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A quest for the Arabian atom? Geopolitics, security, and national identity in the nuclear energy programs in the Middle East



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ABSTRACT

Nuclear energy programs are currently under formalization in countries of the Gulf Cooperation Council (GCC), with the first power plants in the United Arab Emirates (UAE) due to be operational in 2020, and Saudi Arabia's program under development. A political-economic narrative stresses potential benefits such as the diversification of energy sources, the centralization/maintenance of power in the energy supply sector, and the preservation of carbon fuel reserves for export purposes. However, a narrow justification renders the analysis of the nuclear push incomplete, as it is not specific to the nuclear option: i.e., the benefits mentioned apply to other types of alternative energies such as the (relatively) clean options of solar and wind. Economic or domestic considerations might actually be less dominant than geopolitical ones in GCC countries. By analyzing nuclear legacies in the region, this paper highlights the geopolitical considerations behind the nuclear programs of GCC countries, in particular Saudi Arabia and the UAE. The rise of the nuclear energy option in the GCC region coincides with the resurrection of the nuclear program in Iran in the early 2000s. It is linked, in terms of evolution and discourse, to geopolitical rivalry and posturing as well as to the rising tensions in the region, at least in the case of the nuclear ambitions of Saudi Arabia. Despite the political and environmental vulnerabilities of the region, as well as the region-specific risks associated with nuclear power production, nuclear energy seems to be a stable choice in the energy mix policies of these countries.

1. Introduction

In the wake of more ambitious policies of energy-supply diversification, the development of renewable energy has accelerated in recent years in the countries of the Arabian Peninsula as well as in Iran. Here, we focus only on the Gulf Cooperation Council (GCC) countries and do not examine Yemen due to its different political-economic context. These countries have important historical and environmental ties, particularly through their sharing of the Persian Gulf (the term used by the United Nations to refer to this common water body, hereinafter referred to as “the Gulf”). The Gulf is where international trade, major cities, and significant supply installations for oil and gas production, desalinated water and marine food production are located. At the same time, Iran and the GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) seem to have an uneasy relationship due to the geopolitical rivalry between Iran after the 1979 Islamic Revolution and the Saudi Kingdom. Saudi Arabia (with around 30 million inhabitants) is the dominant player in the Arabian Peninsula and has often influenced the stances of GCC countries with regard to their foreign policy

attitudes towards Iran. Other GCC states have smaller populations (between 10 million inhabitants (the UAE) and 1.5 million (Bahrain)) and most of them have good relations with Iran (e.g., Oman, Kuwait, Qatar, and Dubai in the UAE). Moreover, Saudi Arabia has shaped the environmental diplomacy of GCC countries on the global stage and has thus greatly contributed to the historically skeptical attitude of the oil- and gas-exporting countries in the region concerning global actions on ecological challenges such as alternative energies and combatting climate change [1,2]. Saudi Arabia is also the politically dominant actor due to its size, as evidenced by its effectuating the blockade on Qatar in 2017 or influencing the attitudes of other GCC countries towards regional issues, such as the rivalry with Iran and the concern over its nuclear programs.

Due to rising pressure to enhance sustainability and energy-supply diversification, the push for alternative energies (renewables plus nuclear) in the GCC region (but also for renewables in Iran) seems to be accelerating rapidly. Bhutto et al. [3] reviewed some of the earlier efforts of GCC states prior to 2014. They concluded that most of the projects were at a pilot stage, while academic research centered on

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documenting the strong advantages of solar and wind energy. In fact, the high potential for renewables has been thoroughly studied by governments of the GCC states which, during the last two decades, have initiated some reforms (e.g., privatization of parts of the electricity sectors, incentive programs, and national or regional coordination agencies) to strengthen the renewables markets [4,5]. Some of the most relevant initiatives included the establishment of research and development centers such as King Abdullah City for Atomic and Renewable Energy in Saudi Arabia and Masdar City in the UAE, and also the basing of the International Renewable Energy Agency (IRENA) in Abu Dhabi. At the same time, nuclear energy constitutes an important portion of the current agenda in the region of promoting alternative energy for power generation. Despite the debate about the nature of this type of energy as being renewable, non-renewable, or clean, the GCC states have considered nuclear energy for, or even incorporated it into, their future energy-mix policies. Saudi Arabia and the UAE have concrete plans for increasing nuclear power generation up to 20% in Saudi Arabia and 12% in Abu Dhabi in the next decade [5]. Other GCC countries have signaled interest or initiated feasibility studies, whether unilaterally or with a regional approach to utilizing nuclear energy for electricity or desalination [4]. In Iran, plans for the development of peaceful nuclear energy date back to the times before the Islamic Revolution. Almost 40 years later, there is currently one operating nuclear plant of around 1 GW capacity (Bushehr 1, opened in 2013), while the government plans include the development of 20 GW of nuclear power capacity in the next couple of decades [6].

The guiding research question of this paper concerns why GCC countries are incorporating the nuclear power option as a part of their future energy-mix policies. The approach here is to highlight the geopolitical dimension as a significant explanatory factor. In this sense, the paper makes two major empirical contributions. Firstly, it shifts attention away from studying the level of the capacities and potentials of renewables to analyze more case-study-specific issues such as the composition of the energy mix. Indeed, why certain oil- and gas-exporting countries have more renewables than others is poorly understood and difficult to measure through quantitative analysis or large-panel data. This is because of the heterogeneous experiences of carbon-rich countries in the development of alternative energies.

For this paper, cross-country studies on the level of renewable capacity might not be too revealing, since such a capacity is often related to fluid factors such as internal pressures, size of the country, political-economic pressures, leadership, or availability of investments in different periods. This is especially true in light of the lack of regional coordination in many parts of the developing world, or global binding targets for renewables. In contrast, studies on the energy-mix policies can reveal some of the strategic and long-term decisions in the development of alternative energies. Such studies can focus on policy choices such as the organization of energy sectors (e.g., the level of the state involvement, feed-in-tariffs, or the establishment of large-scale plants) or, as is the case with this paper, on the motivation behind the composition of the energy mix (e.g., renewables vs. nuclear vs. carbon sources). Comparing GCC countries with similar socioeconomic characteristics, the level of renewables capacity of certain countries is neither stable nor meaningful. Some countries (e.g., the UAE and Qatar) have been identified as leaders in renewables development due to issues such as policy transfer (i.e., imitating policies implemented elsewhere) and political leadership [7]. Other scholars put Saudi Arabia and the UAE at the forefront of renewables development and cite the research and development capacities in these countries (e.g., pilot projects, academic institutions, hosting of international organizations, etc.) [8]. In fact, the race for alternative energies in the GCC region is changing rapidly through new commitments and policies, making it difficult to pinpoint long-term leaders and laggards. Furthermore, in some small and (carbon-) rich countries (the case with all GCC states except Saudi Arabia), policymakers can make big changes in the energy policy mix at short notice, e.g. by constructing grand plants for solar farms, or a

nuclear reactor. In fact, other small, carbon fuel-exporting countries such as Azerbaijan have also committed to short-term development of renewables [9].

Secondly, apart from the study of energy transformation in the European Union, regional perspectives on the quest for alternative energy are underrepresented in the literature. From an economic perspective, the region that the GCC states and Iran share is particularly interesting as a representative case for carbon-exporting and rich countries. At the same time, politically, it provides a unique example in terms of the tense geopolitical context. While choices inherent in the energy-mix policies involve several socioeconomic factors, the geopolitical dimension is highly important as it allows for insights on a regional level by highlighting a certain governance model, a common security threat, or a pattern of interstate politics. In this context, this paper analyzes the geopolitical considerations behind the rise of nuclear power in the GCC region by relying on international security concepts highlighting the aspects of state rivalry, national identity, symbolism, and strategic posturing. To achieve this, the paper uses mixed qualitative methods of conceptual comparisons between nuclear and renewable energy based on secondary literature (i.e., Can renewables in the Gulf achieve the same political-economic benefits as those associated with nuclear power?) as well as of discourse analysis, together with descriptive data in tracing back the legacies of nuclear power in the Gulf countries. For this, the history of nuclear programs in Saudi Arabia, the UAE, and Iran was studied together with first-hand statements of policymakers on the motivations behind the nuclear power push, as well as major policy papers by international think tanks and research institutions.

The paper first explains the energy transformation in the region and highlights the regional specificities. Later, it contrasts a political-economic analysis framework to a geopolitical one and highlights the importance of examining the two frameworks by relating them to the specific reality of case studies on energy-mix policies. Finally, the paper links the nuclear programs to the state-specific interests and regional geopolitical specificities and discusses future propositions on the proliferation of nuclear power production in the region.

2. Energy Transformation in Carbon-Rich States: Understanding the Nuclear Option

2.1. The push for the alternatives: Specificities of GCC States and Iran

Energy transition in countries characterized by rentierism and carbon energy abundance exhibits specific challenges and paradoxes. For example, these countries have the resources to develop renewables but can be unwilling to abandon fossil fuels [10]. Similarly, despite the reluctance of GCC states to engage with climate change in past decades due to concerns about the security of their carbon energy exports, their policies have been evolving in recent years in a way that acknowledges, and to some extent incorporates, environmental challenges into ambitious national visions for the future. At the same time, commitments to broad environmental reforms (e.g., curbing waste and high per capita consumption, or addressing the negative impacts of rapid development on ecosystems) can be considered modest. For example, as a part of the push towards more diversified, low-carbon and knowledge-based economies, GCC countries have lately shown more engagement with the global sustainability agenda, while countries such as the UAE and Qatar have incorporated more environmental goals and commitments [1,11].

The above is particularly true for the Sustainable Development Goals (SDGs) agenda in the Arab region, as some of these goals – e.g., those related to food security or (transboundary) water management – are highly relevant in the context of this largely dry region [12,13]. However, the search for sustainability, diversification and resource-use efficiency in the GCC region dates back to the first development plans in the 1970s [14], while current policies still reflect a significant level of

state involvement and rentierism (e.g., subsidies of basic services, no individual taxation, benefits for nationals) [15]. Although the rentier state is more institutionalized (i.e., widely acknowledged and openly negotiated) in the Gulf region, such rentier behavior is similar to other parts of the Middle East where the shadow actors (e.g., powerful farmers or tribes) seek to maintain state policies of patronage, privileges, and subsidies [16,17]. Furthermore, the sustainable development agenda of GCC countries is lacking a broad coverage of issues, which is reflected in the modest scoring of these countries on the implementation of the SDGs; e.g., ranking between the 65th (UAE) and 106th (Kuwait) places among 162 countries in the 2019 SDG index [18]. Similarly, in Iran (around 81 million inhabitants), sustainable development and environmental issues were featured more frequently in recent periodic development plans [19], while environmental challenges have grown to include severe water scarcity, droughts, and industrial pollution [20]. Iran is also a carbon-based economy where, until the recent modest subsidy reforms, citizens had been enjoying large giveaways [21]. This is despite the heavy burden of economic and political sanctions on Iran since the Islamic Revolution of 1979 [22]. Internationally, Iran is engaged in UN-based sustainability targets (e.g., the SDGs agenda or the 2015 Paris Agreement) and it holds 58th place in the above-mentioned 2019 SDGs index [18].

While the performance of GCC states with regard to sustainable development and environmental issues is mixed, the use of renewable or alternative energy (alternative energy is used in this paper to include nuclear alongside other non-carbon resources, while renewables are alternative energy minus nuclear) stands out as a key future priority allocated ambitious and relatively concrete targets. In this context, there are several arguments for the choice of renewables for power production over other alternatives such as nuclear power. Firstly, the potential for renewables in the region is huge (e.g. [3,4,5,23,24]). This is especially true for solar energy in the GCC countries, with average radiation equivalent to 1.1. barrel of oil per square meter [25]. Similarly, in Iran, the potential for renewable energy is relatively high, with higher potentials for geothermal energy and hydropower than in the GCC states [6]. In fact, Iran has the highest used capacity for hydropower in the Middle East [26]. Secondly, the relative cost of renewables is decreasing, while the technology is becoming more sophisticated and accessible. Several studies have attested the price competitiveness of current generations of renewables and the availability of heat- and sandstorm-resistant technologies (e.g., self-cleaning solar units) suitable for Gulf countries [3,7,8,23]. In comparison, nuclear energy might not be economic. In Saudi Arabia, Ahmad and Ramana [27] showed in their detailed comparison of nuclear power with natural gas, and even solar energy, that nuclear power economics are not favorable to natural gas – even at the subsidized gas prices – and are not expected to be competitive with solar energy on many parameters, even though the storage capacity of renewables is quite expensive. This is due to several factors specific to the region, such as the high potential of renewables in the region and the high capital costs of nuclear energy. Furthermore, the costs of nuclear waste disposal and management are often underestimated, making nuclear in the future an even more expensive option [28]. Despite this, capacity (willingness to pay) and the interests of GCC states to seek nuclear power are judged quite high in international comparison among nuclear newcomers [29].

With regard to energy plans and targets for renewables, these have seemed to change constantly, particularly after the oil price fall of 2014 and the impetus provided by national visions for economic diversification in the ensuing period. Earlier studies, e.g. [4,5,23], report smaller targets for renewables than more recent ones, e.g. [24,30,31]. The latter put the targets as a proportion of total capacity as follows: 15% for Kuwait by 2020, 5% for Bahrain by 2020, 20% for Qatar by 2030, 24% for the UAE by 2021, and 54 GW for Saudi Arabia by 2040. Some reports of new plants and projects envision mega-plants under planning; for example, a solar plant of 80 GW in Saudi Arabia [30]. It is not quite clear how the final energy mix in 2030 and 2040 will look in

light of the changing priorities regarding other alternative energies such as nuclear. Nuclear power has been on the agenda since the early 2000s, but some plans were abolished for environmental security and economic reasons. Some countries changed policies, however, such as the UAE, which in 2008 announced 1.5 GW of nuclear plants by 2020 [4], and later upgraded the target to 5.6 GW through four nuclear plants [5]. In terms of renewables and nuclear energy targets in Iran, these changed over the years; e.g., from 5 GW of renewables by 2021 to 5% of installed capacity by 2021 [32], while the nuclear targets of 15 GW by 2030 [6] or 20 GW by 2040 [6] remain elusive (given the current capacity of 1 GW).

2.2. Domestic game-changers or geopolitical symbols? Theories and motivations of nuclear power

Public policies in favor of the promotion of nuclear energy instead of, or in addition to, other renewables can be largely driven by tangible domestic factors such as energy potential, cost considerations, infrastructure, know-how, the geography of a country, or nuclear safety considerations. Other domestic but soft factors play a role as well. For example, Marktanner and Salman [33] used data to show that democracies (those with a high polity score as a sign of a good institutional-participatory political system) and a high *per capita* income can predict the presence of nuclear energy, while rentier states are less credible in using nuclear power as a means to socioeconomic development. In contrast, Neumann et al. [34] suggest that countries with lower levels of democratic development are more likely to introduce nuclear power. Moreover, democratic quality (measured through ratings using characteristics such as civil society, pluralism, freedom, liberties, etc.) can predict which countries abandon nuclear power programs [35]. However, these examples of “hard” and “soft” domestic factors in determining the choice of nuclear power cannot be adequately applied to the region. As mentioned earlier, GCC countries are rentier and autocratic states with a high potential for relatively low-cost renewables and little know-how (in contrast to Iran). Furthermore, the geographic proximity and population density (large populations on the coasts) as well as the significance of potentially affected ecosystems (e.g., the Gulf water body) in the event of accidents should render the risks and downsides (e.g., disposal of nuclear waste) of nuclear energy very high. This has indeed been a reason why some GCC countries (e.g., Qatar, Kuwait, and Oman) have not opted for nuclear energy for electricity generation or water desalination [4].

Some domestic reasons for the choice of nuclear energy are indicated in the literature, such as the use of nuclear power production as an avenue for economic diversification, water desalination, or the suitability of this energy type for the authoritarian and centralized political system of the GCC states: i.e. maintaining control and strengthening the coercive apparatus with no protests expected [36]. These reasons are not specific to nuclear power, though, since economic diversification can be achieved through renewable markets. Solar-based desalination is on the rise, with Saudi Arabia building the world's largest solar-based plant (the Al Kafji solar-powered desalination plant). Moreover, the undergoing energy sector reforms in the renewables sector equally maintain state control. For example, Tsai [37] analyzed the political economy of energy policy reforms in the non-oil sector through the single-buy model and hidden subsidies to independent power producers under public or private ownerships. Under these reforms, the oil sector extends control (e.g., through subsidies and power-purchase agreements) over service providers of clean energy, while the state's dominance and the characteristics of the rentier states are maintained.

Another domestic argument concerns the urgency of finding alternative energy sources for producing electricity and meeting domestic energy demands. In Saudi Arabia, for example, the rapidly rising demands can, if not otherwise satisfied, deplete the carbon exports in a matter of a few decades [38]. In Iran, gas reserves are more abundant

than in Saudi Arabia, and they have increasingly been deployed to produce electricity; yet still, energy intensity and demands are increasing. Energy intensity showed an average annual growth of around 3.3% in 1974–2014 [39]. Any energy capacity increase needs to be co-produced through alternative energy resources to achieve some degree of environmental sustainability. However, this urgent need for more energy can be satisfied through renewables (e.g., the construction of solar energy parks), which can be deployed in a shorter time span and in a more scalable fashion than nuclear energy can.

Understanding the nuclear power option in GCC countries through the lens of domestic political-economic factors (e.g., the diversification push after 2014, rising power and water needs, or the nature of the state) can render the analysis incomplete. Instead, we argue that there are important geopolitical reasons to be studied. An illustrative example is the choice of nuclear power over carbon-based options, since such a choice can be linked to energy-independence considerations such as reliance on the importing of gas from Qatar. Qatar is currently the only gas exporter in the GCC region and possesses massive reserves. Utilizing this fact, the GCC countries developed a scheme for a regional pipeline gas trade to satisfy short-term domestic needs but failed to agree on preferential prices of Qatari gas for neighboring states [40]. Since mid-2017, the relationship between Qatar and three of its immediate neighbors – Saudi Arabia, Bahrain and UAE – was strained after the economic blockade imposed on Qatar, citing political reasons. These factors (political disputes) can explain the decision of the UAE to advance the construction phase of its nuclear plants and become independent from its neighbor and historic rival, Qatar. While this choice of nuclear power over gas is deeply rooted in regional geopolitics, a decision against a nuclear and in favor of a renewables-led energy transition is a complicated one with significant geopolitical dimensions. At the same time, the geopolitical nature of such a decision is ambiguous, as countries can decide to engage with nuclear power alongside other alternative energies (e.g., China), disengage after incidents and changes of public opinions (e.g., Germany and Japan), or reconsider the nuclear option after supply cuts (e.g., the Russia–Ukraine crisis) [41].

In studying the geopolitical nature of nuclear power, international studies do not provide clear-cut explanations and should rather be contextualized through the case at hand. On the one hand, from a neo-realist point of view, nuclear power is embedded in a rivalry among states for the acquisition of nuclear technologies that can be manipulated towards nuclear weapons if or when this suits the states' interests. A study of the unpreventable proliferation of nuclear technologies in the Middle East shows that there are complex internal and external factors behind this, mainly centering around the issues of prestige and local rivalries [42]. On the other hand, from the perspective of proliferation theories, an acquisition of nuclear technologies and nuclear energy does not (automatically) lead to nuclear weapons. According to Miller [43], nuclear energy rarely leads to arms proliferation as, with nuclear power plants, countries face higher scrutiny, likelihood of detection, and non-proliferation pressure, as well as costs in the event of sanctions on the nuclear technology or fuel. Other scholars explain nuclear power choices by relating them to the strong interests and influence of the nuclear industry [44]. However, it is difficult to judge whether this influence is higher than the influence of actors such as the currently strong industry of renewables. In the case of GCC states, research on nuclear power proliferation is scant, while some scholars strongly indicate a geopolitical dimension (similar to what the paper at hand concludes). Morady [45] sees the Iranian nuclear program as a vehicle for making Iran a regional power as well as one among the great (nuclear) powers in the East and the West. Abulof [46] gives five reasons for Iran's pursuit of a nuclear energy program: meeting energy needs, prestige, deterrence of enemies, boosting regional influence, and maintaining domestic legitimacy. In contrast to other countries in the wider Middle East region, Luciani [47] regards the motivation of nuclear programs in GCC states to be both economic (available finances for the immediate demands of nuclear technology) and political

(counteracting Iran's growing influence).

3. Nuclear Legacies in the Gulf

3.1. Iran's (peaceful) nuclear program

The Iranian Nuclear Program was established in 1957 following Eisenhower's "Atoms for Peace" initiative, which equipped the Iranian nuclear plants with United States (US)-made reactors. The program started with the Shah's famous speech in 1974 on the value of oil and his belief that Iran's oil would be depleted by 2020: "Petroleum is a noble material, much too valuable to burn...We envision producing, as soon as possible, 23,000 megawatts of electricity using nuclear plants." [48]. This vision was supported not just by the US but also globally due to the international oil crisis (increased oil prices following the Saudi Arabia led reduction in production during the Arab–Israeli war of 1973), which created a fear of dependence on Middle Eastern oil in the international community. Although development of the nuclear program was gradually advancing, the entire program was put on hold following the 1979 revolution.

International attention to Iran's nuclear program surfaced in 2002 when an Iranian dissident revealed two secret nuclear sites that were being built without the knowledge of the International Atomic Energy Agency (IAEA). In order to avoid referral to the UN Security Council, in June 2003, President Mohammad Khatami negotiated with three powers of the European Union (France, Germany, and the United Kingdom) and agreed to stop Iran's nuclear enrichment with the signing of the Tehran Declaration. However, in 2005, with Mahmoud Ahmadinejad's victory in the Iranian presidential elections, the nuclear program was officially restarted, leading to multiple unilateral and multilateral sanctions on the country by the United States, the European Union, and the United Nations Security Council.

Iran has maintained that the nuclear program is for peaceful purposes and that under the Nuclear Non-Proliferation Treaty, it is Iran's right as a sovereign nation to a peaceful nuclear program. The history of its only commercial reactor at Bushehr is given as evidence of this intention. Construction on the plan began in 1975, but it stopped in 1979 after the Islamic Revolution and was eventually re-started in the late 1990s. This reactor became operational in 2011 after significant help and commitment from Russia, an important partner of Iran, despite significant pressures from the West during the 2000s [49]. Western powers had been pushing against the Iranian claim of peaceful use as they claimed that Iran was enriching uranium to build atomic weapons. As such, and after 13 years of negotiations, Iran managed to achieve a broad agreement with the P5+1 (China, France, Russia, United Kingdom, United States, and Germany) on July 14, 2015, which ensures the peaceful nature of the Iranian nuclear program through strict verification mechanisms by the IAEA in exchange for the removal of nuclear-related sanctions.

The Joint Comprehensive Plan of Actions (JCPOA), however, had significant geopolitical consequences. It invoked regional resistance across the region. This resistance was led by in Saudi Arabia and Israel who saw the agreement as not sufficiently dealing with Iranian geopolitical ambitions in the region and as leading to a normalization of relations with their regional rival [50]. This regional rift between Iran and Saudi Arabia further intensified during the presidency of Donald Trump in the US, with the reinstatement of anti-Iran policies to contain and counter Iran's regional influence [51]. With the US withdrawing from the JCPOA in 2018 and adopting a mixed policy of pressuring Iran, decreasing its international military footprint in the region and offering (in public talks) engagement and dialog, the tensions and rivalry in the region increased significantly [52].

One indication of the direct impact of the nuclear program on the UAE and Saudi Arabia is the timeline of these countries' decision to pursue nuclear programs. As will be explained in the following sections, the UAE managed to quickly start the construction of its nuclear plants

within three years of announcing its official intent in April 2008 to evaluate nuclear energy for meeting energy demands. At the same time, Saudi Arabia has significantly fast-tracked its nuclear endeavor following the successful end of JCPOA negotiations, and more so after Donald Trump's victory in November 2016. With the Trump administration's decision to withdraw the United States from the JCPOA, Iran is in "a prime position to ramp up its enrichment activities again," as it has sequentially reduced the implementation of its nuclear commitments [53]. These geopolitical developments could spark and intensify the competition among Iran, Saudi Arabia, and the Emirates in the future.

3.2. (Double) politics of the Saudi nuclear aspirations

Following the intensification of tensions between Iran and the international community over its nuclear program, and the UAE's formalization of plans to build a nuclear energy capacity, Saudi Arabia came to the fore with its own plans to build nuclear plants. In 2009, a Saudi royal decree announced that "The development of atomic energy is essential to meet the kingdom's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources" [54]. With the aim of building a nuclear energy capacity that can generate a fifth of Saudi Arabia's generated electricity by 2032, Riyadh announced plans for the construction of 16 nuclear power reactors starting in 2010 [36]. These plans have not been realized so far, and the intended target of 20% of power generation from nuclear resources by the 2032/2040 deadlines seems unlikely to be achieved. This might be due to budget shortages in light of low oil prices, the expenses relating to its war efforts in Yemen, and/or the large number of infrastructure and development projects.

Saudi Arabia's quest for international approval of its nuclear plans has not allayed the concerns relating to the future nature of the program. Even though Saudi Arabia ratified the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1988 (as Iran did in 1970) and concluded a Comprehensive Safeguards Agreement with the IAEA in 2009, Saudi Arabia, unlike the UAE and similarly to Iran, has not yet signed the additional protocol, which allows for stricter inspections, nor has it signed the Comprehensive Nuclear Test Ban Treaty [54]. Furthermore, while Riyadh has signed agreements with France, Argentina, South Korea, and China with regard to various fields for bilateral cooperation, it has not yet arrived at an understanding with the United States [55]. Saudi Arabia was not able to allay the fears of the Obama administration in signing a cooperation treaty. However, since the victory of Donald Trump – a perceived strong ally in the White House – Saudi Arabia has restarted negotiations with the United States. The aim is to meet conditions and standards set by Section 123 of the US Atomic Energy Act (AEA) for cooperation with other countries, and even to match the voluntary, stricter conditions in the US–UAE agreement (the 123 "Gold Standard").

One contentious issue is Saudi Arabia's insistence on producing its own nuclear fuel, even though it could buy fuel more cheaply abroad. This is a major concern for actors in Washington who fear fuel diversion to a weapons project [56]. While Saudi Arabia argues that it wants to take full advantage of its uranium resources, indigenizing a completely Saudi nuclear program might take more than a decade and would be quite difficult due to the scarcity of Saudi uranium resources [54]. However, some observers are concerned about the Trump administration conceding nuclear capabilities to Saudi Arabia and allowing enrichment for peaceful purposes, thus forgoing the Gold Standard that was agreed with the UAE [57]. In fact, having an indigenous enrichment program using domestic uranium resources is proclaimed by many Saudi officials, whereas such a program can be seen, according to Miller and Volpe, as "a crucial step toward the bomb that could be taken without running afoul of the global nonproliferation regime," as Saudi Arabia is "allowed to enrich uranium under the peaceful uses clause of the NPT," similarly to Iran. [53].

Since the murder of Jamal Khashoggi, a prominent Saudi journalist who was killed in the Saudi consulate in Istanbul in October 2018, along with the intensification of the humanitarian issues related to the war in Yemen, there has been an increased focus on Saudi Arabia, and various members of the U.S. Congress have been calling for a halt to the nuclear negotiations with Saudi Arabia. Increasingly, politicians in the US are arguing that Saudi Arabia cannot be trusted with nuclear programs [58], while the Saudi Kingdom is threatening to abandon its NPT obligations in response to a possible nuclear breakout in Iran. The Saudis have been reiterating that they want a nuclear program similar to Iran's. [58]. In an interview with the US-based show *60 Minutes*, the Saudi Crown Prince, Mohammad bin Salman, argued that "Saudi Arabia does not want to acquire any nuclear bomb, but without a doubt, if Iran developed a nuclear bomb, we will follow suit as soon as possible" [59]. Not only have such statements increased fears of proliferation, but also coupled with the urge to have enrichment capacity, Saudi Arabia's pursuit of nuclear technology might seem more tied to its regional posturing and interest in the prestige associated with being in the "nuclear club" than wanting to decrease dependence on fossil fuels and diversify the energy mix for domestic consumption.

With a lack of clear economic rationale for Saudi Arabia's pursuit of a nuclear energy program, some observers explain the plans through other factors and reasons. They argue that even though nuclear energy "may have some advantages for niche applications like desalination," the main "impetus for the Saudi nuclear program appears to be its regional rivalry with Iran" [60]. If Saudi Arabia is serious about instituting a peaceful nuclear program, it will need to take the necessary measures to address international concerns, which can be done by implementing the Additional Protocol and the IAEA safeguards. Saudi Arabia also has a murky past with regard to its alleged financial assistance of the Pakistani nuclear program, and hence the possibility of Islamabad providing Riyadh with nuclear weapons [61].

3.3. UAE's nuclear push: alternatives and political reality

The UAE announced its intention to build four nuclear power plants in a region 300 kilometers from Abu Dhabi in 2008, and by 2010, with around 24 billion dollars in investments, the UAE contracted a consortium of South Korean companies to build its first of four Barakah nuclear plants [36]. This nuclear push is in accordance with the UAE's National Energy Plan 2050, which foresees a decrease in the carbon footprint of power generation by 70% and an expansion of its renewable energies' contribution to the total energy mix to 50%, (of which 6% from nuclear energy) [62]. According to reports and government projections, the total capacity of the four nuclear plants by 2030 will equal 5.6 GW, which will meet about 25% of the UAE's power demand and at the same time decrease carbon emissions by the same percentage [63]. Furthermore, the Dubai Supreme Energy Council has also set a 2030 target to produce 11% of its electricity from nuclear energy [64].

In 2009, the UAE successfully managed to sign an agreement with the United States. By doing so, the UAE was able to significantly reduce international fears about nuclearization and establish itself as the first country in the Arabian Peninsula to institute nuclear technology on its soil. This agreement is often dubbed as the "gold standard" in nuclear energy collaboration because the UAE voluntarily agreed to not pursue enrichment and reprocessing (ENR) technologies and capabilities, alongside fulfilling the Section 123 conditions of the AEA [65]. This agreement stands in stark contrast to the nuclear program of Iran, which does not have a bilateral agreement with the United States, and also to the (according to Kimball and Kingston) "blanket consent" with respect to ENR that the US has granted to India, Japan, and the European Atomic Energy Community (EURATOM). [66].

In addition, the UAE instituted the Nuclear Energy Program Implementation Organization (NEPIO), the Emirates Nuclear Energy Corporation (ENEC), and the Federal Authority of Nuclear Regulation (FANR) to manage all aspects relating to regulations, international

commitments, and transparency measures. Furthermore, the UAE is a signatory to the NPT and it ratified a safeguards agreement with the IAEA in 2003 and signed the Agency's Additional Protocol in 2009 [67]. These measures and practices, coupled with obligations under the 123 Agreement, serve to assist in making the nuclear push of the Emirates successful. However, considering that the operationalization of the \$24.5 billion Barakah nuclear power plant has repeatedly been postponed, this might not enable the UAE to reach its modest target of 25% of electricity generation from nuclear energy by 2030. The UAE was expecting to operationalize the first nuclear plant by 2017; however, due to some technical difficulties and delays by the South Korean contractors, it was announced that the first plant would go online in early 2020, and the other three will be operationalized one by one in a yearly manner [68]. On the other hand, the UAE is investing in its nuclear capacity through training nationals in such fields by providing scholarships abroad and bringing international experts to transfer the knowledge and know-how [69].

Regardless of the delays and limitations, the UAE's choice to push for nuclear power generation can be questioned with regard to alternatives. It would be feasible to replace the nuclear option with renewables such as solar, or to use gas, considering that the 2050 energy-mix targets for both options are 44% and 38% respectively, in comparison to 6% for nuclear energy [62]. One justification narrative for the nuclear push is the dwindling gas resources of the UAE, and its reluctance to depend on gas imports from Qatar, a gas-rich neighbor with whom the UAE has had tense political problems [70], the UAE–Qatar relationship being at its worst point after the 2017 economic blockade of Qatar. However, the decision to include nuclear power alongside other clean alternatives (rather than to completely rely on renewables) is difficult to understand for a relatively small and resource-rich country such as the UAE.

Some observers argue that the UAE's nuclear program has the potential to contribute to the electricity generation of the pan-GCC power grid by diverting excess nuclear energy production for regional exports [71]. Through the existing GCC interconnection grid, the GCC countries could benefit from having human resources, technical know-how, and other logistics in the UAE, which could serve as a nuclear hub and decrease the needs for other GCC countries apart from Saudi Arabia to establish their own programs in the future [72]. However, other GCC countries (e.g., Qatar) have complained about safety implications and environmental issues arising from the UAE's program and its effect on its immediate neighbors [73].

3.4. *Smaller GCC countries: bystanders?*

Bahrain, Kuwait, Oman and Qatar are other smaller GCC countries that have explored the potential of nuclear energy for power use and expressed concerns about the nuclear programs of their neighbors. Both Kuwait and Bahrain have commissioned analyses and feasibility studies on nuclear energy, with Kuwait signing nuclear cooperation agreements, for example, for water desalination with France in 2010 as well as with other countries. However, none of these studies and agreements have resulted in a decision to construct nuclear power plants, although this decision is still open for Bahrain and Kuwait, while Qatar has indicated that it does not need this alternative energy source [74]. Smaller GCC countries have been clearly concerned with the development of nuclear plants ever since Iran reinstated its nuclear programs. Countries such as Kuwait have concluded that an environmental catastrophe in the Bushehr facility in Iran would have devastating impacts on the inhabitants, particularly in Kuwait City, but also other littoral cities surrounding the Gulf [75].

During heightened tensions between Iran and the West, GCC countries expressed their interest in a common approach to developing their nuclear power [76]. A GCC-wide evaluation of the peaceful use of nuclear energy commenced, and an agreement with the IAEA to cooperate on a feasibility study for a regional nuclear power and

desalination program was signed [77]. One of the primary justifications for this push was the use of nuclear energy for desalination, since most groundwater resources in the region have been depleted [78]. However, given the large amounts of initial capital required, along with the significant risks associated with the establishment of nuclear programs, GCC countries abandoned their Council-wide plans, and only the UAE and Saudi Arabia continued with individual projects. It remains unclear how the proliferation of nuclear energy in the GCC region, as well as in the wider Middle East region – with Egypt, Jordan and Turkey announcing nuclear plans [79] – is going to affect smaller states, or energy-based collaboration among nuclear and non-nuclear states.

4. Discussion and Future Propositions

Although nuclear power in the region is an emergent issue, the analysis of legacies gives credit to the premise of significant geopolitical considerations in decisions about the energy-mix policies. This might be more so with Saudi Arabia's nuclear plans, which are yet to be endorsed internationally and are to date suspected by some countries of having a strong external (geopolitical and symbolic) motivation. Further to this argument, the interest of other countries in the nuclear power option coincides with the resurrection of the Iranian nuclear program. Since this time, some GCC governments refer to the Iranian program at the same time as pointing out the domestic and GCC-wide benefits of nuclear power. Therefore, there is arguably a geopolitical dimension to the nuclear push in the region. This might have been implicitly assumed by observers even without the detailed analysis provided in this paper, although we did not evaluate the perception of nuclear sector practitioners due to the sensitivity of this issue. However, (geo)political motivations behind nuclear power acquisition (alongside some conflicting economic ones) have also been confirmed in other countries such as Turkey and Ghana [80,81]. In the Gulf region, such motivations are prominent. After all, political turmoil and tense interstate relations have been salient features of the region. This is evident in the long-standing regime rivalry, the often-adversarial inter-state powerplay over recent decades, and the lack of a regional cooperation framework, even on soft issues such as environmental or cultural matters.

Highlighting the significance of the geopolitical aspects of the nuclear option has some implications for the alternative energy push in the region. We investigate these implications by suggesting three future propositions.

First, nuclear power seems to be a stable option in the region (but the least desirable one from an environmental perspective). As mentioned before, GCC countries as well as Iran have significant potentials for renewable energies such as solar, wind, and tidal power. Despite this, some of them are opting for nuclear power as a portion of their energy mix for reasons related to geopolitical rivalry, state organization (maintaining rentierism and public jobs), and the compatibility of this type of power production with their top-down governance systems. Furthermore, in the past, the abundance of carbon-based energy has delayed the push for alternative energies, while some countries (e.g., Iran, the UAE, and Qatar) still have enough carbon fuel reserves to go without solar and wind. In this context, alternative energies, including nuclear, are not only good tools for decreasing dependence on carbon resources, but also prime symbols for conveying modernity, power, and integrability in the global sustainability debate. Nuclear power programs can be such a powerful symbol, and GCC countries such as the UAE and Saudi Arabia can well afford the large capital and upfront investments associated with their development. Such high costs have been the primary reasons for the relatively low number of nuclear programs around the world. Even if political economic necessity, cost–benefit relations of other alternatives, and negative downsides in the region (e.g., political instability and vulnerable ecosystems with high economic relevance) are high, countries have decided to integrate nuclear energy as a (so far) small part of their overall energy mix policies.

Secondly, the proliferation of nuclear power programs can reinforce the regional instabilities that partly motivated such proliferation. On the one hand, the notion that the nuclear power programs of GCC countries act as a deterrent to an attack from Iran is weak for several reasons. GCC countries have enjoyed military protection from the USA ever since the end of World War II, and more so since the 1990s. Moreover, the strategic importance of the region for carbon-fuel supply has meant that global powers are eager to hold states back from any direct military confrontation. Such a direct confrontation between GCC countries and Iran has never happened, even at times high of tension during the Iraq–Iran war, or the current escalation after the Trump administration's reimposition of sanctions on Iran, and Iran's intensification of support for its proxies and partners around the region. On the other hand, it has been reiterated by international organizations that centralized control and political stability are important for running nuclear programs (e.g. [64]). In the context of the region, attacks by non-state actors or rogue groups, cyberattacks or terrorism pose a serious security challenge for critical infrastructure in the region, and such a challenge would arguably be higher with the presence of sensitive nuclear power plants. While the UAE denied the reports, in December 2017 the Houthi rebels in Yemen (Ansarullah) announced the firing of a ballistic missile at Abu Dhabi's under-construction nuclear power plants [82].

Thirdly and finally, opting for nuclear power programs in the region might not be an easy or a popular choice, either domestically or from the perspective of the global community towards the region. We argue that the risks associated with the nuclear programs (nuclear waste and the environmental/human costs of accidents) are well known by people and governments in the region. The nuclear push can strain the (so-far peaceful) state–citizen relationships in the GCC region, where carbon energy abundance has shaped the state model through lavish subsidies and free benefits for citizens with no expectations in return. It remains for future research to determine how much support GCC citizens have for nuclear power, or whether this power will strain public budgets (e.g., the continuation of energy price subsidization) as well as hindering the development of the renewables market.

From an international perspective, while nuclear power is a popular option and still considered a “clean” energy in some places (e.g., China, South Korea, South Africa, and some European countries such as Finland and Poland), this is arguably due to its long-term nature (a lifetime of around six decades) as well as its reliability (assuming no accidents). Since the Fukushima nuclear disaster in Japan in 2011, unfavorable public opinions on nuclear power grew around the world, leading to the decision of some countries to partly (e.g., Japan) or fully (e.g., Germany) decommission nuclear plants. While seismic risk is low in the Arabian Peninsula, there are many other geopolitical and environmental risks evident, as mentioned above. National and international concerns about the region's push for nuclear power have been explained earlier. In this context, it is also doubtful whether global or non-state actors (e.g., global civil society actors, epistemic communities, citizens in other countries) have positive attitudes towards this development.

5. Conclusions

The push for alternative energy is commonly justified by countries in the region through domestic political economic factors. These include the push for economic diversification, rising domestic energy demands, the need to save carbon reserves for exports, and sustainability requirements. While these justifications apply to alternative energies as a whole, they do not explain the choice of incorporating a nuclear power option in future energy-mix policies of the region's countries. Furthermore, Saudi Arabia and the UAE are joining Iran in developing nuclear programs (with the Saudi program yet to materialize, and the UAE is near the finish line), while other GCC countries have either signaled interest (Oman), conducted feasibility studies

(Kuwait and Bahrain), or dropped the option altogether (Qatar). Other explanations for the nuclear push in the GCC region include the need for water desalination and the suitability of nuclear power generation for the centralized governance systems in the region. Still, as explained in this paper, these arguments are not specific to nuclear energy. In fact, a purely political economic perspective renders the analysis of the nuclear push in the region incomplete, while geopolitical reasons might be a dominant consideration in the promotion of nuclear energy.

Legacies of nuclear power programs confirm a significant role for geopolitical considerations in the initiation of some of the programs in the Arabian Peninsula. The formalization of country-level plans to establish nuclear power plants along with the GCC-wide push for nuclear energy for the common energy market have coincided with the resurrection of Iran's (peaceful) nuclear program since the early 2000s. While the UAE has quickly moved to satisfy the standards of the international community for peaceful use and to construct the Barakah plants, the Saudi program is still controversial in light of the Saudi demands for domestic enrichment. Furthermore, there are other signs of geopolitical significance such as public references to matching Iran's nuclear programs, as well as the evident geopolitical reality of a region characterized by rivalry and political tensions ever since the 1980s. Moreover, the reluctance of GCC countries (UAE or Saudi Arabia) to depend on gas imports from neighboring Qatar is another reminder of the influence of geopolitics on energy-mix choices. Ever since the increased political tensions following the withdrawal of the Trump administration from the JCPOA agreement, the geopolitical aspects of (nuclear) energy are quite evident, with strong domestic and economic implications.

Evaluating the development of nuclear programs in GCC countries in the sense of a relational geopolitical reaction to Iran's nuclear energy acquisition is reflected in the narratives, legacies, public statements and observation of these programs. Such a conclusion provides important nuances and implications for pure political-economic thoughts on energy-mix policies, and also on theories of international relations dealing with nuclear proliferation. From a political/economic perspective, the nuclear energy option is neither a dominant nor a unique option for GCC countries in terms of reducing costs, saving resources, maintaining control, or providing jobs. However, nuclear energy provides a powerful symbol and a tool of “political posturing” towards Iran, both of which the UAE, and to a large extent Saudi Arabia, can afford despite the high capital costs and environmental risks. At the same time, nuclear energy can exacerbate political tensions in the regions. It adds more highly sensitive infrastructure to the toll of supply infrastructure on the Gulf coasts that are already at risk from a range of possible failures and threats. Furthermore, some observers locally and internationally might question this seemingly difficult decision of promoting nuclear energy in a region that is environmentally and politically vulnerable, and in times when resource-rich and well-developed countries have had second thoughts about the cost–benefit relationship of advancing one energy type over others.

Declaration of Competing Interest

none

References

- [1] M. Al-Saidi, E. Zaidan, S. Hammad, Participation modes and diplomacy of Gulf Cooperation Council (GCC) countries towards the global sustainability agenda, *Development in Practice* 29 (2019) 545–558, <https://doi.org/10.1080/09614524.2019.1597017>.
- [2] J. Depledge, Striving for no: Saudi Arabia in the climate change regime, *Global Environmental Politics* 8 (2008) 9–35, <https://doi.org/10.1162/glep.2008.8.4.9>.
- [3] A.W. Bhutto, A.A. Bazmi, G. Zahedi, J.J. Klemeš, A review of progress in renewable energy implementation in the Gulf Cooperation Council countries, *Journal of Cleaner Production* 71 (2014) 168–180, <https://doi.org/10.1016/j.jclepro.2013.12.073>.
- [4] W.E. Alnaser, N.W. Alnaser, The status of renewable energy in the GCC countries,

- Renewable and Sustainable Energy Reviews 15 (2011) 3074–3098, <https://doi.org/10.1016/j.rser.2011.03.021>.
- [5] Z. Abdmouleh, R.A.M. Alammari, A. Gastli, Recommendations on renewable energy policies for the GCC countries, *Renewable and Sustainable Energy Reviews* 50 (2015) 1181–1191, <https://doi.org/10.1016/j.rser.2015.05.057>.
- [6] A.H. Ghorashi, A. Rahimi, Renewable and non-renewable energy status in Iran: Art of know-how and technology-gaps, *Renewable and Sustainable Energy Reviews* 15 (2011) 729–736, <https://doi.org/10.1016/j.rser.2010.09.037>.
- [7] Y. Atalay, F. Biermann, A. Kalfagianni, Adoption of renewable energy technologies in oil-rich countries: Explaining policy variation in the Gulf Cooperation Council states, *Renewable Energy* 85 (2016) 206–214, <https://doi.org/10.1016/j.renene.2015.06.045>.
- [8] K.D. Patlitzianas, A. Famos, Driving forces for renewable development in GCC countries, *Energy Sources, Part B: Economics, Planning, and Policy* 11, 244–250 (2016); 10.1080/15567249.2011.616571.
- [9] N. Vidadili, E. Suleymanov, C. Bulut, C. Mahmudlu, Transition to renewable energy and sustainable energy development in Azerbaijan, *Renewable and Sustainable Energy Reviews* 80 (2017) 1153–1161, <https://doi.org/10.1016/j.rser.2017.05.168>.
- [10] A.N. Menegaki, K.P. Tsagarakis, Rich enough to go renewable, but too early to leave fossil energy? *Renewable and Sustainable Energy Reviews* 41 (2015) 1465–1477, <https://doi.org/10.1016/j.rser.2014.09.038>.
- [11] S.H. Hammad, M. Al-Saidi, E. Zaidan, Beyond the pledges: reflections on sustainability transitions in the Gulf Cooperation Council (GCC) region, *Development in Practice* 29 (2019) 539–544, <https://doi.org/10.1080/09614524.2019.1628920>.
- [12] R. Mohtar, M. Keulertz, Governance and Cooperation over Food and SDG 2 in the Arab Region, UAE (2019).
- [13] H. Hussein, F. Menga, F. Greco, Monitoring Transboundary Water Cooperation in SDG 6.5.2: How a Critical Hydropolitics Approach Can Spot Inequitable Outcomes, *Sustainability* 10, 3640 (2018); 10.3390/su10103640.
- [14] B.A. Albassam, Economic diversification in Saudi Arabia: Myth or reality? *Resources Policy* 44 (2015) 112–117, <https://doi.org/10.1016/j.resourpol.2015.02.005>.
- [15] E. Zaidan, M. Al-Saidi, S.H. Hammad, Sustainable development in the Arab world – is the Gulf Cooperation Council (GCC) region fit for the challenge? *Development in Practice* 29 (2019) 670–681, <https://doi.org/10.1080/09614524.2019.1628922>.
- [16] H. Hussein, Tomatoes, tribes, bananas, and businessmen: An analysis of the shadow state and of the politics of water in Jordan, *Environmental Science & Policy* 84 (2018) 170–176, <https://doi.org/10.1016/j.envsci.2018.03.018>.
- [17] V. Yorke, Jordan's Shadow State and Water Management: Prospects for Water Security Will Depend on Politics and Regional Cooperation, in: R.F. Hüttl, O. Bens, C. Bismuth, S. Hoehstetter (Eds.), *Society - Water - Technology: A Critical Appraisal of Major Water Engineering Projects*, Springer International Publishing, Cham, 2016, pp. 227–251.
- [18] Bertelsmann Stiftung, Sustainable Development Solutions Network, Sustainable Development Report 2019, Transformations to achieve the Sustainable Development Goals (2019).
- [19] K.N. Mahdei, M. Pouya, F. Taheri, H. Azadi, S. van Passel, Sustainability Indicators of Iran's Developmental Plans: Application of the Sustainability Compass Theory, *Sustainability* 7 (2015) 14647–14660, <https://doi.org/10.3390/su71114647>.
- [20] F. Yazdandoost, Dams, Drought and Water Shortage in Today's Iran, *Iranian Studies* 49 (2016) 1017–1028, <https://doi.org/10.1080/00210862.2016.1241626>.
- [21] D. Salehi-Isfahani, B. Wilson Stucki, J. Deutschmann, The Reform of Energy Subsidies in Iran: The Role of Cash Transfers, *Emerging Markets Finance and Trade* 51 (2015) 1144–1162, <https://doi.org/10.1080/1540496X.2015.1080512>.
- [22] O. Borszik, International sanctions against Iran and Tehran's responses: political effects on the targeted regime, *Contemporary Politics* 22 (2016) 20–39, <https://doi.org/10.1080/13569775.2015.1112951>.
- [23] J. Lilliestam, A. Patt, Barriers, Risks and Policies for Renewables in the Gulf States, *Energies* 8 (2015) 8263–8285, <https://doi.org/10.3390/en8088263>.
- [24] S. Griffiths, Renewable energy policy trends and recommendations for GCC countries, *Energy Transitions* 1 (2017) 3, <https://doi.org/10.1007/s41825-017-0003-6>.
- [25] A.A. Mas'ud, A.V. Wirba, S.J. Alshammari, F. Muhammad-Sukki, M. a.M. Abdullahi, R. Albarracín, M.Z. Hoq, Solar Energy Potentials and Benefits in the Gulf Cooperation Council Countries: A Review of Substantial Issues, *Energies* 11 (2018) 372, <https://doi.org/10.3390/en11020372>.
- [26] A. Mostafaiepour, N. Mostafaiepour, Renewable energy issues and electricity production in Middle East compared with Iran, *Renewable and Sustainable Energy Reviews* 13 (2009) 1641–1645, <https://doi.org/10.1016/j.rser.2008.08.011>.
- [27] A. Ahmad, M.V. Ramana, Too costly to matter: Economics of nuclear power for Saudi Arabia, *Energy* 69 (2014) 682–694, <https://doi.org/10.1016/j.energy.2014.03.064>.
- [28] R.W. Barron, M.C. Hill, A wedge or a weight? Critically examining nuclear power's viability as a low carbon energy source from an intergenerational perspective, *Energy Research & Social Science* 50 (2019) 7–17, <https://doi.org/10.1016/j.erss.2018.10.012>.
- [29] J. Jewell, Ready for nuclear energy?: An assessment of capacities and motivations for launching new national nuclear power programs, *Energy Policy* 39 (2011) 1041–1055, <https://doi.org/10.1016/j.enpol.2010.10.041>.
- [30] M. Al-Saidi, S. Saliba, Water, Energy and Food Supply Security in the Gulf Cooperation Council (GCC) Countries—A Risk Perspective, *Water* 11 (2019) 455, <https://doi.org/10.3390/w11030455>.
- [31] M. Al-Saidi, N.A. Elagib, Ecological modernization and responses for a low-carbon future in the Gulf Cooperation Council countries, *Wiley Interdisciplinary Reviews: Climate Change* 9 (2018) 10.1002/wcc.528.
- [32] A.E. Alookandeh, S. Vaez-Zadeh, eds., 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (IEEIC / I&CPS Europe). IEEE; 6/11/2019 - 6/14/2019.
- [33] M. Marktanner, L. Salman, Economic and geopolitical dimensions of renewable vs. nuclear energy in North Africa, *Energy Policy* 39 (2011) 4479–4489, <https://doi.org/10.1016/j.enpol.2010.12.047>.
- [34] A. Neumann, L. Sorge, C. von Hirschhausen, B. Wealer, Democratic quality and nuclear power: Reviewing the global determinants for the introduction of nuclear energy in 166 countries, *Energy Research & Social Science* 63 (2020) 101389, <https://doi.org/10.1016/j.erss.2019.101389>.
- [35] P. Johnstone, A. Stirling, Comparing nuclear trajectories in Germany and the United Kingdom: From regimes to democracies in sociotechnical transitions and discontinuities, *Energy Research & Social Science* 59 (2020) 101245, <https://doi.org/10.1016/j.erss.2019.101245>.
- [36] J. Krane, A.M. Jaffe, J. Elass, Nuclear energy in the Middle East: Chimera or solution? *Bulletin of the Atomic Scientists* 72 (2016) 44–51, <https://doi.org/10.1080/00963402.2016.1124662>.
- [37] I.-T. Tsai, Political economy of energy policy reforms in the gulf cooperation council: Implications of paradigm change in the rentier social contract, *Energy Research & Social Science* 41 (2018) 89–96, <https://doi.org/10.1016/j.erss.2018.04.028>.
- [38] D. Gately, N. Al-Yousef, H.M.H. Al-Sheikh, The rapid growth of domestic oil consumption in Saudi Arabia and the opportunity cost of oil exports foregone, *Energy Policy* 47 (2012) 57–68, <https://doi.org/10.1016/j.enpol.2012.04.011>.
- [39] H. Dargahi, K.B. Khameneh, Energy intensity determinants in an energy-exporting developing economy: Case of Iran, *Energy* 168 (2019) 1031–1044, <https://doi.org/10.1016/j.energy.2018.12.015>.
- [40] B. Fattouh, H.V. Rogers, P. Stewart, The US shale gas revolution and its impact on Qatar's position in the gas markets. New York; 2015.
- [41] S. Paltsev, The complicated geopolitics of renewable energy, *Bulletin of the Atomic Scientists* 72 (2016) 390–395, <https://doi.org/10.1080/00963402.2016.1240476>.
- [42] S. Bhatia, Nuclear Rivals in the Middle East (2018), <https://content.taylorfrancis.com/books/download?dac=C2015-0-77167-4&isbn=9781315206479&format=googlePreviewPdf>.
- [43] N.L. Miller, Why Nuclear Energy Programs Rarely Lead to Proliferation, *International Security* 42 (2017) 40–77, https://doi.org/10.1162/ISEC_a_00293.
- [44] P. Stoett, Toward Renewed Legitimacy? Nuclear Power, Global Warming, and Security, *Global Environmental Politics* 3 (2003) 99–116, <https://doi.org/10.1162/152638003763336400>.
- [45] F. Morady, Iran ambitious for regional supremacy: the great powers, geopolitics and energy resources, *Journal of the Indian Ocean Region* 7 (2011) 75–94, <https://doi.org/10.1080/19480881.2011.587332>.
- [46] U. Abulof, Revisiting Iran's nuclear rationales, *International Politics* 51 (2014) 404–415, <https://doi.org/10.1057/ip.2014.9>.
- [47] G. Luciani, Nuclear Energy Developments in the Mediterranean and the Gulf, *The International Spectator* 44 (2009) 113–129, <https://doi.org/10.1080/03932720802692947>.
- [48] R.N. Mehta, R.E. Whitlark, Unpacking the Iranian Nuclear Deal: Nuclear Latency and U.S. Foreign Policy, *The Washington Quarterly* 39 (2016) 45–61, <https://doi.org/10.1080/0163660X.2016.1261567>.
- [49] R.O. Freedman, Putin, Iran, and the Nuclear Weapons Issue, *Problems of Post-Communism* 53 (2006) 39–48, <https://doi.org/10.2753/PPC1075-8216530204>.
- [50] A.K. Pasha, Saudi Arabia and the Iranian Nuclear Deal, *Contemporary Review of the Middle East* 3 (2016) 387–404, <https://doi.org/10.1177/2347798916664613>.
- [51] H. Ahmadian, Iran and Saudi Arabia in the Age of Trump, *Survival* 60 (2018) 133–150, <https://doi.org/10.1080/00396338.2018.1448579>.
- [52] A.B. Wolf, After JCPOA: American grand strategy toward Iran, *Comparative Strategy* 37 (2018) 22–34, <https://doi.org/10.1080/01495933.2017.1419719>.
- [53] N.L. Miller, T.A. Volpe, Abstinence or Tolerance: Managing Nuclear Ambitions in Saudi Arabia, *The Washington Quarterly* 41 (2018) 27–46, <https://doi.org/10.1080/0163660X.2018.1484224>.
- [54] O. Heinonen, S. Henderson, *Nuclear Kingdom, Saudi Arabia's Atomic Ambitions*, Washington, 2014 27.03.
- [55] G. Bahgat, *The Changing Saudi Energy Outlook: Strategic Implications*, Middle East Journal 67 (2013) 565–579.
- [56] D.E. Sanger, W.J. Broad, Saudis Want a U.S. Nuclear Deal. Can They Be Trusted Not to Build a Bomb?, *The New York Times* (22.11.2018).
- [57] E. Landau, S. and Stein, Can the United States Prevent Saudi Arabia from Getting Nuclear Weapons?, *The National Interest* (04.12.2018).
- [58] P. Pillar, Why Saudi Arabia Will Acquire Nuclear Weapons, *The National Interest* (26.11.2018).
- [59] Al-Jazeera, MBS: Saudis will pursue nuclear weapons if Iran does, *Al-Jazeera* (15.03.2019).
- [60] James Martin Center for Nonproliferation Studies, *Nuclear Energy in Saudi Arabia*, Accessed September 22 (2019).
- [61] M. Hibbs, How Saudi Arabia Can Go Nuclear (But Prevent Proliferation), *The National Interest* (04.02.2018).
- [62] Government of the United Arab Emirates, UAE Energy Strategy 2050. Accessed September 22, 2019.
- [63] H.M.S. Al-Maamary, H.A. Kazem, M.T. Chaichan, Climate change: The game changer in the Gulf Cooperation Council Region, *Renewable and Sustainable Energy Reviews* 76 (2017) 555–576, <https://doi.org/10.1016/j.rser.2017.03.048>.
- [64] UNESCO, Analysis of Energy Policy Trends in the Arab Region; 2015.
- [65] P.K. Kerr, M.B.D. Nikitin, *Nuclear Cooperation with Other Countries: A Primer* [Updated January 15, 2019], Nuclear Cooperation with Other Countries: A Primer, Library of Congress. Congressional Research Service, Washington, 2019.
- [66] D. Kimball, R. Kingston, The U.S. Atomic Energy Act Section 123 At a Glance.

- Accessed September 22, 2019.
- [67] World Nuclear Association, Nuclear Power in the United Arab Emirates, Accessed September 22 (2019).
- [68] J. Langton, <https://www.thenational.ae/uae/uae-s-first-nuclear-power-plant-delayed-until-late-2019-or-2020-1.734445>, The National (27.05.2018).
- [69] M. Luomi, Mainstreaming Climate Policy in the Gulf Cooperation Council States; 2014.
- [70] J. Krane, S. Wright, Qatar 'rises above' its region: Geopolitics and the rejection of the GCC gas market; 2014.
- [71] Economist, The GCC in 2020: Resources for the future; 2015.
- [72] Y. Almulla, Gulf Cooperation Council (GCC) countries 2040 energy scenario for electricity generation and water desalination, Sweden (2014).
- [73] G. de Clercq, Qatar asks IAEA to intervene over 'threat' posed by UAE nuclear plant, Reuters (20.03.2019).
- [74] A. Sharma, N. Sultan, D. Weir, Going Nuclear in the GCC Countries: Rationale, Challenges, and Politics, in: M.A. Ramady (Ed.), The GCC economies: Stepping up to future challenges, Springer Science + Business Media, New York, 2012, pp. 59–68.
- [75] D. Dassa Kaye, F.M. Wehrey, A Nuclear Iran: The Reactions of Neighbours, Survival 49 (2007) 111–128, <https://doi.org/10.1080/00396330701437777>.
- [76] G. Brumfield, Gulf states plan for nuclear future, Nature 455 (2008) 438–439, <https://doi.org/10.1038/455438a>.
- [77] World Nuclear Association, Emerging Nuclear Energy Countries. Accessed September 20, 2019.
- [78] O. Saif, T. Mezher, H.A. Arafat, Water security in the GCC countries: challenges and opportunities, Journal of Environmental Studies and Sciences 4 (2014) 329–346, <https://doi.org/10.1007/s13412-014-0178-8>.
- [79] L. Sukin, Beyond Iran: Containing Nuclear Development in the Middle East, The Nonproliferation Review 22 (2015) 379–400, <https://doi.org/10.1080/10736700.2016.1152010>.
- [80] M.V. Ramana, P. Agyapong, Thinking big? Ghana, small reactors, and nuclear power, Energy Research & Social Science 21 (2016) 101–113, <https://doi.org/10.1016/j.erss.2016.07.001>.
- [81] J. Jewell, S.A. Ates, Introducing nuclear power in Turkey: A historic state strategy and future prospects, Energy Research & Social Science 10 (2015) 273–282, <https://doi.org/10.1016/j.erss.2015.07.011>.
- [82] Reuters, Yemen's Houthi group says fires missile toward Abu Dhabi nuclear reactor, Reuters (03.12.2017).