Plataforma Tecnológica Española del Hidrógeno y de las Pilas de Combustible

PTE HPC

ITPs en el sector del hidrógeno y de las pilas de combustible

"Impulso de Iniciativas Tecnológicas Prioritarias en Energías Verdes"

Sevilla, a 20 de junio de 2018

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

Acciones prioritarias en I+D+i en hidrógeno

Tres ITPs identificadas desde la PTE HPC:

Producción de H_2 Renovable

Infraestructura de Suministro de H_2

Almacenamiento de Energía con Tecnología de H_2

Infraestructura de suministro de hidrógeno

Alcance y objetivos

¿En qué consiste? Despliegue de la infraestructura de abastecimiento y suministro de H_2 como combustible para el transporte

- Distribución
- Producción in-situ
- Almacenamiento
- Compresión
- Dispensado

Objetivos generales

- ✓ Promoción del empleo de **combustibles alternativos**.
- ✓ Ayuda a la **descarbonización** del sector transporte.
- ✓ Reducción de la dependencia exterior (reducción de importaciones, mejora de **balanza de pagos**).

PTE HPC

Infraestructura de suministro de hidrógeno

¿Cómo funciona un vehículo eléctrico de hidrógeno?

Congreso Mundial de Energía del Hidrógeno 2016 · **www.whec2016.com**

AeH2 Asociación Española del Hidrógeno

whec 21st 2016 Zaragoza Spain

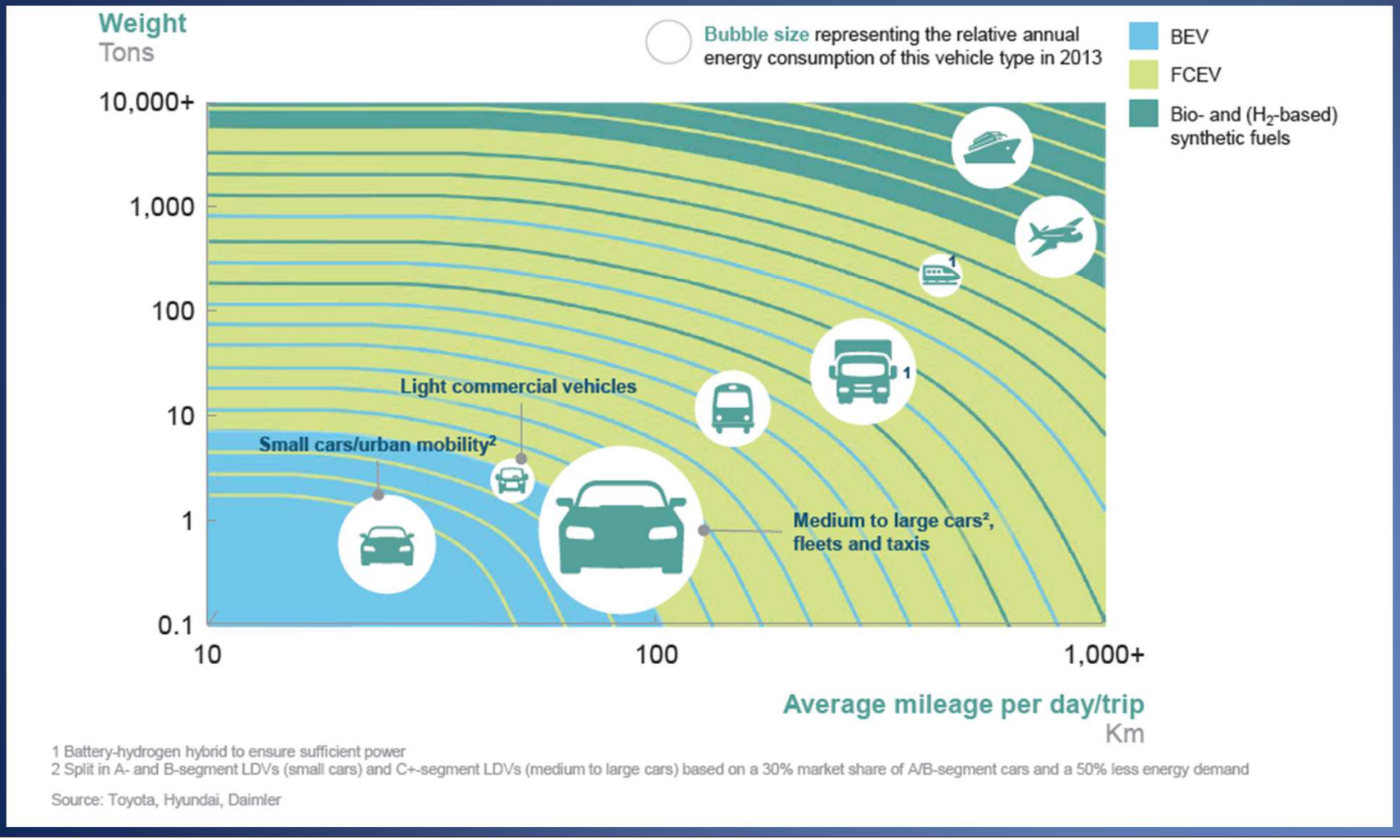
Infraestructura de suministro de hidrógeno

Alcance y objetivos

- ✓ Normativa unificada. Seguridad
- ✓ Consumidor: autonomía, rapidez de repostado; “como siempre”

Infraestructura de suministro de hidrógeno

Alcance y objetivos



1 Battery-hydrogen hybrid to ensure sufficient power
2 Split in A- and B-segment LDVs (small cars) and C+-segment LDVs (medium to large cars) based on a 30% market share of A/B-segment cars and a 50% less energy demand

Source: Toyota, Hyundai, Daimler

Infraestructura de suministro de hidrógeno

Oportunidades detectadas para su desarrollo

- ✓ **Momento estratégico a nivel nacional** (Marco de Acción Nacional de Energías Alternativas para el transporte)

MINISTERIO DE INDUSTRIA, ENERGÍA Y TURISMO

COMBUSTIBLES	PARQUE		INFRAESTRUCTURA ACCESIBLE PÚBLICO (Nº de estaciones)	
	ACTUAL (Aprox.)	ESTIMADO 2020	ACTUAL	ESTIMADO 2020
GNC (ligeros y camiones urbanos)	4.400	17.200	34	85 (20 en construcción y 31 en proyecto)
GNL (camiones pesados)	250	800	15	44 (9 en construcción y 20 en proyecto)
ELECTRICIDAD (ligeros)	18.200	150.000	1.660	3.300
GLP (ligeros)	50.000	200.000 - 250.000	468	800-1.000
HIDRÓGENO (ligeros y autobuses urbanos)	Proyectos Demostración	500	6	20 (4 en proyecto)
BIOCARBURANTES	-	-	100 (87 de biodiesel B>7 y 13 de bioetanol E>5)	100
	Evolución marcada por el Real Decreto 1085/2015, de diciembre, de fomento de los biocarburantes			

Infraestructura de suministro de hidrógeno

Oportunidades detectadas para su desarrollo

- ✓ **Momento estratégico a nivel nacional** (Marco de Acción Nacional de Energías Alternativas para el transporte)
- ✓ **Apoyo europeo a través de la iniciativa de Regions&Cities (FCH JU)**

Infraestructura de suministro de hidrógeno

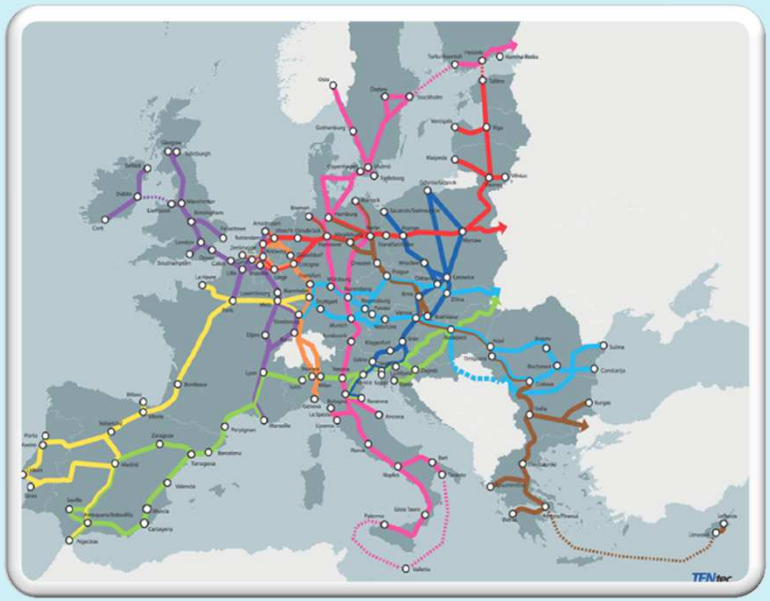
Oportunidades detectadas para su desarrollo

88 Regions/Cities from 22 countries representing ca. one quarter of Europe participate in the study

Infraestructura de suministro de hidrógeno

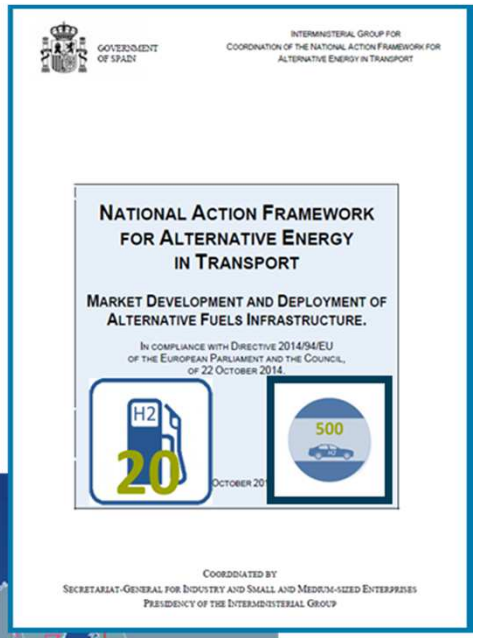
Oportunidades detectadas para su desarrollo

- ✓ **Momento estratégico a nivel nacional** (Marco de Acción Nacional de Energías Alternativas para el transporte)
- ✓ **Apoyo europeo a través de la iniciativa de Regions&Cities (FCH JU)**
- ✓ **España está promoviendo grandes proyectos de demostración**



Infraestructura de suministro de hidrógeno

Oportunidades detectadas para su desarrollo


GOVERNMENT OF SPAIN

INTERMINISTERIAL GROUP FOR COORDINATION OF THE NATIONAL ACTION FRAMEWORK FOR ALTERNATIVE ENERGY IN TRANSPORT

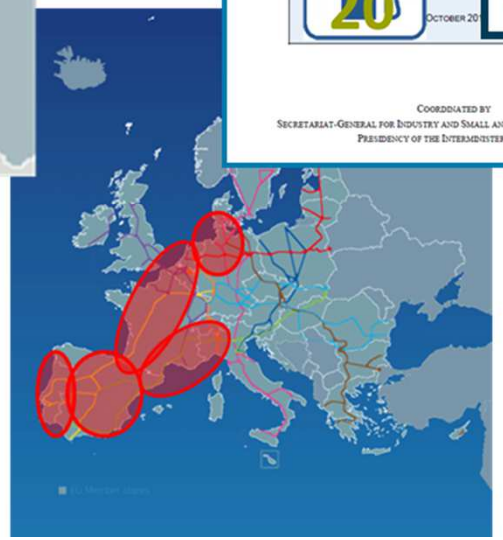
NATIONAL ACTION FRAMEWORK FOR ALTERNATIVE ENERGY IN TRANSPORT

MARKET DEVELOPMENT AND DEPLOYMENT OF ALTERNATIVE FUELS INFRASTRUCTURE.

IN COMPLIANCE WITH DIRECTIVE 2014/94/EU OF THE EUROPEAN PARLIAMENT AND THE COUNCIL, OF 22 OCTOBER 2014.

OCTOBER 20

COORDINATED BY
SECRETARIAT-GENERAL FOR INDUSTRY AND SMALL AND MEDIUM-SIZED ENTERPRISES
PRESIDENCY OF THE INTERMINISTERIAL GROUP



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Fuente: ENAGAS.

Infraestructura de suministro de hidrógeno

Oportunidades detectadas para su desarrollo

- ✓ **Momento estratégico a nivel nacional** (Marco de Acción Nacional de Energías Alternativas para el transporte)
- ✓ **Apoyo europeo a través de la iniciativa de Regions&Cities (FCH JU)**
- ✓ **España está promoviendo grandes proyectos de demostración**
- ✓ **Otras:**
  - ✓ Impulso por parte de la administración al desarrollo de nuevas tecnologías.
  - ✓ Gran potencial de desarrollo industrial y de generación de empleo.
  - ✓ Desarrollo, fabricación, instalación y montaje de depósitos/tanques de almacenamiento de hidrógeno.
  - ✓ Ingeniería básica y de detalle de instalaciones.
  - ✓ Instalación y montaje de sensores y actuadores para hidrógeno.
  - ✓ Efectos en la generación de empleo en los sectores de bienes de equipo (tuberías y racores, valvulería, compresores, aparellaje eléctrico, instrumentación y control).

Grado de madurez y horizonte temporal

1. Trains – "Hydrails"
2. Buses
3. Heavy-duty trucks

1. Cars
2. Delivery vans
3. Garbage trucks
4. Sweepers
5. Construction mobile equipment
6. Material handling
7. Bikes
8. Scooters

1. Ferries
2. Boats
3. Ships
4. Port operations equipment
5. Aircraft
6. Airport ground operations

Infraestructura de suministro de hidrógeno

Grado de madurez y horizonte temporal

Infraestructura de suministro de hidrógeno

Grado de madurez y horizonte temporal

>5 kg/coche; >100 km/kg

~1 M€; 10 €/kg; 1 año

Infraestructura de suministro de hidrógeno

3 Estrategias: Innovación, Industria, Energía

- ✓ Diferentes **medios** de transporte: marítimo, ferroviario, carretera
- ✓ Distribución capilar: **última milla**
- ✓ Innovación **logística**: sectores agroalimentario, agroindustrial, aeronáutico, metalmecánico…

- ✓ Incremento de la **electrificación** a nivel global
- ✓ Sustitución de petróleo por fuentes más limpias
- ✓ Red de áreas logísticas e interconexión. **Sistemas portuarios**
- ✓ Nuevas cadenas de valor para la **industria naval**: buques limpios
- ✓ Usos duales: civil + militar

- ✓ Smart grids
- ✓ Experiencias piloto a nivel **urbano**

Muchas gracias por la atención

África Castro

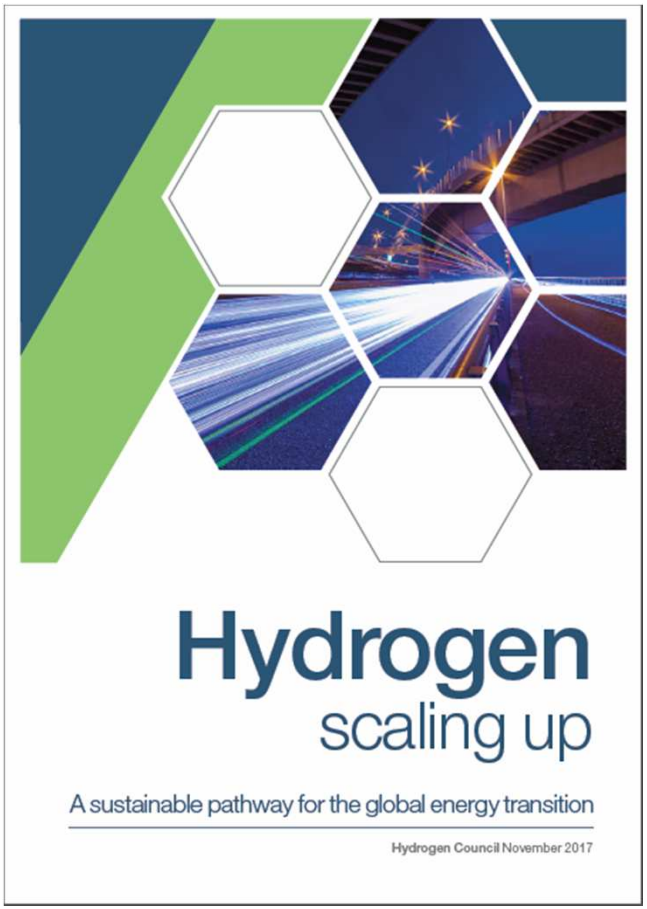
Vicepresidente de la PTE HPC

secretariatecnica@ptehpc.org | www.ptehpc.org

Sevilla, a 20 de junio de 2018

VISIÓN DE LA ECONOMÍA DEL HIDRÓGENO A 2050

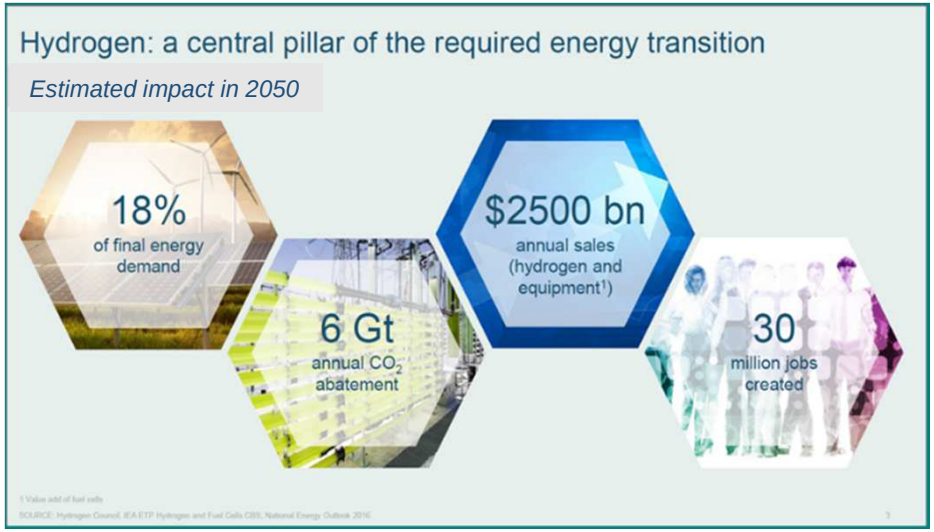
Hydrogen Council
(Noviembre 2017)



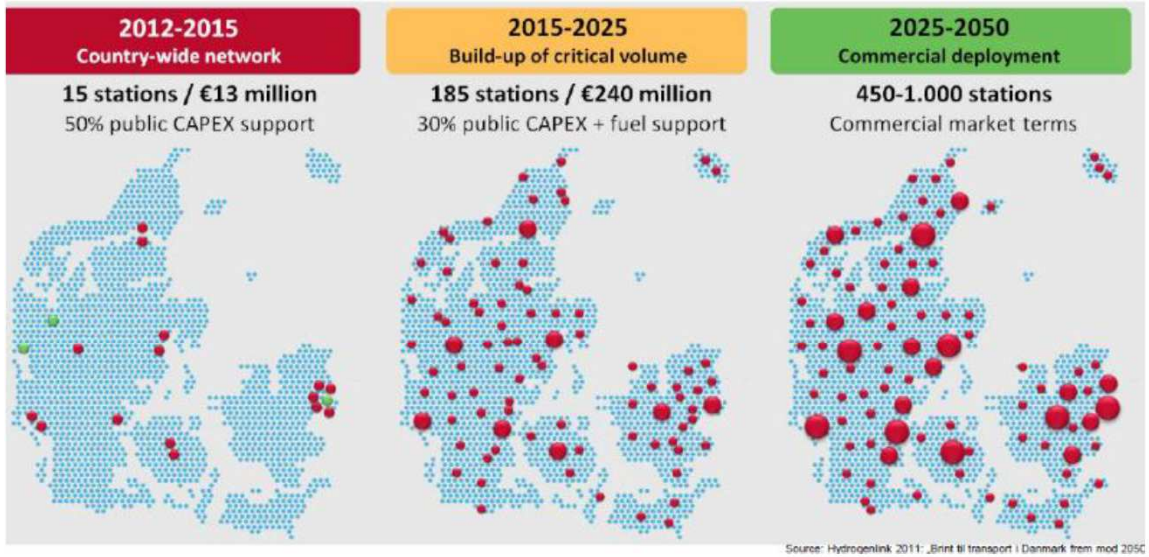
This study is the first comprehensive, ambitious Hydrogen roadmap

Objectives of the study

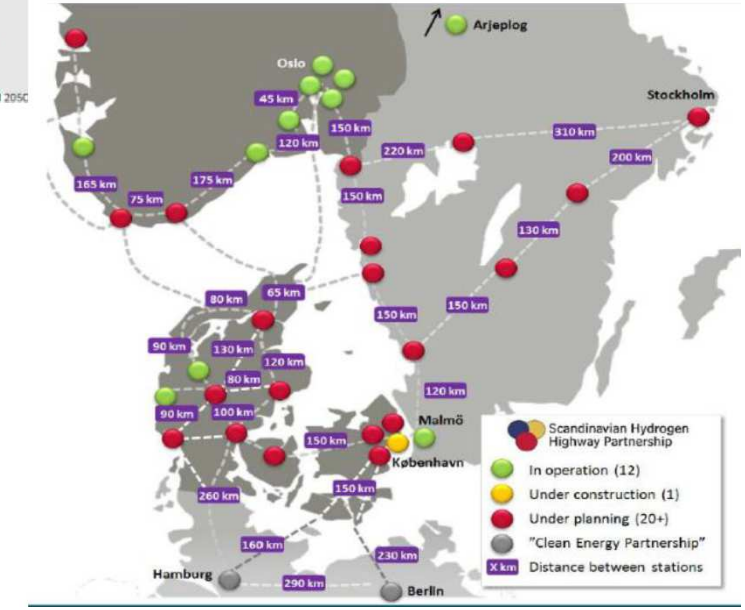
- First **comprehensive quantified vision** and **roadmap** for deployment
- Not a forecast, but an **ambitious yet realistic** scenario
- Answers the question "How could hydrogen contribute to **achieving the two degree scenario**?"



Infraestructura de suministro de hidrógeno



H2moves.eu
SCANDINAVIA



mobilitah2.it

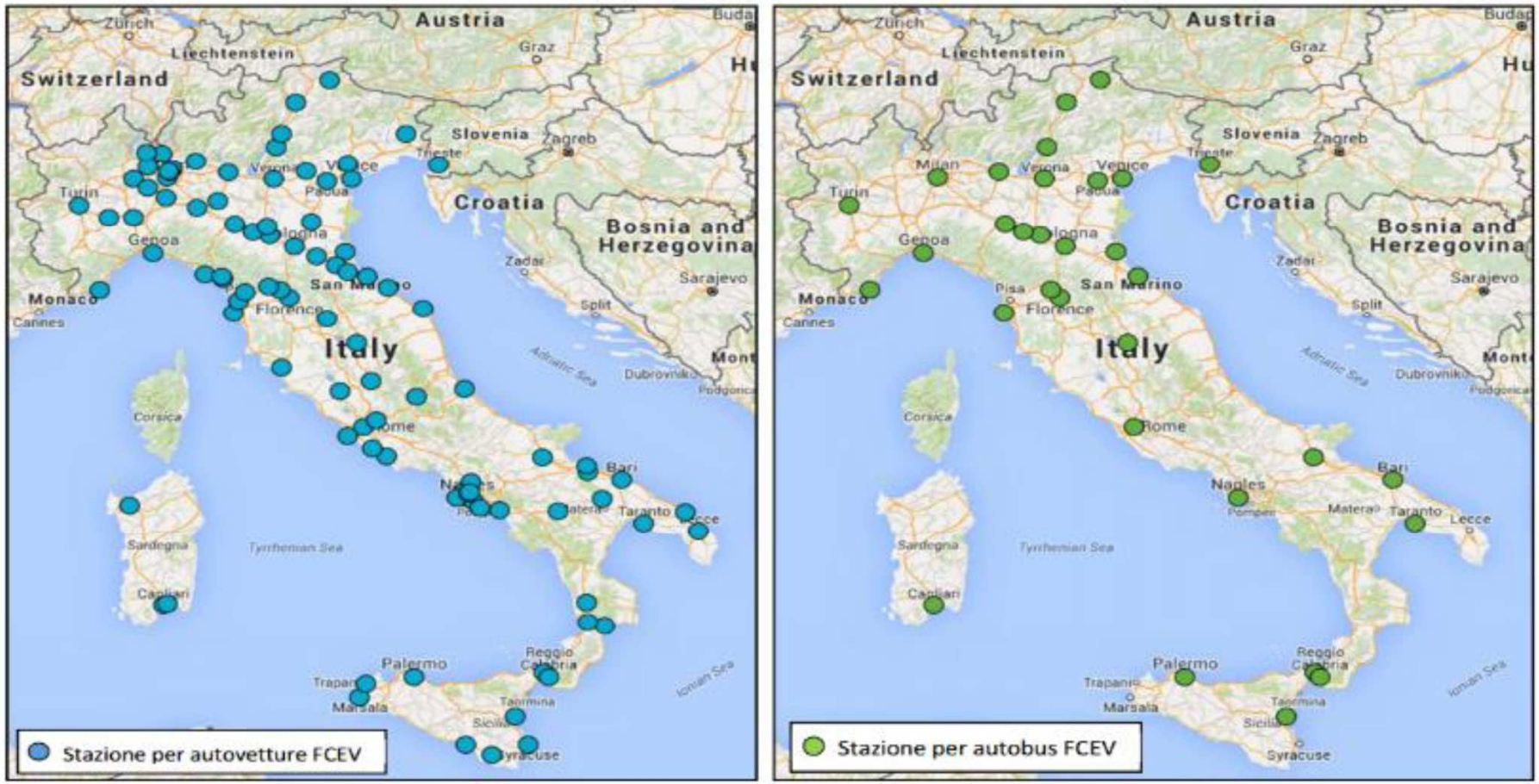


Figura 20: Ubicazione delle stazioni di rifornimento previste al 31/12/2025 per autovetture FCEV (sx) e autobus FCEV (dx)

Infraestructura de suministro de hidrógeno

Figure 10: Assessment of Coverage Provided by Existing and Funded Stations

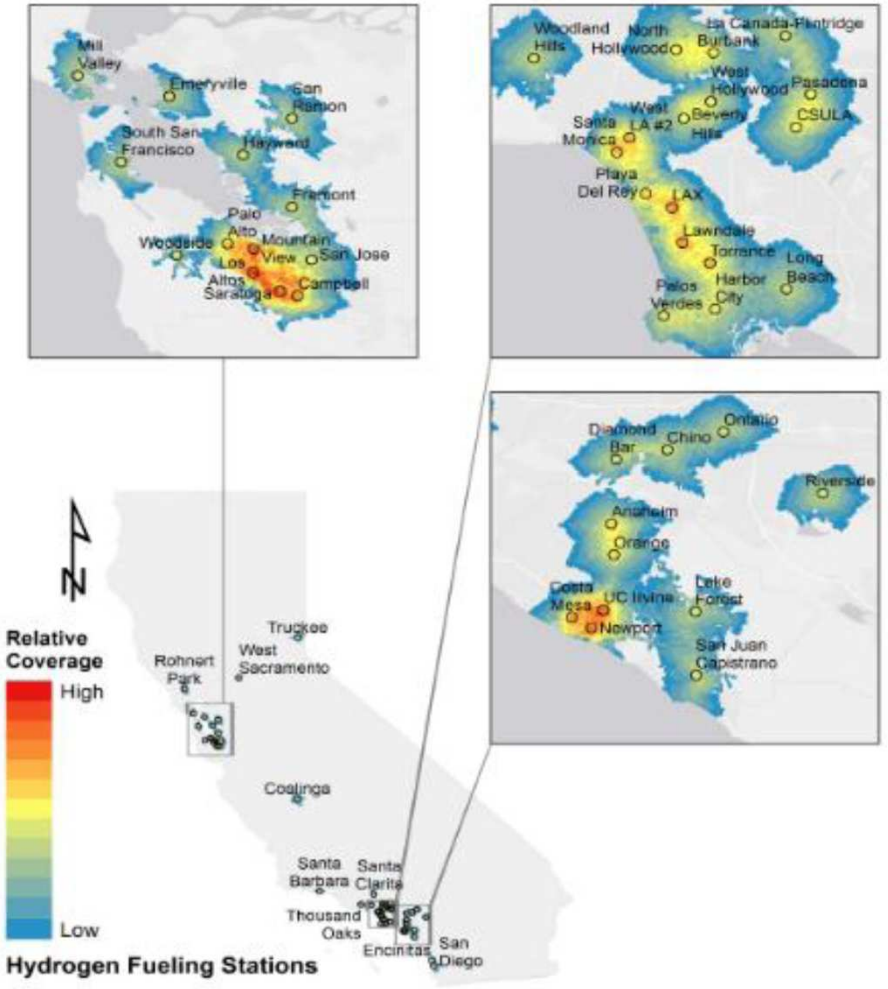
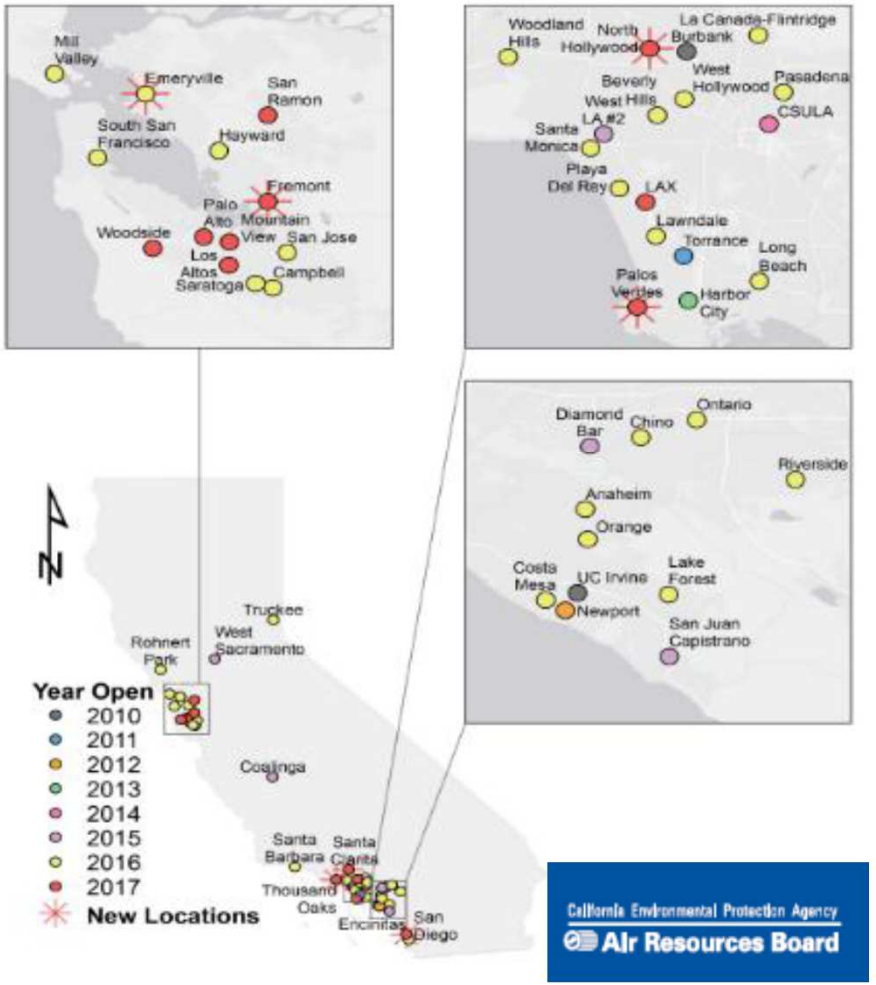


Figure 11: Individual Station Open Year History and Projections



California Environmental Protection Agency
Air Resources Board

Infraestructura de suministro de hidrógeno

https://prensa.toyota.es/japan-h2-mobility-se-acelera-el-despliegue-de-hidrogeneras/

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12 Marzo 2018

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Japan H2 Mobility: se acelera el despliegue de hidrogeneras

- Once empresas dedicarán esfuerzos conjuntos para desarrollar una extensa red de estaciones de hidrógeno para vehículos de pila de combustible —Fuel Cell Vehicles (FCV)— en Japón.
- Japan H2 Mobility (JHyM) está formada por Toyota, Nissan y Honda, como fabricantes de automóviles, y JXTG Nippon Oil & Energy Corporation, Idemitsu Kosan Co., Ltd., Iwatani Corporation, Tokyo Gas Co., Ltd., Toho Gas Co., Ltd., Air Liquide Japan Ltd. más Toyota Tsusho Corporation y Development Bank of Japan Inc. como inversores.
- El objetivo es disponer de 160 hidrogeneras en 2020, para dar servicio a unos 40.000 vehículos de pila de combustible de hidrógeno.

Once empresas japonesas, entre ellas Toyota Motor Corporation (TMC), han constituido *Japan H_2 Mobility* (JHyM), que se dedicará al pleno desarrollo de estaciones de hidrógeno para vehículos de pila de combustible —*Fuel Cell Vehicles* (FCV)— en Japón.

JAPAN H₂ MOBILITY JHyM

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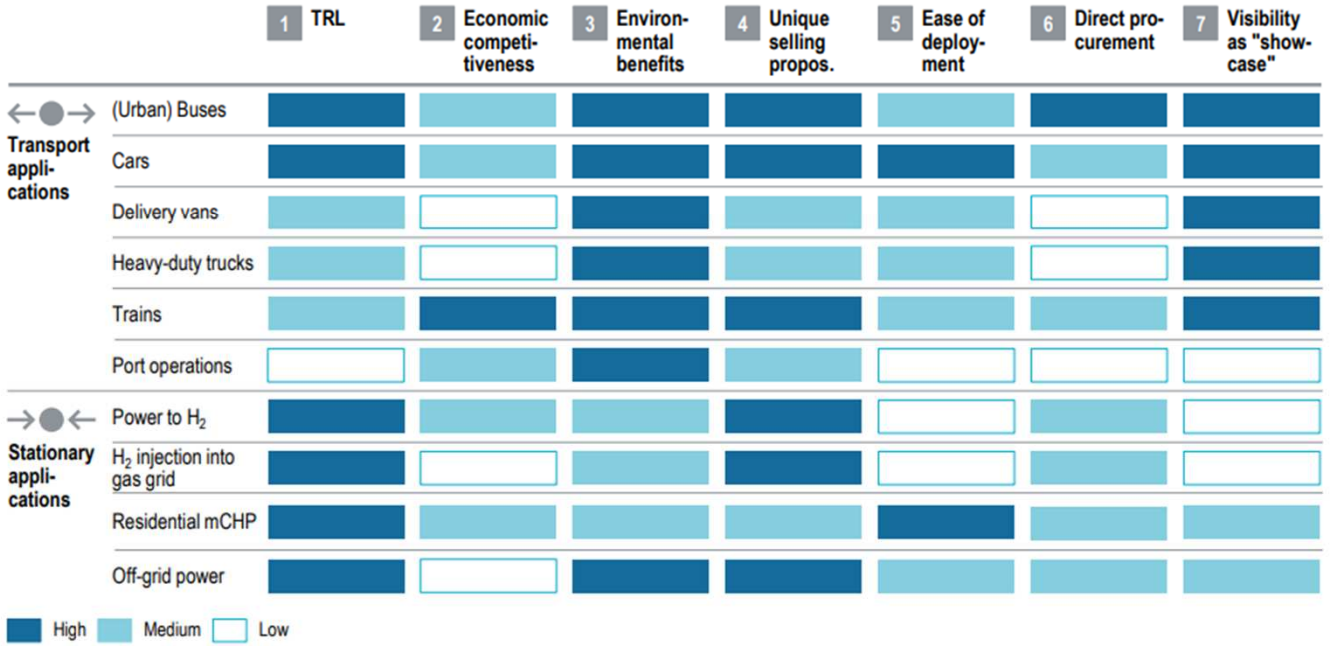
Grado de madurez y horizonte temporal

Las aplicaciones de H_2 y PC son muy heterogéneas en su alcance – Diferentes estados de madurez de la tecnología, competitividad económica y complejidad de despliegue.

Evaluación de 10 aplicaciones de H_2 y PCs en función de siete parámetros.

INDICATIVE



1) Please note that the selection only contains the ten top-ranked applications as stated by the Regions and Cities in the initial self-assessment survey (June 2017)
2) Results differ depending on location, time horizon, benchmark technology as well as specific use case under consideration

Source: Roland Berger

Grado de madurez y horizonte temporal

Fuel cell electric vehicles offer a viable zero-emission alternative compared to combustion engine cars with similar usability

Fuel cell electric vehicles – Cars

Brief description: Fuel cell electric vehicles - cars (i.e. passenger cars powered by fuel cells) use compressed hydrogen gas as a fuel to generate electricity via an energy converter (fuel cell) to power an electric motor. FCEV are refuelled at dedicated filling stations

Use cases: Cities and regions can deploy FCH fleets for municipal/community services; additionally, cities & regions can incentivize the adoption of FCEV cars for private or commercial use e.g. through FCEV car-sharing initiatives or local zero-/low-emission zones

Fuel cell electric vehicles (FCEV) - Cars	
Key components	Fuel cell stack, system module, hydrogen tank, battery, electric motor
Output	70-130 kW
Top speed; consumption; range	160 km/h; 0.76-1 kg H_2/100 km; 385-700 km
Fuel	Hydrogen (700 bar)
Battery	1.6-9 kWh (Toyoty Mirai and Daimler GLC F-cell hybrid)
Approximate unit cost	EUR 51,000 - EUR 78,600
Original equipment manufacturers	Audi, BMW, Daimler, Ford, GM, Honda, Toyota, Hyundai
Fuel cell suppliers	BMW, NuCellSys, Honda, Toyota, Hyundai
Typical customers	Private consumer, public-sector and commercial fleet operators (e.g. car sharing, taxi, fleets run by enterprises)
Competing technologies	Gasoline or diesel combustion, battery powered EV[1)]

1) Electric Vehicle

Source: Roland Berger

Grado de madurez y horizonte temporal

Three different models are already commercially available; several European car manufacturers are about to follow

Fuel cell electric vehicles – Cars

Overall technological readiness: FCEV technology is commercially ready with leading OEMs offering selected models in serial production; widespread market introduction depending on expansion of hydrogen refueling infrastructure and economies of scale / learning-curve effects to lower the premium on the product cost

Demonstration projects / deployment examples (selection)

Project	Country	Start	Scope	Project volume
Hydrogen Mobility Europe (H2ME)		2016	H2ME brings together eight European countries in order to improve hydrogen refuelling infrastructure and to demonstrate feasibility of over 1,400 cars and vans in real-life operations	EUR 164 m
Hydrogen for Innovative Vehicles (HyFIVE)		2014	One of Europe's largest transnational FCEV projects deploying 185 vehicles and creating clusters of refuelling station networks to lead the sectors commercialisation	EUR 39 m

Products / systems available (selection[2])

Name	OEM	Product features	Country	Since	Approx. cost
Clarity Fuel Cell	Honda	Highest driving range of any zero emission car, availability only in California markets outside Japan. Only manufacturer which has its FC technology exclusively located in the engine compartment. Heading towards serial production		2017	EUR 51,000
Mirai	Toyota	Availability in Europe limited to BE, DK, DE, F, N, NL, S, UK		2014	EUR 78,600
ix35 Fuel Cell	Hyundai	In commercial service by car sharing service BeeZero (Munich, Germany) or world's largest FCEV taxi fleet "HYPE" (Paris, France)		2013	EUR 65,400

*) Technology Readiness Level ▼ ≤ 5 ▼ 6-7 ▼ 8-9 2) Selected models commercially available, further market introductions planned by e.g. Daimler (GLC summer 2018), BMW

Source: Roland Berger

Grado de madurez y horizonte temporal

Fuel cell electric buses offer an technologically advanced, zero-emission alternative to the diesel combustion engines

Fuel cell electric buses

Brief description: Fuel cell electric buses built on a conventional chassis (12-18m) use compressed hydrogen gas as a fuel to generate electricity via the fuel cell (FC dominant powertrains). Other hybrid vehicles e.g. with plug-in batteries or FCH range extenders (larger battery, smaller FC) as well as minibuses are pursued as well

Use cases: Regions and cities can use/promote fuel cell electric buses in all fields of urban public road transport where diesel buses are used today; regions and cities can stipulate zero-emission vehicles through tender requirements for new bus fleets

Fuel cell dominant electric buses (FCEBs)[1]	
Key components	Fuel cell module, tank, balance of plant and periphery, battery, e-motor and inverter, mechanical drive line
Output	>100 kW
Efficiency; consumption; range	51-58%; 8-14 kg H_2 /100 km; 250-400 km
Fuel	Hydrogen, 350 bar, ca. 45 kg tank (e.g. total of 3 tanks)
Passenger capacity	Ca. 75-105 (dep. on size and layout)
Approximate unit cost	Approx. EUR 620,000 (upper limit, FCH2 JU JIVE2)[1]
OEMs (selection)	Daimler EvoBus, Van Hool, VDL, Solaris, Toyota, Wrightbus
Fuel cell suppliers (selection)	Ballard, Hydrogenics, UTC Power, NuCellSys (selection)
Typical customers	Municipal public transport operators, (public or private) bus service operators
Competing technologies	Diesel, diesel-hybrid, biofuels/biomethane, CNG, battery EV

1) Range-extender fuel cell electric buses exist as well
2) Recent industry-based analyses led by the FCH2 JU outline production-at-scale scenarios which see average purchase prices fall to approx. EUR 400,000 over the next ca. 10 years
Source: Roland Berger

Grado de madurez y horizonte temporal

There are already large scale deployments of FCH buses in Europe, enabling the transition to a fully commercial application

Fuel cell electric buses

Overall technological readiness: As one of the most advanced FCH applications, fuel cell electric buses are in a pre-commercial phase with large scale transit-based demonstration projects being currently under way and expected to continue over the coming years

Demonstration projects / deployment examples (selection)

Project	Country	Start	Scope	Project volume
Joint Initiative for Hydrogen Vehicles Across Europe (JIVE)		2017	Large scale deployment of 140+ fuel cell buses across 9 European locations in cooperation with FCH JU; coordinated bus procurement activities	EUR 106 m
3EMOTION		2015	Deployment of 21 new and 8 existing FC electric buses in several countries all over Europe including the refuelling infrastructure. 6 public transport operators	EUR 41 m
Integration of Hydrogen Buses in Public Fleets (HIGH V.LO-CITY)		2012	Large scale demonstration of FC buses and refuelling infrastructure addressing key environmental and operational issues, commercial fleets in 3 EU regions	EUR 29.2 m
Clean Hydrogen in European Cities (CHIC)		2011	Flagship zero emission bus project demonstrating readiness of FC electric buses for widespread commercial deployment	EUR 81.8 m

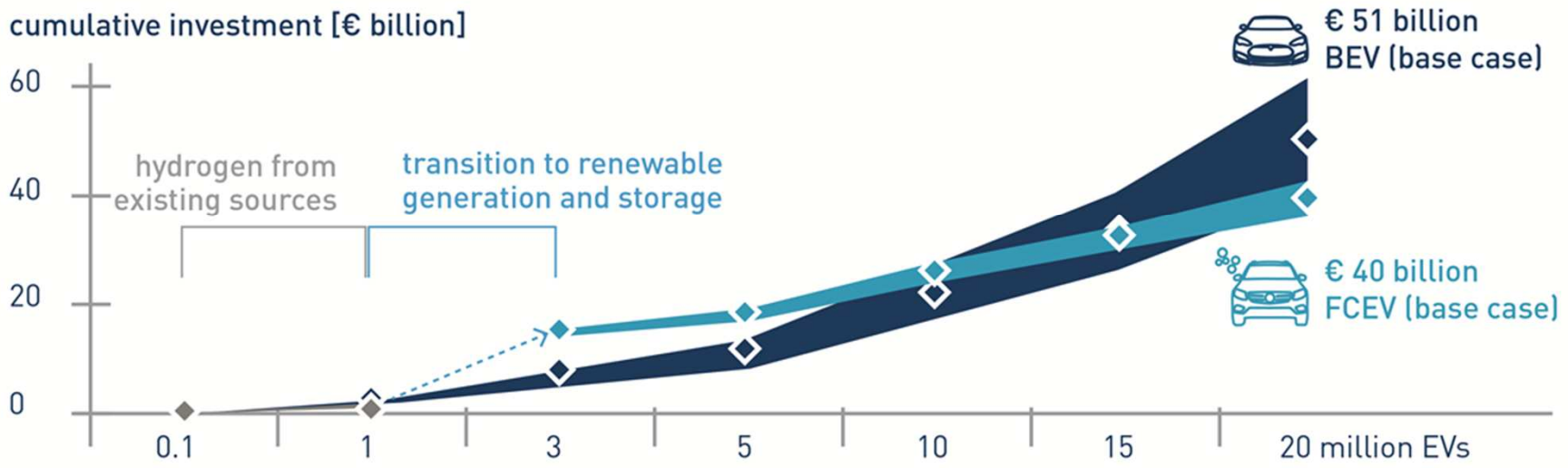
Recent products / systems (selection)

Name	OEM	Product features	Country	Since	Cost
Citea Electric	VDL	Within the framework of H2busses Eindhoven, deployment of 2 18m tri-axles VDL buses with a trailer where formic acid is split into hydrogen		2017	n.a.
Urbino 18.75	Solaris	Deployment of first Solaris Urbino electric buses with fuel cell range extender; deployed on Hamburgs "innovation line"		2014	n.a.
A330	Van Hool	Deployment of 10 13m tri-axles hydrogen buses in Aberdeen, with 50 kg storage capacity, part of strategy to create a hydrogen economy in the region		2014	n.a.

Source: Roland Berger

*) Technology Readiness Level ▼ ≤ 5 ▼ 6-7 ▼ 8-9

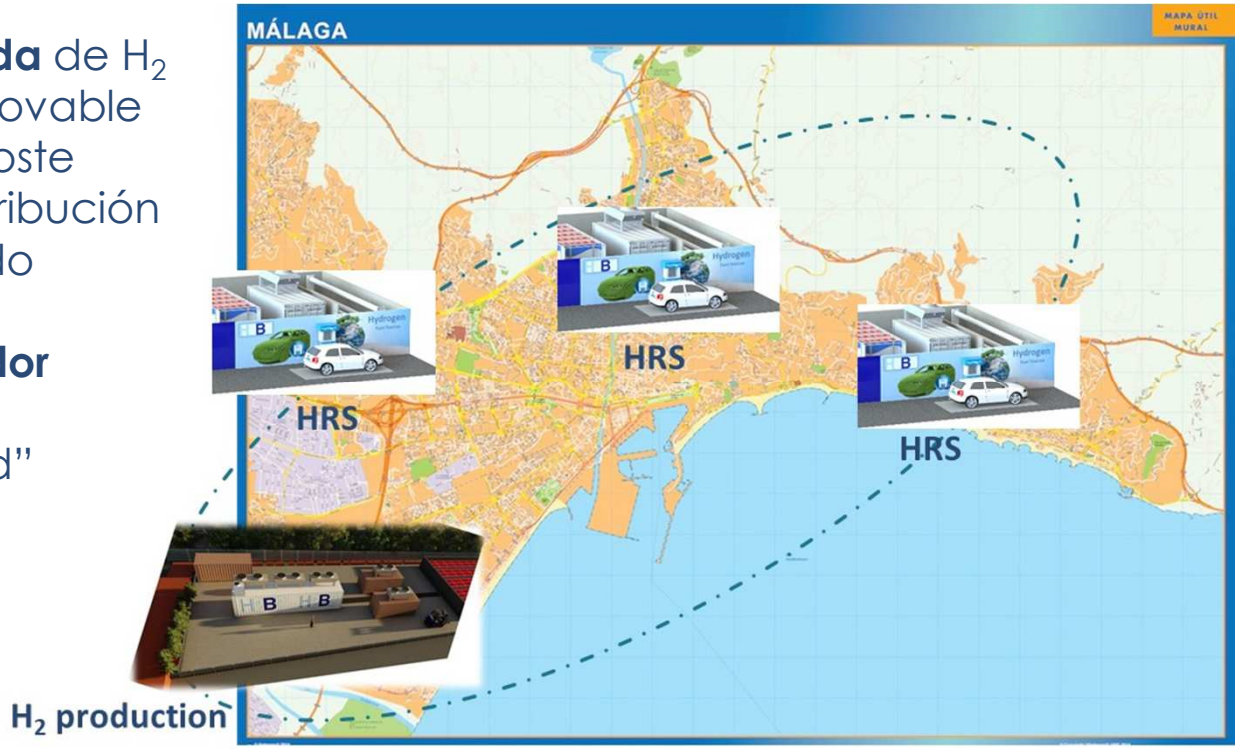
Grado de madurez y horizonte temporal



"Comparative Analysis of Infrastructures: Hydrogen Fueling and Electric Charging of Vehicles". Forschungszentrums Jülich, for H2Mobility. 2018

Proyecto de desarrollo potencial

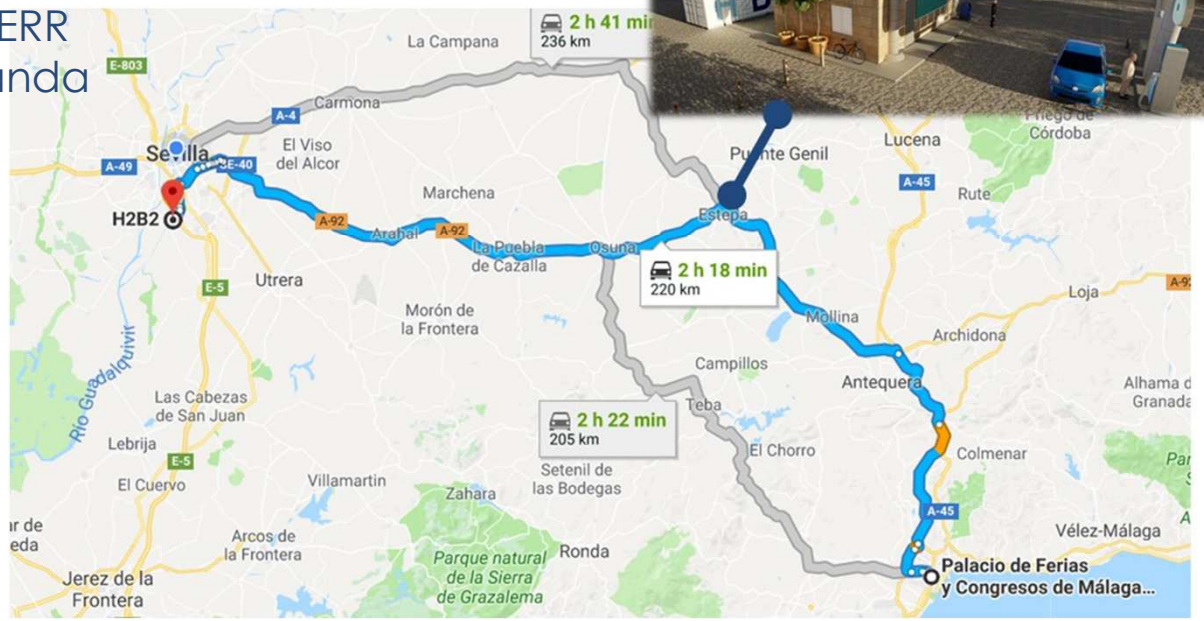
- Despliegue en áreas **urbanas**
  - Elegir una distribución
  - No requiere un nº elevado
- Producción **centralizada** de H_2
  - Disponibilidad renovable
  - Competitivo en coste
  - Red cercana: distribución de gas comprimido
- Orientado al **consumidor**
  - ✓ Diseño de rutas
  - ✓ Eliminar "ansiedad"



Proyecto de desarrollo potencial

- Despliegue en zonas **no urbanas**
  - Vías principales
  - Autónomas

- Producción **distribuida** (in situ) de H_2
  - Espacio no limitado
  - Integración de EERR
  - Ajuste a la demanda



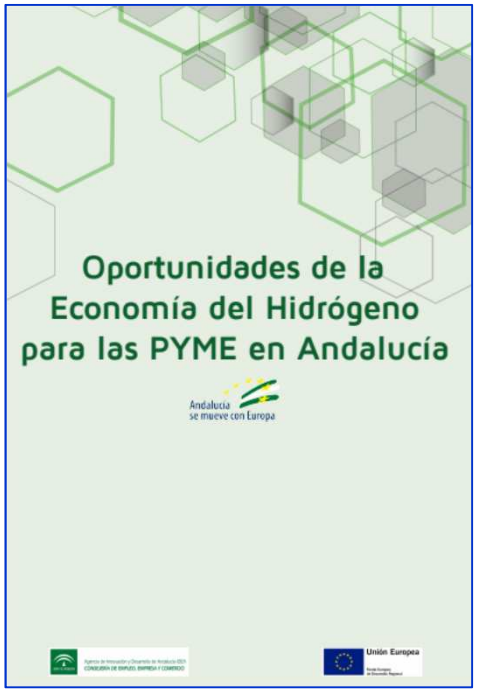
Proyecto de desarrollo potencial

- Despliegue general (regional)
  - Según una **estrategia**
  - Inversiones inteligentes, "**business case**"

  - Flotas (cautivas)
  - Grandes consumidores
  - Corredores

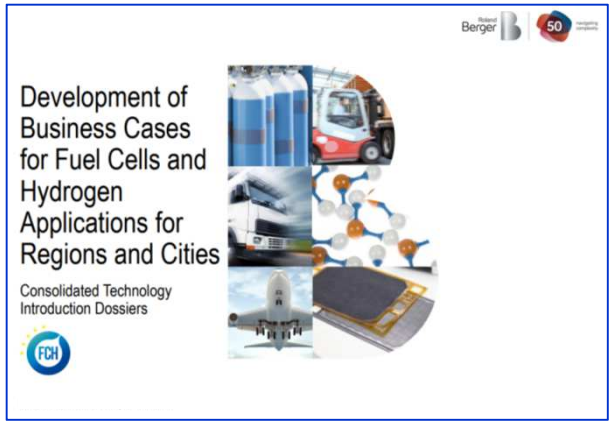
- H_2 renovable
- Pensar el crecimiento

Más información



http://www.aeh2.org/index.php?option=com_content&view=article&id=94&Itemid=37&lang=es

Más información



http://www.fch.europa.eu/page/presentations-2

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