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The current issue is the first of the eleventh volume of the *Athens Journal of Mediterranean Studies (AJMS)*, published by the Athens Institute for Education and Research.

Gregory T. Papanikos
President
Athens Institute

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- Abstract Submission: **25 February 2025**
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- Submission of Paper: **19 May 2025**

### Academic Member Responsible for the Conference

- **Dr. Yannis Stivachtis**, Director, Center for European & Mediterranean Affairs and Associate Professor, Jean Monnet Chair & Director of International Studies Program, Virginia Tech – Virginia Polytechnic Institute & State University, USA.

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# Analyzing Middle Eastern Geopolitics from the Arab Spring to the Israel-Hamas War

*By Yaron Katz*[*]

*Since the Arab Spring of 2011, the Middle East has experienced profound geopolitical, social, and economic transformations that continue to shape the region. The mass uprisings challenged authoritarian regimes, exposed deep-rooted grievances, and led to a realignment of regional power dynamics. The ousting of long-standing rulers, the rise of political Islam, civil wars in countries like Syria, Libya, and Yemen, and external interventions by global powers redefined the region's political landscape. However, despite the initial hope for greater democracy and regional cooperation, the aftermath of the Arab uprisings has been marked by fragmentation, instability, and a reassertion of authoritarianism in many states. Against this backdrop, the emergence of "liquid alliances" coalitions has become a dominant feature of the Middle Eastern geopolitical order. These ad hoc alliances, often based on short-term security concerns rather than shared values, have supplanted formal regional organizations like the Arab League and the Gulf Cooperation Council (GCC), which have struggled to foster meaningful cooperation. The ongoing civil wars, sectarian conflicts, and the retraction of U.S. engagement have further compounded the region's challenges, leaving states to navigate a complex and often volatile power structure. In 2023, the Middle East faced another significant shock with the eruption of the Israel-Hamas war, illustrating how the region's shifting alliances, identity politics, and unresolved tensions continue to drive conflict. This paper examines the changes in the Middle East from the Arab Spring to the Israel-Hamas war, analyzing how regional cooperation, power dynamics, and political identities have evolved over the past decade. By applying realist, constructivist, and neo-Gramscian theoretical frameworks, the study comprehensively explains how internal and external pressures have reshaped the region's political landscape and what this means for its future stability. The Middle East's ongoing struggles with regionalism and cooperation reflect broader challenges of state legitimacy, security, and economic governance. Through this analysis, the paper aims to shed light on the persistent obstacles to peace and cooperation in the regionand explore the factors contributing to its enduring instability.*

## Theoretical Approach

The decade following the Arab Spring in 2011, leading to the Israel-Hamas war, which started on October 7, 2023, has witnessed significant shifts in the Middle East's political landscape. A theoretical framework integrating realism, constructivism, and neo-Gramscian approaches offers valuable insights into the region's evolving dynamics. Each of these theories explains the power

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realignments, the role of non-state actors, and the impact of shifting ideologies and alliances in different but interconnected ways.

Realist Theory provides a crucial lens for understanding how states in the Middle East have recalibrated their foreign and domestic policies in the aftermath of the Arab Spring. Realists argue that the international system is inherently anarchic, and states prioritize their survival by accumulating power and balancing threats (Waltz, 1979). The collapse of state authority in countries like Syria, Libya, and Yemen, coupled with the diminishing role of the U.S. as a hegemonic power, led to a reconfiguration of power dynamics in the region.

In the post-Arab Spring period, regional actors such as Saudi Arabia, Iran, and Turkey have engaged in realpolitik, shifting alliances based on strategic interests rather than ideological commitments. The GCC's role in suppressing uprisings in Bahrain and supporting counter-revolutionary forces in Egypt reflects traditional realist concerns about regime security and the containment of threats (Gause, 2014). The realist theory also explains why states like Saudi Arabia and the UAE viewed the rise of political Islam, particularly the Muslim Brotherhood, as an existential threat. This led them to support counter-revolutionary forces in Egypt and Libya, while Iran, following realist logic, expanded its influence through proxy wars in Syria and Yemen.

"Liquid alliances" are discussed in the context of the post-Arab Spring and Israel-Hamas conflict and align with the realist understanding of power balancing. As traditional security arrangements weakened, such as the U.S. security umbrella, states like Saudi Arabia and the UAE pursued ad hoc coalitions and strategic partnerships with external powers like Russia and China to secure their interests (Zhang, 2023). The realist approach is thus critical in explaining the regional power shifts and how alliances are formed not out of ideological affinity but for survival and power consolidation.

Constructivist Theory emphasizes the role of ideas, identities, and norms in shaping international relations. It provides an essential framework for understanding how ideological shifts and transnational identities, such as pan-Arabism, pan-Islamism, and political Islam, influenced regional politics after the Arab Spring and the Israel-Hamas conflict. Constructivists argue that international politics is not only driven by material interests but also by the shared ideas and social constructs that define state and non-state actors' identities and interests (Wendt, 1999).

The decline of pan-Arabism as a unifying ideology, especially after the Arab Spring, can be understood through constructivist theory. Despite its rhetorical appeal, pan-Arabism failed to sustain itself as a mobilizing force due to the competing national interests of Arab states and the rise of other transnational identities, such as political Islam and sectarianism (Barnett & Solingen, 2007). After the uprisings, political Islam, particularly the Muslim Brotherhood and later ISIS, emerged as an alternative ideological movement. For example, Turkey and Qatar's support for the Brotherhood can be seen as an attempt to reshape the regional order based on a new Islamist identity (Valbjørn & Bank, 2012).

In the context of the Israel-Hamas conflict, constructivism sheds light on how Hamas, a non-state actor, mobilizes Palestinian identity and the broader pan-

Islamic narrative to legitimize its actions against Israel. Iran's role as a Shia state backing Sunni groups like Hamas further complicates the ideological landscape, reflecting how actors may use identity politics strategically to pursue broader geopolitical goals.

A neo-Gramscian perspective offers another dimension to understanding the transformations in the Middle East, particularly regarding hegemonic power, the role of global capitalism, and how ideologies are constructed to maintain dominance. Neo-Gramscian theorists argue that international relations are shaped by the interplay of material power, ideas, and institutions, which work together to sustain the dominance of certain social groups or states over others.

In the Middle East, the U.S.'s hegemonic role as the global leader and primary security provider has eroded, particularly after the Arab Spring. The retreat of U.S. influence and the rise of new actors such as Russia and China signal a shift in global power relations. As U.S. hegemony declined, regional powers like Saudi Arabia and the UAE sought to secure their hegemonic positions by aligning with global capitalist interests, promoting economic reforms, and forging new alliances (Harris, 2022).

From a Neo-Gramscian perspective, the rise of neoliberal economic models and the integration of Middle Eastern economies into the global capitalist system has contributed to the reconfiguration of power structures. For instance, the Abraham Accords - Israel's normalization agreements with the UAE, Bahrain, and other Arab states - can be seen as part of a broader hegemonic strategy that integrates the region into global capitalist networks, prioritizing economic ties and security cooperation over traditional ideological solidarity with the Palestinian cause.

The persistence of non-state actors like Hamas reflects a Neo-Gramscian understanding of counter-hegemonic forces. Hamas represents resistance to both Israeli occupation and the broader hegemonic order that includes Arab states normalizing relations with Israel. This mirrors Gramsci's notion of the war of position, where Hamas contests the prevailing hegemony through counter-narratives and resistance strategies.

## Arab Uprisings and the Limits of Regional Cooperation

The 2011 Arab uprisings exposed the structural weaknesses of many Arab states and revealed the limits of regional cooperation mechanisms like the Arab League and the GCC. The regimes have historically relied on confrontational foreign policies and symbolic commitments to pan-Arabism or pan-Islamism to project power and bolster domestic legitimacy. As Fawcett (2020) notes, these ideologies provided rhetorical tools that regimes could use to legitimize their authority, but in practice, they rarely translated into genuine cooperation. According to Barnett and Solingen (2007), Arab states have long embraced the rhetoric of Arab unity while simultaneously fearing its actual implementation, as empowering regional organizations could undermine regime sovereignty and expose internal vulnerabilities.

The uprisings highlighted these limitations. The revolts, which overthrew longstanding authoritarian rulers in Tunisia, Egypt, and Libya, revealed the deep

discontent beneath the surface. Regimes focused on maintaining control and suppressing dissent ,prioritizing survival over meaningful collaboration. Valbjørn and Bank (2012) argue that invoking Arab solidarity continues as a political tool. However, the lack of domestic legitimacy has historically limited the success of regionalism in the Middle East.

The political landscape of the Middle East post-2011 became more fragmented as regimes threatened by the protests sought to secure their positions through interest-based, short-term alliances rather than committing to formalized regional structures. These alliances, termed "liquid alliances," represent informal, flexible coalitions that emerge to address immediate security concerns, often bypassing traditional regional organizations. For example, Saudi Arabia and the UAE formed a coalition to counter the rise of the Muslim Brotherhood, which they viewed as a destabilizing force (Lynch, 2016). At the same time, Turkey and Qatar backed Islamist movements in an attempt to expand their regional influence. This divergence of interests, driven by different ideological and geopolitical goals, made unified regional action challenging. Additionally, the Syrian civil war is another example of the failure of formal regional cooperation. As states backed rival factions pursuing their agendas, the conflict became a battleground for competing powers. Gause (2014) emphasizes that these informal alliances are shaped by the immediate geopolitical context and shifts in the broader international order, particularly the perceived decline in U.S. engagement in the region.

The role of external actors, especially the United States, has historically shaped the Middle East's regional system (Feldman, 2021). The perceived U.S. withdrawal from the region following the Arab uprisings contributed to heightened insecurity among Arab states, particularly in the Gulf. According to Gause (2014), Arab regimes that traditionally relied on U.S. security guarantees, such as Saudi Arabia and the Gulf monarchies, felt increasingly vulnerable, prompting them to form more transient alliances in response to evolving threats. These international dynamics, coupled with the region's ongoing conflicts—such as the wars in Syria, Libya, and Yemen—further contributed to the fragmentation of the Middle East. As Iran's influence grew in these conflicts, many Arab states saw this as a direct threat to their security, exacerbating regional tensions and complicating efforts at formal cooperation (Smyth, 2015).

The Arab League and the GCC were largely ineffective in addressing the crises that followed the uprisings. While the Arab League initially endorsed international intervention in Libya and imposed sanctions on Syria, these efforts were limited in scope and impact. The fear of empowering regional organizations, which might undermine regime sovereignty, has long prevented these bodies from playing meaningful roles in regional governance. The GCC, often cited as the most effective regional organization in the Middle East, also faced challenges. Despite its intervention in Bahrain and its mediation in Yemen, efforts to transform the GCC into a more robust "Gulf Union" failed due to divergent threat perceptions among its members (Ulrichsen, 2017). The lack of consensus and the overriding focus on regime survival prevented the GCC from developing into a more cohesive and effective regional body.

The Arab uprisings of 2011 accelerated the decline of formal regional cooperation in the Middle East and led to the rise of "liquid alliances" as the dominant form of power balancing. These informal, interest-based coalitions reflect the region's ongoing fragmentation and states' priority on immediate survival rather than long-term collaboration. As long as regimes remain insecure and focused on preserving their authority, liquid alliances will continue to dominate the region's geopolitical landscape. While these alliances allow for flexible, short-term responses to crises, they lack the stability and coherence necessary to promote sustained regional cooperation. The persistence of liquid alliances underscores the failure of traditional notions of Arab unity and the limits of regional organizations in addressing the challenges of a post-Arab Spring Middle East.

## Comparing the Arab Uprisings to the Israel-Hamas Conflict

The dynamics of the Arab Uprising and the Israel-Hamas conflict share some structural similarities, particularly regarding the role of legitimacy, power, and regional alliances. However, they also differ significantly due to the nature of the actors involved, the geopolitical stakes, and the international implications.

The Arab Uprisings were primarily driven by domestic discontent with authoritarian regimes across the Arab world. These protests revealed the fragility of regimes that had relied on a combination of repression and pan-Arabic rhetoric to maintain power. These regimes employed liquid alliances to ensure survival (Kamrava, 2016). Domestic legitimacy was already fragile, and the uprisings exposed the cracks within these states' political structures, making survival the top priority for many regimes (Fawcett, 2020).

In contrast, the Israel-Hamas conflict is primarily centered around nationalistic and ideological legitimacy, with Hamas portraying itself as a defender of Palestinian rights and resistance to Israeli occupation. Hamas, as a non-state actor with a political and military wing, seeks to legitimize its rule over Gaza through a resistance narrative (Kaye, 2023). Israel, on the other hand, asserts its legitimacy through its national security concerns and its right to defend itself from rocket attacks and other forms of violence by Hamas from Gaza and Hezbollah from Lebanon (Khatib, 2023). As explained by Inbar & Fainberg (2022), while Arab regimes were challenged internally during the uprisings, the Israel-Hamas conflict represents an ongoing struggle over territorial legitimacy and control between two competing entities.

The uprisings led to the creation of short-term, flexible alliances as regimes faced new challenges to their rule. For instance, Saudi Arabia and the UAE formed coalitions to counter the influence of the Muslim Brotherhood, while Turkey and Qatar supported Islamist movements in the region. Based on immediate interests, these liquid alliances reflected the region's fragmentation following the uprisings (Gause, 2014).

The Israel-Hamas conflict also involves regional alliances, but these alliances are more deeply rooted in the region's long-standing geopolitical rivalries. Hamas is supported by regional actors like Iran, which uses the group as a proxy to exert

influence in the Israeli-Palestinian conflict. In contrast, Israel receives strong support from Western nations, particularly the United States (Hanieh, 2023). Unlike the fluid alliances seen during the Arab Uprisings, the alliances in the Israel-Hamas conflict are more entrenched and represent broader regional and international ideological divides, particularly between Iran and the Gulf states, on the one hand, and Israel and its Western allies, on the other.

In the aftermath of the Arab uprising, regional organizations like the Arab League and the GCC attempted to mediate and intervene in crises like Libya and Yemen, but their effectiveness was limited. These organizations remained weak as regimes hesitated to empower any regional body that could threaten their sovereignty (Bromley, 2018). This hesitance reflects the broader failure of formal regional cooperation in the Middle East.

The Israel-Hamas conflict, by contrast, draws significant attention from international organizations such as the United Nations, which has been involved in various ceasefire and peace negotiation efforts. Additionally, external actors like the U.S., European countries, and regional powers such as Egypt and Qatar have played critical roles in mediating between Israel and Hamas (Efron, 2023). Unlike the liquid alliances that characterized the post-2011 Middle East, the internationalization of the Israel-Hamas conflict brings a higher level of involvement from powerful external states and institutions, making regional cooperation less central than broader global diplomacy (Darwich, 2021).

A perceived withdrawal of U.S. influence in the region marked the international context of the Arab Uprising. This perceived vacuum contributed to regional instability, as regimes could no longer rely on American support to the same extent as before. The shifting international order encouraged Gulf monarchies to take more active roles in shaping regional outcomes, particularly by supporting counter-revolutionary forces (Ulrichsen, 2020).

In contrast, the Israel-Hamas conflict remains closely tied to international geopolitics. U.S. support for Israel is a cornerstone of the regional security framework, and any military escalation between Israel and Hamas often results in diplomatic interventions from both Western and regional actors. Iran's role in supporting Hamas adds another layer of international complexity, as it positions itself as a challenger to U.S. influence in the region through its backing of proxy groups like Hamas and Hezbollah (Phillips, 2020).

The Arab Uprising and the Israel-Hamas conflict both highlight the limits of regional cooperation in the Middle East, but they do so in different ways. The Arab Uprising led to fragmentation within states and the rise of short-term liquid alliances based on regime survival and immediate interests (Lynch, 2016). Meanwhile, the Israel-Hamas conflict reflects the broader polarization of the region, with entrenched alliances and ideological divides shaping the geopolitical landscape. While both situations reveal the complexity of power dynamics and legitimacy in the Middle East, the uprisings underscore the failure of regionalism. In contrast, the Israel-Hamas conflict demonstrates the persistence of long-standing regional and international rivalries.

**Fragmentation of States and the Rise of Non-State Actors**

The decade following the Arab Spring in 2011 and leading up to the Israel-Hamas conflict had profound shifts in the Middle East's political landscape (Mounir, 2020). These changes can be understood through power realignments, regional fragmentation, the rise of non-state actors, and evolving geopolitical alliances. The region has seen state actors recalibrate their foreign policies in response to domestic instability while international actors have adjusted their influence and involvement.

The Arab Spring exposed the fragility of numerous Arab regimes, with popular uprisings in Tunisia, Egypt, Libya, Yemen, and Syria destabilizing governments and, in some cases, leading to their collapse. The uprisings laid bare deep-seated grievances such as economic inequality, unemployment, and the lack of political freedoms. The most striking outcome was the disintegration of state institutions in countries like Libya, Syria, and Yemen, where civil wars have ravaged the political landscape (Lynch, 2023).

This fragmentation empowered non-state actors like the Houthis in Yemen, ISIS in Iraq and Syria, and various militias in Libya. These actors filled the power vacuum left by the collapse of state authority, further complicating efforts at regional cooperation (Del Sarto, 2017). In contrast, authoritarian regimes in countries like Egypt and Saudi Arabia reinforced their domestic control by suppressing opposition, emphasizing the varied responses to the uprisings (Brown, 2020).

The increasing role of non-state actors in the region is also evident in the Israel-Hamas conflict. Hamas, as a political and militant organization, represents the continuation of this trend. Iran, one of Hamas' prominent supporters, has used non-state actors across the region, such as Hezbollah in Lebanon and various Shiite militias in Iraq and Syria, as tools for projecting its influence (Hertog, 2019). The rise of these non-state actors complicates regional security dynamics and poses challenges to traditional state-centric diplomacy and conflict resolution.

The post-2011 Middle East saw traditional alliances crumble as states pursued fluid and ad hoc coalitions, often based on immediate interests rather than ideological solidarity. This phenomenon has been described as "liquid alliances" in which states shift partners based on short-term geopolitical goals rather than long-term commitments (Fawcett, 2020). For instance, Turkey and Qatar initially backed Muslim Brotherhood- affiliated movements in Egypt and elsewhere, seeing these Islamist parties as vehicles for expanding their influence. In contrast, Saudi Arabia and the UAE, fearing the rise of political Islam, backed counter-revolutionary forces and sought to preserve the status quo. This led to intense rivalries, particularly between Turkey and the UAE, and contributed to the fracturing of regional cooperation mechanisms such as the Gulf Cooperation Council (GCC) (Gause, 2014).

The Israel-Hamas war reflects a continuation of this pattern of shifting alliances, particularly with the realignment of Gulf states. The Abraham Accords, signed between Israel and several Arab states (including the UAE and Bahrain) in 2020, signaled a significant shift in regional politics (Miller & Miller, 2023). These

accords indicate a shift away from traditional Arab solidarity on the Palestinian issue, as some Arab states now prioritize their geopolitical and economic interests over the Palestinian cause (Fathollah-Nejad, 2021). However, the Israel-Hamas war has created tensions within this new framework, as the conflict has reignited public opinion across the Arab world in favor of Palestinian rights, potentially straining these new alliances.

One of the most significant developments between the Arab Spring and the Israel-Hamas conflict has been the perceived retreat of the United States from its dominant role in the region. The Obama administration's cautious approach during the Arab Spring, its "pivot to Asia," and its nuclear deal with Iran (the Joint Comprehensive Plan of Action) were seen by many traditional U.S. allies as a sign of American disengagement from the Middle East (Ulrichsen, 2020). This perceived vacuum allowed regional powers, particularly Saudi Arabia, Turkey, and Iran, to assert themselves more aggressively, both politically and militarily.

As the U.S. recalibrated its presence in the Middle East, Russia expanded its influence, most notably through its military intervention in Syria in 2015 to support the Assad regime. Russia's presence in Syria has solidified its position as a key power broker in the region. Similarly, Iran has continued to extend its influence through its network of non-state actors and proxy groups, as seen in its support for Hezbollah, the Houthis in Yemen, and militias in Iraq and Syria (Smyth, 2015).

The Israel-Hamas conflict, with Iran's continued backing of Hamas, underscores Iran’s strategy of using asymmetric warfare and non-state actors to challenge Israeli and U.S. influence in the region. Meanwhile, U.S. allies like Saudi Arabia have sought to balance their reliance on U.S. security guarantees with attempts to diversify their geopolitical partnerships, as evidenced by Saudi-Iran rapprochement talks facilitated by China in early 2023 (Lavi, 2023).

The Arab Spring revealed the limitations of pan-Arabism and pan-Islamism as unifying ideologies. While the rhetoric of Arab solidarity persisted, especially during moments of regional crisis, in practice, regional cooperation remained weak. The uprisings and subsequent conflicts exposed the deep divisions within the Arab world, with countries like Saudi Arabia and Qatar often working at cross-purposes (Barnett & Solingen, 2007). The failure of the Arab League and the GCC to effectively address the crises in Libya, Syria, and Yemen further highlighted the inefficacy of regional organizations in promoting collective security or political cooperation (Fawcett, 2020).

The erosion of pan-Arabism also impacted the Palestinian cause. While the Israel-Hamas conflict periodically rekindles pan-Arab sentiments, the cause of Palestinian statehood has increasingly taken a backseat in regional politics, especially following the Abraham Accords. Countries like the UAE have pursued normalization with Israel, prioritizing economic and security ties over solidarity with the Palestinians (Riedel, 2021). However, the conflict has revived public and political attention to the issue, raising questions about the sustainability of the accords in the face of renewed violence between Israel and Hamas (Bahgat, 2022).

## Conclusion

The Middle East has undergone significant transformations between the Arab Spring of 2011 and the Israel-Hamas war that started in 2023, shaped by a complex interplay of power, identity, and economic forces. Realist, constructivist, and neo-Gramscian theoretical perspectives provide a comprehensive understanding of these shifts.

From a realist perspective, state survival and security concerns have driven regional actors to forge fluid and short-term alliances, focusing on immediate threats rather than long-term cooperation. The decline of U.S. engagement in the region and the rise of informal coalitions, such as those seen in Yemen and Syria and the normalization agreements with Israel, illustrates how pragmatism has replaced ideology in foreign policy decision-making.

Constructivism reveals how the Arab Spring fractured longstanding identity narratives, such as pan-Arabism and Islamism, leading to new ideological alignments and sectarian divides. The rise of political Islam, the persistence of nationalist movements, and the sectarian schism between Sunni and Shia powers have profoundly impacted the region's political landscape. The Israel-Hamas war underscores how non-state actors continue to mobilize identity and ideological narratives despite shifting state alliances.

From a neo-Gramscian perspective, the integration of Middle Eastern states into the global capitalist system has been marked by neoliberal reforms and hegemonic projects, such as Saudi Arabia's Vision 2030. While these projects aim to secure long-term regime legitimacy, they have also spurred counter-hegemonic movements that challenge the region's political and economic order. The persistence of resistance movements like Hamas, alongside growing public discontent with neoliberal policies, reveals the deep tensions between ruling elites and marginalized populations.

The changes from 2011 reflect a fragmented regional order, where shifting alliances, evolving identities, and economic transformations have reshaped power dynamics. The region remains marked by instability, with traditional regional frameworks proving inadequate in addressing the profound challenges facing Arab states. Looking ahead, the persistence of fluid alliances and the rise of new ideological forces suggest that the Middle East will continue grappling with competing forces of cooperation and conflict, driven by domestic and international pressures.

The Israel-Hamas war can also be analyzed through a constructivist lens. Hamas frames its resistance not only as a national liberation struggle but as a pan-Islamic cause, emphasizing identity and religious solidarity. This draws attention to how non-state actors mobilize ideational resources to garner support, even as some Arab regimes, following normalization with Israel—prioritize pragmatic security concerns over traditional narratives of Arab unity and Palestinian liberation.

Neo-Gramscian theory adds a layer of understanding to the geopolitical and economic transformations of the Middle East between 2011 and 2024 by focusing on hegemony and counter-hegemonic forces. Following the Arab Spring, the

neoliberal economic reforms initiated by states like Saudi Arabia and the UAE, such as Vision 2030, sought to restructure their economies to ensure long-term survival and integration into the global capitalist system. This process is part of the broader global hegemonic project driven by neoliberal capitalism, in which regional elites attempt to secure economic stability and legitimacy amid declining oil revenues and rising youth unemployment.

However, counter-hegemonic forces such as Hamas and Iran-backed militias challenge this status quo, resisting both global capitalism and regional authoritarianism. The persistence of these movements, which draw upon anti-Western and anti-Israel narratives, reflects their opposition to the regional hegemonic order that has emerged post-2011. For instance, while the Abraham Accords represented a move towards economic integration and security cooperation with Israel, they also deepened popular discontent in the region, creating fertile ground for counter-hegemonic movements to gain support by appealing to Islamic and nationalist ideologies.

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# Wind Power Development in Egypt: Historical Overview, Current Status, and Prospects

*By Azza Ghanem[*] & Mohamed Salah Elsobki[±]*

*Many nations are keen to increase their use of renewable energy, given its significance for long-term energy independence, development, and climate change mitigation. The Egyptian government is taking significant steps to promote renewable energy, especially wind energy, which will hopefully contribute 14% of total electricity generation by 2035. This paper discusses the growth of wind power in Egypt, providing valuable information for those interested in developing wind projects. It reviews the national renewable energy plan, policies, and other renewable resources. Additionally, it emphasizes the technical, economic, and environmental aspects of wind power. The paper aims to determine whether wind power is an effective and promising option for electricity generation in Egypt and offers recommendations to policymakers to enhance its growth.*

**Keywords:** *Renewable Energy, Wind Power Development, Wind History, Wind Vision, Egypt*

## Introduction

Many countries are keen on utilizing clean energy potential and incorporating it into their national energy strategies. Fossil fuels are on the verge of depletion sooner or later and will not be able to supply demand in the future in addition to being a source of emissions contributing to climate change. Wind power is one of the most flourishing, cost-effective, and technically mature renewables, accounting for 8% of total electricity generation. It has experienced a growth of 12% over the last decade, achieving 1021 GW of installed capacity worldwide (IRENA, 2023b; REN21, 2024). Naturally, COVID-19 pandemic-related limitations disrupted supply chains, caused unemployment, delayed or postponed bids and investments, and resulted in canceled projects, particularly in onshore wind farms. Despite these challenges, wind energy has adapted and grown in some parts of the world (REN21, 2021). Wind energy is expected to have a critical role in global electricity transformation, giving significant environmental and socioeconomic benefits. By 2050, it would supply more than one-third of the total electricity demand and contribute more than 25% of the total $CO_2$ emissions reductions, which mitigate climate change impacts. Furthermore, it is anticipated that over 6 million employment

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possibilities will be created, necessitating attention to capacity building in the world in order to handle the growth of the wind industry (IRENA, 2019).

Numerous factors influence wind power deployment, including government policies, finance, oil prices, geopolitical risk, political stability, trade openness, $CO_2$ emissions, climatic conditions, industrial infrastructure investment, power demand, public acceptance, environmental effects, and people engagement (Fatima et al., 2021; Wang et al., 2023). Over the last years, cost reductions owing to ongoing technological improvements and subsidy policies contributed to wind farm deployment in most parts of the world. On the other hand, wind energy continues to face some challenges such as grid and transmission infrastructure, prolonged permit duration, policy uncertainty, and social acceptance (IEA, 2020; REN21, 2022). The purpose of this global overview is to highlight the factors that make wind energy a promising and viable resource worldwide, thereby providing a foundation for discussing its potential for expansion in Egypt.

Regarding the growth of renewable sources among Arab nations, Egypt comes in first, followed by Jordan and Morocco (Habib et al., 2023). In addition, Egypt ranked 22nd on the Climate Change Performance Index (CCPI), which evaluates countries' climate protection efforts based on four categories: greenhouse gas emissions, renewable energy, energy use, and climate policy (Burck et al., 2024). Egypt has a variety of renewable energy sources, including hydropower, onshore wind, solar PV, solar CSP, and biomass, and it is also striving to utilize new ones. However, it is heavily reliant on fossil fuels, accounting for more than 85% of total power generation. Despite substantial societal and political changes over the previous decade, progress in renewables has been accomplished. Egypt has succeeded in adding greater than 3 GW to its installed capacity for renewable energy. Egypt has made an effort to enhance the country's investment environment and boost policies for energy transitions (EEHC, 2024; NREA, 2024). In order to meet the growing demand for power for purposes of socioeconomic development, as well as environmental concerns, the Integrated Sustainable Energy Strategy (ISES) was developed, which took into account energy source diversification, expansion of renewable energy sources, and energy use rationalization. The strategy aims to produce 42% by 2035 of total electricity from renewable sources (IRENA, 2018).

Egypt has favorable conditions for wind energy development, including an abundant wind resource that is one of the best in the world, especially in the Gulf of Suez area, where the mean wind power density reaches 600 $W/m^2$ at a height of 50 m, the availability of large uninhabited desert areas, and donor support, which includes studies, capacity building, and grants (ElSobki et al., 2009). Furthermore, Egypt has manufacturing wind turbine components due to its low labor costs, inexpensive industrial energy, and easy access to steel and glass. As a result, some parts of wind turbines, like towers, are more affordable due to local manufacturing (Salah et al., 2022). However, wind power provides for just 3% of Egypt's total electric energy supply (Ritchie et al., 2024b), and future projects are unlikely to meet the target of 14% by 2035.

Hence, this research article aims to describe wind power development over the years in Egypt. It also examines the factors that have supported and hindered

growth, as well as how these factors may change in the future, and it talks about the prerequisites that need to be met before wind power can be implemented on a large scale. Such an article can assist decision-makers and stakeholders in making enlightened decisions on wind energy development.

## Renewable Energy Sources

### *Strategy*

Energy is crucial for economic development. Egypt relies on fossil fuels for power generation, but their stocks are diminishing. Also, electricity generation from fossil fuels is the main source of greenhouse gas emissions, accounting for 88.51 million tons (Mt) (Ritchie et al., 2024a). It is therefore necessary to implement policies for an energy transition to phase out fossil fuels and reduce emissions, and the high potential of wind and solar radiation helps well towards this. On the other side, as the population grows, there will be an increased need for power production to meet the higher demand, as energy consumption per capita increased by 8% between 2020 and 2022 (Ritchie et al., 2024b). The strategic approach of a nation has other goals besides energy security, including environmental sustainability and economic competitiveness (Papanikos, 2017). As a result, an energy development strategy was developed in 2015 with four goals: ensuring energy security of supply, ensuring sustainability, improving institutional and corporate governance, and strengthening competitive markets and regulation. The Energy Strategy (2015 – 2035) aims to expand the deployment of renewable energy sources, as illustrated in Table 1, and to implement suitable infrastructure for projects. Projects involving this strategy will be carried out through public-private partnerships. In addition, the strategy includes policies regarding energy efficiency, nuclear power addition, improved natural gas utilization, reforming energy subsidies, and the inclusion of coal-fired generation with its attendant environmental consequences (SES, 2015).

**Table 1.** *Renewable Energy Targets by 2035*

| Renewable Energy Source | Expected Electric Energy (%) |
|---|---|
| Hydropower | 2 |
| Onshore Wind | 14 |
| Solar PV | 22 |
| Solar CSP | 4 |

Source: (NREA, 2024)

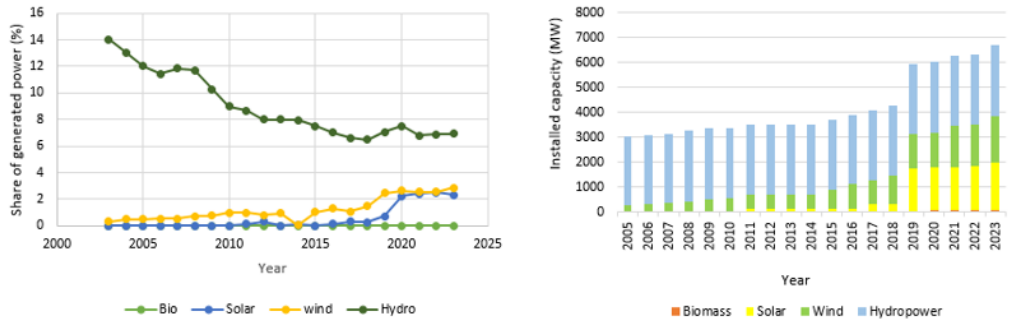
Decree-Law No. 203 was issued in 2014 to grow renewable energy generation. Some policy instruments were adopted to support renewables deployment and investment push: (1) competitive bidding, which is a call for tenders issued by the New and Renewable Energy Authority (NREA) to install a specific number of MW of renewable sources. (2) Feed-in Tariff (FIT) aims to set the energy price and duration of purchase for each type of energy and support

producers at a price above the market. It guarantees a fixed price for energy producers, usually involving a long-term period from 20 to 25 years. Thus, FIT has the potential to minimize economic concerns while increasing investment incentives. (3) Independent Power Producers (IPP), whose developers can either use the generated electricity to power their own loads or to supply distribution utilities depending on consumption. (4) The feed-in tariff system allows investors usufruct rights to the lands required for renewable energy in exchange for 2% of the total energy sold by the project. (5) Electricity subscribers will be obliged to use a certain percentage of renewable energy at reasonable prices. This proportion must be determined at least three months before the beginning of the fiscal year to absorb the electricity generated by the plants that are expected to be operational during the year (ElKhayat, 2016; NREA, 2014).

*Renewable Sources*

Egypt has an abundance of potential for green energy. Egypt is one of the Arab world's pioneers in renewable energy sources, ranking with the largest installed capacity (Habib et al., 2023). Its current renewable energy sources include hydropower, onshore wind power, solar power [PV & CSP], and biomass. Their installed capacity was 6691 MW, which comprised 25875 GWh, or 12% of the total electricity generated, as illustrated in Figure 1 (NREA, 2024; Ritchie et al., 2024b).

**Figure 1.** *Growth of Renewable Energy Sources*




(a) Renewable energy's share of total generated electricity from 2005 to 2023

(b) Installed Capacity of renewable energy sources from 2005 to 2023

Source: (EEHC, 2022; NREA, 2024; Ritchie et al., 2024b)

Furthermore, Egypt seeks to expand its sustainable energy portfolio and incorporate new energy sources like geothermal and nuclear energy to boost the stability of its electrical grids. Geothermal energy is obtained from heat and pressure differentials in the Earth's crust that can provide direct thermal energy or electricity using steam turbines. This makes geothermal a weather-independent renewable energy source. Geothermal energy is theoretically available everywhere, but it may be difficult to obtain in many areas. Besides power generation, it can also meet heating and cooling requirements, as well as value-added mineral extraction. Geothermal power capacity was around 15 GW in the world, which produced 101

TWh of electricity generated and 560 PJ of directly usable heat energy. Geothermal development has numerous advantages, but it also has drawbacks. These include exploration risks, a lengthy implementation period, and high capital costs (IRENA, 2023a; REN21, 2023). For thousands of years, Egyptians have utilized geothermal energy by using the warm water from hot springs for limited health purposes. Egypt still uses geothermal energy for direct heating, not power generation. Most geothermal resources are found in the Western and Eastern Deserts, along the Gulf of Suez. There are further low-thermal springs close to Helwan City that are sulfur-enriched. The most important location is in the Gulf of Suez since constructing geothermal power plants along the Gulf's shore is an important step to start generating electricity. Policymakers have become more interested in geothermal potential as a new type of renewable energy source. Thus, Egyptian and international entities collaborated on a research project to build capacity for both technicians and academics and exploit available geothermal potential (Lashin, 2020; NREA, 2024; Salah et al., 2022).

One sustainable energy source is nuclear energy, which contributes to 9% of the power generated globally (REN21, 2023). Egypt intended to include nuclear energy as part of its energy strategy. By 2035, it is anticipated that nuclear energy will provide 3% of the power generated, helping to fulfill the growing energy demand sustainably and so lowering climate change impacts. Nuclear plants do not produce both $CO_2$ emissions and other air pollutants. Furthermore, the amount of radioactive emission they create may be lower than that of radioactive isotopes present in coal soot and ash. In 2015, the Egyptian and Russian governments signed an agreement to construct the first nuclear power plant, which will be constructed with a 4800 MW capacity and be situated at the El-Dabaa site. But as of right now, not much has been done to finish this project (Salah et al., 2022).

Hydropower

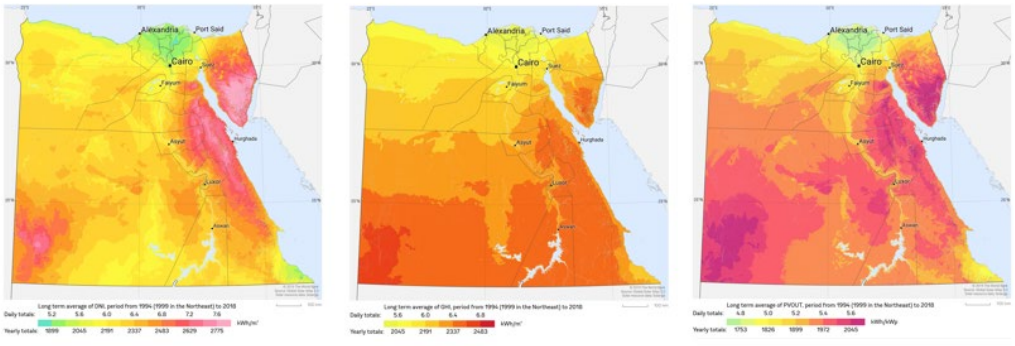
Hydropower is one of the oldest renewable sources in the world, accounting for 14% of total energy production. Despite a 2% decrease in power generated over the last ten years, it remains a significant resource (REN21, 2024). Its ability to store energy and provide a sustainable baseload, unlike other intermittent renewable energy sources, combined with its high efficiency, low maintenance costs, and long life, makes it a clean resource worth deploying (Eshra et al., 2021; Wasti et al., 2021). In Egypt, Hydropower is a significant renewable source. It dammed its only major river, the Nile, where six power plants are suited totaling 2832 MW. Hydropower generated 14967 Gwh, which contributed to 7% of total power generation (NREA, 2024; Ritchie et al., 2024b). The hydropower projects known as Aswan Dam and High Dam were constructed in the 1960s and were able to supply most of Egypt's electrical needs up until the 1980s. In partnership with the Ministry of Water Resources and Public Works, the Aswan 2 power plant was established in 1985. Other projects that followed included the Isna hydropower plant in 1993, the Naga-Hamadi power plant in 2008, and the Assuit project in 2018. The future plan is for a 2,400 MW water pumping and storage project in the Ataqa area to increase hydropower capacity (IRENA, 2018).

Since solar and wind energy dominate the renewable strategy, hydropower share is unlikely to change much shortly and has limited chances to increase its hydro capacity in the future. Hydropower potential will also be negatively impacted by the Grand Ethiopian Renaissance Dam as Egypt would receive less water as a result. Also, hydropower projects are situated along rivers, which are vulnerable to the effects of climate change. Most Egyptian hydropower plants are projected to face a wetter climate with increased precipitation and water flow, which would lead to positive and negative impacts. Egypt is expected to have a greater hydropower generation capacity factor under climate change scenarios. On the other side, the expected rise in severe rainfall and pluvial floods may cause sediment and floating debris that pose a risk to hydropower plants (IEA, 2023).

Solar Power

Solar power PV experienced a noticeable increase from 2013 to 2023, reaching 1185 GW of installed capacity worldwide (REN21, 2024). Based on the Global Solar Atlas in Figure 2, solar energy is dispersed across the country. Egypt is thus among the best areas in the world that can exploit solar radiation for thermal heating and power generation. Sunshine may generate energy with a density of 1970 to 3200 kWh/m$^2$ and occurs between 2900 and 3200 hours on average. Solar can be applied for solar water heaters and photovoltaic or concentrated solar power plant installations. Solar water heaters have been employed in many places since the 1980s, such as new cities and tourist destinations. In addition, solar PV is being installed for lighting on roadways, in remote locations, and in villages. In 2010, a 140 MW CSP project was installed. Due to the high expense of CSP deployment, more attention has been given to expanding PV projects (SES, 2015). In the last few years, solar power installed capacity has increased significantly, reaching 1910 MW for combined CSP at Al Karimat and PV at Kom Ombo, Banana, and Zafarana. (NREA, 2024; Othman & Khallaf, 2023; Salah et al., 2022). It is worth noting that the strategy aspires to achieve 6% of CSP by 2035, the future projects, whether held by the private sector or the New and Renewable Energy Authority (NREA), are entirely solar PV plants, and there are no plans for CSP.

**Figure 2.** *Solar Atlas Maps of Egypt*




(a) Direct normal irradiation (b) Global horizontal irradiation (c) Photovoltaic power potential

Source: (Global Solar Atlas, 2019)

Biomass

Egypt has a lot of biomass resources, including agricultural waste, municipal solid waste, sewage waste, and animal waste. All of these sources have the potential to generate a significant amount of clean electricity, especially in rural areas, but they are currently being used inefficiently. Based on a study, 3.1 million tons of rice straw can create 2477 GWh of electricity in a year. Three biomass plants with a combined capacity of 60 MW have been established over the past few years. Its current contribution is small, but efforts will be undertaken to expand deployment since Egypt wants biomass to play a larger role in the energy mix (Aliyu et al., 2018; NREA, 2024; SES, 2015).

In summary, the current state of renewable energy in Egypt was reviewed in relation to each renewable energy source, as well as the plans and policies that have been implemented. This review is crucial for understanding the available energy sources in Egypt and identifying which ones are competitive with wind energy. Hydropower, for instance, faces challenges that prevent it from competing with wind energy, while biomass is still in its early stages. Other sources, such as nuclear and geothermal energy, are still in the planning phase. On the other hand, solar energy has proven to be a successful source that can compete with wind energy in recent years. This comparison is crucial for understanding the strengths and limitations of each source, as well as for evaluating their potential to contribute to the energy mix. Hence, it becomes easier to identify why wind energy is the focus of this research article and whether it holds promise as a sustainable option for the future.

## Wind Power

This section consists of (a) the history of wind harnessing by the Egyptians, and (b) the use of wind to generate electricity. It highlights the long-standing relationship Egyptians have had with wind, emphasizing both its historical utilization and the growing interest in wind as a resource for electricity generation in the 20th century. While existing literature has touched on various aspects of wind energy, this paper uniquely addresses the historical context in a structured and comprehensive manner, providing valuable insights and contributing to the broader understanding of wind's role in Egypt.

### *History of Harnessing Wind by Egyptians*

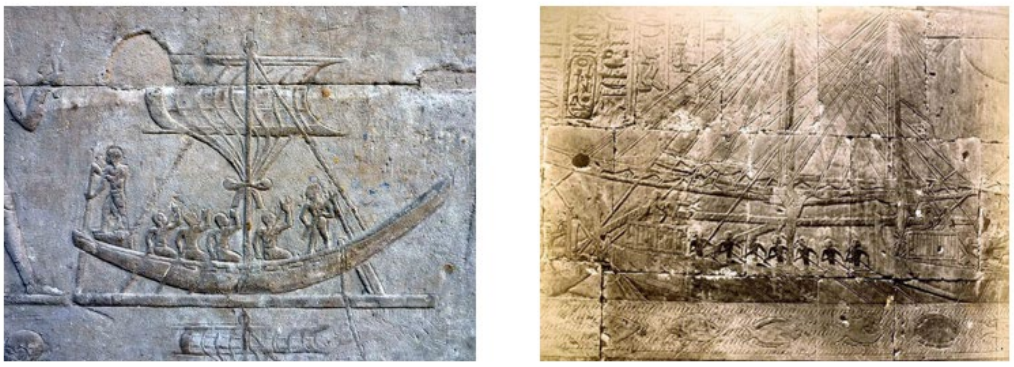
The ancient Egyptians expressed the value and functions of the wind in various contexts, as highlighted through the texts of the Temple of Esna in hieroglyphic language, as seen in Figure 3. Based on ancient Egyptian beliefs, wind was considered a force that sustains life and the Egyptian cosmos (ELSAYED & A., 2018). Since ancient eras, wind resource has been harnessed for various purposes (Rishmany et al., 2017). Egyptians have relied on windmills featuring long vertical shafts and rectangular blades for a variety of uses, such as grain grinding, irrigation, and sugarcane industries (K. R. Rao, 2019).

**Figure 3**. *Boat Navigation in the Ancient Egyptian Representation on Temple of Esna Texts – Luxor*

Source: (Elsayed, 2018)

Over 4000 BC, ancient Egyptians were able to sail wind-powered sailing ships across the Nile River, as shown in Figure 4, allowing them to trade, explore, and communicate. Furthermore, during the Fifth Dynasty of ancient Egypt, around 2500 BC, commercial and exploratory expeditions along the East Coast of Africa to the Land of Punt were made (Ragheb, 2017), which aided in the development and prosperity of Egyptian civilization. Ancient sailors demonstrated their advancement in the art of seamanship and wind knowledge by being able to complete an outward and return voyage using sail power to determine the monsoon's directions (Solari, 2019).

**Figure 4.** *Wind-powered Sailing Ships on the Walls of Egyptian Temples*



(a) Relief for an ancient Egyptian sailing ship on the walls of Edfu Temple, Aswan-Egypt

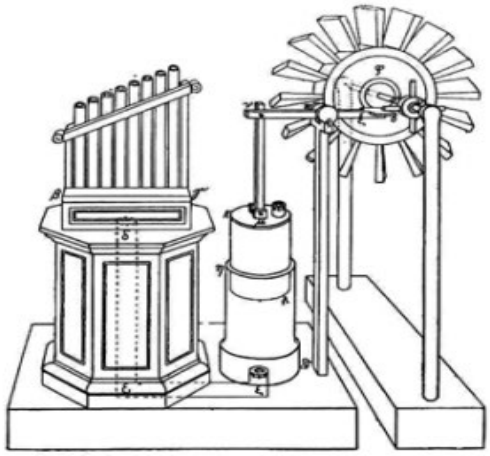
(b) Relief for an ancient Egyptian sailing ship on the walls of Deir Al Bahari Queen Hatshepsut's Temple in Luxor- Egypt

Source:(Alberta, 2023; Ragheb, 2017)

Ancient Greek scientists made significant contributions to and had an impact on world civilizations. In ancient Greek Egypt, Hero of Alexandria "Heron" was a mathematician, physicist, and engineer who invented the first wind-powered machine. Figure 5 depicts Heron's organ, which was also known as a "wind organ" or

"hydraulis". It featured a small windwheel that powered a piston and forced air through the organ pipes, creating music. It was used as an entertainment instrument (Ragheb, 2017; J. S. Rao, 2011).

**Figure 5.** *Heron's Wind-powered Wheel*

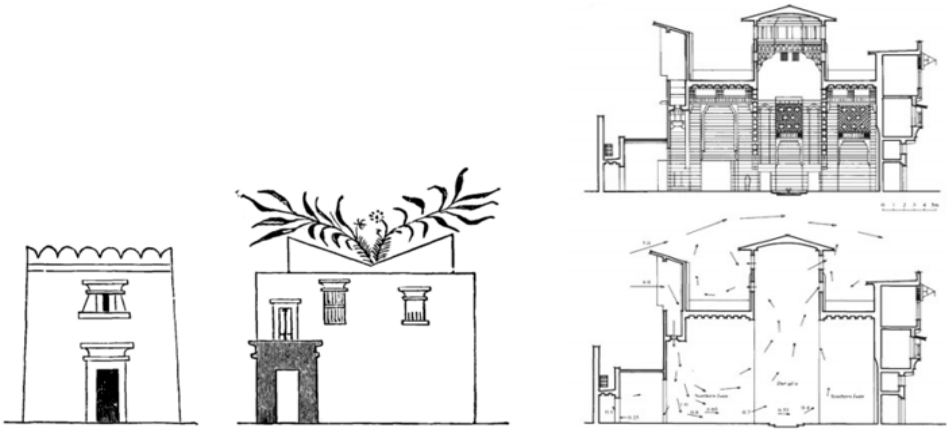


Source: (Papadopoulos, 2007)

In areas vulnerable to extreme weather conditions, humans attempted to induce pleasant winds in their houses or block harmful winds to improve living conditions. Taking wind into consideration during urban planning emerged in ancient Egyptian civilization, as illustrated in Egyptian papyrus 3500 years ago BC. It was simulated in Tell El Amarna, which King Akhenaton established on the banks of the Nile in 1376 BC. The city was ventilated by aligning all of its main roads with the coolest winds. Muslim-Arab architecture also responded to social, urban, and climate conditions. Buildings formerly had natural ventilation systems that provided natural cooling and sufficient lighting without the need to purchase equipment or incur energy expenditures (El-Borombaly & Molina-Prieto, 2015; Solari, 2019).

In order to provide thermal comfort within buildings, wind catchers, also known as wind towers, were first used in Pharaoh houses during the 19th Dynasty in Neb-Amun around 1300 B.C. It is a small roof-mounted tower with an opening facing the predominant wind, which blows colder air than the house's interior. Air in the tower shaft is forced down the shaft to cool the house due to wind velocity at this opening is higher than it is at the lower windows. They additionally perform a natural selection purpose, which means that if the inside air temperature drops below that of the outside, a pressure buildup stops the catcher from bringing in the cool air; if the outside air temperature drops below that of the inside, the wind that enters through the catcher expels the cooler air and radiates throughout the house. Several residences had "Malqaf" on their roofs. Its use during Egyptian civilization can be observed in paintings discovered in Thebes tombs and during the 14th century Bahri Mamluk period, as shown in Figure 6, for a classical house with a central tower for hot air escape and a Malqaf on the left (El-Borombaly & Molina-Prieto, 2015; Solari, 2019).

**Figure 6.** *Use of Wind for Ventilation in Egypt over Times*



(a) Windcatcher in the home of Neb-Amun, in Gourna - Luxor back to the 9th dynasty (1305–1196 BC)

(b) "Malqaf" – Section of Qā'a of Muhib Ad-Din Ash-Shāf'i Al-Muwaqqi house in Cairo - Egypt back to 1350

Source: (El-Borombaly & Molina-Prieto, 2015; Solari, 2019)

It is concluded that natural ventilation improves indoor air quality, lowers costs, and rationalizes energy use, which all have positive socio-economic and environmental effects. Because Egypt has a hot, dry climate and is among the nations likely to experience negative effects from climate change as it gets hotter and drier, it is crucial to raise awareness of climatic architecture in order to prepare for these unfavorable effects of climate change.

**Figure 7.** *Windmills with Multiple Sails in Egypt during the Nineteenth Century*

(a) Windmills with multiple sails in Al Qabbari region - Alexandria in the 19th century

(b) Windmills with multiple sails in Cairo in the 19th century

Source: (Ragheb, 2017; Touregypt, 2024)

Throughout history, windmills have been utilized for a wide range of purposes in numerous countries, including milling grains, grinding spices, sawing lumber, ventilation in mines, producing gunpowder, oil extraction from oil seeds, nuts, and grains, and converting old rags into paper. The Middle Eastern civilizations utilized windmills with woven reed sails over 200–100 BC to grind grain. During the reign of Omar Ibn Al Khattab, the second Islamic Khalifa, a Persian created the first windmill for grains in AD 644. After that, windmills in Egypt were adapted and utilized to smash sugarcane to extract sugar and make molasses (Ragheb, 2017). Multiple sails emerged during the reign of Muhammad Ali Pasha in the

nineteenth century, as depicted in Figure 7 in Alexandria and Cairo. Windmills usually were built on coasts and in the highlands to take advantage of strong winds and thus crush a large amount of grain, as well as far away from residential areas due to the noise they make when rotating. It took hundreds of years for windmills to develop into the various designs, components, and features they have nowadays. This has allowed humanity to harness wind more widely, whether for electricity generation or other purposes.

*Harnessing Wind to Generate Electricity*

The development of wind to generate electricity has emerged considering the 1990s, and currently, wind power is one of Egypt's most significant sustainable energy sources. Egypt began investing in wind power in the Hurghada region in 1993, where an average wind speed of 6 m/s. A 5 MW demonstration wind farm was constructed, and 40% of its components were manufactured locally. It consisted of 42 two-blade and three-blade wind turbines with capacities ranging from 100 to 300 Kw. Capacity factors exceeded 18%, and this project achieved economic and environmental benefits during its operating period, including 5 million kWh, 1000 tons of fuel saved, and 2800 tons of $CO_2$ emissions reduced by the end of 2013 (NREA, 2024).

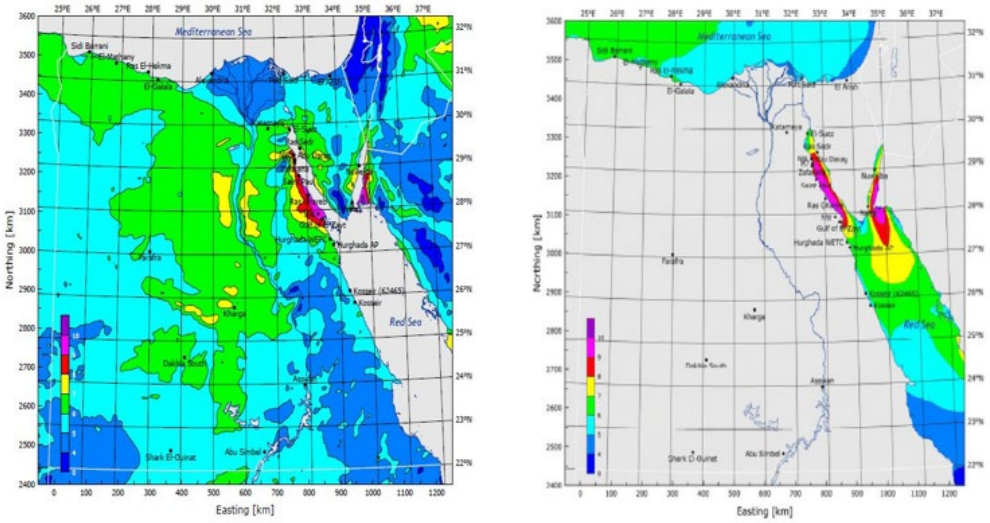
The expansion of wind energy projects necessitates an examination of wind speeds to select suitable sites with high wind power potential for electricity generation, which also supports the design of turbines that suit wind conditions. In collaboration with the New and Renewable Energy Authority (NREA), the Egyptian Meteorological Authority (EMA) and Risø National Laboratory (Risø) have created a comprehensive and diligent Wind Atlas for Egypt using WAsP calculations based on local anemometer measurements for the period 1991 to 2005 at a suitable level for developing bankable projects both onshore and offshore. Figure 8 & Table 2 illustrate that Egypt is distinguished for its strong winds, especially in some areas of the Gulf of Suez and Aqaba, with an average speed exceeding 8 m/s at 50 m. Additionally, promising wind speeds on the Mediterranean and Red Seas are suitable for the installation of offshore wind farms (Mortensen et al., 2005).

**Table 2.** *Wind Power Classes for some Areas at 50 m based on the Wind Atlas for Egypt*

| Areas | Class | Resource potential | Wind speed (m/s) | Wind power density ($W/m^2$) |
|---|---|---|---|---|
| South Sinai | 1 | Poor | 0 – 4 | 0 – 100 |
| Delta region | 2 | Marginal | 4 – 5 | 100 – 200 |
| Eastern Nile | 3 | Moderate | 5 – 6 | 200 – 300 |
| Kharga Oasis | 4 | Good | 6 – 7 | 300 – 400 |
| Western Nile | 5 | Excellent | 7 – 8 | 400 – 500 |
| Gulf of Aqaba | 6 | Outstanding | 8 – 9 | 500 – 600 |
| Gulf of Suez | 7 | Superb | > 9 | > 600 |

Source: (ElSobki et al., 2009; Mortensen et al., 2006)

**Figure 8.** *Wind Resource based on Wind Atlas of Egypt*




Source: (Mortensen et al., 2006)

Beyond high wind power potential, wind farm planning must take into account several technical, economic, environmental, social, and geographical criteria. Egypt can be divided into five regions based on Wind Atlas; some have significant wind potential, while others have several issues that impede full-scale exploitation and have restrictions that prevent project construction or increase its cost (Feng, 2021; Rediske et al., 2021).

1. The Gulf of Suez has a superb wind power density in addition to the criteria availability that make it suitable for installing wind power projects. Therefore, NREA has allocated aside 1220 $km^2$ of the Suez Gulf region for the installation of 3550 MW (NREA, 2024).
2. The Gulf of Aqaba boasts an outstanding wind power density; however, since the area is considered a nature reserve, onshore wind farms cannot be installed there. In terms of offshore wind development, the water depth is above 200 m, which is deemed uneconomical for offshore wind farms (ElSobki et al., 2009).
3. The West Nile region has an excellent wind power density that can reach 500 $W/m^2$. So, NREA has allocated an area of 3636 $km^2$ for installing wind projects with 23350 MW (NREA, 2024).
4. The Western desert areas near Kharga have a good wind power density that can reach 400 $W/m^2$. While the NREA currently has no wind power projects there, it could provide a significant socio-economic benefit to the local community if a wind farm proposal is put forward.
5. The Eastern Nile area has a moderate wind power density, but it is lower than in the western area. As a result, its development should follow that of the western region. NREA has allocated an area of 841 $km^2$ for installing wind projects with 5800 MW.

6. The Delta region is unsuitable for wind power projects as its marginal wind power density, high population density, and the prevalence of agricultural land.
7. The south of the Sinai Peninsula is not suitable for wind power projects due to its classification as a tourist destination and nature reserve, as well as its low wind power density.

Superb areas with high wind power density are considered commercial for large-scale electricity generation, while moderate areas can be used for producing electricity to develop local communities. On the other hand, poor areas can be exploited for limited-scale agricultural purposes. Besides Wind Atlas, several research was conducted to evaluate wind resource in various locations where wind speed would be sufficient for power generation there (Ahmed, 2010; Ahmed 2011; Ahmed 2012; Ahmed 2018b; Essa & Embaby, 2005; Essa & Mubarak, 2006; Shaltout et al., 2021). Other research was conducted, focusing on technical and economic assessments to identify the best locations for investment (Abd El Sattar et al., 2020; Ahmed, 2018a, 2021; Alham et al., 2023; Hamouda, 2012; Ibrahim, 2022; Shata & Hanitsch, 2006; Shata & Hanitsch 2008).

Offshore wind is a valuable resource that can assist Egypt with its electricity shortage, contribute to its wind power targets, and support the broader regional renewable energy goals, including those of Saudi Arabia. In addition, it has less of a visual impact than onshore wind power sites (Mahdy & Bahaj, 2018). Some research has been conducted concerning the feasibility of constructing offshore wind farms. Certain regions surrounding the Red Sea are suitable for offshore wind farm installation based on a variety of criteria, including high wind power potential and minimal impact on nearby tourist resort lands (Mahdy & Bahaj, 2018). Similarly, based on a techno-economic assessment along the Mediterranean Sea, it would be feasible to install offshore wind farms, especially in the El Dabaa area (Abdelhady et al., 2017). In terms of isolated coastal cities with limited infrastructure, floating hybrid power plants of wind and solar combined with a hydrogen energy storage system is an unconventional solution to raising living standards there. Marsa Alam - Red Sea was determined as an appropriate location (Amin et al., 2022). Also, it was found that the installation of floating hybrid power plants—which combine hydropower and wind—would be viable from an environmental, economic, and technical aspect and would aid in the development of upper Egypt's villages along the River Nile (Arslan & Tezdogan, 2019).

It is worth noting that turbine noise can have an impact on both human health and animal life, frightening birds and small rodents and pushing them from their natural habitats. Thus, the best sites are those with no restrictive causes, such as forests, bird sanctuaries, animal habitats, military zones, ancient sites, and tourism destinations. Additionally, there must be enough space between the wind farm and a residential area to avoid disturbing people at a distance of [1000–3000 m]. Locations that are less than 500 m from agricultural areas should be avoided because agricultural areas can lose their agricultural productivity due to wind farm installation. Naturally, some areas are favorable for both agriculture as well as

wind farm construction since turbines occupy only an average of 1% of the area, allowing the land to be used for other purposes (Rediske et al., 2021).

Table 3 & 4 illustrate all wind power projects that are centered in the Suez Gulf region, which has strong winds and capacity factors that can reach 40%, a high value compared to the global average of 37%. Wind power projects are managed by the New and Renewable Energy Authority (NREA), which succeeded in installing a capacity of more than 1370 MW since 2001 thanks to international cooperation, as illustrated in Table 4. Furthermore, the government supported the private sector, resulting in a considerable contribution to investment in wind projects, as seen in Table 5 (IRENA, 2023b; Mortensen, Said, et al., 2006; NREA, 2024).

**Table 3.** *Public Wind Power Projects*

| Project | Capacity (MW) | Status | Development parties |
|---|---|---|---|
| Zafarana | 545 | Operational | Germany –Spain – Denmark – Japan |
| Gabal El Zeit | 580 | Operational | Germany – European Union – Spain – Japan |
| Suez Gulf | 252 | Operational | Germany – European Union – France |

Source: (NREA, 2024)

**Table 4.** *Onshore Wind Farms [Public & Private] in Egypt*

| Wind farm | Latitude | Longitude | Nominal power (KW) | N. Turbines | Manufacturer |
|---|---|---|---|---|---|
| Zafarana 1 | 29° 11' 40.5" | 32° 35' 8.7" | 30,000 | 50 | Nordex N43/600 |
| Zafarana 2 | | | 33,000 | 55 | Nordex N43/600 |
| Zafarana 3 | | | 30,360 | 46 | Vestas V47/660 |
| Zafarana 4 | | | 46,860 | 71 | Vestas V47/660 |
| Zafarana 5 | | | 85,000 | 100 | Gamesa G52/850 |
| Zafarana 6 | | | 79,900 | 96 | Gamesa G52/850 |
| Zafarana 7 | | | 119,850 | 141 | Gamesa G52/850 |
| Zafarana 8 | | | 119,850 | 141 | Gamesa G52/850 |
| Gabal El Zeit 1 | 25° 51' 27.7" | 34° 24' 57.6" | 220,000 | 100 | Gamesa G80/2000 |
| Gabal El Zeit 2 | | | 120,000 | 100 | Gamesa G80/2000 |
| Gabal El Zeit 3 | | | 200,000 | 100 | Gamesa G80/2000 |
| Gabal El Zeit 4 | | | 40,000 | 100 | Gamesa G80/2000 |
| West Bakr | 28° 45' 4" | 32° 46' 16.8" | 252,000 | 96 | Siemens-Gamesa SG 2.6-114 |
| Ras Gharib 1 | 28° 24' 1.8" | 32° 57' 16.6" | 262,500 | 125 | Gamesa G97/2000 |
| Ras Gharib 2 | 28° 8' 1.6" | 33° 15' 36.7" | 5,000,000 | 125 | Gamesa G97/2000 |
| Gulf Of Suez | 28° 21' 19" | 33° 3' 43.9" | 250,000 | 70 | Vestas V105-3.6 MW |

Source: (WPN, 2023)

**Table 5.** *Private Wind Power Projects*

| Project | Size (MW) | Status | Contract |
|---|---|---|---|
| West Bakr | 250 | Operational | BOO scheme |
| Ras Gharib | 262 | Operational | BOO scheme |
| Al Bahr al Ahmar 1 | 500 | Under implementation | BOO scheme |
| Amunet 1 | 500 | Under implementation | BOO scheme |
| Infinity | 200 | Under development | BOO scheme |
| Al Bahr al Ahmar 2 | 150 | Under development | BOO scheme |
| Amunet 2 | 500 | Under development | BOO scheme |
| Gulf Of Suez | 1100 | Under development | BOO scheme |
| Siemens Gamesa | 500 | Under development | BOO scheme |
| ACWA Power | 10000 | Planned Project | BOO scheme |
| Scatec | 500 | Planned Project | BOO scheme |
| Infinity - Hassan Allam | 10000 | Planned Project | BOO scheme |
| Toyota Tsusho - Orascom | 300 | Planned Project | BOO scheme |

Source: (NREA, 2024)

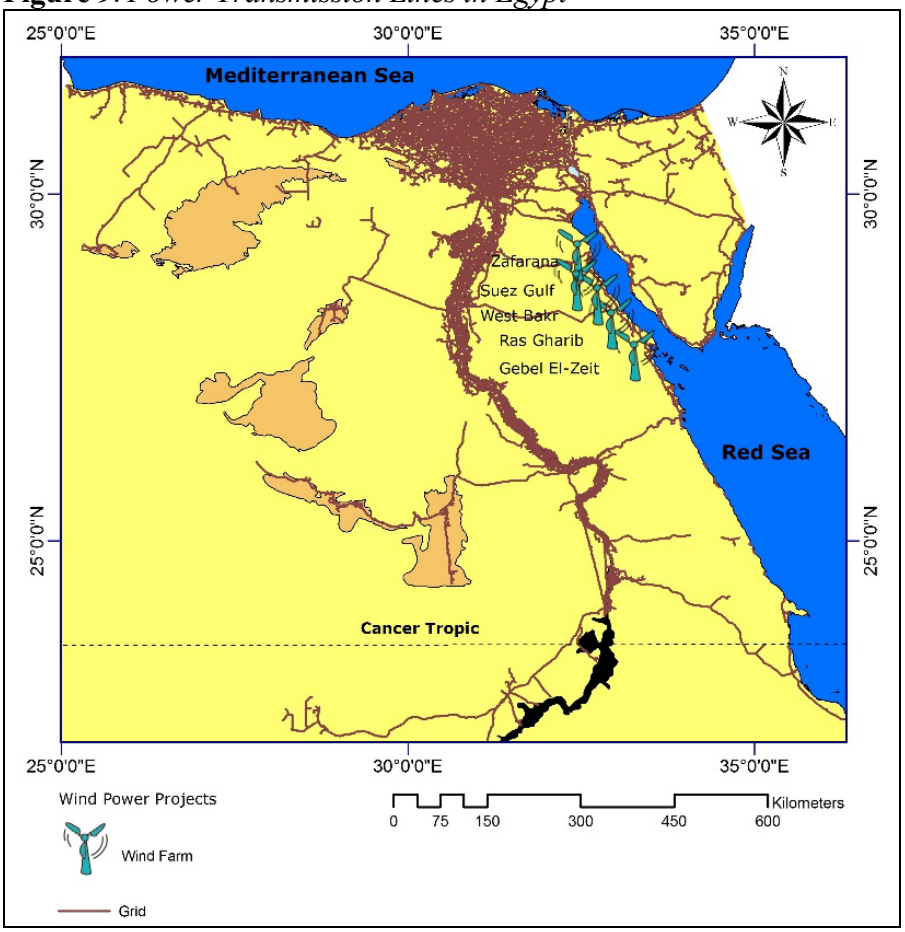
## Technical Aspects of Wind Power

### *Incorporating Wind Power into the Grid*

Power transmission lines are depicted in Figure 9. The plans for significant wind development in the Suez Gulf area certainly necessitate a significant increase in transmission capacity to the area. There is no technical limit to how much wind power can be integrated into the electrical grid. Cost is the main concern: longer transmission lines are more expensive than shorter ones, and as the proportion of wind in the grid increases, more infrastructure will need to be installed to control the quality of the power in the grid.

It has been demonstrated that high-voltage direct current (HVDC) technology is the most cost-effective and efficient when considering economic, environmental, and technical perspectives. This demonstrated how well it worked to integrate renewable energy sources with the national grid and support the increased capacity of the targeted wind farms. Furthermore, because underground heating, ventilation, and air conditioning (HVAC) cables require lower spaces and avoid adverse effects on touristic areas, for instance, they may be more applicable in the Suez Gulf region. This option, however, may necessitate the use of power compensation capacitors. Furthermore, the economic factor must be considered (Elgeziry et al., 2019). Furthermore, hybrid systems are considered to be among the best options for energy sources in isolated areas that have no connection to the national grid (Elsaei et al., 2023; Rashwan et al., 2024). Some studies recommended that hybrid systems, which include wind and other renewable sources, be implemented in remote urban areas and villages in Egypt to supply stable electricity and support communities' development (Effat & El-Zeiny, 2022; Ragab et al., 2021).

**Figure 9**. *Power Transmission Lines in Egypt*




Source: The map was created using ArcGIS, based on data from www.openstreetmap.org

*Manufacturing Wind Turbines*

One approach that could help to lower wind power costs is to manufacture wind power systems locally. Since 2008, the Egyptian investor El-Sewedy Electric Towers (EET) has made plans and investments in the arena for the manufacture of wind energy generation components. Manufacturing enterprises are located in El Ain EL Sokhna - Suez Governorate, near Egypt's largest harbors and the Zafarana and Gabal El Zeit wind projects. The company has been an achievement in becoming a regional leader in the MENA region for energy solutions and its related services, as well as a global leader in cable manufacturing. Annually, it can produce 200 wind turbine towers, which it supplies for projects in Egypt, the USA, Germany, Italy, Poland, and Cyprus (EET, 2024). El-Sewedy officials estimated in a personal interview with the paper's authors that installing locally manufactured wind towers contributes to a 3% reduction in wind farm costs, which is 25% less than the wind tower cost. In addition to the social impacts of recruiting lots of employees about 300 - 400 per project and building capacity via sending technicians to Germany for training to become qualified welders and technicians. All of this supports the economic growth of Egypt. El-Sewedy has the potential to expand into additional wind turbine component production, but this needs strong

governmental incentives and support, which are not in place yet. For example, in reality, the customs duties for wind power equipment, components, and spare parts are subject to 2% customs with no value-added tax, while the locally manufactured components are subject to 14% value-added tax. This negatively impacts the competitiveness of the locally manufactured components, which in turn discourages the investors. The Egyptian government's plan must be detailed, with a specified time frame and outlining a minimum local contents percentage for each project (Shankir, 2024).

Climate change-related extreme weather events impose unique design considerations on wind turbines for adaptation. Rising temperatures along with moisture lead to several difficulties, such as metal corroding, lubricant thinning, impaired electronic performance, and altered motion in mechanical systems. Additionally, low temperatures can lead to sensor and turbine icing (Manwell et al., 2010). El-Sewedy officials stated that the wind turbine components are designed to endure and work effectively at temperatures as high as 50 ℃. However, the impact of climate change on each renewable source available in Egypt has to be evaluated and a plan must be prepared to adapt to these potential impacts accordingly, manufacturers take this into account (Shankir, 2024).

## Environmental Aspects of Wind Power

Wind power projects require vast land, as installing a capacity of 5 to 9 MW necessitates one $km^2$ of land. Egypt not only has vast uninhabited desert areas, but it also has high-speed winds in many areas, allowing it to enhance its wind energy utilization (Mahmoud, 2012). Therefore, about 7650 $Km^2$ has been allocated for wind and solar power development, as indicated in Table 6.

**Table 6.** *Area Land for Renewable Energy Projects*

| Location | Technology | Land area ($Km^2$) | Planned Capacity (MW) |
|---|---|---|---|
| Suez Gulf | Wind Power | 1220 | 3550 |
| East Nile | Wind Power | 841 | 5800 |
| | Solar Power | 1290 | 34900 |
| West Nile | Wind Power | 3636 | 23350 |
| | Solar Power | 606 | 17400 |
| Benban | Solar Power | 37 | 1800 |
| Kom Ombo | Solar Power | 7 | 260 |

Source: (NREA, 2024)

Installing wind power projects that consist of lots of turbines has some potential adverse environmental effects. The Egyptian promising areas with high wind speeds on the Red Sea coast and Suze Gulf intersect with one of the key crossing points for migrating birds from Asia to Africa. Strategic environmental studies were undertaken to identify areas that were highly sensitive to migratory birds and therefore excluded during project planning. This was necessary to reduce

the risk of collisions with wind turbines to conserve soaring birds while utilizing wind power potential. Simultaneously, preventive measures are implemented in the remaining appropriate locations, including monitoring migration routes in spring and fall and determining the appropriate procedure of action for turbines situated along those routes, such as stopping temporarily and determining the duration of the suspension. In addition to photographing and recording data such as bird species and their heights, as well as deaths and injuries (ElKhayat, 2024; RCREEE, 2024). Social and environmental assessments of wind projects were conducted, and the overall conclusion was that these impacts do not pose any significant problems. These effects are minimal when applying sufficient mitigation and monitoring requirements. These studies incorporate the involvement of stakeholders, including the public, to guarantee their support and achieve security and protection for the project via engaging them in employment and purchase opportunities during construction and operation. Public involvement aims to reduce potential negative environmental and social effects, enhance project acceptability, and achieve a balance between development and environmental protection (RCREEE, 2024).

On the other hand, climate change, as an environmental issue, is expected to have an impact on energy infrastructure, supply and demand, and other energy-related sectors. Egypt is considered one of the most vulnerable countries to the potential impacts and threats of climate change (SES, 2015). Therefore, over the past years, the government has given climate change more consideration in its national policies and strategy, which covers the energy sector regarding mitigation and adaptation actions. These actions include assessing the effects of climate change to determine safe locations for the construction of future power plants, as well as building institutional and technical capacity and supporting research and technological development to help the power sector become more climate resilient (IEA, 2023). Some researchers have assessed the impact of climate change on wind power potential under various climate change scenarios. It is expected to vary, with potential increases or decreases in wind power density (Gebaly et al., 2023; Hassaan et al., 2024). The regions with high wind power density will be negatively affected, with a projected decline of up to 1% of land areas. However, the Gulf of Suez area is expected to remain one of the most favorable regions for investment despite the anticipated climate changes (Ghanem et al., 2024).

## Economics of Wind Power

The economic analysis aims to evaluate the cost-effectiveness of wind power compared with available alternatives in Egypt. Natural gas is regarded as a crucial fuel for electricity generation, and it is expected to remain so for the next two decades. The 2022 fossil fuel price increase demonstrated how vulnerable countries that rely on fossil fuels for energy generation are (IRENA, 2023). Egypt has implemented a load-shedding program since the summer of 2023 in response to rising pressure on power stations caused by high local demand (Ahram Online, 2024). When there is not enough gas to adequately serve the power sector due to

export commitments or non-power uses, oil plays its role as a short-term balancing option. Concerning chances for other resources, Egypt does not have significant coal reserves, cannot expand its hydropower capacity, and the development of a nuclear power plant at El Dabaa entails several challenges, such as high initial costs and long construction delays. Increasing the number of wind power plants will be beneficial in the short and medium term. Also, solar PV is a strong alternative to wind power since it generates electricity that is comparable to that of wind. Since 2018, Egypt has taken a step toward moving away from foreign donor funding to private sector investment for wind and solar PV project development. In the private sector, investors require an appealing financial environment in which they can generate profits. Renewable prices are 2.5 US cents/kWh for solar power and 3 US cents/kWh for wind power, which is a favorable indicator of investors' interest in the Egyptian market (NREA, 2024). In order to compare wind and solar projects, capital, operating, and avoided costs should be considered.

*Capital Costs*

Wind energy is considered a capital-intensive investment and the factor that determines the generation costs is the initial capital costs. The wind farm project involves four stages, as indicated in Table 7.

**Table 7.** *Wind Farm Project Timeline*

| | **Development** | **Implementation** | **Operation** | **Decommissioning** |
|---|---|---|---|---|
| Description | Finding a site | Procurement | Operation | Remove |
| | Site Characteristics | Construction | Maintenance | Re-power |
| | Wind farm design | | Administration | |
| | Permissions & licenses | | | |
| | Financing | | | |
| | Public engagement | | | |
| Duration | Up to 5 years | 1 - 2 years | 20 - 25 years | < 1 year |

Source: (Cronin, 2023)

A significant motivation for investing is the capital expenses of wind power in comparison to other electricity generation technologies such as solar PV. The average installed cost of onshore wind power decreased by 42% globally between 2010 and 2022, from USD 2179/kW to USD 1274/kW, with an annual decrease of 10%. Reductions in wind turbine prices were the main cause of this fall. In contrast, solar PV experienced an 83% decrease in total mean installed cost from USD 2.5124/kW in 2010 to USD 876/kW in 2022. Egypt's onshore wind projects [Zafarana and Gulf of El Zayt] cost more than $370 million per MW, while the solar PV project [Benban] cost $2.20 billion (IRENA, 2023; NREA, 2024). Table 8 illustrates the predicted values.

Prices for wind turbines peaked between 2007 and 2010, after a dramatic rise from their lowest point between 2000 and 2002. This was related to advances in turbine design as well as price increases for materials, mainly cement, copper, iron, and steel. Increased government policy support for wind deployment, combined

with a demand-supply mismatch, allowed manufacturers to increase their margins. However, this increased competition does not protect the industry from the effects of supply and demand imbalances. Also, it has resulted in acquisitions in the turbine sector, as well as a shift in production to countries with lower manufacturing costs. In 2022, wind turbine prices decreased, ranging from USD 840/kW to USD 1175/kW, although rotor diameters, hub heights, and nameplate capacities have all increased over the last decade in general. Also, price differences between turbines with different rotor diameters have significantly narrowed. Yet, their prices increased in late 2020 and early 2021 due to COVID-19 and the concurrent market. Inverters and solar PV modules were the main contributors to the 37% cost decrease between 2016 and 2022. All module categories experienced declines at the start of 2023, with declines ranging from 7% to 9%, reflecting an ongoing decreasing trend for module prices (IRENA, 2023).

**Table 8.** *Predicted Investment Costs of Renewables in Egypt*

| Technology | Investment cost ($/KW) | | |
|---|---|---|---|
| | **2015** | **2025** | **2040** |
| Wind | 1200 | 1056 | 1056 |
| PV Utility Scale Size | 1000 | 800 | 742 |
| PV Small Rooftop (<10 - 20kW) | 1200 | 960 | 809 |
| Solar Thermal with Storage (10h – 12h) | 5000 | 4211 | 3027 |
| Solar Thermal Without Storage | 4500 | 3776 | 2715 |

Source: (Giannakidis, 2017)

*Operating Costs*

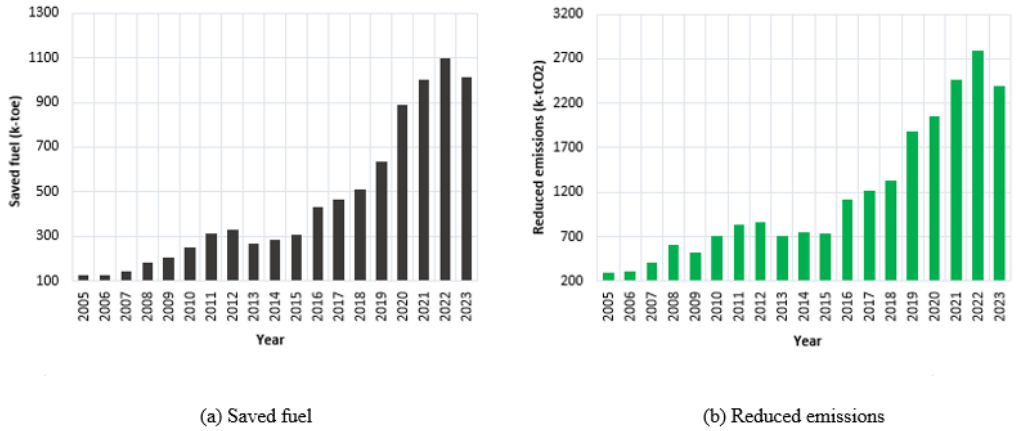
Competitiveness and technological advancements have led to designs that have helped lower operating and maintenance (O&M) costs. Over the last decade, major advancements in onshore wind turbine technology have resulted in higher capacity factors, which have averaged 37% in 2022. The capacity factor is the annual energy output from a wind farm, which is defined by wind resource at the location and turbine of the farm's maximum output. Wind power usually has capacity factors ranging from 25% to 40%. Egypt has excellent wind resources, so its capacity factors may exceed this percentage. For example, Zafarana has a capacity factor of over 35%. High-capacity factors, along with the relatively low cost of local labor and services in Egypt, indicate that O&M costs will be minimal. Also, the global capacity factor of solar PV was 16.9% on average in 2022. This rise can be attributed to two factors: installation in sunnier locations as well as technological advancements. O&M costs for solar PV plants have decreased over the past decade as a result (IRENA, 2023).

*Avoided Costs*

Besides economic and technical maturity, wind-generated electricity ranks second after hydropower in terms of achieving major environmental benefits such as fuel reduction that would be consumed through conventional generating plants.

Also, wind power mitigates the emissions that traditional fossil fuel-based power plants would produce. These emissions include particulates, slag, ash, carbon dioxide ($CO_2$), sulfur dioxide ($SO_2$), and oxides of nitrogen ($NO_x$) and thus contribute to climate change mitigation and air quality improvement. In addition to these direct environmental benefits, wind power generation also offers indirect benefits, including improved public health and political advantages resulting from reduced fossil fuel use. As shown in Figure 10, each GWh of wind-generated electricity in Egypt over the past year has saved 1100 k-toe (22%) of fuel and reduced emissions by 2785 k-t$CO_2$. Whereas, each GWh of solar PV-generated electricity has saved 820 k-toe (18%) of fuel and reduced emissions by 1932 k-t$CO_2$ (Manwell et al., 2010; NREA, 2024).

**Figure 10.** *Environmental Benefits of Wind Power from 2005 to 2023*




(a) Saved fuel (b) Reduced emissions

Source: (NREA, 2024)

## Conclusion and Recommendations

This article provides an in-depth overview of wind energy in Egypt, examining its economic, technical, and environmental dimensions. It also includes a comparative discussion with solar energy, highlighting the advantages and challenges of wind power. Wind power is a highly competitive source and a desirable option for investors due to its economic and technical maturity, as well as the avoided costs associated with the environmental benefits achieved. Egypt has favorable conditions for wind power development, especially in the Gulf of Suez region. However, the ambitious wind energy target of 14% by 2035 may not be achievable unless there is a significant acceleration in current and future projects.

- From the time Egypt's strategy was established in 2015 to 2023, wind power has contributed only 3% of the country's total electricity generation. Given this slow progress, it is advisable to update the plan to more accurately reflect the potential contribution of wind energy based on ongoing projects and future investments. The current strategy may need to

either revise the 14% target downward or scale up investments substantially to meet this ambitious goal. More accurate forecasting would also help set realistic targets for the coming years.

- The expected duration for each project should be clearly determined during the development phase, considering potential delays or challenges that may hinder progress. These include such as inflation, currency fluctuations, policies, and the costs of adaptation to the impacts of climate change. This will help with the evaluation of progress steps by 2035.
- The development of local manufacturing capabilities for wind energy components is a promising approach to reducing costs and enhancing the domestic industry. For this to succeed, strong government support is critical. This could include offering financial incentives to local investors and defining the minimum of local components for each wind project to protect the Egyptian industry.
- Wind power's intermittency imposes a challenge, as it can increase the cost of generating electricity. This challenge is more pronounced for single wind farms, but it diminishes as the number of wind farms expands and their geographical distribution increases. Therefore, it would be beneficial to invest in a more distributed wind energy network, which could help mitigate the risks associated with variance in wind speeds.
- Despite numerous studies indicating that offshore wind farms could provide significant power generation alongside socio-economic and environmental benefits, Egypt's current strategy does not prioritize offshore wind development. It would be beneficial to revisit this approach and explore the feasibility of developing offshore wind farms in addition to expanding onshore wind projects. Offshore wind power offers higher capacity factors and could help Egypt diversify its renewable energy sources, enhancing grid stability and resilience. Wind power is a promising option that could present opportunities for Egypt to export natural gas, which would generate hard currency and improve the country’s economic situation

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# Exploring Opposition Voting Patterns: The Role of Negative Partisanship and Affective Polarization

*By Can Büyükbay*[*]

*This study analyzes the voting behavior of the interviewees who voted for Kemal Kılıçdaroğlu in the May 14 and 28, 2023 presidential elections on the basis of data obtained through in-depth interviews. Findings from in-depth interviews reveal that negative partisanship and affective polarization are evident in opposition voters' preference for Kemal Kılıçdaroğlu. The findings show that voters do not have a strong emotional bond with Kılıçdaroğlu, but voted for him out of a desire to change the current government. The study sheds light on the emotional and identity aspects of political leadership and voter behavior during the presidential election process.*

**Keywords:** *Negative partisanship, affective polarization, voter behavior, in-depth interview.*

## Introduction

The presidential elections in Turkey on May 14 and 28, 2023, offer valuable insights into voter behavior amid significant political rivalry and growing social polarization. The contest between President Recep Tayyip Erdoğan and Kemal Kılıçdaroğlu highlighted how emotional and identity-driven factors influenced voter preferences.

The literature highlights negative partisanship as a rising trend in contemporary democracies, particularly in the United States, where it plays an increasingly influential role in shaping political preferences.[1] Furthermore, negative partisanship often characterizes polarized societies, and Turkey's current political climate exemplifies this theoretical framework. In-depth interviews revealed the tangible effects of this phenomenon, with many Kılıçdaroğlu supporters basing their preferences primarily on opposition to Recep Tayyip Erdoğan and the government.

The study goes beyond quantitative short surveys and aims to examine the attitudes, emotions and political imagination of voters through in-depth interviews. The study's contribution to the literature lies in its in-depth exploration of identity and leader-voter dynamics within Turkey's electoral processes.

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[1]Abramowitz and Webster, *Negative Partisanship*, 119; Abramowitz, "The Great Alignment", 5.

## Theoretical Framework

In recent years, political science literature has developed numerous theories to analyze voter behavior. Notably, the concepts of negative partisanship and affective leader polarization have become crucial in explaining voter preferences within modern democracies.

### *Negative Partisanship*

Research on voter behavior in political science indicates that voting decisions are shaped not only by economic interests and political promises but also by emotional connections between leaders and voters, as well as negative attitudes toward opposing political identities. With the rise of identity-based politics, voters are polarized during elections not just by political ideology but also through emotional ties and a sense of belonging. This leads voters to identify with a group or affiliation through positive or negative partisanship directed at specific leaders or political figures.[2]

Voter dissatisfaction with opposing parties and leaders can grow so intense that, despite concerns about their own party's candidate, voters are often reluctant to shift support. Negative partisanship often involves excluding and marginalizing opposing political identities, while affective leader polarization is fueled by deep emotional bonds fostered through leader-focused rhetoric and symbols. Ultimately, negative partisanship occurs when voters base their preferences more on opposition to a candidate than on the qualities of the candidate they support.[3] In this form of identification, voters' motivation to participate is rooted less in support or approval and more in a desire to block the opposing side. This drives voter preferences toward a negative stance, compelling them to cast a strategic vote aimed at preventing a figure they dislike or oppose.[4]

To sum up, negative partisanship sharpens the divide between "us" and "them" in polarized societies, with voters primarily motivated to back their party as a means to prevent the other from winning. In this framework, negative feelings toward another group or leader significantly influence electoral outcomes. Accordingly, voters' political judgments are largely shaped by negative perceptions of opposing groups, leading to decisions driven more by emotional antagonism than by rational choice. Negative partisanship heightens political polarization not only within individual voter preferences but also across society. Voting as a means of opposing a particular candidate, rather than supporting another, raises crucial questions about democratic processes. Understanding the role of negative partisanship in shaping elections, especially in highly polarized societies, is essential for devising future electoral strategies. Following this exploration of negative partisanship, the concept of affective leader polarization will be further examined.

[2]Abramowitz, "The Great Alignment," 173.
[3]Abramowitz and McCoy, United States, 146–47.
[4]Bankert et al., Measuring Partisanship, 13.

*Affective Leader Polarization and its Effects on Voter Behavior*

Affective leader polarization[5], a concept in political science and social psychology, explores how voters' emotional responses to political leaders influence the broader polarization process. Within this framework, leaders' charisma, rhetorical style, and emotionally charged messages can polarize voters along ideological or identity-based lines.[6] Strong emotions such as admiration for one's leader or hostility toward opposing leaders can significantly shape political preferences, leading to profound societal polarization.[7]

*Emotional Leadership and Polarization Dynamics*

Emotional leadership often centers on a leader's emotional intelligence, empathy, and impact on followers.[8] The concept of affective polarization through leaders highlights how the powerful emotional bonds or negative reactions they evoke affect both their supporters and opponents.[9] This suggests that individuals may polarize not just due to political beliefs but also as a response to emotional reactions against the opposing side.[10] These emotional influences shape voter behavior beyond rational or ideological motivations, creating responses rooted in emotional reactions. In this sense, leaders' language, rhetoric, and the identities they embody can deeply affect voters' emotions and sway their voting preferences. Affective polarization through leadership fosters a strong sense of belonging among a leader's supporters, distinguishing them from other political groups—especially in nations where populist leadership is prominent.[11]

*The Effects of Affective Polarization on Voters and Society*

Affective polarization not only intensifies voter loyalty to certain leaders but also fuels negative partisanship toward opposing leaders and their supporters. As Huddy et al. (2015) suggest, there is a strong link between voters' loyalty to their chosen leaders[12] and negative sentiments toward opposing groups, which can lead voters to view political opponents as threats, especially under the influence of affective polarization.[13] This leader-centered theory of affective polarization enhances leaders' ability to foster a strong sense of belonging among supporters while driving polarization and marginalization among opponents. Thus, affective

[5]Selçuk, in the "The Authoritarian Divide," examines the concept of affective leader polarization, where populist leaders increase polarization among voters through inclusive and exclusionary discourses.
[6]Iyengar et al., Affect, Not Ideology, 406.
[7]Mason, "Uncivil Agreement," 4.
[8]Goleman, "Emotional Intelligence."
[9]Abramowitz, "The Great Alignment," 109.
[10]Iyengar et al., Affect, Not Ideology, 407.
[11]Moffitt, Global Rise of Populism. 4.
[12]Huddy et al., Expressive Partisanship, 3.
[13]Iyengar and Westwood, Fear and Loathing, 690.

leader polarization not only mobilizes a particular constituency but also heightens mutual distrust and conflict within society at large.[14]

To conclude, the effects of affective polarization on leaders are crucial for political systems and democratic culture, deepening voter attachment to leaders and intensifying polarization toward opposing groups. Consequently, political dynamics are shaped not only by ideological divides but also by emotional and identity-based schisms. Affective polarization through leaders manifests when voters form positive or negative emotional bonds with certain leaders, with political preferences shaped more by intense emotions like love or hatred than by specific policy proposals. In this scenario, voters choose based on emotional attachment or opposition rather than a rational assessment of the leader's policies. Traditional theories of political behavior suggest that voters make decisions based on rational self-interest.[15] However, affective polarization centered on leaders often leads voters to stray from this rational framework, making choices rooted in emotional responses. This means that voters may be swayed more by the leader's charisma or ideology than by concrete policy proposals. Emotional attachments to leaders can undermine rational thinking, leading to less objective, emotionally driven choices.[16]

## Research Method

This study was based on semi-structured interviews with 21 participants aged 19 to 66, utilizing the in-depth interview technique, a qualitative research approach. All participants supported Kemal Kılıçdaroğlu in the presidential elections, with most voting for the Republican People's Party (CHP). Participants were selected from various regions across Turkey according to Konda's data, achieving a balanced representation of gender (11 males and 10 females), education levels (7 below high school, 8 high school graduates, and 6 university graduates), age, socioeconomic status, and occupation. Efforts were made to include participants from diverse provinces, providing varied perspectives on electoral motivations. Conducted in June 2023, after the 2023 elections, each interview lasted 60-90 minutes and analyzed the reasons behind voters' support for Kılıçdaroğlu.

The research methodology involved two stages. First, data collection was conducted through in-depth, semi-structured interviews. These were recorded via telephone in June 2023, and later transcribed. In July 2023, the author developed a research framework and semi-structured questionnaire. To keep responses open-ended, guiding topics, concepts, and questions were used during interviews. Questions focused on:

- Demographic information,
- Voting behavior,
- Evaluation of the chosen party/candidate (Kılıçdaroğlu and opposition promises, assessment of Kılıçdaroğlu and motivation to vote),

[14]Mason, "Uncivil Agreement," 4.
[15]Suzuki, "Rationality of Economic Voting," 624–42.
[16]Iyengar and Westwood, Fear and Loathing, 691.

- Assessment of the government (attitudes towards Erdoğan and government rhetoric).

The second stage involved data analysis. Each interview's internal consistency and relationships, as well as comparisons across different categories and demographics, were analyzed. A theory-driven approach was applied using foundational literature, with responses coded around themes related to negative partisanship and leader-based affective polarization.

It is essential to note that these interviews were conducted after the electoral loss. Thus, the responses reflect perspectives formed in a context where the electoral outcome was definite. Consequently, the analysis should be understood as assessing attitudes shaped after the resolution of the electoral possibilities.

## Findings

This study examines the behavior and motivations of voters who supported Kemal Kılıçdaroğlu[17] in Turkey's 2023 presidential elections, interpreting these dynamics through the lenses of negative partisanship and leader-based affective polarization theories.

Findings indicate that voters' preferences were largely driven by opposition to Erdoğan, with Kılıçdaroğlu struggling to forge a strong emotional connection with his supporters. Kılıçdaroğlu's and the opposition's discourse had limited influence on these voters, revealing a gap in fostering a shared passion and message. The study concludes that Kılıçdaroğlu's communication with his base, referred to as interdiscursivity, was notably weak.

A general sense of hesitation and reluctance marked the participants' voting behavior, with many indicating they voted for Kılıçdaroğlu primarily due to a perceived lack of alternatives. Kurdish voters, in particular, mentioned that they were influenced by Selahattin Demirtaş's rhetoric and cast their votes for Kılıçdaroğlu out of a sense of necessity rather than genuine enthusiasm. As a result, it is evident that Kılıçdaroğlu's voters struggled to build a strong emotional affinity with him.

[17]Konda Barometer, December Barometer, 2022. The Konda surveys reveal that Kemal Kılıçdaroğlu was the only leader who evoked more negative emotions than his party and had the highest level of negative partisanship nationwide leading up to the elections. My findings align with Konda's quantitative data: Despite this negative view, due to the opposition voters' strong negative partisanship towards Erdoğan they voted for Kemal Kılıçdaroğlu. See also, Evren Balta's analysis on Negative Party Partisanship in Konda Barometer, 2212.

*Reason to Vote for Kılıçdaroğlu: Role of the Negative Partisanship and Affective Leader Polarization*

The research findings indicate that the majority of voters who chose Kılıçdaroğlu did so primarily out of opposition to Erdoğan. Most participants reported that their decision was driven more by a desire to see a change in the current government than by commitment to Kılıçdaroğlu's promises or political stance, highlighting the significant role of negative partisanship in shaping voter preferences.

As one participant put it, *"The main reason I voted for Kılıçdaroğlu was my opposition to Erdoğan; there was no other option*[18]*",* underscoring how opposition to Erdoğan served as a primary motivator.

The impulse to vote for Kılıçdaroğlu was generally weak and reluctant. Many participants expressed voting for him due to a lack of alternatives. For instance, one participant noted, *"No, I only voted for Kılıçdaroğlu out of obligation. None of his promises or statements impressed me; it was just out of necessity*[19]*".* Another added, *"I decided to vote with a single purpose… I was aware nothing would change even if Kılıçdaroğlu won, I just made this kind of preference to break a chain for a while".*[20] This sentiment underscores negative partisanship, where voters cast their vote not for an appealing leader but out of opposition to the current one. Phrases like *"out of obligation"* or *"to break the chain"* suggest that voters chose Kılıçdaroğlu as a reaction to the existing system rather than out of active support for him. This indicates that electoral preferences were influenced less by candidates' positive attributes and more by negative opinions of the government and the current system.

The comment*, "I knew that nothing would happen even if Kılıçdaroğlu came to power,"* reflects a sense of hopelessness within this negative partisanship. One participant further echoed this reluctance: *"I'm not someone who likes Kılıçdaroğlu... I didn't vote for him willingly; it was out of necessity. Otherwise, I'd say, 'I wish I hadn't voted for him.' I regret it".*[21] These quotes illustrate that voters' preferences were driven more by emotional opposition or a sense of compulsion than by rational decision-making. For these three voters, their decision to support Kemal Kılıçdaroğlu was rooted in a sense of obligation rather than a genuine preference.

Overall, support for Kılıçdaroğlu appears to stem from necessity, despair, and a reaction against the status quo rather than from enthusiastic commitment. Voters struggled to find a figure in politics that truly represented them, ultimately basing their preferences on a desire for change and dissatisfaction with the current administration. This pattern was also reflected in other interviews, showing a consistent theme of reluctant support rooted in opposition to the existing leadership.

In-depth interviews indicated that voting for Kılıçdaroğlu was largely driven by negative partisanship toward the opposing party and by affective polarization directed against Erdoğan:

[18]Interviewee 3.
[19]Interviewee 20.
[20]Interviewee 11.
[21]Interviewee 21.

> To put it plainly: Kemal Kılıçdaroğlu didn't quite possess the stature or ability to serve as president; let's be clear about that upfront. But, as previously mentioned, we voted for him out of necessity. Overall, he didn't instill much confidence... We cast our votes as those who either support Recep Tayyip Erdoğan or oppose him — it was more a matter of those who wanted him and those who didn't.[22]

The concept of affective leader polarization offers a crucial theoretical perspective for understanding how individuals' emotional responses to political leaders and their sense of closeness or distance to them heighten societal polarization. Hence, political divisions are shaped not merely by ideological or policy differences but also by strong emotional reactions toward leaders. The statement, *"We cast our votes as those who either support Recep Tayyip Erdoğan or oppose him"* highlights the significant role of emotionally driven leader polarization in shaping voter behavior.

> It was already clear who we weren't going to vote for. We focused on choosing a candidate who could prevent that person from staying in power, and ultimately, we voted for his opposition.[23]

As illustrated in this excerpt, the participant states that their preference was based not on their preferred candidate's qualities or promises but rather on a desire to prevent the opposing candidate from gaining power. This approach reflects voting behavior driven by negative sentiments toward the opposing leader rather than a positive political commitment. According to affective polarization literature, voters often select a candidate not because they view them as the "best option" but as the most viable alternative to "prevent the opposing candidate" from winning.[24]

This behavior demonstrates how affective polarization is reinforced through leaders, shaping elections around an "oppositional identity" rather than constructive alignment:

> To put it this way: we were at a point where we would vote for a glass if it came to that — and honestly, I still feel the same. We thought, "Whoever it is, it can't be worse than this." Whether the candidate was announced or not, our direction was clear. I was already following the opposition closely every day, down to each of their speeches.[25]

While Kılıçdaroğlu's personality, promises or policies cease to be of primary importance, the main factor determining voting behavior is based on the aim of not supporting the opposing leader. This perspective shows that affective polarization has become a powerful motivator in politics.

With the statement *"Whoever it is, it cannot be worse than this"* the interviewee emphasizes the negative image of the current leader figure in their eyes rather than the candidate. This discourse reflects the tendency of voters to

[22]Interviewee 4.
[23]Interviewee 16.
[24]Abramowitz, "The Great Alignment,"170.
[25]Interviewee 5.

develop extremely negative attitudes towards the opposing group, which is frequently discussed in the affective polarization literature.

By constantly following the opposition and observing the differences in the discourse of the leaders, the voter in this excerpt reinforces the negative feelings she has developed against the current leader figure. Yet another interviewee makes similar statements:

> Nothing directly influenced me, but rather, it was the other side that drove my decision. That's why I voted, to put it simply.[26]

Kurdish voters were also influenced by the rhetoric of Selahattin Demirtaş and again voted compulsorily/unwillingly:

> Well, we cast our vote reluctantly, but what could we do? Mr. Erdoğan is old; we voted, albeit unwillingly, hoping he would step aside and make way for someone else, maybe even bring some change to the current order. And, honestly, we did it because "Selahattin Demirtaş mentioned it.[27]

> If it were just a personal decision, based solely on sentiment, maybe we wouldn't have gone to vote. But, in a way, we also listened to the HDP or the Green Left Party because they advocated for it.[28]

There are also some interviewees who are skeptical about why Kılıçdaroğlu ran for office when he knew he could not win:

> Of course, when Kılıçdaroğlu was nominated, I spoke with my teacher friends and thought, "Oh no," as Kılıçdaroğlu seemed to be exactly who the other side wanted.[29]

At this stage, a sense of reluctant, even hopeless, voting emerges among participants. It appears that neither the opposition nor Kılıçdaroğlu managed to inspire a shared passion or hope among voters. Political alienation, defined as a feeling of indifference or distrust toward the political system, is discussed in the literature in terms of feelings of powerlessness and meaninglessness.[30] The excerpts show that voters lack faith in Kılıçdaroğlu's ability to drive change, even if he were to win. This aligns with political alienation, as voters feel ineffective within the political system. Those with a sense of powerlessness believe that any elected candidate would have limited impact, leading them to cast protest or anti-system votes rather than supporting anyone within the system.

Opposition to Erdoğan was a primary motivation among opposition voters, with many indicating that they saw Kılıçdaroğlu not as a hopeful or ideal leader but as the only alternative to Erdoğan. This underscores the extent of political polarization in Turkey and the influence of negative partisanship on voter behavior.

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[26]Interviewee 3.
[27]Interviewee 4.
[28]Interviewee 6.
[29]Interviewee 13.
[30]Seeman, "On the Meaning of Alienation," 783.

*Ideal Candidate Assessment*

The characteristics that should be present in the ideal leader are the opposite of the aspects that opposition voters complain about President Recep Tayyip Erdoğan. When we asked the participants about the characteristics of the ideal leader and what kind of a leader should govern Turkey, characteristics such as "fair, defending freedom of thought, honest, inclusive" came to the forefront:

> A fair leader in every aspect, one who may be uncompromising when necessary...[31]

> I place honesty at the forefront, because people truly need the truth now — someone genuinely committed to protecting the rights of even the unborn child, someone who does things by the book.[32]

> In other words, the ideal leader should be someone who meets the country's and society's core needs, independent of political affiliation. They should be inclusive and unifying, not a source of division within society.[33]

> Such a leader should be highly knowledgeable, deeply honest, free from deceit, and capable of inspiring trust and belief among all people.[34]

When talking about the characteristics of an ideal leader, the participants stated that Kılıçdaroğlu would be a better president than Erdoğan. This expectation is shaped by the fact that the characteristics that the participants define as the ideal leader (just, honest, inclusive, etc.) are the opposite of Erdoğan's criticized characteristics. Negative partisanship becomes evident here as a process of identification developed against Erdoğan; participants define their ideals in opposition to the characteristics they dislike in the current leader.

In this context, it is observed that voters determine their preferences based on their negative feelings towards the discourses of the current leader, which they perceive as marginalizing and polarizing. This process coincides with the tendency of voters to form their own identities by excluding the opposing camp.[35] While the participants stated that an ideal leader should have inclusive, honest, just and unifying characteristics, it is noteworthy that these values are defined in opposition to Erdoğan's discourse and policies.

Leader-based affective polarization creates a strong sense of belonging among Erdoğan's supporters, whereas it creates feelings of anger and alienation among the opposition. On the other hand, in the process of negative partisanship, criticism against Erdoğan contributes to Kılıçdaroğlu's support. Thus, support for Kılıçdaroğlu is reinforced through negative feelings towards Erdoğan, and the expectation of an ideal leader is set in opposition to Erdoğan's shortcomings.

[31]Interviewee 1.
[32]Interviewee 5.
[33]Interviewee 7.
[34]Interviewee 13.
[35]Iyengar and Westwood, Fear and Loathing, 690.

The majority of respondents said that Kılıçdaroğlu was not the ideal candidate and that it was difficult for him to win from the beginning:

> If you asked anyone, they would say they already knew Kılıçdaroğlu couldn't win. He seemed to be the only one who didn't realize it.[36]

> I'm not sure if the election outcome could have been different, but I don't believe he was the ideal candidate.[37]

> In the public's eyes, Kılıçdaroğlu became a point of failure, a red mark, because he couldn't secure a win. I think another candidate might have had a chance — Yavaş could have won, İmamoğlu could have won.[38]

Emotional leadership refers to a leader's ability to manage own emotions and the emotions of others and emphasizes the role of emotional intelligence in leadership. In emotional leadership, leaders are expected to effectively regulate their own emotions and the emotions of others, thus strengthening group dynamics such as cooperation, cohesion and motivation. Emotional leadership theory also suggests that leaders' ability to create a positive mood within the group can have a positive impact on performance.[39] In this framework, based on the above quotations, it is seen that Kemal Kılıçdaroğlu has not performed adequately in terms of emotional leadership.

Participants think that Kılıçdaroğlu's vote corresponds to the minimum number of votes and that strategically Mansur Yavaş and Ekrem İmamoğlu are close to winning. Participants tend to categorize the leaders as winners and losers:

> Naturally, well-known candidates like Ekrem İmamoğlu and Mansur Yavaş come to mind first, and I believe both would have garnered more votes than Kılıçdaroğlu. To put it simply, I think Kılıçdaroğlu's vote count was already the baseline, and if you or I had run, we probably wouldn't have received fewer votes — that's my humble opinion.[40]

> There's also the fact that İmamoğlu and Yavaş won the elections they contested, establishing themselves as winners. This would have created an extra impact, a momentum boost. In contrast, Kılıçdaroğlu's record of not winning elections automatically cast him as a losing candidate.[41]
> In my view, if İmamoğlu had been the candidate, he would have achieved a higher vote percentage.[42]

When these quotes are evaluated in terms of the concepts of affective polarization and negative partisanship, it is understood that voters' perceptions of

[36]Interviewee 21.
[37]Interviewee 1.
[38]Interviewee 10.
[39]Bass, "Leadership Beyond Expectations."
[40]Interviewee 3.
[41]Interviewee 16.
[42]Interviewee 14.

Kılıçdaroğlu's candidacy are determined by both lack of emotional commitment and hopes for other leader figures. The statements of the participants reveal that although they support Kılıçdaroğlu, they do not see him as the "ideal candidate" and think that his chances of winning are low from the beginning.

Participants' perception of Kılıçdaroğlu as a "defeated" and "outdated" leader contributes to Kılıçdaroğlu not being perceived as a unifying leader. This situation shows voters' negative partisanship tendency towards leaders who do not meet their expectations and their search for an alternative leader figure. As stated in the literature, voters identify leaders by emphasizing their shortcomings rather than an element of belonging, which can be explained by weak emotional attachment and the search for alternatives.[43]

*Promises of Kılıçdaroğlu and the Opposition*

In general, respondents think that the opposition and Kılıçdaroğlu have failed to express themselves clearly:

> ...If they had articulated their stance just once, things might have turned out differently. They failed to communicate their policies effectively...[44]

> Question: Well, is there anything you remember from Kılıçdaroğlu's speeches during this campaign period?
> Answer: I suppose not; I never watched them — I just cast my vote for him.[45]

Interviewees believe that Kılıçdaroğlu is unable to express himself clearly and present a concrete leadership vision. This shows that Kılıçdaroğlu has difficulty in establishing an emotional connection as a leader. In this section, it is noteworthy that the opposition's promises did not impress the voters sufficiently and the ones that stuck in their minds were general and abstract issues.

*Attitudes towards Erdoğan*

When the participants were asked how they felt when Erdoğan won, sadness, disappointment and hopelessness came to the fore:

> *I mean, I remained neutral, really, because, as I said, I'm still young, and I haven't fully grasped what has impacted my life or how. Recep Tayyip Erdoğan has always been the president, for as long as I can remember. So, I didn't feel much about it — it's always been him, it still is, so whatever I feel seems pointless.*[46]

In the first participant's statement, the neutralized emotional response indicates that the long-term rule of the leader creates a "habit" and emotional wear and tear in the individual. Hence, under long-term leadership, voters sometimes

[43]Mason, Uncivil Agreement; Abramowitz, The Great Alignment.
[44]Interviewee 11.
[45]Interviewee 20.
[46]Interviewee 1.

develop a neutralized or accepting attitude instead of extreme polarization. This suggests that leader-based polarization may not only create overly positive or negative emotional reactions, but sometimes it may also be reflected as emotional neutrality.

The fact that Erdoğan's winning the election is seen as a commonplace among opposition voters reveals a state of "emotional dissatisfaction" that this affective polarization may create. One of the respondents expressed that *"Erdoğan has always been the president",* and thus, the election result was met with insensitivity. Voters' apathy towards Erdoğan's victory also points to a lack of leader-voter bonding and individual ineffectiveness:

> Well, it wasn't a big disappointment for us; it was already expected. Like we said, when the votes were being counted, he started with only a few percent. Thanks to Anadolu Agency, as soon as the ballots were opened, they placed him in first, and that was that. So, we didn't feel much disappointment. We had estimated about a 10 percent chance for Mr. Kılıçdaroğlu to win, maybe 10 percent.[47]

The participant's statement is an expression of acceptance that the election outcome was expected and a certain degree of disappointment. These quotes suggest that leader-based affective polarization can also generate a certain degree of emotional acceptance and indifference among voters, rather than strong opposition or support. In this context, these quotes suggest that leader-based affective polarization not only increases emotional intensity through polarization, but can also lead to less intense reactions such as acceptance of the opposing leader or emotional neutrality.

In addition, it is observed that the emotion that stands out in almost half of the participants is anger.

> There was anger and shock, but in my personal life, it was more of an "I told you so" — it was clear that things would turn out this way.[48]

In the participant's statement, his anger at the outcome of the elections is mixed with a personal affirmation of "I told you so". This sentiment reflects a kind of "realistic" acceptance of the political system while feeling anger towards it. The quate suggests that this type of anger can occur within leader-based polarization, especially in the context of a sense of defeat. Instead of experiencing an emotional shock after the results, voters may develop a strategy to reduce anger through a sense of "anticipation" or "living up to expectations".

> Let them sink a little deeper — I don't mean the well-off, who've only gotten richer and richer. I'm talking about the people struggling to survive on pennies, those suffering from hunger. Let them hit rock bottom, and then they'll finally see their day.[49]

[47]Interviewee 4.
[48]Interviewee 3.
[49]Interviewee 2.

The above participant's statement expresses a much more intense anger, and this anger is not only directed at the leader, but also at the leader's supporters and social base. Such a strong expression of anger indicates, leader-based affective polarization sharpens not only political differences between individuals but also societal conflict.

In this context, the fact that the reaction to Erdoğan's victory was expressed in a language of anger and social segregation reveals the impact of negative partisanship. This anger towards Erdoğan's supporters, while holding them responsible, also reveals the marginalization dimension of negative partisanship by placing them in a morally and economically "inferior" position. In the perspective of negative partisanship, this is the tendency to direct anger towards the opposing group and to perceive this group more negatively in the event of the loss of the ideal leader. Thus, the process of negative partisanship increases distrust and anger towards Erdoğan supporters, while at the same time deepening the emotional distance between voters.

This analysis reveals that Erdoğan's victory elicited a variety of reactions such as despair, anger and acceptance among the participants and that these reactions are linked to affective leader polarization and negative partisanship processes. This situation provides an example of both the emotional depth of leader-voter relations and the negative effects discussed in the literature on how polarization in society is reinforced.

The following excerpts reveal how a significant negative perception of President Recep Tayyip Erdoğan is shaped within the framework of leader-based affective polarization. In this context, the fact that Erdoğan is characterized with negative images such as authoritarian and demagogue shows that Kılıçdaroğlu voters perceive this leader figure negatively as a result of affective polarization:

> For one, he's the president of all of Turkey, yet he uses such derogatory, divisive language. Can someone who speaks that way really govern all of us? He should be speaking in a unifying way, defending the rights of everyone.[50]

In the quote, the description of Erdoğan's language as divisive and derogatory reveals the effects of affective polarization. Hence, the language used by leaders can lead to emotional reactions among voters, causing them to develop an emotional positioning towards political leaders. This feeling creates an emotional rupture over common values in society and increases polarization:

> Q: What comes to your mind when you think of Recep Tayyip Erdoğan?
> A: Authority, repression, polarization.
> Q: So, how do you find the current administration of the country?
> A: You can probably tell I'm not satisfied. To put it simply, the administration is irrational, unscientific, unpredictable, lacking merit, and frankly, completely disgraceful.[51]

Q: What comes to your mind when you think of Erdoğan?

[50]Interviewee 8
[51]Interviewee 3.

> A: Demagoguery. In the simplest terms, staying in power by manipulating people's emotions, telling them what they want to hear. He's a powerful demagogue, a strong orator... implementing entirely wrong policies leading the country to disaster.[52]

In this context, views such as Erdoğan's "staying in power by exploiting emotions" and "leading the country to disaster with wrong policies" reflect a perspective that criticizes not only the leader's policies but also his existence, and that is morally and emotionally incompatible with his political line. This can be explained as a reaction of the opposition voters not only to the leader's actions but also to the leader's personality.

> ... No sir, actually they should feel sorry for being put in that situation, I mean, "People have fallen in love with their executioners", what can I say.[53]

Finally, voters' anger against Erdoğan also causes them to emotionally distance themselves from the masses who support him. The expression "people in love with their executioners" illustrates how affective polarization damages social cohesion by creating a distinction between "us" and "them" in a society. Affective polarization affects voters' relations not only with the opposing leader but also with the leader's supporters, which can pave the way for social conflicts. According to the literature, leader-based affective polarization deepens conflict in society, making it difficult to develop a common understanding and perpetuating social divisions in the long run.[54]

By evaluating the quotes within the framework of affective leader polarization and negative partisanship, we can examine how negative emotional reactions towards Erdoğan and the polarizing effect of his leader image are shaped. The participants' frustration, anger and helplessness towards Erdoğan reflect the fact that the leader's discourse and policies have created widespread discontent in the society and led to alienation among the opposition due to the weakness of this emotional bond. In this context, the negative attitude towards Erdoğan becomes evident as an element that strengthens the participants' opposition identity.

## Conclusion and Evaluation

This study analyzed the voting behavior of voters who voted for Kılıçdaroğlu in Turkey's 2023 presidential elections. The findings revealed that opposition voters' emotional opposition to Erdoğan and the government was the main motivation for voting for Kılıçdaroğlu. Voters were motivated by a reaction against Erdoğan rather than a belief in Kılıçdaroğlu's leadership. This shows the depth of affective leader polarization in Turkey and how negative partisanship shapes voter behavior.

In this analysis, we see how emotional reactions to Erdoğan are intertwined with emotional leader polarization and negative partisanship processes. While

[52]Interviewee 5.
[53]Interviewee 2.
[54]Iyengar, Sood, and Lelkes, "Affect, Not Ideology," 405.

Erdoğan's charismatic yet perceived authoritarian image creates a distinct emotional divide between his supporters and opponents, his divisive language, repressive policies and the perception of dependency created through social benefits lead to a strong negative partisanship among the opposition.

The most prominent impression from the interviews is that the voters who voted for Kılıçdaroğlu did not vote for Kılıçdaroğlu because the promises of Kılıçdaroğlu and the opposition gave them excitement or hope, but because of their strong tendency to oppose the government. This shows that Kılıçdaroğlu failed to establish a strong emotional bond with his voters. These findings reveal how Kılıçdaroğlu's lack of emotional leadership affects voters' decision-making process. There is a general hesitation and abstention in the voting behavior of the participants. In general, it is observed that they voted for Kılıçdaroğlu out of a sense of forced lack of choice.

Affective leader polarization is an important indicator of how leaders deepen political polarization in relation to strong emotional reactions in individuals. This polarization can make political divisions in society deeper and more persistent, and the emotional effects of leaders can shape voter behavior and overshadow rational choices. The literature predicts that increased affective polarization may make social cohesion more difficult and weaken political functionality.[55] In Turkey, affective polarization towards leaders is a factor that greatly affects voter behavior. In the presidential elections, emotional reactions towards leaders were a determining factor in voters' preferences.

Future research could examine the long-term effects of affective leader polarization and negative partisanship in Turkey. Moreover, a more detailed examination of the effects of political leaders' emotional leadership skills and discursive strategies on voter behavior could provide important insights into the functioning of democratic processes.

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# An Evaluation of Vitamin D and Bone Turnover Markers Levels in Postmenopausal Women in Albania

*By Esmeralda Hoxhaj[*] & Anila Mitre[±]*

*Vitamin D is a lipophilic prohormone that is synthesized in the skin in response to sunlight, although diet may be a source of much lower amounts of Vitamin D. Receptors of the active form of Vitamin D (VDR), have been identified in the cells of the intestinal epithelium, renal tubules, bone and other tissues and organs, which indicates a broad spectrum of 25(OH)$D_3$ (Miyahara 2002, Woeckel 2010). Besides its role in intestinal calcium absorption, calcitriol may also affect bone health directly, as its receptors are expressed by osteoblasts (Chen et al. 2016). The consequences of vitamin D deficiency are secondary hyperparathyroidism and bone loss, leading to osteoporosis and fractures, mineralization defects, which may lead to osteomalacia in the long term, and muscle weakness, causing falls and fractures (Matsumoto 2011). Therefore, we aimed to investigate the association between serum levels of 25(OH)D and bone turnover markers in postmenopausal women, and their impact on osteoporosis. In this two – years study (2020-2022), we described the epidemiology of vitamin D status across women population in Albania and its potential associations with bone biomarkers (OC, PTH, ALP). Our study showed a clear seasonal variation of bone turnover markers and a negative Pearson correlation between serum 25(OH)D and osteocalcin (OC) ($r= -0.37$, $p<0.05$). Osteoporosis leads to decreased hydroxyapatite crystal formation and hence results in increase in serum osteocalcin levels (Matsumoto 2011, Tilyard 1992). We found reduced 25(OH)D concentrations in postmenopausal women (21.71 ng/mL) and showed that a deficient 25(OH)D concentration is associated with significantly increased markers of bone resorption and decreased bone mineral density (BMD) values.*

**Keywords:** *25-Hydroxyvitamin D, osteocalcin, bone biomarkers, bone density*

## Introduction

Disorders of bone metabolism, most notably osteoporosis, are highly prevalent and predispose to fractures, causing high patient morbidity and mortality. Osteoporosis is a skeletal disorder characterized by low bone mass and micro-architectural deterioration of bone tissue, which leads to increased bone fragility and susceptibility to fractures. In adults the most common types are age-related (senile) osteoporosis and postmenopausal osteoporosis (Tilyard 1992).

The burden of osteoporosis increases with advancing age, and it is estimated that worldwide one in three women and one in five men above the age of 50 years will experience an osteoporotic fracture (International Osteoporosis Foundation,

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2017). Also, the pain, the deformation, the disability, and the loss of proper function of the skeleton, as a consequence of osteoporosis, significantly affect the psychological cost of the patients. Diagnosis, treatment and monitoring of treatment for osteoporosis are of critical importance. Osteoporosis may be defined quantitatively using diagnostic thresholds based on measurements performed at the spine, hip and forearm using photon absorptiometry dual-energy X-ray (DXA). Bone Mineral Density (BMD) is considered the gold standard of the bone status assessment in osteoporosis; however it does not offer the timely response desirable for monitoring. As osteoporosis emerges directly from alternations in the number or activities of osteoblasts and osteoclasts, it follows those biomarkers of the activity of these cells reflects current levels of bone turnover (Chen et al. 2016, Tilyard 1992).

## Literature Review

Bone biomarkers are produced from the bone remodeling process included bone formation biomarkers, bone resorption biomarkers and regulators of bone turnover. Bone Turnover Markers (BTMs) can be categorized first as reflection either bone resorption or formation, and then further categorized into matrix products that are liberated during bone resorption or formation. In an individual bone remodeling unite, specific cells as osteoblasts, osteoclasts and osteocytes work together in a well synchronized cycle way. First the osteoclasts due to their morphology and their metabolic products, they cauterize an indention called lacuna. After this lacuna has reached a certain size (*approx. 200 µm in diameter and 50 µm in depth*) the osteoclasts stop their activity and another family cells, the osteoblasts, settles down on the bottom of the indention. They fill the lacuna with osteoid, which is a mixture of proteins, mainly non-carboxylated osteocalcin and precursors of collagen 1. After carboxylation of the osteocalcin and formation of collagen 1, calcification of the osteoid takes place with the contribution of Vitamin D and eventually the bone returns to its initial situation (Gundberg 1998).

There are two major forms of vitamin D, vitamin D2 (*ergocalciferol*) and vitamin D3 (*cholecalciferol*). Vitamin D2 is found in plants and can be consumed in fortified food products or as a supplement. Vitamin D3 is obtained from either dietary sources or through the conversion of 7- dehydrocholesterol in the skin upon exposure to ultraviolet B (UVB) radiation. Vitamin D3 from the skin is bound to the vitamin D-binding protein, whereas vitamin D2 and vitamin D3 from diet are bound to vitamin D-binding protein and lipoproteins. Both forms are hydroxylated in the liver to 25-hydroxyvitamin D [25(OH)D; D represents D2 or D3]. However, 25(OH)D is inactive and requires hydroxylation in the kidney to form 1,25-dihydroxyvitaminD/ [1,25(OH)2 D, calcitriol]. Calcitriol [1,25(OH)2 D] maintains calcium in the blood and has an array of effects on the body's organs. Calcitriol acts in an endocrine manner to regulate calcium metabolism by enhancing intestinal calcium absorption and mobilizing calcium from the skeleton (Holick 2007, Bouillon 1995, DeLuca 2004). Receptors of the active form of Vitamin D (VDR), have been identified in the cells of the intestinal epithelium,

renal tubules, bone and other tissues and organs, which indicates a broad spectrum of $25(OH)D_3$. Besides its role in intestinal calcium absorption, calcitriol may also affect bone health directly, as its receptors are expressed by osteoblasts (Miyahara T. 2002). On the other hand, there are reports that $1\alpha,25(OH)_2D_3$ produces rapid biological responses that involve opening of chloride and calcium channels to activate exocytosis of bone matrix proteins such as osteocalcin (Mizwicki 2004, Zanello 2004). Osteocalcin is an osteoblast-specific secreted non-collagenous, vitamin K-dependent large protein synthesized by osteoblasts, odontoblasts, and some chondrocytes, and secreted into the general circulation. It binds to hydroxyapatite, and it is deposited in the bone matrix. As osteocalcin fragments are released from the bone matrix during resorption, assays for circulation osteocalcin and its fragments reflect both bone formation and resorption (Cloos 2004, Lerchbaum 2015).

## Materials and Methods

In each patient fasting venous blood samples were collected in the morning. The following serum indicators of bone and mineral metabolism were measured: two bone formation markers (osteocalcin and bone alkalin phosphatase), one bone resorption marker beta-collagen 1 C-terminal cross linked telopeptides (β-CTx serum), parathyroid hormone (iPTH), 25 hydroxyvitamin D [25(OH)D], calcium (Ca), phosphorus (P), alkalin phosphatase (ALP), bone specific alkaline phosphatase (BAP). The serum concentrations of OC, 25OHD, PTH, calcium, phosphor and alkaline phosphatase (ALP) were measured using an electro-chemiluminescent immunoassay (Cobas 6000 analyzer, Roche Diagnostics).

BMD was measured by dual-energy x-ray absorptiometry (DXA) scan (StreeMcare) at the lumbar spine – LS (L1-L4). According to WHO criteria, osteoporosis is defined as the T-score of less or equal to 2.5 and osteopenia as the T-score between 1.0 and 2.5. Vitamin D status was defined as deficient for circulating 25(OH)D concentration <20 ng/mL, as insufficient for 20-30 ng/mL and as optimal >30 ng/mL.

This study was performed from January 2020 to January 2022. We used data from private laboratory INTERMEDICA Center and radiology clinic MedXray, in Albania. Serum bone biomarkers levels were assessed in 50 females. The female patients were divided into two groups: the pre-menopausal (n=24) and the post-menopausal (n=26). Women were also grouped according to the seasons of 25(OH)D measurements: Spring, Summer, Autumn and Winter.

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***1*** *Statistical Analyses*

Most of statistical analyses were performed using Excel 2013 and SPSS 20 statistical package. Multiple comparison test and Post hoc tests was used to identify which categories were significantly different from each other at a level of 5%. The correlation was analyzed by the Pearson linear regression test. Values of $p < 0.05$ were taken as statistically significant.

## Results

The whole study group consisted of 50 adult women (mean age 48.1 ±18.5SD years). Twenty-four of them were premenopausal women and twenty-six were postmenopausal women. The mean serum 25(OH)D concentrations (21.4 ±12.0 ng/mL) of the whole participants was above the vitamin D insufficiency borderline (20 ng/mL). However, the majority of the patients 44% (n= 22) showed deficiency of vitamin D, followed by insufficiency detected in 34 % (n=17) and normal vitamin D levels in 22 % (n=11). Mean β-CTx (0.283 ±0.15 ng/ml) and osteocalcin (22.9 ±18.5 ng/ml) levels were within the normal reference range.

Increased bone loss was also observed by this study. The average value of bone measurement density (BMD) of the participants was T-score = -1.81 g/cm$^3$, which indicates low bone mass (osteopenia) of women. The T-score of the lumbar spine in postmenopausal women ≥ 48 years in Albania is at the level of osteopenia (-1.96 g/cm$^3$). Subjects were grouped into normal (27 %), osteopenic (39.5 %), and osteoporotic (33.5 %) based on the t-scores.

In the investigated period, there were statistically significant differences in the mean T-score results of bone density in all seasons. Also, Albanian women had a clear seasonal dependency within the measurements of 25OHD, with significant differences between winter and autumn groups (p= 0.027). There were no significant seasonal differences in the values of OC, β –CTx, BAP, Ca and phosphor during this two years period study.

**Figure 1.** *Prevalence of Vitamin D Deficiency Status Among Female Patients*

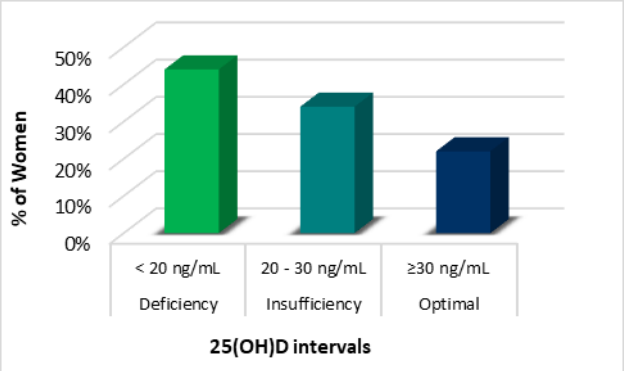



**Figure 2.** *Age Relation of Vitamin D and Osteocalcin*

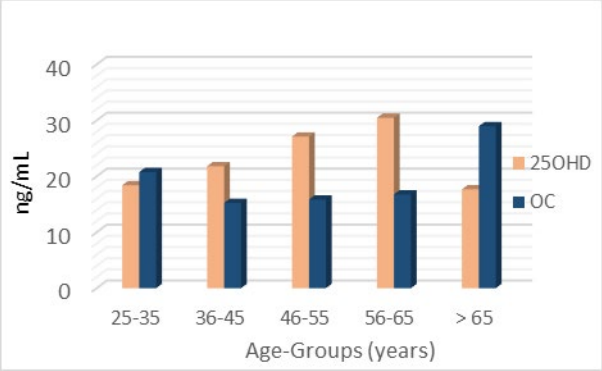


Figure 2 shows the mean value Vitamin D and Osteocalcin in different age groups, in the age group of 25 – 35 years 25OHD was 20.4 ng/mL and OC 20.75 ng/mL. In the age group of 46 – 55 years the mean vale 25OHD was 28.1 and OC 15.85 ng/mL. The age group 56 – 65 years was the only group that had 25OHD concentrations at the borderline of the Optimal Vitamin D level 30.46 ng/mL, but OC had the lowest concentrations 16.76 ng/mL. Women over 65 years showed the lowest 25OHD concentrations 17.67 ng/mL and the highest OC concentrations 28.95 ng/mL.

The association between serological and BMD parameters was assessed using the Pearson's correlation coefficient. The level of 25OHD in Postmenopausal women group indicated a strong significant positive correlation with BMD T-score (r=0.586, *p=0.003*), and negative correlation with bone formation marker Osteocalcin (r= -0.37, *p=0.043*) and bone resorption marker β -CTx (r= -0.512, *p=0.036*). Furthermore, phosphor concentrations showed strong negative correlation with T-score of bone density measurement (r=-0.556, *p=0.048*) and PTH (r= -0.709*, p=0.010*), and strong positive correlation with OC (r=0.592, p=0.033). Also, there was observed a positive correlation between OC and β-CTx concentrations (r=0.591, p=0.012). On the other hand, serum Ca levels showed no significant associations with any of bone formation or bone resorption markers.

In contrast, in Premenopausal women group, there was not any significant correlation between 25OHD concentrations and T-score (p=0.537) and OC levels (p=0.367). Also, it was noticed a strong association between β -CTx and BAP concentrations (r=0.974, p=0.06), and a positive association between Vitamin D and serum β-CTx (r=0.610), but with lower significance (*p=0.081*).

**Figure 3.** *Scatterplot that Shows Exactly the Association of Vitamin D with BMD and OC*

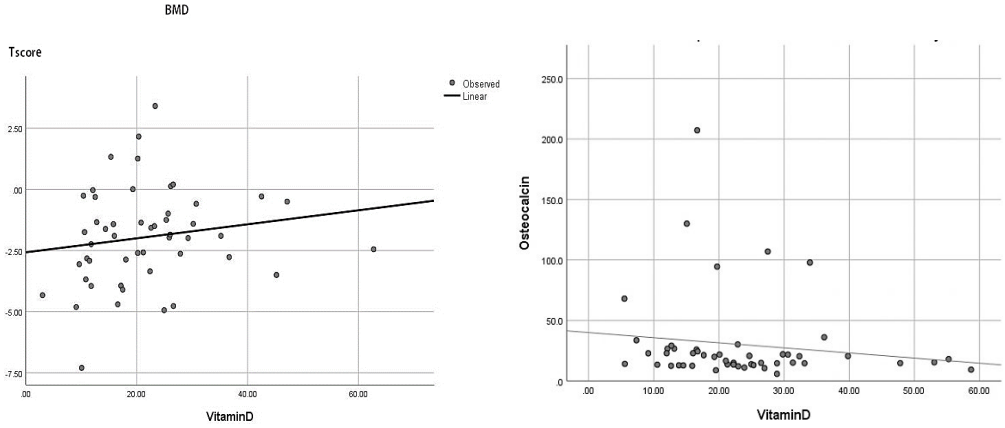
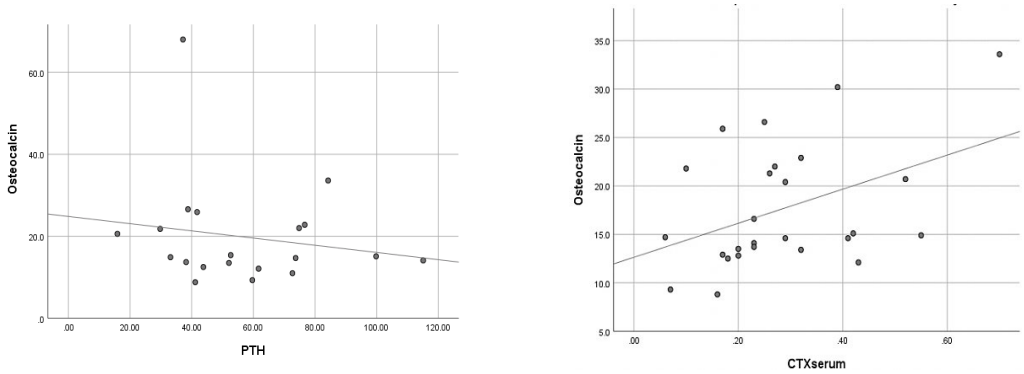


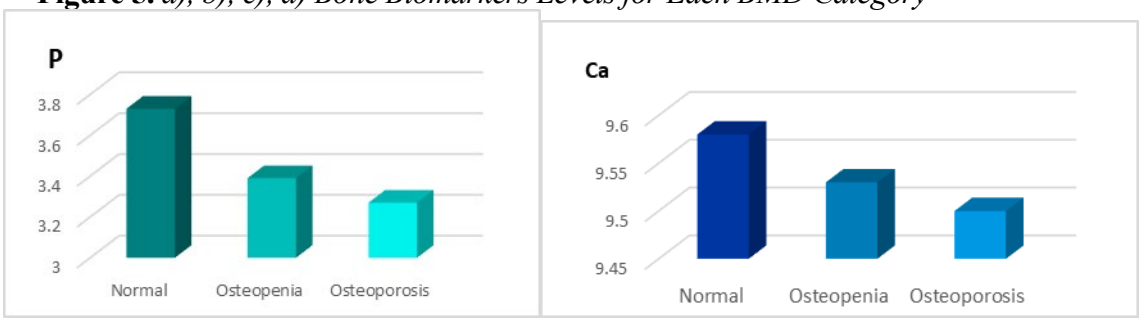
**Figure 4.** *Correlation Between Bone Formation Marker OC with Bone Resorption β-CTx and iPTH*



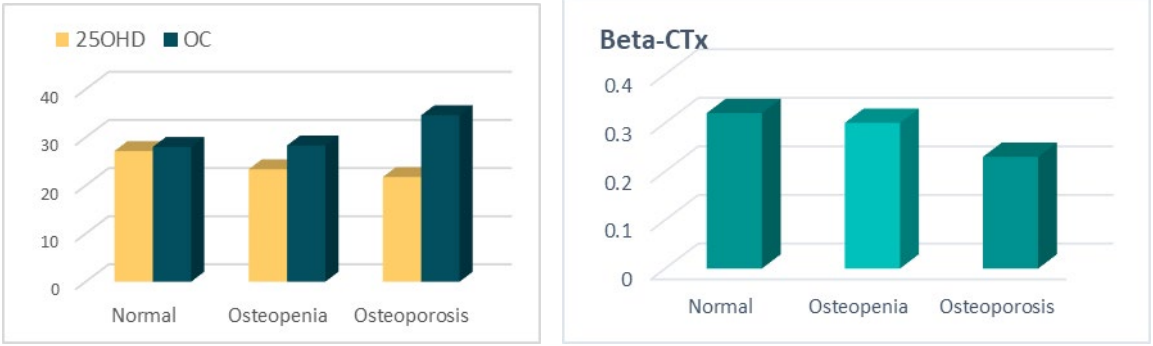

Using Multiple Comparisons, serum levels of Osteocalcin between normal, osteopenic, and osteoporotic groups were significantly different between normal and osteopenic groups (p= 0.017), normal and osteoporotic group (p=0.012). There were no significand differences of Osteocalcin levels between osteopenic and osteoporotic groups (p=0.728). We also found significant differences of Ca levels only among the patients with osteopenia and osteoporosis (p=0.056).

When the whole group was subdivided according to BMD parameters, there were changes in levels of BTMs. In particular, levels of 25OHD, β –CTx, ALP and phosphorus were lower in the osteoporotic group than in the normal group. In contrast, Osteocalcin levels were expressed at higher concentrations in the osteoporotic group compared with the normal group.

**Figure 5.** *a), b), c), d) Bone Biomarkers Levels for Each BMD Category*




a) b)




c) d)

**Table 1.** *Comparison of BTM Between BMD Categories*

| | | Women | | |
|---|---|---|---|---|
| BTMs | **Reference Range** | **Normal** | **Osteopenic** | **Osteoporotic** |
| **25OHD** (ng/mL) | < 20 ng/mL Deficiency<br>20 – 30 ng/mL Insufficiency<br>> 30 ng/mL Normal | 22.48 ±15.6 | 19.25 ±10.7 | 22.34 ±12.2 |
| **OC** (ng/mL) | 11 – 43 ng/mL | 16.5 ±4.5 | 24.26 ±22.08 | 24.0 ±20.2 |
| **ALP** (ng/mL) | 35 – 105 U/L | 76.6 ±20.5 | 62.4 ±15.2 | 69.2 ±14.4 |
| **BAP** (%) | 40 – 75 % | 63.5 ±3.9 | 60.25 ±3.59 | 62.4 ±5.7 |
| **Ca** (mg/dL) | 8.6 – 10 mg/dL | 9.59 ±0.32 | 9.54 ±0.43 | 9.53 ±0.11 |
| **Phosphor** | 2.6 – 4.5 mg/mL | 3.82 ±0.30 | 3.48 ±0.52 | 3.09 ±0.60 |
| **β-CTx** (ng/mL) | < 0.6 ng/mL<br>< 1 ng/mL Post-Menopausal | 0.32 ±0.11 | 0.30 ±0.10 | 0.23 ±0.16 |

We found no certain significant differences in 25OHD parameters between women menopausal groups, F= 3.17, *p=0.088*. Although there was detected a difference in osteocalcin levels, which was significantly decreased in postmenopausal women.

**Table 2.** *Study Population Characteristics*

| | | Pre-Menopausal Women | | | Post-Menopausal Women | | |
|---|---|---|---|---|---|---|---|
| **BTMs** | **Reference Range** | **Normal** | **Osteopenic** | **Osteoporotic** | **Normal** | **Osteopenic** | **Osteoporotic** |
| **25OHD** | < 20 ng/mL Deficiency<br>20 – 30 ng/mL Insufficiency<br>> 30 ng/mL Normal | 22.26 ±6.9 | 22.7 ±9.5 | 18.58 ±8.9 | 22.67 ±18.2 | 15.8 ±8.4 | **26.1** ±13.0 |
| **OC** | 11 – 43 ng/mL | 17.4 ±6.3 | 22.63 ±20.2 | **35.31** ±30.4 | 16.92 ±6.98 | **31.2** ±25.0 | **14.5** ±4.9 |
| **ALP** | 35 – 105 U/L | 53.0 ±0.10 | 57.8 ±12.4 | 72.5 ±12.0 | 85.0 ±4.2 | 65.50 ±2.12 | 64.6 ±21.4 |
| **BAP (%)** | 40 – 75 % | 62.5 ±3.53 | 59.5 ±2.6 | **74.4** ±8.7 | 64.7±3.59 | 62.2 ±2.4 | 62.4 ±5.77 |
| **Ca** | 8.6 – 10 mg/dL | 9.4 ±0.46 | 9.5 ±0.52 | 9.42 ±0.11 | 9.57 ±0.31 | 9.77 ±0.33 | 9.5 ±0.10 |
| **P** | 2.6 – 4.5 mg/mL | 3.80 ±0.40 | 3.3 ±0.26 | 3.2 ±0.60 | 3.58 ±0.50 | 4.01 ±1.04 | **2.9** ±0.65 |
| **PTH** | 15 – 65 ng/L | 50.25 ±10.19 | 57.5 ±38.4 | 60.75 ±28.08 | 55.5 ±27.36 | 54.93 ±25.1 | **57.17** ±25.9 |
| **β-CTx** | < 0.6 ng/mL<br>< 1 ng/mL Post-Menopausal | 0.33 ±0.10 | 0.22 ±0.03 | 0.17 ±0.01 | 0.322 ±0.22 | **0.39** ±0.01 | **1.30** ±0.17 |

## Discussion

The present study examined bone metabolic markers and DEXA parameters in Albanian females. Bone density changes in two stages after birth, first reaching the peak bone mass in the early adult and gradually progressing to the bone-loss

process. T-score parameters of BMD decreased significantly as the age of the participant increases. The average value of bone measurement density (BMD) of the participants was T-score = -1.81 g/cm$^3$, which indicates low bone mass (osteopenia) of Albanian women.

In contrast, Vitamin D levels were not significantly associated with age group. Overall, 44 % of the participants exhibited vitamin D deficiency (25OHD<20 ng/mL). Our results showed a high prevalence of hypovitaminosis D among women in Albania. Different from our study, serum 25(OH)D levels are higher in Northern countries. The indicators of poor income (lowest levels of income, food fortification insufficiency, use of supplements policy) are known to be associated with lower dietary intakes among Southern countries, including Albania (Sharkel 2003).

Our results of seasonal variation among postmenopausal women in Albania confirmed difference in 25(OH)D levels, with lowest levels measured in Summer months. These findings could be attributed to seasonal differences of dietary intake and nutritional status. Owing to its fat-soluble nature, dietary vitamin D (either D2 or D3) is absorbed with other dietary fats in the small intestine. Importantly, while a fraction of newly absorbed intestinal vitamin D is also transported along with amino acids and carbohydrates into the portal system to reach the liver directly, where the first step of activation begin (Holick 1995, Mulligan 2010). According to data publish in literature, the intake of saturated fats, protein, carbohydrate and dietary fibers by women aged between 51and 86 years was lower during summer compered to winter. Considering the differences in intake of minerals and vitamins between seasons, there was a higher intake of calcium, magnesium, phosphorus, thiamin and pyridoxine during winter by women (Rossato 2010).

The synthesis of osteocalcin or bone gla protein (BGP) by osteoblasts is markedly stimulated by 1,25-(OH)2D, a key hormone in the regulation of bone mineralization. The circulating levels of osteocalcin have been shown to reflect both the osteoid matrix production and the formation rate of mineralized bone in several metabolic bone diseases (osteoporosis, thyrotoxicosis, primary hyperparathyroidism) in which both mechanisms are tightly coupled because of the absence of mineralization defect. In accordance with this, in our study the level of 25OHD in the whole group indicated a strong significant negative correlation with bone formation marker Osteocalcin (r= -0.37, *p=0.043*). In postmenopausal women, the mean value of osteocalcin is lower compared to premenopausal women (respectively 20.82 and 25.11 ng/ml), while 25OHD levels were higher in postmenopausal women.

Bone collagen degradation products have been the focus of laboratory procedures used to reflect bone degradation (Demers et al. 2000). An important type of degradation of type I collagen is beta crosslap (β-CTX). The level of this marker in our study appears higher in postmenopausal women compared to premenopausal women (0.336 and 0.24 ng/ml). Also, Postmenopausal women are characterized by higher levels of alkaline phosphatase (71.7 ng/mL) compared to women in premenopause (61.1 ng/mL). These findings are similar with another study in Albania (Hysi 2014), in which higher values of β-CTX show a greater bone resorption in postmenopausal women.

When postmenopausal women were subdivided based on BMD parameters, Osteocalcin, BAP, ALP and phosphorus levels decreased from normal to osteoporotic group, meanwhile β-CTx increased from normal into osteopenic, but decreased again into osteoporotic group. Also, concentrations of 25OHD and PTH increased from normal into osteoporotic group. In the other hand, Osteocalcin concentrations were lower and β-CTx concentrations higher in postmenopausal osteoporotic women compared with premenopausal osteoporotic. In accordance with Garniero et al. (1996), this suggests that in postmenopausal group bone resorption occurs most actively than bone formation (Garnero 1996).

The findings that serum β-CTx and Osteocalcin were significant higher in the osteopenic group of postmenopausal women, consistent with Chavassieux et al. 2015 that reported a strong correlation between s-CTX level and histologic features in bone biopsy, suggested that these BTMs are good markers during the early stage of bone loss, when bone resorption begin to increase (Chavassieux 2015).

Another observation of note in the present study was that phosphorus showed strong negative correlation with PTH (r= -0.709, p=0.010) and BMD (r= -0.556, p= 0.048), and positive association with osteocalcin (r= 0.592, p= 0.033). Phosphate plays several essential roles in our body (Berndt 2007). Phosphate is necessary for proper mineralization of bone as a constituent of hydroxyapatite crystal. Serum phosphate level is regulated by several hormones including parathyroid hormone (PTH), 1,25-dihydroxyvitamin D [1,25$(OH)_2$D] and fibroblast growth factor 23 (FGF23) (Xu, Bai et. al. 2002).

In our study decreased serum phosphor levels are associated with low bone density and low OC levels, and higher levels of PTH and Vitamin D. Low levels of phosphorus may stimulate the secretion of PTH, which activates reactions leading to the formation of 25OHD which may in turn increase phosphorus absorption from the intestine, decrease renal elimination and increase bone resorption, accompanied by low osteocalcin levels. These findings are consistent with those of Galan et al. (2012) (Galan 2012). We did not, however observed any correlation between PTH and 25OHD levels.

Another observation of note in the present study was that mean ALP level was significantly higher in postmenopausal women with low BMD than those of normal BMD. Mean salivary ALP was numerically more in women with low BMD than those with normal BMD but statistically not significant. The finding of high ALP in low BMD group may be related to increase of bone turn over in patients with low BMD rather than bone formation alone. Also periodontal disease may significantly increase the activity of salivary ALP (Dabra et al. 2015).

## Conclusion

In this 2-years follow-up study in female individuals, 25(OH)D levels were 21.1 ng/mL, below optimal reference range30 ng/mL. Our results of seasonal variation among postmenopausal women in Albania confirmed difference in

25(OH)D levels, with lowest levels measured in summer months. These findings could be attributed to seasonal differences of dietary intake and nutritional status.

Concentrations of β-CTx appears higher in postmenopausal women compared to premenopausal women (0.336 and 0.24 ng/mL), in contrast osteocalcin concentrations were lower in postmenopausal women (20.8 and 25.1 ng/mL). These findings are similar with another study in Albania (Hysi 2014), in which higher values of β-CTX and low values of OC showed a greater bone resorption in postmenopausal women.

Here we observed significant strong correlation of 25OHD with Osteocalcin and β-CTx in postmenopausal osteoporotic women. Also, higher levels of β-CTx and OC in osteopenic group, may indicate that the loss of bone mass occurs as a result of increased bone turnover, and lower levels of this OC and phosphorus in osteoporotic group may indicate slow bone remodeling, followed by an inability of the forming process to fill the resorbed spaces.

These data indicate that the overall rates of both bone formation and bone resorption remain high in postmenopausal women in Albania. The rate of bone turnover appears to play an increasing role as a determinant of bone mass. Thus, assessing bone marker levels may be useful in the evaluation of osteoporosis risk.

In conclusion, osteocalcin, β-CTx, ALP and phosphorus were valid biomarkers to diagnose postmenopausal women with low BMD. This may suggest a new promising measure to early diagnose patients at high risk of low BMD and subsequently giving early appropriate treatment.

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