

Article

Energy Efficiency in Egypt's Private Sector: Barriers and Drivers

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Abstract

This study provides a stakeholder-based assessment of the drivers, barriers, and strategic priorities shaping energy efficiency (EE) adoption across Egypt's private sector, focusing on the industry, buildings, and transport sectors. Drawing on 17 semi-structured interviews with stakeholders from government, industry, finance, academia, and development organizations, the study identifies the main factors influencing EE implementation. The findings show that sustainability objectives, particularly carbon reduction commitments and compliance with environmental regulations, alongside donor-funded grants and green finance instruments, are the primary drivers of EE uptake. However, progress remains constrained by institutional and financial barriers, including weak enforcement mechanisms, fragmented governance, limited policy coordination, high upfront costs, restricted access to finance, inflexible banking conditions, and the absence of a domestic EE finance market. Technical and awareness-related challenges further hinder implementation. While gender-related barriers were generally perceived as limited, the analysis revealed underlying disparities in women's leadership and decision-making roles. Financial barriers represented the largest share across all sectors, while institutional barriers ranked second. The absence of enforcement mechanisms was the most significant individual constraint, cited by 13 out of 17 respondents, followed by limited access to finance (10 out of 17) and high upfront costs (9 out of 17). The study highlights the need for stronger regulatory frameworks, clearer institutional mandates, accessible financing mechanisms, and the integration of gender perspectives to accelerate EE adoption and support Egypt's sustainable energy transition.

Keywords: energy efficiency; barriers to energy efficiency; drivers for energy efficiency; Egypt

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1. Introduction

The International Energy Agency (IEA) has identified energy efficiency (EE) as the single most important lever for reducing fossil fuel dependency and mitigating carbon emissions. EE measures and investments not only advance Sustainable Development Goal (SDG) 7, which calls for universal access to affordable, reliable, and sustainable energy by

2030, but also contribute to other SDGs that intersect with Industry, Innovation, and Infrastructure (SDG9); Sustainable Cities (SDG11); Climate Action (SDG13); Strong Institutions (SDG16); and Partnerships for the Goals (SDG17). These linkages position EE not merely as an energy-sector objective but as a cross-cutting enabler of sustainable development [1].

EE has been defined in economic literature from several perspectives. EE has been described as producing the same level of useful services with less energy input, expressed as a ratio of useful output to energy input [2]. Similarly, EE has been defined as the amount of energy services delivered per unit of energy consumed, emphasizing that energy is an input used to produce services such as heating or lighting [3,4]. This discussion has been extended through the concept of the EE gap, referring to the underadoption of technologies that would be socially efficient due to market failures, behavioral factors, or measurement issues [5]. From a macroeconomic perspective, EE has been linked to reductions in energy use per unit of economic output [6]. Following these perspectives, this paper adopts the definition of the IEA, which defines EE as delivering the same or improved energy services while using less energy input.

Central to this agenda is the dual imperative of expanding the share of renewable energy in the global energy mix and doubling the rate of EE improvements. The IEA highlights that achieving the net-zero emissions by 2050 scenario requires a fourfold increase in the current rate of global energy intensity improvement. Yet in 2024, global energy intensity improved by only 1%, well below the historical average of 2% recorded between 2010 and 2019, and far short of the 4% annual improvement recommended by the IEA [1].

Bridging this gap demands sustained public and private investment in energy infrastructure and technologies, alongside comprehensive reforms to regulatory frameworks, policies, and governance structures, supported by targeted awareness and capacity-building efforts [7]. Critically, identifying the specific barriers that impede EE uptake is an essential precondition for effective policy design and successful implementation [8].

Based on recent data from IEA, Egypt achieved a reduction of 3% in its energy intensity between 2000 and 2023, placing it among modest performers, ranked 119 globally out of 150. Total final energy consumption rose sharply by 124.6% over the same period, driven by rapid population growth and sustained economic expansion. The transport sector has emerged as the leading energy consumer, increasing its share of total final energy consumption from 30.3% in 2000 to 32.4% in 2023, with fossil fuels accounting for 97.7% of its energy mix. The industry sector, though still significant, saw its relative share of total consumption decline from 38.1% in 2000 to 27.6% in 2023 [9].

Against this backdrop, this paper investigates the key barriers impeding EE implementation across Egypt's three major energy end-use sectors: industry, transport, and buildings. These sectors collectively account for approximately 85% of Egypt's final energy consumption, making them the most critical entry points for EE policy intervention [9]. A distinguishing feature of this study is its explicit integration of a gender perspective throughout data collection and analysis, recognizing that EE transitions are not gender-neutral in their impacts.

The research addresses four core questions: How does the EE market ecosystem function in Egypt? What are the principal financial, institutional, technical, and informational barriers hindering EE project development? How do these barriers manifest differently across sectors? And what barriers do women face in EE across Egypt's sectors? The paper contributes to the existing literature by providing an updated assessment of EE barriers in Egypt, a topic for which recent comprehensive analyses remain limited despite the country's rapidly growing energy demand. By examining the structural and market constraints affecting EE adoption across the main energy-consuming sectors, this study aims

to generate actionable insights for policymakers, financiers, and practitioners seeking to accelerate EE transitions in emerging economy contexts.

The remainder of the paper is organized as follows: Section 2 reviews the relevant literature; Section 3 provides the background and contextual analysis; Section 4 describes the materials and methods; Section 5 presents the findings and robustness considerations; and Sections 6 and 7 present the policy recommendations and conclusion.

2. Literature Review

2.1. Energy Efficiency and Economic Growth

The relationship between EE and economic growth is neither simple nor uniform, and understanding its complexity is foundational to any serious policy discussion. At the theoretical level, the argument is intuitive: if economies can decouple output from energy consumption by doing more with less, then EE becomes a structural lever for sustainable growth rather than merely an environmental amenity. This picture is complicated, however, by the observation that energy is not a standard production factor amenable to easy substitution, which means efficiency gains are not just desirable but necessary for sustaining growth within bounded resource constraints [10].

Empirically, the evidence leans strongly positive but with important nuances. Cross-country studies of the world's most energy-efficient economies, including Germany, Denmark, Norway, and Australia, confirm that EE improvements generate both direct and indirect economic benefits: reduced energy costs, expanded employment, and enhanced competitiveness in the delivery of essential services such as heating, cooling, and communications [7]. Moreover, this relationship has been quantified with notable precision in China, where EE's elasticity on sustainable economic development ranges from 0.765 in lower-development scenarios to 0.894 in higher ones, a pattern suggesting that the returns to efficiency intensify as economies become more sophisticated [11].

At the macroeconomic level, complementary evidence from the G7 countries demonstrates through Panel Autoregressive Distributed Lag (ARDL) estimation that long-run improvements in EE, alongside renewable energy consumption, institutional effectiveness, and environmental regulation, significantly promote green economic growth. Notably, country-specific results also reveal divergence in policy impacts, reinforcing the broader finding that national contexts shape how efficiency translates into growth outcomes [12].

Yet the picture is not uniformly optimistic. An examination of 37 Organisation for Economic Co-operation and Development (OECD) countries finds a negative relationship between EE and economic growth in several already highly efficient nations, including Japan, France, Switzerland, and the United States. This counterintuitive finding is best interpreted not as evidence against EE but as a signal of diminishing marginal returns at the efficiency frontier: countries that have already optimized heavily face structural constraints on further gains through the same channels. Crucially, the same study finds that renewable energy consistently outperforms fossil fuels in terms of efficiency improvement potential, pointing toward the energy transition as the next frontier of productivity gains [13].

Conventional evaluations have been shown to systematically underestimate the full value of EE interventions, as holistic lifecycle assessments reveal benefits spanning greenhouse gas reductions and job creation, well beyond what narrower operational metrics capture. Beneath the macroeconomic narrative lies a more granular and sobering reality. Across industries, transport systems, and buildings, a remarkably consistent set of barriers recurs regardless of geography or development level. These can be organized into four interlocking categories: financial, institutional, behavioral, and technical, each reinforcing the others in ways that make EE adoption persistently difficult [14].

2.2. Financial and Economic Constraints

Capital scarcity is the dominant financial barrier across all sectors and geographies. In Morocco's industrial zones, nearly half of the surveyed firms identified financial capital constraints as their primary obstacle to EE adoption, with restricted access to credit closely behind [15]. The pattern is strikingly similar in Pakistan, Ghana, and Bangladesh, where cost reduction from lower energy consumption is consistently the leading motivator for EE investment, yet the upfront capital required to realize those savings remains inaccessible to most firms [16–18]. In the Ethiopian cement industry, this dynamic is equally pronounced: cost reductions resulting from lowered energy use rank as the highest-rated driver of decarbonization, yet the absence of economic subsidies simultaneously ranks among the most critical barriers, illustrating the same fundamental tension between financial motivation and capital accessibility [19].

In the buildings sector, this financial bind takes a particular form: high initial capital requirements combine with short payback horizons and low investor appetite for risk, creating a structural disincentive for retrofitting even when the long-term economics are favorable [8,20]. The integration of renewable energy into buildings compounds this challenge further, as hybrid system configurations, while consistently outperforming single-technology approaches in efficiency and resilience, demand substantially greater upfront investment, limiting their deployment to contexts where favorable policy environments and financing instruments are in place [21].

The transport sector faces an analogous problem, where low purchasing power among end users constrains the transition to more energy-efficient vehicles and infrastructure investment remains chronically underfunded [8]. The split-incentive problem, where those who pay energy bills are not those who invest in efficiency improvements, cuts across buildings and industry alike. Landlords have little reason to upgrade tenant-occupied spaces; building owners have limited incentive to invest in equipment whose operating cost savings accrue to occupants.

By artificially suppressing the price of fossil fuels, subsidies erode the economic case for efficiency improvements, reducing the financial returns that would otherwise justify investment [9]. This price distortion is particularly damaging in developing economies, where EE investment already competes against acute capital constraints and where the relative affordability of subsidized fossil fuels further diminishes the urgency and attractiveness of efficiency upgrades [22]. The threat of rising energy prices, conversely, emerges as a significant driver in sectors such as Ethiopian cement manufacturing, where respondents ranked it among the top motivators for pursuing decarbonization, underscoring how the removal of price distortions can unlock latent investment appetite [19].

2.3. Institutional and Regulatory Failures

Institutional barriers are perhaps the most structurally entrenched. In developing economies such as Ghana and Morocco, weak energy policy frameworks leave firms without clear incentives, reliable information channels, or regulatory pressure to improve efficiency [17,23]. Even in more developed settings, the problem is less the absence of regulation than its fragmentation and inconsistency. In the European building sector, convoluted regulatory processes and poorly integrated governance have been identified as key obstacles, while conflicting policy objectives and a chronic lack of long-term planning vision further constrain progress in transport [8,24,25].

In Pakistan's energy sector, these institutional failures are further complicated by a deficit in energy literacy among policymakers and decision-makers. Research demonstrates that the majority of barriers to energy development in Pakistan can be most effectively addressed through improvements in the knowledge and awareness of those in positions of institutional authority, suggesting that institutional reform alone is insufficient

without concurrent investments in those who design and implement policy [25]. Similarly, in Bangladesh's remote rural areas, the absence of adequate market monitoring mechanisms and the proliferation of substandard system components reflect institutional failures in quality regulation, with controllers found to operate well outside recommended parameters and installation practices consistently deviating from technical standards [26].

Institutional inertia can persist even in the presence of government intervention. Evidence from India shows that despite active policy programs, the majority of students remain unaware of any EE activities in their schools; 69% of government school lighting in Lucknow remains inefficient, and fan replacement cycles have stretched beyond three years, representing an estimated 239 GWh of annual avoidable energy waste. The gap between policy design and implementation is itself an institutional failure of the first order [27].

2.4. Behavioral and Informational Barriers

Behavioral barriers are the least tangible yet arguably the most persistent. Across sectors and geographies, a consistent pattern emerges: decision-makers systematically undervalue EE benefits, discount future energy savings too steeply relative to upfront costs, and resist change even when the economic case is demonstrably strong. In Morocco, resistance to change and concern over production disruption together account for one-third of surveyed firms' primary barriers [15]. The tension reveals a fundamental behavioral inconsistency: firms know that efficiency saves money yet remain reluctant to pursue it. In the Ethiopian cement industry, this manifests as weak top-management support ranking among the highest-rated barriers, indicating that organizational-level behavioral inertia, rather than any single technical or financial obstacle, represents the critical bottleneck to decarbonization progress [19].

This is not irrationality in the classical sense but rather reflects well-documented cognitive patterns: loss aversion, status quo bias, and the prioritization of short-term operational continuity over long-term savings. These have been framed as informational and behavioral anomalies in processing information rather than simple ignorance, a distinction with important policy implications. Providing more information does not automatically change behavior if the underlying decision-making heuristics remain unchanged [28,29]. In Pakistan's energy sector, the affective dimension of energy literacy, encompassing attitudes and motivations, has been identified as the single most critical factor in overcoming renewable energy barriers, reinforcing the conclusion that behavioral change requires engagement with underlying values rather than information provision alone [25].

In the transport sector, low trust in public systems and poor environmental concern further dampen uptake of energy-efficient options [8]. In the buildings sector, the behavioral dimension is compounded by the absence of credible, accessible information about savings potential [30]. In Pakistan's industries, company peers, seminars, and conferences were cited as the most reliable sources of EE-related information, underscoring how much behavioral change depends on trusted social and professional networks rather than top-down communication [16].

2.5. Technical Barriers

At the most fundamental level, the shortage of trained technical professionals creates an execution gap that no amount of financial resources or policy ambition can easily overcome. In Bangladesh's textile industry, the lack of technically cost-effective measures, inadequate research and development, and a shortage of energy specialists collectively limit achievable efficiency gains to a narrow band of 3–4%, despite the sector's significant improvement potential [18].

The scarcity of skilled technical personnel compounds institutional weakness. In industries from textiles in Bangladesh to small manufacturing firms across Europe, the shortage of trained professionals capable of identifying, implementing, and managing EE measures creates a persistent execution gap [18,31]. This is not merely a training issue; it reflects broader failures in the systems that generate and distribute technical knowledge, including energy audit regimes, Energy Service Company (ESCO) markets, and professional accreditation frameworks.

The complexity of modern energy systems further amplifies technical barriers. Hidden costs, those associated with disrupting production processes, retraining staff, and integrating new technologies into existing operational workflows, are frequently underestimated or entirely overlooked in investment appraisals, leading firms to systematically underinvest even when headline financial returns appear attractive [32]. This problem is particularly acute in industries where production continuity is paramount, as the risk of operational disruption during technology installation or transition acts as a powerful deterrent [15,16].

In the buildings sector, the diversity and age of the existing stock pose substantial technical challenges for retrofitting. Advanced solutions such as Building Energy Management Systems (BEMS) and Model Predictive Control (MPC) systems, the latter demonstrating energy reductions of over 35% in condensing unit applications [33,34], offer genuine transformative potential. Yet each sector may have more specific barriers, and this is important to consider in the analysis.

2.6. Sector-Level Barriers

While the four-category framework of financial, institutional, behavioral, and technical barriers provides analytical coherence, sectoral variation matters considerably for policy design. Industrial firms face barriers that are heavily shaped by production complexity, firm size, and the degree to which energy is a salient cost item relative to labor or raw materials. Evidence shows that intervention-dependent barriers shift significantly with firm characteristics; what inhibits a large, complex manufacturer differs markedly from what constrains a small, non-energy-intensive enterprise [29]. In Pakistan's energy-intensive industries, equipment lifetime and peer influence emerge as significant but underappreciated drivers [16].

In the transport sector, the challenge is not only technical or financial but also deeply infrastructural. Poor cycling and walking infrastructure, the absence of rail networks, inadequate electric vehicle charging systems, and fragmented governance across transport modes create a layered set of interdependencies that no single policy instrument can adequately address [8]. EE improvements in transport require coordinated investment across infrastructure, vehicle standards, urban planning, and behavioral change programs simultaneously.

In buildings, the diversity of the existing stock, in terms of age, ownership structure, and use type, reinforces the need for tailored rather than generic interventions. In the educational context, the specific conditions of government schools, including inventory management constraints, scalability limitations, and highly variable retrofitting needs, call for customized approaches rather than standardized national programs [27].

What the literature collectively reveals is that EE barriers are not isolated technical or financial problems amenable to single-instrument fixes. They form a system of mutually reinforcing constraints in which weak institutions undermine financial mobilization, poor information perpetuates behavioral inertia, technical capacity gaps limit implementation quality, and behavioral resistance in turn weakens the political economy case for stronger institutions.

This systemic understanding is particularly relevant for contexts like Egypt, where industrial, transport, and building sectors each carry distinct configurations of these barriers. The global literature does not provide a ready-made blueprint, but it offers a clear diagnostic logic: map the specific barrier constellation in each sector, identify the leverage points where intervention will generate the broadest enabling effects, and design policy packages that are sequenced to build institutional and technical capacity alongside market incentives.

2.7. Gender Dimensions in Energy Efficiency: Structural Barriers and Representation Gaps

The intersection of gender and EE remains one of the most underexamined dimensions of the energy transition literature. Despite growing recognition that energy poverty and energy decision-making are deeply gendered phenomena, the systematic integration of gender perspectives into energy policy and efficiency frameworks remains limited. Research on the energy–gender nexus shows that publications in this area are increasing but the field remains dominated by quantitative methods that treat gender as synonymous with biological sex, failing to engage with critical gender theories [35]. At the household level, women account for a disproportionately high share of energy-related activities in domestic settings yet exercise comparatively little influence over energy investment decisions. Females have been found to consistently use lower energy than males in household activities, while gender, income, family composition, and education are among the most significant determinants of energy-saving behavior overall [36].

The policy dimension of this gap is equally pronounced. A review of national-level energy policies across the Asia Pacific region found that only 16 of 385 policies included any reference to gender, revealing a near-total absence of gender-responsive energy planning at the governmental level [37]. Women frequently face compounding barriers to accessing sustainable energy resources, including socio-cultural gender norms that restrict participation in technical and financial decision-making, limited access to financial resources that constrain the adoption of efficient technologies, and systematic exclusion from the institutional processes through which energy priorities are set. Evidence from 36 African countries shows that increases in women’s representation in national parliaments are positively associated with improvements in electricity access and EE, with governance quality moderating the strength of this relationship [38].

Nepal’s experience illustrates how even formally inclusive policy frameworks can fail to translate into practice. Despite a progressive 2015 constitution and a 2021 federal-level gender equality policy, energy policy in Nepal includes only limited provisions for ensuring energy access by marginalized groups and women [39]. The evolution of gender-responsive energy investment has been slow because of a narrow conceptualization of the policy problem and a lack of coherence and synchronization across energy-related plans, policies, and budgets, a finding that resonates with the institutional fragmentation documented in earlier sections of this review. Advancing EE in developing country contexts will therefore require embedding gender analysis into the design of barrier assessments, policy instruments, and stakeholder engagement processes in ways that reflect the lived realities of energy users across the full spectrum of social identities [35].

Despite the breadth of this literature, a clear research gap persists with respect to Egypt specifically. Existing studies on EE barriers in the MENA region tend to be either highly aggregated or focused on the energy supply side, with limited attention to demand-side constraints across multiple sectors simultaneously. Egypt’s combination of rapid energy demand growth, persistent fossil fuel subsidies, weak enforcement institutions, and a nascent EE financing market represents a distinct structural context that is not adequately addressed by existing cross-country analyses. Furthermore, the systematic in-

tegration of a gender lens into multi-sector EE barrier assessments remains exceptionally rare in both the global and regional literature.

This study addresses both gaps by offering an updated, qualitative, multi-sector assessment of EE barriers in Egypt, incorporating gender considerations as a cross-cutting analytical dimension throughout the investigation. More specifically, this study addresses three interrelated gaps in the literature. First, there is no recent multi-sector qualitative assessment of EE barriers in Egypt that simultaneously covers industry, buildings, and transport with primary stakeholder data. Second, while studies in other MENA and African economies have examined individual sectors or general barriers, the interaction and relative weight of institutional, financial, technical, and awareness barriers across sectors in the Egyptian context remain poorly understood. Third, and most distinctively, gender as an analytical dimension in EE barrier research, particularly in Egypt and the broader MENA region, has received almost no systematic scholarly attention, despite the structural gender disparities documented in regional energy governance assessments.

By addressing these three gaps, this study makes an original contribution to both the empirical literature on EE barriers in developing country contexts and to the methodological literature on integrating gender analysis into multi-sector energy research.

3. Egyptian Context

Egypt's performance positions it as a modest improver in terms of energy intensity reduction. With a decrease of 3%, the country trails the strongest performers in the comparison group, particularly Nigeria, India, Turkey, and South Africa, which achieved considerably larger absolute reductions. The most significant declines were recorded by Nigeria (−36%) and India (−36%), followed by Turkey (−32%), South Africa (−30%), and Jordan (−28%). This gap highlights both the challenges that remain for Egypt and the substantial potential for further improvement in energy productivity. In contrast, Brazil was the only country to record a marginal increase of 1%, indicating limited progress in improving energy productivity over the observed period [9]. Energy intensity is measured as total energy supply per unit of GDP, expressed in megajoules per 2015 USD (PPP). The selected comparator countries were chosen as emerging and developing economies sharing similar energy demand patterns and economic growth dynamics with Egypt (see Figure 1).

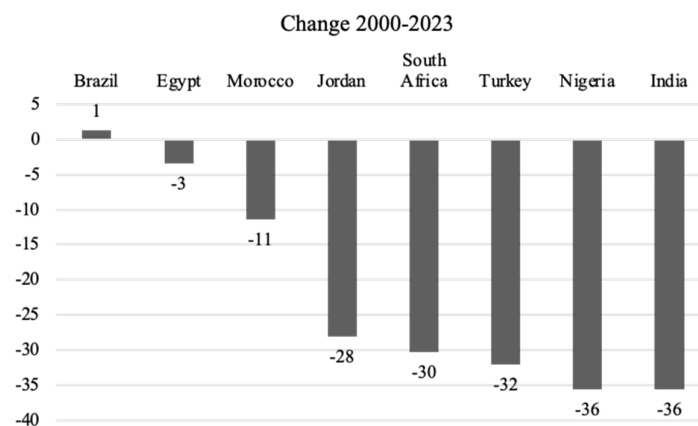


Figure 1. Change in energy intensity of the economy, 2000–2023, Percent of Change. Source: Prepared by the authors based on data from the International Energy Agency (IEA), Egypt–Country Profile, IEA Countries & Regions (2026). Available at: <https://www.iea.org/countries/egypt> accessed 17 February 2026).

Total final energy consumption in Egypt grew substantially between 2000 and 2023, rising by 124.6%, reflecting a prolonged period of economic expansion and demographic growth. This upward trajectory, however, was not uniform. Growth rates were particularly pronounced during peak economic periods, including 2002 (7.1%), 2005 (14.5%), and 2007 (10.0%). A notable post-pandemic rebound of 8.1% was recorded in 2021, driven by the resurgence of suppressed demand following COVID-19 disruptions. The first contraction was observed in 2013 by 2.2%, attributable to energy supply shortfalls and broader macroeconomic pressures. Moreover, there was a 6.8% decline in 2019, coinciding with the commencement of production at the Zohr natural gas field, which significantly altered the composition of the domestic energy supply (see Figure 2) [9].

Egypt's transport sector has strengthened its position as the leading energy consumer, with its share rising from 30.3% in 2000 to 32.4% in 2023 and peaking at 33.3% in 2014. The commercial and public services sector also recorded growth, increasing its share from 4.0% to 6.2% over the same period. In contrast, the industry sector experienced a notable decline, with its share of total final energy consumption falling from 38.1% in 2001 to 27.6% in 2023. The residential sector similarly saw its proportion decrease from 23.4% to 17.9%, reflecting a relative contraction compared to expanding sectors [9].

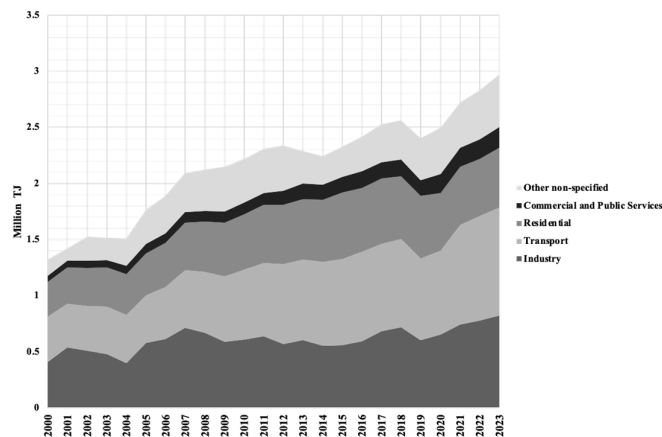


Figure 2. Total final energy consumption by sector in Egypt (2000–2023). Source: Prepared by the authors based on data from the International Energy Agency (IEA), Egypt–Country Profile, IEA Countries & Regions (2026). Available at: <https://www.iea.org/countries/egypt> accessed 17 February 2026).

In 2023, Egypt's total final energy consumption across its three primary sectors exhibited distinct patterns by source. The industrial sector showed the most diversified energy mix, drawing on natural gas (40.0%), oil (26.5%), electricity (22.4%), and coal (11.0%), reflecting the varied thermal and mechanical demands of industrial processes. The transport sector was overwhelmingly dominated by oil (97.7%), with the remaining 2.3% coming from other sources such as natural gas, underscoring the sector's near-exclusive reliance on liquid fossil fuels. The commercial sector presented a markedly different profile, with electricity accounting for 85.3% of consumption and the remaining 14.7% sourced from other fuels such as oil and gas (see Figure 3) [9].

The contrasting energy profiles revealed in Figure 3 carry significant implications for Egypt's EE. The industrial sector's diversified mix necessitates tailored, process-specific interventions, including waste heat recovery and fuel substitution. Transport's near-total dependence on oil identifies it as the most structurally rigid sector, where pathways are long-term and contingent on fleet electrification and alternative fuel deployment. Conversely, the commercial sector's dominant electrification share (85.3%) positions it as the

most immediately actionable sector, where efficiency improvements through upgraded lighting, HVAC systems, and building automation can deliver measurable reductions in electricity demand within relatively short timeframes.

Taken together, the contextual data presented in this section directly justify the five analytical dimensions applied throughout the study. The institutional dimension is warranted by Egypt's fragmented energy governance structure, in which sector regulation is split across the Ministry of Electricity and Renewable Energy and the Ministry of Petroleum and Mineral Resources, with limited coordination between them. The financial dimension is justified by the near-total absence of domestic EE financing instruments, as evidenced by the reliance on donor-funded green finance and the underdevelopment of the commercial banking sector's EE product offering.

The technical dimension reflects the aging and diversified energy mix of Egypt's industrial sector, the most capital- and technology-intensive of the three, and the absence of standardized energy audit frameworks. The awareness dimension is grounded in the persistent gap between available EE incentives and actual uptake documented across sectors. Finally, the gender dimension is contextually justified by Egypt's low representation of women in energy sector leadership and technical roles, which regional gender and energy assessments consistently document as among the lowest in the MENA region.

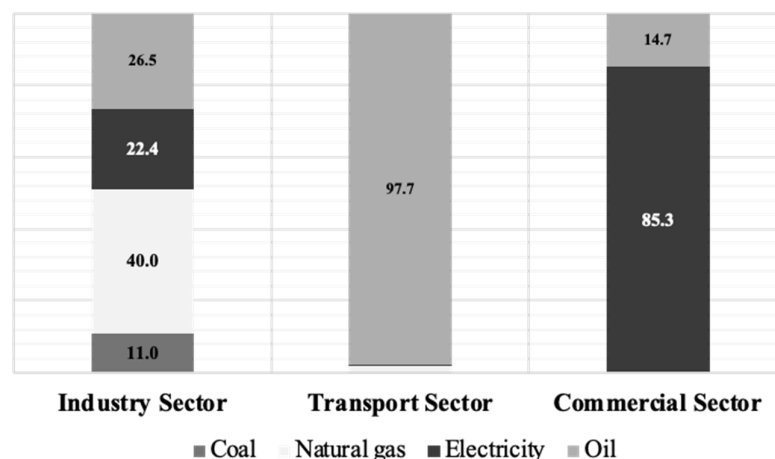
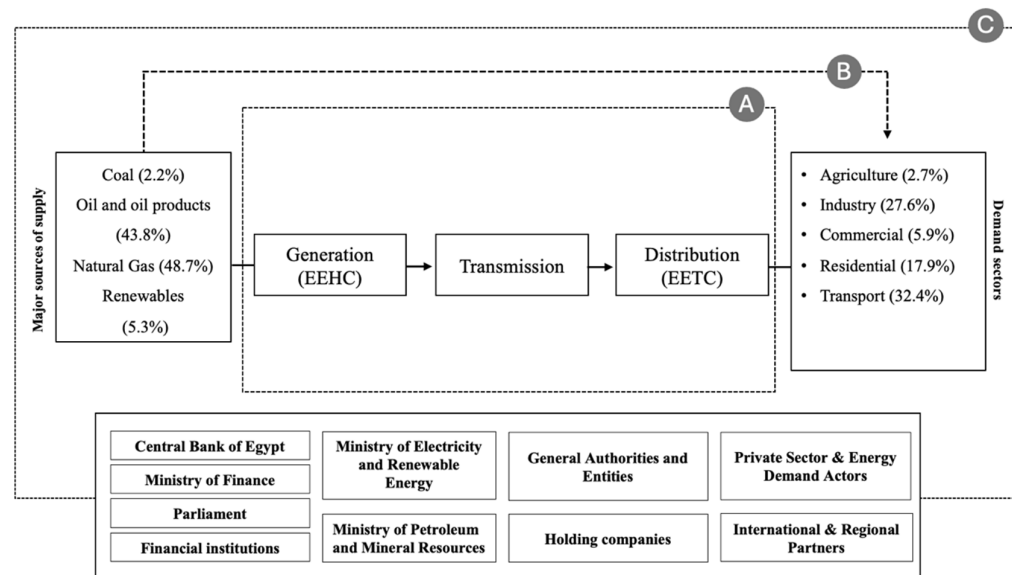


Figure 3. Total final energy consumption by sector in Egypt, 2023, percentage. Source: Prepared by the authors based on data from the International Energy Agency (IEA), Egypt–Country Profile, IEA Countries & Regions (2026). Available at: <https://www.iea.org/countries/egypt> accessed 17 February 2026). Note: Data shown cover the industry, transport, and commercial sectors. Residential sector data are not available from IEA at this level of disaggregation for 2023. For the purposes of this study, the “buildings sector” encompasses all building types (residential, commercial, and public) based on stakeholder interview data; Figure 3 reflects only the commercially available IEA disaggregation.

The following figure shows Egypt's energy system architecture, illustrating the flow from primary supply sources through generation, transmission, and distribution to end-use demand sectors, alongside the institutional governance framework that oversees the system. On the supply side, Egypt's energy mix is dominated by fossil fuels, with natural gas accounting for 48.7% and oil and oil products for 43.8%, together comprising 92.5% of total supply. Renewables contribute only 5.3%, while coal accounts for 2.2%, reflecting a system still heavily anchored in hydrocarbon resources. Electricity flows through a vertically structured chain: generation is managed by the Egyptian Electricity Holding Company (EEHC), transmission by the Egyptian Electricity Transmission Company (EETC),

and distribution to end consumers across five demand sectors: transport (32.4%), industry (27.6%), residential (17.9%), commercial (5.9%), and agriculture (2.7%) (see Figure 4) [9].

Notably, the figure distinguishes three feedback loops: electricity flows (A), non-electricity energy demand flows (B), and the broader energy market interactions (C), capturing the system's multidirectional interdependencies. The institutional layer presents the multi-stakeholder governance structure underpinning Egypt's energy system. Sectoral regulation falls under the Ministry of Electricity and Renewable Energy and the Ministry of Petroleum and Mineral Resources. Operational delivery is channeled through holding companies and general authorities. Private sector actors, the Ministry of Finance, the Central Bank of Egypt, Parliament, financial institutions, and international and regional partners play complementary roles in demand-side engagement and financing.



Note:
A: Electricity, **B:** Energy Demand (Excluding electricity), and **C:** Energy Market
EEHC: Egyptian Electricity Holding Company
EETC: Egyptian Electricity Transmission Company

Figure 4. Egypt's energy market. Source: Adapted from the International Energy Agency (IEA) Egypt Country Profile (2026) and the Egypt Ministry of Petroleum and Mineral Resources, Energy Efficiency Strategy 2022–2035. Note: Percentages represent shares of total energy supply and total energy demand in Egypt.

4. Materials and Methods

This study employs a qualitative, stakeholder-centered research design to investigate the barriers impeding EE implementation across Egypt's three major energy end-use sectors: industry, transport, and buildings. These sectors were selected based on three criteria: their substantial share of national energy demand, the availability of credible sectoral data, and their strategic importance as focal points for scaling up EE financing and policy interventions. Together, they account for approximately 85% of Egypt's total final energy consumption, making them the most consequential entry points for EE policy action [9].

A consistent analytical framework was applied across all sectors, evaluating five dimensions of barriers: institutional, financial, technical, awareness-related, and gender-related. Gender considerations were integrated systematically throughout both data collection and the assessment process, in recognition of the differentiated roles and constraints that shape participation in EE decision-making.

Primary data were collected through 17 in-depth, semi-structured stakeholder interviews conducted with key actors across the Egyptian EE ecosystem. The interviewee sample was drawn from five stakeholder categories, selected to ensure balanced representation of the perspectives and institutional roles relevant to EE implementation: government entities and regulators, banks and financial institutions, international and regional development partners, private sector firms and energy demand actors, and academic institutions and business associations. This purposive sampling strategy enabled the study to capture policy, financing, technical, and market-side perspectives, as well as to document the differentiated roles of diverse actors in shaping EE outcomes. The full composition of the stakeholder sample is provided in Table A1 in the Appendix A.

The sample included participants from the main stakeholder groups active in the sector: policymakers, regulators, project developers, technology suppliers, service providers, consultants, financiers, and end users. Selection also considered diversity across market segments, application areas, institutional perspectives, and gender. Of the 17 interviewees, only 4 were women, reflecting the limited representation of women in Egypt's energy sector rather than a lack of intent to achieve gender balance. While the sample is not statistically representative of the entire market, it provides a balanced cross-section of informed stakeholders with direct experience in the Egyptian EE and renewable energy ecosystem.

Each interview was guided by a semi-structured interview guide organized around five thematic domains: environmental sustainability, financial mechanisms, technological capacity, institutional and policy factors, and cross-cutting issues including gender. Within each domain, respondents were invited to identify and rank relevant barriers and drivers, with multiple response selections permitted to capture the multidimensional nature of EE constraints.

Open-ended probing questions within each domain provided interviewees with the opportunity to elaborate on their responses and introduce context-specific considerations. This design yielded a methodologically robust and contextually grounded evidence base combining structured thematic data with rich qualitative depth. Following each interview, transcripts were coded thematically using a predefined coding framework structured around the five analytical dimensions: institutional, financial, technical, awareness-related, and gender-related barriers and drivers.

5. Findings

5.1. Key Drivers for EE Implementation

The principal drivers of EE implementation reported by stakeholders consistently converged around sustainability commitments and financial incentives. The most prominent motivating factor across all three sectors was the contribution of EE to achieving sustainability objectives and reducing carbon footprints, with particularly strong endorsement in buildings (14 out of 17 interviewees), industry (14 out of 17), and transport (12 out of 17). The experts agreed almost unanimously that environmental goals were a foundational motivator. Financial support mechanisms constituted a second major category of drivers: donor-funded EE grants were strongly cited in transport (13 out of 17), buildings (12 out of 17), and, to a lesser extent, industry (10 out of 17).

The availability of dedicated green finance instruments similarly functioned as a significant enabler, particularly in the buildings and transport sectors (both 12 out of 17) and industry (10 out of 17), underscoring the pivotal role of tailored financial products in accelerating EE adoption. Practical experience with technologies such as LED retrofits also served as a meaningful driver, especially in buildings (12 out of 17) and industry (10 out of 17). Environmental, Social, and Governance (ESG) reporting requirements played a

more moderate but consistent enabling role, cited by approximately 7 out of 17 respondents across industry, buildings, and transport.

5.2. Barriers to EE Implementation

Financial barriers represented the most prevalent constraint across all three sectors. Their share was highest in buildings (accounting for 33% of reported coded segments) and industry (32%), with transport somewhat lower (30%). More than half of the interviewees highlighted high upfront costs, limited access to capital, and extended payback periods as particularly restrictive in industrial processes that require substantial capital investment and in building retrofits that demand significant upfront expenditure.

Institutional barriers constituted the second most significant category, with transport exhibiting the highest share (27% of coded segments), followed by industry (25%) and buildings (22%); these reflected deficiencies in policy implementation, unclear institutional responsibilities, and inadequate inter-agency coordination, challenges that were especially pronounced in the transport sector. Technical barriers were moderate and broadly comparable across industry and buildings (16% each), though slightly higher in transport (18%) (see Figure 5).

Awareness-related barriers were more pronounced in industry (15% of coded segments) and buildings (13%) than in transport (10%), pointing to persistent information and training gaps regarding the benefits and mechanisms of EE, particularly among industrial operators and building owners. Gender-related barriers, though the least prevalent overall, displayed notable variation across sectors, with buildings recording the highest share (16%), followed by transport (15%) and industry (12%).

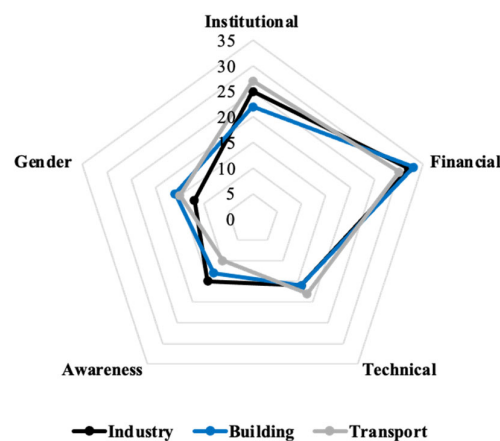


Figure 5. Key barriers to EE projects by sector and category. Source: Author's analysis of stakeholder interviews conducted in 2025. Note: Responses were grouped into five barrier categories, and the percentage of each category was calculated based on its frequency of occurrence relative to the total number of identified barriers.

5.3. Cross-Sector Barriers

Before examining sectoral specificities, the data reveal a convergence of barriers across all three sectors, suggesting that the impediments to EE implementation in Egypt are systemic in nature rather than sector-specific anomalies. Four categories of barriers—institutional, financial, technical, and awareness-related—manifest with remarkable consistency across industry, buildings, and transport, pointing to structural deficiencies that no single-sector intervention can adequately resolve (see Table 1).

Table 1. Barriers to EE projects by sector and category.

		Industry	Building	Transport
Institutional	Without enforcement, EE isn't a budget priority.	13	13	12
	Lack of alignment between green goals and actual funding.	7	8	10
	Lack enforceable regulations	8	8	8
	There's no national fund or roadmap to guide access.	5	4	7
	Decision-makers hesitate due to unfamiliarity or skepticism about EE.	8	4	7
	Lack of clarity in the paperwork and requirements	6	5	5
	Public-private coordination on EE financing is weak.	4	5	5
	Policy gaps across sectors.	6	5	6
	No structured government system.	4	4	4
	The regulatory framework lacks effective legal enforcement for banks.	4	3	4
	Regulatory fragmentation	4	3	4
	Policies are generic, not tailored to our sector's unique needs.	3	2	4
Financial	Limited access to finance	9	9	11
	Bank terms are too rigid: long processes, high interest.	8	11	9
	Only donor-funded green funds support environmental objectives.	7	8	8
	High upfront costs	9	9	8
	Costs, return periods vary by sector.	7	8	7
	Tight annual budgets and no local funding.	5	5	5
	High costs	7	7	5
	High interest rates and collateral requirements deter the projects.	5	7	5
	No financial products are available.	6	5	5
	Banks hesitate unless EE is bundled with something else.	6	5	5
	EE returns are long-term, making financing hard.	6	7	5
Technical	Legacy systems and poor maintenance hinder energy-saving plans.	7	7	7
	Lack of access to modern EE technologies.	5	4	6
	Outdated infrastructure	3	3	6
	No standardized technical documents or audits are required to access finance	6	5	5
	There is a lack of support for system/technology upgrades	6	5	5
	Technical complexity	2	4	4
	lack of tailored technologies	4	4	4
	Required energy audit data is unavailable	4	3	3
Awareness	Lack of technical skills to implement HVAC or machinery upgrades.	2	3	2
	No communication from regulators on available incentives.	5	4	4
	Staff aren't aware such measures and financing exists; no training provided.	4	3	2
Gender	No noticeable gender difference in how EE projects are managed.	10	10	10
	Gender isn't considered, it's seen as neutral.	12	12	10
	Barriers to women's leadership	7	10	10
	No gender lens in EE policies at all.	1	1	4
	Women engineers are present but rarely promoted to lead EE projects.	5	4	4
	Persistent structural barriers hinder women's leadership in finance	2	2	2

Source: Author's analysis of stakeholder interviews conducted in 2025. Note: Results are derived from 17 interviews. Values represent the number of interviewees who identified each barrier.

Financial barriers emerged as the most dominant constraint across the EE landscape. More than half of the interviewees cited limited access to finance (an average of 10 out of 17 respondents); approximately half reported high upfront costs (approximately 9 out of 17); and nearly half identified rigid banking terms characterized by lengthy approval processes and elevated interest rates (approximately 8 out of 17). The cross-sector prevalence of donor-funded green financing as a primary channel (approximately 8 out of 17) is particularly revealing: it indicates the near-total absence of a domestic EE finance market, leaving the sector dependent on externally driven funding mechanisms that are inherently unstable and insufficiently scaled. The reluctance of banks to finance standalone EE projects unless bundled with broader investments reflected a systemic perception of EE as high-risk and low-collateral.

These findings align with studies from Morocco and Pakistan, where restricted access to capital and high investment costs were identified as the most common obstacles regard-

less of industrial context [15,16]. Similarly, unpredictable funding and high investor risk have been shown to discourage private sector engagement in EE [20,30].

Institutional barriers represented the second universal constraint. Almost all interviewees cited the absence of enforcement mechanisms as the most critical issue, with an average of 13 out of 17 respondents (approximately 13 out of 17), the highest-scoring individual indicator in the entire dataset. Poor alignment between green policy objectives and actual funding allocations, noted by approximately half of interviewees (an average of 8 out of 17), further illustrated that the problem is not merely regulatory absence but a deeper disconnection between policy ambition and resource commitment.

These findings are consistent with studies that identified weak energy policy frameworks and information systems as primary contributors to EE gaps in Ghana's industrial sector, and that documented convoluted regulatory processes and poorly integrated governance as defining institutional obstacles across European building and transport sectors [8,17]. Compounding the enforcement deficit, decision-maker reluctance rooted in unfamiliarity or distrust of EE was noted by approximately one-third of interviewees (approximately 6 out of 17), consistent with evidence that institutional failures and imperfect information are key preconditions for EE underinvestment [40].

Technical barriers, while consistently present, occupied a secondary position relative to institutional and financial constraints. Two-thirds of interviewees mentioned legacy systems and poor maintenance practices as shared infrastructure challenges (an average of 7 out of 17 respondents). The absence of standardized technical documentation and mandatory energy audit requirements (approximately 5 out of 17) created a parallel constraint on the financial side, as the lack of bankable technical documentation limits firms' ability to access even the limited financing that exists.

Analogous technical gaps have been identified in Bangladesh's textile sector, where the absence of cost-effective technologies and trained professionals constrained achievable efficiency gains [18]. Furthermore, hidden technical costs associated with production disruption and system integration are systematically underestimated in investment decisions, a dynamic that the Egyptian data appears to reproduce across all three sectors [40].

Awareness barriers, though the least prevalent, revealed a consistent systemic failure in information dissemination. Approximately one quarter of interviewees (approximately 4 out of 17), on average, reported that regulators had not communicated available EE incentives, and approximately 3 out of 17 indicated that staff lacked awareness of existing measures and financing options due to inadequate training. While these shares are lower than those recorded for institutional and financial barriers, they indicated that even where financial instruments and policy frameworks exist, their reach is limited by the absence of effective knowledge transmission mechanisms. Lack of awareness has been identified as one of the top three barriers in non-energy-intensive industries, and behavioral inertia alongside poor information processing have been framed as self-reinforcing obstacles that persist independently of regulatory or financial conditions [28,31,41].

Gender barriers displayed the most consistent and structurally revealing pattern in the dataset. Eleven out of 17 interviewees characterized EE project management as gender-neutral, yet simultaneously 9 out of 17 respondents reported barriers to women's leadership, and 4 out of 17 respondents cited underrepresentation of women engineers in senior positions. This contradiction warrants deeper analysis. The widespread perception of gender neutrality may not reflect an absence of gender barriers but rather a form of "gender blindness" embedded in the sector, a condition in which structural inequalities are so normalized that they become invisible to practitioners operating within them. Interviewee 12 noted, for example, that "gender is not something we think about; the work is technical, and whoever is qualified gets the job," a statement that simultaneously illus-

trates the persistence of meritocratic discourse while obscuring the structural barriers that limit women's access to technical qualifications and senior roles in the first place.

The fact that only 4 of the 17 interviewees were women, a ratio reflective of actual participation rates in Egypt's energy sector, further suggests that the "gender neutrality" reported by a majority of respondents may be a product of sampling from a predominantly male professional community rather than an accurate reflection of gender-equitable outcomes. These findings suggest that gender barriers in EE operate through normalized rather than explicit mechanisms, making them particularly resistant to standard policy interventions and requiring targeted structural remedies rather than awareness campaigns alone.

5.4. Sector-Level Differences

While the preceding section establishes the systemic, cross-cutting nature of EE barriers in Egypt, a sector-level reading of the data reveals meaningful differentiations that carry distinct policy implications. The analysis below focuses exclusively on barriers that are disproportionately pronounced in a specific sector and are not adequately captured by the cross-sector discussion. In the transport sector, the data reveal a distinctively sharp institutional gap that goes beyond the enforcement deficit common to all sectors.

Transport-specific governance fragmentation, defined by the absence of a single coordinating authority across multiple transport modes (road, rail, aviation, and maritime), represents the most acute institutional barrier in this sector. The misalignment between green policy objectives and actual funding allocations is also greatest in transport (10 out of 17), compared with buildings (8 out of 17) and industry (7 out of 17), highlighting a particularly stark disconnect between the sector's strategic importance and the budgetary priority it receives.

Moreover, transport respondents report the highest rate of limited access to finance (11 out of 17) across all sectors, reflecting the capital intensity of fleet modernization and the near-total dependence on fossil fuels (97.7%), which narrows the range of viable EE technologies and complicates the investment case. These sector-specific compounding factors make transport the most structurally constrained sector for EE implementation.

In the buildings sector, the gender dimension presented a particularly distinct profile. While gender barriers were reported as broadly neutral across sectors, the buildings sector showed the highest rate of reported barriers to women's leadership roles (10 out of 17, equal to transport but significantly above industry). More distinctively, gender-related barriers accounted for the highest share of the total barrier mix in buildings (16%), exceeding both industry (12%) and transport (15%).

This suggests that the buildings sector, which encompasses diverse actors from contractors and property developers to building managers and procurement officers, harbors more entrenched structural inequalities in EE-related decision-making, even though these are rarely made explicit by respondents. Several interviewees in the buildings sector acknowledged that women are seldom in positions where they approve procurement or specify technical requirements, despite being well represented in administrative and support roles.

This pattern is consistent with what gender scholars call "horizontal segregation," a concentration of women in roles adjacent to, but not leading, technical and financial decision-making. As Interviewee 7 remarked: "We have women on the team, but they tend to manage communications and documentation rather than the engineering or commercial side." These findings suggest that gender mainstreaming in the buildings sector must go beyond representation metrics to address the functional allocation of roles and the informal norms that shape who holds decision-making authority. This finding warrants dedicated attention in building-sector EE programs and governance frameworks.

5.5. Strategic Priorities for Accelerating EE Uptake

The highest-ranked priorities were institutional in nature. The experts agreed broadly that the development of a coherent and consistent set of EE policies and programs, and the enactment of enforceable EE legislation aligned with environmental objectives, were the most critical needs, each endorsed by more than half of all interviewees. The emphasis on policy reform and regulatory enforcement confirmed that existing frameworks are widely perceived as inadequately implemented or insufficiently backed by legal force (see Table 2).

Financial priorities ranked second, reflecting the financing constraints documented across all sectors. More than half of interviewees signaled continued reliance on international support and donor funding as a priority, underscoring the underdevelopment of the domestic green finance market. Almost equally prominent, the demand for affordable and accessible finance, including low-interest loans, risk-sharing mechanisms, guarantees, and tailored EE financial products, was widely shared across stakeholder categories.

Sector-specific technologies were identified as a priority by a significant share of interviewees, reflecting the heterogeneity of EE needs across industry, buildings, and transport. The establishment of internal environmental targets was mentioned by a number of interviewees, indicating growing organizational awareness of energy management responsibilities. Several interviewees also pointed to the identification of minimum EE measures for quick wins as a pragmatic, phased entry point for implementation.

Awareness-related priorities, though lower-ranked, were noted by several interviewees as critical enabling factors: greater policy clarity and communication, and support for training, innovation, and research, were identified as foundational to translating policy ambition into practice. The lowest-ranked priority, integrating a gender lens into EE policies and increasing representation, confirms that gender remains a peripheral concern for most stakeholders, consistent with the broader pattern of perceived gender neutrality identified in the barriers analysis. As one interviewee from an international development organization observed: “Gender is still seen as a social add-on in EE circles, not as something that changes how you design programs or who you target.”

Table 2. Top priorities to promote EE implementation.

Top Priorities		Category
Framework for Policies and Programs	12	Institutional
Environmental targets must be backed by enforceable EE laws	12	Institutional
Role of International Support & Donors	11	Financial
Provide affordable and accessible finance	10	Financial
Reform policy, enforce EE mandates.	10	Institutional
Needs tech tailored per sector.	9	Technical
Set internal environmental targets	8	Technical
Raise EE profile nationally.	8	Institutional
Identify minimum measures for quick gains	7	Technical
Modernize infrastructure and modern EE technologies	7	Institutional
Clearer policy communication and awareness.	7	Awareness
Train, innovate, support research.	6	Awareness
Expand finance, engage private sector.	5	Financial
Integrate a gender lens into EE policies and increase representation	5	Gender

Source: Author’s analysis of stakeholder interviews conducted in 2025.

5.6. Robustness Considerations

To ensure the robustness and reliability of the study, a structured and systematic approach was adopted for both the interview process and the supporting desk research, consistent with recommended practices for qualitative research in environmental and sus-

tainability studies [42]. Interview questions were developed in advance based on the study objectives and key thematic areas, and all participants were asked a common set of core questions to ensure consistency, while targeted follow-up questions were used to clarify specific issues and elicit evidence-based responses [33]. Predefined analytical categories were established to support the consistent interpretation of interview data, and detailed notes were recorded immediately after each interview to maintain traceability and minimize recall bias.

To reduce the influence of individual perspectives and strengthen the credibility of the findings, interview results were systematically triangulated with evidence from desk research, including peer-reviewed literature, policy documents, technical reports, and publicly available datasets, following established principles for enhancing rigor and credibility through multiple lines of evidence [42]. The analysis focused on identifying recurring patterns and areas of convergence across different sources [43]. As a result, the findings presented in this study are based on the integration and cross-validation of multiple sources of evidence rather than on individual interviews or isolated information sources, thereby increasing the robustness and credibility of the analysis.

Interviews were conducted iteratively until thematic saturation was achieved, defined as the point at which additional interviews no longer yielded substantively new themes or insights. This approach is consistent with established practices in qualitative research and with recommendations for interview-based studies in the fields of building energy and sustainability research, where sample adequacy is determined by information richness and thematic convergence rather than by predetermined sample sizes [44]. The credibility of the findings was further strengthened through triangulation with evidence obtained from desk research and multiple documentary sources, in line with good practice for energy social science and sustainability research [45,46].

6. Policy Recommendations

6.1. Cross-Sectoral Recommended Policies

Across all sectors, stakeholders consistently identified the lack of enforceable EE legislation as the most critical systemic barrier. The government should therefore anchor a national EE strategy in a binding regulatory framework that mandates measurable energy-reduction targets for private-sector entities, backed by clear penalties and compliance mechanisms. This should be complemented by establishing a dedicated national EE fund, managed jointly by public and private stakeholders, to provide affordable, long-term financing instruments that reduce reliance on high-interest commercial credit. Given the high upfront capital burden identified across industry, buildings, and transport, blended finance mechanisms combining donor funds, concessional lending, and tax incentives are essential to unlock private-sector investment at scale.

On the institutional side, the fragmentation of EE responsibilities across ministries must be addressed through a single coordinating body with a cross-sectoral mandate, clear accountability, and the authority to align fiscal, regulatory, and technical support. Alongside this, a national energy auditing protocol, standardized and legally required for firms above a certain energy-consumption threshold, would generate the currently missing baseline data, enabling both evidence-based policymaking and access to structured EE finance. Finally, a sustained awareness and capacity-building program targeting corporate decision-makers and technical staff is needed to close the knowledge gap on available incentives, financing windows, and EE technologies.

6.2. Sector-Specific Recommendations

For the industrial sector, where legacy systems and outdated machinery pose the deepest technical barriers, the government should introduce sector-tailored retrofit programs with co-financing from development finance institutions. Given that industrial interviewees ranked financial access constraints and rigid bank terms among their top concerns, dedicated EE credit lines with flexible collateral requirements and long repayment periods should be negotiated with national banks, supported by partial risk guarantees from the state.

For the buildings sector, mandatory EE performance standards for commercial buildings, including retrofitting requirements tied to property licensing and renewal, would create the regulatory pull needed to mobilize investment. Interviewees in this sector highlighted a particular gap in public–private coordination on EE financing; therefore, a green mortgage or green lease framework that enables building owners and tenants to share the costs and savings of EE upgrades should be piloted in the banking sector under the oversight of the Central Bank of Egypt.

For the transport sector, which recorded the highest average score for financial barriers, policy should prioritize access to green-vehicle financing and tax incentives for fleet electrification or fuel switching. This sector also showed the widest gap in awareness of available measures, suggesting that a targeted outreach and technical assistance program, delivered through industry associations and freight operators, could have significant near-term impact without requiring large capital commitments.

Finally, across all sectors, EE policy must integrate a gender lens. While most interviewees viewed EE management as gender-neutral, structural barriers to women's leadership in both finance and engineering roles were consistently reported. Gender-disaggregated reporting should be required for EE projects, and women's representation must be built into the governance structures of national EE funds and technical committees.

7. Conclusions

This study provided a comprehensive qualitative and exploratory assessment of the drivers, barriers, and strategic priorities shaping EE across Egypt's industry, buildings, and transport sectors. The findings indicated that sustainability objectives and financial incentives were the principal drivers of EE uptake. Nevertheless, implementation remained fundamentally constrained by persistent institutional and financial barriers. Weak enforcement mechanisms, fragmented governance, limited policy coherence, and the misalignment between national green ambitions and actual budgetary allocations consistently undermined EE prioritization.

Financial barriers, including high upfront costs, restricted access to capital, inflexible banking conditions, and the absence of a domestic EE finance market, represented a further critical constraint on investment, particularly for capital-intensive retrofits and infrastructure upgrades. Technical and awareness-related barriers compounded these challenges through legacy systems, insufficient standardization, and inadequate dissemination of information on available EE measures and incentives. Gender-related barriers were broadly perceived as marginal or neutral; however, a closer examination revealed structural disparities in leadership representation and decision-making authority, indicating that gender concerns remained insufficiently mainstreamed within the EE policy framework. Specifically, the buildings sector recorded the highest incidence of gender-related barriers.

This study is subject to two key limitations. First, the EE ecosystem in Egypt remains fragmented and relatively nascent. In addition, there is limited availability of empirical and sector-specific literature on EE in Egypt. Second, while the qualitative approach provides valuable insights into perceived barriers and drivers, further quantitative research

is needed to examine how firm-level characteristics, such as size, sector, ownership structure, and financial capacity, influence the adoption of EE measures. Future studies could build on these findings through larger-scale quantitative analyses across different sectors.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of The American University in Cairo (AUC) (Protocol No. 2026-119). The IRB determined that the study qualified for exempt status, as it employed appropriate procedures to minimize risks to human participants and included adequate measures to ensure participant confidentiality and data anonymity.

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Appendix A

Table A1. Stakeholder composition.

Stakeholder	No. of Interviews	Representative Description
Government & Regulators	2	National Renewable Energy Authority/Regulatory Body.
Banks & Financial Institutions	3	- Major state-owned commercial bank. - Private sector commercial bank. - International development finance institution.
International & Regional Partners	2	- International development cooperation agency. - Regional intergovernmental organization for renewable energy and energy efficiency.
Private Sector & Energy Demand Actors	6	- Multinational industrial gas producer - Large-scale engineering, construction, and infrastructure group - Multinational digital automation and energy management corporation. - Tech-enabled mass transit and mobility platform provider. - National flag carrier airline. - Multinational building automation, HVAC, and energy services provider.

Academic & Business As-			
sociations	4		• Business and trade association representing local commerce. • Private higher education and research institution. • Independent industry and energy consultant. • Professional financial consultant.

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