



Clean Hydrogen In European Cities

CHIC Project - Overview

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Air Products



CHIC Background

CUTE / ECTOS: 2001 – 2005

- Demonstration of a fleet of 30 fuel cell buses in regular public transport

HyFLEET:CUTE: 2006 – 2009

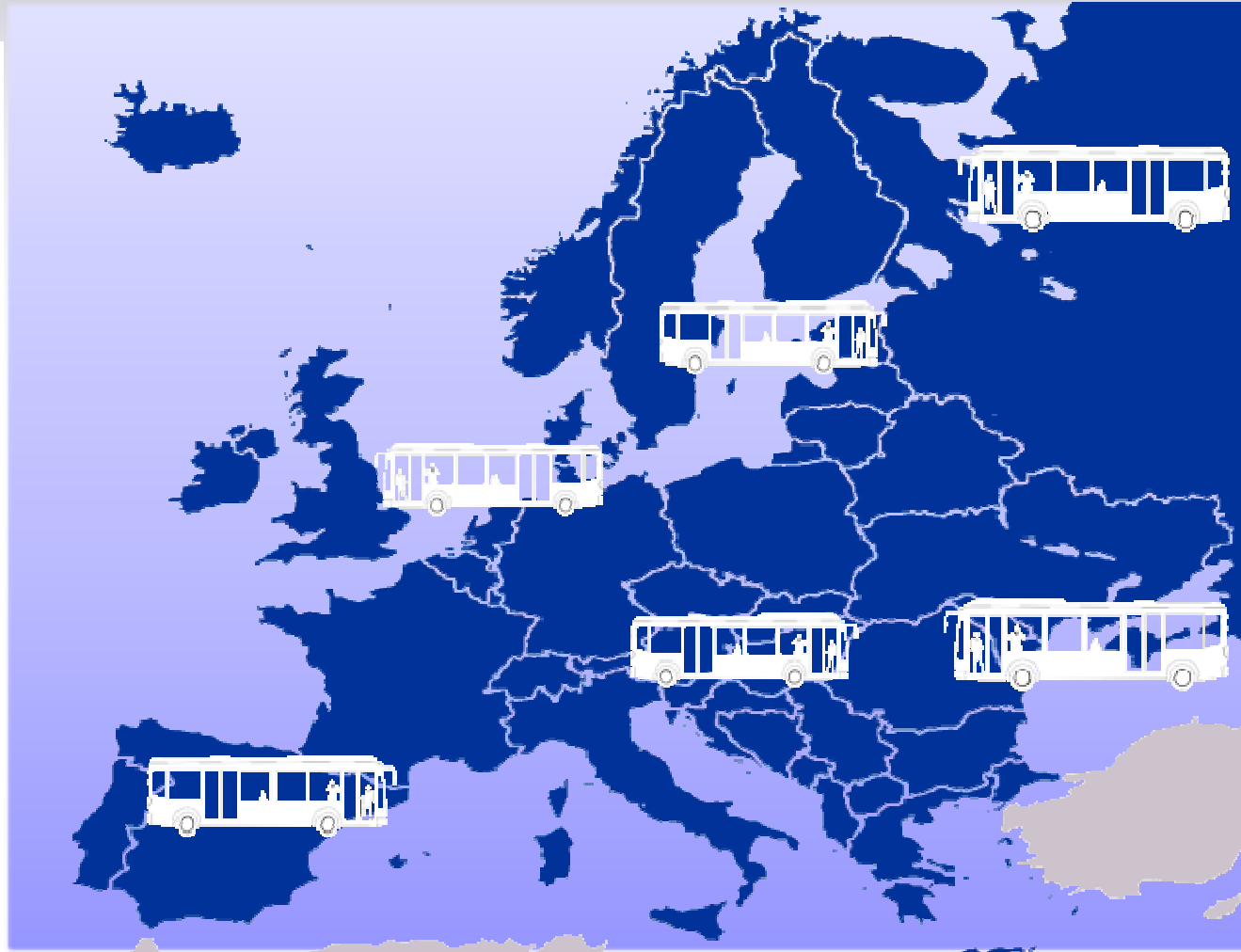
- 47 hydrogen powered buses in public transport
- 2.600.000 km* in public service, 555 tons* of H₂ refuelled and more than 1 million liters of diesel replaced
- Fuel cell buses are suitable for operation in public transport
- Development of a new, fuel efficient FC hybrid bus concept



* figures include CUTE and ECTOS fuel cell bus operation

Where we need to go...

Clean hydrogen transport systems as a commercial reality in Europe



Objectives of CHIC

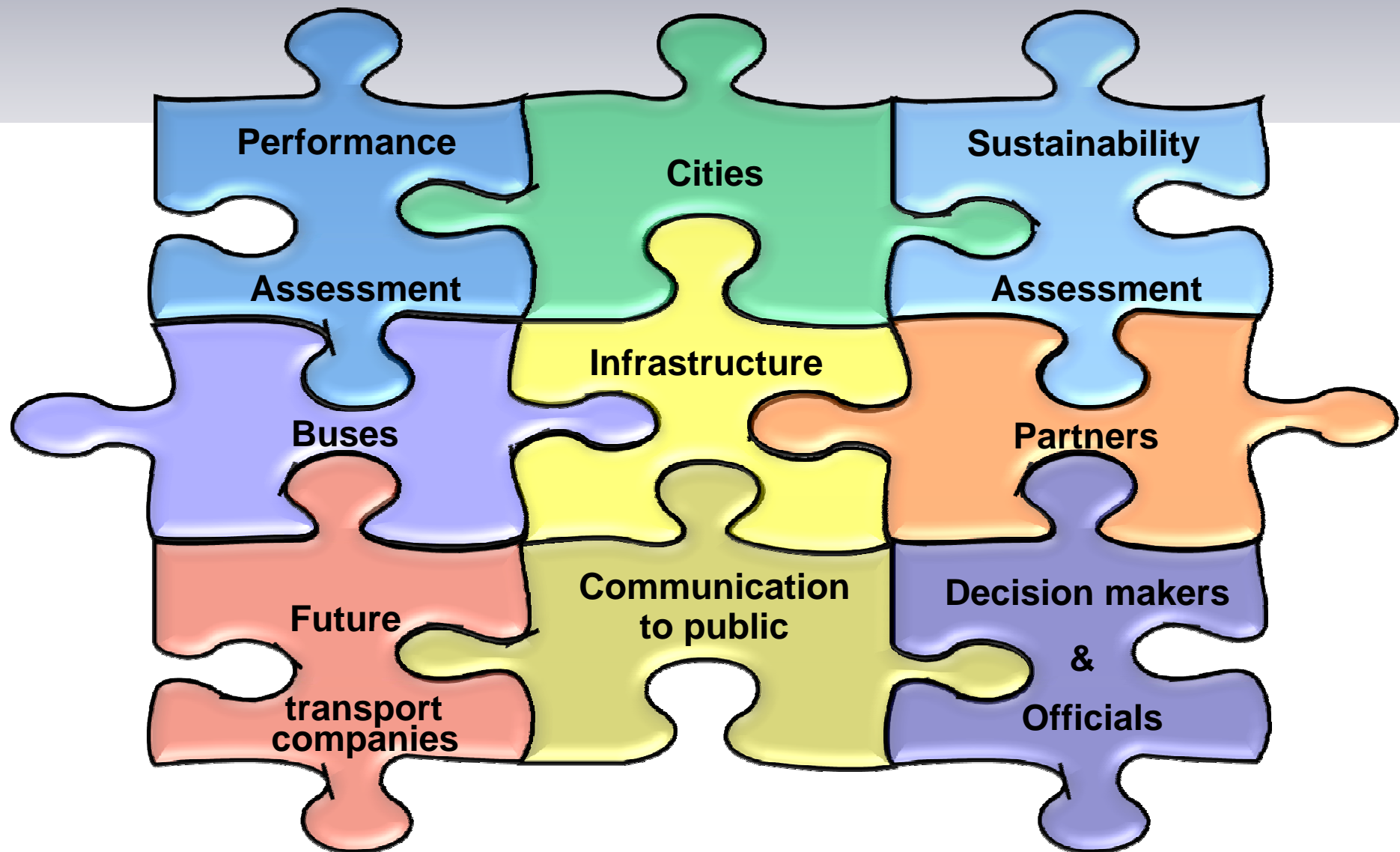
The CHIC project is implementing clean urban mobility in 5 major European regions through the deployment of 26 hybrid FC powered buses in medium sized fleets, and the enlargement of the hydrogen infrastructure systems

The CHIC project will facilitate the development of clean urban public transport systems and mobility action plans into 14 new European regions

The CHIC project will actively collaborate, transfer and secure significant key learning from previous FC projects into the CHIC stakeholders, thereby greatly accelerating the achievement of JTI and EC objectives

The CHIC project will deliver greater community understanding of 'green' hydrogen powered FC buses, leading to increased political acceptance and commitment

Reaching the CHIC Objectives



The Partners

City representatives for Phase 0, Phase 1, Phase 2



Consultants, Universities and Research



Industry

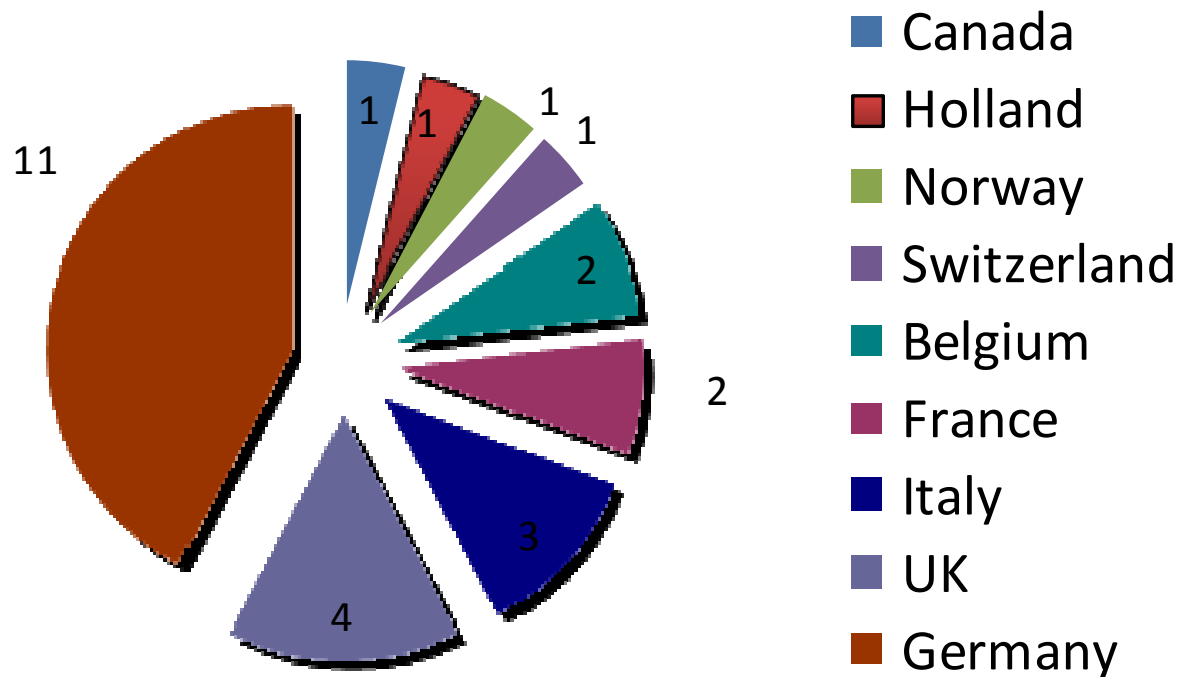


4th International Seminar, 11 Nov 2011, Viana do Castelo

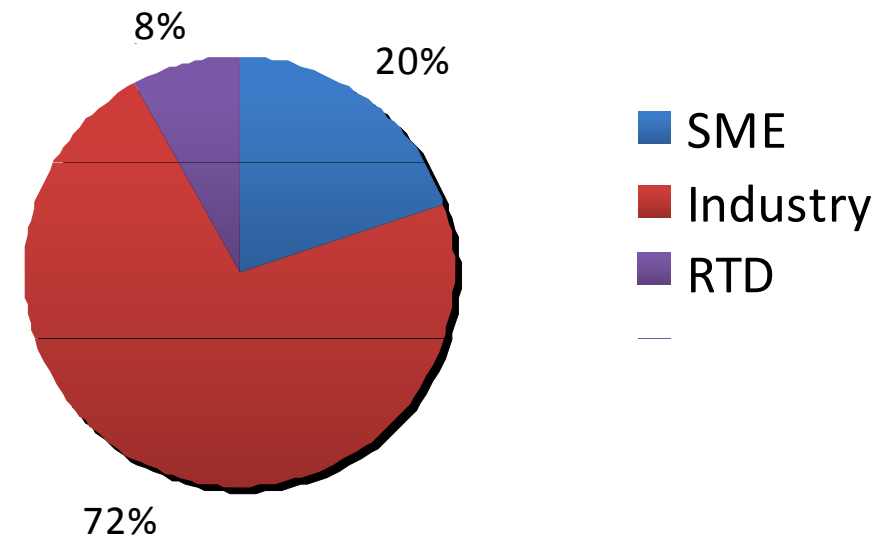


Partner distribution

- 25 partners from 9 countries worldwide



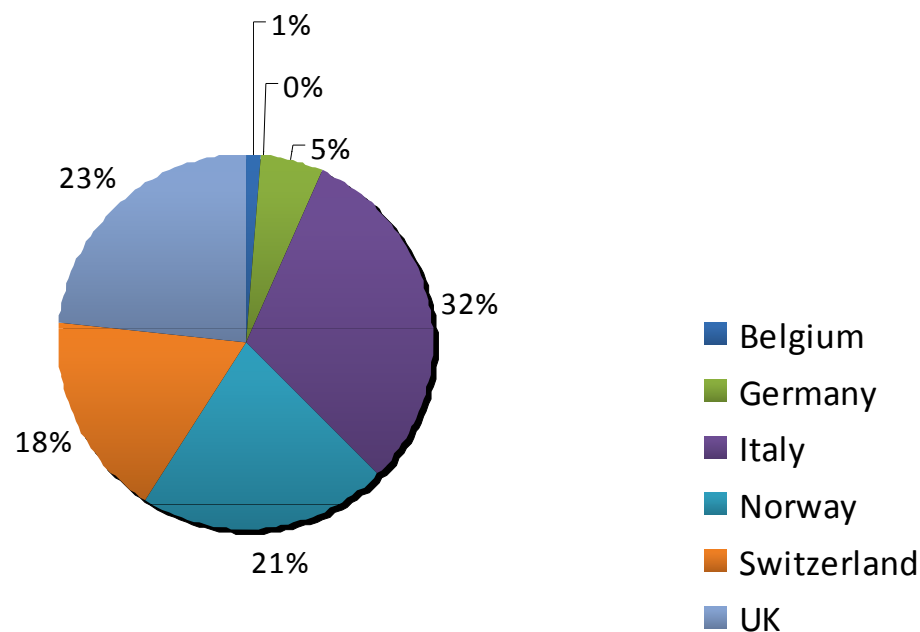
Distribution of number of partner types (in %)



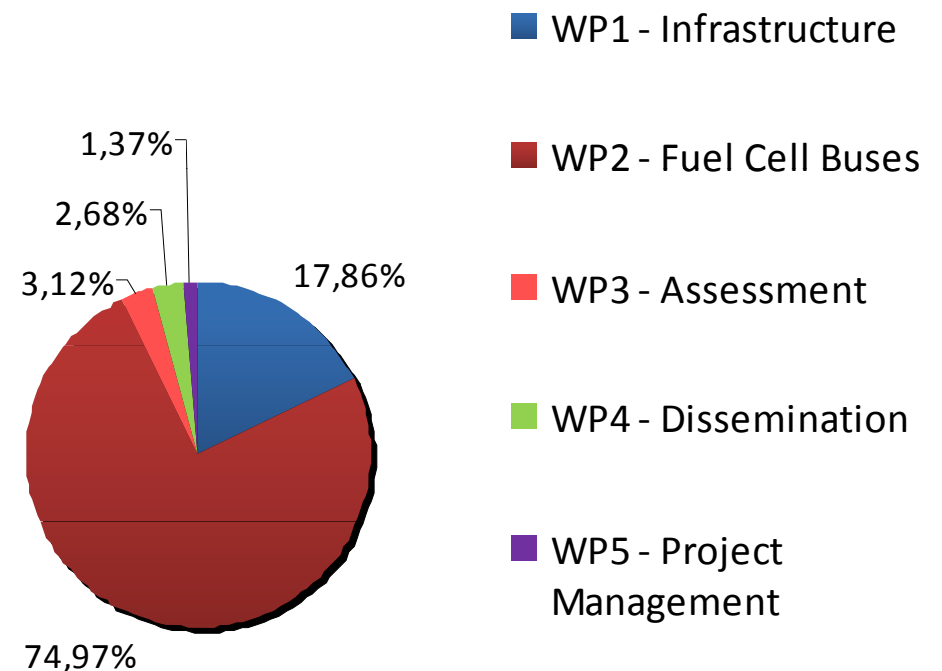
Key Facts

- **Project duration April 2010 – December 2016**
- **29 fuel cell buses operated in 3 “Phase 0” cities**
- **26 fuel cell buses operated in 5 new “Phase 1” cities**
- **At least 3 different bus manufacturers in the Phase 1 cities**
- **2 filling stations per Phase 1 city**
- **25.88 Mio EUR funding, 81.8 Mio EUR costs**

Distribution of requested JTI funding between countries



Total project costs, split by work package



The Phase 0 sites

Passing on the lessons from FCH bus demonstration to the Phase 1 cities



Berlin
fueling
station



Cologne
2 buses



Hamburg
7 buses



Whistler
20 buses

The Phase 1 sites



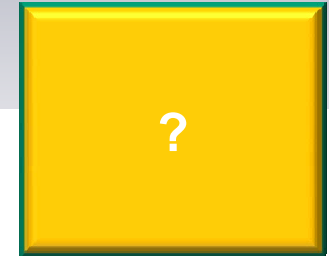
London



8 buses



Bolzano/Bozen



5 buses



Milan



3 buses



Aargau



5 buses



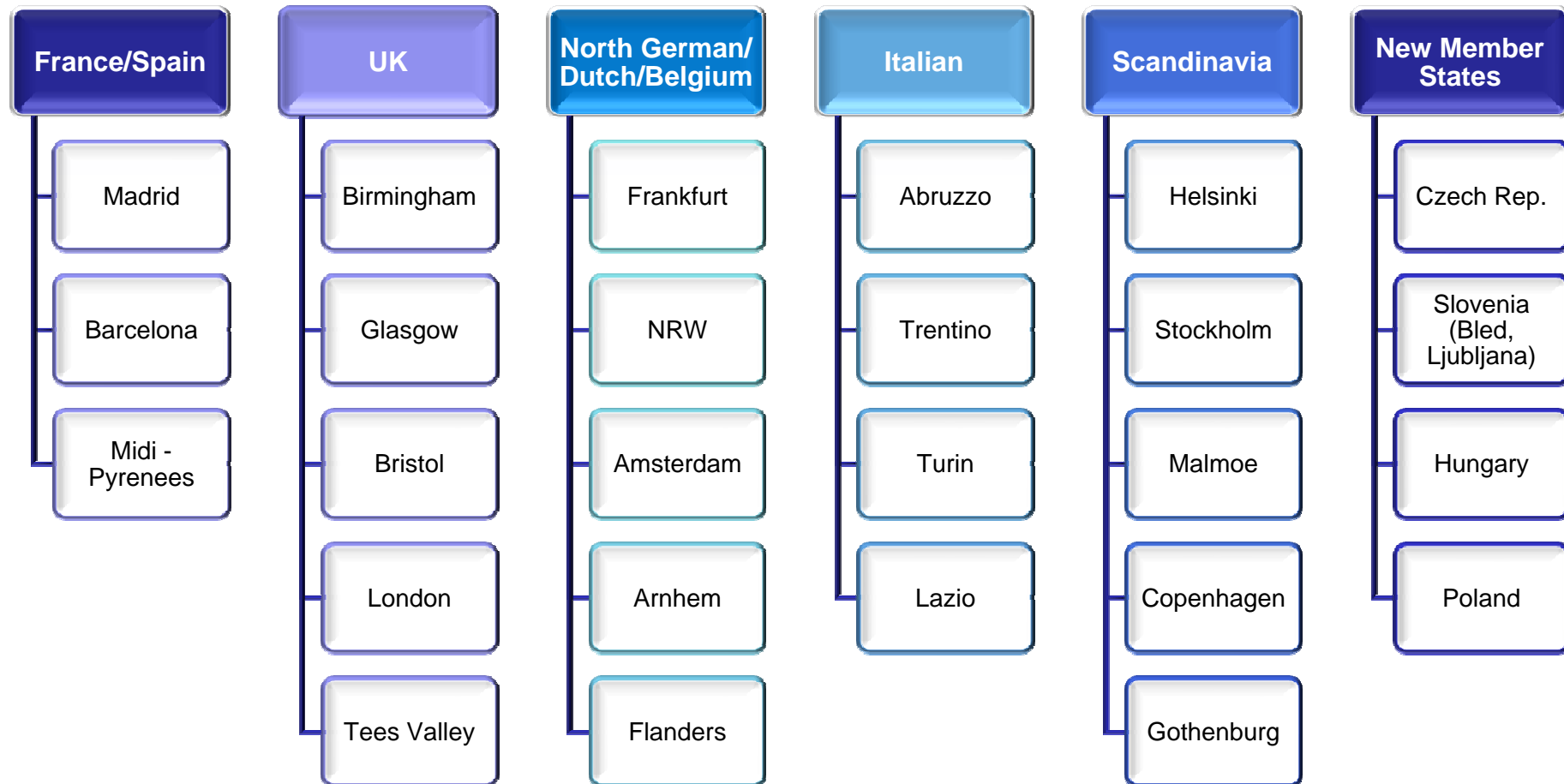
Oslo



5 buses

The Phase 2 sites

Engaging new cities/regions interested in new FCH bus demonstration projects



CHIC Technical Goals - Key indicators for success

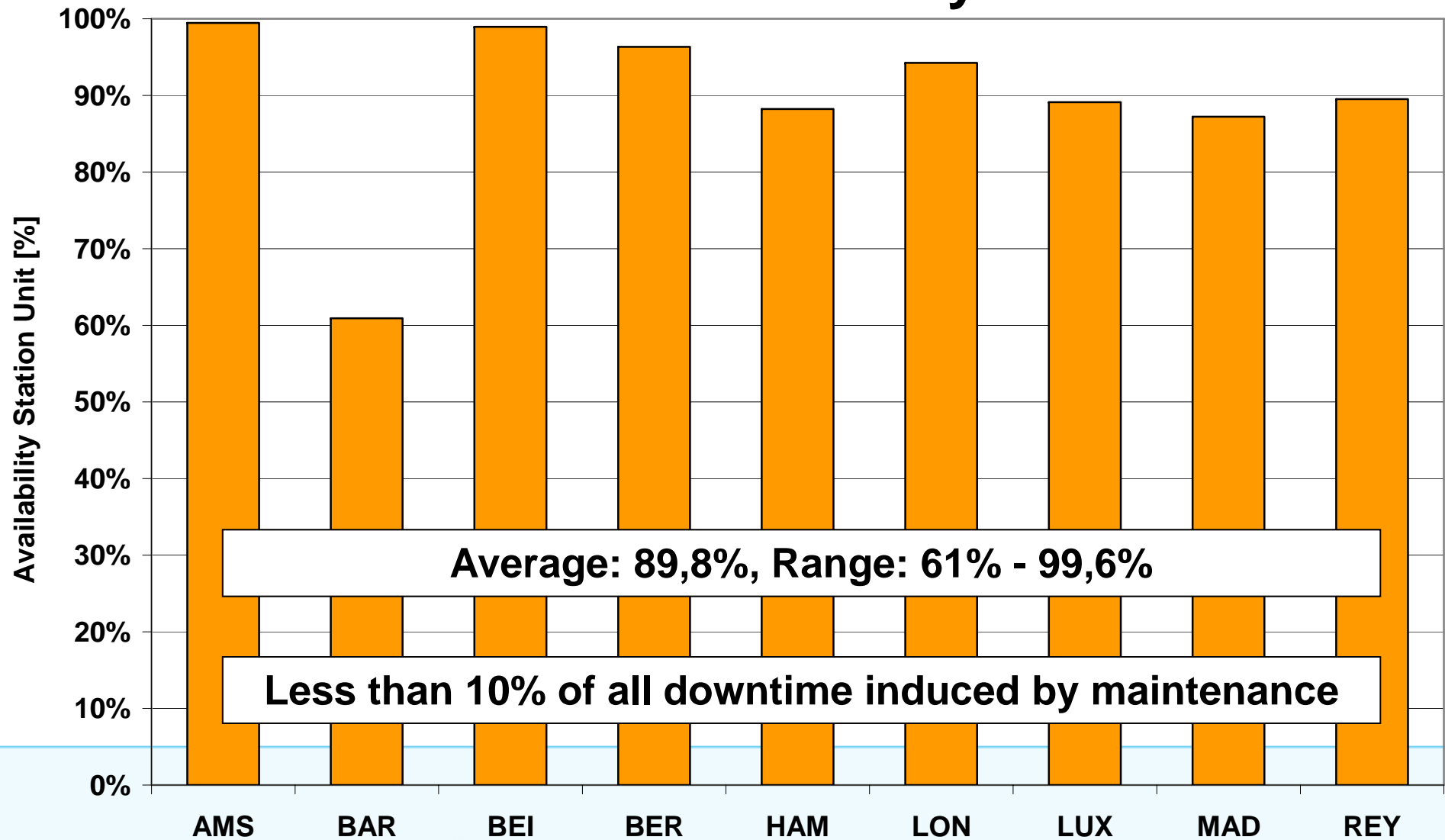
Hydrogen Infrastructure Goals

- Hydrogen fueling station capacity of 200 kg/day
- Average availability of fueling station 98% (based on operation time)
→ **Compare with HyFLEET:CUTE results**
- Production efficiency for H₂ between 50 and 70%
- H₂ OPEX costs less than 10 EUR/kg

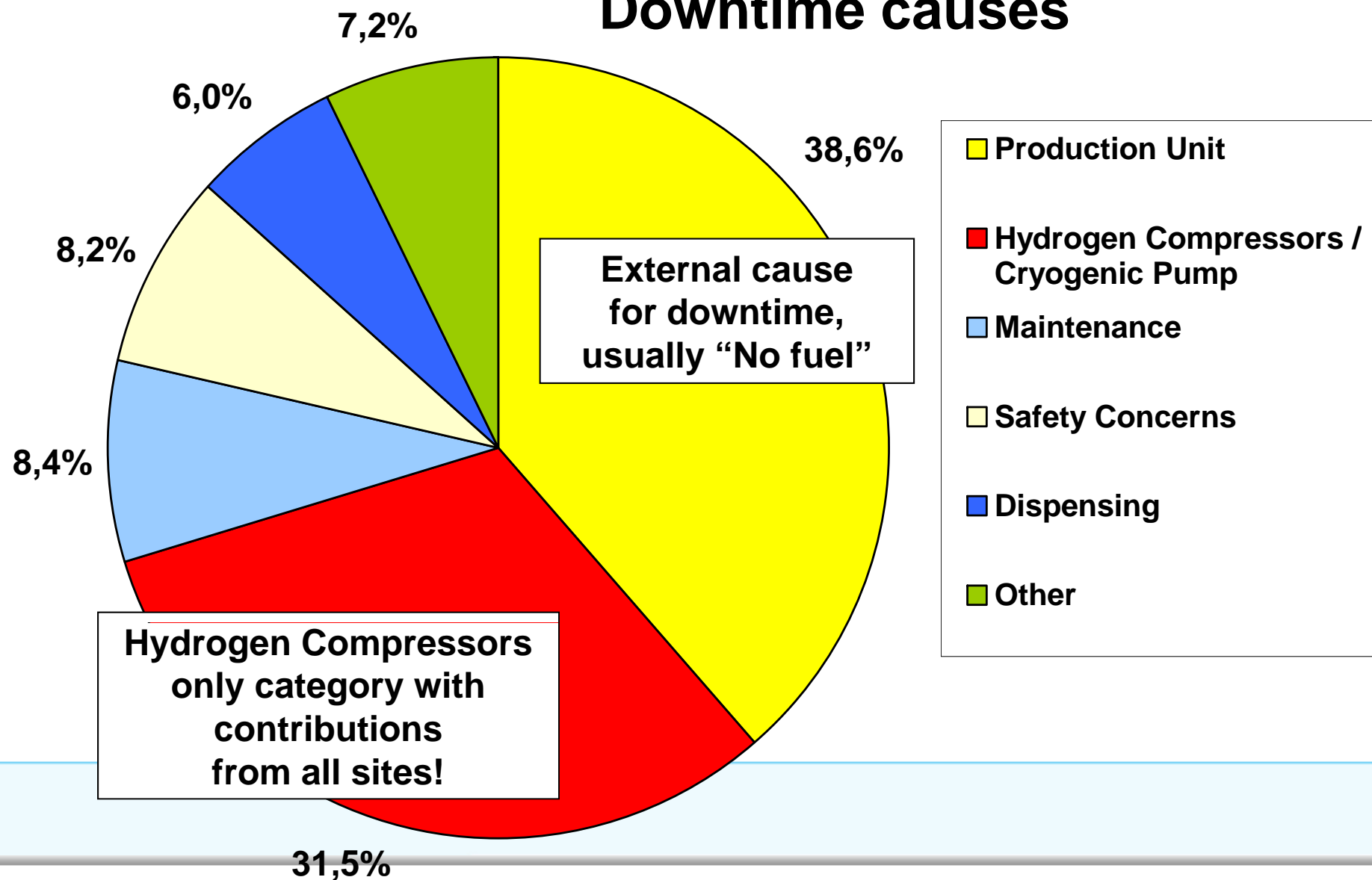
Fuel Cell Bus Goals

- Fuel cell lifetime greater than 6000 h
- Average availability of all fuel cell buses greater than 85%
- Average fuel consumption less than 13 kg/100 km (dep. on drive cycle)

Hydrogen fueling stations: Availability



Hydrogen fueling stations: Downtime causes



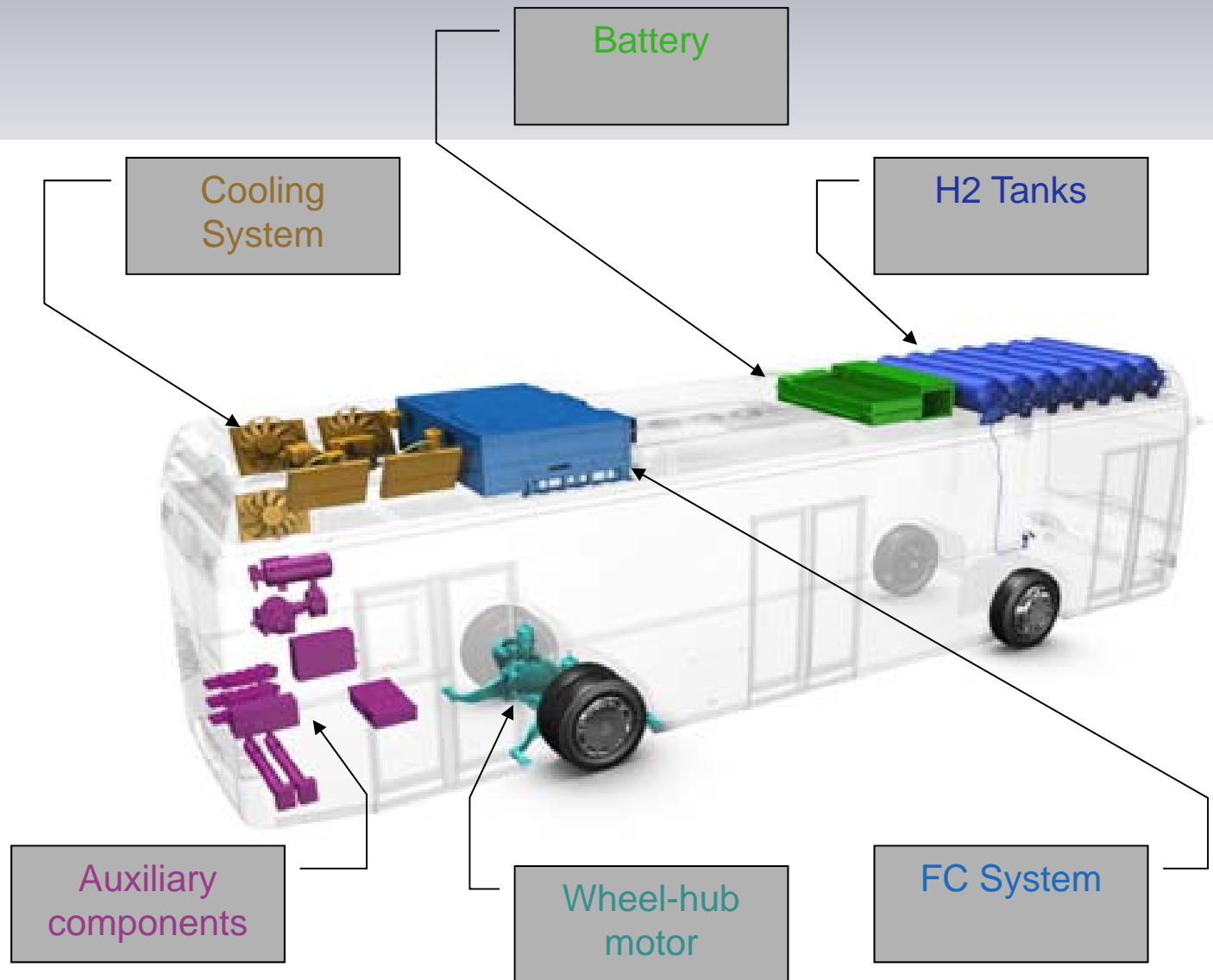
Infrastructure data of phase 1 cities

Phase 1 city	Pre-existing infrastructure: source of H ₂ and daily capacity	Supplier	New infrastructure: source of H ₂ and daily capacity	Infrastructure supplier	Expected start of operation
Aargau	Not required (small towns)	n/a	Onsite electrolyser + trailer delivery, 200kg	Carbagas (Air Liquide)	April 2012
Bolzano	Delivered gaseous – not for FC buses	Sapio (IT)	Onsite electrolyser 400kg	Tbd – not financed through CHIC budget	Tender to be published Nov11, awarding Feb12, start end Dec12
London	Delivered liquid 320kg	Air Products	High pressure tube trailer (up to 500 bar), 100kg	Air Products	July 2012 (before the Olympics)
Milan	Onsite reformer 30kg – currently not operative	Sol (IT)	Onsite electrolyser 200kg	Linde	End June 2012
Oslo	Delivered gaseous, 22kg – not for FC buses	Statoil	Onsite electrolyser (2 units), 250kg	Air Liquide	End March 2012

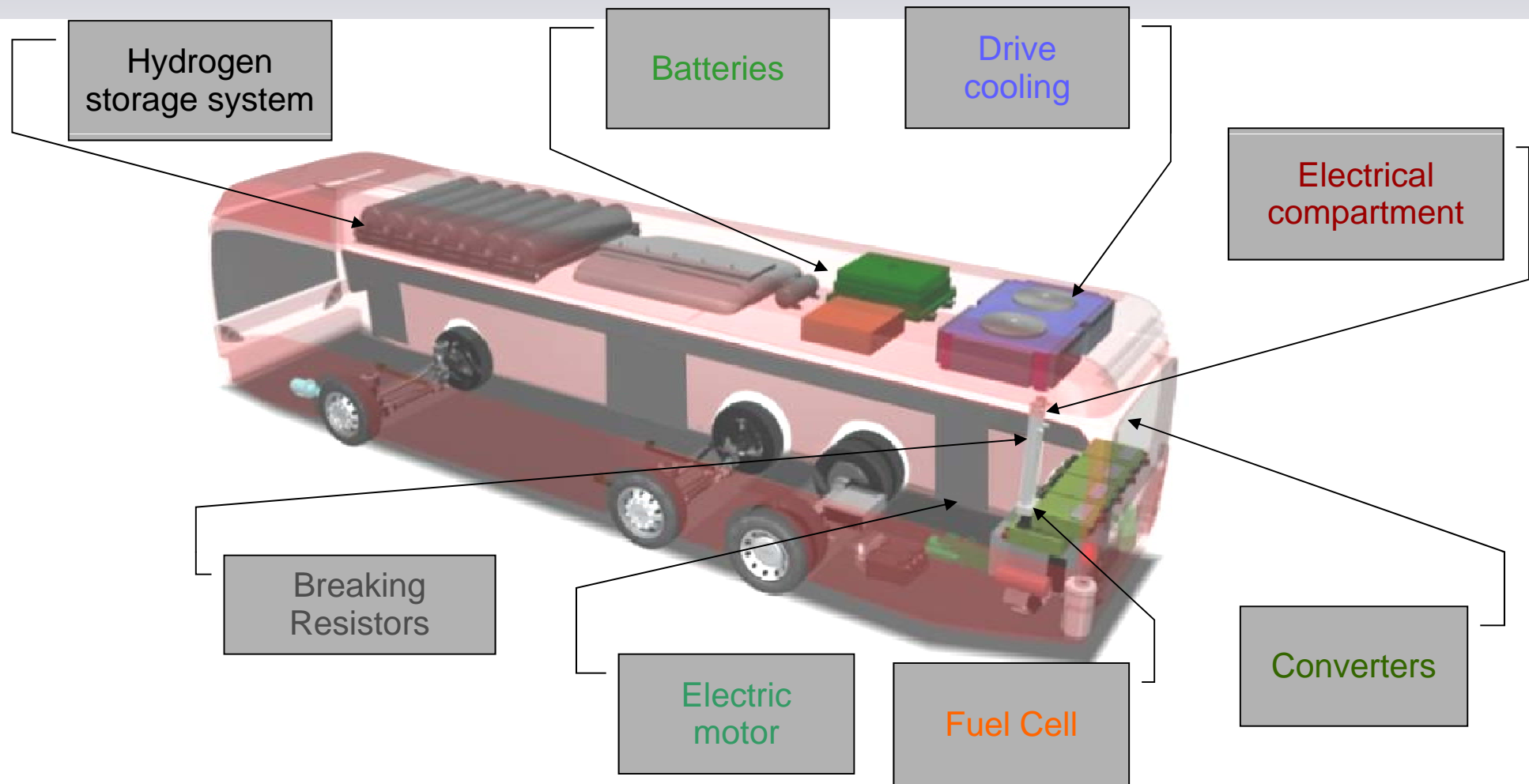
Key technical data of the FC buses

		Phase 0 regions		Phase 1 regions		
		APTS	New Flyer	Citaro	Wrightbus	Van Hool
Key Technical Data of the Vehicle		Unit				
Overall length	m	18,4	12,5	12	12	13,12
Net Weight	kg	16.650	13.000	13.400	11.707	16.900
Max. Passenger Number	No.	120	97	76	49	74
Number of Axles	No.	3	2	2	2	3
Drive Power	kW	200	2x 85 kW	2 x 80	2x 67	2x 85
Power Fuel Cell System	kW	140	Lithium Phosphate	140	75	150
Energy Storage Type (Type of Battery, Supercap)		Li-Ion battery+ Supercap		Li-Ion battery	Ultracaps	Li-Ion battery
Energy Storage Power	kW	approx 100		250	105	100
Energy Storage Capacity	kWh	Supercaps : 2 Battery: 25	47	26	0,748	17,5
Hydrogen Cylinders (@350 bar)	No.	8		7	6	7
Storage Capacity	kg	40		35	46.2	35

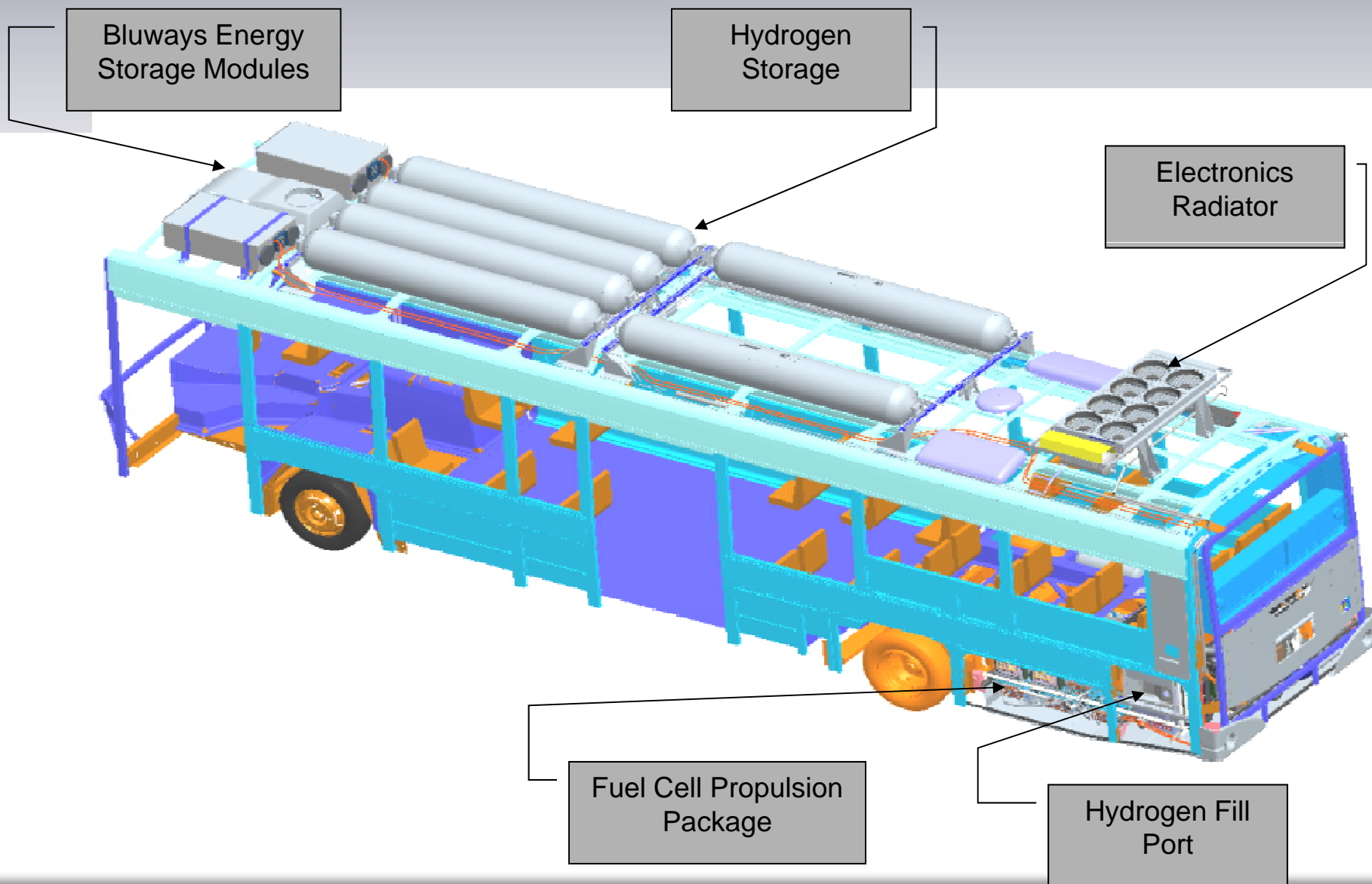
Citaro FuelCELL-Hybrid and its main components



Van Hool A330 FC Bus



Wrightbus FC Hybrid



Sustainability assessment of the use of FCH buses



- **Performance assessment**
 - Monitoring of operation of H₂ infrastructure and H₂ buses
- **Environmental assessment**
 - Environmental profile of the system, incl. LCA
 - Land use and related impacts of fuel production
- **Economic assessment**
 - Development / enhancement of life cycle cost model covering H₂ infrastructure and vehicles
 - Target costing for benchmarking with other alternative buses
- **Social acceptance**
 - Investigating the causative drivers behind different attitudes and perceptions of hydrogen powered public transport buses

CHIC dissemination executed at two levels

The dissemination and outreach is addressed by a separate work package, with two levels of dissemination:

1. General dissemination

- Internal Project Dissemination
- Global Project Level engaging EU and international projects
- Special Events: UITP Annual Conference, CIVITAS Annual Forum, EU Sustainable Energy Week, H2 & FC Fair, F-Cell Stuttgart

2. Dissemination to Phase 2 cities to prepare for FCH powered bus integration in the near future

- Engagement of local and regional transport authorities
- Special Events: Busworld Europe, International Transport Forum

Current Progress in CHIC Cities

Cologne

- Hydrogen is a byproduct from the local chemical industry
- HRS designed, built and maintained by Air Products, current capacity for 4 buses (100 kg/day, 350 bar), modular scale up for 8 buses already planned
- 2 APTS 18-meter articulated hydrogen buses in operation from May 2011, 11700 km driven up to the end Sep 2011
- Buses serve the Rhein-Erft district and the inner-city traffic of Hürth and Brühl



Current Progress in CHIC Cities

Hamburg

- 2 first Citaro FuelCELL hybrid buses handed over in August 2011, in total 7 buses will be operating in 2012
- Buses are refuelled in the refurbished CUTE station, in operation since 8 years. The new station will open end of November 2011 (720 kg/day capacity, 50% onsite electrolysis)



Current Progress in CHIC Cities

Whistler

- BC Transit is an historical non european partner, also participating in the previous HyFLEET:CUTE project
- 20 hybrid FC buses, the biggest FCH bus fleet in the world (only 3 diesel in Whistler village!)
- 1.4 million km driven after 21 months of service
- Hydrogen delivered liquid by Air Liquide, who also built and maintains the refueling station



Current Progress in CHIC Cities

London

- First 5 vehicles entered into service in Jan 2011, operating equivalent to diesel buses (up to 20 h/day), 8 FCH buses in total from Jan 2012
- 77,200 km driven up to the end Sep 2011
- First HRS consist of two 350bar dispensers and 500 kg HP storage refilled with the Air Products dual phase tanker fleet



Thank you for your attention!

For more information: www.chic-project.eu

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