Essential Services Commission of South Australia (ESCOSA)

Off-grid energy consumer protection framework review

Prepayment Meter System Code review—Update

Submission by email: <escosa@escosa.sa.gov.au>

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Submission in response to:

Consultation paper: Off-grid energy consumer protection framework review

Prepayment Meter System Code review—Update paper

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Thank you for the opportunity to make a submission in response to the Essential Services Commission of South Australia (ESCOSA) *Consultation paper: Off-grid energy consumer protection framework review* ('off-grid review') and *Prepayment Meter System Code review—Update paper* ('PMSC review') both dated November 2021. Our submission provides a response to selected issues in both reviews. In making this submission, we refer ESCOSA to our previous submission to the Prepayment Meter

System Code review dated 29 April 2021 ('previous submission') and to our supplementary materials attached.

1 General

The off-grid and PMSC reviews provide a timely opportunity to strengthen consumer protections for South Australia's off-grid customers and to better align protections with National Energy Customer Framework (NECF) benchmarks that apply to grid-connected customers in the state. In view of this opportunity, it is important to note that since the release of the consultation papers in November 2021, regulatory changes have been introduced in South Australia which will likely impact off-grid residential electricity customers in the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, Yalata and Oak Valley, and the context of both reviews. Specifically, we refer to the *Electricity (General) (Payment Condition) Variation Regulations 2021* gazetted on 9 December 2021 (No. 80 p. 4331) ('regulatory changes'). The regulatory changes add a new section 17A to the *Electricity (General) Regulations 2012* (SA) as follows:

> *17A—Prescribed condition—use of prepayment meter system*
>
> *(1) In accordance with section 21(2) of the Act, the Commission is required to impose on the relevant licence the condition that the holder of the licence only sell electricity to prescribed customers using a prepayment meter system.*
>
> *(2) This regulation applies in relation to the relevant licence despite the fact that it was issued before the commencement of this regulation.*

'Prescribed customers' are small customers in the APY Lands, Yalata and Oak Valley not previously paying for electricity i.e., Aboriginal residents of public housing in these communities. The regulations enable the Minister to grant a licence holder an exemption from compliance with section 17A (1) for an individual or specific class of prescribed customers (sections 17A (3)-(4)).

The regulatory changes mean that from 1 July 2022 households in the Remote Area Energy Supply (RAES) Aboriginal Communities (AC) Scheme will for the first time prepay for access to electricity via mandatory prepayment metering. Effectively, residential customers in South Australia's remote Aboriginal communities will pay for their electricity differently to other off-grid and grid-connected customers—conditions which apply to them exclusively and on a mandatory basis. The changes planned for these communities underscore the timeliness of the opportunity represented by the off-grid and PMSC reviews.

As ESCOSA, the South Australian Department for Energy and Mining (DEM) and relevant stakeholders have each made clear, and we acknowledge, the staged introduction of electricity charging is complex and the potential for unintended consequences notable. ESCOSA, DEM, relevant communities and their stakeholders each deserve recognition, as there is much to commend in the current approach to the Remote Area Energy Supply (RAES) Aboriginal Communities (AC) Scheme, particularly the time taken to gain a better understanding of the realities facing many off-grid remote-living residents, who are too often disadvantaged by location, inadequate and energy inefficient housing, low incomes and challenging access to thin labour markets (Tregenza 1998, Willis 2006, Bushlight 2013).

We also note that DEM intends to implement the user pays system in RAES AC communities using a discounted introductory tariff lower than the standard RAES tariff. Although this feature of the plan is not yet apparent in the regulatory changes (DEM 2021a), we do agree that refraining from implementing the full tariff in the context of the regulatory changes repositions energy policy in a way that goes further than a narrow economic lens, to consider the broader implications of the distribution of socio-economic risk and costs for affected communities.

We are very pleased to note that the PMSC review proposes reporting on the number and duration of self-disconnections as a key indicator of prepay customers experiencing hardship, and as a means of obtaining insights into customer behaviour and the effectiveness of consumer protections (PMSC review, p. 4).

We refer ESCOSA to the supplementary materials provided, referencing recent quantitative research by members of our team published in December 2021 and January 2022, regarding the frequency of disconnection for prepayment customers, and the greater likelihood of these customers facing disconnection at times of extreme temperatures when electricity can be most critical for health and comfort:

- Longden, T, Quilty, S, Riley, B, White, LV, Klerck, M, Davis, VN & Frank Jupurrurla, N 2021, 'Energy insecurity during temperature extremes in remote Australia', *Nature Energy*.

  Available at: https://www.nature.com/articles/s41560-021-00942-2.epdf

- Longden, T, Quilty, S, Riley, B, White, LV, Klerck, M, Davis, VN & Jupurrurla, NF, 2022, 'Temperature extremes exacerbate energy insecurity for Indigenous communities in remote Australia', *Nature Energy*, pp.1-2.

  Available at: https://www.nature.com/articles/s41560-021-00968-6.epdf

- Davis, VN, White, LV & Riley, B, 2021, ‘Temperature extremes exacerbate energy insecurity – Australia needs to better support remote Indigenous communities to prepare now’, *Nature Sustainability Community*.

  Available at: go.nature.com/31WxDNn

We acknowledge and accept that some people may prefer to have the choice to prepay for household access to electricity. Our submission here focuses on the critical need for customer choice of payment system and for protections preventing prepay customers, many of whom have limited capacity to pay and struggle with household energy costs, from experiencing frequent involuntary ‘self-disconnection’, events which can negatively impact on health and wellbeing.

Relevant to ESCOSA’s off-grid review and updated prepayment review, we saw (based on 1,674,786 daily observations) that remote living customers on prepayment meters can experience very high rates of involuntary self-disconnection from energy services in the home. In the Northern Territory, 91% of 3,300 households in 28 communities utilising prepayment metering experienced disconnection from electricity at least in the 2018-2019 financial year. 74% of homes were shown to disconnect more than 10 times in a 12-month period (Longden et al. 2021).

Furthermore, analyses found that remote living customers on prepayment meters are most likely to experience disconnection when temperatures are very hot or very cold (Longden et al. 2021). Temperature extremes increase reliance on the services that access to energy provides, while simultaneously increasing the risk of prepay customers experiencing involuntary self-disconnection of those services. This could foreseeably exacerbate risks for residents with underlying health conditions, and cause discomfort even for otherwise healthy residents. It should be noted that customer protections for households within the scope of our research derive from an off-grid regulatory framework, similar in many respects to existing arrangements in South Australia.

Contemporaneous research by Klerck (2020a) shows involuntary disconnection is a common experience also for urban households utilizing prepay in the Northern Territory, as reported in Tangentyere Council’s submission to the Commonwealth’s Inquiry into Homelessness in Australia (Klerck 2020a), shown below.

	Smart Prepayment Meters (PPM) April-June 2019				
	PPMs	PPMs Disconnecting		Mean Duration	
	#	#	%	Minutes	Hours
Darwin	457	331	72%	454	8
Katherine	834	413	50%	460	8
Alice Springs	570	420	74%	455	8
Tennant Creek	513	316	62%	480	8
Total	2374	1480	62%		

Table 1: Prepayment customer involuntary self-disconnection data from Klerk (2020), p 11.

Research by Klerck (2020b) using data provided by Jacana has shown that residents of households in Alice Springs town camps, experience 51 involuntary self-disconnections lasting a total of 238 hours per annum. Involuntary self-disconnection is a ubiquitous feature of prepayment metering across jurisdictions. Corroborating this research documenting experiences from the Northern Territory, we draw ESCOSA's attention to disconnection data and reporting published by the Economic Regulation Authority in Western Authority (ERA). During 2020-21:

- WA government-owned utility Synergy had 11 prepayment households, but 249 disconnections across these households
- WA government-owned remote energy utility Horizon Power had 1,348 prepayment households, but 30,307 disconnections across these households in 2021, which was down slightly on 31,969 disconnections in 2020, and 34,468 involuntary disconnection events during 2019
- For Synergy's prepayment customers, there were 21 instances where disconnections longer than 120 minutes occurred twice or more within any 1-month period
- For Horizon Power's pre-payment customers, there were 2,454 instances where disconnections longer than 120 minutes occurred twice or more within any 1-month period (ERA 2022).

The above data, covering regional and remote communities utilizing prepayment metering, demonstrates that disconnection from household energy services is common among prepayment customers—a situation the PMSC review identifies as being '*a key indicator of customers experiencing hardship*' and a *'valuable insight into the effectiveness of consumer protections',* as mentioned above.

Percentage disconnection rates for prepayment customers in each of the Western Australian utility service areas show that prepayment households are disconnecting multiple times each year, in some instances more than twice in a month and for extended periods. This data is consistent with the frequency and duration of disconnection events evidenced in the Northern Territory, highlighted in our recent research (attached in supplementary materials).

Again, we acknowledge that some people may prefer to have the choice to prepay for household access to electricity. We accept that for many customers 'prepaying' for power may represent an improvement over post-pay billing, and that the trade-offs required by prepay may be preferred to the accrual of unsustainable debts to maintain energy services in the home.

However, we draw attention to involuntary self-disconnection as a chief risk inherent in the way prepayment operates currently. New regulatory and policy solutions are needed to prevent remote-living residents and families from experiencing frequent de-energisation of the home and the attendant failure of refrigeration and lighting, and the spoiling of vital food and medicines (Bushlight 2013, Longden et al 2021).

In framing the off-grid review, ESCOSA observes that "[o]ff-grid energy service provider performance data has not highlighted any major problems with the current consumer protection framework" (ESCOSA 2021, p. 1). Yet, we note that in relation to prepayment customers, there is no performance data for key metrics relating to prepayment meters specifically because off-grid retailers have not previously been approved to offer prepayment arrangements to date. Therefore, a significant gap in the evidence base exists upon which it can be reasonably expected to inform, firstly, the decision to implement mandatory prepayment selectively in remote Aboriginal communities and, consequently, the new circumstances relevant to ESCOSA's review of the PMSC and off-grid consumer protection framework.

Evidence from comparable jurisdictions highlights a range of potential hardships foreseeably faced by Aboriginal communities within South Australia's RAES AC Scheme. Moreover, such issues may only become evident over time, as the electricity tariff for RAES AC consumers transitions from the discounted introductory tariff of 10c/kWh to the standard RAES tariff (currently 32c/kWh), as anticipated by DEM (2021c, p. 2). It is unclear from publicly available documents over what timeframe and in what manner the tariff increases are proposed to occur, a factor which will likely have a substantive impact for customers in affected communities, having implications for 'free, prior and informed consent' upon which any changes are to be made. Consistent with our previous submission, we recommend that people in communities where prepay is to be rolled-out on a mandatory basis should be directly engaged in the design of measures to alleviate the harms of involuntary self-disconnection events, based on bottom-up policy interventions and consumer protections shaped to address the specific needs of residents.

We address issues raised in the off-grid and PMSC reviews below.

2. Off-grid energy consumer protection framework review

2.1 Proposed protections

We commend ESCOSA for its proposal to better align consumer protections across South Australia's off-grid electricity and gas frameworks. We note the protections bring consistency in the areas of:

- Contractual information disclosure
- Price disclosures
- Billing
- Billing reviews and dispute resolution
- Minimum payment methods for small customers.

2.2 Payment methods and billing

As currently framed, the proposed changes for off-grid electricity regulation address minimum payment methods for post-payment customers only. Given the regulatory changes introducing mandatory prepayment metering in remote Aboriginal communities, there is a need for diversity of payment methods for both post payment and prepayment customers. This is particularly the case for remote customers where internet connectivity may be unreliable or at times inaccessible. We draw ESCOSA's attention to DEM's assurance that there "[w]ill be range of payment methods including direct debit, BPay and Centrepay (direct from customer's Centrelink payment)" available to customers where mandatory prepayment metering will be implemented (DEM 2021c, p. 1). Additionally, Centrepay and an option for in-person bill payment or credit purchase (as applicable) should be available to both post-payment and prepayment customers. Most customers in remote communities where prepay is used in Western Australia and Northern Territory buy credit from community stores. This is an important option to have available in those circumstances where online purchase methods are disrupted or present other challenges for community members.

Addressing billing changes, we note that ESCOSA's proposal is that off-grid "licensees must use best endeavours to issue bills at least quarterly" for post payment customers (p. 3). While we support the minimum information requirements for customer bills, quarterly bills may entrench or amplify the potential for financial hardship and debt accumulation amongst some remote off-grid customers, as demonstrated by the experience of customers in Coober Pedy (Ombudsman SA 2021). As ESCOSA is aware, in this case the off-grid retailer allowed customers to accumulate considerable debts sometimes in the order of $10,000 and upwards. This situation has the potential to be most acute in remote and disadvantaged communities; in the absence of adequate financial hardship protections;

and/or where hardship protections are not monitored or implemented effectively by licensed electricity retailers. We acknowledge that service providers in remote areas of South Australia are typically small operations with limited administrative resources, however this should not prevent the long-term interests of South Australian consumers being recognised and appropriately served. Indeed, the use of smart metering technology is suggestive of the possibility for much greater flexibility in billing arrangements. For example, an option for shorter minimum billing intervals is one mechanism which may assist customers in managing household electricity costs, alongside effective financial difficulty and customer hardship programs.

2.3 Off-grid electricity retail code

ESCOSA's proposal for the development and implementation of an off-grid electricity retail code would do much to ensure consistency of consumer protections across licensed service areas where different retailers operate, increasing clarity for off-grid customers by providing a consolidated and easily accessible document outlining retailer obligations and customer rights and protections. Examples of off-grid electricity retail codes include the Tasmanian Electricity Code, which applies to customers in the Bass Strait Islands, and the Western Australian Code of Conduct for the Supply to Electricity to Small Use Customers 2018, which applies to grid-connected and off-grid customers.

Involving key stakeholders such as the South Australian Council of Social Service (SACOSS) and other community- based and First Nations organizations, representing the interests of remote area electricity customers across the state, would be of utility in guiding and informing the development of the proposed code in consultation.

2.4 Off-grid hardship protections

ESCOSA has identified key differences between protections available to grid-connected customers experiencing payment difficulties and hardship under the NECF and National Energy Retail Rules (NERR) and those offered to off-grid customers in South Australia. Generally, off-grid licence requirements, and any future off-grid electricity retail code, should aim to align customer protections for off-grid customers with the national standard where practicable and based on feedback from community-based organizations. In relation to specific proposals:

- *Off-grid retailers should be required to develop and maintain an approved hardship policy that addresses the rights and obligations of consumers experiencing payment difficulties and hardship*

  This policy should be easily accessible and visible to consumers and, as a minimum, prominently published on the retailer's website. Preferably, retailers would have an obligation to communicate their hardship policy to customers consistent with the NECF standard (NERR, rule 71). Experiences of off-grid customers in Coober Pedy demonstrate the importance of hardship policies requiring retailers to proactively identify hardship customers and procedures and staff trained to manage customer needs appropriately and respectfully. In Western Australia, the Economic Regulation Authority (ERA) has recently proposed extending assistance measures offered to customers experiencing payment difficulties to all residential customers who request them (ERA 2021), and we recommend consideration of a similar approach for South Australian residential, off-grid customers.

- *As part of the requirements for a hardship policy, there should be an explicit requirement for off-grid retailers to have hardship programs and processes*

  As in section 2.2 above, the requirement for a hardship policy must be supported by robust programs and processes to ensure the hardship policy is effectively implemented for the benefit of customers. Ultimately, proactive identification of customers experiencing hardship is equally in the interests of off-grid retailers to avoid the burden of retailers carrying significant levels of electricity arrears.

- *Off-grid retailers must be required to proactively identify hardship customers, consistent with NECF standards*

  This requirement is essential to support the effective implementation of hardship policy by off-grid retailers. There remains a risk that customers experiencing hardship will be missed if the onus is solely on the customer to self-identify their needs. This is particularly the case for remote-living customers who are necessarily located at considerable distances from their off-grid retailer's customer service office (e.g., customers from APY Lands and Cowell Electric, which is headquartered in Cowell and Adelaide) and in those circumstances where customers face barriers because their primary language is other than English.

- *Centrepay must be available as a payment option*

  Customers in parts of South Australia supplied by off-grid retailers are amongst the most disadvantaged[1] in Australia (ABS, 2016). Making Centrepay available as a payment option recognises the circumstances faced by these customers and provides them with payment options equivalent to customers who are connected to the national grid.

- *Off-grid retailers' relating to payment plans and information disclosures must be aligned to the NECF standards*

[1] For example, we note that the median weekly personal income for people aged 15 years and over in the APY Lands is $283 while the poverty line in Australia for a single person is $471 p/week (Melbourne Institute 2021).

As noted above, many off-grid customers experience socioeconomic disadvantage and retailers' requirements concerning payment plans and related information disclosures must align with NECF standards and recognise customer's specific circumstances, including requirements for information provision to customers clearly describing their payment obligations under any agreed payment plan and the basis upon which instalments have been calculated.

- *Late payment fees should be waived for customers on instalment plans, or using a flexible payment arrangement*

  The application of late payment fees in the circumstances contemplated has the potential to amplify existing financial and energy stress being experienced by customers. As we understand it, off-grid retailers are not currently required to report numbers of hardship customers or customers on payment plans and therefore the number of customers affected is not known. We urge ESCOSA to consider hardship as an additional key metric for performance reporting by off-grid retailers under the licence requirements. Publicly available data on this issue would be of utility to communities themselves and would assist stakeholders and decisionmakers to better identify areas where policy interventions are required.

2.5 Disconnection protections

ESCOSA identifies four key differences between disconnection protections available under the NECF and those offered to off-grid customers. Off-grid customer protections should wherever possible be aligned with the national standard.

The definition used in South Australia's off-grid licence framework is currently narrower than the definition used in the NERR (rule 3) and does not permit a customer's registered medical practitioner to certify equipment as essential for a person residing at the customer's premises. Consistency with the NERR definition of 'life support equipment' and the way equipment can be recognised as life support equipment under that framework would benefit off-grid consumers. By way of illustration, the Northern Territory Electricity Retail Supply Code adopts the NERR definition, and life support provisions in this code apply to off-grid retailers. We note that the disconnection protections discussed in the off-grid consultation paper focus on post-payment and life support customers.

Typically, prepayment customers remain an exception to the widely accepted principle in the national energy market that disconnection from household energy services is only ever 'a last resort'. For many prepay customers disconnection is effectively routinized, and their vulnerability to household de-energisation has been largely overlooked by government reporting in most jurisdictions until now. Under the proposed mandatory system of prepayment, involuntary disconnection from electricity is likely for many low-income customers, especially over time, as the electricity tariff for RAES AC consumers shifts from the discounted introductory tariff to the standard RAES tariff as discussed above.

Disconnection protections should consider the need for specific and innovative safeguards from involuntary self-disconnection for prepayment customers, in consultation with communities themselves, and particularly given that regulatory changes mandating prepayment metering in remote Aboriginal communities have been introduced while ESCOSA's review was in progress. Mandatory implementation of prepayment metering pre-empts the review processes underway by imposing an outcome on an issue currently the subject of active independent review.

Disconnection protections should be expanded to include consideration of the role that solar photovoltaic (PV) systems installed in support of vulnerable public housing tenants and households (including those using prepayment metering) might feasibly play in support of off-grid customers to reduce the frequency and duration of disconnection events.

3. Prepayment Metering System Code review—proposals

We commend ESCOSA for expanding the scope of its prepayment review. Generally, we submit that use of prepayment metering should be a voluntary and informed decision by the customer, rather than mandated under any circumstance and we note that the mandatory basis of prepayment metering roll-out is incompatible with the existing Prepayment Metering System Code ('prepayment code'), including as it does a requirement for individual customer's explicit informed consent to entry into a prepayment meter contract (clause 2.2) and a minimum 3-month trial period within which customers can switch back to post payment metering without penalty (clause 2.5.1(a) and (b)). The special circumstances of customers with life support needs in affected communities are addressed vaguely by the regulatory changes (c.f. clause 2.5.1(h)-(j) inclusive) and mandatory prepayment is generally inconsistent with requirements that off-grid retailers must offer to switch a prepay customer to post payment metering where they self-identify as experiencing payment difficulties or are identified by the retailer according to specific disconnection metrics (clause 3.4.2).

We address specific matters raised by ESCOSA within the PMSC review below.

3.1 Emergency credit facilities

While emergency credit facilities form a part of the protections offered to prepayment customers under the NECF, they delay disconnection rather than address the systemic factors which lead to higher disconnection rates experienced by prepayment meter customers. Emergency credit is necessarily limited to a defined amount and typically repaid when a customer next tops up their prepay meter, before service is recommenced. The limits to the benefits of emergency credit highlight the need for detailed consideration of additional protections for prepayment customers, in order to avoid instances of involuntary self-disconnection from energy services.

There are potential problems with the proposal for retailers to offer prepayment customers discretionary loans to customers. Firstly, the circumstances where loans might be contemplated are covered by the existing code requirement for retailers to offer to switch prepayment customers to post payment arrangements (clause 3.4.2). Secondly, the introduction of loans adds administrative demands for the retailer and the potential to exacerbate financial vulnerability and debt levels in already disadvantaged households.

While not an ideal position, we do agree that the existing emergency credit requirements are likely preferable to discretionary loans. Existing emergency credit requirements could be strengthened by additional protections designed in partnership with people from communities where use of prepayment meters is contemplated or mandated (as is the case for remote Aboriginal communities). One potential mitigation strategy might be to consider developing a specific health and safety circuit ensuring access to a specified limited number of appliances - such as refrigeration - providing a minimum service level upon the expiry of emergency credit and as an alternative to complete de-energisation of the home.

3.2 Support for customers experiencing payment difficulties

We note the proposal to remove the trial period currently contained in clause 2.5.1(a) and (b) of the code, on the basis that "customers can switch metering modes at any time and that there are no penalty, exit, termination or meter reversion fees for switching between modes" (DEM 2021b, p. 5). However, the ability to switch freely between modes does not seem explicitly available to customers in communities where prepayment metering is to be mandatory. We note DEM's submission (27 April 2021) was made prior to the decision on mandatory prepayment (8 December 2021) so may need to be reconsidered in light of these new circumstances. We note the removal of this protection is inconsistent with NECF benchmarks which prioritise consumer choice and safeguards.

We support the proposal to develop a new standard customer contract covering prepay and post-payment arrangements, provided that both categories of customers are afforded equivalent protections including in respect of disconnection, hardship, financial difficulties, life support protections and COVID-19 hardship protections. These contractual provisions would need to reflect protections for prepayment meter customers integrated into the prepayment code and any future retail code developed by ESCOSA.

Further, we note that in South Australia:

- The connection of customer solar PV systems in RAES micro-grid locations cannot occur without prior written approval from DEM;
- RAES customers may submit a proposal regarding solar PV connection, however connection will not be considered unless the customer can demonstrate that the proposal will not impact on the stability of the existing grid or the security of electricity supply to all customers (SA Govt 2020).

As in other jurisdictions, community and public housing residents typically have few options to make energy efficiency changes to housing without having to navigate complex regulatory burdens. Rooftop solar is currently almost wholly absent from public housing in the relevant communities and we note that there is currently no solar feed-in or zero export tariff structured for off-grid households in South Australia outside of the conditions stipulated above, including for those customers soon to commence prepayment metering, factors which could serve to 'lock-out' these customers from realizing the benefits of rooftop solar PV. The burden of having to submit a proposal demonstrating that a customer connection "will not impact on the stability of the existing grid or the security of electricity supply to all customers" (SA Govt 2020, p. 2) in the RAES area is likely one of numerous barriers making rooftop solar prohibitive for many off-grid customers, including those where prepay is to be implemented.

We wish to highlight that the situation faced by off-grid customers is occurring within a broader context where renewable energy generation in South Australia commonly supplies 100% of grid-based energy demand, many times each week and during the year, and where residential rooftop solar uptake is driving down household energy costs for many consumers. Removing regulatory and technical barriers to rooftop solar for community and public housing in the affected communities is likely beneficial in supporting those experiencing payment difficulties, and in reducing the frequency and duration of involuntary self-disconnection.

3.3 Retailer public reporting requirements

We support the proposal for retailers to have mandatory public reporting obligations on a quarterly basis for specified metrics relevant to prepayment customers (i.e., number of times emergency credit was accessed; number and duration of self-disconnections; number of times the minimum requirements for retailer follow up with customers following disconnection were met, and the reasons for any disconnection). We also encourage ESCOSA to consider reporting requirements for off-grid retailers specifying:

- numbers of prepayment customers

- numbers of prepayment customers self-reporting or identified as experiencing hardship
- numbers of customers who have requested to revert to post payment metering
- numbers of customers who have reverted from prepayment to post payment metering
- numbers of registered life support customers
- numbers of complaints received from prepayment meter customers
- proportion of disconnections above and below temperature thresholds specified in consultation with climate experts and/or epidemiologists.

Existing reporting requirements identify the number of complaints received by off-grid retailers and distributors as being a key metric for determining off-grid licensee performance (ESCOSA 2022). Obviously, this does not yet provide insights about historic performance of the service provider in communities where prepayment metering is yet to be mandated. As we understand it, Aboriginal customers in public housing within the RAES AC scheme have not previously paid for the electricity they consume, they are therefore not considered 'customers' and cannot make complaints. Mandatory reporting requirements should be supported by obligations to off-grid retailers to proactively monitor occurrence of disconnections, and durations of disconnection, for prepay customers. Additionally, quarterly reported data should be made publicly available and published by ESCOSA on its website, at a level of aggregation that avoids potential privacy concerns. This would support the advocacy work of community-based organisations and provide a foundation for evidence-based policymaking while, importantly, making the data visible to consumers themselves.

Given the implementation of prepayment metering in Aboriginal communities it is important to note that energy services networked to information technology introduce novel ways of generating value through data. Internationally the movement to secure local ownership and control of data relating to Indigenous peoples is known as Indigenous data sovereignty (Yu 2012, Kukatai and Taylor 2016). In Australia research is needed to ensure that the energy data rights and interests of Aboriginal communities are secured and leveraged for Aboriginal benefit. The Council of Australian Governments 'Closing the Gap in Partnership: Priority Reform Four' (COAG 2019) calls for the greater sharing of, and access to, data and information at a regional level, noting that "disaggregated data and information is most useful to Aboriginal and Torres Strait Islander organisations and communities to obtain a comprehensive picture of what is happening in their communities and to support decision making" (NACG 2020).

Greater capacity building and sharing of energy data, particularly relating to the frequency and duration of household disconnection events, can do much to support community and service provider efforts to improve energy security for pre-pay customers within remote off-grid communities.

3.4 Prepayment System Customer Consultation Groups

We note the proposal to change existing requirements for each retailer approved to offer prepayment arrangements to establish a consultation group, in favour of groups of retailers establishing an umbrella consultation group (e.g., RAES licensed retailers). We note that there is a need for mechanisms to support fair and equal representation of consumers and consumer advocates from all communities covered by the umbrella group. Additionally, we suggest implementing formal requirements around the conduct and regularity of meetings and processes for decision-making based on community and stakeholder input, particularly as mandatory prepayment is due to commence this year in remote Aboriginal communities within the RAES Scheme. In relation to these communities, the requirement in the prepayment code (clause 3.1.3) that the consultation group continue for at least 3 years is a positive one. It is our view, that if it remains the intention of DEM to transition communities from an introductory tariff to the standard RAES tariff (32c/kWh), it would be both fair and beneficial for the consultation group to continue for a period (potentially 3 years) allowing close monitoring of community impacts, and for ongoing community and stakeholder input.

3.5 Information provision: information provided prior to gaining explicit informed consent

The Essential Services Commission of Victoria observes:

> Increased rates of disconnections are not the only barriers facing First Nations consumers. It was found that for Aboriginal and Torres Strait Islander communities accessing support and information remains a significant barrier to interacting with the market (ESC Victoria 2021, p. 45).

We note ESCOSA and DEM's proposal for the development of a standard explicit informed consent document. There is a need for further monitoring to ensure that retailer compliance processes meaningfully engage consumers about their choices. In particular, the process of obtaining consent needs to acknowledge and serve the diverse linguistic and sociocultural contexts of remote customers. We recommend better aligning the standard consent document which has been developed (DEM 2021b, Annexure 2) with the intent and purpose of explicit informed consent established by clause 2.2 of the code.

As stated in 3 above, mandatory prepayment metering in Aboriginal communities is antithetical to the concept of explicit informed consent under the prepayment code. A standard consent document is convenient for retailers obtaining customer 'consent' retrospectively where prepayment metering is already mandated but does not address the fundamental requirement for consent to be based on choice in the first place. In this context it is incumbent upon the utility to understand consent as an expression of trust both in the utility provider, and in the South Australian government to protect consumers from known and potential harms.

3.6 Limitation on the recovery of debt

There is a proposal to amend the prepayment code to enable off-grid retailers to recover debts owed by prepayment customers (e.g., under a previous post payment contract), by allocating meter credit between the debt and electricity consumption on an agreed basis. Managing carry-over debt in this manner erodes existing consumer protections contained in the prepayment code and diverges from the standard established in the NERR (rule 133). Debt recovery arrangements that introduce additional stressors on daily household energy access are likely to further increase the risk of disconnection for already disadvantaged consumers. Amendments to the prepayment code should focus on the potential for smart-meter technologies to be leveraged to reduce the frequency and duration of families disconnecting from household energy services.

3.7 Life support system definition

We support the submission made by SACOSS to amend the definition of life support equipment in the prepayment code for consistency with the NERR definition.

4. Conclusions

Thank you for the opportunity to make this submission to the off-grid and PMSC reviews. This review offers a timely opportunity to strengthen consumer protections for South Australia's off-grid customers and to better align protections with National Energy Customer Framework (NECF) benchmarks. We hope by detailing areas of remaining risk and highlighting areas where further improvements might be considered that we have contributed to the aims of the reviews. We would be pleased to discuss any aspects of our submission with you or provide further information to assist the review process. Our respective contact details are available above.

Supplementary materials

- Longden, T, Quilty, S, Riley, B, White, LV, Klerck, M, Davis, VN & Frank Jupurrurla, N 2021, 'Energy insecurity during temperature extremes in remote Australia', *Nature Energy*.

  Available at: https://www.nature.com/articles/s41560-021-00942-2.epdf

- Longden, T, Quilty, S, Riley, B, White, LV, Klerck, M, Davis, VN & Jupurrurla, NF, 2022, 'Temperature extremes exacerbate energy insecurity for Indigenous communities in remote Australia', *Nature Energy*, pp.1-2.
  Available at: https://www.nature.com/articles/s41560-021-00968-6.epdf

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Energy insecurity during temperature extremes in remote Australia

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Indigenous communities in remote Australia face dangerous temperature extremes. These extremes are associated with increased risk of mortality and ill health. For many households, temperature extremes increase both their reliance on those services that energy provides, and the risk of those services being disconnected. Poor quality housing, low incomes, poor health and energy insecurity associated with prepayment all exacerbate the risk of temperature-related harm. Here we use daily smart meter data for 3,300 households and regression analysis to assess the relationship between temperature, electricity use and disconnection in 28 remote communities. We find that nearly all households (91%) experienced a disconnection from electricity during the 2018–2019 financial year. Almost three quarters of households (74%) were disconnected more than ten times. Households with high electricity use located in the central climate zones had a one in three chance of a same-day disconnection on very hot or very cold days. A broad suite of interrelated policy responses is required to reduce the frequency, duration and negative effects of disconnection from electricity for remote-living Indigenous residents.

Indigenous communities in remote Australia face temperature extremes that can increase their use of electricity and amplify their risk of being disconnected. Energy is a necessary resource for work, education, participation in social life and for maintaining healthy living practices at home[1–6]. Energy insecurity remains a pressing issue globally, including in countries with an abundance of wealth and resources[4,7–10]. It can be defined as 'an inability to meet basic household energy needs'[5] and is broadly synonymous with the concept of energy poverty[11–13]. Insufficient access to energy has been linked to poor health (both mental and physical) as energy is required to maintain essential services, including food security, lighting, essential medical equipment and thermal comfort/safety during extreme weather[4,5,14–22].

There is a need to better understand the extent of energy insecurity experienced by Australia's remote Indigenous communities, in particular the role that temperature plays in shaping energy insecurity. The vulnerabilities associated with energy insecurity vary spatially on the basis of underlying characteristics, which can be highly regionalized and locally specific[23]. Socio-economic, demographic and behavioural factors, as well as occupancy and structural characteristics (including the size, type and quality of housing stock and appliances), are all key drivers of energy consumption; while the prevailing temperature can affect the security of electricity supply due to the cost of heating or cooling[24,25].

Temperature extremes are likely to act as a risk multiplier, worsening energy insecurity for those at greatest risk as 'vulnerable households typically live in poorer quality housing, and have least resource or opportunity to invest in improvements to its efficiency and heating technology'[6]. The importance of access to energy has prompted governments worldwide to implement policies maintaining this access, many with special attention to reducing the health effects of heat and cold[7,26,27].

The climate of the Northern Territory (NT) ranges from equatorial and tropical regions in the north to hot dry grassland regions in Central Australia (Fig. 1a). Remote Indigenous communities in the NT are mostly off-grid and unregulated by the guidelines of the Australian Energy Regulator[28]. In a situation unusual in Australia, remote living residents prepay for access to electricity and regularly experience disconnection on non-payment. Distant from Australia's urban centres and major electricity grids, these communities have long relied on diesel and gas-fired generators. In recent years, there has been incremental integration of renewable energy into these isolated, high-cost electricity networks.

Australia's remote Indigenous communities face some of the highest temperatures nationally and are vulnerable to the effects of a warming climate (Fig. 1b–d)[29]. Exposure to extreme temperatures has been associated with a range of adverse health outcomes and death[22,30–33]. In the three hottest climate zones in Australia, between 4.5 and 9.1% of all deaths were associated with heat-related mortality, which is an estimate that is much higher than in other Australian regions (2% nationally)[31]. The challenge of maintaining thermal comfort and safety during temperature extremes is a pressing issue for author N.F.J.: "We can't do anything about climate change except turn the power up, but it costs a lot too, don't forget that. Electricity, you're using more power when you turn that air conditioner up!." Temperatures over 35 °C, and even over 40 °C, are increasingly common in the NT as the climate changes (Fig. 1d). There is a need to better understand how extreme temperatures already shape the experience of energy insecurity in remote Indigenous communities.

Because of the health implications of energy disconnection and the subsequent loss of essential services, there are questions around how strongly disconnection events relate to temperature and whether disconnections occur more frequently during extreme

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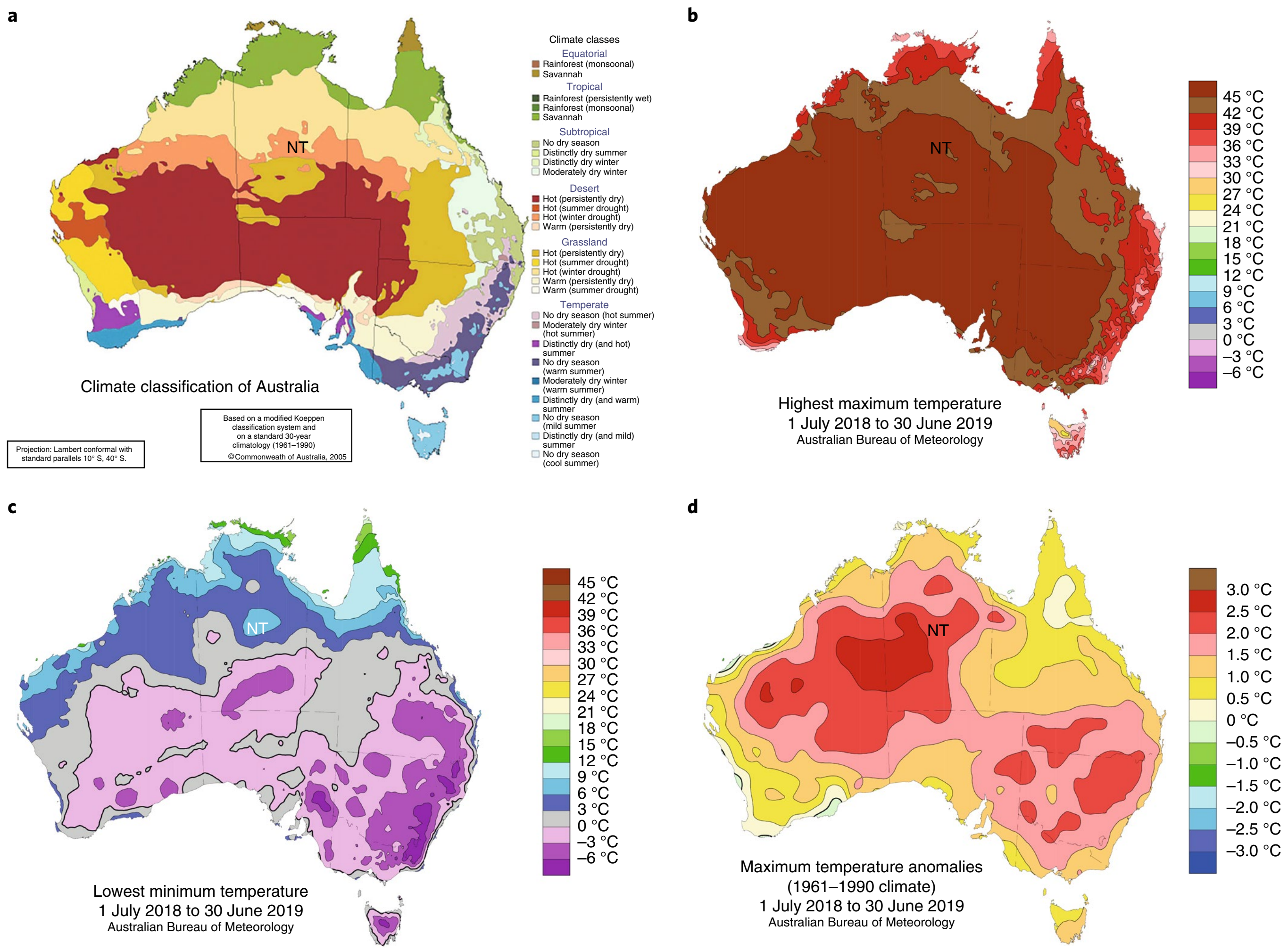

Fig. 1 | NT compared with other Australian regions. a, Climate zones. **b**, Highest maximum temperatures. **c**, Lowest minimum temperatures. **d**, The 12-monthly mean maximum temperature anomaly for Australia compared with 1961 to 1990. Panels reproduced with permission from the Australian Government Bureau of Meteorology under Creative Commons license CC-BY 3.0 AU: **a**, ref. [73]; **b**, ref. [72]; **c**, ref. [74]; **d**, ref. [75].

temperatures. In this paper, we assess the relationship between temperature, electricity use and disconnection using daily smart meter data for 28 remote Indigenous communities in the NT, all of which are using prepayment metering. We then present how many disconnection events occur during example temperatures to indicate the extent and severity of energy insecurity attributable to temperature extremes. Quantification of energy insecurity and how it is related to temperature thresholds could support future policy responses.

Energy injustice and a history of policy exceptionalism

Similar to Indigenous peoples worldwide, communities in the remote NT have long been at greater risk across the three dimensions of energy injustice. Energy justice is concerned with the distribution of costs, benefits and risks in energy transitions and is a principle that arises from theories of distributional justice[2,6,9,34–37]. Distributional injustices in energy systems can be produced by systemic inequalities that arise from ongoing procedural injustices (which is a concept rooted in the failure to accord some groups of people equal rights and respect)[38] and recognition injustices (when certain groups face a lack of cultural respect and are excluded from decision-making)[39]. Procedural injustices extend to differences in legal rights; distributional injustices are reflected in differences in the quality of housing that affects energy use; and injustices in recognition include a lack of acknowledgement of the unique needs of specific communities, including those associated with energy access, use and practices[16]. Some groups, such as remote Australian Indigenous communities, consistently have less access to energy efficient housing, less ability to shape the electricity systems that they are connected to and less ability to pay for higher electricity costs that may result from certain systems[6,9]. These aspects tend to be intertwined.

For author V.N.D., who works on issues related to energy, housing and social justice in Central Australia, maintaining access to electricity during temperature extremes represents a complex suite of interrelated challenges: “Older houses had solar hot water and pot belly stoves for the winter. We could collect wood and the sun heated the water. The new houses built by the Government since the Intervention (in 2007) have electric hot water heaters and no pot belly stoves. When the old houses were upgraded, pot belly stoves were removed. Our houses don’t have heating anymore. Most residents don’t have much money, so residents buy cheap fan heaters and air-cons. The problem with these is that they are expensive to run. Our houses have become expensive to heat and expensive to cool and we run out of money for electricity. When the power goes off it is bad for our health, the food gets spoiled, we can’t wash our clothes and we can’t wash our kids.”

Residents of remote communities live in extremely challenging socio-economic circumstances and in housing that can be extremely crowded (see Supplementary Table 1 for example statistics from the 2016 census). Housing quality is often poor across these remote communities. Approximately half of Indigenous households in the NT fall below the poverty line. The National Indigenous Reform Agreement (Closing the Gap), the core of the Australian Government's agenda to address social and health inequities facing Indigenous Australians, identifies 'healthy homes' as a key priority for healthy living practices[40,41]. Nine priorities are identified, with six pertaining to electricity systems, which are power connection, electrical safety, heating for showering, facilities to wash children, laundry facilities and facilities to store food and prepare food (including refrigeration)[41].

Moreover, Aboriginal and Torres Strait Islander peoples have experienced frequent changes in the policy environment regulating their lives and lands, via a non-Indigenous regime of law. Many communities in the NT have been subject to frequent changes in regulatory practices for electricity and regressive changes in procedural and recognition justice aspects, such as cycles of gain then subsequent loss of representation in governing bodies[37]. Some of this complex regulatory and legislative history is summarized in a non-exhaustive timeline of key developments in policy affecting Indigenous peoples in the Territory between 1967 and 2021 (Fig. 2). This includes the unilateral introduction of a 'user-pays' model for energy provision in 1992. Author and Warumungu elder N.F.J. has lived experience of these deep structural imbalances that impact, too-often detrimentally, on the lives and livelihoods of Indigenous communities in the NT: "I reckon the Government doesn't want to listen to Wumpurrarni (Indigenous) people because I reckon they've had enough and they're just ignoring us now, they think we get everything for free but we struggle for that. Policy is like a bible, for Government, it tells them how they run things, how they can do things. If they don't have a policy, they don't know how things run. And if they have a policy they can jam you and that's what happens to us, they jam us all the time."

Limited protections and prepaying for power in the remote NT

Prepayment for electricity is uncommon in urban Australia. It is heavily regulated in most jurisdictions on the basis of concerns for wellbeing[42–45]. It remains disproportionately common in small and widely dispersed remote communities across the NT, Queensland, Western Australia and South Australia. In the NT prepayment is not limited to urban town camps and remote communities. It is also used in urban and regional settings, including Darwin, Palmerston, Nhulunbuy, Katherine, Tennant Creek and Alice Springs. Many of these communities have prepaid electricity services as their only option for service provision[46]. There is considerable variation in the operation of services and available protections for prepayment consumers subnationally. As an example, in other parts of Australia where consumers are protected by the Australian Energy Regulator guidelines, people cannot be disconnected from electricity when life support medical equipment is being used[43]. This protection is not comprehensively applied in remote NT communities[47,48].

In previous international studies, rates of disconnection among prepayment households ranged from 10% to 53% for the UK, Germany and New Zealand[49–52]. Prepayment disconnection numbers for Australia are not systematically collected or reported by regulators or providers and estimates are scarce. Previous analysis in the NT found prepayment disconnection rates between 59% and 91% (ref. [53]). In comparison, the rate of 'raised disconnections' for postpayment households in other Australian regions that are most at risk of disconnection ranged from 3% to 30% with large variation in disconnection rates associated with local and regional socio-economic characteristics and whether smart meters were commonly used[54]. The St Vincent de Paul Society and Alviss Consulting report defines a 'raised disconnection' as the case when a 'retailer raises a service order with the relevant network business'. These raised disconnections may be rejected, cancelled or completed. They may be rejected on the basis of an invalid address or when disconnection is prohibited for medical reasons. And the disconnection request can be cancelled by the retailer when the payment issue has been resolved. This can be a full payment or the establishment of a payment plan[54]. These rates of disconnections are the higher end of estimates as they are those that were found for the top 30 postcode regions from four Australian areas (that is, New South Wales, Victoria, South East Queensland and South Australia). Across the eastern (and most populous) parts of Australia, the rate of completed disconnections for postpayment households was 1% (ref. [55]).

While data are scarce, issues with prepayment and disconnection in other regions of Australia have been noted by key organizations, including the Essential Services Commission of South Australia[44], Energy and Water Ombudsman New South Wales[45], the Queensland Council of Social Service[56] and Bushlight[46]. The last two raised these concerns specifically in relation to remote Indigenous communities.

Disconnection as an indicator of energy insecurity

While energy insecurity describes more than disconnection rates alone, having an electricity connection is the first part of being able to access electricity to meet household energy needs. Here we assess disconnection rates as a proxy for energy insecurity, while noting that other factors also contribute to the disconnection rates observed. This may include housing design, construction and insulation; sociodemographic factors such as income and health; and entrenched regulatory structures.

When the households in our dataset run out of credit, they face immediate disconnection between 10:00 and 14:00. Outside these hours, credit is extended and the accumulated debt is automatically deducted from the subsequent purchase of energy credit. Energy services are not recommenced until the accrued debt is paid[57].

For the houses in our study with complete data for the 2018–2019 financial year (July 2018 to June 2019), 91% of households experienced a disconnection. Most disconnections were same-day disconnections (92% of the total) where the meter was reconnected when credit was restored on the same day. A total of 71% of households experienced a same-day disconnection more than ten times in a 12-month period. These rates of disconnection are much higher than Australian and international examples (mentioned above). On average, a same-day disconnection lasted for almost 3 h. Multi-day disconnections were less common (0.9% of days), but two thirds of households experienced this type of disconnection, which lasted overnight or longer. Of all households, 7% experienced a multi-day disconnection more than ten times in 1 year. These disconnections could last for many days (the all-region average was almost 4 days). Table 1 shows how these disconnections differed by climate zones.

Electricity use during temperature extremes

To confirm our expectation that temperature affects electricity use, we used linear regression with panel-corrected standard errors to provide estimates for seven daily temperature ranges. These temperature ranges are specified in the regressions as the daily average temperature for the same day as electricity use and the daily average temperature for the 2 days before. We estimate these regressions for all climate regions pooled together, and for each climate region separately. The regressions were also estimated for all houses and then re-estimated for different levels of the average daily use of electricity. Our data did not include any information on household characteristics, so we have used the average level of daily electricity use to group the households. Determinants of the average daily load include occupancy and the use of appliances. For more information, refer to the methods section for more details on the grouping of households with high/low electricity use.

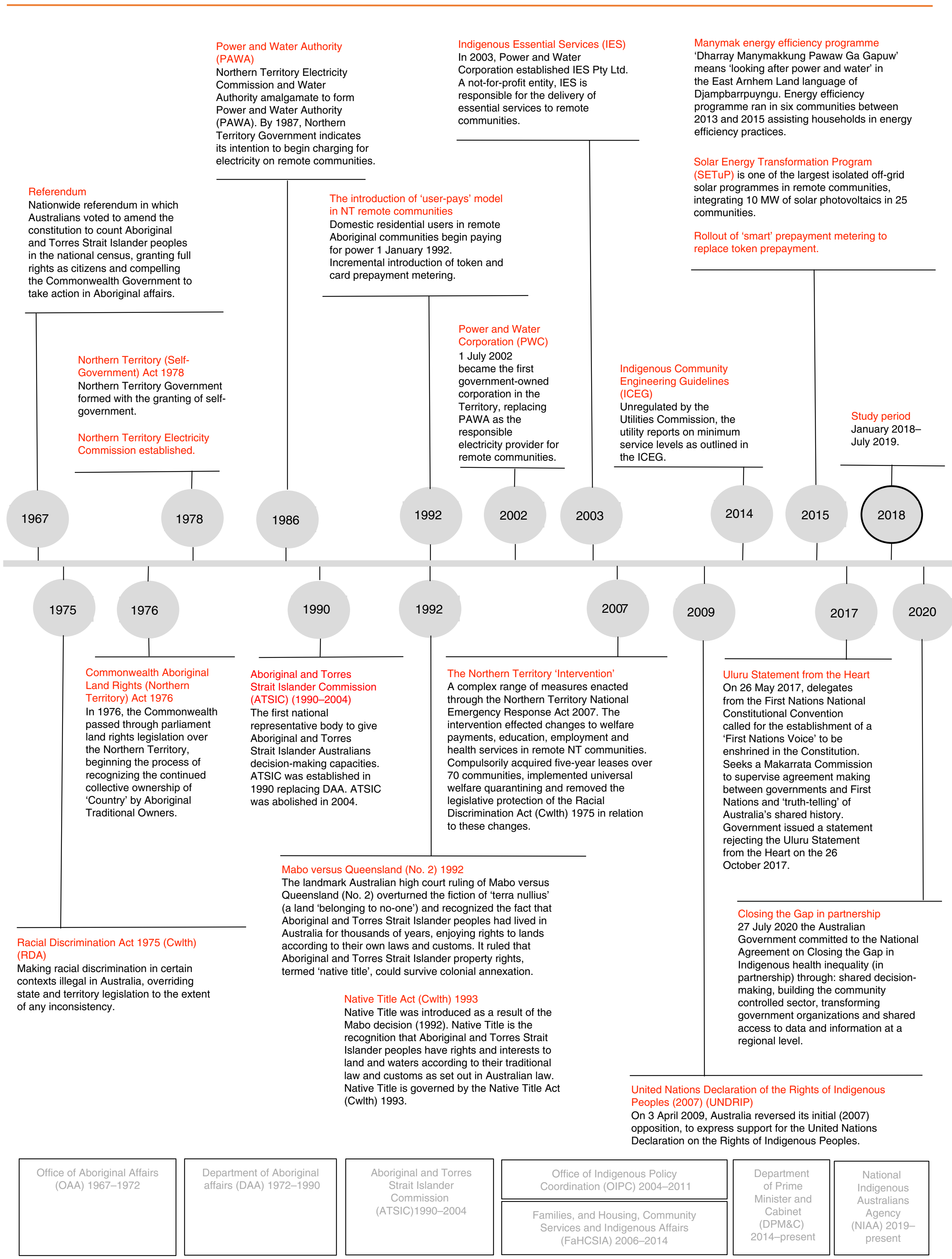

Fig. 2 | Timeline of the complex history of Indigenous policy in Australia. Key developments in Indigenous policy, including remote community energy policy, between 1967 and 2021. Boxes at the bottom are the federal departments or agencies responsible for Indigenous policy.

Table 1 | Disconnection rates by climate zone between July 2018 and June 2019 (n = 1,045,725)

	Equatorial climate zone (most northern)	Coastal tropical climate zone	Savannah tropical climate zone	Hot persistently dry grassland climate zone (most southern)	All regions
Same-day disconnections					
Percentage of households experiencing a same-day disconnection at least once	85	94	90	90	89
Percentage of households experiencing a same-day disconnection at least ten times	60	77	75	75	71
Percentage of days in the sample with a disconnection	7	11	11	10	10
Average length of disconnection (hours)	2.92	2.89	2.69	2.19	2.67
Multi-day disconnections					
Percentage of households experiencing multi-day disconnection at least once	47	68	71	83	66
Percentage of households experiencing multi-day disconnection at least ten times	2	4	9	16	7
Percentage of days in the sample with a disconnection	<1	1	1	2	1
Average length of disconnection (hours)	102.23	87.82	73.29	125.49	98.48
Any type of disconnection					
Percentage of households experiencing any type of disconnection at least once	87	95	91	92	91
Percentage of households experiencing any type of disconnection at least ten times	63	80	78	78	74
Percentage of days in the sample with a disconnection	7	11	12	12	10
Average length of disconnection (hours)	8.60	8.46	8.39	17.66	10.62
Daily electricity use and expenditure					
Daily electricity use (kWh) (s.d.)	21.25 (16.46)	23.29 (15.24)	25.73 (16.86)	26.95 (22.05)	24.13 (17.75)
Daily expenditure (AUD$) (s.d.)	6.09 (4.71)	6.67 (4.37)	7.37 (4.83)	7.72 (6.31)	6.91 (5.08)
Count of observations for balanced panel for 2018–2019 financial year	306,600	229,585	296,380	213,160	1,045,725

The regression estimates confirm that electricity use differs notably by temperature, climate zone and month (Fig. 3). Estimates for temperature-related increases in electricity use are shown in Fig. 3, with the number of days that these temperatures occurred and the estimates for the monthly change in electricity use (without the daily temperature effect). These estimates for temperature and monthly effects should be interpreted in relation to the reference temperature range (daily average temperatures between 20°C and 25 °C).

Given that the climate across the northern half of the NT is characterized by tropical heat (and mild cool nights only during a short winter season), daily electricity use was on average higher in the hottest periods of the year (November to March). This seasonal increase in electricity consumption was most pronounced in high-use households, which also experienced a reciprocal reduction in monthly electricity consumption in the cooler months. As expected in the NT, which generally has a prevailing hot climate, household energy expenditure is greatest during hotter weather due to the need for cooling.

Beyond seasonal effects, the need for heating and cooling can influence the daily use of electricity. The hot persistently dry grassland climate zone is the region that predominantly determines the all-regions result (Fig. 3b). It is the combination of the Central Australian climate zones shown in Fig. 1a. For this climate zone, which unlike the other regions experiences cold nights, the households with the highest electricity use (top tenth percentile of average daily load) increased their electricity use by 30 kWh (on average) on the coldest of nights (between 0°C and 10 °C). The average increase was 17 kWh across all houses in this climate zone. Extremely hot days with average temperatures between 30°C and 40 °C corresponded to a 16–19 kWh increase (on average) for the households with the highest electricity use. When considering all houses, the average increase was 6–8 kWh.

Disconnection during temperature extremes

To assess the question of whether temperature influences the probability of disconnection, we used random-effects probit regressions to estimate the probability of same-day and multi-day disconnections. Figure 4 shows the estimates for temperature-related increases in the probability of a same-day disconnection, which includes daily estimates and the estimates for the monthly change in disconnections (without the daily temperature effect). The estimates are interpreted in relation to a reference temperature range (daily average temperatures between 20°C and 25 °C). These estimates are also re-estimated by the level of electricity use and climate zones.

The probability of a same-day disconnection occurring on any given day (except during weekends and public holidays when disconnection is prohibited) is high (0.04–0.06) and increases on the first day that credit can expire, predominantly the next business day (approximately 0.19). This is captured in our results, with a large

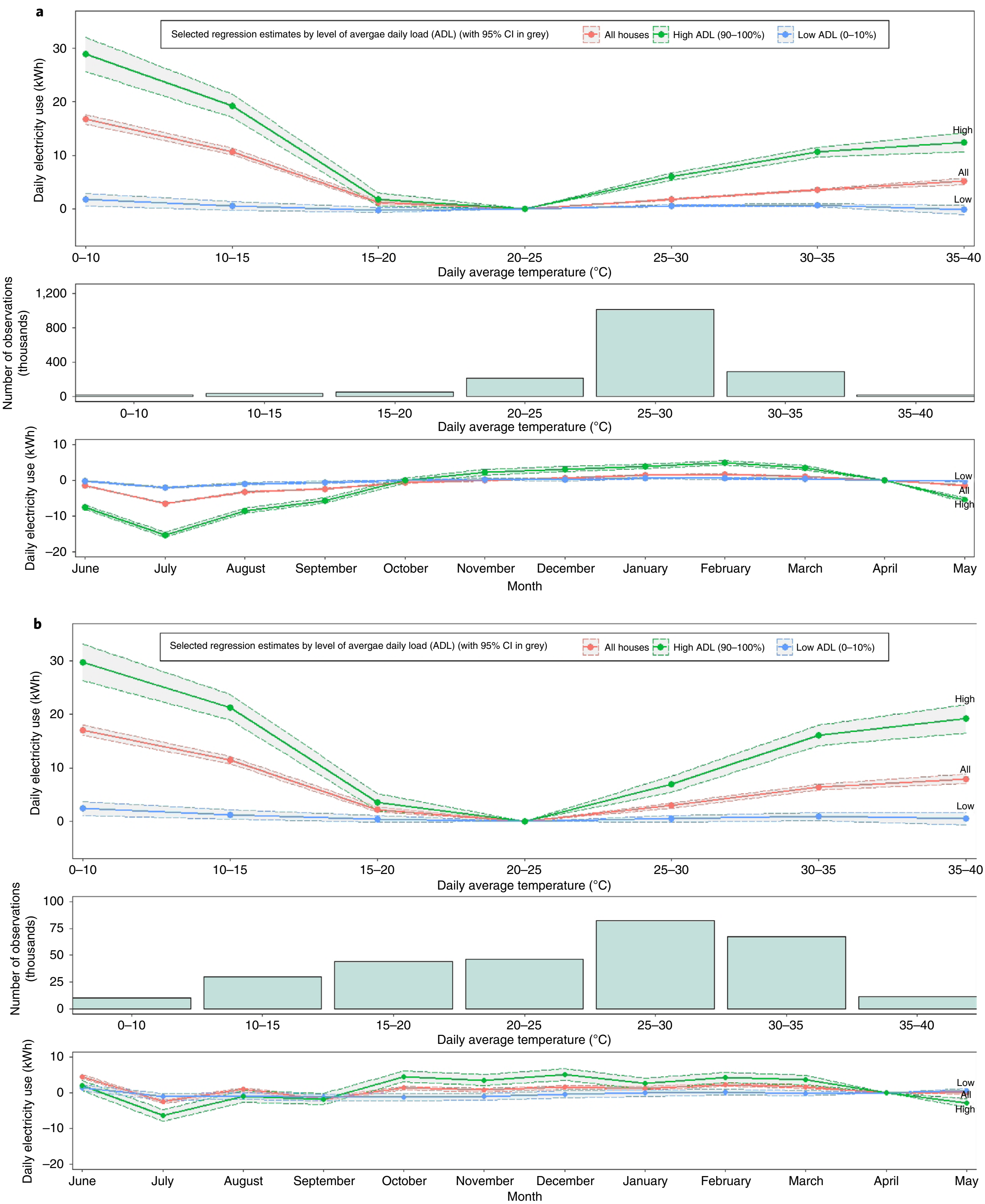

Fig. 3 | Daily electricity use by temperature and month. a, All regions. **b**, Hot persistently dry grassland climate zone. These are the coefficient estimates and 95% confidence intervals from multiple regressions for a sample with 1,674,786 daily observations across 3,300 houses. Regressions were grouped by percentile of electricity use (that is, average daily load) and climate zones. Estimates for all houses, low-electricity-use households and high-electricity-use households are shown here (Supplementary Tables 2–6 have all of the electricity use estimates). Temperature bins are specified using daily average temperatures (in °C). Temperature-based estimates are for a three-day period (that is, temperature on the day of electricity use and the two days before). Temperature estimates are interpreted using 20–25 °C as the reference temperature range. Monthly estimates are interpreted using April as the reference month.

increase in disconnections occurring on Monday and the day after a public holiday (Fig. 4). There is a significant relationship with temperature that is most notable for the households with the highest electricity use in the two southern climate zones.

For the full sample, there was a one in seventeen chance (probability of 0.06) of a same-day disconnection occurring on moderate days with average temperatures between 20°C and 25 °C. This increased to a one in eleven chance (probability of 0.9) on hot days with average temperatures between 35°C and 40 °C. A series of cold nights had a significant effect with an almost one in six chance (probability of 0.18) of a same-day disconnection occurring on cold days with average temperatures between 0°C and 10 °C.

The households with the highest electricity use had a much greater probability of same-day disconnection. For this group, there was almost a one in seven chance (a probability of 0.15) of experiencing a same-day disconnection on moderate days with average temperatures between 20°C and 25 °C. This increased to one in three (probability of 0.35–0.39) for the coldest temperatures (0°C to 15 °C) and one in four (probability of 0.24 to 0.27) for the hottest temperatures (30°C to 40 °C).

Climate zones also influenced the probability of a same-day disconnection occurring (Fig. 4b and Supplementary Information). For households with the highest electricity use in the southern-most climate zone (that is, hot persistently dry grasslands shown in Fig. 4b), a one in seven chance (probability of 0.14) of same-day disconnection for temperatures between 20°C and 25 °C, increased to one in three (probability of 0.31) for the coldest temperatures (0°C to 10 °C) and one in four (probability of 0.23) for the hottest temperatures (30°C to 40 °C). For the households with the highest electricity use in the savannah tropical climate zone, there was a one in four chance (probability of 0.23) of disconnection for temperatures between 20°C and 25 °C, which increased to one in three (probability of 0.37 to 0.39) for the hottest temperatures (3°C to 40 °C).

Only a weak relationship between temperature and multi-day disconnections was found. The estimation results are provided in Supplementary Table 12. While rarer (approximately one-tenth as common), multi-day disconnection events lasted for an average of 4 days (Table 2).

Number of disconnections during temperature extremes

Temperature-related disconnections are driven by an increased need for electricity to maintain thermal comfort and safety during extreme temperatures. We now focus on the proportion of disconnections that occurred during hot and cold temperatures for two reasons. First, these are critical events where expenditure on energy has increased due to cooling/heating, leading to a disconnection that compromises the other functioning of the home, including refrigeration, lighting and life support medical equipment (for example, oxygen concentrators, sleep apnoea machines, home renal dialysis equipment). Second, there is a concern about the impact on health. Protections internationally include several examples of restricting disconnection for vulnerable customers, including on the basis of health risks and outdoor temperatures[7,26,48]. These protections can include disconnection prohibitions based on the time of year (for example, no disconnections during winter months in cold climates), on reaching specific temperature thresholds, and on declarations of extreme weather events (for example, no disconnections during a declared heat wave event)[26]. Using example temperature thresholds to determine the number of temperature-related disconnections, we find that over 49,000 incidences of disconnection (29% of disconnections) occurred during hot and cold temperature extremes (Table 2). We examine both 35°C and 40 °C as the threshold for extreme heat.

Discussion

We begin to address the need to better understand how temperature affects energy insecurity in Australia's remote communities by examining (1) whether temperature affects electricity use, (2) whether temperature influences the probability of disconnection and (3) the proportion of temperature-related disconnections (that is, disconnections that occur during extreme temperatures). Temperature is confirmed to effect electricity use. Correspondingly, disconnections are more likely during extreme temperatures. We find that in the 28 remote Indigenous communities that are the focus of this study, disconnections increase from an already high baseline of one in seventeen during mild temperatures (20–25 °C), to a one in eleven chance of disconnection during hot days (34–40 °C) and a one in six chance during cold days (0–10 °C). Disconnection occurs more frequently for households with the highest electricity use in the central climate zones, which had a one in three chance of a same-day disconnection on very hot or very cold days. This indicates that households are having trouble cooling/heating their homes, which in turn compromises access to other essential services including refrigeration, lighting and essential medical devices. While the level of energy service that is viewed as 'essential' can vary over time and with changing social norms[58], a complete loss of access to energy services constitutes a level of energy insecurity that can harm wellbeing[2]. In the financial year July 2018 to June 2019, disconnection was experienced by 91% of households in the remote NT communities that we have data for.

There are multiple levels of energy injustice in remote Indigenous Australia, and the effects of climate change will exacerbate pre-existing energy insecurity and subsequent effects on health and wellbeing. In considering how to address these issues, it needs to be recognized that there is a disproportionate prevalence of prepayment metering in remote Indigenous communities compared to the rest of Australia[46]. There are questions about whether prepayment is a good option for remote communities that already face compounding distributional injustices. While some studies find that prepayment may be preferred to the accrual of unsustainable debts[50,51], this is only a weak endorsement of prepayment when compared to worse options. The framing of household electricity payment for communities needs to be extended beyond individual fiscal responsibility to incorporate a broader economic lens that accounts for the effects of frequent disconnection from the services that energy provides on Indigenous wellbeing.

In considering such distributional injustices, procedural injustices first need to be addressed by supporting participatory community engagement in energy policy development (for example, increase local access to data/information and community consultations). Indigenous Australians have distinct societal values and perspectives of wellbeing, and for progress across all spheres of inequity

Fig. 4 | Probability of a same-day disconnection by temperature, day and month. a, All regions. **b**, Hot persistently dry grassland climate zone. Coefficient estimates and 95% confidence intervals from multiple regressions for a sample with 1,674,786 daily observations across 3,300 houses are presented above. Regressions were grouped by percentile of electricity use (that is, average daily load) and by climate zone. Estimates for all houses, low-electricity-use households and high-electricity-use households are shown here (Supplementary Tables 7–11 have all same-day disconnection estimates). Temperature bins are specified using daily average temperatures (in °C). Temperature-based estimates are for a three-day period (that is, temperature on the day of disconnection and the two days before). Temperature estimates are interpreted using 20–25 °C as the reference temperature range. Day of the week estimates are interpreted using Wednesday as the reference day. Monthly estimates are interpreted using April as the reference month.

and injustice faced by Indigenous communities there needs to be a recognition of these world views in the context of the realities that these communities face[59].

The Partnership Agreement on Closing the Gap calls for the greater sharing of, and access to, data and information to support shared decision-making (Fig. 2)[60]. With respect to disconnections,

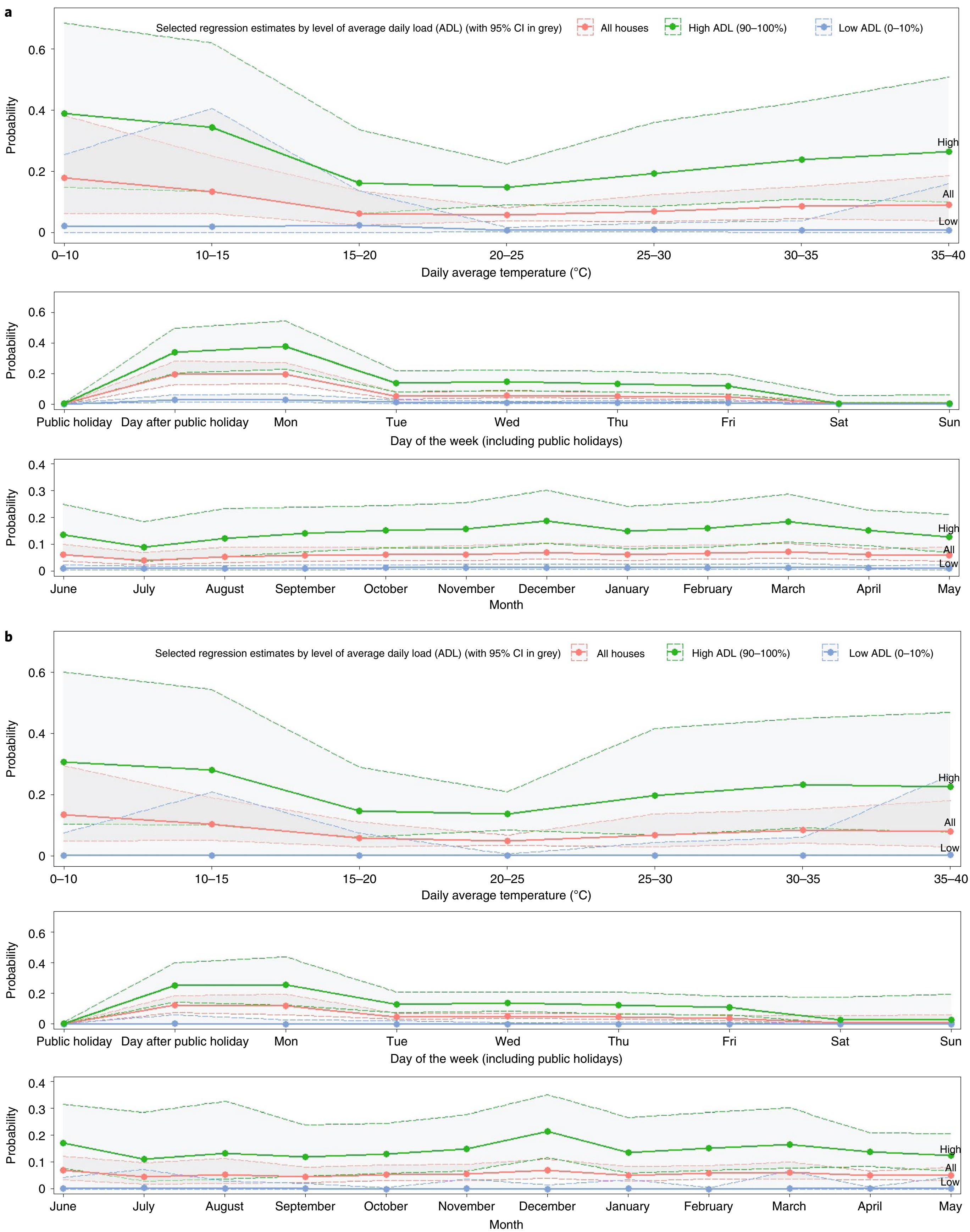

Table 2 | Electricity use and disconnections by climate zones

	Equatorial climate zone (most northern)	Coastal tropical climate zone	Savannah tropical climate zone	Hot persistently dry grassland climate zone (most southern)	All regions
Percentage of disconnections above maximum temperature of 35 °C					
Percentage of same-day disconnections	7	12	34	42	24
Percentage of multi-day disconnections	6	11	36	40	28
Percentage of all disconnections	7	12	34	42	25
Percentage of disconnections above maximum temperature of 40 °C					
Percentage of same-day disconnections	0	0	4	18	5
Percentage of multi-day disconnections	0	0	3	18	7
Percentage of all disconnections	0	0	4	18	5
Percentage of disconnections below minimum temperature of 0 °C					
Percentage of same-day disconnections	0	0	5	12	4
Percentage of multi-day disconnections	0	0	6	11	6
Percentage of all disconnections	0	0	5	12	4
Number of disconnections					
Number of same-day disconnections	32,133	39,212	54,309	30,281	155,935
Number of multi-day disconnections	1,971	2,787	4,841	4,692	14,291
Number of all disconnections	34,104	41,999	59,150	34,973	170,226

a key aim will be reducing the frequency, duration and effects of disconnection. This might include: improving the accessibility and affordability of energy through changes to tariffs or direct access to the benefits of renewable energy such as residential rooftop solar on community housing; improving energy efficiency of infrastructure, buildings and appliances; and improving energy provision for particular critical needs, for example, disconnection prohibitions or tariff reductions during temperature extremes, protections for critical care customers and the use of protected circuits for refrigeration, lighting and essential medical equipment.

In addition to better policy, the language around disconnection events needs to recognize and reflect community experience. The term 'self-disconnection', while in common use, is a misrepresentation as it incorrectly implies that households were making a voluntary choice to disconnect themselves[21,50,61]. The term 'involuntary self-disconnection' emphasizes 'that the household has not chosen to cease their electricity supply' [62].

Limitations

On considering these results there are limitations that need to be considered. First, we were unable to identify the reasons for multi-day disconnections. Once a disconnection occurs, whether it becomes a multi-day disconnection will depend on a number of factors including whether residents can 'top up' credit, pay off 'friendly credit' debt, or make other arrangements. Inter- and intraregional mobility in remote and rural Australia is common (refs. [63–65] and E. Ings, personal communication), which could influence the onset and length of multi-day disconnections. Residents may choose to temporarily relocate to the residence of kin for socio-cultural reasons or because of a disconnection, and disconnection-associated relocations may themselves exacerbate overcrowding and increase electricity demand on households that are not yet disconnected. Future studies should focus on the experiences of energy poverty in these communities and further investigate these issues.

Second, we did not have information on the socio-economic and demographic composition of households. To address this, we used statistical approaches to control for differences across households and estimated the effect of temperature on the basis of the usual level of electricity use and disconnections (during moderate temperatures between 20°C and 25 °C). As a result, when discussing the estimates, we provide the likelihood of disconnections during moderate temperatures. Electricity consumption data were used to estimate relationships for different groups of households. There will be additional determinants for the differences in electricity use and disconnection, which should be investigated further.

Third, this study uses data from 3,300 smart prepayment meters and finds that over 170,000 disconnections occurred across 28 communities over a period spanning 18 months. Note that our dataset is unbalanced due to the timing of the roll out of smart meters in the NT. Thus, we underestimate the total number of disconnections in the NT as there are many more households currently using prepayment metering than just those represented in this study[53]. The vulnerability of prepayment customers is often overlooked by government reporting. Further research on prepayment and disconnection in other jurisdictions is needed, as is greater understanding of the direct health effects of these disconnections.

Conclusions

Australia could do much better at providing protections from disconnection. Policymakers are beginning to consider the importance of electricity to wellbeing in approaches that seek to limit the frequency and duration of disconnection events, particularly in relation to temperature extremes and wellbeing. In the USA, for example, despite not having a formalized definition of energy poverty or federal level protections, many states have utility regulation policies that protect customers from disconnection of service in certain cases, including extreme temperatures[4,26]. Some state consumer protections target vulnerable groups, such as in the state of Texas where prepayment-meter enrolment is prohibted for those diagnosed with severe medical conditions that require electricity services to maintain temperatures or run devices[26,66]. Many European Union states have also introduced protection from disconnection[7], many with particular focus on extreme temperatures and vulnerable groups.

In Australia, the Essential Service Commission (for Victoria) observes that "customers who are disconnected from electricity or gas can face significant risks to their welfare… disconnection for non-payment reasons should only ever be a last resort"[67]. Australia's National Energy Retail Rules require that the retailer not arrange for the de-energization of premises having life support equipment or during an extreme weather event[68], but this is not comprehensively applied in remote NT communities[47,48].

Energy insecurity in remote Indigenous Australia remains a pressing issue. Access to energy has been identified as a key part of the 'critical healthy living priorities' for remote living Indigenous Australians[3]. Ensuring access to essential services is an important prerequisite to improving health and wellbeing outcomes[69]. The focus should not be solely on electricity provision itself, but on maximizing the benefit that households receive from their electricity use and this includes a range of essential services, including heating and cooling.

Methods

Ethics statement. This research was conducted with ethics approval from the Central Australian Health Research Ethics Committee Centre for Remote Health (CA-20-3809).

Autoethnographic quotes. While this is predominantly a quantitative study, our research methodology is based on principles of social justice where Aboriginal people participate in setting the research agenda[70] and we supplement our analysis with insights through autoethnography[71]. These quotes are included by authors, N.F.J. who is a community elder and V.N.D. who is a senior Aboriginal researcher. This paper has more than a single authorial voice, coming as it does from multiple perspectives. These perspectives are from researchers who work at an academic institution (T.L., B.R. and L.V.W.), a regional hospital (S.Q.) and community-based organizations (S.Q., M.K. and V.N.D.).

Dataset. The data used in this paper were sourced from the NT Government owned utility Power and Water Corporation, the Australian Bureau of Meteorology (BOM) and the Australian Bureau of Statistics. Daily electricity use data for 3,300 households with a smart prepayment meter were matched to temperature data from the closest weather station. For cases where there were no temperature data for that day, the next closest weather station was used (6.1% of all observations). If that still resulted in a missing value, then the average for that climate zone was used (0.3% of observations). Data on disconnections were provided along with the time and date that the electricity service was discontinued and subsequently restored. These cases of disconnection were aggregated into daily data and separated into two variables on the basis of whether an electricity service was restored to the household on the same day or not. Selected summary statistics for these data by climate zones are shown in the paper in Tables 1 and 2.

The climate zones we used were sourced from the Australian BOM[31]. We made some modifications to the zones mapped by BOM, which was to reclassify all of the mainland communities that were within 20 km of the coast as a 'coastal tropical climate zone' and combine the Central Australian climate zones into one region that we called the 'hot persistently dry grassland climate zone'. The second modification was due to sample size and a similarity in temperatures. The other climate zones are those prescribed by BOM, shown in Fig. 1c.

Extreme temperatures in remote communities. Those communities that we focus on are typically exposed to extremely hot days and cold nights. Supplementary Table 13 shows the breakdown of key temperature statistics by climate zone for these communities. Figure 1 presents maps produced by the Australian BOM showing how temperature differs across both Australia and the NT[72]. Differences in temperature indicators vary across climate zones (shown in Fig. 1a–c). Central Australia experiences prolonged hot daytime temperatures in summer and cold (below zero) nights in winter. For example, the hottest day (46 °C) and coldest night (−4 °C) in our dataset both occurred in the southern-most 'hot persistently dry grassland climate zone'. Northern regions of the NT experience the southern extent of the tropical monsoon, which brings seasonal cyclonic activity and afternoon storms. Average temperatures decrease north to south. The highest maximum temperature (lowest minimum temperature) increases (decreases) as you move from the north to south (Fig. 1b,c and Supplementary Table 13). The regressions were run using daily average temperatures.

Grouping by average daily electricity use. Energy insecurity and disconnection rates are likely to be determined by a range of factors, including the usual level of electricity use and the inability to pay. While we do not have household data on occupancy or income, we are able to categorize the meters into groups using average daily electricity use. The average daily load will be a function of the types of appliance, intensity of use and the number of residents. The percentile groupings used are shown in Supplementary Table 14 along with the aggregate expenditure on electricity. Note that the data are not a balanced panel due to the incremental roll out of smart meters across communities and we excluded those meters with less than 100 observations.

Regression analysis. To estimate the relationship between electricity use and temperature we used linear regression with panel-corrected standard errors that accounted for heteroscedasticity and autocorrelation. The 28 communities were the level for the panel correction. The software that was used to estimate these relationships was Stata MP 16.1. The 'xtpcse' command was used to estimate the results shown in Fig. 3 and Supplementary Tables 2–6. We also tested for normality in linear panel-data models using the 'xtsktest' command, which did not reject the null hypothesis of normality (Chi-square statistic of 3.28–3.42 (P value of 0.18–0.19)). The 'xtserial' command was used to perform the Wooldridge test for autocorrelation in panel data, which rejected the null hypothesis of no first-order autocorrelation (F-statistic of 6,694.17 (P of 0.00)). We used random-effects probit regressions to estimate the relationship between the probability of same-day/multi-day disconnection and temperature. These estimates were estimated using the 'xtprobit' command in Stata and we clustered the standard errors by community to control for regional differences. The results of the same-day disconnection estimations are shown in Fig. 4 and Supplementary Tables 7–11. When discussing these estimates in the paper we compare them to the likelihood of disconnection during moderate temperatures. The probabilities of disconnection events were converted into an odds ratio (for example, 1:2) and then reported as the chance of a disconnection (for example, one in three). Multi-day disconnection estimates are included in Supplementary Table 12, but are not discussed in the paper as there was no clear relationship between multi-day disconnections and daily average temperature. Note that the regression estimates were graphed using the 'ggplot' command in R.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The data used in this paper are not freely available and were sourced from the data custodians. The electricity data were sourced from Power and Water Corporation (https://www.powerwater.com.au/) and the Australian BOM (http://www.bom.gov.au/). We note that access to data will be a key part of local communities helping to develop appropriate policy responses to the challenges outlined in this paper. The Partnership Agreement on Closing the Gap calls for the greater sharing of, and access to, data and information at a regional level noting that "disaggregated data and information is most useful to Aboriginal and Torres Strait Islander organizations and communities to obtain a comprehensive picture of what is happening in their communities and to support decision-making"[60].

Code availability

The code used to estimate the regressions (in Stata MP 16.1) and create the graphics (in R v.4.1.1) is available on request. The 'xtpcse' and 'xtprobit' commands in Stata MP 16.1 were used for the regressions. The regression estimates were graphed using the 'ggplot' command in R. Statistical tests for normality and autocorrelation were performed in Stata MP 16.1 using the 'xtsktest' and 'xtserial'.

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We acknowledge and thank the Power and Water Corporation for providing the electricity data. We acknowledge the Australian BOM and thank them for providing temperature data and maps. A range of people provided useful advice that helped to shape this paper and they include E. Ings and J. Hulcombe. We thank the Board and staff of Tangentyere Council Aboriginal Corporation in Mparntwe (Alice Springs) and the Board and staff of Julalikari Council Aboriginal Corporation in Tennant Creek. Our research methodology was informed by the principles underpinning ethical Australian Indigenous research outlined in the AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research (AIATSIS 2020): Indigenous self-determination, Indigenous leadership, impact and value, sustainability and accountability. We acknowledge and thank colleagues at the Australian National University. T.L., B.R. and L.V.W. thank their colleagues from the ANU Grand Challenge Zero-Carbon Energy for the Asia-Pacific and the Institute for Climate, Energy and Disaster Solutions.

Author contributions

All authors contributed to the conceptualization of the research. We especially note the contributions of N.F.J. and V.N.D. in shaping our understanding of the key issues faced by Indigenous communities in the NT. S.Q. acquired the key data, and T.L performed the analysis. T.L., S.Q., B.R., L.V.W. and M.K. wrote the initial draft of the manuscript, and all authors contributed to the review and revision. N.F.J. and V.N.D. were engaged in discussions on key issues with the other members of the authorship team and their selected quotes are provided to highlight those themes and the issues that they raised as being the most important (refer to autoethnographic data section for more information).

Competing interests

The authors declare no competing interests.

Additional information

Extended data are available for this paper at https://doi.org/10.1038/s41560-021-00942-2.

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41560-021-00942-2.

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Peer review information *Nature Energy* thanks Kimberley O'Sullivan, Sangeetha Chandrashekeran and Stefan Bouzarovski for their contribution to the peer review of this work

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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

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Data collection	No software was used for data collection.
Data analysis	The software that was used was Stata MP 16.1 and the 'xtpcse' and 'xtprobit' commands were used for the regressions. The regression estimates were graphed using the 'ggplot' command in R 4.1.1. Statistical tests for normality and autocorrelation were performed in Stata MP 16.1 using the 'xtsktest' and 'xtserial'.

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The data used in this paper is not freely available and was sourced from the following data custodians. The electricity data was sourced from Power and Water Corporation (https://www.powerwater.com.au/) and the Australian Bureau of Meteorology (http://www.bom.gov.au/).

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Behavioural & social sciences study design

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Study description	This is a quantitative study that assesses the relationship between temperature and electricity use (including disconnection) using daily smart meter data for 28 remote Indigenous communities.
Research sample	The data set includes the electricity use of 3,300 households across 28 remote Indigenous communities. The data set is unbalanced due to the timing of the roll out of smart meters in the Northern Territory. But the data is representative of the communities where the roll out occurred as we had access to all smart meter data. The electricity data was sourced from Power and Water Corporation (https://www.powerwater.com.au/) and the Australian Bureau of Meteorology (http://www.bom.gov.au/).
Sampling strategy	Most of the tables were created and all of the regressions were performed using all available data. Table 1 is limited to the observations for a balanced panel for 2018/19 financial year (i.e. only the observations with data for every day of the year). This was done to compare to other studies with annual disconnection rates.
Data collection	Data was received from two data custodians and matched at the community level. Daily smart meter data was sourced from Power and Water Corporation. Daily temperature data was sourced from the Australian Bureau of Meteorology. Data was matched based on the location of communities and weather stations. Dr Longden was the only researcher with full access to all of the matched data.
Timing	Unbalanced panel data between January 2018 to July 2019.
Data exclusions	We excluded those meters with less than 100 observations as we required temperature and seasonal variation to estimate the regressions.
Non-participation	No individual participants were involved in the study.
Randomization	No randomization occurred. We had access to all smart meters in those communities that had them installed at that point in time. We grouped households based on daily electricity use and climate zones. The key explanatory variables were exogenous (such as temperature and month) so randomization was not necessary.

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☒	☐	ChIP-seq
☒	☐	Flow cytometry
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Human research participants

Policy information about studies involving human research participants

Population characteristics	The data set includes the electricity use of 3,300 households across 28 remote Indigenous communities. No individual characteristics were collected.
Recruitment	The data set is unbalanced due to the timing of the roll out of smart meters in the Northern Territory. But the data is representative of the communities where the roll out occurred as we had access to all smart meter data.

Ethics oversight	This research was conducted with ethics approval from the Central Australian Health Research Ethics Committee Centre for Remote Health (CA-20-3809).

Note that full information on the approval of the study protocol must also be provided in the manuscript.

policy brief

ENERGY SECURITY

Temperature extremes exacerbate energy insecurity for Indigenous communities in remote Australia

For remote Indigenous communities prepaying for electricity in Australia's Northern Territory, temperature extremes increase reliance on the services that energy provides and the risk of disconnection of those services. Policy should focus on reducing the frequency, duration and negative impacts of disconnection, within the context of a warming climate.

Thomas Longden[1,2], Simon Quilty[3], Brad Riley[2,4], Lee V. White[2,5], Michael Klerck[4,6] ✉, Vanessa Napaltjarri Davis[6] and Norman Frank Jupurrurla[7]

BASED ON: T. Longden et al. *Nature Energy* https://doi.org/10.1038/s41560-021-00942-2 (2021).

The policy problem

In Australia's Northern Territory, most remote Indigenous households are provided with or elect to use prepayment electricity meters. This payment method is associated with high disconnection rates and is uncommon in other Australian urban and rural communities. These remote communities also experience some of the most extreme temperatures in Australia (Fig. 1a). Electricity use to sustain safe indoor temperatures can rapidly deplete available means, resulting in disconnection with little warning. As such, safe temperatures cannot be maintained, and households lose access to other essential services that electricity provides, such as food storage, washing and cooking. This raises the need to understand both the extent of current disconnections and the degree to which they are triggered by temperature. Without this understanding, the existence and severity of problems cannot be identified, and policy cannot be designed to mitigate current harms or prevent future ones.

The findings

Among 28 remote communities in the Northern Territory, we found that 91% of households experienced a disconnection event at least once during the 2018/19 financial year; 74% of households were disconnected over 10 times, and 29% of all disconnections occurred during extreme temperatures. In mild temperatures (20–25 °C), households had a 1 in 17 chance of disconnection on a given day (Fig. 1b). This increased to a 1 in 11 chance during hot days (34–40 °C) and a 1 in 6 chance during cold days (0–10 °C). Households with high electricity use in the central Australian climate zones had a 1 in 3 chance of a same-day disconnection during temperature extremes. Energy insecurity is worsened when energy use is heightened owing to heating or cooling needs (Fig. 1c). Our analysis does not explore all of the complexities underlying energy insecurity in these communities, but we expect that these findings will inform discussions of energy insecurity in regions with extreme temperatures.

Messages for policy

- Electricity disconnections among households with prepayment meters are more frequent during temperature extremes, curtailing access to essential services.
- Households with high electricity use experience more disconnection events, so policy responses should account for household structure and occupancy, as well as the opportunity to use rooftop solar.
- Greater visibility and understanding of data on disconnections in these communities is needed to determine the extent of their energy insecurity.
- Policy should seek to reduce the frequency and duration of involuntary self-disconnections in remote communities, particularly during extreme temperatures.
- To account for the multifaceted nature of energy insecurity, policy responses need to be informed by residents, local councils, healthcare professionals and other relevant organizations.

The study

This analysis used daily smart-meter data from 3,300 households across 28 remote communities in Australia's Northern Territory to identify the incidence of disconnection events. These smart-meter data were matched with daily temperature observations from the closest weather station using data from the Australian Bureau of Meteorology. We estimated the probability of disconnection

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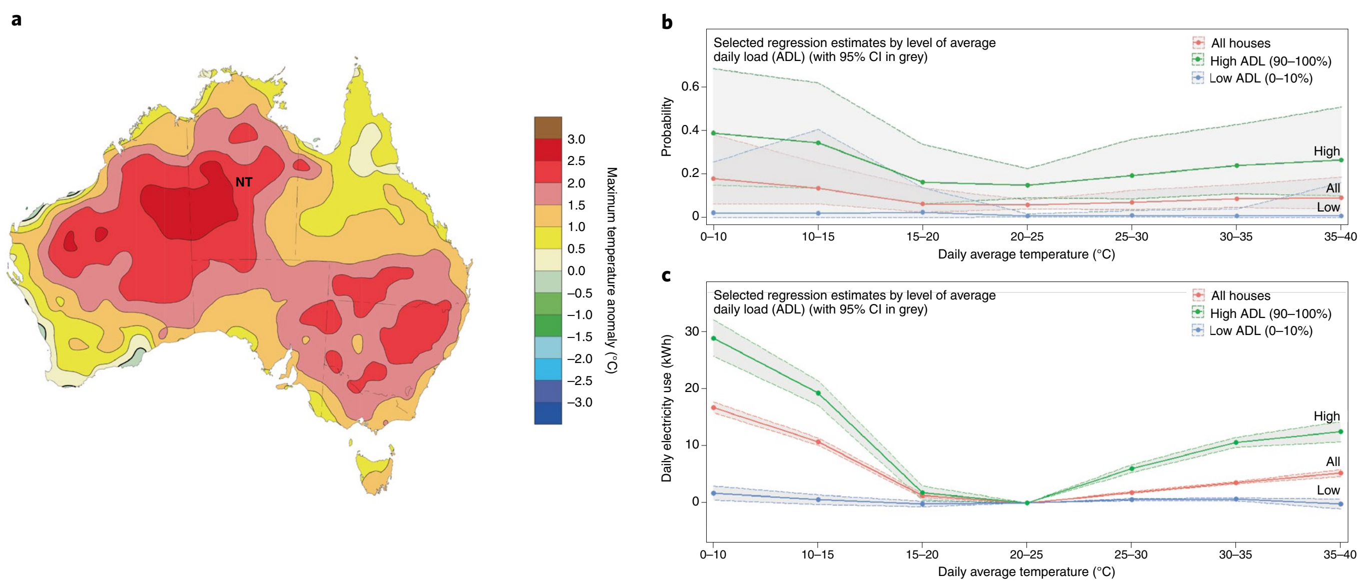

Fig. 1 | Temperature anomalies and the impact of temperature on disconnections and electricity use. a, Maximum temperature anomalies across Australia (July 2018 to June 2019 compared with 1961 to 1990), with the Northern Territory (NT) labelled. **b**, Probability of a same-day disconnection by temperature. **c**, Daily electricity use by temperature. Adapted from: **a**, http://www.bom.gov.au/jsp/awap/temp/archive.jsp under a Creative Commons license CC BY 3.0. Reproduced from: **b**, **c**, Longden, T. et al. *Nat. Energy* https://doi.org/10.1038/s41560-021-00942-2 (2021); Springer Nature Ltd.

across distinct temperature ranges using random-effects probit regressions, which allowed us to include variables for the daily average temperature, month of the year, and different levels of electricity use. Using a reference temperature range allowed us to measure how temperature influenced electricity use and the likelihood of a disconnection during both hot and cold days. This assessment of whether extreme temperatures are a factor determining disconnection events was only possible with access to smart-meter data. As the vulnerability of prepayment customers is often overlooked, we recommend that these data be better monitored and made more accessible to residents, community organizations and researchers. ❐

Published online: 24 January 2022
https://doi.org/10.1038/s41560-021-00968-6

Further Reading

Klerck, M. *Tangentyere Council, Submission to the House of Representatives Inquiry into Homelessness in Australia* (Tangentyere Council Aboriginal Corporation, 2020); https://irp-cdn.multiscreensite.com/d440a6ac/files/uploaded/House%20of%20Representatives%20Inquiry%20into%20Homelessness%20in%20Australia%202020.pdf.
This investigation of data for 570 households prepaying for electricity in Mpwartne/Alice Springs revealed that 420 homes (74%) were disconnected from electricity between April and June 2019.

O'Sullivan, K. C., Howden-Chapman, P. L. & Fougere, G. Making the connection: the relationship between fuel poverty, electricity disconnection, and prepayment metering. *Energy Policy* **39**, 733–741 (2011).
This study finds a connection between fuel poverty, electricity disconnection and the use of prepayment metering for vulnerable older people in New Zealand.

Hernandez, D. Understanding 'energy insecurity' and why it matters to health. *Soc. Sci. Med.* **167**, 1–10 (2016).
This article describes the multidimensional nature of energy insecurity, which includes economic, physical and behavioural dimensions, and identifies the types of adverse environmental, health and social consequences that can occur.

Flaherty, M., Carley, S. & Konisky, D. M. Electric utility disconnection policy and vulnerable populations. *Electr. J.* **33**, 106859 (2020).
This paper explores the differences in utility disconnection policies that have the potential to protect vulnerable populations from exposure to excessive heat or cold.

Longden, T. The impact of temperature on mortality across different climate zones. *Clim. Change* **157**, 221–242 (2019).
This study shows how exposure to extreme temperatures is associated with higher death rates in the three hottest climate zones in Australia, which correspond with the Northern Territory.

Competing interests

The authors declare no competing interests.

Contributor Nature Energy

BEHIND THE PAPER

Temperature extremes exacerbate energy insecurity – Australia needs to better support remote Indigenous communities to prepare now

Remote Indigenous communities in Australia face some of the highest temperatures nationally, worsening energy insecurity for residents who mostly prepay for access to electricity. We need to do better at providing protections from disconnection to improve Indigenous health and wellbeing.

Vanessa Davis and 2 others View all
Senior Aboriginal researcher, Tangentyere Council
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Werte (hello/welcome).

This blogpost tells the story behind our paper *Energy insecurity during temperature extremes in remote Australia*, published in Nature Energy this month.

Co-workers and I at Tangentyere Council Research Hub started investigating the relationship between temperature, electricity use and involuntary self-disconnection in 2018. Extreme heat is a big issue, and the number of extreme temperature days in 2018/19 surpassed even the most severe projections of what we could expect under future climate change scenarios. It concerned our team greatly. Aboriginal social housing residents from Mpwartne/Alice Springs, its Town Camps and remote Central Australia were also reporting frequent disconnection from prepaid residential energy services and concerns about the amount of money spent to power their homes.

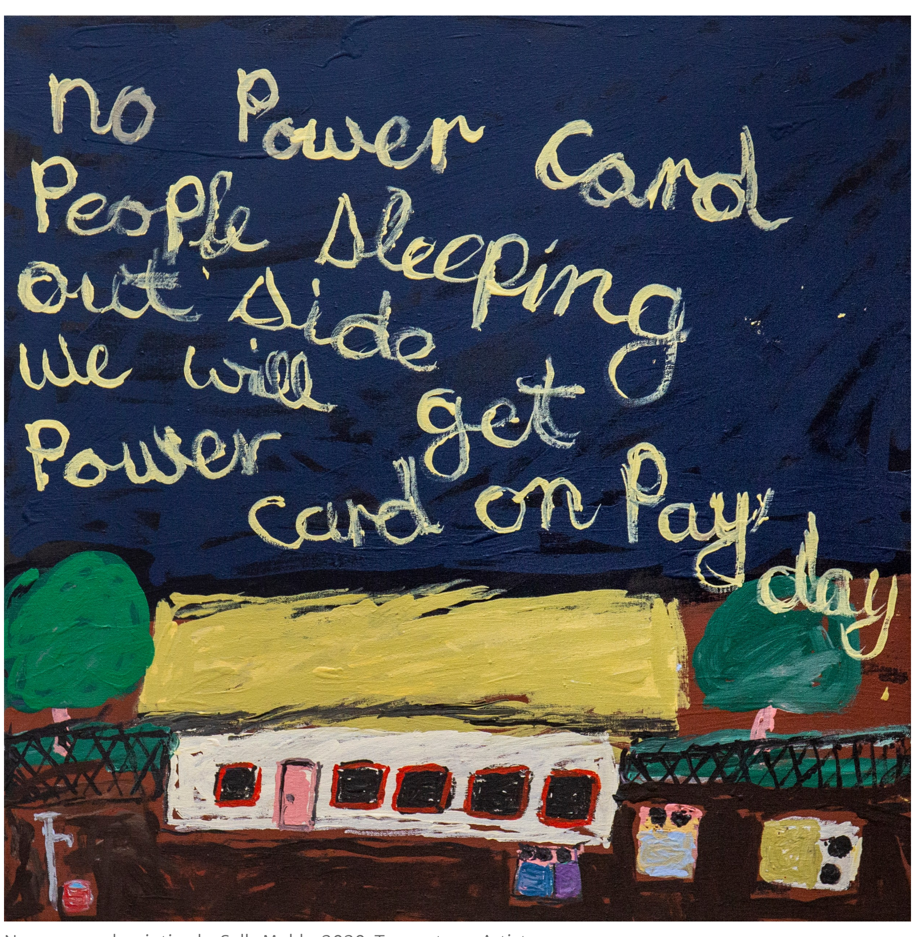
With the cooperation of our local utility, our preliminary investigation of 426 households prepaying for electricity in Town Camp housing revealed that 91 per cent of homes were disconnected from electricity during 2019–20 and many homes had multiple disconnections. Broadening our scope to all major regional centers, we found that in the larger Northern Territory (NT) towns of Darwin, Alice Springs, Katherine, and Tennant Creek, 71% or 1467 (of 2074) households experienced at least one involuntary self-disconnection from electricity in the three months between April and June 2020. The average duration that homes were losing power was almost 5 hours. The average number of disconnections for this period was nearly 9 per household per quarter.

Predicting that a similar situation likely existed in NT remote communities, and supported by data from the utility, we undertook a study with colleagues from Julalikari Council Aboriginal Corporation in Tennant Creek and the Australian National University, to analyze daily electricity use data for 3,300 households matched to temperature data from the nearest weather station. While perhaps unsurprisingly temperature extremes were found to impact energy use, they were also found to increase the risk of remote living residents being disconnected from prepaid energy services in 28 remote Indigenous communities.

Confirming the relationship between temperature, electricity use and disconnection we demonstrate that 49,000 (29% of 170,226) incidences of involuntary self -disconnection occurred during hot and cold temperature extremes. 71% of households experienced a same-day disconnection more than 10 times in a twelve-month period - a rate much higher than other Australian and international examples – while climate zones in the Territory also influence the probability of a same-day disconnection occurring. For those households with the highest electricity use in the two southern climate zones, an already high 1-in-7 chance of experiencing a same-day disconnection on moderate (20ºC and 25ºC) temperature days increased to 1 in 3 for the coldest temperatures (0ºC to 15ºC) and 1 in 4 for the hottest temperatures (30ºC to 40ºC).

While energy insecurity describes more than disconnection rates alone - socio-economic, demographic and behavioral factors, occupancy and structural characteristics are all key drivers of energy consumption - and the level of energy service viewed as 'essential' can vary over time and with changing social norms, a complete loss of access to energy services constitutes a level of energy insecurity that can harm wellbeing.

Wellbeing concerns are particularly paramount for elders in our community, those with chronic co-morbidities and young babies. Disconnections can precipitate households needing to replace food and medicines that have spoilt in the heat. It is not uncommon for residents on lower incomes to face challenging trade-offs - between paying for electricity to maintain thermal safety or paying for food and other necessities.



No powercard, painting by Sally Mulda, 2020, Tangentyere Artist

Disconnection quickly renders housing inadequate during temperature extremes and without access to electricity, many residents choose to sleep outside, as shown in the painting above by Central Australian artist Sally Mulda.

As my co-author Norman Frank Jupurrurla, a respected Warumungu elder from Tennant Creek explains;

"When the power disconnects because we run out of money, you have to hurry up. If you catch it in a few hours, you'll be lucky, otherwise everything goes off in the refrigerator. Then you have to throw everything out. Over recent summers it's been too hot - we have to get out of the house".

Most Australians take reliable uninterrupted access to electricity for granted. But Australia could do much better at providing protections from disconnection for remote and regional First Nations communities.

Australian governments have agreed to 'Closing the Gap' in Indigenous disadvantage in partnership with First Nations. Evidence based policy responses built on foundations of transparent monitoring and reporting of disconnection data, and greater sharing of, and access to, data and information at a regional level with Aboriginal and Torres Strait Islander community-controlled organisations will be crucial. This data provides a comprehensive picture of energy insecurity in remote communities and can be used to help design solutions to reducing the frequency, duration, and negative impacts of disconnection from energy services for remote Indigenous residents.

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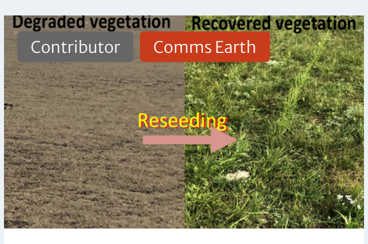

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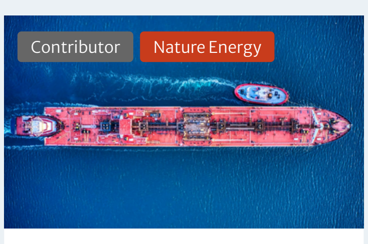
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