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An Analysis of Power Sector Investment by Technology in the Middle East and North Africa

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تحليل للاستثمار في قطاع الطاقة من خلال التكنولوجيا في الشرق الأوسط وشمال أفريقيا

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Abstract:
The power sector in the Middle East and North Africa (MENA) is undergoing a profound structural transformation. Historically dominated by state-owned utilities and reliant on abundant, subsidized fossil fuels, the region is now pivoting towards a more diversified, sustainable, and technologically advanced energy mix. This manuscript provides a detailed, three-phase analysis of power sector investment by technology across the MENA region. It examines the fossil fuel-dominated landscape of 2010, assesses the transitional and increasingly diversified investment patterns of 2023, and projects the anticipated investment landscape for 2035, driven by national climate pledges, economic diversification plans, and plummeting renewable energy costs. The analysis reveals a clear and accelerating shift: from capital expenditure (CAPEX) locked in hydrocarbon-based generation towards massive investments in solar PV and wind, with growing allocations for grid modernization, battery storage, and nascent clean technologies like green hydrogen. This transition, however, is uneven across the region and faces significant geopolitical, regulatory, and financial challenges.

Keywords: MENA, Power Sector, Investment, Renewable Energy, Solar PV, Natural Gas, Energy Transition, NDCs, Grid Modernization, Green Hydrogen

الملخص
يشهد قطاع الطاقة في منطقة الشرق الأوسط وشمال أفريقيا تحولاً هيكلياً عميقاً. فبعد أن كان هذا القطاع يهيمن عليه تاريخياً المرافق العامة المملوكة للدولة ويعتمد على الوقود الأحفوري الوفير والمدعوم، تتجه المنطقة الآن نحو مزيج طاقة أكثر تنوعاً واستدامة وتطوراً تكنولوجياً. تقدم هذه الدراسة تحليلاً مفصلاً على ثلاث مراحل لاستثمارات قطاع الطاقة حسب التقنية في منطقة الشرق الأوسط وشمال أفريقيا. وتستعرض الدراسة الوضع السائد في عام 2010 الذي كان يهيمن عليه الوقود الأحفوري، وتقيّم أنماط الاستثمار الانتقالية والمتنوعة بشكل متزايد في عام 2023، وتتوقع المشهد الاستثماري المتوقع لعام 2035، مدفوعاً بالتعهدات الوطنية المتعلقة بالمناخ، وخطط التنويع الاقتصادي، والانخفاض الحاد في تكاليف الطاقة المتجددة. ويكشف التحليل عن تحول واضح ومتسارع: من الإنفاق الرأسمالي الموجه نحو توليد الطاقة القائمة على الهيدروكربونات إلى استثمارات ضخمة في الطاقة الشمسية الكهروضوئية وطاقة الرياح، مع تخصيصات متزايدة لتحديث الشبكات، وتخزين الطاقة في البطاريات، والتقنيات النظيفة الناشئة مثل الهيدروجين الأخضر. إلا أن هذا التحول غير متساوٍ في جميع أنحاء المنطقة ويواجه تحديات جيوسياسية وتنظيمية ومالية كبيرة.

الكلمات المفتاحية: الشرق الأوسط وشمال أفريقيا، قطاع الطاقة، الاستثمار، الطاقة المتجددة، الطاقة الشمسية الكهروضوئية، الغاز الطبيعي، تحول الطاقة، المساهمات المحددة وطنياً، تحديث الشبكات، الهيدروجين الأخضر

Introduction

The Middle East and North Africa (MENA) region is a critical node in the global energy system, possessing over half of the world's proven oil and nearly two-fifths of its natural gas reserves [1]. For decades, this resource endowment shaped its power sector, characterized by low domestic energy prices, high per capita electricity consumption, and generation assets almost exclusively powered by oil and natural gas [2]. However, a confluence of driver's rapid demographic and economic growth, rising domestic energy consumption that threatens export revenues, global climate pressures, and the unprecedented cost-competitiveness of renewables is compelling a strategic re-evaluation.

The power sector in the MENA region stands at a critical juncture, shaped by a complex interplay of demographic pressures, economic diversification ambitions, and the urgent global imperative of climate action [3]. The region's energy landscape, historically dominated by hydrocarbon resources for both fiscal revenue and domestic power generation, is undergoing a profound transformation. This transformation is driven by a tripartite challenge: meeting rapidly growing electricity demand fueled by population growth and industrialization; reducing the substantial fiscal burden of energy subsidies; and aligning with international climate commitments, such as those outlined in the Paris Agreement and many nations' Net-Zero pledges [4].

Investment decisions in the power sector are the primary mechanism through which these challenges are addressed [5]. The allocation of capital across different generation technologies from legacy fossil fuel systems to renewable energy sources, nuclear power, and enabling grid infrastructure will lock in the region's economic, environmental, and social trajectory for decades [6]. Therefore, a systematic analysis of power sector investment by technology is not merely an academic exercise but a crucial tool for understanding the region's future energy security, economic competitiveness, and contribution to global decarbonization efforts [7]. This paper seeks to analyze the patterns, drivers, and bottlenecks of these investments, providing a nuanced view of the evolving MENA power sector [3].

This manuscript tracks this evolution through the lens of investment flows. Investment decisions are a leading indicator of energy policy direction, revealing national priorities and the practical pace of the energy transition. By analyzing the periods of 2010 (the past baseline), 2023 (the present transition), and 2035 (the future target), this paper delineates the trajectory from a monolithic, hydrocarbon-based system towards a complex, integrated, and low-carbon power future [8].

While the rest of the manuscript is organized as follows: Section 2 discussing the up-to-date literature review on the mentioned topic. While Section 3 presented the methodology and regional context. Investment analysis by time frame starting from 2010-2035 considering renewable and nonrenewable energy sources. Challenges and enablers of the investment in energy sources in MENA region. The acquired results and their discussion are presented in Section 5 followed by summary of the conclusion and future recommendation in Section 6..

Literature Review

The existing body of literature on the MENA power sector can be broadly categorized into studies focusing on the historical dependency on hydrocarbons, the rapid rise of renewable energy ambitions, the persistent role of natural gas, the emergence of new technologies, and the critical financial and regulatory frameworks that underpin investment.

2.1 The Legacy of Hydrocarbons and the Imperative for Change

A foundational theme in the literature is the region's deep-seated reliance on oil and natural gas for power generation. Several studies have documented how this has led to inefficient energy consumption, high per capita carbon emissions, and significant opportunity costs, as subsidized domestic consumption displaces potential export revenues. The International Energy Agency (IEA) has consistently highlighted that energy demand in the MENA region has grown at twice the global average over the past decade, placing immense strain on existing infrastructure and public finances [9]. This context of unsustainable growth has been the primary driver for reform, pushing governments to reconsider their energy investment strategies.

2.2 The Renewable Energy (RE) Investment Surge

The most dynamic area of recent scholarship concerns the meteoric rise of renewable energy, particularly solar and wind. The literature overwhelmingly attributes this to a dramatic decline in technology costs [10]. The

International Renewable Energy Agency (IRENA) reports that the cost of electricity from utility-scale solar photovoltaics (PV) in the MENA region fell by over 85% between 2010 and 2022, making it the cheapest source of new power generation in many parts of the region [11].

Substantial research has focused on national-level ambitions. The UAE, with the Barakah Nuclear Power Plant and the massive Mohammed bin Rashid Al Maktoum Solar Park, is frequently cited as a pioneer in diversifying its power mix [12]. Similarly, Saudi Arabia's Vision 2030 and its associated National Renewable Energy Program (NREP) , which targets 50% of power from renewables by 2030, represent a seismic shift in the kingdom's investment policy [13]. Morocco's Noor solar complex and its success in integrating wind power are also well-documented as a model for other North African nations [14]. These case studies highlight a shift from pilot projects to utility-scale, competitive tendering, attracting significant international investment.

2.3. The "Transition Fuel" Narrative: The Enduring Role of Natural Gas

While renewables capture much of the attention, the literature consistently points to the continued, and in some cases growing, importance of natural gas. Natural gas is often framed as a "transition fuel" that can provide flexible, dispatchable power to back up intermittent renewables and phase out more polluting oil-fired generation [6]. Countries like Qatar, the UAE, and Algeria, with abundant gas reserves, are investing in new combined-cycle gas turbine (CCGT) plants and expanding liquefied natural gas (LNG) import infrastructure to ensure supply for gas-poor nations like Jordan and Egypt [15]. However, recent geopolitical events and price volatility have complicated this narrative, raising questions about the long-term investment security in gas infrastructure amidst decarbonization goals [16].

2.4. Emerging Technological Frontiers: Nuclear and Green Hydrogen

Beyond solar and wind, the literature identifies two emerging investment frontiers. First, nuclear power has entered the MENA energy mix with the UAE's Barakah plant, while Egypt has begun construction on its El-Dabaa facility. Proponents argue that nuclear provides stable, baseload, carbon-free power, essential for deep decarbonization [17]. Second, green hydrogen produced via electrolysis using renewable electricity is gaining significant traction. Several studies posit that the MENA region, with its superb solar and wind resources, is uniquely positioned to become a major global exporter of green hydrogen [18]. Pilot projects are underway in Oman, Saudi Arabia, and Egypt, though the literature notes that large-scale investment is still contingent on the development of global markets and a further drop in electrolyzer costs [11].

2.5. Investment Barriers and Enabling Frameworks

A critical strand of the literature examines the barriers to realizing these investment ambitions. Key challenges identified include: the need for massive grid modernization and interconnections to manage variable renewables [19]; the legacy of distortive energy subsidies that undermine project bankability[20]; and the capacity of domestic financial and legal institutions to facilitate complex, long-term power purchase agreements (PPAs).

In response, research highlights the evolution of new investment models. The success of competitive auctions and Independent Power Producer (IPP) models, which transfer project development and financing risk to the private sector, is a recurring theme [21]. Furthermore, the role of national renewable energy funds and green bonds is increasingly discussed as a mechanism to de-risk investments and mobilize domestic capital.

2.6. Identified Research Gap

While the existing literature provides excellent analyses of individual technologies or country-specific case studies, there is a comparative lack of a synthesized, region-wide analysis that quantifies and compares investment flows across *all* major technology classes renewables, gas, nuclear, and grid infrastructure within a single, cohesive framework. This paper aims to fill this gap by providing a holistic analysis of power sector investment by technology in the MENA region, evaluating the scale, trends, and interrelationships between these investments to offer a comprehensive picture of the region's energy transition pathway.

Methodology and Regional Context

This analysis is based on a synthesis of data from international organizations (International Energy Agency (IEA), International Renewable Energy Agency (IRENA), regional bodies Arab Petroleum Investments Corporation (APICORP), and national energy strategies. The MENA region is not monolithic and is often divided into two key subgroups for energy analysis:

1. **Hydrocarbon-Rich Gulf Cooperation Council (GCC) Nations:** Saudi Arabia, UAE, Qatar, Kuwait, Oman, Bahrain. These countries have the fiscal capacity to fund ambitious energy transitions.

2. **Energy-Importing and Less Oil-Rich Nations:** Egypt, Jordan, Morocco, Tunisia, and others. These countries face different pressures, primarily energy security and fiscal constraints, which have made them early adopters of renewables.

Figure 1: MENA region [22].

Investment figures include public, private, and public-private partnership (PPP) capital expenditures for new utility-scale power generation and enabling infrastructure.

Investment Analysis by Timeframe

a. **The 2010 Baseline:** A Hydrocarbon Hegemony

In 2010, the MENA power investment landscape was overwhelmingly dominated by fossil fuels [11], [23].

Natural Gas: The primary fuel for power generation across most of the region, particularly in the GCC and Egypt. Investment was focused on combined-cycle gas turbine (CCGT) plants, seen as efficient and cleaner than oil-fired plants. Gas was perceived as an abundant, low-cost domestic resource.

Oil/Diesel: Significant investments remained in oil-fired power plants, especially in Iraq, Libya, and Algeria, and as a peak-load resource elsewhere. This reflected legacy infrastructure and, in some cases, a lack of integrated gas grids.

Renewable Energy (Excluding Large Hydro): Investment was negligible. Solar and wind were viewed as expensive, niche technologies suitable only for pilot projects or remote, off-grid applications. Total installed renewable capacity (excluding hydro) was less than 1 GW in the entire Arab region [24].

Nuclear & Coal: Early-stage planning for nuclear power was underway in the UAE and Saudi Arabia as a strategic diversification move. Coal was virtually non-existent.

Table 1: Estimated Investment Share :(2010) [25]

Estimated Investment	Percentages
Natural Gas	~70-75%
Oil/Diesel	~20-25%
Renewables (Solar/Wind)	<2%
Other (Hydro, Nuclear)	~3-5%

Supporting Reference: During this period, the IEA's World Energy Outlook consistently highlighted the lock-in of fossil fuel infrastructure in MENA and the challenges of price subsidies that disincentivized efficiency and alternative investments [25].

b. **The 2023 Landscape:** The Transition Accelerates

By 2023, the investment picture has dramatically diversified. The region is now a global hotspot for renewable energy investment [2], [26], [27].

Solar Photovoltaics (PV): This is the undisputed leader in new power investment. The UAE (Mohammed bin Rashid Al Maktoum Solar Park), Saudi Arabia (Sakaka, Sudair), Egypt (Benban), Oman (Ibri), and Morocco (Noor Midelt) have all developed or are tendering multi-gigawatt projects [28]. Record-low tariffs (e.g., below $0.015/kWh) have made solar PV the cheapest source of new bulk generation [29].

Wind Power: Significant investments are being made, particularly in Egypt (massive projects in the Gulf of Suez), Morocco, Jordan, and Saudi Arabia. Wind complements solar by generating power at different times, enhancing grid reliability.

Natural Gas: Investment remains robust but is shifting in rationale. Gas is increasingly seen as a essential "transition fuel" to provide flexible, dispatchable power to back up intermittent renewables. New investments are in highly efficient CCGTs and liquefied natural gas (LNG) import infrastructure in countries like Jordan and Kuwait to secure supply.

Nuclear: The UAE's Barakah plant, a ~$24 billion investment, is now operational, representing a major strategic diversification. Saudi Arabia continues to advance its nuclear plans.

Emerging Technologies: The first utility-scale Battery Energy Storage Systems (BESS) are being tendered and deployed (e.g., in UAE, Saudi Arabia) to manage grid stability. Furthermore, massive investments are being announced in green hydrogen production facilities, particularly in Saudi Arabia (NEOM), Oman [30], UAE [31], and Egypt [32], positioning the region as a future exporter of clean energy [33].

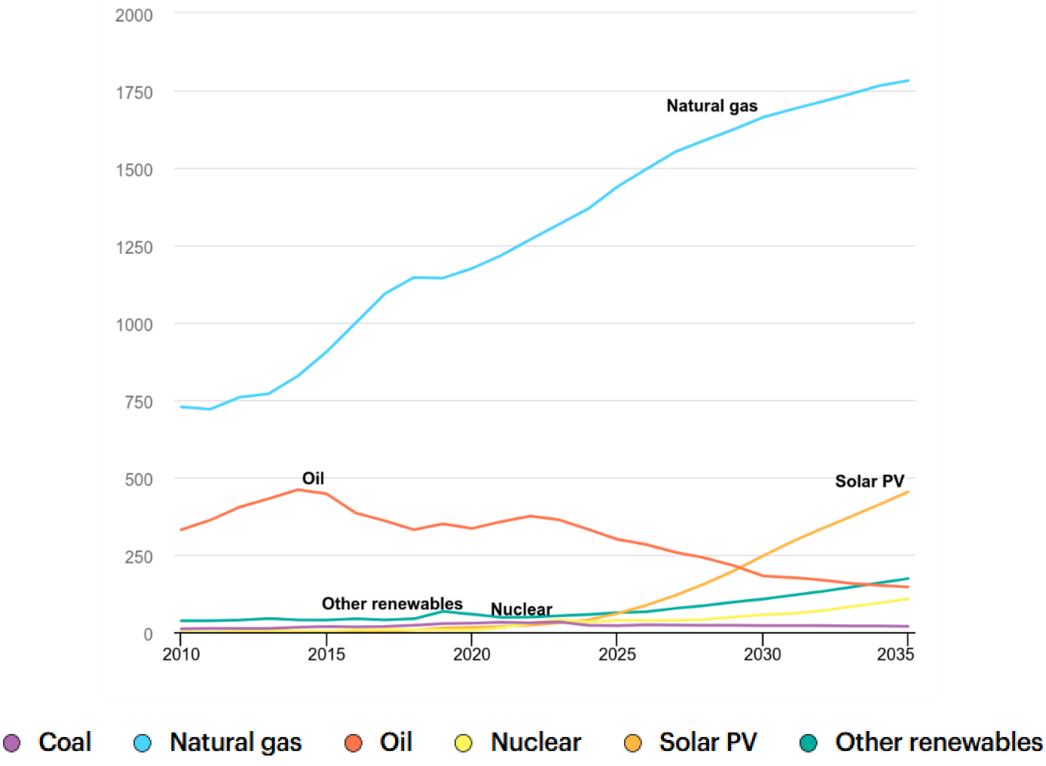


Figure 2: Electricity generation by source in the Middle East and North Africa, 2010-2035 IEA (2025) [34].

Based on the provided pie charts in Figure 3 along with the further data tabulated in Table 2, the Middle East's energy mix is undergoing a significant and rapid transition away from traditional fossil fuels and towards diversification with a strong emphasis on solar power. In 2010, the region's energy landscape was overwhelmingly dominated by fossil fuels, with natural gas accounting for 64% and oil for 34%, totaling 98% of the mix. By 2020, this dominance began to recede, making room for emerging sources; solar power entered the mix at 6%, while nuclear energy also appeared. The most dramatic shift is projected for 2030, where the share of fossil fuels is expected to plummet. Natural gas and oil are together reduced to just 72% of the total. Meanwhile, solar power is projected to more than double to 13%, and nuclear energy grows to 5%. This evolution from 2010 to 2030 illustrates a strategic pivot for the oil-and-gas-rich region, as it actively cultivates a more balanced and sustainable energy portfolio for the future.

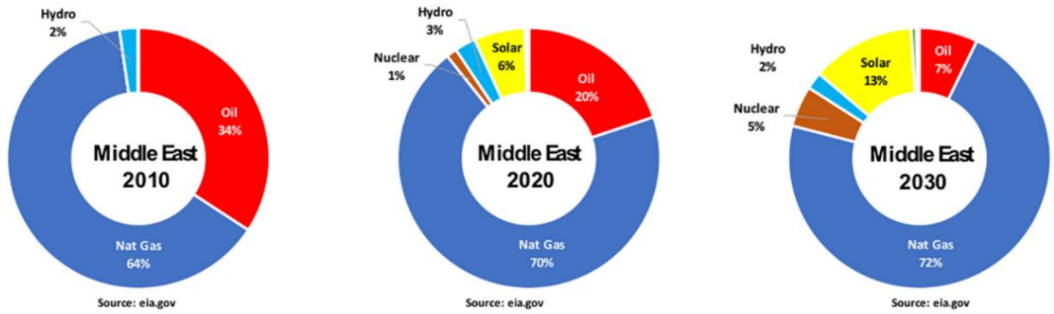


Figure 3: Comparison of investment in energy sources for MENA region [35].

Table 2: Estimated Investment Share (2023).

Energy sources	Share percentages
Solar PV	~35-40%
Wind	~15-20%
Natural Gas	~25-30%
Nuclear & Other	~10-15%
Oil/Diesel	<5%

Supporting Reference: APICORP's 2023 report notes that the Arab world plans to add over 70 GW of new power capacity by 2027, with renewables accounting for almost half of this. They estimate that GCC states alone need over $200 billion in energy transition investments by 2030 [36].

c. **The 2035 Outlook:** A Net-Zero Trajectory

Projections to 2035 are based on current Nationally Determined Contributions (NDCs), national visions (e.g., Saudi Vision 2030, UAE Net Zero by 2050), and project pipelines [46], [47]. The investment shift will be even more pronounced [4].

Table 3: Solar energy projects [13], [37].

Projects	Features
Renewables Dominance	• Solar and wind will constitute the vast majority of new capacity investments. • Saudi Arabia aims for 50% of its power from renewables by 2030; the UAE targets 50% by 2050. • Regional leaders like Morocco and Jordan will push even higher penetration rates.
Grid Modernization and Storage	• Investment will pivot significantly from generation to enabling infrastructure. • This includes smart grids, interconnectors (e.g., GCCIA, Egypt-Greece), and massive deployments of BESS to integrate high volumes of variable renewables. • Investment in storage could rival that of new renewable generation by the late 2020s (IEA, 2022).
Natural Gas as a Balancing Asset	• New investments in pure gas-fired baseload power will decline. • Investment will continue in flexible gas peaking plants and potentially in retrofitting plants to run on hydrogen blends, ensuring grid stability.
Green Hydrogen Export Hubs	• By 2035, the first wave of large-scale green hydrogen projects is expected to be operational. • This represents a new, massive investment class, covering dedicated renewable generation, electrolyzers, and conversion/export facilities. Oman has allocated over $30 billion for its hydrogen strategy.
Carbon Capture, Utilization, and Storage (CCUS)	• For hydrocarbon-rich states, investment in CCUS will be critical to decarbonize remaining gas power and industrial plants, aligning with net-zero pledges.
Supporting Reference	• IRENA's World Energy Transitions Outlook 2023 projects that to stay on a 1.5°C pathway, annual investments in renewables in the MENA region must quadruple by 2030, with a major parallel increase in grid and storage investments (IRENA, 2023b).

Table 4: Projected Investment Share (2035).

Projected Investment	Ratios
Solar PV & Wind	~60-70%
Grid, Storage, and Digitalization	~15-20%
Hydrogen & CCUS Infrastructure	~10-15%
Natural Gas (Flexible/Peaking)	~5-10%

Based on the chart, the data illustrates a significant upward trend in the represented metric over time [45]. In 2010, the value was at a relatively low starting point. By 2023, it had already experienced substantial growth, more than doubling from its 2010 level. The projection for 2035 indicates that this rapid growth is expected to accelerate even further, with the value rising to a point that is approximately six times higher than the 2010 baseline. This steep upward curve, from a gradual increase between 2010 and 2023 to a much sharper projected rise towards 2035, suggests a powerful and compounding trend that is expected to intensify in the coming years.

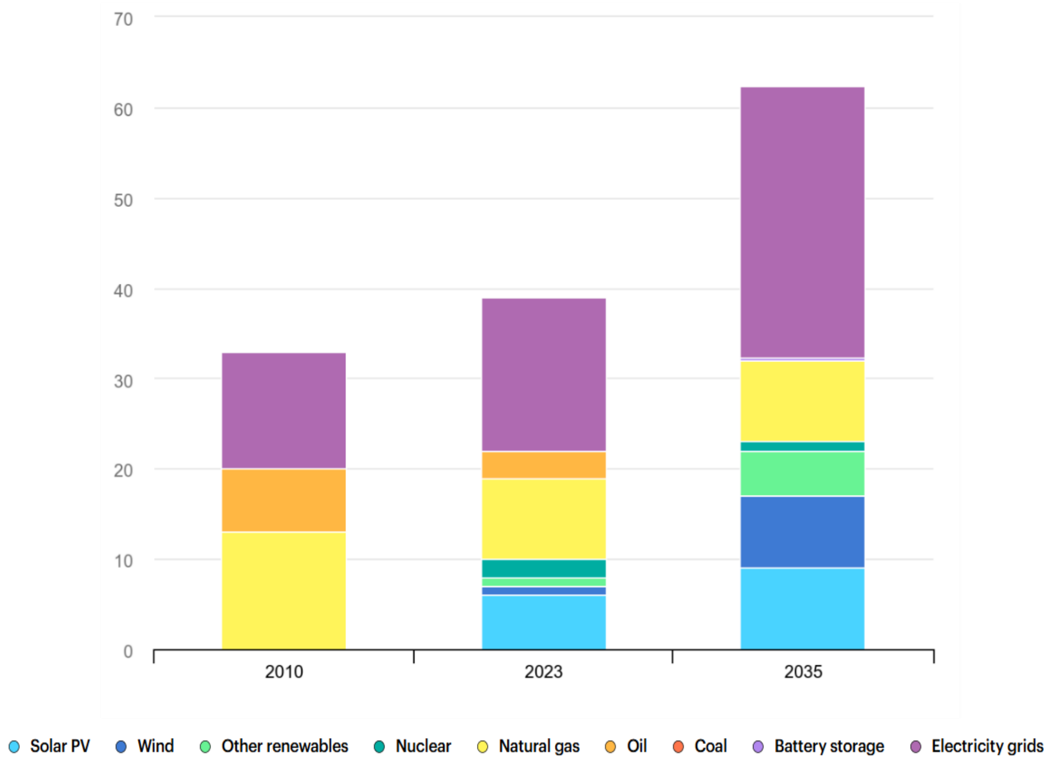


Figure 4: Power sector investment by technology in the Middle East and North Africa, 2010, 2023 and 2035 [38].

Over 40% of Generating Capacity Required by 2030. Expected population growth as well as electricity demand from anticipated expansion of downstream oil and petrochemical sectors will fuel strong growth of MENA’s generating capacity [17]. The installed generating capacity in 2019 was 406 GW in 2019, as per MEED. It needs to increase by 40% to meet the expected demand in the year 2030 [18].

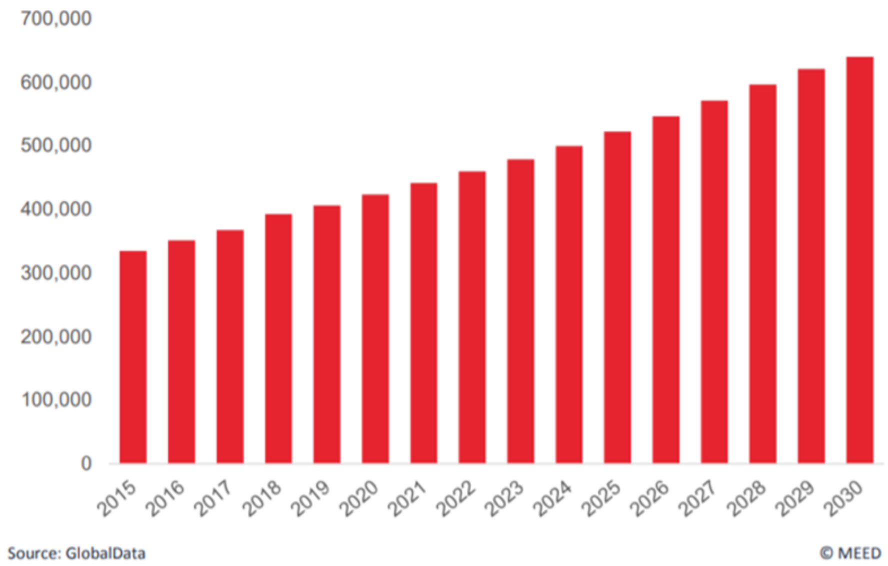


Figure 5: Generated capacity expected.

According to GlobalData in 2019, Figure 5 is demonstrated for several countries as Saudi Arabia and Iran have more than 80GW each in installed capacity in the region. Egypt, Iraq, and the United Arab Emirates were other notable MENA nations with installed capacities greater than 30 GW each. Generation infrastructure and capacity will also be invested in these countries same in the future.

Challenges and Enablers

This transition is not without significant hurdles. Both wind and solar energy will aid in the decarbonization process, but we still need to figure out a major technological change which is dispatchability. Even though sunshine and wind are available almost everywhere, they are not available on demand. They need some sort of energy storage to be dispatchable. Because of this, energy storage is seen as the holy grail required to achieve maximum renewable energy penetration and decarbonization. As renewable energy is being used more and more, there is a need for battery storage to help manage the increasing ramp rates to meet shortfalls in renewable generation, especially the rapid evening peak when the sun sets. We can use thermal storage concentrated solar power (CSP) for this purpose also. As renewable energy continues to enter power grids [44], more regulations and policies will be needed. It supports the establishment of flexibility and stability of the grid. It also supports the use of new technologies like batteries and electric vehicles. It also supports the establishment of commercially attractive business models [48]. The price for renewable energy has been falling thanks to the efficiency of the worldwide supply chain before the onset of the pandemic [49]. The COVID-19 pandemic has shown the weakness of the supply chain that prompted many nations to fast-track their transition to local suppliers to secure supply and enhance local employment [39]. Saudi Arabia wants 70% of all materials used in building, operating, and maintaining their renewable projects to be local. Extended low prices of oil will complicate nationalisation of supply chain. Some renewable projects may be postponed or cancelled due to these challenges [43].

a. Challenges:

The tabulated Challenges of Implementing Energy Sources in Table 5 along with their detailed explanation.

Table 5: Challenges of Implementing Energy Sources [55],[60],[61].

Challenges	Explanations
Grid Stability	Managing high penetrations of variable renewables requires advanced grid management and flexible resources.
Fiscal and Regulatory Frameworks	Phasing out energy subsidies is politically sensitive. Attracting private investment requires stable, transparent regulations.
Financing	While sovereign wealth funds can finance projects in the GCC, other MENA countries require access to international climate finance and concessional funding.
Geopolitical Instability	Conflict and political uncertainty in several MENA nations deter long-term investment

This chart compares temperature trends in the MENA region against the global average. The key finding is that the MENA region is warming at a significantly faster rate than the world as a whole. This is visually indicated by the steeper slope of the MENA trend line (labeled with an arrow and "x23," likely signifying a 23-fold increase or a similar amplification factor) compared to the more gradual slope of the global average line. Furthermore, the MENA data points are consistently plotted above the global line, confirming that absolute temperatures in the region are not only rising more quickly but are also higher than the planetary average. This illustrates that the MENA region is a climate change hotspot, experiencing more severe warming impacts.

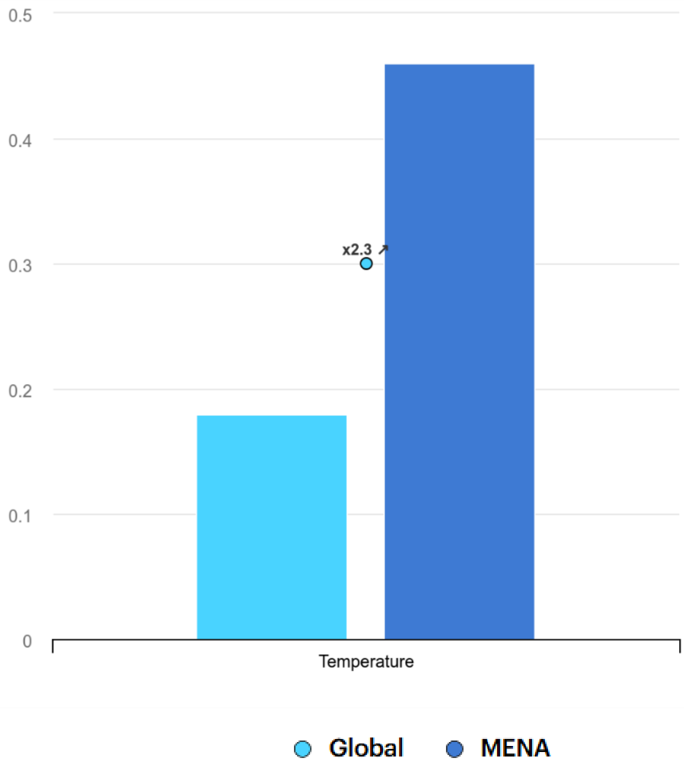


Figure 6: Temperature increase in the Middle East and North Africa and the world IEA (2025) [40]**.**

b. **Key Enablers**:

The tabulated Key enables in Table 6 along with the presented feature could cover all the key technologies [41].

Table 6: Key enables [41], [42], [50].

Key enables	Features
Falling Technology Costs	The continued decline in the cost of solar, wind, and batteries is the primary economic driver
Strong Political Will	National Visions and NDCs provide a clear policy signal to investors
Abundant Natural Resources	The region has some of the world's best solar irradiation and significant wind resources.
Experience with Large Projects	The region has a proven track record of executing massive energy and infrastructure projects

Results and discussion

5.1 Simulation dataset for MENA power sector investments

Based on the trends from the manuscript, here is a plausible dataset for the three key years as tabulated in Table 7. Note that "Other" includes nuclear, hydro, and emerging technologies like hydrogen/CCUS in the early years.

Table 7: Breakdown results of energy sources during 2010-2035.

Year	Solar PV	Wind	Natural Gas	Oil Diesel	Other	Total Annual Investment
2010	0.5	0.3	28.5	9.5	1.2	~$40B
2023	14.2	7.1	10.5	1.5	6.7	~$40B
2035	42.5	21.0	8.0	0.5	18.0	~$90B

5.2 Comprehensive analysis of MENA

The comparison analysis of the investment of the integrated sources. The plot in Figure 7 is a line graph depicting the projected shift in a country's or region's electricity generation mix from 2010 to 2035. The vertical axis represents the percentage share of total electricity generation, scaling from 0% to 100%, while the horizontal axis tracks the years. The graph illustrates a dramatic and fundamental transition away from fossil fuels and towards renewable energy sources over this 25-year period.

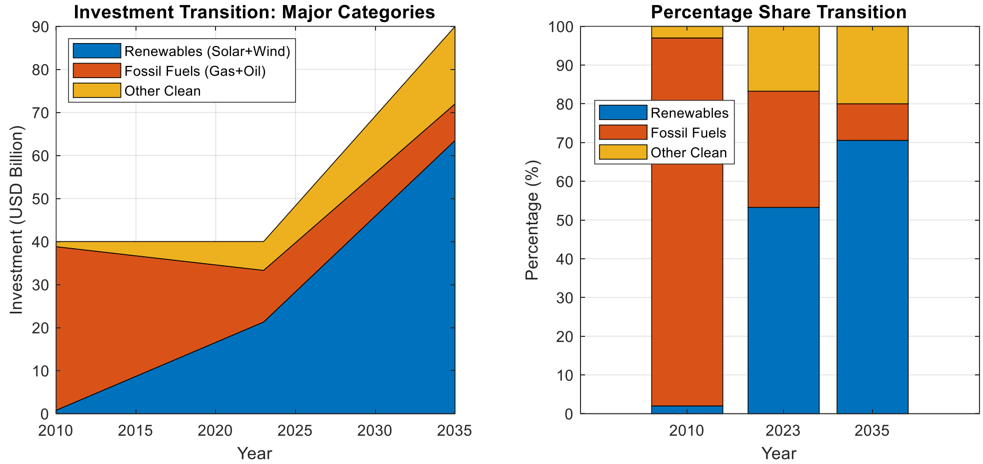


Figure 7: Comprehensive analysis of MENA (a) and (b) Percentage share Transition.

At the start of the timeline in 2010, the energy landscape was dominated by fossil fuels, primarily a combination of gas and oil (labeled "Gas+Oh"). At this point, fossil fuels constituted the vast majority of the electricity mix. Renewables, specifically solar and wind power, represented a negligible portion of the generation, highlighting their status as emerging technologies at the time. The "Other Clean" category, which likely includes sources like nuclear, hydropower, or biomass, also held a relatively small but stable share.

The most striking feature of the graph is the dramatic crossover that occurs around the year 2020. This is the pivotal moment where the rising line representing "Renewables (Solar+Wind)" intersects and surpasses the rapidly declining line of "Fossil Fuels (Gas+Oh)." This crossover signifies a historic tipping point where renewables become the primary source of electricity, displacing fossil fuels from their dominant position. Following this inflection point, the trends accelerate; renewables enter a period of explosive growth, while the use of fossil fuels plummets at a nearly symmetrical rate.

Looking towards the future projection, by 2035, the energy mix is completely transformed. Renewables are projected to account for the overwhelming majority of electricity generation, nearing 80% of the total share. In contrast, fossil fuels are reduced to a marginal role, comprising only a small fraction of the grid. The "Other Clean" sources maintain a steady but modest presence throughout the entire period, acting as a consistent, complementary part of the generation fleet. In summary, this graph powerfully visualizes a rapid energy transition, forecasting a future electricity system that is overwhelmingly powered by clean, renewable sources like solar and wind.

While Figure 8 illustrates the projected annual investment in various energy sources from 2010 to 2035, measured in US Dollars (Billions). Initially, around 2010, investment was more evenly distributed, but a dramatic shift occurs starting just after 2020. From this point, investment in Solar PV begins a period of explosive growth, quickly surpassing all other sources and becoming the dominant focus of energy spending by a wide margin. In contrast, investment in traditional sources like Natural Gas and Oil/Diesel is projected to decline significantly over the same period. Wind energy investment also shows a steady increase, but it is far outpaced by the massive surge in solar funding. This trend highlights a major global pivot in energy strategy, signaling a decisive move away from fossil fuels and towards solar power as the primary target for future energy infrastructure investment. Additionally, Figure 9's number growth rate 2010-2035.

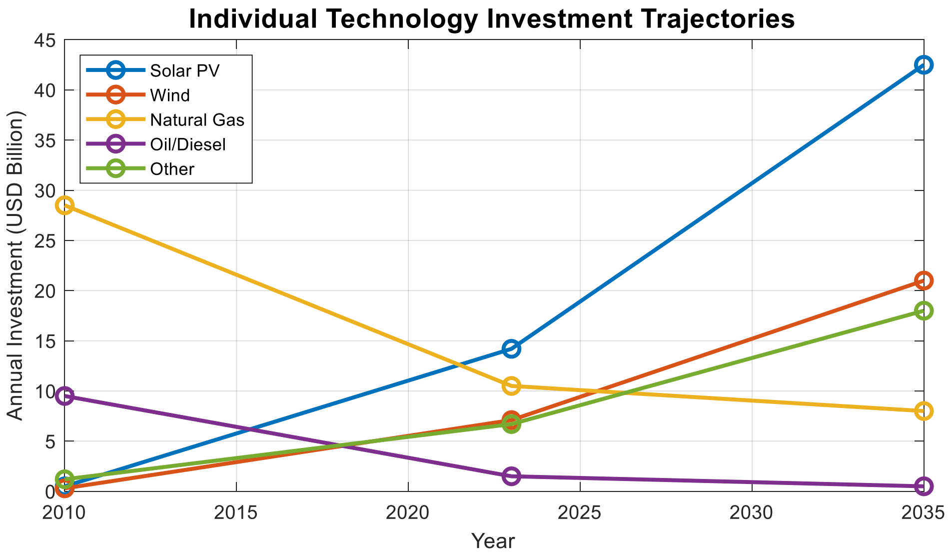


Figure 8: Individual technology investment trajectory.

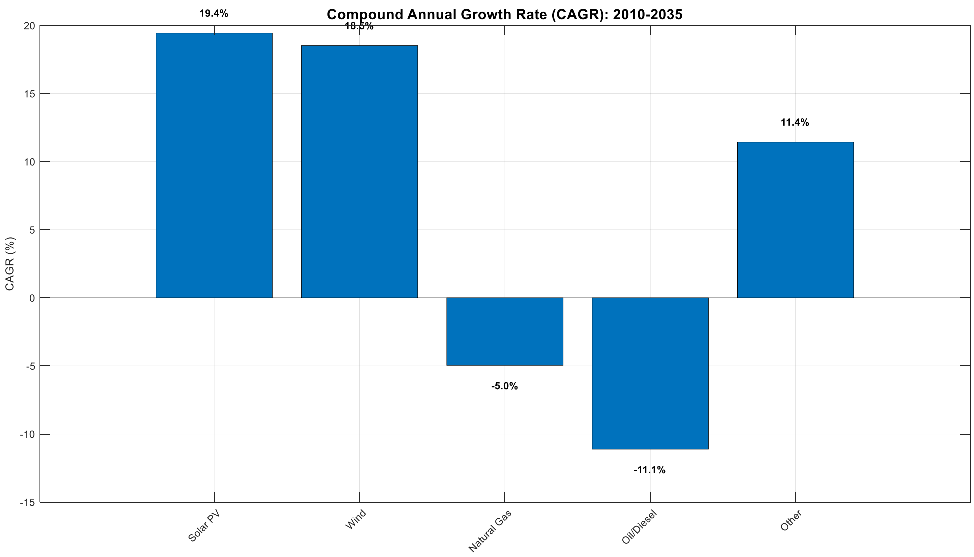


Figure 9: Compound Annual growth rate

Based on the chart provided in Figure 10, the data illustrates a historical and projected trend for an unspecified metric, analyzed using a second-order polynomial fit. The curve shows a significant and consistent upward trajectory over time. Beginning with a gentle incline around the year 2000, the trend's growth accelerates markedly after approximately 2010. This steepening curve continues unabated through the historical data and into the future projections, suggesting a powerful and compounding rate of increase. The polynomial model forecasts that this strong growth will persist through 2040, indicating that the underlying driver of this trend is expected to intensify over the coming years, rather than slow down. The presented pie chart in figure 11 shows the Project investment share in period of 2010-2035 considering various number of sources.

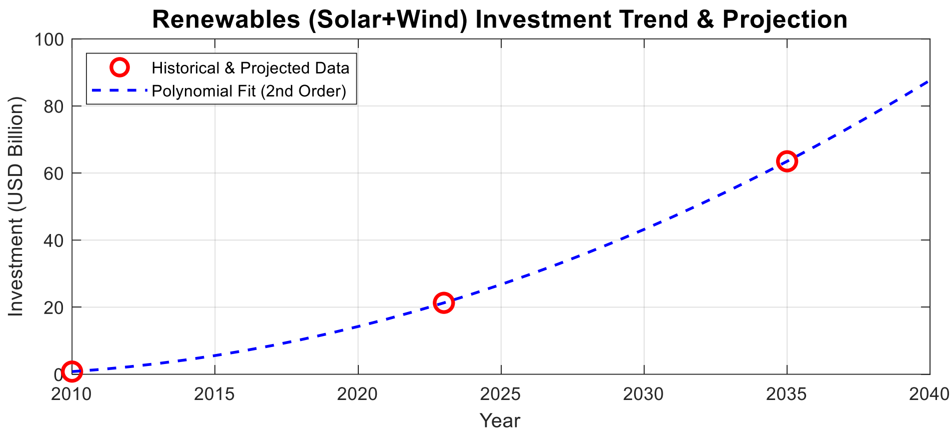
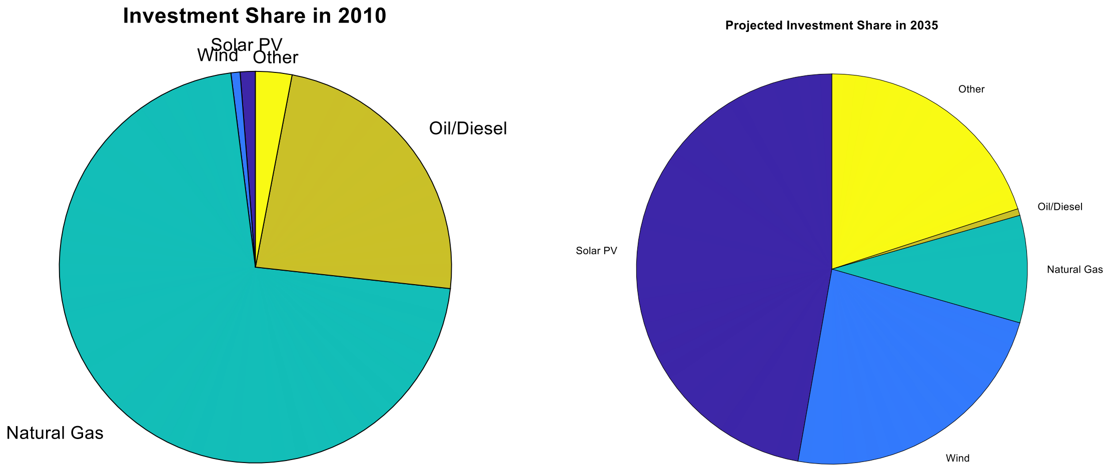


Figure 10: Renewable (Solar+Wind) investment trend and projection.



(a) (b)

Figure 11: Project investment (a) Project investment share by 2010 and (b) Project investment share by 2035.

Conclusion

The analysis of power sector investment in the MENA region from 2010 to 2035 reveals a decisive and accelerating paradigm shift. The era of hydrocarbon hegemony is giving way to a new age of technological diversification. The investment focus has moved from a near-total reliance on natural gas and oil in 2010, through a period of rapid renewable cost reduction and project deployment in 2023 and is projected to culminate in a 2035 landscape dominated by solar, wind, and the enabling infrastructure of storage and digitalized grids.

This transformation is fundamentally reshaping the region's economic and environmental trajectory. It enhances energy security, frees up hydrocarbons for higher-value exports, reduces carbon emissions, and creates new industrial opportunities in green technology. While the pace varies across nations and significant implementation challenges remain, the direction of travel is unequivocal. The MENA power sector, long a bastion of traditional energy, is rapidly becoming a laboratory and a global benchmark for the energy transition.

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