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## Technical and economic aspects of the development of green energy in the Middle East region

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**Abstract.** The effectiveness of solar and wind power plants has been analyzed, as well as the prospects for the development of green energy in the countries of the Middle East region. The development of green energy contributes, on the one hand, to saving fossil fuels extracted from the earth there-by extending their use, and on the other hand, the alternative high-tech complexes working on solar and wind energy could also be widely applied. Comparative characteristics of solar and wind energy are given, as well as an assessment of the effectiveness of its use in the states of Middle East is carried out. It was concluded that it is necessary to develop and create energy-technological complexes based on the synthesis of solar panels and wind generators, and electric energy storage systems. Project proposals for the energy-technological complex of the countries of Middle East based on solar and wind installations are posed.

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## Технико-экономические аспекты развития зеленой энергетики в государствах Арабского Востока

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**Аннотация.** Проанализированы эффективность применения солнечных и ветряных энергоустановок и перспективы зеленой энергетики в странах Арабского Востока. Развитие зеленой энергетики способствует, с одной стороны, экономии добываемых в земле углеводородных топлив и тем



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**Ключевые слова:**

сила ветра, атомная энергия, альтернативные источники энергии, возобновляемые источники энергии, экологическая политика, солнечная энергетика, энергетический рынок

самым продлению сроков их использования, а с другой – применению альтернативных высокотехнологичных комплексов с использованием энергии Солнца и ветра. Приведены сравнительные характеристики применения солнечной и ветряной энергетики, проведена оценка эффективности ее применения в государствах Арабского Востока. Сделан вывод о необходимости разработки и создания энерготехнологических комплексов на базе синтеза солнечных батарей и ветряных генераторов, систем аккумулирования электрической энергии. Представлены проектные предложения по энерготехнологическому комплексу стран Арабского Востока на базе солнечных и ветряных установок.

**Благодарности**

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## Introduction

Today, the use of renewable energy sources has become one of the main directions for the transition to a sustainable energy system [1]. Interest in the production of electricity from renewable energy sources in the world has increased, as it is one of the elements of the national energy balance in most countries. The Russian leadership is showing attention and interest in the problems of renewable energy. “Of course, we need to deal with alternative types of energy – the sun, and wind, and tidal energy, and hydrogen. Of course, we need to do all this in accordance with the volume of consumption today, with the growth rate of the world economy, with the needs in resources and with the level of technology development. But who does this, looking ahead only for political reasons, especially of an opportunistic political nature?” – noted the President of the Russian Federation Vladimir Putin at the Russian Energy Week forum, held in Moscow on October 12–14, 2022.<sup>1</sup>

The 2030 Sustainable Development Plan, adopted by the United Nations in September 2015, provides for the efforts of the entire world community to preserve the environment and reduce harmful emissions. Important for the development of renewable energy is the Paris Agreement on climate

change, concluded on December 12, 2015, which provides for the annual allocation of 100 billion US dollars to developing countries until 2025 to help them reduce harmful emissions.<sup>2</sup>

In the Russian Federation, renewable energy issues are set out in strategic planning documents, which assume the introduction of 12 GW of generation capacity based on renewable energy sources by 2035.

At a meeting with members of the Government of Russia, President of the Russian Federation Vladimir Putin confirmed the leading position of our country in the field of green energy: “The share of energy from nuclear power plants, hydroelectric power plants, wind and solar power plants exceeds 37 percent.”<sup>3</sup> It was also noted that it is necessary to increase the pace of implementation of projects in the nuclear power industry, actively develop small hydroelectric power plants, and use the energy of ebbs and flows. During ten years’ time, from 2010 to 2019, the share of energy derived from renewable sources in the world in total final energy consumption increased by 1.6%. At the same time, over the same period, the total volume of energy con-

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<sup>2</sup> *Measures to combat climate change*. United Nations. (In Russ.) Available from: <https://www.un.org/ru/climatechange/paris-agreement> (accessed: 10.12.2022).

<sup>3</sup> Vladimir Putin announced Russia's leadership in green energy. *Lenta.ru*. 2021, October 5. (In Russ.) Available from: <https://lenta.ru/news/2021/10/05/putinzelen/?ysclid=19yo81ivgi719665991> (accessed: 10.10.2022).

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<sup>1</sup> V.V. Putin spoke about alternative energy sources. *RIA Novosti*. 2022, October 12. (In Russ.) Available from: <https://ria.ru/20221012/putin-1823366363.html> (accessed: 10.10.2022).

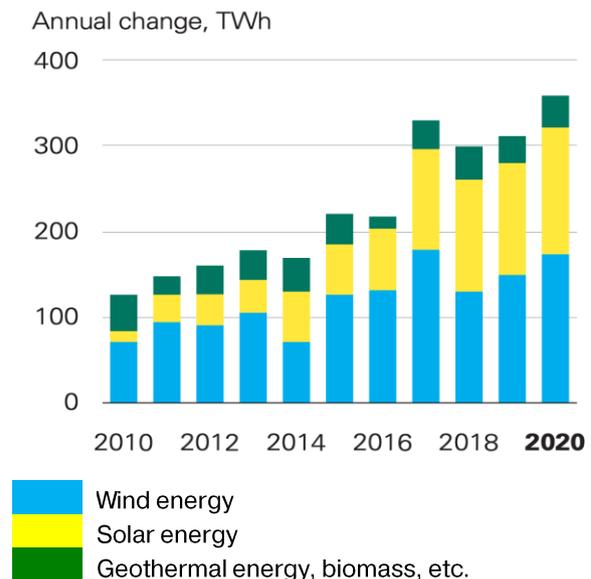
sumption from renewable sources grew much more significantly – by 25%. The most rapid progress is observed in the electricity sector – the share of renewable energy sources in it increased from 19.7% in 2010 to 26.2% in 2019. At the same time, in 2019, this sector accounted for only a fifth of the final energy consumption in the world. Half of global energy consumption comes from thermal generation, but progress in this sector has been modest: in 2019, the share of modern renewable energy was 10.1%, i.e. increased by less than 2% compared to 2010. In 2019, the share of renewable energy sources used in the transport sector reached 3.6%, while in 2010 this figure was 2.6%.

In 2019, traditional uses of biomass, such as burning wood for heating, still generate almost a third of total energy consumption from renewable sources. Effectively addressing climate change will require enhanced policy support across all sectors and effective tools to further mobilize private capital, including for developing countries. Achieving the global energy efficiency target is still possible, but only with significant systematic investment increasing energy efficiency is essential to achieving global climate change goals. To solve the set task by 2030, it is necessary to annually increase energy intensity by 2.6%, which is twice as high as the rates observed from 1990 to 2010 [2].

Global primary energy intensity, calculated as the ratio of total energy use to GDP, decreased from 5.6 MJ/US\$ (2017 purchasing power parity) in 2010 to 4.7 MJ/US\$ in 2019, while the rate of decline averaged 1.9% per year. To meet the Sustainable Development Goals (SDG) target and make up for lost time, the rate of increase in energy intensity by 2030 must average 3.2% per year. This is still possible, but only if there is significant systematic investment in cost-effective energy efficiency technologies. The pace of progress varies from region to region due to differences in economic structure, energy use and electrification levels. The only region that has met the target so far is East and Southeast Asia, where the average annual rate in 2010–2019 was 2.7%, supported by strong economic growth. While the challenge of combating climate change is becoming increasingly urgent, growth in

international public funding for renewable energy had slowed even before the pandemic. International government funding to developing countries to support clean energy development has declined for the second year in a row. In 2019, such financing amounted to \$10.9 billion, which is almost 24% less than a year earlier. In addition, for the first time since 2008, the five-year moving average decreased from \$17.5 billion in 2014–2018 to USD 16.6 billion in 2015–2019. The impact of the COVID-19 pandemic could have caused another downturn in 2020. In 2019, more than 52% of commitments made were for loans. Nearly 17% were grants, indicating an increase in the use of non-indebted aid to developing countries. Another promising way is shares in collective investment such as investment funds, which reached \$191 million in 2019, up 91% from 2018. In 2019, LDCs accounted for 25.2% of pledged aid compared to 21% in 2018, but its volume has decreased from USD 3.0 billion to USD 2.7 billion [3].

The widespread use of renewable energy sources, especially from the Sun (depending on solar photovoltaic technology) and wind, has led to a noticeable decrease in the cost of electricity (an increase in renewable energy production can be seen in Figure 1, where the main share falls on wind and solar energy) [4].



**Figure 1.** Renewable energy production

By 2025, an increase in the rate of electricity generation from renewable energy sources is predicted by about a third, but with a limited increase in the heating and heat production sector, as well as in transport [5].

According to information provided by ourworldindata.org, about 1/3 of the world's electricity generation capacity in 2021 came from low-carbon sources. For example, the share of electricity from low-carbon sources in Saudi Arabia for 2021 was 0.23%; United Arab Emirates – 11.26%; Qatar – 0.25% (Figure 2). The countries of the Middle East, while continuing to increase the pace of production of low-carbon energy (solar, wind, biomass and waste, geothermal, tidal, etc.), continue to lag behind the world leaders.

Renewable energy sources, which make up about 26–28% on a global scale, are actively developing all over the world. If in some countries of the Middle East there is no nuclear energy (Figure 3), then almost all countries are aimed at the active de-

velopment of renewable energy sources, as evidenced by the strategies adopted at the state level and other planning documents. Thus, Egypt and Morocco, despite the uneven dynamics of the development of this segment, demonstrate fluctuations between 13 and 18%, which is commensurate with the use of renewable energy sources in the USA and Russia [6].

The production of electricity per capita is indicative. Despite ongoing efforts to develop renewable energy sources, a large share of energy production per capita comes from gas, coal and oil, as shown in Figure 4.

The increase in renewable energy capacity in the US, China and India combined will lead to a significant reduction in the cost of energy. Currently, many countries are aimed at signing long-term agreements on the purchase of electricity for the needs of public utilities [7].

Figure 4 shows the expected sectoral development of renewable energy demand from 2015 to 2025.

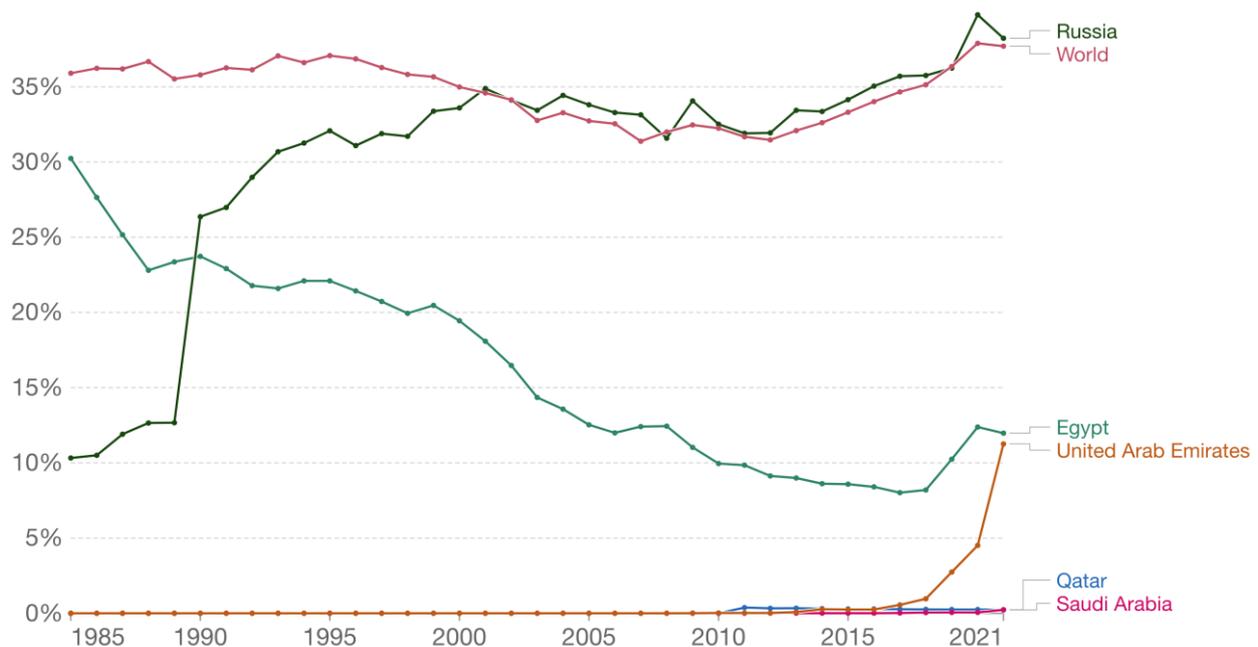
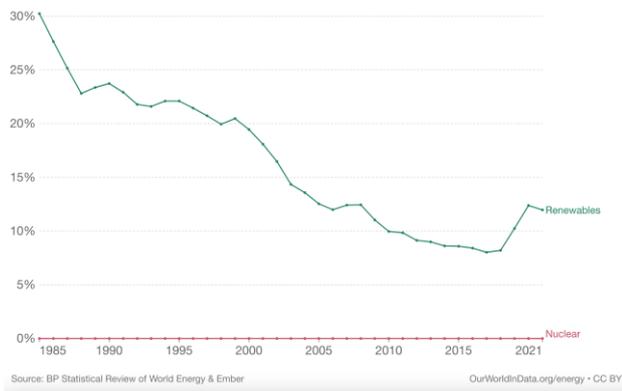
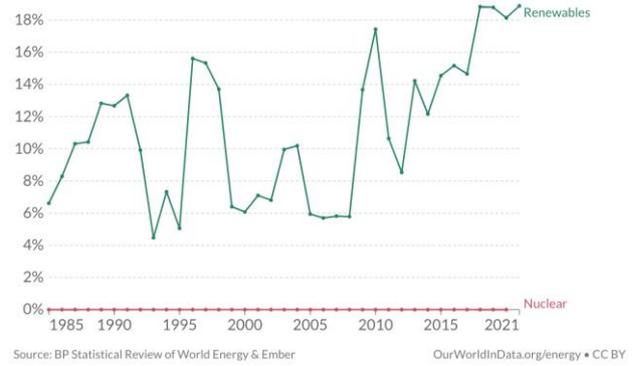


Figure 2. Share of energy from low-carb sources

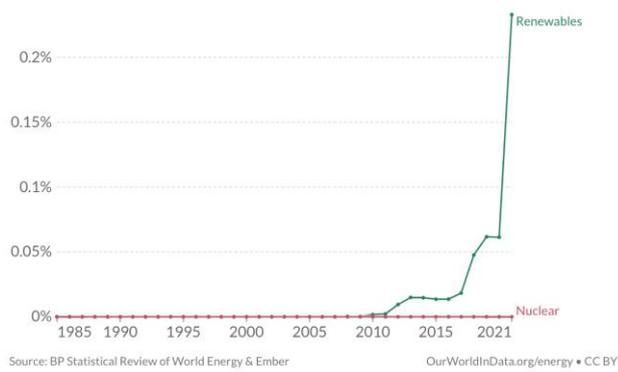
Source: Ritchie H, Roser M. Electricity mix. *Our World in Data*. Available from: <https://ourworldindata.org/electricity-mix> (accessed: 15.11.2022).



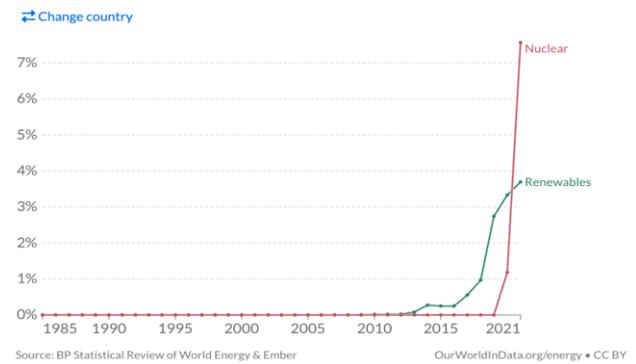
Egypt



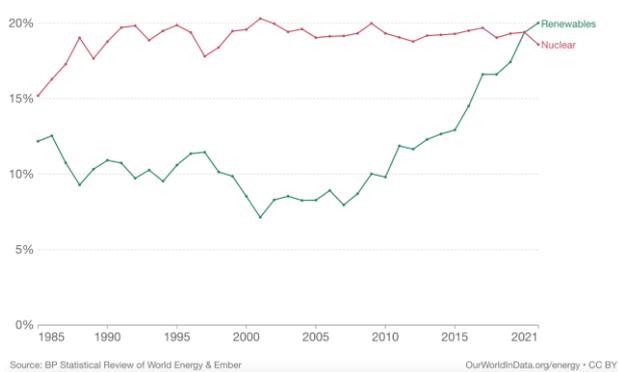
Morocco



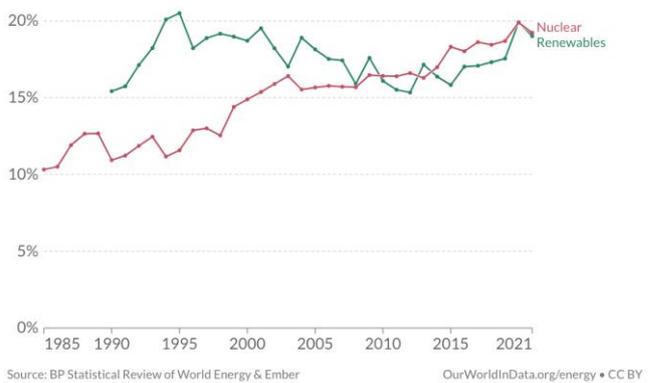
Saudi Arabia



United Arab Emirates



USA



Russia

**Figure 3.** Share of renewable and nuclear energy

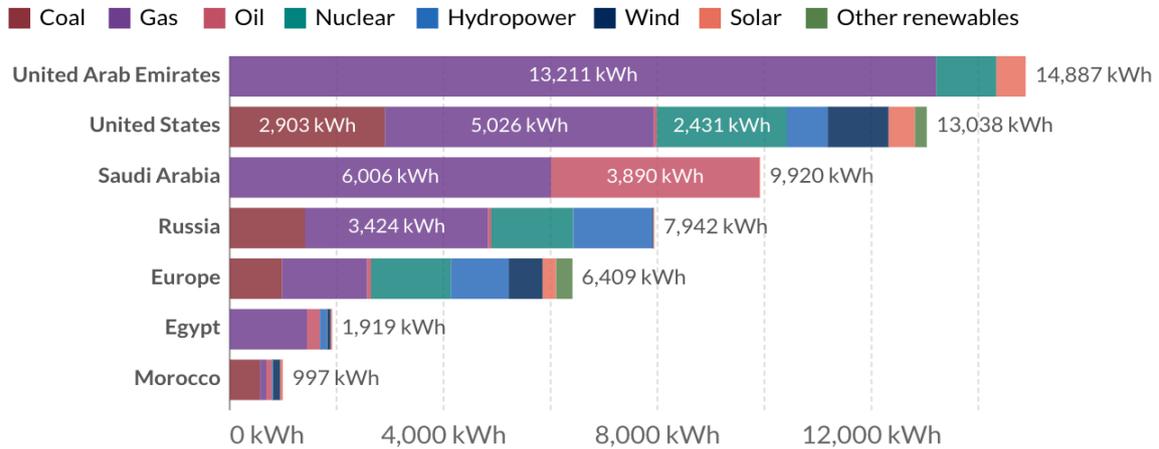


Figure 4. Power generation per capita by source, 2021

Source: Ritchie H, Roser M. Electricity mix. *Our World in Data*. Available from: <https://ourworldindata.org/electricity-mix> (accessed: 15.11.2022).

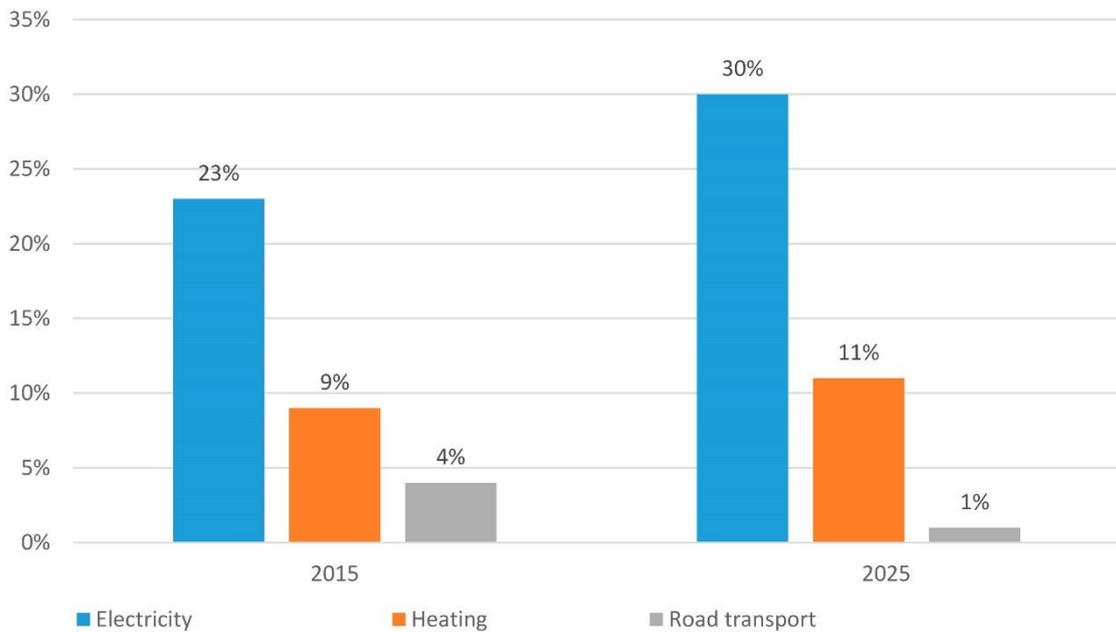


Figure 5. Projected industry development of global renewable energy demand in 2015–2025 [8]

### 1. Features of the technical and economic development of renewable energy in the countries of Middle East

Renewable energy is still a minor issue in public opinion in the countries of the Middle East region. The reason for this may be due to the dominance of the oil sector (oil and gas) in the local energy market

and the neglect of the importance of this modern industry. Preservation of the environment has become the responsibility of the whole world and therefore has stimulated national environmental protection activities during environmental disasters since the industrial revolution. The energy sector contributes to industrial and economic achievements and is a prerequisite for meeting basic human needs [9].

Renewable energy sources play an important role in achieving sustainable development; although studies on it were started by accident in the 30s of the last century, they still cause discussion and study, especially after the energy crisis of the 1970s, which affected the economic and social life in the world. Industrialized countries have been looking for alternatives to achieve economic independence and security, and countries such as China, Denmark, Iceland and Germany have succeeded in this.

The emergence and export of oil in the Arab region was a decisive historical revolution in overcoming the isolation of the region. Suddenly there was a socio-economic transformation. Within a few decades, something like a value revolution took place, the result of which was a crack in the value system, and many crafts were destroyed in favor of the spread of a new production model, which also brought a consumer culture in need for help [10].

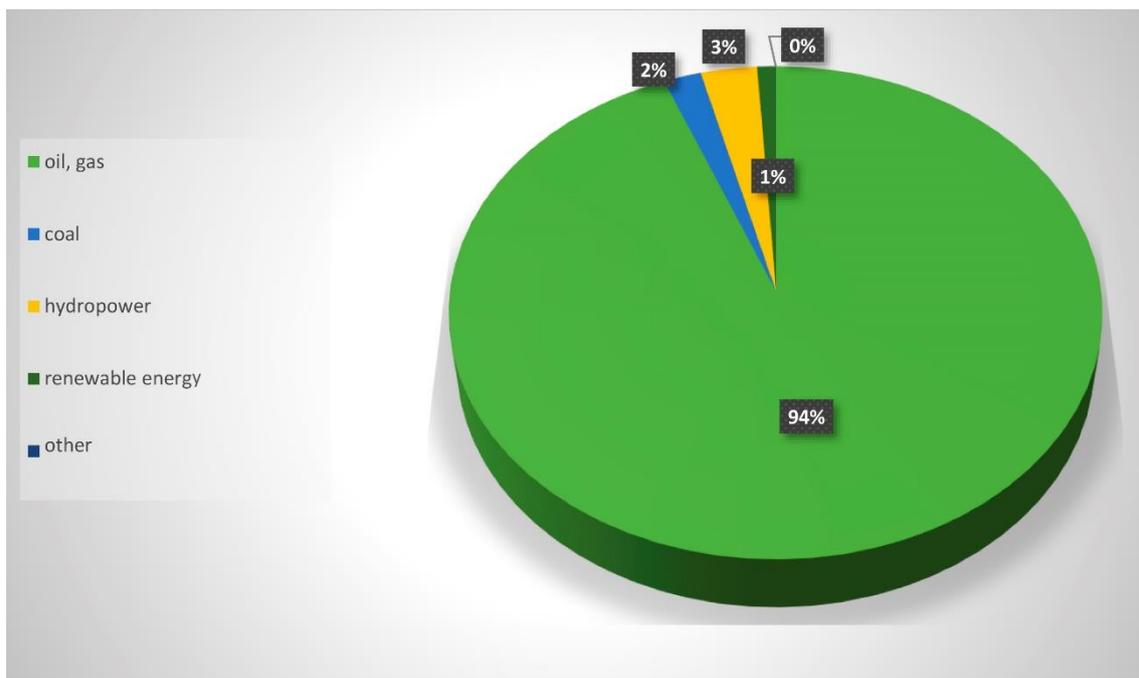
Such components of the natural environment as climate, geographical location and natural resources had a significant impact on social life, since the population density was formed in regions without others, which contributed to the impact on the structure of production and the social organization of these entities, thereby creating cultural diversity and diversity of heritage, some of which were subject to change, while others were reluctant to endure the rigors of the times. It is well known that the society

of the Arab countries of the Persian Gulf as a whole is a tribal society, which, before the discovery of oil, relied on traditional models of production, such as agriculture, herding, pearling and fishing. However, after that it was accompanied by many changes at various levels.

The enormous influence of modern and advanced technologies and facilities has effectively contributed to the growth of modern cities with all their amenities, beauty and speed of expansion. To achieve the seventh United Nations Sustainable Development Goal by providing clean and affordable energy, the Kingdom of Bahrain has worked to capitalize on affordable sustainable renewable energy, and the Electricity and Water Authority has started to promote the use of renewable energy through a project to install solar energy systems in houses, as well as through the implementation of the solar energy plant project with a production capacity of 100 MW.

The Arab countries are approximately 94% dependent on fossil fuels as their main source of electricity generation, with a modest contribution from renewable energy sources (solar and wind). A pleasant exception is the state of Sudan, which receives electricity from the floods of the Nile River in addition to oil.

Figure 5 shows the percentage of the contribution of renewable energy sources to the energy produced in the Middle East region.



**Figure 6.** Percentage of renewable energy contribution to energy produced in the Middle East region, 2017–2022 [11]

In the countries of the Middle East region, there is a growing interest in the use of renewable energy sources (especially solar and wind). Electricity producers in the Arab countries that import energy make a significant contribution to the diversification of the national energy mix.

The total capacity of renewable energy sources (without hydropower) in the Arab countries is about 5100 MW, including 1972 MW from solar photovoltaic system, 2559 MW from wind, 325 MW from solar thermal concentrators and 244 MW from bioenergy. At the end of 2017, Morocco, Egypt, Tunisia, and Jordan, due to the lack of traditional energy sources, have made great strides in using wind energy to generate electricity.

At the end of May 2018, Jordan abandoned the construction project with the participation of the state corporation Rosatom of a large-capacity nuclear power plant worth \$10 billion, on the same days Russia and Jordan signed an agreement on the development of a project for the construction of a small-capacity nuclear power unit (about 200 MW) on the Jordanian territory for Russian project.

The request of the Russian side to pay for the construction of the first nuclear power plant in Jordan with loans from commercial banks caused the cancellation of the agreement signed between the commission and the Russian company Rosatom. The Jordanian leadership has demonstrated a general trend characteristic of the states in the Middle East region – a phased transition to the use of solar energy.<sup>4</sup>

The interest in the use of wind energy of the governments of the states in the Middle East region is increasing in the presence of regions characterized by a “wind rose” in terms of frequency and average annual wind speed, which were obtained as a result of scientific research. A significant role is given to the local industry, which produces some components of wind power equipment.

Photovoltaic solar system technology, given its low cost and suitability for rural and remote areas, is attracting the attention of most countries with different economies and natural resources, whether they are energy exporters or importers (e.g. Algeria, Jordan). PV projects for lighting, water pumping and desalination are expected to continue to expand

in most Arab countries. And at present, Morocco is still the first country in the region in the field of concentrated solar thermal power plants.

## **2. Characteristics of the production of electricity from renewable energy sources in the countries of the Middle East region**

Two millennia after the ancient Egyptians abandoned their God of Sun Ra, their descendants are rediscovering the power of the Sun. In the southern desert, half an hour from Aswan, Egypt is putting the finishing touches on Benban, one of the world's largest solar farms. Its 6-meter panels produce 1.5 GW of energy, enough to power more than 1 million homes. “In ten years, we will still need oil for plastics and other petrochemicals, but not for energy,” says Rabeaa Fattal, a Dubai-based investor in Rising Sun, one of Benban's 40 fields. Most of the energy in the modern Middle East and North Africa is built on oil. This region exports more oil than any other region. A quarter of the Middle East's electricity comes from it, compared to three percent from renewable sources. In the long term, the global trend is towards cleaner energy sources. Renewable energy capacity in the Middle East has doubled to 40 GW over the past decade and should double again by 2024.

Last year, the Arab Republic of Egypt made great strides in renewable energy production as renewable energy production reached nearly 24 GWh. At the same time, wind and solar energy provided 41% of the total amount of energy consumed in the country.

The renewable energy sector in Egypt has been able to make significant gains despite the difficult conditions facing renewable energy markets during the coronavirus pandemic, most notably with the commissioning of a 250 MW wind farm located in the Gulf of Suez. The Arab Republic of Egypt has sold almost 2 million carbon certificates and has made impressive progress in the implementation of a solar photovoltaic power plant near the city of Zaafarany [12].

Egypt is developing projects in the field of solar and wind energy with a total capacity of approximately 3,570 MW. The private sector and foreign investors have purchased about 3,500 MW of these power generation facilities for about \$3.5 billion.

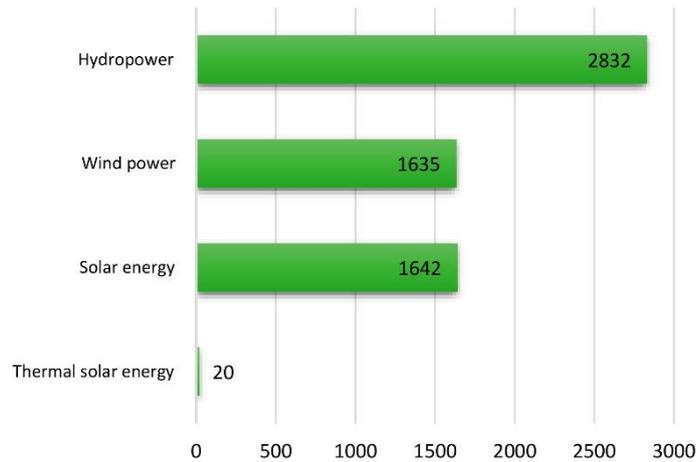
Xlinks has announced the implementation in Morocco, in the area of Guelmim Oued Noun, the largest project to create on an area of 1500 square kilometers of a wind and solar energy facility with a capacity of 10.5 GW. To export the generated energy, 3,800 km of high-voltage DC offshore cables will

<sup>4</sup> Jordan spoke about the reasons for the cancellation of the agreement with Rosatom on nuclear power plants. *RIA Novosti*. 2018, June 11. Available from: <https://ria.ru/20180611/1522520409.html> (accessed: 15.11.2022).

be laid and a huge battery storage facility with a capacity of 5 GW/20 GW per hour will be built.

A total of 111 clean energy projects are in operation and development in Morocco, while the share of renewable energy in the electricity generated in the country is currently about 37–38%. In 2030, the share of renewable energy sources in the Kingdom of Morocco should exceed 50%.

Electric power generated through the use of renewable energy sources, according to the Ministry of Energy of Morocco, in 2021 amounted to 3.95 thousand MW: 1.43 thousand MW due to wind energy (13.4% of the total electricity capacity), 0.75 thousand MW from solar energy (7.03% of total electricity capacity) and 1.77 thousand MW from hydroelectric power (16.57% of total electricity capacity).



**Figure 7.** Annual report of the renewable energy authority of the Arab Republic of Egypt

Investments in renewable energy projects in Morocco amounted to USD 5.8 billion. The goal of implementing large-scale projects is to generate up to 52% of energy from renewable sources and create up to 400 thousand jobs in 20 years.<sup>5</sup>

According to official government sources and other publicly available information, in 2020–2021, in response to the COVID 19 pandemic, Saudi Arabia allocated \$6.50 billion to support various forms of energy through new or changed policies. These government monetary commitments include: \$5.59 billion for unconditional use of fossil fuels under 5 strategies (3 quantitative and 2 non-quantitative).<sup>6</sup> \$906.67 million were allocated for unconditional clean energy under 3 strategies (1 quantitative and 2 non-quantitative). 5.59 billion US dollars were allocated for oil and gas production [13].

<sup>5</sup> Tuma YM. Arab countries eye energy diversification, including renewables. *Mexico Business News*. 2022, June 7. Available from: [https://mexicobusiness-news.translate.goog/trade-and-investment/news/arab-countries-eye-energy-diversification-including-renewables?\\_x\\_tr\\_sl=en&\\_x\\_tr\\_tl=ru&\\_x\\_tr\\_hl=ru&\\_x\\_tr\\_pto=sc](https://mexicobusiness-news.translate.goog/trade-and-investment/news/arab-countries-eye-energy-diversification-including-renewables?_x_tr_sl=en&_x_tr_tl=ru&_x_tr_hl=ru&_x_tr_pto=sc) (accessed: 15.11.2022).

<sup>6</sup> Saudi Arabia. *Energy Policy Tracker*. Available from: <https://www.energypolicytracker.org/country/saudi-arabia/> (accessed: 15.11.2022).

The significant amount of public funds allocated to support the Saudi economy and people through monetary and fiscal policy in response to the crisis could also benefit various elements of the energy sector. However, these values are not available from official legislation and statements and are therefore not included in the database. Meanwhile, in addition to monetary and fiscal measures, the database lists other policies and regulations that can also provide benefits to producers and consumers of various types of energy. These public monetary obligations are in addition to many other public policies that were in place to support various forms of energy prior to the COVID19 pandemic [9].

### 3. Prospects for the development of renewable energy in the countries of the Middle East region

At the third session in Riyadh, the Arab Development Summit adopted the Arab Strategy for the Development of the Use of Renewable Energy Sources for 2010–2030.<sup>7</sup> The strategy provides a scientific and

<sup>7</sup> *Pan-Arab Renewable Energy Strategy 2030*. International Renewable Energy Agency. Available from: [http://www.irena.org/DocumentDownloads/Publications/IRENA\\_PanArab\\_Strategy\\_June%202014.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_PanArab_Strategy_June%202014.pdf) (accessed: 15.11.2022).

theoretical basis for the joint actions of the Arab states in the field of renewable energy sources. Thanks to the implementation of this strategy, the share of renewable energy sources in electricity generation in the Arab region in 2020 reached 5.1%.

The Executive Office of the Arab Council of Ministers of Electricity of the League of Arab States adopted the Guidelines for Arab Countries on Renewable Energy and its Annex – Model of National Renewable Energy Plans, and encouraged the Arab countries to use them as the main guide in preparing

their respective national plans and to coordinate their actions with the Committee of Experts on Renewable Energy and Energy Efficiency (associated with the Council) and, with the help of a special methodology, monitor the implementation of the decisions of the above structure [3].

Table shows countries in the Arab region that have announced official strategic goals and adopted policies related to renewable energy. The Kingdom of Morocco ranks first in terms of completion of renewable electricity projects, followed by Egypt and Jordan.

**Renewable Energy Goals. Total installed capacity of renewable energy sources in the Middle East**

Country	Approved goals for increasing the share of renewable energy sources (% of total electricity production in the country)	Deadlines for achieving the goal	Total installed capacity of renewable energy sources (excluding hydropower) for 2022, MW
Jordan	10	2025	564.4
UAE	25	2030	356.6
Bahrain	10	2035	6
Algeria	27	2030	435.2
Tunisia	30	2030	282.8
Syria	30	2030	13
Sudan	20	2030	202.6
Iraq	11	2025	37
Oman	10	2025	25
Palestine	10	2025	18
Qatar	20	2030	43
Kuwait	15	2030	41
Lebanon	12	2025	30
Libya	10	2025	5
Egypt	20	2022	866
Kingdom of Morocco	52	2030	1260.8
Saudi Arabia	30	2040	92
Mauritania	20	2025	119.2
Yemen	15	2025	400

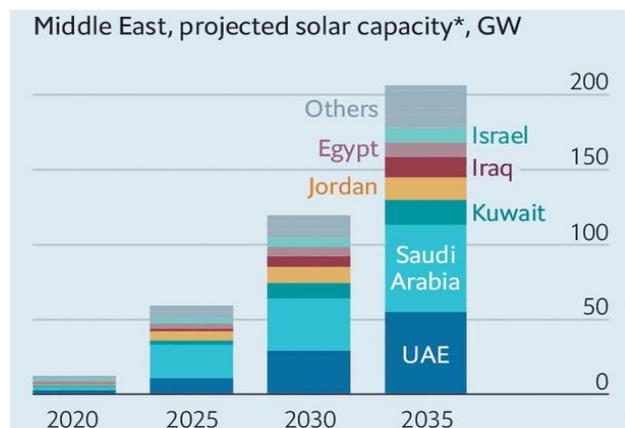
The growing competitiveness of renewable energy gives analysts hope that this trend will continue (Figure 5). Solar farms are cheaper, faster and safer to build and maintain than oil and gas power plants. A new solar power plant in the United Arab Emirates will produce electricity about two-thirds cheaper than gas and one-third cheaper than oil. Several countries in the region are talking about becoming exporters of renewable energy. Investors, however, still have reason to hesitate. First, Arab autocrats often promise more than they deliver. Take, for ex-

ample, Mohammed bin Salman, the de facto ruler of Saudi Arabia, who made renewable energy the basis of his economic reform plan. In 2018, the ruler and Japan's SoftBank announced the world's largest solar power project in the Saudi desert. However, after six months it was postponed.

Regional instability in the states of the Middle East region deters potential investors. The Iraqi Energy Minister blames the protests for derailing his plans to meet 20% of demand from renewable energy by 2030. Conflicts in neighboring countries have

cast doubt on Jordan's efforts to export solar energy to Lebanon. Egypt offered to buy solar power at above market prices to attract investors to Benban.

There is also a risk that, in the long term, lower oil prices will decrease countries' interest in solar energy. Saudi Arabia, for example, may choose to burn more oil for energy. The decline in revenues could force oil-producing states to suspend new solar projects. But such projects are largely driven by the private sector, and they still compare favorably with fossil fuels.



**Figure 8.** A graph demonstrating the planned growing competitiveness of renewable energy sources

Source: Per capita electricity generation by source, 2021. *Our World in Data*. Available from: <https://ourworldindata.org/grapher/per-capita-electricity-source-stacked?country=USA~EGY~Europe~MAR~RUS~SAU~ARE> (accessed: 15.11.2022).

The expansion of the use of renewable energy sources requires the adoption of comprehensive measures, in accordance with national conditions and priorities, which, taking into account the degree of coordination and integration of policies between the relevant sectors and government bodies, will achieve the greatest efficiency of green energy both at the regional and international levels [10]. Nuclear energy is also included among the sources of renewable energy, however, the article itself predetermined the emphasis on solar and wind energy, as the least expensive and affordable for individuals. For example, 70% of energy in Yemen is generated by “domestic” solar panels of private households. The countries of the Middle East region will have to repeat the successful Soviet experience in implementing the GOELRO plan [14].

Jordan's refusal to sign a contract with Rosatom on the construction of a nuclear power plant indicates that this country has chosen solar energy as their priority. An obvious problem with using solar panels is desert

storms that cover the batteries with sand. An important step towards the development of solar and wind energy was the adoption of the Arab Strategy for the Development of the Use of Renewable Energy Sources for 2010–2030, adopted at the third session in Riyadh at the Arab Development Summit. The strategy provides a scientific and theoretical basis for the joint actions of the Arab states in the field of renewable energy sources.

Looking ahead to the future, Paddy Padmanathan of Acwa Power, a Saudi firm that manages renewable energy projects, argues, “Why shall we spend money extracting fuel from the earth and refining it instead of relying on God-given free sun and wind?”

The use of nuclear energy in the countries of the Middle East region causes serious concerns among the world community. Concerns about nuclear safety in the Middle East are limiting the spread of nuclear power. For example, Saudi Arabia and the UAE are concerned about possible terrorist attacks. First of all, this raises the issue of nuclear security, i.e., rapid measures to prevent and detect malicious acts such as theft, sabotage, unauthorized possession and illegal transfer. But there is also the issue of security, i.e. ensuring the operability of nuclear installations, preventing accidents or limiting their consequences. The countries of the Middle East are concerned about the availability of nuclear material for terrorist organizations, which undermines their desire to develop nuclear power in peacetime. The UAE, Turkey, Saudi Arabia, Egypt and Jordan import most of their fissile material for their current programs, and this raises the issue of dependence on other countries. In addition, the region is prone to frequent earthquakes (especially in Iran and Turkey), high temperatures, frequent terrorist attacks, and violent geopolitical disputes. When an earthquake measuring 7.7 on the Richter scale hit Iran in 2013, the disaster caused cracks in the concrete at the Bushehr nuclear power plant. Solar and wind power do not depend of earthquakes, unlike sandstorms. It is completely safe and does not create waste.

Any nuclear leak in the Persian Gulf would be a major problem for those countries dependent on seawater desalination. And finally, the Middle East, with its relatively late start in the development of nuclear energy, suffers from a shortage of qualified specialists and a belated development of related technologies. The problems of using atomic energy are of a political nature and are affiliated with the interests of major world powers. Of course, it is beneficial for Rosatom to build nuclear power plants in the region, which made it possible to strengthen Russia's influ-

ence on the region, however, our rivals use other arguments to gain a foothold in the countries of the Middle East region [8]. The issues of using nuclear reactors in the countries of the Middle East will be looked in more detail in the next article.

## Conclusion

The presented materials make it possible to evaluate both the economic and political effects of the introduction of solar and wind power plants in the countries of the Middle East region. By decision of the Executive Office of the Arab Council of Ministers of Electricity of the League of Arab States, the Guiding Principles for Arab Countries on Renewable Energy Sources “Model of National Plans for Renewable Energy Sources” were adopted. The Arab countries use them as the main guide in preparing their respective national plans and coordinate their actions with the Committee of Experts on Renewable Energy and Energy Efficiency.

The article shows that systems of solar panels and storage batteries are capable of providing up to seventy percent of the needs of the country's population for electrical energy. In conditions of strong sun and a favorable prevailing and dominant winds (windrose diagram), small solar panels and wind turbines located in private houses are ways to solve the global state problems of saturating the country with energy. Numerous programs of the countries of the Middle East region for the development of solar and wind energy indicate the correctness of their chosen strategy. The Russian Federation undoubtedly has the necessary technological resources to help the countries of the Middle East region in the development of solar and wind energy.

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