Demand Management and the Role of Smart Grids

Energy Efficiency and Renewable Technology
TERRY EFFENEY, CEO, ENERGEX
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Overview

1. The electricity supply challenge

2. Emerging issues

3. Where to from here?

4. Summary
Distribution and Customer Service

Legend

$ \rightarrow \text{Wholesale Market / Full Retail Competition}$

$ \rightarrow \text{Regulated monopolies}$
ENERGEX

Electricity distributor SEQ

$8B+ assets

1.3M customers

36,000 km overhead lines

16,000 km underground cables

630,000+ poles

280 substations

3,800+ staff
Strong Growth in SEQ in 10 years

Maximum actual peak demand in MW on the ENERGEX network was recorded on 15 February 2010

This is what we are building for

This is what we are billing for

Energy Growth

Demand Growth

Maximum actual peak demand in MW on the ENERGEX network was recorded on 15 February 2010

Positive Energy
C&I peak demand and energy consumption

Commercial and Industrial Customers - Peak Demand Growth vs Energy Growth

- Growth in peak demand C&I
- Growth in energy sales C&I

- 50% of energy
- 40% of MD
- 20% of assets
Residential peak demand and energy consumption

Residential Customers - Peak Demand Growth vs Energy Growth

- Growth in peak demand residential
- Growth in energy sales residential

Growth in peak demand residential:
- 2001-02: 0%
- 2002-03: 10%
- 2003-04: 20%
- 2004-05: 30%
- 2005-06: 40%
- 2006-07: 50%
- 2007-08: 60%
- 2008-09: 70%
- 2009-10: 50%
- 2010-11: 40%

Growth in energy sales residential:
- 2001-02: 0%
- 2002-03: 0%
- 2003-04: 10%
- 2004-05: 20%
- 2005-06: 30%
- 2006-07: 40%
- 2007-08: 50%
- 2008-09: 60%
- 2009-10: 70%
- 2010-11: 60%
ENERGEX’s LV network - the current state

The low voltage network

• almost 25,000 line kms - 50% of total line kms
• traditionally with minimal requirement to actively monitor and manage
• capacity is based on electricity demand and service level requirements
• requires manual switching and voltage profile adjustments
• is based on the traditional electricity supply chain – one way power flow carrying power to the load
LV Network is a key focus area and enabler

Legend

- $arrow$ Wholesale Market / Full Retail Competition
- $arrow$ Regulated monopolies

Diagram:
- Generation
- Transmission
- Distribution
- Customer

Electricity wholesale market

Retailer
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Changing regulatory environment

- Increased focus on efficiency and prudence
- National benchmarking
- Review of the National Energy Rules potentially impacting future funding proposals
Climate change focus

• Growing national and international focus
• Garnaut Climate Change Review – *Transforming the electricity sector* released in March 2011
• Federal Government proposal of a carbon price from July 2012
• Future policy developments
... and more price issues are on the horizon

More reform will be required

The last time electricity accounted for 2.5% of disposable income, a wave of microeconomic reform was triggered. This time, we should push reforms.
The Rise of the Smart Customer

Electricity supply and consumption patterns are changing:

• the emergence of the **prosumer** (producer-consumer) with solar PV

• increasing focus on energy efficiency…but not at the expense of lifestyle

• increasing opportunities for new players (e.g. demand aggregators)
### Australia and the Rise of Smart Customers

**Figure 3: Attitudes to smart by country**

<table>
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<tr>
<th>Country</th>
<th>Relationship with suppliers</th>
<th>Familiarity with smart</th>
<th>Perception of smart</th>
<th>Attitude to managing energy</th>
<th>Perception of EVs</th>
<th>Willingness to pay</th>
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*Source: Ernst & Young - The Rise of Smart Customers, 2011*
The Rise of Smart Technology

Technology change is coming

- electric vehicles
- stationary battery storage
- fuel cells
- phase out of storage electric hot water
- home energy management
- and who knows what NBN might enable
DER a new consideration for the LV network

• Loading on the LV network is not deterministic, i.e. it is dependent on a number of variables
• This equation is complicated further when distributed energy resources are introduced to the system
  ▪ intermittent embedded generation such as solar PV can result in significant and rapid changes in network loading
  ▪ at high volumes this can even result in rapid changes in the direction of power flow in the network
  ▪ where DER are supplying into the grid at times of low network load, this creates challenges for managing voltage within statutory limits
• Prescriptive and deterministic technical and appliance standards make it difficult to manage the integration of this technology within existing network designs
Emerging challenges in LV networks

- Active participation of consumers in the electricity supply chain has implications for:
  - voltage regulation
  - capacity constraints
  - network protection

- Where solar PV penetration is high - already challenging design limits
The solar PV experience (SEQ)

Qld Solar Bonus Scheme
Grid-connected Solar PV system installed capacity - ENERGEX
... And ENERGEX has to respond
And sometimes there are better ways ...
High Load Day

Light Load Day

Deterministic Voltage Limits
240V +/- 6%
High Load Day
Light Load Day

PV export can result in breach of statutory upper voltage limit
AS/NZS 61000 – Statistical Approach

Part 3.100: Limits—Steady state voltage limits in public electricity systems

PVs are still pushing the voltage well outside the preferred operating zone.
EVs as a catalyst for change

- EVs will initially be a high capacity load but over time could become an energy resource
  - capacity and power quality issues
  - metering and system considerations
  - third party interactions e.g. providers of vehicle charging services
  - distributed energy resource considerations (customer/network)

- The solar PV experience has shown us that:
  - we need to manage uptake and integration of new technologies into the distribution network
  - network technical standards and appliance standards need to support the probabilistic nature of LV network operation and performance

- The industry’s challenge is to avoid significant expenditure without impinging on customer choice whilst transitioning to a DER enabled future

*Look at the issues now to minimise risk and optimise the benefits*
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The end game

- Smart networks – a connective and adaptive network
- Tariffs – cost reflective capacity based network pricing
- Customers – better understanding of customer consumption choices and service expectations
- Australian standards – network technical and appliance standards that support probabilistic outcomes in distribution networks
- Service standards – aligned with what customers are prepared to pay
- Market and industry arrangements – connection, metering, communications and demand side participation

Getting the settings right will take time – we need to transition
Smart Grid Solutions

 **Least cost** supply of 21\textsuperscript{st} century solutions

Enables **lower carbon** outcomes by integrating renewables

**Customer enablement**, greater choice and new entrants

Supports the “digital economy” by improving **reliability**, **security** and **quality of supply**

Supports the **emerging technological** shifts (DER, storage, EVs)

…… But is there a clear roadmap and business case?
…… Who is funding the investment?
…… Are customers ready for the change?
Smart Grid Value Proposition

**Sustainable**
- Business Models
- Skills and resources
- Regulatory Framework

**Value**
- Operational Efficiencies
- Improved Asset Utilisation
- Capital Efficiency
- Innovative Solutions

**Enabling**
- Renewable Energy
- Electric Vehicles
- Customer Participation
- Electricity Markets

**Trust**
- Improve reliability
- Improve power quality
- Increase safety
Managing the transition

Objectives

• Avoid the need for significant investment (cost) in short term
• Understand how to cost effectively capture the benefits
• Balance the risk and service trade off
  ▪ what customers are willing to accept
  ▪ mandated technical and appliance standards
• Set an early standard/precedent through:
  ▪ community and industry education
  ▪ use of controlled load and time of use tariffs
  ▪ connection arrangements of high powered chargers

Need to be wary of promoting uptake if safeguards are not in place
Optimal investment mix

Utility can be balance activities to provide for future customer needs at lowest possible cost

Total Cost to Customers (¢/kWh)

Customer Cost
Variable Supply Side Cost
Fixed EC & DM Cost
Fixed Supply Side Cost

Supply Side Fraction

Least-cost range
Reducing supply side

Diagram source: EPRI
Improving asset utilisation is key

Our Boomerang Paradox scenario flagged the possibility of a doubling of unit prices between 2008 and 2015.

The media is focused on cost of living. We believe this thematic will run for years, not weeks or months.

A smart grid, and what it can do for power system load factor is a genuinely good story for our industry, and our customers.
Demand management programs

2009/10 Programs

- Residential targeted initiatives
- DM for C&I customers
- Reward based tariff trials and policy development
- Energy conservation communities

Air conditioning direct load control
Pool pump direct load control
DM for C&I customers
Reward based tariff trials and policy development
Energy conservation communities
Centre of Excellence

Hot water optimisation
Convert hot water to off-peak
Demand and energy data

$28M
$163M
MW targets for 2010-2015

- Demand and Energy Data
- Reward Based Tariffs
- Centre of Excellence
- Hot Water Optimisation
- Conversion to T33 HWS
- Pool Pump DLC
- Energy Conservation Community
- Air Conditioning DLC
- DM for C&I

System Level Impacts

In most states 100% of vehicle stock could be recharged without the need for additional generation capacity if charged overnight.

Source: P Pudney University SA
EV Charging Scenarios

Unmanaged charging will tend to result in max charge load during the residential evening peak period 6-8pm.

Off-Peak Charging + V2H enables greater utilisation of electricity supply infrastructure.

..but what is the right balance for customers and networks?

Source: CSIRO Electric Driveway Project
Smart Charging

Need to be mindful of unintended consequences.
Large volumes of EVs commencing charge simultaneously at 10pm could:

• create a new peak
• cause voltage and power quality problems
• may not allow sufficient time for some customers to recharge

A managed charging solution will deliver optimal outcomes for all.

• natural management  
  *Tariffs*

• direct management  
  *AFLC, Smart Meters, Smart Grid*
EV – Network Integration

Network Risk

Higher

Simple Managed Charging, e.g. AFLC

Vehicle to Grid

Vehicle to Home

Smart Managed Charging

Time Switched Off Peak Charging

Unmanaged Charging

Lower

Network Benefits

Higher

Lower
Smart Network Trials

- AusGrid’s - Smart Grid Smart City project

- ENERGEX technical trial
  - monitor low voltage networks and voltage at customers’ premises
  - demand Management to reduce network investment
  - allow maximum DER (especially PV) to be connected without undue network investment
  - accommodate EVs with minimum network investment
  - implement 230 Volt standard
  - manage power quality, especially voltage, to not impact on the life cycle of customers’ equipment
  - reduce demand at peak times with voltage reductions
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• Technological change and customer participation is challenging low voltage network design and performance.

• Combined with solar PV, high penetration of electric vehicles pose significant challenges.

• The traditional supply side solution is to invest in more capacity and/or limit installation.

• We need to transition to a smarter network to meet customers 21st century lifestyle expectations.

• Appropriate standards and controls are an essential element.

• Managing this transition is imperative if we are to avoid costly investment in new infrastructure.