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Carbon Emissions Reduction Strategies for Qatar

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INTRODUCTION

Understanding Qatar's Approach to Mitigating Carbon Emissions and Climate Change

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Recognizing the grave threat that climate change poses to people and the planet, the 2015 Paris Agreement, adopted at the United Nations Framework Convention on Climate Change's (UNFCCC) Conference of the Parties (COP21), set an overarching goal of limiting the increase in average global temperature to 1.5°C above pre-industrial levels. However, as greenhouse gas (GHG) emissions have continued to increase, this threshold will certainly be surpassed,[1] placing the world at greater risk of ecological crises and extreme weather events. Indeed, 2024 was the warmest year on record, with average global temperatures at around 1.55°C above pre-industrial levels.[2]

It will take a concerted and coordinated global effort to mitigate the potential negative impact of climate change, and Qatar has the potential to play a leading role on climate action. During the 1990s, Qatar pioneered the production and export of liquified natural gas (LNG), a transition fuel that is cleaner than coal and oil in terms of end use emissions. The gamble paid off, allowing natural gas to replace dirtier coal in many parts of the world and, in the process, helping Qatar become one of the world's wealthiest countries and placing it in a unique position to support global emissions reduction efforts.

Qatar's wealth paved the way for accelerated economic development. Between 1995 and 2015, Gross Domestic Product (GDP) increased from under 20 billion USD to over 160 billion USD (in constant 2015 US dollars) and its population quadrupled from 650,000 in 2000 to over 2.7 million by 2017.[3] However, this rapid growth and expansion had a downside; Qatar became one of the world's highest emitters of GHGs in per capita terms. That said, relative to GDP, Qatar's GHG emissions are lower than the average for all but one of the countries of the Gulf Cooperation Council (GCC).[4] Furthermore, as a small country, Qatar's contribution to global emissions is minimal, representing only 0.3 percent of the total.[5] Qatar is neither the source of the problem nor the core of a solution. Yet, it has committed to play its part.

Qatar's National Vision 2030 emphasizes the importance of balancing development needs with environmental protection, including through supporting international efforts to mitigate the impacts of climate change.[6]. In 2021, Qatar launched its National Climate Change Action Plan aimed at reducing greenhouse gas emissions by 25% (vs. business as usual) by 2030. The plan also identified 36 climate change adaptation measures and over 300 initiatives. In 2024, Qatar's Third National Development Strategy called for the scaling up of carbon capture technologies, the adoption of renewable energy (increasing existing capacity to 4-Gigawatt), and the introduction of energy consumption reduction and efficiency measures.[7]

Over the past two decades, Qatar has invested heavily in building its knowledge base and technical capacity to tackle environmental and climate change issues. The Qatar Environment and Energy Research Institute (QEERI) was established in 2010, the Ministry of Environment and Climate Change was established in 2021, and Earthna: Center for a Sustainable Future was established in 2022. Qatar also hosts the Global Carbon Council (GCC), the first international carbon credit program based in the Global South, established by the Gulf Organisation for Research and Development (GORD) in 2016.

Drawing on the wealth of local expertise, in September 2024, the Middle East Council on Global Affairs and Earthna: Center for a Sustainable Future organized a policy workshop to explore pragmatic approaches to carbon emissions mitigation and reduction that align with Qatar's National Vision 2030, its socio-economic context, and its environmental imperatives. The workshop brought together a group of scholars focused on studying emissions reduction

strategies to explore the policy implications of their research. A group of policy experts and advisors from the Ministry of Environment and Climate Change, Qatar Foundation, Al-Attiyah Foundation, and other institutions joined the discussion.

Following the workshop, several participants agreed to collaborate to publish a dossier focused on carbon emissions reductions strategies for Qatar. Twenty scholars joined this effort, producing a total of ten policy briefs, grouped into four sections.

Section 1 examines the interplay between carbon emissions reduction and Qatar's economy. It includes three chapters. The first, authored by Muez Ali, Abdalftah Hamed Ali, Gonzalo Castro de la Mata, and Alex Amato, discusses the role of Qatar's LNG exports in offsetting emissions globally. The second, by Dhabia M. Al-Mohannadi and Beverley Milton-Edwards, is on energy exports and the low carbon technology debate. The third, authored by Marcello Contestabile, Pankaj Kumar, Carlos Mendez and Maroua Benlahrech, outlines Qatar's pathways to decarbonization and economic diversification.

Section 2 examines carbon alternatives and low carbon technologies in Qatar. It includes four chapters: a chapter on the prospects for solar energy by Justin Dargin, a chapter on nuclear energy's role in decarbonization by S. Duygu Sever, a chapter on hydrogen's role as a catalyst for emissions reduction by Aisha Al-Sarihi, and a chapter on reducing carbon emissions from desalination by Deema Almasri and Mohammad Abu Hawash.

Finally, section 3 examines carbon markets. It includes a chapter on the role of carbon markets in the Paris Agreement and implications for Qatar by Alexandra Soezer, a chapter on carbon markets and emission reduction strategies for achieving net zero emissions in the Middle East and North Africa (MENA) region by Neeshad Shafi, and a chapter on carbon markets as a decarbonization pathway by Omer F. Agca and Ahmet F. Aysan.

Taken together, the dossier chapters explore a wide range of issues related to Qatar's emissions mitigation efforts. The dossier also highlights the progress being made and potential areas of exploration that policy actors in Qatar might pursue to help the country achieve its emissions reduction targets, thus fulfilling its part in global decarbonization efforts to mitigate the negative implications of climate change.

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SECTION ONE

Qatar's Economy and The Debate on Carbon Emissions Reduction

A picture shows the Ras Laffan Industrial City, Qatar's principal site for production of liquefied natural gas and gas-to-liquid, administrated by Qatar Petroleum, some 80 kilometers (50 miles) north of the capital Doha, on February 6, 2017. (Photo by KARIM JAAFAR / AFP)

Offsetting Emissions Through LNG Exports: Past and Future Trends

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Dr. Gonzalo Castro de la Mata is the executive director of Earthna, Qatar Foundation's sustainability center. Dr. Castro de la Mata is an ecologist recognized as a global leader in the promotion of sustainability, with emphasis on innovative free market solutions to environmental issues. As executive director of Earthna, he guides the center's mandate of enhancing Qatar's role within the global sustainability policy ecosystem. Prior to joining Qatar Foundation, Dr. Castro de la Mata was the managing director for External Affairs with Pluspetrol, the largest private gas and oil company in Latin America. From 2014 to 2018, he was the chairman of the World Bank's Inspection Panel in Washington, where he ensured compliance with the Bank's environmental and social standards. He has appeared in numerous publications in topics related to ecology, environment, mining, oil and gas, and sustainable development, and is a regular editorial contributor to El Comercio in Lima, Peru, and Diario Altavoz. He has published over 250 articles in scientific journals, magazines, and book chapters. He also authored two books.

Dr. Alex Amato is a Sustainability and Research Advisor at Earthna, with over 40 years' experience in the built environment. Since 1996, his research has largely focused on the application of Life Cycle Assessment (LCA), quantitatively assessing the environmental impact of buildings, construction systems, and products. Dr. Amato has worked in both the private and public sectors in the UK, Southeast Asia, and in the Middle East. He is currently the Head of Sustainability at the Qatar Green Building Council. Here, he has helped deliver an expanding research and education program. Dr. Amato's work covers a wide gamut, from design, to construction, product development and research. He has taught architectural design, construction technology, and sustainable construction in the faculty of Architecture and Real Estate and Construction, at the University of Hong Kong and wider afield in China, particularly the University of Chong Qing.

INTRODUCTION

Over the past two decades, natural gas has increasingly been adopted as a substitute for more carbon-intensive fuels. This, coupled with lower prices, technological development, and infrastructure expansion, has led to increased demand for natural gas, including liquified natural gas (LNG). These fuels are therefore expected to play a major role in the future of global energy systems. While some studies have indicated potential negative effects of increased use of natural gas, most of the evidence suggests that LNG produces lower greenhouse gas (GHG) emissions per unit of energy than other fossil fuels, such as coal and other heavy hydrocarbons.[1]

As a major exporter of LNG, Qatar has benefited from this global rise in demand, experiencing a 10-fold increase in GDP between 2000 and 2020.[2] Most of Qatar's LNG is exported to Asia, mainly South Korea, Japan and China, where it is primarily used in industry and power generation.[3]

This paper presents the findings of a research exercise that estimated the reductions in carbon dioxide (CO_2) emissions resulting from the use of Qatari LNG as a replacement for more carbon-intensive fuels in Qatar's export markets. The findings show that Qatar's LNG exports likely offset global emissions by 600 Metric tons of CO_2 ($MtCO_2$) between 2005 and 2020, equivalent to 40% of Qatar's domestic emissions during the same period. Yet while this demonstrates the historical contribution of Qatar's LNG to global decarbonization, the future may look different. The global shift away from coal in the power and industrial sectors may reduce the degree to which LNG can offset emissions. However, Qatar can continue to contribute to global decarbonization efforts in several other ways.

QATAR'S COMMITMENTS

In 2019, Qatar's total annual CO_2 emissions were 92 $MtCO_2$ and total GHG emissions (solid red line in Figure 1, Panel A) were 115 $MtCO_2$ equivalent ($MtCO_2e$). Between 2005 and 2019, Qatar's CO_2 and GHG emissions doubled, with an average year-on-year growth of 6.5% and 6.3%, respectively. A large percentage of Qatar's total GHG emissions are fugitive (unintended) emissions from the LNG production process. However, between 2005 to 2019, Qatar's non-CO_2 GHG emissions as a percentage of the total decreased from 22.5% to 19.9%, owing to efficiency gains and in line with state energy firm QatarEnergy's commitments to reduce emissions during the LNG production process.

In 2023, Qatar launched its National Climate Change Action Plan (NCCAP), which targets a 25% reduction in GHG emissions by 2030. In addition, QatarEnergy recently upgraded its sustainability strategy, strengthening its commitment to delivering cleaner LNG. The strategy outlines numerous initiatives to reduce GHG emissions, including deployment of carbon capture technology to capture over 11 $MtCO_2$ per year by 2035.[4] QatarEnergy also committed to driving the energy transition by expanding its LNG production capacity to 126 Mt per annum by 2027,[5] and in early 2024 announced plans of further increases in LNG production to 142 Mt by 2030.[6] The company is focused on achieving zero routine flaring by 2030, through investment in innovative technologies and maintenance procedures.

Over 90% of GHG emissions in Qatar are attributed to energy use (primarily for climate control in buildings due to the extremely hot climate) and the hydrocarbon sector. Reductions in GHG emissions in the LNG supply chain in Qatar will have a significant impact on the country's overall emissions. Some estimates indicate that LNG production accounts for almost half of the total.[7]

QATAR'S CONTRIBUTION TO GLOBAL DECARBONIZATION

Qatari LNG can be assumed to have replaced more carbon-intensive fossil fuels its export customers would otherwise have used, such as coal and oil. Using historical data, this section presents past scenarios in order to estimate the reduction in global GHG emissions that may be attributed to the increased use of LNG. It models a scenario under which Qatar's LNG disappears from the global fuel mix between 2005 and 2020, in order to estimate the contribution of Qatar's LNG exports to reductions in global CO_2 emissions. It then asks how these exports might contribute to future reductions in those emissions, if any.

Several scenarios are considered. In the first, Qatar's LNG is replaced by coal, which represents the highest possible variation from actual emissions (Upper Bound, Figure 1, Panel B), due to coal's much higher carbon intensity compared with LNG. In another, Qatar's LNG is replaced by other fuels in proportion to their existing share in the energy mix, reflecting the lowest possible reduction in emissions attributable to Qatar's LNG exports (Lower Bound, Figure 1, Panel B). This scenario, based on the actual energy mix in Qatar's LNG export markets, assumes the most efficient allocation of the different energy sources to satisfy demand. Another scenario, under which Qatar's LNG would be replaced with LNG from other exporters, would require a 75% annual increase in production by other exporting countries. Therefore, this scenario is not considered here.

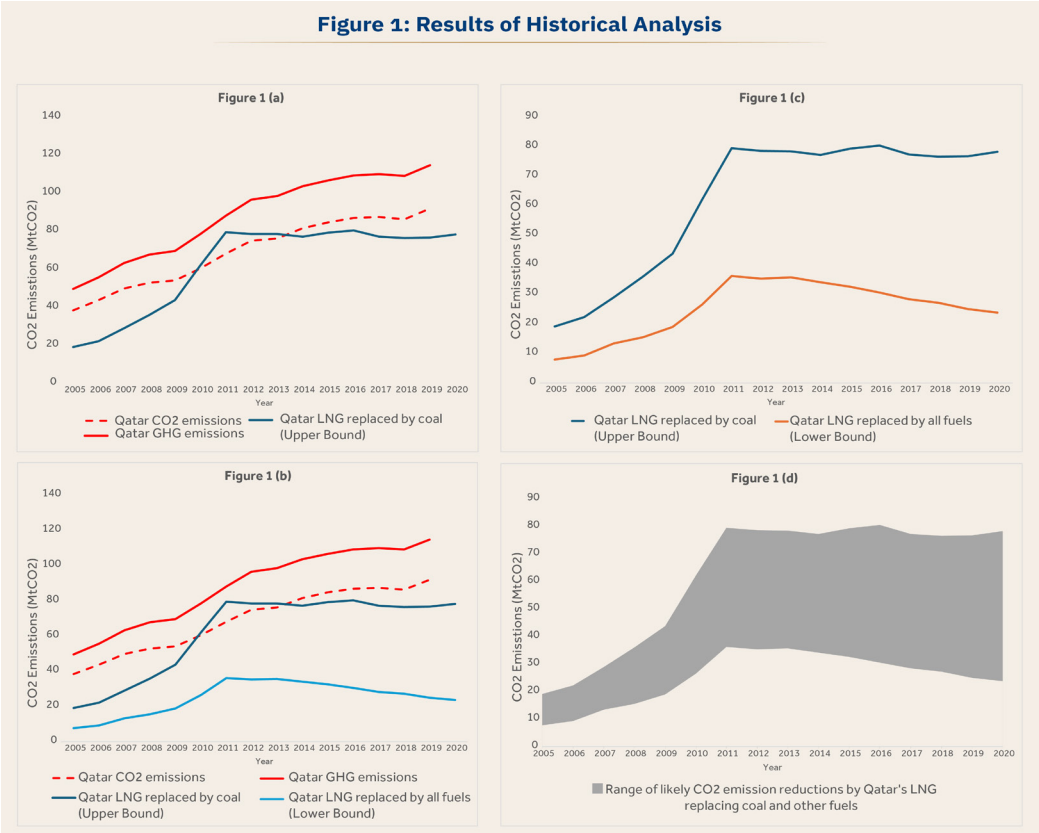
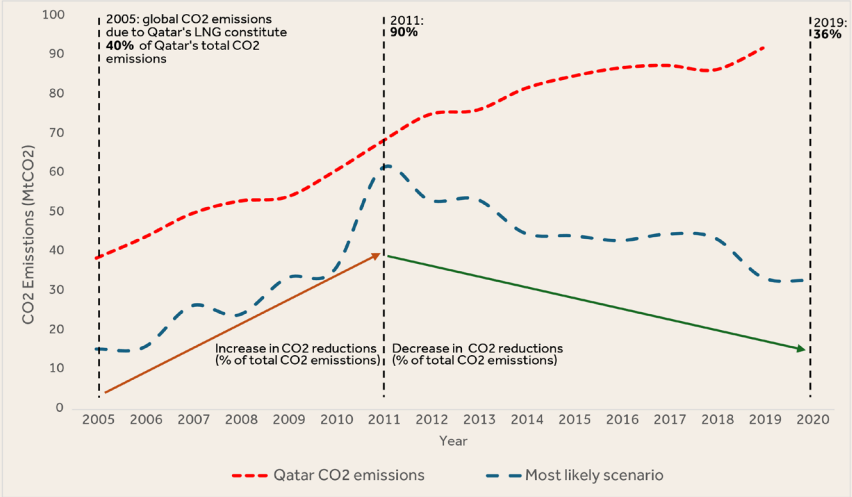


Figure 1.
Results of historical analysis: (a) Total reductions in global CO2 emissions attributable to Qatar's LNG exports if coal had been used instead; (b) total reductions in global CO2 emissions by Qatar's LNG exports compared to the use of coal (dark blue line) or proportional use of the existing energy mix (light blue line); (c) the identified Upper and Lower Bounds of global CO2 emission reductions due to Qatar's LNG exports; (d) the range of likely global CO2 emission reductions due to Qatar's LNG exports replacing coal and other fuels.

The "most likely" scenario is inferred from the Upper and Lower Bounds. Under this scenario, whether coal replaces Qatari LNG (Scenario 1) or all fuels do so proportionally (Scenario 2) depends on the share of coal in the energy mix and the increase in coal usage relative to the growth of total consumption. As a result, the most likely reduction in global CO_2 emissions due to Qatar's LNG exports lies somewhere between the Upper and Lower Bounds. Figure 2 shows the reduction in CO_2 emissions under this scenario (dotted blue line) relative to Qatar's domestic CO_2 emissions.

Figure 2: Contributions to global emissions reductions due to Qatar's LNG exports, 2005 to 2020.



Under this scenario, global CO_2 reductions due to Qatar's LNG exports are equivalent to 40% of Qatar's local CO_2 emissions in 2005 (Figure 2), peaking at 90% in 2011, when both the share of coal in the energy mix in export markets and the growth rate of coal consumption were high. Reductions in CO_2 emissions then decrease gradually after 2011. Consequently, by 2019, the reduction in global CO_2 emissions attributed to Qatar's LNG exports would be equivalent to 36% of local annual emissions. Between 2005 and 2020, this scenario predicts a cumulative reduction in global CO_2 emissions due to Qatar's LNG exports amounting to 605 $MtCO_2$.

Between 2005 and 2011, the increase in reductions can be attributed to increases in coal consumption globally, meaning more hypothetical coal usage was instead offset by Qatar's LNG exports. After 2011, the decrease in reductions, whether absolute or relative to local emissions, can be attributed to two factors: a fall in global coal consumption – and therefore less coal to be replaced – and an increase in local CO_2 emissions in Qatar.

POLICY IMPLICATIONS

Based on the "most likely" scenario, such reductions beyond 2020 are likely to decrease through to 2040. Assuming a business-as-usual scenario for Qatar's local emissions between 2020 and 2040, reductions in global CO_2 emissions as a percentage of local emissions decreases faster than for the period between 2011 and 2020. This is primarily due to a consistent decline in global coal consumption, amounting on average to 5.2% annually between 2020 and 2040. Lower coal consumption globally means that Qatar's LNG exports are more likely to be replacing less carbon-intensive fuels and technologies. Leading up to 2040, given the increase in the adoption of renewable energy globally, Qatar's LNG exports are likely to increase, rather than decrease, global CO_2 emissions.

Consequently, to ensure that Qatar continues to contribute to reductions in global CO_2 emissions while offsetting its domestic emissions, several options may be considered. First, it is important to prioritize local emission reductions through energy efficiency measures that increase buildings' energy efficiency, and by raising public awareness about efficient energy use. Second, Qatar can target the transport sector, through fossil fuel subsidy reforms and promotion of electric vehicles. Third, the government could institute import regulations on energy-intensive goods and services, and adopt circular economy principles across multiple sectors, to incentivize sustainable production and consumption.

A more targeted export strategy that ensures that Qatar's LNG continues to displace coal and other carbon-intensive fuels in its export markets could also help ensure LNG contributes positively to global decarbonization efforts. Exporting to countries with a high share of coal and other carbon-intensive fuels in their energy mix would maximize the net impact of LNG in reducing global GHG emissions. In addition, diversifying Qatar's energy services portfolio to include renewable energy in previously untapped markets could contribute to green growth abroad.

Many developing countries need, and can accommodate, decentralized energy solutions. Unlike hydrocarbons, renewable energy is not heavily dependent on one specific type of infrastructure. While most developing countries lack the financial capacity to expand existing grids to increase the supply of electricity, Qatar is in a unique position to support the expansion of energy access.

Finally, exploring new markets where Qatari LNG could replace more carbon-intensive fossil fuels would simultaneously open up commercial opportunities. Many developing countries, especially in Sub-Saharan Africa, do not possess the necessary infrastructure to import LNG. For example, in 2021 Ghana was the first country in Sub-Saharan Africa – and second on the entire continent, after Egypt in 2015 – to start importing LNG.[8] Developing countries will continue to rely on their existing infrastructure, which was designed around, and continues to cater to, more carbon-intensive fossil fuels. For example, many of the countries in Southern Africa rely on coal imports from South Africa. Developing LNG infrastructure in a select number of developing countries could increase demand for LNG while simultaneously reduce reliance on more carbon-intensive fossil fuels.

CONCLUSION

The substitution of coal and other carbon-intensive fuels by Qatar's LNG exports has historically contributed to reductions in global CO_2 emissions. Between 2005 and 2020, these cuts amounted to around 605 $MtCO_2$, the equivalent to more than three years' worth of emissions in a middle-income country such as Peru. However, such reductions peaked when coal demand was highest in 2011 and have since declined. This decline is likely to continue until 2040, as the world moves away from coal and other hydrocarbons towards cleaner fuels and technologies. It is, therefore, unlikely that global reductions in emissions due to Qatar's LNG exports will increase again.

To ensure that Qatar's contributions to global carbon reduction efforts continue into the future, there are several pathways to consider. First, local emissions could be reduced through energy efficiency measures, fossil fuel subsidy reforms, and the adoption of circular economy principles. Second, an export strategy that targets countries with a high share of coal in their energy mix could ensure that LNG contributes positively to global decarbonization efforts. Third, investing in energy infrastructure in new export markets with future growth prospects, particularly in energy-poor Sub-Saharan African countries, could support a transition away from carbon-intensive fuels and increase access to energy for vulnerable populations.

DISCLAIMER:

This policy brief is based on the working paper Ali, M. et al., *Historical and Future Global Emissions Reductions due to Qatar's LNG Exports*, ERF Working Paper Series, No. 1702 (Cairo, Egypt: Economic Research Forum, 2024), https://erf.org.eg/publications/historical-and-future-global-emissions-reductions-due-to-qatars-lng-exports/

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Qatar, Energy Exports and the Low Carbon Technology Debate

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INTRODUCTION

The debate around energy production and low carbon technologies is of vital importance to Qatar, for two reasons. Firstly, on the domestic front, low carbon technologies can contribute to wider national strategies for tackling the challenges Qatar faces in terms of energy security, economic diversification and climate change. Secondly, Qatar's role as a key player in the global energy market and as a leading exporter of liquefied natural gas (LNG) means it will be impacted by the rise of low carbon technologies. This chapter analyzes the role of low carbon technologies in Qatar's domestic and foreign policies.

AN ENERGY-LED ECONOMY AND CLIMATE CHANGE

Qatar's contemporary state-building, nation-branding, and independence have all been symbiotically tied to energy production and the export revenues accrued to state coffers through sales of fossil fuels. Furthermore, Qatar has historically depended almost entirely on carbon-heavy oil and natural gas for its domestic energy needs. With the rapid development of infrastructure in this urbanizing, climate-challenged city-state, Qatar's decision-makers have had to prioritize meeting the demands of domestic energy consumption. Qatar ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1996 and signed the Kyoto Protocol in 2005. In 2008, the government launched Qatar National Vision 2030, which outlined a series of ambitions for the country's future, covering economic diversification, environmental protection, and sustainable development. The document also outlined technological advances in the area of energy production, as well as proactive policies for mitigating climate change.

In 2012, Qatar hosted the UN's 18th climate change conference (COP18), gathering over 20,000 delegates to discuss climate action. In 2016, Doha signed and subsequently ratified the Paris Agreement, the results of which can be seen on multiple levels. In 2019, the Emir of Qatar pledged $100 million to support small and developing nations in tackling climate change. The subsequent National Climate Change Plan, approved in 2021, set out a strategic framework for Qatar's sustainability goals, aiming to reduce the country's carbon footprint by 25% while balancing its role as a significant LNG producer.[1]

Qatar aims to meet its global climate commitments, prepare for future low carbon energy importers, and secure reliable, long-term contracts for its natural gas exports. Natural gas is viewed by many as a transitional fuel that can bridge the gap between traditional fossil fuels and renewable energy sources. It is less carbon-intensive than other fossil fuels, making it an important component of Qatar's strategic goals of maintaining energy export reliability while reducing emissions. The regularization of the annual National Climate Change Dialogue (organized in partnership with international actors including Germany), as well as wider state-led initiatives and innovation on low carbon technologies have proved important for bolstering Qatar's domestic energy resilience.

The increasing focus on decarbonization and emerging technologies has prompted Qatar to adopt cleaner energy sources, implement mitigation measures, and diversify its energy portfolio. Qatar's transition involves expanding its traditional and clean energy offerings while gradually adopting renewables and launching energy efficiency initiatives, as well as investing in research and new technologies that will enable the transition away from hydrocarbons.

To meet local energy demand, Qatar is not only investing in new energy sources but also in energy and water efficiency, and the electrification of local transport. Energy efficiency is being promoted through the Tarsheed program,[2] an energy efficiency initiative aimed at reducing consumption across all sectors, including residential, commercial, and industrial. At the same time, electric vehicles (EVs) are part of the strategy to reduce local carbon emissions.[3] The country has announced an ambitious plan to increase the adoption of electric vehicles, supported by a network of charging stations to cut emissions from the transport sector.

At the same time, Qatar's North Field—the world's largest natural gas field—is undergoing a significant expansion to dramatically increase production capacity. This ambitious development will not only strengthen Qatar's export capabilities but also restore its position as the world's leading producer of LNG, a status held by the United States in recent years. The expansion project is part of Qatar's long-term strategy to secure energy market dominance and meet growing global demand for cleaner energy. To achieve this, state hydrocarbons firm QatarEnergy has formed partnerships with several international energy majors, including ExxonMobil (U.S.), Total Energies (France), Shell (United Kingdom / Netherlands), ConocoPhillips (U.S.), Eni (Italy), Chevron (U.S.), China National Petroleum Corporation (China), China Petroleum & Chemical Corporation or Sinopec (China), and Korea Gas Corporation or KOGAS (South Korea).[4] These partnerships reflect the global nature of the energy industry itself and Qatar's central role as a supplier.

The LNG expansion could also help further enhance regional energy security. Gulf, including GCC energy and climate dialogues, are increasingly focused on the part that LNG can play in energy security, resilience, integration and meeting the challenge of climate change. It has already been demonstrated that Qatar's abundant natural gas reserves and proactive GCC energy strategies make a difference. This is already seen with deals with Kuwait, the UAE and Oman in the Dolphin project.[5]

QATAR'S APPROACH TO NEW TECHNOLOGIES

While LNG is at the heart of Qatar's energy strategy, emerging technologies such as Small Modular Nuclear Reactors (SMRs), e-fuels, hydrogen, and electrification could disrupt Qatar's LNG market by offering cleaner, competitive alternatives. SMRs, which are gaining traction in energy-intensive countries in Asia and Europe, provide flexible, low carbon power generation.[6]

Qatar's energy partners and allies, such as Japan, South Korea, and France, which already use nuclear energy, are exploring SMRs as a strategic alternative, potentially reducing LNG imports for power generation. E-fuels—synthetic fuels derived from hydrogen and carbon dioxide—offer carbon-neutral solutions for sectors such as aviation and shipping, appealing to industries that have traditionally relied on LNG.[7]

Hydrogen, especially "green" or "pink" hydrogen, is a versatile, zero-emission fuel that could gradually replace LNG in power generation and industrial processes as infrastructure and costs of production improve. This could be coupled with a move to renewables such as wind, hydropower, geothermal and solar power (green hydrogen) as well as nuclear power (pink hydrogen). Other emerging technologies such as carbon pyrolysis offer a way to produce hydrogen from natural gas without CO_2 emissions, potentially transforming LNG into a low-carbon resource.[8]

To reduce industrial emissions, Qatar relies on carbon capture, utilization, and storage (CCS) to cut emissions from natural gas production. The country is now also leveraging its expertise in natural gas production to become a leader in the hydrogen market through investments in blue ammonia, which is an efficient medium for transporting hydrogen, can be used as a clean fuel, and aligns with global efforts to build a hydrogen economy.[9]

Qatar has also made substantial domestic investments in renewable energy projects, with a particular focus on solar power. QatarEnergy has announced the construction of several solar power plants, including the Al Kharsaah solar power plant, with a capacity of 800 megawatts (MW), as well as the industrial cities solar power project, with a combined capacity of 875 MW, and the Dukhan solar power plant with a capacity of 2 gigawatts (GW). These investments reflect Qatar's commitment to renewable energy and to reaching a total renewable energy capacity of 4 GW by the end of the decade[10].

Despite this, Qatar remains one of the highest per capita emitters of greenhouse gases in the world, due to emissions from its hydrocarbon industry and its reliance on electricity for cooling and desalination. Industrial processes, including cement, steel, and petrochemical production, also contribute significantly to emissions, both due to fuel combustion and chemical reactions during the production process. The transport sector, including both public and private vehicles, add to emissions, though its impact has been smaller compared to energy and industry. Emissions from residential and commercial sectors are mainly linked to high electricity consumption, especially for air conditioning.[11]

Qatar has introduced a series of mitigation and transition strategies to address this challenge. For example, the Qatar Research, Development, and Innovation (QRDI) Council has prioritized developing long-term low carbon technologies, efforts that are essential to overcoming technical challenges and ensuring Qatar's position in the global energy transition. Also, while the main mandate of Qatar Investment Authority (QIA) is to diversify Qatar's economy and reduce dependence on hydrocarbons both at home and abroad, its portfolio is also demonstrating the country's investment and strategic interest in low carbon technologies. This includes investing in renewables abroad, such as large-scale renewable energy partnerships in Africa and MENA. QIA is also investing in foreign companies working on battery technologies that are crucial for energy storage.

THE GEOPOLITICS OF ENERGY AND LOW-CARBON TECHNOLOGIES

Today, many energy-producing nations are struggling with the challenges posed by global approaches that prioritize energy security and low carbon technology. Qatar, however, appears to have been proactive in understanding the important strategic and global dimensions of such policies. For example, it demonstrated global leadership in 2023 when it hosted the UN Conference on the Least Developed Countries (LDC5) and has spotlighted issues of climate change and the need for financing and development of low carbon technologies. The LDC5 conference itself adopted the earlier Doha Programme of Action (DPoA)[12] that had also addressed the growing challenge of energy security and how to harness low carbon technologies. Qatar pledged $60 million to implement the DPoA and help build resilience in the LDCs.

Qatar accrues certain power attributes from the geostrategic realities that delimit its role as a small state yet as a significant producer and exporter of LNG. The primary international dimensions of such power attributes can be seen in the relative autonomy and independence of its foreign policy agenda, decision-making, and resourcing. Over the past decade, this has allowed Qatar's leaders to weather a regional blockade, host one of the biggest and most prestigious sporting events in the world—the 2022 FIFA Men's World Cup—and adhere to its constitutional commitments to employ foreign policy not just for national interests, but also to uphold the rules-based international order and play a vital role as peacemaker.

This last point is now evident in Qatar's unrivalled global record of mediation not just in the Middle East, but other regions including Europe and South America.[13] Additionally, the recognition of Qatar's neutrality, balance, and dependability has even encouraged great powers such as the U.S. and Russia to rely on Qatar's mediation for the negotiation of some of the thorniest disputes.

POLICY OUTLOOK

Throughout the past decade, Qatar's decision-makers have oriented its national and foreign policy towards proactive decision-making on energy (including low carbon technologies). A strong nexus has developed between national strategies that address the economy, diversification, and financing for research and innovation—as well as the energy sector, climate and environment policy. Qatar is demonstrating that it can, as former Minister of State for International Cooperation Lolwah Rashid Al Khater asserts, "reconcile multiple priorities, from economic growth to environmental management to human and social development... especially against a backdrop of increasing local and global demand for energy.[14]

However, policymakers in this small state, which faces the increasing challenges of desertification, rising temperatures and sea levels, and other climate change and environmental stressors, understand that they cannot go it alone. Low-carbon technologies have played their part in Qatar's success, and this role may well increase. There is some concern that the adoption of renewable energy has been slower than expected, which does not chime well with Qatar's broader national development and branding ambitions.

Globally, buyers of Qatar's energy are at different stages of their energy transitions. Europe has accelerated its transition to renewable energy, focusing on wind, solar, and hydro power as part of its climate goals. The 2022 energy crisis highlighted Europe's dependence on imported gas, particularly from Russia, pushing for diversification efforts, increased LNG imports outside of Europe, and renewables projects.[15] Russia, meanwhile, has shifted its oil and gas exports towards Asian markets such as China and India, where fossil fuels remain dominant—notably China's appetite for coal. LNG is increasingly popular in these countries, as well as Japan and South Korea. All four are diversifying their supplies and investing in renewable energy and alternatives.[16] China leads the world in terms of renewable energy capacity.[17] Japan, on the other hand, is re-examining the potential of nuclear power, a decade after the Fukushima disaster.[18]

CONCLUSION

Economic, technological, and political factors will all play a role in determining the pace of Qatar's energy transition. The high cost of scaling up technologies like hydrogen production and carbon capture creates another bottleneck. These technologies require significant investments in research and infrastructure, and Qatar must continue to innovate to overcome these barriers. At the same time, it needs to stay ahead by investing in emerging technologies and fostering international partnerships.

Nevertheless, domestic initiatives have already had a positive impact by steering new approaches to low carbon technology across Qatar's entire industrial and production sector. In investment terms, this is seen as further enhancing Qatar's national reputation for reliability, stability and innovation in a region that is far from stable. For example, it is implementing a policy that focuses on revenue, profitability and price stability, not just for itself, but the rest of the world as it transitions.

Qatar has also demonstrated its willingness not only to direct resources towards this endeavor, but also to build the capacity to propel a dynamic and diverse approach to its national energy sector, even as it supports and invests in low carbon alternatives for countries that are more heavily impacted by climate change (such as small island developing states). Taken together, these policies mean the future looks a little bit greener for this small desert country and other climate-affected countries.

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Pathways to Decarbonisation and Economic Diversification in Qatar

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THE CHALLENGES OF CLIMATE CHANGE MITIGATION AND ECONOMIC DIVERSIFICATION IN QATAR

Qatar is a high-income, resource-rich country, with an economy based around the exploitation of its vast fossil fuel reserves, particularly natural gas. As a result of the development of liquefied natural gas (LNG) and other fossil fuel-intensive industries that started in the 1990s, Qatar's Gross Domestic Product (GDP) grew from $18bn to $236bn (in 2024 USD) between the years 2000 and 2022 (i.e.: more than ten-fold).[1] This exceptional growth has enabled the country to achieve rapid societal development and attain high standards of living for its citizens. However, Qatar's dependence on fossil fuel export revenues has made it vulnerable to fossil fuel price fluctuations in the short term and, in the longer term, to the growing international pressure around moving away from fossil fuels.[2] Moreover, the economic model of Qatar, dominated as it is by extractive and energy-intensive industries, is associated with high levels of emissions of greenhouse gases (GHGs) and pollutants, the latter significantly affecting the quality of Qatar's environment.

The pressures put on Qatar's current economic model by global climate change and other environmental issues were explicitly acknowledged by the government of the State of Qatar as far back as 2008, when the Qatar National Vision 2030 (QNV2030) was launched.[3] QNV2030 called for the development of strategies to diversify Qatar's economy and transform it into a more sustainable, knowledge-based economy while protecting the environment. The implementation of the vision set out in QNV2030 is articulated in the three successive National Development Strategies (NDS) that were released since; these are documents outlining specific actions that the State of Qatar is committing to on its journey towards realizing QNV2030.

Since 2008, the State of Qatar has made substantial efforts to diversify away from hydrocarbon exports and fossil fuel-intensive industries and to protect the environment. Qatar's commitment to global climate action was already apparent in 2012, when it hosted the 18th Session of the Conference of Parties (COP18). In 2016, Qatar became a signatory to the Paris Agreement and in 2021 it submitted to the United Nations Framework Convention on Climate Change (UNFCCC) its updated Nationally Determined Contribution (NDC),[4] which for the first time includes quantitative GHG emission reduction targets. In particular, the NDC commits the State of Qatar to reducing its GHG emissions by 25% by 2030, relative to a baseline scenario where no new GHG mitigation measures are introduced after year 2019. Later in 2021, the Qatari government also released its first National Climate Change Action Plan (NCCAP).[5] a document detailing a set of measures that will be undertaken to deliver the GHG mitigation targets of the updated NDC.

In 2024, the third and last National Development Strategy (NDS3)[6] was released, which outlines a strategy and specific actions to complete the delivery of QNV2030. NDS3 clearly acknowledges that, despite the substantial efforts made so far, Qatar's economy has largely failed to diversify and has remained substantially reliant on its fossil fuel and energy intensive industries. For this reason, NDS3 calls for renewed efforts to expand existing industries outside oil and gas and create new ones. In this regard, NDS3 is more specific than the previous development strategies in that it identifies three priority industries that Qatar will focus on: manufacturing, logistics and tourism. These industries, in the plans of policymakers, are expected to drive faster economic growth, for which NDS3 sets a 4% annual

GDP growth target, higher than the previous target of 3%. NDS3 also addresses the issues of protecting the local environment and mitigating GHG emissions, for which it refers to the measures outlined in the NCCAP. Lastly, NDS3 calls for renewed efforts to foster innovation, which is critical to both the creation of a knowledge-based economy and the sustained competitiveness of the domestic industries.

It is however important to note that, *ceteris paribus*, faster economic growth means increased GHG emissions. Therefore, additional measures will be required to achieve the 25% GHG by 2030 compared to those indicated in the NCCAP, and even more beyond 2030 when the impact of the faster growth on GHG emissions will become gradually more substantial. The type of measures needed will clearly depend on the sectors where the additional GHG emissions will come from. As a result, long-term GHG mitigation strategies and infrastructure planning will need to be robust under the uncertainty that changes to the structure of Qatar's economy will bring.

ASSESSING THE INTERPLAY BETWEEN ECONOMIC DIVERSIFICATION AND GHG MITIGATION

To assess the long-term impacts that different economic diversification trajectories may have on Qatar's GHG mitigation efforts and derive policy-relevant insights, we have used Qatar TIMES. This is a computer model of Qatar's energy systems, developed at the Qatar Environment & Energy Research Institute (QEERI) in collaboration with Imperial College London and Kahramaa, funded by the Qatar National Research Fund (QNRF), grant NPRP13S-0204-200250, and with support from Earthna and the Al-Attiyah Foundation. Qatar TIMES is a tool built specifically for Qatar using the TIMES modelling framework,[7] which was originally developed at the International Energy Agency (IEA) and is used by many governments of both developed and developing countries to conduct analysis to inform their energy-environmental policies.[8] Qatar TIMES can identify cost-effective technology pathways to achieve long-term GHG mitigation targets and, working backwards from these using an approach known as back-casting, explore the policies that would be required to enable those pathways.

In our study of GHG mitigation policy in Qatar using Qatar TIMES, we have defined and explored three GHG emissions mitigation scenarios: baseline, NDC and Paris-compatible (PC). These are described in Table 1. We have also tested their sensitivity to different ways in which the structure of the economy may evolve as a result of government efforts to diversify it; to do so, we have considered three scenario variants: NDC baseline, NDS3 manufacturing-led (MF), and NDS3 service-led (SER). These scenarios are described in Table 1.

The rationale behind having two NDS3 variants is that, while NDS3 clearly identifies the three industries previously mentioned – manufacturing, logistics and services – as the ones to prioritize, the measures to support them are yet to be designed and these will have a strong influence on the extent and rate at which each industry develops.

Table 1: GHG mitigation scenarios (left) and economic growth variants (right) modelled with Qatar TIMES

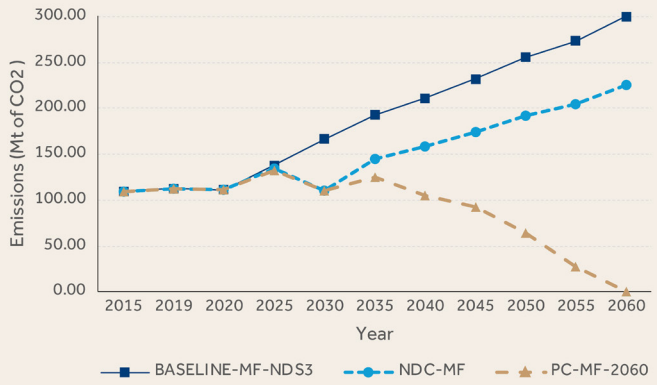
Modeled GHG Mitigation Scenarios	Scenario Description	Modeled Economic Growth Variants	Variant Description
Baseline	No new mitigation measures introduced passed year 2019	NDC baseline economic growth	3%GDP growth to 2060
NDC	25% GHG emission reduction relative to baseline from 2030 to 2060	NDS3 economic growth manufacturing-led	4% growth for industry sector to 2035; 3% growth from then to 2060. 3% growth in all other sectors.
Paris Compatible	25% GHG emission reduction relative to baseline by 2030. From 2030 to 2060 linear GHG emission reduction, reaching carbon neutrality in 2060	NDS3 economic growth manufacturing-led	4% growth for service sector to 2035; 3% growth from then to 2060. 3% growth in all other sectors.

Qatar TIMES uses exogenous scenarios for energy service demand across all sectors of the economy over the time horizon considered, which extends to the year 2060. Energy services, such as lighting and cooling of buildings, transport of passengers and freight, and high-grade heat for industry are inputs to the production of goods and services; hence, demand for energy services is linked with the country's GDP. Demand for specific energy services also depends on the structure of the economy. Therefore, by using specific energy service demand scenarios as an input to Qatar TIMES, we can test the impact of different economic growth and diversification trajectories on the evolution of the energy system and on the technologies needed to reduce its GHG emissions.

As for the three GHG mitigation scenarios modelled, the baseline scenario has no quantitative GHG emission reduction target. In the NDC scenario, we apply the GHG mitigation target of 25% by 2030 relative to the baseline scenario as in the updated NDC of 2021 and we extend it to 2060; this is of course not in line with the requirements of the Paris Agreement, which calls for gradually tightening GHG emission targets, and can therefore be considered as a worst-case scenario for climate action in Qatar. Lastly, the Paris-compatible scenario is one where ambition steadily increases: starting from the 25% target for 2030, GHG emissions are further constrained in the following decades until carbon neutrality is eventually reached. The GHG emission profiles associated with the 3 scenarios are illustrated in Figure 1.

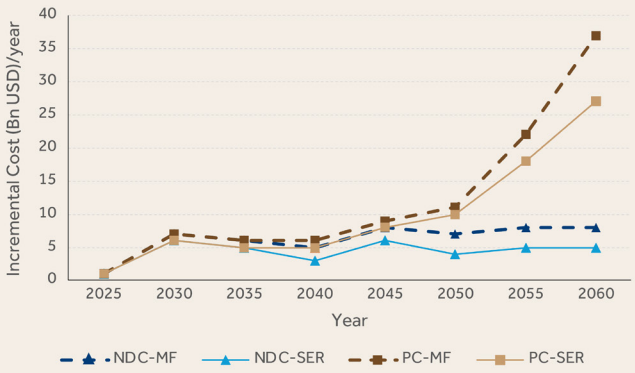
In the NDC scenario, the majority of the required GHG emission reductions can be achieved through measures targeting the oil and gas industry and the manufacturing sector, in a way that does not significantly differ from the measures indicated in the NCCAP for the year 2030. However, putting Qatar on a path to carbon neutrality requires a very different approach, where decisive action needs to be taken to reduce emissions from all sectors simultaneously; this requires deploying a much more comprehensive and aggressive set of measures.

Figure 1: GHG emission trajectories associated with the three scenarios modelled: Baseline, NDC and Paris-compatible



The two economic diversification variants considered, namely manufacturing-led growth and service-led growth, are characterized by different energy demand levels. Manufacturing chemicals and metals is more energy-intensive than the provision of services and also requires different types of energy services, such as high-grade heat and heavy goods transport, as opposed to lighting and cooling of commercial buildings and transport of passengers (which are needed for the services sector). When testing these scenario variants using Qatar TIMES, we find that mitigation costs are very sensitive to uncertainty around future economic diversification pathways: relatively minor changes in the structure of the economy can result in substantially different GHG mitigation costs. This is illustrated in Figure 2.

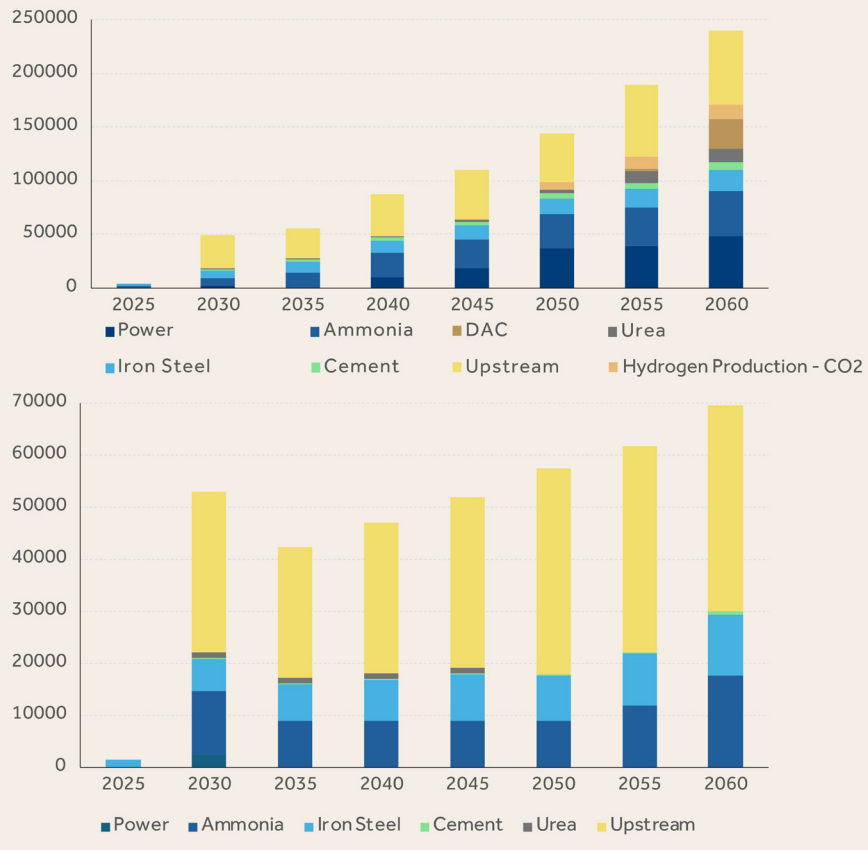
Figure 2: Costs of GHG emissions mitigation, relative to the baseline scenario, for the NDC and Paris-compatible scenarios and theirsensitivity to different economic diversification trajectories (manufacturing-led and service-led)



As is apparent from Figure 2, the effect of different future economic diversification trajectories on GHG mitigation costs also varies over time. This is especially the case for the Paris-compatible scenario, where in the long run, the cost of abatement in the manufacturing-led variant grows significantly higher than in the case of the service-led variant. This is mainly because emissions from energy-intensive manufacturing are harder to abate, which will eventually require the use of more expensive technologies, including Direct Air Capture (DAC), to achieve carbon neutrality. It is important to note that the higher GHG mitigation costs associated with manufacturing-led growth is not in itself an indication that this economic diversification approach is less advantageous for the country. However, the higher investment costs associated with mitigating emissions from manufacturing will require adequate budgeting.

Moreover, assuming large-scale deployment of solar PV capacity but no other form of renewable or low carbon energy (such as wind or nuclear power), no major new energy efficiency measures in buildings, and no major shift in modes of transport, the pathway to achieving carbon neutrality in Qatar will rely very heavily on the deployment of Carbon Capture, Utilization, and Storage (CCUS). In the case of industry-led growth, the need for CCUS will be substantially higher than in the case of service-led growth, which also needs to be considered for planning purposes. Figure 3 compares the CCUS requirement for the NDC and Paris-compatible scenarios, in the case of the industry-led variant. It is apparent that, under the circumstances described above, the need for the CCUS is quite substantial even in the NDC scenario and grows several times more in the case of the Paris-compatible scenario.

Figure 3: CO2 capture volumes (Mt/year) required in the NDC and Paris-compatible scenarios (manufacturing-led variant), broken down by source. Capture of CO2 from both industrial processes and the atmosphere is considered



INSIGHTS FROM OUR ANALYSIS ON LONG-TERM GHG MITIGATION POLICY AND INFRASTRUCTURE PLANNING

Our analysis shows that, in future updates of its NDC, Qatar will need to increase the level of ambition quite significantly if it wants to get onto a path towards achieving carbon neutrality. Moreover, Qatar will need to take decisive action across all sectors in a timely manner, as the transformation that the energy system will have to undergo is characterized by long lead times. Such lead times are dictated by the long lifetime of energy infrastructure, the significant changes that would be required in consumer behavior – for example, even introducing strong incentives, it could take several years for most new car buyers to decide to adopt electric vehicles – and the transformation of the policy and regulatory framework around all this. The problem of long-term GHG mitigation in Qatar is compounded by the fact that the structure of the economy – and, consequently, the contribution that different sectors make to overall emissions – will evolve too, and it will do so in a way that is hard to predict. This makes GHG mitigation policymaking and infrastructure planning an even more complex exercise.

To deal with all this complexity in an effective manner, we recommend that policies to mitigate GHG emissions and diversify the economy are developed in a coordinated fashion, taking a long-term perspective and using all available tools to assess their system-wide impacts, including energy systems models such as Qatar TIMES. It is important that resources are allocated and new infrastructure is planned with the dual goals of mitigating GHG emissions and diversifying the economy in mind. Having a clear sense of the scale at which key technologies such as solar PV and CCUS will be needed, when and in which sector and process, allows planning their future deployment and that of related infrastructures, such as power transmission lines and CO_2 pipelines, in a more robust way. Moreover, it is also critical to recognize the importance that energy efficiency technologies and behavioral changes will have in supporting the achievement of these dual goals: these will not only make it more cost-effective to achieve GHG emission mitigation targets but will make Qatar's economy more competitive as well. Lastly, clean technology, particularly CCUS, will be crucial to Qatar's GHG mitigation efforts and is an area where Qatar could develop a competitive advantage. Therefore, promoting clean technology innovation in strategic areas such as CCUS also needs to be a strong focus of Qatar's economic diversification policy.

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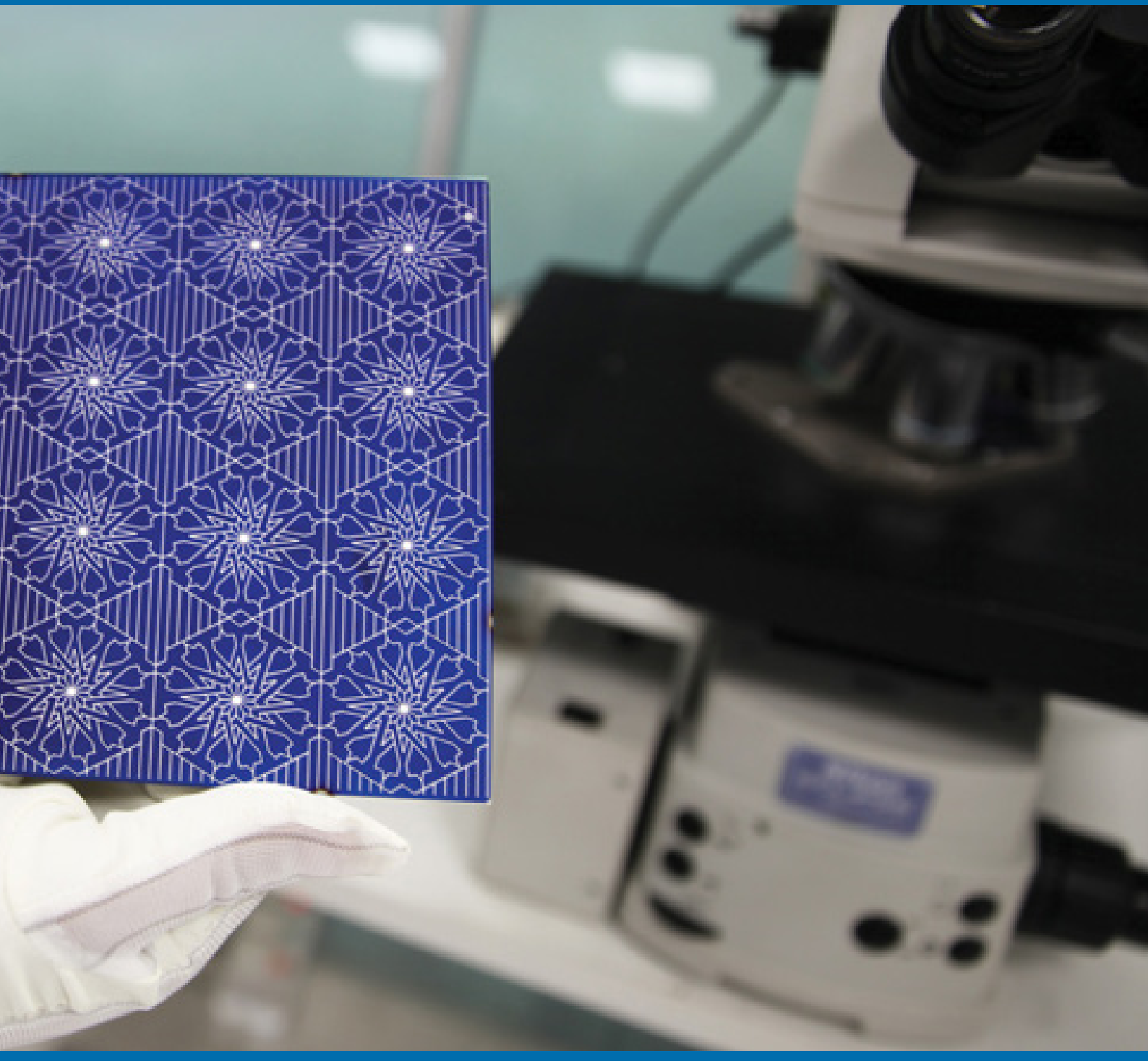
SECTION TWO

Carbon Alternatives for Qatar

An engineer holds a high-efficiency solar panel. (Flickr)



LNG Giant and Solar Dreams: Qatar's Next Energy Chapter

Justin Dargin | Senior Visiting Fellow, Middle East Council on Global Affairs

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INTRODUCTION

Qatar's owes its meteoric economic ascent to the exploitation of the North Field, the world's largest natural gas field, which has positioned the nation as a leading exporter of LNG. In the tumultuous energy landscape of the early 2020s, amplified by the geopolitical disruptions following Russia's invasion of Ukraine and other regional flareups, Qatar's gas export revenues surged to $132 billion.[1] The significant revenue from natural gas has been instrumental in bolstering Qatar's sovereign wealth fund, the Qatar Investment Authority, to a valuation estimated to be $450 billion in 2023.[2] The fund's growth has catalyzed the diversification of the national economy, as per its global investments, augmented the growth of the private sector, and expanded Doha's influence on the global diplomatic stage. The next stage in Qatar's economic development will rely on expanding LNG exports to ensure fiscal stability while simultaneously investing in renewables as a long-term sustainable alternative.

QATAR'S LNG EXPANSION TO FUEL THE GLOBAL TRANSITION

Qatar is rapidly expanding its annual LNG production capacity from 77 million (metric) tonnes (MT) in 2024 to 142 MT by 2030—an 85 percent increase.[3] This growth is designed to establish Qatar as a leading player in the global LNG market, with the potential to control nearly 25 percent of the market by the decade's end. By outpacing competitors like the US and Australia, Qatar aims to strengthen its leadership and maintain a dominant role in the global LNG industry.

The anticipated surge in LNG production and exports is expected to remain a key driver of economic development in Qatar in the coming years. Alongside its LNG expansion, Qatar has strategically positioned itself within global climate change negotiations. Transitioning from its relatively quietist stance in the 2000s, it has consistently advocated for the increased use of natural gas as a low carbon transition fuel within a diversified energy mix.

Qatar has also committed to reducing its domestic reliance on hydrocarbons, but this goal must be viewed in context. Unlike Saudi Arabia and the UAE, which faced significant gas allocation challenges in the late 2000s and early 2010s due to demand-production imbalances, Qatar has consistently managed to meet both domestic needs and export demands through its robust natural gas production.[4] This favorable position is primarily due to its relatively small population size (approximately 2.7 million) and limited domestic consumption, ensuring that export capabilities remain unaffected. Additionally, compared to major oil producers in the Gulf (Saudi Arabia, the UAE, and Kuwait), Qatar's daily oil export levels (around 670,000 barrels) are significantly lower.

Qatar's strategic emphasis on liquefied natural gas (LNG) exports, rather than large-scale oil exports, has provided a degree of insulation from the geopolitical tensions that are frequently present in the global oil market. In addition to this protection from geopolitical instability, Qatar has been progressively adjusting its contractual pricing framework to reflect broader shifts within the LNG market. This includes greater reliance on natural gas hub pricing and increased participation in the spot market, thereby enhancing the resilience of its foreign revenue streams against fluctuations in global oil prices.[5] However, as countries increasingly rely on natural gas for power generation, and the LNG market begins to resemble the international oil market, global LNG trade is projected to become more geopolitically complex. While it is unlikely LNG will be subjected to the same level of geopolitical volatility as oil, the potential for increased tensions, supply disruptions, and strategic competition is undeniable.

INTRODUCING RENEWABLES INTO QATAR'S ENERGY MIX: A STRATEGIC ADVANTAGE

Initiated in 2005, Qatar's exploration of the role that renewable energy plays in the national energy mix transcends climate concerns. Like other Gulf countries, this strategic embrace of renewables is driven by several objectives, such as Qatar's aspirations to become a leading hub of technological innovation, fostering domestic expertise, and potentially capturing a competitive edge in the global clean energy market. Additionally, by actively integrating renewables, Qatar seeks to enhance its international standing as a responsible actor in climate change mitigation efforts.

This pursuit of renewable energy serves to counter potential criticism associated with its reliance on hydrocarbon extraction. Furthermore, integrating renewable energy sources into Qatar's energy mix extends the lifespan of its natural gas reserves. While the scale of domestic demand reduction achievable through renewables may be proportionally small compared to Qatar's vast gas resources, this approach enables a more sustainable management of this finite resource. Reducing domestic reliance on natural gas allows for a more measured depletion, maximizing its economic value over time.[6] Lastly, Qatar, like its Gulf neighbors, possesses a wealth of natural resources that positions it for substantial success in the renewable energy sector. With an average of 9.5 hours of sunlight daily, minimal cloud cover, and extensive land availability, Qatar boasts exceptional conditions for solar energy generation. These inherent advantages provide a potent foundation for accelerating the development of its solar energy industry.[7]

While Qatar's foray into renewable energy began in the early 2000s, a critical distinction exists between initial conceptual exploration, economic feasibility, public pronouncements, and concrete policy implementation. A past tendency to initiate numerous studies and research projects has not always translated into substantial policy frameworks capable of driving a significant shift away from fossil fuels. However, Qatar's ongoing exploration of renewables and certain investments, despite potential implementation limitations, suggests a growing awareness and interest, if not yet a fully crystallized commitment, to diversify its energy mix beyond its historical dependence on hydrocarbons. This tentative embrace of renewables aligns with a broader trend within the GCC, where oil-producing states are increasingly acknowledging the long-term economic and geopolitical advantages of a more diversified energy portfolio.

QATAR'S APPROACH TO RENEWABLE ENERGY: FROM CAUTIOUS EMBRACE TO STRATEGIC IMPERATIVE

Qatar's National Vision 2030, released in 2008, acknowledged environmental concerns and the potential of renewable energy.[8] However, initial targets and policies were cautious. Since then, Qatar's approach has become more refined, reflecting a growing recognition of the need for diversification and decarbonization. This shift began with the inaugural 2010 National Development Strategy (2011-2016), which promoted renewables' potential for economic growth.[9] This suggests Qatar's evolving strategy prioritizes both environmental and economic c0-benefits.

However, this recognition was coupled with an underlying assumption: renewable energy technologies needed to become more cost-effective to warrant large-scale adoption. This focus on affordability led to the formation of the National Renewable Energy Committee,

tasked with developing a national plan contingent upon technological advancements that would drive down costs. The move toward a more proactive approach emerged with the launch of the second National Development Strategy (2018-2022) in 2018, which more explicitly recognized the critical importance of renewable energy for Qatar's future. This document validated the substantial potential for renewable energy generation while also realistically appraising the limited progress achieved to that point.

Qatar's renewable energy efforts took a leap forward with the 800 MW Al Kharsaah solar plant, meeting 7% of peak demand by 2023 and projected to reduce emissions by 26 MT over its lifetime. This key project, launched in 2022, marks a significant step towards the Paris Agreement goals. Qatar is also expanding its solar portfolio with massive projects like the 875 MW Industrial Cities project and the upcoming 2 GW Dukhan plant. By 2030, QatarEnergy's solar capacity is projected to reach 4 GW, contributing nearly 30% of the nation's power generation. [10]

While natural gas is currently positioned as a less carbon-intensive transitional fuel compared to coal and oil, evolving climate discourse places it under increasing scrutiny. As the global transition towards renewable energy accelerates, Qatar's substantial investments in natural gas face the potential risk of becoming "stranded assets." This potential economic loss could occur if future tightening carbon regulations render these investments unviable. International climate negotiations have demonstrated a pattern of progressively targeting specific emission sources: first coal, then oil, and while natural gas currently enjoys an interim surge, it is likely to become a focus of contention in the mid to long-term.

One significant near-term risk is the introduction of EU regulations in August 2024 designed to reduce the methane intensity of both domestically produced and imported oil and natural gas. These regulations require LNG suppliers to submit methane performance profiles. [11] Additionally, the EU has expanded its Emission Trading Scheme (ETS) to include shipping, subjecting a carbon tax on LNG cargoes entering Europe.[12] In the past, Qatar has strengthened its "security of demand" by securing long-term bilateral contracts with customers across various regions. The new EU regulations, which other may eventually be emulated in other jurisdictions, is both a risk and an opportunity for Qatar to differentiate itself from other emerging LNG producers. For example, U.S. LNG producers are often associated with carbon-intensive LNG projects.[13] In this context, Qatar can leverage its position by quickly aligning its LNG production to meet, and even exceed, the EU's stringent methane and carbon intensity regulations.

Qatar's commitment to decarbonizing its LNG production marks a strategically significant step in response to growing environmental concerns surrounding the lifecycle impacts of fossil fuel production. By setting ambitious targets to reduce carbon intensity in its LNG facilities by 35 percent and in upstream operations by 25 percent by 2035, Qatar aims to strengthen its competitive edge in the global LNG market. This proactive strategy positions Qatar to meet the increasing demand for cleaner energy and low-carbon LNG.

Diversifying into downstream sectors could also help mitigate this risk; however, it comes at the cost of significantly reduced profitability. This is due to increasing global production of petrochemicals and other downstream products, as other hydrocarbon-rich nations also pursue downstream-focused industrialization. The petrochemical industry is also under increasing scrutiny due to environmental and health concerns, particularly related to "forever chemicals," endocrine disruptors, and the non-biodegradability of plastics.[14] Over the next

decade, the sector is likely to confront a glut and stricter regulations, which could further limit profitability. While downstream diversification offers a more stable revenue stream with reduced price volatility, it may ultimately be less profitable than direct natural gas exports due to the aforementioned factors.

QATAR'S UNIQUE APPROACH TO DECARBONIZATION

Qatar's approach to decarbonization differs from its neighbors. While they pursue national net-zero targets, Qatar focuses on specific sectors. This reflects concerns about the justifiable feasibility of rapid economic adjustments within the proposed timelines for a net-zero goal. [15] Instead, Qatar targets decarbonization in select industries like the upstream segment of its massive LNG industry. This measured approach balances environmental responsibility with economic growth. While efforts to reduce gas flaring are underway, achieving broader decarbonization in this sector is challenging due to complex technological and technical economic hurdles like infrastructure needs, outdated equipment, and varying gas compositions. [16] Qatar's focus on LNG expansion and renewables has taken the priority and overshadows flaring reduction investments.

The 2021 unveiling of the Qatar National Environment and Climate Change Strategy reiterated Qatar's sectoral decarbonization approach, outlining concrete goals such as the aforementioned 25 percent carbon intensity reduction for LNG production and upstream processes by 2030. Key to LNG decarbonization planning is the North Field expansion project, which envisions the establishment of the largest carbon capture and storage (CCS) facility in the LNG industry, situated in Ras Laffan to capture and sequester up to 11 MT of carbon annually.[17] This is not a novel venture for Qatar; as it has been building on an existing practice of capturing and sequestrating 2.5 MT of carbon annually since 2015/16 .[18] Through these concerted, sectoral efforts, Qatar is attempting to position itself as a leader in environmental responsibility within the upstream LNG industry. However, the success of these initiatives is contingent upon effective practical implementation, continuous evaluation, and technological innovation. It remains to be seen whether Qatar's targeted approach adequately responds to rising international pressure for rapid and comprehensive climate action, which will have long-term implications for Qatar's global standing and its economic diversification objectives.

Qatar's commitment to renewable energy and carbon mitigation is promising, though its full impact may take time to be realized. In the early 2020s, Qatar took a more measured approach to renewable energy adoption, distinguishing itself from the faster-paced strategies pursued by regional counterparts like Saudi Arabia and the UAE. However, this approach reflects Qatar's careful consideration of long-term sustainability goals and its broader energy strategy. This divergence stems from a unique confluence of internal factors. Its small population, robust fiscal position, and the immense scale of its natural gas reserves all shape Qatar's energy strategy and contribute to this disparity.

Additionally, while Qatar is often noted—sometimes unfairly—for having one of the highest per capita carbon emissions globally, largely due to its small population, it is important to recognize that its total national emissions are comparatively low. This paradox raises important questions about historical responsibility and the colonial legacy of the Global North in shaping global climate mitigation efforts. As a result, there may be a perceived lower urgency for Qatar to accelerate its transition away from a hydrocarbon-dependent economy.

RECOMMENDATIONS AND CONCLUSION: STRATEGIC PATHWAYS FOR QATAR'S ENERGY TRANSITION

While progress has been made, the specific direction and pace of Qatar's renewable energy transition is still evolving. Nevertheless, developing a comprehensive policy and regulatory framework that supports the expansion of renewable energy projects, the liberalization of the power sector, the adoption of CCS technology, and multisectoral decarbonization can greatly accelerate progress toward achieving Qatar's climate and Vision 2030 goals.

Qatar's goals to expand renewable energy capacity and achieve decarbonization targets necessitate a comprehensive climate-centered legal and regulatory framework. While Kahramaa currently oversees electricity generation regulations, a more specialized regulatory approach will be vital to supporting this energy transition. Although Qatar's power sector remains largely vertically integrated, the nation is gradually adopting the independent power producer (IPP) model, aligning with Vision 2030's aims to foster innovation and attract investment. To facilitate this expansion, the regulatory framework could integrate mechanisms such as renewable energy certificates, support schemes for CCS technologies—including Public-Private Partnerships (PPPs) with sustainability-oriented financing terms for large-scale renewable energy projects—and green financing instruments such as green bonds.

While Qatar currently lacks the necessary enabling factors for the establishment of a successful national carbon market—such as a relatively small economy and limited market liquidity—the potential success metrics for a domestic market could arise in conjunction with a broader regional carbon market. As neighboring countries such as Saudi Arabia and the UAE develop their own frameworks, Qatar could link a future national carbon market into a regional framework.

All of the green-centered initiatives mentioned would drive renewable energy development, support Qatar's alignment with international climate goals, and establish a foundation for future reforms and environmentally conscious private sector investments, in line with the country's Vision 2030 development objectives. Importantly, given Qatar's significant reliance on natural gas exportation, its long-term interest lies in actively promoting the viability of CCS as a key tool for mitigating potential risks associated with increasingly stringent international climate regulations. However, despite its enormous natural gas patrimony, as global decarbonization accelerates, renewable energy still offers Qatar compelling geopolitical, economic, and environmental benefits.

This enhanced framework would not only create a stable environment for investment and innovation in Qatar's emerging renewable energy sector, supporting its macroeconomic diversification efforts, but it would also provide a strategic opportunity for Qatar to enhance its international standing and advance its geopolitical ambitions. By establishing itself as a leader in responsible climate action, Qatar can also cultivate strategic "climate partnerships" with targeted clean energy and carbon market investments in the Global South. By strategically leveraging climate-oriented South-South cooperation initiatives as a cornerstone of its foreign policy, Qatar can dramatically amplify its geopolitical influence in the rapidly approaching "post-oil world."

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Qatar's Policy Outlook on Nuclear Energy's Role in Decarbonization

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INTRODUCTION

Nuclear energy is at the heart of the ongoing debate about addressing the twin crises of energy security and climate change. As countries strive to reduce greenhouse gas emissions and transition to net-zero economies, nuclear energy is often considered a low-carbon energy source that could complement renewable technologies in decarbonizing electricity generation. Its ability to provide stable, large-scale energy production is seen by some as critical for ensuring a reliable power supply while reducing dependence on fossil fuels.[1]

At COP 28, held in December 2023 in Dubai, nuclear energy was officially recognized for the first time in the final declaration as a component in accelerating zero- and low-emission technologies. Additionally, the joint declaration on tripling nuclear energy capacity by 2050 was launched.[2] Over 20 countries have recognized the essential role that nuclear energy will have in achieving global net-zero emissions, committing to work collaboratively toward this goal and inviting international financial institutions to encourage the inclusion of nuclear energy in national energy portfolios.[3]

However, while many governments have recently increased their ambitions and commitments to reach net-zero emissions, the discussion around nuclear energy comes with its own set of challenges. Issues such as radioactive waste management, nuclear safety, high costs of investment, public support and geostrategic calculations make nuclear energy a complex and multifaceted option within the broader sustainable energy transition.

As of December 2024, nuclear energy accounts for only 9% of global electricity generation, with 440 reactors in operation worldwide.[4] An additional 65 reactors are under construction, around 90 are planned, and over 300 have been proposed.[5] Whether this growing momentum, along with the argument that achieving net zero emissions globally will be more difficult without nuclear energy,[6] will translate into widespread adoption remains uncertain.

Although Qatar currently has no plans to incorporate nuclear energy into its energy strategy, it would be incomplete to exclude nuclear energy options from discussions about alternative paths to decarbonization. Given the heated debates in the international arena surrounding nuclear energy, Qatar's perspective on the role of nuclear energy in addressing climate goals is worth considering as part of the broader dialogue on sustainable energy transitions.

QATAR'S APPROACH TO NUCLEAR SECURITY AND SAFETY

An investigation of nuclear energy's potential role in Qatar's decarbonization path should start with Qatar's position in nuclear security and nuclear safety.

When it comes to references of the term "nuclear" in the official discourse, Qatar emerges as a prominent promoter of nuclear security. Qatar's official stance emphasizes nuclear security as a key component in ensuring international peace and security. In different international platforms, Qatar has rightly expressed concerns over global geostrategic tensions, advocating for progress toward the establishment of a nuclear-weapon-free zone in the Middle East, the fulfillment of nuclear disarmament obligations under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), strengthened support and resources for the International Atomic Energy Agency (IAEA), the mitigation of cyberattack risks, the enhancement of nuclear security systems, and the promotion of a robust security culture.[7]

Qatar holds a similar position on nuclear safety, consistently emphasizing the importance of robust safeguards, safety procedures, and close collaboration with the IAEA. As a matter of fact, Qatar has often expressed caution regarding large-scale civilian nuclear programs in the region, particularly those of the neighboring UAE and Saudi Arabia. On March 20, 2019, Qatar publicly stated that these programs pose significant risks to regional stability and the environment, urging the International Atomic Energy Agency (IAEA) to establish a regional framework for nuclear safety. In a formal letter to IAEA Director General Yukiya Amano, Qatar's Ministry of Foreign Affairs stated: "Qatar believes that the lack of any international cooperation with neighboring states regarding disaster planning, health and safety and the protection of the environment pose a serious threat to the stability of the region and its environment."[8] It is worth noting that this statement was made against the backdrop of the ongoing Gulf diplomatic crisis, in parallel with the prevailing regional context.

Building on this statement, Qatar has continued to call countries with nuclear facilities (especially in the region) to join international efforts and measures on nuclear safety,[9] which has become an increasingly salient issue due to the rise of new risks such as cyber-attacks (as well as traditional risks like harmful radioactive materials), underlining the long-term and transboundary impacts of nuclear accidents.[10] For its part, Qatar is actively working to reinforce its national nuclear legal framework, built on the foundation of the Radiation Protection Law No. 31 of 2002 and the National System for the Account and Control of Nuclear Material Law No. 3 of 2018, with the support of IAEA Legislative Assistance Mission.[11]

QATAR'S ENGAGEMENT IN CIVILIAN NUCLEAR TECHNOLOGY

Qatar has made concerted efforts to expand national capabilities in peaceful applications of nuclear technology, specifically in areas including food security, agriculture, health, water resources management and water desalination. Qatar's underlying aim is to utilize nuclear technology to mitigate the impacts of climate change and achieve United Nations Sustainable Development Goals (SDGs).[12] To this end, the country has been in close cooperation with IAEA for the transfer of technology and knowledge through multiple technical cooperation projects.[13]

In the realm of energy, despite its reservations about large scale nuclear energy programs, recent developments reveal that Qatar is closely monitoring global trends on emerging nuclear technologies. On December 20, 2021, Qatar Investment Authority (QIA), the sovereign wealth fund for the state of Qatar, concluded an agreement to invest USD 112 million (GBP 85 million) in the small modular reactor (SMR) project supported by the British government.[14] With this investment, QIA secured 10 percent shareholding in Rolls-Royce SMR, joining other shareholders including Rolls-Royce, BNF Resources UK and Constellation.[15] Accordingly, Qatar acknowledges the use of SMRs as alternative energy sources for decarbonization, provided that safety procedures are followed, and the risks are carefully managed.[16]

This is a significant development, especially as momentum behind SMRs continues to grow. SMRs represent an effort by the nuclear industry to enhance its contribution to global decarbonization initiatives, while trying to mitigate the difficulties and risks associated with large-scale, conventional nuclear power plants. With capacities of up to 300 Megawatts electric (MWe), SMRs leverage modular technology, allowing for factory-based fabrication. This makes them more manageable from an investment standpoint compared to traditional, large-scale nuclear plants. Designed to be cheaper and quicker to deploy, with shorter market entry times, SMRs promise flexibility, economic viability, and enhanced safety. However,

challenges remain, particularly in the need for developers to gain manufacturing experience to achieve cost reductions. Moreover, SMRs are not yet commercially mature, and further advancements are required before their full potential can be realized.[17]

While investing in this emerging technology does not necessarily signal immediate plans for Qatar to incorporate SMRs into its own domestic energy systems, acquiring shares in Rolls-Royce SMR is a strategic move, enabling Qatar to explore alternative decarbonization technologies on a global scale. This is particularly relevant as Rolls-Royce SMR gains increasing prominence. For instance, on September 19, 2024, the Czech Republic selected the company, after the assessment of seven potential suppliers, to work with its SMR program.[18] A week later, it was announced that Rolls-Royce SMR was shortlisted alongside three international firms in the UK Government's competition to select and contract providers for the country's SMR program.[19] Additionally, SMRs are being extensively investigated for their potential in seawater desalination, making them particularly relevant for the Gulf countries, where water supplies rely on energy-intensive, fossil fuel-based desalination plants.

POLICY IMPLICATIONS FOR QATAR

For energy exporters like Qatar, the path to decarbonization is a multi-level chess game, played simultaneously on national, regional and global stages. At the global arena, Qatar is a key player in the natural gas markets, a role that presents both opportunities and vulnerabilities. While natural gas remains crucial during the transition to a low-carbon future, maintaining stable and uninterrupted supplies will require substantial investments in transportation and distribution infrastructure. This, however, raises the risk of technology lock-in, leading to a dilemma between investing for the immediate need and achieving the long-term goal of sustainability.[20] Qatar's global energy role is deeply intertwined with its national identity and interests, as the country has long relied on hydrocarbon revenues, not only for its development but also to ensure that its national interest in its status as an energy leader is sustained. At the national level, Qatar faces the challenge of decarbonizing both its energy production and consumption, making investments in alternative low carbon resources a priority, particularly for energy-intensive sectors, such as water desalination. At the regional level, the Gulf Cooperation Council (GCC) countries, including Qatar, have been pursuing economic diversification, striving to transition toward sustainable economies, aiming for a comprehensive transformation that redefines their role in the global system.[21] Rather than being seen solely as suppliers of crude and refined hydrocarbons, they aspire to become active, dynamic, and adaptable players in sustainable development.

Accordingly, while navigating the interplay between global, regional and national levels with regards to their respective needs and challenges, Qatar must also keep an eye on the regional dynamics, ensuring that its decarbonization strategies consider the progress of its regional counterparts in sustainability. Overall, decarbonization for Qatar is much more than diversification of its energy portfolio, but also a matter of safeguarding its national interests and geopolitical strategies. Exploring the potential role of nuclear energy in Qatar's decarbonization path cannot be detached from this context, particularly as neighboring Gulf countries like Saudi Arabia and the United Arab Emirates (UAE) advance their own nuclear programs. Saudi Arabia for example, has proposed the development of two nuclear reactors, while the UAE recently completed the fourth unit of the Barakah Nuclear Energy Plant, which is set to generate 25% of the country's electricity needs.[22] Considering this landscape, one of the most important

policy implications for Qatar in the realm of nuclear energy is to continue advocating for the enhancement of nuclear safety culture, increased transparency and the consolidation of credible and independent regulatory bodies to ensure robust nuclear safety measures.

Overall, Qatar's policy options for advancing its decarbonization efforts should include prioritizing investments in new technologies that support research on low-carbon electricity generation. This creates a window of opportunity for Qatar to join and support research on SMRs. Additionally, fostering regional dialogue to enhance increased cooperation through the exchange of experiences, policies, and expertise, will remain essential for building a shared agenda in the Gulf for nuclear security and safety. Qatar can also encourage the creation of open discussion platforms to facilitate transparent and inclusive policy debates or to create joint technical research teams on critical issues (such as radioactive waste management) to deepen regional dialogue on the civilian use of nuclear technologies, based on shared challenges, concerns and opportunities.

Finally, investing in human capital by developing local technical expertise and cultivating experienced policymakers will be critical for driving effective and innovative nuclear energy strategies. There are already some recent examples of how Qatar invests in boosting human capital for the advancement of science on nuclear technology. In March 2024, Qatar co-organized an event on empowering and encouraging women to join nuclear-related fields, which took place on the sidelines of the 68th annual Commission on the Status of Women (CSW68).[23] Similarly, in August 2024, along with 14 other countries, Qatar participated in the first International Nuclear Science Olympiad (INSO), which was held in the Philippines and aimed to attract the next generation of young scientists and engineers to the nuclear field. Out of 55 students, the winners in the silver and bronze categories notably included students from Qatar.[24]

CONCLUSION

Decisions pertaining to the deployment of nuclear energy in complex and turbulent environments such as the Middle East are particularly challenging as they are complicated by considerations that transcend mere technological challenges. Furthermore, investing in nuclear energy generation is a strategic and political decision that requires strong regulations and safety measures across multiple domains.[25] Under current policies and trends, it would be unlikely for Qatar to pursue the construction of a conventional large nuclear power plant in its territory. However, recent developments indicate the country's openness to international collaborations for advancing the civilian use of nuclear technology for sustainable development, in areas including food, health, and water. Within this framework, it is strategically viable for Qatar to continue exploring and investing in emerging technological advancements, including SMRs. This approach can offer Qatar a potential strategic stake in the development of newer, safer and more advanced nuclear energy technologies and provide an opportunity to explore alternative pathways for potentially decarbonizing its own portfolio in the future, particularly for seawater desalination. That said, the nuclear energy industry is highly vulnerable to external shocks, including nuclear accidents, political and economic crises and regional conflicts, which could critically impact decision makers' choices. Consequently, the geopolitical context and dynamic policy landscape in the region will play a critical role in shaping Qatar's approach to nuclear energy.

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Hydrogen as a Catalyst for Emissions Reduction in Qatar

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INTRODUCTION

The world faces a major challenge in the quest to combat climate change: bridging the gap between its current reliance on fossil fuels and the reductions in greenhouse gas (GHG) emissions needed to limit global warming to 1.5-2.0°C above pre-industrial levels. To achieve this, a profound transformation is required, one that would reduce fossil fuel emissions while rapidly increasing the use of cleaner energy sources.

Among the more promising clean energy solutions is hydrogen, which could play a pivotal role in decarbonizing hard-to-tackle sectors, including transportation (particularly shipping and aviation) and industry (e.g., steel and chemicals). In a scenario where net-zero emissions targets are met by 2050, hydrogen would have to contribute up to 20% of the total emissions cuts needed and meet 22% of global energy demand.[1] However, achieving such a target would necessitate a sixfold increase in hydrogen production from current levels.[2]

Currently, hydrogen production is heavily reliant on hydrocarbons, leading to approximately 830 million tons of CO_2 emissions annually.[3] Clean hydrogen accounts for only 1 percent of global hydrogen supply.[4] However, there is strong global momentum towards producing clean hydrogen, with over 520 projects announced in 2021 and 39 countries adopting clean hydrogen strategies.[5] By 2050, major markets for hydrogen are expected to include China, Europe, and North America, collectively accounting for about 60 percent of global demand.[6] The outlook for the global hydrogen market presents a unique opportunity for Qatar to build on its current leadership in the natural gas sector and to establish dominant role in hydrogen production as well.

OPPORTUNITIES FOR HYDROGEN IN QATAR

As one of the world's top producers and exporter of natural gas, Qatar has a major head start in the hydrogen sector. The country's strategic position and abundant, low-cost natural gas resources give it a competitive advantage in blue hydrogen production.[7]

In addition, its access to abundant solar energy could support the transition to green hydrogen.[8] The Al Kharsaah Solar Photovoltaic (PV) project, Qatar's first large-scale solar initiative, along with additional planned solar facilities, could allow for large-scale green hydrogen and ammonia production.

Qatar's exports of liquefied natural gas (LNG) predominantly flow to Asia, accounting for about 80 percent of total exports. Top importers South Korea, India, China, and Japan are all ramping up policies and initiatives to enhance domestic use of hydrogen. Under its Hydrogen Economy Roadmap 2040, announced in 2019, Korea plans to produce 6.2 million fuel cell electric vehicles and roll out at least 1,200 refilling stations by 2040.[9] Similarly, India has announced a National Green Hydrogen Mission, partly to increase the production and export of hydrogen but also to ramp up domestic consumption as part of national decarbonization plans.[10] In 2022, China revealed its first medium- and long-term Hydrogen Industry Development Plan (2021-2035), which aims to put 50,000 hydrogen fuel cell vehicles on the road by 2025 and to scale up the use of clean hydrogen in other sectors: energy storage, electricity generation and industry.[11] China is already the world's largest producer and consumer of hydrogen.[12] In 2017, Japan was one of the first countries to formulate a national strategy for hydrogen, aiming to ramp up use of the fuel in the transport and household sectors, and established a 2-trillion-yen ($12.9-billion) Green Innovation Fund to incentivize development of hydrogen-related technologies, among others.[13] As global hydrogen demand grows, Qatar is positioned to capitalize on its existing

relationships in the LNG market while forging new ones with hydrogen customers. Qatar enjoys the unique advantage that most of its current export destinations are also poised to be centers for hydrogen demand in the future. Moreover, its existing natural gas infrastructure could easily be repurposed for hydrogen storage and export.

CHALLENGES TO QATAR'S HYDROGEN SECTOR

Despite its potential, the hydrogen sector worldwide faces several challenges, including high costs, safety concerns, infrastructure needs (for production, storage, transmission, and export), slow deployment of carbon capture, utilization, and storage (CCUS) technologies, limited demand for clean hydrogen, and the need for globally accepted standards.[14]

The gap in production costs between unclean "grey" hydrogen ($0.8-$2.0 per kilogram), blue hydrogen ($1.64-$3.09/kg) and green hydrogen ($3.0-$7.5/kg) remains a major barrier to clean hydrogen worldwide and explains its limited adoption globally.[15] Regional hydrogen producers such as Saudi Aramco have noted this challenge: "It is very difficult to identify any agreement in Europe [for blue hydrogen]...and they explained it's because of the high cost," said Amin Nasser, Saudi Aramco's Chief Executive.[16]

Clean hydrogen is not currently traded as a commodity. The industry's high costs for production, storage, transmission, and export have discouraged many potential importers from committing to long-term investments in infrastructure, or to long-term purchase contracts.

Safety concerns also deter investment in the industry. The natural gas used for blue hydrogen production requires careful handling; explosions have already occurred in Austria, Germany, and elsewhere during blue hydrogen production. Such headaches will continue to make investors reluctant until safety measures are sufficiently improved and confidence grows in the safety of hydrogen as a fuel source.

Another factor is the need to scale up other low-carbon technologies, such as carbon capture, utilization and storage (CCUS), to limit the greenhouse gas emissions associated with the production of blue hydrogen. According to the International Energy Agency, the installed capacity of captured CO_2 should increase from current levels of 45 Mt CO_2 per year to 1.2 $GtCO_2$ per year by 2030, and up to 7.6 $GtCO_2$ by 2050.[17] Few of the CCUS projects currently in operation are dedicated to blue hydrogen production. The slow adoption of CCUS is due to uncertainties around the viability of the technology. These include the high upfront and operational costs, limited revenue streams to compensate for them, and the lack of a standardized price of carbon. This makes the revenue stream from such projects unpredictable. There is also the risk of CO_2 leakages, which would affect public perceptions and stakeholder acceptance of the viability of CCUS projects.[18]

Additionally, Qatar should be wary of its neighbors, who have made significant strides in hydrogen production, positioning themselves ahead of the game in the emerging regional competition for hydrogen dominance. Countries like Oman, Saudi Arabia and the UAE are already implementing ambitious plans to develop their hydrogen sectors.

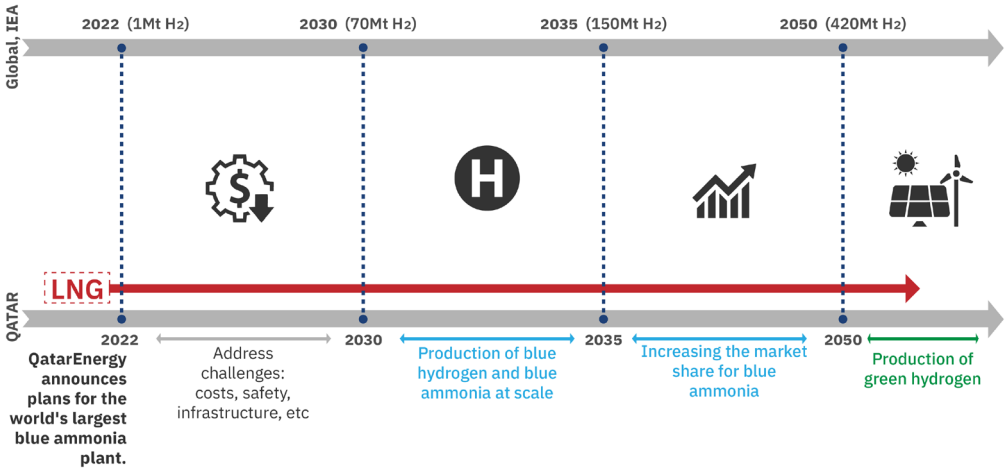
Additionally, despite Qatar's leadership in the LNG market, it has continued to face logistical challenges in transporting both LNG and hydrogen due to its reliance on the Strait of Hormuz, a major maritime chokepoint. Therefore, interruptions to the flow of maritime traffic through the Strait of Hormuz present a critical national security threat.[19] Furthermore, like Oman, Qatar is not part of the India-Middle East-Europe Economic Corridor (IMEC), a US-backed

trade route aimed at fostering economic connectivity between India, the Gulf and Europe. A proposed pipeline to transport hydrogen from India via the Middle East, notably Saudi Arabia and the UAE, could further impact the geopolitical landscape around energy and Qatar's strategy for dealing with it. That said, Doha has an opportunity to collaborate with Muscat, using Oman's Suhar or Duqum Port as an alternative export hub. This could help Qatar bypass the geopolitical vulnerabilities associated with the Strait of Hormuz, ensuring more secure export routes while strengthening regional ties.

In the long term, as green hydrogen production and export ramps up and gradually replaces blue hydrogen, Qatar should capitalize on its renewable energy potential (especially solar) and build up the capacity needed to produce green hydrogen. However, like other small states, due to land constraints, Qatar will face challenges in producing renewable energy at the scale necessary to produce green hydrogen in large quantities. Furthermore, given its heavy reliance on desalination, accessing the water needed for hydrogen production is another challenge. The production of one kilogram of green hydrogen requires around nine liters of freshwater. Blue hydrogen requires even more: 12-19 l/kg. Expanding the hydrogen industry to a large scale would thus require a parallel expansion of desalination plants, which need large amounts of power—currently generated largely by oil or gas. This raises questions about how feasible "green" hydrogen production would actually be.

A HYDROGEN POLICY ROADMAP

Figure 1: Recommendation for Hydrogen roadmap in Qatar



Given the opportunities and challenges discussed above, Qatar appears strategically positioned to become a competitive global player in hydrogen production, thanks to its prominent role in the Asian natural gas market and Asia's push to adopt hydrogen as a fuel source. Figure 1 outlines a roadmap with a timeframe for initiatives that would effectively ramp up Qatar's blue and green hydrogen production.

In the immediate term, given the ongoing challenges facing hydrogen production globally, it makes sense for Qatar to wait for the hydrogen market to become more mature, allowing for key challenges such as those related with cost, infrastructure and safety to be minimized and global demand for clean hydrogen to ramp up. Assuming that the world can address these challenges and that hydrogen becomes a traded commodity by 2030, a key step in the interim would be to develop a national hydrogen strategy to build the institutional capacity needed to administer production, domestic use and export by that date.

Given the abundance of natural gas in Qatar, the production of blue hydrogen and blue ammonia—another valuable chemical, produced by combining nitrogen from the air with blue hydrogen from natural gas—would be a reasonable strategy for Qatar in the mid-term. But for Doha to develop its hydrogen sector effectively, it needs to simultaneously scale up the installation of CCUS technology to mitigate the greenhouse emissions associated with blue hydrogen or blue ammonia production from natural gas. Creating the incentives and regulatory framework necessary for scaling CCUS technologies will be crucial in overcoming challenges related to costs and emissions. In 2022, state-owned firm QatarEnergy announced plans for the world's largest blue ammonia plant. This is a step in the right direction. Compared to blue hydrogen, ammonia is easily transported, and can be used for multiple purposes such as fertilizer production or power generation. Producing and exporting blue hydrogen is viable for Qatar given the abundance of natural gas, which can enhance the country's competitive advantage for another 150 years.

As it grows its hydrogen national capacities, Qatar can leverage existing natural gas partnerships for long-term hydrogen collaborations. For example, it could offer to support its current natural gas customers in Asia as they transition to hydrogen, by negotiating future hydrogen export agreements. Qatar should also begin to take steps towards reconfiguring its existing infrastructure for hydrogen production, use and export.

In the long term, Qatar could capitalize on its solar energy potential and build up the capacity needed to produce green hydrogen. Given the challenges facing green hydrogen production today, especially high production costs and low demand, it may need until 2050 to start producing green hydrogen. However, it is important to note that unlike with its blue hydrogen potential, Qatar cannot build a competitive advantage by relying solely on green hydrogen production.

Finally, given the uncertainties around hydrogen production and market for it, it is important to note that Qatar will continue to lean heavily on LNG exports until hydrogen becomes a viable alternative source for natural gas.

Hydrogen presents a promising avenue for Qatar to join global efforts to reduce carbon emissions and address the climate crisis. It also presents a unique economic tool for Qatar to retain its global energy leadership by transforming itself from a natural gas exporter into a hydrogen exporter. However, a concerted effort will be needed from policymakers, industry players, and researchers if the country is to realize its full potential.

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A Pathway to Cutting Carbon Emissions From Desalination in Qatar

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INTRODUCTION

Qatar has a relatively efficient desalination sector. Most of the country's desalination facilities are integrated within power plants, such as those located at Ras Abu Fontas (known as "independent/integrated water and power plants" or IWPPs). This significantly reduces energy use by directing heat discharge from natural gas-based electricity generation towards multi-stage flash (MSF)[1] or multi-effect distillation (MED) facilities,[2] both of which use thermal processes.

This chapter argues that Qatar could further reduce carbon emissions from desalination in the short term, and potentially eliminate all emissions from desalination in the long term. Early investments in developing new technologies could dramatically accelerate progress towards achieving Qatar's environmental goals.

In the short term, efficiency could be increased at existing IWPPs through minor adjustments and upgrades to existing infrastructure. This also applies to Qatar's growing number of reverse osmosis (RO) facilities, which utilize some of the latest filtration and membrane technologies to desalinate brackish water[3] and seawater.

In the medium-to-long term, as Qatar's energy mix begins to incorporate clean energy technologies that do not discharge heat (for example, solar photovoltaics and wind), the water sector will come under pressure to transition to cleaner methods of desalination. This would require extensive research and development (R&D) efforts to ensure the feasibility of clean desalination for large-scale applications.

Qatar would benefit from a long-term strategy to drastically ramp up investments in desalination R&D to ensure the country's long-term water security. This includes solar, wind, and hydrogen-powered desalination, as well as investing in polymer research, anti-scaling/anti-fouling methods, and brine management solutions.

QATAR'S EXISTING DESALINATION INFRASTRUCTURE

Qatar is an arid country with limited rainfall and freshwater sources. Groundwater, once the only freshwater source, has been heavily depleted throughout the years due to over-abstraction, mainly for agriculture. Furthermore, the rate of natural groundwater recharge is relatively slow due to low rainfall and high evaporation.[4] In 1955, Qatar began desalinating seawater to meet growing water demand. Today, approximately 99% of its municipal water demand is met through desalination.[5]

Desalination in Qatar is dominated by thermal technology, including multi-stage flash (MSF) distillation and multi-effect distillation (MED). Thermal desalination was initially the method of choice, due to the availability of low-cost fuel and its suitability for the Gulf's highly saline feedwater. Membrane-based processes[6] such as reverse osmosis[7] (RO) were introduced in the mid-2010s, after the commissioning of the Ras Abu Fontas A3 desalination plant. RO technology gained momentum due to its lower capital costs, lower energy consumption, lower brine temperature, and generally higher recovery rates, which means less brine[8] output.[9]

Fossil fuel-powered desalination releases 4.7–18.2 times more CO_2 than conventional surface water treatment processes in order to produce a given quantity of potable water. Life cycle assessment (LCA) studies have shown that CO_2 emissions from MSF, MED, and RO systems range between 9.41-25, 7.01-17.6, and 1.75-2.79 kg CO_2 per m^3 of desalinated water, respectively. These numbers vary widely, depending on the energy source, type of fuel, water salinity, and technologies used in the desalination process. RO emits between a quarter and a third of the CO_2 produced by MSF and MED.[10]

The CO_2 emissions from MSF and MED desalination in Qatar are estimated to be lower than global averages. This is partly due to the use of natural gas, which emits less CO_2 at end use, per unit of energy generated, than other fuels such as coal. However, the extensive use of cogeneration—exploiting residual heat from other industrial processes—is the primary reason for these lower emissions. In Qatar's case, large-scale desalination plants use low-pressure steam from power plants nearby, making water desalination a byproduct of power generation. An LCA study conducted on three different MSF plants in Qatar that employed cogeneration reported emissions ranging between 7.32–12.6 kg CO_2 per m^3, which is between 22.2 – 49.6% less than general reported values.[11]

Qatar's third National Development Strategy confirms its commitment to RO for desalination to reduce the country's carbon footprint.[12] Qatar has expanded its RO facilities significantly over the past decade and a half. While RO processes are less energy-intensive, requiring just 16-20% of the energy to operate, thermal desalination is still a viable technology in Qatar.[13] This is mainly due to thermal technologies being more reliable than other methods when treating seawater that is of high salinity,[14] high turbidity,[15] low quality, and high temperature. Furthermore, thermal desalination plants require minimal pre-and post-treatment for red tides[16] compared to RO technology.[17]

Given the various advantages and shortcomings of thermal and membrane technologies, hybrid thermal/membrane configurations may be a sustainable option to reduce carbon emissions and energy operation costs. This is thanks to increased recovery rates and effluent water quality, which reduce the strain on energy consumption, scale, fouling, and production costs.[18] Umm Al Houl Power, an electricity and desalination plant in Qatar, is an example of a hybrid desalination system incorporating both MSF and RO technologies, although the plants run independently.

DESALINATION AND EMISSIONS REDUCTIONS IN THE SHORT TERM

While Qatar has launched many initiatives towards its decarbonization goals, there are some short-term opportunities in the desalination sector that could catalyze emissions reductions over the longer term:

Strengthening Water Conservation and Demand Management

One short-term measure would be to strengthen water conservation and demand management. This could be achieved by implementing comprehensive water conservation measures, both upstream and downstream, to reduce energy use and the associated carbon emissions. For example, water conservation initiatives and policies could include raising public awareness about water conservation and penalizing over-consumption.

In addition, as part of the Qatar General Electricity and Water Corporation's (Kahramaa) initiatives to reduce the loss of desalinated water, Qatar could improve its distribution infrastructure. In October 2024, Qatar's Council of Ministers announced it was incorporating the "Gulf Technical Regulation for Water-Consumption Conservation Products," drafted by the GCC Standardization Organization, into Qatari regulation. The regulation aims to enhance water efficiency by setting standards for water-saving products, and by decreasing leaks. It also aims to reduce individual water consumption and increase competition between suppliers of water-saving technologies and high-quality tools.[19]

Supporting Desalination Research

Another way to enhance technological efficiency in the short term would be to increase funding for desalination research and pilot studies, building on Qatar's existing investments in fundamental and applied research. This could be done by accelerating partnerships between research institutions and industry, such as the 20-year collaboration between the Qatar Environment and Energy Research Institute (QEERI) and the Qatar Electricity and Water Company (QEWC) for the Multi-Effect Distillation with Absorption (MED-AB) pilot plant in Qatar. MED-AB is an innovative desalination technology developed at QEERI to reduce energy consumption and water production costs. Initially installed in Dukhan (western Qatar), with a nominal capacity of 25 m^3/day, this pilot plant can handle seawater with a salt content as high as 57,500 parts per million (ppm), significantly higher than the average salinity of oceans (33,000 to 37,000 ppm).[20]

One way to save and reduce costs is through collaborative research on desalination technologies, with neighboring GCC countries facing similar environmental conditions. One example of a replicable technology can be found in Saudi Arabia's Adsorption Desalination Plant in Al-Uyaynah, which relies on industrial-scale crystalline adsorption cooling and has reduced the kingdom's CO_2 emissions by 3.7 million tonnes annually.[21] Given the climate crisis and the urgent need to reduce carbon footprints, it is important to support such research and the integration of renewable energy into desalination.

Establishing a National Desalination Innovation Hub

Another goal achievable in the short term would be the creation of a National Desalination Innovation Hub, which could serve as a centralized facility where researchers, industry experts, and policymakers could collaborate on innovative desalination projects. This could include hosting regular conferences and workshops to share knowledge and foster innovation. To incentivize local and regional research, the hub could award an international desalination research prize, modeled after Saudi Arabia's Global Prize for Innovation in Desalination.[22] This would incentivize innovation and collaboration with local and regional researchers, aligned with Qatar's sustainability goals.

THE MEDIUM-TO-LONG TERM: THE CASE FOR A QATARI NATIONAL DESALINATION STRATEGY 2025-2060

A national desalination strategy for the coming 30-35 years could guide Qatar's public, private, and nongovernmental sectors towards lower emissions and lower costs. Such a strategy could shape future policies, research, and investments in desalination, provided that progress is regularly monitored and evaluated, and that its goals are updated on a regular basis. The strategy could be geared towards 1) ensuring a smooth transition to the next generation of desalination technologies in Qatar, and 2) turning Qatar into a global leader in desalination research.

The first 25 years of this National Desalination Strategy 2025-2060 (Desal Strategy) would be dedicated to R&D, while the following 10 years would be dedicated to large-scale deployment of the newly developed desalination technologies to replace or upgrade retiring infrastructure.

Qatar's plans to diversify its energy mix in the coming decades offers an opportunity for the water sector.[23] Today, hydrocarbon-based thermal electricity generation accounts for 90% of the country's total capacity.[24] By 2030, clean and primarily non-thermal energy sources will

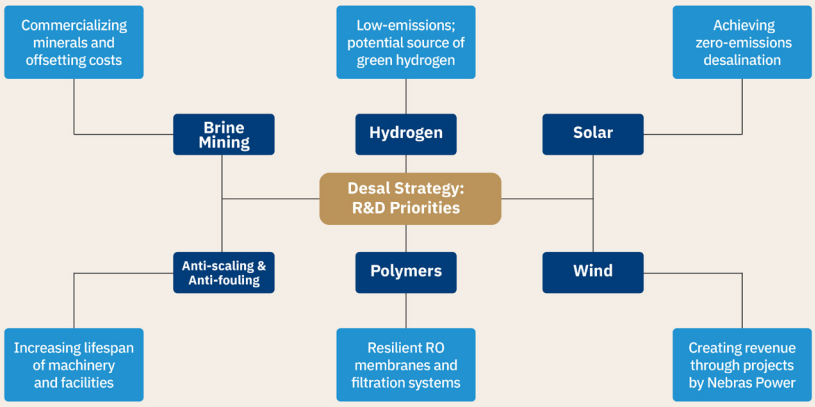
account for 18% of the total,[25] which means the share of thermal electricity will decline to 82%. Solar, wind, hydrogen, and other clean energy sources are potential alternative sources of energy for desalination facilities to replace natural gas.

However, increasing the share of solar and wind power in Qatar's energy mix could reduce the heat discharge from natural gas power plants, on which MSF and MED desalination facilities rely. The proposed Desal Strategy could prioritize research to address this issue.

Unlike solar and wind power, hydrogen power generation discharges a certain amount of heat (that varies by process), which makes it a potential alternative to natural gas in Qatar's IWPPs.[26] Recent studies show that it is possible for existing natural gas IWPPs to be adapted to use hydrogen, although this concept requires extensive R&D.[27] In this case, the proposed Desal Strategy would play a key role in incentivizing hydrogen-powered desalination research, while also prioritizing solar, wind, and other low carbon solutions. Qatar could be a leader in this field and capitalize on the intellectual property gained through R&D, which would then create new export revenue streams. Another potential growth area is the development of integrated desalination and green hydrogen production facilities, since green hydrogen is produced more effectively using distilled water.[28]

Beyond energy, there are other priority issues for Qatar's desalination sector, namely research on polymers,[29] anti-scaling/anti-fouling methods,[30] and brine mining management.[31] Figure 1 outlines how these issues could be integrated into the Desal Strategy and how they could increase efficiency, extend the lifetime of heavy machinery at desalination facilities, and provide new mineral sources and revenue streams.

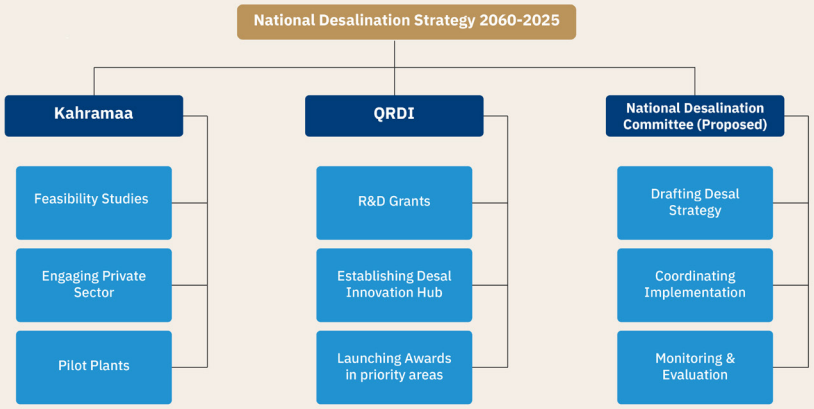
Figure 1: Proposed Desalination R&D Priorities for Qatar



To achieve the ambitious goals of the Desal Strategy, public and private investments would be needed to enhance and expand Qatar's R&D base. This would require increasing funding for existing research institutions, including QEERI, the Center for Advanced Materials at Qatar University, and the Gulf Organization for Research and Development (GORD). The Qatar Research, Development, and Innovation Council (QRDI) could put up dedicated grant funding to accelerate research on solar, wind and hydrogen-powered desalination. Qatar has a comparative advantage in the desalination sector due its decades of experience and relatively highly skilled workforce in the sector, but continuous investment is needed to ensure competitiveness in the long run.

The Desal Strategy would require coordination between several government entities, as proposed in Figure 2. QRDI would be responsible for grant funding programs for R&D in all priority areas, establishing a national innovation hub for desalination, and launching research awards to attract global talent. Kahramaa, as the national utility company, would serve as a sector expert and main stakeholder. The Ministry of Environment and Climate Change (MECC) and QatarEnergy are key stakeholders due to their central role in Qatar's energy transition. Finally, we propose the establishment of a National Desalination Committee, which, in close coordination with the National Planning Council (NPC), would be responsible for drafting the strategy and coordinating between stakeholders.

Figure 2: Key Entities to Engage in Drafting and Implementing the Qatar National Desalination Strategy 2025-2060



Scientific and policy research institutions such as the GORD, QEERI, the Center for Advanced Materials in Qatar University, and Earthna: Center for a Sustainable Future, could also play a role by providing consultations and supporting policy development. Their engagement in the strategy's drafting stage would be crucial given their position as potential grant recipients. New technologies or methods that are developed through QRDI-funded R&D programs would in turn be subjected to a feasibility study. If an R&D project shows promise, then Kahramaa and QEWC (and/or its foreign investment arm, Nebras Power) could determine whether or not to launch a pilot program to explore the possibility of scaling up and/or capitalizing on this technology for domestic and export desalination markets. For example, the growing need for water and high solar energy potential in the MENA region, which receives 22-26% of the earth's total solar energy, makes it an ideal market for exports of solar-powered desalination technology.[32] As for integrated desalination and green hydrogen facilities, Qatar could target the East Asian market, where there is growing demand for hydrogen power.[33] Newly developed wind-aided brine management techniques could also be deployed to support clients who want to reduce brine waste or retrieve valuable minerals.[34]

The private sector could also play a key role in the research, development and piloting of new technologies. Using private investment, enterprises in Qatar could compete for tenders from the national utility company to construct low-emissions IWPPs based on new solar, wind, or hydrogen-powered desalination technologies. This could help reduce risk and encourage private sector participation in the sector. Qatar has already experimented with privately run IWPPs, which have shown potential to succeed and lower costs.[35] Qatar could focus on developing programs to encourage local companies to participate in and support pilot studies, as well as providing financial incentives for entities to collaborate with research institutions and utilize technologies or processes that reduce carbon emissions.

To monitor, evaluate, and capitalize on progress in achieving the goals outlined in the Desal Strategy, the National Desalination Committee (ideally domiciled within the NPC) would be responsible for convening stakeholder meetings, designing and managing periodic monitoring and evaluation efforts, and synthesizing the latest findings and evidence from R&D and implementation.

CONCLUSION

Investments in R&D on desalination could open new avenues for Qatar as it endeavors to increase efficiency and reduce emissions in its desalination sector. In the short term, this means finding solutions for demand management and incentivizing private sector participation to increase competition and develop expertise. In the medium-to-long term, Qatar could benefit significantly from the development of an ambitious and coherent desalination strategy that shapes research and development priorities and streamlines the pilot testing and deployment of new technologies.

This would require establishing a desalination innovation hub to expand the country's research base. Doha has a comparative advantage in desalination, stemming from decades of experience. With a comprehensive and targeted strategy, the desalination sector could generate new sources of revenue, leverage the emerging hydrogen energy market, and support solar-powered desalination efforts worldwide. This would contribute to emission reductions in desalination and create new export opportunities for Qatari companies.

ENDNOTES

1. Multi-stage flash (MSF): A thermal desalination process that distills seawater by "flashing" water, or evaporating then rapidly depressurizing it and condensing the steam into distilled water, over multiple stages.

2. Multi-effect distillation (MED): A thermal desalination process where seawater is heated to lower temperatures (<70°C) by spraying it onto tubes containing steam, then the evaporated water is collected in tubes to heat feed water in the next stage or "effect".

3. Brackish Water: Naturally occurring water with a salinity level between freshwater and seawater.

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6. Membrane-based Processes: Water treatment or desalination technologies that use semipermeable membranes to separate dissolved salts and minerals from water. Examples include RO, nanofiltration, and electrodialysis.

7. Reverse Osmosis (RO): A water treatment process in which feed water enters a semipermeable membrane under higher than osmotic pressure, to separate out dissolved salts and minerals.

8. Brine: The byproduct of desalination; highly saline water containing the salts separated from the desalinated water. It is far more concentrated in salts relative to feed water.

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14. Salinity: The amount of dissolved salts in water, typically measured in parts per thousand (ppt) or grams of salt per liter (g/L) of water.

15. Turbidity: The cloudiness or haziness of a liquid, typically due to the presence of suspended particles that cause water to appear less transparent.

16. Red tides: A harmful algal bloom where certain types of algae, such as dinoflagellates, proliferate in coastal waters, discoloring the water and excreting toxins that potentially harm marine life and human health.

17. Mannan et al., "Examining the Life-Cycle Environmental Impacts," p. 239.

18. Huyen Trang Do Thi and András József Tóth, "Investigation of Carbon Footprints of Three Desalination Technologies: Reverse Osmosis (RO), Multi-Stage Flash Distillation (MSF), and Multi-Effect Distillation (MED)," *Periodica Polytechnica Chemical Engineering* 67, no.1 (February 2023): 43, https://doi.org/10.3311/PPch.20901.

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SECTION THREE

Carbon Markets in Qatar and the MENA Region

This picture, taken on October 18, 2022, shows a view of solar panels at the newly-inaugurated al-Kharsaah solar power plant in Qatar. (Photo by Ivan PISARENKO / AFP)

Unleashing Ambition: the Role of Carbon Markets in the Paris Agreement
Implications and opportunities for Qatar

Alexandra Soezer | Director, GORD Climate Action Center of Excellence

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INTRODUCTION

The Paris Agreement encourages voluntary cooperation among Parties to implement their Nationally Determined Contributions (NDCs) "to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity."[1] This commitment led to the creation of new carbon markets under Article 6 of the Paris Agreement.

Carbon Markets are not new to international climate frameworks. The Kyoto Protocol introduced *Joint Implementation and the Clean Development Mechanism* to facilitate carbon trading. Carbon markets were initially created to provide flexibility for developed countries to meet their climate targets, with no obligations for developing countries, typically a source of carbon credits. Historically, the primary motivation for participating in these markets was cost reduction, enabling countries to meet their targets more economically. Recent research[2] indicates that utilizing carbon markets globally could reduce the total cost of implementing NDCs by more than 50% (approximately $250 billion per year in 2030) or alternatively facilitate the removal of 50% more emissions (approximately 5 gigatons of CO2 per year in 2030) at no additional cost.

The Paris Agreement introduced a shift toward harmonization: all countries now have nationally defined targets and equal flexibility to cooperate with others in achieving their NDCs. This international cooperation aims to promote higher ambition and deliver the benefits of climate actions. Developing countries supported this harmonization in 2015, contingent upon developed nations' commitment to providing $100 billion annually to assist them in meeting their NDCs. Under the Agreement's framework, countries must apply corresponding adjustments to their NDCs to ensure transparent accounting of emissions reductions. This approach marks a substantial departure from the Kyoto Protocol, where the focus of carbon markets was primarily on providing developed countries with the flexibility to meet their targets at a lower cost.

For Qatar, this evolving framework presents opportunities and challenges.[3] As a hydrocarbon-based economy, Qatar stands to benefit from integrating Article 6 mechanisms to finance its transition toward diversified, low-carbon growth, as envisioned in Qatar's National Vision 2030 (QNV2030). Qatar's National Vision emphasizes the achievement of *"a diversified economy that gradually reduces its dependence on hydrocarbon industries"* as a key outcome.[4] The financing mechanisms offered by Article 6 could potentially make Qatar's low-carbon transition more cost-effective. However, new measures will also be required to build the regulatory frameworks and institutional arrangements to operationalize Article 6 domestically.

CARBON MARKETS UNDER THE PARIS AGREEMENT

The Paris Agreement's Article 6 establishes two distinct carbon market mechanisms — Article 6.2[5] and Article 6.4[6] — designed to facilitate international cooperation in achieving NDCs. These mechanisms enable the transfer of carbon credits between countries or entities through two modalities: internationally transferred mitigation outcomes (ITMOs) under Article 6.2, and emission reductions under Article 6.4. Both represent quantifiable climate action, with one unit typically equivalent to one metric ton of CO2 equivalent reduced or removed from the atmosphere.

While these mechanisms provide flexibility for achieving NDCs, their fundamental purpose extends beyond mere compliance — they are designed to drive greater ambition in global climate action.[7] Article 6.2 creates a framework for bilateral or multilateral cooperation, allowing countries to design their own approaches for NDC implementation, provided they adhere to the guidance established in COP26 Decision 2/CMA.3.[8] This decentralized system offers participating nations significant autonomy in structuring cooperative arrangements. In contrast, Article 6.4 operates under centralized UNFCCC oversight, with standardized rules and procedures similar to its predecessor, the Clean Development Mechanism of the Kyoto Protocol. The framework allows eligible CDM projects to transition into the Article 6.4 mechanism. Qatar already has two projects seeking transition: the Al-Shaheen Oil Field Gas Recovery and Utilization Project and the Medium Pressure Steam Condensate water recovery project in Ras Laffan Industrial City.[9]

STRATEGIC OPPORTUNITIES FOR QATAR UNDER ARTICLE 6

For Qatar, Article 6 mechanisms present strategic pathways to harmonize economic growth with climate commitments. The country's resource-based economy and significant energy export sector create unique opportunities under both mechanisms:

- Article 6.2 offers Qatar flexibility to forge bilateral agreements that align with its economic priorities while maintaining climate integrity. These agreements could channel investment into energy efficiency and economic diversification projects, potentially exceeding Qatar's NDC target of 25% GHG emissions reduction by 2030 compared to business-as-usual scenarios.[10]
- Article 6.4, provides a standardized framework for project development and credit generation, building on Qatar's experience with CDM projects while offering new opportunities under UNFCCC oversight.

THE NATURE OF CARBON MARKETS

Carbon markets aim to promote the efficient allocation of resources to meet carbon limitation targets. The market-driven approach is designed to prioritize mitigation actions with the lowest marginal abatement costs,[11] ensuring cost-effective utilization of resources.

However, the intended purpose of cooperation under Article 6 was to facilitate technology transfer and mobilize investment in strategic sectors, enabling countries to adopt advanced technologies that might otherwise be out of reach. Ideally, countries would focus on using their resources to address "low-hanging fruits" (low-cost technologies) while leveraging Article 6 to finance more complex solutions, or "high-hanging fruits," that contribute to long-term decarbonization. While this goal is still being realized, progress is evident in bilaterally authorized projects under Article 6.2,[12] such as the deployment of electric buses in Thailand, the composting of municipal solid waste in Ghana, and solar power initiatives in Vanuatu—each considered high-hanging fruit in their respective contexts. As the framework matures, this list is expected to grow.

This approach can be applied strategically for Qatar's economic context. The country's low-hanging fruits include flaring, efficiency improvements in energy-intensive industries, and enhanced building and infrastructure efficiency. These are cost-effective and achievable with existing resources because the implementation costs are lower than the resulting earnings or resource savings, often leading to negative carbon abatement costs.[13] The fact that some of these measures are already underway without needing carbon finance demonstrates their

cost-effectiveness. For example, QatarEnergy has committed to achieving zero routine flaring by 2030 and is already improving energy efficiency in the oil and gas sector—such as optimizing gas turbine generators and heat recovery systems—as highlighted in Qatar's NDC.[14]

The high-hanging fruits for Qatar would involve more transformative initiatives, such as scaling up carbon capture and storage (CCS), expanding renewable energy capacity—particularly solar power—and green hydrogen[15] in the long term.[16,17] These advanced solutions require substantial capital and technology investment, making them ideal candidates for Article 6 support, potentially through international partnerships facilitating access to advanced decarbonization technologies. Moreover, while renewable energy projects worldwide face criticisms around integrity and financial additionality,[18,19] Qatar could be well positioned to argue the financial additionality of solar power plants, given the low cost of domestic natural gas. In regions where natural gas is more expensive, solar power often becomes a cost-effective option and is considered a low-hanging fruit. However, in Qatar, abundant natural gas makes solar power economically uncompetitive in most cases without added incentives or subsidies. That said, solar projects have already been deployed in Qatar—such as the 800 MW Al Kharsaah solar power plant[20]—suggesting that solar power can still be cost-effective under specific conditions or scale. Ultimately, marginal abatement cost curves[21] for the Qatari economy would inform whether certain mitigation activities would be classified as low- or high-hanging fruits.[22]

Many NDCs were designed using this approach, including low-cost measures as part of their unconditional commitments while listing more advanced technologies as eligible for support under Article 6. Unfortunately, the market for advanced technologies has not yet fully developed, limiting the potential for substantial sectoral transformation. For example, the lifespan of a quick 'cookstove project' is often shorter than the five-year NDC cycle, which restricts its long-term impact on decarbonization.

POLICY IMPLICATIONS OF ITMO TRANSFERS AND CORRESPONDING ADJUSTMENTS

Participation in cooperative approaches under Article 6 involves the transfer of mitigation outcomes from one participating country to another country or entity, such as an airline under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) or a corporation. This means that the originating country cannot use these transferred mitigation outcomes to meet its NDCs. The concept of corresponding adjustments, established through the Paris Agreement work program (Decision 1/CP.21, para 36),[23] ensures that emissions inventories reflect the transfer or receipt of mitigation outcomes.

ENVIRONMENTAL INTEGRITY, REPORTING STANDARDS AND REPORTING REQUIREMENTS

To uphold environmental integrity, cooperative approaches must comply with the Enhanced Reporting Requirements of the Paris Agreement. This includes national inventory reporting, biennial transparency reports, and detailed information on target levels, baselines, and mitigation outcomes. Countries must also demonstrate that their cooperative approaches do not lead to a net increase in global emissions during NDC implementation periods. For policymakers, adhering to these standards is crucial to ensure that climate commitments are met transparently and effectively, therefore enhancing the credibility of carbon markets.

The UNFCCC requires countries participating in Article 6 projects to submit initial reports detailing their cooperative approaches. These reports are subject to a technical expert

review to ensure the cooperation does not hinder the party's ability to meet its NDC targets. Countries must demonstrate how their participation aligns with their NDCs, long-term low-emission development strategies (where submitted) and the goals of the Paris Agreement, as outlined in Decision 2/CMA.3.

The Article 6 framework emphasizes robust governance and high-quality mitigation outcomes, requiring conservative baselines that fall below "business as usual" projections. It mandates the minimization of non-permanence risks across multiple NDC periods and addresses potential reversals in emission reductions. Particular attention is given to avoiding negative environmental, economic, and social impacts while upholding human rights, gender equality, and other core principles outlined in the Paris Agreement. Furthermore, these requirements stress the alignment of cooperative approaches with the Sustainable Development Goals and mandate contributions to adaptation resources and overall global emission reductions. This comprehensive approach ensures that climate action supports broader sustainable development objectives.

CHALLENGES IN ACHIEVING NDC TARGETS THROUGH CARBON MARKETS

Countries participating in ITMO transfers face significant challenges balancing their ambition with environmental integrity. While developing nations anticipated climate finance of at least $100 billion annually from developed countries to support their NDCs, this funding has fallen short. Consequently, many countries have sought to use ITMO transfers to bridge their financing gaps, offering credits in exchange for investments in climate action projects with co-benefits like job creation and reduced environmental hazards. However, this is not the intended use of Article 6 mechanisms. The framework was designed to enable countries to trade genuine surplus emission reductions, allowing purchasing nations to enhance their climate ambitions beyond their initial NDC commitments. ITMOs were not conceived as a substitute for climate finance, as the framework assumed adequate funding would be available to support climate goals in developing nations.

The relationship between ITMO transfers and NDC targets has sparked considerable debate among stakeholders. Developing nations and climate finance institutions argue for flexibility in using ITMOs to address financing gaps, while environmental organizations and some developed countries emphasize the need to maintain environmental integrity. A key point of contention is whether ITMO transfers should be limited to actions listed in conditional NDC targets. While some argue this approach helps ensure transferring countries can still achieve their NDC targets, Article 6 rules make no distinction between conditional and unconditional NDC targets, requiring corresponding adjustments for all mitigation outcomes.

The growing reliance on ITMO transfers as a financing mechanism raises significant concerns about the overall effectiveness of the Article 6 framework. This situation potentially compromises the integrity of international carbon markets and could impede global progress toward meeting the climate goals established under the Paris Agreement.

BUILDING A SCALED AND JUST CARBON MARKET

For carbon markets to effectively support climate action while maintaining environmental integrity, developing countries must carefully balance their participation. A key consideration is the opportunity cost of transferring ITMOs - the value of mitigation outcomes that countries forgo when selling carbon credits. These costs should reflect potential future needs for more expensive emission reduction actions to meet NDC targets. While marginal abatement cost

curves can help guide pricing decisions, current market prices fall significantly below these opportunity costs, making high-integrity projects less attractive to buyers.

The aviation sector's CORSIA program is expected to drive much of the demand for correspondingly adjusted credits. This presents a strategic opportunity for major airlines, particularly in the Gulf region, to develop expertise in sourcing high-quality carbon credits. Building this capacity before CORSIA's mandatory phase begins in 2027 is crucial.[24] Airlines can also help establish local carbon markets by initiating or partnering on regional carbon crediting projects that align with development goals.

A fundamental challenge remains: carbon finance was designed to supplement, not replace, climate finance. The shortfall in promised climate finance to developing countries has created a gap between market expectations and reality. To address this, rules need recalibration to better recognize private sector contributions to NDC targets. Recent climate negotiations, including discussions at COP29 in Azerbaijan, have emphasized expanding financial mechanisms to merge public and private investments.

Blended finance instruments offer a promising path forward. Public funds could cover initial project risks—such as feasibility studies and emission reduction estimations—creating a more favorable environment for private investment. This approach effectively leverages public resources and encourages greater private sector participation, which is essential for scaling climate action. Given the context of unfulfilled climate finance commitments from developed nations, the application of corresponding adjustments for developing countries needs urgent reconsideration. A more nuanced approach, accounting for historical contributions to climate change, could enable expanded climate action while maintaining competitive carbon prices and market liquidity.

A well-functioning global carbon market has the potential to unlock trillions[25,26] in private sector finance, accelerate clean technology innovation, and enable large-scale emissions reductions. Qatar and other GCC countries[i] are strategically positioned to play a leading role in this transformation, leveraging their networks and relationships to shape market dynamics and set high standards for transparency and environmental integrity. This leadership role aligns with their vision of economic diversification and positions them as key players in global climate action.

CONCLUSION AND FUTURE PATHWAYS

Integrating carbon markets under the Paris Agreement presents significant opportunities and challenges for developing countries striving to meet their NDCs. For Qatar, as a prominent oil and gas exporter seeking economic diversification, these markets offer a pathway to a more sustainable economic model while advancing national development goals. The primary barrier remains the gap in climate finance commitments from developed countries. Since carbon finance was designed to supplement rather than replace climate finance, this shortfall hampers the effectiveness of carbon markets in meeting both developed and developing nations' expectations.

i. The Gulf Cooperation Council is a regional, intergovernmental, political, and economic union comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

To bolster Qatar's engagement and effectiveness in carbon markets, the following recommendations are proposed—which are applicable to other countries facing a similar policy context:

- **Adjust opportunity costs:** Implement higher opportunity costs for ITMO transfers to ensure developing countries don't compromise their climate goals for short-term gains. While current market prices fall below optimal levels, using marginal abatement cost curves can guide economically viable decisions.
- **Strengthen Climate Finance:** Developed countries must fulfill their climate finance commitments. For Qatar, the upcoming second NDC update offers an opportunity to clearly define conditional and unconditional mitigation measures, including recent commitments like developing 4 GW of renewable energy capacity by 2030.[27]
- **Engage the private sector:** Develop a national framework for Article 6 engagement during the first implementation phase (2024-2025) of Qatar's Third National Development Strategy. This could promote private sector involvement in key technologies like CCUS and green hydrogen. The first implementation phase (2024-2025) of the Third Qatar National Development Strategy 2024–2030 is a key opportunity window to develop this Article 6 national framework, as this first phase anticipates the introduction of major policy reforms and capacity building for the implementation of the National Development Strategy.[28] Moreover, Article 6 presents opportunities for technology transfer to other countries. For instance, Qatar, a pioneer in district cooling,[29] could benefit from promoting district cooling carbon crediting projects abroad using local technology providers.
- **Establish bilateral agreements:** Following Kuwait and UAE's examples with Rwanda and Paraguay, respectively[30], Qatar could pursue bilateral cooperation agreements under Article 6.2 once its national framework is in place.[31]
- **Leverage CORSIA demand:** Prepare for the aviation sector's mandatory emissions offsetting program starting in 2027. Regional airlines like Qatar Airways could benefit from developing local carbon crediting projects.
- **Reform corresponding adjustments:** Adopt a more conservative approach based on historical climate contributions to enable scaled-up climate action while maintaining market competitiveness.
- **Strengthen regional cooperation:** Establish a united GCC bloc regarding Article 6 implementation. This regional alignment could: create a cohesive regulatory framework aligned with international standards; foster partnerships with both developed and developing nations; enable the GCC to play a more significant role than during the Kyoto Protocol era; facilitate knowledge exchange and investment opportunities; support deployment of advanced monitoring technologies; promote capacity-building initiatives; and create awareness campaigns to engage local businesses and communities
- **Innovate financing solutions**: Develop carbon credit purchase and equity funds to enhance GCC's influence in global carbon markets.

A well-functioning global carbon market has the potential to mobilize trillions in private sector finance, accelerate clean technology innovation, and enable large-scale emissions reductions. Qatar and its GCC partners are uniquely positioned to catalyze this transformation, driving sustainable development and economic diversification while cementing their role in global climate action.

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Carbon Markets and Emission Reduction Strategies for Achieving Net Zero Emissions in the MENA Region

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INTRODUCTION

The world has about a decade left to avoid the irreversible impacts of climate change, according to the UN Intergovernmental Panel on Climate Change (IPCC).[1] Achieving a more sustainable future will require substantial financing, targeted investments, and global cooperation to reduce greenhouse gas (GHG) emissions. Carbon markets can play a role in achieving these goals, but first they need to become more robust and credible. While the global carbon market has evolved fast over the past five years,[2] it remains fragmented into various marketplaces, frameworks, and approaches, hindering rapid decarbonization on a large scale.

These structural and operational challenges include a lack of trust in the environmental integrity, credibility, and additionality of carbon credits. Although compliance carbon markets are well established, they have been adversely affected by diverging regulatory requirements and varying stages of development between jurisdictions, as well as disparate climate ambitions, preventing greater convergence. Voluntary Carbon Markets (VCMs), on which governments, organizations, and individuals can purchase credits, also tend to be fractured, partly because of the sheer number of actors operating within them.

By early 2023, as a growing number of companies looked to implement net-zero strategies, momentum appeared to be gathering in VCMs.[3]Developing countries, such as those in Africa, announced ambitious plans to use revenues from credits generated from their forests to boost their economies.[4] New market arrangements also promised that carbon credits could kickstart climate finance[5] and spur innovation in clean technologies.

Many countries are developing carbon markets, including in the Middle East and North Africa (MENA),[6] where many governments have announced Net Zero targets, including the United Arab Emirates (2050),[7] Oman (2050),[8] Bahrain (2060),[9] Saudi Arabia (2060),[10] Kuwait (2060),[11] Lebanon (2050)[12], and Tunisia (2050), among others.[13] While carbon markets aim to reduce emissions and enhance corporate action, rigorous impact evaluation is needed to ensure that these markets are designed and implemented to ensure equitable and effective climate action.

This chapter aims to provide a comprehensive analysis of current carbon emissions, net zero targets and carbon markets in the MENA region, as well as international collaboration efforts in the Gulf. By leveraging their unique position in the energy market, investing in technological innovation, and fostering international collaboration, Gulf countries can make significant strides towards reducing carbon emissions and achieving their net zero ambitions.

CURRENT CARBON EMISSIONS IN THE MENA REGION

The Middle East is endowed with half the world's known crude oil reserves[14] and 40% of its natural gas.[15] Its per capita annual emissions are among the highest of any region in the world (13 tons of CO2 equivalent, or tCO2e), trailing North America (19 tCO2e) but almost double Europe (7.8 tCO2e). Only half of MENA's 16 nations have committed to net zero targets. The transition to low-carbon energy poses critical questions to the region's oil and gas producers, as it may imply sustained pressure on their hydrocarbon-reliant development models. Without economic reforms, this may translate into macroeconomic imbalances and ultimately put established social contracts in the region at risk. Despite some nations setting ambitious targets, the region's emissions are still forecast at two billion tonnes (Bt) CO2 through 2050.[16]

To reach net zero, the Middle East must electrify and deploy new technologies in its industrial sector and meet increased power demand through fully decarbonized supply, which eliminates emissions from one of the largest sources of greenhouse gases—electricity generation. Heavy industry will require widespread deployment of Carbon Capture, Utilization, and Sequestration (CCUS), with remaining emissions offset through nature-based solutions and carbon markets.

THE ROLE OF CARBON MARKETS

Carbon markets offer a pragmatic and cost-effective approach to decarbonization, functioning as a mechanism for organizations to offset emissions that are challenging to eliminate. Project-based carbon credits are generated through activities that reduce or remove greenhouse gas emissions, such as forestry, mangrove restoration, methane capture, and soil-carbon sequestration. As climate goals become more ambitious, carbon credits will play an increasingly essential role in accelerating decarbonization and contributing to global net-zero objectives. A robust carbon credit strategy can yield additional benefits, including enhanced market access, customer attraction, talent retention, and improved business resilience against climate challenges.

Demand for carbon credits stems primarily from the drive to comply with regulations, fulfillment of corporate net-zero transition frameworks, meeting Paris Agreement climate targets, and meeting voluntary climate-related goals, such as carbon neutrality or net zero.

Many governments use carbon credits to support their climate objectives, by implementing carbon taxes and cap-and-trade schemes, and working towards national Paris Agreement targets. Companies can participate in VCMs either individually or as part of industry-wide schemes. For example, airlines taking part in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which was set up by the aviation sector to offset its greenhouse gas emissions. International airline operators taking part in CORSIA[17] have pledged to offset all the CO2 emissions they produce above a 2019 baseline.

Table 1: Carbon Market Terminologies

Term	Definition
The Global Carbon Market	The Paris Agreement's Article 6 rulebook (6.2, 6.4 & 6.8) provides more consistent carbon-trading standards since COP26, which established an architecture for international carbon markets and clarified how governments should account for credits in national emissions targets.
VCMs	Marketplaces or market initiatives with regulations guiding the supply, demand and use of carbon credits.
Compliance Carbon Market	Marketplaces in which regulated entities buy and surrender emissions allowances or offsets to meet regulatory targets. Examples include the EU Emissions Trading System.

The Paris Agreement's Article 6 rulebook is widely seen as key to helping carbon markets grow. It laid the groundwork for a UN-run global trading system modeled on the Kyoto Protocol's Clean Development Mechanism (CDM). Article 6.2 specifies how to account for carbon credit transfers;[18] Article 6.4 establishes an architecture for international carbon markets and clarifies how governments should account for credits in national emissions targets.

In addition to the United Nations Framework Convention on Climate Change (UNFCCC)'s efforts under Article 6[19] of the Paris Agreement, industry associations and other global organizations are advancing initiatives to bolster market transparency, foster innovation, and deliver carbon credit benefits. Private-sector groups, such as the Integrity Council for the Voluntary Carbon Market (ICVCM)[20] and the demand-side-focused Voluntary Carbon Markets Integrity Initiative (VCMI),[21] are working to build trust in carbon credits and guide businesses on their use.

CARBON MARKETS IN THE MENA REGION

Several MENA countries have launched carbon market programs. The UAE has established the world's region's first regulated carbon credit trading exchange and clearing house.[22] Saudi Arabia launched its Greenhouse Gas Crediting and Offsetting Mechanism to Advance Global Climate Goals (GCOM),[23] while Egypt[24] launched its VCM in July. Oman,[25] Morocco[26] and Tunisia[27] have also established policies and regulations for carbon credit verification and certification standards.

The state of Article 6 mechanisms and VCMs varies across the MENA region. Saudi Arabia is at the forefront, with its Regional Voluntary Carbon Market Company (RVCMC),[28] which aims to scale up VCMs and support sustainable business practices. The UAE is also active, with initiatives like the UAE Carbon Alliance. Egypt has launched Africa's first regulated VCM, facilitating the trading of carbon reduction certificates on the Egyptian Stock Exchange, aligning with global efforts to enhance both voluntary and compliance markets.

The rise of new carbon credit markets, including under Article 6, is reshaping the global landscape, bringing integrity and transparency to global carbon trading. Countries in the Middle East, particularly UAE and Saudi Arabia, are positioning themselves as emerging hubs for carbon offset trading and ecosystem for carbon markets. Dubai Financial Centre (DFM) and Abu Dhabi Global Market (ADGM) are at the forefront of carbon trading initiatives in the UAE, with DFM launching a pilot program for carbon credits trading and ADGM establishing the world's first regulated carbon credit trading exchange. Offset8 Capital has launched the Middle East's first regulated carbon credit fund focusing on nature-based solutions,[29] highlighting the UAE's leadership in creating a sustainable and transparent marketplace for carbon offset initiatives.

Qatar is also actively engaging in discussions on carbon markets and exploring opportunities under Article 6. Qatar's Ministry of Environment and Climate Change has started actively working on carbon markets,[30] including at a workshop ahead of COP29.[31] Although Qatar has low interest in VCMs, the Qatar-based Global Carbon Council in 2019 launched a crediting standard aimed at making its credits eligible both for VCMs and Article 6. Qatar also purchased 1.8 million carbon credits from the Council[32] to help meet its FIFA World Cup 2022

carbon neutrality pledges,[33] a move that was heavily criticized.[34] The Council's decision to qualify renewable energy projects in emerging economies still strongly divides opinion, and carbon credits generated from such projects have failed to obtain a new quality label from the Integrity Council for the Voluntary Carbon Market (ICVCM)[35], an independent watchdog that aims to address widespread concerns over the quality of carbon credits.

Gulf Cooperation Council (GCC) countries also face similar challenges and opportunities in navigating this new terrain. The European Union's Carbon Border Adjustment Mechanism (CBAM) is expected to significantly impact MENA countries by imposing costs on carbon-intensive imports, as well as hitting the shipping industry by increasing operational costs and incentivizing the adoption of cleaner technologies. This could challenge economies that rely on exports of such goods.

Carbon markets nevertheless present a key opportunity for MENA countries to mitigate these impacts. That said, some MENA countries are still developing their carbon market strategies. While some have introduced carbon marketplaces, the region's overall engagement with Article 6 remains in its early stages. The focus is on building capacity and establishing robust frameworks to facilitate participation in both compliance and voluntary markets. This involves collaboration with international bodies and leveraging regional initiatives to align with global carbon market standards and objectives.

Climate commitments and carbon market development in the MENA countries vary significantly. Here is an overview:

Table 2: Emissions Reduction Targets and Carbon Market Initiatives of MENA Arab countries

Country	GHG Reduction Targets (Nationally Determined Contributions)	Net Zero Target	Carbon Market Initiatives
Algeria	7% by 2030	N/A	Involvement in VCMs.
Bahrain	30% by 2035	2060	Active in MENA VCM, launched "Safa" platform for voluntary carbon offsetting.[36]
Egypt	37% by 2030	N/A	FRA regulations for CERs including accreditation and carbon trading[37], Egyptian Carbon Exchange introduced in 2022 ahead of COP27.[38]
Iraq	15% by 2030	N/A	Participates in VCM, first carbon exchange franchise with Capturiant and Sharp Mind Global Ventures.[39]
Jordan	31% by 2030	N/A	Involvement in VCMs through the Ministry of Environment.
Kuwait	7.4% by 2035	2060	Efforts to establish VCM, supported by Kuwait Finance House's carbon offset platform.[40]
Lebanon	20% unconditional, 31% conditional by 2030	2050	Some involvement in carbon markets.
Morocco	18.3% unconditional, 45.5% conditional by 2030	2050	Article 6 MoU with Switzerland, Norway and Singapore MoU to establish regional VCM.[41]

Country	GHG Reduction Targets (Nationally Determined Contributions)	Net Zero Target	Carbon Market Initiatives
Oman	21% by 2030	2050	Draft of general policy framework for carbon markets, aligns with Article 6.
Qatar	25% by 2030	N/A	Developing VCMs, QFC Digital Assets Framework using DLT, houses independent standard Global Carbon Council.
Saudi Arabia	278 million tonnes of CO_2e to be reduced annually by 2030, 50% of energy mix from renewables by 2030	2060	Launch of RVCMC, advancing carbon market with GCOM and established Saudi Carbon Exchange.[42]
Tunisia	41% by 2030	2050	Involvement in VCMs; partnerships with Japan, Singapore, and Switzerland under Article 6.[43]
United Arab Emirates (UAE)	40% by 2030	2050	Active in both Article 6 and VCMs, National Register for Carbon Credits initiative; established first regulated carbon credit trading exchange and clearing house in the world under Abu Dhabi Global Market (ADGM);[44] Dubai Financial Market (DFM) developed pilot program for trading carbon credits.[45]

POLICY RECOMMENDATIONS

It is time to double-down on efforts to make carbon markets a reality in MENA and unblock financial flows that could transform the region and its approach to climate risk. While the private sector's ambition to meet its decarbonization targets has stimulated significant demand for voluntary carbon markets in the MENA region, compliance carbon markets need to catch up. The following recommendations could help accelerate the speed and expand the scale of carbon markets across the MENA region are based on the current challenges faced in the region:

Early entry into carbon markets could deliver numerous benefits for MENA countries. The GCC countries' experience with the CDM since 2012, in which falling CER prices have highlighted the need for a well-functioning market mechanism, provides valuable lessons. Many GCC nations are now exploring domestic carbon markets, and developing effective market-balancing mechanisms will be crucial. Consistent government attention, early institutional development, and proactive capacity-building can help the region act early, seizing opportunities to attract international investments and establish robust carbon trading infrastructures under Article 6.

Establishing a unified MENA regional carbon market regulatory framework, ensuring integrity, transparency, and international recognition would help achieve greater uniformity across the region. A unified carbon market would offer significant advantages over individual national

systems. A larger, regional market would increase liquidity and lower transaction costs, benefiting both buyers and sellers. Harmonized regulations could enhance environmental integrity and promote regional cooperation. The EU Emissions Trading System provides a successful model of a phased approach, cap-and-trade mechanisms, and robust monitoring systems.

Insufficient supporting infrastructure, such as the lack of national registries or Monitoring, Reporting, and Verification (MRV) systems, hampers the development of the Article 6 market in many Middle Eastern countries. To address this, they should establish comprehensive national registries, implement robust MRV systems, and seek technical assistance and capacity building from international organizations like the UNFCCC, World Bank and IETA. This could create a transparent, reliable environment for carbon credits, accelerating the adoption of Article 6. Encourage private sector involvement by offering incentives and creating a favorable investment climate. This could attract more capital for carbon reduction projects and drive innovation in low-carbon technologies in countries in need. They should also commit to significant purchases in other regions that are looking to build out their carbon crediting infrastructure. For example, the private-sector coalition UAE Carbon Alliance has agreed to buy $450 million worth of credits generated in Africa by 2030.

Middle Eastern countries must balance the path to net zero with critical economic and social considerations. Establishing both VCMs and compliance markets is essential, as carbon markets can play a significant complementary role in achieving sustainability goals. However, voluntary trading alone will not be enough; a compliance market must be integrated to ensure that the carbon trading program meets its desired objectives and drives meaningful emissions reductions.

THE WAY FORWARD

Despite recent setbacks, the international community should not lose hope in the potential for voluntary markets to make progress towards global decarbonization targets and net-zero goals. While some may be quick to dismiss VCMs role in the wake of negative press, heightened public scrutiny, and declining credit value, it would be short-sighted to ignore the progress already made in various markets.

Given the growing complexity of the carbon trade ecosystem and the nascency of many carbon-trading networks and platforms in various Middle Eastern countries in supporting their net zero targets, by working closely with international organizations and providing clear guidance on participation, Middle Eastern countries can establish robust, transparent use of carbon credit in net zero plans.

Carbon markets can support both private and government efforts to reduce, avoid, or remove greenhouse gas emissions and contribute to reaching the goals of the Paris Agreement, while providing benefits to multiple stakeholders. Among other things, well-functioning carbon markets can lower the costs of reducing emissions, supporting the transfer of clean technologies and finance, and unlock higher mitigation ambitions over time. If carbon markets are held to high standards of integrity and transparency, they can help accelerate the transformation needed in the Middle East region by effectively putting a price on pollution and creating an economic incentive for reducing emissions. Carbon markets stand on the brink of reaching the size, depth, and maturity they need to mobilize capital flows to clean-energy solutions and advance the global net-zero transition. The world showed a willingness to make this happen when it passed much-awaited rulebooks after discussions at COP27 and COP28. Now it is time to see those ambitions implemented.

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Carbon Markets as a Strategic Pathway to Carbon Reduction in Qatar

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INTRODUCTION

Qatar, with a population of approximately three million people, has a carbon-intensive economy, with annual greenhouse gas emissions of around 120 million metric tons of CO_2 equivalent ($MtCO_2e$) in 2021.[1] According to the production-based calculations of the UN's climate agency UNFCCC, Qatar has some of the highest per-capita emissions worldwide, although its small population means this amounts to a negligible share of global emissions of around 0.3% in 2023.[2] That being said, the energy sector accounts for over 96% of these emissions, including those related to the extraction, transformation, and refining of fossil fuels.[3] This creates a conundrum for Qatar: how to maintain economic growth while addressing the carbon-intensive nature of the economy.

As the global economy moves towards decarbonization, major importers of Qatari energy, including the European Union, South Korea, China, and Japan, are implementing or developing carbon pricing mechanisms such as the Emissions Trading Systems (ETS)[4] and the European Union's Carbon Border Adjustment Mechanisms (CBAM).[5] Failure to align with these frameworks may affect Qatar's energy exports, including of liquefied natural gas (LNG) and petroleum products, which may be liable to certain carbon tariffs. This paper explores the potential for carbon markets in Qatar, and suggests a roadmap for integrating carbon trading mechanisms to help Doha meet its emissions reduction targets.

GLOBAL TRENDS IN CARBON MARKETS

Carbon markets have emerged as a tool for reducing emissions by assigning a price to greenhouse gas (GHG) emissions, mainly targeting emission-intensive and hard-to-abate sectors. Putting a price on carbon incentivizes profit-driven enterprises to reduce emissions in order to remain competitive. In 2023, the EU's compliance carbon market[6] (EU ETS) alone accounted for 38% of the bloc's purchases of carbon credits, generating $47 billion in revenue.[7] Carbon pricing initiatives now cover 18% of total GHG emissions globally, with carbon prices ranging from $5 to $120 per tonne.[8]

Over the past decade, carbon markets have expanded rapidly, with 36 fully operational ETSs worldwide as of 2024, covering some 18% of global GHG emissions. These markets generated over $74 billion in revenues in 2023.[9]

Recently, more sectors and regions have been integrated into ETSs, extending the global reach of carbon markets. Tightening emissions caps have led to upward pressure on carbon prices, reaching record highs of €100 per tonne on the European Union (EU) ETS in early 2023, although this later stabilized. Increasing numbers of companies are making net-zero pledges, driving demand for carbon allowances and offsets. Voluntary carbon markets[10] are growing in importance, especially for companies unable to fully decarbonize in the short term.

Qatar's carbon emissions are predominantly from the energy sector, particularly LNG production, oil refining, and natural gas flaring. In 2023, over 73.7% of Qatar's emissions were from CO_2, while methane (CH_4), a by-product of natural gas extraction, accounted for 25.1%. The energy sector is responsible for 116 $MtCO_2e$ annually, to which methane leakages during natural gas extraction contribute significantly.[11]

Qatar's existing climate commitments, as outlined in its Nationally Determined Contributions (NDCs) under the Paris Agreement, aim to reduce GHG emissions by 25% by 2030 relative to a baseline scenario.[12] However, Qatar has no comprehensive carbon pricing mechanism in place to drive emissions reductions across industries.

Qatar's commitment to reducing emissions by 25% is slightly higher than the Gulf Cooperation Council (GCC) average pledged reduction target of around 21.6%.[13] Qatar's NDC ambition is significant, but will require an elaborate roadmap if it is to be turned into reality.

The trends of expanding carbon market coverage, increasing carbon prices, and the growing importance of carbon credits and offsets may have direct implications for Qatar and the GCC. As major energy exporters, these nations face mounting external pressure to align with stricter international climate measures or risk losing market access and competitiveness. Increasing carbon prices and stringent emissions caps abroad could increase the cost of doing business, potentially forcing Gulf industries to improve production efficiency and adopt cleaner technologies.

CHALLENGES IN ESTABLISHING CARBON MARKETS IN QATAR

Qatar's initial emissions reduction efforts, like those of other GCC countries, rely mainly on voluntary offsets, with programs such as the Global Carbon Council (GCC) and Qatar Airway's offset program. The growing voluntary carbon market allows Qatar and Gulf countries to diversify their economies, develop high-quality offset projects, and leverage their energy expertise to meet rising global demand for credible emission reductions.[14]

However, the global voluntary carbon market was valued at $723 million in 2023,[15] far smaller than compliance markets, which generated $47 billion in the EU alone.[16] Inconsistencies in verification methodologies can cause unwanted consequences, as is evident in the 2022 Qatar World Cup carbon offset program.[17] A compliance market would offer Qatar more predictable revenue streams and stronger regulatory control, with clear rules and government oversight.[18] Some ETSs accept certain types of voluntary carbon offsets. As international carbon policies tighten and key export markets introduce new standards, voluntary markets, complementary to compliance markets, would give polluters in Qatar more of an incentive to further reduce carbon emissions.

As noted above, Qatar has among the highest per-capita emissions globally, although its total emissions remain relatively low due to its small population. Nevertheless, there has been notable progress in addressing climate concerns. For example, the Global Carbon Council, based in Doha, is working to list its carbon credits with exchanges across the MENA region. Qatar Airways' carbon offset program provides corporate customers with a mechanism to reduce their annual emissions. Additionally, the Ministry of Environment and Climate Change is developing a regulatory framework for carbon exchanges in Qatar. While specific details have not been revealed, the effort indicates Doha's commitment to advancing sustainable practices.

Establishing a carbon pricing mechanism—whether in the form of an ETS or a carbon tax—will require comprehensive legislation that is aligned with the country's economic goals. Robust emissions monitoring, reporting, and verification (MRV) systems are essential to ensure transparency and accountability. Qatar's infrastructure and its institutional capacity to implement a carbon market are still in their early stages. Building market readiness will

require investment in data management systems, skilled human capital, and institutional capacity to manage emissions trading. Coordination between the public and private sectors is critical for successful implementation.

The high share of GDP represented by the energy sector, downstream industries and energy-intensive chemical industries means that introducing carbon pricing could impose higher operational costs. On the other hand, such dominance implies a need for more substantial incentives to accelerate emissions cuts in the sector. A phased implementation, with transitional support, will be crucial to avoid economic shocks.

Qatar's key export markets in Asia and Europe are committed to using carbon markets as an emissions reduction mechanism, developing and managing ETSs, and constantly innovating to create new mechanisms such as CBAM. Considering Qatar's carbon-intensive exports to these regions, a lack of preparedness could mean that Qatar loses significant market share in the future.

In response to geopolitical developments in Ukraine and Russia in 2022, the EU accelerated its energy transition, revising the Green Deal (2019) and Fit for 55 (2021) targets, and diversifying its sources of natural gas. The May 2022 REPowerEU plan sets out how the bloc aims to end Russian gas imports by 2027 through enhanced energy efficiency, increased supply diversification—focusing on LNG—and an accelerated shift to renewables. Under this plan, the EU anticipates importing more LNG (+50 billion cubic meters) and additional pipeline gas, supported by a €10 billion investment in LNG infrastructure.

The EU External Energy Strategy, a component of REPowerEU, also outlines new international partnerships for additional gas and hydrogen supplies, engaging several countries—including Qatar.[19] However, the EU's CBAM may adversely affect Qatar's LNG and petrochemical exports to the EU. In October 2023, the EU began the initial phase of its CBAM, requiring importers to disclose the CO_2 emissions associated with certain goods, including steel and cement entering the bloc. This policy aims to protect domestic industries, which are already taking steps towards reducing their emissions, from competition by foreign producers with looser environmental standards. By 2026, the mechanism is slated to impose a carbon tariff on imports equivalent to the costs faced by EU manufacturers, ensuring a level playing field while driving global efforts to produce cleaner, less carbon-intensive products.

These challenges require some urgency in developing new systems to accelerate carbon reduction. Evolving climate policies and carbon border mechanisms introduced by the EU and other regions underscore the importance of timely and strategic action.

STRATEGIC RECOMMENDATIONS FOR QATAR

Qatar could accelerate efforts towards carbon reductions by establishing a dedicated government agency responsible for developing and overseeing carbon markets, including emissions trading systems (ETS) and carbon credits. This body would handle rulemaking for the carbon credit and ETS markets, organize the piloting and official operation of a carbon trading floor, manage allowance allocation, exchange, and surrender, and monitor the national greenhouse gas (GHG) inventory. By establishing a dedicated authority, Qatar could ensure proper oversight of its ETS and tap into a market that could generate revenues similar to other ETS regions, where auction proceeds from allowances have contributed over $74 billion globally.[20]

To ensure that Qatar remains informed about cutting-edge developments in the global carbon market, it would benefit by joining the International Carbon Action Partnership (ICAP) as an observer. ICAP, founded in 2007, brings together policymakers from governments operating or preparing to implement ETSs. Its 34 members and eight observers offer a platform to share practical experiences and knowledge.[21] Qatar's participation in ICAP would allow for early adoption of carbon market technologies and for Qatar to become a regional opinion leader in the Persian Gulf.

Qatar may also consider launching a domestic pilot ETS, initially focusing only on the energy sector, which is responsible for most of the country's GHG emissions. Given Qatar's high emissions from the production and refining of fossil fuels, an ETS with free allocations and a gradually declining cap would be a good starting point. This would allow industries to adjust gradually, encouraging emissions reductions without immediate financial strain. Over time, the system could expand to include other sectors. An ETS in the energy sector with a 2-3% annual declining cap could result in emissions reductions of approximately 3-4 $MtCO_2e$ annually in the early phases, eventually contributing to the pledged 25–30 $MtCO_2e$ reductions in under a decade.

The emergence of the EU's CBAM highlights the importance of being prepared for novel carbon pricing mechanisms. If CBAM-like mechanisms are implemented in the Asia-Pacific region, Qatar's exports could face carbon tariffs, impacting key sectors like LNG, which generated over $42.5 billion in net profits in 2022 for QatarEnergy, the state-owned oil and gas company.[22] A proactive approach, including early adoption of compliance carbon markets and collaboration with international partners, would help Qatar maintain its export competitiveness as these mechanisms take hold globally.

CONCLUSION

Carbon markets offer Qatar a strategic opportunity to reduce GHG emissions, diversify its economy, and maintain international competitiveness. By establishing a domestic ETS, linking with global markets, and channeling the generated revenue into developing carbon-sequestering projects, Qatar can position itself as a regional leader in the transition to a low-carbon economy. Considering the global momentum around carbon pricing, Qatar would benefit from undertaking rapid, strategic measures to safeguard its long-term economic growth and environmental responsibility in a world increasingly shifting away from carbon-intensive practices.

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5. The EU's Carbon Border Adjustment Mechanism (CBAM) is the EU's tool to put a fair price on the carbon emitted during the production of carbon-intensive goods that are entering the EU, and to encourage cleaner industrial production in non-EU countries.

6. A compliance carbon market is a regulated system established by governments or authorities to achieve mandatory carbon reduction targets. It operates on a cap-and-trade basis, where emissions are capped and permits are traded among regulated entities. Participation is mandatory for companies falling under specified emission thresholds, with strict monitoring and verification processes to ensure integrity.

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Conclusion

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CONCLUSION

Qatar has sought to balance its developmental needs with its environmental protection goals. In the process, it has set an ambitious target of reducing greenhouse gas emissions by 25 percent (compared to business as usual) by 2030. Leveraging the deep knowledge and expertise present in the country, in September 2024, the Middle East Council on Global Affairs and Earthna: Center for a Sustainable Future organized a workshop for leading scholars and policy experts to explore the policy implications of Qatar's developmental and environmental programs. The resulting policy briefs of this dossier summarize valuable insights to carbon emissions mitigation and reduction that align with Qatar's National Vision 2030, its socio-economic context, and its environmental imperatives.

The contributors note that the substitution of carbon-intensive fuels by Qatar's LNG exports initially contributed to reductions in global emissions. However, this offset may have declined since 2011, when demand for coal peaked. For Qatar to continue to contribute to global emissions reduction efforts, it needs to develop mitigation and diversification policies in a coordinated fashion across all sectors and in multiple dimensions. To achieve its ambitious decarbonization targets, Qatar can increase energy efficiency measures, expand its renewable energy projects, adopt carbon capture, utilization, and sequestration (CCUS) technologies, and introduce green financing instruments such as green bonds.

There is a unique international development dimension to Qatar's emissions reduction efforts, borne out of its role as a major energy exporter. Qatar's LNG production and expansion plans can continue to contribute to global emissions reductions by developing an export strategy that targets countries with a high share of coal in their energy mix and supporting LNG infrastructure development in energy poor countries that are poised to experience rapid economic growth. Qatar can also cultivate climate partnerships through technology transfers and targeted investments in the Global South.

In terms of clean energy, Qatar could work with international partners to advance the civilian use of nuclear technology, including SMRs, in areas such as food, health, and water. This can be done while being cognizant of the fact that deploying nuclear energy is politically challenging and requires strong regulations and safety measures across multiple domains. Additionally, hydrogen presents another promising avenue for Qatar's clean energy push. However, given the challenges facing hydrogen production and supply chains globally, it makes sense for Qatar to wait for the hydrogen market to mature before investing heavily.

Qatar can benefit from continued investment in emerging low carbon technologies, as developing and scaling up such technologies like CCUS will require significant investments and international partnerships in research, development, and infrastructure. Moreover, investments in R&D on desalination could open a new pathway for Qatar to reduce emissions, especially if guided by long-term institutional commitments. Initially, this would require finding solutions for demand management and incentivizing private sector participation to develop and retain expertise. In the medium-to-long term, Qatar could benefit from an R&D strategy that streamlines the piloting and deployment of new desalination technologies.

Carbon markets also offer Qatar a strategic opportunity to reduce emissions, diversify its economy, and maintain international competitiveness by lowering overall costs and transferring clean technologies and green finance instruments. To leverage carbon markets for its decarbonization efforts, Qatar should define conditional and unconditional mitigation measures, pursue bilateral cooperation agreements, prepare for the aviation sector's mandatory emissions offsetting program starting in 2027, strengthen regional cooperation regarding Article 6 implementation, and develop carbon credit purchase and equity funds to enhance the GCC's influence in global carbon markets.

Qatar can become a leader in the regional and global energy transition if it successfully navigates certain challenges and adopts a more agile policymaking approach to decarbonization. Taken together, the contributions to this dossier provide a rich and nuanced analysis of policy alternatives that Qatar's policymakers can leverage to both diversify their economy and achieve the country's ambitious emissions reduction targets.

ABOUT

THE MIDDLE EAST COUNCIL ON GLOBAL AFFAIRS

The Middle East Council on Global Affairs (ME Council) is an independent, non-profit policy research institution based in Doha, Qatar. The ME Council produces policy-relevant research, convenes meetings and dialogues, and engages policy actors on geopolitical and socioeconomic issues facing the Middle East and North Africa (MENA) region. The ME Council serves as a bridge between the MENA region and the rest of the world, providing a regional perspective on global policy issues and establishing partnerships with other leading research centers and development organizations across the MENA region and the world.

EARTHNA

Earthna Center for a Sustainable Future (Earthna) is a non-profit policy research and advocacy center, established by Qatar Foundation (QF) to promote and enable a coordinated approach to environmental, social, and economic sustainability and future prosperity. Earthna is the facilitator of sustainability efforts and action, and a convenor of climate change thinking and action, in Qatar and other hot and arid countries.

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