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Peak demand and the 'family peak' period in Australia: Understanding practice (in)flexibility in households with children

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ABSTRACT

Smart grid technologies enable introduction of time-of-use (TOU) tariffs which aim to reduce peak demand. TOU tariffs are presented as financial opportunities but outcomes depend on flexibility in household practices. Households with children have higher peak electricity consumption and this paper investigates how and why practices performed during the weekday peak 'hang together'.

We conducted forty-four interviews and home tours followed by a survey (547 responses) of households with children in Australia. Our analysis finds that the family peak is tightly coordinated and routinised. Interlinked bundles of practices were meaningful beyond their commonly assumed functions. For example, bathing of children (re-) connected siblings and parents, occupied children while dinner was prepared or cleaned up, and calmed children in preparation for sleeping. The analysis also shows how flexibility during the peak period is constrained by the relation to other periods of the weekday, along with its synchronisation with school, work and childcare arrangements.

From our analysis of we conclude that TOU tariffs are unlikely to effectively reduce peak period electricity consumption in households with children and may have inequitable financial and/or social impacts for these households. Alternative approaches that better engage with the dynamics of social practice in family households are suggested.

1. Introduction

Smart grids and meters are increasingly being valued for their ability to facilitate dynamic electricity pricing, which aims to incentivise shifts in energy demand away from peak usage times. One popular dynamic pricing structure for households is the time-of-use (TOU) tariff, which is now implemented in a number of countries [12]. TOU pricing typically charges a fixed three-tiered rate involving an off-peak, shoulder and peak rate on weekdays, and an off-peak and shoulder rate on weekends. In Australia, the widespread introduction of smart meters and smart grid demonstration projects has paved the way for TOU tariffs. Implementation and tariff structure varies state-by-state, with some utilities offering it as the default and others making it optional in the competitive marketplace. Even so, the number of Australian households on a TOU tariff is relatively low compared to other tariff types [40].

TOU tariffs are viewed as part of Australia's move towards demand-side participation and smart 'enabling' technologies, which are intended to reduce problematic peaks in demand and facilitate the decarbonisation of the electricity sector [1]. In Australia, household electricity use peaks during the late afternoon and early evening. On days of extreme heat, air conditioned cooling contributes to peaks in demand which have led to dramatic increases in household electricity prices for the majority of Australians [37]. TOU tariffs are one way to incentivise households to shift their energy use outside the peaks on a regular basis, thereby lowering the peakiness of Australia's electricity network overall.

The effectiveness of this strategy for addressing peak demand is still a source of debate in Australia. Internationally, TOU tariffs have been found to induce a drop in peak demand of 3–6% [12], with similar or lower results found in Australian trials [21]. Traditionally, the degree to which these drops can be achieved is thought to 'depend on the proportion of electricity demand that is capable of being shifted between peak and off-peak periods and the change in the price of peak and off-peak tariffs compared against original flat tariff' [21].

Evaluations have therefore focused on discrete 'discretionary' appliances and practices, such as switching the timing of pool pumps or dishwasher usage.

Far less attention has been paid to understanding the daily peak period as a phenomenon itself, located at a specific point of time in

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the day, which takes place within a discrete space (the home).[1] Even less attention has addressed how different groups of households experience this peak period differently. In this paper we aim to understand what constitutes the peak in households with children. We approach this by conceptualising the TOU peak period (3–9 pm on weekdays) as a collection of interlinked practices, which are similarly experienced across this household type. We are interested not only in what practices constitute the peak and how they link together, but how 'flexible' these practices are.

Our focus on households with children is justified on a number of grounds. Firstly, on average households with children have a higher proportion of their electricity consumption concentrated in the TOU tariff peak period compared to other household types. This applies whether parents are working or not, although working parent households are peakier. This means that households with children are most at risk of financial disadvantage when moving from flat rate to three-part TOU electricity tariffs in Australia unless they make substantial shifts in their electricity usage [34]. Despite this risk, there has been virtually no attention to what constitutes the peak in family[2] households, why it is higher than others, or how flexible it might be. Instead, TOU tariffs are presented as financial 'opportunities' and marketed in association with 'simple' actions households can take to shift their electricity use to other times of the day.

The paper begins with a discussion of the conceptual underpinnings inherent in dynamic tariffs such as TOU. We use this discussion to open up an alternative conceptualisation; one which seeks to understand peaks, and techniques to shift them, through the lens of social practice [15,20,27,36]. We continue by employing these ideas in our study of households with children. Our analysis begins by discussing how the peak period is experienced in families. We continue by discussing three bundles of practices common to the family peak: (i) provisioning the evening meal; (ii) television (TV) and information communication technology (ICT)-mediated education, socialising and entertainment; and, (iii) bathtime for young children. Here we are particularly interested in how these bundles link together and are co-dependent during the peak period. We then consider how the peak period links to other times of the day, and to wider institutional arrangements. We discuss the implications of our analysis for the flexibility of practices in the family peak, concluding that TOU is unlikely to be the most effective or equitable strategy for households with children. Instead, we offer alternative approaches to demand management that better engage with the dynamics of social practice in family households.

1.1. (Re) conceptualising the TOU peak

The principles of TOU pricing are firmly grounded in the discipline of economics. Here it is proposed that prices are 'the outcome of the impersonal forces of supply and demand, which are given to economic actors in a situation of perfect competition' [44]. Consumers are assumed to respond to prices by weighing up the costs and benefits a product affords (in this case electricity or the services it provides). This perspective is prevalent through a range of demand management strategies in Australia and internationally, which are underpinned by a key assumption ... 'that consumers will always make the best decision from their viewpoint, based on the prices they face, the technology and equipment they have access to, the information they have and their individual transaction costs' [1].

More recently, the emerging sub-discipline of behavioural economics has gained prominence and popularity in the energy sector in explaining why people don't always behave as rational and economically-motivated agents [41]. Behavioural economics is particularly popular because it avoids fundamentally challenging the principles of neoclassical economics, particularly that: individuals act to maximise their own utility; markets are the most efficient means of allocation; and markets generate equilibrium as they pursue efficiency [19]. As Lutzenhiser [19] notes in his critique of behavioural economics, this sub-discipline is interested in 'amending' these basic premises, by focusing on 'correcting' utility maximisation where it is steered off-course by psychological variables such as consumer perception, judgement and choice. Assessing the effectiveness of TOU therefore remains focused on testing individuals' willingness to make economic 'trade-offs' or 'sacrifices' that involve assessing the (utility) value of individual appliances or discrete activities that use electricity.

A key critique of this prevailing approach and many proposed alternatives is that they overlook what energy is actually used for [33]. By focusing on individuals and their decisions, choices or barriers around energy, we lose site of the everyday practices which constitute demand for energy, such as cooking, laundering, heating and cooling [36,46]. This perspective, premised on theories of social practice [28,30,32,46], provides an increasingly popular alternative to understanding the dynamics of energy demand and consumption more broadly. Within this approach, cost-benefit decisions about energy and how it's priced become less important, or in some cases completely irrelevant, in understanding how and why people use energy.

There are many different definitions of social practice (for a good summary see Gram-Hanssen [14]. In this paper we follow Shove et al.'s [32] definition of practice being both a 'block' or 'pattern' of activity (a definable entity such as laundering), and a performance which is continually reproduced. A practice entity is thought to be composed of a number of 'elements', which are defined by Shove et al. [32] as *meanings* such as ideas, aspirations and understandings which inform and orient the practice; *competences*, involving skill, know-how and technique; and *materials* including things, objects, infrastructures and physical stuff. People do not feature in practice theory as rational or calculated agents, but as carriers of practices [28]. Carriers keep practices alive by performing them; they also change the nature of practices by integrating, modifying and innovating new elements—resulting in a dynamic theory of change [32].

Powells et al. [27], Higginson et al. [15] and Strengers [37] have previously adopted these ideas to understand the practices that constitute the peak in dynamic tariffs, and what makes these practices flexible, or not. Powells et al. (2014) provide a detailed account of the conditions which make some practices more flexible than others in response to TOU, such as how many people are able to perform or required to participate in them. Eating dinner, for example, may be less flexible because it requires participation from all members of a household, thereby restricting availability of when this practice can be performed. Powells et al. and Strengers [37] have also conceptualised dynamic peak tariffs such as TOU as 'disruptions' to everyday practices, arguing that they throw some routines into a state of negotiation and change. However, gaps remain regarding how TOU disrupts normal routines (or permanently shifts them), and why it achieves less load shifting than other dynamic tariffs, such as critical peak pricing[3] [11].

[1] A notable exception is the work being carried out at the DEMAND Centre in the UK [20,42,45].

[2] In this paper, 'family households' and 'households with children' are used interchangeably. We acknowledge that there are other types of family households that do not include children.

[3] Critical peak pricing (also referred to as dynamic peak pricing) generally involves charging customers 20–40 times more than the off-peak rate of electricity during 12–15 critical peak 'events', spontaneously called throughout the year. Events typ-