

Greening of the public transport in Hungary – Green Bus Programme in Hungary

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TOWARDS A GREENER MOBILITY, SUSTAINABLE AND INTELLIGENT MOBILITY SOLUTIONS IN THE VISEGRAD REGION

Green Bus Pilot Programme



Financing Pilot Project

- Budget of HUF 800 million*
- Support for the procurement of electric buses and related charging infrastructure for cities and public service providers

*Amendment of government decree pending. A funding increase of HUF 627 million expected



Demonstration Pilot Project

- Budget of HUF 1200 million
- Presentation and testing of buses
- Demonstration in at least seven municipalities with on-site infrastructure for at least one month

The Demonstration Pilot Project's completed sites



1.

Mercedes eCitaro
Debrecen
(02.09.2020. -
01.10.2020.)



2.

Solaris Urbino 12
Békéscsaba (09.10.2020 -
06.11.2020.)



3.

Ebusco 2.2.
Nyíregyháza
(14.11.2020. - 14.12.2020.)



4.

Ikarus City Pioneer 120.EI
Székesfehérvár
(01.02.2021. - 28.02.2021.)



5.

Mercedes eCitaro
Zalaegerszeg
(22.03.2021. -
18.04.2021.)



6.

Mercedes eCitaro
Esztergom
(12.04.2021. -
09.05.2021.)



7.

Mercedes eCitaro
Kecskemét
(22.04.2021. -
20.05.2021.)



8.

SOR NS 12
Szolnok
(24.05.2021. -
20.06.2021.)



9.

BYD K9UB
Sopron
(09.07.2021. -
06.08.2021.)



10.

MAN Lion's City
Kaposvár
(02.08.2021. - 03.09.2021.)



11.

MAN Lion's City 12E
Veszprém
(01.10.2021. - 03.11.2021.)



12.

BYD K11U (articulated)
Sopron
(08.10.2021. -
21.10.2021.)



13.

BYD K11U (articulated)
Zalaegerszeg
(25.10.2021. - 07.11.2021.)



14.

SOR NS 12
Mosonmagyaróvár
(25.10.2021. - 21.11.2021.)



15.

Ikarus City Pioneer 120.EI
Zalaegerszeg (EIT UM)
(03.11.2021. - 03.12.2021.)



16.

MAN Lion's City 12E
Dunakeszi
(19.11.2021. - 06.01.2022.)



17.

Solaris Urbino 12 electric H2
Bp-Vecsés
(11.02.2022. - 06.03.2022.)

- 14 solo e-bus demos
(7 types of buses)
- 2 articulated e-bus
demos
- 1 H2 solo bus demo

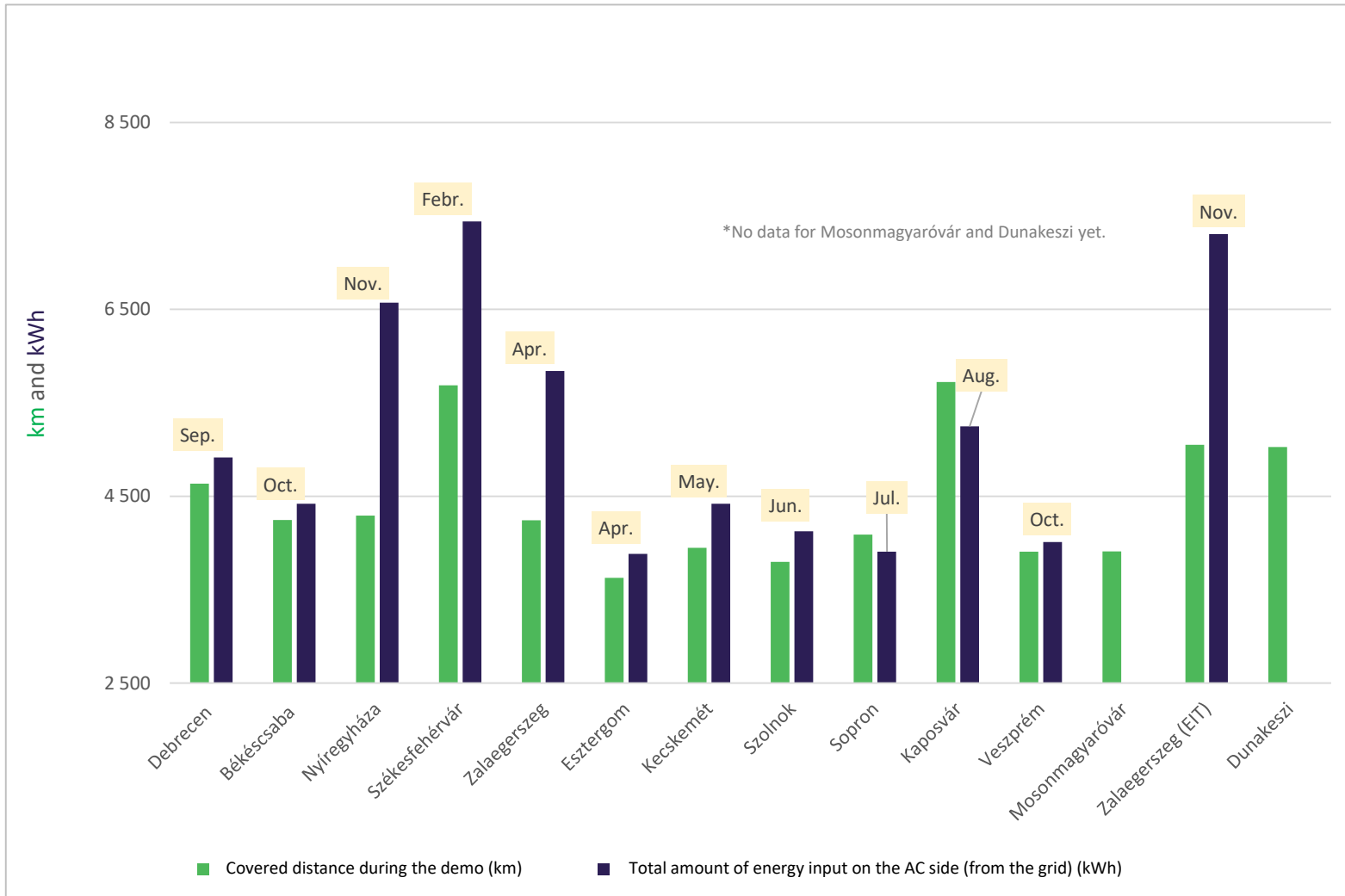
Experiences of the Green Bus Programme demonstrations so far

- **11 solo, 2 articulated, 1 H2 fuel cell solo demonstrations** have been fully evaluated so far
- The solo buses ran **6 days a week** (in some cases 7 days a week) for **4 weeks** in one location, the articulated buses were tested for 2 weeks each
- Overall experience so far has been positive, with **positive** feedback
- It is important to ensure that the vehicle reaches as many neighbourhoods as possible
- Distances over 200 km have been a problem for several buses in adverse conditions
- The most common faults were sensor failures or various dashboard error messages, which were no longer present after a restart or after an end-of-day service at the depo, but several buses had a heater failure



Statistics for the solo bus demos

Relationship between distance travelled and energy consumption

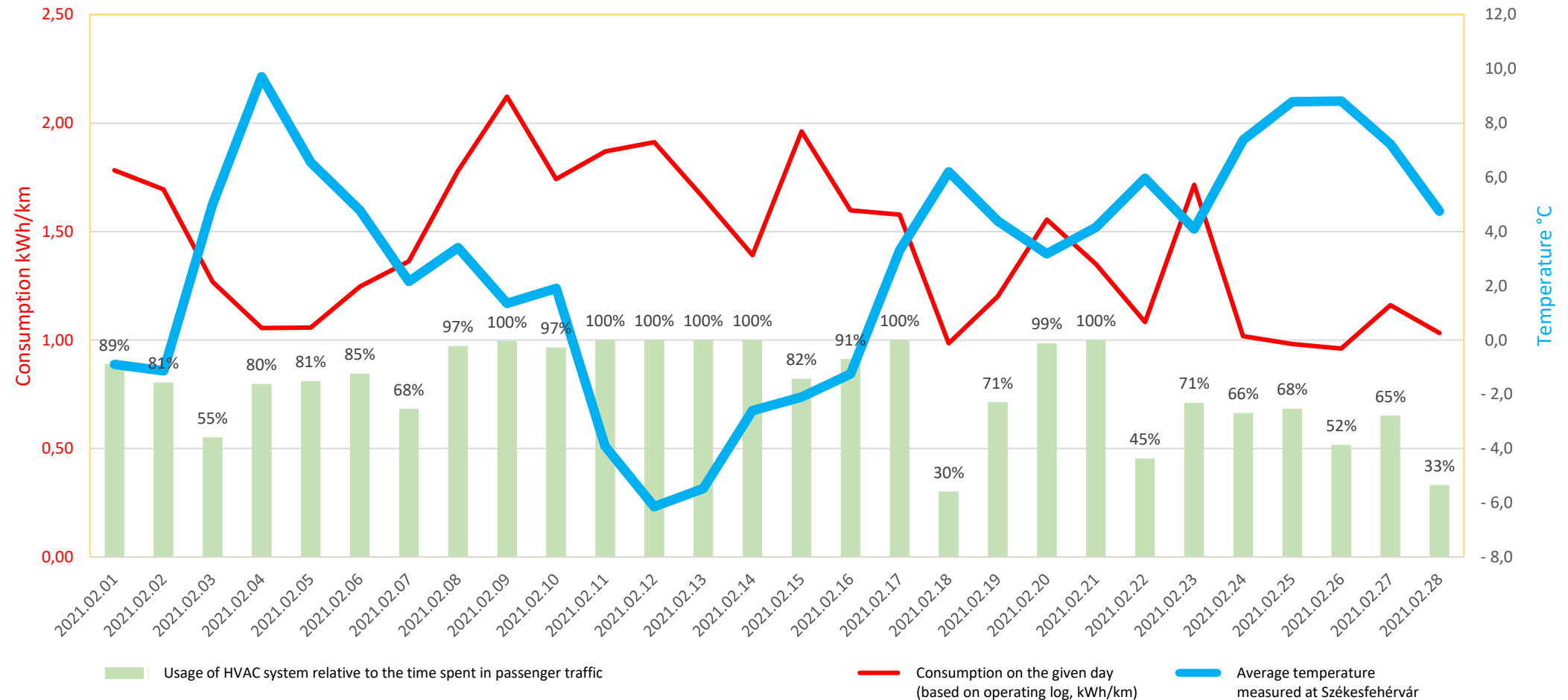


Total distance covered during demos: 62,179 km

- Not all buses were tested in cold weather, but several had to use diesel stoves in addition to electric heating
- There have been buses where the stove required about 3 litres of oil per hour, which can mean 0.12 litres per km
- For comparison, the average consumption of a diesel bus is 0.4 litres/km

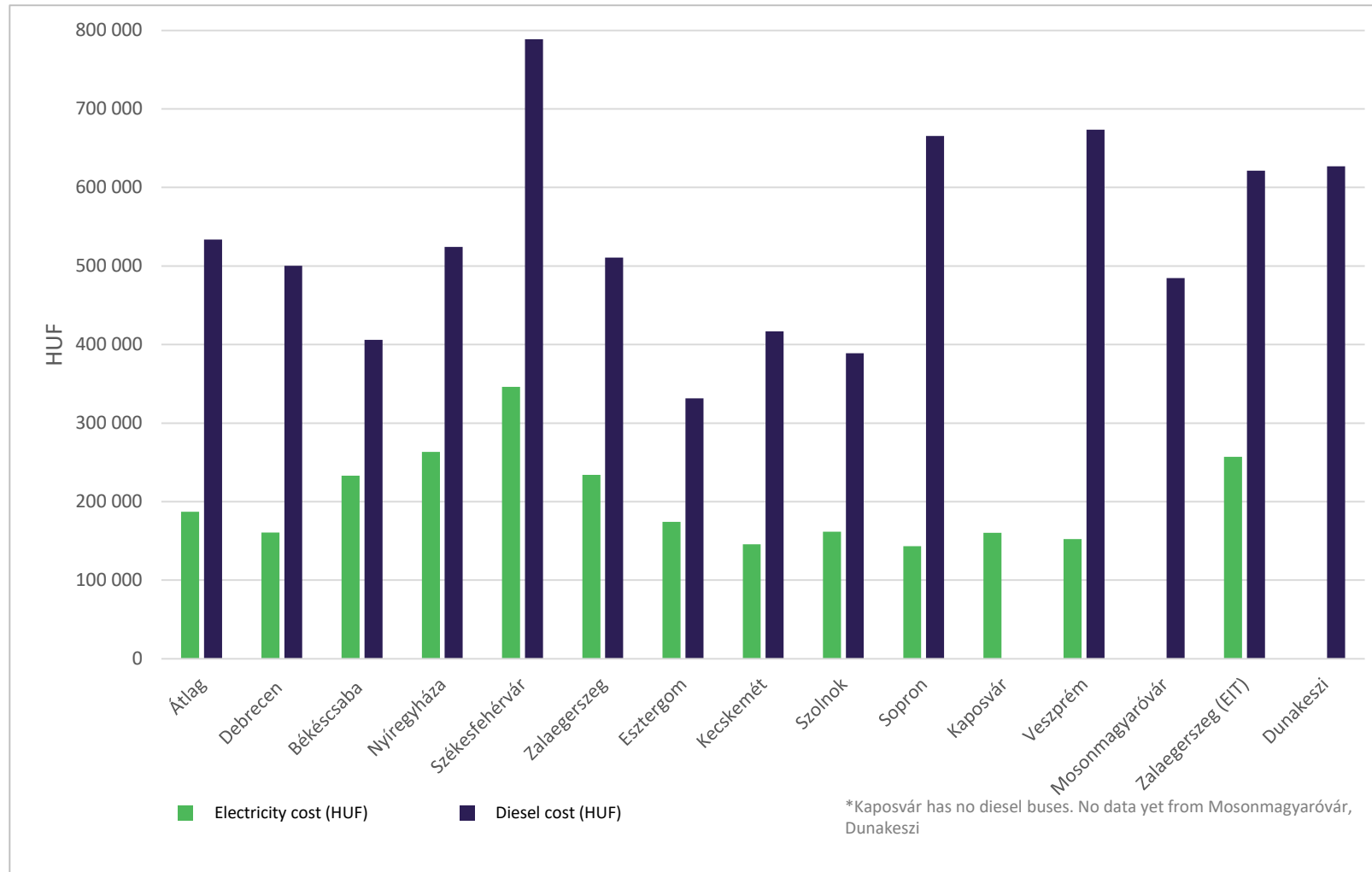
- Bus consumption data are closely related to average temperatures due to the use of heating/cooling (in autumn and spring tests the bus typically consumed less)
- Using the heater uses more battery power than air conditioning

Consumption and temperature correlations in Székesfehérvár



- The consumption curve of the bus mostly fits the temperature, follows it
- The colder the average daytime temperature, the more the bus consumed
- Of course, range is influenced by many factors besides temperature, including other climatic conditions, the driver's driving style, number of passengers, terrain, battery condition, etc.

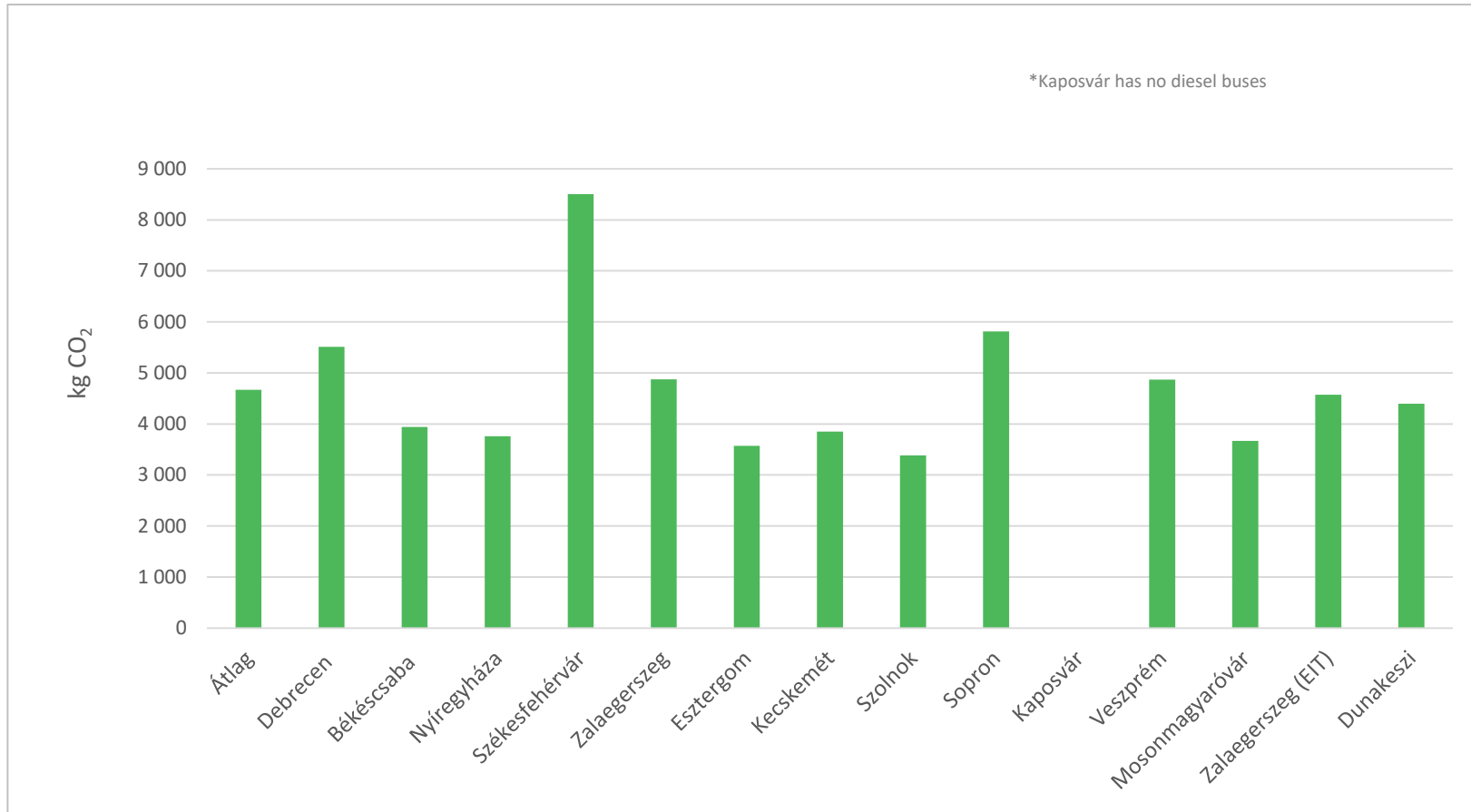
Electric and diesel bus fuel costs during demos



Costs (electricity prices: Ft/kWh and diesel price: Ft/litre) were provided by public service providers

- Fuel costs for e-buses are on average 60 HUF per kilometre cheaper than diesel for diesel buses
- This will save more than HUF 3.5 million per bus per year

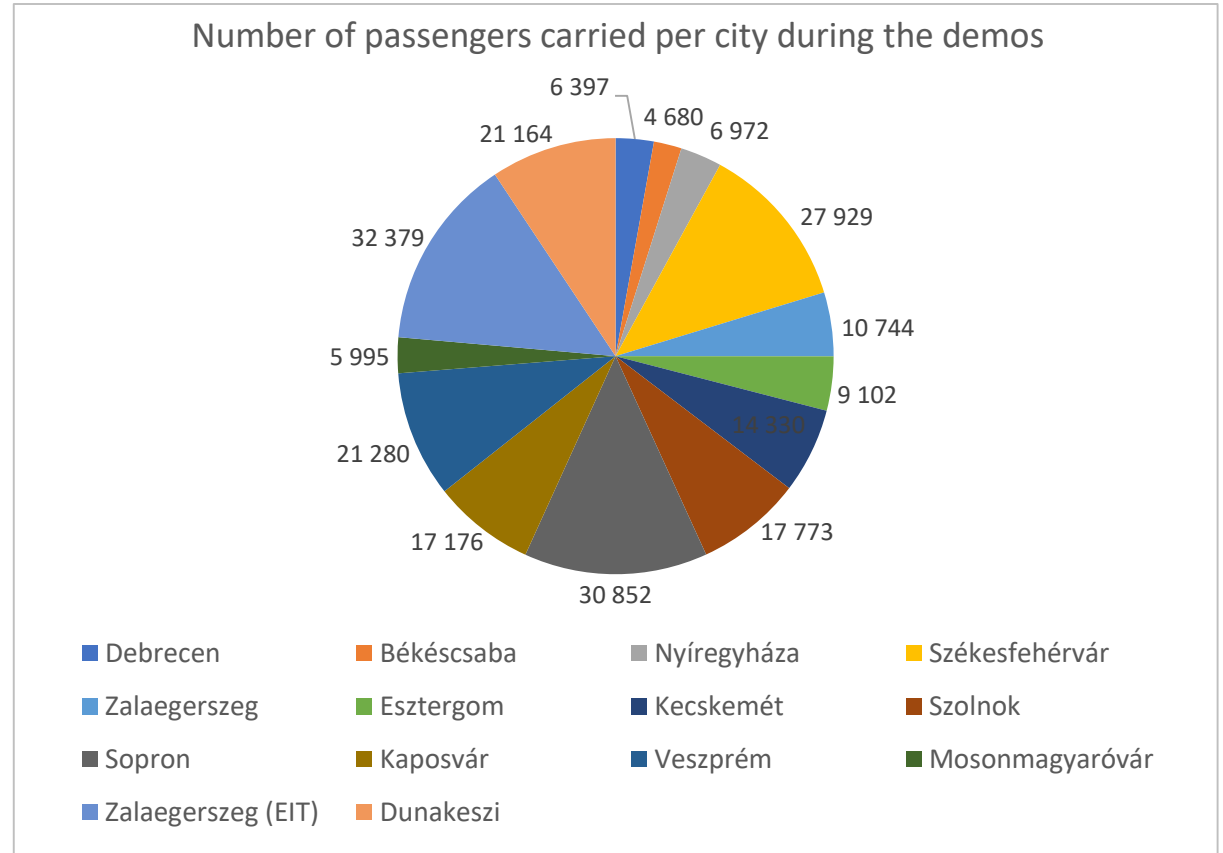
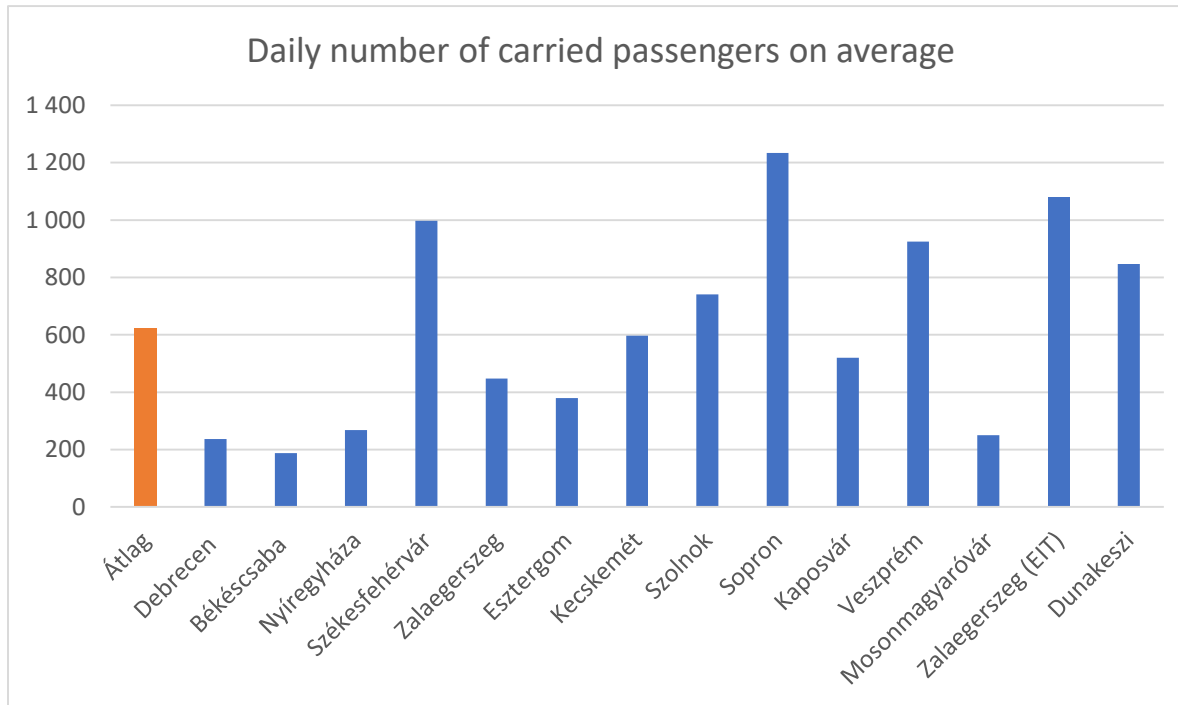
CO2 emission reduction (compared to diesel) (kg)



The conversion factor for diesel engines accepted in the international literature is 2.65 kg CO₂/1 litre of diesel. The consumption (litres/km) of the diesel bus replaced was provided by the public service providers

- During the demonstrations, the buses ran 24-28 days per site (minimum expectation 2x200, 3x150, 1x100 km per week)
- One e-bus means almost 70,000 kg of CO₂ emissions reduction per year (the equivalent of about 1,000 deciduous trees)

Number of passengers carried

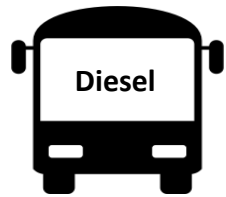


- Almost a quarter of a million passengers tried out the buses at 14 locations
- An average of 16,198 people tested at one site, the most during the Zalaegerszeg demo, but there were slightly more days (30) than average

Basis of calculation:

- Number of days in round trips
- Passenger occupancy estimated by drivers (%)
- Number of passengers a bus can carry

Noise exposure during operation for buses with different drive trains



~79 dB



~69 dB

It follows from the logarithmic basis of the decibel scale that a 10 dB increase in volume has roughly double the volume effect

Health effects of noise exposure:

- **above 60 dB:** prolonged exposure may cause hearing loss
- **above 65 dB:** prolonged exposure to noise increases the risk of cardiovascular disease by 20%
- **above 85 dB:** damaging range, especially for workplaces with high noise levels
- **above 120 dB:** even short exposure can cause hearing loss

For comparison



mosquito

~10 dB



whisper

~30 dB



normal conversation

~60 dB



crying baby

~80 dB



disco

~110 dB

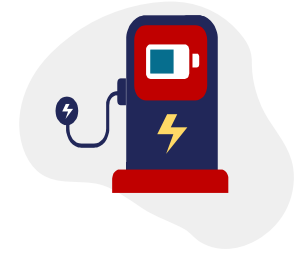


jet aircraft

~130 dB

Main findings, other experiences

Charging experiences, challenges



- Buses **were loaded at night at the depots** (typically **3-3.5 hours** to fill up)
- Several sites did not have sufficient capacity to use the chargers to their maximum capacity
- Some of the chargers could not communicate on the expected OCPP standard
- Battery and passenger compartment temperature control in the garage requires less electricity
- Avoid over-drawing the battery pack

There were also big differences between the battery sizes of the demo buses



Smallest battery-size bus	242 kWh
Largest battery-size bus	480 kWh
On average	327 kWh

Factors that determine charging time include:

- battery size
- state of charge
- charger power
- the amount of energy available
- vehicle battery management system
- outside temperature
- site development
- charging loss

Other experiences, problems to solve

E-bus manufacturers should focus more on passenger compartment temperature control (heating, thermal insulation foils)

E-bus manufacturers should focus more on improving the reliability of sensors

There is no uniform regulation on fire safety in Hungary. There is no relevant section in the National Fire Safety Regulations (NFSR)

Energy security: solar, storage, the need for energy management

Awareness raising, passenger satisfaction surveys:

- cleanliness, predictability and punctuality are the most important aspects for passengers, but air conditioning and environmentally friendly technology are also important
- social media are by far the most important in raising awareness and providing information





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The first hydrogen fuel cell bus demonstration

Experience of the first hydrogen fuel cell bus demonstration

Statistics

- In total, the bus has covered 4713 km including fuel consumption rides in 3 weeks. Of which 3689 km in round trips
- Total amount of hydrogen loaded into the bus 382.7 kg
- Average hydrogen consumption: 8.12 kg/100 km (considered as good)
- Range tested: 388 km at 40% passenger load (from 100% hydrogen charge to 15%)

Type of demo bus:

Solaris Urbino 12 electric H2

Duration of the test:

11.02.2022. - 06.03.2022.

Round trips:

Kőbánya-Kispest - Vecsés connection

Daily distance covered:


~300 km on weekdays and 210 km on weekends

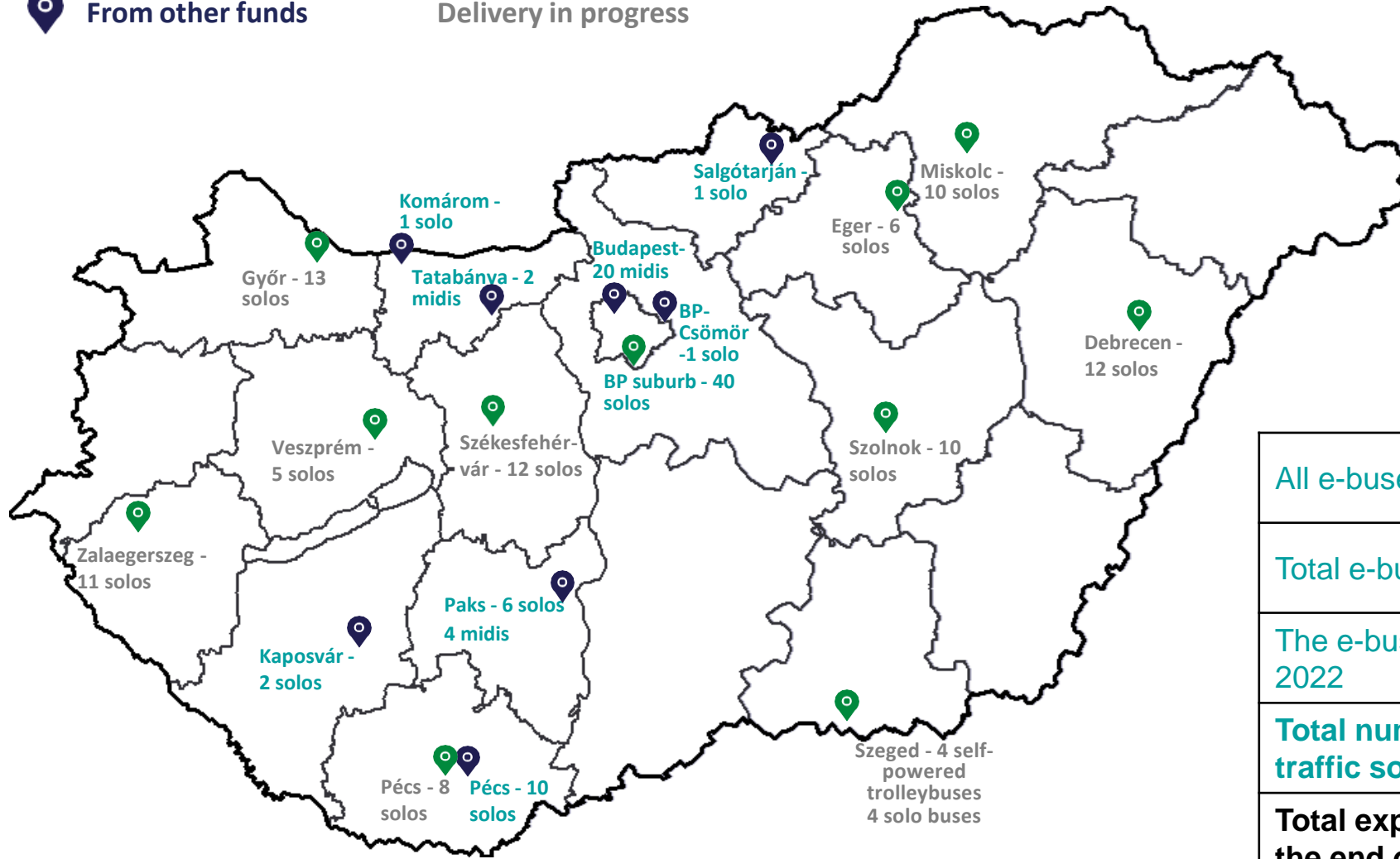
- The **operation** of the bus is **absolutely safe**.
- The vehicle **was able to complete the 300 km round trips without any problems**.
- The bus **reported twice a fault message**, the first time the sensors indicated a hydrogen leak, the fuel cell had to be replaced, the second time the fault was solved after sw-calibration.
- To complete the round trips, **20-25 kg of hydrogen** refuelling was required per **day**.
- In the present demo, the **refuelling took several hours**, and it can be concluded that for a permanent bus operation, a fixed installed station needs to be set up, where a bus can be refuelled within 15 minutes.








Bus purchases under the Green Bus Programme

Zero emission buses in Hungary

-  From GBP funds
-  From other funds
-  Vehicles in road traffic
-  Delivery in progress

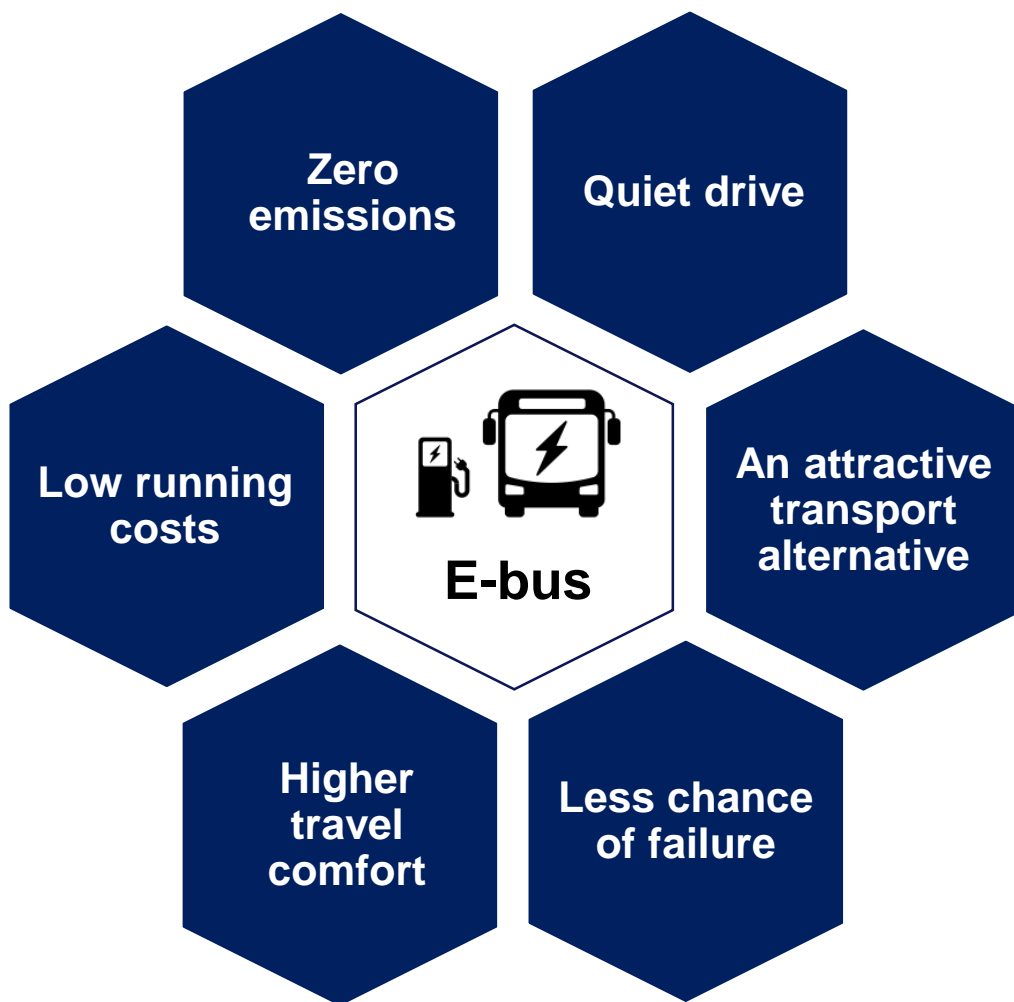


Distribution of existing bus fleet by manufacturer

	14 pieces
	3 pieces
	40 pieces
	20 pieces
	10 pieces

All e-buses in traffic by 2021	43 pieces
Total e-buses in traffic in 2021	42 pieces
The e-buses delivered so far in 2022	2 pieces
Total number of e-buses in traffic so far	87 pieces
Total expected e-bus fleet by the end of 2022	186 pieces

The electric buses



Funds of the Green Bus Programme

Fund	Amount	Status	Number of buses	Reduction of CO2 emissions per year	Annual fuel savings (compared to diesel)
Financing Pilot Project	0.8 + 0.627* billion HUF	In progress	12 pieces	~750 t	~38 mFt
CO2 revenues (HUF 35.9 billion)	HUF 18.37 billion	In progress	127 pcs	~8000 t	~402 mFt
	HUF 17.53 billion	Planned	~120 pieces	~7500 t	~380 mFt
RRF	HUF 52.7 billion	Planned	~300 pieces	~19200 t	~HUF 976 million
ERFA/CF	HUF 91.4 billion	Planned	~630 pieces	~39,000 t	~HUF 1993 million
Total	HUF 180 billion		~1100 pieces	~75000 t	~ HUF 3.8 billion

*Amendment of government decree pending. A funding increase of HUF 627 million expected

Grants awarded in the first bus procurement tender of the Green Bus Programme

Cities	Applicant	Subject of the procurement	Number of vehicles to be purchased	Total project value(HUF)	Fund intensity requested (%)	Total fund requested (HUF)
Budapest suburb	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	40	7 615 434 140	78.28%	5 961 270 147
Eger	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	6	1 172 219 130	77.87%	912 753 548
Győr	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	13	2 482 450 240	74.80%	1 856 940 705
Szeged	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	8	1 531 057 590	69.02%	1 056 703 389
Székesfehérvár	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	12	2 273 006 325	73.94%	1 680 730 184
Szolnok	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	10	1 962 879 770	74.44%	1 461 106 510
Zalaegerszeg	Volánbusz Közlekedési Zrt. and Mobiliti Volánbusz Kft. - consortium	electric bus	11	2 102 145 180	75.48%	1 586 659 150
Miskolc	MVK Miskolc Városi Közlekedési Zrt.	electric bus	10	2 100 377 706	69.440%	1 458 429 997
Pécs	Municipality of the City of Pécs and Tüke Busz Community Transport Ltd. - consortium	electric bus	8	1 675 120 000	69.849%	1 170 054 783
Szeged	Szegedi Közlekedési Kft.	self-powered trolleybus	4	809 826 000	71.31%	577 461 000
Veszprém	V-Busz Veszprémi Közlekedési Kft.	electric bus	5	864 952 100	75.00%	648 714 075
Total			127	24 589 468 181		18 370 823 488

Status of bus procurement

- On 31.08.2021, the first electric buses of the first bus tender of the Green Bus Programme were handed over.
- The 40 vehicles have started improving the suburban transport in the South Buda region, Diósd, Budakeszi, Budaörs and Törökbálint.
- The buses were used for the first time during the special events in autumn 2021, and are being phased in to traffic from March 2022.
- The remaining electric buses for rural cities will be delivered this year. Most beneficiaries are at the tendering or evaluation stage, and in some cases the results have already been announced and contracts have been signed.
- Public procurement not yet completed for the Pécs e-bus and the Szeged self-powered trolleybus → no result yet for the procurement of 8+4 vehicles



Opening ceremony at Hungexpo (31.08.2021)

- HUMDA Zrt. is expected to launch a new call for proposals to subsidy fleetchanges from the RRF until 31 March 2022
- The tender will allow the purchase of ~300 e-buses and connected charging needs



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THANK YOU FOR YOUR ATTENTION!