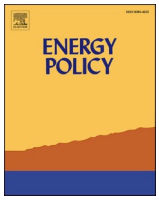
Energy Policy 198 (2025) 114506

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol



The false optimism of electrification: why universal electricity access has not delivered urban energy transformation in South Africa

Charlotte Lemanski [a,*], Anika Nasra Haque [b], Jiska de Groot [c], Natalie McAskill [d]

[a] Department of Geography, University of Cambridge, Downing Site, Cambridge, CB2 3EN, UK. and Department of Political Science, University of the Western Cape, Modderdam Road, Bellville, 7535, South Africa
[b] Department of Environment and Geography, University of York, YO10 5NG, UK
[c] African Climate and Development Initiative, University of Cape Town, Rondebosch 7700, South Africa
[d] Project 90 by 2030, Office 205, 16 Beach Road, Muizenberg, Cape Town, 7945, South Africa

ARTICLE INFO

Keywords:
Universal energy access
Electrification
Energy policy
Urban
Cape town
South Africa

ABSTRACT

Universal access to energy is a global priority, increasingly delivered through grid-tied and off-grid infrastructure. However, energy policies frequently conflate universal access with extending and subsidising networked electricity, resulting in technology-dominated approaches. Rapid urbanisation in the global south has outstripped infrastructure capacity, where urban dwellers' access to affordable, reliable, and sustainable forms of energy are precarious. This failure to reflect human needs and societal expectations alongside technical considerations is threatening the sustainability of urban energy transitions. This paper draws from qualitative data with low-income urban dwellers and municipal policymakers to critically examine South Africa's energy access policies. We demonstrate how prioritising 'electricity for all' via grid connections fails to deliver universal access to affordable energy. First, the state's emphasis on extending and subsidising networked electricity prioritises proximity to grid connections rather than access to energy services, and permanently excludes households living in un-serviceable structures/settlements. Second, limited community participation produces a policy that ignores low-income households' urban practices and creates perverse incentives to distort energy consumption. We argue that delivering an urban energy transition that is economically feasible, locally appropriate and socially desirable requires policy expansion *beyond* physical delivery, working with targeted communities on policy development, knowledge exchange, and capacity building.

1. Introduction: the goal of universal access to energy

Universal access to energy is high on the agenda of policymakers worldwide, ingrained in Sustainable Development Goal 7 (SDG7), to deliver access to affordable, reliable, sustainable and modern energy. Despite recent acknowledgement of the importance of alternative energy solutions, SDG7 implementation in the global south overwhelmingly prioritises extending electricity grids. This is important given that 774 million people, 10% of global population, have no electricity access, with sub-Saharan Africa's (SSA) low electrification rates worsening since Covid-19 (IEA, 2022). However, preoccupation with achieving electrification targets, rather than recognising the needs of the world's most energy-poor communities, ultimately undermines efforts to close the energy access gap. Using the example of South Africa, this paper reveals how high electrification rates [86.5% of South Africa's population in 2022 (World Bank, 2023),] mask everyday realities of severely restricted access due to limitations in policy conception and implementation.

Lack of access to electricity is predominantly conceived as a physical-technical problem requiring delivery of (largely networked) physical infrastructure. However, despite significant global investment in physical electricity delivery, access inequalities remain remarkably persistent. We argue that this is due to a complex mismatch between delivering electricity *connections* and widening *access* to energy. Because electrification data conflate physical proximity to grid connections with access to energy, energy policies erroneously assume that electricity grid expansion will widen energy access. This paper demonstrates how this assumption fails to capture the capacity of households living in

* Corresponding author.
E-mail addresses: cll52@cam.ac.uk (C. Lemanski), anika.haque@york.ac.uk (A.N. Haque), jiska.degroot@uct.ac.za (J. de Groot), nataliem@90by2030.org.za (N. McAskill).

https://doi.org/10.1016/j.enpol.2025.114506
Received 23 September 2024; Received in revised form 10 January 2025; Accepted 16 January 2025
Available online 24 January 2025

proximity to electricity connections to access energy services. Energy services, in this context, refers to the "benefits that energy carriers produce for human well-being" (Modi et al., 2005:9) that extend well beyond grid connections per se.

While urban studies scholarship conceives infrastructure as both technical-physical services *and* socio-political processes (Graham and Marvin, 2001), global policy-agendas overwhelmingly promote physical delivery targets that overlook the socio-political contexts of energy users and policymakers (Caprotti et al., 2020). This is partly because policy stakeholders are caught in the 'rat race' of providing electricity connections to achieve targets, exacerbated by weak understanding of local needs and access constraints (often because energy-poor communities are excluded from policy development). Framing these dual challenges as limits of policy conceptualisation and implementation, respectively, the paper examines why a universal electrification policy has not brought energy transformation. South Africa is a pertinent case because despite high 'formal' electrification rates (86.5%), many South Africans cannot access energy services.

This paper reviews literature on energy access and policies in the global south and South Africa specifically, followed by the qualitative methodology. Interviews with low-income residents and municipal policymakers reveal how South Africa's reliance on delivering energy access via networked electricity permanently excludes urban dwellers living in conditions where grid connections are technologically and administratively unfeasible. Furthermore, because energy-poor communities are omitted from policy development, a high proportion of low-income households with grid connections lack sufficient knowledge to access the energy subsidies that are allegedly targeted at them. The paper concludes that a technology-centric policy focused on the physical delivery of subsidised electricity may meet numerical electrification targets but overlooks human needs, practices, and aspirations, and ultimately fails to secure either universal access or urban energy transformation.

2. Energy in the global south

2.1. Energy access and services: targets and measures

Since the SDGs, the meaning of 'access' to energy has been extensively debated (Bazilian and Pielke, 2013; Mulugetta et al., 2019). Bazilian and Pielke (2013), for example, question 'energy access' as a concept, arguing that the term lacks a proactive ambition, implying that 'access' has a finite end, and that those who currently lack access to electricity require modest amounts in the future. Others argue that "even at low levels of provision, energy access is transformative" (Bisaga and Parikh, 2018:highlights). These apparently opposing approaches are not necessarily mutually exclusive, as they indicate the importance of ensuring that targets and measures for energy access are unambiguous.

Recognising that electricity access is not a binary between 'connected/not connected', the World Bank's Energy Sector Management Assistance Program (ESMAP) introduced the Multi-Tier Framework (MTF) in 2015. Its five tiers each represent progressively higher user demands regarding power delivery and available hours, and among higher tiers also reliability, quality, affordability, legality, and safety (Bhatia and Angelou, 2015) (See Table 1).

The MTF has been fundamental in challenging binary measures of electricity access by recognising the broad spectrum of energy services that electricity provides. However, a limitation of the framework is that it unwittingly 'rewards' governments for achieving low tier connections. This perpetuates a 'tick-box' approach to energy delivery and legitimises policies targeting Tier 1–2 grid-connections that have limited potential to secure energy transformation. Although there is no evidence of MTF application in South Africa, in Ethiopia the MTF was used in 2019 to set national electrification targets of 35% at Tier 1–2 and 65% at Tiers 3–5 by 2025, while Rwanda's rural electrification strategy access target is 35–40% at Tiers 1–2 (World Bank, 2020). To illustrate, a Tier 1 connection provides a minimum of 3W that delivers 4–8 daily hours (including one evening hour) to power task lighting and phone charging (i.e. no appliances for cooking, food storage, heating, washing and other daily essentials). In comparison, Tier 3 access is available for 8+ daily hours at a minimum of 200W, allowing for lighting, charging, television use, plus medium-powered appliances. Thus, while Tier 1 does deliver electricity and is therefore included in data on 'energy access', given its weak availability and capacity, its transformative potential is low.

Nonetheless, the MTF remains essential in demonstrating how different tiers of energy capacity and availability, as well as quality, affordability, health and safety and legality, contribute to access. It also indicates the potential of distributed energy-supply systems in

Table 1
Multi-Tier Framework – measuring household electricity consumption and supply (adapted from Bhatia and Angelou, 2015).

			Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Tier criteria			None	Task lighting and phone charging	General lighting, phone charging and television and fan	Tier 2 + any medium-power appliances	Tier 3 + any high-power appliances	Tier 4 + any very high-power appliances
Attributes	Consumption levels	Annual (KWhs)		≥4.5	≥73	≥365	≥1250	≥3000
		Daily (Whs)		≥12	≥200	≥1000	≥3425	≥8219
	Peak capacity	Power Capacity ratings (W or daily Wh)	–	Min 3W Min 12Wh	Min 50W Min 200 Wh	Min 200W Min 1.0KWh	Min 800W Min 3.4KWh	Min 2 KW Min 8.2KWh
		OR services	–	Lighting of 1000 lumen hrs/day	Electrical lighting, air circulation, television and phone charging possible			
	Availability (duration)	Hours per day		Min 4 Hrs	Min 4 Hrs	Min 8 Hrs	Min 16 Hrs	Min 23 Hrs
		Hours per eve		Min 1 Hr	Min 2 Hrs	Min 3 Hrs	Min 4 Hrs	Min 4 Hrs
	Reliability						Max 14 Disruptions per week	Max 3 disruptions per week of total duration <2hrs
	Quality						Voltage problems do not affect the use of desired appliances	
	Affordability					Cost of a standard consumption package of 365KWh/year <5% of household income		
	Legality						Bill is paid to the utility, pre-paid card seller or authorised representative	
	Health and safety						Absence of past accidents and perception of high risk in future	

contributing to energy access (Odarno et al., 2016). This is important because in many countries, despite electricity policies prioritising the 'modern infrastructure ideal' of uniform energy networks, urban dwellers' access to, and consumption of, energy infrastructure is incremental and heterogenous (Graham and Marvin, 2001; Lawhon et al., 2018). This is concurrent with growing evidence that, dependent on context, mini-/microgrids and stand-alone systems can be more effective and sustainable in providing electricity than networked bulk infrastructure, often at a much lower cost per connection (Phillips et al., 2020; ESMAP, 2022; IEA, 2022). In practice, those living in poor communities frequently self-construct and/or collaboratively organise energy systems to meet their needs in ways that straddle networked and non-networked sources, public and private providers (Silver, 2014; Rateau and Jaglin, 2022). For example, paying technicians to install clandestine connections to the electricity grid and/or bypassing pre-paid meters, buying solar lamps and batteries, generators, wind turbines, alongside using wood, charcoal and paraffin for cooking and heating (Dipura et al., 2024). Through this iterative process, global south consumers translate and adapt technology and legal frameworks (that largely derive from global north contexts) to fit local needs and norms (Monstadt and Schramm, 2017). These hybrid energy strategies are frequently deployed by households with formal grid connections, largely to supplement portions of electricity purchased legally from the network (Rateau and Jaglin, 2022). Consequently, aggregate data indicating that a proportion of properties in a settlement/city have electricity cables installed provides only a partial account of households' energy access strategies. By highlighting this tension, between data on (grid) energy connections and everyday (grid, non-grid and hybrid) energy strategies, we demonstrate the need for policy shifts away from binaries, towards recognising the interrelation between formal and informal energy infrastructure, and the co-existence of grid and off-grid modalities. This requires a re-examination of dominant policy perspectives that conceive off-grid as informal, inadequate, and temporary, whilst also recognising the lived realities of precarity and insecurity within these spaces (Caprotti et al., 2022).

2.2. What distorts energy access?

Having demonstrated that binary connected/not-connected energy access statistics provide simplistic narratives unable to capture access to reliable, affordable, clean and modern services (SE4ALL, 2015); this brief discussion considers access in terms of the availability and capacity of infrastructure (including political constraints on investment), and socio-economic context.

Counting low levels (Tiers 1–2) of energy access within data on universal access can foster projections of future energy consumption that underestimate the energy aspirations of communities and risks perpetuating (energy) poverty (Bazilian and Pielke, 2013; Mulugetta et al., 2019). Whilst recognising that lower-tier energy access is arguably preferable to no access, once electrification targets are met, there is potentially little incentive to invest in long-term infrastructure upgrades so that households and communities can progress to higher tiers. Consequently, policies prioritising the short-term objective of 100% electrification, without financial or infrastructural plans to transition households to higher tiers or engage in demand stimulation, risk abandoning 'electrified' households and communities to permanent energy poverty. To illustrate, Pérez-Arriaga et al. (2018) indicate that in most contexts there is no strategy to move consumers from lower to higher access tiers (grid-based or off-grid).

Similarly, a focus on simply connecting households to, say, the national grid, remains precarious if the electricity supply is unreliable or poor quality. To illustrate, if electricity supply is poor quality this constrains productive activity by households and enterprises, and if the connection is unreliable supplementary infrastructure is needed (e.g. a UPS, Solar PV systems, diesel generator or battery backup), increasing costs for those who can afford and restricting access for those who cannot.

Multiple socio-economic factors limit energy access beyond the physical delivery of infrastructure, including governance processes and access to knowledge (Haque et al., 2021a), the socio-cultural acceptance of technologies by end-users (Dumont et al., 2021; Haque et al., 2021b), and financial barriers (Bouzarovski and Petrova, 2015; Middlemiss et al., 2019). Energy poverty and energy vulnerability help explain why electricity connections do not necessarily bring energy access (Middlemiss et al., 2019; Bouzarovski and Petrova, 2015; Meyer et al., 2018; Sovacool, 2012; Pachauri and Rao, 2013), whereby energy poverty is a function of social circumstances, availability of infrastructure, and the broader political-financial climate (Boardman, 2010; Pachauri and Rao, 2013; Sovacool, 2012; Knox et al., 2017).

The above are important real-world factors to consider in the formulation and implementation of energy access policies that consider the needs and challenges of beneficiaries. The participation of communities and end-users is essential to this.

2.3. Community participation in (energy) policy

Energy transition discourses increasingly acknowledge the value of public engagement and participation in decision-making (Walker et al., 2007; Wahlund and Palm, 2022). Communities possess social capital and local knowledge (alongside energy assumptions and prejudices) that are crucial to securing energy transitions, with interventions lacking public participation frequently rejected by communities as unjust and inappropriate (Dumont et al., 2021; Haque et al., 2021b).

While the benefits and challenges of community participation are well-rehearsed within development agendas (Williams, 2004), there are specific energy-centric implications. First, weak participation in decision-making typically intersects with 'energy invisibility', whereby citizens are socially and psychologically detached from centralized energy systems, thus magnifying multiple exclusions from material and political rights and services (Ambrose, 2020). Second, participation in engagement processes can increase energy consciousness and literacy, potentially influencing energy behavioural change (Sovacool, 2014; Bull and Janda, 2018). This is particularly crucial for renewable energy projects, where social acceptance and community buy-in are essential to technology adoption and behavioural change (Haque et al., 2021b; Lemanski and Massey, 2023).

Global climate agendas promoting energy governance transitions are widely criticised for relying on political-technocratic processes that lack meaningful public participation (Devine-Wright, 2007; Chilvers and Longhurst, 2016). Recently, discourses of 'energy democracy' and 'energy citizenship' have emerged to redress this gap, emphasizing the unequal power dynamics of energy production, and urging the energy transition to 'humanize' (Stephens, 2019; Szulecki and Overland, 2020). Energy democracy scholars argue that inclusive active public engagement will strengthen the legitimacy of energy policies, while energy citizenship debates emphasise object-oriented (e.g. solar panel, electric vehicle) and individualized (e.g. reduced flying) forms of public action to tackle climate change (Ryghaug et al., 2018; Lennon et al., 2020). However, individualized materialistic approaches to energy citizenship potentially undermine the collective nature of energy democracy by ignoring inequalities in citizens' capacity to participate and change behaviour (Wahlund and Palm, 2022). Consequently, 'just' energy transitions require shifting beyond technology-driven strategies and high-level political agendas towards recognising the validity of humans' voices, relationships, and collective goals (Lemanski and Massey, 2023).

3. South Africa: electrification in the context of an energy crisis

3.1. Energy access

South African citizens have a constitutional right to basic services, including electricity *regardless of location*, with municipalities

responsible for service delivery within their boundaries. The National Electrification Programme, launched in 1994, sought to achieve universal electricity access by extending large-scale grid connected bulk infrastructure to un(der-)serviced areas, including informal settlements (Essex and de Groot, 2019). The focus on national grid connection was driven by South Africa's access to cheap and plentiful coal reserves, with electricity generated and distributed through the centralised agency of Eskom. Hailed as a success and a model for energy access delivery in SSA, the number of households connected to electricity increased from 58% in 1996 to 86.5% in 2021 (DoE, 2018; World Bank, 2023) despite population growth and an energy crisis. Although this electrification drive has driven economic growth and improved living standards, a perverse outcome is the entrenchment of apartheid's extreme urban spatial inequality through bulk infrastructure delivery. And, with coal no longer cheap or abundant, inequalities in accessing affordable and reliable electricity remain embedded in the political economy of South Africa (Essex et al., 2023).

While the 1998 White Paper on Energy acknowledged that physical and affordable access are not synonymous- ("many people cannot afford to use electricity optimally, even if they have access to it")-, this guiding document did not address how to implement affordable energy access (RSA, 1998:30). Consequently, the 2008 National Energy Act (RSA, 2008) contains the word affordable only twice, and the 2003 Free Basic Electricity (FBE) and 2007 Free Basic Alternative Energy (FBAE) Policies were introduced to tick this affordability goal (see next sections). Regarding reliability, since 2007 South Africa has experienced an increasingly significant energy crisis, resulting in electricity tariffs rising more than sixfold (~653%)[1] in 14 years whilst inflation over the same period was 129% (Moolman, 2022). Rolling loadshedding (scheduled power cuts as Eskom cannot meet electricity demand) has escalated national electricity insecurity, with loadshedding in 2022-3 identified as the most frequent and severe ever recorded, disrupting 205 days pa at max. 12hrs/day blackout (Nassiep, 2022; CNN, 2023). Although loadshedding was suspended in March 2024 (replaced by load reduction),[2] nearly two decades of loadshedding have fundamentally changed the nation's energy landscape, including public expectations.

3.2. Free Basic Electricity policy

The African National Congress (ANC) 2000 election manifesto promised basic services to poor South Africans. For electricity, this led to the 2003 FBE policy, subsidising 50kWh[3] of electricity per month to 'indigent' grid-connected households, intended to fulfil basic energy needs of poor households for lighting, electronic media, ironing, and cooking.

Although FBE offers revolutionary potential to transform access to affordable electricity, it suffers multiple implementation limitations. First, the 50kWh allocation is insufficient to meet household needs (e.g. an average fridge consumes ~50kWh per month), who realistically require 250-420kWh per month (Ledger, 2021; Ledger and Rampedi, 2022; Essex et al., 2023). The FBE policy justifies this small allowance because: "*households that are 'poor' generally have a low demand for electricity*" (Ledger, 2021:16). As Ledger (Ibid.) notes, this is an outrageous explanation for setting such a low limit, "analogous to using data revealing that the poorest households consume very small amounts of nutritious food as evidence that they have a low demand for nutritious food". Arguably, for energy access to bring opportunities for socio-economic transformation, low-income households require affordable access to *more* energy than currently consumed (Ibid.). However, while Ledger and Rampedi (2022) propose an energy subsidy of ~350kWh pcm, it is important to recognise that access to greater amounts of electricity per se is insufficient to propel households out of poverty, and must be combined with opportunities for productive use of electricity (PUE) to raise incomes at the household scale (Aarakit et al., 2024).

Second, FBE-eligible households are subject to multiple restrictions, including losing rights to FBE for payment defaults or consuming excess electricity[4]; paying the standard domestic tariff if more than 50kWh pcm are used; and household supply typically being limited to 10 amps[5] (Essex et al., 2023). These are significant limitations given that one plot in a low-income settlement typically accommodates multiple households sharing one electricity meter/connection (and thereby one FBE subsidy), effectively punishing large/shared occupancy households for high consumption alongside restricting certain appliances (Lemanski, 2009, 2020; Ledger, 2021). Third, eligibility for indigent status is managed by individual municipalities, with most restricting access to homeowners with an income below ZAR3500 per month (Tissington, 2013).[6] A crucial flaw is that tenants, who may not have exclusive access to an electricity meter/bill, are largely excluded (each meter can accept one FBE voucher per month). Furthermore, because indigent household registration (a precursor to claiming FBE) is restricted to municipal account-holders and requires extensive paperwork,[7] alongside annual re-application, the FBE effectively excludes the poorest and most vulnerable (Wafer et al., 2008; Ledger, 2021).

Fourth, even when households successfully navigate indigent registration, the vast majority do not receive municipal FBE payments. According to Ledger's (2021:31) detailed analysis, from 2014 to 2020 roughly 68–79% of registered indigent households did *not* receive the FBE (6–8 million households pa), despite municipalities receiving subsidy funds for these households from National Treasury. This is related to the complexities of claiming the FBE, lack of awareness among qualifying households on accessing FBE, alongside regulations allowing municipalities to retain unclaimed subsidies for general revenue (Ledger, 2021). Further, the FBE access challenges raised in this section are exacerbated by the absence of an effective oversight mechanism to monitor the implementation of affordable access across tiers of government.

3.3. Alternative energy policies

South Africa's emphasis on extending networked electricity to achieve universal access is increasingly accompanied by recognition that alternative sources, technologies, and distribution models are also required. Initially driven by acknowledgement that not all households live in structures and/or locations that can be grid-connected, loadshedding has forced policy recognition that coal-powered networked electricity cannot meet demand. However, while the 2007 Free Basic Alternative Energy (FBAE) Policy instructs municipalities to provide off-

[1] This figure excludes Eskom's early-2023 19% increase.

[2] Load reduction cuts electricity to areas where consumption is high but payment is low during peak consumption times.

[3] 18 municipalities top this up. For example, the City of Cape Town offers two "Lifeline" tariffs: Block A (60kWh FBE) and Block B (25 kWh FBE) (CoCT, 2017).

[4] Illogically, the City of Cape Town [CoCT, 2021:46] recognises 250kWh per month as a "minimally sufficient household energy supply", and yet indigent households must consume less than 250kWh per month to retain eligibility for maximum Free Basic Electricity units.

[5] The City of Cape Town has specific FBE Homelight tariffs allowing 20 or 60 amps (CoCT, 2021).

[6] For example, the City of Cape Town has criteria for both household income (below ZAR3500pcm) and property value (below ZAR300,000) (Wafer et al., 2008).

[7] Indigent registration requires submitting a form with ward councillor signature, ID document, proof of residence/property ownership, recent municipal bill, proof of income/unemployment, and proof of social grants [Ledger, 2021:29].

grid energy sources[8] to indigent households without grid electricity, adoption is exceptionally low. For example, only 47 of South Africa's 257 municipalities subsidise at least one off-grid energy source to ~180,399 indigent households[9] (0.3% of national population) (StatsSA, 2023). It is unclear why FBAE take-up is so low, although poor awareness is compounded by weak municipal leadership or financial capacity (Masuku, 2024).

More recently, motivated by loadshedding, Eskom's near-collapse, and global decarbonisation targets, national and municipal governments have rapidly released a suite of policies subsidising the private renewable (largely solar) energy sector. For example, the 2011 REIPPPP[10] incentivises private firms to sell renewable electricity to national and municipal grids (Lemanski, 2024). For private households, the 2023 budget introduced a 25% tax rebate for solar photovoltaic panels, whilst Cape Town households can now sell surplus power generated from small-scale renewable electricity to the grid. However, while these alternative energy policies potentially deliver sustainable and reliable energy, they overwhelmingly target businesses and middle/high-income households, while the majority population cannot afford solar energy.

These two examples – an alternative energy policy for the poor that is rarely implemented, alongside significant state investment in renewable energy subsidies for the wealthy[11] – indicate that extending and subsidising grid-connected electricity remains the dominant state agenda for South Africa's low-income majority.

4. Cape Town: grounded case studies

This paper draws from qualitative data collected in two low-income urban settlements in Cape Town during 2019–2020: one township (Nyanga) and one informal settlement (Hillview). These are complemented by qualitative data collected by Project90by2030 (P90, a Cape Town non-profit organization working towards climate and social justice), across multiple low-income settlements during November 2021.

Nyanga, one of Cape Town's oldest and poorest townships,[12] population ~57996 (Haque et al., 2021b; Masiya et al., 2019), is characterised by low-cost brick-built housing structures and informal backyard shacks constructed with corrugated zinc and wood. This diverse housing typifies South Africa's contemporary townships, where low-income fully-serviced residential areas (e.g. roads, streetlights, electricity) have experienced rapid post-apartheid demographic expansion without sufficient infrastructure investment. Consequently, many Nyanga residents live in informal structures in the yards of formal houses, with restricted/no access to the settlement's networked services, including electricity. Resident-led protests at poor service delivery have intensified in frequency and violence since 2011 (Masiya et al., 2019). In contrast, Hillview is a small (~660 households) informal settlement[13] formed in 2005 when backyard dwellers from a nearby township collectively invaded the land due to its proximity to schools and shops. Hillview comprises both temporary and semi-permanent 'shacks' (constructed from wood and zinc with no foundation) and infrastructure provision includes street-lights, communal standpipes and toilets, but no plot-based access to water and sanitation (see Figs. 1 and 2). Hillview received networked electricity with metered connections in all houses in 2016, but many households cannot afford electricity and energy knowledge is low (P90, 2017).

These settlements were selected to explore similarities and differences in electricity access within and between low-income communities. Data were collected by Anika Haque seeking to understand energy practices and knowledge via interviews with representative households, ward councillors, residents, local community leaders, relevant municipal officials, alongside focus groups with local communities and city officials, transect walks, and document analysis (Table 2). Thematic data analysis used inductive coding (primary themes such as energy access, affordability, governance, and secondary themes such as settlement and housing types), and discourse analysis.

These author-collected data are supplemented by qualitative data collected by P90 to understand household electricity challenges in eight low-income settlements in the Cape Flats (Eastridge, Khayelitsha Site C, Nyanga, Hanover Park, Wesbank, Woodlands, Bishop Lavis and Gugulethu). While these are formally-planned fully-serviced townships/post-apartheid housing projects, not all residents can access settlement services, and the data include occupants from two informal settlements on the fringe of townships (Khayelitsha, Nyanga). Data were collected and analysed by community activists who were trained and supported by P90 to randomly sample 'their' community using surveys, focus groups, interviews, and workshops (Table 3).

In drawing from these P90 data we not only extend the time period of the dataset to include the immediate post-lockdown period, but we also demonstrate our commitment as authors to collaborating with local NGOs as valid sites of expert knowledge production.[14] Inevitably these datasets are diverse, with the authors' and P90 data collected for scholarly and activist research purposes respectively.[15] While the paper primarily draws from author-collected data, we use P90 data[16] collected post-covid lockdowns to triangulate and update the primary data we collected immediately prior to lockdown. This diverse methodology, combining data collected and analysed by different groups for similar, but distinct, purposes across a timescale disrupted by covid travel and mixing restrictions, was challenging and unusual, but important to amplify and legitimise the voices and actions of community activists (who themselves live with precarious energy access) in conversation with traditional 'outsider' research methodologies. The combination of these two datasets also represents an important slice of time (pre- and post-covid lockdowns) to understand change and consistency in energy access for marginalised communities (e.g. attitudes to renewable energy change markedly – see section 5.2) and are updated by reference to more recent energy policies and scholarly reports (e.g. lack of knowledge about energy subsidies identified in both data sets – see section 6.3 - are confirmed by Ledger, 2021).

5. Policy conceptualisation: electricity is (not) only the grid

5.1. State perspective: electricity grid as the primary low-income option

South Africa's official municipal policy is to electrify everybody/

[8] Energy sources included in the policy are unsustainable and/or hazardous (paraffin, liquid petroleum gas, (bio) ethanol gel, and coal).

[9] The actual number of municipalities and households participating in FBAE are likely to be much lower. This is because StatsSA record each FBAE source (solar, fire gel, paraffin, other) separately and therefore municipalities and households who deliver/receive more than one type of alternative energy will be counted multiple times.

[10] Renewable Energy Independent Power Producers Procurement Programme.

[11] There is a tiny subsidy (ZAR48 pcm, aprox. GBP2) for rural households using solar energy (https://www.energy.gov.za/files/faqs/faqs_freebasic.html).

[12] Formal townships were established during the apartheid era to accommodate non-white people in segregated spaces, often on the urban periphery. Townships are often densely populated and poorly serviced.

[13] Informal settlements are residential areas that are not approved by authorities for residential development or inhabitancy, and typically host high levels of deprivation and poverty, with patchy access to infrastructure and services (Boardman, 2010).

[14] All three authors have collaborated with P90 on research grants over the past decade, and Jiska de Groot 3 serves on the P90 Board of Trustees.

[15] Consequently, while the authors' data collection has institutional ethical approval, the P90 data do not (and are therefore used as indicative rather than substantive).

[16] This is always indicated in the text as "P90 data".

Fig. 1. (L–R) Hillview and Nyanga (photos taken by Anika Haque, October 2019).

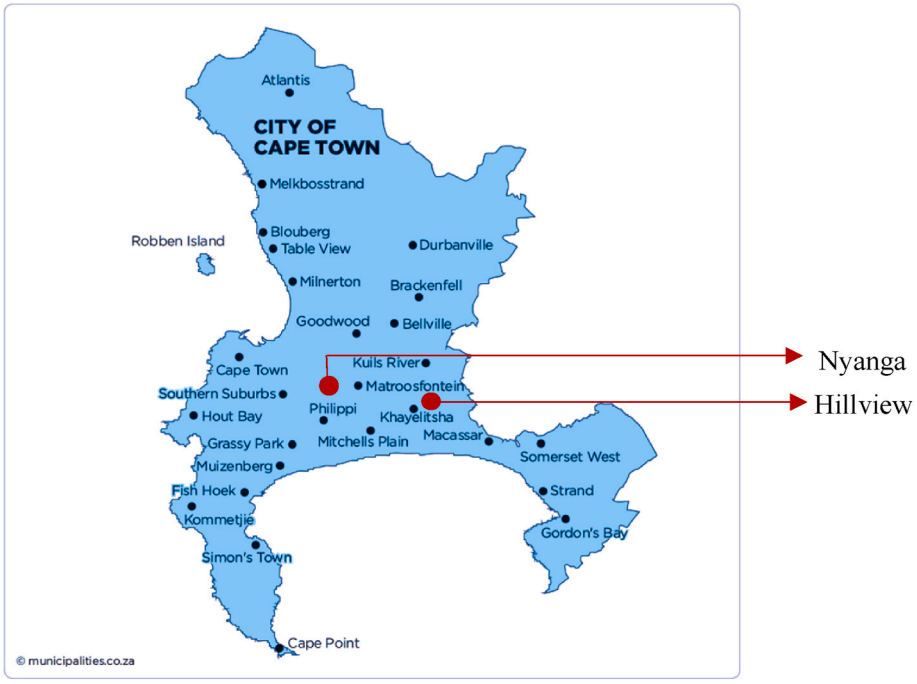


Fig. 2. Location of Nyanga and Hillview (created by Anika Haque).

Table 2
2019–2020 Data Collection methods (by authors).

Methods	Respondents	No	Purpose
Key Informant Interview	Area and Street committee leaders (Nyanga)	4	To explore community-level structures for accessing electricity and community engagement.
	Community leaders (Hillview)	1	
	Households	6 (Nyanga) 7 (Hillview)	To understand households' access to, and consumption of, energy.
	Ward councillors, sub councillors	3	To understand institutional settings, alongside how energy is planned, delivered and financed.
	NGO officials	7	
	Municipal officials	6	
Focus Group Discussion	Local community	1 (Nyanga): with 10 participants 1 (Hillview) with 9 participants	To understand communal perspectives on provision, access, expectations and consumption of energy.
	Municipal officials	1: with 4 participants	To understand the regulatory environment for basic service delivery.
Transect walk	Nyanga, Hillview	Multiple	To explore energy practices and the physical infrastructure provision, alongside engaging in informal conversation with residents.
Document analysis	Policy documents, project reports, media articles, community newsletters, existing research	Multiple	To position the study in wider policy and research fields, and to triangulate primary data.

where feasible via grid connections. Whilst a laudable goal, there are two significant limitations in conceiving energy access almost exclusively as synonymous with grid connections. First, proximity to a grid connection does not ensure access to energy. Despite claims that 98% of households in Cape Town are grid-connected (CoCT, 2021) compared to 86.5% across South Africa (World Bank, 2023), low-income households face challenges accessing reliable, affordable, and available electricity from these connections (see section 6.2). Consequently, the state's focus on delivering and measuring proximity to connections, indicates a narrow and exclusionary conceptualisation of energy access.

Second, not all urban dwellings and/or settlements can receive grid connections, as confirmed by a City of Cape Town Energy directorate

Table 3
2021 Data collection methods (by Project 90 by 2030).

Stage	Methods	Respondents	No	Purpose
01	**Informal Survey**	Settlement dwellers	Not recorded	To map energy challenges in each settlement
02	**Focus group discussion**	Community representatives	1, with 12 participants	To reflect on identified energy challenges
03	**Workshop**	Settlement dwellers	3 (16, 11, 10 participants at each workshop)	To share findings and discuss challenges in a group setting, and identify ways they can be addressed

official,

> *"All the areas in the city that is possible for electrification have already been electrified. Everything has been done, what could be done. Now there are areas which are not serviceable, that is a problem."* CO1,[17] 17/03/2020)

Approximately 20,000 households in Cape Town reside in non-serviceable settlements, and are therefore, potentially permanently, excluded from electrification (NO1, March 27, 2020).[18] Although municipalities are constitutionally obliged to provide electricity access to all residents, including informal settlement dwellers, this is waived in contexts where electricity provision is impractical and/or dangerous (DoE, 2011).[19] Informal settlements are classified according to likely (category 1), unlikely (2) and impossible (3) electrification (Ibid.). However, because electrification for category 1 is slow and complex, facing technical, legal, institutional, financial and cultural barriers, most informal settlements remain unelectrified, reliant on traditional fuels or dangerous illegal connections (SEA, 2012, 2014). Effectively therefore, residents occupying land deemed unserviceable lose their constitutional right to subsidised energy. Given the rapid growth of informal settlements across South Africa, the reliance on grid-expansion (to recognised properties) excludes a growing proportion of highly vulnerable households not only from their constitutional rights, but from the transformative potential of energy access.

This approach is confirmed by an NGO official reflecting that *"the situation in South Africa is that you have full electricity connection, or you have nothing"* (NO1, March 27, 2020). While this implies that the City's binary approach to electrification (i.e. settlement is grid/not-grid connected) produces a binary outcome (i.e. household has full-electricity/no-electricity), practice is more nuanced. While arguably there are legitimate safety reasons not to electrify *settlements* occupying hazardous land (e.g. due to flooding), there are also many un-serviced informal and/or backyard *dwellings* located in electrified settlements, where (informal) grid access is negotiated via personal relationships and financial transactions. Indeed, the City's recent Energy Report indicates that approximately "10,000 households in informal *dwellings* cannot be provided with electricity from the grid, [and] have no access to any energy subsidy" (CoCT, 2021; our emphasis). Households living in informal structures on the fringes of Khayelitsha and Nyanga townships are aware that they cannot receive grid connections because the municipality only services houses situated on council-registered plots (P90 survey data).[20] Consequently, despite living in, or adjacent to, a serviced settlement, these households access 'illegal' connections either via directly tapping the main box or via cables from grid-connected houses, both of which require payment (Khayelitsha residents indicate a ZAR300[21] connection fee, P90 data). These connections are not captured by state data on grid connections and are rarely conflict-free. In addition to being dangerous, numerous unplanned connections can exceed the area's grid capacity, causing electricity outages for everyone (Haque et al., 2021a). This can escalate tensions within communities, between legal and illegal users (Dipura et al., 2024).

This is a direct consequence of access to energy being entangled with land tenure and property ownership. Effectively, only low-income households with tenure rights (including upgraded informal settlements) can access electricity connections and FBE. Those renting backyard structures or informal dwellings within or on the fringes of serviced settlements are not only refused individual electricity boxes or subsidy access, instead remaining reliant on negotiating and paying for electricity from proximate grid-connected houses, but are completely overlooked by energy policy agendas. This is due to a lack of political will and financial capacity rather than technical limitations. A City official explained that the technical infrastructure exists to install separate electricity meters and subsidy accounts for backyard dwellers sharing a plot (and has been implemented for the minority of backyarders living on municipal-owned plots) but that: "*legally the backyarders are not supposed to get any services, there is no national policy around that*" (CO2, March 12, 2020). This is significant given that 8.8% of Cape Town's households live in a backyard dwelling (Western Cape, 2021), concentrated in low-income settlements. For example, 50% of Nyanga's population are either backyard dwellers or have a backyard on their property (P90, 2017). In effect, because the state prioritises grid connections for households living in recognised properties this ignores the needs and practices of those in other (e.g. backyard) dwellings. This narrow interpretation of energy provision according to the legality of housing ownership is highly exclusionary and at odds with state claims to be pro-poor.

5.2. Citizen perspective: electricity grid connection as a means to legal tenure

While the previous section highlighted how state agendas prioritise networked electricity for low-income settlements, citizens are also eager to receive grid connections. NGO officials mentioned that during a mapping process to identify needs in low-income settlements, households overwhelmingly prioritised electricity: "*the settlements had only two taps and 5–6 communal toilets, yet they have been asking for electricity, as they were over-charged for bringing it illegally from other houses*" (NO2, March 12, 2020).

In the context of South Africa's loadshedding, where grid connections do not necessarily deliver electricity, this initially appears a curious preference. However, there are multiple explanations. First, low-income households (including in informal settlements) typically have free access to water and sanitation (e.g. communal water standpipes and toilets) but incur high energy costs (e.g. informal electricity connection and service fees, and/or purchasing alternative sources like firewood, paraffin, candles). Electricity costs from a legal grid connection are expected to be lower and less fraught than negotiating with neighbours,

[17] Interviews are labelled according to professional/personal identity and interview date: **CO** for City Official, **NO** for NGO Official, **ISR** for Informal Settlement Resident, **TR** for Township Resident, **WC** for Ward Councillor. To ensure anonymity, codes do not include residents' or ward councillors' settlement location.

[18] This figure is double the 10,000 unserviceable households referred to in the City's Energy Report (Ledger, 2021).

[19] An informal settlement is deemed unserviceable if affected by: high voltage lines, road or rail reserve, flood-prone area or flood-plain, environmental issues, storm-water retention or detention pond, private land, unstable land, and in an area that pose health or safety hazards – e.g. dump sites (Western Cape, 2021).

[20] While the city does provide informal settlements with collective services (e.g. street lighting, water taps, communal ablutions) it is rare for informal dwellings to receive individual grid connections and electricity meters (Western Cape, 2021).

[21] ZAR300 is ~USD15.5/GBP12.50.

even if households cannot access the FBE. Second, low-income communities perceive that once a settlement receives networked services (i.e. grid electricity) it will subsequently receive legal tenure that brings upgraded housing and services. As an NGO official working on renewable energy provision in low-income settlements mentioned, "there is this understanding within the community that there is a process of formalization, first the services will come and then the land tenure will come … if you are connecting them to off-grid system … they will also be inhibited from getting legal tenure" (NO3, March 15, 2020). While official policy does not confirm this perception, in practice once a settlement receives bulk infrastructure there is pseudo land tenure because the state has a significant financial disincentive to penalise illegal tenure through forced evictions or demolition.

Third, there are negative narratives surrounding renewable energy amongst low-income dwellers. Partly based on perceptions that receiving non-grid services will prohibit the settlement from securing legal tenure and networked services, there is also cultural resistance to renewable technologies perceived as substandard to grid connections (Haque et al., 2021a). While the Nyanga and Hillview households surveyed in 2019 lacked clear understanding about renewable energy: "we heard about it in TV but it is expensive" (ISR, FGD, October 10, 2019), more recent research indicates that cultural apprehension to renewables is changing. During P90's 2021 focus groups, informal settlement residents commented that rising costs for accessing electricity from grid-connected proximate houses was pushing them towards considering more-affordable renewable options. Notably, this was in communities where P90 has conducted energy education workshops, suggesting that education about renewable energy can shift perceptions. Furthermore, as low-income dwellers observe the installation of solar panels in higher-income settlements to avoid rising electricity tariffs and load-shedding (Culwick Fatti and Khanyile, 2023; Lemanski, 2024), perceptions that renewable energy offer inferior services diminish. However, the state is notably absent from the low-income renewable sector in terms of education, delivery, or subsidies. An NGO official remarked, "the policy really does not incentivise to use renewable energy … it is more like i*f you are responsible citizen you feel like doing it"* (NO3, March 15, 2020). Indeed, the FBE subsidy is only available for grid-connected households, and because the FBAE remains poorly implemented in urban areas (see Section 3.3) there is no genuine low-income subsidy for renewable sources (SEA, 2014; Masuku, 2024). This indicates the limitations of a state policy rooted in assumptions that energy access for low-income households should (almost) exclusively be delivered through grid connections.

5.3. Alternative strategies for energy access

Discussion so far has highlighted tensions between the limitations of South Africa's grid-centric approach to delivering 'energy for all', alongside recognition that low-income citizens remain eager to receive grid-connections. In this section we briefly highlight potential alternative non-grid/hybrid strategies for extending energy to low-income settlements and residents. Municipal officials confirmed that there is no active government strategy for low-income alternative energy (beyond removing Value Added Tax from paraffin). While solar water heater (SWH) projects service formal houses with legal tenure in a handful of targeted settlements, this is driven by overseas aid rather than state-directed (Haque et al., 2021b). To address the gap in electrification, NGOs and private firms are slowly electrifying informal settlements via renewable sources.

In the Western Cape, the most successful and longest running project is iShack, established in 2012. This social enterprise delivers state-subsidised[22] off-grid solar electricity to residents of informal settlements on a fee-for-service model. iShack uses Solar Home Systems that generate energy to power lights and energy-efficient media appliances such as LED TVs, radios, tablets, and smart-phones. Envisaged as a temporary solution (while households await grid-connection), it is promoted as a model that municipalities can adopt to deliver their statutory energy obligations (Conway et al., 2019; iShack, 2022). More recently, private sector companies (e.g. DCGo, Zonke Energy) are delivering affordable renewable energy solutions to informal settlements and markets not served by the national grid. Using solar micro-grids powered by photovoltaic generators, these firms offer households different payment tiers depending on consumption, where the most expensive options enable households to power a television, radio, lights, refrigerators, and power tools (Bobbins et al., 2023).

Although these non-state renewable energy initiatives encounter significant challenges regarding acceptability, affordability, and quality of connections, as well as reliance on precarious funding,[23] they successfully reach low-income households excluded from state electrification (although backyard dwellers remain excluded due to economies of scale). However, while these examples of off-grid energy access highlight the importance of non-state actors in addressing energy poverty in informal settlements, they must not absolve the state of its constitutional responsibilities. Furthermore, there are potential injustices between different providers of decentralised energy to low-income communities in terms of regulation over costs and supply. Consequently, our research indicates the urgency of state interventions that prioritise and scale-up renewable energy provision that is semi-permanent and affordable to informal settlements alongside prioritising technically- and culturally-appropriate energy solutions for backyard dwellers. This can only be achieved by re-conceptualising South Africa's low-income energy policy away from its (almost) exclusive focus on grid-connections to achieve electrification.

6. Policy implementation: citizens are (not) passive beneficiaries

This section highlights limitations in implementing the FBE policy, largely stemming from the absence of beneficiaries in policy design and implementation, coupled with low understanding about access, and lack of affordability. Effectively, South Africa's energy policies are implemented in ways that perceive residents as passive beneficiaries who are "users or choosers" of state-delivered services rather than as "active participants who engage in making and shaping … policy" (Cornwall and Gaventa, 2000:50).

6.1. Absence of community participation in policy conception and implementation

Because national energy policy has a pre-determined goal to electrify all feasible households and settlements via extending and subsidising networked electricity, there is no scope to consider alternative strategies or voices. This results in the implementation of an energy policy that not only (frequently inaccurately) presumes to know people's needs, but

[22] Although iShack works in the municipalities of Stellenbosch and Cape Town, only the former contribute energy subsidies (and only after extensive lobbying by iShack).

[23] In addition to iShack's limited municipal funding, they are reliant on grant funding from Universities and international donors. Zonke Energy is also reliant on these forms of funding in addition to private capital investments, while DCGo relies entirely on private capital investments. These funding streams are precarious because South Africa (a middle-income country) is less popular amongst aid donors than other African states, and because private capital is wary of investing in renewable infrastructure that lacks state recognition (i.e. risk of losing capital and low rate of return).

that lacks capacity to consider alternatives, such as lower-carbon technologies (especially for settlements/dwellers unable to receive networked electricity). City officials from Cape Town's Energy Directorate acknowledged that the policy has no scope to include beneficiaries' localised energy needs or preferences: "*communities were not asked what technology interventions they would prefer*" (CO, March 30, 2020).[24]

Residents are acutely aware that they are rarely consulted and are informed about policies after decisions are made: "*Government never comes to meet or consult us, we were never invited to any meetings*" (ISR, FGD, October 10, 2019). For example, surveyed residents (including ward councillors) expressed frustration at discovering significant policy changes (e.g. energy tariffs, municipal takeover of electricity services from Eskom) via public media campaigns rather than established ward governance processes (e.g. ward councillor, community forum):

> *"They changed the meter when they shifted from Eskom to City, but they didn't inform us before. I am a street leader, but they never call me"*. (TR1, 04/11/2019)

> *"I don't have direct access to officials, we must go through call centre and then they will give a reference"*. (WC, 10/10/2019)

In addition to restricting the likelihood that policies will meet the needs of communities, weak communication channels also challenge maintenance. For example, a ward councillor revealed that despite contacting municipal technicians, there was no mechanism to ensure long-term solutions:

> *"… they don't come to fix something properly, they will fix something today, tomorrow you will find it is still not working …. when you call them back, they will say that the problem has been fixed and closed."* (WC, 10/10/2019)

In this context it is hardly surprising that an energy policy lacking community engagement via existing or new governance structures is inaccessible to the very communities it claims to serve.

6.2. Electricity affordability

All residents in Nyanga and Hillview surveyed in 2019-20 were energy poor, with households reportedly spending more than 40% of household income on energy. In this context, South Africa's significant and rapid rise in electricity tariffs (Essex and de Groot, 2019; Essex et al., 2023) render many households unable to afford electricity for basic household activities:

> *"The price has gone higher, but the lower consumption band is still 350.*[25] *So, it is even worse now. The electricity goes off very fast. Before, eight units could go for two days, now it does not even go for one day. I don't know why?"* (ISR, FGD, 10/10/2019)

> *"We get only 4.4 units with 10 rand,*[26] *how can we make food? That is a big challenge"* (ISR, FGD, 10/10/2019)

As these quotations indicate, residents are acutely aware of rising prices (even those with FBE) and attempt to track and priortise the electricity needed to sustain basic household activities. However, lack of education about energy consumption and electricity tariffs, alongside weak knowledge about how FBE impacts electricity bills, results in households distorting energy consumption practices in ways that ultimately damage appliances and weaken access to energy.

6.3. Knowledge gaps

Respondents in Hillview and Nyanga overwhelmingly displayed weak understanding of the technicalities of electricity usage, including electricity meter functionality and household practices that generate high/low energy consumption. This is a direct consequence of a lack of state education. Referring to electricity consumption and metering, respondents mentioned:

> *"I don't use electricity much, I only use the stove, TV, lights and kettle"*. (ISR1, 07/10/2019)

> *"I don't know how the meter works, they never show us. If there is something wrong with the meter, the city will come, open the system and put back in … things work and when they leave, it again stop working …. we are not allowed to touch the box."* (TR2, 04/11/2019)

Despite lack of knowledge, residents attempt trial-and-error strategies to reduce electricity consumption, including turning refrigerators off during daytime and on during nighttime, and placing light-bulbs in strategic locations:

> "*I boil my water first [with kettle], and then cook, otherwise it will take too much electricity. And I use only two lights in two rooms, so two covers the whole house*" (ISR, FGD, 10/10/2019)

However, some residents mentioned that they later became aware that abrupt on/off consumption practices hastened the break-down of electrical appliances: "*every now and then the electricity goes off, and when it comes back it damages our tv, fridge. We understood this by ourselves, they [government] didn't tell us about it*" (TR, FGD, October 11, 2019).

Respondents in Hillview and Nyanga also repeatedly displayed low understanding about accessing FBE. Despite universal eligibility in these settlements, half of surveyed households reported not receiving FBE and not knowing how to access it or who to contact regarding eligibility and access. And in many cases this confusion is exacerbated where FBE access is intermittent; for example, some households reported having previously received FBE before it inexplicably stopped, while others claim that sometimes they can access FBE and sometimes not. Exasperation at lack of knowledge or education about FBE is common throughout interviews,

> *"Yesterday I bought 10 rand* electricity *and got my 60 units [FBE] free. Not all the time I get it. None* [sic] *ever tried to explain this to us, so we don't know how this thing work"* (TR4, 10/10/2019)

> *"For few years I didn't get FBE … I don't know why it stopped, from this year it again started coming. I didn't know where to go and enquire when it stopped"*. (ISR3, 07/10/2019)

This lack of knowledge is aggravated by a complex system that expects low-income households to apply for FBE. The mechanism to apply differs according to whether the settlement is supplied directly by Eskom or the municipality, alongside whether the household qualifies based on indigence, pensioner status, or property value, and requires a significant level of official documentation (see section 3.2). Furthermore, the 'free' electricity portion is dependent on the amount of electricity units the household purchases each month (FBE access is not fixed).[27] Given that FBE claims to target low-income households, who are likely to lack education, literacy and access to digital technology, the complexity of both the policy and application process is significant. It is notable that when P90 created a simple information sheet about FBE, they could not condense it to fewer than four A4 sides and could not avoid some technical terms.[28] Weak access to, and understanding of, FBE amongst

[24] This quote is a written response to fieldwork questions.

[25] Whilst the 350 figure appears incorrect, this refers to FBE eligibility: households consuming below 250kWh pcm can receive 60 units of FBE, while households consuming 250-450kWh pcm can receive 25 units of FBE.

[26] ZAR10 is ~GBP 0.42/~USD 0.52.

[27] Households consuming below 250kWh pcm can receive 60 units of FBE, while households consuming 250-450kWh pcm can receive 25 units of FBE.

[28] https://90by2030.org.za/wp-content/uploads/2022/02/How-to-apply-for-Free-Basic-Electricity-FBE-Factsheet-Project-90-by-2030.pdf.

low-income communities was recognised by City Officials during interviews, including acknowledgement that FBE is too low to meet basic households needs.

In this context it is hardly surprising that fewer than one-third of South Africa's eligible households receive FBE (Ledger, 2021). We argue that these challenges are not an indirect policy by-product, but a direct consequence not only of weak community participation and education regarding energy policy and consumption, but more fundamentally driven by the state's dogged reliance on implementing an energy policy with a pre-determined universal solution (delivering grid connections) that is closed to flexibility or innovation.

7. Conclusions and policy implications

Global politics is currently dominated by policy commitments to energy transformation that prioritise widening access to affordable, reliable, sustainable, and modern energy, a transformation that is increasingly realised through expansion of grid-tied and off-grid infrastructure. Somewhat conversely, global and national energy policies frequently conflate universal energy access with extending and subsidising networked electricity. Collectively, this results in a technology-dominated approach to delivering energy access and securing energy transition. In this paper we argue that energy transformation requires a commitment to understanding and expanding *access* to energy services for low-income urban dwellers rather than delivering energy *connections* per se. Furthermore, a failure to integrate human needs and societal expectations alongside technical considerations is threatening the sustainability of urban energy transitions.

Grounded in qualitative fieldwork across low-income settlements in Cape Town, the paper draws from the voices of urban residents to demonstrates how access to an electricity grid connection does not ensure energy access or enjoyment of the services that access provides. While South Africa's post-apartheid national electrification programme boasts exceptionally high electrification rates for SSA (98% of households in Cape Town and 86.5% nationally (CoCT, 2021; World Bank, 2023)), many households classified as 'electrified' cannot access sufficient energy services via this networked infrastructure to meet household need. For those with a grid connection in their home, this is caused by high tariffs and opaque energy subsidies alongside unreliability and low power capacity, whilst for occupants of informal dwellings that are adjacent to grid-connected properties, this is due to reliance on informal access arrangements compounded by exclusion from subsidies. Consequently, policies prioritising electricity connections to established plots/properties rather than increased energy access to households, serve to meet global targets on energy access whilst risking the permanent exclusion of some households from the transformations that energy can bring. Furthermore, electrification efforts targeting low energy tiers (see Table 1) with no strategy to deliver higher tiers once basic electrification is secured, potentially trap low-income households in permanently low-energy access that is insufficient to survive let alone escape poverty. Consequently, the fixation with electrification targets directly hinders the potential for energy access to deliver socio-economic transformation or sustainable transition.

Findings from this research demonstrate a need to understand the strategies currently used by low-energy communities to meet household needs, and integrate this understanding with energy policies prioritising the delivery of technology for high-tier affordable energy access (whether networked, non-networked, or hybrid). This dual-approach recognises the importance and value of beneficiary voice and participation in policy design, as well as the urgency of adopting alternative technologies that are potentially more flexible (and sustainable) than grid connections. Based on this research, a more flexible policy requires shifting beyond pre-occupation with physical delivery, to include a focus on human needs and societal expectations. In terms of policy conceptualisation, the paper demonstrates how problematic assumptions regarding homogenous consumption needs and demands at the bottom of pyramid markets overlook the diversities of context and community (Balls, 2020). For example, universal access to energy cannot be restricted to networked services and requires expansion to include renewable sources that may be grid-tied and/or off-grid. Within South Africa this could involve re-conceptualising the *Free Basic Electricity* subsidy to *Free Basic Energy* in ways that recognise households' heterogenous energy practices, living circumstances, and evolving lifestyles. Consequently, universal access to energy requires the long-term participation of targeted communities in policy development, knowledge exchange and capacity building, focused on meeting the energy needs and aspirations of low-income households, including those for whom electrification is impossible and/or unsuitable. More fundamentally, an effective low-carbon transition to universal energy access requires broader discussions about the types of lifestyles people in sub-Saharan Africa aspire to (Baptista and Plananska, 2017).

CRediT authorship contribution statement

Charlotte Lemanski: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Anika Nasra Haque:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Jiska de Groot:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Natalie McAskill:** Resources, Methodology.

Declaration of competing interest

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

Acknowledgements

This research was funded by the British Academy Knowledge Frontiers (grant no. KF2/100010): Learning between stakeholders in energy innovation for low-cost housing in the Western Cape, South Africa, led by Charlotte Lemanski (2019–2020). The research was made possible through the advice and support of Lorna Fuller and Thando Lukuko from Project 90 by 2030, an NGO based in South Africa working on social and environmental justice. In addition, the authors are particularly grateful to Project 90 by 2030, and the communities that they work with, for providing access to data collected by Lydia Petersen, Ann October, Lucy Kandisa, Amanda Davids, Aloma Matthew, Luzuko Sipayiri, Arlene Barends, Patrick Madasi, Fatima Swartz, Noncedo Bulana, Beverley Fortuin, and Joyce Malebo during 2021. The authors are also grateful to the Global Energy Research Nexus in Urban Settlements (GENUS), an inter-disciplinary research group at the University of Cambridge, particularly for the inputs from Joanna Watterson, Ruth Massey, Ruchi Choudhary, Minna Sunikka-Blank, Jaideep Prabhu and Andre Neto-Bradley.

Data availability

The data that has been used is confidential.

References

Aarakit, S.M., Ntayi, J.M., Wasswa, F., Buyinza, F., Adaramola, M.S., 2024. Conceptualization and antecedents of productive use of electricity: a systematic literature review. Cleaner Engineering and Technology 20, 100747. https://doi.org/10.1016/j.clet.2024.100747.

Ambrose, A., 2020. Walking with Energy: challenging energy invisibility and connecting citizens with energy futures through participatory research. Futures 117, 102528. https://doi.org/10.1016/j.futures.2020.102528.

Balls, J.N., 2020. Low-cost, adaptable solutions sell: Re-thinking off-grid solar diffusion at the bottom of the pyramid in India. Energy Res. Social Sci. 70, 101811. https://doi.org/10.1016/j.erss.2020.101811.
Baptista, I., Plananska, J., 2017. The landscape of energy initiatives in sub-Saharan Africa: going for systemic change or reinforcing the status quo? Energy Pol. 110, 1–8. https://doi.org/10.1016/j.enpol.2017.08.006.
Bazilian, M., Pielke, R., 2013. Making energy access meaningful. Issues Sci. Technol. 29, 74–78. http://www.jstor.org/stable/43315797.
Bisaga, I., Parikh, P., 2018. To climb or not to climb? Investigating energy use behaviour among Solar Home System adopters through energy ladder and social practice lens. Energy Res. Social Sci. 44, 293–303. https://doi.org/10.1016/j.erss.2018.05.019.
Bhatia, M., Angelou, N., 2015. Beyond Connections, Energy Access Redefined. ESMAP/Sustainable Energy 4 All (SE4ALL). World Bank, Washington DC. Technical Report 008/15.
Bouzarovski, S., Petrova, S., 2015. A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. Energy Res. Social Sci. 10, 31–40. https://doi.org/10.1016/j.erss.2015.06.007.
Boardman, B., 2010. Fixing Fuel Poverty Challenges and Solutions. London, Earthscan.
Bull, R., Janda, K., 2018. Beyond feedback: introducing the 'participation gap' in organisational energy management. Build. Res. Inf. 46 (3), 200–215. https://doi.org/10.1080/09613218.2017.1366748.
Bobbins, K., Caprotti, F., de Groot, J., Pailman, W., Moorlach, M., Schloemann, H., Densmore, A., Finlay, K., Fischat, E., Siwali, S., Links, J., 2023. Smart and disruptive infrastructures: Re-building knowledge on the informal city. Urban Stud. https://doi.org/10.1177/00420980231172582.
Caprotti, F., Essex, S., Phillips, J., de Groot, J., Baker, L., 2020. Scales of governance: translating multiscalar transitional pathways in South Africa's energy landscape. Energy Res. Social Sci. 70, 101700. https://doi.org/10.1016/j.erss.2020.101700.
Caprotti, F., de Groot, J., Bobbins, K., Mathebula, N., Butler, C., Moorlach, M., Schloemann, H., Densmore, A., Finlay, K., 2022. Rethinking the off-grid city. Urban Geogr. 43 (8), 1217–1230. https://doi.org/10.1080/02723638.2022.2036928.
Chilvers, J., Longhurst, N., 2016. Participation in transition(s): reconceiving public engagements in energy transitions as Co-produced, emergent and diverse. J. Environ. Pol. Plann. 18 (5), 585–607. https://doi.org/10.1080/1523908X.2015.1110483.
City of Cape Town (CoCT), 2021. Cape Town state of energy and carbon. https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/CT_State_of%20Energy_and_Carbon_Report_2021.pdf.
City of Cape Town (CoCT), 2017. Annexure 7:Tariff Policies, 2017/18 Budget. https://resource.capetown.gov.za/documentcentre/Documents/Financial%20documents/Annexure%207%20-%20Tariff%20Policies.pdf.
CNN, 2023. South Africa's Energy Crisis Deepened as Blackouts Hit 12 Hours a Day. CNN Business. https://edition.cnn.com/2023/01/18/energy/ramaphosa-davos-south-africa-blackouts/index.html. (Accessed 19 September 2023).
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 Res. Social Sci. 56, 101202. https://doi.org/10.1016/j.erss.2019.05.012.
Cornwall, A., Gaventa, J., 2000. From users and choosers to makers and shapers repositioning participation in social policy. IDS Bull. 31, 50–62. https://doi.org/10.1111/j.1759-5436.2000.mp31004006.x.
Culwick Fatti, C., Khanyile, S., 2023. SA Power Crisis - going off the grid works for the wealthy but may deepen inequality and injustice for the poor. Daily Maverick. https://www.dailymaverick.co.za/article/2023-02-28-sa-power-crisis-going-off-the-grid-works-for-the-wealthy-but-may-deepen-inequality-and-injustice-for-the-poor/. (Accessed 19 September 2023).
Department of Energy (DoE), 2011. Guidelines for electrification of unproclaimed areas (updated September 2015). http://www.energy.gov.za/files/policies/Policy-Guidelines-for-the-Electrification-of-Unproclaimed-Areas-2015.pdf. (Accessed 5 June 2023).
Department of Energy (DoE), 2018. South African Energy Sector Report. Department of Energy, Pretoria. https://www.energy.gov.za/files/media/explained/2018-south-african-energy-sector-report.pdf.
Devine-Wright, P., 2007. Energy citizenship: psychological aspects of evolution in sustainable energy technologies. In: Murphy, J. (Ed.), Governing Technology for Sustainability. Earthscan, London, pp. 41–62.
Dipura, R., Bandauko, E., Arku, R.N., 2024. Precarious power': Implicit infrastructures and electricity access in Witsand, Cape Town (South Africa). Habitat Int. 154 (103228). https://doi.org/10.1016/j.habitatint.2024.103228.
Dumont, K., Hildebrandt, Sempuga, B.C., 2021. The "yuck factor" of biogas technology: naturalness concerns, social acceptance and community dynamics in South Africa. Energy Res. Social Sci. 71. https://doi.org/10.1016/j.erss.2020.101846.
Energy Sector Management Assistance Programme (ESMAP), 2022. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers. The World Bank, Washington DC.
Essex, S., de Groot, J., 2019. Understanding energy transitions: the changing versions of the modern infrastructure ideal and the 'energy underclass' in South Africa, 1860–2019. Energy Pol. 133, 110937. https://doi.org/10.1016/j.enpol.2019.110937.
Essex, S., Caprotti, F., de Groot, J., Phillips, J., Baker, L., Wolpe, P., Reddy, Y., 2023. The 'capability' of South African energy governance to deliver urban sustainable transitions. Urban Research & Practice 1–28. https://doi.org/10.1080/17535069.2023.2261899.
Graham, S., Marvin, S., 2001. Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition. Routledge, London.
Haque, A., Lemanski, C., de Groot, J., 2021a. Is (in)access to infrastructure driven by physical delivery or weak governance? Power and knowledge asymmetries in Cape Town, South Africa. Geoforum 26, 48–58. https://doi.org/10.1016/j.geoforum.2021.07.013.
Haque, A., Lemanski, C., de Groot, J., 2021b. Why do low-income urban dwellers reject energy technologies? Exploring the socio-cultural acceptance of solar adoption in Mumbai and Cape Town. Energy Res. Social Sci. 74, 101954. https://doi.org/10.1016/j.erss.2021.101954.
International Energy Agency (IEA), 2022. World Energy Outlook 2022. IEA.
iShack, 2022. iShack Project: Providing solar energy to under-served communities. https://www.ishackproject.co.za (Accessed 10 August 2023).
Knox, A.J., de Groot, J., Mohlakoana, N., 2017. Post-apartheid spatial inequalities and the built environment: drivers of energy vulnerability for the urban poor in South Africa. In: Simcock, N., Thomson, H., Petrova, S., Bouzarovski, S. (Eds.), Energy Poverty and Vulnerability. Routledge.
Lawhon, M., Nilsson, D., Silver, J., Ernstson, H., Lwasa, S., 2018. Thinking through heterogeneous infrastructure configurations. Urban Stud. 55 (4), 720–732. https://doi.org/10.1177/0042098017720149.
Lemanski, C., 2009. Augmented informality: South Africa's backyard dwellings as a by-product of formal housing policies. Habitat Int. 33 (4), 472–484. https://doi.org/10.1016/j.habitatint.2009.03.002.
Lemanski, C., 2020. Infrastructural citizenship: the everyday citizenship of adapting and/or destroying public housing in Cape Town, South Africa. Trans. Inst. Br. Geogr. 45 (3), 589–605. https://doi.org/10.1111/tran.12370.
Lemanski, C., Massey, R., 2023. Is the grid people or product? Relational infrastructure networks in Cape Town's energy-housing nexus. Urban Geogr. 44 (7), 1305–1329. https://doi.org/10.1080/02723638.2022.2092306.
Lemanski, C., 2024. Infrastructural Citizenship in post-networked contexts: hybridity in South Africa. In: Florentin, D., Coutard, O. (Eds.), Cities and Infrastructure Handbook. Edward Elgar, pp. 323–338.
Ledger, T., 2021. Broken Promises: Electricity Access to Low-Income Households: Good Policy Intentions, Bad Trade-Offs and Unintended Consequences. Public Affairs Research Institute (PARI). https://pari2.wpenginepowered.com/wp-content/uploads/2021/04/broken-promises21-04-21c.pdf.
Ledger, T., Rampedi, M., 2022. Hungry for Electricity. Public Affairs Research Institute (PARI). https://pari2.wpenginepowered.com/wp-content/uploads/2022/09/Hungry-for-Electricity-Digi-19092022.pdf.
Lennon, B., Dunphy, N., Gaffney, C., Revez, A., Mullally, G., O'Connor, P., 2020. Citizen or consumer? Reconsidering energy citizenship. J. Environ. Policy Plan. 22 (2), 184–197. https://doi.org/10.1080/1523908X.2019.1680277.
Masiya, T., Davids, Y.D., Mazenda, A., 2019. Effective public participation in municipal service delivery. Administratio Publica 27 (3), 27–47. https://hdl.handle.net/10520/ejc-adminpub-v27-n3-a3.
Masuku, B., 2024. Rethinking South Africa's household energy poverty through the lens of off-grid energy transition. Dev. South Afr. 41 (3), 467–489. https://doi.org/10.1080/0376835X.2023.2300411.
Meyer, S., Laurence, H., Bart, D., Milddlemiss, L., Marechal, K., 2018. Capturing the multifaceted nature of energy poverty: lessons from Belgium. Energy Res. Social Sci. 40, 273–283. https://doi.org/10.1016/j.erss.2018.01.017.
Middlemiss, L., Ambrosio-Albala, P., Emmel, N., Gillard, R., Gilbertson, J., Hargreaves, T., Mullen, C., Ryan, T., Snell, C., Tod, A., 2019. Energy poverty and social relations: a capabilities approach. Energy Res. Social Sci. 55, 227–235. https://doi.org/10.1016/j.erss.2019.05.002.
Modi, V., McDade, S., Lallement, D., Saghir, J., 2005. Energy Services for the Millennium Development Goals, Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project. World Bank, New York, 2005. https://www.undp.org/sites/g/files/zskgke326/files/publications/MP_Energy2006.pdf.
Monstadt, J., Schramm, S., 2017. Toward the networked city? Translating technological ideals and planning models in water and sanitation systems in dar es salaam. Int. J. Urban Reg. Res. 41 (1), 104–125. https://doi.org/10.1111/1468-2427.12436.
Moolman, S., 2022. 350% increase in a decade: how expensive is electricity in South Africa compared to other countries? 2022 update: Eskom tariff increases vs inflation since 1988 (with projections to 2024. https://poweroptimal.com/2021-update-eskom-tariff-increases-vs-inflation-since-1988/. (Accessed 19 September 2023).
Mulugetta, Y., Hagan, E.B., Kammen, D., 2019. Energy access for sustainable development. Environ. Res. Lett. 14. https://doi.org/10.1088/1748-9326/aaf449.
Nassiep, K., 2022. Energy security for economic growth: city of Cape Town, Cape Town: transforming the electricity market for security of supply and longer term decarbonization. ATA Insight Webinar. https://my.atainsights.com/en/webinar/webinar-cape-town-transforming-the-electricity-market-for-security-of-supply-and-longer-term-decarbonization/.
Odarno, L., Agarwal, A., Devi, A., Takahashi, H., 2016. Strategies for Expanding Access to Electricity Services for Development. Working Paper. World Resources Institute, Washington, DC.
Pachauri, S., Rao, N.D., 2013. Gender impacts and determinants of energy poverty: are we asking the right questions? Curr. Opin. Environ. Sustain. 5, 205–215. https://doi.org/10.1016/j.cosust.2013.04.006.
Pérez-Arriaga, I.J., et al., 2018. A utility approach to accelerate universal electricity access in less developed countries: a regulatory proposal. Economics of Energy & Environmental Policy 8, 1. https://www.jstor.org/stable/27030642.
Phillips, J., Plutshack, V., Yeazel, S., 2020. Lessons for modernizing energy access finance, Part 1: what the electrification experiences of seven countries tell us about the future of connection costs, subsidies, and integrated planning. Duke Nicholas Institute. Duke University.
Project 90 by 2030 (P90), 2017. Energy Smart: Local Governance Report: Fast-Tracking Our Transition to a Healthy. modern, affordable electricity supply for all. https://9

0by2030.org.za/wp-content/uploads/2017/10/EU-SMART-Report_final-version_website-ready_12Oct2017.pdf.
Rateau, M., Jaglin, J., 2022. Co-production of access and hybridisation of configurations: a socio-technical approach to urban electricity in Cotonou and Ibadan. Int. J. Urban Sustain. Dev. 14 (1), 180–195. https://doi.org/10.1080/19463138.2020.1780241.
Republic of South Africa (RSA), 1998. White paper on the energy policy of the republic of South Africa. https://www.energy.gov.za/files/policies/whitepaper_energypolicy_1998.pdf.
Republic of South Africa (RSA), 2008. National energy Act 2008. https://www.gov.za/sites/default/files/gcis_document/201409/316381263.pdf.
Ryghaug, M., Skjølsvold, T.M., Heidenreich, S., 2018. Creating energy citizenship through material participation. Soc. Stud. Sci. 48 (2), 283–303.
SE4ALL, 2015. Beyond connections: introducing the multi-tier framework for tracking energy access. https://www.seforall.org/sites/default/files/Beyond-Connections-Introducing-Multi-Tier-Framework-for-Tracking-Energy-Access.pdf.
Silver, J., 2014. Incremental infrastructures: material improvisation and social collaboration across post-colonial Accra. Urban Geogr. 35, 788–804. https://doi.org/10.1080/02723638.2014.933605.
Sovacool, B.K., 2012. The political economy of energy poverty: a review of key challenges. Energy for Sustainable Development 16, 272–282. https://doi.org/10.1016/j.esd.2012.05.006.
Sovacool, B., 2014. What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. Energy Res. Social Sci. 1, 1–29. https://doi.org/10.1016/j.erss.2014.02.003.
StatsSA, 2023. Non-financial Census of Municipalities for the Year Ended 30 June 2021, P9115. Statistical release. https://www.statssa.gov.za/publications/P9115/P911520021.pdf.
Stephens, J.C., 2019. Energy democracy: redistributing power to the people through renewable transformation. Environ. Sci. Policy Sustain. Dev. 61 (2), 4–13. https://doi.org/10.1080/00139157.2019.1564212.
Sustainable Energy Africa (SEA), 2012. Informal electrification in South Africa: experience, opportunities and challenges. https://www.cityenergy.org.za/uploads/resource_116.pdf.
Sustainable Energy Africa (SEA), 2014. Tackling urban energy poverty in South Africa. https://www.sustainable.org.za/uploads/files/file77.pdf.
Szulecki, K., Overland, I., 2020. Energy democracy as a process, an outcome and a goal: a conceptual review. Energy Res. Social Sci. 69, 101768. https://doi.org/10.1016/j.erss.2020.101768.
Tissington, K., 2013. Targeting the Poor? an Analysis of Free Basic Services (FBS) and Municipal Indigent Policies in South Africa. Socio-Economic Rights Institute of South Africa (SERI), Johannesburg, South Africa.
Wafer, A., Dugard, J., Ngwenya, M., Sibanda, S., 2008. A tale of six buildings: the lived-reality of poor people's access to basic services in Johannesburg's inner-city. Centre for Applied Legal Studies. University of Witwatersrand.
Wahlund, M., Palm, J., 2022. The role of energy democracy and energy citizenship for participatory energy transitions: a comprehensive review. Energy Res. Social Sci. 87. https://doi.org/10.1016/j.erss.2021.102482.
Walker, G., Evans, B., Devine-Wright, P., Hunter, S., Fay, H., 2007. Harnessing community energies: explaining community-based localism in renewable energy policy in the UK. Global Environ. Polit. 7 (2), 64–82. https://doi.org/10.1162/glep.2007.7.2.64.
Western Cape, 2021. Socio-economic profile: city of Cape Town. https://www.westerncape.gov.za/provincial-treasury/sites/provincial-treasury.westerncape.gov.za/files/atoms/files/SEP-LG%202021%20-%20City%20of%20Cape%20Town.pdf. (Accessed 5 June 2023).
Williams, G., 2004. Evaluating participatory development: tyranny, power and Re) politicisation. Third World Q. 25 (3), 557–578. https://www.jstor.org/stable/3993825.
World Bank, 2020. Measuring energy access in multidimensional way through household surveys multi-tier energy access tracking framework global surveys. https://www.worldbank.org/en/results/2020/11/10/measuring-energy-access-in-multidimensional-way-through-household-surveys-multi-tier-energy-access-tracking-framework-global-surveys.
World Bank, 2023. Tracking SDG7: the Energy Progress Report. World Bank, Washington DC. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZA.