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Review

Recent trends on the linkages between energy, SDGs and the Paris Agreement: a review of policy-based studies

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Abstract

Background It has been more than five years since the adoption of the 2030 Agenda for Sustainable Development with its Sustainable Development Goals (SDGs) and the Paris Agreement, which seek to improve the well-being of people and the planet and strengthen the global response to the threat of climate change. While these major international commitments have spurred a lot of policy debates and academic research, a synthesis of how their adoption has shaped the academic discussions in pursuit of these goals in specific sectors such as energy is limited. Using a systematic review method following the PRISMA procedure, we examine the emergent trends in the academic discussions on the linkage between these international agendas and energy with a specific reference to policy-based research publications.

Results Our analysis found that many studies on this subject are predictive/prescriptive, attempting to forecast and map out various pathways by which these international commitments may be achieved. Studies on the progress of implementation of policies and their impacts on these goals are somewhat limited. The three most common policy-related issues identified by the studies reviewed are lack of integrated/cross-sectoral planning, narrow emphasis on energy justice in policies, and the need for more cost-effective strategies in pursuit of the Paris Agreement.

Conclusions This study revealed emerging trends in energy debates and policy discourse within academic discussions addressing the SDGs and the Paris Agreement. Research on the progress of implementation, impacts and critical lessons from current policy efforts to achieve these global agendas are needed. Country case studies, in particular, can encourage policy-learning through cross-country comparisons, which can inform regional and domestic energy policies towards achieving the SDGs and the Paris Agreement.

Keywords Energy policy · Sustainable development · Climate change · Energy transition · Paris Agreement · SDGs

1 Introduction

Energy has long been a significant driver of societal development. Yet, its use has become one of the greatest challenges that the world is facing today, with fossil-based energy being a leading cause of global warming and climate change. Since the inception of the concept of sustainable development in 1987, energy has been identified as a crucial element in achieving this concept; however, its specific role in this process was not made clear [1]. The unsustainable dimension of energy was first acknowledged in the World Energy Assessment Report by the United Nations Development Programme, where the downsides of energy development on the environment and society as a whole were taken into account [2].

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Despite its recognition as a driver of sustainable development and, at the same time, a potential challenge to sustainability, leading international commitments such as the Millennium Development Goals (MDGs) failed to consider energy as a major sustainability concern.

This concern came to light in United Nations (UN) MDG follow-up resolution, which recognised energy as necessary for achieving the MDGs and sustainable development [3]. Consequently, the UN Sustainable Energy for All initiative was launched in 2011, and subsequently, the 2030 Agenda for Sustainable Development (the Sustainable Development Goals-SDGs) was adopted in 2015. The Paris Agreement was adopted in the same year with an ambitious target to limit global warming to 1.5 degrees by 2050. These international commitments have spurred new interests in developing and utilising energy, ranging from emission reduction approaches to justice dimensions in energy access and transitions.

These various dimensions of sustainable energy development regarding how we generate and use energy broadly underpin the concept of the sustainable energy transition, transcending both technological innovations and institutional and behavioural changes. The term socio-technical transition has, thus, become common parlance in sustainable energy discussions, with the socio-technical transitions theory (STT) currently being one of the leading theoretical frameworks applied in sustainable energy transitions research [4]. Sustainable energy development is also known to have costs and benefits and sometimes creates winners and losers [5, 6]. Hence, meeting the world's energy needs in a sustainable and fair manner is a key issue of interest in the energy transition discourse. Consequently, several studies dealing with various aspects of energy justice have emerged over the past few years.

Muller et al. [6], for instance, examined the extent to which energy justice is mainstreamed into renewable energy policies of Sub-Saharan African countries. They noted that mainstreaming energy justice into policies could engender co-benefits of SDG 7 within a broader energy transition context. Upon further analysis of the energy transition process in 34 African countries, Muller et al. [6] found that current policies for energy transitions do not comprehensively address questions of energy justice in Africa. Fathoni et al. [5], on the other hand, studied energy injustices in rural Indonesia with a focus on community renewable energy. They found that the apolitical framing of community renewable energy interventions has the potential to perpetuate energy injustices in rural energy provision.

Sustainable energy, energy transition, and energy justice have become more prominent in contemporary energy and sustainable development discourse. However, studies that synthesise how the adoption of the SDGs and the Paris Agreement has shaped this discussion and the emergent research themes are limited. We argue that such studies are important as they could provide relevant insights for policymakers and researchers on current trends and future pathways for achieving SDG 7 and the target set by the Paris Agreement. Hence, this review seeks to ascertain and examine the emergent trends in the policy and academic discussions on the linkage between SDGs, Paris Agreement and energy, especially on energy policies, energy access, energy transition, and renewable energy.

The methodology used for the review is presented in the ensuing section. Section 3 offers the results and discussion of our findings. Key issues discussed under the results include techno-economic considerations, policy drivers, policy foci, suggested policy changes, and divergent conclusions/views from current research. Section 4 discusses in-depth strategies existing research has offered to advance efforts to fulfil the commitment to the Paris Agreement and achieve the SDGs, especially in the energy sector. Finally, we summarise our findings, draw some conclusions and outline areas for future research in Sect. 5.

2 Methodology of literature search

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [7] procedure was followed in conducting this review. This process includes four main steps: identifying relevant literature, screening, eligibility, and inclusion [7]. In the first stage (identification), a literature search was conducted in the SCOPUS and ScienceDirect. ScienceDirect is a renowned source for scientific publications. It provides access to a bibliometric database that hosts over 19 million articles and book chapters across more than 2650 peer-reviewed journals published by Elsevier [8]. SCOPUS, on the other hand, is a leading database of peer-reviewed journals from different publishers such as Springer Nature, Elsevier, Routledge, Taylor and Francis, etc., with comprehensive bibliometric data of published articles in various disciplines. The database extensively covers inter-disciplinary research topics in a wide range of peer-reviewed journals [9]. Both databases were chosen based on their extensive coverage of peer-reviewed publications. Prior to searching the SCOPUS database for relevant documents, a search criterion was designed. This search criterion included the keywords: renewable energy, sustainable energy, energy, policy, SDGs and Paris Agreement.

The keywords used were renewable energy, sustainable energy, energy, policy, SDGs and Paris Agreement. Two separate searches were conducted for the SDGs and the Paris Agreement. For the ScienceDirect database, the search strings ("renewable energy" OR "sustainable energy" OR "energy") AND "policy" AND "SDGs" and ("renewable energy" OR "sustainable energy" or "energy") AND "policy" AND "Paris Agreement" were used to retrieve relevant documents. The same keywords were searched in the SCOPUS database. Next, the search criteria were narrowed to original research articles, review articles, and book chapters, a period from 2015 onwards, and articles authored in English only. The period was limited to 2015 onwards due to the fact that both the SDGs and Paris Agreement were adopted this year. The subject area was also limited to energy, social science, and environmental science. An example of the final search string in SCOPUS is: *TITLE-ABS-KEY (("renewable energy" OR "sustainable energy" OR "energy") AND "policy" AND "SDGs") AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re") OR LIMIT-TO (DOCTYPE, "ch")) AND (LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (LANGUAGE, "English"))* for SDGs and *TITLE-ABS-KEY (("renewable energy" OR "sustainable energy" OR "energy") AND "policy" AND "paris agreement") AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re") OR LIMIT-TO (DOCTYPE, "ch")) AND (LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (LANGUAGE, "English"))* for the Paris Agreement. These searches were conducted in February 2021.

The initial search of the keyword combinations turned out 5146 documents in Sciendirect and 648 documents in Scopus, hence, a total of 5794 documents from both databases. Limiting to the above criteria resulted in the exclusion of 2687 publications. The remaining 3107 documents were exported to Mendeley library, where their titles and abstracts were screened for eligibility. This screening resulted in the exclusion of 2156 publications that were unsuitable for the study's objectives. In the next step, the remaining 951 publications were assessed for eligibility by skimming the full texts of the documents. Through this process, 675 publications that did not match the objectives of this study were further excluded. Finally, in-depth reading and assessment of the remaining 276 publications were done to select suitable publications for inclusion in the final analysis. Studies that specifically dealt with either the energy policies and SDGs or energy policies and the Paris Agreement were selected for inclusion. The final assessment led to the exclusion of 196 publications. As a result, 80 documents were selected for inclusion in the review. However, in the course of the review, a World Bank report which was referenced in one of the publications was identified from the Google Scholar database and added to the review. Hence, a total of 81 documents were included in the final analysis. The search selection procedure of documents from SCOPUS and ScienceDirect is outlined in the PRISMA flow chart in Fig. 1.

3 Results and discussions

3.1 Characteristics of selected documents

The majority of documents included in the review were original research articles. Original research articles constitute 88% of the publications, while review articles, book chapters and reports constituted 9%, 2%, and 1%, respectively. Elsevier's Energy Policy, Energy Research and Social Science, and Renewable and Sustainable Energy Reviews journals are the top three journals with the highest number of publications on the policy aspects of SDGs and the Paris Agreement. The top ten journals in terms of the number of publications are presented in Fig. 2.

Despite the SDGs and Paris Agreement being launched in 2015, publications on these subjects only started to emerge in 2017. Studies published this year were mainly predictive, trying to map out possible scenarios for achieving the SDGs and the Paris Agreement. Notably, studies focusing on the Paris Agreement [11–13] have all used scenario analysis to map possible pathways for attaining the Paris Agreement. On the other hand, SDG focused studies published this year were review articles [14, 15] and focused on exploring how renewable energies can facilitate the achievement of the SDGs by 2030. Regarding the geographic focus, most of the publications had a global focus, with a significant proportion focusing on Africa (21%) and Asia (17%).

Characteristically, publications with a geographic focus on Africa and some parts of Asia deal more with energy and the SDGs than the Paris Agreement. These regions have some of the lowest energy access rates in the world. With SDG 7 specifically targeting access to clean and affordable energy services, it is understandable that research in these regions focuses on the SDGs. On the other hand, much of the studies with global foci and a focus on Europe, Asia and the Americas tend to emphasise the Paris Agreement, particularly on low emission pathways that can help achieve the 1.5-degree target by 2050. This is also understandable since most of the largest greenhouse gas (GHG) emission countries are in these regions. China, European Union (EU), and the United States, the top three countries

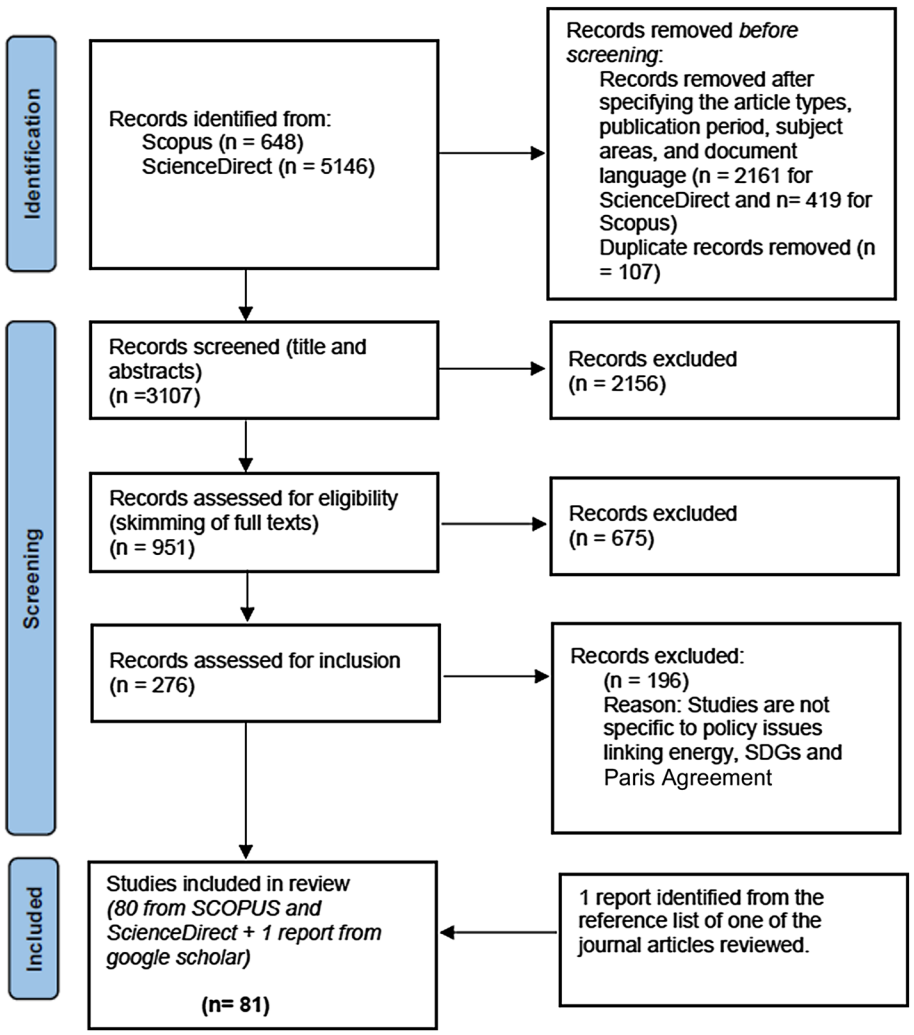

Fig. 1 Document identification and selection process. Adapted from Page et al. [10]

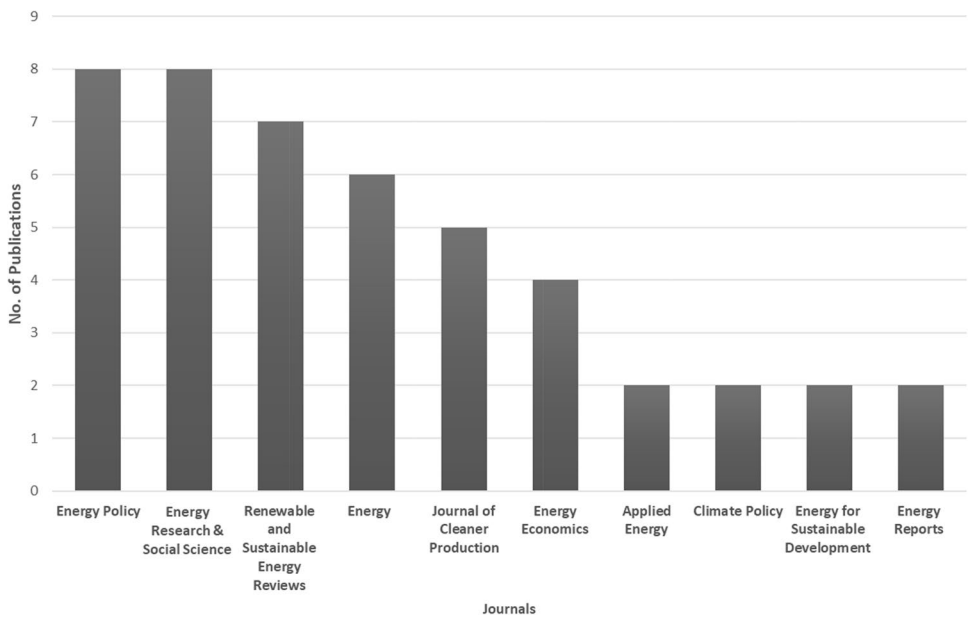

Fig. 2 Top ten journals based on the number of articles published. Source: Authors

and regions with the highest GHG emissions, are in this category [16]. The trend of publications and their regional focus are presented in Figs. 3 and 4, respectively.

The supply side of energy is also dominant in the sectoral focus of publications, with the majority of studies focusing on electricity generation. The second-largest proportion of studies was not specific to any sub-sector but rather the entire energy sector. The dominance of electricity generation as the focus of most publications possibly is because: (i) more energy needs to be generated to meet both unmet and rapidly increasing demand in the global South (SDG focus), and (ii) there is a need to phase out polluting fuels in the energy mix of the advanced countries through renewable energy generation (Paris Agreement focus) in order to engender the attainment of the SDGs and also to reduce global warming. Consequently, the most widely applied method in the research reviewed was quantitative, with modelling/scenario analysis being the dominant approach. Most studies were, thus, predictive and prescriptive in nature, often attempting to forecast possible pathways for achieving the SDGs and the targets of the Paris Agreement. Figs. 5 and 6 present an overview of the sectoral focus and the variety of methods applied in the observed publications, respectively.

Salvia et al. [17] tried to answer whether the EU climate mitigation ambitions will lead to carbon neutrality, while Liobikienė et al. [11] examined the possibilities of the EU meeting the targets of the Paris Agreement. Several other

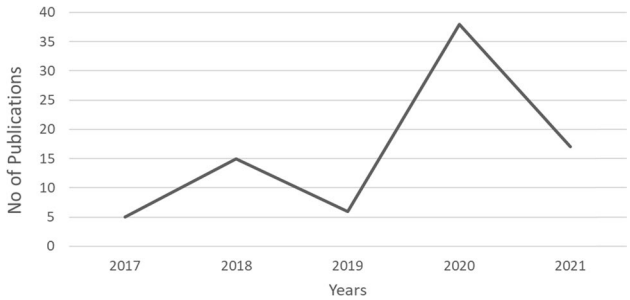

Fig. 3 Trend of publications. Source: Authors

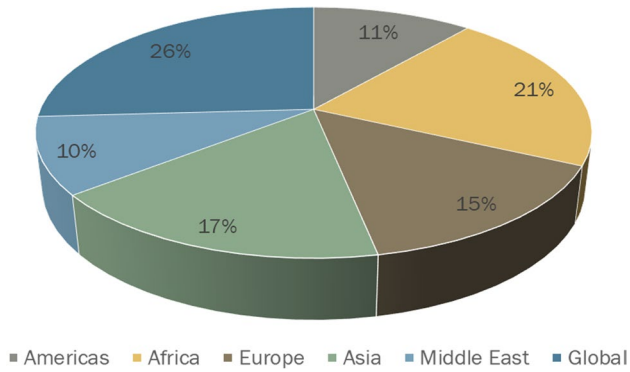

Fig. 4 Regional focus of publications. Source: Authors

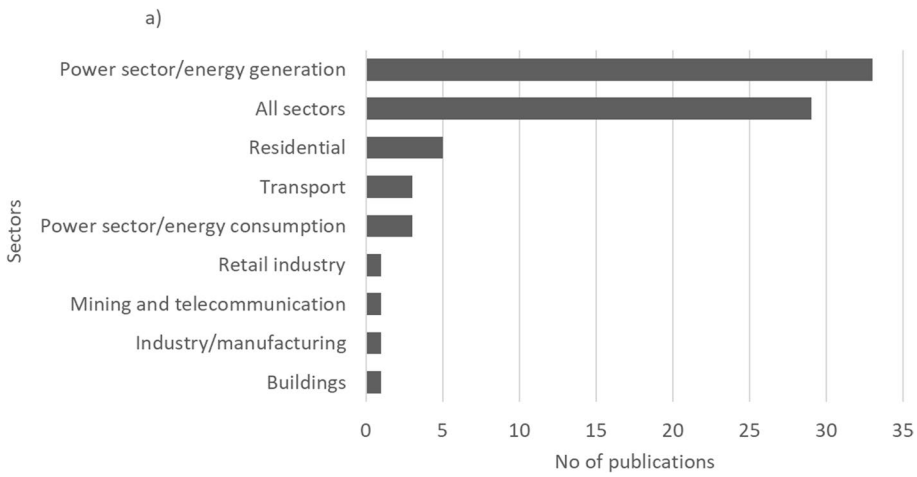

Fig. 5 Sectoral focus of the observed publications Source: Authors

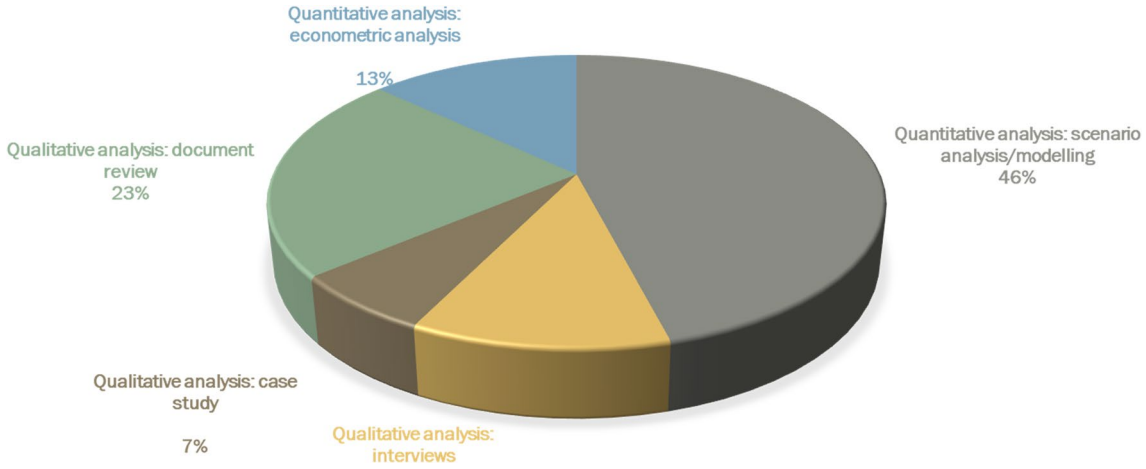

Fig. 6 Methods used in the publications reviewed. Source: Authors

studies [18–21] have used such scenario analysis/modelling approach. The dominance of these modelling/scenario analysis studies indicates that studies on the progress, actual implementation, and impact of policies on achieving these international commitments are quite limited. Takao [22] noted that despite effective renewable energy transition in Japan resulting primarily from conflict-free policy coordination, a great deal of research is yet to be done on mayoral policy coordination, which succeeded or failed in different modalities of key policy coordination.

3.2 Policy focus and key themes

3.2.1 Keywords and themes

Consistent with the SDGs and the Paris Agreement, which were the main focus of this review, the dominant keywords found in the publications were; renewable energy, climate, Paris, SDGs, emissions, greenhouse, and policy, amongst others. Four major themes were, however, deduced from the publications. Hence all 81 documents analysed focused on one of four themes: finance, policy and regulation, climate mitigation and energy-SDGs nexus. These themes and their sub-categories are presented in Fig. 7. A majority of studies (42) fell under the climate mitigation theme. Many studies on this theme dealt with the Paris Agreement, with decarbonisation and GHG emission reduction being the principal focus of most studies. On the other hand, SDG research focuses more on policy/regulations, with issues such as energy poverty, energy justice, energy economics and policy planning being some of the key issues addressed by studies on this theme. These findings reflect the viewpoint of Gunnarsdottir et al. [3], who, upon reviewing the history of sustainable energy development, noted that ensuring equitable access to clean and affordable energy is crucial for attaining sustainable development.

However, transforming the current energy system requires economically viable technologies and realistic energy prices that reflect externalities associated with energy development [3]. Such economic and equity issues are reflected in the policy/regulations theme in Fig. 7. Also, while energy was recognised as a critical element for achieving the SDGs, its development presented possible downsides which could threaten the overall goal of sustainability. Hence, studies investigating the nexus between energy and the SDGs (both positive and negative) emerged not long after the goals were launched. One of the highly influential studies in this respect was carried out by Nerini et al. [23], who examined the synergies and trade-offs between energy and the SDGs. Their study found 143 synergies and 65 trade-offs between energy and the SDGs, implying that while energy development could largely contribute to attaining the SDGs, it also has potential negative impacts that need to be mitigated in the process of its development. Similar studies investigating the interconnections between water, energy, and food (WEF nexus) constitute 16% of the 81 publications reviewed.

Fig. 7 Emergent themes from the studies reviewed. Source: Authors

3.2.2 SDG Policy focus and policy drivers

While the sectoral focus of most publications on the Paris Agreement was on power generation (supply side), SDG research focused more on the demand side of the energy equation. Upon examining the full text of the SDG publications, we assigned keywords regarding the policy focus of these publications. A word cloud (Fig. 8) generated from these keywords shows that demand-side issues such as energy consumption, household energy appliances and energy efficiency were dominant in the SDG research. In terms of the policy drivers, decarbonisation (25%) and clean energy transition (24%) were prevalent in the research on SDGs. The dominance of these issues has tended to overshadow other important dimensions, such as energy justice. Müller et al. [6] further noted that energy transition studies have only selectively engaged with questions of justice and the political qualities of a green transition in the African context. Consequently, they argued that mainstreaming the justice dimension and fostering comprehensive policy frameworks that balance developmental concerns and market creation is essential for the clean energy transition and sustainable development in Africa. The policy focus and key drivers are outlined in Figs. 8 and 9, respectively.

Fig. 8 Policy focus of publications on energy and the SDGs. Source: Authors

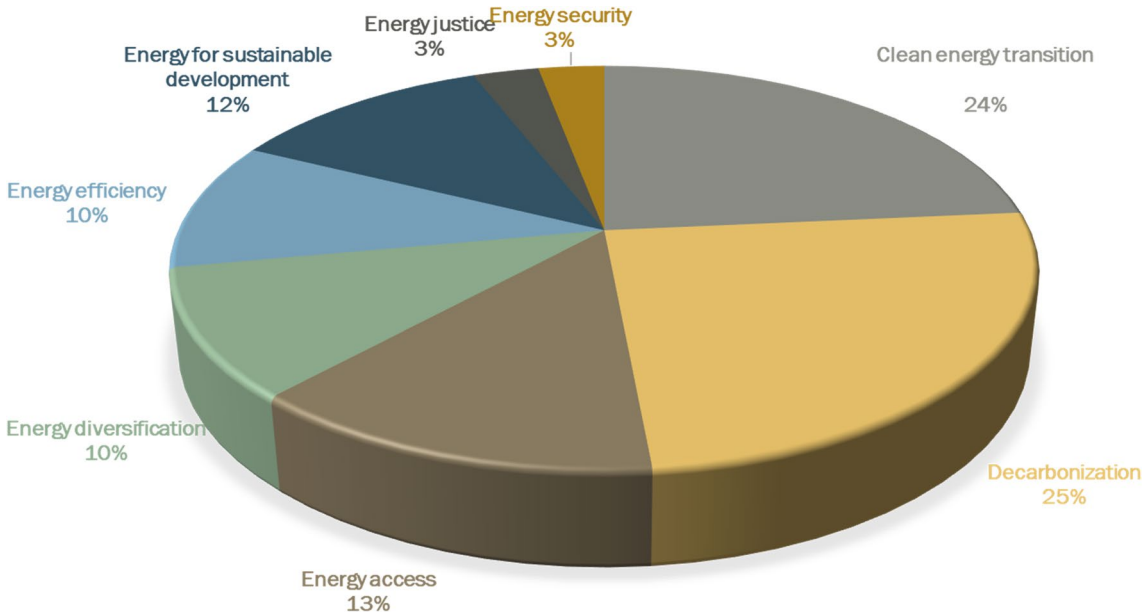

Fig. 9 Key drivers of energy policies for SDGs. Source: Authors

3.3 Some emergent trends from current policies

Studies that have analysed energy policies in pursuit of the SDGs and the Paris Agreement have unveiled some gaps in existing policies of various countries and regions. A summary of these gaps and emerging trends is outlined in Table 1. Battaile et al. [24] found a lack of coordination between policy and industry, with policymakers having limited knowledge of climate mitigation options in industries, resulting in unbalanced/biased policies. Santika et al. [25] noted that in Indonesia, the national policy's focus on a single energy source (gas) is insufficient to achieve the clean cooking targets since most households have low incomes and mostly rely on biomass for their cooking energy

Table 1 Some emergent issues from current policies

Issues	Thematic focus	Policy arguments/ findings	Recommendation	Authors
Policy research and development	Technology and policy deep decarbonisation options for energy-intensive industry production	Knowledge of industry mitigation options is low, leading to skewed policy & effort	Policies combining R&D, commercialisation support and GHG pricing are needed	Bataille et al. [24]
	African renewable energy policies, transitions & energy justice	Transition studies have not comprehensively addressed the issue of energy justice and the politics of green transition in Africa	Balancing market creation with equitable development through mainstreaming energy justice into policy frameworks	Müller et al.[6]
Policy implementation	Policies for a Sustainable Biomass Energy Sector in Malawi	Policy measures aimed at increasing cooking efficiency are not enough to decrease the demand for cooking energy due to high population growth	Biomass energy can be inherently sustainable and should figure prominently in the Sustainable Development Goals	Schuenemann et al. [26]
	Energy policy impacts on achieving Sustainable Development Goal 7 in Indonesia	Energy use is shaped by policies not primarily intended for energy conservation	Favourable regulation is needed to encourage investment in renewable electricity	Santika et al. [25]
Governance and institutions	Institutional conditions for SDG 7 in Haiti	Weak institutional conditions and low political will to curtail corruption constrain the achievement of SDG 7	Institutional and market reforms alongside genuine engagement of stakeholders and political elites	Mombeuil [27]
	Local mayors and renewable energy transitions in Japan	Conflict-free policy coordination brought by forward-looking local mayors leads to effective transitions to renewable energy in Japanese towns	There is a great deal of research yet to be done, in particular on mayoral policy coordination, which succeeded or failed in different modalities of key policy coordination	Takao [22]
	Energy injustices and inequalities in community-based renewable energy in rural Indonesia	Top-down and techno-managerial framing of community-based renewables perpetuates energy injustices at the local level	Decentralised energy planning	Fathoni et al. [5]

Source: Authors

needs. They also found that energy use was not influenced by policies that were purposefully designed for energy conservation. These findings highlight possible trade-offs in energy policies which can be either positive or negative. Another crucial gap that was unearthed was the failure of energy policies to adequately incorporate energy justice issues. This issue was found, particularly in Africa, with many studies not entirely dealing with the question of energy justice in the context of sustainable energy transitions [6].

While many studies have also used scenario analysis/forecasts to predict how and when the SDGs and Paris Agreement targets may be achieved, there are divergent views regarding attaining these international commitments. One stream of studies shows that current policy efforts are on track to fulfilling these commitments, while another stream of studies suggests that this is not the case. One of these divergent perspectives was on the role of biofuels in achieving the SDGs. Even though biofuels are recognised as clean fuels, biomass/biofuel development has negative impacts, especially on agricultural production, and could potentially impact food security [15, 28, 29].

However, some authors argue that biomass should feature more prominently in pursuit of the SDGs because they are inherently sustainable [26]. Diverse standpoints also exist on whether current policy commitments toward the Paris Agreement target are sufficient or otherwise to achieve the target. Some studies [29–31] suggest that current policy efforts are on track toward achieving the Paris Agreement target. In contrast, others suggest that current efforts are insufficient and may need to be doubled to keep the global temperature below 1.5 °C [17, 32].

3.4 Techno-economic and socio-political issues

Three key issues emerged regarding the economic aspects of achieving the SDGs and the Paris Agreement. First, many studies have established that strengthening local financial markets and increasing funding for renewable energies is critical to both the SDGs and the Paris Agreement. Consequently, green finance, green bonds and green investments have become commonly used terms in SDGs and Paris Agreement research. Prakash and Sethi [33] argued that green bonds could boost finance for achieving India's planet-related SDG targets. Chirambo [34] noted that with climate finance, no one would be left behind regarding energy access in Sub-Sahara Africa. Banacloche et al. [35] also found that green investments could increase Mexico's GDP and employment rate by nearly one per cent while significantly reducing carbon emissions. In Brazil, Lima et al. [36] identify tax incentives as a key policy strategy that can stimulate the use of renewable energies.

Despite these direct roles that financial mechanisms have been identified to play in advancing clean energy for the SDGs and the Paris Agreement, significant trade-offs have also been identified. One of these trade-offs is the potential of low-carbon finance to worsen the poverty situation, especially in the global South [37]. Frakgos et al. [31] argued that energy system transformations require significant reallocation of resources/investments towards low-carbon technologies, which presents a potential problem of increasing affordability issues in many countries. In line with this viewpoint, Brunel et al. [37] assert that green transition finance could jeopardise poverty alleviation efforts. Zhou et al. [38] also noted that low-carbon investment would significantly reduce the capital investment needed to achieve the SDG target for air quality even though it would minimally boost the requirements for achieving the targets on clean water and food security.

A second economic issue that emerged from the reviewed literature is the need for cost-effective solutions in pursuit of the Paris Agreement. Quite a number of studies have shown that pursuing the targets of the Paris Agreement could come at some economic costs to countries. According to Liu et al. [32], leaving the Paris Agreement raises the exiting country's GDP even though it reduces some domestic co-benefits in terms of carbon emissions. Similarly, Nong et al. [20] also found that retreating from the Paris Agreement would increase the real GDP and actual private consumption by 1.13% and 0.78%, respectively, in the US, while Kat et al. [19] noted that Turkey's pledge to the Paris Agreement might be possible at a modest economic cost of about 0.8–1% by 2030. These economic downsides possibly accounted for the resistance some countries showed in pursuing the Paris Agreement and, consequently, the US withdrawal from the accord under the Trump administration.

Hence, while meeting the targets are desirable for global sustainability, more cost-effective pathways are needed to ensure that countries stay committed to these targets [39]. Filho et al. [39] noted that the costs associated with implementing the SDGs, alongside a lack of investor awareness of sustainable investments and the perception that investing in sustainability is non-profitable, are critical challenges to realising the SDGs in general. The cost of renewable energy technologies emerged as a crucial factor for sustainable energy development, especially in the global South. According to Gyamfi et al. [40], the cost of renewable energy technologies is a barrier that hampers the integration of renewable energy technologies for sustainable development in Sub-Sahara Africa. Finally, a third economic issue emergent from the literature is the need for good regulations to facilitate energy for sustainable development and the Paris Agreement.

Regulatory uncertainties, for instance, have been found to discourage investments in renewable energies in Indonesia [25]. In line with this finding, Michaelowa et al. [41] argued that policymakers must establish regulatory environments that ensure market mechanisms provide the private sector with the certainty needed to invest in sustainable energies.

With regard to socio-technical and political issues, one recurrent issue was the challenge of policy coordination between various levels of government. Sanderink [42] frames vary strongly across different levels of governance and among multiple types of renewable energy institutions. Consequently, such institutions prioritise climate change with a strong emphasis on universal energy access without considering energy scarcity [42]. Pischke et al. [43] also stressed the need for increased coordination between different levels of government in the implementation of energy policies noting that countries may be spending resources on creating numerous renewable energy policies, but those resources may be wasted while GHGs continue to rise due to a lack of coordination between different levels of government. Concerns for energy justice also feature prominently in research on SDGs in developing regions. According to Muller et al. [6], institutions in Sub-Saharan Africa need to provide support for mainstreaming energy justice and fostering comprehensive policy frameworks that account for developmental concerns and market creation. Table 2 summarises critical techno-economic and socio-political issues across observed literature.

4 Moving forward: rethinking policy change frameworks

The most dominant policy change that emerged from the recommendation of most of the studies reviewed is the need for integrated and cross-sectoral energy planning [26, 46–51] and targeted policy approaches [13, 51–53]. Many authors advocated for the integrated strategy, noting that the lack of integrated and cross-sectoral planning poses a significant challenge to achieving the SDGs [48, 54]. Policymakers could no longer work in silos and develop energy plans based on only assumptions from the energy sector and try to achieve SDG 7 [48] or myopic environmental policies focusing only on GHG emissions [47] and increasing generation capacity [34]. A holistic approach, which covers energy and infrastructure, agriculture, climate, public health and economic growth, underpins a country's development efforts, which is not always the common perspective in policymaking or implementation [55–57]. Policymakers must also incorporate the additional energy demand necessary to accomplish other SDGs and transformation toward decarbonisation [48, 58]. Relevant to this issue, it is found that countries with tangible positive economic growth effects on their per capita CO2 emission made significant advancements in the SDGs, implying that embedding carbon in highly intensive sectors greatly impacts other sectors' carbon footprints [59]. Countries following 'low CO2 emission and high SDG attainment' development pathways or countries with strong agenda on well-being targets have a policy focus to facilitate investment that allows expansion of essential public services coverages, such as health, education, energy, water, and sanitation [23, 34, 59]. It should be noted that each country's advantages vary, and such a strategy is highly possible for countries endowed with rich renewable resources and low energy-intensive sectors. For countries with low GDP per capita and modest decarbonisation targets due to dependency on non-renewable energy sources, minimising the cost of energy transitions by focusing on integrating energy into socially equitable policies is key to benefit from energy transitions [60].

Favourable regulations provide a strong impetus for investments in sustainable energy and green projects [25, 33, 38, 61]. However, regulatory uncertainties remain a significant barrier to renewable energy investments. Santika et al. [25] noted that about five times the current budget allocation for renewable energy development is needed to meet Indonesia's electricity access target by 2025. They argued that resolving regulatory uncertainties could help achieve this target earlier since it will encourage more investments in renewable electricity. In Niger, disarray between energy policies and development blueprint and unsustained and inconsistent energy policies hinder the implementation of sustainable energy projects [62]. Technologically advanced countries can benefit from stricter environmental regulations coupled with the advancement in environmentally friendly technological innovation to offset negative economic shock [63, 64]. Aside from institutional and policy reform necessary to resolve regulatory uncertainties, existing research suggests that environmentally friendly-Foreign Direct Investment (FDI) inflows can be vital in improving prudent policies, implementation, and regulatory quality [65]. For example, FDI-induced clean and modern technological transfer with improved management are vital to achieving environmental sustainability in Sub-Saharan Africa [66].

In a similar viewpoint, Kumi et al.[67] stressed that the private sector could significantly contribute to the SDG corporate social responsibility (CSR). Multi-stakeholder dialogue and partnerships and a regulatory framework are crucial to guide the CSR initiatives toward realising the SDGs and Paris Agreement ambitions, emphasising the need for collaborative planning [21, 67]. In Greece, Gkonis et al. [68] noted that the cost-effectiveness of existing energy efficiency policies obscure opportunities for public–private partnerships regarding investment in sustainable energy. Financial instruments,

Table 2 A summary of the key techno-economic and socio-political issues

Category	Authors	Argument/issues identified
Economic	Prakash and Settin [33]	Financing India's SDG targets could be met with green bonds
	Michaelowa et al.[41]	Market mechanisms need to be managed well to provide the private sector with the certainty necessary to commit to fresh investments
	Chirambo [34]	Climate finance can ensure that "no one is left behind" in energy access
	Banacloche et al. [35]	Green investments in Mexico could increase the Mexican GDP and employment rate by nearly one per cent while simultaneously contributing to the carbon emission footprint
	Brunel et al. [37]	Green transition finance could jeopardise poverty alleviation efforts
	Liu et al. [32]	Withdrawal from Paris Agreement positively impacts the GDP of the leaving country but significantly brings down the domestic co-benefits of controlling CO2 for the country
Techno-economic	Gyamfi et al. [40]	The cost of renewable energy technologies is a barrier to integrating renewable energy technologies for sustainable development in Sub-Saharan Africa
	Giacomelli et al. [44]	Increasing renewable energy rather than directly mitigating emissions yields more economically and environmentally efficient outcomes, favouring a faster and more far-reaching transition to a greener economy
Socio-technical	Pischke et al. [43]	There is a need for coordination between different levels of government in implementing energy policies
	Muller et al. [6]	Transition studies have so far only selectively engaged with questions of justice and the political qualities of a green transition in the African context
	Bataille et al. [24]	Knowledge of industry mitigation options is low, leading to skewed policy & effort
	Leipprand et al. [45]	Sequencing, based on triggering positive and controlling negative feedback, is relevant within and across policies

Source: Authors

thus, could be designed to synergise private funding for investment in sustainable energy while keeping risks at low levels [38, 68]. However, the issues are not only about designing financial instruments. Existing carbon market mechanisms and climate finance institutions have successfully engaged the private sector in a variety of roles, yet unilateral implementation models, such as single Clean Development Mechanism (CDM) projects, have difficulties taking off in many African developing countries. This is due to a lack of domestic capital availability, dependency on subsidy, insufficient emission credit revenue, unmanaged market mechanisms, and lack of synergies between international and national sources of finance in the context of Nationally Determined Contributions (NDCs) [38, 41]. Toward this end, stronger private sector engagement can be forged by simultaneously enabling private sector access to the existing climate mechanisms, such as CDM, and providing the certainty necessary for the private sector to commit to investments [41].

Well-designed policy instruments need to balance government interventions, profit motivations and socio-environmental responsibility taken by the private sector, which means the public sector has to lead in expanding the service coverage and providing necessary guarantees and regulations [33, 59]. With developing countries often suffering from endemic corruption and political insecurity, high financial risk and low payment capacity, setting up institutions to respond to the risks and improving programmatic procedures have proven to be beneficial. Institutions or mechanisms that can monitor the effective implementation of climate funds in the energy sectors are largely missing, and institutional reforms are highly required [27, 34]. Successful examples are the Rural Electrification Development Agency of Madagascar, which conducts feasibility assessments to improve understanding of resource availability and the Ethiopian case of simplifying the registration procedure to access the CDM market. In the context of NDCs, clarifying interrelationships between the government and the private sectors can help provide long-term investment certainty for private actors, including by integrating existing mechanisms relevant to the Paris Agreement and the SDGs with domestic finance mechanisms [41]. The situation in South Africa offers an example where anchoring the NDC into the flagship policy instrument can provide a clear timing and scale of procurement appeals to private investment, having a procedural process and financial guarantees of the government. Existing research also showed that stringent NDCs exert positive impacts on green bond-based investments in renewable energy [69]. Increasing the NDC ambitions for strengthening climate action will contribute to closing the gap toward the required systemic transformation in many countries [31, 69].

Policies on climate change closely relate to domestic interests and need to be understood within the broader development priorities. This explains why despite the national commitment to the Paris Agreement and the SDGs, implementing policy change is a challenging task. Gulf countries, for example, suffer from a narrow operational focus that does not correspond to a resilient understanding of environmental security or to the climate-related risks and fluctuating interest in climate change driven by economic aspirations and regional security, which leads to underperformance with regard to achieving key parts of the SDGs and other global sustainability agenda [70]. For the Gulf countries, regional and domestic issues such as the region's political turmoil and the vital importance of carbon fuels have resulted in reluctant policy integration and fragile institutions relevant to sustainable development and climate change. Narrow policy focus is prevalent in other countries. The Clean Power Plan in the United States, characterised by inexpensive natural gas, needs to be coordinated with other policies to avoid adverse impacts of spillover from upstream fugitive gas emissions [13]. In Indonesia, energy use is shaped by policies not primarily intended for energy conservation, and renewable energy targets are undermined by a growing coal consumption target [25]. Fragile institutional conditions also hinder progress towards SDG 7 in developing countries, such as Haiti, where inadequate political support and corruption compound this problem [27]. Mombeuil [27] suggests that the country needs institutional reforms alongside stakeholders and political elites to advance progress towards achieving SDG 7. Centralised energy planning was also identified as a critical shortfall in current energy policies; hence, decentralised energy planning is advocated for sustainable energy development.

Top-down and techno-managerial framing of community-based renewables might perpetuate energy injustices on the ground [5, 56]. Identification of synergies and trade-offs between actions on SDG 7 and other SDGs can refocus attention on vulnerable population groups and sectors, especially where infrastructure and services are limited [57]. Moreover, public engagement in energy policymaking has enabled vulnerable groups to have a voice in energy transition [56]. Such a decentralised approach helps identify and understand the needs and aspirations of energy users to design appropriate and effective policies that meet their needs. This is important from the perspective of integrating a justice dimension in the renewable energy transition. Bisiga et al. [57] further identified that a limited understanding of user needs and aspirations currently constrains progress towards SDG 7 in Rwanda, especially in the off-grid sector. They suggested that understanding the spending patterns of users and the appropriate system designs in terms of battery sizing, pricing plans, and appliances used is essential for advancing renewable energy development. Even in countries with ambitious historical or forward-looking policies, the provision of comprehensive policy packages addressing user behaviour is key to further expanding their actions [71].

In Indonesia, Fathoni et al. [5] found that the top-down approach to community-based renewable energy could potentially result in exclusion and energy injustices at the local level. In line with this perspective on energy injustice, Muller et al. [6] advocated for a justice approach to energy policy, adding that justice-related renewable energy policies will allow for the creation of a policy framework that pays attention to the social change rationale, which forms the basis of SDG 7. The different transition scenarios within Africa underscore the benefits of justice-based energy policies in achieving the goals of SDG 7 [6, 54]. However, this centralised energy planning continues to be a major challenge in many developing nations [56, 72]. In response to this challenge, current literature suggests that decentralised approach to community energy should be considered to advance sustainable energy development, especially at the community level [73].

5 Conclusions and future research recommendations

It has been six years since the adoption of the 2030 Agenda for Sustainable Development, the SDGs and the Paris Agreement. These two major international commitments have spurred a lot of debates in both the academic and policy spheres. In this review, we provided an overview of the emerging trends in these debates and policy discourse through an examination of published literature on energy and the SDGs, as well as the Paris Agreement. Overall, many of the studies are predictive and prescriptive, attempting to forecast and map out various pathways by which these international commitments may be achieved. Therefore, studies on the progress of implementation and impacts of policies formulated towards these goals are somewhat limited.

One key issue that emerged from studies dealing with the analysis of existing policies is the lack of integrated cross-sectoral planning in energy policies. Many existing policies treat energy or the energy sector in isolation from other sectors, and policies and plans were often formulated exclusively for this sector. Consequently, adopting integrated, cross-sectoral and collaborative planning emerged as one of the key recommendations for amplifying the role of sustainable energy in achieving the SDGs. It was also apparent that energy justice is not mainstreamed into many existing energy policies, especially in the global south. With the process of sustainable energy development known to have both costs and benefits and, in so doing, tends to potentially create winners and losers, it is imperative for the justice dimension to be mainstreamed into energy policies for sustainable development. This issue also came up in many studies focusing on energy transitions. With regard to the Paris Agreement, supply-side studies dominated with a lot of the research focusing on techno-economic issues regarding power generation, especially from renewable energy sources. At the same time mainstreaming environmental issues for sustainable development into national policies is challenging due to existing national development directions that are largely based on domestic factors and political priorities [70]. The cases with Gulf countries show that despite states seeking to accommodate the SDGs into their national strategies, policies on climate change are rather scant, with the notion of low-carbon development mainly attached to economic diversification efforts.

A fundamental concern that emanated from research on this international commitment was that countries stand to make some economic losses in pursuit of the targets. This situation potentially discourages some countries from making more ambitious efforts toward these goals. Hence, more cost-effective pathways are needed to speed up action toward the 1.5 degrees target. This finding is in line with views shared by Filho et al. [39], who noted that costs associated with implementing the SDGs remain among the key challenges to realising the goals by 2030. In light of the above findings, there is a need for future research on the progress of implementation, impacts and critical lessons from current policy efforts on energy for sustainable development. Country case studies are crucial in this regard. In a similar review of the literature on energy policies, Goyal [74] noted that studies examining sub-national policymaking are limited. Rigorous national and sub-national studies can facilitate policy-learning through cross-country comparisons and inform domestic, regional and even international policies on energy and the SDGs. There is also the need for research on effective policy strategies for mainstreaming energy justice in current energy transition efforts, especially in the world's developing regions. Furthermore, more reviews are needed to link research addressing policymaking in general and how such studies offer an understanding of the inevitable and often-wide gaps between policy requirements and actual policy dynamics. The research covered in this review highlighted the need for policy change, with some articles describing practical and valuable experiences of new policy instruments. Yet, there is a general lack of studies that connect what authors think should happen or consider necessary to improve policymaking versus how feasible these solutions would be in real-world contexts.

While our study offers some insights into the recent trends of research on energy policies in pursuit of the SDGs and the Paris Agreement, our findings must be considered with cognisance of the timeframe in which this research, especially the document search, was conducted. The document search was conducted in February 2021; hence new research may

have been published on the subject since this search was conducted. Also, the limitation of the articles to documents authored in English may have resulted in the exclusion of some relevant publications authored in different languages. However, due to the extensive coverage of SCOPUS and ScienceDirect databases, we believe that our analysis has extensively covered the majority of documents on the subject.

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Declarations

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