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Hydrogen future in the Savinjsko-šaleška region

Public transport with zero-emission FCE vehicles for advancing sustainable energy supply with hydrogen as an alternative vector of the energy transition

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007201. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

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Ambition to become a hydrogen valley

OBJECTIVE

Develop and deploy a replicable, balanced and integrated hydrogen economy by facilitating investment into market-ready hydrogen technologies.

CONTEXT

- Make use of available local hydrogen sources and apply it in applications for facilitating the energy transition, starting with zero-emission public transport.

- Establish the demonstration pilot as a development platform (transfer of knowledge) that can be used to replicate similar projects across SEE and other coal intensive regions in transition.

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Core implementation aspects of the projects

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FOCUS

The investment project is primarily constituted from 3 key elements:

I. Construction of a Hydrogen Refueling Station

II. Upgrade of local hydrogen production facilitates (electrolyzer, compressor units, storage, etc.)

III. Modernization of the existing public transport service (currently EURO5 and EURO6 diesel-powered minibuses) with Fuel Cell Electric Vehicles

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Generalized project concept

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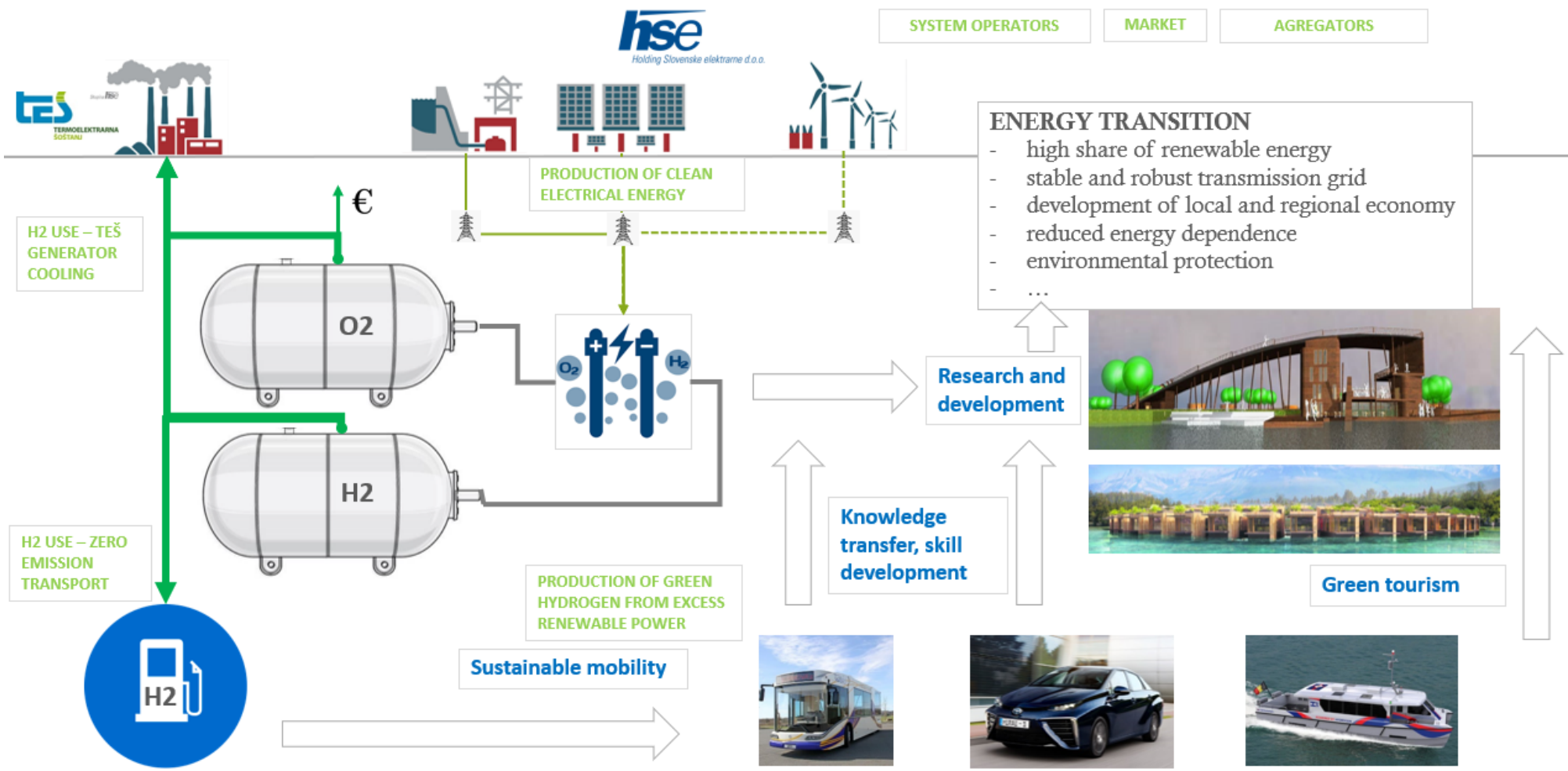

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Analysis of hydrogen requirements and scope of production

STARTING POINT

Modelling of operational use of hydrogen on specific routes (stop and go, inclines, load, thermal management, etc.)

Bus line modelling | Calculation data and assumptions

1. **General data**
   - Average commercial speed (calculated) : 23.3 km/h
   - Service duration on 1 day : 14.7 hours
   - Loop distance : 16.3 km
     (note : Velenje website mentions 21 km, but we calculate 16.3 km - TBC)
   - Stop time at each bus stop : 20 seconds
2. **BUSINOVA H2 Midibus L**
   - Unloaded weight : 12 900 kg
   - Passengers number considered : 25 and 45
   - Total weight
     - At **25 passengers** : 14 600 kg
     - At **45 passengers** : 15 960 kg
3. **Thermal management (passengers and driver compartments temperature)**
   - 3 cases studied (conservative)
     - No air conditioning, when external temperature around 15 to 22°C : **0 kW** for thermal management
     - Moderate thermal management consumption : **3 kW** when :
       - air conditioning for temperatures between approx. 22 to 28°C
       - Additional electrical heating for temperatures below – 5°C
     - High air conditioning for temperatures above 28°C : **5kW** for thermal managment

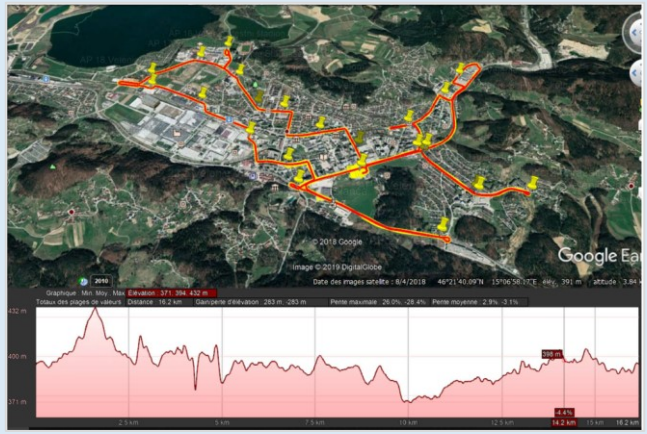
Yellow line modelling | 1st case : autonomy at full H2 consumption

- Useful H2 mass in tanks is 29.1 kg
- Simulation with all energy from H2, battery used only as a buffer (nominal mode)

Passengers #	Thermal management (kW)	Traction energy (excl. regeneration)	Auxiliaries energy (incl. thermal mngt)	Regeneration (energy recovery)	Total energy (kWh/km)	Daily H2 consumption (kg)	Battery SOC final (%)	Autonomy range (km)	Equivalent H2 consumption (kg/100km)
25	0	1,012	0,173	-0,243	**0,942**	29,1	90%	**448**	**6,50**
	3	1,012	0,302	-0,243	**1,071**	29,1	90%	**392**	**7,43**
	5	1,012	0,389	-0,243	**1,158**	29,1	90%	**363**	**8,02**
45	0	1,096	0,173	-0,244	**1,024**	29,1	90%	**410**	**7,09**
	3	1,096	0,302	-0,244	**1,154**	29,1	90%	**364**	**8,00**
	5	1,096	0,389	-0,244	**1,240**	29,1	90%	**339**	**8,59**

- Autonomy in the range 339-448 km using the full H2 tanks and no battery energy
- With moderate thermal management, we can target an average autonomy between 364/392 km and H2 consumption between 7.5 to 8 kg/100km
- Please note that by end of life of the fuel cell, these values would decrease by 10%

→ **in order to increase some autonomy, we can also use the batteries, see next slide**



PARAMETER/ROUTE	BLUE	ORANGE	RED	BROWN	TURQUISE	PURPLE	GREEN	TOTAL
Travelled distance [day]	390,78	63,76	639,58	31,21	696,34	65,57	45,26	**1981,7 km/dan**
Travelled distance [year]	101948,64	16634,03	166855,78	8141,70	181665,18	17104,93	2353,52	**507539,3 km/year**
Time of operation [year]	1948,88	466,72	7769,94	313,06	8493,51	521,77	97,07	**20028,3 hours**
Fuel economy [kg H2/100km]	8,01	6,23	6,94	7,98	6,93	6,20	6,75	**7,16 kg/100 km**
Hydrogen consumption [day]	31,30	3,97	44,39	2,49	48,26	4,07	3,06	**141,57 kg/day**
Hydrogen consumption [year]	8166,09	1036,30	16542,56	649,71	14638,83	1060,51	158,86	**43307,9 kg/year**
Average speed [km/h]	52	36	21	26	21	33	24	**30,58 km/h**
No. of refuellings (indicative)	1,043	0,132	1,480	0,083	1,609	0,136	0,102	**4,72**

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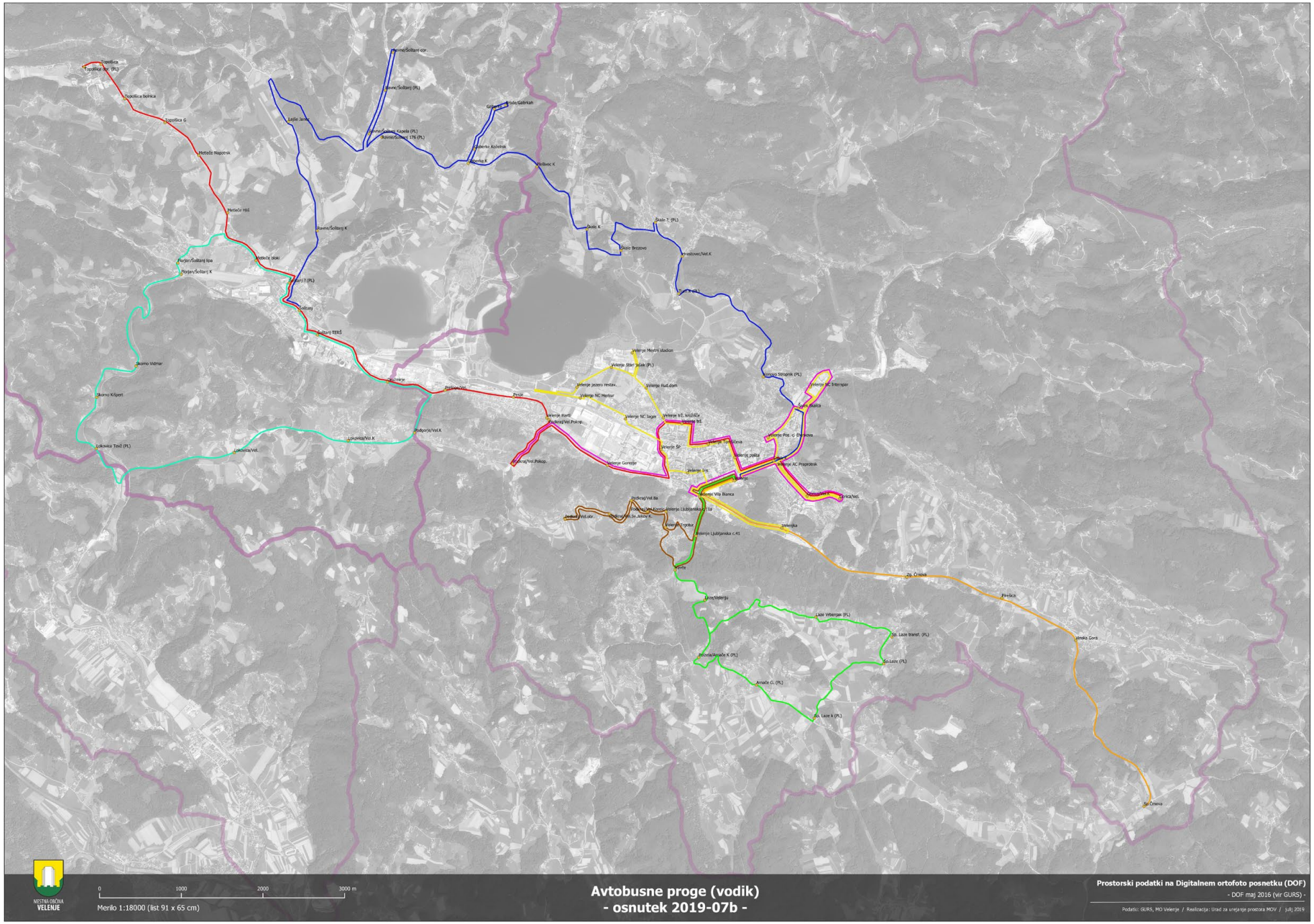

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Main findings and baselines

STARTING POINT

Joint development of routes, stops and travel itineraries together with local communities from the City municipality of Velenje and Municipality of Šoštanj.

GUIDING PRINCIPLES

- Improved access to PTS
- Adaptation of the scope and frequency of travel
- Increase the number of PTS users
- Encouragement of multy-modality

RESULT

7 routes

500.000+ km of traveled distance annualy

450.000,00 passengers using the PTS

Requirement of at least 44 tons of hydrogen per annum

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Next steps

SHORT TERM (2022-2023)

Acquirement of co-financing sources for infrastructure development

Order of FCEVs

MEDIUM TERM (2025)

Vehicle delivery and testing

Civil works and equipment installation (start-up)

Development and signature of the service concession with the chosen PTO

Training of drivers, maintenance crew and infrastructure operators

PTS launch

LONG TERM (2025-2027)

Development of R&D as well as capacity development projects in cooperation with existing stakeholder networks

Awareness raising and promotion

Establishment of the knowledge transfer platform for FCH technology uptake in SEE and the Western Balkans

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Project network of partner and support organizations

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NOMAGO

APS

FCH | FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA INFRASTRUKTURO

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

REPUBLIC OF SLOVENIA
MINISTRY OF DEFENCE

Hydrogen Europe

Roland Berger

Clean Hydrogen Partnership

TEŠ Skupina HSE
TERMOELEKTRARNA ŠOŠTANJ

MESTNA OBČINA VELENJE

MOBILITY AND TRANSPORT

ECUBES ARCOLA
Hydrogen & Flexibility

PETROL

SBRA
Slovenian Business & Research Association

HSE
Holding Slovenske elektrarne d.o.o.

EKO SKLAD
SLOVENSKI OKOLJSKI JAVNI SKLAD

cónot

SRIPACS+
Strateško razvojno inovacijsko partnerstvo na področju Mobilnosti

Univerza v Ljubljani
Fakulteta za strojništvo
Laboratorij za procesno avtomatiko

Univerza v Mariboru
Fakulteta za energetiko

Razvojni center za vodikove tehnologije

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Najlepša hvala! Thank you!

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