

8e journées du stockage d'énergies et du power to gas - 15 novembre 2018 - Paris

Patrick Canal, Délégué général du Club Stockage d'énergies et Power to Gas ATEE

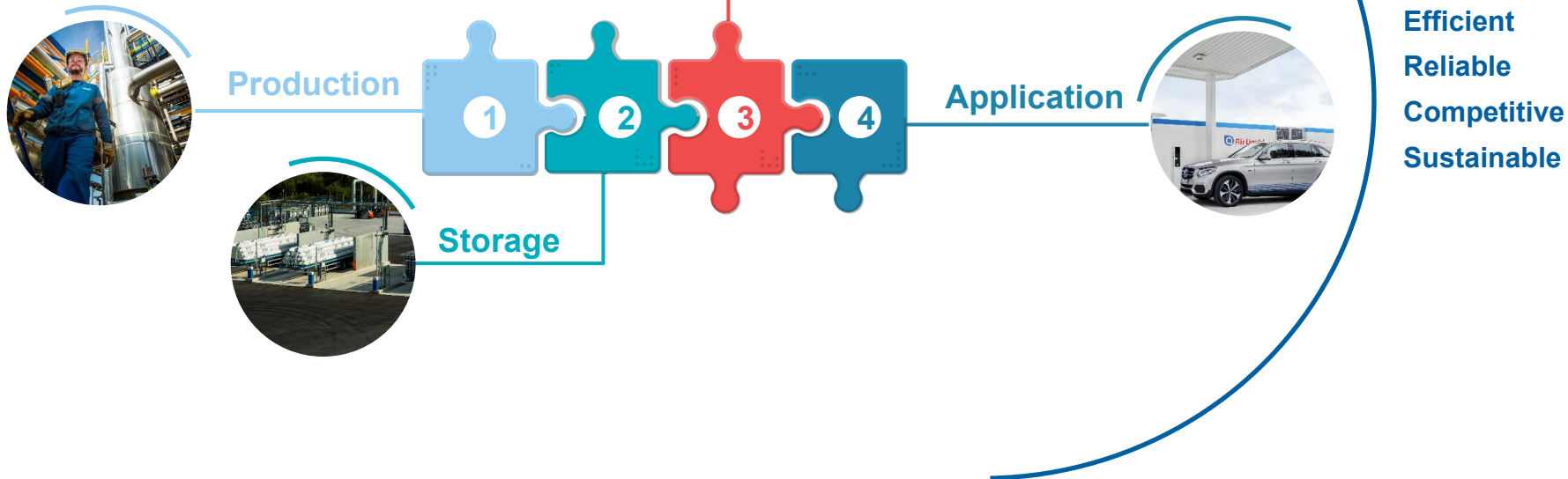
Session 1 Les démonstrateurs sont-ils encore nécessaires pour caler les modèles économiques ?

Présentation de cas concrets

HyBalance



Technology leveraged at every step in the chain



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AIR LIQUIDE, THE WORLD LEADER IN GASES, TECHNOLOGIES AND SERVICES FOR INDUSTRY AND HEALTH

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15/11/2018
David Frimat

ATEE - 8ème journée P2G - Paris

HyBalance
Demonstrating the use of hydrogen in energy systems



Air Liquide already started to invest



Mobility for Professionals
US+EU
9 HRS



Mobility for Consumers
US North-East
12 HRS
+ Supply chain



Mobility for Consumers
California
4 HRS



Mobility for Consumers
Japan
6 HRS



Mobility for Consumers
Dubai
1 HRS



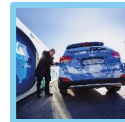
Mobility for Consumers
Korea
1 HRS



Power to Gas
Denmark
5 HRS
+ 1 Electrolyzer



Mobility for Consumers
Germany
12 HRS



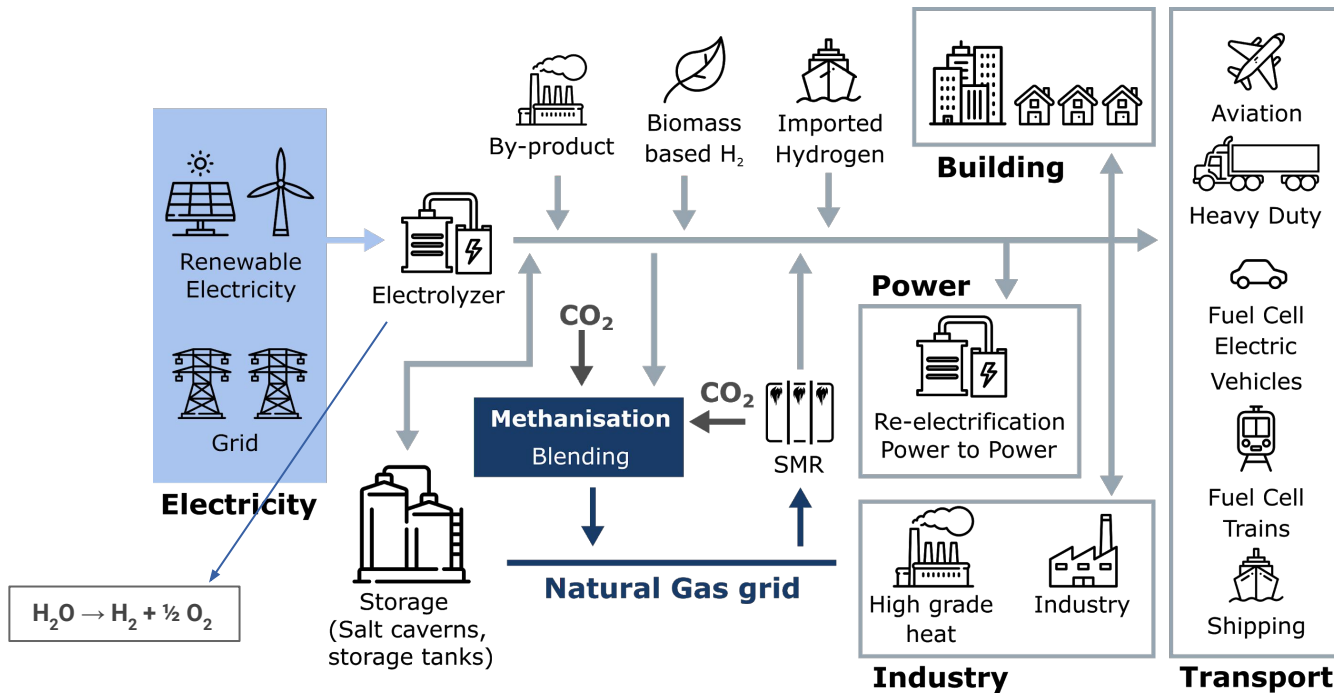
Mobility for Consumers
Paris, Brussels and Rotterdam
5 HRS



14 bn m³/yr
1,850 km H₂ pipelines
46 large H₂/CO plants
40 electrolyzers in operation
2 bn € sales

100 Hydrogen recharging stations (HRS) installed by Air Liquide in the world in which 40 directly invested and operated by Air Liquide

Integration of VRE into end uses by means of hydrogen

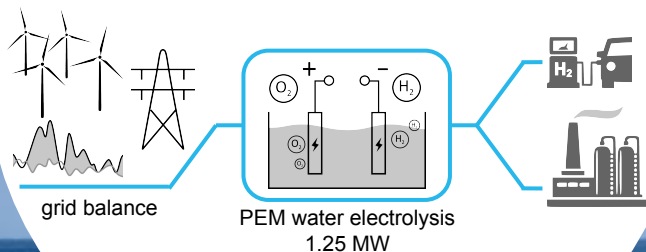


Source: adapted from HYDROGEN FROM RENEWABLE POWER - IRENA sept. 2018

HyBalance

HyBalance is a funded European project lead by Air Liquide.

It is a **flagship project** that demonstrates the use of hydrogen in energy systems.



15 M€ investment
start in 04/2016



Conditioning center:
200 bar – 700 bar

HRS capacity → 50 to 100 kg/d

- On-site Electrolyser
- 700 b supply

Complete Wind to H₂ supply chain



hybalance.eu



Main actors in HyBalance Project

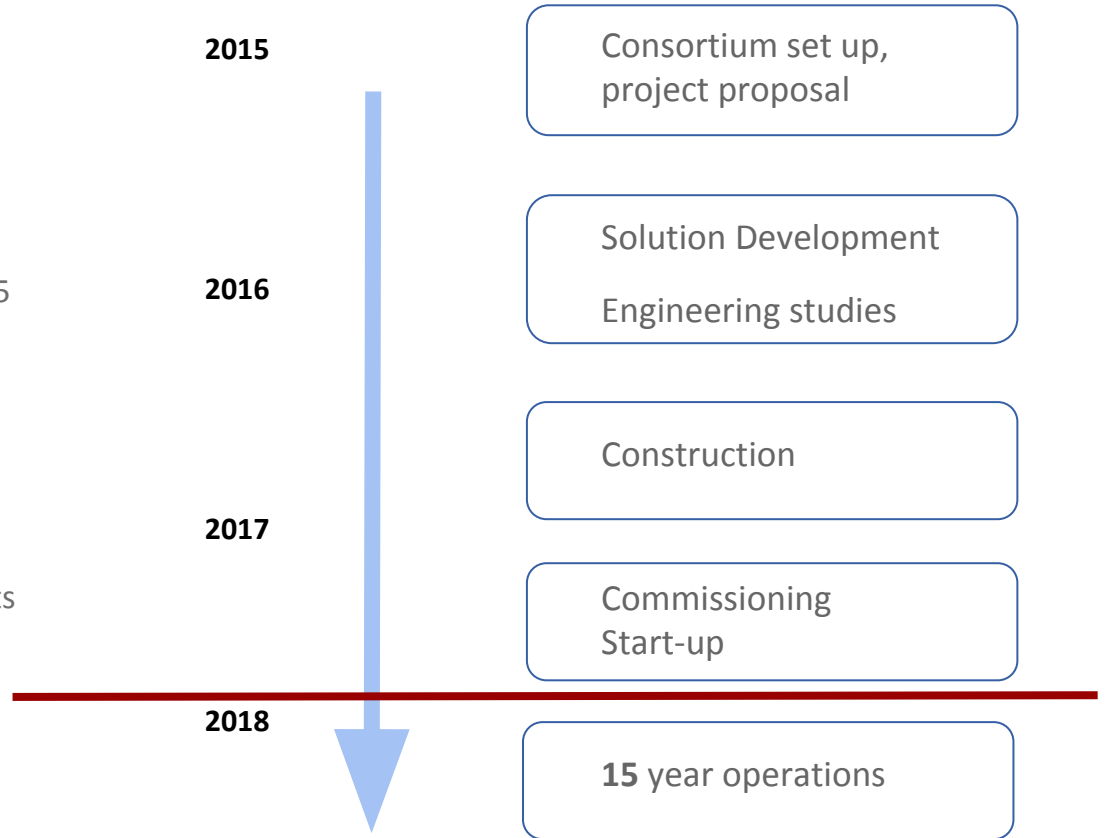


- FCH-JU consortium :

- **ALAB** : Project coordination, follow up
- **CHN (AL)** (Copenhagen Hydrogen Network) : Plant owner and operator
- **E&C (AL)**: Engineering, Procurement and Construction
- **Hydrogenics** : Electrolyzer supply and maintenance
- **NEAS** (Aalborg-DK): Power trading and grid balancing services
- **Hydrogen valley** (Hobro-DK) : Dissemination, local coordination
- **FordonsGas**: *Operation, new partner from 2018*

Key dates

- 2014 : FCH JU Call, awarded in 2015
- April 2016 - Launch of project
- November 2017 - S/U Electrolyzer
- December 2017 - performance tests
- January 2018 - Start of operations



Why Denmark?

- A clear shift away for fossil fuels
- A sharp increase in the share of intermittent renewable in the power mix

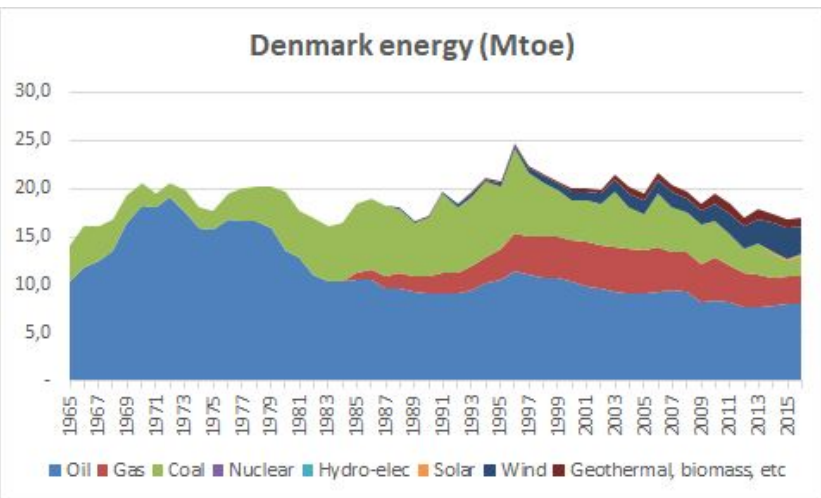
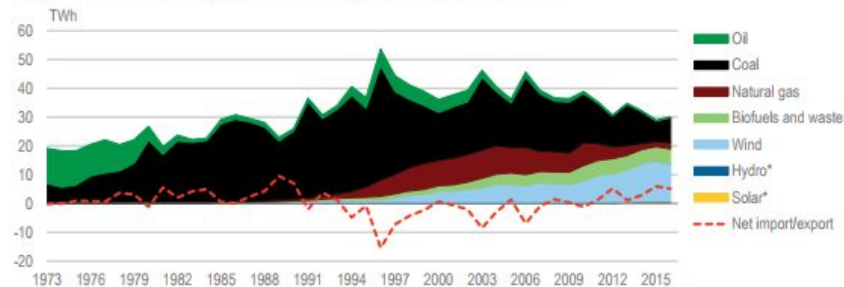


Figure 5.3 Electricity generation by source, 1973-2016



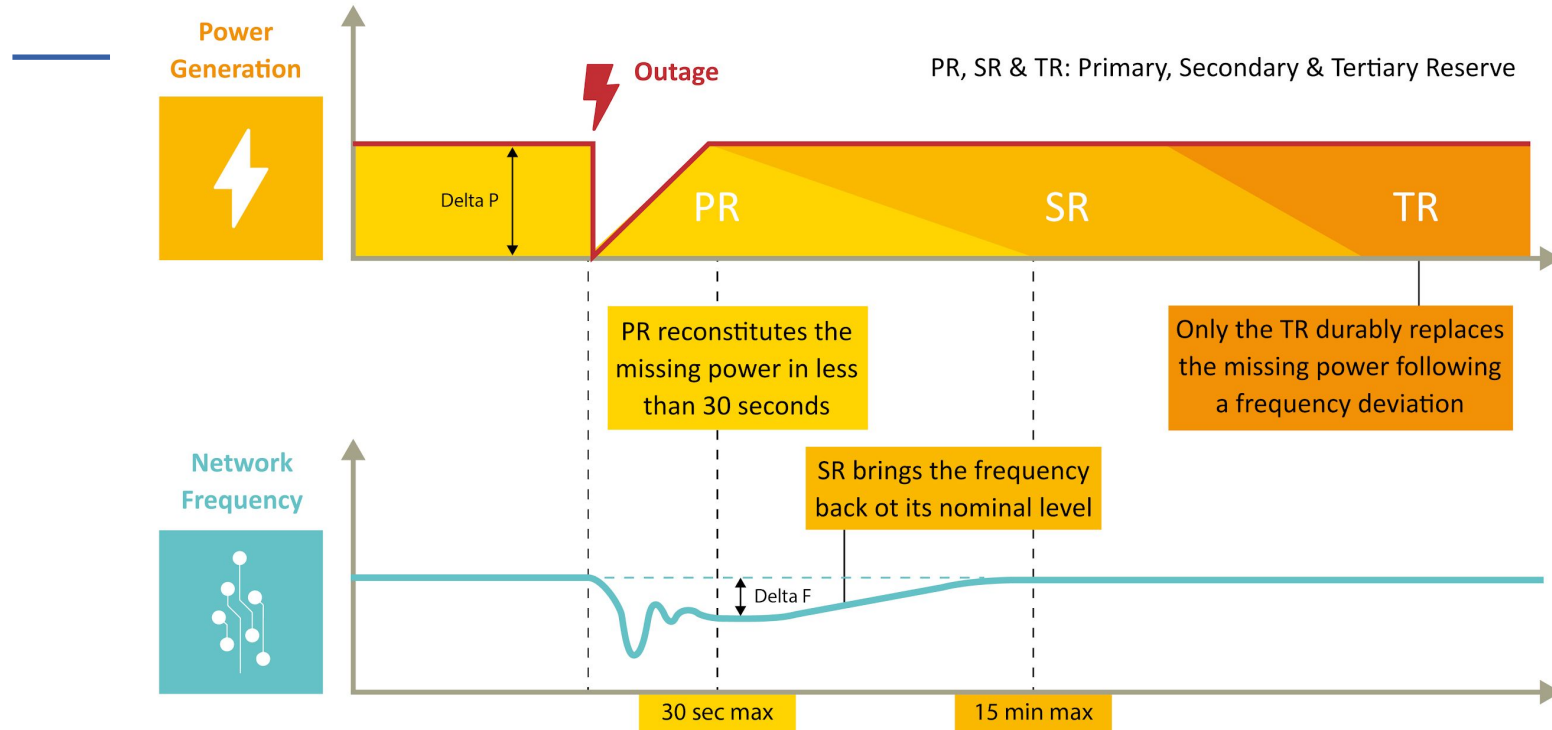
*Negligible.

Note: Data are provisional for 2016.

Source: IEA (2017a), *World Energy Balances 2017*, www.iea.org/statistics/.

Source: BP stat Review 2017

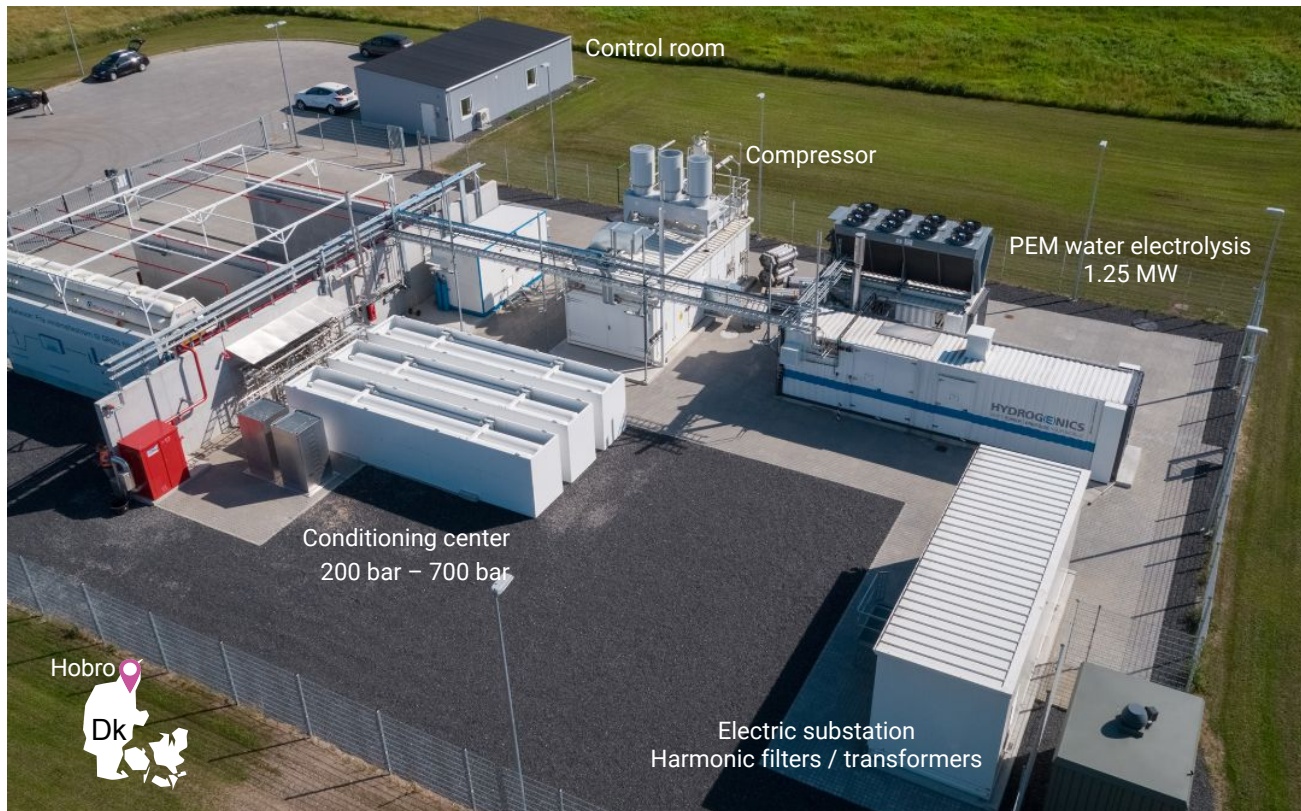
Electrolysis to provide Grid Services



Source: Commission Régulation de l'Énergie



Brief site visit



Brief site visit



Important milestones can be reached already in 2030



1 in 12 passenger cars sold in early-adoption markets
(Germany, California, Japan and South Korea) FCEVs



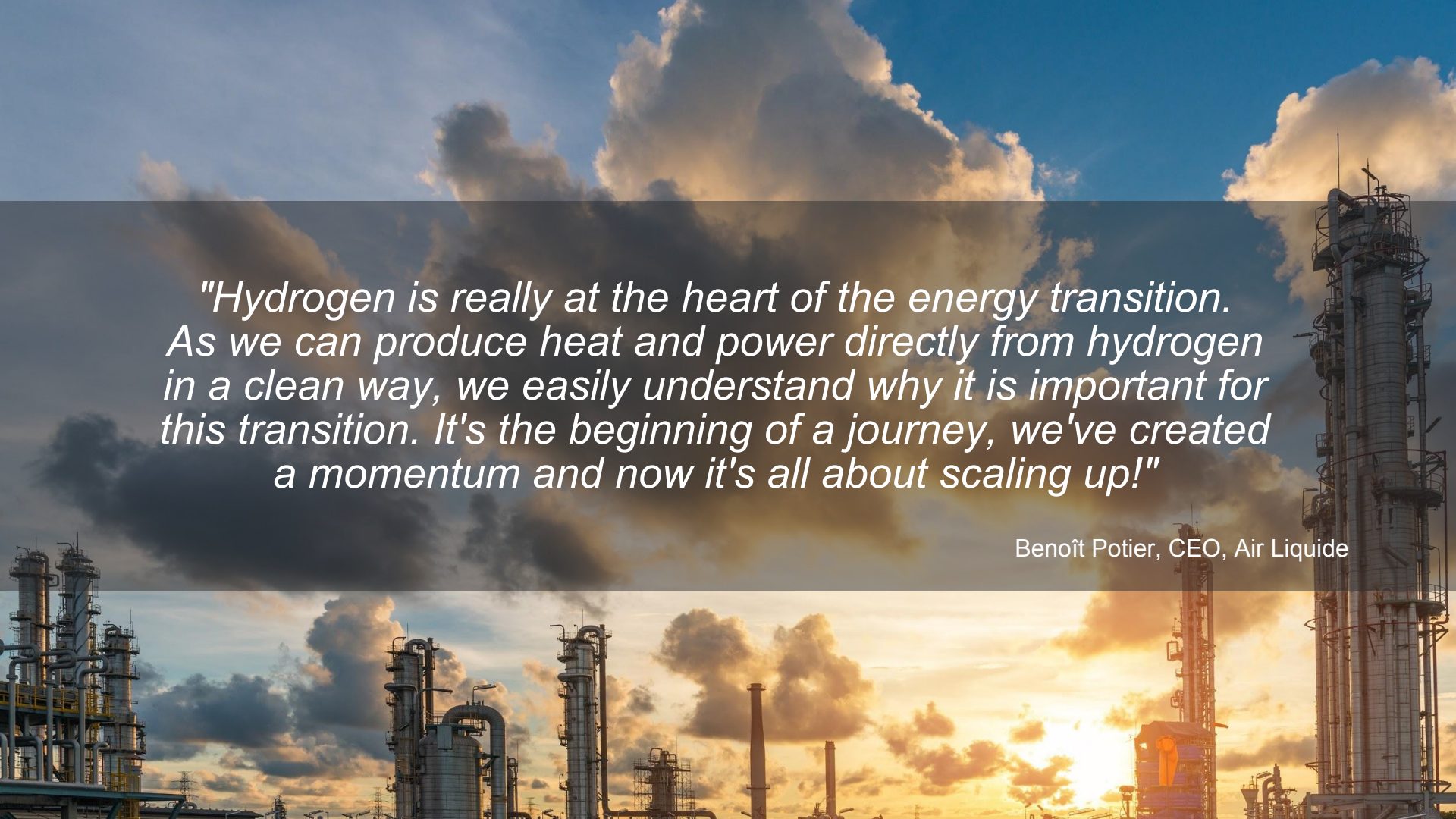
20 Mt CO₂ in converted to chemicals and
intermediates such as **methanol** using hydrogen



3.5 Mt hydrogen used for **high-grade
heat** in first large-scale projects



50 million households connected to a network safely
blending hydrogen and natural gas

A photograph of an industrial facility, likely a refinery or chemical plant, with several tall distillation columns and complex piping. The scene is set against a dramatic sky with large, white and grey clouds, and a bright sun low on the horizon, creating a golden glow. The image is split horizontally, with the top half showing a darker sky and the bottom half showing the sun's glow.

"Hydrogen is really at the heart of the energy transition. As we can produce heat and power directly from hydrogen in a clean way, we easily understand why it is important for this transition. It's the beginning of a journey, we've created a momentum and now it's all about scaling up!"

Benoît Potier, CEO, Air Liquide

No.	Parameter	Unit	State of the art		FCH 2 JU target		
			2012	2017	2020	2024	2030
Generic system							
1	Electricity consumption @nominal capacity	kWh/kg	60	58	55	52	50
2	Capital cost	€/(kg/d) (€/kW)	8,000 (~3,000)	2,900 (1,200)	2,000 (900)	1,500 (700)	1,000 (500)
3	O&M cost	€/ (kg/d)/yr	160	58	41	30	21
Specific system							
4	Hot idle ramp time	sec	60	10	2	1	1
5	Cold start ramp time	sec	300	120	30	10	10
6	Footprint	m2/MW	-	120	100	80	45
Stack							
7	Degradation	%/1000hrs	0.375	0.250	0.190	0.125	0.12
8	Current density PEM	A/cm2	1.7	2.0	2.2	2.4	2.5
9	Use of critical raw materials as catalysts PGM	mg/W	-	5.0	2.7	1.25	0.4
10	Use of critical raw materials as catalysts Pt	mg/W	-	1.0	0.7	0.4	0.1

State-of-the-art and future targets for hydrogen production from renewable electricity for energy storage and grid balancing using PEM electrolyzers

Source: FUEL CELLS and HYDROGEN 2 JOINT UNDERTAKING