

Circular economy for the energy transition in Saint Petersburg, Russia

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Abstract. The pathway to a low-carbon future is circular. Circular economy and the optimization of resources used in the energy system can be seen as a way to improve energy self-sufficiency. In St. Petersburg, stakeholders of International Innovation Forum and International Economic Forum 2018 have discussed foreign experience and circular economy in Russia, and found several solutions. Representatives from Business Finland partnership shared their experience – how environmentally friendly technologies become profitable business. FIRO-O, OptiKom, Charity second-hand store “Spasibo”, Baltika Brewery (Carlsberg group) and St. Petersburg Urban Eco-Cluster are given as successful examples of circular economy principles in Russia and St. Petersburg. Moscow and Saint Petersburg have different programs under the local authorities’ support in the sphere of environmentally-friendly development. Infrastructure of the Russian regions needs more attention and support from all the stakeholders: the business, the government and the society. The triangle cooperation (business-government-society) is needed. Russian company’s cooperation and integration into the global networks of ecologically responsible businesses could lead to the easier and faster solutions.

1 Introduction

Energy transition is one of the major environmental sustainability issues for the 21st century. The main solution to accelerate this transition is the circular economy. The principle of the circular economy is about achieving the most efficient use of resources. It is therefore a major lever for developing innovative energy transition solutions.

The energy industry is not only leading towards a low-carbon energy system by replacing fossil-based fuels with renewable energy, but also plays a key role in enabling circular economy in other industries.

Circular economy in the energy system consists of designs, processes and solutions that maximize the efficient use of natural resources for energy production, end use of energy, excess energy and side streams. Energy is an essential part of a sustainable economic system, as it enables the re-use of materials. Circular economy in the energy industry is promoted by cooperation between industries and companies, as well as by services that decrease the overall consumption of energy.

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The concept of a circular economy is very much related to the management of physical flows. Circular flows are better from an environmental perspective because they reduce the need to extract primary resources, and they reduce the need to dispose of waste. Circular flows can also reduce energy needs.

Recycling, reuse, materials substitution, more materials efficient designs, use of sustainable biomass resources are all part of this concept. Circular economy is therefore closely related to the concept of energy transition that builds on the two pillars of energy efficiency and renewable energy.

Given the shortage of natural resources and the presence of global and economic problems, humanity is forced to look for new development models that are different from those that exist today. Circular economy is one of the possible ways out of the current situation.

Understanding the finiteness of earth's raw materials, makes a call for a new economic model – circular economy. Circular economy aims to replace the established linear economy model, which acts like “take, make, dispose” [1].

At present, many countries have experience in applying the circular economy principles. The transition towards a more resource-efficient society is a core goal of governments worldwide. Circular economy comprises an integral approach to a resource efficient future, necessitating cooperation of all stakeholders along the value chain. Simultaneously, economic, societal and environmental aspects must be considered [2].

To prevent the irrational use of natural resources, it is necessary to adapt to their multiple use, also to reduce the costs of energy, water use, etc., which are essential for primary production.

This type of economy allows not only to take care of the environment, but also to bring financial benefits. Even the smallest cycles — reusing, restoring, modernizing, and re-marketing products and components in industry, help to minimize costs for the buyer and make a profit for the manufacturer.

This model has become more common among the developed countries of the world. It should be noted that in developed countries there is a psychological predisposition to transition to a new economic model.

In addition to the ability to protect the environment, a circular economy also allows countries to stimulate research and development, creating jobs and partially solving the problem of industrial waste.

Studies devoted to the circular economy in Russia are still few.

All of the above determines the relevance of the chosen research topic and emphasizes the need to investigate the experience of the transformation towards a low-carbon and circular economy at the city level.

2 Materials and Methods

Achieving the 2030 United Nations (UN) Sustainable Development Goals and Paris Agreement climate targets will hinge upon the global transition to a low-carbon circular economy. Realizing these goals requires action across the private sector, civil society and governments [3].

The concept of a circular economy has been used since the 1970s. However, there is no agreed and standard definition of circular economy. The Ellen McArthur Foundation definition is (Figure 1): “A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. The concept distinguishes between technical and biological cycles. As envisioned by the originators, a circular economy is a continuous positive development cycle that preserves and

enhances natural capital, optimizes resource yields, and minimizes system risks by managing finite stocks and renewable flows. It works effectively at every scale.”

A circular economy is about more than just recycling. It concerns the fundamental review of products and the systems in which they are applied: longer lifecycle, reduced materials impact, reusability, ease of disassembly for repair and replacement, introduction of new revenue models, such as product-service systems, and supporting other consumption models based on shared use.

There is a general perception that the circular economy field is aimed at sustainability, although circularity does not guarantee sustainability, and the concept is not without its critics. A number of research groups also point out that the current definition and visualization of circular economy creates confusion on how to deal with certain aspects [4]. Renewable materials will play a role in achieving a low-carbon, circular economy. Replacing finite and fossil-based materials with responsibly managed renewable materials can decrease carbon emissions whilst reducing dependency on finite resources. The UN has stated that ‘growing more sustainable forest and the use of long-lasting forest products are currently the most effective forms of carbon capture’ [3].

Prof. Arnold Tukker states, that circularity provides 4-5 times more economic activity in the same planetary limits and focuses on human development (4 times more wealth with the same level of economic activity). He also draws attention to the problems of circularity measurement. Exist economic and industrial ecology tools, country footprints and priorities [2].

Data for the research are collected on the basis of official sources in the public domain: Circular economy package, EU industry policy strategy, The circularity gap report 2019, CE100 CO.PROJECT RENEWABLES report, Renewable materials in the Circular Economy report, results of St. Petersburg International Economic Forum 2018 and XI St. Petersburg International Innovation Forum 2018, St. Petersburg Urban Eco-Cluster Concept 2018.

In our paper Russia in general and St. Petersburg in particular were chosen as an object.

The article is a qualitative study - an empirical study in which data are not presented in the form of numbers [5]. Research methods used: system analysis, synthesis, comparison and generalization, deduction and induction.

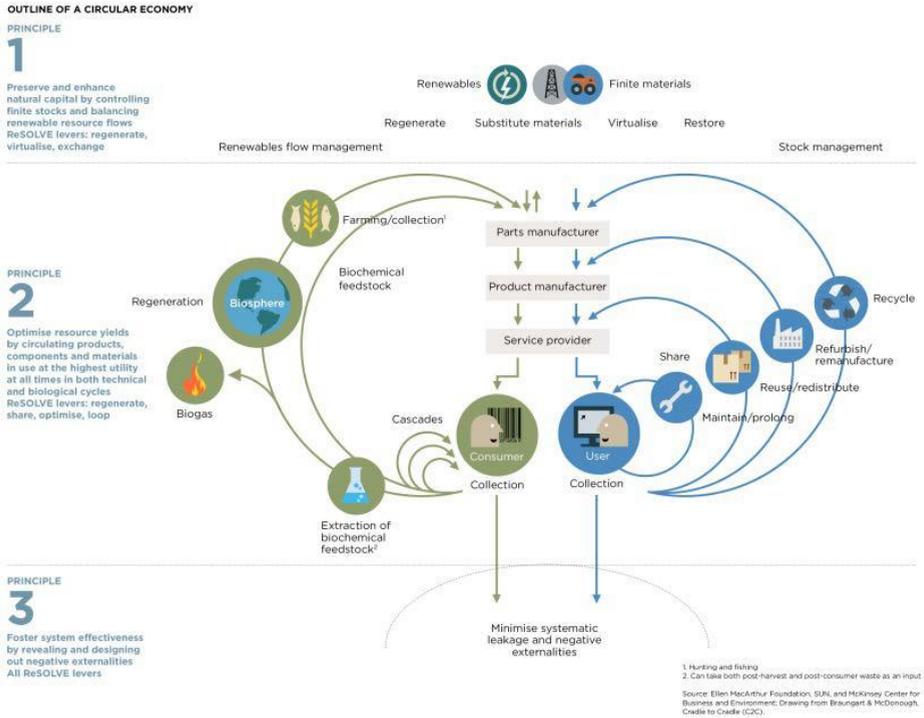


Fig. 1. Outline of a circular economy, as defined by Ellen MacArthur Foundation.

3 Results

In 2015, the UN passed a resolution that contained a set of 17 Sustainable Development Goals, approved by all participating countries including the Russian Federation (RF) [6, 7]. Countries have developed internal documents and strategies to achieve sustainable development goals.

Renewed EU industry policy strategy “Investing in a smart, innovative and sustainable Industry” stated “A stronger development of the bio-economy can also help the EU to accelerate progress towards a circular and low-carbon economy improving production of renewable biological resources and their conversion into bio-based products and bio-energy” [8].

As part of a shift in EU policy towards a circular economy, the European Commission made four legislative proposals introducing new waste-management targets regarding reuse, recycling and landfilling [9].

In RF, the reform of waste management has been launched and will be implemented from January 1, 2019. As part of the reform, the principles of solid municipal waste management are also changing. Thus, each entity is obliged to develop an electronic territorial scheme of waste management, to approve the regional program and standards, as well as to select a regional operator on a competitive basis, which will be responsible for the full cycle of solid waste management [10].

Experts from Business Finland partnership were sharing their opinion during the round table “Circular economy and Finnish experience – how environmentally friendly technologies become profitable business” of the XI St. Petersburg International Innovation Forum 2018.

Stakeholders met at the St. Petersburg International Economic Forum 2018 to discuss foreign experience and circular economy in RF. Key discussion conclusions, issues and solutions are presented in Table 1.

Table 1. St. Petersburg IEF 2018 Circular Economy in Russia: key discussion conclusions, issues and solutions*.

Key discussion conclusions	Issues	Solutions
<p>Russian manufacturing to be BAT by 2021. In 2018 300 largest Russian enterprises (oil, gas and metallurgy) were switching to the Best Available Technologies (BAT). By 2021, all Russian enterprises will have to make this transit.</p>	<p>Circular economy: not just waste issue. All large industrial enterprises consume and discard a lot of water.</p>	<p>Transit to Zero Liquid Discharge System. Industrial enterprises will switch to the technology: once they take water from an external source, they will not take it anymore. It will circulate inside, they will do the treatment and consume it right there.</p>
<p>Russia sets priorities for waste management. There is a pyramid of priorities regarding what to do with waste. In the first place is reduced consumption of raw materials. The second place goes to reduced waste generation. In the third place is recycling, and it can be possible to create secondary resource involved in the turnover. Then it's incineration as a type of disposal. The measure of last resort is a landfill.</p>	<p>Untargeted waste management funds. At the beginning of the decade, responsibility of car makers for recycling old cars was under discussion. As a result, a recycling fee was introduced. But it is not used to develop the waste management industry. Building circular economy requires two components: political will and financial resources. Extended producer responsibility is essential. In Europe, for a number of items the fee can be up to 100%, in Russia it's 7–10%. Importers of goods to Russia are subsidized, but do not encouraged to recycle the waste.</p>	<p>Financial incentive for new technologies. Enterprises that introduce the BAT get tax incentives, lower fees for negative impact, and subsidized loan rates have been subsidized.</p>
<p>Circular economy at the outset. Creating a circular economy model doesn't only mean creating industries that collect, sort and transport garbage. It's a change in the mentality.</p>	<p>Scale key to recycling business attractiveness. It takes high cost to be successful in recycling because there is not enough scale. If it ever gets to a large scale, it won't be costly anymore, and can possibly become</p>	<p>Separate waste collection system to be created. Plastic leaves the biggest carbon footprint compared to other materials. But in terms of energy consumption in production, plastic needs eight times less energy in comparison with aluminium cans. One ton of plastic takes 40 times less CO2 emissions to produce than aluminium. Plastic is used for thermal regulation and insulation, which allows consumers</p>

	<p>profitable. The key question is how to create the scale when all the collected volumes are recycled at the highest benefit possible.</p>	<p>to spend less energy. Plastic materials are lighter, that's why it is used in the transport industry helping to save fuel. Plastic helps keep food and reduce the amount of debris. Packaging helps extend life for meat by 5–7 days. Almost 100% plastic can be recycled. The difficult part is separate waste collection.</p> <p>In a closed cycle everything depends on how waste is collected. Russia doesn't have appropriate infrastructure. There are people, who want to do waste collection, but this requires incentives. There should be a general legislative framework for regulation.</p> <p>Recycling technologies development. Fortum Corporation has a lot of boilers that work on biogas. Duracell has experience in batteries collection. They installed boxes for batteries disposal in retail outlets. 500 boxes give them about 1 thousand tons of batteries, which is 5% of what the country consumes. Batteries go to the only plant in Russia that recycles them.</p> <p>Involving society, business and scientists in problem solving. In order to ensure more sustainable development, representatives of the society and business are needed to be involved in the problem solving process. Carlsberg Group has a programme called Together to zero, which plans to bring CO2 emissions and water effluents down to zero by 2030. They have awarded grants to theses that will enable them to get a solution and make a breakthrough in technology.</p>
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Note: *completed by the authors on information [11].

In Russia as a whole, and in St. Petersburg in particular, there are successful examples of circular economy principles usage in companies: FIRO-O, OptiKom, Charity second-hand store “Spasibo”, Baltika Brewery (Carlsberg group), etc. (presented in Table 2).

Table 2. Examples of circular economy principles usage in Russian companies.

Company	Activity	Circular economy
FIRO-O	The company has operated more than 20 years on the Russian market. The production is located in Leningrad region and operates as a sawmill. The company sees its mission to become a leading supplier of environmentally friendly	In 2014, the company modernized its whole manufacturing and now is one of the biggest deep wood processing organizations. The company invests heavily in the development of its own logging unit, which corresponds to the world standards of the plant of deep wood processing. The company claims that they use every piece of wood in their production, utilizing even the dust and wooden flinders.

	high-quality wood products, through the most modern technologies, as well as production, logistics, and services that are applied according to the world standards.	
OptiKom	The company is a manufacturer, supplier of integrated solutions and expert in the field of packaging, office supplies and household goods for businesses. They introduce advanced technologies in the field of goods and services, ensuring the stable operation of customers, creating a culture of conscious consumption and increasing the environmental responsibility and awareness.	The company implements projects in various areas: from the production of environmentally friendly packaging to improving the energy efficiency of the office, from choosing responsible suppliers to cooperation with environmental organizations. The company focuses to offer its clients safe products for green cleaning, office goods, kitchen wares and many more. The company's office is constructed according to international environmental criteria: usage of LED lamps, water saving is achieved using special nozzles on mixers. In each office, specially marked containers are installed where employees bring paper waste. The collected waste paper is sent for recycling - it serves as a raw material to produce packages of molded paper fibers, which are manufactured and sold by the company. Separately in the office, other waste is collected: plastic and glass bottles, aluminum cans, print cartridges and spent electronics - that can be recycled. Recycled materials reduced the consumption and purchase of new materials, which therefore decreased the expenses.
Charity second-hand store "Spasibo"	The store was established in 2010 in Saint-Petersburg. Its mission is to develop charity organizations in Russia, attract investments into charity and reuse the textile materials that no longer wanted by first owners. It accepts clothes, books, fabriques, toys, equipment which will be recycled or given to those who needs them.	The store has installed more than 90 containers across Saint-Petersburg where citizens can leave unnecessary clothes and other goods, which next will be processed, recycled or sent to shelters, orphanages, charity organizations and so on. Recycled materials are given to textile manufacturers which will produce new pieces of clothes.
Baltika Brewery (Carlsberg group)	Baltika Brewery (BB) was found in Saint-Petersburg in 1990 and in 1992 company started the beer production. Baltika Brewery has branches in Samara, Khabarovsk, Yaroslavl and Tula.	BB is optimizing the operation of the equipment washing systems, setting up the recycling and re-supply systems for technical needs. BB conducts wastewater treatment both on its own and on municipal sewage treatment plants. The branches have built powerful biological treatment facilities, including several technological stages of purification: aerobic, anaerobic and other systems. The biogas project allows to reduce the costs of thermal energy, reduce CO2 emissions and save natural resources. BB optimizes its own activities, decreasing the waste production and increasing the usage of recycled materials. The main type of waste generated in the brewing process is the beer beet. The company uses the systems for processing raw crusher into a dry product, which is then used as a feed additive in dairy and meat cattle breeding. Other biological waste such as spent yeast and grains are sent to farm organizations for feeding the breeding animals.

Note: *completed by the authors on information [1].

4 Discussion and Conclusions

The development of the circular economy affects different stakeholders and needs active participation of all of them: the society, the government and the business. Referring to RF it should be noticed that the development of the circular economy had been launched not so long ago. Nevertheless, the government did a great job issued legal documents and changes in legislation for creating modern scheme of waste management (Federal Law № 89-FZ of June 24, 1998 On production and consumption waste, Federal Law № 458-FL of December 29, 2014). It also had provided the legislative basis for the development in the processing, recycling and disposal of industrial and municipal waste for the period up to 2030. The State Council of RF has the task of active participation in the model of sustainable development. It provided some measures in economic field to support low-carbon, circular economy that had been approved by the President of RF, such as:

- the use of a system of indicators of sustainable development and the identification of mechanisms for their achievement in the period up to 2030 and for the future up to 2050;
- setting targets for the energy efficiency of the economy as a whole and by main sectors;
- implementation of new energy efficiency measures and support of micro-generation based on renewable energy sources [12].

However, these are only few steps toward solid changes in the economy leading it to circularity. Speaking of regional development, it should be noted the unevenness in implementation of the principles of low-carbon and circular economy. The most developed and active users are certainly Moscow and Saint Petersburg. They have different programs under the local authorities' support in the sphere of ecology-friendly environment development.

Presenting the example of St. Petersburg, we choose the project Urban Eco-Cluster [13, 14]. The project Urban Eco-Cluster overall objective is to contribute to Sustainable Agenda 2030 in the Baltic Sea Region, Sustainable Development Goals and Environmental Doctrine of the Russian Federation by fostering cooperation and adaptation of the best Nordic cluster models in the NW Russian Cities. The main deliverable of the project is the conceptualization of the Urban Eco-Cluster of St. Petersburg City, which presents a multilevel, multi-dimensional and multi-stakeholder process. The project serves as a platform where the Nordic partners are contributing with their best practices to better understanding of why this cluster should be created, who could be of interest to approach and develop a dialogue with, identify the right target groups, and how the cluster should be communicated to the selected target groups. The project participants are: Closed Joint Stock Company «International Centre for Social and Economic Research «Leontief Centre»; State Unitary Enterprise «Vodokanal of St. Petersburg»; «Water Academy» Independent noncommercial higher educational organization; «Higher School of Economics «National Research University» External Experts from Malmö, Copenhagen, St. Petersburg. The goal of St. Petersburg Eco-Cluster is to reduce environmental stress without inflicting harm to the regional economy growth. The goal is to be achieved through incorporation and use of St. Petersburg resources in the area of research, environmental educational, nature conservation, presentation, exhibiting and display potential, with taking into account international experience and also through developing cooperation with foreign countries. Therefore, this project reflects several directions of the development of the low-carbon and circular economy: regional development, collaboration of stakeholders, cooperation and getting experience from the global level - Nordic countries.

As for all the rest of the regions the infrastructure is not very diversified. It needs more attention and support from all the stakeholders: the business, the government and the society. The directions towards to widespread adoption the model of sustainable development based on low-carbon and circular economy on the regional level could be: regular reviews of the

standards for production and recycling of waste and meetings on the local authorities' level in order to improve it; regional level strategy's formation in the collaboration with all the stakeholders mentioned above; elaboration of preferential taxation for the companies use the circular business models; effective budget management related to low-carbon and circular economy: budget savings from environmental and recycling fees may help funding and subsidizing of circular business projects, the building of a waste collection and sorting infrastructure and the implementation of closed supply chains by companies [15, 16]. All these directions are the main focus for the government stakeholder.

As for the business concerning Russia, in our opinion Russian companies need the experience and active support from the global level. It's cooperation and integration into the global networks of ecologically responsible businesses could lead to the easier and faster solutions.

Turning to the Russian society it should be mentioned that it did not draw adequate attention to the problems and potentials of the circular economy for a long time. RF didn't implement a lot the principles of circular economy in everyday life via social media as mostly all EU countries did from the very beginning of the development of the concept in 1970s. As for the scientific community Russia needs more research projects focused on new technologies in energy sufficient solutions, new biomaterials that may bring less harmful impact on the environment. Certainly, it should be more projects in the triangle cooperation - business-government-society for speeding up the development of the low-carbon and circular economy.

The issue of concern to the whole world and acutely facing the economy is associated primarily with the future shortage of raw materials and / or its uninterrupted supply. For the production of high-tech products, this raw material is very important, and products, in turn, are vital for economic growth. The linear model, which has been relevant for decades, has reached its limits. A circular economy can not only replace the linear economy, as well as solve complex environmental and social problems. The potential of measures of a circular economy can be realized only if the government and the enterprise actively use all the possibilities. The development of a circular economy will help achieve substantial reductions in emissions in the heavy industry: around 3.6 billion tons per year globally [17].

A fundamental rethink is needed how to adjust regulations in order to create the right incentives. A societal rethinking will be essential to promote customer interest and acknowledge the value that can be created by shifting from linear to circular economy. Circular economy holds promise of significant energy and climate benefits [18, 19].

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