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Taking demand management into the future: Managing flexible loads on the electricity network using smart appliances and controlled loads

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ABSTRACT

Unprecedented changes have occurred over the last five years in the way customers use electricity. These changes are driving electricity distributors to evolve and extend their demand management capabilities to include grid balancing, respond to localised demand and promote and activate smart appliances. In South East Queensland, Australia, two successful forward looking demand management programs are well established. More than 50,000 demand response ready air conditioners have been connected to the network and are able to be controlled by the distributor. Results show that demand reductions from these air conditioners are reliable and sustained for the period of demand events. A second program uses controlled load electric hot water systems as a 'solar sponge' to integrate renewables into the network. This article highlights the potential demand management benefits of using hot water systems to reduce the localised peaks and fill the midday demand trough. The results from both programs show the capability of these demand management tools to improve network utilisation and grid balancing and reduce overall network expenditure. A further demand management initiative identified as having the greatest likelihood of success in delivering benefits to both the utility and customer are tariff structures which incorporate cost reflective pricing. In this way, time of use and magnitude of demand are addressed and positive price signals encouraging load control of appliances are provided. This coupling of demand management and tariffs is shown to be highly effective in achieving demand reductions. Automated load control can support customers' acceptance of new pricing approaches and provide a 'set and forget' solution for optimising the benefits of cost reflective tariffs. The challenge for distributors is how to transition the existing demand management incentives and tariffs to a sustainable future program in an increasingly disaggregated and competitive market.

1. Introduction

Electricity distributors are facing unprecedented changes in the way customers interact with the electricity network as well as the industry within which they operate. These changes include: proliferation of residential roof top PVs; step change in the way customers use electricity; emergence of smart appliances and consensus on the need for more cost reflective pricing (Faruqui, 2015).

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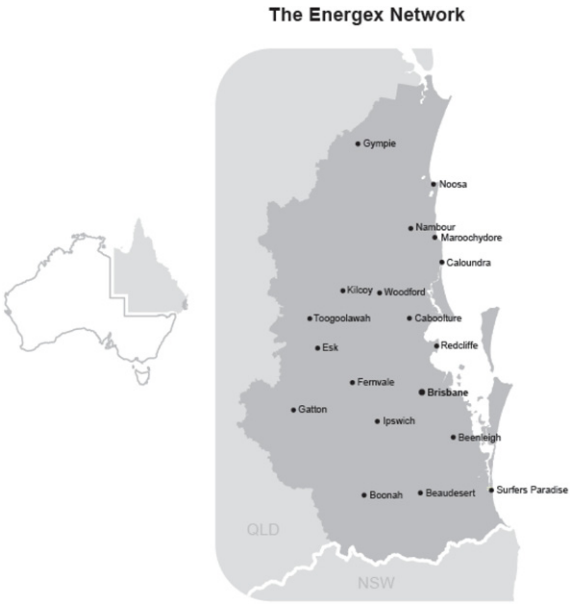

Fig. 1. South east Queensland electricity distribution network area.

These changes are driving distributors to evolve and extend their demand management capabilities to include grid balancing, respond to localised demand and promote and activate smart appliances. This paper provides an overview of recent developments in the demand management program being implemented in South East Queensland (SEQ), Australia. These include the connection and control of more than 50,000 demand response ready air conditioners compliant with Australian Standard AS4755.3.1, '*Interaction of Demand Response Enabling Devices and Electricity Products — Operational Instructions and Connections for Air Conditioners*' and the use of controlled load from electric hot water systems as a 'solar sponge' to assist the proliferation of renewables on the network. These initiatives are delivering network benefits which will ultimately flow through to the customer.

This paper is organised as follows. Section 2 provides a background to the paper while Section 3 discusses demand response ready appliances and the success of managing air conditioning load on the SEQ electricity network. Section 4 discusses controlled load of electric hot water systems and the use of this load as a 'solar sponge'. Section 5 discusses optimising benefits to the utility and customer through cost reflective tariffs which reward load control. Section 6 concludes.

2. Background

The experience in SEQ (of Energex[1]) between 2004 and 2015 reflects that of many Australian electricity distributors (see Fig. 1 and Table 1 for a map and overview of the SEQ network area). It was a period of unprecedented change in the way customers interacted with the electricity grid. Their changing lifestyles coupled with increase in choice of appliances and technologies resulted in lower electricity consumption, greater numbers of roof top PVs and changed residential load profiles. The current environment is now characterised by lower energy consumption and a flattening of demand growth. The recent submissions by Queensland distributors to the Australian Energy Regulator (AER) for the current determination period (2015–20) highlight the change in approach in response to this new environment, with less emphasis on building new capacity and a greater focus on better utilising existing network.

2.1. A changing environment

Between 2004 and 2008 strong economic activity and sharp growth in air conditioner sales resulted in significant pressure on the electricity network in SEQ. Substantial investment in the network was made to ensure capacity met demand. Growth in electricity demand at peak times was strong. The typical load profile was a 'two humped camel' with peaks early morning and early evening and a dip during the middle of the day. Demand management programs were implemented to reduce the peaks.

The 2007/2008 global financial crisis was the beginning of a new era—the pattern that followed was substantially different. From this time onwards, electricity use decreased and peak demand flattened across the network. Smarter

[1] Energex is the electricity distributor for South East Queensland, Australia.

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