

Waterstof: DE weg naar elektrische mobiliteit

Tankpro Congres

11 november 2014



Air Liquide's context



→ The world leader in gases for industry, health and the environment.

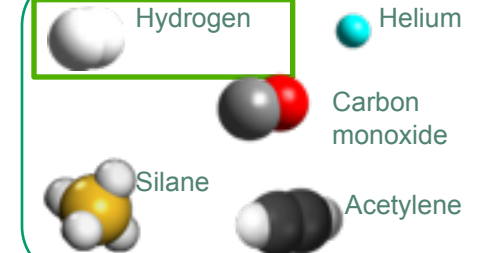
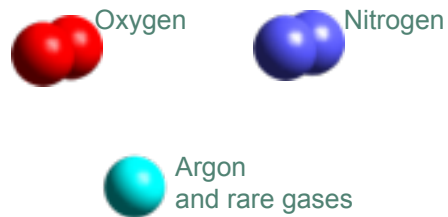
**Historically (1902),
distillation** of air gases



Separating the
components of the
air
to take advantage of
their properties

Producing molecules
from
natural resources
of the Planet

**Air Liquide
Technologies**



Air Liquide in brief

- Total Group revenue 2011 : €14.457 billion
 - 52% from Europe, 24% Asia
 - €1.535 billion net profit, 12,1% ROCE
- Present in 80 countries
- 46 200 employees
- 42% of Group revenue: applications that help preserve the environment, and sustain life
- Sustainable development represents 64% of R&D budget
- 5 strategic growth drivers



Energy



Environment



Health



High-Tech



Developing economies

More than 40 years of experience in hydrogen

Production



Technology E&C

Distribution



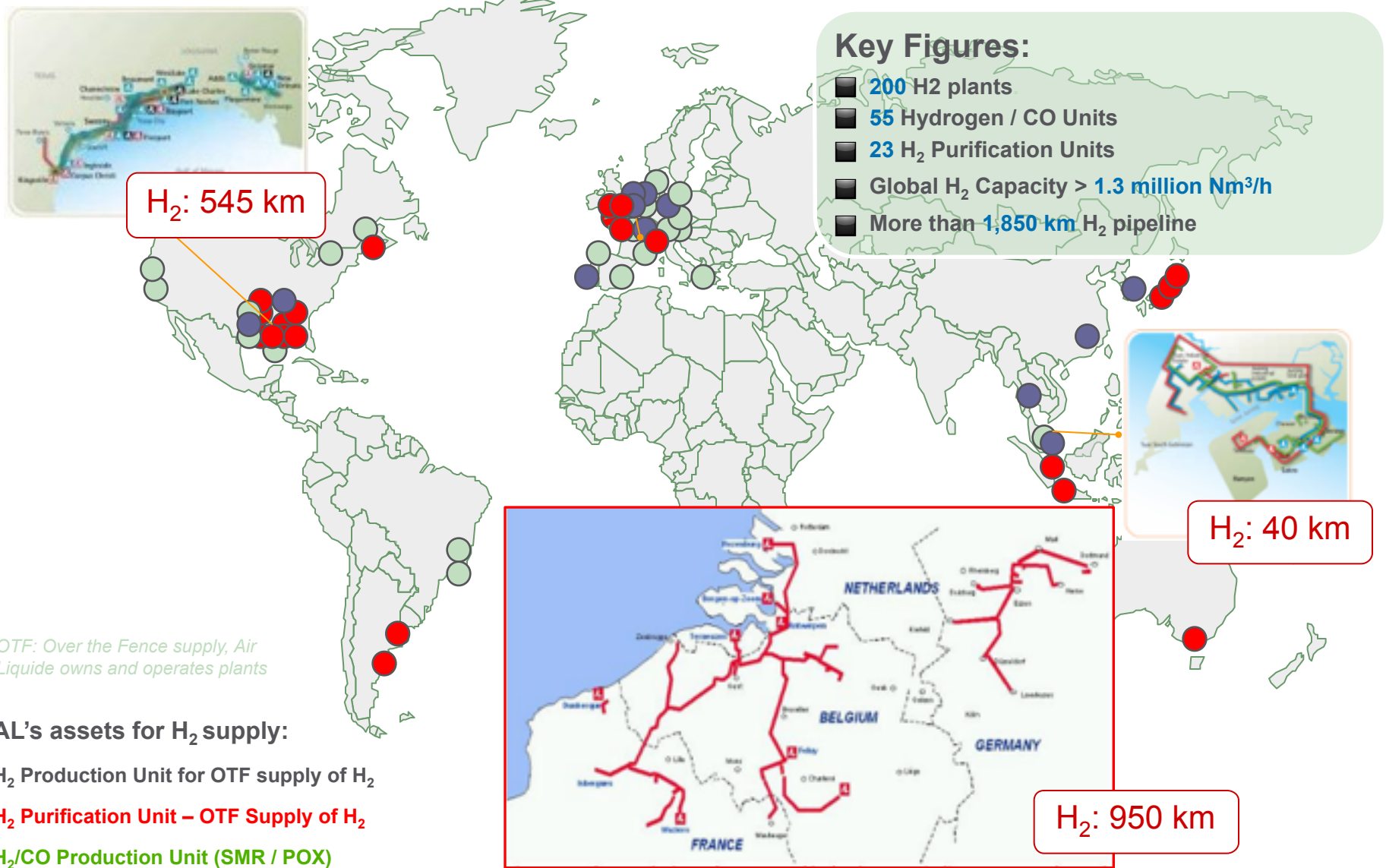
Technology E&C

Application

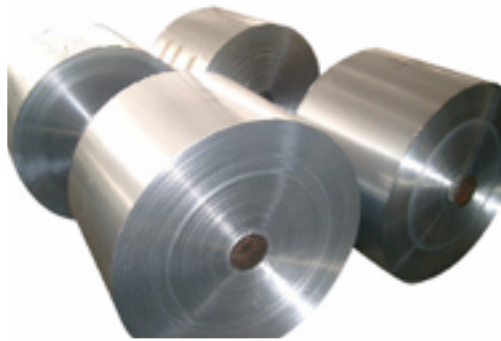


Technology E&C

Air Liquide Worldwide Hydrogen Operations



H₂: many existing applications...



Heat Treatment
10 m³/h (batch) –
1000 m³/h (continuous)



Glass
80 to 500 m³/h



H₂ Ultra pure <1ppb
50 to 500 m³/h



Chemicals
Ex: 0,067 t/ton Aniline
Petroleum refining
(desulphuration & hydrocracking)
10-100 km³/h



Ariane 5
28 t/launch

2015 ?



Fuel cell vehicle
1 kg for 100 km

Transition from industrial H₂ to Hydrogen-Energy

- **A new application** : Hydrogen as an energy vector



New opportunities and new challenges

Hydrogen & Energy: how does it work ?

■ How is hydrogen produced?

- ⋮ Methane reforming (with heat) $\text{CH}_4 + 2\text{H}_2\text{O} \Rightarrow 4\text{H}_2 + \text{CO}_2$
- ⋮ Water electrolysis (with electricity) $\text{H}_2\text{O} \Rightarrow \text{H}_2 + \frac{1}{2} \text{O}_2$

■ Storable as liquid, gas or solid (in various media)



■ Coupled to fuel cells : a power generator



How to transition towards a new energy mix?

- Air Liquide's **Blue Hydrogen** initiative

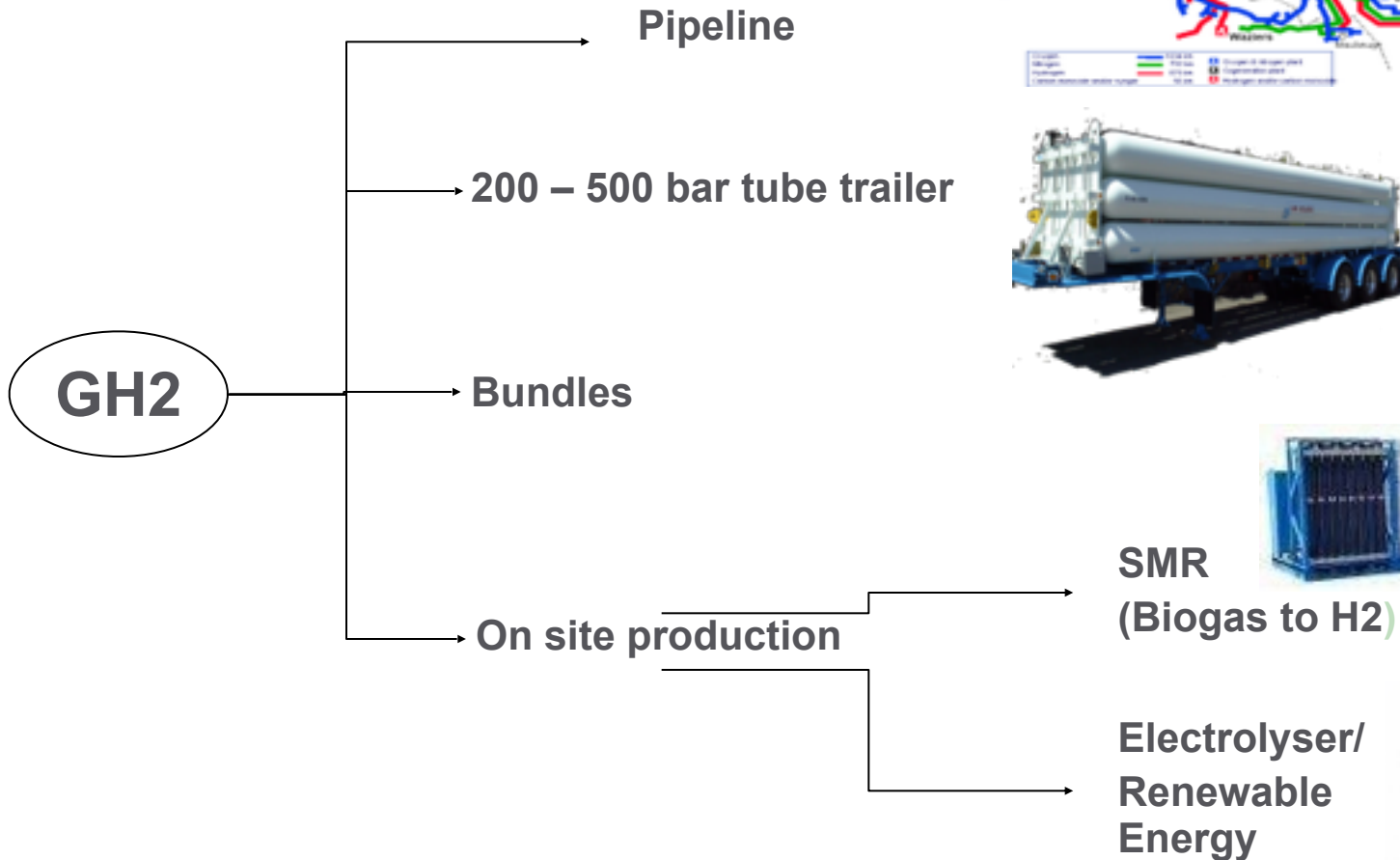


At least 50% of hydrogen energy produced through carbon-free processes by 2020

- ! renewable energy sources, water electrolysis and biogas reforming,
- ! carbon capture and storage technologies with natural gas reforming

→ **A commitment to meet both environmental requirements and social and economic constraints.**

Air Liquide's Hydrogen Distribution Portfolio



**SMR
(Biogas to H₂)**



**Electrolyser/
Renewable
Energy**

■ Hydrogen Refueling Station :

- ⋮ 350 bar fast filling
- ⋮ 700 bar fast filling
- ⋮ hydrogen supply chain management
- ⋮ about 60 systems deployed

■ Standard offer :

- ⋮ 80 kg/day mobile station
- ⋮ 200 kg/day small size
- ⋮ 400 kg/day medium size
- ⋮ 1 000 kg/day large size



Different types of standard HRS units are available



Medium capacity HRS in Düsseldorf, officially opened in Sept. 2012

Small capacity HRS



Air Liquide's standard medium capacity hydrogen refueling station



Overview of the HRS built and commissioned in 2012



Location HRS Rotterdam



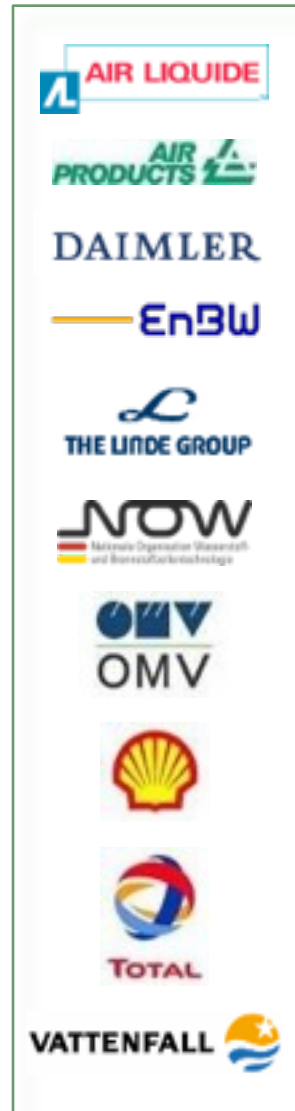
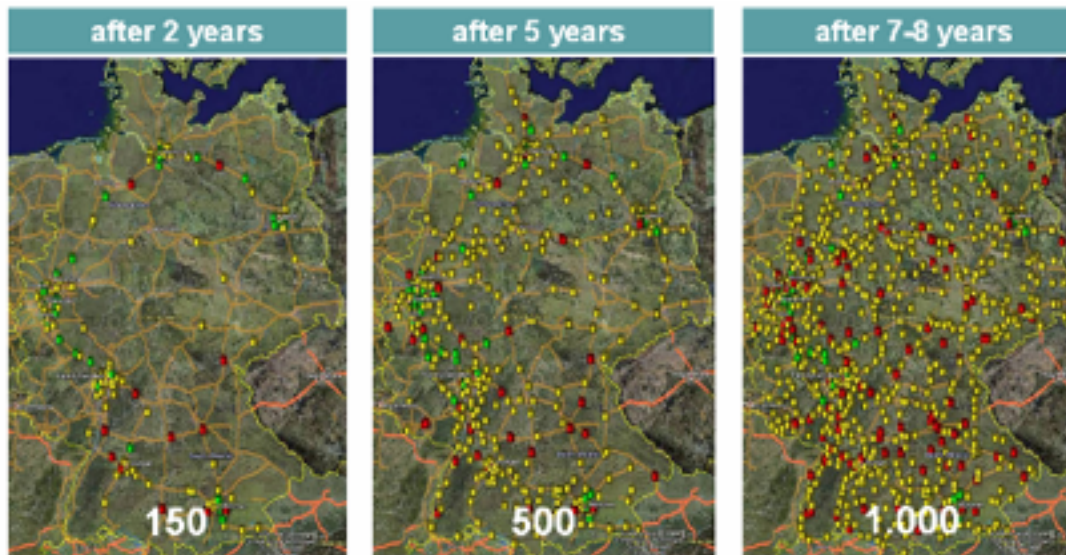
Artist impression



Public Private Partnership H₂-Mobility Growth Path Model

- Germany
- 2009-2015+
- Supported by NOW (German Organization for H₂ & FC)
- Objectives:
 - | Development of a nationwide Hydrogen infrastructure in Germany, allowing FCV's large-scale commercialization by 2015
 - | Important milestone on the way to emission-free mobility
 - | 2009-2011: Evaluation Phase
 - | 2011-2015: Implementation Phase

H₂ Mobility



Thank you for your attention!