



THE CHALLENGES OF FUTURE MOBILITY – HYDROGEN A SOLUTION?

A3PS Conference
Vienna, October 2014



SMARTER MOBILITY

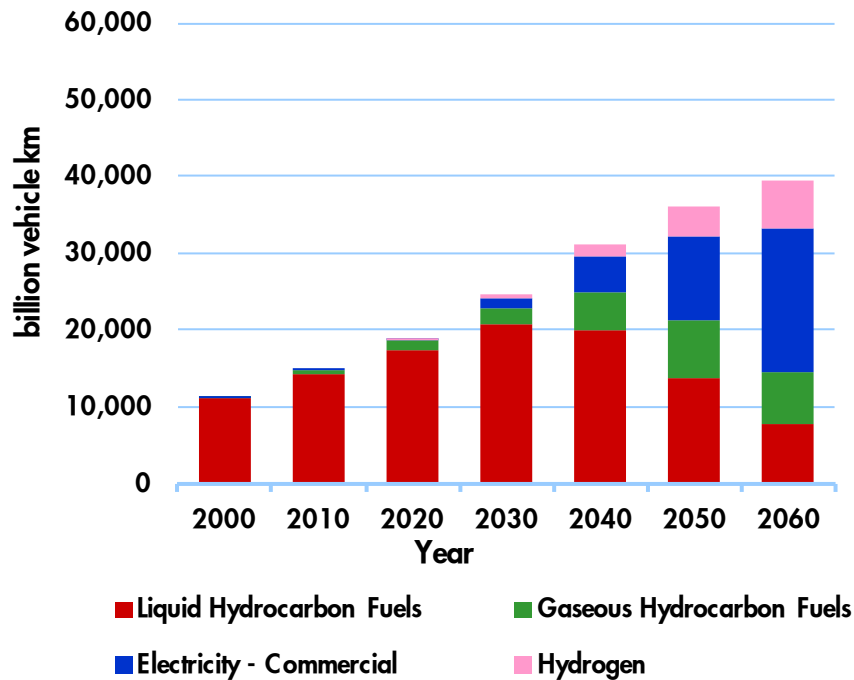


Oliver Bishop
General Manager, Hydrogen
Shell Alternative Energies

PASSENGER CARS: ALL 'ALTERNATIVES' ARE SMALL TODAY, BUT THE DIRECTION OF CHANGE LEADS TO RADICALLY DIFFERENT OUTCOMES

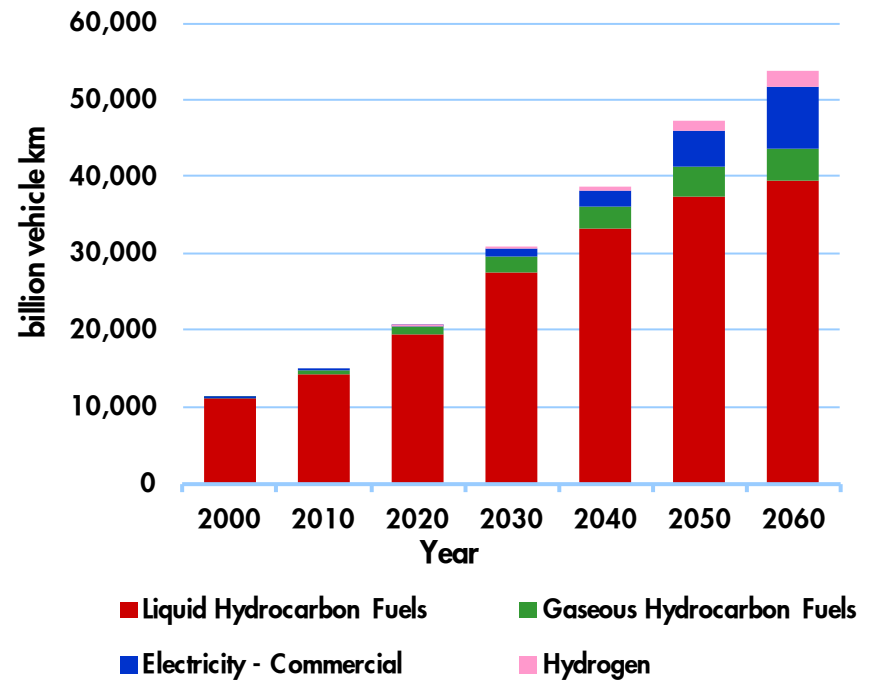
MOUNTAINS

World - Energy Service - By Carrier -
Passenger Transport - Road



OCEANS

World - Energy Service - By Carrier -
Passenger Transport - Road



THE CHALLENGES FOR FUTURE MOBILITY



Access to Energy/Fuels

- Which energy sources will meet the growing demand for mobility?



Total Cost of Ownership

- Which fuel/vehicle combination will allow mobility to remain affordable ?



World Population Growth & Urbanisation

- How will mobility & infrastructure concepts change mobility in Mega cities?



Reduction of GHG & Local & Noise Emissions

- Fuel/vehicle options for lowest amount of GHG and local emissions



New Technology Options

- Vehicle Autonomous Drive, Continuous Connectivity, Safety Features (Night Vision, active braking, distance control, advanced stability control...)



New Mobility Policy

- Taxes /Incentives to manage Mobility & Local Entry Restrictions (Cities)



Changing Consumer Values & Social Acceptance

- New consumer values – „Mobility on Demand“. Which factors drive social acceptance & the resulting uptake of new fuel/powertrain solutions?

FUTURE MOBILITY, DRIVERS AND TRENDS



Emission Free Vehicles
BEV (PHEV)/FCEV

Zero Smog Emission

GHG
Reduction

Noise Reduction

Hybridisation

Combustion Engine
Improvements

Remote Drive

Sub 'Smart'
Vehicles & Pedelcs

World Wide Harmonisation

Gov. R&D Fundings

Trade Barriers

Safety

Emission Limits
(Noise, Smog & GHG)

Lights & Brakes

Legislation



Crude Oil ends

More Gas

Advanced Biofuels

Green Electricity

Renewable Hydrogen

**New
Mobility**

Bike Share

Car Share

Mobility On Demand

Emotional Mobility

Ageing Population

Travel Time

**New Consumer
Values**

New Architecture („Live & Park“)

Urbanisation (Asia)

Suburbanisation (USA)

Traffic Density

Open Up
New Driveways

Urbanisation

Raise in
Goods Transportation

Shrinking Persons
Transport km

Online Purchase
Behavior

Change in Transportation

‘Continuous Online’ Demand & Connectivity

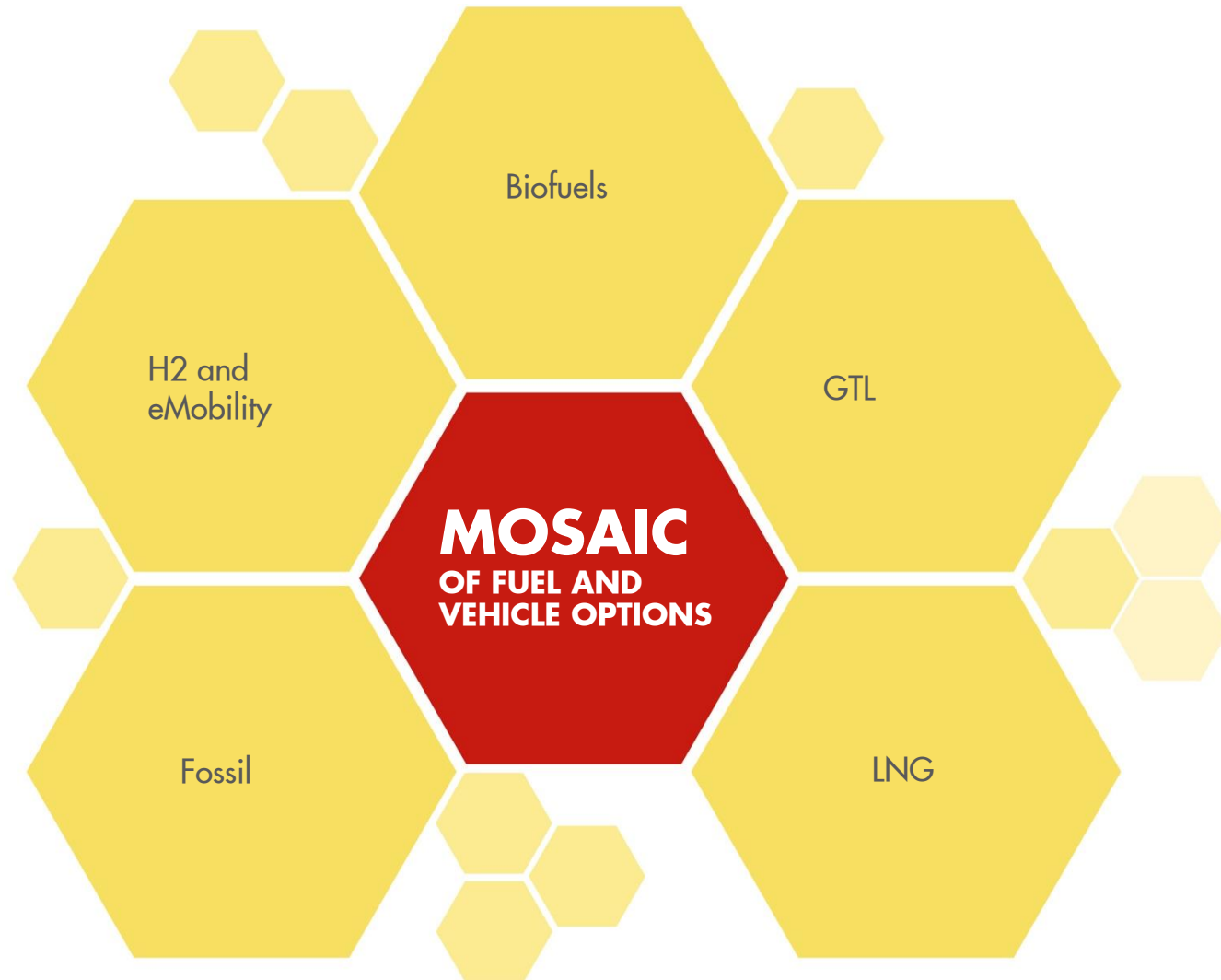
Transport Mile / Vehicle Cost Of Ownership

Refueling
Convenience

Changing Lifestyle
(Remote Work;
Internet Shopping etc)

**Costs &
Convenience**

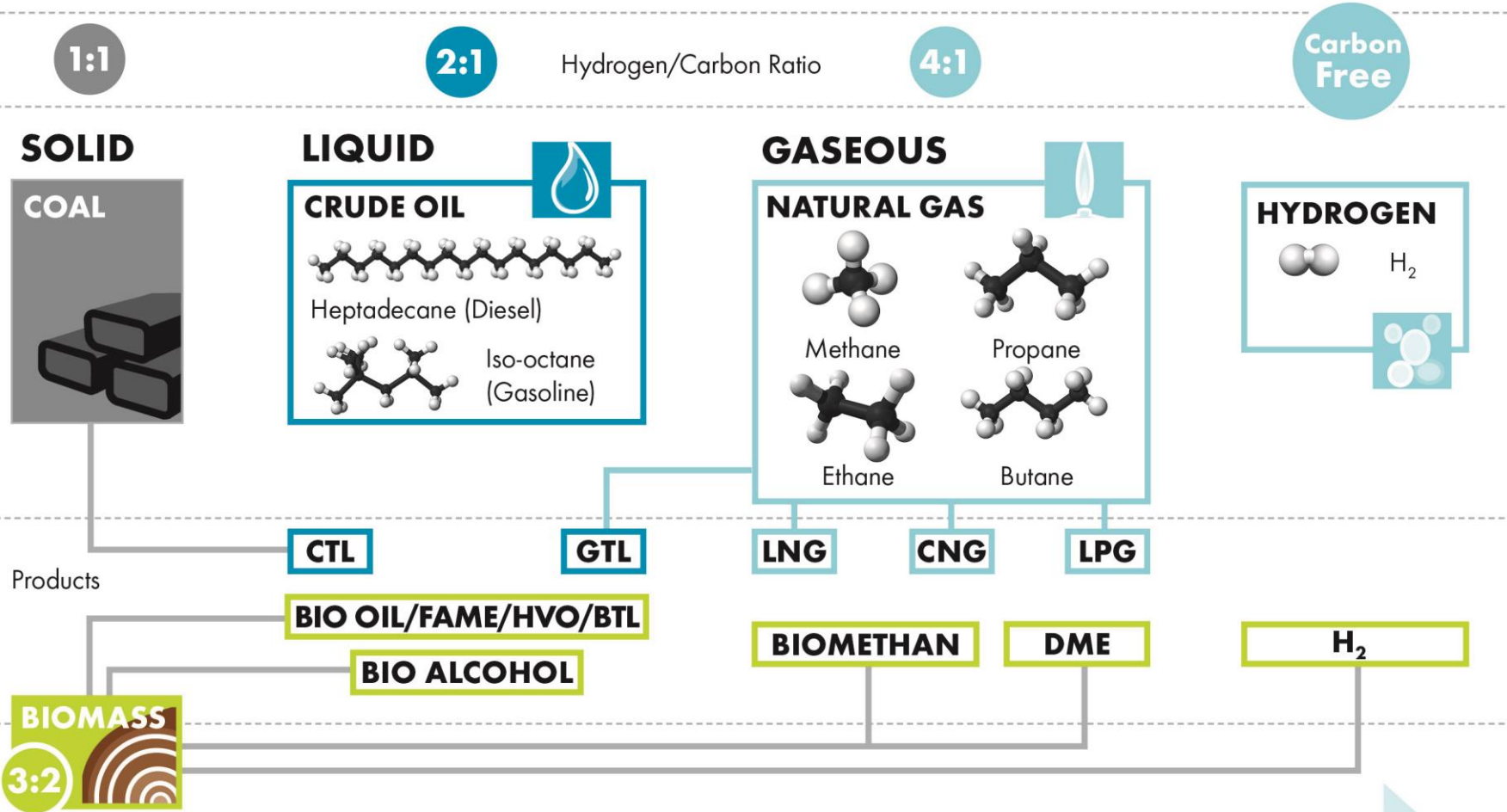
NO SINGLE ALTERNATIVE TO LIQUID FUELS



NO SINGLE ALTERNATIVE TO LIQUID FUELS



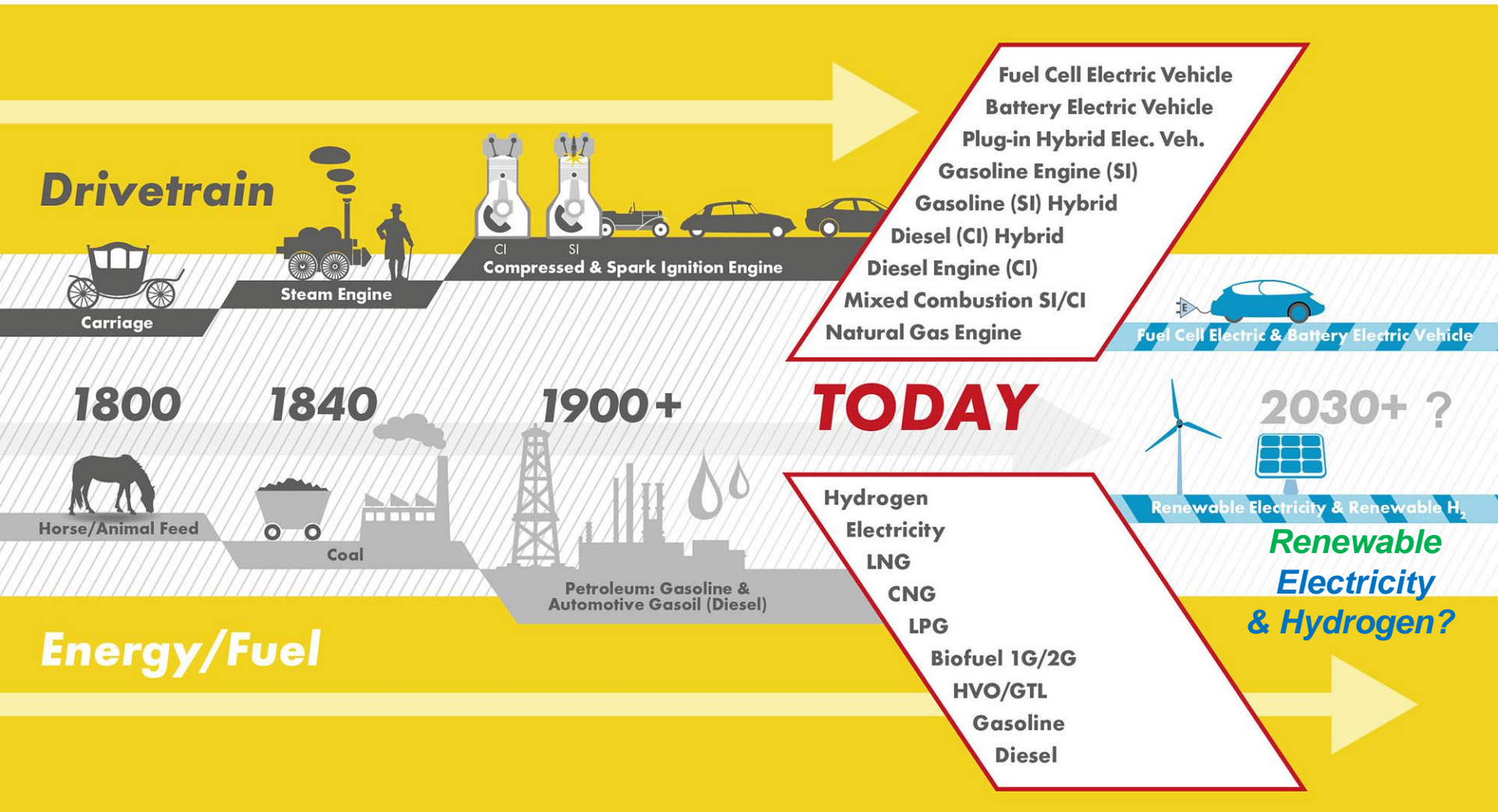
FUELS OPTIONS: DECARBONISATION



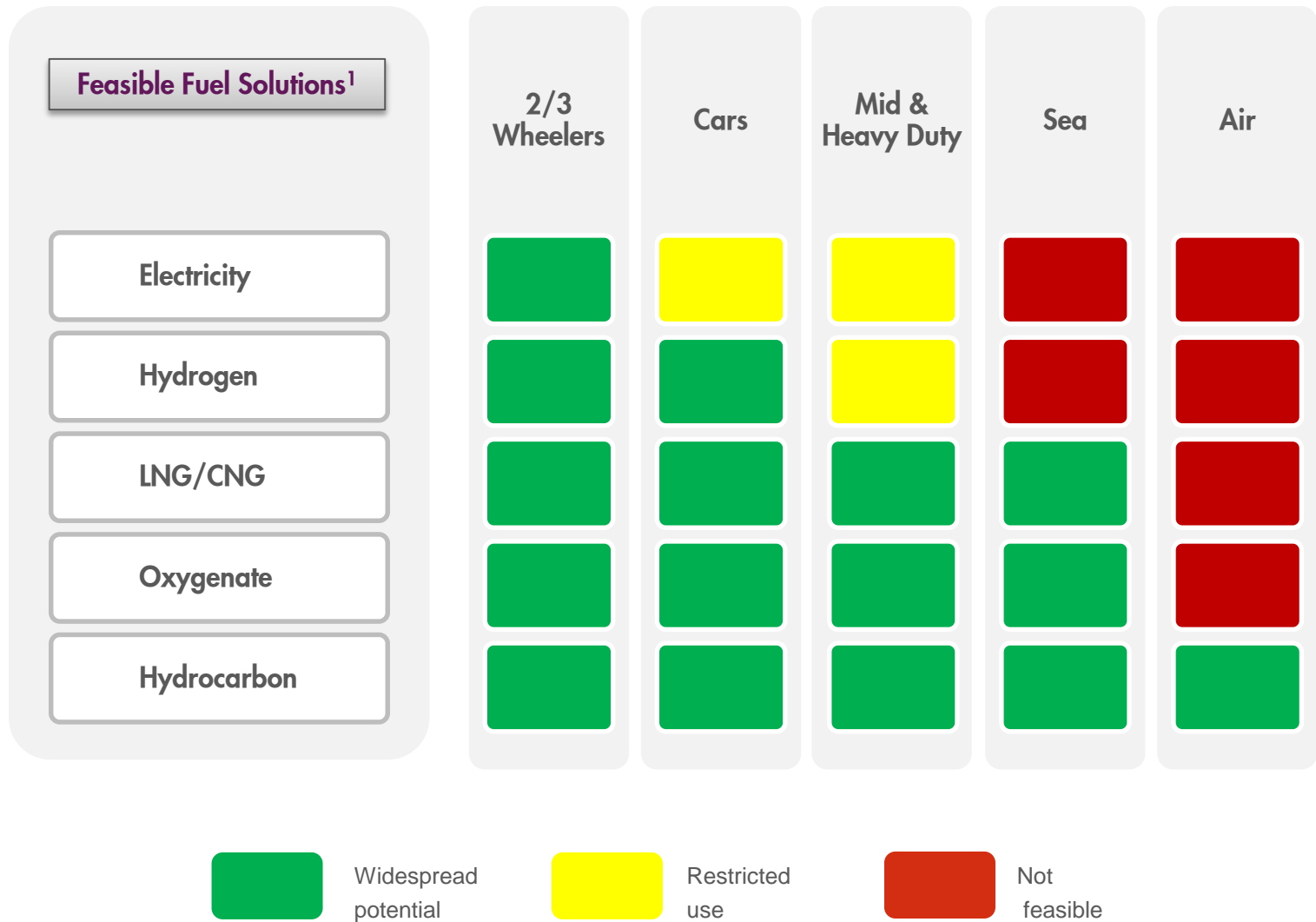
CARBON REDUCTION



HYDROGEN: THE FUTURE FUEL FOR ZERO EMISSIONS?



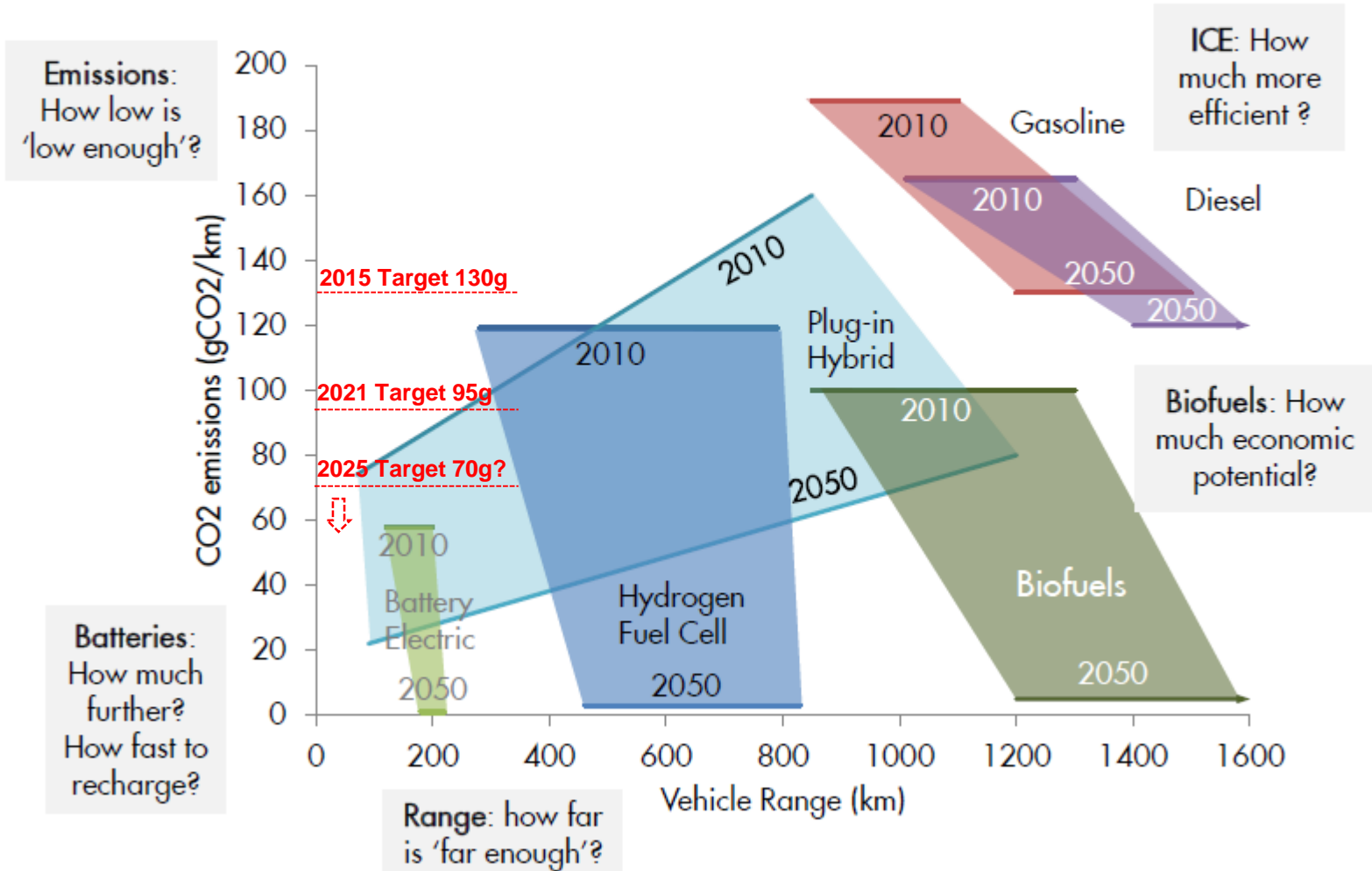
TECHNICAL FUEL POTENTIAL DIFFERS BY TRANSPORT MODE...



¹ Unconstrained potential, practical deployment concepts

H₂ OFFERS CO₂ REDUCTION - WHERE BIOFUELS GROWTH IS CONSTRAINED

Competing Fuel Technologies



130g = 4.9l diesel/100km
 95g = 3.6l diesel/100km

Source for Targets:
ec.europa.eu/clima/policies/transport/vehicles/cars

SHELL HYDROGEN STATIONS 2014: GERMANY & CALIFORNIA

Distribution



Storage Vessels

50 – 500 bar



Compressor

to 1000 bar

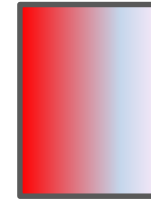


High pressure container



Cooling

- 40°C



Dispenser



California: 2008



California: 2010



California: 2012



Berlin: 2011



Hamburg: 2013



Hamburg: 2014

INTERNATIONAL HYDROGEN INFRASTRUCTURE ACTIVITIES

UK H₂ Mobility

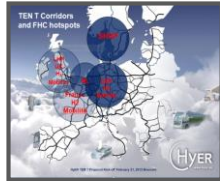
- Phase 2 accomplished



H₂-Mobility France

- In preparation

Hydrogen Infrastructure for Transport (HIT) (TEN-T) 3 HRS



- Scandinavian Hydrogen Highway Partnership
- 45 HRS / 2015
- 500 cars / 2015

H₂ Mobility Germany



- 100 HRS (50 within the CEP) / 2017
- H₂ Mobility Germany JV – 400 HRS



- 10-15 HRS

USA (California)



- 68 HRS till 2015
- 5000 FCEVS till 2015

Japan



- 1000 HRS till 2025
- 1 Mio. FCEV's till 2025

South Korea



- 500 HRS till 2020
- 50.000 FCEV's till 2020

China



- 5 HRS till 2015
- 1.000 FCEV's till 2015

INFRASTRUCTURE COMPANIES AND AUTO.IND. COOPERATE FOR A H₂ MOBILITY SUCCESS



H2 Mobility – Participating companies



Founding of a Joint Venture

- Shell, Total, OMV, Linde, Air Liquide and Daimler decided to work towards foundation of a Joint Venture
- Supported by car OEMs* Toyota, Honda, Nissan, Hyundai, BMW and Volkswagen
- **Definitive Contracts Signed 17 July 2014**
- Currently in Merger Control Process *
- **Expect the JV to be founded by Q1 2015***, first JV operated hydrogen stations may ready by end of 2015

*subject to all approvals and anti-trust clearances

H₂ MOBILITY GERMANY (H2M)



- Air Liquide, Daimler, Linde, OMV, Shell and Total agree on action plan to construct HRS network
- H₂ Retail Stations network to grow to **400 HRS by 2023, 100 of which by 2018**
- **Overall investment of €350mln** planned
- Request for support to the German Federal Government
- Foundation of Joint Venture by the six partners by early 2015*
- Example of industry partnership that shares the risks across the value chain, supported by Government
- **Greatest uncertainty remains car numbers**

H₂ Mobility Initiative

Action plan for the construction of a hydrogen refuelling network in Germany by 2023

~400

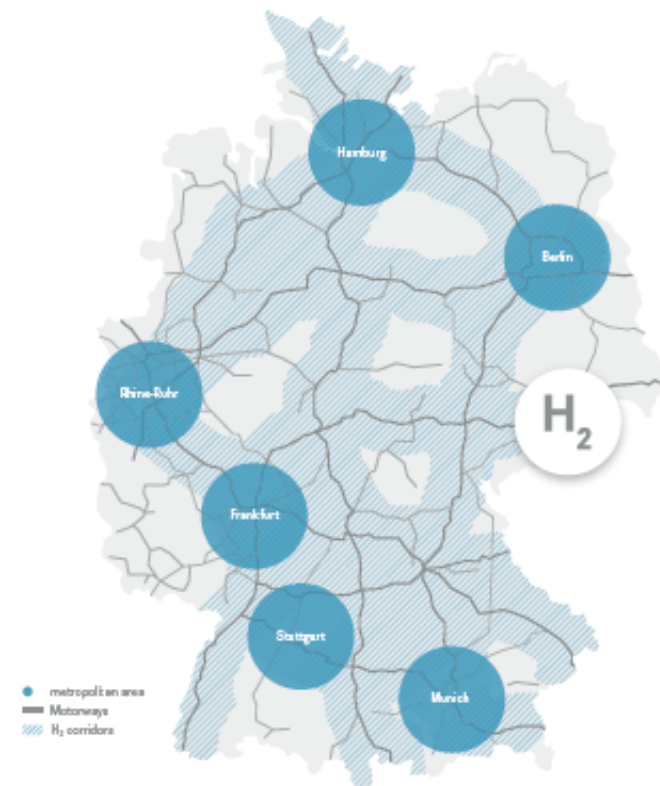
Stations will Germany's public hydrogen refuelling network cover by 2023.

~90

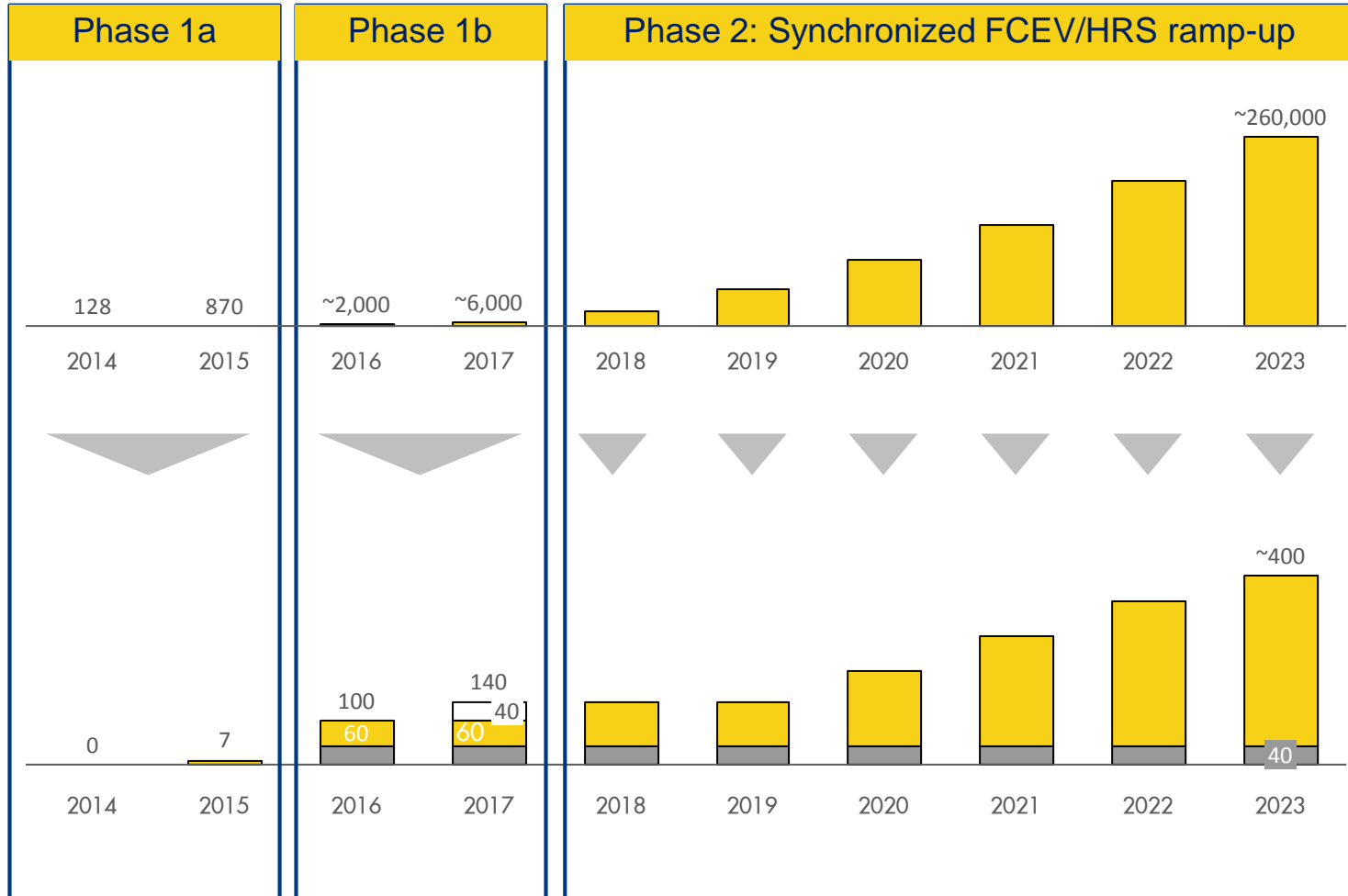
Kilometers lie between the H₂ filling stations on the motorways around the metropolitan areas by 2023

>10

H₂ filling stations will be available in each metropolitan area from 2023



H2M ... BASED ON A THREE-PHASED BUILD-UP PLAN AND IN SYNCHRONIZATION WITH FCEV RAMP-UP



Unconditional ramp-up to 100-140 HRS

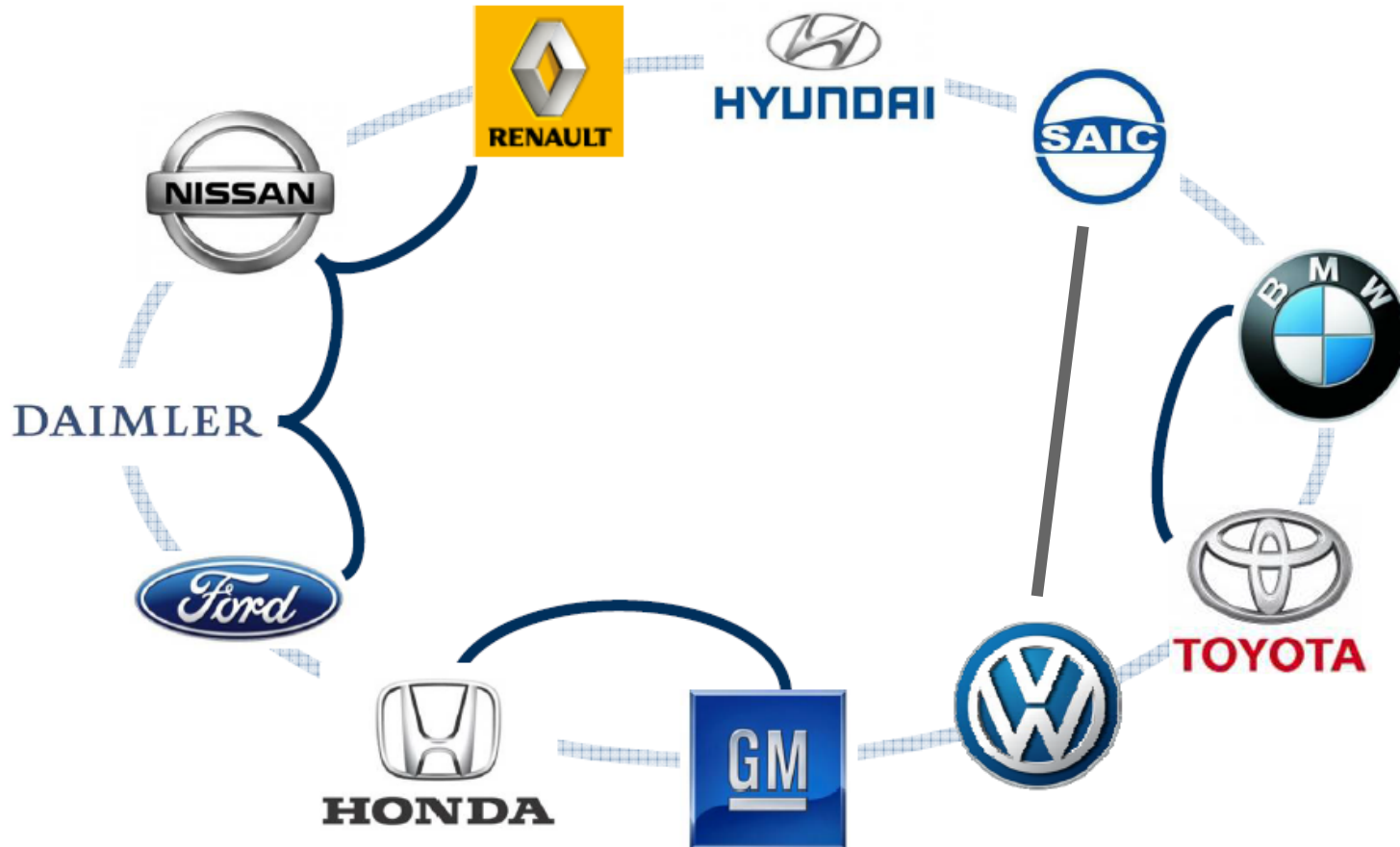
Further HRS build-up synchronized with FCEV ramp-up

H2M HRS
CEP HRS

Fuel Cell
Electric
Vehicles

Hydrogen
Refuelling
Stations
(HRS)

OEMS HAVE FORMED FUEL CELL ALLIANCES (2012-2013)



Note: Based on OEM press releases & public statements

AUTOMOTIVE IND. MOVES ON FCEV – BASED ON PUBLIC STATEMENTS



'Fast-following' OEMs (Daimler, Nissan, GM, Ford)

- MB recently placed bets on Hydrogen – building scale production lines following field test FCEV
- Nissan also has an even bigger bet on BEVs (Leaf), Vehicles on the road 2017
- GM concentrate on FC stack Development in Detroit next to Powertrain Development – 'ready to go' if market is demanding
- Ford is part of 3-way partnership with Daimler & Nissan aimed for 2018 affordable FCEV



'Early-mover' Asian OEMs (Hyundai, Toyota, Honda)

- Already placed big bets on Hydrogen
 - Each already spent over \$1bn
 - Annual spend >\$100mln.
- Vehicles announced for on the road 2014/15.



'Undecided' OEMs (BMW, VW/Audi)

- BMW: Ongoing Hydrogen technology development programmes – same as Ford (BMW spends >\$100mln/yr)
- VW Group: announced to make longterm decisions on drivetrain technology in 2015
- BMW Ford cars could be on the the road in 2020 (?), VW a little later...

