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Original research article

Data governance and open science in energy planning: A case study of the Kenyan ecosystem

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ABSTRACT

There is growing recognition of the need for openness in the governance and management of long-term energy systems planning, including improving data accessibility to inform the planning process. Open data principles offer a way to manage and govern this process more collaboratively and transparently, but they are challenging to implement particularly in resource-constrained and decentralised planning contexts like low- and middle-income countries. For this reason, this paper assesses the viability of open data practices for enhancing transparency and collaboration in energy planning, using Kenya as a case study. Through qualitative analysis of policy documents and stakeholder interviews, this study evaluates the alignment and divergence between internationally accepted values and principles of open science and open data and Kenya's energy planning needs. What emerges is a contrasting picture. The results show that, while open approaches to energy data are theoretically promising for addressing current energy data challenges in Kenya, stakeholders show limited agreement or understanding of practical implementation pathways. These findings aim to support Kenyan stakeholders and decision-makers involved in the ongoing long-term planning process under the Integrated National Energy Plan.

1. Introduction

The need for transparency and accessibility of information is increasingly recognised by governments and global initiatives as a crucial element of good governance [1–4]. Indeed, an open approach to science supports more robust, evidence-based decision-making for the benefit of science and society [5]. Open Science is a broad concept, but there are specific aspects which have the potential to support work at the interface of science and policy. One aspect is "open scientific knowledge", which includes the publication of "open data" and "open-source software" that are publicly findable, accessible, reusable, and extendable without cost or restrictions. Another aspect is "open engagement of societal actors", which strengthens the collaboration between science and society via more inclusive and collaborative knowledge development [5].

Planning the future development of the energy system helps develop understanding of the complex dynamics between supply and demand of energy for security, economic, and environmental purposes [6]. This is relevant as energy services are instrumental to human activities [7,8]. To secure future energy supply, a wide range of historical information and future estimates and projections are required to characterise the system under analysis and plan for future development and investments. This makes the planning process data intensive [6,9,10].

Within the field of energy systems planning, *open data* are becoming increasingly relevant as opposed to traditionally closed and proprietary data, due to the transition towards more open modelling practices [11]. Data inform the energy system modelling process by characterising the existing energy system, documenting progress towards policy targets, and supporting effective and transparent energy system governance [6,12–15]. Open data are being used as inputs to energy system models developed to inform stakeholders on possible configurations and long-term pathways for decarbonisation of the energy system. For example, in Costa Rica open models and data have been used to support the national government in developing the Nationally Determined Contribution (NDC), submitted to the United Nations Framework Convention on Climate Change (UNFCCC) as evidence to their commitment to address climate change [16–20]. These data and models allow for collaborative efforts to enhance the quality and accuracy of analysis and enable decision-makers to scrutinize the planning process, by accessing underlying data, assumptions, and methods – all in the interest of more

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robust and reliable insights [6,9,12,13,21–25].

In light of the increasing importance of open data availability, the international community is developing standards to support their adoption. For instance, the Findable, Accessible, Interoperable, and Reusable (FAIR) data principles were introduced by Wilkinson et al. [26] to guide the process of collecting, documenting, and releasing data as a resource for research and analysis [26,27]. The application of FAIR principles lowers the barrier to entry for open data users, by enhancing accessibility and reuse via open licenses, which respect applicable data protection laws and avoid liabilities. These features can enable access to high quality data in contexts where local resources to collect, collate, and release context-specific data may be limited [28,29]. However, they are not a silver bullet for data access and may not be appropriate everywhere. For instance, in some contexts, providing open access to data can create tensions due to differing objectives and political interests [30,31]. Furthermore, low- and middle-income countries (LMICs) may lack the resources to support this rigorous implementation of open data [32]. Attempting to implement open data under these conditions could result in a failure to launch, wasting resources and creating scepticism around increased transparency.

To examine these tensions, this research focuses on issues of data governance and management within the context of energy policy and planning in Kenya. The case of Kenya is particularly interesting as the country is undergoing the development of its first Integrated National Energy Plan (INEP), under a novel framework intended to streamline energy planning at both national and county levels [33,34]. However, the INEP process is rife with complexities. To ensure the supply of affordable, sustainable, and reliable energy to the country, coordination and collaboration is required between a wide range of institutions and a multitude of stakeholders [35]. Key among these coordination challenges is the flow of data across planning levels.

This paper investigates whether open data is a viable approach to: (a) simplify access to key information, which supports energy planning efforts at county and national levels in Kenya; and (b) enhance the transparency of energy planning in line with the principles of good governance embedded in Kenya's Constitution. It aims to answer the following research question: *is open data within energy data management and governance a viable approach to effectively support robust and inclusive long-term planning for the Kenyan energy system?* Within this context, robust and inclusive refer to a long-lasting, reliable, and effective way to manage and govern energy data for Kenya across the stakeholders involved. This paper first investigates how the current Kenya policy framework defines energy data collection and governance within the long-term energy planning process. Then, through the addition of stakeholder interviews, this paper examines whether and how internationally established values and principles for open science and open data align with local policy and stakeholders' perspectives on the characteristics of an effective energy data management and governance system for Kenya. To the authors' knowledge, it is the first time that this approach has been applied to study Kenya's energy planning process.

This research was conducted as part of the Climate Compatible Growth (CCG) programme and the UK Partnering for Accelerated Climate Transition (UK PACT) programme. Funded by UK aid of the UK Government and the UK Foreign, Commonwealth and Development Office, the CCG and UK PACT programmes in Kenya aim to support the implementation of the energy policy framework via ongoing planning activities at the national- and county-levels [36].

The remainder of this paper is structured as follows. Section 2 presents a short literature review on open science and open data, their contextual relevance within Kenya and Africa more broadly, and background information of the Kenyan case study. Section 3 details the methodology applied to study the relevant policy documents and to collect and analyse the interview data, and it presents the established values and principles of open science and open data under consideration. Section 4 presents the evidence collected via the documents and interview analysis. In addition, it compares the evidence collected with established open science and open data principles. Section 5 synthetises and discusses the findings presented in Section 4. Finally, Section 6 concludes the paper with some limitations of this study and recommendations for future work.

2. Understanding open science and energy planning in Kenya

The following sections provide a historical overview of open science, with specifics to the current work done by African researchers. This is then followed by an introduction to the case study context of energy planning in Kenya.

2.1. Defining open science and its relevance within the African context

The concept of open science can be traced back to the 1980s. However, the 2001 Budapest Open Access Initiative had a strong role in shaping its modern usage, strongly intertwined with the wider dissemination of information technology (IT) and related infrastructures worldwide [37,38]. In 2015 the Organisation for Economic Co-operation and Development (OECD) initiated an effort to "*make open science a reality*" by explicitly defining open science and outlining the way to translate it into practice [39]. In the same year, the Open Data Charter (ODC), brought together over 170 governments and organisations and published six principles defining common norms and practices for promoting and facilitating the release of government-related data more openly [1,40]. In 2016 an influential study by Baker highlighted the difficulty of reproducibility of scientific findings, and the need to verify the robustness and validity of research studies [41]. This prompted a call for "*improving the reliability and efficiency of scientific research*" via a first set of measures to enhance the scientific process towards greater transparency [42]. At the same time, a new research was published focusing on enhancing the reusability of machine-readable data to support science via the definition of guiding principles to make data more Findable, Accessible, Interoperable, and Reusable [26].

This period of growing interest towards open science and open data, led to an increased recognition of the need for more openness in science and research to the benefit of government and society. This led to the release of the 2021 UNESCO Recommendations on Open Science, which outline clear definitions, as well as values and principles, that are integral part of what it is defined as open science today [5].

Within this paper therefore, open science and open data are referred to following the respective definitions provided by the UNESCO Recommendation on Open Science in Table 1. These definitions were endorsed by 196 countries, including Kenya, and therefore provide the latest internationally recognised definitions for open science and open data that are considered relevant for our study.

The historical development of the concepts and practices related to open science has been largely driven by western researchers and institutions. However, also within the African continent, the interest and

Table 1
Established definitions of open science and open data as from the UNESCO Recommendations on Open Science [5].

Terminology	Definition
Open science	"An inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community." [5,p. 7]
Open data	"Open research data are available in a timely and user-friendly, human- and machine-readable and actionable format, in accordance with principles of good data governance and stewardship, notably the FAIR (Findable, Accessible, Interoperable, and Reusable) principles, supported by regular curation and maintenance." [5,p. 9]

recognition for open science has been growing. More specifically, African researchers have started exploring barriers and opportunities, attitudes and potential concerns for various data sharing practices, including open data, across different fields of research [31,43–47]. These studies have predominantly focused on data sharing and highlighted African researchers' perspectives over existing practices, context-specific challenges to implementation, and available resources.

2.2. Case study context: energy planning in Kenya

Over the last 15 years, Kenya has experienced growing momentum for reforms, as well as economic and social development. In 2008, the Government of Kenya launched Vision 2030, a blueprint for transitioning the country to prosperity by creating a middle-income, industrialised society able to compete globally [48,49]. A reform of the Constitution of Kenya was initiated in 2008, following the outburst of civil violence from the contested 2007 political elections. This process led in 2010 to the approval of a new Constitution. Since then, Kenya has worked to implement the political and economic reforms needed to realise what is envisioned in the new Constitution: higher social welfare, political and economic stability for its citizens, as well as decentralising power and responsibilities from the national government to the newly established 47 county governments [4,50,51].

In the last decade, the government of Kenya has also been signatory of two major international agreements, namely the 2030 Agenda for Sustainable Development and the Paris Agreement [52,53]. In addition, the country is seeking to be a leader internationally, for example by hosting the first Africa Climate Summit in 2023 [54].

As established by Sustainable Development Goal (SDG) 7, access to "*affordable, reliable, sustainable, and modern energy for all*" is a key enabler for economic development and job creation, but also for social development [55]. However, in 2020, about 30% of Kenyans still lacked access to electricity [56]. To meet both SDG 7 and Vision 2030, while fulfilling what stated in the new Constitution, the Kenyan government is working on a new approach to long-term energy system planning that aims to ensure "*affordable, competitive, sustainable and reliable supply of energy at the least cost in order to achieve the national and county development needs, while protecting and conserving the environment for intergenerational benefits*." [35,p. 10]. This involves operationalising a new policy framework, outlined in the 2018 National Energy Policy [35] and concretised in the 2019 Energy Act [57]. The National Energy Policy envisages a role for the national government and the 47 county governments for the long-term planning of the energy system via the INEP. It also identifies the need for integration between energy planning efforts and social, economic, and environmental policies, to ensure that energy can support Kenya's development ambitions [35]. The Energy Act builds on the framework outlined in the National Energy Policy and details the functions of the various entities involved. In addition, it aims to regulate the "*production, supply and use*" of various forms of energy and related services, as well as the exploitation of in-country resources, particularly geothermal energy [57,p. 11]. As part of this new framework, various institutions and entities in Kenya are expected to be involved in the process, including: national- and county-level governments, utilities, and regulatory authorities.

To implement the Energy Act and establish the INEP, a key issue is the systematic collation and accessibility of complete, and reliable energy data across stakeholders [58–61]. Such data is critical to adequately characterise the existing energy system, and to ensure that progress is tracked towards defined planning targets and goals as to support effective and transparent governance [1,12,13].

Over the past decade, efforts have been made to support the development of open data portals to facilitate the sharing of government information and datasets in Kenya. The Kenya Open Data Initiative (KODI), for instance, was created to implement the Constitutional mandate by giving Kenyan citizens the right to access government information [62]. The initiative was demanded by civil society and led by the Kenya Information and Communication Technology (ICT) Authority Board and the Kenya National Bureau of Statistics (KNBS), with support from the World Bank, Google and Microsoft [62,63]. At the time of writing, however, the portal is no longer operational. Another is the Kenya Data Portal, which was developed with the support of the African Development Bank Group. The Kenya Data Portal provides open access under CC-BY 4.0 license to some national statistical data produced by the KNBS. The portal suggests an interest and readiness within Kenyan institutions to support data transparency and accessibility. However, the Kenya Data Portal currently provides access only to selected information – e.g. population data and projections, selected macroeconomic data, agriculture, and health data. It does not cover, for instance, data related to the energy sector – e.g. available in-country energy resources, or estimated electricity demand per sector – that are relevant for system planning [64]. In addition, it is worth mentioning in this context that in 2022 approximately 60% of the Kenyan population still did not have access to internet, making open data portals such as the Kenya Data Portal accessible only by a small share of society [65].

Several international organisations, institutions, and programmes support the INEP process. They primarily work with local stakeholders to conduct energy system planning activities feeding into the INEP. These include: World Resource Institute (WRI), which provides assistance with electrification planning; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, which is working on improving access to energy by prioritising clean and reliable solutions; UK Partnering for Accelerated Climate Transitions (PACT) and the Climate Compatible Growth (CCG) programmes, which are supporting collaborations between county and national planning efforts, including advising on energy data management [66–70]. However, to date, there has been little research on the data governance necessary to underpin this complex process; this paper aims to address this gap.

3. Methodological approach

This research investigates whether Kenyan energy planning can be supported by a data governance approach that includes open data. It does this by assessing Kenya's energy policy framework and in-country stakeholders' perceptions of key values, principles, roles, and responsibilities in relation to energy data for planning.

The method consists of four steps. First, the scope of the analysis was defined by collecting evidence from the current energy policy framework and mapping the key institutions or stakeholder groups. This builds upon a previous data ecosystem mapping effort [59,71], which engaged with Kenyan stakeholders to identify the actors that produced or used energy data in county energy planning. Second, a qualitative document analysis was undertaken of the National Energy Policy, the Energy Act, and the 2010 Constitution of Kenya [4,35,57]. This analysis mapped how the concept of energy data was presented across the documents, which actors were expected to be responsible for data governance and management, and identified potential policy gaps that might have affected their effective implementation. Third, semi-structured interviews were conducted with selected stakeholders representing institutions and entities identified in the previous steps. The interviews examined perceptions and use of energy data, reflections on current data handling in Kenya, and vision for improvement from both a governance and management perspective. Fourth, the evidence collected in the previous steps was compared against the core values and principles of open science defined by the UNESCO Recommendation on Open Science, the FAIR data principles, and the related International Open Data Charter principles. This enabled a comparison between in-country data practices and these international standards, to analyse the viability of open data within the Kenya planning ecosystem. Some of these steps are described in more detail below.

3.1. Semi-structured interviews

A total of ten semi-structured interviews were conducted in English with key stakeholders in the collection and management of energy data in Kenya, between May and June 2023. Respondents represented a range of institutions, as summarised in Table 2, that were identified as responsible for data management and governance within the energy policy framework of Kenya and that had direct experience of data collection, curation and modelling for energy planning, which did not include academics. In addition, representatives of selected international organisations were also included, as involved with supporting the relevant institutions and entities in fulfilling their responsibilities. The interviews were conducted in-person or online, depending on the availability of respondents and interviewer.

The interviews aimed to elicit the respondents' professional opinions, experiences, knowledge, and perceptions of different forms of data management and governance. The aim was to understand the potential of different data management and governance approaches to facilitate systematic and effective data exchange between county and national governments and institutions, in support of the INEP.

The interviews were structured around three main themes as presented in Table 3, which were also used as a starting point for the thematic analysis, namely: system designs, transparency and accessibility, and the value of open data.

The first theme explored desired *system designs* for an effective and well-functioning data governance and management framework, with the goal to identify key attributes, values, and structures deemed relevant and fitting for the Kenya context. Respondents were left freedom to define an ideal energy data management system for Kenya, with the attributes they deemed more suitable to describe it, as well as to indicate what structure should such a system have based on their needs and experiences. With regards to what values best represent their perception of energy data in Kenya, they were asked to choose among five issues – social, economic, innovation, security, and legal – introduced by the interviewer with corresponding definitions as provided in Table 4.

The second theme explored *transparency and accessibility* of energy information and data, looking at the current practices and perceived needs for improvement. The respondents were presented with direct quotes from selected articles of Kenya's Constitution, defining values and principles of governance and public service in the country and highlighting aspects related to accessibility of information, and they were asked to comment and reflect on them in relation to energy data.

The third theme explored perceptions of *open data* and its viability within energy data governance and management in Kenya, investigating the respondents' existing knowledge and understanding of the concept of open data, its perceived strengths and weaknesses, their experience with it, and their attitude towards it. Here, respondents were first asked about their knowledge of open data and left free to provide their own definition to it. After, they were presented with some printouts of websites (from both Kenyan institutions and international organisations) hosting open datasets specific to Kenya, and they were asked about their awareness of such resources. In addition, with the use of a set of cards, each presenting a different adjective, they were prompted to define strengths and weaknesses related to open datasets based on their personal experience. Finally, they were asked to describe in their own words their reaction to knowing that some subsets of Kenya energy data are already openly available online. For more details, a copy of the interview protocol is provided as Supplementary material to this paper.

Table 2
List of respondents interviewed for this study.

Category	No. respondents	Abbreviation in text
National government	2	NG1, NG2
County governments	2	CG1, CG2
Energy regulator	1	ER
Energy sector utilities	2	EU1, EU2
Statistics office	1	SO
International organisations	2	IO1, IO2

Table 3
Coding scheme developed for and applied to the interview analysis.

Themes	Categories	Definitions
System design	Attributes	Key characteristics of system design for energy data.
	Values	Embedded values of energy data.
	Structure	Technical features and arrangements of an energy data system.
Transparency and accessibility	Attitude and Perception	Attitude towards and perception of transparency and accessibility in energy data.
	Reality	Current energy data arrangements to enable transparency and accessibility of data.
The value of open data	Knowledge	Existing knowledge on concepts and usage of open energy data.
	Strengths and Weaknesses	Perceived strengths and weaknesses of open data.
	Use	Existing, expected, and foreseen use of open data in energy planning.
	Attitude	Perception and attitude towards open data.

Table 4
List of values, and related definitions, to be associated with energy data as provided by the interviewer to the respondents.

Value	Definition
Social	It is beneficial for the society as it enables societal development – provides basic information that enable awareness of energy services.
Economic	It has a monetary value – data are collected and sold as product, there is a business model that relies on energy data.
Innovation	It provides resources that are key to foster innovation and development – data are key to ideate and find new solutions to deliver products and services.
Security	It concerns the security of the country – data related to energy infrastructure are tightly connected to the vulnerability of the country and its safety and stability.
Legal	Data are key information that are subject to laws and regulations – it is important to clearly define such laws and legal frameworks to ensure security of data.

The interviews were analysed using a deductive thematic approach. The deductive approach was made of two elements: an analytical framework set by the three interview themes described above, and a theoretical approach grounded in the literature on open science and its role in support of good governance.

Given that the study was low risk it did not need ethical approval, however it was granted a research license (license no: NACOSTI/P/23/25617) from the National Commission for Science, Technology and Innovation (NACOSTI) of Kenya.

3.2. Comparing the Kenya energy planning ecosystem with values and principles for open science and open data

To evaluate whether open data could be a viable governance and management approach to address current challenges in the Kenyan energy planning ecosystem, the qualitative document and interview analyses were compared with internationally recognised values and principles of open science and open data.

Qualitative documents were comparatively analysed with UNESCO's values and principles of open science listed in Tables 5 and 6. These provide the latest internationally adopted definitions of open science. Their top-level governance-oriented framework for assessing open science made them fit-for-purpose in relation to the policy documents analysed here [5]. In this analysis, key articles in the Constitution of

Table 5
Recognised values of Open Science as defined by the UNESCO Recommendation on Open Science [5].

Core values of Open Science
I. Quality and integrity
II. Collective benefit
III. Equity and fairness
IV. Diversity and inclusiveness

Table 6
Recognised principles of Open Science as defined by the UNESCO Recommendation on Open Science [5].

Guiding principles of Open Science
a. Transparency, scrutiny, critique and reproducibility
b. Equality of opportunities
c. Responsibility, respect and accountability
d. Collaboration, participation and inclusion
e. Flexibility
f. Sustainability

Kenya (i.e. those that referred to the values and principles of governance and public service) together with stated principles, objectives, and obligations of the energy policy documents, were compared with the definitions of open science value and principles listed in Tables 5 and 6 respectively. The comparison was based on investigating commonalities in stated intents and objectives across Kenya public policy sphere and the wider field of open science.

Interview data were compared with the FAIR data principles and the International ODC Principles listed in Tables 7 and 8 respectively. While other open data and science standards have been developed, such as the U4RIA (Ubuntu, Retrievability, Reusability, Repeatability, Reconstructability, Interoperability, and Auditability) principles [72], the FAIR and ODC Principles are more established and endorsed specifically in the domains of scientific research and governance [73,74]. The FAIR and ODC frameworks were therefore considered more fitting to address the practical implementation of open data to inform governance [1,26,27,74,75].

In this analysis, each piece of evidence derived from the coding analysis was categorised according to the scheme provided in Table 3 and was compared with the detailed definitions of the FAIR data principles and the ODC Principles respectively. This was to compare how the main stakeholders' preferences, perceptions, and opinions aligned with and therefore could be supported by the characteristics of open data.

The complete definitions for each of the values and principles listed in Tables 5, 6, 7, and 8 are provided for reference in the Supplementary material to this paper.

3.3. Positionality

The authors of this paper identify as white European and North American researchers, with previous experience with development research, particularly in the African continent. Therefore, they recognise the impact of their western perspective in investigating the East African context of Kenya, which could cause them to potentially miss some levels of understanding of the respondents' context, perspectives, and experiences.

The authors also recognise the potential limitations of having conducted interviews in English with stakeholders in Kenya. While they acknowledge the multilingual nature of the country, they also clarify that all the interview respondents regularly work, and therefore are comfortable with answering questions, in English.

Two of the authors have experience with developing and applying open science practices for energy system planning, such as the use of open-source tools and the release of open datasets for informing long-term modelling. These authors acknowledge the potential for an underlying bias towards open data as a viable framework to govern and manage energy data to colour their work, despite best efforts to avoid this. In this study, they aim to act as observers of the Kenyan context, where an open approach to energy data constitutes only one of several possible options to govern and manage such resources.

While recognising their inherent and unavoidable subjectivity, the authors aim to minimize the influence of their preconceptions and experiences and take as objective a viewpoint as possible.

4. Results

The following sections present the results of the work. First, the Kenyan energy planning ecosystem is defined by mapping its complex network of stakeholders and institutions. Then, the evidence collected via the qualitative document analysis and the interview analysis is presented. Finally, the outcome of the comparison between the evidence collected and the principles and values of open science and open data is summarised.

4.1. The Kenya energy planning ecosystem

The Kenyan energy planning ecosystem is structured around two governing levels: the national level and the county level, each of which is responsible for different aspects of sectoral planning. The following information mapping these levels builds upon the work by Leonard et al. on data ecosystem mapping in Kenya [71].

Planning at the national level involves de facto several institutions, which are coordinated by the Ministry of Energy and Petroleum of Kenya (MoEP). These include the Energy and Petroleum Regulatory Authority (EPRA) and the utility companies/agencies – i.e., the Kenya Power and Lightning Company (KPLC), the Rural Electrification and

Table 7
Recognised principles for open data in science and governance, as defined by the FAIR data principles [26,27,74].

FAIR data principles
Findable
Accessible
Interoperable
Reusable

Table 8
Recognised principles for open data in science and governance, as defined by the International Open Data Charter Principles [1].

International ODC principles
1. Open by Default
2. Timely and Comprehensive
3. Accessible and Usable
4. Comparable and Interoperable
5. For Improved Governance and Citizens Engagement
6. For Inclusive Development and Innovation

Renewable Energy Corporation (REREC), the Kenya Electricity Transmission Company Limited (KETRACO), the Kenya Electricity Generating Company (KenGen), the Geothermal Development Company (GDC), and the Nuclear Power and Energy agency (NuPEA). Within these institutions, KPLC is the main entity collecting and providing energy data in practice, including generation, transmission, distribution, and demand estimates. Its role has been identified as central for exchanging information and data across other utilities, such as REREC, KETRACO, KenGen, and for informing the MoEP. In addition, KPLC is the main data source for many county governments developing county-level energy plans.

Another important provider of data is KNBS, which sits under the National Treasury and Planning Ministry. KNBS provides census data and information about other sectors relevant for estimating energy service demands.

At the county level, planners use data from national institutions, such as KPLC, to inform their planning processes. There is no formalised common energy data collection process across counties to better characterise local contexts for energy planning at time of writing. However, some counties have conducted independent data collection processes using various tools and processes, and have called for national institutions to provide more locally disaggregated data to better inform county-level demand.

4.2. Qualitative document analysis: the Kenya energy policy framework

The Constitution of Kenya provides key values and principles of governance, which include: "*good governance, integrity, transparency, accountability*" [4,pp. 13–14]. It also sets out the requirement for the state to provide access to information to citizens in a transparent, timely, and accurate manner [4, pp. 22, 98]. This is relevant for this research, as energy data are a form of information regarding the status of critical infrastructure and services.

As described in Section 2, the energy policy framework for Kenya consists of the 2018 National Energy Policy and the 2019 Energy Act. The first document sets overarching objectives, and the latter defines their implementation. What emerges from the analysis of these documents is a clear role for both national- and county-level governments in implementing the devolution envisaged in the 2010 Constitution of Kenya. National and county governments are expected to conduct independent planning processes and to contribute significantly to the collection and maintenance of data related to energy, as mentioned in the National Energy Policy (Section 7.2.1 Functions of the National Government, Sub-sections 1.b and 3.d; and Section 7.2.2 Functions of the County Governments, Sub-sections 1.a and 3.c) and in the Energy Act (Fifth Schedule, Section A. Functions of the National Government, Sub-sections 1.b, 3.e, 3.g; and Section B. Functions of the County Governments, Sub-sections 1.a, 3.d, 3.f). These documents also delegate responsibility for collecting and providing access to data, specifically: EPRA, REREC, and grid operators (i.e. KETRACO).

One issue emerging from the analysis of these two documents is the temporal misalignment of key activities envisaged in the Energy Act, illustrated in Fig. 1. The National Energy Policy is expected to be updated every five years, based on the insights provided by energy planning efforts at both national- and county-levels which are undertaken on a three-year cycle. This misalignment between three- and five-year cycles poses a risk to coordination and may limit the ability for the two related activities to reinforce each other synergistically. This will particularly affect data harmonisation between policy and planning processes, if data collection and maintenance efforts are not well coordinated.

Looking specifically at the Kenya Energy Act, a second issue to emerge is an overlap of roles and responsibilities across the institutions expected to contribute to the energy planning process. Fig. 2 shows the institutions responsible for different types of energy data as listed in the Kenya Energy Act. As illustrated in Fig. 2, the Energy Act outlines separately certain types of data which can be expected to be nested within one another, and others which overlap with one another. Similarly, the responsible parties for different data types overlap, which means that multiple institutions might understand themselves to be responsible for the same type of data, potentially causing duplication of efforts and mismatch of data across sources.

One example of this lack of clarity can be seen in the responsibility for renewable resource maps. These are a sub-category of renewable energy data, belonging to the broader category of energy resource data. The difficulty arises in that each of these nested layers has a different party responsible for their generation. Energy resource data are mentioned in the Energy Act as under the responsibility of the county governments, whereas renewable energy data are the responsibility of REREC, and renewable resource maps are expected to be provided by the Cabinet Secretary of the MoEP. A similar case can be seen in the responsibility for transmission and distribution (T&D) data. T&D lines are considered part of the wider category of energy infrastructures data. However, in the Kenya Energy Act, energy infrastructure data are listed as the responsibility of county governments, while the electricity T&D data are expected to be provided by the grid operator (i.e. KETRACO).

A third issue emerging from the document analysis is the lack of clear definitions of "energy data" and of what types of data are needed to

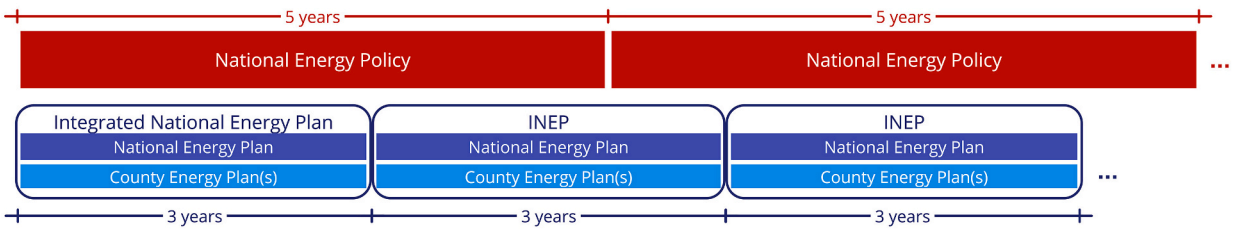

Fig. 1. Kenya Energy Policy and Plan framework, as outlined in the 2019 Energy Act.

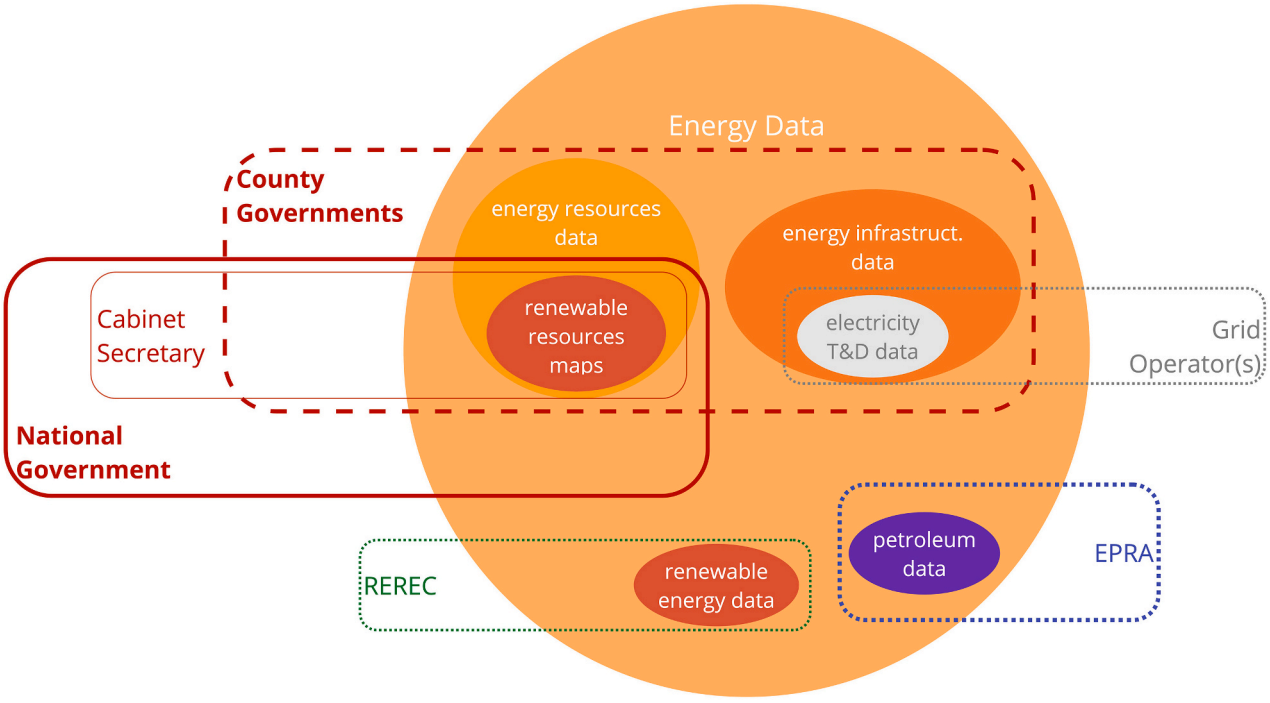

Fig. 2. Representation of energy data types and related ownership in the Kenya planning ecosystem. Source developed by the authors from the Kenya Energy Act document.

inform the planning process. This leaves room for interpretation as to what information is critical for the characterisation of Kenya's energy sector, and therefore what data should be collected and maintained by national and county governments. This can lead to both data gaps and collection of irrelevant data, thus hampering compliance with the energy policy framework.

A final issue is that the documents make no explicit reference to data management, or data governance, including potential legal implications of data generation. For instance, the documents do not mention the potential sensitivity of data – i.e. data that undermine the privacy and anonymity of legal entities or private citizens (individuals or communities). While the documents do not cross-reference the Kenyan Data Protection Act, or clarify the approach to how sensitive data should be handled to inform the planning process, these legal aspects form critical

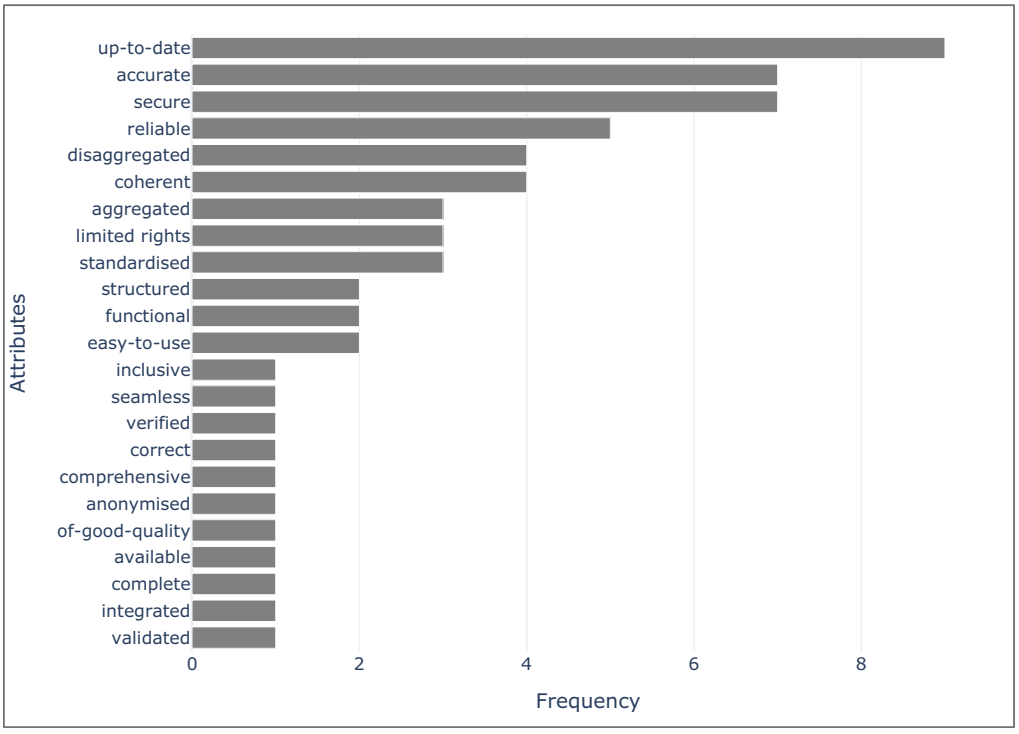

Fig. 3. Key attributes mentioned by respondents for an ideal energy data management system for Kenya.

safeguards and their lack of consideration poses an institutional risk to the government.

4.3. Stakeholder interview analysis

The interview analysis sheds further light on the issues identified in the document analysis. The results provide a deeper understanding of how the respondents perceive energy data, what values they associate with them, whom they go to when in need of specific types of data, and how easily they are able to access the data required for energy planning activities. Additionally, they shed light on respondents' experiences with and perceptions of open energy data.

4.3.1. System design

The interview respondents were asked to describe their ideal energy data management and governance system for supporting the Kenyan energy planning process by choosing preferred attributes and explaining their desired system structure and design for handling the data.

Each respondent was allowed to use multiple attributes to describe their ideal system. The frequency of attributes they mentioned is shown in Fig. 3, which highlights the perceived need for data that are up-to-date, accurate, secure, and reliable.

With regards to the system design, several respondents argued that a centralised data platform is needed to support energy planning in Kenya. Such a platform would support data collection, and provide a single data access point, thus coordinating existing data providers. Five respondents (ER, EU1, EU2, SO, IO2) suggested that access to this centralised platform would need to be controlled to address potential data security concerns. Three respondents (ER, EU1, IO2) also suggested appointing a dedicated data expert team who would have responsibility for the curation and provision of data via this centralised platform. The benefits of such a platform for county-level planning were also mentioned by four respondents (NG2, EU2, SO, CG1). Finally, most respondents perceived the MoEP, and therefore the national government, to be the main institution responsible for coordinating data collection efforts and ensuring access to required data. This contrasts with the National Energy Policy and the Energy Act, which envisage both national and county governments equally fulfilling this role.

The respondents were then asked to choose what values best represent their perception of energy data in Kenya. Social and economic values and perceived benefits dominated their responses.

Concerning the social benefits of energy data, respondents highlighted societal wellbeing. For instance, NG1 mentioned that:

> "*For us sitting at the government, we have to take care of everyone in the energy space*"
>
> (NG1)

In addition, according to SO:

> "*The ultimate purpose is to improve the lives of the people.*"
>
> (SO)

For economic benefits, respondents highlighted the pivotal role of energy in enabling productive activities and therefore economic growth. According to CG1:

> "*Energy is [an] enabler towards manufacturing, industrialization, and all that.*"
>
> (CG1)

In addition, security was often mentioned as an important embedded aspect of energy data in Kenya, as data could expose critical infrastructure locations and vulnerabilities of the energy system.

4.3.2. Transparency and accessibility of energy data

When asked to reflect on the principles of transparency and accessibility of information, most respondents generally highlighted the concept, including within the context of energy data. Respondents generally identified the value of data as: a resource to support decision-making; to garner acceptance of political decisions among the public; and to implement and monitor these decisions in practice. Some respondents highlighted the link between accessible data and trust in society. According to IO1:

> "*Even if they are not using [the data], they can be talking about. […] You know, you have already enlightened these people, and they can even participate now in the development decisions much better from having some basic know-how from the data.*"
>
> (IO1)

Others explicitly mentioned the need for data access to monitor and track progress in policy implementation and ensure the validity of what is implemented. As stated by SO:

> "*Energy data and information are supposed to track the progress of some policies. And at every point of that tracking, [the data] need to ensure that there is transparency in what we are doing and ensure that we are methodologically sound.*"
>
> (SO)

However, several respondents also expressed concerns. On one side, they perceived a risk that accessible information could be misused or distorted. For instance, according to EU1:

> "*One thing you cannot control is who really gets your data and how he uses it, especially in these open platforms.*"
>
> (EU1)

On the other side, they feared that energy data transparency could expose their institutions to scrutiny. This mirrors the previous statement by SO, showing that the same data that can be used to build credibility and trust can also be used to criticise and expose issues. As stated by NG2:

> "*When you become open, there is a lot of scrutiny with what you are doing.*" (NG2)

In a few cases, a perceived lack of trust in information-sharing emerged, both across the institutions involved in the energy planning process and between the public and the institutions. For instance, this was highlighted when it comes to justify costs and provide evidence to motivate decisions that affect the citizens, specifically at the county level. As mentioned by CG1:

> "*The government has been publishing energy information in terms of energy tariffs, energy generation, power generation capacity […] but sometimes we feel that they are not very truthful in terms of how energy is costed.*"
>
> (CG1)

At the same time, respondents highlighted how there are existing practices that contribute to transparent and accessible energy data in Kenya. One respondent (SO) mentioned how their institution is adopting international data standards for their data collection and publication efforts, thus ensuring that data can be compared internationally. Another respondent (EU2) also mentioned ongoing efforts to establish internal data review and approval processes, to ensure compliance with legal and quality standards within their institution.

However, some of the existing practices mentioned by the respondents also highlighted potential barriers to increased data transparency and accessibility. First, several respondents mentioned examples of restricted access to specific types of data, imposed by contractual obligations or by complex bureaucratic processes. The data format was also mentioned as a potential barrier for access to some datasets – e.g. data are often published in online PDF reports, which are difficult to use directly in calculations or modelling efforts informing the planning process. A policy gap also emerged: there is a lack of clear

regulation as to what data should be shared, in what format, and via which platform.

Cutting across all issues, most respondents voiced their frustration towards the lack of coordination and collaboration across institutions involved in energy data collection efforts. This was perceived as the underlying cause for data mismatches across difference sources and misunderstandings over what kind of data are collected and how.

4.3.3. The value of open data

In the last part of the interview, the respondents were asked to reflect on the definition, scope, strengths and weaknesses of open data. They spoke about the current application and acceptance of open data in energy planning activities in Kenya.

When asked to provide their own definition of open data, all respondents but one felt confident enough to answer the question and mainly described open data as accessible and available data, as shown in Fig. 4. Notably, two respondents also mentioned the collaborative aspect of open data in their definition.

When asked about the key strengths and weaknesses of open data based on their experience, several respondents described open data as well-formatted and processed datasets that fit the modelling and analysis needed by the respondents. For example, as described by ER:

> "*I use the [open] data because they have already transformed it for me. So, it makes my life easier*."
>
> (ER)

Four respondents (EU1, NG1, IO1, IO2) also mentioned relying on open data to complement and fill data gaps within local or national data collection efforts, as well as to validate data where the sources or methods used to collect them were not clear. At the same time, one respondent (CG1) criticised the highly aggregated nature of open data sources, which are often only made available at national resolution. The respondent argued that, without approximated disaggregation, this does not allow for specific analysis at sub-national levels, such as the Kenyan counties. Respondents also criticised the lack of regular updates to existing open data sources. In addition, according to ER:

> "*The mismatch in data is one of the weaknesses that we find between different institutions or between different [open] databases*."
>
> (ER)

Finally, some respondents (NG2, IO1, EU2, CG2), perceived a lack of clear data collection and validation methods for most open data sources. They saw this to be critical in weakening the overall credibility of the data. A summary of perceived strengths and weaknesses of open data is provided in Table 9.

In summary, most respondents were familiar with various open data sources. They also generally highlighted open data, mentioning their regular use in complementing and validating data coming from Kenyan institutions. They also described occasionally substituting official data coming from Kenyan institutions with open data, when the open data format or aggregation level was more fitting for the modelling and analysis they were working on. This might pose additional issues of data

Table 9
Perceived strengths and weaknesses of open data, as emerging from the interview respondents.

Strengths	Weaknesses
• Quickly accessible, free • Well-formatted, processed for easy use • Complement in-country data (filling data gaps) • Validate in-country data	• Too aggregated, too generic • Not up-to-date • Lacks validation processes • Lacks credibility (i.e. no clear information provided about the data collection method)

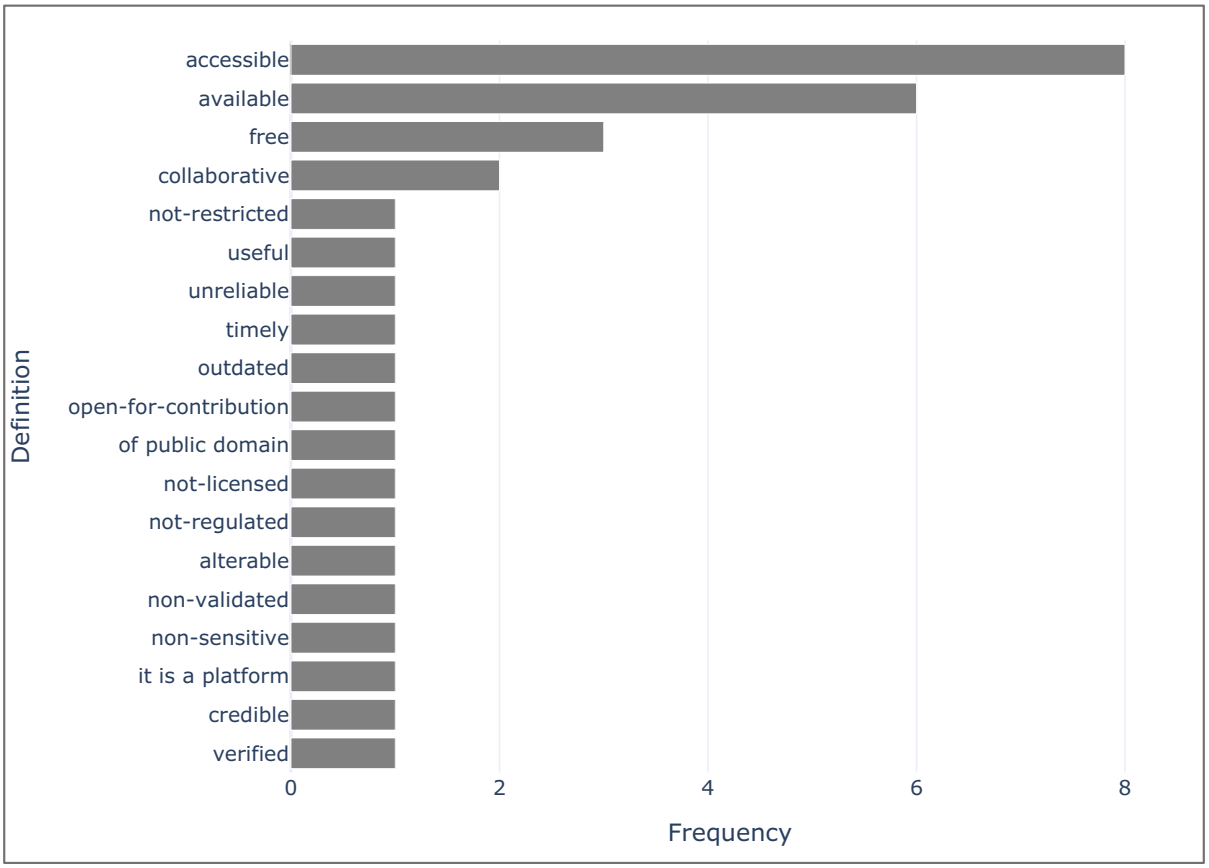

Fig. 4. List of attributes representatives of the interview respondents' knowledge of what open data is.

coherency and harmonisation. However, most respondents highlighted concerns particularly regarding the credibility and up-to-datedness of open data, as well as their handling of sensitive information and data security. Respondents were concerned of the potential implication of providing uncontrolled access to information related to sensitive energy infrastructure (EU) and raised the critical aspect of having to make sure that personal data are correctly processed so as to avoid any privacy breach (SO, CG).

Additionally, it is worth noting that some aspects of open data were only partially mentioned in the interviews. For instance, there was no explicit mention of documentation and provision of metadata as important features of open data, despite some respondents criticising the credibility of open data which can be implicitly linked for instance to the lack of documentation on the data collection methods. There was also no explicit mention of legal aspects related to open data, such as the use of licenses and copyrights to define conditions under which the data can be accessed and used.

4.3.4. The county government perspective

The devolution process outlined in the 2010 Constitution of Kenya and transposed down into the INEP has meant that there is growing interest in and focus on sub-national planning and data generation. For this reason, two interviews were undertaken with representatives of county governments, who provide a distinct angle on the issue of energy data and governance.

County-level respondents were particularly mindful of the local differences across geographies (from county, down to sub-county and ward levels) and social groups, and how these differences are often not captured by both datasets coming from Kenyan institutions as well as from open resources. They perceived the energy system as instrumental to the delivery of services to the community and to enable other relevant sectors that support the economic growth and wealth of the community.

County-level representatives strongly emphasised the need for creating more awareness within society of the benefits that energy services can bring to local communities and activities. This is to enable a better data collection process; respondents argued that citizens were more willing to share information with the authorities when they understood how the process could benefit their daily lives. These aspects signal a demand for more clarity and transparency around the purpose of collecting data and how data are used. In addition, this might also signal a lack of citizens' awareness of their legal rights as detailed within the Kenya Data Protection Act [76], which regulates the way personal data can be handled within and outside of Kenya.

Respondents explained that energy data collection efforts at the county government level are scarce and non-harmonised across counties. To establish accurate, reliable, and systematic data collection at the county level, respondents highlighted the need to build awareness and commitment in the local community. The emphasis was put on helping the community to understand the value that good data can bring in measuring progress towards the fulfilment of needs, as well as bringing transparency (e.g. in the cost accounting of energy services) and accountability (e.g. in measuring progress in implementation) to the process. County-level respondents also highlighted the need to ensure that energy planning is kept up-to-speed with development progress, particularly in rural communities, so that new needs are regularly captured and conveyed in energy plans.

These insights show that understanding the context-specific realities of the county governments is critical. They emphasise the importance of identifying key resources and expertise that can facilitate the energy planning process, including their contribution to the data management and governance.

4.4. Is open data viable for governing and managing energy data in the Kenya planning ecosystem?

This section compares the results discussed in the previous sections with established values and principles of open science and open data. This enables an evaluation of the viability of an open data approach for the Kenyan energy planning ecosystem. For the detailed analysis, see Supplementary material.

4.4.1. Kenyan policy alignment with open science principles

Comparing the results of the document analysis of Kenyan policies with UNESCO values and principles of open science, as presented in Tables 5 and 6, an overall alignment emerges. The policies mention the need to ensure transparency and accountability, and access to accurate information by the public, which strongly aligns with the UNESCO open science principles. This suggests open science may be a viable framework for governing and managing the Kenya energy planning process and its related data, in line with existing policies.

The National Energy Policy of Kenya also refers to the need for dissemination and human resource and capacity development across the planning process. This aligns with the values and principles of open science that aim to generate collective benefit and support equity, fairness, and inclusion by facilitating access to resources and knowledge by all. Open data appear therefore relevant for supporting the inclusive development of human capacity in the country, as they minimize barriers to entry in training and analysis.

That said, these goals are defined in theory but do not fully correspond to actual practices. The implementation of such ambitious goals requires long-term commitment and negotiations among stakeholders to find a common ground for action.

4.4.2. Interview alignment with open data principles

From the comparison of the interview results with established principles of open data from a scientific (FAIR data principles, see Table 7) and governance perspective (ODC principles, see Table 8), a more contrasting and unclear picture emerges.

Respondents acknowledged many potential benefits and uses of open data for Kenyan energy planning in ways that align with these principles. The attributes they desired in a well-functioning data management and governance system align with FAIR and ODC principles, particularly on the points of data reusability, timeliness, and comprehensiveness (FAIR data principle of Reusability and ODC Principle 2). Their focus on reusability highlights the importance of keeping records of data accuracy and reliability, which is typical of the metadata requirements of open data. Meanwhile, their desire for timely and comprehensive data can be met by collaborative data collection efforts, which is explicitly enabled by the Accessibility and Interoperability of FAIR data. Respondents also acknowledged the need for a system design that enables data processing, which can be made easier by the Interoperability and Reusability of FAIR data and the accessibility and usability of open data as envisioned by the ODC Principle 3. Respondents generally held a positive attitude towards transparency and accessibility of energy data, recognising their value to society, in line with Principles 5 and 6 of the ODC. In addition, respondents explicitly acknowledged the strengths of open data, such as their accessibility, their use in data validation, and their complementarity with other data sources. These are in line with the FAIR data principles of Interoperability and Reusability, as well as by ODC Principles 3 and 4. Finally, most respondents made use of existing international open data sources to complement, validate, or substitute official Kenyan data sources when the open data format was more convenient. This was an interesting finding and shows an overall interest towards open data as more easily accessible data within the energy planning landscape of Kenya.

However, the respondents also expressed some concerns that either contrast with previous statements or signal a more sceptical attitude towards data openness, transparency, and accessibility. First, they highlighted data security as a key attribute for an ideal data management system. Security was raised as a concern when discussing the real-life implications of transparent and accessible data, as respondents mentioned that open data could be manipulated and misused to the

detriment of their institution or sector, or to the security and reliability of critical infrastructure. This aspect of security aligns with the FAIR data principle of Accessibility, where openness is defined with possible constraints and where conditions and protocols are needed to regulate the use of the open data. Second, several respondents mentioned a lack of trust towards institutions and the government in Kenya. This undermines the positive attitude expressed towards transparency and accessibility of data and reinforces instead the need for data ownership and the need for security and control, thus contrasting the broader concept of open data and particularly ODC Principles 1 and 3. Third, when it comes to existing knowledge, experiences, and perceptions of open energy data in Kenya, respondents criticised the accuracy, up-to-datedness, validity, and credibility of these resources. Also, a fear towards the misuse of open data, their alteration (hence, their validity, accuracy, credibility), and their overall security were of concern. This contrasts with the FAIR data principles of Accessibility and Reusability and ODC Principles 2 and 4, which aim at providing protocols and rules based on which the use of open data is legally regulated depending on the preferences of the entity that releases the data. This typically translates into choosing an open license that states the "dos and don'ts" of the open datasets upon which it is applied. While these concerns appear to contrast with the open data principles, some key features of open data have the potential to address most of them, but would require changes in working practices and culture. However, these do not emerge from the interviews, despite having the respondents discussing such concerns. This could illuminate either unawareness of these possibilities or their unsuitability in this context. The key concerns can be summarised as follows:

- Ensure the validity, up-to-datedness, and accuracy of open data. The development of metadata and documentation might help with providing information that are designed to address these issues, as detailed by the FAIR data principles of Accessibility and Reusability.
- Define clear rules to address the security concerns related to open data. The selection or definition of a license and the legal aspects under which open data are made accessible and (re-)usable might help addressing this issue. The legal terms under which open data are released can vary depending on the chosen license associated with the release of a set of data. This practice is valid both for open and non-open data and can also help define intermediate degrees of openness in data sharing, as detailed by the FAIR data principle of Accessibility and ODC Principles 1 and 3.

This shows again the discrepancy between established principles for open science and open data and the reality of implementing them in a country-specific context, as the case of Kenya. The interviews show that a significant gap exists between the theory of open data and the reality of data management and governance as perceived and dealt with by relevant stakeholders.

5. Synthesis and feasibility

Overall, an open approach to data management and governance could be advantageous to support the Kenya energy planning ecosystem and address some key issues it is facing. The need for collaboration and simplified data processing expressed by in-country stakeholders can be facilitated by open data formats and the collaborative nature of open practices. The need for data accessibility across all stakeholders involved in the planning process, in respect of quality and security concerns, can be addressed through additional metadata and licenses, enhancing the retrievability and documentation of resources and outlining viable processes and conditions to access data that can be adapted to local needs and preferences. The accountability of data providers and coherence of data sources can also be facilitated by the provision of metadata and documentation associated with the data, and the enhanced collaboration made possible by open data formats and repositories. Finally, the accessibility of open data can also help with unlocking access to information and increasing awareness in society, in line with the principles of governance embedded in the Constitution of Kenya.

However, the interviews revealed a contrasting understanding of what open data entail and how to translate them into practice, which can create challenges during implementation. This may indicate a need for capacity to be built concerning data governance. This may also highlight a need for deeper evaluation of why there exist divergent views on how to translate open data into practice. There may, as previously discussed, be a political economy of energy data prohibiting certain data types from being shared openly irrespective of knowledge and standards implemented. Therefore, various degrees of openness should be investigated based on the sensitivity of specific datasets and information, and on the infrastructure, resources, political will, and expertise available to handle energy data in Kenya. This can enable stakeholders to retrieve relevant data, documentation, and metadata, while still meeting perceived security needs, as well as ensuring that data are up-to-date and reliable.

The emerging discrepancies among the respondents' interviews also point to a potential need for guidelines and protocols for energy data management and governance to be defined and adopted, as well as for a more institutional effort to create a shared data culture for Kenya. This could support the development of common terminologies and understanding for data management and governance across institutions and entities involved in the process, thus addressing concerns as identified in this paper.

Finally, within this analysis, it is worth considering the lack of access to electricity and internet services in Kenya. This adds another significant barrier to the accessibility and usability of energy data and information especially in remote and rural areas, when discussing forms of computer-based data management as it is often the case for open data.

6. Conclusions

This paper investigated whether open data practices are a viable approach to robust and inclusive long-term energy system planning in the context of Kenya. A combination of qualitative document analysis and stakeholder interviews were used, which were compared with established open science and open data values and principles.

The results show that open data both align with stated policy objectives and energy data governance and management needs in Kenya. However, they also raise challenges to this being implemented within energy planning in practice.

The qualitative document analysis highlighted a lack of clarity around the responsibility for the collection and governance of different energy data types. There is therefore a need for Kenyan energy policy to clearly define the expected roles and responsibilities of key stakeholders – national and county governments, as well as a selection of national institutions – and to provide definitions as to what data should be collected to inform the energy planning process. The document analysis also recognised the need for transparency and accessibility of information along the governance processes in Kenya.

The interviews corroborated the lack of clarity about the roles and responsibilities of different institutions in the collection and governance of energy data in Kenya. The respondents mainly pointed towards the MoEP, and therefore the national government, as the key actor expected to provide guidance and instructions, without clearly mentioning any specific roles for other institutions and governments involved in the process. The interviews also provided contrasting opinions over the potential benefits (e.g. accessibility of information, trust-creation) and downsides (e.g. security risks, exposure to scrutiny) of a more transparent and open energy data approach for Kenya.

When comparing the evidence collected with established values and principles of open science, there is strong alignment supporting the viability of open science and open data as helpful approaches to support

the highly complex network of stakeholders involved in Kenya's energy planning process, by providing accessible and transparent resources and enabling collaborative efforts. These principles also aligned with the overall policy framework in which the energy planning process for Kenya sits, and the broader long-term governance direction of the national Constitution. Based on the established principles of open data considered in this paper, an open approach to energy data is also theoretically well suited to help address many of the criticalities of current energy data sources in Kenya, as identified by the interviews' respondents. However, given the discrepancies between stated policy and implementation of data sharing as expressed by stakeholders, it is critical to better understand the way the theoretical principles considered in this study can be implemented. It is also worth considering how open data imply a highly digitalised approach to data management, which might pose challenges in a country like Kenya where electricity access is not yet available to all, as well as access to a computer with an internet connection. This might ultimately affect the overall accessibility of information especially in rural counties, together with the ability to contribute to the data collection efforts.

This paper acknowledges that the process of developing and releasing open data in practice, in accordance with the FAIR data and International ODC principles, is highly time and resource intensive. Therefore, the use of open data as a management and governance solution to inform energy system planning efforts in Kenya needs to be investigated further in its own context, particularly with regards to mapping existing knowledge, resources, and infrastructure that could unlock the full realisation of open energy data in the country. In addition, further research and support is needed to better understand the complexity of norms, ideals, preferences and interpretations of what stated in the existing documents and policies, and how they can be compromised to find a realistic and effective solution for implementation. In light of the previously mentioned lack of access to electricity and internet services in Kenya, this also raises questions about how online data management infrastructures can be realised to ensure relevant stakeholders can access, contribute to, and make use of data.

The insights provided in this paper should also be considered in the broader context of energy data governance and management in support of energy systems planning in developing countries. The example of Kenya shows how key concepts and methods related to data governance and open science practices are still subject to various interpretations. This calls for standards and definitions to be adapted and translated to specific local contexts, preferences, and needs, as well as for more attention to be paid to specific knowledge and understanding of different options. It also highlights the disparity between what is envisioned in existing policy documents and what is implemented. This calls for a more careful comparison and review of stated policy goals and ambitions with existing challenges that come with their realisation. Eventually, what emerges from this study is that context specific analysis and understanding of potential barriers to adoption of open science practices are key to find the viable degree of openness that fits the purpose. More dialogue among those involved in the process is key to a realistic and effective implementation that supports the goal of energy system planning.

Finally, it is important to highlight the leading role that Kenya has in embracing and supporting transparent and collaborative energy planning. If the country succeeds in defining an effective data governance and management solution for energy planning, this could provide a huge stimulus towards efforts elsewhere, showing new paths for effective data management and governance and the potential adoption of open science practices in energy planning.

CRediT authorship contribution statement

Agnese Beltramo: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alycia Leonard:** Writing – review & editing, Methodology, Formal analysis. **Julia Tomei:** Writing – review & editing, Methodology. **Will Usher:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Declaration of competing interest

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

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Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2024.103821.

Data availability

The authors do not have permission to share data.

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