Eco-cities in the paradigm of a circular economy and a comprehensive internet

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Abstract. The article examines the cause-effect relationship of sustainable development and the formation of urban ecosystems on the principles of a circular economy using green technologies. For the purpose of the study, problems of organizing eco-city and eco-city management systems based on the cloud-based sharing platforms were selected. Particular attention was paid to exploring the possibilities of municipal government in the comprehensive Internet aspect.

Introduction
Cloud technologies and the Internet of things allow in a qualitatively different context to create an eco-format of urban space. The circular economy becomes the fundamental basis. International environmental standards of the life quality should be uniform and decisive for all the countries. Self-reliance based on environmental well-being is the main goal of the municipalities’ development. This goal becomes real thanks to the Big data and artificial intelligence technologies. According to the forecasts, by 2050 more than 70% of the world's population will be concentrated in the cities. The world community has long been in need to revise the order of formation and management of urban systems in connection with the growth of environmental risks. Many states independently introduce technologies of smart cities, smart houses and other smart systems for managing urban resources, but this is not enough to reduce not only environmental, but also social risks.

The achievements and publications analysis
The industrial economy can be divided into three types: linear, circular and productive. Linear economics transforms natural resources into materials and the final product, and profit is formed through value added. At the sale time, the buyer receives not only ownership title, but also responsibility for risks and waste. It is he who must decide how things that have served their life will be used. Linear economics is based on the principles: more, better, faster. In other words: fashion, emotions and progress. It is effective when it comes to overcoming the deficit, but wasteful if you need to use resources in saturated markets. Companies are forced to make money by selling large volumes of cheap goods.

The circular economy model looks different. Recycling of goods and materials creates new jobs, saves energy while reducing resource consumption and waste generation. Waste is considered in a completely different aspect - as a “new raw material”, which does not need to be mined, but needs to be included in the production cycle on different principles.
Waste management reduces costs by removing collection and disposal from the chain. In a circular economy, the goal is to increase product utilization at every stage of its service, and even after the expiration date. This creates new jobs. Moreover, there are new markets and collection points that take waste from users and transfer them to manufacturers. Part of the cost of purchasing is returned to the owner of the goods.

The circular economy model is one of the ways to introduce waste-free technologies. A new way of doing things may be more profitable. If earlier people received goods and threw them away after exploitation, now it becomes profitable to reuse resources, closing the chain.

A new way of doing business is changing the economic logic. Production becomes self-sufficient, that is, there is no need to endlessly look for new resources. What is broken can be repaired, outdated things can be improved, and what cannot be repaired or improved can be turned into resources for production. The experience of European countries shows that the transition to a circular economy and non-waste production technologies lead to a reduction in greenhouse gas emissions by up to 70%, while the number of jobs increases by 4%. [1] We emphasize that the business model of a circular economy is represented by two groups: reuse of resources due to repair, reconstruction, modernization, re-equipment and recycling of materials. In addition, both models are based on waste-free technology, that is, everything that is not needed for the main production should be used as efficiently as possible to create other products. [1]

In many respects, thanks to the policies of developed countries, where it is necessary to pay so much for recycling that it is cheaper to invent and implement technologies for its use, the relative purity of the environment in Europe is maintained.

A real example of the functioning of the circular economy is Sweden, which has been building a waste-free ecosystem for almost half a century. More than half of the country’s waste is recycled again, another half is incinerated, and only 0.8% of the waste that cannot be recycled is sent to landfills. In Sweden, 99% of household waste is recycled, and about 80% of heat supply systems are based on household and industrial waste. For the electronics industry, approximately 70% of gold and other precious metals are recovered from waste. Almost 700 thousand tons of garbage Sweden imports additionally from Norway, Ireland and the UK annually. There is a clear hierarchy in waste management: citizens are responsible for the household sorting of garbage, municipalities for the entire collection of urban garbage and transportation to recycling plants, and manufacturers are responsible for recycling packaging and products that have expired. It should be specifically mentioned that the emphasis is placed on mentality - the culture of a society implies the naturalness of caring for the outside world, that is, sorting garbage is obvious for every specific person since childhood. The society creates all the conditions for this and proves the all-round profitability of a healthy ecosystem independent of external supplies of energy resources and materials.

The economy of productivity goes even further. You can not just look for what to do with waste, but to base production on the sale of services, and not goods. The manufacturer retains ownership of the product and the resources invested in it. He is responsible for the waste. But this leads to the fact that the manufacturer has a renewable source of resources. The economy of productivity focuses on solutions, not on products; the source of profit will be self-sufficiency and the prevention of waste. [1]

South Korea, China and the United States support research projects and programs to promote a circular economy by increasing redistribution and reuse of resources. Thus, the Swedish Foundation for Strategic Environmental Research proposed a decision-making contest for a circular economy in 2014, and the European Commission handed over a package of documents on the implementation of a circular economy in December 2015. [1]

The formation of a circular economy is not the only tool that will contribute to sustainable development and at the same time preserve the environmental component of our planet.

Such a socio-economic process as urbanization is rapidly reshaping the picture of the world. In XXI century, megacities are becoming centers of economic growth, a base of new knowledge and technologies, a testing ground for testing the most ambitious innovative concepts. According to UN estimates, by 2050 the global urban population will grow by 2.3 billion people. and will constitute 2/3
of the total population of the Earth. Therefore, the city becomes a central place for the formation of eco-culture. With the rapid growth of the number of cities and the urban population, it is necessary to form a new look of cities.

M.V. Boykova, I.N. Ilina, M.G. Salazkin in their study distinguish three major categories of modern cities in the aspect of the innovation economy:
- global cities - "magnets" - have the status of the capital and / or the largest economic center (Abu Dhabi, Dubai, Seoul, Milan, Seattle);
- cities - “strategists” - introduce innovative development concepts and consider the priority to be the formation of high living standards based on the latest technologies (Vancouver, Charlotte);
- cities - “innovators” - survived the crisis due to the decline of traditional sectors, but managed to apply an innovative approach in creating new sources of growth and attracting the necessary resources (Tilburg, Huddersfield, Emscher Park).

At the same time, the conventionality of this division is noted, since the objects under study can simultaneously have different classification features.

**Formulating goals and setting the work objectives**

Modern humanity faces the task: how to adapt the type of settlement that has developed in the former social conditions to different principles of social and technological organization.

In this vein, the problems of the city are considered as sources of new opportunities, and its development is based on targeted strategies involving innovative management methods. One of the management methods under consideration was put forward by Murray Bookchin. American radical sociologist, political and social philosopher, libertarian socialist and environmentalist. In his opinion, the center of action for creating change must be at the municipal level: “the most important problem is to change the structure of society so that people get power. The best platform for this is the municipalities - cities, towns, and villages - where we have the opportunity to create direct democracy”.

Today we are witnessing the wide spread of alternative communities of a new type. Many communes and communities that emerged in the mid-twentieth century, gradually moved into the status of ecological settlements. The participants of these communities are united by the desire to get away from the shortcomings of civilization, to change their way of life, and most importantly - to harmonize relations not only between people, but also between man and nature. As a rule, such associations are engaged in the production of ecologically clean agricultural products, often using the latest achievements of alternative energy - solar panels and wind turbines.

In Vermont, there is a fairly well-known eco-settlement Cobb-Hill, located in Gartland. Only green technologies and organic farming are used for building houses and farming. [2] The spread of eco-settlements contributes to the preservation of the principle of sustainable coexistence of man and nature. But in parallel, the ongoing process of urbanization is not giving way to the development of eco-settlements. Therefore, in the second half of the last century, a new direction appeared in the world practice of development of urban areas - the construction of eco-cities, which by now has developed into an isolated strategy of urban development. [3]

The concept of “eco-city” was first proposed by R. Register in 1987. Somewhat later, the architect P. Daunton formulated the basic principles for the development of ecopolice, which are generally applicable to eco-cities:
1. Ecopolices do not use spoiled, unsuitable lands for crops, previously destroyed green areas are being restored, and ecological farming is encouraged.
2. Ecopolice must be biologically adapted to the habitat. The settlements under construction should correspond to local climatic and geographical conditions.
3. The roads in the ecopolice should be designed not only for the movement of vehicles, but also for pedestrians. The creation of environmentally friendly, non-motorized vehicles should be encouraged.
4. Energy production should be carried out using renewable sources.
5. It is necessary to support local agriculture, avoid pollution of water and air and follow the motto “Cities belong to all”.
6. It is advisable to encourage the creation of societies and organizations that should have the ability to independently manage the cities where they live.
7. Citizens must live in homes that fit their budget.
8. It is necessary to create decision-making mechanisms that would fully meet the concept of “democracy”.
9. In such cities, it is envisaged to regularly hold various cultural events aimed at preserving the spirit of the city and its history. [4]

Too much of the urban component requires coordinated decisions of civil society as a whole. A supranational platform is needed to provide resources and manage them based on the goodwill of citizens of different countries.

Materials of research and the scientific results justification
The development trend of eco-cities in the conditions of industrial and post-industrial society cannot continue without their interrelation with information technologies, which, if used properly, will contribute to the perfect arrangement of the city. The world is at the epicenter of digital transformation, when technologies help enterprises of entire industries and countries to differentiate existing strategies and designate new ones. This allows you to introduce a huge amount of innovation and to accelerate economic growth.

In Russia, the construction of eco-cities is simply necessary, especially in regions with developed industry and consequently disturbed ecology. It should be noted that in Russia there is a legislative and regulatory framework, as well as the technologies necessary to create eco-cities.

The analysis carried out shows that the considered processes of industrialization, urbanization and the development of information technologies, generate not only global risks. The experience of many countries proves that with proper use of these factors, it is possible not only to minimize risks, but also to achieve a high level of sustainable development with reduced energy, resource and financial costs.

Combining the principles of eco-cities and smart cities, developing according to the circular economy model, and satisfying the requirements of the concept of sustainable development, we present the model of a modern city (see figure 1).

The model is based on an international cloud platform, cloud data centers. The platform is joined by state "clouds". The main goal is to provide municipalities with software and infrastructure at minimal cost. That is, local authorities, not being able to buy a sufficient amount of equipment and software products to manage urban systems, get access to modern smart technologies.

Such companies as Cisco, the global leader in information technology, and AGT International, a global leader in urban infrastructure solutions, Fujitsu (with SPATIOWL basic smart city development), Microsoft with its Azure cloud platform, and many other giants in the IT field, have in their portfolios enough solutions for such a global project.

The model operates on the basis of the Comprehensive Internet, including the Internet of Things. That is, data comes from smart sensors of buildings, cars, smartphones, RFID, from social networks, for analysis, forecasting and optimization of information. Big data and artificial intelligence technologies are becoming available to ensure ongoing life-sustaining activity. The main goal is to form a dynamic virtual model of real cities to monitor the state of water, air, traffic flow, safety, noise level and energy consumption. Two-way communication with citizens is ensured through various applications in all cases.

We describe the schematic diagram of the model:
1. Inclusion - the city authorities, science, education, and the public are involved in the creation of a fundamentally new urban environment
2. Eco-quarters with smart houses are built as elements of the intellectual economy (sensors, sensors of the Internet of Things). Number of floors should be minimal - from one to four.
3. The basic principle is self-sufficiency based on “ecological well-being”: solar panels, generation of secondary energy from waste, waste-free livelihoods and zero energy consumption. Collecting rainwater, using bio reactors to clean and recycle water.

![Figure 1. Principle model of eco-city functioning based on the international cloud platform](image)

4. Use hydroponics to minimize transport costs for the delivery of products.
5. The use of eco-transport, both public and private (cycling, hybrids). Motor transport can be used outside the city, departure - through transport tunnels.
6. Parking should be lowered under the ground to vacate room for lawns.
7. Ensuring employment of the population in new areas of activity - restoring and preventing technologies
8. The housing community can use the norms of a municipal-private partnership for the use of land and infrastructure, or the norms of a “mutual company” (residents own 10% of property and 35% of income they contribute annually to develop and maintain the eco-quarter). In addition, all residents are taxpayers and local budget funds must be involved in a certain proportion necessarily. It is advisable to form a target financial fund for better control over the collection and expenditure of funds for these needs. In fact, it is self-government using the principles of cooperation and the elements of a sharing economy.

The main task is the gradual filling of the urban space with “eco-format”. Residents form their own habitat on the principles of eco-responsibility. Particular importance is attached to the primary sorting and primary processing of waste using mini-installations for 5-7 houses, and energy gain is used for illumination or watering. Solar panels will allow the accumulation of energy, and the "energy positive" houses of eco-materials will contribute to the implementation of the principle of "zero energy consumption". Zones inside the block are mostly pedestrian. All transport communications are hidden under the ground. The new habitat format allows the use of vertical farms for growing vegetables hydroponically (instead of the usual soil the containers are used). Residents use access to cloud services to develop common solutions with city authorities and to
control mutual actions. In addition, real-time cloud services allow you to monitor the implementation of environmental standards on an international scale and to learn best practices. Cloud technologies allow the use of modern software products to ensure safety, including those based on biometrics.

Under new construction, the proposed eco-norms will be used as a priori. In old neighborhoods, residents can optionally join the urban ecosystem by building smart sensors and equipping green areas. Parking will remain a problem, which can be partially solved by vertical multi-tier structures.

Summary

Thus, in the course of the study, it was proved that eco-cities and eco-quarters fully meet the concept of sustainable development and circular economy. Eco-city is an autonomous high-tech system using renewable energy sources, which has informal agricultural land, producing the necessary food stuffs, and at the same time not producing emissions of harmful substances. The design and operation of urban space is based, in turn, on stable thinking and lifestyle. A sustainable city as a basic unit of the modern economy sets the task of minimizing the human impact on the environment, its preservation as the only factor in the survivability of humanity.

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