Executive Summary

Transpower ran a commercial demand response programme between July and December 2013, using its new Demand Response Management System (DRMS).

The programme went a long way to meeting its objectives. There were 8 participants with 134 MW of DR registered at the commencement – which for context is more than the winter peak load of New Plymouth. Over the programme, there were 20 Demand Response events successfully called, with the largest DR call of 175 MW during testing for the HVDC Pole 3 project. Natural price points were found for the types of DR provided, and importantly – non-generation demand response was priced competitively compared to demand response through generation.

Through the testing it was shown that participant fatigue – the point at which participants cease responding to DR events either through lack of ability or willingness – was not apparent. Indeed, participants' feedback at the end showed an overall positive attitude towards the programme and an expectation that they would participate in future demand response programmes.

There are some learnings that Transpower will be taking away to improve the DRMS system and broaden the resources available. For example this programme was over-represented with hot water load from two participants, meaning that events tended to be over-delivered. This also impacted on the 'snap back' effect (where post-event demand increases greater than anticipated, once load that has turned off is put back on the system again).

Through broader development of DR as a transmission alternative, we hope to build participation and demonstrate the value of DR participation with the goal of having private investment innovating and investing in DR technology and infrastructure within the next 3-5 years.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Programme Delivered</th>
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<tbody>
<tr>
<td>100 MW of registered DR by June 2013</td>
<td>134 MW registered.</td>
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<tr>
<td>Test operation of DRMS and Distributor co-ordination</td>
<td>All 20 Demand Response events went ahead without any coordination issues. The DRMS performed as expected during these events. The programme identified there were still some barriers to participation and demonstrated there could be a reduction in benefits from the “snapback” effect of bringing load back on.</td>
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<tr>
<td>Determine the natural price points DR types</td>
<td>Different price points were found, however the sample set was small.</td>
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<td>Inform next steps</td>
<td>A demand response roadmap has been created with set goals.</td>
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<td></td>
<td>• We are aiming to establish new DR equivalent to 10% of peak demand (about 650 MW)</td>
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<td></td>
<td>• We will target medium commercial and industrial consumers with peak demand between 20 and 200 kW</td>
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<td></td>
<td>• We will improve the DRMS platform including the development of phone applications to lower or remove barriers and complexity.</td>
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1 Introduction
Transpower started investigating DR as an alternative to transmission investment in 2007 with an Upper South Island DR pilot. In 2011, we implemented an off-the-shelf web-based system – Demand Response Management System (DRMS) to help lower the barrier to participation. Using this new system Transpower ran a commercial demand response programme between July and December 2013. This paper summarises the main results from that 6 month programme.

The objectives of the market programme were to:
- confirm operation of DRMS including:
  - successful offering of DR up to at least 100 MW
  - coordination of providers with DRMS and between load types
  - understanding of interaction with other demand side regimes such as Interruptible Load
- determine the natural price points for different DR providers
- help determine next steps of embedding DR in NZ context

Additionally, at the end of the programme a market impact analysis was completed. Key findings from this are provided in Section 4.

2 Confirm Operation of DRMS

2.1 The DR Products
Two DR products were made available for participation:
1. Security product
   - Availability fees ($/MW) agreed prior to programme commencement, paid monthly
   - Delivery fees ($/MWh) agreed prior to programme commencement paid monthly based on performance during events
   - Participation in events mandatory if called
2. Price responsive product
   - Delivery fees ($/MWh) agreed for each event paid monthly based on performance during events
   - Participants notified of event details ($/MWh and requested MW amount), with an option to accept, decline or offer a lower price.
   - Participation mandatory if selected for the event

2.2 Participants
There were 8 DR participants, with 133.7 MW of registered DR at commencement (during the course of the programme many participants increased their participation levels in the Price Response product):

<table>
<thead>
<tr>
<th>Participant</th>
<th>Nature of business</th>
<th>Type of load offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector</td>
<td>Local lines company</td>
<td>Hot water</td>
</tr>
<tr>
<td>Counties Power</td>
<td>Local lines company</td>
<td>Hot water</td>
</tr>
<tr>
<td>Vodafone NZ</td>
<td>Telecommunications</td>
<td>Load management, standby generator, battery backup</td>
</tr>
<tr>
<td>Nelson Marlborough District Health Board</td>
<td>Hospital</td>
<td>Load management, standby generator</td>
</tr>
</tbody>
</table>
Simply Energy
Third party curtailment service provider
Mixed portfolio of load management, standby generator

Trustpower
Generator
Non-market generation

Refining New Zealand
Industrial consumer
Load management, standby generator

Callaghan Innovation
Medium sized consumer
Load management

As well as the DR participants the other roles through the programme were:

<table>
<thead>
<tr>
<th>Who</th>
<th>Role</th>
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<tbody>
<tr>
<td>Transpower Demand Response Operator</td>
<td>Management of the power system in real time</td>
</tr>
<tr>
<td>System Operator</td>
<td></td>
</tr>
</tbody>
</table>

Local lines companies
Informed:
- upon registration of a DR resource in their network (to understand any impact on ability to provide AUFLS)
- of any DR events being called in their network through communications to their control rooms prior to the event

2.3 Operational Coordination
The coordination of DR events was managed through a system of operating processes and procedures and Transpower’s DRMS. Communication of events with programme participants was exclusively through the DRMS, while coordination with the System Operator and local lines companies was through agreed operating procedures that included telephone calls and emails.

Two hours prior to an event the Demand Response operator would call the System Operator to confirm the expected amount of MW being reduced at each GXP. Another call was made 15 minutes prior to commencement to confirm the event could still go ahead as planned.

Local lines companies were made aware of any DR events being called on their network, through communications (email and follow up phone calls) with their control rooms.

DR event coordination with participants was relatively straightforward through the DRMS system with the DR operator creating an event, and emails and web service feeds sending the relevant info out to participants. Over the 20 events called, no participants missed an event due to not receiving/missing event notifications from the DRMS.

Two DR participants were also Interruptible Load (IL) participants. Verification that they had managed their IL obligations was a manual process that required the System Operator to review IL offers after each event. One participant managed their IL obligations as required, but the other participant did not adjust their IL participation to reflect DR participation.

2.4 Results
Over the 6 month programme, 20 DR Events were called:
• Average DR call - 38 MW.
• Largest DR Call - 175.72 MW (9th September 2013)
• Average Call length - 2 hours
• Average Event Cost - $27,500
• Total spent for all DR Calls - $550,000
• Total Availability Cost for Security Programme - $195,000
• MW delivered vs dispatched (%): 135
• Net demand reduction (MWh): 1583
• Average price ($/MWH): 470

Accordingly, the objective of having 100 MW of Demand Response offered was met, although calls did not commence until August 2013.

2.5 Other programme findings

2.5.1 Over delivery
415 MWh was over-delivered, mainly by the distributors through their hot water control. The positive aspect of over-delivery is that DR was more than 100% reliable. The design of the programme catered for this over delivery by capping payment at the maximum agreed MW quantity for each participant at the start of each event.

2.5.2 ‘Snapback’
Snapback is where post-event demand (ie following DR completion) was greater than anticipated, causing issues for the System Operator (see graph of an actual snapback event of 8 September). Management of snapback is possible through staggering DR resources during an event (ie starting and stopping DR participants and different times).

2.5.3 Participant fatigue
Participant fatigue is the point at which participants cease responding to DR events either through lack of ability or willingness. Fatigue was forced by calling a series of events on consecutive days at the same time period each day. The two main outcomes noted were:
• Performance was not affected by fatigue. The performance of participants that participated did not decrease their performance.
• Calling Price Response DR events on weekends/holidays demonstrated a lower response (in MW) from participants.

2.5.4 Participant Feedback
A survey of DR participants following completion of the DR programme ended showed an overall positive attitude towards the programme and an expectation that they would participate in future demand response programmes. Other key themes were:

• DRMS needs to be more user friendly
• Was a good learning process (about their load) for participants
• Biggest difficulty was in finalising contracts with Transpower – seemed to be a slow process, but they didn’t consider a major issue.
• A phone app to manage events would be useful – ‘especially on weekends when not near a computer’

3 Pricing
A key objective was to determine the natural price points for different DR providers. The graph illustrates the range of cost by resource type.

3.1 Hot water
Price point: $120-$500/MW

Pros
• Lowest cost resource
• Greatest delivery of MW reduction

Cons
• Snapback can create operational issues for System Operator if it happens quickly.
• Even if snapback managed correctly, a peak may move to a later trading period, which can create issues with the market price.

3.2 Load Reduction (No generation)
Price point: $200-$1000/MW

Pros
• Lower cost than generation
• Good where participants have predictable (eg conforming) demand

Cons
• Good understanding required by participants of their demand at different times
• Not good where participants have variable demand (participation less likely or variable response during events)
3.3 Load Reduction (via generation)
Price point: $1,000-$4,000/MW

Pros
- With more generation participants competition could result in downward pressure on prices (Price Responsive programme)

Cons
- Most expensive

4 Market Impact Analysis
Following completion of the programme, a market impact analysis was performed to consider the impact on the programme on:
- Load Market Cost – ie the cost paid by load in the energy market (price x quantity)
- System Cost – the ‘cost’ of resources offered into the energy market
- Reserves Prices – for both the Fast Instantaneous and Sustained Instantaneous Reserves markets.

Total market benefits were calculated as the sum of the reduced load market costs and reduced system costs.

The analysis showed that:
- A majority of the DR events gave a market benefit due to lower load market costs (due to lower spot price) with the DR
- A large portion of DR market benefits were eroded through the DR rebound effect
- Net load market benefit > DR event cost
- Net load market benefit < DR event cost + DR availability cost
- IR cost increase small relative to load market cost reduction
5 Next Steps

International DR programmes demonstrate that diversity of resources is one of the defining characteristics of successful DR regimes. Therefore, if we aim to create a sustainable DR capability for New Zealand then we must encourage and enable the expansion of DR beyond established capabilities such as hot water.

We will target new resources through a series of DR programmes over the next few years. This will enable better understanding on both sides of what it takes to participate in a DR programme and we are hopeful that we can further reduce the barriers to participation.

The 2013 programme demonstrated that the contracted Commercial & Industrial (C&I) DR was both economic and reliable however we didn’t get a wide enough sample set to determine differing cost bands for a range of DR resources.

Each additional consumer segment will require detailed segmentation to understand their demographic – what type of consumers are included and how should they be targeted for participation in DR? There may be a logical progression from commercial office buildings to include supermarkets, universities and hospitals, however each consumer type will have its own unique requirements, drivers and barriers. Therefore specific planning is necessary to ensure high levels of engagement are achieved.

Through development of DR as a transmission alternative, we will build participation and demonstrate the value of DR participation with the goal of having private investment innovating and investing in DR technology and infrastructure within the next 3-5 years. As we gain a better understanding of the price points for DR it will be used as a deferral mechanism for grid and major regional projects.

Following the completion of the programme and in part based on the results, we have set out a Demand Response Roadmap. Key features of the roadmap are:

- setting an aspirational target of 10% of peak load (650 MW) for new DR capacity (this is in line with international best practice)
- small-medium commercial hold promise for further DR, that’s next. Development of DR as a transmission alternative made up of small-medium commercial and industrial consumer segments (eg consumers with peak demand between 20-200 kW)
- further reduction in market entry barriers including (for example)
  - mobile application
  - usability improvements to the DRMS system
  - review accessibility to DR contracts and tendering
- ‘Walk the talk blueprint’ – Transpower House to be set up to take part in the DR programme.