



Miejskie Zakłady Autobusowe Sp. z o.o.



The case of Warsaw:  
overview of municipal bus company activities  
in the field of electric mobility



## MZA – basic information

- the largest local bus operator in Poland
- nearly 1400 buses (including 160 electric)
- 4 depots
- 4700 employees (over 3500 are bus drivers)
- operate on 201 urban and suburban lines
- 200+ m EUR turnover per year





## Bus transport operation

- MZA operates in Warsaw Metropolitan Area: the capital city and 33 neighboring municipalities
- 900 000 passengers daily in Warsaw public transport (1,2 m before pandemic)  
– 50% travel with buses
- MZA: over 7 000 000 vehicle-km monthly
- almost 75% of total bus-km in Warsaw covered by MZA

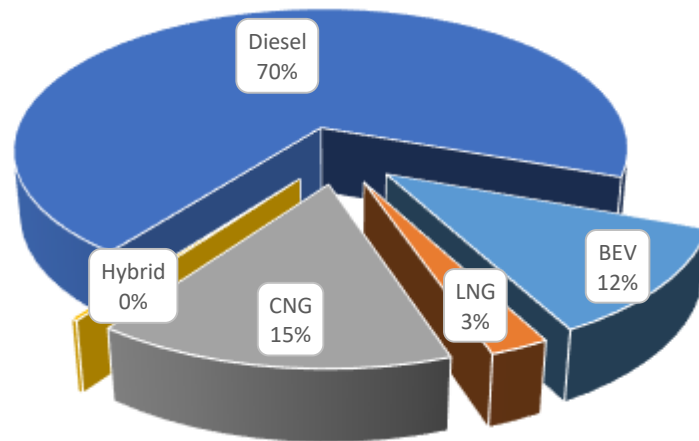




## MZA – bus fleet segmented by drive (Feb. 2022)

- although our bus fleet is based on diesel engines, we intensively invest in technological improvements, as well as low emission drives
- our fleet comprises of 1375 buses of which approximately 1150 are in daily operation
- the average age of the fleet: 8 years

MZA bus fleet segmented by drive



# Testing new drives



In 2011 MZA purchased 4 Solaris Urbino 18 Hybrid buses. They were one of the first vehicles of this type in Poland.

In 2015 MZA as the second city in Europe started the operation of buses with the innovative LNG technology (35 Solbus SM18LC buses).



In 2018 MZA signed a contract with MAN for 110 CNG buses.

In 2020 MZA signed a contract with  SBC for 70 CNG buses  
 AUTOSAN for 90 LNG buses

In 2021 MZA signed a contract with SBC for 30 CNG buses.





# Preparations for e-bus fleet growth

## Solaris Urbino 12 Electric



- 10 BEVs since 2015
- Plug-in (after modernization also pantograph)
- Line 222 in the city center
- **In 2018 another 10 e-buses contracted**

## Ursus CS2 City Smile



- 10 BEVs since 2017
- Plug-in and pantograph
- Different lines



# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

The project compliant with Warsaw low emission strategy

1) Purchase of 130 articulated electric busses to operate mainly in the city center

→ Delivery of 130 zero-emission buses completed in 2020

2) Installing charging points at the ends of the bus lines

→ Installation of 19 pantograph chargers completed, 2 are still in progress

- Co-financing from the EU: 281 888 900 PLN – 60.5 m EUR
- Total project value: 408 660 574 PLN – 87.7 m EUR
- Co-financing rate: 85%



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Milestones in the project

- **Feasibility Study**
  - strategic option analysis
  - risk assessment
  - financial plan
- **Technical expertise**
  - decision on the battery type
  - estimate the battery life span
  - simulations on time of charging in real life conditions
- **Pilot activities**
  - articulated electric bus for tests in Warsaw – to collect operational data
  - first pantograph charger
- **Public procurement for vehicles and chargers**



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

Operational data to consider – comparison of daily ranges

Type of bus	Energy	Technology	Type of battery	Battery capacity [kWh]	Range (only traction) [km]	Range (traction and thermal comfort)
12m	EE	high energy	NMC2	480	274	206
12m	EE	high power	LTO	125	71	54
18m	EE	high energy	NMC2	640	274	202
18m	EE	high power	LTO	175	75	55



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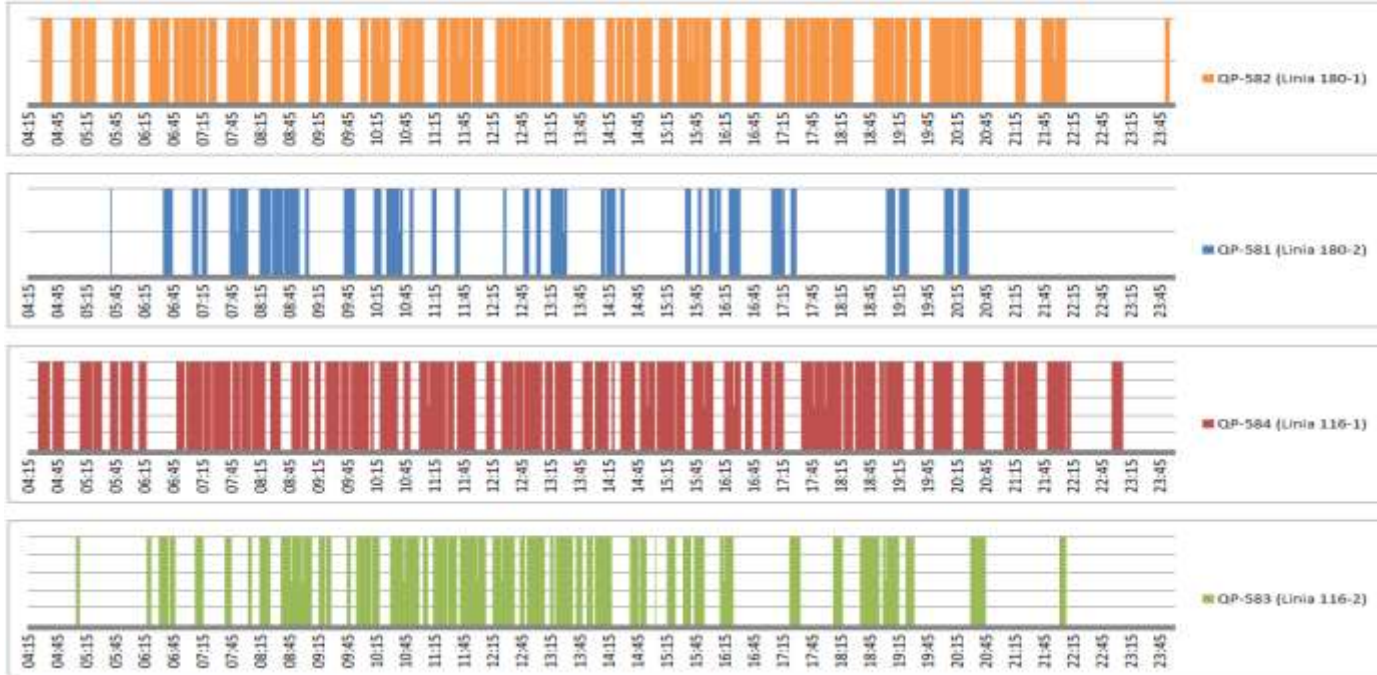






# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Charging points usage time graph



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## State of charge (SOC)



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

State of charge (SOC)



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

Estimated range



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Assumed and performed mileage

	09.2021	10.2021	11.2021	12.2021
mileage per month - <b>real</b>	667 795	724 332	674 053	687 356
mileage per month - <b>projected</b>	642 915	642 915	642 915	642 915
performance rate	104%	113%	105%	107%

ilość wzkm rocznie	tys. wzkm	2019	2020	2021	2022
	jedn.	7 714,96			
W1	tys. kg NMVOC		0,05	0,05	0,05
W2	tys. kg NMVOC		4,93	4,93	4,93
W0	tys. kg NMVOC		20,36	20,36	20,36
<b>oszczędność emisji NMVOC</b>					
W1	tys. kg CO2		20,31	20,31	20,31
W2	tys. kg CO2		15,44	15,44	15,44
	jedn.	2019	2020	2021	2022
W1	tys. kg NOx		11,70	11,70	11,70
W2	tys. kg NOx		15,16	15,16	15,16
W0	tys. kg NOx		154,94	154,94	154,94
<b>oszczędność emisji NOx</b>					
W1	tys. kg NOx		143,24	143,24	143,24
W2	tys. kg NOx		139,78	139,78	139,78
	jedn.	2019	2020	2021	2022
W1	tys. kg SO2		28,17	28,17	28,17
W2	tys. kg SO2		0,00	0,00	0,00
W0	tys. kg SO2		0,00	0,00	0,00
<b>oszczędność emisji SO2</b>					
W1	tys. kg SO2		-28,17	-28,17	-28,17
W2	tys. kg SO2		0,00	0,00	0,00
	jedn.	2019	2020	2021	2022
W1	tys. kg PM 2.5		0,32	0,32	0,32
W2	tys. kg PM 2.5		0,38	0,38	0,38
W0	tys. kg PM 2.5		0,89	0,89	0,89
<b>oszczędność emisji PM 2.5</b>					
W1	tys. kg PM 2.5		0,56	0,56	0,56
W2	tys. kg PM 2.5		0,51	0,51	0,51



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Conclusions/lessons learned

- electrification of the bus line possible without changing the timetables (properly designed technical and operational solutions)
- a need to adapt the IT infrastructure and procedures
- for Warsaw the best solution is a bus equipped with *high power* LTO batteries combined with energy supplementation at the bus ends by the pantograph charging system
- battery charging – 10 minutes under normal conditions, the bus leaves the end of the line with the battery charged to 80-90% capacity



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# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Infrastructure issues

- Obtaining proper consent to use the municipal land to build chargers – very difficult, especially in the city centre – as a result some locations were changed
- Installing chargers at streetside locations – agreements needed (problems in historic areas)
- Providing power capacity – prolonged process (18+ months)
- Number of approvals required to start exploiting the charger
- Standardisation/unification essential



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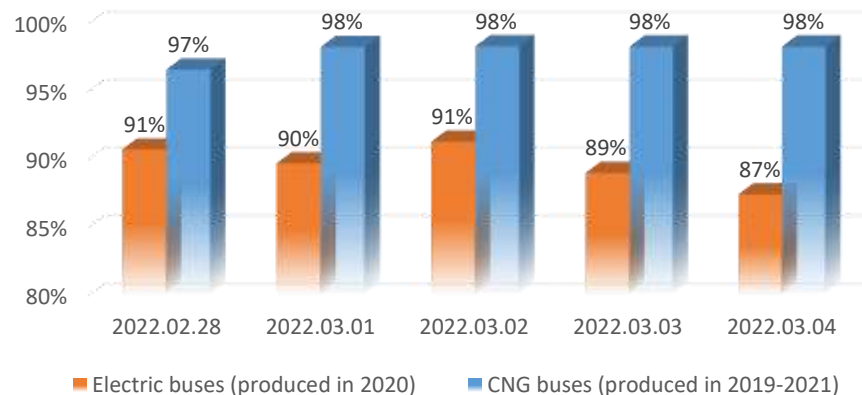


# Investment in low emission bus fleet (130 low floor buses) and necessary infrastructure

## Vehicle issues:

- New technology to learn – technical staff and drivers
- Availability rate of e-buses still lower than gas and standard diesel buses
- Vehicles dependent on infrastructure and bound to specific lines

AVAILABILITY RATE OF CERTAIN TYPES OF BUSES IN MZA



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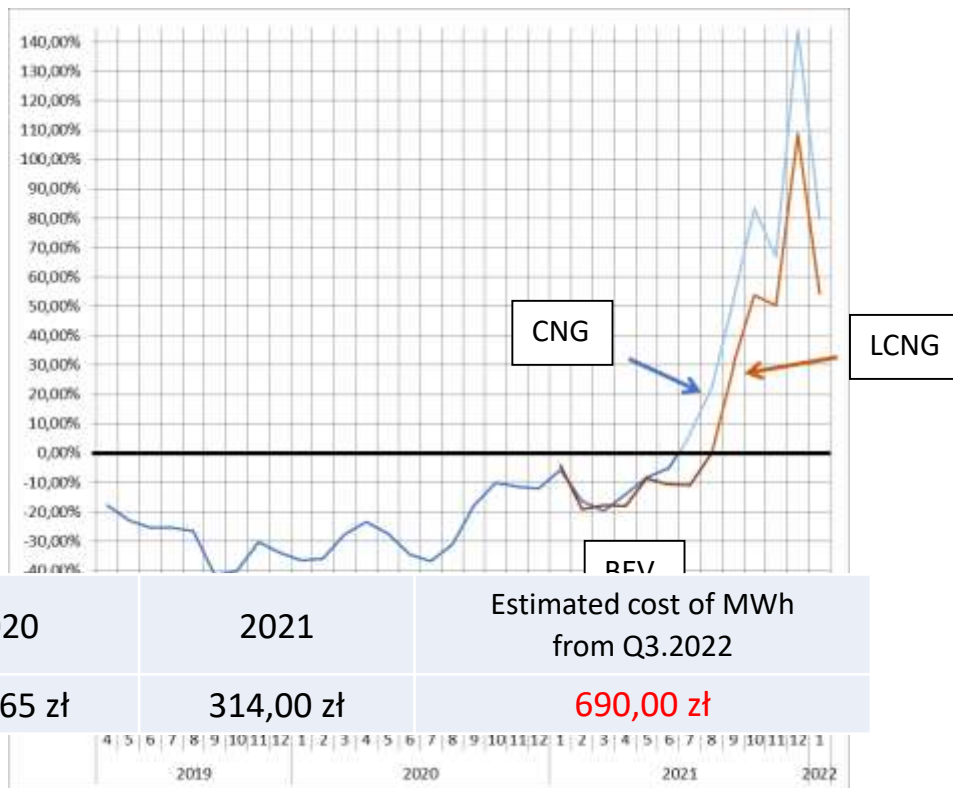




# Plans for the future

Cost of vehicle-km (gas, electric) in relation to the cost of diesel bus vehicle-km

- EU and domestic regulations on low- and zeroemission fleet
- Rapid changes in prices of alternative fuels and energy
- Inflation
- Unstable political and military situation in Europe



2018	2019	2020	2021	Estimated cost of MWh from Q3.2022
335,05 zł	370,00 zł	257,65 zł	314,00 zł	<b>690,00 zł</b>

# Plans for the future

## Hydrogen buses

- Currently possible only as a pilot and only with EU funds (+60% more expensive than electric bus);
- Large-scale operation impossible due to immature technology and lack of infrastructure (public hydrogen station suitable for buses presently unavailable in Poland)
- Fuel costs difficult to estimate (market estimates: +500%)







# Thank you

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# More Information

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