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Review of mineral resource management in a circular economy infrastructure

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Abstract

Purpose is to substantiate foundations of sustainable management of mineral resources while implementing a circular economy model.

Methods. The study has applied following research approaches: synthetic method (unification of the singled out aspects); induction method (analysis of a circular economy features); life cycle assessment (evaluation of the product influence on the environment from the viewpoint of each stage of its life cycle); circular economy toolkit (determination and evaluation of the periodicity of circular economy products and indicators); and circular economy indicator prototype (evaluation of the cyclic product efficiency).

Findings. Circular economy is one of the key directions of a sustainable development policy as for conservation and protection of mineral resources; it is aimed at more efficient use and improvement of raw material extraction from industrial waste. Formation of a market infrastructure of the circular economy has been proposed based upon mining sector waste use to process it and reduce as well as to repurpose wasteless production and secondary processing of raw materials. The need has been substantiated to contribute to conservation of mineral resources for their sustainable use on the basis of the development of market infrastructure of a stable economy and mining sector waste use to process it and reduce as well as to repurpose wasteless production and secondary processing of raw materials.

Originality. A concept for further development of the circular economy market infrastructure has been specified as a platform of production waste supply/demand to optimize the use and conservation of mineral resources on the principles of sustainable growth. It has been proposed to analyze assessment of business development along the lines of a circular economy while calculating parameters when manufacturing is applying primary mineral resources and industrial waste as a raw material for its further processing.

Practical implications. The proposed approach of interaction between economic entities on the basis of a circular economy will provide rational use of mineral resources and contribute to the development of a sector of industrial waste processing. The abovementioned will help terminate decrease in the availability of mineral resources and form new milestones of social development on the principles of environmental friendliness and rationalism in the process of interaction with nature.

Keywords: *circular economy, mineral resources, rational use, market infrastructure*

1. Introduction

A decrease in the level of resource availability for economic activities, climate change, and increase in environmental pollution as a result of human relationships factor into loss of biodiversity pushing a society towards the development of inequality, intensification of social conflicts due to the restricted access to the key life-activity resources (being minerals, energy, and land), and encouraging to changes in the path of the world economy development [1]. Classical economic relations, which primary goal is to obtain and accumulate financial effect regardless of the sustainable economic growth, have caused problems of the global economy regeneration. Unreasonable resource use by economic entities has turned into industrial waste accumulation, influencing negatively the ecosystem, and into depletion of natural resources on the whole [2]. Consequently, the need for rational attitude to mineral resources and their renewal, industrial waste recycling, and secondary use of products have

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become an integral part of the development of both national and international economic entities in all spheres.

Business faces difficult choices caused by changes in the traditional logic: in some cases, expenses related to benefits for the society being mitigation of environmental risks if waste stream resulting from their activities is either decreased or dried up completely [3].

Implementation of adequate business measures needs fundamental changes in their traditional approaches to economic management; the abovementioned does not necessarily mean transition to the complicated industrial processes [4]. Support of innovations; and comprehensive analysis of economic activities to define new reserves of potential tendencies improving business on the principles of a circular economy open up new possibilities for economic entities, i.e. product range expansion; new relations with representatives of other industries; rapprochement with society; and identification of its requirements to favour approximating the conformity of product qualities to consumer needs.

Ukraine is a leading mineral state; it involves almost 117 types of minerals which is about 5% of the global mineral reserves [5]. In view of natural limitation, the matter of mineral resources has become of strategic importance. Sufficient amount of minerals ensures economic security of the country, autonomy of existence, and protection against global crises [6].

Restraining the development of processing industry (being technological backwardness, low level of innovative activities of economic entities, obsolete technical and technological facilities of a processing industry, heavy technological dependence upon foreign countries etc.) as well as hi-tech production in Ukraine have provided its status as a "resource-based state". The abovementioned favours prompt depletion of mineral resources of the country with their further export and development of foreign manufacturers while generating higher income at the expense of the created added value.

Hence, at the moment of rapid transition of international business to the circular economy principles, Ukraine needs cardinal changes in its progress which would provide maximum conservation of mineral resources; their rational extraction and use; investment attraction to renovate business production processes; increase in competitiveness of industrial enterprises; efficient commodity production on the principles of a circular economy; and promotion of development and strengthen the interaction between economic entities for the expansion of domestic commodity production.

The research objective is substantiation of the needs to apply mineral resources in the process of social relations on the principles of a circular economy and development of practical recommendations to favour market infrastructure of the circular economy for the accelerated implementation of strategic decisions of corresponding direction in the practices of economic relations. The research should solve following problems:

– identify a circular economy place in social development;

– study a process of the circular economy formation and development;

– analyze the tendency of mineral resource use in Ukraine;

– detect deficiencies and reserves to improve the situation with mineral resource use;

– develop recommendations to provide favourable conditions for progress of social relations on the circular economy principles with the aim of using the mineral resources rationally.

2. Literature review

Circular economy is rather a new idea of economic growth. It is still at the research stage and needs attention of scientists as for the search for alternatives to make optimum decisions for a certain number of questions [7]. Currently, there is no unified idea how to define a circular economy; each scientist understands it from his/her own viewpoint and describes its essence relying upon proper worldview.

Zhou & Smulders define circular economy as a closed-loop economy, which replaced a linear one. It is intended to develop production of goods and services, which would restrict formation of various pollution types as well as reduction of industrial waste [8]. The European Environment Agency (EEA) defines circular economy as such influencing mainly physical and material resources while processing them, decreasing their amount in manufacturing processes, and recycling them [9]. Circular economy is an economy of a new type; it is based upon implementation of the closed-loop cycles in all production processes [10].

From the viewpoint of involvement of resources in production activities, O. Shkurenko considers circular economy as a smooth (the repeated product use by means of its renewal and repair) and system-based process (the repeated use of materials as a guarantor of preservation of natural resources; element of the ecosystem) [7].

John Proops believes that circular economy performs such key useful functions of the surrounding world as resourcing and waste assimilation; in such a way, it is the basis of goodness. Everything is a part of other processes [11]. The development course of a circular economy is not limited by resource management. It has a wider sphere of influence involving: efficient use of energy resources; control and conservation of land reserves and rational approach for their use; and favouring protection of the environment, soil, and water basins [12]. Spheres of a circular economy influence involve rational use of primary natural resources as well as decrease in their extraction; renovation of old consumption models providing that significance of the raw materials and products will be maintained. Circular economy focuses on the two kinds of influence: continuous circulation of resources and development of consumption standards [13].

Rational use of mineral resources on the circular economy principles is an object of modern studies as well as a component of innovations in economic activities. Practical studies are carried out actively as for the circular economy development to preserve and recycle natural resources: ratio between the growth dynamics of mineral resources consumption and changes in their mining conditions [14]; search for the tendencies of implementing resource conservation based upon successful world innovations and the possibilities to adapt them to the current conditions [15]; and introduction of balance on the principles of environmental component into all sectors of economy [16].

Mainly, recent legislative amendments focus on favouring the circular economy growth towards changes in attitude to waste [17]. Nevertheless, the question remains open. Moreover, further scientific studies are required to update economic processes while transiting to the economy renovation. Lack of alternative economic mechanisms on the circular economy principles as for their implementation in the progress of economic activities inhibits business development, forms its uncompetitiveness, and decreases investment attractiveness.

It is an important tendency of further studies to provide conditions for interaction of economic entities, for the development of cooperation on the principles of a circular economy, and for sharing information as well as own activity results. Studies towards development of infrastructural elements of a circular economy will favour rapprochement between business entities and scientific institutions; creation of conditions which would provide formation of places where business representatives can meet with investors and manufacturers of technological equipment for conducting economic activities on the circular economy principles.

3. Methods

Study of orientation vector concerning efficient growth of domestic circular economy has helped analyze tendencies of waste formation and management in Ukraine. As a result, certain ways of the circular economy growth, adapted for domestic conditions, have been proposed.

The research has applied comparative analysis, which identified development problems of business on the circular economy principles as well as the necessity to implement relevant improvement measures.

Comparative method has analyzed development tendencies of a circular economy abroad; reserves have been identified to introduce certain development elements at the national level. The potentials of domestic manufacturers and society for changes in their attitude to lands resources have been identified while proper progress continuing taking into consideration the environmental preservation and protection.

Analysis of domestic business transparency owing to data synthesis and abstraction technique has helped understand readiness of economic entities to cooperation. Placement of information on the websites of companies concerning services for product recycling or finding investors for further development of economic activities on the basis of circular economy have made it possible to draw a conclusion what measures economic entities need to accelerate the cooperation. The abovementioned has helped us conclude that it is required to develop market elements of the circular economy infrastructure.

The requirements to favour further development of a circular economy through legislation as well as through the research continuation have been defined owing to the methods of mathematical statistics. Increase of waste amount in Ukraine and negative tendency excess of the generated waste over the disposed one have been determined. The aforesaid influences negatively the environment, favours depletion of mineral resources due to impossibility to process the disposed waste, and retards or disables implementation of scientific and technical developments (because of lack of assets and insufficient awareness) by businesses in their economic activities based on a circular economy.

Empiric research techniques have been applied to define both relevance and importance of the circular economy growth to protect and preserve mineral resources as well as environmental protection. A need has been identified to carry out further research for the development of infrastructural elements of a circular economy market. Specific attention should be paid to the Internet site improvement as a "meeting" place for supply and demand of the circular economy possibilities.

The World Business Council for Sustainable Development singles out the three assessment technique for a circular economy: a life cycle assessment being a method evaluating product influence on the environment in the context of all stages of its life, i.e. from raw material extraction up to its recycling; the circular economy toolkit determining and assessing potential improvement of product circulation; and a circular economy indicator prototype to assess the cyclic product efficiency [18].

4. Results and their discussion

In the middle of the 20th century under the conditions of rapid growth of classical (linear) economy, representing "take-make-dispose" process, American economist K. Boulding was the first who mentioned the limited nature of the Earth's resources comparing life on earth with life on a spaceship; he described human need for determination of proper place within the "cyclic ecosystem" [19]. Scientists interested in the idea; a decade later, it experienced its development through a message on the necessity to study new approaches to manufacture products which can be either reused or recycled [20]. Currently, the process is known as recycling being an innovative trend of conscious consumption, processing, and waste disposal [21].

Circular economy is a separate component of a green economy as well as one of the ways to favour sustainable development (Fig. 1). Consequently, its development goal unites elements of the key goals of the latter being represented in the environmental preservation and protection; support of increasing level of social development; and their interaction.

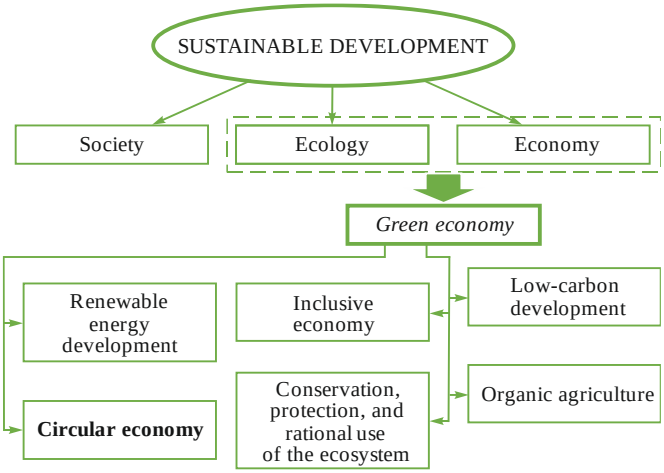

Figure 1. Circular economy place in the social development

Hence, circular economy can be defined as a progressive tendency of economic activity functioning within the framework of sustainable development of social activities, and focusing on the product reuse or recycle until its qualities, values, and possibilities to be useful are exhausted.

Circular economy started its development during Industry 4.0; it is characterized by a transition from the traditional system of production and consumption process with the final stage of waste understanding as "something unwanted and not worthy of attention" up to industrial waste understanding as a "reserve of development and raw materials for commodity production". The results of historical studies of shaping the circular economy have helped us form a visual process of its development shown in Figure 2.

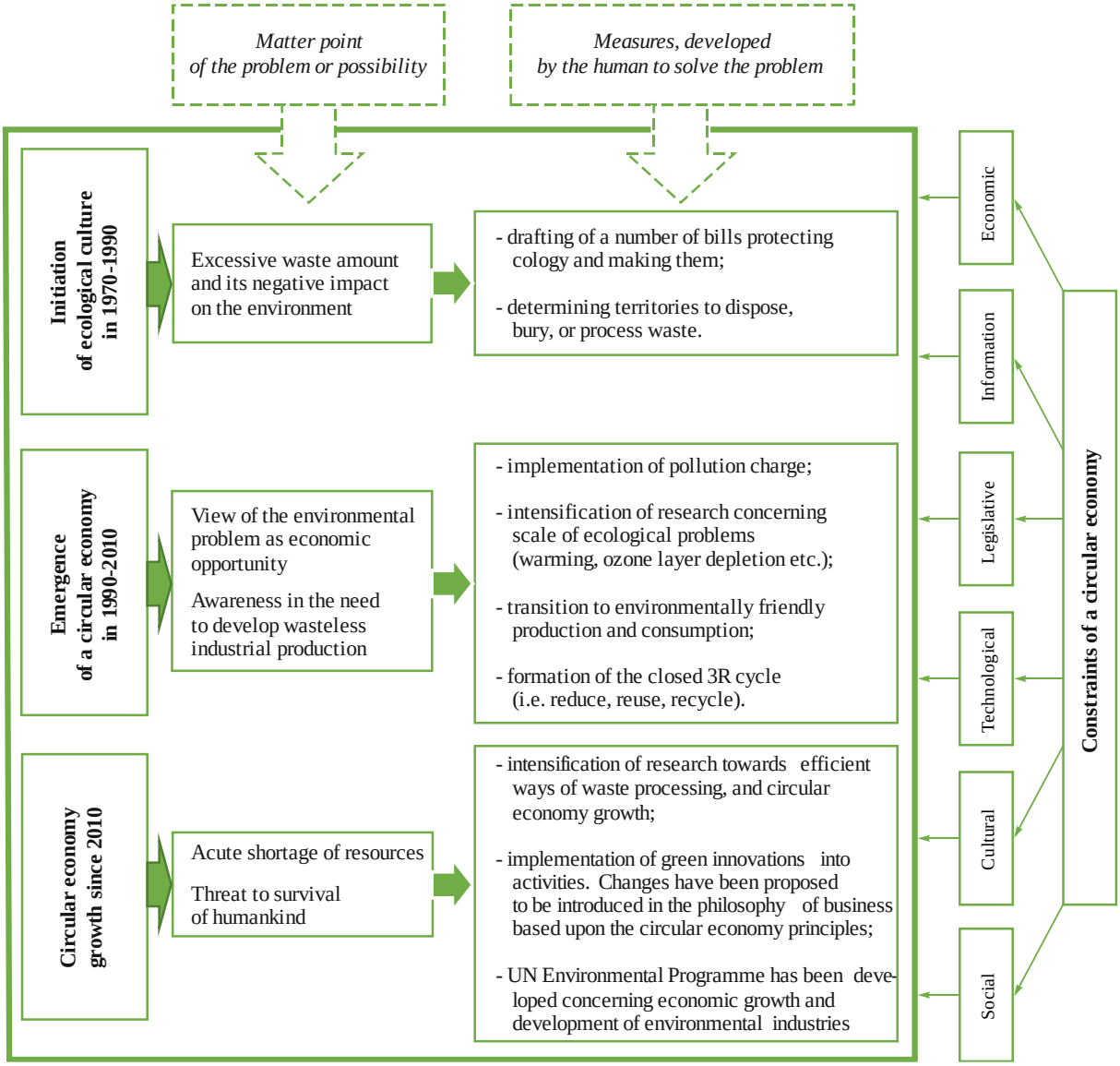

Figure 2. Development process of a circular economy (systemized based upon [22]-[24])

Currently, circular economy includes following types of its implementation into management practices of economic entities favouring significant bringing down environmental loads, preservation and conservation of mineral resources, and environmental protection [10]:

– planning of product with vision of its further repair, renewal, and a potential to be used after its validity period end;

– following separation of materials: applicable for reuse or utility exhaustion, disposition without harming environment;

– search for environmentally friendly ways of energy generation;

– favouring development of a recommendation for several clients to apply goods and services;

– transition to rational resource use at each stage of the product manufacturing;

– decline in the cost of goods owing to the decrease in the natural resource use;

– further use of a product by another customer after its first buyer applied it;

– favouring maximum prolongation of a product usage before its disposal;

– new product development from the components of other product which cannot be used anymore;

– target reorientation of a product, i.e. its reuse for other purposes;

– energy generation while applying used product elements.

Circular economy growth favours obtaining environmental effect while promoting social progress of a society while increasing job number as well as public thinking reorientation towards human functioning on the basis of the ecosystem conservation and protection. Circular economy growth activates functions by raw material processing industries, service industries, repair industries, construction industries etc. [13].

Currently, circular economy growth in Ukraine is a live issue since the country is characterized by excessive areas of dumps and landfills to compare with the total area of its nature reserve fund. Moreover, 42.3% of the landfills are not certified; 32984 dumps are unauthorized. Ukraine is among the countries with the highest indices of waste generation, and the lowest efficiency of mineral resource use. Mining and processing enterprises are the key waste suppliers [25]. Figure 3 shows the amounts in Ukraine over the year of 2020.

Ukraine demonstrates progressive tendency of waste accumulation. It results from the restrained development of its neutralization management as well as lack of infrastructure of handling it.

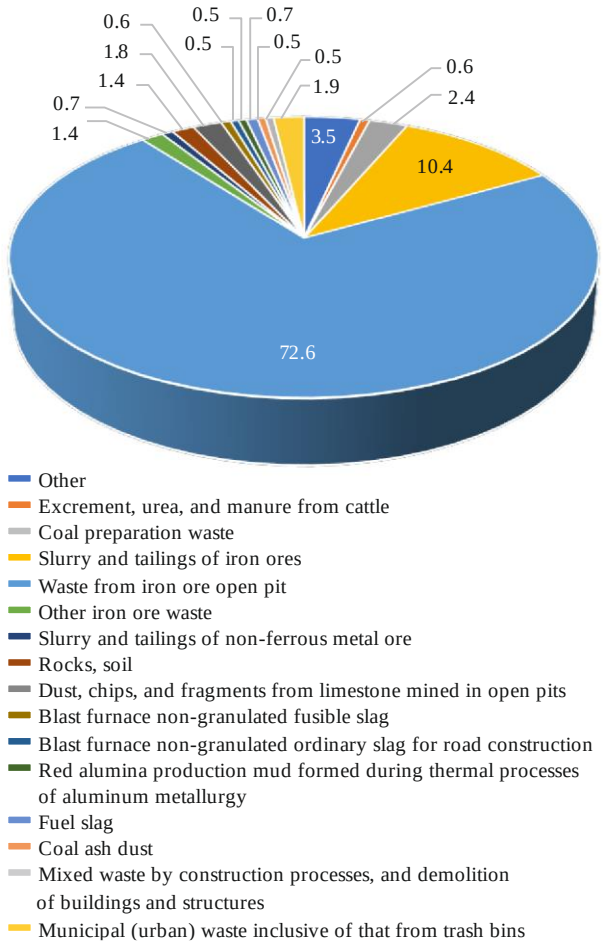

Figure 3. Waste amount in Ukraine in 2020, % (calculated for State Statistics Service of Ukraine [26])

Annual increase in waste amount and low indicators of its use factor into significant accumulation of industrial and municipal solid residues, which major share ends up in landfills. The reason is the necessity for Ukraine to reconsider the industrial waste structure. For instance, slag materials, are viewed in Ukraine as industrial waste. In turn, the slag, resulting from energy generation by thermal power stations, is applied in the EU countries for construction (among other things, roads are meant), for cement sector etc.

In such a way, a threat of technogenic and economic danger has intensified; and problems arise as for land allocation to place the municipal waste. It would be expedient to use the areas for other purposes being more economically feasible, and socially necessary.

As Figure 4 explains, Ukraine demonstrates a tendency of the generated waste domination over the recycled one. The abovementioned causes the necessity to search for new areas of its placement which provokes environmental pollution; irrational land use; and decrease in the possibility (or its nonavailability) for further use of the land due to lack of the waste sorting as well as improper storage conditions degrading the raw materials.

The problems can be solved while implementing intonations into the development of a circular economy in Ukraine towards upgrading of business processes through low-and non-waste procedures. Practices of the world strategies, heading rapidly for green economy growth, could be the example. Below you can find the alternatives of innovative tendencies for the development of their business processes, which may be applied by the domestic enterprise structures [27], [28]:

– progress of society as the basis for the functioning of the total system of economic development;

– expansion of the closed cycle of plastic recycling: use of carbon filters for certain product types, and waste reduction while recycling and applying it;

– search for ways to manufacture environmentally friendly goods favouring the waste liquidation;

– implementation of innovative engineering and technological ideas into the business process to mitigate load on the environment while performing diagnostics by means of technical facilities.

Imperfect legislation, poor knowledge and awareness of the society concerning its development towards green economy, lack of clear understanding of possibilities and needs to allocate funds for the environment preservation and protection, and nonavailable infrastructure of the circular economy growth restraint its progress in Ukraine. Last years have demonstrated the decreased number of innovatively active enterprises engaged in waste collection, process, and disposal. The fact needs significant government attention (Table 1).

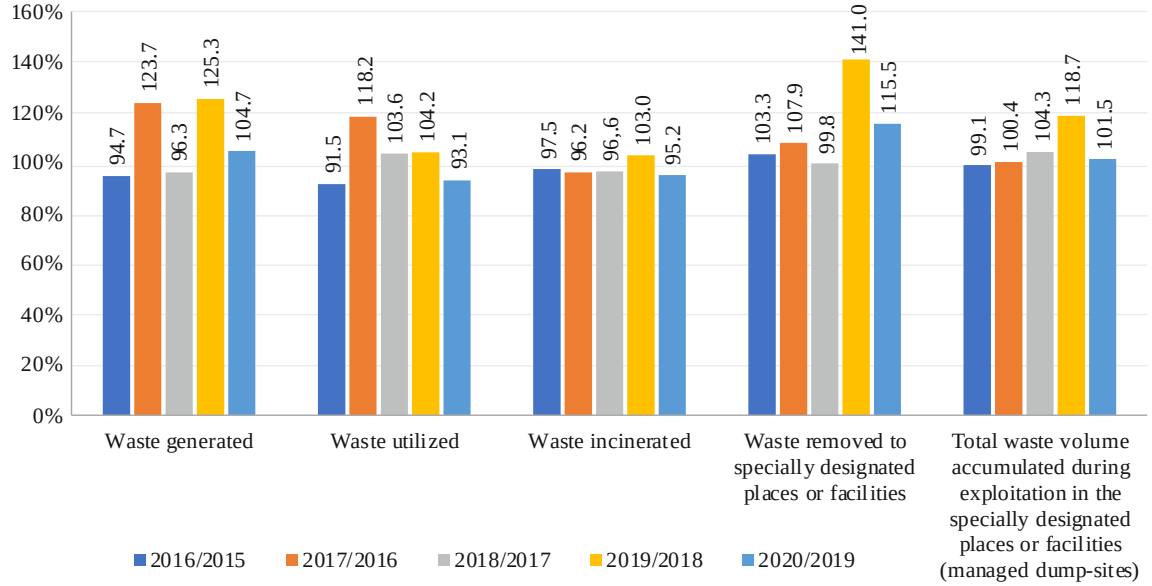

Figure 4. 2015-2020 tendency in Ukraine to generate and manage waste, % (calculated for State Statistics Service of Ukraine [26])

Table 1. 2018-2020 indicators of innovative business activities to collect, process, and dispose waste, and recycling of materials in Ukraine (Source: calculated for State Statistics Service of Ukraine [26])

Indicator	2018	2020	2020 as a percentage of 2018
Number of innovatively active enterprises as for waste collection, processing, and disposal; recycling of materials, units	83	9	10.8
Percent of the number of innovatively active enterprises as for waste collection, processing, and disposal; recycling of materials among the total number of innovatively active businesses	17.1	6.7	10.4*
Innovative expenditures connected with waste collection, processing, and disposal; recycling of materials, UAH mln	25.6	30.9	120.7
Percentage of innovative expenditures connected with waste collection, processing, and disposal; recycling of materials among the total expenditures connected with types of economic activities	0.10	0.13	0.03*
Total volume of the sold innovative production (goods and services) on the types of economic activities	20.3	0.0	0.0

It is required to single out activities of companies involved in the promotion of implementation of the circular economy elements into their business processes connected with mineral resource substitution for secondary inorganic raw materials and with the reduced energy consumption.

Circular economy is improved owing to cooperation between different branches of production [7]. Circular economy is the innovative approach helping reorient resource assignment in the economic system. Industrial waste is the important capital good to manufacture other goods [29]. As it has been mentioned, similar practice is observed in the national economy; however, its scales are far from being all-inclusive. Circular economy development generates a tendency to reduce consumption of deficient resources as well as those ones impacting the environment [30]. All that provides competitiveness for environmentally friendly manufacturing with opposition to the increase in mining of rare mineral resources.

The limited financial resources of domestic economic entities counteract rapid growth of a circular economy in Ukraine. Hence, it is required to develop low-budget programs of its progress. We believe that the society encouraging to address sustainable development challenges and inculcate a sense of responsibility in each citizen for the environment preservation and protection is the topical tendency to solve the problem. Thus, measures should be established to familiarize with aftereffects of a society-nature interaction, search for ways improving the situation, and introduce new life goals of the society which would base upon green development fundamentals. The measures will favour increase in intellectual possessions of labour resources of economic entities towards the sustainable economic growth. They are implemented into the influence to activate revival of a circular economy itself.

Circular economy may be manifested at two levels:

1) within the business;

2) as a result of interbranch cooperation.

In the first case, commodity production, based upon the circular economy fundamentals, should mainly involve domestic economic efforts. The second level needs more efforts inclusive of search for stakeholders concerning waste supply and demand, search for potentials to unite them, and search for development or implementation of innovations to introduce actions on the waste management as part of a circular economy.

A conclusion has been drawn that it is necessary to organize a market of the circular economy opportunities; in other words, a market as a platform managing supply and demand of industrial waste, and a platform of technical and technological facilities required for commodity production on the basis of circular economy (Fig. 5). Waste supply and demand should be generated; that will shape new approaches for the circular economy growth as well as the need to develop appropriate technical tools and procedures.

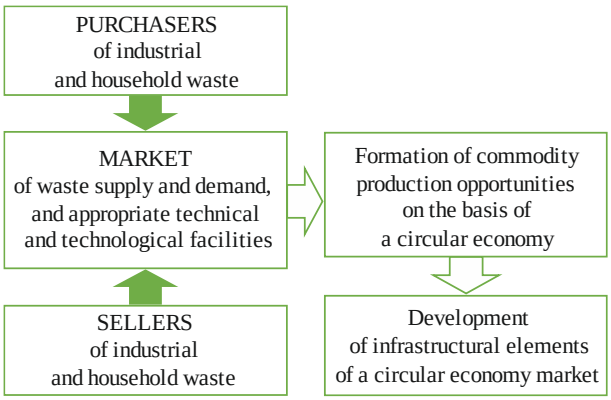

Figure 5. Process of the circular economy potential market growth (based on the research results)

Circular economy development needs waste market management as places for meeting and interbranch cooperation, which shaping will favour progress of its infrastructural formations. First of all, transition to a circular economy involves singling out possibilities of each sector. Transparency of relevant information allocation from the interested economic actors will help accelerate solving the formulated problems. Consequently, the businesses, having difficulties with implementation of the required actions concerning conservation of natural resources and their rational use, should represent on their sites tendencies of potential changes in their economic activities to search for potential suppliers the required technical and technological facilities. In turn, businesses, able to render such services, should propose possible tendencies, alternatives or goods favouring achievement of the circular economy objectives. Analysis of changes in open reporting by business representatives as for emphasis of their economic activities towards the circular economy growth has helped identify the following [31]-[33]:

1) implementation of innovations to promote circular economy progress relying upon the most efficient consumption of natural resources and their prolonged use while minimizing waste and generating value owing to renewable resources on the basis of:

a) chemical recycling;

b) concept of a biomass balance promoting the renewable raw material use in the integrated production system to cut carbon emissions;

c) biotechnologies as substitutes for natural resources to reduce carbon footprint;

2) business expansion on the circular economy principles inclusive of reduction in energy costs for manufacturer and carrier to mitigate environmental load and development of biodegradable packaging;

3) offer of cooperation to build a waste-processing plant on a bioremediation technology;

4) investment in waste-processing business under the conditions of varying ratio between annual waste generation and establishment of waste-processing companies (waste treatment and sorting) for an appropriate sector development;

5) promotion of companies engaged in waste receiving, processing, and return of the material to production cycles based upon industrial waste outsourcing with the help of available range of modern technical facilities being vehicle fleet and the required equipment for raw material processing. In such a way, an example is assistance to a plastic processing company as one of the most important components of environmental pollution. Film manufacture, using recyclables, is one of the progressive activities of processing business.

To conserve mineral resources in the context of the circular economy growth, enterprises should analyze assessment of corresponding development through proper activities. Such indicators have to be the potential of business development on the circular economy principles. They involve:

– percentage of content indicators of virgin raw material and the recycled one in the certain product;

– indicator of production waste (*WP*):

$$WP = \frac{W_{di}}{W_r}, \quad (1)$$

where:

W_{di} – amount of production waste to be disposed or burned;

W_r – amount of the waste to be recycled;

– material circularity indicator (*MCI*):

$$MCI = 1 - LFI \cdot F(X), \quad (2)$$

where:

LFI – linear flow index calculated as the total of a new raw material amount in the product composition and amount of non-recyclable industrial waste divided into the double total output;

$F(X)$ – coefficient of the product use represented as a function of utility (X) [34].

Relevant business analysis will help assess activity level of an enterprise operating on the circular economy basis; moreover, it can be used as a tool for investors and potential business partners to make decisions and enable to study state-of-the-art of the certain branch of economy for further research.

Findings of the abovementioned research make it possible to see positive moves of business and society towards a circular economy. Further favouring growth in the latter as well as taking into consideration rapid development of social changes suggests that the urgent current need is to support and intensify cooperation between the circular economy market players. Business entities (mainly, small and medium-sized ones) cannot implement the circular economy elements into their economic activities due to insufficient financial opportunities, lack of time to search for possible innovation implementation into manufacturing stages etc. Hence, it is urgent today to create conditions accelerating meetings and further cooperation of potential market players of a circular economy. Concentration of demand for certain tendencies of business improvement based upon the circular economy principles as well as the required scientific, information, technical, and technological offers concerning rational use of natural resources, potentials of re-processing of goods etc. in terms of definite Internet platforms will provide the accelerated information and experience sharing among economic agents and promote efficient growth of a circular economy, rational use of natural resources, environmental protection, and soil conservation.

Taking into consideration recent active use of the Internet by consumers and business representatives, we would like to pay attention to the fact that it is important to develop intermediary model of Internet business of a circular economy (i.e. Brokerage) intended to provide meeting between businesses and consumers (B2C) for their cooperation.

To increase meeting opportunities of the circular economy agents, it is required to favour the development of infrastructural components of its market. The abovementioned will accelerate information delivery to business representatives concerning potential tendencies of their progress on the circular economy principles while opening possibilities and problems for future improvements in the field of processing, preserving, and rational use of natural resources (Fig. 6).

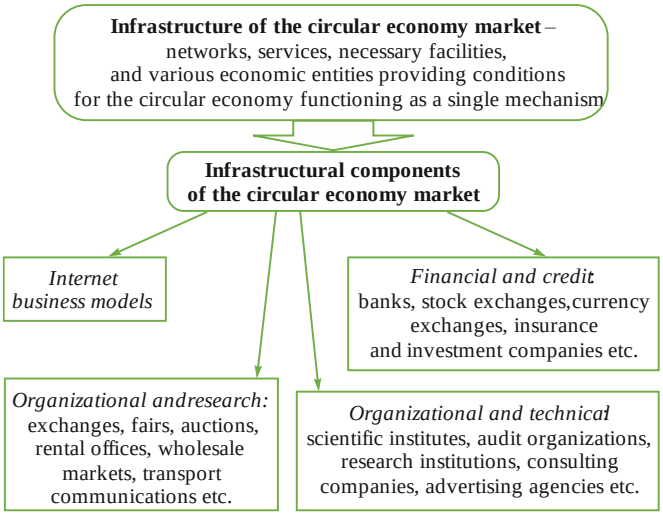

Figure 6. Elements of market infrastructure of a circular economy (based on the research results)

Development of the elements of market infrastructure of a circular economy will accelerate cooperation between economic entities towards progress of their business activities basing upon the principles of rational use of mineral resources. Relevant strategy of economic growth will expand the possibilities of the interested business subjects in exchange and mutual assistance as for:

– implementation of business advances while introducing the circular economy model;

– use of achievements of scientific and technological progress for the circular economy growth;

– business investment promotion based upon the rational use of mineral resources.

The tendency is extremely important for the development of enterprises with the insufficient financial support, and lack of time to conduct relevant research and introduce innovations. Owing to the development of elements of market infrastructure of a circular economy, they will be able to present their capabilities and needs, and receive advisory, practical or investment assistance for their activity advance on the principles of rational use of mineral resources.

Circular economy growth makes adjustments to business processes encouraging implementation of following changes:

– *shift in business focuses on the circular economy principles:* improvement of logistics system of resources and goods circulation, development of waste recycling as the basis of business; changes in approaches for material resource use etc.;

– *promotion of market infrastructure development of a circular economy:* use it as a platform to manage industrial waste supply and demand; and technical and technological facilities to organize rational waste treatment to provide financial, technical, and managerial business capabilities as for implementation of innovations according to the circular economy principles;

– *introduction of analysis to assess development of business on the circular economy principles* as an enterprise potential defining its competitive level being the selection criterion for possible business connections with investors and other partners etc.;

– *transparent business development* which will provide long-term partnership, and help assess the current business needs concerning future tendencies to improve activities based upon a circular economy;

– *legal framework improvement* in terms of protection and rational attitude to mineral resources along with favouring business efficiency in different branches on the circular economy principles;

– *promotion of the processing industry growth*, and upgrading of technical and technological support of business for our state reorientation from the raw materials country which increases in such a way the national budget through the created added value; the abovementioned will help decrease mineral mining and improve the national economy.

The problem of rational use of mineral resources remains topical; it needs comprehensive attention as for its analysis. A number of publications by domestic and foreign scholars concern the issues of the circular economy growth. The papers focus on the offers to make relevant decisions in the companies as well as develop adequate infrastructure. The problem is still under study; in this context, the necessity to develop infrastructural formations of the circular economy market is stressed. In this paper, we propose such a trend for the development of market infrastructure of a circular economy as a platform to organize cooperation between economic entities, which will provide acceleration for sharing experience, mutual assistance while making common strategic decisions, and favouring investment in the context of the tendency towards business progress. The research has demonstrated domestic business readiness for the development of its further activities on the way to rational use of mineral resources. Consequently, future research should concern organization of information support as for possible development strategies on the circular economy principles in the context of all types of businesses regardless of their financial opportunities. Information transparency as to needs and offers of economic entities concerning rational use of mineral resources will provide efficient sharing business results and investment increase favouring in the corresponding field of economic growth.

5. Conclusions

Circular economy functioning as a dominant financial system at the current stage of social development stimulates both renewal and reorientation of social thinking and the world perception. Implementation of the circular economy model promotes retargeting from financial enrichment of society to accumulation of rationality and search for the balance of resource use.

Unsatisfactory state of the ecosystem and negative aftereffects of social economic development need cardinal changes in the future results of business activities. Circular economy should become one of the basic principles of economic policy in Ukraine, the driver of the main innovative changes in technical and technological equipment of entrepreneurial activities, and the key to the society transition to a new development of cooperation being environmental priority, and conservation and protection of mineral resources. It is topical today to promote the development of market infrastructure of a circular economy. Market elements of a circular economy will help expand possibilities for those economic entities whose limited financial or other nonavailable potentials make it impossible to get information on implementation of innovations for rational use of mineral resources. For example, sharing information on the organized Internet platforms will help assess cost-effectively business needs and opportunities as for the use of appropriate scientific and technological developments.

Hence, growth of the state-sponsored circular economy needs the following: increase in the level of social knowledge concerning importance of the ecological balance support which component is rational use of mineral resources; development of organizational and technical infrastructural elements of a circular economy to attract as many interested people as possible; and favouring information cooperation between enterprises operating based upon the circular economy and those ones unable to introduce innovations or have no data on the business reorientation towards rational use of mineral resources to share the information and elaborate practical recommendations.

Unsatisfactory state of the ecosystem and negative aftereffects of social economic development need cardinal changes in the future results of business activities. Circular economy should become one of the basic principles of economic policy in Ukraine; the driver of the main innovative changes in technical and technological equipment of entrepreneurial activities; and the key to the society transition to a new development of cooperation being environmental priority, and conservation and protection of mineral resources.

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Огляд управління мінеральними ресурсами в інфраструктурі економіки замкненого циклу

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Мета. Обґрунтування засад сталого управління мінеральними ресурсами при реалізації моделі економіки замкнутого циклу.

Методика. В процесі проведеного дослідження використано наступні методи наукового дослідження: методи синтезу (об'єднання виділених аспектів), індукції (вивчення ознак економіки замкнутого циклу), Life Cycle Assessment (оцінки впливу продукту на навколишнє середовище в розрізі усіх етапів його життєвого циклу); Circular Economy Toolkit (визначення і оцінка циклічності продуктів та індикаторів економіки замкнутого циклу); Circular Economy Indicator Prototype (оцінка продуктивності циклічної продукції).

Результати. Циркулярна економіка є одним із ключових напрямів політики сталого розвитку щодо збереження та захисту мінеральних ресурсів, яка спрямована на більш ефективне її використання та підвищення рівня вилучення корисних компонентів із відходів. Запропоновано формування інфраструктури ринку циркулярної економіки на основі використання відходів гірничовидобувного сектору з метою їх переробки та скорочення, а також перепрофілювання безвідходного виробництва та вторинної переробки сировини. Обґрунтовано потребу в сприянні збереження мінеральних ресурсів для сталого використання на основі розвитку інфраструктури ринку циркулярної економіки та використання відходів гірничодобувного сектору з метою їх переробки та скорочення, а також перепрофілювання безвідходного виробництва та вторинної переробки сировини.

Наукова новизна. Уточнена концепція подальшого розвитку інфраструктури ринку циркулярної економіки, як платформи з попиту та пропозиції відходів товаровиробництва, з метою оптимізації використання та збереження мінеральних ресурсів на принципах сталого розвитку. Запропоновано проведення аналізу оцінки розвитку бізнесу на принципах циркулярної економіки шляхом розрахунку параметрів використання у виробництві товару первинних мінеральних ресурсів та відходів виробництва як сировини для подальшої переробки.

Практична значимість. Запропонований підхід взаємодії суб'єктів господарювання на засадах циркулярної економіки забезпечить раціональне використання мінеральних ресурсів та сприятиме розвитку галузі переробки відходів виробництва, що дозволить припинити зниження рівня забезпеченості мінеральними ресурсами, сформувати нові віхи суспільного розвитку на принципах екологічності та раціоналізму в процесі взаємодії його з природою.

Ключові слова: *циркуляційна економіка, мінеральні ресурси, раціональне використання, інфраструктури ринку*