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## RESEARCH ON APPLICATION OF CIRCULAR ECONOMY FOR COAL INDUSTRY OF VIETNAM

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**Abstract:** To meet the demand for coal of the economy, coal industry of Vietnam causes many kinds of waste in large amounts and negative impacts on the environment for its mining and processing. Therefore, it is necessary to find suitable solutions to solve the environmental pollution problems on the one hand and to create economic benefits from waste on the other hand. It is also critical to learn about the circular economy because this model supports the sustainable development of the economy coping with the exhaustion of resources and solving environmental pollution from waste. This paper reviews the circular economy in general and the application of this model for the coal mining and processing through options of recycling and reuse the waste of coal mining and processing. Besides, the paper also proposes some solutions to implement a circular economy of the coal industry in Vietnam.

**Keywords:** Circular economy, coal industry, Vinacomin

### 1. INTRODUCTION

The coal mining of Vietnam is mainly located in Quang Ninh Province, distributed in districts from Dong Trieu, Uong Bi, Hon Gai to Cam Pha. The coal production process has caused changes in topography; mining pits create an adverse terrain while the disposal sites create artificial hills with a height of up to 300m of the slope, such as Dong Cao Son disposal site in 2019. The soil in the mining area has lost the rich layers and is prone to erosion. Coal production not only causes pollution of the rivers, streams, and lakes system but also causes degradation, exhaustion, and pollution of underground water sources.

Besides, the air environment in the coal mining area is heavily polluted by dust, toxic gas, explosive gas, and noise, especially in Uong Bi and Cam Pha. Also, most of coal mines in Vietnam have been in operation for decades, thus, the exploitation goes deeper into the ground. In contrast, the mining technology has not been synchronized and modernized completely. This fact leads to a considerable loss of coal resources and the fuel needed during the mining process.

According to the Coal Industry Development Plan to 2030 approved in Decision 403/2016/QĐ-TTg, the amount of wasted rock and soil from surface mining (excluding local coal mines and peat mines) will be discharged to the environment from 2021 is 2,675,536 thousand m<sup>3</sup> and be divided by regions as in the following table:

Table 1: Amount of rock and soil waste according to Decision 403

Unit: 1000m<sup>3</sup>

Area	Total	Amount of rock and soil waste		
		2021 to 2025	2026 to 2030	After 2030
Total	2,675,536	1,069,856	562,890	1,042,790
Uong Bi	168,045	62,198	38,900	66,947
Hon Gai	276,526	276,526		
Cam Pha	1,430,326	613,202	401,310	415,814
Noi dia	800,639	117,930	122,680	560,029

Source: (Decision 403/2016 / QĐ-TTg)

Wasted water from mining, repairing, and mechanical factories till 2030 are estimated based on the annual average coal production volume. The average mining wasted water for each ton of coal as follows:



Table 2: Amount of estimated mining wastewater to 2030

Category	Unit	2021 to 2025	2026 to 2030
Raw coal production amount	Million of tons per year	52.5	57.5
Average mining wasted water	m <sup>3</sup> per ton	2	2
Average mining wasted water	Million of m <sup>3</sup> per year	105	115

Source: (TKV, 2018)

Additionally, in the process of coal production, the coal industry also generates dust, mine emissions, wastes from the materials used, including many hazardous wastes, etc.

Due to the above reasons, the coal industry and coal enterprises need to have practical solutions to reduce material consumption, reduce resource losses, and especially recycling the waste in the process of exploitation to minimize environmental pollution and increase its economic value. To achieve those goals, it is necessary to study and apply a circular economy - a model that is highly effective in reducing waste of resources and reducing negative impacts on the environment through specific activities such as repairing, reusing, and recycling.

## 2. THE CONTENT

### 2.1. The theoretical basis of the circular economy

#### 2.1.1. Concept of circular economy

Many authors offer the concept idea of the circular economy. For example:

The circular economy describes an industrial economy designed to produce no waste or pollution (Anna Littleboy et al, 2016).

A circular economy is an economic system of closed loops in which raw materials, components, and products lose their

value as little as possible, renewable energy sources are used, and systems thinking is at the core.

The circular economy is a new economic model with a vast economic potential in zero waste creation (Ellen MacArthur Foundation, 2013).

Päivi Kinnunen, (2019) "A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro-level (products, companies, consumers), meso-level (eco-industrial parks) and macro-level (city, region, nation and beyond), to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

According to the Journal of Environment (2020): The circular economy is an economic model in which design, production, and service activities aim to extend the life of material and eliminate negative impacts on the environment.

Thus, the circular economy focuses on managing and regenerating resources in a closed circle to avoid generating waste based on reusing what can be reused, recycling what can not, repair what is broken, reproduce what cannot be fixed.

#### 2.1.2. The role of the circular economy

To avoid creating waste in production and consumption, the circular economy plays an essential role in the development of enterprises in particular and the economy in general. Specifically:

- For enterprises:

- + To save input costs by utilizing raw materials in the production process and



creating products from recycling waste at the same time.

- + To reduce waste and thereby reduce environmental costs due to emission reduction and economic damage caused by environmental pollution from waste.

- + To ensure occupational safety and health of the employees and the local people.

- + To show the corporate social responsibility as a basis to improve their images and competitive positions in the market.

- For the national economy:

- + The circular economy provides opportunities for rapid and sustainable development of the economy through socio-economic indicators and reducing impacts on climate change.

- + The circular economy brings excellent social and economic efficiency, especially in the context of challenges that non-renewable mineral resources are becoming exhausted, the waste increases and the climate changes are in negative directions.

- + The circular economy is a useful tool for fulfilling environmental commitments and sustainable development.

## **2.2. Activities to reduce the environmental pollution of the coal industry in Vietnam**

Recently, Vietnam National Coal and Mineral Industry Holding Corporation Limited (Vinacomin) has been implementing many activities to overcome impacts of coal mining on the environment, such as:

- Renovating large discharge areas with high risk of landslides, such as 7-8 Ha Tu, Chinh Bac, Nam Lo Phong, and Nam Deo Nai, etc., to reduce dangers during rainy seasons.

- Constructing and operating wastewater process stations. Quang Ninh province currently occupies 57 stations with a capacity of 15m<sup>3</sup>/h to 2,400m<sup>3</sup>/h (Vinacomin, 2017), meeting the

requirements of treating mine wastewater up to the standards for the coal industry.

- Building 21 specialized transport routes with a total length of 131km (Vinacomin, 2017). Therefore, since 2008 Vinacomin has stopped transporting coal on national and provincial roads to limit the generation of dust and noise, minimizing the effects of coal transportation, and contributing to improve the environment and landscape of urban areas and population in the province.

- Investing in over 90 dust spraying systems, installing dust screens, solidifying screening areas and warehouses; building 2 car-wash stations (Nui Beo, Coc Sau), 3 carriage-wash stations (Cua Ong, Nam Cau Trang) (Vinacomin, 2017); carrying out watering against dust and canvases on means of transportation and warehouse, reducing the generation of dust and noise, contributing to improve the landscape environment. Factories processing minerals, thermal power, cement are invested in synchronous emission treatment lines and technological lines, automatically controlled, ensuring emission standards before being discharged into the environment.

- Before 2016, Vinacomin planted over 1,000 ha of greening the disposal area, equivalent to 35% of the area. From 2016 to 2018, with the solution of high density planting, Vinacomin has rehabilitated 415 ha of landfill such as Chinh Bac of Nui Beo mine, Nam Khe Tam, Dong Khe Sim, Mong Gioang, Khe De and Dong Cao Son.

- The industrial hazardous waste treatment factory in Cam Pha - Quang Ninh, operated since 2014 with a capacity of 6,900T per year, handled 172/196 hazardous waste codes generated in production. The wastes are treated following the regulations, some of hazardous wastes are recycled into materials for other industrial production units.



Thus, the coal industry of Vietnam has many activities to minimize the negative impact on the environment. However, there are some remain disadvantages:

- There is no plan to treat and recycle all types of coal waste given rehabilitate pit roads and mines, recovering methane, ordinary wastes, and hazardous waste.

- Most of the activities have been implemented only to reduce negative impacts on the environment without taking into account the economic values brought to businesses, the coal industry, and the economy. This does not encourage coal companies to handle actively and recycle wastes to protect the environment.

- The development speed of environmental treatment and recycling activities has not kept pace with the growth rate of coal production due to inadequate planning.

- Waste treatment, recycling, and ecological rehabilitation do not have a combination of related industries leading to ineffective efficiency, causing waste of secondary resources, and negative impacts on the environment.

### **2.3. Building a circular economy for coal mining and processing**

As analyzed above, there are certain limitations in activities to reduce environmental pollution in the coal industry. To solve this problem, the coal industry in Vietnam needs to develop and apply a circular economy. This model will cover the most exhaustive streams of coal production and processing, along with recycling and reuse directions to reduce environmental pollution on the one hand and to raise the value of waste on the other hand. The authors propose a circular economy applied to coal mining and processing, as shown in Fig 1.

- Recycle wasted rock and soil from mining and shift into construction sand (replacing natural sand which is currently restricted from exploitation). Two alternatives are using of waste rock and soil as materials to fill the void after underground mining to limit the subsidence or for pits, roadbeds, as backfilling materials to create construction land fund, etc.

- Recycle a part of mine wastewater into clean water for coal production and other daily needs, especially in Quang Ninh, where water demand is increasing, while freshwater source is limited.

- Research and apply technology to recover methane ( $CH_4$ ) from coal seams to generate electricity and heat energy, from the lessons learned of the USA, Australia, China, Germany, and England. According to the experience of these countries, if the mining enterprises can ensure electricity and heat, coal prices will be reduced by up to 30% (the reduction depends on the proportion of electricity cost in the price).

- Renovate an open pit to become a water reservoir; backfill, revert and develop forest economy on the area of the discharged sites, the exploitation area that has ended its operation; improving the galleries into material storages, etc.

- Reclaim and recycle coal dust in the coal processing line to sort appropriate products for using as domestic fuels or construction materials, etc.

- Collect ordinary waste such as automobile tires, broken conveyor belts, broken machine parts, and anti-broken steel, etc. to recycle without releasing into the environment.

- Hazardous wastes such as grease and batteries are collected, processed, and recycled to other useful products for industrial production.



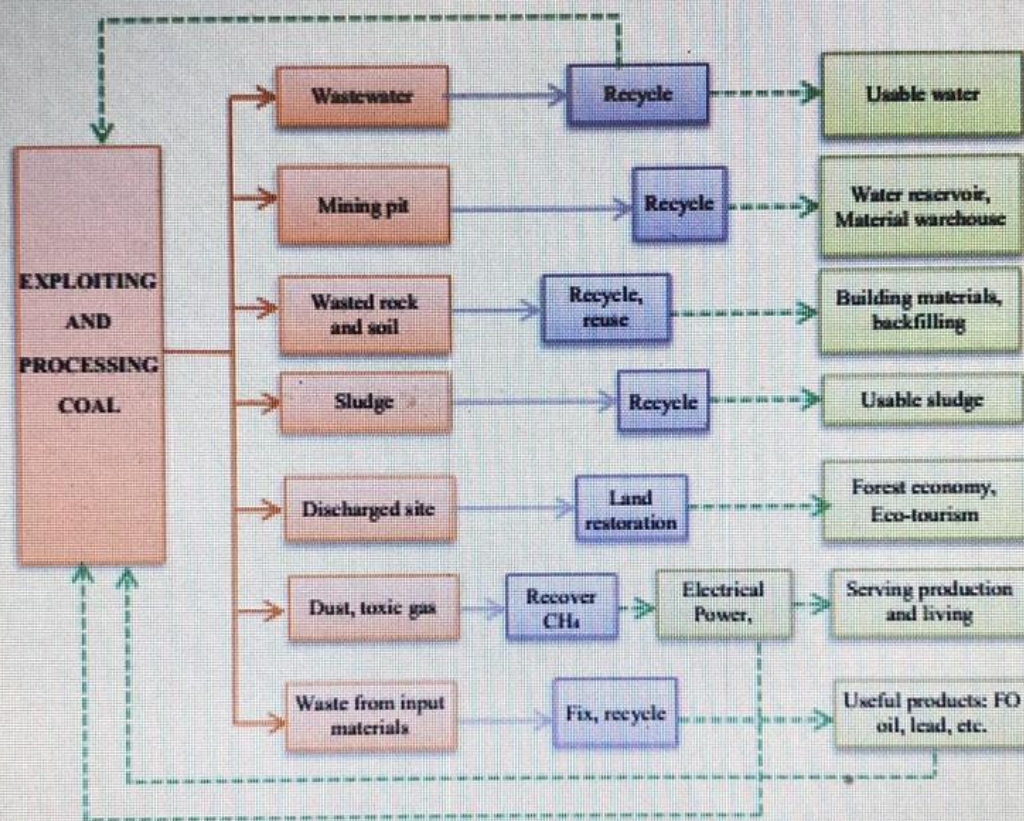


Fig 1. The circular economy applied to coal mining and processing.

#### 2.4. Proposing solutions to implement circular economy for coal mining and processing

Currently, the coal industry is applying many solutions to recover, recycle, and reuse some types of waste. However, the amount and types of recycled waste is still limited. To move towards a circular economy, the coal industry of Vietnam can consider the following suggestions.

Firstly, Vinacomin develops a mechanism to encourage coal mining and processing enterprises to recycle and reuse the waste to reduce the amount of waste at the source.

Secondly, Vinacomin researches and applies appropriate technology to recover

methane gas from coal mines and coal as fuel to produce electricity and thermal energy on-site for production at coal mining and processing enterprises. At the same time, it can serve other industrial enterprises as well as for living in the area.

Thirdly, Vinacomin expeditiously prepares projects to renovate mines and tunnels for underground mining after all surface mining totally close by the end of 2021.

Fourthly, factories to treat and recycle hazardous wastes should be expanded or improved the capacity to create economic values from wastes and minimize environmental pollution.



Finally, the coal industry combines with other sectors of transportation, construction, and private businesses to improve the value of waste rock and soil by using it to level the roads and producing artificial sands.

### 3. RECOMMENDATIONS

The application of the circular economy is an indispensable and objective trend, especially for the current coal industry, when challenges of exhausting coal resources, discharging of waste, and negative impacts on the environment are increasing. Here are some recommendations to facilitate the application of a circular economy for the coal industry of Vietnam.

- In-depth study on the circular economy, given the state-of-the-art in the economy of Vietnam and the coal industry.
- Introduce widely of the circular economy to labor force, entrepreneurs and authorities to raise awareness about the circular economy.
- Develop mechanisms and policies on the implementation of the circular economy with related issues, such as implementation process, application roadmap, evaluation criteria on the extent of application and the effectiveness, etc.
- Create favorable conditions for the coal industry to have the capital to invest in renovating mining technology and equipment by allowing coal prices to operate according to the market mechanism.
- Encourage investment in mine waste recycling projects with preferential policies on tax, capital, and land use, even subsidies.
- Adopting policies to promote the use of recycled products from waste.

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