Concept Note – Clean Electricity Equity Index (CEEI)

1. Introduction

The urgency of the current energy transition from a fossil-fuel based global economy to one powered by cleaner, low- to no-carbon sources has been emphasized in recent reports from climate scientists. An important dimension of this process is that, without specific efforts made to ensure an equitable transition, not everyone will benefit equally[1]. Despite the growing literature discussing the pace of the energy transition[2,3] and the variations in transition pathways and their positive and negative impacts on households[4], there is a key research gap in comprehensively exploring the spatial distribution of opportunities and burden associated with the transition. This gap extends to understanding how these factors might intersect with existing geographical patterns of socioeconomic inequality[5], especially in countries in the Global South.

Building upon the principles of energy transition[6], energy[7] and spatial justice theory[5], the primary focus of this research is to develop a dynamic and evidence-based spatial composite index – the clean electricity equity index (CEEI). This indicator aims to evaluate, on a fine-scale basis, the urgency, potential, and the available means and resources for a transition to renewable electricity. By identifying areas requiring an immediate transition, which are less likely to benefit from it, and where existing inequalities might be exacerbated, this indicator would facilitate more targeted investments in decentralized renewable electricity.

With just over five years until 2030, achieving SDG7 demands accelerated investments. In 2019, residential electricity funding fell short, less than a third of the required USD 41 billion annually for universal access by 2030[8]. Urgently increasing investments, especially for vulnerable populations, is crucial for a just transition, benefiting over 1 billion currently without access. The insights generated by the spatial composite index have the potential to be more purposeful, offering valuable support for development policies.

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[1] Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. *Nature Energy*, 5(8), 569-577.
[2] Sovacool BK. How long will it take? Conceptualizing the temporal dynamics of energy transitions. Energy research & social science. 2016 Mar 1;13:202-15.
[3] Fouquet R. Historical energy transitions: Speed, prices and system transformation. Energy research & social science. 2016 Dec 1;22:7-12.
[4] Markard J. The next phase of the energy transition and its implications for research and policy. Nature Energy. 2018 Aug;3(8):628-33.
[5] Garvey A, Norman JB, Büchs M, Barrett J. A "spatially just" transition? A critical review of regional equity in decarbonisation pathways. Energy Research & Social Science. 2022 Jun 1;88:102630.
[6] Fouquet R. Historical energy transitions: Speed, prices and system transformation. Energy research & social science. 2016 Dec 1;22:7-12.
[7] Jenkins K, McCauley D, Heffron R, Stephan H, Rehner R. Energy justice: A conceptual review. Energy Research & Social Science. 2016 Jan 1;11:174-82.
[8] Finance, E. (2020). Understanding the Landscape. Sustainable Energy for All: Vienna, Austria.

2. **Literature highlights: a brief overview**
   a. **Energy transition, energy justice and 'spatially just' transition**

The literature on energy transition has expanded significantly, initially concentrating on the speed of transition. As it progressed, the focus shifted to examining diverse transition pathways and the dual impacts—positive and negative—on households. Beyond recognizing that transitions are multi-dimensional[9], involving socio-economic, political and technological changes, this evolution underscores that transitions result in winners and losers, emphasizing the crucial importance of considering inclusivity and distributional aspects in the transition process[1].

The literature on energy justice, a distinct branch of environmental justice, focuses on assessing equitable energy systems throughout the lifecycle. It advocates for affordable, safe, and sustainable energy access, inclusive decision-making, and recognition of historical inequalities. Core tenets of the literature include distributional (focusing on the distribution of benefits and burdens across populations), procedural (exploring who is included in energy decision-making processes), and recognition justice (understanding of historic and ongoing inequalities, and prescribes efforts that seek to reconcile these inequalities). Pulling from these tenets, the literature indicates that assessing energy justice should include, aspects related to availability, access, affordability and intra-generational equity, among others[1].

Based on the above, several scholars have empirically assessed ways in which the energy transition is already affecting adversely communities around the world. The effects are frequently expressed as excessive burden or a lack of access to energy transition opportunities[1].

For the first type of effect, studies show that communities, especially those of colour and lower incomes, often bear the negative externalities of energy technologies, such as noise disruptions from wind turbines or pollution from landfill facilities[10]. Despite the environmental benefits, the decline in carbon-intensive energy resources might also lead to job losses, economic downturns, and social disruptions in regions heavily dependent on industries like coal mining[11]. Studies have also stressed that renewable investments in developing countries are currently insufficient to meet the required scale of change. The existing energy supply gap, coupled with financial constraints, as well as the higher capital costs and low-capacity factors associated with renewable energy sources, may lead to elevated energy costs. This, in turn, could worsen the already significant issue of unmet energy demand, further restricting affordable access to energy. These challenges may intensify trade-offs, such as facing 'heat or eat' financial decisions. [12,1]

For the second, scholars have focused on the regional and spatial aspects of the justice implications associated with the energy transition. The shift toward more efficient and lower-carbon energy resources creates job opportunities, but the employment distribution is often imbalanced. Additionally, decision-making procedures related to the energy transition often lack inclusivity, especially concerning communities hosting new infrastructure such as solar

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[9] Chapman A, Shigetomi Y, Ohno H, McLellan B, Shinozaki A. Evaluating the global impact of low-carbon energy transitions on social equity. Environmental Innovation and Societal Transitions. 2021 Sep 1;40:332-47.
[10] Welton S, Eisen J. Clean energy justice: charting an emerging agenda. Harv. Envtl. L. Rev.. 2019;43:307.
[11] Ruppert Bulmer E, Pela K, Eberhard-Ruiz A, Montoya J. Global perspective on coal jobs and managing labor transition out of coal.
[12] Heras A, Gupta J. Fossil fuels, stranded assets, and the energy transition in the Global South: A systematic literature review. Wiley Interdisciplinary Reviews: Climate Change. 2023:e866.

panels and wind turbines. The lack of universal access to these technologies can be attributed to high upfront costs, eligibility criteria based on credit and tax payment, and misalignment with living conditions[1]. It is also important to highlight that the majority of existing literature on energy justice is qualitative, and empirical contributions often rely on case studies with a focus on developed countries [13].

Also related to energy justice, there is an understudied area concerning the interplay between urgency and justice. Policymakers are faced with growing urgency to act upon climate change, while at the same time, justice considerations are increasingly foregrounded in discussions on energy transition policies. A stock-taking paper suggests that three primary themes emerge from the limited literature: urgency and justice as trade-offs, urgency and justice reinforcing each other, and the urgency of addressing injustice in the energy system. However, a notable observation is that most scholars only provide brief considerations and reflections on this relationship, lacking detailed case studies or empirical applications. [14]

Another growing but still limited body of theoretical and empirical literature aims to investigate equity aspects in the transition using geographical lens – that is, considering its spatial and scalar implications. The concept of 'spatial justice' can be broadly defined as the fair geographic distribution of benefits and burdens associated with, and arising from, the low carbon transition[5]. For some scholars, concept of 'spatial justice' requires both the description and evaluation of spatial inequalities as well as an examination of the geographical processes through which these injustices are (re)produced. In this line of thinking, space is not a neutral container within which the social world 'happens' – rather, it is socially constructed through social relations and practices, and space in turn constitutes those very relationships and practices. Therefore, space not only provides a backdrop for the manifestation of inequalities, but also actively produces and maintains them. In addition, the dominant focus of previous research has been on the spatial dimensions of distributive justice[15].

When assessing the spatial scales considered in analyses of energy transition, a recent literature review has emphasized a consensus critique of the use of national scale assessment exclusively, with proposals for multi-scalar approaches (e.g., subnational) to more effectively identify issues of equity and justice[5]. Aggregating and averaging figures over units of political and material space both reveals and hides differences; justice in terms of distribution, procedure or recognition defined at one scale does not necessarily mean justice is achieved elsewhere. For example, analysis at the global or continental levels can demonstrate difference or similarity between nations states, but masks any disparities that exist within those nation states. Similarly, studies focusing solely on local-level inequalities can mask wider variations – for example, rates of energy access within a city may not display any clear spatial discrepancies and concentrations, but at a larger scale the urban centre as a whole might have a much greater overall access rate compared to other urban areas[14].

Also, a significant research gap mapped by several studies concerns the spatial implications of the transition for developing countries, especially regarding justice issues[1,5]. There is also a pressing need for the creation of concrete policy tools that extend beyond theoretical

[13] Apergi M, Eicke L, Goldthau A, Hashem M, Huneeus S, de Oliveira RL, Otieno M, Schuch E, Veit K. An energy justice index for the energy transition in the global South. Renewable and Sustainable Energy Reviews. 2024 Mar 1;192:114238.
[14] van Bommel N, Höffken JI. The urgency of climate action and the aim for justice in energy transitions–dynamics and complexity. Environmental Innovation and Societal Transitions. 2023 Sep 1;48:100763.
[15] Bouzarovski S, Simcock N. Spatializing energy justice. Energy Policy. 2017 Aug 1;107:640-8.

frameworks, aiming to seamlessly integrate spatial aspects for the empirical monitoring and assessment of equity dimensions in the transition[12].

b. Composite indices

Scholars emphasize the need for a multidimensional approach to comprehensively assess equity aspects in energy transitions, examining their diverse impacts across communities and stakeholders. Composite indices play a crucial role by deviating from one-dimensional measures and incorporating sub-indicators that integrate explicit factors into easily interpretable metrics. These factors encompass geographical/spatial disparities, socio-economic conditions, and environmental considerations, among others. Moreover, the utility of a composite index extends to three primary dimensions: policy monitoring, public communication, and the generation of rankings. Such indices are increasingly employed in the comparative analysis of territorial benchmarking, facilitating simple comparisons between spatial units, such as countries, regions, provinces, etc.[16]

Several composite indices have been developed particularly for the energy transition context. Indices such as the International Energy Agency's Energy Development Index (EDI)[17], the Multidimensional Energy Poverty Index (MEPI)[18], and the Sustainable Energy Development Index (SEDI)[19] link energy access and human development in different ways. The World Bank's Regulatory Indicators for Sustainable Energy benchmarks policies and regulatory frameworks at the country level on energy access, energy efficiency, and renewable energy[20]. The World Energy Council's Energy Trilemma Index[21] provides an assessment of countries' abilities to balance trade-offs between energy security, energy equity, and environmental sustainability. The Energy Security Index from Global Energy Institute[22] measures energy security risks for major energy consuming countries, and the Global Energy Vulnerability Index[23] combines metrics related to a country's energy intensity, carbon emissions, and degree of reliance on energy resources into a composite indicator to identify vulnerable regions and facilitate comparisons across regions.

Particularly on equity, a recent study[24] introduces a novel analytical framework also utilizing composite indexes to objectively and quantitatively assess social equity (i.e., people's quality of life) in the energy transition context for 99 countries over a 26-year period (1990–2015). The framework consolidates five indicators—energy cost, health, environmental improvement, employment, and participation—into a composite Energy-Related Social Equity (ESE) index. These indicators were selected based on prior research and stakeholder engagement conducted through nationally representative surveys, aiming to identify critical energy and

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[16] Baker E, Carley S, Castellanos S, Nock D, Bozeman III JF, Konisky D, Monyei CG, Shah M, Sovacool B. Metrics for Decision-Making in Energy Justice. Annual Review of Environment and Resources. 2023 Nov 13;48:737-60.
[17] International Energy Agency. World energy outlook. Paris: OECD/IEA; 2009.
[18] Nussbaumer P, Bazilian M, Modi V. Measuring energy poverty: Focusing on what matters. Renewable and Sustainable Energy Reviews. 2012 Jan 1;16(1):231-43.
[19] Iddrisu I, Bhattacharyya SC. Sustainable Energy Development Index: A multi-dimensional indicator for measuring sustainable energy development. Renewable and Sustainable Energy Reviews. 2015 Oct 1;50:513-30.
[20] World Bank, Regulatory indicators of sustainable energy, https://rise.esmap.org/
[21] World Energy Council, Energy Trilemma index, https://trilemma.worldenergy. org
[22] Global Energy Institute, Energy security risk index, https://www.globalenergyinstitute.org/energy-security-risk-index
[23] Gatto A, Busato F. Energy vulnerability around the world: The global energy vulnerability index (GEVI). Journal of Cleaner Production. 2020 Apr 20;253:118691.
[24] Nakaishi T, Chapman A, Kagawa S. Shedding Light on the energy-related social equity of nations toward a just transition. Socio-Economic Planning Sciences. 2022 Oct 1;83:101350.

social equity characteristics. Specifically, the participation indicator gauges citizens' access to modern energy services, while the health indicator assesses whether countries have achieved a society supported by clean energy, promoting good health. The environmental indicator evaluates the environmental friendliness of energy consumption, and the energy poverty indicator sheds light on the impact of energy prices on impoverished populations. Lastly, the employment indicator measures the effects of changes in energy prices and consumption structure on a country's economic aspects.

While the paper makes a commendable contribution to the existing literature, the analysis is aspatial, as it relies on national-level data, potentially concealing trends that might be occurring at the subnational scale.

3. Objectives/Scope

Rooted in the principles of energy transition, energy justice, and spatial justice theory, this research aims to evaluate the capacity and necessity of various geographical areas to transition to clean energy. Factors considered include clean electricity potential, available resources for a just transition, and the urgency of the transition. To encompass its multidimensional nature, equity metrics at the subnational scale are categorized into social, economic/financial, and environmental/technical dimensions and synthesized into a unified metric – the CEEI.

We focus on constructing the CEEI for African countries[25], with a special attention in Sub-Saharan Africa. This region hosts about 572 million people living without reliable access to electricity, nearly 57% of the global population currently living in the dark[26]. Achieving full electrification by 2030 requires an estimated annual investment of USD 17 billion, in addition to baseline investments [27]. If not addressed properly, energy-related interventions might exacerbate already existing vulnerabilities. While our initial emphasis is on Africa, it is important to highlight that the CEEI' framework can serve as a starting point for future improvements and region and country-specific efforts, depending on data availability.

The CEEI facilitates objective, standardized, quantitative comparisons of transition processes across countries at the subnational level, providing indication that particular areas are more vulnerable than others. This makes the index a powerful tool for policymakers and development practitioners to (i) identify and address issues for improving energy justice and guide policy interventions, and (ii) support a better targeting of decentralized electricity investments, particularly in renewables.

[25] Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Cote D'Ivoire, Cameroon, Democratic Republic of the Congo, Congo, Comoros, Cabo Verde, Djibouti, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Equatorial Guinea, Guinea-Bissau, Kenya, Liberia, Libya, Lesotho, Morocco, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Somalia, South Sudan, Swaziland, Seychelles, Chad, Togo, Tunisia, Tanzania, Uganda, South Africa, Zambia and Zimbabwe.
[26] https://data.undp.org/insights/achieving-universal-electricity-access/electricity-access-from-space
[27] Sahadevan, D., et al., SDG Push+ Accelerating universal electricity access and its effects on sustainable development indicators. UNDP, 2023.

4. Methodology

The CEEI will be built following established best practices guidelines on composite indexes[28]. The conceptual framework is the foundation for constructing a composite indicator, providing a structured and coherent basis for integrating diverse dimensions into a unified metric.

Based on an extensive but not exhaustive literature review, the conceptual framework of the CEEI is defined around the potential, available resources, and urgency of different geographical areas for conducting a just transition. The 'potential' component assesses the natural capacity of specific regions to harness clean electricity sources, such as solar and wind. 'Resources/means' identifies the capability of a population in a given area to independently transition to cleaner electricity, considering the means and resources at their disposal. The aspect of 'urgency' pinpoints specific areas where a transition is urgently needed, taking into account considerations of energy security and environmental sustainability.

Equity aspects are embedded throughout, grouped into three main dimensions: social, economic/financial, and environmental/technical. Each equity dimension has several indicators, which can be quantified and evaluated. For example, social can be assessed by examining trends in indicators related to employment, education and access to electricity, while environmental aspects are evaluated according to solar and wind power potential, available grid infrastructure, and carbon emissions.

Despite having a broad range of indicators under each equity dimension, the categorization is not perfect. Equity outcomes are highly interconnected, and as such, it is likely that certain indicators fall under more than one equity dimension. For instance, an energy-related intervention that enhances household access to electricity might have a compounding negative effect if renewable energy sources are not feasible from both technical and economic standpoints[29]. Thus, this framework is intended to serve as a simplified, flexible, and practical guide for stakeholders to quantitatively evaluate equity outcomes, and users can adapt it based on data availability, as well as regional and country needs.

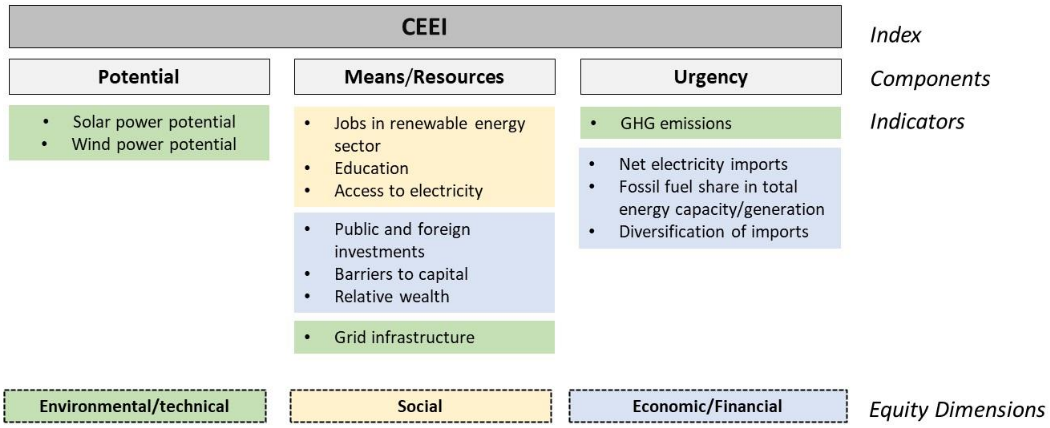
In the CEEI, justice is framed against its distributional and recognition tenets, involving the evaluation of the opportunities and burdens of transition, as well as the assessment of past and present disparities across space. This is primarily influenced by the nature of the data used in the CEEI (e.g., subnational).

Figure 1 presents, in details, the preliminary conceptual framework of the CEEI.

[28] Joint Research Centre-European Commission. (2008). Handbook on constructing composite indicators: methodology and user guide. OECD publishing.

[29] Kime S, Jacome V, Pellow D, Deshmukh R. Evaluating equity and justice in low-carbon energy transitions. Environmental Research Letters. 2023 Nov 17;18(12):123003.

Figure 1. Conceptual framework of the CEEI



The datasets utilized in generating the CEEI are detailed in Table 1. Throughout the identification process, priority has been given to datasets with broader coverage, including global or regional datasets that encompass the largest possible number of countries. Among the 13 indicators, seven include subnational-level data, available in various resolutions. Notably, most economic and financial-related datasets only provide data at the national level. Additional exploration of alternative datasets capable of providing data at a more refined spatial disaggregation will be undertaken prior to the calculation of the CEEI. Additional details on the conceptual framework, datasets, and the rationale for including the indicators are provided in Annex 1.

Table 1. Input data sources.

Dataset	Source	Spatial resolution	Temporal Resolution	Year used
Solar radiation	World Bank: https://globalsolaratlas.info/	250 m	Annual	2022
Wind speed	World Bank: https://globalwindatlas.info/en	250 m	Annual/Montly/Hour	2022
Jobs in renewable energy sector	IRENA: https://pxweb.irena.org/pxweb/en/IRENASTAT	-	Annual	2021
Education (from HDI)	UNDP: https://hdr.undp.org/content/subnational-human-development-index-moving-beyond-country-level-averages	Subnational (province)	Annual	2021
Public and foreign (aid) investments on renewable energy (per capita)	IRENA: https://pxweb.irena.org/pxweb/en/IRENASTAT; OECD: https://stats.oecd.org/Index.aspx?DataSetCode=crs1#	-	Annual	2021
Loans by households from commercial banks (% of GDP)	IMF: https://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C	-	Annual	2022
Relative Wealth Index	Meta: https://dataforgood.facebook.com/dfg/tools/relative-wealth-index	2.4 km	Annual	2021
Grid density	World Bank - Gridfinder: https://gridfinder.rdrn.me/	40 m	Annual	2020
High resolution energy access (HREA)	UNDP/University Michigan: https://geohub.data.undp.org/	Subnational (district)	Annual	2020
Net electricity imports (MwH, per capita)	World Bank: https://data.worldbank.org/indicator/EG.IMP.CONS.ZS	-	Annual	2015
Fossil fuel share of energy capacity and generation	IRENA: https://pxweb.irena.org/pxweb/en/IRENASTAT	-	Annual	2022
Diversification of import counterparts (Hirschman Herfindahl index)	World Bank: https://wits.worldbank.org/	-	Annual	2021
GHG Emissions	JRC/EC: https://edgar.jrc.ec.europa.eu/dataset_ghg70	~110 m	Annual/Monthly	2021

Note: all data sources listed are openly available online.

In addition to the conceptual framework, the construction of the CEEI includes data preparation, such as outlier treatment (used to reduce the effect of possibly spurious outliers), imputation of missing data (testing different algorithms) and normalisation (to ensure comparability between indicators that existed naturally at different scales and ranges).

Weighting and aggregation of the indicators are also critical steps of the process. Specifically, the review and definition of weights used in the CEEI will greatly benefit from expert consultations and stakeholder feedback, both within and outside UNDP. This collaborative approach aims to ensure the robustness and relevance of the index for policy and investment initiatives.

5. Expected outcomes

Beyond offering a flexible framework to assess equity aspects of the transition at a subnational scale, the CEEI database will be accessible as a geospatial application on Geohub, a cloud-based geospatial analytics tool developed by UNDP. This will enable users to perform advanced simulations and customizations of CEEI (uploading their own datasets and variables, changing weights, etc.). Serving as an open platform, it caters to policymakers, the private sector, and the broader development community.

6. Partnerships and Collaboration

The CEEI is an initiative currently under development by UNDP as part of the IBM Sustainability Accelerator environmental cohort. This initiative brings together experts and leverages innovative technologies to address urgent environmental challenges. Prioritizing the imperative transition to clean energy, this cohort focuses on supporting marginalized communities for fair and equitable access to sustainable energy resources. This aligns with the global goal of achieving UN SDG7 and makes a substantial contribution to the broader global energy transition. Additionally, the CEEI draws insights and expertise from Stony Brook University (SBU), which has previously developed a CEEI for New York City.

ANNEX 1 – The conceptual framework of the CEEI, in detail

Index	Description	Component	Description	Sub-component	Equity Dimensions	Indicators	Rationale	References (scientific support)	Data sources
CEEi	The CEEI assesses the ability and need of various entities (administrative units: countries, provinces, districts) to transition to clean energy. It takes into account factors such as clean energy potential, available means for a just transition, and the level of urgency for the transition.	*Potential* (Clean Electricity)	It identifies the natural potential of a certain area to develop clean energy (solar, wind)	Resource potential (solar and wind)	E	Solar radiation	Indicates the technical feasibility and capacity of harnessing solar/wind power as a sustainable and clean energy source.	https://www.pnas.org/doi/epdf/10.1073/pnas.2205429119	https://globalsolaratlas.info/
					E	Wind speed	Indicates the technical feasibility and capacity of harnessing solar/wind power as a sustainable and clean energy source.	https://backend.orbit.dtu.dk/ws/portalfiles/portal/238494910/GWA_64011_0347_FinalReport.pdf	https://globalwindatlas.info/en
		Means/resources to transition	It identifies the ability of a population living in a particular area to transition to cleaner energy independently with means and resources available	Human capital/resources	S	Jobs in renewable energy sector	Indicates the amount of jobs (i.e., human capital) available in the RE sector (e.g., manufacturing, installation, maintenance, and research and development). Human resources are pivotal in advancing solar and wind energy production and a diverse and skilled workforce can accelerate the transition to clean energy.	https://www.sciencedirect.com/science/article/pii/S2214629622003371#bb0150	https://www.irena.org/Data/View-data-by-topic/Benefits/Renewable-Energy-Employment-by-Country
					S	Education Component of HDI (i.e., literacy)	A well-informed and educated person is more likely to grasp the environmental challenges linked to fossil fuels and recognize the advantages of embracing renewables. This awareness translates into informed decision-making, with educated individuals advocating for renewable energy policies, supporting clean energy initiatives, and engaging in community projects.	https://www.sciencedirect.com/science/article/pii/S0959652618327288	https://hdr.undp.org/content/subnational-human-development-index-moving-beyond-country-level-averages
				Economic capital/resources	F	Public and foreign (aid) investments on renewable energy, per capita	Public flows on renewable energy can indicate political commitment towards clean energy. The public sector remains a major source of financing and is central in leveraging private capital, particularly in developing countries and in a post-COVID context. Total public flow needs to be converted in per capita terms. We also add external aid directed to renewables (data from OECD). Capital is necessary to fund infrastructure, enable grid integration, attract financing, and support the entire project lifecycle. Capital investments drive innovation, scale up production, and make renewable energy more affordable.	https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1873204	https://pxweb.irena.org/pxweb/en/IRENASTAT/IRENASTAT__Finance/PUBFIN_2022_cycle2.px/; https://stats.oecd.org/Index.aspx?DataSetCode=crs1#
					F	Loans by households from commercial banks (% of GDP) (i.e., barriers to capital)	Financial access is a crucial component of the clean energy transition, as investments in renewable energy projects, energy efficiency measures, and innovative technologies often require significant upfront capital. Limited access to financial resources can hinder the adoption of clean energy solutions, particularly for low-income and marginalized communities. The indicator is a proxy for 'financial inclusion'.	https://www.sciencedirect.com/science/article/pii/S0960148122012228	https://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C
					F	Relative wealth index (wealth)	Proxy for ability to pay. Higher-income individuals often have more financial resources to invest in renewable energy technologies, such as solar panels and wind turbines. They can afford the upfront costs of purchasing and installing these systems, making adoption more accessible.	https://www.sciencedirect.com/science/article/pii/S0959652618327288	https://undpgeohub.org/?operator=and&limit=15&breadcrumbs=Home&queryoperator=and&sortby=name%2Casc&query=relative+wealth#2.02/0.46/11.93
				Physical capital/resources	E	Infrastructure (Grid density)	Captures the presence of existing grid infrastructure which can indicate a more cost-effective expansion, installation and operations. Grid infrastructure acts as the bridge that connects renewable energy potential to the broader electricity system.	[illegible] 7-4; https://www.sciencedirect.com/science/article/pii [illegible]	https://gridfinder.rdrn.me/
				Access to reliable energy	S	Hight resolution energy access (HREA)	Indicates the areas in which people do not have access to reliable electricity. This contigent of people can benefit from low-power devices (e.g., small solar panels)	https://link.springer.com/article/10.1007/s40518-019-00130-7	https://geohub.data.undp.org/?operator=and&limit=15&breadcrumbs=Home&query=access&theme=Electricity+Access&resolution=500m&queryoperator=and&sortby=name%2Casc#3/0/0
		Urgency	It identifies the specific areas where transition is urgently required, considering energy security and environmental sustainability	Diversity of supply	F	Net electricity imports (MwH, per capita)	The security of a country's primary energy supplies may be threatened if it is reliant on a high proportion of imports (especially if these are concentrated among relatively few trade partners). A higher net import rate indicates an exposure to supply shocks and price spikes in commodities, and risks stemming from political decisions that might restrict trade with energy suppliers	[illegible] s/pii/S0360544214006896; https://www.sciencedirect.com/science/article/ab [illegible]	http://data.worldbank.org/indicator/EG.IMP.CONS.ZS/countries
				Dependency	F	Fossil fuel share of energy capacity and generation	Capture reliance on fossil fuel. Reliance on fossil fuels can leave a country or region vulnerable from an energy security perspective, increasing exposure to supply disruptions, price shocks, and geopolitical tensions.	https://www.sciencedirect.com/science/article/abs/pii/B9780128244401000035	https://pxweb.irena.org/pxweb/en/IRENASTAT?_gl=1*30b66q*_ga*MTQyNzY0MzUzNC4xNjg0MjM4NDg3*_ga_7W6ZEF19K4*MTY4NjczMDk4NC41LjEuMTY4NjczMTE3MC41MC4wLjA.
					F	Diversification of import counterparts (Hirschman Herfindahl index)	Having a variety of import counterparts means market risk diversification including exposure to supply shocks, tariffs and price spikes in commodities, and risk stemming from political decisions that might restrict trade with energy suppliers. A diverse import portfolio can mitigate these potential risks.	https://journals.sagepub.com/doi/abs/10.1177/ [illegible]	https://wits.worldbank.org/CountryProfile/en/country/by-country/startyear/LTST/endyear/LTST/indicator/HH-MKT-CNCNTRTN-NDX
				Environmental sustainability	E	GHG Emissions	Indicates the CO2 emissions from fossil fuel combustion sources. The higher the GHG emissions, the greater the urgency to transition to cleaner energy sources.	https://www.nature.com/articles/s41560-020-0641-6	https://edgar.jrc.ec.europa.eu/dataset_ghg70

Note: S - Social, E - Environmental /Technical, F - Economic/Financial