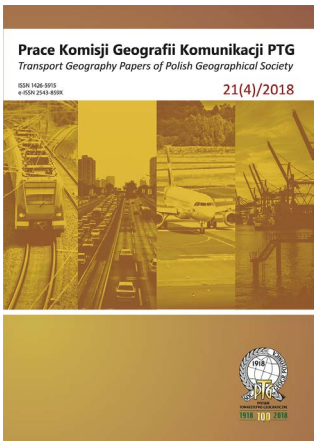

Transport Geography Papers of Polish Geographical Society

2018, 21(4), 44-59

DOI 10.4467/2543859XPKG.18.023.10781

Received: 30.09.2018
Received in revised form: 14.12.2018
Accepted: 15.12.2018
Published: 31.12.2018

TRENDS IN THE DEVELOPMENT OF TROLLEYBUS TRANSPORT IN POLAND AT THE END OF THE SECOND DECADE OF THE 21ST CENTURY

Trendy rozwojowe transportu trolejbusowego w Polsce pod koniec drugiej dekady XXI wieku

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Citation:
Połom M., 2018, Trends in the development of trolleybus transport in Poland at the end of the second decade of the 21st century, *Prace Komisji Geografii Komunikacji PTG,* 21(4), 44–59.

Abstract: Trolleybus transport played a changing role in Poland. Historically, these were both periods of dynamic development and rapid regression. The article analyzes the period from 2004 to 2018. An attempt was made to systematize and organize information on the development of trolleybus transport in this period. The available scientific literature as well as the economic, organizational and technological conditions for the functioning of trolleybus transport were analyzed. The analyzed period was undoubtedly a time of dynamic development of all three existing trolleybus systems in Poland. The structural funds of the European Union played a significant role in this, allowing to revitalize neglected and underinvested systems. At the same time, climate change has influenced global and local conditions in terms of the approach to transport in cities. Trolleybuses perfectly respond to the demands to reduce emissions from transport in cities. Also thanks to the development of battery technologies, trolleybuses have become more flexible in operation. The article compares the years 2004 and 2018, additionally illustrating the changes taking place on the maps.

Key words: trolleybus transport, electrobility, sustainable transport, urban transport development

1. Introduction

In the last decade, trolleybus transport has undergone a significant transformation and, at the same time, a major change in its perception. Some urban transport researchers believed that there was no future for trolleybuses, because vehicles dependent on the overhead catenary were inflexible in terms of movement and costly to maintain. Two factors helped trolleybuses losing economic calculations. The first one concerns the dynamic development of battery technology, in particular increasing their capacity, while reducing the size and, above all, weight. The second factor is related to the introduction of increasingly restrictive policies in the field of climate protection. Negative climate change in the last decade has accelerated, and with it the European Union and other developed countries are tightening transport policies by favoring zero-emission vehicles (Połom, 2015b; Rasiński, 2018).

In Poland, trolleybus transport enjoyed variable popularity. After World War II, it allowed to rebuild passenger transport in many cities. Then it was displaced by diesel buses, which began to be produced domestically. During this period, trolleybuses were imported, first from France and then from Germany and Czechoslovakia. In the 1970s and 1980s, attention was paid to trolleybuses again due to the liquid fuel crisis. At that time, it was planned to create many new trolleybus systems, but the implementation of these plans was opposed by the general economic crisis in Poland. The political transformation at the turn of the 1980s and 1990s brought many changes also in transport. Public transport shifted from central financing to local governments, which contributed to the regression of expensive electric transport systems, i.e. trams and trolleybuses. During this period, trolleybuses in Dębica (1992), Warsaw (1995) and Słupsk (1999) were abolished. The remaining three trolleybus networks (Gdynia with Sopot, Lublin and Tychy) survived the difficult period and although decommissioning was considered in all three cases, the plan was not implemented for various reasons (Połom, 2015b).

The beginning of the 21st century is a completely different reality. Poland's accession to the European Union made it possible first to use pre-accession funds, and then structural funds, and slowly rebuild underinvested trolleybus systems, and then modernize and develop them. Since 2004, trolleybus networks in Gdynia with Sopot, Lublin and Tychy have undergone a huge transformation, becoming even exemplary in Europe. Many model solutions were developed in these three trolleybus networks, which were then used by other European cities.

The article is both organizing and comparative. It presents all the most important activities undertaken in the field of trolleybus transport in Poland in the period 2004-2018. In the second part of the study, the condition of trolleybus transport in three cities for 2004 and 2018 was compared. The research assumption of the article was to verify the claim that trolleybus transport in Poland has survived and is developing thanks to the aid of the European Union, and the achievements in the field of technological solutions are a model that they use other carriers and local governments in Europe.

The study used literature sources and statistics published by the Economic Chamber of Public Transport (Izba Gospodarcza Komunikacji Miejskiej - IGKM), as well as unpublished materials of trolleybus companies and transport authorities from Gdynia, Lublin and Tychy. Based on the dispersed sources, original drawings were prepared, which illustrate the spatial development and infrastructure investments made in the period 2004-2018.

2. Scientific background

In the scientific literature the subject of trolleybus transport is still relatively rare. Despite the fact that trolleybuses perfectly respond to the postulates of transport policies from the local to the national level in terms of reducing the impact of transport on the environment. In recent years, mainly issues related to technical aspects have been addressed. There are no studies comparing trolleybus transport with other means of urban transport and analyzes related to the actual impact of trolleybuses on the state of the environment in cities, taking into account various sources of electricity (e.g. in Poland from fossil fuels). Although urban transport remains an important element of research in the field of transport economics, there are few scientific papers devoted to the economic accounting of trolleybuses, especially in relation to other modes of urban transport. Since the beginning of the 21st century, several dozen works have been written on various aspects of the functioning of trolleybus transport in Poland and in the world, which have been collected and presented in tab. 1.

Tab. 1. Review of the scientific literature on trolleybus transport in Poland and in the world.

Described aspects:		Sources:
Economic efficiency	economic comparison with other means of public transport	Bartłomiejczyk et al., 2012; Klucininkas, Matulevicius, 2009; Kühne, 2010, Połom, 2015b; Wołek, Wyszomirski, 2013
	economic efficiency of trolleybus transport	Bartłomiejczyk, Mirchevski, 2014; Grzelec, Wyszomirski, 2010; Falvo, 2012; Hebel, 2014; Jagiełło, 2016; Jagiełło, Gałka, 2016; Jagiełło, Wołek, 2017; Kliucininkas, Matulevicius, Martuzevicius, 2012; Połom, 2015b; Tica et al., 2011; Wołek, Wyszomirski, 2013
	vehicle market	Kołoś, Taczanowski, 2018; Połom, Turżański, 2011; Połom, 2015a; Połom, 2015b; Połom, Turżański, Bartłomiejczyk, 2015; Połom, 2016;
Technological aspects	alternative power sources	Bartłomiejczyk, Połom, 2011; Bartłomiejczyk, Połom, 2013; Połom, Bartłomiejczyk, 2011; Połom, 2015b; Wołek, Wyszomirski, 2013; Zalewska, 2017.
	catenary and power system	Bartłomiejczyk, Połom, Staroński, 2013; Bartłomiejczyk, 2016; Bartłomiejczyk, Mirchevski, 2014; Hamacek et. al. 2014; Sopov, Biryukov, Vorfolomeyev, 2006;
	depot and workshops	Jarzmik, 2008; Połom, 2015b;
	vehicles	Bartłomiejczyk et al., 2012; Bartłomiejczyk, 2016; Bartłomiejczyk, Mirchevski, 2014; Borowik, Cywiński, 2016; Brazis, Latkovskis, Grigans, 2010; Dyr, 2013; Gładysz et al., 2016; Hamacek et. al. 2014, Molecki, 2018; Połom, Bartłomiejczyk, 2012; Połom, Bartłomiejczyk, 2015; Połom, 2015b; Wołek, Wyszomirski, 2013
Transport policies	comparison of operation with other means of public transport	Costa, Fernandes, 2012; Falvo, 2012; Klucininkas, Matulevicius, 2009; Połom, 2015b; Tica et al., 2011;
	impact on the environment	Klucininkas, Matulevicius, 2009; Połom, 2015b; Rasiński, 2018; Tica et al., 2011;
	organization of trolleybus transport	Anisiewicz, 2004; Bartłomiejczyk, Połom, 2013; Bartłomiejczyk, Połom, Goliszek, 2016; Bogusławski, 2006; Borowik, Cywiński, 2016; Cywiński, Brud, 2017; Falvo, 2012; Khorovitch, 2004; Molecki, 2011; Molecki, 2018; Molecki, 2013; Połom, 2014; Połom, 2015b; Rulaff, 2013; Tarnawski, Zalewska, 2018; Tica et al., 2011;Tuszyński, 2015; Wołek, 2012; Wołek, 2013; Wołek, Wyszomirski, 2013; Wyszomirski, Hebel, 2013

Source: Own elaboration.

3. Characteristics of the trends in the functioning of trolleybus transport in Europe and in the world in the 21st century

In the 21st century, trolleybuses began to gain popularity again, especially in cities that already had infrastructure. The aforementioned policy of counteracting climate change drew the attention of local governments to the often neglected trolleybus systems, which in many cases were to be ultimately liquidated at the expense of buses. Thanks to the structural measures of the European Union, a significant part of the existing trolleybus systems has been revitalized and several new ones have been put into operation. Changes in the functioning of trolleybus transport in Europe and in the world can be divided according to the impact factors illustrated in tab. 2.

Tab. 2. Factors of changes in the assessment of trolleybus transport.

Group of factors:	Detailed:
Economic	- development of the market of trolleybus producers (increased competitiveness), - subsidies for the purchase of low- and zero-emission vehicles, - improving the effectiveness of trolleybus operators (reducing technical departments, e.g. through outsourcing services).
Political	- the impact of climate change on the awarding of low-emission and zero-emission vehicles, - introducing a policy at the level of countries and the European Union regarding the development of electromobility and the complete exclusion of emission vehicles in cities, - use of trolleybus transport to increase ecological awareness (a showcase of the pro-ecological city).
Technological	- changing the drives to more energy-efficient (energy recovery during braking), - development of combustion unit technology (partial independence from the overhead network), - development of battery technology (partial independence from the overhead network and maintaining the advantages of a fully electric vehicle), - development of fully low-floor vehicles, - vehicle size development - bi-articulated trolleybuses, - modernization of solutions in the field of overhead traction not limiting the speed of trolleybuses.

Source: Own elaboration.

4. Spatial changes in trolleybus transport in Poland after 2004

An indispensable element of the development of trolleybus transport systems in Poland after 2004 were spatial changes related to the construction of new traction infrastructure (new parts of the traction network) and the launch of new connections. Creating new connections in trolleybus transport was associated with the use of the newly built catenary, but also thanks to alternative power sources installed in trolleybuses.

In fig. 1-2 illustrates the changes taking place in 2004-2018 in Gdynia. The main infrastructure investments include new sections of the catenary in the south-western part of the city, serving the districts of Dąbrowa and Dąbrówka, as well as two short branches, the first from the main cross-city artery (Morska Street) to the Fast Urban Rail (PKP SKM) stop in the Grabówek district, and the second in as a street loop (ul. 3 Maja). The remaining new sections were serviced by trolleybuses equipped with batteries. The new routes made it possible to service parts of Gdynia and Sopot that had not been serviced by trolleybuses so far. These were, in particular, connections to the Fikakowo estate in the Wielki Kack district, to Kościuszko Square and the Southern Pier (Molo Południowe) in the city center, as well as to the border of Sopot and Gdańsk at the Ergo Arena sports hall (Jagiełło, Gałka, 2017). In the following years, along with the deliveries of the ordered trolleybuses, new connections will be launched, in 2019 a new line 34 will be opened to the Demptowo district. The route of line 27 will also be modified to serve the office center at Łużycka str. and sports facilities at Sportowa str. using power from batteries. It is also planned to partially service the bus line 181, connecting Gdynia and Sopot via Karwiny by trolleybuses. In 2020, the launch of another new trolleybus line 32 is planned, which will replace the 170 bus line serving the northern part of the city (Połom, 2015b).

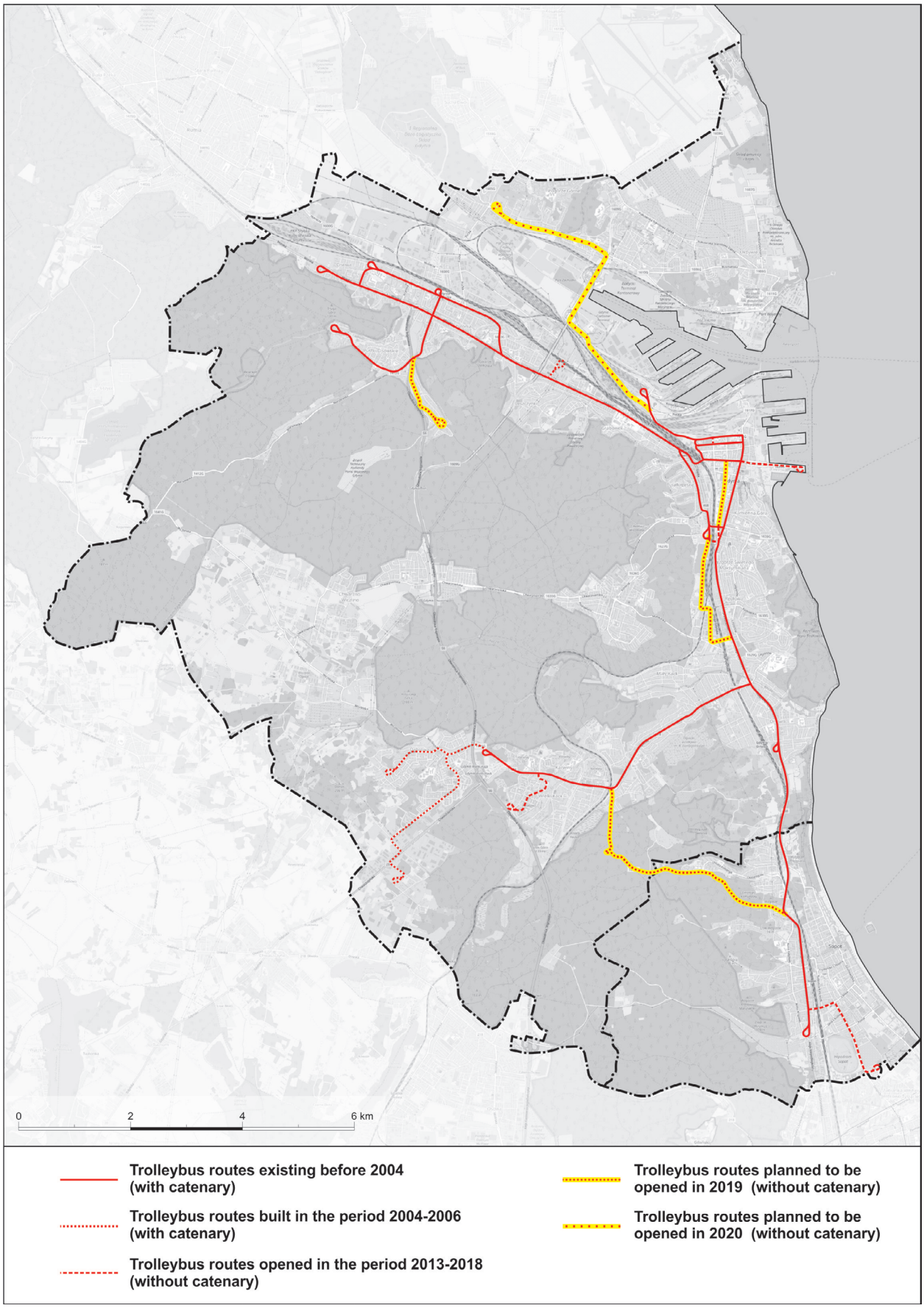


Fig. 1. Spatial development of trolleybus routes in Gdynia and Sopot.

Source: Own elaboration.

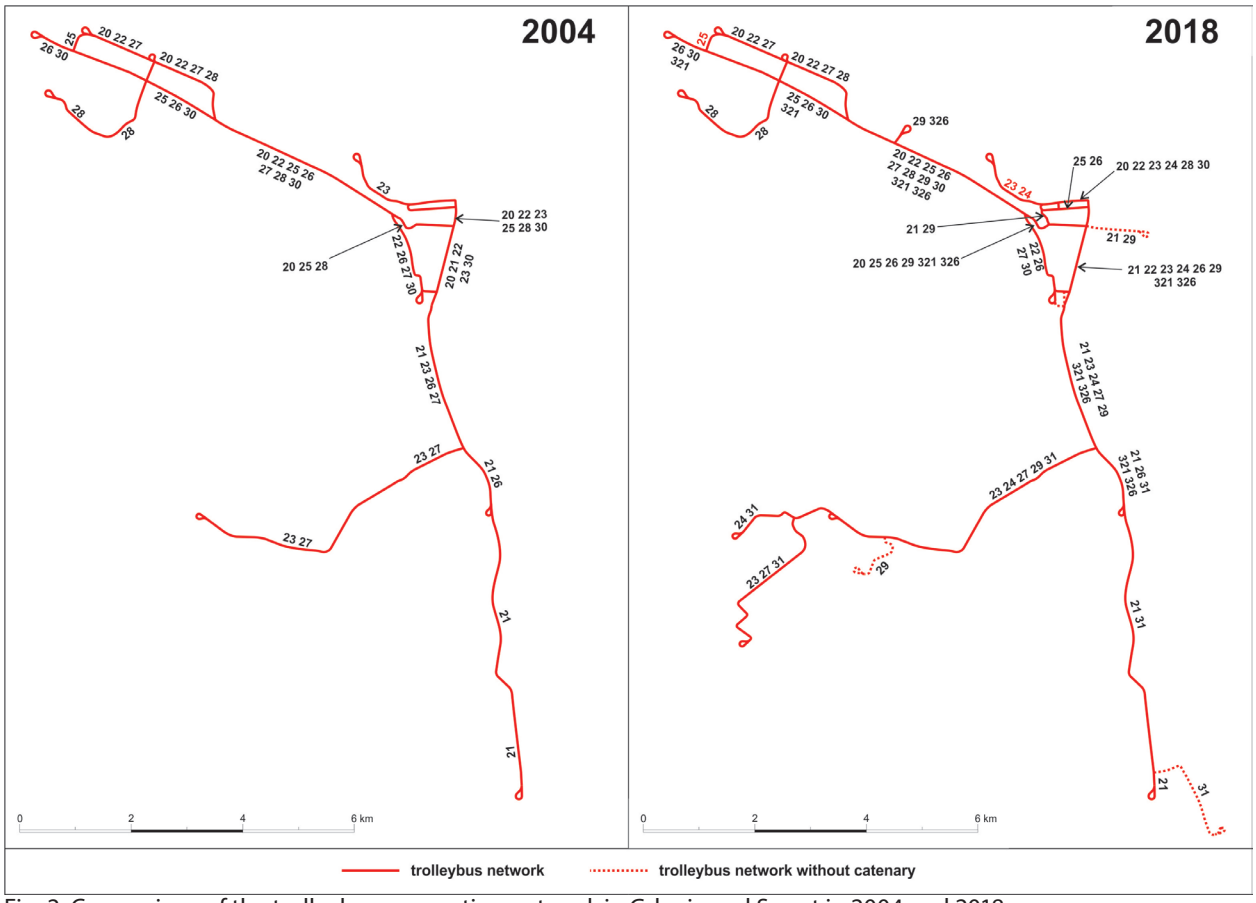


Fig. 2. Comparison of the trolleybus connection network in Gdynia and Sopot in 2004 and 2018.

Source: Own elaboration.

In fig. 3-4 presents changes in the network of trolleybus connections and presents the new traction infrastructure in Lublin. The years 2004-2018 abounded in numerous investments co-financed from European Union funds. The traction network has doubled. There were new routes that led to the Czuby district. The number of routes towards Węglin and to Czechów was developed. Connections with Abramowice and Majdanek were extended. The routes in Śródmieście were also compacted. Figure 4 illustrates a significant increase in trolleybus lines in Lublin between 2004 and 2018. In 2004, there were eight trolleybus lines (150-153, 155-156, 158, 160). Over the following years, three more were launched (154, 157, 159). Two bus lines were also electrified. The route number 10 was changed to 160, and the bus route number 19 began to be serviced by trolleybuses without renumbering. On some routes, alternative power sources installed in vehicles (power generators and batteries) were used. At the end of the analyzed period, other trolleybus routes were also under construction (Połom, 2015b; Tarnawski, Zalewska, 2018).

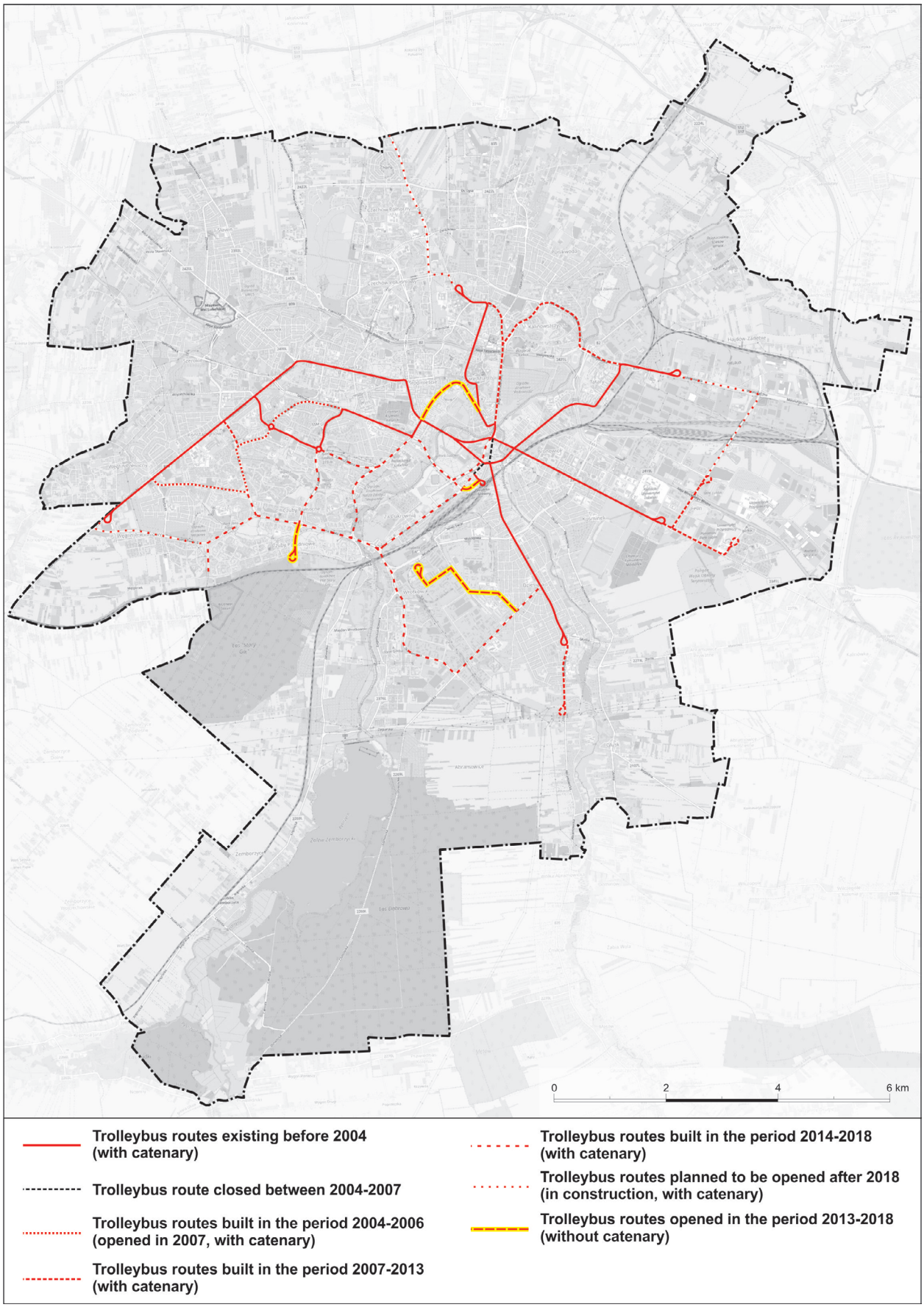


Fig. 3. Spatial development of trolleybus routes in Lublin.

Source: Own elaboration.

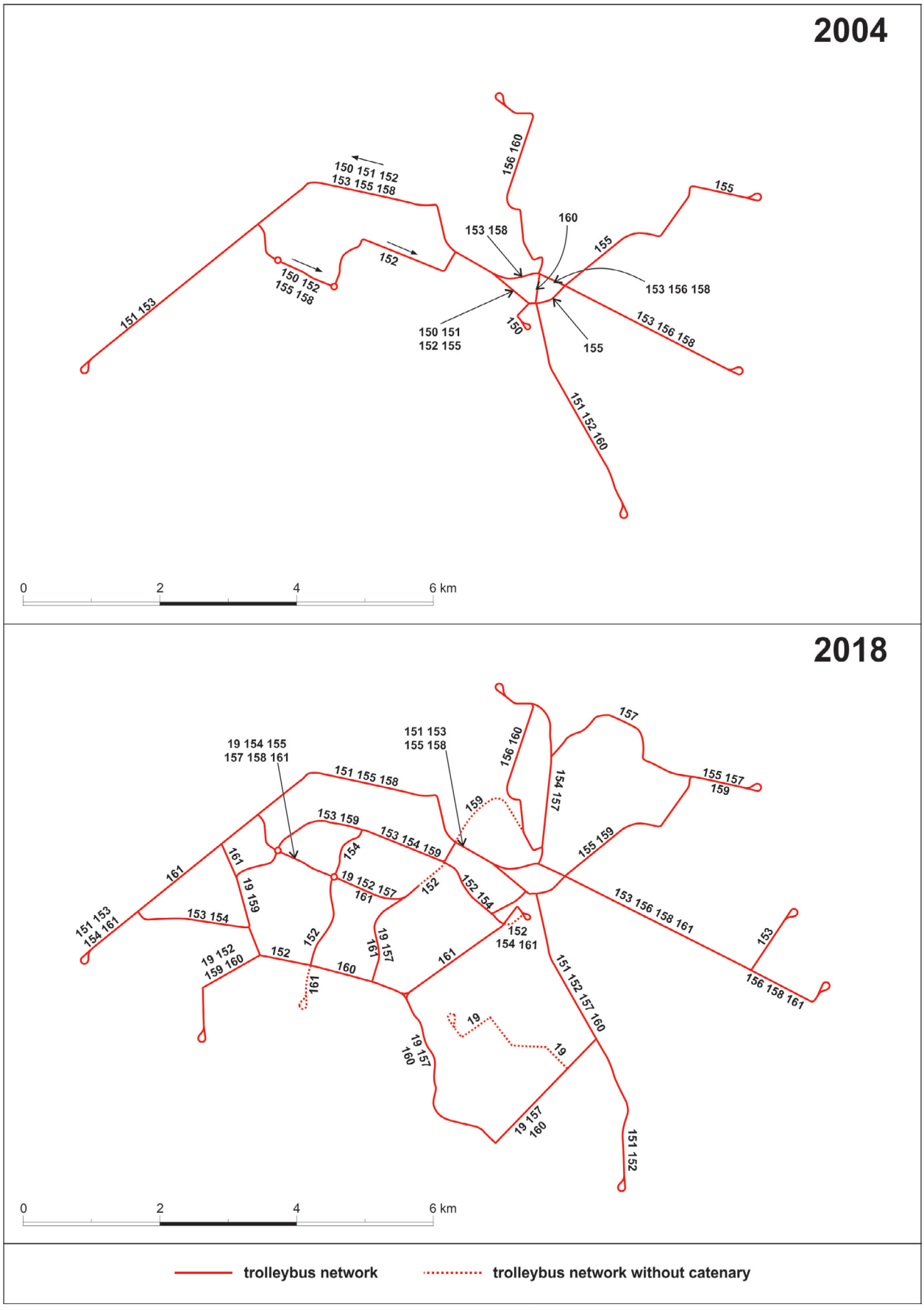


Fig. 4. Comparison of the trolleybus connection network in Lublin in 2004 and 2018.

Source: Own elaboration.

As in the case of the two previous trolleybus systems, also in Tychy, in the period 2004-2018 there were spatial changes. However, they mainly concerned connections. During this period, no new infrastructure was built in Tychy. At the end of 2018, i.e. the analyzed period, the only new route was under construction. It was a connection constituting an extension from the loop in the Paprocany district towards the south to the Z and Z1 estates. In the analyzed period, the number of trolleybus lines marked with letters increased to six. The only new line marked as F ran from the Paprocany district to the center, which it circled in the form of a street loop. The remaining A-E lines ran on different routes connecting the railway station. In 2019, a new trolleybus line is planned to be launched, partly using battery power (Borowik, Cywiński, 2017; Cywiński, Brud, 2017; Dyr, 2013; Połom, 2015).

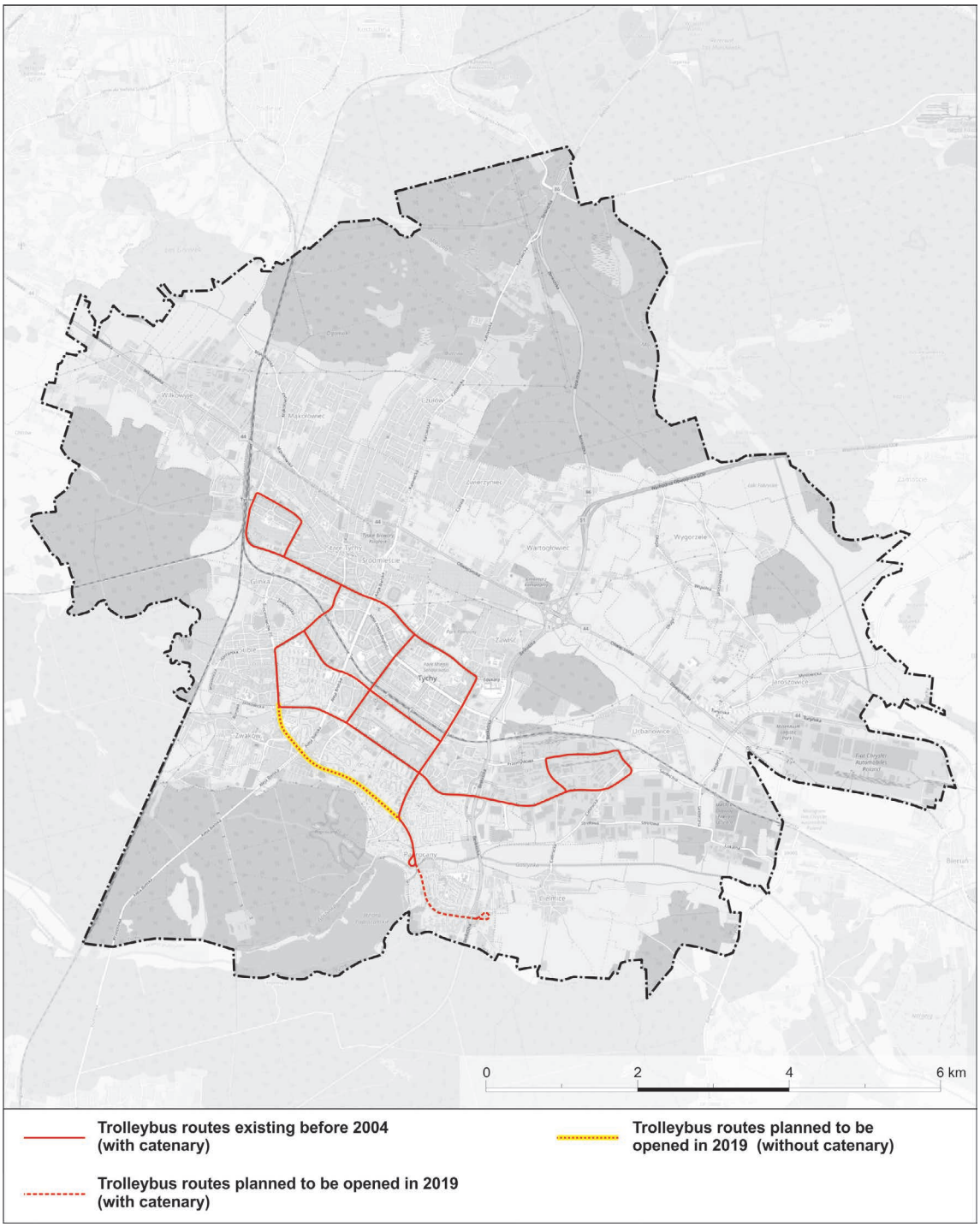


Fig. 5. Spatial development of routes operated by trolleybuses in Tychy.

Source: Own elaboration.

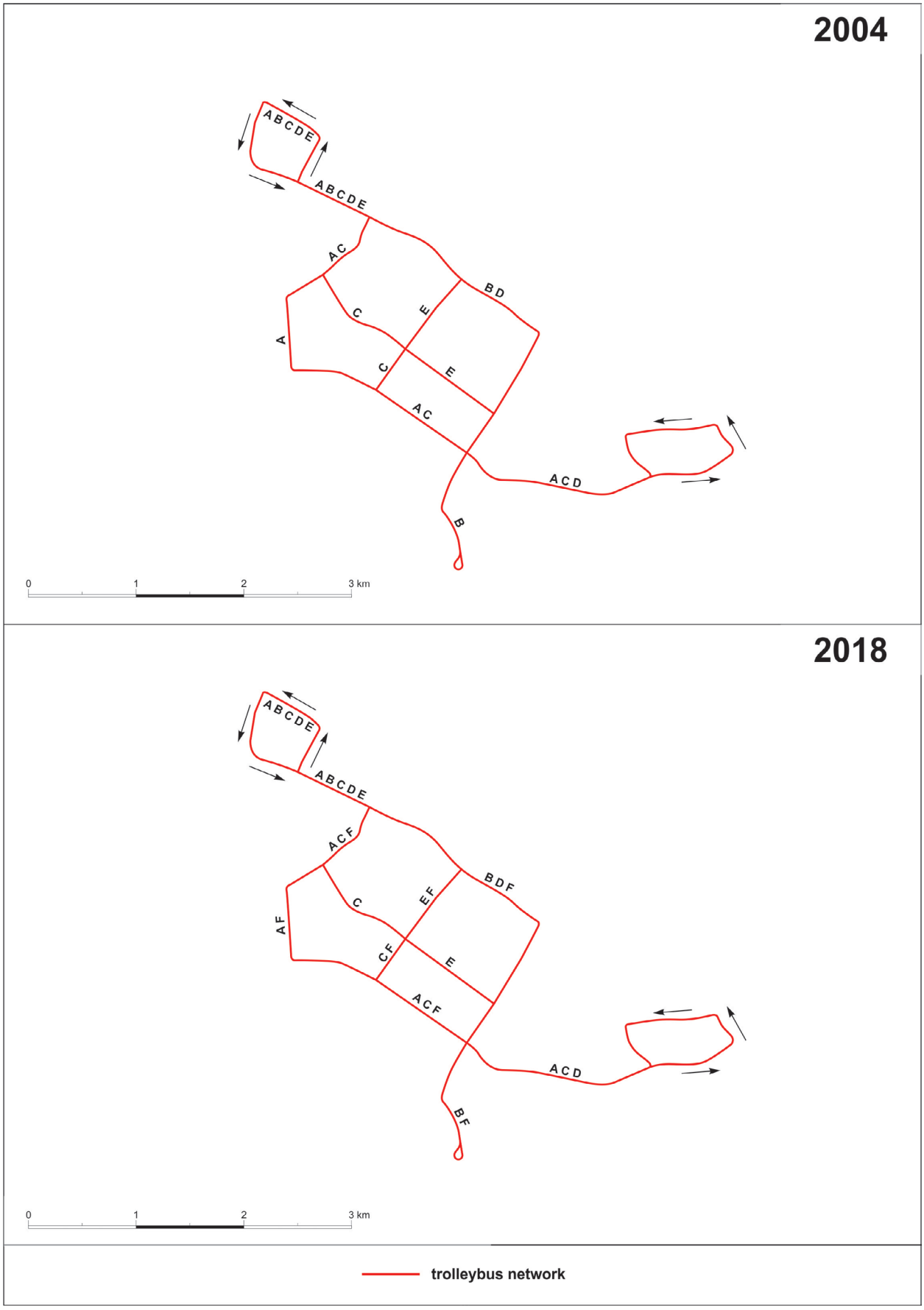


Fig. 6. Comparison of the trolleybus connection network in Tychy in 2004 and 2018.

Source: Own elaboration.

5. The phenomenon of diffusion of innovation in Polish trolleybus transport systems

In recent years, trolleybus transport has undergone a number of changes in all three existing systems in Poland. Particularly noteworthy is the phenomenon of diffusion of technological innovations, which significantly influenced the contemporary image of trolleybuses. The model examples include the conversion of buses with diesel engines purchased from the secondary market in Gdynia. At the beginning of the 21st century, the market of producers of new low-floor trolleybuses in Europe was very hermetic, and the costs of vehicles significantly exceeded the investment possibilities of Polish carriers. Moreover, the reconstruction needs of the trolleybus fleet parks were significant. In 2003, i.e. a year before the analysis undertaken in this article, the disproportion between the quality of trolleybus and bus communication in Gdynia was significant. Therefore, the concept of building trolleybuses based on the bodies of low-floor buses from the secondary market appeared. Such a solution was not a novelty in Gdynia because it was already used, for example, in the 1970s and 1980s, with brand new or worn-out high-floor bodies being built at that time. A similar solution was also used in Lublin. In the years 2004-2014, 36 trolleybuses were built in Gdynia in this way, including 28 trolleybuses based on Mercedes Benz O405N bodies, 2 using Mercedes Benz O530 and 3 Solaris Urbino 12 bodies. Until the end of 2018, a dozen of the youngest of them remained in service although the converted vehicles had an estimated life expectancy of seven years (Bartłomiejczyk et al., 2012, Połom, Bartłomiejczyk, 2015). Based on the same idea, a batch of 3 vehicles was made in Tychy in 2006-2008, but with the use of brand new Solaris bodies. In the same period, in Lublin, using a similar idea, a batch of 3 high-floor vehicles was made, then 3 Solaris trolleybuses, 1 trolleybus based on the MAZ body and another 3 Jelcz low-entry trolleybuses. The appearance of a significant number of low-floor vehicles in the trolleybus transport offer influenced the perception of this means of transport.

The second example of innovation in trolleybus transport, which became popular in all three trolleybus networks in Poland, was the introduction of modern solutions in the field of catenary, which would not limit the speed of trolleybuses. The first prototype solution was used in 1998 in Gdynia, where tests of the radio-controlled network switch began. Positive experiences with the operation of this device and then with other network solutions have led to a complete transformation of the perception of trolleybuses as very slow and even slower vehicles on turns and crossings. At the end of the second decade of the 21st century, such solutions became widely used in all three Polish trolleybus systems (Połom, 2015b).

One of the features that influenced the negative perception of trolleybuses was the dependence on the catenary. In the event of congestion, breakdown, road collision, street renovation, etc., trolleybuses had to be replaced by buses. Maintaining an additional reserve in the form of replacement vehicles worsened the economic balance. The solution to this problem was provided by alternative power sources for trolleybuses. Initially, these were diesel combustion units mounted directly on the vehicle. Such a solution began to be used in a batch of 20 Solaris trolleybuses in Lublin. In such a case, however, it is difficult to defend the argument about the lack of emission of trolleybuses at the place of operation and their positive impact on the environment. Another route was sought in Gdynia, where an attempt was made to equip brand new and converted trolleybuses with batteries. At that time, it was still an unpopular alternative to power generators and burdened with a certain level of risk. The first trolleybuses with batteries (in nickel-cadmium technology) appeared in Gdynia in 2010-2011. These were 28 Solaris vehicles purchased as part of a project co-financed by the European Union. The capacity of the batteries at that time made it possible to treat them as an alternative source in the event of a detour, renovation of a section of the route or other unforeseen situations. Good operating experience and constant development of battery technologies, mainly by increasing their capacity while reducing their size, and especially weight, allowed for the development of this idea. Another new trolleybuses in Gdynia were ordered equipped with increasingly larger and more effective battery power sources, and the other carriers from Lublin and Tychy went in the same direction. At the end of 2018, over 60% of trolleybuses operating in Gdynia were equipped with various battery power sources. It is worth noting that Gdynia has become a precursor to the use of battery-powered trolleybuses in constant line traffic, which is currently also happening in other Polish cities (Bartłomiejczyk, Połom, 2011; Połom, 2015).

Similar experiences concerned technical facilities. The first new trolleybus depot was built in Gdynia. It was put into operation in 2007. Based on the Gdynia experience, including the negative ones, a new trolleybus depot in Lublin was designed and built in 2015 (Bartłomiejczyk, Połom, 2013; Bartłomiejczyk, Goliszek, Połom, 2016).

6. Development of trolleybus production in Poland

The development of trolleybus transport in the first and second decade of the 21st century was also associated with the functioning of a large and significant producer of trolleybuses on the domestic market. From the beginning of the 20th century, the production of trolleybuses in various configurations and with the participation of various partners was developed by the Solaris Bus & Coach company from Bolechowo. In the years 2000-2018, it produced a total of 1,210 trolleybuses for various recipients, mainly foreign, in particular in Bulgaria, the Czech Republic, Latvia and Germany. The first trolleybuses of this brand were produced in 2000-2001 and delivered to Gdynia and Riga. In the following years, the Solaris brand was developed and trolleybuses of various sizes (12, 15 and 18 meters) were produced and in cooperation with various suppliers of drives and components. Figure 7 shows the connections of the Polish manufacturer with propulsion manufacturers, which shows that they were four out of the seven main companies in the passenger electric transport industry. The next illustration shows the chronological relations between Solaris and the propulsion suppliers (fig. 8).

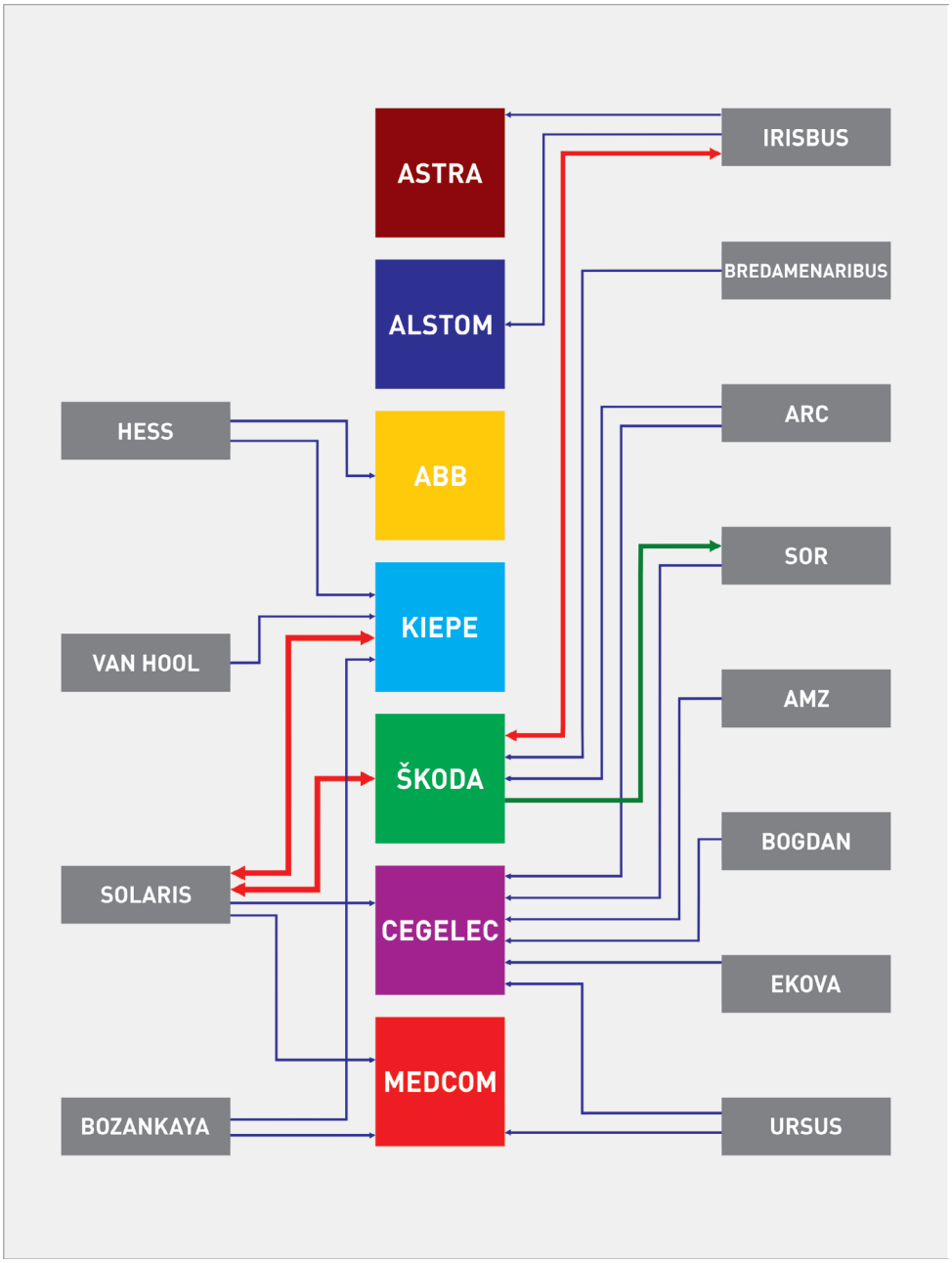
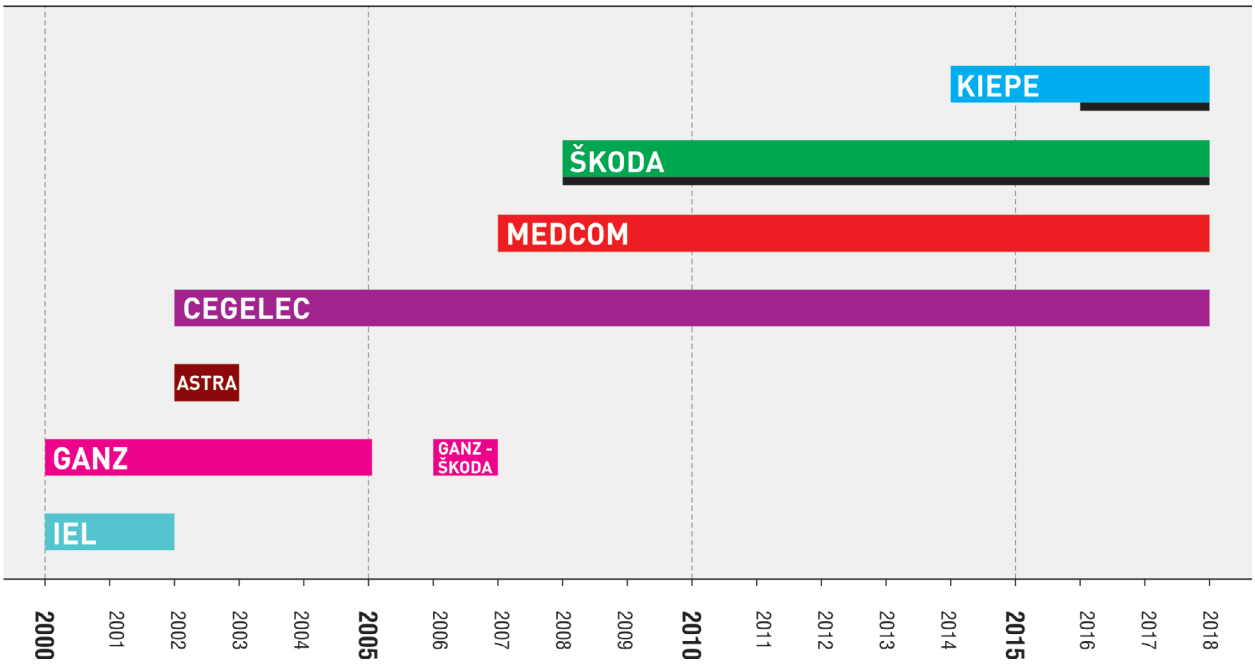


Fig. 7. Connections between trolleybus producers and producers of trolleybus drives (in the middle of the diagram).

Source: Own elaboration.



IEL – Institute of Electrical Engineering, Poland; GANZ/Ganz-Škoda, Hungary; Astra, Romania; Cegelec, Czechia; Medcom, Škoda Czechia; Kiepe, Germany. Black line – time when the trolleybuses were purchased as final product of that company too, not as Solaris.

Fig. 8. Chronology of cooperation between Solaris and suppliers of trolleybus drives.

Source: Own elaboration.

In the years 2004-2018, new Solaris trolleybuses were purchased in all three Polish trolleybus systems, and a local supplier, the Ursus company, also appeared in Lublin. Initially, in cooperation with the Ukrainian producer of buses and trolleybuses, Bogdan Motors, 38 low-floor trolleybuses with a length of 12 meters were delivered to Lublin and equipped with batteries allowing for go up to 10 km without power supply from the catenary. Then Ursus started producing vehicles based on its own bodies (previously developed by another Polish company AMZ from Kutno). This type of articulated trolleybuses were also delivered to Lublin in the following years. In 2019, Ursus, due to financial problems, completely ceased the production of buses and trolleybuses, thus failing to complete the last order from Lublin for 10 trolleybuses with a length of 12 meters. Tables 3 and 4 show purchases of trolleybuses in 2004-2018 in Poland (Połom, Turżański, 2011; Połom, Turżański, Bartłomiejczyk, 2015; Połom, 2015a; Połom, 2016).

Tab. 3. Number of trolleybuses delivered to Polish cities in 2004-2018.

City/year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	sum:
Gdynia	3	8	14	6	6	6	17	10	7	3	2		4		18	104
Lublin		3				5		18	15	25	24	21			15	126
Tychy	1	1	2		1				1	14					2	22
sum:	4	12	16	6	7	11	17	28	23	42	26	21	4		35	252

Source: Own elaboration.

Tab. 4. Trolleybuses put into operation in 2004-2018 in Polish cities, broken down by type.

City (sum)	Brand	Number (pcs.)	Years of production	Optional accessories
Gdynia	Solaris Trollino 12AC	15	2004-2008	
	Mercedes Benz O405NE	22	2004-2009	reclaimed drive, vehicle converted from buses
	Mercedes Benz O405NI	1	2008	impulse drive, vehicle converted from the bus
	Mercedes Benz O405NAC	5	2009-2010	low capacity nickel-cadmium batteries, asynchronous drive, vehicle converted from buses
	Mercedes Benz O530AC	2	2012	low capacity nickel-cadmium batteries, asynchronous drive, vehicle converted from buses
	Solaris Urbino 12AC	3	2012-2013	low capacity nickel-cadmium batteries, asynchronous drive, vehicle converted from buses
	Solaris Trollino 12M	38	2009-2016	nickel-cadmium batteries
	Solaris Trollino 12M (IV gen.)	13	2018	lithium-ion batteries
	Solaris Trollino 18M (IV gen.)	5	2018	lithium-ion batteries
Lublin	Jelcz 120MT	3	2005	vehicles built on the basis of new bodies
	Solaris Trollino 12M	3	2009	vehicles built on the basis of new bodies
	Solaris Trollino 12AC	1	2009	
	MAZ 203T	1	2009	vehicles built on the basis of new bodies
	Jelcz 121ME	3	2011	vehicles built on the basis of new bodies
	Solaris Trollino 12S	30	2011-2012	
	Solaris Trollino 12M	20	2013	additional diesel drive
	Ursus T70116	38	2013-2015	lithium-ion batteries
	Solaris Trollino 18M	12	2014	lithium-ion batteries
	Ursus CS18LFT	15	2018	lithium-ion batteries
Tychy	Solaris Trollino 12 AC	2	2004-2005	
	Solaris Trollino 12DCR	3	2006-2008	vehicles built on the basis of new bodies
	Solaris Trollino 12M	15	2012-2013	nickel-cadmium batteries
	Solaris Trollino 12M (IV gen.)	2	2018	lithium-ion batteries

Source: Own elaboration.

The analysis shows that in the years 2004-2018, 252 trolleybuses were delivered to Polish cities, including 219 brand new and previously not operated. The largest number of new trolleybuses was purchased by Lublin - 126. Over the years, trolleybuses were equipped with additional power sources, initially with a diesel generator or traction batteries with a smaller capacity, then with high-capacity lithium-ion batteries allowing for line operation on selected parts without the overhead network (Gładysz et al., 2016) .

Summary

The article analyzes the state and dynamics of changes in Polish trolleybus systems in the years 2004-2018. The study contains information on the status of the organization, rolling stock and infrastructure of trolleybus networks in Gdynia (with Sopot), Lublin and Tychy. The considerations were carried out in relation to literature sources concerning the situation in Europe and in the world. The analysis shows that trolleybus transport plays an important role in the above-mentioned urban centers and this role increased in the analyzed period. In order to modernize trolleybus transport, it was mainly financed by the European Union. Trolleybus transport is in line with the assumptions adopted by the European Union in the field of reducing emissions of pollutants into the environment, so the funding opportunities were successfully used. In the years 2004-2018, 252 trolleybuses were put into operation in Polish trolleybus transport, including 219 new ones. Most of them were vehicles manufactured in Poland, as one of the producers became an important player on the market of bus and trolleybus producers in Europe, supplying many vehicles for export.

The development of technologies in the field of auxiliary drives, in particular batteries and traction network, made it possible to eliminate the disproportion between bus and trolleybus transport. The auxiliary power supply was successfully used both in emergency and regular traffic, extending the transport offer by trolleybuses, e.g. in areas with a lower population density, where the construction of the traction network would be unprofitable.

In all analyzed centers there were spatial changes both in the length of the traction network and the number of connections. In particular, most new sections of the catenary were put into operation in Lublin.

Trolleybus transport has regained importance due to unfavorable climate changes and the need to adapt various spheres of the economy to the reduced emission of pollutants. The analysis shows that there are still no scientific and expert studies on the impact of trolleybus transport on the environment and comparative studies with other means of urban transport, in particular buses. Reliable scientific studies would allow to refute the myths unfavorable for trolleybuses and perhaps make the plans of some cities related to the introduction of electric buses more realistic.

Acknowledgements

The article has been written on the basis of research project "Socio-economic, environmental and technical conditions of electrical transport development and operation in Poland". The project has been financed from the National Science Centre – UMO-2016/23/D/HS4/03085.

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