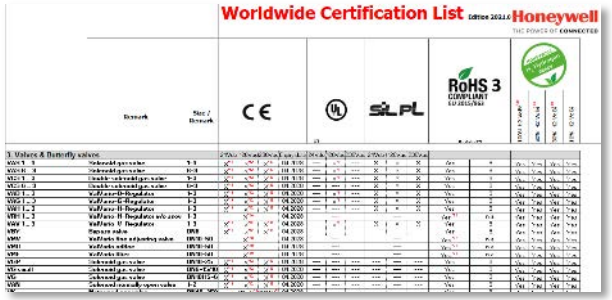


# HTS HYDROGEN COMBUSTION ASSETS


Webpage
ThermalSolutions.Honeywell.com/ZeroCarbon


Whitepaper

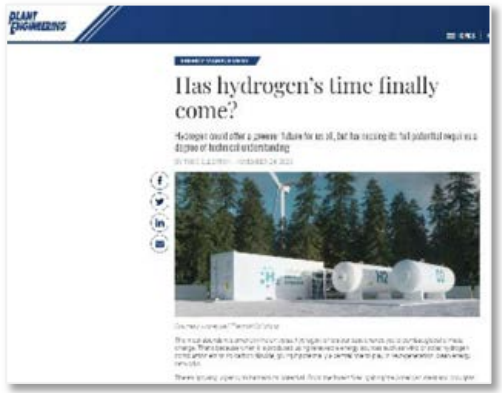

Technical Brochure




Worldwide Certification List

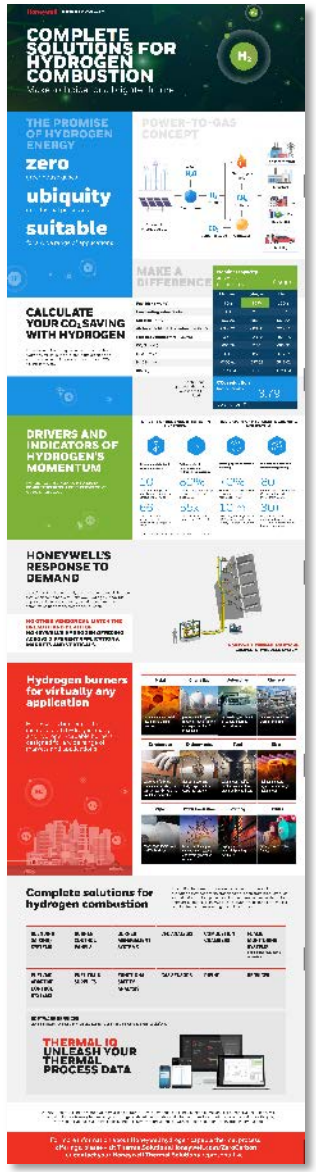

Video


On-demand webinar




Byline – Plant Engineering

Brochure




Interactive infographic with $CO_2$ saving calculator

**Many Resources and Tools Available Online**

# EFFICIENCY AND CARBON REDUCTION

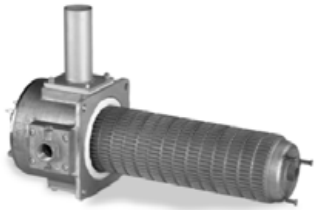
- **Improving efficiency of your operations means you can reduce fuel usage**
  - Less fuel into the process means fewer carbon emissions

- **Capturing waste heat allows you to harness thermal energy you would otherwise let escape out the stack and put it to work in your process.**

- **Honeywell Thermal Solutions has the profolio to help with improved efficiency and waste heat recovery.**

# EFFICIENCY

Heat Recovery & Recuperation



Precision Fuel/Air Ratio Control

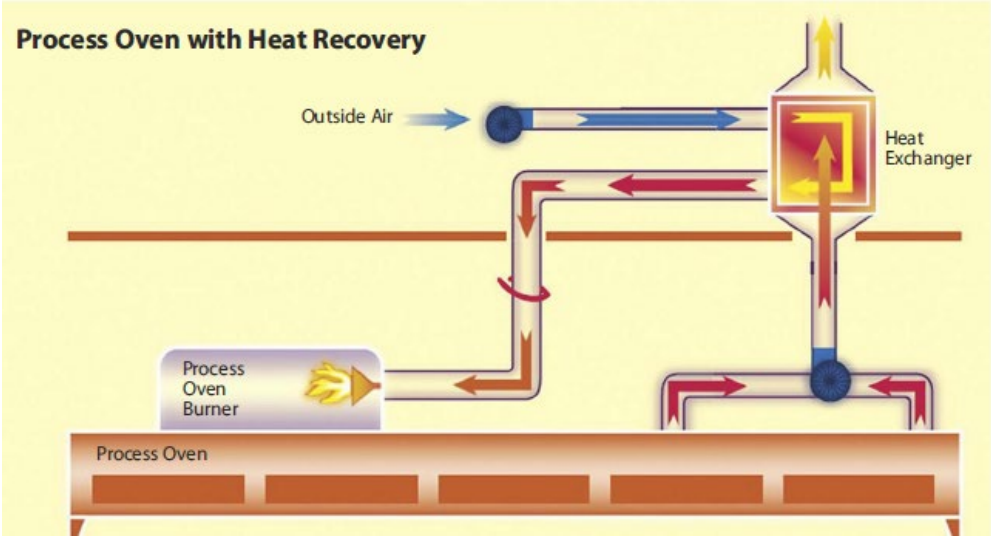
Routine Inspection and Maintenance

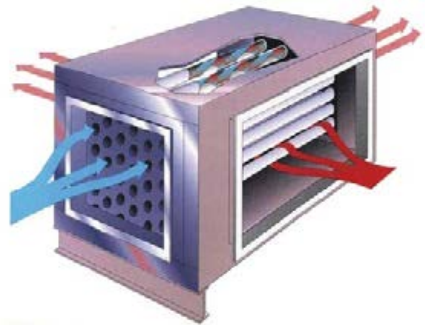
Process Monitoring


**Numerous products and systems to reduce your customer’s carbon footprint**

# HEAT RECOVERY

- **Recovering waste heat from your industrial processes lets you capture thermal energy and put it to work in your process**
  - Improve efficiency
  - Save money
  - Reduce carbon emissions
- **The most straight forward method to capture waste heat energy is through a heat exchanger device to transfer heat from one medium (typically air, gas, or fluid) to another**
  - The two media are separated by a solid wall, plate or tube
  - Heat is exchanged between the two media to heat or cool one medium to the desired temperature
  - Heat exchangers can be added to nearly any industrial process
  - A variety of materials, patterns, and configurations are available depending on application specifics.
- **Another method is with self recuperative burners or burners with plug-in recuperator systems**



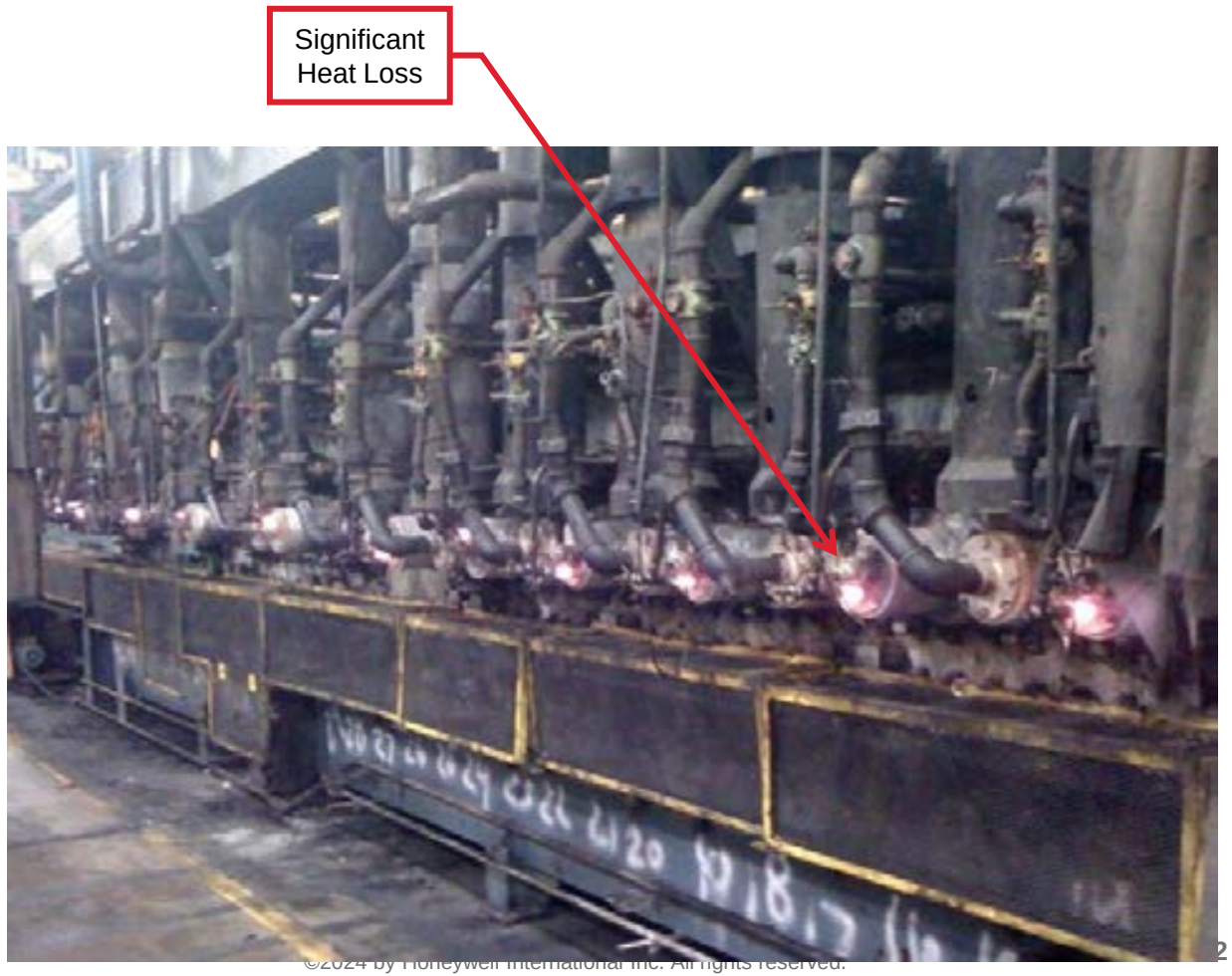



# HEAT RECOVERY CASE STUDY

- Continuous Furnace for Bright Annealing
- Utilizing radiant tube burners (U-Tubes) with recuperators

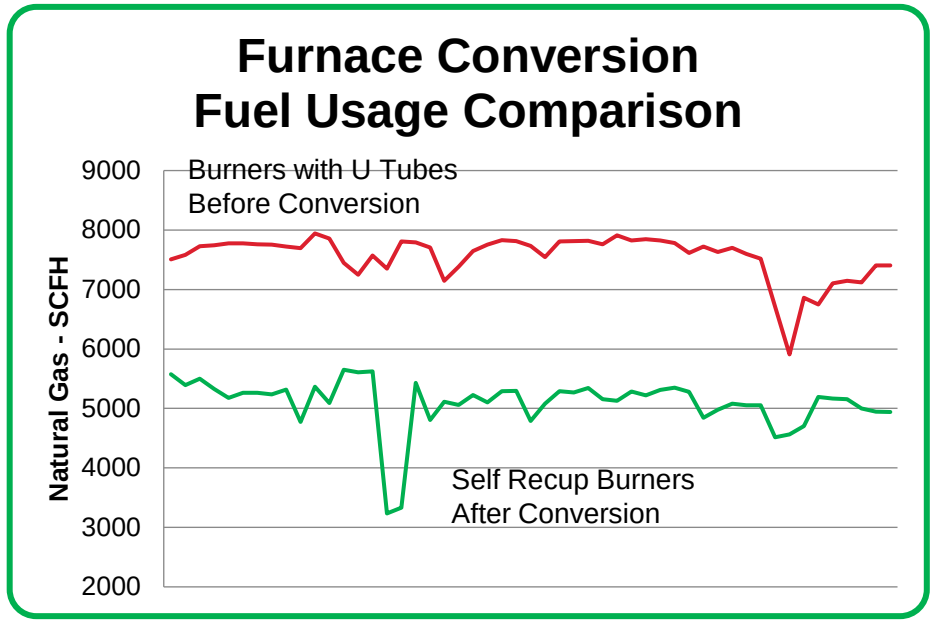
- **Customer was experiencing:**
  - High temperatures outside the furnace due to exposed sections of radiant tube and pilot.
    - Lost heat = wasted fuel = increased CO2 emissions
  - Short U-Tube life
    - Reduced uptime due to increased frequency of tube changes
  - Leakage between burner & recuperator
    - Another source of lost heat

- **Decision: Furnace Upgrade Required to:**
  - Reduce maintenance
  - Increase runtime
  - Increase efficiency
  - Improve tube life



# HEAT RECOVERY CASE STUDY

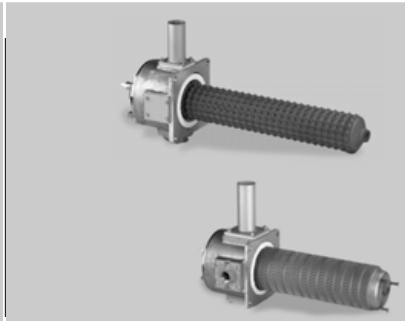
- **Upgrade: Conversion from burners in U-tubes to Self-Recuperative (SER) Single Ended Radiant Tube Burners**
  - 18.3% Increased production
  - Hot spots removed
  - Approximately 30% reduction in fuel usage
    - Translates directly to a reduction in $CO_2$ emissions




*Before*

*After*

# RECUPERATIVE BURNERS

| | ECOMAX® LE | ECOMAX® (standard) | SER | Tube Firing Burner (TFB) |
|---|---|---|---|---|
| |  |  |  |  |
| Performance | Best in class NOx emissions with 7% increased efficiency over standard | High efficiency, energy saving | Up to 70% efficiency | TFB pairs with Bayonet Ultra Recuperator for efficiency improvement of up to 60%+ |
| Application | Metals, heat treating | Metals, heat treating | Metals, heat treating | Metals – tempering, hardening, annealing, galvanizing; Liquid Heating |
| Features | Self recuperative, improved efficiency, flameless mode (Direct or Indirect Fired) | Ceramic & metallic recuperators and tubes (Direct or Indirect Fired) | Internally insulated, ceramic recuperator, metallic or ceramic outer SER tubes | Up to 40% fuel savings, improved temperature uniformity |

# HEAT EXCHANGERS

| |  |  |  |
|---|---|---|---|
| | **Tubular** | **Sinusoidal Plate** | **Dimple Plate** |
| **Temperature** | Low to High | Low | Low |
| **Price** | Lower | Highest | Moderate |
| **Heat Transfer Effectiveness** | Lower | High | Medium |
| **Flow Configurations** | Variety | Variety | Variety |
| **Process Air Cleanliness** | Dirty | Clean | Moderate |
| **Easy to Clean?** | Yes | No | Moderately |
| **Key Differentiators** | High temperature heat recovery, customizable flow configurations | Compact, high heat transfer effectiveness, lighter weight | Thick plates for abrasive/ corrosive applications, in-line dimples accommodate dirtier streams |
| **Choose When** | Robust heat recovery is needed, high temperature applications | High heat transfer effectiveness is required | Process air is dirty, abrasive, corrosive |

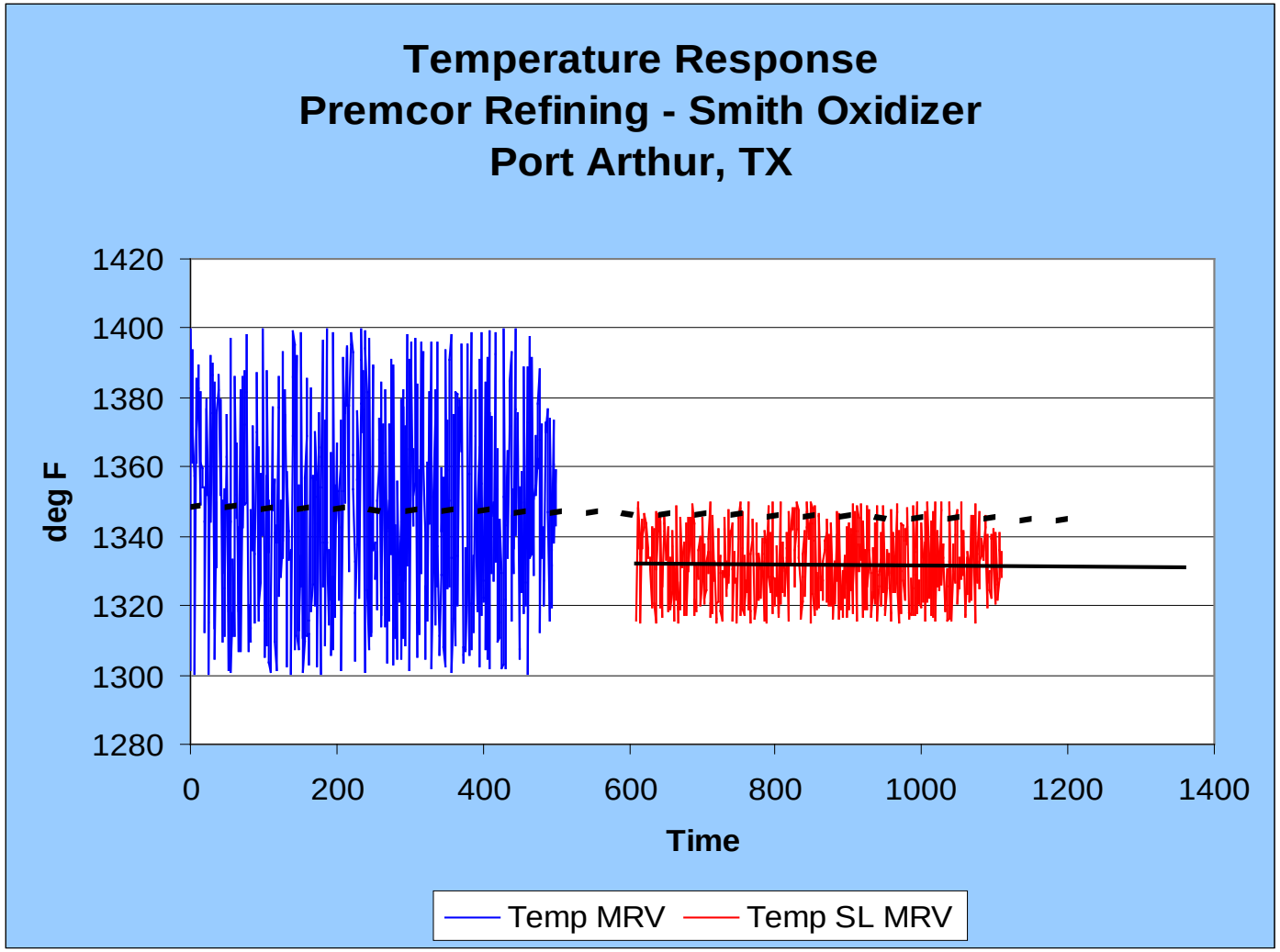
# HTS SOLUTIONS TO IMPROVE EFFICIENCY

## AIR / FUEL RATIO CONTROL

- The ability to maintain a tighter air / fuel ratio throughout the operational range of the combustion system will help increase efficiency and reduce fuel usage.

- High precision actuators eliminate variations in set points and assure repeatability in performance, reliability, and emissions.


# AIR-FUEL RATIO CASE STUDY




| Heat Generation Opportunities | |
|---|---|
| Performance Improvement | Savings |
| • Control air-to fuel ratio | 5% to 25% |

# THANK YOU!

## Contact us:

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A KELE COMPANY

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