New Institutionalisms and Mechanisms of Comparative Policy Analysis

Abdulaziz Al-Qadhib

A dissertation

submitted in partial fulfilment of the

requirements for the degree of

Doctor of Philosophy

University of Washington

2025

Reading Committee:

Jan Whittington, Chair

Qing Shen

Sofia Dermisi

Program Authorized to Offer Degree:
Urban Design and Planning

University of Washington

Abstract

New Institutionalisms and Mechanisms of Comparative Policy Analysis

Abdulaziz Al-Qadhib

Chair of the Supervisory Committee:

Jan Whittington

Urban Design and Planning

This dissertation examines why renewable energy transitions unfold differently across political and economic institutional systems by comparing the structures shaping solar development in Texas and Saudi Arabia. Both regions possess strong solar resources and face decarbonization pressures; however, their trajectories diverge in terms of pace, coordination, and policy effectiveness. This study evaluates the institutional environments, governance arrangements, and historical pathways' structural opportunities and constraints in renewable energy transitions.

Using a comparative institutional framework integrating New Institutional Economics, Transaction Cost Economics, and Path Dependence, the research applies process tracing, archival research, and project-level comparison supported by regulatory filings, operational data, national planning documents, and reports from public energy institutions.

The findings show that decentralized, contract-based institutional systems reduce uncertainty and coordination hazards, while hierarchical, layered systems elevate administrative transactions and reinforce carbon-centric routines, shaping transition outcomes.

Table of Content

Table of Figure

Chapter 1: Introduction

The escalating impacts of climate change constitute one of the foremost challenges facing global societies in the 21st century. Anthropogenic greenhouse gas emissions, primarily from fossil fuel combustion, have driven global warming to approximately 1.1°C above pre-industrial levels, a threshold confirmed by the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report.[1] This warming is manifested by rising global temperatures, increased frequency and severity of extreme weather events, sea-level rise, and disruptions to ecosystems and human livelihoods. Without significant mitigation efforts, projections indicate that global temperatures could exceed 1.5°C by mid-century, risking irreversible consequences, such as biodiversity loss and the intensification of natural disasters.[2] These phenomena threaten environmental stability and exacerbate socioeconomic inequalities, particularly in regions that are heavily dependent on fossil fuel economies.[3]

In response, the international community has mobilized through frameworks such as the Paris Agreement, which commits parties to limiting warming to well below 2°C while pursuing efforts to cap the increase at 1.5°C. [4] Central to achieving these targets is the global energy

---

Intergovernmental Panel on Climate Change (IPCC), *AR6 Synthesis Report: Summary for Policymakers*, 5.[1]
{Citation}

[2] Intergovernmental Panel on Climate Change (IPCC), *AR6 Synthesis Report: Summary for Policymakers*, 12–14; Alley et al., “Abrupt Climate Change,” 2005.

[3] Pörtner et al., *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 15.

[4] Nations, *Paris Agreement*, art. 2.

transition, a systemic shift from carbon-intensive fossil fuels to low-carbon alternatives, including renewable sources such as solar power. This transition is imperative for deep decarbonization; however, it presents significant challenges for economies that are historically reliant on oil and gas revenues, necessitating economic diversification, institutional reforms, and technological innovation to align with global sustainability objectives. The urgency of this transition is underscored by recent data: in 2023, renewables accounted for more than ~30% of global electricity generation, with solar photovoltaic (PV) capacity experiencing unprecedented growth. Nevertheless, fossil fuels continue to dominate the primary energy supply, contributing to over 80% of the global energy-related carbon emissions.[5]

This dissertation examines the energy transition policies of two fossil fuel-dependent regions: Saudi Arabia and Texas, United States. Both exemplify the complexities of shifting from oil dominance to renewable energy integration, particularly solar power, amid mounting climate imperatives. Saudi Arabia, the world's largest oil exporter, derives approximately 70% of its government revenue from fossil fuel production.[6] Texas, a subnational entity within the United States, accounts for over 43% of the national crude oil production and leads in natural gas output.[7] Despite these structural similarities, their institutional contexts diverge sharply: Saudi

---

[5] The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*; International Energy Agency (IEA), *Global Energy Review 2025*.
[6] Al Ghamdi, *Growth Through Diversification and Energy Efficiency: Energy Productivity in Saudi Arabia*, 10, 17; World Bank, *Saudi Arabia Economic Monitor*.
[7] International Energy Agency (IEA), *World Energy Investment 2024*.

Arabia is governed as a centralized monarchy with state-led economic planning, [8] whereas Texas operates within a federal democracy that emphasizes market-driven policy and substantial subnational autonomy. [9]

Recent policy developments underscore these dynamics. Saudi Arabia's Vision 2030 targets 50 percent renewable electricity by 2030, with solar projects such as the Skaka IPP contributing to a national installed photovoltaic capacity exceeding 2 GW by 2023–2024.[10] In contrast, Texas set new records for solar deployment in early 2024, surpassing 18 GW of installed, utility-scale solar capacity.[11] These trajectories illustrate both the shared challenges of decarbonization and the divergent institutional arrangements that shape energy transition pathways.

A comparative analysis of Saudi Arabia and Texas illuminates how institutional structures, historical dependencies, and policy frameworks condition the pace and character of energy transition. Saudi Arabia's efforts, articulated through Vision 2030, target an ambitious 58.7 GW of renewable energy capacity by 2030, emphasizing solar and wind energy to diversify

---

[8] Bureau of Experts at the Council of Ministers, *Basic Law of Governance*.
[9] United States Congress, *U.S. Constitution: Tenth Amendment*; Senate Bill 20, 79th Legislature, Regular Session (Texas).
[10] ACWA Power, *Skaka IPP Completion Announcement*; The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*; Vision Realization Programs, "Saudi Green Initiative."
[11] U.S. Energy Information Administration (EIA), *Electric Power Monthly — October 2025 Edition*; American Clean Power Association (ACPA), *Clean Power Quarterly Market Report Q2 2024*.

the economy beyond oil rents and advance a circular carbon economy.[12] By contrast, Texas's transition has been driven by market-oriented mechanisms such as the Competitive Renewable Energy Zones (CREZ) program, which has enabled the deployment of over 40 GW of wind and solar capacity, establishing Texas as a U.S. renewable energy leader despite its deep-rooted fossil fuel heritage.[13] This comparison reveals divergent pathways: a state-directed model in Saudi Arabia and a market-driven model in Texas, each contending with its own forms of path dependence and institutional inertia.[14]

This dissertation asks: *Why do energy transition pathways diverge in fossil-fuel-dependent settings?* It addresses three sub-questions: How do the institutional environments of the United States (Texas) and Saudi Arabia shape their transitions to renewable energy? What role does path dependence play in facilitating or hindering renewable energy initiatives in these countries? How does transaction cost economics apply to the renewable energy transition in the United States and Saudi Arabia, particularly regarding institutional arrangements? In Chapter 3,

---

[12] Vision Realization Office, *Vision 2030 of Saudi Arabia*, 45; Saudi Industrial Development Fund (SIDF), *Market in Focus: Solar Photovoltaics (PV)*; The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*, 15, 34, 38; Al-Saidi, "Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?," 312–14; Samargandi et al., "Towards Realizing Vision 2030: Input Demand for Renewable Energy Production in Saudi Arabia."

[13] Zarnikau, *Successful Renewable Energy Development in a Competitive Electricity Market: A Texas Case Study*, 3906–10; U.S. Energy Information Administration (EIA), "Texas: Profile Analysis"; U.S. Energy Information Administration (EIA), "Texas State Energy Profile."

[14] Public Utility Commission of Texas (PUCT), *Report to the 78th Texas Legislature on Electric Restructuring*; Samadi and Alipourian, "The Transition to Sustainable Energy and Institutional Inertia"; Hertog, *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*, 1–5, 18–25; Mitchell, *Carbon Democracy: Political Power in the Age of Oil*, 206–10; Zarnikau, *Successful Renewable Energy Development in a Competitive Electricity Market: A Texas Case Study*, 3909.

the research design and methods are described, including assessment of documentary evidence, time-ordered sequences, and comparable project-development milestones.

As suggested by the three subquestions in this research, this study employs a multi-theoretical framework integrating New Institutional Economics (NIE), path dependence, and a synthesized Theory of the State. NIE provides a rational choice and transaction-cost perspective on institutional arrangements; path dependence emphasizes the enduring influence of historical sequences and self-reinforcing mechanisms; and the Theory of the State foregrounds the role of political bargaining and governance structures. By layering these theoretical perspectives, this study offers a nuanced explanation of how institutions, historical trajectories, and political dynamics intersect renewable energy adoption in fossil fuel-dependent contexts.

The first analytical lens, New Institutional Economics (NIE), draws primarily from Douglass C. North, who conceptualizes institutions as the "*rules of the game*" that structure economic and political behavior.[15] North further explains that institutions emerge to reduce uncertainty in human interaction, but in fossil-fuel-dependent economies, they often reinforce rent-seeking and persistent path-dependent structures.[16] Building on this foundation, Daron Acemoglu and James Robinson differentiate between institutional types by contrasting inclusive

[15] North, *Institutions, Institutional Change and Economic Performance*, 3.
[16] North, *Institutions, Institutional Change and Economic Performance*, 3; North, *Understanding the Process of Economic Change*, 49.

institutions, which diffuse power and encourage innovation, with extractive institutions, which concentrate power and resources. Their framework explains how Saudi Arabia's centralized resource control supports stability yet imposes constraints on diversification, whereas Texas's more pluralistic institutional environment enables adaptive change.[17] The second analytical lens, path dependence, elucidates how historical sequences and increasing returns shape institutional and technological inertia. W. Brian Arthur highlights self-reinforcing mechanisms, where early advantages become entrenched, rendering alternative pathways less feasible.[18] Paul David's research on technological lock-in, famously illustrated by the QWERTY keyboard, in which he demonstrates how initial conditions and network effects can embed suboptimal systems[19] In the political realm, Paul Pierson extends these concepts, arguing that increasing returns and positive feedback can produce path-dependent political outcomes resistant to reform. [20] Unruh further applied this to climate and energy, coining the concept of "*carbon lock-in*" to describe how intertwined infrastructures, policies, and skills create a techno-institutional complex that perpetuates fossil fuel dependence despite the availability of renewable alternatives. [21] In both Saudi Arabia and Texas, the historical dominance of oil has locked in capital investment,

---

[17] Acemoglu and Robinson, "The Role of Institutions in Growth and Development," 136–38; Acemoglu and Robinson, *Why Nations Fail : The Origins of Power, Prosperity, and Poverty*, 74–83.
[18] Arthur, *Increasing Returns and Path Dependence in the Economy*, chap. 2.
[19] David, "Clio and the Economics of QWERTY," 332; David, "Path Dependence, Political Institutions and the Rise of the West," 217–19.
[20] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 251.
[21] Unruh, "Understanding Carbon Lock-In," 817–18.

regulatory frameworks, and workforce capabilities, complicating efforts to integrate solar energy, even as technological viability improves.[22] Recent literature reinforces this view, noting that initial conditions and self-reinforcing feedback can slow down innovation and hinder effective climate policy.[23]

The third lens involves the incorporation of transaction cost economic analysis to ground the empirics of infrastructure development in renewable energy to the higher level institutional environments of Saudi Arabia and Texas. Oliver E. Williamson's Transaction Cost Economics (TCE) emphasizes that governance structures are shaped to minimize transaction costs, particularly where asset specificity is high, a defining feature of energy systems, where capital-intensive oil and gas infrastructure creates substantial barriers to switching and technological reconfiguration.[24] Taken together, the NIE lens highlights how institutional efficiency, incentives, and adaptive capacity shape barriers and pathways for energy transitions in resource-dependent regions.

Structuring research to compare and contrast the salience of institutional theories applied to comparative political cases of renewable energy transition, this dissertation is written to address a second research question: *At what institutional level of analysis can research*

---

[22] Arthur, *Increasing Returns and Path Dependence in the Economy*, 111–12; Pierson, "Increasing Returns, Path Dependence, and the Study of Politics"; Unruh, "Understanding Carbon Lock-In."
[23] Aghion et al., *Path Dependence, Innovation and the Economics of Climate Change*, 95–97.
[24] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 52–56.

effectively compare and contrast the empirical contributions of institutional theory on the topic of infrastructure development (macro, meso, micro)? The question and its associate hypothesis draws from Douglass North's distinction between rent-seeking (centralized revenue control) and contract (inclusive) states, [25] with B. Guy Peters' *meso-level* institutional analysis, which emphasizes the role of intermediate organizations such as bureaucracies and policy networks in shaping governance outcomes.[26] In rent-seeking states, as seen in Saudi Arabia's historical oil governance, state structures focus on controlling fossil fuel revenues to support a centralized authority and economic stability.[27] In contrast, contract states, as seen in Texas's approach to energy markets, are characterized by the rule of law and regulatory frameworks designed to support competitive market arrangements.[28] Meso-level analysis bridges macro-level state forms and micro-level incentives by examining how institutional processes, bureaucratic actors and policy networks mediate the translation of overarching policy goals into concrete outcomes[29] This perspective foregrounds the processes of stakeholder bargaining and coordination that underlie divergent energy transition pathways.

---

[25] North, *Structure and Change in Economic History*, 15–30.
[26] Peters, *Comparative Politics: Theory and Methods*, 78; Bouckaert et al., *The Coordination of Public Sector Organizations*, chap. 1.
[27] Al-Saidi, "Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?"
[28] Public Utility Commission of Texas (PUCT), *Report to the 78th Texas Legislature on Electric Restructuring*.
[29] Bouckaert et al., *The Coordination of Public Sector Organizations*, 13.

By employing these theoretical lenses, this dissertation systematically addresses the research questions regarding the determinants of energy transition trajectories in fossil fuel-dependent regions. This comparative, multilevel approach highlights both convergences, such as shared pressures for economic diversification, and divergences, notably in governance styles and institutional adaptation, thereby contributing to the policy literature on just transitions and institutional change.[30]

The significance of this study lies in its theoretical and practical contributions. Theoretically, it operationalizes a multi-lens framework, integrating New Institutional Economics, Transaction Cost Economics, and path dependence, at the Theory of the State/meso-level analysis, to advance the understanding of complex energy transitions. Practically, in a context where global renewable energy capacity reached 3,870 GW in 2023, with solar energy leading new additions, [31] insights drawn from the comparative experiences of Saudi Arabia and Texas offer guidance for other hydrocarbon-dependent regions seeking equitable, just transitions that mitigate socioeconomic disruption. [32]

The dissertation that follows is structured as follows: Chapter 2 synthesizes the literature on energy transitions and institutional theory; Chapter 3 presents the methodology; Chapter 4

---

[30] Aghion et al., *Path Dependence, Innovation and the Economics of Climate Change*, 1; Belaid and Al Sarihi, *Energy Transition in Saudi Arabia: Key Initiatives and Challenges*, 12–16.

[31] The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*, 1–3.

[32] Almulhim and Al-Saidi, "Circular Economy and the Resource Nexus: Realignment and Progress Towards Sustainable Development in Saudi Arabia," 100851.

delivers comparative findings from Saudi Arabia and Texas; Chapter 5 discusses theoretical and policy implications; and Chapter 6 offers conclusions and recommendations.

Chapter 2: Literature Review

Literature on energy transitions forms the scholarly context for analyzing the institutional, historical, and political dimensions of renewable energy adoption in fossil fuel-dependent economies. This review synthesizes key theoretical contributions, empirical studies, and policy analyses to delineate both the global imperatives of decarbonization and the regional specificities of Saudi Arabia and Texas. The discussion begins with a broader discourse on climate change and the restructuring of energy systems, highlighting systemic vulnerabilities and strategies for building resilience.[33]

The subsequent sections examine the contrasting energy transitions of Saudi Arabia and Texas, focusing on policy mechanisms, institutional barriers, and socioeconomic impacts.[34] Special attention is given to how each context's unique institutional structure shapes the pace and direction of renewable energy adoption. Therefore, collecting the literature that are related to the main question of this dissertation, his dissertation asks: *Why do energy transition pathways*

[33] The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*, 3–12; Lazard, *Lazard's Levelized Cost of Energy Analysis—Version 16.0*, 5–11.

[34] Fremeth and Marcus, "The Role of Governance in Energy Transitions: Lessons from the US Renewable Energy Sector"; Anwar A. Gasim and Matar, "Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia," 2023, 8–23.

diverge in fossil-fuel-dependent settings? At what institutional level of analysis can research effectively compare and contrast the empirical contributions of institutional theory on the topic of infrastructure development (macro, meso, micro)?

The review then provides an exposition of the integrated theoretical frameworks underpinning this dissertation: New Institutional Economics (NIE), Transaction Cost Economics (TCE), Path Dependence, and the Theory of the State as articulated by North, [35] with an emphasis on meso-level analysis. The NIE perspective draws from North, [36] complemented by Williamson's foundational work on TCE, which examines how governance structures, markets versus hierarchies, minimize transaction costs in economic exchanges, particularly under conditions of uncertainty and asset specificity.[37] This lens is crucial for understanding the efficiency of institutional arrangements in the energy sector, where hierarchical state-led models (as in Saudi Arabia) may incur higher costs than market-driven hybrids (as in Texas). This integration reveals how institutional environments may perpetuate inefficiencies or facilitate adaptation, providing insights into the divergent paths of energy transition in centralized versus decentralized political systems. Such a layered approach moves beyond the limitations of

---

[35] North, *Structure and Change in Economic History*, chaps. 1–2.
[36] North, *Institutions, Institutional Change and Economic Performance*, 3–10.
[37] Williamson, *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*, 1st ed., 20–40; Williamson, *The Mechanisms of Governance*, 17–29.

isolated theoretical applications and enables a more nuanced and comparative understanding of energy transition dynamics.

2.1 Climate Change and Global Energy Transitions

Scholarly discourse on global energy transitions is anchored in the scientific consensus regarding anthropogenic climate change, as articulated in authoritative syntheses by the Intergovernmental Panel on Climate Change (IPCC). Greenhouse gas emissions, predominantly from fossil fuel combustion, have elevated global temperatures by approximately 1.1°C relative to pre-industrial levels, with projections of exceeding 1.5°C by mid-century without stringent mitigation measures.[38] This warming has multifaceted impacts, including amplified extreme weather events, sea-level rise, ecosystem degradation, and heightened socioeconomic disparities, with disproportionate effects on economies reliant on fossil fuels.[39]

In response, the Paris Agreement mandates collective action to constrain warming to well below 2°C, ideally 1.5°C, through nationally determined contributions prioritizing renewable energy integration.[40] Renewable capacity has expanded exponentially in recent years, attaining

---

[38] Masson-Delmotte, *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 4; Change, "The Physical Science Basis"; Intergovernmental Panel on Climate Change (IPCC), "Regional Context. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA. (2014)," 1–2.
[39] Alley et al., "Abrupt Climate Change," 2005; Pörtner et al., *IPBES-IPCC Co-Sponsored Workshop Report on Biodiversity and Climate Change*, 1.
[40] United Nation (UN), *Paris Agreement*, 1.

approximately 4,452 GW globally by the end of 2024, with solar additions of 452 GW and wind additions of 113 GW, comprising 92.5% of new power additions and representing 46% of global installed power capacity.[41] Nonetheless, fossil fuels retain dominance in the primary energy supply, accounting for over 80% of emissions, underscoring entrenched systemic barriers.[42]

Theoretical models conceptualize energy transition as a socio-technical regime shift, wherein niche innovations disrupt incumbent fossil fuel paradigms.[43] Fouquet's historical analysis of major energy shifts, from biomass to coal and beyond, demonstrates that transitions typically unfold over extended periods, shaped by price signals and institutional inertia, suggesting that contemporary decarbonization efforts require deliberate policy acceleration to overcome structural resistance.[44] Unruh's concept of carbon lock-in highlights how mutually reinforcing networks of technology, regulation, and social norms maintain fossil fuel dominance, necessitating targeted policy interventions to effectively disrupt them.[45]

From an economic perspective, models such as directed technical change argue that well-designed subsidies and carbon pricing can redirect innovation from polluting technologies to

---

[41] The International Renewable Energy Agency (IRENA), *Renewable Energy Capacity Statistics 2023*, 2–5.
[42] International Energy Agency (IEA), *World Energy Investment 2025*, 119; OECD, *Aligning Policies for a Low-Carbon Economy*, 3; International Renewable Energy Agency (IRENA), *Global Energy Transformation: A Roadmap to 2050*, 1.
[43] Geels, "Technological Transitions as Evolutionary Reconfiguration Processes," 1257.
[44] Fouquet, "Historical Energy Transitions: Speed, Prices and System Transformation," 7.
[45] Unruh, "Understanding Carbon Lock-In," 817; Unruh, "Escaping Carbon Lock-In," 317.

cleaner pathways, thereby enabling growth while reducing negative externalities.[46] The literature on resilience frames energy transitions as adaptive processes in response to the dual pressures of climate variability and resource depletion. Newman et al. outline a spectrum of potential urban futures–collapse, ruralized, divided, or resilient–emphasizing the necessity of renewable-oriented city redesign to reduce oil vulnerability, as demonstrated by post-Katrina reconstruction efforts.[47] Finally, Sovacool et al. integrated the principle of energy justice, advocating for the equitable distribution of benefits and burdens in the low-carbon transition, with a focus on marginalized communities.[48]

These contributions are essential because they frame energy transitions as multidimensional processes that intersect technological feasibility with institutional, socio-economic, and equity considerations.[49] For Saudi Arabia and Texas, this literature elucidates how global imperatives interact with local path dependencies, underscoring the need for theoretical frameworks that capture rational incentives, historical constraints and political agency.[50]

---

[46] Aghion et al., *Path Dependence, Innovation and the Economics of Climate Change*, 3–4; Acemoglu and Robinson, "The Role of Institutions in Growth and Development," 136–38; Acemoglu and Robinson, "Persistence of Power, Elites, and Institutions," 267.
[47] Newman et al., "Resilient Cities," 59.
[48] Sovacool et al., *Energy Decisions Reframed as Justice and Ethical Concerns*, 581; Sovacool and Dworkin, "Energy Justice," 435.
[49] Geels, "Technological Transitions as Evolutionary Reconfiguration Processes"; Sovacool and Dworkin, "Energy Justice"; Fouquet, "Historical Energy Transitions: Speed, Prices and System Transformation," 7.
[50] Unruh, "Understanding Carbon Lock-In," 817; Mahoney and Thelen, *Explaining Institutional Change*, chap. 1.

2.2 Energy Transitions in Saudi Arabia

The scholarly literature on Saudi Arabia's energy transition highlights the country's gradual shift from an oil-dominated system toward a more diversified energy mix, with Vision 2030 serving as the cornerstone of the policy initiative. Vision 2030, launched in 2016, articulates ambitious targets of 58.7 GW of renewable energy by 2030, comprising 40 GW solar PV and 16 GW wind, framed as a response to fiscal vulnerability from hydrocarbon dependency and global decarbonization pressures.[51] By 2024, the country's operational solar capacity exceeded 2 GW, highlighted by landmark projects such as the Skaka IPP, which is internationally recognized for its record-low tariffs and cost efficiency.[52]

However, most analysts have characterized the Kingdom's progress as incremental, reflecting established institutional and political structures. As Al-Saidi observes, Saudi Arabia's approach to renewable energy reflects a structured adjustment to maintain economic balance, where policy ambition aligns with the ongoing management of fossil fuel subsidies and the established interests within the rent-seeking state model (which exceeded $40 billion annually in

---

[51] Al Ghamdi, *Growth Through Diversification and Energy Efficiency: Energy Productivity in Saudi Arabia*, 2; Vision Realization Office, *Vision 2030 of Saudi Arabia*.

[52] ACWA Power, *Skaka IPP Completion Announcement*; Al Bawaba, "ACWA Power's Sakaka SolarPlant in Saudi Arabia Wins Top Award."

the 2010s).[53] These subsidies distort energy markets and serve as structural impediments to the economic competitiveness of renewables.[54]

Political economy analyses further highlight that Saudi Arabia's centralized, state-led governance structure, anchored by the Ministry of Energy and Saudi Aramco, manages private sector participation and innovation to align with national priorities, despite the country's world-class solar resource base.[55] Consequently, renewable energy sources accounted for less than 1% of the national power mix as of 2023. Belaïd and Al-Sarihi identify aspects of grid integration and financing within the current framework but also point to emerging opportunities, such as adopting circular carbon economy principles.[56]

Institutional analysis finds that Saudi Arabia's energy transition involves "*institutional layering*," wherein new agencies and renewable policies are integrated with the existing fossil fuel economy, supporting system continuity.[57] The dominance of formal state actors is supported

---

53 Al-Saidi, "Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?," 312; Anwar A. Gasim and Matar, "Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia," 2023; International Monetary Fund (IMF), *Saudi Arabia: Article IV Consultation Report*; International Monetary Fund (IMF), *Energy Subsidy Reform in the Middle East and North Africa*; International Energy Agency (IEA), *World Energy Outlook 2014*.

54 Anwar A. Gasim and Matar, "Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia," 2023.

55 Alharbi, "The Political Economy of Renewable Energy Deployment in Saudi Arabia," 70; Al Garni and Awasthi, "Solar PV Power Plant Site Selection Using a GIS-AHP Based Approach With Application in Saudi Arabia," 1225.

56 Belaïd and Al-Sarihi, "Saudi Arabia's Energy Transition in a Post-Paris Agreement Era: A Multi-Level Perspective Analysis," 15; Almulhim and Al-Saidi, "Circular Economy and the Resource Nexus: Realignment and Progress Towards Sustainable Development in Saudi Arabia."

57 Thelen, *How Institutions Evolve*, 34–37; Hertog, *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*, 212–17.

by informal norms of rentier distribution and a focus on maintaining economic stability within the market framework.[58]

Empirical studies confirm the measured pace of change: fossil fuels accounted for approximately 97% of electricity generation in 2023, while renewables contributed ~4 GW by 2024 of installed capacity as part of the progression toward the 2030 target.[59] Key projects, such as the Sudair Solar PV, have experienced multi-year timelines as part of structured regulatory processes.[60]

Although Vision 2030 has set out a formal strategy for renewable energy deployment, the transition remains incremental, shaped by the management of subsidies, administrative processes, and institutional structures. Most experts agree that accelerating progress will require subsidy reform, clearer property rights, and greater empowerment of market actors.[61]

From a governance perspective, scholars emphasize that Saudi Arabia's rent-seeking - state model remains deeply entrenched, with oil revenues underpinning political legitimacy and social stability.[62] The distributive logic of the state, where state-controlled fossil fuel revenues

---

[58] Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 224; Hertog, *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*, 212–17.
[59] Elshurafa et al., *Macroeconomic, Energy and Emission Effects of Solar PV Deployment at Utility and Distributed Scales in Saudi Arabia*, 12; International Energy Agency (IEA), "World Energy Balances."
[60] Aldubyan and Gasim, "Energy Price Reform in Saudi Arabia: Modeling the Economic and Environmental Impacts and Understanding the Demand Response," 1.
[61] Anwar Gasim and Matar, *Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia*; Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 229.
[62] Hertog, *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*, 19–22.

support social benefits, creates a resilient social contract while shaping energy sector reform implementation. Such reforms threaten the foundational bargain between rulers and citizens: sustained social benefits, subsidized utilities, and employment in exchange for political quiescence.[63]

Classic rent-seeking behavior in the state highlights, in theory, resource allocation and energy subsidies as mechanisms for political and economic stability. Alshamy challenges simplistic characterizations, arguing that Vision 2030 introduces substantial reforms, including regulatory changes, labor market nationalization (Saudization), and industrial diversification, signaling that governance is Tsai's comparative political economy evolving beyond simple rent distribution.[64]

Amran et al. highlight the potential of renewables to address growing domestic energy demand and reduce reliance on fossil fuels, while IRENA underscores opportunities for green hydrogen exports as a pathway to new revenue streams; however, these prospects depend on phasing out fossil fuel subsidies to avoid market distortions.[65] For instance, as of mid-2025, Saudi Arabia has connected approximately 6.1 GW of renewable energy capacity to the grid,

---

[63] Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 45, 229; Luciani, "The Oil Rent, the Fiscal Crisis of the State and Democratization," 135–36.
[64] Alshamy, *Saudi Arabia, More Than Just Oil Rents: Reassessing the Rentier State Label*, 5.
[65] Amran et al., "Renewable and Sustainable Energy Production in Saudi Arabia According to Saudi Vision 2030: Current Status and Future Prospects," 1–3, 5–7; Bianco and Blanco, *Green Hydrogen: A Guide to Policy Making*, 33.

with an additional ~45 GW under development, demonstrating tangible progress in capacity expansion amid broader institutional reconfiguration.[66] According to the King Abdullah Petroleum Studies and Research Center (KAPSARC), persistent energy subsidies in Saudi Arabia continue to distort markets by maintaining artificially low domestic energy prices. Their comprehensive analysis, based on detailed price and consumption data, shows that despite ongoing reforms, substantial subsidies remain. This results in forgone government revenues and inefficiencies in energy allocation, underscoring the challenges of fully aligning domestic energy prices with international market levels.[67]

Tsai's comparative political economy suggests a paradigm shift in the Gulf Cooperation Council (GCC) states, where growing populations and fiscal pressures have led to the replacement of broad energy subsidies with targeted employment premiums, such as public-sector jobs and Saudization, as mechanisms for controlled revenue distribution.[68] Hertog, however, cautions that these labor market policies may reinforce new forms of path dependence and controlled revenue.[69] A broader literature similarly argues that historical rent-seeking and path-dependent state–society relations limit formal energy reforms, so that Vision 2030's

---

[66] Saudi Green Initiative (SGI), "Saudi Green Initiative: Projects"; Utility Business MENA, "Saudi Arabia Signs Landmark $8.3 Billion Renewable Energy Deals for 15 GW of Solar and Wind Projects."

[67] Anwar Gasim and Matar, *Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia*, 14.

[68] Tsai, "Political Economy of Energy Policy Reforms in the Gulf Cooperation Council: Implications of Paradigm Change in the Rentier Social Contract," 93–95.

[69] Hertog, "The Political Economy of Distribution in the Middle East: Is There Scope for a New Social Contract?," 106.

institutional layering, integrating new agencies and clean energy targets alongside established fossil-fuel actors, has thus far facilitated only incremental progress while preserving the underlying framework.[70] At the same time, Saudi Arabia's energy transition serves geopolitical objectives related to international reputation, market share, and energy security: Alfehaid and Young suggest that renewables and economic diversification can strengthen the Kingdom's influence and resilience,[71] while Van de Graaf and Verbruggen describe an evolving "*oil endgame*," in which changing global demand pressures exporters to adapt strategically. [72] Taken together, this scholarship frames Saudi Arabia's energy transition as a high-stakes institutional reconfiguration that must simultaneously reconcile path-dependent governance, fiscal imperatives, demographic pressures, and the increasingly salient norms of global sustainability.[73]

2.3 Energy Transitions in Texas

Texas's rise as a renewable energy leader is rooted in a long history of deep fossil-fuel dependence. For most of the twentieth century, Texas was emblematic of the global oil age: the 1901 Spindletop gusher near Beaumont, which Daniel Yergin describes as a turning point that "ushered in the modern petroleum industry," anchored the state's identity and economy around

---

[70] Thelen, *How Institutions Evolve*, 34–35; Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 45.
[71] Alfehaid and Young, "Saudi Arabia's Renewable Energy Initiatives and Their Geopolitical Implications."
[72] Van de Graaf and Verbruggen, "The Oil Endgame: Strategies of Oil Exporters in a Carbon-Constrained World," 456.
[73] Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 45; Anwar A. Gasim and Matar, "Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia," 2023, 245–46, 248–50, 251–53.

oil production and refining.[74] The Texas State Historical Association likewise emphasizes that Spindletop triggered the "*Texas oil boom*," drawing massive capital into exploration and making petroleum central to the state's industrialization and political economy. By the early 1980s, oil and gas accounted for more than one-quarter of Texas's economy, even after the first major price shocks and subsequent bust began to erode that share. [75]

Institutionally, the Texas Railroad Commission (TRC) played a pivotal coordinating role in this fossil-fuel era, regulating production through portioning and effectively acting as a swing producer well into the early 1970s. Yergin and other energy historians note that the TRC's quota system stabilized prices and volumes in a way that later inspired OPEC's collective production management, reinforcing Texas's position at the core of the global oil order.[76] Parallel developments in natural gas and coal further entrenched fossil-fuel infrastructure: the Gulf Coast refining and petrochemical complex, the build-out of gas pipelines, and lignite-fired power plants along the Texas Gulf Coast all deepened the state's hydrocarbon lock-in through sunk capital, specialized assets, and dense regulatory institutions.[77]

This fossil dominance extended into the electricity sector well into the early twenty-first century. EIA data show that Texas remains the top U.S. producer and consumer of natural gas

---

[74] Yergin, *The Prize: The Epic Quest for Oil, Money, & Power*, 69, 75–78.
[75] Olien, "The History of Oil Production in Texas."
[76] Yergin, *The Prize: The Epic Quest for Oil, Money, & Power*; Yergin, "The 1973 Oil Crisis."
[77] U.S. Energy Information Administration (EIA), *Texas Electricity Profile 2024*.

and one of the largest lignite users, with gas-fired and coal-fired plants supplying the bulk of electricity generation through the 1990s and early 2000s, while non-hydro renewables contributed only a marginal share.[78] Even as wind development began to accelerate in the early 2000s, analysts such as Hartley underline that natural gas and coal still dominated the state's generation mix, and that other non-hydro renewables remained small and relatively stable at the time.[79] Houston and the wider Gulf Coast corridor thus functioned as a global hub for oil, gas, and petrochemicals, with Rice University's Baker Institute characterizing the region as "*the energy capital of the world*" well into the 2010s, an emblem of deep hydrocarbon path dependence that makes Texas's later renewable surge appear paradoxical.[80]

Scholarly literature on Texas depicts a paradoxical evolution from an oil epicenter to a renewable energy vanguard, propelled by a combination of market liberalization and institutional agility in the state. By 2024, renewable energy sources supplied 34% of Texas's electricity, with installed wind capacity reaching 37 GW and solar capacity approximately 18 GW, both figures surpassing those of all other U.S. states. This remarkable transformation was largely enabled by the Competitive Renewable Energy Zones (CREZ) initiative, a $7 billion investment designed to

---

[78] U.S. Energy Information Administration (EIA), *Texas Electricity Profile 2024*.
[79] Hartley et al., "Local Employment Impact from Competing Energy Sources: Shale Gas versus Wind Generation in Texas."
[80] Medlock, "The Future of Houston as Energy Transitions."

unlock remote wind and solar resources and facilitate the integration of more than 40 GW of new renewable energy capacity into the grid.[81]

The CREZ initiative represented a pivotal institutional innovation, combining regulatory foresight and strategic infrastructure planning to overcome the geographic mismatch between abundant renewable resources and major electricity demand centers. By funding and coordinating the construction of high-capacity transmission lines, CREZ effectively bridged remote generation sites, primarily in West and North Texas, with population hubs in the eastern part of the state. This infrastructure investment was essential to alleviating transmission bottlenecks that had previously constrained renewable energy development despite Texas's vast wind and solar potential.[82]

This large-scale grid expansion was overseen and facilitated by the Public Utility Commission of Texas (PUCT), which played a critical regulatory role in enabling CREZ's execution. PUCT's governance framework minimized transaction and coordination costs by fostering a hybrid model that encouraged public–private partnerships and broad stakeholder engagement. This approach allowed for efficient management of complex logistical, financial,

[81] U.S. Energy Information Administration (EIA), "Texas State Energy Profile"; American Clean Power Association (ACPA), *Clean Power Annual Market Report 2024*.
[82] Cohn and Jankovska, *Texas Renewable Energy Policy: A Rapid Transition to Renewables*; Electric Reliability Council of Texas (ERCOT), *2024 Report on Existing and Potential Electric System Constraints and Needs*; U.S. Energy Information Administration (EIA), *Texas Electricity Profile 2024*.

and environmental challenges associated with constructing new transmission corridors, ensuring timely project completion and cost containment.[83]

Complementing CREZ's infrastructure development, the Electric Reliability Council of Texas (ERCOT) executed targeted grid modernization efforts, investing heavily in upgrading transmission networks specifically in regions with the highest renewable energy potential. According to a New York Times article, ERCOT's geographically focused investments alleviated critical transmission constraints and enhanced the reliability of energy delivery from remote wind and solar farms to urban demand centers. These strategic grid improvements ensured that the substantial renewable capacity unlocked by CREZ could be reliably integrated into the state's electricity system, overcoming longstanding infrastructure challenges and supporting the rapid growth of renewables.[84]

Texas's renewable energy expansion was further supported by a deregulated electricity market structure characterized by an "energy-only" design, which incentivized innovation and attracted significant private investment in renewable generation and grid technologies. Bipartisan political support reinforced these market-based incentives, enabling Texas to leverage its fossil

[83] Cohn and Jankovska, *Texas CREZ Lines: How Stakeholders Shape Major Energy Infrastructure Projects*; Du and Rubin, "Transition and Integration of the ERCOT Market with the Competitive Renewable Energy Zones Project"; Brown and Potoski, "Transaction Costs and Institutional Explanations for Government Service Production Decisions."

[84] Electric Reliability Council of Texas (ERCOT), *2024 Report on Existing and Potential Electric System Constraints and Needs*; Goodman, "Facing Brutal Heat, the Texas Electric Grid Has a New Ally: Solar Power"; Galbraith, "As Governor, Perry Backed Wind, Gas and Coal - The New York Times."

fuel heritage while transitioning to a cleaner energy mix. Solar energy experienced a surge in 2024, significantly altering the daily generation profile and contributing to reductions in peak electricity prices. ERCOT's proactive management of grid resources also facilitated the integration of emerging technologies such as battery storage, which enhanced grid flexibility and system reliability.[85]

Nonetheless, this market-driven model revealed vulnerabilities during extreme events, most notably Winter Storm Uri in 2021, which exposed critical weaknesses in grid resilience and led to widespread outages. In response, ERCOT, PUCT, and other stakeholders accelerated investments in battery storage and further grid modernization efforts, reflecting an adaptive governance approach aimed at bolstering system reliability and mitigating risks from extreme weather and other stressors.[86]

Institutional analyses highlight the hybrid governance structure of CREZ as a key factor in minimizing transaction and coordination costs while enabling broad stakeholder engagement and public-private collaboration. Together with ERCOT's geographically targeted grid investments and PUCT's regulatory oversight, this institutional framework exemplifies how

---

[85] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets*; Electric Reliability Council of Texas (ERCOT), *2024 Report on Existing and Potential Electric System Constraints and Needs*; U.S. Energy Information Administration (EIA), *Texas Electricity Profile 2024*; Lazard, *Lazard's Levelized Cost of Energy Analysis—Version 16.0*.
[86] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets*; Baldwin and Tang, "Locational Marginal Pricing and Market Coordination in ERCOT."

Texas's deregulated markets, collaborative governance, and infrastructure strategy have synergistically accelerated the state's energy transition. This integrative model stands in sharp contrast to more centralized or hierarchical energy systems, positioning Texas as a national leader in renewable energy deployment and grid modernization.[87]

Institutional analyses underscore the role of CREZ's hybrid governance structure in minimizing transaction and coordination costs, while enabling broad stakeholder engagement.[88] These contributions demonstrate how Texas's combination of deregulated markets, public–private collaboration, and institutional flexibility has accelerated the energy transition, offering a sharp contrast to more-centralized or hierarchical energy systems.

2.4 Comparative Aspects

Comparative analyses of Saudi Arabia and Texas underscore how divergent governance structures fundamentally shape energy transition pathways and their outcomes. Al-Saidi contrasts Saudi Arabia's rent-seeking governance structure, where fossil fuel revenues support political economic prosperity and guide central policy, with Texas's competitive market model,

[87] Fremeth and Marcus, "The Role of Governance in Energy Transitions: Lessons from the US Renewable Energy Sector"; Cohn and Jankovska, *Texas Renewable Energy Policy: A Rapid Transition to Renewables*; Brown and Potoski, "Transaction Costs and Institutional Explanations for Government Service Production Decisions"; North, *Institutions, Institutional Change and Economic Performance*.
[88] Fremeth and Marcus, "The Role of Governance in Energy Transitions: Lessons from the US Renewable Energy Sector," 254–57, 258–60; Cohn and Jankovska, *Texas CREZ Lines: How Stakeholders Shape Major Energy Infrastructure Projects*.

characterized by private sector dynamism and incentive-based regulation.[89] Both cases face persistent path dependencies, but their institutional responses differ: Saudi Arabia pursues top-down reforms and scales investments through sovereign wealth funds, whereas Texas leverages federal incentives, such as the Inflation Reduction Act, to attract private investment and spur technological innovation.[90]

Faudot critiques the persistent "*rentier trap*" embedded in Vision 2030, arguing that the ongoing subsidy regimes distort markets and impede efficient resource allocation in Saudi Arabia.[91] Tsai's analysis of GCC-wide reforms identifies a regional paradigm shift from broad energy subsidies toward job-based controlled revenue distribution, reshaping infrastructure priorities and social contracts.[92] For instance, as of mid-2025, Texas has focused primarily on solar development with approximately 44 GW of installed solar capacity, [93] supported by over 42 GW of wind capacity that bolsters the state's renewable transition policies through market incentives and rapid solar additions exceeding 11 GW this year,[94] while Saudi Arabia's renewable efforts emphasize solar, with installed capacity reaching around 10 GW and a pipeline

---

[89] Al-Saidi, "Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?," 312–13.

[90] Al-Saidi, "Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?," 312; Krane, *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*, 90.

[91] Faudot, "Saudi Arabia and the Rentier Regime Trap: A Critical Assessment of the Plan Vision 2030," 94.

[92] Tsai, "Political Economy of Energy Policy Reforms in the Gulf Cooperation Council: Implications of Paradigm Change in the Rentier Social Contract," 91–95.

[93] Solar Energy Industries Association (SEIA), "Solar Industry Research Data – SEIA."

[94] U.S. Energy Information Administration, "Solar, Battery Storage to Lead New U.S. Generating Capacity Additions in 2025."

exceeding 50 GW, including recent multi-GW solar agreements that exemplify centralized scaling amid rentier constraints.[95]

Collectively, these studies highlight that the structure of political institutions, centralized and controlled revenue distribution in Saudi Arabia, and market orientation in Texas critically mediate the effectiveness and trajectory of energy transition strategies. These comparative insights reinforce the value of integrating perspectives from New Institutional Economics, path dependence, and theories of the state in the analysis of global energy transitions.

2.5 Theoretical Frameworks: Rationale and Integration

This dissertation applies to a multidimensional theoretical framework to analyze the institutional dynamics shaping energy transitions in fossil fuel-dependent contexts. The approach is anchored in three foundational perspectives: New Institutional Economics (NIE), Transaction Cost Economics (TCE), and Path Dependence, each selected for its unique explanatory power in addressing rational, organizational, and historical sources of continuity and change. To enhance the analytical depth, two cross-cutting concepts, North's Theory of the State and Meso-Level Analysis, are systematically integrated, functioning not as standalone theories but as contextual

[95] "Saudi Arabia's Renewable Energy Initiatives and Their Geopolitical Implications - Center on Global Energy Policy at Columbia University SIPA | CGEP %"; World Energy Council, *Issues Monitor 2024 Saudi Arabia Commentary*.

lenses that enrich the primary frameworks and enable a nuanced account of institutional evolution and transformation.

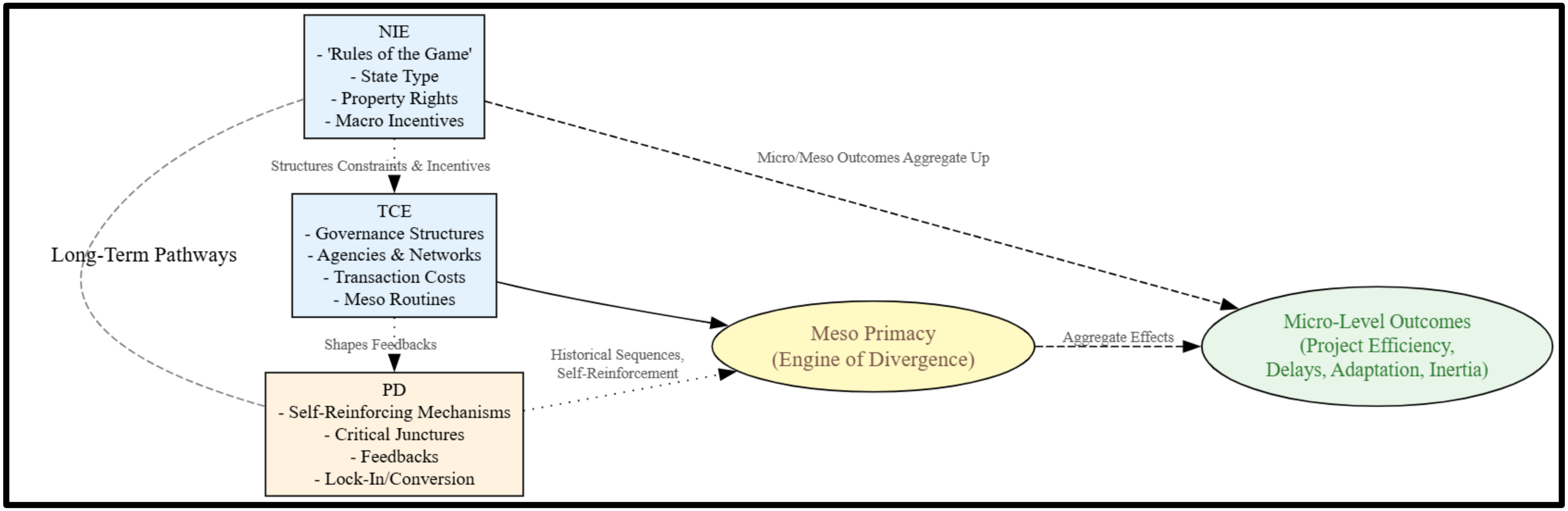


Figure 1. Multi-Level Institutional Framework for Comparative Energy Transitions

Figure.1 above summarizes how these lenses are integrated across the macro, meso, and micro levels and clarifies why meso-level governance is treated as the primary site where institutional divergence becomes observable. New Institutional Economics (NIE) provides the essential lens for understanding how formal and informal institutions, conceived as the "*rules of the game,*" structure incentives, reduce uncertainty, and shape interactions among actors. [96] While these rules foster stability, they can also perpetuate inefficiencies due to high transaction costs, bounded rationality, and the interests of the dominant coalitions.[97] The adaptive nature of institutions becomes particularly salient in the energy sector, where the interplay of regulations, norms, and market practices critically determines sectoral performance.

Building on this foundation, Acemoglu and Robinson argue that the distribution of political power determines whether institutions widen participation or entrench control.[98] Where political institutions distribute authority broadly and generate credible constraints on rulers and elites, economic institutions tend to be more *inclusive*: they protect property rights, reduce arbitrary confiscation, and keep markets open enough that new entrants can expect to capture returns from innovation rather than having them appropriated. Where political power is concentrated and weakly constrained, elites can design and enforce *extractive* economic

---

[96] North, *Institutions, Institutional Change and Economic Performance*, 3–4, 6–7.
[97] North, *Institutions, Institutional Change and Economic Performance*, 6–7; Ménard and Shirley, "Introduction: Handbook of New Institutional Economics," 1–18.
[98] Acemoglu and Robinson, *Why Nations Fail : The Origins of Power, Prosperity, and Poverty*, 80–83, 430–32; Acemoglu and Robinson, "Persistence of Power, Elites, and Institutions," 267.

institutions that preserve rents, often by restricting entry, allocating privileges, and selectively enforcing rules. The key mechanism is not that elites "*dislike technology*," but that they rationally fear innovations that reallocate bargaining power and wealth; they therefore invest in maintaining both *de jure* power (formal political control) and *de facto* power (coalitional, coercive, and economic capacity) to keep institutional arrangements aligned with elite survival.[99] In the same logic, institutional divergence persists because those with power can reproduce it: extractive arrangements are durable not by accident but because political power structures the feasible set of reforms, and reform itself is a political contest over future rents.[100] Empirically, this framework is consistent with their broader institutional-development research showing that institutional trajectories can become self-reinforcing, with early power arrangements shaping later institutional forms and economic outcomes.[101]In Saudi Arabia, this lens clarifies how rent-seeking state dynamics and policy structures manifested in energy subsidies are maintained through established political alignments.[102]

Transaction Cost Economics (TCE), a key component of New Institutional Economics (NIE) developed by Williamson, investigates the governance structures that arise to minimize

---

99 Acemoglu and Robinson, "Persistence of Power, Elites, and Institutions," 267–68.
100 Acemoglu and Robinson, "The Role of Institutions in Growth and Development," 160.
101 Acemoglu et al., "The Colonial Origins of Comparative Development," 1369–71.
102 Al-Saidi, "Instruments of Energy Subsidy Reforms in Arab Countries — The Case of the Gulf Cooperation Council (GCC) Countries," 74–78; Acemoglu and Robinson, *Why Nations Fail : The Origins of Power, Prosperity, and Poverty*, 430–32.

transaction costs in economic exchanges, treating markets and hierarchies as alternative structures for governing exchange.[103] Williamson situates this agenda within NIE, which he characterizes as concerned with the origins, incidence, and consequences of transaction costs.[104] This perspective is especially relevant in energy transitions, where asset specificity and sunk costs increase the risks of opportunism and lock-in. In TCE, asset specificity refers to the degree to which an asset can be redeployed to alternative uses and alternative users without sacrificing productive value; when redeployability is low, the investment becomes transaction-specific and its opportunity cost is lower in best alternative uses.[105] Once made, these transaction-specific investments become sunk costs, i.e., the irreversible and nonsalvageable portion of an advance commitment, which heightens exposure to opportunism, which is defined as "*self-interest seeking with guile*," when parties become bilaterally dependent and opportunism can give way to ex post renegotiation.[106] The combination generates a "hold-up" hazard: after one party is locked into specific, sunk investments, counterparties can exploit bargaining leverage through strategic renegotiation, delay, or selective compliance, increasing contracting and enforcement costs.[107]

---

[103] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 16–18, 30–31; Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–34.
[104] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[105] Williamson, *The Mechanisms of Governance*, 59, 105–6; Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 47–48, 55–56.
[106] Williamson, *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*, 1st ed., 31; Williamson, *The Mechanisms of Governance*, 125, 379.
[107] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 238–39.

Applied to energy transitions, the contractual hazards recognized in TCE analyses are not abstract: they explain how legacy arrangements are maintained or modified because actors seek governance forms that protect quasi-rents and reduce exposure to opportunism**.** TCE explains why legacy systems persist in both contexts: in Saudi Arabia, renegotiation processes support subsidy regimes within the rentier state framework, while in Texas, transaction costs in grid management both enable and constrain renewables integration. [108]

Path dependence provides a historical-institutional lens for analyzing how early choices become self-reinforcing when adoption itself generates increasing returns, a dynamic in which the likelihood of further adoption rises as a technology or policy trajectory gains adherents.[109] Positive feedback is the causal engine of this persistence: Arthur identifies four generic sources that amplify early advantages, large set-up or fixed costs, learning effects, coordination effects, and self-reinforcing expectations, so that small early events can cumulate into lock-in rather than converge on a single "*best*" outcome.[110] David's QWERTY case is the canonical illustration of this mechanism in technology adoption, showing how historically contingent sequence effects and coordination dynamics can stabilize an incumbent standard even when alternatives exist.[111]

---

108 Al-Saidi, "Instruments of Energy Subsidy Reforms in Arab Countries — The Case of the Gulf Cooperation Council (GCC) Countries"; Fremeth and Marcus, "The Role of Governance in Energy Transition: Evidence from Texas," 230–36.
109 Arthur, *Increasing Returns and Path Dependence in the Economy*, 3.
110 Arthur, *Increasing Returns and Path Dependence in the Economy*, 112.
111 David, "Clio and the Economics of QWERTY," 332–33.

Pierson extends the same increasing-returns logic to politics by arguing that institutional investments, learning, and coordination raise the costs of reversal over time and thereby generate policy inertia.[112] Unruh then applies these self-reinforcing dynamics to energy systems, arguing that technological infrastructures and institutions co-evolve into "*carbon lock-in*" through increasing returns that inhibit low-carbon diffusion absent deliberate institutional change.[113]

North's Theory of the State specifies why state structure conditions institutional reform:[114] The state is not a neutral backdrop but "*an organization with a comparative advantage in violence"* whose boundaries reflect its *"power to tax constituents*." North distinguishes between two broad logics of how states specify and enforce property rights. Under the *contract* view, the state can support growth by supplying a framework that facilitates exchange and lowers the costs of transacting. Under the *predatory/exploitation* view, the state specifies property rights in ways that prioritize revenue for the ruling coalition, even when those choices do not maximize aggregate wealth. He then explains the mechanism: rulers trade "*protection and justice*" for revenue, attempt to behave like a "*discriminating monopolist*" in tailoring rights across constituent groups, and are constrained by the opportunity costs of constituents and rival suppliers of protection. These incentives help explain why states often sustain inefficient

[112] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 251–53.
[113] Unruh, "Understanding Carbon Lock-In," 817–18.
[114] North, *Structure and Change in Economic History*, 21–25.

property-rights structures and why institutional change is frequently gradual and contested rather than purely efficiency-driven. Applied to this dissertation's comparison, Saudi Arabia's centralized rent-seeking and administrative allocation mechanisms are more consistent with North's revenue-centered logic, where reforms that reduce transaction costs can face higher political and organizational hurdles, whereas Texas's more pluralistic governance environment is more compatible with the contract logic, where lowering contracting and enforcement transactions can support adaptation and policy experimentation.

Guy Peters, offering guidance on comparative political research, describes the meso level,[115] as an intermediate "*ladder of generality*" in comparative analysis. Positioned between macro-level explanations that emphasize system properties and micro-level accounts centered on individuals, the meso level instead targets specific institutions, processes, and bounded clusters of cases. Peters's justification is methodological: macro approaches risk reifying the system and often cannot specify how actual choices are produced, while meso-level theorizing relies on middle-range explanation to avoid excessive generality and to improve specification without abandoning comparison. In this sense, the meso level is where policy is translated into practice through institutional routines and organizational interactions, allowing analysts to connect system context to implementation dynamics without collapsing into either abstraction or

115 Peters, *Comparative Politics: Theory and Methods*, 116–18, 217.

individualism. He emphasizes that meso-level work improves analytic leverage by focusing on institutions and policy processes where causal claims can be specified more precisely than at the macro level. This focus also limits conceptual stretching by narrowing comparison to clusters of substantively similar cases and institutional settings, rather than treating "*the system*" as the unit of explanation. Methodologically, it directs attention to where variation is produced, how organizations interpret rules, coordinate with other actors, and routinize implementation, thereby clarifying why similar macro conditions can yield different outcomes. Building on this logic, the dissertation operationalizes the meso level as the arena of regulatory agencies, procurement and contracting arrangements, and governance networks that mediate macro constraints and generate observable implementation patterns in renewable energy projects.

Collectively, this dissertation's integrated theoretical framework is designed to examine the central research question: *Why do energy transition pathways diverge in fossil-fuel-dependent settings?* With a methodological corollary: *At what institutional level of analysis can research effectively compare and contrast the empirical contributions of institutional theory on the topic of infrastructure development (macro, meso, micro)?* Drawing on complementary strands of institutional, organizational, historical, and political analysis, the framework seeks to address the limits of any single theory by treating divergence as an outcome of interacting incentive structures, governance arrangements, and self-reinforcing historical sequences. Applied to the contrasting cases of Saudi Arabia and Texas, it may help clarify why some reforms gain traction while others reproduce continuity, and it provides a structured foundation for the subsequent empirical analysis. Recent work in energy-transition governance and policy-mix research likewise suggests that integrative approaches are often necessary to unpack complex real-world institutional change and to identify where reform efforts are most likely to be feasible and consequential.[116] The theoretical lenses employed in this dissertation are applied with a deliberate division of labor across levels of analysis, ensuring that each framework contributes distinct analytical expectations, rather than overlapping explanations. New Institutional Economics, Path Dependence, and Transaction Cost Economics were mobilized to illuminate different dimensions of institutional structure, historical sequencing, and governance performance, respectively. Figure 2 summarizes how these literature streams map onto macro, meso, and micro level analyses, highlighting the meso-level as the primary site where institutional arrangements are translated into observable project outcomes. This structured allocation of analytical roles provides a conceptual bridge to the methodological procedures outlined in the following section.

[116] Kivimaa and Kern, "Creative Destruction or Mere Niche Support? Innovation Policy Mixes for Sustainability Transitions," 205; Kern et al., "Policy Mixes for Sustainability Transitions: New Approaches and Insights Through Bridging Innovation and Policy Studies"; Sovacool et al., "Sociotechnical Agendas: Reviewing Future Directions for Energy and Climate Research," 101617.

Level of analysis	New Institutional Economics and Theory of the State	Path Dependence and historical sequencing	Transaction Cost Economics and governance economizing	Energy Transitions and infrastructure governance
Macro State structure (Context)	**Explains well** • "Rules of the game" shaping incentives and enforcement. • State capacity and credible-commitment conditions. • Constraints on feasible institutional arrangements. **Cannot explain alone** • Why similar goals yield different implementation routines. • Project-level frictions without tracing governance processes.	**Explains well** • How early choices structure later options (sequence effects). • Positive feedback and rising costs of reversal. • Critical junctures that reset trajectories. **Cannot explain alone** • Which governance instruments reduce frictions in practice. • Cost consequences of contracting under uncertainty.	**Explains well** • Why governance forms differ under uncertainty and opportunism. • Bounded rationality and contracting hazards. • Comparative logic of market, hybrid, and hierarchy. **Cannot explain alone** • Macro political constraints that shape feasible governance. • Long-run lock-in and sequencing without historical tracing.	**Explains well** • Technology diffusion, policy mixes, and infrastructure needs. • Grid integration and planning requirements. • Implementation challenges across institutions. **Cannot explain alone** • Micro governance frictions without a contracting lens. • How institutional history produces persistent bottlenecks.
Meso Governance (Integration)	**Explains well** • Observable mandates, rule stability, and enforcement pathways. • Institutional overlap and role assignment. • Commitment signals embedded in procedures. **Cannot explain alone** • Which routines persist due to self-reinforcement mechanisms. • How governance frictions translate into measurable costs.	**Explains well** • Institutional reproduction via layering, drift, conversion. • Event sequences that reinforce or disrupt existing routines. • Empirical coding of change events over time. **Cannot explain alone** • Cost consequences of negotiation, monitoring, and delay. • How contracts economize hazards inside specific governance forms.	**Explains well** • Governance attributes that minimize coordination burdens. • Transaction-cost channels: negotiation, enforcement, adaptation. • How administrative design shapes project interfaces. **Cannot explain alone** • Why some governance forms persist historically despite inefficiency. • Political constraints that shape enforcement credibility.	**Explains well** • Institutional designs supporting planning, interconnection, procurement. • Implementation capacity and procedural predictability. • Governance conditions for scaling infrastructure. **Cannot explain alone** • Lock-in dynamics without sequence-based analysis. • Contracting hazards without a transaction-cost framework.
Micro Projects & contracts (Interface)	**Explains well** • Contract enforceability signals and dispute-resolution availability. • Stability of procurement rules affecting private participation. • Organizational mandates visible in project processes. **Cannot explain alone** • Detailed cost accounting of governance frictions. • How delays accumulate across contracting stages.	**Explains well** • How learning, sunk investments, and coordination routines persist. • Self-reinforcing sequences that shape later contracting space. • Micro-level enactment of historically structured routines. **Cannot explain alone** • Which governance mechanisms economize hazards at the interface. • How institutional redesign reduces transaction costs.	**Explains well** • Contract design under asset specificity and uncertainty. • Governance-related frictions that slow execution. • Comparability via component-based cost accounting. **Cannot explain alone** • Long-run institutional persistence without historical analysis. • Macro constraints that shape feasible contract enforcement.	**Explains well** • Project delivery constraints (permitting, interconnection, procurement). • Coordination between developers, grid operators, and regulators. • Implementation barriers and administrative throughput. **Cannot explain alone** • Contracting hazards and governance economizing logic. • Historical reproduction mechanisms behind recurring barriers.

How to read: Each cell separates what a literature explains well from what it leaves underdetermined without complementary lenses.

Design logic: The meso-level is emphasized because governance outcomes are operationalized as observable features of how development is governed in practice.

Figure 2. . Literature Streams and Analytical Roles Across Levels of Analysis

Chapter 3: Methodology

This chapter describes the methods used to conduct a comparative institutional analysis of renewable energy transitions in Texas and Saudi Arabia. The research design includes the application of New Institutional Economics (NIE) (including the Theory of the State), Path Dependence (PD), and Transaction Cost Economics (TCE) to the same empirical cases. The purpose of the application of three separate theories and their empirical mechanisms is to offer a more complete account of the plausible roles of institutions in divergent infrastructural outcomes and to be able to compare and contrast the empirical contributions of these three areas of theory. Lastly, this research design offers evidence of the value of focusing at the meso level to understand the empirical validity of theories of institutions in infrastructure development.

The chapter is organized as follows. First, it states the overarching research question, which consists of main research questions and sub questions that align with the three elements of my theoretical framework, and introduces the framework-specific research questions and hypotheses that guide each analytical lens. Second, it presents the sampling plan and case selection logic, describing the comparative analysis cases (Texas and Saudi Arabia) and the nested project-level cases, used to minimize extraneous error while maximizing experimental variance.[117] . Third, it specifies the data sources and collection strategy, including the

[117] Peters, *Comparative Politics: Theory and Methods*, 38–41, 58–61.

documentary and archival materials, policy and regulatory records, and project documentation used for within-case reconstruction and cross-case comparison. Fourth, it provides the methods of categorizing the data applied under each framework, New Institutional Economics and the Theory of the State, Path Dependence and Institutional Change, and Transaction Cost Economics, clarifying how evidence is organized, interpreted, and compared across cases. Then, it applies the analytical methods of each lens of the theoretical framework. The chapter closes by identifying limitations of the data, the comparative design, and the analytic strategy, and by noting how these limitations are addressed through triangulation and structured within-case and cross-case comparisons.[118]

3.1 Research Question and Hypotheses and Observable Implications

3.1.1 Research Question

The main research question is: *Why do energy transition pathways diverge in fossil-fuel-dependent settings?* More specifically, in the comparative case of Texas (USA) and Saudi Arabia, this dissertation investigates how institutions can explain divergence or variation in the transition to renewable energy. The overarching question is intentionally broad: it frames divergence as an institutional phenomenon rather than a technological problem, while remaining compatible with multiple institutional theories that emphasize different causal features of political–economic systems.

---

[118] Peters, *Comparative Politics: Theory and Methods*, 58–60.

There is a second overarching research question that speaks more to the researcher than the practitioner: *At what institutional level of analysis can research effectively compare and contrast the empirical contributions of institutional theory on the topic of infrastructure development (macro, meso, micro)?* Institutions can be as broad in their application as the world itself, and so micro as to be esoteric to the question. In reviewing the literature, it became clear that the way to organize the many possible sources of information for institutional analysis would be to view what is available at all levels and sort into macro, meso, and micro categories. The working hypothesis of this dissertation is that the institutional evidence that matters for comparative theoretical exposition is at the meso level.

Because this dissertation is designed as a comparative study in politics and governance, the overarching question is pursued through sub-questions aligned with three institutional frameworks. The three questions are asked in a deliberate sequence, first specifying institutional environments (NIE), then examining historical dynamics (PD), and then evaluating governance performance through observed transactions (TCE).

Consistent with the methodological purpose of Chapter 3, the research questions and hypotheses below are accompanied by descriptions of empirically observable implications, cross-case patterns and document-traceable indicators in institutional rules, project timelines, and contracting transactions—meaningful at the meso level. Where quantitative indicators are used (the Path Dependence Index components and the transaction-cost accounting components), they serve as structured measurement procedures applied consistently across cases, not as substitutes for sequence reconstruction.

3.1.2 Lens I: New Institutional Economics and the Theory of the State

Regarding the New Institutional Economics and the Theory of the State, the question asked in this dissertation is: *How do the institutional environments of the USA and Saudi Arabia shape their transitions to renewable energy?*

This sub-question contributes to the main question by specifying the institutional environment within which renewable transitions occur. In methodological terms, NIE treats institutions as the "*rules of the game,*" formal rules and constraints that structure incentives and shape the costs and feasibility of the collective. The Theory of the State component focuses its attention on how state structures shape enforcement conditions, administrative capacity, and the credibility of policy commitments over time. The purpose of this question in the dissertation's design is not to restate institutional theory, but to establish an empirically grounded institutional map in diagrams for each case: who has authority to decide, how authority is delegated, how rules are made predictable, and how compliance and performance expectations are enforced.

The intention in answering this question is that it directs the analysis to institutional and governance documentation, statutory and regulatory texts, formal mandates and organizational responsibilities, procurement and program rules for renewables, and official planning and reporting documents that clarify decision rights and enforcement arrangements. The output of this sub-question is a comparable description of each case's institutional environment as it relates to renewable deployment, which provides the "*starting conditions*" for the path-dependent sequences and transaction-cost patterns examined below.

From an NIE perspective, the core expectation is that institutional environments shape the incentive structure within which energy transition policies are initiated, negotiated, and implemented. This dissertation therefore hypothesizes that cross-case differences in state structure, understood as differences in the state's relationship to property rights, enforcement, and credible commitment, will be associated with systemic differences in the pace and reliability of renewable energy transition outcomes. In North's terms, states may be characterized by a spectrum of structures running from rent-seeking (revenue-maximizing) to contract-based forms (where constraints on rulers and more secure property rights support exchange and investment). The hypothesis is not that one type deterministically produces one outcome, but that the institutional logic of a contract state should be more compatible with rule-bound, predictable investment conditions, whereas predatory features tend to widen discretionary space, increasing uncertainty for long-horizon investments such as infrastructure. In the documentary record, this hypothesis calls attention to:

1. Publicly legible process rules (market or procurement rules; interconnection/permitting sequences) that persist across comparable rounds or cycles.
2. Traceable enforcement or dispute-resolution pathways defined ex ante (e.g., rule-bound forums, compliance mechanisms, or enforcement provisions).
3. Organizational mandates and decision-right allocations remain sufficiently stable for external parties to plan against them, rather than requiring repeated reauthorization or discretionary reinterpretation.

Evidence is coded as the presence, clarity, and stability of these mechanisms in formal documents and dated rule changes, not as inferred success or failure.

3.1.3 Lens II: Path Dependence and Institutional Change

Applying a path dependence approach, this research asks: *What role does Path Dependence play in either facilitating or hindering renewable energy initiatives in these countries?*

This sub-question adds to the overarching question by introducing the time dimension and previous events and decisions that NIE alone does not fully specify. Where NIE establishes how institutional environments shape incentives and feasibility, PD focuses on how earlier choices become self-reinforcing through increasing returns and positive feedback, producing durable patterns of continuity even when alternatives exist. In methodological terms, PD is applied in this dissertation because the overarching research question is fundamentally about divergent pathways, not simply different equilibrium outcomes. "*Pathways*" implies sequences: what comes first, what follows, which reforms stick, and which are reversed or layered without changing underlying governance routines.

The purpose of answering this question is to generate evidence suitable for sequence reconstruction and mechanism identification. The dissertation therefore traces institutional and policy trajectories over time using documentary records that mark turning points (policy introductions, reorganizations, procurement redesigns, regulatory changes) and that reveal reinforcement dynamics (repeat adoption of the same procedural sequence, persistence of overlapping mandates, recurring implementation bottlenecks, continued reliance on legacy infrastructures). The output of this question is an empirically traceable account of continuity and change, indicating where transition pathways exhibit increasing returns and lock-in effects versus where they exhibit adaptation and reconfiguration.

Path dependence generates a second set of expectations about divergence: that differences in institutional trajectories may persist even when external conditions change, because early institutional choices can generate increasing returns and self-reinforcing feedback. This dissertation therefore hypothesizes that where energy institutions are embedded in dense organizational arrangements and legacy infrastructures that reward continuity, transition pathways will display stronger persistence, more incremental adjustment, and slower displacement of incumbent routines. Conversely, where institutional arrangements permit reconfiguration, through policy learning, repurposing of institutions, or faster reallocation of authority, self-reinforcing dynamics should be weaker and adaptive change more likely. In documentation, this hypothesis implies that the Path Dependence Index components will be supported by indicators such as:

1. Sunk-cost persistence: continued commitment of capital and organizational capacity to incumbent generation and grid practices.
2. Concentration and continuity in planning assumptions: stable planning routines and assumptions that reproduce incumbent arrangements.
3. Institutional density through layering/accretion: growth in overlapping mandates, agencies, or procedural requirements without consolidation.
4. Change events that are relatively infrequent and disproportionately reinforcing rather than disruptive, assessed by coding institutional change events as path-reinforcing, path-neutral, or path-disruption based on dated documents and reorganizations.

Where event typologies are needed for coding, institutional change is treated as an observable phenomenon with distinguishable forms (e.g., layering, drift, conversion, displacement) that can be coded from dated documents and reorganizations

3.1.4 Lens III: Transaction Cost Economics

From a transaction cost economics standpoint, this research asks: *How can Transaction Cost Economic measures of comparative infrastructure project performance assist in explaining the effects of institutions on energy transitions in the USA and Saudi Arabia?*

This sub-question adds to the overarching question by translating institutional arrangements into observable implementation costs of transactions. While NIE establishes the governing "*rules of the game*," and PD specifies how sequences become self-reinforcing over time, TCE focuses on how governance structures, "*play of the game*," economize (or fail to economize) on the transaction costs of coordinating, contracting, and implementing complex projects under uncertainty. The practical value of TCE here is methodological: it provides a disciplined way to treat procedural transactions, negotiation burdens, coordination costs, enforcement/monitoring requirements, and delay risks as an empirical window into institutional performance at the meso level.

The use of TCE in this dissertation creates the opportunity to assess whether institutional arrangements associated with renewable deployment generate relatively predictable, routinized pathways for project development or instead produce comparatively prolonged sequencing, repeated handoffs, and compounding delays consistent with higher transaction costs. The analysis is anchored in nested project cases, where compared institutional arrangements become visible as concrete steps and time-bound milestones, allowing a structured comparison of transaction-cost patterns across cases.

Transaction Cost Economics provides a third set of expectations that focuses not on the macro character of the state or the historical stickiness of institutions, but on the governance performance of the institutional arrangements that organize transactions under uncertainty. This dissertation therefore hypothesizes that institutional environments exhibiting clearer allocation of authority, more standardized procedures, and more predictable enforcement will be associated with lower transaction costs in renewable project development. Conversely, institutional environments characterized by overlapping mandates, sequential approvals, and higher uncertainty about enforcement or adaptation will be reflected on the institutional arrangements and then will be associated with higher transaction costs, expressed in greater negotiation burdens, more intensive monitoring and coordination requirements, and higher delay-related costs over the project lifecycle.

Crucially, this is not framed as a claim that any single organization "*causes*" high or low transaction costs. Rather, it is an institutional hypothesis: transaction cost burdens serve as an observable diagnostic of the institutional health of the governance structures for infrastructure development operating at the meso level. Because both cases face similar global equipment markets and technological feasibility constraints, systematic differences in transaction cost burdens are treated as evidence of institutional and governance differences rather than as artifacts of technology availability.

Holding constant the common milestones in infrastructure project development, this hypothesis implies:

1. Longer elapsed time between comparable milestones where governance is less predictable and approvals are more sequential.
2. More documented interface points requiring coordination among agencies and contracting parties (additional handoffs, sequential approvals, or repeated gatekeeping steps).

3. Greater reliance on ex post adaptation mechanisms (amendments, redesigns, administrative rework) traceable in dated records.

Quantitatively, it implies higher measured transaction-cost components, bounded by the owner's-services envelope and delay valuation rules specified in Chapter 3, without assuming that total project cost differences are themselves proof of governance performance.

3.2 Sampling Plan: Comparative Analysis Case Studies

The research in this dissertation includes a comparative analysis case-study design. The comparative cases selected for this research can be described according to their geographic, political, bureaucratic/governmental structure, infrastructural economic characteristics, especially with respect to the energy sector, and time period of study. Also, included in comparative analysis are plans and projects for solar (or more generally renewable energy) development and their associated policies. Tables one and two provide a summary of these characteristics, organized into the general categories of selection to maximize experimental variance and to control extraneous variance. Note that, as a study in comparative politics, this study examines variation in institutions between the two case studies, while selecting nested case studies, which are Roserock Solar (Texas) and Sakaka Solar IPP (Saudi Arabia), in the form of utility scale solar projects and associated policies in order to minimize the effects of extraneous factors.[119]

In comparative-politics terms, the intent of this sampling strategy is to make institutional variation analytically salient while holding constant, or at minimum explicitly bracketing, several

---

[119] Peters, *Comparative Politics: Theory and Methods*, 30, 58–60.

confounding influences that could otherwise dominate interpretation. Peters' frames comparative research design in terms of the basic methodological imperative to "*maximize experimental variance, minimize error variance, and control extraneous variance,*" emphasizing that comparative inference depends on careful ex-ante case selection rather than ex-post statistical controls.[120] Consistent with that approach, Texas and Saudi Arabia are selected as "*edge*" cases in institutional and political structure within fossil fuel–dependent settings. The comparison therefore seeks to preserve meaningful variance in the independent variables of interest, political structure, bureaucratic organization, market design, and the institutional pathways through which renewable policy is translated into projects, while reducing the likelihood that observed divergence is attributable primarily to technology availability or global cost trends.

The selection of Texas and Saudi Arabia also reflects an explicit effort to distinguish two levels of comparison. First, at the macro-institutional level, the cases are compared as political and administrative systems with different configurations of authority, delegation, and coordination in the energy sector. Second, at the meso-to-project level, the dissertation employs nested case studies, utility-scale solar projects, Roserock Solar (Texas) and Sakaka Solar IPP (Saudi Arabia), and the policies directly associated with their development, to reduce the influence of extraneous factors and to keep the analysis focused on institutional processes that are observable in documentary records.[121] The design is intended to tighten causal leverage by examining how case-level institutional arrangements are expressed through concrete project approval sequences, contracting structures, and implementation timelines.

[120] Peters, *Comparative Politics: Theory and Methods*, 30, 59.
[121] Peters, "Managing Horizontal Government," 142.

At the comparative level, the cases are described along the following dimensions. Geographically, Texas and Saudi Arabia are distinct jurisdictions with different spatial scales and governance boundaries, yet both are large, energy-producing polities with substantial electricity systems and active renewable energy ambitions. Politically, the cases differ in constitutional form and governing structure, shaping how policy authority is allocated and how commitments are made credible over time. Bureaucratically, the cases differ in the organization of energy-sector responsibilities, including the number of agencies involved, the degree of coordination required across organizations, and the extent to which mandates overlap or are clearly separated. Economically and infrastructurally, the cases differ in the organization of the electricity sector, including the role of market competition versus administrative allocation, the sequencing of planning and procurement, and the institutional channels through which private actors participate in project development. Finally, the cases are bounded by a common time period of study aligned with the contemporary era of utility-scale renewable development and the associated policy reforms in both settings; within that shared period, the dissertation traces institutional sequences and project development processes using documentary evidence and archived records. To make the sampling logic transparent, Tables 1 and 2, summarize the characteristics of the two cases using Peters' comparative-design framing. The table separates those characteristics intended to *maximize experimental variance*, the institutional and political differences that the dissertation treats as explanatory, from those intended to *control extraneous variance*, background conditions that are treated as shared constraints or common contextual features across fossil fuel–dependent settings.[122] The purpose of this organization is not to claim complete control over confounding factors, but to state explicitly what is being varied and what

[122] Peters, "Managing Horizontal Government," 30, 59.

is being held constant in the comparative logic, and to justify how the nested project cases, Roserock Solar and Skaka IPP, help minimize the effects of extraneous influences.

Table 1. Summary of Case Study Characteristics (Maximize Experimental Variance)

	characteristic	Texas	Saudi Arabia
Maximize experimental variance	**Political structure and history**	Subnational jurisdiction; restructuring history shapes authority and delegation in the electricity sector.[123]	Central state authority: reform trajectory embedded in national development programs[124]
	Bureaucratic structure of the energy sector	Multi-actor governance (regulator, system operator, market oversight) documented in public regulatory and market reports.[125]	Energy-sector bureaucracy organized through national ministries and procurement entities (programmatic structure and mandates).[126]
	Economic organization of the energy sector	Competitive market design and transmission planning decisions documented in statutory and regulatory records.[127]	State-led procurement and programmatic deployment via national renewable procurement mechanisms.[128]
	Societal expectations from the energy sector	Public emphasis on reliability, affordability, and market performance. reflected in regulatory framing and reforms[129]	Public emphasis on reliability, affordability, and national development targets reflected in Vision and program reporting.[130]
	Institutional change over time, for energy transitions	Documented evolution of transmission, market rules, and renewable integration (including CREZ-era planning and subsequent reforms).[131]	Documented evolution of institutional architecture for renewable procurement and program execution.[132]
	Contractual arrangements for renewable energy	Contracting and delivery structured through Texas market/regulatory arrangements (project participation via market rules, interconnection, and procurement variants).[133]	Contracting structured through state-led utility-scale procurement and standardized tendering/award processes.[134]

123 Texas Legislative Council, *Summary of Senate Bill 7: Electric Utility Restructuring*, 7; Zarnikau, "A Review of Efforts to Restructure Texas' Electricity Market."

124 Vision Realization Office, *Vision 2030 of Saudi Arabia*; Hertog, *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*.

125 Public Utility Commission of Texas (PUCT), *Annual Report of the Public Utility Commission of Texas*; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets*.

126 Ministry of Energy (MoE), *Electricity in Saudi Arabia in 2023*; *Royal Decree A/133 Establishing the Renewable Energy Project Development Office (REPDO)*; Saudi Power Procurement Company (SPPC), *Annual Report 2024*.

127 Texas Legislative Council, *Summary of Senate Bill 7: Electric Utility Restructuring*, 199; Du and Rubin, "Transition and Integration of the ERCOT Market with the Competitive Renewable Energy Zones Project"; Public Utility Commission of Texas (PUCT), *Scope of Competition in Electric Markets in Texas*.

128 Saudi Power Procurement Company (SPPC), *Renewable Energy Projects Status Report 2024*; Ministry of Energy (MoE), "Optimum Energy Mix"; Krane, "Energy Governance in Saudi Arabia."

129 Public Utility Commission of Texas (PUCT), *Annual Report of the Public Utility Commission of Texas*.

130 Saudi Vision 2030 Program, *Annual Report 2024*.

131 Public Utility Commission of Texas (PUCT), *CREZ Implementation Report*; Cohn and Jankovska, *Texas CREZ Lines: How Stakeholders Shape Major Energy Infrastructure Projects*; Electric Reliability Council of Texas (ERCOT), *2018 Long-Term System Assessment for the ERCOT Region*.

132 *Royal Decree A/133 Establishing the Renewable Energy Project Development Office (REPDO)*; Renewable Energy Project Development Office (REPDO), *Saudi Arabia Awards Sakaka Solar Project at Record Low Price*; Saudi Power Procurement Company (SPPC), *Annual Report 2024*.

133 Public Utility Commission of Texas (PUCT), *Scope of Competition in Electric Markets in Texas: Report to the 82nd Texas Legislature*; Electric Reliability Council of Texas (ERCOT), *Capacity, Demand and Reserves Report*.

134 *Royal Decree A/133 Establishing the Renewable Energy Project Development Office (REPDO)*; Saudi Power Procurement Company (SPPC), *Annual Report 2024*; ACWA Power, *ACWA Power and AlGihaz Achieve Financial Closure for Sakaka PV IPP*.

Table 2. Summary of Case Study Characteristics (Control Extraneous Variance)

Control extraneous variance	**Political autonomy**	High jurisdictional autonomy over electricity policy within Texas governance.[135]	sovereign autonomy over electricity policy within national governance.[136]
	Legacy of fossil fuel extraction & use	Fossil-fuel legacy and energy profile documented in official statistics.[137]	Fossil-fuel legacy and energy profile documented in official statistics.[138]
	Geographically endowed capacity for solar and wind development	Strong resource endowment relevant to renewable buildout (treated as shared background condition).[139]	Strong resource endowment relevant to renewable buildout (treated as shared background condition).[140]
	Global market for renewable energy systems & components[141]	Exposed to global cost and supply trends (not treated as a case differentiator).	Exposed to global cost and supply trends (not treated as a case differentiator)
	History of solar & wind project development	Established track record documented in official market/sector reporting.[142]	Emerging utility-scale track record documented in procurement/program reporting.[143]
	Time period of study [144]	Common contemporary period (specified in Chapter 3 scope statement)	Common contemporary period (specified in Chapter 3 scope statement)

135 Texas Legislative Council, *Summary of Senate Bill 7: Electric Utility Restructuring*.
136 Vision Realization Office, *Vision 2030 of Saudi Arabia*.
137 U.S. Energy Information Administration (EIA), "Texas State Energy Profile."
138 U.S. Energy Information Administration (EIA), *Country Analysis Brief: Saudi Arabia*.
139 U.S. Energy Information Administration (EIA), *Texas State Profile and Energy Estimates*.
140 International Renewable Energy Agency (IRENA), *Renewable Energy Roadmap for Saudi Arabia*; Ministry of Energy (MoE), "Optimum Energy Mix."
141 International Energy Agency (IEA), *World Energy Investment 2025*; International Renewable Energy Agency (IRENA), *Renewable Power Generation Costs in 2020*.
142 Public Utility Commission of Texas (PUCT), *Texas Renewable Energy Market Update*; U.S. Energy Information Administration (EIA), "Texas: Profile Analysis."
143 Saudi Power Procurement Company (SPPC), *Annual Report 2024*; Ministry of Energy (MoE), "Power and Electricity in the Kingdom of Saudi Arabia."
144 Peters, "Managing Horizontal Government," 30, 59.

3.4 Data Sources and Collection

As noted, the research in this dissertation includes a comparative institutional analysis between two cases, Texas and Saudi Arabia, using nested project evidence to trace how institutional environments shape meso-level governance outcomes in renewable energy development. The evidence base is documentary and archival; the research does not rely on interviews. The analytic strategy applies New Institutional Economics and the Theory of the State, then Path Dependence, and then Transaction Cost Economics sequentially to the same empirical cases and synthesizes the resulting insights into a single comparative account. In this design, meso-level governance outcomes are the central outcomes of interest, while macro-level institutional evidence provides the conditioning environment and micro-level or project-level evidence provides observable traces of contracting and implementation transactions.[145]

The data sources are organized into four categories, Primary Institutional Sources; Technical & Statistical Sources; Academic & Theoretical Sources; and Project & Market Data, because each category plays a distinct methodological role in the sequential application of NIE/Theory of the State, Path Dependence, and TCE, and in the reconstruction of time-ordered sequences for process tracing.

3.4.1. Primary Institutional Sources

Primary institutional sources provide the documentary basis for identifying formal rules, mandates, and organizational responsibilities, and for reconstructing how authority and coordination are structured across the electricity sector. For Saudi Arabia, this category includes institutional reporting and official documents from the Saudi Electricity Company (SEC), Saudi

[145] North, *Institutions, Institutional Change and Economic Performance*, 3; Peters, *Comparative Politics: Theory and Methods*, 30–40.

Aramco, the Public Investment Fund (PIF), the Ministry of Finance (MoF), Vision 2030 publications, National Renewable Energy Program documentation (NREP) , Royal Decrees, the Saudi Power Procurement Company (SPPC) , King Abdullah City for Atomic and Renewable Energy (KACARE) related documentation where applicable, and King Abdullah Petroleum Studies and Research Center (KAPSARC) institutional publications. For Texas, this category includes U.S. Congressional and federal documentary sources where relevant to energy governance, The Electric Reliability Council of Texas (ERCOT) publications, the Public Utility Commission of Texas (PUCT) records, Competitive Renewable Energy Zone (CREZ) documentation, and project-facing institutional documentation tied to the nested solar case. In both cases, ministerial and national archival records, together with the The United Nations Framework Convention on Climate Change (UNFCCC) and National Data Centers-related documentation where used, support the reconstruction of policy intentions, formal commitments, and institutional sequencing.

Methodologically, these sources are the core input for the NIE/Theory of the State stage, because they allow the dissertation to specify the institutional environment as the "*rules of the game*" and the enforcement/commitment conditions within which renewable governance operates.[146] They also support the Path Dependence stage by providing dated institutional actions and reforms that can be placed into sequences and evaluated for persistence, reinforcement, and changing constraints over time. They provide the institutional "*arena map*" needed before project-level transactions can be interpreted as governance performance rather than isolated project idiosyncrasies.

---

146 North, *Structure and Change in Economic History*, 23–30.

3.4.2. Technical & Statistical Sources

Technical and statistical sources provide standardized benchmarks and comparable descriptive context for the electricity and renewable energy systems in each case. This category includes datasets and reporting from the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the U.S. Energy Information Administration (EIA), the National Renewable Energy Laboratory (NREL), and the Intergovernmental Panel on Climate Change (IPCC) assessment datasets where the dissertation uses them for definitional benchmarks or system-level context. It also includes Lazard LCOE reports (v16–v18), World Bank and the International Finance Corporation (IFC) solar/PPP guidance documents used for procedural and cost-structure benchmarks, and United Nation (UN) energy statistics and global supply-chain datasets where they are used to bound technology and market explanations.

These sources serve three methodological purposes. First, they support controlling extraneous variance by providing a consistent backdrop for technology-cost and global market conditions, preventing the analysis from attributing institutional divergence to shifting technology assumptions. Second, they provide consistent benchmarks used when operationalizing indicators (e.g., cost assumptions or typical development windows) so that comparisons are not driven by ad hoc parameter choices. Third, they support *process tracing* by validating whether observed timing and system conditions in the project sequences fall within plausible ranges, while keeping causal inference grounded in the documentary record rather than in aggregate statistics alone.[147]

[147] Peters, *Comparative Politics: Theory and Methods*, 30–41.

3.4.3. Academic & Theoretical Sources

Academic and theoretical sources are used to discipline inference, define mechanism expectations, and maintain consistent coding rules across cases. They are not treated as evidence of what occurred in Texas or Saudi Arabia; rather, they specify what kinds of observations would count as mechanism-consistent evidence during process tracing.

For the NIE and state-theory stage, the dissertation relies on North and related institutional scholarship (including Demsetz, Barzel, and Acemoglu & Robinson) to establish analytic categories for institutions, enforcement, and commitment problems. For the Path Dependence stage, it relies on Arthur, Unruh and Pierson, along with comparative-historical and historical-institutionalist scholarship associated with Mahoney and Thelen, to identify what increasing returns, positive feedback, and reinforcement mechanisms should look like in sequences. [148] For the TCE stage, the dissertation relies on Williamson and Coase, and relevant market/governance work such as Joskow where used in the draft, to define transaction-cost categories and the governance logic of contracting, monitoring, and adaptation under uncertainty.[149]

3.4.4. Project & Market Data

Project and market data provide the nested empirical material used to observe how sector governance is instantiated at the project interface and to compute project-facing indicators. For Texas, this category includes Roserock-specific documentation sufficient to reconstruct dated milestones and project characteristics such as timelines, interconnection context, CAPEX-related disclosures where used, and the project's relationship to enabling infrastructure such as CREZ

---

[148] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics."
[149] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 30–33.

access. For Saudi Arabia, it includes Skaka and Sudair tender and procurement documentation were used in the dissertation, NREP-related project pipeline and procurement data, and relevant SEC/PIF reporting used to contextualize project implementation and governance interfaces.

This category is essential for two stages of sequential design. For Path Dependence, project timelines and milestone sequences become within-case observations that can be placed against the broader institutional trajectory to evaluate whether institutional arrangements are reproducing themselves, changing through identifiable modes, or generating reinforcement effects. For TCE, project and market records provide the empirical basis for measuring contracting and implementation transactions, particularly those reflected in negotiation burdens, procedural layering, and delay intervals, without treating these measures as the dissertation's central outcome. Instead, these project-level measures are interpreted as *micro-level traces* that help characterize meso-level governance outcomes.[150]

Project and market data also supply the inputs for PDI-related metrics as used in the dissertation, sunk costs, reform frequency, institutional density, governance centralization, and energy mix concentration, so that claims about persistence and governance complexity can be expressed transparently and compared across cases. These metrics are used to support comparability and clarity; they do not replace the causal account built through the process-traced sequences.

---

[150] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 30–33.

3.5 Categorizing Data for Analysis at the Meso level: Process Tracing and Causal Sequence Analysis

Comparative case studies that include the analysis of institutional settings can involve historical research and the digestion of large volumes of qualitative materials in order to reduce results down to a comparative qualitative or quantitative outcome. This section of the methods chapter describes the steps taken to sort the volumes of materials in ways conducive to categorizing evidence as useful to analyses within NIE, PDI, and TCE frameworks.

This dissertation applies process tracing as the primary qualitative strategy in a comparative institutional analysis of Texas and Saudi Arabia. The purpose of process tracing here is not to produce a narrative chronology for its own sake; it is to reconstruct time-ordered sequences of institutional decisions and project-development milestones and to evaluate whether the observed ordering, duration, and pace of events are consistent with the dissertation's institutional hypotheses about divergence. Comparative-historical research treats process tracing as indispensable for establishing the features of events that compose sequences and for identifying the causal mechanisms that link them.[151]

The dissertation's primary outcomes of interest are meso-level governance outcomes, the functioning and performance of the governance arrangements through which renewable development is organized (e.g., procedural predictability, coordination routines, mandate clarity, and implementation capacity). Between NIE and TCE, macro-level institutional conditions and project-level contracting transactions are not treated as competing "*outcomes*"; they are treated as evidence that helps characterize meso-level governance performance. This level-linking logic is consistent with comparative politics guidance that emphasizes case selection and research

[151] Falleti and Mahoney, "The Comparative Sequential Method," 212.

design strategies to control extraneous variance and maximizing experimental variance.[152] In this design, the nested project sequences, Roserock Solar (Texas) and Skaka PV IPP (Saudi Arabia), operate as comparative analysis sites where sector governance becomes visible in practice (through dated milestones, approvals, and contracting steps), without redefining the two political-institutional systems as anything other than the primary cases.

Step 1: Define the institutional arena and assemble the evidence log

The process begins by defining the institutional arena relevant to utility-scale solar development in each case and compiling an evidence log that records each document's issuer, date, document type, and institutional function. Evidence is organized using the dissertation's four data categories (Primary Institutional Sources; Technical & Statistical Sources; Academic & Theoretical Sources; Project & Market Data). The purpose of this evidence log is methodological discipline: it makes transparent what kinds of institutional claims are drawn from which document types, and it supports triangulation across issuers and genres (e.g., regulatory documents versus procurement announcements versus sponsor disclosures).

At this stage, Primary Institutional Sources are used to identify the governance architecture, formal mandates, decision rights, and procedural responsibilities, relevant to renewable procurement and grid integration. This stage supports the first analytical lens (NIE and the theory of the state) by specifying the institutional environment as the formal "*rules of the game*" that structure incentives and enforcement conditions.[153] Importantly, the objective in Chapter 3 is not to interpret these institutions as "*good*" or "*bad*," yet to document the constraint set within which meso-level coordination occurs.

152 Peters, *Comparative Politics: Theory and Methods*, 35–38.
153 North, *Institutions, Institutional Change and Economic Performance*, 7.

Step 2: Reconstruct within-case chronologies at two nested scales

Next, I reconstruct chronologies at two nested scales for each case. First, I build a sector-governance chronology that records dated policy initiatives, organizational reforms, and procedural changes relevant to renewable development and electricity-sector governance. This chronology is built primarily from Primary Institutional Sources and cross-checked against Technical & Statistical Sources where those sources provide dated reporting that confirms timing or administrative sequencing.

Second, I reconstruct project chronologies for Roserock and Skaka using Project & Market Data (supplemented by primary institutional records where procurement entities or regulators document milestone timing). Project chronologies are structured using a consistent set of milestone categories so the two projects can be compared without importing results into the method: solicitation/tender initiation, bid evaluation/award, power purchase agreement execution, financial close (where observable), start of construction/notice to proceed (where observable), and commercial operation date. These milestones are then used as the backbone for later operationalization of TCE indicators, but at the process-tracing stage they function primarily as dated events that allow sequence comparison and mechanism testing.

Step 3: Identify mechanism-consistent observations using a sequential lens order

After building chronologies, I code each sequence for mechanism-consistent observations in the dissertation's fixed lens order: first NIE/Theory of the State, then Path Dependence, then TCE. The coding does not "*apply theory to everything*"; it is bounded by the evidence and by a disciplined question for each lens.

For NIE and the theory of the state, the process-tracing task is to identify how authority and enforcement are structured in ways that plausibly condition renewable development: where decision rights reside, how mandates are allocated, and how commitments are stabilized through formal procedures. The output is a case-specific institutional map that specifies the governance arena through which meso-level outcomes are produced, grounded in primary institutional documents rather than interpretive claims.[154]

For Path Dependence, the task is to evaluate whether the reconstructed sequences exhibit self-reinforcing patterns, including continuity dynamics and reinforcement mechanisms that make reversal or redesign costly over time. This stage focuses explicitly on sequence significance, properties, ordering, pace, and duration, and on whether early steps appear to influence later steps in a reproducing direction. Comparative-historical scholarship emphasizes that distinguishing causal sequences from strictly temporal sequences and assessing whether early steps induce subsequent movement in the same direction are analytically central for sequence-based explanations.[155] Accordingly, the dissertation codes institutional actions and project milestones to evaluate whether the observed trajectories are consistent with continuity, self-amplification, or other reproduction dynamics, and then carries these coded observations forward into the comparative analysis.

For Transaction Cost Economics, the "*play of the game,*" the task is to identify where governance transactions become observable at the project interface (e.g., points of protracted negotiation, sequential approvals, monitoring and adaptation burdens, and implementation delays). These are treated as micro-level traces that allow us to characterize meso-level governance performance, not as stand-alone outcomes. The project chronological and associated documentary records are structured specifically so that later indicator construction (negotiation

---

[154] North, *Institutions, Institutional Change and Economic Performance*, 7.
[155] Falleti and Mahoney, "The Comparative Sequential Method," 216.

and relational contracting components, and delay-related costs) is grounded in dated milestones rather than inferred from generalized claims.

Step 4: Evaluate alternative explanations and control extraneous variance

A process-tracing strategy is merely as strong as its discipline with rival explanations. For this reason, I assess alternative explanations that might plausibly account for observed timing and sequence differences independent of institutions, especially solar resource endowment, global technology-cost trends, and global supply chain conditions. These alternatives are treated as background conditions to be bounded rather than exhaustively modeled. Technical & Statistical Sources are used to confirm that both cases operate within broadly comparable global technological conditions and to reduce the risk that observed differences are mistakenly attributed to institutions when they are more plausibly attributable to exogenous technology or market shifts.[156] Where alternative explanations are consistent with the observed sequence, they are recorded as potential contributing conditions rather than ignored.

Step 5: Cross-case comparison and synthesis into meso-level governance outcomes

Finally, I synthesize the within-case findings into a structured cross-case comparison. The comparative step is built on the same sequence architecture in both cases: the same categories of institutional documents, the same milestone structure for the nested projects, and the same lens order for coding. This structure, I assume, enables the dissertation to compare how differing institutional environments condition the governance arena, how sequences reproduce continuity or facilitate adaptation, and how project-level transactions present as observable manifestations of governance performance. The synthesis stage produces the dissertation's meso-

---

[156] Peters, *Comparative Politics: Theory and Methods*, 35, 38.

level governance findings and supports later presentation of PDI- and TCE-derived indicators as structured summaries of those findings, rather than as substitutes for the causal narrative.

3.6 Analytical Methods

This section explains how the dissertation includes the application of the three analytical lenses, New Institutional Economics (NIE), Path Dependence (via the Path Dependence Index), and Transaction Cost Economics (TCE), into *observable, document-traceable evidence* for the two nested project cases (Skaka Solar PV and Roserock Solar). The procedural purpose is to make the dissertation's evidence pipeline transparent: what was coded from archival and documentary sources, how those codes were converted into structured case timelines and measured indicators, and how the same operational rules were applied across both cases.

The operationalization strategy is explicitly aligned with the dissertation's main question, *why energy-transition pathways diverge in fossil-fuel-dependent settings*, but it does so without advancing any findings. In other words, this section defines *how divergence was discovered and recorded* (through institutional rule structures, sequence evidence, and governance-related transaction-cost traces), while Chapter 4 reports results

3.6.1 New Institutional Economics (NIE): Transaction-Based Coding of the Institutional Environment

Consistent with NIE and the Williamsonian tradition, the unit of analysis for NIE operationalization is the *transaction*: a documented exchange or decision-right allocation that structures how renewable projects are permitted, procured, interconnected, and enforced. Here, "*transaction*" is not treated as a market trade; it is treated as an "*institutionally governed transfer* *of decision rights and obligations"* (e.g., rule issuance, mandate assignment, procurement authority, dispute resolution pathways, approval steps, and enforcement mechanisms).[157]

The NIE coding does not "score" outcomes. It constructs an auditable map of the formal institutional arena within which the two project transactions occurred. This map is then used in Chapter 4 to (i) report the within-case institutional and policy context, and (ii) anchor the dated sequence reconstruction (what formal rule existed when, who had authority when, and what approvals were formally required).

NIE coding was derived from primary institutional documents, prioritized as follows:

1. Binding legal and regulatory texts (decrees, statutes, formal regulator orders, official procurement rules).
2. Official governance publications (organizational mandates, program frameworks, procedural rulebooks).
3. Corporate disclosures and audited reports *only where they document formal obligations, dates, or statutory relationships* rather than corporate narratives.

When documents conflicted, the coding retained the higher-authority text and flagged the inconsistency in the evidence log rather than "resolving" it by interpretation.

Each governance transaction in the institutional environment was coded into four fields, each tied to explicit documentary language:

1. **Authority allocation and mandate clarity.**

[157] North, *Institutions, Institutional Change and Economic Performance*; Williamson, *The Mechanisms of Governance*; Williamson, *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*, 1st ed.

- What organizations held decision rights over renewable procurement, grid planning/interconnection, approval, contracting, and compliance?
- Was authority concentrated in one chain of command or distributed across multiple formally empowered bodies?
- Were mandates delineated cleanly, or did documents indicate overlap and sequential sign-offs?

For Saudi Arabia, the NIE map explicitly codes the documentary roles of the Ministry of Energy (MoE), King Abdullah City for Atomic and Renewable Energy (KACARE) (where relevant to earlier renewable institutional design), the Public Investment Fund (PIF) where it appears as a financing/sponsorship authority, the Saudi Electricity Company (SEC) where it appears as a sector operator/utility counterpart, and the Principal Buyer institution where designated in procurement documentation. KAPSARC is coded as a documentary and statistical source used for triangulation (i.e., evidence input), not as a decision-right holder unless a primary governance text assigns it authority. (All organizational roles are recorded only as documented in mandates, decrees, program frameworks, procurement rules, and official publications.)

2. **Rule formality and procedural standardization.**

    - Are procedures documented as standardized steps with stable rule references and legible sequencing (forms, published process stages, clear approvals), or are they case-specific and discretionary?
    - Are timelines and milestone definitions explicitly documented, or only implied?

3. **Credible commitment and enforcement mechanisms (coded conservatively).**

   This field codes only observable institutional devices that support rule credibility without inferring credibility from outcomes. Documentary indicators include:

   - Existence of rule-bound dispute-resolution pathways.
   - Stability of procurement rules across rounds (where multiple rounds exist).
   - Enforcement provisions governing contract performance or market participation.
   - Institutional constraints that limit discretionary reversal.

4. **Dated institutional change events.**

   Formal changes (rule revisions, mandate transfers, creation/abolition/redesign of authorities, procedural redesigns) were coded only when documentary evidence provided a date and an authoritative text. Where appropriate, these events were also labeled using an established taxonomy of change modes (layering, conversion, drift, displacement) strictly as a classification device rather than an interpretive claim.[158]

Every NIE code entry includes: (i) source document ID, (ii) issuance date, (iii) the exact clause/section used, and (iv) the coding decision (field values). This log is what allows Chapter 4 to report institutional context descriptively without rearguing the coding logic.

3.6.2 Path Dependence:

Path dependence is operationalized as observable lock-in conditions and self-reinforcing constraints that can be coded from documentary records and administrative statistics. The dissertation uses a Path Dependence Index (PDI) to summarize these lock-in conditions in a

---

[158] Thelen, *How Institutions Evolve*; Streeck and Thelen, *Beyond Continuity: Institutional Change in Advanced Political Economies*; Mahoney and Thelen, *Explaining Institutional Change*.

comparable form across cases. This dissertation develops an original Path Dependence Index (PDI) that synthesizes mechanisms or factors identified in the path dependence and institutional change literatures such as Arthur; Pierson; Unruh; Mahoney; Streeck and Thelen; Collier and Collier and implements them using authoritative system statistics and subsidy/externality assessments (e.g., U.S. EIA; IMF). The resulting coding rubric and 0–100 aggregation rule is author-constructed and have not, to the best of my knowledge, been implemented in this specific form for these cases. The PDI is not a claim of causality on its own; it is a structured measurement procedure that produces an auditable descriptive profile of lock-in intensity.

The PDI is built in three steps:

Step 1: Compute five component scores from documentary/statistical inputs using case-symmetric rubric. Each component is scaled so that higher values represent stronger lock-in conditions.

Step 2: Normalize to a common 0–100 scale. Component scores are rescaled to ensure comparability across components and across cases.

Step 3: Combine components using fixed weights (held constant across cases and documented in the index codebook).

PDI formula. Let each component score be S_k for $k = 1,2,3,4,5$, where $S_k \in [0,100]$. Let weights be w_k with $\sum_{k=1}^{5} w_k = 1$. The overall index is:

$$PDI = \sum_{k=1}^{5} w_k S_k$$

Weights are not tuned case-by-case. They are fixed ex ante and documented so that the reader can reproduce the index from the same evidence inputs.

Each component is operationalized as follows (with documentary traceability built into the rubric):

1. **Generation-mix concentration (HHI-based).**

Concentration is computed using the Herfindahl–Hirschman Index (HHI), where s_i is the share of generation from source i:

$$HHI = \sum_{i=1}^{n} s_i^2$$

HHI values are then rescaled to the 0–100 component scale for integration with the other PDI dimensions. This component uses authoritative system/energy statistics for generation shares and applies the same computation rules across years and cases.[159]

2. **Sunk costs in incumbent (legacy) infrastructure** [160]

Because "sunk costs" are not available as a single comparable statistic across the two cases, this component is coded using a documented rubric built from audited reporting and sector investment records. The rubric prioritizes direction and persistence of commitment (continued reinvestment/refurbishment/expansion versus durable redirection away from incumbent assets) rather than any single-year expenditure.

3. **Institutional density and bureaucratic complexity (mapping + rubric).**[161]

This component codes the coordination burden implied by the number of formally empowered organizations and the degree of mandate overlap affecting utility-scale project

[159] Rhoades, "The Herfindahl-Hirschman Index."
[160] Arthur, *Increasing Returns and Path Dependence in the Economy*, 112–13.
[161] Streeck and Thelen, *Beyond Continuity: Institutional Change in Advanced Political Economies*; Mahoney and Thelen, "A Theory of Gradual Institutional Change"; Thelen, *How Institutions Evolve*.

development. Inputs include official mandates, organizational charts, program frameworks, procurement process documents, and legally grounded descriptions of responsibilities. The score increases with (i) more decision points and (ii) more formally documented overlap requiring sequential approvals or inter-agency coordination.

4. **Frequency and direction of critical junctures.** [162]

This component records dated institutional change events and codes (i) how frequently they occur and (ii) whether the documentary record indicates they are path-reinforcing, path-neutral, or plausibly path-disrupting with respect to renewable development governance (e.g., creation/redesign of procurement authorities, major rule redesigns, reforms that alter approval pathways). The scoring logic increases when change events are rare and predominantly self-reinforcing and decreases when reforms are more frequent and plausibly disruptive.

5. **Unaddressed externalities and subsidy persistence.** [163]

This component captures persistence of institutional conditions that maintain incumbent advantage, coded from official policy documents and credible technical assessments. Because externality pricing is not coded as a single comparable number here, the rubric emphasizes whether reforms are partial versus durable and whether documented instruments plausibly shift incentives toward low-carbon investment (coded from formal policy texts and authoritative assessments, with any ambiguity flagged).

[162] Capoccia and Kelemen, "The Study of Critical Junctures"; Collier, "Understanding Process Tracing"; Mahoney, "Path Dependence in Historical Sociology."
[163] Victor, *The Politics of Fossil-Fuel Subsidies: Untold Billions — Fossil-Fuel Subsidies, Their Impacts and the Path to Reform*; Baumol, "On Taxation and the Control of Externalities"; Black et al., *IMF Fossil Fuel Subsidies Data: 2023 Update*; Kojima and Koplow, *Fossil Fuel Subsidies: Approaches and Valuation*.

Several components are constructed measures rather than single statistics. For this reason, the PDI codebook records (i) the rubric thresholds, (ii) the documentary/statistical inputs used, (iii) the date range covered, and (iv) any contested values or missing data flags. The index is therefore reproducible as a measurement procedure, even when the documentary record contains ambiguity.

3.6.3 Transaction Cost Economics (TCE): Transaction-Cost Components, Coding Rules, and Formulas

For TCE, the unit of analysis is the project development and implementation transaction, the contracting and governance process that links procurement to delivery for each project. The aim is not to produce a full project cost model; it is to construct a bounded, comparable accounting of transaction costs that appear at the project interface as documentary traces (negotiation effort, monitoring/enforcement burdens, sequential approvals, and implementation slippage).[164]

To reduce extraneous variance (Table. 2), the TCE analysis treats the underlying transaction type as controlled by selecting comparable nested cases (utility-scale solar projects) within their respective institutional environments (Texas and Saudi Arabia) and by applying the same component definitions, milestone rules, and cost-conversion logic to both projects. This is not a claim that the projects are identical; it is a design rule to keep the comparison anchored to the same transaction category. The projects are, however, comparable from project management, engineering, construction, and operational standpoint, and they were delivered within similar timeframes.

[164] Williamson, *The Mechanisms of Governance*.

The dissertation operationalizes transaction costs using four components:

1. **Owner's Services (OS) as the soft-cost envelope.**

Owner's Services is treated as the authoritative envelope for project soft costs associated with development coordination, permitting-facing activities, owner management, and interconnection-facing administration. To prevent opportunistic inflation across cases, OS is anchored to an external benchmark and documented in the parameter appendix.

Formula (benchmark form):

$$OS = \alpha \cdot EPC$$

where EPC is the engineering–procurement–construction cost baseline and α is the benchmark share (documented ex ante in the parameter appendix).

2. **Negotiation Costs (NC) as a share of OS**:

Negotiation Costs capture tendering and bid evaluation burden, contracting iterations, procedural requirements to reach a bankable agreement, and other documented ex ante contracting transactions. Operationally, NC is defined as a bounded share of OS to avoid double counting.

Formula:

$$NC = \beta \cdot OS$$

where β is a documented parameter applied consistently across cases.

3. **Relational Contracting and Regulatory Compliance Costs (RCC) as the residual share of OS.**

RCC captures ongoing governance burdens: monitoring, enforcement, reporting, inter-agency coordination, and adaptive problem-solving demands observable in the documentary record. RCC is operationalized as the residual portion of OS after NC is assigned, preserving boundedness and preventing an unstructured narrative category.

Formula (residual form):

$$RCC = OS - NC$$

4. **Implementation and Delay Costs (ID) as time-based cost conversion (ex post slippage).**

This component captures slippage between contract execution and commercial operation as a time-based cost, derived from documented milestones rather than generalized claims. Let:

- D be total calendar days between the documented Power Purchase Agreement date and Commercial Operation Date,
- D^*be the benchmark implementation window (documented ex ante), and
- $D_{net} = max\ (0, D - D^*)$ be "excess" time beyond the benchmark.

Milestone rule: Dates are taken only from dated documentary records (contract notices, official announcements, audited disclosures, regulatory records). If dates differ across sources, the evidence logs the discrepancy and applies to the evidentiary hierarchy rather than smoothing the conflict.

ID is valued using two parallel conversions when the documentary record supports the necessary parameters:

- **Carry-cost approach (finance-based):** converts excess time into cost using documented or benchmarked financing assumptions (e.g., cost of capital and capital structure assumptions documented in the appendix). A general form is:

$$ID_{carry} = K \cdot r_{daily} \cdot D_{net}$$

where $K$is the financed capital base used for the carry calculation and $r_{daily}$is the daily financing rate derived from the documented annual assumption.

- **Tariff-based cross-check (revenue-based):** converts time into cost using the project's documented tariff and plausible capacity-factor ranges, strictly as a sensitivity check when those parameters are documented and defensible:

$$ID_{tariff} = Rev_{daily} \cdot D_{net}$$

where $Rev_{daily}$is derived from tariff × capacity × capacity factor (all bounded by documented parameters and explicitly reported ranges).

When both approaches are feasible from documentary parameters, the dissertation reports two Saudi totals: one grounded in the benchmark carry-cost approach and one tariff-based cross-check. This is a transparency device to show sensitivity to revenue-based assumptions, not a claim that one number is "true" and the other is not.

The total transaction cost estimate is reported as:

$$TC_{total} = OS + ID$$

with OS internally partitioned into NC and RCC for transparency:

$$OS = NC + RCC$$

This keeps the TCE structure bounded, comparable, and directly tied to documentary milestones and documented parameter choices.

3.6.4 Coding the Outcome Domain: Meso-Level Governance as the Reported Result Category

In this dissertation, meso-level governance is treated as the outcome domain, the organized procedural performance of the institutions that mediate between macro institutional environment and project-level execution. It is not introduced as a theory or an explanatory framework in Chapter 3. Operationally, meso-level governance outcomes are coded descriptively from documentary traces that can be reported in Chapter 4 without interpretation, including:

- **Procedural predictability:** whether documentary records show stable, standardized steps and legible sequencing for procurement, approvals, and interconnection-facing requirements.
- **Coordination burden:** the number and ordering of formal decision points and any documentary evidence of sequential approvals or mandated inter-agency coordination.
- **Mandate clarity in execution:** whether institutional documents and project records indicate clean handoffs versus repeated re-routing across authorities.
- **Implementation capacity signals:** documented schedule updates, extensions, or milestone slippage recorded as dated events (without attributing reasons unless explicitly documented).

The empirical "*display*" of this outcome coding in Chapter 4 is strictly descriptive: it appears as (i) institutional role maps and dated change events, (ii) within-case timelines and milestone tables, and (iii) the reported PDI and TCE indicator tables computed using the rules above.

3.7 Limitations and Robustness

This dissertation is designed for analytic explanation of institutional mechanisms rather than statistical generalization. The approach has three principal limitations, document availability and bias, measurement uncertainty, and scope conditions, addressed through explicit robustness practices.

3.7.1 Data gaps and document bias

Because the study relies on documentary and archival sources, the evidentiary record is shaped by what institutions publish, preserve, and disclose. Official documents may omit informal negotiations, unrecorded coordination costs, or politically sensitive rationale for delays and redesigns. Cross-case comparability is also constrained by differences in transparency norms and archival completeness. To mitigate these risks, the dissertation triangulates claims across document types (statutory and regulatory texts, agency planning reports, procurement artifacts, financial disclosures, and dated project milestones) and maintains an evidence log that records the provenance, date, and institutional function of each key claim.

3.7.2 Measure uncertainty and coding discretion

Several measurements embed uncertainty: milestone dates may be reported differently across sources; some procedural steps are only indirectly observable; and cost components require parameterization (e.g., bounding "owner's services" and valuing delay). To limit discretion, the dissertation applies one milestone scheme and one set of coding rules across cases, documents all parameters in an appendix, and uses sensitivity checks to confirm that the direction of comparative claims is not an artifact of any single threshold, weighting choice, or disputed date. Where ambiguity cannot be eliminated, the coding records range and flags contested values rather than forcing spurious precision.

3.7.3 Case-specific generalizability and scope conditions

With two macro cases and nested project studies, generalization is theory-guided and mechanism-based rather than probabilistic. The findings are intended to travel to settings that share the relevant scope conditions: fossil-fuel-dependent political economies pursuing utility-scale renewables through institutionalized procurement and grid integration. The dissertation therefore treats its claims as conditional on institutional comparability (similar project type, broadly comparable procurement interface, and traceable documentary sequences), and it distinguishes mechanism evidence from contextual background when drawing cross-case inferences.

3.7.4 Robustness practices

Robustness is pursued through (a) transparent operationalization (codebooks, parameter appendix, and reproducible calculations), (b) triangulation across independent documentary sources, (c) explicit alternative-explanation checks within the same sequences, and (d) maintaining a strict separation between measurement in Chapter 3 and empirical evaluation in Chapters 4–5.

Chapter 3 specified how the dissertation conducts a comparative analysis, documentary-based institutional analysis: data collection, process tracing, and the operationalization of New Institutional Economics and Theory of the State indicators, the Path Dependence Index, and Transaction Cost Economics components, with meso-level governance treated as the outcome and coded through an explicit rubric. These procedures establish a transparent basis for Chapter 4's empirical chronologies, coded governance outcomes, and project-level measurements, and for Chapter 5's mechanism-based comparison.

Chapter 4: Results

4.1Scope and Organization of the Results

This chapter reports the empirical record pertinent to the dissertation's central research question: *Why do energy transition pathways diverge in fossil-fuel-dependent settings?* And its methodological corollary: *At what institutional level of analysis can research effectively compare and contrast the empirical contributions of institutional theory on the topic of infrastructure development (macro, meso, micro)?* The purpose here is not to explain divergence, evaluate institutional performance, or advance causal claims. Instead, Chapter 4 assembles the traceable empirical basis needed for interpretation by presenting what can be documented about (1) the institutional and policy settings of the two comparative cases, Saudi Arabia and Texas, and (2) the development sequences of the two nested utility-scale solar projects used for project-level evidence, Skaka Solar PV (Saudi Arabia) and Roserock Solar (Texas). The chapter therefore focuses on *what occurred, when it occurred, which formally mandated entities acted, what decisions or milestones can be verified, and what measured indicators can be derived from those verified steps*. The reporting emphasis is deliberately narrow and verifiable: *named institutions in their documented roles, dated milestones, recorded approvals, formal procurement steps, and observable phase durations*. Where the documentary record is uneven across the two cases, an expected feature of cross-national institutional research, this chapter reports only what can be established from the available corpus and maintains a strict separation between documented steps and steps that cannot be observed in the sources.

The chapter is organized to make divergence empirically visible before it is interpreted. It follows a within-case structure first, and a cross-case display last, to maximize transparency and comparability. Sections 4.2 and 4.3 present the Saudi Arabia and Texas cases separately using a parallel organization: each begins with a descriptive account of the institutional and policy context as it appears in the documentary record; then tables show the reconstructs of the policy-and-project development sequence through dated milestones; and then reports project-level evidence for the nested solar project through observable procurement, contracting, construction, and commissioning markers. Each case also reports the measured indicators specified in Chapter 3, including the Path Dependence Index (and its components) and the Transaction Cost Economics accounting components derived from documented timelines, milestone intervals, and observable administrative or contractual steps. In this chapter, these indicators are presented strictly as measured outcomes and descriptive contrasts (e.g., higher/lower values; longer/shorter durations), not as explanations.

Section 4.4 then provides a descriptive cross-case juxtaposition of the observed outcomes across Saudi Arabia and Texas using summary tables and displays. This comparative section is intentionally limited to factual contrasts, differences in documented sequencing, milestone timing, and measured values, without attributing causes. The chapter closes by summarizing what the evidence establishes

4.2 Saudi Arabia Case Study: Institutional Context and the Skaka Solar IPP

This section reports the documentary record for the Skaka (Sakaka) Independent Power Producer (IPP) transaction in Saudi Arabia. At the outset of the results section, it is essential to clarify that IPP denotes Independent Power Producer, a governance model wherein private entities, often consortia such as ACWA Power in the Skaka case, are responsible for the development, ownership, and operation of power plants. These entities sell electricity to a public off-taker, such as the Saudi Power Procurement Company, under long-term power purchase agreements (PPAs). This model stands in contrast to vertically integrated utilities and aligns with the Transaction Cost Economics (TCE) framework by emphasizing transaction structures that address asset specificity and coordination hazards within hierarchical systems. Consistent with the chapter's purpose, it describes (i) the institutional and policy setting that defines the transaction environment, and (ii) the observable sequence of decisions and administrative steps that appear in the project record, before turning to transaction-level contracting transactions in the subsequent subsection.

4.2.1 Institutional and Policy Context

The documentary record situates the Skaka transaction within a highly centralized governance environment in which formal authority over energy-sector strategy and procurement is concentrated in state institutions and their designated procurement vehicles. Secondary institutional accounts describe Saudi state organization as one where policy implementation and allocation frequently proceed through hierarchically managed administrative channels rather than through decentralized regulatory bargaining. Within the energy sector specifically, governance assessments characterize decision rights and implementation capacity as clustered around ministerial authority and state-linked entities, with institutional responsibilities distributed across multiple organizations whose mandates are periodically reconfigured through reform programs and administrative redesign.

This study aims to elucidate the economic structures of institutions in Saudi Arabia, thereby facilitating the process tracing analysis. To mimic Williamson's four-level framework, the Saudi renewable energy institutional map is organized as a vertically ordered institutional system in which authority, delegation, predictability, and enforcement are distributed across distinct organizational layers.[165] The ultimate authority resides at the state apex, with decision rights cascading downward through sector ministries and state-owned entities.[166]

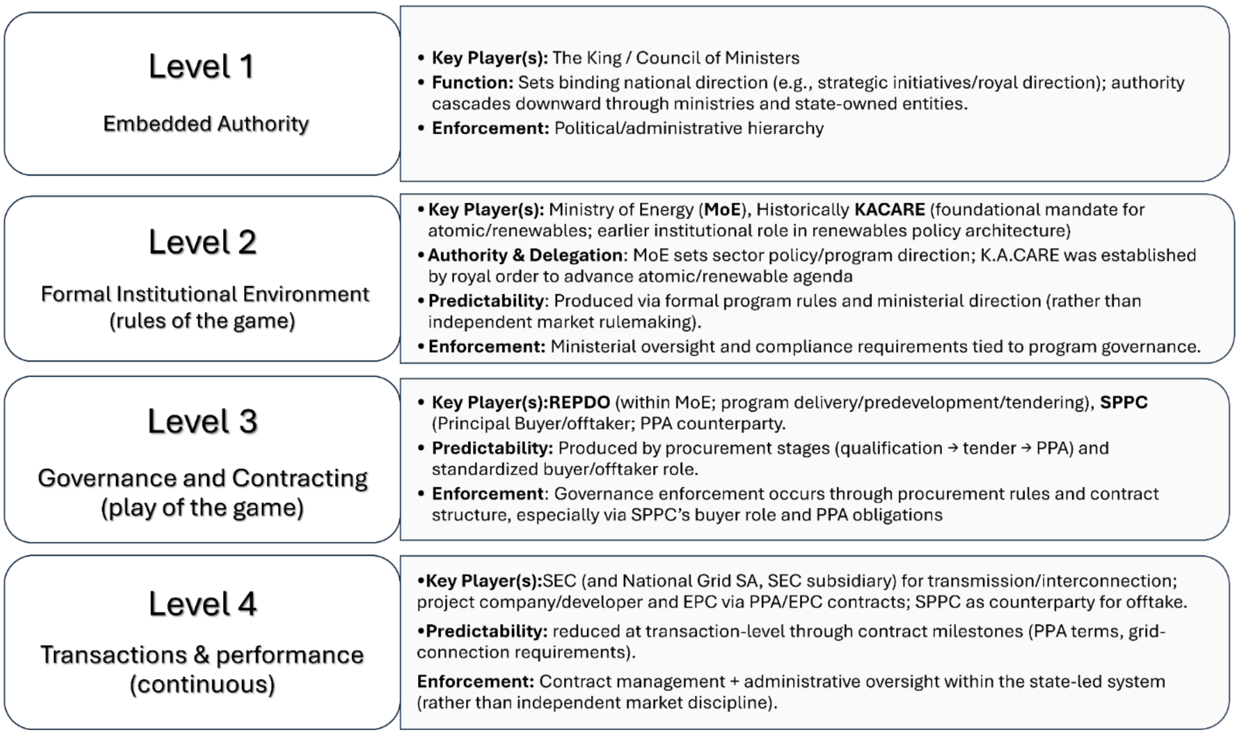


Figure 3. Institutional Layers of Renewable Energy Governance in Saudi Arabia (Skaka Solar IPP)

To situate the Skaka Solar IPP within its institutional context, the Saudi renewable energy system can be understood as a layered governance structure spanning authority, rule-making, contracting, and transaction execution. Figure 3 summarizes these institutional layers and identifies the key public actors, enforcement mechanisms, and sources of predictability operating at each level. At the institutional-environment level, formal rule-setting authority is exercised by

[165] Williamson, "The New Institutional Economics: Taking Stock, Looking Ahead," 596–98.
[166] Krane, "Energy Governance in Saudi Arabia," 3–5.

the Ministry of Energy, which leads and supervises the National Renewable Energy Program.[167] At the governance and contracting levels, implementation authority is delegated to REPDO and SPPC: REPDO is the office responsible for delivery of NREP within the Ministry, while SPPC (the Principal Buyer) is responsible for predevelopment, tendering, and offtake.[168] At the transaction and performance levels, SEC's operational remit spans generation, transmission, and distribution, providing the system interface within which renewable PPAs and EPC contracts are executed.[169] It is worth mentioning that there is organizational ambiguity in the authority and delegations in both levels three and four, which shows that the rules are not well defined.

As a conclusion for this section, policy documents tied to Vision 2030 frame electricity-sector reform and renewable deployment as part of a broader restructuring of the energy economy, including shifts in pricing policy and fiscal reform that appear in the record as formal reform initiatives rather than market-led restructuring. In parallel, scenario-based sector planning documents describe utility-scale renewables as embedded in a system planning problem defined by grid integration, stability constraints, and capital requirements, with projected renewable

[167] Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW."
[168] Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW"; Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
[169] Saudi Electricity Company (SEC), *Annual Report 2023*.

expansion treated as a long-run infrastructure and governance task rather than a discrete technology substitution.

Within that setting, the Skaka project appears in the record as an early utility-scale solar procurement executed through a state-led programmatic channel. Project documentation identifies Skaka as a 300 MW PV IPP and reports milestone progression through grid connection and commercial operation, with the project later publicly marked as a national-level inauguration event. These materials present the Skaka transaction as structured through a formal offtake arrangement consistent with the IPP model, i.e., a long-term purchase commitment supporting private delivery under a state-directed procurement architecture, rather than as a merchant, price-exposed project.

4.2.2 Path Dependence Indicators (PDI)

Employing the Path Dependence Index (PDI) coding protocol, as delineated in Chapter 3, the context of the electricity transition in Saudi Arabia, specifically the Skaka PV IPP, was assigned a PDI score of 86 out of 100. This score represents a descriptive index output rather than a causal finding, derived from coded indicators that encompass system concentration, legacy capital stock, institutional density and overlap, frequency of junctures, and network externalities. The protocol allocates scores on a scale of 0–100 for each component, with higher values signifying a stronger degree of lock-in. These scores were equally weighted and averaged to determine the overall PDI score. The scores are obtained from quantitative metrics where feasible, such as the Herfindahl-Hirschman Index (HHI), or from qualitative rubrics applied to documentary evidence, with thresholds calibrated in relation to the scale of the case, for instance, by benchmarking sunk costs against GDP or peer economies to ensure defensibility.

The concentration component in Saudi Arabia is coded as high, as evidenced by a Herfindahl-Hirschman Index (HHI)[170] of approximately 0.98. This index suggests an electricity supply structure that is nearly maximally concentrated by technology or fuel category, according to the operational definition used in this dissertation. The calculation considers fossil fuels as a single category due to their predominance, with the HHI determined by the sum of squared market shares: (0.99) ^2 for fossil fuels and (0.01) ^2 for renewables, resulting in an HHI of approximately 0.98. This value was rescaled to 96 on a 0–100 component scale, where an HHI greater than 0.9 corresponds to a high concentration range of 90–100. The coding is based on data from IRENA, which indicates that renewables constitute less than 1% of Saudi Arabia's installed capacity,[171] and is corroborated by the EIA, which confirms that fossil fuels (natural gas and oil) account for over 99% of electricity generation in 2023.[172]

The sunk-cost component is coded as high, reflecting the scale of legacy infrastructure and accumulated capital commitments in the oil power complex, where such assets function as

---

170 Rhoades, "The Herfindahl-Hirschman Index," 188.
171 International Renewable Energy Agency (IRENA), *Renewable Capacity Statistics 2023*, 15.
172 U.S. Energy Information Administration (EIA), "Saudi Arabia - EIA."

durable barriers to change. Evidence includes KAPSARC estimates of $600 billion in cumulative historical investments in fossil-based generation, transmission, and distribution systems,[173] alongside SEC Annual Report 2023 detailing $150 billion in net fixed assets tied to oil and gas plants as of year-end.[174] A score of 99 is assigned using the protocol's rubric, which scales absolute sunk costs relative to GDP (Saudi GDP ≈ $1.1 trillion in 2025; ratio ≈ 0.55), with thresholds >0.5 = 90–100 for high intensity, as this magnitude exceeds benchmarks for fossil-dependent peers like Russia ($400 billion sunk costs, ratio 0.4, scoring ~80.[175]

The network externalities component is coded as high, capturing the required approvals and interdependencies for project progress, which creates coordination challenges. This is evidenced by the multi-agency involvement in NREP procurement, as documented in REPDO's Round Two bidding timeline requiring alignments across MoE, SPPC, and SEC,[176] and SPPC RFQ processes involving layered reviews.[177] A score of 85 is based on the protocol's count of key entities (5: MoE, K.A.CARE, REPDO, SPPC, SEC), scaled at 17 points per entity for high externalities (threshold: 1–2 entities = 20–40 low, 3–4 = 50–70 medium, 5+ = 80–100 high, as more actors exponentially increase hazards beyond linearity).

---

173 Hasan et al., *Saudi Arabia's Unfolding Power Sector Reform: Features, Challenges and Opportunities for Market Integration*, 12.
174 Saudi Electricity Company (SEC), *Annual Report 2023*, 45–47.
175 World Bank, *Fossil Fuel Energy Sector Reform*, 22–25.
176 Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
177 Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW," 1.

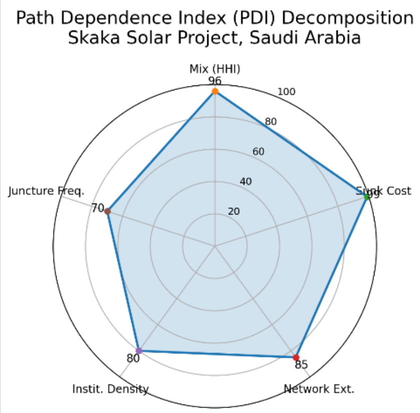
The institutional density component is coded as high, indicating an overlap among regulatory-planning bodies that heightens coordination burdens. Evidence draws from the institutional map (Figure Y Above), showing overlapping mandates between KACARE, MoE, REPDO, and SPPC,[178] and the organizational ambiguity noted in Levels 3 and 4. A score of 80 scales this density based on the number of interfaces documented in the map and sequences (threshold: 1–2 bodies = 20–40 low, 3–4 = 50–70 medium, 5+ = 80–100 high, reflecting the compounding effect of overlap on burdens).

The juncture frequency component is coded as medium-high, reflecting a low rate of major reforms (high rigidity) with incremental adjustments rather than a break in the series. This is based on the sequence in Table 3, where reforms like Vision 2030 (2016) and NREP rounds (2019–2025) build on existing hierarchies without fundamental shifts, as analyzed in KAPSARC reports on gradual subsidy reforms.[179] A score of 70 assigns weight to the infrequency of junctures according to the temporal logic of the protocol (threshold: >3 junctures per decade = 20–40 low rigidity, 2–3 = 50–60 medium rigidity, 1 or fewer = 70–100 high rigidity, as each additional juncture reduces rigidity by 20–30 points to reflect the potential for adaptation). Applying the Path Dependence Index protocol outlined in Chapter 3, this subsection reports the component-level scores for the Skaka PV IPP. Figure 4 presents the relative contributions of the

---

178 Krane, "Energy Governance in Saudi Arabia," 3–6.
179 Hasan et al., *Saudi Arabia's Unfolding Power Sector Reform: Features, Challenges and Opportunities for Market Integration*, 8.

generation mix concentration, sunk costs, network externalities, institutional density, and reform frequency to the project's overall path-dependent profile.



Higher values reflect greater lock-in / barrier.

Short Axis Label	Full Factor Name & Description	Score
Mix (HHI)	Generation Mix Concentration (Herfindahl–Hirschman Index): Share of dominant fuel(s) in power generation. High = less diversity, more lock-in.	96
Sunk Cost	Sunk Cost Intensity: Legacy investment in infrastructure (fossil, grid, etc.). High = larger economic barrier to change.	99
Network Ext.	Network Externalities: Required approvals and interdependencies for project progress. High = more actors/barriers, slower change.	85
Instit. Density	Institutional Density: How many regulatory/planning bodies are involved. High = more overlap and coordination challenges.	80
Juncture Freq.	Frequency of Major Reform Junctures: High = rare reforms, system is rigid; Low = frequent reforms, adaptive.	70

Figure: PDI component scores for Skaka (Saudi Arabia).

Figure 4. Path Dependence Index Component Scores for the Skaka Solar Project (Saudi Arabia)

To operationalize the path dependence lens in the Saudi results, this section delineates the renewable energy governance trajectory as a dated sequence of institutional and policy events observable in official program documents and procurement records, referred to here as documentary records: archival evidence supporting process tracing. The descriptive task is sequence reconstruction: identifying the timing and ordering of reform moves, procurement milestones, and repeated implementation routines that structure how utility-scale renewable projects are advanced under the National Renewable Energy Program. In the Saudi case, program delivery functions are explicitly organized through the Renewable Energy Project Development Office (REPDO) within the Ministry of Energy (then MoE), which frames renewable procurement as a phased program with standardized tendering steps and a centralized execution authority.[180]

Table 3. Saudi Renewable Procurement Sequence Events and Descriptive Roles (Skaka Context)

Date	Observable institutional / policy event	Sequence role (descriptive)
17 Apr 2010. [181]	Royal decree established King Abdullah City for Atomic and Renewable Energy (KACARE).	Early institutional layering attempt preceding later program consolidation.
29 Jan 2019. [182]	REPDO (within MEIM) launches Round Two of the National Renewable Energy Program (NREP) via Expressions of Interest for seven solar PV projects.	Formalization of centralized program delivery and staged procurement sequencing.
08 Jul 2019. [183]	REPDO publishes Round Two bidding timeline and procurement schedule.	Routinization of tender sequencing and calendarized implementation.
12 Nov 2023. [184]	SPPC announces RFQ for Round 5 solar projects (3,700 MW) under NREP supervision.	Repetition of centralized Principal Buyer Procurement Model.
26 Sep 2024. [185]	SPPC announces RFQ for Round 6 solar and wind projects under NREP supervision.	Reinforcement of established procurement pathways through new rounds.
13 Jul 2025. [186]	Principal Buyer (SPPC) signs PPAs for seven new renewable projects totaling 15,000 MW.	Consolidation of authority and enforcement through PPA offtake model.

---

[180] Renewable Energy Project Development Office, *REPDO Launches Round Two of the National Renewable Energy Program*, 1–2.
[181] Government of Saudi Arabia, *Royal Decree of 17/04/2010 on the King Abdullah City for Atomic and Renewable Energy (K.A.CARE)*.
[182] Renewable Energy Project Development Office, *REPDO Launches Round Two of the National Renewable Energy Program*.
[183] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
[184] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*; Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW."
[185] Saudi Power Procurement Company (SPPC), *Renewable Energy Capacity Update 2024*.
[186] Ministry of Energ (MoE)y, *Principal Buyer Signs Power Purchase Agreements for Seven New Renewable Energy Projects with Total Capacity of 15,000 MW*.

Table 3 provides the dated backbone for the Saudi sequence by consolidating key milestones documented in REPDO's Round Two launch and bidding timeline, SPPC procurement announcements for subsequent rounds, and the Ministry of Energy's description of SPPC's Principal Buyer role in tendering and offtake through power purchase agreements. The table is intentionally descriptive: it is used later to assess whether observed outcomes reflect reinforcement through repeated administrative sequencing (persistence of program routines) or incremental reconfiguration (modifications layered onto a stable, centralized procurement structure) in the discussion that follows.[187]

The process of institutional change in Saudi Arabia's renewable energy sector exemplifies the concept of layering, where new organizational elements and rules are introduced alongside existing structures without dismantling foundational arrangements.

Evidence from Saudi Arabia aligns most closely with the concept of layering, which involves the introduction of new rules or organizational elements "*on top of or alongside*" existing ones, without dismantling foundational arrangements.[188] Within the Skaka transaction environment, documentary records indicate that renewable procurement is being institutionalized through the addition of entities and procedural steps (e.g., NREP rounds and procurement

---

[187] Ministry of Energ (MoE)y, *Principal Buyer Signs Power Purchase Agreements for Seven New Renewable Energy Projects with Total Capacity of 15,000 MW*.
[188] Mahoney and Thelen, "A Theory of Gradual Institutional Change," 15–17.

instruments), while the legacy sector authorities and operational hierarchies remain unchanged. This pattern corresponds with the PDI profile, characterized by high institutional density/overlap and significant network externalities, since layering increases the number of interfaces and approvals that must be coordinated, rather than simplifying or repurposing a single rule system.[189]

Substantively, the Skaka sequence suggests that reforms accumulate as additions, such as new procurement rounds, new coordinating/procurement bodies, and additional review layers, rather than as a documented replacement of the core legacy electricity governance. This mechanism illustrates how layering can effect change while preserving the existing structure: amendments and additions can be significant, yet they maintain older arrangements that continue to influence coordination burdens and timing outcomes.[190] The results section already empirically indicates this through high institutional density and high network-externality coding (multiple entities and sequential approvals) and through the "medium-high" rigidity in juncture frequency (few major breaks), which is consistent with change occurring through accumulated add-ons rather than a reorganization of the underlying transaction pathway.[191]

---

189 Mahoney and Thelen, "A Theory of Gradual Institutional Change"; Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*; Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW."

190 Mahoney and Thelen, "A Theory of Gradual Institutional Change," 15–17.

191 Hasan et al., *Saudi Arabia's Unfolding Power Sector Reform: Features, Challenges and Opportunities for Market Integration*, 8; Renewable Energy Project Development Office, *REPDO Launches Round Two of the National Renewable Energy Program*; Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW."

4.2.3 Transaction-Cost Outputs (TCE): Skaka PV IPP

This subsection reports the transaction-level outputs of the Transaction Cost Economics (TCE) protocol (Chapter 3) for the Skaka PV IPP, which refers to a private entity that develops, owns, and operates a power generation facility, typically selling electricity to a utility or off-taker under a long-term power purchase agreement (PPA). The unit of analysis is the transaction, operationalized as the procurement-and-contracting transaction (tender-to-PPA) and the implementation transaction (PPA-to-commercial operation) as evidenced in contract milestones, financing closure, and schedule realization.

The Skaka PV IPP transaction is executed within the National Renewable Energy Program (NREP) procurement architecture, where multiple state entities occupy distinct roles across procurement, contracting, and implementation oversight. Three roles are particularly relevant to the transaction interface documented for Skaka:

- **The Ministry of Energy (MoE)** functions as the sectoral authority responsible for national electricity policy direction and for the institutional architecture within which renewable procurement is executed. In the documentary record, the renewable program is situated within a broader electricity-sector restructuring agenda and a centrally managed procurement framework.[192]
- **Renewable Energy Project Development Office (REPDO)** appears in the record as the institutional unit established to develop and manage renewable procurement under the national program framework. As an institutional design feature, REPDO concentrates

[192] Ministry of Energy (MoE), *Electricity in Saudi Arabia in 2023*.

project development responsibilities (programmatic planning, tender development, and procurement management) within a centralized mandate.[193]

- **Saudi Power Procurement Company (SPPC)** appears as the principal buyer and program-facing procurement entity through which PPAs are executed and standardized procurement processes are reported. In the record used by this dissertation, SPPC is the institutional body that formalizes procurement outputs and reports program execution through official announcements and annual reporting.[194]

These institutional placements matter for the Transaction Cost Economics' results because they define the governance pathway through which the transaction progresses: a transaction executed through programmatic supervision and sequenced coordination across state entities implies more interfaces where contracting work, documentation cycles, and execution monitoring occur, thereby expanding the surface area where transaction costs can accumulate.[195]

Component results for Skaka under the dissertation's protocol

Earlier in Table 4 and Figure 5 the Skaka Transaction Cost Economics component outputs generated by the dissertation's standardized coding and costing rules.

- **Owner's Services (OS): US$16.0 million (5.0% of EPC).**

Owner's Services is coded as the standardized soft-cost envelope at 5% of EPC for comparability,[196] then partitioned into Negotiation Costs and Relational/Contracting Costs. This

---

[193] Al-Yemni, "Saudi Arabia: National Renewable Energy Program."
[194] Saudi Power Procurement Company (SPPC), *Annual Report 2024*; Saudi Power Procurement Company (SPPC), *Renewable Energy Capacity Update 2024*; Saudi Power Procurement Company (SPPC), *Renewable Energy Projects Status Report 2024*.
[195] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 52–56.
[196] Sargent & Lundy et al., *Capital Cost and Performance Characteristics for Utility-Scale Electric Power Generating Technologies*.

envelope reflects the governance and coordination labor required to execute procurement and manage project execution in a centrally administered program environment.[197]

Negotiation Costs (NC): US$4.8 million (1.5%).

Negotiation Costs are coded as 30% of Owner's Services. Substantively, this cost category corresponds to the pre-contract transaction work associated with tendering and reaching a bankable agreement: documentation cycles, bid evaluation, bargaining over contractual terms, and the governance work required to reach the PPA milestone. Because the unit of analysis is the transaction, this category does not claim which actor "caused" negotiation to be costly; it records that the transaction required a non-trivial share of soft-cost effort at the procurement interface consistent with TCE's focus on contracting and governance as costly activities.[198]

- **Relational/Contracting Costs (RCC): US$11.2 million (3.5%)**.

Relational/Contracting Costs are coded as 70% of Owner's Services. This category captures the post-award governance and relational management work associated with contract administration, monitoring, and managing implementation obligations across the transaction's execution phase. In a programmatic procurement environment, relational contracting encompasses monitoring and compliance within a multi-entity governance pathway, where the principal buyer's standardized procedures, sectoral authority oversight, and project development office mandates create recurring governance interactions during execution.[199]

- **Permitting Delay (PD): US$0.00 million (0.0%).**

---

[197] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 52–56.
[198] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[199] Saudi Power Procurement Company (SPPC), *Annual Report 2024*; Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*.

Permitting delay is coded as zero under the dissertation's benchmark rule (≤ 24 months). This does not imply that permitting was effortless; it indicates that, under the protocol's threshold logic, the observed permitting-facing interval does not exceed the benchmark duration required to trigger a priced permitting delay premium in the standardized accounting.

- **Investment/Implementation Delay (ID): US$23.89 million (7.47%), primary financing-based estimate**.

Implementation delay is the dominant driver of Skaka's total transaction-cost burden under the primary method. Under the dissertation protocol, this component translates the observed delay interval into a monetized premium using a financing-based costing approach. Empirically, this reflects that the Skaka transaction's implementation phase, as reconstructed from documentary milestones, exhibits a sufficiently extended interval to trigger the benchmark rule and therefore to be priced as an implementation-delay premium rather than treated as normal project duration.

- **Tariff-based cross-check (ID range): US$18.86–US$22.96 million (5.89%–7.17%).**

The tariff-based cross-check applies an alternative monetization logic to the same delay interval and reports a bounded range. The point of reporting the range is not to replace the primary estimate but to show that even when a revenue-based logic is applied under bounded assumptions, the delay component remains large enough to meaningfully shape the transaction-cost total.

- **Total transaction costs (primary): US$39.89 million (12.5%).**
- **Total transaction costs (tariff cross-check): US$34.86 million (10.9%).**

Under both pricing approaches, Skaka's total transaction cost envelope is driven primarily by implementation-delay costs rather than by owner's-services alone. This pattern is important because it identifies the locus of governance transactions as execution slippage in the implementation phase, rather than as pre-contract bargaining only.

1. **Interpreting Skaka totals:**

Within this dissertation's descriptive scope, the TCE output indicates that Skaka's higher transaction-cost burden is not simply an artifact of a larger soft-cost envelope; it is produced by the priced delay premium that is triggered by the observed implementation interval. Transaction Cost Economics offers a vocabulary for interpreting this kind of pattern: when implementation requires sustained governance effort across institutional interfaces, and when execution is vulnerable to slippage that must be carried financially, the transaction exhibits higher measured governance costs even if the parties successfully reach agreement and financial close.[200]

Institutionally, the Skaka record reflects a programmatically supervised pathway in which procurement and implementation are mediated through a principal buyer and a dedicated project-development office under ministerial direction. In TCE terms, architecture can expand the number of interfaces through which information must pass and approvals must be sequenced, thereby increasing the likelihood that coordination and compliance demands accumulate into execution slippage. This is not a claim that centralization is always inefficient; it is a transaction-specific interpretation of how the Skaka implementation pathway is recorded and how the delay premium becomes the dominant cost component in the standardized accounting.[201]

---

[200] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[201] Al-Yemni, "Saudi Arabia: National Renewable Energy Program"; Saudi Power Procurement Company (SPPC), *Annual Report 2024*.

Table.4 shows the outcomes of Transaction Cost Economics analysis. Owners' services are benchmarked at 5% of EPC, yielding US$16.0M (5.0% of CAPEX). Negotiation costs are defined as ex-ante contracting effort and set at 30% of owner's services, yielding US$4.8M (1.5%), while relational/contracting costs are the remaining 70%, yielding US$11.2M (3.5%). Permitting delay is defined as delay beyond a 24-month benchmark and is therefore US$0.00M (0.0%) when the benchmark is not exceeded. Implementation delay is estimated in two ways: a financing-based method yielding US$23.89M (7.47%) and a tariff-based cross-check yielding US$18.86 – US$22.96M (5.89% - 7.17%). Total transaction costs are NC + RCC + ID, giving US$39.89M (12.5%) under the financing-based method and US$34.86 – US$38.96M (10.9%–12.2%) under the tariff-based cross-check; the "*two totals*" reflect alternative implementation-delay calculations, not different component definitions.

Table 4. Skaka Solar IPP Transaction Cost Components and Totals

Component	Operational definition	Skaka estimate	Share of total capex
Owner's services	Benchmark at 5% of EPC	$16.0M	5.0%
Negotiation costs (NC)	30% of owner's services	$4.8M	1.5%
Relational/contracting costs (RCC)	70% of owner's services	$11.2M	3.5%
Permitting delay (PD)	Set to 0 if ≤ 24-month benchmark	$0.00M	0.0%
Investment Delay (ID)	Financing-based	$23.89M	7.47%
Investment Delay (ID)	Tariff-based	$18.86–$22.96M	5.89%–7.17%
Total transaction costs	NC + RCC + ID (primary)	$39.89M	12.5%
Total transaction costs	NC + RCC + ID (tariff)	$34.86M	10.9%

4.3 Texas Case Study: Institutional Context and the Roserock Solar

This section reports the documentary record for the Roserock Solar Farm transaction in Texas. It describes (i) the institutional and policy context in which the transaction is documented, (ii) the observed sequence of project milestones as recorded in the case materials, and (iii) the transaction-cost accounting outputs produced by applying the Chapter 3 protocol to Roserock. The section is descriptive and limited to the Roserock transaction.

4.3.1 Institutional and Policy Context

The Texas electricity sector is documented as operating through a rules-based structure in which market organization and regulatory oversight are separated across specialized entities, with the Public Utility Commission of Texas (PUCT) serving as the formal regulator and the Electric Reliability Council of Texas (ERCOT) operating the grid and market functions within its jurisdiction. For renewable integration, the documentary record identifies the Competitive Renewable Energy Zones (CREZ) initiative as a formal, statute-backed institutional channel through which transmission buildout was planned and implemented to support large-scale renewable delivery, with recorded stakeholder participation and implementation sequencing documented in CREZ history.

This study aims to elucidate the economic structures of institutions in Texas, thereby facilitating the process tracing analysis. This endeavor will contribute to a comprehensive understanding of the documentary records in this subsection and the sequence records in the subsequent subsection. In an effort to mirror Williamson's four-level ordering of institutions and governance, [202] the institutional map of the Texas electricity system governing utility-scale renewables is organized as a rule-based, decentralized order in which authority, delegation, predictability, and enforcement are distributed across legally distinct organizations. Consistent with NIE's emphasis on formal rules and enforcement as constraints that shape transactions,[203] decision rights in ERCOT are separated between (1) state rulemaking and oversight, (2) system coordination within a defined mandate, and (3) private project execution through standardized procedures and contracts. Therefore, predictability is produced primarily ex-ante through codified rules and transparent protocols rather than ex-post administrative discretion.[204]

---

[202] Williamson, "The New Institutional Economics: Taking Stock, Looking Ahead," 596–98.
[203] North, *Institutions, Institutional Change and Economic Performance*, 3–5, 47–49.
[204] Paxton, *Opinion No. KP-0363: Whether under the Utilities Code the Public Utility Commission Has the Legal Authority to Issue Orders Affecting Pricing for the Wholesale Electricity Market and Ancillary Services (RQ-0401-KP)*, 1–2; Public Utility Commission of Texas (PUCT), *Chapter 25: Substantive Rules Applicable to Electric Service Providers (Revised Compilation)*, 44–45.

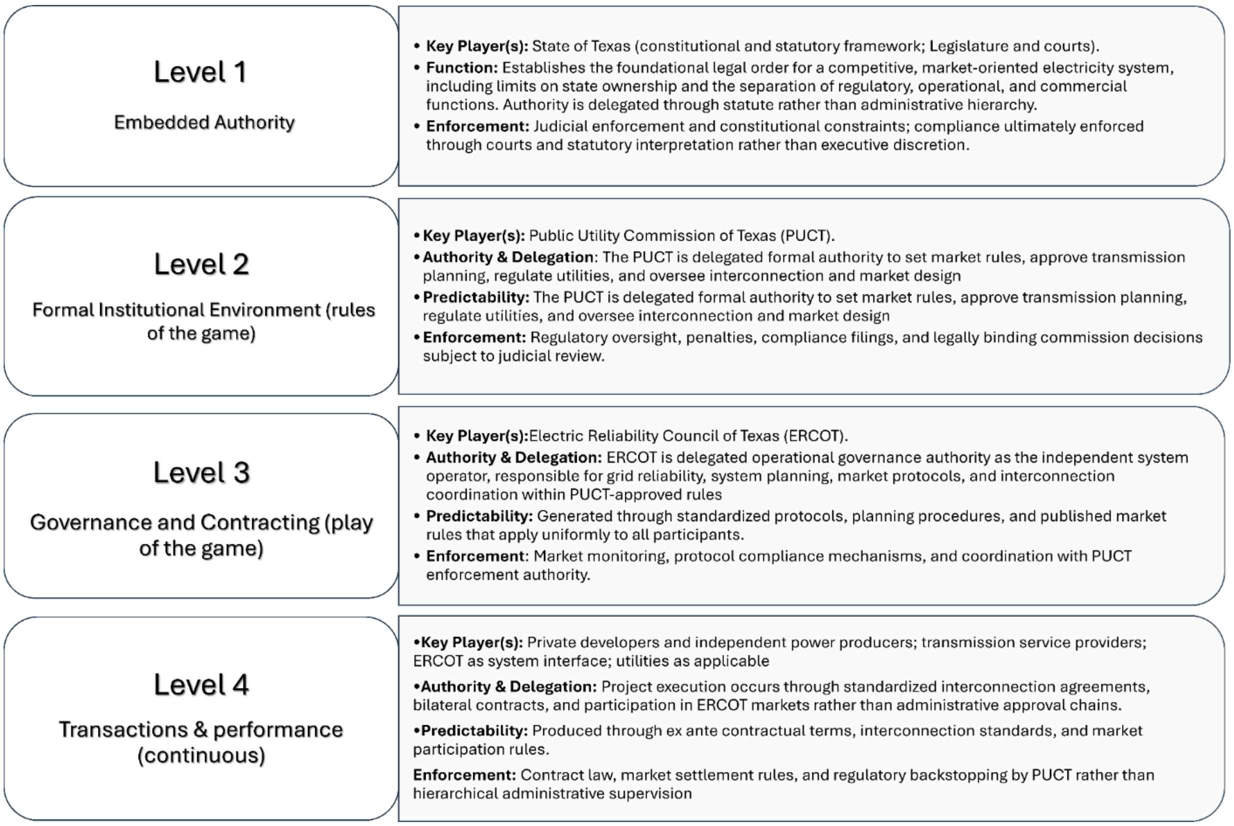


Figure 5. Institutional Layers of Renewable Energy Governance in Texas (Roserock Solar Context)

Figure. 5 locates decision rights, coordination authority, and enforcement mechanisms in the Texas case and provides a baseline for interpreting observed project timelines and transaction-cost outcomes in the results that follow. At the institutional-environment level, formal rule-setting and enforcement authority reside with the Public Utility Commission of Texas (PUCT), which adopts and enforces reliability and accounting rules for the Texas electricity market and retains oversight and review, even when responsibilities are delegated.[205]

[205] Paxton, *Opinion No. KP-0363: Whether under the Utilities Code the Public Utility Commission Has the Legal Authority to Issue Orders Affecting Pricing for the Wholesale Electricity Market and Ancillary Services (RQ-0401-KP)*.

At the governance level, operational coordination is delegated to the Electric Reliability Council of Texas (ERCOT), an independent organization responsible for managing system and market operations for most of the Texas load, within the oversight architecture described above.[206] At the transaction and performance levels, private developers and market participants execute utility-scale projects through standardized interconnection, technical, and contracting requirements administered through transmission/distribution and market interfaces, with compliance enforced through rule-governed interconnection agreements, technical standards, and oversight processes rather than hierarchical administrative control.[207] Finally, monitoring and performance assessment are institutionalized through the Independent Market Monitor reporting function and related oversight channels that evaluate market outcomes and recommend reforms within the PUCT–ERCOT governance framework.[208]

Within this documented setting, Roserock is treated in this dissertation as a utility-scale solar facility developed inside ERCOT's market and interconnection environment, and thus subject to ERCOT-facing procedural interfaces and PUCT-facing regulatory governance as reported in the institution.

---

[206] Paxton, *Opinion No. KP-0363: Whether under the Utilities Code the Public Utility Commission Has the Legal Authority to Issue Orders Affecting Pricing for the Wholesale Electricity Market and Ancillary Services (RQ-0401-KP)*; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics for the Public Utility Commission of Texas and ERCOT, 2024).
[207] Public Utility Commission of Texas (PUCT), *Chapter 25: Substantive Rules Applicable to Electric Service Providers (Revised Compilation)*, 320–27.
[208] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics for the Public Utility Commission of Texas and ERCOT, 2024), I.

The record used in this dissertation describes Texas as an electricity system shaped by prior restructuring and transmission planning decisions that persist as background institutional conditions for later renewable transactions. In the CREZ documentation, transmission planning and implementation are recorded as multi-year institutional undertakings, defined by formal designation, planning, and buildout steps, rather than as one-off project-by-project adjustments, thereby forming an observable institutional trajectory within which later solar investments occur. Separately, ERCOT planning documents are used in this dissertation as a system-context record describing load growth and forward system conditions relevant to the setting in which utility-scale additions are planned and integrated.

For Chapter 4 purposes, the Roserock case is bounded to the transaction interfaces that appear in the record and are operationalized in Chapter 3's protocol: the project's contracting and compliance activities within ERCOT/PUCT governance, and the post-contract implementation interval as coded against benchmark timing rules.

4.3.2 Path Dependence Index Output for Texas

4.3.2.1: Texas Path Dependence Index (PDI)

When the Path Dependence Index (PDI) of the dissertation is applied to the context of Texas, it results in a PDI score of 38 out of 100. This score represents the feedback dynamics within the institutional environment in which Roserock was documented. It is presented as a descriptive index output and is linked to coded indicators derived from the Texas institutional record, which includes documented governance arrangements and CREZ planning and implementation pathways in Texas.

The concentration component of Texas is coded as medium (HHI ≈0.43, score 43), reflecting diversification that mitigates lock-in. This score is derived from the Herfindahl-Hirschman Index (HHI), [209] calculation based on Texas's energy mix, which includes significant shares of natural gas (45%), renewables (28%), coal (20%), and nuclear (7%) energy, as reported in recent EIA data. The HHI is computed as the sum of squared market shares: $(0.45^2 + 0.28^2 + 0.20^2 + 0.07^2) \approx 0.43$. In path dependence terms, lower concentration reduces self-reinforcing mechanisms that favor dominant technologies, as diversified sources allow for easier substitution without systemic disruption. Thresholds for scoring are set as low (<0.25 = 0–25), medium (0.25–0.50 = 26–50), and high (>0.50 = 51–100), drawing on Unruh's framework for carbon lock-in; Texas's medium level thus scores 43, indicating moderate but not overwhelming reinforcement of fossil pathways. [210]

The sunk-cost component is coded as medium-high (score 67), with $70 billion in fossil investments creating barriers, but less than Saudi Arabia. This score is based on the ratio of sunk fossil fuel infrastructure costs to state GDP, using EIA capital expenditure data for oil, gas, and

---

[209] Rhoades, "The Herfindahl-Hirschman Index."

[210] Unruh, "Understanding Carbon Lock-In"; U.S. Energy Information Administration (EIA), "Texas State Energy Profile," 2.

coal facilities in Texas (approximately $70 billion cumulative over the past decades)[211] divided by Texas's 2023 GDP of $2.4 trillion, yielding ≈0.03. Path dependence emphasizes how such investments generate increasing returns that deter shifts, but Texas's ratio falls in a medium-high threshold (0.02 - 0.05 = 60–70), reflecting substantial lock-in from refineries and pipelines, yet offset by growing renewable investments that dilute overall inertia. Comparatively, Saudi Arabia's higher ratio (≈0.10) underscores Texas's relative flexibility .[212](GDP ratio ≈0.03, threshold 0.02–0.05 = 60–70).

The network externalities component is coded as low (score 20), with routinized interfaces reducing hazards. Scoring here assesses the number and complexity of interdependent actors in the energy system, where ERCOT, PUCT, and wholesale market participants form a trio of well-defined entities with standardized protocols for grid integration and pricing. Each entity contributes roughly 6.7 points to the score (three, but well-defined role entities × 6.7 = 20), based on a low-complexity threshold (1–3 entities = 0–30) that minimizes coordination failures. In Unruh's terms, these routinized networks facilitate positive externalities for new entrants like renewables, avoiding the high interdependencies that entrench incumbents in more fragmented

[211] U.S. Energy Information Administration (EIA), "Texas State Energy Profile."
[212] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics"; U.S. Energy Information Administration (EIA), "Texas State Energy Profile."

systems. In Texas there are three, but well-defined roles, entities that are scaled at 6.7 points each.[213]

The institutional density component is coded as low (score 30), with minimal overlap enabling adaptation. This derives from counting overlapping regulatory bodies in Texas's energy governance, primarily limited to PUCT and ERCOT with little redundancy, scoring in the low threshold (1–2 bodies = 20–40). Dense institutions reinforce path dependence through the use of veto points and bureaucratic inertia. However, Texas's lean structure, in contrast to Saudi Arabia's multilayered entities like SEC, Aramco, and PIF, allows for agile reforms, reducing the self-reinforcement of fossil pathways.[214]

The juncture frequency component is coded as low (score 30), with frequent reforms, such as the CREZ, facilitating change. Scoring evaluates the number of critical junctures per decade, with Texas experiencing over three (e.g., CREZ in 2005–2014, market reforms in 2019 and 2021 post-winter storm) [215] falling in the low path dependence threshold (>3 per decade = 20–40). Pierson highlights how frequent junctures disrupt increasing returns, enabling path

---

[213] Unruh, "Understanding Carbon Lock-In"; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics for the Public Utility Commission of Texas and ERCOT, 2024), i.
[214] Thelen, "How Institutions Evolve: Insights from Comparative Historical Analysis"; Krane, "Energy Governance in Saudi Arabia," 3.
[215] U.S. Energy Information Administration (EIA), *Winter Storm Uri: Impacts on Texas Energy Infrastructure*.

shifts; Texas's reforms exemplify this, lowering overall lock-in by creating windows for renewable integration (threshold >3 per decade = 20–40).[216]

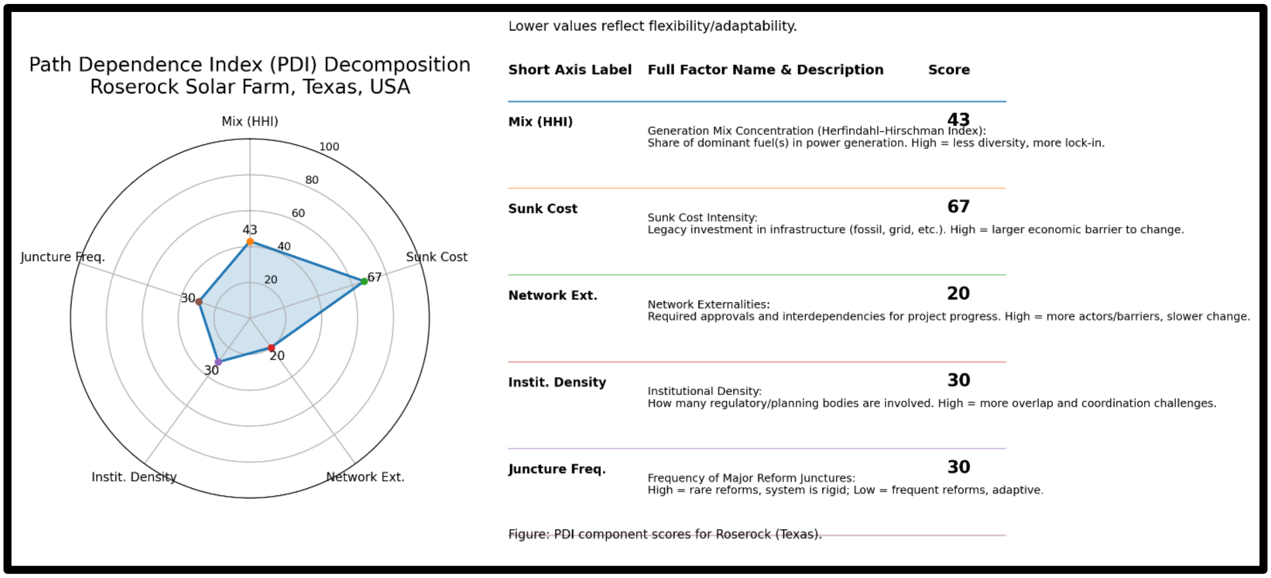


Figure 6. Path Dependence Index Component Scores for the Roserock Solar Farm (Texas, USA)

To operationalize the path dependence lens in the Texas results, Figure 7 reconstructs the sequence of institutional and policy events that constitute the empirical basis for the following analysis. The evidentiary burden begins with establishing timing and ordering through documentary records: archival evidence supporting process tracing of early statutory and regulatory choices that defined the restructured ERCOT governance environment, followed by subsequent rounds of implementation in which oversight arrangements and operating protocols were refined rather than replaced. In Texas, restructuring implementation and market oversight

[216] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics"; Potomac Economics, *2022 State of the Market Report for the ERCOT Electricity Markets*.

were explicitly assigned to the Public Utility Commission of Texas (PUCT) and the Electric Reliability Council of Texas (ERCOT), with ERCOT serving as the independent system operator under a legally defined mandate.[217]

Table 5. Texas Electricity Governance Sequence Events and Descriptive Roles (Roserock Context)

Date / period	Observable event	Organizations involved	Sequence role (descriptive)
1999. [218]	Texas adopts electricity restructuring framework establishing competitive generation and market unbundling.	Texas Legislature; Public Utility Commission of Texas (PUCT)	Foundational institutional choice defining market-based governance path.
2000. [219]	Implementation and oversight roles for restructuring clarified; ERCOT identified as system operator under PUCT oversight.	Electric Utility Restructuring Legislative Oversight Committee; PUCT; ERCOT	Early delegation of authority and separation of governance functions.
2005–2014. [220]	CREZ transmission planning, approval, and build-out sequence institutionalizes renewable integration infrastructure.	PUCT; ERCOT; Transmission providers	Long-term infrastructure commitment reinforcing the chosen market path.
2010s–present (codified 2023).[221]	PUCT substantive rules codify interconnection, market participation, and utility oversight procedures.	PUCT	Rule-based predictability through formal codification.
2010s–present (protocols	ERCOT administers nodal protocols governing market operations, reliability, and interconnection.	ERCOT; PUCT oversight	Operational governance reinforcement through protocol administration.

[217] Texas Legislative Council, *Summary of Senate Bill 7: Electric Utility Restructuring*.
[218] Texas Legislative Council, *Summary of Senate Bill 7: Electric Utility Restructuring*, 7.
[219] Electric Utility Restructuring Legislative Oversight Committee, *Report to the 77th Legislature*, 17–18, 20–22.
[220] World Bank and Energy Sector Management Assistance Program, *Texas CREZ Transmission and Renewable Energy Zones*, 9–16.
[221] Public Utility Commission of Texas, *16 Texas Administrative Code, Chapter 25: Substantive Rules Applicable to Electric Service Providers (Revised Compilation 2023), §§25.211–25.212*.

version 2022). [222]			
2023 report year / 2024 release. [223]	Independent Market Monitor reports market performance and compliance to PUCT.	Potomac Economics (IMM); ERCOT; PUCT	Ongoing monitoring and incremental adjustment within the same governance architecture.

Table 5 summarizes this core sequence using observable events documented in statutory restructuring and rule implementation, complemented by independent market monitoring reported to the PUCT. The Independent Market Monitor's annual reporting function is explicitly framed as a report to the PUCT in its market-monitoring role.[224] The table is intentionally descriptive: it provides the dated backbone used later to interpret whether subsequent outcomes reflect reinforcement (increasing returns to an established market design) or adaptive reconfiguration (incremental revision without abandoning the core governance structure).

The institutional changes in Texas' energy sector demonstrate a process of conversion, where existing formal rules are strategically adapted rather than replaced. This is evident in the

[222] Electric Reliability Council of Texas, *ERCOT Nodal Protocols*, 3.
[223] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).
[224] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).

integration of renewable energy within established market structures and regulatory routines, reflecting the repurposing of governance mechanisms to support a new generation mix.

The sequence evidence from Texas aligns most closely with the concept of conversion, which is characterized by maintaining formal rules while altering their implementation, strategically reproducing existing institutional frameworks for new objectives.[225] Within the Roserock context, documentary records indicate that renewable energy sources are being integrated through a standardized market structure and established regulatory and operational routines, rather than by establishing a separate approval hierarchy. This observation is consistent with the lower PDI scores related to institutional density and network externalities: the presence of fewer overlapping entities and reduced coordination transactions aligns with a trajectory in which existing institutions are adapted to accommodate a new generation mix.[226]

Empirical evidence suggests that the Roserock, characterized by moderate concentration, lower network externalities, reduced institutional density, and increased policy flexibility, supports the interpretation that institutional changes in Texas are primarily observed as the repurposing of existing governance mechanisms rather than the additive layering of new authorities. In terms of conversion, the principal outcome is not the proliferation of new rules

[225] Mahoney and Thelen, "A Theory of Gradual Institutional Change," 15–18.
[226] Mahoney and Thelen, "A Theory of Gradual Institutional Change," 17–18; Potomac Economics, *2022 State of the Market Report for the ERCOT Electricity Markets*.

alongside existing ones but rather the interpretation and application of current arrangements (such as regulatory oversight, system operations, and market participation procedures) to accommodate renewable energy on a large scale. This is consistent with the depiction of standardized interfaces structuring the transaction pathway.[227]

4.3.3 Transaction-Cost Outputs for Roserock (TCE Protocol)

Transaction Cost Economics (TCE) provides a lens for assessing how governance structures in Texas shape the costs of coordinating, contracting, and implementing solar projects. As Williamson emphasizes, TCE focuses on the transaction as the unit of analysis, where hazards such as asset specificity, the degree to which investments are tailored to a particular use and difficult to redeploy, and behavioral uncertainty arise, necessitating alignments that minimize opportunism and hold-up risks (Williamson, "Transaction-Cost Economics," 1979, pp. 233–35; Williamson, The Economic Institutions of Capitalism, 1985, pp. 52–56). In the context of renewable energy transitions, these hazards manifest in project development, where site-specific infrastructure and regulatory dependencies create quasi-rents that are vulnerable to renegotiation or delays. The dissertation's TCE protocol operationalizes these through four components (negotiation costs (NC), relational contracting costs (RCC), risk capital costs (RCC),

---

[227] Mahoney and Thelen, "A Theory of Gradual Institutional Change," 17–18; U.S. Energy Information Administration (EIA), "Texas State Energy Profile"; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).

and investment delay (ID)) derived from documented milestones, permitting intervals, and financing benchmarks. Applied to the case of Roserock (Texas), the results reveal lower and more predictable costs in Texas's rule-bound market environment.

The Roserock Solar transaction is situated in a market-oriented institutional environment in which renewable project development interfaces with rule-bounded regulatory and system-operations institutions. The documentary record used in this dissertation emphasizes three relevant characteristics of the Texas institutional surface:

- **Rule-bounded regulatory oversight,** where public actors' decision-making discretion is constrained by codified procedures rather than by discretionary case-by-case bargaining.
- **System-operator coordination,** where interconnection and system-planning tasks are operationalized through standard market coordination processes.
- **Institutionalized stakeholder processes and market monitoring**, which, within the documentary record, reduce the degree to which individual project progress depends on ad hoc inter-agency sequencing.

These institutional characteristics are reflected in the Texas sources used in the dissertation's documentary base, including ERCOT system assessments and market reporting and PUCT documentation of market scope and transmission-related planning processes.[228]

Component results for Roserock under the dissertation's protocol

[228] Public Utility Commission of Texas (PUCT), *Annual Report on Texas Electricity Market*; Electric Reliability Council of Texas (ERCOT), *Report on the Capacity, Demand and Reserves May 2024 Revised*.

Figure 6 reports on the Roserock component outputs generated by applying the Chapter 3 coding rules.

- **Permitting Delay (PD): US$0.00 million (0.0%)**.

Permitting delay is coded as zero under the dissertation's benchmark rule. This does not mean the project faced no regulatory steps; rather, under the protocol's threshold logic, the observed record does not support pricing an additional permitting-delay premium.

- **Negotiation Costs (NC): US$2.75 million (1.0%).**

Negotiation costs are coded within the Owner's Services envelope at 1.0% of CAPEX for the Texas case. This corresponds to the pre-contract and contracting interface work required to reach agreement under a rule-bounded, market-oriented institutional environment. In TCE terms, it represents the transaction's bargaining and contracting effort, real costs that exist even in routineized environments.[229]

- **Relational/Contracting Costs (RCC): US$11.00 million (4.0%).**

Relational/contracting costs constitute the remainder of Owner's Services under the protocol. This category captures the governance work of implementing and managing the transaction through execution and monitoring, contract administration, coordination with market/system processes, and the relational work needed to reach completion. Importantly, in the Roserock outputs, these costs remain meaningful but do not expand into a priced implementation-delay premium under the benchmark rule, which is precisely why the total remains concentrated in owner's services rather than in delay.

[229] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.

- **Investment/Implementation Delay (ID): US$0.00 million (0.0%).**

Implementation delay is coded as zero under the dissertation's benchmark rule. This is not a claim that construction was instantaneous or that project management was transactionless; it is a statement about the protocol's threshold logic and the documentary record's ability to justify pricing a separate delay premium beyond the standardized transaction-cost envelope.

- **Total transaction costs: US$13.75 million (5.0%).**

Taken together, the Roserock transaction cost outputs indicate a transaction-cost profile where governance costs are present but concentrated in the predictable soft-cost envelope rather than in priced delay premium.

This subsection reports the transaction-cost component outputs for the Roserock Solar Farm generated by applying the Transaction Cost Economics protocol defined in Chapter 3. Table 6 summarizes the estimated negotiation, relational contracting, and delay-related costs and reports the resulting total transaction-cost burden for the Texas case. Within the dissertation's bounded two-case design, Roserock's TCE profile is consistent with a transaction executed within a governance environment that routinizes key interfaces and constrains discretion through codified procedures. The transaction still requires negotiation and relational contracting, TCE predicts these are unavoidable features of contracting under uncertainty, but the standardized accounting does not detect a large priced delay component triggered by the benchmark rule, which indicates that governance transactions did not translate into the same magnitude of monetized implementation slippage captured for Skaka.[230]

[230] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.

The documentary basis for this interpretation is the institutional record that situates Texas renewable development within a structured regulatory and system-operator environment and within market-monitoring frameworks that lower the need for project-specific discretionary coordination across multiple state entities. [231]

Table 6. Roserock Solar Farm Transaction Cost Components and Totals (TCE Protocol Output)

Component	**Operational definition**	**Roserock estimate**	**Share of capex**
Permitting delay (PD)	Added only if observed duration exceeds benchmark threshold	$0.00m	0.0%
Negotiation costs (NC)	Inside owner's-services envelope; coded at 1.0% of CAPEX for U.S. case	$2.75m	1.0%
Relational contracting Cost (RCC)	Owner's-services remainder; coded at 4.0% of CAPEX for U.S. case	$11.00m	4.0%
Investment delay (ID)	Added only if delay premium applies under benchmark rule	$0.00m	0.0%
Total transaction costs		**$13.75m**	**5.0%**

4.4 Cross-case Findings and Hypothesis Assessment

This section brings the Chapter 4 evidence together and interprets what the documentary record shows across the two bounded cases, using the dissertation's meso-level governance bridge to keep the interpretation aligned across lenses.[232] The purpose is not to introduce new data or extend the analysis beyond the Skaka and Roserock transactions, but to consolidate the

[231] Public Utility Commission of Texas (PUCT), *Annual Report on Texas Electricity Market*; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024); Electric Reliability Council of Texas (ERCOT), *Report on the Capacity, Demand and Reserves May 2024 Revised*.
[232] Peters, "Managing Horizontal Government," 31–34.

empirical results presented separately across Sections 4.2–4.4 and to assess how those results align with the observable expectations derived from the dissertation's three lenses (New Institutional Economics and the Theory of the State, Path Dependence, and Transaction Cost Economics).

The interpretation is organized by lenses to match the dissertation's analytical sequence. Within each lens, the text restates the relevant observable expectation (as stated in Chapter 3 as a document-traceable pattern rather than a causal claim), identifies the Chapter 4 results that bear on that expectation, and clarifies what the evidence supports, what it does not support, and where the record is silent.

4.5.1 New Institutional Economics and the Theory of the State: Institutional Constraints as the Framing Condition

The New Institutional Economics framing treats the transaction as embedded in an institutional environment of formal rules, organizational mandates, and enforcement constraints. The Theory of the State component adds an expectation about the degree of discretion and the credibility of commitments: where public authority is constrained by rule-bound procedures (a contract-state logic), the observable record should show predictable, standardized decision pathways and limited scope for discretionary renegotiation across stages of the transaction; where revenue control and centralized gatekeeping dominate (a revenue-control / rent-seeking logic), the record should show greater institutional discretion, more sequential approvals, and more transaction exposure to coordination burdens across public principals.[233]

Figure 7 presents a documentary, stage-by-stage map of the project transaction pathway for the Skaka Solar Project in Saudi Arabia and a comparable utility-scale solar pathway in Texas. It translates the institutional environment into observable, traceable steps, from mandate and sector planning to permitting, procurement, contracting, grid connection, and operations, while identifying the primary organizations responsible for each stage. The purpose is descriptive: by laying out the hierarchy-dominated, state-driven sequence in Saudi Arabia alongside the market-led, rule-based sequence in Texas, the figure makes explicit where coordination nodes, approval interfaces, and standardized procedures enter the transaction, providing a transparent reference point for the subsequent process-tracing narrative and comparative PDI and transaction-cost assessments.

---

[233] North, *Structure and Change in Economic History*, 20–22.

Figure 7. Documented Project Transaction Pathways in Saudi Arabia and Texas

Chapter 4 shows that Saudi's case materials consistently situate the Skaka transaction within a state-led renewable procurement environment characterized by centralized gatekeeping, multiple public principals, and layered mandates. The governance architecture relevant to the Skaka transaction appears in the documentary record as a chain of public authorities and state-linked organizations that structure how the transaction proceeds from policy target to bankable contract. In the dissertation's Saudi documentary base, the recurring institutional nodes include (at minimum) the Ministry of Energy, REPDO, SPPC, PIF, KACARE, and SEC (as the incumbent electricity system organization).

The Texas case materials, by contrast, locate Roserock within a rule-governed, decentralized market design and a separation between regulatory oversight and system operations. The Public Utility Commission of Texas (PUCT) appears as a statutory regulator constrained by published rules and formal procedures, while ERCOT appears as the independent system operator administering interconnection, market protocols, and planning processes within a stakeholder-governed framework. In this setting, Roserock is documented as operating inside a competitive market organization in which the project's transaction pathway is structured by standardized interfaces (interconnection and market participation procedures) rather than by sequential approvals across multiple state principals. (This contrast is the institutional "*setup*" that Chapter 4 later connects to PDI and TCE differences.).

The two transactions are governed under qualitatively different constraint environments, and this difference is most visible in the observable location of discretion. In the Texas case, the documentary record indicates that institutional constraints are external to the transaction in the sense that ERCOT and PUCT can make consequential decisions, but those decisions are bounded by codified protocols, published procedures, and formally delimited authority. This resembles a contract-state logic in which institutional limits bind public actors and reduce the scope for discretionary renegotiation across stages of the transaction.[234]

In the Saudi case, the record indicates that institutional constraints are more internal to the transaction in the sense that the transaction must pass through multiple public principals and organizational mandates in sequence. The observable architecture implies a wider set of veto points and a greater dependence on inter-agency coordination. This does not require inferring intent; it is an institutional fact about how many organizational counterparts structure the transaction pathway and how authority is distributed across them in the documentary record. The interpretation relevant to Chapter 4 is therefore procedural: the Saudi governance chain creates more points where sequencing and coordination can produce delay and bargaining burdens, while the Texas structure pushes more of the transaction's compliance burden into standardized, rule-bound interfaces.

[234] North, *Structure and Change in Economic History*, 20–25.

In the record used here, the MoE functions as the central policy authority that sets renewable procurement direction and supervises the mandates through which renewable tenders and contracts are issued. For Skaka, MoE is coded as shaping the institutional environment surrounding the transaction by defining program objectives and by structuring the chain of authority that other entities follow.

Renewable Energy Project Development Office (REPDO) appears in the record as the program-level procurement unit for renewable tenders. In transaction terms, REPDO is coded as the entity responsible for the tender sequence that converts policy objectives into a bankable project package: bid submission, evaluation, award preparation, and pre-contract coordination. REPDO matters in this dissertation not because it is assumed to determine outcomes, but because its institutional placement inside the state apparatus makes the procurement phase sensitive to inter-agency sequencing and mandate clarity. [235]

Saudi Power Procurement Company (SPPC) appears in the record as the offtaker executing the power purchase agreement. SPPC is coded as the contractual counterparty through which the state formalizes revenue commitments to the project developer. This role is analytically important because the PPA is the central contract that transforms a policy target into

---

[235] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.

an enforceable revenue stream, and any institutional complexity surrounding PPA finalization becomes a measurable point of transaction in TCE terms. [236]

Public Investment Fund (PIF) appears in the record as a state investment platform that can shape project pipelines, sponsor entities, and financing arrangements. Transactionally, PIF is coded as relevant where it changes who represents the state's interest in the transaction, what financing architecture is available, and whether project objectives extend beyond power delivery into state investment strategy.

King Abdullah City for Atomic and Renewable Energy (KACARE)[237] appears in the documentary timeline as an earlier institutional vehicle associated with renewable ambitions and later mandate reorganization. For coding purposes, KACARE is treated as evidence of institutional layering and reallocation: the presence of successive bodies tasked with renewable policy indicates that the institutional environment surrounding Skaka includes reorganizations that can complicate continuity in authority and procedure.

Saudi Electricity Company (SEC) appears as the incumbent utility and a required system counterpart. For transaction coding, SEC is relevant where grid connection, system operations,

[236] Saudi Power Procurement Company (SPPC), *Renewable Energy Projects Status Report 2024*.
[237] Government of Saudi Arabia, *Royal Decree of 17/04/2010 on the King Abdullah City for Atomic and Renewable Energy (K.A.CARE)*.

and incumbent infrastructure requirements shape the practical feasibility and timing of project milestones.

This mapping clarifies how the dissertation uses "*contract-state constraint*" and "*rent-seeking state*" as analytic descriptors. The claim is not that specific actors seek rents in a moral sense. Rather, the claim is that a revenue-control institutional environment concentrates authority over contracts and revenue streams in ways that expand discretionary gatekeeping and increase the need for bargaining and coordination across multiple public principals. Conversely, the contract-state contrast is not treated as a claim that Texas is "*better*"; it is treated as a claim that the institutional constraints are more rule-bound and externally codified, which should be visible in lower measured transaction transactions.

The New Institutional Economics (NIE) and /Theory of the State observable hypothesis is supported by the pattern the chapter documents: the Texas case is consistent with a contract-state constraint environment (bounded discretion, standardized interfaces), while the Saudi case is consistent with a revenue-control environment (centralized gatekeeping, multi-principal sequencing). This interpretation is confined to the documentary record and does not assert causality beyond the two transactions.

4.5.2 Path dependence: measured lock-in and institutional inertia

The path dependence lens treats long-run infrastructure commitments, organizational accretion, and market concentration as generating increasing returns and institutional inertia.[238] The observable hypothesis is that a more locked-in system should exhibit higher concentration, larger sunk-cost legacies, denser and more layered institutional arrangements, and slower or more constrained reconfiguration in ways that limit the range of feasible governance reforms and institutional experimentation.

Results suggest a large divergence on the dissertation's Path Dependence Index (PDI): Saudi Arabia = 86/100 and Texas = 38/100. This difference is the summary output of the dissertation's operationalization of concentration, sunk costs, institutional density, reform frequency, and reinforcement mechanisms as measurable contextual conditions.

Saudi Arabia's electricity supply structure is coded as highly concentrated, with the record reflecting a near-monopoly utility structure and a Herfindahl–Hirschman Index (HHI) ≈ 0.98. Texas is coded as far less concentrated, with HHI ≈ 0.32, consistent with a more plural market organization. In the dissertation's interpretive logic, these concentration measures matter because they summarize how authority and market power are distributed among actors who can shape transaction pathways and rule evolution.

[238] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 251–53; Mahoney, "Path Dependence in Historical Sociology," 507–8.

Saudi Arabia's fossil infrastructure legacy is coded at approximately US$600B, throughout the decades, in sunk costs, while Texas's renewables legacy is coded at approximately US$70B. In the dissertation's PDI protocol, these values operationalize the magnitude of historically embedded investments that generate increasing returns and institutional commitment to incumbent systems. The purpose is not to claim that sunk costs deterministically create delay, but to interpret them as a durability condition that shapes what kinds of change are administratively and politically feasible within the institutional environment around a new renewable transaction.

Interpretation of the path dependence index suggests that institutional density is higher on the Saudi side and lower on the Texas side, and that reform frequency is comparatively higher in Texas and lower in Saudi Arabia, producing a cross-case ordering consistent with the PDI totals. Reinforcement mechanisms are interpreted as stronger in Saudi Arabia (given concentration and legacy infrastructure) and weaker in Texas (given plural market structure). The PDI synthesis, therefore, does not rest on a single indicator; it rests on the internally consistent pattern that these components jointly point in the same direction as the summary scores (86 vs. 38).

Table. 7 provides a compact cross-case comparison of the documentary features that correspond to Unruh's lock-in triad, organizations, rules, and vested routines, using the same evidence base reported in the Chapter 4 sequences and institutional maps.[239] In the Saudi case, the record is most consistent with layering: renewable deployment is organized through additional programmatic entities and staged procurement routines that sit alongside incumbent sector arrangements, expanding the number of decision interfaces through which a transaction must pass.[240] In Texas, the record is most consistent with conversion: renewable transactions are processed through a stable market governance architecture in which existing protocols and compliance routines are repurposed to accommodate large-scale renewable participation without adding an equivalent multi-principal approval chain.[241] Therefore, the table functions as a qualitative bridge between the PDI totals and the observed transaction pathways by showing how the two systems differ in the number and type of governance handoffs that structure project execution.

---

[239] Unruh, "Escaping Carbon Lock-In."
[240] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*; Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW."
[241] Electric Reliability Council of Texas, *ERCOT Nodal Protocols*; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).

Table 7. Comparative Evidence on Transaction Pathway Governance and Administrative Routines: Saudi Arabia and Texas

Comparison dimension	Saudi Arabia (Skaka PV IPP context)	Texas (Roserock Solar context)
Mode observed in Chapter 4 (interpretive label)	Layering (additive governance): the documented pathway adds procurement/program layers and staged tender routines alongside an incumbent sector structure, increasing the number of interfaces that must align across the transaction sequence.[242]	Conversion (repurposing within stable architecture): the documentary record emphasizes governance executed through ongoing market institutions and codified protocols (standardized interfaces), rather than building a parallel approval hierarchy.[243]
Organizations that structure the pathway	Renewable procurement and implementation roles are distributed across identifiable bodies and interfaces (program execution and principal-buyer procurement), producing multiple handoffs across the documented pathway.[244]	Governance functions are concentrated in a small set of stable market institutions (system/market operator and regulator), with independent market monitoring institutionalized through routine reporting.[245]
Rules that formally structure action	The procurement process is documented as a staged tender pipeline (e.g., scheduled releases within a defined round), indicating formal sequencing rules that add decision points and coordination requirements.[246]	Codified protocols define standardized participation and operational requirements through a published rulebook organized by protocol section, indicating governance through standing rules rather than bespoke approvals.[247]

[242] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
[243] Electric Reliability Council of Texas, *ERCOT Nodal Protocols*.
[244] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*; Saudi Press Agency (SPA), "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW," 6.
[245] Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).
[246] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
[247] Electric Reliability Council of Texas (ERCOT), "Current Protocols - Nodal."

Repeated administrative routines	A repeatable round-based tender routine is evidenced through recurring RFQ/RFP steps and centralized tender administration, consistent with routinized but multi-step sequencing. [248]	A repeatable market-governance routine is evidenced by protocol maintenance (posted updates by section) and annual monitoring/reporting cycles that evaluate outcomes and recommend rule changes.[249]
Implication for coordination burden (interpretation tied to evidence)	Added layers and staged procurement steps increase the number of interfaces and sequencing dependencies, consistent with higher coordination hazards in the transaction pathway.[250]	Standardized interfaces and codified protocols reduce the need for bespoke bargaining at each step; oversight is routinized via published monitoring rather than discretionary review, consistent with lower coordination hazards.[251]
Link to your PDI result	Interprets Saudi PDI = 86/100 as consistent with an additive, multi-interface pathway (more steps/hand-offs documented in the sequence evidence).	Interprets Texas PDI = 38/100 as consistent with repurposing stable market institutions through standardized interfaces (fewer overlapping mandates in the pathway).

[248] Renewable Energy Project Development Office (REPDO), *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*.
[249] Electric Reliability Council of Texas (ERCOT), "Current Protocols - Nodal"; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).
[250] Renewable Energy Project Development Office, *REPDO Launches Round Two of the National Renewable Energy Program*.
[251] Electric Reliability Council of Texas (ERCOT), "Current Protocols - Nodal"; Potomac Economics, *2023 State of the Market Report for the ERCOT Electricity Markets* (Potomac Economics, 2024).

The path dependence hypothesis is supported: the Saudi system is empirically coded as the higher lock-in environment and Texas as the lower lock-in environment, using the dissertation's own indicators and coding protocol. Importantly, results treat this as a measured contextual condition rather than a causal estimate.

4.5.3 Transaction Cost Economics: transaction-level manifestations of governance structure

The TCE lens treats governance structures as observable through transaction-level transactions[252]: negotiation, coordination, contracting, and delay costs that are documented in project sequences and institutional processes. The observable expectation is that where the institutional environment is more centralized and coordination burdens are higher, the transaction should exhibit higher measurable transaction-cost totals, especially through delay and contracting transactions that reflect governance complexity rather than engineering complexity alone. This subsection compares the documented timing of the two project transactions by separating ex-ante governance duration (tender to power purchase agreement) from ex post duration (power purchase agreement to commercial operation). Figure 8 summarizes these timelines for Skaka and Rose Rock to make cross-case differences in sequencing and delay exposure directly observable.

Figure 8.

[252] Williamson, "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives," 270–79.

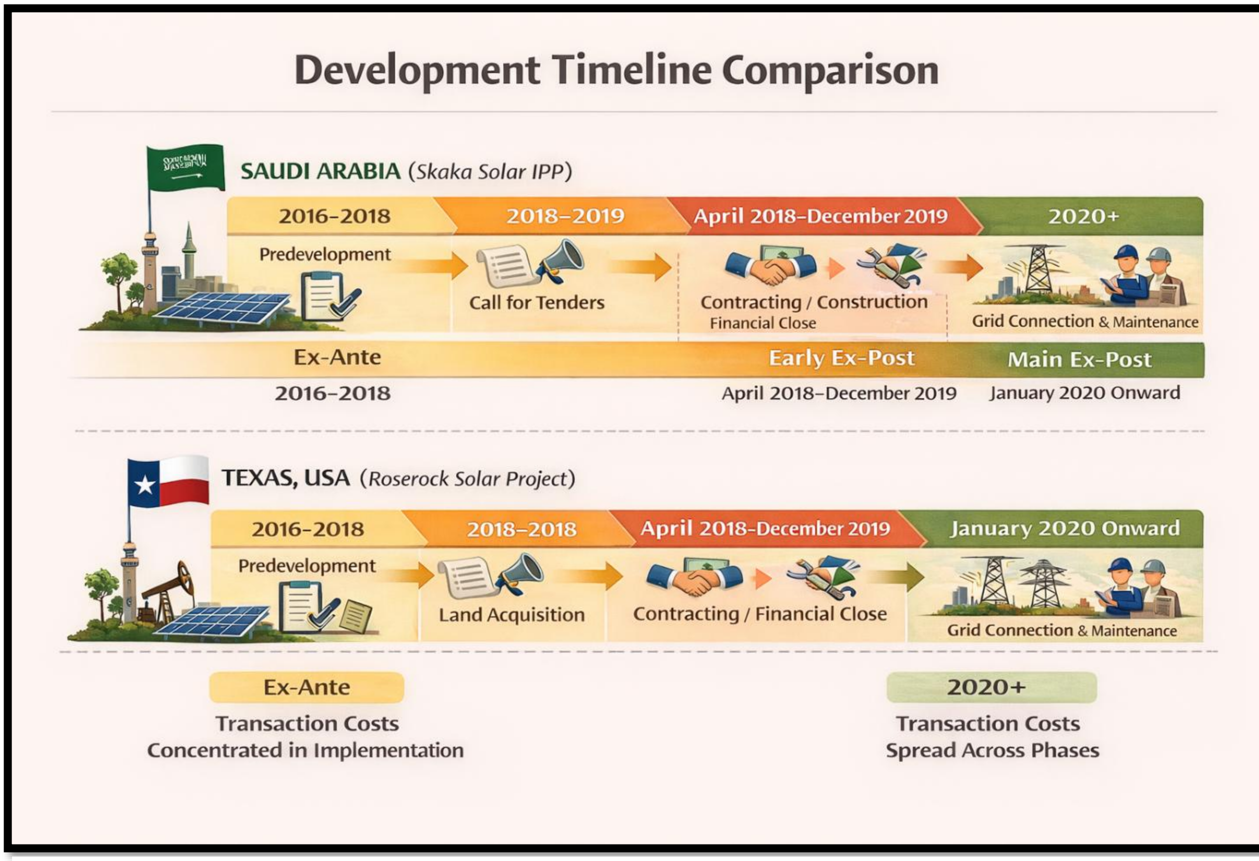


Figure 8 . Comparative Governance Delay Timelines: Ex-Ante and Ex-Post Durations for Skaka and Roserock

Results suggest that the Skaka transaction generates higher transaction-cost totals than Roserock under the dissertation's TCE protocol:

- ***Skaka total transaction costs***: US$39.89M (12.5% of CAPEX) as the primary estimate.
- ***Skaka tariff-based cross-check***: US$34.86M (10.9% of CAPEX) as an alternative monetization pathway used as a validation exercise.

- ***Roserock total transaction costs***: US$13.75M (5.0% of CAPEX) under the protocol (with the protocol logic concentrating costs in negotiation and relational contracting and adding delay premia only when threshold rules are triggered).

The chapter results in the "two totals" for Skaka as a methodological robustness feature rather than two different empirical realities. The protocol generates (1) a primary transaction-cost total and (2) a tariff-based cross-check total that uses a different monetization basis to validate whether the order of magnitude is stable. The interpretive implication is therefore not that Skaka has two transaction-cost levels, but that the dissertation shows the reader that the Skaka result is not a single-point estimate dependent on one pricing basis.

The divergence observed within cases of transaction cost economics is attributable to the fact that standardized accounting contrasts cross-case comparisons empirically discernible at the transaction level. Both transactions incur significant owner service costs, aligning with the perspective of transaction cost economics (TCE) that contracting and relational governance are inherently costly activities (Williamson, The Economic Institutions of Capitalism, 1985, pp. 52–56). Divergence is evident in two areas:

The proportional magnitude of the total transaction-cost envelope

Skaka's total transaction cost share is substantially larger than Roserock's under both the primary method and the tariff-based cross-check. Because the protocol is standardized across cases, this is not an artifact of different definitions; it is a comparative result of the same accounting structure applied to two distinct transaction records.

The difference: implementation-delay premium versus owner's-services alone.

The Skaka transaction-cost profile is dominated by the priced implementation-delay premium, whereas Roserock's profile is concentrated in owner's-services (negotiation and relational contracting) without a priced delay premium under the benchmark rule. In the accounting framework used here, this indicates that the core empirical difference is not that one transaction involves "*more contracting*" in general; it is that one transaction's governance transactions manifest as monetized execution slippage that becomes large enough to dominate the standardized transaction-cost total.

These results are reported as outputs of the protocol and are interpreted as transaction-level signatures of governance transactions within each case. The dissertation does not treat these results as universal claims about contract states or rentier governance, nor does it generalize beyond the two transactions. The hypothesis-facing interpretation of what these outputs imply for each theoretical lens is taken up in Section 4.5.3, where the results are assessed against the dissertation's stated expectations and evidence limits.

4.5.4 Consolidated results and assessment of the lens-derived expectations

This subsection consolidates the principal empirical outcomes across the three lenses and states explicitly what the Chapter 4 evidence supports with respect to the observable/hypotheses. This subsection synthesizes the case evidence by aligning the macro-level institutional context, meso-level governance processes, and micro-level project outcomes for each transaction. Figure 9 summarizes how the differing modes of institutional change, conversion in Texas and layering in Saudi Arabia, correspond to the contrasting transaction costs and delivery outcomes in the two projects.

Result 1: The documentary record supports a clear institutional contrast between a rule-bound, decentralized governance environment in Texas (PUCT/ ERCOT, standardized interfaces, competitive market organization) and a state-led, centralized procurement environment in Saudi Arabia (Skaka embedded in a chain of state entities and sequential program structures). This supports the NIE/Theory-of-the-State hypothesis that contract-state constraint environments will show more predictable procedural interfaces, while revenue-control environments will show more transaction exposure to discretionary sequencing and coordination burdens across public principals.

Result 2: The PDI outputs place Saudi Arabia at 86/100 and Texas at 38/100, alongside major structural contrasts: HHI ≈ 0.98 versus ≈ 0.32 and sunk-cost legacies ≈ US$600B versus ≈ US$70B. These are direct Chapter 4 results, interpreted as measured contextual conditions. They support the path dependence expectation that a more concentrated, legacy-heavy system will exhibit higher lock-in and thus narrower feasible governance adaptation space for renewable deployment within the bounded case context.

Result 3: The TCE outputs show Skaka's transaction costs are higher in absolute terms and as a percentage of CAPEX (US$39.89M; 12.5% primary; US$34.86M; 10.9% tariff cross-check) compared to Roserock (US$13.75M; 5.0%). This supports the TCE hypothesis that governance complexity and coordination burdens will manifest in measurable transaction transactions at the project level under a consistent protocol. Tables 4 and 6 operationalize this difference through the component breakdowns, making the transaction-cost gap interpretable as governance-cost structure rather than as technology performance difference.

In order to integrate the interpretation and the hypotheses within the dissertation's design constraints (transaction as unit of analysis; documentary evidence; no causal inference beyond the cases), the three lenses converge on a coherent descriptive pattern: the institutional architecture differs (contract-state constraint versus revenue-control), the lock-in context differs (PDI 38 versus 86), and the transaction transactions differ (TCE 5.0% versus 10.9%-12.5%). The meso-level governance bridge is what allows these to be interpreted together without overclaiming: the chapter shows that the same governance architecture that defines authority distribution and procedural constraint is also the architecture in which lock-in conditions and transaction transactions are observed and measured.[253].

[253] Peters, *Comparative Politics: Theory and Methods*, 31–34.

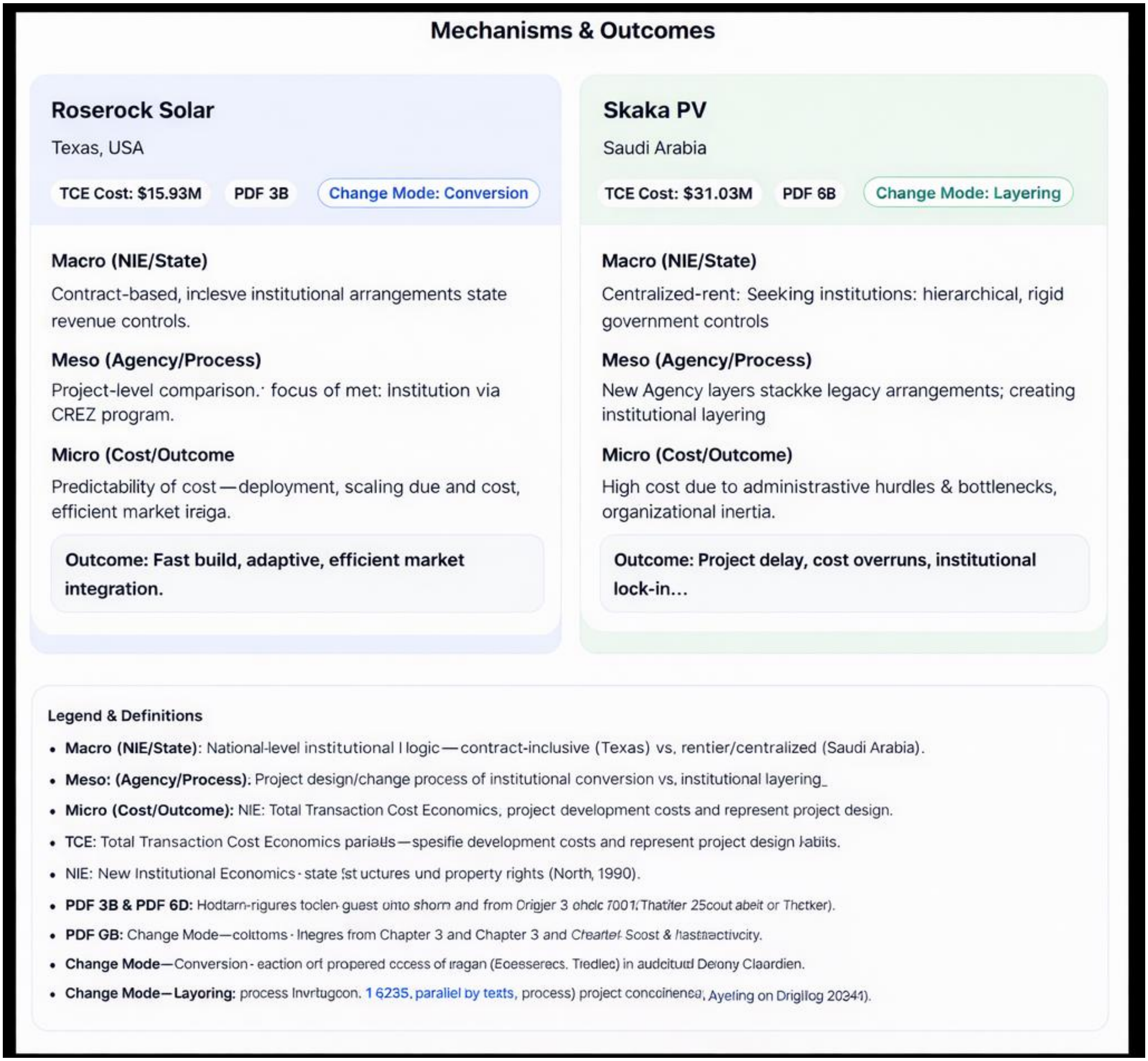


Figure 10. Comparative Institutional Mechanisms and Project Outcomes: Roserock and Skaka

5. Discussion

5.1 Contributions of the Theoretical Framework

This study's main methodological contribution is to show, within two nested utility-scale solar transactions, how institutional theories become empirically tractable when they are evaluated at the meso level and anchored in transaction-level evidence. Rather than treating the energy transition as a technology adoption problem alone, the analysis treats it as a sequence of transactions executed under different governance arrangements, where institutional environments and historical trajectories become visible through observable contracting transactions, sequencing constraints, and measured transaction-cost burdens.[254]

The first contribution made by this research is to begin describing the institutions that structure exchange by defining the formal constraints, enforcement conditions, and organizational mandates that shape what kinds of agreements are feasible and how costly they are to execute.[255] Relatedly, the Theory of the State clarifies why similar sectoral objectives can be pursued through different institutional logics: in more rule-bounded environments, public actors' discretion at the project interface is constrained by codified procedures; in more centralized environments, authority is exercised through sequenced approvals and programmatic supervision that can expand coordination demands across state entities. This distinction is used

[254] Williamson et al., *The Nature of the Firm : Origins, Evolution, and Development*, 91, 96.
[255] North, *Structure and Change in Economic History*, 22–24.

here as an interpretive frame for the two transactions, not as a claim about all projects or all periods.

A second contribution is substantive: the study links the path dependence literature's abstract claims about increasing returns to a transparent, comparative description of lock-in conditions across two fossil-fuel-dependent settings. Pierson's account emphasizes that positive-feedback processes, including learning effects, coordination effects, and adaptive expectations, can stabilize existing trajectories and raise the costs of departure over time.[256] The dissertation's measured contrasts (PDI, HHI, and sunk costs) are used to translate this temporal logic into explicit, comparable descriptors of institutional and infrastructural reinforcement, while avoiding claims that exceed the two-case design.

A third contribution is theoretical integration with level discipline: the study shows how meso-level governance is an empirically productive level for comparing institutional theories of energy transition. Peters describes meso-level theorizing as comparative analysis concerned with "*the functioning of specific institutions, processes, and perhaps groups of countries*," offering a middle range between overly general macro accounts and overly narrow micro accounts.[257] Within the dissertation's scope, macro-level characterizations establish context but do not alone discriminate project-level divergence; micro-level contract descriptions capture project

[256] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 255.
[257] Peters, *Comparative Politics: Theory and Methods*, 117.

transactions but do not alone explain why those transactions differ systematically across settings. The meso level, where mandates, sequencing, and institutional density shape how transactions move, provides the clearest empirical leverage for comparing NIE, Path Dependence, and TCE against the same evidence base.

Finally, this study positions transaction cost economics as a practical diagnostic for institutional performance in renewable deployment, without converting TCE into a universal efficiency claim. Williamson emphasizes that transaction cost economics treats the transaction as the basic unit of analysis and derives "refutable implications" through a "*discriminating match*" between transaction attributes and feasible governance structures.[258] In this dissertation, that claim is used narrowly and descriptively: transaction-cost totals and their component logic provide a standardized way to compare the governance-cost envelope of two project transactions and to interpret those differences as observable signatures of institutional congestion, sequencing burden, and implementation transaction within the two cases.

Taken together, these contributions position the dissertation as a meso-level comparative institutional analysis that is explicit about evidence limits: it advances interpretation through theory-facing synthesis of two nested transactions, clarifies which levels of analysis make institutional theories empirically meaningful in this design, and demonstrates a portable

---

[258] Williamson et al., *The Nature of the Firm : Origins, Evolution, and Development*, 91, 96.

diagnostic logic (what to observe, how to code, and how to compare) rather than a universal causal claim.

The purpose is not to generalize about Texas or Saudi Arabia as whole political economies, but to identify where the two nested utility-scale solar transactions first begin to diverge once they are treated as sequences of agreements executed under distinct institutional environments. In NIE terms, institutions are the "*rules of the game*" that structure incentives and constrain feasible exchanges; in the Theory of the State, those same rules are not merely efficiency devices but instruments that reflect how authority is organized, how commitments are enforced, and how political order is reproduced through organizations that control access to rights, permits, and approvals.[259]

The central empirical claim that can be made here, consistent with the dissertation's descriptive scope, is that divergence begins before engineering or finance differences matter, and before project contracts become visible as a signed PPA. Divergence begins at the meso level where institutional mandates, approval sequences, and enforcement conditions shape what can be agreed to, by whom, and through what procedural path. That is the first point at which "*institutional environment*" becomes an observable property of a transaction rather than an abstract background condition.[260]

---

[259] North, *Structure and Change in Economic History*, 20–26; North, *Institutions, Institutional Change and Economic Performance*, 3–5; North, "Institutions," 97–99.
[260] Williamson, "The Logic of Economic Organization," 91; North, *Structure and Change in Economic History*, 20–21.

5.2 Making Institutions Visible: Rules, Authority, and Project Transactions

Having stated these contributions, the next step is to specify the limited but defensible empirical claims that follow from the dissertation's evidence for the three theoretical frameworks starting with New Institutional Economics, Path Dependence and then Transaction Cost Economics.

Because the unit of analysis is the transaction and the comparison is organized at the meso level, the relevant test is whether the institutional features emphasized in the literature, rules, enforcement, and the organization of authority at the project interface, are observable in the Chapter 4 documentary record as repeatable procedural artifacts and sequenced approval dependencies.[261] Therefore, the claim is not a general characterization of Texas or Saudi Arabia as political economies, but a bounded inference derived from what can be documented and compared across the two transactions in Chapter 4's tables and sequence exhibits.[262]

Chapter 2's NIE and Theory of the State framework argues that cross-case divergence should be observable in the clarity and stability of formal rules relevant to exchange, the predictability of enforcement and monitoring, and the organizational form through which public authority interfaces with private contracting.[263] The Chapter 4 documentary record is consistent with this expectation in a strictly transaction-bounded sense: the Roserock interface is organized through codified procedures and recurring oversight artifacts that render decisions legible and

[261] North, *Institutions, Institutional Change and Economic Performance*; North, *Structure and Change in Economic History*.
[262] Williamson, "The Logic of Economic Organization"; Williamson et al., *The Nature of the Firm : Origins, Evolution, and Development*, 91–96.
[263] North, *Institutions, Institutional Change and Economic Performance*; North, *Structure and Change in Economic History*.

reviewable over time, aligning with a rule-bound form of public involvement, [264] whereas the Skaka interface is structured through designated procurement roles and program supervision such that transaction movement is conditioned on sequential institutional clearances and inter-organizational coordination, aligning with a sequenced, supervised form of authority at the project interface.[265] The bounded generalization this study can defend is that institutional environments become empirically comparable when they are operationalized as transaction-interface properties, decision-right allocation, procedural form, and enforcement/monitoring artifacts, and that is similar infrastructure transactions can be expected to diverge early when these properties differ systematically. The contribution is methodological and comparative: the dissertation specifies a replicable way to translate NIE and Theory of the State concepts into documentary indicators displayable in Chapter 4 tables and sequence exhibits, enabling theory-facing comparison on a shared evidence base rather than relying on macro typologies or post hoc inference.[266] The next section looks at whether the different transaction-interface patterns from Chapter 4 also show the time-related processes discussed in path dependence studies. This means checking if reinforcement and increasing returns are seen as lock-in conditions and ongoing paths. Based on this, it explains the general ideas and contributions that can be supported for the Path Dependence view in this two-transaction setup.[267]

---

[264] Public Utility Commission of Texas (PUCT), *Annual Report on Texas Electricity Market*; Public Utility Commission of Texas (PUCT), *Scope of Competition in Electric Markets in Texas: Report to the 82nd Texas Legislature*.

[265] Ministry of Energy (MoE), “Saudi Power Procurement Company (SPPC) Signs Power Purchase Agreements for Three New Solar Energy Projects with a Total Capacity of 5,500 MW”; North, *Institutions, Institutional Change and Economic Performance*, 54–60.

[266] Williamson et al., *The Nature of the Firm : Origins, Evolution, and Development*; Williamson, “The Logic of Economic Organization”; North and Weingast, “Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England,” 803–6.

[267] Pierson, “Increasing Returns, Path Dependence, and the Study of Politics,” 251–53.

5.3 Process Tracing and Self-Reinforcement: Path Dependence in Nested Energy Transactions

This dissertation applies path dependence as a theory of self-reinforcing trajectories in which prior commitments generate increasing returns that raise the costs of switching, making divergence observable through reinforcement mechanisms and sequence structure rather than through contemporaneous preferences alone.[268] Unruh's carbon lock-in formulation specifies how this logic appears in energy systems through the co-evolution of technology, organizations, rules, and entrenched routines that stabilize carbon-intensive trajectories.[269] Chapter 4 operationalizes these expectations descriptively using the PDI, reporting a higher lock-in profile for Saudi Arabia and a lower lock-in profile for Texas, and documents transaction sequences in which the Skaka pathway proceeds through a supervised, clearance-dependent coordination architecture, while the Roserock pathway is processed through routinized and rule-bound interfaces. In these sequences, the Saudi case is consistent with change occurring through additive program structures layered onto existing sector routines, whereas the Texas case is consistent with repurposing existing rule-bound institutions to process renewable transactions through established interfaces.[270] In comparative terms, the Saudi evidence is most consistent with a reinforcement environment in which high concentration and legacy commitments are paired with dense coordination requirements that reproduce existing administrative routines, whereas the Texas evidence is most consistent with a reinforcement environment in which a diversified system structure and routinized processing capacity reduce dependence on clearance-

---

[268] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 251–53, 255; Mahoney, "Path Dependence in Historical Sociology," 507–8.
[269] Unruh, "Escaping Carbon Lock-In."
[270] Ministry of Energ (MoE)y, *Principal Buyer Signs Power Purchase Agreements for Seven New Renewable Energy Projects with Total Capacity of 15,000 MW*; Public Utility Commission of Texas (PUCT), *Annual Report on Texas Electricity Market*; Public Utility Commission of Texas (PUCT), *Scope of Competition in Electric Markets in Texas: Report to the 82nd Texas Legislature*.

gated supervision for renewable transactions.[271] The bounded generalization that this study can defend is that path dependence becomes empirically assessable in infrastructure transitions when reinforcement is made comparable through explicit indicators of lock-in intensity and interpreted against the observed transaction sequence. Within this two-transaction design, higher lock-in conditions coincide with a pathway that is more dependent on supervised coordination and sequencing, whereas lower lock-in conditions coincide with a pathway that is more readily absorbed by standardized institutional routines. The contribution under the Path Dependence lens is methodological and interpretive: the dissertation converts reinforcement arguments into transparent, case-bounded empirical descriptors (PDI and documented sequences), enabling theory-facing comparison with explicit evidence limits rather than relying on macro-narrative inference. The next section shifts from path dependence's temporal account of reinforcement to Transaction Cost Economics, using the transaction as the unit of analysis to compare how the Skaka and Roserock governance arrangements translate sequencing and coordination requirements into observable negotiation, contracting, and implementation burdens.[272]

5.4 Comparing Transaction Cost Patterns in High Asset Specificity Infrastructure Projects

The structure of the analysis in this dissertation resembles Whittington's empirical analysis of nested cases of highway development transactions in Washington State.[273] Whittington's selection of cases, like those found in this dissertation, are projects that are carried out through transactions equally weighted in terms of asset specificity. The research design of this dissertation compares cases in widely varying institutional environments, yet it follows the

[271] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics"; Unruh, "Escaping Carbon Lock-In."
[272] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[273] Whittington, "When to Partner for Public Infrastructure?"

same comparative logic that Whittington uses to keep transactions comparable while making governance differences empirically visible. [274]

Consistent with Transaction Cost Economics, the unit of analysis here is the transaction, operationalized as the documented project-development and delivery sequence from procurement through contractual close and implementation, and the interpretive task is to show how governance arrangements become observable in the transaction record through negotiation, contracting/coordination, monitoring, and (where document-traceable) implementation slippage.[275] Mirroring Whittington's approach, the dissertation does not treat delivery form or institutional setting as explanatory labels; it treats them as hypotheses about where costs should appear across stages of the transaction, and it therefore reports costs in decomposed components rather than as a single undifferentiated total.[276] In this protocol, Owner's Services function as a standardized soft-cost envelope for transaction-intensive work and are partitioned into Negotiation Costs and Relational Contracting Costs so that the documentary record can be compared using the same accounting logic across cases.[277] Implementation Delay is coded only when documentary milestones establish an observable interval, and the dissertation's benchmark rule triggers a priced premium. For Skaka, the same observed interval is reported under two pricing logics (financing-based and tariff-based) as a bounded cross-check rather than as separate "*events*."[278]

---

[274] Whittington, "When to Partner for Public Infrastructure?," 269–72.
[275] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations"; Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, 52–56.
[276] Whittington, "When to Partner for Public Infrastructure?," 271, 280–82.
[277] Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[278] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*.

Read against the literature, Chapter 4's results are consistent with Whittington's central methodological claim that the empirically relevant comparison is not simply whether a project is "*fast*" or "*slow*," but how governance structures redistribute transaction burdens across stages when asset specificity and coordination hazards are present.[279] The Roserock record is characterized by routinized, rule-bound interfaces that reduce clearance-gated coordination and compress transaction-intensive work into standardized procedures. In contrast, the Skaka record is characterized by supervised sequencing and inter-organizational handoffs that expand coordination and contracting burdens within the transaction sequence. The bounded generalization this study can defend is that infrastructure transactions with high asset specificity become comparably "*diagnosable*" across institutional environments when governance is measured as decomposed, document-traceable transaction-cost components rather than inferred from delivery labels or macro institutional descriptions.[280] The contribution is methodological and comparative: the dissertation adapts Whittington's nested-case, task- and stage-sensitive transaction-cost evaluation to a cross-environment design (Saudi Arabia vs. Texas), demonstrating how the same TCE logic can be used to interpret renewable infrastructure implementation as observable governance work, negotiation, relational contracting, and sequenced coordination, within explicit evidence limits set by a two-transaction study.[281]

---

[279] Whittington, "When to Partner for Public Infrastructure?," 280–82.
[280] Williamson, *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*; Whittington, "When to Partner for Public Infrastructure?," 271, 280–82.
[281] Whittington, "When to Partner for Public Infrastructure?," 269–72; Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.

5.5 Integrating Institutional Lenses: Interpreting Divergence at the Meso Level

Allison's core methodological point is that analysts do not simply "*find*" explanations in the world; they impose conceptual models that define what counts as evidence, which causal elements are foregrounded, and which puzzles become legible.[282] Therefore, the value of applying three institutional theories comparatively to the same two nested transactions is not redundancy but discipline.

First, it reduces single-lens bias by requiring that observed documentary artifacts, mandates, sequencing rules, organizational handoffs, and measurable transaction-cost components, be interpretable under multiple models rather than treated as self-explanatory, much as Allison's Rational Actor Model assumes unitary decision-making, Organizational Process highlights routines, and Governmental Politics reveals bargaining, exposing oversights in isolated views.[283] For instance, viewing Skaka's sequenced approvals solely through TCE reveals coordination burdens, but layering PD exposes how these routines self-reinforce over time, while NIE clarifies the state logic of control that bounds feasibility, collectively uncovering nuances that a single lens might miss.

Second, it generates discriminating leverage: NIE/Theory of the State identifies the rule structure and enforcement conditions that make particular agreements feasible; Path Dependence interprets why those governance patterns persist as self-reinforcing routines; and TCE shows how the same arrangements become visible inside the transaction as negotiation, contracting, coordination, and implementation burdens, paralleling how Allison's models dissect the Missile

---

[282] Allison, *Essence of Decision: Explaining the Cuban Missile Crisis*, 4–8.
[283] Allison, *Essence of Decision: Explaining the Cuban Missile Crisis*, . 4–8, 67–100, 162–181.

Crisis to uncover multifaceted causality.[284] This approach discriminates, for example, by showing how NIE frames Saudi's veto points as distributional tools, PD temporalizes Texas's CREZ as path disruption, and TCE quantifies Roserock's lower transactions, yielding layered insights into institutional fits.

Third, the approach strengthens the generalizability of this study: not a national story about "*Texas*" or "*Saudi Arabia,*" but a portable comparative claim about how institutional environments become empirically tractable when operationalized at the meso level and traced into transaction-level observables across contrasting governance systems, echoing Allison's demonstration that multi-model analysis yields more robust, defensible interpretations.[285] By mirroring Allison's method, this choice not only validates the bounded two-case design but also equips future analyses of energy transitions with a toolkit for avoiding theoretical silos, fostering interpretations that are both rigorous and multifaceted.

5.6 Limitations

The interpretations in Chapter 5 are bounded by three scope conditions designed to preserve consistency with the dissertation's case-specific descriptive research design: First, the chapter interprets observable institutional arrangements and documents project outputs for two nested utility-scale solar transactions and does not claim causal effects or generalizable relationships beyond the Skaka and Roserock evidentiary record. Therefore, the analysis

[284] North, *Institutions, Institutional Change and Economic Performance*, 3–10; Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 251–53; Williamson, "Transaction-Cost Economics: The Governance of Contractual Relations," 233–35.
[285] Peters, *Comparative Politics: Theory and Methods*, 117–27; Allison, *Essence of Decision: Explaining the Cuban Missile Crisis*, 4–8, 245–50.

advances bounded inferences about institutional divergence as it appears within these transactions, rather than explanations of national energy transition outcomes.

Second, the discussion of Saudi governance entities (Ministry of Energy, REPDO, SPPC, PIF, KACARE, SEC) is limited to transaction-relevant roles, mandates, and handoffs visible in the documentary record. This chapter refrains from conjecture where internal workflows, informal coordination practices, or discretionary decision rules are not documented. Interpretation is restricted to the empirically observable implication that multiple public principals and overlapping mandates shape the transaction sequence and increase coordination exposure without asserting how coordination is internally resolved within each organization.

Third, the Path Dependence Index and Transaction Cost Economics outputs were treated as protocol-generated diagnostic descriptors used to standardize comparisons across the two cases. These measures support interpretation by applying consistent accounting and coding logic to both transactions; however, they are not employed as predictive tools, welfare measures, or bases for extrapolation beyond the study design. The PDI functions as an index of relative lock-in intensity rather than a causal model, and the transaction cost estimates represent accounting constructs rather than efficiency or performance benchmarks.

Finally, the chapter's interpretations are constrained by the study's reliance on publicly available documentary sources, including policy documents, regulatory reports, project records, and published timelines, without interviews or access to the government's internal administrative files. This evidentiary boundary reinforces the descriptive orientation of this chapter, and limits claims to what can be systematically observed, compared, and documented across both cases.

Taken together, these constraints ensure that Chapter 5 delivers a level-disciplined synthesis that integrates multiple institutional theories through a careful interpretation of two nested transactions while maintaining fidelity to the dissertation's comparative, meso-level, and evidence-bound objectives.

Chapter 6. Conclusion

This dissertation sets out to explain why renewable-energy transition pathways diverge in fossil-fuel-dependent settings and to assess which levels of analysis best support empirical comparison of institutional theories. Using two nested utility-scale solar projects, Roserock in Texas and Skaka in Saudi Arabia, the study applied a multi-lens institutional framework integrating New Institutional Economics, Path Dependence, and Transaction Cost Economics within a primarily qualitative, process-tracing design.

The findings show that divergence in transition pathways is not primarily explained by technology availability or stated policy ambition, but by differences in meso-level governance structures that translate institutional environments into project-level outcomes. Across the two cases, higher degrees of institutional concentration, legacy sunk costs, and historical reinforcement are associated with heavier governance burdens and higher measured transaction costs. Texas exhibits lower lock-in conditions and lower transaction-cost signatures, while Saudi Arabia exhibits stronger lock-in and higher governance costs for an otherwise comparable project transaction. Within the bounds of these cases, divergence is therefore observable as a patterned difference in how institutions shape the feasibility and cost of executing renewable-energy transactions.

The comparative analysis also clarifies the relative empirical leverage of institutional theories. New Institutional Economics is effective in characterizing the constraint environment within which transactions occur, but it is insufficient on its own to explain variation in project-level performance. Path Dependence provides the temporal logic needed to understand why those constraints persist and intensify over time. Transaction Cost Economics offers the most proximate empirical leverage by translating institutional and historical conditions into observable costs and evidence of governance at the transaction level. Together, the three lenses are complementary rather than substitutive, with the meso level serving as the critical site where their insights converge.

Methodologically, the dissertation demonstrates that meso-level, transaction-centered comparison offers a defensible middle ground between macro institutional typologies and micro contractual descriptions. By anchoring theory to process-traced project sequences and standardized indicators, the study shows how institutional analysis can remain analytically rigorous while avoiding overgeneralization from a small number of cases. The resulting framework is portable as a diagnostic approach, clarifying what to observe and compare, without claiming universal causal validity.

In sum, this study contributes a disciplined comparative account of institutional divergence in renewable-energy deployment, showing how governance structures and historical trajectories shape transaction outcomes in fossil-fuel-dependent systems. Its central finding is that the pace and cost of energy transitions are mediated less by technological constraints than by the institutional arrangements through which projects are governed.

Bibliography:

Acemoglu, Daron, and James A. Robinson. "Persistence of Power, Elites, and Institutions." *American Economic Review* 98, no. 1 (2008): 267–93. https://doi.org/10.1257/aer.98.1.267.

Acemoglu, Daron, and James A. Robinson. "The Role of Institutions in Growth and Development." In *Leadership and Growth*, edited by David W. Brady and Michael Spence. World Bank Publications for the Commission on Growth and Development, 2010. https://doi.org/10.1596/978-0-8213-8100-7.

Acemoglu, Daron, and James A. Robinson. *Why Nations Fail : The Origins of Power, Prosperity, and Poverty*. Curency, an imprint of the Crown Publishing Group, a division of Penguin Random House LLC, 2013.

ACWA Power. *ACWA Power Annual Report 2020*. ACWA Power, 2020. https://www.acwapower.com/media/341297/annual-report-2020-en.pdf.

ACWA Power. *Skaka IPP Annual Report*. ACWA Power, 2020.

ACWA Power. *Skaka IPP Completion Announcement*. ACWA Power, 2020. https://www.acwapower.com/en/projects/skaka-ipp/.
ACWA Power. "Sudair PV IPP." 2021. https://acwapower.com/en/projects/sudair-pv-ipp/.

Aghion, Philippe, Cameron Hepburn, Alexander Teytelboym, and Dimitri Zenghelis. *Path Dependence, Innovation and the Economics of Climate Change*. Edward Elgar Publishing, 2019. https://doi.org/10.4337/9781788110686.00011.

Al Bawaba. "ACWA Power's Sakaka SolarPlant in Saudi Arabia Wins Top Award." April 23, 2023. https://www.albawaba.com/business/acwa-powers-sakaka-solar-plant-saudi-arabia-wins-top-award-1473548.

Al Garni, Hassan Z., and Anjali Awasthi. "Solar PV Power Plant Site Selection Using a GIS-AHP Based Approach With Application in Saudi Arabia." *Applied Energy* 206 (November 2017): 1225–40. https://doi.org/10.1016/j.apenergy.2017.10.024.

Al Ghamdi, Abeer. *Growth Through Diversification and Energy Efficiency: Energy Productivity in Saudi Arabia*. King Abdullah Petroleum Studies and Research Center (KAPSARC), 2017. https://doi.org/10.30573/KS--2017-DP024.

Aldubyan, Mohammad, and Anwar Gasim. "Energy Price Reform in Saudi Arabia: Modeling the Economic and Environmental Impacts and Understanding the Demand Response." *Energy Policy* 148 (January 2021): 111941. https://doi.org/10.1016/j.enpol.2020.111941.

Alfehaid, Rawan M., and Karen E. Young. "Saudi Arabia's Renewable Energy Initiatives and Their Geopolitical Implications." *Energy Explained*, Center on Global Energy Policy, Columbia University, October 29, 2024. https://www.energypolicy.columbia.edu.

Alharbi, Ahlam M. "The Political Economy of Renewable Energy Deployment in Saudi Arabia." *Energy Policy Studies* 10, no. 2 (2022): 70–85.

Alley, R. B., J. Marotzke, W. D. Nordhaus, et al. "Abrupt Climate Change." *Science* 299, no. 5615 (2003): 2005–10. https://doi.org/10.1126/science.1081056.

Allison, Graham T. *Essence of Decision: Explaining the Cuban Missile Crisis*. Little, Brown, 1971.

Almulhim, Abdulaziz I., and Mohammad Al-Saidi. “Circular Economy and the Resource Nexus: Realignment and Progress Towards Sustainable Development in Saudi Arabia.” *Environmental Development* 46 (June 2023): 4–20. Crossref. https://doi.org/10.1016/j.envdev.2023.100851.

Al-Saidi, Mohammad. “Energy Transition in Saudi Arabia: Giant Leap or Necessary Adjustment for a Large Carbon Economy?” *Energy Reports* 8 (June 2022): 312–18. Crossref. https://doi.org/10.1016/j.egyr.2022.01.015.

Al-Saidi, Mohammad. “Instruments of Energy Subsidy Reforms in Arab Countries — The Case of the Gulf Cooperation Council (GCC) Countries.” *The 6th International Conference on Energy and Environment Research - Energy and Environment: Challenges towards Circular Economy* 6 (February 2020): 68–73. https://doi.org/10.1016/j.egyr.2019.08.020.

Al-Saidi, Mohammad, and Nadir Ahmed Elagib. “Towards Understanding the Integrative Approach of the Water, Energy and Food Nexus.” *Science of The Total Environment* 574 (January 2017): 1131–39. https://doi.org/10.1016/j.scitotenv.2016.09.046.

Alshamy, Yahya Abdullah. *Saudi Arabia, More Than Just Oil Rents: Reassessing the Rentier State Label*. King Faisal Center for Research & Islamic Studies (KFCRIS), 2025. https://www.kfcris.com/pdf/be3270ea3844db1218a84f35cbdfe88067e12f79871ff.pdf.

Al-Yemni, Faisal. “Saudi Arabia: National Renewable Energy Program.” 1st IEF-IRENA Seminar on Renewable and Clean Energy Technology Outlooks (in Collaboration with KAPSARC) (Riyadh, Saudi Arabia), International Energy Forum (IEF), February 20, 2020. https://www.ief.org/_resources/files/events/1st-ief-irena-seminar-on-renewable-and-clean-energy-technology-outlooks/faisal-al-yemni.pdf.

American Clean Power Association (ACPA). *Clean Power Annual Market Report 2024*. American Clean Power Association, 2025. https://cleanpower.org/market-report-2024/.

American Clean Power Association (ACPA). *Clean Power Quarterly Market Report Q2 2024*. ACP, 2024. https://cleanpower.org/news/market-report-2024-snapshot/.

Americans for a Clean Energy Grid. *Texas as a National Model for Bringing Clean Energy to the Grid*. Americans for a Clean Energy Grid, 2017. https://cleanenergygrid.org/texas-crez-case-study/.

Amran, Y.H. Ahssein, Y.H. Mugahed Amran, Rayed Alyousef, and Hisham Alabduljabbar. “Renewable and Sustainable Energy Production in Saudi Arabia According to Saudi Vision 2030: Current Status and Future Prospects.” *Journal of Cleaner Production* 247 (February 2020): 119602. https://doi.org/10.1016/j.jclepro.2019.119602.

Aoki, Masahiko. *Toward a Comparative Institutional Analysis*. MIT Press, 2001. https://direct.mit.edu/books/monograph/2377/Toward-a-Comparative-Institutional-Analysis.

Apajalahti, Eeva-Lotta, and Gregor Kungl. “Path Dependence and Path Break-Out in the Electricity Sector.” *Environmental Innovation and Societal Transitions* 43 (June 2022): 220–36. https://doi.org/10.1016/j.eist.2022.03.010.

Arthur, W. Brian. “Competing Technologies, Increasing Returns, and Lock-In by Historical Events.” *The Economic Journal* 99, no. 394 (1989): 116–31. https://doi.org/10.2307/2234208.

Arthur, W. Brian. *Increasing Returns and Path Dependence in the Economy*. University of Michigan Press, 1994. https://www.press.umich.edu/14274/increasing_returns_and_path_dependence_in_the_economy.

Arthur, W. Brian. “Positive Feedbacks in the Economy.” *Scientific American* 262, no. 2 (1990): 92–99.

Baldwin, Emily, and Kai Tang. “Locational Marginal Pricing and Market Coordination in ERCOT.” *Energy Economics* 94 (2021): 47. https://doi.org/10.1016/j.eneco.2021.105034.

Barzel, Yoram. *Economic Analysis of Property Rights*. 2nd ed. Political Economy of Institutions and Decisions. Cambridge University Press, 1997. Cambridge Core. https://doi.org/10.1017/CBO9780511609398.

Baumol, William J. “On Taxation and the Control of Externalities.” *American Economic Review* 62, no. 3 (1972): 307–22.

Belaïd, Faris, and Aisha Al-Sarihi. “Saudi Arabia’s Energy Transition in a Post-Paris Agreement Era: A Multi-Level Perspective Analysis.” *Research in International Business and Finance* 64 (2023): 102086.

Belaid, Fateh, and Aisha Al Sarihi. *Energy Transition in Saudi Arabia: Key Initiatives and Challenges*. International Association for Energy Economics (Saudi Chapter), 2022. https://www.saudi-aee.sa/wp-content/uploads/2022/01/1-Energy-Transition-in-Saudi-Arabia.pdf.

Bellini, Emiliano. “Saudi Arabia’s 300 MW Sakaka Solar Plant Comes Online.” *PV Magazine International* (Berlin), pv magazine, November 27, 2019. https://www.pv-magazine.com/2019/11/27/saudi-arabias-300-mw-sakaka-solar-plant-comes-online/.

Bianco, Emanuele, and Herib Blanco. *Green Hydrogen: A Guide to Policy Making*. International Renewable Energy Agency (IRENA), 2020.

Black, Simon, Antung A. Liu, Ian W.H. Parry, and Nate Vernon. *IMF Fossil Fuel Subsidies Data: 2023 Update*. WP/23/169. IMF Working Papers. International Monetary Fund, 2023. https://www.imf.org/-/media/files/publications/wp/2023/english/wpiea2023169-print-pdf.pdf.

Bouckaert, Geert, B. Guy Peters, and Koen Verhoest. *The Coordination of Public Sector Organizations*. Palgrave Macmillan UK, 2010. https://doi.org/10.1057/9780230275256.

Brown, Trevor L., and Matthew Potoski. “Transaction Costs and Institutional Explanations for Government Service Production Decisions.” *Journal of Public Administration Research and Theory* 13, no. 4 (2003): 441–68. https://doi.org/10.1093/jopart/mug030.

Bureau of Experts at the Council of Ministers, Kingdom of Saudi Arabia. *Basic Law of Governance. Official English Translation*. Bureau of Experts at the Council of Ministers, 1992. /mnt/data/النظام الأساسي للحكم (1).pdf.

Campbell, John L. *Institutional Change and Globalization*. Princeton University Press, 2004. https://openlibrary.org/books/OL3302613M/Institutional_change_and_globalization.

Capoccia, Giovanni, and R. Daniel Kelemen. “The Study of Critical Junctures: Theory, Narrative, and Counterfactuals in Historical Institutionalism.” *World Politics* 59, no. 3 (2007): 341–69.

Change, IPCC Climate. “The Physical Science Basis.” (No Title), 2013. https://cir.nii.ac.jp/crid/1371413280484207233.

Climate Action Tracker. “Saudi Arabia – Policies & Action.” Climate Action Tracker, November 1, 2025. https://climateactiontracker.org/countries/saudi-arabia/policies-action/.

Coase, Ronald H. “The Nature of the Firm.” *Economica* 4, no. 16 (1937): 386–405. https://doi.org/10.1111/j.1468-0335.1937.tb00002.x.

Coase, Ronald H. “The Problem of Social Cost.” *The Journal of Law and Economics* 3 (October 1960): 1–44. https://doi.org/10.1086/466560.

Cohn, Benjamin, and Olga Jankovska. *Texas Renewable Energy Policy: A Rapid Transition to Renewables*. 2020.

Cohn, Julie, and Olivera Jankovska. *Texas CREZ Lines: How Stakeholders Shape Major Energy Infrastructure Projects*. Baker Institute for Public Policy, Rice University, 2020. https://doi.org/10.25613/261m-4215.

Collier, David. "Understanding Process Tracing." *PS: Political Science and Politics* 44, no. 4 (2011): 823–30.

Commons, John R. *Legal Foundations of Capitalism*. Macmillan, 1924. https://doi.org/10.4324/9780203787373.

Crouch, Colin, and Henry Farrell. "Breaking the Path of Institutional Development? Alternatives to the New Determinism." *Rationality and Society* 16, no. 1 (2004): 5–43. https://doi.org/10.1177/1043463104039874.

David, Paul A. "Clio and the Economics of QWERTY." *The American Economic Review* 75, no. 2 (1985): 332–37.

David, Paul A. "Path Dependence, Political Institutions and the Rise of the West." *Politics & Society* 24, no. 4 (1996): 215–45.

Demsetz, Harold. "Toward a Theory of Property Rights." *The American Economic Review* (Menasha, Wis) 57, no. 2 (1967): 347–59.

Du, X., and O. D. Rubin. "Transition and Integration of the ERCOT Market with the Competitive Renewable Energy Zones Project." *The Energy Journal* 39, no. 4 (2018): 235–60. https://doi.org/10.5547/01956574.39.4.oru.

Electric Reliability Council of Texas (ERCOT). *2024 Report on Existing and Potential Electric System Constraints and Needs*. ERCOT, 2024. https://www.ercot.com/files/docs/2024/12/20/2024-report-on-existing-and-potential-electric-system-constraints-and-needs.pdf.

Electric Reliability Council of Texas. *ERCOT Nodal Protocols*. Portable Document Format (PDF). Electric Reliability Council of Texas (ERCOT), 2022. https://www.ercot.com/files/docs/2022/05/31/June%201%2C%202022%20Nodal%20Protocols.pdf.

Electric Reliability Council of Texas (ERCOT). "Current Protocols - Nodal." Electric Reliability Council of Texas, 2025. https://www.ercot.com/mktrules/nprotocols/current.

Electric Reliability Council of Texas (ERCOT). *ERCOT Monthly: July 2025*. ERCOT, 2025. https://www.ercot.com/files/docs/2025/08/06/ERCOT-Monthly-July-2025.pdf.

Electric Reliability Council of Texas (ERCOT). *Long-Term Load Forecast, April 2025*. ERCOT, 2025.

Electric Reliability Council of Texas (ERCOT). *Monthly Outlook for Resource Adequacy (MORA): December 2025*. Electric Reliability Council of Texas, 2025. https://www.ercot.com/files/docs/2025/10/03/MORA_December2025.pdf.

Electric Reliability Council of Texas (ERCOT). *Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2026-2030 May 2025 (Revised).* Electric Reliability Council of Texas, 2025. https://www.ercot.com/files/docs/2025/05/16/CapacityDemandandReservesReport_May2025_Revised.pdf.

Electric Reliability Council of Texas (ERCOT). *Report on the Capacity, Demand and Reserves in the ERCOT Region*. Electric Reliability Council of Texas, 2025. https://www.ercot.com/files/docs/2025/05/16/2025-Summer-CDR.pdf.

Electric Reliability Council of Texas (ERCOT). *Report on the Capacity, Demand and Reserves May 2024 Revised*. Electric Reliability Council of Texas, 2024. https://www.ercot.com/files/docs/2024/05/24/CapacityDemandandReservesReport_May2024_Revised.pdf.

Electric Utility Restructuring Legislative Oversight Committee. *Report to the 77th Legislature*. Texas Legislature, 2000. https://lrl.texas.gov/scanned/committeeReports/77-0-ELUROC.pdf.

Elshurafa, Amro M., Fakhri J. Hasanov, and Lester C. Hunt. *Macroeconomic, Energy and Emission Effects of Solar PV Deployment at Utility and Distributed Scales in Saudi Arabia*. King Abdullah Petroleum Studies and

Research Center (KAPSARC), 2023. https://doi.org/10.30573/KS--2023-DP10.
Evans, Peter B., Dietrich Rueschemeyer, and Theda Skocpol. *Bringing the State Back In*. Edited by Peter B. Evans,Dietrich Rueschemeyer, and Theda Skocpol. Cambridge University Press, 1985. https://doi.org/10.1017/CBO9780511628283.

Faudot, Adrien. "Saudi Arabia and the Rentier Regime Trap: A Critical Assessment of the Plan Vision 2030." *Resources Policy* 62 (August 2019): 94–101. https://doi.org/10.1016/j.resourpol.2019.03.009.

Feldman, David, Jarett Zuboy, Krysta Dummit, et al. *Fall 2024 Solar Industry Update*. 2024. https://doi.org/10.2172/2496617.

Fouquet, Roger. "Historical Energy Transitions: Speed, Prices and System Transformation." *Energy Research & Social Science* 22 (December 2016): 7–12. https://doi.org/10.1016/j.erss.2016.08.014.

Foxhall, Emily. "Sheep Graze on Texas Solar Farms as Renewable Energy Companies Embrace Agriculture." *The Texas Tribune*, October 27, 2023. https://www.texastribune.org/2023/10/27/texas-solar-farm-sheep-agrivoltaics/.

Fremeth, Adam, and Alfred Marcus. "The Role of Governance in Energy Transition: Evidence from Texas." *Energy Policy* 88 (2016): 222–32. https://doi.org/10.1016/j.enpol.2015.10.002.

Fremeth, Adam, and Alfred A. Marcus. "The Role of Governance in Energy Transitions: Lessons from the US Renewable Energy Sector." In *The Political Economy of Clean Energy Transitions*. Oxford University Press, 2016. https://doi.org/10.1093/acprof:oso/9780198802242.003.0013.

Fremeth, Adam, and Alfred A. Marcus. "The Role of Governance Systems and Rules in Wind Energy Development: Evidence From Minnesota and Texas." *Business and Politics* 18, no. 3 (2016): 337–65. https://doi.org/10.1515/bap-2015-0045.

Fu, Ran, David Feldman, and Robert Margolis. *U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018*. NREL/TP-6A20-72399. National Renewable Energy Laboratory, 2018. https://www.nrel.gov/docs/fy19osti/72399.pdf.

Galbraith, Kate. "As Governor, Perry Backed Wind, Gas and Coal - The New York Times." 2011. https://www.nytimes.com/2011/08/21/us/21ttenergy.html.

Gasim, Anwar A., and Walid Matar. "Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia." *The Energy Journal* 44, no. 1 (2023): 245–76. https://doi.org/10.5547/01956574.44.1.agas.

Gasim, Anwar, and Walid Matar. *Revisiting Energy Subsidy Calculations: A Focus on Saudi Arabia*. 12, no. 3 (2023): 6. https://doi.org/10.1002/wene.466.
Geels, Frank W. "Technological Transitions as Evolutionary Reconfiguration Processes." *Research Policy* 31, no. 8 (2002): 1257–74.

General Authority for Statistics. *Renewable Energy Statistics 2024*. General Authority for Statistics, 2024. https://www.stats.gov.sa/documents/20117/2435281/Renewable+energy+statistics+2024-+EN+%281%29.pdf/c325b937-bfcd-3667-a147-5af885fa5d74?t=1752486868718.

Global Energy Monitor. "Ghawar Oil and Gas Project (Saudi Arabia)." February 22, 2025. https://www.gem.wiki/Ghawar_Oil_and_Gas_Project_%28Saudi_Arabia%29.

GlobalData. *Sakaka Solar PV Park Profile Snapshot*. Power Technology, 2024. https://www.power-technology.com/data-insights/power-plant-profile-sakaka-solar-pv-park-saudi-arabia/.

Goodman, J. David. "Facing Brutal Heat, the Texas Electric Grid Has a New Ally: Solar Power." *The New York Times* (New York), June 23, 2023. https://www.nytimes.com/2023/06/23/us/texas-heat-solar-energy.html.

Government of Saudi Arabia. *Royal Decree of 17/04/2010 on the King Abdullah City for Atomic and Renewable Energy (K.A.CARE).* International Energy Agency (policy database), 2010. https://www.iea.org/policies/4951-royal-decree-of-17042010-on-the-king-abdullah-city-for-atomic-and-renewable-energies-karare.

Greif, Avner. "Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies." *Journal of Political Economy* 102, no. 5 (1994): 912–50. https://doi.org/10.1086/261959.

Greif, Avner. *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. Cambridge University Press, 2006. https://doi.org/10.1017/CBO9780511791303.

Hartley, Peter R., Kenneth B. Medlock, Ted Temzelides, and Xinya Zhang. "Local Employment Impact from Competing Energy Sources: Shale Gas versus Wind Generation in Texas." *Energy Economics* 49 (May 2015): 610–19. https://doi.org/10.1016/j.eneco.2015.02.023.

Hasan, Mahdi, Faisal Alaqeel, and Nashid Peerbocus. *Saudi Arabia's Unfolding Power Sector Reform: Features, Challenges and Opportunities for Market Integration*. King Abdullah Petroleum Studies and Research Center (KAPSARC), 2020. https://www.kapsarc.org/research/publications/saudi-arabias-unfolding-power-sector-reform/.

Hertog, Steffen. *Princes, Brokers, and Bureaucrats: Oil and the State in Saudi Arabia*. 1st ed. Cornell University Press, 2010. JSTOR. http://www.jstor.org/stable/10.7591/j.ctt7zbkq.

Hertog, Steffen. "The Political Economy of Distribution in the Middle East: Is There Scope for a New Social Contract?" In *Combining Economic and Political Development: The Experience of MENA*, edited by Giacomo Luciani. Brill, 2017.

Intergovernmental Panel on Climate Change (IPCC). *AR6 Synthesis Report: Summary for Policymakers*. Intergovernmental Panel on Climate Change, 2021. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf.

Intergovernmental Panel on Climate Change (IPCC). "Regional Context. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the

Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK and New York, NY, USA. (2014)." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability*, edited by C.B.Field; V.R. Barros; D.J. Dokken; K.J. Mach; M.D. Mastrandrea; T.E. Bilir; M. Chatterjee; K.L. Ebi; Y.O. Estrada; R.C. Genova; B. Girma; E.S. Kissel; A.N. Levy; S. MacCracken; P.R. Mastrandrea; L.L. White (eds.). Cambridge University Press, 2014. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap21_FINAL.pdf.

International Energy Agency (IEA). *Global Energy Review 2025*. International Energy Agency, 2025. https://www.iea.org/reports/global-energy-review-2025.

International Energy Agency (IEA). "World Energy Balances." International Energy Agency, August 2025. https://www.iea.org/data-and-statistics/data-product/world-energy-balances.

International Energy Agency (IEA). *World Energy Investment 2024*. Investment Report. IEA, 2024. https://www.iea.org/reports/world-energy-investment-2024.

International Energy Agency (IEA). *World Energy Investment 2025*. IEA Publications, 2025. https://www.iea.org/reports/world-energy-investment-2025.

International Energy Agency (IEA). *World Energy Outlook 2014*. IEA, 2014. https://www.iea.org/reports/world-energy-outlook-2014.

International Monetary Fund (IMF). *Energy Subsidy Reform in the Middle East and North Africa*. IMF, 2014. https://www.imf.org/en/Publications/Policy-Papers/Issues/2016/12/31/Energy-Subsidy-Reform-in-the-Middle-East-and-North-Africa-PP4874.

International Monetary Fund (IMF). *Saudi Arabia: Article IV Consultation Report*. International Monetary Fund, 2023.

International Renewable Energy Agency (IRENA). *Global Energy Transformation: A Roadmap to 2050*. Nos. 978-92-9260-137–5. International Renewable Energy Agency, 2019. file:///mnt/data/IRENA_Global_Energy_Transformation_2019.pdf.

The International Renewable Energy Agency (IRENA). *Renewable Energy Capacity Statistics 2023*. International Renewable Energy Agency, 2023. https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023.

Invenergy LLC. "Samson Solar Energy Center." Invenergy Case Studies, Invenergy LLC, 2024. https://invenergy.com/projects/case-studies/samson-solar-energy-center.

Kern, Florian, Karoline S. Rogge, and Michael Howlett. "Policy Mixes for Sustainability Transitions: New Approaches and Insights Through Bridging Innovation and Policy Studies." *Policy Mixes for Sustainability Transitions: New Approaches and Insights through Bridging Innovation and Policy Studies* 48, no. 10 (2019): 103832. https://doi.org/10.1016/j.respol.2019.103832.

King Abdullah Petroleum Studies and Research Center (KAPSARC). "Net-Zero Transition and Employment in Saudi Arabia's Energy Sector." KAPSARC, n.d. Accessed June 25, 2025. https://www.kapsarc.org/research/publications/net-zero-transition-and-employment-in-saudi-arabias-energy-sector/.

King Abdullah Petroleum Studies and Research Center (KAPSARC). "Renewable Energy Projects Dashboard." KAPSARC Data Portal, KAPSARC, November 27, 2025. https://apps.kapsarc.org/appboard/renewableprojects.

King Abdullah Petroleum Studies and Research Center (KAPSARC). *Saudi Arabia's Net-Zero GHG Emissions by 2060: Transformation of the Electricity Sector*. King Abdullah Petroleum Studies and Research Center (KAPSARC), 2023. https://www.kapsarc.org/media/ixcegiou/saudi-arabia-net-zero-ghg-emissions-by-2060-transformation-of-the-electricity-sector.html.

Kivimaa, Paula, and Florian Kern. "Creative Destruction or Mere Niche Support? Innovation Policy Mixes for Sustainability Transitions." *Research Policy* 45, no. 1 (2016): 205–17. https://doi.org/10.1016/j.respol.2015.09.008.

Kojima, Masami, and Doug Koplow. *Fossil Fuel Subsidies: Approaches and Valuation*. No. WPS7220. Policy Research Working Paper Series. World Bank, 2015. https://documents1.worldbank.org/curated/en/961661467990086330/pdf/WPS7220.pdf.

Krane, Jim. "Energy Governance in Saudi Arabia: An Assessment of the Kingdom's Resources, Policies, and Climate Approach." Research Paper, January 22, 2019, 36.

Krane, Jim. *Energy Kingdoms: Oil and Political Survival in the Persian Gulf*. Columbia University Press, 2019. https://cup.columbia.edu/book/energy-kingdoms/9780231179300.

Lazard. *Lazard's Levelized Cost of Energy Analysis—Version 16.0*. No. 18. 2025. https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/.

Levi, Margaret. "A Model, a Method, and a Map: Rational Choice in Comparative and Historical Analysis." In *Comparative Politics: Rationality, Culture, and Structure*, edited by Mark Irving Lichbach and Alan S. Zuckerman. Cambridge University Press, 1997.

Luciani, Giacomo. "Allocation vs. Production States: A Theoretical Framework." In *The Arab State*, 1st ed., edited by Giacomo Luciani. Routledge, 1990. https://doi.org/10.4324/9781315685229-4.

Luciani, Giacomo. "The Oil Rent, the Fiscal Crisis of the State and Democratization." In *Democracy without Democrats?* I.B. Tauris, 1994.

Mahoney, James. "Path Dependence in Historical Sociology." *Theory and Society* 29, no. 4 (2000): 507–48.

Mahoney, James, and Kathleen Thelen. *Explaining Institutional Change: Ambiguity, Agency, and Power*. Cambridge University Press, 2010.

Mahoney, J., and K. Thelen. "A Theory of Gradual Institutional Change." In *Explaining Institutional Change*. Cambridge University Press, 2010.

Masson-Delmotte, V.; Zhai, P.; Pirani, A.; Connors, S. L.; Péan, C.; Berger, S.; Caud, N.; Chen, Y.; Goldfarb, L.; Gomis, M. I.; Huang, M.; Leitzell, K.; Lonnoy, E.; Matthews, J. B. R.; Maycock, T. K.; Waterfield, T.; Yelekçi, O.; Yu, R.; Zhou, B. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Nos. 978-1-009-10206–1. Cambridge University Press, 2021. https://doi.org/10.1017/9781009157896.

Medlock, Kenneth B. "The Future of Houston as Energy Transitions." Rice University's Baker Institute for Public Policy, no. 05.13.21. (May 2021). https://www.bakerinstitute.org/research/future-houston-energy-transitions.

Ménard, Claude. "The Economics of Hybrid Organizations." *Journal of Institutional and Theoretical Economics (JITE) / Zeitschrift Fr Die Gesamte Staatswissenschaft* 160, no. 3 (2004): 345–76.

Ménard, Claude, and Mary M. Shirley. "Introduction: Handbook of New Institutional Economics." In *Handbook of New Institutional Economics*, edited by Claude Ménard and Mary M. Shirley. Springer Nature Switzerland, 2025. https://doi.org/10.1007/978-3-031-50810-3_1.

Ministry of Energy(MoE)y. *Principal Buyer Signs Power Purchase Agreements for Seven New Renewable Energy Projects with Total Capacity of 15,000 MW*. Ministry of Energy, 2024. https://www.moenergy.gov.sa/en/media-center/news/principal-buyer-signs-power-purchase-agreements-seven-new-renewable-energy-projects-total-capacity-15000-mw.

Ministry of Energy (MoE). *Electricity in Saudi Arabia in 2023*. Ministry of Energy, 2024. https://cdn.moenergy.gov.sa/portal/host/file-management/619f7d6a-4ff2-b6f5-3fb4-3a177fe2b861.pdf.

Ministry of Energy (MoE). "Saudi Power Procurement Company (SPPC) Signs Power Purchase Agreements for Three New Solar Energy Projects with a Total Capacity of 5,500 MW." 2024. http://www.moenergy.gov.sa/en/MediaCenter/News/Pages/SPPC-Signs-PPA-for-Three-New-Solar-Energy-Projects-with-5500MW-Capacity.aspx?
Mitchell, Timothy. *Carbon Democracy: Political Power in the Age of Oil*. Verso, 2011. https://www.versobooks.com/books/9781844677450-carbon-democracy.

Newman, Peter, Timothy Beatley, and Heather Boyer. "Resilient Cities: Responding to Peak Oil and Climate Change." *Australian Planner* 46, no. 1 (2009): 59–59. https://doi.org/10.1080/07293682.2009.9995295.

Nogueras Ramos, Carlos. "Why a Central Texas Farmer Is on a One-Man Mission to Stop Renewable Energy." *The Texas Tribune*, May 20, 2025. https://www.texastribune.org/2025/05/20/texas-farmer-renewable-energy-debate/.

North, Douglass C. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, 1990.

North, Douglass C. "Institutions." *Journal of Economic Perspectives* 5, no. 1 (1991): 97–112. https://doi.org/10.1257/jep.5.1.97.

North, Douglass C. *Structure and Change in Economic History*. W. W. Norton, 1981.
North, Douglass C. *Understanding the Process of Economic Change*. Princeton University Press, 2005. JSTOR. http://www.jstor.org/stable/j.ctt7zvbxt.

North, Douglass C., and Robert Paul Thomas. *The Rise of the Western World: A New Economic History*. Cambridge University Press, 1973.

North, Douglass C., and Barry R. Weingast. "Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England." *The Journal of Economic History* 49, no. 4 (1989): 803–32. Cambridge Core. https://doi.org/10.1017/S0022050700009451.

NS Energy. "Sakaka Solar Project." NS Energy, 2021. https://www.nsenergybusiness.com/projects/sakaka-solar-project/.

OECD. *Aligning Policies for a Low-Carbon Economy*. OECD, 2015. https://doi.org/10.1787/9789264233294-en.

Olien, Roger M. "The History of Oil Production in Texas: From Discovery to Challenges." Texas State Historical Association, 1995. https://www.tshaonline.org/handbook/entries/oil-and-gas-industry.

Paxton, Ken. *Opinion No. KP-0363: Whether under the Utilities Code the Public Utility Commission Has the Legal Authority to Issue Orders Affecting Pricing for the Wholesale Electricity Market and Ancillary Services (RQ-0401-KP).* Texas Office of the Attorney General, 2021. https://www.texasattorneygeneral.gov/sites/default/files/opinion-files/opinion/2021/kp-0363.pdf.

Peters, B. Guy. *Comparative Politics: Theory and Methods*. Comparative Government and Politics. Red Globe Press, 1998. https://doi.org/10.1007/978-1-349-26926-6.

Peters, B. Guy. "Managing Horizontal Government: The Politics of Co-Ordination." *Public Administration* 76, no. 2 (1998): 295–311. https://doi.org/10.1111/1467-9299.00102.

Peters, B. Guy. *Institutional Theory in Political Science, Fourth Edition: The New Institutionalism*. Edward Elgar Publishing, 2019.

Pierson, Paul. “Increasing Returns, Path Dependence, and the Study of Politics.” *American Political Science Review* 94, no. 2 (2000): 251–67. Cambridge Core. https://doi.org/10.2307/2586011.

Polanyi, Karl. *The Great Transformation: The Political and Economic Origins of Our Time*. Beacon Press, 1944. https://archive.org/details/in.ernet.dli.2015.46560.

Pörtner, Hans-Otto, Debra C. Roberts, Melinda M.B. Tignor, et al. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2022. https://doi.org/10.1017/9781009325844.

Pörtner, Hans-Otto, Robert J. Scholes, John Agard, et al. *IPBES-IPCC Co-Sponsored Workshop Report on Biodiversity and Climate Change*. Version 2. Zenodo, 2021. https://doi.org/10.5281/ZENODO.4782538.

Potomac Economics. *2022 State of the Market Report for the ERCOT Electricity Markets*. ERCOT / Potomac Economics, 2023. https://www.potomaceconomics.com/wp-content/uploads/2023/06/2022-State-of-the-Market-Report.pdf.

Potomac Economics. *2023 State of the Market Report for the ERCOT Electricity Markets*. Potomac Economics for the Public Utility Commission of Texas and ERCOT, 2024. https://www.potomaceconomics.com/wp-content/uploads/2024/06/2023-ERCOT-State-of-the-Market-Report.pdf.

Power Technology. “Sakaka Photovoltaic Solar Project.” *Power Technology*, Verdict Media Limited, April 20, 2021. https://www.power-technology.com/projects/sakaka-photovoltaic-solar-project/.

Public Utility Commission of Texas. *16 Texas Administrative Code, Chapter 25: Substantive Rules Applicable to Electric Service Providers (Revised Compilation 2023), §§25.211–25.212.* Public Utility Commission of Texas, 2023. https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/Default.aspx.

Public Utility Commission of Texas (PUCT). *Annual Report on Texas Electricity Market*. Public Utility Commission of Texas, 2024.

Public Utility Commission of Texas (PUCT). *Chapter 25: Substantive Rules Applicable to Electric Service Providers (Revised Compilation).* Public Utility Commission of Texas, 2024. https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/Default.aspx.

Public Utility Commission of Texas (PUCT). *CREZ Implementation Report*. PUCT, 2024.

Public Utility Commission of Texas (PUCT). *Report to the 78th Texas Legislature on Electric Restructuring*. Public Utility Commission of Texas, 2003. https://www.puc.texas.gov/industry/electric/reports/3168/ERCOT_2003.aspx.

Public Utility Commission of Texas (PUCT). *Report to the 78th Texas Legislature on Electric Restructuring*. Public Utility Commission of Texas, 2003. https://www.puc.texas.gov/industry/electric/reports/3168/ERCOT_2003.aspx.

Renewable Energy Project Development Office. *REPDO Launches Round Two of the National Renewable Energy Program*. Ministry of Energy, Kingdom of Saudi Arabia, 2019. https://www.energy.gov.sa/en/renewable-energy-project-development-office/Pages/default.aspx.

Renewable Energy Project Development Office (REPDO). *Embarking on Round Two of Saudi Arabia's National Renewable Energy Program*. Ministry of Energy (Saudi Arabia), 2019. https://powersaudiarabia.com.sa/web/attach/news/Press-Release-080719-REPDO-Round2RFQ-EN.pdf.

Rhoades, Stephen A. "The Herfindahl-Hirschman Index." *Federal Reserve Bulletin* 79, no. 3 (1993): 188–89.

Roselund, Christian. "Work Begins on 212 MW Solar Project in West Texas." *Pv Magazine International* (Berlin), pv magazine, November 30, 2015. https://www.pv-magazine.com/2015/11/30/work-begins-on-212-mw-solar-project-in-west-texas_100022199/.

Sabel, Charles F., and Jonathan Zeitlin. *Experimentalist Governance in the European Union: Towards a New Architecture*. Edited by 1st. Oxford University Press, 2010.

Samadi, Ali Hussein, and Masoumeh Alipourian. "The Transition to Sustainable Energy and Institutional Inertia." In *Institutional Inertia: Theory and Evidence*, edited by Nezameddin Faghih and Ali Hussein Samadi. Springer Nature Switzerland, 2024. https://doi.org/10.1007/978-3-031-51175-2_11.

Samargandi, Nahla, Md. Monirul Islam, and Kazi Sohag. "Towards Realizing Vision 2030: Input Demand for Renewable Energy Production in Saudi Arabia." *Energy, Environment and Sustainability: Future Directions* 127 (March 2024): 47–64. https://doi.org/10.1016/j.gr.2023.05.019.

"Saudi Arabia's Renewable Energy Initiatives and Their Geopolitical Implications - Center on Global Energy Policy at Columbia University SIPA | CGEP %." Center on Global Energy Policy at Columbia University SIPA | CGEP, n.d. Accessed July 14, 2025. https://www.energypolicy.columbia.edu/saudi-arabias-renewable-energy-initiatives-and-their-geopolitical-implications/.

Saudi Electricity Company (SEC). *Annual Report 2023*. Saudi Electricity Company, 2023. https://www.se.com.sa/en-us/invshareholder/Documents/Annual_Report_2023_English.pdf.

Saudi Green Initiative (SGI). "Saudi Green Initiative: Projects." Saudi Green Initiative, 2025. https://www.saudigreeninitiative.org/projects/.

Saudi Industrial Development Fund (SIDF). *Market in Focus: Solar Photovoltaics (PV).* Institutional

Market Report Not Applicable. Market in Focus: Solar Photovoltaics (PV), no. Not Applicable. Saudi Industrial Development Fund, 2022. file:///mnt/data/Solar Photovoltaics PV.pdf.

Saudi Power Procurement Company (SPPC). *Annual Report 2024*. SPPC, 2024. https://www.sppc.sa/media/3e0hdo0v/annual-report-2024.pdf.

Saudi Power Procurement Company (SPPC). *Renewable Energy Capacity Update 2024*. Saudi Power Procurement Company, 2024. https://sppc.sa.

Saudi Power Procurement Company (SPPC). *Renewable Energy Projects Status Report 2024*. Ministry of Energy, Saudi Arabia, 2024. https://www.sppc.sa.

Saudi Press Agency (SPA). "GASTAT: Capacity of Renewable Energy Projects Operated Reaches 6,551 MW by End of 2024." *Saudi Press Agency (SPA) News*, July 14, 2025. https://www.spa.gov.sa/N2360215.

Saudi Press Agency (SPA). "SPPC Releases RFQ for Round 6 Solar and Wind Projects with Total Capacity of 4500 MW." *Saudi Press Agency (English)* (Riyadh), September 26, 2024. https://www.spa.gov.sa/en/N2177992.

Saudi Vision 2030 Program. *Annual Report 2024*. Office of the Secretariat General for the Council of Economic and Development Affairs, Kingdom of Saudi Arabia, 2025. https://www.vision2030.gov.sa/media/25042025ev1/En-Annual%20Report-Vision2030-2024.pdf.

Senate Bill 20, 79th Legislature, Regular Session (Texas) (2005). https://www.legis.state.tx.us/tlodocs/791/billtext/html/SB00020F.HTM.

Shidore, Sarang, and Joshua Busby. *Assessing the Political Feasibility of Decarbonizing the U.S. Transport Sector*. UT Energy Institute, University of Texas at Austin, 2020. https://energy.utexas.edu/sites/default/files/Polit-Feasibility-Decarb-US-Transport.pdf.

Skocpol, Theda. *States and Social Revolutions: A Comparative Analysis of France, Russia, and China*. Cambridge University Press, 1979. https://doi.org/10.1017/CBO9780511815805.

Solar Energy Industries Association (SEIA). "Solar Industry Research Data – SEIA." 2025. https://seia.org/research-resources/solar-industry-research-data.

Southern Power; Recurrent Energy. *Roserock Solar Facility Factsheet*. Southern Power Company, 2020. https://www.southernpowercompany.com/portfolio/project/roserock-solar-facility/.

Sovacool, Benjamin K., Matthew Burke, Lucy Baker, Chaitanya Kumar Kotikalapudi, and Holle Wlokas. *Energy Decisions Reframed as Justice and Ethical Concerns*. 4 (2019): 581–88. https://doi.org/10.1038/s41560-019-0366-2.

Sovacool, Benjamin K., and Michael H. Dworkin. "Energy Justice: Conceptual Insights and Practical Applications." *Applied Energy* 142 (March 2015): 435–44. https://doi.org/10.1016/j.apenergy.2015.01.002.

Sovacool, Benjamin K., David J. Hess, Sulfikar Amir, et al. "Sociotechnical Agendas: Reviewing Future Directions for Energy and Climate Research." *Energy Research & Social Science* 70 (December 2020): 10160–101635. https://doi.org/10.1016/j.erss.2020.101617.

Streeck, Wolfgang, and Kathleen Thelen. *Beyond Continuity: Institutional Change in Advanced Political Economies*. Oxford University Press, 2005.

Texas Legislative Council. *Summary of Senate Bill 7: Electric Utility Restructuring*. Texas Legislative Council, 1999. https://tlc.texas.gov/docs/sessions/76/elecutilityrestructuring.pdf.

Thelen, Kathleen. "How Institutions Evolve: Insights from Comparative Historical Analysis." In *Comparative Historical Analysis in the Social Sciences*, edited by James Mahoney and Dietrich Rueschemeyer. Cambridge University Press, 2004. https://doi.org/10.1017/CBO9780511803963.008.

Thelen, Kathleen. *How Institutions Evolve: The Political Economy of Skills in Germany, Britain, the United States, and Japan*. 1st ed. Cambridge University Press, 2004. https://doi.org/10.1017/CBO9780511790997.

Tisheva, Plamena. "Saudi Arabia's 1.5-GW Sudair Solar Park Now Fully Operational." *Renewables Now*, January 5, 2024. https://renewablesnow.com/news/saudi-arabias-1-5-gw-sudair-solar-park-now-fully-operational-844969/.

Tsai, I-Tsung. "Political Economy of Energy Policy Reforms in the Gulf Cooperation Council: Implications of Paradigm Change in the Rentier Social Contract." *Energy Infrastructure and the Fate of the Nation* 41 (July 2018): 89–96. https://doi.org/10.1016/j.erss.2018.04.028.

United Nations. *Paris Agreement*. United Nations Framework Convention on Climate Change, 2015. https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

United States Congress. "U.S. Constitution: Tenth Amendment." National Archives and Records Administration, 1791. https://www.archives.gov/founding-docs/bill-of-rights-transcript.

Unruh, Gregory C. "Understanding Carbon Lock-In." *Energy Policy* 28, no. 12 (2000): 817–30. https://doi.org/10.1016/S0301-4215(00)00070-7.

Unruh, Gregory C. "Escaping Carbon Lock-In." *Energy Policy* 30, no. 4 (2002): 317–25. https://doi.org/10.1016/S0301-4215(01)00098-2.

U.S. Department of Energy and Lawrence Berkeley National Laboratory. *Land-Based Wind Market Report: 2024 Edition*. U.S. Department of Energy, 2025. https://energy.gov.

U.S. Energy Information Administration. "Solar, Battery Storage to Lead New U.S. Generating Capacity Additions in 2025." 2025. https://www.eia.gov/todayinenergy/detail.php?id=64586.

U.S. Energy Information Administration (EIA). *Electric Power Monthly — October 2025 Edition*. U.S. Energy Information Administration, 2025. https://www.eia.gov/electricity/monthly/current_month/october2025.pdf.

U.S. Energy Information Administration (EIA). "ERCOT Increasingly Meets Rising Demand With Solar, Wind, and Batteries." *Today in Energy*, U.S. Energy Information Administration, October 24, 2025. https://www.eia.gov/todayinenergy/detail.php?id=66464.

U.S. Energy Information Administration (EIA). "Solar Capacity Additions Are Changing the Shape of Daily Electricity Supply in Texas." *Today in Energy*, March 5, 2024. https://www.eia.gov/todayinenergy/detail.php?id=61783.

U.S. Energy Information Administration (EIA). "Saudi Arabia - EIA." 2024. https://www.eia.gov/international/overview/country/sau.

U.S. Energy Information Administration (EIA). *Texas Electricity Profile*. U.S. Department of Energy, 2024. https://www.eia.gov/state/?sid=TX.

U.S. Energy Information Administration (EIA). *Texas Electricity Profile 2024*. U.S. Energy Information Administration, 2025. https://www.eia.gov/electricity/state/texas/.

U.S. Energy Information Administration (EIA). "Texas: Profile Analysis." State Profile and Analysis, AccessDate 2025. https://www.eia.gov/state/analysis.php?sid=TX.

U.S. Energy Information Administration (EIA). "Texas State Energy Profile." U.S. Energy Information Administration, July 18, 2024. https://www.eia.gov/state/analysis.php?sid=TX.

U.S. Energy Information Administration (EIA). *Winter Storm Uri: Impacts on Texas Energy Infrastructure*. U.S. Energy Information Administration, 2021.

Utility Business MENA. "Saudi Arabia Signs Landmark $8.3 Billion Renewable Energy Deals for 15 GW of Solar and Wind Projects." *Utility Business MENA*, July 14, 2025. https://www.utilitybusinessmena.com/renewable-energy/saudi-arabia-signs-landmark-8-3-billion-renewable-energy-deals-for-15-gw-of-solar-and-wind-projects.

Van de Graaf, Thijs, and Aviel Verbruggen. "The Oil Endgame: Strategies of Oil Exporters in a Carbon-Constrained World." *Environmental Science & Policy* 54 (December 2015): 456–62. https://doi.org/10.1016/j.envsci.2015.08.004.

Veblen, Thorstein. "The Theory of the Leisure Class." *Journal of Political Economy* 8, no. 1 (1899): 106–17.

Victor, David G. *The Politics of Fossil-Fuel Subsidies: Untold Billions — Fossil-Fuel Subsidies, Their Impacts and the Path to Reform*. Nos. 978-1-894784-32–0. International Institute for Sustainable Development (IISD), Global Subsidies Initiative (GSI), 2009. https://www.iisd.org/sites/default/files/gsi/politics_ffs.pdf.

Vision Realization Office. *Vision 2030 of Saudi Arabia*. Riyadh, 2017. https://www.vision2030.gov.sa/media/quudi5wq/vision-2030-overview.pdf.

Vision Realization Programs. "Saudi Green Initiative." *Vision 2030 Annual Report 2023*, 2023. https://www.vision2030.gov.sa/en/explore/projects/saudi-green-initiative.

Weber, Max. *Wirtschaft und Gesellschaft: Grundriss der verstehenden Soziologie*. Mohr (Siebeck), 1922.

Whittington, Jan. "When to Partner for Public Infrastructure? Transaction Cost Evaluation of Design-Build Delivery." *Journal of the American Planning Association* 78, no. 3 (2012): 269–85.

Williamson, Oliver E. *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*. 1st ed. Free Press, 1975.

Williamson, Oliver E. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. Free Press, 1985.

Williamson, Oliver E. "Transaction-Cost Economics: The Governance of Contractual Relations." *The Journal of Law & Economics* (Chicago) 22, no. 2 (1979): 233–61. https://doi.org/10.1086/466942.

Williamson, Oliver E. "The Logic of Economic Organization." *The Journal of Law, Economics, and Organization* 4, no. 1 (1988): 65–93. https://doi.org/10.1093/oxfordjournals.jleo.a036949.

Williamson, Oliver E. "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives." *Administrative Science Quarterly* (ITHACA) 36, no. 2 (1991): 269–96. https://doi.org/10.2307/2393356.

Williamson, Oliver E. *The Mechanisms of Governance*. Oxford University Press, 1996.

Williamson, Oliver E. "The New Institutional Economics: Taking Stock, Looking Ahead." *Journal of Economic Literature* 38, no. 3 (2000): 595–613. https://doi.org/10.1257/jel.38.3.595.

Williamson, Oliver E, Sidney G Winter, R. H. (Ronald Harry) Coase, Oliver E Williamson, Sidney G Winter, and R. H. (Ronald Harry) Coase. *The Nature of the Firm : Origins, Evolution, and Development*. New York : Oxford University Press, 1991.

World Bank. *Fossil Fuel Energy Sector Reform*. World Bank, 2019.

World Bank. *Saudi Arabia Economic Monitor*. World Bank, 2023. https://www.worldbank.org/en/country/saudiarabia/publication/saudi-arabia-economic-monitor.

World Bank and Energy Sector Management Assistance Program. *Texas CREZ Transmission and Renewable Energy Zones*. World Bank, 2014. https://openknowledge.worldbank.org/handle/10986/18490.

World Energy Council. *Issues Monitor 2024 Saudi Arabia Commentary*. 2024. https://www.worldenergy.org/assets/downloads/Issues_Monitor_2024_Saudi_Arabia_commentary.pdf.

Yergin, Daniel. "The 1973 Oil Crisis: Three Crises in One—and the Lessons for Today." Center on Global Energy Policy at Columbia University SIPA | CGEP, October 16, 2023.

https://www.energypolicy.columbia.edu/publications/the-1973-oil-crisis-three-crises-in-one-and-the-lessons-for-today/.

Yergin, Daniel. *The Prize: The Epic Quest for Oil, Money, & Power*. Simon & Schuster, 1991.

Zarnikau, Jay. *Successful Renewable Energy Development in a Competitive Electricity Market: A Texas Case Study*. 39, no. 7 (2011): 3906–13. https://doi.org/10.1016/j.enpol.2011.03.064