

Security Policy Review: Credible Event Management

Appendix 3 - Costing Assumptions & Examples

December 2009



SYSTEM OPERATOR

Keeping the energy flowing

TRANSPower



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Appendix 3 – Costing Assumptions & Examples

Summary of Costing Assumptions

Assumptions with regard to the cost of management measures are listed below.

- Wider Voltage Agreements
 - Application of measure: free of charge
- Pre-arranged pre-event load /generation agreements
 - Application of measure: \$10,000/MWh.
- Pre-event security constraints / Constrain load pre-event
 - Application of measure: \$10,000/MWh.
- Manual system re-configuration pre-event and/or post event
 - Application of measure: No cost
 - Consequence of measure: potential reduced security
- Reduced security by agreement
 - Application of measure: No cost
 - Consequence of measure: loss of supply
- Off-load time or 24 hour emergency ratings
 - Application of measure: No cost
- Instantaneous reserves (Fast Instantaneous Reserves FIR and Sustained Instantaneous Reserves SIR)
 - Application of measure:
 - North Island FIR & SIR – \$5/MW
 - South Island FIR & SIR – \$1/MW
 - North Island 260 MW of FIR and 415 MW of SIR.
 - South Island 90 MW of FIR and 150 MW of SIR
- Overfrequency reserves (armed pre-event)
 - Overfrequency reserve is procured for the South Island
 - Application of measure: \$54,000 per month
- Special Protection Schemes (armed pre-event)
 - Application of system re-configuration: No cost
 - Application of generation runback: No cost
 - Application of planned load shedding (intertrip, AUVLS): three scenarios using average values of \$2000/MWh, \$5000/MWh and \$10,000/MWh
- Switching of capacitor banks and condensers
 - Application of system re-configuration: No cost
- Automatic load shedding AUFLS
 - Application of measure: \$20,000/MWh for interrupted load.

- Post-event re-dispatch of generation
 - Application of measure: generation re-dispatch is determined by SPD the cost of which is based on market prices at the time of dispatch. The costs associated with re-dispatch will not be included in the costing of event management.
- Dispatched post-event emergency load shedding
 - Application of measure: a cost of \$20,000/MWh
- Pre-arranged post-event load and/or generation agreements
 - Application of measure: three scenarios using average values of \$2000/MWh, \$5000/MWh and \$10,000/MWh

Example 1 Event Costing

Event: Loss of Redclyffe 220kV Busbar A

Region: Hawkes Bay

Event Risk Factor: 0.021

Average Duration: 7.5 h

SE Approach: *Post-event unplanned load shedding*

Pre-event measures: None

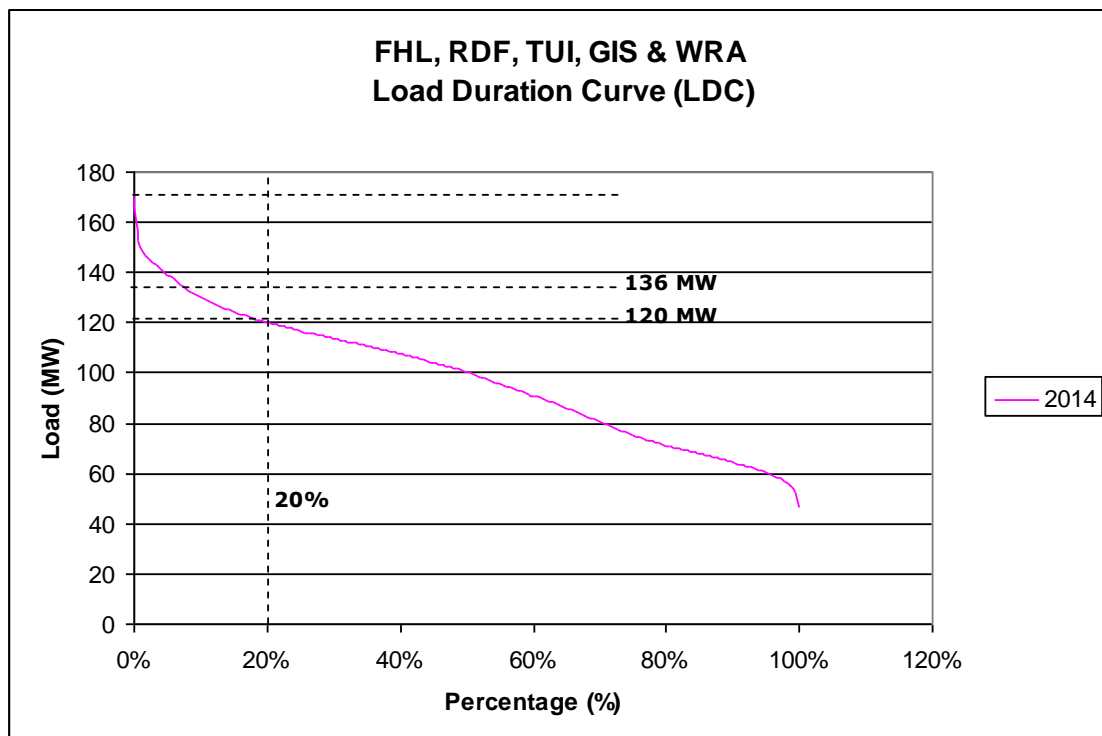
Assumptions: Tuai generation set to 18MW

Post event: Loss of Redclyffe transformer T3
Loss of Redclyffe-Whirinaki-220kV- 1
Loss of Redclyffe-Whakatu-220kV- 1

Consequence: Redclyffe transformer T4 will be overloaded to 158MVA.
Winter 24 hour post contingency rating of Redclyffe T4 is 120MVA.
Loss of supply to Redclyffe, Tuai, Gisborne, Wairoa & Fernhill load.

Constraint: Load Constraint Limit in the Hawkes Bay region 120MVA.
For 2014, the constraint is exceeded for 20% of the time.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MWh)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
Unplanned load shedding	136	7.5	20,000	20.40	0.021	0.2	0.086



CE Approach: Pre-event security constraints

Pre-event measures: Arrange 16MW load constraint in the Hawkes Bay region.

Post event: The remaining load in the Hawkes Bay region will be secured.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MWh)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
Pre-event load constraint	16	8760	10,000	n/a	n/a	0.2	280.32

ECE Approach: Pre-arranged post-event planned load shedding

Pre-event measures: Arrange 16MW post event load shedding in the Hawkes Bay region.

Post event: The remaining load in the Hawkes Bay region will be secured.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MWh)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
Planned load shedding	16	7.5	10,000	1.20	0.021	0.2	0.005

Example 2 Event Costing

Event: Loss of Bunnythorpe 220kV Busbar A1

Region: Bunnythorpe

Event Risk Factor: 0.021

Average Duration: 7.5 h

SE Approach: *Post-event unplanned load shedding*

Assumptions:

HVDC Pole 2 South transfer 400MW, Pole 1 HVDC out of service

No generation at Mangahao

Te Apiti generation is in service

Under these conditions, the Wilton T8 overloads and is switched out of service.

Post event:

Loss of Bunnythorpe T1 and supply transformer T9

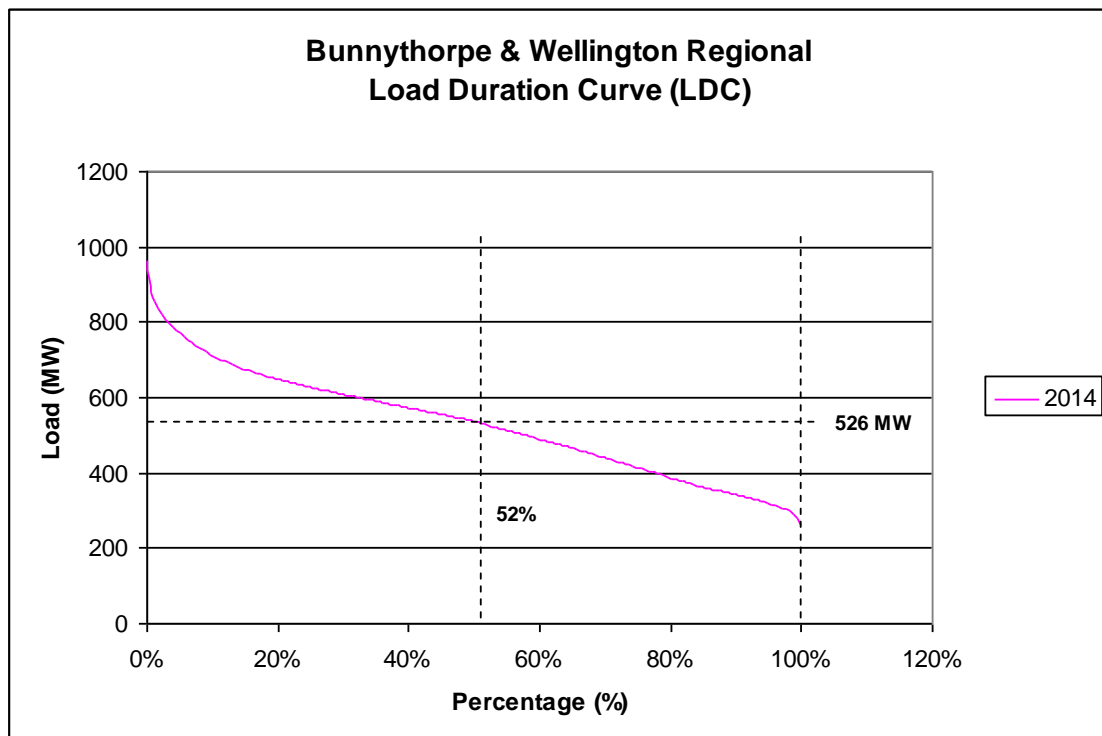
Loss of 220kV Bunnythorpe-Wilton-1, Bunnythorpe-TWC/Linton- 1, Bunnythorpe-Brunswick-2 and Bunnythorpe-Tangiwai-1

Consequence:

Voltage collapse and loss of supply to the Bunnythorpe and Wellington regions.

HVDC will trip.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MWh)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
Unplanned load shedding	526	7.5	20,000	78.9	0.021	1.00	1.657
HVDC Tripping	220	-	1250	0.275	0.021	0.20	0.0012
TOTAL							1.6582



CE Approach: Pre-event security constraints

The application of a pre-event security constraint on HVDC south transfer as a management measure for treatment as a Contingent Event is not considered to be an economic option.

ECE Approach 1: Post-event reduction/Interruption of HVDC south transfer (pre 2012)

Pre-event measures: Reduce HVDC transfer to 80MW post event (but since HVDC does not currently have this capability, all transfer is interrupted).

Post event: Bunnythorpe and Wellington regional load is secured.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MW)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
HVDC Tripping	220	-	1250	0.275	0.021	0.20	0.0012

ECE Approach 2: Post-event reduction of HVDC south transfer (post 2012)

Pre-event measures: Reduce HVDC to 80MW post event from an average load of 240MW.

Average load is greater than 80MW for 13% of the time.

Constrain HVDC by 160MW (average load).

Post event: Bunnythorpe and Wellington regional load is secured.

Event Measure	Average Load (MW)	Duration (h)	Unit Cost (\$/MW)	Event Cost (\$m)	Event Risk Factor	Load Risk Factor	Annual Cost (\$m)
Reduce HVDC (post 2012)	160	-	1250	0.2	0.021	0.13	0.00055