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King Abdullah Petroleum Studies and Research Center

cce INDEX
Circular Carbon Economy Index
مؤشر الاقتصاد الدائري للكربون

Discussion Paper

Saudi Arabia and the Circular Carbon Economy

From Vision to Implementation

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About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia's energy sector and inform global policies through evidence-based advice and applied research.

This publication is also available in Arabic.

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Executive Summary and Key Points

The circular carbon economy (CCE) concept has played a central role in Saudi Arabia's approach to climate change mitigation, including in pursuing the net-zero greenhouse gas (GHG) emissions target for 2060 it announced in 2021 (SPA 2021). Similarly, the Kingdom's current nationally determined contribution (NDC) to the Paris Agreement positions the CCE as a framework for achieving its targets. The CCE concept aims to address carbon dioxide (CO_2) and other GHG emissions through a holistic framework approach and emphasizes the need for using all available mitigation technologies in a cost-effective, context-appropriate and equitable way. In a complete CCE, sources and removals of CO_2 and other GHG emissions are balanced, resulting in net-zero emissions.

This KAPSARC Discussion Paper provides an analysis of Saudi Arabia's current CCE performance and its enabling environments for the CCE transition, relative to other countries. It places these results in the context of the Kingdom's current policy targets and measures to understand their directional alignment with its stated policy goals. By doing so, the analysis seeks to help inform the Saudi government as it prepares its second NDC ahead of the 2025 United Nations' submission deadline. The paper uses KAPSARC's 2023 Circular Carbon Economy Index as its framework of analysis, which comprises two main sub-indices: CCE Performance and CCE Enablers. In addition, the paper provides an overview of the 2023 results of the CCE Index Oil Producers Lens, an add-on score for major oil- and gas-producing countries.

In the 2023 edition of the CCE Index, Saudi Arabia ranked 20th out of the 64 countries included. Within the sub-indices, it ranked 16th in CCE Performance and 13th in CCE Enablers. On balance, Saudi Arabia's results place it above the global average, and well above the average scores of Middle East and North Africa (MENA), Gulf Cooperation Council (GCC) countries, and non-industrialized countries. Saudi Arabia's country score has also improved over the three years covered by the Index.

In CCE Performance, Saudi Arabia ranked third out of the 14 MENA region countries included in the 2023 Index. In addition to its sizeable carbon capture, utilization and storage (CCUS) project pipeline, the country's results are underpinned by the progress it has made in recent years in switching from oil-based liquid fuels to natural gas in its power sector. Relative to other major economies across the world, Saudi Arabia's clean energy deployment is still below the global average. Looking forward, the Kingdom's performance could improve if it is able to implement its ambitious targets of reaching 50% renewable energy in its power generation capacity by 2030 and significant production levels of clean hydrogen. The electrification of its industries and transportation and improving the overall energy efficiency of the economy are further crucial areas in which Saudi Arabia's CCE can be strengthened.

In CCE Enablers, Saudi Arabia ranked fourth in the MENA region. Its results were again on par with the global and

average above industrializing countries' averages. The country's strongest enablers are business environments and system resilience, where it scores higher than most of its peer groups. In the finance and investment dimension, Saudi Arabia's score was well below its peer groups. As bright spots in this area, CCE investments are starting to scale up, and the country's financial frameworks are relatively robust, performing above the regional and industrializing countries' averages. With an increasing focus on green and CCE finance and carbon markets, the prospects for higher levels of CCE investments are promising.

In oil and gas producer-specific metrics, Saudi Arabia performs well. It received a higher score than the global average, and a higher score than all its peer groups in most indicators, including top scores in the carbon intensity of its crude oil production and the flaring intensity of its oil production. Government and industry commitments in this area can be expected to keep the Kingdom among the highest-ranking hydrocarbon producers in these metrics going forward.

Overall, Saudi Arabia has already come a long way on its net-zero journey by developing and setting the CCE concept as the framework for its major transition ahead. The 2023 CCE Index paints a picture of a country that is already among the leading countries in the CCE in its region, with high ambition and significant potential to do even more.

1. Introduction

The circular carbon economy (CCE) concept has played a central role in Saudi Arabia's approach to climate change mitigation, including in pursuing the net-zero greenhouse gas (GHG) emission target for 2060 it announced in 2021 (SPA 2021). Similarly, the Kingdom's current nationally determined contribution (NDC) to the Paris Agreement positions the CCE as a framework for achieving its targets.[1] Saudi Arabia intends to achieve its emission targets through pursuing economic diversification and plans that also result in mitigation co-benefits. Data-based insights are a crucial policy tool to support realizing these efforts and can help in three crucial ways.

First, while economic diversification away from oil revenue dependence and absolute GHG emission reductions can be measured through straightforward metrics, providing a holistic picture of how the country is deploying various technologies and approaches with mitigation co-benefits to reach a full CCE – or net-zero emissions – can provide more insights. Second, it is crucial to gauge how well the country is positioned to make further progress toward a CCE, supported by various enabling factors, while ensuring economic growth and well-being are not compromised. Third, while analyzing Saudi Arabia individually can provide a good overview of its current CCE performance and potential, a comparison between Saudi Arabia and other countries – and particularly peer country groups – allows for a more comprehensive understanding of how the Kingdom is faring on its CCE journey.

This KAPSARC Discussion Paper aims to achieve two primary objectives. First, it provides an analysis of Saudi Arabia's current performance on the CCE, and its enabling environments for the CCE transition, relative to other countries. Second, it places this in the context of the Kingdom's current policy targets and measures to understand their directional alignment with its stated policy goals. By doing so, the analysis seeks to help inform the Saudi government as it prepares its second NDC ahead of the United Nations' 2025 submission deadline.[2]

As its framework for the analysis, the paper uses KAPSARC's 2023 Circular Carbon Economy (CCE) Index. The latest edition was launched in December 2023, and all underlying results and data, as well as global, regional and country analyses, are available via the CCE Index web portal: https://cceindex.kapsarc.org/. A previous KAPSARC paper, titled "How the Circular Carbon Economy Index Can Serve Policymaking: Case Study of Saudi Arabia," provided a snapshot of the Kingdom's performance using the 2021 edition of the CCE Index. While the 2021 edition covered 30 countries, the 2023 CCE Index edition includes 64 major economies from all global regions, and this paper provides an updated and significantly expanded analysis of Saudi Arabia's standing in comparison to various country peer groups.

The paper takes the following approach: Section 2 briefly introduces the CCE Index and provides a comparative overview of Saudi Arabia's standing in the 2023 edition. Section 3 analyzes Saudi Arabia's performance on the CCE using the 2023 CCE Index Performance results. Section 4 conducts a similar analysis of CCE transition potential by using the 2023 CCE Enablers results. Section 5 unpacks the results of an add-on score for major oil- and gas-producing countries called the Oil Producers Lens. Section 6 provides conclusions.

2. The CCE Index – Focus on Saudi Arabia

The CCE Index was developed by KAPSARC to serve as a tool for policymakers to assess country performances and their potential to achieve CCEs – understood as the equivalent of reaching net-zero emissions. The CCE concept aims to address carbon dioxide (and GHG) emissions through a holistic framework approach. It emphasizes the need to use all available mitigation technologies in a cost-effective, context-appropriate and equitable way. The CCE framework is structured around four "Rs" that encompass all CCE-related activities: reduce, recycle, reuse, and remove. Figure 1 illustrates the different technologies under each "Rs."

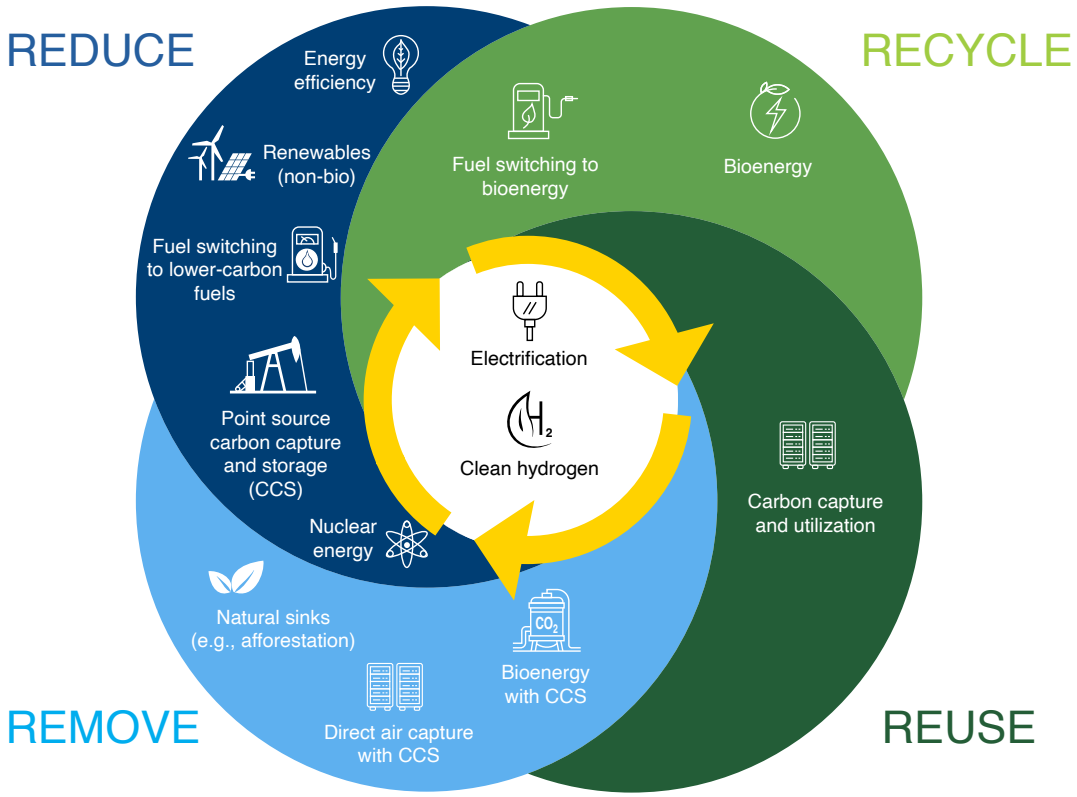
The CCE Index compares countries across different sub-indices (CCE Performance and CCE Enablers), dimensions (the five components of the CCE Enablers sub-index, namely policies, technology, finance, business environments and system resilience), and indicators (a total of 43 indicators across the sub-indices and dimensions). Each country receives a score on a scale of 0-100 on each of the indicators, which are then aggregated to form scores at various levels. In addition, five indicators are included in the CCE Performance score for top oil- and gas-producing countries to form an add-on score called the Oil Producers Lens. These scores together give a detailed view of each country's strengths and weaknesses and highlight areas for further CCE development. This function is illustrated in this paper with the case of Saudi Arabia. Figure 2 shows the indicator framework for the 2023 CCE Index and the 2023 Oil Producers Lens. The CCE Index methodology is available in Luomi, Yilmaz, and Alshehri (2021), and the full results of the 2023 edition of the CCE Index, which this paper builds on, are presented and analyzed in Luomi, Yilmaz, and Alshehri (2024).

Figure 3 provides a snapshot of the total 2023 CCE Index scores and rankings. In this edition of the CCE Index, Saudi Arabia ranked 20th out of the 64 countries included. Within the sub-indices, it ranked 16th in CCE Performance and 13th in CCE Enablers.

As shown in Figure 3, Saudi Arabia's total CCE Index score in 2023 was slightly higher than the global average, well above its regional peer group averages for the Middle East and North Africa (MENA),[3] the Gulf Cooperation Council (GCC) and non-industrialized countries. It scored lower than the high-income country group and Group of Twenty (G20) averages. Saudi Arabia's score and ranking is consistent with the observation that high-income countries, along with the G20, tend to do better on the CCE Index – a common feature of country-comparison indices. Saudi Arabia tends to perform better than its closest neighbors (GCC countries) and other developing economies (non-OECD countries).

As shown in Figure 4, over the past three years, Saudi Arabia's total CCE Index score increased from 34 in 2021

Figure 1. The circular carbon economy.



Source: KAPSARC (2023).

to 36 in 2022, and to 41 in 2023, marking a 7-point increase over this period.[4] This change holds more meaning when compared to the global average score, which increased by 3 points, and the MENA average score, which increased by 2 points, over the same period (Figure 4). Saudi Arabia's overall ranking was 31 and 32 in 2021 and 2022, respectively. This means that the country's rank improved by 11 points between 2021 and 2023, which translated into the second-largest increase in total country rank – second only to Indonesia and matched by South Africa.

The following sections decompose the CCE Index score, first focusing on Saudi Arabia's performance on the CCE, then analyzing its enabling environments for CCE transitions, and finally comparing Saudi Arabia's progress on industrial carbon circularity to that of the world's top 30 oil and gas producers.

Figure 2. 2023 CCE index Indicator framework – Total CCE Index and Oil Producers Lens.

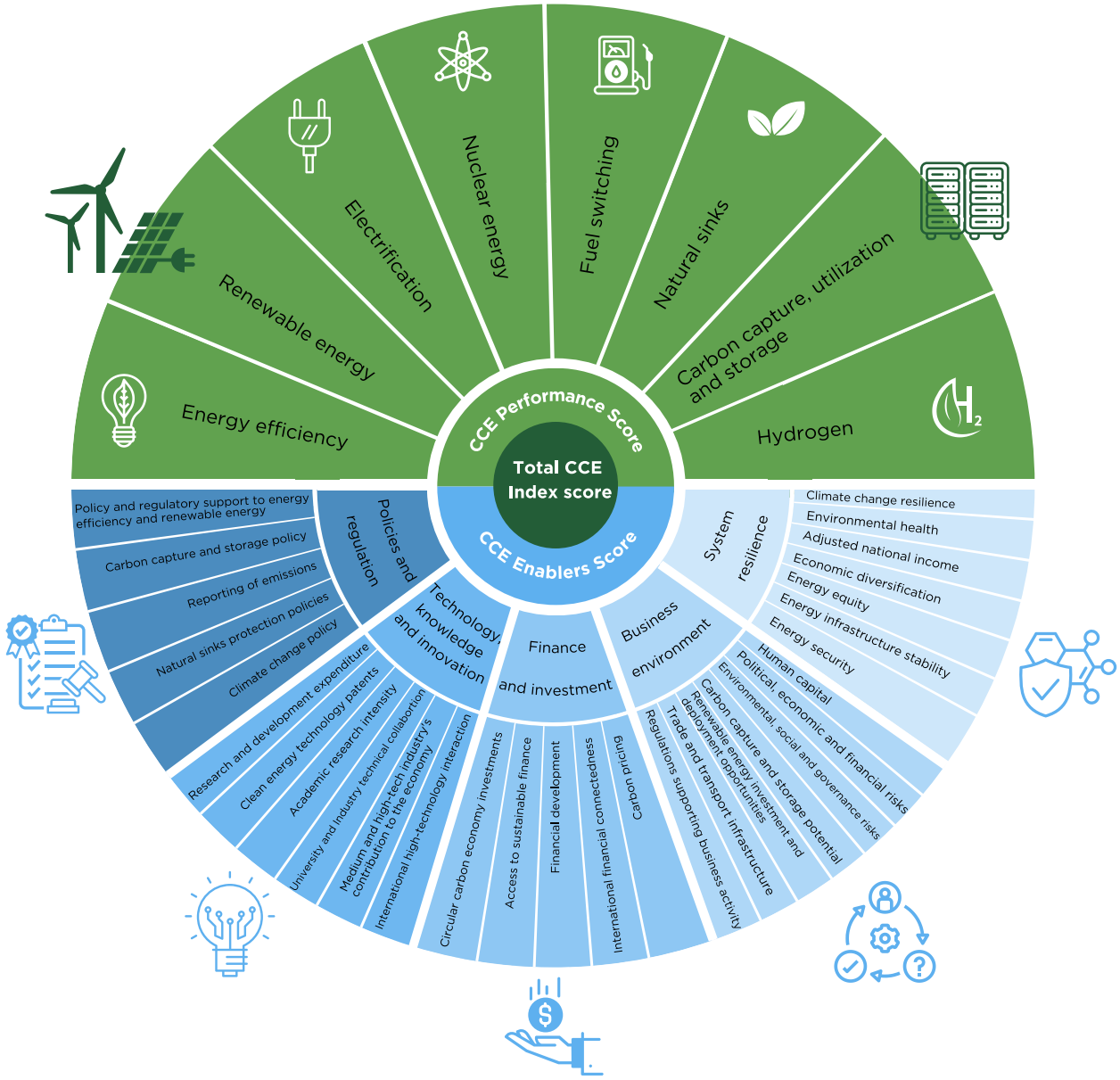


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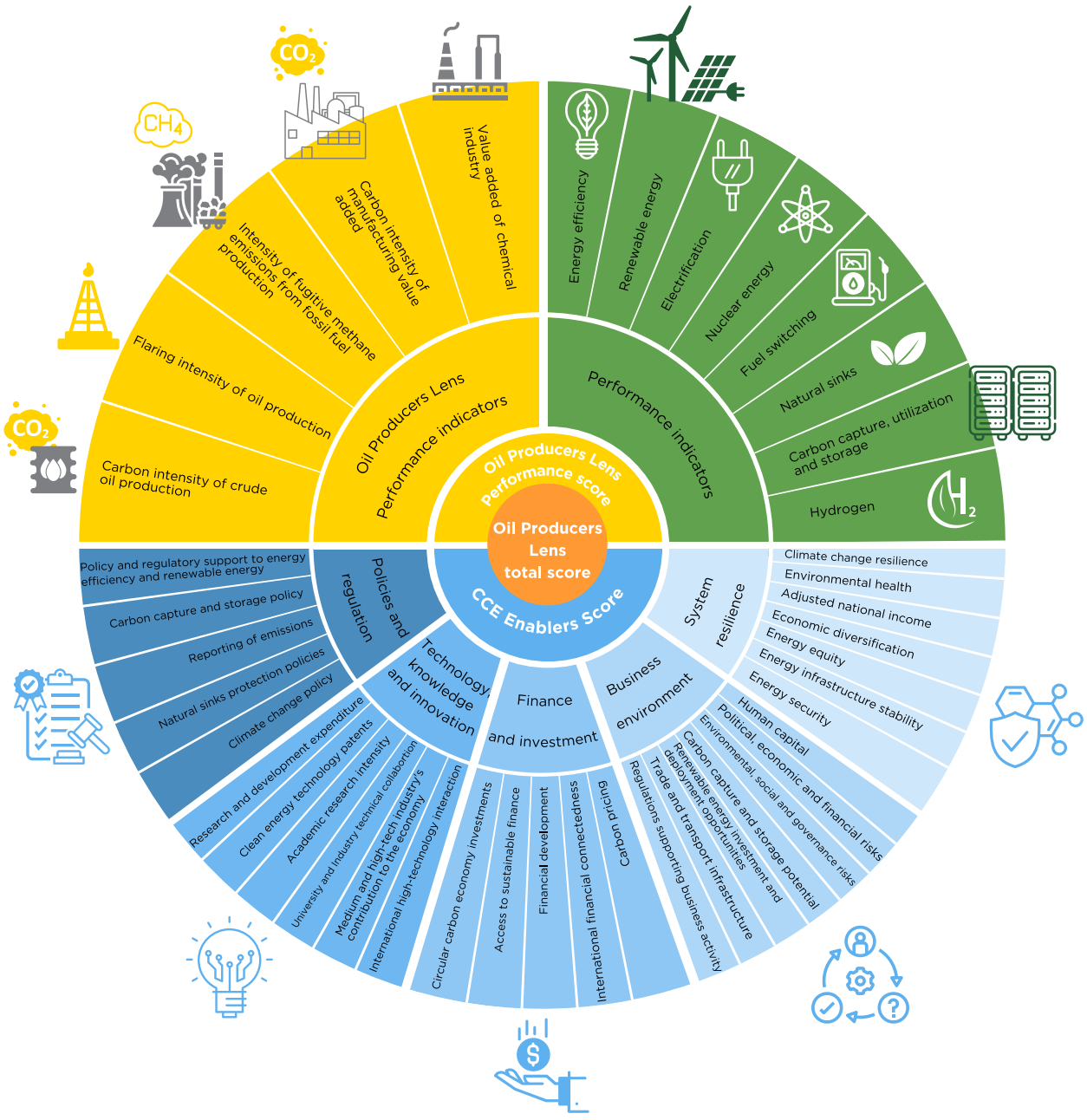
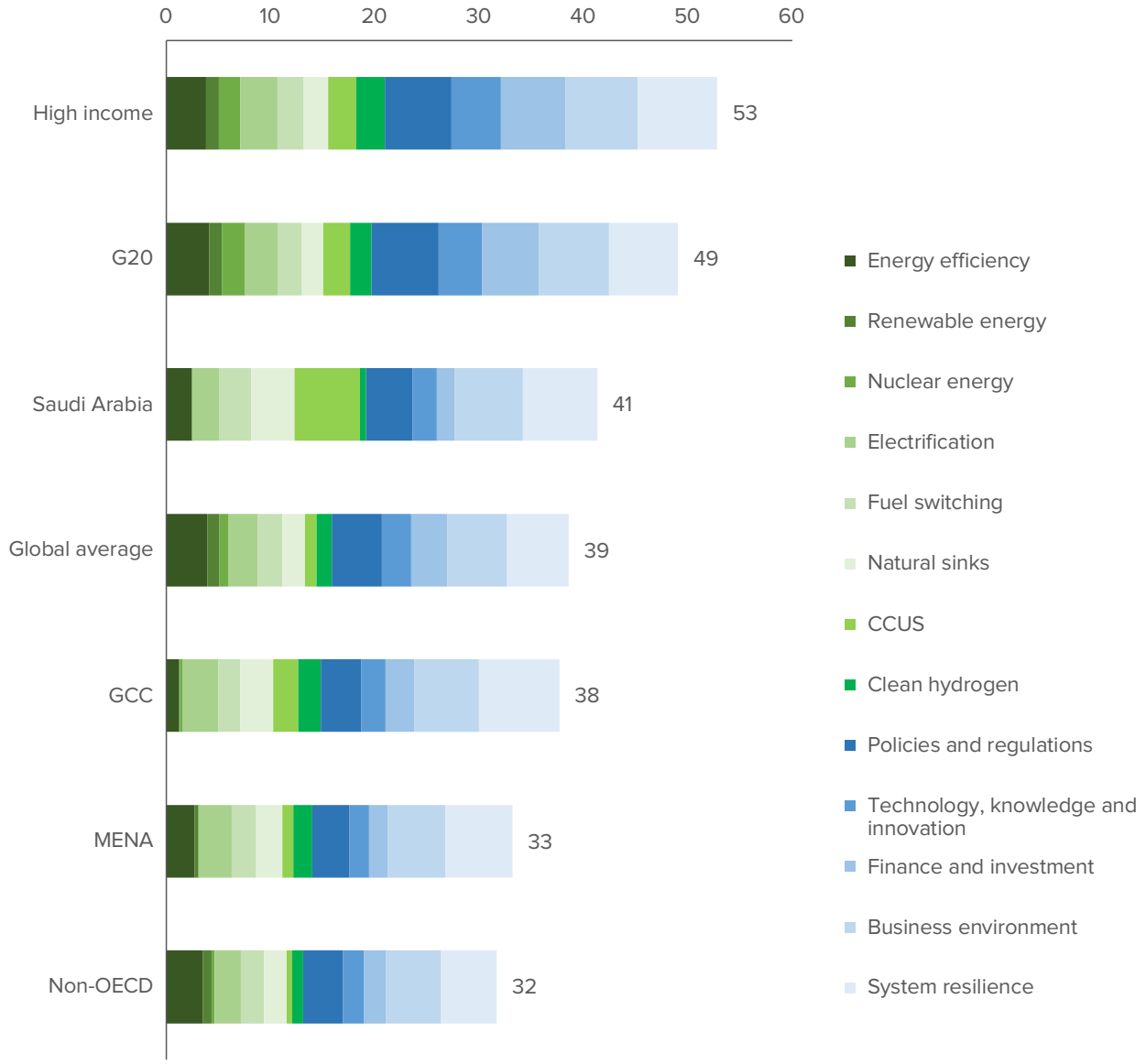
Figure 2. (*continued*)



Source: KAPSARC (2023).

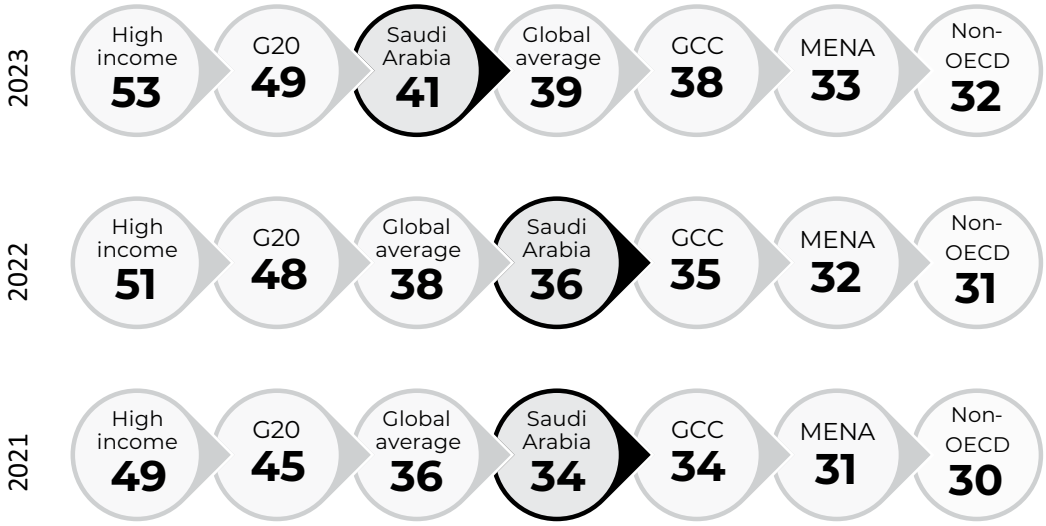
Figure 3. Total 2023 CCE Index results for Saudi Arabia and selected countries and groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: Colors in the chart indicate the proportional contributions of each component to the total CCE Index score.

Figure 4. Total CCE Index scores in 2021-2023, Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

3. Saudi Arabia and CCE Performance

This section analyzes how Saudi Arabia is currently faring on the CCE via eight indicators that gauge the deployment of key carbon circularity technologies and approaches. The comparisons are relative to the 64 countries included in the 2023 edition of the Index and to Saudi Arabia's major peer groups.[5] For each of the eight indicators, the section also provides an overview of the relevant policy targets and measures currently in place (or in some cases planned) to shed light on how the Kingdom's performance can be expected to evolve.

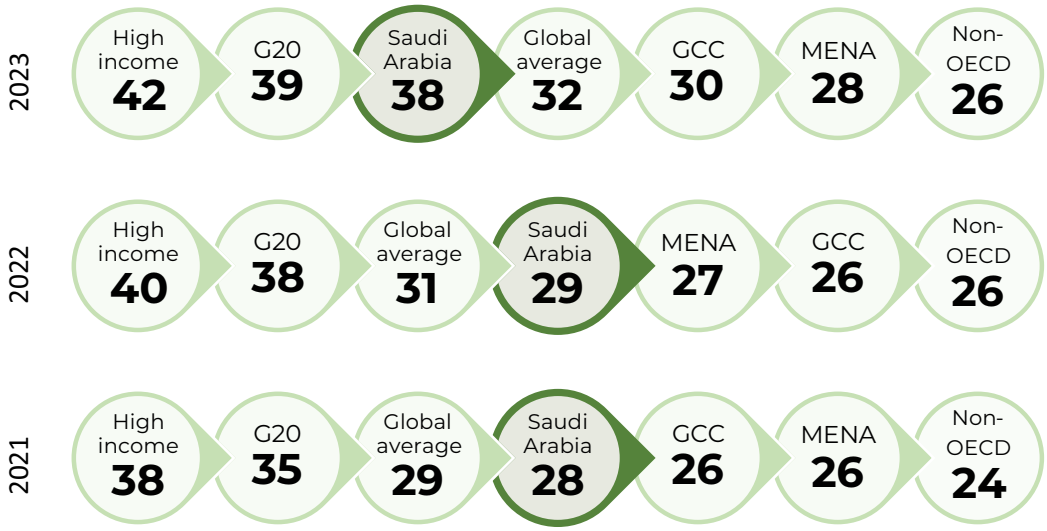
Overall, Saudi Arabia stands out for its CCE performance in the MENA region, underpinned by fuel switching and its large carbon capture, utilization and storage (CCUS) project pipeline. Its performance is below the global average for clean energy deployment (both current and under development). Figures 5 and 6 show the 2023 CCE Performance scores at aggregate and indicator levels for Saudi Arabia and its peer groups, as well as the global average, visualized in different ways (see also Figure A.1.a in the appendix). In 2023, Saudi Arabia's total CCE Performance score was higher than the global average and the averages for the GCC, MENA, and non-OECD countries. The difference in the Kingdom's score to the two other groups (the G20 and high-income countries) was relatively small. Compared to previous years, Saudi Arabia's score increased significantly, with a 10-point increase since the first edition of the Index (see Figure A.2 in the appendix). On average, all 64 countries and the 14 MENA countries included in the 2023 CCE Index improved their Performance scores by 3 points and 2 points, respectively, over this three-year period.

The following sub-sections unpack Saudi Arabia's CCE Performance score by examining the results for each indicator individually. Each section begins by explaining the relationship of the indicator to the CCE, followed by an analysis of Saudi Arabia's 2023 results on the indicator and an overview of relevant policy targets and measures implemented, or, in some cases, planned.

3.1. Energy Efficiency

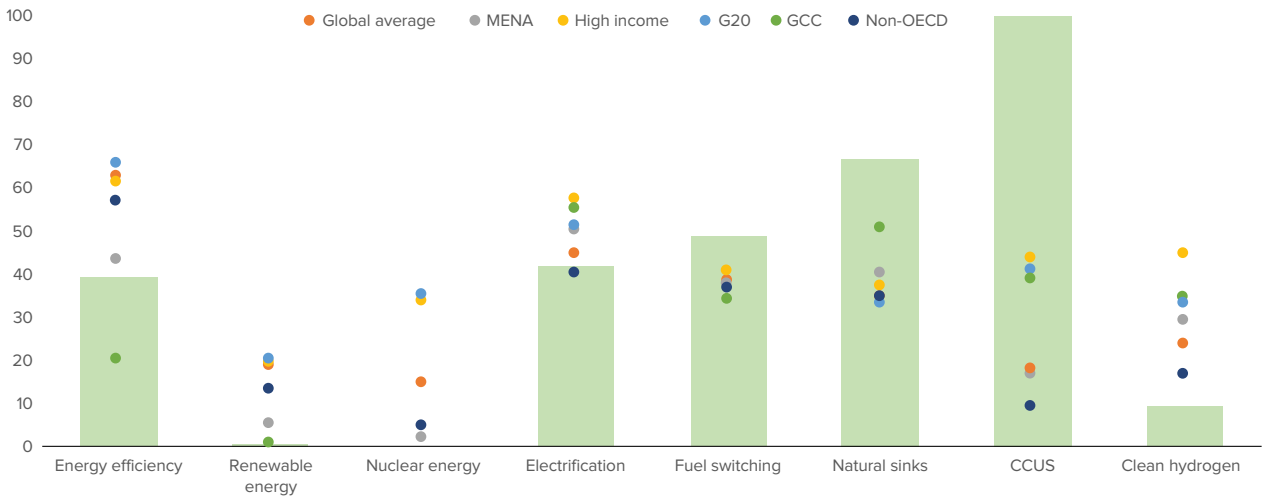
Improvements in energy efficiency are essential for achieving a CCE. Such improvements directly contribute to reductions in total carbon emissions as long as the carbon intensity of the energy mix does not increase. A common metric for energy efficiency is the energy intensity of various economic activities. While not a perfect measure (see e.g., Chang [2014]), it is considered the best measure available when making global comparisons, and it is also used as the energy efficiency

Figure 5. 2023 CCE Performance scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz and Alshehri (2024).

Figure 6. 2023 CCE Performance indicator scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).
Note: The bars represent Saudi Arabia's indicator scores. The dots indicate indicator average scores for selected groups.

indicator in the UN's Sustainable Development Goal (SDG) 7 (UN DESA 2023). The energy efficiency indicator in the 2023 CCE Index measures the energy intensity of the economy as a ratio of primary energy consumption (in kilograms of oil equivalent [koe]) to gross domestic product (GDP) (in purchasing power parity [PPP] indexed to 2015, GDP 2015 United States dollars [US$] PPP).

On this metric, in 2023, Saudi Arabia received a score of 39, which is lower than the global (63), high-income countries' (61), G20 (65), non-OECD (56) and MENA (43) averages. The Saudi score is only higher than the GCC average (20) (Figure 6). The high energy intensity of Saudi Arabia and the GCC countries is largely attributable to their energy-intensive industrial activities. In Saudi Arabia,

the industrial sector accounts for 47% of the country's primary energy consumption, followed by the buildings sector (28%) and transport (20%) (MOE 2024a). The country's high energy consumption is also attributed to high, sustained economic growth, combined with relatively low domestic energy prices. Additionally, Saudi Arabia has an arid climate with high ambient temperatures, which leads to an increased demand for air-conditioning and water desalination (IEA 2019). Furthermore, the country's energy efficiency performance is suboptimal across economic sectors, ranging from industrial equipment and processes, through housing insulation, to appliances and vehicles. This is due to the country's relatively low energy pricing on both supply and demand sides (Gasim and Aldubayan 2020).

Saudi Arabia's industrial policy is based on low energy costs. Consequently, highly energy-intensive products and commodities like petrochemicals, iron, steel, and cement comprise a large share of its industrial output. Countries scoring high on energy efficiency in the CCE Index generally have highly developed industries with more service- or high-technology-based economies, which are characteristically less energy intensive than product-based manufacturing-dependent economies. Although high-income and G20 countries tend to perform higher on this indicator, more than half of the top 20 countries in the Index are middle-income countries.[6] The bottom scorers in this category are Russia, Bahrain, and Kuwait, which all received a zero. Similar to Saudi Arabia, these countries have large energy-intensive industries and much scope for adopting further energy efficiency measures and policies.

Saudi Arabia's energy efficiency score in the CCE Index has decreased since 2021 (Figure A.2). While this could be interpreted as the result of increased energy demand during this period, further analysis shows that it is a direct result of a temporary fall in the country's GDP relative to energy use during the COVID-19 period (Enerdata 2024).

In an effort to improve the economy's competitiveness via increased energy efficiency, the government has implemented many measures over the past decade. These include the establishment of the Saudi Energy Efficiency Program (SEEP) and Saudi Energy Efficiency Center (SEEC). These initiatives aim to improve energy efficiency across multiple sectors via mandatory standards, other mandatory performance-based targets, as well as economic incentives. In an effort to manage demand, the Saudi government has also implemented a number of energy price reforms that address fuel, electricity, and water prices (Gasim and Aldubayan 2020). Table A.1 in the appendix provides an overview of major energy efficiency policy instruments that the Saudi government has implemented to date.

3.2. Renewable Energy

Renewable energy is an essential technology for reducing energy sector emissions and achieving CCEs. This indicator measures the share of commercial renewable energy in total primary energy consumption. It covers nine renewable energy technologies from wind and solar to geothermal and biofuels. Notably, traditional bioenergy sources, such as firewood, are excluded due to their generally detrimental human health effects and contribution to deforestation.

As of 2021 – the year used for the 2023 CCE Performance score for this indicator – Saudi Arabia had only a 0.1% share of renewables in its total energy consumption, rendering it a score of 0 in the Index. The global average score on this indicator was 19, and the regional averages for the GCC and MENA were 1 and 5, respectively (Figure 6). This indicator has a top-heavy distribution, where only four countries score 50 or more (Costa Rica 100, Norway 100, Brazil 60, and the Philippines 50) and 28 countries – almost half of the countries included in the Index – score below 10. These low-scoring countries are largely developing countries, representing all income groups and regions (except North America), which indicates that scaling up renewable energy remains a challenge across the developing world, particularly in the MENA region.[7] The MENA region has benefited from large

hydrocarbon wealth, which has created its own path dependencies in the energy sector, visible in the low scores for non-hydrocarbon energy technologies, namely renewable and nuclear energy (see next sub-section). In the GCC, the United Arab Emirates (UAE) is the only country that scored above zero (owing to a 2% share of renewables in its energy mix).

Between 2021 and 2023, Saudi Arabia's renewable energy score remained constant at zero, despite an added 0.33 gigawatts (GW) of solar capacity coming online between 2019 and 2021 (Figure A.2). It is worth noting, however, that there was no considerable change in the global and regional average scores over this period either. The global average score increased by 1 and the MENA score remained constant.

Despite the slow initial progress in this area, the medium-term outlook for renewable energy technologies in Saudi Arabia is bright. The government has signaled its commitment to develop renewable energy technologies and increase its market penetration in the coming decade. This falls under the umbrella of Saudi Vision 2030, a blueprint for economic diversification, with one of its primary objectives being a 50% renewable electricity generation capacity share by 2030. This was echoed by the Energy Minister His Royal Highness Prince Abdulaziz bin Salman Al-Saud, who in 2023 reportedly stated that Saudi is committed to increasing its renewable energy capacity by 20 GW annually, aiming to reach 130 GW of total capacity by 2030 (Saudi Gazette 2023a). As of mid-2024, Saudi Arabia had 4.1 GW of renewables connected to the grid and 8.2 GW under construction (MOE 2024b). The scaling up of the country's renewables capacity is taking place through competitive tendering led by the Ministry of Energy, under the umbrella of the National Renewable Energy Program (MOE 2024b).

3.3. Nuclear Energy

Increasing the share of nuclear power in the electricity mix also helps reduce emissions. In the CCE Index, this indicator measures this technology's share of total primary energy consumption. The share of nuclear power in electricity generation globally is currently around 10%, with some projections anticipating a two-fold demand increase as countries decarbonize their energy sources (IEA 2024). Saudi Arabia does not currently produce nuclear power. This is also the case for 44 out of the 64 countries covered in the 2023 CCE Index, which all received a score of 0 on this metric. The global average score for nuclear energy is 15, and the MENA regional average score is 2 – underpinned by the UAE and Iran, which in 2021 generated 3.2% and 0.3% of their total energy consumption from this source (corresponding to power generation shares of 6.8% and 0.9%, respectively [Enerdata 2024]) (Figure 6). As could be expected, high-income and G20 countries scored higher on this indicator, with averages of 35 and 37, respectively. The highest-scoring country in this category, France, has a large installed capacity of nuclear power, which in 2021 represented a 41% share of its total primary energy consumption and 68% of its electricity generation (Enerdata 2024).[8]

Although Saudi Arabia has demonstrated interest in developing nuclear power, it does not currently have a formalized capacity target in place.[9] However, the country's strong interest in this clean form of energy is evidenced through its various strategic initiatives. These include the formation of the comprehensive National Project for Atomic Energy, the establishment of the Nuclear and Radiological Regulatory Commission, the inception of the Saudi Nuclear Energy Holding Company, and the solicitation of technical bids for the construction of two nuclear reactors in 2022 (CRS 2023). As of 2019, the Kingdom has confirmed its intent to build two reactors totaling 3-4 GW (Mansouri 2020).

3.4. Electrification

The electrification of transport and industrial processes is a central element in achieving sustainable energy transitions (IPCC 2018). It can play a role in reducing carbon emissions associated with fuel combustion and improving efficiency in many applications, with the caveat that electricity generation originates from clean sources. In the 2023 CCE Index, a country's electrification score is based on the share of electricity in its total final energy consumption. As an aggregate of the entire economy,

high levels of electrification can point to a highly electrified industrial sector and a high specialization in services. Service-oriented economies generally have lower energy intensities than those based on heavy industry, or in some cases even high electricity consumption in the residential sector.

Saudi Arabia's score (42) is close to the global average (45). However, it scores below all its peer group averages: the MENA (50) GCC (57), high-income countries (57), and G20 countries (51). The two countries that received a score of 100 in this category were Norway, with a 47% share of electricity in its final energy consumption, and Bahrain, with a 42% share, in 2021. Norway's high electrification share is due, in part, to its leading position in electrified transportation (SWECO 2019). In the case of Bahrain, Saudi Arabia's closest neighbor, its level of electricity consumption per capita is six times the global average at 42%. This is due to the country's electrified industrial processes, particularly its large aluminum industry.[10] As of 2021, Saudi Arabia's electrification share was only about 18%, owing at least partly to its large industrial sector.

Between 2021 and 2023, Saudi Arabia's electrification score increased by four points (Figure A.2), whereas globally it increased by only 1 point on average (Figure 6). This reflects a 2% increase in Saudi Arabia's share of electricity in its total consumption, which was caused by an increase in demand for residential and commercial electricity driven by population and GDP growth (IEA 2024). Looking ahead, the Saudi government has invested in expanding its domestic electric vehicles (EV) market, as outlined in Saudi Vision 2030. To that end, the Kingdom has launched the Electric Vehicles Infrastructure Company, a joint venture between Saudi Arabia's Public Investment Fund (PIF) and the Saudi Electricity Company (SEC) to develop reliable charging infrastructure. It also launched the first Saudi EV car brand Ceer, and opened a factory in Jeddah for the American electric luxury car group Lucid.

In terms of electrifying the industrial sector, there are still some challenges to be addressed. First, the economic benefit of electrifying the industrial process (in the form of carbon pricing, for example) remains too low compared to the projected costs of electricity and transitioning existing processes and machinery. Additionally, while there are options currently available for electrified low- and medium-temperature heat, further technology development is required for high-temperature heat (Systems Change Lab 2024).

3.5. Fuel Switching

Switching from coal and oil-based liquid fuels to cleaner sources, including renewables, nuclear energy and natural gas, contributes to the reduction of carbon dioxide emissions.[11] The fuel switching indicator's score is made up of two components. The first component measures the share of coal and oil in total electricity production for the latest available year (2021 for the 2023 CCE Index score), and the second measures the rate of change in this share over the latest available five-year period (2016–2021 for the 2023 Index). On this indicator, Saudi Arabia's score (49) is higher than the global average (38) and its peer groups: MENA (37), GCC (31), high-income countries (40), and G20 countries (31) (Figure 6). This high performance is due, in part, to the country's growing use of natural gas for electricity production, which increased from 46.9% in 2016 to 58.4% in 2021 (Enerdata 2024). The top four performers for this indicator in the 2023 Index were Ghana, Angola, the Dominican Republic, and Iraq. All four countries made a considerable switch away from oil in the five-year period.[12]

While Saudi Arabia is currently performing well in fuel switching, its score has declined from 62 in 2021 to 49 in 2023 (Figure A.2). The global average and MENA regional average scores have also declined over the three years of available index scores, albeit at a slower rate. Given that the 2022 and 2023 scores cover the COVID-19 pandemic period (2020-2021), only subsequent Index editions will reveal whether this slowdown could be attributed to COVID-related disruptions, or perhaps other correlated economic and technological factors.

As part of Saudi Vision 2030, the Kingdom launched the Liquid Displacement Program, which aims to displace 1 million barrels of liquid fuels per day across utility, industry, and agriculture sectors by 2030.

Natural gas will be used for power generation and industrial energy requirements as an alternative to liquid fuels (MARAFIQ 2024). Saudi Arabia's recent investments in natural gas development underscore the country's commitment to the global shift toward cleaner energy sources. Saudi Aramco's agreement to acquire a stake in MidOcean Energy marks its first venture into liquified natural gas (LNG). Aramco plans to invest U.S. $110 billion in developing the Jafurah gas field, aiming to double its output by 2030 and position the Kingdom as a gas exporter for the first time (Bloomberg 2023a). By 2030, the company aspires to be among the world's top three natural gas producers, with its gas production expected to double to 23 billion standard cubic feet per day (Saudi Aramco 2020). This expansion will be driven by both infrastructure enhancements to existing projects and tapping into large, untapped gas reserves, particularly unconventional gas fields like Jafurah, which contains an estimated 200 trillion standard cubic feet of natural gas. The increased gas production is poised to also help significantly reduce domestic oil consumption and serve as a cost-effective feedstock for blue hydrogen production (Saudi Aramco 2023).

Leading up to 2030, Saudi Arabia will see many developments related to its natural gas industry and the use of gas for power generation. Building on its current fuel switching initiatives, the Saudi government has signaled its intent to expand the use of natural gas in various sectors, namely power generation, and it has made investments to increase natural gas production to meet growing demand. In its most recent NDC, the Saudi government describes its plan to reform its domestic energy sector and states its aim for natural gas to comprise 50% of its total electricity generation capacity by 2030 (Government of Saudi Arabia 2021). Importantly, in 2023, the Saudi energy minister reportedly announced that all new thermal power plants would be required to be built with carbon capture capabilities (Utilities Middle East 2023).

3.6. Natural Sinks

Maintaining the size and health of natural carbon sinks is important in reducing net emissions as they contribute to the capture and removal of carbon dioxide from the atmosphere. In addition, nature-based solutions provide various co-benefits, such as supporting ecosystem conservation and strengthening resilience to negative climate change impacts, including coastal erosion. In the CCE Index, this indicator rates countries based on two components: first, on the relative size of their natural sinks (forest areas); and, second, on how well these are managed (based on the ecosystem services score from the Environmental Performance Index).

Saudi Arabia's score (67) was significantly higher than the global average (34) and its peer group averages: MENA (38), GCC (47), high-income countries (36), and G20 countries (32) (Figure 6). At the same time, the country's forest area is relatively small, covering only 0.45% of its total land area in 2020. It acts as a sink for 7.5 million tons of CO_2 ($MtCO_2$), equivalent to 1.2% of the country's total CO_2 emissions (CDM-DNA 2024a). However, its ecosystem services score, which measures tree cover loss as a proportion of original cover, is high. This is indicative of the country's ongoing efforts to plant, protect, and promote the health of its natural sinks. The most notable of these efforts is the Saudi Green Initiative (SGI), which has set targets to plant 10 billion trees and rehabilitate 40 million hectares of land across the country. As of 2023, 43 million trees have been planted and 94,000 hectares of degraded land have been rehabilitated (Saudi Gazette 2023b).

Given that the Environmental Performance Index is not updated on an annual basis, and changes in the proportional forest area in most cases are relatively minor, there are generally few changes in countries' scores over the three-year period tracked by the 2023 CCE Index. Saudi Arabia's score, for example, has not changed since 2021. As noted above, however, there is strong evidence of the government's commitment to expanding the country's green cover. The outlook for the short- to medium-term is contingent on achieving targets set forth by the Saudi government and other stakeholders, like Saudi Aramco, who have made numerous investments in planting and protecting mangroves across Saudi Arabia (Saudi Aramco 2023). Box 2 details Aramco's plans in this area.

3.7. Carbon Capture, Utilization and Storage

CCUS is an important tool for achieving a CCE. CCUS technologies can help both reduce and remove carbon dioxide emissions from the atmosphere. Scaling up CCUS has the potential to reduce overall mitigation costs and increase flexibility in achieving a CCE (Kamboj et al. 2023).

Carbon capture and storage is widely seen as a key mitigation technology for hard-to-abate sectors, whereas carbon capture and utilization can help generate revenue while lowering or delaying the release of emissions. In the Index, this suite of technologies is measured by the total capture capacity of CCUS projects in various stages of development (operational, in construction, advanced or in early development, or in evaluation).[13] For the purpose of comparability, the capacity is scaled to the size of the respective economies.

On CCUS, Saudi Arabia received a score of 100, which is significantly higher than the global average score (16) and that of all its peer group averages: MENA (10), GCC (26), high-income countries (41), and G20 countries (38) (Figure 6). In total, seven other countries received a score of 100 on CCUS: Norway, Indonesia, Canada, the United States, Netherlands, Australia, and the United Kingdom. On this metric, 35 countries received a score of 0, which is indicative of the unequal global uptake of this technology. Among the high scorers, the United States has the highest absolute capture capacity (787 $MtCO_2$/year) in the pipeline, followed by Indonesia (308 $MtCO_2$/year), and Canada (80 $MtCO_2$/year) (BNEF 2023). It is worth noting that all countries that scored highly on this metric are oil producers, which is consistent with the observation that CCUS is typically deployed in countries with large fossil fuel or energy-intensive industries as it utilizes similar, or complementary, technologies, resources, and infrastructure.

For Saudi Arabia, the total capture capacity in the pipeline, listed in the Bloomberg New Energy Finance (BNEF) database the Index draws from, is 19 $MtCO_2$/year. This includes two operational CCUS projects. The Uthmaniyah demonstration project (0.8 $MtCO_2$/year), which is operated by Saudi Aramco, captures CO_2 from a natural gas plant and reuses it for enhanced oil recovery, and the Carbon Utilization Project operated by SABIC captures CO_2 from an ethylene glycol plant and reuses it for methanol and fertilizer production (OGCI 2021). Additional contributions to the Saudi CCUS score come from four new projects that are in their early development stages. These additional projects also drove a major increase in Saudi Arabia's CCUS score, from 7 in 2021 (Figure A.2).

Looking ahead, Saudi Arabia is well suited to expand its CCUS deployment. Due to its natural geological formations, which include oil and gas fields and deep saline aquifers, it has vast potential for carbon dioxide storage (Ye et al. 2023). Additionally, major CC(U)S hubs can be developed around intensive carbon emissions areas in the Kingdom. These include regions of the country where heavy industrial activity takes place, namely the industrial cities of Jubail and Yanbu. Clustering is essential in establishing a cost-effective CCS roll-out that benefits from economies of scale. For example, Saudi Arabia's eastern region, where most of the oil extraction and refining activity takes place, is an ideal location for developing CCUS hubs. The area is home to a diverse cross-sectoral profile of industries and has suitable geological characteristics for carbon storage. Additionally, carbon utilization applications can add financial incentives for implementing this technology. In most cases, carbon removal and carbon utilization objectives are tightly connected and synergetic cooperation between the two sectors is highly beneficial. Saudi Aramco is currently developing the Aramco Jubail CCUS Hub that will capture up to 9 $MtCO_2$/year from 2027, which will contribute to the Kingdom's overall target to capture 44 $MtCO_2$ by 2035 (Saudi Aramco 2024a).

3.8. Clean Hydrogen

Clean hydrogen can act as a clean energy carrier and be used in lieu of fossil fuels for powering hard-to-abate sectors like transportation, electricity generation, and various industrial processes. It is highly efficient and produces fewer emissions than conventional energy sources, provided it is produced either from clean sources or the carbon dioxide associated with production is captured and stored. In this sense, clean hydrogen contributes to a CCE by reducing the amount of carbon emitted through traditional fuels. Even though clean hydrogen technologies are mature enough to be rolled out, their costs remain high and their global development and operations are still in the early stages. While many projects are in the demonstration stage, total production capacity remains limited. In the CCE Index, the clean hydrogen indicator measures the total capacity of countries' clean hydrogen project pipelines (commissioned, financed, under construction, at feasibility study phase, and with planning begun). For comparison, production capacities are scaled to the size of the respective economies, similar to the CCUS indicator.

In this indicator, Saudi Arabia received a score of 9. Its score was lower than the global average (24) and below

all other peer group averages: MENA (31), GCC (40), high-income countries (46), and G20 countries (34) (Figure 6). Eleven countries received a score of 100 on clean hydrogen: Australia, Canada, Chile, Egypt, Morocco, Kazakhstan, the Netherlands, Oman, South Africa, Norway, and the United Kingdom. The countries with the largest absolute total production capacity pipelines were Canada (45.2 million tons [Mt] of clean hydrogen/year), Australia (9.7 Mt), the United States (7.4 Mt), the United Kingdom (6.2 Mt), and Egypt (5.6 Mt). Saudi Arabia's total pipeline capacity registered by BNEF through the end of 2022 was 219,000 tons per year. At the other end of the scale, nearly half of the countries (a total of 28) received a score of 0. This illustrates how, similar to CCUS, a relatively small group of countries are still involved in developing hydrogen technologies worldwide. Saudi Arabia's score has decreased slightly since 2021, as its GDP has grown while its hydrogen pipeline capacity has remained the same (Figure A.2).

Partly explaining the relatively low score for Saudi Arabia is the fact that the clean hydrogen indicator covers projects in their various stages, including ones still in planning stages, which in many countries tend to amount to significant capacity levels. Also, Saudi Arabia is a large developing economy, which means that a higher score in the index requires it to have in place a larger project pipeline than smaller economies, as the score in the CCE Index is generated by dividing the total production capacity by the country's GDP. Additionally, for the clean hydrogen score calculation, similar to the CCUS indicator, the 2023 CCE Index applied GDPs based on purchasing power parities, which generally results in higher GDP sizes for developing economies than for developed economies.

Despite having a smaller pipeline capacity relative to its GDP than many of its peer countries, Saudi Arabia has been seeking to proactively address the key barriers to wide hydrogen deployment. These include high production costs, the need for regulatory frameworks, the need for offtake agreements, and the scaling up of infrastructure to boost both domestic and international trade in low-carbon hydrogen. Saudi Arabia's strategic aim to host the world's largest green hydrogen plant underscores its commitment to leveraging its abundant renewable resources and technical expertise. The government has set targets for clean (green and blue) hydrogen production of 4 Mt/year by 2030 (Braun et al. 2024).

4. Saudi Arabia and CCE Enablers

This section provides an overview of how well Saudi Arabia is positioned to make progress in the CCE transition compared to other major economies and country peer groups. The analysis is based on the CCE Enablers sub-index results from the 2023 CCE Index. This sub-index gauges the robustness of countries' enabling environments via 30 indicators divided into five areas: policies and regulation; technology, knowledge and innovation; finance and investment; business environment; and system resilience.

Saudi Arabia's strongest CCE enablers are in the areas of business environments and system resilience, where it scores higher than most of its peer groups. In policy and technology, Saudi Arabia scored above the MENA regional average but below the global average. In the area of finance and investment, Saudi Arabia scored lower than all its peer groups, on average. However, its CCE investments are starting to scale up, and the country's financial frameworks are relatively robust, performing above the regional and non-OECD averages.

Figures 7 and 8 show the 2023 CCE Enablers scores at aggregate and indicator levels for Saudi Arabia and its peer groups, as well as the global averages (see also Figure A.1.b in the appendix). In contrast to the Kingdom's CCE Performance score, its Enablers score was on par with the global average, below those of high-income countries, the G20 and the GCC, but higher than those of the MENA region and the non-OECD group. From 2021 to 2023, Saudi Arabia's Enablers score increased by three points. On average, all 64 countries and the 14 MENA countries included in the 2023 CCE Index improved their Enablers scores by two points over this period.

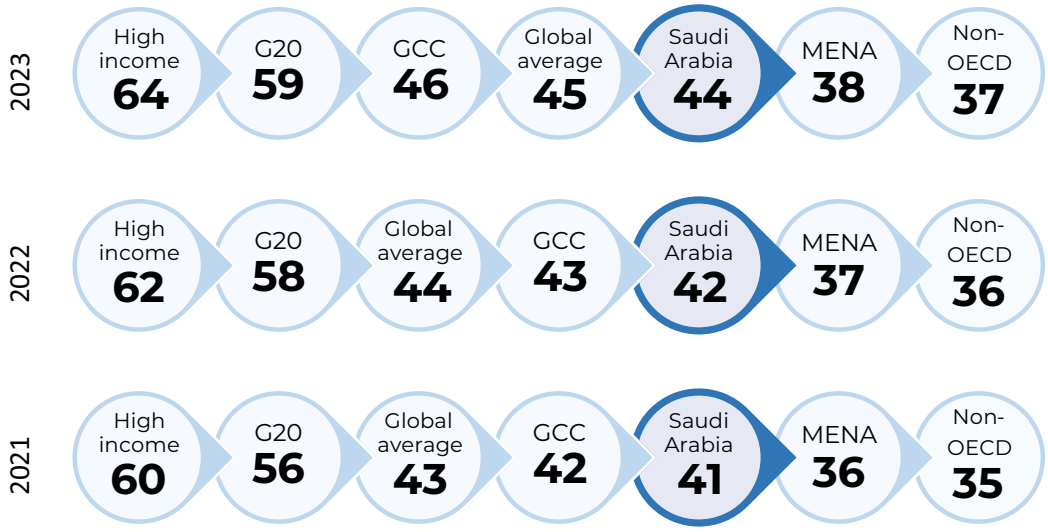
Section 4.1, below, presents highlights from each of the five CCE Enabler dimensions from the 2023 CCE Index. Given that Saudi Arabia displays the largest scope for improvement in the finance and investment dimension, the following sub-section (section 4.2) presents an indicator-by-indicator results analysis for this Enabler dimension. As in the CCE Performance section, this sub-section also presents policy targets and measures currently in place (or planned) relevant to the five finance and investment indicators.

4.1. CCE Enabler Dimensions

The policies and regulation dimension contains five indicators that measure enabling policy environments for renewable energy and energy efficiency, CCS, and natural sinks protection. The dimension also scores countries based on their adherence to the United Nations Framework Convention on Climate Change's (UNFCCC's) reporting obligations, whether they have set a net-zero emissions target and how binding this target is (i.e., declaration, policy document or law).

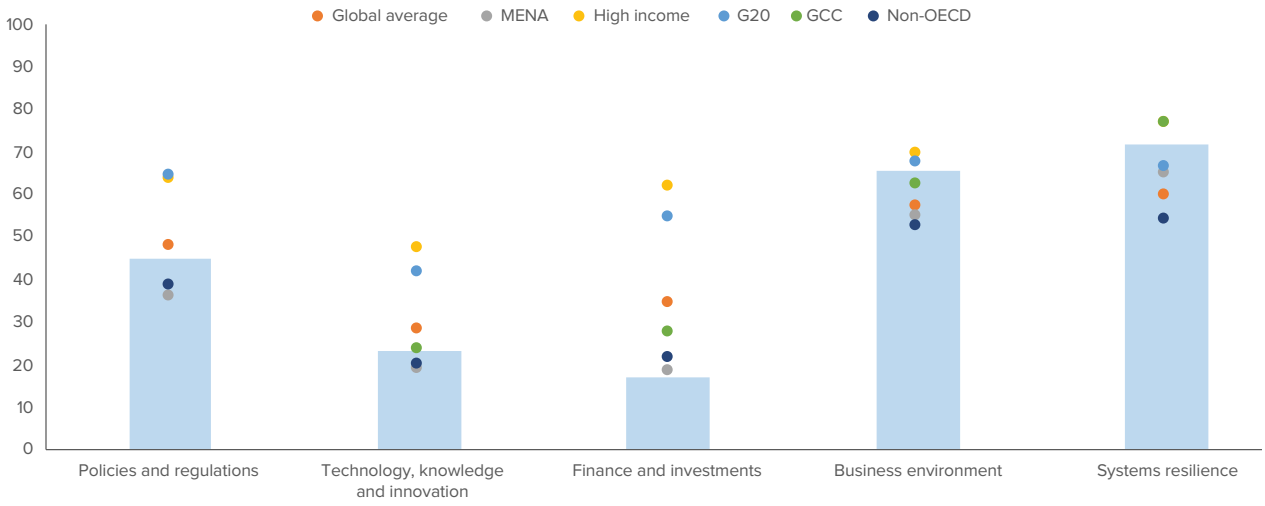
In this area in 2023, Saudi Arabia (45) scored slightly below the global average (48) and well below the G20 average (64) (Figure 8). Compared to its regional peer groups (MENA 36 and GCC 38), it fared better. Saudi Arabia's enabling policies in the areas of renewable energy, energy efficiency and CCS are on par with the global average and, on average, slightly stronger than those of the GCC and non-OECD countries. Its natural sink protection policies, measured by the share of key biodiversity areas that are protected, have significantly

Figure 7. 2023 CCE Enabler scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Figure 8. 2023 CCE Enabler indicator scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The bars represent Saudi Arabia's indicator scores. The dots indicate indicator average scores for selected groups.

lower coverage than the global average or any of its peer groups. However, the Saudi Green Initiative has plans to expand the coverage of the country's protected areas to 30% of its terrestrial and marine area by 2030, in line with global targets (SGI 2024).

In the MENA region, the best-performing country in this dimension was the UAE (55), which in comparison to Saudi Arabia achieved higher scores in energy efficiency, renewable energy, and biodiversity protection policies. Saudi ranked third in this dimension in the MENA region and second in the GCC region. From 2021 to 2023, Saudi Arabia's score increased by 10 points on the back of improvements in the country's energy efficiency and renewable energy policy frameworks, and its net-zero target.

The technology, knowledge and innovation dimension comprises six indicators, which measure technology creation and diffusion. On the creation side are indicators for research and development (R&D) expenditure, clean energy technology patents and the 'intensity' of academic research (high-quality research outputs in relation to population size). On the diffusion side, countries are measured based on their university-industry technical collaboration levels (World Intellectual Property Organization survey), medium- and high-tech industry's contribution to the economy, and international high-technology interaction (exports and imports).

In 2023, Saudi Arabia scored 23 in this dimension, which is lower than the global (28) and GCC (24) averages, but higher than the MENA average (19) (Figure 8). Saudi Arabia's score was also significantly lower than the group averages for high-income countries (47) and the G20 (42), but it scored higher than the non-OECD countries (20). At the indicator level, compared to the global averages, Saudi Arabia displays stronger performances in university-industry collaboration and in the technology industry's value added to the economy, but scores worse in the four other metrics.

In the MENA region, the UAE (34) scored the highest in this dimension as well, demonstrating more robust enablers than Saudi Arabia, particularly in the areas of R&D expenditure (as a proportion of the GDP) and high technology trade. The Kingdom ranked third in both the MENA and GCC regions in this dimension. From 2021 to 2023, Saudi Arabia's score saw a small improvement of one point.

The finance and investment dimension contains five indicators, three of which are CCE-specific and two more generic indicators of the state of the enabling environment in this area. Indicators of CCE investments, sustainable finance and carbon pricing gauge the availability of resources for the net-zero transition. Indicators of financial development and international financial connectedness, in turn, indicate the overall maturity and interconnectedness of a country's financial system.

In the 2023 Index, Saudi Arabia scored 17 in this dimension, which is lower than all its peer group averages, namely global (34), high-income countries (62), G20 (54), GCC (27), non-OECD (21) and MENA (18) (Figure 8).

In the MENA region, the UAE again scored the highest (47), followed by Bahrain, Qatar, Oman, and Saudi Arabia in the fifth spot. Notably, in the MENA region, Bahrain achieved a top score (100) in sustainable finance.

From 2021 to 2023, Saudi Arabia's score improved by five points – similar to the GCC average – driven by improvements across all indicators except carbon pricing. This dimension is discussed in more detail in section 4.2.

The business environment dimension combines various aggregate measures of enabling environments provided to businesses and investments. Similar to the other dimensions, it contains CCE-specific and more generic indicators. Specific indicators measure renewable energy investment attractiveness and the development of CO_2 storage resources. More generic indicators track aspects including business regulations, trade and transport infrastructure, environmental, social and governance (ESG) risks, political, economic and financial risks, and human capital (labor productivity).

In 2023, Saudi Arabia scored 65 in this dimension, higher than the global (57), GCC (62), MENA (55) and non-OECD (52) averages, and only slightly below those of high-income countries (69) and the G20 (67) (Figure 8).

In the MENA region, the UAE again ranked the highest in this dimension, with a score of 71, with Saudi Arabia ranking second. Compared to the global averages at the indicator level, Saudi Arabia's enabling environments are particularly strong in the areas of CO_2 storage development (40 compared to a global average of 79) and political economic and financial risk (71 compared to a global average of 82). For human capital, Saudi Arabia's score is slightly below the global average.

From 2021 to 2023, Saudi Arabia's score for this dimension improved by four points, largely due to its stronger performance in trade and logistics and lower political, economic, and financial risk levels.

The system resilience dimension contains energy-related and more generic indicators that map the resilience and stability of the overall systems in which CCE transitions are taking place. These conditions facilitate the transitions and should not suffer in the pursuit of net-zero emissions. Three energy-specific indicators measure energy security (share of fuel imports of total imports of goods and services), energy infrastructure stability (grid interruption duration and frequency), and energy access and affordability (energy equity score of the World Energy Council's Energy Trilemma Index [WEC 2023]). Other system indicators measure economic

complexity and diversification, adjusted national income, environmental health (outdoor and indoor air pollution-related life years lost due to exposure) and climate change resilience (the Global Climate Risk Index by Germanwatch [2023]).

In 2023, Saudi Arabia scored 72 in this dimension, which is higher than the global average (59) and the averages for the MENA (65), G20 (66) and non-OECD (54) countries, but slightly below those of the high-income group (76) GCC (77) (Figure 8).

The MENA region's leaders in this area are Qatar (85) and Kuwait (83), which score higher than Saudi Arabia on energy security, economic and environmental health, and security metrics, but lower in economic complexity. Compared to global averages in the various indicators of this dimension, Saudi Arabia's strengths lie in the areas of energy security, energy equity and grid stability.

System resilience is the only dimension where Saudi Arabia's score decreased in the period 2021-2023. It fell by two points due to a drop in its energy security score, which was primarily caused by a significant increase in fuel imports from Egypt, the UAE, and India.[14]

4.2. Finance and Investment Dimension

This section dives deeper into the five indicators of the CCE Index finance and investment dimension, examining Saudi Arabia's performance in these metrics relative to other countries. Figures 9 and 10 show a high-level overview and a breakdown of Saudi Arabia's finance and investment dimension scores compared to the global average and five of its peer groups (see also figures A.1.c and A.2 in the appendix). As mentioned above, in the 2023 Index, Saudi Arabia's score (17) was lower than all its peer group averages. However, it improved by 5 points from 2021, which was less than the average G20 improvement (7 points) but similar to the average GCC improvement (6 points) and more than the global (3 points), MENA (1 point) and non-OECD (1 point) average improvements.

The following sub-sections unpack the results for each indicator individually. Each begins by explaining the relationship of the indicator to the CCE, followed by an analysis of Saudi Arabia's 2023 results for each indicator, an overview of relevant policy targets, and implemented and planned measures.

4.2.1. CCE Investments

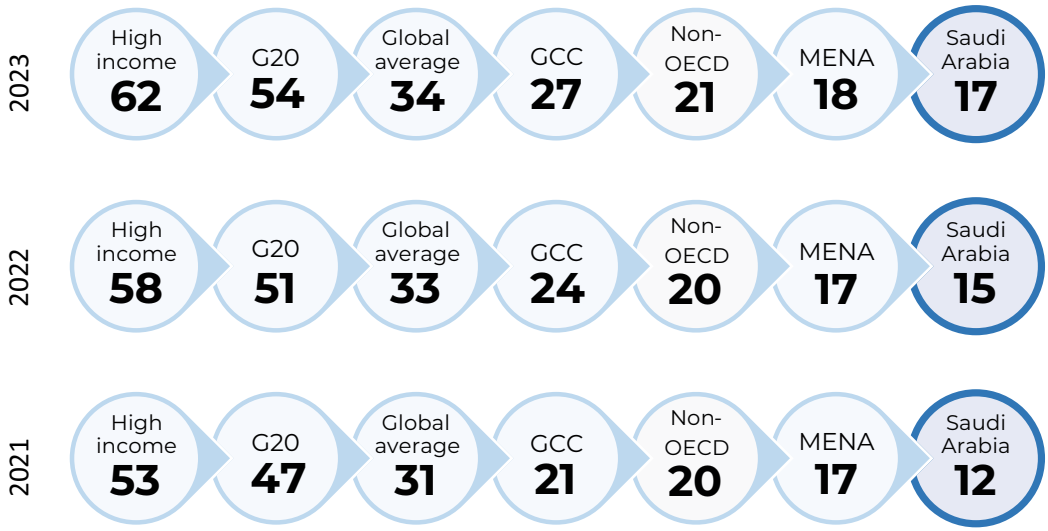
The CCE investment indicator measures a country's investments (in billions of US$ per GDP) in a host of CCE technologies, including renewable energy, clean hydrogen, energy storage, electrified transport, nuclear energy, and sustainable materials. It captures all CCE investments from both the public and private sectors. The data originates from BNEF (2023). The investments are scaled to the size of a country's economy (GDP) for comparability among countries.

Saudi Arabia's score on this indicator in the 2023 CCE Index (6) was significantly below the global average (29), as well as all country group averages: MENA (11), high-income (58), G20 (54), GCC (14), and non-OECD (14) (Figure 10).

The top scorers in the CCE Index in this category were Norway, the Netherlands and Spain, which invested U.S. $11 billion, U.S. $19 billion and U.S. $30 billion respectively, per year on average, over the period 2020–2022, in CCE technologies (BNEF 2023). In absolute terms, the largest annual investments over this period, on average, were made by China (U.S. $391 billion), the United States (U.S. $198 billion), and Germany (U.S. $57 billion) (BNEF 2023). Saudi Arabia's average annual CCE investments in this period totaled U.S. $1.3 billion, which, scaled to its economy size, ranked it 44 out of 64. In the MENA region, the UAE (score 54, rank 16) led in CCE investments, with average annual CCE investments of U.S. $4.7 billion in 2020-2022, underpinned by recent large-scale investments in both renewable and nuclear energy (BNEF 2023).

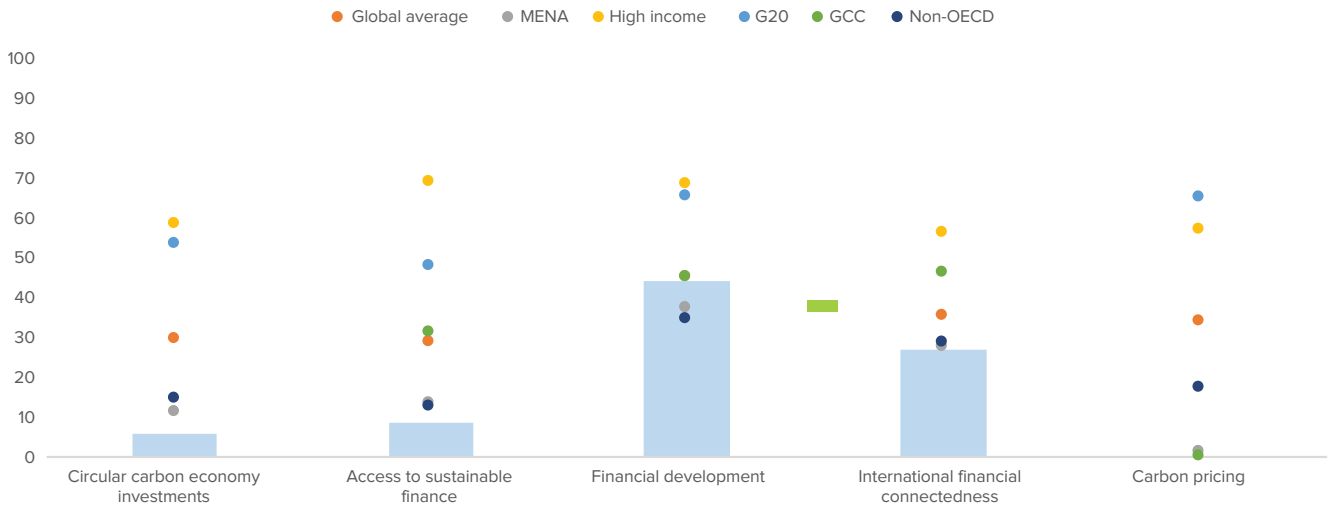
On a positive note, Saudi Arabia's score has increased since 2021 by a rate equal to the global average and higher than the regional average, which saw a negative rate of change in this period (Figure A.2). This is reflective of the country's commitment to develop its renewable energy capacity as part of the Saudi Vision 2030 strategy and in line with its 2030 renewable energy generation target of 50%, which will require significant scaling up of investments in this area. BNEF (2023) registered no major types of CCE investments by Saudi Arabia other than renewable energy in the period 2018-2022. Virtually all countries scoring high in this indicator made substantial investments in CCUS and other CCE technologies, alongside renewables, over this period.[15]

Figure 9. 2023 Finance and Investment CCE Enablers dimension scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Figure 10. 2023 Finance and Investment indicator scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The bars represent Saudi Arabia's indicator scores. The dots indicate indicator average scores for selected groups.

Recent developments signal a significant increase in investments in sustainable technologies in Saudi Arabia in the coming years. The Public Investment Fund (PIF), the country's largest wealth fund with a focus on sustainability, is committed to developing 70% of the additional renewable capacity required to achieve a 50% renewable power generation target (PIF 2022). As part of its Green Financing Framework, PIF outlines a list of green projects that are eligible for financing, which are aligned with the United Nations SDGs, including renewables, energy efficiency, green hydrogen, and clean transportation technologies. The current PIF portfolio includes companies such as CEER (a domestic EV manufacturing company established in 2022), the Electric Vehicle Infrastructure Company (EVIQ, established in 2023), the Saudi Investment Recycling Company (established in 2017), and the National Energy Services Company (aimed at increasing the Kingdom's energy efficiency, established in 2017). Additionally, PIF is the primary investor in Saudi giga-projects like Neom, which is working toward large-scale renewable energy and green hydrogen production and exports (PIF 2024).

Beyond PIF, the Saudi Industrial Development Fund, the primary financial enabler for the industrial transformation in Saudi Arabia, highlights the renewable energy sector as one of the targeted sectors in the Kingdom's Vision 2030, and it is actively investing in various renewable energy and energy efficiency projects. Furthermore, Saudi Aramco has invested in developing CCUS technologies, green and blue hydrogen, renewable energy, and energy efficiency improvements, particularly in fuel-efficient car engines (Saudi Aramco 2023).

4.2.2. Access to Sustainable Finance

In order to achieve CCEs, it is imperative to recognize that the investments required globally to meet the goals of the Paris Agreement surpass the capabilities of public funding alone. Engaging private financial resources and facilitating access to green finance tools emerge as critical steps in bridging this funding gap. This indicator measures sustainable – green, social and sustainability-linked – bond and loan issuances per country of domicile. While debt is typically issued by the government, government-affiliated entities (e.g., utilities, local government or sovereign funds), or the financial/private sector, the funds are generally raised from private sources. Similar to the CCE investments indicator, the data is scaled to GDP for comparability, and an average of the previous three years (2020-2022 for the 2023 Index scores) is used.

Because this indicator is based on issuance by country of domicile, it also serves to gauge the broader enabling conditions within a country involved in raising sustainable finance. Bahrain is a good example from the MENA region of an economy that, relative to its size, has been successful in fostering an environment for sustainable debt issuance, achieving a top 100 score in this indicator and ranking fifth, with annual issuances averaging U.S. $2.6 billion, equal to 3.2% of its 2021 GDP (BNEF 2023b).[16] For this indicator, Saudi Arabia's score (8) was below all its peer group averages, including for MENA and GCC countries. Average annual sustainable debt issuances in Saudi Arabia in 2020-2022 totaled U.S. $3 billion, or 0.2% of its 2021 GDP (BNEF 2023b) (Figure 10).

Saudi Arabia's score increased from 2021, when it scored 3 (Figure A.2), albeit the rate of change was much smaller than that observed in the regional and global average scores. This increase was due to a U.S. $3.6 billion green loan issuance by the Red Sea Real Estate Development Company in 2021 (which was not factored into the previous CCE Index scores) (Red Sea Global 2021). All other sustainable debt issuances in Saudi Arabia in 2018-2021 totaled less than U.S. $1 billion, and more than half of them were issued in 2021 alone. The most common form of debt was green loans for the utilities sector or renewable energy projects (BNEF 2023b).

In the three highest-scoring countries for this indicator (the Netherlands, France, and Singapore), sustainable debt issuances equaled 4.2%-6.3% of their GDP (BNEF 2023b). In absolute terms, the leaders were the United States, issuing U.S. $296 billion, France issuing U.S. $146 billion, and Germany issuing U.S. $103 billion per year, on average, in 2020-2022 (BNEF 2023b). In the MENA region, the largest issuer in absolute terms was the UAE, with an average debt issuance of U.S. $4.2 billion (BNEF 2023b). By contrast, the UAE's economy is about 40% the size of the Saudi economy, meaning it has been raising 2.5 times more debt than Saudi Arabia.

Cognizant of the potential opportunities enabled by attracting sustainable financing and the urgency of the need to scale up available resources, in March 2024, Saudi Arabia's Ministry of Finance released the Green

Financing Framework for the Kingdom (Ministry of Finance 2024).[17] Aligned with the International Capital Market Association's Green Bond Principles, the Green Financing Framework enables entities in Saudi Arabia to issue green bonds or green 'sukuk' (Shariah-compliant bonds) by laying out the rules and principles for the use of proceeds, the evaluation and selection process, the management of proceeds, reporting, and review.

To support ESG reporting and transparency more broadly, in 2019, the Saudi Capital Market Authority introduced the ESG Disclosure Guidelines, which require companies listed on the Saudi stock exchange, Tadawul, to disclose ESG-related information. Additionally, many Saudi banks have sustainability financing frameworks in place (e.g., Riyadh Bank, the Saudi National Bank [SNB], Alrajhi Bank, and Saudi Awwal Bank [SAB]).

4.2.3. Financial Development

Strong financial development boosts economic growth and, in turn, promotes swift and sustainable transitions. This is because it mobilizes savings, promotes information sharing, improves resource allocation, facilitates diversification and risk management, and promotes financial stability. The overall robustness of financial institutions also affects countries' abilities to raise and deploy energy transition finance; strong financial development levels are a necessary condition, given the measuring, reporting, and verification requirements of sustainable finance (e.g., ESG).[18] This indicator, based on the International Monetary Fund's Financial Development Index, measures the development of countries' financial institutions and markets by assessing their depth, access, and efficiency (IMF 2023).

For this indicator, Saudi Arabia's score (44) was on par with the global average (45) and higher than the MENA and non-OECD countries' averages (37 and 35, respectively) (Figure 10). In the MENA region, the top-performing countries were Qatar (53), Iran (52), the UAE (49), and Bahrain (46), with Saudi Arabia ranking in the fifth spot. Of the areas measured by the Financial Development Index, Qatar, Iran, and Bahrain all boast strong scores in financial institutions' efficiency, and Iran shows strong performance in access to financial institutions. Bahrain, the UAE, and Qatar share high scores in financial market access, whereas the UAE, Saudi Arabia, Qatar, and Bahrain all perform relatively well in financial market depth (IMF 2023).

Between 2021 and 2023, Saudi Arabia's score increased at a higher rate than both the global and regional averages (Figure A.2). This highlights the Saudi economy's rate of growth, which was the fastest among the G20 countries, in line with targets set forth in the Kingdom's Saudi Vision 2030.

4.2.4. International Financial Connectedness

Countries' connectedness to international private capital markets is critical for financing CCE transitions. This CCE Index indicator measures net foreign direct investment (FDI) in and outflows relative to the size of a country's economy. Inward FDI flows support national transitions, and outflows help other countries progress toward this aim. Measuring FDI inflows only would create a bias toward many developing countries, as higher-income developing countries often invest more globally than they receive capital from the rest of the world. This indicator therefore also recognizes countries' contributions to scaling up financing in other countries. While CCE-specific datasets are not readily available, generic FDI data can serve as a proxy for net-zero transition investments.

Saudi Arabia's score on this indicator (27) was below both the global average (36) and all its peer group averages, including the MENA (28) and GCC (46) (Figure 10). With the exception of Qatar, all GCC countries received higher scores than Saudi Arabia. Notably, however, the country's score increased by almost 10 points between 2021 and 2023 driven by a significant increase in FDI in 2021 (which was the final year taken into account in the 2023 CCE Index score) (Figure A.2). According to the Saudi Ministry of Investment, FDI inflows grew from 30 billion Saudi Arabian riyals (SAR) (approximately U.S. $8 billion) in 2020 (start of the COVID-19 pandemic) to SAR 102 billion (U.S. $27 billion) in 2021 and again SAR 123 billion (U.S. $33 billion) in 2022 (Ministry of Investment 2024). This was on the back of an improving investment environment and efforts to improve the competitiveness and strength of the private sector.

Global leaders on this indicator were Singapore, Switzerland, Netherlands and the UAE, where the total FD in- and outflows represented high shares of their GDP – 41%, 29%, 27% and 10%, respectively. These countries are all known as global financial hubs and, expectedly, indicate a strong profile in international financial connectedness. Saudi Arabia's share was less than 3% of

its GDP. In 2021, the Saudi government announced its aim to increase FDI 20-fold by 2030 (National Investment Strategy 2021). Some of the Kingdom's efforts to achieve this include improvements to the existing investment policy framework and the development of four special economic zones that provide incentives targeted at attracting foreign investment.

4.2.5. Carbon Pricing

Carbon pricing mechanisms can contribute to reducing emissions by sending market signals and providing economic (dis)incentives for emitters. If well designed, carbon market mechanisms can also lower the costs of mitigation as they encourage reductions to take place where they are least costly. In the CCE Index, this indicator rewards countries that have implemented, scheduled, or are considering, one of the three main regulated carbon pricing instruments, namely a carbon tax, an emissions trading scheme, or a crediting mechanism. Since Saudi Arabia's Greenhouse Gas Crediting and Offsetting Mechanism (GCOM), originally announced in 2022, had not yet declared sufficient details to be included in the World Bank's 2023 Carbon Pricing Dashboard (World Bank 2023b), it scored 0 in this indicator in the 2023 CCE Index (Figure 10).

There are currently no active regulated carbon pricing schemes in the entire MENA region. Morocco has been considering a carbon tax since 2022 (World Bank 2023b). The global average score for this indicator was 34. Eight countries out of 64 achieved a full score (100), which required having in place either a national-level carbon tax or an emissions trading scheme (ETS) and a crediting mechanism. Half of the index countries (34) had in place at least one type of regulated carbon pricing instrument – half of these were middle-income countries and almost half were among the world's top 30 oil- and gas-producing countries. As of June 2024, there were a total of 110 regulated carbon pricing mechanisms in implementation worldwide in 53 national and 40 sub-national jurisdictions (World Bank 2024).

At the time of writing, the Saudi GCOM was expected to become operational in 2024. Once a project supply has been established, it will allow interested companies and other entities to procure carbon credits for voluntary offsetting purposes.[19] The scope of the mechanism is expected to include all sectors, and all entities from all sectors, including subsidiaries of international companies active in the country, will be eligible to participate (CDM-DNA 2024b).

In parallel, since late 2021, PIF has been developing its so-called Voluntary Carbon Market. In October 2022, it established the Regional Voluntary Carbon Market Company (RVCMC) with the Tadawul Group to spearhead the initiative (see e.g., Arab News [2022]; VCM [2024]). The company has, to date, held two major carbon credit auctions. The auctions saw the sale of a total of 3.4 million tons of credits from projects implemented in various emerging economies. Major Saudi companies that purchased credits included Saudi Aramco, mining company Ma'aden, chemicals company SABIC, the Saudi National Bank, the airline Saudia, and Neom's utilities arm ENOWA. I

5. Saudi Arabia and the Oil Producers Lens Metrics

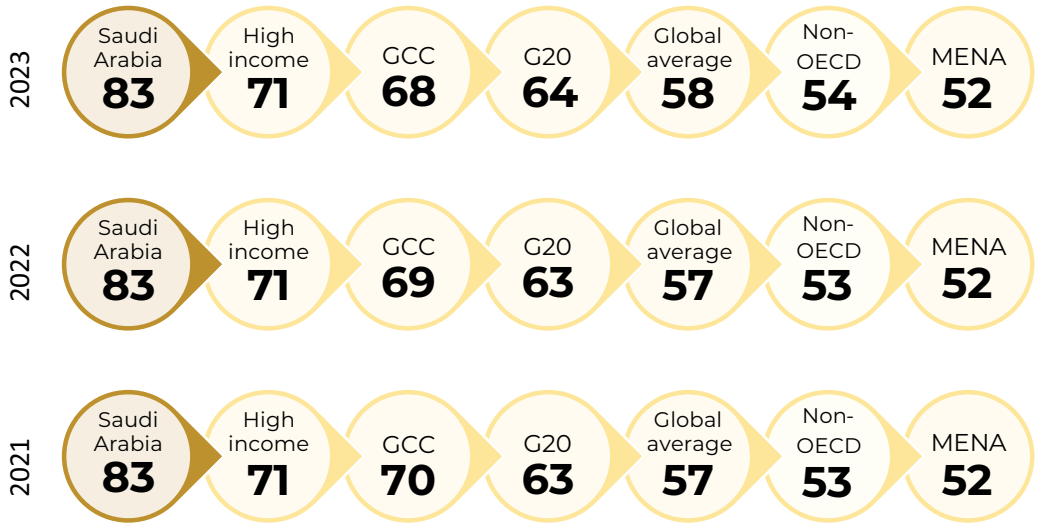
As shown in Figure 2, the CCE Index results also include the Oil Producers Lens (OPL) score, which serves as an additional comparative tool for major oil and gas producers featured in the CCE Index, highlighting the specific challenges and opportunities they face during the net-zero transition. The OPL score incorporates five indicators related to carbon circularity performance and readiness into the existing CCE Performance sub-index. The OPL indicators measure the carbon intensity of crude oil production, the flaring intensity of oil production, the intensity of fugitive methane emissions from fossil fuel production, the carbon intensity of manufacturing value added, and the value added of the chemical industry. Together these indicators provide a snapshot assessment of the efficiency and carbon intensity of oil producers' industry characteristics and configuration, and reflect their readiness to transition to CCEs.

The aggregate OPL score is comprised of contributions from these five OPL indicators (25%), the original eight CCE Performance indicators (25%), and the 30 CCE Enablers indicators (50%). In the 2023 CCE Index, Saudi ranked fifth in the five OPL Performance metrics and eighth overall among the oil- and gas-producing countries. This section zooms in on the five OPL indicators for a comparative overview.

Figures 11 and 12 show the 2023 OPL indicator scores at aggregate and indicator levels for Saudi Arabia and its peer groups, as well as the global averages (see also figure A.1.d in the appendix). On these indicators, Saudi Arabia performed very well overall. It received a higher score than the global average and a higher score than all of its peer groups on all indicators, except for one (the carbon intensity of its manufacturing value added). It also received a score of 100 on two indicators: the carbon intensity of its crude oil production and the flaring intensity of its oil production.

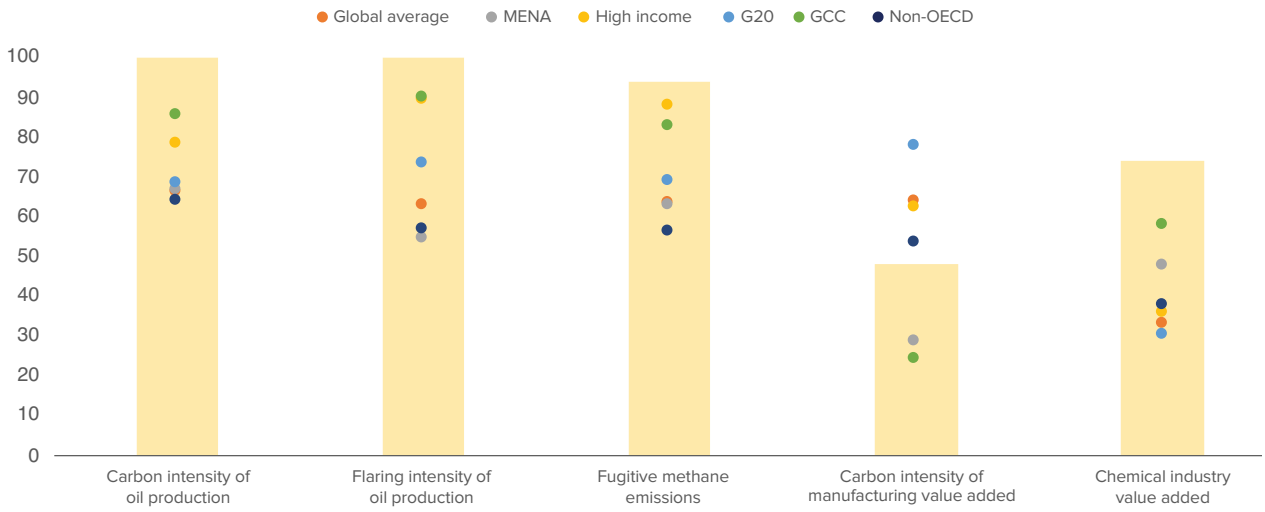
These results can be largely attributed to the Saudi oil and gas industry's high levels of efficiency and sophistication. Additionally, the type of oil found in Saudi Arabia, Arab Light, lends itself to lower-carbon extraction and refining. It is easily extracted due to favorable well conditions and requires less processing due to its lower sulfur content compared to other countries' hydrocarbon resources. The Kingdom's low rate of methane flaring is a result of strict flaring reduction and monitoring practices, and implementing programs like the Leak Detection and Repair Program (LDAR), which launched in 2018 (Saudi Aramco 2024b). More broadly, it is underpinned by Saudi Arabia's strategic decision in the 1970s to establish the

Figure 11. 2023 CCE Oil Producers Lens metric scores for Saudi Arabia and selected countries and groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Figure 12. 2023 Oil Producers Lens indicator scores for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The bars represent Saudi Arabia's indicator scores. The dots indicate indicator average scores for selected groups.

Master Gas System to capture and utilize associated gas that was previously being flared and vented, and to monetize it for energy and industrial use, including in the purpose-built industrial cities of Jubail and Yanbu (Al-Suwailem 2020). A recent KAPSARC study using satellite monitoring techniques found that Saudi Arabia's methane emissions from the oil and gas sector are likely to be even lower than the International Energy Agency's estimates – the source used in the CCE Index (Gasim, Matar, and Muhsen 2023).

In order to ensure the sector's alignment with the country's net-zero by 2060 goal, Saudi Arabia participates in the Global Methane Pledge, which targets a global methane emissions reduction of at least 30% from 2020 levels by 2030 (Global Methane Pledge 2023). Saudi Aramco and the Saudi chemicals giant SABIC have both set net-zero targets for operational (scopes 1 and 2) emissions by 2050, and Saudi Aramco is part of the industry group Oil and Gas Climate Initiative, which has pledged to strive to reach near-zero methane emissions and zero routine flaring by 2030 (OGCI 2021).

6. Conclusions

This study has shown how the CCE Index can be used to analyze a country's CCE Performance and Enablers in a holistic manner and relative to other countries. Saudi Arabia is an extremely relevant country to examine in this context, given the centrality of the CCE concept in its climate change and energy transition policy.

One-dimensional metrics – such as total GHG emissions, the carbon or energy intensity of the economy, or shares of hydrocarbon revenue in total government revenue – suggest that Saudi Arabia still has some way to go to reach net-zero emissions. However, the CCE Performance sub-index provides a more detailed picture of how the Kingdom is currently deploying various mitigation approaches and technologies. The CCE Enablers sub-index, in turn, gives a multi-dimensional outlook for the country's potential to speed up its net-zero transition, including its related strengths and areas for further work.

In the 2023 edition of the CCE Index, Saudi Arabia ranked 20th out of the 64 countries included. Within the sub-indices, it ranked 16 in CCE Performance and 30 in CCE Enablers. Saudi Arabia's results place it above the global average, well above the average scores of the MENA and GCC countries, and above the average for non-industrialized countries. The country's score has also improved over the three years of the Index.

On CCE Performance, Saudi Arabia ranked the third-highest in the MENA region. In addition to its sizeable CCUS project pipeline, driven by an ambitious carbon capture target of 44 Mt per year by 2035, the country's results are underpinned by the progress it has made in recent years in switching from oil-based liquid fuels to natural gas in its power sector. Saudi Arabia's Performance score has improved significantly since 2021 on the back of its CCUS project pipeline. With these projects still in their early stages, however, Saudi Arabia will need to follow through with these projects to truly 'earn' its improved standing. Relative to other major economies across the world, Saudi Arabia's clean energy deployment and pipelines – from renewable and nuclear energy to clean hydrogen – are still below the global average. Saudi Arabia's renewable energy projects have started to scale up more recently and are not yet fully reflected in the 2023 Index results. While all countries are pursuing the same objective of increasing the deployment of clean energy, Saudi Arabia's performance could improve in the coming years if it is able to implement its ambitious targets of 50% renewable energy in power generation by 2030 and significant increases in clean hydrogen production. The electrification of its industries and transport, and improving the overall energy efficiency of its economy, are further crucial areas where Saudi Arabia's CCE can be strengthened.

In CCE Enablers, Saudi Arabia ranked fourth out of the 14 MENA region countries included in the 2023 Index. Its results were again on par with the global average and above the MENA and non-OECD averages. The country's enablers are the strongest in business environments and system resilience, where it scores higher than most of its peer groups. In the policy and regulation and the technology, knowledge and innovation dimensions, Saudi Arabia generally performs above the MENA average but remains below the global average. In the finance and investment dimension, Saudi Arabia's score was well below its peer groups, on average. As bright spots in this area, CCE investments are starting to scale up, and the country's financial frameworks are relatively robust, performing above the regional and non-OECD averages. The operationalization of Saudi Arabia's carbon crediting mechanism, GCOM, is also expected to show in future editions of the Index. Finally, with an increasing focus on green and CCE finance, attested by the Kingdom's adoption in 2024 of the Green Financing Framework, the prospects of higher levels of CCE finance and investment in the country are promising. Notwithstanding this, at all levels – from the global to the regional and

national – significant redirection of financial flows to align with net-zero emission pathways and CCEs will be required if countries are to meet the goals of the Paris Agreement.

In oil and gas producer-specific metrics gauged by the Oil Producers Lens, Saudi Arabia performs well overall. On these indicators, it received a higher score than the global average, and a higher score than all of its peer groups on all indicators, except for one – carbon intensity of manufacturing value added. It also received a top score of 100 in the carbon intensity of its crude oil production and the flaring intensity of its oil production. Government and industry commitments in this area can be expected to keep the Kingdom among the highest-ranking hydrocarbon producers in these metrics going forward.

Overall, Saudi Arabia has already come a long way on its net-zero journey by developing and setting the CCE concept as the framework for the major transition ahead. The 2023 CCE Index paints a picture of a country that is already among the leaders in the CCE in its region, with high ambition and significant potential to do even more.

Endnotes

[1] Saudi Arabia's current NDC target is to reduce, avoid, and remove 278 million tons of carbon dioxide equivalent (MtCO2e) by 2030 compared to two baseline emission scenarios (Government of Saudi Arabia 2021). Data points relating to the two dynamic baseline scenarios referred to in Saudi Arabia's first NDC and its update have not been disclosed. However, the quantity is significant if compared to the country's total GHG emissions, which in 2016 stood at an estimated 668 MtCO2e (CDM-DNA 2022). Regarding Saudi Arabia's 2016 emissions data, KAPSARC experts have converted the inventory data from the country's 2022 Biennial Update Report with the conversion factors for the 100-year global warming potential for methane and nitrous oxide from the IPCC's Fifth Assessment Report.

[2] The Paris Agreement requires each party to communicate a new NDC every five years. Each NDC should represent a progression compared to the previous one. The second NDCs will be due in early 2025. Saudi Arabia's first NDC was made in 2015 and updated in 2021.

[3] The 2023 edition of the CCE Index covered 14 MENA region countries: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, and the United Arab Emirates.

[4] This paper analyzes the data and results contained within the 2023 CCE Index edition, which was launched in December 2023. This edition contains scores and rankings for 64 countries for the years 2021-2023. When displaying data for the years 2021 and 2022, it is important to note that these are also from the 2023 edition of the Index. Each year, data is re-retrieved as part of the Index development process to ensure that the most recent (and therefore also the best possible quality) data is used. Due to retroactive data updates by many of the data providers for the datasets used in the CCE Index, the underlying values for historical data often change. Consequently, the data and results in previous editions (2021 and 2022 editions) differ from those of the 2023 edition. Users of the CCE Index should always consult and use the latest available edition of the CCE Index.

[5] The boundary values (i.e., the minimum and maximum scores) are set using the following hierarchy: 1. Existing indicator scoring ranges (for all indicators that originate from existing indices, as applicable). 2. Technical or otherwise globally accepted limits (e.g., positive values in fuel switching for changes in oil and coal use equal to a zero score). 3. An average of the lowest and highest values: a. For the globally applied indicators, the minimum (min.)/maximum (max.) scores are calculated from the average of the three bottom/top values (i.e., the 10% percentile); b. For the Oil Producers Lens indicators, the minimum/maximum scores are calculated from the average of the two bottom/top values (i.e., the 10% percentile). When applying the third method (the average of the top/bottom performers), for some indicators, we excluded outliers that would have distorted the results (Luomi, Yilmaz, and Alshehri 2021).

[6] The top three scorers in this category are Sri Lanka (100), Switzerland (100), and the Dominican Republic (99). In the case of Sri Lanka, the country's high score is attributed to its low energy requirement for its economic activity, coupled with integrated energy efficiency measures and a lower GDP (World Bank 2023a). In the case of Switzerland, the country's score is attributed to its strong energy efficiency policy framework, which resulted in a sustained decrease in energy demand across all sectors (ODYSSEE-MURE 2021). Finally, the Dominican Republic's high score reflects the relatively low energy requirement of its economic activity (i.e., agriculture, manufactured goods, and tourism) (ITA 2024).

[7] Following a similar trend to energy efficiency, the high-income countries' average score (20) and the G20 countries' average (21) are higher than the global average score (19). In comparison, the highest performing countries in renewable energy are Norway, with a score of (100) and a 43% share of renewables, Costa Rica (100), with a 42% share of renewables, and Brazil (60), with a 21% share of renewables. These countries' electricity generation comes almost exclusively from renewable energy sources, including wind, solar, hydropower, and biofuels. Regionally, the top three performers are Jordan, Iraq, and Morocco, with a share of renewable energy ranging from 4%-8%. This highlights the state of renewable energy deployments in the MENA region compared to the global trend.

[8] Both Switzerland and the Republic of Korea also received a score of 100, with 22% and 14% shares of nuclear energy, respectively. The GCC countries' average (5) is low for this indicator, with the UAE being the only country with nuclear power generation, representing 3% of its primary energy consumption.

[9] Initially, the country aimed to install 17-19 GW of nuclear power by 2032, but this goal has since been abandoned (WNA 2024).

[10] Kuwait, another GCC country, also scored high (70) in this indicator. Factors contributing to this score include a higher share of electricity in final energy consumption in its industrial sector (20% versus an 11% share in Saudi), increased demand due to population growth, increased water demand (desalination) and high summer temperatures, and highly subsidized electricity rates for consumers (IEA 2024c, EIA 2023).

[11] Compared to coal and oil-based fuels, natural gas burns more efficiently and emits less carbon dioxide per unit of energy produced.

[12] Notably, because this indicator rewards countries for both their levels of non-oil/coal sources and the move away from these, it inevitably rewards those countries less that have either moved away from these sources prior to the period measured or have never relied on them. Examples of such countries include Bahrain, Nigeria, and Qatar.

[13] Enhanced oil recovery (EOR) is included in this indicator, as most of the carbon dioxide injected is permanently sequestered over a project's lifetime.

[14] The data years used for the 2022 and 2023 Index scores, respectively, were 2020 and 2021. According to the World Bank's World Integrated Trade Solution database, the total value of fuel imports from these three countries (Egypt, the UAE, and India) increased from U.S. $ 2.2 billion in 2020 to U.S. $4.9 billion in 2021. Based on media reports, Saudi Arabia has been importing fuel oil from Egypt, for example, for use in its power plants (Bloomberg 2022). Diesel imports from Russia are likely to show in future editions of the index (see e.g., Bloomberg [2023b]).

[15] Alongside renewable energy investments, of the top 10 countries in this indicator – Norway, Netherlands, Spain, China, United Kingdom, Germany, Australia, Viet Nam, Chile and France – all but two (Spain and Viet Nam) also recorded investments in CCS, and all but one (Viet Nam) recorded other CCE technology investments in 2020-2022.

[16] The GDP data used in the 2023 CCE Index is from the World Bank and is for current international U.S. dollars, adjusted for purchasing power parity. According to this data, Saudi Arabia's GDP in 2021 was U.S. $1,848 billion.

[17] The document starts with the affirmation that "the Kingdom will require large amounts of investment, stemming from both the public and private sectors, to finance [its] climate commitments" (MoF 2024).

[18] Furthermore, conventional finance can also be utilized in transition projects, which makes tracking related enabling conditions relevant.

[19] The term 'voluntary carbon market' can refer to two things. The first, and more common use of the term, relates to the creation and trade of carbon credits via independent standards, such as the Gold Standard or the Verified Carbon Standard (more commonly known by the name of its administrator, Verra), which generally are not connected to compliance markets. These voluntary carbon markets are commonly referred to as the VCM. The opposite of the VCM, compliance markets, in turn, refer to the trade in allowances or credits taking place under government-regulated carbon market mechanisms, most prominently ETS. The second use of the term 'voluntary carbon market' can relate to the use of carbon crediting mechanisms (also known as baseline-and-credit mechanisms) for offsetting emissions. In Saudi Arabia, the soon-to-be-operationalized crediting mechanism 'GCOM' is referred to as a 'voluntary carbon market mechanism.' This is factually correct in the sense that participation in a crediting mechanism is always voluntary, even in cases where the mechanism is linked to a compliance mechanism, such as an ETS or carbon tax. The most useful way to distinguish between what is happening in Saudi Arabia around 'voluntary carbon markets' is to differentiate between non-regulated (i.e., VCM/independent) and regulated (i.e., government-led) carbon markets.

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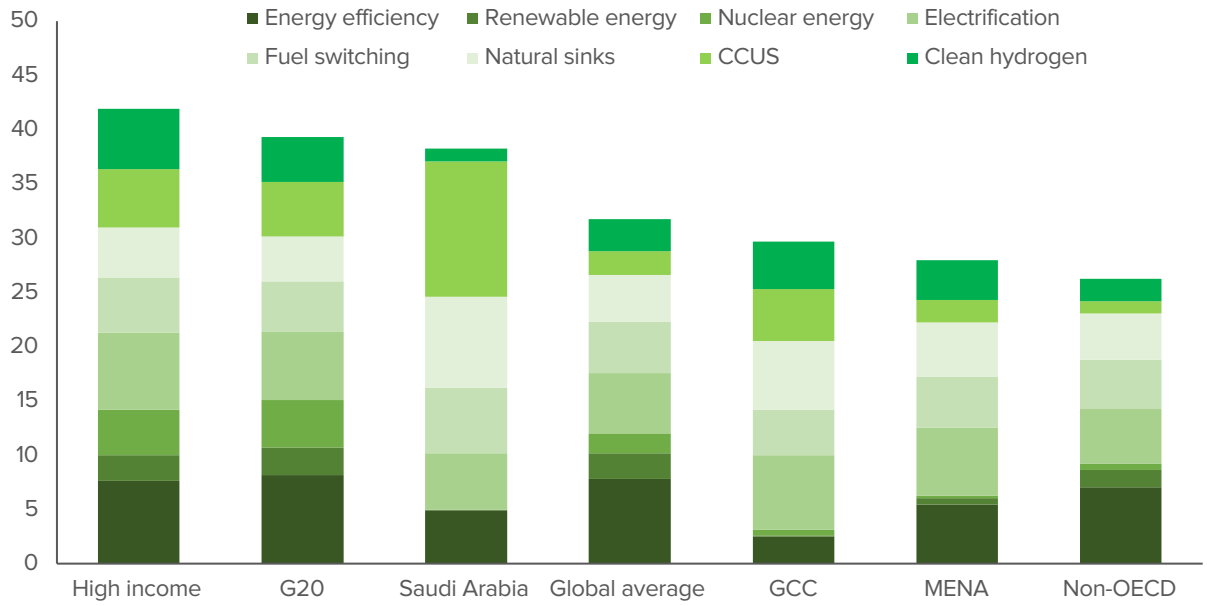
Appendix

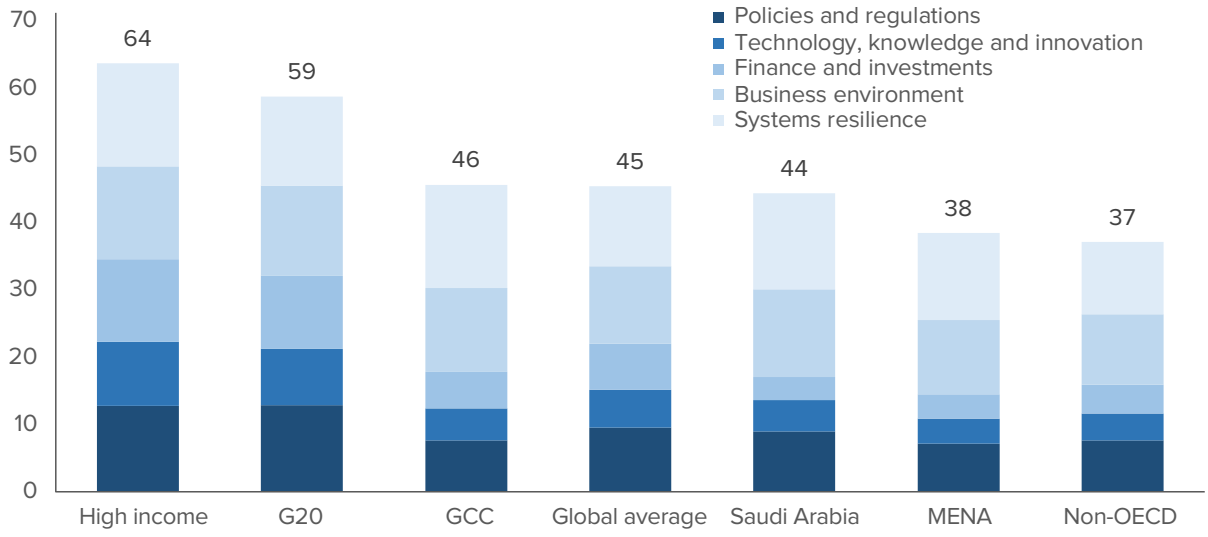
Figure A.1.a. 2023 CCE Performance results for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The height of each component represents its proportional contribution to the CCE Performance score.

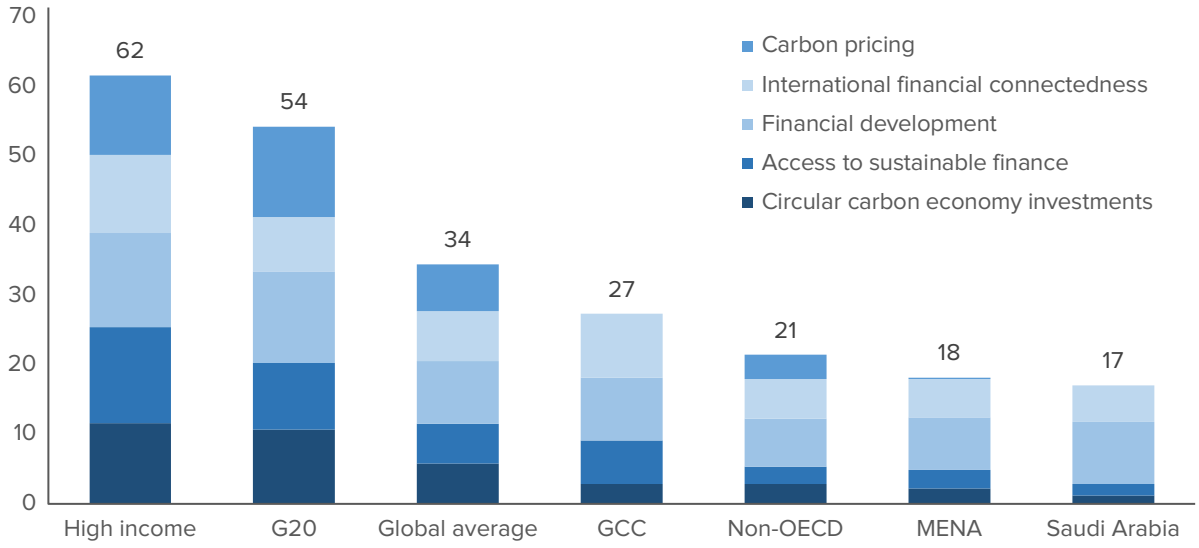
Figure A.1.b. 2023 CCE Enablers results for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The height of each component represents its proportional contribution to the CCE Enablers score.

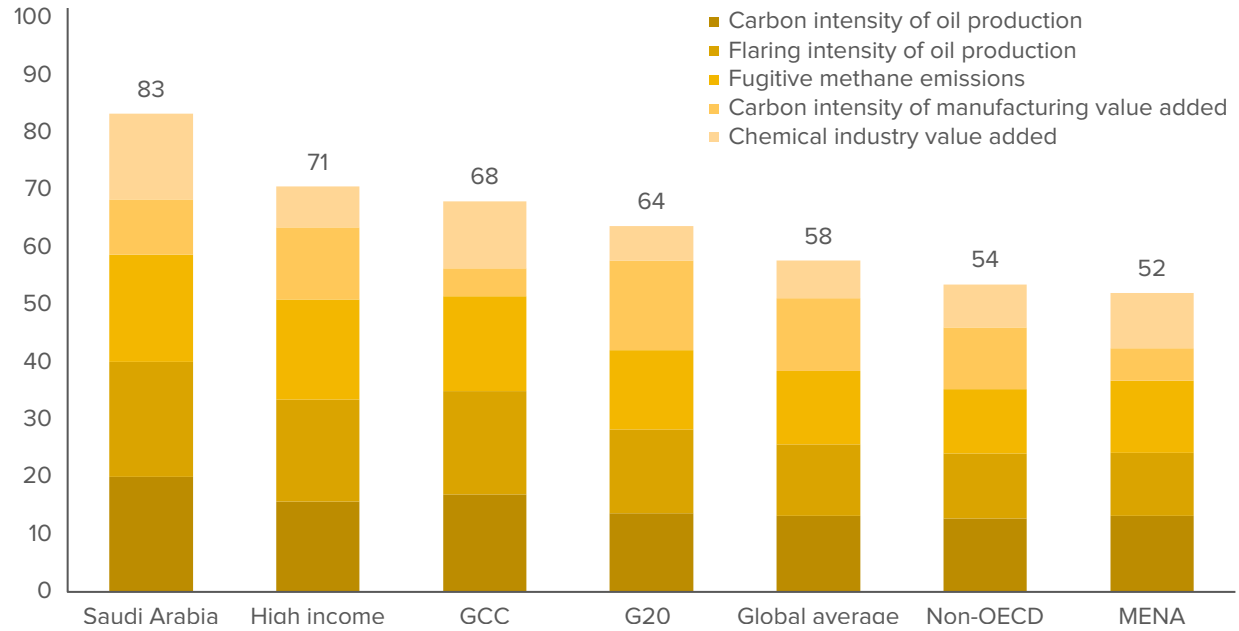
Figure A.1.c. 2023 Finance and investment Enabler dimension results for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The height of each component represents its proportional contribution to the finance and investment dimension score.

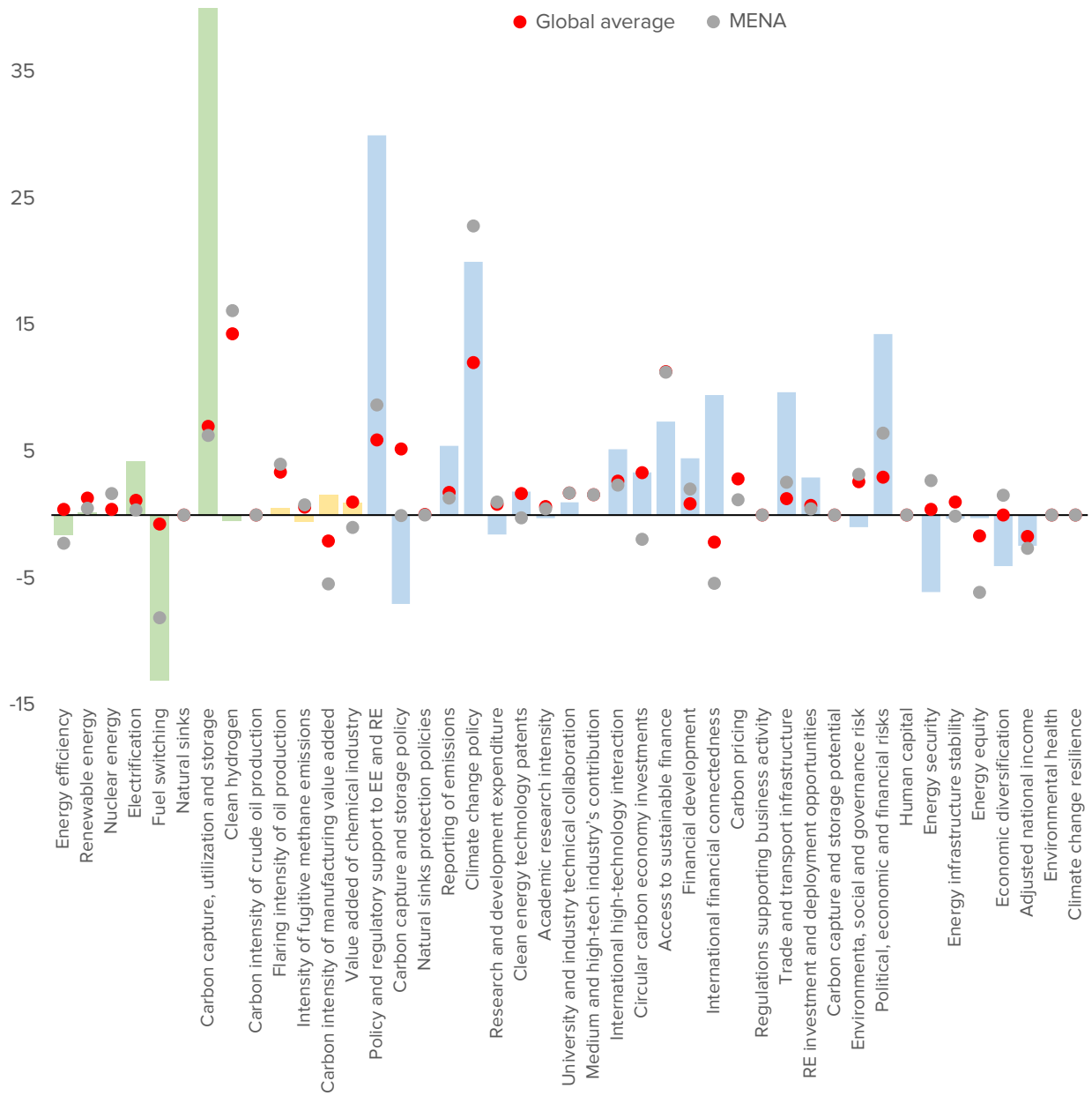
Figure A.1.d. 2023 Oil Producers Lens metrics for Saudi Arabia and selected groups.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The height of each component represents its proportional contribution to the OPL indicators score.

Figure A.2. Score changes for all CCE Index indicators from 2021 to 2023, Saudi Arabia.



Source: Luomi, Yilmaz, and Alshehri (2024).

Note: The bars represent indicator score changes (in points) for Saudi Arabia between 2021 and 2023. Indicator colors are as follows: CCE Performance, green; Oil Producers' Lens, yellow; and CCE Enablers, blue.
The dots indicate indicator average score changes for all countries and the MENA countries included in the 2023 CCE Index.

Table A.1. List of implemented energy efficiency policy instruments in Saudi Arabia.

Policy	Definition	Sectoral scope	Context for Saudi Arabia
Energy price reform	The removal of explicit or implicit subsidies on regulated energy prices, bringing the prices closer or up to what their levels would be in deregulated markets.	Various	Two major phases of energy price reform (EPR) were implemented at the end of 2015 and at the start of 2018, and further gradual EPRs continue to be implemented.
Energy efficiency equipment subsidy	Payments on energy efficiency (EE) equipment (e.g., through a rebate), thereby reducing its price.	Buildings	Estbdal initiative: citizens can benefit from an incentive amount of SAR 1,000 on every replaced window air conditioner (AC). Each citizen can claim for up to six window ACs.
Energy efficiency equipment loan program	A loan program set up to support the purchase and implementation of energy efficiency equipment for various sectors.	Various	Saudi Industrial Development Fund (SIDF) – the Tanafusiya program provides loans under its energy efficiency track to manufacturers for techniques that reduce energy consumption. The program uses energy auditing and management systems to support the continuous improvements of energy performance, including energy efficiency, energy security, and energy consumption.
Energy efficiency resource standard	An energy efficiency resource standard (EERS) establishes long-term energy efficiency or savings targets that utilities are obliged to meet.	Power	The aim is to improve the energy efficiency of power generation, cogeneration, water desalination sectors, and electricity transmission and distribution networks for existing and future assets through collecting data from utilities and setting targets to be achieved by 2025 using the Regulatory Framework for Utility Energy Efficiency.
Minimum energy performance (MEP) standards for appliances	A minimum energy performance standard for appliances is a specification containing a number of performance requirements for an energy-using device. It effectively limits the maximum amount of energy that may be consumed by a product in performing a specified task.	Buildings	Energy efficiency standards were implemented for six appliances/ products: ACs, freezers, washing machines, clothes dryers, water heaters, and lighting. MEPs continue to be increased. Standby and off-mode requirements: a standard that specifies the energy consumption during standby and off-modes for various electrical and electronic equipment.

Table A.1. (*continued*)

Policy	Definition	Sectoral scope	Context for Saudi Arabia
Vehicle fuel economy standards	Fuel economy standards require manufacturers to achieve a minimum average miles per gallon for the vehicles they sell (they could focus on specific types of vehicles, such as heavy vehicles).	Transport	Saudi Arabia has adopted the Corporate Average Fuel Economy (CAFE) standards for light-duty vehicles, which target an improvement in the overall fuel economy at an average rate of 4% annually. This would increase the country's fuel economy for light-duty vehicles from its current level of 12 km per liter to 19 km per liter by 2025.
Vehicle technical specification standards	Vehicle technical specification standards require vehicle manufacturers to change the design of their vehicles to reduce emissions and energy consumption.	Transport	Aerodynamic device regulation for incoming and existing heavy-duty vehicles; improving the fuel economy of all HDVs through enforcing anti-idling and aerodynamics.
Tire energy efficiency standards	Standards that require tire manufacturers to abide by specific requirements that aim to increase energy efficiency.	Transport	The first phase of the tire energy efficiency standard was implemented in November 2015, with the second phase implemented in November 2019 and 2020 for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs), respectively.
Industrial energy efficiency (EE) performance	Industrial energy efficiency standards limit energy consumption per unit of product (e.g., amount of gigajoules (GJ) and kilowatthours (kWh) per tonne of cement manufactured).	Industry	Existing petrochemical, cement, steel, and aluminum plants are required to achieve the second quartile of energy efficiency (EE) levels in accordance with a benchmark set by SEEC in the baseline year 2018. These targets are to be the minimum EE levels in the target year during the EE cycle. For new plants in the above industrial sub-sectors, EE targets are required to achieve the average first quartile of EE levels, in accordance with the benchmark approved by SEEC in the plant design year.
Building energy efficiency standards	Mandatory efficiency standards for buildings, e.g., thermal insulation for all new buildings.	Buildings	The thermal insulation requirements in the Saudi Building Code have been applied throughout the Kingdom since 01/01/2019. On-going projects include updates to thermal insulation material standards.

Policy	Definition	Sectoral scope	Context for Saudi Arabia
Green/sustainable building standard/ certificate	A ratings system that focuses on the sustainability of a building, either in the construction phase, operation phase, or both. Can be introduced as a mandatory requirement by the government.	Buildings	Mostadam is Saudi Arabia's new green building rating system.
Energy efficiency-related green procurement/ technology implementation	Green public procurement applied to a specific technology.	Building	(1) Tarshid has an exclusive right to retrofit all public buildings and facilities managed by government agencies. It can also service private entities. Tarshid is always looking for existing energy service companies (ESCOs) to participate in the development and management of projects. Tarshid also supports the establishment of new private ESCOs in the Kingdom and encourages participation in international ESCOs. (2) The Saudi Electricity Company (SEC) completed the installation and replacement of more than 10 million smart electricity meters in 2021.
Vehicle energy efficiency labeling	An energy efficiency label that provides a clear and simple indication of the energy efficiency and other key features of products at the point of purchase to encourage consumers to save money by reducing their energy consumption.	Transport	Vehicle distributors need to apply to the Saudi Standards Metrology and Quality Organization (SASO) to get energy efficiency labels for each of their vehicles.
Appliance energy efficiency labeling	An energy efficiency label that provides a clear and simple indication of the energy efficiency and other key features of products at the point of purchase to encourage consumers to save money by reducing their energy consumption.	Buildings	Appliance distributors need to apply to SASO to get energy efficiency labels for their appliances.

Table A.1. (*continued*)

Policy	Definition	Sectoral scope	Context for Saudi Arabia
Tire energy efficiency labeling	An energy efficiency label that provides a clear and simple indication of the energy efficiency and other key features of products at the point of purchase to encourage consumers to save money by reducing their energy consumption.	Transport	The distributors need to apply to SASO to get energy efficiency labels for their tires.
Education/ awareness campaign	A campaign that targets the general public or part of a society to change their behaviors by either discouraging unsustainable practices or encouraging sustainable practices. It runs for a specified duration.	Various	(1) Energy efficiency awareness for small and medium plants; SEEC established the Energy Management Program, which aims to enhance the energy efficiency culture across various sectors in Saudi Arabia. The program contains multiple supportive tools and an organizing set of processes to enable facilities to adopt energy management systems (EnMS). (2) The Energy Intensity in Buildings Initiative (EUI) is an electronic platform that enables beneficiaries to use the simulation tool to issue and energy efficiency cards. It contributes to improving the energy efficiency of new and existing buildings, and enables beneficiaries to compare the energy efficiency of buildings when buying or renting.

Source: SEEC (2024a), SIDF (2024), SEEC (2024b), SASO (2024), UNEP (2021), SEEC (2022), ALPIN (2020), and Tarshid (2024).

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About the Project

KAPSARC's Circular Carbon Economy (CCE) Index project seeks to expand and add rigor to the conceptual basis of the CCE, as well as its practical operationalization, by developing a robust quantitative framework to measure countries' performance and their progress toward CCEs. The resulting CCE Index is a composite indicator that measures various dimensions of the CCE in a national context and across countries. Its main foci are current performances and enabling factors for future progress.

The first edition of the CCE Index, published in November 2021, covered 30 countries. From the 2022 edition onward, the Index covers 64 major economies and oil and gas-producing countries. The Index is disseminated through various research outputs, including KAPSARC discussion papers and commentaries, which present the index results and analyze them in depth, as well as KAPSARC methodology papers, conferences, workshops and other events, and an online platform, located at https://cceindex.kapsarc.org/. The Index is updated annually, with the 2023 edition launched in December 2023.

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