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Climate and sustainability co-governance in Kenya: A multi-criteria analysis of stakeholders' perceptions and consensus

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ABSTRACT

The Paris Agreement and the 2030 Agenda for Sustainable Development embody highly intertwined targets to act for climate in conjunction with sustainable development. This, however, entails different meanings and challenges across the world. Kenya, in particular, needs to address serious sustainability threats, like poverty and lack of modern and affordable energy access. This study uses a multi-criteria group decision aid and consensus measuring framework, to integrate both agendas, and engages with Kenyan stakeholders to help inform future mitigation research and policy in the country. Results showed that stakeholders highlight topics largely underrepresented in model-based mitigation analysis, such as biodiversity preservation and demand-side transformations, while pointing to gaps in cross-sectoral policies in relation to access to modern energy, agriculture, life on land, and climate change mitigation. With numerous past and recent policies aiming at these issues, persistent stakeholder concerns over these topics hint at limited success. Sectoral and technological priorities only recently emphasised in Kenyan policy efforts are also correlated with stakeholders' concerns, highlighting that progress is not only a matter of legislation, but also of coordination, consistency of targets, and comprehensibility. Higher bias is found among the preferences of stakeholders coming from the country's private sector. Results from this exercise can inform national policymakers on effectively reshaping the future direction of the country, as well as modelling efforts aimed at underpinning Kenya's energy, climate and sustainable development policy.

Introduction

Climate change is undeniably one of the most severe threats to sustainability, although its impacts are expected to differ across the globe, across different geographical/environmental contexts as well as levels and progress of economic development. These different impacts affect countries' need and capacity to mitigate and/or adapt to the climate crisis in an uneven way, establishing the necessity for national and regional priorities to be well aligned with their local context. Narrowing down to the developing African countries, climate change is considered a major challenge due to distinctive socioeconomic (Ochieng et al., 2016; Sanneh, 2018), climate and geographic (Sanneh, 2018) factors in the region. The Paris Agreement and the 2030 Agenda for Sustainable Development, both established in 2015, embody highly intertwined targets and guidelines to act for the climate crisis in conjunction with sustainable development (Nikas, Gambhir, et al., 2021), but for the developing world these targets have contexts and meanings that transcend the mitigation-oriented focus of high-income, major emitters. Many countries in the African region have already begun the coordination and initiation of governance mechanisms for the implementation of Sustainable Development Goals (SDGs) by setting respective roadmaps and action plans in response to climate change (Allen et al., 2018). However, progress towards sustainable development is still very limited for a multitude of reasons.

For Kenya, in particular, one of the most prominent bottlenecks hindering progress can be found in limited access to energy (Moner-Girona et al., 2018). This is, despite significant improvements on the

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electrification rate of the country in the last decade (Taneja, 2018), which jumped to 84.5% in 2019 (IEA, 2020) from about 20% in the early 2010s (Dagnachew et al., 2017; Schwerhoff & Sy, 2019), in impressive contrast to the delayed progress in the broader Eastern African region, where electrification increased moderately from 23% to less than 40% in the same period (Dominguez et al., 2021). The energy access problem is further observed in rural areas (Moner-Girona et al., 2019), with concerns remaining over the ability of rural households to afford current electricity prices (Taneja, 2018). With inadequate power generation capacity—less than 2 GW a decade ago, and little reported progress by 2020, remaining slightly below 3 GW (IRENA, 2021; Kazimierczuk, 2019)—and an unreliable and costly grid (Winther et al., 2018), energy needs in Kenya also rely on alternative fuels like biomass for cooking purposes and oil in the transportation sector (Dalla Longa & van der Zwaan, 2017). It is noteworthy that reliance on traditional biomass is higher in Sub-Saharan Africa (SSA) than in any other region (Leimbach et al., 2018), while more than half of Kenyan households rely on traditional biomass stoves to accommodate their cooking needs—even more so in rural areas. The majority of these biomass resources are being extracted unsustainably due to rapidly growing energy demand, and a trend towards charcoal use, requiring more biomass resources per unit of final energy (Bailis et al., 2015).

Moving away from the energy domain, the availability and quality of food supply in Kenya faces limitations since most open-access sites feature poor ecological conditions, regarding coral reefs and fishing grounds, affecting many coastal communities relying on fisheries (D'agata et al., 2020). In another dimension showcasing the interplay of climate change and other sustainability priorities, global warming threatens the productivity of crop yields and the efficiency of the agricultural sector (Mason-D'Croz et al., 2019), one of the key pillars of the Kenyan economy (Kogo et al., 2021). This, in turn, threatens the ability of agricultural enterprises to secure their productivity and overall capacity to preserve the local environment (Norese et al., 2020), considering that the agriculture, forestry, and land use (AFOLU) sector produces the highest amount (around half, in 2018) of net greenhouse gas (GHG) emissions (Climate Watch Historical GHG Emissions, 2021). Combined with extreme poverty and a very low GDP per capita in the broader region (Leimbach et al., 2018), these conditions contribute to nutrition being of poor and low calorific quality. In particular, stunting in children under 5 was 35.2% in 2009, only moderately falling to 26.6% in 2020 (Action Against Hunger, 2020; World Health Organization, 2015).

Lack of energy access, extreme poverty, low food consumption, unsafe water supplies and insufficient sanitation, as well as indoor air pollution have consequently caused significant health-related issues in the region, leading to high mortality shares. For example, household air pollution is killing 60 per 100,000 residents mainly due to poor cooking technologies or fuels (Dagnachew et al., 2020). And, despite high vaccination preparedness (León et al., 2019), Kenya ranks poorly in child and maternal health (Luque et al., 2017), as well as provision of clean water (Hyvärinen et al., 2020) and sanitation (Lucas et al., 2019) to children (e.g., in 2008, diarrhoeal deaths in children under 15 years old were estimated around 23,500; World Health Organization, 2015).

So far, mitigation analysis in the region has largely been based on climate-economy models, or what are broadly called Integrated Assessment Models (IAMs). Such model-based, short-term assessments aiming to inform Kenya's (and neighbouring countries') Nationally Determined Contributions (NDC) to climate efforts have proposed various energy technological solutions to drive a sustainable pathway addressing the most pressing threats, like biogas (Forouli et al., 2020), geothermal energy (Musonye et al., 2021; Schwerhoff & Sy, 2019) and PV micro-grids (Dagnachew et al., 2017, 2018; Johannsen et al., 2020). However, concerns have been raised over the ability of African countries, and especially in the SSA region, to achieve high investments in, and penetration of, renewable energy sources (RES) (e.g., Dalla Longa & van der Zwaan, 2017). Projections inter alia stress that the pipeline of currently planned power plants and projects for the next decade and the expected small share of non-hydro renewable energy (Alova et al., 2021) will possibly render 2030 targets much harder to achieve than initially anticipated. At the same time, these models typically focus on supply-side transformations in power generation to achieve climate targets (Creutzig et al., 2018), paying little attention to demand-side aspects and other sectors, or to broader sustainability dimensions. Given geographic granularity limitations, they also typically lack national-level disaggregation and instead look into much broader regions. In particular, Kenya is usually grouped differently, depending on the IAM employed (e.g., as part of Africa as a whole, the Sub-Saharan region, or Eastern Africa), thereby undermining the local context and needs (e.g., the higher progress in terms of access to electricty).

Considering the gap between model preferences and feasibility, the predominant focus on mitigation rather than the broader sustainability space (which has only recently started being implemented in the models, see van Vuuren et al., 2022), as well as the inconsistencies between geographic granularity and national policy priorities, scenarios produced by model-based mitigation studies alone can be difficult to implement at the national level. Complexity (Sachs et al., 2019) and limitations in modelling capabilities relating to social goals (Allen et al., 2016), which significantly influence final policy prescriptions, can furthermore cause reluctance when the scientific process is detached from stakeholders, who are hesitant to translate outputs into action (Doukas et al., 2018). Establishing good governance practices that enhance active collaboration among participating groups, achieve balanced representation of experts and non-experts, and incorporate a diversity of interests can boost implementation effectiveness (Leal Filho et al., 2018; Musch & von Streit, 2020), broaden positive societal impacts (Restrepo et al., 2020), and improve public awareness and acceptance (Neofytou et al., 2020). To bridge this gap and establish new approaches in scientific support of climate action and sustainable development, while addressing potential policy spillovers across sectors and domains (McCollum et al., 2018), multi-criteria decision aid (MCDA) has been used to engage stakeholders in the process and support decisions in policymaking for climate (Bonilla et al., 2021; da Ponte et al., 2021; Doukas & Nikas, 2020; Workman et al., 2020) and sustainable development (Diaz-Sarachaga et al., 2017; Nhamo et al., 2020).

This study attempts to engage with Kenyan stakeholders to capture their perceptions of prioritising action for SDGs and sectoral decarbonisation, in light of all these highly intertwined sustainability challenges (Rosenthal et al., 2018) and the ever-growing jigsaw of relevant policies recently put together by the Kenyan government (see also Section 2). Drawing from Koasidis et al. (2021), it builds on an MCDA framework based on the 2-tuple group TOPSIS model (Labella et al., 2020), which is designed to facilitate eliciting stakeholders' unbiased assessments, aiming to inform policy design and prioritisation, as well as future national modelling efforts. In particular, our research is motivated by the need to capture local perspectives on (a) which are the priority topics in the climate and sustainability context of the country; (b) what has the most recent national policy framework achieved; and (c) how can Kenya's policy direction be reshaped, in light of the pending update of the national climate action plan.

In Section 2, we perform a deep-dive in Kenya's policy context to understand the regulatory landscape reflecting the country's priorities, ambition, and progress from a policy perspective. Section 3 presents the methods and tools employed in the study, while Section 4 features the application of the methodological framework and discusses the findings of the study. Finally, Section 5 summarises the key takeaways and discusses the added value and possible next steps for research and policy alike.

The Kenyan policy context

Boosting energy access has been among Kenya's major challenges and priorities. In May 2004, the National Energy Policy (NEP) was legislated, aiming to sustainably increase energy access. Its objectives included promotion of energy conservation, and use of—as well as regulations for private investments in—RES (Ochieng et al., 2019; Olang & Esteban, 2017). Two years later, the Government introduced the Energy Act, establishing regulatory authorities towards achieving the NEP targets (Kiplagat et al., 2011), including the Energy Regulatory Commission, for increasing the diffusion of renewables (Olang & Esteban, 2017), and the Rural Electrification Authority, for improving energy access levels in rural areas and promoting socioeconomic development (Mutangili, 2021). This link between energy access and socioeconomic development was also highlighted in 2008, in Kenya's Vision 2030 roadmap, aiming to industrialise the country, as well as achieve sustainable living standards by 2030 (Andersen et al., 2021) and an annual growth rate of 10% (Kieti et al., 2020), which in turn require multiple energy infrastructure investments (Rambo, 2013), and aiming for an electricity access rate of 100% by 2030 (Saulo et al., 2010). The importance of power access for Kenya's economic growth is also reflected in its revised Constitution (in 2010), notably introducing governance devolution to various regional authorities in the endeavour to achieve nation-wide power access (de Bercegol & Monstadt, 2018); as well as multiple reforms on institutions, such as the judiciary system, in support of RES investments— these reforms were deemed critical after the reduced flow of foreign investments following the 2007–2008 post-election violence (Rambo, 2013). The government had also introduced legislation further regulating the energy sector, including the feed-in tariffs policy in 2008 (revised in 2010 and 2012), to reinforce RES investments (Olang & Esteban, 2017), as well as the 2012 Energy Regulations for solar photovoltaics, solar heating, and energy management and household energy efficiency (Yatich, 2018). More recent efforts to deliver on its overarching objective to improve energy access include the Power Generation and Transmission Master Plan, the Long Term Plan 2015–2030, the National Electrification Strategy 2018, and the Energy Act 2019. The former proposes a framework favouring competition in electricity generation and retailing, and regulates private investment in RES, as well as discussing exploitation of nuclear energy, following studies for a nuclear power plant on the Tana River (Muigua, 2020; Njeru et al., 2021).

Kenya's legislation had predominantly focused on increasing energy access and economic growth, without stressing climate change and sustainability, until 2010, when the government aligned with the Kyoto Protocol and introduced the National Climate Change Response Strategy (NCCRS) (Kwanya, 2014), highlighting already observed impacts on temperature rise and irregular, damaging rainfalls. The NCCRS promoted mitigation and adaptation measures in government planning and budgeting, focusing on objectives like energy efficiency, renewables, and low-carbon transport (Kwanya, 2014). Ahead of the Paris Agreement and the UN's 2030 Agenda for Sustainable Development, two noteworthy plans were introduced in 2013: the National Environment Policy broadly introduced a framework for protecting Kenya's national resources and environment (Gichenje et al., 2019), acknowledging the importance of energy in socioeconomic development and including objectives for cleaner energy production; and the National Climate Change Action Plan 2013–2017 (NCCAP), building on NCCRS and Vision 2030, setting a 30% CO_2 emissions reduction target by 2030, which was recently raised to 32% in the 2020 update of Kenya's NDC (against a 143MtCO_2eq baseline) (Brandt et al., 2018; Munene, 2019; UNFCCC, 2020), heavily relying on increased diffusion of geothermal energy (Dalla Longa & van der Zwaan, 2017).

Specifically targeting mitigation, Kenya has also introduced policies and participated in various initiatives launched by non-governmental institutions. For example, in 2013, GIZ, SNV, and the Global Alliance for Clean Cookstoves proposed the Country Action Plan (CAP), aiming to install modern cookstoves in 5 million Kenyan houses by 2020 (Carvalho et al., 2020; Petrichenko et al., 2020). Furthermore, Kenya has been participating in the UN SE4All initiative since 2015, aiming to achieve 100% access to electricity and modern cooking appliances, high energy efficiency, and RES diffusion by 2030 (Vezzoli et al., 2018). In the same year, the Draft Strategy and Action Plan for Bioenergy and LPG Development in Kenya was proposed, aiming to increase the diffusion of LPG, modern and efficient bioenergy systems, as well as the use of more efficient cookstoves by 2020 (Carvalho et al., 2019). The 2020 update of the Bioenergy Strategy (2020–2027) further acknowledges the importance of biomass, heading to the the final decade of the SDG framework.

Taking more drastic action, in 2016, Kenya legislated the Climate Change Act and the Kenya National Adaptation Plan. The former sets a regulatory framework for observing climate change (e.g. the creation of a climate change council), supports private investment towards this direction (Gannon et al., 2021), and stresses the importance of adaptation in the country's policies (Mayer, 2021). The latter was based on the realization of Vision 2030 regarding sustainability on economic, political and social aspects. It also proposes specific actions towards the country's adaptation to climate change (Karani, 2018). To further strengthen its mitigation effort, the government expanded its NCCAP for the period 2018–2022 to deliver on the country's NDC (Ageyo & Muchunku, 2020), also proposing a more diversified energy mix based on geothermal, wind, and solar energy, further suggesting the adoption of energy efficiency technologies and a more ambitious (optional) target of 60% emissions cuts by 2030. It is noteworthy, however, that this revision featured significantly higher 2030 baseline emissions. In the same context, in 2020, the Kenya National Energy Efficiency Conservation Strategy was proposed, comprising five pillars (households, buildings, industry and agriculture, transport, and power utilities), as one of the first Kenyan plans explicitly focusing on energy efficiency.

From a sustainability perspective, climate action and energy access aside, Kenya also focused on sustainable agriculture and biodiversity protection. The Agriculture (Farm Forestry) Rules, legislated in 2009, mandated that each landowner maintain 10% forest cover, for conserving the country's forests (Chisika et al., 2019). In 2012, Kenya proposed the Agriculture Act, including objectives for the sustainability of agriculture by promoting the conservation of soil, efficient land management, and good husbandry. However, not unlike the energy policies of the same period, legislation here mostly prioritised the financial rather than the environmental sustainability of the sector. It was much later that the government legislated the Kenya Climate Smart Agriculture Strategy 2017–2026, proposing the integration of food security, climate change, and agriculture (Faling, 2020), including objectives such as mitigating agricultural emissions and enhancing the sector's resilience to climate change to meet the increased food demands (Waaswa et al., 2021). Finally, Kenya's government legislated the National Wildlife Strategy 2030, aimed at protecting Kenya's wildlife from climate change impacts, which is critical from a tourism perspective (Kieti et al., 2020).

Based on this analysis, for the purposes of this study the Kenyan policy context can be perceived in three different stages. First, early energy and broader sustainability policies (mostly related to agriculture) between 2009 and 2013 acknowledged the challenges faced and tried to address them in line with the economic growth of the country, but with lower mitigation ambition. Then, during 2013–2017, the country raised mitigation and/or adaptation ambition, but still the motivation was predominantly towards economic sustainability. It was the third period from 2017 to 2020 that showed a significant acceleration of incorpating climate action in key legislations, resulting in numerous policies for RES, energy efficiency, bioenergy, and smart agriculture that accompany the broader action plans and strategies hint the start of a new policy period. Still, this jigsaw of strategies and legislations faced criticism over its comprehensibility from citizens, who seem to lack adequate information on climate and sustainability (Ageyo & Muchunku, 2020), hindering the effectiveness of policies, as is the case for example with the limited uptake of improved and modern/clean cook stove technologies (Osiolo, 2021). As such, moving onto this decade, which enforces achieving progress in SDGs as well as concludes the Vision 2030, engaging with local stakeholders seems vital to understand the contemporary issues in the country, which could also shed light on the results of all these years of policies from their perspective. As we head to a new policy period with a pending cornerstone update of the NCCAP for the period 2022–2027, which will be the final 5-year revision of the action plan to be concluded before 2030, this process could enable true co-goverance among stakeholders in the country and help avoid mistakes of the past in shaping future legislations.

Methods and tools

Stakeholder engagement and elicitation of preferences

In the context of the PARIS REINFORCE research and innovation project orienting on stakeholder-driven modelling in support of climate action, a regional stakeholder workshop was held with experts from Kenya, on 28 October 2020. In the workshop, held virtually due to COVID-19 implications for travel and organisation of events, 23 stakeholders participated in a dedicated session and live polling, in order to evaluate and help (a) assess the sectoral decarbonisation priorities in terms of contributing to sustainable development; and (b) prioritise the urgency of each SDG in the context of the country's climate action. Stakeholders were identified and invited from contacts of the Technical University of Mombasa (TUM), relevant to the scope of the exercise. In particular, to ensure that this selection is as objective as possible, the initial contact database of the TUM was screened to identify stakeholders that meet the following criteria: (i) appropriate level of professional knowledge and skills (in particular related to the decarbonisation of the energy sector and/or sustainable development); (ii) knowledge of English (which would be used in the workshop and questionnaire); (iii) knowledge of and experience in the Kenyan context and development. Although using a university database as a starting point features the risk of creating a predominantly academic sample, this risk was mitigated on two levels: first a threshold was established to ensure that less than half of the participants came from academia; second, analysis was also performed based on the occupancy of the participants to accompany the aggregated results, to shed light on the differences introduced by the different background of the participants. The intention was not to recruit vast numbers, but rather a variety of backgrounds and areas of expertise, so as to examine the full possibility space. Still, significant effort has been put to ensure that there is an adequate number of participants and responders to the questionnaires, to surpass the theoretical threshold in the group decision field to classify the group as large and the process as large-scale group decision making (Xu et al., 2015; Zhang et al., 2017). Following ethical standards put in place by the National Technical University of Athens (scientific coordinator of the PARIS REINFORCE project), the workshop and the polling session were conducted after the approval of the Data Protection Officer of the Energy Policy Unit of the National Technical University of Athens. Participants were informed that their votes would be anonymous and that their working capacity, collected during polling, would be used for aggregated statistics on the participants.

In the workshop session, stakeholders were asked to express their preferences in two questionnaires filled in via an online polling platform, sli.do,[1] with regard to prioritising decarbonisation action in Kenya by sectors, in terms of sustainable development; and sustainable development, as broken down into SDGs in the UN's 2030 Agenda, in terms of climate action in the country. The questionnaires allowed stakeholders to use familiar linguistic terms, to then be used in the analysis, thereby increasing human perception of both the inputs and the outputs in the same format (Doukas et al., 2010).

In the first questionnaire, stakeholders were invited to assess the importance of the decarbonisation of six sectors, namely power generation (POWER), agriculture, forestry and land use (AFOLU), heavy and light industry (INDUSTRY), the tertiary and public services sector (SERVICES), residential buildings and energy use (RESIDENTIAL), and public and private transportation (TRANSPORT), based on four criteria: human development, resource use, earth system conservation, and equality. Stakeholders were provided with brief elaborations of the criteria, in the form of examples (see Table 1), to ensure that participants would have a fundamentally shared understanding of the distinctions between them. Similarly, in the second questionnaire, the engaged stakeholders were asked to evaluate fourteen out of the seventeen SDGs, based on their relevance to climate change and action, the trend of progress in Kenya, the national policy ambition, and their importance in the Kenyan context. SDG 13 (climate action) is not included as an alternative in the questionnaire, as it is with respect to climate action that SDGs are evaluated. Similarly, SDGs 16 (peace, justice, and strong institutions) and 17 (partnership for the goals) are excluded from the questionnaire, because they are found underrepresented in the PARIS REINFORCE modelling ensemble (Giarola et al., 2021; Nikas, Elia, et al., 2021; Sognnaes et al., 2021). Tables 1 and 2 summarise key information of each questionnaire.

Multiple-criteria group decision analysis

To analyse stakeholder input and carry out the multiple-criteria analysis, we employ APOLLO (Labella et al., 2020), a multi-criteria group decision support model that uses the 2-tuple TOPSIS method.

The 2-tuple group TOPSIS MCDA framework essentially comprises (a) the TOPSIS multi-criteria framework (Yoon & Hwang, 1981) that is among the most popular MCDA methods in climate change decision making (Doukas & Nikas, 2020) and sustainable development (Koasidis et al., 2021), (b) the 2-tuple linguistic representation model (Martinez & Herrera, 2012), and (c) the group TOPSIS variant (Krohling & Campanharo, 2011) as enhanced in a two-stage TOPSIS approach by Nikas et al. (2018). The objective is to calculate a weighting preference for different alternatives and derive to a final ranking based on minimising and maximising the distance from a positive and negative ideal solution respectively. The use of linguistic scales for both the input and the output of this model (see Tables 1, 2) is a key advantage of the adopted approach, as it enhances comprehensibility of the results contrary to arbitrary quantified values.

Consensus measuring

Two of the main criticisms TOPSIS and other ranking MCDA methods receive focus on the lack of internal procedure to calculate the weights

Table 1
Alternatives, criteria, and linguistic scale of questionnaire on sectoral decarbonisation priorities in terms of contributing to Kenya's sustainable development.

Alternatives	Evaluation criteria	Linguistic scale
RESIDENTIAL POWER INDUSTRY SERVICES TRANSPORT AFOLU	C1. Human Development How important would decarbonising this sector be for human development (growth, employment, education, health)? C2. Resource Use How important would decarbonising this sector be for resource use (clean/affordable energy, food, water)? C3. Earth System Conservation How important would decarbonising this sector be for earth system conservation (biodiversity, climate)? C4. Equality How important would decarbonising this sector be for equality (social, gender)?	Evaluation Scale {none, very low, low, medium, high, very high, excellent} Weight Scale {very low, low, medium, high, very high}

[1] https://www.sli.do/

Table 2
Alternatives, criteria, and linguistic scale of questionnaire on the urgency of each SDG in the context of Kenya's climate action.

Alternatives	Evaluation Criteria	Linguistic Scale
SDG 1: No Poverty SDG 2: Zero Hunger SDG 3: Good Health and Well-Being	C1. Significance How significant do you find this SDG is to address in the Kenyan Context?	Universal Scale {very low, low, medium, high, very high}
SDG 4: Quality Education SDG 5: Gender Equality SDG 6: Clean Water and Sanitation	C2. Relevance How relevant to climate action do you think this SDG is?	
SDG 7: Affordable and Clean Energy SDG 8: Decent Work and Economic Growth SDG 9: Industry, Innovation & Infrastructure	C3. Trend of Progress How do you perceive the trend of progress in meeting the goals of this SDG so far?	
SDG 10: Reduced Inequalities SDG 11: Sustainable Cities and Communities SDG 12: Responsible Consumption & Production SDG 14: Life Below Water SDG 15: Life on Land	C4. Ambition How do you perceive the ambition of the Kenyan policy towards meeting the goals of this SDG so far?	

of criteria, and the subjectivity of information provided by the stakeholders, when used in decision-making problems (Huang & Li, 2012; Shafabakhsh et al., 2014). Furthermore, such participatory settings feature conflicting natures associated with stakeholders coming from different backgrounds; in such group decision making problems forcing a middle solution may yield a result of low acceptance (Ben-Arieh & Chen, 2006; Fu & Yang, 2010). It is, therefore, interesting to explore the gaps between different stakeholder groups as well as couple each alternative with a consensus level.

Using the 2-tuple variant of TOPSIS, like other fuzzy solutions to these issues (Bayram & Şahin, 2016; Mangla et al., 2015), and further coupling it with a coherent methodology for measuring the levels of agreement, the proposed framework attempts to address these challenges. The employed consensus measuring framework is described in Labella et al. (2020).

Increasing robustness: integrating the two individual exercises into one

The two seemingly separate individual MCDA exercises, where action for climate change and various dimensions of sustainability comprise the alternatives and the evaluation criteria respectively in the first, and vice versa in the second, are then coupled by using the second exercise as feedback to the first one, allowing to modify the criteria weights and increase robustness of the results. In particular, the four criteria used in the sectoral analysis are used as clusters of the SDGs: we draw from the SDG classification made by van Soest et al. (2019), as shown in Fig. 1 (coloured ovals), and adapt to the Kenyan context as well as the scope of our study and the SDG representation, by focusing on equality instead of infrastructure as the fourth cluster of our analysis. The mapping of the SDGs onto the four criteria was not discussed with the participants (apart from the simple examples provided; see Table 1), as the purpose of the integration of the two questionnaires was to capture indirect preferences from the stakeholders.

Considering this interplay between the two questionnaires, the analysis is performed in two phases. First, the assessments of the stakeholders are analysed independently, serving to directly elicit their tacit preferences. Second, considering the connection between the SDGs and their clusters used as criteria in the sectoral analysis, the assessments of the stakeholders from the two questionnaires are integrated as illustrated in Fig. 1. Assuming that providing assessments for the SDG analysis requires a broader and more holistic understanding of sustainable development in Kenya, this second questionnaire is used as a criteria weight filtering for the first exercise: the SDG analysis results are used as a correction for the criteria weights provided by the stakeholders, grouped and producing an average value depending on their affiliation with the respective criterion. By doing so, we can improve the consensus levels of the engaged group and increase the robustness of the analysis outcomes.

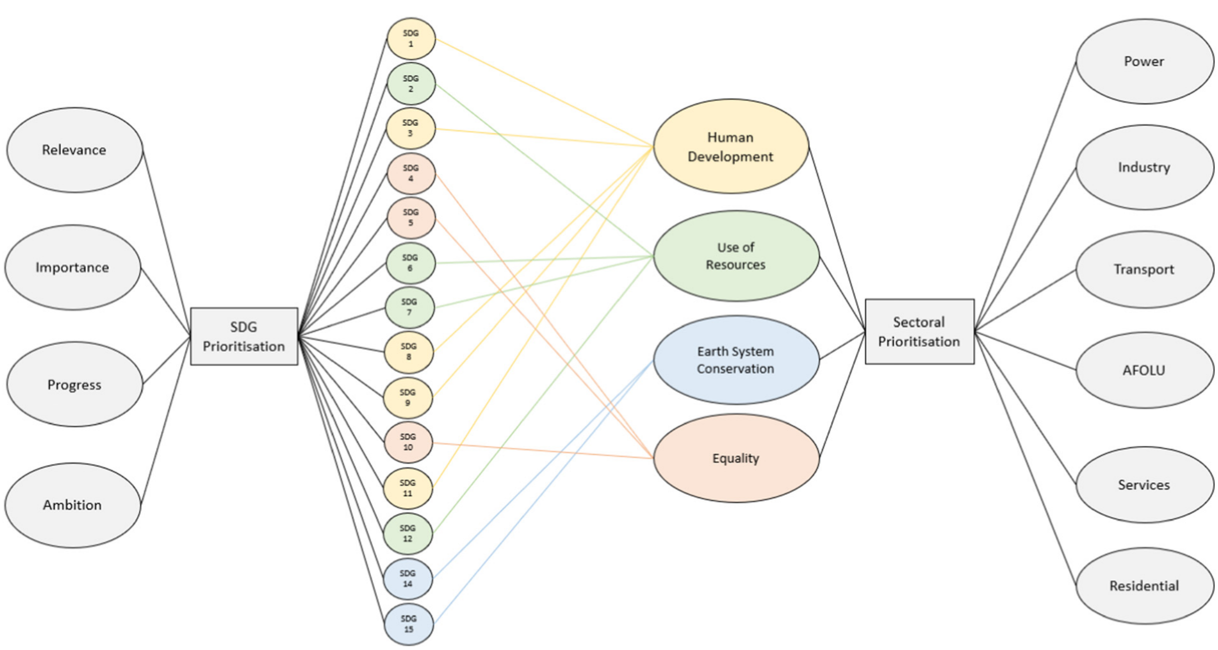


Fig. 1. Integration of the two MCDA exercises.

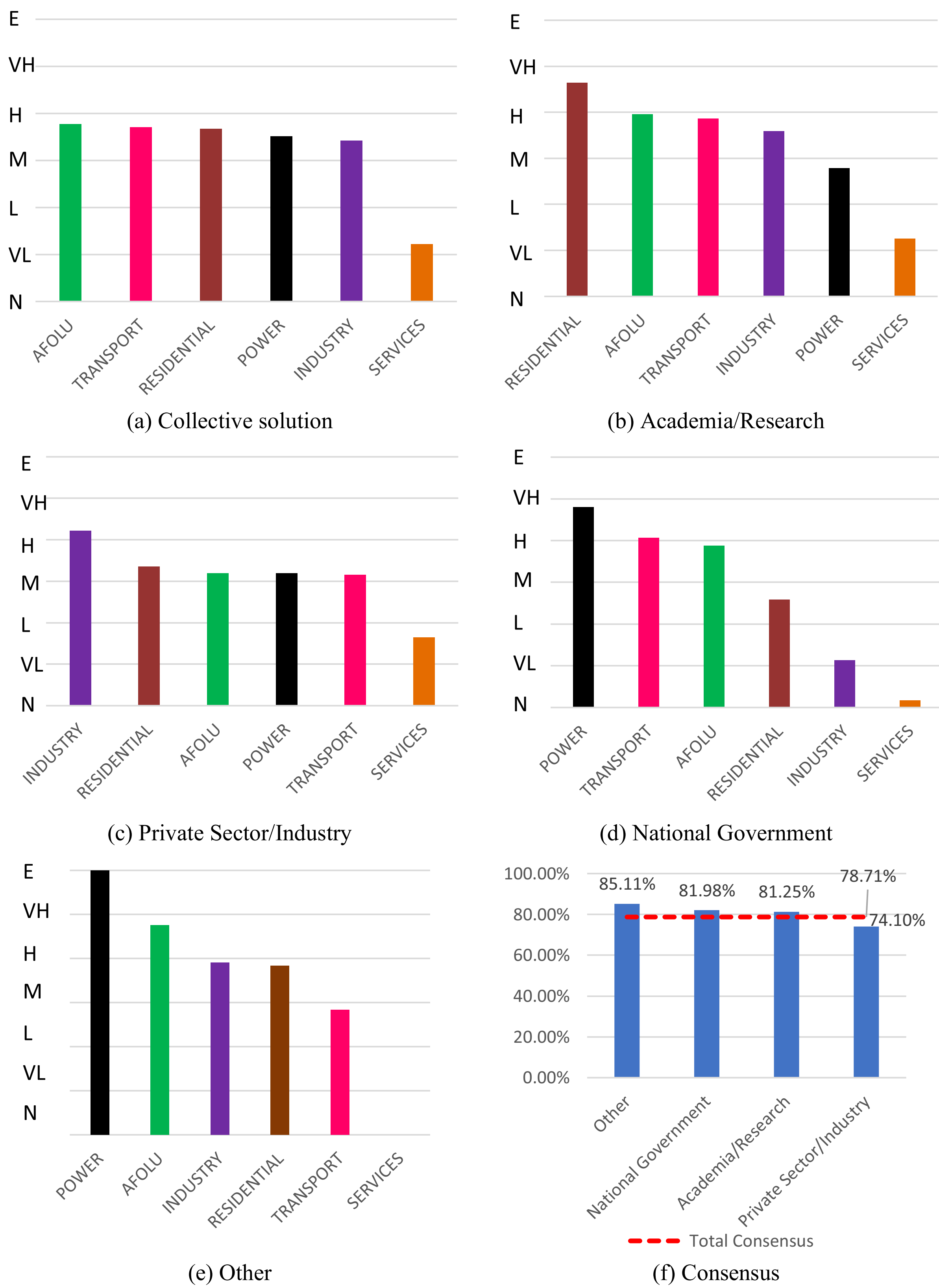


Fig. 2. Prioritisation of sectoral decarbonisation based on (a) the collective group, (b) academia, (c) private sector/industry, (d) national governments, (e) other, and (f) the consensus of each solution. The scale of the vertical axis reflects the linguistic scale {none, very low, low, medium, high, very high, excellent} used in the exercise.

Results and discussion

Initial sectoral analysis

During the first session, 21 stakeholders featuring different backgrounds and levels of expertise from academia (43%), industry (29%), national government (14%), and other (9%) evaluated the importance of decarbonising each economic sector in different sustainability pillars, as clusters of SDGs (note: one of the stakeholders did not disclose how they would describe their current working capacity). It should be noted that, despite being expectedly fewer than the other two groups, participants coming from the national government offer a unique and authoritative, high-level policymaking perspective; they are thus considered as an independent group in the analysis. This is also in line with other expert surveys of this scale, in which policymakers are represented in similar shares (Fedak et al., 2019). Based on the assessments of the stakeholders in a seven-term scale of importance, {None, Very Low, Low, Medium, High, Very High, Excellent}, and the methodology described in Section 3, the global solution (i.e. sectoral ranking) of the MCDA problem is calculated. The ranking of each alternative is presented in Fig. 2a. From this initial prioritisation, no clear group preference can be derived for the sectors, as decarbonisation is deemed as similarly important across them. A distinction can be made about services, which was the only sector with a very low evaluation, indicating that stakeholders perceive the decarbonisation of the other more carbon-intensive sectors as more urgent and relevant to sustainable development overall. Compared to the other alternatives, services received varying evaluations across the stakeholder pool, even in the criteria that the importance of the sector performed highly; it was also deemed less critical in terms of human development and equality.

Although the AFOLU sector, being critical in terms of both contribution to the national economy and emissions produced, seems to receive the highest prioritisation, it is not deemed as markedly more important than the remaining sectors. In fact, due to the negligible differences among their evaluations and with the exception of services, all sectors ended on the medium-to-high scale. Since TOPSIS calculates the distance between the positive and negative ideal solution, this intermediate evaluation should not be interpreted as a medium importance of all sectors, rather than a lack of strong preference over each alternative. This initial collective group prioritisation of Fig. 2a received a low consensus level of 78.1%, with stakeholders individually showcasing a large range of personal consensus fluctuating from 65% to 92%, as seen in Fig. 2f, thereby highlighting the limited capacity to produce robust insights without taking the consensus into account. Fig. 3 expands the decision-making process to include not only the evaluation, but also the consensus level of each alternative in this collective solution. Despite the indifference in preferences, consensus allows a better distinction among the alternatives. The agricultural sector presents the highest consensus among the examined alternatives, being the only sector that tilts in the higher consensus area, i.e. outperforming the global consensus levels. On the other hand, the residential and transport sectors seem to be more of a "middle-of-the-road" solution, while industry and power generation display low consensus. To better understand how these differences are produced, the internal solution of each stakeholder group is also presented in Fig. 2b-e.

Each group of stakeholders considers different sectors as critical to decarbonise, with respect to sustainable development. Academia and research stakeholders favour the residential sector, with AFOLU being the second most important sector, according to their responses. As already presented in the Kenyan context above, the residential sector is an important factor regarding air pollution since households rely on traditional biomass for their energy needs due to lack of access to electricity and modern energy sources, a correlation well understood by academia (Rao et al., 2016) but less so by other groups. On the other hand, national government stakeholders consider the power sector as the most important, indicating that lack of access to electricity should be sought in transformations in power generation. Stressing the importance of the power sector's decarbonisation was expected for this group, since the Kenyan Government has introduced multiple legislative acts and policies towards combating the lack of power access in conjunction with mitigating the sector's emissions through regulations for higher RES diffusion. It is also important to mention that both groups consider the agricultural sector highly important. Finally, private and industrial sector representatives appear to consider that industry is the most important one to decarbonise in Kenya. High prioritisation of their professional domain may seem biased; however, the remainder of their ranking follows similar patterns to the broader stakeholder pool, placing the residential and agricultural sectors at the second and third position, respectively.

The fluctuation highlighted in Fig. 2b-e confirms the outputs of our consensus analysis, with the AFOLU sector, despite not being evaluated as the most important sector by any group, appearing consistently in the higher places of the ranking. The rest of the alternatives display significant fluctuations, especially power and industry, justifying the lower ranks in the consensus axis (Fig. 3). In fact, the power sector, despite ranking first among two groups, was evaluated poorly by the others. Similarly, the bias of private and industrial sector stakeholders in upvoting their sector is also observed in Fig. 2f, where the internal consensus of the group is lower than the global consensus, while all other groups expectedly had higher internal consensus.

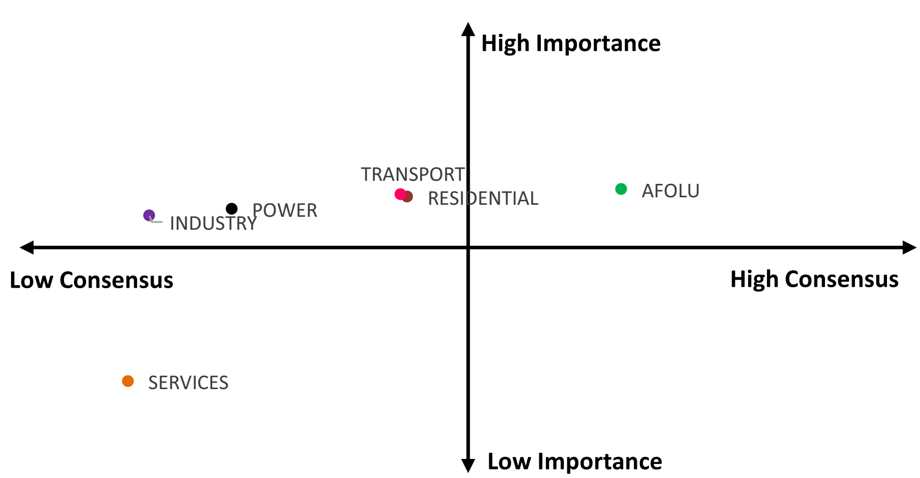
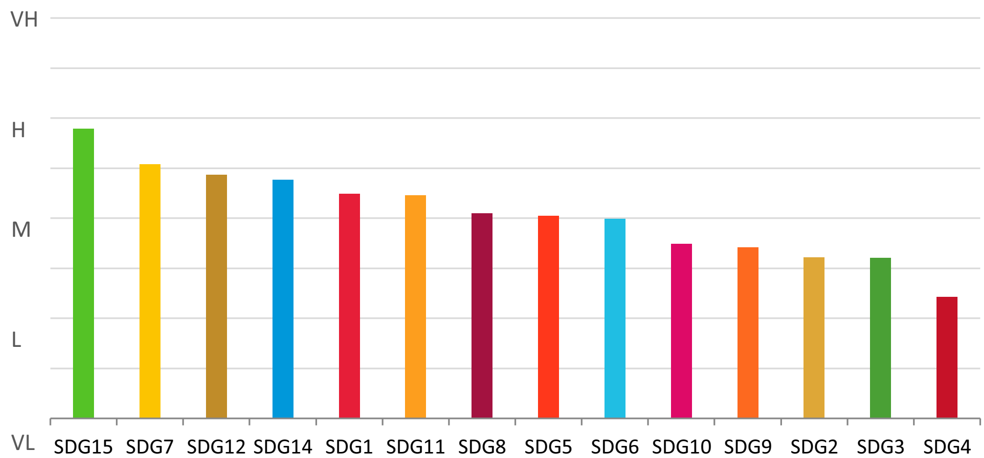
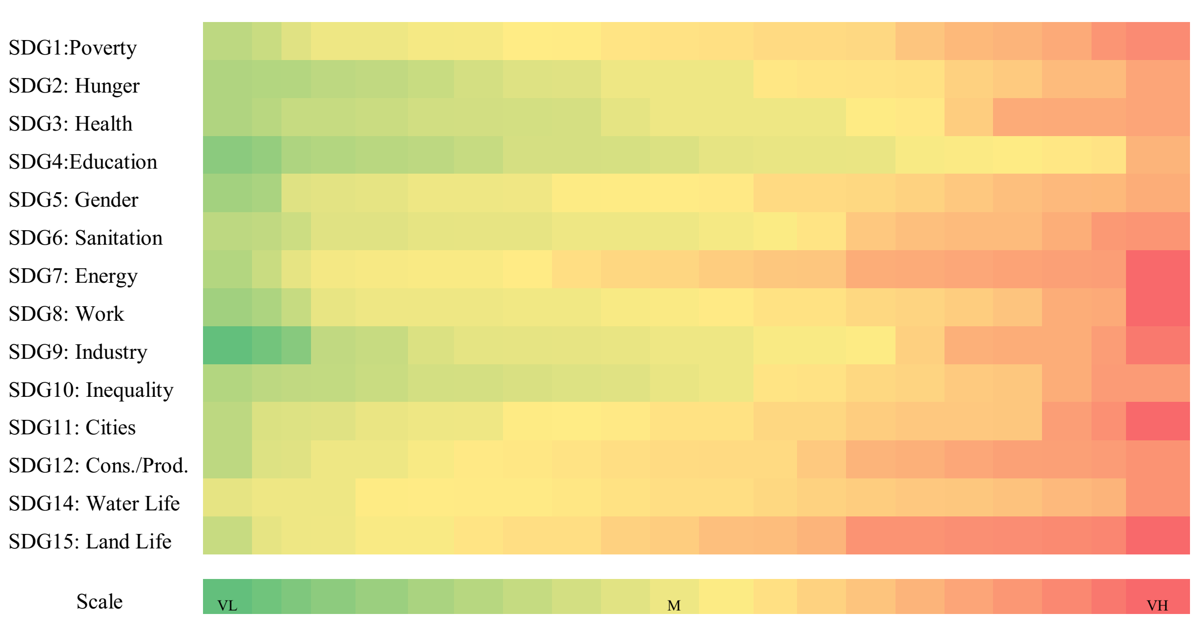


Fig. 3. Importance-Consensus levels of each sector in the initial analysis.



(a) Collective solution

(b) SDG ranking per stakeholder group



(c) SDG intensity heatmap

SDG analysis

The first exercise showed unclear prioritisation of sectors for decarbonisation with regard to sustainability gains, also backed by low consensus levels among stakeholders. A second exercise was carried out, with two objectives: first, to prioritise SDGs as key research topics in mitigation analysis; and, second, to reinforce in a feedback mechanism the sectoral analysis, by introducing weights to the evaluation criteria used in that exercise. This time, following a kind invitation motivating those with a broader understanding of the SDG framework, its progress and relevance to the country's context and its relationship with climate change and action, sixteen stakeholders participating in the workshop chose to engage in this exercise coming from academia (50%), international institutions (13%), industry (31%) and national governments (6%).

Applying the methodological framework described in Section 3, Fig. 4a illustrates the global results of the exercise, ranking the 14 SDGs according to stakeholders' responses. Evidently, SDG15 (Life on Land)—the only SDG with a decreasing progress trend in Kenya (Sachs et al., 2020)—received the highest prioritisation with an evaluation of (High, −0.11). Both the connection between mitigation and SDG15 and of its impact towards achieving the sub-goals of this SDG are well-established (Hamidov et al., 2018): Kenya heavily depends on traditional and non-sustainable biomass, leading to significant implications for land use change, agriculture, and deforestation. Considering the trade-offs between these aspects and SDG15 (Campbell et al., 2018) as well as land degradation risks (SDG 15.3) (Hirons, 2020; Herrick et al., 2019) and the corresponding food implications (SDG2) and health impacts (SDG3) identified in the local context, without overlooking the numerous endangered species of the country (Earth's Endangered Creatures, 2020), this provides an initial validation for the high prioritisation of the importance of the changes in the AFOLU sector, as established in the first questionnaire. Also, it indicates that stakeholders prioritised AFOLU based both on the sector's importance for the economy and emissions, and on broader land use and biodiversity concerns. It is noteworthy that legislation in the country has focused on wildlife, especially megafauna, since it is deemed critical for the sustainability of the tourism sector (Kieti et al., 2020); next focal areas in this respect should include land-use diversity, landscape heterogeneity, and ecosystem services (Tyrrell et al., 2020). But SDG15 priotisation can also trace back to poor legislation regarding the use of non-renewable biomass in households: the only relevant policies are either not government-driven (see Kenya Country Action Plan and SE4All Initiative) or limited to draft versions (Draft Strategy and Action Plan for Bioenergy and LPG Development in Kenya) (see Section 2). Chisika et al. (2019) further argued that the Agriculture (Farm Forestry) Rules feature inconsistencies, while Faling (2020) that the Kenya Climate Smart Agriculture Strategy 2017–2026 is very complex, without leading to radical transformations of the country's agriculture sector.

Fig. 4b presents the fluctuations of rankings by different groups, which mostly followed the patterns of the global ranking. Interesting outliers are also present, with stakeholders from international institutions prioritising SDG11 (sustainable cities and communities), and government representatives highlighting the importance of SDGs 10 (reduced inequalities), 3 (good health and well-being), and 6 (clean water and sanitation). While most of these issues are well-established threats to Kenya's sustainability, these preferences hint that the government is prioritising efforts on the social dimension, possibly reflecting confidence over current legislative efforts on energy access and sustainability. Interestingly, however, this group drove evaluations higher compared to the other stakeholders; private sector stakeholders showed overall indifference to SDGs, including those ranked the most important.

Fear of biodiversity loss could be another driver for the prioritisation of SDG15 as the most important sustainability goal, due to the perceived relationship between habitat destruction and the current global health emergency (IPBES, 2020). Aside from COVID-19, although health issues in general, like high mortality especially in children, are already identified as a major threat in the broader SSA region, the corresponding goal (SDG3) was not found among the top priorities, ranking in fact second to last. However, this should not be interpreted as indifference towards such issues, as the evaluation considers the importance of each SDG in relation to climate change, with mitigation and SDG3 progress sharing indirect co-benefits. Nevertheless, it is an important finding, as most mitigation studies in the literature exploring interactions between climate action and other SDGs in the region focus inter alia on SDG3 (e.g. Forouli et al., 2020; Rafaj et al., 2021; Van de Ven et al., 2019; Vandyck et al., 2018), mostly targeting sub-goals and indicators like air quality (Iyer et al., 2018), which remains an important and fairly studied aspect, but missing the link to broader systemic drivers, which apparently stakeholders consider of further importance.

SDG7 (affordable and clean energy), another SDG with strong feedbacks on other goals (McCollum et al., 2018) directly related to threats identified in the country, was the only other SDG with an evaluation in the high range of the linguistic scale. Severe lack of energy access appears to be the root of major issues the country faces, with stakeholders expressing the need to address this threat in conjunction with climate change. Achieving the targets of this SDG requires more than securing universal energy access, especially for developing countries. Emphasis needs to be placed on providing clean and affordable energy access (SDG7.1), as well as on drawing significant investments towards clean energy research and infrastructure (SDGs 7.a.1 and 7.b.1): lack of various policies or financing mechanisms supporting them is a characteristic of many African countries (Adom, 2019; Adom et al., 2018), including Kenya, where RES policy efforts are poorly coordinated and may depend on aid from international donors (Naess et al., 2015). Recent energy-innovation initiatives in the country need to be expanded to maximise impact on the local community (Chan et al., 2017). At the same time, improvements in energy efficiency (SDG7.3) should not be disregarded, especially considering that SDG12 (responsible consumption and production) also ranked high. With African countries, including Kenya, facing an uphill battle to achieve widespread penetration of renewables until 2030 (Alova et al., 2021), energy efficiency can have a significant impact on improving energy access in the near-term (du Can et al., 2018), with the country currently showcasing limited policy support in various aspects of energy efficiency (e.g. Figueroa et al., 2019). Therefore, according to the participating stakeholders, establishing a comprehensive investment plan towards clean energy infrastructure and research that also considers distinct local elements, such as reliance on non-sustainable biomass and energy efficiency, should be among the top priorities of a national strategy for a sustainable transition.

SDG4 (quality education) is ranked last according to the stakeholders, in fact with a large gap separating it from the other SDGs, performing in the low importance term of the scale (Low, 0.21). Most educational issues Kenya faces are related to higher education (McCowan, 2018) and, although improvements in access to education rates have been noted in the last decades, stagnation of quality indicators like completion rates still pose major challenges (Sifuna, 2007). However, it should be noted that previous studies showed stakeholders also prioritise improvements in the quality of education in primary and secondary schools, when assessing the impact of demand-side

Fig. 4. Prioritisation of SDGs in relation to climate action in Kenya. The scale of the vertical axis in Fig. 4a reflects the linguistic scale {very low, low, medium, high, very high} used in the exercise.

electricity sector transformations (Dal Maso et al., 2020). In our case, it could be that this impact was disregarded by the pool of stakeholders, that it was considered indirect in SDG13 interacting with SDG7 interacting in turn with SDG4, or that implementing demand-side solutions with clear implications for climate change is perceived to have an impact on education but not vice versa.

The heatmap of Fig. 4c illustrates the distribution of stakeholders' multi-criteria assessments of each SDG, which can be extracted within APOLLO as an intermediate step of the MCDA framework: TOPSIS is first applied on the alternatives against the criteria for each stakeholder, and then once more on the alternatives against the stakeholder assessments (Nikas et al., 2018). In addition to validating previous insights, we can see that SDG9 (industry, innovation and infrastructure) was rather favourly assessed by some stakeholders, yet did not manage to place among the least critical SDGs. Apart from displaying significant variance in responses and therefore low consensus levels, this consistently confirms the low sectoral prioritisation of industry in the first exercise, further hinting that stakeholders of the corresponding group slightly boosted the sector and respective SDG in the rankings. It is also an indication of this bias with respect to SDG9, as highlighted in Fig. 5a. Apart from SDG9 and SDG14 (life below water), most SDGs orbit around the centre of the axes, with fluctuations that generally follow the patterns identified in the absolute ranking. Although SDG14 did not stand out in the ranking, it showed the highest consensus among the stakeholders meaning that almost all groups agreed on its importance, in line with literature emphasising the necessity for mitigating marine pollution and addressing known issues like overfishing (Alati et al., 2020). Generally, the group here presented much higher consensus (85.23%) than the sectoral exercise, hinting that using the preferences of this questionnaire to feed the previous one can be an effective strategy to improve the solution and the respective outcomes.

Revisiting the sectoral analysis

As explained in Section 3, the weights of the criteria of the first exercise are revisited to reflect the prioritisation of the SDGs from the second exercise. In particular, the evaluation criteria weights are modified based on the average evaluations of the SDGs included in each cluster, and therefore calibrated to minimise errors induced by human subjectivity. Fig. 6a displays the rankings of the initial analysis, i.e. the analysis with the unmodified weights as provided by the stakeholders, and the rankings after calibration of the weights based on the results of the second exercise. In the initial solution, the five sectors, excluding services that in both cases ranked poorly, were placed around the medium scale, making it difficult to establish clear prioritisation. After the weight calibration process, the final ranking shows a clearer distribution, with the residential sector emerging as the most important sector and an evaluation around Very High. In fact, the sector presented the highest difference compared to the initial prioritisation. The key difference that led to this change is the improved consensus: the residential sector seems to be evaluated as highly important by most stakeholder groups despite not necessarily ranking first for all groups. The process drove consensus to reach a level of 82.6%, rising from 78.8% in the initial exercise.

A common criticism of MCDA methods having no internal weight (re-)calculation method seems to apply, as the calibration process has had an impact on the final ranking, albeit limited, but most importantly it has had an impact on the achieved consensus. Fig. 6b shows the differences in the internal (stakeholder group) consensus in the two analyses, with and without weight calibrations. The increase in total consensus is overall evident across all groups, with the only exception being the "other" group category, which however is not homogeneous to provide a meaningful output (and is thus omitted from the analysis). Notably, the weight calibration process significantly increased the internal consensus of the private sector/industry group by reducing the bias induced by members of the group towards evaluating their own sector. Overall, these discrepancies were not enough to impact the ranking of the global solution; however, as part of climate diplomacy, the goal is not only to reach or improve global consensus, but also to understand the different dynamics and conflicts among different groups. Climate policy has much to gain by attempting to implicitly elicit stakeholder assessments to reduce human subjectivity and understand the driving motives of each participant. In particular, both the academics and the much smaller national government group increased their consensus, but the fact that that these fluctuations are in a much smaller level than the private sector indicates that members of the latter group present higher degrees of bias, which is something that should be taken into account in future expert elicitation studies.

Improvements in consensus are also evident in Fig. 7, with the majority of alternatives being placed in the high priority-high consensus quadrant, while preserving the distinctions among the sectors. In fact, although most sectors improved their position consensus-wise, the

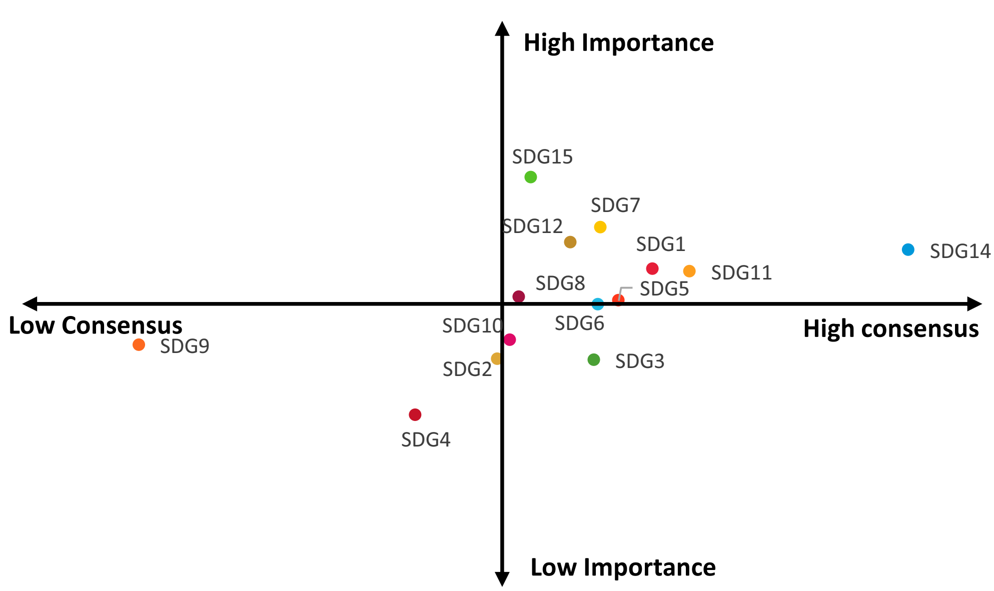
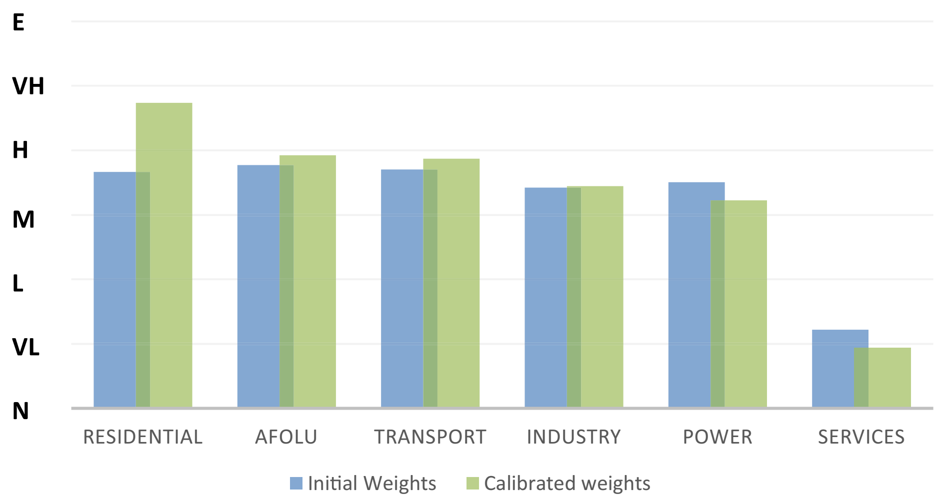
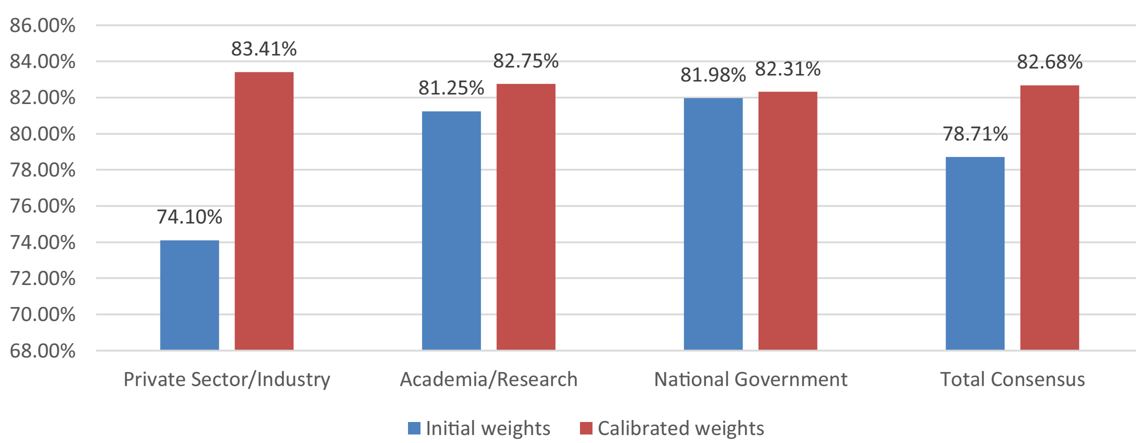


Fig. 5. Introducing the consensus in the prioritisation of each SDG.



(a) Comparison of the collective solution in the two cases.



(b) Comparison of internal consensus levels per stakeholder group with and without weight calibration.

Fig. 6. Prioritisation and consensus of the sectors based on the two approaches. The scale of the vertical axis in Fig. 6a reflects the linguistic scale {none, very low, low, medium, high, very high, excellent} used in the exercise.

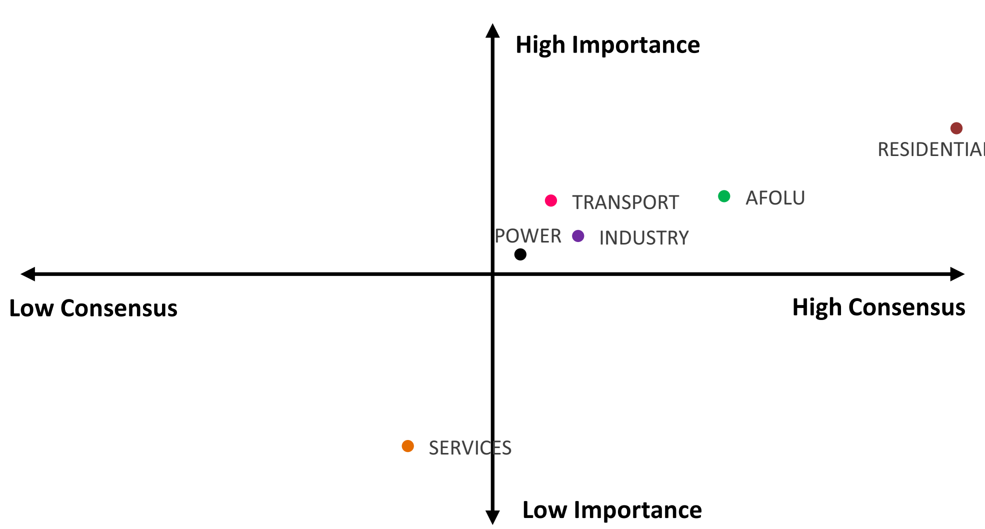


Fig. 7. Importance-Consensus of each sector in the final analysis.

AFOLU sector maintained its position in the scatter, indicating that the strong preference of the participating stakeholders from the initial steps holds after criteria weight calibration, without being affected by the modified weights nor the shift towards the residential sector, indicating robust preference, as hinted and discussed earlier.

This prioritisation of the residential and AFOLU sectors fit and enhance the narrative from both a sectoral and an SDG perspective. Stakeholders are concerned over the lack of access to electricity and related issues, such as reliance on non-sustainable biomass and implications over AFOLU and SDG15. The group of experts, in a better informed MCDA framework of the Kenyan sustainability context, also provide additional insights into the preferred prioritisation of these issues. Pointing towards SDG7 and the residential sector while stepping back from power generation, the results suggest that the engaged stakeholders on aggregate reveal that deep penetration of renewables is likely to be harder than anticipated and therefore prefer to prioritise near-term demand-side transformations, with the transport sector following closely. This is consistent with Olang et al. (2018), also stressing the need to look at specific characteristics of the households as well as user perspectives to improve energy access and achieve the target of the respective SDG. In the broader African region, emphasis has been placed on single-sector studies on agriculture-focused pathways that aim to increase adaptive capacity (England et al., 2018), which in the case of Kenya and Eastern Africa is very limited (Epule et al., 2017). However, considering the discrepancies between national strategies and sectoral policies, which in the case of the AFOLU sector have so far led focus to orient on economic growth (Faling, 2020), our results indicate the necessity to build cross-sectoral policies between AFOLU and the residential sector accounting for the impact on SDGs 15 and 7, and especially the key threats identified in the context of Kenya, like limited electricity access, extensive use of non-sustainable biomass and respective health implications.

The fact that the residential sector was ranked as the most critical for decarbonisation provides various helpful insights. Although the Kenyan Government has proposed various legislation towards increasing power access and RES diffusion, there is a lack of important energy efficiency policies, with the first policy officially addressing energy efficiency being legislated in 2020 (Adom, 2019). Moreover, poor dissemination of authoritative, scientific knowledge on climate change hinders the capacity for Kenyans to follow the ambitious policies set by the government (Ageyo & Muchunku, 2020). Although this affects all sectors, it is especially evident in the residential sector, which requires the highest adoption rate of policies to ensure success, especially given the lack of authorities to effectively monitor/regulate household energy use. It is also evident in agriculture and relevant policies, such as the Climate Smart Agriculture Strategy 2017–2026, which is valued mainly by stakeholders acknowledging the linkages between climate change, food security, and the environment (Faling, 2020).

Conclusions

This study aims to gain insights from Kenyan stakeholders into the interplay between their country's climate action at the sectoral level on the one hand and sustainable development on the other. The starting point of the analysis is the need to design an effective and sustainable transition pathway, considering the five intertwined sustainability threats looming large in the country: climate change, lack of energy access, extreme poverty, poor cooking means/nutrition, and health challenges. To better address these threats in line with Paris Agreement targets and the 2030 Agenda for Sustainable Development, an MCDA framework based on the 2-tuple group TOPSIS and a consensus measuring approach was designed and implemented in a Kenyan stakeholder workshop, via two seemingly separate yet highly intertwined questionnaires. The first aimed at assessing the importance of the decarbonisation of economic sectors for four sustainable development axes, and the second at prioritising SDGs in relation to progress, ambition, as well as relation to climate action and the national context.

In the initial analysis, stakeholders assessed economic sectors in relation to how decarbonisation action can help make progress across the four sustainability axes. This exercise first indicated that, despite scientific focus mostly on power generation, all sectors were considered equally important, with the only exception being the services sector standing out as relatively insignificant, and with only the AFOLU sector featuring significant levels of agreement in its prioritisation. This preference was further confirmed in the subsequent analysis aiming to prioritise sustainability goals for both research on and policy in Kenya, with SDG15 (life on land) ranking first as the most critical SDG, due to limited progress so far. These outputs trace back to the national and regional context, where limited electricity production and unreliable grid have prolonged the reliance on non-renewable biomass—especially fuelwood—and the employment of poor cooking methods leading to indoor air pollution and dangers to health and well-being. Within their evaluations, stakeholders highlighted the importance of not only AFOLU, but also biodiversity and ecosystem implications of the region's sustainable transition, especially orienting on biomass use and the switch to more efficient fuels. From a (modelling) research perspective, this exercise inter alia indicated that indirect links between society and climate change should also be considered outside the traditional energy access and mitigation metric-based evaluations commonly explored.

After modifying the research framework and integrating the two analyses, the modified sectoral decarbonisation exercise singled out the residential sector, which emerged as a top policy and research priority, while featuring the highest agreement levels among stakeholders. The AFOLU sector, although now outranked, still remained fairly important as a result of the steadily strong consensus. This new prioritisation can also be linked to the prioritisation of the goal to achieve clean, affordable, and accessible energy (SDG7), which apart from SDG15 was the only other SDG receiving a high evaluation. This further highlighted stakeholders' concerns over the challenge of limited access to modern energy, notably despite the multitude of relevant legislative acts and policies. At the same time, stakeholders hinted that solutions in the shorter run (and research underpinning those) should not orient exclusively towards renewable energy diffusion, which can prove much harder than anticipated, but also consider demand-side transformations in the residential sector, which is insufficiently directed by modelling research for mitigation analysis (Nikas et al., 2020) and the current Kenyan policy context alike. Increasing energy efficiency with targeted research and improving fuel quality can be an effective way to promote renewables and address AFOLU challenges and concerns. Overall, future cross-sectoral policies in the AFOLU and residential sectors should consider implications on these issues and progress towards the respective SDGs.

On a policy level, the prioritisation provided by the stakeholders appears to be well-linked to the key challenges faced in Kenya despite years of legislation and efforts to address them. With less than a decade to implement an ambitious agenda by 2030, which inter alia includes absolute access to energy and clean cooking methods, efforts need to be significantly intensified. Recent policy initiatives shed light on energy efficiency, biomass, and smart agriculture, as well as a long quest to increase RES penetration. Notably, these are the topics stakeholders highlighted as priority in this research, indicating that—at least from a policy perspective—the country is headed in the right direction. But lack of policies was not an issue for Kenya in the past, but mostly coordination, dedication to the targets and comprehensibility from non-experts. The NCCAP update, expected in 2022, provides an excellent opportunity to integrate these strategies in a comprehensive and holistic climate action plan drawing from stakeholders' concerns as expressed in this study in a co-governance approach to effectively reshape the future direction of the country.

As mixed methodologies have been found to perform better in terms of mitigation analysis (Scholten et al., 2017; van Vliet et al., 2020), MCDA has been used to supplement climate policy modelling to handle uncertainty (e.g., Baležentis & Streimikiene, 2017; Jun et al., 2013; Shmelev & Van Den Bergh, 2016). However, given its capacity to facilitate eliciting stakeholder preferences to inform scenario planning (Sadr et al., 2018; Zheng et al., 2016), MCDA can also be used to provide input for better informed, context-relevant, stakeholder-driven modelling, resulting in insights that are beneficial from multiple perspectives (Nikas, Gambhir, et al., 2021). In that sense, drawing from the outputs of this study and much like Kenyan policy, future modelling advancements and exercises should prioritise analysis of the sectors and SDGs identified as most pertinent by the Kenyan stakeholders, to shed light on Paris-compliant national pathways that both address local threats and ensure the country's sustainable development. Future research should also shed light on and take into account the inherent bias presented in the initial preferences of members from the private sector group.

CRediT authorship contribution statement

K. Koasidis: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **A. Nikas:** Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **A. Karamaneas:** Formal analysis, Investigation, Visualization, Writing – original draft. **M. Saulo:** Data curation, Validation, Writing – original draft. **I. Tsipouridis:** Data curation, Validation, Writing – original draft. **L. Campagnolo:** Conceptualization, Validation, Writing – review & editing. **A. Gambhir:** Conceptualization, Writing – review & editing. **D.-J. Van de Ven:** Conceptualization, Writing – review & editing. **Ben McWilliams:** Data curation, Validation, Writing – original draft. **H. Doukas:** Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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