# 1

# Introduction

> A crisis with multiple dimensions requires solutions that are similarly all-encompassing. Ultimately, what is required is not just to diversify away from a single energy commodity but to change the energy system itself, and to do so while maintaining the affordable and secure provision of energy services. . . . In short, we have to transform the energy system both to stave off even more severe climate change and to cope with the climate change that is already with us.
>
> *–Fatih Birol, Executive Director of the International Energy Agency, Remarks in the foreword to* IEA 2023 World Energy Outlook

In 2009 at the G20 Summit in Pittsburgh, President Susilo Bambang Yudhoyono of Indonesia – or SBY as he is commonly known – issued an ambitious emissions reduction target of 26% by 2020 from business as usual (BAU) and up to 41% with international support (Fogarty 2009). This substantial emissions reduction pledge stood in stark contrast to Indonesia's trajectory as a major carbon emitter: As a historical oil producer and one of the world's leading coal exporters, Indonesia was among the top 10 global carbon emitters in 2023, largely due to land conversion, deforestation, and energy use (Friedrich et al. 2023; IEA 2021a). The announcement of the 26/41 Commitment followed the 2007 United Nations (UN) Climate Conference of Parties (COP-13) in Bali, where Indonesia, as the host, was thrust into the international spotlight as an emerging economy with growing carbon emissions and increasing energy demands. The declaration by SBY was seen as motivated by a desire to boost Indonesia's reputation on the global stage as a leader instead of a laggard, while also signaling the need for international support to enable the country's transition pathway. The declaration of the 26/41 Commitment coincided with Indonesia's rising energy insecurity following its shift to becoming a net importer of oil after nearly 50 years of being a net exporter, and its official exit from the Organization of the Petroleum Exporting Countries (OPEC) in 2008.

Indonesia's voluntary international commitments on emissions reduction led to later substantive impacts domestically. Following the COP-13 and the G20 Summit in 2009, a series of changes were made to domestic institutions: First came the creation of the National Climate Change Council and the incorporation of climate change considerations into national development planning through the Ministry of National Development Planning/National Development Planning Agency [*Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional*] (BAPPENAS) followed by the creation of a separate unit for renewable energy, the Directorate of Renewable Energy and Energy Conservation [*Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi*] (EBTKE), within the Ministry of Energy and Mineral Resources [*Kementerian Energi dan Sumber Daya Mineral*] (MEMR). In 2011, Indonesia then adopted regulations to create the National Action Plan on Emission Reduction and the National Greenhouse Gas (GHG) Inventory (Purnomo et al. 2013). Indonesia's international commitments and later domestic policy and institutional changes occurred in the wake of substantial international attention and support in the form of targeted development aid to foster the country's continued decarbonization efforts and energy transition decoupled from its continued economic growth.

Global climate change norms diffused by international actors led to changes in policymaking and domestic institutions in Indonesia. To realize the targets set at the COP-13 and the G20 Summit, Indonesia committed to reducing carbon emissions through major emitting sectors, first through efforts to curb deforestation, but increasingly through energy sector transformation. Indonesia's successive electrification plans and energy development plans have aimed to address energy insecurity by focusing on domestic supply where Indonesia has a competitive advantage, primarily through natural gas and coal, but also through a growing share of renewables, including geothermal power, hydropower, and solar power. Indonesia must meet the dual challenges of decarbonizing while decreasing energy poverty, and at the same time solving the technical task of matching supply and demand across a complex of electric grids spanning the archipelago.

To tackle these energy transition goals, Indonesia's Fast Track I and Fast Track II plans (2006 and 2010, respectively) aimed to spur the development of 20 GW of capacity, followed by the "35,000 MW Plan" launched under Indonesian President Joko Widodo (commonly referred to as "Jokowi") in 2014. These plans were created in alignment with the National Energy Policy (2005–2025) and Blueprint of National Energy Management (KEN) [*Kebijakan Energi Nasional*], which set the short- and long-term development objectives in the electricity sector. Both sets of energy development plans faced many delays and challenges in implementation due to domestic political barriers, and only accomplished a share of the deployment targets, albeit more than would have been likely in the absence of these programs. Successive iterations and amendments to these plans increasingly incorporated larger shares of renewables, likely in response to international criticism for continued prioritization of coal and natural gas as a replacement to oil. Despite this criticism, coal and natural gas continued to dominate the energy plans.

By the G20 Summit in Bali in 2021 at the Partnership for Global Infrastructure and Investment (PGII), Indonesia had joined the Just Energy Transition Partnership (JETP), an international financing mechanism between coal-dependent emerging economies and leaders of the International Partners Group (IPG). In Indonesia's case, these partners included the United States, Japan, Canada, Denmark, the European Union, France, Germany, Italy, Norway, and the United Kingdom (UK) (IISD 2022; USWH 2022). Under the JETP, Indonesia committed to an ambitious 2050 net zero plan, which would expedite its emissions reduction goals and ramp up renewable energy generation to 34% by 2030 under the condition of significant support from multilateral development banks, and bilateral development aid and private financing (IISD 2022; USWH 2022). Over the 13-year period between the G20 Pittsburgh Summit in 2009 where the infamous 26/41 Commitment was made and the G20 Bali Summit in 2021, Indonesia's energy development plans had evolved with variable yet slowly increasing integration of renewables as a solution to address energy insecurity. The country has stayed the course in its ambitious international commitment to emissions reduction under the condition of substantial international support but has also been slow to implement on the ground.

Indonesia's shift toward an energy transition – in symbolic statements and headline-catching domestic policy targets – is a response to international pressure and international financial, technical, and policy support for decarbonization. However, the country's progress toward achieving these targets through deployment of installed capacity has met with delays, various domestic political barriers, and resistance from vested interests through various political administrations.

The Indonesian situation is representative of how the assemblage of multilateral, bilateral, transnational, and private non-governmental actors – the clean energy regime complex – interact with domestic politics in emerging markets and developing economies (EMDEs) to foster energy transitions. The ripple effects of international norms regarding energy transitions are visible in domestic institutional change in Indonesia. The slow progress of the energy transition is also indicative of the domestic political barriers and fossil fuel lock-in that mitigate the impact of the clean energy regime complex.

The international system, with its variable distribution of power and wealth across nation-states, has a significant impact on domestic politics, whether through ideas, trade, or conflict (Gourevitch 1978), just as a state's position in international negotiations is constrained by domestic politics (Putnam 1988). This book examines the conditions under which complex global governance can be effective in solving global governance problems and facilitating change by addressing political barriers at the domestic level. I argue that the regime complex can be effective by taking advantage of political windows of opportunity and providing appropriately matched incentives to overcome vested interests, in the process changing perspectives and norms around energy transitions as a pathway to improving energy security. This effectiveness is inevitably limited by political will and the ability of the regime complex to address domestic political barriers through political incentives (see Figure 1.2).

Achieving energy transitions will require addressing energy security, particularly in EMDEs. Energy security was classically defined by the International Energy Agency (IEA) as uninterrupted availability of supply at affordable prices.[1] However, in the wake of volatile geopolitics and energy shocks, global supply chain constraints, and the political economy implications of energy transitions, energy security definitions must expand to incorporate new dimensions (Nature Energy Editorial Board 2023; Svobodova 2023; Yergin 2022). Energy security in EMDEs involves not only security of supply and affordability to ensure continued economic growth, but also addressing growing energy demand and improving energy access and poverty alleviation in regions that lack access to electricity, while buffering energy price shocks to avoid political unrest (Urpelainen 2023; Yergin 2011). Thus, energy security definitions must include security of supply and affordability, as well as efficiency, environmental stewardship and climate change impacts, equity and access, and reliability of trade and supply chains for the raw materials needed for energy transitions (Sovacool 2011; Sovacool and Brown 2010; Yergin 2022).

If we strive to achieve global net zero ambitions to avoid a global climate catastrophe, it is critical that we understand the conditions under which global governance and international institutions can be effective in influencing the trajectory of energy transitions in EMDEs and address the underlying energy security concerns posed by a transition. As of 2023, EMDEs represent two-thirds of global emissions (IMF 2023). As their economies and populations experience the explosive growth projected over the coming decade, their carbon footprints are expected to rise in step without any interventions under BAU scenarios (McKinsey 2023). The global energy transition to net zero will require a tremendous capital investment in EMDEs to spur and enable an energy transition to curtail the forecasted emissions growth from the developing world and avoid catastrophic climate impacts from continued rising global temperatures (IMF 2023). Under the Paris Agreement, 196 parties have signed on and pledged to reduce their emissions along different pathways – termed Nationally Determined Contributions (NDCs) – to achieve net zero emissions and avoid surpassing the 2°C threshold (UNFCCC 2015).[2]

Defining how to reach net zero is not black and white in terms of the balance needed between mitigation of carbon emissions and carbon removal. As

[1] See www.iea.org/about/emergency-response-and-energy-security.
[2] See www.un.org/en/climatechange/paris-agreement.

Fankhauser et al. (2022) underscore, “net zero” can be defined along several lines, such as different approaches to emissions reductions, cautious use of carbon dioxide removal, and effective regulation of carbon offsets, as well as equitable transition to net zero. On the latter point, the Paris Agreement and previous global environmental agreements such as at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (1992) and the Kyoto Protocol (1998) were carefully designed to ensure that there are “common but differentiated responsibilities” (CBDR) separated according to the socioeconomic situation of the industrialized (Annex-I countries) and developing economies (non-Annex-I countries) (Hey and Paulini 2021). The CBDRs apply not only in terms of the variable speed of climate mitigation across countries, but also in terms of the responsibility among Annex-I countries to support the energy transition in non-Annex-I countries through financial aid, technical support, and capacity building.

The IEA estimates that annual investment in clean energy in EMDEs needs to more than triple from 2022 rates of USD 770 billion to USD 2.2–2.8 trillion by the early 2030s and remain at these rates through 2050 to meet net zero energy needs that align with the Paris Agreement (IEA 2023b). However, the majority of all clean energy investments to date have been concentrated in larger EMDEs like China, India, and Brazil. China represents two-thirds, and China, India, and Brazil combined represent three-quarters of all clean energy investments. Thus, if China is excluded, then the increase in clean energy investments needs to meet net zero targets by 2050 are even steeper – amounting to as much as a sevenfold increase in investment to USD 1.4–1.9 trillion from the current rate of USD 260 billion (IEA 2023b). To meet targets set under the Paris Agreement, climate investment needs are split according to these categories: low emissions generation (35%), end-use sectors such as efficient cooling and electric mobility (35%), and electricity grid and storage (31%), with the remaining investment needed in clean fuels (8%). See Figure 1.1.

Achieving universal access to clean electricity and clean cooking fuels by 2030 is estimated to cost USD 45 billion/year, less than 2% of overall spending on clean energy (IEA 2023b). The technological solutions to improve access to electricity include grid extensions, mini-grids, and stand-alone generation, while clean cookstoves utilizing electricity and modern bioenergy, biogas, and liquefied petroleum gas improve access to clean cooking (IEA 2023b). The transition to net zero will look different in every country as embedded within that country’s domestic political economy and natural resource abundance, reflecting a unique set of priorities for energy security, the domestic workforce, and poverty alleviation (Fankhauser et al. 2022).

The global energy transition and systematic transformation of various sectors requires enormous resources, grid modernization, the overhaul of regulatory frameworks and electricity markets, and the amelioration of intersecting political,

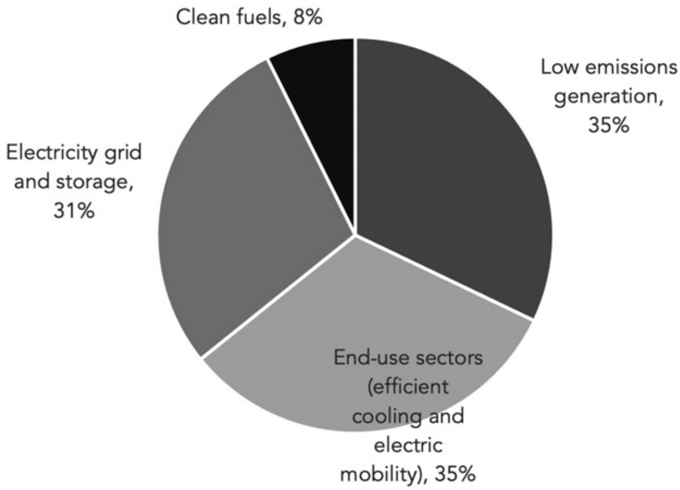


Figure 1.1 UNFCCC Paris Agreement climate investment needs to achieve net zero.
Source: IEA 2023b

regulatory, sociocultural, technological, and financial barriers to technology and policy implementation in the domestic political economy (Hochstetler 2020). The term *clean energy* refers to the technologies, services, and processes that produce low to zero carbon emissions, reduce energy consumption, and enable a transition to a zero carbon-based economy.[3] Emerging markets and developing economies face added barriers to clean energy development. The slow pace of clean technology adoption in EMDEs is largely attributed to market and institutional failures such as lack of information, high transaction costs, weak financing institutions, poor technological adaptability to the developing country's absorptive capacity, or fledgling technological sectors (Acemoglu et al. 2012; Dechezleprêtre et al. 2012; Stoneman and Diederen 1994). Trade barriers, property rights issues related to patent protection, credit access constraints, and lack of knowledge spillover are other barriers particular to developing countries (Dechezleprêtre et al. 2012; Keller 2004; Worrell et al. 2001). Research by Gallagher (2014) and Lewis (2015) finds that these barriers have not limited technology diffusion in EMDEs like China that have found ways to navigate these barriers and technological lock-in to leapfrog; nevertheless, strong technology absorptive capacity is necessary, as supported by market formation, financing, technical capacity building, and technology-sharing agreements.

[3] For the purpose of this book, clean energy refers to renewable energy technologies and will not include nuclear energy due to the different policies, regulatory frameworks, and international organizations governing nuclear energy.

Barriers to energy transitions are not unique to EMDEs, however. Industrialized economies also face vested interests and political and institutional barriers to energy transitions (Conway and Oreskes 2011; Culhane et al. 2021; Mann 2021; Mildenberger 2020; Stokes 2020). Legacies of investment in fossil fuel industries and the vested interests against the transition to clean technologies represent major barriers to overcome in countries around the world. Carbon lock-in, which occurs when energy systems dependent on fossil fuels perpetuate their use and prevent transitions, jeopardizes our ability to meet NDCs to reduce emissions and avoid surpassing 2°C global warming as agreed upon in the UN Paris Agreement (Sato et al. 2021; Unruh 2000, 2002). The existing global energy infrastructure installed as of 2018 was forecasted to expend the carbon budget limits needed to stay within a 1.5°C warming scenario, while new installations of fossil fuel infrastructure would push the world well beyond the 1.5°C scenario (Tong et al. 2019). In order to prevent catastrophic climate change effects, early retirements and halted investment in new fossil fuel infrastructure are urgently needed. The need to shift to low- and zero-carbon energy resources faces the hurdle of constrained political will, particularly in EMDEs confronting other pressing challenges that take precedence, such as poverty, food shortages, and political or economic instability. This is evident in the enormous gap between climate change mitigation needs and progress toward meeting NDCs under the Paris Agreement. In spite of the goals set for global carbon emissions reduction post Paris, the findings from the 2021 United Nations Framework Convention on Climate Change (UNFCCC) report that GHG emissions are actually projected to increase 16% by 2030, triggering a 2.7°C warming scenario by the end of the century, with potentially disastrous results (UNFCCC 2021).

## Geothermal Technology and the Energy Transition

Much of the energy transition literature has focused on solar and wind power as the principal climate-mitigating technologies, and undoubtedly the remarkable cost improvements ensure that these technologies will remain critical drivers of the transition. However, less attention has been paid to geothermal technologies despite the significant role the technology can play in enabling us to meet global net zero targets. This book focuses on large-scale geothermal technology for electricity production to help fill the gap in the energy transition literature. Unlike intermittent renewables, geothermal energy provides renewable baseload power as well as flexible operation in support of electricity grid stability (IRENA and IGA 2023). Geothermal energy thus presents the opportunity to replace dirty baseload power supply – such as coal plants – with 24/7, carbon-free, firm, and dispatchable power that operates year-round at high-capacity factors (IRENA 2022).

Although geothermal technology is a unique renewable energy technology that faces a specific set of barriers and constraints, I argue that all renewable energy technologies – whether wind power, solar power, or hydropower – face a set of similar barriers across the world, such as siting, permitting, and contestation over land use, supply chain constraints, interconnection and transmission costs and timeline delays, as well as the financing scheme needed to compensate production and spur investment; in fact there are many commonalities across technologies. The land needs for renewable energy projects are projected to be enormous to meet the global net zero goals: by some estimates, more than 10 times per unit of power produced compared to fossil fuels (Gross 2020). Geothermal development uses significantly less land than other renewables and fossil fuels according to the US Department of Energy (DOE). On a per-GWh basis, geothermal uses 404 m2 compared to coal at 3,642 m2/GWh, wind at 1,335 m2/GWh, and solar photovoltaic (PV) power stations at 3,237 m2/GWh (GTO n.d.). While land needs for renewables can vary according to technology type, there is relative flexibility in siting geothermal projects where drilling can be adjusted within a general working area to potentially reduce the land use impacts.

The first large-scale geothermal power plant in California – The Geysers – went into operation in 1960 and has since expanded to become one of the largest geothermal complexes in the world (USGS 2023). The majority of geothermal power plants in operation today use dry steam, flash steam, or more recently, binary-cycle turbines (IRENA 2022; Kagel et al. 2007). These technologies either utilize the steam and heat directly from the natural underground geothermal reservoirs to turn turbines and produce electricity (dry steam) or inject fluid into the geothermal reservoir wells that vaporizes and creates steam that drives a turbine and generator (flash steam). Binary-cycle power plants can utilize lower-temperature geothermal resources, expanding deployment opportunities, and are closed-loop systems, which virtually eliminates emissions (Kagel et al. 2007). Geothermal energy production provides low-cost electricity (between USD 0.049/kwh and USD 0.085/kwh on average over the past decade) and can be incentivized to provide further ancillary services to the electricity system (IRENA 2022). This book focuses on this mature technology, but it is important to note that the latest technological advancements will open wider opportunities to deploy geothermal in new locations, as well as exploit other lower-quality geothermal resources.

Geothermal technology is experiencing a renaissance with new technological advancements applying advanced drilling technologies from the oil and gas industries and fusion research to geothermal drilling. While traditional geothermal drilling technologies were limited geographically to areas with high-quality steam (high heat, low acidity), which are concentrated in areas around the world with volcanic activity along tectonic plate boundaries, new geothermal technology advancements could unlock geothermal potential around the world. Enhanced geothermal drilling is one such technological advancement, which applies hydraulic fracturing techniques at greater depths (3 > 10 km) and higher heat (> 200°C/400° F) than other traditional geothermal drilling techniques (Augustine et al. 2023; CATF 2022; Kim 2024a). Other geothermal technological advancements incorporate both oil and gas drilling practices combined with fusion technology, including millimeter wave drilling at even greater depths (up to 20 km) and higher heat (500°C/930°F), which are in various stages of research & development (R&D)/testing (Newcomb 2022). The technological advancements of drilling technologies are opening new opportunities to scale geothermal in the US and globally.

Geothermal technology is an underutilized renewable energy resource that has tremendous potential around the world, particularly in EMDEs, from Africa's Rift Valley to the Andes to Southeast Asia (ESMAP 2015). The countries with the most installed geothermal generating capacity to date include the United States, Indonesia, the Philippines, Turkey, New Zealand, Mexico, Kenya, Italy, Iceland, and Japan (ThinkGeoEnergy 2023). The World Bank estimates that only 15% of geothermal reserves around the world are exploited for electricity production, which translated to 13 GW out of a potential of up to 80 GW as of 2017 (World Bank 2017a). The financial barriers associated with geothermal development continue to be a persistent limitation to scaling the technology around the world: geothermal energy has considerable financial risks, including high up-front costs for early-stage exploration and associated high risk of failure associated with the exploration stage (World Bank 2017a). Furthermore, technological limitations in accessing and harnessing the high heat and depth remain a challenge, which may be addressed through the various R&D and technological advancements making headway.

Owing to the potential for geothermal development in EMDEs, development aid and international institutions play a critical role in de-risking private investments, addressing various financial, regulatory, and technical barriers to deployment through financial support, capacity building, and technical assistance, and determining norms and best practices in developing markets. This book focuses on how the clean energy regime complex has played a role in addressing the various barriers to geothermal development in EMDEs. Geothermal technology is an excellent case to study regime complex impacts owing to the need for international support to address domestic political barriers to deployment of this mature technology.

## The Global Governance of Energy Transitions

Much of the environmental governance literature argues that a legally binding international regime is a highly effective form of governance for solving a global environmental problem (Mitchell 2003; Young 1989). A regime can be defined as a social institution consisting of sets of agreed-upon principles norms, rules, and decision-making procedures that govern the interactions of actors in specific issue areas or specifiable activities (Krasner 1983; Levy et al. 1995; Young 1989). International regimes help states to overcome cooperation problems by creating norms that constrain state behavior and provide monitoring and enforcement mechanisms. Regimes reduce transaction costs by increasing information, standardizing patterns of behavior, and increasing the opportunities for state interactions (Keohane 1982, 1984; Krasner 1983; Martin 1982; Ruggie 1993).

However, in a world where international politics increasingly face “gridlock” in solving “wicked problems” such as climate change and global warming (see Hale and Held 2017; Rittel and Webber 1973; Victor 2011), we are less likely to see formal international regimes with universal adoption of legally binding treaties. This is particularly the case for contentious issues like placing limits on economic growth or changing conceptualizations around energy security. Thus, global governance is increasingly complex, with fragmented, loosely coupled institutions focused on overlapping issue areas, driven by divergent state interests, forum shopping, organizational expansion, and institutional interplay (Chelminski et al. 2022). This governance sphere can be conceptualized as a regime complex, which is an arrangement of partially overlapping, semi-hierarchical institutions, rules, and norms governing a particular issue area (Alter and Meunier 2009; Alter and Raustiala 2018; Raustiala and Victor 2004). The regime complex is a useful conceptualization of the purposeful order surrounding clean energy, since the governance is decentralized and multifaceted, and lacks a guiding international legal agreement on clean energy (Alter and Raustiala 2018; Cherp et al. 2011; Dubash and Florini 2011; Florini and Dubash 2013; Orsini et al. 2013; Van de Graaf and Sovacool 2020).

The increasing proliferation of initiatives and expansion of existing international organizations into the clean energy issue domain suggests a shift in global governance for clean energy (Colgan, Keohane, and Van de Graaf 2012). Recently created international organizations such as the International Renewable Energy Agency (IRENA) and the Sustainable Energy for All (SE4All) initiative were created, while long-standing international organizations like the IEA and the United Nations Development Programme (UNDP) expanded their programming and projects on sustainable energy development. Over time, international climate agreements increasingly incorporated mechanisms to facilitate financing for climate mitigation and adaptation and technology transfer between industrialized and developing economies. Owing to the organizational proliferation and the numerous barriers to expansion of renewables in developing countries, the governance of clean energy is also complex and decentralized, characterized by overlapping regimes, duplications, and synergies.[4] Thus, I conceptualize global governance of energy transitions as the clean energy regime complex, which emerges from overlap and interplay between clean and conventional energy regimes (Chelminski et al. 2022). I trace the history of the clean energy regime complex in Chapter 3.

### *Conceptualizing Effectiveness*

Much of the international relations and environmental governance literature on effectiveness is devoted to evaluating the effectiveness of integrated regimes. In this literature, effectiveness can be measured in distinct ways, such as (1) *problem-solving*, or the extent to which a regime or treaty addresses the governance problem it was designed to solve; (2) *behavioral*, asking if the regime directly causes behavior to change; (3) *process*; (4) *capacity*, the extent to which states comply with the rules or enforce them within domestic legal contexts; and (5) *transformation*, how a regime can empower experts to change state interests or practices (Haas 1989; Victor et al. 1998; Young 1992, 1996; Young and Levy 1999). The growing literature on institutional complexity, fragmented governance, and polycentrism elaborates the positive and negative effects that are expected to result from complex or fragmented governance compared to an integrated, formal regime (Biermann and Kim 2020; Gomez-Mera et al. 2020). Some of the expected negative effects to result from fragmented, complex governance include inequalities in access that further strengthen power asymmetries, institutional proliferation encouraging forum shopping, weak compliance or enforcement mechanisms, and increased redundancies and overlaps across institutions leading to conflict and turf wars (Aggarwal 1998; Alter and Meunier 2009; Alter and Raustiala 2018; Biermann et al. 2009; Davis 2009; Drezner 2009; Hale et al. 2013; Held and Young 2013; Orsini et al. 2013; Pauwelyn et al. 2012a; Raustiala and Victor 2004).

As this literature has evolved, scholars have increasingly found positive or synergistic effects of complex, fragmented, and transnational governance, such as increased information sharing across networks and collective pooling of information, increased flexibility, creation and diffusion of norms, governance entrepreneurship, expanded cooperation through alternative frameworks, spillover and

[4] I use clean energy to refer not only to the renewable energy technologies, services, and processes that reduce energy consumption and enable a transition to a zero carbon-based economy.

cross-linkages across jurisdictions and organizations, and improved capacity building (Andonova 2017; Andonova et al. 2009; Andonova and Mitchell 2010; Keohane and Victor 2011; Lesage and Van de Graaf 2013; Slaughter 2004; Van de Graaf and Colgan 2016). The existing scholarship, however, largely remains focused on the *transformational* approach to examining effects of complex governance at the international institutional level to evaluate how state interests may change on international issues. Research by Alter and Meunier (2009), Colgan, Green, and Hale (2012), Henning and Pratt (2023), and Johnson and Urpelainen (2012) examines conditions under which regime complexes have effects, although these studies of outcomes remain focused on changes across the international institutional landscape.

I find three major gaps in the existing regime complex literature that limit how we understand and measure regime complex effectiveness. Much of the existing complex governance literature focuses on effectiveness at the international level. However, tackling the effectiveness of complex governance in catalyzing energy transitions, state interests, and behaviors at the international level alone is insufficient without the perspective of behavior change at the domestic level, specifically enabling and implementing changes to shift to net zero at the domestic level. Without this added focus on the domestic politics, it will be impossible to understand governance effectiveness in moving toward net zero. This book adopts a *problem-solving* or *process* approach to measuring effectiveness of complex governance in solving the governance problem around which institutions are designed, with a focus on domestic-level impacts. The comparative environmental politics literature has contributed substantially to advancing our understanding of the interactive effects of international and domestic environmental politics (Hochstetler 2020; Sowers et al. 2023; Steinberg and VanDeveer 2012).

The second major gap in the regime complex literature is the limited theoretical treatment of the conditions under which regime complexes can be effective or ineffective in implementing change at the domestic level. Limited studies operationalize mechanisms of regime complex effectiveness to enable replicable studies across different cases.

Lastly, there are limited empirical analyses of effectiveness beyond examinations of effectiveness at the international institutional level, and most of the studies use ex post facto description of empirics. This book helps fill a gap in existing scholarship by providing a rigorous empirical examination through comparative case studies of the conditions under which a regime complex can be effective in changing domestic politics to catalyze a just transition.

I conceptualize the effectiveness of complex governance through the utility modifier mechanism, the capacity-building mechanism, and the social learning mechanism (see Table 2.1). The *utility modifier mechanism* changes actors' cost-benefit analysis as new rules or opportunities are introduced. The mechanism reduces the financial barriers to renewable energy development and improves access to financing, which complements other forms of financial support. The *social learning mechanism* facilitates a change in behavior through the introduction of new information and discourses via international forums, workshops, and policy advice offered by numerous multilateral and bilateral actors. The regime complex diffuses renewable energy norms to policymakers at the national and subnational levels to support policy reform, resulting in cognitive shifts that help address regulatory barriers to renewable energy development. The *capacity-building mechanism* is the provision of resources directed to building technical capacity through training and education. The regime complex's training and capacity building supports the development of human and institutional capacity, reducing technical and institutional barriers to renewable energy development.

I examine how these mechanisms interplay with domestic politics to result in variable outcomes. I expect that regime complex effectiveness will be mediated by the convergence or divergence of domestic political interests concerning the ideas and norms channeled by the regime complex. I argue that the regime complex will be effective when it can provide political incentives that are appropriately matched to domestic political interests and shifting perspectives on renewable energy technologies as a solution to energy security concerns. Political incentives change the cost-benefit analysis around certain policy decisions – such as regulatory reform – that can unlock barriers or overcome vested interests. However, policy entrepreneurs must be able to seize opportunities to leverage political incentives or promote alternative approaches to solving problems (Derthick and Quirk 1985; Karapin 2016; Kingdon 1984; Moe 2015). As an example of appropriately designed political incentives, when designing new renewable energy policy that would shift the authority for permitting away from local governments to the central government, incorporating project-appropriate tax benefits to local governments may abate concerns and thus quell vested interests.

As depicted in Figure 1.2, the potential opportunity for change widens as political will increases, which can be catalyzed by exogenous shocks that affect energy security coupled with appropriately matched political incentives. Policy windows or issue attention cycles are opportunities for action on a given initiative when three elements converge: high issue salience among the public and political elites, viable policy solutions, and high political will (Downs 1972; Karapin 2016; Kingdon 1984). "Windows of opportunity" open when an issue has "gotten hot" and can be triggered by a change in political administration, renewal, or an economic crisis such as the collapse of a major sector of the economy (Karapin 2016: 62; Kingdon 1984). For example, the Philippines power-sector crises in the

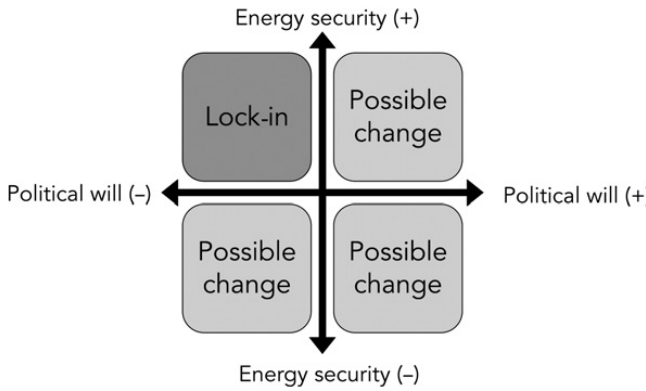


Figure 1.2 Regime complex opportunity matrix.

1980s and 1990s led to urgency to resolve energy insecurity, which opened a political opportunity for increasing renewable energy in the domestic supply. However, exogenous shocks can also hinder policy initiatives if there is an absence of political will when changes are perceived to negatively impact energy security and threaten political stability. This dynamic can be characterized as lock-in, when pathways to change are limited or unlikely.

As the regime complex literature is largely focused on institutional and state dynamics at the international level, theoretical and empirical analysis of regime complex effectiveness and impacts at the domestic level is limited. Understanding the dynamics between global governance and the domestic political economies in EMDEs is integral to understanding the present and future of climate politics and how to unlock barriers to global energy transitions (Hochstetler 2020; Urpelainen 2022). Indonesia and the Philippines are model cases to investigate the intricate dynamics of agents, institutions, and interests at subnational, national, and international levels, owing to the complexity of barriers that they face in transitioning to clean energy while maintaining economic growth.

## Indonesia and the Philippines as Comparative Case Studies

Among the top geothermal producers in the world, Indonesia and the Philippines represent a puzzling trajectory as the second- and third-largest producers after the United States. Both countries are located along the Ring of Fire, an area in the Asian Pacific characterized by high seismic and volcanic activity. Historically, Indonesia has lagged behind the Philippines in terms of installed capacity built, despite having by far more potential capacity in geothermal energy to exploit (23.6 GW worth by latest estimates, compared to 4 GW in the Philippines) (Alhusni et al. 2023; Fronda et al. 2021; MEMR 2023), yet both countries have received substantial levels of development aid earmarked for geothermal development since the 1970s. The Philippines was the world's second-largest producer until 2018, when it was surpassed by Indonesia. These cases present an interesting variation that enables the exploration of the relative effectiveness of the clean energy regime complex in fostering energy transitions in both countries.

Geothermal energy technology is fitting for analysis across these two cases owing to their relative abundance in geothermal resources, as well as the challenges and barriers facing geothermal development in comparison to other renewable energy technologies. These barriers include comparatively high risks and costs of early-stage exploration and development without appropriately matched finance mechanisms, regulatory barriers related to land access when geothermal reserves are located in protected areas or on ancestral lands, and technical capacity barriers requiring a skilled technical workforce.

As the world's second-largest producer of geothermal energy, Indonesia holds 40% of the world's reserves in geothermal energy, and the Philippines follows as the third-largest producer of geothermal energy. However, despite Indonesia's more developed economy and higher amount of potential geothermal generation capacity, it has historically fallen behind the Philippines in terms of the total installed capacity and continues to fall behind on the share of geothermal potential harnessed. Indonesia has developed 11% of its potential capacity (2.6 GW out of a potential of 23.6 GW), whereas the Philippines has developed more than 49% of its potential capacity (1.95 GW out of a potential of 4 GW) (DOE 2021, 2023b; MEMR 2023). This presents a puzzle: why are there disparities in the advancement of geothermal development? Why is the Philippines ahead of Indonesia in terms of total share of geothermal installed capacity compared to reserves, even though Indonesia is more economically advanced and both countries are recipients of substantial clean energy finance? Indonesia is selected as the primary case study, with the Philippines as a secondary case study for comparison.

This study analyzes the variation in regime complex impact – through the utility modifier, social learning, and capacity-building mechanisms – on domestic political barriers as measured through the outcome of growth in installed geothermal capacity over time. Variation in the clean energy regime complex's impact across cases could indicate disparities in the type of multilateral and bilateral development support allocated, such as financial assistance, policy advising, trainings, workshops and international forums on domestic policy interests, technical assistance, and technical capacity building. Variation could also be indicative of how effectively the regime complex addresses vested interests and domestic political barriers across cases.

Indonesia was selected from the World Bank's list of middle-income countries as an understudied case compared to other major EMDEs like China and India. As mentioned, Indonesia is among the top 10 largest carbon emitters in the world. While deforestation, land conversion, and energy and transportation emissions represent the country's largest sources of carbon emissions, Indonesia has also become one of the world's largest coal exporters. It is also notorious for its history of high fossil fuel subsidies, encouraging energy consumption due to cheap fuel prices (Chelminski 2018). With rapidly increasing urban population and a growing middle class, the country's primary energy consumption grew at a rate of 44% between 2002 and 2012 and then at a rate of 16% between 2010 and 2020 (EIA 2014, 2021).

On the opportunity matrix (Figure 1.2), Indonesia has high energy security and low political will to embrace the energy transition. Indonesia is a leader among EMDEs in its engagement in the clean energy regime complex and adoption of ambitious policy for both the acceleration of renewable energy and emissions reduction (Cahyafitri 2014; Purnomo et al. 2013; PwC 2013). Yet, despite its aspirational targets, the slow pace of policy implementation and deployment paints a different picture, one that sheds light on persistent barriers to technology deployment and an ongoing dependency on fossil fuels (Damuri and Atje 2012). For example, while Indonesia targeted renewables to constitute 23% of the country's energy mix by 2025 as outlined in the 2014 KEN, as of 2023, only 13% of the energy mix was generated by renewables as depicted in Figure 1.3 (MEMR 2023). Through the primary case of Indonesia, I investigate the impacts of the clean energy

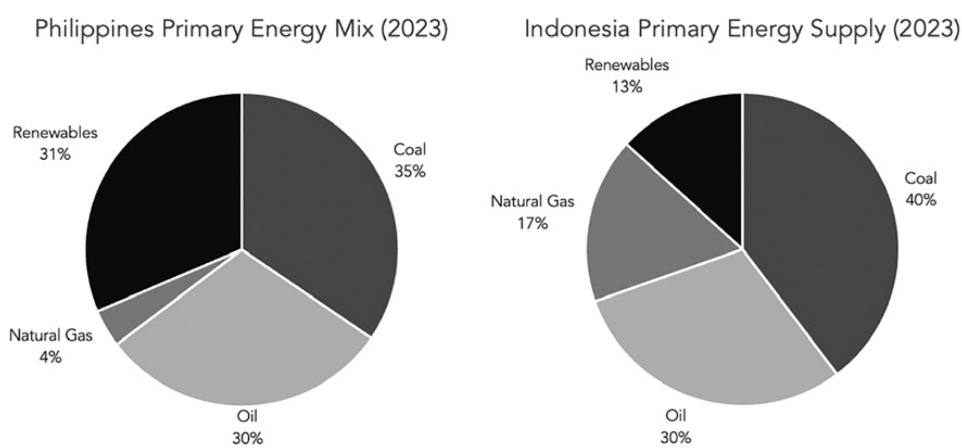


Figure 1.3 Primary energy supply in Indonesia and the Philippines. Oil, coal, and natural gas shares are inclusive of domestic supply and imported fossil fuels.
Source: DOE 2023b; MEMR 2023

regime complex on the renewable energy policy evolution (Chapter 4) and the development of the domestic geothermal energy installed capacity (Chapter 5).

Indonesia has high geothermal generation capacity potential noted by the national government and international community, but it faces several barriers to optimizing this potential, and, as a result, more than 89% of this potential has yet to be developed (MEMR 2020). While the country's government has adopted ambitious targets for ramping up renewable energy with a strong emphasis on geothermal energy, the targets remain unfulfilled. The largest barrier to renewable energy development is seen as the deeply embedded subnational political interests in coal and natural gas, as well as corruption related to the "oil and gas mafia," cronyism, and rent-seeking (Cahyafitri 2015; Winters and Cawvey 2015). Between 1983 and 2023, Indonesia received nearly USD 16 billion for geothermal energy development from multilateral and bilateral donors.[5]

The Philippines serves as a fitting secondary case study for comparison with Indonesia, as it differs in its lack of energy security due to limited domestic supply and subsequent vulnerability to energy crises and is therefore characterized by high political will to transition and improve the country's energy security through diversification of the energy supply. The country has a limited domestic supply of fossil fuels, which could explain the political will to develop its renewable energy and specifically geothermal energy, which the country has in abundance for domestic supply. Until 2018, the Philippines was the second-largest producer of geothermal energy in the world and has developed nearly half of its forecasted geothermal potential capacity (DOE 2021). Furthermore, the power generation mix in the Philippines has a higher portion of renewable energy than in Indonesia (31% compared to 13%, respectively) (see Figure 1.3). The Philippines received approximately USD 7.5 billion in international public development aid earmarked for geothermal development, although not at equivalent rates to Indonesia.[6] Furthermore, the regulatory framework supporting renewable energy development in the Philippines is more advanced than that in Indonesia. Can the Philippines' advanced renewable energy development be attributed to its limited domestic fossil fuel resources and willingness to develop renewables compared to Indonesia, or has international development assistance more ably targeted barriers to technology development? Chapter 6 provides an extensive analysis of the factors that led to the Philippines' evolution as a leader in geothermal development.

Indonesia and the Philippines present generalizable case studies: they are both EMDEs; both face significant issues with corruption and rent-seeking throughout

[5] The Indonesia analysis was calculated using the following data sources: ADB 2016, 2024; JICA 2008, 2024; KfW et al. 2015; OECD 2024; UNEP DTU 2016; World Bank 2016a, 2024b.

[6] The Philippines analysis was calculated using the following data sources: ADB 2004, 2016, 2024; JICA 2016; OECD 2024; UNEP DTU 2016, World Bank 2016a, 2024b.

their respective political and economic histories; both have histories of authoritarianism and subsequent democratization; and lastly, both demonstrate issues with renewable energy development related to privatization and state-owned enterprises (SOEs). The study of the regime complex impacts in Indonesia and the Philippines is therefore applicable to many other EMDEs facing similar challenges to energy transitions.

## Major Contributions

This book makes three major contributions. First, it examines the effectiveness of regime complexes, which has only been tackled in the existing literature to a limited extent through empirical analysis. I operationalize the impact and effectiveness of complex governance by proposing a set of mechanisms of impact, building upon previous theoretical work. Second, the book brings domestic politics into the regime complex literature, which I argue is critical to answering questions of effectiveness. My approach builds upon literature examining the interplay between state sovereignty and international environmental governance (Green and Colgan 2013; Jinnah 2014). I examine the effectiveness of the regime complex in impacting domestic politics through the empirical comparative case studies in Indonesia and the Philippines. Third, this book contributes to the energy transition literature by examining not only an underrepresented technology critical to the transition (geothermal), but also two underrepresented case studies (Indonesia and the Philippines) that are also important to the energy transition owing to their carbon emissions and representative dynamics as EMDEs. As such, the comparative case studies illustrate the impacts of climate finance in Indonesian and Philippine renewable energy development and provide important lessons about how climate finance and global governance more broadly must meet the challenges of implementing energy transitions on the ground in EMDEs.

## Comparative Case Studies and Methodological Overview

This book analyzes the effectiveness of the regime complex in addressing barriers to renewable energy development in EMDEs and its relative impact at the national and subnational levels. The methodological approach to conduct this research uses qualitative methods and field research, including interviews, process tracing, and comparative case study analysis of the clean energy regime complex's impacts on the evolution of domestic policy and geothermal energy development in Indonesia and the Philippines (see Collier 2011 and George and Bennett 2005 for reference on methodologies). The in-depth examination of the deployment of this technology

Table 1.1 *Variation across cases*

| Variables | Indonesia | Philippines |
|---|---|---|
| Political will | Low | High |
| Energy security | High | Low |

across these two countries allows for a better understanding of the interaction between the regime complex and domestic politics.

Two chapters are dedicated to Indonesia in order to isolate the impacts of the regime complex on policy (Chapter 4) with actual deployment of geothermal projects (Chapter 5), whereas only one chapter focuses on the Philippines geothermal development (Chapter 6), since the Philippines is treated as a secondary case study. Both countries vary in terms of relative political will and energy security throughout the more than 40-year period of analysis studied in this book, with Indonesia as the case of high energy security and low political will, and the Philippines as the case of low energy security and high political will (see Table 1.1). The three mechanisms of clean energy regime complex impact – utility modifier, social learning, and capacity building – are operationalized through a coding of climate finance and earmarked development aid mobilized over the time periods examined throughout the history of geothermal development in Indonesia and the Philippines.

I collected data over the course of three one-month field research trips – two to Indonesia during 2014 and 2015 and one to the Philippines in 2016 – as well as follow-up interviews conducted from 2020 to 2024. During field research and follow-ups, I conducted approximately 150 interviews with officials from a variety of relevant state and substate level government ministries, geothermal energy companies, state-owned enterprises, international and transnational actors/institutions including multilateral development banks, bilateral agencies, non-governmental organizations (NGOs), international organizations, and research institutions and think tanks.

The main advantage of field research and interviews is the collection of new data and the opportunity to capture in-country dynamics and institutional knowledge. For interviews, I chose the semi-structured format, which allows for specific topics to be covered in line with research questions, and also opens the conversations to unforeseen insights and perspectives. However, there is also potential for bias during interviews through the semi-structured format and framing of questions. To avoid leading questions, I asked both semi-structured and open-ended questions, and often took the lead from my interviewees on their areas of expertise. The semi-structured interviews focused on how various forms of international support such as development aid and climate finance (utility modifier mechanism), policy advising (social learning mechanism), and technical assistance (capacity-building mechanism) helped remove domestic barriers to geothermal development in the countries. The questions probed the extent to which complex global governance and the proliferation of international institutions matter in ameliorating major political/regulatory, financial, and technical barriers to renewable energy policy adoption and geothermal energy development within the domestic contexts in Indonesia and the Philippines. I further conducted process tracing to understand how, and under what conditions, international institutions and norms impact domestic politics.

The interviews were complemented with analysis of primary and secondary documents, such as financial aid data and reports from multilateral organizations including the IEA and UNFCCC, multilateral development banks such as the World Bank, the Asian Development Bank (ADB), government ministries, private-sector companies, and international NGOs, as well as bilateral development agencies like the German Development Bank [*Gesellschaft für Internationale Zusammenarbeit*] (GIZ), the US Agency for International Development (USAID), and the Japan International Cooperation Agency (JICA). I further supplemented these sources with policy, historical, and theoretical analysis from secondary literature. These methodologies provide a nuanced history and account of the evolution of geothermal development in the countries and the role played by the clean energy regime complex.

## Organization of the Book

I begin with a theoretical approach to conceptualizing the effectiveness of complex governance. I operationalize mechanisms of the regime complex effectiveness by measuring how the mechanisms facilitate change at the substate level in domestic politics. I first summarize the history of the emergence of the clean energy regime complex at an international level, focusing on the international, state, and non-state actors – for example, transnational, multilateral, and bilateral organizations – involved in regime complex formation. Then I delve into the empirical comparative case studies that examine the interaction between the clean energy regime complex and domestic political interests in Indonesia and the Philippines relevant to their energy transitions. The empirical chapters trace the clean energy regime complex's three mechanisms of effectiveness – utility modifier, social learning, and capacity building – and their interaction with domestic politics across the cases of the Philippines and Indonesia.

Chapter 2 sets the theoretical framework for the book, which provides tools to aid in operationalizing the regime complex mechanisms of effectiveness. The chapter operationalizes regime complex mechanisms of effectiveness as the utility modifier mechanism, social learning mechanism, and capacity-building mechanism to break down the major impacts of the regime complex on barriers to renewable energy development on the ground in EMDEs. This study advances novel theorizing on regime complex effectiveness by combining approaches from private governance and regime theory to conceptualize mechanisms of impact. The theoretical framework thus provides tools to guide the examination of the interaction between regime complexes and domestic political actors. It shows how a regime complex impacts financial, regulatory, and technical barriers to renewable energy development as analyzed in the comparative case studies in Indonesia and the Philippines (Chapters 4–6).

Chapter 3 examines the history of the clean energy regime complex, which helps set the stage to delve into questions of its effectiveness in later chapters. This chapter traces the role played by states, multilateral and bilateral organizations, transnational initiatives, and norm diffusion in driving regime complex emergence over the three periods of analysis (Period 1: 1980–2001; Period 2: 2002–2008; Period 3: 2009–2023). The chapter demonstrates that diverging state interests alone do not explain the regime complex's emergence, but that organizational expansion, transnational actor agency, normative change, and institutional interplay all contribute to its formation.

I then shift to an empirical analysis of the impacts and effectiveness of the clean energy regime complex, and the diverse network of institutions it encompasses, on the promotion of renewable energy policy and geothermal technology development in Indonesia (Chapters 4–5) and the Philippines (Chapter 6). Chapter 4 first outlines the Indonesian case study and summarizes key regulations and actors affecting renewable energy development, and then examines the influence of the regime complex and its impacts on domestic policy adoption and reform in Indonesia in further renewable energy development. This chapter reveals evidence of Indonesia's adoption of climate mitigation and emissions reduction policies resulting from the clean energy regime complex, specifically social learning, policy diffusion, and international pressure on the Indonesian government to reduce emissions in the wake of the COP-13 in Bali.

Chapter 5 shifts focus to the impacts of the regime complex – particularly financial and technical assistance (utility modifier and capacity-building mechanisms) coupled with policy advising (social learning mechanism) – on the removal of barriers to geothermal development in Indonesia. The chapter provides a political economy analysis of the domestic actors and interests involved in the energy sector in Indonesia, and then recounts the history of geothermal development in Indonesia with a focus on the impacts of the clean energy regime complex actors on the dynamics of barriers to geothermal development over time. This analysis reveals that the clean energy regime complex, through financial and technical assistance combined with policy advising, is critical to impacting geothermal development in Indonesia by filling gaps in financing for high-risk exploration and early-stage development. One of the critical examples of the regime complex impact centers around the largest financial barrier to geothermal development: de-risking exploration drilling. Financial support and capacity building provided by development banks were important in incrementally shifting substantial regulatory and financial barriers to geothermal development. This chapter provides insights on how the regime complex impacted domestic politics and geothermal barriers, despite the absence of a legally binding framework. It also sheds light on the narrow pathway of change in the face of persistent domestic political barriers and energy security concerns affecting political will.

Following the chapters on Indonesia, Chapter 6 transitions to the case of the Philippines to provide a comparative analysis of regime complex effectiveness. The chapter begins with a political economy analysis of the domestic actors and interests involved in the energy sector in the Philippines, then delves into the history of geothermal development with an analysis of the impacts of the clean energy regime complex actors on barriers to geothermal development over time. The major findings of this chapter indicate that early domestic political support for geothermal development under the Marcos and Ramos regimes was a response to the exogenous shocks of energy crises. This response to exogenous shocks opened pathways of change that were key in catalyzing geothermal development in the country that later placed the Philippines as the world's second-largest producer for several decades. The regime complex's impacts through bilateral and multilateral financial and technical assistance were highly effective in supporting the energy transition and spurring geothermal deployment in the Philippines; the embrace of the energy transition enabled the positive impact of the clean energy regime complex on geothermal development. In Indonesia, domestic political resistance to the energy transition limited the regime complex's effectiveness.

Chapter 7 provides a comparative analysis of the regime complex's effectiveness across cases to better reveal the conditions for impact and how intervening variables such as energy crises or domestic political interests mediate effectiveness. Through the three mechanisms – utility modifier, social learning, capacity building – the regime complex has had a notably different impact in moving renewable energy development in Indonesia and the Philippines. This chapter examines and explains the variable outcomes in geothermal development between the Philippines and Indonesia by illuminating the key role of political will at the domestic level. Major findings of this chapter demonstrate that throughout the case studies, diverging domestic political interests and lack of political will to develop geothermal energy or adopt renewable energy regulations are key in explaining the variation in effectiveness of the clean energy complex across case studies.

The book concludes in Chapter 8 with a summary of the major theoretical and empirical findings on the clean energy regime complex's emergence and effectiveness across Indonesia and the Philippines, and a discussion of the theory's broader generalizability. Chapter 8 closes with a summary of further research opportunities, policy implications, and recommendations for fostering energy transitions in a world of complex governance.