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TRANSNATIONAL HANDBOOK FOR ENERGY-EFFICIENT PUBLIC TRANSPORT INFRASTRUCTURE TECHNOLOGIES DEPLOYMENT

(1) Energy efficiency for depots

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About the EfficienCE project

EfficienCE was a cooperation project funded by the Interreg CENTRAL EUROPE programme that aimed at reducing the carbon footprint in the region. Most central European cities have extensive public transport systems, which can form the basis of low-carbon mobility services. More than 63% of commuters in the region are using public transport. Measures to increase the energy efficiency and share of renewables in public transport infrastructure can thus have a particularly high impact on reducing CO2.
This was achieved by supporting local authorities, public transport authorities and operators by developing planning strategies and action plans, implementing pilot actions, developing tools and trainings to plan and operate low-carbon infrastructure, and by transferring knowledge and best practices on energy-efficient measures across Central European regions.
Twelve partners, including seven public transport authorities/companies from seven countries were working together for three years to exploit the untapped potentials in this sector and to contribute to the EU's 'White Paper' goals to cut transport emissions by 60 percent by 2050 and to halve the use of 'conventionally fuelled' cars in urban transport by 2030.

Contents

Executive Summary

Photo by City of Leipzig

Although the non-traction energy is a minor expense, environmental and geopolitical pressure for energy transformation delivers arguments to search improvements in depots.

The depot consumes electric energy but also gas, oil, and district heating. The structure depends on the particular case and the usage depends on such factors like technical condition of buildings, availability of renewable energy sources, equipment (painting facilities, lightning) as well as procedures implemented to save energy consumption.

Literature review brought only partial answer for the topic of the energy efficiency for depots. Majority of papers focused on the use of the renewable energy sources. The issue of the energy and thermal efficiency of the technical facilities of public transport operators is scarcely mentioned in the literature.

Using selected six case studies of different public transport operators from Central Europe, a thorough analysis was conducted. It showed that there are a variety of different activities focused on the increasing energy efficiency of depots. Their scale is dependent not only on the size of the operator, but also on local circumstances and national legal framework.

These actions were clustered into five main groups including buildings, heating, renewable energy sources, lighting, and paint shops as they represent very specific area of daily exploitation.

Optimising energy use at the depot is an integral part of improving public transport companies' energy and economic efficiency. This is particularly important when fossil fuel and electricity prices are soaring and are unpredictable as never before.

1. Introduction

For many years making depots energy-efficient has been secondary or tertiary challenge for majority of operators. Recent years witnessed mass acquisition of modern rolling stock under a flag of electrification. Nowadays, over half a million electric vehicles are used in urban transport worldwide and scale of electrification is increasing. It is estimated that by 2040 electric buses may exceed 2/3rd of the urban transport fleet globally. A parallel trend is the growing role of hydrogen vehicles, which may account for 6% of urban transport vehicles in 2040[1]. The main focus was put on energy storage systems in vehicles. Among three available technologies (battery, supercapacitor, flywheel)[2], the battery seems to be leading technology, leaving behind supercapacitors and flywheels. The in-motion charging technology is regarded as a new opportunity for trolleybus use, also due to its technological maturity[3].

Although the non-traction energy is a minor expense[4], environmental and geopolitical pressure for energy transformation delivers arguments to search improvements in depots.

The depot consumes electric energy but also gas, oil, and district heating. The structure depends on the case and the usage depends on such factors like technical condition of buildings, availability of renewable energy sources, equipment (painting facilities, lightning) as well as procedures implemented to save energy consumption.

1.1 Literature Review

Currently, technological progress is focused primarily on electricity storage represented by different generations of batteries[5].

In the paper of M. Bartłomiejczyk, the first PV system for supplying an energy for the trolleybus system in Gdynia (Poland) was proposed. Uneven load in the traction power supply resulting from different solar radiation and uneven reception of the energy from trolleybuses (road congestion), make possible to use more than 70% of energy that can be produced from the PV instillation of 500 kW. Introduction of a bilateral power supply increases the ability to use energy. The optimal solar system power depends in a wide range on the local structure of the power system and traffic conditions. For large substations it is recommended to develop PV with a power of 400-500 kW, for smaller ones – 100 to 150 kW. For PV system connected to traction catenary in weak points a maximum power of PV up to 50 kW is recommended[6].

“A cost-efficient energy management system” analysed in another paper, considered an energy produced by PV supported by the energy storage system. Main barriers of such solution were high upfront capital costs, specific technical requirements (i.e., large area required, relevant construction) and intermittency, which was highlighted as the major problem of the PV system. On the other hand, “effective integration and energy management of PV and ESS in the depot charging ecosystem can result in smoothing of the intermittency impact”[7], peak load reduction on the distribution grid[8] and

1 Electric Vehicle Council. Electric Vehicle Outlook 2020. Executive Summary; Electric Vehicle Council:Sydney, Australia, 2020
2 Deliverable D.T2.3.1 State of the art & peer review for energy-efficient PT infrastructure technologies deployment. Energy storage in public transport infrastructure. Redmint, prepared within EfficienCE project, 2022
3 Wołek M. et. al.: Ensuring sustainable development of urban public transport: A case study of the trolleybus system in Gdynia and Sopot (Poland). “Journal of Cleaner Production” 2021 nr 279
4 For instance, the non-traction energy bought in 2017 by one of PT operators in Poland was about 5 percent of the overall bought energy. Still, it was worth more than 1M PLN (ca. 213 thous. EUR as of 12.05.2022)
5 Wołek M., Szmelter-Jarosz A., Koniak M., Golejewska A.: Transformation of Trolleybus Transport in Poland. Does In-Motion Charging (Technology) Matter? “Sustainability” 2020 nr 12
6 Bartłomiejczyk M.: Potential application of solar energy systems for electrified urban transportation systems. “Energies” 2018 nr 11(4)
7 Dai Q., Liu J., Wei Q.: Optimal photovoltaic/battery energy storage/electric vehicle charging station design based on multi-agent particle swarm optimization algorithm. “Sustainability” 2019 nr 11 (7) 1973.
8 W. Khan, F. Ahmad, M.S. Alam, Fast EV charging station integration with grid ensuring optimal and quality power exchange, “Engineering Science and Technology, an International Journal” 2019 nr 22 (1)

to reduce the energy cost for the depot owner[9].

Based on the simulation conducted for Shanghai, it was proved that photovoltaic battery energy storage system was the most cost-effective solution[10]. On the other hand, based on a case study in Singapore, an analysis was provided to reduce peak-demand changes at bus end-stations equipped with fast charging stations supported by stationary energy storage units. The study showed that the cost reduction potential reduces with increasing levels of bus-line electrification[11]. Another study pointed out on hybridization of storage energy systems, using batteries and supercapacitors that can be used in different renewable energy systems, especially PV systems[12].

The recent paper based on the research conducted within TROLLEY 2.0 project, diagnosed a mismatch between energy generation from renewable sources and intermittent bus schedules. As a result, considerable excess of energy makes the whole system not feasible from economic point of view. A study covered PV and wind energy was modelled based on a case study of Arnhem city (the only city in the Netherlands that operates trolleybus system). The best recommendation was to aggregate the generation from the whole grid. The best result was achieved when a hybrid solution (53% PV and 47% of wind) has been deployed supported by installation of energy storage system. This is because the wind generation better follows the bus demand trend on a yearly basis[13].

Literature review brought only partial answer for the topic of the energy efficiency for depots. Majority of papers focused on the use of the renewable energy sources. The issue of the energy and thermal efficiency of the technical facilities of public transport operators is scarcely mentioned in the literature.

1.2 Case study selection process

The case study method was chosen to fill the research gaps identified within literature review. The selection of particular case studies was conducted according to city size, operator's size, different means of transport and advancement towards using of renewable energy sources. Table 1 presents selected case studies for further analysis. The study focused on the operators from Central Europe – companies, instead of the whole public transport systems. This allowed for greater precision in data acquisition and further research in the form of individual interviews with relevant operators' representatives.

Table 1. Main characteristics of case studies selected for the analysis

Operator	Country	Buses	Trolleybuses	Trams	Supply [mio. veh-kms]	PV
DPMB Brno	Czechia	334	142	340	37.2	N
DPO Ostrava	Czechia	298	68	239	30.7	N
MPK Wroclaw	Poland	328	0	285	22.2	Y
MZA Warszawa	Poland	1422	0	0	89	Y
PKT Gdynia	Poland	0	100	0	5.3	P
SZKT Szeged	Hungary	0	61	43	No data	P

Y – yes, N – no, P - planned

9 Zahedmanesh A., Muttaqi K.M., Sutanto D.: A Consecutive Energy Management Approach for a VPP Comprising Commercial Loads and Electric Vehicle Parking Lots Integrated with Solar PV Units and Energy Storage Systems. [In:]: 2019 1st Global Power, Energy and Communication Conference (GPECOM), IEEE, 2019

10 Dai Q., Liu J., Wei Q.: Optimal photovoltaic/battery energy storage/electric vehicle charging station design based on multi-agent particle swarm optimization algorithm. "Sustainability" 2019 nr 11 (7) 1973.

11 Trocker F. et. al.: City-scale assessment of stationary energy storage supporting end-station fast charging for different bus-fleet electrification levels. "Journal of Energy Storage" 2020 nr 32

12 Z. Cabrane, J. Kim, K. Yoo, M. Ouassaid: HESS-based photovoltaic/batteries/supercapacitors: Energy management strategy and DC bus voltage stabilization. "Solar Energy" 2021 nr 216

13 I. Diab, B. Scheurwater, A. Saffirio, G. R. Chandra-Mouli, P. Bauer: Placement and sizing of solar PV and Wind systems in trolleybus grids. "Journal of Cleaner Production" 2022 nr 352

2. Use case

2.1 DPMB Brno

The only owner of the DPMB is the city of Brno. Annual ridership in 2020 exceeded 272 mio. of trips, and decreased by 25% in comparison to 2019[14]. In total, electric traction provided 52% of public transport supply in Brno in 2020. DPMB is planning to develop the trolleybus subsystem, making more use of the advantages of in-motion charging[15].

Figure 1: Skoda Solaris trolleybus in the two-storey trolleybus depot in Brno (Photo by Marcin Wolek)

2.2 DPO Ostrava

Dopravni Podnik Ostravy a.s. is the operator of public transport in Ostrava owned by the city of Ostrava. The supply of DPO amounted to 30.7 mio. of vehicle-kms. In total, electric traction provided 46% of public transport supply in Ostrava in 2020[16] but it will be increased due to expected introduction of the electric battery buses since 2022. Moreover, there is a plan in Ostrava to build hydrogen filling station in the Hranecnik depot.

Figure 2: The trolleybus system in Ostrava services part of the city and has a share of 10% in total public transport supply (Photo by Marcin Wolek)

14 Výroční Zpráva Dopravní Podnik Města Brna, A. S. 2020. Brno 2021
15 https://ceetransport.com/40-sor-trolleybus-kits-to-be-assembled-by-brno-carrier-637/
16 Dopravní Podnik Ostrava, Výroční Zpráva 2020. Ostrava 2021

2.3 MPK Wrocław

Figure 3: MPK Wrocław operates large fleet of tramways (Photo by Marcin Wolek)

MPK Wrocław was established in 1995 and is wholly owned by the city of Wrocław (640,000 inhabitants). MPK performed 22.2 million vehicle-km in 2019. A tender for the supply of electric buses was awarded in 2022, which will result in the delivery of 11 Mercedes e-Citaro G articulated buses. Hybrid chargers 5x60 kW and 6x60 kW will be installed at the depot in Obornicka Street, as well as one high-power charger on the loop (400 kW).

2.4 MZA Warszawa

MZA is the most significant public transport operator in Poland, employing approx. 4500 employees. MZA vehicles performed about 89 million vehicle-km in 2019 with 1422 vehicles at their disposal, including 160 electric buses. This puts Warsaw in the position of electromobility leader in Poland, with the share of the electric fleet at the level of 11%.

Figure 4: MZA Warszawa operates the largest bus fleet in Poland (Photo by Marcin Wolek)

2.5 PKT Gdynia

PKT Gdynia is the municipal trolleybus operator servicing Gdynia and neighboring city of Sopot. In 2020 trolleybuses executed ca. 5.3 mio. of vehicle-kms and fleet consisted of nearly 100 vehicles. In recent time, two diesel bus lines were replaced by in-motion charging trolleybuses. Moreover, the operator constantly introduces in-motion charging model. In 2019 nearly 10% of the trolleybus vehicle-kms were operated without catenary[17]. This trend is very promising as oil prices are high and unstable.

Figure 5: A trolleybus of PKT Gdynia in in-motion charging operational mode in Gdynia (Photo by Marcin Wolek)

2.6 SZKT Szeged

Figure 6: A converted trolleybus of SZKT in Szeged [Photo by SZKT Szeged]

The trolleybuses and tramways are operated by the Szegedi Közlekedési Kft. (SZKT), which is 100% owned by the Municipality of Szeged. It is one of four Hungarian cities with trams and one of only three that operates trolleybuses. The Szeged public transport planning aims to further expand the existing electrical transport infrastructure to cover as many areas of local public transport as possible. Current diesel buses are to be replaced in the future. The overhead line infrastructure in Szeged has existed since 1979 and has been continuously expanded since then.

17 Wołek M. et. al.: Ensuring sustainable development of urban public transport: A case study of the trolleybus system in Gdynia and Sopot (Poland). "Journal of Cleaner Production" 2021 nr 279

Photo by City of Leipzig

2.7 General features of the depots

General features of the public transport depots are as following:

the depot building is usually big, with high gates that are often opened;

depots have varying levels of technical equipment and additional facilities (i.e., painting facility);

inside the building there is a large space to heat and much light needed;

depots operate virtually non-stop, during the day and night with special requirements for the comfort and safety of employees;

heating systems vary from depot to depot;

the power system must be easy to maintain because of the aforementioned.

The structure of the total energy consumption for the PKT Gdynia (Poland) shows that the depot consumes ca. 9,3% of the total energy being used by the operator (electric, fuels and heating considered). A painting workshop itself has a marginal share in the total energy consumption (Fig. 7).

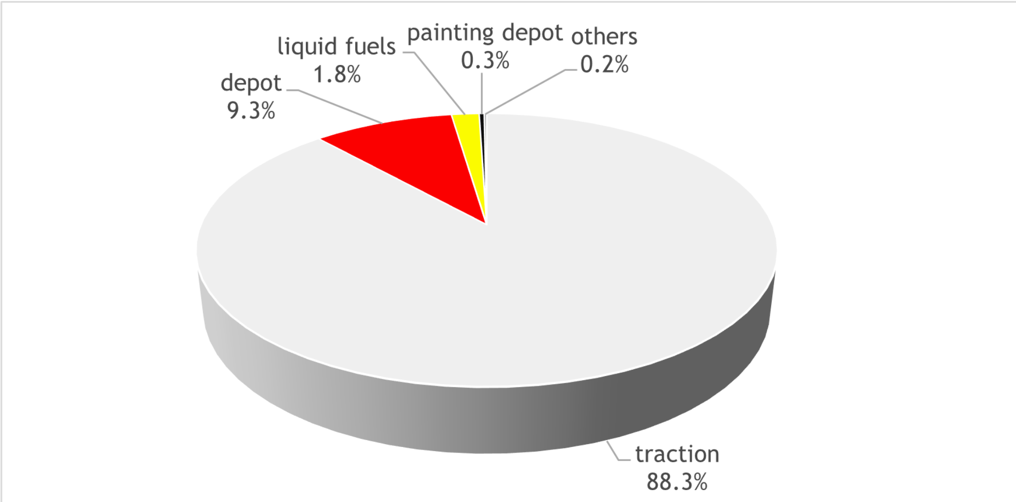

Figure 7: Total energy consumption of PKT Gdynia in 2020

Source: based on the Energy audit for the PKT Gdynia

3. Use cases analysis

A thorough analysis of the selected use cases supported by the interviews conducted with relevant stakeholders enabled the selection of the most common activities leading to increased energy efficiency. In general, all identified activities could be clustered into several common groups (Fig. 8). Charging infrastructure for vehicles located in particular depots was excluded from analysis.

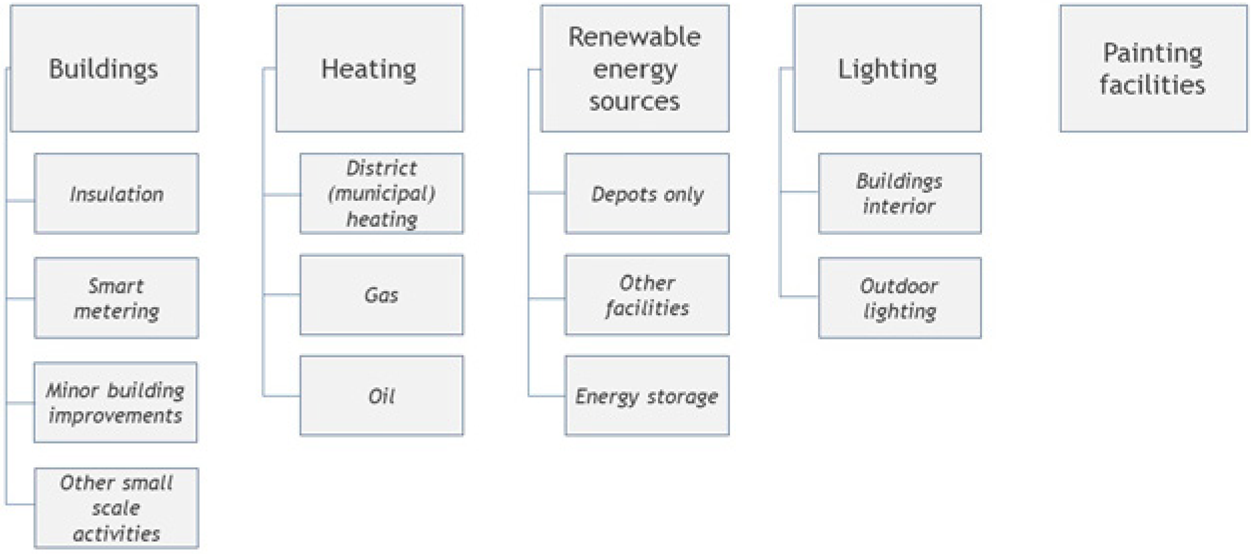

Figure 8: Clustering of the activities for higher energy efficiency for the public transport depots

Photo by Rupprecht Consult

3.1 Buildings

3.1.1 Insulation

Many depot buildings were built in the last century, some even date back to the early 20th century. Therefore there are a variety of technical conditions making each case specific and different. Complex insulation of buildings is quite common activity supported by small scale actions. For example in Ostrava (Czechia) the project of upgrading of the trolleybus depot was based on the recommendation to perform insulation, roof structures, replacement of roof skylights and reconstruction of the lighting system of the interior. The implementation of above measures would save energy for heating compared to the initial state by ca. 37%.

3.1.2 Smart metering

All facilities at the disposal of the DPO Ostrava are metered for the consumption of all utilities (electricity, heat, water). The software of Czech company AYISIS enables real-time monitoring of all utilities at a specific location. There is, for example, the generation of hourly electricity consumption profiles. It allows, among other things, to control the temperature inside the buildings taking into account the weather conditions at a given moment (data is obtained from the company's weather station).

A BMS (Building Management System) was installed in the depot building of PKT Gdynia. The company worked out which utilities should be covered by the system in the first phase. In PKT, heat energy was prioritised and the switchgear and 13 heaters were replaced along with the wiring and control system. The heaters are linked to temperature sensors in each of the three depot zones (inspection, cleaning, maintenance).

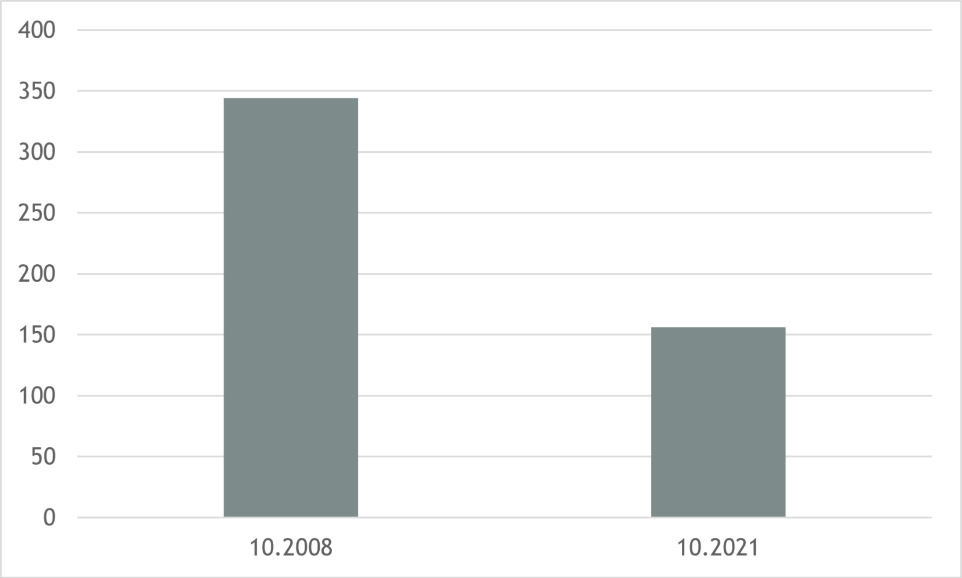

Figure 9: Heat consumption of the trolleybus depot of PKT Gdynia in October 2008 and October 2021 [GJ]

Source: based on the data provided by the PKT Gdynia sp. z o. o.

After installing the BMS, the difference in heat consumption during the winter months was about 200 GJ, which translates into savings of about 12 000 PLN. Heat consumption in October 2008 amounted to 344 GJ and in October 2021 it was substantially decreased to 156 GJ (Fig. 9). The system is supported by the external temperature monitoring.

This also made it possible to reduce the power ordered, resulting in savings of around PLN 18,000 (EUR 3840) per year.

3.1.3 Minor building improvements

The depot building of PKT Gdynia (Poland) was designed with skylights and windows for the catenary, which is a standard solution for tram and trolleybus depots. In the depot there is a control of the thermal centre to make the best use of the building's thermal energy. By replacing the insulation layers on the roof, the thermal insulation of the roof was immediately improved.

Figure 10: Trolleybus depot of PKT Gdynia (Photo by Marcin Wolek)

When the skylights were replaced at the PKT Gdynia depot, their surface area was increased. They now take up 1/3 of the roof area (Fig. 11). The new skylights also have a higher fire resistance standard and higher thermal insulation parameters.

Figure 11: Roof skylights replaced at the depot of PKT Gdynia (Photo by Marcin Wolek)

3.1.4 Other small-scale activities

In the daily service halls, due to the specific nature of their operating regime (including the frequent opening of doors with a large surface area), the installation of air mixing devices (destrifiers) should be considered. The heated air rises upwards on cold days, collecting under the roof, and the temperature perceived by the worker at ground level is therefore lower. To evenly distribute the air temperature in these rooms, air mixing devices are used, whose main task is to keep the air temperature balance under the roof and at the ground of the building. In this way, heating costs can be reduced. Such a solution was successfully implemented in one of the depots of MZA Warszawa (Poland).

Thermal insulation of valves and flange connections to reduce heat losses can also be a low-cost measure with a short payback period. In the case of MPK Wrocław, the estimated outlays for this measured amount to approx. 1 300 PLN, with annual savings of 4 841 kWh. This gives a return after less than two years.

DPMB Brno (Czechia) has implemented ISO 50001, an international energy management standard. The standard provisions are intended to improve the energy efficiency of enterprises regardless of their size, industry, or number of employees. DPMB does not need to conduct an energy audit by implementing this standard. Other benefits include inter alia identifying and managing risks associated with future energy supply, measuring and monitoring energy use to identify areas for efficiency improvements, and demonstrating environmental care to meet tender requirements.

3.2 Heating

Three MZA Warsaw depots are connected to district heating (Veolia). One depot is powered by gas fuel. MZA has a new paint depot, completed a few years ago, equipped with a double ventilation system and dust extraction. Both paint shops are integrated with the depot energy system.

All MPK Wrocław depots are connected to district heating. The installation of heat pumps was not foreseen soon because the buildings were constructed at different times, and there is no justification for reconstructing them to install heat pumps potentially.

In case of SZKT, the company's buildings are a rather mixed picture. There are buildings that are 100 years old, barely maintained and no longer up to current standards, as well as modern new buildings that meet the latest architectural and energy requirements. Most of the buildings are designed for their intended purpose, i.e. large hall-type workshops, small compact station buildings and service buildings, heated and unheated buildings, as well as air-conditioned buildings.

Therefore the heating of buildings is also quite varied. Most of the plant halls have radiant or thermoventilator heating. In the larger buildings, hot water central heating is used, partly with condensing boilers. In the older and more dilapidated small buildings, individual gas convector heating is used, but there are also rooms with electric heaters. Domestic hot water supply is centralised in the tram and trolleybus depot areas, with adequate storage capacity, while in the other buildings there are mostly instantaneous electric hot water generators[18].

3.3 Renewable energy sources

Warszawa (Poland) was the first in Poland to equip buses with photovoltaic panels on the roofs on a large scale. They allow improving the energy balance of vehicles and saving fuel up to five percent. In addition, the installation of a solar power plant on the roof of the "Woronicza" depot has allowed meeting the needs of the ordinary operation of the plant. Energy efficiency is also increased by replacing several hundred lamp posts mounted on the depots with energy-saving LEDs.

Photovoltaic panels with a power of approx. 65 kW were installed on the daily service hall of MZA Warszawa at Włościańska 52 Street. This required the fulfilment of several obligations. After the introduction of electric buses, electricity consumption on the base has increased so much that de facto, there is no sale of energy to the outside. Another PV installation includes depot at Woronicza Str. (74 kW).

On two bus depots (tram depot in Powstańców Śląskich Street and bus depot in Obornicka Street) belonging to MPK Wrocław, photovoltaic installations of approx. 50 kW each was installed in recent years. Thanks to this, one of the halls in which, among others, buses are washed and repaired, will be largely self-sufficient. The solar installation on its roof will cover half of the hall demand, which will allow to save 30 thousand PLN annually. The investment cost was PLN 212 000 net (EUR 45 211). MPK estimates that the money will pay off in energy within 8 years.

Further development of photovoltaics is planned on all roofs of buildings belonging to MPK Wrocław sp. z o.o. Currently, another photovoltaic installation with 50 kW is being built in the depot on

18 Energy audit for the SZKT, Szeged 2019

Obornicka street (Fig. 12).

Since MPK Wrocław does not have covered parking areas, the photovoltaic energy from installations on the operator's premises will not be significant for traction purposes.

A longer rate of return period was obtained in calculations for a photovoltaic farm for one of the depots of SZKT Szeged (Hungary) with a planned capacity of 150 kW. The annual electricity production was estimated at 174,000 kWh. Without external co-financing, the payback period was 12.7 years, with 30% co-financing of the investment costs - just under 9 years. An increase in energy prices due to war and instability makes the expected rate of return shorter.

Figure 12: The PV installation on the top of the roof of tram depot of MPK Wrocław (Photo by Marcin Wolek)

There is a PV farm at one of the trolleybus depots located in the central part of Brno, but the lessee (i.e., the city) only charges a fee for the use of the infrastructure for the farm.

PKT Gdynia (Poland) plans to develop a photovoltaic farm (ca. 500 kW) on the top of the roof of its depot (ca. 5000 m2), which would cover up to 5% of the energy consumed by trolleybuses. Adding a storage energy system would increase the share. Using high-efficiency monocrystalline photovoltaic panels, the maximum output of the installation was determined to be 499.8 kWp. Based on detailed data obtained from a photovoltaic installation with similar parameters, PKT Sp. z o. o. made calculations of the solar energy yield. The estimated annual yield was: 431 391 kWh/year[19].

19 Energy audit of the PKT Gdynia, PKT Gdynia September 2021

Assuming that the photovoltaic installation will be connected to the Grabówek substation, it will be able to cover its annual energy demand in more than 22.5%, although there will be a very strong monthly variation (Fig. 13). The average annual primary energy saving will be 431.39 MWh i.e., 37.09 toe/year. It would therefore be possible to cover the entire electricity consumption of the depot (406.7 MWh). Additionally, there is a possibility to install panels on other facilities belonging to PKT Gdynia, which could translate into the production of an additional 99.5 MWh[20].

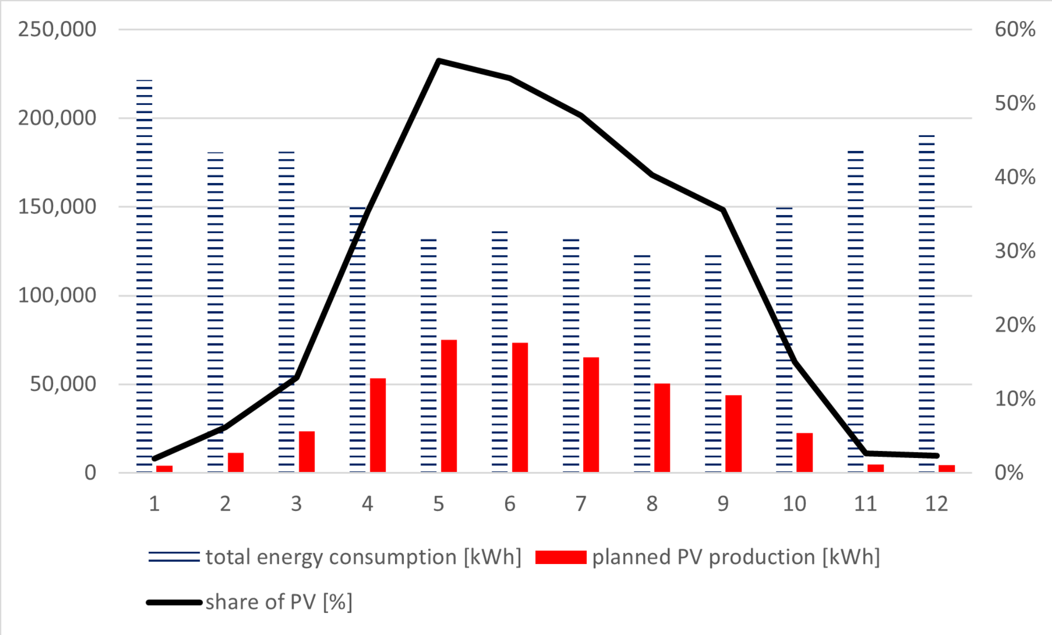

Figure 13: Monthly energy consumption and planned energy from the PV for the substation of Grabówek, PKT Gdynia (Poland)

Source: based on Energy audit of the PKT Gdynia, September 2021

3.4 Lighting

The modern LED lamps not only need less energy, their estimated lifespan is much longer than an incandescent light bulb or even a fluorescent lamp (Fig. 14).

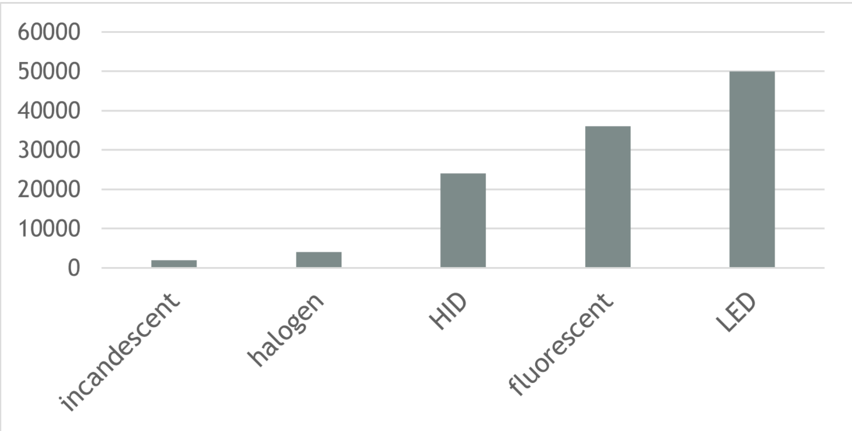

Figure 14: Typical average rated life for various types of bulbs [hours]

20 Energy audit of the PKT Gdynia, PKT Gdynia September 2021

Comprehensive luminaire replacement brings a rapid return on investment. They can be implemented separately or as part of a building modernisation and insulation project.

Figure 15: Lighting of the square in front of the hall in MPK Wrocław sp. o. o.

The costs incurred for the modernisation of lighting amounted to 314 000 PLN. The annual savings on electricity amounted to 258 939 kWh, resulting in savings of 112 000 PLN and reduction of 186 tonnes of CO2 emissions. In this case, the return on investment will be achieved after less than 3 years[21]. The lighting modernisation was also implemented outdoors (Fig. 15).

The energy audit of SZKT Szeged (Hungary) contains similar conclusions. With the investment of replacing the lighting with LED (HUF 5.12 Mio = EUR 13 600), the payback period will be less than 3 years[22].

3.5 Paint shop

In PKT Gdynia sp. z o.o. the paint shop uses fuel oil because of the need for temporary high thermal energy. District heating was abandoned in favor of liquid fuel, because of the high cost of the power ordered from the heat distributor. Annual consumption of the fuel equals to ca. 3 440 litres of oil[23].

MZA Warszawa has a new paint shop, completed a few years ago, equipped with a double ventilation system and dust extraction. Both paint shops are integrated with the depot energy system.

21 Energy Audit for the MPK Wrocław sp. z o.o. Attachement 2: Buildings. Audytel, Wrocław 2021, p. 89 and next
22 Energy audit for the SZKT, Szeged 2019
23 Energy audit of the PKT Gdynia, PKT Gdynia September 2021

4. Conclusions

Although most electricity is used for traction, depots also consume electric and thermal energy. Optimising energy use at the depot is integral to improving public transport companies' energy and economic efficiency.

Depots in public transport companies present a very diverse picture. They differ in the year of construction, the means of transport operated, and the extent of modernisation and equipment carried out. All of this affects energy consumption and other utilities (e.g., water).

The review of selected examples indicates certain regularities in the search by operators for ways to improve the energy efficiency of facilities.

Among the basic investment activities, a modernisation of buildings to improve their thermal parameters is very often. Building metering often accompanies such measures. It can be complete and cover all utilities (energy, heat, and water) or be implemented gradually and target the highest cost generating utilities. The scope of technical modernisation of the building may also include activities with low impact but improving the comfort of work in the vehicle service hall and, at the same time, improving fire safety (e.g., replacement and enlargement of roof skylights).

A good course of action is the installation of PV on the roofs of depots. The electricity generated in this way is usually used for the depot's own needs. The installation of electricity storage devices should accompany the installation of photovoltaic panels.

As part of a larger whole, low-cost measures play an essential role. Although it does not result in significant savings for the entire company, investment in retrofitting lighting has a short payback period. It can be implemented gradually, even without essential investment resources.

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