AIUE
AFRICA & INTERNATIONAL USE OF ENERGY

ISBN 978-0-6398429-3-6

PROCEEDINGS OF THE 3RD ENERGY AND HUMAN HABITAT CONFERENCE

28-29 NOVEMBER 2022
CASTLE OF GOOD HOPE - CAPE TOWN

EDITOR: PROF MTE KAHN

Proceedings of the

3rd Energy and Human Habitat Conference

(28&29 November 2022)

Cape Town / Castle of Good Hope

Edited by Prof Mohamed Tariq Ekeramodien Kahn

ISBN 978 0 6398429 3 6

Published by

AIUE Conferences

In conjunction with Energy Institute , Cape Peninsula

University of Technology, University of the Western Cape.

https:/aiue.co.za

ISBN 978 0 6398429 3 6

Publication Date :

28 July 2022

3rd Energy and Human Habitat Conference 2022

Editor's Synopsis

This Proceedings includes the papers presented at the 3rd Energy and Human Habitat Conference which took place between 28-29 November, 2022, in Cape Town, South Africa as a face to face event at the Castle of Good Hope.

The Conference was organized by the African and International Use of Energy platform consisting of academics from the Cape Peninsula University of Technology, the University of the Western Cape, University of South Africa, and University of Stellenbosch. The organizing committee, advisory board and review board, as well as the editors are grateful to the delegates who had submitted and presented papers.

The conference papers included experimental as well as overview studies applicable to Energy and the application or enhancement of human habitat. Although the conference was open for inclusion of studies from an energy policy and energy economics perspective, almost all the papers received in this call were of a more technical nature.

The conference received papers via its online submission platform and responded by related email. Reviews were double blind with two reviewers per paper and a third editorial review for decision to include the paper in the proceedings. Several paper abstracts were received but was not of sufficient quality to meet initial review requirements and some were also outside the scope of the conference. The conference received over 48 abstracts and received 38 papers as submissions. Only 21 papers were accepted and graded for inclusion in this Proceedings after peer review and these included only highly positive reviews with minimal corrective work.. The rejection ratio of papers was 44% rejection.The highest single institution papers accepted for publication was 28%, hence meeting the South African DHET requirement.

The authors were required to avail themselves for a face to face presentation with session chairs at the conference venue.

Prof MTE Kahn

Energy Institute, Cape Peninsula University of Technology

28 November 2022

Opening Remarks
Dr Marco Adonis, HOD , DEECE, CPUT
3rd Energy and Human habitat Conference

28 & 29 November 2022, Castle of Good Hope, Cape Town, South Africa

Distinguished Participants, Colleagues, Ladies and Gentlemen,

Good Morning.

I am very honoured to deliver opening remarks on behalf of the Department of Electrical Electronic and Computer Engineering of the Cape Peninsula University of Technology, at this esteemed Conference.

I would like to welcome all participants for their keen interest and enormous efforts to make this meeting possible.

At the outset, I would like to thank co-organizers of this event. My special thanks goes to Professor Mohamed Tariq Kahn, Director of the Energy Institute, and Convenor of this Conference. Prof Kahn have been at the helm of the energy conferences since 2012 and have done a first for us in organising this event at the Castle of Good Hope. A Special Thanks to the Organising Committee, and the Review Committee, the Session Chairs and the many students and staff that were involved in making this event happen here today. For two years the conference continued as a digital event, and this is the fist face to face event since 2019.

I think you, the delegates here, will be more experienced and knowledgeable than myself on the theme of Energy and Human Habitat . So my remarks will be very short. I just would like to highlight the huge potential of Energy Technology in the achievement of SDGs , which are an important international achievement for the 2030 goals and beyond.

More than 700 million people on the African continent still do not have access to modern, productive energy sources, and many of them continue to use antiquated, ineffective traditional energy sources. The difficulty is still in successfully and sustainably getting this solution to the most remote off-grid areas, even though the answers already exist.

Energy poverty is still a problem, and many homes haven't been able to connect to the electricity despite significant attempts to expand the grid to several towns, produce more megawatts, and offer various "low cost" energy products and services for the "poor". Microgrids and effective use of modern technological advances hold the key to bridge the gap with Human Habitat and electrification. Grid extension alone does not provide energy access as long as the end-use energy dilemma is not resolved.

In addition to this, since the Paris Agreement went into force in 2016, reducing greenhouse gas emissions has become another important mission for all. Our nation is embarking on the Just Transition in the Energy sector to address concerns with job losses and re-skilling that could be associated with such a change from fossil fuels to renewables. This is why Conferences like these are important. To create networks of researchers that can share their views and ideas in order to create better understanding and co-operation.

I would like to thank all the presenters, facilitators, and participants, for making the time to be here. Thank you

3rd Energy and Human Habitat Conference 2022

Conference Advisory Board and Organizing Commitee

Dr C. Nyirenda (Chair) University of the Western Cape
Prof MTE Kahn Energy Institute (Convenor)
Dr A Ayeleso (Administration), Energy Institute
Prof M. Taha , Rafik Hareri University, Lebanon
Prof Y. Soufi , Univeristy of Algeria
Prof O Okoro, Nigeria
Prof H. Hatez, Turkey
Dr A Alwayer, Libya
Dr M. Giraneza (Administration), Energy Institute
Dr K Kanyarusoke, Univeristy of Uganda
Clement Matasane, Cape Peninsula University Of Technology
Dr F Ismail, Cape Peninsula University Of Technology
D Martin, Donix Systems
Z Casiem, Africa Energy Ventures
Dr S Khamlisch, NESDAF
Prof. Li Wenfeng, University of Xian, China
Dr B Batidzirai, University of Stellenbosch
Dr S Pasupathi, University of the Western Cape
Prof Furong Li, University of Bath, UK
Prof EKhlat, Cigre, USA
Dr H Mehrabi, University of Sunderland, UK
Dr F Shahnia, Murdock University, Australia
Prof M. Morgan, Liverpool John Moores University, UK
Prof O Oyakola, Cape Peninsula University of Technology
Dr R.Ngebu , Namibia
Dr Erik V. Mgaya, ATC, Tanzania
Dr A Mohamed, Costech, Tanzania
Colin Openshaw, (Consultant)
Dr G Manuel, NECSA
Erik Kiderlen, SAIRAC
Sean Hendricks, Tellumat
Prof Gary Wills, University of Southampton

3rd Energy and Human Habitat Conference 2022

Conference Reviewers

Prof MTE Kahn, Energy Institute (Chair)
Dr Norman Mathebule, University of Cape Town (Co-Chair)
Dr Nasiru Zakaria, NNRA (Nigeria)
Dr Haithem A. B. Mustafa, University of Massachusettes (USA)
Prof Seun Oyakola, Cape Peninsula University Of Technology
Dr Ouassini Nemraoui, Algeria
Dr Fareed Ismail, Cape Peninsula University Of Technology
Dr Bothwel Batidzira, University of Cape Town
Prof Jasson Gryzagoridis, University of Cape Town
Dr Ayo Imoru, Federal University of Technology, Mina -Nigeria
Dr Ali Almaktoof, Cape Peninsula University Of Technology
Dr Clement Nyirenda, University of The Western Cape
Dr Tafadzwa Makonese, University of Johannesburg
Dr Bothwell Batidzirai, University of Stellenbosch
Mathew Schouw, Cape Penisnsula University of Technology
Prof Pius Oba, University of Witwatersrand
Prof Josiah Munda, Tshwane University of Technology
Dr Raj Naidoo, University of Pretoria
Dr Rosalia Ngembu, Namibia
Colin Openshaw, Consultant
Dhevan Pillay, LTM Energy
Ayanda Dyantyi, Eskom
Dr JanvierKamanzi, Rwanda
Dr Effe Oyarmou, Nigeria
Dr Ayokunle Ayeleso, CPUT
Dr Shahie Fazludien, CSIR
Prof David Chien-Liang Kuo, Chinese Culture University, Taiwan
Prof Yongrae Cho, Baylor University, USA
Dr M Almihat, CPUT
Dr Farhad Shahnia, Murdoch University, Australia
Dr Carl Kriger, Cape Peninsula University Of Technology
Prof Roger Morgan, Liverpool John Moores University, UK
Prof. Ahmed Hamza Ali, Assiut University, Egypt
Zahied Cassiem, Africa Energy Ventures
Prof Sayed Abulanwar, Mansoura University, Egypt
Prof Mohamed Hassan, King Fahd University of Petroleum & Minerals, Saudi Arabia
Prof Ahmed Mokhtar, American University of Sharjah, UAE
Prof Mohammad Elsaeed Rizk, Mansoura University Egypt
Dr Md Hossam Haider, Military Institute of Science and Technology Bangladesh
Dr Michael Mutingi, Namibia University of Science & Technology
Prof Jiangfeng Zhang, Sydney University of Technology, Australia
Dr. Md. Apel Mahmud, Swinburne University of Technology,Australia
Dr. I.D.Margaris, National Technical University of Athens, Greece
Prof Francois Bruno, Ecole Centrale de Lille, University of Lille (France)
Prof. Yen-Shin Lai, National Taipei University of Technology, Taiwan
Prof Jin Jiang, University of Western Ontario, Canada
Prof Rajesh Gupta, Motilal Nehru National Institute of Technology, India
Professor Wojciech Paszke, Universityof Zeilona, Poland
Prof Khaled Aboalez, Cape Penisnsula University of Technology
Dr Zipho Ngcobo, University of Zululand

CONFERENCE Editorial Policy

The conference disseminates original research and new developments which are published in this conference proceedings. The conference covers the following disciplines in the field of energy:
Energy and Society,
Smart Energy
Renewable Energy
Blockchain and smart contracts in energy
Smart Grids, Microgrids and Minigrids
EV and Electric Transportation
Energy Storage and Power Electronics
Energy Efficiency
Energy Economics
Energy Development

Publications produced for the conference

The following publications ensure that the research reports given during the conference are disseminated widely

Conference Proceedings

The conference proceedings contain full papers which are subjected to a blind peer review process.

The proceedings with ISBN number, will be digitally disseminated, and will be published online on our website, as well as co-published on either Elsevier SSRN and its associated e-Journals or Zenodo under the AIUE e-Journal.This is a digital library under OpenAIR and the CERN. OpenAir as the vanguard of the open access and open data movements in Europe was commissioned by the EC to support their nascent Open Data policy by providing a catch-all repository for research and is open to all search engines. This provides a high quality repository of scientific information and dissemination. A DOI number to be associated with the individual research papers.
The target audience for the proceedings are specialists in the field.

Editorial and the Review Process

Our review board consists of international and national experts in specialist fields covered in the conferences. They are from different academic institutions, and from industry. Authors are invited to submit an abstract prior to submission of a paper. The abstracts of proposed conference papers are sent for evaluation, and only accepted abstracts would lead to the invitation to submit a full paper which is then reviewed by no less than two reviewers. A third editorial review is done before the papers are accepted for publication in the proceedings.

The Chairman and/ or Conference Administrator informs each main author of the outcome of the evaluation timeously, inviting the successful author(s) to submit a print-ready manuscript in accordance with possible comments and the instructions and guidelines provided in the conference paper template.
The author submits his paper via the electronic paper submission and review process, indicating the original paper number.

Upon receipt of the manuscript the paper is sent for review to at least two members of the editorial panel who specialise in the disciplines covered in the paper. Reviewer members of the editorial panel, review the paper by answering specific questions, indicating if the paper meets specific set criteria. A separate section allows for comments on the quality of the paper addressed separately to the editors and to the authors. These comments often also indicate what needs to be done to improve the quality of the paper. The reviewer has the option to attach an annotated copy of the manuscript which is returned to the authors with the review reports.

Once sufficient reviews have been received, the Conference Chair and/or Administrator informs the author(s) of the outcome of the evaluation, which is either that the paper is rejected or accepted for publication in the proceedings, or the author may be invited to improve the paper in line with recommendations from the editorial panel and then resubmitted.

The papers are checked and corrected for typographical errors and adherence to the template provided, which satisfies also the requirements of the digital repository styleguide. Only papers which have been accepted by the editor(s) are published in the conference proceedings.

Criteria used by editorial panel members when evaluating papers

Originality - Novel and interesting, warranting publication. The paper contains original research and /or new developments
Contents: Relevant to conference and socio-economic needs.
Title and abstract: Clearly describes the contents is suggested that he article
Language: Paper is clearly written without grammatical or other errors
Introduction: It clearly states the objective and the problem being investigated
Method: The author explains accurately how the data was collected and the information is suitable for answering the questions posed in the research
Result: The analysis and/or model is clearly presented, in a logical sequence and discussed sufficiently.
The paper is technically sound.
Conclusion: Claims are supported by the results and are reasonable, sound and justifiable
Reference: References are complete, adequate and appropriate
Figures and tables: All necessary and acceptable, suitable for a quality publication?
Units formulas and abbreviations conform to accepted standards

AIUE Proceedings of the 3rd Energy and Human Habitat Conference 2022

DOES BASIC OFF-GRID ENERGY ACCESS IMPROVE WELL-BEING IN OFF-GRID INFORMAL SETTLEMENTS? A FIELD EXPERIMENT WITH OFF-GRID SOLAR POWER IN CAPE TOWN

Norman Mathebula[*1], Jiska de Groot[1], Mascha Moorlach[2], Federico Caprotti[2], Catherine Butler[3], Hendrik Schloemann[4], Alex Densmore[4], and Kimenthrie Finlay[5]

[1,2] University of Cape Town, South Africa; [2,3] University of Exeter, United Kingdom, [4] Zonke energy, Cape Town; [5] Thrie Energy Collective, South Africa

Abstract

A major national challenge in South Africa is the continuous and sustainable provision of energy throughout various settlement regions. This research was conducted to examine the impact of clean energy access on the well-being of people through the provision of mini-grids based electricity in a selected off-grid informal urban settlement in Cape Town. A renewable energy social enterprise, called Zonke Energy installed four mini-grids towers. Interviews and surveys were used to collect data from both Zonke customers and Non-Zonke participants. Before and after intervention data were collected to assess the resultant impact of mini-grid power provision on residents' well-being. Health, children's education, and income savings improved among Zonke Energy Customers.

Keywords: Wellbeing, *Wellbeing, mini-grid electricity, off-grid electricity, informal urban settlements, Zonke energy*

***Corresponding Author** Email: norman.mathebula@gmail.com*

I. INTRODUCTION

Informal settlements have become a major part of the urban landscape in most developing countries, and they occur when development lags behind rapid urbanization (Mpembamoto et al., 2017). One in three people residing in urban settlement areas lives in informal urban settlements or informal settlements in the global South (over 900 million) (Runsten et al., 2018). In sub-Saharan Africa, 72% of the population in urban areas live under informal urban settlement conditions (UNPF, 2007) while in South Africa, it is 12,9% of the population (Statistics, South Africa, 2015). Although there are different definitions of informal settlements, common to them is the emphasis on the dwelling type. Informal settlements are temporary structures made from rudimentary materials (Marutlulle, 2017).

Generally, informal settlements have low levels of services and infrastructure such as water, sanitation, roads, drainage, schools, health centers, market places, waste collection, street lighting and electricity (Gaunt et al., 2012). Lack of basic services has a severe impact on the well-being of people. Well-being can be understood both in relation to objective measures, such as household income, educational resources, and health status; and subjective indicators such as happiness, perceptions of quality of life, and life satisfaction (Stathams and Chase, 2010). Well-being is multidimensional (Atkinson, 2013) involving important aspects of life, including mental health,

physical health, economic well-being, social well-being, and liveability. Access to clean electricity is vital to advancing human well-being (Samarakoon, 2019) and plays a fundamental role in achieving sustainable development goals such as Sustainable Development Goal 7 (SDG 7) (IRENA, 2019). Achieving SDG 7, for instance, can lead to contribution towards making progress to the other SDGs such as the SDGs on poverty eradication, gender equality, climate change mitigation and adaptation, health, education, jobs, and innovation (UN-DESA, 2019). Mini-grids are expected to play a significant role in the UN Sustainable Energy in promoting universal energy access (Vargas et al., 2015), especially in informal settlements. However, there is a shortage of data on the well-being impacts of mini-grids (Eales et al., 2018) particularly in informal urban settlements around Cape Town. Few available mini-grids projects around Cape Town are in their pilot phases (see Conway et al., 2019). The aim of this work was to examine energy sources used in Qandu Qandu, an informal settlement around Cape Town, and the impact such energy sources have on the well-being of people but also the impact of off-grid energy access after the intervention (through mini-grids installation)

II. LITERATURE

1. Wellbeing defining the context in Global and North and South

Many of the studies that conceptualize well-being have been generated by researchers from the Global North. These are mainly researchers from the University of Bath in the United Kingdom (UK) - Wellbeing in Developing Countries Research Group (Copestake and Camfield, 2009; White, 2009; 2015). These studies covered the definition of the well-being concept and a generic framework for measuring well-being across the world. Although there are insights that can be drawn from these studies according to Wassel and Dodge (2015) interpretations of well-being varies with contexts. Despite many similarities that may exist, the utility and the relevance of transporting a well-being framework from the Global North into the Global South context have been questioned (Durand, 2013). For instance, people's environment, relationships, and circumstances of people in the Global South differ from their counterparts in the Global North (Mahali et al. 2018). Furthermore, many countries e.g., in South East Asia and Sub-Saharan Africa have some shared characteristics, challenges, and interests different from those in the Global North (Mahali et al. 2018; Samarakoon, 2019). For instance, many people living in these regions are experiencing energy poverty and essential issues of energy access (Samarakoon, 2019).

2 Approach to well-being measurement

Methods for measuring well-being depend on the conceptual approach that is taken by the researcher (Alatartseva and Barysheva, 2015). For instance, some researchers measure well-being through a single domain of psychological well-being (White, 2009) while others measure well-being by considering objective or subjective aspects of both subjective and objective aspects of well-being (White, 2009). The subjective measures of well-being are described through categories such as respect and self-respect, confidence, satisfaction, harmony, harmonious physiological and psycho-emotional state, the feeling of love, affection, friendship, necessity, the person's own place (Alatartseva and Barysheva, 2015). Objective measures, on the other hand, are captured via categories such as material well-being, health, longevity, literacy, and education (Alatartseva and Barysheva, 2015). Objective measures are frequently referred to as 'social indicators' and include data like housing standards, income and employment, educational attainment, and poverty (Copestake and Camfield, 2009).

However, there is consensus among scholars that both approaches are necessary (ESRC Research Group, 2008). Combining objective and subjective aspects in measuring well-being allows for the evaluation of well-being in addition to its measurement (Alatartseva and Barysheva, 2015). To avoid mistakes, criteria for measuring well-being should include all the key determinants to be used in measuring assessment framework and values which must be tangible and relevant to the people (Alatartseva and Barysheva, 2015). A better understanding of what domains should be included in measuring well-being and life satisfaction is necessary (Charlemagne-Badal et al., 2015).

III. METHODS

1 Interview and surveys

The research consisted of pre-intervention and post-intervention phases. The pre-intervention phase aimed at installing four mini-grids by Zonke Energy across four sections and collecting baseline data on the energy sources used and how they impact on the well-being of the people. After the installation, potential Zonke Energy Customers within 30 meters radius of the towers were identified through a community liaison officer and presented with three energy packages: 1) Security and Indoor lights and mobile phone charger package (R150), 2) Radio package (with lights and mobile charger) (R310), 3) TV package (with lights and mobile phone charger) (R420). Qualitative data were collected through face-to-face interviews on two separate occasions, before and after the intervention only with Zonke Energy Customers (n=22) which allowed for comparing the energy-related well-being between pre-intervention and post-intervention phases. Qualitative questions before the intervention included an individual definition of well-being, and their well-being areas such as safety and income, as impacted by using, e.g., paraffin and illegally connected electricity.

Quantitative data was collected through smartphone technologies surveys not only from the Zonke Energy Customers but also from the Non-Zonke Customers (n=300) which included energy sources used, income, energy expenses, the cost of charging phones, electrical appliances, and well-being questions. The data collected that was from the broader community – Non-Zonke Customers allowed for comparing well-being between the Non-Zonke Customers and Zonke Customers.

2 Personal observation

During the field visit, the researchers undertook personal observation. Through personal observation, the researchers also acquired data that could not be verbally shared during both rounds of face-to-face interviews. This enabled the acquisition of data that respondents were uncomfortable sharing during the interviews such as the prevalence of illegal connections but also endorsed certain statements made such as the magnitude of poor socio-economic conditions as expressed during interviews and surveys.

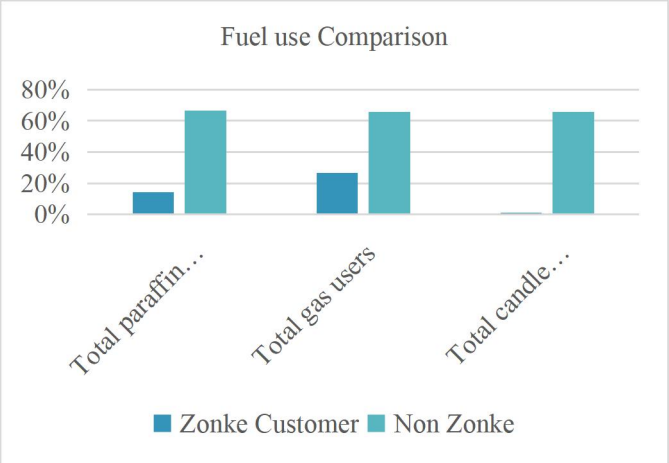
3 Data analysis

The quantitative data was analysed through descriptive statistics while qualitative data was analysed through emerging themes and transcribing and coding data based using NVIVO. This involved subdividing the data based on the emerging sub-sub-themes. These data were in the form of direct quotations from participants' responses about the changes associated with access to clean energy to all those who had subscribed to Zonke energy. The changes were measured against well-being indicators/dimensions adapted from the Organisation for Economic Co-operation and Development Framework (OECD) (See Durand, 2013). This framework was recommended in 2009 by the Commission on the Measurement of Economic Performance and Social Progress to be used in measuring well-being (Durand, 2013). The Framework is built around three distinct elements: current well-being (which in this study was assessed during the pre-intervention interviews), inequalities in well-being outcomes, and resources for future well-being.

IV. RESULTS AND DISCUSSION

1 Quantitive data

After the intervention, many Zonke Customers used less paraffin, gas, and candles than Non-Zonke Customers



2 Qualitative data

Different participants defined well-being and well-being areas differently:

"To me, well-being means having electricity and staying in a proper place not here emacocombehi (Xhosa word meaning informal settlement)"

"Well-being means you must have a house and a job to be able to support your family."

As a result of clean energy access through mini-grids, life under different well-being dimensions improved

Safety
"*It is good for lighting, for charging phones and much safer for the kids since than candles*" (QQ_T1_Female 11_2021).

Access to information (and Job)
"Access to electricity has changed our lives. We can go online to send a CV for job application" (QQ_T3_Female 11_2021).

Health
"Since using Zonke, I have not had an asthmatic attack" (QQ_T2_Male 20_2021).

Children Education
"My daughter can study anytime. Before she had to do schoolwork only during the day because candles are not bright enough" (QQ_T2_Female 22_2021).

Social connection
"My family and friends have noticed that I am now available. I communicate with them now more often than before. We are much closer now." (QQ_T3_Female 06_2021).

Energy reliability
"We just hear that there is load shedding but with Zonke there is no such" (QQ_T4_Female 8_2021).

V Conclusion

Different definitions of well-being by participants show that well-being varies from one person to another which is aligned with the findings by the CDC (2018) that there is no single definition of well-being that is universally accepted and applicable across all disciplines. However, common to the participant's definition was the need to stay in a proper shelter demonstrating that defining well-being does not happen in a vacuum but is based on the parameters that people perceive to be important to their lives. This concurs with a report by Behara et al. (2014). It is evident that through clean energy access via mini-grids, informal settlement communities can reduce the usage of paraffin and candles. Less exposure to paraffin and candles will improve their health-related well-being as demonstrated by some asthmatic participants whose asthmatic attacks reduced after energy access. Moreover, through the ability to charge cell phones, informal dwellers in South Africa can have better access to information and job opportunities while safety and the children's education can improve through electric lights.

Off-grid energy access via Zonke Energy means social enterprises have an important role to play in relieving energy poverty in informal settlements as found by other scholars (Sengupta and Sahay, 2017), thereby improving their energy-related well-being. In India, for example, approximately 240 million people with a lack of access to energy have received electricity through renewable energy social enterprises (IEA 2015). Therefore, it is clear that to achieve Sustainable Development Goal 7 by 2030, innovative approaches such as mini-grids will be required to fastrack electricity access to informal settlements (Conway et al., 2019). This will improve the South African government's effort to address the energy crisis in the informal settlement and avoid long waiting periods to receive grid electricity from Eskom, a public power utility in South Africa (DPME, 2018).

References

Alatartseva, E., Barysheva, G., 2015. Well-being: Subjective and Objective Aspects. Procedia - Soc. Behav. Sci. 166, 36–42. https://doi.org/10.1016/j.sbspro.2014.12.479

Atkinson, S., 2013. Beyond Components of Wellbeing: The Effects of Relational and Situated Assemblage. Topoi 32, 137–144. https://doi.org/10.1007/s11245-013-9164-0

Baye F., Wegayehu, F., Mulugeta, S. (2020). Drivers of informal settlements at the peri-urban areas of Woldia: Assessment on the demographic and socio-economic trigger factors. *Land Use Policy* 95, June 2020, 104573

https://doi.org/10.1016/j.landusepol.2020.104573

Behara RS., Agarwal A., Pulumati P, Jain R., Rao V. (2014). Predictive modeling for wellness and chronic conditions. 2014 IEEE International conference on bioinformatics and bioengineering. *Boca Raton*: IEEE. pp. 394–8

Carbon Trust, CSIR, 2017. Integrating off-grid solutions into South Africa's electrification programme. Prepared for Commonwealth office

Conway, D., Robinson, B., Mudimu, P., Chitekwe, T., Koranteng, K., Swilling, M. (2019). Exploring hybrid models for universal access to basic solar energy services in informal settlements: Case studies from South Africa and Zimbabwe. *Energy Research and Social Science*. 56, 101202. https://doi.org/10.1016/j.erss.2019.05.012.

Copestake, J., Camfield, L., 2009. Measuring subjective wellbeing in Bangladesh, Ethiopia, Peru and Thailand using a personal life goal satisfaction approach, in: WeD Working Paper 09/45. University of Bath/Wellbeing in Developing Countries Research Group, Bath, UK
Department of Planning Monitoring and Evaluation (DPME), "Energy,". (2018). [Online]. Available: http:// https://www.dpme.gov.za/news/Documents/NPC% 20Energy%20Paper.pdf [Accessed: 08-11-2022].

Durand, M., 2013. The OECD Better Life Initiative: How's Life? and the Measurement of Well-Being. Rev. Income Wealth 61, 4–17. https://doi.org/10.1111/roiw.1215

ESRC Research Group, 2008. Wellbeing, Poverty, and Conflict. ESRC Research Group on Wellbeing in Developing Countries, University of Bath, UK.

IEA (International Energy Agency). (2015). Secure sustainability together. World energy outlook 2015, OECD/IEA, Paris

IRENA, 2019. Off-grid renewable energy solutions to expand electricity access: An opportunity not to be missed. International Renewable Energy Agency, Abu Dhabi.

Mahali, A., Lynch, I., Wilson-Fadiji, A., Tolla, T., Khumalo, S., & Naicker, S. (2018). Networks of well-being in the global south: A critical review of current scholarship. *Journal of Developing Societies, 34*(3), 1-28.

Marutlulle, N.K., 2017. Causes of informal settlements in Ekurhuleni Metropolitan Municipality: *An exploration. Afr. Public Serv. Deliv. Perform.* Rev. 5, 11

Runsten, S., Fuso Nerini, F., Tait, L., 2018. Energy provision in South African informal urban Settlements - A multi-criteria sustainability analysis. *Energy Strategy Reviews*. 19, 76–84. https://doi.org/10.1016/j.esr.2017.12.004

Sengupta, S., Sahay, A. 2017. Social entrepreneurship research in Asia-Pacific: perspectives and opportunities. *Social Enterprise Journal 13*(1):17-37 DOI: 10.1108/SEJ-11-2016-0050

Stats SA (2015). Metropolitan data. Available at: [Online]. Available: http:// https://www.dpme.gov.za/news/Documents/NPC% 20Energy%20Paper.pdf [Accessed: 08-11-2022] http://www.statssa.gov.za/?page_id=964

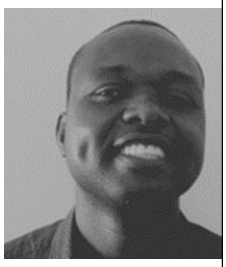
Weimann, A., Oni, T. 2019. A Systematised Review of the Health Impact of Urban Informal Settlements and Implications for Upgrading Interventions in South Africa, a Rapidly Urbanising Middle-Income Country. *International Journal of Environmental Resources and Public Health* 16, 3608. https://doi.org/10.3390/ijerph16193608

UN-DESA, 2019. Accelerating SDG 7 achievement: SDG 7 policy briefs in support of the high-level political forum 2019. United Nations Department of Economic and Social Affairs.

United Nations Population Fund (UNPF). 2007. UNPF state of world population 2007. Unleashing the Potential of Urban Growth. United Nations. New York

Author Biographies

Jiska de Groot is a human geographer and did her PhD at the University of Plymouth in United Kingdom. She working as Senior Researcher at the African Climate and Development Initiative (ACDI), University of Cape Town, she works on the human dimensions of sustainable energy access, energy poverty, gender and capacity building. She has a strong focus on co-designed and participatory research that is policy- and practice-relevant for achieving local development benefits and change processes



Norman Mathebula was born in South Africa. He did his Bachelor's degree and Honours in Environmental Sciences at the University of Venda, Masters degree in Environmental Management at the University of Cape Town and PhD in Environmental Sciences at the University of The Witwatersrand. He was a Postdoctoral Researcher at UCT for the past four years where he on social aspects of sustainable energy access and energy poverty amongst others. He recently joined the University of Limpopo where he is a Postdoctoral fellow at the Risk and Vulnerability Science Centre