Case Study

aramco

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Global Standards for Digital Intelligence

on

DIGITAL-ESG FOR THE ENERGY SECTOR

Cross Carbon Economy

Climate change is a global existential threat. More than 70 countries covering about 76% of global emissions, as well as the world's largest corporations, have committed to achieve net zero emissions within the next few decades.[1] The energy sector, which represents the source of about three-quarters of global emissions, holds the key to achieve this goal.

Today's energy sector has been heavily impacted by the conflict in Ukraine and faces unprecedented vulnerability. Driven by not only geopolitical tensions but also a rebound in energy demand after the COVID-19 pandemic, the global energy market suffers from increasing energy prices and concerns on security-of-supply. How can these net zero pledges be translated into tangible actions peacefully, inclusively, and practically?

This Digital-ESG Case Study (the case study) for the Energy Sector was developed as part of the Digital-ESG White Paper publication in collaboration with the Saudi Arabian Oil Company (Aramco) and the DQ Institute. This case study examined how Aramco's sustainability goals can be better served by reconceiving their *Circular Carbon Economy* model as a *Cross Carbon Economy* model. The *Cross Carbon Economy model* emphasizes creating value from carbon waste and does so in a way that is more equitable to the world inclusively.

This approach will provide practical insights and valuable tools to all stakeholders in the energy sector to shape a global energy system that better balances affordable energy, energy security, and net zero goals.

NEED FOR INCLUSIVITY IN THE EAST-WEST ESG NARRATIVES

Currently, ESG discussions on net zero emissions focus primarily on the energy transition from fossil fuel-based energy systems (e.g., oil, gas, and coal) to lower-carbon energy systems (e.g., renewables, hydropower, nuclear and bioenergy). It was estimated that approximately USD $50 trillion in incremental investments is required by 2050 for the global economy to make the energy transition to achieve net-zero emissions.[2] A coordinated effort after the COVID-19 pandemic has accelerated this energy transition.[3] For instance, the European Investment Fund signed climate funding commitments totalling 247 million euros at the recent UN Climate Change Conference (COP27).[4] More notably, the EU is poised to set the global benchmark for ESG rulemaking encompassing broader topics under the environment component including *climate change*, *pollution*, *resource and circular economy*, all of which are related to the energy transition.[5] This EU ESG regulation is anticipated to impact business globally and in turn influence legislation even in countries outside the EU in what is known as the "ESG Brussels Effect".[6]

The question we need to ask is whether such an aggressive push for energy transition is practical worldwide? How inclusive is this approach? Is the energy transition the only solution to achieve net zero goals?

The energy transition indeed requires a concerted effort by policymakers, businesses, and consumers at the national level of each country. Climate policies and related legal instruments need to be established and supported by public sentiment and acceptance. For businesses, the technology and infrastructure transformation related to the energy transition requires significant capital investment. In addition, it requires technology and manpower expertise to efficiently lead and manage the transformation process. Apart from those matters, public sentiment and local consumer behaviours also play important roles in the transition.[7-8] These latter considerations are determined by the level of consumer awareness and consumer appetite, which are also indirectly influenced by energy prices and the national economic landscape.

The "Western" world (the West), represented by the Global North countries with advanced economies comprising regions such as Europe and North America, have greater capacity to support the energy transition, especially in terms of financing the technology and infrastructure transformation. Moreover, a high level of awareness on climate issues and net zero goals among the public promotes greater consumer acceptance towards lower carbon energy sources, which in turn encourages businesses to adopt the model as well.

In contrast, the "Eastern" world (the East), where many of the Global South countries with emerging market economies are situated, tends to prioritize economic growth over the sustainable energy agenda. For instance, 940 million people (around 13% of the global population), the majority of whom are from low income countries in Africa, Asia, and the Middle East, still do not have basic access to electricity.[9] In these regions, securing an affordable energy supply and economic growth remains the top priority. Moreover, many Asian countries including China, which is often regarded as the world's factory, heavily rely on energy-intensive industrial and manufacturing activities as well as on high levels of product consumption as primary drivers of their economy. Thus, in these countries, there is an

inclination to use less expensive fossil fuel-based energy sources rather than more expensive lower carbon energy sources.

Despite the systematic push to realize the energy transition in the West (i.e., from fossil fuel- to renewable-based energy sources), the global demand for fossil-fuels is expected to continue growing within the next 5 years.[9] All of the world's potential growth in emissions is expected to come from emerging and developing countries due to a fossil fuel-intensive energy use. Moreover, it is projected to likely drop when there is an uptake in the global EV market and a considerable decrease in the use of oil in domestic power and heat generation. However, the dynamics of such energy-related consumer markets will also depend heavily on the situation in emerging and developing countries in the East, given their status as a major driver of global growth with growing population and rising demand for energy and materials.

In summary, the current ESG narratives for the energy transition tend to work exclusively for Western countries with advanced economies. As such, there is a growing need to foster balanced and inclusive dialogue that considers the perspectives and values from the East.

This need arises in part because developed economies contend with aging populations whereas the populations of emerging economies are growing rapidly. Also, poorer countries face difficulties in accessing affordable finance and technology for the energy transition. A ban on financing fossil fuel projects in low- and middle-income countries would place additional burdens on vulnerable groups, often women. In developing countries, basic development tasks remain paramount, such as providing access to affordable energy, improving healthcare and education systems, building infrastructure, and growing job opportunities.

Different levels of economic development in each country give rise to different perspectives and values on demand for energy, materials and wealth pathways. The path in any kind of economic transition (e.g., following the linear, circular, or any other economic model), and more critically the cost associated with it, matters. Also, it is important to consider multiple paths that are affordable, inclusive, and practical.

NEED FOR RECOGNIZING THE VALUE OF CARBON

Current sustainability narratives put carbon into a negative light, featuring it only as polluting emission to the earth's atmosphere (in the form of CO_2). Carbon pricing mechanisms, such as a carbon tax or a cap-and-trade system that depends on government allotments, address the negative impact of carbon emission on the earth's atmosphere. However, this represents only half of the equation and completely neglects an equally important aspect of the net zero transition – carbon as an invaluable molecular building block.

After all, over 90% of all manufactured goods contain carbon-based chemistry. Carbon represents the fundamental molecular building block of most consumer products, being present not only in the starting materials and end-products but also as precursors or additives in a variety of materials

production processes.[10] More importantly, carbon constitutes the hydrocarbon chains in materials that are generated by the oil and gas industry, which includes petroleum fuel, petrochemicals, and plastics.

In other words, technologies aimed at reducing emissions such as wind turbines, solar panels, batteries and storage devices, as well as all clean modes of transportation also depend on advanced, durable materials transformed from carbon. For instance, in our attempt to reduce emissions through the migration from petrol to hybrid and electric vehicles, petrochemicals and plastics are still extensively used to produce multiple automobile parts and components[11] (such as batteries, lightweight body panels and interiors, which are primarily in the form of polymer composites). Furthermore, the use of electricity for vehicle propulsion also requires significant energy to be produced, which is heavily dependent on traditional energy sources.

Similarly, the development of infrastructure to produce other forms of renewable energies (e.g., the construction of the blades of wind turbines, solar panels, etc.) also relies heavily on polymeric materials. In fact, every megawatt of installed renewables capacity requires eight to eleven tons of petrochemical products.[12-13] In addition, carbon-based materials are likely to be used as substitutes for higher-emission intensity materials such as steel, glass and cement.

Along this line, it is crucial to note that the carbon-based materials remain essential even as the world shifts towards more sustainable living and adopts the use of renewable energy sources; this future world is likely to be both energy and materials intensive. It is important to acknowledge carbon as the molecular building block for products that need to be generated in creating a sustainable future.

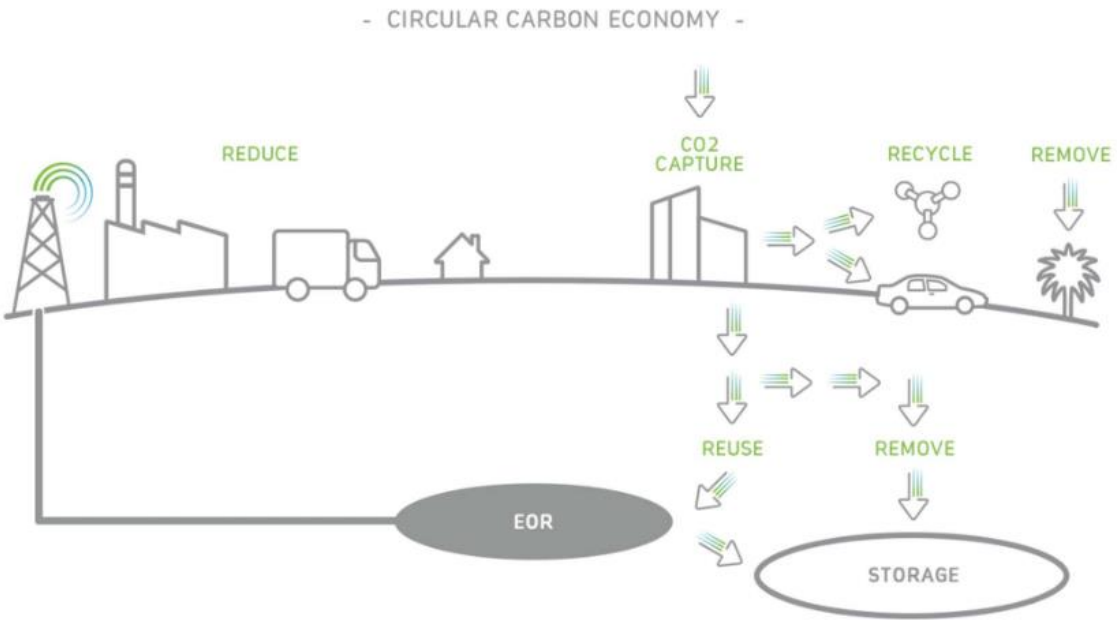
CIRCULAR CARBON ECONOMY VS. CROSS CARBON ECONOMY

The *Circular Carbon Economy* proposed by the Kingdom of Saudi Arabia during its presidency of the G20 is a framework for managing and reducing emissions while creating a closed loop system involving 4Rs: reduce, reuse, recycle, and remove.[14]

- Reduce: Reducing emissions is a top priority toward mitigating climate change. It can be achieved not only through fossil fuel reduction through substitution with lower carbon energy sources like renewables, hydropower, nuclear and bioenergy, but also through enhanced energy efficiency and flaring minimization.
- Reuse: CO_2 has value and using innovative technologies to capture it means that it can be reused in useful products, such as fuels, bioenergy, chemicals, building materials, food and beverages.
- Recycle: CO_2 is chemically transformed into new products, such as fertilizer or cement, or other forms of energy such as synthetic fuels.
- Remove: Using technology to capture and store CO_2 is an important way to achieve large-scale reduction of emissions, and increasing photosynthesis by planting flora also contributes toward reduction.

Figure 1 describes the *Circular Carbon Economy*'s holistic approach, which involves a wide range of carbon mitigation strategies that work systematically in tandem to achieve emissions reduction.[15] Its concept was endorsed by the leaders of the G20 and 30 countries as a way to manage emissions across all industries while promoting economic growth.[16]

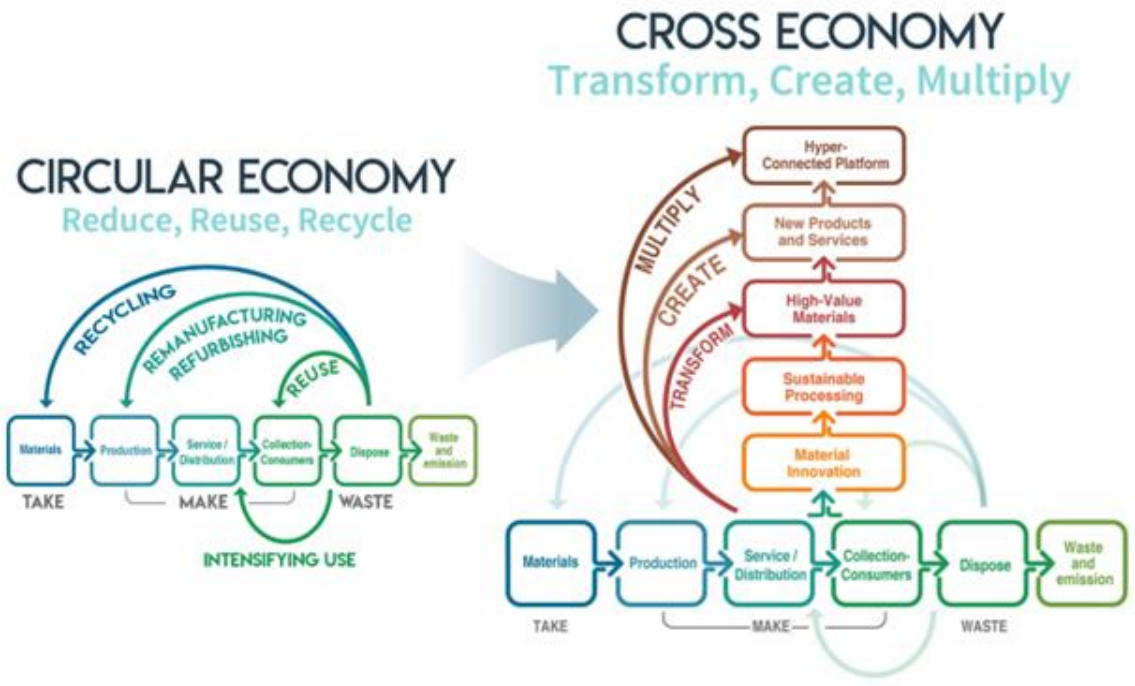
Figure 1: Conceptual framework of *Circular Carbon Economy* (Source: Aramco)



An alternative to the Circular Economy has recently been independently developed by the DQ Institute and Nanyang Technological University in Singapore. The Cross Economy model is illustrated in Figure 2, which compares it with the Circular Economy. With the catchphrase: "Transform, Create, Multiply," the key idea of the Cross Economy is not simply to "Reduce, Reuse, Recycle" as described in the Circular Economy, but rather to create something new and valuable based on waste or other resources that are traditionally considered to have low or zero value.

The Cross Economy provides a conceptual framework for businesses to enhance their profitability while reducing and/or removing negative impacts on sustainability through responsible and moral use of technology.

Figure 2: Conceptual Frameworks for Circular Economy and Cross Economy



The *Circular Carbon Economy* is an exemplary model of Cross Economy.

In fact, the *Circular Carbon Economy* is more adequately explained through the economic model of the Cross Economy, rather than through that of the Circular Economy. Carbon waste, which is treated as a pollutant, cannot be circled back through the original value chain of energy creation, like the typical reuse-recycle-reduce mechanism of the circular economy in the case of plastic drinking bottles or aluminium cans. The *Circular Carbon Economy's* 4R processes explain the mechanism of the Cross Economy that transforms carbon waste into other high-value materials through the use of cutting-edge materials processing technologies. It further creates new products, services, and value propositions that can multiply economic and social benefits. Below are some examples of how the CCE can realize innovation and value creation while enhancing sustainability through the Cross Economy model based on the concepts of "Transform, Create, Multiply."

Reduce – Recycle:[14]

- *Transform*: the CO_2 waste is converted to clean, high-value materials with significant performance, cost, and carbon footprint characteristics by chemical transformation technologies
- *Create*: these materials are used to create new products of high-performance polyols.
- *Multiply*: the creation of high-performance polyols in turn serves as advanced starting materials that lead to the production of a diverse range of intermediate materials for the production of consumer products such as consumer and industrial adhesives, insulation, food packaging, sealants, and elastomer applications.

Reuse – Remove:

- *Transform*: CO_2 emissions captured through carbon capture, utilization, and storage (CCUS) technologies are transformed into a resource or feedstock in existing production processes
- *Create*: This carbon is created into a resource or feedstock in existing production processes (e.g., oil refinery)
- *Multiply*: This resource is multiplied by unlocking the trapped oil after waterflooding and a sizable portion of the CO_2 remains sequestered in the reservoir.

Thus, hereafter, we will refer to *Circular Carbon Economy* as "***Cross Carbon Economy***" (CCE). The beauty of the CCE lies in its practical applicability to realize ethical growth. In a business context, ethical growth "is a continuous process in which a company enhances its profitability and market performance while reducing and/or removing negative impacts on societal and environmental resources and human wellbeing; it does this in the course of its commercial activities by deliberately designing and using technology from an ethical perspective." (DQI White Paper, 2022). This means that the CCE enables the energy sector to bring great impact in reducing global emissions, while at the same time ensuring consistent economic growth.

It is important to note that the CCE has opened diverse pathways to achieve the net zero goal. The CCE provides a tangible framework that the energy sector can consider beyond the conventional energy transition described as one component of the first R (*Reduce*) of the 4R. The *Reuse, Recycle, and Remove* processes of the 4R version of the CCE acknowledge the positive value of carbon, and provide new strategies for the energy sector not only to reduce and/or remove emissions, but also to develop innovative cross economy business models that can bring higher industry profitability through carbon-based materials innovation and related new value creation.

CCE as an Affordable, Inclusive, and Practical Net Zero Solution

The CCE redefines the conventional concept of the “energy transition” from fossil fuel-based energy sources (e.g., oil, gas, and coal) to lower-carbon energy sources (e.g., renewables, hydropower, nuclear and bioenergy) into a broad concept of the "energy transition” to a lower emissions future. It focuses on the goal of lowing emissions, regardless of energy sources. And it opens a wide range of affordable, inclusive, and practical net zero solutions to all.

For instance, while the conventional energy transition to lower-carbon energy sources may be relevant and applicable to the West, where natural resources are depleting and the population is shrinking, the comprehensive approaches of the CCE are relevant and applicable to all, especially to countries in the East.

The CCE can help nations and industries achieve net-zero emissions by optimally utilizing carbon-based resources while transforming carbon waste into precursor materials that can be used to produce high-value commodities. This can be attained through chemical processes that break down molecular carbon entities that can be reassembled into more complex functional materials. This will also promote technology innovation and bring economic industrial growth.

Due to its economic and social benefits, we envision that the inclusive CCE approach to carbon-based materials innovation will be well-received by the nations and industries, with greater acceptance and practical adoption. This is especially important in the East where there is rapid economic growth, and they can leverage on the growing population and high abundance of natural resources to implement the concept. The CCE may allow these countries to achieve sustainability goals without foregoing existing production processes that represent primary drivers of their rapid economic growth. As such, the CCE can provide a holistic framework for creating affordable, inclusive, and practical net zero processes across all nations and industries.

DIGITAL-ESG FOR CCE

Through the concept of the *Cross Carbon Economy* (CCE), the Digital-ESG for the energy sector aims to provide criteria that business and investment communities need to consider in managing and reducing carbon emissions and in optimizing market performance through the 4Rs.

The practices of 4Rs are facilitated by the digital transformation - adoption and advancement of enabling technologies that include material transformation, low-carbon technologies, and sustainable processing combined with digital technology. Energy corporations need to actively embrace such digital transformation that will enable them to develop a safe, efficient, and sustainable energy system. It will deliver increased operational efficiency and workplace safety and empowerment, as well as minimize the carbon footprint of the industry by reducing CO_2 emissions, enhancing fuel efficiency, conserving water. It will further create new and innovative materials that make consumer products lighter and stronger. It is therefore essential for these energy corporations to foster digital innovation, partner with leading technology companies and research institutions, and invest in the digital skills of their own workforce. In the process of digital transformation, they need to proactively identify, evaluate, and manage digital-related risks and opportunities.

It is important to note that the Digital-ESG is not designed to replace the existing ESG framework but to serve as an extra layer on top of it. It especially aims to compensate for the areas in which existing ESG standards may fall short, namely digital-related opportunities and risks related to the 4Rs through digital transformation. Specifically, the detailed indicators and metrics will be further developed for the Digital-ESG for the energy sector in the following 3 areas in the 8 digital-ESG criteria.

- DESG1: Human-Centred Transformation
- DESG2: Operational Efficiency
- DESG7: Digital Skills & Human Capital Development

Figure 3: 8 Digital-ESG Criteria

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