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Political economy of low-carbon electricity: Governance effects across 198 countries

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ABSTRACT

Which countries best foster low-carbon electricity transitions – authoritarian regimes or democratic societies? Crucial for understanding how transitions unfold is identifying contextual factors conditioning propensity to adopt specific forms of energy production. This research assesses the relationship between quality of governance within 198 countries and domestic electricity production from all major energy sources, across the years 2002–2020. Governance quality is measured via a range of comprehensive, internationally recognised metrics, focusing predominantly on the World Bank's worldwide governance indicators. The data reveal that a future, decarbonised electricity system via wind, solar, and/or nuclear appears most likely in countries where the traditions and institutions by which authority is exercised support good governance. Over the last two decades, the association between electricity from solar and wind and good governance has progressively strengthened globally. Beyond governance, national measures of economic (in)equality are strongly related to electricity production from nuclear and hydropower. These findings offer a point of departure for assessing how governance systems might predispose countries to particular energy choices.

1. Introduction

An abundance of research has emphasized the optimal policy mixes to be calibrated for low-carbon transitions [1–4], or mapped the merits and effects of varying energy and climate policies (for example, see Ref. [5]). Far less work has explored the *politics* of such transitions, even though better comprehending the political and governance dynamics of electricity transitions is often a critical driver of their development [6–9].

Even within the governance literature, comparative work at a global scale is rare; analysis is typically limited to a single (or few) countries, or a single energy source. A large corpus of research has examined the implications of national-level governance for how energy systems develop [10–15]. Much of this research explores implications of governance for development of a specific form of energy development for a single country or small group of countries – for example, hydropower in Brazil [16] or Nepal [17], nuclear energy in China and India [18], solar power in Morocco [19] or Sub-Saharan Africa [20], and wind energy in Germany [21] or Denmark [22,23]. Such studies explore in depth the contextual, political, economic, and historical factors operating within these countries. It has emerged, through all of these studies, that the direction of transition in electricity systems does indeed depend on local circumstances [8]. Nevertheless, a gap in academic understanding is the extent to which larger cross-contextual patterns can also be observed.

Other extant research examines the effects of governance across various energy sources and pathways within one country [24–26], or a small set of countries [12,27–32]. Further studies systematically compare the effects of governance on a single energy source across a large number of countries [33,34]. Each approach has it merits, from exhaustive nuanced analysis of a wide range of domestic dynamics to broad systematic quantitative comparisons that include fewer variables but offer more insight into the transferability of findings across national contexts.

This study explores the degree to which authoritarian and democratic societies (and all those in between) foster low-carbon electricity transitions. To operationalise this theme, this study explores: which

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Abbreviations:

FITW	Freedom in the world
GDP	Gross domestic product
IRENA	International Renewable Energy Agency
WGI	Worldwide governance indicators
WJP	World Justice Project

electricity sources associate with positive (or negative) governance patterns? Under which governance systems and in which countries can one predict that institutions and norms will support a future, decarbonized electricity system?

This study's core research question is: To what extent does good governance relate to the electricity mix in countries across the globe? No study to date has examined this question in a large sample of nations covering the entire world and comparing across all major forms of electricity production simultaneously.

The methodological approach here is simultaneously to model the effect of governance systems on energy choices in a large selection of countries globally (n = 198), and across a suite of energy options (electricity production from solar, wind, hydropower, nuclear, gas, oil, and coal). This study systematically documents the extent to which governance – the traditions and institutions by which authority in a country is exercised – effect national choices about energy (operationalised as electricity production). This research operationalises governance as including the 'process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them' [35].

2. Context and theory on politics of energy production

Because this research assesses the relationship between electricity production and good governance across all major energy sources, this study is necessarily parsimonious in its review of the literature on each source. Table 1 presents hypotheses for expected relationships between good governance and each low-carbon source. To be clear, not all of these hypotheses posit a clear direction of the relationship between good governance and electricity production from that energy source [36–38]. Nevertheless, such hypotheses are included because they are worth testing for clarity on the direction and strength of any relationship and they also enable broader comparative analysis between countries' governance approaches and electricity transitions. To avoid repetition, this study confines its review of theory and empirical data about specific energy sources to Table 1. Although data exists, to varying extents, on all of these hypotheses, no single study has examined the full range of energy sources across a global sample. This research allows for systematic comparison of these relationships between each energy source.

On the general level of energy transitions, i.e., a shift from one means of producing and/or distributing energy to another, this study expects change is more likely in countries with stronger governance traditions and institutions. Brisbois [39,40] demonstrates how new renewables (e.g., wind and solar) require some decentralisation of responsibility, authority, and resources, due to being far more distributed means of production than traditional fossil, nuclear, or hydropower sources. Rescaling of governance functions (e.g., to city and local levels) [40], and transparency [39] needed to allow for coordinated distributed energy production, relies on good national governance.

When government accountability is weak, special interests are often strong, favouring the status quo and stymieing electricity transitions [41]; furthermore, viability of low-carbon transitions is increased by governance and civil society engagement across scales [42]. Presence of

Table 1
Five core hypotheses about the governance of electricity transitions.

Hypothesis	References	Supported by this study's data?
H_1: Good governance will associate **positively** with increased **solar energy** in a country's electricity production mix.	• Stephenson et al. [31] – governance norms potentially support renewables in energy culture (e.g., Denmark) • Carafa et al. [19] – strong governance structures can allow for clear policies that spur investment (Morocco)	Yes
H_2: Good governance will associate **positively** with increased **wind energy** in a country's electricity production mix.	• Cantarero [45] – democratically-structured institutions, transparency, participation, and accountability support renewables • Burke and Stephens [46]/Szulecki and Overland [47] – strong democratic policies, particularly citizen engagement, could foster renewables, especially distributed electricity production	Yes
H_3: Good governance will associate **negatively** with increased **hydropower** in a country's electricity production mix.	• Sovacool and Walter [33] – hydropower projects linked with corruption • Hancock and Sovacool [48] – hydropower linked with resource curse • Huda [28] – autocratisation enhances likelihood of hydro megaprojects • Sovacool and Cooper [49] – megaprojects can consolidate wealth among elites • Foran et al. [50] – large hydropower often lacks policy legitimacy • Alsaleh and Abdul-Rahim [51] – link between good governance and hydropower, but in the EU	Yes
H_4: Good governance will associate **negatively** and **positively** with increased **nuclear power** in a country's electricity production mix, depending on the measure of governance assessed.	• Sovacool and Valentine [18]/Valentine and Sovacool [52] – factors influencing nuclear development (i.e., subordination of challenges to authority, low civil activism, technocratic ideology) map clearly onto (lack of) good governance indicators • Ting and Lin [34] – empowerment of civil society and deliberative democracy reduce dependence on nuclear, but presence of electoral democracy increases dependence on nuclear	Partially
H5: Good governance will associate (weakly) **negatively** with increased **fossil fuel use** (e.g., oil, goal, and gas) in a country's electricity production mix	• Literature on the resource curse [53] suggests that corruption [54], concentration of political/economic power [55], wasted spending [56], conflicts [57], and reduced public participation [58] associate with fossil fuel production and use. • Gamarra et al. [59] – geopolitical risks are higher for electricity production from gas vs solar • Some research points to a lack of association between fossil fuel resources or heavy fossil fuel reliance, but generally suggests a lack of relationship rather than a positive one [60–62]. • Pérez-Sindín [63] – coal-fired power plant megaprojects can be associated with governance failures that foster social ills	Partially

political constraints and veto players, which have been shown to reduce uptake of renewable energy, are also more likely in weak governance systems [43]. Good governance further increases opportunities for planning and regulation to lead, rather than merely follow, infrastructural development in the electricity sector [44]. For example, in a study of solar energy development, Carafa et al. [19] point to clear government commitment, strong domestic institutional capacity for delivering concrete projects, and strong commitment of development finance institutions as pre-requisites for transition to solar.

In-depth analysis of specific projects – for example, hydropower projects in Nepal [17,64], Brazil [16,65,66], China [67,68] and Southeast Asia [69,70] – builds the basis for theoretical postulates about the extent to which and ways in which governance shapes energy choices. In this instance, leading to the expectation that governance failures – in terms of consultation with the public, quality of regulation, and lack of corruption – lead to expanded hydropower projects. This focused local analysis is a precursor to global analyses of such relationships.

Large-scale systematic analysis on a global scale is needed to discern the extent to which such relationships are robust across regions. For example, research on the EU specifically, with its generally high standards for governance, seems to suggest a different relationship between hydropower and good governance [51,71]. This gap is tackled head on in this research; the study focuses on a global analysis of four critical low-carbon technologies (wind, solar, hydro, and nuclear power), as well as three fossil fuels, drawn from a novel mix of state-of-the-art data and corresponding governance metrics.

3. Material and methods

3.1. Data collection

Seeking to analyse relationships between measures of good governance and relative contribution of various sources to domestic electricity production, we first collected multiple recognised indicators of good governance. Initially, we drew data from three robust and multi-faceted data sets; they were selected for their comprehensive operationalisation of good governance through multiple metrics, their strength of data collection, their representation of a broad constellation of countries globally, and availability of data over multiple years.

1. *The World Justice Project's Rule of Law Index* [72] – a rating of governance at a national level based on eight factors (with 44 sub-factors): (a) constrains on government powers, (b) absence of corruption, (c) open government, (d) fundamental rights, (e) order and security, (f) regulatory enforcement, (g) civil justice, and (h) criminal justice. Each country receives a score on each factor and an overall composite score. The scores are generated through a representative survey of the general population in each country ($n = 1000$) and a 'qualified respondent questionnaire' to legal practitioners and academic experts in each country ($n =$ approx. 300). The 2020 data set includes 128 countries.
2. *The World Bank's Worldwide Governance Indicators* [35] – six composite measures of governance in the areas of: (a) voice and accountability, (b) political stability and absence of violence/terrorism, (c) government effectiveness, (d) regulatory quality, (e) rule of law, and (f) control of corruption. The score for each of the six indicators is derived from a large compilation of data from public sector organisations, non-governmental organisations, commercial business information providers, and items from existing surveys of households. The 2020 data set includes 198 countries.
3. *Freedom in the World* [73] – an assessment of political rights (10 indicators) and civil liberties (15 indicators) that gives separate scores for these two sub-domains and for overall quality of governance. The country scores are generated by a team of over 100 analysts using 'news articles, academic analyses, reports from nongovernmental organisations, individual professional contacts, and on-the-ground research'. The scores given are discussed and defended at review meetings; the ratings are reviewed by outside advisors. The 2020 data set includes 185 countries.

In our analysis, we make use of all three data sets for a more comprehensive assessment, and to check the reliability of the operationalisations of good governance. Ultimately, the national scores correlate well across the data sets (Table 2). Therefore, we examine the connections between electricity production and all three measures of good governance in 2020, but we then rely exclusively on the Worldwide Governance Indicators (WGI) for our analysis over time. This choice is because the WGI are available for a much larger number of countries than the Rule of Law Index, and the six WGI indicators are more comprehensive than the two dimensions of the Freedom in the World scores.

The six WGI indicators each measure important components of good governance, but still pool together very well into a single construct. For each year we used in our analysis (2002–2020), an exploratory factor analysis revealed that the six WGI pooled together on one factor, with a minimum of 83 % variance explained, the lowest factor loading at 0.70, and a Cronbach's alpha reliability of at least 0.96. Therefore, in our analysis, we averaged all six indicator scores together to generate a single composite WGI for each year; the WGI value for 2020 is displayed visually in Fig. 1. This allows for more parsimonious modelling of the relationships between good governance and electricity production.

Our data on electricity production come primarily from Ember's Global Electricity Review [74] and BP's Statistical Review of World Energy [75]. Our World in Data [76] combines these two data sets to provide the percentage that each of seven energy sources contributes to domestic electricity production in over 200 countries. In our analysis, we only include the 198 countries that overlap with the WGI data set. Note that throughout our data analysis, the sample size of countries included frequently changes. This is due to the extent of overlap in which countries have data available in each data set. Our two primary data sets contain information for the same 198 countries; however, some of the other variables used in subsequent analyses have data on as few as 101 of those countries. The sample size for each analysis is stated clearly when that analysis is presented.

As a robustness check on the electricity production data, we also included data on percentage share of electricity production from the International Renewable Energy Agency (IRENA) in our analysis. Table 3 reveals that the correlations between percentages reported by Ember/BP vs IRENA were very high for nuclear, wind, and hydropower, and reasonable for solar. Correlations with fossil fuels were not possible to compute due to the way the IRENA data measured electricity

Table 2
Bivariate correlations between good governance indicators, 2020.

	WGI-psav[c]	WGI-va	WGI-ge	WGI-rq	WGI-rl	WGI-cc
WJP[a] overall score	0.78	0.82	0.91	0.91	0.95	0.96
FITW[b] political rights	0.65	0.97	0.61	0.66	0.67	0.68
FITW civil liberties	0.72	0.98	0.68	0.72	0.74	0.74
FITW overall score	0.70	0.99	0.66	0.70	0.72	0.72

All correlations are significant at $p < 0.001$.
[a] Correlations with the World Justice Project Rule of Law dataset have a sample size of 128 countries (i.e., the overlap between the countries included in WJP and WGI data sets).
[b] Correlations with the Freedom in the World dataset have a sample size of 185 countries.
[c] Worldwide Governance Indicators (WGI): psav = political stability and absence of violence, va = voice and accountability, ge = government effectiveness, rq = regulatory quality, rl = rule of law, cc = control of corruption.

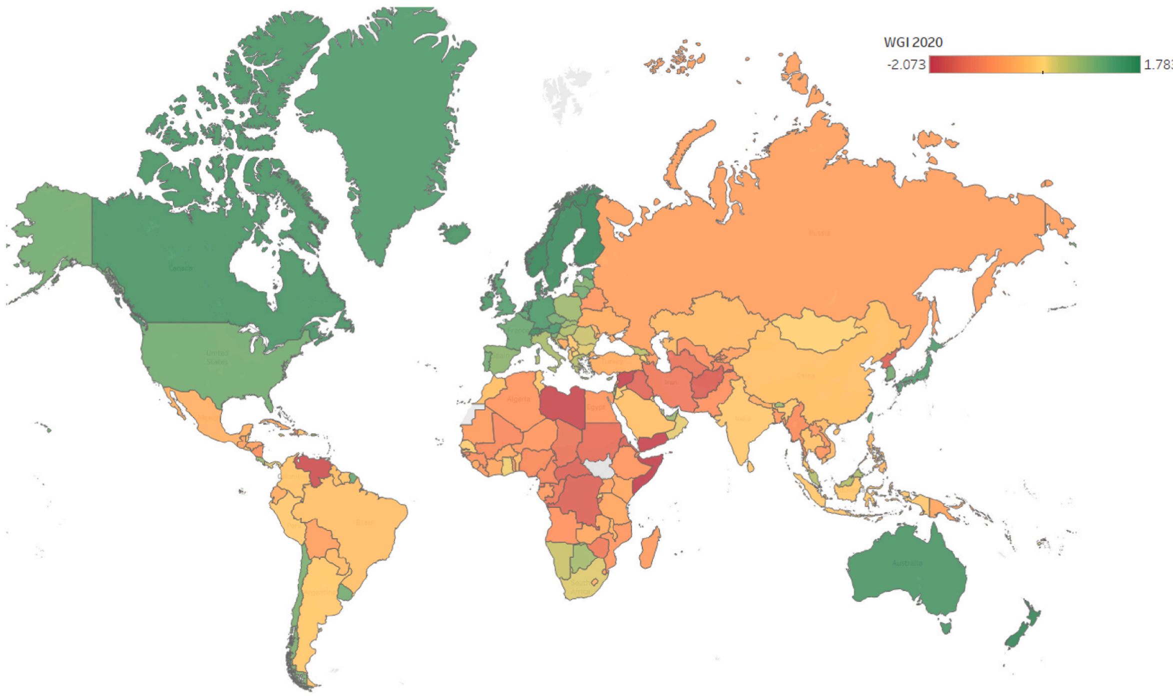

Fig. 1. Composite Worldwide Governance Indicators score for 2020.

Table 3
Correlations between BP and IRENA electricity percentage datasets (195 countries).

	Correlation
Solar, 2019	0.765
Wind, 2019	0.973
Hydro, 2019	0.960
Nuclear, 2019	1.000

production from fossil fuels.

The lower correlation for solar is predominantly driven by instances where no solar generation is reported in the Ember/BP data set, but a large percentage is given in the IRENA data set, usually in relation to a small island state (e.g., Kiribati, Samoa, Tonga). Nevertheless, there were also cases of the solar percentage being far lower by comparison in the IRENA data (e.g., Mauritania, Luxembourg). Ultimately, we used the Ember/BP data for our multi-year comparisons due to it extending to 2020 (with IRENA's only going through 2019), and the Ember/BP data more clearly disaggregating fossil fuels into oil, gas, and coal (whereas IRENA had an additional category for fossil fuels 'not mentioned elsewhere' that sometimes held a substantial percentage of the share of electricity production). We still analyse good governance measures against both the IRENA and Ember/BP data sets for 2019 as a robustness check. Note that we seek to use the most recent data available for any analyses when possible. This is often 2020, but in some instances we use 2019, as just mentioned, due to data limitations. We clearly display the year of the data used in each analysis we provide.

3.2. Data analysis

Our analysis begins with a large series of correlations to establish the nature of the relationship between good governance and percentage of electricity production from each of the seven sources, each year from 2002 through 2020. In 2020 alone, this was assessed via each of the three measures of good governance (described at the start of the data collection section), and only by the WGI for 2002–2019. We then ran fixed effects repeated measures regressions to assess the extent to which good governance (WGI) scores across countries predicted percentage of electricity from each source, after accounting for changes over the years in percent electricity from that source.

Beyond bivariate relationships between electricity production and good governance, we sought to understand contribution of other political economy factors to electricity production. We first explored correlations between electricity production and GDP, GDP *per capita*, percentage of population at the national poverty line, consumption/income *per capita*, and the Gini index (measure of inequality in income distribution). All data were obtained from the World Bank [77,78]. Due to variations in economic data availability, country sample sizes for these correlations ranged from 101 to 189.

We only included data for these political economy factors for 2019, due to lack of data for many countries for certain years. Furthermore, because data only existed every five years or so for the poverty and inequality indicators for many countries, with the year of availability varying, we took available values on these indicators from 2015 to 2020 to use as proxy values for 2019, if there was not data for 2019 specifically. We chose the closest year to 2019 for which data was available. Following the exploratory correlation work, we analysed the relative contribution of good governance and the economic measures together in multiple linear regressions, with each source of electricity as a separate dependent variable in each regression.

3.3. Limitations

This research is novel and fills a notable academic gap, due to analysing patterns and trends across seven energy sources, 198 countries, and nineteen years. Nevertheless, the scale of data analysis precludes delving into the specifics of individual countries. As discussed in the literature review, a number of studies already take this approach. Whilst there are certainly many additional countries for which such in-depth investigation into the political economy factors shaping energy production could be valuable, that objective is separate from this study. In no way do this study's objectives seek to downplay or negate the important role played by context-specific local conditions in shaping energy systems and energy choices. This research is, however, looking at broad patterns and trends, to see if certain clear messages emerge globally about the relationship between good governance and electricity production choices, despite the noise created by context-specific idiosyncrasies.

A second limitation that must be acknowledged is that of missing data. Whilst some excellent data sets come together in this research, no data set can be expected to include every country in the world, for every year, and not have missing values. Especially when the analysis moves beyond bivariate relationships to multivariate analysis, the sample size drops (e.g., to 110 countries in the linear regression), due to the cumulative effect of some countries having missing values on one variable and other countries having missing data for other variables. It is certainly possibly that in these analyses with lower samples sizes there may be some inherent bias, in that countries in which data collection is of poor quality or difficult to conduct or access could vary systematically from other countries in terms of their energy choices and options. Nevertheless, the research still includes a sample size of over one hundred geographically and socio-economically diverse countries in every analysis. Furthermore, the results of the analyses with large sample sizes (e.g., 198) can be compared to the other results to help inform perspectives on whether systematic differences in the samples may exist.

A final limitation relates not to the data that is missing, but the data that is present. The study uses as its core independent variable robust indicators of quality of domestic governance globally. This is a composite measure that includes a number of important characteristics. These measures are systematically assessed and compiled by teams of experts, but in this study, they are something of a black box. Little can be known about the mechanisms that condition exactly how good (or poor) governance might be driving domestic policies, incentives, investment, or approaches to electricity production. All of these questions are worthy objects of future study, but as with the first limitation, are more appropriate for research focused on one country or a small set of countries.

4. Results

4.1. Good governance and sources of electricity production

Fig. 2 displays that the relationship between good governance and percentage of electricity production was clearly stronger for some sources of energy (nuclear, wind, solar hydro) than for others (gas, oil, coal). Wind, nuclear, and solar are all continuously positively associated with good governance, whilst hydropower is negatively associated with good governance for all 19 years in our sample.

Table 4 details the correlations and level of significance in each year for each energy source. Wind, nuclear, and hydro always have significant correlations; oil and gas never have significant correlations; the correlations for solar are significant except for in 2002, 2006, and 2007; and the correlations for coal are significant except for in 2017–2020.

In addition to differences across energy sources, some temporal trends are evident. The extent to which a relationship exists between electricity production from a certain source and good governance increases over time (higher absolute value) for wind and solar, and decreases over time for hydro, nuclear, and coal. Fig. 2 and Table 4 show that wind and solar become more strongly associated with good governance, nuclear and coal become less associated with good governance, and hydro becomes less associated with bad governance.

As a robustness check for our operationalisation of good governance via the WGI, we compared the 2020 correlations between the WGI and electricity production to correlations between the other two composite measures of good governance and electricity production from the various sources. The results are displayed in Table 5, where the only two instances in which notable variation occurred were that the FITW measure differed for hydropower and for gas. The WGI and WJP rule of law correlations with electricity production were highly consistent. The FITW score is the least comprehensive of the governance measures, and the data in Table 2 reveals FITW scores are more closely aligned with the ‘voice and accountability’ domain of the WGI than the full composite measure.

Our fixed effects repeated measures regressions assess, across the 19-years in our data set, the effect of good governance on percentage electricity production from the various sources, after controlling for year-to-year changes in production percentages. The standardised beta coefficients in Table 6 reveal the same relationships as the correlation data from Table 4 and from Fig. 1. The unstandardised beta estimates reveal the modelled difference in percentage production from each electricity source that could be expected from a one-unit increase in the

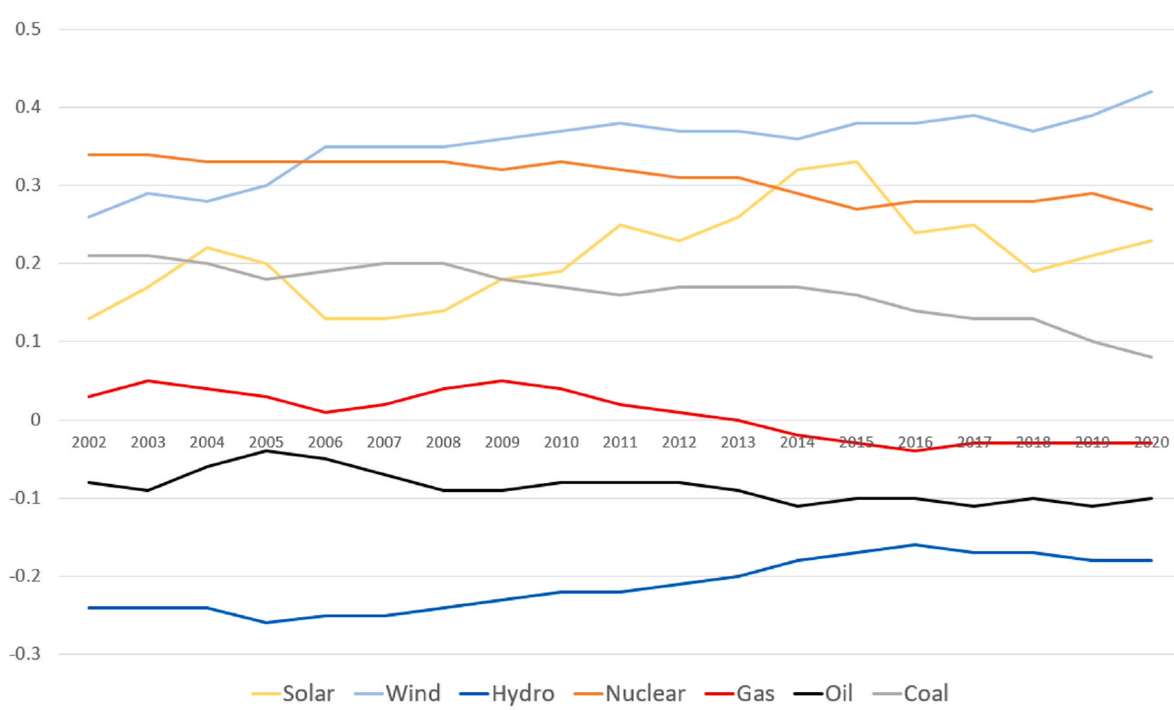

Fig. 2. Pearson bivariate correlations between percentage electricity production from each source and WGI, 2002–2020.

Table 4
WGI composite measure correlations with electricity percentages (2002–2020).

Year	solar	wind	hydro	nuclear	gas	oil	coal
2020 (n = 198)	0.23***	0.42***	−0.18**	0.27**	−0.03	−0.10	0.08
2019 (n = 198)	0.21**	0.39***	−0.18*	0.29***	−0.03	−0.11	0.10
2018 (n = 198)	0.19**	0.37***	−0.17*	0.28***	−0.03	−0.10	0.13
2017 (n = 197)	0.25***	0.39***	−0.17*	0.28***	−0.03	−0.11	0.13
2016 (n = 197)	0.24***	0.38***	−0.16*	0.28***	−0.04	−0.10	0.14*
2015 (n = 197)	0.33***	0.38***	−0.17*	0.27***	−0.03	−0.10	0.16*
2014 (n = 197)	0.32***	0.36***	−0.18*	0.29***	−0.02	−0.11	0.17*
2013 (n = 198)	0.26***	0.37***	−0.20**	0.31***	−0.00	−0.09	0.17*
2012 (n = 198)	0.23**	0.37***	−0.21**	0.31***	0.01	−0.08	0.17*
2011 (n = 198)	0.25***	0.38***	−0.22**	0.32***	0.02	−0.08	0.16*
2010 (n = 198)	0.19**	0.37***	−0.22**	0.33***	0.04	−0.08	0.17*
2009 (n = 198)	0.18*	0.36***	−0.23**	0.32***	0.05	−0.09	0.18**
2008 (n = 196)	0.14*	0.35***	−0.24***	0.33***	0.04	−0.09	0.20**
2007 (n = 197)	0.13	0.35***	−0.25***	0.33***	0.02	−0.07	0.20**
2006 (n = 197)	0.13	0.35***	−0.25***	0.33***	0.01	−0.05	0.19**
2005 (n = 197)	0.20**	0.30***	−0.26***	0.33***	0.03	−0.04	0.18*
2004 (n = 197)	0.22**	0.28***	−0.24***	0.33***	0.04	−0.06	0.20**
2003 (n = 192)	0.17*	0.29***	−0.24***	0.34***	0.05	−0.09	0.21**
2002 (n = 192)	0.13	0.26***	−0.24***	0.34***	0.03	−0.08	0.21**

Table 5
Relationship between good governance, low-carbon electricity production, and fossil fuels (2020).

Indicator	solar	wind	hydro	nuclear	gas	oil	coal
WJP overall score (n = 128)	0.26**	0.50***	−0.25**	0.33***	0.02	−0.13	0.03
FITW overall score (n = 185)	0.25***	0.41***	−0.10	0.28***	−0.22**	−0.01	0.05
WGI composite measure (n = 198)	0.23***	0.42***	−0.18**	0.27**	−0.03	−0.10	0.08

Table 6
Fixed effects repeated measures regressions for effect of good governance on percentage electricity production by source, (n = 3740[a]).

Dependent variable[b]	R^2 change[a]	unstandardised beta coefficient	standardised beta coefficient	significance
Solar (%)	0.022	0.28	0.15	0.000
Wind (%)	0.095	1.53	0.31	0.000
Hydropower (%)	0.045	−7.45	−0.21	0.000
Nuclear power (%)	0.096	4.11	0.31	0.000
Coal (%)	0.028	4.12	0.17	0.000
Natural gas (%)	0.000	0.20	0.01	0.699
Oil (%)	0.007	−3.53	−0.09	0.000

[a] Sample size is based on 19 observations each for 198 countries, with 22 missing data points.
[b] Change in R^2 value (effect size), after controlling for year-to-year variation.

WGI composite measure of good governance (measured on a five-point scale, from −2.5 to 2.5). For example, on average, after controlling for changes in production across time, a one-unit increase in WGI score equates to 1.53 % more of total electricity production in a country coming from wind energy, or 7.45 % less of total electricity production coming from hydropower, or 3.53 % less of total electricity production coming from oil.

4.2. *Electricity production and other political economy factors*

Our hypotheses focus on the effect of good governance on sources of electricity production, but governance dynamics do not exist in a vacuum. Table 7 presents the extent to which five factors beyond governance are associated with source of electricity production; the correlations with WGI are presented for comparison. Because the IRENA data showed some variation from the Ember/BP data, particularly for solar energy, we report correlations for the economic factors with both electricity production data sets. The message is generally clear that GDP *per capita* and consumption/income *per capita* have similar magnitude and direction of effects on source of electricity as good governance does. Higher *per capita* GDP and consumption/income values are associated

Table 7
GDP and poverty indicators, correlations with electricity percentages (2019).

Indicator	solar	wind	hydro	nuclear	gas	oil	coal
WGI composite (n = 198)	0.21**	0.39***	−0.18*	0.29***	−0.03	−0.11	0.10
	*0.17**	*0.41****	*−0.18**	*0.29****			
GDP (n = 189)	0.06	0.05	−0.04	0.09	0.02	−0.10	0.14
	0.05	*0.11*	*−0.09*	*0.18**			
GDP *per capita* (n = 189)	0.22**	0.36***	−0.16*	0.24***	0.18*	−0.18*	−0.04
	0.04	*0.36****	*−0.17**	*0.26****			
Gini Index (n = 124)	−0.04	−0.13	0.30***	−0.34***	−0.19*	0.08	−0.09
	0.06	*−0.14*	*0.29****	*−0.34****			
Consumption/income *per capita* (n = 101)	0.34***	0.44***	−0.22*	0.35***	0.14	−0.21*	−0.15
	0.15	*0.42****	*−0.24**	*0.35****			
% at national poverty line (n = 115)	−0.10	−0.21*	0.19*	−0.28**	−0.17	0.34***	−0.35***
	−0.05	*−0.24**	*0.25***	*−0.28***			

Note: Italics for solar, wind, hydro, and nuclear use the IRENA 2019 data. Non-italicised values are correlations with the Ember/BP data.

with higher percentages of production from solar, wind, and nuclear, but with a lower percentage from hydropower. The IRENA data, however, shows all the economic factors as having non-significance for solar, perhaps due to the larger number of small island states reported as having notable production of electricity from solar, compared with the Ember/BP data.

To examine the effects of good governance and the other political economic factors in concert, when controlling for each other, we ran a series of multiple linear regressions, reported in Table 8. This analysis reveals that good governance is particularly strong predictor of national percentage electricity production from wind. The Gini Index (measure of economic inequality) dominates amongst the four political economy factors for predicting percentage from hydropower and nuclear energy; more inequality predicts more hydropower and less nuclear energy. Percentage of the national population at the national poverty line is the leading predictor for percentage electricity production from coal and oil (more poverty associates with more oil and less coal). The regression models are weak for solar and natural gas, with no significant independent variables and a low effect size (R^2).

5. Discussion

The data confirm some of our expectations based on previous scholarship, but they also challenge other assumptions. The novelty in our findings does not come from an unexpected result, but rather from the comprehensiveness of our analysis, across seven energy sources, 198 countries, and nineteen years – allowing for the effects of governance on electricity production to be viewed systematically, holistically, and comparatively across political geography, means of production, and time.

The data support our hypotheses in relation to wind and solar (i.e., the new renewables at the forefront of electricity transitions); not only is the share of electricity production from these sources consistently associated with good governance, but also the magnitude of this relationship is increasing over time. As more countries become involved in solar and wind energy production, the share from these sources is growing most quickly in countries with robust governance systems. In 2002, 180 countries (out of 198 total) had no solar energy production and 157 had no wind energy production. This reduced to 49 countries with no solar energy production and 98 with no wind energy production in 2020. Several of the countries with the largest increases in solar production over the two decades also scored relatively high on good governance (e.g., Australia, Belgium, Chile, Cook Islands, Cyprus, Germany, Italy, Japan, Luxembourg, Malta, Mauritius, Netherlands, Spain, and Réunion). The increases in solar production are displayed in Fig. 3; compare this with Fig. 1 for countries with good (or poor) governance. The case was similar for wind, but the countries with the largest increases in wind production had even higher WGI scores, as seen in Fig. 4 (e.g., Aruba, Belgium, Denmark, Estonia, Finland, Germany, Ireland, Lithuania, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom, and Uruguay).

The hypothesis about hydropower was also supported; prior research linked hydropower projects to corruption [33], deficits in legitimacy [50], and potential for a resource curse [48]; this seems supported in the data. Furthermore, the linear regression data from Table 8 reveal that economic inequality, via the Gini coefficient, has an even stronger association with hydropower production than governance does, and likely shares variance with poor governance (due to governance becoming a non-significant predictor in the regression). Causality is open to debate here; it could be that poor governance facilitates hydropower production, which in part fosters additional economic inequality. This is consistent with lack of transparency, accountability, and limited decentralisation of authority being linked to special interests, status quo, and low opportunity for electricity transitions [8,39–41].

Despite the negative association between hydropower and good governance, we see a slight but continuous decrease in the magnitude of this relationship (from a correlation of −0.24 in 2002 to −0.18 in 2020). A number of countries that obtained considerable proportions of their electricity from hydropower in 2002 decreased in their share of electricity from hydropower by 2020, as indicated in Fig. 5. Several of these countries scored low on the WGI (e.g., Argentina, Belize, Bolivia, Brazil, Burundi, Cameroon, Congo, Haiti, Kenya, Laos, Madagascar, Mali, Mozambique, Tanzania, Togo, and Vietnam).

The findings for nuclear both contradict and support the conflicting assessments that have been offered in previous research on the political economy of nuclear energy. Although some research has associated nuclear power with lack of at least certain components of good governance [18,52], more recent work using a larger sample of countries has shown a clear positive relationship between presence of electoral democracy and use of nuclear power [34].

Ting and Lin [34], nevertheless, also reveal a negative relationship between civil society participation and percentage of electricity production from nuclear energy. Our findings do not support this; the WGI sub-metric of voice and accountability and the World Justice Project sub-metric of open government are the clearest measurements of civil society participation in our data set. These indicators have correlations of 0.28 and 0.39 respectively with percentage of electricity production from nuclear power. Furthermore, the linear regression in Table 8 reveals that economic *equality* (via the Gini coefficient) has an even stronger association with nuclear energy production than good governance does. Nuclear energy production is more likely in countries with more equal societies. This is not necessarily surprising, considering the identities of many of the countries with considerable levels of nuclear power.

Only 34 of the 198 countries in our sample produced any electricity from nuclear power. If only analysing the sub-sample of 34 countries, the correlation with good governance (WGI) is still positive (0.25 in 2020), although no longer significant, due to the reduced sample size. Nevertheless, even the reduced sample has a significant positive correlation with civil society participation via the voice and accountability indicator (0.34 in 2020). It is clear that countries with nuclear power production on aggregate tend towards better than average governance. For example, of the top 20 nuclear power producers in 2020 (by percentage of domestic electricity production), only three had negative WGI scores (on a scale of −2.5 to 2.5). Six of these top 20 nuclear producers were also amongst the top 20 out of all 198 on their WGI scores (i.e., Finland, Switzerland, Sweden, Canada, Germany, and the UK). The connection between nuclear power production and good governance is

Table 8
Linear Regressions for factors predicting percentage electricity production by source, 2019 (n = 110).

Dependent variable[a]	WGI composite	GDP *per capita*	Gini index	% at national poverty line	R^2 (adj.)
Solar (%)	0.23	0.16	0.10	0.02	0.08
Wind (%)	**0.40****	0.23	0.05	0.06	0.29
Hydropower (%)	−0.11	0.10	**0.33****	−0.01	0.08
Nuclear power (%)	0.24	−0.01	**−0.25***	−0.05	0.15
Coal (%)	−0.12	−0.20	−0.05	**−0.46*****	0.16
Natural gas (%)	−0.28	0.16	−0.13	−0.18	0.03
Oil (%)	0.10	−0.23	−0.15	**0.38*****	0.12
Solar (%)	0.28	−0.08	0.17	−0.02	0.02
Wind (%)	**0.47****	0.14	0.03	0.05	0.28
Hydropower (%)	−0.16	0.11	**0.29****	0.05	0.09
Nuclear power (%)	0.24	−0.01	**−0.25***	−0.05	0.15

Note: values in cells are standardised beta coefficients; **bold** beta values are significant: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.
[a] The first set of seven regressions uses the Ember/BP data for the dependent variables, the latter set of four regressions uses the IRENA data.

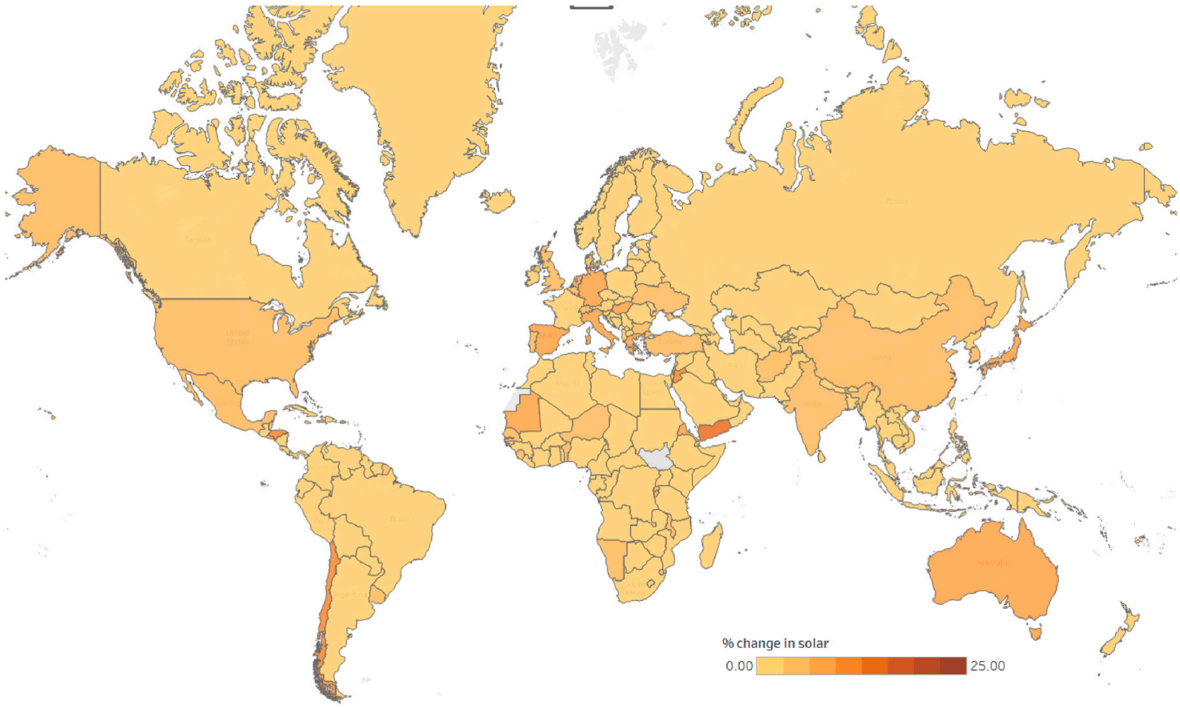

Fig. 3. Increase in electricity production from solar energy, 2002–2020.

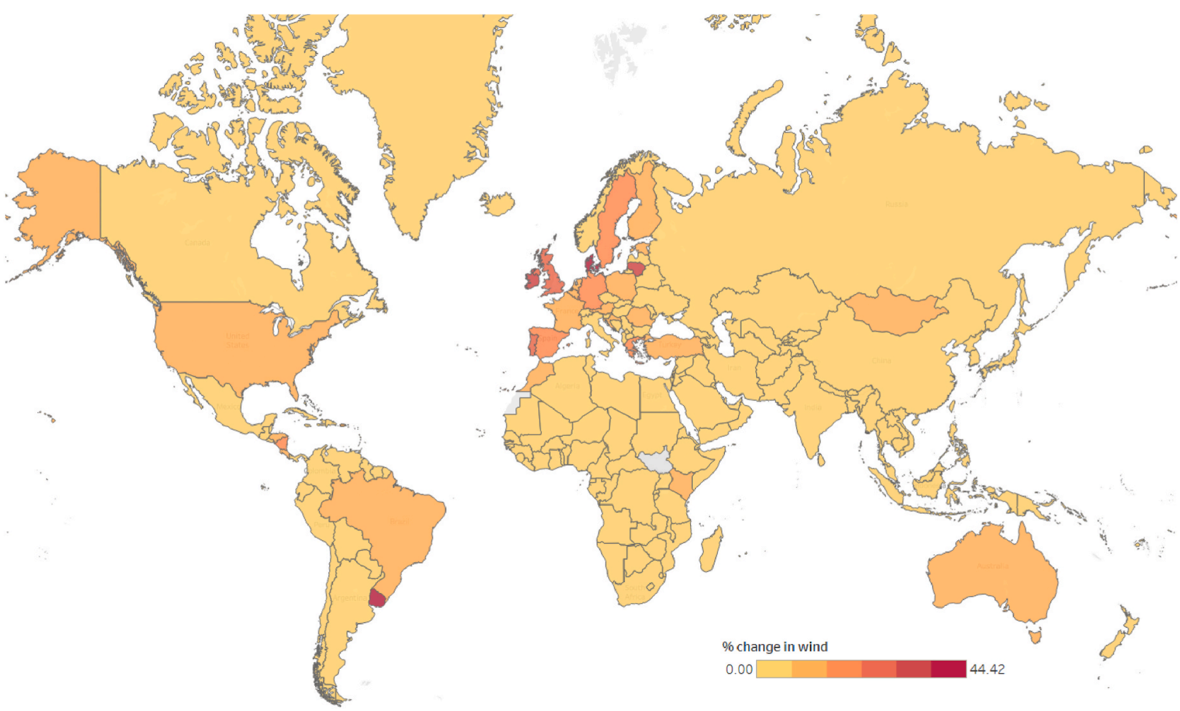

Fig. 4. Increase in electricity production from wind energy, 2002–2020.

robust, but is decreasing, as indicated in Fig. 2. Several countries with particularly high good governance scores reduced their percentage of electricity from nuclear over the 19-year period of our analysis (e.g., Switzerland, Sweden, Germany, Japan, UK, Taiwan, Belgium, France, Lithuania, and South Korea). Conversely, three of the six countries to increase their share of nuclear power by 5 % or more from 2002 to 2020 had notably low governance scores (i.e., Pakistan, Russia, and Ukraine).

The story for all three fossil fuels in our analysis is more mixed and muddled. There are few significant relationships between electricity production from these fuels and good governance. We hypothesised a weak negative relationship – due to resource curse research on oil and gas, but other studies questioning the existence of such a curse. In 2017–2020, we see no significant correlations with governance for any of the fossil fuels. Nevertheless, percentage electricity generation from oil has a negative relationship with good governance across all 19 years – never with a significant correlation within a single year, but the association is significant in the fixed effects repeated measures regression, due to the larger sample size. Electricity production from oil also has a

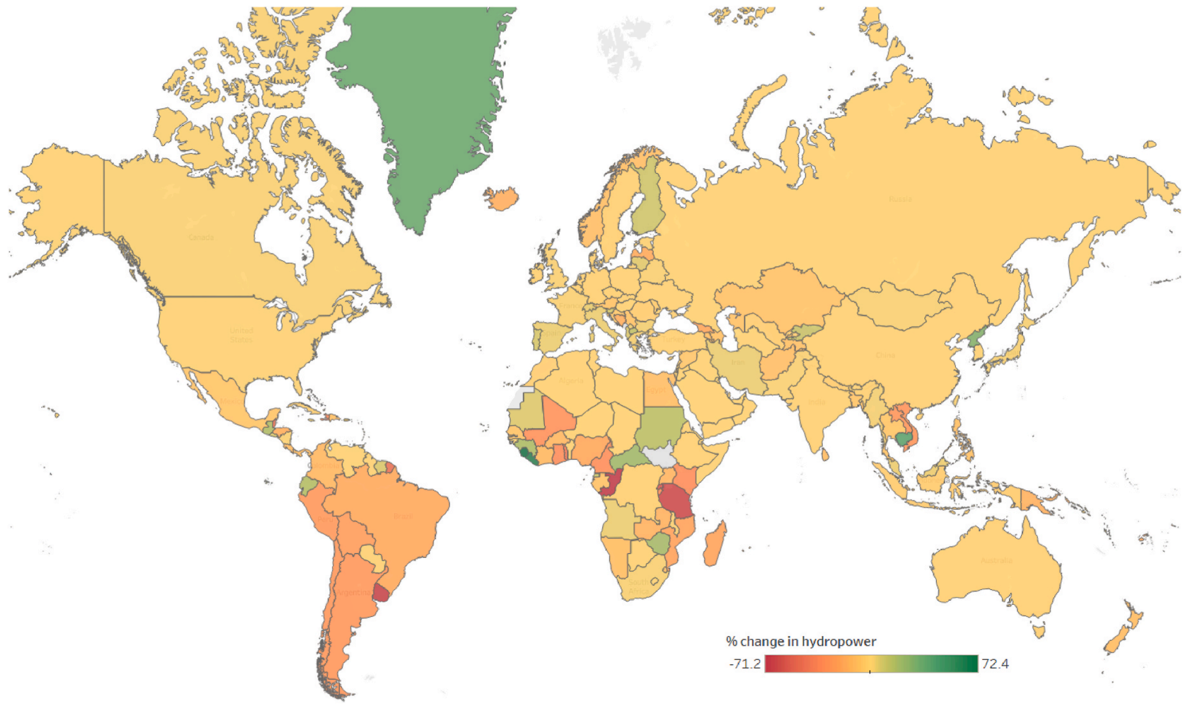

Fig. 5. Change in electricity production from hydropower, 2002–2020.

strong positive relationship with the percentage of a country's population living below the national poverty line, revealed in Table 8; that is, reliance on oil corresponds with increased poverty. This suggests potential recursive feedback loops between poor governance, corruption, concentration of power and wealth, and energy system choices.

Significant positive correlations, nevertheless, exist between good governance and coal electricity production in 2002–2016. It is likely history plays a notable role here [31], with fossil fuel resource availability also strongly shaping domestic production choices. Institutional and discursive lock-in has been shown to strongly influence maintained electricity generation from coal [79–81]. Such lock-in might also explain at least some of the strong negative association between percentage below the national poverty line and electricity production from coal in Table 8. We caution against any causal attribution here, perhaps beyond acknowledging that some countries with reasonably strong governance scores have struggled to phase out coal (e.g., Australia, Hong Kong, Taiwan, Czechia, South Korea, Japan, Slovenia, Mauritius, Germany, Chile, and the United States [82]). We should remain cognisant, nonetheless, of the consistent decrease in the positive relationship between good governance and coal-fired electricity production over time. Perhaps efforts such as the Powering Past Coal Alliance are starting to realise results [83].

6. Conclusion

The findings paint a more complete picture of the relationship between governance systems and energy production than has been afforded to date. Of course, the systematic analysis and breadth of the sample of countries and energy sources restricts our ability for granular investigations into the specifics of individual countries. In this sense, the research offers a point of departure for examining individual countries further. For example, particularly valuable in-depth domestic analyses might look at the countries that showed the largest increases in solar or wind over the two decades in this research. What aspects of good governance are shaping the electricity transition in these countries, and how? The reverse transition could also be beneficial for a full understanding of transitions; for example, what governance dynamics are at play in countries shifting away from coal and nuclear? Especially in relation to solar, additional research on transitions in specific countries could allow for understanding of the far lower correlation between the Ember/BP data and the IRENA data, which would then offer clarity on the nature of solar energy transitions in small island states and their relationship with domestic governance.

This study did not seek to explore specifics of individual countries – this has been competently performed many times elsewhere (see introduction) – nor did it seek to contest the important role of local circumstances in electricity transitions. Instead, the purpose of this research was to elucidate, in spite of the important contextual variations between countries, what patterns were still manifest between good governance and electricity transitions.

The broad patterns revealed herein offer strong cues as to how countries may develop in their renewable and low-carbon energy programmes in the years and decades to come. Of course, contextual/material factors and intricate understandings of unique domestic socio-political and economic dynamics and history are necessary for a full awareness of a country's energy path and trajectory. Also required is follow-up analysis of the extent to which the trends revealed in this study continue into the future. Will the increasing positive association between wind and solar and good governance continue to increase? Will it plateau? Will it eventually decline as early adopters level out in their percentage share of these technologies, and other nations with weaker governance catch up in the transition? This further analysis, providing a longer time scale to the 19-years assessed in this study, would also offer indications of which nations are driving the observed relationships between governance and electricity production.

Even the data in this study, however, offer a point of departure for assessing how certain types of governance systems might predispose countries to particular energy choices, with clear implications for future research on political economy, governance, and policy. It is encouraging that countries with good governance are expanding use of wind and solar, and at an increasing rate. However, the other side of this relationship suggests that countries with a leading role in wind and solar deployment might need to work to devise incentive structures (resistant to poor governance and corruption) to help increase solar and wind deployment in countries with weak governance. Climate change mitigation efforts obviously span more sectors than energy alone, and energy involves much beyond electricity generation; nevertheless, in this one area, there is still substantial opportunity for reducing emissions. A global effort will rely, however, on participation in the transition from a broad constellation of countries.

Credit author statement

Darrick Evensen: Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing – original draft; Writing – review & editing. Benjamin Sovacool: Conceptualization; Project administration; Investigation; Methodology; Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All of the data used is secondary data that are publicly available on the Internet. We clearly identify the sources for our data.

References

[1] Greco M, Germani F, Grimaldi M, Radicic D. Policy mix or policy mess? Effects of cross-instrumental policy mix on eco-innovation in German firms. Technovation; 2020, 102194.
[2] Kern F, Kivimaa P, Martiskainen M. Policy packaging or policy patching? The development of complex energy efficiency policy mixes. Energy Res Social Sci 2017;23:11–25.
[3] Kivimaa P, Kern F. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. Res Pol 2016;45(1):205–17.
[4] Rogge KS, Reichardt K. Policy mixes for sustainability transitions: an extended concept and framework for analysis. Res Pol 2016;45(8):1620–35.
[5] Lamb WF, Antal M, Bohnenberger K, Brand-Correa LI, Müller-Hansen F, Jakob M, Sovacool BK. What are the social outcomes of climate policies? A systematic map and review of the ex-post literature. Environ Res Lett 2020;15(11):113006.
[6] Breetz H, Mildenberger M, Stokes L. The political logics of clean energy transitions. Bus Polit 2018;20(4):492–522.
[7] Lockwood M, Kuzemko C, Mitchell C, Hoggett R. Historical institutionalism and the politics of sustainable energy transitions: a research agenda. Environ Plan C Politics Space 2017;35(2):312–33.
[8] Rothfuß E, Boamah F. Politics and (Self)-Organisation of electricity system transitions in a global north–south perspective. Polit Govern 2020;8(3):162–72.
[9] Scrase I, Smith A. The (non-) politics of managing low carbon socio-technical transitions. Environ Polit 2009;18(5):707–26.
[10] Florini A, Sovacool BK. Bridging the gaps in global energy governance. Global Governance 2011:57–74.
[11] Goldthau A, Sovacool BK. The uniqueness of the energy security, justice, and governance problem. Energy Pol 2012;41:232–40.
[12] McGowan F. Policy learning or politics as usual? Explaining the rise and retrenchment of renewable electricity support policies in Europe. Environ Polit 2020;29(4):589–608.
[13] Schaffer LM, Bernauer T. Explaining government choices for promoting renewable energy. Energy Pol 2014;68:15–27.
[14] Stern PC, Sovacool BK, Dietz T. Towards a science of climate and energy choices. Nat Clim Change 2016;6(6):547–55.
[15] Stirling A. Transforming power: social science and the politics of energy choices. Energy Res Social Sci 2014;1:83–95.
[16] Hanna P, Vanclay F, Langdon EJ, Arts J. The importance of cultural aspects in impact assessment and project development: reflections from a case study of a hydroelectric dam in Brazil. Impact Assess Proj Apprais 2016;34(4):306–18.
[17] Crootof A, Shrestha R, Albrecht T, Ptak T, Scott CA. Sacrificing the local to support the national: politics, sustainability, and governance in Nepal's hydropower paradox. Energy Res Social Sci 2021;80:102206.
[18] Sovacool BK, Valentine SV. The socio-political economy of nuclear energy in China and India. Energy 2010;35(9):3803–13.
[19] Carafa L, Frisari G, Vidican G. Electricity transition in the Middle East and North Africa: a de-risking governance approach. J Clean Prod 2016;128:34–47.
[20] Dagnachew AG, Hof AF, Roelfsema MR, van Vuuren DP. Actors and governance in the transition toward universal electricity access in Sub-Saharan Africa. Energy Pol 2020;143:111572.
[21] Biehl J, Köppel J, Grimm M. Creating space for wind energy in a polycentric governance setting. Renew Sustain Energy Rev 2021;152:111672.
[22] Agnolucci P. Wind electricity in Denmark: a survey of policies, their effectiveness and factors motivating their introduction. Renew Sustain Energy Rev 2007;11(5): 951–63.
[23] Mey F, Diesendorf M. Who owns an energy transition? Strategic action fields and community wind energy in Denmark. Energy Res Social Sci 2018;35:108–17.
[24] Baker L, Newell P, Phillips J. The political economy of energy transitions: the case of South Africa. New Polit Econ 2014;19(6):791–818.
[25] Li FG, Pye S. Uncertainty, politics, and technology: expert perceptions on energy transitions in the United Kingdom. Energy Res Social Sci 2018;37:122–32.
[26] Munro PG. Energy political ecologies in the South Pacific: the politics of energy transitions in Vanuatu. Camb J Reg Econ Soc 2021;14(2):361–78.
[27] Haas T. Struggles in European Union energy politics: a Gramscian perspective on power in energy transitions. Energy Res Social Sci 2019;48:66–74.
[28] Huda MS. Autocratic power? Energy megaprojects in the age of democratic backsliding. Energy Res Social Sci 2022;90:102605.
[29] Liu C, Hale T, Urpelainen J. Explaining the energy mix in China's electricity projects under the belt and road initiative. Environ Polit 2022:1–23.
[30] Sovacool BK. An international comparison of four polycentric approaches to climate and energy governance. Energy Pol 2011;39(6):3832–44.
[31] Stephenson JR, Sovacool BK, Inderberg THJ. Energy cultures and national decarbonisation pathways. Renew Sustain Energy Rev 2021;137:110592.
[32] van de Graaf T, Sovacool BK. Thinking big: politics, progress, and security in the management of Asian and European energy megaprojects. Energy Pol 2014;74: 16–27.
[33] Sovacool BK, Walter G. Internationalizing the political economy of hydroelectricity: security, development and sustainability in hydropower states. Rev Int Polit Econ 2019;26(1):49–79.
[34] Ting YC, Lin TH. For security or sustainability? Investigating the global nexus of nuclear power, democracies, and civil society. Energy Res Social Sci 2021;81: 102284.
[35] World Bank. Worldwide governance indicators. 2022. Retrieved from: http://info.worldbank.org/governance/wgi/Home/Documents#wgiDataSources. [Accessed 15 May 2022].
[36] Leonard A, Ahsan A, Charbonnier F, Hirmer S. The resource curse in renewable energy: a framework for risk assessment. Energy Strategy Rev 2022;41:100841.
[37] Månsson A. A resource curse for renewables? Conflict and cooperation in the renewable energy sector. Energy Res Social Sci 2015;10:1–9.
[38] Sarpong SY, Bein MA. The relationship between good governance and CO2 emissions in oil-and non-oil-producing countries: a dynamic panel study of sub-Saharan Africa. Environ Sci Pollut Control Ser 2020;27(17):21986–2003.
[39] Brisbois MC. Decentralised energy, decentralised accountability? Lessons on how to govern decentralised electricity transitions from multi-level natural resource governance. Global Transitions 2020;2:16–25.
[40] Brisbois MC. Shifting political power in an era of electricity decentralization: rescaling, reorganization and battles for influence. Environ Innov Soc Transit 2020; 36:49–69.
[41] Scott A, Seth P. The political economy of electricity distribution in developing countries. Overseas Development Institute; 2013.
[42] Kortetmäki T, Huttunen S. Responsibilities for just transition to low-carbon societies: a role-based framework. Environ Polit 2022:1–22.
[43] Bayulgen O, Ladewig JW. Vetoing the future: political constraints and renewable energy. Environ Polit 2017;26(1):49–70.
[44] Baker L, Phillips J. Tensions in the transition: the politics of electricity distribution in South Africa. Environ Plan C Politics Space 2019;37(1):177–96.
[45] Cantarero MMV. Of renewable energy, energy democracy, and sustainable development: a roadmap to accelerate the energy transition in developing countries. Energy Res Social Sci 2020;70:101716.
[46] Burke MJ, Stephens JC. Energy democracy: goals and policy instruments for sociotechnical transitions. Energy Res Social Sci 2017;33:35–48.
[47] Szulecki K, Overland I. Energy democracy as a process, an outcome and a goal: a conceptual review. Energy Res Social Sci 2020;69:101768.
[48] Hancock KJ, Sovacool BK. International political economy and renewable energy: hydroelectric power and the resource curse. Int Stud Rev 2018;20(4):615–32.
[49] Sovacool BK, Cooper CJ. The governance of energy megaprojects: politics, hubris and energy security. Edward Elgar Publishing; 2013.
[50] Foran T, Kiik L, Hatt S, Fullbrook D, Dawkins A, Walker S, Chen Y. Large hydropower and legitimacy: a policy regime analysis, applied to Myanmar. Energy Pol 2017;110:619–30.
[51] Alsaleh M, Abdul-Rahim AS. The nexus between worldwide governance indicators and hydropower sustainable growth in EU 28 region. Int J Environ Res 2021;15(6): 1001–15.
[52] Valentine SV, Sovacool BK. The socio-political economy of nuclear power development in Japan and South Korea. Energy Pol 2010;38(12):7971–9.
[53] Yang J, Rizvi SKA, Tan Z, Umar M, Koondhar MA. The competing role of natural gas and oil as fossil fuel and the non-linear dynamics of resource curse in Russia. Resour Pol 2021;72:102100.
[54] Mori A. Impact of the China-induced coal boom in Indonesia: a resource governance perspective. China's Clim-Energy Pol: Dom Int Impacts 2018:167–97.
[55] Bilgin M. Energy security and Russia's gas strategy: the symbiotic relationship between the state and firms. Commun Post Commun Stud 2011;44(2):119–27.
[56] Colgan JD. Oil, domestic politics, and international conflict. Energy Res Social Sci 2014;1:198–205.
[57] Nyman E. Offshore oil development and maritime conflict in the 20th century: a statistical analysis of international trends. Energy Res Social Sci 2015;6:1–7.
[58] Poncian J, Jose J. National resource ownership and community engagement in Tanzania's natural gas governance. Energy Pol 2019;133:110903.
[59] Gamarra AR, Lechón Y, Escribano G, Lilliestam J, Lázaro L, Caldés N. Assessing dependence and governance as value chain risks: natural Gas versus Concentrated Solar power plants in Mexico. Environ Impact Assess Rev 2022;93:106708.

[60] Hoffmann C. Beyond the resource curse and pipeline conspiracies: energy as a social relation in the Middle East. Energy Res Social Sci 2018;41:39–47.
[61] Marques AC, Pires PS. Is there a resource curse phenomenon for natural gas? Evidence from countries with abundant natural gas. Resour Pol 2019;63:101466.
[62] Weber JG. A decade of natural gas development: the makings of a resource curse? Resour Energy Econ 2014;37:168–83.
[63] Pérez-Sindín XS. Are energy megaprojects socially disruptive? Assessing the impacts of the As Pontes fossil fueled power plant in Spain. Energy Res Social Sci 2021;80:102229.
[64] Lord A. Citizens of a hydropower nation: territory and agency at the frontiers of hydropower development in Nepal. Econ Anthropol 2016;3(1):145–60.
[65] Diamond S, Poirier C. Brazil's native peoples and the Belo Monte Dam: a case study. NACLA Rep Am 2010;43(5):25–9.
[66] Pulice S, Paiva M, Moretto E. The financial compensation and the development of Brazilian municipalities flooded by hydroelectric dams. Ambiente Sociedade 2017;20:103–26.
[67] Heming L, Waley P, Rees P. Reservoir resettlement in China: past experience and the three gorges dam. Geogr J 2001;167(3):195–212.
[68] Wang P, Wolf SA, Lassoie JP, Dong S. Compensation policy for displacement caused by dam construction in China: an institutional analysis. Geoforum 2013;48:1–9.
[69] Delang CO, Toro M. Hydropower-induced displacement and resettlement in the Lao PDR. S East Asia Res 2011;19(3):567–94.
[70] Grumbine RE, Dore J, Xu J. Mekong hydropower: drivers of change and governance challenges. Front Ecol Environ 2012;10(2):91–8.
[71] Larsen SV, Hansen AM, Lyhne I, Aaen SB, Ritter E, Nielsen H. Social impact assessment in Europe: a study of social impacts in three Danish cases. J Environ Assess Pol Manag 2015;17(4):1550038.
[72] World Justice Project (WJP). WJP rule of law index 2021. 2021. Retrieved from, https://worldjusticeproject.org/our-work/research-and-data/wjp-rule-law-index-2021. [Accessed 15 May 2022].
[73] Freedom House. Freedom in the world research methodology. 2022. Retrieved from, https://freedomhouse.org/reports/freedom-world/freedom-world-research-methodology. [Accessed 15 May 2022].
[74] Ember. Global electricity review 2022. 2022. Retrieved from: https://ember-climate.org/insights/research/global-electricity-review-2022/. [Accessed 15 May 2022].
[75] BP. BP statistical review of world energy. 2021. July 2021, 70th edition. Retrieved from, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html. [Accessed 15 May 2022].
[76] Our World in Data. Share of electricity production by source. 2022. Retrieved from: https://ourworldindata.org/grapher/share-elec-by-source. [Accessed 15 May 2022].
[77] World Bank. Data: poverty. 2022. Retrieved from: https://data.worldbank.org/topic/poverty. [Accessed 15 May 2022].
[78] World Bank. Data: economy & growth. 2022. Retrieved from: https://data.worldbank.org/topic/economy-and-growth?view=chart. [Accessed 15 May 2022].
[79] Leipprand A, Flachsland C. Regime destabilization in energy transitions: the German debate on the future of coal. Energy Res Social Sci 2018;40:190–204.
[80] Rentier G, Lelieveldt H, Kramer GJ. Varieties of coal-fired power phase-out across Europe. Energy Pol 2019;132:620–32.
[81] Trencher G, Healy N, Hasegawa K, Asuka J. Discursive resistance to phasing out coal-fired electricity: narratives in Japan's coal regime. Energy Pol 2019;132:782–96.
[82] Kalt T. Jobs vs. climate justice? Contentious narratives of labor and climate movements in the coal transition in Germany. Environ Polit 2021;30(7):1135–54.
[83] Blondeel M, Van de Graaf T, Haesebrouck T. Moving beyond coal: exploring and explaining the powering past coal alliance. Energy Res Social Sci 2020;59:101304.