Resource recycling as new field for innovative technologies

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Abstract. This study substantiates the necessity of transition from the natural resource model of socioeconomic development towards an industrially reproducible type of raw material, which is particularly relevant in the context of the global resource crisis. The key role of innovative technologies in the solution to this problem is questioned. Theoretical and methodological principles of the modern economy functioning are examined based on the resource factor. A new concept of "resource recycling", which reflects industrial resource recovery, is introduced. An innovative model of a resource base for economic reproduction is provided, the necessity of transition from the existing linear economic model towards a closed resource cycle model is shown, and three resource cycle models are examined in terms of their objectives, forms, and content. The major problems in the implementation of the innovative model and ways of solving them are defined, which makes it possible to reduce the risk of a resource provision crisis. The conclusion that resource recycling serves as a new sphere of innovative technologies is substantiated. The historical analogy method and the evolutionary systems approach are used.

1 Introduction

Humanity is on the brink of a new period in its history, with nature's capability of sustaining the society decreasing rapidly. Humanity is entering an era of resource crisis that affects every area of life in the society.

"The previous sustainable development has come to an end… However, rejecting the idea of sustainable development is similar to giving permission to commit a murder on a planetary scale." [1, p. 436, 7] The world is in turmoil. The level of uncertainty and anxiety is very high. It is true that we live in a global crisis, and resource depletion is its primary cause. It has spread across all countries, including Russia. People are fighting over what is left of the planet's resources. The world has changed. It will never be the same again.

The question is whether a new civilization model for the development of the society will be found, and whether another long period of economic growth will begin. The author believes that a new lasting period of economic growth can only facilitate the transition from a natural resource model of socioeconomic development towards an industrially reproducible type of raw material. This is a fundamental and difficult task. However, there is no other way to stabilize the situation. The author believes that "resource recycling" serves as a strategic direction for the solution to the above-stated problem. Let us consider the nature of this problem, its origins, concept and prospects.

2 The necessity of changing resource provision models and the role of new technologies

The theory of a resource transition from a natural resource model of socioeconomic development towards an industrially reproducible type of raw material has been conceived by the author (L.L. Kamenik). [2] "It is based on an evolutionary-revolutionary transition towards a new model of resource provision. According to this model, a revolution in the resource use is expected in the upcoming decade". [3, p. 3]

History shows that before the Neolithic revolution, humanity faced an acute crisis: the existing technologies of hunting and gathering were not enough to sustain humanity. According to the estimation of specialists, the population reduced by 90% during the crisis. People had to find a new path to the future, and so they did: that path involved the technologies of grain crop cultivation and domestication of animals, which helped solve the problem of hunger.

The solution to this problem fits into the foundations of the theory of great cycles developed by the Russian economist N.D. Kondratiev, who concluded that the world economy developed in cycles and waves. [4] The theory of great cycles can be applied when looking for a solution to the problem in question.

The current situation can be characterized by three main points. Firstly, according to the estimation of experts, only 2% of substances extracted from the earth are used beneficially, while 98% goes to waste, one way

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or another. Secondly, the technologies that are currently used by the society are remarkably wasteful and are hardly aimed at a beneficial use of the resulting waste. Thirdly, at the turn of the 19th century, the great Russian chemist D.I. Mendeleev communicated a message to the future generations, which says, in a nutshell, that there is no waste in chemistry – only unused material. Mendeleev's second commandment was to reuse all mineral resources extracted from the earth. [5] There is another aspect that deserves attention. Academician V.I. Vernadsky [6,7] was far ahead of his time when he developed the foundations of his concept of harmonious interaction between mankind and nature – the noosphere. The ideas of these brilliant scientists should find their way into a new model of resource provision, shifting its focus towards evolution, technological innovations, and systems approach. This imposes new requirements on the science itself and the formation of scientific foundations of the economy's resource base.

What is so special about the present situation is that the leading countries are currently engaged in a transition towards the sixth wave of innovation based on interdisciplinary scientific approaches. It is now being defined which technologies are going to be at the cutting edge. [8] Solving the resource problem requires an interdisciplinary approach, which comprises engineering and technology, chemistry, physics, biology, economics, philosophy, etc.

The stone age ended not because there were no stones left, but because new technologies were introduced.

The planet is running out of natural resources, while the amount of waste resources is enormous. A feature of these reserves is that they are reproducible and the reproduction is permanently ongoing. The transition towards an industrially reproducible type of raw material is inevitable. This task is more complex and difficult than the transition towards an industrially reproducible food economy, which has already been successfully implemented. No need to panic. We need to consider this problem, keeping in mind the gravity of the moment. The time factor suggests there is not much time left – about 13 years. By 2030, the problem of resource transition must be solved. In order to achieve this, new innovative technologies are required.

3 Fundamental contradiction and its solution

Science has made a mistake. The logic behind the analysis of the economic reproduction process indicates that we currently have a linear economic model, which requires continuous involvement of new natural resources in the economic turnover in order to achieve reproduction. The current economic model is a linear natural resource model based on the principle of constant consumption of natural resources, which are non-reproducible. There are two conclusions to be made in connection herewith. Conclusion one. There is a fundamental contradiction: continuous economic reproduction based on non-reproducible resources. Conclusion two. The existing economic model is based on the principles of a closed resource cycle. In the context of increasingly depleting resources, exacerbating resource crisis and the ensuing economic crisis on the one hand, and large volumes of production and consumption waste on the other, there is an urgent need for the return of waste into the economic turnover as well as for a new resource base. This will help resolve the fundamental contradiction of continuous economic reproduction and non-reproducible resource base. Besides, it will help tackle the environmental problem.

It is necessary to close the resource and economic cycles. This can be achieved using a single principle – the principle of industrial reproduction of raw material based on innovative technologies and innovative economic methods. It will be a different kind of model – an innovative model for the resource base of economic reproduction based on innovative technologies, innovative economic methods and active participation of progressive business.

4 Resource recycling. Closed resource cycle

The terminology of industrial reproduction of raw material is yet to be developed. This is essentially a targeted large-scale process of industrial production of raw material from production and consumption waste. Considering the scale of work on creating a new resource base and its importance for characterizing this peculiar process, we believe that a new term should be introduced into the economic turnover – one that would reflect the nature of the process – "resource recycling". [9] The term "resource recycling" shows that the goal is not to extract new resources from nature, but rather to industrially produce (reproduce) them from the resources that are already at hand but in a different form (waste) as a result of the initial consumption of resources. Waste resources are our new resource base as we have no other option... We believe that this process of targeted transformation of one form of resource into another as a result of its industrial reproduction can be termed as resource recycling. The prefix "re" means renewal, repeatability. A cycle (from the Greek "kyklos" – wheel, circle, circuit) is a combination of certain phenomena, work, processes that complete a full circle of development during a specific time period; a production cycle is the complete circle of work that results in a final product or a final range of phenomena within the same subject matter. Now let us trace the process of waste treatment as a whole and determine the potential role of business from the point of the proposed term "resource recycling" and its understanding as a process of industrial resource (raw material) reproduction.

From the standpoint of business interests and organization of its activity in the field of resource recycling, it should be noted that flow cycles can be different. In terms of their purpose, they can have three models depending on their form and content [9]:

1. Product cycle. This is a product flow cycle: product1→ waste1→raw material2→product2. Its objective is to track a product flow and ensure the continuity of production of a new product (product 2). The key word here is "product".

2. Waste flow cycle: waste1→raw material1→ product1→waste2... Its objective is to track a waste flow and generation with due regard to its reproduction (waste2). This is waste recycling. Here, the key word is "waste".

3. Resource (raw material) cycle. This is a resource flow cycle: raw material1→ product1→waste1→raw material2. Its objective is to track a raw material flow and production of a new raw material (raw material 2), i.e. resource reproduction. This is resource recycling. Here, the key word is "resources". The resource cycle is closed: it starts with a raw material and ends in a raw material, but in a new form.

With this procedure that reflects the entire raw material flow cycle we get a closed resource cycle. According to the author's interpretation, the closed resource cycle and recycling are fundamentally different from the similar terms that are being used, which get down to waste use in a narrow sense. [10, 11] Recycling is reprocessing of utility waste. Recycling as an international symbol of reprocessing.

For those involved in business organization it is important to know where the entrepreneurial cycle begins and ends, and what is the key word in his business profile. The truth is that one can engage in any of the three model types: collect data on waste generation, be its "keeper", sell it, categorize it according to the amount, composition, and region of this valuable raw material; take part in the process of resource recycling, i.e. industrial (re)production of resources, be the keeper of "new technologies". The business has already begun working in this direction. However, it can be stated that in terms of the required (necessary) volumes of the recycled waste, particularly with the prospect of transition towards an industrially reproducible resource base, this process is still in its early stages of development. There are enormous opportunities for business activities and very good prospects for business development.

The modern practice lacks clear terminological definition in the field of waste treatment and its branches. Multiple terms are being used: "waste handling" – too abstract, describes the problem as a whole, does not specify; "waste management"[12] – inherently wrong, one cannot manage waste, one can only manage something dynamic; "waste recycling"[13] – long existing, rather narrow but popular, yet does not correspond to the long-term objectives of the formation of a new resource base. Literally, "waste recycling" means "waste reproduction", which is incorrect in terms of semantic meaning: firstly, one cannot reproduce waste on purpose; secondly, it is population that reproduces waste. Thus, it can be stated that the proposed term "resource recycling" complements and expands the concepts in this business area, serves its intended purpose, points directly at the set objective and the ultimate goal – industrial reproduction of resources with further production of raw materials from these resources.

The logic behind the validation for the project of a new resource base and its role in the implementation of innovative technologies is presented in general terms in the diagram (fig. 1).

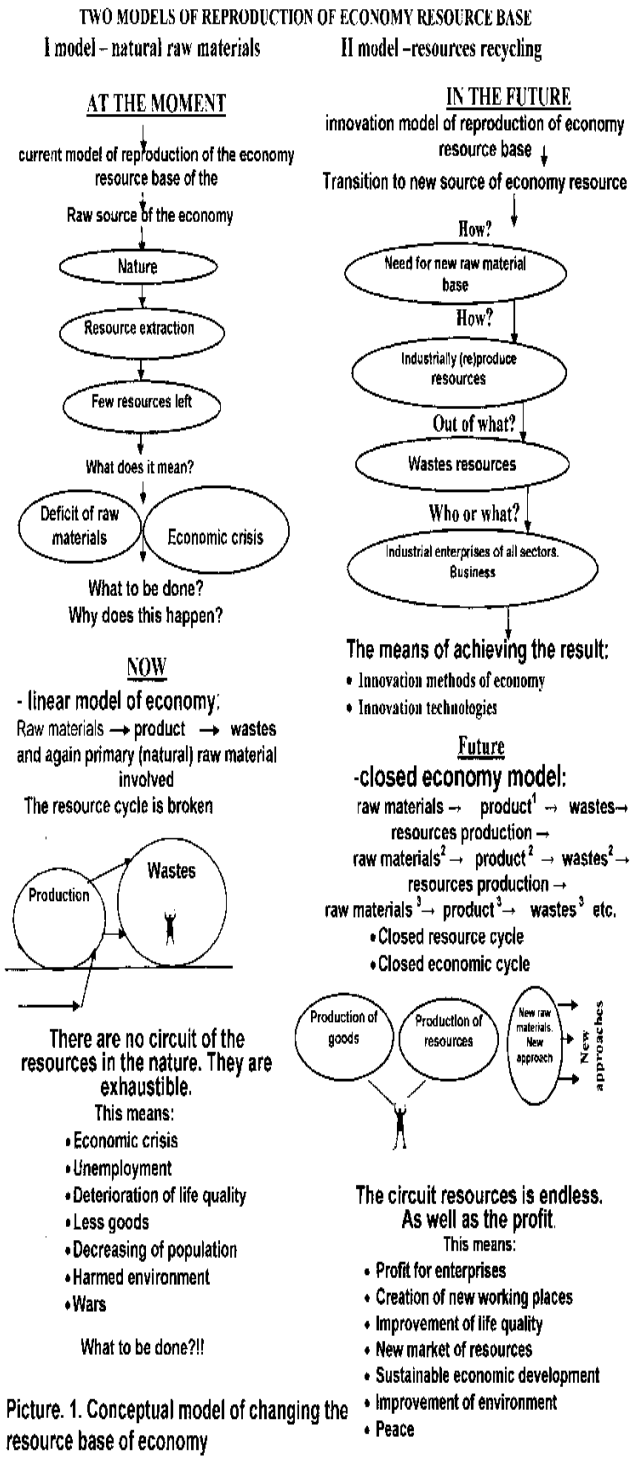

Fig. 1. Conceptual model of changes in the resource base of economic reproduction.

4 Problems of resource recycling implementation

In order to implement resource recycling as a new economic reproduction resource base model, four categories of problems need to be solved:

- **political.** Undertaking such a large-scale project as formation of a new resource base requires political will at the government level. In terms of sheer scale and importance, this project is similar to the development and implementation of the GOELRO plan, plan on the electrification of Russia;

- **technological.** Innovations must have a specific purpose. The development of innovative technologies is very much in demand and is more efficient if it has a clear focus, i.e. it is "attached" to the solution of specific problems. Here, in the field of resource recycling, there is a strong potential for the development of cutting-edge technologies. In Russia, there is already a full-scale bottom-up transition of small and medium enterprises towards non-conventional, original, innovative technologies of resource recycling and environmentally friendly technologies [14, 15, 16, 17, 18];

- **economic.** Economists have overlooked the fundamental contradictions in economic reproduction, which has led the society to a dead end. Nowadays, the resource factor of the economy is a blind spot in science. New economic mechanisms capable of ensuring the functioning of resource recycling need to be developed.

- **organizational**. Our future lies with companies involved in resource recycling and handling the full range of issues: from the development of innovative technologies to their implementation and realization of products.

The future of industrially developed countries will depend on how quickly, cost-efficiently and environmentally friendly they will be able to return production and consumption waste into the economic turnover. The country that will travel this path shall prevail.

5 Conclusions

Resource recycling is a social mandate for the development of innovative technologies. It is a test for the maturity of society as well as its ability to organize themselves and survive. The world has changed. We need to work for the future. It can be stated with confidence that resource recycling will have top priority in the seventh wave of innovation

References

1 Alan Atkisson, *How Sustainability Can Improve Organizational Performance and Transform the World* (BINOM, Laboratory of Knowledge, Moscow, 2015)

2 L.L. Kamenik, Resource-Saving Policy and the Mechanism of Its Realization in the Format of Transformational Growth (SUAI, St. Petersburg, 2012)

3 G.G. Malinetsky, Waste recycling, **6**, 3 (2014)

4 N.D. Kondratiev, D.N. Oparin, *Great Business Cycles, reports and their discussion at the Institute of Economics* (Moscow, 1928)

5 D.I. Mendeleev, *Cherished Thoughts* (Thought, Moscow, 1995)

6 V.I. Vernadsky, *Biosphere and Noosphere: monograph* (Science, Moscow, 1989)

7 G.B. Naumov, *Three Syntheses of Space* (LENAND, Moscow, 2014)

8 A.I. Tatarkin, *Foresight Russia: New Industrial Policy Design, compendium of the St. Petersburg International Economic Congress 2015,* 65-87 (2016)

9 L.L. Kamenik, *Foresight Russia: New Industrial Policy Design, compendium of the St. Petersburg International Economic Congress 2015,* 147-158 (2016)

10 *GOST 30772. Recycling as a Process of Waste and Emission Recovery* (2001)

11 Robin Murray, *Zero Waste* (OMNNO Greenpeace Council, Moscow, 2004)

12 A. Mavropoulos, PDW Solid Domestic Waste, **1(102)** (2015)

13 Waste Recycling (St. Petersburg)

14 S.D. Bodrunov, *Forthcoming. The new industrial society: the reboot: monograph* (Culture of revolution, Moscow, 2016)

15 S.Y. Glazyev, New course: breakthrough strategy. Economic strategy, **16**, **1(117)**, 6-15 (2014)

16 S.Y. Glazyev, *Strategy of advanced development of Russia in conditions of global crisis* (Economy, Moscow, 2010)

17 S.S. Gubanov, *Sovereign breakthrough. Neoindustrialization of Russia and vertical integration* (Book world, Moscow, 2012)

18 A.J. Toynbee, *Civilization on Trial* (Ayris-Press, Moscow, 2006)