HYDROGEN

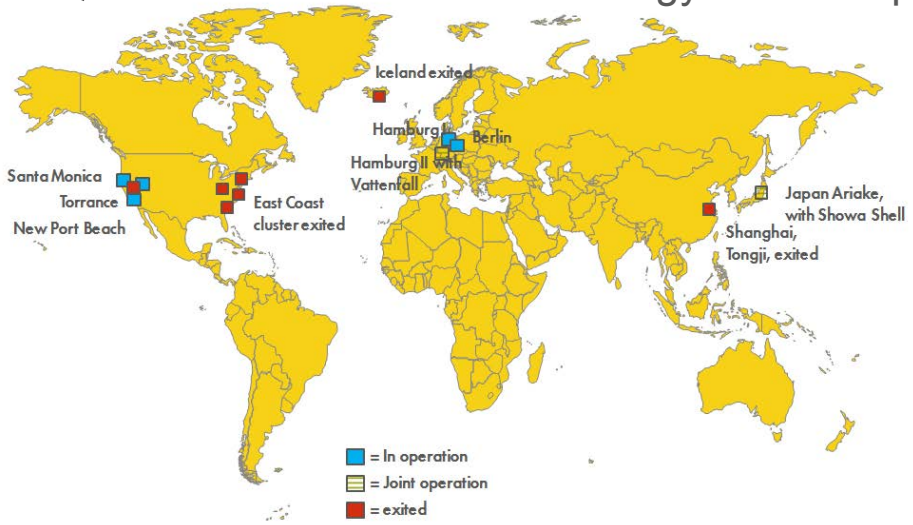
PROVIDING INFRASTRUCTURE

Herie Soto

Hydrogen Technology, US

SHELL HYDROGEN JOURNEY – OVER 15 YEAR HISTORY

1999	Shell Hydrogen founded
2003	H_2 project starts up in Washington DC with GM
2005-08	5 more HRS introduced in NY and CA
2008	Increased focus on Germany and CA
2009	Vehicle demand did not materialize. Closure of 5 H_2 Stations begins in East Coast
2011/12	Torrance and Newport Beach (CA) H_2 stations open
2011/13	Berlin and Hamburg stations open
Q4 2013	H_2 Mobility term sheet signed
Q3 2014	H_2 Mobility JV agreement signed
Q1 2015	Hamburg HRS opened (March 16)
Q2 2015	H_2 Mobility JV starts
Q3 2015	UK HRS announced
Q4 2015	Chair of Clean Energy Partnership



SHELL HYDROGEN ACTIVITIES

- Retail fuelling operations in Germany and the US (California)
- Stations demonstrate onsite SMR, electrolysis, compressed hydrogen gas delivery, liquid hydrogen, pipeline gas
- Extensive growth planned for German retail network
- Stations announced for United Kingdom market
- Investigating more market opportunities.
- R&D in flow metering, quality control, liquid hydrogen, dispensing and onsite production (electrolysis, SOFCs, SMR)
- New hydrogen lab being constructed in Amsterdam.
- Leader in establishing standards for safe dispensing of hydrogen.
- Interested in developing other aspects of value chain, e.g. wind to hydrogen production projects

SHELL HYDROGEN STATIONS - CALIFORNIA

Torrance

Newport Beach

	Torrance (Los Angeles)	Newport Beach
Start up	2010	2012
Supply	H2 Pipeline	On site reforming
Delivery pressure	350 / 700 bar	350 / 700 bar
Capacity	50 kg/ day	100 kg/ day
Utilization	70 %	10%

SHELL HYDROGEN STATIONS - GERMANY

Berlin

Hamburg Bramfeld

HH Schnackenburgallee

	Berlin	Hamburg I	Hamburg II
Start up	2011	2013	Q1 2015
Supply	Liquid	Gaseous	PEM Electrolysis
Delivery pressure	350 / 700 bar	700 bar	700 bar
Capacity	1000 kg/ day	70 kg/ day	80 kg/ day
Utilization	< 5%	< 5%	tbd

RECENT ACHIEVEMENTS

- **H2 Mobility Germany JV** (400 HRS program): company founded, officially launched, first 7 stations are under permitting and construction
- **UK**: agreement reached with ITM and FCH-JU to deliver 3 refuelling stations in the Greater London Area; first station open mid 2016
- Opened **3rd station in Germany** in 2015 (Proton's electrolyser)
- **Technology innovation funnel** filled with projects to support the commercial program: onsite production of hydrogen, quality sensor devices, safety, standards, cost reduction. Opening of H2 lab in Amsterdam
- **US**: successfully certified to sell hydrogen at Newport Beach. California remains a very important market.
- **Germany**: Chair of Clean Energy Partnership
- Working closely with **Partners** (OEMs, IGCs, Governments)

….and pursuing **new projects** which have to be remain confidential for now.

WHY DOES H2 MOBILITY GERMANY JV WORK? IT SHARES RISKS AND COORDINATES STATION ROLLOUT WITH VEHICLES

Hydrogen mobility – "chicken and egg" situation

- Full Cell Electric Vehicles (FCEVs) will only be bought by customer if there is refueling infrastructure
- Refueling infrastructure is only commercially attractive if there are FCEV customers

Solution – aligned ramp-up of FCEVs and stations

Main objective of H_2 Mobility

- Coordinate activities for ramping up FCEV and hydrogen refueling infrastructure.
- Develop a basic hydrogen refueling infrastructure in Germany to enable the launch of series-produced FCEVs.
- Overcome risk of market failure through joint cross-industry action until infrastructure buildup is commercially viable.

H2 Mobility is a success if…

- Hydrogen mobility is established in Germany and becomes a business opportunity beyond a first phase.
- A large number of coalition members jointly create this new market.

HYDROGEN REFUELLING STATION CHALLENGES

Technical

- HRS need to be integrated into existing network – (**reduce footprint**)
- Increased accuracy of flow meter needed (need to **sell hydrogen**!)
- Installation of HRS to be "plug and play" (**limit time on site**!)
- Power requirements need to reduced

Commercial

- Operational costs are still high (**unreliable equipment)**
- Communication to general public (**urgent need to communicate** more)
- Vehicles (remains the **biggest risk**)
- Permitting could be speeded up (work on communication, standards, etc.)

But – costs are coming down with more suppliers entering the market. Good to see OEMs announcing vehicles.

HOW CAN THE REGULATOR HELP?

Considerations

- **(Joint) communication**: (i) an FCEV is an EV; (ii) de-mystify the technology to public in a fact based manner; (iii) explain the technology is safe
- **Research & development support** – this remains crucial to reducing footprint, increasing reliability & performance of equipment
- **Financial support** (capex and opex) from regulator is required over a period of time (up to10 years) to build the infrastructure ahead of FCEVs coming
- **Risk sharing** with partners is very important (OEMs, Retailers, Governments)
- Assist in speeding up **permitting**, initial **waiver for metering** hydrogen
- **Public sector fleets** – can local city councils procure vehicles?