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CIRCULAR ECONOMY IN SUSTAINABLE WATER MANAGEMENT – THEORY AND PRACTICE

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ABSTRACT: The article presents the principles of the circular economy implemented in the management of water resources. Special attention was paid to problems in water management in new market conditions related to the adoption of the new Water Law. Changes in water management were reviewed in the light of the provisions of the adopted new Water Law and threats resulting from its introduction, especially in the light of the impact on budgets of households and enterprises. Examples of good practices in the implementation of the circular management principles in water ecosystems in the country and around the world were also presented.

KEY WORDS: sustainable development of water management, circular economy, water reuse, new Water Law

Introduction

Sustainable water management should satisfy various needs: water supply and sewage drainage, use of water resources for energy, marine, agricultural, fishing and tourist purposes as well as ensure respective protection against the water element and the effects of drought. It should also provide appropriate quantity and quality of water resources allowing the functioning and protection of water ecosystems and systems dependent on water. The formulation, and then implementation of a water management program according to the principle of sustainable development requires interaction of various industries using the water resources, cooperation with naturalists as well as cooperation with the society. The system of managing and financing water management in Poland requires improvement. This is necessary due to the need to fulfil Poland's obligations resulting from catchment nature of the water policy, also including fulfilment of diverse – and important for the economy and the society – needs and expectations related to the protection of water ecosystems in combination with the principle of sustainable development and postulates of the circular economy. The new act – Water Law adopted by Sejm RP is supposed to foster full implementation of the above principle. Presently the new Water Law significantly varies from the previous laws and many of its regulations raise numerous controversies. One of them applies to the principle of refund of water services costs. It turns out that very many ways of using water will entail higher fees than before, and the fees themselves will apply to many more various kinds of operations. Today we are asking the question how will it affect the budgets of households and enterprises?

In the article an attempt has been made to assess changes in water management in the light of implementing the provisions of the new Water Law and also the principles and postulates related to building a closed circulation economy. The article also presents practical examples of water supply – sewage enterprises implementing the principles of closed circulation economy and sustainable development.

Research methods

The presented article is a theoretical study and consequently the basic research methods were:

- analysis of the domestic and foreign subject literature and thematic studies in this problem area,
- presentation of a case study related to water recycling,
- expert assessment of the solutions presented.

Building circular economy in water supply and sewage companies in practice

Circular economy has been the subject of interest of many researchers (see: Boulding, 1966; Stahel, Reday, 1976; Stahel, Reday, 1981; Pearce, Turner, 1990; Sauvé et al., 2016; Preston, 2012; Mitchell, 2015; Qiao, Qiao, 2013; McDowall et al., 2017; Heck, 2006; Ghisellini et al., 2016; Kirchherr, Reike, Hekkert, 2017; Rizos, Tuokko, Behrens, 2017; Fiedor, 2002; Lorek, Lorek, 2011) and is currently an inherent part of the concept of sustainable development.

Circular economy is a system in which the production of energy, goods and services and consumption are organized so as to maximally reduce the demand for original fuel, raw materials, water, soil and other natural resources. Projects being part of the implementation of circular economy assume closed circulation of raw materials, including water, and water recycling is an option which benefits all parties (both nature and people). It should however be noted that, when access to resources is free or fees for use are low, there is a tendency to waste them, and circular economy solutions do not raise interest. Consequently, what is necessary is to promote such solutions using political instruments, such as fees and rates. Already in 2015, the European Commission concluded that circular economy is a key element in establishing a competitive economy based on sustainable development (see Closing the loop…). The European Commission recommends member states to develop new economy models, in which a transition is made from selling goods to offering high quality services. In practice, this means heading towards a less material and waste intensive economy. Such activities can be profitable and bring along a number of successful achievements. Re-use of sewage treated in safe and profitable conditions is a valuable, but little used method to increase water resources and offer a relief to the excessively exploited water resources in the European Union. For instance, re-use of water in agriculture contributes to recycling of nutrients which replace solid fertilizers. The European Commission makes a number of efforts in order to encourage re-use of treated sewage. From more than 40 billion m^3 of sewage treated within the European Union every year, only 964 million m^3 are re-used (Gieleciak, 2017). Treated sewage recycling contributes to rational water management and thus is compatible with sustainable water management. This brings along measurable environmental, economic and social benefits (Common Implementation Strategy for the Water Framework Directive and the Floods Directive, 2016).

Among the environmental benefits from the application of closed circulation economy, the following can be mentioned: reduced frequency of using

artificial fertilizers, much lower negative environmental aspect than for alternative ways of obtaining water.

Economic benefits are first of all demand for effective water recovery and recirculation technologies, opportunity to take advantage of the potential of sewage and stimulation of innovation.

Social benefits come down to stimulation of development of various sectors of the economy and growth in employment (Korzyści społeczne z gospodarki obiegu zamkniętego, 2016).

Such operations can be profitable and bring along a number of successful achievements to the businesses. Examples of recycling treated sewage and re-use of "recovered" water are already known worldwide. And so:

- in the United States treated sewage is used for irrigating agricultural crops, golf courses, school areas, parks, streets, greenery belts and supplying underground waters as well as industrial applications (EPA, 2012),
- Italy – for irrigating agricultural crops, for industrial applications. Extensive use of "recovered" water for irrigating crops takes also place in other Mediterranean countries (Spain, Cyprus, Greece) (Bixio, Wintgens, 2006) and in Israel (Voulvoulis, 2018),
- France – treated sewage is used for irrigating arable fields, orchards, tree plantations, forests, meadows and gardens (Gieleciak, 2017),
- UK – treated sewage is used for proper maintenance of river flow, 30% of household sewage is returned after cleaning to houses equipped with a double water supply system (Gieleciak, 2017).

In Poland, we can also give examples of recycling treated sewage. For instance, Nakło and Włosów sugar factories use biologically cleaned sewage in process circulation for rinsing and cooling gas, cooling pumps and washing beets. On the other hand, AQUA sewage treatment plant (Bielsko-Biała) supplements water in fish ponds. The Commune of Gołuchów irrigates hemp willow crops and uses treated sewage for watering greenery. The power company Tauron Ciepło sp. z.o.o. supplements cooling systems with treated sewage.

An example of a company that applies the principles of closed circulation economy in management and operates on the basis of the sustainable development guidelines is Regionalne Centrum Gospodarki Wodno – Ściekowej S.A. in Tychy. It is the only Polish company that has been distinguished by European award EMAS AWARDS 2015, known as Oscar in ecology. The company operates based on the minimum emission and no emission to the environment, minimization of the quantities of generated waste, energy self-sufficiency, rationalization of water use, optimization of incoming sewage and rationalization of technological processes. Following the mentioned actions, the company has achieved the following effects:

- after introducing treated sewage to Gostynki reservoir, improvement in water quality in the river was diagnosed,
- after closing water – sewage circulations with maximum secondary use of treated sewage, annual drinking water consumption was reduced by more than 160 000 m^3/year, yielding savings in the amount of PLN 900 000/year,
- after introducing new cleaning technologies high quality treated sewage has been produced, with very small content of pathogenic microorganisms. Also, the energy effect has been obtained by using treated sewage in the production of eko-fuel and nutrients have been maximally recovered as energy substrates.

The company perceives technological progress not only through the prism of generated profit, but also fulfilment of social and environmental standards. It achieves environmental effects, energy, time and human work savings. It is an example of a model water-sewage company pursuing the principles of closed circulation economy and sustainable development (Gieleciak, 2017).

From the presented overview of the states following the principles of circular economy in sustainable water management, it can be inferred that there are no consistent, uniform regulations governing the quality of treated sewage intended for re-use for environmental purposes. It should be noted that there are individual regulations concerning sewage recycling created by EU member states, states from outside the European Union and international organizations, such as WHO. This opinion is confirmed by the analysis drawn up by Voulvoulis (2018) who reviewed the existing re-use systems and the regulations governing their operation (required cleaning level, acceptable levels of contamination in recovered water) all around the world. As the author states, most regulations are limited to the required water quality for various final applications. Some regulations were created years ago and now they need to be updated in order to reflect the present water crisis, at the same time taking account of today's technologies. These problems are also very significant due to the need to obtain social approval for such type of solutions. As the earlier cited author indicates, the initiatives for re-use of water in the USA have stimulated the growing social objection (e.g. worries about cleanliness and safety of potable water and water used for irrigating crops) and consequently, several of them have been suspended, despite substantial financial outlays that have been expended to perform them (Voulvoulis, 2018). To sum up, it can be stated that an effect of the broad implementation of the assumptions of closed circulation economy should be development of uniform legal regulations concerning sewage recycling.

Legal and economic determinants of water management under the conditions of the Polish economy

Safety and rational management of water resources are some major elements forming the state's environmental policy. The fundamental legal act establishing the framework for the Community action in the field of water policy of the European Union is the Directive of the European Parliament and the European Council no. 2000/60/EC of 22 December 2000, commonly called Water Framework Directive (RDW). It introduces the integrated water policy, aimed among others, to ensure access to clean drinking water for people, which will permit economic and social growth, simultaneously respecting the needs of the environment.

The new Water Law act adopted by the Polish Parliament, valid as from 1.01.2018 is to order the water management system, implementing the EU directives and introducing changes for many entrepreneurs, offices of state administration, local government and other entities using water resources. The main assumption behind the reform of the organizational and legal framework of the water management system is centralization of water resource management. It is proven by a number of tasks presently being within the responsibility of local government units, which are to be concentrated in the hands of a specially established entity – State Water Company "Polish Waters". The new Water Law replaces the previous model by a new concept, i.e. "one river, one owner". According to the Ministry of Environment, the purpose of these changes is to allow complex water management as well as implement circular economy principles.

According to Article 9 of the Water Directive, member states of the EU should take account of the principle of refund of the costs of water services, including environmental and material costs as well as take account of economic analysis and the principle "the contaminating party bears the costs", which in practice means that such fees for water uptake and disposal of sewage must be fixed by entities providing water supply and sewage drainage services as to cover the actual costs of providing these services. In the course of the works on preparation of updated water management plans in the areas of river basins, the Ministry of Environment prepared an economic analysis, according to Appendix III to RDW, which demonstrated that costs of water services are presently refunded on the level from 22% to 24%, which proves a very low degree of implementation of this fundamental principle of water management in the domestic legal order. It seems justified for companies to incur full costs for using waters in industrial processes. It should also be remembered that the fees are to be balanced so as to stimulate rational use of water, and their absence so far has caused poor interest in solutions based on

the closed circulation concept. The new act introduces water price discrimination depending on the source of its origin Underground water will be nearly twice as expensive as surface water. The provisions of the act will significantly affect the operations of farms and will be reflected in higher production costs. The Ministry of Environment will aim (like in the case of power industry) to make a rates system for the fees subject to maximum water uptake – if it does not harm the resources, this fee will be lower, otherwise the fee will grow. The new regulations introduce additional charges for power plants, heat and power stations, farmers or fish breeders, which, affecting their production, will result in higher costs for electricity, heat, and other goods, in consequence also charging consumers' budgets. As a result of modernization and expansion of water sector infrastructure and simultaneous frequent absence of adjustments on the side of operating costs, the total cost of water and sewage services borne by Polish families is dangerously approaching in many cases a socially acceptable level. In Poland, the term "water poverty" is being used more and more often. The notion applies to the group of the poorest households, which will not be able to afford the fees for using water supply and sewage services. The open question asked at the beginning of the paper still remains – how will these changes in the new Water Law affect budgets of households and enterprises? Time will show how large these rises will be, one has to be aware that water is necessary for almost everything. Loose estimates indicate that one household, due to the new water fees, will spend PLN 70 per year more in shopping than now. However, to carefully estimate the effects of water price rises, it is necessary to dispose of credible data and this will be possible only after the transitional periods are finished and the regulations discussed are fully implemented.

Conclusions

The deliberations about water management in the new market conditions presented in the article, and the hazards resulting from introducing the new water law prove the effect of the new solutions on budgets of households and enterprises. What could withhold growth in prices of water and sewage services is greater importance attached to business aspects of water and sewage companies' operations and consideration given to a new market model, in which cooperation between companies would be strengthened – consolidation, regionalization or other forms of cooperation, making it possible to use the effect of scale. It will be of fundamental importance to introduce a business model based on the principles of circular economy. This will undoubtedly bring large savings along. Large savings may stimulate the

development of power from RES. Large quantities of water are used in mines for rinsing coal, in power plants for cooling the systems, like in other heavy industry plants, such as steelworks, nitrogen plants. The average world water uptake for the power industry is 7 percent, in Germany it is 18 percent, in Poland 70 percent. So far, power plants have not been paying for collected water. After introducing fees for power plants, the new water law, the average increase in the electricity price is to amount to approx. PLN 2–2.5 per year, in the years of drought even PLN 10 per person (of Greenpeace International, 2016). Still, any growth in prices will be reflected in prices of all products and services at the production of which electricity is used. Costs could be avoided, if the Polish economy and the companies operating in it followed the principles of circular economy. Consolidation conducted in Poland should be based on good models taken from the countries where such type of experience has been successful. Only general principles of sustaining the fees have been presented in the article. It is beyond doubt that they are extremely complicated, partly ambiguous, contributing to the high risk of mistakes or disputes as to fee levels. However, certainly after the new provisions take effect, the use of water will be very expensive. This will stimulate water savings, however will surely also make the price of many goods grow, if water is necessary to manufacture them, which consumers will probably experience soon.

The contribution of the authors

Elżbieta Lorek – 50% (conception, literature review, presentation of a case study related to water recycling; expert assessment of the solutions presented).

Agnieszka Lorek – 50% (conception, literature review, presentation of a case study related to water recycling; expert assessment of the solutions presented).

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