Section 8 Committee

14 March 2017

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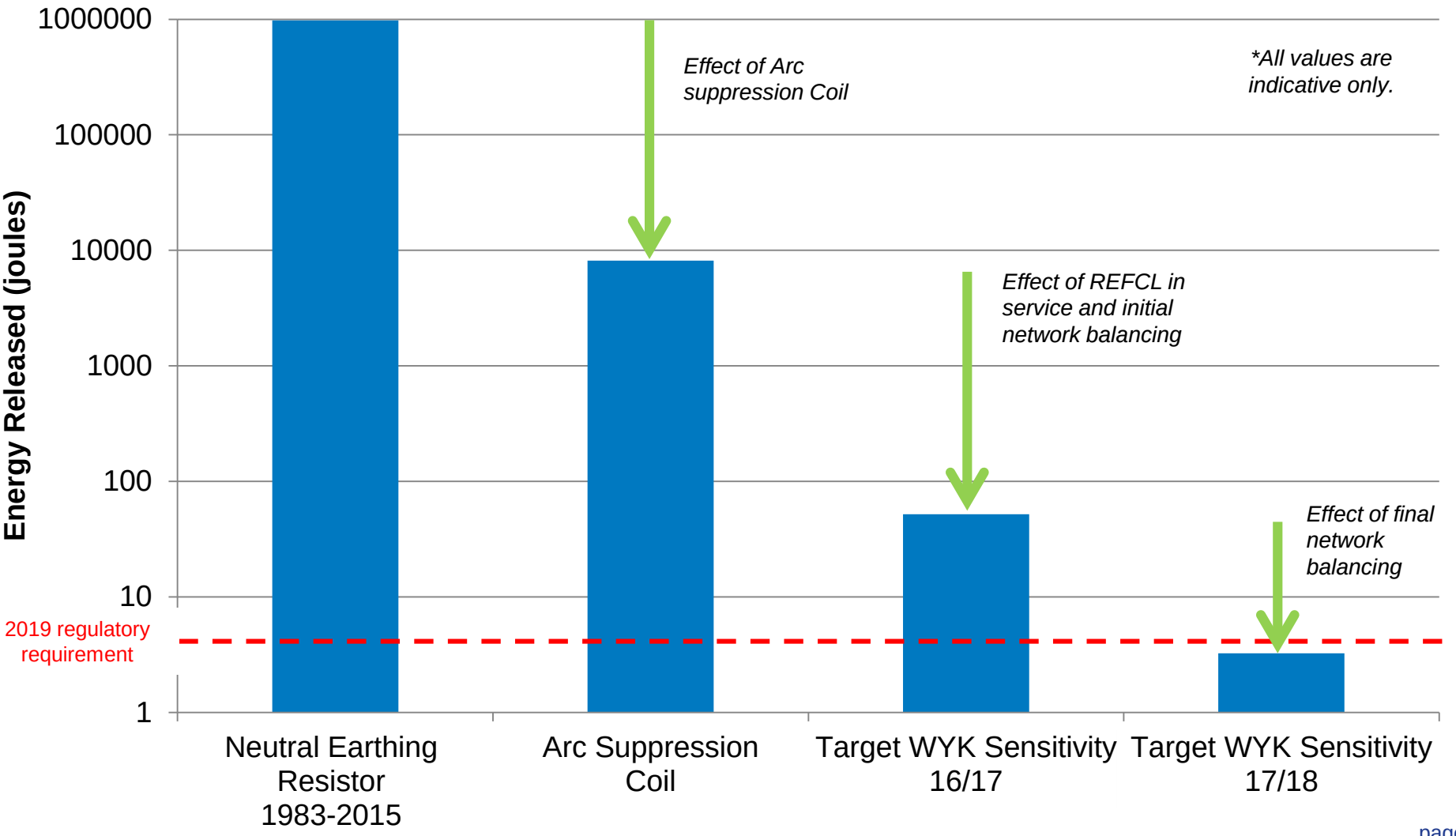
GM, Electricity Networks, (Powercor) GM Regulation and Network Strategy (AusNet)

REFCL Trials – Current Status

Woori Yallock Progress: Energy Released During Fault



Technical Issues Impacting To Date

Issue	Nature of problem	Response	Impact
Gisborne REFCL Issue	Underrated components caused failure of control circuitry	Swedish Neutral re designed correctly rated hardware now installed	2 month delay
Woori Yallock REFCL	Inverter tripping continuously on its overcurrent protection	Ramp and timing setting optimised to prevent inverter injecting large transient currents	4 month delay putting REFCL into service as all four of these problems were impacting on the ability to diagnose either of them and it require Swedish Neutrals specialist knowledge of their bespoke system.
Woori Yallock REFCL	Hardware Problem – Intermittent communication fault caused inverter's main contactors to open randomly during inverter operation	Fault found to be an optical fibre communications module that required an earthing connection. Redesign required.	
Woori Yallock REFCL	Software freezing	The communication module discussed above caused these issues. Earthing this module also fixed this problem	
Woori Yallock REFCL	Software Problem- GFN Backup function not working consistently	Issue only present during fault simulation. This will be fixed in next SN Software release	
LV Capacitors (PAL)	22kV Transformer issue due to unusual use of transformer on a compensated network	Returned to manufacturer for rectification.	3 month delay to supply
Woori Yallock REFCL	Intermittent Inverter issue. Works ok for permanent faults but trips occasionally for transient faults	Under investigation	Currently one month delay

GSB/WND Trial Sites

GSB REFCL

- Commissioned September 2016
  - Two cable failures during commissioning
  - 75% availability since switched into service 24/7
- Fire risk mode trialled for the 2016/17 summer
  - Compensate, soft fault confirm and direct trip CB for permanent faults
  - Assessing the reliability impact of this mode
- Two sensitivities available
  - 12.7kΩ (1.0A) selected for TFB days
  - 8kΩ used at all other times

WND REFCL

- Network stress testing complete on all 22kV buses without major incident
  - Two blown surge arrestors (only 1 found – Bowthorpe 24kV)
- Out of service until balancing works can be completed
  - Dependent on three phase balancing solution
  - Anticipated full commissioning date is late May 2017

Gisborne in service since September 2016, but not at required capacity

GSB Balancing Units

Capacitive Balancing Transformers

- Three phase balancing units are instrumental in the overall balancing strategy
  - Obtaining the required sensitivity is not possible without finite control
- Typical transformer design has not been successful
  - A prototype has recently been tested successfully
    - Awaiting the production of extra units such that the third phase of testing can commence

Product Issues

- Failure of grid balancing phase selector due to incorrectly specified changeover switch
- Failure of auxiliary contact on RCC/ balancing circuit due to poor design
  - Approximately three weeks out-of-service for redesign and repair
- Failure of latching relay in tuning circuit
  - Remained in service at reduced capacity
- Reliability of soft fault confirmation algorithm
  - Suspected false positives leading to large outages
- Management and testing of GFN firmware

Critical project milestone (fine balancing) in coming weeks

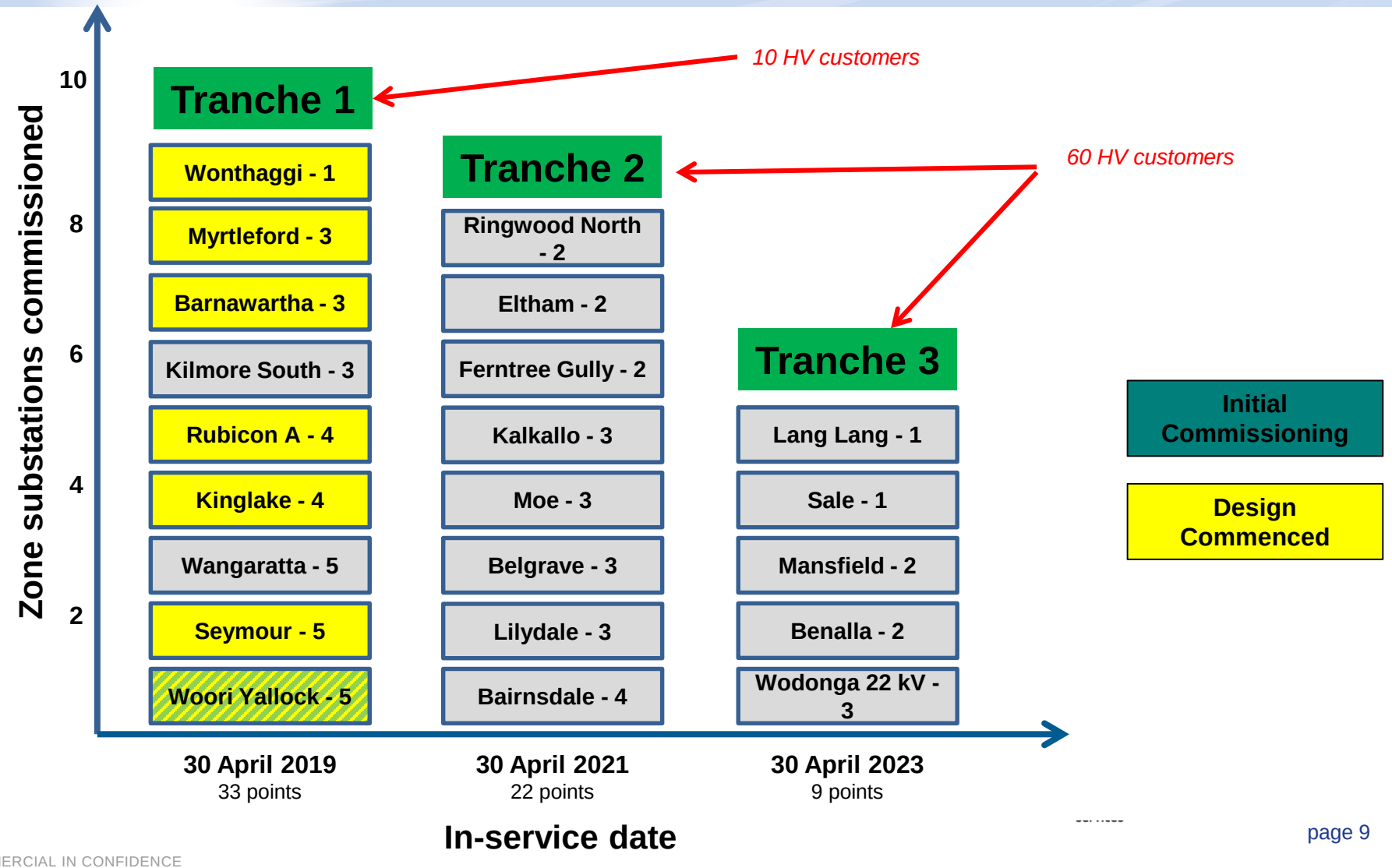
Operating Mode

Operating mode	Operational process
Fire risk mode	• When a fault is detected the REFCL compensates immediately • Waits a few seconds before performing a 'soft' fault confirmation test • If the fault is gone (transient), remove compensation • If the fault is permanent, trip the faulted feeder at the circuit breaker and remove compensation
Normal mode	• When a fault is detected the REFCL compensates immediately • Waits a few seconds before performing a 'classic' fault confirmation test • If the fault is gone (transient), remove compensation • If the fault is permanent, trip the faulted feeder at the circuit breaker or ACR and remove compensation
Bypass mode	• When a fault is detected the REFCL compensates immediately • Waits a few seconds before performing a soft fault confirmation test • If the fault is gone (transient), remove compensation • If the fault is permanent, bypass the REFCL increasing the fault current allowing protection devices to isolate the fault through normal discrimination (as per status quo)

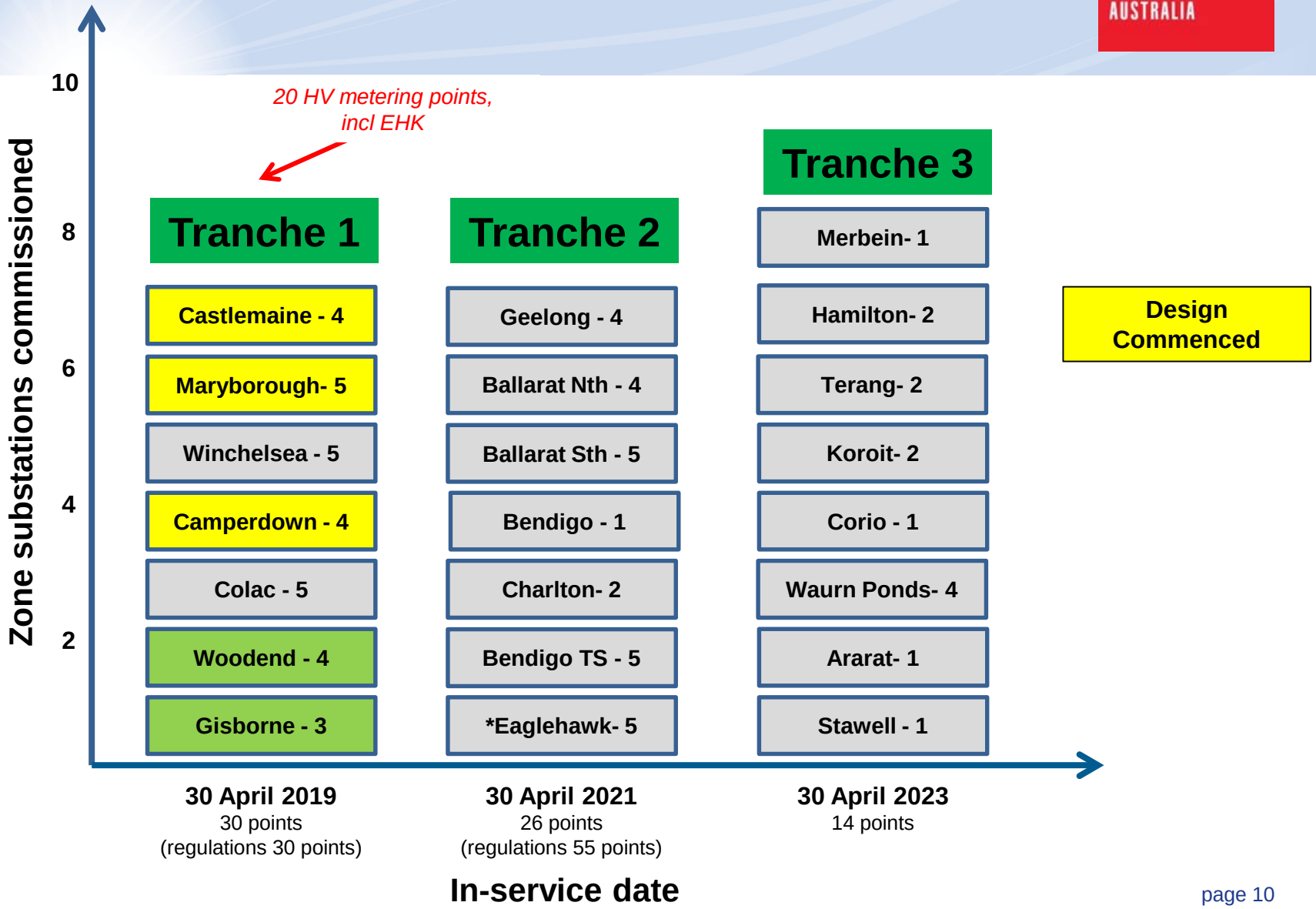
Fire risk mode = TFB days (min), plus trial for full fire season (Oct to March)
Normal mode = low fire risk days
Bypass mode = non-TFB days when fire risk and normal mode not deployed

Timeline & Contingent Project

REFCL Program - Timetable



REFCL Program - Timetable



Contingent Project
Powercor Tranche 1 (9 x GFNs)

Submission date targeted for 31 March 2017:

- Surge Arrestor replacement approach reviewed by external consultants GHD
- Expenditure estimation had to be completed before confirmation that compliance can be achieved at the GSB and WND initial trial sites.
- As no anticipated changes to the allowed voltage limits at HV customer connection points in the Distribution Code, isolating substations have been costed into the Application to maintain voltages within the Code.
- The Eaglehawk (EHK) project funding has been brought into the Tranche 1 Contingent Project Application to help mitigate penalties from any delayed projects.
- AER has 100 business days to assess the Application. The businesses aim to ensure the revenue requirements can start to be included in the 2018 Tariffs.

Contingent Project
Powercor Tranche 1 (9 x GFNs)

Expenditure driver	CDN	CLC	CMN	MRO	WIN	EHK
Customer numbers Customer numbers impact balancing requirements, control room operations and commissioning costs	5,717	16,584	11,473	9,504	3,337	15,376
Surge arrestor sites Surge arrestor sites are a key labour driver (noting three phase replacements require more labour than single phase) and also impact traffic management	1,933	2,467	2,054	1,665	736	2,021
ACR volumes ACR models that are not compatible with the operation of a REFCL network need to be replaced	9	19	5	9	3	10
Network capacitance (A) Network capacitance is a driver of the number of GFNs required to be installed at each zone substation	64	182	111	74	336	174
Total route length (km) Total route length impacts capacitive balancing requirements	918	1,323	906	946	479	936
Remote-controlled switching sections Three phase balancing requirements are primarily driven by the sections of our network bounded by remote-controlled switching devices	31	28	20	21	7	15
Number of feeders Commissioning costs are impacted by the number of feeders	5	7	5	6	3	8
Number of HV customers Isolation substations are required at each HV customer point of connection	2	9	5	-	-	9

Civil Penalties Bill

Civil Penalties Bill

Unintended consequences	Technical challenges in achieving "required capacity" of 0.5amps	Single supplier	Distribution code and HV customers
potential for a "deliver at all costs" mindset	may not be achievable, no recognition of R&D nature of trials	even more leverage for single supplier to call the shots	both are critical paths to the commencement of commissioning
bring-forward works place more pressure on timeline	R&D works; isolating transformers, kiosk regulators, capacitive balancing	significant risk with procurement of product	lead-times for realistic customer-side solutions are significant
bring-forward works reduces opportunities for alternate suppliers			support to HV customers is unfunded and unclear

Distribution Code & HV Customers

Electricity Distribution Code

Table 1

STANDARD NOMINAL VOLTAGE VARIATIONS				
Voltage Level in kV	**Voltage Range for Time Periods**			**Impulse Voltage**
	Steady State	**Less than 1 minute**	**Less than 10 seconds**	
< 1.0	+10% - 6%	+14% - 10%	Phase to Earth +50%-100% Phase to Phase +20%-100%	6 kV peak
1-6.6	± 6 %	± 10%	Phase to Earth +80%-100%	60 kV peak
11	(± 10 %		Phase to Phase +20%-100%	95 kV peak
22	Rural Areas)			150 kV peak
66	± 10%	± 15%	Phase to Earth +50%-100% Phase to Phase +20%-100%	325 kV peak

- **REFCL operation is outside distribution code voltage range**
- **ESC has decline to act on 'no action' request or code change**
  - Consider REFCL regs trump distribution code; **but**
  - Distributors continue to be liable for HV customer equipment damage and economic loss

AusNet HV Customers

70 Customer Sites with approximately 360 HV transformers of which

- **Infrastructure Owners** (5 Customers with 218 Tx)
  - Jemena (Off Kalkallo, 3 entire feeders, 76 Tx)
  - Australian Defence Force (6 sites, 87 Tx)
  - Metro Rail (13 sites, 38 Tx)
  - Melbourne Water (7 sites, 12 Tx)
  - United Energy (off 2 Feeders, 10 Tx)
- **Large Customers (4 or more Tx)** (10 Customers with 94 Tx)
  - Murray Goulburn, Leongatha (17 Tx),
  - Nestle (Uncle Tobys), Barnawartha (13 Tx), Thales Australia, (12 Tx)
  - Murray Goulburn, Maffra(9 Tx), Australian Textile Mills, Wangaratta (7 Tx)

    <7 Tx and >4 Tx
  - Wonthaggi Windfarm, D&R Henderson, Carter Holt Harvey,
  - AGL, Olex, Central Gipps Water, Nestle (Simplot)
- **Small Customers** (23 Customers with 46 Tx)

Potential Costs – Site Report, $20k/site ($1.2m), HV Testing, average $70k/site ($3.5m) and Customer Asset Replacement average $50k/Tx (Includes all assets $18m).
Total <$23m verses $105m for Isolating Transformers

AusNet HV Customers

Tranche 1

Infrastructure = 2, 39 Tx (Melb Water and Dept of Defence)

Large Customers = 4, 30 Tx (Woolworths, Nestle, AGL, Wonthaggi WF)

Small Customers = 4, 7 Tx (Pacific Hydro, Nat' Paper Ind, Aus' Textile Mill)

Tranche 2

Infrastructure = 20, 121 Tx (71 Tx Jemena, Melb Water, Metro, United)

Large Customers = 4, 25 Tx (Olex, Murray Goulburn, Gipps Water)

Small Customers = 16, 33 Tx

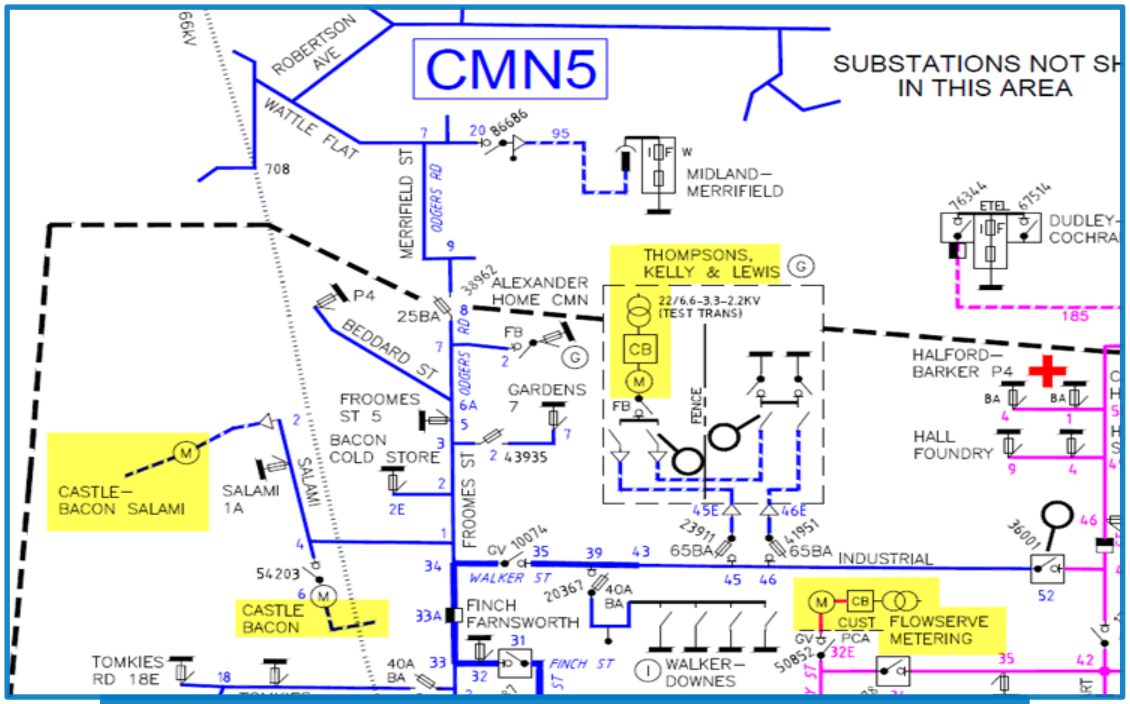
Tranche 3

Infrastructure = 8, 58 Tx

Large Customers = 8, 39 Tx

Small Customers = 3, 6Tx

PAL HV Customers



Tranche 1 = 20 HV metering points

Tranche 2 = 20 HV metering points

Tranche 3 = 18 HV metering points

PAL has no records of HV customer assets

Example – Castlemaine

- 2 HV customers (Flowserve and Dons Smallgoods)
- 4 metering points
- No visibility of HV assets beyond the meter

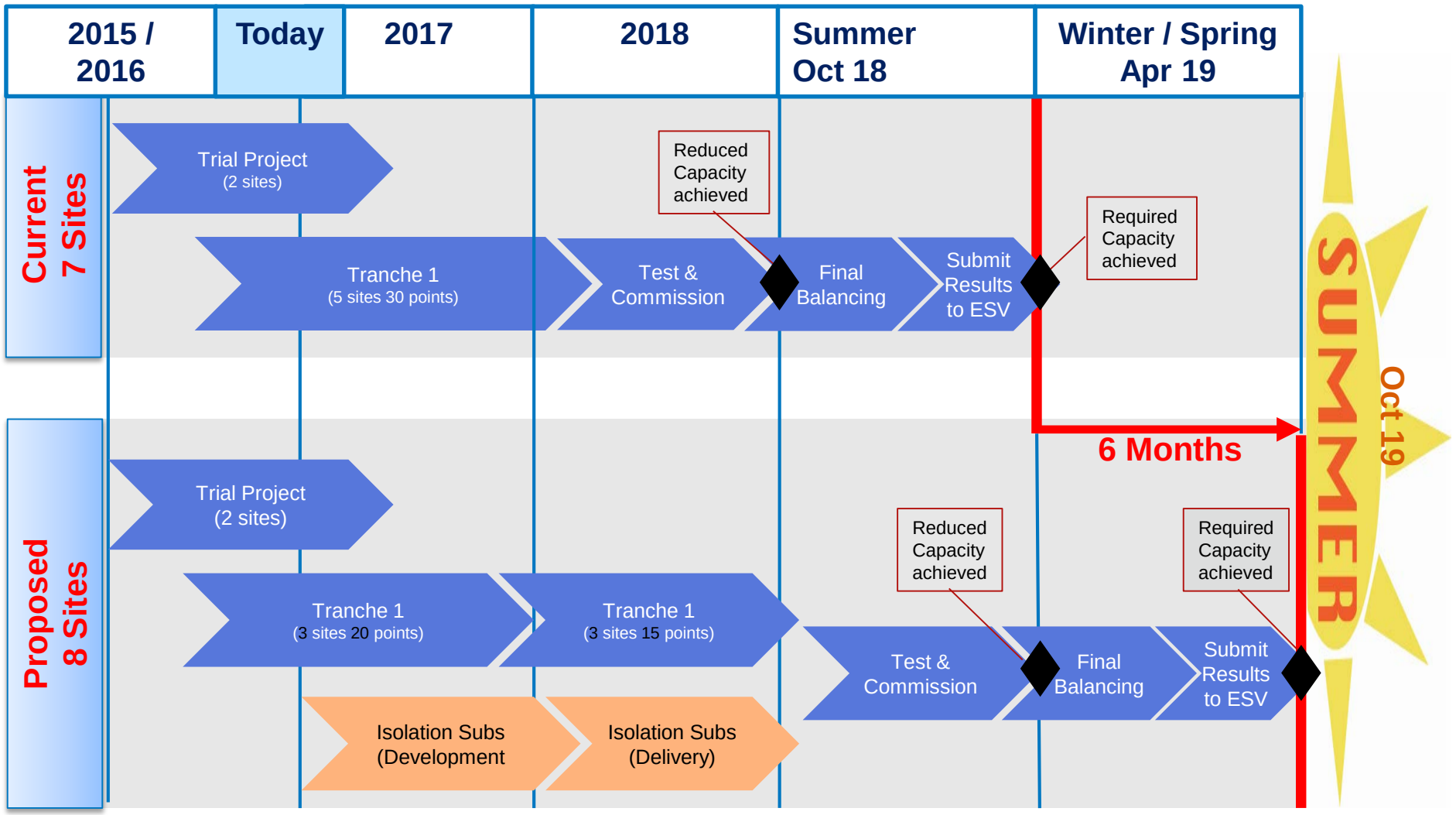
Network Solution

HV isolating transformers

- significant R&D required
- no guarantee these will work
- significant capital cost impost
- unlikely to be best economic solution for many situations
- significant time impacts
  - unknown procurement lead-times
  - land acquisition and 3rd party approvals required
  - must align with customer's requirements
    - annual outages, financial year cycles

Extension to Tranche 1

Request For Extension Tranche 1

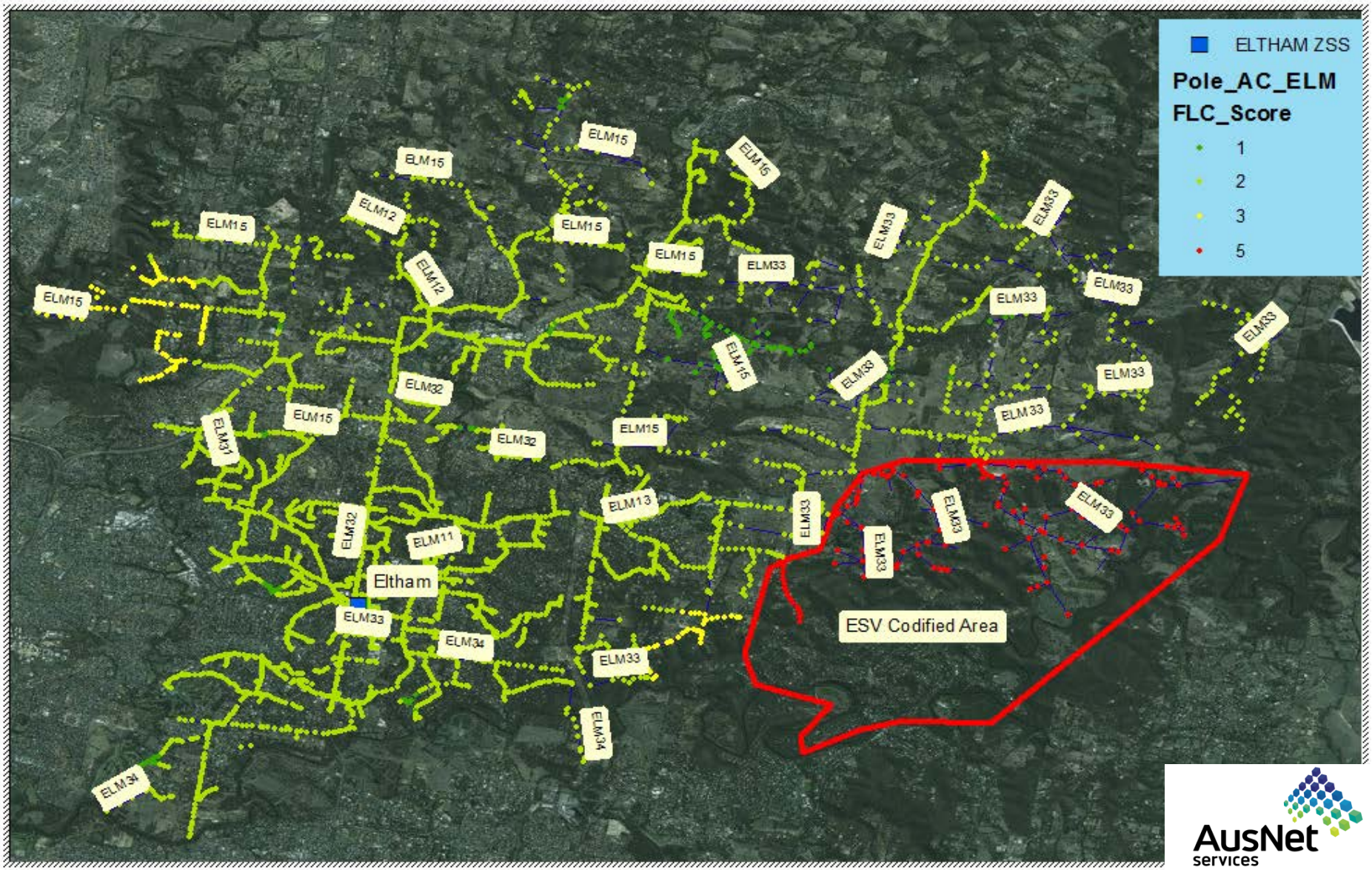


Alternate Technical Solutions

Alternate Solutions

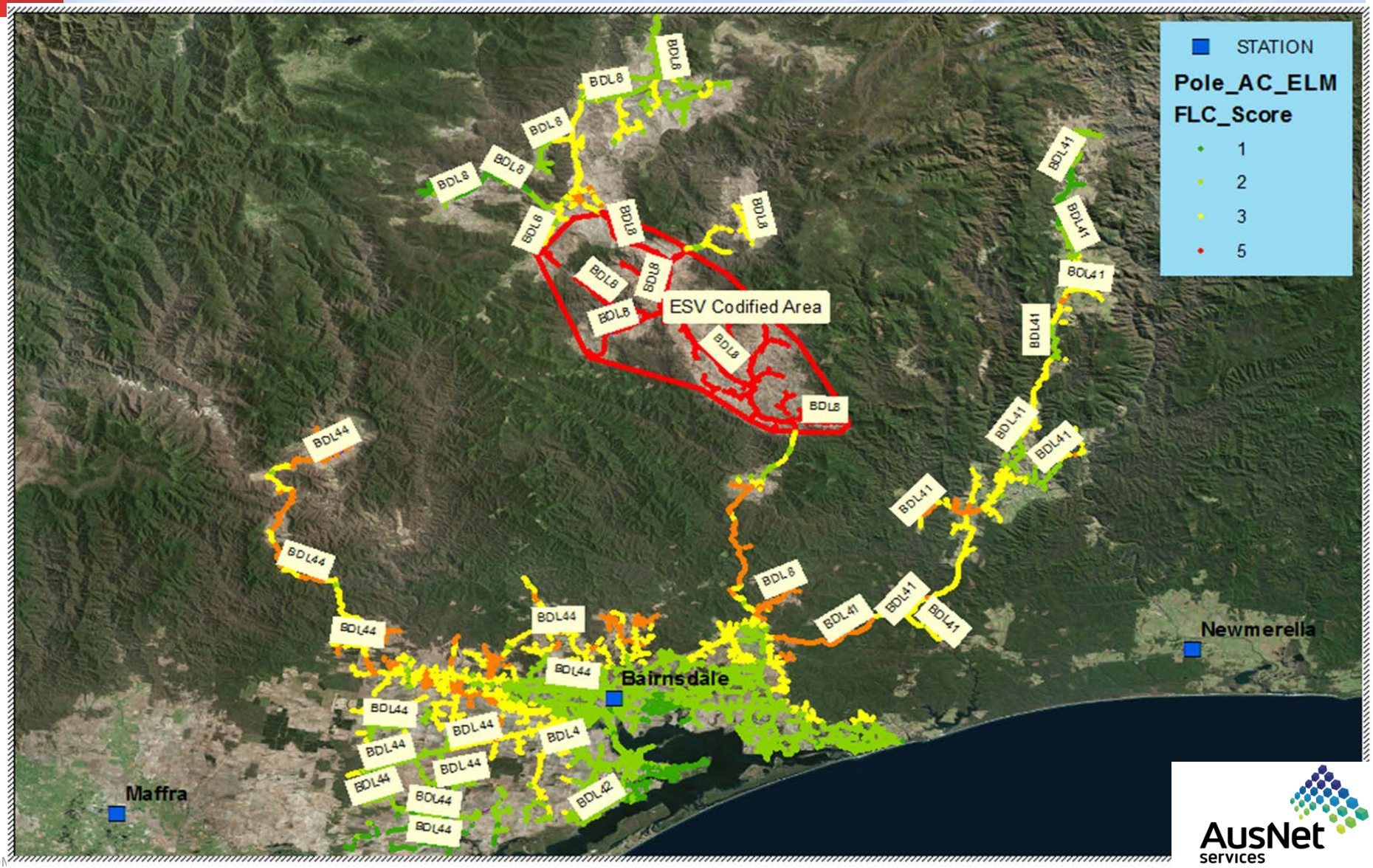
- Several zone substations identified for REFCL have very concentrated but geographically limited risk
- Creates considerable cost in network hardening and balancing in areas that are low risk
- Possible alternative solutions include:
  - Undergrounding high risk areas
  - Operating the REFCL on specific feeders rather than the whole station
- Seek support from ESV / Section 8 for flexibility in technical solution
  - Provide same level of risk reduction

Eltham Zone Substation



AusNet services

Bairnsdale Zone Substation



AusNet services

Questions