Clean Hydrogen In European Cities CHIC

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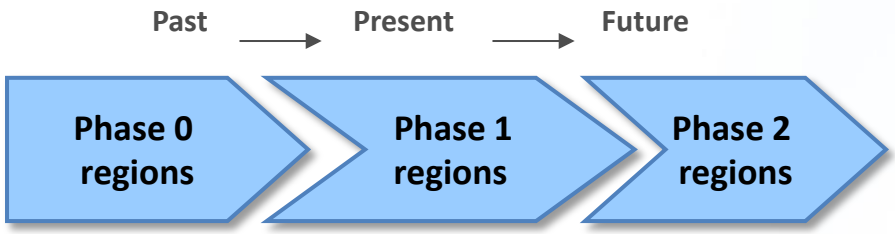
http://chic-project.eu/

PROJECT OVERVIEW

City Involvement



H_2 Infrastructure & 26 H_2FC Buses

Stage of Implementation

In Brief

- Call: SP1-JTI-FCH.2013.1.1
- Category: Transport and Refuelling Infrastructure
- April 1,2010 - December 31, 2016 (81 months)
- €25.83 Mio. EU funding /€81.8 Mio total funding
- **23 partners** from **8 countries** (10 transport companies; 8 industry partners; 5 research / consultants)
- **26 fuel cell buses** operated in 5 Phase 1 cities; together with Phase 0 cities more than **56 H_2FC buses** demonstrated in total, plus **4 ICE H_2** buses

PROJECT TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
AIP : Hydrogen Infrastructure			
Capacity of 200kg/day, upgradable to 100 vehicles per day	Capacity of 200kg/day; upgradable to 100 vehicles per day (400kg)	All Phase 1 cities have installed the required refuelling capacity and ensured 'up-gradability'	100%
Availability of station 98%	Availability of station 98%	> 98% at most sites > 93% at all sites about 96% across all sites	100%
Production efficiency target 50-70%	Production efficiency target 50-70%	> 50% except one site	100%
Additional target	Replacement of 500.000l diesel fuel	Phase 0 cities: 2.797.940 Phase 1 cities: 1.207.839	100%

PROJECT TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
AIP: Fuel Cell Buses			
>4000h lifetime initially, min.6000h lifetime as program target	Fuel cell lifetime > 6000h	7.886h/bus excluding ICE buses in Berlin	100%
Fuel consumption < 11-13kg/100km depending on drive cycle	Average fuel consumption < 13kg depending on drive cycle	12,0 kg/100km (excl. ICE H_2 & incl. 18m buses) 9,8 kg/100 km Phase 1 cities (12m, 13m in Oslo)	100%
Additional target	Minimum running distance of 2,75 Mio km of fleet	8,35 Million km	100%
Additional target	Minimum of 160.000h of operation of fleet	425.854h	100%

PROJECT TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement & explanation
AIP: Targets that present challenges for CHIC			
Hydrogen purity and vehicle refueling time (according to SAE or analogous specification)	Hydrogen purity and vehicle refueling time (according to SAE or analogous specification)	Refuelling times have been fully achieved Hydrogen Purity measurement an issue	100% 95% Hydrogen purity is not an issue in CHIC
OPEX < 10€/kg (excl. tax)	OPEX < 10€/kg (excl. tax)	All available OPEX figures from the Phase 1 Sites currently exceed the 10 €/kg	<5% Contractual arrangements (such as service charges) may keep OPEX at a rather high level in the Cities
Availability > 85% with maintenance as for conventional buses	Average availability of fuel cell buses > 85%	70% based on operation time	100%. Steady improvement occuring as technical issus resolved

CHIC ACHIEVEMENTS COMPARED STATE OF ART

	Current status NREL Report (Range)	NREL Ultimate Target	Current status CHIC	Comment
Bus Lifetime years/km	2.5-5 years/ 12.347-175.263 km	12/804.500	1-4,5/ 33.351 - 205.915	Similar bus life time
Range km	233-473	483	213-438 excluding ICE H_2 buses in Berlin	Comparable operating ranges
Fuel Economy kg H_2/100 km	9,26-16,34	8,82	8,0-16,4 (16,4 Kg is for 18 m, all NREL values are for 40 ft buses)	Slightly better fuel economy in CHIC
Bus Availability	45%-72%	90%	38%-85%	Availability remains a challenge in all bus projects

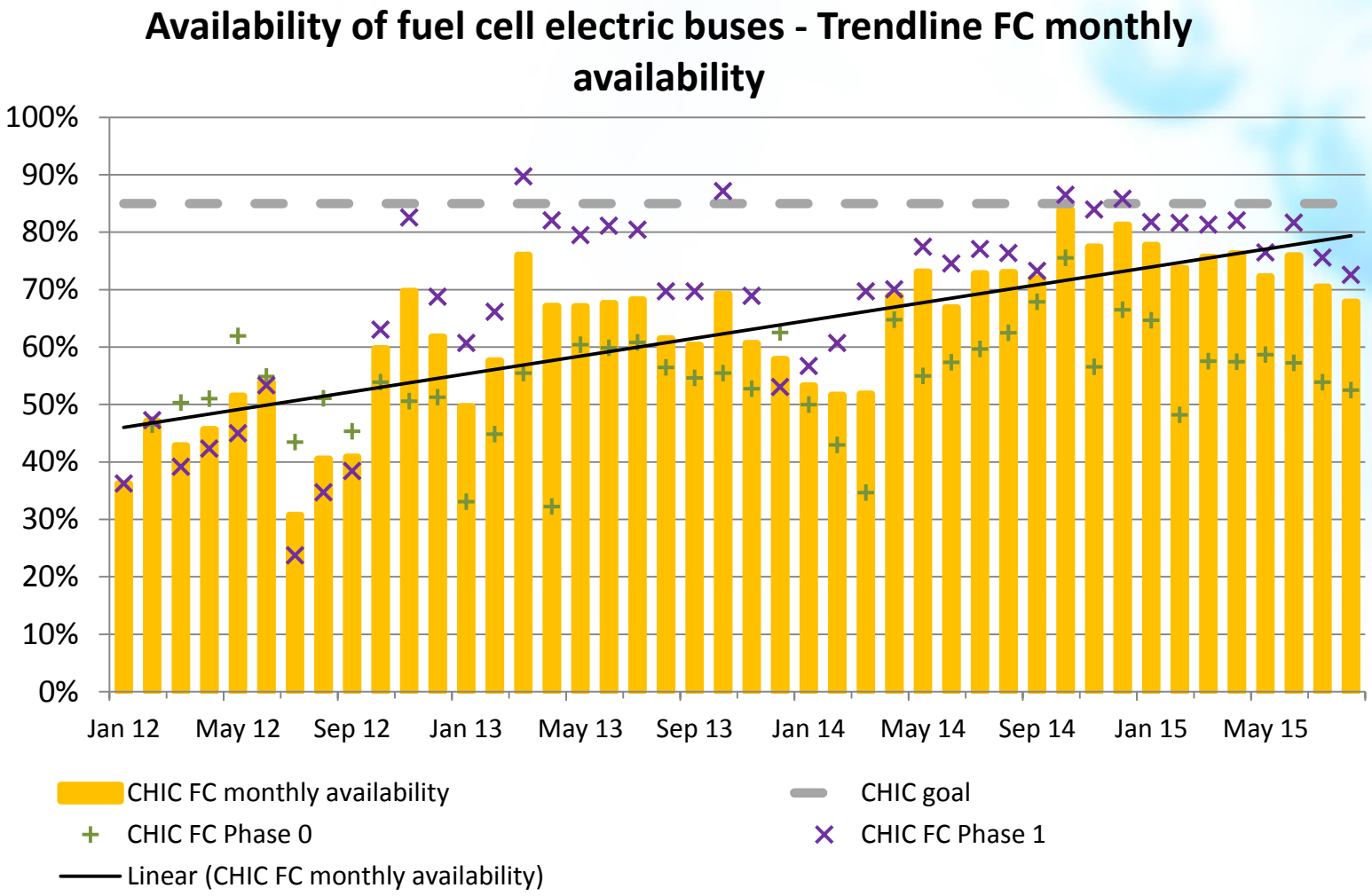
Next Steps?

- The CHIC cities are:
  - Continuing to add to learning on the technology until end 2016
  - considering continuing the operation of fuel cell buses after the end of the project in December 2016
  - considering adding fuel cell buses to their current bus fleet
  - participating (most) in the FCH JU Fuel Cell Bus Commercialisation Study, which is making plans to deploy a larger pan-European fleet of 300-600 buses by 2020, with the explicit aim of realising cost reduction.
- Supporting additional EU-funded projects deploying fuel cell buses which have started since the inception of CHIC:
  - CHIC continuing to engage with a range of other projects to share information (e.g. High V.Lo; 3 Emotion)
  - CHIC project partners are actively engaging with cities to become Phase 2 partners
  - The CHIC project partners have developed materials for cities interested in fuel cell bus deployment on HRS implementation procedures and investments, analysis on bus workshops investments, lessons learnt on trainings etc.

RISKS AND MITIGATION

- Bus Availability Target: > 85% with maintenance as for conventional buses
- Bottlenecks and risks: The move to the hybrid architecture and the daily operation closer to conventional buses has led to a considerably lower availability in the early years of the project than was the target. Monthly availability has ranged between 40% and 80%.
- An action plan from the bus OEMs, implemented after the midterm project review in January 2014, has successfully managed and helped to bring the availability to the target level, with some cities now reaching above 90% availability in the last few months.At that time the average monthly availability for all cities was below 60%.The actual availability in August 2015 is 70% which is closer to the KPI and shows the improvements following the action plan.
- Revision of targets: No

Trend of FC Bus Availability



RISKS AND MITIGATION

- Hydrogen OPEX (Operational Expenses) Target: <10€/kg
- Bottlenecks and risks:
  All available OPEX figures from the Phase 1 Sites currently exceed the 10 €/kg target. This is partly due to low capacity factors of the units for on-site generation and therefore likely to improve with expected higher availabilities of the buses.

  On the other hand, contractual arrangements (such as service charges) may keep OPEX at a rather high level in the cities. An estimation of power prices for example in Aargau give the following values: 12,2 ct/kWh (= about EU average / power for industry) -> Efficiency of Electrolysis 70% – 50% -> Power costs of 5,80 – 8,13 €/kg H_2. Similarly the power prices in Hamburg and Oslo range from about 16 and 12 ct/kWh.
- Revision of targets:
  The 5€/kg target cannot be reached, 10€/kg may be reachable.

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES: European and International

FCH and FP projects	Nature of interaction and joint activities
CUTE/ HyFLEET:CUTE	Sequential demos of clean, hydrogen powered bus technology [H_2FC and H_2 ICE (HfC)] in public service for the first time → lessons learned used to plan and set targets for CHIC
High VLO-City	Integration of hydrogen buses in public fleets in Flanders, Liguria and Scotland → exchange of information with CHIC
HyTEC	Demo. of H_2FC taxies, passenger cars and scooters in London and Copenhagen → exchange of information (LCA Model)
HyTransit	H_2FC cell bus demo. in Scotland → exchange of information (Data reporting methodology based on CHIC)

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES: European ad International

FCH and FP projects	Nature of interaction and joint activities
3Emotion	Deployment of 21 H_2FC buses in the UK, Italy, the Netherlands, France and Belgium, as well as two new fueling stations (France & Italy) → CHIC lessons learned being shared
Fuel Cell bus commerciali-sation study / strategy	CHIC workshop held at the study general assembly in Dec. 2014; CHIC partners participated in the study and are involved in the set-up of city clusters; in addition CHIC workshops are being organised at the national clusters meetings
North America	•20 fuel cell buses in public service in Whistler until March 2014. BC Transit is a "Phase 0 city" within the project, exchanging data and knowledge •International Fuel Cell Bus Workshops: Held concurrently with Bi-Annual meeting in Hamburg 2013. Collaboration on California Workshop 2015

HORIZONTAL ACTIVITIES

Activity type	Description of activities/achievements
Training and education	On going, special training is being provided to bus drivers, technicians and emergency personnel in each participating city
Safety, Regulations, codes and standards	•Public report on the procurement of HRS •Public report on the certification of fuel cell buses and refueling infrastructure sharing the experience of Hamburg (DE), Cologne (DE), Whistler (CA), Oslo (NO), Aarau (CH), London (UK), Milan (IT) and Bolzano (IT)
Public awareness	Awareness raising among the public is mainly taking place in the cities operating the buses by means of school visits, participation in fairs or city's festivals, bus shuttle service at public events, radio and TV interviews, articles in the local press

DISSEMINATION ACTIVITIES

Activity type	Description of activities/achievements
Conferences	•Key industrial events engaging the hydrogen community •Public transport events
Workshops	<u>2013 & 2015</u> International Fuel Cell Bus Workshops Hamburg, California <u>2014/2015</u> Workshops with possible Phase 2 Cities: Stockholm and Lisbon Fuel Cell Bus Study and CHIC (EE), in the framework of the FCB commercialisation study, with possible Phase 2 Cities: e.g. Riga, Paris and London
Publications	•Eurotransport Magazine issue 3-2015 (June 2015) •EU research Results N^0 41 - 2015 •Regional publications (numerous): e.g.Umweltbuch Südtirol 2014
Other	•Bilateral meetings with other stakeholders •Awards: Swiss Energy Watt d'Or (2013); shortlisted Norwegian Transnova Prize (2014)

EXPLOITATION PLAN/EXPECTED IMPACT

What has your project changed in the panorama of FCH technology development

- Significantly improved H_2FC bus fuel efficiency
- Further proved & improved bus and infrastructure durability and reliability
- Documented technological & commercial lessons & promoted these to regions
- Contributed to regulatory framework for H_2 powered vehicles.
- Increased numbers and knowledge of OEMs and HRS suppliers in H_2 vehicles
- Provided much greater clarity about pre-conditions for commercialisation

How will the project's results be exploited? When? By whom?

- FCH JU Plan (FCS) being implemented to deploy a pan-European fleet of 300-600 fuel cell buses by 2020.
- CHIC Partners: Cities participating in FCS Phase 2: setting-up city clusters at national level, with the aim to jointly procure fuel cell buses.
- Industry partners continuing involvement in Bus and HRS production.

Thank You - The CHIC Partners

City representatives for Phase 0, Phase 1, Phase 2

ATM Azienda Trasporti Milanesi S.p.A.

BCTransit

BVG Berliner Verkehrsbetriebe

HyCologne

hy SOLUTIONS Hamburgs Antrieb Wasserstoff

infraserv höchst

London Bus Services

PostAuto DIE POST

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STA Sudtiroler TransportStrukturen A.G. Strutture Trasporto Alto Adige S.p.A

Consultants, Universities and Research

element energy

thinkstep

PLANET GbR

SPILETT new technologies

Universität Stuttgart

Industry

AIR LIQUIDE

Shell Downstream Services International BV

AIR PRODUCTS

TOTAL

DAIMLER

VATTENFALL

Linde

WRIGHTBUS

CHIC