

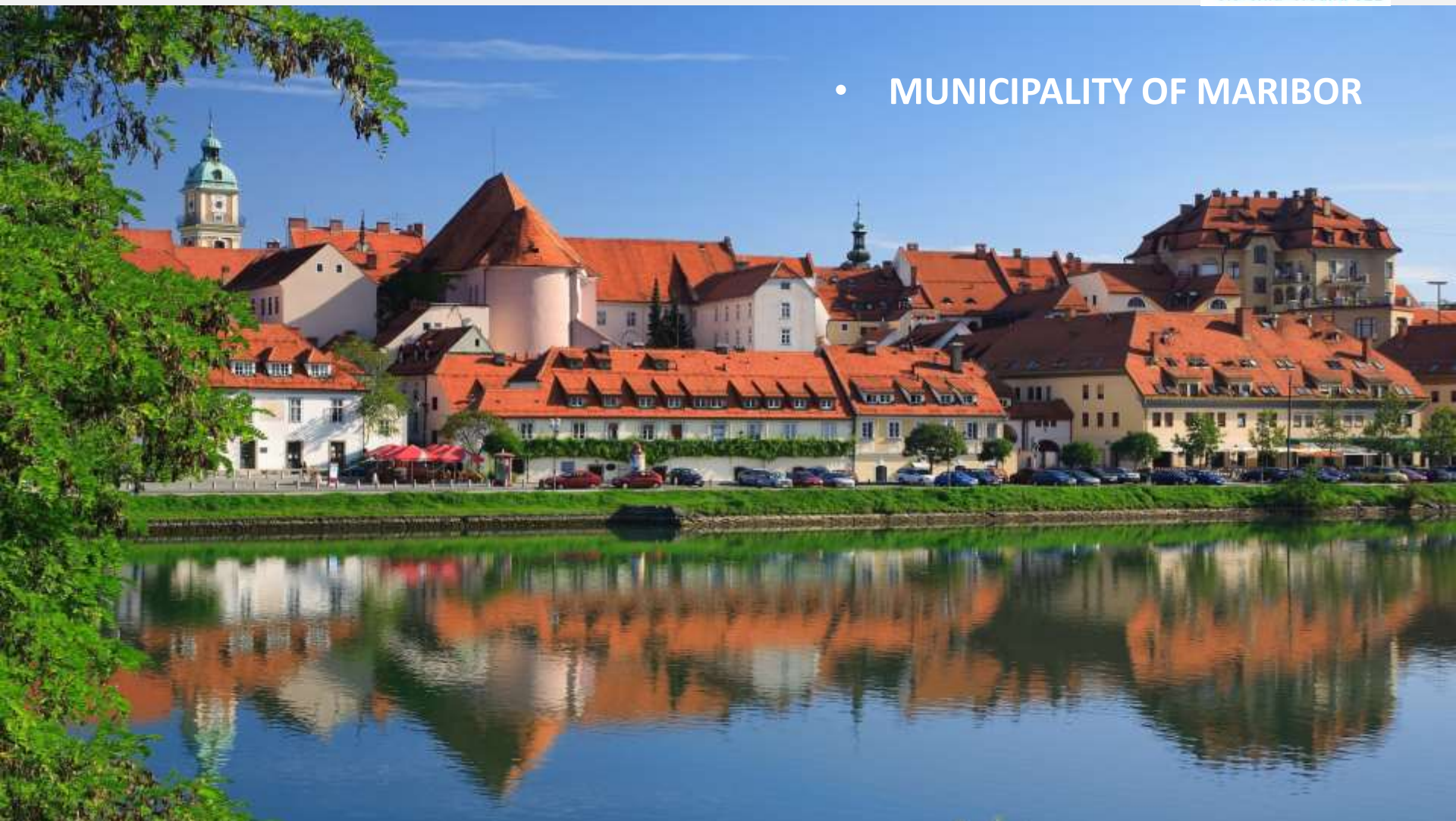


**9. godišnja skupština mreže
CIVINET Slovenija-Hrvatska-Jugoistočna Europa i
Skup: Gradovi, klima i promet
Zagreb, 17. i 18. ožujak/mart 2022.**

- Električki avtobusi u gradskom prijevozu

Električni avtobusi u gradskom prijevozu

- MUNICIPALITY OF MARIBOR



MUNICIPALITY OF MARIBOR

Municipality of Maribor (MOM) is the second largest city in Slovenia and the central local community in the Podravska region. (112000 inhabitants - 20000 students, 15000 schoolchildren), 147 m2

- MOM is the public decision -making body for transport planning incl. infrastructure and is responsible for public transport infrastructure
- Responsible: Public utility and traffic department



SUMP – adopted by city council in august 2015

- no energent for bus service favorised
- Increase quality of service (faster service (15 km/h), headway – 7 minutes on main corridors)
- 40 new buses (20 for replacement, 20 new)
- **SEAP aim** reducing the energy consumption of the transport system by 3%



City bus service in Maribor

- One municipality owned PT operator – MARPROM
- 21 city bus lines with 230 km total length
- 68 buses (capacity - 1.550 seats, 2.246 stands)
- 70,6 % diesel buses, 26,4 % CNG, 3 ebus – pedestrian zone, 1 electric hybrid
- Average age of buses 11,3 in 2014; 5,8 in 2018
- 121 drivers
- 2,8 mil km on yearly basis
- Budget 6,3 mil. € (Subsidy 4,1 mil. €)

Standard	Number
EURO 1	0
EURO 2	0
EURO 3	5
EURO 4	8
EURO 5	12
EURO 5 EEV	2
EURO 6	40
Electric (mini)	3
SUM	68



Context information – Maribor's efforts for electromobility

- first fast-charging station – 2012
- 56 e-car sharing spots in MB,
180 in Slovenia)
- 20 fast EV charging stations + 6 Tesla EV chargers
- Additional 23 fast EV charging station planned in 2021
- 62 free parking for EV
- AVANT CAR – 100% CAR SHARING system



Context information - Maribor's efforts for electric PT

- 2014 ELIPTIC, activities for electrifying PT (Electrifying PT route 6)
- 2019 EFFICIENCE,



EXPECTATIONS FROM THE PROJECT ELIPTIC

- Best practice examples from other cities (London, Berlin, Madrid, Budapest, Oberhausen, Bremen, Gdynia...)
- Costs/savings
- Impacts (economic, environmental, operational)
- Administrative procedures
- Technical characteristic
- Transferability
- Evidence based approach (scientific view)
- Real-life experience



Testing

EU project ELIPTIC – 2014-2018



- Hybrid bus (Iveco Urbanway electric hybrid) testing in 2016 –
- Since may 2018 in operation
- 25 % less fuel consumption than diesel/high investment and maintenance cost



Testing

EU project ELIPTIC – 2014-2019



- E-bus (Solaris Urbino – full electric) - testing in 2017 –
 - average consumption 1,1 kWh/km,
 - impact of heating (up to 1,4 kWh/km),
 - hilly terrain – no higher consumption E-Bus
- E-bus (HEULIEZ IVECO – full electric) – testing in 2019
- E-bus (TAM Vero, Mercedes eCitaro, MAN Lions City E) in 2020, 2021



E-bus – experience

- Not successful public procurement of 5 plug-in electric buses in 2018
- Is the market ready?
- MOM started new project EFFICIENCY in 2019



CHALLENGES regarding PT infrastructure

Project EfficienCE, 2019 - 2022

- No common vision on Public transport infrastructure
- Finding optimal relation between batteries size and e-bus charging power/technology (LCC, efficiency of the battery systems, additional energy storage for e-bus charges, smart grid)
- no real experience in using of full sustainable energy
- Administrative procedures for E-bus charging building and operating permit may slow down the implementation
- Vandalism
- Gauge (opp charger and oversized transport)
- Influence of weather on operations – cable car (full stop in cases of wind/heavy rain – 2 to 3 times per year)
- Energy overload at bigger events (e.g worldcup in bike downhill, golden fox FIS SKI WOLRD CUP)

ROLE IN THE PROJECT

MOM

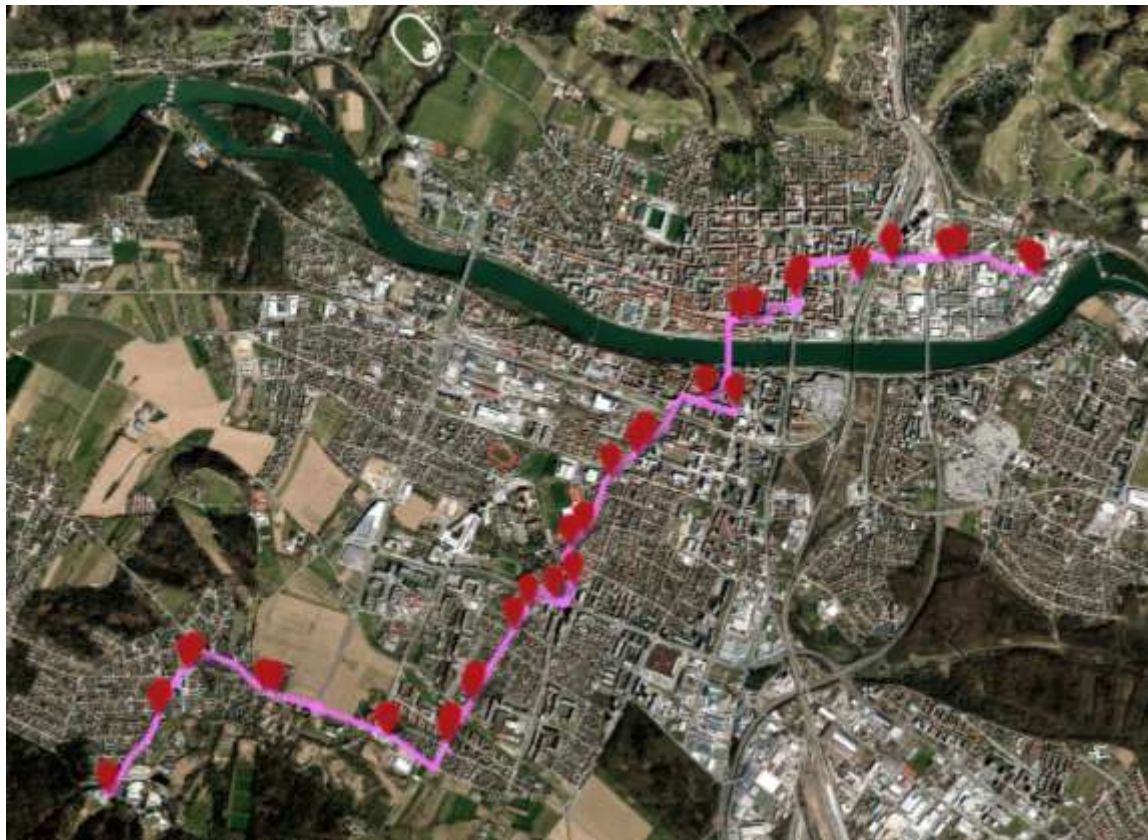
- Aim is to partly electrify public transport (bus)
- Action Plan of Multipurpose PT infrastructure
- Investment in **multipurpose PT infrastructure for cable car, e-bus, e-car** on the the turning point of bus line 6



University of Maribor; The Faculty of Civil Engineering, Transportation Engineering and Architecture:

- Support in the preparation of documentation for MOM
- Testing a multipurpose PT infrastrucutre (together with MOM) according to the timetable and e-network stability

CITY/ PT NETWORK MAP – Line 6



MAIN ACTIVITIES – PROJECT PARTNER MOM and UMFGPA

- **Preparation phase MOM, UM FGPA and MARPROM (03.2020)**
 - investment documentation
 - technical feasibility studies (upgrade of cable car substation, identification for e-bus charger and battery power)
 - Concept of Multipurpose PT infrastructure
 - Building and operation permit/planning permission
 - call for tender (end of 2019)
- **Test phase (12 months leasing)**
 - incl. construction & connection to the grid works & public launch event (09. 2020)
- **Pilot evaluating**
 - energy performance indicators for energy-efficient PT infrastructure in Maribor & assessment of pilot transferability & replicability (10. 2021)
- **Purchase in 2021?, Evaluation report (03.2022)**

E-bus – comparison of technologies

Poznamo dva načina hitrega polnjenja:

Invertni pantograf (Panto down)



- 1 Teža kontaktnih sani na e-busu ~7kg
- 2 Manj stroškov vzdrževanja avtobusa, vzdrževanja pantografov zunanji izvajalec
- 3 Cenejši avtobus, dražja polnilnica (170-210k€)
- 4 Ob nedelovanju pantografa, se avtobus polni na bližnjem pantografu
- 5 Kontaktne sani na e-busu so lahko katerekoli znamke/proizvajalca



Pantograf na busu (Panto up)



- 1 Teža pantografa na e-busu ~60kg
- 2 Večji stroški vzdrževanja avtobusov, vzdrževanje pantografov v delavnici
- 3 Cenejša polnilna postaja (130-160k€), dražji avtobus
- 4 Ob nedelovanju pantografa je avtobus neuporaben.
- 5 Pantograf na avtobus mora biti kompatibilen z infrastrukturo



E-bus – selected option for Maribor



Priložnostno polnjenje (invertni pantograf)

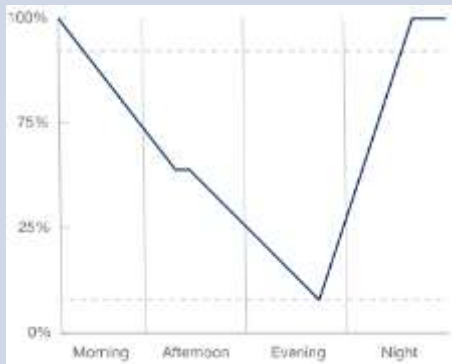
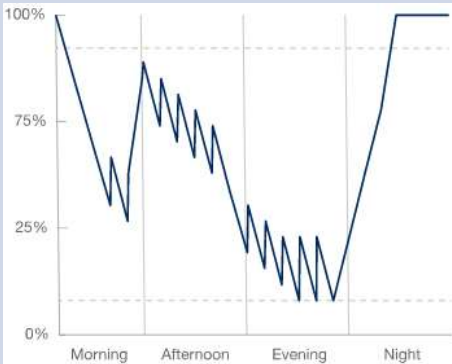
Slika	Opis	Cena na kos
	Hitra polnilnica s pantografom (kontaktne sani na strehi avtobusa) Okvirne dimenzije: 5520 x 4850 x 1060 mm (VŠG) S komunikacijskim vmesnikom	300kW DC <u>output</u>: 170.000 – 210.000 EUR
	Polnilnik Okvirne dimenzije: 770 x 2340 x 2030 mm	

E-bus – selected option for Maribor

Nočno polnjenje		
Slika	Opis	Cena na kos
 	Plug in Potrebno je ročno povezati in odklopiti avtobus iz polnilne postaje	50kW DC output 20.000 – 30.000 EUR
 	Invertni pantograf  Nočna polnilnica –avtomatski priklop s pantografom, s komunikacijskim vmesnikom Pantograf nameščen na stropu garaže Cena nočne polnilnice je nižja zaradi manjšega polnilca	max. 150 kW DC output 95.000 – 125.000 EUR

E-bus – comparison of technologies

Glavne razlike med nočnim in priložnostnim polnjenjem

Strategija polnjenja	Počasno (v delavnici)	Priložnostno polnjenje (v delavnici in čez dan)
Tip polnjenja	Delavnica: od 35 do 150 kW	Delavnica: od 35 do 150 kW Priložnostno: od 150 do 600 kW
Čas polnjenja	Delavnica: od 3 do 10 ur	Delavnica: od 3 do 10 ur Priložnostno: do 10 minut (na postaji)
Profil polnjenja (poenostavljeno)		
Doseg	100-200 km na dan	200-500 km na dan
Stroški	1 Višji stroški baterije 2 Cenejša polnilna infrastruktura	1 Nižji stroški baterije 2 Dražja polnilna infrastruktura 3 Višji stroški vzdrževanja

Current research

Simulation of driving cycle on line 6

Technical feasibility studies for e-bus charging infrastructure and E-buses

Investment documentation for 5 e-buses (12 m) and 3 e-fast Opp chargers

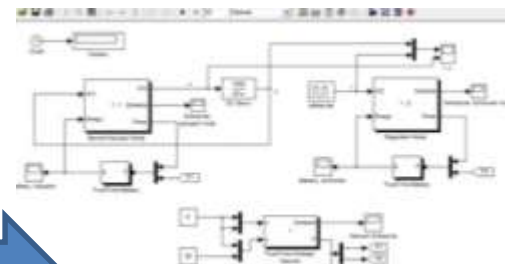
100 kWh batteries/ 200 kW e-chargers



GPS/GPX localisation



Speed diagram
Latitude



Matlab Simulation

Speed, Torque,
Power and battery size need
with recuperation



Vehicle parameters



E-bus – now, 2022

- city centre mini e-bus (since 2017), 3 in operation in 2021
- 1 new in 2022



E-bus – now, 2022

- public procurement for 5 full electric buses, MAY 2022
- IVECO „E-WAY, 12m“



E-bus – now, 2022

- Public procurement for 2 fast charger 150kW and 300kW, APRIL 2022
- Main BUS station, 300kW, ABB



E-bus – now, 2022

- Public procurement for 2 fast charger 150kW and 300kW, APRIL 2022
- Station „Vzpenjača“, 150kW, ABB



E-bus – now, 2022



E-bus – now, 2022



E-bus – Plan 2022, 2023



- e-Shuttle, 8,4m, plug-in, 4 vehicles in 2022
- 2 vehicles 9,5m, panto-down, 2022-2023
- 2 vehicles 12m , panto-down, 2023



Thank you for your attention!

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MESTNA OBČINA
MARIBOR