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Impact of the implementation of EU, national and local policies and legislation on the transition towards eco-cities in Poland

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Abstract. Transforming cities towards eco-cities constitutes a significant effort in mitigating and adapting to climate change. The implementation of legal acts and diverse environmentally oriented sectoral policies plays an important role in that process. The objective of this paper is to determine the antecedences and effects of the transformation of cities in accordance with the eco-city concept in Poland in the context of implemented policies, legislation and initiatives. The study reviews the normative acts and programme-strategic documents that provide the framework for the shift towards eco-city at the international and EU level, as well as identifying changes in legislation and policy initiatives resulting from their implementation at national and local level. A set of 24 original indices referring to six aspects of the eco-city (waste management, water and wastewater management, transport and urban mobility, application of RES in energy engineering, air quality, and urban green areas) were applied in multi-criterion analyses in selected case studies. This permitted us to identify the key factors that power the transition towards eco-city. The legal and policy measures are implemented in a top-down approach. Actions are usually initiated at national level and implemented by local authorities, who operate according to their assigned tasks and using dedicated tools (e.g. LEPs, SUMPs). Significant effect of the implementation of eco-city solutions were identified in waste management, sustainable transport, urban mobility, and air quality improvement. Recommendations for future measures include implementing plans and demonstrative projects of eco-cities or eco-districts, conducting complex pro-ecological measures, and increasing the role of bottom-up actions.

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1. Introduction

The development of cities in accordance with the eco-city concept is one of the most important challenges in the transformation of existing cities and constitutes a primary element of creating cities from the ground up (Węcławowicz-Bilska, 2015). Building an eco-city is a complex process (Joss, 2010). The key task in implementing the idea is to solve problems related to the climate crisis (Tomozeiu and Joss, 2013), including reducing negative impacts on the environment, which in turn includes using energy from renewable sources, implementing circular economy solutions, developing ecological public transport, and the appropriate structuring of green areas in the city (Rzeńca, 2016). The eco-city is therefore characterised by self-sufficiency in obtaining renewable energy sources, low emission of greenhouse gases, a properly organised waste recycling system, energy efficiency in construction, and sustainable mobility involving the dominance of pedestrian, cycling and public transport traffic over private motorised traffic (Węcławowicz-Bilska, 2014). Striving for the development of eco-cities is also expected to allow for high quality of life of residents (Sas-Bojarska and Walewska, 2013), owing to the provision of access to green areas (Grzymała, 2016) and best housing standards (Tomozeiu and Joss, 2013). The transformation towards the eco-city itself should be based on the principle of social justice, providing all residents access to the city's resources (Wieteska-Rosiak, 2013). Therefore, the essence of the eco-city concept comprises on the one hand the creation of coherent and resilient cities in line with the principles of sustainable development in three main areas, namely economic, social and ecological (Lewandowska, 2016), and on the other hand maximally efficient governance of the city to prevent environmental degradation (Gutkowski, 2014).

The term "eco-city" is relatively new, although the striving to improve the worsening life conditions of rapidly industrialising cities by introducing new environmental and social solutions originated in the second half of the 19th century. The problems were addressed by the garden city concept proposed by English urban planner Ebenezer Howard (Howard, 1898). This concept is currently considered the "prototype" of the modern eco-city (Hu et al., 2016). Another solution was the neighbourhood unit concept articulated by American architect Clarence Perry in 1929 (Węcławowicz-Bilska, 2015) that focused on regulating road traffic, eliminating function collision, and mitigating environmental problems (Hu et al., 2016). The intensification of threats resulting from climate change and accelerated urbanisation since the 1980s has triggered the large-scale introduction of pro-ecological solutions. The history of development of the eco-city concept can be divided into three phases (Joss, 2010). The first occurred in the 1980s and 1990s, when the theoretical basics were developed and the definition of the term "eco-city" was introduced, focusing on the balance between urban development and nature (Register, 1987). The concept was rarely implemented in cities at the time. The second phase occurred at the end of the 20th century, right after the United Nations Conference on Environment and Development (Earth Summit) in 1992 devoted to preparing an

action plan for sustainable development (*Agenda 21*). The third phase occurred at the beginning of the 21st century with the development of global awareness on progressing climate change and its effects on the environment and human life, which triggered a number of pro-ecological activities (Joss, 2011). The eco-city concept became an important issue of environmentally oriented policies and initiatives and has been increasingly frequently implemented in practice (Hu et al., 2016). The eco-city concept corresponds with the horizontal EU measures for introducing the principles of sustainable development and climate change mitigation.

An important issue in implementing the eco-city concept is the evaluation of the level of development or transformation of cities (Hu et al., 2016). It should employ indices assessing the range of the various aspects of sustainable development that determine the environmental, economic, social and cultural elements of the eco-city concept, in order to allow the monitoring of results and the evaluation of the degree to which the pro-ecological initiatives' objectives have been met (Kenworthy, 2006). The global "eco-development" trend led to the designation of a set of indices (e.g. the Green City Index developed by the Economist Intelligence Unit in cooperation with Siemens) that were applied in the development of international rankings of ecological cities (e.g. by means of the European Green City Index, the Latin American Green City Index, US and Canada Green City Index, African Green City Index, the Asian Green City Index) (Joss 2010). It should be emphasised that sustainable development, and thus eco-city features, are analysed in many ways, and therefore a broad and variable scope of indices should be applied that is adjusted to the specificity and character of each country (Joss et al., 2012). This is exemplified by national rankings of eco-cities, e.g. the ACF Sustainable Cities Index in Australia (Trigg et al., 2010). This trend was also joined by Poland, where the national competition "Eco-Miasto" is held annually and rankings of eco-cities and sustainable cities are created, e.g. the ranking of Gazeta Wyborcza or the Arcadis ranking of Polish sustainable cities. They aim at pointing to good practices inspiring pro-ecological measures.

The implementation of the eco-city concept differs around the world. It can occur in a top-down or bottom-up approach, depending on the logic adopted in each country. In the top-down approach, planning and governance of any projects and initiatives relating to eco-cities is primarily the responsibility of the government, local government, and/or public–private partnership. The activities are based on the undertaking and implementation of relevant legislative solutions, as well as strategic documents and programmes at the national and supranational level (Hu et al., 2016). Financing is largely provided from national budgets (de Jong et al., 2016), and serves to incentivise local authorities to implement pro-ecological solutions that provide residents with a high standard of life while also having a minimal environmental impact (Lin, 2018). This approach to implementing the eco-city concept is particularly favoured in the countries of East Asia. Considering their rapid urbanisation, the governments of China, South Korea and Japan conduct activities to initiate and support (including financially) the design and creation of eco-cities (Lee et al., 2014; Lin, 2018). They see it as a great opportunity to deviate from existing techno-social regimes based on fossil fuels towards new green regimes based on ecology (Hu et al., 2016). In the bottom-up approach, pro-ecological initiatives and actions are undertaken by residents, non-governmental organisations (NGOs), banks, and investors collaborating with local governments (Yin et al., 2016). Financing derives from the private resources of the entities involved in projects, or in public–private partnership (Hu et al., 2016). Such solutions are more frequently applied in the countries of Western Europe, where it is believed that involving the local community and NGOs in the arrangement, design and implementation of the urban planning and governance of eco-cities increases the efficiency of the implemented measures (Hofmeister et al., 2014). Examples of successful implementations are observed in, for example, Germany and Denmark (Hu et al., 2016). It should be emphasised that in both top-down and bottom approaches, the implementation of solutions in the scope of the eco-city concept is regulated by international agreements and legal principles and, in the case of EU states, also by EU law, as introduced in national (domestic) law and in acts of local law.

The objective of the paper is to determine the antecedences and effects of the transformation of

cities based on the eco-city concept in Poland in the context of the implemented environmentally oriented policies, legislation and initiatives at the national and local level. Detailed analyses covered the following eco-city aspects: waste management, water and wastewater management, energy engineering and the use of renewable energy sources, transport and urban mobility, green areas, and air quality. The analyses attempted to answer the following research questions:

1. Who is the initiator of transformations towards the eco-city, depending on the ascribed scope of activities of governmental administration and local government authorities?
2. How do revisions of national and local policies and legislation change the particular eco-city aspects ?

Considering the complexity of the issue resulting from the process of building eco-cities, this paper employs case studies to compare and confirm observations resulting from the analysis of each of the cities of interest (Yin, 1994). To answer the research questions, two cities leading in rankings of eco-cities in Poland were selected and analysed (Lublin and Kraków). For a better understanding of the antecedences of the eco-city concept in Poland, and the Polish context of creating eco-cities, the analysis covered initiatives, normative acts, and strategic and programming documents at the international and EU level the implementation of which resulting in changes in legislation and policies conducted by the government and local authorities to transform cities towards regimes based on ecology.

1.1. Legislation and policies on implementing the eco-city concept

1.1.1. International and EU level

Legislative initiatives for mitigating the effects of climate change and accelerated urbanisation at the international level were initiated by the United Nations (hereinafter: UN) at the end of the 1980s. They resulted in adopting a programme of activities in the scope of climate change introducing, among others, the principle of sustainable development. Binding arrangements were concluded at the Earth Summit 1992 in Rio de Janeiro, where the United Nations Framework Convention on Climate Change (hereinafter: the Convention or UNFCCC) was adopted (FCC/INFORMAL/84/Rev.1, GE.14-20481) that specifies the basis of international cooperation to limit greenhouse gas emission (came into force in 1994), as well as the *Action Programme – Agenda 21* (https://sustainabledevelopment.un.org/outcomedocuments/agenda21) that proposes voluntary action to reduce pollution, conserve natural resources and develop in a sustainable manner. It was followed by further documents binding signatories to undertake activities aimed at countering global warming. The *Kyoto Protocol* (FCCC/CP/1997/L.7/Add.1) operationalises the Convention and obliged UNFCCC parties that ratified the protocol to reduce greenhouse gas emissions in accordance with agreed individual targets (by at least 5% in comparison to 1990, Art. 3 sec. 1) and presented economic instruments to facilitate the achievement of these objectives. Owing to a complex ratification process, it came into force in 2005. The issue of reduction of air pollution is regulated by, among others, the *1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone* (hereinafter: *Gothenburg Protocol*) under the *1979 Convention on Long-Range Transboundary Air Pollution* (hereinafter: *Air Convention; LRTAP Convention*) (entered into force in 2005). The response of the UN to the need to prepare countries and cities for climate change was *The Nairobi work programme on impacts, vulnerability, and adaptation to climate change* (COP11; decision 2/CP.11) established in 2005. The intensification of pro-ecological initiatives in the second decade of the 21st century was reflected on the one hand in the passing of the *Transforming our world: the 2030 Agenda for Sustainable Development* (A/RES/70/1) in 2015, where UN member states undertook to achieve 17 Sustainable Development Goals (SDGs), and 169 related targets constituting a continuation of activities in the scope of implementation of the Eight Millennial Development Goals (MDGs). On the other hand, activities were undertaken for the protection of air and reduction

of emission of pollutants, leading to the revision of the *Gothenburg Protocol* in 2012 (Decision 2012/1, Decision 2012/2, ECE/EB.AIR/111/Add.1), or further steps to migrate of the global effects of climate change through a decrease in air temperature and achieving climate neutrality, resulting in the signing of the *Paris Agreement* in 2015 (COP21; FCCC/CP/2015/10/Add.1; decision 1/CP.21), and development of its implementation guidelines included in the so-called *Katowice climate package* (COP24, FCCC/CP/2018/10/Add.1). To contribute to the implementation of the *Paris Agreement* goals, all member parties are required to submit extensive *National Climate Action Plans* (NCAP) and their Nationally Determined contributions (NDCs).

The arrangements adopted at the international level are implemented in the EU and its member states,[1] including through transposing international provisions to dedicated sectoral policies and the EU and national law. It should be emphasised that pursuant to the Lisbon Treaty that came into effect in 2009, acts of EU law were divided into legislative (issued by the European Parliament and the Council) and non-legislative (executory and delegated – primarily issued by the European Commission [hereinafter: EC or the Commission]). EU legislation can be issued in packages composed of several directives and/or regulations (which usually concern the implementation of EU sectoral policies, e.g. climate and energy, transport, etc.). Regulations are acts of derivative EU law that unify the law. On entry into force, they become part of the national law of the member states. Directives harmonise the law of the EU member states and are binding as to their purpose. They are implemented in the legislation of the member states. Communications issued by the European Commission stipulate, among others, the assumptions of EU policies and their strategic and programming documents and promote a common understanding of how to develop those policies. They also indicate the areas in which public administration, enterprises and citizens of the EU need to undertake action to best prepare for the prospective changes resulting from their implementation (Gilowski and Kuś 2010; Całka 2016). The operationalisation of EU policies is reflected in strategic documents, plans and programmes that determine the directions of horizontal activities (usually in medium-term perspectives of, e.g., 10 years: 2010, 2020, 2030), and vertical activities for the member states.

The European Union (hereinafter: EU) and its member states constituting UN members, initiated a larger scale of implementation of pro-ecological solutions in policies and legislation in the first decade of the 21st century. It initially resulted from the implementation of the *Kyoto Protocol,* the provisions of which were finally approved by the Council Decision in 2002 (2002/358/EC, OJ L 130, 15.5.2002).[2] In the scope of the activities, the *European Climate Change Programme* (hereinafter: ECCP) was initiated (2000) concerning the reduction of greenhouse gases, as was II ECCP (2005), which focuses on reducing emission of pollutants from transport, and particularly road transport. Solutions in the scope of applying RES in the economy and transport, and of improving energy efficiency and decarbonisation, also began to be promoted and implemented on a broad scale. In 2007 the Commission released its energy policy package *Energy for a Changing World* that includes, for example, the Communications *An Energy Policy for Europe* (COM/2007/1 final), and *Renewable energy road map - Renewable energies in the 21st century: building a more sustainable future* (COM/2006/848 final). In response, the Council proposed a set of measures necessary for the reduction of greenhouse gases, and adopted new environmental targets even more ambitious than those under the *Kyoto Protocol.* The plan included the so-called "three 20 targets" by 2020: reduce by 20% the emissions of greenhouse gases compared to 1990 levels; increase by 20% the energy efficiency in the EU; and achieve a 20% share of renewable energy sources in total energy consumption in the EU (and 10% for biofuels in the transport sector). Following the agreements on European energy policy and climate targets, the Commission adopted a *2020 Climate and Energy Package* with legal measures to implement policy targets. The package (the so-called *3 x 20% package*) was adopted in December 2008 and came into force in 2009 in the form of five directives and a regulation, including *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources* (hereinafter: *Renewable Energy Directive – RED*) (OJ L 140, 5.6.2009). The *Renewable Energy Directive* introduced, for example, national targets

for the share of energy from renewable sources and required member states to adopt *National Renewable Energy Action Plans* (NREAP). A set of binding measures to help the EU reach its 20% energy efficiency target by 2020 was established in the *Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency* (hereinafter: *EED*) (OJ L 315, 14.11.2012). Under its provisions, EU countries were required to draw up the *National Energy Efficiency Action Plans* (NEEAP), which set out estimated energy consumption, planned energy efficiency measures, and long-term renovation strategies. In subsequent years, pursuant to the *Paris Arrangement* concluded on behalf of the EU in 2016 by the *Decision of the Council (EU) 2016/1841 of 5 October 2016* (COM 2016/1841; OJ L 282, 19.10.2016), the "three 20 targets" were revised (in December 2020, the following values were adopted in the 2030 perspective: at least 55%, at least 32%, and 32.5%). The regulatory framework to operationalise the EU climate-energy objectives by 2030 and contribute to implementing the energy union and building a cohesive EU electricity market was set out in 2016 in the Commisssion Communication *Clean Energy For All Europeans* (COM/2016/0860). It consists of a package of eight legislative proposals to facilitate the transition to a clean energy economy. Measures related to amending existing climate change legislation include a fully revised *RED* (*Directive EU 2018/2001)* and the fully revised *EED* (*Directive EU 2018/2002)* (OJ L 328, 21.12.2018). The package resulted in the preparation by the member states of integrated *National Energy and Climate Plans* (NECP), and national long-term strategies (pursuant to the *Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action*, OJ L 328, 21.12.2018).

Measures for the reduction of greenhouse gas emissions were closely related to the issue of air protection in the member states, becoming the subject of the *Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe* (the *CAFE [Clean Air for Europe] Directive*) (O JL 152, 11.6.2008) in 2008. It imposed, among other things, norms of acceptable concentration of PM10 dust in air (annual mean of 40 μg/m³ and daily mean of 50 μg/m³ that can occur on a maximum of 35 days in a year). As a step towards improving air quality, the European Commission adopted in 2013 *A Clean Air Policy Package* (COM/2013/0918 final) including *A Clean Air Programme for Europe* (COM/2013/918 final) setting targets for 2020 and 2030, and accompanying legislative measures. *Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants* (the so-called *National Emission reduction Commitments Directive – NEC Directive*) (OJ L 344, 17.12.2016) transposes obligations in the scope of emission reduction for 2020 adopted by the EU and its member states at the international level under the *2012 revised Gothenburg Protocol*[3] and stipulates more ambitious emission reduction targets for 2030. Further, the *NEC Directive* requires that the member states prepare *National Air Pollution Control Programmes* (NAPCP) that should contribute to the successful implementation of air quality plans established under the *CAFE Directive* (2008/50/EC) (the common format of NAPCPs was specified in the *Commission Implementing Decision (EU) 2018/1522*; OJ L 2018.256/87). In 2018, the Commission adopted the Communication *A Europe that protects*: *Clean air for all* (COM/2018/330 final) that provides national, regional and local actors with practical help to improve air quality in Europe.

Regarding adaptations for climate changes, the Commission implementing the provisions of the *Nairobi work programme* (COP11; decision 2/CP.11), published in 2009 the *White Paper: Adapting to climate change: Towards a European framework for action* (COM/2009/147), specifying the scope of activities of EU member states, including in the context of development of adaptation strategies. *An EU Strategy on adaptation to climate change* (COM/2013/216) published in 2013 intensified these measures, and the member states began large-scale preparation and implementation of documents, including at a local level, aimed at improving resilience to current and expected climate changes (including *Urban Adaptation Plans*).

The directions for achieving a competitive, clean and resource-efficient transport system were set out in 2011 in the *White Paper – Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*

(COM/2011/144). Particular attention was paid to the issues of coordination of activities for achieving sustainable mobility in cities and supporting the development of the market for alternative fuels and investment in their infrastructure. It involved the implementation of initiatives specified in the *Action Plan on Urban Mobility* (COM/2009/490 final) and *Clean Power for Transport: A European alternative fuels strategy* (COM/2013/17 final). In the Commission Communication *Together towards competitive and resource-efficient urban mobility* (COM/2013/913 final), constituting the central element of the *Urban Mobility Package*, the European Commission points to the need to prepare strategic documents aimed at achieving EU assumptions regarding climate and energy efficiency in the form of the *Sustainable Urban Mobility Plan* (hereinafter: SUMP) (the SUMP concept is set out in Annex 1 of the Communication). The package is supplemented by the Commission Staff Working Documents on: urban logistics (SWD/2013/524 final), urban road safety (SWD/2013/525 final), urban vehicle access regulations (SWD/2013/526 final), and deployment of Intelligent Transport System solutions in urban areas (SWD/2013/527 final). They include key provisions supporting mobility in cities. Greater coherence and interoperability of Intelligent Transport Systems (ITS) solutions are introduced by *Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport* (hereinafter: *ITS Directive*) (OJ L 207, 6.8.2010). In order to trigger investment in sustainable transport and support decarbonisation in the transport sector, the *Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuel infrastructure* (OJ L 307, 28.10.2014) was adopted.

The *Our life insurance, our natural capital: an EU biodiversity strategy to 2020* (COM/2011/244 final) adopted in 2011 obliged the EC to prepare a Communication *Green Infrastructure (GI) — Enhancing Europe's Natural Capital* (COM/2013/249 final), which clearly indicates that the issues of protection and strengthening of natural environmental values should be considered in spatial planning and territorial development of the member states.

Measures concerning the implementation of the eco-city concept are also reflected in changes in the functioning of waste management. The basic legal regulations were included in *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste* (OJ L 312, 22.11.2008), and the consequence of its implementation of the passing of *National Waste Management Plans* (NWMP) aimed at strengthening the cohesion of activities throughout the European Union. In 2015, the Commission announced an action package for the circular economy, the *Circular Economy Package*, specifying new objectives of waste management that must be achieved by 2030. The package includes four revised legislative proposals: on waste (2018/851/EU), landfill waste (2018/850/EU), packaging materials (2018/852/EU) and end-of-life vehicles (ELV), batteries and waste electrical and electronic equipment (WEEE) (2018/849/EU). *Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste* (hereinafter: *Waste Framework Directive – WFD*) (OJ L 150, 14.6.2018) introduces, among other things, higher targets of waste recycling, or the obligation of selective collection of biowaste in the member states. The measures included in legislative proposals are supplemented by *Closing the loop – An EU action plan for the Circular Economy* (COM/2015/614 final). It points to key actions related to sustainable production and consumption (under the implementation of the 12 SDG), reducing environmental impacts of resource use, and injecting new value into waste products.

Recent years have brought new activities in the scope of clean energy, pollution reduction, sustainable mobility and climate actions. In 2019 and 2020, EU policy adopted as a new target the achievement of climate neutrality, i.e. zero net balance of greenhouse gas emission, by 2050 (pursuant to the *Paris Agreement* provisions). In the scope of implementation of this objective, in 2019, the *European Green Deal* (COM/2019/ 640 final) was adopted – an action plan for the implementation of climate ambitions of the EU relating to reducing emissions in the energy sector, mitigating and adapting to climate change, enhancing biodiversity, reducing coal extraction, transitioning to the circular economy, and introducing environmentally friendly technologies and ecological forms of public

transport. Its implementation is accompanied by legislative initiatives, new strategies, programmes and action plans, which. provisions will be introduced to the legislation and policies of member states in the coming years.

1.1.2. National and local level

The provisions of EU policies in the form of strategies, programmes and plans are used by the member states to develop programming and strategic documents, respecting the principle of hierarchy. Once it enters into force, EU legislation becomes part of the national legal order of the EU member states. Directives are obligatorily implemented into the law of the member states. In accordance with the Court of Justice of the European Union case-law, directives are implemented by issuing or amending generally binding national legal acts, i.e. acts, regulations, and acts of local law. For example, the Court excluded administrative practice as a method of directive implementation (see: *Judgment of the Court of 6 May 1980. Commission of the European Communities v Kingdom of Belgium. Case 102/79* (ECLI:EU:C:1980:120) and further judicature). Therefore, the issuance of programming and strategic documents such as national, regional and local programmes, plans and strategies is not sufficient for the proper implementation of the directive.

In the scope of decarbonisation, the provisions of the *2000 climate and energy package* are implemented gradually through amendments to the *Act of 10 April 1997 – Energy law* (Journal of Laws 1997 No. 54 item 348 as amended) and the adoption of new legal acts and programming documents. Issues concerning the energy use and production from renewable sources are addressed in the *National Renewable Energy Action Plan* (2010), and finally implemented in Polish legislation in the *Act of 20 February 2015 on Renewable Energy Sources* (so-called: *RES Act*) (Journal of Laws 2015 item 478 as amended) (under implementation of the Directive 2009/28/CE). As a result of the implementation of the provisions of the new *Renewable Energy Directive* (2018/2001) in Poland, the *RES Act* was amended, allowing individual recipients (prosumers) to engage in the large-scale production and obtaining of energy from renewable sources. Implementing the provisions of the *3x20% package* related to the energy efficiency targets the *Act of 15 April 2011 on energy efficiency* (Journal of Laws No 94, item 551 as amended) was adopted. Under the *EED* (2012/27/EU) provisions, the *National Energy Efficiency Action Plan for Poland 2014* (2014) was prepared and updated in 2017. At the local level, *Low-emission Economy Plans* (hereinafter: LEP) are being prepared, specifying activities of increasing the energy efficiency and use of local RES potential and improving air quality. In the scope of implementing the *Paris Agreement* and the provisions of the *Regulations of the European Parliament and the Council* (COM 2018/1999) (part of the *Winter Package*), in 2019, the *National Energy and Climate Plan for the years 2021–2030* (NECP PL) was passed and submitted to the EC. It stipulated the Nationally Determined Contributions (NDCs) by 2030.[4]

Provisions concerning the system of air quality assessment and management that results from implementing the *CAFE Directive* (2008/50/EC) were introduced by the amendments of the *Act of 27 April 2001 – Environmental Protection Law (EPL Act)* (Journal of Laws: 2008 No. 25, item 150 as amended; 2020, item 1219 as amended). Its amendment in 2015 (the so-called *Anti-Smog Act*) (Journal of Laws 2015 item 1593) permits local governments to fine persons who fail to observe local resolutions on use of permitted fuels for heating houses (so-called *Anti-Smog Resolutions*). The instruments of *EPL Act* to improve air quality on the regional (Voivodship) level are *Air Protection Programmes* (APP) and the short-term action plans. Their scope is specified in the *Regulation of the Minister of Environment* (Journal of Laws 2012 item 1028; 2019 item 1159). The programmes are prepared for, among others, urban agglomeration zones with populations exceeding 250,000, and the largest cities in voivodships – those of more than 100,000 residents. At the national level, the EU legislation was implemented in the provisions of the *National Programme for Air Protection by 2020 (with a perspective by 2030)* in 2015 and the *National Programme for Air Pollution Control* (NPAPC) (under the *NEC Directive*; 2016/2284/EU) in 2019. Norms regarding air pollution levels were implemented in the regulations of the *Regulation of the Minister of Environment* (Journal of Laws 2012 item 1031). For example, for daily concentrations of

PM10, the alarm level is set at 300 μg/m³ and the notification level at 200 μg/m³. As one of the results of the implementation of the *NEC Directive*, a new *Regulation of the Minister of Environment* (Journal of Laws 2019, item 1931) reduced these values by half only in 2019.

Regulation of the waste management system is set out in the *Act of 13 September 1996 on Maintaining Cleanliness and Order in Communes* (the so-called *Trash Act*) (Journal of Laws 1996 No. 132, item 622 as amended). In 2014, an amendment to the act introduced waste segregation (fractions: mixed, non-mixed), and a new system of rates for waste collection from properties. The implementation of the provisions of the *Circular Economy Package* resulted in the introduction of the new *Regulations of the Minister of Environment*, specifying new levels of recycling and methods to prepare to reuse and recycle certain fractions of municipal waste (Journal of Laws 2016 item 2167) and stipulating ways to selectively collect specific fractions of waste (Journal of Laws 2017 item 19). Another amendment of the *Trash Act* from mid-2019 (Journal of Laws 2019 item 1579), resulting from the implementation of the *Waste Framework Directive* (2018/851/EU), introduced far-reaching changes concerning accruing fees for waste disposal, and brought in a system of fines for lack of selective waste collection, as well as regulating issues relating to reaching the levels for reducing biodegradable municipal waste mass. As in the case of air protection, applicable *Waste Management Plans* are developed at regional level pursuant to the *Act of 14 December 2012 on Waste* (Journal of Laws 2013 item 21 as amended), with consideration of particular regions of municipal waste management. *Analyses of the state of municipal waste management* are prepared annually at the local level (pursuant to the *Trash Act*; Journal of Laws 2019 item 2010 as amended). In 2019, the *Roadmap of transformation towards Circular Economy* was adopted.

Provisions concerning water and wastewater management are included in the *Act of 7 June 2001 on Collective Supply of Water and Collective Waste Disposal* (Journal of Laws 2001, No. 72, item 747 as amended) and the way tariffs are accrued is regulated by the relevant *Regulation of the Minister of Marine Economy and Inland Navigation* (Journal of Laws 2018 item 472). Pursuant to the amendment of the *Act of 20 July 2017 – New Water Law* (Journal of Laws 2017 item 1566 as amended), tariffs for uptake of surface and groundwaters prepared by self-government authorities are submitted for the opinion of organisational units of the Polish Waters, i.e. to Regional Water Management Authorities (hereinafter: RWMA). They can modify them, directly affecting fees for water supply and sewage disposal in communes. Until recently, the Polish legal system had no clear definition of the terms "rainwater" and "snowmelt water", nor guidelines for their management within a real-estate property. They were only introduced by the *New Water Law Act*. It was also reflected in the relevant *Regulation of the Minister of Infrastructure* (Journal of Laws 2019 item 1065).

The basic legal regulations in the scope of organisational conditions and technical guidelines regarding transport are stipulated in the *Act of 20 June 1997 – Road Traffic Law* (Journal of Laws 1997 No. 98 item 602 as amended) and the *Act of 16 December 2010 on Collective Public Transport* (Journal of Laws 2011 No. 5 item 13 as amended) and, in the case of cycling infrastructure, also the relevant *Regulation of the Minister of Infrastructure* (Journal of Laws 2019 item 1643). The legal basis for the creation of Clean Transport Zones in cities is provided by the *Act of 11 January 2018 on electromobility and alternative fuels* (the so-called *Electromobility Act*) (Journal of Laws 2018, item 317, as amended) being implemented under the *Directive 2014/94/EU*. A legislative procedure is currently underway to amend the *Electromobility Act*, which provides that the local government of each city with more than 100,000 inhabitants (there are 37 in Poland) will have to designate a Clean Transport Zone (hereinafter: CTZ) by 2030. To increase the availability and provision of a high level of mobility and transport in cities the *Sustainable Urban Mobility Plans* (SUMP) (resulting from the *Urban Mobility Package*, COM/2013/913 final) are approved at local level. The result of the implementation of the *ITS Directive* (2010/40/EU) is the development of Intelligent Transport Systems solutions in cities.

The entry into force of the *Act of 16 December 2016 amending the Act on the Nature Conservation and the Act on Forests* (Journal of Laws 2016, item 2249) (so-called *Lex Szyszko Act*, named after

the minister responsible for its preparation), had a significant impact on expanding the entitlements of local governments and private individuals to clear growing trees and bushes on land they own. The act was at evident variance with the EU optics regarding environmental law included in the *EU Biodiversity Strategy* (COM/2011/244 final) and was a clearly political measure. Increasing the extent of green areas in cities can be indirectly affected by the implementation of the *Act of 8 March 1990 on Local Self-Government* (Journal of Laws 1990 No. 16, item 95 as amended), introducing participatory budgeting (from 2019 obligatory in poviat cities). Urban greenery projects are implemented under the participatory budgets.

Regarding mitigating of climate change resulting from the implementation of the *White paper* (COM/2009/0147) and *An EU strategy on adaptation to climate change* (COM/2013/0216) by the member states, the *Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030* (reffered to as NAS 2020) was adopted in 2013. The provisions of the strategy were implemented through the pilot project of the Ministry of Environment "*MPA: Development of plans of adaptation to climate change in cities with a population of over 100 thousand*" (2017–2019). It resulted in the preparation of 44 model *Urban Adaptation Plans* (http://44mpa.pl/miejskie-plany-adaptacji).

In accordance with the principle of legality, local self-governments implement eco-city solutions resulting from commonly binding acts of local law (acts commonly binding in the area of the issuing authority, in this case a territorial self-government unit). In the scope of waste management, communes pass resolutions with detailed provisions concerning the functioning of the waste management and recycling system, and determining the tariffs for waste management, water supply and sewage disposal (eventually approved by RWMA of Polish Waters). Within the framework of low-emission measures, local authorities prepare and pass *Low-emission Economy Plans*, and in the aspect of transport and urban mobility, *Sustainable Urban Mobility Plans* are implemented, as well as plans and strategies dedicated to cycling or public collective transport.

Priority governmental programmes of the Ministry of Environment (since 2019 Ministry of Climate and Environment) are also important in the scope of implementation of eco-city solutions. They are intended to contribute to the meeting of Poland's international and EU commitments to clean air, energy efficiency and RES targets, and to encourage residents to engage in pro-environmental action. In the 2010s, national programmes began to be implemented that aimed at reducing the emission of pollutants, as a result of adjustment to the requirements of the *CAFE Directive*. These included, among others, the Priority Programme "*Green Investment Scheme – GIS*" (including Programme GIS *GEPARD (CHEETAH) – zero-emission public transport*), Priority Programme "*Air Quality Improvement" (KAWKA, KAWKAPlus* subsidising the replacement of coal heating with more ecological systems, *TermoKAWKA* – window replacement, *GAZELA, GAZELABis* – the purchase of a low-emission public transport fleet, *BOCIAN* and *PROSUMENT* – RES investments, *LEMUR* – thermal modernisation of buildings). The beneficiaries were voivodships. Some of the pilot programmes were implemented in cities (e.g. *KAWKA* in Poznań and Wrocław, *GAZELA* in Częstochowa and Gdynia). The "*Air Quality Improvement*" programme has been extended into the "*Clean Air*" programme launched in 2018 together with complementary support instruments.[6] The "*STOP SMOG*" programme implemented as of 2020 in municipalities where the *Anti-Smog Act* is in force provides residents with subsidies for replacing high-emission heat sources with low-emission ones, as well as for thermal modernisation measures. The "*My Electricity*" programme being implemented since 2019 promotes a prosumer energy policy. The programme aims to increase the production of energy from micro photovoltaic sources and the development of distributed energy systems. Under the programme, residents obtain subsidies for the purchase and installation of solar panels. The "*My Water*" programme being implemented since 2020 aims at increasing small retention in properties, and the use of precipitation and melt water for the development of blue and green infrastructure.

National and self-government authorities' implementation measures in the scope of the eco-city concept can be funded by external resources

and funds, including European Structural and Investment Funds (at the level of investment and R&D&I, promotion and education) and the "Horizon 2020" programme (at the research level). The implementation of these objectives is also supported by the EU's long-term financial frameworks. Financing or co-financing of measures from EU funds is provided under National Operational Programmes (hereinafter: NOP), Regional Operational Programmes (hereinafter ROP), and supra-regional programmes (East Poland), and those dedicated to cities and their functional areas (under Integrated Territorial Investments 2014–2020). Alternatives to EU funds are those from the state budget. Funds for the implementation of objectives related to the provisions of EU documents and national policies and governmental programmes come from the National Fund for Environmental Protection and Water Management and the Voivodship Fund for Environmental Protection and Water Management, and the Environmental Protection Bank which, among other things, grants loans for undertakings related to thermal modernisation, point-source emission reduction, or water and wastewater management. Another form of supporting of eco-city activities is the Participatory Budget, which includes financing e.g. projects related to developing green areas in cities. Self-governments also allocate pools from their budgets to programmes, the recipients of which are residents, supporting the improvement of air quality, efficient water management, or small retention.

2. Material and research methods

The paper employed both qualitative and quantitative methods. The works were conducted based on a comparative case study (Yin, 1994). Case studies were selected by the expert selection method (Frankfort-Nachmias et al., 2015) based on analysis of rankings of Polish ecological cities and sustainable cities. This was based on results of the "Eco-Miasto" competition, the ranking of Gazeta Wyborcza, and the Arcadis ranking of sustainable cities. Three criteria (features) were considered: 1) cities with a high position in competitions and rankings, 2) cities with the highest number of first places in the "Eco-Miasto" competition, and 3) cities highly specialised in different eco-city aspects. Two cities were selected: Lublin – the largest city of eastern Poland (population 339,000, 147.5 km^2) with five first-place awards in the "Eco-Miasto" competition, and a leader in activities concerning sustainable mobility; and Kraków (population 779,000, 327 km^2) – a city granted nine awards (including 4 first-place awards) in the "Eco-Miasto" competition, and which focuses on environmental activities to improve air quality.

The discussion of issues regarding the implementation of the eco-city concept was based on legal acts and strategic and programme documents at the supranational (UN, EU), national, and local level. Governmental programmes and local self-government initiatives were also considered. The effect that changes in national and local legal provisions and the implementing of governmental programmes and self-government authority initiatives had on the implementation of the eco-city concept in the case studies was assessed using 24 original indices relating to six eco-city aspects. These were: waste management, water and wastewater management, transport and mobility, use of RES in energy engineering, air quality, and urban green areas (Table 1). The quantitative analyses were performed by means of the index method (Czyż, 2016) for the years 2011-2019. The analysis employed data from the Bank of Local Data (BDL) of Statistics Poland (GUS), *Reports on the state of the City of Kraków* (www.bip.krakow.pl/?mmi=509), and *Reports on the state of the City of Lublin* (https://bip.lublin.eu/rada-miasta-lublin/raport-o-stanie-miasta-lublin). *Analyses of the state of municipal waste management* in Lublin and Kraków prepared for the years 2014–2019 were used as the database for waste management. The analysis of cycling transport employed data from the operators of the bicycle-sharing systems, i.e. Wavelo in Kraków and Lubelski Rower Miejski in Lublin, and data regarding parking zones were obtained from the Road Administration of the City of Kraków and Road and Bridge Administration in Lublin. The data supplemented the index analyses. The results were described and presented as tables.

Table 1. Acts of national and local law and corresponding indexes and data applied in the analysis of eco-city aspects

No.	Act of national law	Data and index	Act of local law		Data and index
			Kraków	Lublin	
			Waste management		
1.	*Act on Maintaining Cleanliness and Order in Communes* (Journals of Laws: 2013 item 228; 2017 item 19; 2019 item 1579)	mean monthly rate for waste disposal per 1 resident (PLN)	*Resolution No. LXXXVIII/1313/13* on *the Selection of the Method of Determination of the Rate…*	*Resolution No. 704/XXVIII/2013 on the Selection of the Method of Determination of the Rate…*	mean monthly rate for waste disposal per 1 resident (PLN)
			Resolution No. III/37/18 on the Selection of the Method of Determination of the Rate…	*Resolution No. 18/II/2018 on the Selection of the Method of Determination of the Rate…*	
2.		costs of functioning of the waste disposal system (PLN)			
3.		amount of collected mixed waste (thousand tonnes)			
4.	*Regulation on Levels of Recycling…* (Journal of Laws 2016 item 2167)	level of recycling of paper, metal, plastic, and glass waste (%)			
5.	*Regulation on Detailed Method of Selective Collection…* (Journal of Laws 2017 item 19)	amount of collected mixed waste (m^3)			
			Water and wastewater management		
6.	*Act on Collective Supply of Water …* (Journal of Laws 2001 No. 72, item 747 as amended)	mean monthly water consumption in households (m^3)			
7.		mean monthly water uptake (m^3)			
8.		mean monthly production of municipal sewage (m^3)			
9.		share of population using a municipal wastewater treatment plant (%)			
10.	*Regulation on the Determination of Tariffs,…* (Journal of Laws 2018 item 472)	rate of charge for water supply and sewage disposal per 1 resident (PLN)	*Resolutions No. XCII/1365/13 XXXI/514/15 LVIII/1230/16 LXXXVIII/2176/17 on the Approval of the Tariff…*	*Resolution No. 664/XXV/2017 on the Approval of the Tariff…*	monthly rate for water supply and sewage disposal per 1 resident (PLN)
	New Water Law Act (Journal of Laws 2017 item 1566 as amended)		*Decision No. KR.RET.070.257.2018 on the Approval of the Tariff…*	*Decision No. LU.RET.070.1.3.2018.PW for Collective Water Supply…*	
			Energy engineering and RES		
11.	*Act on Renewable Energy Sources* (Journal of Laws 2015 item 478 as amended)	share of carriers of energy from renewable sources used for electricity production (%)			
12.	*Energy Law Act* (Journal of Laws 1997 No. 54, item 348 as amended)	mean monthly use of electricity per 1 resident (MWh)			
			Transport and urban mobility		
13.			*"Concept of Development of the Cycling Transport System …"* (attachment to the *Resolution No. 1/IV/2015)*	*Resolution No. 1123/XLII/2014 on Adopting the "Strategy of Implementation of a System of Cycling Routes…"*	length of cycling routes (km)
14.			*"Study of Basic Cycling Routes of the City of Kraków"* (2019)	*Resolution No. 260/XV/2011 on Adopting the "Concept of Development of Cycling Transport…"*	number of bicycles in the city's bicycle-sharing system (items)
15.				*Resolution No. 224/XIV/2011 on Adopting the "Cycling Policy…"*	number of stations of the city's bicycle-sharing system (items)

16.			*Resolution No. XLVII/848/16 on Adopting the "Transport Policy…"*	*Resolution No. 674/XXVII/2013 on Adopting the "Plan of sustainable development of the collective public transport system…"*	length of bus routes of collective transport (km)
17.			*Resolution No. LXXX/1220/13 on Adopting the "Plan of Sustainable Development of Collective Public Transport…"*	*Resolution No. 1075/XLI/2018 on Adopting the "Mobility Plan of the Lublin Functional Area …"*	number of stops of collective transport (items)
18.			*Resolution No. XXII/456/19 on the Designation of the Paid Parking Zone…*	"*Concept of the Development of Transport of the Lublin Functional Area*" (attachment No.2 to the *Resolution No. 2/2020*)	number of paid parking spots (items)
			Urban green areas		
19.	*Act on the Nature Conservation* (Journal of Laws 2016 item 2249 as amended)	number of lost trees (items)			
20.			*Resolution No. LXI/863/12 on Approval of the "Municipal Environmental Protection Programme ...."*		area of urban greenery (ha)
			Resolution No. 2282/2019 – "Directions of Development and Management of Green Areas ..."		share of urban greenery per 1 km^2 of the city area (ha/km^2)
			Air quality		
21.	*Regulation on Levels of Certain Substances…* (Journal of Laws 2012 item 1031)	mean daily concentration of suspended dust PM10 in the air [$\mu g/m^3$]	*Resolution No. XLII/662/13 on the "Air Protection Programme for the Małopolskie Voivodeship ..."*	*Resolution No. XXXVII/608/2013 on Adopting the Updated "Air Protection Programme for the zone - Lublin agglomeration ..."*	mean daily concentration of suspended dust PM10 in the air [$\mu g/m^3$]
			Resolution No. XXXII/451/17 on Adopting the "Air Protection Programme for the Małopolskie Voivodeship ..."	*Resolution No. XXXV/483/2017 on Adopting the Updated "Air Protection Programme for the zone - Lublin agglomeration ..."*	
			Resolution No. XVIII/243/16 on the Introduction in the Area of the Urban Commune of Kraków of Restrictions…		

Source:: *authors' elaboration*

3. Results

Waste management

In the aspect of waste management, an important element indicating the "eco" approach in both cities is an increase in the level of segregation of fractions (the achieved values correlate with number of residents, hence in Kraków they are three times higher), as well as an increase in the level of recycling (double in Kraków). It is worth emphasising that the amount of collected mixed municipal waste showed a decreasing trend in Lublin, and an increasing one in Kraków. This was closely related with an increase (Lublin) or stagnation (Kraków) of mean monthly tariffs for waste disposal (Table 2) that were also subject to modifications (initially depending on the number of persons in a household, type of housing, and method of waste collection, and the rate is currently accrued per resident inhabiting the property, depending on the method of waste collection). Only the increase in the tariffs in Kraków in 2020 caused a decrease in the volume of the mixed fraction (from 217,000 tonnes in 2019 to 184,000 tonnes in 2020).

Water and wastewater management

Lublin and Kraków are well equipped in water and sewage infrastructure (Table 3). They also have efficiently functioning wastewater treatment plants that have been modernised and expanded in recent years. Over the analysed years, inconsiderable changes were observed in the uptake and use of water and in the production of municipal sewage

Table 2. Waste management in Lublin and Kraków in the years 2014–2019

year	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin		Kraków	
	amount of collected mixed waste (thousand tonnes)		costs of functioning of the waste disposal system (million PLN)		level of recycling of paper, metal, plastic, and glass waste (%)		mean monthly rate for waste disposal per 1 resident (PLN)			
							selectively	non-selectively	selectively	non-selectively
2014	86 906	185 829	39	124	34.2	19.7	21	27	20.5	30.5
2015	nd	191 769	nd	155	46.4	27.9	21	27	20.5	30.5
2016	82 064	206 191	44	158	53.7	33	21	27	20.5	30.5
2017	83 831	214 679	44	169	49.8	32.1	21	27	20.5	30.5
2018	82 355	222 212	50	182	88.2	42	21	27	20.5	30.5
2019	73 400	217 607	69	213	44.12*	42	33	66	20.5	30.5

*data only for inhabited properties; nd – no data
Source: authors' elaboration

Table 3. Water and wastewater management in Lublin and Kraków in the years 2011–2019

year	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków
	mean monthly water consumption in households (m^3)		mean monthly water uptake (m^3)		mean monthly production of municipal sewage (m^3)		share of population using a municipal wastewater treatment plant (%)		monthly rate for water supply per 1 resident (PLN)		monthly rate for waste disposal per 1 resident (PLN)	
2011	1066	2 954	1 506	4975	1 647	6 744	95.4	91.1	3.31	2.85	4.51	3.80
2012	1052	2 920	1 485	4954	1 609	5 625	96.4	91.0	3.31	3.06	4.51	4.50
2013	1 022	2 909	1 455	4 877	1 594	6 519	96.7	91.5	3.47	3.32	4.65	5.00
2014	997	2 895	1 440	4 851	1 583	6 264	97.1	97.6	3.47	3.53	4.65	5.00
2015	1 011	2 898	1 452	4 950	1 586	6 042	97.3	98.6	3.47	3.69	4.65	5.15
2016	990	2 851	1 425	4 945	1 606	6 147	96.6	98.3	3.47	4.21	4.65	5.32
2017	971	2 897	1 435	5 055	1 615	6 360	96.1	97.7	3.47	4.21	4.65	5.94
2018	977	2 981	1 478	5 180	1 629	6 150	96.0	97.3	3.44	4.21	4.81	5.94
2019	963	3 019	1 489	5 220	1 643	6 780	95.0	96.3	3.44	4.32	4.,81	6.08

Source: authors' elaboration

(Table 3) (higher values for Kraków result from the three times larger population), with Lublin showing a sustained decreasing trend, and Kraków a growing trend. In the case of Lublin, this may be affected by increases in tariffs for water consumption and sewage disposal. No such correlations were observed in Kraków, and the economic factor caused no change in the habits of residents (Table 3).

Energy engineering and RES

In energy engineering, the implementation of the eco-city principles manifests as a small decrease in the use of energy (differences in Kraków result from the higher number of residents and greater industrial activity) and a continuously increasing share of carriers of RES energy in the city's energy balance (Table 4).

Transport and urban mobility

Table 4. Energy engineering and RES in Lublin and Kraków in the years 2011–2019

year	Lublin	Kraków	Lublin	Kraków
	mean monthly use of electricity per 1 resident (MWh)		share of carriers of energy from renewable sources used for electricity production (%)	
2011	20 771	65 217	nd	nd
2012	20 444	64 154	nd	nd
2013	20 313	63 847	11.37	9.74
2014	19 886	61 562	11.49	10.09
2015	19 693	60 518	11.74	10.11
2016	19 521	60 914	11.29	10.91
2017	20 937	65 497	10.97	8.78
2018	20 228	64 592	nd	12.03
2019	20 231	65 215	13.78	12.03

nd – no data
Source: authors' elaboration

Table 5. Collective transport in Lublin and Kraków in the years 2011–2019

year	Lublin		Kraków		Lublin		Kraków	
	length of bus routes of collective transport (km)				number of stops of collective transport (items)			
	total	per 1 km^2	total	per 1 km^2	total	per 1 km^2	total	per 1 km^2
2014	187	1.3	400	1.2	nd	nd	nd	nd
2015	189	1.3	419	1.3	758	5.2	1 850	5.7
2016	210	1.4	443	1.3	761	5.2	1 850	5.7
2017	221	1.5	399	1.2	790	5.4	1 850	5.7
2018	220	1.5	444	1.4	824	5.6	1 876	5.7
2019	227	1.5	467	1.4	826	5.6	1 895	5.9

nd – no data
Source: authors' elaboration

Table 6. Car transport in Lublin and Kraków in the years 2011–2019

year	Lublin		Kraków		Lublin		Kraków	
	number of paid parking spots (item)				number of passenger cars (item)			
	total	per 1 km^2	total	per 1 km^2	total	per 1000 persons	total	per 1000 persons
2011	nd	nd	nd	nd	142 808	410	364 386	480
2012	1 755	12	nd	nd	147 763	425	381 442	503
2013	1 755	12	nd	nd	153 554	447	395 435	521
2014	1 755	12	nd	nd	158 354	463	406 840	534
2015	1 755	12	nd	nd	164 605	483	423 915	557
2016	2 450	17	28 837	88	172 140	505	448 018	585
2017	2 450	17	18 689	57	180 392	530	468 619	610
2018	2 450	17	18 689	57	189 271	557	493 484	640
2019	2 450	17	19 438	59	196 361	577	514 216	660

nd – no data
Source: authors' elaboration

Table 7. Bicycle transport in Lublin and Kraków in the years 2011–2019

year	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin		Kraków	
	number of bicycles in the city's bicycle-sharing system (items)		number of stations of the city's bicycle-sharing system (items)		number of rentals of urban bicycles (items)		length of cycling routes (km)			
							total	per 1 km^2	total	per 1 km^2
2011	nd.	120	nd	16	nd	60 376	nd	nd	114	0.35
2012	nd	120	nd	30	nd	nd	67	0.5	127	0.39
2013	nd	120	nd	30	nd	nd	85	0.6	136	0.42
2014	400	305	40	34	128 644	320 000	118	0.8	142	0.44
2015	430	300	43	34	436 965	330 000	130	0.9	150	0.5
2016	891	100	90	15	854 881	3 779	139	0.9	159	0.5
2017	901	300	91	157	562 000	749 495	145	1.0	165	0.5
2018	951	840	97	165	745 000	987 204	160	1.1	174	0.53
2019	961	1 500	98	168	658 700	842 303	174	1.2	169	0.52

nd – no data
Source: authors' elaboration

Table 8. Urban green areas in Lublin and Kraków in the years 2011–2019

year	Lublin	Kraków	Lublin	Kraków	Lublin		Kraków	
	area of urban greenery (ha)		share of urban greenery per 1 km^2 of the city area (ha/km^2)		number of lost trees (items)			
					trees	shrubs	trees	shrubs
2011	1 011	3 082	6.88	9.43	983	2 202	3 470	7 363
2012	1 011	3 082	6.88	9.43	610	274	2 130	1 728
2013	1 102	3 153	7.5	9.64	1 693	21 579	1 847	2 163
2014	1 103	3 150	7.5	9.63	1 031	2 219	2 237	6 848
2015	1 114	3 188	7.58	9.75	744	102	1 425	947
2016	1 086	3 257	7.39	9.96	3 410	533	1 091	1 567
2017	1 099	3 297	7.48	10.08	2 058	4 984	2 151	23 841
2018	1 095	3 425	7.45	10.47	610	nd	3 090	nd
2019	1 112	3 552	7.56	10.86	691	nd	2 528	nd

nd – no data
Source: authors' elaboration

Table 9. Air quality in Lublin and Kraków in the years 2011–2019

year	Lublin	Kraków
	mean daily concentration of suspended dust PM10 in the air (μg/m^3)	
2011	30.64	64.65
2012	30.59	56.72
2013	29.39	46.78
2014	30.07	47.71
2015	29.23	48.44
2016	25.08	39.18
2017	26.96	40.2
2018	27.58	40.41
2019	22.5	34.93

Source: authors' elaboration

Public transport plays a key role in implementing the eco-city concept. The length of bus routes and number of public transport stops is trending upwards in both cities, whereas their density is shaped at a similar level (Table 5). Both cities use considerable EU funding to develop ecological forms of collective transport. In Lublin, the trolley bus traction is continuously being expanded (by 55% in 2019 in comparison to 2012), as is the bus transportation system in Kraków (by 15% in 2019 in comparison to 2010), with fleets constantly beeing updated. It is worth emphasising the dynamic development of the cycling infrastructure in Lublin (where routes are comparable to Kraków in length, and their density is more than double). This also translates into the number of users of the urban bicycle-sharing system that has been functioning since 2014 (Table 7). Fluctuations in those terms in Kraków were caused by a discontinuity resulting from a change of operator. The number of parking spots (Table 7) depends on the expansion (Lublin) or reorganisation of traffic (Kraków – in the years 2017–2019 streets were converted to one-way streets, and cycling paths were introduced, as well as contraflow lanes and bus lanes) in paid parking zones (PPZ). A negative phenomenon in the scope of urban transport in both cities is an increase in the number of cars (Table 6). The traffic density is substantially lower in Lublin, particularly after the construction of the ring road (in 2014–16) and several key sections of so-called small ring roads within the city, and of P&R parking lots. Due to this, Lublin has again gone to the top of rankings of driver-friendly cities in 2021.

Urban green areas

In Lublin and Kraków, the area of urban greenery increased in the period 2011–2019, (by 15% in Kraków, 10% in Lublin), and the disproportions primarily result from the difference in the surface area of both cities. An unsettling phenomenon is the constantly high level of loss of trees and bushes (Kraków), and the intensification of clearing trees and bushes in the period 2016–17 (Lublin) (Table 8) after the *Lex Szyszko Act* came into force.

Air quality

Both cities showed improvement in terms of air quality. In the years 2011–19, the mean daily concentration of suspended dust PM10 in air decreased (by 36% in Lublin and by half in Kraków) (Table 9), whereas the double concentrations of pollutants in Kraków result from the city's location and character of industrial activity.

4. Discussion

Solutions in line with the principles of the eco-city concept are increasingly being introduced in cities (Hofmeister et al., 2014; Hu et al., 2016; Yin et al., 2016; Lin, 2018). As our study demonstrates, that legislation initiatives regarding the "eco" approach are largely launched at the international level (UN). In the case of the EU, relevant regulations are implemented in the system of EU legislation and, based on the rule of legalism, are introduced in the national legal order of the member states. In Poland, the activities are mainly based on the development of relevant legislation solutions by passing and amending binding legal acts and implementing appropriate pro-environmental policies in the form of governmental and self-governmental strategies, plans and programmes. Financing obtained from operational programmes (national and regional) and from the state budget (governmental or ministerial, less frequently local programmes) allows city authorities and residents to implement pro-ecological solutions. This is in accordance with a broader context of undertaking activities for the circular economy, rational water management, energy efficiency, and sustainable mobility and urban green areas, which are currently priority tasks of national, regional and local policies (Węcławowicz-Bilska, 2015; Tomozeiu and Joss, 2014). We indicate that the implementation of the eco-city concept is dominated by a top-down approach, where the main actors are national and self-governmental authorities. To a certain extent this relates to the approach applied in the countries of South and East Asia (Hu et al., 2016; de Jong et al., 2016; Yin et al., 2016). The difference is that in Asian countries the

development of eco-cities constitutes an important element of the implementation of innovative urban policy (Lin, 2018). Therefore, they are built in an organised and comprehensive manner using dedicated tools, often within the scope of special governmental programmes (de Jong et al., 2016; Lin, 2018). The elaboration and implementation of demonstration projects of eco-cities is particularly worth attention. Exemplary cases of solutions in this scope exist in China, where based on indices and guidelines formulated by each of the three central ministries, self-governments prepare plans for eco-cities. Among these, the central authorities select those that meet the criteria of the national policy. More than a hundred new eco-cities have been established so far in China, and more than 250 existing cities have announced their plans to implement eco-city objectives (Hu et al., 2016). In Japan in 2008, the national government launched a complex programme, "*Eco-Model Cities*", where twenty-three model ecological cities have been designated (Lin, 2018). There are also examples of this type of initiative being implemented in Western Europe, such as the French national "*Eco-city*" programme that specifies standards and guidelines for creating so-called "eco-districts" (Boxenbaum et al., 2011), and the English governmental initiative concerning the creation of ecological cities for the purpose of minimising the intensifying urbanisation and climate change (Tomozeiu and Joss, 2014). Our research shows that in Poland, unlike in the aforementioned examples, no complex governmental programmes are being developed that would pertain to transforming cities towards eco-cities, or to building them from the ground up. On a broader scale, only programmes to implement selected aspects of the eco-city concept, such as for air quality improvement, or application of RES in energy production ("*Air Quality Improvement*", "*Clean Air*", "*My Electricity*") Are being conducted to support meeting the national energy and climate targets.

Alongside national authorities, local authorities also fulfil an important role in initiating activities for transformation towards the eco-city. Considering various conditions and variability of the conducted policy, in particular countries city authorities get involved in activities to various degrees (de Jong et al., 2016; Yin et al. 2016). In Asian cities, particularly in China, the local authorities rarely undertake independent initiatives, serving as more of a contractor of decisions taken at the central level (de Jong et al., 2016). In European cities, local authorities play a greater role in creating eco-cities by implementing the assumptions of EU policy as well as their own initiatives such as sustainable transportation, CE solutions or climate actions. Examples include: the *Bicycle Track Priority Plan* and the *Climate Adaptation Plan* implemented in Copenhagen (Chodkowska-Miszczuk and Lewandowska, 2018), local strategies for the development of green areas undertaken in Stockholm (Mączka and Milewicz, 2020), or implementation of the circular economy provisions in the Amsterdam Metropolitan Area (Heurkens and Dąbrowski, 2021). Although all the eco-city aspects are part of the municipality's tasks, according to our research, local authorities are closely involved in issues relating to developing the urban mobility and transportation, air quality improvement, and, more seldom, urban greenery. An important tool comprises *Low-emission Economy Plans* and *Sustainable Urban Mobility Plans*, or separate documents concerning, for example, cycling policy, and the programming documents *Directions of Development and Management of Green Areas* adopted by several cities (including Kraków and Wrocław). Waste and water and sewage management is carried out by dedicated municipal companies or entities as well as private companies that have won tenders.

The results show that implementing acts of EU law in the national and local law changes particular eco-city aspects to various degrees. A perfect example is waste management, where the necessity to implement EU provisions (*Directive on Waste*, 2008 and *Circular Economy Package*, 2015) forced an amendment of the provisions of the *Trash Act* (in 2014, 2017, 2019) that triggered the implementation of a circular economy at a broader scale (Table 2) (Lewandowska and Szymańska, 2019). An increase in system operation costs for cities resulting in an increase in fees for residents was of substantial importance in the process. The top-down approach is still dominant, however, with support from self-governmental initiatives (including concessions in fees introduced in Świdnik for composting biowaste by residents) which are mostly limited to

conducting promotional-educational actions (e.g. in Lublin, the campaign "*The city is Your home*", and "*Eko-collection*" activities). Poland lacks the bottom-up initiatives that are common in cities in EU countries, especially in the "old Union". An example is the FORCE project ("*Cities Cooperating for Circular Economy*") based on the concept of shared management, where different public and non-public actors together develop and implement eco-innovative solutions for promoting the circular economy in their cities (Izdebska and Knieling, 2021). Lublin is an observer city in this project.

In the case of supporting cities in shifting towards resource-efficient and low-carbon economy, regulations introduced by the implementation of the provisions of the *3x20% package* (2008) resulted in passing the *Act on energy efficiency* (2011) and the *RES Act* (2015), and are referred to in acts of local law, e.g. in the *Low-emission Economy Plan*, which is a mandatory document for obtaining subsidies for eco-energy and air-quality improvement investments under ROPs and dedicated NOPs (e.g. Operational Programme Infrastructure and Environment) and governmental programmes, and is often perceived by local authorities in this context (Rzeńca and Mysiala, 2019). According to our research, these policy and legislative actions were not largely reflected in the analysed indices (Table 4). Broader application of RES in energy production by prosumers was limited by the government in favour of the use of fossil fuels until the end of the 2010s. Only the obligations arising from the NECP PL and the achievement of the NDC targets – as well as the possibility of obtaining EU funds for green transition – caused a change in the optics of the governing elites, and broader support for RES (e.g. through the implementation of the governmental "*My Electricity*" programme since 2019), but without adequate development of the system enabling connection of green installations and energy storage. As in the case of waste management, so too here, bottom-up initiatives are scarce. The situation is different in Western Europe. One example is the city of Freiburg in Germany, where resident protests against the construction of a nuclear power plant resulted in the city's transition to a low-emission policy, from the use of renewable energy to ecological transport. As a result of close cooperation between all stakeholders in the eco-city project, Samsö Island in Denmark has become independent from external energy sources, and free from fossil fuels (Hu et al., 2016).

In the scope of introducing sustainable urban mobility and transport, the implementation of the provisions of the *White Paper* (2011) and provisions of the *Urban Mobility Package* (2013) was of utmost importance. They were reflected in acts of local law, e.g. in urban mobility plans or strategies and programmes regarding bicycle transport. The implementation of these documents (Table 1), supported by financing from the EU,[6] was reflected in an increase in all the analysed indices in both cities (Tables 6, 7, 8). It should also be emphasised that the development of sustainable urban transport, particularly bicycle transport, is also largely determined by other factors, e.g. transport rates (e.g. discounts on the city card, introduction of free minutes for renting an urban bicycle), the continued functioning of urban bicycle-sharing system, and bottom-up initiatives undertaken by residents and non-governmental organisations.[7] Lublin deserves particular attention here. Its cycling infrastructure has been considerably expanded in recent years, and cooperation between many stakeholders has led to the development a specific cycling ecosystem (Kociuba and Wieliniec, 2020). The bottom-up action "*Cities for People*" initiated under the 2014 Year of Jan Gehl resulted in the issuance of Poland's first resolution implementing standards and directions for the development of pedestrian mobility (*Resolution No. 20/2/2017*), which was prepared in a participatory manner (Kociuba and Maj, 2020). In Kraków, many activities have been initiated to limit car traffic (including by developing cycling transport, introducing the "Tempo30" zone and the first CTZ in Poland, constructing P&R or paid parking zones) that have been successfully implemented in other Polish cities, e.g. in Wrocław, Poznań and Szczecin (Dybalski et al., 2017). These solutions mostly constitute the application of good practices that have proven successful abroad, e.g. in Copenhagen, which is a leader in bicycle transport and implementing an urban bicycle system (Chodkowska-Miszczuk and Lewandowska, 2018), or in London, where special zones are established in the city centre – (Ultra) Low Emission Zone – forbidding entrance to diesel vehicles, or zones in which drivers are obliged to pay a high fee for

entrance (a congestion charge) (Widłak, 2013; Broaddus et al., 2015).

The implementation of sustainable transportation solutions is related to the issue of air quality improvement. This is one of the primary objectives of EU and national climate policies. A significant contribution to air protection was made by the implementation of the *CAFE* (2008) and *NEC* (2016) Directives provisions that were introduced to the Polish legislation (e.g. *Anti-Smog Act*, 2015; *Anti-Smog Resolutions*) and programme documents (NPAP, 2015; NAPCP, 2019). A steady decrease in pollution level has been brought about by government programmes (particularly "*Clean Air*", at a smaller scale "*STOP Smog*" due to the criterion of adopting the *Anti-Smog Act* by the commune) and by increasingly numerous initiatives by self-governments involving the co-financing of investments limiting point-source emission (e.g. the replacement of coal-based heating with more ecological alternatives). Kraków deserves particular attention here. A World Health Organisation report in 2016 classified it as the 11th most polluted city of the EU. Increasing budgets for counteracting smog and effective city authority activities, which culminated in the 2016 adoption of one of Poland's first *Anti-Smog Resolutions* (*Resolution No. XVIII/243/16*) banning burning coal in heating stoves from 1 September 2019 onwards, brought quantifiable results in the form of considerable improvement in air quality (Table 9). In Lublin, activities to reduce point-source emissions (especially emissions from heat production for central heating and from traffic) are of systemic and participatory character. In 2013, the *PONE* programme was initiated, subsidising the replacement of solid fuel heating systems. In 2017, a citizens' panel was held, where the city's air quality improvement solutions currently in place were developed with the participation of residents. Concentrations of PM10 dust recorded in the two cities (Table 9) are in line with those of other Polish cities (more than 30 μg/m^3, e.g. in Wrocław, Poznań or Gdynia). They are, however, substantially higher than in other cities, particularly of Western Europe (e.g. in Copenhagen in 2018, a level of 11 μg/m^3 was reached [Mazurek, 2018]; and in Stockholm 3–4 μg/m^3 [*Co wiemy o smogu?*..., 2015]). This difference is caused by the relatively late involvement of the government (2019) and regional self-governments responsible for air protection policy (e.g. Lubelskie Voivodeship only in 2021 signed the *Anti-Smog Resolution*) in co-financing activities for lowemission economy, and the setting of high notification and alarm levels (e.g. for suspended dusts PM10 in air 300 μg/m^3, and 150 μg/m^3 since 2019): the equivalent levels are much lower in European countries, e.g. in Paris, a smog alarm is announced after exceeding 80 μg/m^3 (*Co wiemy o smogu?*..., 2015).

According to the research, the implementation of the EU Blue and Green Infrastructure policy (hereinafter: BGI) has not been adequately reflected in legislation, and the *Lex Szyszko Act* is a striking example of this. Still until recently, there were no relevant provisions regarding rainwater and snowmelt water management within properties, which inhibited the broad implementation of solutions related to, among others, small retention. Therefore, relevant activities are only in the initial phase. Since recently, they are subsidised as part of a governmental programme ("*My Water*" 2020) and local programmes (e.g. "*Catch Rainwater*" in Lublin, "*Catch the Rain*" in Wrocław, and similar ones in Warsaw, Gdynia, Gdańsk and Łódź). In 2020, the Ministry of Climate together with the National Fund for Environmental Protection and Water Management launched a pilot competition for self-governments called "*City with a climate – green-blue infrastructure*". Certain elements related to BGI are included in the MPAs, but the scale of their enforcement is still small. Regarding green infrastructure, an important role in the development of green areas in cities is played by self-government initiatives (e.g. Kraków is deploying the "*Kraków in Green*" project and adopted the "*Poviat programme for increasing forest cover for the years 2018–2040", Resolution No. XXX/793/19*), actions undertaken by municipalities in cooperation with NGOs and private investors (e.g. "*One million trees for Warsaw*") and bottom-up activities (e.g. the Krajobrazy Foundation in Lublin, or the Immo Foundation in Bydgoszcz) involving planting trees and bushes in cities and promoting and supporting good practices in urban greenery. Residents are eager to submit projects related to green areas funded from participatory budgets (Lublin has a separate budget dedicated to green areas – the so called Green Budget) (Rzeńca, 2018; Kociuba and Bielecka, 2021). The cities' authorities are also

involved in implementing international projects and programmes allowing for more efficient adaptation to climate change through the introduction of green areas. An example is the "*Grow Green*" project being implemented in six European cities, including Wrocław, Manchester and Valencia. It involves the development and implementation of nature-based solutions (e.g. green roofs, rain gardens, pocket parks) (https://www.wroclaw.pl/growgreen/). It should be emphasised that these are sporadic initiatives, and local self-governments are rarely aware of the need to invest in greenery. Moreover, green areas are very often treated as a reserve of land for parking lots and housing development. This results in many social conflicts. This is despite the fact that actions for blue and green infrastructure resulting from the implementation of the *EU 2020 Biodiversity Strategy* (2011) or the *Strategy on Green Infrastructure* (2013) have been treated as an effective tool for counteracting the effects of climate change (SWD/2019/184 final), and BGI solutions have widely been introduced in the EU. One good example is the *Copenhagen Climate Adaptation Plan*, which aims at introducing green areas on all the newly constructed buildings in the form of green roofs, and green walls and facades, in accordance with detailed guidelines for the introduction of such solutions (Ilmurzyńska, 2016). Examples of good practices for effective water management and strengthening the contribution of local communities in local activities are projects for precipitation water management implemented in German cities. For example, in Berlin, artificial wetlands store rainwater, and its excess is used for sanitary purposes in municipal buildings (Iwaszuk et al., 2019). It should be emphasised that investment in BGI in Polish cities should intensify due to the implementation of the provisions of the *EU Biodiversity Strategy for 2030* (COM/2020/380 final), which points to the need to prepare "greening plans" for cities of more than 20,000 residents (23% of cities in Poland). The common introduction of management plans for blue and green infrastructure as a tool for implementing the "greening plan" is also recommended by scientists and practitioners as part of works on the new *National Urban Policy* (Szulczewska et al., 2021).

5. Conclusions and recommendations

The study focuses on determining the antecedences and effects of eco-city transformations in Poland in the legal and policy context. The review of changes in legislation and policies, and of national and local initiatives provided an answer to research question No. 1. It was determined that the eco-city concept is being implemented according to a top-down approach, and the primary initiators of city transformations towards ecology-based regimes are national authorities, and more seldom self-governments. The activities are mainly based on implementing appropriate pro-environmental policies and developing relevant legislative solutions. Due to the diverse aspects of the eco-city, it is expected that various tools will be used to implement the concept depending on the allocated scope of activities of governmental bodies and self-governmental authorities (Table 10). Tasks concerning waste management, energy engineering, the use of renewable energy sources and the improvement of air quality are initiated and coordinated primarily by the central authorities. These tasks include the implementation of provisions of international and EU programming and strategic documents and legal acts into Polish policies and legislation, or in the form of governmental programmes. Self-governmental authorities implement and execute the provisions of these documents within the framework of their competences and tasks, but they can also introduce solutions relating to the aforementioned aspects of the eco-city concept; however, to a great extent they result from regulations and obligations of a higher level. For example, local authorities are contractors of programmes and plans regarding air protection and waste management prepared at the regional level, although developing the method by which the stipulated objectives are reached is the task of communes. Local authorities are also responsible for issues regarding low emission, sustainable transportation, water and wastewater management and green areas arising from the implementation of the climate and energy policy frameworks. Changes in particular eco-city aspects are determined, in some cases, not only by the implementation of commonly binding legal provision but also

Table 10. Effect of statutory and non-statutory factors on the implementation of particular eco-city aspects

Eco-city aspects	Changes in law		Governmental programmes		Activities of local authorities		Bottom-up activities		Fees	
	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków	Lublin	Kraków
Waste management	+	-/+	-	-	+	+	-	-	+	+
Water and wastewater management	+	-	+	-	+	+	-	-	+	-
Energy engineering and RES	-	+	+	+	+	+	-	-	-	-
Transport and urban mobility	-	-	-	-	+	+	+	+	+	+
Green urban areas	+	-	-	-	+	+	+	+	-	-
Air quality	+	+	+	+	+	+	-	-	-	-

"+" – effect, "-" – no effect
Source: authors' elaboration

by their implied increases in fees introduced by local authorities, which change resident habits, thereby intensifying pro-ecological activities (as is particularly evident in the case of changes in waste management fees). The governmental programmes and municipal initiatives focuses on reduction of point-source emission and improving air quality and the use of RES in the energy sector. Bottom-up activities have a positive effect on urban mobility, and especially bicycle transport and green areas.

Multi-criterion analyses conducted within the study allowed research question No. 2 to be answered. It was determined that transposing acts of EU law into national and local law and implementing provisions of pro-ecological policies at the local level contribute, to various degrees, to changing the analysed indices in particular aspects. The results were best for waste management (particularly in the transition to circular economy), sustainable transport, urban mobility (the expansion of systems of collective public transport and urban bicycles), and air quality improvement – that is, in all areas in which self-governments can largely generate development through legislation and policies aimed at implementing eco solutions., using a dedicated set of tools (e.g. LEP, SUMP). No significant changes were observed in the scope of water and wastewater management and green areas. This largely results from the weakness of legislation, which considerably delays the undertaking of systemic activities for blue–green infrastructure and, in the case of green areas, even weakens them (the *Lex Szyszko Act*). No substantial improvement was also recorded in energy engineering and the use of RES. This results from the national energy policy (which is partly at variance with the provisions of programming documents), which has been partially reoriented only in recent years to take advantage of financing activities related to implementing the European Green Deal (including green transition).

Based on the theoretical analysis of the eco-city concept, global, national and local legislation and policies, as well as studies based on quantitative indices, recommendations were developed that can be implemented in cities to support and improve the eco-city solutions. They are:

1. Implementing plans and demonstrative projects of eco cities or districts modelled after Asian eco-cities (de Jong et al., 2016) or Western European initiatives (Boxenbaum et al., 2011; Tomozeiu, Joss, 2014). The role of authorities and local conditions is important here, because the complexity and specificity of eco-cities do not allow for the wholesale adoption of a set of development activities from another city (Hu et al., 2016).
2. Conducting complex pro-ecological measures in cities, focusing on aspects related to climate change and BGI (obligatory development and implementation of MPAs, modelled after the *Copenhagen Climate Adaptation Plan,* and/or dedicated blue–green infrastructure management plans; set aside allocations

for Green Budget in city budgets; small retention actions), energy efficiency, RES and air quality (lowering alarm and notification levels for air pollutants to values applied in Western Europe; increasing the scale of finance and implementation of programmes aimed at co-financing the replacement of heat sources with low-emission ones and the use of RES in households and public transport; thermal modernisation actions in public and private sector to improve housing standards ; systemic investments in green infrastructure and increasing the flexibility of the energy transmission, distribution and storage systems, especially construction of energy storage facilities, including low-cost heat storage for individual users), waste management (increase the scale of financing and implementation of programmes supporting the transition towards CE in the built environment ; development of local Strategies for Circular Economy), and urban mobility and transport (development of SUMPs and other dedicated strategies, concepts and plans; promoting and supporting urban mobility actions; introduction of "Tempo30" zones and Clear Transport Zones, especially in the centres of large cities; preparation and implementation of standards for pedestrian mobility; construction of a coherent system of bicycle paths within cities and their functional areas). These actions should be supported by targeted educational and promotional campaigns.

3. Increasing the importance of the bottom-up approach in the transformation towards eco-cities via pro-ecological activities involving residents and private entities (Hofmeister et al., 2014). Examples in this context include the *FORCE* project (Izdebska and Knieling, 2021), the creation of the Lublin bicycle ecosystem (Kociuba and Wieliniec, 2020), activities of the authorities and residents towards a transition to a low-carbon economy (Hu et al., 2016), or involving cities in national and international networks related to promoting green solutions and implementing good practices (developed, e.g., under the "*Grow Green*" project).Particular attention should be paid to authorities building relationships with other entities, to how different stakeholders in favour of the eco-city transformation interact, and to what role different public and private entities play in the process (Hu et al., 2016; Yin et al., 2016). Residents should be particularly involved in the transition process, as it is their activities that result in negative environmental externalities such as: over-production of waste, appropriation of space, and point-source emission from, for exaample, private transport and local furnaces.

Finally, it should be emphasised that some of these activities may necessitate the implementation of provisions of the European Green Deal, resulting in the amendment and adoption of new packages (e.g. *Fit For 55* package), normative acts (including the *European Climate Law*, COM/2020/563 final), strategies (*EU Biodiversity Strategy for 2030: Bringing Nature Back into Our Lives,* COM/2020/380 final; *Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change*, COM/2021/82 final), programmes, and plans (*Pathway to a Healthy Planet for All. EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil"*, COM/2021/400 final; *A new Circular Economy Action Plan for a Cleaner and More Competitive Europe,* COM/2020/98 final) that will result in further changes in legislation and policies of member states and impact on the eco-city concept implementation.

Notes

1. All EU countries are UN members. Since 1974, the Community has the status of a permanent observer in the United Nations General Assembly. Since 2011, EU representatives have been able to present the position of the EU and its member states at the UN forum, including submitting comments, conclusions and amendments even at an early stage of works, and

participating in the general debate at the opening session. The EU is the only party to more than 50 UN conventions that is not a country and has full right of vote in three UN bodies.

2. Emission targets under the *Kyoto Protocol* were determined based on subsequent Commission decisions (2006/944/WE, OJ L 358, 16.12.2006; 2010/778/UE, OJ L 332, 16.12.2010; 2013/644/EU, OJ L 301, 12.11.2013).
3. The amended *Gothenburg Protocol* establishes legally binding emissions reduction commitments for 2020 and beyond for the major air pollutants: sulphur dioxide (SO_2), nitrogen oxides (NOx), ammonia (NH_3), volatile organic compounds (VOCs) and fine Particulate Matter (PM2.5).
4. In 2030 they cover: a -7% reduction in greenhouse gas emission in non-ETS sectors (compared to 2005), a 21–23% share of RES in final gross energy consumption (the objective of 23% will be achievable if Poland is granted additional EU resources, including those allocated for Just Transition), including a 14% share of renewable energy in transport, and, moreover, a 23% increase in energy efficiency and a 56–60% reduction in the share of coal in electricity production.
5. They are the so-called thermal modernisation commission (payment by the state of up to 20% of a loan incurred for a thermal modernisation undertaking), thermal modernisation concession (tax concession accrued to a specified amount – currently PLN 53,000), and a bank loan for a pro-ecological investment ("*Transparent loan*" at the Environmental Protection Bank).
6. Each of the cities implemented projects financed as part of national and regional operational programmes related to the expansion of the trolley bus traction (Lublin) and tram traction (Kraków), purchase of a low-emission fleet, construction of P&R/B&R parking lots and transport hubs, and expansion of public transport management systems and ITS, including the introduce of the electronic city card (Kraków) and electronic agglomeration ticket (Lublin), which constitute a cheaper option for the user and permit the optimal use of several types of collective transportation.
7. The initiatives involve participation in supranational actions and campaigns promoting sustainable transport and urban mobility, e.g. European Sustainable Transport Week (Kociuba and Wieliniec, 2020), actions *"STARS – Cycling to School" or "Battle for Kilometres"* (Kostrzewska, 2016), or activities of cities conducted together with the city's activist environment (e.g. the *"Cycling to the University"* campaign in Lublin, or "*I Cycle to Work*" in Gdynia).

References

Boxenbaum, E. Acquier, A. Pinheiro-Croisel, R. Garza de Linde, G. (2011). *Process of Institutional Innovation: Reference Tools for Eco-cities in France and Denmark*, 1-36, PUCA, France.

Broaddus, A. Brownie, M. Allen, J. (2015). Sustainable Freight: Impacts of the London Congestion Charge and Low Emissions Zones. *Transportation Research Record: Journal of the Transportation*, 2478(2): 1-11. DOI: https://doi.org/10.3141/2478-01

Całka, E. (2016). The Primacy of European Union Law over National Law under the Constitutional Treaty (in Polish). *Studia Iuridica Lublinensia*, 25(1): 47-58. DOI: https://doi.org/10.17951/sil.2016.25.1.47

Chodkowska-Miszczuk, J. Lewandowska, A. (2018). Creating a sustainable urban transport on the case study of Copenhagen – selected aspects (in Polish). *Prace Komisji Geografii Komunikacji PTG*, 21(3): 45-59. DOI: https://doi.org/10.4467/2543859XPKG.18.014.10139

Co wiemy o smogu? Informacje o zanieczyszczeniu powietrza w Polsce. (2015). Kraków: Krakowski Alarm Smogowy.

Czyż, T. (2016). The index method in socio-economic geography (in Polish). *Rozwój Regionalny i Polityka Regionalna*, 34: 9–19

de Jong, M. Yu, Ch. Joss, S. Wennersten, R. Yu, L. Zhang, X. Ma, X. (2016). Eco city development in China: addressing the policy implementation challenge. *Journal of Cleaner Production*, 134A: 31-41. DOI: https://doi.org/10.1016/j.jclepro.2016.03.083

Dybalski, J. Mosiej, M. Puzyński, J. Syryjczyk, T. Grobelny, M. (2017). *Parkingi a transport zbiorowy a miastach*. Kongres Transportu Publicznego. Warszawa.

Frankfort-Nachmias, C. Nachmias, D. DeWaard, J. (2015). *Research Methods in the Social Sciences*. Worth Publishers Inc., New York. U.S.

Gilowski, P. Kuś, A. (eds.) (2010). *Prawo Unii Europejskiej z uwzględnieniem Traktatu z Lizbony*, Wydawnictwo KUL, Lublin.

Gutowski, B. (2006). *Przestrzeń marzycieli. Miasto jako projekt utopijny*. Oficyna Wydawnicza Feniks. Warszawa.

Grzymała, Z. (2016). Eco-Cities - Case Studies and Development Perspectives (In Polish). *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 432: 61-66. DOI: https://doi.org/10.15611/pn.2016.432.06

Heurkens, E. Dąbrowski, M. (2020). Circling the square: governance of the circular economy transition in the Amsterdam Metropolitan Area. *European Spatial Research and Policy*, 37(2): 11-31. DOI: https://doi.org/10.18778/1231-1952.27.2.02

Hofmeister, W. Rueppel, P. Fook, L.J. (ed.) (2014). *Eco-cities: sharing European and Asian best practices and experiences.* Konrad-Adenauer-Stiftung – Singapore, East Asia Institute, European Union Policy Centre in Singapore, Brussels, Belgium: European Policy Centre.

Howard, E. (1898). *Tomorrow, a Peaceful Path of Real Reform* (Reissued as Garden Cities of Tomorrow in 1902). MIT Press. Cambridge.

Hu, M. Lagerstedt Wadin, J. Lo, H. Huang, J-Y. (2016). Transformation toward an eco-city: lessons from three Asian cities. *Journal of Cleaner Production*, 123: 77-87. DOI: https://doi.org/10.1016/j.jclepro.2015.09.033

Ilmurzyńska, K. (2016) Zieleń w miastach. Część 2 – przykłady „zielonej polityki", *Builder*, 20: 12-16.

Iwaszuk, E. Rudik, G. Duin, L. Mederake, L. Davis, M. Naumann, S. Wagner, I. (2019). *Błękitno-zielona infrastruktura dla łagodzenia zmian klimatu – katalog techniczny*. Fundacja Sendzimira. Berlin – Kraków.

Izdebska, O. Knieling, J. (2021). Citizen involvement in waste management and circular economy in cities: key elements for planning and implementation. *European Spatial Research and Policy*, 37(2): 115-129. DOI: https://doi.org/10.18778/1231-1952.27.2.08

Jakubowski, K. (2018). Involving residents in green activities (in Polish). *Zrównoważony Rozwój — Zastosowania*, 6: 57-71.

Joss, S. (2010). Eco-cities: a global survey 2009. *WIT Transactions on Ecology and the Environment*, 129: 239-250. DOI: https://doi.org/10.2495/SC100211

Joss, S. (2011). Eco-cities: the mainstreaming of urban sustainability; key characteristics and driving factors. *International Journal of Sustainable Development and Planning*, 6(3): 268-285. DOI: https://doi.org/10.2495/SDP-V6-N3-268-285

Joss, S. Tomozeiu, D. Cowley, R. (2012). Eco-city indicators: governance challenges. *WIT Transactions on Ecology and the Environment*, 155: 109-120. DOI: https://doi.org/10.2495/SC120101

Kenworthy J. (2006). The Eco-city: Ten Key Transport and Planning Dimensions for Sustainable City Development. *Environment and Urbanization* 18(1): 67-85 DOI: https://doi.org/10.1177/0956247806063947

Kociuba, D. Wieliniec, D. (2020). Development of Cycling Infrastructure in the Context of Functioning of Urban Bicycle-Sharing System - Case Study of Cracow and Lublin (in Polish). *Annales UMCS, sec. B,* 75: 213-252. DOI: https://doi.org/10.17951/b.2020.75.0.213-252

Kociuba, D. Maj, M. (2020). Walkable city and universal design in theory and practice in Poland. *Bulletin of Geography. Socio-economic Series*, 50: 113-132. DOI: http://doi.org/10.2478/bog-2020-0036

Kociuba, D. Bielecka, M. (2021). Influence of the Amendment to the Law on Municipal Self-Government on the Implementation of Participatory Budgeting in Voivodship Cities in Poland (in Polish). *Studia Regionalne i Lokalne*, 1(83): 84-112. DOI: DOI: https://doi.org/10.7366/1509499518305

Kostrzewska, M. (2016). Urban regeneration through the sporting events and initiatives (in Polish). *Przestrzeń, Ekonomia, Społeczeństwo*, 9(1): 51-65.

Lee, J.H. Hancock, M.G. Hu, M.C. (2014). Towards an effective framework for building smart cities: lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*, 89: 80-99. DOI: https://doi.org/10.1016/j.techfore.2013.08.033

Lewandowska, A. (2016). *Implementacja zrównoważonego rozwoju w miastach azjatyckich*. in: Marszałek-Kawa, J. (ed.). *Chiny i świat zewnętrzny*, 197-211. Wydawnictwo Adam Marszałek, Toruń.

Lewandowska, A. Szymańska, D. (2019). Municipal waste recycling in big cities in Poland in the context of ecologisation. *Bulletin of Geography. Socio-economic Series*, 43(43): 131-141 DOI: https://doi.org/10.2478/bog-2019-0009

Lin, Z. (2018). Ecological urbanism in East Asia: A comparative assessment of two eco-cities in Japan and China. *Landscape and Urban Planning*, 179: 90-102. DOI: https://doi.org/10.1016/j.landurbplan.2018.07.008

Mączka, K. Milewicz, M. (2020). *Wrocławscy i Sztokholmscy: ekologia po polsku i po szwedzku*. Fortum.

Register, R. (1987). *Eco-city Berkeley: Building Cities for a Healthy Future*. Berkley: North Atlantic Books.

Rzeńca, A. (2016). *Zrównoważony rozwój miast*. in: Rzeńca A. (ed.), *EkoMiasto#Środowisko. Zrównoważony, inteligentny i partycypacyjny rozwój miasta*, 49-61. Wydawnictwo Uniwersytetu Łódzkiego.

Rzeńca, A. (2018). Green Participatory Budgets (in Polish). *Zrównoważony Rozwój - zastosowania*, 6: 120-132.

Rzeńca, A. Mysiala, R. (2019). Low-Emission Economy Plans – Planning and Implementation Dilemmas. The Case of Cities in the Lodz Metropolitan Area. *Ekomonia i Środowisko*, 4(71): 95-106. DOI: https://doi.org/10.34659/2019/4/51

Sas-Bojarska, A. Walewska, A. (2014). Od garden city do ecocity. in: P. Lorens, I. Mironowicz (eds). W*ybrane teorie współczesnej urbanistyki*, 118-152. Gdańsk University of Technology. DOI: https://doi.org/10.13140/2.1.4283.8084

Szulczewska, B. Sobol, A. Legutko-Kobus, P. Hajto, M. Pawlik, Ł. (2021). Rozwój błękitno-zielonej infrastruktury w miastach. https://kongres.miasta.pl/wp-content/uploads/2021/06/S.01-2_ROZWI%C4%84ZANIE.pdf

Tomozeiu, D. Joss, S. (2014). Adapting adaptation: the English eco-town initiative as governanace process,. *Ecology and Society*, 19(2): 20. DOI: http://dx.doi.org/10.5751/ES-06411-190220

Trigg, M. Richter, M. McMillan, S. O'Rourke, S. Wong, V. (2010). *Sustainable Cities Index. Ranking Australia's 20 largest cities in 2010.* Australian Conservation Foundation.

Węcławowicz-Bilska, E. (2014). Polish cities of the future - trends, concepts, implementations (in Polish). *Czasopismo techniczne Architektura*, 2-A: 307-326.

Węcławowicz-Bilska, E. (2015). The idea of a green city (in Polish). *Czasopismo techniczne Architektura*, 12-A: 49-74.

Widłak, R. (2013). *Kopenhaga – jedno z najbardziej „zielonych" miast na świecie. in: Jankowska,* M. (ed.) *Miasta z wizją*, 107-130. Warszawa: Wydawnictwo Instytut Obywatelski.

Wieteska-Rosiak, B. (2013). *Koncepcje rozwoju miast w świetle zrównoważonego rozwoju*. in: Nowakowska, A. (ed.), *Zrozumieć terytorium. Idea i praktyka*, 399-413. Łódź. Wydawnictwo Uniwersytetu Łódzkiego.

Yin, R. (1994). *Case Study Research: Design and Methods*, secondo Ed. Sage Publications, Thousand Oaks, CA.

Yin, Y. Rader Olsson, A. Håkansson, M. (2016). The role of local governance and environmental policy integration in Swedish and Chinese eco-city development. *Journal of Cleaner Production*, 134a: 78-86. DOI: https://doi.org/10.1016/j.jclepro.2015.10.087