Opportunities and Challenges in Green Mobility

HUMDA

SZÉCHENYI EGYETEMI CSOPORT TAGJA

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Budapest,
November 7, 2024

BE DEDUCTIVE

Conclusions First

1. **Transport emissions – first signs of results in Hungary**
2. **No carbon-neutral mobility without green energy**
3. **No green energy without appropriate energy strorage**
4. **No generic or „jolly joker” solution – diversity is a must – systemwise complexity**
   a) **Target of mobility?**
   b) **Means of mobility?**
   c) **Surroundings, local conditions of mobility?**
   d) **Business case?**
5. **The importance of data analyses and pilots – HUMDA projects**

→ **ADJUSTED GLOCAL CARBON –NEUTRAL SOLUTIONS**

MOBILITY DOES NOT „STAND ALONE”

Energy production → Energy storage → Energy use cases

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The role of clean technologies in CO2 reduction

Transport emissions – first promising signs can be seen

Globally 1,1 % growth in CO2 emissions 2022/2023 – big differences in regions

Figure 3: Change in CO_2 emissions from energy combustion and avoided emissions from deployment of major clean technologies, 2019-2023

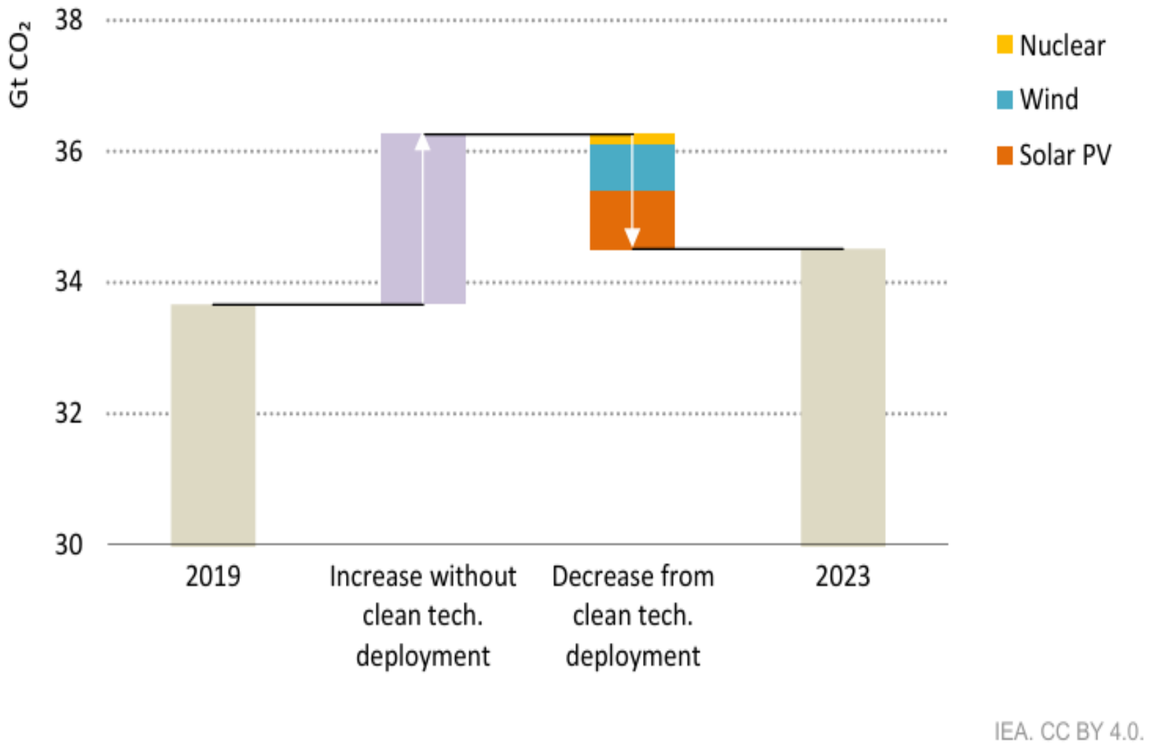
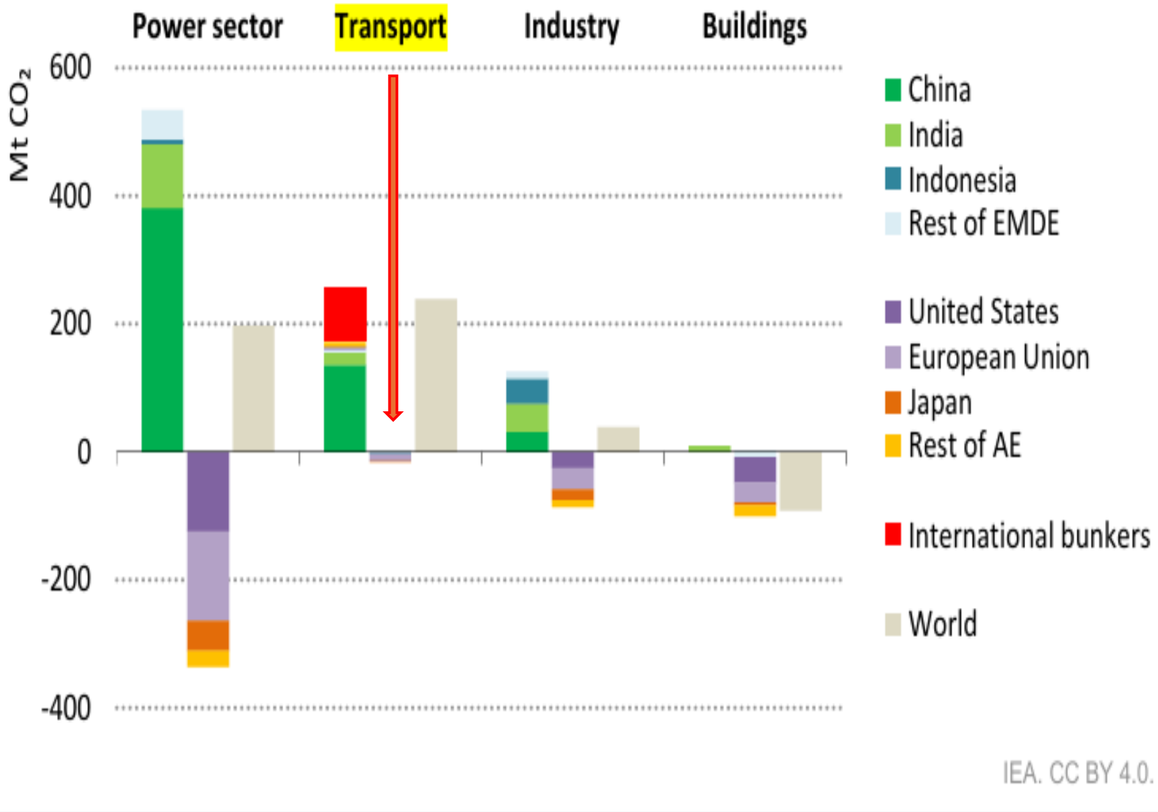


Figure 15: Change in CO_2 emissions from combustion by sector and region, 2022-2023



Carbon-Neutral Transportation – The Importance of Carbon-Neutral Public Transport

Forrás: www.iea.org CO2 emissions in 2023, IEA

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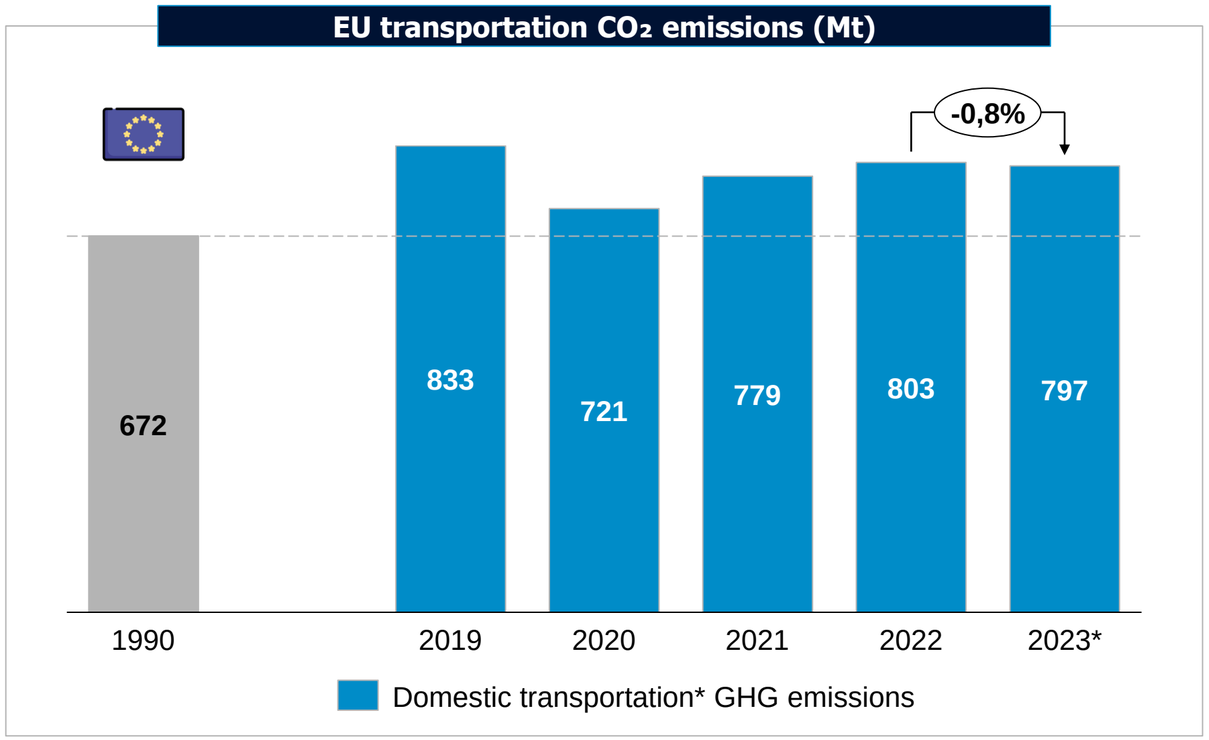
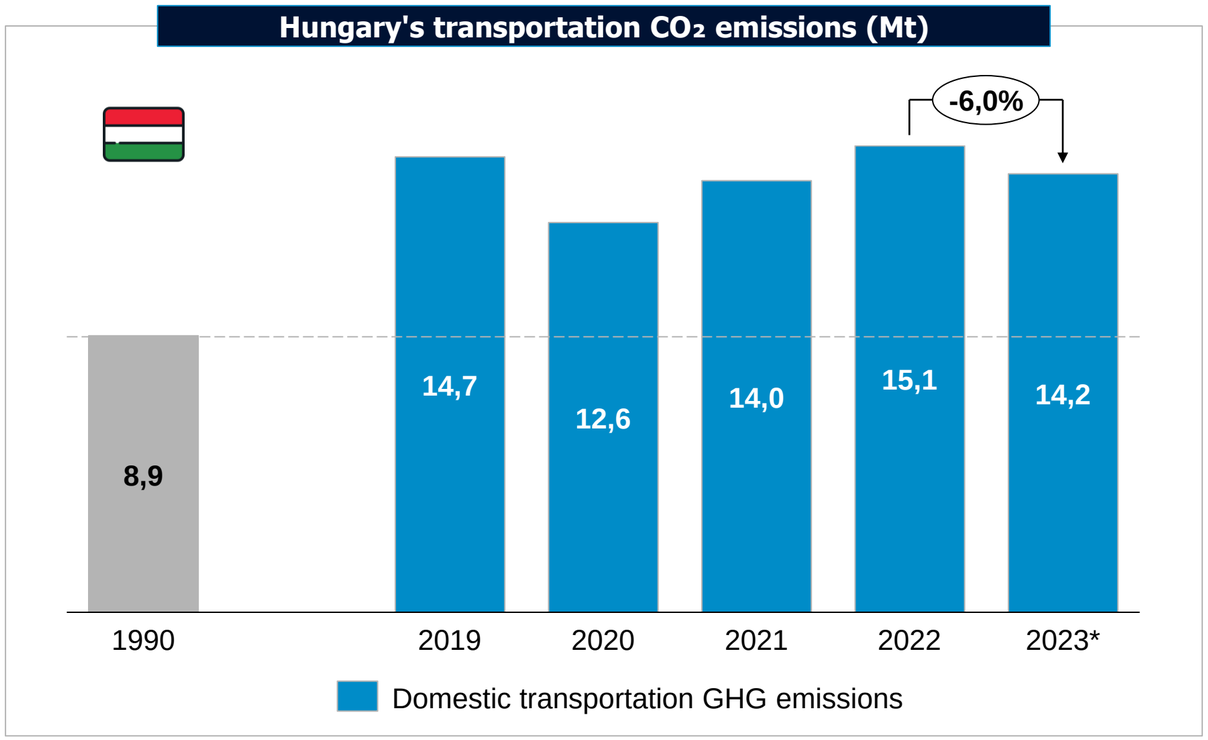
The emissions of the domestic transportation sector are expected to decrease in 2023 for both the EU-27 and Hungary





- Preliminary data indicates that **transportation sector emissions are expected to decline in 2023** for **both the EU-27 and Hungary**, breaking the moderate upward trend that followed the drop caused by the Covid-19 pandemic in 2020.
- **In Hungary, a 6% reduction in transportation emissions is anticipated for 2023**, exceeding the EU-27 average.
- Reducing transportation emissions has **shown limited progress over the past decades**. **Since 2005, the sector's emissions have not decreased significantly**, and projections suggest they may only fall below 1990 levels by 2032.

**The 2023 data is based on preliminary (approximate) GHG inventories prepared by Member States*
Source: European Environment Agency (GHG inventory)

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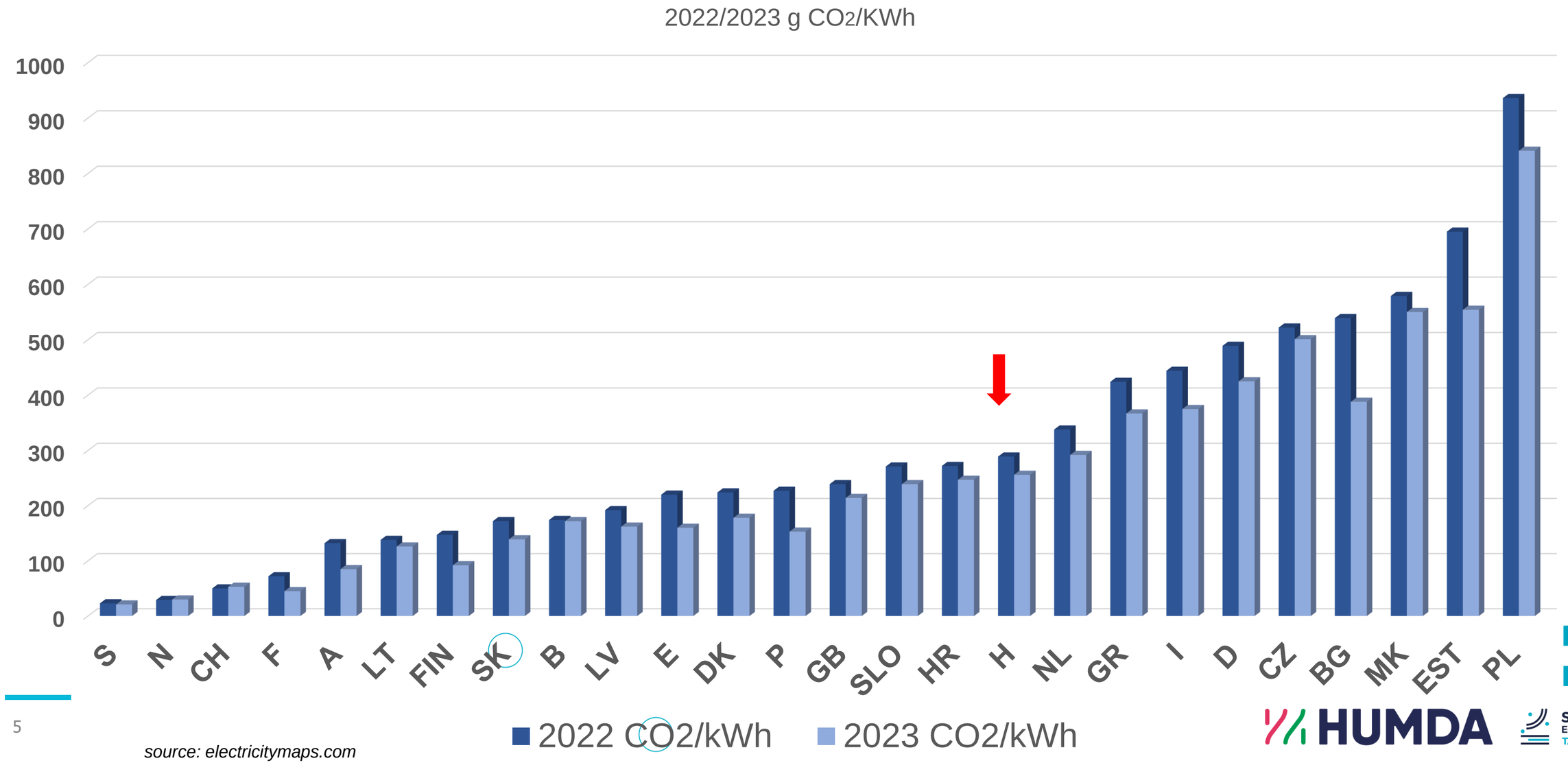
EU27 specific CO_2 emissions of electricity - the importance of source of energy

No carbon-neutral mobility without renewables

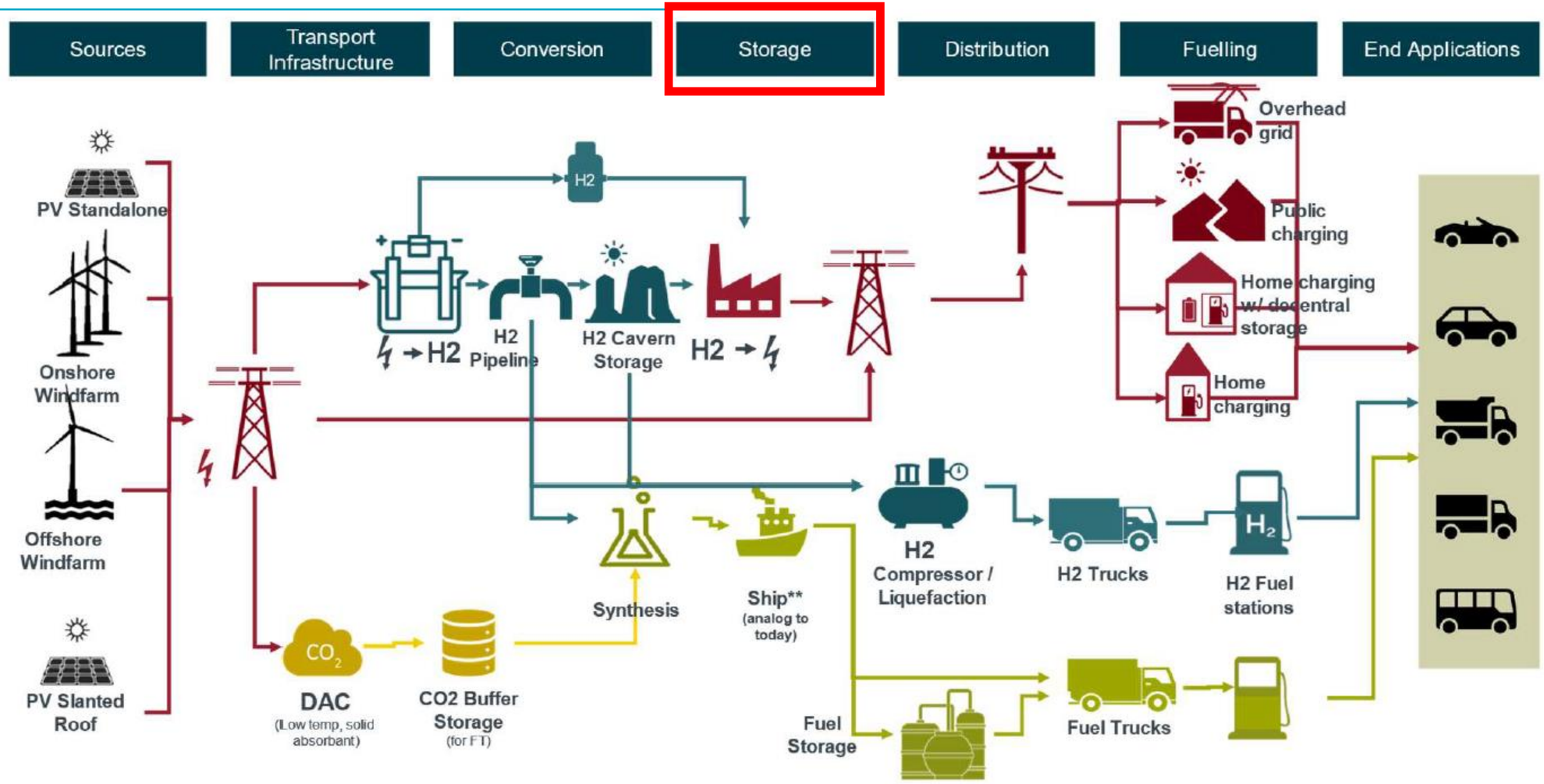


Based on LCA

source: electricitymaps.com

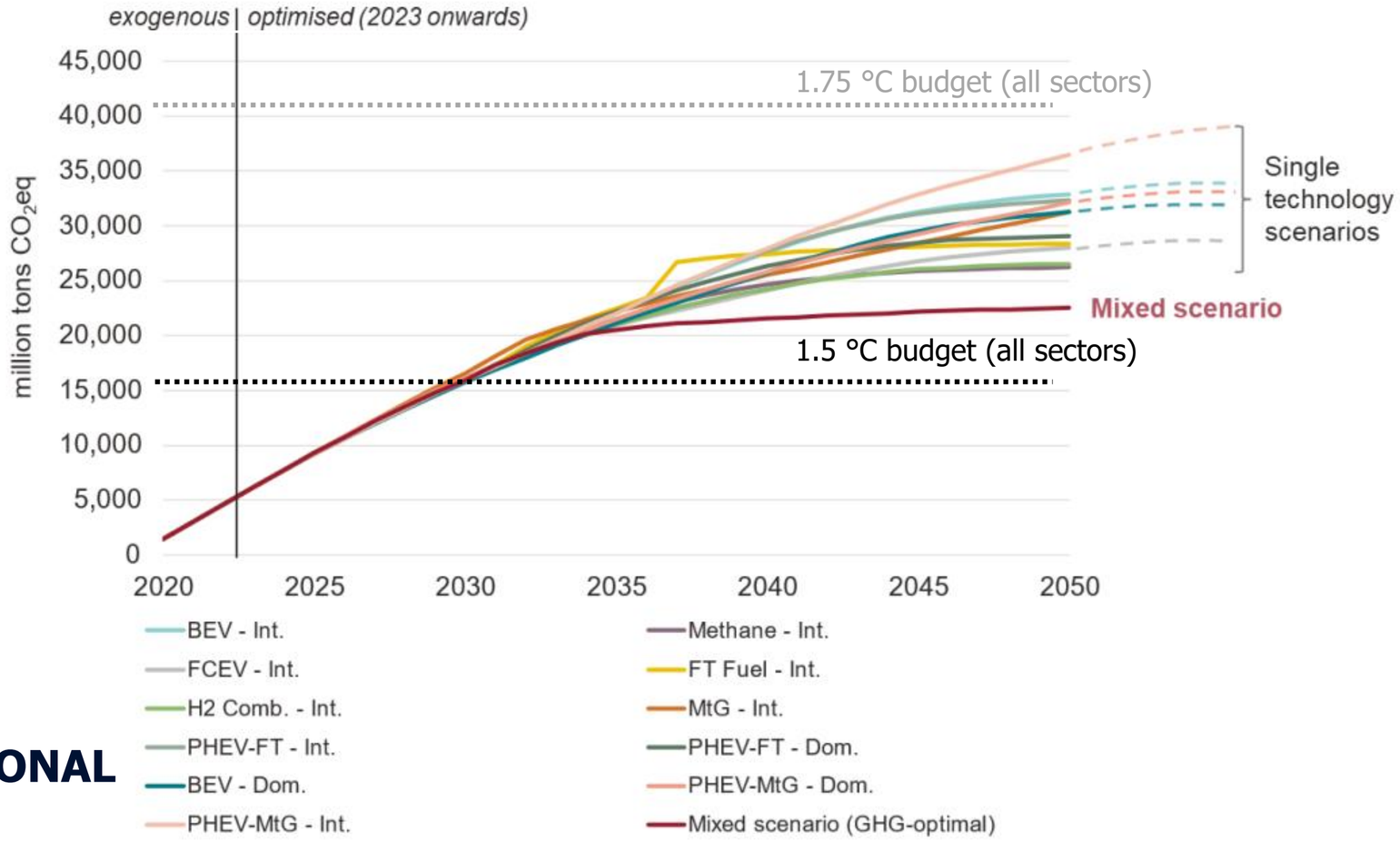
The Carbon-Neutral Energy Supply for Transportation

No green energy without appropriate energy strorage



Source: Presentation of Dr. Barna Hanula, HUMDA Summer University

Technological diversity is more carbon-neutral” and accelerates the transition



How road sector GHG emissions could be minimized?

Single scenarios face bottlenecks limiting maximum deployment rate

Mix of carbon-neutral powertrains has accelerating effect

HYDROGEN IS MULTIFUNCTIONAL

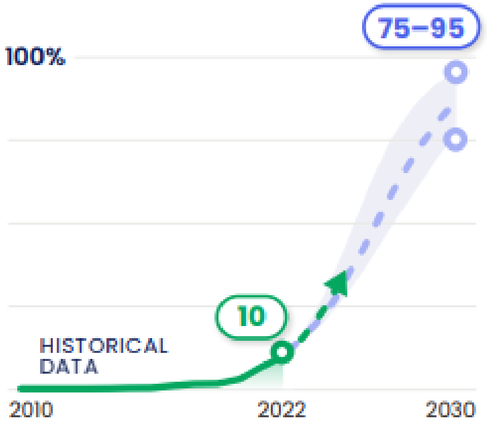
Figure 2: Cumulated GHG emissions in mixed technologies scenario and single technology scenarios. Note: Given technical bottlenecks and vehicle lifetime assumptions, no full decarbonisation is reached in single technology scenarios of BEV Dom./Int., FCEV, PHEV-FT Int. and PHEV-MtG Int. by 2050 (dashed lines).

State of Climate Action 2023 – Unused decarbonization potential of public transport & HDV sector

RIGHT DIRECTION, ON TRACK

TRANSPORT N/A[b]

Increase the share of EVs to 75–95% of total annual LDV sales.

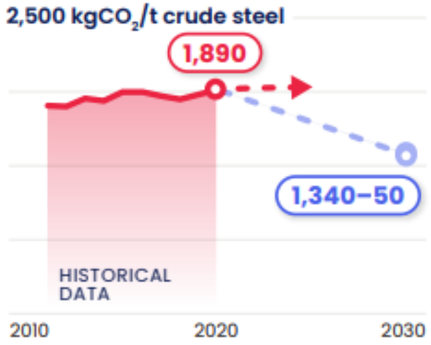


The share of BEVs and FCEVs in the heavy-duty vehicle sector needs to be increased

WRONG DIRECTION, U-TURN NEEDED

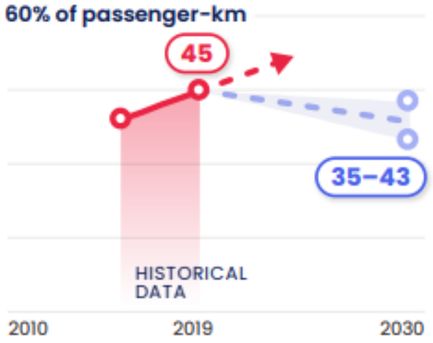
INDUSTRY U-turn needed

Lower the carbon intensity of global steel production to 1,340–50 $kgCO_2/t$ crude steel.



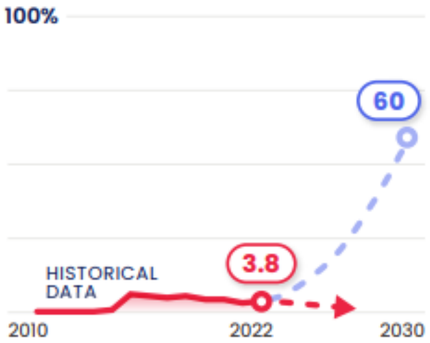
TRANSPORT U-turn needed

Reduce the percentage of trips made in passenger cars to 35-43%.



TRANSPORT U-turn needed[b]

Increase the share of BEVs and FCEVs to 60% of total annual bus sales.



ENERGY EFFICIENCY

Complex Systems

- **Micromobility**
- **Sustainability**
- **Urban mobility plans**

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Carbon-neutral solutions in HDVs

The hydrogen engine
Why H_2-engine for commercial applications?

ALLIANZ WASSERSTOFF MOTOR
Die Technikinitiative zur nachhaltigen Transformation

Goal

Fast, resilient and sustainable contribution to a holistic CO_2 reduction

Use Case - Technologies

Battery

Fuel-Cell

+ liquid renewable fuels

Hydrogen-Engine

Commercial vehicle applications are highly heterogeneous (load, power, range, terrain, ...)
We need all technologies, to meet customer and societal needs of all applications

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The expected development of the total cost of ownership (TCO) for conventional diesel, electric, and hydrogen buses + OPEX issues

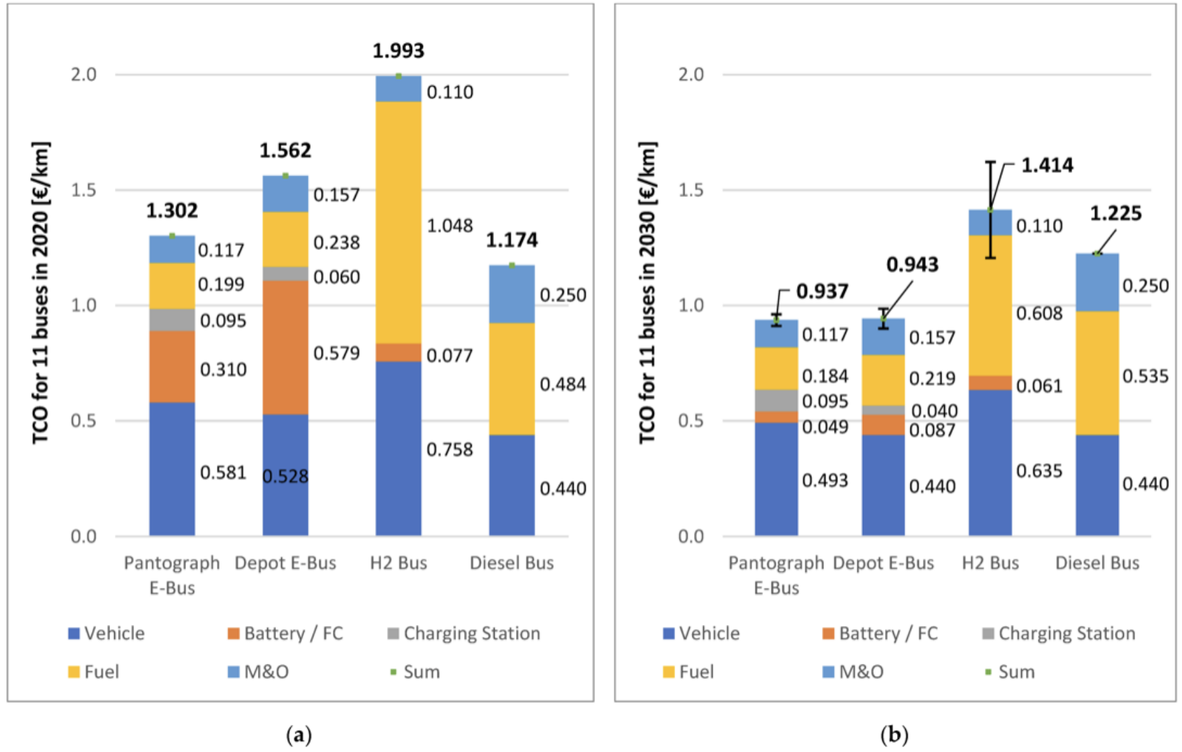


Fig. 17. Consumption, distances, and operational costs from January 2021 to April 2022 for the analysed ZEB fleet. The following cost figures were used in combination with the monitored data: costs: (i) 13.80 €/kg H2 in IIT's station [49]; (ii) 0.40 €/kWh for recharges in public streets [62].

Type	Consumption		Conversion	Consumption (kWh/km)	Fuel price (HUF/kg; HUF/l; Ft/kWh)	Cost (HUF/km)	Pwertrain CO_2 emissions/km
CNG	47	kg/100 km	14	6,58	900	423	1812
Dízel	52,2	l/100 km	11	5,742	583	304,326	1119
FCEB	6	kg/100 km	33,3	1,998	6272	376,32	0
BEB	110	kWh/100 km	1	1,1	100	110	0

Source: Kim et. al. Comparative TCO Analysis of Battery Electric and Hydrogen Fuel Cell Buses for Public Transport System in Small to Midsize Cities. Energies 2021, 14, 4384. https://doi.org/10.3390/en14144384

Integrator role of HUMDA in Green Mobility

Policy dimension

Implementation Dimension

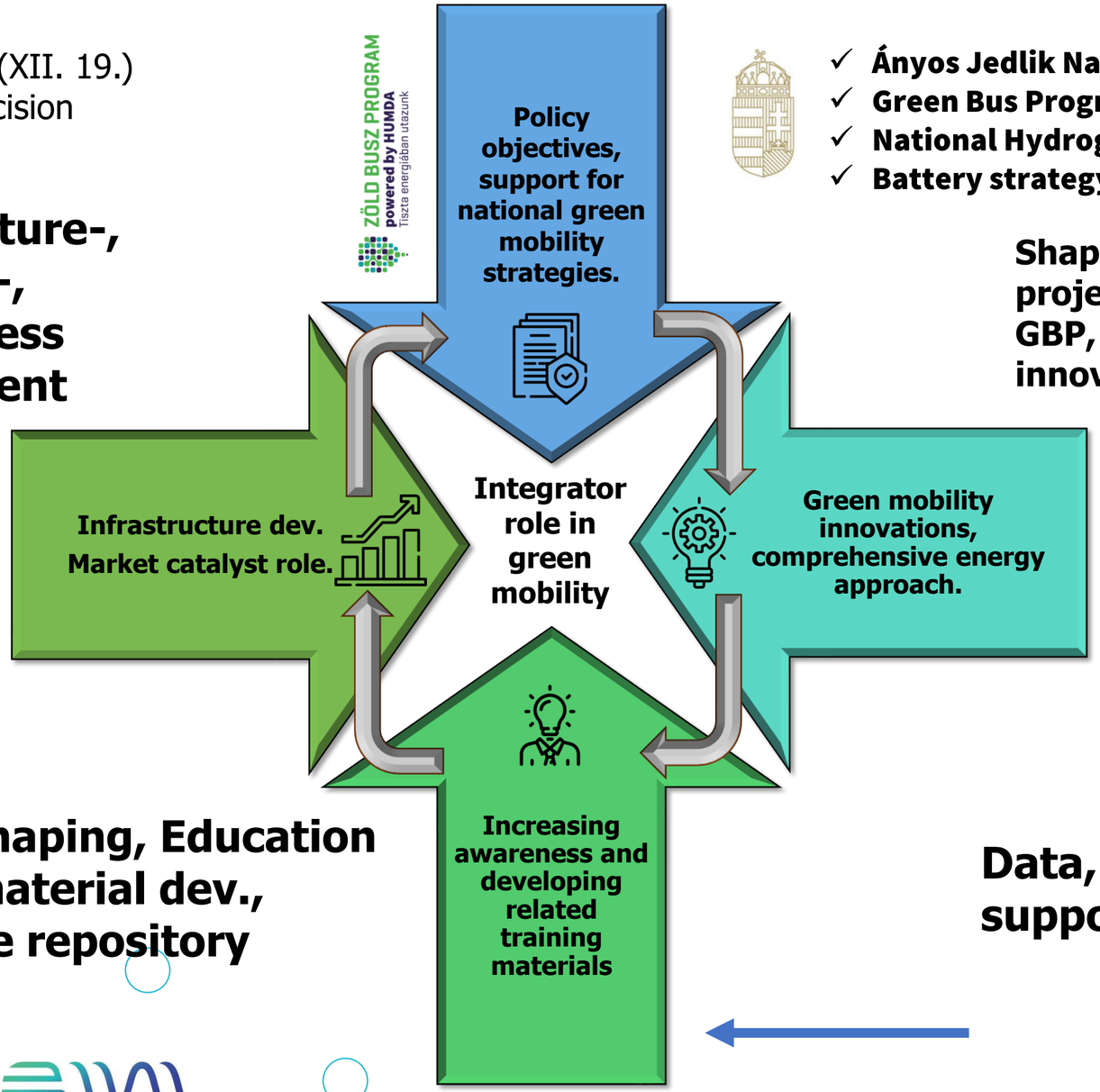
Social dimension

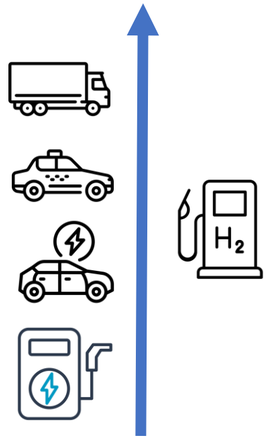
1641/2022. (XII. 19.)
Gov. Decision

**Infrastructure-,
Education-,
ECS Business
Development**

- ✓ **Ányos Jedlik National Plan**
- ✓ **Green Bus Program**
- ✓ **National Hydrogen Strategy**
- ✓ **Battery strategy**

**Shaping and implementation of projects,
GBP, H2 (system approach and innovative focus)**





**Attitude shaping, Education
Training material dev.,
Knowledge repository**

Data, analyses – decision support, dissemination

Energiaügyi Minisztérium

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Széchenyi Egyetemi Csoport Tagja

Results of subsidy programmes 2016 - 2021

2016 → EV-CHARGER → CAR → TAXI → MOTOR-CYCLE → E-SCOOTER → PEDELEC → BUS → CARGO BIKE → 2021

Green licence plates and benefits

171 EV chargers

Electric taxi fleets

Subsidy programmes

~ 7500 electric cars

~ 600 e-scooters, 14 000 e-bikes, 270 cargo bikes

Industrial development programme

135 zero emission urban buses (until 2023)

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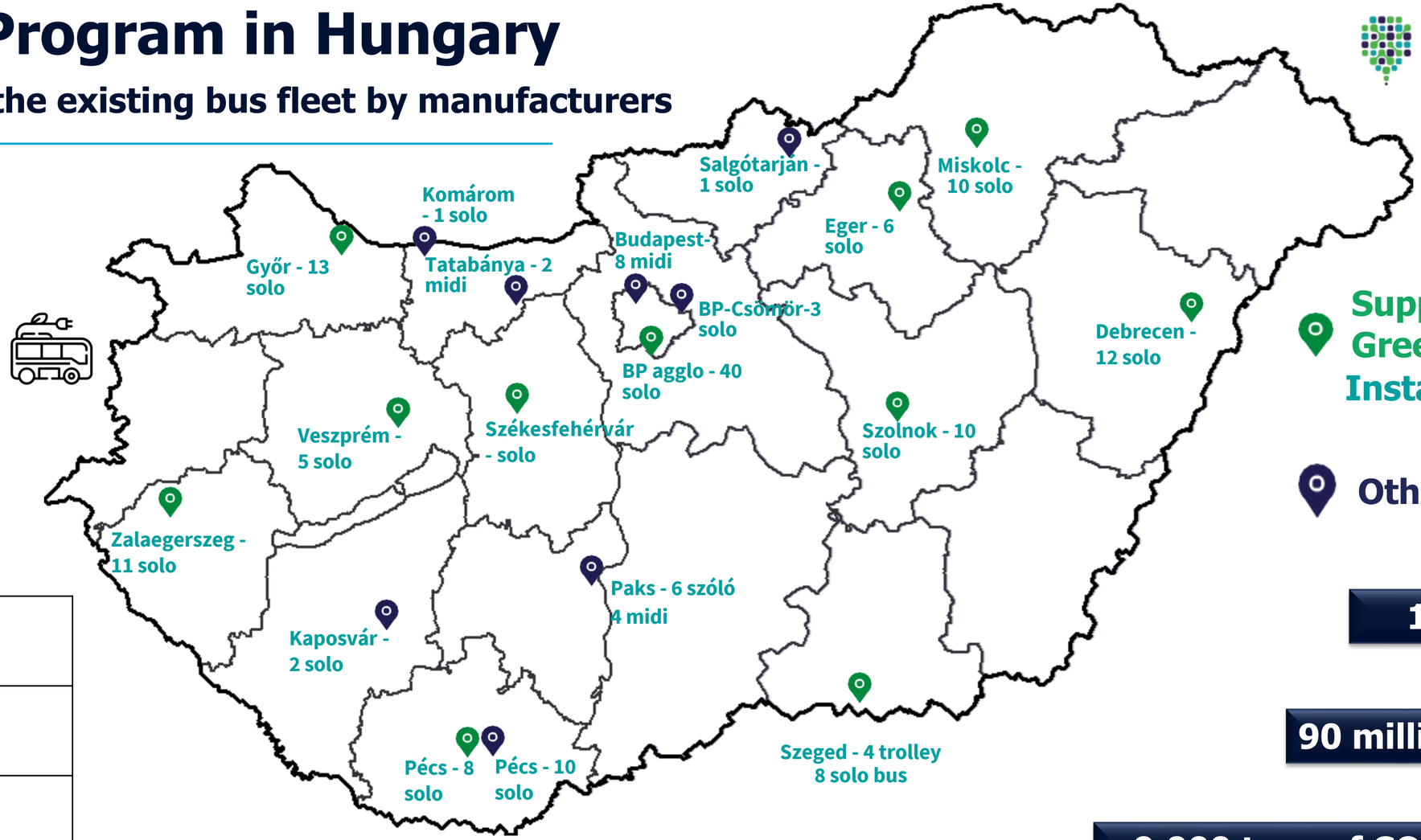
Green Bus Program in Hungary

The distribution of the existing bus fleet by manufacturers

BYD	72
IKARUS	17
IMAN	7
	60
MODULO	8
SOLARIS	10



Supported by the Green Bus Program Installed

Other support

Installed E-bus fleet by 2021	37
Installation of E-buses in 2021	10
Installation of E-buses in 2022	81
Installation of E-buses in 2023	56
Installation of E-buses in 2024	2
Current total E-bus fleet	174

135 e-bus

90 million EUR

9,000 tons of CO2 reduction per year

In Hungary, the electric bus fleet will quadruple with the support of the Green Bus Program

ZÖLD BUSZ PROGRAM powered by HUMDA
Tiszta energiában utazunk

ENERGIAÜGYI MINISZTÉRIUM

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Green Bus Programme first annual maintenance report data

11 county towns

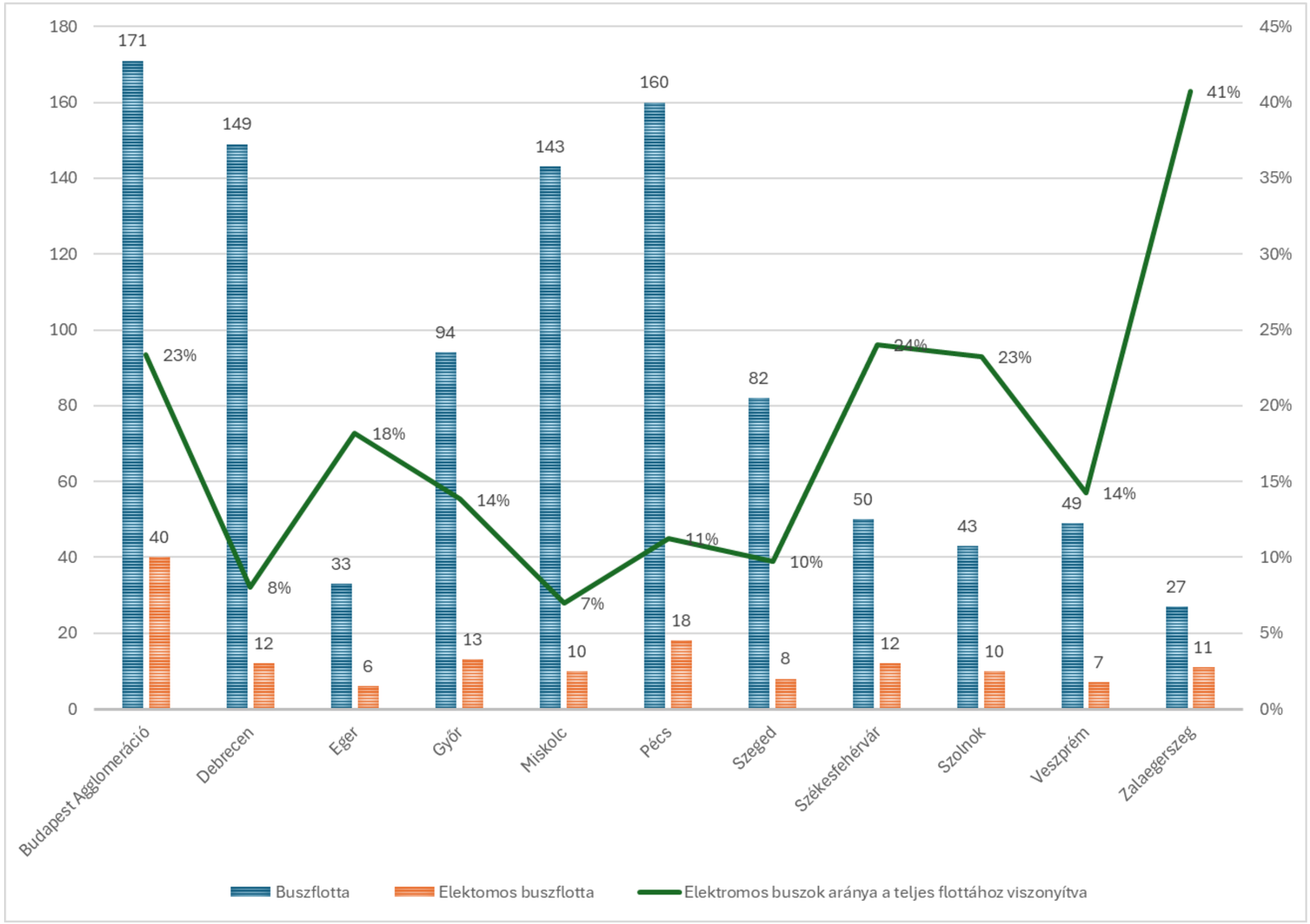
135 buses

8 million km mileage

1,1 kWh/km average consumption

Typical failures:

- Outdoor operation
- Heating/cooling equipment
- Stabilisers
- Heat failure
- Electric drive
- Battery pack



Hydrogen fuel cell bus pilot project

ÉZFF/208/2022-TIM-SZERZ - „BIG HYDROGEN PROJECT”

Kick off the implementation of the National Hydrogen Strategy in public bus transport

DEMONSTRATION

- **Two buses**
- **During one year (2024)**
- **In six county towns & in the surrounding suburbs of Budapest**
- **Installed and mobile (light) fuelling**

OBJECTIVES

- **Systematic data collection and analyses**
- **Operational experiences (vehicles, drivers, charging, PTO-s)**
- **Running a passenger survey for a year**
- **Flagship awareness raising campaign**
- **Promotion of hydrogen technology**
- **Preparing decisions for decisionmakers, input for future subsidy programmes**

DKV

VOLÁNBUSZ

KeKo Kecskeméti közlekedés

itk HOLDING

Kaposvári Közlekedési Zrt.

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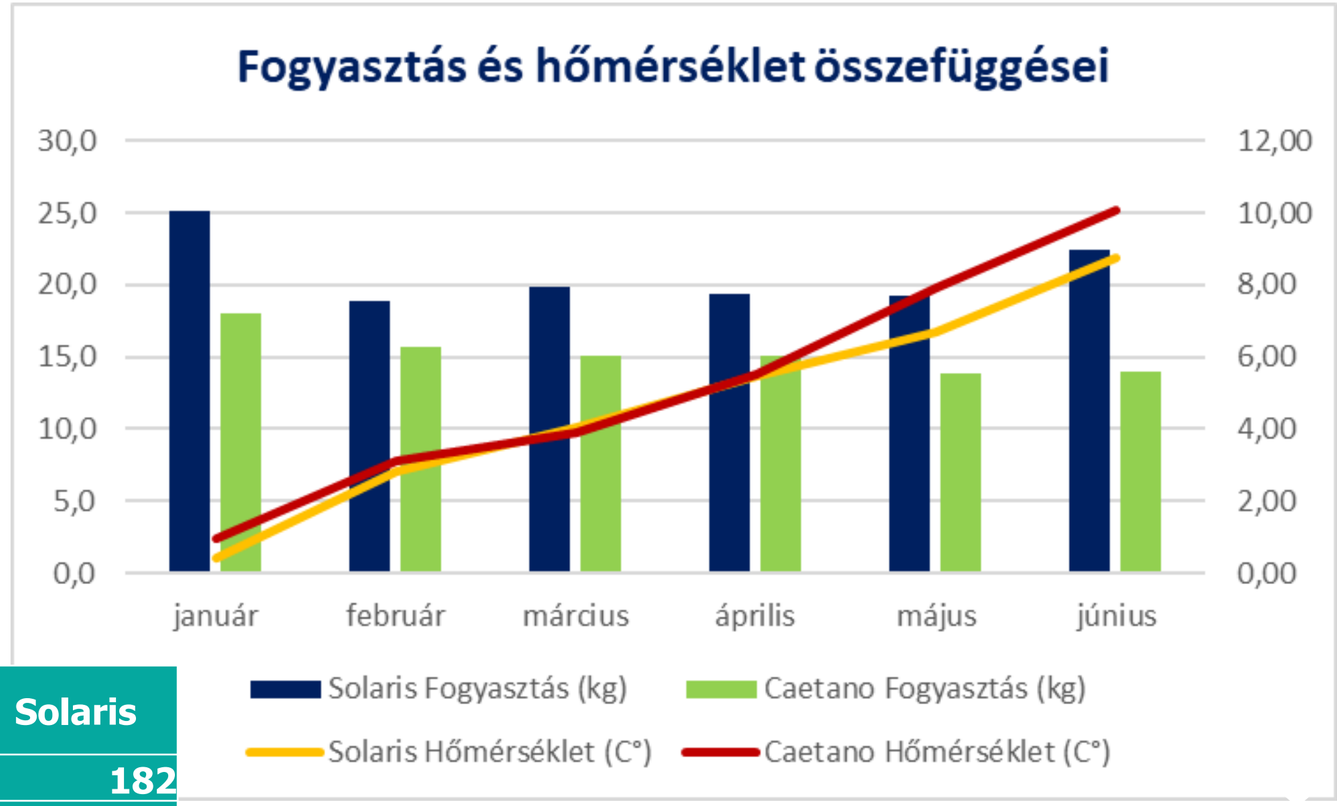
Hydrogen bus pilot project experiences so far in numbers

- So far, over **60,000 kilometers traveled**
- An average of **214 kilometers traveled per bus per day**
- Nearly **4,500 kilograms** of **H2 consumed**
- **40 tons of CO2 saved**



	Toyota-Caetano	Solaris
Number of days in service	156	182
Distance traveled (km)	41 986	33 271
Average distance traveled (km/day)	225	181
Average temperature (°C)	19,2	14
Average charge level at the start of charging (%)	51,8	19
Average charging time (hour:minute)	0:22	0:40
Hydrogen consumption (kg)	2 489	2 409
Average consumption (kg/100km)	5,93	8
CO2 emissions reduction (kg)	20 938	19 828

★ Január és június hónapok között

☆ Január és augusztus hónapok között

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Innovative charging solution: Cantron Robotics pilot in ZalaZONE

New Distributed Power Structure

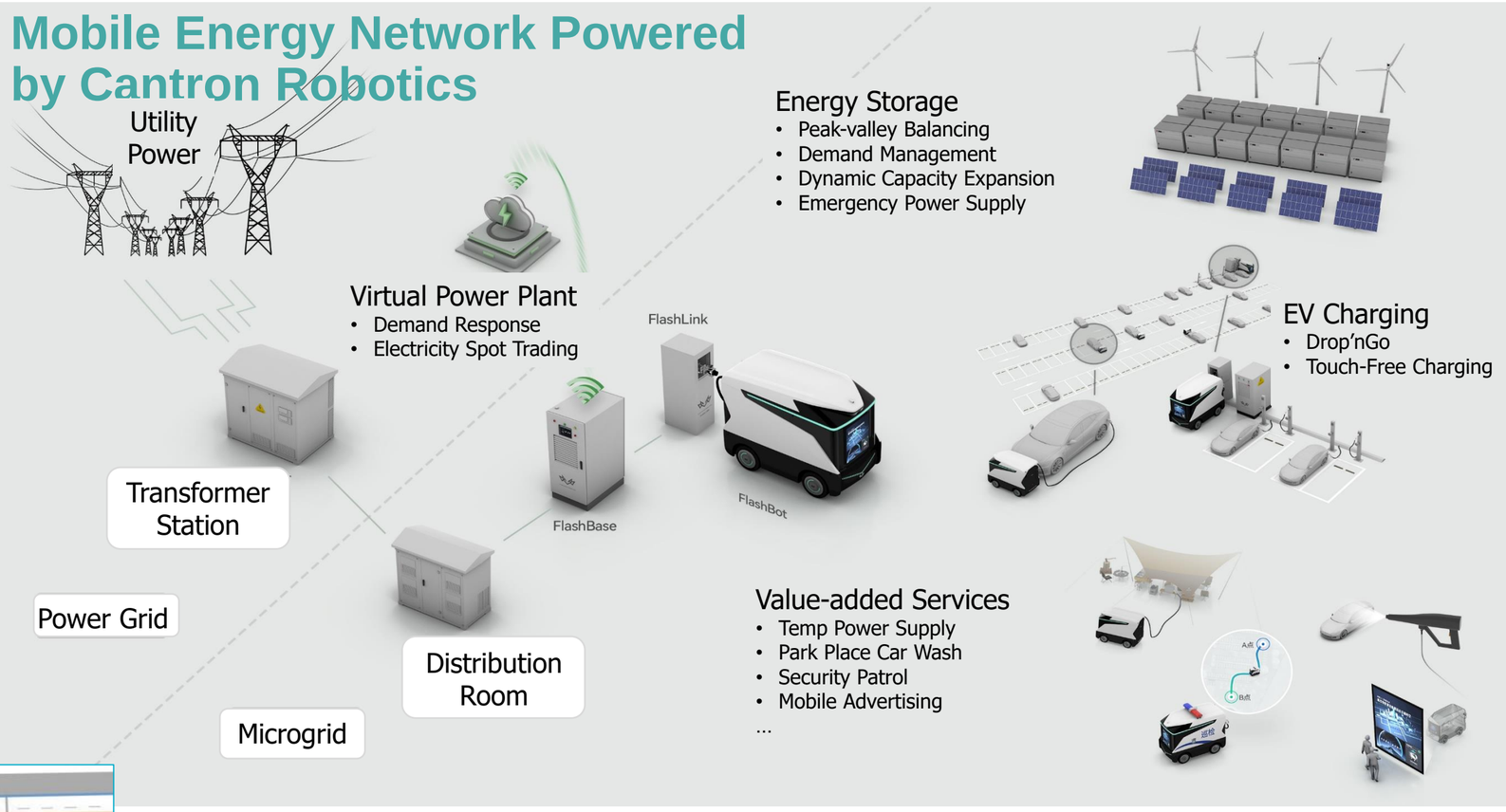
Low-carbon Energy, like Wind, Solar, Hydrogen

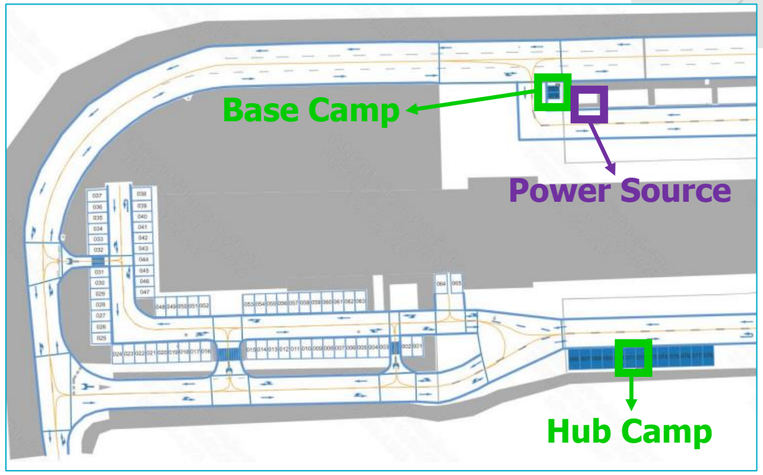
Autonomous Driving + Energy Storage

End User

EV Charging, Energy Storage in Campus, Temporary Power Demands ...

Mobile Energy Network Powered by Cantron Robotics





- Interlinking Mobile Charging Service with Fixed Charging Service:
- One Bot docks with the existing parking area to provide EV services
- Another Bot docks with the newly added fixed charing parking area to provide Hub services

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EIPP project 4 – Development of decarbonization strategies in the commercial vehicle sector

HUMDA: DRT pilot (Demand Responsive Transport)

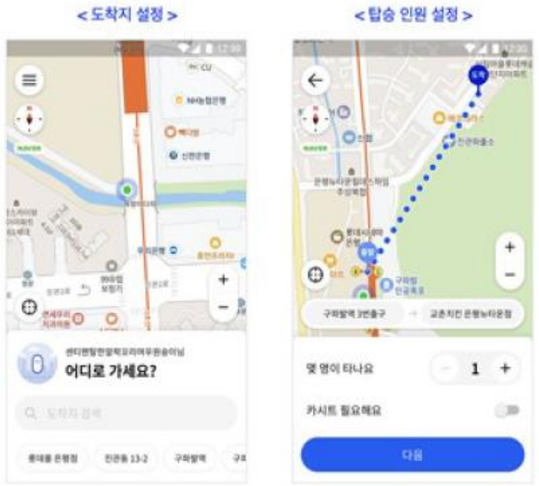
Pilot focus and schedule:

2024

- **Conduct a market survey** to assess the international frameworks that can inform the development of a **future decarbonization strategy** for the **commercial vehicle sector**

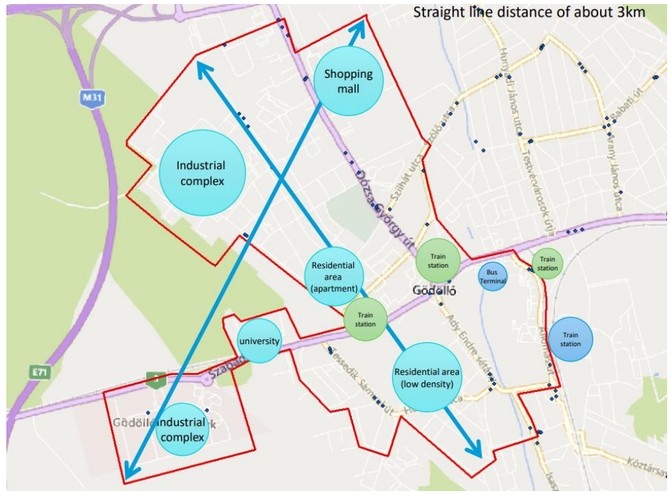
2025

- **Identify potential opportunities for DRT pilot projects**, gather international best practices, and incorporate relevant insights
- **Plan and implement the DRT** pilot project
- **Collect and analyze data** from the DRT pilot project's operational per



Potential pilot:

- **Reduced waiting times,** resulting in enhanced user satisfaction
- **No fixed routes or timetables**
- **Mobile phone application is essential, as it serves as the core co mponent of the system**
- Gödöllő: Realistic budget planning indicates that 2 vehicles would suffice. However, to achieve higher user satisfaction and ensure a successful futur e rollout of DRT in Gödöllő, operating 3 vehicles would be preferable



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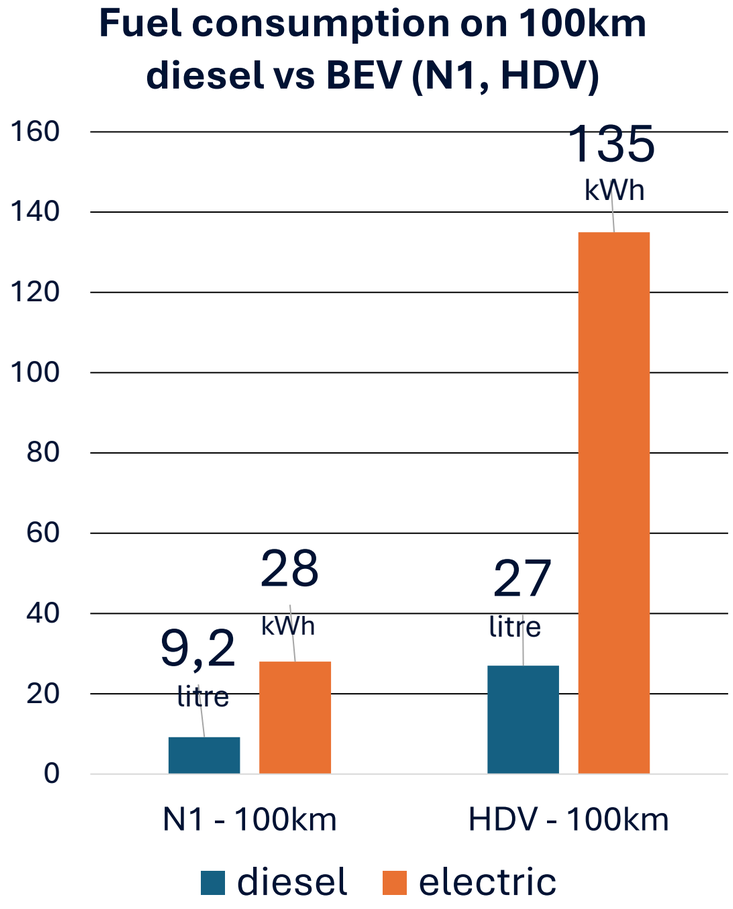
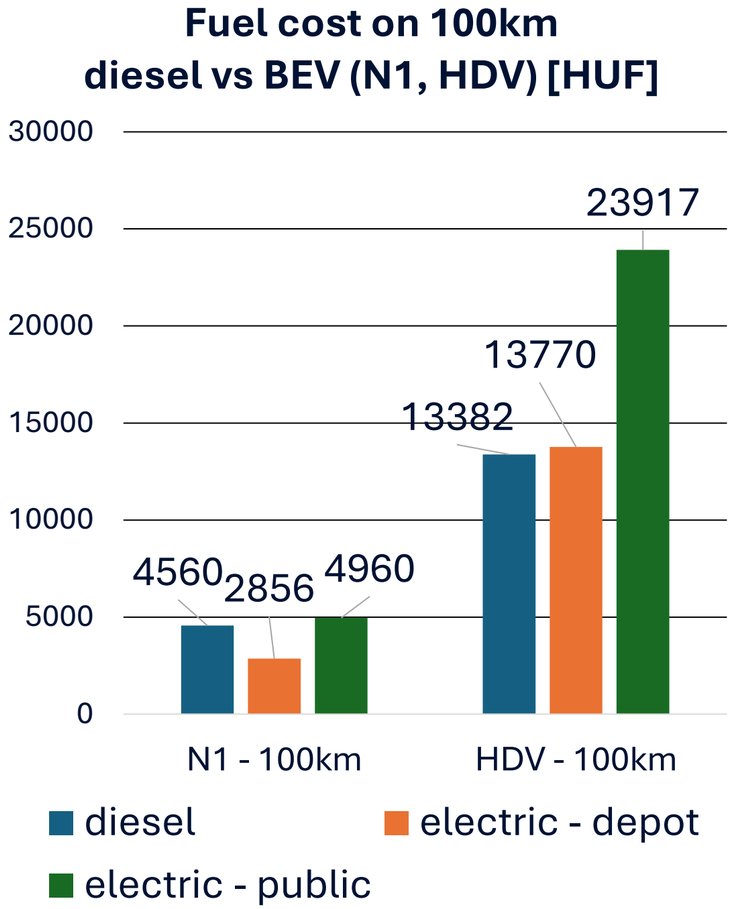
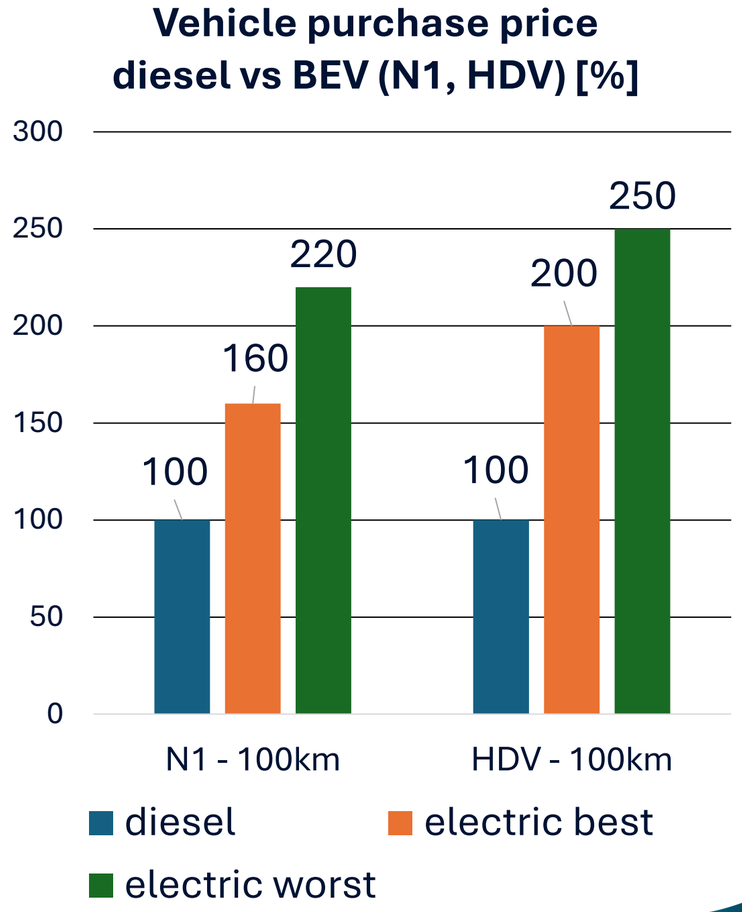
Carbon neutral drivetrains in logistics







Diagrams based on data from HUMDA survey for Article in Logistics yearbook; participants: Magyar Posta, WIN Capital, TRH

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HUMDA industry partners

Electromobility

BYD
MVM Titán
voltie
KEMPOWER
mobiliti / Powered by MVM
EKO ENERGETYKA SMART ENERGY SYSTEMS
MAN
NIO
IKARUS
EBUSCO®
CANTRON ROBOTICS
IVECO BUS
SOR

Energiaügyi Minisztérium
Nemzetgazdasági Minisztérium
Építési és Közlekedési Minisztérium
MEKH Magyar Energetikai és Közmű-szabályozási Hivatal
KTI Magyar Közlekedéstudományi és Logisztikai Intézet
MVK Zrt. A Miskolc Csoport tagja
VOLÁNBUSZ
SZEGEDI KÖZLEKEDÉSI TÁRSASÁG
KeKo Kecskeméti közlekedés
DKV
V-BUSZ
TükeBUSZ Együtt célba érünk!
KK Kaposvári Közlekedési Zrt.
itk HOLDING

Hydrogen economy

MESSER Gases for Life
Linde
MVM
CSP Make Science to real Business
PRIM VOL TRADE DEBRECEN
ALKATRÉSZ TRUCK TRAILER SZERVIZ
Salvador Caetano
Magyar Hidrogén és Tüzelőanyag-cella Egyesület
SOLARIS
TEQTOS
VITALFORCE
zone
TOYOTA
TRENECON Tanácsadó és Tervező Kft.
DUNAGÁZ
HYUNDAI
NEMZETKÖZI FEJLESZTÉSI ÉS FORRÁSKOORDINÁCIÓS ÜGYNÖKSÉG ZRT.
ZKK ZÉRŐ KARBON KÖZPONT
smart-inno expert
tal management
MAGYAR HIDROGÉNTECHNOLÓGIAI SZÖVETSÉG
HORVÁTH IFUA
ttk
UNIVERSITAS-GYŐR NONPROFIT Kft.
MŰEGYETEM 1782
ÓBUDAI EGYETEM ÓBUDA UNIVERSITY
MISKOLCI EGYETEM UNIVERSITY OF MISKOLC
SZÉCHENYI EGYETEM UNIVERSITY OF GYŐR
UNIVERSITAS QUINQUEECCLESIENSIS
Pannon Egyetem University of Pannonia
DEBRECENI EGYETEM
NJE Neumann János Egyetem
SZTE SZEGEDI TUDOMÁNYEGYETEM

International relations

Hydrogen Europe™
UITP ADVANCING PUBLIC TRANSPORT
ALLIANZ WASSERSTOFF MOTOR
DialogUngarn Deutsch-Ungarisches Wirtschaftsnetzwerk
HUMDA
SZÉCHENYI EGYETEMI CSOPORT TAGJA

Thank you for your kind attention!

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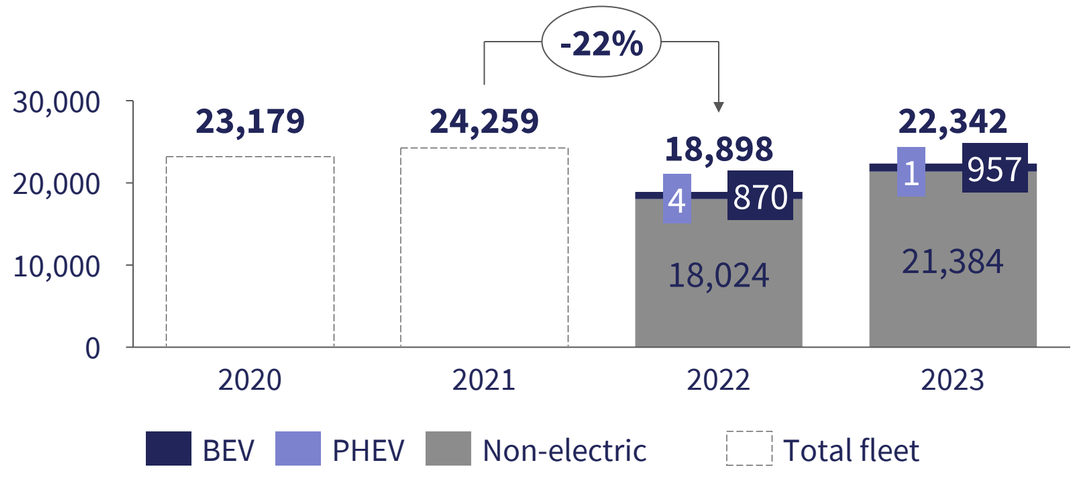
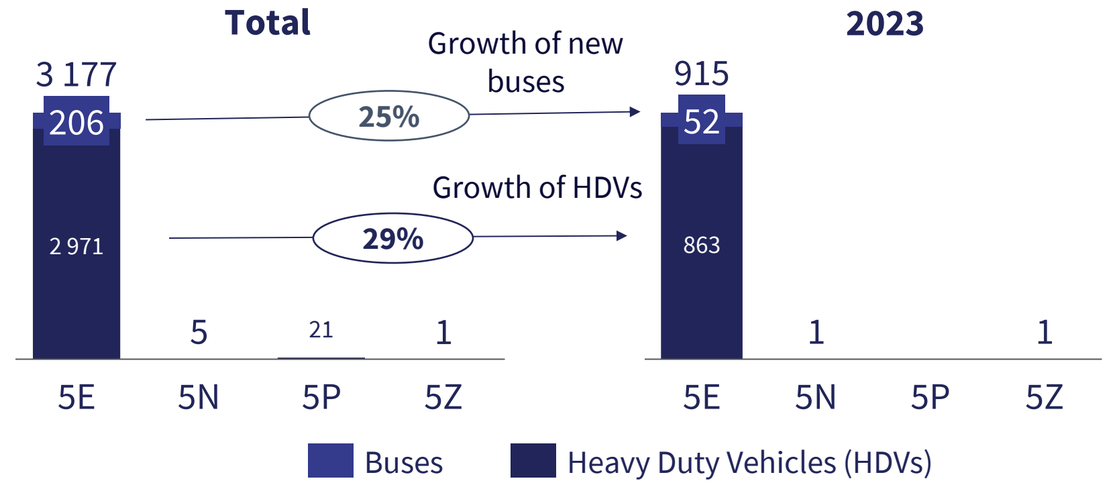
The expansion of electromobility in local and intercity public and freight transport is not progressing at the desired pace

Targeted incentives are necessary

Number of newly registered trucks (units)



Trucks and buses with green licence plate and the number of new registrations in 2023 (units)

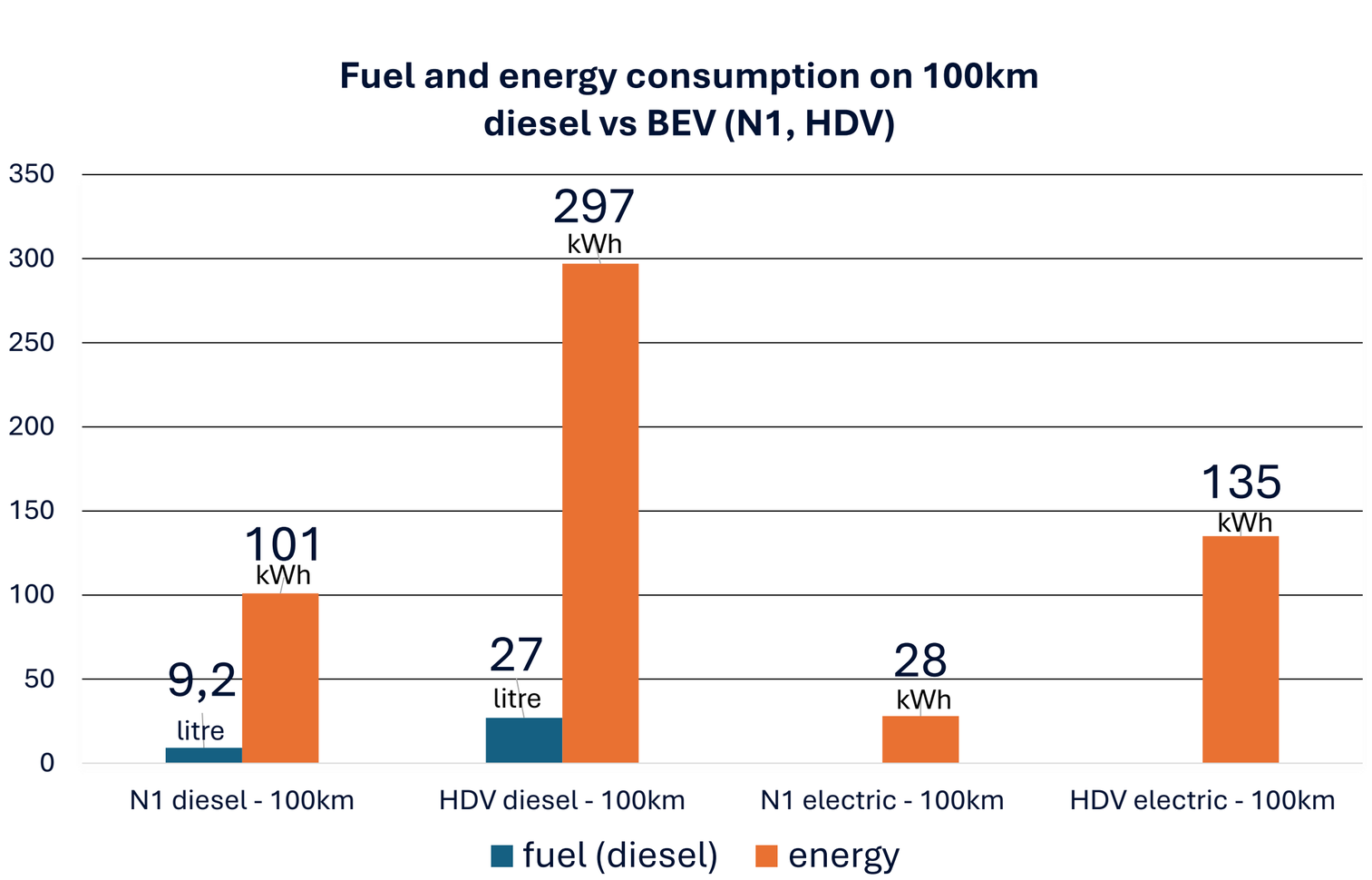


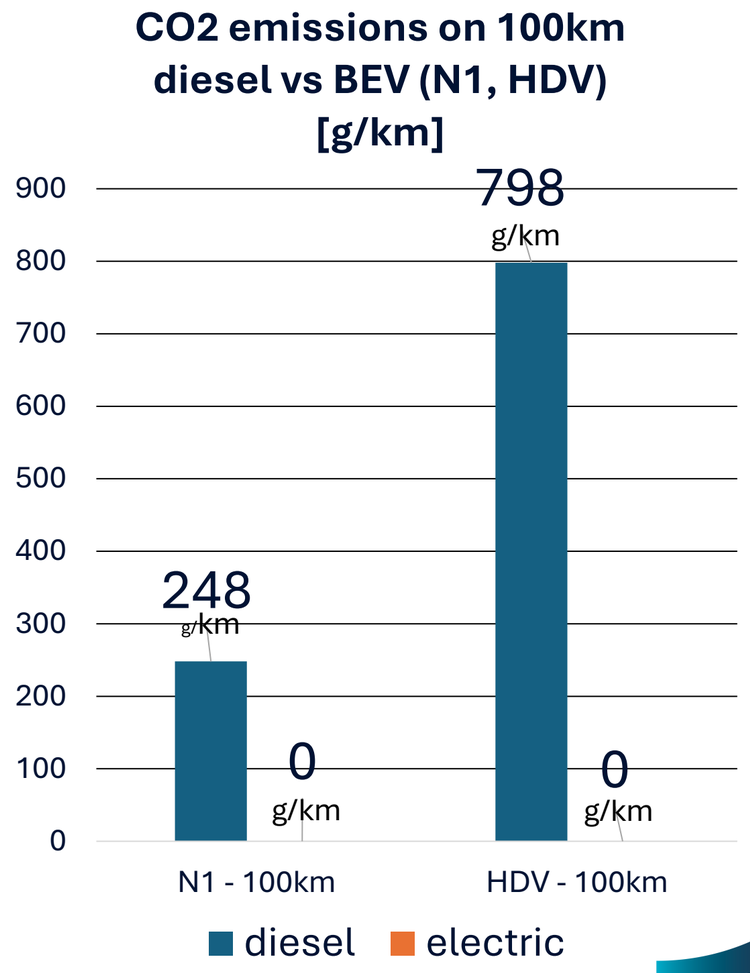
- **In 2022, there was a significant drop in new HDV registrations** due to supply chain problems caused by the Russian-Ukrainian war.
- **In 2023, 4% of newly registered** HDVs were **electric.**
- **Current battery technology does not allow trucks to achieve the required range, especially in adverse weather conditions. Limited storage space** is also a constraint.
- **Therefore, other alternative powertrains (e.g. hydrogen, e-fuel and biofuels) could be a potential solution for greening the segment.**

- In 2023, **3.7% of green licence plate numbers were for HDVs and buses**. The same year, the number of HDVs with green plates increased by 29% and that of buses increased by 25%.
- Electric buses account for **2.2%* of the current local bus fleet** (205 buses*).
- The National Energy Strategy foresees the **purchase of 1290 electric buses** by 2030.
- The CVD commitment foresees a minimum of **400 electric buses** by 2030, but the timing is difficult to predict.
- As for HDVs, vehicles with alternative powertrains (e.g. hydrogen, e-fuel and biofuels) could be a potential solution for greening the local bus fleet.

*Source: BM, KSH, Magyar Mérnöki Kamara, *https://greendex.hu/elektromos-buszok-magyarorszagon/*

Carbon neutral drivetrains in logistics





Diagrams based on data from HUMDA survey for Article in Logistics yearbook; participants: Magyar Posta, WIN Capital, TRH

HUMDA

SZÉCHENYI EGYETEMI CSOPORT TAGJA