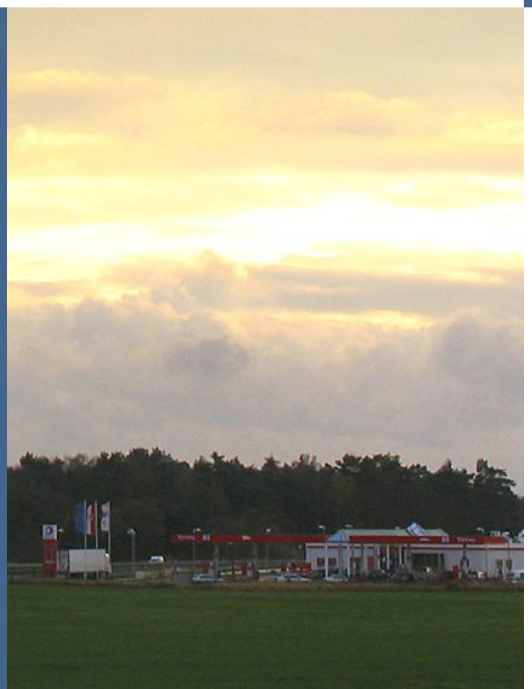


IPHE-Workshop - E-mobility

TOTAL's Activities towards Sustainable Mobility

Hydrogen Infrastructure: Existing Projects, Green Sources and Ramp-up Scenarios

Carsten Retzke
Head of Special Projects / Hydrogen
TOTAL Deutschland GmbH

July 15th, 2010 @ Ulm

TOTAL

A Snapshot of TOTAL Hydrogen Activities

HyPac Platform
HyFrance 3 WG
(French Roadmap)

FCH JU Support / Projects
NEW-IG Founding Member
H2 Prod. & Distr. AA expert

Sponsor of
UC Davis STEPS
Programme incl.
H2 Thread

TOTAL

HRS Developments
•NIP (CEP Lead)
•FP6 HyFleet:CUTE
and follower

Technical Cooperations
With OEMs & Tier I Suppliers

Signatory of
September 10th,
2009
MoU H2_Mobility
(Berlin)

DAIMLER
EnBW
Linde
OMV
OMV
TOTAL
NOW
Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie
Shell Hydrogen
VATTENFALL

TOTAL

Focus on TOTAL HRS Activities

- **Early involvement in 2002 in Berlin:**
  1st HRS to provide CGH_2 to BVG busses.

- **Further evaluation of H_2 distribution technologies & operation through different Demo programmes in the field so as :**

  - **To contribute to technical improvements,**
  - **To gain hands on experience on the day to day operation of HRS,**
  - **To evaluate the costs associated (CAPEX & OPEX),**
  - **To study the end-user behaviour (Social Acceptance).**

- **Critical to liase closely with H_2 vehicles providers (Alignment).**

TOTAL

Berlin Spandau - 2006

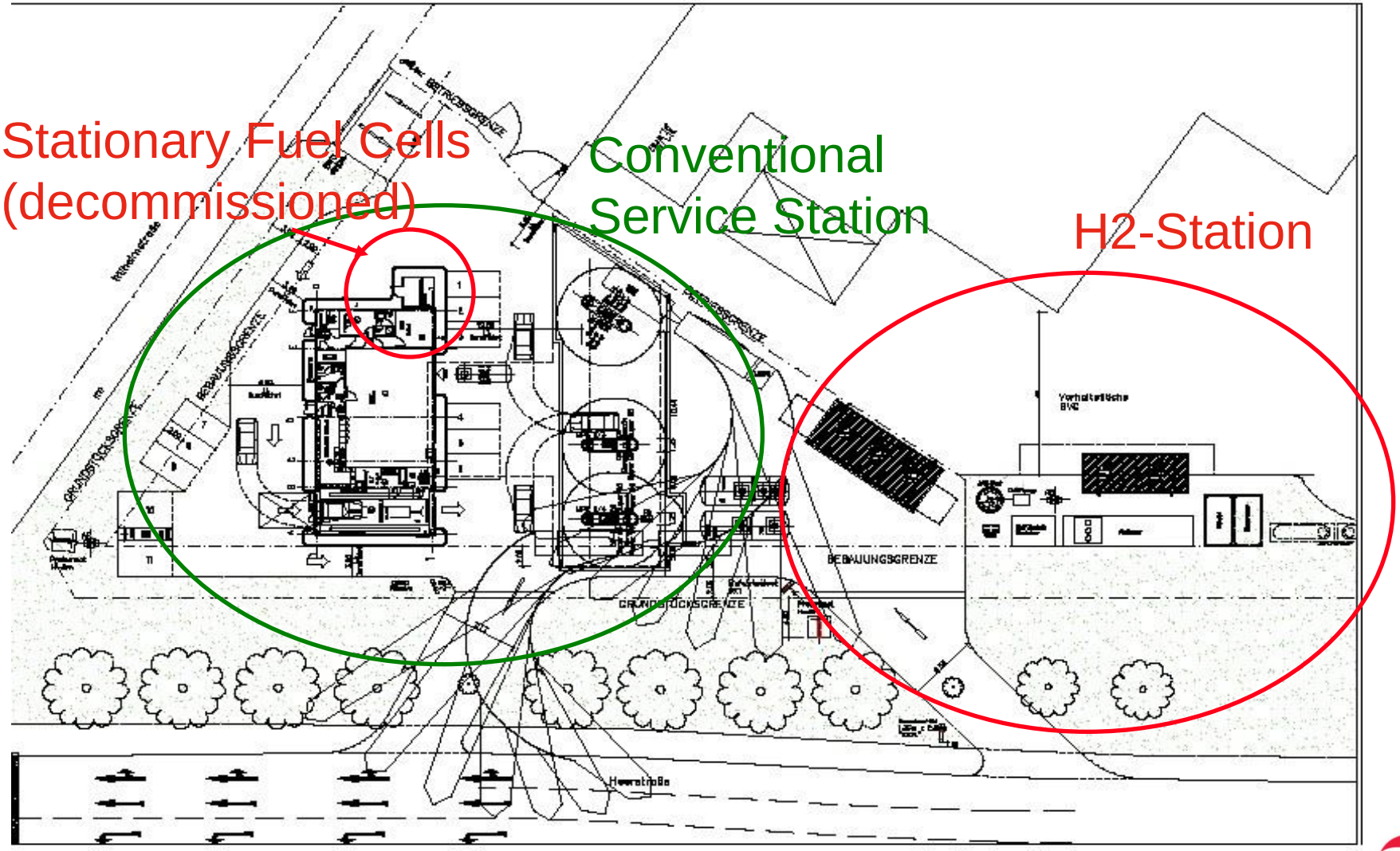
Munich
Detmoldstraβe - 2007

Brussels Ruisbroek - 2008

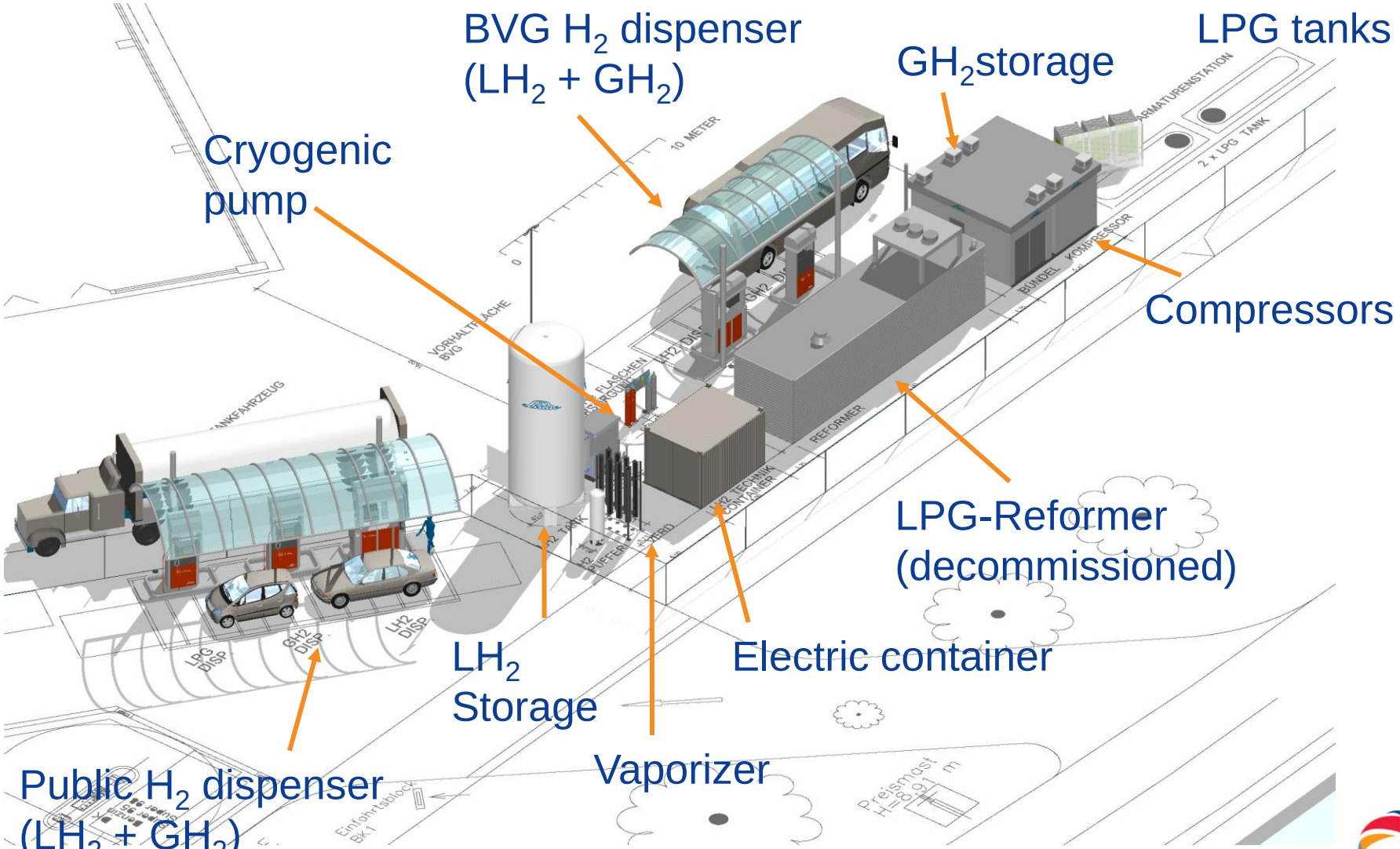
Hydrogen Station, Berlin Heerstraße

TOTAL

Public Hydrogen station of TOTAL in Berlin, Heerstrasse



Public Hydrogen station of TOTAL in Berlin, Heerstrasse



Public Hydrogen station of TOTAL in Berlin, Heerstrasse

LH_2

- Trucked-in LH_2
- Storage of LH_2 in supra-isolated Cryo-Tank (Capacity: 17,600 Liter)
- 2 LH2-Dispenser

GH_2

- Vaporisation of LH_2
- Trucked-in GH2 (200bar)
- Compression to 350 bar and 700 bar
- Piston compressor / Ionic compressor

TOTAL

HyFLEET:CUTE

TOTAL

HyFLEET:CUTE

EU-Project under the 6th Framework Program:

- 31 Partners from 12 European MSs
- Total Budget 40 Million € / EC funded 19.7 Million €
- Budget for Berlin 17 Million € / EU funded 7.2 Million €
- Project duration: 10. January 2006 – End 2009

HyFLEET:CUTE

Berlin:

- **Operation of the TOTAL hydrogen station on Heerstraße**
  - Installation of an LPG-Reformer, ionic compressor and two stationary Fuel Cells
- **Development and operation of 14 H_2-ICE buses from MAN in Berlin**
- **Scientific studies by the Berlin University of Technology**
  - Stationary Fuel Cell operation
  - Study on the use of Bio-DME (substitute to LPG)
  - Study on CO_2 capture and utilisation
  - Public hydrogen acceptance study
- **Development of a Safety Management System**

Former CUTE:

- **Continued operation of the Mercedes-Benz fuel cell buses in 7 European cities as well as in Beijing, Reykjavik and Perth**
- **Development of a new generation of hybrid fuel cell bus by Daimler**

TOTAL

Clean Energy Partnership (CEP)

TOTAL

Clean Energy Partnership Berlin (CEP)

- Unites 13 companies from France, Germany, Norway, Sweden, United Kingdom and the US
- International Public-Private Partnership
- Supported by the German Federal Government through the *National Innovation Programme of Hydrogen and Fuel Cell Technology (NIP)*
- Phase I: 2002 – 2007; Phase II: 2008 – 2010; Phase III: 2011 - 2016

TOTAL

Clean Energy Partnership Berlin (CEP)

- **Aim: Market preparation of hydrogen activities**

- **Continuation of CEP from 2008 – 2016**
  - Phase II: 2008-2010
  - Phase III: 2011-2016

- **Larger quantities of H2 vehicles**
  - Phase II: up to 40 cars
  - Phase III: several hundred cars, up to 30 busses (Hamburg+Berlin)

- **Increased H2 production**
  - Target end 2010: 20% from renewable sources
  - Target end 2016: 50% from renewable sources

- **New hydrogen stations in Berlin**
  - Improvement of the existing TOTAL station Heerstraße
  - New TOTAL station (GH2 in cooperation with StatoilHydro)
  - New joint TOTAL/ BVG station after 2010

- **Integration of Hamburg and Berlin**

CEP: Operation of station Berlin, Heerstrasse

Clean Energy Partnership CEP

Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie (nip)

Quantities refuelled

- 2009: 5,453 kg LH2 and 1,664 kg GH2 distributed to passenger cars
- 2008: 5,363 kg LH2 and 564 kg GH2 distributed to passenger cars
- In 2007: 2,777 kg LH2 and 230 kg GH2 have been distributed to 16 passenger within CEP

TOTAL

CEP: Upgrading to 700bar in 2008

Clean Energy Partnership
CEP
Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie
nip

700bar Technology

- World premiere: Infrared interface for data communication between car and station
- Ultra-Low Cold-Fill (-40°C)
- Refilling 5kg hydrogen within three minutes to passenger cars at 700bar

TOTAL

Clean Energy Partnership
CEP
Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie
nip

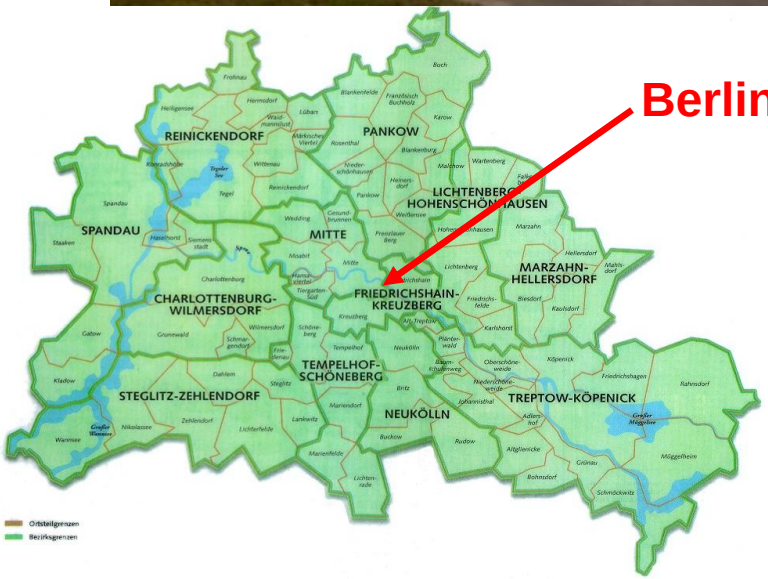
Hydrogen Station, Berlin Holzmarktstr.

TOTAL

TOTAL Holzmarktstreet: The Vision

- Fully integrated hydrogen station downtown Berlin
- Refuelling for 700bar cars and 350bar cars and busses
- Self-Service 24/7
- On-Site production of hydrogen via electrolyser
- Use of green power, orientated on the real time availability from renewable sources
- Integration of further applications such as H2 micro CHP system, LH2 dispenser with boil-off management, photovoltaic system, micro wind turbines

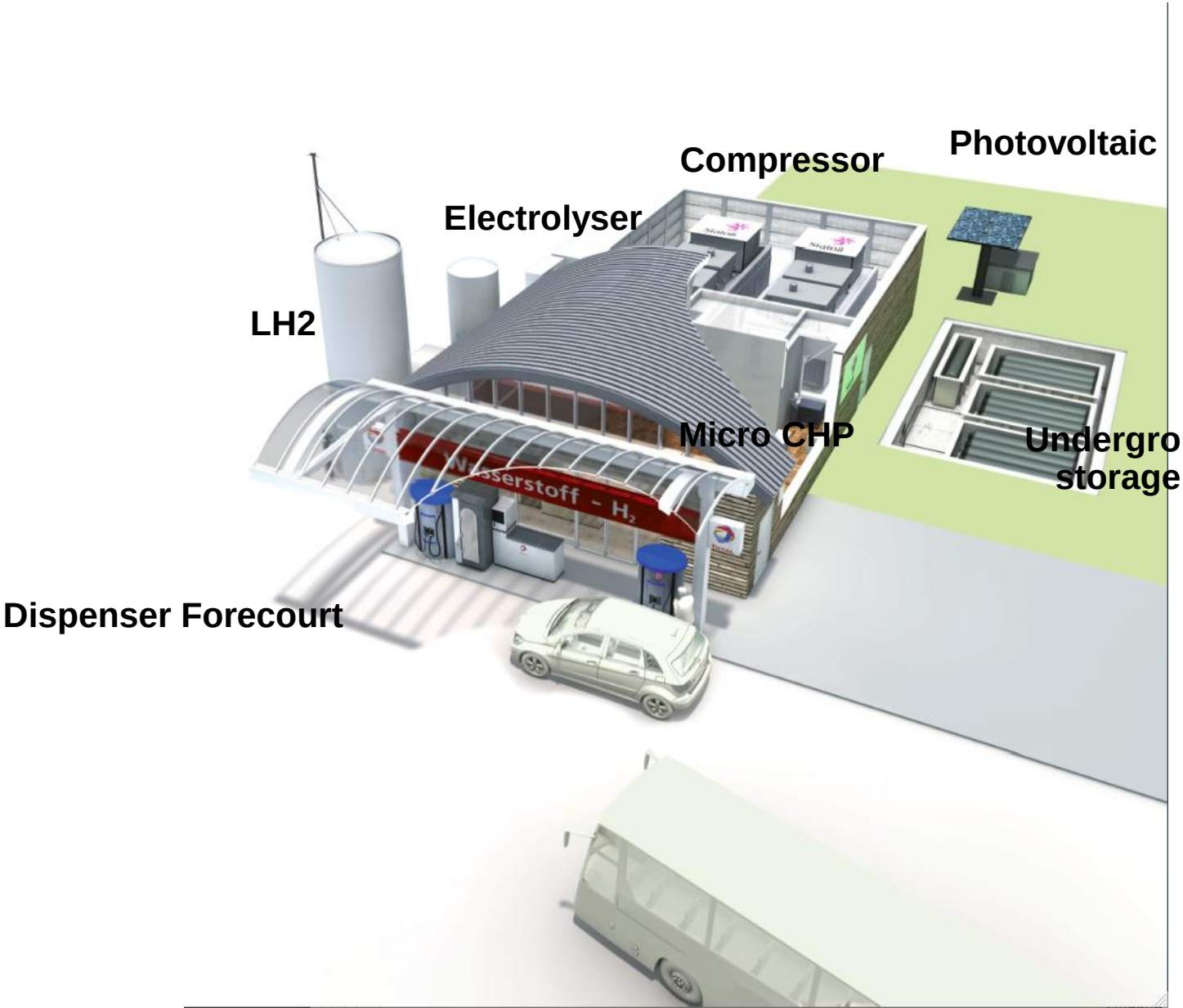
TOTAL Holzmarktstreet: Location Berlin Downtown



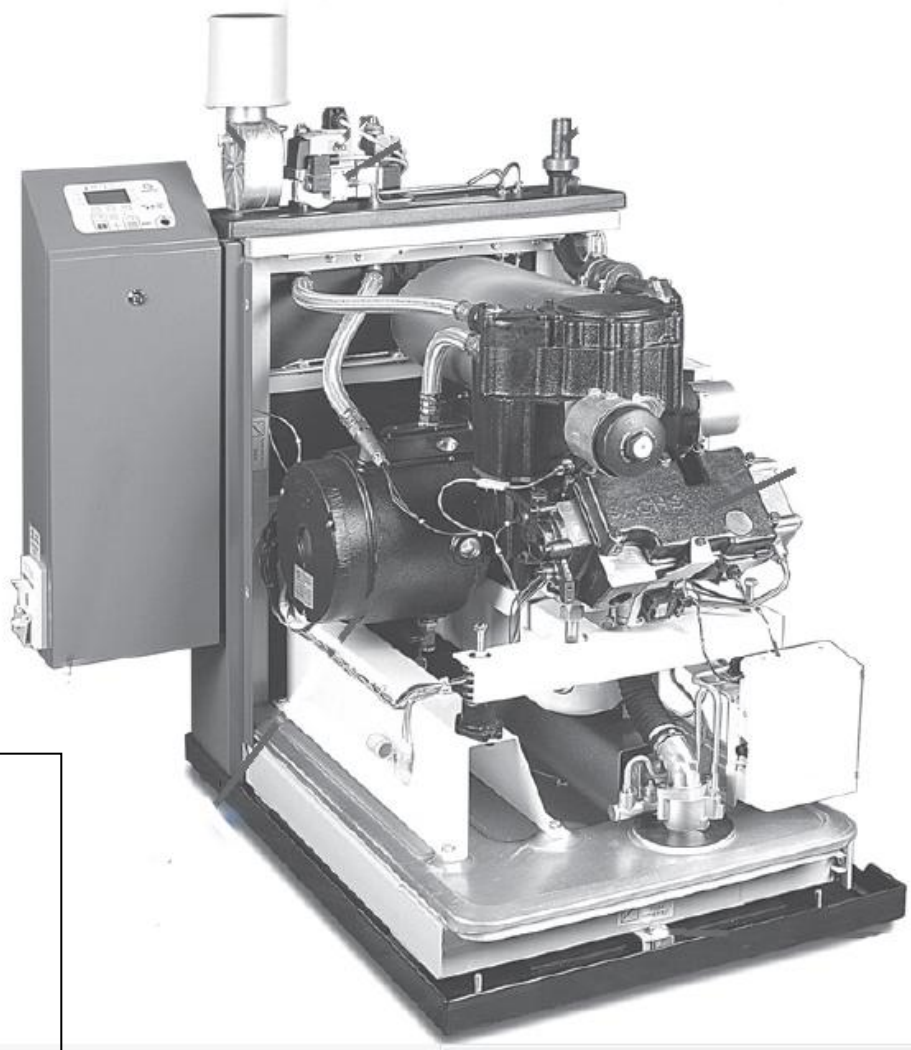
Berlin Holzmarktstreet 36-42

- **Site integrated in an existing TOTAL retail station**
- **500 meter South of the Berlin City Hall**

TOTAL Holzmarktstreet: General System Layout



TOTAL Holzmarktstreet: H2 Micro-CHP System

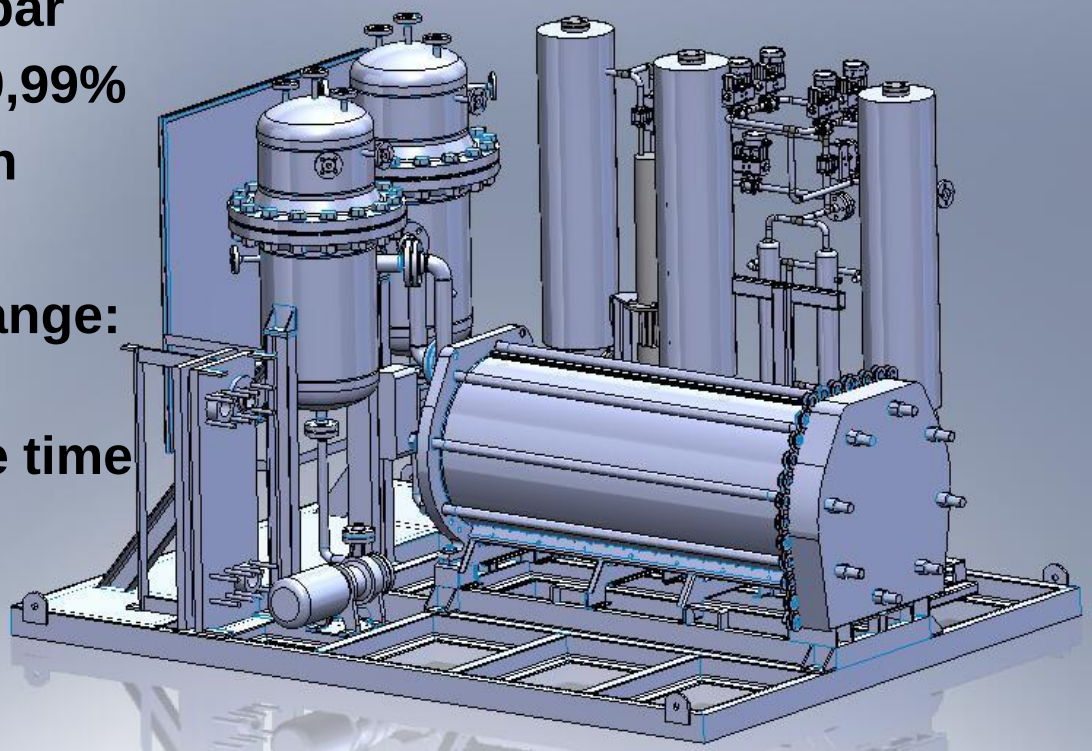


5kWh electrical: additional electricity supply H2 station

12kWh heat: heating of the conference centre

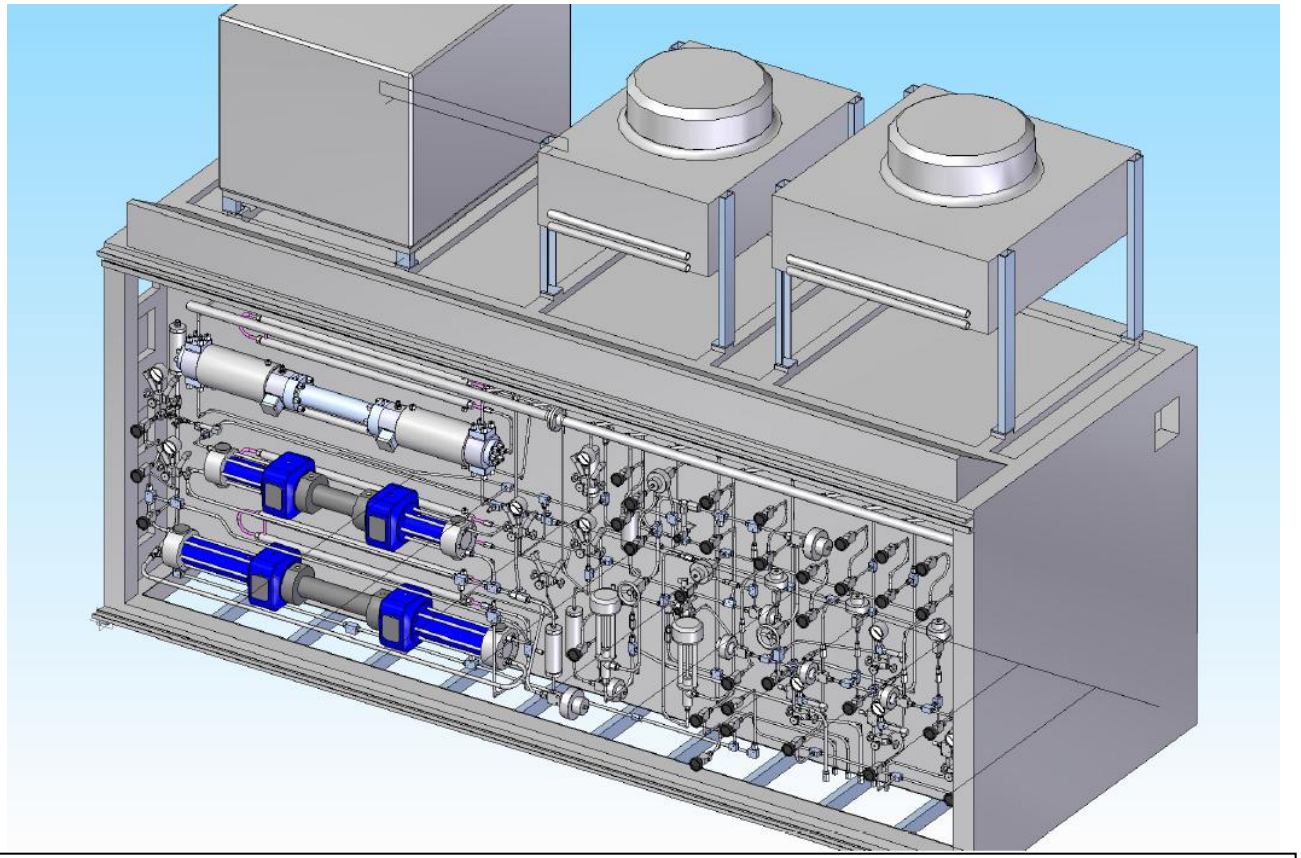
TOTAL Holzmarktstreet: Pressurized Statoil Alkaline Electrolyser

- Alkaline technology
- Up to 60 Nm^3/h
- Pressure: 15 bar
- Gas Purity: 99,99%
- Robust design
- Compact
- Operational range: 5 – 100%
- Fast response time
- Containerised solution
- Turn Key



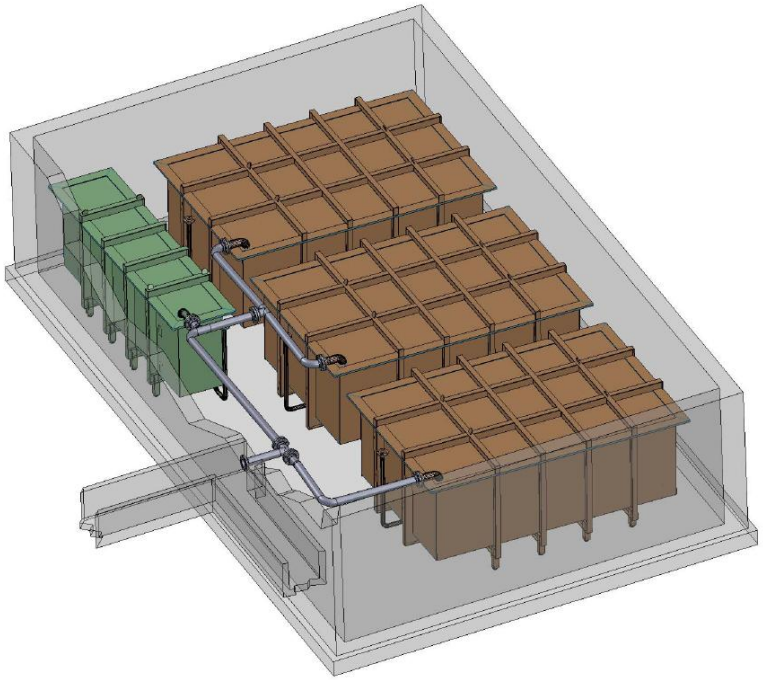
TOTAL

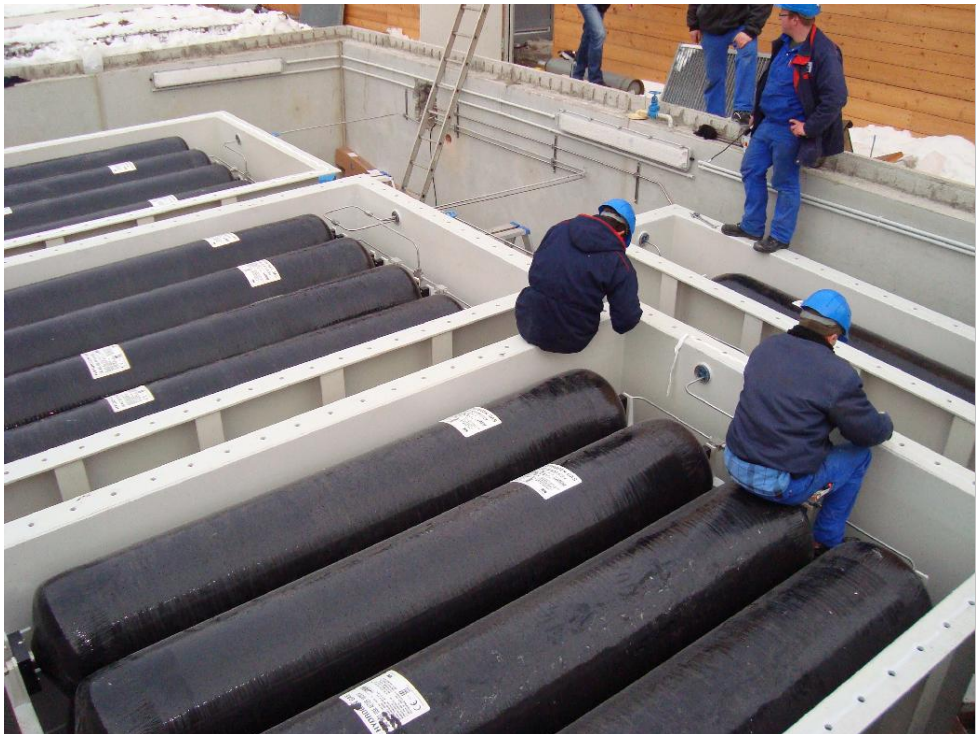
TOTAL Holzmarktstreet: High Pressure Compressor System, developed by Hofer, integrated by Statoil



- Based on serial system from Hofer
- Robust, approved and reliable technology
- Flexible operation 5 - 100%
- Maximum Pressure of 500 bar and 1050 bar

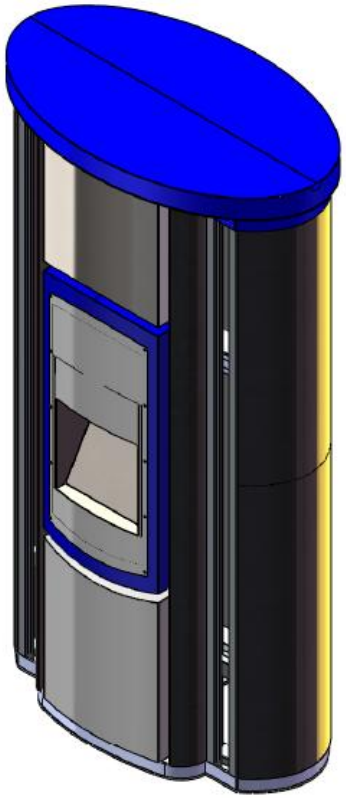
TOTAL Holzmarktstreet : High Pressure Underground Storage





- 2 x 250l 105 MPa + 24 x 520l 50 MPa
- Storage coffins filled with water / glycol mixture
- Leakage detection, temperature sensors

TOTAL Holzmarktstreet : Integration Concept for the Forecourt



- 70 MPa dispenser with IR Communication
- LH2 dispenser
- 35 Mpa dispenser with two nozzles
- Card reader

TOTAL Holzmarktstreet: Energy from Renewable Sources

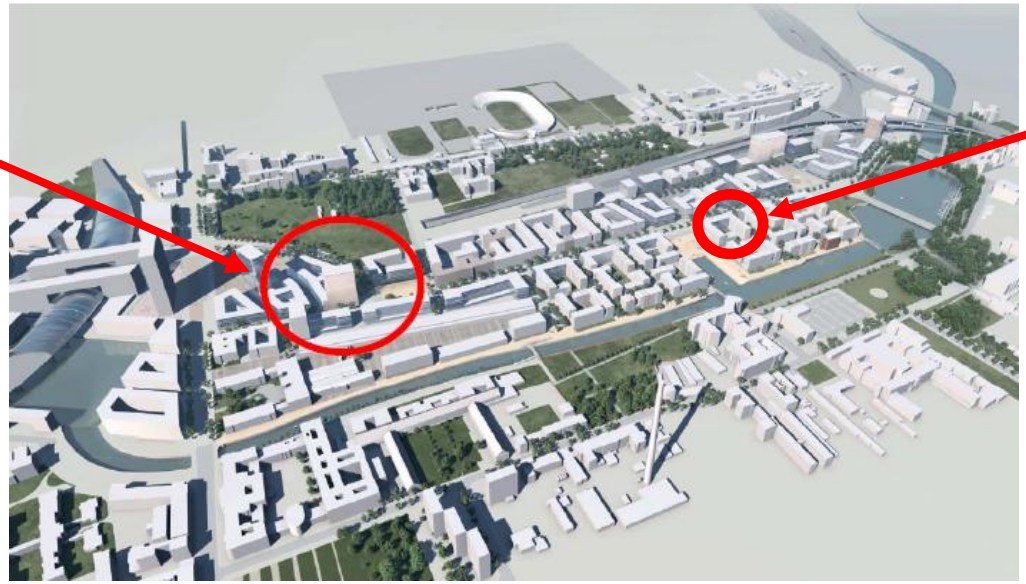
- **Green energy is used for the electrolyser.**
  A system for a certified supply - orientated on the real time availability of renewable energy in Germany - is in preparation.

- **The integration of a photovoltaic system gives the possibility to generate real-time data for further evaluation.**

- **Planned micro wind turbines are not feasible in the moment. This is caused by absence of the needed products (size, noise reduction) and resistance from some local authorities.**

Within the framework of NIP/CEP incl. Konjunktur Paket II, TOTAL is committed to deploy new HRS in Germany (Pilot Region) esp. In Berlin & Hamburg as a 1st step.

New Headquarter TOTAL



TOTAL Station with H2 integration (35/70MPa)

Study with Enertrag - Hydrogen production

- Enertrag is operating more than 400 wind mills in Germany, France and the UK (Investment volume of more than 850 Mio Euro)

- Enertrag builds the first German Hybrid Power Plant:
  - Production of hydrogen from Wind-Power through electrolysis
  - Production of Biogas
  - feedstock for production of electricity and heat or feed into the natural gas grid
  - Use of Hydrogen for Transport Applications

- Demonstration project start in 2010 (electrolyzer with 120 Nm^3/h, Biogas unit of 625 kW el, production capacity of 350 kW el with 30% from Biogas and 70% from H2.

Result of the Enertrag and TOTAL joint study:

- Production of > 3 ton H_2 per day in the Berlin area

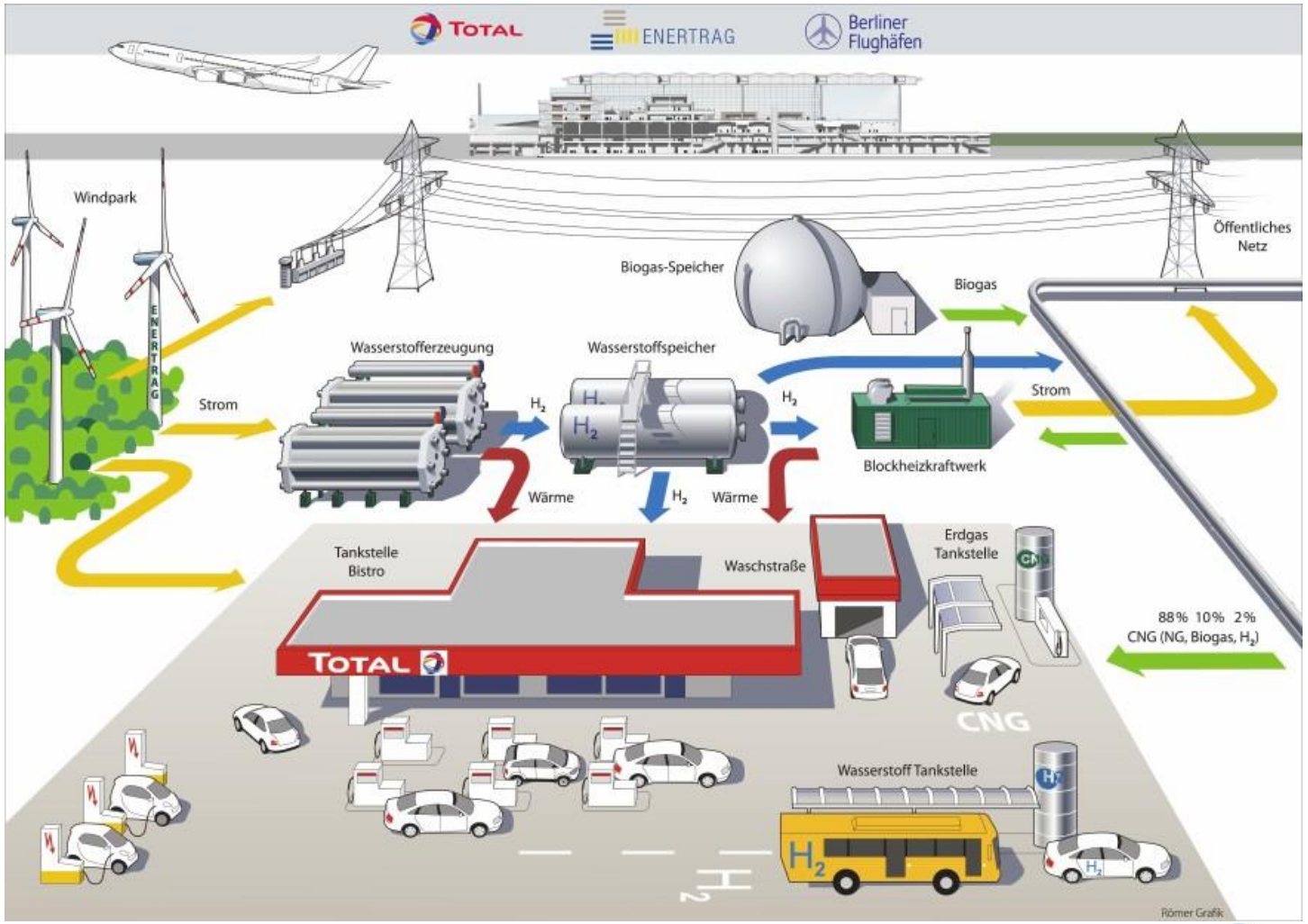
Outcome: Price H_2 # 8€/ kg with current technology

TOTAL

Berlin Airport: Hydrogen production, storage a

Building the first CO2-free Station

- Windparc
- Biogas
- Electrolyser
- Storage
- H2-Distribution
- integrated CHP
- feed into natural gas network
- GH2 dispenser



a Way Forward : the H2-Mobility initiative

DAIMLER EnBW THE LINDE GROUP NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

OMV SHELL TOTAL VATTENFALL

- A strong Partnership of motivated Stakeholders,
- Germany as a Pilot Region for Europe,
- Additional Partners (Air Products, Air Liquide) has joint

✓ Leading industrial companies to agree upon a built up plan for a nationwide infrastructure

✓Significant expansion of hydrogen fuelling stations network by the end of 2011

✓Important milestone on the way to emission-free mobility

✓Leading vehicle manufacturers pursue the development and commercialization of electric vehicles with fuel cell. Commercialization with several hundred thousand units anticipated from 2015 onwards

TOTAL

Organisation of the H2-Mobility Consortium

- **2 successive Phases defined :**

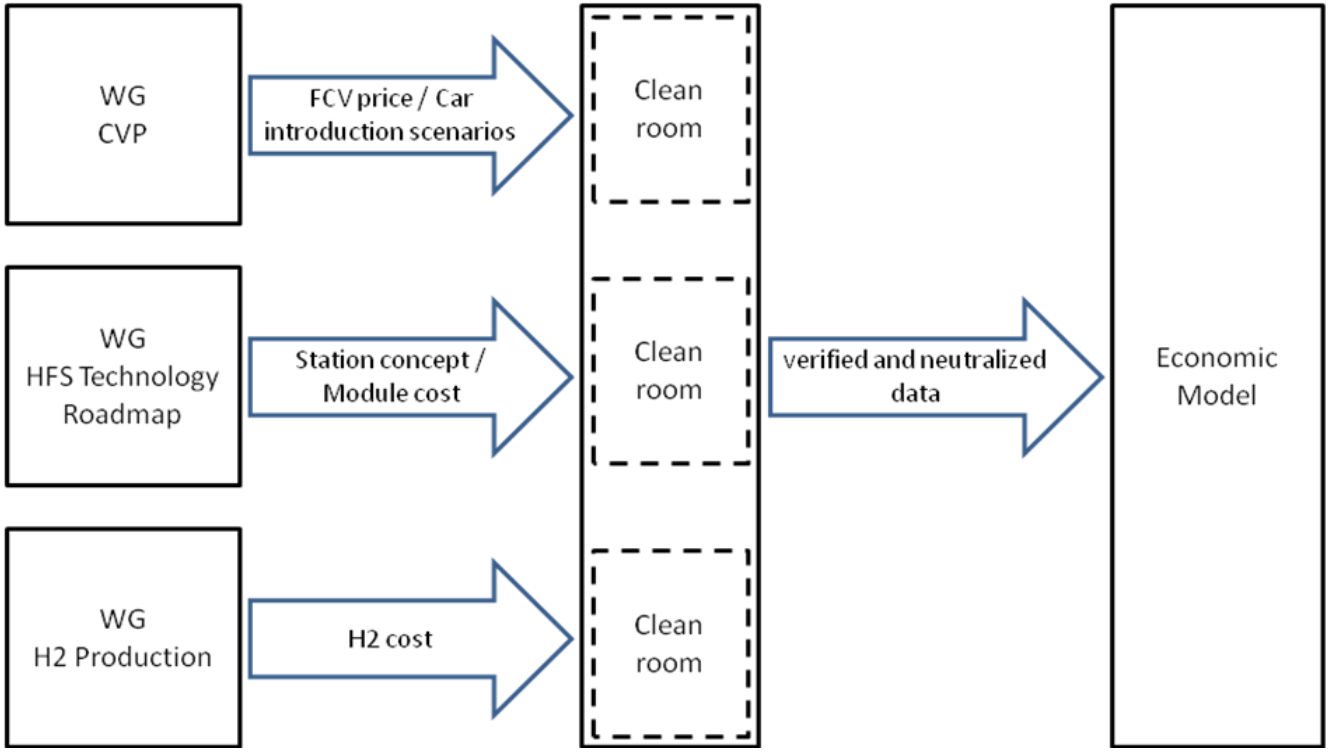
  - **Phase 1: 2009-2011**
    - Technico-economical evaluation of the feasibility to deploy a network of HFS alongside the expected deployment of FCVs in Germany by 2015 (2009 - 2010)
    - Definition of the future Consortium Agreement Contract / Partners negotiation phase (2011)
    - Deployment of new HFS supported by the German Administration (Konjunkturpaket II subsidy scheme)

  - **Phase 2: 2011+**
    - Implementation of the Business Plan defined in Phase 1 through the agreed definitive agreement between partners

Organisation of the H2-Mobility Consortium

9 WGs set up to achieve Phase 1:

- CVP, Economic Modelling, H_2 Production & Supply, Future Consortium, Environment, HFS Technology Roadmap, Legislation, Incentives Schemes, Marketing & Communication.



A Way Forward : the H2-Mobility Initiative

"Our field experience gained over the years in siting Hydrogen Refuelling Stations in Germany has allowed us to demonstrate that hydrogen based technologies may provide a sound answer to clean mobility. A significant leapfrog for both hydrogen vehicles & infrastructure deployments is now required, and this agreement intends to achieve this ambitious target."

Michel Mallet, Managing Director, Total Deutschland GmbH (September 10, 2009)

TOTAL

TOTAL

Thank you for your attention!