

KEY DRIVERS IN THE DEVELOPMENT OF THE GREEN ECONOMY IN THE GULF AND LEVANT STATES

Dmitriy L. Lopatnikov^{1*}, Tatiana A. Gladenkova¹

¹Laboratory of World Development Geography, Institute of Geography, Russian Academy of Sciences, 29 Staromonetny lane, building 4, Moscow, 119017, Russian Federation¹

*Corresponding author: imartos@mail.ru

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ABSTRACT. This study identifies the main factors and trends in green economy development across the Gulf and Levant countries and examines their spatial patterns. The environmentally significant processes observed in these countries suggest the possible, though not predetermined, onset of a long-term transition toward more sustainable economies. However, it remains too early to conclude that a genuine transition toward decarbonization is underway. The Gulf and Levant region has long been, and is likely to remain, an important supplier of fossil fuels to the global economy, particularly oil and natural gas. This paper examines the drivers of renewable-energy adoption in the region and identifies two groups of countries with different motivations for this transition, helping to explain this apparent paradox. The study draws on approaches at the intersection of human geography and geocology, statistical-data visualization, retrospective analysis, and comparative geographical analysis.

The studied region presents a wide range of multidirectional trends in the context of agreements to combat global climate change and the implementation of a green economy in various areas. The renewable energy sector is developing dynamically in the Gulf and Levant states. Local countries can be divided into two main groups. The first group includes wealthy countries for which renewable energy is a matter of prestige and an attempt to join the global green agenda. The second group includes poor countries for which renewable energy is a matter of energy security due to the lack of hydrocarbons and other energy resources. The Gulf and Levant states have the potential to develop green and blue hydrogen production on an industrial scale and turn the region into one of the major hydrogen-production hubs. The UAE is the regional leader in expanding green and blue hydrogen production capacity. One of the important components of the modern environmental and economic strategy of the Gulf and Levant countries is attracting foreign direct investment (FDI) into this sector.

KEYWORDS: green economy, Gulf and Levant countries, low-carbon transition, decarbonization, renewable energy sources, environmental image.

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INTRODUCTION

Target setting

Green-economy policies and initiatives have become prominent features of the 21st century. This should be taken for granted regardless of the goal (global climate change, air pollution control, etc.). Its introduction scale, considering significant transregional and intercountry differences, has become quite literally global. That is why to comprehend that phenomenon, not only economic and environmental but also economic-geographical studies of the green economy are in demand. These studies provide insight into the spatial mosaic of the green economy expansion worldwide, to bring the motives, factors, and tendencies in

the development of environmentally oriented trends in the global economy to light, which makes it possible to better comprehend the real panorama of this phenomenon. This paper builds on research conducted at the Laboratory of World Development Geography of the IG RAS.

The theoretical foundation of the study is the low-carbon transition concept proposed by D.L. Lopatnikov within an economic-geographical interpretation of the Kuznets environmental curve (Lopatnikov2020). According to the Kuznets environmental curve, with the growth of common welfare, which is determined by the growth of GDP per capita, the contamination volumes per capita and other types of negative anthropogenic impact increase up to a certain level and then begin to decline. This interpretation of the Kuznets curve belongs to J.

¹Laboratory of World Development Geography, Institute of Geography, Russian Academy of Sciences, 29 Staromonetny lane, building 4, Moscow, 119017, Russian Federation

Grossman and A. Krueger. The curve, called the “Kuznets environmental curve” (KEC), has an inverted U-shape and describes the synergies between the overall growth of common welfare and environmental costs of socio-economic development (Grossman and Krueger 1995). Once a certain threshold level of GDP per capita is reached, the level of environmental pollution and degradation begins to decrease. Since the mid-1990s, numerous studies have been conducted applying various methods and variations of the KEC concept (Environmental Kuznets..., 2019; Naveed et al., 2022). Most environmental economics empirical studies focus on the verification of the KEC hypothesis for various countries and regions, but their conclusions are split [Le, Ozturk, 2020]. The Kuznets environmental curve remains controversial, which serves as one of the valid motives to continue research into the mosaic of environmentally negative and positive trends in different macro-regions and countries of the world (Lorente, Álvarez-Herranz, 2016, Shahbaz, Sinha, 2019, Naveed, Ahmad, Zadeh Aghdam, Menegaki, 2022).

The economic-geographical interpretation of the ecological version of Kuznets’ curve allows us to identify the positions of various countries and regions in the Kuznets curve, in particular, relative to the turning point depending on the level of GDP per capita. Previous studies have shown that most highly developed post-industrial countries have passed the turning point in the economic-geographical version and that, since the end of the last century, decoupling has begun in them, in which, together with socio-economic development, ecologically positive trends clearly prevail (Lopatnikov, 2000). Previously, articles devoted to environmentally significant trends in India, China, and Japan (Alekseeva, Lopatnikov, Bancheva, 2024), in Latin American countries (Kovalev, Lopatnikov, 2024) and their positions in the context of low-carbon transition were published.

One of the mainstream manifestations of the geo-ecological transition in the first decades of the current century was the trend toward low-carbon development, which is associated with a large-scale campaign to combat global climate change. Sequestering anthropogenic carbon dioxide emissions has become imperative in achieving the goals of the Paris Agreement. In 2024, 137 countries announced their goals to achieve carbon neutrality by 2030–2100. At the same time, 80 Low Carbon Development Strategies (LCDS) were registered with the UNFCCC. Global investment in low-carbon technologies reached \$2 trillion in 2024.

The global process of decarbonization and low-carbon transition is uneven, with geographic features driven by numerous economic, social, political, ideological, technical, and cultural factors. Studying the spatial specifics of decarbonization within countries and regions is a sought-after subject of geographical research.

The development of the green economy, and decarbonization in particular, has become a prominent topic in both public discourse and academic research. Within the framework of economic and geographical research, conceptual papers by both domestic and foreign researchers are devoted to this subject. Among Russian scientists, papers of N.N. Alekseeva, V.R. Bitukova, P.V. Druzhinin, Yu.Yu. Kovalev, D.A. Pletnev, and others should be noted. Among foreign economic and geographical studies, papers of Chen K., Yang M., Zhou X., Liu Z., Li P., Tang J., Peng C., Le Quere C., Korsbakken J.I., Wilson C., Tosun J., Andrew R., Andres R.J., Canadell J.G., and others. There are a few papers devoted to the Gulf and Levant region. Among them are papers that analyze sustainable development

trends in the studied region, such as those by Alamri A.Y., Ghanem M.A., Hossam M.N., Nafadi M.S., Rahma A.T.M., and others.

Low-carbon development became mainstream in the first decades of the current century and, simultaneously, one of the key indicators of the geo-ecological transition at various levels of the territorial hierarchy, from the global to the national and even local. In this paper for analysis the authors have chosen a group of the 12 countries of the Gulf and Levant, including Israel to analyze: Bahrain, Israel, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates (UAE), Yemen.

One of the most important directions of environmentally oriented development, which could potentially result in a low-carbon transition in the form of decoupling in the selected countries of the Gulf and Levant regions, is the focus on green economy development.

Hypothesis: The concept of a geo-ecological low-carbon transition is multilevel and applicable to comparative interregional and cross-country analysis. Its relevance to reality can be illustrated by a set of quantitative and qualitative indicators of the development level, trends, and characteristics of the formation of a “green economy” in various regions of the world, even in the Gulf and Levant region, which has been one of the world’s key oil and gas regions for over half a century and remains so.

The purpose of this study is to identify the factors and trends of the progressive development of the “green economy” in the traditionally oil and gas region of the Gulf and Levant, as well as the geography of this modern phenomenon.

The implementation of this goal will allow us to test the proposed hypothesis and evaluate both its predictive potential and possible limitations.

MATERIAL AND METHODS

Time series data on carbon dioxide and other greenhouse gas emissions were analyzed. Panel data series for the period 2000–2022 were used, as well as continuous observation series for particulate matter available for the period 2010–2022.

For a comparative assessment of the level of greening of the local economies of the studied region, we used data from world rankings based on the indices of environmental efficiency, pollution, green economy, and innovative environmentally friendly technologies. Each of them separately does not provide a holistic environmental characterization, but if interpreted correctly, they allow us to assess the problems and contradictions of the development of the green economy of the countries under consideration from different angles.

The study is based on approaches at the intersection of socio-economic geography and geo-ecology, visualization of statistical data, and retrospective analysis, as well as on the comparative-geographical method.

The main sources on which the analysis and conclusions of this publication were based were statistical data from international organizations: World Bank (World Bank), International Energy Agency (IEA), Food and Agriculture Organization of the United Nations (FAO), statistical agencies “Enerdata”, “Low Carbon”, “Our World in data”. State programs (SNAP) and national low-carbon development strategies presented in the UNFCCC were used to assess the priority areas and activities of national policies to achieve climate neutrality.

The environmental and economic parameters of the Gulf and Levant countries were compared based on

statistical data from the World Bank (World Development Indicators..., 2023), OECD (OECD environmental data..., 2023), and national databases (Portal Site of Official..., 2023). Preference was given to comparable data from international organizations, as the statistical databases of countries are based on different methods and units for estimating emissions and concentrations of pollutants (discrepancies can reach 50-60% (Ding et al, 2022)).

RESEARCH RESULTS

Internal agents of the course towards a green economy in the Gulf and Levant countries

In the 2000s, important environmentally significant socio-economic processes are taking place in the Gulf and Levant countries, which are at very different stages of socio-economic development. Despite the persistent dependence on oil set pattern of many Arab countries of the Gulf and the Levant region, there is currently a turn towards economic diversification, including a focus on the development of a green economy in those countries, especially in the countries of the Cooperation Council for the Arab States of the Gulf (GCC)². The green economy has also developed in countries where there is no significant oil production, such as Israel and Jordan.

There are several reasons for the zero-carbon transition in the region. In countries where energy exports are one of the pillars of their economies, there are sustainability risks due to limited or depleting resources. The risk of a possible fall in oil prices increases pressure on producers to maximize their revenues by exporting more crude oil instead of burning it.

The green economy issue is also becoming increasingly relevant for the Gulf and Levant states because of the region's main vulnerability – water scarcity. Most of the countries in the region are among the least supplied with freshwater³. Among the local states, Lebanon has the highest rate – 1,000 m³ and Kuwait the lowest (7 m³). Against the backdrop of scarcity of freshwater, average water consumption in the region is 9 times higher than water availability. The most serious gap is observed in Kuwait – 63 times, in the UAE – 39 times. The introduction of green energy can make a significant contribution to increasing desalination in the regional countries.

Wealthy Middle Eastern countries can overcome water shortages through expensive seawater desalination projects⁴ and freshwater imports⁵, but that seems unlikely for poor countries.

There is a great need in electricity for water desalination. For example, Saudi Arabia's consumption of electricity and desalinated water is so high that it burns crude oil to meet half of its domestic electricity and water needs.

Another equally important problem of the regional countries is the lack and inefficient use of land resources

suitable for agriculture. For example, in Jordan, for which the agricultural sector is an important part of its economy, only 10% of the country is suitable for cultivation, and cropland accounts for 3% of the total area (Irrigation in the Middle East region in figures, 2009). In opposition to Jordan, in Israel, cropland accounts for 19%.

The climate agenda remains one of the reasons for the fuel switching. The region is exposed to the negative effects of global warming, which is reflected in the increasing frequency of droughts and desertification.

Against the backdrop of accelerating desertification, regional countries witness food security challenges more and more often. Wealthy countries address that problem by increasing their imports of goods, expanding the number and geography of importers, and investing in agricultural lands and agribusiness abroad (in Africa, South-East Asia, Europe, the United States, Australia, Canada) (Spatial socio-economic inequality of the European Union, 2024). However, for the poor countries of the region, which cannot even ensure stable and diversified imports of cereals on acceptable terms, such ways of solving the problem are not relevant (Irrigation in the Middle East region in figures, 2009). That area requires the introduction of new technologies (precision farming, drought-resistant crops, efficient irrigation systems, etc.), that enables the development of a green economy.

The region is experiencing a growing population and dynamic urbanization. For the local countries smart cities and green buildings projects designed with energy-efficient and environmental practices are becoming a high priority. For example, the UAE is building a carbon-neutral and zero-waste city – Masdar City. Another example is the NEOM complex project in Saudi Arabia. Within its framework, it is planned to build in the desert The Line – 170 km-long city as a sustainable alternative to traditional cities.

Challenge response to the global climate change and the processes of decarbonization of the economies of the Gulf and Levant states

Among the top greenhouse gas emitters in the region are Saudi Arabia, the UAE, Iraq, and Qatar. Saudi Arabia ranks 10th in the world ranking of CO₂ emitters. Those states highly depend on the development level of the oil industry and oil exports. As a consequence, gross greenhouse gas emissions there are significant, and in most countries of the region they keep growing (Fig. 1).

At the same time, countries with large populations and high total GDP produce large amounts of CO₂ emissions (Figs. 2, 3).

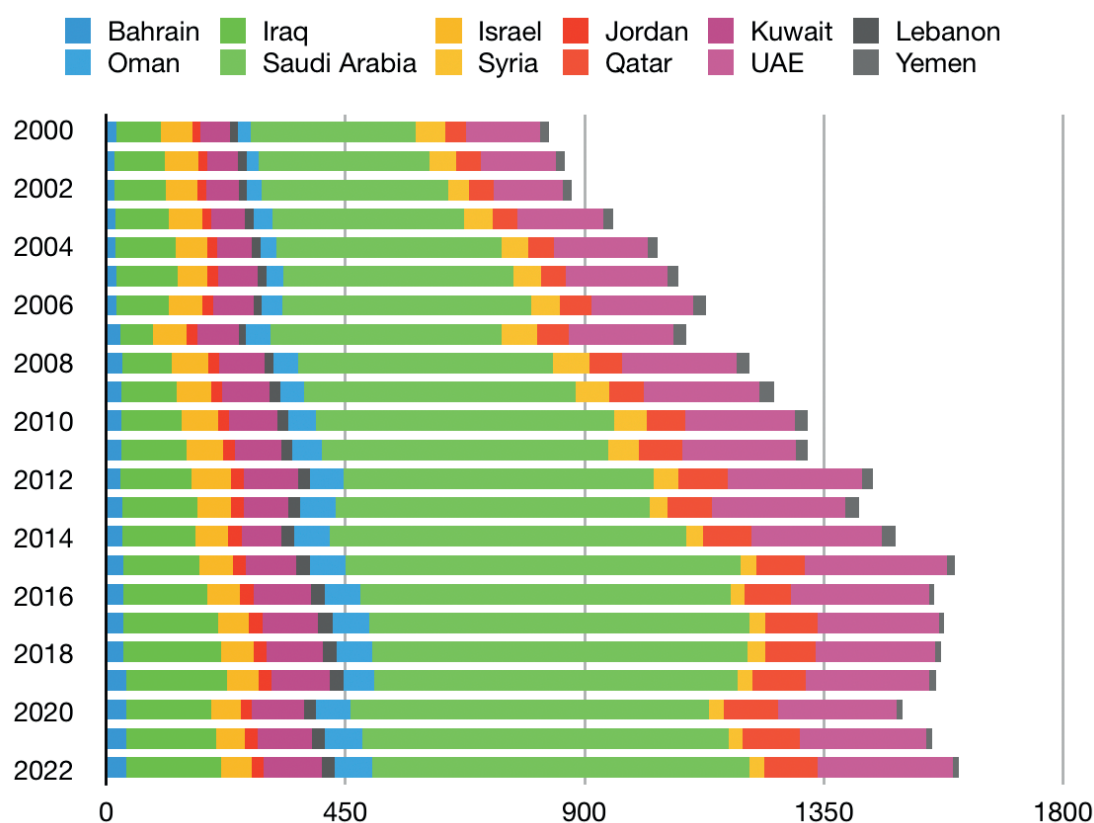
If we consider per capita indicators and specific indicators per unit of output, the trend is completely different. In general, in the present region during the first decades of the current

²The Cooperation Council for the Arab States of the Gulf (GCC) is a regional organization comprising six Arab countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE).

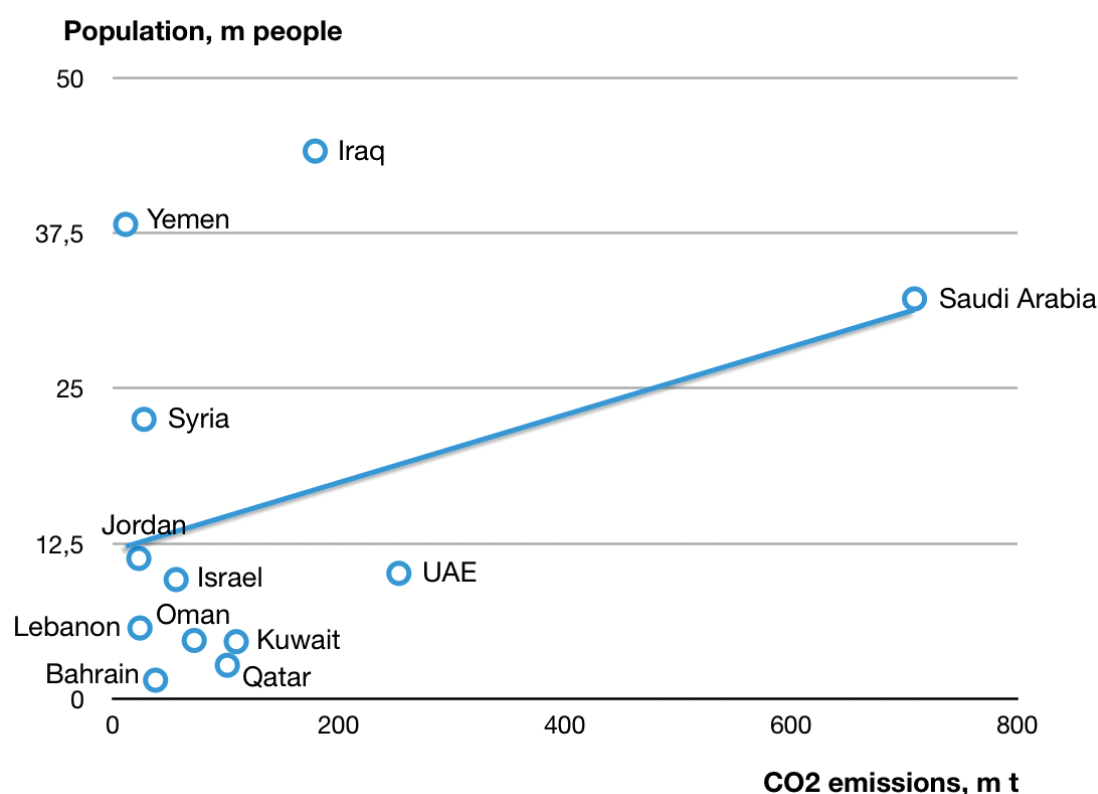
³The threshold for renewable water availability per person in the world is 1,000 m³ per year.

⁴According to Arab News, Saudi Arabia uses 1.5 million barrels of oil daily in its desalination plants, which provide 50–70% of the country's fresh water. Saudi Arabia opened the world's largest plant in April 2014, producing 1 million m³ of water and 2,600 MW of electricity per day. The cost of the project is \$7.2 billion.

⁵The UAE is developing a project (UAE Iceberg Project) to purchase and transport icebergs from Antarctica to the shores of the emirate of Al-Fujairah. Projects to transport water from neighboring countries have also been repeatedly discussed. In 1986, the construction of two pipelines from Turkey was proposed to transport water from the Seyhan and Ceyhan rivers. The possibility of importing water from the Nile through Saudi Arabia to other countries in the region was considered. In 2003, an agreement was signed between Kuwait and Iran to transport water by pipeline. A preliminary feasibility study has been conducted to import water from India through the Gulf of Oman to the UAE and then through pipelines to other Middle Eastern states. There are more exotic ways of extracting clean water. For example, the UAE is experimenting with the formation of rain clouds – in 2011 it was reported that \$11 million had been allocated for the project.

Fig. 1. CO₂ emissions in Gulf and Levant countries, 2000–2022, million t

Source: Our World in Data

Fig. 2. Ratio between population (million people) and CO₂ emissions (million t) in Gulf and Levant countries, 2022

century per capita CO₂ emission rates (Figs. 4–6) and energy intensity per dollar of GDP (Fig. 7) have declined. In terms of CO₂ emissions per capita, Qatar was ranked 1st (31.7 t CO₂ per capita) (global average 4.3 t CO₂ per capita), Kuwait was ranked 2nd (23.1 t CO₂ per capita), and the UAE was ranked 5th (19.3 t CO₂ per capita). Oman was ranked 6th (15.4), Saudi Arabia – 9th (13.8) – along with the USA (13.8) and Canada (13.2). UAE CO₂ emissions per capita rate (2021) – 19.3 t CO₂ per capita – 3rd

in the regional ranking and 5th in the global ranking (global average – 4.3 t CO₂ per capita). Over the period of 2000 and 2021, the UAE's rate decreased by 21%.

The emission reduction in Israel, Jordan, the UAE, Qatar, and Kuwait (Fig. 5) might be caused by their focus on the green economy aiming to join the global agenda and thereby attract FDI. For Israel and Jordan, which have a poor resource base, that's also a matter of reducing dependence

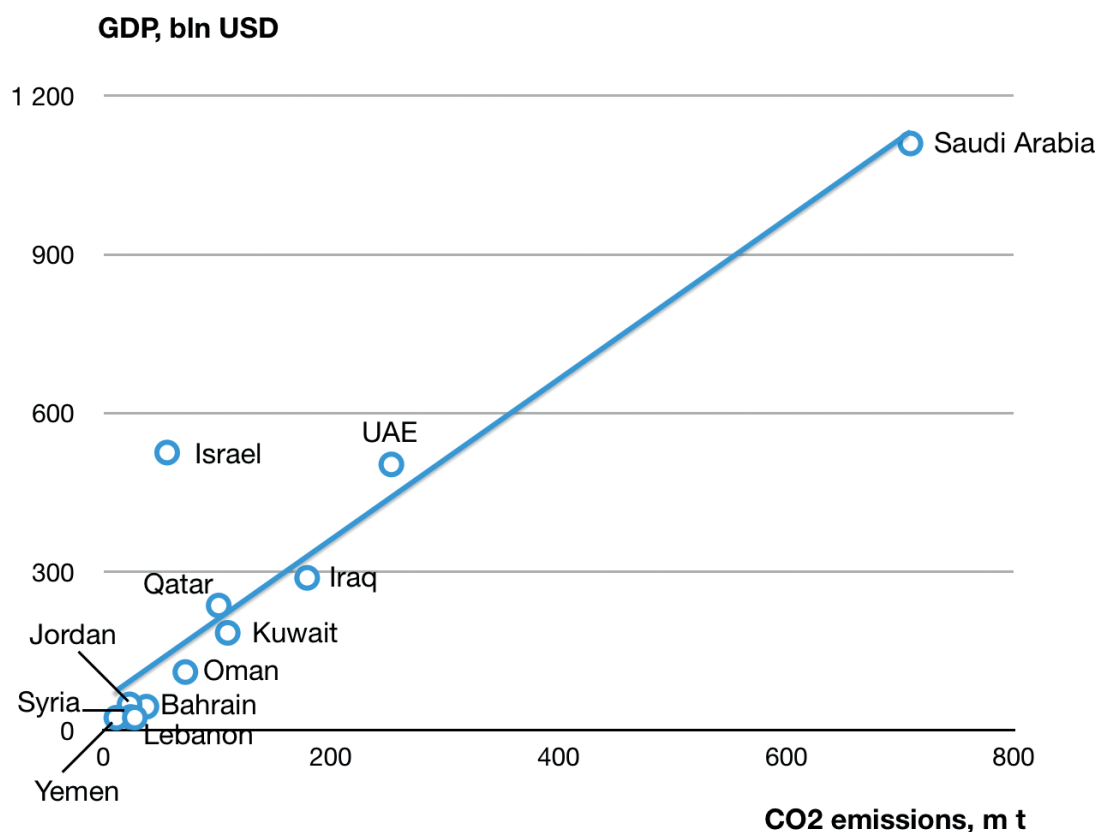


Fig. 3. Ratio between GDP (nominal, billion USD) and CO₂ emissions (million t) in Gulf and Levant countries, 2022

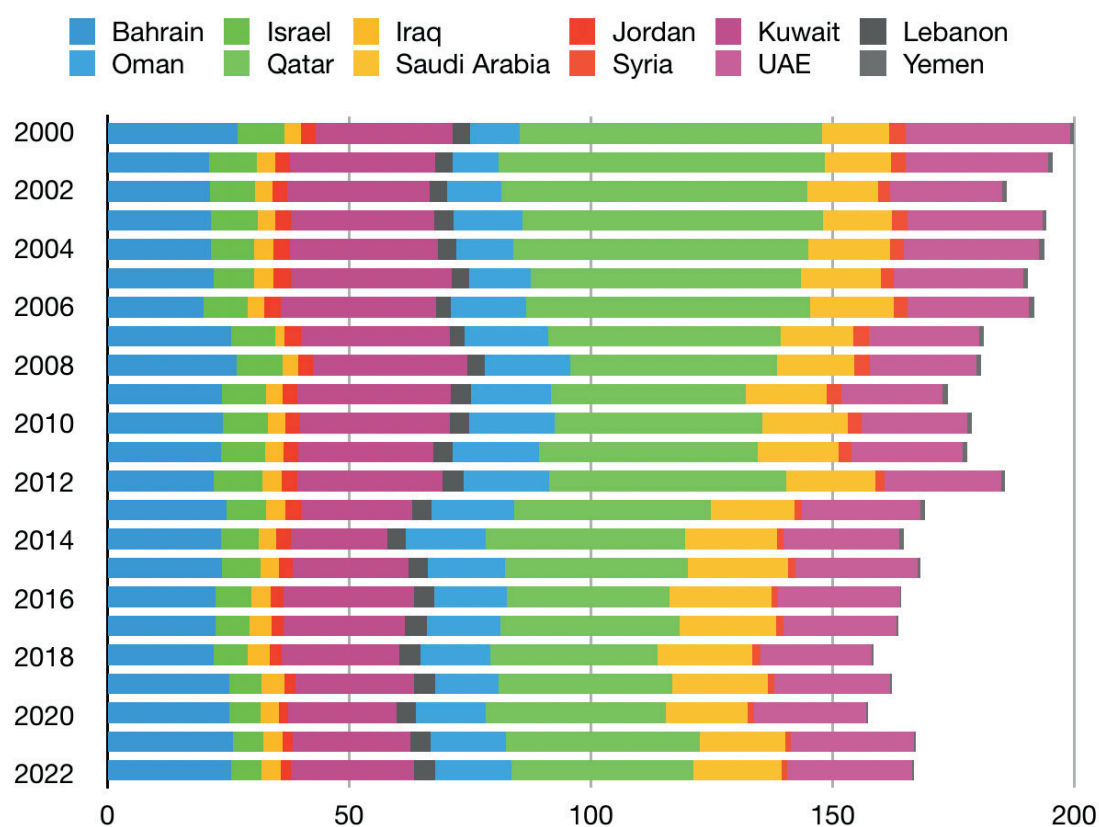


Fig. 4. CO₂ emissions per capita in Gulf and Levant countries, 2000–2022, t per capita

on hydrocarbon imports. In Syria and Yemen, the emission reduction highly likely might be caused by an unstable situation in those countries due to martial law and, as a result, a reduction in production.

The increase in CO₂ emissions in the studied group of countries (Fig. 6) might be caused by their relatively undiversified economies, which are focused on hydrocarbon exports (with the exception of Lebanon). The increase in

emissions in Lebanon, in turn, may be due to the unstable situation in the country, which makes it impossible to develop the renewable energy sector and improve the efficiency of the industrial sector as a whole.

Despite the reduction in specific emissions of CO₂ and the number of other greenhouse gases, overall, specific greenhouse gas emissions are still higher in countries with higher GDP per capita (Fig. 8).

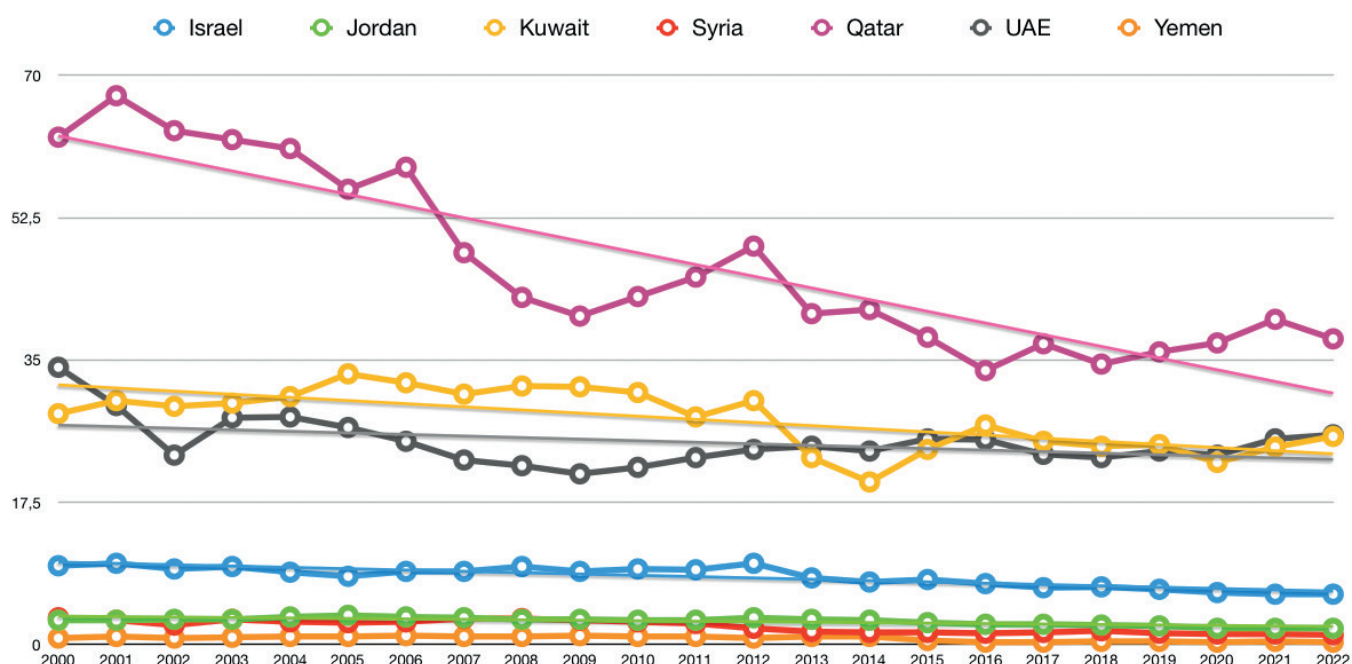


Fig. 5. Gulf and Levant countries where CO₂ emissions per capita rate have decreased, 2000–2022, t per capita

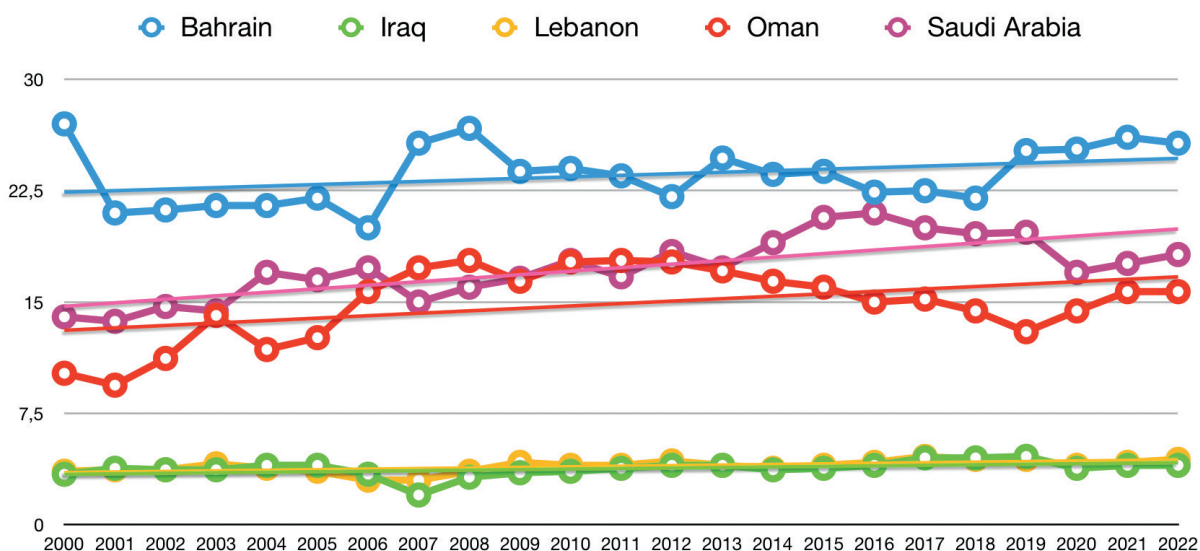


Fig. 6. Gulf and Levant countries where CO₂ emissions per capita rate have increased, 2000–2022, t per capita

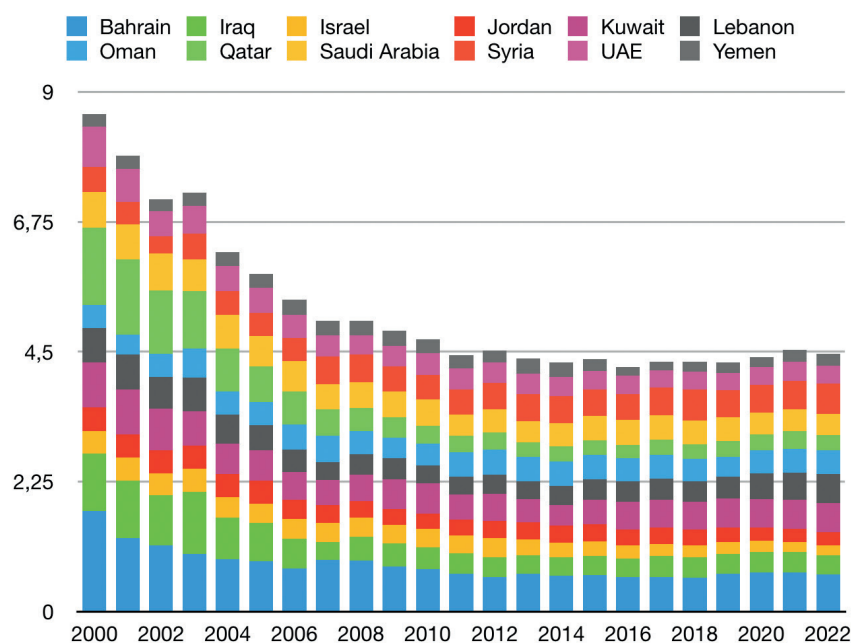


Fig. 7. Carbon intensity of the Gulf and Levant countries: CO₂ emissions per dollar of GDP, 2000–2022, kg/\$ GDP

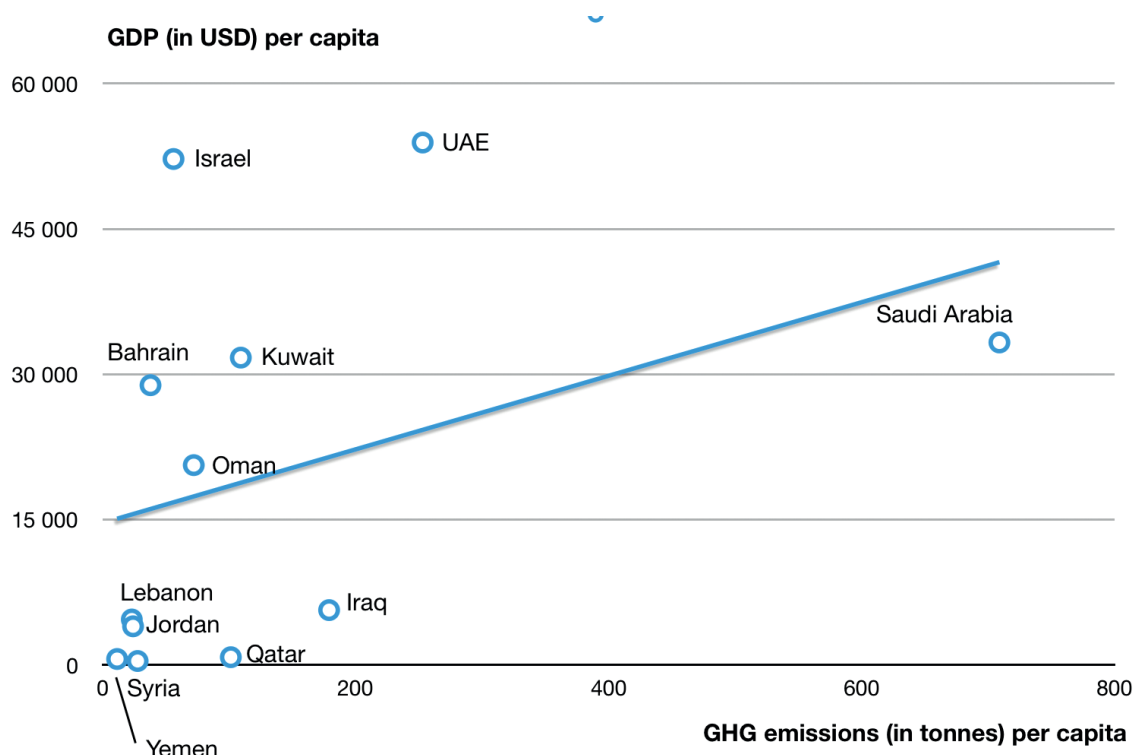


Fig. 8. Ratio between greenhouse gas GHG emissions per capita and GDP per capita, 2021

The contribution of different sectors and industries to CO₂ emissions varies. The main source of CO₂ emissions in Saudi Arabia is the electricity sector (50.3%). In terms of electricity generation, Saudi Arabia is ranked 1st in the region – 409,000 GWh – 33% of the total regional electricity generation. The main sources of electricity generation are natural gas (58%) and oil (41.3%). Solar energy accounts for only 0.2% so far. In 2021, CO₂ emissions from oil use in Saudi Arabia accounted for 314.9 Mt CO₂ for millions of tonnes – 63% of total CO₂ emissions from fuel combustion – 1st place in the Middle East (total regional CO₂ emissions from oil – 766 Mt, i.e., Saudi Arabia accounts for 41% of total local emissions). Over the period of 2000–2021 that indicator increased by 88%.

In terms of CO₂ emissions from oil combustion, Saudi Arabia is followed by Kuwait (46.5 Mt), the UAE (43.6), Oman (15.8), Qatar (15.7), Yemen (7.7), Bahrain (4.1) (United Arab Emirates, 2024). Natural gas provides 100% of electricity in Qatar, 90.5% in Oman, and 70.2% in the UAE (2021).

In 2021, total CO₂ emissions from coal in the Middle East reached 17.7 Mt CO₂. The UAE was the largest emitter – 10.3 Mt CO₂ (58%) – 6% of its total CO₂ emissions. The figure increased by 13,975% over a period of 2001–2021, hitting overload in 2021. Coal accounts for 2% of the UAE's total electricity generation (3013 GWh – on a par with Hungary (3105) and Ireland (3042), ahead of Argentina (2785)). The UAE is the only country in the region that uses coal for electricity generation – 79% of total regional production. Coal was used 100% for industry. In 2022, the UAE stopped using coal to generate electricity (previously, only one power plant using coal as fuel was in operation). In 2023, the UAE became a member of the coal-free Powering Past Coal Alliance (UAE joins Powering Past Coal Alliance, 2023).

The UAE and Qatar have announced a decision to strive for carbon neutrality by 2050, Saudi Arabia, by 2060. Those countries intend to control emissions by increasing electricity generation from alternative sources. Saudi Arabia has implemented the Saudi Vision-2030 program – among other challenges, it sets a target of generating 50% of its energy from renewable energy sources by 2030 and achieving carbon neutrality by 2050.

In terms of methane and nitrogen oxide emissions, the Gulf and Levant countries are characterized by great variability. One third (33%) of anthropogenic methane emissions occurs due to emissions from fuel extraction and delivery, mainly from atmospheric discharges and gas leaks. Another third occurs due to livestock farming (30%); primarily cattle and sheep (Sykes, 2018; Vidican, Mălinaș, Moldovan, Pleșa, Ranta, 2023). The third most significant category of emissions is domestic waste: landfills and wastewater treatment (18%). Qatar, Iraq, Bahrain, Oman, Kuwait – “oil powers” – lead the pack in terms of the methane share in the structure of GHG emissions, which, probably, may indicate the inefficiency of hydrocarbon extraction in those countries. Increased indicators in Jordan and Israel, probably, can be a consequence of meat-animal breeding development in those states.

Over the period 2000–2023, total methane emissions increased in all countries of the region, except Syria. The largest increase was observed in Israel, Jordan, and Iraq – almost 2.5 times (from 6.6 million t to 17.5 million t; from 2.9 million t to 6.9 million t; from 66.4 million t to 169.8 million t, respectively) (Greenhouse gas emissions, 2024). In the rest of the states, the indicator increased by half. However, if we consider per capita methane emissions, the opposite trend emerges: the countries under consideration show a decrease or a slight increase (Israel, Jordan, Iraq) in the indicator. That demonstrates that the main methane emitters are oil and gas producers and cattle breeding.

Among main sources of nitrogen oxide emissions are combustion products of thermal power plants, exhaust gases and vapors emitted by motor vehicles, salvage, as well as nitrogen fertilizer use. Israel, Jordan, and Iraq are the leaders in terms of the nitrogen oxide share in the structure of total GHG emissions. Those countries have developed (compared to other members of the group) mining industries, metal processing, and machine building, as well as agriculture. Thus, Israel and Jordan extract phosphate rock, copper, potassium salts (potash), bromine and magnesium, clay, and quartz sand and produce cement and concrete. Iraq also mines phosphates, salts, and sulfur. In Israel, Jordan, and Iraq, in addition to hydrocarbons,

thermal power plants use coal (about 20% of the electricity generation profile) (Jordan Coal, 2016).

Total nitrogen oxide emissions increased in all Gulf and Levant countries, except Syria, over the period of 2000–2023. The greatest increase was observed in the UAE (in half) and Qatar (3 times (Greenhouse gas emissions, 2024)). In the rest of the states, the indicator increased by about 1.5 times. However, if we consider nitrogen oxide emissions per capita, as in the case of methane emissions, the opposite trend emerges: all countries under consideration show reduced performance.

Despite the carbon intensity reduction, in general, specific greenhouse gas emissions are still higher in countries with higher GDP per capita (Fig. 8), which indicates that it is too early to speak of the beginning of a real geo-ecological transition towards decarbonization of the local economies.

Development of renewable energy sources (RES), green and blue hydrogen

The countries of the Gulf and Levant hold the potential to increase renewable energy capacity: the large number of sunny days and wind conditions are opportune for the development of renewable-energy facilities. Moreover, the regional countries account for 45% of the world's renewable energy production potential. Only 1% of that potential is currently being used.

The UAE is particularly proactive in the renewable energy sector – as of October 2022, the country has invested around \$40 billion in developing its own green energy. Over the period of 2014–2022, the share of solar energy in the UAE's energy profile increased from 0.3% to 4.5% (Share of electricity generated by solar power, 2024), and installed capacity increased from 133 MW to 3,040 MW (Total installed capacity of solar energy across the United Arab Emirates from 2014 to 2022, 2023). Major international banks are now proactive in the UAE solar energy market. This is due to the fact that the UAE has an excellent credit rating (AA S&P). The UAE and other Gulf countries such as Saudi Arabia, Qatar, and Kuwait are considered very safe, and regional and international banks are convenient for governmental projects lending. In addition, the UAE dirham is dollar-pegged, which eliminates the currency risk normally associated with RES. The UAE government is also actively investing (about \$16.8 billion) in RES projects abroad, thus promoting the development of the trend in more than 70 countries.

As part of Saudi Arabia's Vision 2030 program, in November 2022, TNC ACWA Power⁶ and water and electricity holding company Badeel entered into an agreement to build the world's largest monoblock solar photovoltaic power plant (2,060 MW capacity) in Al-Shuaiba, Makkah province, scheduled to be put into operation in 2025 (Saudi Arabia launches world's largest solar-power plant, 2023). The largest national oil company Aramco also shows interest in the rapidly developing solar energy sector. For example, it has acquired a 30% stake in the recently completed Sudair photovoltaic solar plant project (the project is overseen by ACWA Power, covers an area of 14 miles², includes 3.3 million panels, and can supply about 185,000 houses with electricity) (Saudi Arabia Eyes a Future Beyond Oil, 2024). The company plans to build a large underground greenhouse gas storage

business. Aramco also finances so-called e-fuels projects originating from carbon dioxide and hydrogen, particularly at the Bilbao refinery in Spain, owned by Spanish energy company Repsol.

RES is a challenging business opportunity for Saudi Arabia: aiming to become the world's low-cost producer of renewable energy, the kingdom already boasts some of the lowest solar tariffs in the world. In 2020, Saudi Arabia produced around 500 MW of renewable electricity. The country aims to reach 60 GW by 2030, mainly from solar PV and concentrated solar power. However, in 2002, the Kingdom government changed the code of laws and rules to allow the private sector to acquire and operate utilities such as power plants. That provoked the private sector's interest in solar power (nowadays the local solar installation market is presented by 64 local companies) (Solar System Installers in Saudi Arabia, 2024). Moreover, against the background of still high international energy prices, Saudi Arabia plans to increase exports of released surplus oil and gas.

By 2030, Qatar plans to generate 20% of all electricity from renewable energy sources and to become carbon neutral by 2050. Qatar's first major solar power plant, Al Kharsaa, was opened in 2022 and consists of more than 1.8 million solar panels that are supposed to generate around 2 TWh of electricity per year. Qatar has announced its \$630 million investment in new solar power plant projects in the Mesaieed and Ras Laffan industrial zones, which together have a peak capacity of 880 MW.

To further diversify its energy portfolio, Qatar is exploring opportunities to convert waste into energy. Currently, the domestic solid waste management center in Mesaieed generates 50 MW of electricity per day. In 2022, Qatar announced plans to improve its recycling initiative by creating a new waste management center where electricity will be produced by recycling and reusing waste.

Another important area is the development of blue hydrogen. These days about 10% of the world's Carbon capture, use and storage (CCUS) capacity is located in the Middle East – large commercial CCUS storage facilities are located in the UAE, Saudi Arabia and Qatar. Unlike green hydrogen, blue hydrogen is expected to retain its market price, according to Fitch – a fact that makes the Gulf and Levant an ideal region to lead that market, considering its rich CCUS storage resources and access to cheap gas. Another aspect helping develop regional blue hydrogen production is that its price is about half that of green hydrogen, with an estimated market value of \$500 billion by 2050.

The UAE is a regional leader in the development of green and blue hydrogen production capacity, accounting for 29% of export-oriented hydrogen projects (MENA Green Hydrogen Index: Weak Renewables Rewards Weigh Down Hydrogen Suitability Index, (2023). Saudi Arabia accounts for 6.45%. In addition to RES capacity increase, the UAE creates a political landscape helping to develop the green hydrogen industry.

Saudi Arabia, in turn, plans to become the largest supplier of hydrogen and increase exports of it up to 4 million tons by 2030. At this stage, one of the country's key tasks is to increase the use of green hydrogen for city buses and railways. In 2022, Saudi Arabia signed eight memoranda of understanding to adapt the use of green hydrogen in its transport sector.

⁶ACWA Power is a developer, investor, co-owner and operator of a portfolio of power plants and desalinated water plants with a presence in 13 countries, including the Middle East, Africa, Central and South East Asia. TNC owns 5 solar power plants in Saudi Arabia, 3 in the UAE (Dubai) as part of the Mohammed bin Rashid Al Maktoum Solar Park project (hybrid project, 950 MW capacity), and 2 in Jordan (Mafrq and Risha).

Saudi Arabia, in particular, considers the export of green electricity a way to develop its partnership with Middle Eastern energy importers. The GCC countries already have an efficient electricity grid that has allowed energy trading between their six members for more than 10 years, and this network is gradually being integrated with those of neighboring countries such as Iraq and Jordan. By offering them a reliable supply of green electricity from its rapidly expanding solar power plants, Saudi Arabia expects to improve its relations with those countries, which might help the kingdom to achieve its regional foreign policy goals.

In August 2022, Qatar declared its intention of constructing the world's largest blue ammonia plant (Qatar to build world's largest blue ammonia plant, 2022), which will be operational by 2026 and will produce around 1.2 million tons of the mentioned fuel per year. Moreover, by using CCUS technology, the plant will be able to reduce CO₂ emissions by 1.5 million tons annually.

For the Gulf and Levant countries, which are relatively new to technological progress, the introduction of renewable energy can become an important driver of economic growth by increasing production efficiency, promoting innovation, and creating jobs in new areas.

Jordan is a regional leader in the RES application and ranks 15th in the world ranking on that measure (Powering up Jordan's Renewable Energy Market, 2023) (in 2013 it ranked 145th) (Fig. 9). Within 10 years (2013–2023), investment (most particularly FDI) in renewable energy increased by \$4 billion (2013 – \$0). In 2023, RES (solar and wind energy) accounted for 30% of the energy consumption profile, while in 2013 it was 0%. The main driver of RES development in Jordan is the lack of its own

resource portfolio, primarily – fossil fuels. That makes the local economy vulnerable to hydrocarbon and coal price fluctuations, as well as directly dependent on the overall situation in the region.

One of the components of the Gulf economic strategies is striving for foreign direct investment (FDI). That's especially the case of the capital assets that the largest Western TNCs can attract to the regional countries, due to not only the rapid development of sustainable projects, but also the development of ESG⁷-financing instruments. The region is becoming increasingly promising for investors.

Historically, by having ensured support of foreign investors local policymakers have focused on a combination of tax incentives and regulatory reforms (Bahrain and the UAE (especially Dubai) are prime examples). However, in the era of sustainable development, many local investment funds have adopted green investment codes⁸. Therefore, any project they want to contribute to should clearly demonstrate a commitment to environmental protection. Thuswise, GCC governments oriented to remain investor-friendly have to go the extra mile to prove the greenness of their economies. That's, among other things, one of the reasons why, for instance, Saudi Arabia promotes the green nature of its new NEOM project at the northern tip of the Red Sea.

An economic and geographical interpretation of the Kuznets ecological curve allows us to identify the positions of the Gulf and Levant countries in the Kuznets curve, in particular in reference to the bifurcation point depending on the level of GDP per capita. Statistical data analysis reflected in the graphs and diagrams shows that it is still too early to speak of the shift from predominantly eco-negative to eco-positive trends. As noted, for example, total

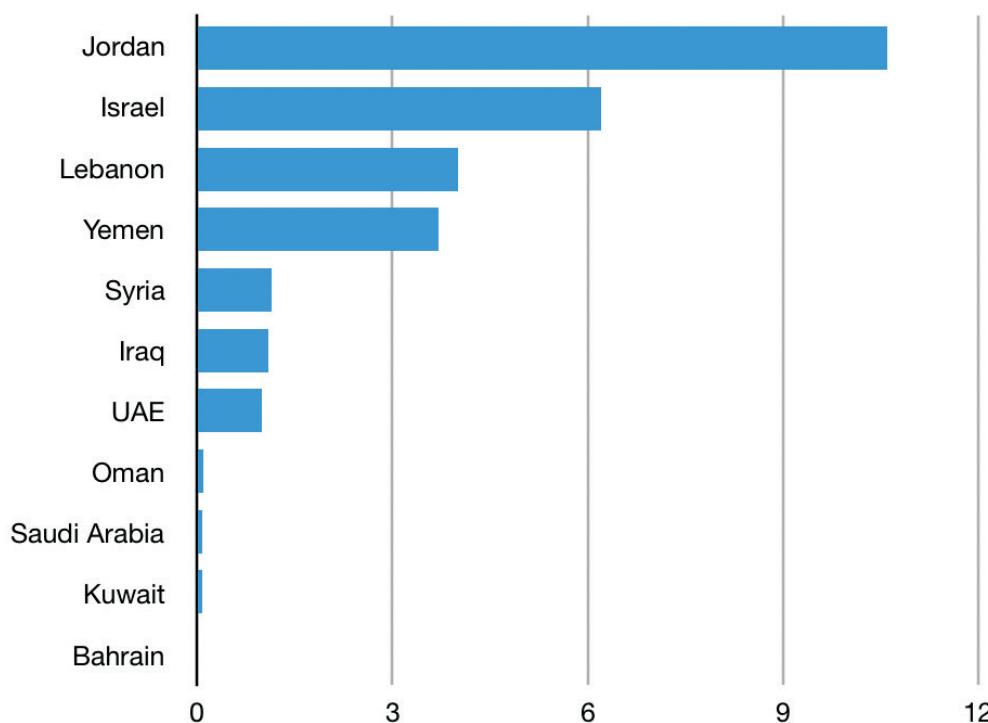


Fig. 9. Share of RES in final energy consumption, 2021, %

⁷Environmental, Social, and Corporate Governance (ESG) is a set of characteristics of a company's governance that achieves the company's involvement in environmental, social, and governance issues. ESG is a set of company performance standards that socially responsible investors use to vet potential investments. Environmental criteria define how a company acts as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers and the community. Corporate governance concerns the company's governance, executive compensation, auditing, internal controls and shareholder rights. ESG are three parameters according to which companies ensure sustainability management.

⁸Over the past few years, Islamic finance has cemented its status as a fast-growing and promising industry. The market for green Islamic finance is also showing rapid growth – the issuance of green sukuk (an analogue of bonds) has grown by 35% to 8.1 billion in 2022.

CO₂ emissions, one of the core indicators of the transition to carbon neutrality and a green economy, are still increasing. At the same time, in different countries of the region, there are multidirectional trends in CO₂ emissions by specific indicators, as well as positive trends in the development of renewable energy sources, green and blue hydrogen industry, which indicates the possible beginning of a zero-carbon transition in the region. In the long term, one of the most important areas of environmentally oriented development of the Gulf and Levant countries, which could potentially result in a real zero-carbon transition in the format of decoupling, is the course towards the development of a green economy.

CONCLUSION

In recent decades, a number of trends aimed at developing a green economy have emerged in the Gulf and Levant countries.

As evidence of the proposed hypothesis, the internal and external evolution drivers of a green economy in the Gulf and Levant countries were identified. There are several internal factors driving the transition to a "green economy" in the region. In countries where energy exports are one of the foundations of their economies, there are risks of loss of sustainability due to limited or depleted resources, as well as a potential drop in hydrocarbon prices on the world market. Another factor is the water shortage in most countries of the region. The introduction of green energy can make a significant contribution to increasing water desalination volumes.

One of the main external factors encouraging the transition to renewable energy sources is the global climate agenda. Local countries, especially the wealthier ones, are keen to show their commitment to combating global climate change. At the same time, the region is genuinely vulnerable to the negative effects of global warming, which is reflected in more frequent droughts and desertification.

One of the core indicators of the transition to a green economy is CO₂ emissions. CO₂ emissions in the Gulf and Levant countries have been increasing in the first decades of the current century. At the same time, specific emissions per capita and per unit of output have been declining, which indicates that the regional countries have zero-carbon transition potential with the possible likelihood of reducing not only specific but also absolute CO₂ emissions.

Despite reducing CO₂ and a number of other greenhouse gas emissions, overall, specific greenhouse gas emissions are still higher in countries with higher GDP per capita, which indicates that it's too early to speak of the beginning of a real geo-ecological transition towards decarbonization of the economies of the Gulf and Levant states. Criticism of the Paris Agreement's zero-carbon

development strategy in the regional countries indicates that the topic remains controversial.

Renewable energy is developing rapidly in the Gulf and Levant region. The countries of the region can be notionally divided into two main groups: 1) those for which RES is a matter of prestige and an attempt to join the global green agenda (wealthy Gulf countries – Bahrain, Qatar, Kuwait, UAE, Saudi Arabia), 2) those for which RES is a matter of survival due to the lack of hydrocarbons and other resources (Jordan, Yemen, Lebanon, Syria). The first group leader is the UAE; over the period of 2014–2022, the share of solar energy in the UAE's energy profile increased from 0.3% to 4.5%. The most representative country in the second group is Jordan, a relatively poor state – a regional leader in the RES application and ranks 15th in the global ranking.

Local countries have the potential to start producing industrially green and blue hydrogen and turn the region into one of the world's hydrogen production centers. Among the regional countries, the UAE is a regional leader in the development of green and blue hydrogen production capacity.

The green agenda has largely become a matter of the image of Middle Eastern countries on the global stage. One of the components of the Gulf economic strategies is striving for foreign direct investment (FDI). That's especially the case of the capital assets that the large TNCs can invest in the regional countries.

Overall, the progressive development of a green economy in the Gulf and Levant states is one of the manifestations of the initial stage of the zero-carbon transition. However, despite a number of emerging, clearly expressed eco-positive trends, it is still too early to speak of the predetermination of the low-carbon transition according to the optimistic scenario based on the Kuznets ecological curve for the Gulf and Levant region. This is a kind of limitation of the proposed hypothesis but does not diminish its relevance. The low-carbon transition is not predetermined and does not eliminate the likelihood of new waves of ecologically negative processes in the foreseeable future. That requires further long-term monitoring of environmentally significant socio-economic processes using various ecological indicators.

The development of a green economy in the Gulf and Levant countries is a reality of the first decades of the current century. So far, we can observe the initial stage of this process. The study showed that the green agenda has already started to "materialize" in the studied region in a number of key areas, such as carbon footprint control and the focus on carbon neutrality, the development of renewable energy sources, the development of green and blue hydrogen production, and other so-called "sustainable" projects. ■

REFERENCES

- Abdel-Rahman A. M. M. (2002). The determinants of foreign direct investment in the Kingdom of Saudi Arabia. *Economic Research Forum*.
- Adel M. Ghanem and Yosef A. Alamri (2023). The impact of the green Middle East initiative on sustainable development in the Kingdom of Saudi Arabia. *Journal of the Saudi Society of Agricultural Sciences*, Volume 22, Issue 1, pp. 35-46. DOI: 10.1016/JSSAS202206001.
- Alekseeva N.N., Bancheva A.I., Grinfeldt Y.S., Petrov L.A., and Tretyachenko D.A. (2024). Estimation of carbon emissions due to land use changes at global and regional levels in foreign studies. *Geography and Natural Resources*, 1, 15-26. DOI: 10.15372/GIPR20240102 (in Russian with English summary).
- Bityukova V.R. and Popov A.A. (2015). Ecological consequences of structural shifts in Russian industry in 1990-2014. *Ecology and Industry of Russia*, 6, 4-10. (in Russian with English summary).
- Blam I.Y. and Kovalev S.Y. (2020). Low-carbon trend in investment policy: search for effective adaptation mechanisms *ECO*, 3, 160-176. DOI: 10.30680/ECO0131-7652-2020-3-160-176. (in Russian with English summary).
- Bukvich R.M. and Petrovich D.R. (2017). Greenhouse effect and Market mechanisms of the Kyoto Protocol. *Vestnik NSTEI*, 1 (68), 139-158. (in Russian with English summary).
- Burima L. Y. (2018). Environmental security of the energy sector as a necessary condition for sustainable development. *Vestnik Prikamsky Social Institute*, 1 (79), 72-83. (in Russian with English summary).
- Chen K., Yang M., Zhou X., Liu Z., Li P., Tang J., and Peng C. (2022). Recent advances in carbon footprint studies of urban ecosystems: Overview, application, and future challenges. *Environ. Rev.*; 30:342–356. DOI: 10.1139/er-2021-0111. <https://doi.org/10.1139/er-2021-0111>.
- Climate Change 2021: The Physical Science Basis. Technical Summary. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. - Cambridge; NY: Cambridge University Press, 33- 44. DOI: 10.1017/9781009157896.002.
- Druzhinin P. V. and Shkiperova, G. T. (2014). Assessment of the mutual influence of economic and environmental processes. *Economic and Social Changes: Facts, Trends, Forecasts*, 32 (2), 213-224, (in Russian with English summary), DOI: 10.15838/esc/2014.2.32.16.
- Druzhinin P. V., Shkiperova G. T., and Potasheva O. V. (2018). The ecological curve of the Blacksmith: the case of Russia and Finland. *Economics: Yesterday, Today, Tomorrow*, 8 (11A), 83-97, (in Russian with English summary).
- Grossman G. and Krueger A. (1995). Economic growth and the environment, *The Quarterly J. of Economics*, 110, 353–377.
- Heinonen J., Ottelin J., Ala-Mantila S., Wiedmann T., Clarke J., and Junnila S. (2020). Spatial consumption-based carbon footprint assessments—A review of recent developments in the field. *J. Clean. Prod.* 2020;256:120335. doi: 10.1016/j.jclepro.2020.120335.
- Hertwich E.G. and Peters G.P. (2009). Carbon footprint of nations: A global, trade-linked analysis. *Environ. Sci. Technol*;43:6414–6420. doi: 10.1021/es803496a.
- Hossam M.N. (2021). Towards a Green Economy as a tool for sustainable development in developing countries: Egypt as a case study. Master's thesis.
- Hua Y. and Dong F. (2022) How can new energy vehicles become qualified relays from the perspective of carbon neutralization? Literature review and research prospect based on the CiteSpace knowledge map. *Environ. Sci. Pollut. Res.* ;29:55473–55491. doi: 10.1007/s11356-022-21096-y.
- Kaika D. and Zervas, E. (2013) The Environmental Kuznets Curve (EKC) theory // *Energy Policy*. . V. 62. P. 1392–1411. 14. Kuznets S. Economic growth and income inequality // *American Economic Rev.* 1955. V. 45. № 1. P. 1–28.
- Kondratiev K.Y. and Demirchyan K.S. (2001). Earth's Climate and the 'Kyoto Protocol'. *Bulletin of the Russian Academy of Sciences*, 71,11. (in Russian with English summary)
- Kovalev U. U. and Lopatnikov D. L. (2024). Argentina, Brasil y Mexico en el camino hacia la neutralidad climatica // *Iberoamérica*. 2024, 4. 122–146. (in Spanish with English summary) DOI: 10.37656/s20768400-2024-04-06.
- Krasnoyarova B.A., Nazarenko A.E., Plutalova T.G., and Sharabarina S.N. (2025). Carbon footprint of agriculture: structure, assessment methods, impact factors *Geography and Natural Resources*, 1, 164-175. DOI: 10.15372/GIPR20250116 (in Russian with English summary).
- Kumar R., Karmakar S., Minz A., Singh J., and Kumar A. (2021). Assessment of greenhouse gases emission in maize-wheat cropping system under varied N fertilizer application using cool farm tool // *Frontiers in Environmental Science*. 9, Article 710108.
- Le H.P. and Ozturk I. (2020). The impacts of globalization, financial development, government expenditures, and institutional quality on CO₂ emissions in the presence of environmental Kuznets curve, *Environmental Science and Pollution Research*, 27, 2680–2269.
- Le Quere C., Korsbakken J.I., Wilson C., Tosun J., Andrew R., Andres R.J., Canadell J.G., Jordan A., Peters G.P., and van Vuuren D.P. (2019). Drivers of declining CO₂ emissions in 18 developed economies. *Nat. Clim. Change*, (9), 213-217.
- Lombardi M., Laiola E., Tricase C., and Rana R. (2017). Assessing the urban carbon footprint: An overview. *Environ. Impact Assess. Rev.* 66: 43–52. DOI: 10.1016/j.eiar.2017.06.005. <https://doi.org/10.1016/j.eiar.2017.06.005>
- Lorente D.B. and Álvarez-Herranz A. (2016). Economic Growth and Energy Regulation in the environmental Kuznets Curve, *Environmental Science and Pollution Research*, 2016, vol. 25, p. 16478–94.
- Lopatnikov D. L. (2013). Ecological transition. *Regional studies*, 41 (3), 4-8, (in Russian with English summary).
- Lopatnikov D. L. (2020). Migration of the world center of ecological distress and the «geoecological transition». *Proceedings of the Russian Academy of Sciences. Geographical Series*, 5, 728-736, (in Russian with English summary), DOI: 10.31857/S2587556620050106.
- Manual A., Özcan B., and Öztürk I. (eds.) (2019). *Environmental Kuznets Curve*. Academic Press, 162.
- Nafadi, M. S. (2017). The green economy as one of the sustainable development mechanisms to attract foreign investment. *Scientific Journal of the Trade Sector*, 17(1), pp. 640-671.
- Naveed A., Ahmad N., Zadeh Aghdam R.F., and Menegaki A.N. (2022). What have we learned from environmental Kuznets Curve hypothesis? A citation-based systematic literature review and content analysis, *Energy Strategy Reviews*, 44, 100946.
- Pletnev D. A., Popova A. V., and Murashkin S. V. (2022). Economic drivers of decarbonization
- Rotondo F., Perchinunno P, L'Abbate S., and Mongelli L. (2025). Ecological transition and sustainable development: integrated statistical indicators to support public policies, 2022 <https://www.nature.com/articles/s41598-022-23085-0> (01.08.2025).
- Vestnik of Chelyabinsk State University*, 4 (462). *Economic Sciences*, 76, 201-209. DOI: 10.47475/1994-2796-2022-10420 (in Russian with English summary).
- Quesada B., Arneth A., Robertson E., and de Noblet-Ducoudre N. (2018). Potential strong contribution of future anthropogenic land-use and land-cover change to the terrestrial carbon cycle // *Environmental Research Letters*, 13, 6, 064023.
- Shahbaz M. and Sinha A. (2019). Environmental Kuznets curve for CO₂ emissions: a literature survey, *J. Econ Stud.*, 2019, vol. 46, p. 106–168.
- Sykes A.J. (2018). Developing an environmental calculator for application in the beef industry. - Edinburgh: University of Edinburgh School of Geosciences, 315 p.

- Strokov A.S. (2021). Jemissija parnikovyh gazov pri proizvodstve rastenievodcheskoj produkcii.
- Tomlinson B., Black R.W., and Patterson D.J. et al. (2024). The carbon emissions of writing and illustrating are lower for AI than for humans. *Sci Rep* 14, 3732. <https://doi.org/10.1038/s41598-024-54271-x>.
- Vestn. RAN, 91, 3, 265-272. DOI: 10.31857/S0869587321030099 (in Russian with English summary).
- Vidican R., Mălinaş A., Moldovan C., Pleşa A., and Ranta M. (2023). Assessment of greenhouse gas emissions from dairy farming using The Cool Farm Tool. *Journ. of Applied Life Sciences and Environment*, 55, Iss. 3 (191), 323-333.
- Wright L., Kemp S., and Williams I. (2011). «Carbon footprinting»: towards a universally accepted definition. *Carbon Management*, 2 (1), 61-72. DOI: 10.4155/cmt.10.39.
- Wiedmann T., Schandl H., Lenzen M., Moran D., and Kanemoto K. (2013). The material footprint of nations. *Proc. Natl. Acad. Sci. USA*. 112:6271–6276. DOI: 10.1073/pnas.1220362110.
- Umnov V.A., Korobova O.S., and Skryabina A.A. (2020). Carbon footprint as an indicator of the impact of the economy on the climate system. *Vestnik RGGU. Series Economics. Management. Law*, 2, 85-93. DOI: 10.28995/2073-6304-2020-2-85-93 (in Russian with English summary).
- Yandle B., Vijayaraghavan M., and Bhattacharai M. (2002). The Environmental Kuznets Curve: A Primer. *The Property and Environment Research Center*. 2002. PERC Res. Study 02-1.
- Zhang J. (2021). Environmental Kuznets Curve Hypothesis on CO₂ Emissions: Evidence for China, *J. of Risk and Financial management*, 2021, vol. 14, 93.