



## PERCEPTIONS ON ACCELERATED TRANSITION TO RENEWABLE ENERGY IN NAIROBI, KENYA

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**Abstract:** The clamor for renewable energy has accelerated in the last decade, presenting unique opportunities for growing cities to become sustainable. The transition from fossil fuels to renewable energy underscores a new frontier in the energy sector and highlights the benefits for environmental sustainability. Nairobi city is presented with a golden opportunity to transit to a sustainable city through accelerated transition to renewable energy by reviewing its energy policies and Institutions. This paper analyzes the perceptions on transition to renewable energy in Nairobi, Kenya for economic growth via green energy jobs, human welfare and a sustainable clean environment. Data was collected from 92 households and five key informants (n=97) using semi-structured questionnaires, interviews and observations. *Data Envelopment Analysis (DEA)* was used to illustrate the nexus between renewable energy and environmental sustainability. Respondents' understanding of green renewable energy was average ( $59.0 \pm 1.42$ ) with the majority having awareness of energy policies and regulations ( $56.7 \pm 1.62$ ). Respondent's significantly ( $56.7 \pm 1.40$ ) agreed that transition to renewable energy would enhance cost effectiveness, creation of green energy jobs ( $69.7 \pm 1.66$ ), and ( $54.6 \pm 1.51$ ) for a clean and safe environment. Majority expressed willingness to transit to green renewable energy for perceived benefits socially, economically and environmentally cementing the acceleration for renewable energy transition. Accelerated transition to renewable energy will transform the socio-economic and environmental outlook for Nairobi city.

**Keywords:** Renewable Energy, Accelerated Energy Transition, Traditional Fossil fuels Environmental Sustainability

### 1. Introduction

The global energy demand is on an upward trajectory where in 2017, it increased by 2.1% with an expected double increase by 2050 (OECD, 2019; OECD & IEA, 2018). Thus, the need to accelerate the transition to a renewable-based energy system creates unique opportunities for sustainable cities ultimately mitigating the effects of climate change and fueling economic growth, creating new employment and business opportunities (IRENA, 2016, 2019). The Paris Agreement of 2015 on Nationally Determined Contributions ratified by 164 countries explicates the global commitment to capitalize on renewable energy transition (IRENA, 2019; WEF, 2019). Decisions made on the energy sector investments today have an influence on economic growth and development of the other sectors for the coming decades fostering environmental sustainability (IEA, 2019; IRENA, 2019; OECD & IEA, 2018). The impacts of these decisions include the ability to decarbonize energy, critical in mitigating climate change thus providing the roadmap for transition from traditional fossil fuels (Carlock & Mangan, 2018; IPCC, 2018; OECD & IEA, 2018). The transition to a renewable-based system when accelerated can generate new sources of growth, increasing incomes, creating green energy jobs and improving health and wellbeing of millions and most essentially underscoring environmental sustainability (Fuso Nerini et al., 2018; IRENA, 2019; WEF, 2019).

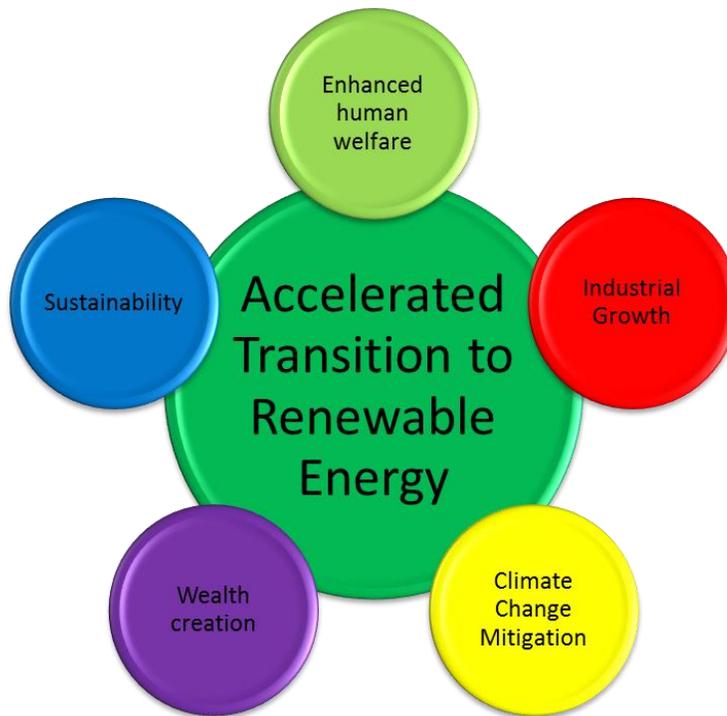
Acceleration in deployment of renewable energy spurs economic growth with every sector presented with numerous opportunities for human welfare enhancement and contributing to a climate safe future

(Garcia-Casals et al., 2019; Hafner et al., 2018; IPCC, 2018; OECD & IEA, 2018). Notably, the advances in renewable energy technologies and growing cost-competitiveness have strengthened the transition to renewable energy that Kenya can leverage on in transforming its energy systems (Bowen et al., 2017; Kiplagat et al., 2011; KIPPRA, 2018; Morris & Jungjohann, 2017). The benefits accrued from scaling up renewable energy transition exceed cost competitiveness and mitigates climate change effects enhanced by continued use of traditional fossil fuels (Hickel & Kallis, 2020; IPCC, 2018; IRENA, 2019). Accelerating the transition in Kenya intimates that it can meet the energy needs of a growing population, drive development and improve well-being, while reducing greenhouse gas emissions and increasing natural resource productivity (Kazimierczuk, 2019; KIPPRA, 2018; Thomas, 2020).

Additionally, socio-economic benefits of renewable energy transition go well beyond the traditional and limited measurements of economic performance and have tenets of sustainability (George et al., 2019; IRENA, 2016, 2019; Kazimierczuk, 2019). Kenya has a unique opportunity to leverage on the trade in renewable energy transition equipment and other investment goods and services which will increase as a result of the scaled-up transition and adoption by various economic sectors (IEA, 2019; KIPPRA, 2018; WEF, 2019). Subsequently, a decrease in trade of other energy sources, specifically fossil fuels will be curtailed reducing the carbon emissions and environmental degradation especially with a rapid population growth in Nairobi city (George et al., 2019; IPCC, 2018; OECD & IEA, 2017; World Bank, 2015).

Kenya's energy sector can maximize the benefits of the transition to sustainable energy for their national economy through enhanced green jobs and wealth creation forums, thus improving both human and environmental welfare (Bowen et al., 2017; Kathambi & M'Ikiugu, 2018). Enabling factors for acceleration to renewable energy transition include a diversified economy and sufficient market capacity, including training and education that help build a skilled and versatile workforce whose perception on transition to green energy will be improved (Fuso Nerini et al., 2018; Government of Kenya GOK, 2007; Kathambi & M'Ikiugu, 2018; KIPPRA, 2018).

Kenya's energy sector has a pivotal role in economic growth with productive inter-linkages on other socio-economic activities such as industrial services, agricultural, commercial, social institutions and households (Kiplagat et al., 2011; KIPPRA, 2018). Nairobi city plays a fundamental role in accelerating the transition to renewable energy through its unique position of hosting policy makers and regulators in the energy sector (EMCA, 2006; Kathambi & M'Ikiugu, 2018). The opportunities presented through accelerated transition to renewable energy are supported with a keen note that electricity and petroleum are the major forms of energy, with electricity consumption having increased by 2.9% in 2016 and petroleum consumption by about 6.5% (George et al., 2019; KIPPRA, 2018; World Bank, 2015). Remarkably, the perception of low cost electricity gives an accelerated realization of Kenya's "Big Four" agenda which will benefit awesomely from renewable energy transition (IRENA, 2019; KIPPRA, 2018; NEMA, 2009). Through the "Big Four Agenda" Nairobi city underscores necessity for accelerating transition to renewable energy to cater for the increasing population demand for energy particularly green energy that has less negative impacts on the environment (IPCC, 2018; Kathambi & M'Ikiugu, 2018; Kazimierczuk, 2019; Morris & Jungjohann, 2017). Augmenting on the above trajectory, the accelerated transition to renewable energy illustrates unique opportunities for economic growth, wealth creation and environmental sustainability in Nairobi.



**Figure 1: Conceptual Framework on Perceptions on Accelerated Transition to Renewable Energy**

## 2. Materials and Method

The paper utilized the conceptual framework (Fig. 1) which illustrates the perceptions of benefits accrued to accelerated transition to renewable energy which focuses on enhancing environmental sustainability. The concept being that accelerated transition to renewable energy has positive effects such as sustainability, wealth creation, climate change mitigation, industrial growth and enhanced human welfare.

The theoretical framework focused on institutional capacity theory and resource based view theory. Institutional capacity theories highlights the critical role of institutions in accelerating the renewable energy transition by ensuring there is capacity building among the respondents, continued monitoring and evaluation of the processes undertaken (Breukers & Wolsink, 2007; Polk, 2011). On the other hand the resource based view theory focuses on the strategic and competitive advantage organizations or communities can use on the resource in a sustainable manner (Kraaijenbrink et al., 2010; Maina & Maina, 2016). The enhancement of the energy sector institutions will foster much more acceleration in the transition to renewable energy by building their capacity to create awareness and further implementation (Breukers & Wolsink, 2007; Hamdy et al., 1998; Polk, 2011).

The utilitarianism of renewable energy resource supports the strategic and competitive advantage underscored by the resource based view theory where acceleration in green energy transition gives the communities and institutions better leverage (Kraaijenbrink et al., 2010; Maina & Maina, 2016). Attaining the competitive advantage will also impact the environment positively mitigating the climate change effects and ensuring better human welfare from reduced fossil fuels effects (George et al., 2019; Kraaijenbrink et al., 2010). Based on the theoretical framework of institutional and resource based view suggest that a coercive push and perceived resource benefits were expected to accelerate the transition to renewable energy (Hussey and Hussey, 2013, Williams, 2007).

The study adopted a correlational research design which utilizes both qualitative and quantitative data (Apuke, 2017; Williams, 2011). Data collection for primary data was done through semi-structured questionnaires and key informant interviews from people with a vast experience in energy related issues. The study area Nairobi City was purposively chosen because of its pivotal role as an enabler to transition to renewable energy and a host to numerous environmental organizations like UNEP, government ministry and other NGOs. *Data Envelopment Analysis (DEA) method* was utilized to evaluate the human perceptions, decisions, activities as they related to accelerated transition to renewable energy through environmental sustainability (Anouze & Bou-Hamad, 2019; Cooper et al., 2011; Santos et al., 2013; Williams, 2011). A sample size of Ninety two (92) household heads were sampled through a sampling formula, surveyed and five (5) key informants interviewed chosen purposively due to their expertise and experience in the subject matter.

Data on perceptions, knowledge, attitudes and practices on transition to renewable energy was collected in the study area. To enhance data reliability and credibility, open and closed questions as well as qualitative and quantitative questions were used as previously described (Collis & Hussey, 2014; Kothari & Garg, 2019). The indicators for accelerated transition to renewable energy transition were weighed according to their socio-economic importance and their impacts on environmental sustainability ( $P \leq 0.05$ ,  $n=97$ ). Statistical bias was minimized by triangulation through key informant interviews and desktop reviews by integrating previously described methodology (Collis & Hussey, 2014; Kothari & Garg, 2019). Data was analyzed using the SPSS software to give statistical significance to the data collected and presented in pie charts, histograms and tables (Kothari & Garg, 2019).

### 3. Results

#### *Knowledge, Attitudes and Practice on Transition to Renewable Energy for Environmental Sustainability*

The data presented in Table 1 and 2 indicate that the respondents' understanding of green energy was averagely significant to the positive ( $59.0 \pm 1.42$ ). Additionally, majority had awareness of existing governance instruments regulating environmental management ( $56.7 \pm 1.62$ ) although majority did not have knowledge of the renewable energy legal provisions ( $85.9 \pm 2.98$ ). Majority of the respondents ( $56.7 \pm 1.40$ ) agreed that transition to green renewable energy would enhance cost effectiveness, create green energy jobs ( $69.7 \pm 1.66$ ) and enhance environmental sustainability through a clean and safe environment ( $54.6 \pm 1.51$ ).

*Table 1: Respondents knowledge on renewable Energy transition and the governance instruments*

Parameter	Yes (positive) (%)	No (negative) (%)
Understanding of Renewable Energy	$59.0 \pm 1.42^a$	$41.0 \pm 1.03^b$
Awareness of existing governance instruments	$56.7 \pm 1.62^a$	$43.3 \pm 1.67^a$
Knowledge of renewable energy legal provisions	$14.1 \pm 1.16^a$	$85.9 \pm 2.98^b$

*Table 2: Respondents perceptions on Renewable Energy Transition Impacts*

Parameter	agree (positive) (%)	disagree (negative) (%)
Cost effectiveness	56.7±1.40 <sup>a</sup>	43.3±1.49 <sup>b</sup>
Green Energy Jobs	69.7±1.66 <sup>b</sup>	30.3±1.59 <sup>a</sup>
Clean and Safe Environment	54.6±1.51 <sup>a</sup>	45.4±1.09 <sup>b</sup>

*Factors Affecting Transition to Renewable Energy from Traditional Fossil Fuels*

The data in Table 3, majority of the respondents (57.6±1.36) were of the view that lack of awareness was the factor affecting the transition from traditional fossil fuels to green renewable energy. Majority of the respondents in Table 3 had the view that compromised integrity in energy transition processes (68.4±1.69) and individual lack of renewable energy knowledge (58.3±2.11,) have a huge bearing on transition to renewable energy. Notably, a majority (48.7±1.42, 51.3±1.48) had a view that inadequate institutional and state good capacity evidently impedes the transition from traditional fossil fuels to green energy.

*Table 3: Respondents' Perceived factors affecting compliance in Renewable Energy Transition*

Parameter	agree (positive) (%)	disagree (negative) (%)
Lack of awareness on Renewable Energy	57.6±1.36 <sup>a</sup>	39.4±1.48 <sup>b</sup>
Inadequate institutional and state capacity	48.7±1.42 <sup>a</sup>	51.3±1.48 <sup>a</sup>
Compromised Integrity in Energy Transition Processes	31.6±1.69 <sup>a</sup>	68.4±1.87 <sup>b</sup>
Individual lack of Renewable Energy Knowledge	38.7±1.97 <sup>a</sup>	58.3±2.11 <sup>b</sup>

Results in figure 2 and 3 illustrate majority of the respondents have the willingness individually to transit to renewable energy from traditional fossil fuels which they agreed that it would create jobs thus improving livelihoods and enhancing environmental sustainability in Nairobi city. Similarly, majority of the respondents agreed that renewable energy transition would provide avenues for wealth creation through green energy jobs.

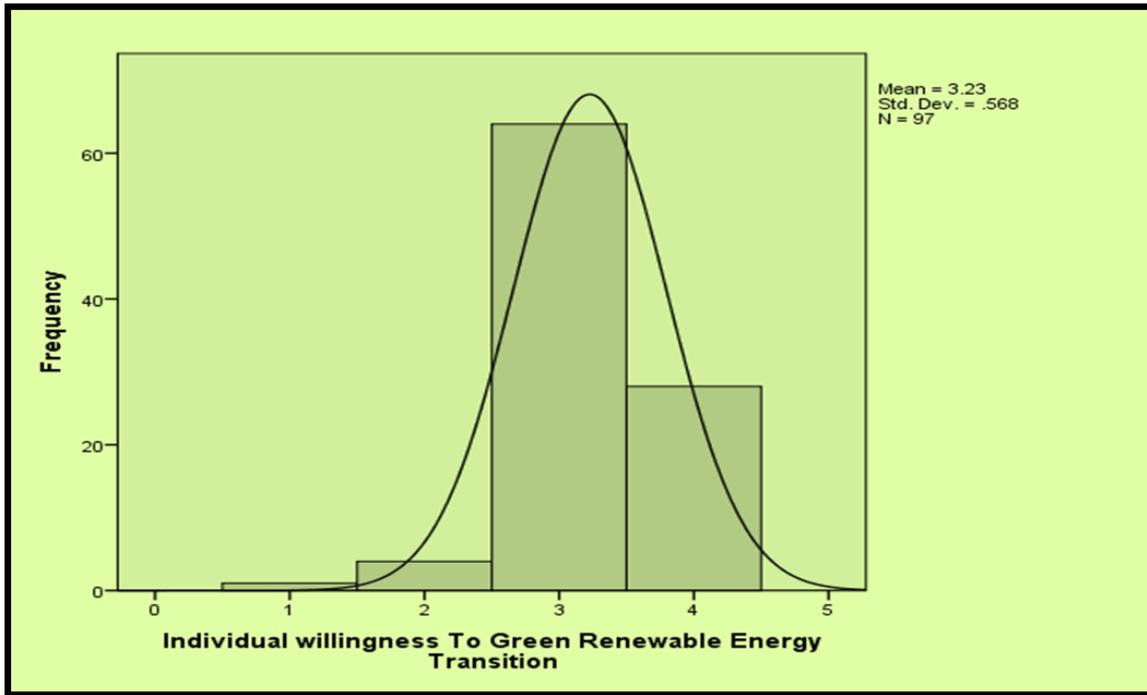


Figure 2. Respondents' Willingness to Renewable Energy Transition

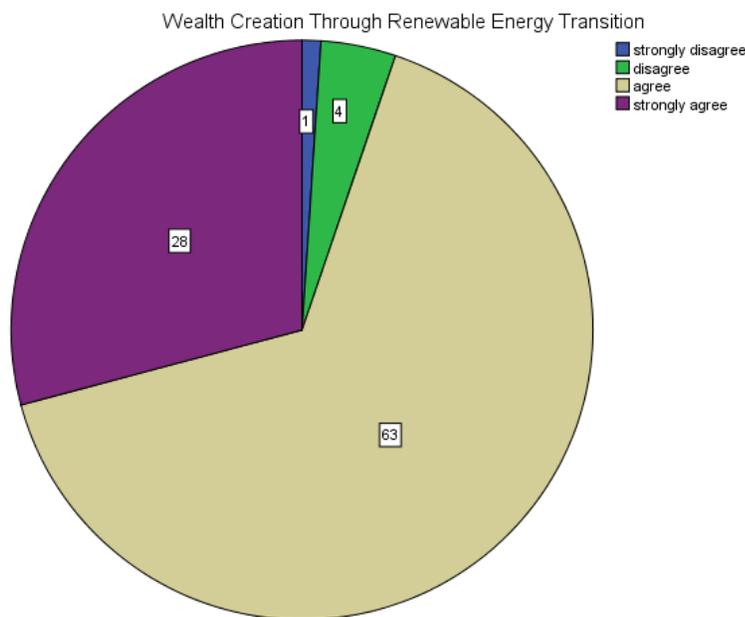


Figure 3. Creation of Green Energy Jobs through Green Renewable Energy Transition

#### 4. Discussion

Acceleration for transition to renewable energy was supported by the results with utilitarian basis fostering it (OECD & IEA, 2018; World Bank, 2015). Different perspectives on the socio-economic benefits for the renewable energy transition underscoring the willingness by respondents (Carlock & Mangan, 2018; IEA, 2019; IRENA, 2016, 2019).

Additionally, the respondents' knowledge for the legal provisions for renewable energy transition was significantly low which impacts the acceleration for the transition (Kathambi & M'Ikiugu, 2018; OECD & IEA, 2017; Tidemann, 2019). The respondents seemly agreed that accelerating the transition to renewable based energy would foster economic growth through jobs creation and enhance environmental sustainability mitigating climate change (IPCC, 2018; IRENA, 2015, 2018). Interestingly, respondents had a significant knowledge base for renewable energy forms and had clear and concise understanding of their impacts on their socio-economic outlook (IRENA, 2019; Kathambi & M'Ikiugu, 2018; REN21, 2019; Renner et al., 2019).

Perceived socio-economic benefits solidified urgency in accelerating renewable energy transition which is supported by the respondents' willingness to adopt new green energy forms (Kathambi & M'Ikiugu, 2018; Kazimierczuk, 2019; OECD, 2019; Thomas, 2020). The decry of the respondents on the impacts of traditional fossils fuels on the environment and their human welfare enhanced why the acceleration will lead to a new frontier in the energy sector in Nairobi (Garcia-Casals et al., 2019; IRENA, 2019; KIPPRA, 2018; OECD, 2019). The global projection for cities population to double by 2050, renewable energy transition would provide the pathways for compensating the energy deficits thereby accelerating adoption of various green energy forms for environmental sustainability (Fuso Nerini et al., 2018; Gielen et al., 2019; Jacobson et al., 2017; Kathambi & M'Ikiugu, 2018).

In the Kenyan context, Nairobi ranked as one the rapid transforming city in East Africa would be a beneficiary for the accelerated transition to renewable energy (Adedeji et al., 2019; Dong & Mori, 2017; Droege, 2008; KIPPRA, 2018). The elevation of Nairobi City has transit point for international flights and a vibrant business center cements the urgent call to accelerate transition to renewable energy (Dong & Mori, 2017; George et al., 2019; Gielen et al., 2019). Subsequently, this data, as suggested by other previous authors support that acceleration to green renewable energy provides an avenue to support economic growth sustainably without further environmental degradation as witnessed by traditional fossil fuels (George et al., 2019; IRENA, 2019; Kathambi & M'Ikiugu, 2018; OECD & IEA, 2017; WEF, 2019). Accelerating the transition to green energy spur development growth in all facets of the economy in Nairobi city based on our finding that is supported by data that shows respondents agreed there were benefits attributed to the transition (Adedeji et al., 2019; Kathambi & M'Ikiugu, 2018; KIPPRA, 2018; Morris & Jungjohann, 2017; Renner et al., 2019). Thus, institutions/ policies play a definitive role in the acceleration in transition to green renewable energy in Nairobi city and the same would be replicated nationally through the devolution process (Droege, 2008; Gielen et al., 2019; KIPPRA, 2018; World Bank, 2016).

Our results show that respondents were willing to transit to green renewable energy underpins the opportunities present for Nairobi residents if awareness creation, education and revision of policy frameworks in the energy sector were implemented (Bowen et al., 2017; Dong & Mori, 2017; George et al., 2019; Kathambi & M'Ikiugu, 2018). The data suggests that utilitarian value strategy would enhance the acceleration of the transit to green renewable energy by taking into account the peoples' material well-being, and emotions that give them satisfaction in cost effectiveness and environmental conservation (Fuso Nerini et al., 2018; OECD & IEA, 2018; Polk, 2011; Renner et al., 2019). The implication of not having to travel far and wide to search fuel wood, reduced cooking time and daily costs for purchasing fossil fuels enhances the respondents' willingness to transit to renewable energy (Garcia-Casals et al., 2019; Hafner et al., 2018; Kathambi & M'Ikiugu, 2018). The potential for mitigating climate change effects from destruction of forests for fuel wood advocates for accelerated transition to green energy (Adedeji et al., 2019; Creutzig et al., 2017; Gielen et al., 2019; Renner et al., 2019).

The environmental perceived benefits by the respondents implicate the acceleration in that the pollution from traditional fossil fuels will be tackled and its effects on climate mitigated (IPCC, 2018;

IRENA, 2018; REN21, 2019). Taking note of the country's 'Big Four Agenda', Nairobi city economic status becomes elevated and the benefits accrued are in support of the resource based view theory for strategic and competitive advantage in the green energy sector (Dong & Mori, 2017; George et al., 2019; Hafner et al., 2018; KIPPRA, 2018). Nairobi city hosts various industries that manufacture goods and services required nationally thus, when the transition to renewable energy is attained, the profit margins will improve (Bilgili et al., 2016; Creutzig et al., 2017; KIPPRA, 2018). Transition to renewable energy in Nairobi will cater for the nationwide energy deficit and through reduction from overdependence on traditional fossil fuels to create a sustainable green energy powered city (Garcia-Casals et al., 2019; Gielen et al., 2019; KIPPRA, 2018; Renner et al., 2019). Nairobi County serving as model for the other counties, acceleration to transit to renewable energy will build upcoming counties and be able to share their experiences through the devolution process (Kathambi & M'Ikiugu, 2018; Kiplagat et al., 2011; KIPPRA, 2018).

Accelerating the renewable energy transition will also enhance the institutional capacity in the energy sector thereby increasing efficiency, effectiveness and competitiveness required for sustainable economic growth (Creutzig et al., 2017; Fuso Nerini et al., 2018; Goldthau, 2011; Jacobson et al., 2017). Currently, the Kenyan energy sector institutions have not fully attained their full potential and capacity building in terms of human resources, financial portfolio and enhanced policy implementation will serve to increase acceleration to green energy (Adedeji et al., 2019; World Bank, 2015). The potential for the transition to green energy supports the various sectors of the Kenyan economy that are highly dependent on energy whose bottom line will be enhanced (Adedeji et al., 2019; George et al., 2019; KIPPRA, 2018; NEMA, 2009). The socio-economic dynamics present the acceleration to renewable energy transition golden opportunities in increasing profits, mitigating climate change effects from traditional fossils and improving human welfare in totality (Creutzig et al., 2017; Hafner et al., 2018; IPCC, 2018; Newell & Phillips, 2016).

Environmental sustainability enhanced by accelerated green energy adoption in Nairobi owing to its unique features such as a national park thereby mitigating effects of fossil fuels dependency (Fuso Nerini et al., 2018; George et al., 2019; Kathambi & M'Ikiugu, 2018). The average resident in Nairobi still has to use various forms of energy so as to meet the energy demand thus the renewable energy transition creates avenues to satisfy the demand (Jacobson et al., 2017; Newell & Phillips, 2016). The utilitarian value for accelerated renewable energy transition models for other sub-Saharan cities and contributes to reduction the region's energy deficit (Adedeji et al., 2019; Gielen et al., 2019; IRENA, 2019; Newell & Phillips, 2016). Acceleration in deployment of renewable energy underscores the urgency from a global level to a national level which Nairobi is best placed to undertaken (Adedeji et al., 2019; Dong & Mori, 2017; Quitzow et al., 2019; Renner et al., 2019). Due to the transition, the realization of the 'Big Four Agenda' in Nairobi would enhance its economic viability and resultantly would help conserve biodiversity, enhance environmental sustainability (Garcia-Casals et al., 2019; IPCC, 2018; IRENA, 2019; Kathambi & M'Ikiugu, 2018; KIPPRA, 2018; OECD, 2019).

## **5. Conclusion**

Transition to renewable energy is enhanced by the perceived benefits and utilitarian value as illustrated by the findings. Nairobi's energy sector is set to benefit from the accelerated renewable energy transition decreasing its energy deficit. Additionally, the findings illustrate the economic, social and environmental benefits accrued from accelerated transition to green energy from traditional fossil fuels which support constituents of global sustainable cities. Further, the findings highlight the opportunities that can be adopted to double economic growths, ensure human welfare and mitigate climate change in Nairobi city. The findings underpin the need for policy framework reviews to enhance accelerated transition to renewable energy for environmental sustainability through enhanced institutional capacity.

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## 8. Disclosure Statement

No potential conflict of interest was reported by the authors.

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