Examining energy sufficiency and energy mobility in the global south through the energy justice framework

Monyei, C. G.[1,2,3,5], Jenkins, K.[4], Serestina, V.[3] and Adewumi, A. O.[2,3]

[1]Gidia Oaks Centre for Energy Research, Lagos, Nigeria

[2]Applied Artificial Intelligence Research Unit, School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban 4000, South Africa

[3]School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban 4000, South Africa

[4]School of Environment and Technology, University of Brighton, Cockcroft Building, Moulsecoomb, Brighton, BN2 4GJ, United Kingdom

[5]Corresponding author

Abstract

The widespread adoption of the energy justice framework notwithstanding, arguments offered have not been able to provide tangible definitions of sufficientarianism and energy mobility. Considering widening disparities on what constitutes sufficient energy (electricity) access between the global north (North America, Europe, Australia) and the global south (sub-Saharan Africa, SSA), this paper highlights the influence of 'western reality' on the energy narrative. This paper also attempts to propose a model that evaluates off-grid electrification projects (in the global south) and their ability to guarantee sufficientarianism by examining the prospects of such projects in providing connected households access (energy security and sustainability of energy supply) and mobility (transition from a lower to higher energy level through the purchase of additional electrical equipment). Furthermore, this paper explores and provides arguments on energy bullying (by industrialized nations on developing countries mostly in SSA) while also offering suggestions for improvements in Clean Development Mechanism (CDM) projects. In essence, this paper formulates the endemic problems of energy access and energy mobility (plaguing the global south) as a justice problem and further provides insight into the exacerbation of injustice and bullying exhibited by the global north. Examples from South Africa have been utilized as case study.

Keywords - energy justice; sufficientarianism; energy access; energy mobility; energy bullying.

Contents

Highlights

✓ Identifies varying narratives to sufficient energy access and mobility.

✓ Identifies the effect of western narrative on national energy policies.

✓ Critiques commitment of the global north to mitigating emissions.

✓ Provides policy discussions to improving sufficient energy access and energy mobility.

1 Introduction

Dominant western energy narratives mean that we lack appropriate, context sensitive definitions of "sufficient" energy and "energy mobility". In drumming up support for the adoption of renewable energy technologies in the global south, the global north has failed to highlight the continued contribution of 'dirty energy' sources to sustaining its own economy as well as the internalised benefits of research and development (R&D) for alternative energy sources. This approach is usually encouraged by public news outlets, which fail to account for renewable energy potential, electricity demand, and the effects of seasonal climatic variance on energy provision, amongst other factors [see Nield 2016; Coren 2016; Neslen 2015; Sims 2016; Walker 2017]. What is more, these narratives are extremely influential. Western accounts of renewable energy provision influence their policies on investments in sub-Saharan Africa (SSA), the primary case study used throughout this paper, for instance. Indeed, according to the main United States development finance institution, the Overseas Private Investment Corporation (OPIC) prefer mainly to invest in solar, wind and other low-emissions energy projects

(Lomborg 2014). As a consequence, over the past five years, the OPIC has invested in more than 40 new energy projects, for which all but two were in renewables. Positive on the one hand, such approaches are open to critique. Bjorn Lomborg, the president of the Copenhagen Consensus Centre, stated, for instance, that "... if Obama spends the next $10 billion on gas electrification, he can help lift 90 million people out of poverty. If he only uses renewables, the same $10 billion can help just 20 million - 27 million people. Using renewables, we will deliberately choose to leave more than 60 million people in darkness and poverty... (KFF 2014)." Arguably, then, the wholesale promotion of renewables can be a perverse approach and an act of "energy bullying", without consciousness of what it means to have energy sufficiency and energy mobility. We position this as a fundamental energy justice challenge.

Against this background, the paper argues that the current energy justice framework is not yet complete. Among the academic literature, we identify reluctance from energy justice scholars to establish tangible definitions of what constitutes sufficient energy access, a failure that may be influenced by the "access connotes sufficiency" narrative. This narrative finds support in the divergent view between the global north and the global south on energy poverty. While energy (fuel) poverty in the global north is about affordability (i.e. the ability of households to afford sufficient energy for adequate heating), in the global south, energy poverty is a problem of accessing clean energy sources for domestic uses. Thus, in the global north, sufficiency is a problem of the "ability to purchase", inherently implying that homes connected to the grid can access as much electricity as possible if they are willing to pay. This narrative is consistent with the ideal of fuel poverty where, as Katsoulakos (2011) outlines, expenditure beyond 10% of disposable income on energy (fuel) connotes energy poverty and World Bank (2017) figures, which show that electricity access for the EU is 100%, while for the OECD countries it is 99.92% (as of 2014). In contrast, for the global south, access to clean energy sources is comparatively low (less than 40%) and poverty levels are very high, especially in SSA where the figure is about 41% of the population (Baurzhan and Jenkins 2016; World Bank 2017). Thus, energy poverty in a global south context is a "problem of access". This ideal is supported by the dual causal link between energy and poverty, which leads to low energy demand (especially in rural areas (DME 2009)) and the fact that electricity consumption is a function of both the ownership of electrical appliances and duration of usage (Monyei and Adewumi 2017, p.308). Households in the global south are thus forced to exploit other means of accessing energy sources like firewood and liquid petroleum gas, which do not offer the same quality when compared to grid electricity. As a result, for non-grid homes in South Africa, over 47% are evaluated to be energy poor (using 10% of household disposable income as benchmark) (DOE 2012a).

In short, global energy and climate policy formulation is heavily construed in favour of the global north. Alongside being historically and currently responsible for the majority of greenhouse gas (GHG) emissions, the global north is also the major player in the conceptualization and formulation of climate change mitigation policies. This is not without issue. According to Moner-Girona et al. (2016), the Clean Development Mechanism (CDM) under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) permits industrialized countries (Annex I countries) with GHG reduction commitments to 'offshore' investments in emissions reducing projects to developing countries as an alternative to costly reduction strategies "back home". The extent of CDM's usefulness is controversial, with widespread debate surround the ability of CDM projects in developing countries (non-Annex I countries) to guarantee sufficient energy access and energy mobility (Lim and Lam 2014). Millock (2013) outlines that debatable issues include the low-hanging fruit argument, transaction cost, and contribution to sustainability, amongst others. As an illustration, Costa-Jnior et al. (2013) evaluate the contribution of 75 CDM projects for technology initiatives and the promotion of cleaner technologies in Brazil, showing that not more than 21% of the projects led to implementation of cleaner technologies. This led to the conclusion that CDM projects in Brazil have not encouraged a cleaner model of development.

In addition, the absence of a penalty framework that fines Annex I countries who fail to meet pre-determined emissions reduction targets has further contributed to lack of commitment to ensuring that more active steps are taken to increase the roll-outs of CDM projects with verifiable contributions to improvement in quality of life and sustainability. This view is supported by Barkindo (2006) who outlines that the developed countries did not support initiatives preceding the Kyoto Protocol agreement announcement, but rather converted to 'mechanisms for investment' such as the compensation fund and the Brazilian proposal for a clean development fund. The developed countries have thus eliminated measures that would demand sustained commitment to the increased development of sustainable energy projects in developing countries. A case in hand is Germany's default on its emissions reduction target, which would attract no penalty or fine (news24 2017).

In light of this background, this paper makes several arguments: (1) that existing energy justice frameworks have not sufficiently explored concepts of energy sufficiency and energy mobility; (2) that the Global North has engaged in energy bullying by promoting renewable energy in the Global South while continuing to develop fossil fuels; (3) as a result, that South Africa's off-grid electrification policy is flawed; and (4) that off-grid projects in the global south should make use of features like hybrid solar-diesel technology which would give these projects greater value in providing sufficient access and in accommodating users' needs when energy demands increase over time. Following an introduction to the basics of South African energy policy, each section of our paper further develops each of these points in turn.

2 South African energy policy: An introduction

To begin, we provide an intentionally brief introduction to the South African energy policy case study referenced throughout this piece, necessary to give context to the empirical material that follows. With attention to the United Nations (UN) Sustainable Development Goals (SDGs) 7 and 11 (UN 2015), and in mitigating the effects of the planned decommissioning of ageing power plants (Njobeni 2017), Eskom, a South African electricity public utility, has recently stepped up its construction of additional electricity supply capacity (Eskom 2015). The accelerated efforts by Eskom coincide with the energy crisis that has plagued South Africa since 2008, leading to massive blackouts, load shedding and huge economic losses (Shezi 2015; Kohler 2014). This rapid electrification program has seen electrification rate move rapidly from less than 33% (in 1990) to 58% (1996) and 90% (2016) and has succeeded largely due to various government policies and interventions (Marquard et al.

2007).

Yet in terms of the socio-economic background of the population, evidence suggests that electrification rates remain deeply uneven between differing ethnic groups and across urban and rural areas. For instance, across the South African provinces, household electrification rates for Black African, Coloured households, Indian/Asian population group varies significantly with 54.14% of Black African households electrified compared to 47.87% for Coloured households, 59.29% for Indian/Asian households and 77.40% for White households (STATSSA 2015). According to the DME (2009) this necessitates government responsibility for ensuring the electrification of all its citizens, and especially the rural poor, in order to improve living conditions.

As a step towards achieving universal access to electricity by 2019, the free basic electricity (FBE) policy was introduced in 2004 to completely subsidize 50 kWh of electricity monthly for the very poor households connected to the grid (GNESD 2018). This is in line with the 1998 energy policy White Paper, where emphasis was placed on households access to adequate energy services for cooking, heating, lighting and communication (DOE 2012b). In addition, the Non Grid Electrification Policy Guidelines identify non-grid solar home systems (SHS) as a suitable temporary alternative to grid electricity for rural, poor and off-grid homes. In order to extend this electricity access, energy service companies (ESCO), concessionaires and service providers act on behalf of the Department of Energy (DOE) to roll out SHS delivery DME (2009).

According to the DME (2009), the SHS, which are being introduced now, should produce about 250Wh daily and power a black and white television (for 4 hours), lighting (4 hours), portable radio (10 hours) and phone charging points daily. The implication of this is that on average each off-grid rural poor home gets 7.5 kWh monthly from the SHS. Yet, as this paper goes on to argue, this scheme is ethically flawed, and, echoing failures of the energy justice literature, overlooks key issues of western energy bullying.

3 The limitations of the energy justice approach: Sufficiency and mobility

The increasingly popular energy justice framework faces a major limitation: it fails to engage with definitions of "sufficient energy" and "energy mobility". Yet, as our introduction has shown, this is entirely necessary as existing notions of energy access have focused on problems faced by the Global North, and they have tended to overlook problems of sufficiency and energy mobility that are significant concerns in sub-Saharan Africa (SSA) in particular. Here we introduce this limitation. The concept of energy justice is already a much-researched topic with the energy and social science literature, seeking to establish a nexus between energy in terms of generation and delivery on the one hand and justice (taken to be synonymous with equity/fairness) on the other (Jenkins et al. 2016). Islar et al. (2017, p.671) define it as "respecting universal human rights and ensuring that every person has a right to the level of energy required to attain a minimum level of well-being". In keeping, Sovacool et al. (2017a) present energy justice as a global system that is both representative and impartial, and fairly distributes the benefits and costs of energy services.

As an outline of the debates it presents, Sovacool and Dworkin (2015) suggest that energy justice can take on conceptual, analytical and decision-making roles. In presenting energy justice as an analytical tool, Sovacool and Dworkin (2015) outline an energy justice framework that helps in understanding how values can be built into energy systems. Conceptually, Jenkins et al. (2016) lay out a three-tenet framework in which the tenets of distributive justice, procedural justice and recognition are used as a means of understanding energy justice dilemmas. Through both, energy justice is then described as playing a role in assisting the energy decision process and choices of consumers and energy planners by presenting itself as a useful decision making tool. As an illustration of the application of such approaches to date (of which there are many), Bouzarovski and Simcock (2017) recognise the implicitly spatial nature of distribution, procedure and recognition and include this spatial dimension in their conceptualisation of energy poverty as a form of injustice. Heffron et al. (2015) present energy justice as the solution to the Energy Trilemma, whereas Islar et al. (2017) evaluate the national energy policies of Nepal by applying key aspects of the energy justice framework to show the feasibility of geopolitical and biophysical constraining factors in the implementation of just energy policies. As a final example, Yenneti and Day (2016) qualitatively evaluate the distributional justice concerns in the implementation of a large-scale solar park in India. These seemingly disparate examples are united by a shared concern for the social justice implications of energy infrastructure and use, and demonstrate that the energy justice framework is a widely applicable and successful one.

Yet despite its success, there are failings in the energy justice literature and its application. A critical examination of the energy justice framework as proposed by Sovacool and Dworkin (2015) shows that while arguments are proffered for the principles of (1) availability (bordering on energy security, energy sufficiency and reliability of energy source), (2) affordability (encompassing stable and equitable prices), (3) due process (ensuring active community participation), (4) good governance (promoting access to information and establishment of transparent frameworks for preserving that access), (5) sustainability (promoting frugal utilization of resources that minimize waste and negative impact on the environment), (6) intra-generational equity (distributive justice between different communities), (7) intergenerational equity (distributive justice between present and future generations) and (8) responsibility, tangible expressions have not been provided to the following: what constitutes sufficient energy of high quality and beyond energy access, and how do electrification projects guarantee energy mobility for connected households? We address each in turn.

3.1 What constitutes sufficient energy of high quality?

Considering the widening gap in terms of quality of life (QoL) between residents in the global north (North America, Europe, Australia) and the global south (sub-Saharan Africa, SSA), as well as the varying weather conditions these regions experience, it becomes obvious that energy requirements vary. What, therefore, constitutes the "minimum energy access" (kWh/month/individual) that is capable of meeting the basic needs of an individual? A review of literature on energy justice framework shows vagueness around a definition of sufficient energy access. Also worrisome is the translation of this vagueness into policies that countries in SSA are deploying in 'mitigating' energy poverty. Considering the low access to electricity in SSA (71.6% in the urban areas and 15.3% in the rural areas), Solar Home Systems (SHS) have been adopted by most SSA countries in order to increase electricity access for off-grid rural communities (Baurzhan and Jenkins 2016). Yet despite the widespread penetration of SHS in rural communities, there has been no noticeable reduction in rural peripheralisation[1]. Indeed, according to (Baurzhan and Jenkins 2016) there has been little or no effect of SHS on poverty alleviation at all, with 727 million people in SSA still relying on traditional biomass and charcoal as their primary cooking fuel.

Evidence of the SHS's failures to decrease poverty burdens is further corroborated by (Urmee and Md 2016), who posit that end-users expectations of SHS and the performance of these SHS did not match, especially in terms of load capacity and hours of utilisation, where most end-users had expected grid quality electricity levels. Overall, this evidence implies that the increasing widespread use of SHS has not significantly improved electricity per capita (kWh) for SSA which, according to Baurzhan and Jenkins (2016), is about 511.90 kWh compared to an average of 3064.50kWh for the world. Nor has there been any significant contribution of SHS to GHG emission reduction.

As was briefly introduced above, in order to reach the goal of achieving universal access to electricity by 2019 in South Africa, the Free Basic Electricity (FBE) policy was introduced in 2004 with the aim of completely subsidizing 50 kWh of electricity monthly for the very poor households connected to the grid (GNESD 2018). This action is in line with the 1998 White Paper on energy policy, where emphasis was placed on households' access to adequate energy services for cooking, heating, lighting and communication (DOE 2012b). Similarly, for off-grid poor homes, the FBE enables a 250Wp SHS per home. In this context, while it may be argued that the poor off-grid homes have been provided 'access', the disparity and injustice in the distribution of resources between poor homes that are grid connected and off-grid is obvious. Further, while grid connected poor homes are guaranteed stable electricity supply (up to 50kWh/month) with "no limit"[2] on peak demand and usage of electrical appliances, off-grid poor homes are placed entirely at the mercy of weather conditions and have their peak demand capped (maximum inverter capacity). Finally, off-grid poor homes with SHS are not guaranteed stable power supply and have a limited range in terms of choice of electrical appliances. Our argument here is that a failure to define "sufficient access" or "sufficiency" is leaving some social groups unfairly burdened.

3.2 Beyond energy access, do electrification projects guarantee energy mobility for connected households?

Another lacuna observed in the principles proposed by the energy justice framework is the absence of energy mobility thinking. By energy mobility we do not mean transport from energy, but the ability of households to increase their energy demand due to an increase in the number of electrical appliances they own or extnsion in usage of already owned electrical appliances. While it may be argued that the availability principle encompasses

[1] By rural peripheralisation we extend its meaning beyond Sovacool et al. (2017b) to mean discrimination in quality and quantity of electricity access to households of the same income bracket due to their proximity to the national grid.

[2] no limit for grid connected homes does not imply infinite loading. While electricity consumption is a function of ownership of electrical appliances and duration of use, maximum demand from a house is limited by the ampere (current) rating of its connection. Typical houses under the FBE are 20 A connected which means that at any time, maximum current that can be drawn is 20 A.

energy mobility, the vagueness around the above question raises doubts. Arguably, the FBE policy that advocates for the implementation of SHS in off-grid poor homes boosts rural peripheralisation and caps electrical appliance ownership by households. Considering the fact that most poor rural homes cannot afford the SHS (which are subsidized heavily by the government), it follows that upgrading the SHS - increasing the number of photovoltaic (PV) panels, increasing inverter capacity, increasing storage etc., may not be affordable for the poor households. Furthermore, considering the fact that the value of the SHS depreciates, non-upgrade of these SHS leave households poorer (energy-wise) year-on-year. The result is a vicious cycle: according to Azimoh et al. (2017), electrification cannot solve the entirety of the developmental problems plaguing rural households, and households cannot access development assistance opportunities without having access to electricity. In addition, since productivity is linked to electricity access and with over 55.5% of households in South Africa poor (STATSSA 2017), and 47% of non-electrified households in South Africa experiencing energy poverty (DOE 2012a), the need arises for concerted and robust arguments capable of precipitating policies that guarantee poor households energy mobility in addition to access to a minimum quantity of energy (electricity). At the moment, energy justice scholarship has not engaged with this challenge.

4 Flawed policy and energy bullying: Evidence of key findings

In this section we address the assertion briefly covered in the introduction, that the Global North has engaged in energy bullying by promoting renewable energy in the Global South while continuing to develop fossil fuels. We then further outline that as a result, South Africa's off-grid electrification policy is fundamentally flawed. According to Valer et al. (2017), 45kWh/month/household is currently the minimum for any electrification project that aims to receive funds from the *Conta de Desenvolvimento Energetico - CDE*. The 45kWh/month per household is evaluated and based on the assumption that it is the minimum energy required for lighting, communication and refrigeration. This value is similar to the 50-100kWh/year/person for basic energy needs referenced by Sovacool et al. (2012, p.718) (if average household size for off-grid rural households is estimated at 4 persons/household) and the FBE allocation of 50 kWh/month for poor grid connected households, outlined above. Yet these figures are not being reached in some instances. Here we explore why.

4.1 On electricity consumption and population size

Figure 1 from World Bank (2017) shows the population of the OECD, EU and SSA countries, including that for Germany, South Africa and Nigeria from 1971-2016. It is seen from Figure 1 that across the years under consideration, growth rate has been uniform (and almost constant) for South Africa, Germany and EU countries, with steep growth rates observed for Nigeria, SSA and OECD countries. However, as shown in Figure 2, electricity consumption (kWh/capita) is highly varied (World Bank 2017). For example, in 2014 electricity consumption per capita (kWh/capita) for Germany with a population of 80,982,500 was 7,035.48, while for SSA with a population of 978,625,082 it was 483.12 (with a significant portion of that due to South Africa's use). An implication of this is that Germany with a population growth of 3.4% between 1971-2014 has increased electricity consumption by 73.1%. This is in contrast to SSA with population increase of 225.8% and electricity consumption increase of 51.6%. Whilst this is a perhaps unsurprising figure, it is one worth repeating. The consequence of the low electricity consumption for SSA has led to increased poverty (estimated to be 41% of the population (World Bank 2017)) in the region, which has further decimated electricity access. In turn, this low energy (electricity) access reduces the quality of life (QoL) of households and forces them to explore alternative energy sources like firewood which exposes residents to diseases such as childhood pneumonia, chronic obstructive pulmonary disease (COPD), and lung cancer from smoke emanating from these alternative energy sources (Baurzhan and Jenkins 2016). We seek to demonstrate here, the serious implications of insufficient energy policy gains.

4.2 On dirty energy and sustainable growth and development

The OECD countries are the major drivers of clean energy initiatives worldwide, with the EU at the forefront of international efforts towards a global climate deal (EU 2017). From the United Nations Framework Convention on Climate Change (UNFCCC) to the Kyoto Protocol and then the Paris Agreement, developed countries (particularly within the EU) have been setting ambitious plans to reduce GHG emissions significantly below 1990 levels. However, despite efforts geared towards reducing the use of energy polluting sources for electricity generation, a prominent dirty energy source has continued to play a major role in the overall electricity generation mix of the OECD countries: coal. IPCC (2007) outlines that the largest 15 countries (including the EU-25 as one) make up 80% of global GHG emissions. Within those, Figure 3 (a and b) shows that coal exploitation in electricity generation for the OECD countries still makes up about 31% (as at 2014) of the total generation mix, producing over 3,000 TWh of electricity (as of 2014) compared to over 2,000 TWh in 1980 (EIA 2017). This represents about a 50% increase in utilization of coal between 1980-2014. This dirty, albeit cheap source of electricity has fuelled development and sustained the 'green' economies of the developed nations.

Doubts thus arise over the sincerity of these developed countries (OECD/EU) in mitigating GHG emissions considering their historical responsibility (IPCC 2007) and current contribution to GHG emissions. Germany (which, according to DW (2017), is poised to miss its 2020 climate target by up to 7%) currently produces about 40% of its electricity from coal. As Figures 4a and 4b show, this represents just around 16% drop in coal utilization between 1980-2014. According to news24 (2017), "Merkel has opposed stricter EU emissions limits for cars, fought planned diesel bans in cities suffering toxic air pollution and shelved a plan to get one million electric vehicles onto German roads by 2020." This is further corroborated by the inability of Merkel to form a coalition majority government owing to her disagreement with bold cuts to coal power generation (Oltermann 2017). The fallout of this double standard is energy bullying and inconsistency in policy formulation and implementation. For this paper, we define energy bullying as attempts by developed countries in the global north to force developing countries (especially in the global south) to adopt electrification options that suit the (predominantly renewables focused) narrative of the developed nations, thereby ensuring the reliance of developing nations on technical expertise from the developed nations. This occurs through stifling policies on loans, financing, aids and trade, amongst other mechanisms. On the whole, the electrification options being adopted do not guarantee equity in electricity access for poor households in developing nations.

4.3 Energy bullying of the global south by the global north

The Nigerian finance minister was recently quoted (verbatim) to have said "We also do need consistency of policies by the multilateral institutions and western countries. Let me give you an example. In Nigeria, we have coal and there is power coal. It does not take a genius to work out what it will take to get coal fired power. Yet, we are being blocked. I think there is some hypocrisy in that. We have an entire western industrialisation that was built on coal-fired energy and that is the competitive advantage that has been used to develop Britain, where I grew up. Now, Africa wants to do it, and they are saying it is not green. It means that we can not do (coal) and that we should go and do solar (and) wind, which are the most expensive power projects. Yes, we are going to have the narrative around infrastructure... but we must also make sure the playing field is level. The west cannot say after polluting the atmosphere for 100 years, and when Africa wants to explore its resources, they say no. If we want to stop coal, those who started it over 200 years ago, should first stop using coal before telling us to stop. This is because by doing so, you are only pushing us to the cycle of underdevelopment" (Amanze-Nwachuku and Chima 2016).

The decision by the World Bank to fund the construction of the Medupi power station, a coal-fired power station being built by Eskom in the Limpopo province of South Africa, was greeted with public outcry especially from the United States, Britain, the Netherlands, Norway and Italy (all OECD members) (Goldenberg 2010). The criticisms notwithstanding, the bank's decision was sequel to the energy crisis that was plaguing South Africa (Shezi 2015). While coal can produce over 92% of South Africas electricity (as of 2014), in real terms, this translates to 225 TWh compared to 259 TWh for Germany (45% for 2014) and 3,222 TWh for OECD countries (31% for 2014). Figure 5 (a and b) presents electricity generation breakdown by source for South Africa from 1980-2014 (EIA 2017). As further history, while the United States (under Barack Obama) condemned the World Bank's decision to fund the construction of the Medupi power station (Goldenberg 2010), the same United States (under Donald Trump) is pulling out of the Paris agreement to enable it to exploit 'dirty energy' sources (especially coal) without strict caps on emission (DiChristopher 2017). This is no different to Germany's inability to meet its own reduction target (news24 2017). Due to their far-reaching global influence, developed nations thus find it easy to renege on agreements relating to policy targets without repercussions (since they also constitute the watchdogs). According to (Lomborg 2014), China lifted 680 million people out of poverty over the past 30 years through cheap coal thus showing the strong connection between growth and energy availability. It thus becomes immoral, unethical, unjust and a case of bullying when OECD countries that derive over 60% of their energy from polluting sources (coal, gas etc.) decide to only fund renewable energy projects to increase electricity access in Africa.

5 Improving energy projects for sufficiency and mobility

This section engages with the final argument of our paper, that in light of the critiques above, off-grid projects in the global south should make use of features like hybrid solar-diesel technology which would give these projects greater value in providing sufficient access and in accommodating users' needs when energy demands increase over time. Considering the disparities in quality of life between the global north and the global south, the proposals made for evaluating energy projects are confined to SSA.

In South Africa, the Non Grid Electrification Policy (DME 2009) is ethically flawed. This is because the Non Grid Electrification Policy does not incorporate values into its delivery based on its non-consideration of the effect of weather variations across and within the provinces on SHS output, and secondarily based on its basic electricity needs standard of 7.5 kWh/month/household. Furthermore, the Non Grid Electrification Policy creates injustice in terms of electricity access between poor households that are differentiated by grid access. While poor households with a grid connection can access the most efficient source of lighting for all needs including productive purposes, poor households with SHS are forced to heavily complement their energy mix with alternative fuel sources like wood and LPG (Kaygusuz 2010). The additional expenditure by poor households on alternative fuel and monthly surcharges for the SHS further impoverishes off-grid poor households. Thus, while grid access limits free electricity consumption to 50 kWh/month/household (for poor households), it offers them energy security and guaranteed availability with no restriction on usage option (cooking, heating, lighting and entertainment). We need a more appropriate alternative, based on an alternative vision.

In navigating the gap between descriptive and prescriptive claims outlined by Sovacool and Dworkin (2015), the need arises for "realistic utopia" of what could be based on real world case studies from real world contexts. For the purposes of this paper and with reference to the South African case, we define realistic utopia to be an ideal setting in which households are responsible in meeting their monthly billing obligations, GHG emissions is minimized (not necessarily eliminated), egalitarianism is constrained by the ownership of electrical appliances, libertarianism is bounded by the ability of households to influence decision as regards usage of their electricity allocation, utilitarianism is a function of improvement in quality of life as shown by improvement in productivity or ownership of electrical appliances, and sufficientarianism is limited by electrical appliances ownership and ability to pay for electricity usage. This is, in essence, our guiding vision of an "energy just" setting.

Within this realistic utopia, energy sources must be able to provide households with consistent access to energy (electricity). The grid connected poor households in South Africa are guaranteed availability under the FBE. To remedy the most significant failing - availability for off-grid poor homes - we promote centralized generation schemes backed up with diesel/petrol generators. These generators would provide regular interventions during the day when high energy consuming appliances (electric cooker, electric kettle, pressing iron) can be used. Further, during days of low solar irradiance, the generators can be run to augment for low power production from the centralized SHS system. Of course, it can be said that the inclusion of the diesel generator is "unsustainable", but in keeping with the argument presented throughout, it is also a mode of achieving social justice that should not be dismissed, especially as it has so long been used elsewhere (Azimoh et al. 2016). Still, to mitigate against climate change, an environmental surcharge that is a fraction of total household bill could be applied to generate funds for increasing the availability of battery and the number of photovoltaic (PV) panels. The billing of the system should be conducted in a way that guarantees sustainability and minimises or decreases government intervention (subsidy). This can be achieved through a graduated billing system that increases energy bills (with the consensus of the community) yearly at a fixed rate. We argue that CDM projects (especially solar based projects like SHS) should also adopt hybrid configurations (SHS/diesel generators).

While the ability to achieve emission targets would be reduced due to the incorporation of the generators, the executed projects are capable of greatly improving the quality of life of households, precipitating economic growth and mitigating poverty. Arguments for the adoption of hybrid configurations that include fossil fuel based sources stem from the fact that sustainable development cannot be achieved while the majority of the population is still poor and has limited means by which to reverse this trend, as is the case for an estimated 55% of South Africans (STATSSA 2017) and whilst the global north shows an inability to reduce non-fossil energy sources to below 60% of its generation capacity. With this in mind, the 50 kWh/month guaranteed grid connected model for poor households is equivalent to about 8% of the total monthly consumption of an average household (consuming 600 kWh/month). Sufficiency is, however, guaranteed by the grid connection which allows households increased consumption by purchasing more units. In contrast, sufficiency is only guaranteed for off-grid consumers through hybrid SHS/diesel generator schemes which enables households connected to the hybrid schemes to increase the consumption of electricity up to a level through extended usage of currently owned electrical appliances or purchase of new electrical appliances. Based on the scheduled intervention of the diesel generator and our definition for a realistic utopia, households could have the operation time (start time or period of operation) of their high electricity consuming devices slightly varied (utilizing artificial intelligence (AI) tools) to ensure that peak demand is minimized.

Energy mobility for households can be construed as an index for measuring quality of life. Electrification projects must thus be able to guarantee households the opportunity in migrating from a lower level of energy consumption to a higher one through extended usage of electricity or increase in ownership of electrical appliances. Grid connected houses under the FBE are guaranteed mobility due to the regular grid expansion model employed by the utility in increasing electricity supply capacity. In South Africa, the Transmission Development Plan (TDP) provides a guide as to how utility supply capacity is regularly increased to meet projected demand growth (Eskom 2015). In contrast, the current Non Grid Electrification Policy does not guarantee energy mobility for SHS connected households due to the high and prohibitive costs in expanding its capacity. As earlier advocated, the incorporation of an alternative energy (electricity) generation source like diesel generators and a centralized system of generation (rather than the conventional individual household approach) guarantees mobility. With the incorporation of smart load dispatch algorithms, increasing demand motivated by the increase in ownership of electrical appliances by households is easily resolved by optimally scheduling the dispatch time of the high energy consuming loads during the scheduled intervention of the diesel generators.

In extending discussions on what constitutes sufficient energy access and allowances for energy mobility to CDM projects, we argue that these CDM projects must be able to offer similar quality of life to connected households in the developing countries to ensure justice. For example, it is unjust to assume that the GHG emissions reduction of a unilateral CDM project by an Annex I country such as solar lighting for a remote location or distribution of cooking stoves in a non-Annex I country would offer the same contribution to quality if life as a fossil based project emitting same quantity of GHG in a developed country.

6 Conclusion

This paper has critically examined the dual problems of energy sufficiency and energy mobility for the global south using South Africa as a case study. We have identified the problem of vagueness in the definitions of these terms, as well as proposed improvement for both conceptual and policy thinking. In so doing, this paper identifies the disparity in narratives between the global north and the global south as to what constitutes sufficient energy access, energy mobility and as an outcome of both, energy poverty: issues that we describe as fundamental to the energy justice challenge. These failings are routed in the persistent effects of the 'western narrative' on the national energy policies of developing countries. We have evidenced this by identifying the emerging case of energy bullying by the global north on the global south while also presenting cases of policy inconsistencies by the global north especially on commitments to emissions reduction. Considering the huge technical gap between the Annex I and non-Annex I countries and the role of CDM projects in precipitating sustainable developments in non-Annex I countries, this paper advocates for the adoption of hybrid electricity generation systems with alternative/complementary generation sources (diesel, gasoline) for CDM projects such as solar based electricity scheme for remote locations in developing countries. Within the realistic utopia presented, it is argued that the adoption of a hybrid and centralized electricity generation scheme would guarantee off-grid poor households under the Non Grid Electrification Policy sufficient energy access and energy mobility compared to what is currently obtainable. In sum, the 'western narrative' on energy must adopt justice principles in the execution of CDM projects and the formulation of energy policies for investments in developing countries in order to guarantee sufficient access and mobility of households. It is only fair.

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References

[1] David Nield. *95% of Germany's Energy Was Provided by Renewables Last Sunday.* [online] Accessed: 2017-11-23. 2016. URL: https://www.sciencealert.com/last-sunday-95-percent-of-germany-s-energy-was-provided-by-renewables.

[2] Michael J. Coren. *Germany had so much renewable energy on Sunday that it had to pay people to use electricity.* [online] Accessed: 2017-11-23. 2016. URL: https://qz.com/680661/germany-had-so-much-renewable-energy-on-sunday-that-it-had-to-pay-people-to-use-electricity/.

[3] Arthur Neslen. *Wind power generates 140% of Denmark's electricity demand.* [online] Accessed: 2017-11-23. 2015. URL: https://www.theguardian.com/environment/2015/jul/10/denmark-wind-windfarm-power-exceed-electricity-demand.

[4] Alexandra Sims. *Sweden on target to run entirely on renewable energy by 2040.* [online] Accessed: 2017-11-23. 2016. URL: http://www.independent.co.uk/news/world/europe/sweden-renewable-energy-target-2040-country-on-track-a7381686.html.

[5] Peter Walker. *Denmark runs entirely on wind energy for a day.* [online] Accessed: 2017-11-23. 2017. URL: http://www.independent.co.uk/news/world/europe/denmark-ran-entirely-on-wind-energy-for-a-day-a7607991.html.

[6] Bjorn Lomborg. *Lomborg: Obama energy policy hurts African poor.* [online] Accessed: 2017-11-23. 2014. URL: https://www.usatoday.com/story/opinion/2014/02/08/bjorn-lomborg-africa-energy/5284631/.

[7] KFF. *Obama Administration Should Focus Energy Development In Africa On Gas Electrification.* [online] Accessed: 2017-11-23. 2014. URL: https://www.kff.org/news-summary/obama-administration-should-focus-energy-development-in-africa-on-gas-electrification/.

[8] Nikolas Katsoulakos. "Combating Energy Poverty in Mountainous Areas Through Energy-saving Interventions: Insights From Metsovo, Greece". en. In: *Mountain Research and Development* 31.4 (Nov. 2011), pp. 284–292. ISSN: 0276-4741, 1994-7151. DOI: 10.1659/MRD-JOURNAL-D-11-00049.1. URL: http://www.bioone.org/doi/10.1659/MRD-JOURNAL-D-11-00049.1 (visited on 10/15/2017).

[9] The World Bank. *World Development Indicators.* [online] Accessed: 2017-11-23. 2017. URL: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

[10] Saule Baurzhan and Glenn P. Jenkins. "Off-grid solar PV: Is it an affordable or appropriate solution for rural electrification in Sub-Saharan African countries?" In: *Renewable and Sustainable Energy Reviews* 60.Supplement C (2016), pp. 1405 –1418. ISSN: 1364-0321. DOI: https://doi.org/10.1016/j.rser.2016.03.016. URL: http://www.sciencedirect.com/science/article/pii/S1364032116002513.

[11] DME. *Non-Grid Households Electrification Policy Guidelines - Revision 0003.* [online] Accessed: 2017-10-01. 2009. URL: http://www.energy.gov.za/files/policies/electrification/Non-grid%20policy%202009.pdf.

[12] C.G. Monyei and A.O. Adewumi. "Demand Side Management potentials for mitigating energy poverty in South Africa". In: *Energy Policy* 111.Supplement C (2017), pp. 298 –311. ISSN: 0301-4215. DOI: https://doi.org/10.1016/j.enpol.2017.09.039. URL: http://www.sciencedirect.com/science/article/pii/S0301421517305992.

[13] DOE. *A survey of energy-related behaviour and perceptions in South Africa: The Residential Sector*. Tech. rep. Pretoria: Department of Energy, 2012.

[14] M. Moner-Girona, S. Szabo, and S. Bhattacharyya. "Off-Grid Photovoltaic Technologies in the Solar Belt: Finance Mechanisms and Incentives". en. In: *Reference Module in Earth Systems and Environmental Sciences*. DOI: 10.1016/B978-0-12-409548-9.09713-X. Elsevier, 2016. ISBN: 978-0-12-409548-9. URL: http://linkinghub.elsevier.com/retrieve/pii/B978012409548909713X (visited on 10/15/2017).

[15] Xin-Le Lim and Wei-Haur Lam. "Review on Clean Development Mechanism (CDM) implementation in Malaysia". en. In: *Renewable and Sustainable Energy Reviews* 29 (Jan. 2014), pp. 276–285. ISSN: 13640321. URL: http://linkinghub.elsevier.com/retrieve/pii/S1364032113006552.

[16] K. Millock. "Clean Development Mechanism". en. In: Elsevier, 2013, pp. 15–21. URL: http://linkinghub.elsevier.com/retrieve/pii/B9780123750679001273.

[17] Antnio Costa-Jnior, Kristian Pasini, and Clio Andrade. "Clean Development Mechanism in Brazil: an instrument for technology transfer and the promotion of cleaner technologies?" en. In: *Journal of Cleaner Production* 46 (May 2013), pp. 67–73. ISSN: 09596526. URL: http://linkinghub.elsevier.com/retrieve/pii/S095965261200515X.

[18] Mohammed Barkindo. *The Clean Development Mechanism: Is it meeting the expectations?* [online] Accessed: 2017-11-23. 2006. URL: http://www.opec.org/opec_web/en/990.htm.

[19] news24. *Heat on 'climate chancellor' Merkel over coal and cars*. [online] Accessed: 2017-11-23. 2017. URL: https://www.news24.com/Green/News/heat-on-climate-chancellor-merkel-over-coal-and-cars-20171114.

[20] UN. *Sustainable Development Goals*. [Online] Accessed: 2017-05-03. 2015. URL: http://www.un.org/sustainabledevelopment/sustainable-development-goals/.

[21] Siseko Njobeni. *Eskom wants to mothball five plants*. [Online] Accessed: 2017-05-18. 2017. URL: http://www.iol.co.za/business-report/energy/eskom-wants-to-mothball-five-plants-8180946.

[22] Eskom. *Transmission Development Plan 2016-2025*. [Online] Accessed: 2017-05-18. 2015. URL: http://www.eskom.co.za/Whatweredoing/TransmissionDevelopmentPlan/Documents/TransDevPlan2016-2025Brochure.pdf.

[23] Shezi. *Loadshedding to run from 8am to 10pm today*. [online] Accessed: 2017-05-01. 2015. URL: http://www.htxt.co.za/2015/05/21/loadshedding-to-run-from-8am-to-10pm-today/.

[24] Marcel Kohler. “Differential electricity pricing and energy efficiency in South Africa”. In: *Energy* 64 (2014), pp. 524–532. DOI: 10.1016/j.energy.2013.11.047. URL: http://linkinghub.elsevier.com/retrieve/pii/S0360544213010177.

[25] Andrew Marquard et al. *South Africa’s Electrification Programme an overview and assessment.* 2007. URL: https://www.gsb.uct.ac.za/files/SAElectrificationworkingpaperfinal.pdf.

[26] STATSSA. *General House Survey 2015: Statistical Release P0318.* Tech. rep. Pretoria: Statistics South Africa, 2015.

[27] GNESD. *South African Electrification Programme.* [Online] Accessed: 2017-10-15. 2018. URL: http://energy-access.gnesd.org/cases/22-south-african-electrification-programme.html.

[28] DOE. *Non Grid Electrification Policy Guidelines.* [online] Accessed: 2017-10-01. 2012. URL: http://www.energy.gov.za/files/policies/electrification/NON%20GRID%20ELECTRIFICATION%20POLICY%202012.13.pdf.

[29] Kirsten Jenkins et al. “Energy justice: A conceptual review”. en. In: *Energy Research & Social Science* 11 (Jan. 2016), pp. 174–182. ISSN: 22146296. DOI: 10.1016/j.erss.2015.10.004. URL: http://linkinghub.elsevier.com/retrieve/pii/S2214629615300669 (visited on 10/15/2017).

[30] Mine Islar, Sara Brogaard, and Martin Lemberg-Pedersen. “Feasibility of energy justice: Exploring national and local efforts for energy development in Nepal”. In: *Energy Policy* 105.Supplement C (2017), pp. 668 –676. ISSN: 0301-4215. DOI: https://doi.org/10.1016/j.enpol.2017.03.004. URL: http://www.sciencedirect.com/science/article/pii/S0301421517301453.

[31] Benjamin K. Sovacool et al. “New frontiers and conceptual frameworks for energy justice”. en. In: *Energy Policy* 105 (June 2017), pp. 677–691. ISSN: 03014215. DOI: 10.1016/j.enpol.2017.03.005. URL: http://linkinghub.elsevier.com/retrieve/pii/S0301421517301441 (visited on 10/15/2017).

[32] Benjamin K. Sovacool and Michael H. Dworkin. “Energy justice: Conceptual insights and practical applications”. en. In: *Applied Energy* 142 (Mar. 2015), pp. 435–444. ISSN: 03062619. DOI: 10.1016/j.apenergy.2015.01.002. URL: http://linkinghub.elsevier.com/retrieve/pii/S0306261915000082 (visited on 10/15/2017).

[33] Stefan Bouzarovski and Neil Simcock. “Spatializing energy justice”. In: *Energy Policy* 107.Supplement C (2017), pp. 640 –648. ISSN: 0301-4215. DOI: https://doi.org/10.1016/j.enpol.2017.03.064. URL: http://www.sciencedirect.com/science/article/pii/S0301421517302185.

[34] Raphael J. Heffron, Darren McCauley, and Benjamin K. Sovacool. “Resolving society’s energy trilemma through the Energy Justice Metric”. en. In: *Energy Policy* 87 (Dec. 2015), pp. 168–176. ISSN: 03014215. DOI: 10.1016/j.enpol.2015.08.033. URL: http://linkinghub.elsevier.com/retrieve/pii/S030142151530077X (visited on 10/15/2017).

[35] Komali Yenneti and Rosie Day. "Distributional justice in solar energy implementation in India: The case of Charanka solar park". In: *Journal of Rural Studies* 46.Supplement C (2016), pp. 35 –46. ISSN: 0743-0167. DOI: https://doi.org/10.1016/j.jrurstud.2016.05.009. URL: http://www.sciencedirect.com/science/article/pii/S0743016716300791.

[36] Benjamin K. Sovacool et al. "Vulnerability and resistance in the United Kingdom's smart meter transition". In: *Energy Policy* 109.Supplement C (2017), pp. 767 –781. ISSN: 0301-4215. DOI: https://doi.org/10.1016/j.enpol.2017.07.037. URL: http://www.sciencedirect.com/science/article/pii/S0301421517304688.

[37] Tania Urmee and Anisuzzaman Md. "Social, cultural and political dimensions of off-grid renewable energy programs in developing countries". In: *Renewable Energy* 93.Supplement C (2016), pp. 159 –167. ISSN: 0960-1481. DOI: https://doi.org/10.1016/j.renene.2016.02.040. URL: http://www.sciencedirect.com/science/article/pii/S0960148116301410.

[38] Chukwuma Leonard Azimoh et al. "Replicability and scalability of mini-grid solution to rural electrification programs in sub-Saharan Africa". en. In: *Renewable Energy* 106 (June 2017), pp. 222–231. ISSN: 09601481. DOI: 10.1016/j.renene.2017.01.017. URL: http://linkinghub.elsevier.com/retrieve/pii/S0960148117300174 (visited on 10/15/2017).

[39] STATSSA. *Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2015.* Tech. rep. Pretoria: Statistics South Africa, 2017.

[40] L. Roberto Valer et al. "Issues in PV systems applied to rural electrification in Brazil". en. In: *Renewable and Sustainable Energy Reviews* 78 (Oct. 2017), pp. 1033–1043. ISSN: 13640321. DOI: 10.1016/j.rser.2017.05.016. URL: http://linkinghub.elsevier.com/retrieve/pii/S1364032117306512 (visited on 10/15/2017).

[41] Benjamin K. Sovacool et al. "What moves and works: Broadening the consideration of energy poverty". en. In: *Energy Policy* 42 (Mar. 2012), pp. 715–719. ISSN: 03014215. DOI: 10.1016/j.enpol.2011.12.007. URL: http://linkinghub.elsevier.com/retrieve/pii/S0301421511009992 (visited on 10/15/2017).

[42] EU. *Climate Action.* [online] Accessed: 2017-11-23. 2017. URL: https://ec.europa.eu/clima/policies/international/negotiations/paris_en.

[43] IPCC. *International agreements (climate change agreements and other arrangements).* [online] Accessed: 2017-11-23. 2007. URL: https://www.ipcc.ch/publications_and_data/ar4/wg3/en/tssts-ts-13-4-international-agreements.html.

[44] EIA. *Breakdown of Electricity Generation by Energy Source.* [online] Accessed: 2017-11-23. 2017. URL: www.tsp-data-portal.org.

[45] DW. *Germany's Greens want Merkel to shut coal power plants in any coalition.* [online] Accessed: 2017-11-23. 2017. URL: http://www.dw.com/en/germanys-greens-want-merkel-to-shut-coal-power-plants-in-any-coalition/a-40450968.

[46] Philip Oltermann. *German coalition talks collapse after deadlock on migration and energy*. [online] Accessed: 2017-11-23. 2017. URL: https://www.theguardian.com/world/2017/nov/19/german-coalition-talks-close-to-collapse-angela-merkel.

[47] Chika Amanze-Nwachuku and Obinna Chima. *Adeosun Decries Frustration of Nigerias Coal-to-Power Projects*. [Online] Accessed: 2017-11-22. 2016. URL: https://www.thisdaylive.com/index.php/2016/10/06/adeosun-decries-frustration-of-nigerias-coal-to-power-projects/.

[48] Suzanne Goldenberg. *World Bank's $3.75bn coal plant loan defies environment criticism*. [online] Accessed: 2017-11-23. 2010. URL: https://www.theguardian.com/business/2010/apr/09/world-bank-criticised-over-power-station.

[49] Tom DiChristopher. *Trump is still pulling out of Paris Agreement, despite chatter of a reversal, experts say*. [online] Accessed: 2017-11-23. 2017. URL: https://www.cnbc.com/2017/09/19/trump-is-not-reversing-on-paris-agreement-heres-why.html.

[50] K. Kaygusuz. "Energy Services and Energy Poverty for Rural Regions". en. In: *Energy Sources, Part B: Economics, Planning, and Policy* 5.4 (Sept. 2010), pp. 424–433. ISSN: 1556-7249, 1556-7257. DOI: 10.1080/15567240802458716. URL: http://www.tandfonline.com/doi/abs/10.1080/15567240802458716 (visited on 10/15/2017).

[51] Chukwuma Leonard Azimoh et al. "Electricity for development: Mini-grid solution for rural electrification in South Africa". In: *Energy Conversion and Management* 110 (2016), pp. 268 –277. ISSN: 0196-8904. DOI: https://doi.org/10.1016/j.enconman.2015.12.015. URL: http://www.sciencedirect.com/science/article/pii/S0196890415011152.

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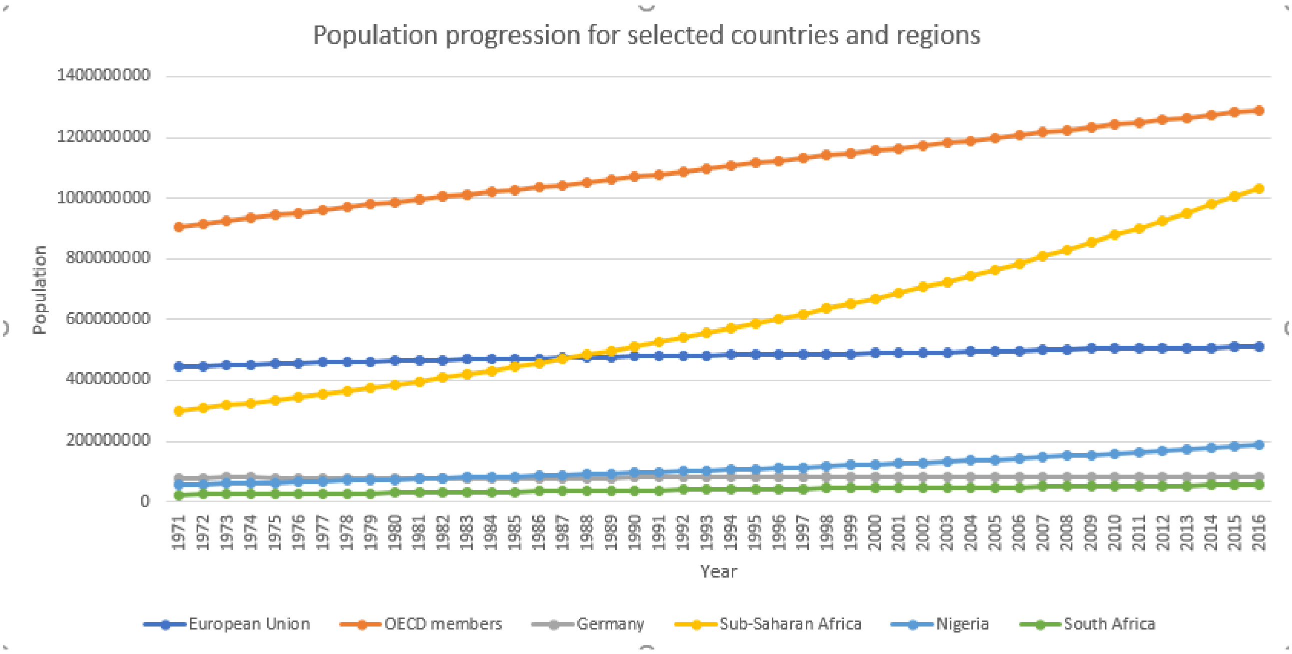


Figure 1: Population progression for selected countries and regions Bank 2017.

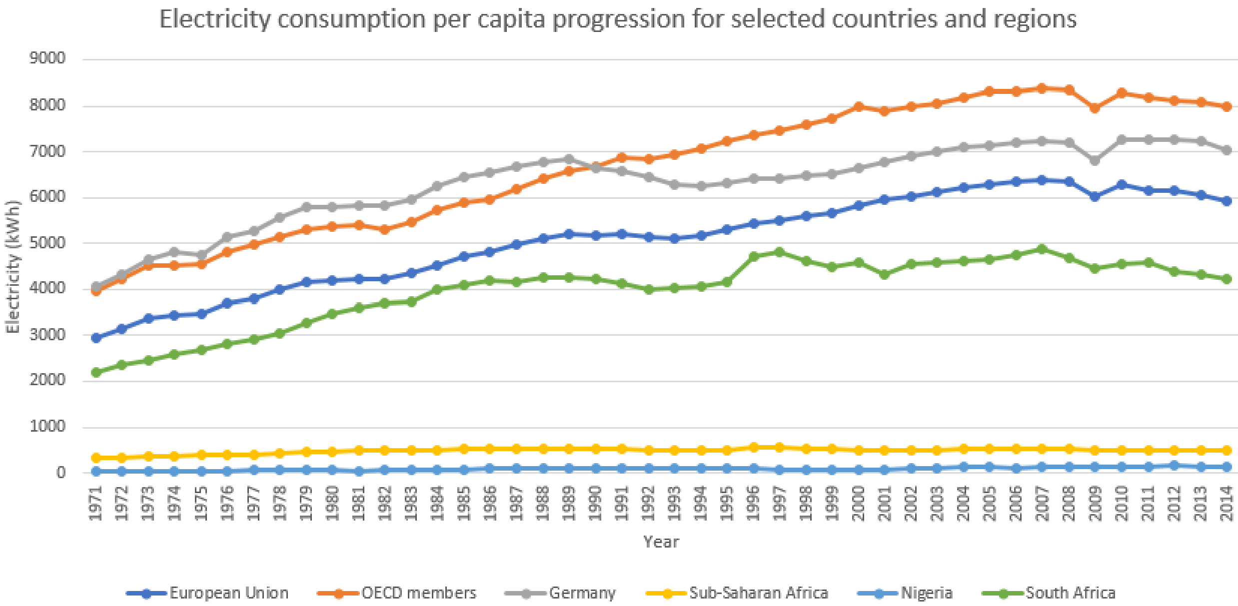


Figure 2: Electricity consumption (kWh/capita) progression for selected countries and regions Bank 2017.

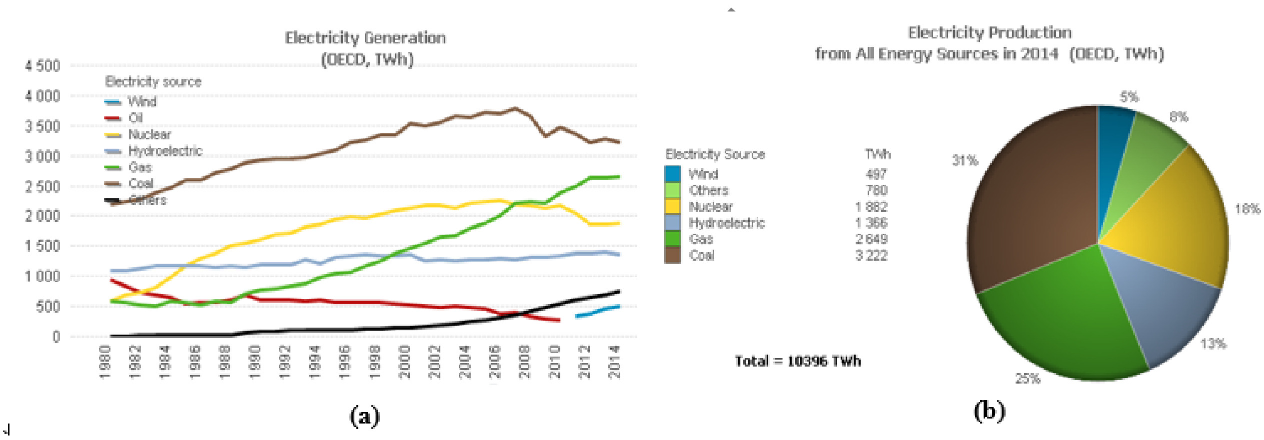
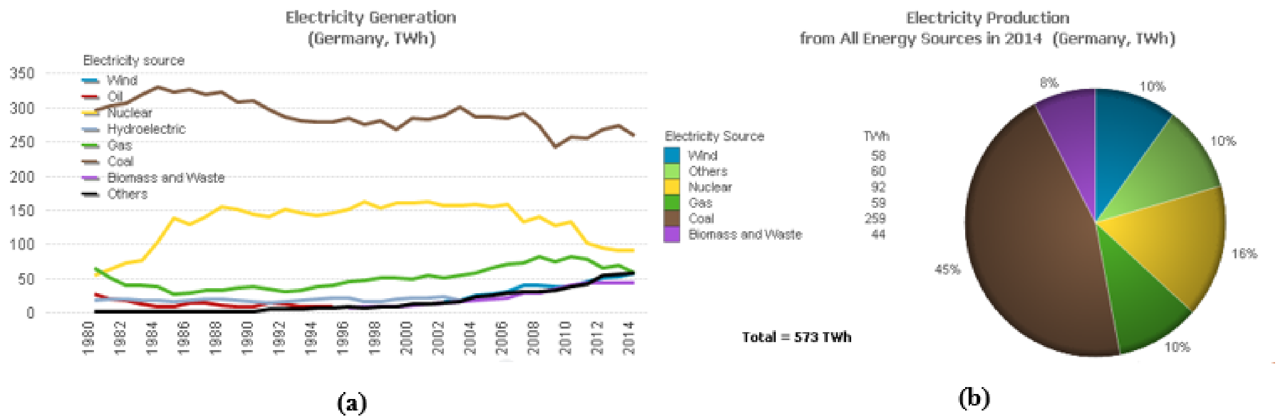


Figure 3: Electricity generation mix for OECD (a) from 1980 - 2014 and (b) for 2014 EIA 2017.



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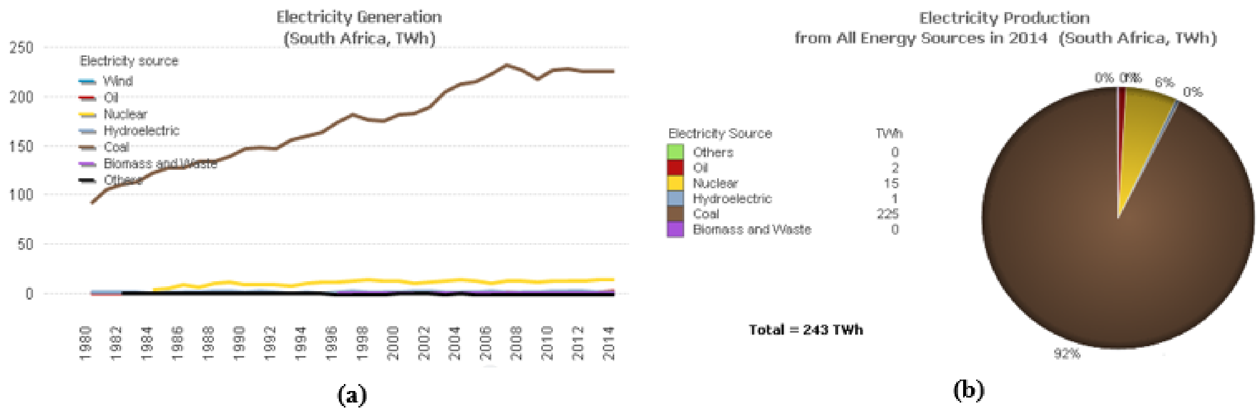

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