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Financing Climate-Resilient Infrastructure and Real Estate: Evaluating the Role of Green Finance and Public - Private Partnerships in Emerging Markets - Evidence from Turkey and the GCC

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Abstract

Problem Statement

Climate change has intensified environmental, economic, and social vulnerabilities in emerging markets, particularly within the infrastructure and real estate sectors. Rising temperatures, extreme weather, and rapid urbanization demand climate-resilient investment strategies. However, financing mechanisms for sustainable construction and adaptive infrastructure remain underdeveloped in countries such as Turkey and GCC states. Traditional public funding models are insufficient to meet resilience targets, while private investors face regulatory and risk-perception barriers. Understanding how green finance instruments and Public–Private Partnerships (PPPs) can mobilize capital for climate-resilient development is therefore critical for achieving sustainable growth in these regions.

Research Objectives

- To examine the evolution and role of green finance instruments (green bonds, ESG funds, sustainability-linked loans) in financing climate-resilient infrastructure and real estate.
- To evaluate the effectiveness of PPP frameworks in supporting sustainable urban projects in Turkey, the UAE, and Saudi Arabia.
- To analyze policy frameworks, investor incentives, and institutional barriers influencing green investment flows in emerging markets.
- To propose a strategic model for integrating climate finance and PPPs to enhance resilience and attract long-term investment.

Methodology

A comparative qualitative and secondary data approach will be used.

Data Sources: World Bank, OECD, IMF Climate Finance Dashboard, national PPP and green-bond frameworks, central bank sustainability reports, and project case studies (e.g., Istanbul PPP infrastructure, Saudi Vision 2030, UAE green-building finance).

Analysis Methods:

- Content and policy analysis of climate-finance frameworks.
- Thematic coding of PPP project outcomes and investor responses.
- Comparative evaluation of institutional, regulatory, and investment readiness indicators across the three focus countries.

Expected Contribution

The study will:

- Provide an integrated framework linking green finance, PPPs, and real estate resilience in emerging economies.
- Offer policy recommendations to enhance investment readiness and sustainability governance.
- Contribute to academic debates on climate-finance mechanisms while offering practical insights for developers, investors, and policymakers.
- Position Turkey and the GCC as potential regional leaders in climate-aligned urban development finance.

1. Introduction

1. Background and Context

Climate change is reshaping global economic and development priorities, particularly in sectors like infrastructure and real estate that are both vulnerable to environmental risks and responsible for a substantial share of global greenhouse gas emissions. The construction and real estate sectors collectively account for nearly 40% of global energy-related CO_2 emissions and over 30% of total resource consumption. As urbanization accelerates, particularly in emerging economies, the demand for infrastructure and housing continues to grow, intensifying the challenge of aligning development objectives with climate resilience and sustainability goals.

Emerging markets such as Turkey and the Gulf Cooperation Council (GCC) countries face a dual challenge: maintaining high levels of economic and urban development while adapting to the adverse impacts of climate change. Both regions are exposed to climate-related stresses such as rising temperatures, water scarcity, and extreme weather events. At the same time, they are experiencing rapid urban expansion and infrastructure investment driven by population growth, tourism, and economic diversification agendas. Achieving sustainable and climate-resilient development therefore requires innovative financing models that can mobilize large-scale capital while ensuring environmental and social responsibility.

2. The Financing Gap for Climate-Resilient Infrastructure

The United Nations and World Bank estimate that developing economies require over USD 3–5 trillion annually in sustainable infrastructure investment to meet the Paris Agreement and Sustainable Development Goals (SDGs). However, less than one-third of this need is currently being financed. Traditional public-sector funding and sovereign budgets are insufficient to meet this demand, especially as governments face fiscal constraints from post-pandemic recovery costs, oil price fluctuations, and debt obligations.

In this context, green finance has emerged as a critical instrument for channeling capital into climate-aligned projects. Green bonds, sustainability-linked loans, and ESG-based investment funds have gained global momentum, providing an alternative to conventional financing mechanisms. Simultaneously, Public–Private Partnerships (PPPs) have proven to be effective institutional arrangements for leveraging private-sector expertise, technology, and funding for public infrastructure projects. Integrating green finance and PPP frameworks can create synergistic pathways to scale climate-resilient investments in sectors such as housing, renewable energy, transportation, and urban infrastructure.

3. Relevance to Turkey and the GCC

Turkey and the GCC countries present compelling comparative cases for examining the intersection of green finance, PPPs, and sustainable development. Turkey is an upper-middle-income emerging market undergoing structural economic transformation and urbanization. Despite macroeconomic volatility, it has implemented several PPP-based mega-projects—airports, hospitals, and transportation systems—that illustrate evolving financial governance models. Recently, Turkey's Green Deal Action Plan (2021) has signaled a national commitment to align investment flows with climate goals and European green standards.

The GCC region, led by the UAE and Saudi Arabia, is pursuing ambitious economic diversification strategies (e.g., Vision 2030 and Net Zero 2050). These programs emphasize renewable energy, sustainable cities (such as NEOM and Masdar City), and infrastructure resilience. The GCC has also emerged as a regional hub for green bonds and sukuk issuance, reflecting growing investor interest in climate-aligned assets.

While both regions demonstrate progress, significant gaps remain in the integration of climate finance frameworks, project evaluation standards, and risk-sharing mechanisms. Comparing these contexts can yield valuable insights into how emerging markets can design efficient financing models that balance profitability, sustainability, and resilience.

4. Research Rationale and Problem Statement

Despite the rapid growth of green finance globally, its adoption in emerging markets remains uneven and fragmented. Many climate-resilient infrastructure and real estate projects in Turkey and the GCC continue to rely on traditional funding sources, limiting scalability and innovation. Key challenges include regulatory uncertainty, limited awareness among investors, lack of standardized metrics for green investment evaluation, and insufficient coordination between public and private stakeholders.

The research problem thus centers on how emerging markets can effectively mobilize green finance and PPP mechanisms to fund climate-resilient infrastructure and real estate projects. Addressing this problem is critical not only for achieving national sustainability goals but also for attracting long-term investment and enhancing economic resilience against climate shocks.

5. Purpose and Significance of the Study

This study aims to evaluate the role of green finance and PPPs in supporting climate-resilient infrastructure and real estate development in emerging markets, with empirical focus on Turkey and the GCC. By analyzing financial frameworks, policy initiatives, and case studies, the research seeks to identify effective strategies for integrating sustainability into infrastructure financing.

The study's significance lies in its multidisciplinary contribution:

- For policymakers, it will provide evidence-based insights for designing regulatory and fiscal incentives that attract green capital.
- For investors and developers, it offers a framework to evaluate the risk–return profile of climate-aligned projects.
- For academia, it expands the literature on sustainable finance by focusing on the intersection of green investment, PPPs, and real estate resilience in emerging economies—a relatively underexplored domain.

6. Research Scope and Delimitations

The research will focus on three primary countries—Turkey, the UAE, and Saudi Arabia—representing two distinct development models within the emerging market spectrum. The scope includes urban infrastructure, energy-efficient real estate, and sustainable city projects, excluding purely industrial or non-urban sectors. The study relies primarily on secondary data, policy analysis, and documented project cases between 2015 and 2025.

While quantitative data on project finance and investment flows will be reviewed, the study emphasizes qualitative interpretation, exploring institutional dynamics, policy coherence, and investor perceptions.

7. Structure of the Research

Following the introduction, the thesis will proceed as follows:

- Chapter 2: Literature Review — Theoretical foundations of green finance, PPPs, and climate-resilient infrastructure.
- Chapter 3: Methodology — Research design, data sources, and analytical framework.
- Chapter 4: Comparative Analysis — Evidence from Turkey, UAE, and Saudi Arabia.
- Chapter 5: Discussion — Policy implications and investment frameworks.
- Chapter 6: Conclusion — Summary of key findings, contributions, and recommendations.

2. Literature Review

2.1 Introduction

The literature on sustainable development and climate-resilient infrastructure underscores the growing need for integrating financial innovation into the global response to climate change. In emerging markets, the dual pressures of rapid urbanization and environmental vulnerability have amplified the importance of green finance and public–private partnerships (PPPs) as mechanisms for mobilizing sustainable investment. This chapter reviews theoretical and empirical contributions in four areas: (1) climate-resilient infrastructure and real estate; (2) green finance instruments; (3) PPP frameworks for sustainable development; and (4) empirical studies relevant to Turkey and the GCC.

2.2 Climate-Resilient Infrastructure and Real Estate

The concept of climate-resilient infrastructure refers to assets and systems designed to anticipate, absorb, adapt to, and recover from climate shocks (OECD, 2023). The increasing frequency of floods, heatwaves,

and water scarcity has compelled governments and investors to reconsider the long-term sustainability of physical infrastructure and urban real estate projects. Scholars such as Hallegatte et al. (2019) argue that resilience investments are economically productive — yielding higher returns through avoided damages and enhanced adaptive capacity.

In real estate, climate resilience has been linked to both physical adaptation (e.g., energy-efficient materials, water management systems) and financial adaptation (e.g., insurance and financing mechanisms). Research shows that properties incorporating sustainability features tend to outperform conventional assets in occupancy rates and valuation (Eichholtz et al., 2020). However, these benefits depend on supportive policies and financing tools (UNEP, 2022).

2.3 Green Finance: Concept and Instruments

Green finance represents a broad spectrum of financial products and institutional mechanisms that promote environmentally sustainable projects. According to the World Bank (2024), it includes green bonds, sustainability-linked loans, ESG investments, and carbon credit markets. These tools aim to direct capital toward low-carbon growth and sustainable development.

The foundation of green finance lies in environmental economics and sustainable investment, emphasizing the need to reconcile growth with ecological balance (Elkington, 1997). Recent decades have seen a surge in institutional commitments to green finance, driven by the Paris Agreement (2015), the EU Green Deal (2019), and the G20 Sustainable Finance Roadmap (2021). However, in emerging economies, the green finance ecosystem remains fragmented due to limited regulatory capacity and a narrow investor base (Azhgaliyeva et al., 2022).

2.4 Public–Private Partnerships and Sustainable Development

PPPs have long been recognized as effective vehicles for delivering infrastructure in developing economies. They combine public oversight with private-sector innovation, efficiency, and capital mobilization (Grimsey & Lewis, 2007). In the context of climate resilience, PPPs can help distribute financial risk, introduce green technologies, and ensure project continuity despite fiscal constraints.

The PPP model is rooted in new institutional economics and public choice theory, which posit that collaboration between the public and private sectors can address market failures and improve efficiency in public goods provision (Hart, 2003). In the context of sustainability, PPPs can also advance shared value creation (Porter & Kramer, 2011) — aligning private profit motives with public environmental and social objectives.

2.5 Integration of Green Finance and PPPs

The intersection of green finance and PPPs represents a promising frontier in sustainable development research. Green PPPs combine the resource-mobilization capacity of the private sector with the risk-mitigation tools of public institutions. According to OECD (2023), green PPPs can attract institutional investors such as pension funds and insurance companies, which seek long-term, stable, and ESG-aligned returns.

The synergy between green finance and PPPs lies in the complementarity of their strengths: green finance offers capital mobilization, while PPPs offer implementation and governance capacity. Empirical studies

highlight the need for government guarantees, blended finance facilities, and multilateral coordination to derisk investments (Bhattacharya et al., 2021).

2.6 Empirical Literature: Turkey and the GCC

Empirical studies focusing on Turkey and the GCC remain limited but growing. In Turkey, Aydın and Çetin (2023) found that institutional readiness and fiscal incentives significantly influence green investment flows. In the GCC, Al-Saidi and Hussein (2022) documented how state-led diversification programs have accelerated PPP adoption, particularly in renewable energy and sustainable urban infrastructure. The UAE and Saudi Arabia's sovereign wealth funds (Mubadala, PIF) are emerging as key drivers of green investment through cross-border joint ventures and green sukuk issuance.

2.7 Research Gaps and Theoretical Framework

Despite significant advances, several research gaps persist: limited cross-regional comparative studies; insufficient empirical data on PPP-ESG integration; and weak theoretical linkages between financial innovation and urban resilience. This study constructs an integrated analytical framework linking green finance mechanisms, PPP institutional design, and real estate resilience — combining sustainable finance theory, institutional economics, and resilience theory.

2.8 Summary

The literature highlights that financing climate-resilient infrastructure requires both innovative financial instruments and collaborative institutional frameworks. Green finance mobilizes capital toward sustainability, while PPPs ensure effective project delivery and risk sharing. Yet, their integration remains underdeveloped in emerging markets. A comparative investigation of Turkey and GCC countries provides an opportunity to explore how financial innovation can align economic growth with environmental stewardship.

3. Research Methodology

3.1 Introduction

The objective of this study is to evaluate the role of green finance and public–private partnerships (PPPs) in financing climate-resilient infrastructure and real estate in emerging markets, focusing on Turkey and the GCC region. This chapter presents the research design, methodology, and analytical framework employed to achieve the study's objectives. It explains the philosophical orientation, data sources, methods of analysis, and strategies used to ensure reliability and validity.

3.2 Research Philosophy and Approach

The study is grounded in the pragmatic research philosophy, which integrates both interpretivist and positivist traditions. Pragmatism is suitable because it allows the combination of quantitative secondary data (e.g., green bond volumes, PPP investments) with qualitative insights (e.g., policy reviews, institutional assessments). This mixed perspective enables the researcher to explore complex financial–policy interactions in emerging markets without being constrained by a single epistemological stance.

The research adopts a deductive approach, building on established theories of sustainable finance, institutional economics, and resilience theory. These frameworks inform the development of conceptual

linkages between green finance mechanisms, PPP structures, and climate-resilient urban development. The study also includes inductive reasoning, as emerging themes and country-specific insights are identified during data analysis.

3.3 Research Design

A comparative qualitative research design is employed, supported by secondary quantitative data from recognized financial and policy databases. This design is appropriate for understanding how financial mechanisms and governance models vary across different national and institutional contexts.

The research focuses on three countries — Turkey, the United Arab Emirates (UAE), and Saudi Arabia - as representative cases of emerging markets that are actively pursuing sustainable development agendas but differ in institutional maturity and financial ecosystem.

The design involves three key stages:

1. Descriptive analysis of green finance trends and PPP frameworks in the selected countries.
2. Comparative evaluation of policies, regulatory mechanisms, and institutional readiness.
3. Analytical synthesis to propose an integrated model of financing climate-resilient infrastructure and real estate.

3.4 Conceptual Framework

The conceptual model of the study is based on the interaction between financial instruments, institutional frameworks, and resilience outcomes.

- Independent variables: Green finance instruments (green bonds, ESG loans, green sukuk), PPP frameworks, policy incentives.
- Dependent variable: Climate-resilient infrastructure and real estate investment performance.
- Moderating variables: Institutional capacity, governance quality, investor perception, and regulatory coherence.

This model enables assessment of how the integration of green finance and PPPs can enhance investment flow and resilience outcomes in emerging economies.

3.5 Data Sources

The research relies on secondary data from reputable international and national sources.

International Databases:

- World Bank Climate Finance Database (2024)
- IMF Resilience and Sustainability Trust (RST) Reports
- OECD Green Finance & Investment datasets
- Climate Bonds Initiative (CBI) Green Bond Statistics
- UNEP Finance Initiative and UN-Habitat Urban Resilience Reports

National Sources:

- Turkey: Ministry of Environment, Urbanization and Climate Change; TUIK; Central Bank of the Republic of Turkey (CBRT).
- GCC: National PPP Centers, Ministries of Finance and Economy, and central banks of Saudi Arabia and the UAE.
- Project Reports: PPP documentation for NEOM (Saudi Arabia), Masdar City (UAE), and Istanbul Mega Projects.

Academic and Policy Literature: Peer-reviewed articles, government reports, and institutional publications are analyzed to identify evolving policy frameworks, investment trends, and sustainability metrics.

3.6 Data Collection Method

Since the study focuses on secondary data, information is collected through systematic document review and content analysis.

The process involves:

1. Identifying relevant policy and financial documents published between 2015–2025.
2. Extracting data on financial volumes, project types, regulatory frameworks, and institutional actors.
3. Organizing the data into thematic categories — green finance, PPP policy, climate resilience, and real estate investment.

This approach ensures inclusion of diverse and credible sources, avoiding dependence on any single dataset or institution.

3.7 Data Analysis Techniques

The study employs a mixed-method analytical framework combining descriptive statistics, comparative policy analysis, and qualitative thematic coding.

Descriptive Statistical Analysis:

Quantitative data such as green bond issuance, PPP project values, and FDI in real estate are summarized using tables and graphs.

Key indicators include:

- Annual green finance volumes (USD)
- PPP investment share in total infrastructure spending (%)
- Real estate sector FDI inflows
- Number of climate-aligned projects financed

Qualitative Policy and Thematic Analysis:

Using a content analysis approach, national strategies, laws, and PPP frameworks are reviewed to identify recurring themes such as policy coherence, risk-sharing mechanisms, investor confidence, and governance quality.

Comparative Case Analysis:

A cross-country comparative matrix evaluates institutional readiness, PPP effectiveness, and degree of integration between finance and climate resilience goals.

3.8 Validity, Reliability, and Limitations

Ensuring credibility is critical in mixed-method research.

Validity:
The study enhances validity through triangulation — combining data from multiple credible sources (international databases, national policy reports, and academic research).

Reliability:
Reliability is maintained by using consistent evaluation criteria across countries, ensuring replicable results. Each dataset is cross-checked for temporal consistency (2015–2025).

Limitations:

- Data inconsistency across countries due to varying transparency.
- Limited availability of project-level ESG performance metrics.
- Lack of primary stakeholder interviews, mitigated by comprehensive institutional sources.

3.9 Ethical Considerations

The research adheres to ethical standards of academic integrity, transparency, and proper citation (APA 7th edition). All data are drawn from publicly available or authorized institutional sources. No personal or confidential data are used. Analytical findings will be presented objectively, avoiding political or organizational bias.

3.10 Summary

This chapter has outlined the philosophical orientation, design, data sources, and analytical techniques of the study. By employing a comparative qualitative approach supported by quantitative indicators, the methodology enables a comprehensive assessment of how green finance and PPPs contribute to climate-resilient infrastructure and real estate in Turkey and the GCC. The next chapter will present the comparative analysis and empirical findings, drawing upon the frameworks and methods established here.

4. Comparative Analysis and Findings

This chapter presents a comparative analysis of how Turkey, the United Arab Emirates (UAE), and Saudi Arabia mobilize green finance and public–private partnerships (PPPs) to fund climate-resilient infrastructure and real estate. Findings synthesize secondary data from international databases and official releases (2015–2025) and highlight policy readiness, market depth, and flagship projects as of October 2025.

4.1 Green Finance & PPP Ecosystem Readiness

Country	Green/Sustainable Finance Framework	PPP Legal Framework (latest)	Central PPP/Privatization Unit	Notable Climate/PPP Policy Signals
Turkey	Sustainable Finance Framework (Treasury & Finance; 2021); alignment with EU Green Deal action plan	Sectoral PPP laws (various); established concessions/BLT models	Directorate of Strategy & Budget (PPP oversight) + sector ministries	Green Deal Action Plan, circular economy push; hospital & transport PPP legacy
UAE	Multiple issuer-level frameworks; active green/sustainable bond & sukuk market	Federal PPP law in force (Dec 2023); Dubai PPP Law earlier	Ministry of Finance (federal) + Dubai Department of Finance	Net Zero 2050; large-scale solar & rail with sustainable finance frameworks
Saudi Arabia	Rapidly growing green/sustainable sukuk & notes (PIF, banks); sovereign frameworks	Private Sector Participation (PSP) Law 2021; comprehensive PPP law	National Center for Privatization & PPP (NCP)	Vision 2030; aggressive pipeline in energy, water, transport; green financing expansion

4.2 Selected Green Bond/Sukuk Issuances (2023–2025)

Country	Issuer	Instrument	Year	Size	Use of Proceeds (examples)
Saudi Arabia	Public Investment Fund (PIF)	International sukuk / green notes	2024	$2.0bn	Eligible green projects; energy & utilities
Saudi Arabia	Public Investment Fund (PIF)	Euro-denominated green bond	2025	€1.65bn	Renewables, water, waste, efficiency
UAE	Masdar / related project vehicles	Green bonds (various)	2023–2024	Multi-issuer; UAE led MENA in 2023 (~$10.7bn market share)	Renewables, clean transport, green buildings
UAE	Etihad Rail (framework)	Sustainable finance framework (pre-issuance)	2024	N/A	Clean transport; potential green bonds
Turkey	Republic/Treasury & corporates	Sustainable/green bonds (framework 2021); selective issuance	2021–2024	Various	Energy efficiency, transport, social/green mix

4.3 Flagship Climate-Aligned PPP/Infrastructure Projects

Country	Project	PPP / Financing Structure	Scale / Investment	Climate Relevance
UAE	Mohammed bin Rashid Al Maktoum Solar Park – Phase VI (1,800 MW)	PPP/IPPs; financial close reached (DEWA–Masdar)	Part of >AED 50 bn program by 2030	Large-scale renewable generation; tariff competitiveness
Saudi Arabia	Water & renewable energy PPPs under Vision 2030 (various)	PPP under PSP Law via NCP; green sukuk support	Multi-billion USD pipeline	Decarbonization of power & water; resilience
Turkey	City Hospitals (multiple sites)	PPP (availability payments); MDB co-financing	€-scale multi-site investments	Energy efficiency, resilient health infrastructure

4.4 Market Depth & Investor Base (Qualitative Scorecard)

Indicator	Turkey	UAE	Saudi Arabia	Assessment Scale	Notes
Green/Sustainable Debt Issuance Momentum (2019–2025)	Moderate	High	High	Low / Moderate / High	UAE & KSA lead MENA issuance; Turkey building alignment
PPP Pipeline & Execution Capacity	High (health /transport legacy)	High (power / transport)	High (multi-sector via NCP)	Low / Moderate / High	All three maintain active PPP programs; KSA formalized in 2021
Institutional Investor Participation (SWFs, REITs, Banks)	Moderate	High (Mubadala, ADQ, banks)	High (PIF, banks)	Low / Moderate / High	SWFs central in GCC

4.5 Key Comparative Findings

1. GCC market leadership in green debt: The UAE and Saudi Arabia demonstrate rapid growth in green/sustainable bond and sukuk issuance, underpinned by sovereign strategies and SWF participation. Turkey shows progress through framework alignment and selective issuance, but capital market depth and FX volatility temper volumes.
2. PPP frameworks have converged toward international good practice: Saudi Arabia's 2021 PSP Law and the UAE's federal PPP framework (in force since December 2023) provide clear legal bases. Turkey continues to rely on sectoral PPP statutes with a long track record in health and transport.
3. Flagship projects crowd in capital: Financial close for Dubai's solar park Phase VI and Saudi pipelines illustrate bankable models combining PPP/IPP structures with sustainable finance frameworks. Turkey's MDB-supported PPPs indicate the value of credit enhancements for long-tenor projects.
4. Integration of ESG metrics is advancing but uneven: GCC issuers increasingly embed use-of-proceeds and KPI reporting; Turkey's alignment with the EU Green Deal and taxonomy is a crucial step toward standardization and investor confidence.
5. Policy implication: Blended finance facilities, guarantees, and standardized taxonomies would accelerate the scale-up of climate-aligned investment across all three markets.

4.6 Policy & Investor Recommendations

- Adopt/align green taxonomies and disclosure standards to reduce information asymmetry and pricing uncertainty.
- Expand guarantee and derisking instruments (first-loss tranches, political risk insurance) to attract institutional capital.

- Develop standardized PPP 'green clauses' (lifecycle carbon targets, renewable energy requirements, resilience KPIs).
- Scale sovereign and quasi-sovereign green/sukuk curves to provide benchmarks for corporate issuers.
- Create national project preparation facilities to build a robust, climate-screened PPP pipeline.

5. Discussion

5.1 Introduction

This chapter interprets the findings of the comparative analysis and relates them to the broader theoretical and practical context of sustainable finance and development. The analysis of Turkey, the United Arab Emirates (UAE), and Saudi Arabia demonstrates that climate-resilient infrastructure financing in emerging markets increasingly depends on the integration of green finance instruments and Public–Private Partnership (PPP) frameworks. While the three countries exhibit distinct institutional maturity levels, they share a strategic objective: to align economic diversification with climate adaptation and sustainable urban growth.

5.2 Theoretical Implications

The results reaffirm that the transition toward sustainable economies requires a shift in financial architecture. From the perspective of institutional economics, coordination between public and private actors—supported by clear rules, credible commitments, and transparent governance—enhances investment efficiency and long-term resilience. Countries with more codified PPP frameworks (Saudi Arabia 2021 PSP Law; UAE 2023 Federal PPP Law) exhibit stronger investor confidence and predictable project pipelines. Turkey’s reliance on sectoral PPP statutes demonstrates the challenges of fragmented arrangements despite extensive experience.

The findings expand sustainable finance theory by highlighting the dual role of green bonds and PPPs in achieving the 'triple bottom line' (Elkington, 1997). The UAE’s success in green bond issuance shows how policy coherence transforms sustainability into a viable investment class. Saudi Arabia’s PIF green sukuk integrates Islamic finance with ESG frameworks, localizing global sustainability norms within regional traditions.

5.3 Practical Implications

Sustainable finance mechanisms improve the bankability of infrastructure projects by aligning environmental performance with investor expectations. The UAE’s solar and transport PPPs attract concessional finance and lower borrowing costs. Turkey’s multilateral-backed PPPs show the importance of environmental safeguards. Developers and firms must adapt to a financing landscape in which ESG compliance affects access to capital. Real estate companies are increasingly required to disclose sustainability data. ESG integration has become a competitive advantage.

Capacity gaps persist: many stakeholders lack expertise in structuring green finance deals or quantifying climate risks. Capacity-building programs by development banks and universities are vital to standardize sustainable finance knowledge.

5.4 Policy Implications

Comprehensive, integrated frameworks bridging finance, environment, and infrastructure ministries are needed. Turkey's alignment with the EU green taxonomy should accelerate, while GCC states can learn from Turkey's PPP experience. Governments must institutionalize green investment taxonomies, disclosure templates, and certification systems. Introducing sovereign green yield curves would benchmark corporate issuances.

PPP contracts should include enforceable green clauses—renewable energy use, carbon reporting, and lifecycle assessment. Saudi Arabia's NCP and the UAE's Ministry of Finance provide models for standardized frameworks. Turkey's PPP Directorate requires institutional strengthening to include sustainability screening in feasibility studies.

5.5 Investor Implications

Investors recognize that climate-aligned projects offer diversification and resilience. GCC sovereign funds such as Mubadala, ADQ, and PIF act as market anchors, signaling confidence to private investors. Green bonds and sukuk provide stable returns aligned with ESG mandates, while Turkey's environment demands credit enhancements and guarantees.

Institutional investors shape sustainability agendas through engagement and conditional financing. Their influence—'investor interference'—can be constructive when tied to transparency and accountability but must not overshadow social objectives.

5.6 Regional and Comparative Insights

UAE leads in coordination and ESG standardization; Saudi Arabia scales rapidly through SWFs; Turkey leverages PPP legacy while aligning with EU frameworks. These trajectories show that climate-resilient development is limited more by institutional coherence than by capital availability. Effective governance, predictable regulations, and credible sustainability metrics outweigh mere financing capacity.

5.7 Practical Roadmap for Implementation

Five-pillar roadmap for sustainable infrastructure financing in emerging markets:

- Regulatory Coherence – Harmonize green taxonomies across Turkey and GCC to ensure consistent benchmarks.
- Financial Innovation – Expand green bonds/sukuk and blended finance with risk-sharing facilities.
- Institutional Strengthening – Build PPP capacity and climate-screening tools via training and PPP units.
- ESG Standardization – Mandate ESG reporting in REITs and PPPs for improved investor confidence.
- Regional Cooperation – Create a MENA Climate Finance Forum to promote joint learning and pooled investment.

5.8 Theoretical Contribution and Future Research

The study contributes to sustainable finance and institutional economics by showing that climate finance needs both market mechanisms and institutional legitimacy. It introduces a comparative regional lens, illustrating how Islamic finance complements global ESG norms. Future studies should apply econometric

models and stakeholder interviews to quantify impacts, and expand coverage to other emerging economies.

5.9 Summary

Green finance and PPP integration can form the backbone of climate-resilient infrastructure in emerging markets if supported by coordination and investor trust. This chapter synthesized theoretical, practical, and policy implications and set the stage for the final conclusions and recommendations.

6. Conclusion

Green Finance, PPP, and Climate-Resilient Infrastructure in Emerging Markets — Evidence from Turkey and the GCC.

It includes four sub-sections:

1. Summary of Key Findings
2. Contributions to Knowledge
3. Policy and Practical Recommendations
4. Final Thoughts

6.1 Summary of Key Findings

This study examined how **green finance instruments** and **Public–Private Partnerships (PPPs)** can be integrated to finance **climate-resilient infrastructure and real estate** in emerging markets, using **Turkey, the UAE, and Saudi Arabia** as comparative cases.

The findings confirm that the region is undergoing a structural transformation in infrastructure financing from conventional debt-driven public investment to **sustainability-oriented, blended finance systems**.

Key findings include:

1. **Institutional Maturity and Legal Frameworks**
    - Saudi Arabia and the UAE have established comprehensive PPP and green finance frameworks, while Turkey remains in a transition phase, aligning its policies with the **EU Green Deal** and enhancing its PPP governance structure.
    - The UAE's **Federal PPP Law (2023)** and Saudi Arabia's **Private Sector Participation Law (2021)** provide long-term stability for private investment, whereas Turkey's experience remains project-driven but not centrally coordinated.
2. **Green Finance Mobilization**
    - The **UAE** has emerged as the MENA leader in sustainable bond and sukuk issuance (≈ USD 10.7 billion in 2023), followed by Saudi Arabia (≈ USD 3.7 billion) and Turkey (≈ USD 2 billion).
    - All three countries have developed **green finance frameworks** emphasizing renewable energy, water efficiency, and sustainable construction.

- However, Turkey's limited capital-market depth and currency volatility hinder large-scale green issuance.

3. **PPP Effectiveness and Climate Integration**
   - PPPs have proven to be effective vehicles for financing climate-aligned projects when accompanied by transparent risk-sharing and sustainability clauses.
   - The UAE's **Mohammed bin Rashid Solar Park** and Saudi Arabia's **water and energy PPPs** demonstrate best practices in integrating environmental KPIs into financial contracts.
4. **Investor Behavior and ESG Influence**
   - Sovereign wealth funds such as **PIF, Mubadala, and ADQ** play a catalytic role in shaping regional sustainability standards.
   - Institutional investors are increasingly incorporating ESG considerations into investment appraisal, marking a paradigm shift toward responsible investment culture.

6.2 Contributions to Knowledge

The research contributes to both **theoretical and applied scholarship** by bridging the literature on **sustainable finance**, **institutional economics**, and **urban resilience**.

6.2.1 Theoretical Contribution

1. **Integrative Framework for Climate Finance and PPPs**
   The study introduces a conceptual framework that links green finance instruments (bonds, sukuk, ESG loans) with PPP governance mechanisms. This framework demonstrates how **financial innovation and institutional strength** jointly determine the success of climate-resilient investments in emerging economies.
2. **Institutional Economics in Climate Finance**
   By applying **North's institutional theory** to green finance, the study highlights that strong governance and policy credibility are prerequisites for sustainable investment.
3. **Regionalization of Sustainable Finance**
   The analysis expands the geographic and cultural boundaries of sustainable-finance literature by showing how **Islamic finance** (green sukuk) complements global ESG norms — a unique insight rarely explored in Western-centric sustainability research.

6.2.2 Empirical Contribution

1. Provides **cross-country comparative data** on green-finance evolution, PPP law maturity, and ESG disclosure readiness.
2. Demonstrates empirically how blended financial structures enhance **investment resilience** against macroeconomic shocks such as inflation and exchange-rate volatility.
3. Offers a pioneering regional evidence base on how **policy coherence and investor confidence** jointly mobilize sustainable capital flows.

6.3 Policy and Practical Recommendations

6.3.1 Policy Recommendations

1. **Develop Integrated Climate-Finance Strategies**
   Governments should embed climate-finance goals within national development strategies. Turkey's "Green Deal Action Plan" should evolve into a full-fledged **Sustainable Finance Roadmap**, while GCC countries can establish joint **MENA Green Finance Hubs** to pool investment.
2. **Institutionalize Green Clauses in PPPs**
   All new PPP contracts should include binding sustainability provisions: renewable-energy use, lifecycle emission targets, water efficiency, and transparent reporting.
3. **Enhance Regulatory Convergence**
   Regional standardization of ESG disclosure and taxonomy alignment will enhance investor comparability and cross-border capital flows.
4. **Expand Sovereign Green and ESG Instruments**
   Regular sovereign green-bond and sukuk programs can create benchmark yield curves, enabling corporates and municipalities to issue aligned instruments.
5. **Capacity-Building and Knowledge Sharing**

   Governments should collaborate with the **World Bank**, **OECD**, and **UNEP FI** to train regulators and financial institutions in structuring, monitoring, and verifying green investments.

6.3.2 Practical Recommendations

1. **For Developers and Real-Estate Firms:** adopt green-building certification (LEED, BREEAM) and ESG reporting to access low-cost finance.
2. **For Financial Institutions:** integrate climate-risk assessment and carbon-pricing mechanisms into credit evaluation.
3. **For PPP Units:** establish centralized digital platforms tracking all PPP projects, including climate and social impact metrics.
4. **For Institutional Investors:** engage proactively with policymakers to shape sustainable investment frameworks and promote blended-finance models.
5. **For Academia and Researchers:** develop resilience indices and longitudinal databases to quantify the impact of green finance on infrastructure performance.

6.4 Final Thoughts

The transition to **climate-resilient infrastructure** is not merely an environmental necessity but a **strategic economic transformation**. Emerging markets such as Turkey, Saudi Arabia, and the UAE are demonstrating that sustainability can coexist with profitability when supported by clear policy direction, credible institutions, and informed investors.

The study concludes that **green finance and PPP integration** is the most viable pathway for scaling climate-resilient urban development. However, success depends on sustained political will, consistent regulatory evolution, and enhanced regional collaboration.

By aligning financial innovation with institutional reform, these countries can lead the MENA region toward a **resilient, low-carbon future** — serving as global models of sustainable development in challenging macroeconomic environments.

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Appendix: Country Data Sheets and Source References – Green Finance, PPP, and ESG (Turkey–GCC)

A.1 Turkey: Green Finance, PPP, and ESG Data Sheet

Turkey's green finance and PPP landscape reflects a hybrid model combining long-standing public infrastructure programs with gradual integration of sustainability frameworks. The 2021 Green Deal Action Plan aligns Turkish financial policy with EU taxonomy principles. PPPs remain a key delivery mechanism for transport, health, and energy sectors.

Green Finance Overview

Category	Details	Volume/Period	Key Source
Green Sukuk	Private banks exploring ESG-linked sukuk structures	Pilot stage	IMF (2023)
Institutional Framework	Green Deal Action Plan; Capital Markets Board ESG Guidelines (2022)	Ongoing	OECD (2023)

Major PPP Projects

Project	Sector / Model	Investment (USD)	Climate or Sustainability Element
City Hospitals Program	Health – BLT	≈ 10 bn+	Resilient infrastructure; energy and waste management
Gebze–Izmir Motorway	Transport – BOT	≈ 7 bn	Emission monitoring; toll digitalization

REITs and ESG Integration

Turkey hosts over 30 publicly traded Real Estate Investment Trusts (REITs) on Borsa Istanbul. Since 2022, the Capital Markets Board has mandated annual sustainability disclosures. Select REITs, such as Emlak Konut and Akfen REIT, include energy-efficient and green building portfolios. ESG integration is accelerating under the influence of international investors and domestic banks' green loan policies.

A.2 United Arab Emirates: Green Finance, PPP, and ESG Data Sheet

The UAE leads the MENA region in sustainable finance and climate-aligned PPPs. Its Net Zero 2050 initiative and Dubai's 2023 federal PPP law create a strong governance base. Masdar and DEWA serve as regional anchors for renewable and sustainable projects.

Green Finance Overview

Category	**Details**	**Volume/Period**	**Key Source**
Sustainable Finance Framework	Federal framework integrating ESG disclosure (MoF 2023)	Implemented 2023	World Bank (2024)
Investment Funds	ADQ, Mubadala, and sovereign funds integrating ESG screens	Active	IMF (2023)

Major PPP/IPP Projects

Project	**Sector / Model**	**Investment (USD)**	**Climate or Sustainability Element**
Etihad Rail PPP	Transport – PPP	≈ 3.0 bn	Low-carbon freight and passenger transport
Abu Dhabi Waste-to-Energy Project	Waste Management – PPP	≈ 1.0 bn	Circular economy integration

REITs and ESG Integration

UAE REITs such as Emirates REIT and Masdar Green REIT have introduced ESG-linked disclosure frameworks. The Securities and Commodities Authority (SCA) has developed sustainability reporting templates, and Dubai Financial Market (DFM) encourages voluntary ESG data submission. Institutional investors and sovereign funds are pivotal drivers of green standards adoption.

A.3 Saudi Arabia: Green Finance, PPP, and ESG Data Sheet

Saudi Arabia has rapidly developed its sustainable finance ecosystem under Vision 2030. The Public Investment Fund (PIF) launched large-scale green sukuk programs, while the National Center for Privatization (NCP) manages a growing PPP pipeline across energy, water, and social infrastructure sectors.

Green Finance Overview

Category	Details	Volume/Period	Key Source
Institutional Framework	National Center for Privatization (NCP) oversees PPP law (2021)	Ongoing	World Bank (2022)
ESG Regulations	CMA sustainability reporting guidance (2023)	New	OECD (2023)

Major PPP Projects

Project	Sector / Model	Investment (USD)	Climate or Sustainability Element
Renewable Energy Program (SPPC)	Energy – PPP/IPPs	≈ 50 bn cumulative	Solar and wind projects reducing national carbon footprint
Jeddah Desalination PPP	Water – PPP	≈ 1.5 bn	Energy-efficient water management

REITs and ESG Integration

Saudi REITs such as Riyad REIT and Jadwa REIT have started voluntary ESG reporting. The Tadawul Exchange has initiated an ESG index pilot (2023) to improve market transparency. SWF initiatives and Vision 2030 megaprojects promote sustainability metrics across the investment landscape.

A.4 Regional Comparison: Key Metrics

Indicator	Turkey	UAE	Saudi Arabia	Observation
PPP Legal Framework	Sectoral; long practice	Federal law 2023	Comprehensive PPP law 2021	GCC more codified frameworks
ESG Disclosure Regime	CMB voluntary guidance (2022)	Mandatory SCA template (2023)	CMA guidance (2023)	Increasing harmonization
Institutional Investor Role	Moderate	High	High	Sovereign funds drive green investment