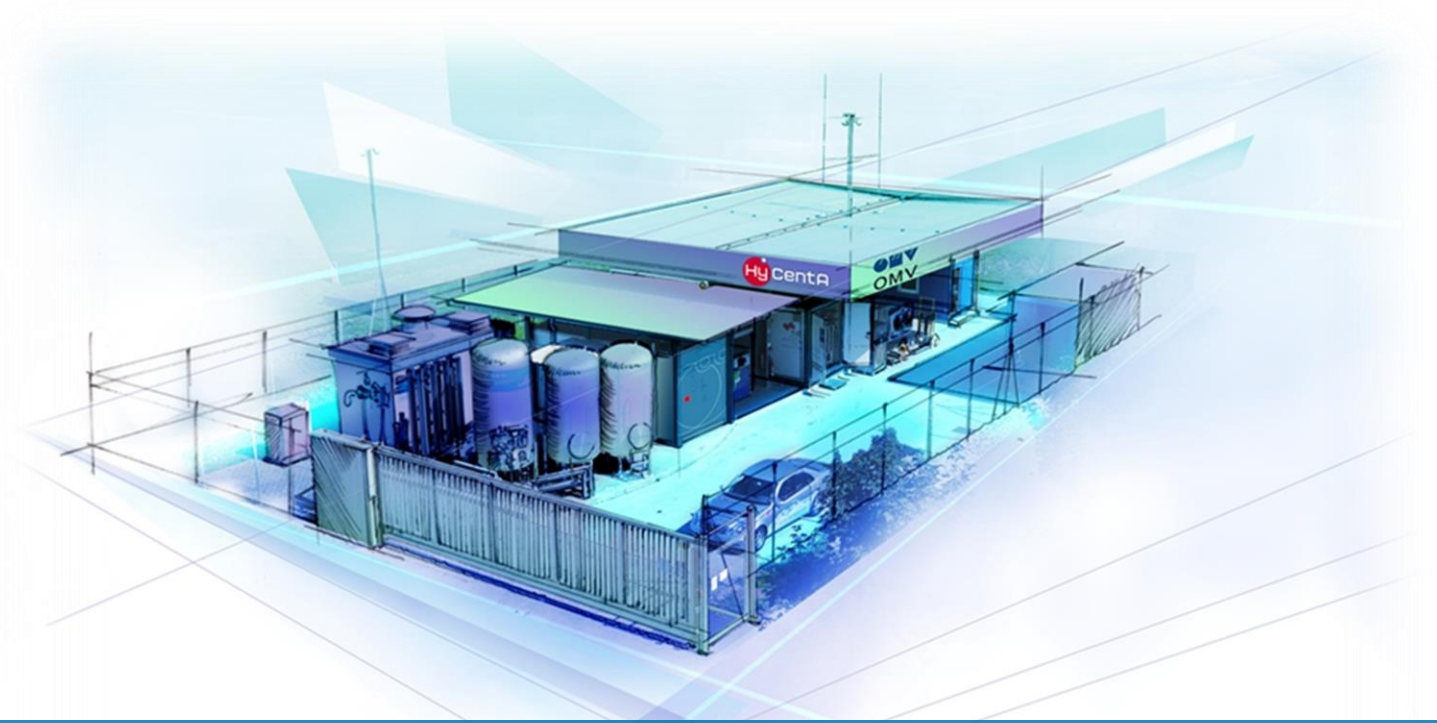


Fuel Cells in Individual and Heavy-Duty Mobility – Potentials and Examples

Dr. Patrick Pertl

Dr. Alexander Trattner

Vienna, 13. November 2018

Hydrogen Center Austria

Only Austrian extra-university research institution exclusively for hydrogen located on the premises of Graz University of Technology since 2005

More than 13 years expertise in the fields of production, storage and application of hydrogen.

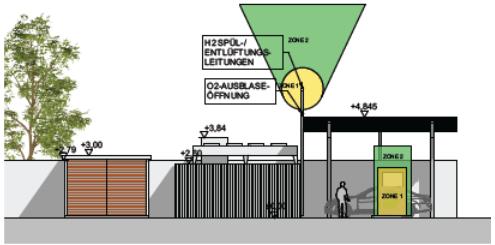
HyCentA - Fields of Expertise

ENG
ineering

SIM
ulation

TES
ting

PUB
lications



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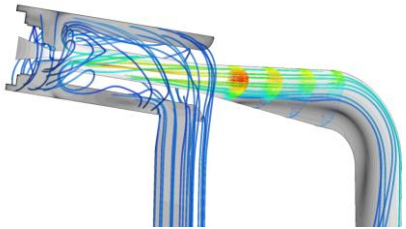
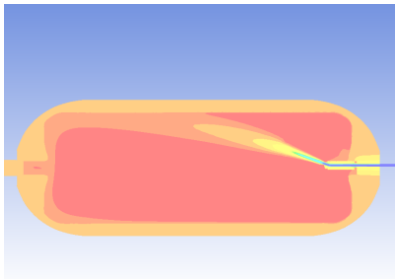
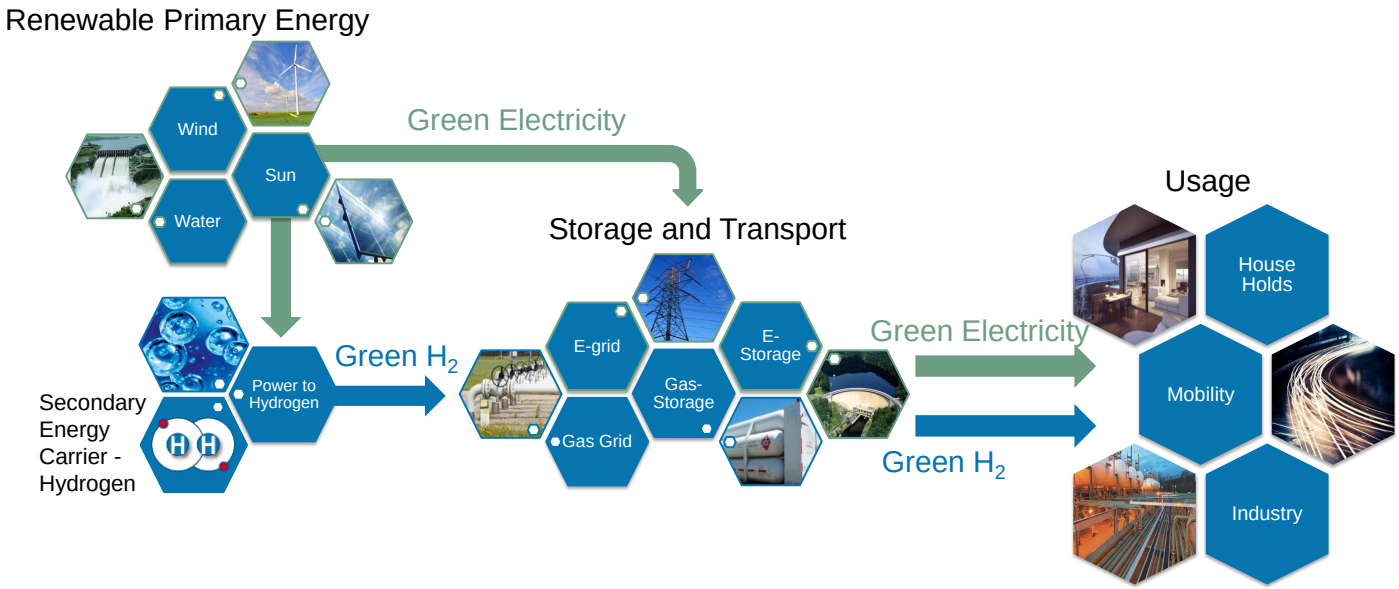




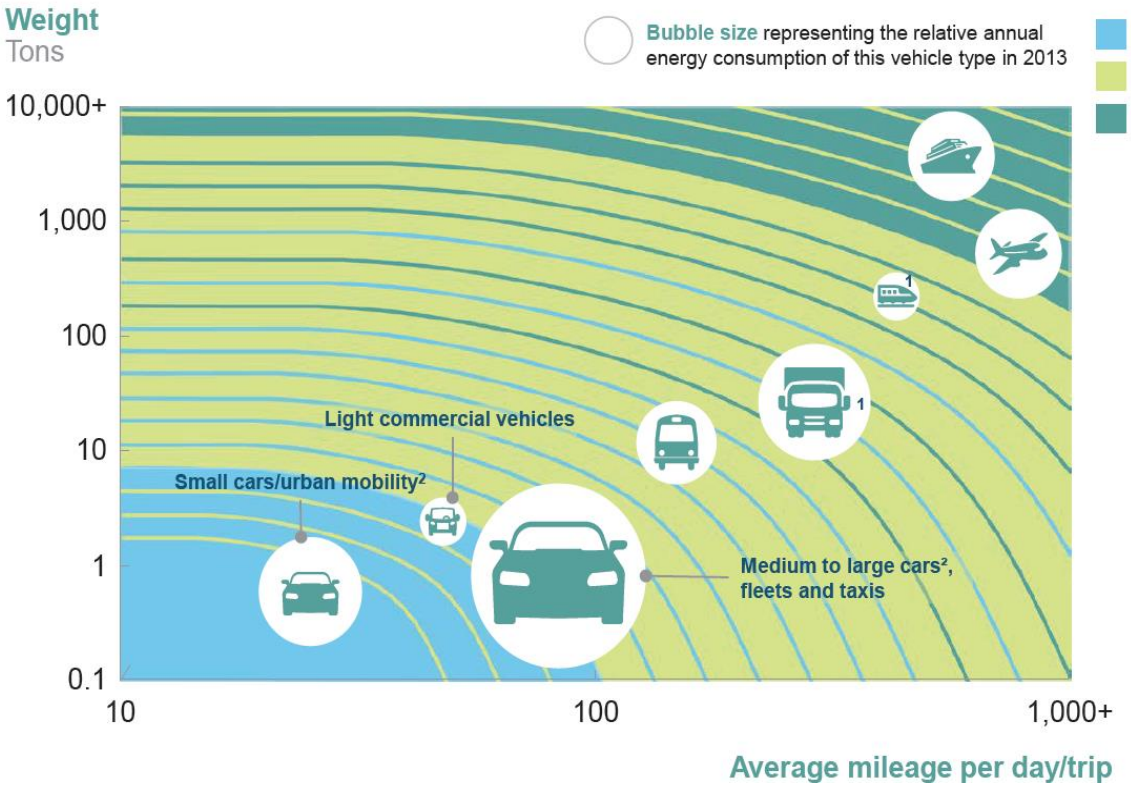
Realization of the Vision

Hydrogen enables a renewable and emission-free energy cycle



- **Fluctuating electrical energy production requires hydrogen as energy storage**
- **For energy distribution electricity and gas grid are required**
- **Hydrogen can be used in all segments: mobility, industry and households**

Role of Fuel Cell Electric Vehicles - FCEVs



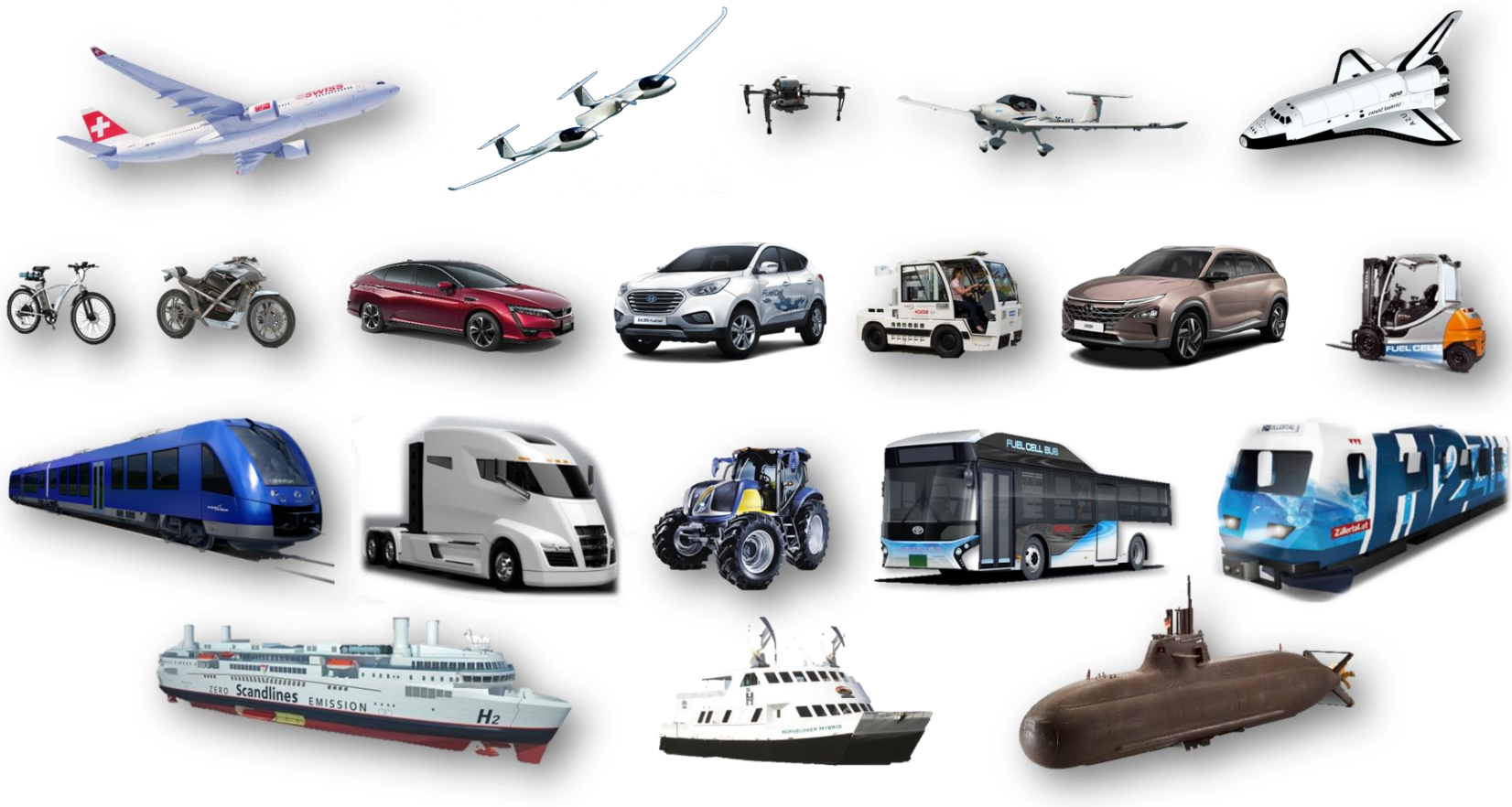
Long Driving Range

Short Fueling Time

High Efficiency

Source: Hydrogen Council 2017

Fuel Cell - A Technology of Today!



H_2 passenger cars – Series vehicles

Hyundai ix35 FCEV

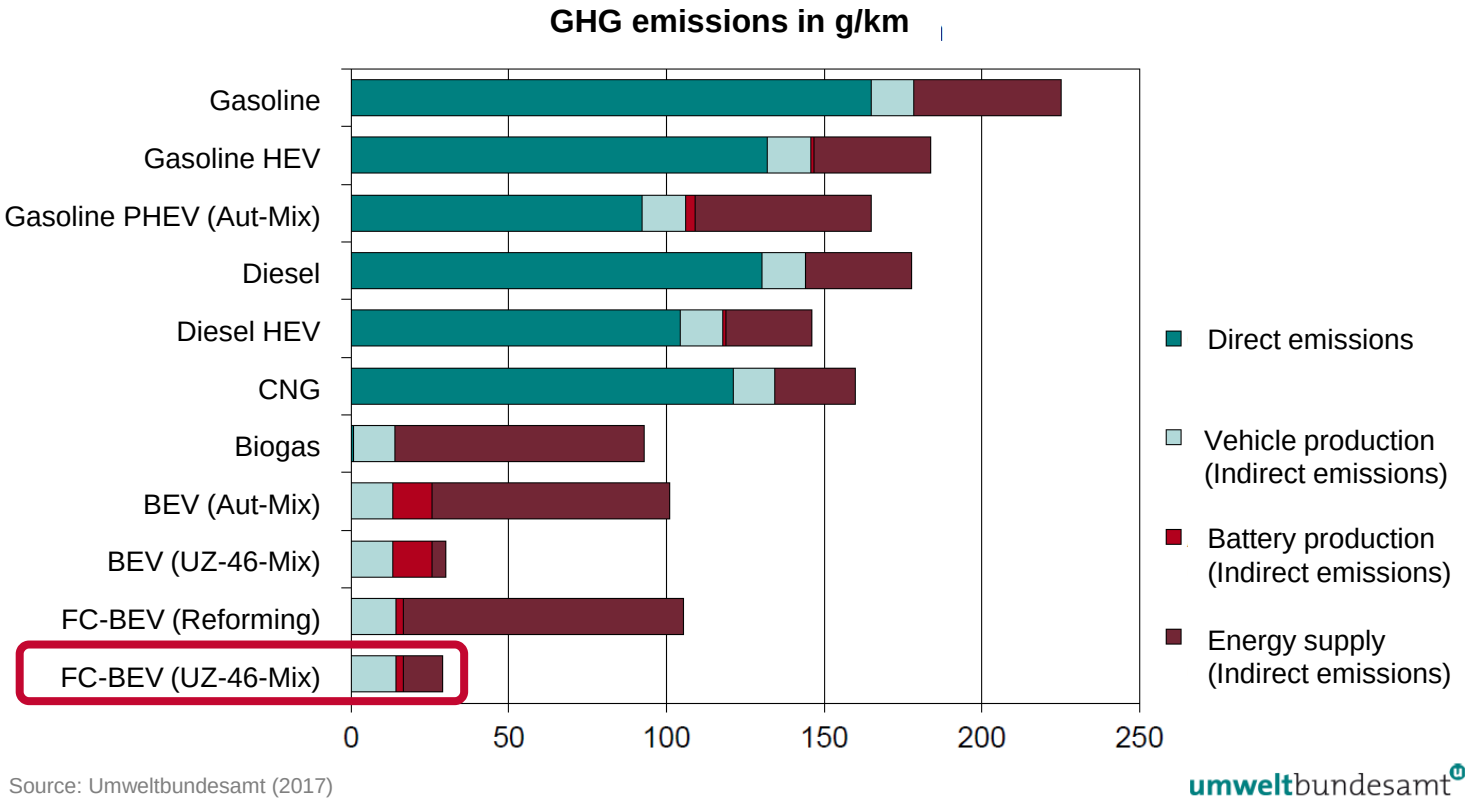
Hyundai NEXO

Mercedes GLC F-Cell

Honda Clarity

Toyota Mirai

H_2 passenger cars - Total CO_2 Emissions

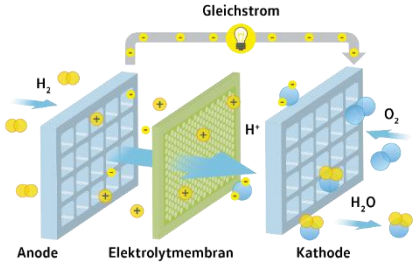


Source: Umweltbundesamt (2017)

umweltbundesamt

H_2 passenger cars – Costs vs. Range

Fuel Cell Electric Vehicle - FCEV



Battery Electric Vehicle - BEV

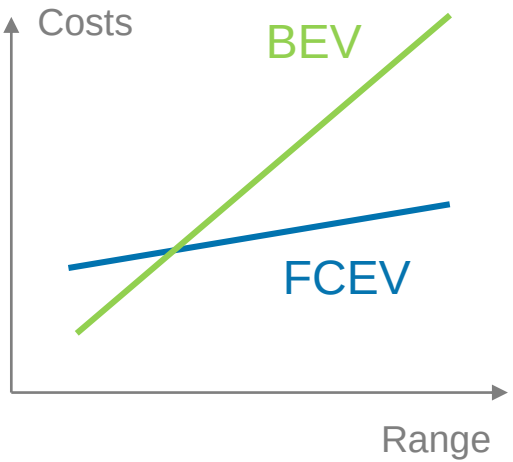
Cost Comparison

Data of DOE for high volume series production

	Driving Range in km	100	200	300	400	500	600
FCEV	PEMFC - 100 kW	€ 4.000	€ 4.000	€ 4.000	€ 4.000	€ 4.000	€ 4.000
	Battery 2 kWh	€ 225	€ 225	€ 225	€ 225	€ 225	€ 225
	Hydrogen Storage System	€ 255	€ 510	€ 765	€ 1.020	€ 1.275	€ 1.530
BEV	Energy net in kWh	15	30	45	60	75	90
	Energy name-plate in kWh	22	45	67	90	112	134
	Costs at € 112,5 per kWh	€ 2.517	€ 5.035	€ 7.552	€ 10.070	€ 12.587	€ 15.105
Vehicle	FCEV	€ 4.480	€ 4.735	€ 4.990	€ 5.245	€ 5.500	€ 5.755
	BEV	€ 2.517	€ 5.035	€ 7.552	€ 10.070	€ 12.587	€ 15.105

Source: Hydrogen Council 2017

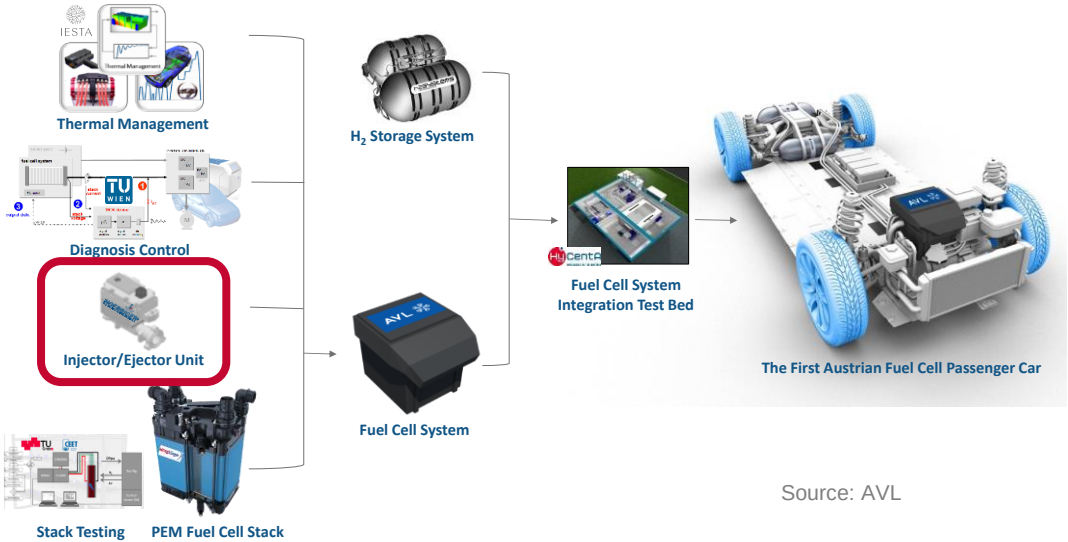
BEV ⟵ | ⟶ FCEV



H_2 passenger cars – Project KeyTech4EV

Key Technologies for Low-cost Electric Vehicle Platforms

Innovative key technologies for the demonstration of green hybridized electric vehicle, with particular focus on energy efficiency and costs



Source: AVL

Heavy-Duty Fuel Cell Applications

Van Hool

COOP / H2energy

Alstom

Toyota

Toyota

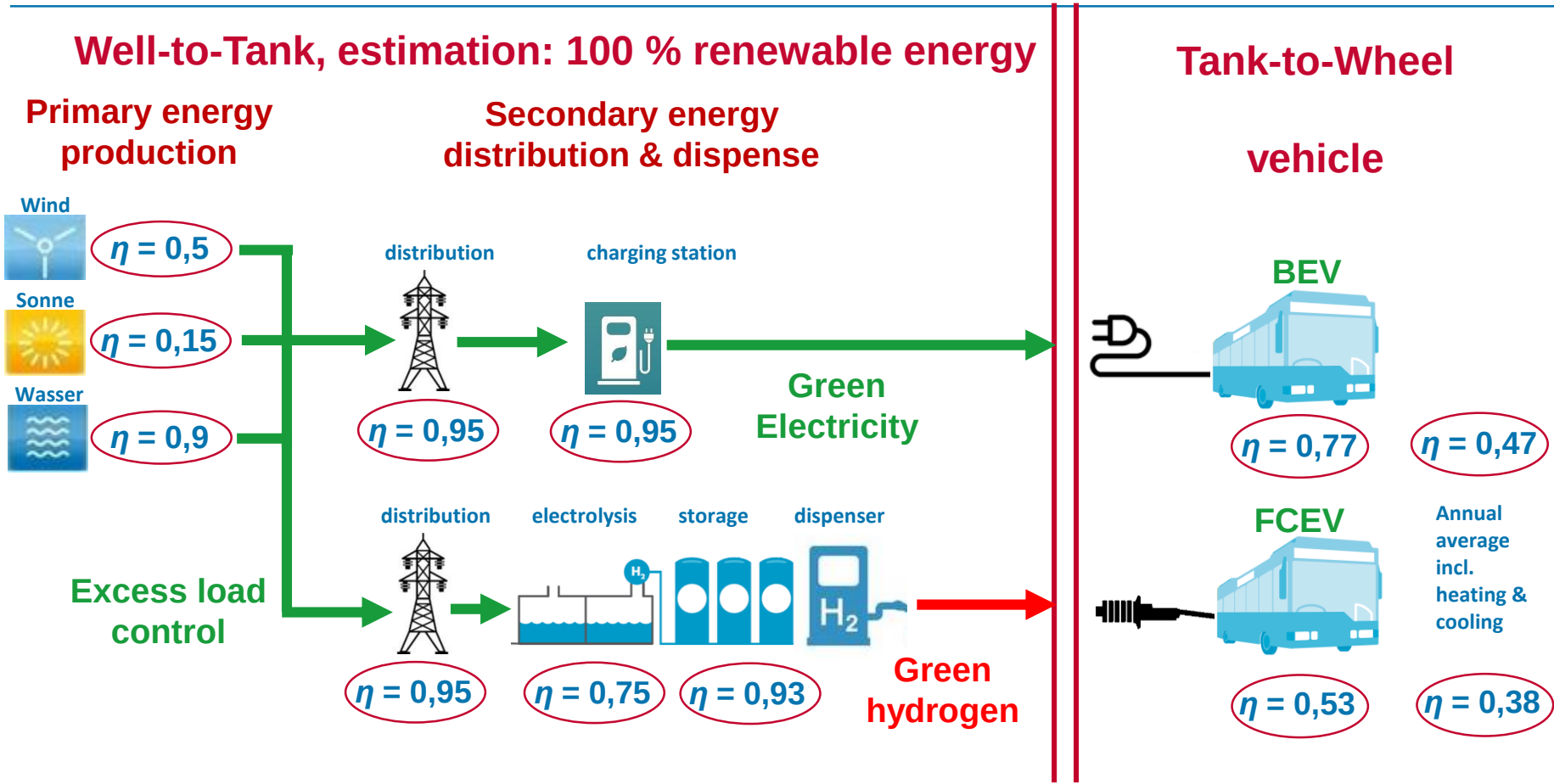
CSR

Mercedes-Benz

Scania / ASKO

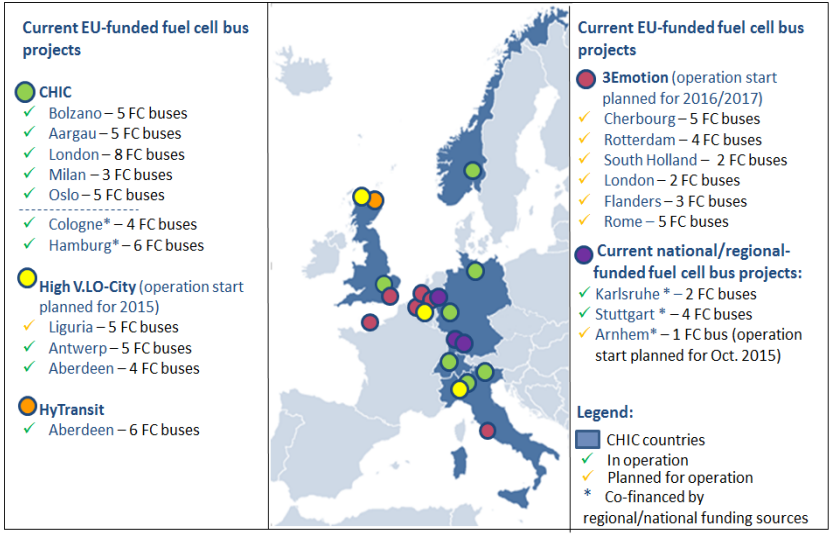
Hyundai

Efficiency – BEV vs. FCEV



H_2 Busses – Best Practice

- **World wide:**
  - about 30 manufacturers of H_2 busses
  - over 100 H_2 busses proven and used
- **Range as Diesel busses**
- **No changes in operation necessary**
- **Locally free from emissions**
- **Refuelling less than 10 min**



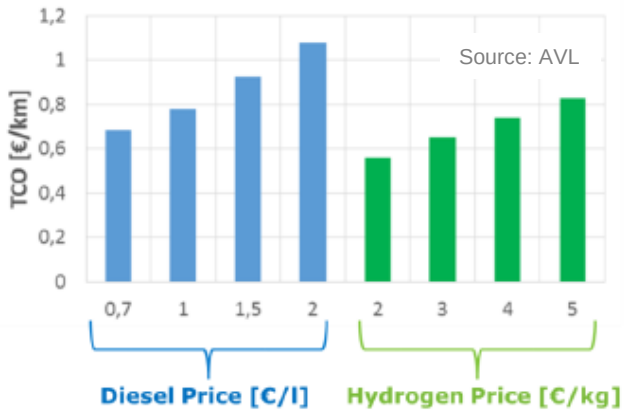
Brugg (Aarau)	**Bolzano**	**London**	**Milano**	**Oslo**
				
5 Evo Busse (seit Dezember 2011)	5 Evo Busse (seit November 2013)	8 Wright Busse (seit Januar 2011)	3 Evo Busse (seit Oktober 2013)	3 van Hool Busse (seit April 2013)
1,3 Mio. Km	481'454 Km	1,3 Mio. Km	178'396 Km	546'223 Km

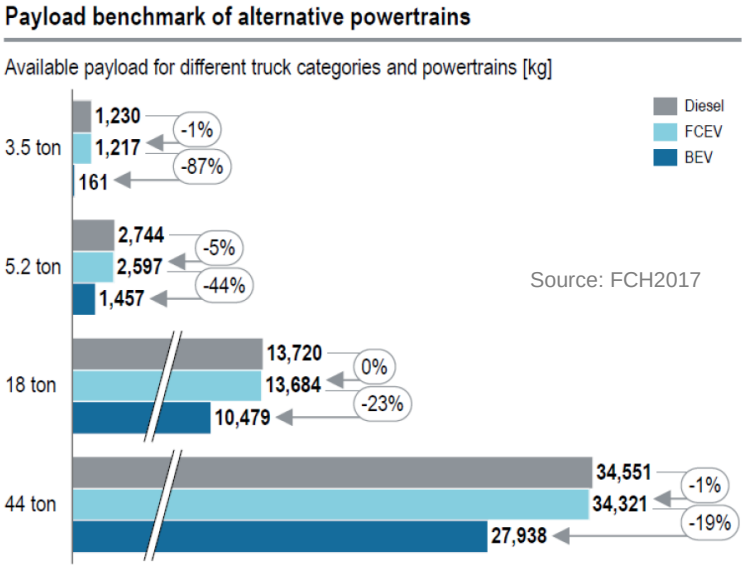
Source: Brennstoffzellenbusse in Europa (http://chic-project.eu/)

H_2 Trucks – Project HyTruck

Development of Heavy-duty FC systems and key technologies

- Increased payload cargo
- Separate scalability of power and energy storage capacity
- Fast refilling of hydrogen – flexibility and range like Diesel
- Reduction of TCO (capital costs vs. OPEX)
- Reduction of powertrain costs

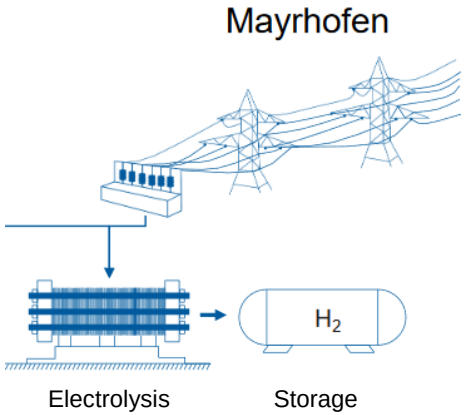


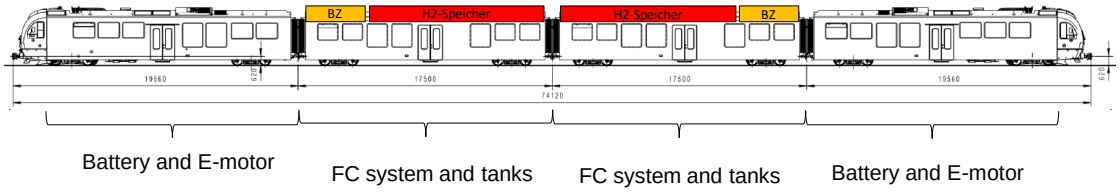


Source: AVL

H_2 Trains – Project Zillertalbahn 2020+

First narrow-gauge railway in the world powered by „green“ hydrogen





Summary

- **Technology suitable for every application**
- **Heavy-duty applications ideal for ramp-up of hydrogen as fuel**
  1. Busses
  2. Trucks at distribution centres
  3. Trains
- **Passenger cars require industrialisation and extensive expansion of refuelling infrastructure**
- **Further support and funding for development and implementation of demonstration fleets required**

« *Einfach Wasserstoff* »

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Vision

Das HyCentA (Hydrogen Center Austria) fördert die Nutzung der von Wasserstoff als regenerativem Energieträger. Mit einem Wasserstoffprüfzentrum und der ersten österreichischen Wasserstoffabgabestelle fungiert das HyCentA als Kristallisationspunkt und Informationsplattform für wasserstoffbezogene Forschungs- und Entwicklungsaktivitäten.