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Negotiating urban energy transitions in Greater Maputo: Street-level politics and infrastructural heterogeneity

Mathias Koepke [a,*], Jochen Monstadt [b], Kei Otsuki [a]

[a] Department of Human Geography and Spatial Planning, Faculty of Geosciences, Utrecht University, Princetonlaan 8a, Utrecht, 3584 CB, the Netherlands
[b] German Institute of Urban Affairs, Zimmerstraße 13–15, Berlin, 10969, Germany

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ABSTRACT

Research on urban energy transitions in sub-Saharan Africa has focused either on formal governance or on micropolitics in low-income neighborhoods, providing limited insight into how transition policies addressing access, cost recovery, reliability, and greening are contested across heterogeneous urban infrastructural settings. We address this shortcoming by examining the politics of policy implementation in Greater Maputo, Mozambique, through a street-level bureaucracy lens. Drawing on qualitative data, we show how the electricity utility and its staff exercise discretion in an access-first energy transition setting, amid competing accountabilities and uneven material conditions. Across three ideal-typical settings—peri-urban grid-expansion zones, low-income neighborhoods constrained by affordability, and areas demanding premium reliability—we identify policy divergence patterns: illusory implementation, selective enforcement, and informal service differentiation. These patterns help actors to reconcile conflicting demands but also adversely affect service reliability, undermine greening objectives, and increase socio-spatial inequalities across the city. By showing how material conditions mediate implementation choices, we explain how street-level politics reconfigure heterogeneous urban infrastructures.

1. Introduction

Sustainability and urban infrastructure scholarship increasingly foreground that urban energy transitions in the global North and South are inherently political [1–3]. Beyond technical fixes, transitions are shaped by power, interests, and conflict, producing a need to explain "how power, politics, and inequalities across the city" shape the planning and implementation of transition policies [4: 857]. Research on heterogeneous infrastructures in cities of the global South indicates that spatial and socio-technical diversity is central for understanding change processes here [e.g., 5]. Consequently, studies have examined the everyday practices bridging the formal–informal divide in low-income settlements [6] or how heterogeneity has reworked power relations between providers and consumers [7]. Yet, few studies systematically examine the politics of energy transitions under urban and infrastructural heterogeneity. Most research concentrates on strategies and regulations advanced by a narrow set of actors in formal energy governance [e.g., 8] or on the "micropolitics" in informal settlements [e.g., 9]. Less attention has been paid to how decision-making, implementation, and resource distribution vary across diverse urban settings. We therefore understand heterogeneity not as a backdrop but as integral to political struggles over urban energy transitions.

In practice, transition policies often misalign with urban realities in sub-Saharan Africa [e.g., 10,11]. Here, transitions must address issues of access and affordability, increase renewable generation, and ensure reliable, financially sustainable grid operations. Policy rationales assume that governments, monopolistic utilities, and international donors can deliver universal, integrated grid services. This conflicts with the multiple socio-technical channels at play, various actors involved, and limited state capacity [12]. Understanding implementation across different socio-spatial and infrastructural contexts thus requires paying attention not only to low-income areas [e.g., 13,14] but also to a broader range of actors, their power relations, and how they mobilize local infrastructures [15,16]. Building on Rutherford's call to trace how policies are practically "reinterpreted (or misinterpreted), reiterated and contested by the different groups" [17: 41], we thus focus on implementation-level mechanisms that reveal how frontline actors negotiate energy transition policies across settings within a city and on the role of socio-technical heterogeneity in these processes.

We focus on frontline discretion, multi-source accountabilities, and

* Corresponding author.
E-mail addresses: m.koepke@uu.nl (M. Koepke), monstadt@difu.de (J. Monstadt), k.otsuki@uu.nl (K. Otsuki).

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socio-material conditions shaping compliance with and divergence from stated policy. Using the lens of street-level bureaucracy (SLB), we treat the electricity utility as a street-level organization [18], or SLO, whose staff "interact with and have wide discretion over the dispensation of benefits" [19: xi]. Rather than privileging formal design, SLB emphasizes everyday choices that generate patterned divergences between policy and practice, as implementers juggle multiple, often conflicting accountabilities "beyond hierarchy" [20]. Research has demonstrated that SLOs and individual bureaucrats are accountable not only to superiors and regulators, but also to professional norms, clients and communities, market pressures, and political ideologies [18,21,22].

Building on socio-material accounts of discretion [23,24], we apply a broadened understanding of SLB by explicitly considering material characteristics such as grid topology, equipment capacity, or the built environment as core variables shaping discretionary choices. From this perspective, material artifacts, especially infrastructural assets, condense past political choices and agendas while constituting the contemporary "terrain" on which contestation unfolds [25: 11]. Technical artifacts such as wires, transformers, meters, or solar home systems (SHS) thus mediate implementation by functioning as possibilities for action, or affordances and constraints [26]. We argue that divergences from stated policies should not simply be read as implementation failures, but as patterned outcomes of street-level discretion under competing accountabilities and uneven material conditions that help explain the reproduction of heterogeneous urban infrastructures. We examine this argument through a case study of Greater Maputo, Mozambique, where sectoral reforms, an ambitious Energy for All agenda, and dynamic urbanization intersect with prevalent heterogeneity [27].

The paper proceeds as follows: Section 2 reviews work on urban energy transitions in the global South, foregrounding urban and infrastructural heterogeneity. Section 3 develops an implementation-focused framework for urban energy politics that addresses how choices are made under multiple pressures and material constraints. Section 4 presents the embedded case-study design and methodology. Section 5 introduces Mozambique's conflicting electricity sector goals and the accountabilities they generate for implementers. Section 6 analyzes how the utility and its staff exercise discretion to negotiate multiple accountabilities amid varying socio-material conditions and politicizations across three ideal-typical urban settings. Section 7 discusses the resulting divergence patterns and their role in reconfiguring socio-technical constellations of electricity provision and use, before we conclude by reflecting on what a street-level perspective adds to research on urban energy transitions in sub-Saharan African cities.

2. Political aspects of urban energy transitions under heterogeneity

Urban energy transitions in the global South—and sub-Saharan Africa in particular—have gained attention over the past decade [4,28]. Scholars emphasize the political nature of these transitions [5] and the need to explore the "processes that produce divergent visions of future energy transition and moments of tension and conflict" [4: 857], much in line with urban infrastructure debates that consider (energy) infrastructures and processes of change to be deeply political and highly contested [29,30]. Heterogeneous constellations of electricity provision and use highlight the place-based character of transitions [31], and the concept of heterogeneity has also been considered useful for exploring transition pathways in such contexts [32]. This heterogeneity is characterized by a diverse range of technical artifacts, user practices, and actors involved in co-producing and governing service delivery [33]. Although the importance of heterogeneity for energy transitions is well established, fewer studies [see, e.g., 7,34] examine the direct relationship between urban energy politics and infrastructural heterogeneity. Four characteristics in the literature on heterogeneity suggest the need for more political readings.

2.1. Political characteristics of infrastructural heterogeneity

First, actors' plurality and their interactions across scales shape electricity provision and governance beyond public authorities, utilities, and donors. Urban infrastructures are key arenas where actors and coalitions challenge national policy agendas and private interests [35]. How change unfolds depends on agency, resources, and alliance-building within multi-level, networked governance arrangements that interpret higher-level goals and implement them locally [2]. In heterogeneous settings, informal co-providers, community groups, and individual users—each with specific interests, visions, and distinct capacities—voice concerns and politicize policy implementation in place-specific ways [36,37]. Governments and state-owned utilities still design and implement policy but often face fiscal constraints and bureaucratic inefficiencies [12,38]. International development partners, including development agencies, banks, and consultants, fill financial, organizational, and technical gaps [39], making them pivotal "in constituting visions and capacities for externally imposed energy transitions" [4: 857]. They frequently promote cost-recovery logics through tariff increases, prepayment meters, or regularization programs [40,41]. In some cases, these principles align with a financial value regime that prioritizes creditworthiness and bankability, an alignment that can pervade utility structures and practices, and "attempts at disciplining workers and consumers, and new legislative efforts" [42: 2]. These shifts rebalance the role of different governance modalities in the electricity sector [12] and set the stage for conflict over how, where, and to what ends policies are implemented.

Second, competing objectives complicate transition pathways beyond decarbonization and efficiency. In sub-Saharan Africa, urban energy transitions must simultaneously pursue cost recovery, loss reduction, technical viability, territorial extension, and affordability [e.g., 43]: goals that are often incompatible and yield contradictory guidance for on-the-ground implementers. For example, prepayment and regularization efforts can advance revenue goals yet strain affordability and legitimacy [6,37]. Conflicts emerge when policies combine these priorities without addressing system-wide and spatial trade-offs.

Third, power asymmetries shape whose priorities prevail. Unequal power relationships, which are often constructed "through national and international infrastructure policies" [31: 3], are pronounced in heterogeneous contexts, yet remain understudied. Power differentials are particularly noticeable between actors that dominate national policymaking and local actors (city governments, local communities, and small providers) [44,45]. Within state structures, multi-level interactions often reflect "complex and unstable power and resistance patterns rather than stable co-operation processes" [46: 1394]. Furthermore, the position and role of urban elites and affluent residents warrant particular attention [15,16]. Pilo's study in Jamaica [7] demonstrates how socio-technical heterogeneity alters power relations when resourceful users can reshape their relationships with providers—for instance, by leaving the grid. Whose priorities are pursued thus depends on asymmetries of power and influence, including local financial, organizational, and knowledge capacities, political authority, and infrastructural legacies [47,48].

Fourth, materiality, in particular the physical properties and spatial configuration of infrastructures and artifacts, affects the potential for action. Urban infrastructure scholars see technical artifacts not as a neutral substrate or "primarily passive receptacles of policymaking" [49: 2195] but as dynamically co-shaping decisions, as contestations and conflicts revolve around objects and their associated knowledge. However, material politics research also claims that "there is nothing intrinsically political about […] materials" [50: 152]; their political relevance is "a relational, practical and contingent achievement" [50: 183]. Consequently, while technical devices and systems are configured to enact political goals [51], they often work through "seemingly small and mundane decisions" [29: 6]. Hence, "the political is mediated and becomes manifest in different material forms," while those forms also

constitute the "terrain" on which conflicts unfold [25: 11]. In sub-Saharan African cities, what can be implemented, where, and at what cost is particularly shaped by heterogeneous material conditions. Here, established neighborhoods with colonial-era grids coexist with sprawling peripheral settlements that rely on mixed on- and off-grid systems [32,36], producing splintered networks and place-specific constraints and opportunities for implementing change. For example, dense low-income settlements may lack rights-of-way and transformer space, making grid expansion costly even when policymakers prioritize increasing connection numbers. Such priorities can disregard material realities and provoke local contestation. How these processes play out depends on socio-economic status, built environment, and service delivery characteristics, such as the availability and state of existing grids or alternatives [6,52]. At the same time, users and providers intervene "in and through the materiality of infrastructures" [3: 10]. By tinkering with meters and wires or contributing labor and materials, they may advance formal policy goals, or contest and undermine them [38,53]. Attention to materialities foregrounds the historical legacies and geographies of energy systems—grid topology, meter types, and proximity to resources—and the ongoing reconfiguration of their spatial patterns [47].

2.2. Toward an implementation-focused perspective

Together, these dimensions support an urban energy politics perspective on sub-Saharan transitions. We define "urban energy politics" as the power-laden, multi-actor, and multi-scalar processes in which governments, utilities, donors, "informal" co-providers, civil society, and users struggle over and implement decisions regarding future energy generation, distribution, and use in urban contexts. These processes reflect broader disputes concerning access, authority, equity, and sustainability, shaping who benefits and who bears the costs of transitions.

We argue that more systematic political readings of transitions under heterogeneity must thus foreground implementation-level processes. Heterogeneity is shaped through negotiations among unequally powerful actors, competing objectives, and local material conditions. Attention must extend further than formal policy-making that is largely concerned with advancing conventional grid logics and explicitly include the "fragmented, dispersed and often unregulated set of infrastructures outside the formal system of (urban) energy governance" [4: 848]. Here, conventional infrastructural politics driven by formal utilities, regulators, and donors coexist and collide with "popular infrastructural politics" [54] involving neighborhood providers, community initiatives, and everyday user practices. In such contexts, actors omitted from policy formulation, such as street-level staff and organized users, can act as "ultimate policymakers" [14], continuously adjusting and transforming urban energy futures under contradictory pressures [55].

Comparative analyses of differently characterized settings within cities are useful to mobilize this perspective and relate contrasting socio-material conditions to the politics of implementation. The next section develops an implementation-focused approach centered on frontline decision-making and mediation through technical infrastructures.

3. Conceptualizing the street-level politics of urban energy transitions

We analyze urban energy politics through street-level bureaucracy (SLB), treating the utility and its units as a street-level organization (SLO). SLB explains policy enactment through discretionary decisions by officials who "interact with and have wide discretion over the dispensation of benefits" [19: xi]. Subsequent work has shown how frontline organizations—agencies, utilities, local offices—structure and channel discretion through routines, resources, and internal priorities [18]. In Southern urban contexts with limited state capacity, volatile policymaking, and unequal access to services, SLB helps explain patterned divergences between policy aspirations and implementation outcomes [14,55].

We broaden classical readings of SLB along two dimensions to study urban energy politics under heterogeneity. First, building on accountability "beyond hierarchy," we conceptualize multiple, partly conflicting sources of accountability—upward to superiors, regulators, and policymakers; sideways to professional peers, norms, and ideologies; and downward to affected societal actors (communities and users)—each linked to distinct evaluative criteria that are differentially politicized across the city [20–22]. Conflicts over ownership, tariffs, siting, standards, and investment and their reflection in divergent policy goals can thus be read as competing accountability demands that frontline staff must reconcile in specific places with corresponding actors [e.g., 46,56]. Second, we operationalize materiality within SLB. Drawing on distinctly socio-material readings of discretion [23,24], we treat infrastructural artifacts and system parameters as affordances and constraints [26] that configure discretionary choices. Artifact properties and associated knowledge interact with frontline routines and accountabilities, shaping the feasibility, cost, visibility, risk, reversibility, and durability of action. Wires, transformers, meters, SHS, and generators serve as mediators of implementation, rather than merely technical components. They influence where connections can be added, the reliability of supply, or payment enforcement.

Our adapted SLB framework thus foregrounds three interlocking dimensions that structure the politics of implementation under heterogeneity:

1) Frontline discretion under pressure: different transition policies are implemented, altered, or diverted by situated choices made under organizational, political, and practical preferences and constraints;
2) Multiple sources of accountability and politicization: implementers answer not only to hierarchical superiors and regulators but also to professional standards, communities and organized users, market logics, and political principles, which weigh unevenly across urban settings;
3) Material mediation: physical features like grid topologies, component capacities, applied metering technologies, and the built environment condition implementation pathways and outcomes.

Together, these dimensions highlight how different socio-material conditions within cities and competing accountabilities lead to distinct implementation choices. This perspective shows how policy is negotiated under heterogeneity and how these processes reshape electricity constellations. This responds to calls to move studies of heterogeneity "beyond describing complexity" [16] and interrogate how infrastructures shape urban energy transitions locally.

4. Methodology

Our qualitative case study examines the implementation and contestation of energy transition policies across Greater Maputo's heterogeneous infrastructural landscape. Within this case, we compare policy implementation across settings that share the same national policy and governance structure. Fieldwork was conducted between 2021 and 2025, with delays and sequencing shaped by COVID-19-related restrictions. Neighborhoods were selected to capture distinct urban forms, histories, functions, income structure, infrastructure provision, and development patterns. These included Maputo's colonial core, low-income unplanned areas, new peri-urban developments, affluent peripheral neighborhoods and mixed industrial-residential areas. We group them into three ideal-typical settings by dominant electricity challenge—affordability, connectivity, and power quality—and the respective political processes driven by prevalent implementation pressures. Fig. 1 shows the selected fieldwork sites. The grouping structures our comparative analysis while acknowledging that

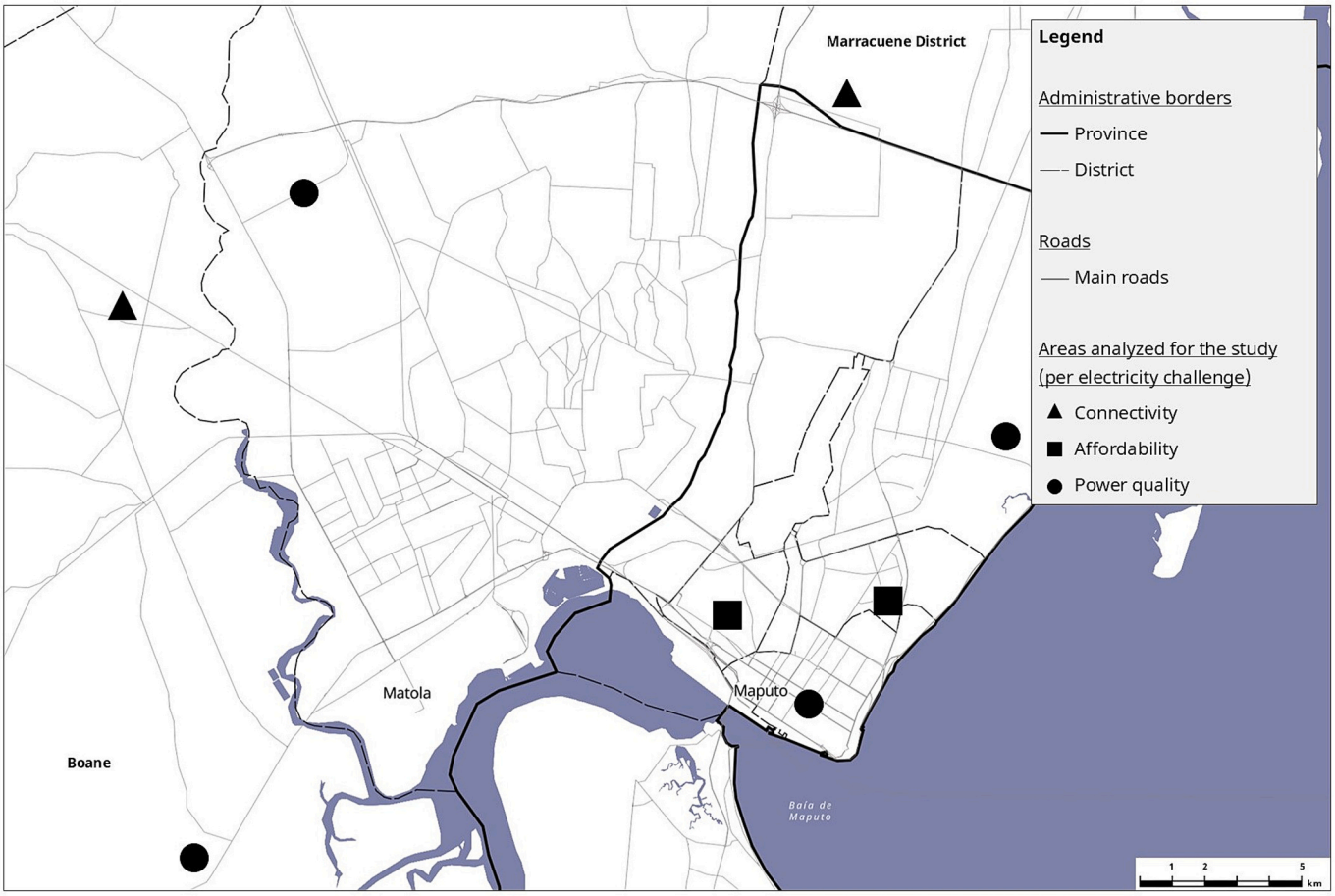


Fig. 1. Selected Greater Maputo fieldwork sites by dominant electricity challenge.

challenges overlap in practice.

The data consist primarily of 59 semi-structured expert interviews on electricity provision and use as well as policy design, regulation, and implementation. Interviewees include EDM staff at headquarters and local levels, national and municipal authorities, international development partners, private-sector actors, researchers and NGOs. Interview guides varied by role but covered policy conflicts, grid functioning and expansion, tariffs, revenue protection, renewable electricity, and local discretion. We triangulated this data with 17 expert interviews from an earlier study on sustainability assessment tools in the electricity sector (such as impact assessments or strategic plans) conducted in 2018 and 2019 [39]. These interviews serve as background material on sectoral reform, donor influence and policy evolution.

Expert interviews are complemented by observations of practices and technical routines from field visits and three Community of Practice workshops, plus 40 interviews with users and community leaders. These neighborhood-level interviews and observations balance the top-down perspectives of institutional actors with those of partly marginalized users. We used snowball-sampling since access to respondents relied on the introduction from local leaders, which limited the applicability of more comprehensive sampling methods. Beginning with local leaders, we identified nearby residents through referrals. This approach necessarily overrepresents residents connected to local leaders and households that were physically accessible during fieldwork. Thus, we use findings from these interviews not as representative evidence. The interviews focused on everyday practices, technical artifacts, experiences of service provision, and users' roles in implementing or contesting official policies. Areas characterized by power-quality concerns are somewhat overrepresented because they include affluent, mixed industrial-residential, and colonial-core neighborhoods. The number of respondents in each group and their role in our analysis are summarized in Table 1.

In addition to interviews, we analyzed national policies and strategies, development project reports, company reports, strategic documents, energy system plans and secondary empirical literature on Greater Maputo's urban and energy landscape. The material was examined through qualitative content analysis by the lead author using MaxQDA. Initial coding combined framework-derived and inductive themes, including policy goals and outcomes, actors and interactions, material infrastructures, implementation practices, and conflicts. A second coding stage compared these themes across settings and supported the identification of persistent divergence patterns.

The resulting analytical categories inform the empirical analysis that follows. The next section first introduces Mozambique's electricity-sector policies and the accountabilities they generate for implementers like EDM, before Section 6 traces how these accountabilities are negotiated and materially mediated across three different settings in Greater Maputo.

5. Conflicting policy goals and multi-source accountabilities in Mozambique's electricity sector

Mozambique's electricity sector is predominantly shaped by national state actors, most notably the FRELIMO-controlled Government of Mozambique (GoM), and by Electricidade de Moçambique (EDM), the vertically integrated, state-owned utility. Since independence, and inspired by socialist ideals, state actors have advanced a public service vision of electricity, "to serve the population" [57: 85], characterized by low tariffs, cross-subsidization, and an orientation toward manufacturing-led growth. Two operational principles followed from

Table 1
Overview of interview respondent groups.

Respondent category	Number of interviews (additional ones from [39])	Role in analysis
EDM headquarters	11 (10)	Organizational priorities, performance metrics and sector reform approaches.
EDM local and district offices	7 (2)	Local implementation routines, discretion, and conflict management.
National-level authorities	7 (2)	Policy objectives, regulation and sector reform priorities.
Urban planners and municipal officials	6 (1)	Urban development context, land-use change and cross-sector coordination.
Donors, international development actors, and consultants	11 (2)	Financing logics, donor metrics and priorities, relationships with national actors.
Private companies: Energy providers, real-estate companies, financial institutions	8	Off-grid markets, financing, real-estate and user-demand perspectives.
Researchers & NGOs	9	Various perspectives on prevalent issues; independent interpretation of phenomena.
Local authorities and community leaders	9	Perception of and interaction with electricity sector actors. Community pressures and contestation of implementation.
Users in peri-urban areas	9	Grid expansion experiences, SHS use and local co-production.
Users in inner-city low-income areas	9	Affordability, prepayment, coping strategies and informal access.
Users in areas with premium reliability requirements	13	Reliability demands, differentiated service expectations, and co-production.

this ideal. First, large agglomerations such as Greater Maputo were to receive universal, integrated grids, making household connections a key indicator of policy implementation. Second, the state used electricity exports, which are primarily to South Africa, to generate public revenue. Although export earnings were not systematically reinvested into sector expansion, the public service model required EDM to supply electricity below cost, which undermined the company's financial sustainability over time [58]. These legacies still shape EDM's operations, even as other accountabilities have emerged. Macro-level power relations are not abstractly linked to policy implementation, but concretely shape EDM's accountability pressures upward, through party and state expectations and regulations, while politically mediated user claims shape downward accountability.

After the civil war, external financing and technical assistance needs grew in the electricity sector. Mozambique adopted structural adjustment programs promoted by the World Bank and key bilateral donors (notably Scandinavian partners). Following the World Bank's "standard model" [59], reforms were aimed at addressing financial sustainability and attracting private investment. EDM had to internalize commercial logics alongside its public mandate by installing prepaid meters to improve revenue collection [40], policing to reduce illegal connections and commercial losses [60], and introducing managerial and institutional reforms. Cost recovery was pursued through tariff increases to better reflect procurement costs. In parallel, EDM's public reporting increasingly foregrounded economic and managerial performance indicators [61]. These indicators translate reform priorities into specific expectations for EDM units concerning connection numbers, revenue and loss reduction, and service quality. Although these shifts aligned the utility with upward, market and regulatory accountabilities (creditworthiness, loss reduction, and cost-recovery principles), they had unintended effects: efforts to save costs, even as connection numbers rose, resulted in stagnation in equipment condition, service reliability and power quality [cf. 43]. Alongside universal-service expectations, these metrics create conflicting implementation accountabilities.

From 2018 onward, tensions between public service and cost recovery were compounded by an access-first transition agenda aimed at meeting the Sustainable Development Goal of "Energy for All" [62]. Under the ProEnergia program [63], connection fee waivers and results-based financing accelerated grid expansion. The output-focused program pressures EDM to increase the number of connections, which is sometimes at odds with financial sustainability. An expert at a bilateral development organization noted:

"The donors come with their priorities that are kind of colored by policy back home. […] There's been a lot of pressure on donors to have quantifiable objectives and indicators and so counting connections, obviously, it's quantifiable. […] These projects have impaired the reliability of EDM's grid. And they have impaired the financial situation of EDM." (Interview 1).

Quantifiable targets push EDM to connect low- and middle-income customers whose loads strain capacity and reliability while their limited consumption cannot recover extension costs. Connection numbers thus signal progress while weakening service quality and EDM's financial performance in practice.

In parallel, greening the sector by introducing renewable generation has gained visibility. For example, the Rural Electrification Fund FUNAE is responsible for administering off-grid electrification efforts via stand-alone systems (notably SHS) with donor-backed market development, technical assistance, and results-based incentives to private firms, e.g., through BRILHO [64] and FASER [65]. These programs expand renewable generation beyond EDM but conflict with universal-grid ideals as they partly provide access in areas where residents eventually expect grid connections. On-grid, the PROLER initiative, led by the GoM and European partners, issues tenders for private photovoltaic (PV) power plants. However, their costs have occasionally exceeded EDM's end-user tariffs (Interview 2), creating a mismatch between renewable procurement, regulated tariffs, and cost-recovery responsibilities. Greening is thus sidelined at EDM, which keeps its focus on access, cost recovery, and reliability as key goals in daily operations.

Summarizing, Mozambique's policy mix comprises the following, somewhat irreconcilable goals:

a) A public service ideal (affordable and universal electricity supply) pursued alongside state revenue from exports;
b) Cost recovery to ensure EDM's financial sustainability, attract investment, and reduce public subsidies;
c) Energy access for all, aligned with international development agendas that prioritize connection numbers;
d) Green energy expansion through off-grid (stand-alone systems, mini-grids) and on-grid renewables, although weakly operationalized.

Energy efficiency has only recently been formalized in policymaking through the 2023–2033 Energy Efficiency Strategy [66], but has not yet materialized in concrete instruments shaping EDM's local operations or users' electricity practices.

Official documents rarely acknowledge these tensions among goals. Instead, a coherent narrative is presented that aligns with and legitimizes donor-promoted changes and pressures. This narrative has institutional effects, including new units, planning templates, or reporting lines [cf. 39] and sectoral reconfigurations (policy design, investment programs, procurement). FUNAE's mandate to focus on unprofitable, off-grid areas can disadvantage rural communities, who are left waiting for uncertain service levels [42], a situation at odds with ideals of public service and universal access. Furthermore, creditworthiness and bankability [42] have infused sector practice with financial value-regime

criteria misaligned with affordability needs and distribution-network conditions.

These incompatibilities in policy formulation translate macro-level power relations—above all, influential donors' priorities and the GoM's alignment with them—and create conflicting accountabilities for EDM and its staff. However, little is known about how conflicts are negotiated in practice and how they shape local infrastructural outcomes. Because heterogeneity is barely integrated into policy design, a key question is how Greater Maputo's existing electricity constellations shape and are being shaped by implementation practice. We examine three ideal-typical settings in which EDM and its units interpret, reconcile, and contest competing accountabilities under varying material conditions and politicizations: peri-urban grid-expansion zones, low-income inner-city areas, and areas with premium reliability requirements. Read through our SLB lens, we highlight the discretionary practices and material affordances and constraints that turn policymakers' goals into patterned divergences on the ground.

6. Contested place-based implementations of energy transition policies across Greater Maputo

As the largest agglomeration and electricity consumer in Mozambique, Greater Maputo is a focus of policy implementation pressures. Diverse settlement forms coexist here: sprawling peri-urban areas requiring grid extensions for connectivity [67], low-income neighborhoods where affordability is paramount [e.g., 57], and areas where users demand premium reliability [43], including Maputo's residential-commercial colonial core, affluent peripheral districts, and mixed industrial-residential zones [43]. Because EDM cannot fully and simultaneously satisfy all demands, users and private providers mobilize alternative socio-technical channels, from illegal grid extensions and shared meters to generators and SHS [27]. These form place-based, heterogeneous electricity constellations with varying socio-technical conditions and unequal power relations that affect policymakers' actions amid conflicting transition goals. In practice, these conflicts are negotiated through artifacts that enable and constrain action by EDM's managers, their staff, and users. We thus analyze how conflicts are addressed during implementation in three settings across Maputo, Matola, Boane, and Marracuene (Fig. 1) and show how discretion mediates accountabilities across socio-material environments. The settings are ideal-typical problems rather than coherent, spatially bounded settlements with exclusive challenges. In reality, affordability, connectivity, and reliability concerns are intertwined, especially where low-income settlements, industrial uses, and middle-class housing exist in close proximity.

6.1. Expanding peri-urban connectivity: navigating donor policies and local pressures

Largely unregulated, market-driven land development at Greater Maputo's urban fringes generates incessant demand for household connections. These settlements are the main arenas for EDM's expansion efforts under its public service narrative and the Energy for All agenda. Macro-political pressure intensified after the President announced connection fee waivers [68], while through programs like ProEnergia, donors pushed for high-value-for-money investments that privilege low-cost connections per beneficiary. Confronted with the cost of extending coverage across sprawling neighborhoods, EDM prioritizes "grid densification" pockets to improve the capital-expenditure-per-connection ratio, regardless of administrative boundaries (Interviews 3 & 4). Residents just outside these pockets face uncertain, poorly communicated timelines as grid expansion works bypass their streets.

Peri-urban communities respond with collective strategies to contest or accelerate EDM's plans. Some organize extensions themselves by providing materials and labor, sometimes in coordination with EDM, sometimes via illegal extensions when the utility remains unresponsive. Others leverage political networks to lodge complaints about unimplemented policies, or stage protests at local offices. As one EDM manager put it:

"People come and protest, it's not easy [to respond]. It depends on the moment: I must start from the critical. 'This is critical, I have to solve this first' and then I go back in priorities. […] The prospective customers make lots of pressure. They come again and call, then submit letters, they complain every day." (Interview 5).

Staff triage neighborhoods, cluster works around transformer capacity and construction costs, and authorize provisional solutions requiring later legalization or component adjustment. This balances headquarters and donor targets, professional norms, and timely service within wire and transformer capacity, existing loads, and technical standards. While delivering reportable connections, this practice overloads low-voltage circuits and transformers. The connection-centered logic has direct material consequences. Under-dimensioned components embed poor power quality and require later upgrades, which become costlier, but are less visible in reporting. Risks shift to pre-investing communities and to EDM, whose grid portfolio grows unsustainably.

As a consequence of these grid-expansion dynamics, off-grid greening through SHS often functions as an interim solution rather than a durable alternative. Multiple donor initiatives (e.g., BRILHO or Beyond the Grid Africa) have stimulated these markets, aligning with European donors' "green access" narratives (Interviews 1 & 6). The GoM acknowledges on- and off-grid systems' coexistence (Interview 7), but this conflicts with universal-grid, cost-recovery, and access-first logics. Donors' emphasis on high-price, high-quality SHS does not match households' expectations, especially as households expect the centralized grid to support larger loads, cost less, and not have the temporal constraints of using SHS (Interview 8). Providers therefore allow recovery and resale of partially paid systems, reducing household risk (Interview 9). These adjustments reconcile short-term user and company interests, but they undercut the green access narrative of sustained off-grid solar electricity use as a direct consequence of SHS' low and limited power output [cf. 65]. The temporary character of SHS use is, however, not merely technical, but reflects an anticipatory practice whereby households expecting EDM grid access postpone SHS purchases or treat existing systems as assets to be resold [27]. Rather than operating as a stable green alternative, off-grid solar is made provisional by the access-first agenda. Households face uncertain grid access and costly interim SHS due to financing rules, results-based indicators, and local discretion that favor rapid on- and off-grid connection numbers.

6.2. Safeguarding affordability in low-income areas: negotiating revenue protection and social mandates

In dense, low-income neighborhoods near the city's colonial core, contestations mainly concern affordability as a central challenge. Increased cost-recovery pressures by ARENE [69] and the Energy for All expansion have led to higher tariffs which intensify household budget stress. The *tarifa social* (the lifeline tariff intended "to accelerate development and access to electricity" [70: 45]) has little practical relevance because EDM does not proactively inform customers about its existence and has created a very bureaucratic application procedure for it. This protects the utility's revenue base, an outcome enabled by the regulator ARENE not intervening to force corrective action. The result is clear: only 0.02% of Greater Maputo residential customers benefit from the *tarifa social*, and lifeline tariffs represent just 0.01% of residential sales [71]. Some international actors question the tariff, arguing that inability to pay is "a myth" because grid power is cheaper than popular alternatives like kerosene or generators (Interview 1).

Households respond by withholding payment, tapping networks with peers or hired electricians (Interview 10), and sharing meters. These tactics undermine EDM's cost-recovery efforts, which have become resource-intensive as the utility and partners invest in

commercial loss reduction (such as enhanced inspection and fines) institutionalized through a revenue protection directorate. One technological fix being pursued is smart metering with remote monitoring, as inspection patrols occur largely during daytime, but some thefts involve nocturnal connections (Interview 10). Some inspection teams nevertheless waive petty-theft fines or delay sanctions to preserve social cohesion (Interview 11). Such discretion balances revenue protection pressures against fairness and continued access.

Prepaid meters shift revenue enforcement from negotiable billing and disconnection practices toward technically mediated payment discipline. Income volatility drives small top-ups, rationing, and recurrent credit lapses despite formal connection. Households then use candles, kerosene, charcoal, or small generators: costly, lower-quality, and often unsafe, but divisible into manageable purchases. Small solar devices, although increasingly available in local markets, did not emerge in the examined field sites as a major substitute for grid electricity. While our interviews did not systematically establish the reasons for this, the relatively high upfront cost may explain this limited uptake, as shown by evidence on PV adoption in Ghana [72].

The interaction between tariffs, prepayment, and household cash flow reproduces energy poverty but in new forms. Enforcement intensifies when commercial losses or safety concerns become salient, whereas pragmatic leniency prevails when petty-theft sanctions threaten legitimacy or risk escalating conflicts (Interviews 10 & 11). Illegality thus persists alongside partial regularization of connections. Overloaded components and safety deficits prompt EDM staff to enforce minimum standards even when full cost recovery is unlikely, thus requiring staff to constantly balance revenue protection with risk reduction and legitimacy. Meters, inspection routines, and old infrastructural assets thereby shape practical compliance.

6.3. Navigating premium reliability demands: discretion via co-financing

In commercial areas, mixed industrial-residential zones, and affluent residential districts, user demands center on reliability, power quality, and assured capacity. Often, these areas are not homogeneous enclaves. Commercial activities coexist with high-rise housing in the colonial core, while middle-class developments directly border light industry in Matola. Upstream generation and transmission projects such as the World Bank-supported PERIP and the EU/Norway-financed Short-Term Investment Plan (STIP) have improved material conditions on the supply side through grid reinforcements [73]. Larger commercial and industrial clients connected directly to the upgraded grid components benefit most directly from these projects. However, bottlenecks remain in the low- and medium-voltage grids to which residential customers are directly connected. These grids often receive less priority because the Energy for All agenda rewards distribution quality less than connection numbers (Interview 12). The effect is a decoupling: EDM can accommodate more customers and avoid major high-voltage interruptions, but local reliability for sensitive loads stagnates [73]. Spillovers to low-voltage grids exist, but depend on grid topology, leaving residents exposed to transformer capacity constraints and service-line failures. Influential users, especially those with ties to business elites and FRELIMO, exert political pressure for prioritized upgrades, adding a distinctive political accountability to EDM managers on several levels [cf. 74]. Despite paying lower tariffs, commercial clients can pressure EDM to install dedicated equipment to meet their needs.

Because EDM remains discursively and institutionally bound by the universal service ideal, overt service differentiation is difficult to justify. It would also require higher tariffs reflecting premium quality to align with cost-recovery logics. In practice, EDM has adopted pragmatic workarounds. First, extra resources are used to reinforce distribution in the old colonial core areas, where complaints are politically consequential. Second, EDM negotiates co-financing with large users who fund dedicated transformers, feeders, or upgrades for priority access to these assets (Interviews 13 & 14). Such arrangements are materially possible because dedicated assets can be attached to clients' large premises, industrial plots, or condominium developments while remaining connected to EDM's grid. Reliability is thus negotiated through the siting, sizing, ownership, and operation of grid components rather than through formal service classes and differentiated tariffs. Case-specific co-ownership and provision models yield mixed entitlements, including guaranteed client capacity and residual capacity for adjacent loads. Benefits for nearby residential and other users depend on opaque agreements with contributing clients.

These mechanisms shift cost recovery from tariffs toward capital contributions and self-provision, allowing EDM to meet reliability demands without formally abandoning universalism. In the absence of strong regulatory oversight (Interview 15), such arrangements can be opaque and difficult to monitor. At the same time, they satisfy powerful actors, preserve EDM's financial assets, and stabilize public narratives around universal service provision. Compared with peri-urban fee waivers recouped through increased tariffs, premium reliability represents an opposite divergence. One strategy visibly creates connectivity; the other quietly negotiates reliability while retaining the public-service narrative. Dedicated asset siting, sizing, ownership, and operation turn discretionary accommodation into durable infrastructural privilege. Selective improvements produce uneven spillovers, especially in mixed industrial-residential areas, reproducing socio-spatial discrimination beneath formal universalism.

Affluent residents complement negotiated grid arrangements with distributed PV and solar thermal self-provision. As part of individual reliability strategies, and alongside generators and battery-inverter systems, they help users to partly insulate themselves from grid-quality issues and tariff increases [27]. This partial "off-gridding" is thus primarily a reliability strategy rather than a coordinated decarbonization pathway. However, it complicates EDM's cost-recovery efforts as revenue declines while the grid must maintain its reliability and capacity functions.

Across the settings, the same national policy mix produces different pressures and outcomes through organizational and frontline discretion. In peri-urban areas, connection counts are pursued through material compromises in low-voltage networks; in low-income areas, cost recovery is enforced through prepaid meters and inspections while selective tolerance helps balance this with affordability and local legitimacy; and in the various areas demanding premium reliability, mechanisms dedicating financial and physical assets allow privileged users to negotiate and access higher service quality without formal tariff differentiation. These are not ad-hoc "policy failures", but patterned divergences emerging from interactions among EDM routines, political pressures, and varying material conditions. Below, we discuss how these processes reproduce and reconfigure heterogeneous electricity constellations across Greater Maputo.

7. Discussion

The Greater Maputo case illustrates how an access-first, grid-centered energy transition unfolds through localized implementation patterns amid urban and infrastructural heterogeneity. From an SLB perspective, divergences from national goals do not appear as "policy failure" but as patterned outcomes of frontline and organizational discretion under competing accountabilities. Macro-level power relations among the GoM, donors, and EDM translate into performance metrics, cost-recovery pressures, and politically mediated user claims. EDM, its offices, and its individual staff must negotiate such pressures under varying material conditions throughout Greater Maputo which shape what is feasible and contestable in each setting. Discretion is distributed across EDM's organizational levels. Whereas national-level management sets processes, targets, and rules, district offices negotiate deviations and allocate respective resources, and field staff must balance enforcement and leniency in daily user interactions. Table 2 summarizes the resulting processes and divergence patterns.

Table 2
Street-level implementation processes and divergence patterns across ideal-typical settings in Greater Maputo.

Urban setting & user groups	Discretionary practices	Accountabilities & politicization	Material constraints & affordances	Divergence pattern
Sprawling peri-urban neighborhoods; grid expansion zones. Low- and middle-income residents as prospective grid customers and SHS users.	Prioritization of densification along cost-efficiency metrics; ad-hoc sequencing under connection pressure; community co-production exploited to reduce cost; flexible handling of capacity standards.	Upward: GoM/EDM HQ for connection targets; donor results-based financing & value-for-money. Downward: communities, local leaders, party channels (protests, letters). Professional: reasonability, basic safety, minimum reliability.	Long cables (voltage drop/thermal stress) and transformer size; connection standards; built environment (dense pockets vs. scattered developments); SHS output (limited loads).	**Illusory implementation**: fast, countable connections without matching capacity; overloaded grids, voltage drops, delayed upgrades; SHS as provisional strategy due to anticipated and preferred grid access.
Low-income inner-city neighborhoods with dense fabric. Low-income users, largely tenants; with shared and informal connections.	Selective inspections; waiving/softening of fines for petty theft and pragmatic tolerance of shared meters by frontline workers; prioritization of enforcement according to professional norms and legitimacy considerations.	Upward: EDM HQ/government & donors for loss reduction and cost recovery; regulator for cost-reflective tariffs. Downward: users and local leaders contesting cut-offs; legitimacy.	Prepayment meters mediate payment discipline and intermittent access; dense built structures hampering inspection; properties of non-electric alternatives (cost in small increments).	**Selective enforcement**: partial formalization and enforcement of cost recovery alongside persistent leniency concerning illegal practices and meter sharing.
Mixed residential-commercial/industrial areas & affluent neighborhoods. Mainly affluent, powerful, and high-consumption users driving premium reliability demands.	Closed-door negotiations for co-financing and operation/maintenance responsibilities of dedicated assets as well as residual capacities thereof; prioritized reinforcement; occasionally: reallocation of funds.	Upward: universal-service narrative; donor-funded reinforcements, cost-recovery. Downward: influential firms, business associations, elites (with party ties).	Cable and transformer capacity and siting; space on clients' plots. Grid-connected PV and battery equipment for self-provision.	**Informal service differentiation**: premium reliability for key clients via case-by-case, co-financed assets, and access agreements; opaque process with uneven spillovers in residential areas and durable infrastructural privilege for powerful customers; public service discourse retained.

In peri-urban areas, the GoM's and donors' emphasis on connection numbers aligns with residents' pressure for rapid grid access. Local offices use discretion to prioritize densification pockets, cluster works to keep costs and voltage levels manageable, and sometimes tolerate co-production or provisional solutions. Long low-voltage wires and transformer capacities limit how many customers and loads can be added without impairing quality. The result is *illusory implementation*: fast, reportable connection numbers alongside overloaded grids and deferred upgrading and maintenance burdens. Meanwhile, donor-stimulated SHS function as interim solutions. As many users treat SHS as temporary and abandon them after achieving grid access, long-term "green access" claims are undermined. EDM's discretionary practices prioritize traceable targets under different material constraints, jeopardizing public-service and greening goals and creating future upgrading and maintenance burdens.

In densely populated, low-income neighborhoods, cost-recovery and loss-reduction agendas come up against limited ability to pay and expectations of affordable, continuous service. Although prepayment helps EDM reassert control, rising tariffs mean that households must increasingly ration their consumption. Residents cope by sharing meters, reducing and deferring usage, and making illegal connections. EDM responds with costly and contested inspections and penalties, but frontline teams adapt enforcement to protect its legitimacy and social order, upholding the public service narrative. This pattern can be described as *selective enforcement*: a hampered loss-reduction initiative, with frontline staff trying to maintain basic access by tolerating illegal practices. Consequently, affordability stress and illegality persist, cost recovery is limited, and reliance on substitutes like candles, kerosene, or generators remains high.

In commercial cores, industrial areas, and affluent neighborhoods, party-connected business elites and residents politicize reliability and capacity constraints. Upstream reinforcements help EDM boost reliability numbers, but low- and medium-voltage bottlenecks persist and access-focused programs place less importance on them. EDM meets premium demands through opaque, case-specific co-financing of dedicated transformers and cable upgrades without formal service differentiation. This *informal service differentiation* stabilizes premium provision for key actors and protects EDM's asset base, but it also entrenches inequitable service and power imbalances, effectively undermining the public service ideal and the target of universal and homogeneous grid provision.

The three divergence patterns interact across settings. Illusory implementation in peri-urban areas, for example, creates future reliability challenges, with added costs of technical losses and necessary reinforcements feeding back into EDM's cost-recovery pressures. These pressures particularly affect low-income neighborhoods, where financial sustainability ambitions channeled through tariff increases, prepayment metering, and loss-reduction campaigns result in intermittent access and persistent illegality. At the same time, informal service differentiation allows resourceful users to circumvent these negative effects by co-financing dedicated assets or self-providing electricity. Users potentially leaving the grid may further weaken EDM's revenue base and intensify pressures on expansion projects or revenue-protection efforts. Divergence is therefore an intertwined set of political processes, not merely spatial variation in implementation. Accommodation in one setting can reinforce social and material constraints elsewhere. Greening agendas are folded into these dynamics, rather than being a separate transition dimension. SHS have not been practically established as a strategic, long-term solution in peri-urban areas, low-income users are not opting for solar devices to tackle times without grid access, and affluent users' adoption of PV and the deployment of utility-scale PV systems introduce additional cost-recovery and grid-integration challenges.

Across the three settings, energy transition goals are negotiated and contested in locally distinct ways, resulting in the three divergence patterns described above. These patterns, advanced by EDM, its local managers, and its frontline staff, are clearly enabled or constrained by heterogeneous electricity constellations characterized by earlier

deployed material assets, available technological fixes, and diverse built environments. Importantly, actors' discretion is rooted in material constraints and affordances, allowing pressures from multiple accountabilities to be weighed and negotiated, but also foreclosing certain pathways. By affecting Greater Maputo's heterogeneous electricity constellations in this way, street-level politics help explain how heterogeneity persists and is actively reconfigured through urban energy transitions.

8. Conclusion

This paper examined the politics of implementing urban energy transition policies through Greater Maputo's access-first, distribution-centered setting. We investigated how conflicting goals—public service ideals, cost recovery, universal access, and greening—are contested and prioritized across diverse urban settings amid complex power dynamics and varying socio-material conditions. We used an adapted street-level bureaucracy (SLB) framework to examine how EDM functions as a street-level organization, focusing particularly on local managers and frontline workers negotiating place-specific demands under uneven socio-material conditions. These processes result in patterned divergences from officially stated policy that sustain and reshape heterogeneous urban electricity constellations.

Our approach contributes to the scholarship on urban energy transitions and their governance in sub-Saharan Africa [4,16,28,31]. Using the lens of SLB helps explain why policy goals are pursued differently across urban agglomerations: implementers face varying degrees of upward accountability to superiors, regulators, and donors, downward accountability to users and communities, and lateral accountability to peers, professional norms, and organizational practices and ideologies. Crucially, these pressures are mediated by urban and infrastructural heterogeneity, including actors' political priorities in each setting, their unequal power relations, and differing material conditions (component characteristics and the built environment). In turn, these material conditions shape what is feasible, legible, and politically salient in each setting through their interaction with accountabilities and frontline routines: grid distance, wire and transformer capacity, metering technologies, and the capacities of SHS shape where connections can be added, whether expansion undermines reliability, how payment discipline is enforced, and how users can compensate for inadequate service. Thus, heterogeneity is not only a backdrop constraining policy efforts. It also creates room for discretionary compromises that reconcile different—often conflicting and convoluted—demands. In this process, heterogeneity is reshaped by frontline discretion and becomes an outcome of place-based struggles over energy transition pathways.

At the same time, street-level processes remain connected to party-state interests, donor reporting and financing conditions, and claims by organized users and elites. The patterned divergences identified—"illusory implementation", "selective enforcement" and "informal service differentiation"—can be understood as modes through which utilities as frontline organizations reconcile these macro-level pressures with financial and technical constraints, and socially embedded practices. These modes do not reflect discrete, isolated outcomes limited to specific neighborhood settings, but rather reveal complex, multi-scalar urban infrastructure politics that evolve amid heterogeneity and are linked to wider questions of splintering, differentiated citizenship, and inequality across whole urban regions. The SLB framework thus elucidates heterogeneity beyond description [16] and helps explain the political-material mechanisms that reproduce it.

Empirically, the study yields three key insights into urban energy politics in sub-Saharan Africa. The first is that multiple transition goals are negotiated across scales and locales in response to varying interests of actors, power dynamics, and material conditions. A lack of attention to varied urban infrastructure geographies risks contestation during implementation, while policy ambiguity encourages a pragmatic street-level response from frontline actors. While low-carbon efforts play a minor role in Greater Maputo's energy transition agenda, cost recovery of grid services is a key concern and most rigorously pursued in low-income neighborhoods, whereas peri-urban and affluent areas feature systematic deviations through fee waivers and informal service differentiation. Second, powerful alliances often require frontline actors to disproportionately attend to elite interests when seeking workable compromises. These compromises further sideline weakly operationalized greening agendas, but also public-service goals, while shifting the risk of future unreliable supply and unaffordable tariffs toward disadvantaged residents. Third, although policies focus on homogeneous, centralized grid access, urban energy politics revolve around various socio-technical channels and refigure them. The poorly communicated and unpredictable grid expansion in peri-urban neighborhoods affects the uptake of SHS and greening possibilities; cost-recovery efforts reinforce illegal electricity patterns, meter sharing, and non-electric alternatives in low-income areas; and co-financed upgrades make reliability a selective and negotiated good amid ongoing talk of universalization. Thereby, the place-based politicization of transition policies produces socio-materially complex and spatially fragmented outcomes.

These findings have significant policy implications. Current approaches overlook place-based interests and how groups experience and contest grid-focused implementation. Policies must acknowledge and address the interdependence of various goals and the actors pursuing them, rather than treating them as separate. More emphasis must be placed on how interventions redistribute service quality, costs, and risks across places and user groups, while accounting for the effects they have on existing socio-material arrangements. This requires criteria beyond connection numbers, as well as the systematic assessment of spillovers across settings, users, and access channels. In turn, more spatially differentiated investment priorities, protection of basic consumption for low-income users, and transparent rules for co-financed or decentralized assets are needed. Crucially, negotiating trade-offs before implementation through the institutionalized participation of local utility staff and affected users can reduce reliance on opaque, ad-hoc discretionary decisions and help prevent progress in one setting from producing higher costs, risks, and infrastructural constraints elsewhere.

Finally, the paper raises questions for further research. As a single-case, qualitative study, our argument is necessarily shaped by the specific political economy, donor landscape, and infrastructural history of Mozambique's electricity sector. Nevertheless, the findings suggest that future research on urban energy politics should pay greater attention to implementation as an important political arena in its own right. Rather than treating local departures from policy as isolated outcomes, studies should examine how local-level decisions accumulate, interact across places, and become embedded in infrastructure and service provision and use. This perspective helps clarify how implementation shapes urban energy transition pathways over time, including their social and ecological dimensions, and enables us to think through alternatives to current developments.

CRediT authorship contribution statement

Mathias Koepke: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization, Data curation, Project administration. **Jochen Monstadt:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization, Project administration. **Kei Otsuki:** Writing – review & editing, Supervision, Conceptualization, Project administration.

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Appendix A. Cited interviews

1. Senior Advisor, bilateral development organization.
2. Director, EDM.
3. Engineer, Electrification and Projects Directorate, EDM.
4. Senior Energy Specialist, international development organization.
5. Delegation Manager, EDM.
6. Portfolio Manager, bilateral development organization.
7. Head of Department, Ministry of Mineral Resources and Energy.
8. Renewable Energy Industry Expert.
9. Chief Executive, private off-grid energy provider.
10. Director, EDM.
11. Founder and Director, local housing NGO.
12. Chief Executive, private engineering firm.
13. Director, EDM.
14. General Director, industrial client of EDM.
15. Consultant & Former Chairman, EDM.

Data availability

The data generated and analyzed for this study are confidential. Data may be made available upon reasonable request and with the agreement of the respective participants.

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