

CIRCULAR ECONOMY AND ENVIRONMENTAL RESPONSIBILITY – A SYMBIOSIS FOR A COMPANY’S SUSTAINABLE DEVELOPMENT

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Abstract

The growing consumption of resources and the environmental consequences it gives rise to require a change in the economic model. The concept of circular economy, as part of this change, is directed towards reducing energy consumption, creating sustainable production, dramatic reduction of waste generation and further increase of the capacities for their recycling and re-use. This allows the gradual transformation of production into a resource-efficient, environmentally friendly, competitive and low-carbon process.

This study on the leading mining company in Bulgaria, Dundee Precious Metals Chelopech EAD for the 2011-2017 period, shows that the continuous process of improving the efficiency of the resources used in ore mining and processing and increasing the degree to which they are re-used as a result of implemented environmentally responsible business practices based on the circular economy principles create opportunities for business sustainability in its three dimensions – reducing environmental impact, improving working conditions and care for society, achieving significant economic and environmentally sustainable results.

The aim of this report is to demonstrate the link between a company’s economic and environmental sustainability and the results of implementing environmentally responsible practices based on the circular economy principles. The analysis we carried out shows that thanks to the innovative methods applied in the company’s management and investments made in environmentally friendly and resource-efficient technologies, the company managed to change from a losing, decapitalized and unattractive one into a modern, sustainable and leading company in the mining industry.

Key words: circular economy, sustainable development, resource efficiency, environmentally responsible practices

JEL: Q50, Q51, Q56, Q58

1. INTRODUCTION

Contrary to the linear economy model (resource extraction – production – consumption – waste), circular economy manufactures goods and services while restricting the consumption of raw materials and energy on the one hand, and reducing waste generation, on the other. According to the definition of the Environment and Energy Management Agency (ADEME2014), “the circular economy is an economic system for exchange and production which, at all stages of the product life cycle (goods and services), aims to increase the efficiency of resource use and reduce the impact on the environment, while enabling people to live well.”¹ This is a closed cycle which covers each of the three areas: producer supply and responsible choice, consumer demand and behaviour, and waste management. The essence of this type of economy lies in the aggregation of various production methods and practices, ordered hierarchically depending on their impact and aiming to optimize raw material and energy use.

In order to meet modern economic challenges related, on the one hand, to scarce, depletable and increasingly expensive resources, and, on the other, to environmental needs, circular economy rests upon three fundamental principles:

- Optimization of resource use
- Natural capital preservation and development
- Creation and utilization of closed-loop systems, eliminating negative external effects

Implementing each of these principles leads to economical, responsible and effective use of resources. This is realized through control on the use of depletable resources and balancing the renewable resource flows. The focus is on dematerializing goods whenever possible and careful selection of and encouraging the use of technological processes which allow renewability of resources at the highest efficiency possible. The effect is a threefold dividend – economic, environmental, and social. This is why this model is an integral part of the sustainable development concept.

Circular economy provides the main guidelines on what should be done to significantly and sustainably reduce the economy's dependence on resources and proceed towards overcoming the scarcity of non-renewable natural resources. It is a new way of viewing existing relations between markets and economic entities and rethinking the perception of waste as a natural resource. The development and promotion of this model can turn into a generator of a new type of economic growth and additional jobs, while resolving serious challenges of social significance related to the depletable of natural resources and their continuously rising prices on international markets, as well as the environmental footprint.

This model has significant economic potential. In modern production, material costs amount to over 40% of total costs, compared to less than 20% of labor costs. Having in mind the rising prices and resource depletion, this is becoming a growing risk factor for company development. This is why the interest towards reducing these costs, their more efficient use and optimization of raw material flows is economically justified.

Together with purely economic advantages, the circular model also has significant environmental benefits. Table 1 summarizes some of the possible effects.

Table 1 Advantages of circular economy

Social and economic advantages	Environmental advantages
Reduction and rationalization of company costs on raw materials and materials	Restricting resource consumption (raw materials, water, energy) by minimizing their inefficient use, increasing recycling and reuse, thus preserving the natural capital
Enhanced competitiveness	Suspending programmed product obsolescence
Relative reduction of insecurity in resource	Reducing greenhouse emissions and countering

¹ <http://www.ademe.fr/sites/default/files/assets/documents/fiche-technique-economie-circulaire-oct-2014.pdf>

procurement and guaranteeing greater sustainability	climate change
Possibility for entering new areas of economic activity (recycling, refurbishment and maintenance, technological innovations)	Ecosystems maintenance and preservation
Creating accompanying jobs	
Enhancing company commitment in the field of corporate social responsibility	
Enhanced social image	

For the business, the transition towards a circular model is attractive because of its economic benefits and the jobs it creates, but this is not sufficient for the transition to take place (Ivanova, V., Slavova, I.).

Drivers of circular economy transition can include:

- Reducing use of hazardous or hard to recycle materials;
- Creating products with better features and longer service life;
- More efficient production processes which turn waste into resources using new technologies.
- Designing products which are more easily refurbished, upgraded and recycled;
- Providing incentives for reducing waste;

The goal is to increase the efficiency of resource use, reduce the negative impact on the environment and at the same time increase the welfare of consumers. "Greening" company operations for the purpose of gaining greater competitive advantage and production sustainability is now becoming an inevitable necessity (Bansal, P. and Roth, K., 2000).

The main focus here is on resource efficiency, which results in a reduction of production costs and growth of productivity. In this respect, activities related to waste utilization, reuse and actual limiting of waste quantities carry significant potential (Fricker, A., 2003).

The application of the new circular economy model should contribute to the radical change in production and consumer behavior models while integrating itself in the new territorial and regional development concepts. This would allow:

- Reduction of energy consumption, both by the business and by households;
- Creation of sustainable cities;
- Drastic reduction of waste generation and even greater increase of the possibilities for their recycling and reuse;
- Opening new "green" jobs in the industries related to environmental protection.

Corporate environmental responsibility has a significant contribution to the development of the idea of circular economy, as one of the subconstructs of "the responsibility of enterprises for their impact on society," according to the new definition of corporate social responsibility (CSR) of European Commission (EC, 2011 г., p.6).

Additional efforts of the companies integrating environmental considerations in their business operations and interaction with stakeholders (Williamson et al., 2006), can reduce the environmental implications of implemented business operations, created products and facilities used. (Peicheva, M., 2018)

Corporate environmental responsibility, as a clearly distinguished part of the comprehensive concept of corporate social responsibility, has its own identity and is viewed as: "... a set of initiatives aimed at mitigating a firm's impact on the natural environment. The initiatives can include changes to the firm's products, processes, and policies, such as reducing energy consumption and waste generation, using ecological sustainable resources, and implementing an environment management system. The concept of corporate ecological responsiveness refers not to what a firm should do, but to the initiatives that reduced the firm's ecological footprint" (Bansal, P. и Roth, K., 2000, p. 717).

Corporate environmental responsibility is manifested in diverse forms: environmentally responsible business practices; application of certified international systems for environmental management; involvement in local environmental initiatives, etc. In accordance with the research goals of the study, this paper analyzes only the environmentally responsible business practices implemented in accordance with circular economy principles in the mining industry and the results of their implementation are analyzed using environmental performance indicators.

In academic literature, corporate environmental responsibility is defined and considered in various ways (Rahman, N., Post, C., 2012). In accordance with the research goals, environmentally responsible practices (one of the manifestations of environmental responsibility) are analyzed according to circular economy principles and the focus is on the results of their interaction and achieving economic and environmental sustainability.

1.1 Methodology

The aim of the report is to demonstrate the relationship between the firm's economic and environmental sustainability and the results of applying environmentally responsible practices based on circular economy principles.

The research tasks implemented in the course of the study include:

- Present the results of applying environmentally responsible practices based on circular economy principles.
- Analyze environmental sustainability using a set of environmental performance indicators for the 2011 – 2017 period.
- Demonstrate the firm's economic sustainability resulting from implemented environmental practices

Hypothesis: The symbiosis between the continuous improvement of corporate environmental responsibility and adherence to circular economy principles is a prerequisite and contributing factor for sustainable business development.

The research is based on the case study method. The in-depth analysis of Dundee Precious Metals Chelopech EAD mining company is based on data from documents published on the company website – written policies, corporate values, code of ethics; sustainable development reports of the mother company Dundee Precious Metals (DPM), as well as its financial reports; information in the press and online media on Dundee Precious Metals Chelopech EAD, as well as interviews with company representatives. This study traces the results from the continuous improvement of environmental responsibility for the 2011 – 2017 period based on environmental performance indicators. The company implements the Global Accountability Initiative and data from its sustainable development reports were used. Analytical and comparative methods were applied.

2. ANALYSIS OF RESULTS AND DISCUSSION

Dundee Precious Metals Chelopech EAD is an enterprise for extraction and processing of gold-copper-pyrite ores from the Chelopech deposit. Ore mining in the Chelopech mine began in 1954, and its development underwent various stages. By force of a privatization agreement with the Bulgarian government, Chelopech mine became the property of Navan and after its bankruptcy in September 2003, DPM completed the purchase. Annual processed ore production increased from 523,810 tonnes in 2004 to 2,218,717 tonnes in 2017. Today, the Chelopech mine is the sector leader in Bulgaria – its operations have been completely modernized and the investments in environmental protection have led to significant improvements. The company's investments to a high degree contribute to the development of the region, where mining has traditionally been a source of household income for more than a century. Although modern mining operations face significant challenges, the management's capacity to successfully implement positive changes and introduce innovations has been justified.

The very nature of the production process – extraction and processing of copper and gold-containing ore – has an adverse impact on the environment. This is why environmental protection is a major priority in the company activities and one of their main goals.

The continuity of environmental protection activities carried out by the company is evidenced by the growing investments in new environmental projects, as well as the environmental results achieved, which are shown in

Table 2.

Table 2 Efficient use of resources

Indicators	2011	2012	2013	2014	2015	2016	2017
Ore processed (tonnes)	1,353,733	1,819,687	2,032,002	2,076,112	2,052,138	2,212,340	2,218,717
Cement (tonnes)	not reported	33,725	35,053	38,589	35,876	45,648	38,834
Cement used per tonne ore processed		18,5	17,2	18,5	17,5	20,6	17,5
Water withdrawn – surface water: rivers, dams (cubic meters)	1,149,823	525,063	756,846	778,015	930,579	678,490	756,846
Water withdrawn – surface water: rivers, dams (cubic meters) used per tonne ore processed	0,85	0,29	0,37	0,37	0,45	0,31	0,34
Electricity (Gigajoules)	361,885	364,696	407,963	384,095	390,179	395,443	391,201
Electricity used per tonne ore processed	74,2	55,6	55,7	51,4	52,8	49,6	48,9
Diesel – mine, process plant, light vehicles (liters)	2952, 514	3554815	2,538,081	2,497,735	2,550,919	2,635,976	2,551,666
Fuel's consumption(l.) per tonne ore processed	2,18	1,95	1,24	1,20	1,24	1,19	1,15
GHG emissions (tonnes of CO2) - Scope 1,2 and 3	116224	116684	123939	123939	119599	128584	120 099
GHG emissions (tonnes of CO2) per tonne ore processed	85,85	64,12	60,99	59,69	58,28	58,12	54,12

Source: SUSTAINABILITY PERFORMANCE DATA SUPPLEMENT DUNDEE PRECIOUS METALS, 2012, 2015, 2017

The corporate environmentally responsible business practices implemented by the company in accordance with circular economy principles are related to improvement of the production process (expansion and modernization)

along the whole value chain and have resulted in significantly enhanced energy and resource efficiency and reduction of the environmental footprint.

- *More effective ore mining, while significantly reducing negative impact on the environment and subsurface resources*

By implementing a new ore mining system in 2005, the company replaced the sub-level caving system employed for more than 40 years with the long-hole stoping with fill method, as per the conditions in the Chelopech mine. The benefits for the environment and landscape brought about by the new ore mining method are irrefutable, the most significant of which are: about 40%-per-tonne-mined reduction in flotation tailings in the tailing management facility (TMF) 2004 - 2017 (from 0.92 t. flotation/ tailings per tonne mined in 2004, it has been reduced to 0.52 t. waste per tonne mined in 2017), thorough utilization of waste rock as backfill material, prevention of surface cavings and waste rock stockpiles above ground, and environmental protection for both surface and groundwater.

- *Enhanced resource efficiency*

The innovative solutions introduced by the company management for enhancing resource efficiency replaced the hydraulic fill plant commissioned in 2008 with a new paste fill plant in 2010. Data show that in the 2012-2013 period, the amount of cement used in the backfill was reduced by about 50% per tonne mined compared to 2009 (43 thousand t. per tonne mined), and after 2011, when production was over 2 Mt/y, the quantity of cement used per tonne mined is within 17-18.5 thousand t. (2011-2017). According to experts, this is the result of improvements in production processes based on expertise and experience acquired so far.

- *Enhancing energy efficiency and use of renewable energy sources*

Despite the fact that in the 2011-2017 period energy efficiency increased and modern equipment and facilities are used in ore mining and processing, the company still has high electricity consumption.

The data in Table 2 show that the amount of electricity consumed for the production of one tonne of ore was reduced by approximately 30% - from 72 kWh electricity consumption per tonne produced in 2011 to 48.9 kWh per tonne ore produced in 2017, which is mostly due to the efficient management of the reclaim water system and improvements in the mine's ventilation system.

One of the most significant innovative solutions for green energy consumption was the commissioning of solar heating collectors installed on the roof of the mine's administrative building.

- *Optimization of the transportation system for mined ore and the end product – reduction in diesel fuel consumption per tonne mined*

Diesel fuel consumption in ore transportation was reduced by about 47% per tonne of ore (from 2.18 l. diesel fuel per tonne mined in 2011 to 1.15 l. fuel per tonne mined), thanks to the underground crushing system and the orepass system constructed in 2012. This complete system for crushing and belting the ore from the underground mine to the surface ensures integrity of the work process and protection of the environment and human health.

The 2013 optimization of the end product (copper concentrate) transportation process – shortening the distance – has led to an over 50% reduction in the amount of fuel used for copper concentrate transportation, which significantly reduces greenhouse gas emissions, especially carbon dioxide emissions.

- *Reduction of greenhouse gas emissions*

As a result of the implemented environmentally responsible business practices described above and employing the best technologies in ore mining and processing, greenhouse gas emissions have been reduced significantly – the carbon footprint per tonne of ore produced was reduced by 37% in the 2011 – 2017 period.

Required energy consumption (and greenhouse gases emitted, respectively) has been reduced by currently operational technologies for tailings dewatering, recycling wastewater, utilization of significant amounts of tailings for slope filling (paste fill), improvement of the mine's ventilation system, etc. Required fuel consumption has been reduced by the current orepass system, utilization of the restored railway section for loading of copper concentrate, as well as the solar panels installed on the mine's administrative building.

The continuous environmental protection activities implemented by the company, the growing investments in new environmental projects, efficient resource use, and successful management have led to the economic results presented in Table 3.

Table 3 Key Financial Highlights(\$ thousands, unless otherwise indicated)

Financial Highlights	2011	2012	2013	2014	2015	2016	2017
Revenue	199,465	263,577	231,887	187,220	131,695	161,626	206,253
Adjusted EBITDA	133,368	196,012	152,587	118,347	100,532	87,299	107,869
Capital expenditures	2011	2012	2013	2014	2015	2016	2017
Growth	59,019	41,833	28,992	19,932	5,675	2,856	3,656
Sustaining	13,053	12,690	13,302	10,185	12,793	10,421	12,830
Total capital expenditures	72,072	54,523	42,294	30,117	18,468	13,277	16,486

Source: DUNDEE PRECIOUS METALS, ANNUAL REPORT 2012, 2015, 2017

The company has invested close to 90% of its profits to transform the mine from an undercapitalized operation into a modern and viable one that meets international standards for worker safety, environmental protection and sustainable development.

The implementation of all these projects has resulted in a unique and innovative management of an efficient, safe and environmentally friendly underground mining through a complete crushing and orepass system for transporting the ore from the underground mine to the surface, where it is processed by high-performance and modern facilities, tailings are stored in a safe and environmentally friendly manner, thus achieving integrity and sustainability of the whole production process.

Total investments in environmental protection include several components:

- 17.4 million leva in specific environmental protection activities, achieving compliance with legislation and rehabilitation of disturbed areas for the 2004-2012 period;
- 29 million leva as a positive side effect of production modernization from 2010 to 2013.
- 3.6 million leva concession deductions and 40.95 million leva guarantee for shutdown and recultivation to the benefit of the government of the Republic of Bulgaria.

In its operations, Dundee Precious Metals Chelopech EAD has proven that increasing production in no way means greater environmental impact.

Namely, investments in production expansion and modernization provide an opportunity to enhance energy and resource efficiency, as well as to reduce the environmental footprint.

3. CONCLUSION

Circular economy is not just an option. It is an opportunity for development which should not be postponed,

unless we want to see the environmental crisis turn into a catastrophe. The analysis of DPM's business model implies that the symbiosis of economic interests and environmental responsibility produces positive results.

This study has shown that the successful operation of Dundee Precious Metals Chelopech EAD is demonstrated not only by the revenues generated from sales and increased production, but also by the growing amount of investments in technologies and the environment. Environmentally responsible business practices and the application of circular economy principles are supported by technology – environmental technologies characterized by lower quantities of polluting emissions, reasonable resource and energy consumption, higher quantities of recycled waste and products, and an environmentally acceptable method of waste disposal.

The analysis of the environmentally responsible practices implemented by the company indicates that at all stages of the production process (along the whole value chain), the company applies innovative high-quality techniques and technologies, characteristic of the mining industry, and achieves significant results.

The monitoring of the continuous improvement of environmental responsibility via environmental performance indicators shows highly efficient use of resources (water, fuel, electricity, cement) and natural resources reuse (water, waste, soil) in ore mining and processing, as well as the company's efforts to implement a circular economy model. The existence of a symbiosis between corporate environmental responsibility and circular economy is a prerequisite for business sustainability.

By adhering to circular economy principles and implementing its characteristic technologies and methods, the company has managed to improve its production and financial results.

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