# Case study: Riga public transport

1th Polish Hydrogen Energy Conference
Gdynia

25th October 2018

# Riga chronology

- Study "Use of hydrogen technologies in Riga public transport, environmental and economic aspects";

- Study “Commercialisation Strategy for Fuel Cell Electric Buses in Europe”. Funded by FCH JU;

- HIT 2 – Corridors  Hydrogen Infrastructure for Transport. As par of this project HRS where deployed in Gothenburg, Stockholm and Voikoski (Finland). HRS implementation plans for Finland, Riga region, Poland and Belgium were developed. Study: Hydrogen as transport fuel refueling infrastructure implementation in Riga and Riga region. Co-financed by TEN-T;

- “NewBusFuel” - Engineering studies for hydrogen refueling infrastructure development for large scale bus depots. Funded by FCH JU;

# “H2 Nodes”

GA CEF TRANSPORT No: **INEA/CEF/TRAN/M2014/1025986**
Action No.: 2014-EU-TM-0643-S
H2Nodes – evolution of a European hydrogen refueling station network by mobilizing the **local demand** and value chains.

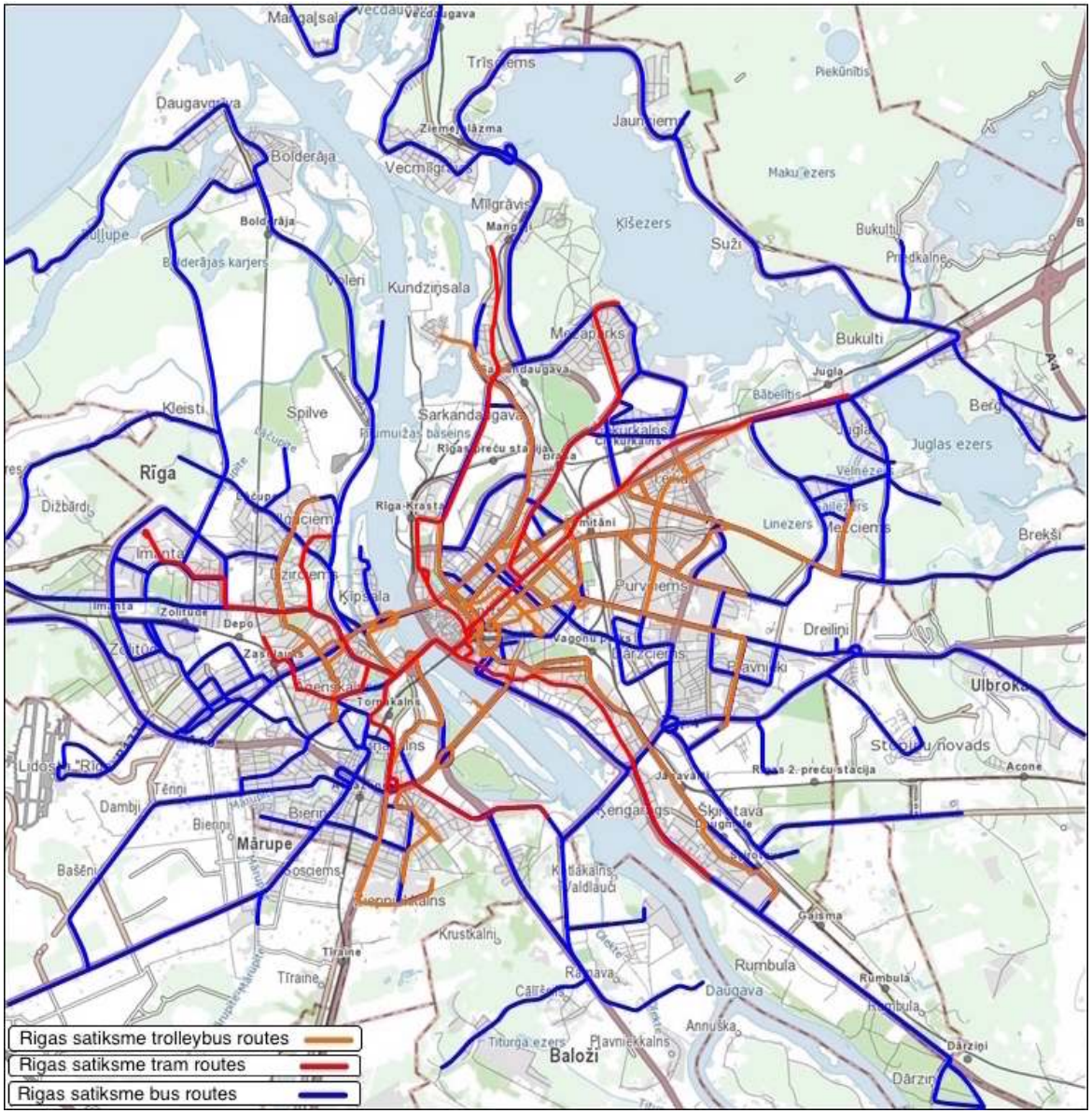
- H2Nodes Action looks into planning and realizing a chain of HRS and boosting implementation of FCEV along the **North Sea - Baltic** TEN-T core network corridor;

- The focus is on market sided **innovation** by **real-life deployment** with local studies and processes to boost market introduction;

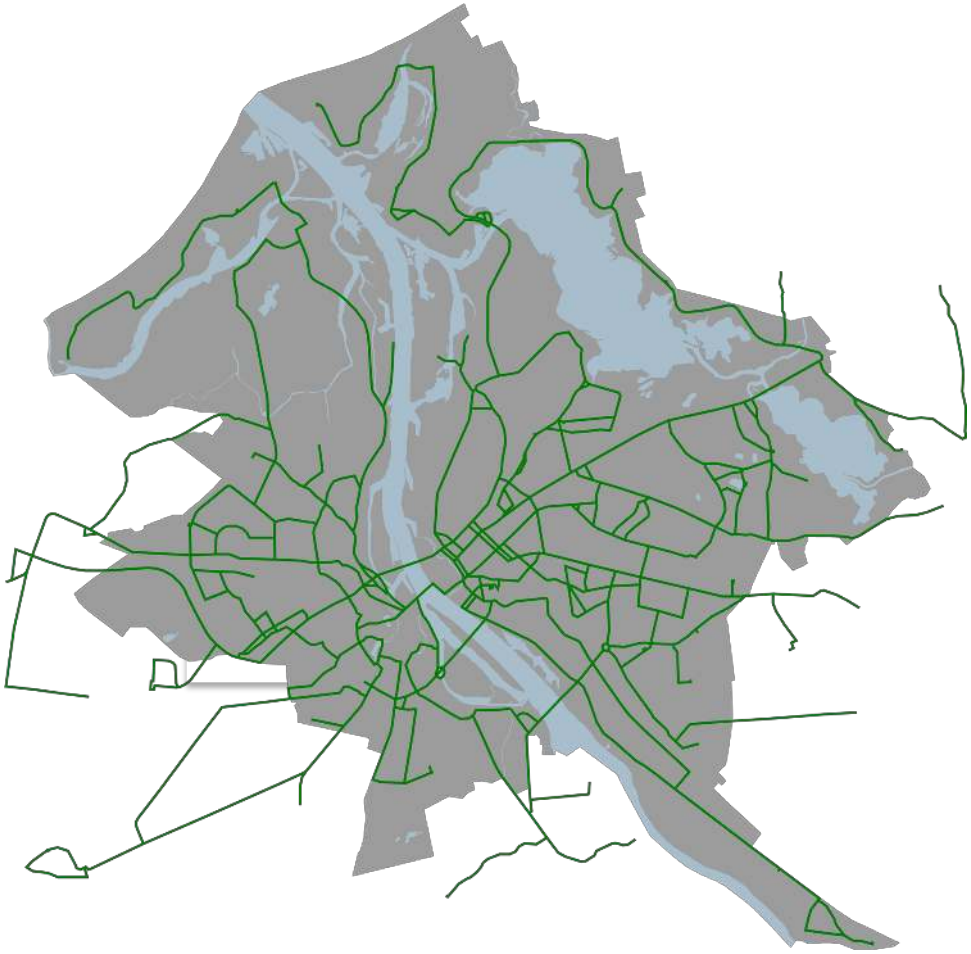
- RM LLC “Rīgas Satiksme” pilot of the innovative **concept HyTrolleys** where two alternative fuels **electricity and hydrogen** are combined to allow the benefit from the advantages of both technologies and provide greater **flexibility** in the urban transport system - **less noise**, **zero emissions** and better **energy efficiency**

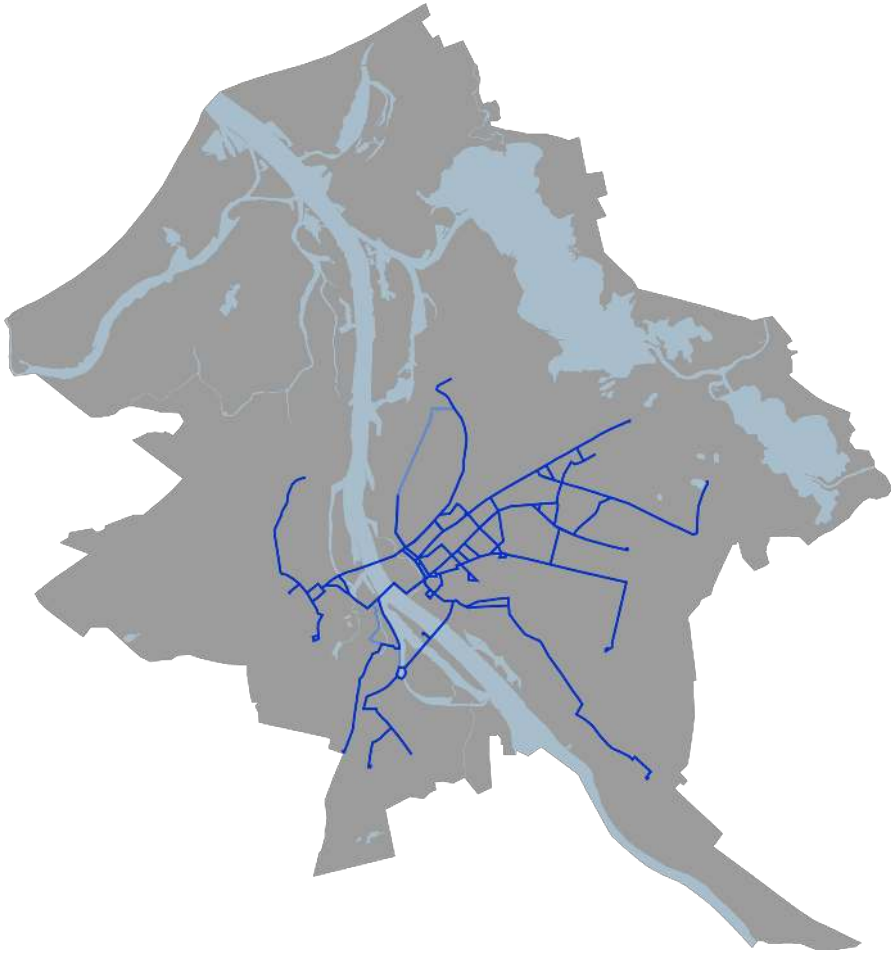
Co-financed by the European Union
Connecting Europe Facility

# Riga city public transport routes

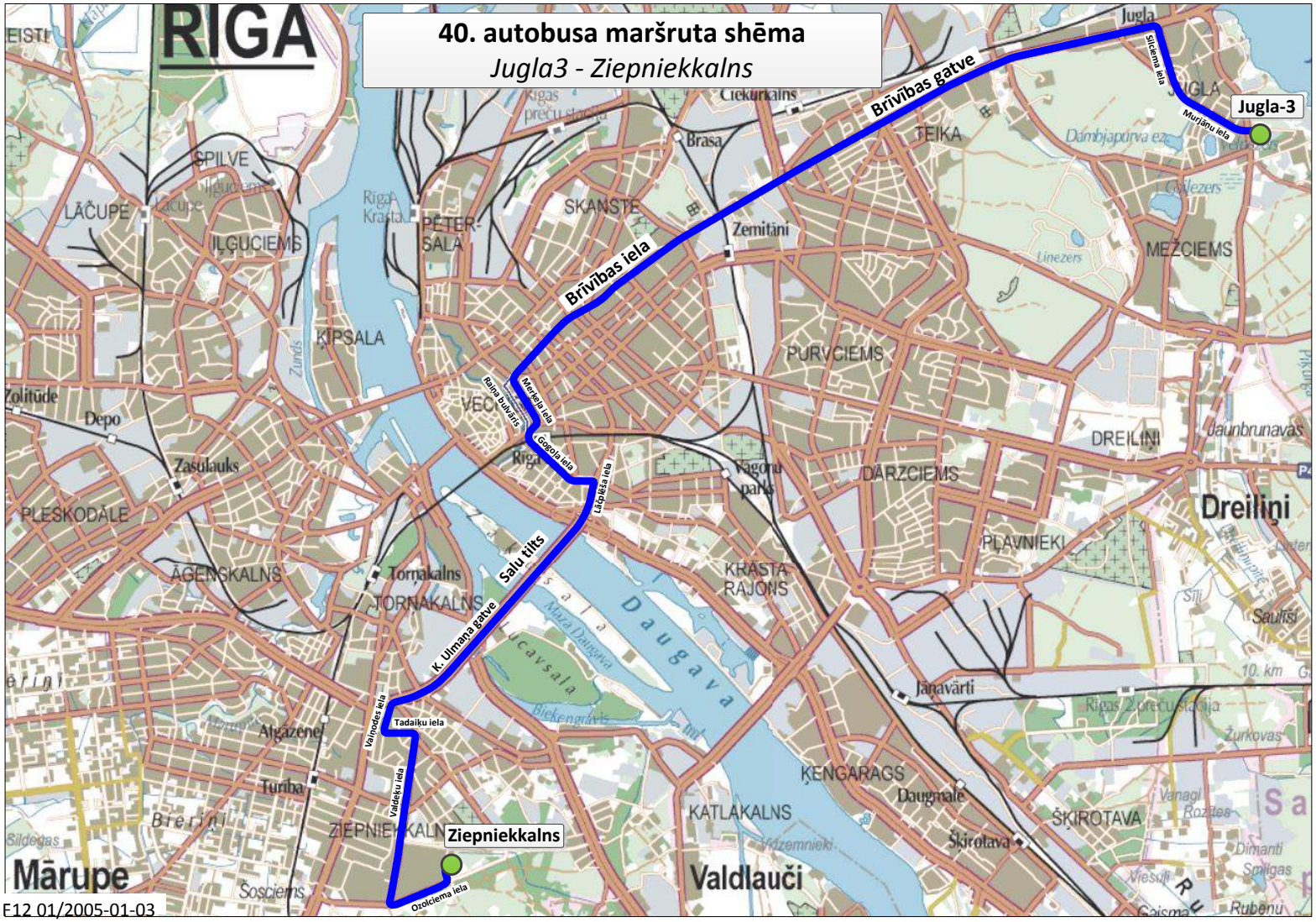


# Riga city, bus and trolleybus routes





# bus route nr.40: *Jugla3 - Ziepniekkalns*




E12 01/2005-01-03

# Bus routes replacement

By evaluating existing routes of diesel buses, for replacement possibilities by trolleybus with spare traction power provided by diesel generator or hydrogen fuel cell, it was concluded that it is feasible. In the calculation were compared spare traction power providing diesel generators and hydrogen fuel cell FC velocity HD7 operating expenses.

Potential savings:

Bus / Trolleybuss with diesel genset - 25 %

Bus / Trolleybuss with FC - 27 - 35%*

* Significant impact on results have hydrogen source and production solution.

# Comparison of different powertrains

**Similar performance**

**Passenger capacity**

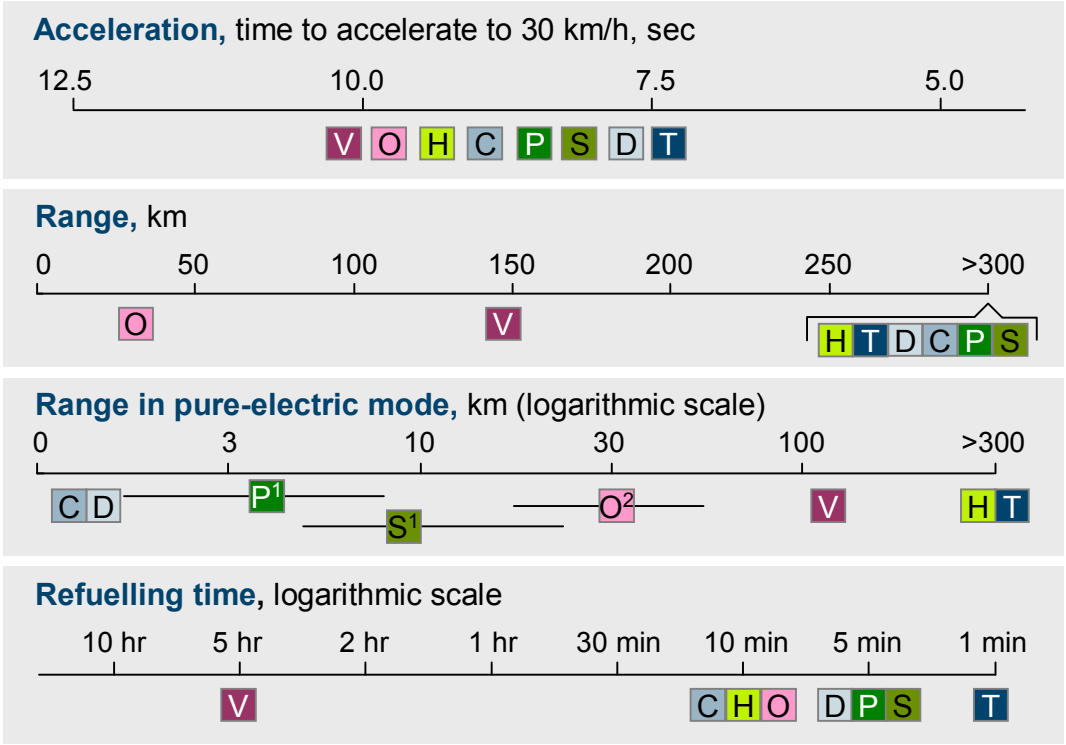
**Curb weight**
(12-m bus)

*Lowest:*
Diesel (11.6 t)

*Highest:*
Overnight e-bus
(13.5 t)

**Differentiated performance**

D Diesel | P Diesel parallel hybrid | H Hydrogen fuel cell | O Opportunity e-bus
C CNG | S Diesel serial hybrid | T Trolley | V Overnight e-bus

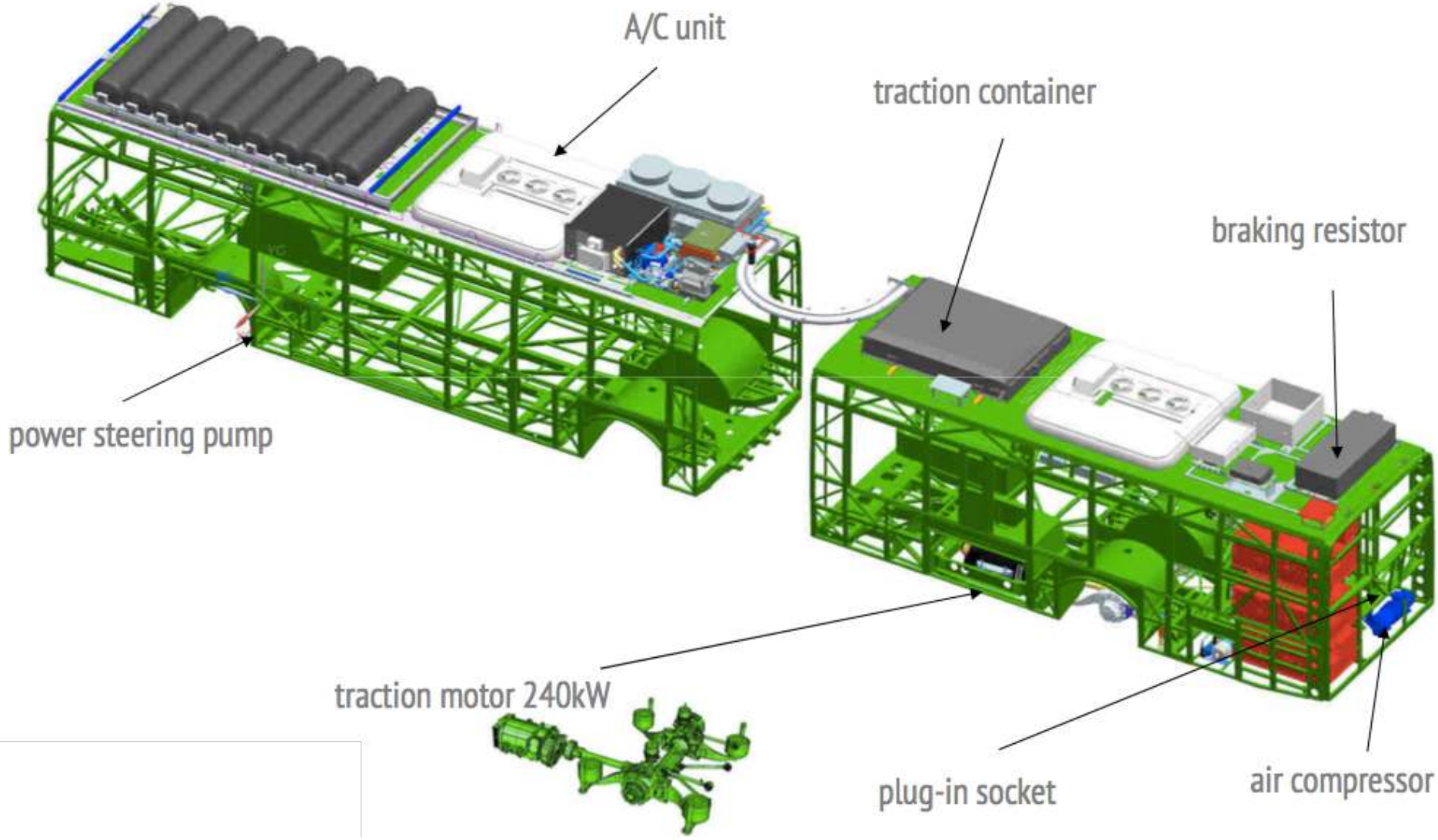



- **Only hydrogen fuel cell** and **trolley** can drive with **zero emissions** at almost **no range limitation**
- **E-buses limited** in operational range – long charging times for overnight
- **Diesel hybrids, serial in particular, capable of zero emission** driving on certain stretches of the route with same operational conditions as conventional powertrain; serial

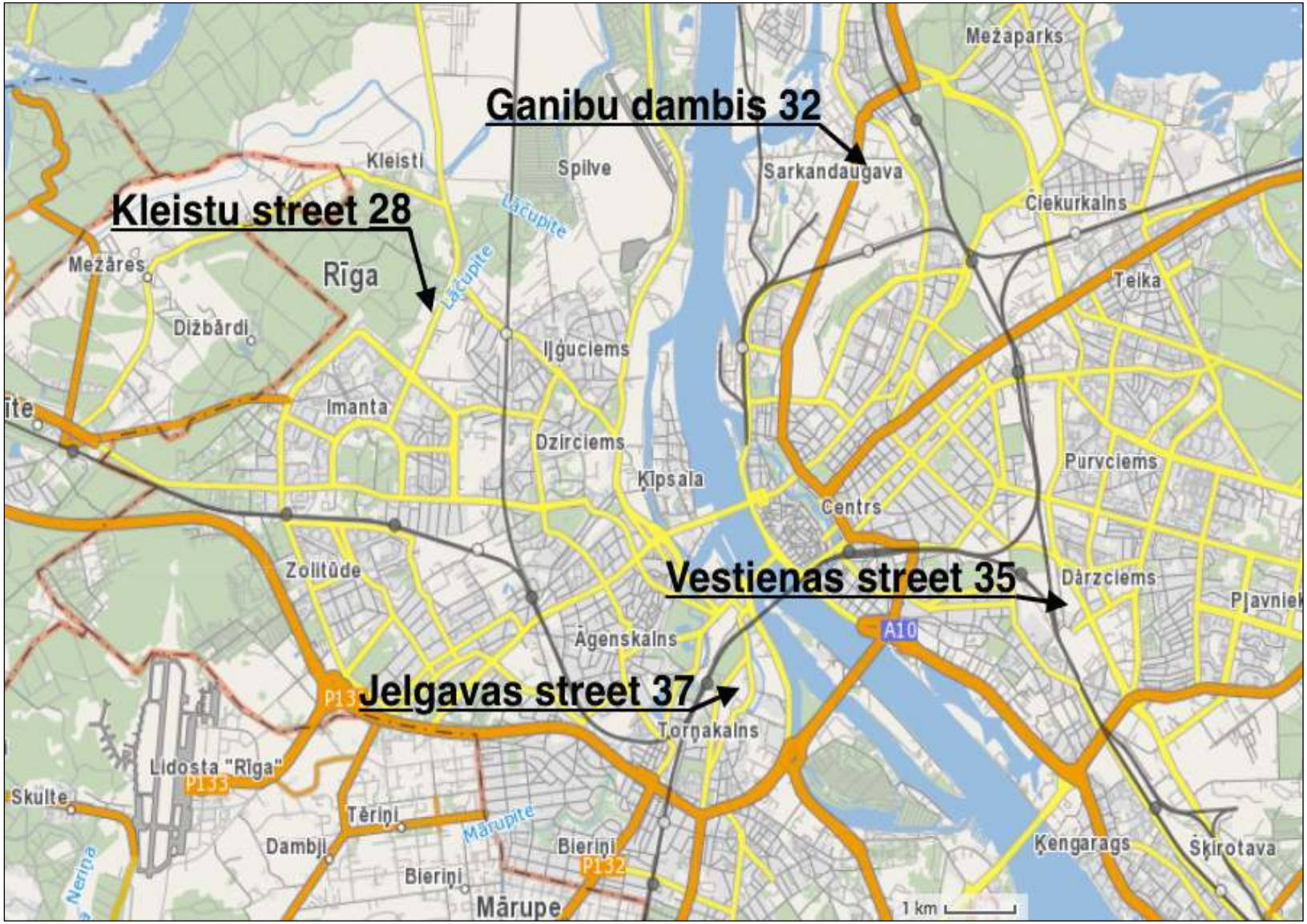
1 Typical values shown here – pure electric range of hybrid powertrains varies depending on concept of auxiliary units and battery capacity
2 Based on a 60 kWh battery and a consumption (incl. losses from charging) of 2 kWh/km

Source: FCH JU study “Urban buses, alternative powertrains for Europe”

# Technical solution



# Bus and trolleybus depots



# Bus and trolleybus depots


*Operating 142 diesel buses, total area of depo 80 170 m², diesel storage for refueling 250 000 L*


*Operating 256 diesel buses, total area of depo 47 547 m² and additional is ~ 32 000 m², diesel storage for refueling 250 000 L*


*Operating 123 trolleybuses (67 equipped with diesel APU). Total area of depo 56 693 m², diesel storage for refueling 9 000 L*


*Operating 126 trolleybuses. Total area of depo 56 693 m², diesel storage for refueling 9 800 L*

# Hydrogen Refueling Station

Main characteristics:

- H2 production capacity 300 kg/day
- 350 bar and 700 bar dispensers
- H2 storage 600 kg

*Disposition of the HRS next to Riga Municipal LLC “Rigas satiksme” 2nd trolleybus park in Jelgavas street 37*

# Findings

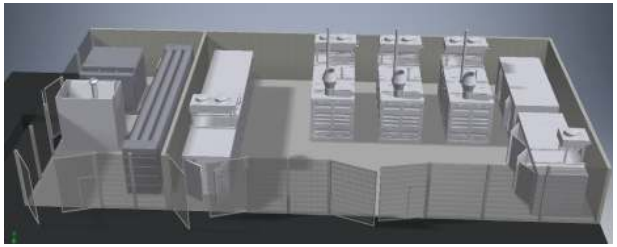
- **Traction power** for public transport most efficiently can be provided with **electric motor;**

- **Security of energy supply** and **energy efficiency** of public transport and urban infrastructure can be provided through introduction of **alternative fuels** and **energy resources diversity** by universal energy carriers - **electricity and hydrogen;**

- The greatest benefits for **air quality** and **environment** by implementing **alternative fuels** and **zero emission vehicles** can be achieved in **urban areas;**

# Riga summary

- **“H2 Nodes”** - HRS and 10 FC range extended trolleybuses;



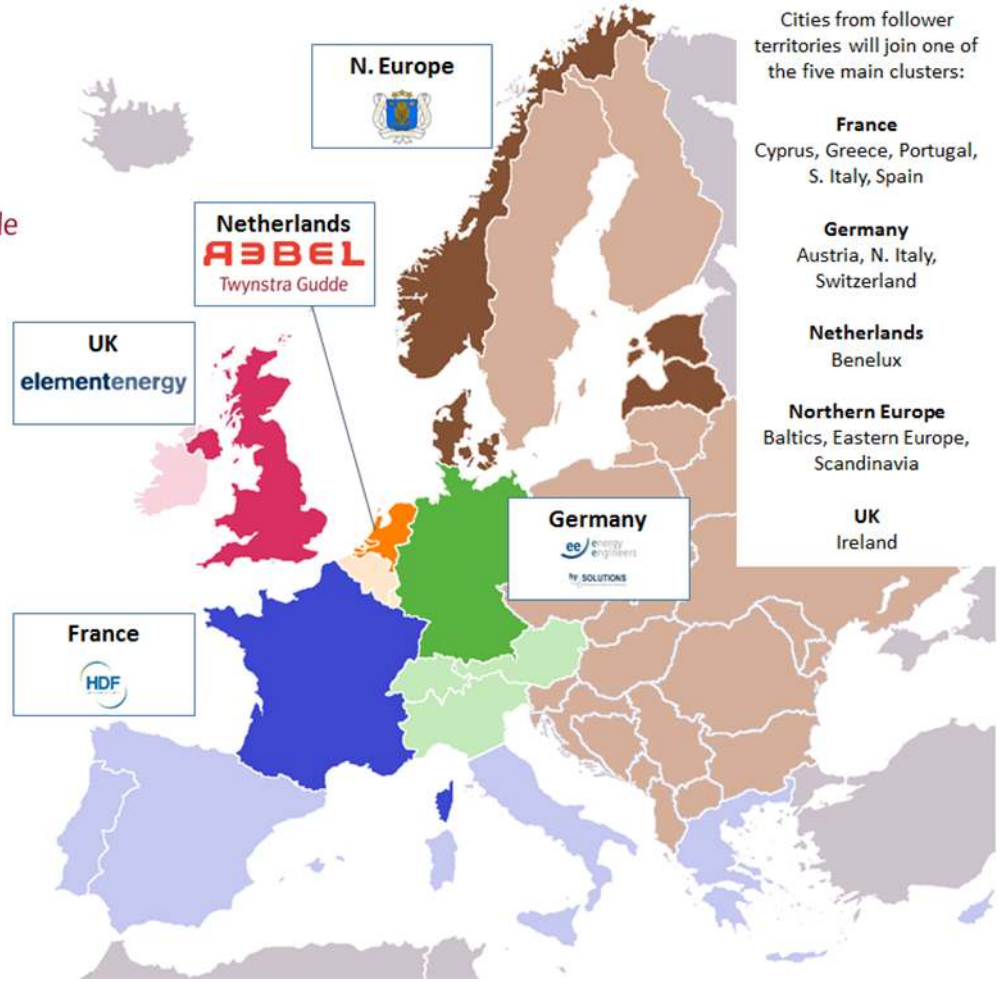
- **“JIVE”** – 10 FCE buses;

- **EIB loan – 75 M EUR** for construction of hydrogen refueling, production and storage facility, purchase of 10 hydrogen fuel cell (HFC) buses and 10 Hytrolleys with HFC range extenders. Purchase of 20 new low-floor tram units to operate in the city of Riga, and modernisation of tramway infrastructure and depot.

# EU regional clusters for Fuel Cell Electric Buses Joint Procurement activities


The consultancy team is being led by Element Energy (also the UK cluster coordinator), and includes partners to coordinate activities across Europe:

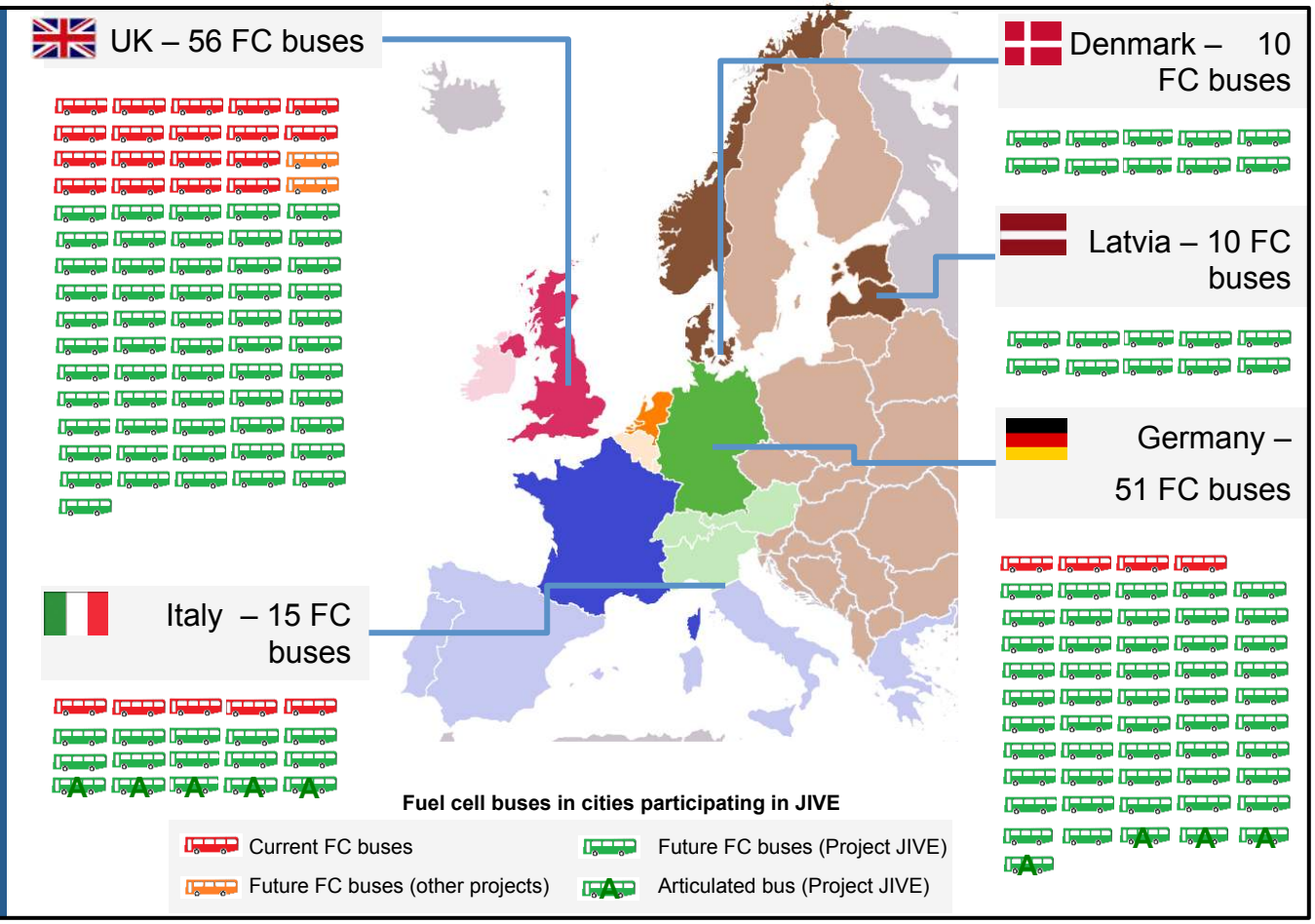
- **France** – Hydrogène de France
- **Germany** – ee energy engineers & hySOLUTIONS
- **Netherlands** – Rebel Group & Twynstra Gudde
- **Northern Europe** – Latvian Academy of Sciences
- **UK** – Element Energy



# JIVE: Joint Initiative for hydrogen Vehicles across Europe

## Objectives

- Deploy 142 FC buses across nine cities
- Achieve 30% cost reduction versus state of the art
- Operate 50% of the vehicles for at least 36 months
- Deploy the largest capacity HRS in Europe
- Achieve near 100% reliability of HRS
- Demonstrate technological readiness of FC buses and HRS
- Encourage further uptake




**JIVE will be a six year project, that started on the 25th of January 2017**

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

# JIVE 2: Joint Initiative for hydrogen Vehicles across Europe Phase 2

## Objectives

- Deploy 152 FC buses across 14 cities
- Achieve a maximum price of €625k for a standard fuel cell bus
- Operate buses for at least three years / 150,000 km
- Validate large scale fleets in operation
- Enable new entrants to trial the technology
- Demonstrate routes to low cost renewable $H_2$
- Stimulate further large scale uptake

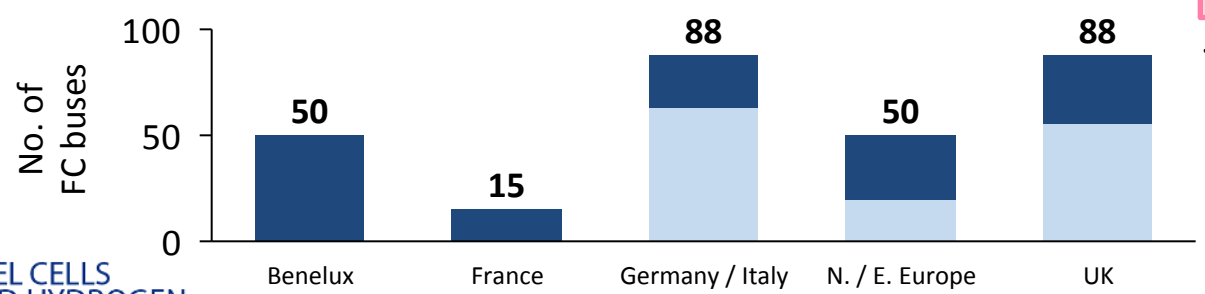
**Benelux Cluster (50 FC buses)**

**France Cluster (15 FC buses)**

**Germany / Italy Cluster (88 FC buses)**

**Northern / Eastern Europe Cluster (50 FC buses)**

**UK Cluster (88 FC buses)**




**Total = 291** new FC buses for Europe

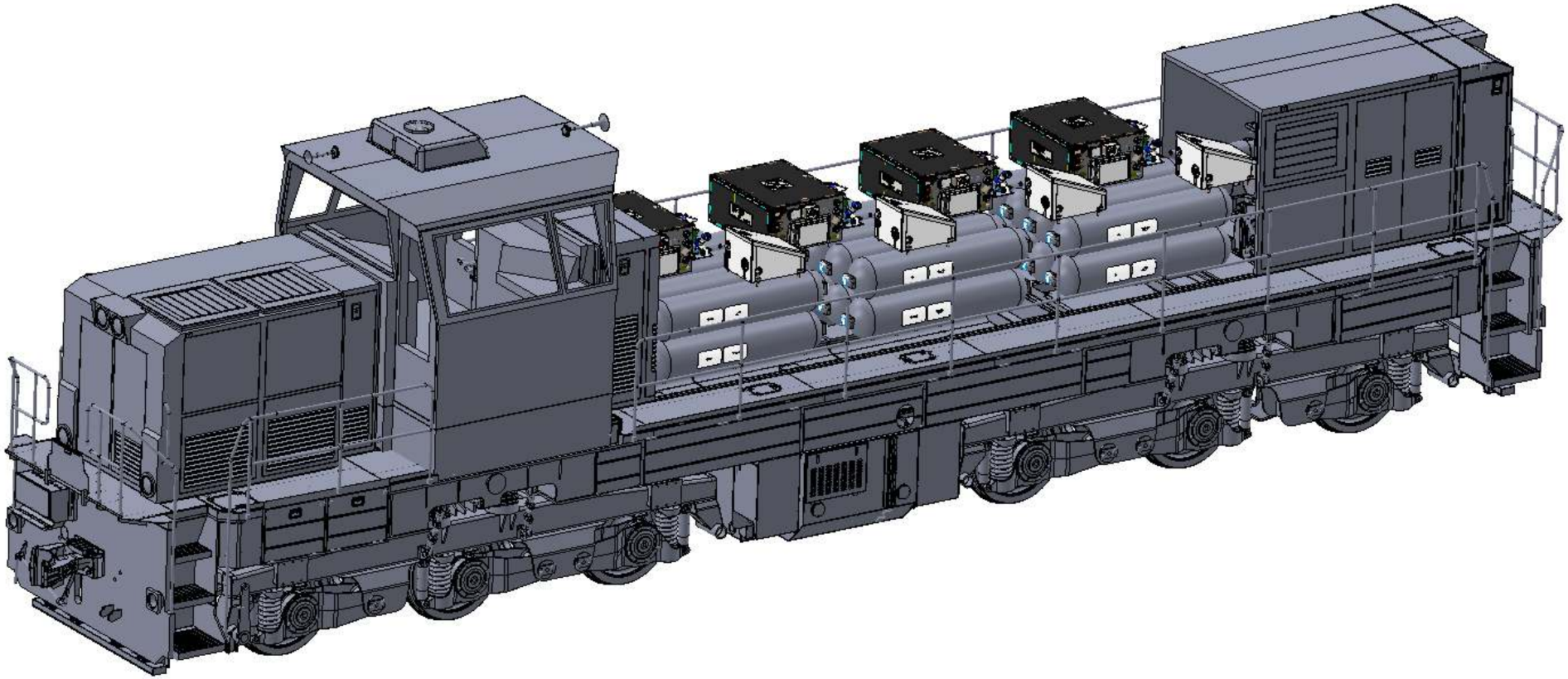
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

# Whats next?

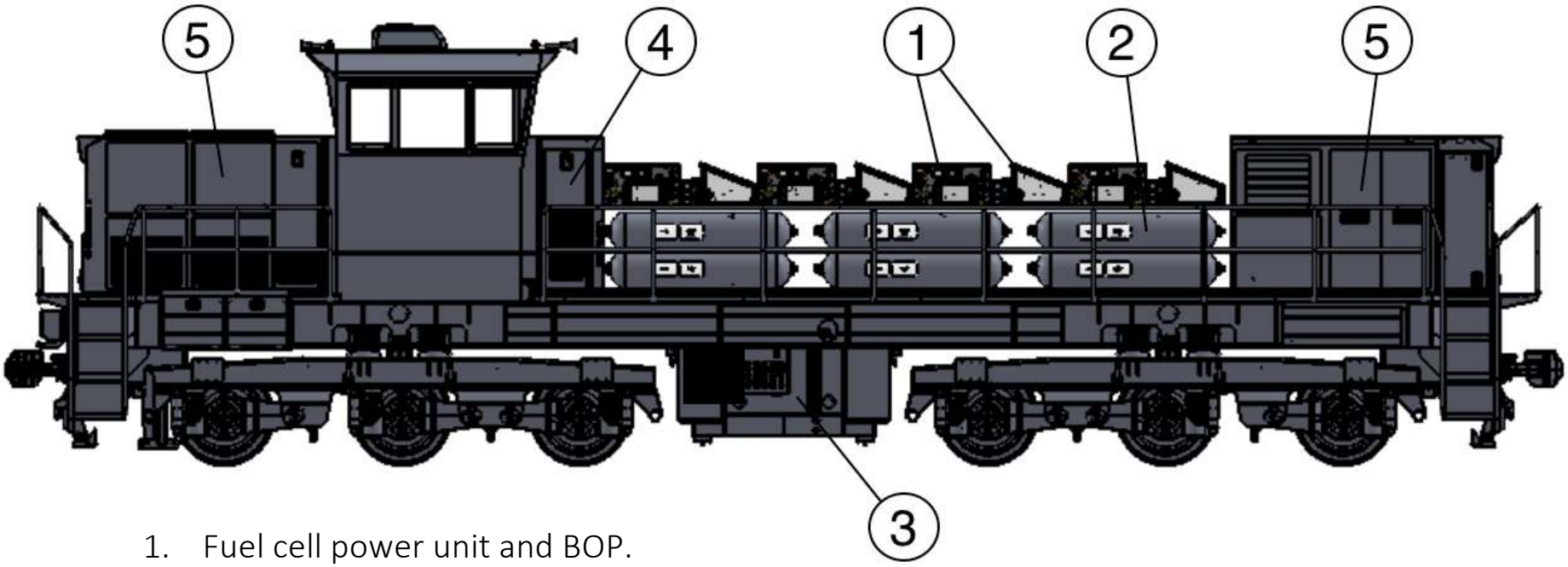
## FC and hydrogen potential in railways

- **Modernization** of the **existing** shunting locomotives by replacing diesel genset with FC;
- In operational use the FC-electric shunting locomotive reduces the **local emissions** (CO, NOx, NMVOC and PM) **to zero** and significantly reduces noise and vibration levels;
- **Economic benefits** compared to existing alternatives in the market;
- Possibility to **use** FC-electric **locomotives in closed areas**, warehouses and in places **where it is technically** and geographically challenging or **impossible to implement** railway **electrification** (Last mile) e.g. Railway depo, cargo ports, shunting yard;

# ČME3M-H2



# ČME3M-H2 technology




1. Fuel cell power unit and BOP.
2. Hydrogen storage system (tanks for compressed gaseous hydrogen).
3. Battery module and Electricity transformer units (traction electromotor power supply).
4. TCMS, power management system, High voltage switch gear.
5. Auxiliary units and systems (air compressor, traction electric motor fan, brake resistor and other auxiliary unit power supply).

# Thank You for attention!

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FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Co-financed by the European Union
Connecting Europe Facility

Hydrogen Europe

# Hydrogen as an Enabler for the
# plementation of the European low carbon econo

# Fuel Cell & Hydrogen Joint Undertaking 2

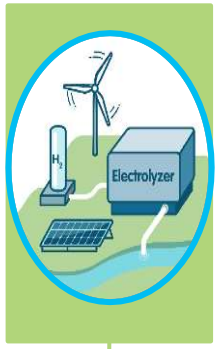
Hydrogen Europe
Industry

**European Union**
represented by the European Commission

Hydrogen Europe
Research


**A portfolio of clean, efficient and competitive solutions** based on fuel cells and hydrogen technologies **in energy and transport**

# Decarbonising Energy Systems



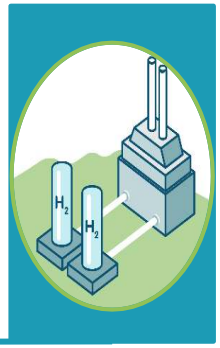

**Easy ← complexity to decarbonise → Hard**

**Transport**

**Power**

**Industry**

**Heat**



Sources: based on Equinor, 2018

*Multiple technologies to address the challenge*

# Hydrogen for the Transport sector: Buses

**EU-funded projects**

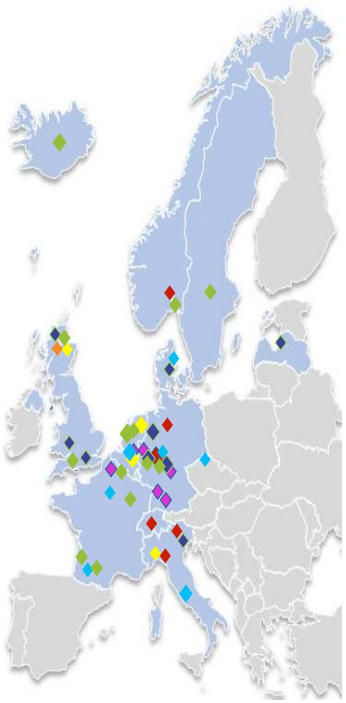
**CHIC**
**(36 buses, plus 20 in Canada)**
- ✓ Aargau, CH;
- ✓ Bolzano, IT; London, UK; Milan, IT; Oslo, NO; Cologne, DE*; Hamburg, DE*

**High V.LO-City**
**(14 buses)**
- ✓ Antwerp, BE; Aberdeen, UK; Groningen, NL; San Remo, IT

**HyTransit**
**(6 buses)**
- ✓ Aberdeen, UK

**3Emotion**
**(21 buses)**
- ✓ London, UK
- ✓ Aalborg, DK; Pau, FR; Rome, IT; South Rotterdam, NL; South Holland; Versailles, FR

**National/regional-funded projects**
- ✓ Karlsruhe, DE; Stuttgart, DE; Frankfurt, DE;
- ✓ Arnhem, NL; North Brabant, NL; Artois Gohelle, FR

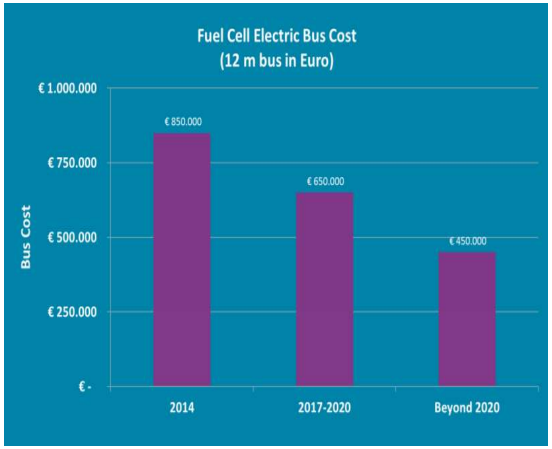


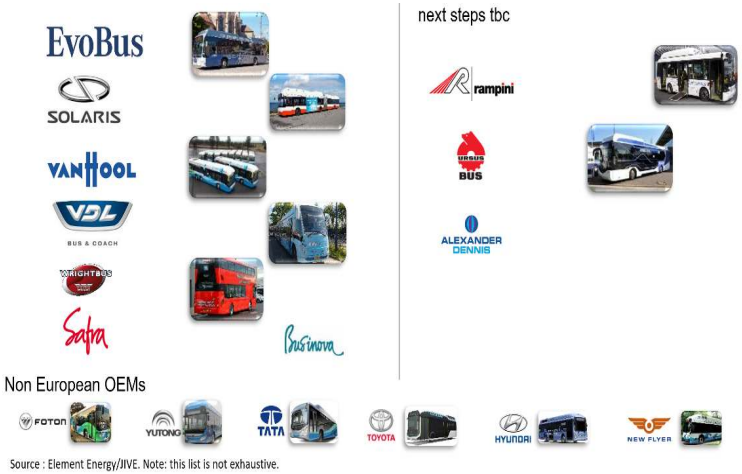
**Legend**

- Countries with (upcoming) FC buses
- ✓ In operation
- ✓ Planned or operation ended
- * National funding

**JIVE**
**(139 buses)**
- ✓ Aberdeen, UK – 10 FC buses
- ✓ Birmingham – 20 FC buses
- ✓ Bolzano, IT – 12 FC buses
- ✓ Cologne region, DE – 30 FC buses
- ✓ Herning, DK – 10 buses
- ✓ London, UK – 26 FC buses
- ✓ Rhein-Main region, DE – 11 FC buses
- ✓ Riga, LV – 10 FC buses
- ✓ Wuppertal, DE – 10 buses

**JIVE 2**
**(152 buses)**
- ✓ UK – 20 buses
- ✓ Dundee, UK – 12 buses
- ✓ Groningen, NL – 20 buses
- ✓ North Brabant, NL – 10 buses
- ✓ South Holland, NL – 20 buses
- ✓ Auxerre, FR – 5 buses
- ✓ Pau, FR – 5 buses
- ✓ Toulouse, FR – 5 buses
- ✓ Cologne region, DE – 1
- ✓ Germany – 15 buses
- ✓ Iceland – 10 buses
- ✓ Sweden – 5 buses
- ✓ Akershus, NO – 10 bus






Source: JIVE/ JIVE2

Last update: April 2018

# Hydrogen for the Transport sector: HDV

### FCH-JU H2ME project Batt+RE

| SPECIFICATIONS | |
|---|---|
| Location | France |
| Manufacturer | Symbio Renault |
| Autonomy | Tbc |
| Tank cap. | Tbc |
| Capacity | Tbc |
| Filling time | Tbc |

### ESORO COOP


| SPECIFICATIONS | |
|---|---|
| Location | Switzerland |
| Manufacturer | ESORO |
| Autonomy | 400 KM |
| Tank capacity | 31 KG |
| Capacity | 34'000 KG |
| Filling time | 10 min |

### ASKO-SCANIA

| SPECIFICATIONS | |
|---|---|
| Location | Norway |
| Manufacturer | SCANIA |
| Deployment | 2018 |
| Autonomy | 500 km |
| Transport Capacity | 27'000 KG |

### VDL - COLRUYT

| SPECIFICATIONS | |
|---|---|
| Location | Belgium |
| Manufacturer | VDL Group |
| Deployment | 2018 |
| Transport Capacity | 37'000 KG |

FCH-JU started with FC in trucks by researching APU's (3 projects) then Range Extenders in H2ME, by end 2017 about 15 garbage trucks expect to be funded

Nicola Trucks

Toyota Truck @LA port

Kenworth FC drayage truck

Partners planning 2,000 commercial vehicles on the road in next 3 years.

Toyota and 7-eleven study to use FC


# Want to know more?

2018 EUROPEAN
ZERO EMISSION BUS
CONFERENCE

**27th – 28th NOVEMBER 2018**
**FLORA COLOGNE, GERMANY**

*Organised under the patronage of* Stadt Köln

Technology and policy experts will lead a two-day conference to drive forward the realisation of zero emission public transport for Europe.

**Agenda overview**

- Technological readiness
- Zero emission bus deployment
- Lessons learned
- New business and financing models
- Scaling up – going from small bus fleets to complete zero

**DETAILS & REGISTRATION**: zebconference.com/eu

ZERO EMISSION · Hydrogen Europe · elementenergy · FCH

**In partnership with** EnergieAgentur.NRW & ElektroMobilität NRW

@EUZEBconference
#ZEB2018

# Thank you! Questions?

Hydrogen Europe

**Contacts**

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