Network Resilience – Potential benefits of a requirement to provide for resilience

Text

Final

23 December 2020

TOTAL ENVIRONMENT CENTRE

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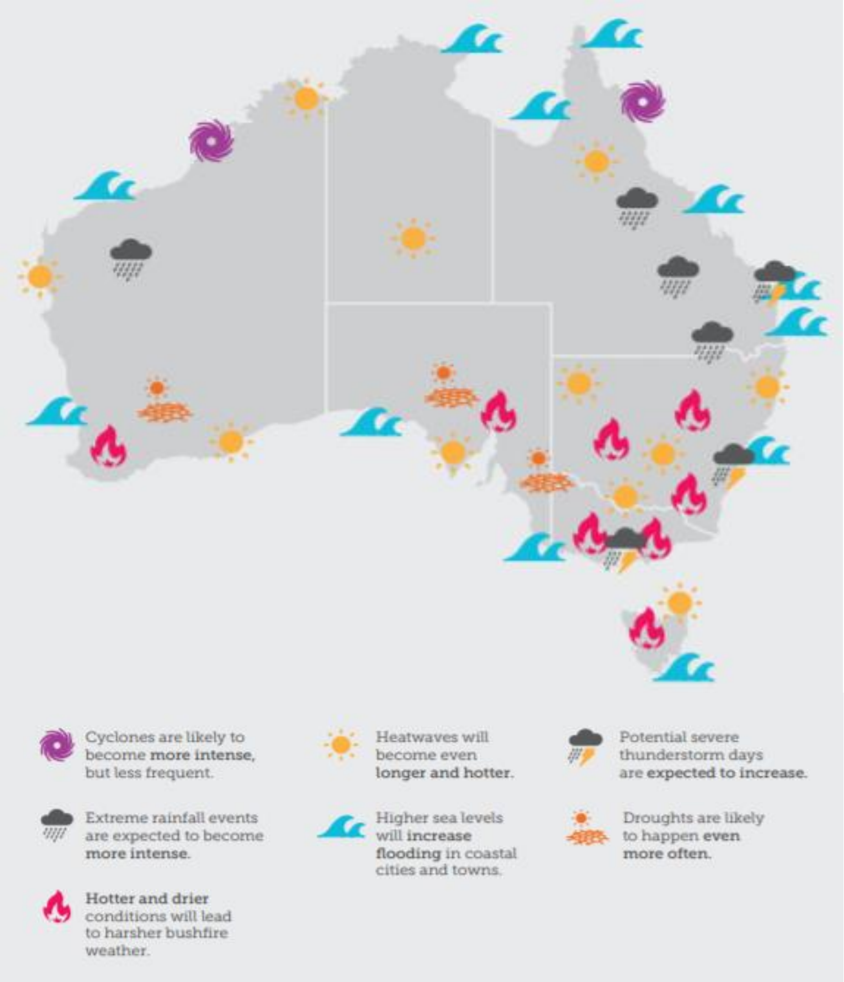
Natural hazard events affect electricity network infrastructure leading to localised long duration outages:

- Strong winds directly bring down overhead lines and poles;
- Fallen trees and debris cause damage to overhead lines and lift underground cables;
- Flooding inundates substations and underground assets, rendering them unusable;
- Bushfires burn through above-ground network assets;
- Lightning shuts down networks
- Networks are potentially a source of ignition for bushfires on extreme fire weather days;

In 2020, three applications have been submitted to recover an unprecedented AUD$42.67M from customers as a result of the recent bushfire and severe weather events.



Source: Climate Council of Australia 2019 Dangerous Summer: Escalating Bushfire, Heat and Drought Risk, p. 6.

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Background

1. There is currently no positive obligation for networks to invest in resilience to natural hazard events
2. Networks do already invest in network resilience, particularly related to:
   - Vegetation management to prevent bushfires started by network assets
   - Reliability to improve performance under the STPIS schemes

   These mechanisms are not well suited to improving resilience to natural hazard events
3. As the frequency of natural hazard events increase under climate change:
   - The cost pass through mechanism will be triggered more frequently
   - Insurance costs will increase / networks will need to self insure to a greater extent
4. TEC is considering a potential rule change request to explicitly require network businesses to provide for resilience

This study

1. Has a focus on provision of Stand Alone Power Systems (SAPS) as a critical measure for networks to provide for increased resilience
2. Assesses the total potential for resilience based SAPS across the NEM
3. Represents a first-pass based on high level assumptions of total net benefit
4. Considers broader measures that DNSPs may invest in to improve resilience via a qualitative assessment

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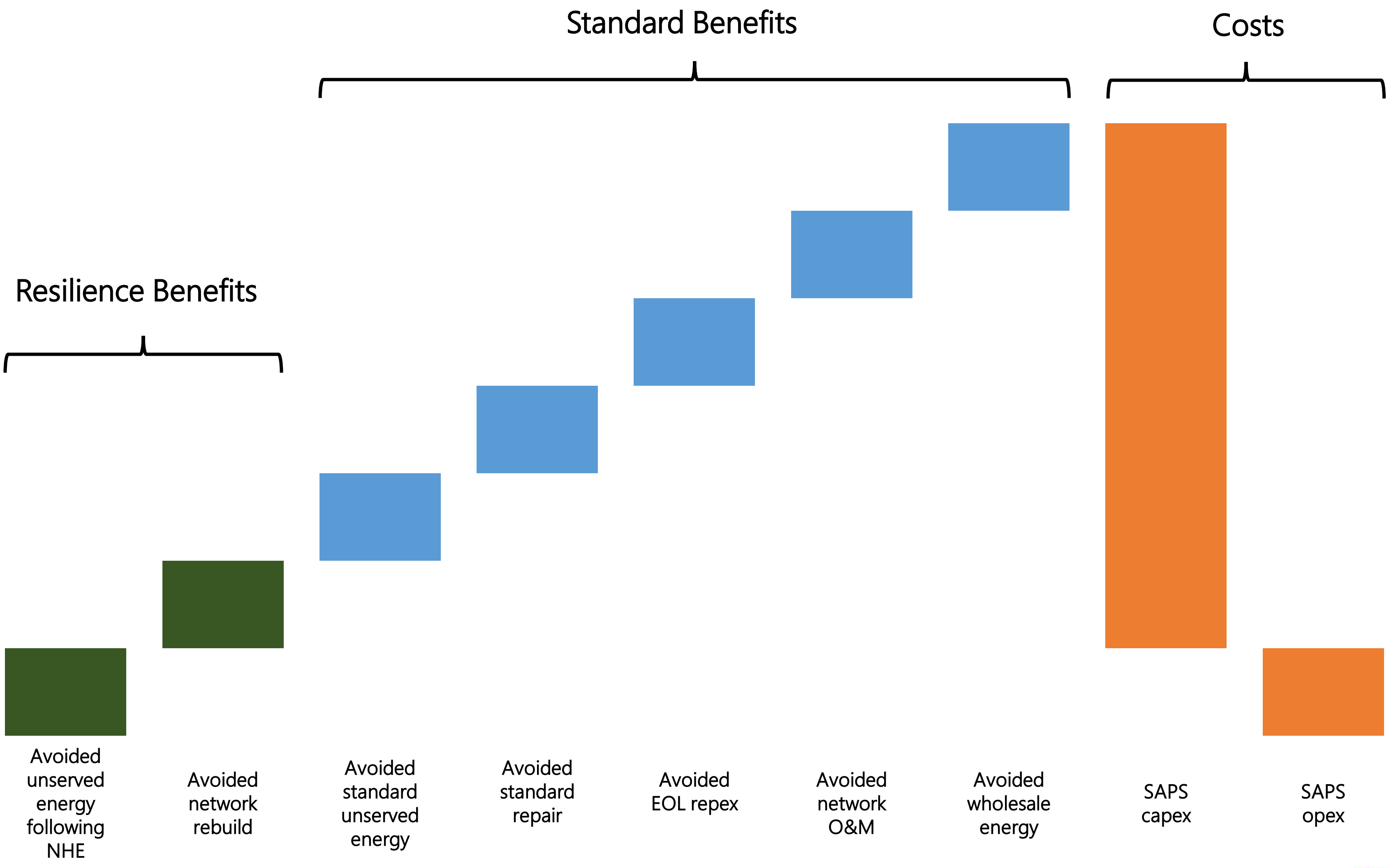
1. **Natural hazard events:** refers to naturally occurring physical phenomena including bushfires, floods, storms, cyclones, heatwaves, earthquakes and tsunamis, that disrupt and cause loss in society.
2. **Resilience**: the capacity of communities to prepare for, absorb and recover from natural hazard events and to learn, adapt and transform in ways that enhance these capacities in the face of future events.
3. **Stand-alone power systems (SAPS)**: an electricity supply arrangement which does not rely on physical connection to the national grid.
4. **Individual power systems (IPS)**: refers to a subset of stand-alone power systems that supply electricity to a single customer.

Resilience-based SAPS Value Stack (Stylised)



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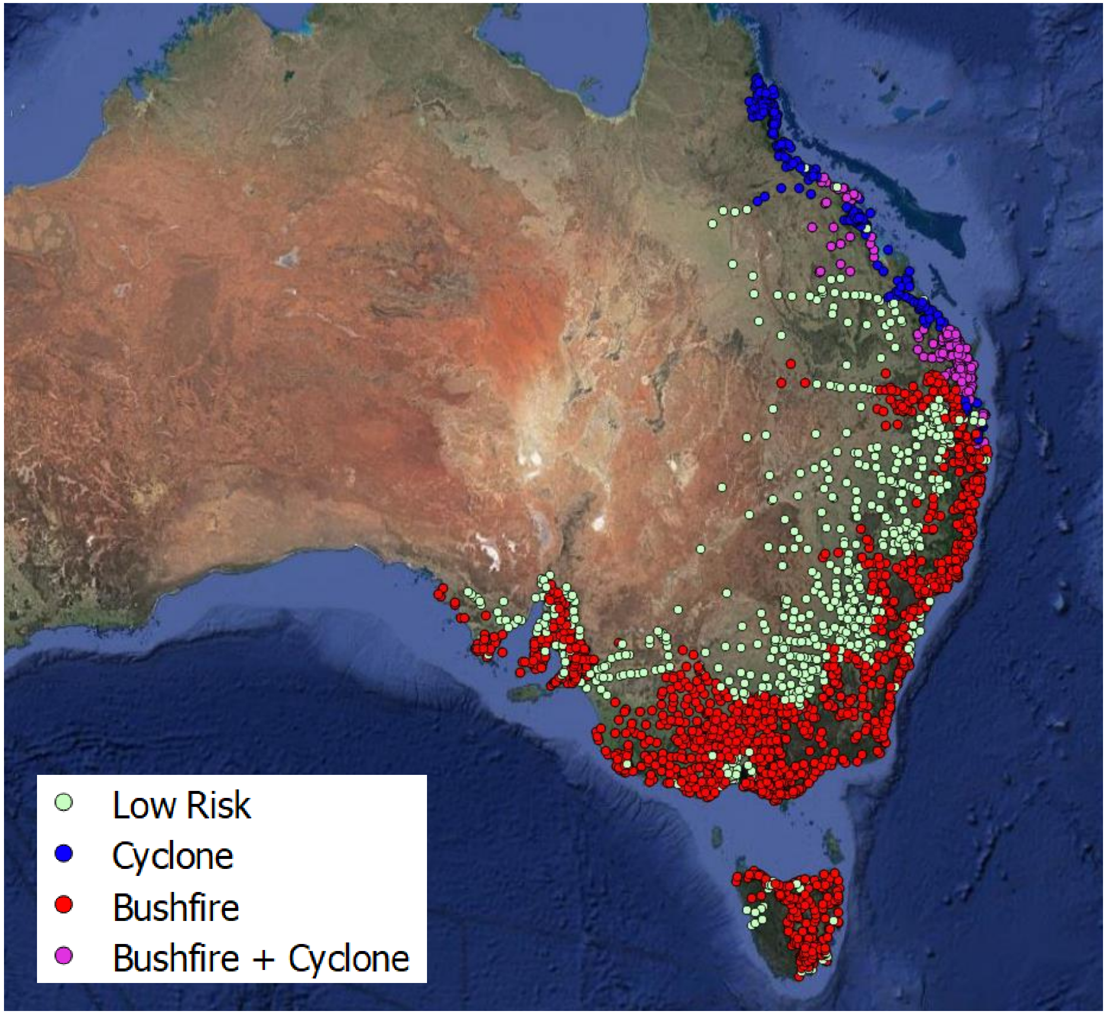

- 2,336 towns, villages and hamlets* across the NEM were assessed
- 1,605 identified as in bushfire risk areas
- 362 identified as in cyclone risk areas
- Additional filters reduced to 1,270 eligible locations that were modelled at a high level
- From these 18 case studies were selected across a range of:
  - Cyclone and bushfire risks
  - # Town dwellings
  - # Surrounding IPS sites
  - Climate regions
  - Distance to shared distribution network

*Town defined as a grouping of residential meshblocks within 1km from ABS catalogue 1270 and 2074

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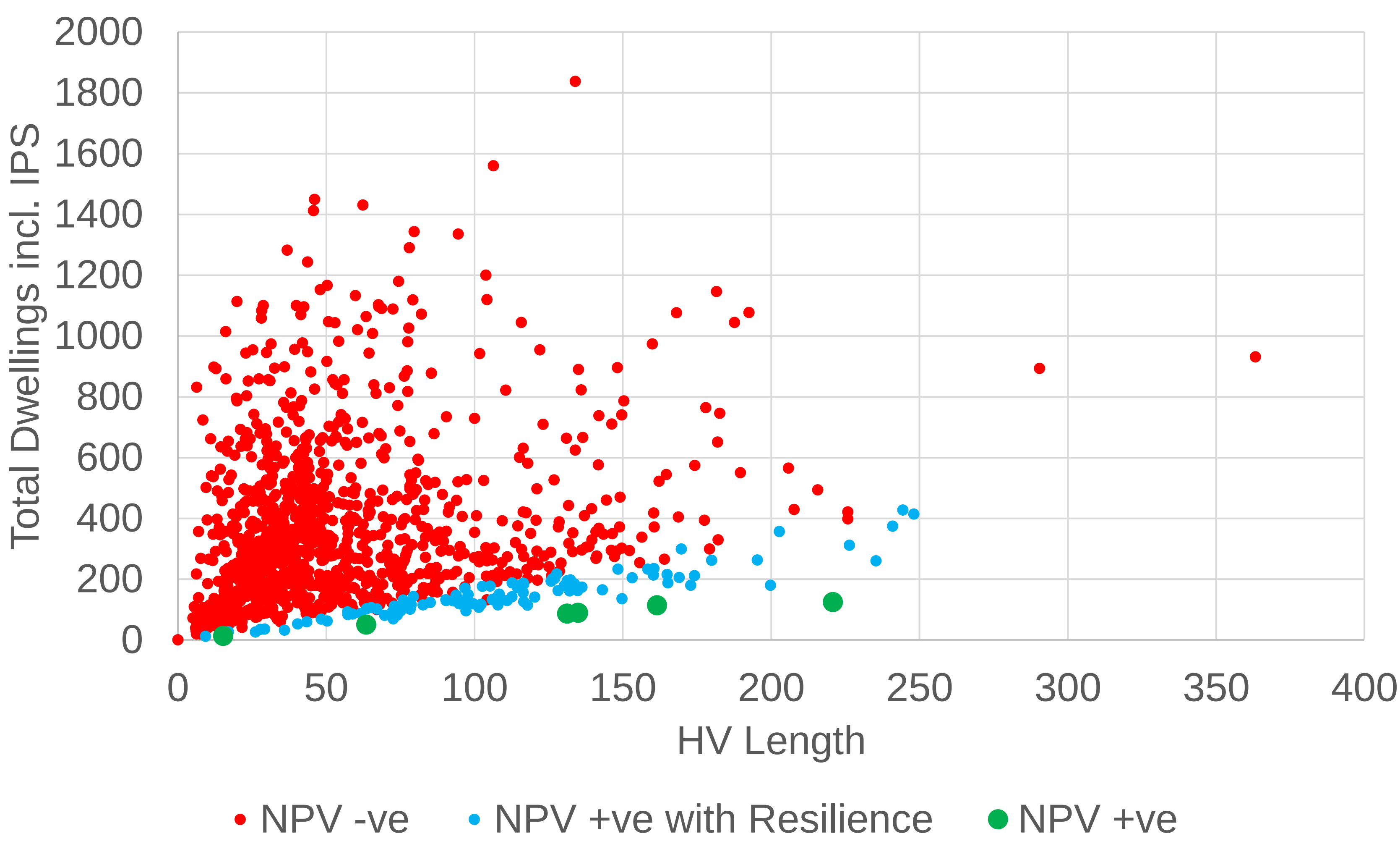
Total Dwellings incl. IPS
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
50
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250
300
350
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HV Length
NPV -ve
NPV +ve with Resilience
NPV +ve

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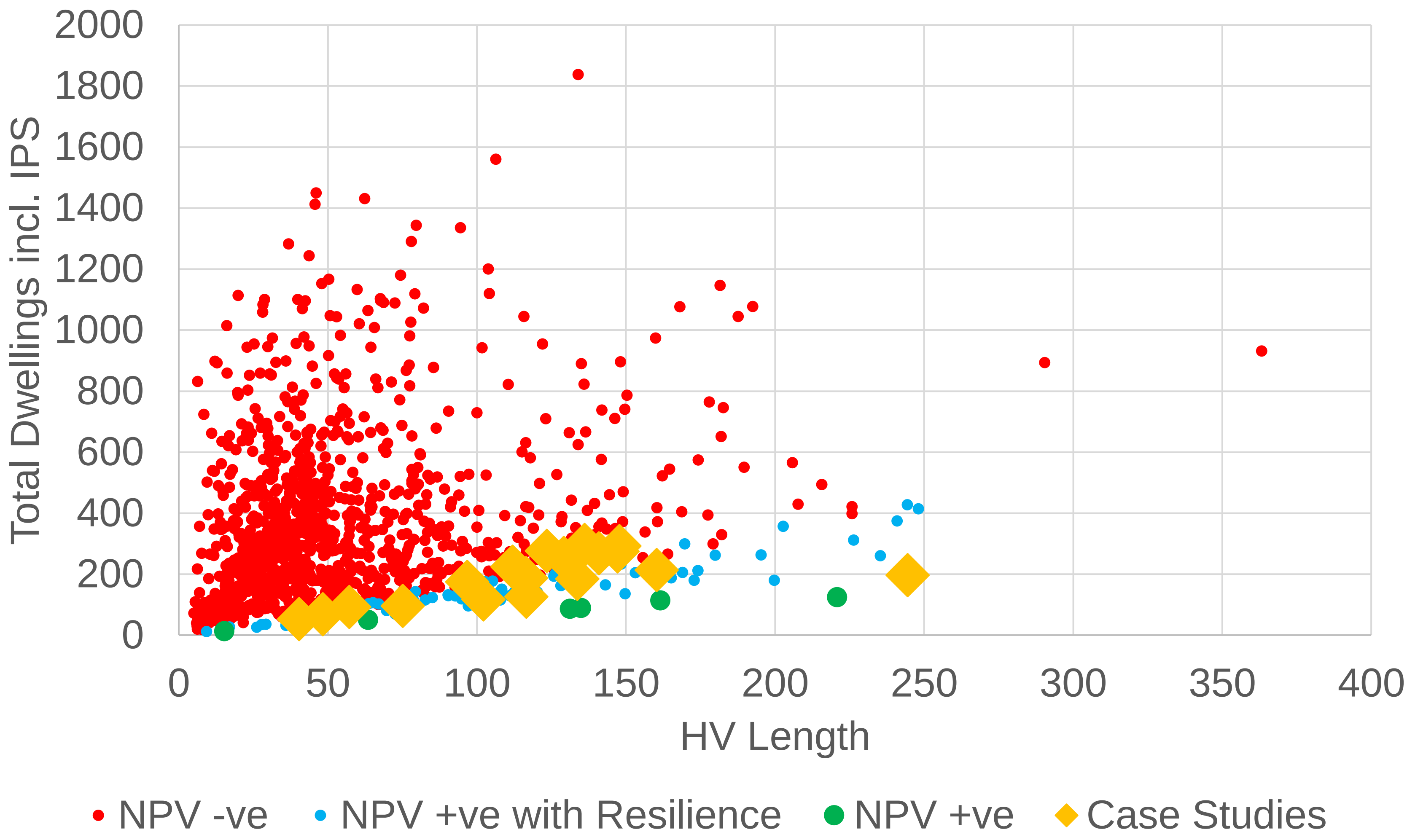
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300
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HV Length
NPV -ve
NPV +ve with Resilience
NPV +ve
Case Studies

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Results

Classification					Representative Case Study				Case Study Results			
Climate Zone	Village size	# IPS	HV feeder length	NHE Risk Type	Village dwellings	Required IPS	Feeder length main grid to village	Feeder length incl. spurs to IPS sites	NPV without Resilience	Base - NPV with Resilience	Climate change - NPV with Resilience	# Similar Towns
Southern	Small	Low	Medium	Bushfire	50	3	38	40	$-1.4m	$1.7m	$3.1m	26
Southern	Small	Low	Long	Bushfire	44	82	68	117	$-3.4m	$5.7m	$9.5m	5
Southern	Small	Medium	Short	Bushfire	37	138	12	97	$-9.8m	$-1.9m	$1.2m	14
Southern	Small	Medium	Medium	Bushfire	71	197	29	141	$-15.2m	$-1.7m	$3.7m	4
Southern	Small	High	Short	Bushfire	45	251	22	136	$-18.8m	$-3.1m	$3.3m	11
Southern	Medium	Low	Long	Bushfire	89	4	57	57	$-3.4m	$0.8m	$2.6m	5
Southern	Large	Low	Long	Bushfire	174	79	70	129	$-12.5m	$-2.6m	$1.2m	10
Southern	Large	Medium	Long	Bushfire	114	161	54	147	$-14.6m	$-1.0m	$4.5m	11
Central	Small	Low	Medium	Bushfire	34	62	29	75	$-3.5m	$2.5m	$5.0m	18
Central	Small	Medium	Short	Bushfire	45	179	19	112	$-13.3m	$-2.5m	$2.0m	21
Central	Small	Medium	Medium	Bushfire	44	141	29	134	$-7.9m	$2.3m	$6.3m	15
Central	Medium	Medium	Short	Bushfire	91	185	25	123	$-16.7m	$-4.4m	$0.5m	4
Central	Large	Medium	Long	Bushfire	111	103	84	160	$-7.4m	$7.3m	$13.3m	11
Central	Small	Low	Medium	Bushfire	42	75	46	102	$-3.4m	$3.7m	$6.5m	5
Central	Small	Medium	Medium	Bushfire	67	120	30	116	$-8.7m	$0.2m	$3.8m	10
Central	Large	Medium	Medium	Bushfire	151	142	42	148	$-15.0m	$-2.9m	$1.7m	10
Central	Small	Low	Short	Bushfire	14	55	8	48	$-3.1m	$1.3m	$3.3m	9
Northern	Small			Cyclone	41	156	129	244	$-1.1m	$3.1m	$3.6m	3

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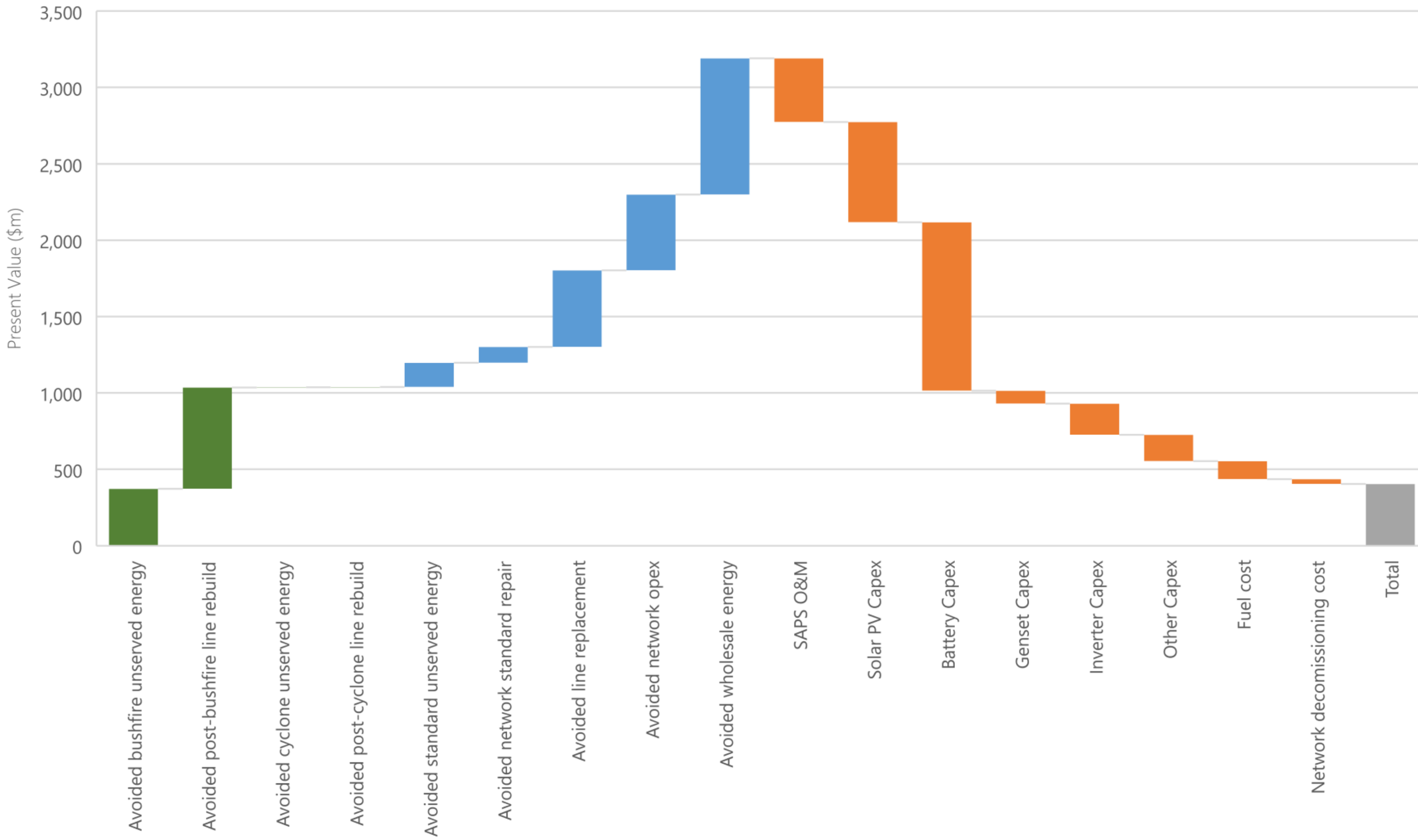
Results



Note: Base case, positive NPV locations only

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Net Present Value ($M)

	Baseline (current climate)	Changed climate (50% ↑ in bushfire freq) (400% ↑ in cyclone freq)
VCR (50% ↑)	$580M	$1,500M
VCR (standard)	$382M	$980M

Customers (w resilience benefits)

	Baseline (current climate)	Changed climate (50% ↑ in bushfire freq) (400% ↑ in cyclone freq)
VCR (50% ↑)	26k	48k
VCR (standard)	17k	35K

Capex ($B)

	Baseline (current climate)	Changed climate (50% ↑ in bushfire freq) (400% ↑ in cyclone freq)
VCR (50% ↑)	$2.0B	$3.7B
VCR (standard)	$1.3B	$2.7B

Communities (w resilience benefits)

	Baseline (current climate)	Changed climate (50% ↑ in bushfire freq) (400% ↑ in cyclone freq)
VCR (50% ↑)	149	244
VCR (standard)	109	192

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Conclusions

1. There appears to be large net economic benefits of between $382M and $1.5B in transitioning small towns in bushfire prone regions to SAPS
2. For the vast majority of these towns, the business case is not favourable, unless resilience benefits are taken into account
3. Deploying resilience-based SAPS across the NEM would likely reduce overall network costs (and consumer bills) by:
    1. Reducing network opex associated with repairing and maintaining rural feeders
    2. Reducing the size and potential for cost-pass through applications
4. The large capital component would be provided by the private sector (under the AEMC's proposed SAPS framework)

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1. Lack of access to comprehensive network asset maps (zone substation data from AREMI is patchy and no information of LV assets):
   - HV feeder to town is based on distance to nearest town that is larger to the town itself, or town with other 1,000 dwellings, or nearest zone substation
   - HV feeder length to IPS is assumption based (depends on density of area)
   - Limited ability to assess whether network decommissioning will impact other towns
2. Land use data could be incorporated to better reflect forested areas and natural hazard event risk (land use data tends to be state based and uses different categorisation)
3. No consideration of commercial premises in townships (unlikely to be comprehensive data sets, would require manual process or assumption based process)
4. Only currently considering high risk areas, could be expanded to lower risk areas where additional benefits may be realised (especially under climate change scenarios).
5. There may be practical constraints associated with individual towns that require some ground-truthing (e.g existing network assets)
6. Case study approach assumes representativeness

We are proposing to undertake a Stage 2 which would seek to address the above limitations, enabling us to provide more certainty around the potential communities to be targeted.

Other resilience measures

Measure		Resilience benefits: Avoided fire starts by network	Reduced outage duration	Reduced outage frequency	Indicative cost	Likelihood CBA > 0
Underground network	Replacement of overhead cables with underground cables to minimise contact with vegetation and exposure to weather events	✓		✓	Very high Due to high cost materials and civil works especially in built-up areas	Low Likely only where there is very high frequency of weather events and/or greenfield
De-energisation	Disconnection of sections of network in bushfire prone areas to avoid network initiated fires on high-risk days. Potential for combining with islandable temporary SAPS	✓			High Value of unserved energy to consumers and/or additional high cost SAPS assets	Medium Already implemented by some networks (but without SAPS) in very high bushfire risk areas
Redundancy	Construction of a second (or third) system that has essentially equal performance to the primary system in case the latter fails, ensuring geographic diversity of systems		✓	✓	Very high As expensive (if not more) than the primary system as new land and easements are needed to build the network	Low Except in greenfield where redundancy is required in any case
Auto-reclosers	Installation of auto-reclosers (HV electric switches) on the network so that minor network trips do not necessarily lead to outages	✓	✓		Low Equipment cost is low and roll-out can be targeted to areas where reclosers are most effective	High Already implemented by some networks in bushfire risk areas
Fault Location Isolation & Supply Restoration (Automation)	Install technology that determines the location of network faults and recommends (or issues) controls of switching devices to isolate faulted network and restore power		✓		Low Achieved through existing or upgraded network ADMS and deployment of controllable switching on network	High Some networks are currently implementing or considering (but largely for STPIS purposes, rather than resilience)

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Other resilience measures

Measure		Resilience benefits: Avoided fire starts by network	Resilience benefits: Reduced outage duration	Resilience benefits: Reduced outage frequency	Indicative cost	Likelihood CBA > 0
Back-up generation	Procurement of a fleet of mobile generation which may be deployed at any given location after or before a natural hazard event and/or permanently establishing back-up generation at high risk locations		✓	✓	Medium Investment for widespread back-up generation is high but roll-out can be targeted to areas where back-up is most effective	Medium Already implemented by some networks with extensive bushfire risk areas
Islandable SAPS	Provision of generation and/or storage assets to enable customers to temporarily be disconnected from the grid before or following a natural hazard event	✓	✓	✓	Medium Lower cost than a permanent SAPS if sized to meet reduced emergency level of demand	Low Network benefits of SAPS are not able to be realised due to line having to be maintained
Vehicle to Grid (V2G)	Enable electric vehicles to provide for supply either to individual customers or as part of an islandable SAPS		✓	✓	Medium Potentially low cost where V2G is already enabled. Likely to be complexity in arrangements where part of larger SAPS	High Likely to be high potential net benefits where V2G already in place
Demand response mechanisms	Utilisation of demand response to reduce the demand to be met by an islandable SAPS during temporary disconnection. May also be used as part of a permanent SAPS solution to reduce cost of overall solution		✓	✓	Low Low cost where there is consumer acceptance	Very High Very high net benefit when compared to SAPS without DR

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Appendix

NPV model

1. Modelling period: 50 years
2. WACC: 2.80%

Town attributes

1. Bushfire high risk zone: SGS Economics and Planning and IAG - Natural Perils Risks (Medium, High, Very High)
2. Cyclone high risk zone (Y/N): SGS Economics and Planning and IAG - Natural Perils Risks (Very High, Extreme)
3. Number of dwellings: Based on ABS 2074.0 - Census of Population and Housing: Mesh Block Counts, Australia, 2016
4. Number of IPS: Individual customers assigned to townships based on ABS 2074.0 - Census of Population and Housing: Mesh Block Counts, Australia, 2016, where mesh block type is primary production

Network asset attributes

1. Remaining life: 20 years
2. Reliability: HV outages of 2.61 min/km/year
3. Length of feeder able to be decommissioned (to town): Calculated based on distance between town and nearest zone substation and/or nearest town (as the crow flies) larger than itself
4. Total length of feeders able to be decommissioned (to IPS): Calculated based on estimated average metres per rural customer, adjusted for area (in sq km) per rural dwelling.
5. Length of feeder that traverses forested area: Assumed 70% for bushfire areas (for purposes of preparing scatter plots), then adjusted manually for individually case studies based on inspection.

Assumptions and data sources

Network costs

1. Avoided standard O&M: 3% of build cost
2. Avoided standard outages: $2,000 per fault
3. Avoided rebuild costs: $65,000/km

Wholesale Costs

1. Wholesale electricity price: $80/MWh

Natural hazard event attributes

1. Annual probability of bushfire (current): 3% (medium risk area), 3.5% (high risk area), 4% (very high risk area)
2. Plausible probability of bushfire in very high risk area (with 2 degrees warming): 6% chance per annum
3. Probability of severe cyclone (current): 0.2% per annum
4. Plausible probability of severe cyclone (with 2 degrees warming): 0.9% per annum
5. Outage duration per natural hazard event: 12 days
6. Value of customer reliability during natural hazard event: $21.43/kWh

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Assumptions and data sources

SAPS costs

1. Solar cost: $1,500/kW (2020)
2. Solar cost trajectory: $1,020/kW (2045)
3. Solar replacement period: 25 years
4. Battery cost: $1,500/kWh (2020)
5. Battery cost trajectory: $357/kWh (2035)
6. Battery replacement period: 15 years
7. Inverter cost: $1,200/kW (2020)
8. Inverter cost trajectory: $816/kW (2035)
9. Inverter replacement period: 15 years
10. Diesel genset cost: $250/kW (2020)
11. Diesel genset cost trajectory: $200/kW (2045)
12. Diesel genset replacement period: 25 years
13. Diesel fuel cost: $1.31/L
14. Other O&M: 3% of capital cost per annum
15. Other costs town SAPS: $2,000/kW of peak demand
16. Fixed costs IPS: $10,000

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