Effective approaches for the successful integration of the circular economy concept into Vietnam's energy industry

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The development of a circular economy (CE) in Vietnam's energy industry is crucial for achieving sustainable socio-economic growth and reducing emissions. The Ministry of Natural Resources and Environment (MONRE) has assigned Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE) to collaborate with relevant organizations to create a "National Action Plan for the Implementation of CE". This Plan aims to promote the application of CE principles and strategies in various sectors, with a particular emphasis on the mining and energy sector.

The CE framework revolves around minimizing resource consumption, maximizing resource efficiency and reducing waste generation. By transitioning to a CE, Vietnam's energy industry can reduce its environmental impacts, enhance resource efficiency, and contribute to the goal of achieving net-zero emissions by 2050. The specific details of the Draft Plan for the mining and energy sector may vary, but it is likely to include certain fundamental measures and initiatives.

Valuable insights on the efficient execution and utilization of the CE model in Vietnam's energy sector can be gained by consulting experts, notably such as Professor Nguyễn Xuân Huy, Faculty of Geology and Petroleum Engineering, Ho Chi Minh (HCM) University of Technology, Viet Nam National University of HCM City. These consultations can also suggest context-specific implication on the distinct challenges and opportunities within the country's energy industry.

• At present, Vietnam is recognized for having the highest greenhouse gas (GHG) emissions in its energy industry, and it is projected that this emission rate will continue to rise in the future. What is your evaluation of this situation? Furthermore, how do you regard the Vietnam Government's initiative to promote the development of renewable energy as a means to mitigate these emissions?

Prof. Nguyễn Xuân Huy: Based on a GHG inventory report from the Ministry of Natural Resources and Environment, Vietnam observed a significant surge in total GHG emissions between 1994 and 2016. Specifically, these emissions soared from 103.8 million tons to an alarming level of 316.7 million tons of CO_2 equivalent during this period (Nishioka, 2016). Notably, it was the energy sector that experienced the highest growth as its emissions skyrocketed from 25.6 million tons to a staggering 206 million tons of CO_2 equivalent, constituting close to 65% of Vietnam's overall GHG emissions. The primary contributor to GHG emissions is the utilization of fossil fuels, particularly coal or oil for producing electricity. This practice serves as the major factor behind carbon emissions. Furthermore, in Vietnam, industries dependent on fossil fuel consumption and the transportation sector also play a substantial role in contributing to emissions.

In response to the aforementioned threats, Vietnam has implemented various policies aiming to decrease emissions in the energy industry by those promoting the development of renewable energy sources. Notably, measures such as implementing feed-in tariffs (FIT) for electricity and providing tax benefits have been incorporated within the revised Power Plan VII issued by the Government in 2017 to encourage the establishment of renewable energy ventures. Consequently, solar and wind power have experienced substantial growth and now play a more prominent part in the nation's energy composition, representing 27% of the overall installed power capacity (Figure 1). Nonetheless, re-

newable energy sources only contribute around 15% to the commercial electricity output, while traditional methods like coal thermal power still prevailing at over 40%, followed by hydropower at approximately 35%.

The proportion of coal-fired power in Vietnam's energy structure has decreased in recent years, from more than 60% before 2020 to about 50% today. This is a positive development that signals Vietnam's commitment in reducing its dependence on coal while increasing the share of renewable energy in its energy mix. However, renewable energy sources such as solar power and wind power are unstable due to their dependence on weather conditions, which can cause challenges to the stability of the national grid system and power transmission.

In order to promote the use of renewable energy, the Government has announced ambitious targets for its expansion in Vietnam. By 2030, they aim to raise the percentage of electricity generated from renewable sources to 30%, and by 2050, this is expected to reach 50%. Despite these aspirations, there are numerous obstacles that need to be overcome for Vietnam to successfully transition into a low-carbon economy. These challenges include financial limitations, lacking of proper institutional capabilities, as well as insufficient awareness and participation from the public.

Furthermore, according to Decision No. 687/QD-TTg issued by the Government to endorse the CE Development Project in Vietnam, a specific aim has been declared whereby CE initiatives will be implemented and enhanced with regard to their impacts on the economy, society, technology and environment by 2025 (Tran and Nguyen, 2023). This objective encompasses activities such as resource retrieval, decreased energy usage, and an augmented share of renewable energy within the overall primary energy supply. Consequently, it becomes imperative to implement CE models within Vietnam's energy industry in order to accomplish the aforementioned target.

**** To achieve "zero" net emissions by 2050 and maximize energy utilization, it will be essential for Vietnam's energy sector to adopt CE frameworks in the near future. Could you please provide information on successful research models that have been implemented globally and specifically in Vietnam to achieve this target?***

Prof. Nguyễn Xuân Huy: The term "CE" emerged in the 1980s within the field of industrial ecology, which focuses on understanding industrial systems and their relationship with the environment. However, it was British economist David Pearce who introduced the concept in a 1990 report titled "Blueprint for a Green Economy", commissioned by the European Commission (Barbier, 2013).

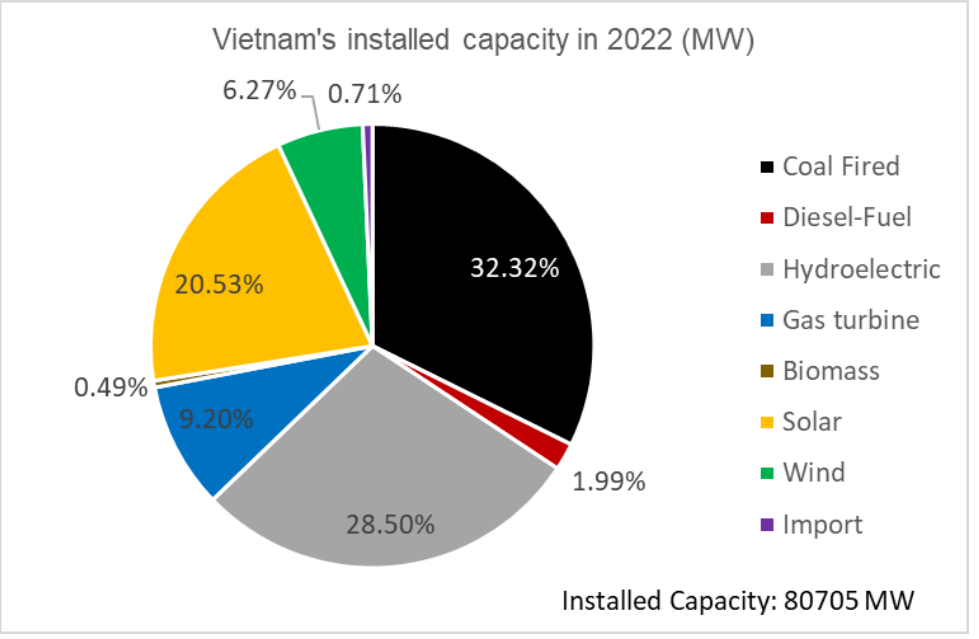
In the early 2010s, the CE gained wider recognition, largely due to the efforts of the Ellen MacArthur Foundation (EMAF, 2013). This UK-based charity, founded by sailor and environmentalist Ellen MacArthur, has been instrumental in promoting the CE as a means to create a more prosperous and sustainable future.

The Ellen MacArthur Foundation's 2013 report "Towards a CE: Economic and business rationale for an accelerated transition", played a significant role in popularizing the concept and providing a practical roadmap for its implementation across various sectors. The report highlighted the economic and environmental benefits of transitioning from a linear "take-make-dispose" model to a circular model that focuses on minimizing waste, maximizing resource efficiency, and promoting closed-loop systems.

Since then, the CE has gained increasing attention in sustainability discussions and policymaking globally. Governments, businesses, and organizations recognize the potential of the CE to address resource scarcity, reduce environmental impacts, and foster economic growth. Efforts are being made to integrate CE principles into national policies, business strategies, and academic research to drive the transition towards a more sustainable and regenerative economic model.

The CE offers a comprehensive framework for rethinking production, consumption, and waste management, aiming to create a closed-loop system where resources are used and reused in a sustainable manner. By promoting the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems, the CE presents a compelling vision for building a more resilient and sustainable future.

While the term "CE" may be relatively new, the concept of integrated agricultural systems and resource optimization has long been practiced in Vietnam, particularly in the agricultural sector. The VAC (Garden - Pond - Barn) integrated production model in Vietnam is an excellent example of a CE approach in agriculture (Trinh Thu, 2023). This model emphasizes the interconnectivity and synergy between different components of farming, such as crops, livestock, and aquaculture. By integrating these elements, farmers can maximize resource efficiency and economic returns while minimizing waste and environmental impacts.



▲ *Figure 1: Vietnam's power capacity installed in 2022*

In the VAC model, the garden represents the cultivation of crops, the pond refers to fish farming or aquaculture, and the barn represents livestock rearing. These components are interdependent and they create a closed-loop system where the waste outputs from one component become inputs for another. For example, crop residues can be used as animal feed or organic fertilizer, while animal waste can be utilized as fertilizer for crops or as feed for fish.

By adopting the VAC model, farmers can optimize land, water and solar energy resources usage, reducing the need for external investments and enhancing overall productivity. This integrated approach aligns with the principles of the CE by emphasizing resource efficiency, waste reduction and the regeneration of natural systems.

The rising advancements in data information connection systems, including IoT (internet of things), big data, cloud storage…, have led to the widespread adoption of information technology. This has resulted in the emergence of popular practices such as resource sharing among individuals. Instead of owning possessions like cars, houses, equipment and tools outrightly, people can now share them with others. Companies like Airbnb, Uber and Grab have played a pivotal role in popularizing this model by enabling individuals to rent out their homes or vehicles for a specified fee (Esposito et al., 2017).

TerraCycle, an enterprise focusing on waste management, specializes in recycling materials that are typically challenging to recycle and developing circular solutions across different sectors (Wallace, 2015). They collaborate with manufacturers of consumer goods, retailers, and local authorities to gather and recycle items and packaging that would otherwise be disposed of end up in landfills. Additionally, they create inventive business strategies like the "Loop" platform which facilitates the delivery of products using reusable containers that can be collected, cleaned and refilled. This CE model is gaining significant traction among Vietnamese companies.

Renault, the automobile company from France, has implemented the concepts of CE in its production procedures (Lopes, 2007). They have established a facility dedicated to restoring and repairing used components like engines and transmissions for resale at reduced prices. By adopting this strategy, Renault effectively minimizes waste generation, preserves valuable resources, and lessens the environmental repercussions associated with manufacturing brand new parts.

The application of CE principles in sugar cane factories in Vietnam is a commendable example of resource optimization and waste reduction (Nguyen et al., 2022). The utilization of sugarcane bagasse, the residue left over from sugarcane processing, as a source of energy through combustion is an efficient way to extract value from what would otherwise be considered waste. By carefully transporting bagasse to power-generating boilers, factories can generate heat and steam, which can be used for various purposes within the factory, such as electricity generation and process heat. The combustion of bagasse not only provides a renewable source of energy but also helps to reduce the reliance on fossil fuels and decrease GHG emissions. It is a sustainable alternative to traditional energy sources.

Furthermore, the conversion of bagasse ash into biochar highlights the commitment to closing the loop and extracting value from waste streams. Biochar, a stable form of carbon, can be used as a soil amendment, contributing to improved soil health, carbon sequestration, and

nutrient retention. By transforming the ash into biochar, factories are effectively repurposing the waste into a valuable resource with beneficial uses, such as agricultural applications.

The implementation of strict quality control measures throughout the entire process chain ensures the efficiency, sustainability, and environmental friendliness of the production process. This commitment to quality control helps to maintain the integrity of the CE model and ensures that the generated energy and byproducts meet the required standards.

By applying CE principles in sugar cane factories, such as utilizing bagasse for energy generation and converting ash into biochar, the industry can reduce waste, optimize resource use, and contribute to a more sustainable and environmentally friendly production process. This approach aligns with the broader goals of the CE by minimizing waste, maximizing resource efficiency, and promoting a closed-loop system.

• ***ISPONRE has been tasked by the MONRE to collaborate with relevant group of experts in order to develop and propose the "National Action Plan for implementing the CE" to the Prime Minister for approval. Do you have any opinions or evaluations regarding this objective? The Draft Plan outlines specific objectives, principles, roadmap and priority industries such as mining and energy that will be focused on during the implementation of CE practices?***

Prof. Nguyễn Xuân Huy: The concept of a CE is crucial in attaining sustainable development and the mining and energy industries have a vital role in achieving these objectives. They contribute by keeping resources in use for as long as possible, extracting maximum value from them, while minimizing waste and pollution. In order to grasp the significance of the CE in relation to mining and energy sectors, it is crucial to acknowledge their significant role in global GHG emissions and resource utilization. Notably, these industries play a major part in extracting minerals and metals that are vital components across various products such as electronics, vehicles, and infrastructure. However, the extraction and processing procedures associated with these materials often require substantial amounts of energy while also producing considerable waste and pollution.

The energy industry plays a crucial role in harnessing different forms of energy to support socio-economic progress. However, the majority of electricity production relies on non-renewable resources like coal and oil, which not only contribute to climate change but also lead to other environmental issues. To address this, shifting towards renewable energy sources and enhancing energy efficiency can help alleviate these problems. Nevertheless, implementing such measures would necessitate substantial investment and alterations in both production and consumption practices that consume energy.

Promoting sustainable resource use and waste reduction, the CE presents a solution to these challenges. One such approach involves creating long-lasting and recyclable products, minimizing the demand for new resources and maximizing the lifespan of materials already in existence. Similarly, closed-loop supply chains can be implemented to minimize waste and pollution while also generating fresh economic prospects.

The Draft National Action Plan for CE implementation specifies priority sectors and industries. From my perspective, a crucial area to focus on is the advancement of electric vehicles, which heavily rely on mining mineral resources like lithium, cobalt, and rare earths. By prioritizing responsible sourcing, recycling, and reutilization of these materials, we can effectively reduce the environmental consequences associated with electric vehicle manufacturing and usage.

The construction industry is another significant domain, wherein the construction and functioning of buildings contribute greatly to worldwide energy usage and GHG emissions. By prioritizing energy-efficient building designs, utilizing eco-friendly materials, and adopting circular approaches like recycling and reusing construction elements, we have the potential to decrease these effects and foster the development of more sustainable urban areas and communities.

In the mining and energy sectors, generally it is important for groups and industries embracing the concept of a CE to establish clear objectives and detailed action plans in order to attain optimal results. Accomplishing this objective will necessitate collaboration among industry players, Government bodies and other relevant parties. Although realizing this vision may be challenging, the potential rewards are substantial. However, reaching this objective will demand considerable investments in research, innovation, infrastructure, as well as policy adjustments and shifts in consumer attitudes.

• ***In the forthcoming years, what suggestions do you offer for Vietnam to successfully adopt and put into practice CE principles within the energy sector?***

Prof. Nguyễn Xuân Huy: The key strategies for driving the implementation of a CE in the energy sector comprise: *Firstly*, policy and regulatory assistance: The Government has the ability to establish a conducive policy environment by enacting regulations and providing incentives that encourage the adoption of CE practices within the energy sector. These measures may include tax refiefs, subsidies and financial aid specifically aimed at supporting clean technologies, renewable energy ventures and initiatives related to CE principles.

Secondly, promoting sustainable finance options, such as the issuance of green bonds, stocks, and credits, can incentivize private investment in energy sector CE initiatives. By highlighting the proven positive impacts on the environment, society, and finances that come with CE projects, it becomes feasible to establish an appealing investment climate and gather essential resources for facilitating this transition.

Thirdly, Vietnam possesses considerable prospects for generating electricity through renewable energy sources like solar, wind, and biomass. These alternatives offer opportunities for the nation to shift away from fossil fuel reliance, lower GHG emissions, and foster job creation. By promoting the expansion of distributed energy systems such as autonomous rooftop solar setups and residential-based wind power projects, Vietnam can enhance energy accessibility, lessen dependency on traditional grids, and stimulate localized economic progress. Embracing this decentralized approach also enhances the overall resilience and flexibility of Vietnam's energy infrastructure.

Fourthly, enhancing energy efficiency across diverse sectors, such as industrial, commercial, and residential areas, can contribute to a decrease in overall energy usage. This can be achieved through the adoption of energy-saving technologies, implementation of building energy codes, and encouraging consumers to adopt energy-saving practices.

Fifthly, the waste-to-energy program offers Vietnam a chance to tackle issues pertaining to waste management and energy generation. It is crucial to promote investments in waste-to-energy initiatives, including the production of biogas from agricultural waste or the recovery of gas from landfills. These projects not only generate clean energy, but also help minimize both waste and pollution.

Sixthly, the development of smart grids involves the investment in technology that can enhance energy efficiency and management, minimize transmission losses, and seamlessly integrate a greater amount of renewable energy into the power grid. By implementing smart grids, there is an opportunity to improve demand response capabilities, as well as achieve real-time monitoring and control of energy usage. This enables the optimization of energy consumption and reduces unnecessary wastage.

Seventhly, to encourage recycling and the recovery of materials: The establishment of infrastructure and systems for material recycling and recovery can contribute to waste reduction, reclaiming valuable resources, and fostering new business opportunities. Some initiatives embraced by the newly-formed alliance are e-waste recycling, battery recycling, and construction material recycling.

Eighthly, encouraging the use of sustainable transportation options, like electric vehicles, can aid Vietnam in decreasing its reliance on fossil fuels and lowering GHG emissions. By backing the expansion of charging infrastructure for electric vehicles and offering incentives to promote their adoption, there is potential to foster widespread usage of electric vehicles throughout Vietnam.

Ninthly, enhancing the circumstances for industrial symbiosis by setting up hubs or platforms where companies can swap by-products, waste, or resources can contribute to the development of closed-loop systems and decreased resource usage. As an illustration, surplus heat from industrial operations could be harnessed to generate power or supply warmth to neighboring structures, while waste material can serve as a valuable input for other sectors.

Tenthly, the establishment of research and development and innovation centers specifically dedicated to CE solutions can expedite the advancement and implementation of new technologies and practices in the energy industry. These centers serve as a hub for collaboration between Government, universities, academia and industry, facilitating knowledge exchange and the generation of novel business prospects.

• ***Thank you very much!***

CHÂU LOAN