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STRATEGIC PLANS TO SUPPORT ACTION AGAINST CLIMATE CHANGE IN THE ARAB COUNTRIES IN THE MIDDLE EAST REGION

Mohammad Danish* and Rima J. Isaifan**

ABSTRACT

Climate change has become a global challenge due to its critical impact on the natural as well as the human environment. This article focuses on the effects of climate change in the Middle East (ME) region and the strategies suggested to combat its impacts. The research involves reviewing and analyzing published articles from major databases in this domain. The literature shows that countries in the ME region, with a particular focus on the Arab countries, have also realized that urgent actions should be taken to decrease climate change threats. Several countries are committing to international principles, supporting the global effort against climate change, such as adopting renewable sources for efficient energy production. Moreover, some of the ME region countries are considered a hub for emitting CO_2 because of their hot climate, which requires the use of energy for air-conditioning, high-water desalination demands due to water scarcity, and the dependence on energy-exhaustive industries. Recently, Saudi Arabia, Qatar, and the United Arab Emirates have proposed strict measures to reduce their energy consumption and move towards renewable energy sources like solar and wind energy. Some countries have also funded projects for developing green buildings to create a sustainable environment. However, this paper emphasizes the need to establish strict regulations to impose policies and practices to achieve the global temperature rise limit below 1.5°C. Moreover, all ME countries must invest

in renewable energy sources by promoting education, research, and implementing carbon pricing mechanisms. Nevertheless, as part of the Paris Agreement and other international commitments, there is a growing need to develop more socio-economic policies to meet this vision.

Keywords: climate change; mitigation, Middle East, Arab world; global warming; sea level

1. INTRODUCTION

Climate change has become an emerging concern to the natural and man-made ecosystems on land as well as across all seas and oceans. The Gulf countries, along with all other countries in the Middle East region, are also expected to face adverse effects due to climate change because of the increase in the population, causing rapid urbanization growth and development.[1]

Climate change has, directly and indirectly, impacted the world's food requirements, generating several food management challenges for most countries. Food security is considered one of the most critical components for the survival of any state or country. Most Arab countries depend on importing essential food supplies from around the world. Arab countries with a significant proportion of agricultural land have

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1 Latifa Saeed Al Blooshi and others, 'Modeling Current and Future Climate Change in the UAE Using Various GCMs in MarksimGCMR' (2019) 13 The Open Atmospheric Science Journal 56.

minimized the gap between food production and their need by introducing national visions or plans to enhance farming sector production capacities and become self-sufficient. There is another important concern regarding the availability of water in the Arab zones that have water reserves of only 1% of the total resources of the world. Their population also accounts for 5% of the world's population. Therefore, water shortage is an increasing concern, and there are about 12 Arab countries that have an acute deficiency of water, as estimated by the United Nations. The residents also have low access to renewable water sources at less than 500 m^3 per capita annually. Rainfall is considered an alternate source of irrigation in some areas of the world. However, most Arab countries have insufficient rainfall and rely entirely on artificial sources of irrigation to develop agriculture and produce food crops to meet their national needs. Therefore, improving agricultural and irrigational sectors depends on enhancing the social and economic conditions of the country.[2]

The Middle East mainly consists of Arab countries, which have huge resources of oil and gases that make this area critically important throughout the globe. The boundaries of this Arab area are not fully established since North Africa and the Middle East are considered one region in some studies. The countries from the Gulf Cooperation Council (GCC) are known for their relatively high per capita emissions of CO_2.[3] The main

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[2] Nassar Atef and Fawzy Gamal, 'Food Security Via Improving Crop Water Productivity in Some Arab Countries' (2019) 2 World Journal of Agriculture and Soil Science <https://irispublishers.com/wjass/fulltext/food-security-via-improving-crop-water-productivity-in-some-arab-countries.ID.000532.php>.

[3] Muatasim Ismaeel, 'Transformation toward Clean Energy in the Middle East: A Multilevel Perspective' in Hassan Qudrat-Ullah and Aymen A Kayal (eds), Understanding Complex Systems (Springer 2019) <http://www.springer.com/series/5394> accessed 7 April 2020; Mari Luomi, Mainstreaming Climate Policy in the Gulf Cooperation Council States (Oxford Institute for Energy Studies 2014)

reasons behind these emissions are the hot temperature of the region, which increases energy demand, dependence on fossil fuels for energy needs, water desalination requirements, and many energy-exhaustive industries. All the countries in the Arab zones have recently started to realize the threat of climate change. They are following various international principles and signing agreements to address climate change and contribute towards minimizing its impacts. However, few countries committed to reducing their greenhouse gas emissions, and they have also included these commitments in their national vision.[4] Therefore, it is shown that the introduction of policies and commitments for energy requirements are not only because of greenhouse gases, but the Arab countries are influenced by struggles and efforts worldwide to mitigate and resist climate change.[5] Concerning environmental conditions and pledges throughout the globe, the circumstances of switching to clean energy are greatly supported by economic conditions in this region. In addition, the development in the technological sector and the constant reduction in renewable energy production costs have smoothed that conversion path.[6] For the countries that import net oil, energy security is increased by adopting renewable energy production techniques. The reduction in oil charges in 2014 urged many countries to find alternative ways of meeting energy needs and substituting them with cheap and reliable methods and sources.

<http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/02/MEP-7.pdf> accessed 8 April 2020.

4 Ismaeel (n 3); Luomi (n 3).

5 Ismaeel (n 3).

6 Joel Krupa and Rahmatallah Poudineh, Financing Renewable Electricity in the Resource-Rich Countries of the Middle East and North Africa: A Review (Oxford Institute for Energy Studies 2017) <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/02/Financing-renewable-electricity-in-the-resource-rich-countries-of-the-Middle-East-and-North-Africa-A-review-EL-22.pdf> accessed 8 April 2020.

This transformation to renewable energy resources also benefits countries that export oil to produce additional income, thereby balancing their economic issues.[7]

The Arab countries have started to take initiatives to combat climate change in various ways. However, the association between these initiatives has yet to be proven. Electricity production is a very significant energy evolution that has quite effective results. The main goal of an energy transition to renewable sources is to reduce energy consumption to enhance energy efficiency by considering low-cost inputs. Generally, the energy consumption of electricity and buildings is mainly responsible for the conversion to renewable energy than the industrial and transportation region.[8] Moreover, the Middle East area is overshadowed by many industries and transportation. There are some tangible initiatives by a few Arab countries, including Qatar and the United Arab Emirates (UAE), to develop effective green buildings in the region.[9] Due to the hot climate in most Middle Eastern countries, they have a great potential of producing renewable energy, i.e., solar energy. There is also little potential to make wind energy to some degree.[10] In addition, some countries also have renewable

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7 Jean-François Seznec, Renewable Energy in the Middle East - Atlantic Council (Atlantic Council 2018) <https://www.atlanticcouncil.org/in-depth-research-reports /report/ renewable-energy-in-the-middle-east/> accessed 8 April 2020.

8 Hanadi Al-Thani, Muammer Koc and Rima J Isaifan, 'Investigations on Deposited Dust Fallout in Urban Doha : Characterization , Source Apportionment and Mitigation' (2018) 6 Environment and Ecology Research 493; Hanadi Al-Thani and others, 'Evaluation of Particulate Matter Emissions from Non-Passenger Diesel Vehicles in Qatar' (2020) 70 Journal of the Air and Waste Management Association 228 <https://www.tandfonline.com/doi/abs/10.1080/10962247.2019.1704939> acce ssed 16 May 2022.

9 Ismaeel (n 3); Luomi (n 3).

10 Seznec (n 7); Rahmatallah Poudineh, Anupama Sen and Bassam Fattouh, 'Advancing Renewable Energy in Resource-Rich Economies of the MENA' (2018) 123 Renewable Energy 135 <https://linkinghub.elsevier.com/retrieve/pii/S0960148118301587> accessed 8 April 2020.

biological, nuclear, hydrothermal, and geothermal resources. However, the critical and dominant source of producing renewable energy is still solar energy, particularly electricity.[11]

The purpose of this article is to identify the primary sources of greenhouse gas emissions that induce climate change impact, identify the main climate change risks, address the potential climate change threats, and present the initiatives and commitments taken by Arab countries in the Middle East region to abate these risks in line with global efforts in this domain.

2. METHODOLOGY

This article is based on published sources, research analysis, and reports from different entities that examine strategic plans and initiatives taken by Arab countries in the Middle East to address and combat climate change. The literature sources in this study were obtained using search engines such as Google, Google Scholar, Scopus, ScienceDirect, and other databases. The searched articles and reports used in this article consisted of several keywords, including climate change, GHG emissions, human health, water availability, water resources, air pollution, food security, floods, drought, agriculture, Middle East, UAE, Qatar, KSA as shown in **Figure 1**. All collected sources were thoroughly analyzed against our objectives, and the articles irrelevant to our scope of study were filtered out. The articles and reports relevant to our research were used in this review, where our focus was on studying the impact of

[11] Omid Nematollahi and others, 'Energy Demands and Renewable Energy Resources in the Middle East' (2016) 54 Renewable and Sustainable Energy Reviews 1172 <https://linkinghub.elsevier.com/retrieve/pii/S1364032115011375> accessed 8 April 2020.

climate change on air quality, human health, water resources, and agriculture, as well as looking into the strategies and plans adopted to mitigate the impact of climate change.

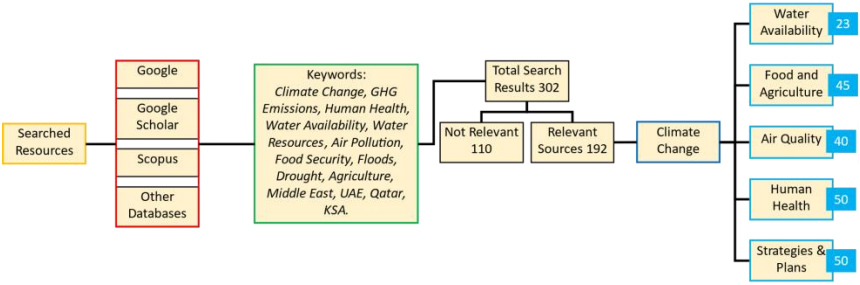

Figure 1: Flow chart of our study, including sources, keywords, and topics covered in the review.

3. REVIEW OF LITERATURE

Climate change is warming our planet and changing the temperature significantly yearly. Nearly 12.5 % of species on earth are endangered and at risk of extinction. Consequently, forests and oceans are experiencing pollution, leading to devastating effects on biodiversity, ecosystems, and the environment's overall health.[12] This is because the atmospheric concentrations of GHGs such as CH_4, CO_2, and N_2O have increased by 156%, 47%, and 23% since the start of the

[12] IPBES, 'Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (2019) <https://ipbes.net /sites/default/files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf>; Sandi Knez, Snežana Štrbac and Iztok Podbregar, 'Climate Change in the Western Balkans and EU Green Deal: Status, Mitigation and Challenges' (2022) 12 Energy, Sustainability and Society 1 <https://energsustainsoc.biomedcentral.com/articles /10.1186/s13705-021-00328-y>.

industrial revolution.[13] The persistent emission of these GHGs into the atmosphere will lead to increased global warming cascading impacts on our ecosystem and terrestrial and aquatic environment, as shown in Figure 2.[14] Therefore, it has become a serious issue to resolve despite implementing bold efforts to mitigate its effects, yet it continues to worsen due to breaks in the climate system.[15]

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[13] IPCC, Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (and B Zhou Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu ed, 2021).

[14] Maureen Papas, 'Causes and Impacts of Climate Change in Asia Pacific: Integrated Responses and Need for Change in Decision Making in Australia', Handbook of Climate Change Resilience (Springer International Publishing 2020) <http://link.springer.com/10.1007/978-3-319-93336-8_35>.

[15] IPCC, Global Warming of 1.5°c : An IPCC Special Report on Impacts of Global Warming of 1.5°c above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Contex of Strengthening the Global Response to the Thereat of Blimate Change, Su (Valérie Masson-Delmotte and IPCC eds, Cambridge University Press 2022).

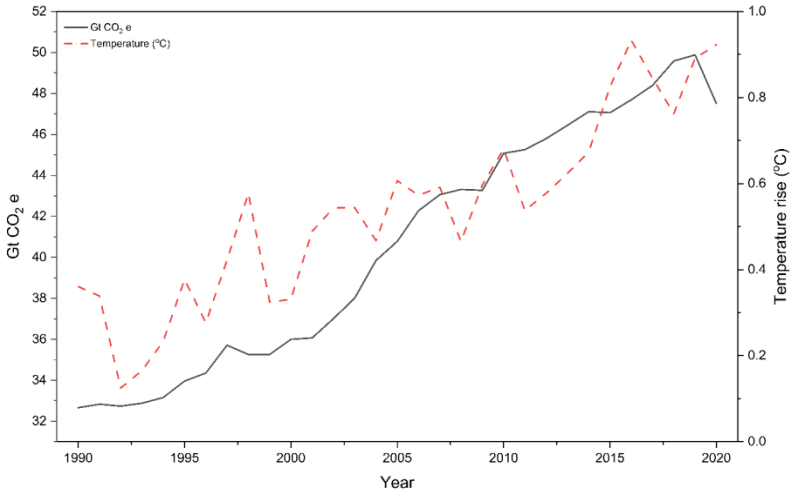

Figure 2: The total GHG emissions as CO_2 equivalent and temperature rise from 1990 to 2020. The data was extracted from climatewatch[16] and ourworldindata.[17]

3.1 Global Impact of Climate Change on Human Health

Health professionals have taken the responsibility to address the issues caused by climate change globally. The Intergovernmental Panel on Climate Change (IPCC) has urged to stop its devastating impacts affecting millions of people across the globe and to limit the increase in temperatures by 1.5°C. Considering the global warming of 1.5°C is very high, a slight increase in a tenth of a degree order can significantly harm human lives. Climate change affects the main factors sustaining human health, such as clean air, drinking water, food, and shelter. According to WHO, from 2030 to 2050,

[16] Climate Watch, 'Historical GHG Emissions' (Climate Watch Data, 2023) <https://www.climatewatchdata.org/ghg-emissions>.

[17] Our World in Data, 'Temperature Anomaly, Global' (2022) <https://ourworldindata.org/grapher/temperature-anomaly>.

climate change is projected to result in an estimated annual increase of around 250,000 fatalities due to malnutrition, malaria, diarrhea, and heat-related illness.[18] Climate change consists of rising temperatures, alterations in rainfall patterns and weather events, and increased sea levels. These incidents put our health at risk by altering the quality and composition of our food, water, and air. Therefore, the impact of these risks will vary depending upon the geographical location because of people's access to health care and safety systems, as well as the community's economic status. As a result, poor and developing countries may be more susceptible to global health risks.[19]

3.2 Global Impact on Water Availability

Water and climate change are closely linked to each other. Climate change has intricated implications for the water resources of the world. These effects include droughts, irregular rainfall patterns, melting of glaciers and ice sheets, and floods, causing high sea levels. Therefore, climate change directly impacts water resources and their availability.20 The earth has a limited freshwater supply, around 0.5% of the total freshwater available, directly affected by climate change.21 According to the Sustainable Development Goal report of 2022, about 2 billion people lack access to clean water.

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18 WHO, 'Climate Change and Health' (World Health Organization, 2021) <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>.

19 EPA, 'Climate Impacts on Human Health' (Climate change, 2022) <https://climatechange.chicago.gov/climate-impacts/climate-impacts-human-health>.

20 UN-Water, 'Water and Climate Change' (2023) <https://www.unwater.org/water-facts/water-and-climate-change>.

21 WMO, 'Improved Water Management, Monitoring and Early Warnings Needed in Face of Growing Water-Related Hazards and Stress' (2021) <https://public.wmo.int/en/media/press-release/wake-looming-water-crisis-report-warns>.

Furthermore, half the world's population faces a significant water shortage.22

Climate change has significantly impacted the earth's hydrological cycle, leading to severe events of drought and floods. A case in point is the Po River in Italy, historically renowned as one of the longest rivers in the country, earning it the moniker "king of rivers." However, Northern Italy faced severe drought for nearly 70 years, causing this river to vanish in numerous locations completely. The author vividly recounts this experience: "Next to Saluzzo, upstream of Turin, I walked from one bank to the other without wetting my feet. There was only white gravel with buddleia where the "great river" was supposed to be."[23] Similarly, drought has affected many parts of the world, such as northern Ontario, California, South America, Central Africa and Asia, and central and southern Europe. The effects of climate change can also be observed in floods worldwide. There were numerous flood events taking place all around the world. Still, the deadliest occurred in Pakistan in 2022, followed by heavy monsoon rainfalls, affecting 33 million people, displacing 8 million people from their homes, and causing 1739 fatalities.[24] Many flood events occurred recently in 2022 globally, such as in eastern Australia, Brazil, and South Sudan.[25] These events resulted in severe water

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[22] IPCC, 'Fact Sheet -Food and Water, SIXTH ASSESSMENT REPORT Working Group II –Impacts, Adaptation and Vulnerability' (2022); United Nations, 'The Sustainable Development Goals Report-Clean Water and Sanitation' (2022) <https://unstats.un.org/sdgs/report/2022/Goal-06/>.

[23] Tobias Jones, 'Quiet Flows the Po: The Life and Slow Death of Italy's Longest River' (The Guardian, 2022) <https://www.theguardian.com/environment/2022/jul/10/po-river-italy-drought-climate>.

[24] OCHA, 'Pakistan: Floods - Jul 2022' (Reliefweb, 2022) <https://reliefweb.int/disaster/fl-2022-000254-pak>.

[25] OCHA, 'Sudan: Floods - Jun 2022' (Reliefweb, 2022) <https://reliefweb.int/disaster/fl-2022-000277-sdn>.

stress in the respected regions, resulting in many diseases and even costing the lives of human beings.

3.3 Global Impact on Food and Agriculture

Agriculture is highly affected by weather and climate conditions, and its success is closely related to significant factors such as land, water, and other natural resources, all of which are impacted by changing climate.[26] While alterations in climatic conditions, such as shifts in temperature and rainfall patterns, may be suitable for growing crops in a specific area, they will also challenge agricultural methods and production in other areas.[27] Climate change can impact various aspects of agriculture, including crops, livestock, soil, and water resources. However, it is essential to understand that the agricultural sector is a source of GHG emissions that contributes to the problem of climate change.[28] Agriculture is the primary source of 30 to 40% of GHG emissions globally, making it a leading cause of earth warming and facing a significant impact of climate change.[29] The microbial activities in the soil produce methane, which is 25 times worse than carbon dioxide. However, in organic farming, bacteria mostly absorb these gases, and GHG emissions can be as lower as 50% than the conventional agricultural practices.[30] Around 37% of methane released globally comes from livestock operations.

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26 Prasanna H Gowda and others, 'Chapter 10 : Agriculture and Rural Communities. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II' (2018) <https://nca2018.globalchange.gov/chapter/10/>.

27 EPA, 'Climate Change Impacts on Agriculture and Food Supply' (2022) <https://www.epa.gov/climateimpacts/climate-change-impacts-agriculture-and-food-supply#10foot> accessed 13 September 2023.

28 ibid. EPA

29 Andrea Monica D Ortiz and others, 'A Review of the Interactions between Biodiversity, Agriculture, Climate Change, and International Trade: Research and Policy Priorities' (2021) 4 One Earth 88.

30 BMU, 'Climate Action in Figures Facts, Trends and Incentives for German Climate Policy' (2018).

Moreover, N_2O is 300 times worse for climate than CO_2 and is removed from fertilizer applications. Additionally, food distribution through transportation also results in significant CO_2 emissions.[31]

Approximately 80% of the world's population is facing the highest risk of crop failures and hunger due to climate change occurrence throughout the world, including Sub-Saharan Africa, South Asia, and Southeast Asia. These regions contain farming communities with financial problems and are particularly vulnerable to the effects of climate change.[32] These issues and difficulties lead to food security because agriculture covers two primary aspects: the economic condition of people and food security. Food security was defined by the World Food Summit in 1996. It is quoted by FAO as "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."[33] Therefore, the events resulting from climate change can lead to severe food security problems. Additionally, many social and economic settings have facilitated the conversion of 40% of arable lands to degraded land. Using agrochemicals has turned 64% of agricultural land into contaminated land. Therefore, it is necessary to adapt to modern and more sustainable practices that can maintain our climate by less

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[31] Thomas F Stocker and others, Climate Change 2013 – The Physical Science Basis, vol 9781107057 (Intergovernmental Panel on Climate Change ed, Cambridge University Press 2014) <http://ebooks.cambridge.org/ref/id/CBO9781107415324> accessed 6 April 2020.

[32] The World Bank, 'What You Need to Know About Food Security and Climate Change' (2022) <https://www.worldbank.org/en/news/feature/2022/10/17/what-you-need-to-know-about-food-security-and-climate-change>.

[33] FAO, 'Food Security' (2006) 2.

deterioration to the soil and environment, such as agroforestry, organic agriculture, integrated agriculture, etc.[34]

4. AIR POLLUTION EMISSIONS

The critical factors of population growth accompanied by economic growth are resulting in the release of a considerable amount of greenhouse gas emissions, especially CO_2. The most apparent source of emission of CO_2 is mainly the combustion of fossil fuels. There was a sharp increase in the financial growth of countries around the entire globe between 2000 and 2010, but the impact on the population was somewhat similar in the previous decades. The current state shows that there is a likelihood that the global mean temperature shall be limited to 2°C. This means there is a chance that the emissions from the greenhouse gas effect will be reduced by 40-70% if compared with 2010 by the middle of the 21st century. To minimize the elevated greenhouse gas emissions, it is essential to analyze the leading causes for the increase in the emissions affecting different sectors of finance, industries, building and construction, transport, agricultural land use, forest management, and most importantly, energy sectors. The addition of CO_2 emissions from different industrial processes and the combustion of fossil fuels have increased the total greenhouse gas levels to about 78% from 1970 to 2010. Other organizations are working on making policies and strategies for

[34] Fiona HM Tang and others, 'Risk of Pesticide Pollution at the Global Scale' (2021) 14 Nature Geoscience 206 <https://www.nature.com/articles/s41561-021-00712-5>; Akila Wijerathna-Yapa and Ranjith Pathirana, 'Sustainable Agro-Food Systems for Addressing Climate Change and Food Security' (2022) 12 Agriculture 1554 <https://www.mdpi.com/2077-0472/12/10/1554>.

reducing these emissions to much lower levels, including policymakers' recommendations and contributions while considering all possible scenarios of the past and present. It has been brought to a closure that the emissions from greenhouses are likely to remain as such because the advancement is pushing this issue up in economic behaviors and population increase throughout the entire world. The Under-Secretary-General of the UN and the executive director of UNEP "Achim Steiner" has appreciated the assessment of the (IPCC) team for their outstanding work in the evaluation and providing recommendations to fight and address the issue of climate change more efficiently. The UNEP aims to continue helping other countries in policy designing and implementation to build societies and economies based on low or zero carbon.[35]

Regarding sources, about one-fourth of the world's greenhouse gas emissions are related to transportation, creating severe air pollution in cities.[36] To transform the transportation system into a sustainable one, there is a need to address critical challenges in this sector, such as dependency on fossil fuels.[37] The new type of vehicles that are operated through electricity, such as Plug-in Hybrid Electric Vehicles (PHEV), Battery Electric Vehicles (BEV), and Hybrid Electric Vehicles (HEV), are the essential options for reducing fuel consumption and ultimately replacing the conventional vehicles that are polluting the atmosphere by

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[35] IPCC, 'IPCC Presents Assessment on Measures to Mitigate Climate Change' (2019, 2014) <https://www.unenvironment.org/news-and-stories/press-release/ipcc-presents-assessment-measures-mitigate-climate-change> accessed 26 February 2020.

[36] Al-Thani, Koc and Isaifan (n 8).

[37] Mehdi Noori and others, 'Light-Duty Electric Vehicles to Improve the Integrity of the Electricity Grid through Vehicle-to-Grid Technology: Analysis of Regional Net Revenue and Emissions Savings' (2016) 168 Applied Energy 146 <http://dx.doi.org /10.1016/j.apenergy.2016.01.030>.

their exhaust emissions.[38] Several countries worldwide are interested in reducing these emissions and have planned to completely ban vehicles that run on diesel and gasoline in the next few decades. These countries include Norway, India, Britain, Germany, France, and China. At the same time, some countries go further and make executive goals for selling these electric vehicles, such as the Netherlands, South Korea, Portugal, Japan, Australia, Denmark, Spain, and Ireland.[39]

Qatar has also significantly contributed to reducing emissions by participating with other countries and strategically aiming to convert 10% of the vehicles into electrical ones by 2030. Because the development of environmental, social, and economic systems is among the main sustainable development goals, they are emphasized in the 2030 national vision of Qatar. Table 1 shows the differentiation between Arab countries in terms of per capita energy supply,[40] the number of threatened species in different countries (including vertebrates, invertebrates, and plants),[41] and annual outdoor exposure to particulate matter ($PM_{2.5}$).[42]

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38 Hanadi Al-Thani and others, 'A Review of the Integrated Renewable Energy Systems for Sustainable Urban Mobility' (2022) 14 Sustainability 10517 <https://www.mdpi .com/2071-1050/14/17/10517/htm> accessed 10 March 2023.

39 Nuri Cihat Onat, Nour NM Aboushaqrah and Murat Kucukvar, 'Supply Chain Linked Sustainability Assessment of Electric Vehicles: The Case for Qatar', 2019 IEEE 6th International Conference on Industrial Engineering and Applications (ICIEA) (IEEE 2019) <https://ieeexplore.ieee.org/document/8715205/>.

40 UN, 'Production, Trade and Supply of Coke' (2018) <https://data.un.org/_Docs /SYB/PDFs/SYB62_263_201904_Production, Trade and Supply of Energy.pdf> accessed 9 April 2020.

41 UN, 'IUCN Red List of Threatened Species', vol 49 (2012).

42 The World Bank, 'PM2.5 Air Pollution, Mean Annual Exposure (Micrograms per Cubic Meter) - Russian Federation | Data' (2017) <https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3?locations=RU&most_recent_value_desc=true> accessed 9 April 2020.

Table 1: Updated data of Middle Eastern Countries on Energy Supplying per capita,[43] Threatened species in respective areas,[44] and Outdoor Annual Exposure of $PM_{2.5}$.[45]

Middle East Countries	Energy Supply per Capita (GJ per Capita)		Threatened Species (Numbers)		Outdoor $PM_{2.5}$ Annual Exposure (µg/m³)	
	2015	2016	2018	2019	2015	2016
Bahrain	422	391	40	46	79.13	79.69
Kuwait	360	373	52	56	109.08	110.96
Morocco	23	23	223	227	25.22	25.41
Qatar	737	686	45	50	147.54	148.24
Saudi Arabia	308	267	132	141	182.92	187.87
South Africa	58	57	607	603	35.52	35.91
Tunisia	40	40	101	101	35.87	35.57
United Arab Emirates	364	370	60	64	102.93	105.12
Iran	126	130	140	152	48.62	48.95
Turkey	68	71	400	426	37.16	37.25
Egypt	37	39	163	169	124.88	126.03
Lebanon	53	53	99	104	32.38	32.56
Jordan	39	38	117	124	37.25	37.21
Oman	262	242	105	108	76.43	77.96
Cyprus	73	78	78	83	17.9	17.86

Onat et al.[46] have performed a life cycle assessment of electric vehicles using the supply chain approach. The study was done

[43] UN (n 40).
[44] ibid.
[45] Onat, Aboushaqrah and Kucukvar (n 39).
[46] ibid.

to estimate the impact of converting vehicles from diesel or gasoline to electricity on the environment. They found that these electric vehicles can reduce greenhouse emissions by 71%, cut the life cycle cost by 28%, cut down the formation of secondary pollutants from photochemical reactions by 51%, and ultimately minimize the transportation effects on human health by 63%.[47]

5. IMPACT OF CLIMATE CHANGE ON THE ARAB WORLD

5.1 Impacts on Human Health

Researchers have reported that climate change is a critical risk factor for human health. Several studies have predicted that climate change has adverse effects on human health. Health effects can be direct, such as extreme weather events, storms, floods, and heat, or indirect, such as changes in the presence of disease vectors (e.g., mosquitoes) and aquatic pathogens, posing a potential risk in maintaining the quality of water, air, and food and also affecting their availability. In addition, the actual health effects in different Arab countries vary depending on the local environmental and socio-economic conditions and the range of social, institutional, technical, and behavioural measures adopted and implemented in the specified areas.[48]

Research in some Arab countries has demonstrated that environmental changes significantly spread irresistible vector-borne illnesses, e.g., schistosomiasis and malaria, in the different Arab regions, especially Egypt, Morocco, and Sudan. It additionally influences the regular convergences of specific

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47 UN (n 41).

48 MK Tolba and NW Saab, 'Arab Environment: Climate Change' (2009) <http://www.droughtmanagement.info/literature/AFED_climate_change_arab_countries_ 2009.pdf>.

allergens in the air, causing unfavourable susceptible responses and pneumonic sicknesses. It also intensifies the general well-being effect of heatwaves with blistering summer atmospheres.[49]

Recently, the pandemic situation caused by COVID-19 has caused severe impacts on human health and the environment throughout the globe.[50] The effect of COVID-19 is more potent in urban areas rather than in rural. The possible reason could be related to higher air pollution levels inside the cities due to urbanization and population exposure to toxic levels of air pollution. However, more studies are being conducted to link the spread of COVID-19 with air pollution, as many respiratory diseases are linked to air pollution. This needs further research to evaluate these exposures.[51] Moreover, the impact of this pandemic on the environment has been assessed in the sense that due to lockdown situations in many countries, there was less traffic on roads, and there may be fewer emissions of nitrogen dioxides (NO_2).[52] Fig. 1 shows that the Arab countries, after the lockdown, have a lower pollution index than the previous years.[53]

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[49] ibid.

[50] RJ Isaifan, 'The Dramatic Impact of Coronavirus Outbreak on Air Quality: Has It Saved as Much as It Has Killed so Far?' (2020) 6 Global Journal of Environmental Science and Management 275 <https://www.gjesm.net/article_38731.html> accessed 16 May 2022.

[51] Waterloo Region, 'Air Quality and COVID-19' (European Environment Agency, 2008) 1 <https://www.eea.europa.eu/themes/air/air-quality-and-covid19/air-quality-and-covid19> accessed 10 April 2020.

[52] ibid; James Poetzscher and Rima J Isaifan, 'The Impact of COVID-19-Induced Lockdowns during Spring 2020 on Nitrogen Dioxide Levels over Major American Counties' (2021) 9 Elementa </elementa/article/9/1/00002/117779/The-impact-of-COVID-19-induced-lockdowns-during> accessed 16 May 2022.

[53] NUMBEO, 'Pollution Index by Country 2020' (2020) <https://www.numbeo.com/pollution/rankings_by_country.jsp?title=2020&displayColumn=0> accessed 10 April 2020.

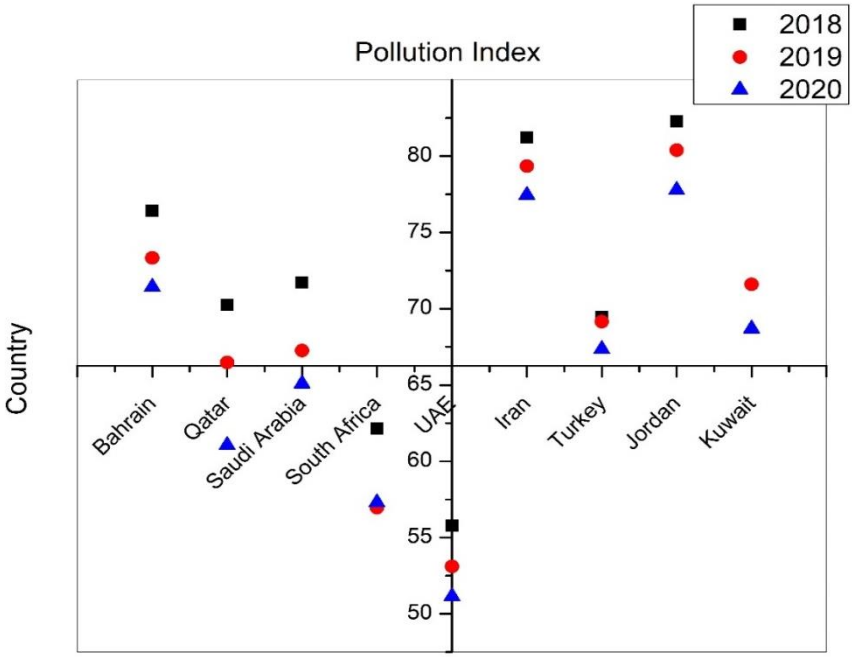

Figure 3: The pollution index in some Middle Eastern countries in 3 recent years.[54]

Another risk of climate change is related to rising ocean water levels, resulting in the flooding of coastal areas that consequently contributes to malnourishment due to the lack of a healthy diet and hunger. Moreover, lower precipitation and increased atmospheric temperatures because of global warming may disturb water availability, negatively affecting human health. Therefore, the management of these issues in the Arab

[54] ibid.

world should be addressed and arranged to overcome the environmental change caused by climate change.[55]

5.2 Impact on Water Availability

Water is limited throughout the Arab areas, with annual water sources beneath 1000 m^3 per capita in all Arab international locations. Even though the Arab world area covers 10% of the planet, it has less than 1% of the world's freshwater sources. The elevated average temperatures in the Arab world have impacted irregular precipitation, which consequently aggravated an already severe exposure situation, creating areas that are even under more significant stress of restricted freshwater assets. In these areas, freshwater sources' amounts and properties are at risk. The extreme population growth and the higher water consumption per capita make this situation even more critical, with around 80% of freshwater resources devoted to agriculture.[56]

Hence, the Arab countries are going through very harsh conditions of severe water shortages except for Syria, Iraq, and Lebanon. Climate change has affected the weather badly, resulting in an uneven distribution of rainfall, floods of the rivers in the high rainfall days, and very intensive and extensive dry periods due to the lack of rain, degrading the quality of soil suitable for plant growths.[57] Some countries that are adversely affected by climate change have started adopting the technologies of growing modified crops to cut down water consumption to enable the crops to proliferate by using

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55 Tolba and Saab (n 48).

56 ibid; Hamad Al-Mebayedh, 'Climate Changes and Its Effects on the Arab Area', APCBEE Procedia (Elsevier 2013) <http://dx.doi.org/10.1016/j.apcbee.2013.05.001>.

57 Al-Mebayedh (n 56); Mostafa K Tolba and Najib W Saab, Arab Environment: Future Challenges. Arab Forum for Environment and Development. (2008) <http://www.afed online.org/afedreport/full english report.pdf>.

breeding and genetics techniques. Such practices include using crops that use less water and are resistant to extreme drought conditions to meet their country's food needs.[58]

5.3 Impact on Food and Agriculture

Qatar is one of the countries that aim to be self-sufficient in terms of food production after the 2008 food crisis. In 2009, Qatar's government started a new program called the Qatar National Food Security Program (QNFSP). This program plans to increase food production from 10 to 70% by 2030. In 2013, the program was ready with all the plans to ensure food security by enhancing freedom and business arrangements and encouraging investments from other international countries.[59] This program also considered other national interests, including providing water security, balanced energy consumption, and collaboration with foreign and local companies. On the federal level, Qatar made steps to discourage food wastage and enhance the quality and quantity of food produced locally to increase its market value ultimately. They adopted technologies such as hydroponics, desalination, and greenhouse production methods. Water security is also a significant problem in Qatar, where the utilization of freshwater resources is not sustainable. Therefore, the country uses expensive desalination and has environmental and social issues.[60]

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58 Al-Mebayedh (n 56); Tolba and Saab (n 57).

59 Semsia Al Ali Mustafa, 'Growing Food Pyramids in the Sand: How Sustainable Are Qatar's Self-Sufficiency and Foreign Agro-Investment Policies?' (Istituto agronomico per l'Oltremare, 2017) 409.

60 Idowu Ajibade, Michael Egge and Arun Pallathadka, 'Climate Change and the Sustainable Development Goal on Food Security: Barriers and Opportunities for Progressive Realization in Qatar and Nigeria' (2020) 10 Journal of Sustainable Development Law and Policy (The) 158.

6. ACTIONS AND STRATEGIC PLANS TO ABATE CLIMATE CHANGE

6.1 The United Arab Emirates

The United Arab Emirates is a large-scale business market with high economic growth and is considered a favourable tourist destination for foreigners worldwide. However, the current scenarios of ice melting from glaciers and global warming are posing severe issues for the UAE in terms of increasing temperature, water shortage, and building up of salts in its coastal areas. Therefore, the country has defined its objectives and aims to produce clean and renewable energy by reducing its carbon footprint by 70% and increasing the production of renewable energy from 25 to 50% by 2050. The country started the Emirates Waste to Energy (EWTE) company with Masdar, aiming to convert municipal solid waste obtained from landfills into energy for home use in 2021. They plan to convert 0.3 million tons of waste into an energy output of 30 megawatts (MW) per annum to light up 28,000 houses.

In 2019, Ellen MacArthur Foundation described in their report that steel, plastic, aluminum, food, and cement have the potential to minimize the emissions of greenhouse gasses of 9.3 billion tons by 2050, which will set up the basis for making the economy circular. While adapting to climate change, the thought is to improve resistance to the severe impacts of environmental change, focusing on food shortage and outrageous weather impacts. Regular improvement measures include the development of sea walls and enhancing the research on genetically modified crops in agriculture in which the plantation of more drought-resistant varieties of crops can grow in deserted areas. Climate change has impacted the concept of sustainability around the globe. The UAE started recognizing that this sustainability pathway has economic

benefits besides improving the environment against climate change. It was emphasized that the climate change issue is of very serious concern, and it requires collaboration and pledges from all societies because a single solution cannot overcome it.[61]

The UAE is achieving diversification in its economic growth and aims to enhance its level of awareness through the Carbon Ambassador Program (CA). The main aim of this program is to increase awareness among the public about the impacts of climate change since less than half of the population of UAE is unaware of this serious issue. To ensure this, the Ministry of Climate Change and Environment (MOCCAE) has signed a Memorandum of Understanding (MOU) with Dubai Electricity and Water Authority (DEWA) to address the climate change issue.[62] The DEWA is managing the CA program with the collaboration of the Dubai Carbon Center of Excellence. They aim to raise university students' awareness of lowering carbon footprints and economic and environmental sustainability. In this way, they address mitigation and adaptation strategies against climate change to move towards a clean, healthy, and more sustainable environment. The MOCCAE plays the sponsor role for this program to organize training sessions for the members of the CA program.[63] Moreover, the MOCCAE of the country has started the National Climate Adaptation Program (NCAP), and they also

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[61] Salim Al Owais, 'UAE Takes on Climate Change Challenge | Analysis – Gulf News' Gulf News (2020) <https://gulfnews.com/business/analysis/uae-takes-on-climate-change-challenge-1.69709135> accessed 10 March 2020.

[62] DEWA, 'Dubai Electricity & Water Authority (DEWA) | Ministry of Climate Change and Environment Signs MoU with DEWA to Sponsor Carbon Ambassadors Programme' (2017) <https://www.dewa.gov.ae/en/about-us/media-publications/latest -news/2017/10/ministry-of-climate-change-and-environment-signs-mou-with-dewa-to-sponsor-carbon> accessed 11 March 2020.

[63] ibid.

set the UAE National Climate Change Plan of 2017, which all aim at adopting ways to reduce emissions from greenhouse gasses and changing the lifestyle of people in terms of construction, transportation, and energy consumption.[64]

Moreover, the UAE has a vision of enhancing electricity production from renewable sources rather than fossil fuels by about 27 and 50% by 2021 and 2050, respectively. They have announced official pledges to reduce these fossil fuel consumptions to the United Nations Framework Convention on Climate Change (UNFCCC). The UAE also commits to the Paris Agreement in working with collaboration to limit the overall temperature increase below 2 degrees.[65]

6.2 Qatar

Qatar has aimed to lower its reliance on fossil fuels. This target was enlisted as the topmost priority in the Qatar National Development Strategy and the National Vision of Qatar in 2030. The government of Qatar has taken significant measures to reduce its CO_2 emissions. The national vision stresses adopting actions to improve the environment towards sustainability, increasing social and economic growth, and conserving the environment in the best and mutually suitable way. Qatar has aimed to start its tender of a 200-megawatt solar plant shortly, as indicated by some current reports. In the Qatar 2030 vision, a solar power plant of 10 GW capacity is expected to start in the coming years. In this way, Qatar produces environmentally friendly renewable energy sources

[64] MOCCAE, 'Ministry of Climate Change and Environment Or- Ganizes Media Briefing on UAE National Climate Change Plan 2017-2050' (2017).

[65] Derek Baldwin, 'Climate Change Will Hit UAE Sectors, Says Report' (2017) <https://gulfnews.com/uae/environment/climate-change-will-hit-uae-sectors-says-report-1.2001267> accessed 11 March 2020; Manar Fawzi Bani Mfarrej, 'Climate Change Patterns in the UAE: A Qualitative Research and Review' (2019) 18 Nature Environment and Pollution Technology 261.

by utilizing solar radiation to become a sustainable hub. In alignment with these efforts, the role of the Qatar Foundation (QF) has been significant by providing evidence-based knowledge to improve the environment by encouraging innovation and creativity among people. It emphasizes the practices of sustainability goals to improve the local lifestyle of people in the country. Moreover, Qatar Foundation is working on developing a forum for global climate change and an institute for research in climate change in collaboration with the Potsdam Institute for Climate Impact Research, which is well known for solving critical issues, mitigating environmental hazards, adapting to these dangers and playing a supporting role in creating resistance in our climate. These developments relate to the MOU signed at the 18th conference of UNFCC in Doha in 2012.[66] This center also completed a project of an innovative solar grid that has added the photovoltaic (PV) of 1.68 MW in different systems. These PV systems have reduced CO_2 emissions by 2,590 tons annually by producing 5,180 MWh of clean-sourced energy and taking part in reducing environmental contamination. The Qatar Green Building Council, which is a member of QF, has contributed to promoting sustainability in Qatar by adopting several building practices that are cost-effective and friendly to the environment. They are making a hasty development in the sector of green buildings in Qatar, including producing sustainable construction at a world-class level. It is also worth noting that Qatar has the fifth-highest LEED-certified facilities outside the United States.

[66] UNCC, 'Doha Climate Change Conference' (United Nations Climate Change Conference, 2012) <https://unfccc.int/process-and-meetings/conferences/past-conferences/doha-climate-change-conference-november-2012/doha-climate-change-confe rence-november-2012> accessed 15 March 2020.

The UNFCC conference in Doha was hosted at the Qatar National Convention Center (QNCC). This center has the largest installed solar rooftop system and the first certified project by LEED in Qatar. In addition, Qatar Foundation has the largest PV pipeline installations in Qatar and green buildings certified by LEED. Qatar Foundation has its largest clean efforts in the Gulf region, with more than five MW installations of solar power plants. Moreover, the development of the student-housing complex at the Education City is among the few student-housing complexes in the world with platinum certification by LEED. Qatar has availed 12 Platinum certifications awarded by LEED as new construction from the Green Building Council of the United States. In this way, Qatar became the top country in the gulf, achieving the highest number of LEED certifications of the platinum grade.[67]

Qatar Solar Energy (QSE) has already started one of the most extensive PV modules in the MENA region that are integrated vertically. Qatar has begun accomplishing its 2030 vision by installing a 300 MW facility in the industrial area of Doha. This will decrease the country's dependence on fossil fuels and directly promote renewable energy sources. Kahramaa, the Qatar electricity and water company, has its ambitions towards updating 85% of rooftops of the reservoirs into solar panels with the limited source of land available for use as it is essential for the countries having low available land to promote these types of activities. Qatar aims to adopt a scattered PV model ranging from small to medium installations. Qatar also has significant efforts in combating climate change by initiating

[67] Chris Newton, 'Fuelling the Fight against Climate Change' (EcoMena, 2018) <https://www.ifminvestors.com/docs/default-source/insights/art_ifm004_thought_leadership_07_infra_climate-change_v2.pdf?sfvrsn=3fe12c05_6> accessed 11 March 2020.

projects of operating their transport sector on compressed natural gas.[68]

Food security is also essential for countries with fewer available food sources. Hence, Qatar's National Food Security Program (QNFSP) is also considered the motivating force for creating and maintaining the desire for renewable energy, mainly the consumption of solar radiation, by forming efficient strategic plans. Qatar Foundation owns 70% of Qatar's solar technology and aims to increase its energy capture capabilities. They have also announced the creation of a solar farm in the Industrial City with a land area of 297 acres. Qatar also equipped all their football stadiums with solar panels in the welcoming FIFA World Cup in 2022. These stadiums have been self-sufficient in their operating energy requirement, fulfilling the aim of sustainable functionality.[69]

6.3 Saudi Arabia

In 2014, Saudi Arabia consumed 6937 kg of equivalent oil per capita, about 3.6 times higher than the average energy use worldwide. At the same time, its CO_2 emissions were at the seventh rank with a per capita contribution of 19.53 metric tons. Moreover, the country is characterized by sensitive ecosystems, limited freshwater resources, and substantial coastal developments, which makes it susceptible to climate change. In addition, Saudi Arabia has recently set off its sustainable policies for urban areas and concentrated on mitigating and adapting climate change in major metropolitan areas.[70] According to the World Bank, Saudi Arabia has

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[68] ibid.

[69] ibid.

[70] Ismaila Rimi Abubakar and Umar Lawal Dano, 'Sustainable Urban Planning Strategies for Mitigating Climate Change in Saudi Arabia' [2019] Environment, Development and Sustainability 1.

objectives against climate change in increasing resistance and measures to expand its economy sustainably.[71] The country has a ground plan to integrate and manage its water sources and transportation in urban areas, protect marine life, find solutions for decertified lands, ameliorate the degradation of their coastal areas, and develop primary cautionary techniques. Saudi Arabia collaborates with international organizations to promote research activities related to mitigating climate change with the ultimate benefit of improving the economy sustainably. They have also developed wastewater treatment facilities for reuse in the irrigation of crops and landscapes and introduced conservation techniques at residential buildings. They also aimed to introduce modern technologies for detecting leakage of water in the main cities of Saudi Arabia. Saudi Arabia needs to develop policies for protecting their groundwater resources that are limited from the pollution and invasion by saline water caused by poor coastal management. Information regarding the availability of water resources and risks associated with various areas needs to be communicated at all stages because the awareness of the public and their involvement plays a vital role in adapting to future challenges posed by climate change. There is a need to develop funding options and increase the capacity for long-term plans for improving the existing models.[72] Saudi Arabia, as a G20 member, is planning to introduce a carbon exchange system to expand its energy deliveries and lower the emissions caused by carbon compounds. In this way, the country is struggling to decrease the emissions caused by greenhouse gases. Saudi Arabia is operating a utilization plant for capturing carbon, the world's largest plant to convert CO_2

[71] World Bank, 'World Bank Climate Change Knowledge Portal: Bangladesh Overview' (2016)<http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile &CCode=BGD> accessed 15 March 2020.

[72] ibid.

of half a million tons into beneficial compounds such as fertilizers and methanol.[73]

According to the Climate Action Tracker, Saudi Arabia is categorized as "Critically Insufficient" for their 2030 NDC target. It means their policies are not meeting the Paris Agreement of lowering the global temperature by 2°C. This category implies that Saudi Arabia's current targets for climate change contribute to the worldwide warming temperature of more than 4°C. However, they have some development strategies that can reduce emissions soon. The renewable energy transformation of Saudi Arabia is included in their "Vision 2030" to convert the dependency of the country's economy from oil. According to the analysis by Climate Action Tracker, this country, along with its current policies, could reach the last limit of the "Critically Insufficient" category. However, it might be challenging for Saudi Arabia to achieve its National Determined Contributions (NDC) with their current policies. In their opinion, the emissions from Saudi Arabia are expected to increase from 92 to 108% from 2010 to 2030. However, Saudi Arabia has supported environmental technologies through patents and encouraging a knowledge-based society, as shown in Figure 4.

[73] Rania El Gamal, 'Saudi Arabia Plans to Launch Carbon Trading Scheme' (Reuters, 30 October 2019) <https://www.reuters.com/article/us-saudi-investments-energy/saudi-arabia-plans-to-launch-carbon-trading-scheme-idUSKBN1X91M1> accessed 15 March 2020.

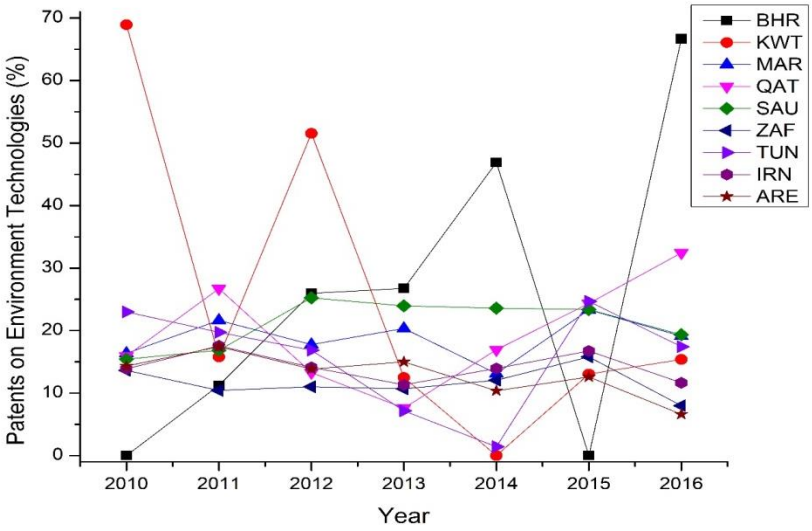

Figure 4: Patents on developing environmental technologies in different Arab countries.[74]

7. CONCLUSIONS

Many emissions are associated with global warming and climate change, i.e., CH_4 and N_2O, in the Middle East region that require actions and measures for mitigation. Therefore, considering the urgent need to address climate change, this paper has examined the strategic plans and initiatives undertaken by Arab countries. These nations are aware of their environmental challenges and have taken significant steps to fight climate change and its associated impacts.

[74] OECD, 'Environmental Policy - Patents on Environment Technologies' (2019) <https://data.oecd.org/envpolicy/patents-on-environment-technologies.htm> accessed 9 April 2020.

The United Arab Emirates has set ambitious targets to reduce its carbon footprint and increase renewable energy production. Their initiatives, such as the EWTE project, exemplify their commitment to these targets. Similarly, Qatar is actively pursuing a transition towards sustainable and renewable energy sources, aiming to utilize the potential of solar energy through extensive solar projects. Additionally, the QNFS program mixes the sectors of food security and renewable energy strategies. As a member of the G20, Saudi Arabia has recognized the necessity to reduce emissions. Therefore, they have taken initiatives such as carbon exchange systems and carbon capture utilization plants to demonstrate their commitment to sustainable practices. These efforts are not without their challenges, and it is essential to note that there is room for improvement. The assessment of Saudi Arabia's 2030 NDC target stresses the need for further policy refinement to align with the temperature aims of the Paris Agreement.

In conclusion, Arab countries in the Middle East are making commendable strides towards combatting climate change. Their endeavors in renewable energy, water conservation, and sustainable urban planning exemplify their commitment to a more resilient and environmentally friendly future. However, constant alertness, international cooperation, and sustained innovation will be essential to meet the formidable challenges of climate change. For this purpose, these countries need to increase their investment in sustainable technologies such as renewable energy and increase their energy efficiency. Afforestation can be a sustainable approach to combat desertification and a carbon sink in the region. The governments should build international collaborations and implement carbon pricing markets to help or encourage green technologies and infrastructure. Furthermore, education should

be provided to create awareness in the local public to adopt sustainable technologies.

Nomenclature

BEV	Battery Electric Vehicle
CH_4	Methane
COVID-19	SARS-CoV-2 disease identified in 2019
EWTE	Emirates Waste to Energy
FIFA	Federation International de Football Association
G20	The Group of Twenty countries has progressed, and emerging economies.
GW	Gigawatt
HEV	Hybrid Electric Vehicle
IPCC	Intergovernmental Panel on Climate Change
MOU	Memorandum of understanding
MW	Megawatts
N_2O	Nitrous oxide/Laughing gas
NDC	National Determined Contributions
PHEV	Plug-in Hybrid Electric Vehicle
$PM_{2.5}$	Particulate matter having a diameter ≤ 2.5 microns
QF	Qatar Foundation
QNFSP	Qatar National Food Security Program
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
UAE	United Arab Emirates
UN	United Nations
UNEP	United Nations Environment Program