

October 2, 2026

Revisiting the Circular Carbon Economy

Yoshikazu Kobayashi

Chief Economist

Director for Research Strategy & Energy Security

The Institute of Energy Economics, Japan

The concept of a “Circular Carbon Economy” (CCE) was proposed several years ago, but its relevance is worth reconsidering in light of today’s changing energy landscape. The concept views carbon dioxide (CO₂) not simply as a waste product to be emitted, but as a substance that should be continuously circulated, to achieve both climate action and economic growth. The concept was advocated by Saudi Arabia during its G20 presidency in 2020 and was incorporated into the G20 Leaders’ Declaration.

At the core of the Circular Carbon Economy are the elements known as the “4Rs.” The first R stands for “Reduce,” meaning the reduction of CO₂ emissions through measures such as energy efficiency and the deployment of renewable energy. Many conventional decarbonization policies fall under this category. The second R is “Reuse.” This refers to technologies that use captured CO₂ in its original form, for example, as dry ice or in carbonated beverages. These technologies fall under the direct-use category of Carbon Capture and Utilization (CCU). The third R is “Recycle.” While there is some overlap with Reuse, Recycle refers to converting captured CO₂ chemically into other substances and using it in products such as chemicals and synthetic fuels, thereby actively circulating carbon within the economy. The fourth R is “Remove.” In addition to carbon dioxide removal through measures such as afforestation, enhanced weathering, and Direct Air Capture (DAC), the CCE concept also includes Carbon Capture and Storage (CCS), in which CO₂ generated from fossil fuel use is captured and stored underground, under the category of Remove.

In this way, CCE is a holistic concept that encompasses not only conventional decarbonization measures such as energy efficiency, renewable energy, and nuclear power, but also hydrogen/ammonia, CCUS, and carbon removal. Underlying this concept is the principle of technology neutrality: as long as different technologies can contribute to the common goal of reducing the concentration of CO₂ in the atmosphere, they should be combined and utilized without assigning a priori superiority to any particular technology.

This approach also has practical implications for countries and industries where it is difficult to move away from fossil fuels rapidly. Energy resources, industrial structures, and stages of economic development vary from one country or region to another, making it difficult to apply a single decarbonization pathway to all countries. By promoting real emissions reductions through a combination of diverse technologies, CCE can be seen as an approach that takes these realities into account. At the Institute of Energy Economics, Japan (IEEJ), we have also developed long-term energy supply and demand scenarios based on the CCE concept in our annual IEEJ Outlook¹.

CCE, however, has also faced criticism. First, because the concept was proposed by Saudi Arabia, an oil-producing country, it has been argued that the notion that CO₂ emissions can be captured or removed later could potentially be used to justify the continued production and consumption of fossil fuels. Second, CCE may be “too comprehensive.” While it allows for a wide range of decarbonization options, it does not specify how different technologies should be combined or in what proportions. As a result, some argue that it may be difficult for emerging and developing countries with limited knowledge, financial resources, and human capital in decarbonization technologies to use CCE as a concrete policy guide.

Nevertheless, in light of the current energy landscape, CCE is a concept to be revisited. When CCE was first proposed in 2020, momentum toward net zero was rapidly building around the world. Since then, a series of events, including the war in Ukraine and the recent Hormuz crisis, have threatened the stability of energy supplies. These experiences have heightened the need to view decarbonization not only through the lens of climate action, but also in relation to energy security and economic security.

From this perspective, all four Rs of CCE have important implications. The importance of Reduce is self-evident. Reducing dependence on fossil fuels through energy efficiency and the deployment of renewable energy not only lowers CO₂ emissions but also reduces reliance on energy imports from abroad, thereby strengthening energy security. Following the experience of the Hormuz crisis, this dimension has become even more significant.

Reuse and Recycling also take on new significance. Capturing carbon from domestic emission sources, biomass, waste, and other sources, and using it for direct CO₂ utilization, e-methane, synthetic fuels, or chemical feedstocks could contribute to circulating carbon domestically. While significant barriers remain to be overcome, the commercialization of such technologies could potentially substitute for a portion of imported oil and natural gas.

The importance of Remove is also increasing. In situations where the importance of coal as an alternative to LNG rises in the wake of a Hormuz crisis, the challenge becomes how to reduce

¹ The Institute of Energy Economics, Japan, IEEJ Outlook 2022: Challenges toward Carbon Neutrality (October 2021).

the CO₂ emissions associated with coal use. One of the most promising options is CCS. In other words, even when energy security has to be prioritized, combining fossil fuel use with technologies such as CCS could create opportunities to reconcile stable energy supplies with decarbonization.

Another important feature of CCE is its flexibility to incorporate future technological innovations as they emerge, including technologies that are not yet commercially viable. Looking back over the past two decades, several technological developments that were not necessarily widely anticipated at the outset have become realities, including the shale revolution, the rapid deployment of renewable energy, and the dramatic decline in the cost of battery electric vehicles (BEVs). At a time when concerns about energy security have reached unprecedented levels, new technological breakthroughs may well emerge in the future. Rather than relying in advance on any particular technology, the ability to continually adjust the optimal combination of decarbonization measures in response to technological progress and changes in the social and economic environment can therefore be seen as a major strength of CCE.

From the perspective of international cooperation, CCE is also highly compatible with the concept of the Asia Zero Emission Community (AZEC), promoted by the Japanese government. AZEC was proposed by former Prime Minister Fumio Kishida in 2022. It aims to enable Asian countries with diverse stages of economic development and different energy circumstances to pursue decarbonization in ways suited to their respective circumstances, while simultaneously achieving economic growth and energy security. As discussed above, the technology-neutral principle underlying AZEC—that while carbon neutrality is a common goal, there is no single pathway to achieving it—is fundamentally consistent with the 4Rs of CCE.

There are also many similarities in terms of specific decarbonization measures. AZEC envisages a wide range of options, including not only renewable energy and energy efficiency but also CCUS, carbon recycling, and the use of hydrogen and ammonia. This overlaps with the CCE approach, which combines conventional decarbonization measures such as energy efficiency, renewable energy, and nuclear power under Reduce with CCUS and carbon removal under Reuse, Recycle, and Remove.

Having experienced multiple energy supply crises, including the war in Ukraine and the Hormuz crisis, the world is now reassessing decarbonization from a more pragmatic perspective. Decarbonization must be pursued not only as a response to climate change, but also in conjunction with multiple policy objectives, including energy security, economic security, and industrial competitiveness. Rather than viewing decarbonization and energy security as competing policy objectives, we need to pursue both simultaneously. To achieve this, a broad and flexible combination of available technologies should be employed. Now, after experiencing successive

energy crises, it may be precisely the right time to take a fresh look at the concept of the Circular Carbon Economy.

Contact: report@tky.ieej.or.jp