Approaching the Electrostate: Leaders and Laggards in the Global Transition to Net Zero Electricity

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A Major Paper submitted to the Faculty of Environmental and Urban Change in partial fulfillment of the requirements for the degree of Master in Environmental Studies, York University, Toronto, Ontario, Canada

July 31, 2026

Abstract:

The Kyoto Protocol and Paris Agreement are two legally binding international frameworks that outline commitments to remaining within safe levels of planetary warming. Central to these frameworks are Net Zero commitments—which include pledges to decarbonize national electricity infrastructure—communicated through Nationally Determined Contributions (NDCs). Previous research has examined what enables large-scale transitions; what constrains a country from dismantling its fossil fuel infrastructure; and which independent variables may influence clean energy adoption. However, research to date has not examined a large sample of countries across an extended period with multiple variables and categorization schemas in one rigorous analysis. Using country-level electricity data from the International Energy Agency (IEA) between 2000 and 2023/2024, this paper applies Spearman rank correlation and data visualization methods across 144 countries and 15 independent variables to determine not only which countries are decarbonizing their electricity systems the swiftest—measured through an original composite metric, the Electro-Transition Score (ETS)—but which variables and institutional alignments most strongly correlate with that progress. This paper determines that, beyond eight existing electrostates—defined as >99.5 percent clean energy generation (CEG)—countries within certain institutional blocs are accelerating faster than others, and that governance and development variables outweigh resource endowment in their association with CEG. However, outliers arise within the data that challenge the rigidity of these assertions, indicating that clean energy adoption is not one-size-fits-all. This paper thus illustrates the global picture of the ongoing 21st century energy transition from once-dominant fossil fuels to that of clean energy systems.

Keywords: Electrostates, Electro-Transition Score, Global Energy Transition, Electricity Decarbonization, Energy Sovereignty, Net Zero Electricity, Carbon Lock-In, Coal Phaseout, Cross-National Analysis, Renewable Energy, Clean Energy Generation, Multi-Level Perspectives.

Foreword:

This Major Research Paper has been prepared in fulfillment of the requirements of the Master of Environmental Studies (MES) degree at the Faculty of Environmental and Urban Change (EUC) at York University. Additionally, this paper fulfills the requirements of the Diploma in Business and Environment, administered jointly by the EUC and Schulich faculties. My Plan of Study in preparation for writing this paper identified three core areas of inquiry: which electrostates already exist and how they achieved that status, which countries are transitioning the swiftest to becoming electrostates, and which institutional blocs and independent variables positively correlate with those transitions. To answer these questions, this paper examines electricity data for 144 countries between 2000 and 2023/2024 (whichever year is most recently available), under five conceptual clusters, including governance capacity, development capacity, fossil fuel dependency, renewable endowment, and climate vulnerability and energy sovereignty. The requirements for the Business and Environment Diploma are fulfilled through an examination of the historical and current landscape of financial flows, encompassing government investment into clean energy technologies domestically and abroad, and the response of public and private corporations to the shifting landscape through technological innovation and financial commitments. I chose the topic of electrostates and the global energy transition because of not only my passion for renewable energies, but also because of their importance on the world stage for mitigating further planetary warming, especially as nations wean themselves off fossil fuels. Climate change now feels omnipresent. To do anything less than everything we can to stop it is our moral imperative as a species. What is worth doing on a burning planet?

Dedication:

This major paper is dedicated to my partner Magdalena, who supported me throughout the entire paper—and who also became my fiancée during the writing of it.

This paper is also dedicated to my mom, who raised me to be curious and driven; to my sister, who convinced me through her own similar decisions that enrolling in school as a mature student was a responsible and intelligent choice; to my friends, who keep me grounded; to my colleagues and peers; and to my cat Gus, who sat on my lap for approximately forty percent of the writing of this paper.

A last quick thank you to those who work diligently and tirelessly to advance the technological efficiency and capabilities of clean energy technologies all over the world, and to those who make it their mission to bring the cost of these technologies down to affordable levels. It is through this work that humanity will one day achieve the global electro-transition to a *Net Zero Planet*.

Other thanks go to:

- Dr. Mark Winfield and his team for writing *Sustainable Transitions in Canada,* and for being my supervisor during this Major Research Paper.
- Dr. Lina Brand-Correa for educating me across four different courses and being my second reader.
- Frank W. Geels and his seminal work on sustainable transitional theory and multi-level perspectives.
- Dr. Gregory Unruh's theories on carbon lock-in and escape.
- Dr. Hoes for sending the missing countries' hydropower potential data.

Acknowledgements:

This major paper, with assistance from an AI LLM (Claude: Haiku, Sonnet, Opus), generated approximately 5-10 kilograms of CO_2 and used ~25-50 litres of water, based on best estimates. AI assisted with the process of:

- Modelling of the *Electro-Transition Score* composite metric.
- General proofreading (spelling, grammar, syntax, etc.)
- Verifying the accuracy of tests conducted (Spearman, Pearson, Shapiro-Wilk).
- Generating figures used within this paper (1, 5, 6, 7, 8, 9).
- Verifying academic references and claims within Section 2.
- Ensuring quantitative data stated in paper matched original raw data.

Acronyms:

AI: Artificial Intelligence

ASEAN: Association of Southeast Asian Nations

BRICS: Brazil, Russia, India, China, South Africa

CE: Clean Energy

CEG: Clean Energy Generation

COP: Conference of the Parties

CREA: Centre for Research on Energy and Clean Air

DR Congo: Democratic Republic of Congo

EKC: Environmental Kuznets Curve

ES: Electrostate

ETS: Electro-Transition Score

EU: European Union

GDP: Gross Domestic Product

GHG: Greenhouse Gas

GHI: Global Horizontal Irradiance

HDI: Human Development Index

IEA: International Energy Agency

IPCC: Intergovernmental Panel on Climate Change

LCOE: Levelized Cost of Energy

NDC: Nationally Determined Contribution

NES: Near-Electrostate

NZC: Net Zero Commitment

NZE: Net Zero Electricity

OECD: Organization for Economic Cooperation and Development

OPEC/+: Organization of Petroleum Exporting Countries and Declaration of Cooperation Countries

RE: Renewable Energy

TIC: Techno-Institutional Complex

UN: United Nations

UNEP: United Nations Environment Program

UNFCCC: United Nations Framework Convention on Climate Change

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Section 1: Introduction

1.1: The Beginnings of Global Coalitions on Climate Action

Civilization is rapidly careening toward anthropogenic warming of planetary temperatures not recorded since the Pliocene epoch. This era, and its wholly alien climate patterns, predates Homo sapiens by over two-and-a-half million years (Hansen et al., 2013). In their latest *Emissions Gap Report* (UNEP, 2025), the United Nations Environment Programme (UNEP) estimates that based on current policies, anthropogenic activity will drive planetary warming to approximately 2.8°C by 2100, "leaving the world heading for a serious escalation of climate risks and damages." Further, global warming is evidently speeding *up*, with the past 11 years being the consecutively warmest on record (WMO, 2026), prompting UN Secretary-General António Guterres to state: "The Earth's climate is more out of balance than at any time in observed history." Knowledge of atmospheric warming effects from greenhouse gasses (GHGs) is not new; Swedish scientist Svante Arrhenius was one of the first individuals to publish findings in 1896, addressing the science of the potential warming properties of carbon dioxide (CO_2) in the atmosphere (Arrhenius, 1896). Sixteen years later, in 1912, New Zealand's *The Rodney and Otamatea Times* would publish a now semi-famous climate article titled "*COAL CONSUMPTION AFFECTING CLIMATE"* (Papers Past, 2021).

Nearly one century after Arrhenius' initial publication, the newly formed Intergovernmental Panel on Climate Change (IPCC) would release its first *Assessment Report* in 1990 (IPCC, 1992). The assessment report served as a foundational scientific basis for the formation of the United Nations Framework Convention on Climate Change (UNFCCC), which is the United Nations' body for "negotiating an agreement to limit

dangerous climate change." Taking place in Rio de Janeiro in 1992, the first UNFCCC agreement was signed by 154 countries, with the framework's main objective being the "… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (United Nations, 1992). By 1995, states had launched negotiations to strengthen the global response to climate change, leading to the creation of the *Kyoto Protocol* in 1997 (UNTC, 1997).

The Kyoto Protocol is a legally binding international framework for emissions reductions targets, aimed at an overall 5 percent reduction of GHG emissions below 1990 levels during 2008–2012. In 2011, Canada formally withdrew from the Kyoto Protocol (UNFCCC, 2014), becoming the first and only country to do so. In 2015, eighteen years after the Kyoto Protocol, the landmark *Paris Agreement* was signed at the Conference of the Parties (COP) 21 (UNFCCC, 2015), paving the way for two central targets: to contain global warming well below 2.0°C above pre-industrial levels, with concerted efforts to limit warming to 1.5°C (UNFCCC, n.d.-a). Subsequent IPCC modelling estimated that meeting the 1.5°C target would require a 43 percent reduction in global GHG emissions by 2030. However, as mentioned by the UNEP, the world is currently not on track (UNFCCC, n.d.-b) to "meet the long-term temperature goal of the Agreement, reach necessary levels of resilience, and mobilize and align necessary financial flows."

The Paris Agreement was adopted by 195 parties—but later twice withdrawn from by the United States—and, like the Kyoto Protocol, is legally binding, requiring countries to submit Nationally Determined Contributions (NDCs). An NDC is an officially documented policy submission by nation-states to the UN which outlines the signatories' commitment to reducing GHG emissions. NDCs are the primary mechanism through

which countries formalize commitments toward what is colloquially known as “Net Zero”. In short, Net Zero refers to reducing GHG emissions to effectively zero, or to an amount that can be absorbed naturally by the environment.

The concept of Net Zero electricity (NZE) specifically and the global geopolitical commitments to reaching it are a driving force behind this paper; specifically, the complex changes required to overhaul existing, fossil fuel-dominated global energy systems. Before these topics are analyzed, this paper outlines the historical steps which laid the foundation for the necessity of the Paris Agreement framework and NZE in the first place. Later, this paper will address the current state of the ongoing electrification/decarbonization landscape and the rising adoption of clean energies such as wind, solar, hydroelectric, nuclear, and geothermal, to determine which countries are taking the commitments outlined in the Kyoto Protocol and Paris Agreement seriously, and which countries are not. This paper will also analyze numerous variables that may influence or correspond positively with clean energy (CE) transitions, where these transitions are happening the swiftest, and which countries have already achieved full decarbonization of their electricity systems.

1.2: The Industrial Revolution, Coal, and Post-WWII Accelerationism

Coal became a prominent fuel for energy production during the burgeoning Industrial Revolution of the 18th and 19th centuries, where it became increasingly integral for steam engine and iron-making machines (Landes, 1991). As coal's immense potential to enhance modern technologies was realized, it quickly rose to become the most utilized energy source on the planet—enabling machine tools, larger blast furnaces, expanded

textile production, and the first railroads upon which many modern economies still rely today. Eventually, coal began to be used to generate electricity, with the first-ever coal-powered station opening in London in 1882; titled the *Edison Electric Light Station* (US DOE, 2013). Prior to the 20th century, biomass (wood) was the dominant source of energy generation worldwide, providing 6,111 TWh of global energy in 1900 (Ritchie et al., 2024), but was permanently overtaken by coal in 1910.

Coal continues to dominate the global energy landscape to this day, producing 34.4 percent of the world's electricity as of 2024 (Ember Energy, 2026c). However, for all the technological and economic benefits coal has wrought, it remains the most carbon-intensive form of fossil fuels. Just as Arrhenius predicted in his experiments, the unfettered burning of coal over the last few centuries has produced an excess of GHG emissions which are currently pooling in the atmosphere—both warming the planet and disrupting global climate patterns. When Arrhenius first published his findings in 1896, the atmospheric CO_2 concentration was at 295 (2 Degrees Institute, 2026). Today this number sits at approximately 430 ppm—roughly 46 percent higher than in 1896. This enormous rise in carbon dioxide has come not just from coal, but other fossil fuels as well including oil and fossil gas. Still, coal is responsible for a sizable portion of existing planetary warming—accounting for approximately 0.3°C of the current ~1.3°C of pre-industrial warming (ClientEarth, 2025).

Following the end of World War II, an event now referred to as the *Great Acceleration* began (Globaia, 2025). This event is visible in energy consumption data (Ritchie et al., 2024)—but also in other forms of data, including global population, carbon dioxide emissions, land surface temperature, ocean acidification, water use, and so on.

Following the war, European and Asian nations rebuilt while the United States continued to grow; globalization began and international trade expanded; and economically developing nations began building vast amounts of fossil fuel infrastructure to power themselves. Energy production was at the time closely tied to GDP growth; nations that expanded their energy output expanded their wealth. Economically, fossil fuels also offered a much lower Levelized Cost of Energy (LCOE) than clean energies (Our World in Data, 2025), which, other than hydropower/nuclear, were non-existent post-WWII. It would not be until approximately 2015 that renewables like wind and solar became cost competitive with fossil fuels (Lazard, 2025).

1.3: Why Focus on Electricity? The Current Global Greenhouse Pie

Of all the global sectors that produce GHG emissions, one stands above all others with the largest share by more than double the next (Ge et al., 2026). At approximately 32.7 percent of total GHGs as of 2023, electricity and heating generation are the biggest source of global emissions, as seen in Figure 1. For this paper, electricity alone—specifically individual country-level generation and its changes between two specific timeframes—will be the focus. Generating electricity for homes, businesses, hospitals, data centres, and anything else that requires it is the top sectoral emitter because, as mentioned earlier, vast amounts of society's electricity generation is sourced from carbon-intensive fossil fuels including coal, oil, and gas. A full global electricity breakdown by source is in Appendix B (Table B1). However, the energy landscape is rapidly changing. With clean energies becoming cheaper year-over-year, and international climate policy commitment milestones on the horizon, the disruption of global fossil fuels is already underway.

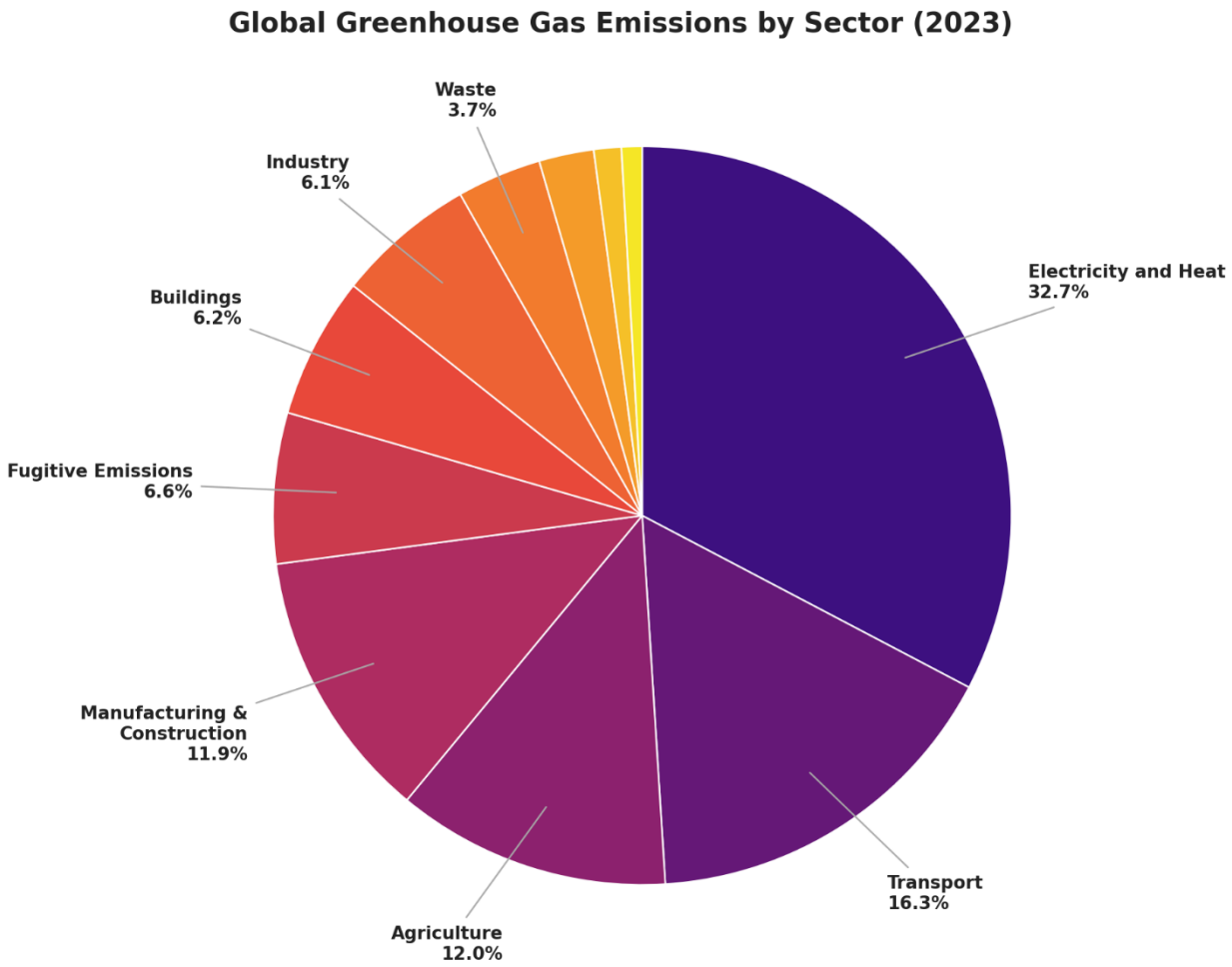


Figure 1: Greenhouse Gas Emissions by Sector, Our World in Data: Climate Watch (2026).

Notably, the International Energy Agency (IEA)—the premier institution for global energy analysis—has begun framing the present moment as the "Age of Electricity", a designation reflecting that electricity demand is set to grow strongly through 2030 as the electrification of transport, heating, and industry intensifies (IEA, 2026a). Though global GHG emissions grew by 0.8 percent in 2024 (IEA, 2025b), some expect this trend to either flatten or decline by the end of this decade, if not sooner (Voosen, 2025). These claims are supported by the fact that in 2025, more than 40 percent of global electricity was produced by clean energy sources (Ember Energy, 2025b). Furthermore, the IEA projects that global

renewable power capacity will roughly double between 2024 and 2030, adding approximately 4,600 GW of capacity—an expansion equivalent to the combined current power generation capacity of China, the European Union, and Japan (IEA, 2025c). Beyond electric vehicles (EVs) (BNEF, 2026a), heat pumps (Olano, 2023), and heavy industry, the modern rise of artificial intelligence (AI) is also greatly accelerating the demand for electricity (IEA, 2025e), as AI models require large, energy-intensive data centres to operate effectively. As AI technologies progress, so too will data centres need to scale to match the growth in demand and compute—requiring ever more electricity. In the coming years and decades, this "*electrification of everything*" will force a re-examination of current energy systems and how they will adapt to the changing landscape of growing demand.

While electricity represents the largest share of global emissions, it also represents the lowest hanging fruit. Wind and solar energies now have the lowest LCOE (Lazard, 2025), with solar prices falling from $359/MWh in 2009 to $58/MWh as of 2025. It increasingly makes economic sense to switch from fossil fuels—especially for countries which are not only replacing end-of-life infrastructure, but also building out new, decarbonized domestic capacity. Beyond declining costs and tightening climate policies, a third force is also reshaping the transition: energy sovereignty, which is the strategic imperative of reducing dependence on imported energy. For nations reliant on foreign fuel supplies, domestic clean generation offers not only emissions reductions but insulation from the price volatility and geopolitical leverage that accompany import dependency. This concept is extensively examined in Section 5.11.

Further, the commitment to decarbonizing electricity systems is intertwined into dozens of countries' NDCs, each of which involves reducing GHG emissions. A small number of countries have already achieved a full decarbonization of their national electricity grids, earning them the classification of *electrostates*, representing zero (or <0.5%) fossil fuels utilized for electricity generation. However, global electrostates are still in the minority. With the economic, technological, and policy foundations now falling into place however, the empirical question becomes: which countries are translating these emerging conditions into sustainable transition outcomes, and which are not?

1.4: Research Questions, Significance, Objectives, and Statement

This paper poses a three-part research question. First, which of the 144 countries in this paper's dataset have most substantially advanced toward electrostate status during the study period of 2000 to 2023/2024? Second, which national-level variables most strongly correlate with clean energy adoption and transitional progress toward fully decarbonized electricity generation? Third, to what extent do institutional bloc memberships, particularly the *Organization for Economic Cooperation and Development* (OECD) versus *Organization of the Petroleum Exporting Countries* (OPEC/+) affiliations predict divergent transition trajectories, and what do potential outlier cases outside these political blocs reveal about the limitations of this framing?

To quantify grid electrification progress, this paper introduces an original composite metric titled the *Electro-Transition Score* (ETS), which measures the degree to which a country's electricity grid has shifted toward clean energy sources and the quality of that growth between 2000 and 2023/2024. The construction and methodology of the

ETS are detailed in Section 3.4. By applying a novel composite metric across 144 countries and 15 independent variables, this paper offers a cross-national analytical approach not previously undertaken in the energy transition literature to this author's knowledge. Correlations are tested using Spearman rank correlation as the primary method, with Shapiro-Wilk normality testing as methodological justification, and Pearson correlation as a robustness check. The full methodology is detailed in Section 3.

This paper also advances the position that strong institutional and human development variables such as robust democratic governance, low corruption, and growing economic capacity are stronger predictors of clean energy transition progress than geographic resource endowment alone, and that the structural divide between blocs such as OECD and OPEC/+ nations reflects entrenched political-economic barriers rather than differences in renewable energy (RE) potential. These findings and their implications are examined in the Discussion and Conclusion sections, and the five conceptual clusters that encompass this paper's independent variables—Governance Capacity, Human Development and Economic Capacity, Fossil Fuel Structural Dependency, Renewable Resource Endowment, and Climate Vulnerability and Energy Sovereignty—are outlined from a literature perspective in Section 2 and a methodologies position in Section 3. Drawing on the five conceptual clusters established above, this paper advances the following directional hypotheses:

- **H1:** Higher democratic governance quality, lower corruption, and existing Net Zero commitments are positively associated with ETS.
- **H2:** Higher human development, overall GDP growth, and GDP per capita growth are positively associated with ETS.

- **H3:** Higher fossil fuel—coal, oil, gas—rents as a share of GDP are negatively associated with ETS. OPEC/+ membership, treated as a classification schema, is negatively associated with ETS.
- **H4:** Greater renewable resource endowment/capture potential is positively associated with ETS, though this relationship is expected to be weaker than governance, economic, and institutional predictors.
- **H5:** Greater climate vulnerability (flooding, drought, sea-level rise) and higher net energy import dependency are positively associated with ETS.

With the legally binding, international commitments made in both the *1997 Kyoto Protocol* and the *2015 Paris Agreement*, the subsequent implementation of NDCs, and the rising risk of climate systems breakdown, promises from nations to decarbonize their electricity systems can no longer be mere lip service. This paper analyzes the 21st century energy landscape transition to date—examining what unfolded once the global community began to confront the planetary consequences of historically relying so heavily on fossil fuels. It assesses the influence of the UNFCCC, the Kyoto Protocol, and the Paris Agreement on contemporary electricity systems, and evaluates whether the modern picture of national electricity generation has shifted in response to the scientific consensus and internationally binding commitments. The sections that follow document where transition has materialized, where it has stalled, and which structural conditions distinguish the two.

Section 2: Literature Review

2.1: Energy Transition Theory: Understanding Systemic Change

Energy transitions are sociotechnical processes—the co-evolution of technologies, markets, user practices, policy frameworks, and industrial structures—rather than purely technical or economic phenomena (Geels, 2002; Geels et al., 2017). This paper draws its theoretical architecture from Geels' multi-level perspective (MLP), which conceptualizes transitions as the outcome of interactions across three levels: niches, regimes, and landscapes (Geels, 2002, 2011). Niches are protected spaces—R&D laboratories, subsidized demonstrations, and specialized markets—where radical innovations mature. The regime is the meso-level structure of shared rules, routines, and institutional arrangements that entrenches incumbent systems and explains their persistence; and the landscape is the slow-moving external context of demographic, macroeconomic, and geopolitical pressures that can destabilize regimes when exogenous shocks such as oil crises or international climate coalitions open windows of opportunity (Geels, 2011; Geels et al., 2017). Transitions proceed through broadly sequential phases such as experimentation, stabilization, diffusion, and institutionalization, though contingency and timing remain decisive, with Geels and Schot (2007, as cited in Geels, 2011) identifying four distinct pathways that vary by the nature of multi-level interaction.

A central mechanism stabilizing incumbent systems is lock-in: sunk infrastructure investments, scale economies, institutional commitments, and incumbent lobbying reinforce prevailing configurations and generate the technological momentum that resists displacement (Geels, 2011; Sovacool, 2016). Sovacool (2016) synthesizes the historical record on transition timescales, documenting that global fuel transitions—

wood to coal, coal to oil—have typically required fifty to over one hundred years, reflecting both the physical scale of infrastructure replacement and the sequential nature of scaling from experimentation to global diffusion. Crucially, however, Sovacool also identifies national-level cases that moved considerably faster, undermining the assumption that transitions are inherently slow—a finding directly pertinent to the cross-national variation this paper examines. Emerging scholarship extends the MLP to multi-system interactions, demonstrating that electricity transitions generate cascading couplings with transport and heating that accelerate Net Zero electrification (Andersen & Geels, 2023). Meadowcroft and Rosenbloom (2023) synthesize this transition scholarship to caution against "dead-end pathways"—policy measures that secure incremental emissions reductions but divert investment away from configurations capable of reaching Net Zero, thereby consuming resources without advancing systemic transformation.

A parallel quantitative literature seeks the structural determinants of renewable deployment, with broadly consistent findings that renewable support policies and international climate commitments both matter while the influence of income, fossil fuel prices, and institutional quality remains contested (Bourcet, 2020; Hao & Shao, 2021). Taken together, these literatures identify the measurable conceptual frameworks (governance quality, economic capacity, fossil fuel dependency, resource endowment, and climate vulnerability) that the following sections examine further.

2.2: Governance Capacity: Democracy, Corruption, Policy, and Institutions

Within the MLP, governance variables operate primarily at the regime level, where institutional rules and political norms either enable or obstruct niche innovations such as wind and solar (Geels, 2011). A substantial body of literature links democratic governance to renewable adoption, though the relationship is conditional rather than direct: democracies tend to exhibit higher low-carbon shares and respond more readily to environmental signals, yet deepening democracy within wealthy economies can inhibit deployment where established processes are captured by incumbent fossil fuel interests, and democratic commitment does not reliably translate into environmental outcomes (Chen et al., 2021; Clulow & Reiner, 2022; Neumayer, 2002; Pickering et al., 2020). This within-country tension reinforces the MLP's emphasis on regime-level lock-in persisting even within ostensibly democratic systems (Geels, 2011).

Corruption represents a distinct governance failure with direct consequences for transition. Amoah et al. (2022) establish a robust negative relationship between perceived corruption and renewable energy consumption across 32 African countries, using an instrumental-variable approach to address endogeneity. Yin and Liu (2025) deepen this through a Sub-Saharan focus, identifying procurement bribery, the misallocation of climate funds, and regulatory capture by fossil fuel interests as specific channels, while noting that dependency on foreign aid renders the region's transition particularly vulnerable. The corruption-energy nexus extends well beyond Africa, with documented risks across renewable sectors in several middle-income economies (Sovacool, 2021).

Governance capacity therefore shapes outcomes through three mechanisms: democratic institutions determine whether public preferences and environmental signals translate into policy, while corruption determines whether that policy and its associated investment reach their intended targets. A third dimension concerns the form of state intervention. Meadowcroft and Rosenbloom (2023) draw on Mazzucato (2013) to argue that "mission-driven innovation", in which governments actively identify strategic options, prioritize sectors, and de-risk learning-by-doing, outperforms passive subsidy allocation that advantages well-resourced incumbents skilled at navigating bureaucratic processes—a distinction relevant to the cross-national variation in governance quality this paper examines.

2.3: Human Development and Economic Capacity: Enabling Conditions for Transitions

Economic development and human capital are widely treated as enabling conditions for clean energy adoption, though the relationship is neither linear nor uniform. The most direct evidence comes from Sadorsky (2009), who estimates that a 1 percent rise in real GDP per capita increases per capita renewable energy consumption by roughly 3.5 percent across emerging economies—an elasticity far exceeding that of conventional electricity demand—while finding no short-run bidirectional causality, such that the relationship operates through long-run equilibrium adjustment rather than immediate feedback. Subsequent work confirms that income, emissions, and oil prices jointly determine renewable consumption over the long run, reinforcing that rising

income creates both the fiscal capacity and the political conditions for clean energy investment (Salim & Rafiq, 2012).

The broader development-environment relationship is theorized through the Environmental Kuznets Curve (EKC), which posits that degradation rises with income before declining past a turning point. Stern (2004) demonstrates that the EKC's statistical foundations are far weaker than commonly assumed, and that developing countries increasingly address environmental problems with shorter lags than the curve predicts—a "revised EKC" in which the curve shifts downward and leftward through technological change and policy diffusion. This perspective is pertinent to this paper's finding that GDP per capita levels, rather than aggregate GDP growth, predicts a high Electro-Transition Score, suggesting that individual economic capacity matters more than aggregate economic size. Beyond income, studies of the Human Development Index (HDI)-renewable relationship find a reinforcing, frequently bidirectional cycle in which human development builds the capacity to adopt clean energy while deployment improves development outcomes (Sasmaz et al., 2020; Zheng & Wang, 2022). This justifies including HDI alongside GDP per capita, as it captures dimensions of absorptive capacity—education, health, and living standards—that income alone does not.

2.4: Fossil Fuel Structural Dependency: Lock-In and the Resource Curse

The persistence of fossil-fuel–dependent systems despite the rising competitiveness of clean alternatives is a structural condition rooted in the century-long co-evolution of technologies and institutions. This section draws on the carbon lock-in and resource curse literatures to inform the use of coal, oil, and fossil gas rents as a

percentage of GDP. Unruh (2000) provides the foundational theorization of carbon lock-in, introducing the Techno-Institutional Complex (TIC) to capture how technological systems and governing institutions co-evolve into self-reinforcing configurations: fossil fuel infrastructure generates sunk costs, which produce constituencies that lobby for favourable regulation, which in turn directs further investment toward incumbent technologies, perpetuating the market and policy failures that inhibit carbon-saving alternatives. In subsequent work, Unruh (2002) argues that because of the TIC's self-referential nature, escape is unlikely through internal reform alone—exogenous landscape shocks or sustained external policy intervention are typically required—an argument that maps directly onto the MLP's account of windows of opportunity (Geels, 2002, 2011). Within this framework, Meadowcroft and Rosenbloom (2023) emphasize that the deliberate phase-out of incumbent technologies—through mandated coal exit dates, combustion-vehicle bans, or gas connection prohibitions—constitutes a distinct and underutilized policy instrument class that directly erodes the sunk-cost constituencies at the heart of the TIC rather than simply competing against them.

Where economies are structurally dependent on extraction, lock-in operates through the political economy of resource wealth. Ross (1999) synthesizes three mechanisms by which resource abundance impedes development: the Dutch Disease, in which resource revenues appreciate the currency and crowd out other exports; rent-seeking, in which easily captured rents encourage unproductive behaviour and corruption; and the erosion of institutional capacity as states grow dependent on resource revenue rather than broad-based taxation. Ross (2012) extends this to petroleum specifically, demonstrating through cross-national data that oil-rich states have failed to

grow faster than oil-poor ones despite their endowments, and that oil wealth has bolstered authoritarian regimes and narrowed economic bases. These dynamics intensify during the current transition, as the bulk of proven reserves must remain unextracted to limit warming to 1.5°C(!), implying not only stranded-asset revenue loss but a fundamental threat to the fiscal and employment structures built around extraction (Mesa Puyo, 2024).

Even wealthy, institutionally robust petrostates illustrate the intractability of lock-in, where capital, interests, and values remain inextricably tied to fossil fuel activity in ways that exert a dampening effect on low-carbon transitions (Sareen et al., 2026). Meadowcroft and Rosenbloom (2023) argue that proactively managing the distributional consequences of transition—through retraining, regional reinvestment, and economic diversification for fossil fuel–dependent workers and communities—is not merely normatively desirable but also functionally accelerative, reducing the political resistance that lock-in generates—a mechanism the MLP identifies at the regime level but does not operationalize as policy.

2.5: Renewable Resource Endowment: Geographic Advantages and their Limitations

A country's endowment of solar, wind, and hydro capture potential offers the most intuitive explanation for cross-national variation in clean energy adoption, yet the empirical literature is more ambiguous than that intuition suggests. Overland et al. (2022) establish that capturable renewable resources are more evenly distributed than fossil fuels—though less dramatically than commonly assumed, with solar and wind widely

dispersed but hydropower highly concentrated—implying a less asymmetric geopolitical landscape in which meaningful inequalities nonetheless persist. This directly motivates treating solar, wind, and hydropower potential as separate independent variables.

Whether endowment translates into deployment is a separate question. Gosens (2017) finds that natural resource endowment is not a strong driver of wind or solar deployment; policy frameworks, institutional capacity, and economic conditions exert considerably greater influence, such that low-quality resources do not preclude high renewable market shares. This shifts analytical weight toward the governance and economic variables of Section 2.2 and Section 2.3, and aligns with Sadorsky's (2009) finding that income elasticities far exceed resource effects. Complementary work confirms that the translation of resource wealth into deployment varies by resource type and is strongest in developed economies, and that renewable development reduces import dependency—rendering endowment an energy-security incentive as much as a climate opportunity (Han et al., 2023; Yadav & Mahalik, 2024). Resource endowment thus functions as a facilitating condition rather than a sufficient driver of transition.

2.6: Climate Vulnerability and Energy Sovereignty: Incentives to Transition

Both climate vulnerability and energy sovereignty function primarily as motivational rather than enabling variables: countries most exposed to sea-level rise, extreme weather, and agricultural disruption have strong incentives to decarbonize, though whether motivation yields outcomes depends on the capacity constraints examined above. Further, energy sovereignty reflects the strategic exposure of import

dependency; both operate as push factors, shaping why a country feels compelled to decarbonize rather than whether it is equipped to do so. The cross-national evidence shows vulnerability positively associated with renewable deployment, though the effect has weakened over time as exposure becomes more widespread, and small island states have leveraged coalition cohesion to secure outsized diplomatic influence despite minimal capacity to translate commitments into grid-level change (Betzold et al., 2012; Hao & Shao, 2021). Nepal illustrates the forward-facing case: a highly vulnerable, low-income country that has nonetheless reached electrostate status through abundant hydropower and development-driven electrification, building clean infrastructure from the outset rather than displacing an incumbent fossil regime—a dynamic the ETS is designed to recognize (Suman, 2021).

2.7: Synthesis: Gaps, Limitations, and Contribution of Paper

Read together, the literature reveals a consistent hierarchy in which institutional and economic variables dominate geographic and resource-based explanations, with governance quality, corruption, and fossil fuel lock-in emerging as more powerful predictors than resource endowment (Gosens, 2017; Ross, 1999; Unruh, 2000). Many of these relationships are non-linear and conditional rather than direct, which justifies this paper's use of Spearman rank correlation as its primary method—with Pearson as a robustness check—rather than regression models that would require stronger causal assumptions than a cross-sectional dataset of 144 countries can support.

Several gaps motivate this paper's contribution. First, few studies examine the full range of governance, economic, resource potential, fossil fuel dependency, and climate

vulnerability and energy sovereignty variables simultaneously within a single cross-national framework. Second, most existing literature measures clean energy consumption or share—static metrics that do not capture the directionality of change within a country's system—whereas the Electro-Transition Score measures the degree and quality of transition between two fixed points in time. Third, the literature has given limited attention to countries already operating near-100 percent clean grids, namely, the electrostates and near-electrostates this paper identifies as a distinct category.

The ETS is best distinguished from the World Economic Forum's (WEF) Energy Transition Index (ETI), which scores countries on a weighted composite of present system performance and forward-looking transition readiness. The two are complementary rather than competing: the ETI assesses where countries currently stand and what enabling conditions they possess, while the ETS isolates the electricity grid, measures structural change in clean energy share between two fixed temporal points, and is bounded between -1 and 1 to capture both progress and regression on a single directional dimension. Finally, this paper's central OECD-versus-OPEC/+ framing—qualified by electrostate outliers—combines the resource curse and carbon lock-in traditions with an original composite transition metric applied across the full range of global income levels, institutional types, and resource endowments, an integration the existing literature has not systematically pursued. The following section outlines the methodologies through which this paper operationalizes these contributions.

Section 3: Methodologies

3.1 Research Design

This paper applies a cross-national, quantitative, correlational research design. The unit of analysis is the *nation-state* (n = 144), with a study window spanning the years 2000 to 2023/2024. The variation in end date reflects data availability constraints within the IEA dataset: generation records for many Global South countries extend to 2023, while data for many Global North countries extend to 2024—but the rule is not absolute. A complete breakdown of the data end year applied for each of the 144 countries is provided in Appendix A (Table A2).

The ETS dependent variable (DV) is an original composite metric developed specifically for this paper, first introduced in Section 1.4 and formally outlined in Section 3.4. This paper examines 15 independent variables (IVs) distributed across five conceptual clusters, each established in the literature reviewed in Section 2. Figure 2 maps these clusters and their relationship to the DV, whereas Table 3 reflects each IV and its corresponding cluster. Each of the five clusters comprises exactly three independent variables, yielding a balanced 15-variable framework that affords equal analytical weight to every conceptual dimension and guards against overrepresenting any single determinant of transition.

A correlational rather than causal design was selected for two reasons. First, the objective of this paper is to identify which structural and institutional variables associate most strongly with positive ETS outcomes across nation-states—an aim that is better served by a broad correlational approach than by causal modelling. Second, a breadth-over-depth approach was deliberately chosen to complement the high-level scope of the

climate challenge this paper addresses. Given that nearly all 144 nations in this sample are signatories to both the Kyoto Protocol and the Paris Agreement and report NDCs, a global lens is analytically appropriate. By design, this paper is non-experimental; all findings are interpreted as structural associations rather than causal relationships.

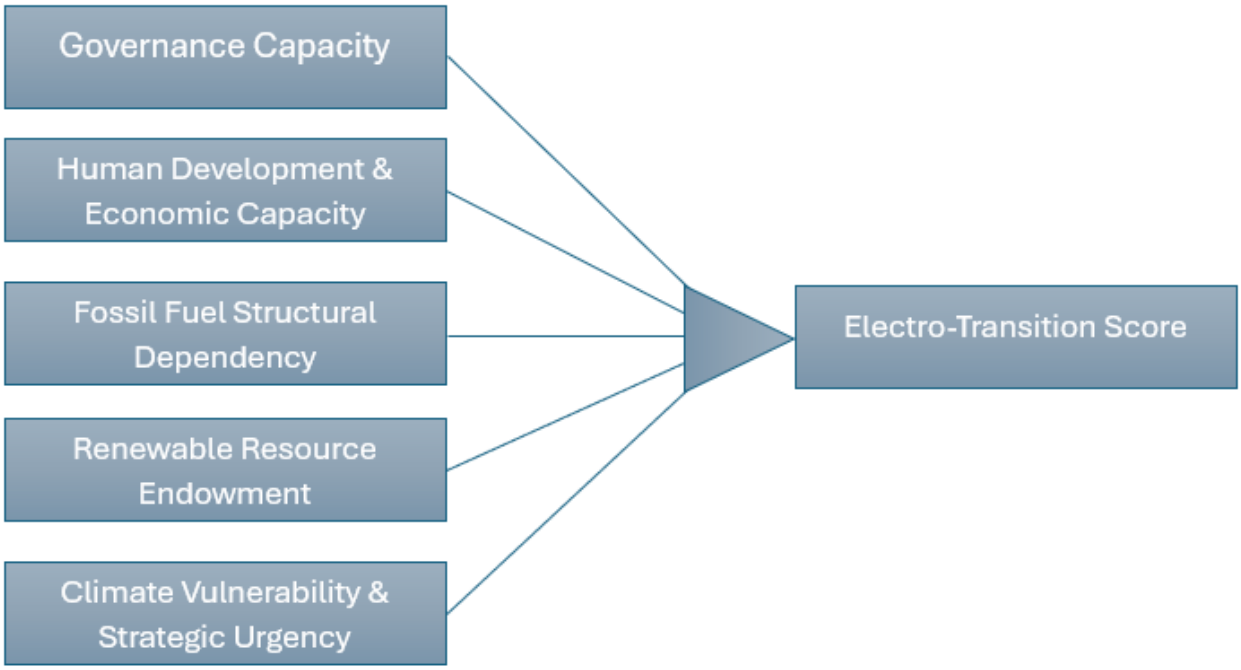


Figure 2: Conceptual Clusters' Relationship to Dependent Variable.

3.2 Data Collection, Sources, and Rationale for Operationalization

The following paragraphs detail the primary data sources for the 15 independent variables across the five conceptual clusters, alongside the rationale for the operationalization chosen in each case. Two approaches are applied throughout, according to the nature of the variable. Variables measuring a country's structural position—its institutional, developmental, or resource standing—use the most recent

available value, capturing where a country stands rather than how far it has shifted. Variables measuring structural change use the delta between 2000 and the most recently available year, capturing directional trajectory rather than a static snapshot. The choice in each case reflects which measure carries the more behaviourally meaningful signal.

Governance Capacity encompasses Liberal-Democracy Score, Corruption Score, and Net Zero Commitment Level. Liberal-Democracy Score data are drawn from the V-Dem's *Democracy Report 2025* (V-Dem, 2025) (n = 142). The most recent score (2024) is used; a delta would treat a modest improvement from an already-low baseline as equivalent to a consistently high score, obscuring a country's absolute democratic quality. Corruption Score data are sourced from Transparency International's 2025 *Corruption Perceptions Index* (Transparency International, 2025) (n = 142), applying the 2025 score on the same basis. Net Zero Commitment Level data are sourced from the Energy and Climate Intelligence Unit's *Net Zero Tracker* (ECIU, 2026), which classifies countries into four policy categories—commitment in law, in policy document, declaration or pledge, and proposed or in discussion—and are assigned scores of 1.00, 0.75, 0.50, and 0.25 respectively, while no recorded commitment scores 0.

Human Development and Economic Capacity encompasses total GDP growth, GDP per capita growth, and Human Development Index (HDI) score. Both GDP measures are sourced from the World Bank Group (World Bank Group, 2024a, 2024b) (n = 137 and n = 138), operationalized as the 2000–2024 delta to capture the trajectory of economic growth or contraction. HDI data are sourced from the UNDP's *Human Development Reports* (UNDP, 2024) (n = 134), using the most recent available score as a composite measure of a country's current human development.

Fossil Fuel Structural Dependency encompasses coal, oil, and fossil gas rents as a percentage of total GDP. All three are sourced from the World Bank Group (World Bank Group, 2022a, 2022b, 2022c) (n = 144 each), operationalized as the 2000–2021 delta to capture the directional trajectory of a country's reliance on fossil fuel rent revenues; 2021 was the most recent year available for the data.

Renewable Resource Endowment encompasses solar, wind, and hydropower capture potential. Solar global horizontal irradiance (GHI) data are drawn from the World Bank's *Global Photovoltaic Power Potential* dataset (World Bank Group, 2025) (n = 140); wind potential from the World Bank's *Global Wind Atlas* (World Bank Group, 2026) (n = 143); and hydropower potential from (Hoes et al., 2017) (n = 140). For all three, unadjusted natural potential was used rather than values relative to installed generation, as the objective is to assess whether a country's geographic exposure to a renewable resource independently associates with transition progress, not whether it has already acted upon it.

Climate Vulnerability and Energy Sovereignty encompasses climate risk rank change, projected temperature rise, and net energy imports. Climate risk rank data are sourced from Germanwatch's *Climate Risk Index 2026* (Germanwatch, 2026), with the delta in a country's global risk ranking used as the operationalized variable (n = 129); because the dataset originates in 1995—prior to the Kyoto Protocol and standardized risk assessment—the delta captures how assessed climate exposure risk grows over time. Projected temperature rise data are sourced from Climate Impact Lab's *Impact Map* (Climate Impact Lab, 2026) (n = 144), using the mid-century window (2040–2059) under a moderate emissions scenario (SSP2-4.5). The near-term window (2020–2039) was excluded as it is partly elapsed and the end-of-century window (2080–2099) was deemed too distant

to bear on policy urgency, while the moderate—rather than moderate-high or high—scenario was selected as the most policy-relevant trajectory, consistent with the UNEP *Emissions Gap Report* mentioned in Section 1.1. Net energy imports as a percentage of total energy use are sourced from the World Bank Group (World Bank Group, 2025a) (n = 133), using the most recent value (2022) to capture structural exposure to energy insecurity and price volatility. A delta was considered and tested but returned a negative Spearman value, reflecting that reduced import dependency may be achieved through domestic fossil fuel expansion rather than renewable deployment—a dynamic this paper examines further in Section 5.

3.3 Sampling Strategy

The sampling strategy for this paper was directly shaped by the data available from the IEA, which was selected as the primary institutional source based on its standing as the most internationally recognized repository of country-level electricity data. While an initial scope of 10–20 curated country case studies was considered, the decision was made to include all 144 countries available within the IEA database, prioritizing breadth of coverage to enable the most globally representative cross-national comparison possible. This maximized sample size increases the likelihood of identifying meaningful structural patterns that would not be visible in a smaller, regionally bounded sample.

Each of the 144 countries was assigned to one or more classification schemas, which play a central analytical role in Sections 4 and 5. These include membership in international economic and governmental organizations such as OECD, OPEC/+, G20, and Association of Southeast Asian Nations (ASEAN), as well as formal and informal

country groupings including the European Union and BRICS (original five members). Countries were further classified by continental and sub-regional geography, and where applicable, assigned Electrostate or Near-Electrostate designations. The data for these categorization schemas can be found in Appendix A, Table A3a/b.

By maximizing the available IEA sample (n = 144) and applying multi-dimensional classification schemas, this paper broadly deepens representativeness across income levels, institutional affiliations, and regional contexts. Despite the sectoral limitations of the ETS noted in Section 3.4, this sample size enables a robust cross-national comparison spanning approximately two and a half decades of the global clean energy transition, encompassing the implementation periods of both the Kyoto Protocol and the Paris Agreement.

3.4 The Electro-Transition Score: Construction and Methodology

The ETS formula comprises two equally weighted signals that together capture distinct dimensions of a country's clean energy transition, as detailed below.

Signal 1 – Structural Transition

$$S_1 = \frac{2023/2024\ CE\ Generation - 2000\ CE\ Generation}{1 - 2000\ CE\ Generation}$$

Notes:

- S_1 is bounded to [-1, 1].
- Exception: if both 2000 and 2023/2024 clean energy (CE) generation >0.95, then S_1 = 2023/2024 CE generation.

Signal 2 – Quality of Growth

$$S_2 = \frac{CE\ Generation\ Increase\ [\Delta] - FF\ Generation\ Increase[\Delta]}{|CE\ Generation\ Increase\ [\Delta]| + |FF\ Generation\ Increase\ [\Delta]|}$$

Notes:

- Where CE Generation Increase ≠ 0 or FF Generation Increase ≠ 0; else $S_2 = 0$.

Composite Electro-Transition Score:

$$ET = \frac{S_1 + S_2}{2},\ ET \in [-1, 1]$$

Signal 1—the *Structural Transition* signal—measures the change in a country's clean energy share of total grid generation between 2000 and 2023/2024, normalized against the remaining fossil fuel headroom available at the start of the study period. This normalization accounts for the fact that countries beginning with already-high clean energy shares have less structural room to grow; a country moving from 60 percent to 90 percent CE share has accomplished more proportionally than one moving from 10 percent to 40 percent, despite an identical absolute change. Signal 2—the *Quality of Growth* signal—examines the absolute change in total grid generation over the study period and determines what proportion was attributable to clean energy versus fossil fuel additions or deductions. This captures the directionality of a country's infrastructure investment: a country may maintain a stable CE share while massively expanding fossil fuel generation, a dynamic Signal 1 alone would not detect. By combining both signals into a single composite score bounded between -1 and 1, the Electro-Transition Score captures both the *degree* and *quality* of grid decarbonization—a more dynamic measure of transition

progress than the static renewable energy share snapshots prevalent in the existing literature.

A score of 1 represents an *electrostate*: a country whose electricity grid is effectively fully decarbonized. Scores between 0 and just below 1 indicate varying degrees of clean energy adoption and grid decarbonization; the more a country's score approaches 1, the more said country has expanded clean energy generation (CEG), dismantled fossil fuel generation, or both. Countries with a CEG rate of 95–99.49 percent in study end year are classified as *near-electrostates* for the purposes of this paper and are subject to a conditional adjustment in Signal 1 to prevent formula distortion arising from a near-zero denominator. Negative scores, between 0 to -1, indicate that a country has either dismantled clean energy generation over the study period or, more commonly, expanded fossil fuel infrastructure at a rate that outpaces clean energy additions. Such trajectories reflect poorly on a country's commitments under the Kyoto Protocol and Paris Agreement and are reflected in their ETS.

One manual override was required: Paraguay held 100 percent CEG in both 2000 and 2023, rendering Signal 1 undefined through a decommissioning-related edge case in the denominator, and was accordingly assigned an ETS of 1. The score also carries a design limitation worth noting here: it addresses only a country's national electricity sector, capturing neither total primary energy consumption nor GHG emissions trajectories, and does not account quantitatively for any gains at the residential-level CEG or increased/reduced electricity imports from other nations.

3.5 Normality Testing and Analytical Approach

Following the application of the ETS across all 144 nation-states, three quantitative tests were applied across the 15 independent variables: a normality test (Shapiro-Wilk), a non-parametric correlation test (Spearman), and a parametric correlation test (Pearson). The Shapiro-Wilk test returned non-normal distributions for all 15 variables, providing the methodological justification for Spearman rank correlation as the primary analytical method. These tests determine which independent variables most strongly correlate with higher ETS values, and by extension which structural and institutional conditions accompany meaningful clean energy transition progress across nation-states.

Spearman rank correlation serves as the primary test, with results interpreted using ρ values and significance thresholds (*, **, ***); full results are presented in Section 4.3. A Pearson correlation was conducted as a robustness check, returning a convergence of $r = 0.932$ across all 15 IVs, confirming that the Spearman findings are not an artifact of the rank transformation. Two-tailed testing with pairwise deletion was applied throughout to manage missing data while maintaining continuity across variables and sample sizes.

Multi-variable regression modelling—specifically linear and logistic regression—was considered but ultimately excluded from the primary analytical framework; the risk of omitted variable bias and multicollinearity across 15 IVs rendered regression coefficients difficult to interpret with confidence. Spearman correlation, by contrast, makes no distributional assumptions and is well-suited to the ordinal and non-normal structure of the data. In place of regression, a visualization-forward, analytical discussion

approach has been adopted, directing analytical attention toward the patterns emergent from ETS distributions, country classifications, and IV correlations—the implications of which are discussed in Section 5.

3.6 Limitations

Several limitations arise from the methodological choices outlined in this section. The correlational, cross-sectional design precludes causal inference; no single independent variable can be identified as a definitive driver of ETS outcomes, each instead being assessed for the strength and direction of its co-movement with the DV. The exclusion of regression modelling further limits the scope of cross-IV quantitative analysis, a gap this paper addresses through a substantive visual analysis approach in Sections 4. Additionally, despite the inclusion of 15 independent variables spanning five conceptual clusters, the chance of external risk remains—given the multi-causal, exogenous nature of energy transitions, factors such as conflict or economic recession may exert influence not captured by the current variable framework. This is acknowledged in Section 5.11.

Several limitations also pertain to the IEA data specifically. As noted in Section 3.1, the disparity in data end dates—2024 for many Global North countries and 2023 for many Global South countries—means the most recent years of clean energy growth, among the highest on record according to IEA reporting, are not uniformly captured across the full sample. This is most consequential for large emerging economies such as China and India and is addressed in Section 5.8. A further limitation is the absence of residential-level RE adoption and subnational variation, as country-level aggregation

necessarily obscures regional disparities within federated states. To partially address this, Pakistan is discussed at the residential level in Section 5.6 and Canada at the subnational level in Section 5.9, given its federal structure and the meaningful divergence in clean energy adoption across provinces. Finally, as established in Section 3.4, the ETS is bounded by its focus on national electricity grid generation—it does not capture changes in primary energy consumption across industry, buildings, or transportation.

Section 4: Analysis and Results

4.1 Descriptive Statistics

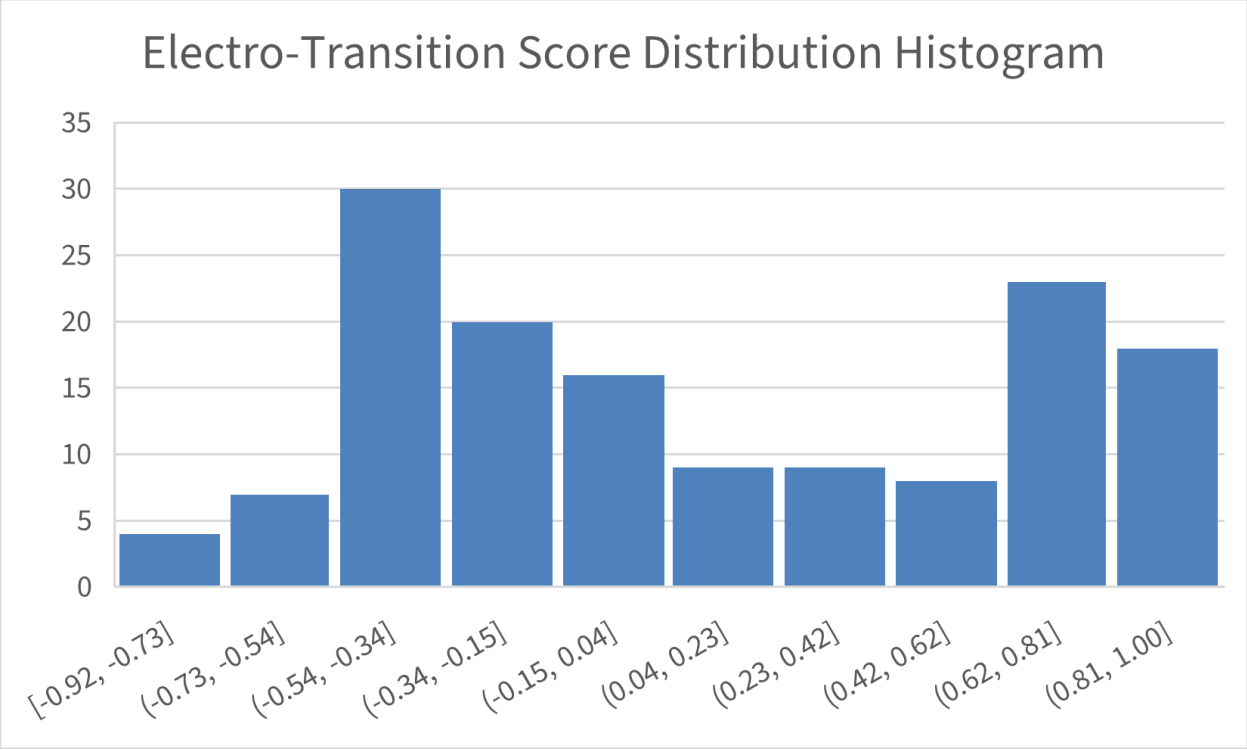


Figure 3: Histogram Distribution of Electro-Transition Scores Across Full Data Sample.

Table A1 (located in Appendix A) presents the clean energy generation share for each of the 144 countries in both 2000 and 2023/2024, alongside the delta between those

years and the resulting ETS. Of the 144 countries observed in this paper, Electro-Transition Scores range from -0.92 to 1, with a mean of 0.102, median of -0.043, and standard deviation of 0.553. The distribution is non-symmetric and bimodal, with one concentration of countries in the negative-to-near-zero range and a second in the upper-positive range. This suggests a polarized global transition landscape rather than a normal progression toward decarbonization, as illustrated in Figure 3.

Across the 144 countries, eight achieved electrostate status and six near-electrostate status by 2023/2024—defined as CEG of 99.5–100 percent and 95–99.49 percent respectively. As illustrated in Table 1, the electrostates and near-electrostates collectively representing the upper bound of clean energy generation achievement.

Table 1: Electrostates and Near-Electrostates.

Country	ES/NES	CEG (%, 2000)	CEG (%, 2023/24)	Change (Δ)
Albania	ES	96.15	100.00	3.85
Nepal	ES	98.37	100.00	1.63
Paraguay	ES	100.00	100.00	0.00
Ethiopia	ES	98.63	99.99	1.36
Iceland	ES	99.93	99.98	0.04
DR Congo	ES	99.95	99.96	0.01
Switzerland	ES	98.40	99.66	1.26
Sweden	ES	96.88	99.52	2.64
Norway	NES	99.80	98.97	-0.83
Namibia	NES	99.22	98.03	-1.18
Luxembourg	NES	81.60	97.73	16.13
Uganda	NES	99.62	97.32	-2.30
Finland	NES	65.91	96.10	30.19
France	NES	90.83	95.30	4.48

Table 2 summarizes mean and median ETSs across both institutional blocs and geographic regions. The divergence between OECD and OPEC/+ groupings is particularly pronounced—mean ETSs of 0.578 and -0.257 respectively—providing aggregate quantitative support for the institutional divide that forms the central analytical frame of this paper. European and EU groupings record the highest regional averages, while the Middle East, OPEC/+, and Africa record the lowest median scores. These patterns are examined in depth in Section 5.

Table 2: Institutional and Regional ETS Summary Statistics.

Group	***n***	***Mean***	***Median***	***Min***	***Max***
ASEAN	9	-0.238	-0.211	-0.586	0.126
BRICS	5	0.092	-0.007	-0.218	0.439
EU	27	0.692	0.733	0.008	0.998
G20	19	0.195	0.212	-0.488	0.785
OECD	38	0.578	0.725	-0.479	1.000
OPEC/+	21	-0.257	-0.450	-0.710	0.812
Africa	34	-0.141	-0.365	-0.921	1.000
Americas & Caribbean	25	0.075	-0.064	-0.843	1.000
Asia (Central/East)	16	-0.159	-0.268	-0.566	1.000
Asia (S/SE) & Oceania	15	-0.076	-0.183	-0.586	0.731
Europe	39	0.625	0.733	-0.223	1.000
Middle East	15	-0.206	-0.403	-0.554	0.653
Global	**144**	**0.102**	**-0.043**	**-0.921**	**1.000**

Table 3 presents the full 16-variable framework applied in this paper, including the dependent and independent variables, their corresponding conceptual cluster, and available sample size. Human Development and Economic Capacity is abbreviated throughout as HD & EC. Variable sample sizes vary due to data availability constraints

across source institutions, as discussed in Section 3.2. Full independent variable data for all 144 countries are provided in Appendix A (Table A6a-e).

Table 3: Dependent and Independent Variable Titles, Conceptual Clusters, Source, and Sample Size (n).

Variables	Conceptual Cluster	Source	Sample Size (n)
Electro-Transition Score	Dependent Variable	IEA	144
Net Zero Commitment Level	Governance Capacity	ECIU	144
V-Dem LD Score (2024)	Governance Capacity	V-DEM	142
Corruption Score (2025)	Governance Capacity	Transparency Intl.	142
HDI Score (2024)	HD & EC	UNDP	134
GDP Δ (2000-2024)	HD & EC	World Bank	137
GDP Per Capita Δ (2000-2024)	HD & EC	World Bank	138
Oil %/GDP Δ (2000-2021)	Fossil Fuel Dependence	World Bank	144
Coal %/GDP Δ (2000-2021)	Fossil Fuel Dependence	World Bank	144
Natural Gas %/GDP Δ (2000-2021)	Fossil Fuel Dependence	World Bank	144
Solar Potential (GHI, kWh/m2/day)	Renewable Endowment	World Bank	140
Wind Power Potential (W/m2 @ 100m)	Renewable Endowment	Global Wind Atlas	143
Hydropower Potential (GWh/year)	Renewable Endowment	Hoes et al. (2017)	140
Net Energy Import, % of use (2022)	Climate Vulnerability	World Bank	133
Climate Risk Rank Δ (1995-2024)	Climate Vulnerability	GermanWatch	129
Climate Risk Temp. Δ (SSP2.5-4)	Climate Vulnerability	Climate Impact Lab	144

4.2 Normality Testing Results

Table 4 presents the Shapiro-Wilk normality test results for all 15 independent variables and the dependent variable.

Table 4: Shapiro-Wilk Normality Test for Dependent and Independent Variables.

Variable	n	W Statistic	p-value	Normally Distributed?
Net Zero Commitment	144	0.808	< .001	No
V-Dem LD Score	142	0.921	< .001	No
HDI Score	134	0.940	< .001	No
Corruption Score	142	0.959	< .001	No
GDP Change (2000–2024)	137	0.230	< .001	No
GDP Per Capita Change	138	0.765	< .001	No

Net Energy Imports (% of use)	133	0.799	< .001	No
Oil % / GDP Change	144	0.600	< .001	No
Coal % / GDP Change	144	0.287	< .001	No
Fossil gas % / GDP Change	144	0.341	< .001	No
Climate Risk (Rank Δ)	129	0.974	0.013	No
Climate Risk (Temp Δ)	144	0.961	< .001	No
Solar Potential (GHI)	140	0.953	< .001	No
Wind Power Potential	143	0.688	< .001	No
Hydropower Potential	140	0.411	< .001	No
Electro-Transition Score (DV)	**144**	**0.919**	**< .001**	**No**

Following normality testing via the Shapiro-Wilk test, all 15 independent variables returned statistically significant results ($p < .05$), confirming non-normal distributions across the full sample. As presented in Table 4, W statistics range from 0.230 to 0.974, with no variable meeting the threshold for normality. These results provide the methodological justification for Spearman rank correlation as the primary analytical method, as established in Section 3.5 and presented in Section 4.3.

4.3 Spearman Rank Correlation Results

Table 5 presents the full Spearman rank correlation results for all 15 independent variables against the ETS, ranked high-to-low by their correlational strength.

Table 5: Spearman Rank Correlation Results.

Independent Variable	n	Spearman's ρ	p-value	Significance
V-Dem LD Score	142	0.462	< .001	***
Net Zero Commitment	144	0.440	< .001	***
HDI Score	134	0.415	< .001	***
GDP Per Capita Change	138	0.389	< .001	***
Net Energy Imports (% of use)	133	0.348	< .001	***

Corruption Score	142	0.333	< .001	***
Wind Power Potential	143	0.297	< .001	***
Climate Risk (Rank Δ)	129	0.273	0.002	**
GDP Change (2000–2024)	137	0.228	0.007	**
Oil % / GDP Change	144	0.194	0.020	*
Climate Risk (Temp Δ)	144	0.190	0.023	*
Hydropower Potential	140	0.104	0.223	ns
Coal % / GDP Change	144	-0.158	0.059	ns
Fossil gas % / GDP Change	144	-0.377	< .001	***
Solar Potential (GHI)	140	-0.417	< .001	***

Governance Capacity Cluster: the V-Dem Liberal Democracy Score returned the strongest correlation of all 15 variables ($\rho = 0.462$, $p < .001$), followed closely by Net Zero Commitment Level ($\rho = 0.440$, $p < .001$) and Corruption Score ($\rho = 0.333$, $p < .001$). The consistent significance across all three governance variables reinforces the central argument that institutional capacity is a reliable associate of clean energy transition progress.

Human Development and Economic Capacity Cluster: HDI ($\rho = 0.415$, $p < .001$) and GDP per capita ($\rho = 0.389$, $p < .001$) both returned strong positive correlations, while GDP total returned a weaker but statistically significant result ($\rho = 0.228$, $p < .01$). This cluster produced consistently significant results, suggesting that broader human development capacity is a reliable associate of clean energy transition progress.

Fossil Fuel Structural Dependency Cluster: fossil gas rents as a percentage of GDP returned the strongest negative correlation in the cluster ($\rho = -0.377$, $p < .001$), while oil rents as a percentage of GDP returned a modest positive correlation ($\rho = 0.194$, $p < .05$). Coal rents returned a non-significant result ($\rho = -0.158$, ns). The negative direction of the fossil gas result is consistent with the carbon lock-in and resource curse frameworks

examined in Section 2.4, and the divergence across fossil fuel types is discussed further in Section 5.

Renewable Resource Endowment Cluster: wind potential returned the strongest positive correlational result in the cluster ($\rho = 0.297$, $p < .001$). Solar GHI, however, returned the strongest negative correlation of all 15 variables ($\rho = -0.417$, $p < .001$)—a counterintuitive finding discussed in depth in Section 5.6. Hydropower potential returned a non-significant result ($\rho = 0.104$, ns).

Climate Vulnerability and Energy Sovereignty Cluster: net energy imports returned the strongest positive correlation in the cluster ($\rho = 0.348$, $p < .001$). Both vulnerability variables returned positive and statistically significant correlations—climate risk rank change ($\rho = 0.273$, $p < .01$) and projected temperature rise ($\rho = 0.190$, $p < .05$)—suggesting that countries facing escalating climate exposure show modestly stronger transition progress, though the effect sizes are among the smaller in the framework.

Strongest positive correlates: The three strongest positive correlates—V-Dem Liberal Democracy Score ($\rho = 0.462$), Net Zero Commitment Level ($\rho = 0.440$), and HDI ($\rho = 0.415$)—are all governance or human development variables, consistent with this paper's directional hypothesis that institutional and development capacity outperform geographic resource endowment as predictors of transition progress.

Strongest negative correlates: The two strongest negative correlates are Solar GHI ($\rho = -0.417$) and fossil gas rents as a percentage of GDP ($\rho = -0.377$), with oil rents returning a modest positive result ($\rho = 0.194$) rather than the negative direction initially hypothesized.

Non-significant variables: Two variables returned non-significant results: hydropower potential (ρ = 0.104, ns) and coal rents as a percentage of GDP (ρ = -0.158, ns). The non-significance of hydropower potential aligns with Gosens' (2017) finding that natural resource endowment is not a strong driver of renewable deployment, even though most electrostate electricity comes from hydropower, as illustrated in Table 14. One potential explanation is that much of the easily accessible global hydropower has already long been developed, which as a concept is further examined in Section 5.2. Figure 4 presents a bar chart comparing the Spearman rank correlation results across all 15 independent variables.

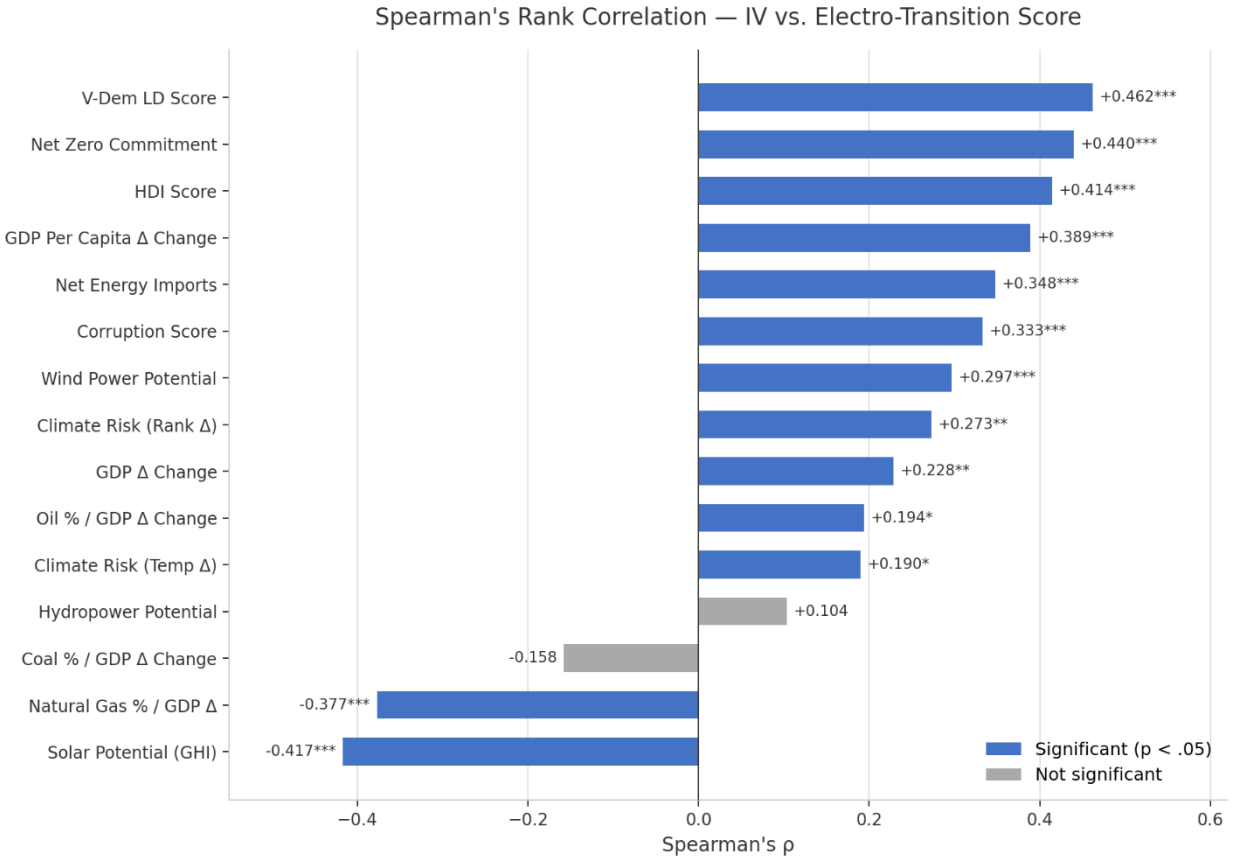


Figure 4: Spearman's Rank Correlation Test Results.

4.4 Pearson Robustness Check

As a robustness check, a Pearson correlation was conducted across all 15 independent variables. The results returned a convergence of r = 0.932 with the Spearman findings, confirming that the rank-based correlations presented in Section 4.3 are not an artifact of the rank transformation applied by the Spearman method. Given the near-identical ordering and directionality of results across both methods, Spearman rank correlation is retained as the primary analytical method for all subsequent interpretation. Notable divergences include GDP total, which returned significance under Spearman (ρ = 0.228, p < .01) but not Pearson (r = 0.076, ns), and fossil gas rents likewise diverged sharply—significant under Spearman (ρ = −0.377, p < .001) but not under Pearson (r = −0.078, ns)—suggesting that associations with ETS are rank-dependent rather than linear.

Table 6: Pearson Correlation Test Results.

Independent Variable	n	Pearson r	t-statistic	p-value	Significance
V-Dem LD Score	142	0.505	6.916	< .001	***
GDP Per Capita Change	138	0.414	5.305	< .001	***
Net Zero Commitment	144	0.408	5.329	< .001	***
HDI Score	134	0.384	4.775	< .001	***
Corruption Score	142	0.377	4.810	< .001	***
Wind Power Potential	143	0.308	3.846	<.001	***
Climate Risk (Rank Δ)	129	0.258	3.003	0.003	**
Net Energy Imports (% of use)	133	0.228	2.681	0.008	**
Oil % / GDP Change	144	0.209	2.540	0.012	*
Climate Risk (Temp Δ)	144	0.166	2.007	0.047	*
GDP Change (2000–2024)	137	0.076	0.886	0.377	ns
Hydropower Potential	140	0.009	0.103	0.918	ns
Fossil gas % / GDP Change	144	-0.078	-0.928	0.355	ns
Coal % / GDP Change	144	-0.118	-1.413	0.160	ns
Solar Potential (GHI)	140	-0.447	-5.861	< .001	***

4.5 Key Figures and Visualizations

This section presents a range of figures and tables that further contextualize the data analyzed in Section 5. **Figure 5** presents a world map representing Electro-Transition Score across all 144 countries, with colour gradation indicating transition progress from negative to positive scores. Yellow indicates electrostates. Geographic clustering is evident, with OECD and European nations concentrated in the upper range and African and Middle Eastern nations in the lower range—with a few notable exceptions. Electrostates, outliers, and patterns from this figure are discussed in depth in Section 5.2.

Figure 6 plots Electro-Transition Scores (y-axis) against 2023/2024 clean energy generation share (x-axis) for all 144 countries, with bubble size representing total generation growth over the study period. In some cases, where grid generation fell overall between the study period, the smallest bubble size was used. G20 member countries are labelled, illustrating the institutional divergence quantified in Table 2.

Figure 7 displays the distribution of ETS by continental and regional grouping. Europe and the Americas show rightward distributions, while Africa, the Middle East, and Asia show a mostly pronounced leftward skew. However, in most regions—save for the Middle East—there are notable outliers present on the upper-maximum rightward skew of the distributional band. These outliers from varying global regions are further discussed in Section 5.2.

Electro-Transition Scores Ranked: Table A4, located in Appendix A, ranks all 144 countries by ETS in descending order, providing a direct comparative overview of transition progress across the full sample.

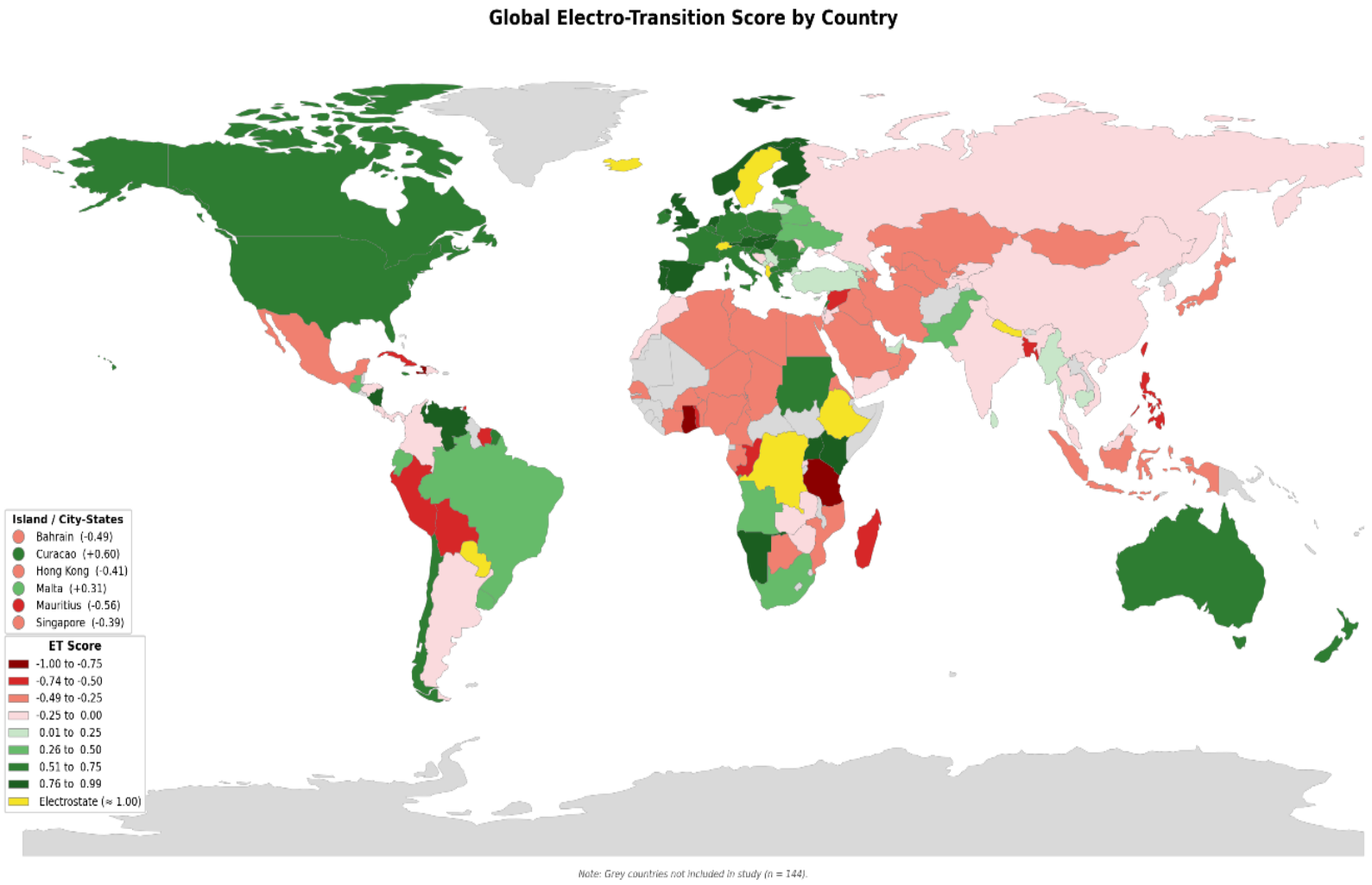


Figure 5: Visualized Global Map of Electro-Transition Scores by Country.

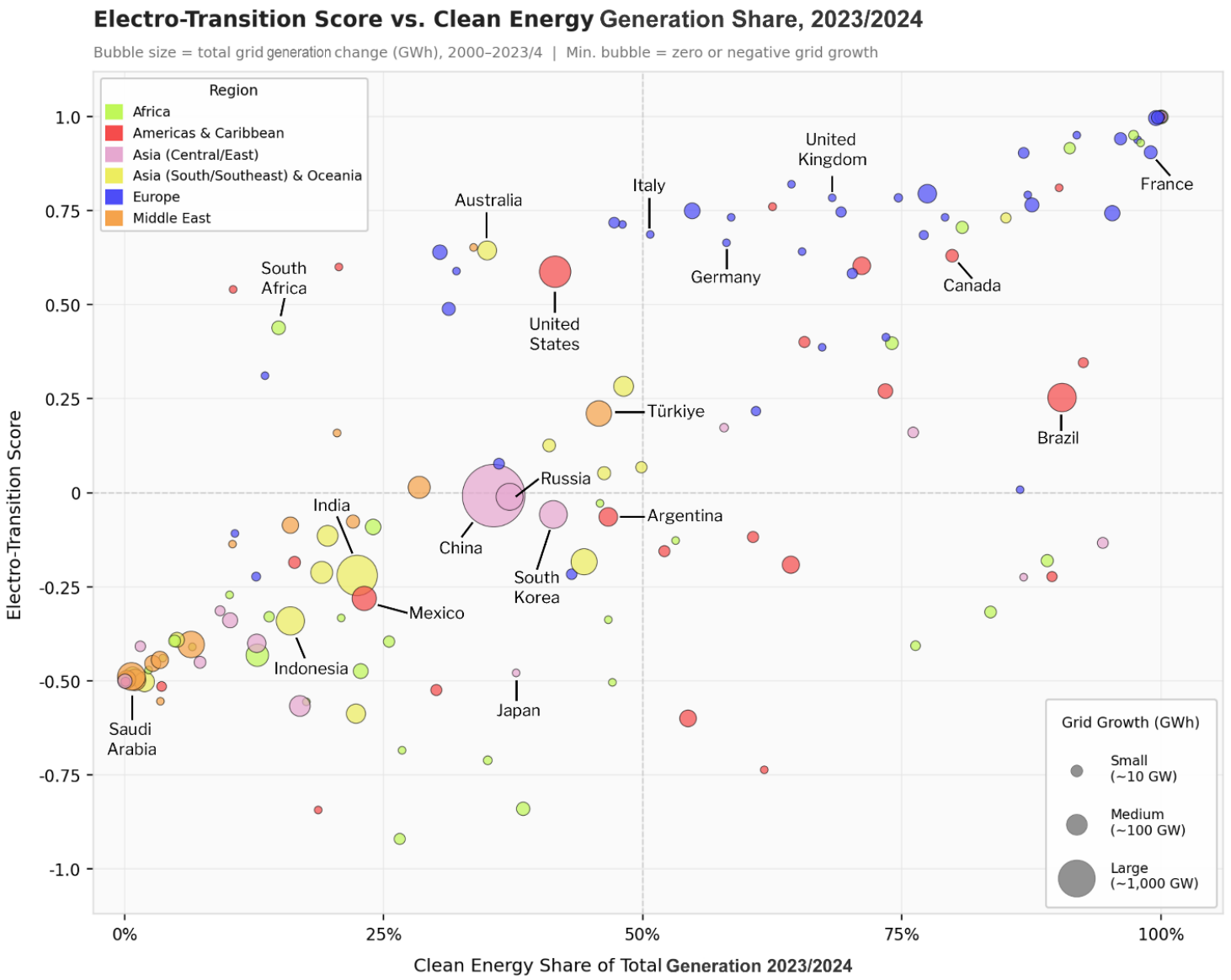


Figure 6: ETS (y-axis) and CEG (%/2023/2024) (x-axis); colouring based on region. Text labels assigned to G20 countries.

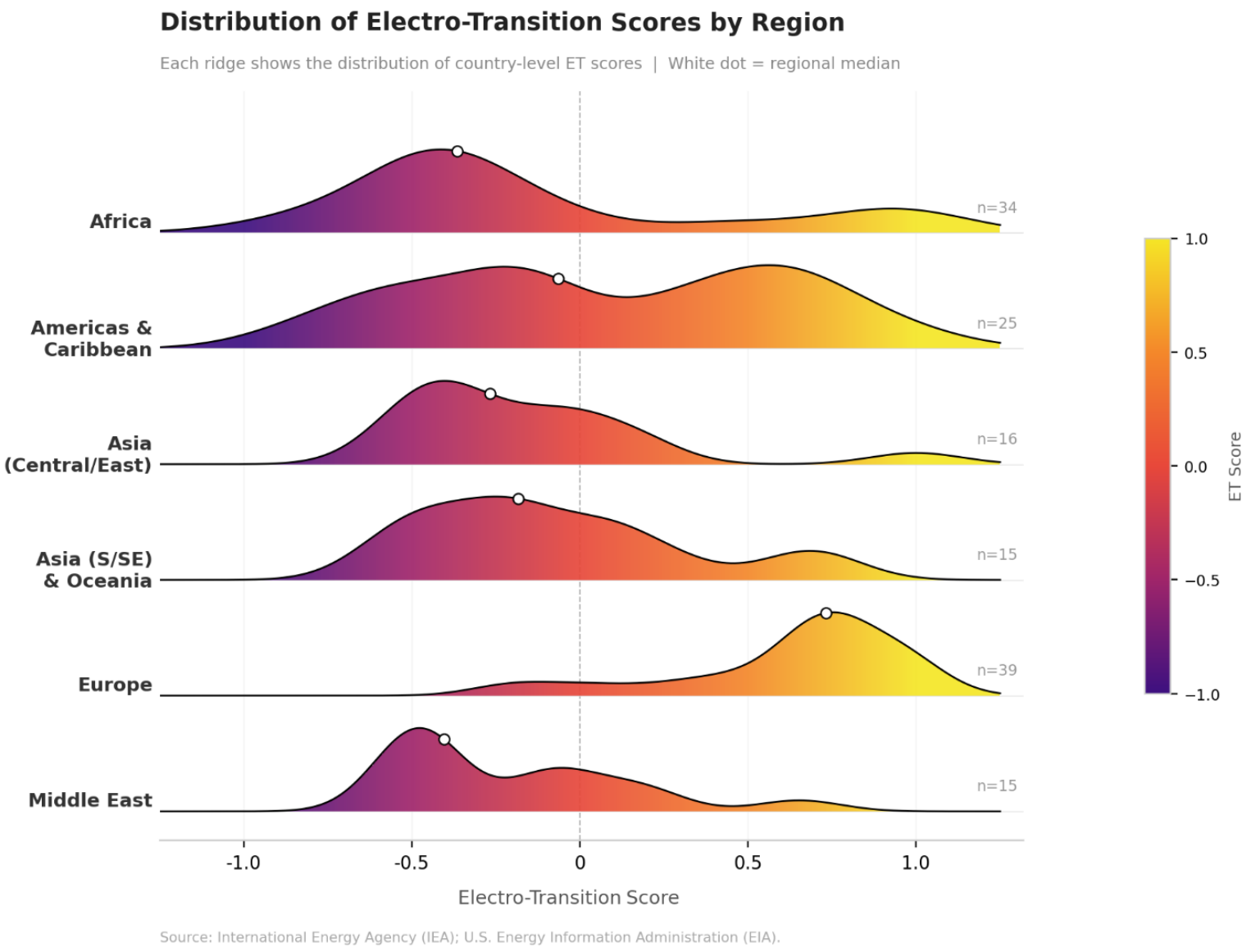


Figure 7: Regional distribution of ETSs as a ridgeline visualization.

Biggest clean energy generation gainers: Table 7 presents the 25 countries recording the greatest percentage point change in CEG share between 2000 and 2023/2024. Denmark leads the group for largest overall positive changes in clean energy adoption, achieving an ETS of 0.95, the highest among non-electrostate countries. Results are discussed in Section 5.4, and the full list can be in Appendix A, Table A5.

Table 7: Largest Global Gainers of Clean Energy Generation Share.

Country	ETS	CEG (%, 2000)	CEG (%, 2023/24)	Change (Δ)
Denmark	0.95	17.11	91.84	74.74
Estonia	0.82	0.21	64.34	64.13
Portugal	0.90	30.89	86.72	55.83
Netherlands	0.75	9.32	54.74	45.42
Kenya	0.92	47.05	91.20	44.16
United Kingdom	0.79	26.06	68.26	42.20
Nicaragua	0.76	21.40	62.48	41.09
Ireland	0.72	6.23	47.21	40.98
Cambodia	0.13	0.22	40.94	40.72
Greece	0.72	8.78	48.01	39.23
Czech Republic	0.73	22.37	58.52	36.15
Sudan	0.71	46.05	80.81	34.76
Hungary	0.78	41.14	74.66	33.52
Spain	0.80	44.93	77.45	32.52
Belarus	0.49	0.10	31.25	31.15
Finland	0.94	65.91	96.10	30.19
Romania	0.75	38.96	69.09	30.13
Italy	0.69	21.28	50.72	29.44
Lebanon	0.65	4.48	33.63	29.15
United Arab Emirates	0.01	0.00	28.37	28.37
Poland	0.64	3.04	30.39	27.34
Australia	0.64	8.54	34.98	26.44
Chile	0.60	48.55	71.10	22.55
Jordan	-0.08	0.61	22.02	21.41
Türkiye	0.21	24.98	45.76	20.78

Biggest clean energy generation losers: Table 8 presents the 25 countries recording the greatest absolute declines in CEG over the study period. Many of these countries such as Republic of Congo, Cameroon and others had near-total clean energy grids in 2000, but the expansion of fossil fuel-based infrastructure—mostly in the form of fossil gas—eroded what would be a high ETS. Results are discussed in Section 5.5.

Table 8: Largest Global Losers of Clean Energy Generation Share.

Country Name	ETS	CEG (%, 2000)	CEG (%, 2023/24)	Change (Δ)
Congo, Republic	-0.71	99.67	35.03	-64.64
Tanzania	-0.92	86.54	26.54	-59.99
Ghana	-0.84	91.50	38.46	-53.04
Haiti	-0.84	51.74	18.66	-33.08
Peru	-0.60	86.06	54.37	-31.69
Togo	-0.68	57.14	26.78	-30.36
Suriname	-0.74	88.40	61.70	-26.70
Madagascar	-0.50	69.79	47.02	-22.76
Cameroon	-0.41	98.91	76.32	-22.59
Bolivia	-0.52	51.52	30.05	-21.47
Philippines	-0.59	42.89	22.28	-20.61
Mozambique	-0.32	99.55	83.54	-16.00
Gabon	-0.34	61.60	46.63	-14.96
Nigeria	-0.47	37.28	22.75	-14.53
Mauritius	-0.56	29.64	17.54	-12.10
Colombia	-0.19	75.53	64.25	-11.28
Cote D'Ivoire	-0.39	36.75	25.52	-11.23
Viet Nam	-0.18	54.78	44.33	-10.45
Zambia	-0.18	99.39	89.04	-10.35
Rwanda	-0.13	63.47	53.16	-10.31
Honduras	-0.15	61.97	52.05	-9.93
Panama	-0.12	70.43	60.63	-9.80
Taiwan	-0.57	26.60	16.87	-9.73
Costa Rica	-0.22	99.15	89.46	-9.69
Syria	-0.55	12.81	3.44	-9.37

Solar gainers: Table 9 presents the countries recording the greatest growth in solar generation between 2000 and 2023/2024. The concentration of high-income, industrially dominant nations in the upper rankings reinforces the solar paradox finding in Section 4.3—that solar resource endowment alone does not predict deployment, but economic and institutional capacity does. Results are discussed in Section 5.6.

Table 9: Top Solar PV Gainers Between 2000 and 2023/2024.

Country	Solar PV GWh (2000)	Solar PV GWh (2023/24)	Change (GWh)
China	22	584,150	584,128
United States	183	272,526	272,343
India	2	118,528	118,526
Japan	356	97,894	97,538
Germany	60	74,297	74,237
Brazil	0	70,664	70,664
Spain	14	53,706	53,692
Australia	38	48,596	48,558
Italy	18	35,993	35,975
South Korea	5	33,408	33,403
Viet Nam	0	27,222	27,222
Türkiye	0	26,277	26,277
Mexico	7	24,274	24,267
France	5	23,623	23,618
Netherlands	8	21,266	21,258
Chile	0	20,817	20,817
Poland	0	15,231	15,231
United Kingdom	1	14,789	14,788
United Arab Emirates	0	13,312	13,312
Taiwan	0	12,908	12,908
Israel	0	10,793	10,793
Greece	0	9,466	9,466
Hungary	0	9,136	9,136
Belgium	0	8,000	8,000
Canada	0	7,948	7,948

Wind gainers: Table 10 presents the countries recording the greatest growth in wind generation between 2000 and 2023/2024, consistent with wind potential's positive Spearman correlation ($\rho = 0.297$, $p < .001$) reported in Section 4.3. Results are discussed in Section 5.7.

Table 10: Top Wind Gainers Between 2000 and 2023/2024.

Country	Wind GWh (2000)	Wind GWh (2023/24)	Change (GWh)
China	615	885,870	885,255
United States	5,650	458,511	452,861
Germany	9,352	138,914	129,562
Brazil	2	107,654	107,652
India	1,684	93,465	91,781
United Kingdom	947	84,057	83,110
Spain	4,727	62,090	57,363
France	48	47,245	47,197
Canada	264	46,634	46,370
Sweden	457	40,419	39,962
Türkiye	33	36,627	36,594
Netherlands	829	33,500	32,671
Australia	58	30,991	30,933
Poland	5	24,763	24,758
Italy	563	22,306	21,743
Mexico	19	19,952	19,933
Finland	78	19,405	19,327
Denmark	4,241	20,552	16,311
Argentina	35	16,170	16,135
Norway	31	14,544	14,513
Portugal	168	14,396	14,228
Belgium	16	13,975	13,959
Japan	108	11,984	11,876
South Africa	0	11,586	11,586
Viet Nam	0	11,583	11,583

Coal gainers/losers: Table 11 presents the top and bottom ten countries recording the greatest gains and losses in coal generation between 2000 and 2023/2024. Countries with the largest coal additions are concentrated among rapidly industrializing economies, while coal generation reductions are predominantly observed across OECD nations—patterns which are discussed further in Section 5.8.

Table 11: Top Coal Gainers and Losers Between 2000 and 2023/2024.

Country	Coal GWh (2000)	Coal GWh (2023/24)	Change (GWh)
China	1,060,372	5,856,538	4,796,166
India	386,523	1,478,683	1,092,160
Indonesia	34,002	299,628	265,626
Viet Nam	3135	122,646	119,511
South Korea	110,309	198,021	87,712
Türkiye	38,187	120,377	82,190
Malaysia	7,691	86,882	79,191
Japan	228,204	295,322	67,118
Philippines	16,663	73,753	57,090
Russia	175,615	210,563	34,948
-	-	-	-
Ukraine	51,514	23,325	-28,189
France	30,860	2,038	-28,822
Greece	34,313	3,269	-31,044
Poland	137,921	94,638	-43,283
Australia	174,245	128,542	-45,703
Spain	80,858	3,466	-77,392
Canada	117,588	18,147	-99,441
United Kingdom	122,300	2,660	-119,640
Germany	304,162	120,016	-184,146
United States	212,9498	720,517	-1,408,981

Nuclear gainers/losers: Table 12 presents the countries recording the greatest gains and losses in nuclear generation over the study period. Given the Ember Institute's classification of nuclear energy as clean—a framing consistent with this paper's framework—meaningful nuclear additions contribute positively to a country's ETS. Notably, Germany and Japan, which are described by Aldrich et al. (2019) as "extreme test cases" for post-Fukushima nuclear policy, account for the steepest losses: Germany completed its deliberate phase-out of all plants by 2022, while Japan, though retaining nuclear for energy sovereignty, sharply curtailed output. In both cases the loss reflects policy choice rather than resource constraint, distinguishing it from the hydropower-to-fossil-gas reversals discussed in Section 5.5.

China, conversely, stands out as a dominant adopter of nuclear energy, generating over 400,000 more GWh in 2023 than it did in 2000. As of April 2026, China has a further 39 plants undergoing construction, with 41 plants in the planning stage (Gaudiaut, 2026). The next leading countries are Russia and India with a collective 15 plants under construction and 37 planned. Canada and the United States—countries with longstanding histories as early nuclear energy adopters—continue to refurbish and expand their existing nuclear capacity as well. As nuclear continues to slowly regain broader acceptance within international energy policy, the technology may play a growing part in meeting future rising demand. Nuclear still has a higher economic barrier than most other clean energies available, but this may change over time through economies of scale. Alternatively, the cost barriers to nuclear energy may never reach a level required for widespread adoption.

Table 12: Top Nuclear Gainers and Losers Between 2000 and 2023/2024.

Country	Nuclear GWh (2000)	Nuclear GWh (2023/24)	Change (GWh)
China	16,737	434,720	417,983
Russia	130,715	217,000	86,285
South Korea	108,964	188,754	79,790
United Arab Emirates	0	33,063	33,063
India	16,902	47,937	31,035
Pakistan	1,997	26,169	24,172
United States	797,718	815,554	17,836
Czech Republic	13,590	29,696	16,106
Canada	72,799	86,066	13,267
Belarus	0	11,804	118,04
-	-	-	-
Sweden	57,316	50,412	-6,904
Spain	62,206	54,532	-7,674
Lithuania	8,419	0	-8,419
Belgium	48,157	31,254	-16,903
Taiwan	38,503	17,801	-20,702
Ukraine	77,341	51,989	-25,352
France	415,162	380,451	-34,711
United Kingdom	85,063	40,587	-44,476
Germany	169,606	0	-169,606
Japan	322,049	93,482	-228,567

Geothermal gainers: Table 13 presents the countries recording the greatest growth in geothermal generation over the study period. As compared to the other energy types, adoption of geothermal energy is less by comparison but still noted within this paper due to its rising prevalence. Given geothermal energy's relatively limited geographic availability, the rankings are unsurprisingly concentrated among a small number of volcanically active nations; however, their contributions to national ETSs are noted where applicable.

While geothermal energy remains nascent, the IEA believes the technology will play a much larger role in global energy production in the coming decades (IEA, 2024d), with the potential to supply 15 percent of global electricity demand by 2050. Projections like these are being made possible by next-generation advancements in geothermal technologies, such as enhanced geothermal systems (EGS) and closed-loop geothermal (CLG) (IEA, 2026c). The list presented below is exhaustive—representing all countries in the dataset that added any geothermal generation whatsoever during the study period—illustrating geothermal energy's infancy as compared to other clean energy technologies.

Table 13: Top Geothermal Gainers Between 2000 and 2023/2024.

Country	Geothermal GWh (2000)	Geothermal GWh (2024/23)	Change (GWh)
Indonesia	4,869	16,936	12,067
Türkiye	76	11,241	11,165
New Zealand	2,921	9,265	6,344
Kenya	429	5,551	5,122
Iceland	1,323	6,197	4,874
United States	14,621	18,185	3,564
Italy	4,705	5,648	943
Nicaragua	134	751	617
Japan	3,347	3,870	523
Costa Rica	976	1,498	522
Russia	58	455	397
Honduras	-	318	318
Chile	-	308	308
Germany	-	214	214
France	-	128	128
Portugal	80	201	121
China	109	195	86
Taiwan	-	23	23
Croatia	-	20	20
Hungary	-	11	11

Section 5: Discussion

5.1 Introduction, Overview, and Roadmap

At its core, this paper sought to determine which countries are leading the race—and which are falling behind—toward Net Zero electricity, thus achieving electrostate status, in a time of rising climate urgency. The Electro-Transition Score, constructed in Section 3.4, assigns a single value to the strength—or weakness—of a country's clean energy transition across the 21st century landscape. Its two-signal logic rewards countries only where clean energy expansion is paired with the dismantling of existing fossil fuel infrastructure: one without the other yields a middling score, both together approach 1, and fossil expansion atop stagnant clean generation approaches –1. The metric therefore measures substitution rather than mere addition, capturing which of the 144 countries translated the commitments of the Kyoto Protocol and Paris Agreement into structural change between 2000 and 2023/2024.

The analysis that follows returns a consistent throughline: transition outcomes divide along institutional and structural lines far more than geographic or resource-based ones. Three mechanisms recur—the primacy of governance and economic capacity over raw resource endowment, fossil gas as the principal vehicle of backsliding, and energy sovereignty as an emerging structural driver—each complicated by outlier electrostates that resist any simple income- or bloc-based categorization. Favourable resource or cost conditions do not deploy themselves; whether they translate into generation depends on the governance stability, policy continuity, and economic slack required to finance and sustain buildout, which is why resource-rich but capacity-poor states so often

underperform their endowment. These relationships are correlational, and the discussion is framed accordingly.

Together, these threads structure the progression that follows, which advances from the transition's most settled cases toward its most contested and volatile fronts. This spans established global clean energy leaders including existing electrostates and the inherited-versus-achieved distinction that explains them (5.2–5.3); the sharpest movers in both CEG growth and reduction (5.4–5.5); the resource paradoxes of solar energy and the converging institutional capacity to capitalize on wind availability (5.6–5.7); sectoral and national deep-dives into coal expansions and reductions, Canada's federal fragmentation, and the U.S.–China divergence in global energy markets (5.8–5.10); and finally the geopolitical and capital forces that increasingly shape the global energy landscape and its ongoing transitions (5.11–5.12).

5.2 Electrostates, Near-Electrostates, and the Unifying Nexus

As reflected in Section 4.1, Table 1, eight countries have already achieved full electrostate status, with Paraguay achieving 100 percent CEG in both 2000 and 2023. Norway and Uganda were both ES in 2000, but by 2023/2024 fell to NES status, totalling six near-electrostate countries. Three of these countries already had NES status in 2000—indicating their basis for *maintenance*-versus-*growth*—while three represent extensive growth in clean generation in the years since 2000. These three CEG growth countries are France, Luxembourg, and Finland, which grew from 90.83, 81.60, and 65.91 percent respectively to >95 percent. In this regard, maintaining an already-clean grid is a meaningfully different achievement than building one from a position of deficit—and it

is the latter that the ETS is designed to illustrate. A notable development arises when examining the primary energy sources for these countries. For all eight electrostates and all but two of the near-electrostates, their main source of electricity is hydropower, as observed in Table 14.

Table 14: Primary Electricity Source for Electrostates and Near-Electrostates.

Country	Primary Electricity Source	Region
Albania	Hydropower	Europe
Nepal	Hydropower	Asia (Central/East)
Paraguay	Hydropower	Americas & Caribbean
Ethiopia	Hydropower	Africa
Iceland	Hydropower	Europe
DR Congo	Hydropower	Africa
Switzerland	Hydropower	Europe
Sweden	Hydropower	Europe
Norway	Hydropower	Europe
Namibia	Hydropower	Africa
Luxembourg	Hydropower	Europe
Uganda	Hydropower	Africa
Finland	Nuclear*	Europe
France	Nuclear*	Europe

**Finland and France's second-largest source of electricity is hydropower.*

This observation runs somewhat counter to the independent variable *Hydropower Potential,* which lands on the lower end of the Spearman result ($\rho = 0.104$). Though regions for these countries vary, one finding emerges: the historical enablement of ES and NES status is strengthened by proximity to hydropower, even though access to hydropower potential itself is not an indicator of becoming an electrostate. Given that hydropower is a mature technology, with the first dams generating electricity in the late 19th century, this provides a partial explanation for why most established ES and NES countries are

powered by hydro. Historically, for countries that did not have proximity to hydropower, they would have had to rely on fossil fuels such as coal in the 20th century, or fossil gas in the 21st century. Essentially, it was the fortunate proximity to hydropower that enabled the existing ES and NES countries to achieve that status before 2000 rather than after—or not at all. It was only this century that alternative clean energies such as wind and solar became economically viable, so countries currently seeking electrostate status without proximity to hydropower will now need to rely on RE or nuclear to close the existing gap.

While 8 of the 14 countries in Table 14 are developed European countries, notable exceptions and outliers exist—and will be discussed in the next subsection. A critical distinction underpins this examination: Global South countries including Democratic Republic of Congo, Ethiopia, Paraguay, and Uganda established high CEG early on through fortunate, proximal access to hydropower capture potential—never having built a fossil fuel regime to displace—whereas countries such as France, Luxembourg, and Finland achieved it through a deliberate transition during the study period.

5.3 Electrostate Outliers as a Counternarrative to an Income-Dependent Transition

Nepal, Paraguay, Ethiopia, and the DR Congo are all developing, Global South electrostates. Furthermore, African nations including Uganda, Namibia, and Kenya have clean generation ranging between 91.20–98.03 percent. These countries and others, like Tajikistan and Venezuela (94.38 and 90.13 percent CEG) challenge the conventional academic notion that only wealthy, developed states can fully decarbonize. Each of these countries—save for Kenya—gets a majority of its electricity from hydropower. Kenya's

primary source is geothermal. To determine where these countries lie on the top five Spearman variables, Table 15 was generated. The full list of countries and independent variable scores can be found in Appendix A (Table A6a-e).

Table 15: Top Five Independent Variable Scores For High CEG/ES Countries.

Country	CEC (%/2023/24)	LD Score (ρ = 0.4620)	NZC (ρ = 0.4395)	HDI Score (ρ = 4145)	GDPPC Δ (ρ = 0.3890)	Imports (ρ = 0.3477)
Nepal	100	0.52	0.75	0.62	$ 1,223.48	27.41
Paraguay	100	0.39	0	0.84	$ 4,679.98	5.65
Ethiopia	100	0.1	0.75	0.5	$ 1,011.61	10.79
DRC	100	0.13	0	0.52	$ 271.45	1.60
Uganda	97.32	0.2	0.75	0.58	$ 819.86	20.49
Namibia	98.03	0.52	0.75	0.67	$ 2,256.45	60.50
Kenya	91.2	0.43	0	0.63	$ 1,717.80	22.44
Zambia	89.04	0.39	0	0.58	$ 827.68	9.03
Tajikistan	94.38	0.05	0	0.69	$ 1,204.27	28.05
Venezuela	90.13	0.05	0	0.74	-$ 558.69	-73.91

Given that the five strongest Spearman correlates focus on robust democracy, climate policy, human development, GDP per capita, and energy imports, this would predict that to achieve a meaningful transition to electrostate status, high scores across these variables would be a prerequisite for meaningful transition progress, and that low-income, low-governance countries should be among the weakest performers. As Table 15 reflects, however, these countries run counter to that hypothesis.

Among the countries, a pattern emerges—with one outlier. All 10 countries—apart from Kenya—had very high levels of CEG in 2000, at the beginning study date. This indicates that they achieved a mostly clean electricity grid long before any external international climate commitments. Kenya on the other hand, went from 47.05 to 91.20 percent CEG between the observed study dates, illustrating the high level of achieved clean energy development, versus longstanding inherited development. The 9 countries excluding Kenya did not need to transition drastically away from a fossil fuel-based energy infrastructure, because they never had large systems to begin with, at least going

into the year 2000. Again, fortunate proximal access to hydropower and no incumbent fossil fuel infrastructure lock-in enabled this outcome. The outlier, Kenya, has never used coal to produce electricity—only oil (IEA, 2024b). In 2000, oil was Kenya's largest source of electricity production, with notable peaks in 2009 and 2017. By 2023, Kenya had reduced its oil generation to one-third of its peak generation levels. As reflected in Section 4.5, Table 13, Kenya ranks 4th in the world for geothermal adoption, a trend that accelerated in 2013 when Kenya rapidly started building out the technology. In 2014, it overtook hydropower to be the largest electricity source for the country. Though Kenya scores in the middle to low ranges on the five Spearman variables in Table 15, it directed a deliberate adoption of geothermal energy through policy implementations, becoming a global leader in the technology. These variables fail to predict CEG in this context is itself analytically meaningful rather than a weakness of the framework, and further, complements the discussion of energy sovereignty, a topic further examined in Section 5.11.

When observing the energy import data in Table 15, the data reflects that all but one country imports some percentage of their used energy. The largest importer—Namibia—imports roughly 60 percent of its total energy usage, with Nepal, Uganda, Kenya, and Tajikistan importing between 20–30 percent. The only country here which is a net exporter is Venezuela. This suggests that because many of these countries rely at least somewhat on energy imports; hydropower is not an "environmental" choice, but a structural and economic necessity. This is because dependency on energy imports from other countries pushes domestic electricity production—in this case via hydropower—as a financial and strategic imperative for these countries versus a policy prerogative.

Otherwise, these developing countries would historically be likely to build-out large amounts of fossil fuel infrastructure, a fiscally prohibitive proposition for countries operating on constrained budgets. The Spearman result for Net Energy Imports ($\rho = 0.348$) provides a statistical anchor for this argument. Energy sovereignty has become an increasingly prominent feature of global energy policy discourse, particularly in the years following Russia's 2022 invasion of Ukraine and the subsequent European pivot toward domestic renewable generation—a topic discussed further in Section 5.11.

5.4 Biggest Clean Energy Leaders

This section is devoted to examining the top countries in Table 7 that rapidly accelerated their CEG while also reducing their fossil fuel generation. Of the 144 countries, Denmark stands as the largest accelerator of clean energy generation change in the sample, growing its clean energy generation from 17.11 to 91.84 percent in 24 years—in turn approaching near-electrostate status. Denmark's growth trajectory is examined more substantively in Section 5.7. Furthermore—within Table 7—seven out of the top ten countries are based in Europe, with six being members of the EU. This empirically reinforces Table 2's EU bloc mean (0.692) and illustrates the relationship between the most strongly correlated independent variables and the Electro-Transition Score. EU member states rank highly across the governance IVs, including V-Dem LD ($\rho = 0.462$), Corruption ($\rho = 0.333$), and NZC ($\rho = 0.440$), each of which offers an institutional substrate that enables these relationships and outcomes.

The EU's policy harmonization, carbon pricing mechanisms, and binding renewable mandates—embodied in the *2019 European Green Deal, 2021 European Climate*

Law, and *2021 Fit for 55* package—are the regime-level enablers in MLP terms (Geels, 2011) and offer an explanation as to why most of the countries which most rapidly accelerated clean energy generation are EU members. The United Kingdom (+ 42.2 percent CEG), though no longer an EU member, achieved comparable transition outcomes through analogous policy mechanisms, including its own legally binding Net Zero commitment and accelerated coal phase-out as discussed in Section 5.8.

Aside from Denmark—Estonia (+64.13 percent), Portugal (+55.83 percent), and the Netherlands (+45.42 percent) stand out for their energy transformations and grid decarbonization. What makes Estonia unique is that unlike other European countries, it started with under 1 percent CEG in 2000 and ended with 64.34 percent in 2024, meaning its entire fossil fuel-based grid had to be radically altered to accommodate clean energy deployment—a formidable undertaking. Also present in the group of countries with <1 CEG in 2000 is Cambodia (+40.72 percent), which grew its CEG to 40.94 percent by 2023. However, Cambodia simultaneously built out a sizeable amount of coal infrastructure alongside clean energy, thus earning it a lower ETS of 0.13.

Kenya (+44.16 percent) and Nicaragua (+41.09 percent) also stand as unique amongst this group in the sense that—like Cambodia—both are Global South, economically developing countries, which ties back to the discussion in Section 5.3 regarding inherited-versus-achieved energy transitions. This reinforces the notion that institutional variables alone do not fully determine transition pathways, and in the economic-enabling conditions literature of Section 2.3 (Sadorsky, 2009; Stern, 2004), the concentration of high-HDI, high-GDP-per-capita nations in the top 10 directionally confirms H2. For European countries that entered the study period with extensive fossil

fuel infrastructure, the act of replacement progressively lowers the marginal cost of further transition—consistent with the carbon lock-in and escape conditions discussed in Section 2.4 (Unruh, 2000; Unruh, 2002). The complete, ranked list for CEG change within the study period can be found in Appendix A, Table A5.

5.5 Biggest Clean Energy Laggards

This section is devoted to examining the top countries which systematically reduced their CEG over the study period. Table 8 reflects the countries that began with strong levels of CEG—mostly via hydropower—but over time reduced it by constructing fossil fuel infrastructure. Of the top ten countries present, all are developing economies. Six are located in Africa; the other four are in Latin America and the Caribbean. Table 8 further illustrates that most failed to *maintain* their initially high CEG status: Republic of Congo (-64.6 percent), Tanzania (-60.0 percent), Ghana (-53.0 percent), Peru (-31.7 percent), Suriname (-26.7 percent), and Cameroon (-22.6 percent) all began with CEG exceeding 86 percent—some even at the electrostate and near-electrostate level—but by the end of the study period had dropped markedly. This is not a failure of their energy *transition*; rather, these countries had mostly-clean grids and chose, or were structurally compelled, to move away from them. Further, all ten countries had more hydropower *potential* generation than their current *installed* generation in 2000 (Hoes et al., 2017), indicating bandwidth for further deployment. By contrast, some of their African and Latin electrostate counterparts such as Ethiopia, the DR Congo, Namibia, Uganda, and Paraguay were able to fully maintain their CEG status, indicating distinct structural policy choice differences.

For most of the top ten countries in Table 8—save for Suriname, Madagascar, and Haiti—the rapid build-out of fossil fuel infrastructure can be attributed to increased deployment of fossil gas. Peru specifically increased gas generation by 26,647 GWh—over 3000 percent—during the study period (IEA, 2024c). Why then did Peru embrace fossil gas, while fellow Latin country Paraguay maintained its hydro-powered, clean energy status? In this scenario, fossil gas rents ($\rho = -0.377$, $p < .001$) supply both the statistical and qualitative explanation. Many of the countries in Table 8 already had existing fossil gas infrastructure in 2000, albeit however small. But by leaning *into* that infrastructure as opposed to turning *away* from it, they continued down a precarious path of re-carbonization and fossil fuel lock-in, as Unruh (2000) examines with his framework on the Techno-Institutional Complex.

Unlike the rapid CEG adopters in Section 5.4, these ten countries represent the opposite governance profile. Most have low liberal-democracy and corruption scores, and many do not have strong Net Zero climate policies in place or even in discussion. Whereas strong governance institutions may have enforced more rigorous clean energy policies after the signing of the Kyoto Protocol and Paris Agreement, or resisted incumbent gas interests, weak governance created space for infrastructure decisions that contradicted both national CEG trajectories and international climate commitments.

Furthermore, when examining bloc affiliations, the Republic of Congo is a member of OPEC/+—the global petroleum producer organization. While no direct causal line can be drawn to its ranking as the largest CEG loser over the study period, it does warrant noting. This further pertains to Section 2.4 and Ross' (1999, 2012) resource curse framework, wherein Ross establishes that resource wealth distorts economic

diversification, entrenches institutional dependency on extraction revenues, and crowds out the alternative development pathways that might otherwise incentivize a transition toward clean energy. Counterintuitively, the positive oil rents Spearman result ($\rho = 0.194$) likely reflects the distinction between oil as an export revenue source—which is used for gasoline and diesel fuels, chemicals manufacturing, and various other applications—versus oil as a domestic electricity generation input. Countries earning high oil rents are primarily exporters, and that export revenue does not necessarily translate into oil-fired electricity infrastructure domestically—unlike gas—making the rent measure a poor proxy for domestic fossil fuel lock-in in the electricity sector specifically.

5.6 The Solar Endowment Paradox

Across all 15 independent variables applied in this paper, Solar GHI produced the strongest negative Spearman correlate ($\rho = -0.417$, $p < .001$), which suggests that countries with the greatest available solar radiation as a resource endowment are more likely to have *lower* Electro-Transition Scores. Naturally, higher GHI is concentrated in regions near the equator, while lower potential characterizes the northern and southern latitudes. This equatorial proximity applies to regions including North and Sub-Saharan Africa, the Middle East, Southeast Asia, Central America and the Caribbean. The correlating factor here is that countries closer to the equator are—most often—Global South, developing nations. Given that such abundant solar availability correlates with a low likelihood of transitioning to clean energy, this relationship warrants explanation.

This is where Gosens' (2017) research applies, suggesting what this variable reflects: that natural endowment is not a strong driver of wind or PV deployment; instead,

institutional and economic conditions are. In combination, the two may produce complementary effects; however, resource endowment without accompanying economic stability and governance capacity is usually insufficient to achieve high adoption. This applies to near-equatorial countries such as Tanzania or Ghana that are based in regions with low governance scores, HDI, and GDP per capita, meaning the very countries with the highest GHI potential lack the institutional and economic means to exploit it.

The inverse holds equally true: the EU—characterized by high institutional capacity, strong governance, and binding renewable mandates—saw wind and solar generation collectively surpass fossil fuels as a share of electricity generation for the first time in 2025, reaching 30 percent versus 29 percent (Ember Energy, 2026a). This figure is up from 20 percent from five years prior, with renewables now routinely supplying the majority of EU electricity during summer months (Eurostat, 2025). The paradox is therefore less about solar availability than about the mediating role of governance and development capacity, which is visible in Table 9. These trends are swiftly changing among Global South countries however, with falling costs of solar and rising imports of panels from China (Jones, 2025). As Ember Energy reports, solar imports in Africa rose 60 percent between June 2024 and 2025, totalling 15,032 MW worth of panels. As the price for solar continues to fall, countries everywhere—developing or not—will increasingly be able to afford to procure solar technologies.

One country has embraced the falling cost of solar dramatically, eclipsing the rest of the world. Pakistan—the global leader of solar imports—has been deploying record amounts of solar, not only at the state level, but at the residential level as a means to combat the unreliability of national grids (Muhammadi et al., 2024). In 2024, Pakistan

imported 17 GW of solar panels from China (IEA, 2025a)—more than all of Africa imported in both 2024 and 2025. The adoption was assisted by favourable net metering policies enabled by the Government of Pakistan (Shahid et al., 2022), which directed state electricity distribution companies to assist residential adopters in being *prosumers*: individual entities that both consume and produce electricity. Between 2020-2024, Pakistan imported approximately USD $4.1 billion worth of panels (Renewables First, 2024) in response to high energy tariffs, with Pakistan's industrial sector also beginning to adopt the technology as a cost-saving measure. Not only has solar lowered energy costs for many residents across Pakistan, but it has also softened oil-demand spikes driven by regional instability from the 2026 Iran conflict (Pike & Clark, 2026), a topic further examined in Section 5.11. The soaring residential adoption by citizens of Pakistan presents an example of both top-down positive government policy as well as bottom-up grassroots citizen action—a model that will ideally emerge in other developing nations.

Pakistan's solar trajectory does illustrate one of the inherent limitations of the Electro-Transition Score; however, its exclusive focus on state-level generation means distributed residential adoption remains outside its analytical scope. Regarding the global geographic distribution of renewables, Overland et al. (2022) observe that solar is widely dispersed but deployment remains concentrated in wealthier nations. This is further discussed in Section 5.7, which examines the global adoption of wind energy. Growth in wind power has occurred primarily in high governance, high economic capacity regions that can also take advantage of wind-potential endowment, which corresponds positively to H4.

5.7 Wind Deployment and the Institutional Alignment

Where abundant solar endowment paradoxically predicts lower CEG, wind provides the counternarrative. While solar GHI returned the strongest negative correlate ($\rho = -0.417$), wind potential returned a significant positive result ($\rho = 0.297$, $p < .001$). Based on the Global Wind Atlas, unlike solar GHI, wind energy potential is greatest in the lower and higher latitudes and especially near coastlines—coincidentally near countries with strong economic and governance institutions. As such, this encompasses regions including Europe, North America, and the coastal areas of Latin America, East and South Asia, and Oceania—regions that overlap heavily with OECD membership, high LD scores, HDI, and strong Net Zero commitments. This geographic advantage means wind endowment and institutional capacity coexist in a way that solar endowment and institutional capacity do not. The work of Overland et al. (2022) applies once again, in that renewable resources are more evenly distributed than fossil fuels, but wind's distribution happens to align more favourably with existing institutional maturity than solar does. As Table 10 shows, each country present falls within these geographic regions.

The distinction between onshore and offshore wind potential is consequential for maximum energy yield. While numerous countries like China, Australia, and the United States have vast onshore potential, the greatest energy potential is located offshore. This underpins the aggressive CEG rise of Denmark and other North Sea-adjacent countries. In fact, the exceptional wind energy located in that region of Europe has enabled substantial offshore wind deployment for all countries that border it. While these countries have individually constructed impressive levels of offshore wind, the United Kingdom, Belgium, Denmark, France, Germany, Iceland, Ireland, Luxembourg, the

Netherlands, and Norway met jointly in 2026 to sign a clean energy security pact (UK Gov., 2026), enabling signatories to share electricity from a proposed 100 GW of joint offshore wind projects. This cooperative framework illustrates that institutional alignment operates not only at the national level but increasingly at the supranational level as well, with German Chancellor Friedrich Merz stating he wants to co-create the "largest reservoir of clean energy worldwide" (Almeida & Ambrose, 2026).

The contrast with high-solar, low-governance countries making minimal deployment progress sharpens the argument that endowment is insufficient on its own. This complements H4, in that resource endowment is positively associated with ETS, though weaker than institutional and economic predictors. Wind partially confirms H4 while solar complicates it, and together they suggest that H4 holds conditionally: where endowment and institutional capacity are co-located, the relationship is positive; where they diverge geographically, endowment alone predicts little. Furthermore, many of the countries in Table 10 maximized their ETS not just by installing large amounts of wind energy, but by decommissioning fossil fuel infrastructure, which leads into the next subsection discussion regarding coal dismantling among high clean energy adopters.

5.8 Coal: Dismantlers, Growers, and Giants

For the first time, renewables overtook coal to produce more global electricity in 2025 (Ember Energy, 2025a), with renewables producing 34.3 percent and coal 33.1 percent. As Ember reports in its *Global Electricity Mid-Year Insights 2025* report, this was due to global RE additions of approximately 363 TWh. Meanwhile, global coal generation fell by 31 TWh. Across the developed world, leading economies, particularly in Europe

and North America, have been phasing out coal at an accelerating pace, which is evident in the IEA's *Global Energy Review 2025* report (IEA, 2025b). The report illustrates that coal demand peaked for advanced economies in 2007, falling by approximately 872.4 million tonnes of coal equivalent (Mtce) by 2024. Nowhere is this shift more evident than in the United Kingdom, which, in 2024, closed its last domestic coal plant (World Resources Institute, 2024). The fact that the United Kingdom was the birthplace of the Industrial Revolution—which brought coal power to the world stage—makes this closure all the more significant.

The United Kingdom is not the only country to drastically draw down its coal generation however, as reflected in Table 11. The United States had the largest absolute coal retirement (-1,408,981 GWh during the study period)—a colossal 7.6 times decline compared to Germany in second place (-184,146 GWh). Canada has also decommissioned numerous coal plants across the country (-99,441 GWh), which will be discussed in Section 5.9. As coal generation continues to decline in many countries, the EU and Europe as a region is dismantling the swiftest, as indicated in Table 11 by Germany, Spain, Poland, Greece, and France.

Australia, a historically large coal-exporting nation, ranks 6th among the largest dismantlers, with the state of New South Wales moving to block new coal mine approvals (Hunt, 2026), and its national grid now relying on renewables nearly as much as coal (Morton, 2026). That a single state is constraining coal expansion while the nation remains among the world's largest coal exporters illustrates a recurring pattern: subnational governments diverging from national fossil-fuel posture—a topic further examined in depth for Canada and the United States in Sections 5.9 and 5.10. The non-significant coal

rents Spearman result ($\rho = -0.158$, ns) suggests that, unlike fossil gas, coal dependency does not produce the same degree of financial lock-in at the country level—a finding consistent with the accelerating pace of coal retirements observed across OECD nations, and one that implies Unruh's (2000) Techno-Institutional Complex may be more readily escaped in the coal context than in oil and gas sectors.

International commitments to phasing out coal power are not only integral to avoiding catastrophes that stem from global warming and climate change but are becoming increasingly visible at the forefront of transnational cooperation. This is reflected in the *Powering Past Coal Alliance,* which boasts 63 national government members (Powering Past Coal, n.d.). Perhaps unsurprisingly, most of the 63 members are based in Europe and are part of the EU, however, some fossil-fuel-exporting members are also part of the alliance, including Israel, Bahrain, and the United Arab Emirates (UAE). Two notable countries are not part of the coalition however and must be examined due to their enormous use of coal power.

Both China and India—the global leaders in coal—together generate more than twice the rest of the world combined (7,335,221 GWh versus 3,263,070 GWh). Furthermore, China, which can only be described as a coal behemoth, generates nearly four times the amount of coal power as India, which itself uses approximately as much coal as the United States, Indonesia, Japan, and Russia *combined.* In 2023, coal accounted for 79 percent of China's total CO_2 emissions from fuel combustion (IEA, 2024a). If decarbonizing global electricity represents the most immediate lever for emissions reductions, then tackling China's and India's coal power sector is the single most consequential challenge within it. Addressing it alone would substantially widen the window for global climate action.

Encouragingly, even though both China and India are the two largest consumers of coal, they are also among the two largest adopters of clean energy. In fact, across four out of the five clean energy generation categories, China ranks first for CEG gains in hydropower, wind, solar, and nuclear. Also in these categories, India ranks 3rd, 5th, 3rd, and 5th, respectively. A visualization can be seen in Figure 9, Section 5.10. This rapid clean energy adoption is offsetting the two countries' coal power industries as well, with 2025 being the year when coal power generation fell for the first time in the countries since the 1970s (Ambrose, 2026), potentially marking an inflection point in coal consumption for both nations. Regarding continued economic growth, as Ember reports in their *Global Electricity Review 2026* report, India is "set to follow a less coal-reliant growth path than China" (Ember Energy, 2026b), already showing "divergence from the coal-heavy growth model experienced by China in the first two decades of the 21st century."

India, which has committed to achieving Net Zero emissions by 2070, has been increasingly leveraging clean energy for its development, whereas during the same period of economic growth in the early 2000s to 2010 China relied on coal to do so. Critically, as Ember reports, India's electricity demand per capita is currently less than half China's at the same GDP level, positioning the country to peak its coal generation much earlier in its development curve. This trajectory suggests India may bend the Environmental Kuznets Curve (EKC) downward, decoupling emissions from growth at a lower income threshold than its predecessors—the very "revised EKC" that Stern (2004) attributes to technological change and policy diffusion. Where China ascended the conventional curve on coal, India appears positioned to flatten it through earlier access to more affordable clean energy adoption. China's CEG expansions are further discussed in Section 5.10.

5.9 Canada: A Study in Federal v. Provincial Political Fragmentation

As a federal state, Canada devolves energy policy authority to its constituent provinces—a structural arrangement shared with Germany and Australia—meaning subnational governments, not Ottawa, determine renewable deployment and grid composition. Among G7 nations however, Canada ranks as the worst performer in CO_2 emissions reductions relative to 1990 levels (Global Carbon Atlas, 2025)—an outcome that invites examination of whether subnational political fragmentation under federalism constrains transition capacity. Canada exemplifies how strong federal climate commitments—such as Net Zero electricity by 2035 (Liberal Party of Canada, n.d.)—can coexist with dramatic provincial policy fragmentation, largely along political lines.

While Canada is a relatively "clean" nation—achieving approximately 80 percent CEG as of 2024 and an ETS of 0.63—certain provinces are accelerating this transition faster than others. Canada's V-Dem Liberal Democracy Score (0.74/1), Net Zero Commitment level (1/1), and HDI score (0.94/1) would predict strong transition performance at the national level specifically, and indeed, at the aggregate, Canada performs respectably. However, these country-level variables mask considerable subnational fragmentation. Provincial and territorial jurisdiction over electricity production and other domains such as healthcare and housing produces divergent outcomes that a single national score cannot capture—illustrating the gap between commitments at the federal level and implementation at the provincial and territorial level. Figure 8 further illustrates the provincial and territorial distribution of electricity generation by clean energy share.

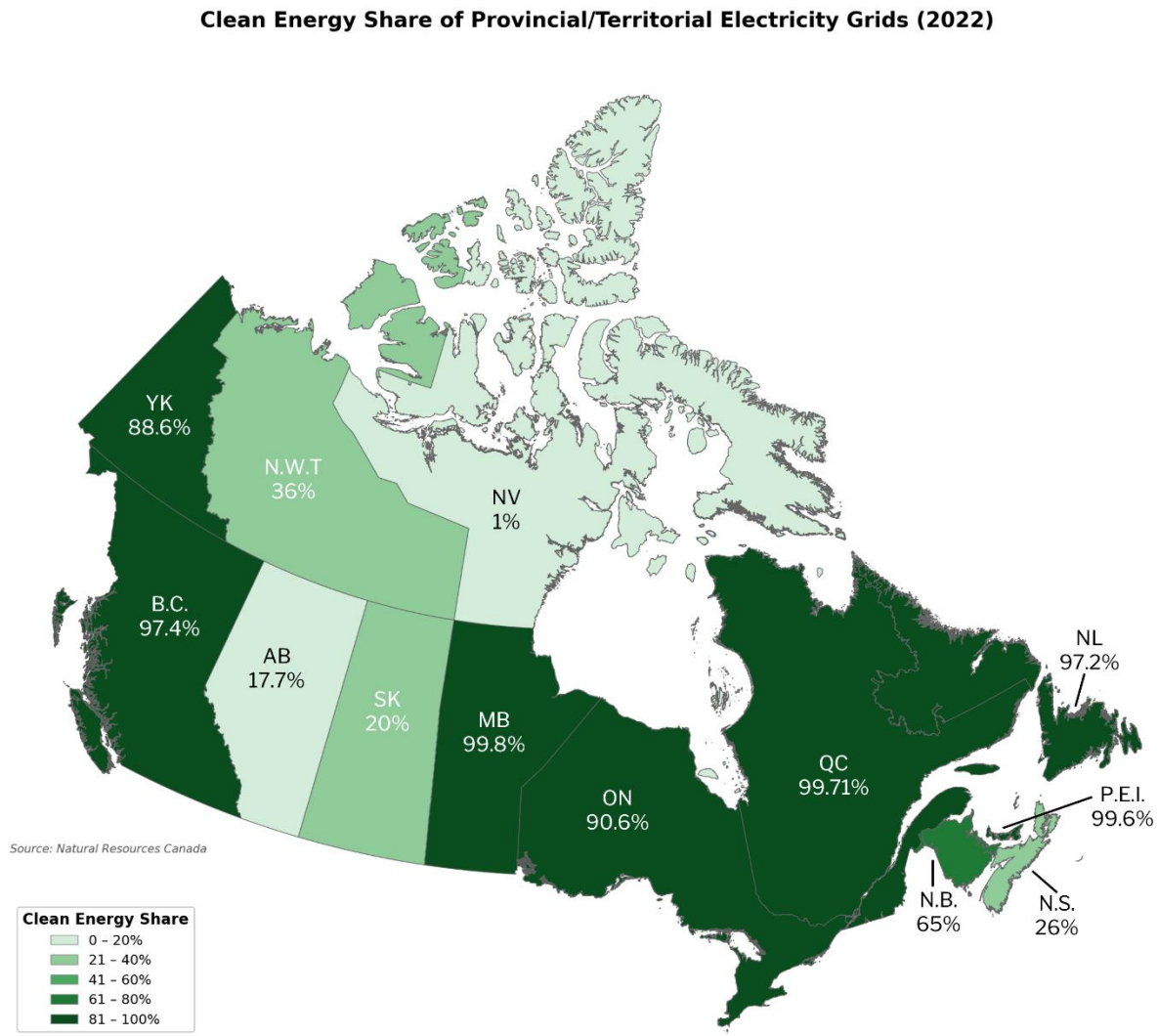


Figure 8: Canadian Provincial and Territorial Breakdown of Percentage of Electricity Grid Clean Energy Share.

Notably, scenarios similar to those in Table 14 arise, where provinces and territories that were able to achieve a high level of grid decarbonization have done so through proximal access to hydropower. The two exceptions to this are Ontario, which sources considerably more electricity from nuclear than hydropower—like France and Finland—and Prince Edward Island, which sources 94 percent of its electricity from wind. Conversely, the provinces and territories recording the *lowest* grid clean energy shares are Alberta, Saskatchewan, New Brunswick, Nova Scotia, the Northwest Territories (NWT), and

Nunavut. The NWT and Nunavut are partially located within the Arctic Circle, which has eluded them from building any meaningful clean energy infrastructure—instead historically relying on diesel fuel burned in generators for electricity. The other four provinces, however, face no comparable geographic constraints, making their continued reliance on fossil fuels a matter of policy choice rather than necessity.

In 2016, the Federal Government of Canada under former Liberal Party Prime Minister Justin Trudeau announced plans to phase out all domestic coal power plants by 2030 (CER, 2024). Between 2005–2021, coal power fell by 66 percent across Canada, and by 2021 coal comprised only 5 percent of national electricity generation, with plants remaining in Alberta, Saskatchewan, New Brunswick, and Nova Scotia at that time. As of 2026, only eight coal plants now remain in the entire country. Replacing coal in some provinces has not been without friction, however. For example, in 2025, the Saskatchewan Party under Premier Scott Moe issued a statement declaring: "We are going to get to that [secured energy] future by extending the life of our coal facilities and utilizing our Saskatchewan coal reserves that have kept the lights on in this province for generations." (Saskatchewan Gov., 2025). Saskatchewan's provincial stance represents one example of where subnational rhetoric directly contradicts federal policy goals.

And while neighbouring province Alberta did shutter its final coal plant in 2024, it has relied heavily on the use of fossil gas rather than clean energy. This penchant for fossil fuels is unsurprising however, given that Alberta is Canada's largest oil- and gas-producing province. Unruh's (2000) Techno-Institutional Complex offers a structural explanation: decades of co-evolution between Alberta's fossil fuel infrastructure, its fiscal dependence on resource royalties, and the political constituencies built around extraction

have produced a self-reinforcing configuration in which gas displacement of coal—rather than clean energy displacement of both—represents the path of least institutional resistance. It appears that policy action under United Conservative Premier of Alberta Danielle Smith has not only favoured oil and gas infrastructure, but deliberately obstructed renewable expansion, evident in Smith's 2023 moratorium (Wang & Noel, 2023). The moratorium imposed a seven-month pause on wind, solar, and geothermal projects exceeding 1 MW, stalling 118 projects worth CAD $33 billion. This disruption proved particularly significant: Alberta had accounted for 77 percent of Canada's 1.8 GW of renewable capacity installed in 2022. Pembina—a Canadian clean energy policy think tank—later found that due to the moratorium, enough renewable energy projects had been cancelled in Alberta to power almost *all* its provincial homes (Noel et al., 2024).

Similar cancellations of renewable energy projects were made by Progressive Conservative Premier of Ontario Doug Ford shortly after his election in 2018. Within months, Ford passed both the *Cap-and-Trade Cancellation Act* and the *Green Energy Repeal Act* in September 2018 (Hill et al., 2023). The latter led to the cancellation of 758 RE projects that were in the approval and development pipeline, with one—the White Pines project—costing the province CAD $231 million to remove already-installed, near-operating wind turbines. Moreover, when Ford assumed office in 2018, fossil gas accounted for 6.2 percent of Ontario's electricity mix (OEB, 2019). As of 2025, gas had risen to represent 19.3 percent of the province's generation (IESO, 2026)—a more than 200 percent increase. This preference for gas over renewables threatens not only federal climate commitments like NZE by 2035 but also exposes the province to the risk of lock-in as well. In this regard, Ontario, whose grid was much cleaner prior to Ford's

premiership, is trending toward being a clean energy "loser"—mirroring countries in Table 8 that abandoned established clean energy systems like hydropower in favour of fossil gas expansion.

Encouragingly, not all conservative politicians in Canada are resistant to clean energy policy implementation. In Nova Scotia, Progressive Conservative Party Premier Tim Houston has remained steadfast in the province's commitment to phasing out coal power by 2030. The province recently installed two grid-scale battery facilities (Price, 2026), and is working with current Liberal Party Prime Minister Mark Carney alongside New Brunswick Liberal Premier Susan Holt to connect over 60 GW of offshore wind power capacity around Nova Scotia, New Brunswick, and greater Atlantic Canada, as outlined in the federal *Canada Strong Budget 2025* (Government of Canada, 2025).

When differing political ideologies come together under a common understanding of the risk of climate change and the necessity of clean energy growth, meaningful progress becomes achievable. It bears noting however that Canada did formally leave the Kyoto Protocol in 2011 under Conservative Party of Canada Prime Minister Stephen Harper. Therefore, if political fragmentation among party lines at the federal and provincial levels of Canada continues, the country will find it difficult in the long-term to meet its climate commitments. The Canadian case study therefore illustrates that national-level IV scores such as HDI, NZC, and Liberal Democracy, while collectively meaningful, do not guarantee subnational policy implementation—and that the political conditions enabling or obstructing the clean energy transition can vary dramatically within a single federation's borders. Similar cases of federal fragmentation exist within the United States as well and will be discussed in the next section.

5.10 The US/China Divide: Two Diametrically Opposed Superpowers on Diverging Energy Pathways

The United States and China are the de facto superpowers of the 21st century. Both countries boast the two largest economies in the world, with a combined GDP of over USD $50 trillion (Worldometer, 2026), and are each other's foremost geopolitical rivals—consistently contending for economic, technological, and diplomatic supremacy. This rivalry now permeates the global energy landscape, where the two nations are approaching the transition from diametrically opposed directions. Between 2021 and 2025 alone, China installed more clean electricity capacity than the ***entire*** United States' existing grid—fossil fuels and all (Bloomberg News, 2026a). While China did produce the largest amount of GHG emissions of any country in the 21st century (European Commission, 2025), it also produced at least double or more hydroelectric, wind, solar, and nuclear electricity generation of the next-ranked country within those categories between 2000-2023, as seen in Figure 9.

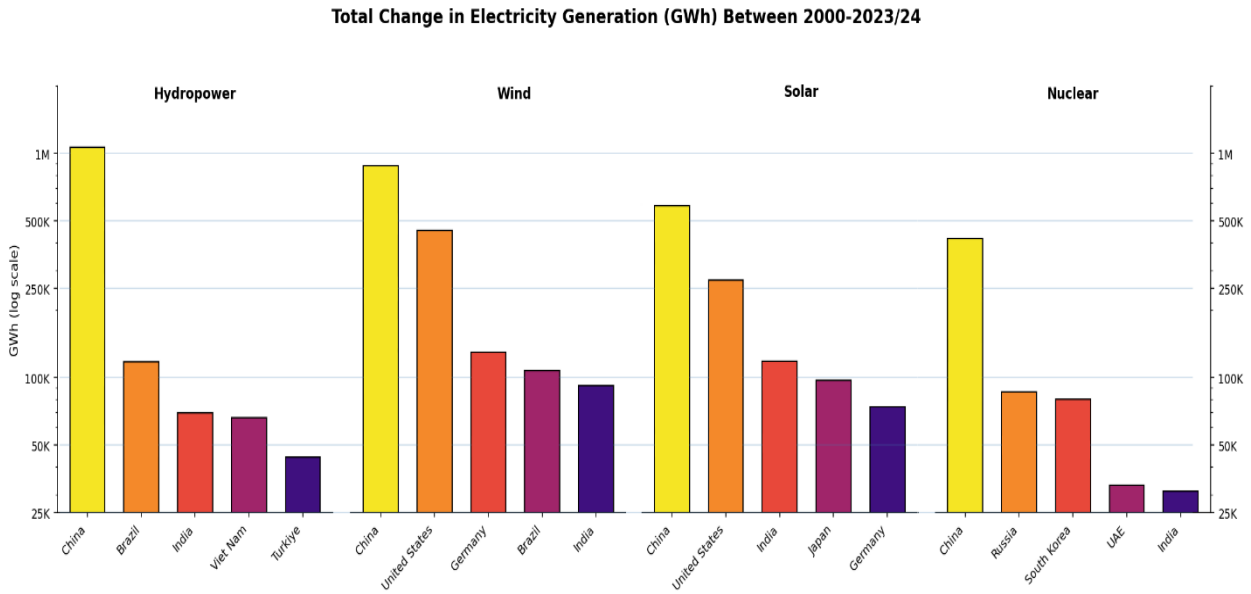


Figure 9: Total Change in Electricity Generation (GWh) Between 2000-2023/2024, Ranked by Top 5 Countries.

As of 2025, China's share in all the manufacturing stages of solar panels—including polysilicon, ingots, wafers, cells, and modules—exceeded 80 percent of the global market share (IEA, 2022), with the country being home to the world's top ten suppliers of solar PV manufacturing equipment. Solar PV is not the only clean energy market China has cornered: over the past decade, it has also come to dominate the critical mineral supply chain, securing 70 percent market share for 19 out of 20 strategic minerals (IEA, 2025g). While the IEA reports that China accounted for roughly 60 percent of global mining output for these critical minerals in 2024, it represented approximately 91 percent of the separation and refining stages for the supply chain, which is integral for cleantech such as wind turbines, lithium-ion batteries, hydrogen fuel cells, and nuclear fuel pellets. Consequently, the future of mass clean energy adoption and nations meeting their Net Zero targets' hinges on the accessibility of these technologies from China.

Unfortunately, even with the progress made through its colossal domestic CEG growth, this dominance is not fully reflected in China's Electro-Transition Score. Though the state has installed more clean energy than any other country by a substantial margin, its ETS stands at -0.01 per the 2023 data. Specifically, this is because of all the clean electricity generated between 2000–2023, CEG was *still* dwarfed by coal power additions. Granted, in 2000, China was a very different country than it is today—developing economically by many global standards. That said, China's solar generating capacity is expected to surpass coal for the first time in 2026, according to the country's top electricity industry group (Bloomberg News, 2026b), with its total GHG emissions having already peaked in 2024 (Myllyvirta, 2026a). Furthermore, despite being the world's fifth-largest oil producer (Worldometer, 2024), China's strategic orientation appears less

concerned with dominating fossil fuel markets than with leading the emerging clean energy supply chain—a stark inversion of the resource-based hegemonic model the United States has pursued throughout the 20th and 21st centuries. Under Unruh's (2000) framework, China's fossil fuel lock-in is real and quantifiable in its ETS, but the trajectory of its investment and manufacturing dominance suggests an intentional long-term escape from that lock-in on its own strategic terms. China's *14th Five-Year Plan*—though structurally distinct from the EU's Green Deal—similarly establishes binding targets for emissions reductions and clean energy expansion (Chinese Govt., 2021). While the phrase "Net Zero" is omitted from the document, Chinese President Xi Jinping has pledged to reach peak carbon emissions before 2030 and achieve carbon neutrality by 2060, as established by the Department of Resource Conservation and Environmental Protection of China in 2021 (Chinese Gov., 2021b). The document features a myriad of commitments to accelerating the comprehensive "green transition" within the country.

The divergence between the two nations is also reflected in their governance profiles: the United States (0.75) scores considerably higher on the V-Dem *Liberal Democracy Index* than China (0.04), yet the ETS reveals that democratic governance alone does not guarantee transition quality, nor does autocratic governance preclude it, as China's unprecedented clean energy deployment demonstrates. Autocratic systems do appear to enable swifter policy adoption and infrastructure deployment than democracies—a structural advantage, not an endorsement, but one that warrants acknowledgment in understanding transition trajectories. By comparison, the United States is currently pursuing a dramatically different course. In his first term as president, Donald Trump became the first leader of a G20 nation to withdraw from the Paris

Agreement—a decision his successor, President Joseph Biden, reversed. When Donald Trump was elected president a second time, he once again withdrew from the Paris Agreement on his first day in office, while also retracting President Biden's Net Zero by 2050 commitment—and has pursued a series of environmentally regressive policies since. For example, under the second Trump Administration, the Republican-led U.S. House of Representatives repealed numerous financial and policy initiatives put in place by President Joseph Biden through the landmark Inflation Reduction Act (IRA). The revocations include hundreds of billions of dollars in cuts to major climate programs, including financing and subsidies for clean energy projects, as well as tax credits for EVs. Beyond the numerous cuts to programs that would otherwise strengthen the American clean energy industry, the Trump Administration has targeted the Environmental Protection Agency, specifically overturning the *2009 Greenhouse Gas Endangerment Finding*, which had classified GHGs as a threat to public health and served as the legal basis for regulating automobile emissions under the Clean Air Act. President Trump has long been a prominent and vocal denier of climate change's severity, repeatedly calling the crisis a "hoax"—even during his speech to world leaders at the United Nations' 80th General Assembly (UN Affairs, 2025).

Despite the first and second Trump Administrations' interference in clean energy policies and its preference toward fossil fuels, wind and solar still grew during his first term (2017–2021), while coal generation fell sharply. In fact, the United States ranked second for wind and solar generation growth during the study period, as shown in Figure 9. These dynamics are reflected in the United States' ETS of 0.59—a relatively strong result driven by substantial coal retirements and meaningful CEG that continued largely

independent of federal policy direction, underscoring that transition momentum, once established at the infrastructure and market level, can persist even in the absence of federal commitment. To this claim: the United States, like Canada, has governor-led states that lean left and right politically. However, unlike Canada, historically right-leaning states such as Texas and Florida have been at the forefront of renewables deployment alongside left-leaning California—installing some of the largest wind and solar projects nationwide (CLEO News, 2025). Notably, even with the strong growth in RE, the United States led the world in fossil gas generation during the study period, recording 634,290 GWh in 2000 to 1,925,354 GWh in 2024—a 203.5 percent increase. This growth masks a structural substitution: coal displacement yielded not total decarbonization but a shift from coal lock-in to gas lock-in—a pattern mirrored at the subnational scale by Ontario's and Alberta's preference for gas expansion over the maintenance and expansion of its clean energy portfolio mix.

Even accounting for the cuts to clean energy funding from the IRA, the U.S. Energy Information Administration (EIA) reported that in 2026, combined generation from wind and solar with the assistance of battery storage are poised to outpace even fossil gas generation (EIA, 2026)—America's current largest source of electricity generation. Moreover, with a lack of commitment at the federal level, many governors in a bipartisan coalition called the *United States Climate Alliance* (U.S. Climate Alliance, n.d.) have committed to upholding the goals and objectives of the Paris Agreement at the state level. Regardless of these state-level commitments however, the Trump Administration seems intent on expanding domestic oil drilling, even in environmentally high-risk areas such as the Arctic (United States Gov., 2025). These policies perpetuate The United States's

dominance as the world's largest oil producer (Worldometer, 2024), yielding more than double the output of the next-largest producer, Saudi Arabia. Beyond oil, the administration allocated USD $700 million for supporting domestic coal power plants in 2026 as well (Gardner & Renshaw, 2026), signaling a long-term preference for fossil fuels.

The stark contrast between both global superpowers has never been more visible. While the United States seems intent on forging ahead as the dominant global producer of oil, China is conversely investing comprehensively across the full cleantech supply chain, with intent to be the international supplier of every segment for these markets. The timing of this divergence is rather consequential, as society has only just begun this decade to collectively and rapidly accelerate toward clean energy technologies. As The United States dismantles programs and funding for its own domestic clean energy industry, China has seemingly seized a rare opportunity, capitalizing on a significantly strategic miscalculation by its economic rival. In some sense, the contest over the dominant energy paradigm of the 21st century bears more than passing resemblance to the ideological rivalries of the previous century, as Alcobra (2026) argues, calling the emerging battle a "Green Cold War". If civilization truly is undergoing a pivotal moment of change toward an electrostate future, China may very well be best positioned to displace America's century-long hegemony, just as the U.S. did to its predecessor.

While the Trump Administration cancels large-scale clean energy projects at a financial loss (Gallucci, 2026), China is planning to build the largest hydroelectric dam in the world (Bloomberg News, 2025). While the United States exerts economic and political pressure on fossil fuel-endowed nations to secure resource access, China is signing landmark trade agreements with advanced economies *and* assisting developing nations

through its *Belt and Road* infrastructure program—backing more than half of the new hydropower plants being built in the Global South (IEA, 2021). While the United States seeks to continue dominating the global, oil-based hegemonic order, China appears to desire not only to decarbonize its own electricity grids, but to enable other countries around the world to decarbonize as well—with intentions of supplanting their rival as the dominant international supplier of energy in the 21st century throughout the process.

By comparison, the United States remains tethered to carbon-intensive infrastructure, enabling their own lock-in—which is incompatible with international climate commitments—while China builds with strategic foresight. Other countries are acknowledging the shifting energy landscape and the importance of reliable energy access as well. During his speech at the 2026 World Economic Forum, Canadian Prime Minister Mark Carney aptly stated: "We know the older order is not coming back. We shouldn't mourn it. Nostalgia is not a strategy." (WEF, 2026). The time to pivot to clean energy technologies is *now*, and the quality of policy foresight will determine the success of national transitions. However, regardless of policy implementation or economic levers, there are often changes that arise during transitions that can throw markets into turmoil. Notably, these disruptions often come in the form of exogenous shocks.

5.11 Geopolitical Shocks as Transition Accelerants: Russia, Iran, and the Energy Sovereignty Imperative

Two major conflicts between 2022 and 2026 had widespread effects on global energy, food, and consumer markets. The first occurred when Russia invaded Ukraine in 2022, and the second, when the United States and Israel launched an assault on Iran in

2026. Prior to the invasion of Ukraine in 2022, the EU imported approximately 1,200 million-cubic-metres (MCM) of fossil gas on average each month through the Nord Stream 1 pipeline, save for July and August when demand was low (Keliauskaitė, n.d.). After the invasion, sanctions were implemented, and strategic decisions were made to curtail the import of Russian gas. In May of 2022, EU imports dropped from their peak to effectively zero in July, experiencing a slight rebound but falling back to zero by September. Since then, the EU has imported zero gas through the Nord Stream pipeline. This response aligns with this paper's energy sovereignty framing, wherein the Net Energy Imports Spearman result ($\rho = 0.348$, $p < .001$) identifies import dependency as a structural incentive for transition, with the EU's post-invasion CE acceleration being perhaps the most dramatic empirical confirmation of that relationship within the study period. The Nord Stream 2 pipeline, which was completed in 2021 with the intent to expand the EU's import of Russian gas, subsequently never entered into service (Cookman, 2022).

Following the US/Iran conflict in March 2026, global fossil fuel markets were thrown into turmoil. After the assault, approximately 20 percent of the world's oil and gas—which previously transited through the Strait of Hormuz—were disrupted (Zero Carbon Analytics, 2026). Many government officials and pundits drew parallels to the 1970s energy crisis, which led to global shortages of fuel—primarily in Western countries—and elevated prices. Now, early data reflect similar parallels from the 2026 conflict, with the IEA stating: "The war in the Middle East is creating the largest supply disruption in the history of the global oil market" (Smith, 2026).

Presently however, those that will be most affected by shortages are Asian countries (Zero Carbon Analytics, 2026) such as China, India, Japan, and South Korea, which account for 75 percent of oil and 59 percent of gas imports. That is not to say, however, that Western nations will not be affected by changing oil prices from the conflict either. Numerous other Asian countries have been severely affected as well, including Thailand, Vietnam, the Philippines, and Pakistan, all of which have implemented work-from-home or four-day work week policies (Carbonaro, 2026). Bangladesh shuttered universities due to fuel shortages (Anadolu & Reuters, 2026), and in Australia—a developed OECD nation—hundreds of gas stations ran out of fuel (Butler, 2026). The Strait of Hormuz—a channel approximately 39 kilometres wide at its narrowest point—is a global chokepoint for oil, fossil gas, and fertilizer as well, with countries including the United States, Brazil, India, China, Australia, South Africa and others relying heavily on imports through the strait (Hebebrand, 2026). Notably, the shortages of fertilizer are reminiscent of the global wheat shocks that were experienced after the Ukraine invasion, as Devadoss & Ridley (2024) examine.

The central argument of this subsection is that geopolitical shocks, devastating as their humanitarian consequences are, have historically accelerated structural energy transitions. This pattern is consistent with Geels' (2002) multi-level perspective, in which exogenous landscape shocks such as oil crises and geopolitical disruptions destabilize incumbent regimes while opening windows of opportunity for niche innovations to break through previously existing barriers. In response to the 1970s energy crisis, The United States implemented the Corporate Average Fuel Economy (CAFE) standards (NHTSA, 2015) with the intent of regulating oil consumption in vehicles. The knock-on effect of

CAFE standards was that American automobiles became more efficient, consuming less gasoline and therefore emitting less CO_2. The policy further allowed competition from Asian automakers such as Honda, Nissan, and Toyota to find niches in markets for smaller passenger vehicles. In Unruh's (2000) terms, the 1970s energy crisis constituted precisely the kind of exogenous landscape-level shock capable of destabilizing an incumbent fossil fuel regime—a dynamic that appears to be repeating in the wake of the 2026 conflict. If 2022 was the turning point for the EU rejecting Russian gas, 2026 may mark a similar inflection point for Asian countries and their CEG acceleration.

Real-world cases are quickly emerging, with demand for EVs soaring across virtually all markets, including Canada and the United States (Woody, 2026), Asia and Latin America (Stock & Pike, 2026), and Europe (Nimmo & Rudgard, 2026)—with global sales rising 75 percent between February and March 2026. Beyond EVs, demand for clean energy is soaring as well, with global power generation from fossil fuels falling sharply and CEG growing dramatically (Myllyvirta, 2026b). Excluding data from China, global coal power generation fell the most (-9.7 TWh) in the months following the assault, followed by fossil gas (-9.5 TWh), whereas solar generation grew markedly (+16.3 TWh), as did wind (+9.3 TWh) and hydropower (+3.4 TWh). Seaborne coal shipments have fallen to the lowest levels since 2022, and even though some have suggested the 2026 oil crisis will spark a “return to coal” for many countries, this has seemingly not happened on at scale. In fact, based on reporting from the Centre for Research on Energy and Clean Air (CREA), numerous countries have announced strong clean energy policies as a response.

Table 16: Countries and their Policy Announcements in Response to the 2026 Iran Assault. Source: CREA.

Country	**Clean Energy Policy Announcement**
France	Creating a plan to electrify key sectors of the economy to reduce reliance on imported fossil fuels, suggesting the measures could be funded from increased corporate tax revenue from fossil fuel companies.
Egypt	Adding 2,500 megawatts (MW) of RE capacity to its national electricity grid before the summer, with part of purchase agreements (PPAs) covering RE capacity, in addition to a deal to develop standalone battery energy storage systems (BESS), with a combined capacity of 5,620 MW.
India	Issuing bidding trajectory for RE power procurement bids of 50 GW per annum by 'Renewable Energy Implementing Agencies' (REIAs) beginning in FY 2027–28.
Indonesia	Announcing the formation of a ministerial task force to implement President Prabowo's 100 GW solar vision (first announced in 2025), with the first rollout of 13 GW of solar expected in 2026.
Japan	Expanding offshore wind permits.
South Korea	₩500 billion to energy transition, funding grid infrastructure upgrades and increasing overall annual support for RE projects to a record ₩1.1 trillion, with ₩400 billion in low-interest loans to be provided to remote villages to accelerate deployment.
Türkiye	Pledging to invest $80 billion in RE by 2035 to reach its 120 GW target.
China	Securing a $1.9 billion solar and storage project in Abu Dhabi, boosting UAE clean energy goals, grid stability, and renewable capacity growth.
United Kingdom	Outlining a plan to decarbonize future housing with heat pumps and solar.

Vietnam	Updating the country's "Just Energy Transition Partnership" (JETP) implementation plan, signaling a sharper shift away from coal, phasing out coal-fired plants from new energy infrastructure after 2030.

The policy announcements catalogued in Table 16 are a mere fraction of the positive ongoing international policy changes and, in real time, improve the variable this paper identifies as the second strongest predictor of ETS performance: Net Zero Commitment ($\rho = 0.440$, $p < .001$). Each national clean energy pledge represents a measurable shift in the institutional conditions that the Spearman results indicate are most consequential for transition outcomes, suggesting that the 2026 conflict may be compressing into months the kind of policy momentum that would otherwise unfold over years or decades. This echoes Sovacool's (2016) assertion that national-level transitions can accelerate dramatically when external pressures bypass the gradual scaling processes that typically govern energy system change.

The convergence of energy sovereignty concerns and decarbonization imperatives is now explicit in the framing of policymakers and energy institutions alike. South Korea's Minister of Climate, Energy and Environment, Kim Sungwhan, articulates this directly:

> The war in the Middle East, following the conflict in Ukraine, has starkly demonstrated that energy sovereignty is a critical issue directly tied to a nation's survival. An energy structure that relies excessively on fossil fuels such as oil and gas is inevitably vulnerable to external shocks. In response, countries around the world are increasingly viewing the transition to domestically and reliably produced

energy, particularly renewable energy, as a key national security strategy (Rathi et al., 2026).

Further, the IEA's *World Energy Outlook 2025* opens with the assertion that "In a volatile world, energy sovereignty takes centre stage," noting that "pressing threats and longer-term hazards are elevating energy to a core issue of economic and national security" (IEA, 2025d). Carlyle's *New Joule Order* analysis reaches a complementary conclusion, stating: "security is now paramount," "peak oil has arrived as peak trade," and "there is no diversification without electrification" (Carlyle, 2025). The Carlyle formulation closes the conceptual loop: energy sovereignty, increasingly understood as the central security concern of the coming decades, cannot be achieved through fossil fuels because they are by their nature traded across borders—and are becoming increasingly unreliable. Decarbonization is the diversification mechanism, and cleantech is what makes electrification a security strategy rather than merely a climate one. The UAE's departure from OPEC on April 28, 2026 (Reuters, 2026) offers a fitting postscript to this framing. Ranked 20th in CEG growth and having secured a major solar and battery storage agreement with China, the UAE's exit suggests that even historically oil-dependent OPEC/+ members are beginning to recalibrate their long-term energy strategies—an institutional signal that energy sovereignty concerns are now permeating the very bloc most structurally committed to continued fossil fuel extraction.

Whether the 2026 oil crisis will serve as the catalyst for an accelerated global clean energy transition remains to be seen, but early indicators suggest the conditions for such a shift are rapidly converging. Of all the countries that may benefit from the adoption of clean energy technologies, China, for reasons mentioned in Section 5.10, is uniquely

positioned to take advantage of the circumstances. This dynamic is already measurable: in March 2026, following the immediate aftermath of the assault, China's clean technology exports exceeded USD $20 billion (Rathi et al., 2026), driven disproportionately by demand from Asian and African markets—a concrete indication that the post-assault adoption surge is being routed through Chinese cleantech supply chains. For this reason, Deutsche Bank has declared China the "energy winner in the age of war" (Mookerjee, 2026). Paradoxically, the Trump Administrations' geopolitical decisions may have inadvertently fostered the very conditions most conducive to meeting the goals of the Paris Agreement, potentially creating the catalyst needed to decisively accelerate the transition to a globally decarbonized energy system.

Major conflicts are abstract, exogenous variables which are difficult to quantify, and for this reason they were not included as an independent variable within this paper. Unfortunately, due to the multi-faceted effects on global markets and policy changes—operating simultaneously across the niche, regime, and landscape levels that Geels (2002, 2011) identifies as jointly constitutive of sociotechnical transitions—conflict represents a gap in the analytical scope of both the Electro-Transition Score and the energy sovereignty framework this paper asserts. What *can* be measured is changes to CEG data, policy decisions, and actions at a global scale. Regardless, only time will determine whether this current period acted as a driver of society's decades-long commitments to achieving Net Zero.

5.12 Beyond Policy: Private Capital, Corporate Procurement, and Clean Technologies

As important as the government build-out of domestic clean energy technologies is, so too is the mobilization of public and private capital. Bloomberg NEF (BNEF)—a leading research provider covering global commodity markets and disruptive technologies—reported that investment in the global energy transition reached USD $2.3 trillion in 2025, up 8 percent from 2024 (BNEF, 2026b). Asia Pacific was the largest region for investment, while U.S. investment rose 3.5 percent to USD $378 billion despite policy headwinds from the Trump Administration. This concentration aligns with this paper's GDP total Spearman result ($\rho = 0.228$, $p < .01$), reinforcing that aggregate economic scale enables disproportionate clean energy capital deployment. BNEF further projects transition investment climbing to as much as USD $2.9 trillion within five years.

In 2010, Canada announced its "Fast-Start Financing" commitment (Canadian Gov., 2024), pledging CAD $1.2 billion over 2010–2013 in climate financing to developing countries. It has since committed a further $2.65 billion between 2015–2021 and $5.3 billion between 2021–2026 under the *Climate Finance Delivery Plan*, signed jointly with the United Kingdom and Germany (Canadian Gov., 2021). This funding targets four areas: clean energy transition and coal phase-out, climate-smart agriculture and food systems, nature-based solutions and biodiversity, and climate governance. International climate finance of this kind functions as a niche-enabling mechanism in Geels' (2011) MLP framework, reducing the economic barriers that otherwise prevent landscape-level pressure from translating into regime-level transition in lower-income contexts.

Though international climate finance has grown over the previous decades, it is not immune to external political pressures. As Yildirim and Vanwalleghem (2026) examine, the rise and fall of the 2021 Net Zero Banking Alliance (NZBA) is a prominent example. Structural changes made by 2022 under the UN-backed *Race to Zero* framework—tightened membership criteria and requirements that banks phase out support for unabated fossil fuels and align lobbying with Net Zero objectives—triggered resistance from members. The re-election of Donald Trump in 2024 accelerated the alliance's demise, prompting the top banks in the United States, Canada, and Japan to withdraw. This represents a measurable erosion of the institutional climate commitment conditions that this paper's Net Zero Commitment Spearman result ($\rho = 0.440$, $p < .001$) identifies as among the strongest predictors of transition performance. The same pressures created an unfavourable environment for Environmental, Social, and Governance (ESG) investing—so much so that Republican legislators in New Hampshire proposed making the investment of state funds according to ESG criteria a felony punishable by up to 20 years in prison (Responsible Investor, 2024).

Despite institutional setbacks, the Climate Council of Australia reports that U.S. states and businesses continue to advance clean energy commitments regardless of political opposition (Climate Council, 2025). Several companies focused on emerging cleantech solutions are growing rapidly: Quaise Energy is developing millimetre wave (gyrotron) drilling technology to reach geothermal depths beyond conventional techniques (Quaise Energy, 2024); Redwood Materials, based in Nevada, is maximizing the recyclability of EV batteries—which is increasingly critical as EV sales accelerate in the wake of the 2026 US/Iran conflict; and Oklo—a publicly traded nuclear energy

company—is pursuing nuclear fuel recycling (Oklo, n.d.), which, if successful, would ease the spent-fuel storage challenge that has long constrained the industry.

As public and private companies play an increasing role in the global energy transition, one technology is poised to potentially upend much of the progress made so far. Between 2000 and 2024, average U.S. electricity growth was stable at 0.2 to 0.9 percent per year (Wilson, 2025), a plateau driven by efficiency gains and the offshoring of energy-intensive manufacturing rather than deliberate policy interventions. That plateau, however, is now coming to an end. The IEA's *Electricity 2026 Report* (IEA, 2026a) observes that demand growth in advanced economies is accelerating again after 15 years of stagnation, driven by data centre build-out, EV adoption, the electrification of space heating, and heavy industry. The implication is consequential; the United States is entering a period of rising electricity demand precisely as it dismantles the policy infrastructure that would have enabled that demand to be met cleanly. As artificial intelligence and large language models (LLMs) become more widespread, the data centres required to run them—and their electricity (and water) demands—will grow in tandem. The United States is already seeing rising electricity prices from data centre expansion (Saul, 2025), with demand expected to accelerate further in coming years. Given the seemingly insatiable demand for AI, the IEA projects that the industry could consume more than 1,000 TWh of electricity—or approximately 3 percent of all global electricity consumed—by 2030 (IEA, 2025f).

Currently, the IEA reports that most AI electricity demand is met by gas in the United States and coal in China; a pattern that may persist through 2035, as data centres require large, constant supplies of electricity that traditional RE struggles to provide. In

Canada, a data centre partnership between the Government of Alberta and Meta began in 2026. The agreement—for Meta to build a 1 GW data centre northeast of Edmonton at a cost of approximately CAD $13 billion (Bellefontaine, 2026)—will ultimately be powered by fossil gas, similar to existing data centres in the United States. Given Alberta's oil-and-gas lock-in examined in Section 5.9, the choice of gas is unsurprising, though it again conflicts with federal Canadian climate targets. The project proceeds under the November 2025 Canada–Alberta Memorandum of Understanding (Canadian Govt, 2025), which commits the federal government to exempting Alberta from the federal Clean Electricity Regulations for self-generating data centre projects—though the formal steps to end their application remained pending. That Meta simultaneously claims to run the facility on "100 percent clean energy" through renewable energy certificates, while physically burning gas, illustrates precisely the accounting-based decoupling the ETS is designed to see past.

Notably, the IEA argues that advances in emerging nuclear and geothermal technologies—which can be reliable and localized—may eventually displace the case for fossil fuels in this role. However, economic barriers remain high, and novel technologies remain unproven at scale. Several of the largest technology companies have recognized nuclear energy’s potential: Microsoft, Google, Amazon, Meta, and OpenAI all plan to forge multibillion-dollar nuclear partnerships (Johnson, 2024), though presently, most of the electricity generated for these companies data centres originates from fossil gas. The "Big Tech" capital expenditures for AI—over USD $400 billion in 2025 alone and growing (IEA, 2026b)— comes at a critical juncture, when sustainability and clean energy must be prioritized if society is to meet its climate targets. This challenge encapsulates the two-

pronged nature of the objective society currently faces: meeting growing electricity demands as sectors decarbonize, while also doing so in a sustainable manner that does not further enable a reliance on fossil fuels or promote lock-in to existing systems. Achieving these objectives requires efforts that must be made from *both* government and enterprise alike, which, if done correctly, ensures the financial flows for clean energy technologies is sufficient to meet the demands of a rapidly electrifying global landscape.

Section 6: Conclusion

6.1 Restating the Problem and Approach

"Nothing is more powerful than an idea whose time has come." This quote, attributed to French author Victor Hugo aptly frames the current global energy transition. This paper set out to determine which countries are seriously undertaking the transitional work to become electrostates—and which are not. As the global community approaches the 2030 emissions-reduction milestone required to keep the Paris Agreement's 1.5°C target within reach, the empirical record across 144 countries reveals stark divergence in transition trajectories: a divergence this paper has sought to explain.

Existing scholarship has examined determinants of clean energy deployment in regional and single-cluster framings, but no prior study has integrated 144 countries, 15 independent variables, and an original composite transition metric within a single cross-national analysis to this author's knowledge. By applying Spearman rank correlation tests across five conceptual variable clusters, this paper has identified which structural conditions most strongly correlate with the Electro-Transition Score—a metric that

captures both the expansion of clean energy generation and the dismantling of fossil fuel infrastructure. The findings of that analysis, and their implications for how the global transition is understood, are the subject of this concluding section.

6.2 Returning to the Research Questions

This paper proposed three research questions. First, which countries have most substantially advanced toward electrostate status during the study period by expanding clean energy and dismantling fossil fuels? Denmark stands out as the strongest case, successfully transitioning from 17.11 percent CEG in 2000 to 91.84 percent CEG in 2024, with Estonia and Portugal following.

Second, which national-level variables most strongly correlate with ETS across 144 countries from 2000 to 2023/2024? As examined, V-Dem Liberal Democracy ($\rho = 0.462$), Net Zero Commitment ($\rho = 0.440$), HDI ($\rho = 0.415$), and GDP per capita ($\rho = 0.389$) are the leading independent variables that *correlate* strongly with successful transition pathways, but do not explicitly indicate *causation*. Resource endowment, including Wind Power Potential ($\rho = 0.297$), Hydropower Potential ($\rho = 0.104$), and Solar GHI ($\rho = -0.417$), underperformed institutional variables, with solar GHI returning the strongest negative correlation.

The third research question examined institutional bloc divergence, particularly between OECD and OPEC/+ member states—with attention to potential outlier cases. Results present that OECD membership corresponded with markedly higher ETSs (mean = 0.578) than OPEC/+ membership (mean = –0.257). Outlier cases did occur, with electrostates existing in numerous developing regions, including Africa (Ethiopia and the

Democratic Republic of Congo), Latin America (Paraguay), and Central/East Asia (Nepal). The five hypotheses advanced in Section 1.4 received varied empirical support.

Hypothesis 1, which posited that governance capacity is positively associated with ETS, was fully confirmed—V-Dem Liberal Democracy (ρ = 0.462), Net Zero Commitment (ρ = 0.440), and Corruption Score (ρ = 0.333) all returned robust positive correlations.

Hypothesis 2, which posited that economic and human development are positively associated with ETS, was likewise fully confirmed, with HDI (ρ = 0.415), GDP per capita (ρ = 0.389), and total GDP (ρ = 0.228).

Hypothesis 3, which posited that GDP-derived fossil fuel dependency is negatively associated with ETS, was partially confirmed: fossil gas and coal rent dependencies returned the expected negative correlations (ρ = -0.377, ρ = -0.158), whereas oil rents counterintuitively returned a positive correlation (ρ = 0.194)—complicating the resource curse framing in the oil-specific case. This is likely because oil has larger international market applications beyond energy such as chemicals manufacturing and gasoline fuels. Further, the expectation of OPEC/+ members that would have lower ETS values was confirmed, with a mean bloc ETS of -0.257.

Hypothesis 4, which posited that renewable resource endowment is positively associated with ETS, was the most divided of the set: wind potential returned the expected positive correlation (ρ = 0.297), but solar GHI returned a strong negative correlation (ρ = -0.417), a result this paper has examined as the "solar paradox." Hydropower potential (ρ = 0.104) was positively correlated, but not enough to indicate that capture potential encouraged a significant adoption.

Hypothesis 5, which posited that climate vulnerability and net energy imports are positively associated with ETS, was directionally confirmed, with Climate Risk Rank Δ ($\rho = 0.273$) and projected temperature rise ($\rho = 0.190$) returning positive correlations. Net Energy Imports ($\rho = 0.348$) was the strongest variable in the cluster, indicating a reliance on others as a driver of clean energy adoption.

6.3 Synthesis of Findings

Five interpretive threads emerge from the analysis when read across the variable hierarchies, bloc comparisons, and outlier cases documented in Sections 4 and 5.

Thread 1: Institutions over geography. The strongest correlates of transition were institutional, economic, and developmental in nature, including high levels of democracy, Net Zero commitment, human development, and GDP per capita, alongside low corruption levels. These correlations are strong but not deterministic; China, Sudan, Nicaragua, and the United Arab Emirates for example, despite low liberal-democracy scores, have added substantial clean energy generation, demonstrating that the institutional capacity driving transition can take authoritarian as well as democratic forms. Contrary to intuition, resource endowment alone or large renewable availability did not predict deployment. Solar's negative correlation is the sharpest expression of this: the countries with the most solar GHI are largely those without the institutional substrate to capture it, as these countries are often located in the least developed global regions. Thus, institutional capacity, rather than geography, has accelerated most transitions to date—though this may shift as solar technologies become cheaper and more widely accessible, particularly from suppliers in China. The results of the 2000 versus 2023/2024

change in CEG indicate that certain institutional blocs, such as the European Union—with its strong climate policies—are accelerating their clean energy transitions faster than nations with weak democratic institutions, in most cases. While Europe hosts four out of the eight electrostates in the world, four others from various regions challenge this notion of institutional necessity.

Thread 2: The electrostate counternarrative. A cluster of electrostates was found in developing, Global South countries, including Ethiopia, DR Congo, Nepal, and Paraguay. These electrostate outliers challenge the assumption that energy transitions are contingent on national wealth alone and indicate that institutional affiliation is a strong predictor of high CEG enablement but *not* a deterministic one. Furthermore, they demonstrate that the *inherited-versus-achieved* transition distinction matters, as Section 5.2 illustrated; proximity to hydropower *without* the influence of the "resource curse" or "Dutch Disease" allowed these economically developing outliers to achieve their electrostate status early on. The ETS, by design, distinguishes this inherited-versus-achieved transition, with Kenya standing out as the lone Global South country to approach near-electrostate status through deliberate transition—largely through the adoption of geothermal energy. These results complicate any outright OECD versus OPEC/+ or regional binary assumptions.

Thread 3: Subnational fragmentation. National-level independent variable scores presented in the ETS can mask substantial, within-country divergence. Canada's V-Dem, HDI, and Net Zero scores predict strong performance, yet provincial-level reversals—such as Alberta's renewables moratorium and Ontario's expansion of fossil gas—illustrate that aggregate scores miss the political conditions that determine

implementation, an insight reinforced by the work of Hill et al. (2023). Similar fragmentation appears in other federal systems, notably the United States, where state-level energy policy diverges sharply mostly along partisan lines with the inverse being present in Australia—a dynamic that aggregate national-level variables cannot capture.

Thread 4: Energy sovereignty as a structural incentive. The positive Spearman result for net energy imports ($\rho = 0.348$) suggests that import dependency is not just a vulnerability but a transition driver. The post-2022 EU pivot on fossil gas, triggered by Russia's invasion of Ukraine and the resulting weaponization of European gas dependency, is the clearest empirical confirmation. The 2026 Iran conflict appears to be compressing similar dynamics for Asian importers, accelerating the timeline of their clean energy adoption. It is becoming clear that even as globalization continues to deepen across most domains, energy is becoming increasingly divorced from that trajectory. In the previous century, when fossil fuels were essentially the only way to produce electricity—other than hydropower, which depended on geographical proximity, and nuclear, which was cost-prohibitive—reliance on countries that provided such fuels was unavoidable. Now, technologies such as wind, solar, and battery storage offer alternative pathways for countries looking to maximize their energy sovereignty.

Thread 5: Fossil gas as the transition reversal vehicle. The bounded design of the ETS reveals that transitions are not merely incomplete in some countries—they are actively reversing. Fossil gas rents returned the second strongest negative correlation in the study ($\rho = -0.377$), and gas is the common thread connecting nearly every reversal documented: Tanzania, Peru, and the Republic of Congo abandoned inherited clean grids for gas expansion; Ontario more than tripled its gas share following the repeal of RE

legislation; and the United States recorded the world's largest fossil gas growth, substituting one lock-in for another rather than decarbonizing outright. In Unruh's (2000) terms, gas represents the path of least institutional resistance—a politically palatable "bridge" that entrenches new carbon commitments precisely where clean alternatives were viable. Reversal, this paper finds, is not an anomaly but a measurable, gas-driven pathway. Taken together, these five findings reframe the energy transition not as a question of geographic luck or income alone, but as one shaped by institutional capacity, the structural incentives of import dependency, and the political conditions under which national commitments translate into subnational implementation.

6.4 Contribution, Limitations of Paper and Future Research

This paper advances three contributions to the energy transition literature. The first is methodological. The Electro-Transition Score offers a composite metric that captures both the structural shift in a country's clean energy share and the quality of grid growth between two fixed points in time. This addresses a documented gap in the existing scholarship, where dependent variables have largely been static RE shares or installed generation figures rather than directional measures of change. The bounded -1 to 1 design further enables the measurement of transition reversal, a phenomenon that positive-only composite indices, including the WEF's *Energy Transition Index*, are unable to capture.

The second contribution is analytical. By combining governance, economic, fossil fuel dependency, resource endowment, and climate vulnerability and energy sovereignty variables across 144 countries, this paper enables cross-national comparisons not previously available. Most existing studies are regionally bounded—including Amoah et

al. (2022) on African countries and Yin and Liu (2025) on Sub-Saharan Africa—or focused on narrow variable clusters. The 15-variable, five-cluster framework applied across nearly the full IEA-tracked country database expands the empirical foundation for understanding transition determinants.

The third contribution is structural. The OECD-versus-OPEC/+ central comparison, qualified by the electrostate outliers in Africa, Latin America, and Asia, offers a more nuanced analytical structure than the binary developed-versus-developing framing common in the transition literature. This builds on the resource curse and carbon lock-in foundations established by Ross (1999, 2012) and Unruh (2000, 2002) and operates within the multi-level perspective on sociotechnical transitions advanced by Geels (2002), while accommodating the cases those foundations cannot fully explain.

Several limitations qualify these contributions. The ETS measures clean electricity transition specifically but does not capture transport, heating, industry, or primary energy use, where the substantive challenges of decarbonization remain considerable. Furthermore, the ETS is designed to capture changes at only the national aggregate of state-level energy transitions, leaving a blind spot toward exogenous variables and residential adoption such as in Pakistan. The cross-sectional, correlational design prevents causal inference; the variable hierarchies identified in this paper describe co-movement, not causation. While Spearman rank correlation was the methodologically appropriate primary test given the non-normal distributions confirmed by Shapiro-Wilk testing across all variables, the pairwise design cannot adjudicate between competing explanations when independent variables are theoretically correlated, as several variables in this paper demonstrably are. The metric also under-captures countries such as China

and India, where simultaneous mass growth in fossil fuels *and* clean energy mutes the ETS despite unprecedented absolute CE build-out. As with any empirical study, up-to-date data will always produce the clearest picture, especially as energy transitions accelerate in coming years. Finally, the exclusion of armed conflict and major economic shocks as quantified variables, despite their evident influence on transition acceleration in the 2022 Russia-Ukraine and 2026 U.S./Iran cases, leaves a meaningful gap in the explanatory framework that struggles to capture exogenous variables such as these.

These limitations indicate productive directions for further inquiry. Future research could pursue panel-data extensions to capture year-over-year transition dynamics rather than two-point snapshots, multivariate regression modelling to isolate the independent effects of correlated institutional and developmental variables, sectoral decomposition that extends transition measurement beyond electricity, and explicit modelling of geopolitical shocks as transition accelerants—picking up where the tipping points work of Geels and Ayoub (2023) leaves off. The trajectory documented in this paper is, in this light, a baseline against which subsequent work can measure both progress and its conditions.

6.5 Concluding Remarks

In this moment, humanity continues to produce perilous levels of greenhouse emissions. As Mike Barrett of the World Wildlife Fund warned in (2018): "We are sleepwalking toward the edge of a cliff." To avoid the most dangerous of the IPCC climate scenarios (8.5°C, which would lead to societal collapse), the work of achieving a fully decarbonized global electricity system rests squarely on the present generations—but will

ultimately most affect those who come after. This paper illustrates that global clean energy adoption is rapidly accelerating, and so too are the number of countries approaching electrostate status. Should society sustain this growth toward NZE, key targets such as staying below 2.0°C remain *potentially* within reach, rather than 2.8°C as currently estimated by the UNEP. The key to successfully achieving this transition is increased and consistent global stability—through the upholding of democratic institutions, strategic economic growth that avoids lock-in, and open markets where clean energy technologies can flourish across trade borders.

By addressing the more tractable challenge of global electricity decarbonization, the likelihood of remaining within safer temperature thresholds improves meaningfully. As other industries like aviation and heavy industry begin to decarbonize as well, the likelihood will only compound. Moreover, geopolitical shocks and exogenous disruptions have repeatedly demonstrated their capacity to compress decades of policy momentum into months, illustrating that disasters and conflicts are not merely *just* crises—but potential inflection points to be capitalized upon. Within this framing, humanity must now face a choice: to continue accelerating the progress of clean energy adoption everywhere, for everyone, or to continue enabling the deeply entrenched fossil fuel systems that powered the previous eras yet risk incalculable levels of catastrophe by the end of the century. The 2015 Paris Agreement is then, in the final analysis, a promise made by the present to the future. Whether it is kept will be measured not in international frameworks or history textbooks, but in the rapidly evolving climate systems of the world the future generations grow up in. A world that is ideally abundant with affordable, sustainable, clean energy technologies in every village, city, and country.

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Section 8: Appendixes

8.1 Appendix A

Table A16: Alphabetical Country Name, ETS, CEG percent (2000, 2023/2024), Change.

Country Name	ETS	CEG (%, 2000)	CEG (%, 2023/24)	Change (Δ)
Albania	1.00	96.15	100.00	3.85
Algeria	-0.49	0.21	0.76	0.54
Angola	0.40	63.11	74.01	10.90
Argentina	-0.06	47.92	46.63	-1.29
Armenia	0.17	54.82	57.80	2.99
Australia	0.64	8.54	34.98	26.44
Austria	0.77	73.40	87.53	14.13
Azerbaijan	-0.45	8.20	7.24	-0.97
Bahrain	-0.49	0.01	0.29	0.28
Bangladesh	-0.50	4.86	1.90	-2.96
Belarus	0.49	0.10	31.25	31.15
Belgium	0.73	60.95	79.14	18.19
Benin	-0.41	2.38	6.53	4.15
Bolivia	-0.52	51.52	30.05	-21.47
Bosnia	-0.22	48.89	43.10	-5.79
Botswana	-0.49	0.09	0.31	0.22
Brazil	0.25	92.38	90.42	-1.95
Brunei	-0.50	0.04	0.09	0.05
Bulgaria	0.64	51.67	65.33	13.66
Burkina Faso	-0.33	25.4	20.86	-4.27
Cambodia	0.13	0.22	40.94	40.72
Cameroon	-0.41	98.91	76.32	-22.59
Canada	0.63	72.67	79.85	7.18
Chad	-0.47	1.49	2.31	0.82
Chile	0.60	48.55	71.10	22.55
China	-0.01	17.87	35.60	17.72
Colombia	-0.19	75.53	64.25	-11.28

Congo, Republic	-0.71	99.67	35.03	-64.64
Costa Rica	-0.22	99.15	89.46	-9.69
Cote D'Ivoire	-0.39	36.75	25.52	-11.23
Croatia	0.58	57.37	70.20	12.83
Cuba	-0.51	6.32	3.53	-2.79
Curacao	0.60	0.71	20.66	19.94
Cyprus	0.16	0.03	20.48	20.45
Czech Republic	0.73	22.37	58.52	36.15
Denmark	0.95	17.11	91.84	74.74
Dominican Republic	-0.19	7.65	16.37	8.72
DR Congo	1.00	99.95	99.96	0.01
Ecuador	0.27	71.72	73.40	1.68
Egypt	-0.43	17.70	12.76	-4.94
Eritrea	-0.27	0.46	10.12	9.67
Estonia	0.82	0.21	64.34	64.13
Ethiopia	1.00	98.63	99.99	1.36
Finland	0.94	65.91	96.10	30.19
France	0.74	90.83	95.30	4.48
Gabon	-0.34	61.60	46.63	-14.96
Georgia	0.16	78.93	76.06	-2.87
Germany	0.67	37.31	58.03	20.72
Ghana	-0.84	91.50	38.46	-53.04
Greece	0.72	8.78	48.01	39.23
Guatemala	0.40	51.72	65.57	13.85
Haiti	-0.84	51.74	18.66	-33.08
Honduras	-0.15	61.97	52.05	-9.93
Hong Kong	-0.41	0.00	1.47	1.47
Hungary	0.78	41.14	74.66	33.52
Iceland	1.00	99.93	99.98	0.04
India	-0.22	16.62	22.41	5.78
Indonesia	-0.34	15.96	15.98	0.03
Iran	-0.40	3.05	6.40	3.35
Iraq	-0.50	1.92	1.00	-0.92

Ireland	0.72	6.23	47.21	40.98
Israel	-0.09	0.07	15.97	15.90
Italy	0.69	21.28	50.72	29.44
Jamaica	0.54	2.27	10.45	8.18
Japan	-0.48	42.32	37.73	-4.59
Jordan	-0.08	0.61	22.02	21.41
Kazakhstan	-0.40	14.67	12.74	-1.94
Kenya	0.92	47.05	91.20	44.16
Kosovo	-0.22	1.76	12.66	10.90
Kuwait	-0.50	0.00	0.19	0.19
Kyrgyzstan	-0.22	85.90	86.71	0.81
Latvia	0.41	68.25	73.44	5.10
Lebanon	0.65	4.48	33.63	29.15
Libya	-0.50	0.01	0.03	0.02
Lithuania	0.01	80.12	86.39	6.27
Luxembourg	0.94	81.60	97.73	16.13
Madagascar	-0.50	69.79	47.02	-22.76
Malaysia	-0.21	10.06	18.98	8.92
Malta	0.31	0.05	13.54	13.48
Mauritius	-0.56	29.64	17.54	-12.10
Mexico	-0.28	23.80	23.12	-0.68
Moldova	-0.11	6.72	10.59	3.86
Mongolia	-0.31	0.14	9.20	9.06
Montenegro	0.22	50.00	60.91	10.91
Morocco	-0.09	6.08	23.96	17.88
Mozambique	-0.32	99.55	83.54	-16.00
Myanmar	0.05	38.36	46.25	7.89
Namibia	0.93	99.22	98.03	-1.18
Nepal	1.00	98.37	100.00	1.63
Netherlands	0.75	9.32	54.74	45.42
New Zealand	0.73	72.09	84.99	12.90
Nicaragua	0.76	21.40	62.48	41.09
Niger	-0.44	0.48	3.67	3.19

Nigeria	-0.47	37.28	22.75	-14.53
North Macedonia	0.59	17.18	32.00	14.83
Norway	0.91	99.80	98.97	-0.83
Oman	-0.45	0.01	2.71	2.70
Pakistan	0.28	28.17	48.11	19.93
Panama	-0.12	70.43	60.63	-9.80
Paraguay	1.00	100.00	100.00	0.00
Peru	-0.60	86.06	54.37	-31.69
Philippines	-0.59	42.89	22.28	-20.61
Poland	0.64	3.04	30.39	27.34
Portugal	0.90	30.89	86.72	55.83
Qatar	-0.44	0.01	3.35	3.33
Romania	0.75	38.96	69.09	30.13
Russia	-0.01	34.03	37.11	3.08
Rwanda	-0.13	63.47	53.16	-10.31
Saudi Arabia	-0.49	0.00	0.63	0.63
Senegal	-0.33	9.98	13.93	3.95
Serbia	0.08	31.83	36.12	4.29
Singapore	-0.39	1.55	5.00	3.45
Slovakia	0.79	69.01	87.14	18.13
Slovenia	0.69	63.60	77.09	13.49
South Africa	0.44	8.19	14.86	6.67
South Korea	-0.06	39.67	41.35	1.68
Spain	0.80	44.93	77.45	32.52
Sri Lanka	0.07	45.80	49.83	4.03
Sudan	0.71	46.05	80.81	34.76
Suriname	-0.74	88.40	61.70	-26.70
Sweden	1.00	96.88	99.52	2.64
Switzerland	1.00	98.40	99.66	1.26
Syria	-0.55	12.81	3.44	-9.37
Taiwan	-0.57	26.60	16.87	-9.73
Tajikistan	-0.13	98.44	94.38	-4.06
Tanzania	-0.92	86.54	26.54	-59.99

Thailand	-0.11	6.84	19.56	12.72
Togo	-0.68	57.14	26.78	-30.36
Trinidad & Tobago	-0.50	0.37	0.06	-0.30
Tunisia	-0.39	0.82	4.77	3.95
Türkiye	0.21	24.98	45.76	20.78
Turkmenistan	-0.50	0.03	0.02	-0.02
Uganda	0.95	99.62	97.32	-2.30
Ukraine	0.39	51.79	67.26	15.47
United Arab Emirates	0.01	0.00	28.37	28.37
United Kingdom	0.79	26.06	68.26	42.20
United States	0.59	28.88	41.50	12.62
Uruguay	0.35	93.38	92.51	-0.87
Uzbekistan	-0.34	7.53	10.18	2.66
Venezuela	0.81	73.75	90.13	16.38
Viet Nam	-0.18	54.78	44.33	-10.45
Yemen	-0.14	0.03	10.36	10.33
Zambia	-0.18	99.39	89.04	-10.35
Zimbabwe	-0.03	45.66	45.85	0.19

Table A2: National End-Year for IEA Clean Energy Generation Data (2023/2024)

Country	**Data Year**	**Country**	**Data Year**	**Country**	**Data Year**
Albania	2023	Germany	2024	Oman	2023
Algeria	2023	Ghana	2023	Pakistan	2023
Angola	2023	Greece	2024	Panama	2023
Argentina	2024	Guatemala	2023	Paraguay	2023
Armenia	2023	Haiti	2023	Peru	2023
Australia	2024	Honduras	2023	Philippines	2023
Austria	2024	Hong Kong	2023	Poland	2024
Azerbaijan	2023	Hungary	2024	Portugal	2024
Bahrain	2023	Iceland	2024	Qatar	2023
Bangladesh	2023	India	2023	Romania	2023
Belarus	2023	Indonesia	2023	Russia	2023

Belgium	2024	Iran	2023	Rwanda	2023
Benin	2023	Iraq	2023	Saudi Arabia	2023
Bolivia	2023	Ireland	2024	Senegal	2023
Bosnia	2023	Israel	2024	Serbia	2023
Botswana	2023	Italy	2024	Singapore	2023
Brazil	2024	Jamaica	2023	Slovakia	2024
Brunei	2023	Japan	2024	Slovenia	2024
Bulgaria	2023	Jordan	2023	South Africa	2023
Burkina Faso	2023	Kazakhstan	2023	South Korea	2024
Cambodia	2023	Kenya	2024	Spain	2024
Cameroon	2023	Kosovo	2023	Sri Lanka	2023
Canada	2024	Kuwait	2023	Sudan	2023
Chad	2023	Kyrgyzstan	2023	Suriname	2023
Chile	2024	Latvia	2024	Sweden	2024
China	2023	Lebanon	2023	Switzerland	2024
Colombia	2024	Libya	2023	Syria	2023
Congo, Republic	2023	Lithuania	2024	Taiwan	2023
Costa Rica	2024	Luxembourg	2024	Tajikistan	2023
Cote D'Ivoire	2023	Madagascar	2023	Tanzania	2023
Croatia	2023	Malaysia	2023	Thailand	2023
Cuba	2023	Malta	2023	Togo	2023
Curacao	2023	Mauritius	2023	Trinidad & Tobago	2023
Cyprus	2023	Mexico	2024	Tunisia	2023
Czech Republic	2024	Moldova	2023	Türkiye	2024
Denmark	2024	Mongolia	2023	Turkmenistan	2023
Dominican Republic	2023	Montenegro	2023	Uganda	2023
DRC	2023	Morocco	2023	Ukraine	2023
Ecuador	2023	Mozambique	2023	United Arab Emirates	2023
Egypt	2023	Myanmar	2023	United Kingdom	2024
Eritrea	2023	Namibia	2023	United States	2024

Estonia	2024	Nepal	2023	Uruguay	2023
Ethiopia	2023	Netherlands	2024	Uzbekistan	2023
Finland	2024	New Zealand	2024	Venezuela	2023
France	2024	Nicaragua	2023	Viet Nam	2023
Gabon	2023	Niger	2023	Yemen	2023
Georgia	2023	Nigeria	2023	Zambia	2023
North Macedonia	2023	Norway	2024	Zimbabwe	2023

Table A3a: Categorized Countries based on ES Status and Bloc Institution Membership.

Country	***ETS***	***ES/NES (x/xx)***	***G20***	***OECD***	***OPEC/+***	***ASEAN***	***EU***	***BRICS***
Albania	1.000	x						
Algeria	-0.488				x			
Angola	0.399							
Argentina	-0.064		x					
Armenia	0.174							
Australia	0.645		x	x				
Austria	0.766			x			x	
Azerbaijan	-0.450				x			
Bahrain	-0.494				x			
Bangladesh	-0.502							
Belarus	0.489							
Belgium	0.733			x			x	
Benin	-0.408							
Bolivia	-0.524							
Bosnia	-0.215							
Botswana	-0.495							
Brazil	0.254		x		x			x
Brunei	-0.498				x	x		
Bulgaria	0.641						x	
Burkina Faso	-0.332							
Cambodia	0.126					x		

Cameroon	-0.405							
Canada	0.631		x	x				
Chad	-0.471							
Chile	0.605			x				
China	-0.007		x					x
Colombia	-0.191			x				
Congo, Republic of	-0.710				x			
Costa Rica	-0.223			x				
Cote D'Ivoire	-0.395							
Croatia	0.584						x	
Cuba	-0.515							
Curacao	0.600							
Cyprus	0.160						x	
Czech Republic	0.733			x			x	
Denmark	0.951			x			x	
Dominican Republic	-0.185							
DR Congo	0.999	x						
Ecuador	0.271							
Egypt	-0.431							
Eritrea	-0.271							
Estonia	0.821			x			x	
Ethiopia	1.000	x						
Finland	0.943	xx		x				
France	0.744	xx	x	x			x	
Gabon	-0.337				x			
Georgia	0.162							
Germany	0.665		x	x			x	
Ghana	-0.840							
Greece	0.715			x			x	
Guatemala	0.402							
Haiti	-0.843							
Honduras	-0.154							

Hong Kong	-0.408							
Hungary	0.785			x			x	
Iceland	1.000	x		x				
India	-0.218		x					x
Indonesia	-0.340		x			x		
Iran	-0.403				x			
Iraq	-0.497				x			
Ireland	0.719			x			x	
Israel	-0.086			x				
Italy	0.687		x	x			x	
Jamaica	0.542							
Japan	-0.479		x	x				
Jordan	-0.076							
Kazakhstan	-0.400				x			
Kenya	0.917							
Kosovo	-0.223							
Kuwait	-0.496				x			
Kyrgyzstan	-0.223							
Latvia	0.414			x			x	
Lebanon	0.653							
Libya	-0.499				x			
Lithuania	0.008			x			x	
Luxembourg	0.938	xx		x			x	
Madagascar	-0.504							
Malaysia	-0.211				x	x		
Malta	0.313						x	
Mauritius	-0.556							
Mexico	-0.281		x	x	x			
Moldova	-0.108							
Mongolia	-0.313							
Montenegro	0.218							
Morocco	-0.091							

Mozambique	-0.317							
Myanmar	0.053					x		
Namibia	0.931	xx						
Nepal	1.000	x						
Netherlands	0.750			x			x	
New Zealand	0.731			x				
Nicaragua	0.761							
Niger	-0.439							
Nigeria	-0.473				x			
North Macedonia	0.590							
Norway	0.907	xx		x				
Oman	-0.452				x			
Pakistan	0.284							
Panama	-0.118							
Paraguay	1.000	x						
Peru	-0.60							
Philippines	-0.586					x		
Poland	0.641			x			x	
Portugal	0.904			x			x	
Qatar	-0.443							
Romania	0.747						x	
Russia	-0.010		x		x			x
Rwanda	-0.126							
Saudi Arabia	-0.488		x		x			
Senegal	-0.329							
Serbia	0.078							
Singapore	-0.391					x		
Slovakia	0.793			x			x	
Slovenia	0.685			x			x	
South Africa	0.439		x					x
South Korea	-0.057		x	x				
Spain	0.795			x			x	

Sri Lanka	0.068							
Sudan	0.706				x			
Suriname	-0.735							
Sweden	0.998	x		x			x	
Switzerland	0.998	x		x			x	
Syria	-0.554							
Taiwan	-0.566							
Tajikistan	-0.132							
Tanzania	-0.921							
Thailand	-0.114					x		
Togo	-0.685							
Trinidad & Tobago	-0.502							
Tunisia	-0.393							
Türkiye	0.212		x	x				
Turkmenistan	-0.500							
Uganda	0.952	xx						
Ukraine	0.388							
United Arab Emirates	0.014				x			
United Kingdom	0.785		x	x				
United States	0.589		x	x				
Uruguay	0.347							
Uzbekistan	-0.339							
Venezuela	0.812				x			
Viet Nam	-0.183					x		
Yemen	-0.136							
Zambia	-0.179							
Zimbabwe	-0.028							

Table A3b: Categorized Countries based on Continental Region.

Country	***Africa***	***Americas & Caribbean***	***Asia (C/E)***	***Asia (S/SE) & Oceania***	***Europe***	***Middle East***
Albania					x	
Algeria	x					
Angola	x					
Argentina		x				
Armenia			x			
Australia				x		
Austria					x	
Azerbaijan			x			
Bahrain						x
Bangladesh				x		
Belarus					x	
Belgium					x	
Benin	x					
Bolivia		x				
Bosnia					x	
Botswana	x					
Brazil		x				
Brunei				x		
Bulgaria					x	
Burkina Faso	x					
Cambodia				x		
Cameroon	x					
Canada		x				
Chad	x					
Chile		x				
China			x			
Colombia		x				
Congo, Republic of	x					
Costa Rica		x				

Cote D'Ivoire	x					
Croatia					x	
Cuba		x				
Curacao		x				
Cyprus						x
Czech Republic					x	
Denmark					x	
Dominican Republic		x				
DR Congo	x					
Ecuador		x				
Egypt	x					
Eritrea	x					
Estonia					x	
Ethiopia	x					
Finland					x	
France					x	
Gabon	x					
Georgia			x			
Germany					x	
Ghana	x					
Greece					x	
Guatemala		x				
Haiti		x				
Honduras		x				
Hong Kong			x			
Hungary					x	
Iceland					x	
India				x		
Indonesia				x		
Iran						x
Iraq						x

Ireland					x	
Israel						x
Italy					x	
Jamaica		x				
Japan			x			
Jordan						x
Kazakhstan			x			
Kenya	x					
Kosovo					x	
Kuwait						x
Kyrgyzstan			x			
Latvia					x	
Lebanon						x
Libya	x					
Lithuania					x	
Luxembourg					x	
Madagascar	x					
Malaysia				x		
Malta					x	
Mauritius	x					
Mexico		x				
Moldova					x	
Mongolia			x			
Montenegro					x	
Morocco	x					
Mozambique	x					
Myanmar				x		
Namibia	x					
Nepal			x			
Netherlands					x	
New Zealand				x		
Nicaragua		x				

Niger	x					
Nigeria	x					
North Macedonia					x	
Norway					x	
Oman						x
Pakistan				x		
Panama		x				
Paraguay		x				
Peru		x				
Philippines				x		
Poland					x	
Portugal					x	
Qatar						x
Romania					x	
Russia			x			
Rwanda	x					
Saudi Arabia						x
Senegal	x					
Serbia					x	
Singapore				x		
Slovakia					x	
Slovenia					x	
South Africa	x					
South Korea			x			
Spain					x	
Sri Lanka				x		
Sudan	x					
Suriname		x				
Sweden					x	
Switzerland					x	
Syria						x
Taiwan			x			

Tajikistan			x			
Tanzania	x					
Thailand				x		
Togo	x					
Trinidad & Tobago		x				
Tunisia	x					
Türkiye						x
Turkmenistan			x			
Uganda	x					
Ukraine					x	
United Arab Emirates						x
United Kingdom					x	
United States		x				
Uruguay		x				
Uzbekistan			x			
Venezuela		x				
Viet Nam				x		
Yemen						x
Zambia	x					
Zimbabwe	x					

Table A4: Electro-Transition Scores Ranked in Descending Order.

Country Name	**ETS**	**CEG (%, 2000)**	**CEG (%, 2023/24)**	**Change (Δ)**
Albania	1.00	96.15	100.00	3.85
Nepal	1.00	98.37	100.00	1.63
Paraguay	1.00	100.00	100.00	0.00
Ethiopia	1.00	98.63	99.99	1.36
Iceland	1.00	99.93	99.98	0.04
DR Congo	1.00	99.95	99.96	0.01
Switzerland	1.00	98.40	99.66	1.26
Sweden	1.00	96.88	99.52	2.64

Uganda	0.95	99.62	97.32	-2.30
Denmark	0.95	17.11	91.84	74.74
Finland	0.94	65.91	96.10	30.19
Luxembourg	0.94	81.60	97.73	16.13
Namibia	0.93	99.22	98.03	-1.18
Kenya	0.92	47.05	91.20	44.16
Norway	0.91	99.80	98.97	-0.83
Portugal	0.90	30.89	86.72	55.83
Estonia	0.82	0.21	64.34	64.13
Venezuela	0.81	73.75	90.13	16.38
Spain	0.80	44.93	77.45	32.52
Slovakia	0.79	69.01	87.14	18.13
United Kingdom	0.79	26.06	68.26	42.20
Hungary	0.78	41.14	74.66	33.52
Austria	0.77	73.40	87.53	14.13
Nicaragua	0.76	21.40	62.48	41.09
Netherlands	0.75	9.32	54.74	45.42
Romania	0.75	38.96	69.09	30.13
France	0.74	90.83	95.30	4.48
Belgium	0.73	60.95	79.14	18.19
Czech Republic	0.73	22.37	58.52	36.15
New Zealand	0.73	72.09	84.99	12.90
Ireland	0.72	6.23	47.21	40.98
Greece	0.72	8.78	48.01	39.23
Sudan	0.71	46.05	80.81	34.76
Italy	0.69	21.28	50.72	29.44
Slovenia	0.69	63.60	77.09	13.49
Germany	0.67	37.31	58.03	20.72
Lebanon	0.65	4.48	33.63	29.15
Australia	0.64	8.54	34.98	26.44
Bulgaria	0.64	51.67	65.33	13.66
Poland	0.64	3.04	30.39	27.34
Canada	0.63	72.67	79.85	7.18

Chile	0.60	48.55	71.10	22.55
Curacao	0.60	0.71	20.66	19.94
North Macedonia	0.59	17.18	32.00	14.83
United States	0.59	28.88	41.50	12.62
Croatia	0.58	57.37	70.20	12.83
Jamaica	0.54	2.27	10.45	8.18
Belarus	0.49	0.10	31.25	31.15
South Africa	0.44	8.19	14.86	6.67
Latvia	0.41	68.25	73.44	5.10
Guatemala	0.40	51.72	65.57	13.85
Angola	0.40	63.11	74.01	10.90
Ukraine	0.39	51.79	67.26	15.47
Uruguay	0.35	93.38	92.51	-0.87
Malta	0.31	0.05	13.54	13.48
Pakistan	0.28	28.17	48.11	19.93
Ecuador	0.27	71.72	73.40	1.68
Brazil	0.25	92.38	90.42	-1.95
Montenegro	0.22	50.00	60.91	10.91
Türkiye	0.21	24.98	45.76	20.78
Armenia	0.17	54.82	57.80	2.99
Georgia	0.16	78.93	76.06	-2.87
Cyprus	0.16	0.03	20.48	20.45
Cambodia	0.13	0.22	40.94	40.72
Serbia	0.08	31.83	36.12	4.29
Sri Lanka	0.07	45.80	49.83	4.03
Myanmar	0.05	38.36	46.25	7.89
United Arab Emirates	0.01	0.00	28.37	28.37
Lithuania	0.01	80.12	86.39	6.27
China	-0.01	17.87	35.60	17.72
Russia	-0.01	34.03	37.11	3.08
Zimbabwe	-0.03	45.66	45.85	0.19
South Korea	-0.06	39.67	41.35	1.68
Argentina	-0.06	47.92	46.63	-1.29

Jordan	-0.08	0.61	22.02	21.41
Israel	-0.09	0.07	15.97	15.90
Morocco	-0.09	6.08	23.96	17.88
Moldova	-0.11	6.72	10.59	3.86
Thailand	-0.11	6.84	19.56	12.72
Panama	-0.12	70.43	60.63	-9.80
Rwanda	-0.13	63.47	53.16	-10.31
Tajikistan	-0.13	98.44	94.38	-4.06
Yemen	-0.14	0.03	10.36	10.33
Honduras	-0.15	61.97	52.05	-9.93
Zambia	-0.18	99.39	89.04	-10.35
Viet Nam	-0.18	54.78	44.33	-10.45
Dominican Republic	-0.19	7.65	16.37	8.72
Colombia	-0.19	75.53	64.25	-11.28
Malaysia	-0.21	10.06	18.98	8.92
Bosnia	-0.22	48.89	43.10	-5.79
India	-0.22	16.62	22.41	5.78
Costa Rica	-0.22	99.15	89.46	-9.69
Kosovo	-0.22	1.76	12.66	10.90
Kyrgyzstan	-0.22	85.90	86.71	0.81
Eritrea	-0.27	0.46	10.12	9.67
Mexico	-0.28	23.80	23.12	-0.68
Mongolia	-0.31	0.14	9.20	9.06
Mozambique	-0.32	99.55	83.54	-16.00
Senegal	-0.33	9.98	13.93	3.95
Burkina Faso	-0.33	25.4	20.86	-4.27
Gabon	-0.34	61.60	46.63	-14.96
Uzbekistan	-0.34	7.53	10.18	2.66
Indonesia	-0.34	15.96	15.98	0.03
Singapore	-0.39	1.55	5.00	3.45
Tunisia	-0.39	0.82	4.77	3.95
Cote D'Ivoire	-0.39	36.75	25.52	-11.23
Kazakhstan	-0.40	14.67	12.74	-1.94

Iran	-0.40	3.05	6.40	3.35
Cameroon	-0.41	98.91	76.32	-22.59
Hong Kong	-0.41	0.00	1.47	1.47
Benin	-0.41	2.38	6.53	4.15
Egypt	-0.43	17.70	12.76	-4.94
Niger	-0.44	0.48	3.67	3.19
Qatar	-0.44	0.01	3.35	3.33
Azerbaijan	-0.45	8.20	7.24	-0.97
Oman	-0.45	0.01	2.71	2.70
Chad	-0.47	1.49	2.31	0.82
Nigeria	-0.47	37.28	22.75	-14.53
Japan	-0.48	42.32	37.73	-4.59
Algeria	-0.49	0.21	0.76	0.54
Saudi Arabia	-0.49	0.00	0.63	0.63
Bahrain	-0.49	0.01	0.29	0.28
Botswana	-0.49	0.09	0.31	0.22
Kuwait	-0.50	0.00	0.19	0.19
Iraq	-0.50	1.92	1.00	-0.92
Brunei	-0.50	0.04	0.09	0.05
Libya	-0.50	0.01	0.03	0.02
Turkmenistan	-0.50	0.03	0.02	-0.02
Trinidad & Tobago	-0.50	0.37	0.06	-0.30
Bangladesh	-0.50	4.86	1.90	-2.96
Madagascar	-0.50	69.79	47.02	-22.76
Cuba	-0.51	6.32	3.53	-2.79
Bolivia	-0.52	51.52	30.05	-21.47
Syria	-0.55	12.81	3.44	-9.37
Mauritius	-0.56	29.64	17.54	-12.10
Taiwan	-0.57	26.60	16.87	-9.73
Philippines	-0.59	42.89	22.28	-20.61
Peru	-0.60	86.06	54.37	-31.69
Togo	-0.68	57.14	26.78	-30.36
Congo, Republic	-0.71	99.67	35.03	-64.64

Suriname	-0.74	88.40	61.70	-26.70
Ghana	-0.84	91.50	38.46	-53.04
Haiti	-0.84	51.74	18.66	-33.08
Tanzania	-0.92	86.54	26.54	-59.99

Table A5: Change in CEG During the Study Period Ranked in Descending Order.

Country	ET Score	CEC (%, 2000)	CEC (%, 2023/24)	Change (Δ)
Denmark	0.95	17.11	91.84	74.74
Estonia	0.82	0.21	64.34	64.13
Portugal	0.90	30.89	86.72	55.83
Netherlands	0.75	9.32	54.74	45.42
Kenya	0.92	47.05	91.20	44.16
United Kingdom	0.79	26.06	68.26	42.20
Nicaragua	0.76	21.40	62.48	41.09
Ireland	0.72	6.23	47.21	40.98
Cambodia	0.13	0.22	40.94	40.72
Greece	0.72	8.78	48.01	39.23
Czech Republic	0.73	22.37	58.52	36.15
Sudan	0.71	46.05	80.81	34.76
Hungary	0.78	41.14	74.66	33.52
Spain	0.80	44.93	77.45	32.52
Belarus	0.49	0.10	31.25	31.15
Finland	0.94	65.91	96.10	30.19
Romania	0.75	38.96	69.09	30.13
Italy	0.69	21.28	50.72	29.44
Lebanon	0.65	4.48	33.63	29.15
United Arab Emirates	0.01	0.00	28.37	28.37
Poland	0.64	3.04	30.39	27.34
Australia	0.64	8.54	34.98	26.44
Chile	0.60	48.55	71.10	22.55
Jordan	-0.08	0.61	22.02	21.41
Turkiye	0.21	24.98	45.76	20.78

Germany	0.67	37.31	58.03	20.72
Cyprus	0.16	0.03	20.48	20.45
Curacao	0.60	0.71	20.66	19.94
Pakistan	0.28	28.17	48.11	19.93
Belgium	0.73	60.95	79.14	18.19
Slovakia	0.79	69.01	87.14	18.13
Morocco	-0.09	6.08	23.96	17.88
China	-0.01	17.87	35.60	17.72
Venezuela	0.81	73.75	90.13	16.38
Luxembourg	0.94	81.60	97.73	16.13
Israel	-0.09	0.07	15.97	15.90
Ukraine	0.39	51.79	67.26	15.47
North Macedonia	0.59	17.18	32.00	14.83
Austria	0.77	73.40	87.53	14.13
Guatemala	0.40	51.72	65.57	13.85
Bulgaria	0.64	51.67	65.33	13.66
Slovenia	0.69	63.60	77.09	13.49
Malta	0.31	0.05	13.54	13.48
New Zealand	0.73	72.09	84.99	12.90
Croatia	0.58	57.37	70.20	12.83
Thailand	-0.11	6.84	19.56	12.72
United States	0.59	28.88	41.50	12.62
Montenegro	0.22	50.00	60.91	10.91
Kosovo	-0.22	1.76	12.66	10.90
Angola	0.40	63.11	74.01	10.90
Yemen	-0.14	0.03	10.36	10.33
Eritrea	-0.27	0.46	10.12	9.67
Mongolia	-0.31	0.14	9.20	9.06
Malaysia	-0.21	10.06	18.98	8.92
Dominican Republic	-0.19	7.65	16.37	8.72
Jamaica	0.54	2.27	10.45	8.18
Myanmar	0.05	38.36	46.25	7.89

Canada	0.63	72.67	79.85	7.18
South Africa	0.44	8.19	14.86	6.67
Lithuania	0.01	80.12	86.39	6.27
India	-0.22	16.62	22.41	5.78
Latvia	0.41	68.25	73.44	5.19
France	0.74	90.83	95.30	4.48
Serbia	0.08	31.83	36.12	4.29
Benin	-0.41	2.38	6.53	4.15
Sri Lanka	0.07	45.80	49.83	4.03
Senegal	-0.33	9.98	13.93	3.95
Tunisia	-0.39	0.82	4.77	3.95
Moldova	-0.11	6.72	10.59	3.86
Albania	1.00	96.15	100.00	3.85
Singapore	-0.39	1.55	5.00	3.45
Iran	-0.40	3.05	6.40	3.35
Qatar	-0.44	0.01	3.35	3.33
Niger	-0.44	0.48	3.67	3.19
Russia	-0.01	34.03	37.11	3.08
Armenia	0.17	54.82	57.80	2.99
Oman	-0.45	0.01	2.71	2.70
Uzbekistan	-0.34	7.53	10.18	2.66
Sweden	1.00	96.88	99.52	2.64
South Korea	-0.06	39.67	41.35	1.68
Ecuador	0.27	71.72	73.40	1.68
Nepal	1.00	98.37	100.00	1.63
Hong Kong	-0.41	0.00	1.47	1.47
Ethiopia	1.00	98.63	99.99	1.36
Switzerland	1.00	98.40	99.66	1.26
Chad	-0.47	1.49	2.31	0.82
Kyrgyzstan	-0.22	85.90	86.71	0.81
Saudi Arabia	-0.49	0.00	0.63	0.63
Algeria	-0.49	0.21	0.76	0.54
Bahrain	-0.49	0.01	0.29	0.28

Botswana	-0.49	0.09	0.31	0.22
Kuwait	-0.50	0.00	0.19	0.19
Zimbabwe	-0.03	45.66	45.85	0.19
Brunei	-0.50	0.04	0.09	0.05
Iceland	1.00	99.93	99.98	0.04
Indonesia	-0.34	15.96	15.98	0.03
Libya	-0.50	0.01	0.03	0.02
DRC	1.00	99.95	99.96	0.01
Paraguay	1.00	100.00	100.00	0.00
Turkmenistan	-0.50	0.03	0.02	-0.02
Trinidad & Tobago	-0.50	0.37	0.06	-0.30
Mexico	-0.28	23.80	23.12	-0.68
Norway	0.91	99.80	98.97	-0.83
Uruguay	0.35	93.38	92.51	-0.87
Iraq	-0.50	1.92	1.00	-0.92
Azerbaijan	-0.45	8.20	7.24	-0.97
Namibia	0.93	99.22	98.03	-1.18
Argentina	-0.06	47.92	46.63	-1.29
Kazakhstan	-0.40	14.67	12.74	-1.94
Brazil	0.25	92.38	90.42	-1.95
Uganda	0.95	99.62	97.32	-2.30
Cuba	-0.51	6.32	3.53	-2.79
Georgia	0.16	78.93	76.06	-2.87
Bangladesh	-0.50	4.86	1.90	-2.96
Tajikistan	-0.13	98.44	94.38	-4.06
Burkina Faso	-0.33	25.13	20.86	-4.27
Japan	-0.48	42.32	37.73	-4.59
Egypt	-0.43	17.70	12.76	-4.94
Bosnia	-0.22	48.89	43.10	-5.79
Syria	-0.55	12.81	3.44	-9.37
Costa Rica	-0.22	99.15	89.46	-9.69
Taiwan	-0.57	26.60	16.87	-9.73

Panama	-0.12	70.43	60.63	-9.80
Honduras	-0.15	61.97	52.05	-9.93
Rwanda	-0.13	63.47	53.16	-10.31
Zambia	-0.18	99.39	89.04	-10.35
Viet Nam	-0.18	54.78	44.33	-10.45
Cote D'Ivoire	-0.39	36.75	25.52	-11.23
Colombia	-0.19	75.53	64.25	-11.28
Mauritius	-0.56	29.64	17.54	-12.10
Nigeria	-0.47	37.28	22.75	-14.53
Gabon	-0.34	61.60	46.63	-14.96
Mozambique	-0.32	99.55	83.54	-16.00
Philippines	-0.59	42.89	22.28	-20.61
Bolivia	-0.52	51.52	30.05	-21.47
Cameroon	-0.41	98.91	76.32	-22.59
Madagascar	-0.50	69.79	47.02	-22.76
Suriname	-0.74	88.40	61.70	-26.70
Togo	-0.68	57.14	26.78	-30.36
Peru	-0.60	86.06	54.37	-31.69
Haiti	-0.84	51.74	18.66	-33.08
Ghana	-0.84	91.50	38.46	-53.04
Tanzania	-0.92	86.54	26.54	-59.99
Congo, Republic	-0.71	99.67	35.03	-64.64

Table A6a: Independent Variable Data for All Countries (Governance Capacity Segment).

Country Name	***Net Zero Commitment***	***V-Dem LD Score (2024)***	***Corruption Score (2025)***
Albania	0	0.40	39
Algeria	0	0.12	34
Angola	0.5	0.16	32
Argentina	0.75	0.55	36
Armenia	1	0.41	46

Australia	1	0.81	76
Austria	1	0.76	69
Azerbaijan	0	0.05	30
Bahrain	0.5	0.05	50
Bangladesh	0.75	0.07	24
Belarus	0	0.04	31
Belgium	1	0.81	69
Benin	0	0.33	45
Bolivia	0	0.31	28
Bosnia	0	0.34	34
Botswana	0	0.48	58
Brazil	0.75	0.71	35
Brunei	0.75	-	-
Bulgaria	1	0.51	40
Burkina Faso	0.75	0.13	40
Cambodia	0.75	0.06	20
Cameroon	0	0.14	26
Canada	1	0.74	75
Chad	0	0.05	22
Chile	1	0.79	63
China	0.75	0.04	43
Colombia	1	0.56	37
Congo, Republic of	0.25	0.12	23
Costa Rica	0.75	0.81	56
Cote D'Ivoire	0	0.25	43
Croatia	1	0.62	47
Cuba	0	0.06	40
Curacao	0	-	-
Cyprus	1	0.65	55
Czech Republic	1	0.82	59
Denmark	0.75	0.88	89
Dominican Republic	0.75	0.45	37
DR Congo	0	0.13	20
Ecuador	0	0.45	33
Egypt	0	0.13	30

Eritrea	0	0.01	13
Estonia	1	0.85	76
Ethiopia	0.75	0.10	38
Finland	1	0.80	88
France	1	0.80	66
Gabon	0	0.16	29
Georgia	0.75	0.33	50
Germany	1	0.79	77
Ghana	0.5	0.57	43
Greece	1	0.58	50
Guatemala	0	0.47	26
Haiti	0.25	0.08	16
Honduras	0.75	0.38	22
Hong Kong	0	0.13	76
Hungary	1	0.32	40
Iceland	1	0.76	77
India	1	0.29	39
Indonesia	0.5	0.33	34
Iran	0	0.09	23
Iraq	0	0.23	28
Ireland	1	0.83	76
Israel	0.25	0.62	62
Italy	1	0.71	53
Jamaica	0.5	0.68	44
Japan	0.75	0.73	71
Jordan	0	0.27	50
Kazakhstan	1	0.13	38
Kenya	0	0.43	30
Kosovo	0	0.47	43
Kuwait	0.5	0.27	46
Kyrgyzstan	0.25	0.18	26
Latvia	1	0.77	60
Lebanon	0.75	0.21	23
Libya	0	0.11	13
Lithuania	1	0.73	65

Luxembourg	1	0.78	78
Madagascar	0.25	0.22	25
Malaysia	0.75	0.36	52
Malta	1	0.64	49
Mauritius	0.25	0.37	48
Mexico	0.75	0.25	27
Moldova	1	0.52	42
Mongolia	0.5	0.39	31
Montenegro	0.5	0.48	46
Morocco	0	0.25	39
Mozambique	0.25	0.17	21
Myanmar	0.25	0.02	16
Namibia	0.75	0.52	46
Nepal	0.75	0.52	34
Netherlands	1	0.76	78
New Zealand	1	0.81	81
Nicaragua	0.25	0.02	14
Niger	0.25	0.18	31
Nigeria	1	0.32	26
North Macedonia	0	0.37	40
Norway	0	0.84	81
Oman	0.75	0.14	52
Pakistan	0.25	0.20	28
Panama	0.75	0.58	33
Paraguay	0	0.39	24
Peru	0.75	0.49	30
Philippines	0	0.31	32
Poland	1	0.62	53
Portugal	1	0.75	56
Qatar	0	0.08	58
Romania	1	0.45	45
Russia	1	0.06	22
Rwanda	0	0.09	58
Saudi Arabia	0.5	0.05	57
Senegal	0	0.46	46

Serbia	0	0.22	33
Singapore	0.75	0.34	84
Slovakia	1	0.58	48
Slovenia	1	0.62	58
South Africa	0.75	0.65	41
South Korea	1	0.63	63
Spain	1	0.75	55
Sri Lanka	0.75	0.49	35
Sudan	0.25	0.04	14
Suriname	0	0.64	38
Sweden	1	0.85	80
Switzerland	1	0.85	80
Syria	0	0.05	15
Taiwan	0	0.70	68
Tajikistan	0	0.05	19
Tanzania	0.75	0.37	40
Thailand	0.75	0.29	33
Togo	0.25	0.17	32
Trinidad & Tobago	0.25	0.63	41
Tunisia	0.75	0.26	39
Türkiye	0.75	0.12	31
Turkmenistan	0	0.03	17
Uganda	0.75	0.20	25
Ukraine	1	0.23	36
United Arab Emirates	0.75	0.08	69
United Kingdom	1	0.75	70
United States	0	0.75	64
Uruguay	0.75	0.77	73
Uzbekistan	0.5	0.08	31
Venezuela	0	0.05	10
Viet Nam	0.75	0.12	41
Yemen	0.25	0.05	13
Zambia	0	0.39	37
Zimbabwe	0	0.16	22

Table A6b: Independent Variable Data for All Countries (Human Development and Economic Capacity Segment).

Country Name	***HDI Score (2024)***	***GDP Change (2000-2024)***	***GDP Per Capita Δ (2000-2024)***
Albania	0.81	$23,461,859,131.82	$10,217.36
Algeria	0.76	$214,531,883,094.45	$3,980.06
Angola	0.62	$91,869,321,810.93	$2,102.14
Argentina	0.87	$354,161,705,340.04	$6,332.77
Armenia	0.81	$24,043,711,711.18	$7,962.76
Australia	0.96	$1,340,120,489,489.4	$42,694.99
Austria	0.93	$338,609,120,635.54	$33,781.58
Azerbaijan	0.79	$69,043,266,629.97	$6,628.75
Bahrain	0.90	$38,046,835,372.34	$15,439.09
Bangladesh	0.69	$396,749,644,750.23	$2,196.75
Belarus	0.82	$63,225,008,643.93	$7,041.34
Belgium	0.95	$434,577,621,323.94	$33,515.68
Benin	0.52	$17,962,652,265.95	$997.96
Bolivia	0.73	$46,483,471,968.20	$3,445.39
Bosnia	0.80	$24,045,799,254.09	$8,020.31
Botswana	0.73	$13,613,733,903.75	$4,244.94
Brazil	0.79	$1,530,373,460,684	$6,544.00
Brunei	0.84	$8,769,809,504.91	$13,023.21
Bulgaria	0.85	$100,097,365,505.53	$15,974.76
Burkina Faso	-	$20,156,359,765.42	$733.08
Cambodia	0.61	$42,658,478,057.92	$2,331.45
Cameroon	0.59	$42,730,115,025.22	$1,121.44
Canada	0.94	$1,498,863,410,702.2	$30,069.35
Chad	0.42	$18,130,312,979.70	$798.44
Chile	0.88	$251,927,386,650.23	$11,656.90
China	0.80	$17,520,048,250,856	$12,333.95
Colombia	0.79	$318,943,079,928.24	$5,364.20
Congo, Republic of	0.65	$12,492,058,379.07	$1,457.95
Costa Rica	0.83	$80,336,793,514.70	$14,774.40
Cote D'Ivoire	0.58	$70,535,645,257.41	$1,791.25
Croatia	0.89	$70,849,399,031.44	$19,096.79
Cuba	0.76	-	-

Curacao	-	$1,440,666,967.16	$6,991.64
Cyprus	0.91	$27,648,686,018.04	$24,285.94
Czech Republic	0.92	$284,858,420,690.39	$25,760.39
Denmark	0.96	$260,480,904,813.46	$40,304.45
Dominican Republic	0.78	$99,976,465,009.90	$8,044.20
DR Congo	0.52	$51,874,139,484.91	$271.45
Ecuador	0.78	$107,136,619,972.64	$5,492.48
Egypt	0.75	$289,221,367,043.49	$1,972.38
Eritrea	-	-	-
Estonia	0.91	$37,443,840,081.81	$27,357.74
Ethiopia	0.50	$141,497,948,335.12	$1,011.61
Finland	0.95	$172,729,140,187.07	$28,813.85
France	0.92	$1,799,483,552,987.6	$23,762.49
Gabon	0.73	$15,815,200,797.15	$4,247.13
Georgia	0.84	$31,131,948,209.81	$8,491.58
Germany	0.96	$2,718,611,876,659.6	$32,177.87
Ghana	0.63	$77,325,259,724.26	$2,137.02
Greece	0.91	$130,478,205,553.31	$12,987.95
Guatemala	0.66	$93,910,652,128.15	$4,501.06
Haiti	0.55	$18,410,588,891.93	$1,322.02
Honduras	0.65	$29,906,927,824.98	$2,333.87
Hong Kong	0.96	$235,194,505,292.99	$28,317.92
Hungary	0.87	$175,446,784,496.68	$18,662.41
Iceland	0.97	$24,115,012,546.58	$53,536.95
India	0.69	$3,441,496,012,203.6	$2,251.99
Indonesia	0.73	$1,231,279,086,113.16	$4,161.72
Iran	0.80	$365,660,381,413.20	$3,540.16
Iraq	0.70	$231,277,006,671.48	$4,093.42
Ireland	0.95	$508,949,849,317.30	$86,560.38
Israel	0.92	$403,867,620,719.66	$32,470.16
Italy	0.92	$1,231,163,713,804.22	$20,195.34
Jamaica	0.72	$13,009,332,614.84	$4,300.71
Japan	0.93	-$940,761,552,406.01	-$6,682.28
Jordan	0.75	$44,891,499,732.61	$3,047.49
Kazakhstan	0.84	$273,188,283,986.79	$12,974.59

Kenya	0.63	$107,634,207,808.13	$1,717.80
Kosovo	-	-	-
Kuwait	0.85	$122,508,529,573.26	$13,421.37
Kyrgyzstan	0.72	$16,108,571,161.19	$2,140.57
Latvia	0.89	$35,923,001,825.18	$20,130.90
Lebanon	0.46	-	-$509.11
Libya	0.72	$10,216,197,077.23	-$644.94
Lithuania	0.90	$73,318,519,786.13	$26,083.38
Luxembourg	0.92	$72,049,668,874.10	$89,122.08
Madagascar	0.49	$12,791,254,286.28	$264.71
Malaysia	0.82	$328,437,268,586.58	$7,790.90
Malta	0.92	$20,934,764,686.98	$33,550.09
Mauritius	0.81	$10,211,753,163.69	$8,008.80
Mexico	0.79	$1,114,304,286,416.81	$6,661.75
Moldova	-	$16,911,911,461.85	$7,135.66
Mongolia	0.75	$22,657,643,900.90	$6,274.60
Montenegro	-	$7,285,723,627.06	$11,636.26
Morocco	0.71	$117,593,538,652.89	$2,654.08
Mozambique	0.49	$16,814,656,090.45	$329.65
Myanmar	0.61	$65,163,283,360.22	$1,162.43
Namibia	0.67	$9,450,122,346.88	$2,256.45
Nepal	0.62	$37,420,016,078.81	$1,223.48
Netherlands	0.96	$797,278,416,418.93	$41,295.25
New Zealand	0.94	$207,549,103,140.91	$35,564.08
Nicaragua	0.71	$14,584,395,917.62	$1,830.23
Niger	0.42	$17,634,375,292.97	$540.50
Nigeria	0.56	$183,090,428,513.90	$536.84
North Macedonia	0.82	$13,178,823,211.22	$7,429.96
Norway	0.97	$312,135,446,377.33	$48,607.19
Oman	0.86	$84,877,640,902.03	$10,531.38
Pakistan	0.54	$272,085,197,776.74	$836.43
Panama	0.76	$74,557,462,083.10	$15,186.13
Paraguay	0.84	$35,602,413,257.89	$4,679.98
Peru	0.79	$237,477,219,929.73	$6,506.96
Philippines	0.72	$377,947,721,405.43	$2,934.04

Poland	0.91	$744,813,579,113.75	$20,582.93
Portugal	0.89	$194,665,992,207.71	$17,765.87
Qatar	0.89	$201,402,747,252.75	$49,153.51
Romania	0.85	$345,310,478,477.74	$18,420.28
Russia	0.83	$1,914,125,664,474.71	$13,117.43
Rwanda	0.58	$12,182,805,480.72	$747.78
Saudi Arabia	0.90	$1,050,289,600,000	$23,407.10
Senegal	0.53	$26,794,871,596.97	$1,169.99
Serbia	0.83	$82,771,392,077.00	$12,704.48
Singapore	0.95	$451,310,105,966.11	$66,821.23
Slovakia	0.88	$111,718,350,527.60	$20,571.03
Slovenia	0.93	$52,812,824,495.71	$24,165.31
South Africa	0.74	$249,392,241,158.28	$3,049.34
South Korea	0.94	$1,277,901,035,927.7	$23,528.34
Spain	0.92	$1,127,568,797,986.11	$20,583.50
Sri Lanka	0.78	$82,367,302,690.96	$3,655.37
Sudan	-	$37,415,136,365.82	$622.49
Suriname	-	$3,469,103,142.40	$4,973.57
Sweden	0.96	$340,811,663,985.52	$27,484.90
Switzerland	0.97	$657,348,164,178.31	$65,133.17
Syria	0.56	-	-
Taiwan	-	-	-
Tajikistan	0.69	$13,344,033,706.29	$1,204.27
Tanzania	0.56	$65,472,638,303.48	$785.02
Thailand	0.80	$400,125,434,587.89	$5,340.64
Togo	0.57	$8,544,331,394.25	$709.49
Trinidad & Tobago	0.81	$17,479,202,413.38	$12,554.82
Tunisia	0.75	$29,858,757,495.76	$1,982.10
Türkiye	0.85	$1,084,375,305,595	$11,693.34
Turkmenistan	-	$48,482,546,561.32	$6,222.82
Uganda	0.58	$47,718,660,249.06	$819.86
Ukraine	0.78	$158,366,178,479.88	$4,736.18
United Arab Emirates	0.94	$447,987,474,472.43	$20,408.01
United Kingdom	0.95	$2,014,435,223,329.2	$24,862.49
United States	0.94	$18,500,008,133,731	$48,204.08

Uruguay	0.86	$58,138,240,181.47	$16,918.81
Uzbekistan	0.74	$101,204,779,497.30	$2,606.55
Venezuela	0.71	$2,656,497,255.12	-$558.69
Viet Nam	0.77	$445,215,711,903.86	$4,313.26
Yemen	0.47	-	-
Zambia	0.60	$21,702,553,230.84	$827.68
Zimbabwe	0.60	$34,846,161,516.44	$1,934.37

Table A6c: Independent Variable Data for All Countries (Fossil Fuel Rents Segment).

Country Name	***Oil %/GDP Δ (2000-2021)***	***Coal %/GDP Δ (2000-2021)***	***Gas %/GDP Δ (2000-2021)***
Albania	-0.03	0.03	0.04
Algeria	-5.74	0.00	1.63
Angola	-29.24	0.00	0.82
Argentina	-0.49	0.00	0.11
Armenia	0.00	0.00	0.00
Australia	-0.61	0.60	1.17
Austria	-0.02	0.00	0.00
Azerbaijan	-11.96	0.00	6.47
Bahrain	-7.77	0.00	1.80
Bangladesh	0.00	0.01	-0.20
Belarus	-0.97	0.00	0.00
Belgium	0.03	0.00	0.00
Benin	0.00	0.00	0.00
Bolivia	-1.94	0.00	1.08
Bosnia	0.00	0.16	0.00
Botswana	0.00	0.36	0.00
Brazil	1.19	0.01	0.05
Brunei	-13.12	0.00	2.44
Bulgaria	-0.05	0.02	0.00
Burkina Faso	0.00	0.00	0.00
Cambodia	0.04	0.00	0.00
Cameroon	-3.29	0.00	0.58
Canada	1.36	0.01	-1.90

Chad	16.75	0.00	0.01
Chile	-0.05	0.00	-0.03
China	-1.73	0.46	0.06
Colombia	-1.71	0.72	0.06
Congo, Republic of	-21.57	0.00	0.36
Costa Rica	0.01	0.00	0.00
Cote D'Ivoire	0.39	0.00	0.09
Croatia	-0.35	0.00	0.01
Cuba	-0.83	0.00	-0.04
Curacao	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00
Czech Republic	-0.03	-0.11	0.00
Denmark	-1.10	0.00	-0.07
Dominican Republic	0.00	0.00	0.00
DR Congo	-0.21	0.00	0.00
Ecuador	-9.93	0.00	0.00
Egypt	-3.49	0.00	1.24
Eritrea	0.00	0.00	0.00
Estonia	-0.57	0.00	0.00
Ethiopia	0.00	0.00	0.00
Finland	0.05	0.00	0.00
France	-0.01	0.00	0.00
Gabon	-28.14	0.00	0.19
Georgia	-0.37	0.01	-0.03
Germany	-0.01	0.00	0.00
Ghana	3.07	0.00	0.37
Greece	-0.01	-0.01	0.00
Guatemala	-0.69	0.00	0.00
Haiti	0.00	0.00	0.00
Honduras	0.00	0.00	0.00
Hong Kong	0.00	0.00	0.00
Hungary	-0.19	-0.01	-0.01
Iceland	0.00	0.00	0.00
India	-0.87	0.79	-0.10
Indonesia	-5.75	1.08	-1.82

Iran	-12.40	0.01	6.51
Iraq	-5.79	0.00	0.38
Ireland	0.00	0.00	0.03
Israel	0.01	0.00	0.43
Italy	0.03	0.00	-0.01
Jamaica	0.29	0.00	0.00
Japan	0.00	0.00	0.01
Jordan	0.01	0.00	-0.09
Kazakhstan	-9.86	0.09	1.09
Kenya	0.00	0.00	0.00
Kosovo	0.00	0.38	0.00
Kuwait	-22.69	0.00	0.63
Kyrgyzstan	-0.82	0.22	-0.02
Latvia	0.07	0.00	0.00
Lebanon	0.00	0.00	0.00
Libya	22.79	0.00	3.93
Lithuania	-0.33	0.00	0.00
Luxembourg	0.00	0.00	0.00
Madagascar	0.08	0.00	0.00
Malaysia	-3.16	0.02	0.05
Malta	0.00	0.00	0.00
Mauritius	0.00	0.00	0.00
Mexico	-1.27	0.02	-0.01
Moldova	-0.03	0.00	0.00
Mongolia	1.38	3.37	0.00
Montenegro	0.00	0.14	0.00
Morocco	-0.01	0.00	0.00
Mozambique	0.08	3.78	3.57
Myanmar	-1.27	0.04	1.15
Namibia	0.00	0.00	0.00
Nepal	0.00	0.00	0.00
Netherlands	-0.02	0.00	-0.03
New Zealand	-0.42	0.00	-0.48
Nicaragua	0.02	0.00	0.00
Niger	0.62	0.01	0.03

Nigeria	-15.80	0.00	0.60
North Macedonia	0.00	0.01	0.00
Norway	-5.50	0.00	3.26
Oman	-20.94	0.00	3.72
Pakistan	-0.20	0.09	-0.33
Panama	0.00	0.00	0.00
Paraguay	0.07	0.00	0.00
Peru	-1.22	0.00	0.25
Philippines	0.02	0.09	0.16
Poland	-0.01	0.06	0.05
Portugal	0.05	0.00	0.00
Qatar	-25.49	0.00	6.21
Romania	-1.67	-0.02	-0.27
Russia	-5.68	0.35	1.71
Rwanda	0.00	0.00	0.05
Saudi Arabia	-17.98	0.00	0.72
Senegal	0.00	0.00	0.00
Serbia	-1.37	-0.14	-0.06
Singapore	0.00	0.00	0.00
Slovakia	-0.02	-0.01	0.00
Slovenia	0.00	0.01	0.00
South Africa	-0.48	1.16	-0.01
South Korea	0.01	0.00	0.01
Spain	0.00	0.00	0.00
Sri Lanka	0.00	0.00	0.00
Sudan	-7.38	0.00	0.00
Suriname	-1.72	0.00	0.01
Sweden	0.03	0.00	0.00
Switzerland	0.00	0.00	0.00
Syria	-2.14	0.00	1.98
Taiwan	0.00	0.00	0.00
Tajikistan	-0.02	0.48	0.08
Tanzania	0.00	0.04	0.22
Thailand	-0.21	-0.01	-0.06
Togo	0.00	0.00	0.00

Trinidad & Tobago	-8.00	0.00	1.75
Tunisia	-1.68	0.00	0.13
Türkiye	0.02	0.03	0.00
Turkmenistan	-24.74	0.00	-21.21
Uganda	0.00	0.00	0.00
Ukraine	-0.71	-0.53	0.22
United Arab Emirates	-5.17	0.00	0.42
United Kingdom	-0.48	0.00	0.03
United States	0.30	0.03	-0.22
Uruguay	0.01	0.00	0.00
Uzbekistan	-4.53	0.03	3.59
Venezuela	-8.70	0.00	-0.05
Viet Nam	-7.01	0.34	0.02
Yemen	-36.41	0.00	-0.17
Zambia	0.00	0.18	0.00
Zimbabwe	0.05	-0.43	0.00

Table A6d: Independent Variable Data for All Countries (Renewable Endowment Segment).

Country Name	***Solar Potential (GHI)***	***Wind Power Potential (watt/m2)***	***Hydropower Potential (GWh/year)***
Albania	4.20	754	34000
Algeria	5.92	550	14000
Angola	5.75	148	484000
Argentina	5.12	1926	641000
Armenia	4.22	760	8000
Australia	5.76	401	176000
Austria	3.21	1259	85000
Azerbaijan	4.04	748	23000
Bahrain	5.75	299	0
Bangladesh	4.60	122	56000
Belarus	2.94	313	7000
Belgium	2.94	473	3000
Benin	5.33	155	10000
Bolivia	5.42	439	816000

Bosnia	3.66	708	62000
Botswana	6.07	226	5000
Brazil	5.28	260	3630000
Brunei	4.84	45	2000
Bulgaria	3.87	373	33000
Burkina Faso	5.81	231	2000
Cambodia	5.09	174	103000
Cameroon	5.30	181	382000
Canada	3.25	858	3064000
Chad	6.26	862	51000
Chile	5.76	3789	494000
China	4.13	717	7168000
Colombia	4.87	231	1641000
Congo, Republic of	4.86	98	227000
Costa Rica	4.89	803	113000
Cote D'Ivoire	5.05	89	55000
Croatia	3.74	808	35000
Cuba	5.41	290	3000
Curacao	5.96	569	
Cyprus	5.21	259	0
Czech Republic	3.08	430	12000
Denmark	2.77	728	1000
Dominican Republic	5.42	336	8000
DR Congo	5.19	124	1686000
Ecuador	4.30	526	239000
Egypt	6.26	573	195000
Eritrea	6.07	737	4000
Estonia	2.72	472	3000
Ethiopia	5.85	363	628000
Finland	-	424	31000
France	3.48	670	221000
Gabon	4.54	56	167000
Georgia	3.72	725	77000
Germany	2.98	504	94000
Ghana	5.10	159	24000

Greece	4.45	793	38000
Guatemala	5.25	311	213000
Haiti	5.54	466	7000
Honduras	5.16	457	67000
Hong Kong	3.91	577	-
Hungary	3.52	308	8000
Iceland	-	2431	88000
India	5.10	255	3652000
Indonesia	4.62	114	2112000
Iran	-	773	385000
Iraq	5.46	420	128000
Ireland	2.53	1202	9000
Israel	5.75	325	1000
Italy	4.07	682	178000
Jamaica	5.21	403	5000
Japan	3.61	624	302000
Jordan	6.02	396	1000
Kazakhstan	3.82	602	136000
Kenya	5.78	647	101000
Kosovo	3.85	523	-
Kuwait	5.68	468	0
Kyrgyzstan	4.11	1062	139000
Latvia	2.77	376	7000
Lebanon	5.36	562	9000
Libya	6.13	489	1000
Lithuania	2.82	387	6000
Luxembourg	3.02	355	0
Madagascar	5.63	691	511000
Malaysia	4.71	65	305000
Malta	5.01	519	0
Mauritius	5.01	625	0
Mexico	5.73	400	558000
Moldova	3.55	320	2000
Mongolia	4.32	723	62000
Montenegro	3.86	841	29000

Morocco	5.56	842	16000
Mozambique	5.38	231	502000
Myanmar	4.69	176	1425000
Namibia	6.40	423	50000
Nepal	4.53	549	789000
Netherlands	2.86	616	2000
New Zealand	3.54	2564	275000
Nicaragua	5.04	711	45000
Niger	6.26	549	15000
Nigeria	5.44	272	326000
North Macedonia	4.05	429	8000
Norway	2.58	1783	253000
Oman	6.28	576	1000
Pakistan	5.34	589	833000
Panama	4.74	617	79000
Paraguay	5.08	296	76000
Peru	5.15	251	1145000
Philippines	4.73	507	230000
Poland	2.98	400	27000
Portugal	4.57	461	39000
Qatar	5.90	292	0
Romania	3.57	377	64000
Russia	3.12	813	3503000
Rwanda	5.08	86	6000
Saudi Arabia	6.21	400	0
Senegal	5.80	258	4000
Serbia	3.68	368	35000
Singapore	4.49	65	0
Slovakia	3.25	443	17000
Slovenia	3.45	675	23000
South Africa	5.63	563	100000
South Korea	3.99	492	28000
Spain	4.58	725	143000
Sri Lanka	5.28	416	29000
Sudan	6.32	639	263000

Suriname	5.38	81	54000
Sweden	2.69	776	118000
Switzerland	3.36	1337	87000
Syria	5.45	588	27000
Taiwan	-	-	-
Tajikistan	4.51	1102	200000
Tanzania	5.66	296	189000
Thailand	4.93	201	154000
Togo	5.22	153	5000
Trinidad & Tobago	5.38	194	0
Tunisia	5.30	609	5000
Türkiye	4.60	561	431000
Turkmenistan	4.72	573	113000
Uganda	5.64	155	101000
Ukraine	3.35	359	39000
United Arab Emirates	6.05	287	0
United Kingdom	2.59	1401	45000
United States	4.50	1047	2564000
Uruguay	4.79	418	18000
Uzbekistan	4.51	536	65000
Venezuela	5.35	301	742000
Viet Nam	4.25	393	223000
Yemen	6.47	545	0
Zambia	5.88	227	419000
Zimbabwe	5.78	225	261000

Table A6e: Independent Variable Data for All Countries (Climate Vulnerability and Energy Sovereignty Segment).

Country Name	***Net Energy Import (% of use) (2022)***	***Climate Risk Rank Δ (1995-2024)***	***Climate Risk Temperature Δ***
Albania	32.28	73.00	3.60
Algeria	-127.24	-18.00	3.34
Angola	-353.97	-19.00	2.32
Argentina	1.96	-59.00	2.06
Armenia	76.87	-71.00	3.43

Australia	-234.28	-14.00	1.86
Austria	76.81	-7.00	3.25
Azerbaijan	-263.13	10.00	3.33
Bahrain	-45.48	-	3.19
Bangladesh	44.31	0.00	1.85
Belarus	77.08	18.00	3.87
Belgium	86.76	87.00	2.46
Benin	40.90	-34.00	2.26
Bolivia	-67.33	-3.00	2.81
Bosnia	26.37	-69.00	3.59
Botswana	23.68	-53.00	2.82
Brazil	-7.29	-28.00	2.29
Brunei	-172.55	-	1.96
Bulgaria	37.96	114.00	3.53
Burkina Faso	-	1.00	2.37
Cambodia	-	124.00	2.11
Cameroon	-28.71	-60.00	2.26
Canada	-89.49	-57.00	4.34
Chad	-177.76	-59.00	2.54
Chile	66.27	-71.00	1.99
China	20.62	19.00	3.15
Colombia	-139.12	-28.00	2.28
Congo, Republic of	-347.42	-5.00	2.09
Costa Rica	53.08	-47.00	2.16
Cote D'Ivoire	14.38	-71.00	2.24
Croatia	61.90	56.00	3.49
Cuba	62.81	-	2.05
Curacao	-	-	1.89
Cyprus	117.04	-42.00	2.78
Czech Republic	42.02	-35.00	3.32
Denmark	47.40	-15.00	2.95
Dominican Republic	94.42	46.00	2.17
DR Congo	1.60	-32.00	2.22
Ecuador	-69.40	-59.00	2.18
Egypt	9.79	-22.00	3.03

Eritrea	-	-	2.59
Estonia	6.83	-9.00	3.91
Ethiopia	10.79	15.00	2.42
Finland	42.38	-47.00	4.05
France	54.32	85.00	2.76
Gabon	-187.60	-82.00	2.09
Georgia	79.58	15.00	3.55
Germany	71.75	21.00	2.96
Ghana	-22.37	0.00	2.31
Greece	92.91	37.00	3.27
Guatemala	38.36	43.00	2.46
Haiti	-	53.00	2.05
Honduras	55.51	72.00	2.41
Hong Kong	175.71	-	2.49
Hungary	64.44	57.00	3.72
Iceland	-	-	2.71
India	36.53	6.00	2.20
Indonesia	-82.92	-21.00	1.90
Iran	-32.49	-	3.51
Iraq	-274.88	-27.00	3.71
Ireland	85.98	-4.00	1.55
Israel	26.09	14.00	2.92
Italy	83.63	88.00	3.20
Jamaica	112.58	-73.00	1.92
Japan	89.97	-37.00	2.91
Jordan	96.35	18.00	3.12
Kazakhstan	-119.31	-42.00	4.24
Kenya	22.44	6.00	2.18
Kosovo	-	-	3.12
Kuwait	-283.10	-16.00	3.40
Kyrgyzstan	33.78	-47.00	3.73
Latvia	40.40	10.00	3.79
Lebanon	96.92	-95.00	2.94
Libya	-249.73	84.00	3.02
Lithuania	76.17	26.00	3.74

Luxembourg	110.30	24.00	2.80
Madagascar	-	-13.00	2.07
Malaysia	-0.58	26.00	1.88
Malta	389.55	-24.00	2.83
Mauritius	-	-62.00	1.62
Mexico	21.11	-23.00	2.60
Moldova	86.56	68.00	3.72
Mongolia	-226.43	97.00	3.72
Montenegro	29.62	-43.00	3.72
Morocco	94.00	13.00	2.67
Mozambique	-106.35	30.00	2.28
Myanmar	-19.03	7.00	2.07
Namibia	60.50	2.00	2.74
Nepal	27.41	-20.00	2.49
Netherlands	99.36	7.00	2.22
New Zealand	28.82	-40.00	1.44
Nicaragua	46.49	101.00	2.46
Niger	5.41	-45.00	2.75
Nigeria	-66.29	-42.00	2.28
N. Macedonia	63.88	57.00	3.60
Norway	-746.72	-10.00	3.44
Oman	-213.63	-51.00	2.76
Pakistan	39.79	32.00	3.12
Panama	171.19	-76.00	2.04
Paraguay	5.65	67.00	2.69
Peru	12.19	23.00	2.46
Philippines	54.43	0.00	1.96
Poland	46.84	-39.00	3.45
Portugal	81.51	12.00	2.18
Qatar	-396.07	-49.00	3.11
Romania	32.46	35.00	3.71
Russia	-75.14	30.00	4.00
Rwanda	10.58	10.00	2.33
Saudi Arabia	-178.20	-97.00	3.32
Senegal	69.39	-21.00	2.34

Serbia	45.31	93.00	3.80
Singapore	258.43	-	1.93
Slovakia	68.89	-29.00	3.44
Slovenia	53.55	117.00	3.50
South Africa	-14.15	-16.00	2.51
South Korea	85.50	-45.00	3.70
Spain	82.87	-4.00	2.63
Sri Lanka	60.04	11.00	1.75
Sudan	18.86	0.00	2.67
Suriname	17.10	-19.00	2.08
Sweden	28.70	15.00	3.49
Switzerland	51.73	3.00	3.16
Syria	61.27	-	3.33
Taiwan	-	-	2.34
Tajikistan	28.05	55.00	3.62
Tanzania	12.93	-59.00	2.24
Thailand	57.12	-5.00	2.13
Togo	-	-68.00	2.32
Trinidad & Tobago	-75.46	-28.00	1.93
Tunisia	53.14	6.00	3.22
Türkiye	72.70	-7.00	3.31
Turkmenistan	-109.78	-	3.39
Uganda	20.49	-23.00	2.35
Ukraine	23.37	58.00	3.81
United Arab Emirates	-171.48	-70.00	3.23
United Kingdom	39.18	41.00	1.88
United States	-6.50	3.00	3.67
Uruguay	46.21	-37.00	1.62
Uzbekistan	1.55	7.00	3.76
Venezuela	-73.91	-	2.43
Viet Nam	34.00	-4.00	2.26
Yemen	-11.05	-	2.35
Zambia	9.03	-66.00	2.54
Zimbabwe	16.98	-9.00	2.79

Appendix B:

Table B1: Global Electricity Mix in 2024 Pie Chart (Source: International Energy Agency).

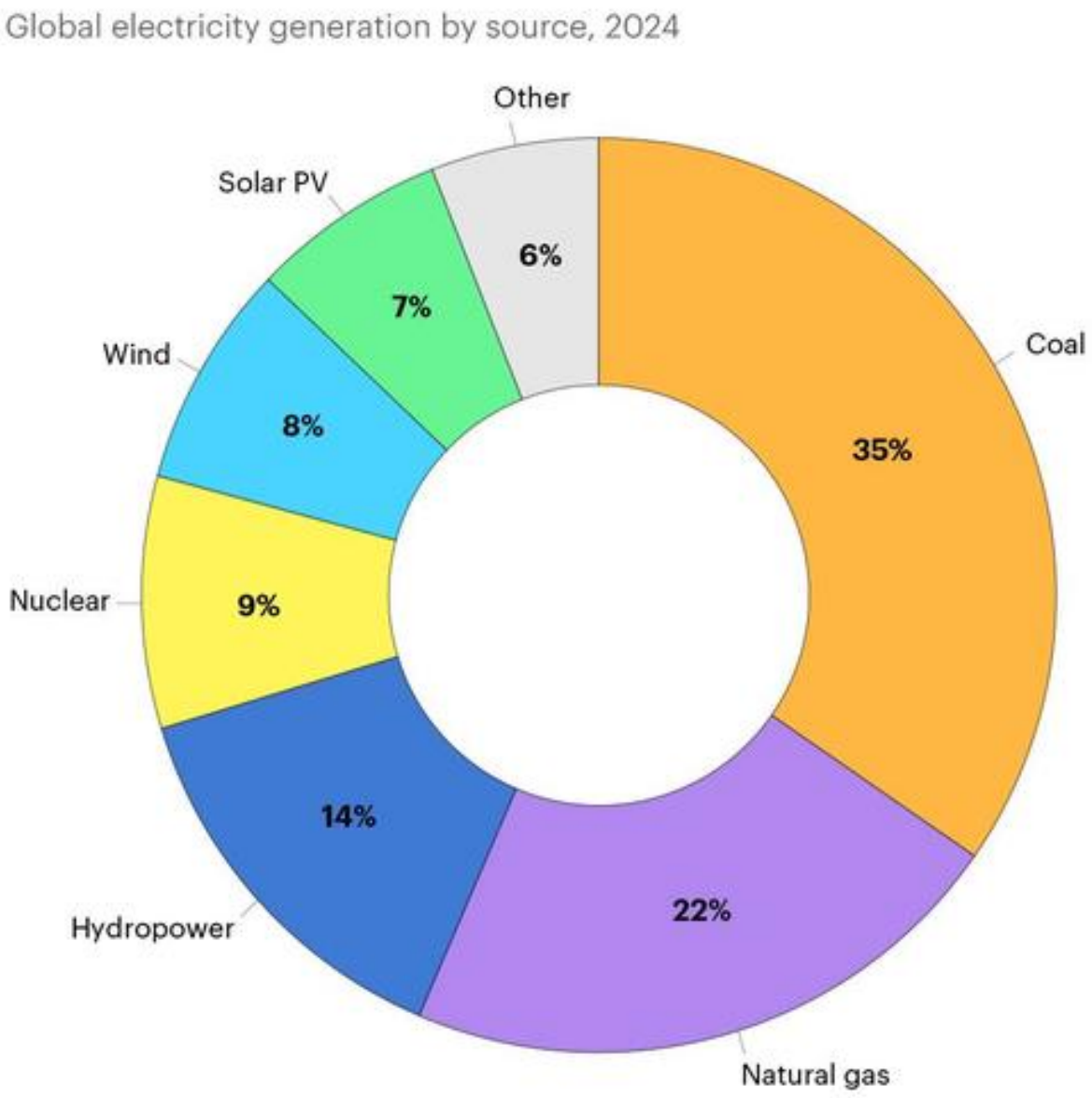


Table B2: Clean Energy Generation, Fossil Fuels Generation, and Total Generation Change, (GWh, 2000, 2023/2024)

Country	CEG (2000)	CEG (23/24)	FFG (2000)	FFG (23/24)	Total GWh Δ
Albania	4,594	9,005	184	0	4,227
Algeria	54	722	25,358	94,903	70,213
Angola	912	11,620	533	4,080	14,255
Argentina	42,650	71,462	46,344	81,790	64,258
Armenia	3,266	5,089	2,692	3,715	2,846
Australia	17,950	97,848	192,274	181,853	69,477
Austria	44,965	71,685	16,292	10,213	20,641
Azerbaijan	1,534	2,121	17,165	27,182	10,604
Bahrain	1	107	13,859	37,383	23,630
Bangladesh	767	1,921	15,004	99,006	85,156
Belarus	27	13,033	26,074	28,672	15,604
Belgium	51,208	59,888	32,804	15,786	-8,338
Benin	2	51	82	730	697
Bolivia	1,999	3,597	1,881	8,372	8,089
Bosnia	5,103	7,406	5,335	9,779	6,747
Botswana	1	10	1,146	3,217	2,080
Brazil	366,459	679,391	30,243	71,940	354,629
Brunei	1	5	2,543	5,604	3,065
Bulgaria	21,144	26,296	19,780	13,956	-672
Burkina Faso	98	374	292	1,419	1,403
Cambodia	1	5,961	447	8,598	14,111
Cameroon	3,442	6,217	38	1,929	4,666
Canada	440,627	494,865	165,750	124,897	13,385
Chad	1	8	66	338	279
Chile	19,457	65,317	20,621	26,548	51,787
China	242,325	3,398,583	1,113,413	6,148,953	8,191,798
Colombia	32,576	57,962	10,555	32,256	47,087
Congo, Republic of	298	1,219	1	2,261	3,181
Costa Rica	6,860	11,296	59	1,331	5,708
Cote D'Ivoire	1,764	3,469	3,036	10,126	8,795
Croatia	6,472	12,313	4,809	5,226	6,258
Cuba	944	699	13,999	19,105	4,861
Curacao	8	189	1,113	726	-206
Cyprus	1	1,091	3,370	4,236	1,956
Czech Republic	16,435	43,232	57,031	30,643	409
Denmark	6,167	32,431	29,886	2,881	-741
Dominican Republic	1,009	3,973	12,180	20,290	11,074

DR Congo	5,978	13,369	3	6	7,394
Ecuador	7,611	25,955	3,001	9,406	24,749
Egypt	13,834	27,450	64,309	187,678	136,985
Eritrea	1	49	217	435	266
Estonia	18	3,529	8,495	1,956	-3,028
Ethiopia	1,651	20,513	23	2	18,841
Finland	46,121	78,709	23,855	3,193	11,926
France	490,415	542,752	49,539	26,753	29,551
Gabon	810	1,461	505	1,672	1,818
Georgia	5,860	10,949	1,564	3,446	6,971
Germany	215,101	295,966	361,442	214,068	-66,509
Ghana	6,609	9,333	614	14,933	17,043
Greece	4,725	26,121	49,118	28,292	570
Guatemala	3,128	9,288	2,920	4,878	8,118
Haiti	283	189	264	824	466
Honduras	2,267	6,187	1,391	5,700	8,229
Hong Kong	1	559	31,331	37,386	6,613
Hungary	14,478	28,288	20,713	9,599	2,696
Iceland	7,679	19,504	5	4	11,824
India	93,265	445,174	467,795	1,541,600	1,425,714
Indonesia	14,891	69,276	78,434	364,182	340,133
Iran	3,701	24,653	117,682	360,582	263,852
Iraq	611	1,443	31,289	143,249	112,792
Ireland	1,494	14,664	22,488	16,398	7,080
Israel	31	13,011	42,630	68,462	38,812
Italy	58,879	138,624	217,762	134,666	-3,351
Jamaica	150	489	6,456	4,189	-1,928
Japan	451,888	369,975	615,916	610,582	-87,247
Jordan	45	5,239	7,332	18,553	16,415
Kazakhstan	7,531	14,468	43,793	99,115	62,259
Kenya	1,887	11,707	2,124	1,129	8,825
Kosovo	52	804	2,905	5,547	3,394
Kuwait	1	171	32,323	87,845	55,692
Kyrgyzstan	12,825	12,030	2,106	1,844	-1,057
Latvia	2,823	4,640	1,313	1,678	2,182
Lebanon	444	2,096	9,469	4,136	-3,681
Libya	1	9	15,496	33,737	18,249
Lithuania	9,154	6,989	2,271	1,101	-3,335
Luxembourg	949	2,803	214	65	1,705
Madagascar	552	1,239	239	1,396	1,844
Malaysia	6,966	36,625	62,289	156,360	123,730

Malta	1	317	1,917	2,025	424
Mauritius	527	572	1,251	2,690	1,484
Mexico	48,953	90,552	156,722	301,103	185,980
Moldova	377	680	5,229	5,742	816
Mongolia	4	762	2,942	7,520	5,336
Montenegro	1	2,549	1	1,636	4,183
Morocco	782	10,472	12,081	33,235	30,844
Mozambique	9,660	16,634	44	3,277	10,207
Myanmar	2,008	9,708	3,226	11,282	15,756
Namibia	1,396	1,795	11	36	424
Nepal	1,632	12,235	27	0	10,576
Netherlands	8,354	67,409	81,277	55,743	33,521
New Zealand	28,393	38,497	10,992	6,799	5,911
Nicaragua	503	2,826	1,848	1,697	2,172
Niger	1	36	206	945	774
Nigeria	5,628	9,318	9,467	31,640	25,863
North Macedonia	1,170	2,199	5,641	4,672	60
Norway	142,690	156,522	292	1,631	15,171
Oman	1	1,215	9,111	43,555	35,658
Pakistan	19,191	72,628	48,925	78,349	82,861
Panama	3,442	7,947	1,445	5,160	8,220
Paraguay	53,492	53,039	1	1	-453
Peru	16,329	33,077	2,646	27,764	41,866
Philippines	19,425	26,296	25,865	91,724	72,730
Poland	4,419	51,461	140,765	117,890	24,167
Portugal	13,517	44,275	30,247	6,780	7,291
Qatar	1	1,882	9,134	54,367	47,114
Romania	20,234	40,059	31,700	17,921	6,046
Russia	298,688	431,158	579,078	730,647	284,039
Rwanda	106	630	61	555	1,018
Saudi Arabia	1	2,772	126,191	438,725	315,305
Senegal	160	1,101	1,444	6,803	6,300
Serbia	10,337	14,458	22,140	25,566	7,547
Singapore	490	2,892	31,175	54,939	26,166
Slovakia	21,501	25,602	9,657	3,778	-1,778
Slovenia	8,665	13,420	4,959	3,988	3,784
South Africa	17,251	34,076	193,419	195,230	18,636
South Korea	114,689	251,142	174,426	356,203	318,230
Spain	100,854	222,915	123,614	64,918	63,365
Sri Lanka	3,208	7,795	3,796	7,849	8,640
Sudan	1,183	11,625	1,386	2,761	11,817

Suriname	1,036	1,271	136	789	888
Sweden	140,735	171,271	4,531	820	26,825
Switzerland	66,436	81,900	1,083	281	14,662
Syria	3,231	860	21,986	24,133	-224
Taiwan	49,166	47,593	135,674	234,561	97,314
Tajikistan	14,025	20,632	222	1,228	7,613
Tanzania	2,166	2,807	337	7,768	8,072
Thailand	6,565	38,364	89,412	157,741	100,128
Togo	100	192	75	525	542
Trinidad & Tobago	20	6	5,439	9,502	4,049
Tunisia	87	1,015	10,509	20,257	10,676
Türkiye	31,208	159,663	93,714	189,237	223,978
Turkmenistan	3	5	9,842	32,594	22,754
Uganda	1,581	6,094	6	168	4,675
Ukraine	88,797	70,761	82,648	34,443	-66,241
United Arab Emirates	1	47,536	39,944	119,994	127,585
United Kingdom	98,246	194,491	278,823	90,448	-92,130
United States	1,170,397	1,897,769	2,882,270	2,675,416	520,518
Uruguay	7,086	11,970	502	969	5,351
Uzbekistan	3,528	7,569	43,334	66,757	27,464
Venezuela	62,886	63,387	22,385	6,945	-14,939
Viet Nam	14,551	121,477	12,010	152,539	247,455
Yemen	1	532	3,433	4,604	1,702
Zambia	7,789	17,332	48	2,134	11,629
Zimbabwe	3,194	3,709	3,801	4,381	1,095

Table B3a: Country-Level Electricity Generation (GWh) Data (2000, 2023/2024): Coal.

Country	Coal GWh (2000)	Coal GWh (23/24)	Change (GWh)	Change (%)
China	1,060,372	5,856,538	4,796,166	452.3%
India	386,523	1,478,683	1,092,160	282.6%
Indonesia	34,002	299,628	265,626	781.2%
Viet Nam	3,135	122,646	119,511	3812.2%
South Korea	110,309	198,021	87,712	79.5%
Türkiye	38,187	120,377	82,190	215.2%
Malaysia	7,691	86,882	79,191	1029.7%
Japan	228,204	295,322	67,118	29.4%
Philippines	16,663	73,753	57,090	342.6%
Russia	175,615	210,563	34,948	19.9%

Taiwan	86,975	119,157	32,182	37.0%
Kazakhstan	35,645	66,291	30,646	86.0%
Pakistan	241	19,300	19,059	7908.3%
Morocco	8,783	27,148	18,365	209.1%
Thailand	17,520	28,665	11,145	63.6%
Mexico	18,994	29,874	10,880	57.3%
Bangladesh	-	10,686	10,686	N/A
Colombia	2,201	11,205	9,004	409.1%
Cambodia	-	8,550	8,550	N/A
Dominican Republic	-	7,420	7,420	N/A
Uzbekistan	1,913	8,271	6,358	332.4%
Chile	8,467	13,558	5,091	60.1%
Sri Lanka	-	4,646	4,646	N/A
Bosnia	5,287	9,696	4,409	83.4%
Mongolia	2,854	7,055	4,201	147.2%
Brazil	11,006	14,756	3,750	34.1%
Jordan	-	2,989	2,989	N/A
Kosovo	2,886	5,534	2,648	91.8%
Serbia	21,433	23,580	2,147	10.0%
Zambia	14	2,126	2,112	15085.7%
Botswana	1,119	3,190	2,071	185.1%
Guatemala	539	2,381	1,842	341.7%
Montenegro	1	1,636	1,635	163500.0%
Brunei	-	1,144	1,144	N/A
Myanmar	-	1,118	1,118	N/A
Tajikistan	-	1,005	1,005	N/A
Kyrgyzstan	641	1,589	948	147.9%
New Zealand	1,546	2,400	854	55.2%
Mauritius	363	1,095	732	201.7%
Zimbabwe	3,735	4,381	646	17.3%
Singapore	-	520	520	N/A
Madagascar	-	513	513	N/A
Panama	-	457	457	N/A
Iran	484	697	213	44.0%
Rwanda	-	170	170	N/A

Senegal	-	89	89	N/A
Honduras	-	62	62	N/A
Norway	72	122	50	69.4%
Niger	135	168	33	24.4%
Belarus	-	24	24	N/A
Namibia	11	30	19	172.7%
Albania	-	-	-	N/A
Algeria	-	-	-	N/A
Angola	-	-	-	N/A
Armenia	-	-	-	N/A
Azerbaijan	-	-	-	N/A
Bahrain	-	-	-	N/A
Benin	-	-	-	N/A
Bolivia	-	-	-	N/A
Burkina Faso	-	-	-	N/A
Cameroon	-	-	-	N/A
Chad	-	-	-	N/A
Congo, Republic	-	-	-	N/A
Costa Rica	-	-	-	N/A
Cote D'Ivoire	-	-	-	N/A
Cuba	-	-	-	N/A
Curacao	-	-	-	N/A
Cyprus	-	-	-	N/A
DRC	-	-	-	N/A
Ecuador	-	-	-	N/A
Egypt	-	-	-	N/A
Eritrea	-	-	-	N/A
Ethiopia	-	-	-	N/A
Gabon	-	-	-	N/A
Georgia	-	-	-	N/A
Ghana	-	-	-	N/A
Haiti	-	-	-	N/A
Iceland	-	-	-	N/A
Iraq	-	-	-	N/A
Jamaica	-	-	-	N/A

Kenya	-	-	-		N/A
Kuwait	-	-	-		N/A
Lebanon	-	-	-		N/A
Libya	-	-	-		N/A
Lithuania	-	-	-		N/A
Luxembourg	-	-	-		N/A
Malta	-	-	-		N/A
Mozambique	-	-	-		N/A
Nepal	-	-	-		N/A
Nicaragua	-	-	-		N/A
Nigeria	-	-	-		N/A
Oman	-	-	-		N/A
Paraguay	-	-	-		N/A
Qatar	-	-	-		N/A
Saudi Arabia	-	-	-		N/A
Sudan	-	-	-		N/A
Suriname	-	-	-		N/A
Switzerland	-	-	-		N/A
Syria	-	-	-		N/A
Togo	-	-	-		N/A
Trinidad & Tobago	-	-	-		N/A
Tunisia	-	-	-		N/A
Turkmenistan	-	-	-		N/A
Uganda	-	-	-		N/A
United Arab Emirates	-	-	-		N/A
Uruguay	-	-	-		N/A
Venezuela	-	-	-		N/A
Yemen	-	-	-		N/A
Tanzania	67	-	-	67	-100.0%
Latvia	78	-	-	78	-100.0%
Argentina	1,568	1,404	-	164	-10.5%
Moldova	165	-	-	165	-100.0%
Croatia	1,551	1,325	-	226	-14.6%
Peru	286	36	-	250	-87.4%
Slovenia	4,611	3,498	-	1,113	-24.1%

Sweden	2,536	366	-	2,170	-85.6%
North Macedonia	5,209	2,765	-	2,444	-46.9%
Austria	6,739	1,959	-	4,780	-70.9%
Slovakia	6,111	904	-	5,207	-85.2%
Bulgaria	17,207	11,733	-	5,474	-31.8%
Estonia	7,843	1,916	-	5,927	-75.6%
South Africa	193,419	187,114	-	6,305	-3.3%
Hong Kong	18,938	12,559	-	6,379	-33.7%
Hungary	9,707	2,444	-	7,263	-74.8%
Ireland	8,587	632	-	7,955	-92.6%
Finland	13,137	2,289	-	10,848	-82.6%
Romania	19,300	8,091	-	11,209	-58.1%
Belgium	16,030	2,166	-	13,864	-86.5%
Portugal	14,688	-	-	14,688	-100.0%
Denmark	16,673	1,750	-	14,923	-89.5%
Netherlands	27,114	10,127	-	16,987	-62.7%
Israel	29,352	11,383	-	17,969	-61.2%
Italy	30,524	4,684	-	25,840	-84.7%
Czech Republic	54,968	26,817	-	28,151	-51.2%
Ukraine	51,514	23,325	-	28,189	-54.7%
France	30,860	2,038	-	28,822	-93.4%
Greece	34,313	3,269	-	31,044	-90.5%
Poland	137,921	94,638	-	43,283	-31.4%
Australia	174,245	128,542	-	45,703	-26.2%
Spain	80,858	3,466	-	77,392	-95.7%
Canada	117,588	18,147	-	99,441	-84.6%
United Kingdom	122,300	2,660	-	119,640	-97.8%
Germany	304,162	120,016	-	184,146	-60.5%
United States	2,129,498	720,517	-	1,408,981	-66.2%

Table B3b: Country-Level Electricity Generation (GWh) Data: Oil.

Country	Oil GWh (2000)	Oil GWh (2024/23)	Change (GWh)	% Change
Saudi Arabia	68,103	181,659	113,556	166.7%
Iraq	25,304	67,567	42,263	167.0%

Iran	25,360	57,092	31,732	125.1%
Bangladesh	1,020	21,889	20,869	2046.0%
Egypt	7,566	24,570	17,004	224.7%
Kuwait	21,676	32,786	11,110	51.3%
South Africa	-	8,116	8,116	N/A
Ecuador	3,001	8,454	5,453	181.7%
Senegal	1,441	6,698	5,257	364.8%
Honduras	1,391	5,638	4,247	305.3%
Cuba	12,692	16,518	3,826	30.1%
Colombia	101	3,651	3,550	3514.9%
Australia	1,784	4,822	3,038	170.3%
Argentina	2,927	5,510	2,583	88.2%
Angola	533	2,695	2,162	405.6%
Sudan	1,386	2,761	1,375	99.2%
Costa Rica	59	1,331	1,272	2155.9%
Burkina Faso	292	1,419	1,127	386.0%
Yemen	3,433	4,541	1,108	32.3%
Cyprus	3,370	4,236	866	25.7%
Cote D'Ivoire	13	729	716	5507.7%
Mauritius	888	1,595	707	79.6%
Niger	71	726	655	922.5%
Suriname	136	789	653	480.1%
Madagascar	239	883	644	269.5%
Panama	1,445	1,913	468	32.4%
Uruguay	502	969	467	93.0%
Mongolia	88	465	377	428.4%
Poland	1,916	2,267	351	18.3%
Cameroon	38	342	304	800.0%
Hong Kong	153	439	286	186.9%
Chad	66	338	272	412.1%
Moldova	32	300	268	837.5%
Gabon	270	529	259	95.9%
Eritrea	217	435	218	100.5%
Uganda	6	168	162	2700.0%
Bolivia	34	193	159	467.6%

Germany	4,785	4,913		128	2.7%
Mozambique	42	159		117	278.6%
Tanzania	270	387		117	43.3%
Guatemala	2,381	2,497		116	4.9%
Benin	82	193		111	135.4%
North Macedonia	431	525		94	21.8%
Kyrgyzstan	-	54		54	N/A
Congo, Republic	1	46		45	4500.0%
Trinidad & Tobago	3	35		32	1066.7%
Norway	9	39		30	333.3%
Bosnia	48	74		26	54.2%
New Zealand	-	26		26	N/A
Rwanda	61	86		25	41.0%
Brunei	23	41		18	78.3%
Namibia	-	6		6	N/A
DRC	3	6		3	100.0%
Bahrain	-	1		1	N/A
Armenia	-	-		-	N/A
Botswana	27	27		-	0.0%
Luxembourg	-	-		-	N/A
Montenegro	-	-		-	N/A
Nigeria	-	-		-	N/A
Paraguay	1	1		-	0.0%
Qatar	-	-		-	N/A
Tajikistan	-	-		-	N/A
Turkmenistan	-	-		-	N/A
Iceland	5	4	-	1	-20.0%
Kosovo	19	13	-	6	-31.6%
Ethiopia	23	2	-	21	-91.3%
Zambia	34	8	-	26	-76.5%
Nepal	27	-	-	27	-100.0%
Slovakia	202	166	-	36	-17.8%
Estonia	56	17	-	39	-69.6%
Slovenia	55	8	-	47	-85.5%
Belarus	1,714	1,658	-	56	-3.3%

Zimbabwe	66	-	-	66	-100.0%
Ghana	614	547	-	67	-10.9%
Togo	75	2	-	73	-97.3%
Latvia	107	-	-	107	-100.0%
Nicaragua	1,848	1,697	-	151	-8.2%
France	7,165	7,004	-	161	-2.2%
Albania	184	-	-	184	-100.0%
Switzerland	226	28	-	198	-87.6%
Haiti	264	-	-	264	-100.0%
Georgia	274	-	-	274	-100.0%
Serbia	315	20	-	295	-93.7%
Czech Republic	372	72	-	300	-80.6%
Finland	587	229	-	358	-61.0%
Bulgaria	661	281	-	380	-57.5%
Curacao	1,113	726	-	387	-34.8%
Cambodia	447	48	-	399	-89.3%
Lithuania	655	180	-	475	-72.5%
Algeria	773	267	-	506	-65.5%
Belgium	797	245	-	552	-69.3%
Myanmar	691	126	-	565	-81.8%
Sri Lanka	3,796	3,203	-	593	-15.6%
United Arab Emirates	1,524	905	-	619	-40.6%
Oman	1,564	782	-	782	-50.0%
Austria	1,702	718	-	984	-57.8%
Kenya	2,124	1,129	-	995	-46.8%
Viet Nam	4,519	3,521	-	998	-22.1%
Ukraine	1,187	142	-	1,045	-88.0%
Tunisia	1,229	26	-	1,203	-97.9%
Sweden	1,533	300	-	1,233	-80.4%
Peru	1,572	293	-	1,279	-81.4%
Netherlands	2,641	1,354	-	1,287	-48.7%
Chile	1,705	322	-	1,383	-81.1%
Syria	12,630	11,187	-	1,443	-11.4%
Morocco	3,298	1,828	-	1,470	-44.6%
Malaysia	3,600	2,050	-	1,550	-43.1%

Croatia	1,687	37	-	1,650	-97.8%
Malta	1,917	16	-	1,901	-99.2%
Kazakhstan	2,668	496	-	2,172	-81.4%
Uzbekistan	4,707	2,102	-	2,605	-55.3%
Romania	3,399	679	-	2,720	-80.0%
Libya	12,096	8,840	-	3,256	-26.9%
Ireland	4,638	601	-	4,037	-87.0%
Denmark	4,439	223	-	4,216	-95.0%
Greece	8,885	4,648	-	4,237	-47.7%
Hungary	4,404	64	-	4,340	-98.5%
Venezuela	7,901	3,257	-	4,644	-58.8%
Jamaica	6,456	1,378	-	5,078	-78.7%
Lebanon	9,469	4,136	-	5,333	-56.3%
Jordan	6,521	892	-	5,629	-86.3%
Brazil	15,169	9,392	-	5,777	-38.1%
Thailand	9,972	3,244	-	6,728	-67.5%
United Kingdom	8,446	1,489	-	6,957	-82.4%
Portugal	8,421	1,146	-	7,275	-86.4%
Philippines	9,185	1,303	-	7,882	-85.8%
Türkiye	9,311	1,028	-	8,283	-89.0%
Dominican Republic	12,180	3,616	-	8,564	-70.3%
Pakistan	26,904	17,192	-	9,712	-36.1%
Canada	14,690	4,951	-	9,739	-66.3%
Indonesia	18,342	8,576	-	9,766	-53.2%
Israel	13,265	200	-	13,065	-98.5%
Azerbaijan	13,454	106	-	13,348	-99.2%
Spain	22,578	9,123	-	13,455	-59.6%
India	25,308	4,153	-	21,155	-83.6%
Russia	33,091	9,254	-	23,837	-72.0%
Singapore	25,317	216	-	25,101	-99.1%
Taiwan	31,042	3,775	-	27,267	-87.8%
South Korea	34,581	6,979	-	27,602	-79.8%
China	47,268	9,131	-	38,137	-80.7%
Mexico	93,599	28,933	-	64,666	-69.1%
Italy	85,878	8,545	-	77,333	-90.0%

United States	118,482	29,545	-	88,937	-75.1%
Japan	133,153	22,400	-	110,753	-83.2%

Table B3c: Country-Level Electricity Generation (GWh) Data: Gas.

Country	Natural gas GWh (2000)	Natural gas GWh (2024/23)	Change (GWh)	% Change
United States	634,290	1,925,354	1,291,064	203.5%
China	5,773	283,284	277,511	4807.1%
Iran	91,838	302,793	210,955	229.7%
Saudi Arabia	58,088	257,066	198,978	342.5%
Mexico	44,129	242,296	198,167	449.1%
Russia	370,372	510,830	140,458	37.9%
South Korea	29,536	151,203	121,667	411.9%
Egypt	56,743	163,108	106,365	187.5%
Taiwan	17,657	111,629	93,972	532.2%
United Arab Emirates	38,420	119,089	80,669	210.0%
Algeria	24,585	94,636	70,051	284.9%
Iraq	5,985	75,682	69,697	1164.5%
Canada	33,472	101,799	68,327	204.1%
Thailand	61,920	125,832	63,912	103.2%
Israel	13	56,879	56,866	437430%
Bangladesh	13,984	66,431	52,447	375.1%
Singapore	5,858	54,203	48,345	825.3%
Qatar	9,134	54,367	45,233	495.2%
Kuwait	10,647	55,059	44,412	417.1%
Brazil	4,068	47,792	43,724	1074.8%
Japan	254,559	292,860	38,301	15.0%
Germany	52,495	89,139	36,644	69.8%
Oman	7,547	42,773	35,226	466.8%
Argentina	41,849	74,876	33,027	78.9%
Australia	16,245	48,489	32,244	198.5%
Spain	20,178	52,329	32,151	159.3%

Indonesia	26,090	55,978	29,888	114.6%
Kazakhstan	5,480	32,328	26,848	489.9%
Peru	788	27,435	26,647	3381.6%
Bahrain	13,859	37,382	23,523	169.7%
Azerbaijan	3,711	27,076	23,365	629.6%
Turkmenistan	9,842	32,594	22,752	231.2%
Nigeria	9,467	31,640	22,173	234.2%
Viet Nam	4,356	26,372	22,016	505.4%
Türkiye	46,216	67,832	21,616	46.8%
Libya	3,400	24,897	21,497	632.3%
Italy	101,360	121,437	20,077	19.8%
Pakistan	21,780	41,857	20,077	92.2%
Poland	928	20,985	20,057	2161.3%
Uzbekistan	36,714	56,384	19,670	53.6%
Philippines	17	16,668	16,651	97947.1%
Malaysia	50,998	67,428	16,430	32.2%
Greece	5,920	20,375	14,455	244.2%
Ghana	-	14,386	14,386	N/A
Jordan	811	14,672	13,861	1709.1%
Hong Kong	12,240	24,388	12,148	99.2%
Tunisia	9,280	20,231	10,951	118.0%
Dominican Republic	-	9,254	9,254	N/A
Colombia	8,253	17,400	9,147	110.8%
Myanmar	2,535	10,038	7,503	296.0%
Tanzania	-	7,381	7,381	N/A
Cote D'Ivoire	3,023	9,397	6,374	210.9%
Bolivia	1,847	8,179	6,332	342.8%
France	11,514	17,711	6,197	53.8%
Ireland	9,263	15,165	5,902	63.7%
Morocco	-	4,259	4,259	N/A
Trinidad & Tobago	5,436	9,467	4,031	74.2%
Syria	9,356	12,946	3,590	38.4%
Mozambique	2	3,118	3,116	155800.0%

Jamaica	-	2,811	2,811	N/A
India	55,964	58,764	2,800	5.0%
Panama	-	2,790	2,790	N/A
Belarus	24,360	26,990	2,630	10.8%
Croatia	1,571	3,864	2,293	146.0%
Chile	10,449	12,668	2,219	21.2%
Congo, Republic	-	2,215	2,215	N/A
Georgia	1,290	3,446	2,156	167.1%
Czech Republic	1,691	3,754	2,063	122.0%
Malta	-	2,009	2,009	N/A
Brunei	2,520	4,419	1,899	75.4%
Cameroon	-	1,587	1,587	N/A
Serbia	392	1,966	1,574	401.5%
Angola	-	1,385	1,385	N/A
North Macedonia	1	1,382	1,381	138100.0%
Norway	211	1,470	1,259	596.7%
Cuba	1,307	2,498	1,191	91.1%
Armenia	2,692	3,715	1,023	38.0%
Ecuador	-	952	952	N/A
Gabon	235	1,143	908	386.4%
Latvia	1,128	1,678	550	48.8%
Benin	-	537	537	N/A
Togo	-	523	523	N/A
Hungary	6,602	7,091	489	7.4%
Moldova	5,032	5,442	410	8.1%
Rwanda	-	299	299	N/A
Slovenia	293	482	189	64.5%
Romania	9,001	9,151	150	1.7%
Yemen	-	63	63	N/A
Niger	-	51	51	N/A
Bulgaria	1,912	1,942	30	1.6%
Senegal	3	16	13	433.3%
Bosnia	-	9	9	N/A
Tajikistan	222	223	1	0.5%
Albania	-	-	-	N/A

Botswana	-	-	-		N/A
Burkina Faso	-	-	-		N/A
Cambodia	-	-	-		N/A
Chad	-	-	-		N/A
Costa Rica	-	-	-		N/A
Curacao	-	-	-		N/A
Cyprus	-	-	-		N/A
DRC	-	-	-		N/A
Eritrea	-	-	-		N/A
Ethiopia	-	-	-		N/A
Guatemala	-	-	-		N/A
Haiti	-	-	-		N/A
Honduras	-	-	-		N/A
Iceland	-	-	-		N/A
Kenya	-	-	-		N/A
Kosovo	-	-	-		N/A
Lebanon	-	-	-		N/A
Madagascar	-	-	-		N/A
Mauritius	-	-	-		N/A
Mongolia	-	-	-		N/A
Montenegro	-	-	-		N/A
Namibia	-	-	-		N/A
Nepal	-	-	-		N/A
Nicaragua	-	-	-		N/A
Paraguay	-	-	-		N/A
South Africa	-	-	-		N/A
Sri Lanka	-	-	-		N/A
Sudan	-	-	-		N/A
Suriname	-	-	-		N/A
Uganda	-	-	-		N/A
Uruguay	-	-	-		N/A
Zambia	-	-	-		N/A
Zimbabwe	-	-	-		N/A
Luxembourg	214	65	-	149	-69.6%
Sweden	462	154	-	308	-66.7%

Austria	7,851	7,536	-	315	-4.0%
Estonia	596	23	-	573	-96.1%
Switzerland	857	253	-	604	-70.5%
Slovakia	3,344	2,708	-	636	-19.0%
Lithuania	1,616	921	-	695	-43.0%
Kyrgyzstan	1,465	201	-	1,264	-86.3%
Portugal	7,138	5,634	-	1,504	-21.1%
Belgium	15,977	13,375	-	2,602	-16.3%
New Zealand	9,446	4,373	-	5,073	-53.7%
Netherlands	51,522	44,262	-	7,260	-14.1%
Denmark	8,774	908	-	7,866	-89.7%
Finland	10,131	675	-	9,456	-93.3%
Venezuela	14,484	3,688	-	10,796	-74.5%
Ukraine	29,947	10,976	-	18,971	-63.3%
United Kingdom	148,077	86,299	-	61,778	-41.7%

Table B3d: Country-Level Electricity Generation (GWh) Data: Hydropower.

Country	Hydro GWh (2000)	Hydro GWh (2024/23)	Change (GWh)	% Change
China	222,414	1,285,850	1,063,436	478.1%
Brazil	304,403	421,799	117,396	38.6%
India	74,462	143,890	69,428	93.2%
Viet Nam	14,551	80,595	66,044	453.9%
Türkiye	30,879	74,867	43,988	142.5%
Russia	165,375	202,366	36,991	22.4%
Malaysia	6,966	31,896	24,930	357.9%
Pakistan	17,194	40,453	23,259	135.3%
Colombia	32,074	52,600	20,526	64.0%
Ethiopia	1,646	19,796	18,150	1102.7%
Ecuador	7,611	25,349	17,738	233.1%
Indonesia	10,016	24,590	14,574	145.5%
Iran	3,664	16,940	13,276	362.3%
Peru	16,168	29,087	12,919	79.9%

Switzerland	38,229	48,820	10,591	27.7%
Nepal	1,632	12,125	10,493	643.0%
Sudan	1,183	11,500	10,317	872.1%
Angola	912	11,220	10,308	1130.3%
Zambia	7,750	17,090	9,340	120.5%
Spain	31,807	40,813	9,006	28.3%
Chile	18,516	27,228	8,712	47.1%
Myanmar	1,892	9,281	7,389	390.5%
DRC	5,978	13,312	7,334	122.7%
Iceland	6,356	13,301	6,945	109.3%
Portugal	11,715	18,594	6,879	58.7%
Mozambique	9,652	16,484	6,832	70.8%
Tajikistan	14,025	20,632	6,607	47.1%
France	71,133	77,461	6,328	8.9%
Austria	43,219	49,355	6,136	14.2%
Cambodia	-	5,022	5,022	N/A
Georgia	5,860	10,863	5,003	85.4%
Albania	4,594	8,708	4,114	89.6%
Uganda	1,551	5,628	4,077	262.9%
Romania	14,778	18,649	3,871	26.2%
Nigeria	5,628	9,107	3,479	61.8%
Uzbekistan	3,528	6,940	3,412	96.7%
South Korea	5,610	8,977	3,367	60.0%
Italy	50,899	54,236	3,337	6.6%
Germany	25,962	28,862	2,900	11.2%
Sri Lanka	3,197	5,951	2,754	86.1%
Serbia	10,337	13,080	2,743	26.5%
South Africa	3,934	6,671	2,737	69.6%
Panama	3,418	6,147	2,729	79.8%
Costa Rica	5,684	8,412	2,728	48.0%
Cameroon	3,442	6,084	2,642	76.8%
Ghana	6,609	9,186	2,577	39.0%
Philippines	7,799	10,287	2,488	31.9%
Kenya	1,325	3,630	2,305	174.0%
Montenegro	1	2,221	2,220	222000.0%

Guatemala	2,514	4,339	1,825	72.6%
Croatia	6,471	8,248	1,777	27.5%
Egypt	13,697	15,458	1,761	12.9%
Slovenia	3,834	5,528	1,694	44.2%
Bosnia	5,094	6,761	1,667	32.7%
Argentina	36,052	37,560	1,508	4.2%
Cote D'Ivoire	1,764	3,200	1,436	81.4%
Kazakhstan	7,531	8,809	1,278	17.0%
Czech Republic	2,313	3,584	1,271	55.0%
Honduras	2,260	3,208	948	41.9%
Congo, Republic	298	1,219	921	309.1%
Ukraine	11,450	12,354	904	7.9%
Iraq	611	1,382	771	126.2%
Thailand	6,026	6,758	732	12.1%
Gabon	803	1,450	647	80.6%
Tanzania	2,135	2,699	564	26.4%
Dominican Republic	934	1,438	504	54.0%
Rwanda	105	590	485	461.9%
Luxembourg	870	1,337	467	53.7%
Zimbabwe	3,194	3,649	455	14.2%
North Macedonia	1,170	1,622	452	38.6%
Madagascar	540	982	442	81.9%
Venezuela	62,886	63,291	405	0.6%
Latvia	2,819	3,208	389	13.8%
Armenia	1,261	1,645	384	30.5%
Bolivia	1,945	2,323	378	19.4%
Lithuania	644	1,010	366	56.8%
Kosovo	52	393	341	655.8%
Slovakia	4,975	5,284	309	6.2%
Belarus	27	300	273	1011.1%
Nicaragua	210	469	259	123.3%
Azerbaijan	1,534	1,763	229	14.9%
Suriname	1,036	1,258	222	21.4%
Bulgaria	2,951	3,130	179	6.1%

Lebanon	444	546	102		23.0%
Mongolia	4	63	59		1475.0%
Hungary	178	231	53		29.8%
United Kingdom	7,780	7,824	44		0.6%
Estonia	5	29	24		480.0%
Cuba	89	106	17		19.1%
Turkmenistan	3	5	2		66.7%
Bahrain	-	-	-		N/A
Botswana	-	-	-		N/A
Brunei	-	-	-		N/A
Chad	-	-	-		N/A
Curacao	-	-	-		N/A
Cyprus	-	-	-		N/A
Eritrea	-	-	-		N/A
Hong Kong	1	1	-		0.0%
Kuwait	-	-	-		N/A
Libya	-	-	-		N/A
Malta	-	-	-		N/A
Niger	-	-	-		N/A
Oman	-	-	-		N/A
Qatar	-	-	-		N/A
Saudi Arabia	-	-	-		N/A
Senegal	-	-	-		N/A
Singapore	-	-	-		N/A
Trinidad & Tobago	-	-	-		N/A
United Arab Emirates	-	-	-		N/A
Yemen	-	-	-		N/A
Benin	2	-	-	2	-100.0%
Mauritius	96	94	-	2	-2.1%
Jamaica	115	110	-	5	-4.3%
Denmark	30	22	-	8	-26.7%
Togo	100	92	-	8	-8.0%
Burkina Faso	98	89	-	9	-9.2%

Jordan	39	22	-	17	-43.6%
Algeria	54	23	-	31	-57.4%
Israel	31	-	-	31	-100.0%
Tunisia	64	9	-	55	-85.9%
Ireland	1,151	1,095	-	56	-4.9%
Netherlands	142	85	-	57	-40.1%
Moldova	377	304	-	73	-19.4%
Namibia	1,396	1,323	-	73	-5.2%
Belgium	1,699	1,619	-	80	-4.7%
Greece	4,111	4,023	-	88	-2.1%
Bangladesh	767	646	-	121	-15.8%
Morocco	718	515	-	203	-28.3%
Haiti	283	-	-	283	-100.0%
Finland	14,660	14,298	-	362	-2.5%
New Zealand	24,432	23,840	-	592	-2.4%
Paraguay	53,492	52,812	-	680	-1.3%
Kyrgyzstan	12,825	12,030	-	795	-6.2%
Poland	4,116	3,135	-	981	-23.8%
Norway	142,289	140,654	-	1,635	-1.1%
Australia	16,720	14,960	-	1,760	-10.5%
Taiwan	8,870	7,019	-	1,851	-20.9%
Syria	3,231	754	-	2,477	-76.7%
Uruguay	7,051	3,516	-	3,535	-50.1%
Mexico	33,133	24,285	-	8,848	-26.7%
Japan	96,817	85,328	-	11,489	-11.9%
United States	279,986	267,129	-	12,857	-4.6%
Sweden	78,619	64,878	-	13,741	-17.5%
Canada	358,620	343,271	-	15,349	-4.3%

Table B3e: Country-Level Electricity Generation (GWh) Data: Solar.

Country	Solar PV GWh (2000)	Solar PV GWh (2024/23)	Change (GWh)	% Change
China	22	584,150	584,128	2655127.3%

United States	183	272,526	272,343	148821.3%
India	2	118,528	118,526	5926300.0%
Japan	356	97,894	97,538	27398.3%
Germany	60	74,297	74,237	123728.3%
Brazil	-	70,664	70,664	N/A
Spain	14	53,706	53,692	383514.3%
Australia	38	48,596	48,558	127784.2%
Italy	18	35,993	35,975	199861.1%
South Korea	5	33,408	33,403	668060.0%
Viet Nam	-	27,222	27,222	N/A
Türkiye	-	26,277	26,277	N/A
Mexico	7	24,274	24,267	346671.4%
France	5	23,623	23,618	472360.0%
Netherlands	8	21,266	21,258	265725.0%
Chile	-	20,817	20,817	N/A
Poland	-	15,231	15,231	N/A
United Kingdom	1	14,789	14,788	1478800.0%
United Arab Emirates	-	13,312	13,312	N/A
Taiwan	-	12,908	12,908	N/A
Israel	-	10,793	10,793	N/A
Greece	-	9,466	9,466	N/A
Hungary	-	9,136	9,136	N/A
Belgium	-	8,000	8,000	N/A
Canada	-	7,948	7,948	N/A
Austria	3	7,644	7,641	254700.0%
Portugal	1	7,079	7,078	707800.0%
Switzerland	11	5,903	5,892	53563.6%
Thailand	-	5,346	5,346	N/A
Egypt	-	5,271	5,271	N/A
South Africa	-	5,259	5,259	N/A
Ukraine	-	4,599	4,599	N/A
Sweden	1	4,147	4,146	414600.0%
Argentina	-	3,980	3,980	N/A
Denmark	1	3,776	3,775	377500.0%

Czech Republic	-	3,592	3,592	N/A
Jordan	-	3,570	3,570	N/A
Bulgaria	-	3,520	3,520	N/A
Malaysia	-	3,417	3,417	N/A
Russia	-	2,709	2,709	N/A
Philippines	-	2,563	2,563	N/A
Romania	-	2,227	2,227	N/A
Colombia	6	2,058	2,052	34200.0%
Qatar	1	1,882	1,881	188100.0%
Kazakhstan	-	1,872	1,872	N/A
Slovenia	-	1,782	1,782	N/A
Lebanon	-	1,550	1,550	N/A
Lithuania	-	1,397	1,397	N/A
Singapore	-	1,386	1,386	N/A
Bangladesh	-	1,270	1,270	N/A
Dominican Republic	-	1,181	1,181	N/A
Finland	2	1,155	1,153	57650.0%
Oman	-	1,101	1,101	N/A
Honduras	-	1,094	1,094	N/A
Pakistan	-	1,077	1,077	N/A
Saudi Arabia	-	1,049	1,049	N/A
Estonia	-	1,004	1,004	N/A
Peru	2	956	954	47700.0%
Iran	-	921	921	N/A
Panama	-	871	871	N/A
Cambodia	1	862	861	86100.0%
Sri Lanka	8	859	851	10637.5%
Cyprus	-	830	830	N/A
Armenia	-	733	733	N/A
Ireland	-	713	713	N/A
Indonesia	-	712	712	N/A
Slovakia	-	695	695	N/A
Algeria	-	686	686	N/A
Uzbekistan	-	622	622	N/A

Morocco	-	612	612	N/A
New Zealand	-	607	607	N/A
Senegal	2	582	580	29000.0%
Latvia	-	536	536	N/A
Norway	-	533	533	N/A
Yemen	1	532	531	53100.0%
Uruguay	-	492	492	N/A
Tunisia	-	486	486	N/A
Luxembourg	-	485	485	N/A
Kenya	-	460	460	N/A
Namibia	-	451	451	N/A
Croatia	-	413	413	N/A
Angola	-	400	400	N/A
Bolivia	-	375	375	N/A
North Macedonia	-	355	355	N/A
Malta	1	308	307	30700.0%
Albania	-	297	297	N/A
Belarus	-	287	287	N/A
Hong Kong	-	282	282	N/A
Guatemala	-	256	256	N/A
Bosnia	-	253	253	N/A
Madagascar	-	233	233	N/A
Nigeria	-	211	211	N/A
Mongolia	-	195	195	N/A
Burkina Faso	-	194	194	N/A
Cuba	-	167	167	N/A
Zambia	-	164	164	N/A
Moldova	-	162	162	N/A
Myanmar	-	158	158	N/A
Mauritius	-	148	148	N/A
Ghana	-	147	147	N/A
Uganda	-	144	144	N/A
Jamaica	-	133	133	N/A
Sudan	-	125	125	N/A
Syria	-	106	106	N/A

Nepal	-	105	105	N/A
Bahrain	-	103	103	N/A
Togo	-	99	99	N/A
Cameroon	-	88	88	N/A
Costa Rica	-	88	88	N/A
Mozambique	-	84	84	N/A
Azerbaijan	-	80	80	N/A
Iraq	-	61	61	N/A
Benin	-	51	51	N/A
Eritrea	1	47	46	4600.0%
Serbia	-	46	46	N/A
Ecuador	-	41	41	N/A
Rwanda	-	39	39	N/A
Cote D'Ivoire	-	37	37	N/A
Niger	1	36	35	3500.0%
Tanzania	-	35	35	N/A
Ethiopia	-	33	33	N/A
DRC	-	30	30	N/A
Nicaragua	-	27	27	N/A
Kuwait	-	20	20	N/A
Montenegro	-	17	17	N/A
Zimbabwe	-	16	16	N/A
Curacao	-	15	15	N/A
Suriname	-	13	13	N/A
Botswana	1	10	9	900.0%
Kosovo	-	9	9	N/A
Libya	1	9	8	800.0%
Venezuela	-	8	8	N/A
Trinidad & Tobago	-	6	6	N/A
Haiti	-	5	5	N/A
Brunei	1	5	4	400.0%
Chad	-	2	2	N/A
Congo, Republic	-	-	-	N/A
Gabon	-	-	-	N/A

Georgia	-	-	-	N/A
Iceland	-	-	-	N/A
Kyrgyzstan	-	-	-	N/A
Paraguay	-	-	-	N/A
Tajikistan	-	-	-	N/A
Turkmenistan	-	-	-	N/A

Table B3f: Country-Level Electricity Generation (GWh) Data: Wind.

Country	Wind GWh (2000)	Wind GWh (2024/23)	Change (GWh)	% Change
China	615	885,870	885,255	143943.9%
United States	5,650	458,511	452,861	8015.2%
Germany	9,352	138,914	129,562	1385.4%
Brazil	2	107,654	107,652	5382600.0%
India	1,684	93,465	91,781	5450.2%
United Kingdom	947	84,057	83,110	8776.1%
Spain	4,727	62,090	57,363	1213.5%
France	48	47,245	47,197	98327.1%
Canada	264	46,634	46,370	17564.4%
Sweden	457	40,419	39,962	8744.4%
Türkiye	33	36,627	36,594	110890.9%
Netherlands	829	33,500	32,671	3941.0%
Australia	58	30,991	30,933	53332.8%
Poland	5	24,763	24,758	495160.0%
Italy	563	22,306	21,743	3862.0%
Mexico	19	19,952	19,933	104910.5%
Finland	78	19,405	19,327	24778.2%
Denmark	4,241	20,552	16,311	384.6%
Argentina	35	16,170	16,135	46100.0%
Norway	31	14,544	14,513	46816.1%
Portugal	168	14,396	14,228	8469.0%
Belgium	16	13,975	13,959	87243.8%
Japan	108	11,984	11,876	10996.3%

South Africa	-	11,586	11,586	N/A
Viet Nam	-	11,583	11,583	N/A
Greece	451	11,934	11,483	2546.1%
Ireland	248	11,555	11,307	4559.3%
Chile	-	10,880	10,880	N/A
Austria	67	9,257	9,190	13716.4%
Romania	-	7,548	7,548	N/A
Egypt	137	6,686	6,549	4780.3%
Morocco	64	6,545	6,481	10126.6%
Taiwan	1	6,238	6,237	623700.0%
Russia	2	4,776	4,774	238700.0%
Uruguay	-	4,764	4,764	N/A
Pakistan	-	4,086	4,086	N/A
New Zealand	120	3,956	3,836	3196.7%
Kazakhstan	-	3,786	3,786	N/A
Thailand	-	3,519	3,519	N/A
Lithuania	-	3,448	3,448	N/A
South Korea	17	3,384	3,367	19805.9%
Croatia	-	2,586	2,586	N/A
Peru	1	2,355	2,354	235400.0%
Kenya	-	1,797	1,797	N/A
Jordan	3	1,647	1,644	54800.0%
Saudi Arabia	1	1,588	1,587	158700.0%
Bulgaria	-	1,583	1,583	N/A
Israel	-	1,319	1,319	N/A
Philippines	-	1,308	1,308	N/A
Estonia	-	1,164	1,164	N/A
Dominican Republic	-	1,129	1,129	N/A
Serbia	-	1,067	1,067	N/A
Costa Rica	183	1,239	1,056	577.0%
Ukraine	6	1,033	1,027	17116.7%
Panama	-	886	886	N/A
Sri Lanka	3	818	815	27166.7%
Honduras	-	770	770	N/A

Iran	37	761	724	1956.8%
Czech Republic	1	716	715	71500.0%
Ethiopia	-	684	684	N/A
Nicaragua	-	665	665	N/A
Hungary	-	659	659	N/A
Mongolia	-	504	504	N/A
Indonesia	-	481	481	N/A
Bolivia	-	479	479	N/A
Colombia	-	453	453	N/A
Luxembourg	24	473	449	1870.8%
Kosovo	-	402	402	N/A
Senegal	-	382	382	N/A
Bosnia	-	356	356	N/A
Guatemala	-	343	343	N/A
Tunisia	23	338	315	1369.6%
Montenegro	-	311	311	N/A
Latvia	4	275	271	6775.0%
Jamaica	-	232	232	N/A
Ecuador	-	209	209	N/A
Cyprus	-	208	208	N/A
Moldova	-	192	192	N/A
Belarus	-	183	183	N/A
Switzerland	3	170	167	5566.7%
Curacao	8	174	166	2075.0%
North Macedonia	-	157	157	N/A
Oman	1	114	113	11300.0%
Venezuela	-	88	88	N/A
Georgia	-	86	86	N/A
Cuba	-	68	68	N/A
United Arab Emirates	1	60	59	5900.0%
Azerbaijan	-	55	55	N/A
Kuwait	1	35	34	3400.0%
Namibia	-	21	21	N/A
Algeria	-	13	13	N/A

Mauritius	-	8	8	N/A
Uzbekistan	-	7	7	N/A
Iceland	-	6	6	N/A
Slovenia	-	6	6	N/A
Bangladesh	-	5	5	N/A
Chad	1	6	5	500.0%
Nepal	-	5	5	N/A
Slovakia	-	4	4	N/A
Bahrain	1	4	3	300.0%
Armenia	-	2	2	N/A
Eritrea	-	2	2	N/A
Albania	-	-	-	N/A
Angola	-	-	-	N/A
Benin	-	-	-	N/A
Botswana	-	-	-	N/A
Brunei	-	-	-	N/A
Burkina Faso	-	-	-	N/A
Cambodia	-	-	-	N/A
Cameroon	-	-	-	N/A
Congo, Republic	-	-	-	N/A
Cote D'Ivoire	-	-	-	N/A
DRC	-	-	-	N/A
Gabon	-	-	-	N/A
Ghana	-	-	-	N/A
Haiti	-	-	-	N/A
Hong Kong	-	-	-	N/A
Iraq	-	-	-	N/A
Kyrgyzstan	-	-	-	N/A
Lebanon	-	-	-	N/A
Libya	-	-	-	N/A
Madagascar	-	-	-	N/A
Malaysia	-	-	-	N/A
Malta	-	-	-	N/A
Mozambique	-	-	-	N/A
Myanmar	-	-	-	N/A

Niger	-	-	-	N/A
Nigeria	-	-	-	N/A
Paraguay	-	-	-	N/A
Qatar	-	-	-	N/A
Rwanda	-	-	-	N/A
Singapore	-	-	-	N/A
Sudan	-	-	-	N/A
Suriname	-	-	-	N/A
Syria	-	-	-	N/A
Tajikistan	-	-	-	N/A
Tanzania	-	-	-	N/A
Togo	-	-	-	N/A
Trinidad & Tobago	-	-	-	N/A
Turkmenistan	-	-	-	N/A
Uganda	-	-	-	N/A
Yemen	-	-	-	N/A
Zambia	-	-	-	N/A
Zimbabwe	-	-	-	N/A

Table B3g: Country-Level Electricity Generation (GWh) Data: Nuclear.

Country	Nuclear GWh (2000)	Nuclear GWh (2024/23)	Change (GWh)	% Change
China	16,737	434,720	417,983	2497.4%
Russia	130,715	217,000	86,285	66.0%
South Korea	108,964	188,754	79,790	73.2%
United Arab Emirates	-	33,063	33,063	N/A
India	16,902	47,937	31,035	183.6%
Pakistan	1,997	26,169	24,172	1210.4%
United States	797,718	815,554	17,836	2.2%
Czech Republic	13,590	29,696	16,106	118.5%
Canada	72,799	86,066	13,267	18.2%

Belarus	-	11,804	11,804	N/A
Finland	22,479	32,599	10,120	45.0%
Brazil	6,046	15,766	9,720	160.8%
Iran	-	6,013	6,013	N/A
Romania	5,456	11,191	5,735	105.1%
Argentina	6,177	11,175	4,998	80.9%
Mexico	8,221	12,266	4,045	49.2%
Hungary	14,180	16,017	1,837	13.0%
Slovakia	16,494	18,200	1,706	10.3%
Slovenia	4,761	5,835	1,074	22.6%
Armenia	2,005	2,709	704	35.1%
Albania	-	-	-	N/A
Algeria	-	-	-	N/A
Angola	-	-	-	N/A
Australia	-	-	-	N/A
Austria	-	-	-	N/A
Azerbaijan	-	-	-	N/A
Bahrain	-	-	-	N/A
Bangladesh	-	-	-	N/A
Benin	-	-	-	N/A
Bolivia	-	-	-	N/A
Bosnia	-	-	-	N/A
Botswana	-	-	-	N/A
Brunei	-	-	-	N/A
Burkina Faso	-	-	-	N/A
Cambodia	-	-	-	N/A
Cameroon	-	-	-	N/A
Chad	-	-	-	N/A
Chile	-	-	-	N/A
Colombia	-	-	-	N/A
Congo, Republic	-	-	-	N/A
Costa Rica	-	-	-	N/A
Cote D'Ivoire	-	-	-	N/A
Croatia	-	-	-	N/A
Cuba	-	-	-	N/A

Curacao	-	-	-	N/A
Cyprus	-	-	-	N/A
Denmark	-	-	-	N/A
Dominican Republic	-	-	-	N/A
DRC	-	-	-	N/A
Ecuador	-	-	-	N/A
Egypt	-	-	-	N/A
Eritrea	-	-	-	N/A
Estonia	-	-	-	N/A
Ethiopia	-	-	-	N/A
Gabon	-	-	-	N/A
Georgia	-	-	-	N/A
Ghana	-	-	-	N/A
Greece	-	-	-	N/A
Guatemala	-	-	-	N/A
Haiti	-	-	-	N/A
Honduras	-	-	-	N/A
Hong Kong	-	-	-	N/A
Iceland	-	-	-	N/A
Indonesia	-	-	-	N/A
Iraq	-	-	-	N/A
Ireland	-	-	-	N/A
Israel	-	-	-	N/A
Italy	-	-	-	N/A
Jamaica	-	-	-	N/A
Jordan	-	-	-	N/A
Kazakhstan	-	-	-	N/A
Kenya	-	-	-	N/A
Kosovo	-	-	-	N/A
Kuwait	-	-	-	N/A
Kyrgyzstan	-	-	-	N/A
Latvia	-	-	-	N/A
Lebanon	-	-	-	N/A
Libya	-	-	-	N/A

Luxembourg	-	-	-	N/A
Madagascar	-	-	-	N/A
Malaysia	-	-	-	N/A
Malta	-	-	-	N/A
Mauritius	-	-	-	N/A
Moldova	-	-	-	N/A
Mongolia	-	-	-	N/A
Montenegro	-	-	-	N/A
Morocco	-	-	-	N/A
Mozambique	-	-	-	N/A
Myanmar	-	-	-	N/A
Namibia	-	-	-	N/A
Nepal	-	-	-	N/A
New Zealand	-	-	-	N/A
Nicaragua	-	-	-	N/A
Niger	-	-	-	N/A
Nigeria	-	-	-	N/A
North Macedonia	-	-	-	N/A
Norway	-	-	-	N/A
Oman	-	-	-	N/A
Panama	-	-	-	N/A
Paraguay	-	-	-	N/A
Peru	-	-	-	N/A
Philippines	-	-	-	N/A
Poland	-	-	-	N/A
Portugal	-	-	-	N/A
Qatar	-	-	-	N/A
Rwanda	-	-	-	N/A
Saudi Arabia	-	-	-	N/A
Senegal	-	-	-	N/A
Serbia	-	-	-	N/A
Singapore	-	-	-	N/A
Sri Lanka	-	-	-	N/A
Sudan	-	-	-	N/A
Suriname	-	-	-	N/A

Syria	-	-	-		N/A
Tajikistan	-	-	-		N/A
Tanzania	-	-	-		N/A
Thailand	-	-	-		N/A
Togo	-	-	-		N/A
Trinidad & Tobago	-	-	-		N/A
Tunisia	-	-	-		N/A
Türkiye	-	-	-		N/A
Turkmenistan	-	-	-		N/A
Uganda	-	-	-		N/A
Uruguay	-	-	-		N/A
Uzbekistan	-	-	-		N/A
Venezuela	-	-	-		N/A
Viet Nam	-	-	-		N/A
Yemen	-	-	-		N/A
Zambia	-	-	-		N/A
Zimbabwe	-	-	-		N/A
Netherlands	3,926	3,573	-	353	-9.0%
Bulgaria	18,178	16,163	-	2,015	-11.1%
Switzerland	26,446	24,017	-	2,429	-9.2%
South Africa	13,010	8,543	-	4,467	-34.3%
Sweden	57,316	50,412	-	6,904	-12.0%
Spain	62,206	54,532	-	7,674	-12.3%
Lithuania	8,419	-	-	8,419	-100.0%
Belgium	48,157	31,254	-	16,903	-35.1%
Taiwan	38,503	17,801	-	20,702	-53.8%
Ukraine	77,341	51,989	-	25,352	-32.8%
France	415,162	380,451	-	34,711	-8.4%
United Kingdom	85,063	40,587	-	44,476	-52.3%
Germany	169,606	-	-	169,606	-100.0%
Japan	322,049	93,482	-	228,567	-71.0%

Table B3h: Country-Level Electricity Generation (GWh) Data: Geothermal.

Country	Geothermal GWh (2000)	Geothermal GWh (2024/23)	Change (GWh)	% Change
Indonesia	4,869	16,936	12,067	247.8%
Türkiye	76	11,241	11,165	14690.8%
New Zealand	2,921	9,265	6,344	217.2%
Kenya	429	5,551	5,122	1193.9%
Iceland	1,323	6,197	4,874	368.4%
United States	14,621	18,185	3,564	24.4%
Italy	4,705	5,648	943	20.0%
Nicaragua	134	751	617	460.4%
Japan	3,347	3,870	523	15.6%
Costa Rica	976	1,498	522	53.5%
Russia	58	455	397	684.5%
Honduras	-	318	318	N/A
Chile	-	308	308	N/A
Germany	-	214	214	N/A
France	-	128	128	N/A
Portugal	80	201	121	151.3%
China	109	195	86	78.9%
Taiwan	-	23	23	N/A
Croatia	-	20	20	N/A
Hungary	-	11	11	N/A
Albania	-	-	-	N/A
Algeria	-	-	-	N/A
Angola	-	-	-	N/A
Argentina	-	-	-	N/A
Armenia	-	-	-	N/A
Australia	-	-	-	N/A
Austria	-	-	-	N/A
Azerbaijan	-	-	-	N/A
Bahrain	-	-	-	N/A
Bangladesh	-	-	-	N/A
Belarus	-	-	-	N/A
Belgium	-	-	-	N/A

Benin	-	-	-	N/A
Bolivia	-	-	-	N/A
Bosnia	-	-	-	N/A
Botswana	-	-	-	N/A
Brazil	-	-	-	N/A
Brunei	-	-	-	N/A
Bulgaria	-	-	-	N/A
Burkina Faso	-	-	-	N/A
Cambodia	-	-	-	N/A
Cameroon	-	-	-	N/A
Canada	-	-	-	N/A
Chad	-	-	-	N/A
Colombia	-	-	-	N/A
Congo, Republic	-	-	-	N/A
Cote D'Ivoire	-	-	-	N/A
Cuba	-	-	-	N/A
Curacao	-	-	-	N/A
Cyprus	-	-	-	N/A
Czech Republic	-	-	-	N/A
Denmark	-	-	-	N/A
Dominican Republic	-	-	-	N/A
DRC	-	-	-	N/A
Ecuador	-	-	-	N/A
Egypt	-	-	-	N/A
Eritrea	-	-	-	N/A
Estonia	-	-	-	N/A
Finland	-	-	-	N/A
Gabon	-	-	-	N/A
Georgia	-	-	-	N/A
Ghana	-	-	-	N/A
Greece	-	-	-	N/A
Guatemala	-	-	-	N/A
Haiti	-	-	-	N/A
Hong Kong	-	-	-	N/A

India	-	-	-	N/A
Iran	-	-	-	N/A
Iraq	-	-	-	N/A
Ireland	-	-	-	N/A
Israel	-	-	-	N/A
Jamaica	-	-	-	N/A
Jordan	-	-	-	N/A
Kazakhstan	-	-	-	N/A
Kosovo	-	-	-	N/A
Kuwait	-	-	-	N/A
Kyrgyzstan	-	-	-	N/A
Latvia	-	-	-	N/A
Lebanon	-	-	-	N/A
Libya	-	-	-	N/A
Lithuania	-	-	-	N/A
Luxembourg	-	-	-	N/A
Madagascar	-	-	-	N/A
Malaysia	-	-	-	N/A
Malta	-	-	-	N/A
Mauritius	-	-	-	N/A
Moldova	-	-	-	N/A
Mongolia	-	-	-	N/A
Montenegro	-	-	-	N/A
Morocco	-	-	-	N/A
Mozambique	-	-	-	N/A
Myanmar	-	-	-	N/A
Namibia	-	-	-	N/A
Nepal	-	-	-	N/A
Netherlands	-	-	-	N/A
Niger	-	-	-	N/A
Nigeria	-	-	-	N/A
North Macedonia	-	-	-	N/A
Norway	-	-	-	N/A
Oman	-	-	-	N/A
Pakistan	-	-	-	N/A

Panama	-	-	-	N/A
Paraguay	-	-	-	N/A
Peru	-	-	-	N/A
Poland	-	-	-	N/A
Qatar	-	-	-	N/A
Romania	-	-	-	N/A
Rwanda	-	-	-	N/A
Saudi Arabia	-	-	-	N/A
Senegal	-	-	-	N/A
Serbia	-	-	-	N/A
Singapore	-	-	-	N/A
Slovakia	-	-	-	N/A
Slovenia	-	-	-	N/A
South Africa	-	-	-	N/A
South Korea	-	-	-	N/A
Spain	-	-	-	N/A
Sri Lanka	-	-	-	N/A
Sudan	-	-	-	N/A
Suriname	-	-	-	N/A
Sweden	-	-	-	N/A
Switzerland	-	-	-	N/A
Syria	-	-	-	N/A
Tajikistan	-	-	-	N/A
Tanzania	-	-	-	N/A
Togo	-	-	-	N/A
Trinidad & Tobago	-	-	-	N/A
Tunisia	-	-	-	N/A
Turkmenistan	-	-	-	N/A
Uganda	-	-	-	N/A
Ukraine	-	-	-	N/A
United Arab Emirates	-	-	-	N/A
United Kingdom	-	-	-	N/A
Uruguay	-	-	-	N/A

Uzbekistan	-	-	-		N/A
Venezuela	-	-	-		N/A
Viet Nam	-	-	-		N/A
Yemen	-	-	-		N/A
Zambia	-	-	-		N/A
Zimbabwe	-	-	-		N/A
Thailand	2	1	-	1	-50.0%
Ethiopia	5	-	-	5	-100.0%
Philippines	11,626	10,730	-	896	-7.7%
Mexico	5,901	3,696	-	2,205	-37.4%