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Perspective

The prepay "poverty premium": Perspective on Australia's Northern Territory prepayment tariff

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ABSTRACT

The affordability of prepaid electricity - in common use in jurisdictions where the proportion of Indigenous Australians living remotely is greatest and Indigenous poverty rates are uniquely high (above 40 %) - represents an exceptional yet under examined aspect of the nation's energy transition. Here we explore a previously overlooked element of the prepaid electricity system in Australia's remote and regional Northern Territory (NT): how it disproportionately burdens high consumption households with a "poverty premium". Our findings reveal financial disparities arising from the application of two discrete electricity payment types operating throughout the Territory since 1998: the prepayment tariff versus the residential tariff plus fixed daily supply charge. By appraising three decades of NT Electricity Pricing Orders (EPOs) we highlight the mechanism by which prepay households using more than a threshold rate of electricity - that has varied over time - are penalized financially. Using known rates of household energy consumption, we demonstrate that while a subset of households are better off, prepay imposes an annual premium of AUD$57–$253 on those with higher consumption (26-48kWh daily in 2018/19) - homes that incongruously experience both an elevated risk of disconnection during temperature extremes and greater energy expenses than all other Territorians. Our perspective complicates the trope that prepay is a fairer way to distribute energy costs in Australia's most remote jurisdiction.

1. Introduction

A significant number of Aboriginal and Torres Strait Islander people live in remote parts of Australia - on lands they have cared for over millennia, now increasingly cast as central to the nation's ambitions of becoming a renewable energy 'superpower' [1]. Yet these same regions continue to experience some of the starkest disparities in living conditions and socio-economic outcomes between Indigenous and non-Indigenous Australians [2]. Complicating narratives of green energy opportunities in remote Australia is a more prosaic, persistent reality: essential service provision in remote and regional Indigenous communities - particularly for electricity, housing, and water supply and quality - continue to fall short of national standards [3,4].

Addressing these systemic inequalities is vital to advancing social and energy justice in Australia; ensuring that the benefits of energy transition are equitably shared, that marginalized voices are meaningfully included, and that outcomes are not only fair but reparative [5–8]. These tensions are particularly pronounced in the Northern Territory (NT), where Australia's system of horizontal fiscal equalisation - a tax redistribution model designed to ensure equitable service delivery by redistributing GST revenues across states - has failed to address deep-seated structural disadvantage and persistent capital underinvestment [9,10]. This challenge is highlighted in the most recent Closing the Gap Annual Report, which tracks Australian government commitments to

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health equality for Indigenous Australians [11].[1] Target 9(b), one of 19 national socio-economic targets across areas that have an impact on life outcomes for Aboriginal and Torres Strait Islander people, aims to 'ensure that (by 2031) all Aboriginal and Torres Strait Islander households within discrete communities receive essential services that meet or exceed jurisdictional standards' [12] (p. 9). Yet the Australian Government acknowledges this target 'is not able to be reported against, as there is no data source currently available which includes all required data elements' [13]. As Australia's most remote and sparsely populated contiguous jurisdiction, the NT faces unique challenges in delivering essential services, across a vast service area of >1.3 million square kilometres – a territory roughly equivalent in size to France, Germany, and Spain combined. The very high costs of service delivery, coupled with small, widely dispersed, low-income customer bases, necessitate substantial government support within a policy environment shaped by limited resources [14], shifting notions of jurisdictional responsibility [15], and an increasing reliance on market-based access regimes that prioritize the ability to pay over genuine need [16].

In this perspective, we focus on persistent disparities - a "poverty premium" - between prepaid and standard billing arrangements in the NT's residential electricity sector. We explore this context because of an apparent paradox: the affordability of electricity in the NT is generally considered to be good [17].[2] Yet the energy landscape is characterized by high household consumption - driven by Australia's hottest climate - and widespread financial hardship, in the nation's least populous and most economically disadvantaged jurisdiction, where prepay has long been the default for town based and remote Indigenous communities [18].

A poverty premium is identifiable when individuals experiencing poverty are disadvantaged in ways that result in them being charged higher rates for necessities compared to those with greater means [19]. It is a structural penalty only incurred by those least able to afford it. The poverty premium has not been extensively researched in places outside the major electricity grid in Australia. However, international studies have demonstrated several instances where prepaid electricity, almost exclusively consumed by poorer households, has proven more expensive for some [18–22] - a pattern we show is consistent with the Australian experience. Low-income families in inefficient homes in hot climates using prepay can face a vicious cycle: they require more power for basic needs yet, without means for efficiency upgrades, either pay disproportionately more for power or limit essential energy use [22–25]. This is the prepaid paradox – intended to curb energy use in high-cost settings, prepay can inadvertently penalize the poor, through higher costs for high consumption households or via the knock-on expenses associated with involuntary self-disconnections.[3]

To provide context, we begin by highlighting present day socio-economic disparities in the NT, as illustrated by Indigenous income poverty rates by region, and their changes between the 2016 and 2021 national censuses (Fig. 1). We outline the Territory's energy policy landscape (Section 2), including the introduction of the prepay tariff and its operation in the Territory since 1998 (Table 1). Drawing on typical household energy consumption rates published by the utility (Table 2), we quantify energy cost disparities – the poverty premium (Section 3) – for a single year (Australia's hottest year on record, 2018–2019) (Fig. 3) [26] to show how the prepay tariff places a disproportionate financial burden on high-consumption households – often those least able to afford it. Through analysing 25 years of NT Electricity Pricing Orders (EPO's) (Section 5) we trace how this policy driven disparity has evolved over a quarter of a century, revealing inconsistencies in the relative energy breakeven (in kWh) across different policy periods (Fig. 4). Finally, we discuss some of the implications arising from this previously unexplored example of policy exceptionalism (Section 6). Our perspective demonstrates how the differential pricing policy creates a structural "poverty premium" unique to high-consumption households under prepay, highlighting the need for more attentive policy support for this cohort.

2. Background

2.1. The Northern Territory context

The Northern Territory has Australia's highest proportion of First Nations people, who make up one-third of its estimated 250,000 residents, and the highest proportion of people living in remote areas of any Australian state or territory [27]. The major urban centres of Garamilla (Darwin), Mparntwe (Alice Springs), Jurnkkurakurr (Tennant Creek) and Emungalan (Katherine) include discrete Indigenous living areas known as Town Camps, of which there are 43 across the Territory, almost half of which are in Mparntwe [28]. Nearly three-quarters of the NT's Indigenous population live in remote communities, including 73 larger settlements with populations from approximately 100 to over 3000 residents, and 600 smaller traditional homelands [29].

This settlement pattern reflects Aboriginal and Torres Strait Islander peoples' deep connections to Country, culture and kin, enabling residents to remain on their ancestral lands, uphold law and sustain livelihoods, and carry forward traditions central to the world's oldest continuing cultures. Yet this continued presence on Country occurs within a broader context of ongoing structural inequality. Census data show First Nations people in the Northern Territory face the highest levels of socio-economic disadvantage among Indigenous populations across Australia, reflecting long-standing inequities in access to housing, education, health services and employment compared to other states and territories [2]. Following the failed national referendum on the Indigenous Voice to Parliament in October 2023 [30] the Territory continues to face social and political challenges compounded by post-pandemic cost-of-living pressures, in the context of the most

[1] The recent Northern Territory Government *Submission in response to the First Nations Clean Energy Strategy Consultation Paper* calls for greater accountability, insisting that 'government, industry and community commitment will be vital to the Strategy's success, as will explicit recognition of the need to address information asymmetry and the different needs of the broad range of stakeholders. The Strategy could benefit from a commitment to applying the National Agreement on Closing the Gap to provide greater policy alignment at the national level and highlight the importance of the First Nations Clean Energy Strategy (FNCES) in contributing to the National Agreement Targets (e.g. 9b and 15)' p. 7.

[2] Affordability refers to the ability of households to meet their need for energy services, which the literature often defines based on indicators of between 6 and 10 % of income [119]. Affordability of electricity in the NT is generally considered to be good, when considered in relation to the more populous National Energy Customer Framework (NECF) jurisdictions; although noting that 'when compared to electricity bills for consumers on market offer contracts in NECF jurisdictions, the NT was the second least affordable jurisdiction for both low- and average-income households, with only South Australia being marginally worse' (p. 8).

[3] Disconnection is defined by the retailer as 'an action to prevent the flow of electricity to the premises but does not include an interruption'. Self-disconnection is defined as meaning 'an interruption to the supply of electricity, because the prepayment meter has no credit' [120]. Critics observe the term 'self-disconnection' is arguably a misnomer, as it misleadingly suggests families that can't afford energy are 'choosing' household de-energisation. We use it in this perspective because it is the term employed by utilities to distinguish the energy insecurity of prepay customers from the disconnections experienced by billed customers – and which are typically considered a 'measure of last resort' by responsible policymakers. See also the work of O'Sullivan et al. [91,121].

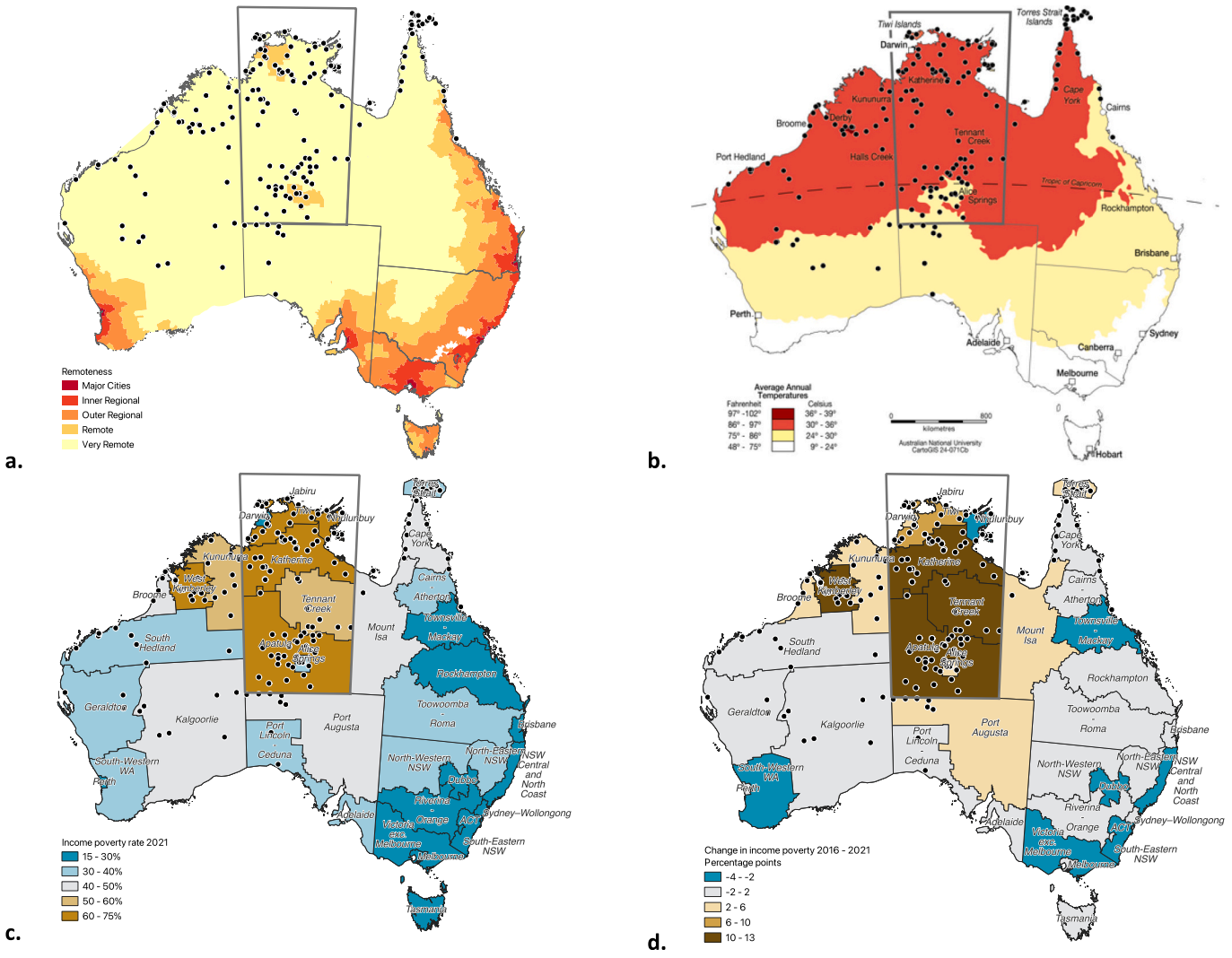

Fig. 1. First Nations communities across the four regions of Australia where residential electricity prepayment operates (>14,802 households nationally) and Australia's remote Northern Territory (shown). a. Accessibility and Remoteness Index of Australia (ARIA+). b. Nationwide average annual temperatures. c. Author's analysis of Indigenous income poverty rates by Indigenous Region in the 2021 Census d. Author's analysis of changes in Indigenous income poverty rates by Indigenous Region between 2016 and 2021 Censuses, [125]. Settlement data from White et al. [48] doi:https://doi.org/10.6084/m9.figshare.24550585.

constrained fiscal base in the federation [31]. In remote settings, the chronic lack of employment opportunities exacerbates financial pressure on Indigenous households [32] many of whom are navigating escalating costs for essentials such as energy [33], housing [34], food [34–36], and fuel [37].[4]

For First Nations residents prepaying for essential services in poorly performing public housing in the Territory - homes that are too hot in summer and too cold in winter - widespread cash poverty manifests in a high prevalence of energy insecurity [38].[5] Recent submissions by Aboriginal community-controlled organizations in response to government inquiries from 2019 [28] confirm research showing frequent self-disconnections - which worsen during temperature extremes - affect 91 % of prepaid households and disproportionately impact those with greater energy requirements (see [39]). Here we show that prepay can inadvertently deepen economic inequalities for these high consumption households living in energy inefficient or overcrowded housing ill-suited to the Territory's harsh climate - homes that remain statistically invisible, due to government reporting shortfalls and policies that frame self-disconnection as unavoidable, on the basis that its triggers are ambiguous [40].[6]

Recent energy justice scholarship emphasizes the need to understand households in their socioeconomic and geographical contexts, rather

[4] As outlined by the Central Land Council in their submission to the Senate Select Committee Inquiry on the Cost of Living in Australia: "Our constituents are struggling to keep the power on: to keep cool in summer and stay warm in winter (in an increasingly extreme climate), to refrigerate food and medicines, to run the washing machine and keep the lights on to do homework and spend time inside in the evenings. Unlike almost everywhere else in the country, remote households in the NT (the majority of which are Aboriginal) pay for their power using prepayment electricity meters. This means when money runs out, so does the power. Our constituents have been reporting significant energy hardship this summer as Central Australia experienced its third hottest summer on record. The impact of such frequent disconnections on people's health and wellbeing, and the social and economic lives of communities is significant, and at times extreme" CLC, 24th April 2024.

[5] Where energy insecurity is 'an inability to meet basic household energy needs', see for example the work of Hernandez (2016 p.1) [122].

[6] The Northern Territory Utilities Commission recently observed that "further research is needed to understand what drives the high rates of disconnections in households using those prepayment meters as anecdotal evidence indicates there may be reasons other than payment difficulties or hardship".

Table 1
Northern Territory electricity policy, responsible entities and retail pricing (1992–2024).

		Year	Prepay tariff (*p*)	Standard tariff (*s*)	Fixed charge (*f*)	Breakeven daily kWh (*d*)	Breakeven annual ~kWh (*a*)	References
Northern Territory Electricity Pricing Order (EPO)	Sets the maximum price that retailers can charge households and businesses. Applies a uniform tariff policy so customers pay the same price regardless of their location and cost of supply. Government owned suppliers have access to Community Service Obligations (CSO's) which subsidize the cost of generation.	1992	0.1203	0.1203	0.2541	–	–	[53,54]
		1993	0.1203	0.1203	0.2541	–	–	[53]
		1998	0.1600	0.1291	0.2541	8.2	3000	[53,55]
		2000	0.1472	0.1290	0.2541	14.0	5100	[53,56]
Utilities Commission (UC) of the Northern Territory	Local electricity regulator tasked with protecting the long-term interests of consumers of services provided by regulated industries, with respect to price, reliability and quality. The UC monitors compliance with the EPO.	2005	0.1870	0.1402	0.2762	5.9	2150	[57]
		2006	0.1642	0.1438	0.2834	13.9	5100	[58]
		2007	0.1642	0.1438	0.2834	13.9	5070	[59]
		2008	0.1714	0.1501	0.2959	13.9	5070	[60]
System and Market Operator	Territory owned Power and Water Corporation is the Electricity System and Market Operator (ESMO) responsible for managing electricity markets and power systems across the Territory.	2009	0.1772	0.1552	0.3060	13.9	5070	[61]
		2015	0.2808	0.2554	0.5035	19.8	7200	[62]
		2017	0.2808	0.2554	0.5035	19.8	7200	[63]
		2019	0.2864	0.2605	0.5136	19.8	7200	[64]
Office of Sustainable Energy (OSE)	Office of Sustainable Energy coordinates energy policy and the transition to renewables across government. Priority tasks include developing strategies for advancing the government's renewable energy target of 50 % by 2030.	2020	0.2864	0.2605	0.5136	19.8	7200	[65]
		2021	0.2930	0.2665	0.5254	19.8	7200	[66]
		2022	0.3009	0.2737	0.5396	19.8	7200	[67]
		2023	0.3090	0.2811	0.5542	19.9	7250	[40,68]

Notes: 1. Tariff (nominal AUD$/kWh). 2. Breakeven (annual/kWh).
Source: Northern Territory Government [52].

Table 2
Daily and annual prepaid differential (%) for average energy use 1, 2, 3 & 4-bedroom households in NT. Source: Jacana Energy, using data from the Australian Energy Regulator (indicative only, 2023). See Annexure Fig. 4.

	Volumetric tariff	Fixed daily charge	Energy use by household size							
	$/kWh	$/day	1 bedroom		2 bedroom		3 bedroom		4 bedroom	
kWh p/day			11		27		28		30	
			Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
Standard Tariff and fixed daily charge (AUD)	0.281	0.5542	$3.647	$1331	$8.145	$2973	$8.426	$3076	$8.989	$3281
Prepay Tariff (AUD)	0.3090	n/a	$3.399	$1240	$8.344	$3045	$8.653	$3158	$9.271	$3384
Prepay premium (%)			93.2		102.5		102.7		103.2	

than focussing solely on discrete attributes [40–43], which highlights the importance of recognizing how poverty is patterned differently by remoteness for Indigenous and non-Indigenous people in Australia. The five major categories of remoteness according to the Accessibility and Remoteness Index of Australia (ARIA+) are major cities, inner regional, outer regional, remote and very remote (Fig. 1a). These remote regions also coincide with Australia's hottest climates (Fig. 1b).[7] Poverty rates among Indigenous people in Australia follow a remoteness gradient, with rates reaching 41 % in remote areas and 57.1 % in very remote regions (Fig. 1c). There is no comparable remoteness gradient for poverty among non-Indigenous Australians. Rates of Indigenous poverty in the Northern Territory are exceptionally high, a situation that has worsened in recent years (Fig. 1d) [44]. In communities where poverty and energy access are intertwined, socioeconomic disparities profoundly influence affordability and the everyday experience of essential energy services [45–47].

2.2. Energy landscape and prepaid power

The NT's energy landscape is shaped by its unique history, demography, geography, regulatory framework and scale. Three major electricity grids - the Darwin to Katherine interconnected system, the Tennant Creek network and the southern Alice Springs network - serve the four main population centres, while regulated minor centres, non-regulated remote communities and small unlicensed power systems service the many smaller hinterland settlements [49]. Unlike the National Electricity Market (NEM) on Australia's more populous east coast, the NT (as well as Western Australia and off-grid South Australia) operate under separate regulations. The Territory's regulatory framework stems from the *Electricity Reform Act* (2000) and the *Electricity Reform (Administration) Regulations* (2000) [50] and aims for progressive implementation of the National Electricity Law and the National Electricity Rules (NER) in the three larger networks over time [51].

Key entities include the Power and Water Corporation (network provider and system, market operator[8] and sole utility for remote communities), Territory Generation (electricity generation), Jacana Energy (retailer in major networks) and the Office of Sustainable Energy (energy policy coordination) (Table 2). The Utilities Commission of the Northern Territory (UCNT) regulates the sector, protecting consumer interests, including those with limited political and market power. Retail prices are regulated through Electricity Pricing Orders (EPO) which are issued annually and the UCNT enforces compliance with the EPO under the *Utilities Commission Act* (2000). Given high fuel costs and the vast distances between small service hubs, electricity in the Territory is heavily subsidized. A uniform tariff policy aims to ensure that customers

[7] NT households are thought to consume over 8500 kWh annually - well above the Australian average - primarily due to extensive air conditioning needs to combat extreme heat and humidity.

[8] The utility is a significant employer of First Nations people in the Territory, with >150 essential service officers employed in remote communities, to monitor and maintain vital power, water and wastewater-management infrastructure.

pay the same price regardless of location or cost of supply, while frequent financial shortfalls are covered by the Northern Territory government.[9]

In this context, electricity tariff structures have a crucial role to play in balancing financial sustainability for energy utilities, economic efficiency, and distributional fairness [69]. Prepayment tariffs typically range from simple volumetric (or linear) charges to Inclined Block Tariffs (IBTs) that increase with consumption, and hybrid models which combine both fixed and variable components [52–54]. Prepaid tariff designs require navigating complex political, economic, and ethical decisions: to apply uniform rates, discourage high-consumption, or to offer targeted supports [61–63]. These choices are particularly consequential in low-income, remote or under resourced areas, or where households may be (mis) characterized as uniformly low (or high) consumption users [76]. For instance, Johannesburg's recent reforms introduced a tiered prepayment model: customers on the "low" tariff pay a per unit premium, while those on the "high" prepaid tariff face both higher usage rates and fixed service charges [55,56]. As Klug et al. [71] note, prepay tariffs can be used to promote energy conservation and reduce arrears, yet block tariff structures can also disproportionately impact low-income users when poorly targeted [53,57]. International evidence from Ghana, the UK, and New Zealand all similarly highlight the need for protective measures whenever prepay tariffs are deployed in low-income communities [53,56,58].

In the Northern Territory, prepaid electricity – known locally as the 'powercard' system - was introduced in 1992[10] as part of implementing a 'user pays' model for essential services in Australia's most remote Indigenous communities and Town Camps. Residents purchase energy 'credit' through participating retailers (typically community stores incentivized to act as agents) or online, prior to power being made available in the home. As in other contexts where research has shown prepay is popular with users for diverse reasons, the powercard system is seen locally in the NT as having both benefits and drawbacks [73–79]. For utilities, prepay immediately addressed several persistent challenges, including seasonal flooding restricting access to communities, and a lack of banking or postal infrastructure, which made postpaid billing impractical [80].[11] Prepay shifted transaction and credit risk onto consumers, guaranteeing upfront revenue and eliminating debt collection costs, enabling automatic 'self-disconnection' of supply once credit is exhausted - typically during prescribed hours between 10 a.m. and 3 p.m. on weekdays, or during store opening hours [18]. For consumers, prepay allows small, flexible payments to be made which helps to avoid the accrual of large debts that can be difficult to repay, while avoiding formal disconnection fees and reconnection delays. In the remote parts of Australia where prepayment is now common, it is associated with very high rates of self-disconnection, especially during heatwaves (or cold snaps during central Australian winters) [81], when demand for cooling (heating) increases, and affordability becomes critical [38].

Uniquely, Northern Territory legislation was amended in 1994 to allow differential tariffs based on meter type. This empowered the (then) Power and Water Authority to set distinct rates for prepaid and postpaid users, as well as for commercial customers. Initially, both residential tariffs were aligned, under a price freeze, with volumetric rates equalised [59,60]. When the price freeze lifted, in 1998, separate payment regimes began operating: the postpaid tariff includes a fixed daily supply charge ('f') plus a variable usage rate ('s'), while the prepay tariff adopted a single, slightly higher volumetric rate ('p'), intended to recover both usage and fixed costs. Designed for simplicity, this model would go on to have diverging impacts for households based on usage, with larger and multi-family First Nations households experiencing greater expenses once they exceeded utility-designated rates of consumption.

Today, prepaid electricity serves as the standard arrangement - either by voluntary choice or default - for nearly 15,000 First Nations households (approximately 65,000 residents) across four Australian jurisdictions. The Northern Territory accounts for over half of these, with 7684 homes on prepay, covering "about half of all public housing residents in urban areas and all public housing residents in remote communities" [17] p. 8.[12]

3. The prepay "poverty premium"

In recent years, studies from the UK and elsewhere have drawn policymakers' attention to the issue of a "poverty premium" associated with prepaid electricity systems [22,82,83]. A poverty premium is a structural penalty that disproportionately affects low-income households, forcing them to pay more for the basics simply because they are poor [21,22]. For example, families managing tight budgets often rely on nearby stores despite higher prices, as the resources required for bulk purchases or transport to more affordable retailers can be prohibitive. Low-income borrowers with limited collateral encounter elevated charges when accessing loans and credit [18,84]. In Australia, research by the social advocacy group Anglicare has documented low-income households spending up to 10 % more on fuel and 142 % more on phone data [86]. Remote communities in particular face additional challenges, due to reduced competition, higher transport costs and limited-service options which drive up prices, with few available alternatives. Household cooling (heating) appliances often cost more in remote areas than in major centres, while the limited selection of inefficient models available adds to household energy burdens over longer timeframes [35,86].

Previous studies have sought to quantify the poverty premium to show the way that those on low incomes may pay more for goods and services, including loans, insurance, food [88] and public transport [89]. Evans et al. [90] demonstrate how household energy inefficiency in particular, compounds financial hardship by forcing disadvantaged households to bear greater energy costs, deepening the cycle of poverty. They identify household energy inefficiency as the "key site of unfairness" - where factors including tenure, (un) affordability, consumer behaviour and policy frameworks act to reinforce the poverty premium [90] a pattern clearly observable in the NT, which has both the highest proportion of renters - 62 % of Indigenous residents rent from government or live in social housing - and the highest overcrowding rates

[9] The Northern Territory government provides Community Service Obligation (CSO) funding to address the shortfall between the cost of supply and the maximum regulated electricity tariffs for residential and business customers consuming below 750 MWh per annum in the Darwin-Katherine, Alice Springs and Tennant Creek networks, and the minor centres. These CSO's were budgeted to be AUD$124 million in 2023/24. Thereafter, approximately 60 % of the cost of supply in Indigenous Essential Services remote communities is funded through grants from NT Government Department of Territory Families, Communities and Housing.

[10] Contemporaneous work by social scientist Diane Smith in the Territory at the time noted that "with a high proportion of income being spent on basic commodities, many households do not have cash to pay for service provision" [123].

[11] The ongoing integration of digital technologies promises improvements in addressing these access challenges, enabling remote monitoring, virtual payment options and automated service management.

[12] Prepaid electricity is in use in 14,706 First Nations households across remote, regional, and off-grid communities in Australia. These households are distributed across four regions: 7684 households in the NT, 5144 in North Queensland and the Torres Strait Islands, 1426 in northern Western Australia, and 452 on the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, Yalata and Maralinga Tjarutja (Oak Valley) in South Australia. Collectively, these communities are home to approximately 65,000 residents.

nationally: 55 % in very remote areas and 32 % in remote areas according to the 2021 Census.[13]

International research confirms that prepaid electricity, predominantly used by lower-income households, often charges higher per-unit rates than postpaid options. For example, O'Sullivan et al. found prepay metering consistently more expensive in New Zealand [91]. Prepay households of limited means may risk disconnecting during frequent heatwaves (or cold weather events) while spending significant - generally overlooked - time and resources feeding the meter [23].[14] UK survey data from social housing contexts have previously revealed that almost all low-income households surveyed (n = 741) experienced at least one type of poverty premium [24,89].

4. Methods

This perspective aims to situate financial disparities arising from the Northern Territory's dual tariff system - prepaid and postpaid - within its broader socioeconomic, geographic and historical contexts, where Indigenous poverty rates follow a distinct remoteness gradient. We initially mapped this landscape using average annual temperatures and remoteness data - factors relevant to regions with high Indigenous populations where prepay metering is common. Fig. 1a–d were created using QGIS 3.40.0 (Bratislava) combining a customised settlement geography dataset, available as supplementary data in White et al. via Figshare [3]. For Fig. 1a we visualized remoteness using Australian Bureau of Statistics Remoteness Area 2021 shapefiles. Fig. 1b incorporates average annual temperature data sourced from the Australian Bureau of Meteorology[15] modifying the presentation to collapse temperatures into 4 bands (rather than 5) and converting to Fahrenheit. Socioeconomic data (Fig. 1c and d) were derived from an analysis of the Australian Bureau of Statistics (ABS) 2021 Census of Population and Housing augmented with unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey (Wave 21) [92]. HILDA enabled interpolation of income distributions within the income brackets recorded in the Census data and conversion from gross to disposable income.

We acknowledge that 'poverty lines' are politically contested measures. Some, like the Antipoverty Centre [93] urge the adoption of the Henderson Poverty Line, which at the time of the last Census was $613 per week for a single person before housing. In our analysis we applied a threshold set at 50 % of the median disposable equivalised household income before housing, or approximately AUD$492 per week. This should not be interpreted as a normative judgement of adequacy, which must be made with reference to the needs of people in different life circumstances, not by using arbitrary poverty lines. We add the caveat that the rates illustrated at Fig. 1c and d significantly understate hardship in remote areas, as they do not factor in the elevated costs of goods and services discussed above [87].

Tracking the poverty premium over time presented numerous challenges, due to the staggered nature of smart meter rollouts, significant gaps in publicly available reporting, and generally very limited access to disaggregated energy data in the Territory. Legacy 'Ampy' meters use disposable tokens and do not store household energy usage data, concealing self-disconnection rates and household energy rationing patterns. As a consequence, many estimates of the poverty premium rely primarily on theoretical rates of energy consumption, rather than observed usage - because actual usage relates to consumer affordability and the cost paid (i.e. the fact that a poverty premium exists means that less of a service is consumed). Moreover, historical perspectives on energy use in remote communities in Australia have evolved. The Australian Greenhouse Office in 1997 estimated remote Aboriginal households as using approximately 6 kWh per person daily. By 2000, Anda et al. documented wider variations, with modest daily household use ranging from 13 kWh (frugal usage) to double that amount [94]. Since then, growing reliance on air conditioning for thermal safety and comfort has driven substantial increases in electricity demand [39].

In our analysis we employ two complementary approaches. First, we used theoretical estimates based on Territory wide household data and the relevant pricing order for the year 2023. Over the last decade, the local electricity retailer has begun reporting average daily usage figures drawn from indicative data (see Annexure Fig. 4 Source: Jacana Energy calculated on figures provide by the Australian Energy Regulator (AER) [95]), as published on all postpaid bills.[16] These benchmarks - used in Table 2 – were reported as being: 11 kWh/day (1-bedroom), 27 kWh (2-bed), 28 kWh (3-bed), and 30 kWh (4-bed) [85]. Second, empirically derived data using statistical distributions of actual daily consumption are drawn from data contained in Annexure Table 3, Electricity use and expenditure by percentile group (Jan 2018–July 2019), from Longden et al. as used in Fig. 2. [39].

In parallel, we reviewed Electricity Pricing Orders (EPOs) from 1992 to 2023, accessed through publicly available NT Government sources [55–72]. These orders, summarized in Table 1, enabled us to trace the evolution of both prepaid and standard residential tariffs (in nominal AUD) to calculate the "breakeven point" - the consumption threshold at which costs between prepayment and postpaid systems converge: ($d = (p-f)/s$). Calculations were performed for the years 1998, 2000, 2005, 2009, 2015, and 2023 to highlight policy shifts, and to show differential financial impacts by energy use rates across time. Graphics were created using Stata MP 18.0 and R 4.5.0.

5. Results: where the poor pay more or less

Table 2 illustrates the daily and annual prepaid tariff differential (%) across four typical household sizes (1–4 bedrooms) to reveal prepay costs ranging from 93.2 % to 103.2 % of standard postpaid rates, depending on consumption. Applying statistical distributions of actual daily consumption[17] Fig. 2a shows the annual energy cost comparison by average daily load, while Fig. 2b illustrates the difference paid per household in nominal $AUD - reaching approximately $250 more annually for the highest consumption households. Most homes fall in the middle consumption bands (approximately 16–30 kWh/day) with fewer households at both the lowest and highest consumption levels (Fig. 2c). This consumption pattern results in corresponding variations in electricity costs (Fig. 2d). We calculate the difference - the poverty premium - as ranging from $57 - $253 annually for households with median consumption of 26–48 kWh, or $82–$103 annually for 2-, 3- and 4-bedroom households averaging 27-30kWh daily (Table 2 & Fig. 2b).

The relationship between daily average electricity usage and costs under the different payment types demonstrate a widening disparity once consumption exceeds specific thresholds, which have evolved over the past twenty-five years. Lower-consumption households – households using <5.9 kWh per day in 2005, increasing to 19.9 kWh per day by 2023 - have benefitted from cheaper prepay rates, while households

[13] In the 2021 Census data overcrowding is defined as a situation where a dwelling requires one or more additional bedrooms to adequately house its inhabitants, considering the number, age, sex, and relationships of household members.

[14] Including third party merchant charges on energy related transactions.

[15] Available at http://www.bom.gov.au/jsp/ncc/climate_averages/temperature/index.jsp.

[16] Noting that <2.5 % of 4857 remote tenancies under the National Partnership Agreement are single bedroom homes, while more than half of all tenancies are 3-bedroom homes or larger. Source: Based on dwelling by bedroom count data provided to Aboriginal Housing NT as an addendum to a letter to Minister Uibo, written in response to sector concerns about bedroom-based rent calculations [124]. For further background see also Markham and Klerck [34]

[17] Drawn from Supplementary Table 14: Electricity use and expenditure by percentile group (Jan 2018–July 2019), from Longden et al. [39].

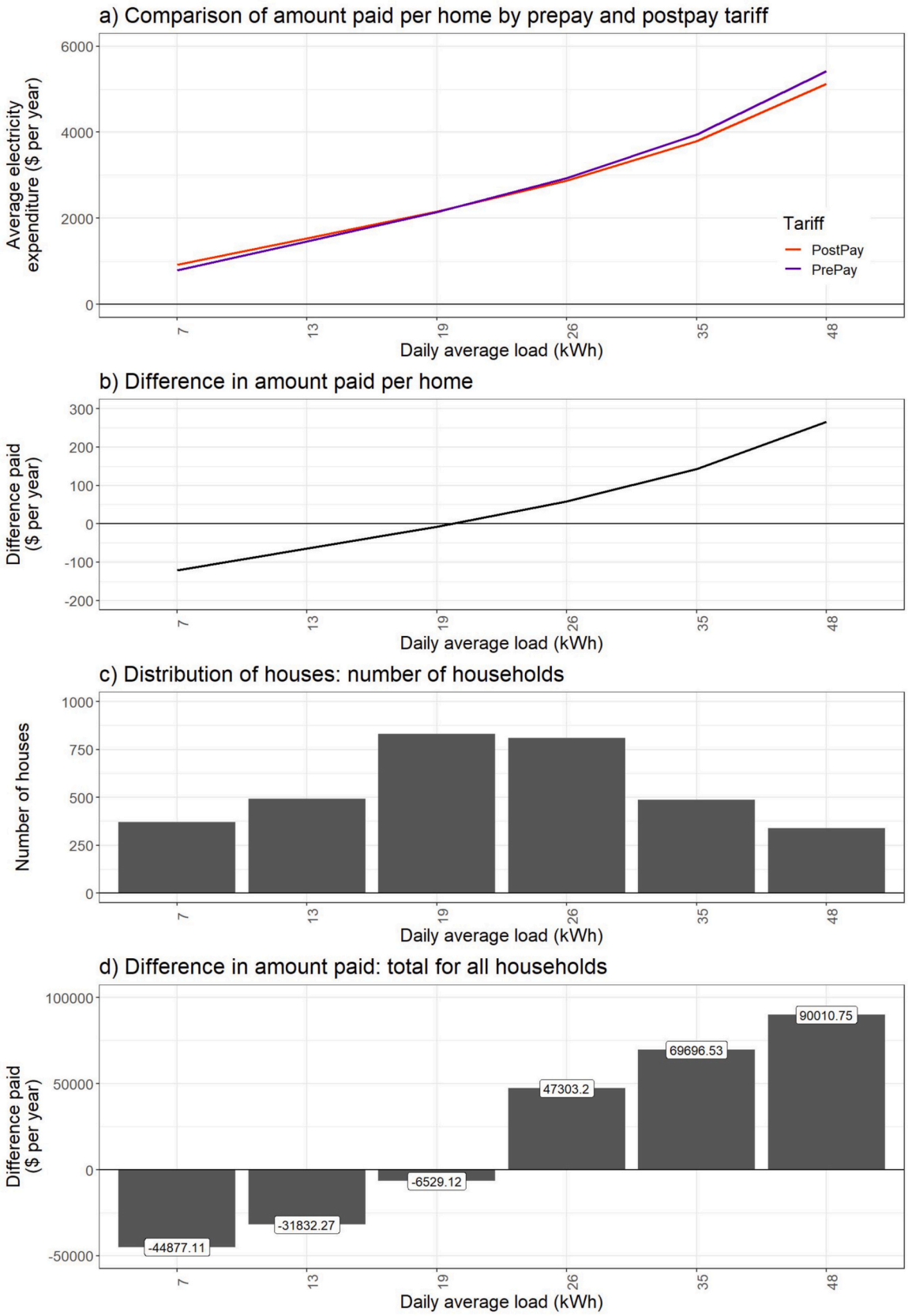

Fig. 2. Comparison of energy costs under both Prepayment tariff and Standard Residential tariff plus daily supply charge a) energy cost comparison by average daily load b) difference paid per home c) distribution of households by average daily load d) difference in amount paid. 3300 households calculated in AUD$, data for year 2018/19 Source: Supplementary Table 14 - Electricity use and expenditure by percentile group from Longden et al. [126].

consuming above the threshold face penalties. Closer examination of distributional inequities shows some moderation in cost allocation between the payment types over time. The steadily rising breakeven point has transformed the financial relationship between payment options, yet consistently disadvantaged high-consumption households exceeding the annual upper limit. If the initial rollouts of prepay in the 1990's focused on smaller households or areas with lower average energy consumption, early data may have contributed to the creation of a now persistent policy narrative that regularly overlooks or dismisses higher energy costs for larger households as merely reflecting increased consumption. This impact is particularly significant when considering that 17 % of Aboriginal households in the Northern Territory accommodate more than one family under the same roof [27].

Fig. 3a illustrates the relationship by comparing the two payment types, showing the difference paid per electricity unit (the prepaid variable premium) relative to the postpaid fixed daily charge. The comparison spans the years 1998, 2000, 2005, 2009, 2015, and 2023, to demonstrate how the breakeven - the electricity usage level at which prepaid and postpaid costs equalize – has shifted based on analysis of the NT Electricity Pricing Orders, outlined at Fig. 3b.

From 2000 to 2015, the breakeven remained relatively stable at approximately 14 kWh daily before rising to approximately 20 kWh during the last decade. The year 2005 stands as an outlier, when the higher variable premium meant prepay households using more than a daily average of 5.9 kWh paid substantially more than postpaid counterparts. Further complicating the landscape, approximately 1300 remote living public housing residents relying on older Ampy style magnetic strip meters - which require in-person technician visits for updates - have had unchanged electricity pricing since 2016. A program replacing these outdated meters with newer smart meters, configured with current tariffs, has resulted in an immediate 14 % price increase for these customers [96,97]. The Territory government has stated:

> “the Northern Territory is transitioning to uniform electricity pricing, ending a system where prepaid customers sometimes paid different rates. From July 1st (2024), all consumers will pay the same government-set tariff. Energy costs are directly linked to consumption patterns, with larger households and heavier air conditioning use typically resulting in higher bills. Managing these costs effectively requires practical steps like ensuring air-conditioned spaces are sealed and turning off unused appliances”.
>
> [96,98]

6. Discussion and policy implications

Our findings have direct policy relevance for the energy and housing strategies employed in a region already facing extreme heat and increasingly vulnerable to climate change impacts [99,100]. Tackling systemic inequities embedded in the poverty premium demand understanding how technical and economic interventions entrench or alleviate this burden - and commitments to actively redressing its impact. While recognition of the challenges faced by prepay customers has grown, including through recent national roundtables under the Federal Government's National First Nations Clean Energy Strategy (2024), prepaid electricity remains tightly bound to broader issues of affordability for First Nations households in the Territory [101]. Expanded concessions access begins to acknowledge these structural inequities. Primary public housing tenants with NT Concession Scheme membership can apply electricity concessions direct to token, e-meter, and secure meters, with tokens or credits issued biannually. NT Seniors Recognition Scheme participants receive prepaid cards [17]. Moreover, the rollout of smart metering technology is incrementally increasing the transparency of household energy (in)security in grid-connected settings (see Annexure: Table 4. Source: Utilities Commission Northern Territory Retail Review 2022–23 [40]) and improving the remote applicability of concessions. In undertaking reforms to the Electricity Industry Performance Code in 2023, the NT Utilities Commission has emphasized the importance of prepayment customer indicators in retail performance reporting requirements, observing:

> Prepayment meters are generally used by struggling customers. We have special pricing within the pricing order for prepaid meters, therefore (it is) important to have an understanding of how many there are, and how these customers are travelling. (2017, p. 29)
>
> [102]

Reforms to Australian Energy Regulator guidelines in 2024, include additional indicators for prepayment meter customers that are not yet captured in the Northern Territory [81]. Extending retail reporting requirements to remote communities with capable prepay meters - including total number of prepayment meter customers, total number of prepay meters capable of detecting and reporting disconnections and tracking how many prepayment meter customers receive energy concessions - would enable policymakers and community organizations to better understand whether eligible prepay households are accessing all available supports in the Territory [103,104].

Progress toward the inclusion of prepay households in the Territory's energy transition has also slowly begun, building on pioneering experiences of the first household connection of rooftop solar to prepay in Tennant Creek in 2023 [105]; successful integration of PV solar panels with prepayment systems on community centres in Alice Springs town camps in the same year [106]; and a trial installing solar panels on 15 public housing households using prepay meters in Central Australia - each of which reported reductions in objective measures of energy insecurity, including disconnections [49]. These represent important advances, as regulatory and policy barriers stemming from technical constraints unique to prepay customers have historically excluded First Nations prepay customers from participating in energy transition, during a period when one in three households in the Territory, predominantly homeowners, have benefited from generous government solar incentives [107].

Recent Federal and Territory government commitments are poised to have significant impacts; through the Social Housing Energy Performance Initiative AUD$10 million has been allocated for reverse cycle air conditioners in over 600 public housing households [108]. Under the National Partnership Agreement, the Australian Government has committed to delivering at least 1950 new bedrooms in the NT through the “Room to Breathe” program and new housing construction [109]. Despite having the hottest climate in the country, the Northern Territory Government has yet to adopt the minimum energy efficiency standards set out in the National Construction Code (NCC 2022), which require new homes to achieve 7-star rating under the Nationwide House Energy Rating Scheme (NatHERS). Instead, the Territory allows compliance through achieving a 5-star rating in accordance with the 2009 Building Code of Australia.

As air conditioning transitions from being a luxury to a necessity for basic safety amid rising temperatures, each of these policy decisions will have an impact on the poverty premium paid by high consumption prepay households going forward. With electricity becoming essential for effective climate adaptation, the current pricing structure - which explicitly penalizes usage beyond a threshold value - deserves critical reconsideration by the NTG and Indigenous interests. The issue is becoming pressing, for governments are actively promoting comprehensive household electrification for cooling, water heating, cooking, and transport to achieve national targets, while prepaid metering remains the norm. Several jurisdictions have implemented innovative solutions to address these challenges; for example, remote off-grid South Australian communities benefit from heavily subsidized “lifeline” tariffs, while some very remote Western Australian desert communities operate with reduced rates, in acknowledgement of the circumstances faced by low-income prepay customers in remote settlements [102,103]. These practical responses acknowledge electricity as a necessity - without it, homes become unsafe and potentially uninhabitable. Electricity is

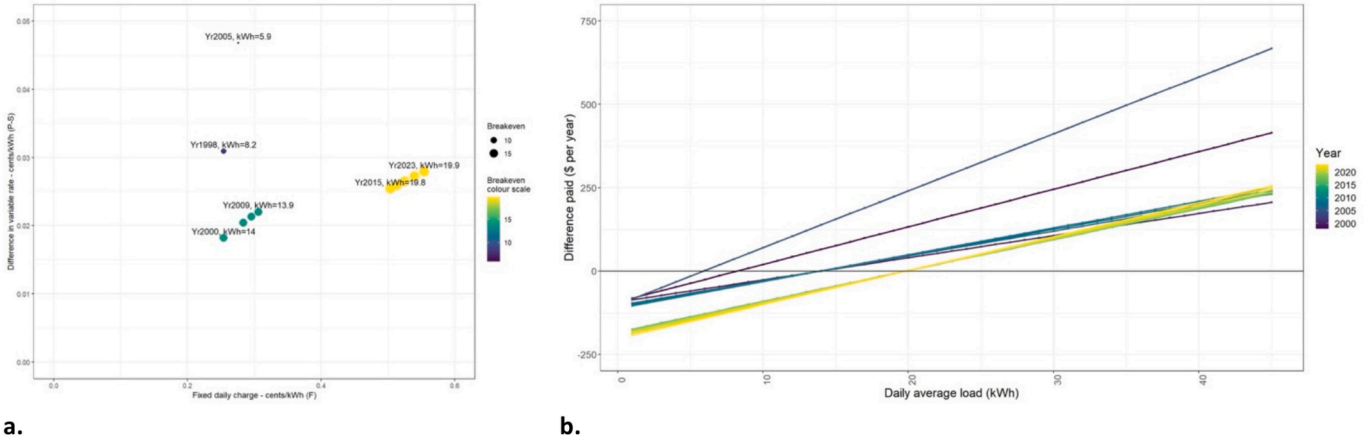

Fig. 3. (a) Difference in variable (prepaid) premium (cents/kWh $AUD) against (postpaid) fixed daily supply charge ($AUD) shows the energy breakeven (kWh) for the years 1998, 2000, 2005, 2009, 2015 and 2023. (b) Prepay Tariff versus Standard Tariff plus Fixed Daily Charge matched to NT Electricity Pricing Orders (1998–2023).
Source: Northern Territory Government [52].

essential for maintaining liveable conditions: powering refrigerators for food security, providing hot and cold water, enabling washing, ensuring communication and lighting, and creating safe indoor spaces - functions increasingly critical as climate extremes intensify [110,111].

Potential policy remedies could include raising the consumption threshold to better align with actual prepay household usage, eliminating the volumetric premium in recognition of prepay customers' financial constraints, or implementing targeted measures for affected households. Internationally, recent reforms in the UK have eliminated the poverty premium on prepaid electricity by equalizing electricity unit rates and introducing daily standing charges for all customers [112]. However, recovering costs through fixed charges may simply replace one inequity with another - forcing low use households to pay substantial costs regardless of actual consumption, or to pay standing fees even during periods of disconnection [113]. Fawcett et al. note that direct payments provide a targeted solution, effectively mitigating unintended consequences for specific cohorts through making payments remotely to meters [78].

Addressing the prepay poverty premium requires comprehensive policy responses that recognize how poverty alleviation in remote Indigenous communities in Australia [87] intersect with the energy, housing and climate adaptation strategies that are now vital in the face of a warming climate. As Oppermann et al. aptly put it “cool inclusion demands explicit attention to social justice” [114]. While expanded hardship concessions might provide immediate relief, they fail to address the underlying drivers of high energy consumption or the systemic inequalities that create energy affordability barriers. A comprehensive policy suite targeting improved household thermal performance, incentivized renewables self-consumption for prepay households, and energy-efficient appliance programs - particularly for cooling to mitigate climate extremes - offers a costly but potentially transformative long-term solution to reducing the poverty premium faced by prepaid customers in public housing. Effective interventions must prioritize previously marginalized groups - particularly remote and regional First Nations households currently prepaying for essential energy services from limited incomes and with fewer consumer protections. Centring their perspectives in governance and decision-making is a key step to ensuring a more equitable energy transition in remote and regional Australia.

7. Conclusion

Remote Indigenous communities in Australia experience some of the highest temperatures nationally, affecting energy insecurity for residents who mostly prepay for access to electricity. In this perspective we contextualize the widespread use of prepaid electricity systems in remote and regional First Nations communities, by connecting their prevalence to socio-economic indicators to illuminate prepays' geographic and economic patterning, including in relation to Indigenous income poverty rates by Indigenous region. Through a focused analysis of the Northern Territory, we show how the prepayment tariff, legislated in 1994 and implemented from 1998, established a persistent structural “poverty premium” for those households whose energy consumption exceeded the utility's designated thresholds. While homes with minimal usage may benefit under the system, it imposes an additional financial burden on those with higher consumption – households consuming >5.9 kWh per day in 2005, increasing to 19.9 kWh per day by 2023.

Paradoxically, while prepay is promoted as a culturally responsive and flexible solution aligned with community needs, it can also disproportionately impact high-use households through elevated per-unit charges. Our perspective complicates the prevailing trope that prepay is necessarily a fairer way to distribute energy costs in low-income communities. That higher costs fall most heavily on those experiencing energy insecurity is an outcome anathema to families with limited financial resources and contradicts high-level Indigenous public policy commitments made by Australian governments. As the Territory - like other jurisdictions - transitions to smart meters and distributed solar technologies, policy must address both the underlying poverty and the structural ‘premium’ imposed on high-consumption households using prepay. This requires Australian governments confront questions of income inadequacy in remote areas, while removing the disproportionate burden on those with greater energy needs. The persistence of the prepay poverty premium underscores the need for a more inclusive, reparative, and just energy transition in Australia - one that not only addresses historic disparities but learns from them to prevent their recurrence.

8. Limitations and context

Our analytical framework emerges from research within the Northern Territory's unique regulatory context. These findings have limited applicability to other jurisdictions, where distinct legislative frameworks, regulatory structures, and policy environments govern on and off-grid energy systems. In South Australia, “prescribed customers” refer to residential electricity customers in remote Aboriginal communities and associated homelands required to use prepayment meters by default in the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, Yalata, and Oak Valley, where approximately 452 households (or 2500 Anangu

residents) pay a reduced (albeit temporary) prepayment tariff. The Essential Services Commission of South Australia has committed to reporting on performance metrics for these customers annually. In the state of Western Australia, prepayment meter data for approximately 1300 First Nations households using prepay is reported by the regional utility via the Economic Regulation Authority of Western Australia (ERAWA) [118]. Prepayment for residential customers has been discontinued in the state of Tasmania where regulations permitting the use of prepay were withdrawn in 2022 [18]. Despite a recent regulatory review by the Australian Energy Regulator [81], public reporting for approximately 5144 card operated meter households (functionally equivalent to prepay) in Far North Queensland and the Torres Strait Islands are not available due to historical factors - the Queensland Competition Authority (QCA) has some regulatory functions covering COM arrangements instead of the Australian Energy Regulator (AER) in the state of Queensland, leaving the AER without authority to mandate public data reporting on the energy security of First Nations card operated meter customers in that state. Ergon Energy Corporation Limited provides COM related reporting directly to the Department of Energy and Climate (DEC). There has been only very limited visibility of performance reporting for this cohort since the introduction of COMs in Queensland in the 1990's [103]. The Utilities Commission of the Northern Territory (UCNT) has recently been undertaking a review of the Electricity Industry Performance Code in the Territory. At present retail indicators are publicly reported for residential customers (including prepayment meter customers) across the major centres of Darwin, Katherine, Tennant Creek and Alice Springs. No public reporting of retail performance indicators - the number of customers, how customers pay for electricity (prepayment or post-payment), and how often and for how long household disconnect from electricity - are applicable in remote Indigenous communities relying on isolated networks [104].

CRediT authorship contribution statement

Bradley Riley: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Michael Klerck:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. **Francis Markham:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis. **Thomas Longden:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Vanessa Napaltjari-Davis:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Simon Quilty:** Writing – review & editing, Writing – original draft, Investigation. **Jimmy Frank-Jupurrurla:** Writing – review & editing, Writing – original draft, Investigation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Claude 3.5 Sonnet to simplify double-barrelled sentences and improve the overall readability of half a dozen complex passages. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

MK, SQ have utilized postpaid billing in the jurisdiction described for more than two decades, while VND and JFJ have been utilizing electricity prepayment since its introduction in the 1990's. The authors declare they have no relationships or competing financial interests that could have appeared to influence the work reported in this paper.

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Appendix A. Annexures

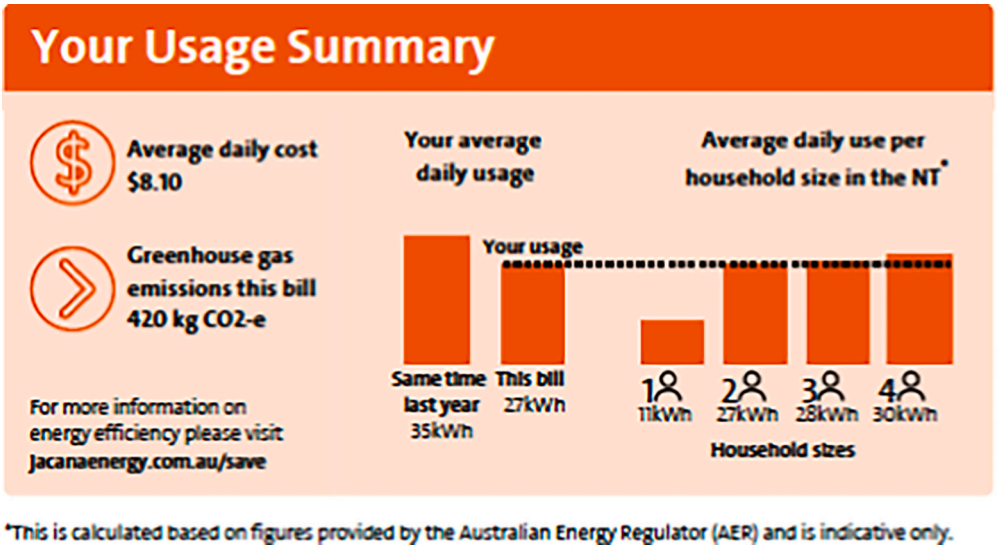

Fig. 4. Average daily energy use by household size in the NT (2021). Source: Jacana Energy calculated on figures provide by the Australian Energy Regulator (AER) as indicative only [95].

Table 3
Daily electricity usage for 3300 prepaid households across 28 remote communities in four climate zones, Australia's Northern Territory.

Average daily electricity use groups	Range of average daily electricity use for grouping meters	Median daily electricity use	Median expenditure without concessions ($ AUD)	Number of households	Number of observations
Percentiles 0–10	<12	7	1187	370	185,929
Percentiles 0–10	12–16	13	2136	493	250,115
Percentiles 0–10	16–23	19	2900	832	417,262
Percentiles 0–10	23–32	26	4019	811	408,647
Percentiles 0–10	32–43	35	5381	486	245,057
Percentiles 0–10	>43	48	7156	338	167,776
All houses	All observations	24	3333	3330	1,674,786

Source: Supplementary Table 14 – Electricity use and expenditure by percentile group (January 2018–July 2019) from Longden et al. [39].

Table 4
Prepayment meter indicators for smart meters reported in the four major centres, Northern Territory (2019–2023) These figures exceed those seen internationally [20,78,115–117], reflecting both the Territory's harsh climate and socioeconomic realities facing First Nations residents prepaying for power in the Territory.

	2019–20	2020–21	2021–22	2022–23
Prepayment meters as at 30 June	2063	2187	2172	2441
Prepayment meters capable of reporting self-disconnections[a] as at 30 June	2049	2173	2158	2430
Total prepayment meter self-disconnection events over the year (all quarters)	69,888[b]	84,439	89,252	103,895
Prepayment meter self-disconnection events per prepayment meter[c] over the year	34.1	38.9	41.4	42.8
Average duration of self-disconnection events (minutes) over the year	380	504	408	355

Note: Whilst most prepayment meters are 'smart' meters and capable of reporting disconnections, there remains a small amount of older analogue meters without this functionality as there is no mobile network available in that location to facilitate a vending solution for smart prepayment meters.

[a] An interruption to the supply of energy because a prepayment meter system has no credit (including emergency credit) available.

[b] Does not include July 2019 as data was unavailable.

[c] Per number of meters as at 30 June.

Source: Utilities Commission Northern Territory Retail Review 2022–23 [40].

Data availability

All data used in this perspective are taken from publicly available sources cited.

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