Facilitating Demand-Side Participation in the Australian NEM: Aggregating up, and sending market prices down

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Balancing the ‘Energy Trilemma’

**Energy Security**
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

**Energy Equity**
Accessibility and affordability of energy supply across the population.

**Environmental Sustainability**
Encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.

“To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –

- price, quality, safety, reliability, and security of supply of electricity; and
- the reliability, safety and security of the national electricity system.”

National Electricity Law (Schedule to the National Electricity (South Australia) Act 1996), s:7

(World Energy Council, 2016)
Electricity emissions intensity comparison

(shrink that footprint)

Australia, South Africa, China, United States, UK, Germany, Japan, Spain, Russia, Canada, Brazil, France, Norway

- Direct
- Indirect
- Losses

Australian residential energy prices index

(Australian Energy Statistics Update 2017)

Integrating demand response and energy efficiency into energy markets

(ACCC, 2017)

Australian residential energy prices index

(Australian Energy Statistics Update 2017)
The opportunity - a greater role for energy-users in our energy future

- A growing appreciation of our diverse energy users and contexts
- New opportunities for energy users to engage
  - PV, Storage, demand-side participation, energy efficiency
- Improving regulatory, market and policy efforts to appropriately facilitate end-user engagement
  - From assumptions of rational, utility maximising individual customers driven by prices… to amore complex appreciation of energy decision making, individual yet also collective goals and actions, and hence coordination, sharing
  - From heavy metal to orchestration … to Jazz
- New ways to explore these challenges & opportunities; learn, disseminate and broaden the conversation

Australia’s residential PV penetration (Finkel Review into NEM Security, 2017)
Energy users – a changing industry context

- From clients
  - Early tailored industrial or commercial (lighting) applications

- ..to citizens
  - Electricity as an essential public good – rural electrification

- ..to consumers
  - The vertically integrated utility of growing size and scope

- ..to customers
  - Electricity industry ‘reform’, liberalisation, deregulation, restructuring

- ..to perhaps partners, competitors, or even ‘deserters’?
  - Demand Response, Self-generation, Energy Storage…

*Now all of the above – how do we design appropriate interface?*

*(MacGill & Smith, Consumers or prosumers, customers or competitors?—Some Australian perspectives on possible energy users of the future., EEEP, 2017)*
NEM regulatory-commercial end-user interface

(adapted from Outhred, 2010)

Generation Sector:
- Generator 1
- Generator Y

Transmission Sector: – TNSPS

Multi-region five-minute energy & FCAS markets

Distribution Sector: – DNSPS

Retail sector
- Retailer 1
- Retailer Z

Retail Markets

End-users

AEMO: market & system operator

Intentions, offers & payments

Intentions, bids & payments

Derivative trading for risk, investment

Electricity flow

Cash flow

End-use Sector: end-use equipment

Electricity flow

Generators

Transmission

Distribution

Retailers

End-users
Do we have a ‘real’ retail electricity market?

Depends who you ask
- Internationally, NEM often argued to be a leading example
- …but Current measures of competition miss key issues
  - Yes, NEM high switching rates – but real customer choice or just churn?
  - Yes, NEM price spreads – but reflect competition or stickiness

Certainly little focus on energy services and engagement

“… an important reason there is effective competition in Victoria is .. because the provision of energy is viewed as a homogenous, low engagement service”  (AEMC, 2008)

- An oligopoly of large ‘gentailers’

Integrating demand response and energy efficiency
Integrating demand response and energy efficiency into energy markets

Why choose EnergyAustralia?

Award winning

Easy online sign up

Carbon neutral

Powering Australia

Why we're different

Energy rates and plans

Solar Solutions

Business Plans

Join AGL Rewards

Get our Energy App
Retail competition failing on its own terms

This year's review found that while competition in the retail energy market continues to evolve, it is currently not delivering the expected benefits to consumers. After a period of stable or improving customer satisfaction, levels of residential and small business consumer confidence and satisfaction with retail energy market have declined significantly over the last year. In particular:

- consumers have generally experienced substantial increases in retail energy prices. These price increases have been driven largely by increasing wholesale costs. Network costs are also a significant component of retail prices, and retailers have not actively engaged in the network pricing process on behalf of consumers.
- retail energy offers, particularly the discounting behaviour, are confusing for consumers. Consumers tend to only get a better deal if they leave or threaten to leave a retailer.

This has led to concerns over energy affordability, and increased interest in the sector from Governments and other regulatory bodies. With retailers being slow to innovate on tariff, pricing and products, consumers have also taken matters into their own hands, with increased investment in distributed energy resources, such as solar PV systems and batteries.
What of DSP?

- “DSP provides a tool for consumers to actively participate in the market, by offering a suite of options for them to manage their electricity consumption and, in turn, their electricity expenditure. It includes actions such as energy efficiency, peak demand shifting, changing consumption patterns, and consumers generating their own electricity.” (AEMC)

- In practice, a complex concept in the electricity industry
  - from paying your bills to being paid for service provision
Nothing so new about demand-side participation particularly in Australia with widespread deployment of ripple-control/timed off-peak hot water systems from 1960s onwards.

future urban energy grids
Facilitating greater consumer engagement – demand-side participation

Efficient markets are characterised by effective participation of both the supply and demand side. The supply side of the market provides a product or service at a price, and the demand side (i.e., consumers) responds to the price/value of the product or service being offered.

While there is some evidence of uptake of DSP in the NEM over recent years, the efficiency of the electricity market can be improved by more active participation by the demand side. This will require changes to some aspects of how the supply side of the electricity market operates and interacts with consumers.

The Power of choice review has identified opportunities for consumers to make more informed choices about the way they use electricity. Consumers require tools - information, education, and technology, and flexible pricing options - to make efficient consumption decisions. Recommendations presented in this report will support these conditions and enable consumers to have more control of their electricity expenditure.
Integrating demand response and energy efficiency into energy markets

NEM regulatory-commercial end-user interface

(adapted from Outhred, 2010)

Generation Sector
Generator Y
Generator 1

Derivative trading for risk, investment
Intentions, offers & payments

Multi-region five-minute energy & FCAS markets

Sending prices down – e.g. spot exposure

Sending down cost reflective n/w tariffs

AEMO: market & system operator

Retail sector
Retailer Z
Retailer 1

Transmission Sector: – TNSPS

End-use Sector: - end-use equipment

Electricity flow

Distribution Sector: - DNSPS

Electricity flow

End-use sector
End-users

Sending prices down – e.g. spot exposure

Generation Sector: large generators

Intentions, offers & payments

E.g. spot exposure

Sending down cost reflective n/w tariffs

Electricity flow

End-use equipment
Integrating demand response and energy efficiency into energy markets

NEM regulatory-commercial end-user interface
(adapted from Outhred, 2010)

Generators
- Generation Sector
- Large generators
- Generator 1
- Generator Y

Energy Flows
- Generation Sector: Electricity flow
- Transmission Sector: TNSPS
- Distribution Sector: DNSPS
- Retail sector: Retail Markets
- End-users: End-use equipment

Markets
- Multi-region five-minute energy & FCAS markets
- Derivative trading for risk, investment
- Intention, offers & payments

Retailers
- Retailer Z
- Retailer 1

Aggregating upwards to wholesale energy/FCAS

AEMO: market & system operator

Cash Flow

Intention, offers & payments

If/when prices

End-use Sector: End-use equipment
New rules for cost-reflective network prices

27 November 2014

The National Electricity Rules will be changed from 1 December 2014 to require regulated network companies to structure their prices to better reflect the consumption choices of individual consumers.

Under these changes, network prices will reflect the costs of providing the electricity to consumers with different patterns of consumption.

The new rules follow extensive consultation over the past year, and take into account submissions received when the draft rules were released in August.

AEMC Chairman John Pierce said the prices we pay for electricity would actively respond to the different ways people choose to use it under these new rules.

“These changes put consumers at the centre of future decision-making about energy,” he said.

“By having prices that reflect the costs of different patterns of consumption, we are giving consumers clearer choices as we develop a more efficient, incentive-based network regulation framework.”
Tariffs as a social construct

- A ‘basic’ flat rate tariff (without any ‘risk relief’) is significantly more appealing to consumers than:
  - any form of capacity pricing, even with a money-back guarantee or automatic enabling technology; and
  - real-time pricing without any such ‘risk relievers’.

- **Real-time** pricing must come with a compelling money-back guarantee in order to approach the appeal of a basic flat rate tariff, or have even a chance of being accepted.

- Even with the prospect of a risk-free trial, or an enabling device to help maximise the advantages of the new plan, there is limited consumer interest in shifting to novel, demand-based pricing structures like capacity pricing.

- A flat rate tariff offer with money-back guarantee achieves an unparalleled level of consumer acceptance, unmatched by any other combination of tariff and risk relief.

- Only a limited set of cost-reflective pricing offers seem to rival consumer acceptance of flat rate tariffs, specifically:
  - peak time rebates with the offer of a free automation device (aimed at easing management and maximising consumer benefit from the tariff); and
  - time of use tariffs, or critical peak pricing, when accompanied by the money-back guarantee (aimed at alleviating consumers’ perceived risks in trialling the new offer).
Facilitating greater engagement in practice?

‘Cost Reflective Tariff’ reform to date seems to involve steep declining block tariffs, increasing fixed charges, ‘non-peak demand’ demand charges

All limit consumer options to invest in new technologies and behave in ways that reduce bills while also reducing longer-term network expenditure

(Renewconomy, 2015)
A rather more successful market response

Australia’s residential PV penetration
(Finkel Review into NEM Security, 2017)

(AEMO, National Forecasting Report, 2015)
Aggregating up: VPPs embedded networks…

(AER, Embedded Network Rule Change, 2016)
Is NEM failing on aggregation too? Some progress… and less successful efforts to date

Demand response can and already is happening in the NEM. There are no barriers to the continued proliferation of demand response that is currently underway.

In light of the absence of any regulatory barriers in the Rules to the uptake of demand side participation, the Commission has not made a rule to implement the proposed demand response mechanism. The Commission acknowledges that demand response can be of benefit where it is an efficient form of market response to price signals. However, the proposed mechanism is costly and adds little benefit to consumers, because the benefits of demand side participation can, and already are, accessible under current arrangements. While the Commission acknowledges that there may currently be commercial reasons that complicate access to demand response for some consumers, implementing a market wide mechanism in the Rules, at considerable cost to all consumers, is not the appropriate vehicle to address these reasons. Nor would it encourage an efficient level of demand response.
Some successes
Aggregating up to FCAS
e.g. ENEL/X
What might real pricing look like?

- NEM wholesale market has prices for energy, services
  - Locational and temporally varying and uncertain spot and future prices for energy, ancillary and network services
  - *Although limited locational pricing, opaque derivatives, market power and inefficient by design because don’t include env. externalities*

- Predetermined retail electricity tariffs for energy
  - Not a price in ‘economic efficiency’ sense of term, and not selling what the energy user wants; energy services
  - *Major reform of interface b/n supply + demand sides of electricity sector and NSPs required before genuine ‘price discovery’ can occur*

- Possible ‘pricing’ paths forward for end-user engagement
  - Bring end-users to wholesale market, network services
    - *Aggregate users to participate in wholesale, ancillary, derivative mkts*
  - Bring wholesale market, ancillary and network services to energy users
    - *Real-time pricing (with futures hedging), value-reflective network tariffs*
What might a real mkt look like? A focus on

- Consumer energy services rather than ‘commodity’ kWh/MWh prices
- Consumers’ long-term interests, including need for energy transition
- Facilitation for energy users to participate in a wide range of services
  - Aggregating up vital for all the value that takes coordinated behaviour
    *Although NEM currently has limited locational pricing, opaque derivatives, market power and inefficient by design because don’t include env. externalities*
  - Sending prices down also vital in appropriate circumstances,
    *but very consumer and context dependent; and major reform of interface b/n supply + demand sides of electricity sector and NSPs required before genuine ‘price discovery’ can occur. We need ESCOs, not retailers*
  - Have to properly support new players with innovative business, community and other models for efficiently delivering end-user energy services, coordinated end-user participation in wider market services

Integrating demand response and energy efficiency into energy markets
Possible ‘coordination’ paths forward

**Single Integrated Platform (SIP)** - The single platform model envisages a unitary point of entry to the entirety of the NEM and WEM. Under this option, the platform would be an extension of the wholesale market. AEMO would provide the platform as part of its market and system responsibilities and along with the individual distribution utilities will develop a single integrated platform that will use a set of agreed standard interfaces to support the participation in the integrated multi-directional market by retailers, aggregators, and VPP platform companies. The SIP will then simultaneously solve local security constraints and support wholesale market entry. Under this configuration, access to the platform will be a one-stop shop that provides market participants the opportunity to participate anywhere in the NEM or WEM without having to develop separate systems or tools to integrate with the various individual distribution platforms. Network businesses will be linked into the platform, with distribution business providing information on local constraints to AEMO. AEMO would consider this information and economically dispatch these resources alongside other resources (transmission connected load, large scale generation etc.).

**Two Step Tiered Regulated Platforms** - A second alternative is a model where there is a layered distribution level platform interface operated by the local distribution network and an interface between the distribution network’s platform and AEMO. Under this design, individual distribution networks can design interfaces that best meet their system requirements. Participants would then need to communicate directly with the distribution level platform for the local constraint issues and the distribution network would optimise these resources against local network constraints based on bids from the aggregators servicing the area.

**Independent DSO** - A third option, that is a variant of the second, is for an independent party - a DSO that is separate from AEMO and the distribution utility. Under this model the independent DSO would work with the distribution utility to optimise the dispatch of the DER based upon local system constraints that are provided by the network business, provide the aggregated bids to AEMO for incorporation into the larger dispatch. This option will be more complex than the others and may be significantly more costly.
Open data, tools ... and processes

CEEM's researchers believe in the value of open source modelling in the Energy and Environmental research space. In this regard, we have developed a series of open source tools which are listed below. For a list of some of our under development tools you can refer CEEM’s Github page.

**NEMO SIS** - NEM Open Source Information Service:
Open-source access to Australian National Electricity Market data.
Links: Github

**NEMO** - National Electricity Market Optimiser Tool:
NEMO, the National Electricity Market Optimiser, is a chronological dispatch model for trading and optimising different portfolios of conventional and renewable electricity generation technologies. It has been developed since 2011 and is maintained by Ben Elliston through his PhD at CEEM. NEMO is available under a free software licence (GPL version 3) and requires no proprietary software to run, making it particularly accessible to the governments of developing countries, academic researchers and students. The model is available for others to inspect and to validate results.
Links: Github, OzLabs

**TDA** - Tariff Design and Analysis Tool:
We have developed a modelling tool to assist stakeholders wishing to contribute to network tariff design in the Australian National Electricity Market. It is an open source modelling tool to assist stakeholders in assessing the implications of different possible network tariff designs, and hence facilitate broader engagement in the relevant rule making and regulatory processes in the NEM. Our tool takes public energy consumption data from over 5000 households in NSW, and allows users to test a wide range of existing, proposed and possible tariffs structures to see their impacts on network revenue and household bills.
Demographic survey data of the households you explore the impacts of these tariffs on particular household types — for example, families with young children. The tool can also show how well different tariffs align these household bills with a households’ contribution to network peak demand. The tool and data are open source — you can check, validate and add your own data sets; test existing or even design your own tariffs; and validate and even modify the underlying algorithms.
Links: Project page, Github, Researchgate

**Local Solar Sharing Scheme Model**:
Intended for modelling embedded networks, local solar and peer to peer electricity networks. This software was developed by Naomi Stringer, Luke Marshall and Rob Passy at CEEM. A working build with a simple user interface for CSX can be found here.
Links: Github

**NemLite** - Open Source model of NEM Dispatch Engine:
Intended to replicate the performance of the National Electricity Market Dispatch Engine (NEMDE).
Links: Github
SPREE/CEEM open-source DER modelling tools
Thankyou from the SPREE/CEEM Distributed Energy Modelling and Analysis Team

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