



# HYDROG(E)NICS

SHIFT POWER | ENERGIZE YOUR WORLD

HYDROGEN: INDUSTRY PERSPECTIVE  
IN CENTRAL, EAST AND SOUTH EUROPE

**Denis THOMAS, Hydrogenics Europe N.V.**

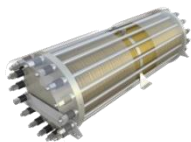
EU Regulatory Affairs and Business Development  
Manager for Renewable Hydrogen



**HYDROGEN SUMMIT**  
SOFIA, BULGARIA 28 MAY 2018



# Leading Hydrogen TECHNOLOGY PROVIDER



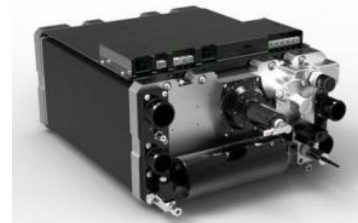
## Onsite Generation | Electrolysers



Industrial Hydrogen



Hydrogen Fueling



## Power Systems | Fuel Cell Modules



Stand-by Power



Mobility Power

# Hydrogenics, a 100% global hydrogen company

## Hydrogenics Corporation



- **Headquarter**
- Mississauga, Ontario, Canada
- Since 1948
- +/- 70 employees
- Areas of expertise: Fuel cells, PEM electrolysis, Power-to-Gas
- Previously: The Electrolyser Company, Stuart Energy

## Hydrogenics Europe



- Oevel, Belgium
- Since 1987
- +/- 70 employees
- Areas of expertise: pressurized alkaline electrolysis, hydrogen refueling stations, Power-to-Gas
- Previously: Vandenborre Hydrogen Systems

## Hydrogenics GmbH



- Gladbeck, Germany
- Since 2002
- +/- 15 employees
- Areas of expertise: Fuel cells, mobility projects, Power-to-Gas

- In total: +170 employees
- Incorporated in 2000 [NASDAQ: HYGS; TSX: HYG]
- More than 3,000 products deployed in 100 countries worldwide
- Total revenues (2017): 48.1 Mio \$
- Over 65 years of electrolysis leadership

● Production facility

○ Sales office

# World hydrogen market



But most of the hydrogen produced today is not CO<sub>2</sub>-free (from gas, oil, coal)



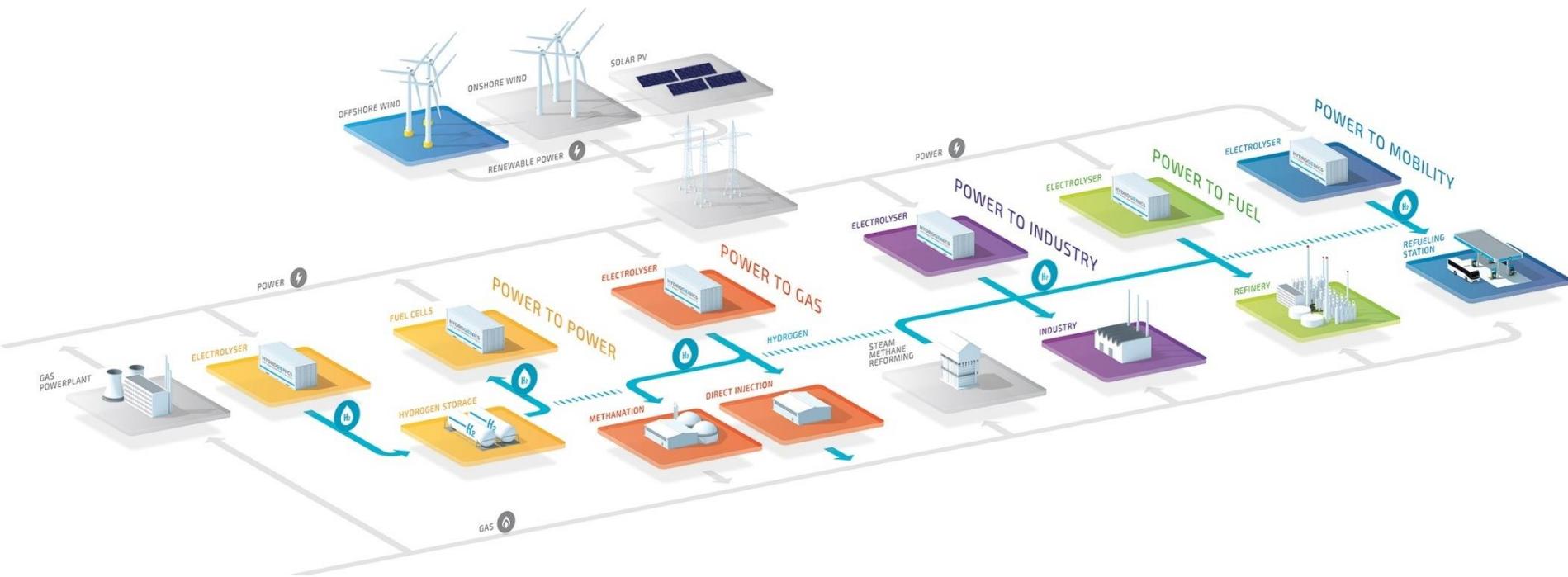
If produced from renewable power via electrolysis, hydrogen is fully renewable and CO<sub>2</sub>-free.



Renewable hydrogen has the potential to decarbonize a large range of applications



# Renewable Hydrogen



# Alkaline & PEM electrolysis | Product's line

## Alkaline



## PEM (Proton Exchange Membrane)



	HySTAT®-15-10/30	HySTAT®-60-10	HySTAT®-100-10	HyLYZER®-300-30	HyLYZER®-1000-30	HyLYZER®-3,000-30
Output pressure	10 barg – 27 barg	10 barg		30 barg		
Number of cell stacks	1	4	6	1	2	6
Nominal Hydrogen Flow	15 Nm <sup>3</sup> /h	60 Nm <sup>3</sup> /h	100 Nm <sup>3</sup> /h	300 Nm <sup>3</sup> /h	1000 Nm <sup>3</sup> /h	3000 Nm <sup>3</sup> /h
Nominal input power	80 kW	300 kW	500 kW	1.5 MW	5 MW	15 MW
AC power consumption (utilities included, at nominal capacity)	5.0-5.4 kWh/Nm <sup>3</sup>			5.0-5.4 kWh/Nm <sup>3</sup>		
Hydrogen flow range	40-100%	10-100%	5-100%	1-100%		
Hydrogen purity	99.998% O <sub>2</sub> < 2 ppm, N <sub>2</sub> < 12 ppm (higher purities optional)			99.998% O <sub>2</sub> < 2 ppm, N <sub>2</sub> < 12 ppm (higher purities optional)		
Tap water consumption	<1.7 liters / Nm <sup>3</sup> H <sub>2</sub>			<1.4 liters / Nm <sup>3</sup> H <sub>2</sub>		
Footprint	20 ft container	40 ft container	40 ft container	40 ft container	2 x 40 ft container	600 m <sup>2</sup> (indoor)

# Extensive experience with alkaline technology



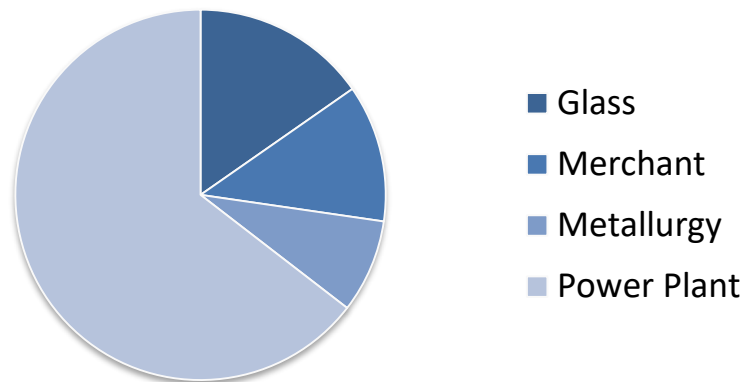
**> 300 ALKALINE PROJECTS DELIVERED**



## Status in CEE countries

- By Hydrogenics
- Over period 2001-2018
- $\pm 2$  MW of electrolyser capacity
- 31 alkaline electrolysers
- Majority of small units ( $<10 \text{ Nm}^3/\text{h}$ ) in power plants
- A few medium size industrial projects (glass, metallurgy, merchant)

**Electrolyser capacity delivered by Hydrogenics (2001-2018)**



CEE Countries considered: Belarus, Bosnia, Bulgaria, Estonia, Kosovo, Lithuania, Moldova, Poland, Romania, Slovenia



# Selection of our key references

## Electrolysis



700 bar Hydrogen Refueling Station  
Aberdeen, Scotland (UK)



1,5 MW PEM P2G (direct  
injection), Hamburg, Germany



1 MW alkaline P2G (methanation)  
BIOCAT, Copenhagen, Denmark

## Fuel cells



1 MW stationary Fuel cell (H<sub>2</sub> repowering)  
Kolon, South-Korea



Fuel cell for mobility (H<sub>2</sub> trains)  
Alstom Coradia iLint , Germany

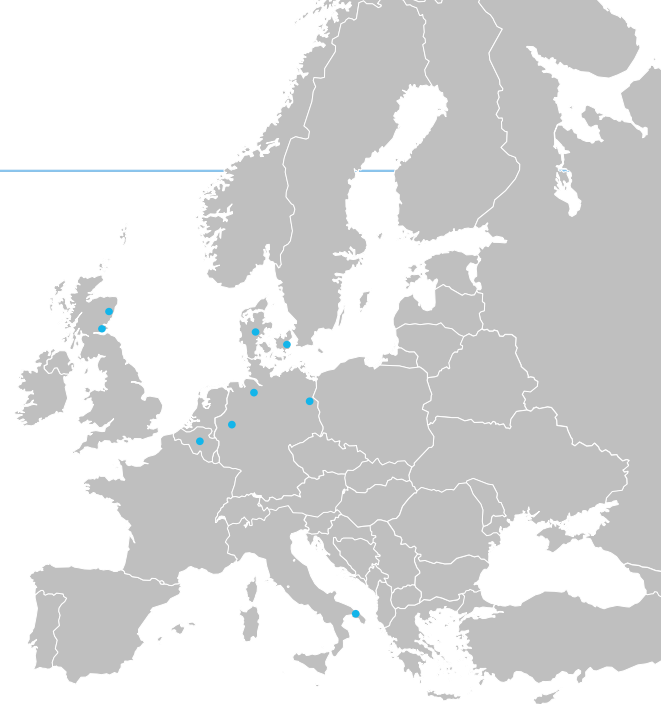


Fuel cell for mobility (H<sub>2</sub> buses), China

# [Renewable] hydrogen

## Selection of recent demonstration projects

Country	Project	Size	Year	Electrolyser technology	Power	Gas	Industry	Mobility	Fuel
Norway	Haeolus	2 MW + 100 kW FC	2018	PEM	•				
Germany	MefCO2	1 MW	2018	PEM					•
Germany	WindGas Brunsbüttel	2.4 MW	2017	PEM		•			
Thailand	EGAT	1 MW + 300 kW FC	2017	PEM	•				
Canada	Embridge P2G	2.4 MW + 100 kW FC	2017	PEM		•			
Denmark	HyBalance	1.2 MW	2017	PEM			•	•	
Denmark	BioCat	1 MW	2016	Alkaline		•			
Italy	Ingrid	1 MW + 100 kW FC	2016	Alkaline	•	•	•		
UK	Aberdeen	1 MW	2016	Alkaline				•	
Germany	WindGas Reitbrook	1.5 MW	2015	PEM		•			
Belgium	DonQuichote	150 kW + 100 kW FC	2015	Alkaline + PEM	•			•	
Germany	WindGas Falkenhagen	2 MW	2014	Alkaline		•			



### Main conclusions from these projects:

1. Hydrogen **technologies work fine** and deliver according to expectations.
2. There is still room for further technical improvement but **no technology breakthrough is expected**.
3. There is a important potential for further **cost reduction**: going from project manufacturing to product manufacturing
4. Energy **regulatory framework is no suited** for these applications and **business operation** of these projects **remains very challenging**

## Concluding messages

- Hydrogen and Fuel Cell (FCH) **technologies are mature and ready**
- Some electrolyser capacity already present in CEE countries, mainly in power plants and some industries (glass, metallurgy)
- **Massive cost reduction is expected** for FCH technologies : from project to product manufacturing & product up scaling
- Massive **CO<sub>2</sub> reduction potential in power, gas, transport and industry**
- For a large deployment of FCH technologies, **a favorable regulatory framework is needed** (EU and national) containing (at least)
  1. Green hydrogen certification mechanism
  2. Premium value for end product / application
  3. Access to renewable electricity at low cost
  4. Grid connection to deliver balancing services

# Thank you for your attention



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