



By Engineers, For Everyone.

Development of Net-Zero Energy Technologies within the GCC

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Executive Summary

This research project evaluates the potential for strengthening the regional economic system of the Gulf Cooperation Council (GCC) to support the development and deployment of net-zero energy technologies. It maps key private, public, and non-profit entities, analyzes funding opportunities and partnerships, and assesses the challenges and drivers for adopting these technologies. The project's impact includes reducing reliance on hydrocarbons and addressing climate change, aligning with global sustainability goals.

The methodology involves desk research, stakeholder interviews, and data analysis to evaluate the maturity of the region's innovation ecosystem and compare it with global best practices.

The funding for net-zero energy initiatives in GCC countries comes from both the public and private sectors, with government investments playing a crucial role. Sovereign wealth funds like Saudi Arabia's Public Investment Fund and Qatar's Investment Authority have strategically invested in renewable energy projects. The private sector is increasingly involved, with venture capital firms and corporate entities supporting clean energy startups and innovation. Educational and research institutions, such as the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia and Qatar Science & Technology Park in Qatar, are driving research and development in renewable technologies. The United Arab Emirates, Saudi Arabia, and Qatar have implemented various incentives and policies to attract investments in renewable energy, aiming to diversify their economies away from hydrocarbons. Despite significant efforts, challenges remain, including the region's heavy reliance on fossil fuels, high subsidies, and the harsh environmental conditions that complicate the deployment of renewable energy systems. However, the GCC's commitment to international climate agreements and the long-term economic benefits of renewable energy are gradually reshaping the region's energy strategies. As global energy markets evolve, the GCC countries are increasingly focusing on clean energy to ensure economic stability and sustainability in the future.

A benchmarking study was conducted, comparing the peer program of the United States' Inflation Reduction Act with the initiatives in the GCC countries. While the GCC countries are dedicated to investing in renewable energy, the Inflation Reduction Act's centralized and well-structured approach differs from the more diverse and dispersed efforts seen across the GCC. The study shows that the U.S. is utilizing extensive financial resources and a solid policy strategy to spearhead green technology adoption, while the GCC is advancing significantly in solar and wind energy but contends with distinct challenges stemming from its economic dependence on fossil fuels.

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Project Background

Scope

This research aims to explore the potential for strengthening the regional economic system of the Gulf Cooperation Council (GCC) to promote the development and deployment of net-zero energy technologies. The scope includes identifying key private and public sector entities and evaluating their roles in supporting innovation ecosystems around these technologies. Additionally, it assesses funding mechanisms, partnerships, and the current landscape of programs and initiatives driving net-zero energy.

Objectives

The primary objectives of the project are:

- To map the existing private, public, and non-profit entities that are crucial to developing net-zero energy technologies within the GCC.
- To analyze the regional funding opportunities, partnerships, and policies that can accelerate the deployment of these technologies.
- To provide insights into key challenges, drivers, and incentives that shape the adoption of net-zero energy technologies in the GCC.

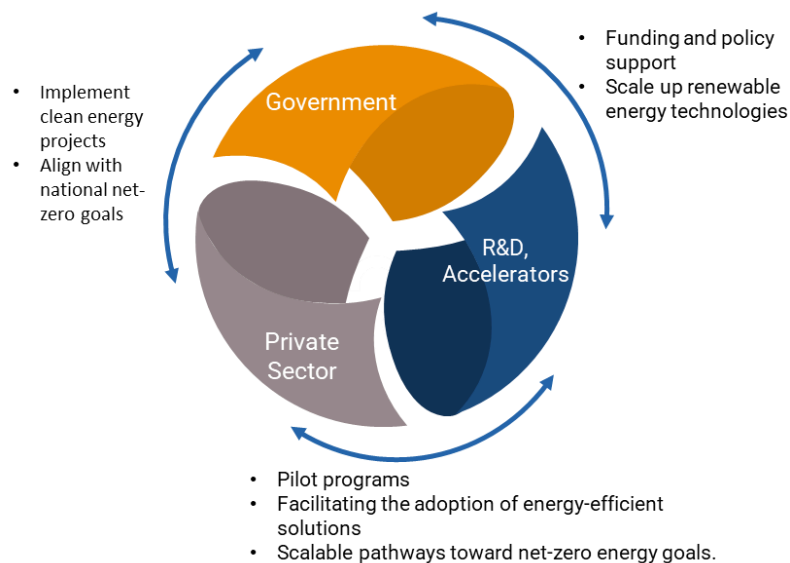


Figure 1. Relationship between net-zero energy stakeholders in the GCC.

Source: Author

Impact

The outcomes of this project are significant for both the energy transition and economic diversification goals of the GCC. By fostering the development and deployment of net-zero energy technologies, the region can reduce its reliance on hydrocarbons, create new job opportunities, and address the challenges of climate change, aligning with the global push for sustainability.

Methodology

The methodology follows a structured approach to ensure comprehensive coverage of net-zero energy technologies in the GCC. The key steps are as follows:

1. Desk research:
 - a. Reviewing documents and understanding the scope of work
 - b. Desk research: conducting a literature review to identify existing research, frameworks, and global best practices for the field.
2. Stakeholder interviews:
 - a. Shortlisting of entities: identifying and shortlisting key private, public, and non-profit entities, including universities, investors, and technical labs.
 - b. Setting out communication protocol.
 - c. Interviews.
3. Analysis & discussion: Analyzing the data to assess the maturity of the region's innovation ecosystem and presenting the findings through detailed discussion, including comparison with global regions.



Figure 2. Methodology of the Research.
Source: Engineering for Change

Current Initiatives in the GCC Region

Net-Zero Commitment of GCC Nations

The Paris Climate Agreement has led many nations, including those in the Gulf Cooperation Council (GCC), to commit to ambitious targets for net-zero carbon emissions by mid-century. Net-zero energy refers to systems that generate or use energy from renewable sources while balancing total energy consumption with energy production to achieve net-zero emissions.

With over 30% of the world’s proven oil reserves¹ and a growing interest in renewable energy, GCC countries are facing both the challenges of a carbon-intensive economy and opportunities to transition towards sustainable, low-carbon energy solutions.

The GCC region - comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE) - holds significant renewable energy potential, particularly in solar and wind energy. The region's vast desert landscapes, high solar irradiance, and coastal winds make it an ideal location for deploying renewable energy technologies. With global efforts to combat climate change accelerating, the GCC countries are seeking to transition toward net-zero energy systems, which means achieving a balance between the energy consumed and the renewable energy generated, while also reducing carbon emissions. They are setting ambitious targets to transition to net-zero emissions by mid-century. These commitments, outlined in Table 1, vary between 2050 and 2060, with the UAE and Saudi Arabia leading with more detailed road maps.

While renewable energy deployment in the GCC is progressing, the region faces challenges related to policy implementation, economic dependency on hydrocarbons, and technical hurdles like grid integration. However, investment in large-scale renewable projects, like Saudi Arabia's “Neom” and the UAE’s “Noor Abu Dhabi”, showcases the growing commitment to sustainable energy.

Table 1. GCC Countries' Strategic Targets

Country	Renewable Energy Target	Net-Zero Energy Target	Key Initiatives
UAE	50% by 2050 ²	2050	Energy Strategy 2050, Masdar Initiative
Saudi Arabia	50% by 2030	2060	Saudi Green Initiative, Neom
Qatar	18% by 2030 ³	No Target	National Environment and Climate Strategy
Kuwait	15-30% by 2030 50% by 2050 ⁴	No Target	National Development Strategy
Oman	30% by 2030	2050 ⁶	National Energy Efficiency Strategy

¹ Al-Maamary, Hilal MS, Hussein A. Kazem, and Miqdam T. Chaichan. "Renewable energy and GCC States energy challenges in the 21st century: A review." International Journal of Computation and Applied Sciences IJOCAAS 2, no. 1 (2017): 11-18.

² Al Naqbi, S., I. Tsai, and T. Mezher. "Market design for successful implementation of UAE 2050 energy strategy." Renewable and Sustainable Energy Reviews 116 (2019): 109429.

³ Qatar News Agency. (2024, June 29). *Kahramaa's director of production planning to QNA: Qatar's renewable energy set to rise to 18% of energy mix by 2030*. Retrieved 20-Sep-2024

⁴ Government of Kuwait. (n.d.). *State of Kuwait steps up efforts in renewable energy*. Retrieve 20-Sep-2024, from <https://e.gov.kw/sites/kgenglish/Pages/ApplicationPages/NewsDetail.aspx?nid=26565794>

⁶ Electricity and Water Regulatory Authority (Oman). (2023). *Net zero carbon report 2023*.

	70% by 2040 ⁵		
Bahrain	10% by 2035 ⁷	2060	National Renewable Energy Action Plan

Significant Initiatives

This overview highlights the renewable energy initiatives and developments across GCC countries, focusing on their efforts to diversify energy sources and reduce reliance on fossil fuels. Each country - Oman, Bahrain, Kuwait, Qatar, Saudi Arabia, and the UAE - has launched significant projects and strategies to increase renewable energy capacity, enhance energy efficiency, and align with global sustainability goals. From large-scale solar projects to investments in wind energy, these nations are progressively working towards achieving their energy transition targets, with a particular emphasis on solar, wind, and nuclear energy^{8,9,10}.

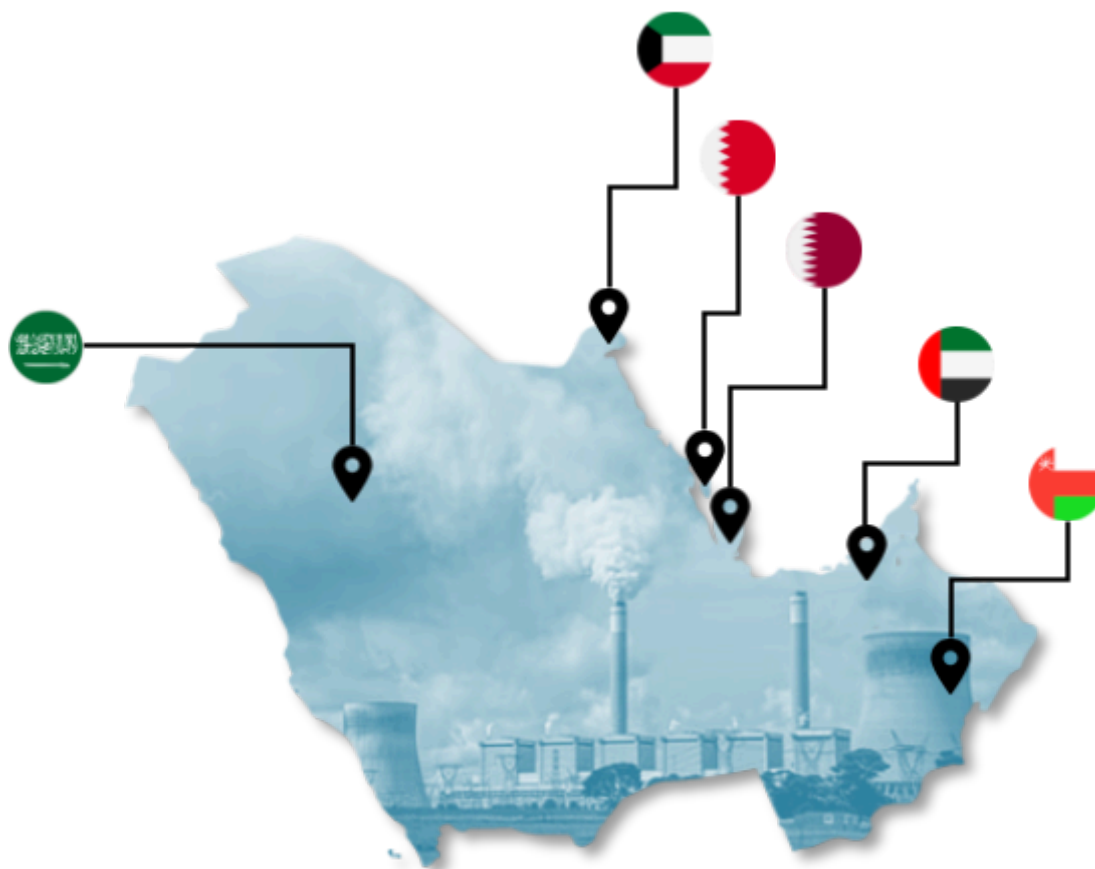


Figure 3. National flags of the Gulf Cooperation Council member countries.
Source: Author

⁵ Times of Oman. (2023, September 16). *Oman to produce 30% of energy from renewable sources by 2030*. Retrieved 20-Sep-2024

⁷ Sustainable Energy Authority (SEA), Kingdom of Bahrain. (n.d.). *National Renewable Energy Action Plan (NREAP)*. Sustainable Energy Authority.

⁸ IRENA. (2023). *Renewable energy markets: GCC 2023*. International Renewable Energy Agency. <https://www.irena.org/publications>

⁹ Gulf Research Center. (2023). *GCC energy & power industry report*. Gulf Research Center. <https://www.grc.net>

¹⁰ GCC Unified Manufacturing Strategy

Oman

Though not a member of the Organization of the Petroleum Exporting Countries (OPEC), Oman is a key producer of oil and natural gas in the Middle East, relying primarily on fossil fuels for energy and exporting its surplus. The country is self-sufficient in energy due to domestic production.

Despite this, there have been recent developments in Oman's renewable energy sector¹¹. These include:

- **Ibri Solar Power Plant:** This is Oman's largest solar power project, with a capacity of 500 MW. It plays a crucial role in the country's strategy to generate 30% of its electricity from renewable sources by 2030.
- **Dhofar Wind Farm:** Oman's first large-scale wind farm, Dhofar, has a capacity of 50 MW and is part of the country's efforts to diversify its energy mix and utilize its renewable resources.
- **A 100 MW solar photovoltaics (PV) project** at Amin, developed by a group led by Japan's Marubeni and Petroleum Development Oman (PDO), was initiated through a power purchase agreement (PPA).

As of 2021, Oman produced more electricity than needed, with 100% of the population having access to power. In 2020, total electricity generation was 38,256 GWh, with renewables contributing 211 GWh, primarily from solar and wind. Oman plans to generate 30% of its electricity from renewable sources by 2030, aligning with Oman Vision 2040 and opening opportunities for international business partnerships.

Bahrain

Bahrain is the smallest oil and gas producer in the Gulf region, but its energy independence may grow due to recent oil and gas discoveries. The country has two key oil fields: the onshore Bahrain (Awali) field and the offshore Abu Safah field, the latter jointly owned with Saudi Arabia. Bahrain's Ministry of Oil and Gas, in partnership with international companies, is also exploring deeper gas reserves in the onshore field.

Key renewable energy developments in Bahrain include:

- **Bahrain Solar PV Park¹²:** Bahrain has launched a tender for its first utility-scale solar photovoltaics (PV) park, which is expected to have a capacity of 100 MW. This project aligns with Bahrain's National Renewable Energy Action Plan.
- **Waste-to-Energy Projects:** Bahrain is also exploring waste-to-energy (WTE) technologies, which aim to reduce waste while generating electricity, contributing to the country's renewable energy and environmental goals. Currently, the leading WTE project is the Askar 25MW biopower project, owned by the Ministry of Works, Municipalities Affairs and Urban Planning. The project is planned to start the construction phase in 2026¹³.

Bahrain produces 2 billion cubic feet of gas daily for electricity and industrial use, with plans to import LPG to ensure supply during peak hours¹⁴. In 2022, Bahrain generated 33,958 GWh of electricity, with only 84 GWh from

¹¹ Amoatey, Patrick, Amer Al-Hinai, Abdullah Al-Mamun, and Mahad Said Baawain. "A review of recent renewable energy status and potentials in Oman." *Sustainable Energy Technologies and Assessments* 51 (2022): 101919.

¹² Emiliano Bellini, "Bahrain launches 100 MW PV tender." *PV Magazine* (2024). Retrieved 05-Nov-2024 from <https://www.pv-magazine.com/2024/02/13/bahrain-launches-100-mw-pv-tender-2/>

¹³ World Future Energy Summit. (n.d.). "Waste to energy: Powering the future". Retrieved 20-Sep-2024, from <https://www.worldfutureenergysummit.com/en-gb/future-insights-blog/blogs/waste-to-energy.html#:~:text=Currently%2C%20the%20leading%20WTE%20project,operations%20starting%20the%20following%20year.>

¹⁴ Ron Bousso, "CERAWEEK-Bahrain explores constructing LNG export facility." *Reuters Business* (2023). Retrieved 05-Nov-2024

renewables, primarily solar (98.8%) and wind (1.2%)¹⁵. The country aims to diversify its energy sources, focusing on renewable energy and energy efficiency infrastructure, while aligning with Vision 2030 to reduce carbon emissions and promote sustainability.

Kuwait

Kuwait is one of the world's leading producers and exporters of petroleum liquids. It is heavily dependent on fossil fuels for its energy needs and water desalination, which supplies 90% of the country's water¹⁶. The government heavily subsidizes electricity, water, and oil products, covering nearly 95% of electricity production costs. Although there have been new oil discoveries, the progress in Kuwait's regulated oil sector has been slow, with some efforts focused on improving oil recovery.

Key energy sector initiatives in Kuwait include:

- **Shagaya Renewable Energy Park**¹⁷: This project is Kuwait's flagship renewable energy initiative, with a target capacity of 3.2 GW by 2030. The park will include a mix of solar PV, concentrated solar power (CSP), and wind energy projects.
- **Two major refinery projects**¹⁸: the Clean Fuels project and the Fourth Refinery, with expansions planned for the Mina Abdulla and Mina Al-Ahmadi refinery complexes. These projects are expected to cost the country \$50 billion and show an overall strategy targeted towards the downstream petroleum industry.
- **Solar power plants**: In June 2023, the Kuwait Oil Tanker Company (KOTC) began the construction of two solar power plants, expected to generate 7 megawatts of power in an effort to contribute towards achieving net-zero energy targets by 2050.¹⁹

In 2022, total energy production reached 83,544 GWh, with only 1900 GWh from renewables. In contrast to Bahrain, the renewable energy source is mainly wind (90.6%), while the remaining 9.4% is from solar energy. Kuwait plans to increase renewable energy projects and aims to meet 15% of energy demand from renewables by 2030. As energy demand is projected to triple by 2030, Kuwait is focusing on diversifying its energy mix, emphasizing solar and wind. The Kuwait Petroleum Corporation simultaneously plans to boost oil and natural gas production by 2030²⁰

<https://www.reuters.com/business/energy/cerawee-bahrain-explores-constructing-lng-export-facility-2023-03-08/#:~:text=Bahrain%20produces%20around%202%20billion,offshore%20field%2C%20according%20to%20Nogaholding>.

¹⁵ International Renewable Energy Agency (n.d.). "Energy Profile: Bahrain". Retrieved 05-Nov-2024 from https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Middle%20East/Bahrain_Middle%20East_RE_SP.pdf

¹⁶ Alhajer, Nawaf S., Fahad M. Al-Fadhli, Ahmed Z. Aly, Andrew Reimrs, and Michael E. Webber. "Electric power system profile in Kuwait: electricity and water generation, fuel consumption, and cost estimation." *ACS Sustainable Chemistry & Engineering* 6, no. 8 (2018): 10323-10334.

¹⁷ Steensma, Gilein, Rubén Román, Craig Marshall, Julián Bermejo, Krishnaswamy Iyer, Salem Al-Hajraf, and Ayman Al-Qattan. "Shagaya renewable energy park project." In *AIP Conference Proceedings*, vol. 2126, no. 1. AIP Publishing, 2019.

¹⁸ Oxford Business Group (n.d.). "Two Kuwaiti energy projects aim to improve local refining capacity and petrochemicals production". Retrieved 05-Nov-2024 from <https://oxfordbusinessgroup.com/reports/kuwait/2019-report/economy/front-and-centre-two-projects-aim-to-dramatically-improve-local-refining-capacity-and-petrochemicals-production>

¹⁹ State of Kuwait Ministry of Oil (2023). "(KOTC) inaugurates the construction of two electricity generation stations using solar energy". Retrieved 05-Nov-2024 from <https://www.moo.gov.kw/single-news.aspx?par1=9441>.

²⁰ International Energy Agency (2023). "Energy system of Kuwait". Retrieved 05-Nov-24 from <https://www.iea.org/countries/kuwait>

Qatar

According to the 2021 statistics from the United States Energy Information Administration, Qatar possessed the sixth-largest reserve of dry natural gas, ranked the second-largest exporter of liquefied natural gas (LNG), and was the third-largest producer of natural gas overall²¹. Its high natural gas production yields valuable byproducts like hydrocarbon gas plant liquids (HGLs) and lease condensates. Qatar is also a leader in gas-to-liquids (GTL) production, housing the largest GTL facility worldwide.

The energy sector is vital to Qatar's economy, contributing 81% of total revenues in 2021, up from 77% in 2020. Hydrocarbon export revenues also rose, increasing from \$47 billion in 2020 to nearly \$77 billion in 2021.

Key initiatives in Qatar's energy sector include:

- **Al Kharsaah Solar PV Plant²²**: Qatar's first large-scale solar power plant, Al Kharsaah, has a capacity of 800 MW and is expected to meet around 10% of the country's peak electricity demand once fully operational.
- **Umm Al Houl Power Plant²³**: Although primarily a desalination and power generation plant, it includes renewable energy components and is part of Qatar's broader strategy to incorporate sustainable energy solutions.
- **Awarding a contract to McDermott Middle East Inc.** for the LNG North Field Expansion Project in early 2022²⁴.

Bioenergy made up 79% and solar 21% of Qatar's renewable capacity in 2021. Qatar Energy's Sustainability Strategy focuses on reducing carbon emissions and aligns with Qatar National Vision 2030, the UN's Sustainable Development Goals, and the Paris Agreement.

Saudi Arabia

Saudi Arabia possesses approximately 15% of the world's proven oil reserves and is the leading exporter of crude oil globally. To address the growing energy demand from residential and commercial sectors, the country is enhancing its power sector and striving to diversify its energy mix.

Key renewable energy initiatives include:

- **New energy sources**: Replacing 42% of the petroleum used for generating 110 GW of electricity daily with a balanced mix of natural gas and renewable energy by 2030. The Ministry of Energy plans to invest \$293 billion in power and renewable projects by then.
- **Establishing the Saudi Nuclear Energy Holding Company** to expand nuclear energy capacity.

²¹ U.S. Energy Information Administration (2023). "Qatar natural gas production and exports stable as country eyes expansion". Retrieved from <https://www.eia.gov/todayinenergy/detail.php?id=57300#:~:text=In%202021%2C%20Qatar%20was%20the,updated%20Country%20Analysis%20Brief%3A%20Qatar>.

²² Power Technology (2023). "Al Kharsaah Solar Power Project". Retrieved from <https://www.power-technology.com/projects/al-kharsaah-solar-power-project/?cf-view>

²³ Power Technology (2024). "Power plant profile: Umm Al Houl IWPP, Qatar". Retrieved from <https://www.power-technology.com/data-insights/power-plant-profile-umm-al-houl-iwpp-qatar/>

²⁴ McDermott (2024). "QatarEnergy LNG Awards McDermott EPCI Contract for the North Field South Offshore Pipelines and Cables Project". Retrieved from <https://www.mcdermott-investors.com/news/press-release-details/2024/QatarEnergy-LNG-Awards-McDermott-EPCI-Contract-for-the-North-Field-South-Offshore-Pipelines-and-Cables-Project/default.aspx>

- **Launching the Sudair Solar Plant Project**, which aims to be Saudi Arabia's largest solar plant, is expected to provide 70% of the country's renewable energy by 2030.

Saudi Arabia is the second-largest global producer of petroleum liquids and the largest crude oil producer in OPEC, with a capacity of nearly 12 million barrels per day. To reduce oil use in power generation, Saudi Arabia plans to develop 58 GW of solar and wind energy, phase out diesel power stations, and implement smart grid technology. By 2040, the country aims to double its power generation capacity to 160 GW, investing \$5 billion annually in generation and \$4 billion in distribution and transmission. The government also plans to privatize all electricity generation by 2025 to improve efficiency and meet environmental standards.

United Arab Emirates

The UAE, with 100 million barrels of proven oil reserves in Abu Dhabi, ranks as the world's sixth-largest oil producer, with a daily output of 3.2 million barrels of petroleum and liquids. Oil and gas contribute around 30% to the country's GDP and 13% of its total exports. In response to increasing energy demand, the UAE is focusing on developing a balanced energy mix for sustainable growth.

Key initiatives include:

- **Hosting the annual World Future Energy Summit** for clean energy and sustainability since 2008, with the 2023 event held in Abu Dhabi.
- **Signing a Memorandum of Cooperation with Japan** on hydrogen in 2021.
- **Partnering with Russia in 2021** to develop hydrogen production, transportation, and storage.
- **Launching the Net Zero 2050 strategy**, aiming to achieve net zero emissions by 2050, while promoting sustainable economic growth.
- **Barakah Nuclear Power Plant**: Although primarily a nuclear energy project, Barakah's significance lies in its contribution to the UAE's clean energy mix, aiming to provide a significant portion of the country's electricity needs with zero emissions.
- **Mohammed bin Rashid Al Maktoum Solar Park**: Located in Dubai, this is one of the world's largest solar parks, with a planned capacity of 5 GW by 2030. The project has been instrumental in reducing the UAE's carbon footprint and is central to Dubai's Clean Energy Strategy.
- **Al Dhafra Solar PV Project**: This solar power project, located in Abu Dhabi, is set to be the world's largest single-site solar plant with a capacity of 2 GW. It has achieved a world-record low tariff for solar energy, highlighting the UAE's leadership in cost-effective renewable energy development.

The UAE leads the GCC in energy transition, driven by strong government commitment. Its renewable energy sector is set to grow significantly, with renewable capacity projected to increase by 16.7% annually from 2021 to 2030, making up 11.3% of the energy mix by 2030. The UAE plans to focus more on green hydrogen and solar energy, aligning with its Net Zero by 2050 goals.

Existing Private & Public Sectors Supporting Net-Zero Energy

Accelerators

Accelerators play a pivotal role in advancing net-zero energy technologies by providing crucial financial backing, mentorship, and access to networks. These programs foster innovation by supporting startups and early-stage companies that are developing cutting-edge solutions aimed at reducing carbon emissions. In the GCC region, several accelerators are driving the growth of sustainable energy ventures, helping to bridge the gap between innovative ideas and market deployment.

Table 2. GCC Accelerators/Programs.

Country	Accelerator	Program	Rational	Sample of Projects
UAE	Catalyst		A technology start-up accelerator focused on sustainability and clean technology.	
	Al Qasimi Foundation	Seed Research Grants	Start-up funding (maximum 50,000 AED)	
	Hub71	Hub71+ ClimateTech	Elevate startups that aim to accelerate decarbonization and sustainable technologies.	
Saudi Arabia	King Abdullah University of Science and Technology (KAUST)	Taqadam		• Eden GeoPower • Mirai Solar
	Aramco	LAB7	LAB7 provides resources, mentorship, and technical expertise to help innovators develop and scale their ideas, particularly in areas related to energy, sustainability, and technology.	
		Wa'ed Venture	Aramco's venture capital fund supporting the start-up ecosystem in Saudi Arabia by investing in local tech-based start-ups and localizing pioneering global innovations, including in the energy industry.	
		Taleed	Focuses on enhancing the capabilities of SMEs through access to financing, market opportunities, and mentorship, aiming to contribute to the diversification and growth of the Saudi economy, in line with the Vision 2030 goals.	
	King Abdulaziz City for	NSTIP Grants	The National Science, Technology, and Innovation Plan (NSTIP) offers grants focusing on strategic technologies essential for development, including renewable energy,	

	Science and Technology (KACST)		biotechnology, and IT.	
		Technology Incubators and Accelerators Program (TIAP)	This program aims to promote the concept of technology entrepreneurship and transform technological projects into successful business opportunities.	
		The Garage	A startup accelerator designed to foster innovation and entrepreneurship in Saudi Arabia aligning with the Kingdom's Vision 2030 goals.	
Qatar	Qatar Science and Technology Park (QSTP)	Product Development Fund	Funding of up to 50% of the cost of a product or service proposal. Total funding value/project of up to QAR 1.2M. Aimed at local small and medium-sized enterprises (SMEs), or startups in the private sector, with at least 20% Qatari share ownership with a focus on one of the priority sectors: Energy, Environment, Healthcare, or ICT.	• Iberdrola
		Research to Startup Program (RTS)	QSTP has developed the Research to Startup (RTS) program to direct this notable initiative in an effort to support both researchers and entrepreneurs.	• Applab Software Trading • Twyla Technology WLL
		ELV8	A launchpad for Qatar's tech startups, helping to expand their business into new international markets.	
	Digital Incubation Center	Idea Camp	IdeaCamp accepts applications for emerging technologies. Priority is given to entrepreneurs who submit ideas that serve the many sectors, including sustainability.	
	Qatar Business Incubation Center (QBIC)	Lean Acceleration Program	An initiative aimed at fast-tracking the growth of early-stage startups in Qatar. It offers entrepreneurs intensive mentorship, funding, and resources to refine their business models and scale their ventures rapidly, supporting Qatar's vision of becoming a hub for innovation and entrepreneurship.	
		The Lean Startup Program (LSP)	Helps early-stage startups quickly validate and scale their business ideas through mentorship, funding, and resources, fostering innovation and entrepreneurship in Qatar.	
	TASMU	Tasmu Accelerator	For companies in Environmental, Logistics, Health, Transportation Management System (TMS), Angel, Pre-seed, or Seed.	

Investors

This list highlights key investors focused on renewable energy in the GCC region, including sovereign wealth funds, private equity firms, and corporate entities. These investors are driving significant capital into solar, wind, and other sustainable energy projects, aligning with the region's goals of energy diversification and sustainability.

Table 3. GCC Investors.

Country	Investor	Rational	Sample of Projects
UAE	Dutco	A UAE-based conglomerate. Invested in X-NOOR, a joint venture between X-ELIO and DUTCO, that focuses on investing in and developing large-scale renewable energy projects in the Middle East.	● X-NOOR
Saudi Arabia	Public Investment Fund (PIF)	A sovereign wealth fund driving the Kingdom's Vision 2030, focusing on diversifying the economy. PIF is heavily investing in renewable energy projects, including the NEOM Green Hydrogen project and various large-scale solar and wind initiatives, to position Saudi Arabia as a global leader in clean energy.	● Industrialization & Energy Services Company (Taqa) ● National Energy Services Company (Tarshid)
	Desert Technology		● Nurun Digital Energy ● Capton Energy
	Aramco	Namaat works on transaction deals that form ventures with leading businesses around the world, pooling our resources to bring new ideas to life. All this helps us play a key role in developing a vibrant, world-class, competitive energy and industrial ecosystem.	● Namaat program
Oman	Green Energy Oman (A consortium Project)	A large-scale renewable energy project funded by a consortium of international and local partners. The key stakeholders involved in funding and developing the project include InterContinental Energy, Enertech, and OQ, Oman's integrated energy company.	
Kuwait	EnerTech Holding Company		
	National Technology Enterprises Company		

Significant Funded Projects

Eden GeoPower

Specialized in developing scientific and practical patent-protected technical solutions to sustainably extract natural resources faster and cheaper than traditional solutions currently available in the market.

It is supported by local entities like NEOM, Petroleum Development Oman, Oman Ministry of Energy and Minerals, and International entities like Arpa Awardee, National Science Foundation (NSF), Good Growth Capital, Tech Energy Ventures, Mass Ventures, Portfolia, AngloAmerican, Think & Act Differently

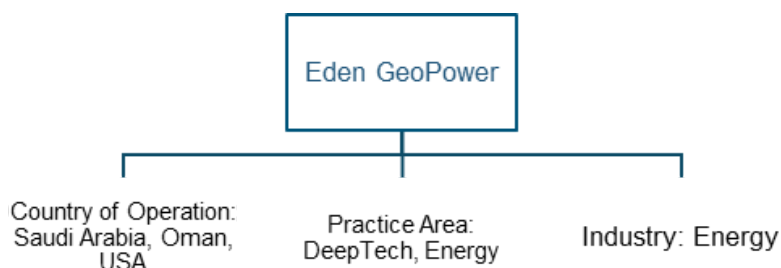


Figure 4. Eden GeoPower operations overview.
Source: Author

Iberdrola

An expansion to the Spanish group's Research, Development, and Innovation (RDI) activities. It is a multinational electric utility company focused on providing quality service with clean energy sources.

Iberdrola Innovation Middle East was launched in 2016 and is mainly located in Qatar Science and Technology Park; however, it also has cooperation with TASMU, Qatar Research Development and Innovation Council, Qatar National Research Fund, Hamad Bin Khalifa University, Kahramaa, and the Ministry of Commerce & Industry.

Aims to:

- Establish a world-leading innovation center to advance digital utility in Qatar.
- Advance the digital utility industry by unlocking the growth potential of the RDI ecosystem in Qatar.
- Develop local talent through Iberdrola's skills development and training programs. Similarly, it entails Iberdrola's transfer of knowledge as well as the sharing of Intellectual Property rights with relevant educational and industrial institutions.

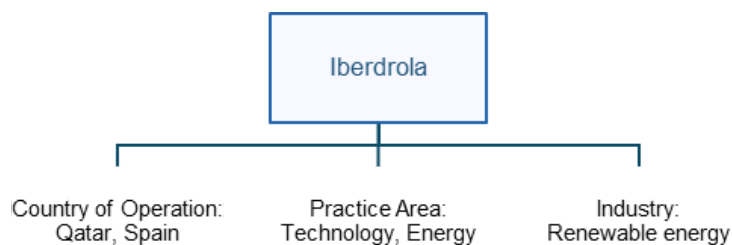


Figure 5. Iberdrola operations overview.
Source: Author

Desert Technologies

Desert Technologies is a Saudi Arabian company specializing in the production of solar energy solutions. As a fully integrated solar company, it focuses on manufacturing, developing, and investing in solar projects across the Middle East and Africa.

The company was founded as a declaration from the King of Saudi Arabia to play a significant role in advancing Saudi Arabia’s renewable energy goals by providing innovative solar technologies and supporting the region’s transition to clean energy.

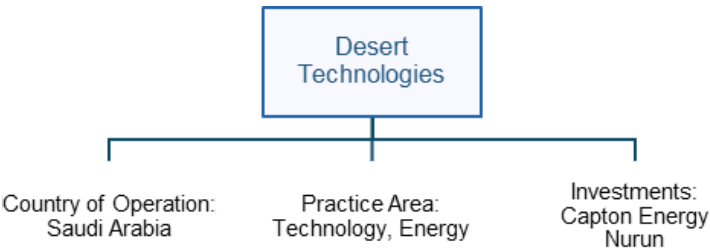


Figure 6. Desert Technologies operations overview.
Source: Author

Mirai Solar

Mirai Solar is a Saudi Arabian company that was founded with support from KAUST. The company specializes in developing innovative solar technologies, including lightweight and flexible solar panels designed for various applications. Mirai Solar aims to enhance the adoption of renewable energy in the region by providing versatile and efficient solar solutions, contributing to Saudi Arabia's sustainability and energy diversification goals.

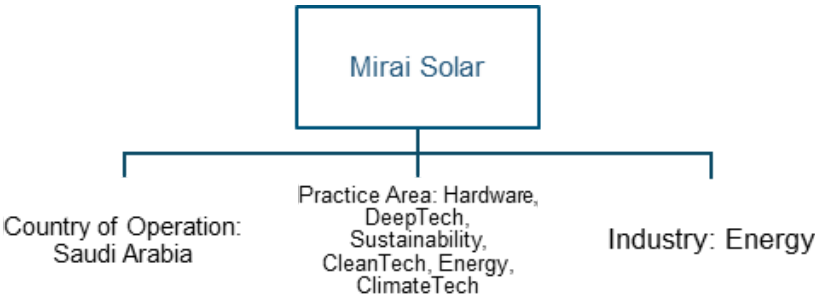


Figure 7. Mirai Solar operations overview.
Source: Author

Discussion

Sources of Funding

Sources of funding for net-zero energy initiatives in GCC countries are diverse and stem from both the public and private sectors. Government funding plays a central role, with several countries in the region allocating substantial resources through national strategies aimed at promoting sustainable energy and reducing carbon emissions.

Sovereign Wealth Funds

Such as the Saudi Public Investment Fund and the Qatar Investment Authority, have made strategic investments in renewable energy projects and green technologies. The list of the sovereign wealth funds in each GCC country:

1. United Arab Emirates: Abu Dhabi Investment Authority, Investment Corporation of Dubai
2. Saudi Arabia: Public Investment Fund
3. Qatar: Qatar Investment Authority
4. Oman: Oman Investment Authority
5. Kuwait: Kuwait Investment Authority
6. Bahrain: Mumtalakat Holding Company

Private Sector

Private sector contributions are growing, with venture capital firms and corporate entities increasingly investing in clean energy startups and innovation hubs.

Educational and Research Institutes

In addition to accelerators and sovereign wealth funds, educational and research institutes play a crucial role in fostering innovation and supporting net-zero energy technologies across the GCC. Some key institutions include:

1. **King Abdullah University of Science and Technology (KAUST) – Saudi Arabia:**

KAUST is a leader in clean energy research, focusing on areas such as solar energy, energy storage, and environmental sustainability. The university also fosters collaboration between academia and industry to drive innovation.

2. **Qatar Science & Technology Park (QSTP) – Qatar:**

QSTP is a hub for research, development, and innovation, supporting startups and established companies in developing cutting-edge technologies, including clean energy solutions. It offers incubation services and access to funding and mentorship.

3. **Masdar Institute of Science and Technology (part of Khalifa University) – United Arab Emirates:**

This research-driven graduate university is heavily involved in advancing renewable energy technologies and sustainability. It works closely with Masdar City, a pioneering sustainable urban development.

4. **Sultan Qaboos University – Oman:**

Sultan Qaboos University has a growing focus on research related to renewable energy and environmental sustainability, with initiatives aimed at reducing the carbon footprint and supporting Oman's transition to cleaner energy.

International Organizations and Financial Institutions

Such as the World Bank and the International Renewable Energy Agency also provide grants and loans to support renewable energy development in the region.

Together, these funding sources create a robust financial ecosystem that is crucial for the successful deployment of net-zero energy technologies across the GCC.

Incentives

GCC countries are increasingly offering a range of incentives to bolster renewable energy startups, positioning the region as a hub for clean technology innovation. Governments are implementing favorable policies, grants, tax benefits, and low-cost financing to attract entrepreneurs and foster a vibrant renewable energy ecosystem. For example, in the UAE, renewable energy startups benefit from incentives such as full foreign ownership in free zones like Masdar City, tax exemptions, and access to state-of-the-art research and development facilities. Additionally, the UAE has launched initiatives such as Dubai Future Accelerators and Masdar's incubator programs, which provide financial support, mentorship, and strategic partnerships for startups innovating in solar energy, energy efficiency, and sustainable technologies.

In Saudi Arabia, the government is actively driving renewable energy through Vision 2030 and initiatives like Wa'ed Ventures, Aramco's venture capital arm, which offers funding to early-stage companies in the clean energy sector. Wa'ed Ventures also provides startups with access to ecosystem resources, mentorship, and support through partnerships with established industry players. Additionally, Saudi Arabia's SAGIA (Saudi Arabian General Investment Authority) offers a range of incentives such as tax reductions and subsidies for renewable energy projects, ensuring a business-friendly environment for innovators.

In Qatar, Qatar Science & Technology Park (QSTP) serves as a key accelerator for renewable energy startups, offering seed funding, incubator facilities, and R&D support. QSTP collaborates with international and local institutions to create a thriving ecosystem for startups focused on solar and wind energy, as well as energy storage technologies. Qatar also promotes access to government contracts and strategic partnerships for startups, along with significant financial incentives and low-cost operational environments. Furthermore, regional initiatives such as the NEOM Green Hydrogen Project in Saudi Arabia and ACWA Power's extensive renewable energy projects provide additional opportunities for startups to collaborate and contribute to large-scale clean energy initiatives.

Together, these incentives create a dynamic environment that supports the growth of renewable energy startups, contributing to the GCC's broader net-zero energy goals²⁵.

²⁵ Saudi Aramco. (2023). *Brand architecture interactive*. Saudi Aramco.

Interest in Renewable Energy

GCC aims to bring these countries together through shared objectives, political alignment, and cultural values. Notably, these nations rank among the top 25 for the highest CO2 emissions per capita. Fossil fuels dominate the region's energy consumption, with low costs for primary energy and electricity. Saudi Arabia has the largest oil reserves (267.19 billion barrels), followed by Kuwait (101.50 billion barrels) and the UAE (111.00 billion barrels). Qatar also possesses one of the world's largest natural gas reserves. However, the abundance of fossil fuels in these countries has led to relatively low investment in renewable energy sources.

The attitude towards renewable energy in the GCC region is shaped by several unique factors, including the affordability and availability of fossil fuels. Historically, energy in the GCC has been heavily subsidized, making it cheaper for residential and industrial consumers, which reduces the immediate economic incentives to transition to renewable energy. The region has benefited from selling oil and natural gas domestically at significantly reduced prices, which has created a barrier for renewable energy adoption. As a result, both residential and commercial sectors have been slow to adopt renewable technologies, even though the technical merits of solutions like solar photovoltaic (PV) systems are recognized²⁶.

Wejdan Alghamdi, the manager at Mirai Solar, stated that their company has observed limited interest in renewable energy among the people in Saudi Arabia, with the USA market showing greater receptiveness to their products, followed by European markets. She attributed this to low awareness and affordable energy costs in the GCC region, which reduce the incentives for transitioning to renewable energy.

This reliance on inexpensive fossil fuels, combined with abundant reserves, has traditionally disincentivized the shift towards renewable energy. However, as the global energy landscape evolves, GCC countries are beginning to realize the importance of diversifying their energy mix to reduce reliance on hydrocarbons. Government initiatives and energy price reforms, particularly in Saudi Arabia, Oman, and the UAE, are helping create a more favorable environment for renewable energy by encouraging investments in technologies like solar and wind²⁷. Despite the slow pace of change, there is growing awareness of the long-term economic and environmental benefits of renewable energy, with large-scale projects like Saudi Arabia's NEOM and the UAE's Energy Strategy 2050 leading the way.

Thus, while cheap fossil fuels have contributed to a slow transition towards renewable energy in the GCC, rising awareness of climate change, energy security concerns, and economic diversification needs are gradually reshaping the region's energy strategy.

Reflection on challenges in the project

In alignment with the project methodology, which emphasizes conducting a comprehensive range of interviews, the project team successfully reached out to approximately 21 entities, with some entities involving more than one representative. However, despite these efforts, interviews were conducted with only two companies. The response rate was notably low, indicating a limited level of engagement and a less established connection between companies and research in the renewable energy sector. This situation highlights an additional, less visible challenge to advancing the energy transition in the region.

²⁶IRENA. (2023). Renewable energy markets: GCC 2023. International Renewable Energy Agency. <https://www.irena.org/publications>

²⁷ Gulf Research Center. (2023). *GCC energy & power industry report*. Gulf Research Center. <https://www.grc.net>.

Main Drivers and Challenges

Main Drivers

The transition to net-zero energy in the GCC faces several key drivers and challenges. One of the main drivers is **the need for economic diversification**, as the region's heavy reliance on hydrocarbons exposes it to global oil price fluctuations and declining demand for fossil fuels. Governments in the region, especially in Saudi Arabia and the UAE, have set ambitious renewable energy targets to reduce this dependence, with plans such as Saudi Arabia's Vision 2030 and the UAE's Energy Strategy 2050. Both countries aim to significantly increase their renewable energy capacity, leveraging their abundant solar resources²⁸.

Another important driver is the **region's commitment to international climate agreements**. Countries like the UAE and Saudi Arabia have pledged to reach net-zero emissions by 2050 and 2060, respectively, aligning their energy policies with global climate goals²⁹. Additionally, GCC countries are exploring the potential of new technologies such as carbon capture, utilization, and storage, as well as hydrogen production, to complement their renewable energy initiatives³⁰.

Challenges

However, there are significant challenges as well. **The cost of renewable energy projects in the region remains higher than traditional fossil fuel-based power generation**, partly due to the high subsidies for fossil fuels, which reduce the competitiveness of clean energy. Furthermore, the region's harsh environmental conditions, such as high temperatures and dust, present operational challenges for renewable energy systems, particularly solar PV³¹. There is also a need to enhance public awareness and engagement, as many citizens and businesses have been slow to adopt renewable energy technologies due to historically low energy prices³².

Energy price fluctuations and emissions pricing could significantly affect the financial markets in GCC countries, as **their economies are heavily reliant on energy exports**. Climate change could lead to a 1% annual GDP loss for these nations, highlighting the need for clean energy to support economic growth. Kuwait, one of the top 10 oil producers globally, derives 90% of its export income and 40% of its GDP from oil. Despite financial and political stability, the Gulf economies face vulnerabilities due to their over-reliance on oil and gas exports, posing a risk of economic downturns.

²⁸ Gulf Research Center. (2023). *GCC energy & power industry report*. Gulf Research Center. <https://www.grc.net>

²⁹ Al-Sarihi, A. (2021). *Climate action in the GCC: Current status and future prospects*. JIME-IEEJ International Symposium.

³⁰ Dr. Samuel Short, Cop26: visions for a net-zero future regional profile for the arabian peninsula

³¹ IRENA. (2023). *Renewable energy markets: GCC 2023*. International Renewable Energy Agency. <https://www.irena.org/publications>

³² Babonneau, F., Badran, A., Haurie, A., Schenckery, M., & Vielle, M. (2023). *GCC countries strategic options in a global transition to zero-net emissions*. *Environmental Modeling & Assessment*, 28, 709–733. <https://doi.org/10.1007/s10666-023-09904-2>

Benchmarking

Inflation Reduction Act

The Inflation Reduction Act (IRA) is a landmark U.S. legislation aimed at addressing inflation, reducing carbon emissions, and accelerating the transition to clean energy through significant investments in renewable energy, green technologies, and climate initiatives.

An expert recommendation through the research has pointed out the necessity to learn from the IRA experience in the GCC energy market. Comparing the IRA with the efforts of GCC countries is crucial because it highlights the different approaches and scales of investment in renewable energy. The GCC, heavily reliant on fossil fuels, faces unique challenges and opportunities in transitioning to a sustainable energy future, making such a comparison essential for understanding global energy shifts and regional economic impacts.

While both the IRA and GCC countries are committed to renewable energy investments, the IRA's centralized and comprehensive approach contrasts with the more fragmented and varied efforts across the GCC. The U.S. is leveraging significant financial resources and a coordinated policy framework to lead in green technology adoption, whereas the GCC is making substantial progress, particularly in solar and wind, but faces unique challenges due to its economic reliance on fossil fuels. The success of both will ultimately depend on the ability to scale investments, integrate advanced technologies, and achieve long-term sustainability goals.

Table 3. GCC Comparison Against IRA

Subject	IRA	GCC
Scale and scope of investments	The IRA represents a historic investment of over \$369 billion in climate and energy initiatives over the next decade. It includes tax incentives, grants, and loans aimed at accelerating the adoption of renewable energy, electric vehicles, and green projects. ³³	While GCC countries are making significant strides in renewable energy, their investments are generally more fragmented and often tied to specific national visions, such as Saudi Arabia's Vision 2030 or the UAE's Energy Strategy 2050. The scale of investment, though substantial, is spread across multiple countries and initiatives, making it more challenging to match the concentrated funding approach of the IRA.
Policy and regulatory framework	The IRA provides a comprehensive and coordinated policy framework that incentivizes the private sector to invest in renewable energy, with a clear focus on reducing emissions and promoting green technologies across the U.S. ³⁴	GCC countries are also developing regulatory frameworks, but these vary widely between nations. For example, Saudi Arabia has launched initiatives like the National Renewable Energy Program, while the UAE has developed the Energy Strategy 2050. However, the policy environment in the GCC can be less coordinated, and incentives may not be as

³³ United Nations Conference on Trade and Development (UNCTAD). (n.d.). *\$369 billion in investment incentives to address energy security and climate change*. Retrieved

³⁴ U.S. Environmental Protection Agency. (n.d.). *Summary of Inflation Reduction Act provisions related to renewable energy*. Retrieved 20-Sep-2024, from

<https://www.epa.gov/green-power-markets/summary-inflation-reduction-act-provisions-related-renewable-energy>

		comprehensive or uniformly applied as in the IRA.
Focus on green technologies	The IRA focuses heavily on cutting-edge green technologies, such as hydrogen, carbon capture, and storage (CCS), and large-scale renewable energy projects. It encourages innovation and the commercialization of these technologies. ³⁵	GCC investments also target green technologies, particularly solar and wind energy. Saudi Arabia's NEOM project and UAE's Masdar City are examples of high-tech, large-scale investments in renewables. However, the adoption of advanced technologies like hydrogen and CCS is still emerging, with ongoing investments in research and development.
Public-private partnerships	The IRA strongly encourages public-private partnerships, providing a robust ecosystem for companies to collaborate with the government on renewable energy projects. ³⁶	Public-private partnerships are also a focus in the GCC, with sovereign wealth funds like Saudi Arabia's PIF and Qatar's QIA playing a pivotal role in driving investments in renewable energy. However, the extent of private sector involvement varies, and in some cases, state-owned entities dominate the energy sector.
Impact and outcomes	The IRA is expected to significantly accelerate the U.S. transition to a low-carbon economy, with clear benchmarks and targets to track progress.	The impact in the GCC is promising but more gradual. Countries like Saudi Arabia and the UAE are setting ambitious targets, but the transition is complicated by the region's heavy reliance on hydrocarbons. The outcomes will depend on sustained commitment and the successful integration of renewables into their energy mix.

³⁵ U.S. Environmental Protection Agency. (n.d.). *Summary of Inflation Reduction Act provisions related to renewable energy*. Retrieved 20-Sep-2024, from

<https://www.epa.gov/green-power-markets/summary-inflation-reduction-act-provisions-related-renewable-energy>

³⁶ Business Council for Sustainable Energy. (2022, August 16). *With President Biden's signature of the Inflation Reduction Act, clean energy enters new era*. Retrieved [Insert National Development Strategy's date], from <https://bcse.org/with-president-bidens-signature-of-the-inflation-reduction-act-clean-energy-enters-new-era/>

Conclusion

This report shows the significant opportunities and challenges the GCC faces in its journey toward adopting net-zero energy systems. The region has abundant potential in solar and wind energy, supported by its natural resources and strategic location. Initiatives by government entities, universities like KAUST and QSTP, and accelerators are helping to drive progress in clean energy innovation. These efforts align with the GCC's economic diversification plans and its commitments to international climate goals. However, there are still significant obstacles, including reliance on fossil fuels in their economy and exports, the high cost of renewable energy projects in the region, and environmental challenges like extreme heat and dust, which affect the performance of renewable systems.

When comparing the GCC's efforts with the U.S. Inflation Reduction Act (IRA), it becomes clear that the IRA uses a centralized approach to provide clear policies, incentives, and funding, while the GCC's efforts are spread across different countries and programs. This scattered approach makes it harder to achieve large-scale impacts. Learning from the IRA, the GCC can improve by creating stronger policies, encouraging private sector investments, and accelerating the adoption of advanced technologies like hydrogen and carbon capture.

The findings also underline the importance of working together across the region. A shared vision, coupled with improved funding systems and strong partnerships between governments and private companies, is essential. Raising public awareness and upgrading infrastructure are also critical for overcoming barriers, as many people and businesses in the region still rely on cheap fossil fuels and are slow to adopt renewable energy.

With consistent effort, strategic planning, and collaboration, the GCC has the potential to lead in clean energy innovation. This will not only help the region reduce its economic dependence on hydrocarbons but also contribute to global efforts to combat climate change. To achieve this, the GCC needs to turn its ambitious goals into practical actions with strong and solid governance, ensuring its resources are used effectively to build a sustainable, inclusive, and green energy future.

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