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INSIGHT BRIEF

March 2020

The Circular Carbon Economy

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KEY POINTS:

- **While renewable technologies are part of the solution towards climate mitigation, holistic whole system solutions are required long-term due to the continued reliance on fossil fuels.**
- **The Circular Carbon Economy employs a technology-neutral whole systems approach to achieve energy market stability, responsible and inclusive economic growth, and sustainable development goals.**
- **The four R's of the Circular Carbon Economy include:**
    1. **Reduce:** using all carbon mitigation options and fuels with a reduced carbon footprint
    2. **Reuse:** carbon capture and utilisation without chemically altering carbon
    3. **Recycle:** create new value-add products by chemically altering carbon
    4. **Remove:** carbon capture utilisation storage (CCUS), direct air capture, and natural sinks
- **The implementation of the Circular Carbon Economy depends on several variables:**
    - Continued investment in carbon-conversion technology and finding synergies between different technologies,
    - Government policy support to create market enablers, and
    - Data transparency and standardisation on carbon emissions use and storage.

CONTEXT:

With global demand for energy growing into the future, sustainable and responsible energy development is crucial to achieving shared goals. According to main energy outlooks, fossil fuels will continue to play a major role in the future energy mix, and the carbon dioxide (CO_2) and other harmful emissions must be managed appropriately to meet Sustainable Development Goals and keep global warming within acceptable thresholds. Although the adoption of renewable energy technologies and electrification of transport along with associated efficiency efforts are part of the solution towards achieving shared goals, the role of CO_2 emissions from oil and gas operations cannot be ignored. One way to absorb such emissions is through Carbon, Capture, Utilisation and Storage or CCUS which is a set of technologies that capture CO_2 emissions at source, preventing them from entering the atmosphere, or capturing them directly from the air. The CO_2 emissions are then turned into value-add products and processes or stored underground.

THE FRAMEWORK:

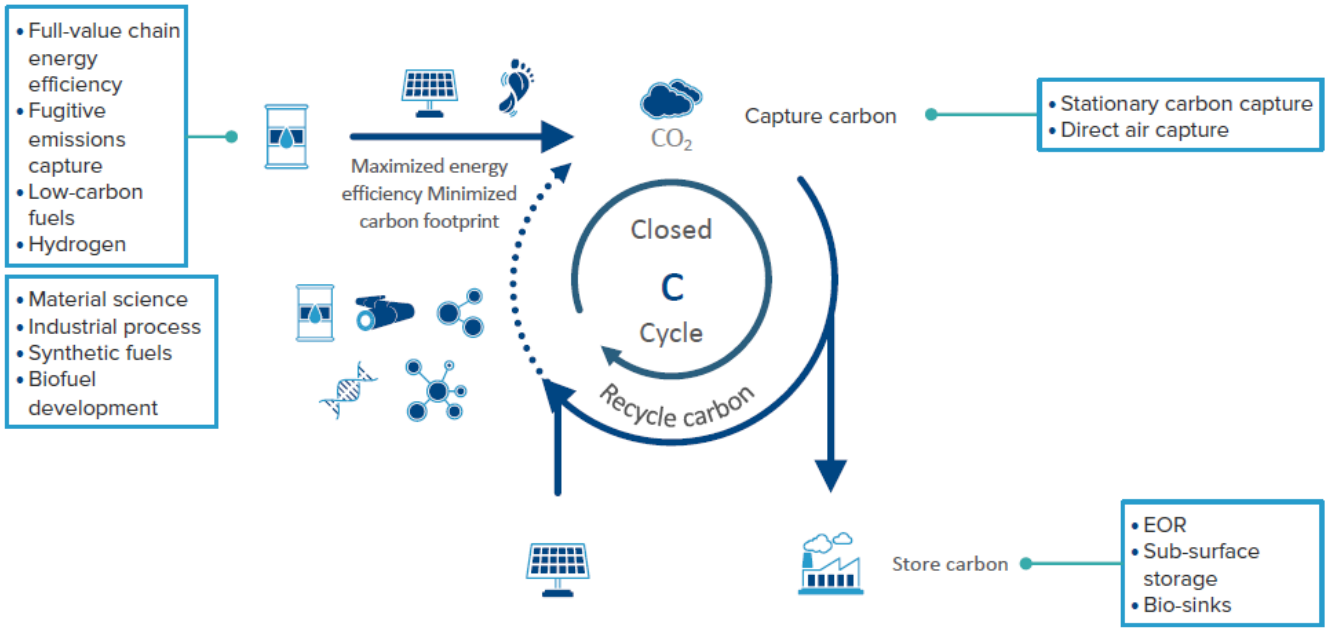
The Circular Carbon Economy is based on all carbon mitigation options working together providing a comprehensive whole systems approach to emissions reduction. CCUS can enable a circular carbon economy, a framework in which emissions of carbon and other greenhouse gases are mitigated through the **4 Rs: Reduce; Reuse; Recycle; Remove**. The circular economy moves industry processes and the life-cycle of products from a linear model, where materials are used and then disposed, to a circular system through the reduction of consumption, reuse, and recycling of materials and by-products, or cost-effective removal into storage in combination with other processes. For circular carbon use, CO_2 emissions from hydrocarbon combustion are captured, reused, and recycled in other forms of energy or products or stored underground to close the carbon cycle efficiently.

Carbon emissions can be turned into value-add products including plastics, blue hydrogen, fertilizers and used in building materials to reduce emission into the atmosphere. Carbon emissions are already reused for enhanced oil and gas recovery and to generate heat and power more optimally or produce synthetic fuels. Recycling CO_2 to produce other energy sources and materials while simultaneously removing emissions from the atmosphere through nature-based solutions helps to enhance carbon efficiency and restores the carbon balance of the global economy.

The Circular Carbon Economy employs a technology-neutral whole systems approach to achieve responsible and inclusive economic growth while delivering on all sustainable development goals including providing universal access to modern energy services and mitigating climate change. The approach combines advances in renewable technology, carbon sequestration and builds on existing and new energy infrastructure to effectively manage carbon emissions for a secure, sustainable, and affordable energy future.

Collaboration on innovation and technologies

Laboratory R&D focus guided by the demands of CCE



THE FOUR R's:

The 4 R's are the central tenets behind a Circular Carbon Economy, but policy support for effectively mobilising investment will be vital in ensuring its implementation. The combined effect of the 4 R's will eventually lead to economic growth along with a carbon-neutral energy system.

Reduce – This represents all carbon mitigation options that reduce the amount of carbon entering the atmosphere. This includes efforts towards energy efficiency through new technologies, policies, and solutions that lead to reduced energy consumption and associated carbon emissions. Reduction can also include increased adoption of fuel types that have no carbon footprint such as nuclear energy and fuel-switching from coal to natural gas. Blue hydrogen developed from natural gas via steam reforming in combination with CCUS can act as a fuel carrier and serve multiple sectors which can potentially achieve multi-sector decarbonisation.

Reuse (CO_2 not chemically reacted) – Carbon captured through CCUS does not have to be chemically converted to create value-add products. It can also be reused for other processes that require carbon including Enhanced Oil Recovery (EOR) where carbon dioxide is pumped into the oil-bearing rock formation to recover more oil. Another application can be in the form of power generation where carbon can be sequestered underground which results in methane rising to the surface. This natural gas can then be used to generate electricity or power the sequestration itself.

Recycle (CO_2 chemically reacted) – Capturing and converting carbon through conversion technologies to useful feedstock for industry or other value-add products is favourable for both greenhouse gas mitigation and carbon-resource utilisation. Reusing carbon for products such as fertilizers, ammonia, methanol, and concrete enhances efficiency but also forms the basis for carbon neutrality. Continued investment in carbon-to-value conversion technologies will be required to ensure carbon can be reused to its maximum potential.

Remove – The final 'R' of the circular carbon economy closes the carbon loop in the system by removing carbon from the atmosphere which goes further than the traditional Circular Economy (Reduce, Reuse, Recycle). The "Remove" aspect incorporates climate mitigation into the framework where carbon is removed from the atmosphere through natural sinks and direct air capture technologies. Natural sinks can be enhanced through reforestation initiatives and aggressive conservation efforts.

RECOMMENDATIONS:

1. **Pursue dialogue on how synergies between carbon conversion, CCUS and "Fourth Industrial Revolution" technologies can strengthen the holistic and technology-neutral framework of the Circular Carbon Economy.**

   Deepen dialogue on carbon conversion technologies including catalytic, electrochemical, mineralisation, and biological processes to create value-add products. Greater collaboration is needed on exploring efficiencies and cost-reductions on CCUS technology, and how blue and green hydrogen can be leveraged as part of the Circular Carbon Economy framework. The incorporation of digitalisation and artificial intelligence into the Circular Carbon Economy model would make the framework more resilient and productive while enhancing synergies among technologies would accelerate orderly energy transitions and help achieve shared goals over the next decade.

2. **Examine how governments can help achieve the implementation of a Circular Carbon Economy through ensuring the adoption of low carbon alternatives, funding to spur investment in infrastructure, and continued research and development.**

   Capital intensive projects such as a Circular Carbon Economy requires willingness from governments to drive such projects forward. Enabling policies in combination with public-private partnerships have the potential to accelerate research investment in the various types of technologies essential for a Circular Carbon Economy. Furthermore, CCU companies need transportation infrastructure, from pipelines and policies that encourage the clustering of CCU projects close to sources of high-quality CO_2, to cut down on transportation costs. Taking all this into consideration, the role of government and policy is profound and will impact how the Circular Carbon Economy will move forward.

3. **Deepen commitment to maximising energy data transparency and working towards achieving standardisation on carbon measurements to ensure consistency in tracking carbon dioxide emissions, use, and storage, and encourage data-sharing across jurisdictions.**

   To meet globally shared goals, the changes in energy data requirements will demand new carbon emissions datasets that are consistent across jurisdictions. The Joint Organisations Data Initiative (JODI) could maximise the use of its current dataset, including by exploring calculation of emissions and carbon intensity. This will only be possible through strengthening interactions among relevant data providers, users, academia, and research communities, and expand outreach to access new potential JODI participants and build on mutual strengths to broaden the platform.

CONCLUSION:

Under the Saudi Presidency of the G20, the Circular Carbon Economy has taken centre stage as a whole system solution to manage carbon emissions. Given that main energy outlooks forecast fossil fuels to comprise a major part of the global energy mix, it also means CO_2 emissions will also remain a reality for the foreseeable future. The Circular Carbon Economy offers a realistic, holistic, and technology-neutral model that focusses on carbon *management* as opposed to carbon *elimination* that will ultimately lead to a carbon-neutral energy future. A more diversified energy economy based on carbon management will also lead to less market volatility.

As a novel approach to energy, implementing the Circular Carbon Economy would require ongoing investment and finding synergies between different technologies leading to economies of scale, support from governments through enabling policies, and increased data transparency related to CO_2 emissions, use and storage. The IEF continues to be a leader and advocate of the Circular Carbon Economy and whole system solutions and will advance the dialogue on these themes at the 17th International Energy Forum Ministerial hosted by Saudi Arabia on 25-26 September 2020.

> Technology-neutral dialogue on whole systems solutions from renewables to circular carbon models create a more predictable investment environment.
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> IEF Key Message at the G20 Energy Sustainability Working Group, 7-8 March 2020