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Designing more cost reflective electricity network tariffs with demand charges

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ABSTRACT

There is growing policy and regulatory interest in better aligning electricity tariffs with the cost of providing network services to customers: to provide a better price signal for economically efficient use of the network, and reduce cross subsidies between different customers. Given that network costs are significantly driven by peak capacity requirements, many proposals for more cost-reflective tariffs include a demand (capacity) component. However, there are many complexities in the implementation of such tariffs. This paper first presents a method to visually assess how cost-reflective a particular demand charge network tariffs is. We apply it to a typical demand charge network tariff proposal within the Australian National Electricity Market and actual consumption data of 3876 Sydney households, and find it to have low cost-reflectivity in terms of aligning customer bills with their contribution towards network peak demand. Such misalignment has potentially significant adverse impacts on the economic efficiency of such tariffs – an issue that does not appear to have received sufficient policy attention. We then use this assessment method to demonstrate how a demand charge tariff structure can be adjusted to make it significantly more cost-reflective. This method can be applied to any tariff that includes a capacity-based component.

1. Introduction

In the large interconnected electricity industries serving most electricity customers around the world, network costs generally represent a significant proportion of total delivered electricity costs, particularly for smaller customers. In Australia, for example, network costs can approach half the bill for households (AEMC, 2016). Even in restructured electricity industries with some form of competitive wholesale and retail electricity markets, the natural monopoly and essential 'public good' role of network infrastructure has generally seen the sector structured as monopoly network businesses subject to economic regulation. Such regulation seeks to motivate efficient investment and operational expenditure by these businesses, typically through revenue or price caps intended to provide appropriate returns on 'efficient' investment and network operation. The underlying network economics are challenging; in particular, networks are very asset intensive and reliable electricity provision requires that network assets be sized to meet uncertain future peak demand at all locations.

There has traditionally been little focus on the efficiency of the tariffs charged to residential customers. In part, this was due to the fairly simple accumulation metering used for small customers, in part the belief that these customers would be unwilling or unable to engage effectively with more complex tariffs, and in part deliberate government policy to provide cross subsidies between different customer classes. Tariffs for small customers have therefore typically had some proportion of fixed and volumetric (consumption) components with often little or no variation across large geographical regions (Productivity Commission, 2013). Even the introduction of competitive wholesale markets where electrical energy prices vary by time and location has generally not seen small customers (residential and small business) exposed to time and locational-dependent prices.

Such arrangements, however, are under increasing pressure in many electricity industries around the world. In Australia as just one example, significant uptake of air-conditioning (with a strong temporal alignment during extreme weather events) has resulted in declining network load factors and has required substantial network investment to meet increasing peak demand (Productivity Commission, 2013). This increased expenditure saw rising electricity bills which, among other

Abbreviations used is this paper are as follows: AER, Australian Energy Regulator; DNSPs, distribution network service providers; GST, Goods and Services Tax; kW, kilowatt; kWh, kilowatt hour; NEM, National Electricity Market; NPO, Network Pricing Objective; NSW, New South Wales; PV, photovoltaic; SAPN, South Australia Power Network; SGSC, Smart Grid Smart City; TNSPs, transmission network service providers; TSS, Tariff Structure Statement

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factors, contributed to falling per-capita household and commercial consumption, exacerbating declining load factors (Saddler, 2013). Existing, largely volumetric network tariffs did not assist in managing these issues.

Large industrial and commercial energy users in many electricity industries have separate energy and network contracts, with the network tariff having fixed, TOU volumetric and peak demand components of various kinds. Interval metering with smart communications including in-house displays and load control capabilities is now being rolled out to small customers. Consumer appliances themselves are becoming smarter and more connected, while there is a growing range of other distributed energy resources including rooftop photovoltaics (PV) and, increasingly, battery storage systems. In Australia, over 1.6 million households (over 20%) have a rooftop PV system, with the states Queensland and South Australia being over 30%.[1]

The challenges of rising peak demand and declining network load factors, and the arrival of new technologies that allow customers to respond to prices, have seen growing interest by policy makers and regulators in the development of more cost-reflective network tariffs. Cost-reflective tariffs should, in theory, charge customers according to the costs they impose on network businesses. This should ensure that customers cover the costs they cause and, very importantly, now see price signals that incentivise efficient investment and operation of their own loads, storage and distributed generation. The benefits of cost-reflective tariffs are well documented in the literature and are summarised in Hledik (2015): better alignment of prices and costs, smarter load management, improved utility cost-recovery, reduced cross subsidies, and familiarity for regulators.[2]

Their practical application, however, is more challenging. One question is which costs need to be reflected – past (sunk), present (short-run marginal) or future (long-run marginal costs). Past cost recovery is a key aspect of network business financial sustainability while present costs are key to efficient operation of existing assets. Reflecting future costs in prices is key in terms of incentivising efficient investment, which has been the focus of cost-reflective tariffs introduced in response to peak demand increases and declining network load factors (Hledik, 2015). However, future costs are complex and fundamentally problematic to calculate. They are also very location-specific and invariably change over time. Increasingly, too, distributed energy resources offer an alternative to traditional network service delivery (Eurelectric, 2016a).

Despite these challenges it is clear that conventional, primarily volumetric, tariffs are unlikely to be efficient in incentivising efficient customer decision-making given the key role that their contribution to network peak demand plays in network costs. A key focus of cost-reflective tariff efforts has therefore been the use of peak demand charges (Hledik, 2015; Brown et al., 2015; Faruqui, 2016). Still, there is a very robust discussion on the optimal design of such tariffs, and the degree to which such tariffs are even possible. One important influence on tariff design, whether cost-reflective or not, is the structure of the electricity market, and the degree to which generation, transmission/distribution and retail are integrated.

This paper presents work undertaken to progress this policy discussion in the context of the Australian National Electricity Market (NEM) and the various efforts underway there to develop more cost-reflective tariffs.

The NEM consists of five regional wholesale and retail competitive markets, and regulated monopoly networks. This is most similar to the situation in the EU (Eurelectric, 2016a), whereas the US generally has vertically integrated network and retail arms (Borenstein and Bushnell, 2015). Australian networks are operated by Transmission Network Service Providers (TNSPs) and Distribution Network Service Providers (DNSPs).

The Network Pricing Objective (NPO) of the NEM is that the tariffs charged by a DNSP to provide services to a customer should reflect the DNSP's efficient costs of service delivery to that customer i.e. they should be cost-reflective. Very similar requirements are being actively pursued by governments and utilities in the EU (Ropenus et al., 2011; Eurelectric, 2016a) and the US (USDOE, 2015). In Australia, the main driver behind this objective is as discussed above and in Hall et al. (2016), and is essentially to reduce future residential demand peaks, which have recently been increasing and driving up network augmentation costs and hence electricity tariffs.

DNSPs in Australia submit Tariff Structure Statements (TSSs) to the Australian Energy Regulator (AER), which provide overall guidance on how they are going to design tariffs over a specified period, generally three years, and the AER assesses the TSSs for compliance with the NEM Rules. Once the TSS is approved, the DNSP will then submit a Pricing Proposal for approval by the AER that provides specifics on tariffs (both structure and rates) for the coming year. The AER has identified four steps in designing cost-reflective tariffs, which can be summarised into: (i) how to calculate and apply the long run marginal costs of network construction, (ii) deciding on a tariff structure, whether that be time of use, critical peak price, demand charge etc., (iii) recovery of the residual (or sunk) costs, and (iv) setting the recovered revenue to be between the standalone and avoidable costs of service provision.

Thus, tariff design can be divided into two quite separate stages. The first stage involves designing the structure of a tariff to create its different components - which for a demand tariff are typically fixed, volume-based (kWh) and capacity-based (kW) - and determining how they will be applied. The second stage involves how to allocate the types of network costs (sunk, operational and marginal) to those different components i.e. the weighting of the different components. Rather than attempting to focus on both the structure and the allocation, here we focus only on the structure, specifically of the demand charge component (i.e. step (ii) of the AER's four steps above). This can be analysed independently of how the various costs are then allocated across fixed, volumetric and demand charges.

Most Australian DNSPs have used demand charge tariffs as their most cost-reflective tariffs in their current TSSs. The NPO is not prescriptive, and so does not specify exactly how DNSPs should design their cost-reflective tariffs. As discussed in Section 2, the demand charge tariffs provided in the current TSSs all have the same basic design, which is the same as that of most network demand charge tariffs used internationally (Ropenus et al., 2011; Hledik, 2015; Brown et al., 2015; Picciariello et al., 2015; Faruqui, 2016; Eurelectric, 2016a; Snook and Grabel, 2016). These tariffs consist of a usage charge, some form of daily charge, and a demand charge that is applied to the customer's maximum demand during a specified time window. Such tariffs are different to Critical Peak Pricing, where customers are notified shortly in advance that they will be exposed to significantly higher prices at certain times on a limited number of days (Hu et al., 2015).

This paper firstly assesses an Australian DNSP's demand charge tariff in terms of its cost-reflectivity, then uses the same approach to alter the structure of this demand charge tariff so that is significantly more cost-reflective. The rest of the paper is organised as follows: Section 2 describes the method we have developed to assess the cost-reflectivity of different tariffs while Section 3 presents the results of our assessment of the Australian DNSP's demand charge tariff, as well as the outcomes of developing a more cost-reflective tariff, Section 4 then discusses these findings, and Section 5 presents the conclusions arising from our work.

2. Method

In this paper we first assess how well typical demand charge network tariffs reflect the long-run marginal costs of providing the network

[1] Calculated from http://pv-map.apvi.org.au/historical.

[2] Hledik (2015) also cites customer friendliness and protection for small customers, however these claims are more contentious (Stenner et al., 2015).