Revista Brasileira de Ciências Ambientais
Brazilian Journal of Environmental Sciences

Energy well-being: conceptions and indicators in light of sustainable development

Bem-estar energético: concepções e indicadores à luz do desenvolvimento sustentável

Marta Arantes Godoy[1], *Debora Sotto*[1], *Arlindo Philippi Junior*[1]

ABSTRACT

This article addresses theoretical and empirical aspects of energy well-being. It examines citizens' access to electric power and local governance in the context of economic decarbonization and increasing extreme climate events. It aims to discuss energy well-being concepts and their embedded values, including quality of life, welfare, equity, human health and global health, sustainable development, and the Paris Agreement and SDG7 goals. It also addresses the integrated key uses and dimensions of equitable access to electricity, leading to well-being with energy justice for the people. Methodological aspects include a narrative literature and documental review, as well as an assessment of empirical evidence gathered from insights by energy companies based on technical, environmental, social, economic, and regulatory aspects of well-being. Information gathering and analyses allowed the understanding of conceptions and application, resulting in a set of indicators to assess energy well-being that can leverage future studies and applications already available for use. These indicators contribute toward improving the quality of life of local populations, helping businesses in the sector and local governance to build public policies in order to improve energy efficiency and access. It concludes that individual and collective well-being can bring about multiple socioenvironmental and economic benefits at the local scale, particularly when energy poverty and distributive injustice are combated. Additionally, the proposition of specific indicators for energy well-being within sustainable development, public health, and global health context addresses a significant knowledge gap.

Keywords: access to electricity; distributed energy justice; quality of life; energy in global health; SDG 7.

RESUMO

O artigo aborda aspectos teóricos e práticos do bem-estar energético. Examina o acesso dos cidadãos à energia elétrica e a governança local no contexto da descarbonização das economias e do aumento dos eventos extremos do clima. Tem como objetivo abordar conceitos de bem-estar energético e princípios nele envolvidos, passando por qualidade de vida, bem-estar, equidade, saúde humana e saúde global, desenvolvimento sustentável, metas do ODS7 e do Acordo de Paris. Também discorre sobre usos preponderantes e dimensões do acesso equitativo à eletricidade, para atingimento de bem-estar com justiça energética pelo cidadão. Utiliza como método a revisão narrativa de literatura e análise documental, lançando mão também de evidências empíricas de empresas do setor energético no levantamento de aspectos técnicos, ambientais, sociais, econômicos e regulatórios do bem-estar. Como resultado das definições e experiências analisadas, foi possível conhecer concepções, avaliar aplicações e construir um conjunto de indicadores de bem-estar energético, que podem alavancar futuros estudos e aplicações já disponíveis para uso. Esses indicadores contribuem para a melhoria da qualidade de vida de populações locais, auxiliando empresas do setor e a governança local na composição de políticas públicas voltadas ao acesso à eletricidade com eficiência energética. É possível concluir que o aumento do bem-estar individual e de coletividades pode trazer múltiplos benefícios socioambientais e econômicos na escala local, particularmente se combatida a pobreza energética e a injustiça distributiva. Além disso, a proposição de indicadores específicos de bem-estar energético em sua relação com o desenvolvimento sustentável, saúde pública e saúde global vem preencher importante lacuna de conhecimento.

Palavras-chave: acesso à eletricidade; justiça energética distributiva; qualidade de vida; energia na saúde global; ODS 7.

[1]University of São Paulo – São Paulo (SP), Brazil.

Corresponding author: Marta Arantes Godoy – Faculdade de Saúde Pública – Avenida Dr. Arnaldo, 715 – Cerqueira César – CEP: 01246-904 – São Paulo (SP), Brazil. E-mail: martaagodoy@gmail.com

Funding: none.

Conflicts of interest: the authors declare no conflicts of interest.

Received on: 10/21/2024. Accepted on: 04/05/2025.

https://doi.org/10.5327/Z2176-94782315

Introduction

Available energy is essential to tackling challenges such as climate emergency, energy transition, sustainable development, human well-being, and global security while facing global constraints in accessibility, impacts on the production and transmission chain, and inequality in distribution and consumption, impacting the health of populations around the world (IEA, 2023).

Energy is a public good that should be accessible to all, as agreed in Paris during the 21st Conference of the Parties (COP21) in 2015 and established by the United Nations' (UN) Agenda 2030 under Sustainable Development Goal (SDG) 7. The shift from fossil-based energy systems to renewable sources, alongside the adoption of modern technologies aimed at decarbonization, is expected to keep the global temperature rise below 1.5°C by 2050, as recommended by the Intergovernmental Panel on Climate Change (IPCC, 2023).

Moreover, the energy system is still heavily reliant on sources such as oil, coal, and natural gas, the leading causes of air pollution affecting over 90% of the world's population and the premature mortality rate of over 6 million people yearly (IEA, 2023).

Events such as the COVID-19 pandemic, armed conflict in the Middle East and Eastern Europe, and widespread economic turmoil have hindered progress toward access to electricity and modern cooking, harming health and well-being and aggravating inequalities. "An additional 23 million people were pushed into extreme poverty, and over 100 million more suffered from hunger in 2022 compared to 2019. [...] overall global health progress has decelerated alarmingly since 2015" (UN, 2024a, p. 3), and nearly ten years of progress on life expectancy has been undone. Furthermore, 685 million people lacked access to electricity, and 2.1 billion were without fuel for clean cooking (UN, 2024a).

The transition toward clean energy has the potential to promote health through reduced illnesses due to air pollution related to fossil fuel use, behavioral change and positive psychological impacts such as satisfaction and increased self-esteem. However, it can also bring about adverse effects such as stress and anxiety due to change, thus requiring integration between policies on well-being and energy transition to mitigate social and cultural costs stemming from this inevitable change (Proscanu and Proscanu, 2023). Global evidence of the detrimental impacts of energy poverty on public health (Pan et al., 2021) and the conceptualization of declining subjective well-being corroborate these findings (Churchill et al., 2020).

Thus, regarding human well-being, the ethical nature of global health comes to the forefront. It leads to reflection on everyday principles, issues, and solutions beyond borders to protect everyone's well-being in an era of climate emergency that affects the whole planet and how energy is produced, traded, and consumed.

A sense of social justice and equity is also a concern of global health, considering the human, economic, and technical resources distributed by governments (Fortes, 2015). Individuals are connected with governance at the various levels of distributive justice, allowing for the implementation of the energy well-being concept, on which this investigation focuses. Therefore, the research is founded on principles of social justice, equity, and sustainability, aiming to explore conceptions and understand the scope and application of the term energy well-being.

Additionally, the state-of-the-art review identifies a critical knowledge gap regarding multifaceted indicators encompassing aspects such as global health, access to electric power, and human well-being, in the present context of climate emergency and pressing sustainable development needs. The lack of such methodology justifies the development of specific energy well-being indicators addressing the local scale to be refined and empirically tested in terms of their metrics in future studies.

Materials and Method

The primary research method adopted a narrative literature review and an assessment of well-established and newly proposed concepts in the scientific community regarding human well-being, more specifically, its relationship with access to electricity, the object of the research. The literature review encompassed theoretical aspects and an assessment of documents, studies, and publications from energy planning and research institutions, academia, businesses, and energy sector associations.

The study searched reliable online platforms such as Scopus, Web of Science, Elsevier, ScienceDirect, and SciELO using terms and combinations of keywords, such as "energy well-being"; "clean energy, health and well-being"; "distributed generation and sustainable development"; and "energy well-being indicators", in the socioenvironmental context of renewable energy use and distributed energy generation. Other sources included multilateral finance institutions to assess project evaluation methods and energy sector companies and associations' websites for information on new clean infrastructure technologies and energy research, besides the most up-to-date publications from national and international organizations on implementing the UN Agenda 2030 SDG 7.

This research and empirical evidence resulted in findings about aspects and variables that constitute or are associated with energy well-being, culminating in identifying and listing indicators. These indicators can help the scientific community and local governments to address the issue according to their interests. It should be noted that this set of indicators is preliminary; they require testing and development in future research since this would go beyond the scope of the present investigation.

Foundations of energy well-being within sustainable development

Conceptions of well-being are prioritized beyond their obvious correlation with human health, encompassing sustainable development's social, economic, and environmental dimensions. They also

consider aspects such as global health, energy transition, climate emergency, energy well-being, and quality of life.

The World Health Organization (WHO), in its 1978 Alma-Ata Declaration, affirms the human right to health as a fundamental principle and frames it as the most critical global social goal that requires coordinated, multisectoral action in healthcare, including basic access to energy. The Declaration guarantees the right of individuals and communities to participate in the planning and implementation of healthcare services, emphasizing social justice and outlining a clear path toward democratizing access that is just, inclusive, and equitable.

The 1987 Ottawa Charter acknowledges the intrinsic link between well-being and human health, fighting inequalities at every level. Rawls (1999) also addresses equity in his revised Theory of Justice of 1971, proposing individual rights and freedoms as inviolable and placed above general well-being.

The link between well-being and health is multifaceted. In economic thought, Nussbaum (1987) indicates that well-being is determined by life's capacity to function in several dimensions: physically, socially, and emotionally. Sen (2000) adds that freedom in development and the metric of well-being go beyond economic growth to include health in a broader sense, upon which well-being and full societal participation are contingent.

From a social perspective, Wilkinson and Pickett (2009) propose that the best results in health and well-being can only be found in more egalitarian societies and highlight that mental illnesses, violence, and lower life expectancy are associated with social and economic inequalities. Deaton (2013) further defends that today´s world is better than before, with healthier, more prosperous, and long-lived individuals. Despite this, it did not prevent the descent of so many into destitution, leading to inequalities between peoples and nations and inequalities in health exacerbated by unequal economic growth. Piketty (Caprara, 2014) analyzes inequitable income distribution, economic growth, and capitalism's evolution, concluding that wealth concentration is responsible for the unequal global economy.

On the road to sustainable development and according to Ignacy Sachs acknowledged humanistic approach, ecodevelopment and well-being stem from a deep integration between economic growth, social equity, and environmental protection, reflecting concepts dear to global health.

It is not without reason that the International Energy Agency (IEA, 2023) underscores universal energy access with clean fuels for cooking and electricity as a fundamental condition of people's well-being due to its impact on health, education, and productivity, particularly in African and Asian countries. The IEA defines energy well-being, considering economic accessibility, trustworthiness and provision, environmental sustainability, and energy security, as critical elements for sustainable development and improved quality of life.

In the European Community, energy poverty is a reality. Many citizens cannot address their basic needs, facing prolonged shortages and inadequate indoor climate control offered at unaffordable prices. The Energy Poverty Advisory Hub (EPAH, 2022) finds that difficulties increase depending on geographical location, climate, housing conditions, indoor heating/cooling equipment, and wider geopolitical aspects that impact energy prices. This is further aggravated by individual factors such as age, health conditions, family setting, socioeconomic status, and ongoing climate change consequences. Energy poverty has multiple effects on health and well-being, exacerbating respiratory and cardiovascular diseases, heatstroke and high death rates, and health problems due to cold weather, besides detrimental impacts on school performance and social and emotional well-being (Oliveras et al., 2021).

In Brazil, energy policy and strategic planning aimed at well-being are addressed by the Energy Research Enterprise (EPE, *Empresa de Pesquisa Energética*) of the Ministry of Mines and Energy (MME, *Ministério de Minas e Energia*). EPE and Diversa Sustentabilidade (2022) identifies the lack of access to energy services as its main obstacle. It emphasizes the importance of reducing inequalities, combatting energy poverty, and promoting energy justice (EPE, 2024), and places the transition to renewable and safe sources accessible to all as the foundation for the National Energy Policy, adding the benefits of distributed energy resources (REDs, *Recursos Energéticos Distribuídos*). Consumers can generate and manage their energy by adopting distributed generation through energy storage, electric vehicles, recharge through energy efficiency measures, and demand-side management. In other words, a consumer can become a producer-consumer or *prosumer.* There is a growing trend in decentralized energy production and digital technologies in the urban environment, demanding investment and new business models from consumers and local governments.

Energy justice leads to social justice and transparency in the energy production chain, where environmental justice and climate justice converge, resulting in just and democratic societies with social equity (Lacey-Barnacle et al., 2020). It should be mentioned that equity in distributing the impact of the production chain and energy access is the object of distributive energy. In this case, energy poverty can be understood as a form of distributive injustice, an argument made by Bouzarovski in 2018 and emphasized by EPE (2024). Milčiuvienė et al. (2019) focus on energy justice and support the development of national regulation to warrant universal energy access and responsible resource use. However, they are skeptical about *prosumers*' attitudes without regulation, particularly in securing intragenerational equity. Sovacool et al. (2014) define energy poverty as the lack of access to energy and its modern services, emphasizing the dependence on traditional biomass, such as wood and dung, for cooking, which causes health problems for its users. Despite prospective improvements, the advancement of clean technologies for cooking in disadvantaged households is insufficient to attain the SDG 7 goals by 2030 (IEA, 2023).

To quantify energy deprivation intensity, Nussbaumer et al. (2012) developed the Multiple Dimensional Energy Poverty Index

(MEPI) to go beyond measuring energy access and families' capacity to pay. It monitors the quality, trustworthiness, and accessibility of energy services. Poveda et al. (2021) applied the MEPI methodology adapted to Brazil and found that 11.5% of Brazilian households are multidimensional energy poor, with a deprivation intensity of 31.9%; the majority are located in rural areas of the North and Northeast, the most energy poor regions of the country. Also, the MEPI index demonstrated that "the most energy-poor regions in Brazil are those with the highest rate of financially poor people" based on data from the Survey of Family Budgets of the Brazilian Institute of Geography and Statistics (IBGE POF, *Pesquisa de Orçamentos Familiares do Instituto Brasileiro de Geografia e Estatística*) of 2017–2018 (Poveda et al., 2021, p. 15). Sermarini et al. (2024) analyzed default rates and the application of social tariffs for low-income consumers to determine energy and economic poverty. The authors suggest specific photovoltaic energy policies in a distributed generation to secure gains from energy savings for *prosumers*.

Torchio et al. (2020) propose using indicators to analyze national trends and compare performances, overweighting economic and human figures such as gross domestic product (GDP) and the human development index (HDI), besides considering solely quantitative energy aspects such as primary energy provision and losses. Volodzkiene and Streimikiene (2023) developed indicators to evaluate and measure energy well-being, exploring content, conceptualization, and individual drivers of energy inequality, besides identifying dimensions, indicators, and ways to reduce it in the European Community.

A joint study on Brazil and Argentina is noted for postulating a better fit in treating energy transition more as a diversification of energy systems and that this process may not represent a socially inclusive, fair and sustainable transformation since "neither energy poverty nor energy justice are the object of institutional measuring or policy design in either country" (Lampis et al., 2022, p. 8). They conclude that energy poverty merits better coordination between central government, finance, governance, and energy justice, representing the continuity of existing social inequalities.

Primary data from research by Riva et al. (2024) on energy poverty in a small Canadian town of Nova Scotia found that many families (38% of the interviewees) faced difficulties. Despite being located in an energy-rich country with high energy security, they were exposed to unequal distribution and high energy costs in the region.

According to the study, 21% of the interviewees could not heat their homes adequately, and approximately 30% faced difficulties paying their energy bills, often having to cut their food and transport expenses to keep warm. When applying health and well-being indicators, significantly more energy-poor interviewees reported worse mental and general health, higher daily stress, and less social support. Women, less educated people, and inhabitants of precarious housing using diesel-powered heating were significantly more prone to face energy poverty. The authors concluded that energy poverty is associated with poorer health and less well-being and should be a priority in local action toward a just energy transition.

Results, Discussion, and Propositions

The resulting information from assessments and analyses is summarized below, according to the section. They identify theoretical and empirical aspects relevant to the understanding of energy well-being and its implications, leading to the development of indicators to assess the quality of life associated with energy access.

National and international networks for sustainable development

The UN´s annual progress monitoring in meeting the SDGs has a local counterpart in the Sustainable Development Solutions Network (SDSN). According to the Sustainable Development Report 2024 (Sachs et al., 2024), in 2021, Brazil was placed 52nd out of 167 countries globally in meeting Agenda 2030´s 17 SDG, with a score of 73.78/100, demonstrating a general medium level. None of the 17 SDG targets is likely to be reached by 2030; progress towards their goals was verified to be about 16% at the time of this manuscript´s writing. Regarding SDG 7, however, it is worth mentioning that in 2023, 97.6% of the urban population worldwide had electricity access, according to the UN and the World Bank´s Report on Energy Progress, supported by data from the IEA, Irena and WHO tracking annual progress towards sustainable energy[1] (Table 1).

The Cities' Sustainable Development Index (IDSC, *Índice de Desenvolvimento Sustentável das Cidades*), developed by the Sustainable Cities Program (PCS, *Programa Cidades Sustentáveis*), has been a valuable tool for municipal management in Brazil. The IDSC-BR (ICS, 2024) monitors 100 indicators that guide local priorities according to challenges identified in updated official data from Brazilian sources. Indicators for SDG 7 are: i. Percentage of households with access to electricity; and ii. Level of energy vulnerability. There is, however, an essential gap in measuring renewable energy consumption. The IDSC-BR indicators are simple; they are linked to public policies and results that measure the municipality's gap in achieving SDG goals.

The study's approach to assessing social well-being and sustainability focuses on public policies within the sustainability, innovation, and inclusion nexus (Buckeridge and Philippi Jr, 2024). It also discusses the energy axis, including the SDG 7 and SDG 3 goals, resulting in specific proposals (Table 2) at the federal (F), state (E), and municipal (M) levels.

In the 2030 Agenda (UN, 2024a), except for SDG 7, no SDGs explicitly mention energy as fundamental. In SDG 3 – Health and well-being, no specific target or indicator identifies energy accessibility in public health facilities or households. However, SDG 4 – Quality education establishes the need for an internet access index in public elementary and middle schools, for which energy access is essential. In SDG 9 – Industry innovation and infrastructure, an indicator for public investment in urban infrastructure per inhabitant does not mention energy.

[1] TN. See https://trackingsdg7.esmap.org/

Table 1 – Indicators associated with Sustainable Development Goal 7.

Goal	Indicator
7.1.1	The proportion of the population with access to electricity (urban and rural percentages)
7.1.2	The proportion of population with primary reliance on clean fuels and technology (percentage of total)
7.2.1	Renewable energy share in total final energy consumption (percentage of total)
7.3.1	Energy intensity in terms of primary energy and GDP (kWh/USD)
7.a.1	International financial flows to developing countries for research and development on clean energy and renewable energy production (USD)
7.b.1	Installed renewable energy-generating capacity in developed and developing countries (watts per capita)

Source: United Nations (2024b).
GDP: gross domestic product; USD: United States dolar.

Table 2 – Sustainable Development Goals 3 and 7 agenda items from an energy perspective.

SDG 3 – Health and well-being from an energy perspective.
- Promote Research, Development and Innovation (RDI) programs to develop efficient technologies for urban mobility and freight in the country (F, E)
- Facilitate and promote agreements between municipalities and universities to develop research labs in electric mobility and distributed energy, enhancing replication in similar municipalities (M).
- Promote RDI programs to increase renewable energy sources' availability and use in heating, water harvesting, treatment and management, as well as in other unavailable services, further enhancing the use of energy resources in rural and isolated communities (E, M).
- Improve energy efficiency programs, including renewable energy sources (solar panels, photovoltaic modules, wind energy, waste-to-energy systems, etc.) and ensure access to all (F).
- Expand energy universalization programs, considering the possibility of developing local economic activities and entrepreneurship in addition to basic subsistence services (F).

SDG 7 – Energy
- Establish and expand renewable energy incentive policies, including energy efficiency practices, using each region's primary resource potential, such as solid waste, biogas and other biomass sources available in several municipalities, as well as wind, solar and hydropower potential (F, E, M).
- Integrate regulatory agencies, monitoring and control bodies, the productive sector, research centers and universities to establish joint agendas addressing strategic development pathways regarding energy and its use. Enhance support for innovative energy initiatives such as PDI Aneel, ANP, CT-Energ, and Finep e Lei do Bem (F, E).
- Guarantee energy provision throughout the national territory, improving energy supply quality, particularly in isolated systems and rural areas (F).
- Develop public policies to balance costs, charges and the final value of the energy input of its various uses (lighting, water pumping, transport and mobility, cooking etc.) for low-income populations (F).
- Discuss a paradigm shift in the nuclear power supply system with society, from using large plants to a model with multiple plants based on small modular reactors and microreactors (F).

Source: Buckeridge and Philippi Junior (2024).
DI Aneel: Brazilian Electricity Regulatory Agency's Research, Development and Innovation Program; ANP: Brazilian National Agency of Petroleum, Natural Gas and Biofuels; Finep: Studies and Projects Funding.

Therefore, despite its obvious intersectionality and cross-cutting nature, energy access is not explicitly mentioned; it is an object of attention and measurement only in the SDG 7.

Civil Society Technical Group

In Brazil, tracking SDG implementation progress is undertaken by the Civil Society Technical Group (GTSC, *Grupo Técnico da Sociedade Civil*) from the perspective of overcoming inequalities, promoting sustainable development, and combating injustices. Concerning energy accessibility as per SDG 7, the GTSC highlights that in 2022, "seven out of ten families stopped buying food to afford the energy bill" (GTSC, 2023, p. 51). A survey by Datafolha in 2022 reports that energy "became a significant item in [the household] budget in the past 12 months, according to 85% of Brazilians" (ABRACEEL and Datafolha, 2022, p. 25).

The GTSC (2023, p. 51) further reports that in 2021, 40.0% of the low-income population were unable to pay their energy bill, demonstrating that the current social tariff (TSEE, *Tarifa Social de Energia Elétrica*) is still insufficient to tackle energy poverty. This condition is an expression of environmental racism since "access to electricity is more difficult for households composed of Black individuals and/or headed by women" (GTSC, 2023, p. 51). This is true, especially in urban settlements on the outskirts of cities, where power outages occur more frequently and for more extended periods, affecting food security, as the majority of electricity expenses in households with a monthly income of up to two minimum wages are directed toward food preservation, as reported by EPE/MME in 2022 (Instituto Pólis, 2022).

The GTSC (2024) also reports that Brazil has not met any of the five SDG 7 targets; their implementation is either stalled, insufficient, or at risk. Despite not having developed a specific policy on just energy transition, in 2023, the government designed an Ecological Transformation Plan that includes an Energy Transformation Axis. The Light Report 2024 (*Relatório-Luz 2024*) presents 160 recommendations for

SDG implementation, of which 11 are for SDG7; it emphasizes the following: suggestion for an energy consumption subsidies and benefits policy contemplating low income families within the Renewable Energy Social Program (PERS, *Programa Social de Energia Renovável*) integrated with the TSEE and exemption from the Distribution System Usage Tariff (TUSD, *Tarifa de Uso do Sistema de Distribuição*); promoting public policies for the autonomy of vulnerable populations to generate and manage energy, individually or collectively, strengthening local banks; investing in improved distribution networks; adopting criteria to mitigate climate change and energy supply equity; revising tolerance limits in energy outages; disincentivizing fossil energy, reassigning financial resources to renewable sources taking socioenvironmental aspects into consideration; developing the transformation of the energy market, establishing criteria for the expansion of the power generation capacity, monitoring and reducing socioenvironmental impacts; awareness building about energy consumption patterns and energy efficiency classification; and promoting the viability of mechanisms to attract international financial flows to developing countries and promoting partnerships that prioritize the Global South and vulnerable groups.

The financial sector, metrics and assessment sector, regulatory bodies and entrepreneurs

International bodies evaluate the effectiveness and impacts of enterprises in the renewable energy supply chain. They analyze their projects' financial, technical, and socioenvironmental viability, and develop scenarios and risk assessments. Meeting the environmental and social requirements of the host country is essential.

In addition to compliance with legislation and licensing procedures that require an Environmental Impact Assessment (EIA), evaluation methods that address environmental, social, and governance (ESG) aspects of corporations, and their projects include the World Bank's International Finance Corporation (IFC), key performance indicators (KPI), compliance with the Equator Principles, and the ESG standards. They must also follow national and international guidelines, such as the International Organization for Standardization – ISO 14001, specifying socioenvironmental management requirements and ISO 50001, for enterprises' effective, sustainable and economic energy management, besides the municipal building codes that address local energy efficiency.

The World Bank finances energy infrastructure projects and requires strict compliance with the environmental legal framework of host countries. It measures energy accessibility performance and improvement using the Multi-Tier Framework (MTF). The multilevel approach goes beyond the binary "having access or not having access" metric. It considers capacity, duration, availability, reliability, quality, accessibility, legal compliance, convenience, health, and security. The MTF parameters assess the dimension of energy use and metrics for access to cooking and electricity solutions, adapted and updated where applicable.

The Equator Principles evaluate the socioenvironmental risks of infrastructure and industrial projects according to their potential for adverse impacts, serving as a baseline for risk management. They are applied to consultancy services, project-related corporate loans, bridge loans, refinancing, and acquisition financing. They are characterized by independent assessments based on relevant national and international laws and standards integrated into the internal policies and procedures of the banks that adopt them. The ten Equator Principles reflecting the areas where progress is expected are: 1. Review and Categorization – classifying projects based on their environmental and social risk level; 2. Environmental and Social Assessment – conducting detailed assessments of potential impacts; 3. Applicable Environmental and Social Standards – applying relevant standards, such as IFC Performance Standards and local regulations; 4. Environmental and Social Management System and Action Plan – establishing systems and plans to manage identified risks; 5. Stakeholder Engagement – ensuring effective consultation with affected communities and stakeholders; 6. Grievance Mechanism – providing a process for communities to raise concerns; 7. Independent Review – requiring independent environmental and social due diligence; 8. Covenants – including binding environmental and social commitments in financing agreements; 9. Independent Monitoring and Reporting – ensuring independent follow-up on compliance and performance; 10. Reporting and Transparency – promoting disclosure of project impacts and compliance with the principles (Equator Principles, 2020).

The ESG performance tool is increasingly used to demonstrate environmental, social, and governance concerns. It was launched in the 1990s and strengthened in the 2000s after the Who Cares Wins report was published by the UN Global Compact and UN Environment Program's (UNEP) Finance Initiative. Its principles and good practice standards measure organizational performance regarding the company's sustainability, social, and environmental responsibility, adequate management, and compliance with the 2030 Agenda SDGs. In 2019, the UN Global Compact – Brazil network presented a tool for the implementation of the ESG standards in corporations, comprising five steps summarized as follows: 1. Understanding the SDGs; 2. Defining priorities; 3. Establishing goals and indicators; 4. Including the SDGs in everyday activities; and 5. Communicating progress. Therefore, good ESG performance demonstrates corporate sustainability through good environmental, social, and governance practices. It addresses impacts, minimizing the negatives and maximizing the positives, while addressing any damage that may have already been caused.

Energy planning and research organizations

The EPE's research on energy well-being in Brazil and worldwide since 2022 strongly underpins this study. The EPE launched an initial publication grounded in debates on the relationship between energy and human well-being, culminating in a foundational text ("Concept Map") and a subsequent "Preliminary List of Indicators by Key Concepts," aimed at developing the Energy, Environment, and Society Indicator System (SIEMAS), composed of indicators related to energy, well-being, income inequality, territory, family structure, gender, race, among others in Brazil.

Table 3 – Aspects and factors for energy well-being indicators.

Well-being	Relevant aspect	Factors (1st, 2nd, and 3rd levels) according to key concepts
Physical	Healthy eating	i) Energy poverty and vulnerability: energy usage patterns; energy efficiency; thermal comfort; household standard; energy economic accessibility; fuel; transport and mobility poverty; household lighting; cooking; appliances; food storage; entertainment; communication/internet; modern energy services (energy availability, quality and reliability); and education; ii) Sustainable energy development: energy sovereignty, environmental sustainability (energy conservation, environmental impacts minimization, clean and renewable energy sources), energy transition, energy matrix, social tariffs, energy tariffs, energy cost and subsidies, public services (public lighting, public transport, health services), sanitation (water supply, sewage, urban cleaning), drainage, energy system expansion (regional development: economic dynamization, job generation, tax revenue increase, innovation and technology; power generation, transmission and distribution expansion), production of petroleum derivatives, biofuels and natural gas); iii) Energy equity and justice: distributive justice (energy coverage, distribution of energy infrastructures' benefits and damages, unequal financial impact of tariffs, energy inequalities and intersectionality, territory, race, income, gender, generational, family structure); procedural justice (transparency, accountability, collaborative process, knowledge inclusion); recognition justice (inclusive decision-making, recognition of local, traditional and marginalized communities, energy equity, energy benefits equity, investments for clean energy).
	Physical safety	
	Physical health	
	Sanitary conditions	
	Environmental health	
Social	Social cohesion	
	Social inclusion	
	Citizenship	
	Social health	
	Social justice	
Economic	Economic equity	
	Access to goods and services	
	Economic opportunity	
	Income level and distribution	
	Economic security	
	Cost of living	
Psychic	Mental, emotional, intellectual, and professional health	
	Sense of security	

Source: Energy Research Enterprise and Diversa Sustentabilidade (2022).

The EPE held several workshops to develop the indicators, and the main consensus was on access to clean energy for all. The key concepts discussed were energy poverty, energy justice, and sustainable energy development; others included energy vulnerability and equity. The workshops' outcome was to identify the factors involved, variable interdependence, and the network of influence (Table 3), aiming to develop the corporate energy well-being indicators (EPE and Diversa Sustentabilidade, 2022).

EPE highlights energy justice due to its importance for the well-being and health of individuals and the community. To meet this goal, energy provision services must prioritize the following parameters: i. availability; ii. financial accessibility (corresponding to a strain of less than 10% on family income); iii. appropriate legal process; iv. transparency and accountability; v. sustainability; vi. intragenerational and intergenerational equity; and vii. responsibility. Based on analyses of the complexity issues between energy and well-being, EPE and Diversa Sustentabilidade (2022) developed and presented the preliminary list with 63 indicators for energy well-being related to three key concepts:

Energy poverty and vulnerability: coverage of the electric power system; fuel expenditure; electric power usage; residential fuel usage; impact of transport and energy expenses on the household budget; structure and type of housing; access to the internet; ownership of electronic and electric appliances; and level of continuity of energy supply.

Energy justice and equity: impact of energy cost according to specific groups; residential sector delinquency; consumer units covered by social tariffs; and energy coverage.

Sustainable energy development: greenhouse gas emissions; water availability; electric power and energy matrixes' level of renewability; transition to renewable energy systems; energy usage in economic activity; technical loss; technological innovation in electric power conservation; energy consumption; job creation; income generation; level of energy import; and level of prioritization of socioenvironmental issues in research and development (R&D) investment.

Policies and incentives for energy well-being in Brazil

Brazil has practically universal energy access except for rural areas and isolated communities in the North region. Nonetheless, families nationwide spend a disproportionate part of their income on energy. Advancing energy well-being of socially vulnerable families has increased due to the social tariff mechanism TSEE established by the Energy Development Account (CDE, *Conta de Desenvolvimento Energético*) to benefit low-income families. It is implemented and supported by the Incentive Program for Alternative Electric Power Sources (Proinfa, *Programa de Incentivo às Fontes Alternativas de Energia Elétrica*). Indigenous and Quilombola[2] families registered in the Brazilian "Single Registry" (CadÚnico) are also beneficiaries. Families in rural and remote areas of the state of Amazonia served by isolated electric power

[2] Quilombola communities in Brazil are groups formed by the descendants of enslaved Africans who fled from plantations and other forced labor situations during the colonial and imperial periods, between the 17th and 19th centuries.

systems are subsidized through the National Program for Universalization of Access and Use of Electrical Energy – "Light for All" (*Luz para Todos*) (Aneel, 2024).

However, guaranteeing that all regions in Brazil have reliable access to reasonably priced energy remains a challenge. Tariffs are periodically subject to inflation, high generation costs, seasonality, and climate restraints. It is noticed that developing integrated public policies is needed. Besides prioritizing supply, they should consider its economic accessibility and quality, increasing the electric power system's resilience to extreme climate events, such as gales, cyclones, and hurricanes, and modernizing infrastructure, particularly the overhead transmission and distribution network system.

At the local level, the sector should use renewable energy sources and increase production with consumers' contribution to improve energy security. Distributed generation up to 5MW has been allowed in Brazil since 2012 and is regulated by Law 14.300/2022 (Aneel, 2023), which establishes the legal framework for distributed energy and micro-generation. It includes the Electric Energy Compensation System (SCEE, *Sistema de Compensação de Energia Elétrica*) and the PERS. Through PERS, based on Bill 624/2023, approved by the Chamber of Deputies in May 2024 and currently under review in the Federal Senate, the program provides for the free installation of photovoltaic energy systems for low-income families, including older adults and persons with disabilities who receive Continuous Cash Benefit (BPC, *Benefício de Prestação Continuada*).

Distributed generation (DG) has proven to be a solution to democratizing renewable energy and is steadily growing in Brazil and worldwide. In 2024, there were more than 47 GW of operational photovoltaic solar systems in Brazil, about 32 GW (68%) of which were DG (ABSolar, 2024). Distributed generation has grown increasingly in recent years throughout Brazil. All states have DG plants, of which São Paulo has the most significant participation (14.1%), followed by Minas Gerais (12.8%), and Rio Grande do Sul and Paraná (9.3% each). At the local level, state capitals Brasília, Cuiabá, and Campo Grande stand out, accounting for the largest installed capacity in GD.

The interrelationship between energy, health, and well-being and indicators approach

This research was based on analyses of the following: conceptual framework, pro-sustainable development network evaluations, requirements of the financial, regulatory and entrepreneurial sectors, energy and academic research outcomes, and incentives for clean energy from DG in Brazil. Furthermore, it builds on empirical data collected by the author during decades of professional experience as a socioenvironmental risk and scenario analyst in the energy sector. The knowledge acquired helped identify the unequivocal relation between renewable energy usage and consumption and human well-being in various sectors of everyday life.

Table 4 – Relationship between clean energy, health and well-being.

Variables	Relevant aspects of clean energy usage in cities
Public and environmental health	Proper functioning of hospitals, clinics, and equipment with appropriate lighting, and refrigeration for vaccines and drugs sensitive to temperature contributes to adequate public health conditions in cities. Reducing air pollution and greenhouse gas emissions contributes to avoiding the onset of respiratory, cardiovascular, and cancer diseases. It also helps to reduce global temperature rise, which directly affects human health due to intense heatwaves and droughts, waterborne diseases caused by floods, significant biodiversity loss, and food insecurity, among other deleterious effects on the health of living creatures in water and land.
Basic sanitation	Water treatment and supply, and adequate wastewater and solid waste treatment prevent waterborne infectious diseases and illnesses caused by methane emissions.
Food security	The adequate use of machinery, irrigation, and processing in the agriculture production chain, as well as proper food refrigeration in households, contribute to avoiding food deterioration and contamination.
Indoors climate control	Indoor heating and cooling prevent extreme hot or cold illnesses; adequate indoor air filtering reduces exposure to indoor pollutants and allergens.
Power plant construction and operation	Implementing solar photovoltaic, wind, small hydropower plants, and organic waste-to-energy facilities can cause socioenvironmental impacts. These impacts include nuisances to the surrounding population, affecting their well-being due to the suppression of forested and/or agriculture areas that result in habitat loss for local fauna and loss of vulnerable and food production areas, among others. However, the general balance of impacts is positive due to adopting renewable sources that do not emit greenhouse gases during their operation and life cycle.
Mental health	Electric power access minimizes impacts on mental health related to stress, anxiety, feelings of insecurity, and other psychological conditions due to the inability to carry out daily activities in the event of electricity deprivation.
Energy poverty	Inadequate access to electric power due to economic or physical limitations can trigger vulnerability to health, education, and other problems related to services essential to everyday life and society.
Energy justice	Just access to electric power reduces inequality and eliminates social inequities in distribution and maintenance services.

Several variables demonstrate aspects relevant to health and favorable living conditions (Table 4) and to which clean energy access is critical.

This study evaluated relevant clean energy uses, the growing urbanization trend worldwide, and the frequency and intensity of extreme climate events that demand local solutions. Additionally, concepts of energy well-being were analyzed along with cases and indicators available in the literature, especially those developed by EPE and Diversa Sustentabilidade (2022), WHO (2024), and the UN (2024a) for SDG 7. The assessment allowed for addressing aspects of well-being and proposing a preliminary list of indicators (Table 5) that overcomes a crucial methodological gap to be developed and tested in future research. Some indicators are measurable, while others are binary or classificatory.

Table 5 – List of energy well-being indicators for the local scale.

Aspect	Characteristics of the investigation
Accessibility	Percentage of the population with energy access via distributed generation/ distributed energy resources
	Percentage of the population using fossil fuel for cooking
	Percentage of public health facilities, education, and other essential services with complementary access to clean energy (generator, battery)
	Frequency and duration of energy outages
	Unequal territorial distribution of centralized energy index
	Identification of community energy initiatives
Cost	Average cost of energy for individual residential consumers
	Percentage of energy cost compared to average family income
	Usage level of social energy tariffs
Quality of supply	Percentage of customer satisfaction with energy supply
	Response time for resolution of problems and complaints indexes
	Intersectoral service provision inequality index
Sustainability	Percentage of renewable energy sources
	Greenhouse gas emissions associated with nonrenewable energy local generation
	Level of socioenvironmental impact linked to cogeneration and local distribution
Public health	Number of cardiovascular and respiratory diseases (asthma, bronchitis) and lung cancer cases in areas of high exposure to pollutants and premature deaths due to specific pollutants.
	Local concentration levels of pollutants [particulate matter ($PM_{2,5}$ and PM_{10}), nitrogen dioxide (NO_2) and ozone (O_3)]
	Health impact assessment (HIA) and cost-benefit analysis (CBA) to quantify the economic cost of pollution in the health system (expenses with treatment, lost working days, and medical assistance)
	Personal exposure to pollution index through court studies and control cases (using individual monitoring devices)
Energy efficiency	Level of modern technology local usage (REDs) and energy efficiency practices (households, schools, health facilities, clubs, churches, commerce, industry)
	Quantity of permanent municipal programs on energy efficiency incentive
Energy equity	Percentage of the population with democratic and just energy access
	Quantity of municipal policies to combat energy poverty and democratic actions in the climate action plan
Infrastructure and technology	Percentage of energy equipment used for energy generation and distribution to the local population
	Percentage of modern technology for energy equipment using REDs (smart meters, photovoltaic panels, wind turbines, urban solid waste to energy, small hydroelectric plants, and clean batteries for energy storage)
Engagement and governance	Percentage of individual and community participation in energy management
	Percentage of public policies to support cogeneration initiatives and smart grids
	Quantity of legal instruments for the regulation of and incentive to distributed generation
Protection and resilience	Community capacity to deal with extreme climate events.
	Quantity of civil defense, recovery, and contingency municipal plans
Education, communication, and awareness	Quantity of environmental education programs on sustainable energy and responsible consumption, and healthy and rational use of the internet and artificial intelligence (AI) for entertainment and learning (radio, TV, computer, cellphone)
	Level of the population's knowledge of climate change, energy transition, use of renewable energy sources, distributed energy resources, responsible consumption, and resilience

This study considered energy transition needs, sustainable development, and global health principles to develop indicators beyond the metrics of simple access to energy. It scrutinized the access to clean energy through distributed generation and related local resources, founded on social and distributive justice, fighting energy poverty and protecting public health and the environment beyond borders, principles that underpinned this investigation.

The proposition of these indicators is based on theoretical and documental evidence, considering socioenvironmental values and experience in the energy sector. However, it is not only conceptual but also a recommendation that can be replicated. It is a technical product with a solid theoretical foundation that guides an assessment of state-of-the-art indicators generally applied to develop specific energy well-being indicators.

The result is a set of indicators in a broader context comprising global health interests and sustainable development public policies aiming at energy accessibility at the local level. Formulating metrics and testing extrapolates the scope of this investigation, thus opening up an avenue for future research.

Nevertheless, approaching energy well-being concepts and definitions together with the development of specific indicators, considering sustainable development and guidelines for public health and global health, allowed the observation of the multiple socioenvironmental and economic benefits; these results can be obtained when governance includes fighting energy poverty and securing energy efficiency through just energy distribution and the adoption of local REDs.

Conclusion

This investigation suggests that promoting energy well-being in Brazil and worldwide entails facing challenges such as those identified in the 2030 Agenda SDGs. They include finding the means to guarantee universal energy access that is also socially and economically just, with energy security for all. Other SDGs can also attain benefits through efforts to reduce global temperature rise (SDG 13), improve living and health conditions for the population (SDG 3), provide services for more resilient cities (SDG11), and adopt clean infrastructure (SDG 9), as well as implement more sustainable production and consumption (SDG 12). The increase in individual and collective energy well-being yields multiple socioenvironmental and economic benefits, particularly if supported by local governance efforts to fight energy poverty, increase energy efficiency, and the just distribution of energy through REDs.

The theoretical, documentary, and experimental approach addressing socioenvironmental instances of the energy production and distribution chain allowed the investigation of energy well-being amplitude and its indicators. The research identified its interrelation with global health, climate vulnerabilities, decarbonization, and locally oriented sustainable development principles. The results addressed a significant gap in the literature; metrics and evaluation methods can be further developed and tested in new empirical studies. Meanwhile, these findings can contribute to the understanding of energy well-being by specialists, local governments and the scientific community in addressing the issue in their municipalities.

It may be concluded that far beyond simple access to energy, energy well-being involves meeting the needs of energy transition, sustainable development, and global health principles. It implies access to clean energy through distributed generation and related local resources, founded on social and distributive justice, fighting energy poverty, and protecting public health and the environment beyond borders. These principles underpinned the research from the beginning.

Authors' Contributions

Godoy, M.A.: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, writing – original draft, writing – review & editing; **Sotto**, D.: conceptualization, writing – review & editing; **Philippi Junior**, A.: conceptualization, supervision.

References

Agência Nacional de Energia Elétrica (Aneel), 2023. ANEEL regulamenta marco legal da Micro e Minigeração Distribuída (Accessed August 04, 2024) at:. https://www.gov.br/aneel/pt-br/assuntos/noticias/2023/aneel-regulamenta-marco-legal-da-micro-e-minigeracao-distribuida#:~:text=A%20Lei%20 14.300%2C%20em%20seu,%25%20acima%20de%201000%20kW.

Agência Nacional de Energia Elétrica (Aneel), 2024. Programa Luz Para Todos. (Accessed August 03, 2024) at:. https://www.gov.br/secom/pt-br/acesso-a-informacao/comunicabr/lista-de-acoes-e-programas/programa-luz-para-todos.

Associação Brasileira de Comercializadores de Energia (ABRACEEL); Datafolha Instituto de Pesquisas, 2022. Opinião sobre o setor elétrico 2022 (Accessed September 18, 2024) at:. https://abraceel.com.br/wp-content/uploads/post/2022/11/Pesquisa-Datafolha2022-1.pdf.

Associação Brasileira de Energia Solar Fotovoltaica (ABSolar), 2024. Infográfico (Accessed September 18, 2024) at:. https://www.absolar.org.br/mercado/infografico.

Buckeridge. M.S.; Philippi Junior, A., 2024. Agendas para políticas públicas brasileiras: uma contribuição da USP para a sociedade. Eixos Temáticos USP. Editora da Universidade de São Paulo, São Paulo, 178 p.

Caprara, B., 2017. Thomas Piketty e o capital no século XXI: da economia política à sociologia contemporânea. Sociologias, v. 19 (44), 424-439. https://doi.org/10.1590/15174522-019004431.

Churchill, S.A.; Smyth, R.; Farrell, L., 2020. Fuel poverty and subjective well-being. Energy Economics, v. 86, 104650. https://doi.org/10.1016/j.eneco.2019.104650.

Deaton, A., 2013. The great escape: health, wealth, and the origins of inequality. Princeton University Press, Princeton, New Jersey, 362 p.

Empresa de Pesquisa Energética (EPE), 2024. Análise de experiências estatais internacionais relativas à pobreza e justiça energética: definições, indicadores, medidas e governança. Nota Técnica EPE/DEA/SMA/001/2024 (Accessed November 30, 2024) at:. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-802/NT%20Experi%C3%AAncias%20internacionais_finalSMA19_03_2024.pdf.

Empresa de Pesquisa Energética (EPE); Diversa Sustentabilidade, 2022. Indicadores de bem-estar energético. SIEMAS Bem-estar 2022 (Accessed June 3, 2024) at:. https://www.epe.gov.br/sites-pt/acesso-a-informacao/participacao-social/Documents/SIEMAS%20Bem-estar_Documento%20Base.pdf.

Energy Poverty Advisory Hub (EPAH), 2022. Introduction to the Energy Poverty Advisory Hub Handbooks: A Guide to Understanding and Addressing Energy Poverty published by the Energy Poverty Advisory Hub (Accessed July 24, 2024) at:. https://energy-poverty.ec.europa.eu/system/files/2024-05/EPAH%20handbook_ introduction.pdf.

Equator Principles, 2020. Equator principles EP4 - July 2020 (Accessed July 28, 2024) at:. https://equator-principles.com/app/uploads/The-Equator-Principles_EP4_July2020.pdf.

Fortes, P.A.C., 2015. Refletindo sobre valores éticos da saúde global. SciElo Brazil. Saúde Sociedade, v. 24 (Suppl 1), 152-161. https://doi.org/10.1590/S0104-12902015S01013.

Grupo de Trabalho da Sociedade Civil para a Agenda 2030 (GTSC), 2023. VII Relatório Luz do Desenvolvimento Sustentável (Accessed August 08, 2024) at:. https://gtagenda2030.org.br/relatorio-luz/relatorio-luz-2023/.

Grupo de Trabalho da Sociedade Civil para a Agenda 2030 (GTSC), 2024. VIII Relatório Luz do Desenvolvimento Sustentável (Accessed January 14, 2025) at:. https://gtagenda2030.org.br/relatorio-luz/relatorio-luz-2024/

Instituto de Cidades Sustentáveis (ICS), 2024. Índice de desenvolvimento sustentável das cidades – Brasil. IDSC – BR (Accessed August 21, 2024) at:. https://idsc.cidadessustentaveis.org.br/.

Instituto Pólis, 2022. Justiça energética nas cidades brasileiras, o que se reivindica? (Accessed July 16, 2024) at:. https://polis.org.br/estudos/justica-energetica/.

Intergovernmental Panel on Climate Change (IPCC), 2023. AR6 Synthesis Report (SYR) (Accessed June 06, 2024) at:. https://www.ipcc.ch/report/sixth-assessment-report-cycle/.

International Energy Agency (IEA), 2023. World Energy Outlook 2023 - executive summary (Accessed August 07, 2024) at:. https://www.iea.org/reports/world-energy-outlook-2023/executive-summary.

Lacey-Barnacle, M.; Robison, R.; Foulds, C., 2020. Energy justice in the developing world: a review of theoretical frameworks, key research themes and policy implications. ScienceDirect-Elsevier. Energy for Sustainable Development, v. 55, 122-138. https://doi.org/10.1016/j.esd.2020.01.010.

Lampis, A.; Martín, M.I.; Zabaloy, M.F.; Soares, R.S.; Guzowski, C.; Mandai, S.S.; Lazaro, L.L.B. Hermsdorff, S.M.GL; Bermann, C., 2022. Energy transition or energy diversification? Critical thoughts from Argentina and Brazil. Energy Policy, v. 171, 113246. https://doi.org/10.1016/j.enpol.2022.113246.

Milčiuvienė, S.; Kiršienė, J.; Doheijo, E.; Urbonas, R.; Milčius, D., 2019. The role of renewable energy prosumers in implementing energy justice theory. Sustainability, v. 11 (19), 5286. https://doi.org/10.3390/su11195286.

Nussbaum, M., 1987 Nature, function, and capability: Aristotle on political distribution. World Institute for Development Economics Research, Helsinki. Oxford Studies in Ancient Philosophy, 1988; Proceedings of the 11th Symposium Aristotelicum. Ed. G. Patzig (Accessed April 13, 2024) at:. https://www.wider.unu.edu/sites/default/files/WP31.pdf.

Nussbaumer, P.; Bazilian M.; Modi, V., 2012. Measuring energy poverty: focusing on what matters. Renewable and Sustainable Energy Reviews, v. 16 (1), 231-243. https://doi.org/10.1016/j.rser.2011.07.150.

Oliveras, L.; Peralta, A.; Palència, L.; Gotsens, M.; María José López, M.J.; Artazcoz, L.; Borrell, C.; Marí-Dell'Olmo, M.M., 2021. Energy poverty and health: trends in the European Union before and during the economic crisis, 2007–2016. Health & Place, v. 67, 102294. https://doi.org/10.1016/j.healthplace.2020.102294.

Pan, L.; Biru, A.; Lettu, S., 2021. Energy poverty and public health: global evidence. Energy Economics, v. 101, 105423. https://doi.org/10.1016/j.eneco.2021.105423.

Poveda, Y.E.M.; Losekann, L.D.; Silva, N.R., 2021. Medindo a pobreza energética no Brasil: uma proposta fundamentada no Índice de Pobreza Energética Multidimensional (MEPI) (Accessed September 04, 2024) at:. https://www.anpec.org.br/encontro/2021/submissao/files_I/i12-c15c6e2ebe361586df6f56d963fb3f54.pdf.

Proscanu, M.; Proscanu, C., 2023. Examining the potential influence of energy transition on overall well-being. EMERG, v. X (2/2023), 19-29 (Accessed September 11, 2024) at:. https://emerg.ro/wp-content/uploads/2024/07/2-EXAMINING-THE-POTENTIAL-INFLUENCE-OF-ENERGY-TRANSITION-ON-OVERALL-WELL-BEING.pdf.

Rawls, J., 1999. A theory of justice: revised edition. Harvard University Press, Belknap Press, [S.l.], 560 p. https://doi.org/10.2307/j.ctvkjb25m.

Riva, M.; Debanné, L.; Kutuka, S.; Bertheussen, M.; O'Sullivan, K.C.; Das. R.R., 2024. Energy poverty and well-being at the local level: insights from a community-wide survey in Atlantic Canada. Energy Research & Social Science, v. 117, 103709. https://doi.org/10.1016/j.erss.2024.103709.

Sachs, J.D., Lafortune, G., Fuller, G., 2024. The SDGs and the UN summit of the future. Sustainable Development Report 2024. Dublin University Press (Accessed July 20, 2024) at:. https://www.dublinuniversitypress.com/_files/ugd/ace0db_9e9056cbf445437fba265cd5b90c0f37.pdf.

Sen, A. Development as freedom, 2000. Knopf, Inc., New York (Accessed June 06, 2024) at:. https://kuangalia.com/wp-content/uploads/2017/07/amartya_kumar_sen_development_as_freedombookfi.pdf.

Sermarini, A.C.P.; Azevedo, J.H.P.; Albuquerque, V.C.; Calili, R.F.; Gonçalves, F.; Januzzi, G., 2024. Recursos energéticos distribuídos em comunidades de baixa renda: uma proposta de política pública para o Brasil. Energy Policy, v. 187 (2024), 114030. https://doi.org/10.1016/j.enpol.2024.114030.

Sovacool, B.K; Halff, A.; Rozhon, J. (Eds.), 2015. Energy poverty: global challenges and local solutions. Oxford Academic, Oxford. https://doi.org//10.1093/acprof:oso/9780199682362.001.0001.

Torchio, M.F.; Lucia, U.; Grisolia, G., 2020. Economic and human features for energy and environmental indicators: a tool to assess countries' progress towards sustainability. Sustainability, v.12 (22), 9716. https://doi.org/10.3390/su12229716.

United Nations (UN), 2024a. The Sustainable Development Goals Report (Accessed October 17, 2024) at:. https://unstats.un.org/sdgs/report/2024/goal-07/.

United Nations (UN), 2024b. UN Energy: targets & indicators (Accessed March 17, 2025) at:. https://www.un.org/en/energy/page/sdg7-targets-indicators.

Volodzkiene, L.; Streimikiene, D., 2023. Energy inequality indicators: a comprehensive review for exploring ways to reduce inequality. Energie, v. 16 (16), 6075. https://doi.org/10.3390/en16166075.

Wilkinson, R.; Pickett, K., 2009. The spirit level - why more equal societies almost always do better. Social Justice Research, v. 25 (1). https://doi.org/10.1007/s11211-012-0148-9.

World Health Organization (WHO), 1978. Report of the International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September (Acessed June 01, 2024) at:. https://www.who.int/publications/i/item/9241800011

World Health Organization (WHO), 2024. Health impact assessment (HIA) methods (Accessed on October 02, 2024) at:. https://www.who.int/tools/health-impact-assessments.