ERF Policy Brief

Technologies and Innovation in the GCC Energy Sector: Differences Between the Scope and the Direction of Technological Change

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About the authors

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In a nutshell

- *GCC countries require a dual digital and energy transition, and significant progress has already been made in this regard.*
- *The GCC has significant alternative resources for the production of renewable energy (solar, wind, and hydrogen), and new investments, projects, and natural endowments could position it as a key player in future technological advances.*
- *Numerous technologies are available, and the GCC must become an active participant in determining the future technologies that will shape the energy transition.*
- *Three technologies are of particular interest to the region: CO2 storage and capture, batteries and rare earth elements, and alternative fuels such as hydrogen and ethanol.*
- *Strengthening the entrepreneurial ecosystem, establishing a collaborative regional energy technology R&D institution, and launching initiatives with key global technology players are strategies that could enable the GCC to significantly influence the "direction" of energy technologies in a way that benefits the region.*

1. Introduction

The nations of the Gulf Cooperation Council (GCC) have long been prominent in the global energy landscape, and their abundant hydrocarbon resources have served as the foundation of their economic growth and development. More recently, the GCC energy sector has been at the forefront of a transformative wave of technology and innovation that is reshaping established paradigms in energy production, distribution, and consumption.

As the global energy landscape shifts toward greater sustainability and resilience, GCC countries face the imperative of diversifying their energy portfolios and embracing innovative technologies to meet new challenges. The range of technological options is extensive, from renewable energy sources to advanced grid management systems, offering GCC countries opportunities to adapt to the evolving energy dynamics. However, the extent and direction of technological change in the GCC energy sector will be influenced by a variety of factors, including geopolitical dynamics, economic constraints, and regional cooperation efforts.

GCC countries, with their higher per capita emissions, are responsible for about 70 percent of the MENA region's emissions, despite having greater resources to mitigate them.[1] In contrast, the non-GCC MENA countries, with lower GDP per capita and emissions, contribute about 30 percent of the region's emissions. Moreover, these non-GCC countries are home to about 70 percent of the MENA region's population.[2] This disparity sets different, critical priorities for decarbonization and energy transition. The wealthier, higher-emitting GCC countries are challenged to reduce their emissions intensity in sectors such as electricity, gas, and oil without compromising the living standards and employment opportunities of their citizens. In addition, given their heavy reliance on conventional energy exports for fiscal and development purposes, these countries must ensure a just transition while maintaining their energy competitiveness.

To promote a low-carbon economy and facilitate the energy transition, a clear direction for technological change is essential. The scope of technological change encompasses a wide range of technologies from traditional hydrocarbon-based methods to innovative renewable energy and smart grid technologies. At the same time, the direction of technological change includes strategic pathways and policy frameworks that guide the adoption and integration of these technologies. Understanding the interplay between the scope and direction of technological change is critical for policymakers, industry stakeholders, and researchers as they navigate the complexities of transitioning the GCC energy sector to a more sustainable and resilient future.

This policy brief explores the complex dynamics of technological change in the GCC energy sector, with a particular focus on understanding the differences between the scope and direction of these advances.

2. Important Shifts in the Labor Market Status of Young Women During the Period

The world economy is entering a new era characterized by multiple threats that reinforce the relevance of 20th-century calamities: cold and real wars, pandemics, economic crises…etc. Moreover, the 21st century poses increasing risks of global warming and potential challenges associated with disruptive technologies, but also offers numerous opportunities, especially through a labor-augmenting and green economy-enabling technological revolution (especially in artificial intelligence (AI), blockchains, and genomics).

Economic activity is cyclical, marked by various crises over time. However, the frequency and severity of these crises are becoming increasingly significant. Events such as the subprime crisis, the ICT crisis, the debt crisis, the pandemic, the Russian-Ukrainian war, and the recent conflict in Gaza are all impacting the global economy and creating structural instability. Uncertainty has become a structural element. Alongside this, the climate crisis remains an ongoing challenge, characterized by heat waves, loss of biodiversity, deforestation, and pollution. Climate disasters, such as the flood in Derna, Libya, are becoming more severe, and the potential collapse of biodiversity could exacerbate climate crises. Approximately 3.3 to 3.6 billion people live in areas that are highly vulnerable to climate change.[3] Human and ecosystem vulnerability are interdependent. Regions and people facing significant development challenges are highly susceptible to climate hazards, with increasing weather and climate extremes exposing millions to acute food insecurity.

[1] World Economic Forum (2023). Closing the Climate Action Gap: Accelerating Decarbonization and the Energy Transition in MENA.

[2] World Economic Forum (2023). Closing the Climate Action Gap: Accelerating Decarbonization and the Energy Transition in MENA.

[3] IPCC. (2023). Climate Change 2023

While the global crisis poses many challenges, the world now has access to new technologies to address these challenges. The proliferation of the Internet and advances in computing power, along with the collection and structuring of massive amounts of data worldwide, have led to new disruptive technologies. The Fourth Technological Revolution, or Industry 4.0, is currently underway, with a number of new technologies (mostly general-purpose technologies, also known as GPTs) that offer an array of opportunities. If harnessed responsibly, these technologies could drive humanity toward a new era of prosperity, sustainability, and innovation. This unique context is leading to a major transformation across all sectors.

Digital transformation is ushering in a new era for industries, services, education, health, and lifestyles. In a sense, Humanity 4.0 is already upon us, where the augmentation of human capabilities is now possible. These technologies can address the challenges of the climate crisis and enable economic growth and prosperity. Further, they are becoming central to the international race among companies, nations, and coalitions. Most of the GPTs of Industry 4.0 can potentially be used to address the climate crisis at different levels, facilitating a dual transition.[4] The context of the first quarter of the new century is unprecedented in human history in terms of technological development, and the prospect of superintelligent AI is predicted by most technology leaders.

Therefore, humanity needs a managed process of technological change.[5] Evidence from today and past events demonstrates that the decisions we make regarding technology will determine how far we can go. Innovative production and communication strategies have the potential to either further the exclusive interests of a select few or lay the groundwork for prosperity for all. This has never been more true than with the current fork in the road. Digital technologies and AI have the potential to revolutionize the labor market and improve or worsen people's lives, contingent on the political, social, and economic decisions we make.

3. GCC countries: The crossroads presented by this context

Like most global economies, the GCC, located in a region marked by significant geopolitical instability and conflict, is navigating a new context filled with both threats and opportunities. Although 2022 was dubbed the "year of oil," the story of 2023 revolves around the growth of the non-oil economy. The non-oil share of the economy has held steady, but this masks significant growth that has been overshadowed by high oil prices. However, energy prices, as the main source of economic activity, are subject to high volatility. Wars and economic crises have a major impact on their economic growth and performance.

At the same time, climate change is emerging as a threat to the GCC economies and the world at large, prompting world leaders to accelerate their energy transition initiatives (such as reducing subsidies for hydrocarbons, shifting to electric vehicles, banning diesel and thermal cars by 2030, and investing in energy efficiency) and designing carbon markets that will affect the overall use of oil and gas. However, this transition is not straightforward. These trends also affect the future of the GCC economies, where the possibility of stranded assets cannot be ruled out. Managing oil revenues to transform and diversify the economy is becoming a critical challenge. However, the rapid pace of technology, the severity of climate change, and geopolitical instability put this transition at risk.

GCC countries have a significant opportunity to manage their twin transitions (environmental and digital) in the midst of chronic international disruptions. They have already made ambitious commitments to the energy transition.

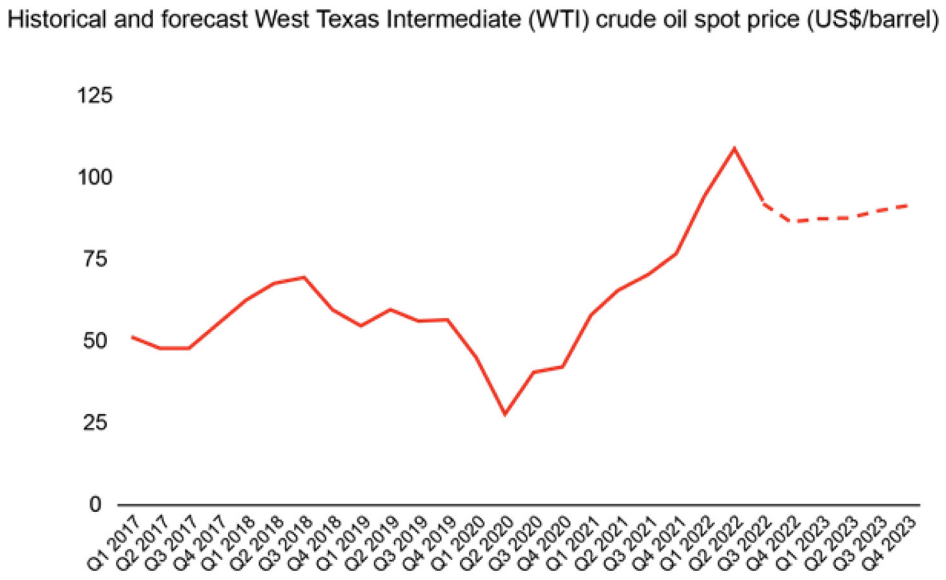
First, the GCC has significant alternative resources for renewable energy production (solar, wind, and hydrogen), potentially positioning them as key players in these technologies in the future through new investments, projects, and their natural endowments.[6] In GCC countries, desalination is a critical component of the water supply system. Although the region is a world leader in desalination, it relies largely on conventional methods, including thermal distillation and reverse osmosis, often fueled by fossil fuels. Of the 24 billion m^3 of desalinated water produced globally each year, the GCC produces about 40 percent, and the MENA region accounts for 38 percent of the world's total capacity. However, as of 2016, less than one percent of the MENA region's desalinated water was produced from renewable sources. This striking statistic highlights an area ripe for improvement and transformation. With strategic policy shifts and targeted

[4] Ben Youssef, A. (2023). Digitalization for the Green Transition in the Mediterranean. IEMED

[5] Acemoglu, D. and Jonson, S. (2023). Power and Progress: Our Thousand-Year Struggle Over Technology and Prosperity.

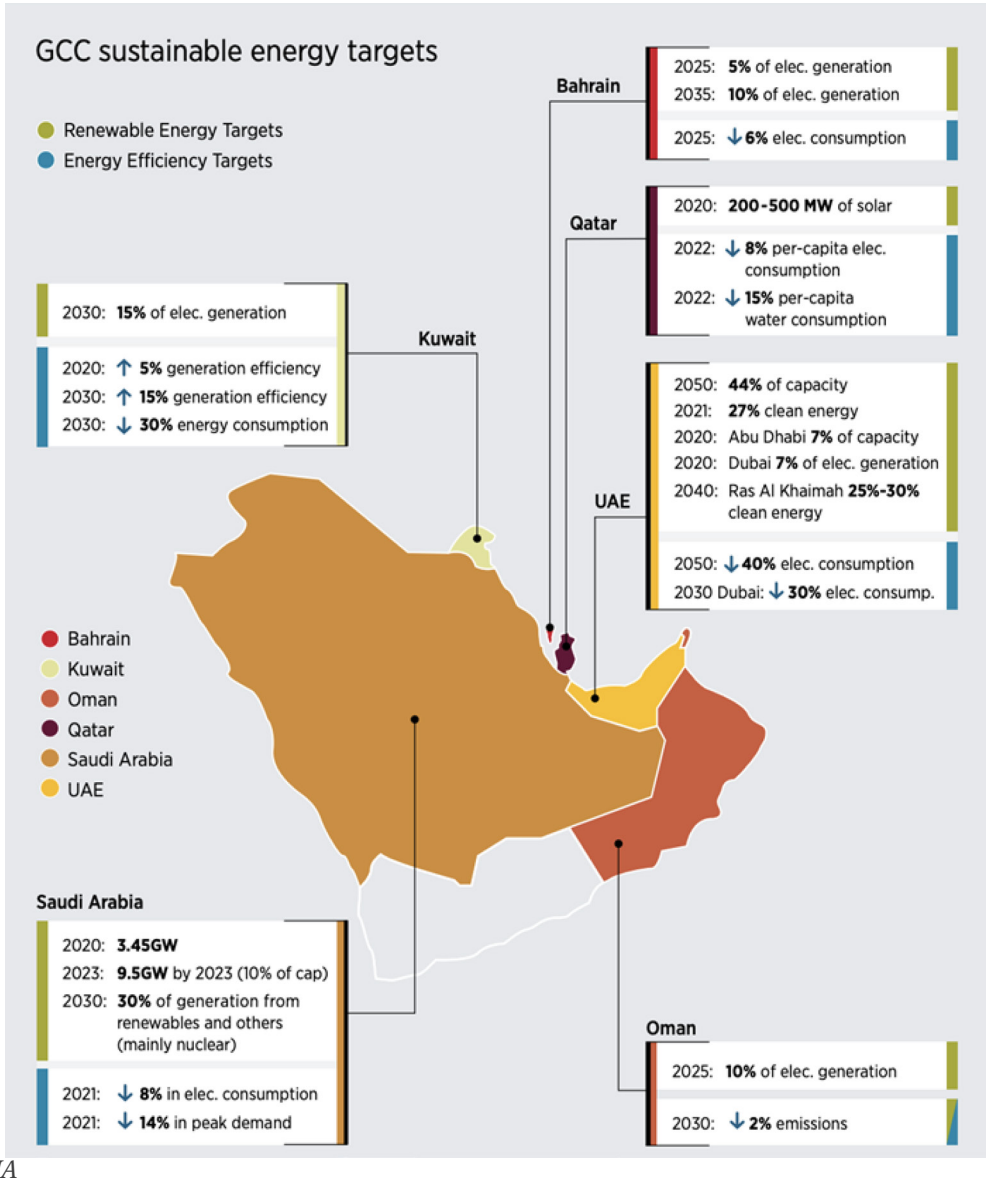
[6] At the same time, the potential of energy efficiency is huge for the GCC. For example, Saudi Arabia can realize half of its NDC with Energy Efficiency (Belaid et al.).

Figure 1: Oil prices in the GCC



Source: Energy Information Administration.

Figure 2: Planned energy targets for GCC countries



Source: IRENA

investments in renewable energy, the region could significantly increase renewable desalination. Saudi Arabia's Al Khafji desalination plant is a good example of the region's renewable desalination movement, using reverse osmosis technologies powered by solar photovoltaics to produce 60,000 m^3/day of clean water, with a peak capacity of 90,000 m^3/day.[7]

Second, oil and gas production in the GCC has one of the lowest emission intensities in the world. The GCC commands 30 percent of global oil and 21 percent of global gas reserves, lasting around 76 and 98 years, with 70 percent of the global spare oil production capacity. Their advantage is further enhanced by the lowest production costs in the world.[8] This uniquely advantageous position makes the MENA region, including GCC countries, the natural choice to supply the world with oil and gas, capitalizing on its low cost and low emissions profile.

Third, the Fourth Industrial Revolution presents an opportunity for GCC countries to become key players in new technologies and related services, serving as a "booster" for the diversification of their economies. For example, the UAE is emerging as a major player in the field of AI and is establishing a major startup hub for this technology. Saudi Arabia is becoming an international hub for innovation, and the performance of its universities is increasingly impressive, contributing to the GCC's digital and green transition.

Fourth, AI can significantly support the energy transition. A 2017 comparative study by the IEA found that AI-based digitization has the potential to save the electricity sector around USD 80 billion annually, or five percent of cumulative global electricity costs. Given that the MENA region is currently lagging in renewable energy integration, AI paves the way for this integration by matching energy demand to times when solar power is unavailable, and wind is optimal for power generation.

4. Technological change: Differences in scope, speed, and direction

The technology landscape is currently undergoing significant changes, with several GPTs emerging and evolving rapidly. These technologies are being developed by various actors, including countries (China, the US, Europe, Russia, Japan, India, South Africa… etc.) and multinational corporations (GAFAM and BATX). Investments in these technologies are reaching unprecedented levels. The scope of technological change is vast and includes AI, blockchain, genomics, cognitive science, drones, big data, and robots. These technologies are being applied in various fields: Industry 4.0, Education 4.0, Health 4.0…etc. Moreover, as these technologies are contextualized in different parts of the world, they are evolving rapidly and causing multiple disruptions at the global economic level. At a holistic level, we are transitioning to Humanity 4.0, where the human ecosystem is being transformed and the functioning of economies and societies is being redesigned. The global economy is becoming more technologically interconnected, and the best way to harness all this technological progress is through an open innovation approach.

"The direction of technological change is not neutral for the GCC."

With multiple competing technologies and major players, the direction of technological change becomes a critical question. This direction is not neutral.[9] It depends on the purpose of the technology and its legal framework. Historically, there have been cases where the direction of technology has been changed to maintain the dominance of certain firms or countries. Defensive innovation becomes the norm. For example, Verdier and Thoening (American Economic Review) discuss how cloud computing emerged to solve the problem of intellectual property rights (IPR) disputes within the World Trade Organization. Currently, around 1,000 scientists are expressing concern about the direction of Generative AI. This concern could extend to genomics and other key transformative technologies.

However, the direction of transformative technologies in terms of the energy transition and climate remains undetermined, given the divergent positions of countries in climate negotiations. The energy transition in the GCC is a complex process influenced by various factors, and the direction of technological change is far from neutral.

This raises the following questions: What is the desirable direction of technological change for GCC countries in terms of climate technology? How can we ensure that this trajectory is achieved?

[7] Vision 2030, Alkhafji Desalination Plant: https://www.vision2030.gov.sa/en/projects/alkhafji/

[8] Al Moneef, M. (2023). The Saudi Economy in the Era of Global Energy Transition. The Third ERF GCC Conference KAPSARC, Riyadh 30-31 October 2023.

[9] Ben Youssef, A. (2020). How Industry 4.0 Can Contribute to Combatting Climate Change? Industrial Economics Review (French Industrial Economics Review), June 2020, vol. 169.

The neutrality of these technologies is debatable, as their widespread adoption can either support or hinder the environmental goals of GCC countries, depending on factors such as efficiency, environmental impact, and accessibility. The adoption of emerging technologies such as AI, the Internet of Things (IoT), and 5G has the potential to revolutionize various sectors. However, the environmental impact of manufacturing and disposing of electronic devices, the energy consumption of data centers, and the potential increase in e-waste challenge the neutral stance on technological change. Balancing the benefits of these technologies with their environmental footprint is critical for a meaningful environmental transition.

Continued innovation is needed to address existing challenges and maximize potential. Breakthroughs in energy storage, grid integration, and efficiency improvements are essential to overcome current limitations. The direction of technological progress, whether leading to incremental improvements or disruptive innovations, remains uncertain and can have a significant impact on the overall success of energy transition efforts. Recognizing the non-neutral nature of technological change is critical to developing effective strategies that align with global sustainability goals while addressing the challenges and opportunities that are unique to the GCC.

5. Technologies driving the energy transition: Three examples

There are around 12 technologies that can help address climate problems.[10] Their level of maturity varies; alternative proteins and carbon removal technologies are still in the early stages of development, while renewable energies like solar and wind power are being deployed more frequently and are already cost-competitive with fossil fuels in some areas. Although they are the foundation for many others, renewable energies alone cannot bring about net-zero outcomes.

In order to understand the problem of the direction of technological change on energy, it is important to understand the cases of CO2 sequestration, green hydrogen, and batteries.

5.1. CO2 sequestration technologies

CO2 Carbon Capture, Utilization, and Storage (CCUS) technologies are among the most critical technologies that can help the GCC achieve the goals of the Paris Agreement and avoid stranded assets. Several options for these technologies are already mature and could enable GCC economies to recycle greenhouse gas (GHG) emissions. For example, in Qatar, the use of CCUS is already a leading technology for decarbonizing LNG and is expected to play a significant role in the future. However, these technologies are not fully mature, and the direction of their future development remains uncertain. The GCC needs to be involved in determining the future technological development of these sensitive technologies. In fact, CO2 sequestration technologies can prolong the use of fossil fuels while contributing to the global effort to achieve net zero. The options for their development need to be tailored to the characteristics and specificities of the GCC. CCUS is technically and economically more suitable for industries characterized by high-purity CO2 streams, resulting from the ease of separating CO2 from other gases and impurities in flue gas streams.

New market opportunities in hydrogen export and CO2 storage services could generate between USD 15.5 billion and USD 44 billion in gross value added (GVA) for the GCC by 2050 and support between 87,300 and 245,400 jobs. Several GCC countries, particularly Saudi Arabia and Oman, have explored the use of CO2 for enhanced oil recovery. Some GCC countries have also initiated pilot projects and feasibility studies to assess the viability of CCS technologies. The UAE, for example, has shown interest in developing CCS projects, and discussions are underway on possible international cooperation to implement these technologies.

5.2. Green hydrogen

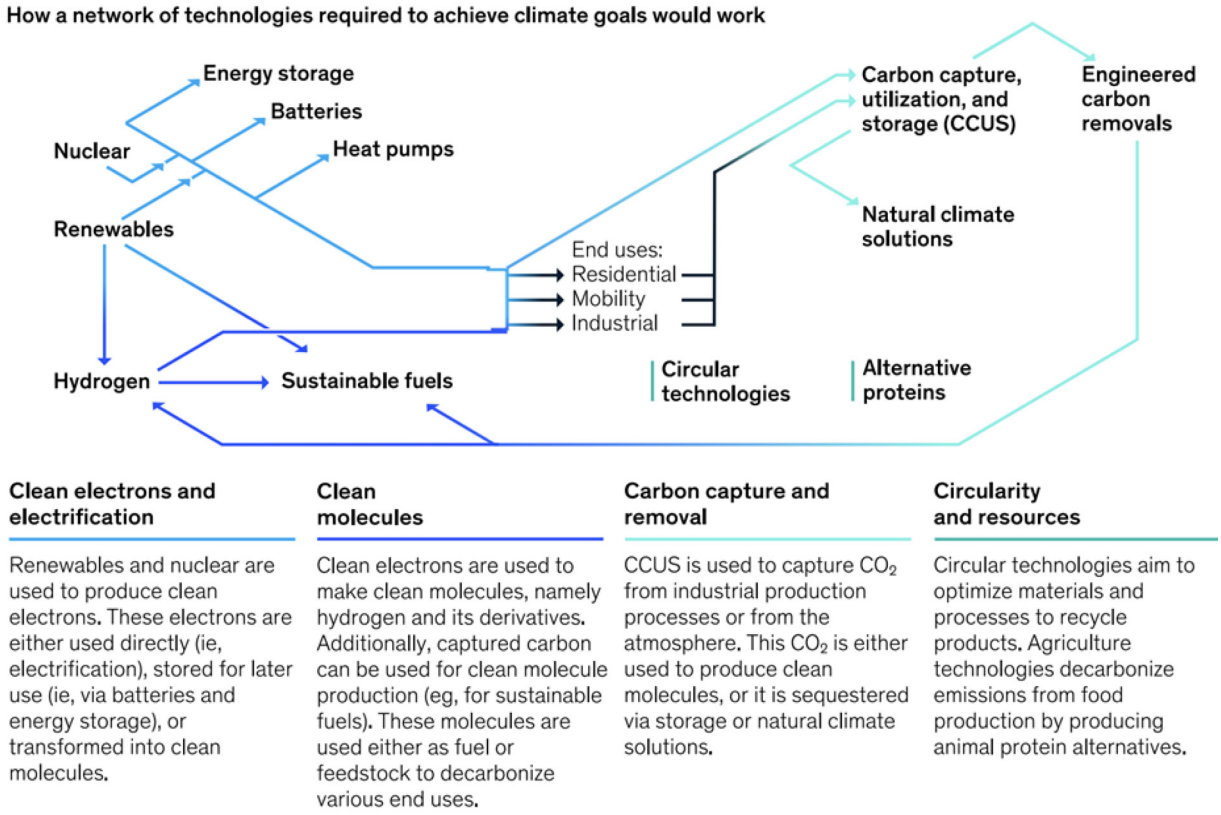
There is currently a consensus that alternative fuels can help the global economy achieve net-zero goals while allowing countries to maintain economic growth. One option for deeply decarbonizing industries like steel, cement, and chemicals—which presently contribute around 20 percent[11] of global emissions—is clean hydrogen, both low-carbon and renewable. Aircraft, ships, trucks, and other heavy-duty vehicles can be powered by hydrogen and its byproducts, including methanol and ammonia. Because hydrogen can store renewable energy as molecules and enable grid blending and long-distance transportation, it also makes the integration of renewable energies easier.[12]

[10] McKinsey (2023). Preview: What Would It Take to Scale Critical Climate Technologies?

[11] McKinsey (2023). Preview: What Would It Take to Scale Critical Climate Technologies?

[12] McKinsey (2023). Preview: What Would It Take to Scale Critical Climate Technologies?

Figure 3: Technologies for achieving climate goals



Source: McKinsey (2023).

While some countries are already producing and using hydrogen and ethanol, there is still considerable room for technological development.[13] These technologies are still in their infancy and the avenues for their development remain wide open. This situation presents an opportunity for GCC countries to contribute to the direction of technological development of these key technologies throughout their value chains.

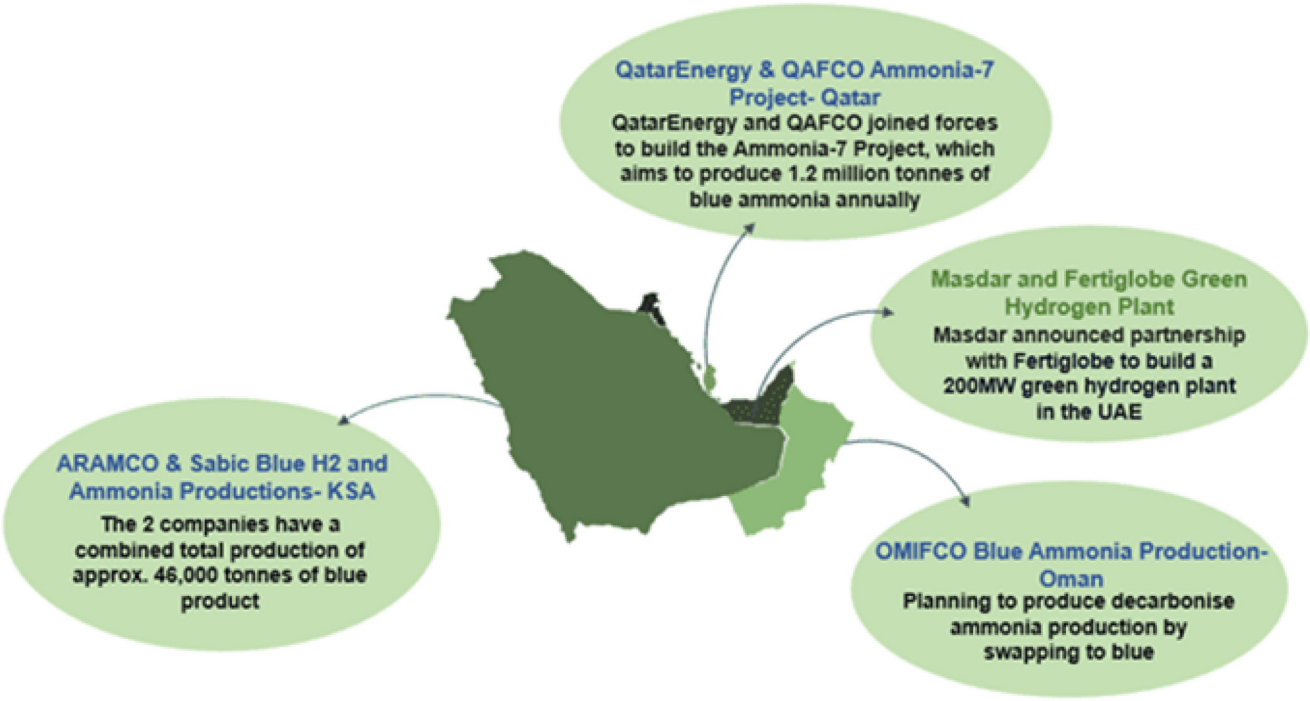
Hydrogen and ethanol offer promising prospects for GCC countries to diversify their energy sources, enhance energy security, and contribute to global climate change mitigation efforts. Green hydrogen in particular is set to play a significant role in a decarbonized future, especially in transportation and industrial processes, including industries with emission levels that are more difficult to reduce. While the current goal is to produce green hydrogen at a commercial scale by 2030, blue hydrogen will serve as an interim bridge. This transition is feasible, particularly in the GCC context. However, several financial and technological hurdles need to be overcome before a full transition to green hydrogen can take place.

However, the hydrogen strategy is not a pure win-win, since it requires energy to create it.[14] Companies claim their hydrogen production is clean, but this claim is questionable given that 95 percent of current hydrogen energy is derived from fracked gas. Only five percent of hydrogen, labeled as "green" hydrogen, is produced by splitting water molecules using renewable energy. Even if green hydrogen could be scaled up, it remains inefficient with fuel cells operating at only 30 percent efficiency compared to renewable-powered batteries at 80 percent, making hydrogen more expensive than renewable-based electricity. Additionally, hydrogen production is water-intensive, consuming at least 5,000 liters per megawatt-hour, far surpassing the water usage of solar and wind alternatives. Beyond economic and environmental concerns, hydrogen presents safety risks, being highly volatile and flammable, with incidents of explosions from hydrogen pipelines. The current storage of hydrogen as ammonia further raises safety issues due to its hazardous nature.

[13] Pal, A., Kakran, S., Kumar, A., Ben Youssef, A., Singh, U. P., & Sidhu, A. (2024). Powering Squarely Into the Future: A Strategic Analysis of Hydrogen Energy in Quad Nations. International Journal of Hydrogen Energy, 49, 16-41. https://doi.org/10.1016/j.ijhydene.2023.06.169

[14] https://www.foodandwaterwatch.org/2022/10/24/the-dirty-side-of-green-hydrogen/

Figure 4: Blue and green projects in the GCC



Source: GPCA research (2023).

5.3. Batteries

The net-zero scenario requires a new wave of electrification of economies. Technologies can help GCC countries in their energy transition (renewables and energy efficiency), maintain the option of using hydrocarbon assets, avoid the stranded asset hypothesis, and potentially benefit from other resources such as sands and rare earths (for batteries). Further, the petrochemical industry is diversified, and some of its products are crucial components for the energy transition, especially solar panels, wind turbine blades, thermal insulation, batteries, and other electric vehicle parts.[15] Battery electric vehicles relying on lithium-ion batteries benefit from high "tank to wheel" energy efficiency. Although emission reductions depend on the local power mix and the carbon emission footprint of the battery pack, which typically accounts for 40 to 60 percent[16] of upstream emissions of a battery EV, their embedded lifetime emissions are up to 85 percent lower than those of vehicles with internal combustion engines.

With rapid industrialization and urbanization in the GCC, energy consumption has increased. As a result, effective energy storage solutions are becoming increasingly important to manage peak demand and ensure a stable power supply. Lithium-ion batteries, with their high energy density and fast response times, can meet these needs. They improve overall energy security by enabling the grid to adapt to fluctuations in electricity supply and demand, thereby reducing the risk of blackouts.

The commitment to electric mobility in the GCC region is also driving the lithium-ion battery market. To combat air pollution and reduce greenhouse gas emissions, governments in the region are implementing policies and incentives to encourage the adoption of electric vehicles (EVs). The increasing sales of EVs and the growing demand for lithium-ion batteries for use in EVs and charging infrastructure represent a significant market opportunity. The expansion of the GCC lithium-ion battery market is being driven by collaborations between international technology companies, private sector players, and regional governments. These partnerships facilitate the transfer of knowledge, capital, and technology, spurring innovation and the development of advanced battery technologies better suited to the region's environmental conditions.

Batteries are critical to the success of the GCC's energy transition. By strategically investing in battery technologies, the GCC can not only achieve sustainable

[15] Al Moneef, M. (2023). The Saudi Economy in the Era of Global Energy Transition. The Third ERF GCC Conference KAPSARC, Riyadh 30-31 October 2023.

[16] McKinsey (2023). Preview: What Would It Take to Scale Critical Climate Technologies?

and diversified energy sources but also position itself as a global leader in the renewable energy and battery markets. A comprehensive approach that addresses environmental concerns, strengthens the supply chain, and promotes innovation will pave the way for a prosperous and sustainable future in the region.

6. Key messages and recommendations

6.1. Key messages

This policy brief aimed to gain a deeper understanding of the dynamics of technological change in the GCC energy sector, focusing on the nuances that distinguish the scope and direction of these advances. Five key findings are presented below.

First, the global economic context has a significant impact on the GCC, which needs to strengthen its economic and social resilience. Global crises, such as recessions, economic downturns, and the COVID-19 pandemic, have affected demand for oil and other commodities, thereby affecting GCC export revenues. Economic challenges facing key trading partners are also affecting the GCC's economic performance. In addition, the geopolitical landscape, including regional conflicts and tensions, affects the stability of GCC countries. Political instability in the region or disruptions to trade routes can have significant economic consequences.

Second, technology and innovation are accelerating, creating new opportunities and threats for the GCC. GCC countries are exploring AI and robotics in various sectors, including healthcare, finance, and manufacturing. AI applications range from chatbots and virtual assistants to more complex systems for data analysis and decision-making. Several GCC countries, such as the UAE and Saudi Arabia, are investing heavily in smart city initiatives, aiming to use technology to enhance urban life, improve infrastructure, and increase service efficiency.

Third, the scope of technological change is widening, with new actors and resources. Many GCC countries have launched ambitious national strategies and initiatives to diversify their economies and reduce their dependence on oil. These initiatives often involve significant investments in technology, innovation, and infrastructure development. Beyond the traditional sectors, there is a growing presence of new players, including startups, entrepreneurs, and technology companies that are contributing to the technological landscape with innovative solutions and driving digital transformation across industries.

Fourth, the direction of technological change is not neutral and requires defensive innovation. The direction of technological change can have both positive and negative impacts on environmental and energy transitions. It is crucial to consider the environmental impacts of new technologies and to implement policies and practices that promote sustainable and environmentally friendly solutions. Moreover, relying on technological innovation alone may not be sufficient; a holistic approach, including implementing regulatory measures, raising awareness, and promoting responsible consumption, is essential for a successful transition to a more sustainable future.

Fifth, there is a link between digital technologies and the green economy. From renewable energy solutions to smart infrastructure and sustainable manufacturing practices, technology plays a crucial role in shaping a more environmentally conscious and economically sustainable future. However, careful consideration of potential challenges and ethical implications is essential to ensure that technological advancements genuinely contribute to a greener and more equitable world. Harnessing the power of technology for environmental conservation will be paramount in achieving a harmonious balance between economic prosperity and ecological well-being as we navigate the complexities of the 21st century.

6.2. Policy implications

There are several policy implications.

First, the GCC needs to increase its investment in technology and innovation and take a leading role in shaping technology for their economies. Investing in technology and innovation ecosystems can stimulate entrepreneurship and the growth of startups. Supporting a vibrant startup culture, especially in the areas of green technology and energy transition, can lead to the development of new technologies and solutions that contribute to economic dynamism and the green transition.

Second, there is a need for GCC countries to build coalitions and initiate collaborations at various levels, including with groups such as the G77+China, GAFAM (Google, Apple, Facebook, Amazon, Microsoft), or BATX (Baidu, Alibaba, Tencent, Xiaomi), to advance green and energy transition efforts. Partnering with technology giants such as GAFAM and BATX can facilitate the transfer of green technologies and innovations, accelerating the adoption of sustainable practices in the GCC. This would, consequently, promote economic growth and environmental conservation.

Third, the transition to renewable energy-based desalination should be a crucial step for GCC countries to address environmental concerns, achieve economic benefits, and strategically position themselves as leaders in sustainable development. By embracing clean energy technologies, these nations can pave the way for a more resilient, secure, and environmentally conscious future. This shift not only aligns with global sustainability goals but also ensures the long-term prosperity of the GCC region.

Fourth, an increase in battery projects is critical as they are a key component of the energy transition over the next quarter century. Batteries help manage the intermittent nature of renewable energy sources such as solar and wind by storing excess energy when available and releasing it during periods of high demand or when renewable sources are not generating power.

Fifth, the GCC should embrace carbon capture technologies. CO2 sequestration technologies can have a significant impact on the future use of hydrocarbons and help avoid the scenario of stranded assets. The effectiveness of CO2 sequestration technologies in combating climate change depends on their widespread adoption and integration into global emission reduction strategies.

Sixth, nature-based solutions are essential because technology and innovation are part of the solution, but not the whole. Nature-based solutions often take advantage of ecosystem services such as carbon sequestration, water purification, and biodiversity conservation. These services are fundamental to maintaining a healthy and resilient environment.

ERF at a Glance: *The Economic Research Forum (ERF) is a regional network dedicated to promoting high-quality economic research for sustainable development in the Arab countries, Iran and Turkey. Established in 1993, ERF's core objectives are to build a strong research capacity in the region; to encourage the production of independent, high-quality research; and to disseminate research output to a wide and diverse audience. To achieve these objectives, ERF's portfolio of activities includes managing carefully selected regional research initiatives; providing training and mentoring to junior researchers; and disseminating the research findings through seminars, conferences and a variety of publications. The network is headquartered in Egypt but its affiliates come primarily from different countries in the region.*

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