SμRF

SouthCoast Microgrid Reliability Feasibility

SuRF Project

Aim: How might microgrids contribute to a better energy future for the Eurobodalla and regional Australia?

SHASA
Southcoast Health and Sustainability Alliance

Australian National University

Battery Storage and Grid Integration Program
An initiative of The Australian National University

essential energy

zepben

December 2021 – project kick off

Project activities

April 2024 – project ends

Agenda

Part 1 Background

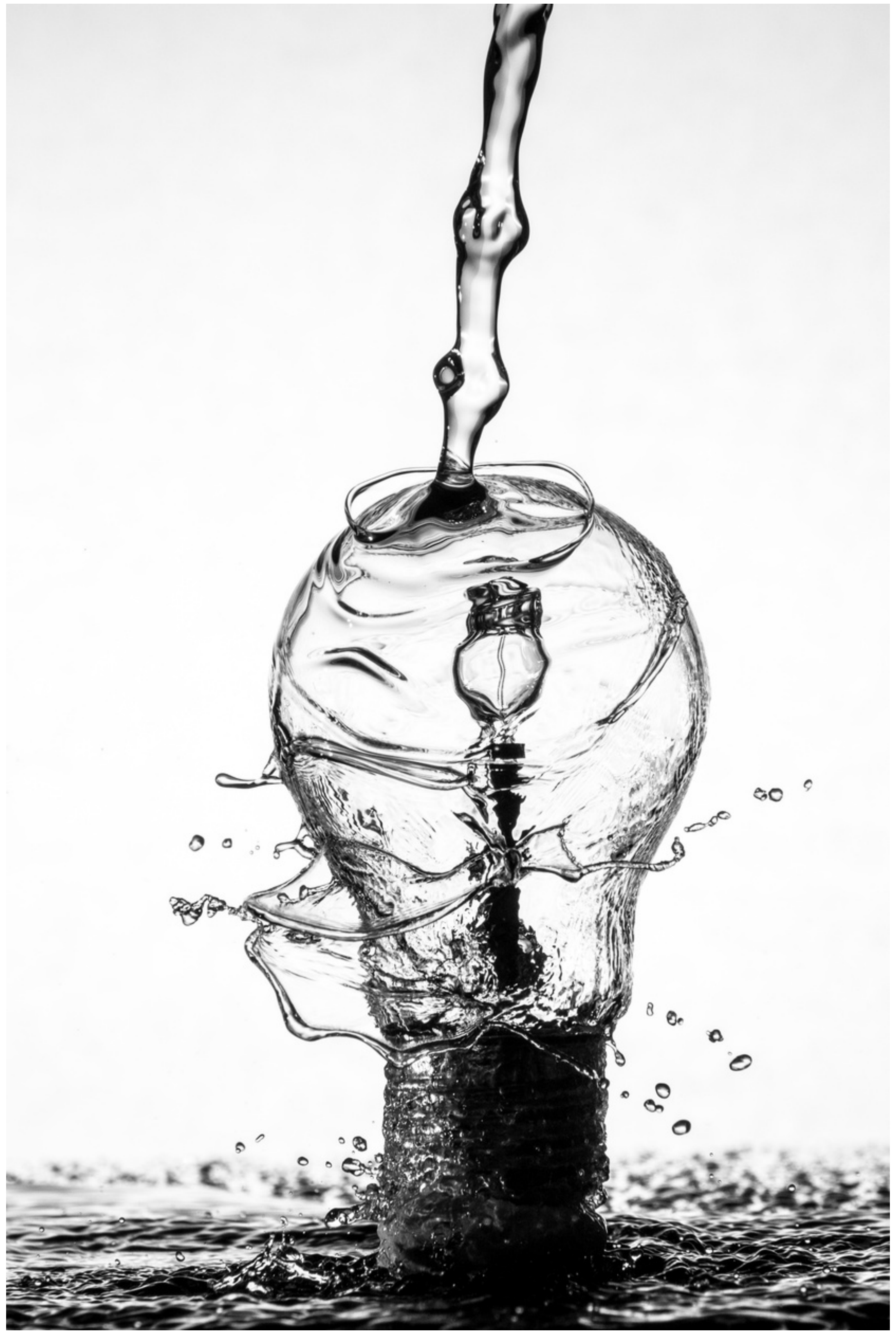
1. Your electricity supply and resilience- Essential Energy – Q&A
2. Microgrids – ANU - Q&A

Break – 10 minutes

Part 2 Discussion of local context

1. Process to date
2. Conceptual microgrid designs for your community (Matt, ITP)
3. Discussion

SμRF



Part 1

Background information

Southcoast µ-grid Reliability Feasibility (SµRF) project

Essential Energy

May – July 2023

One of Australia’s largest distribution networks

1.4M
power poles

163,417km
of powerlines in designated bushfire zones

364
zone substations and 139,303 distribution substations

3,000
employees approximately

115
apprentices working – recruiting for 95 more in 2022–23

95
depots

95%
of NSW and parts of southern Queensland

183,099 km
of overhead powerlines

4.75
customers per km of powerline – the lowest customer density in the National Electricity Market

36.8 years
average age of network assets

1, 209
heavy vehicles

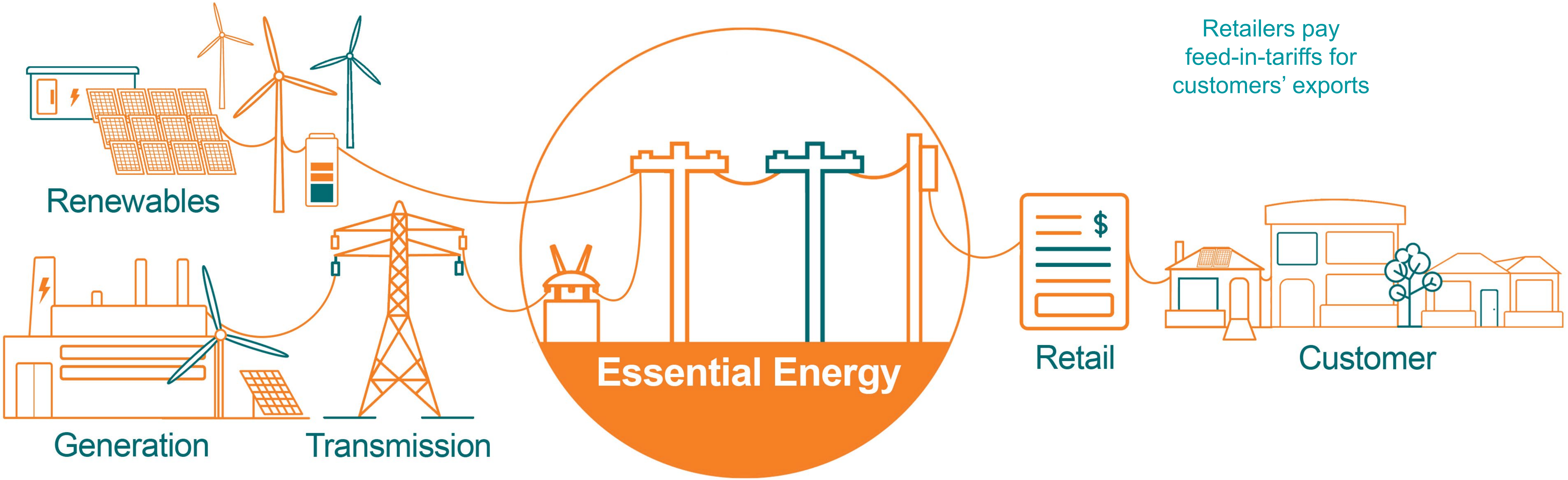
2,548
light vehicles

168
radio towers

>870,000
electricity customers

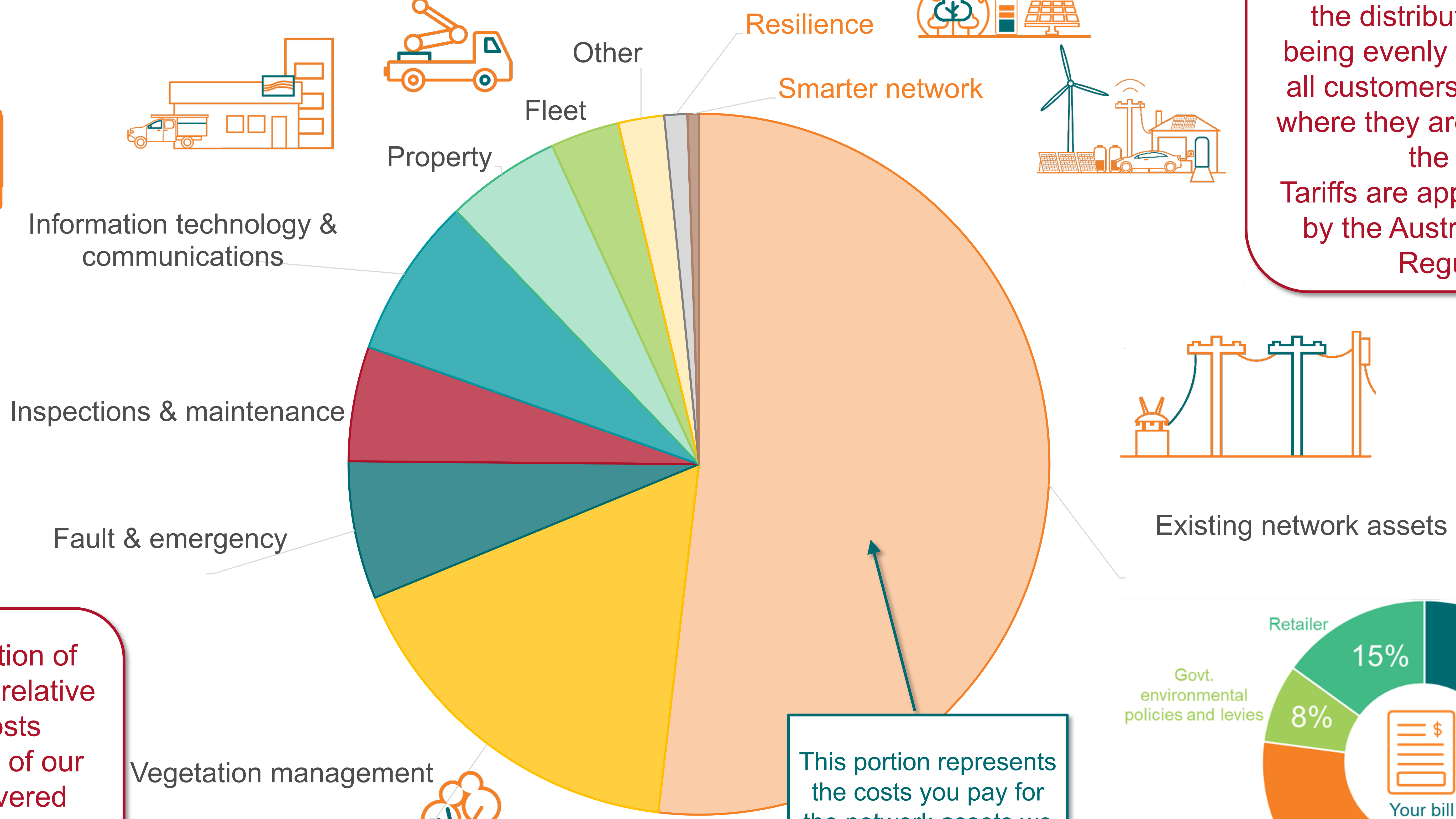
364
zone substations and 139,303 distribution substations

The electricity supply chain



GENERATION	TRANSMISSION	DISTRIBUTION	RETAILER	GOVT. ENVIRONMENTAL POLICIES & LEVIES
32% of your bill Generate electricity	**8% of your bill** Carry power efficiently over long distances at a high voltage	**37% of your bill** Transports power at lower voltages to homes and businesses	**15% of your bill** Package all components into retail products and provide your electricity bill	**8% of your bill**

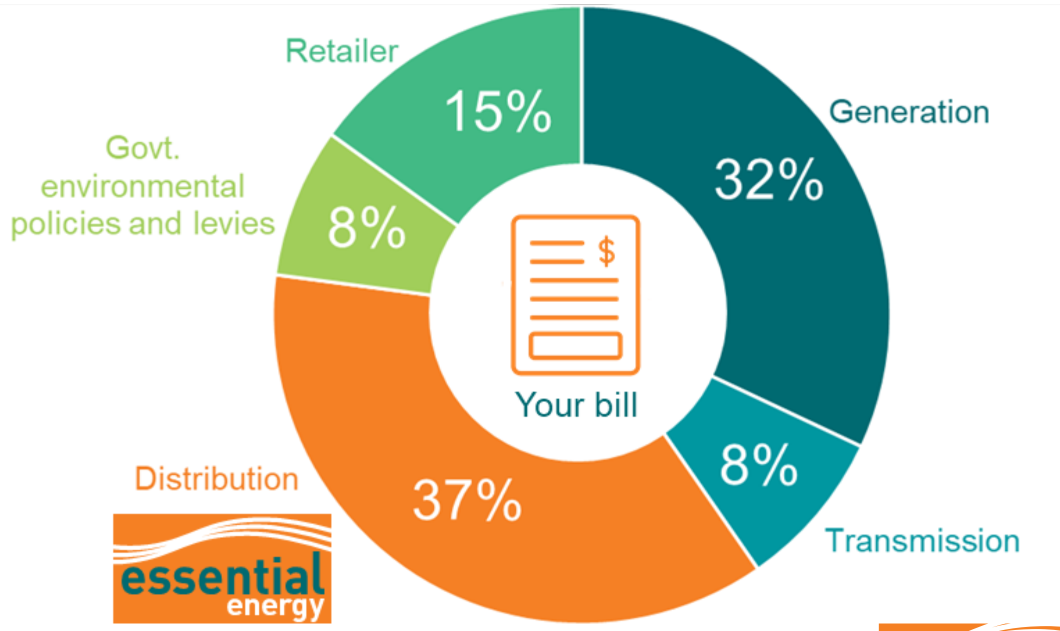
Our network costs



Postage Stamp pricing refers to the cost of running the distribution network being evenly shared across all customers regardless of where they are connected to the grid.
Tariffs are approved and set by the Australian Energy Regulator

This portion represents the costs you pay for the network assets we have already built

But the fixed portion of our tariffs is small relative to our fixed costs
This means most of our revenue is recovered through consumption charges



Three key factors shape how we invest on the Network

VALUE

How much value does the project bring to customers?

By how much do the benefits outweigh the costs?
What is the 'best bang for buck'?

SERVICE

How is the project adding to our customers' experience?

The higher the service outcome the better

RISK

What level of risk will the project alleviate?

The higher the risk alleviation the better

DECISION

The risks we currently consider

Projects include things like replacing a pole, upgrading a substation or restringing wires

The project will reduce the risk of power interruptions

The project will reduce the risk of a negative customer experience

The project will reduce safety risks for the public, contractors or staff

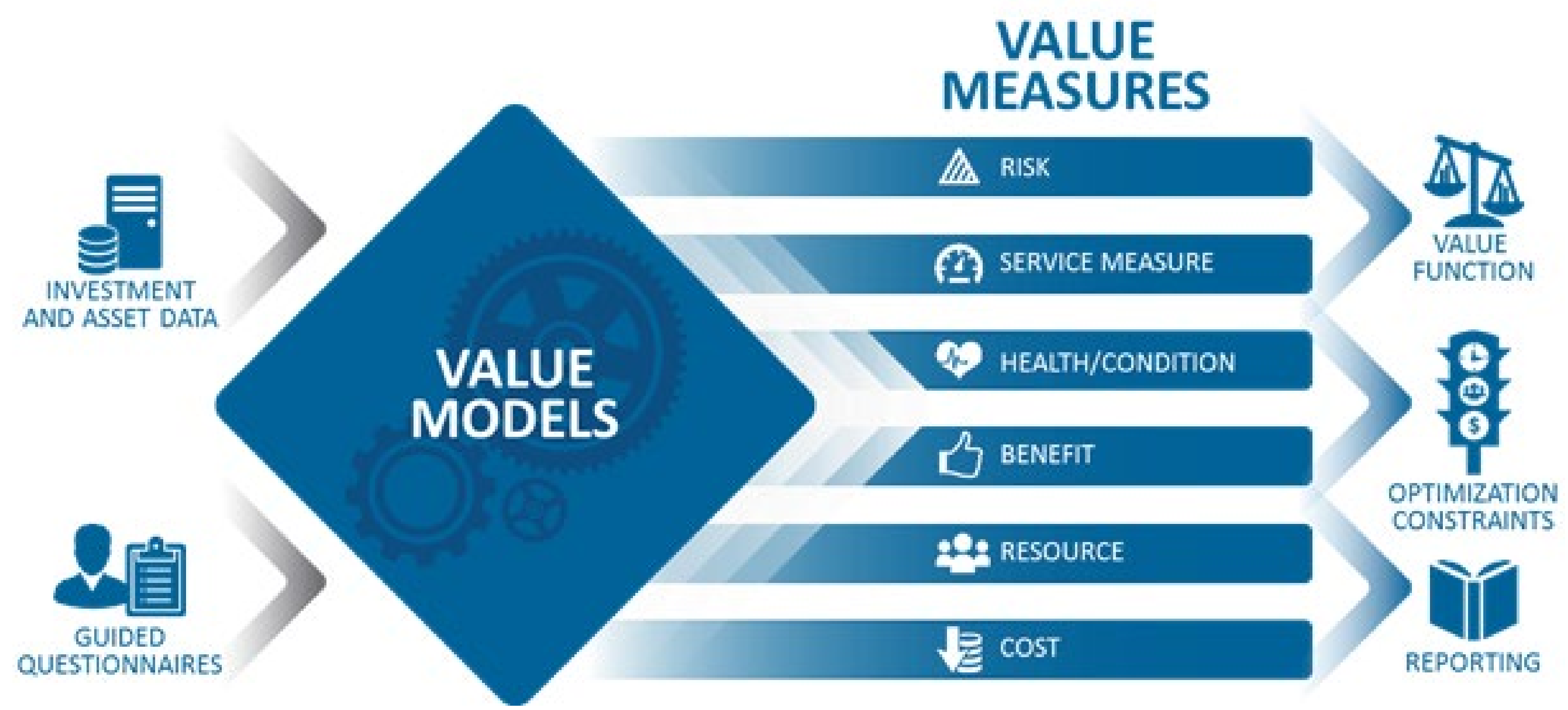
The project will reduce the likelihood of network initiated fires

The project will reduce risks to the biological or physical environment or heritage items

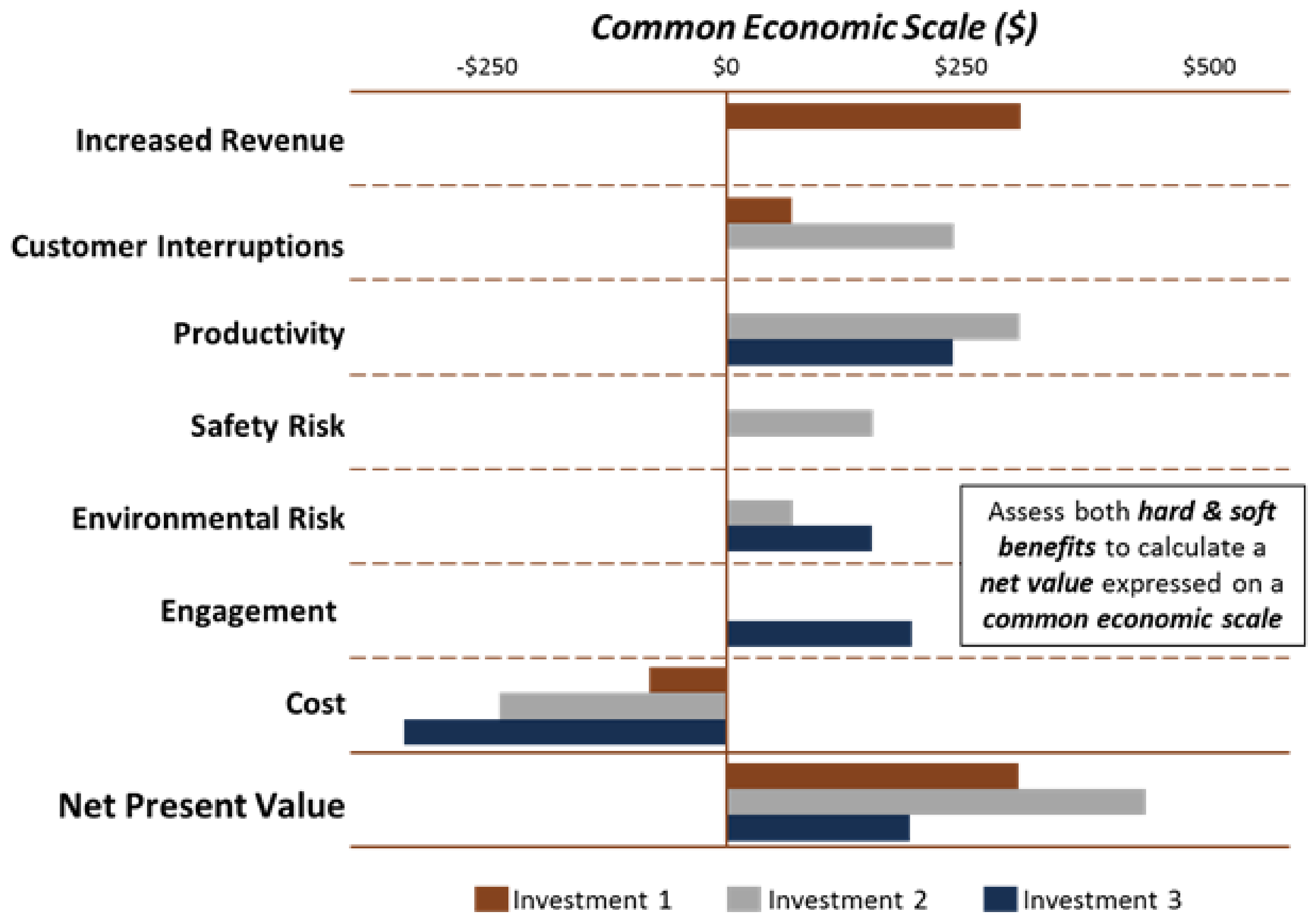
Decision Making in Practice

The Value-based Decision Making approach can be simplified into two primary activities:

- Develop a unique Value Framework that captures the organization`s key value measures, financial parameters and risk matrix, and are aligned with the overall organizational goals;
- Use this Framework in order to evaluate and optimize potential investments.



Evaluate Investments On A Common Economic Scale



Bushfire Preparedness

PRE-SUMMER BUSHFIRE INSPECTIONS
Identify and rectify network defects and vegetation intrusions that have the potential to initiate a fire in high bushfire risk areas.

LiDAR VEGETATION CLEARANCE INSPECTIONS
Identifies existing and future vegetation intrusions into the vegetation clearance envelope.

NETWORK STABILITY MANAGEMENT
Participation in AEMO/TransGrid co-ordinated load shedding events that affect NSW due to loss of generation reserve

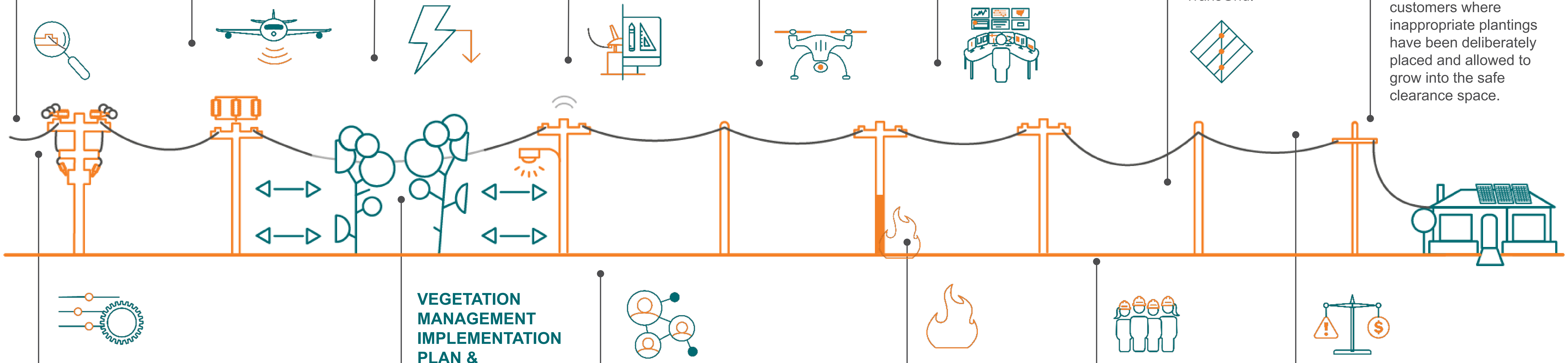
NETWORK PLANNING AND DESIGN
Consideration of covered conductor in P1 bushfire risk areas, and specific design parameters for bare overhead lines in P1 bushfire risk locations.

DRONE PHOTOGRAPHY
Provides the basis for detailed inspection of pole top and other overhead components including those that have the potential to initiate a bushfire.

SYSTEM OPERATIONS AND FIELD PROTOCOLS ON TOTAL FIRE BAN DAYS
Total fire ban day protocols restrict operations on the network and in the field to minimise the possibility of initiating a fire.

INCREASED COMMUNICATIONS RESILIENCE BETWEEN SYSTEM OPERATIONS AND TRANSGRID
Alternative links are in place between system control rooms and TransGrid.

INSPECTIONS ON PRIVATE LINES
Private lines are inspected and directions issued to land owners to ensure maintenance on defective assets is performed. Costs associated with vegetation management may also be passed on to customers where inappropriate plantings have been deliberately placed and allowed to grow into the safe clearance space.



RECLOSER PROTECTION MECHANISMS
Distribution Protection Guidelines have been updated to establish a dedicated setting group in the recloser to be enabled during declared Total Fire Ban days. This setting group has reduced grading margins with downstream protection to give faster fault clearance times to reduce the risk of a fault initiating a bushfire. “Auto reclose” of reclosers is also disabled on Total Fire Ban days.

VEGETATION MANAGEMENT IMPLEMENTATION PLAN & VEGETATION CLEARANCES
To achieve compliance with ISSC3 vegetation clearance guidelines in high priority areas (P1 areas), improve and maintain the vegetation clearance envelope.

INDUSTRY/EXTERNAL AGENCY ENGAGEMENT
Includes a wide range of stakeholders and forums including NSW RFS, TransGrid and AEMO, Energy and Utility Services Functional Area Coordinator (EUSFAC); Bushfire and Natural Hazards CRC, University of Melbourne, Wollongong University and CSIRO to develop understanding of bushfire risk across the network.

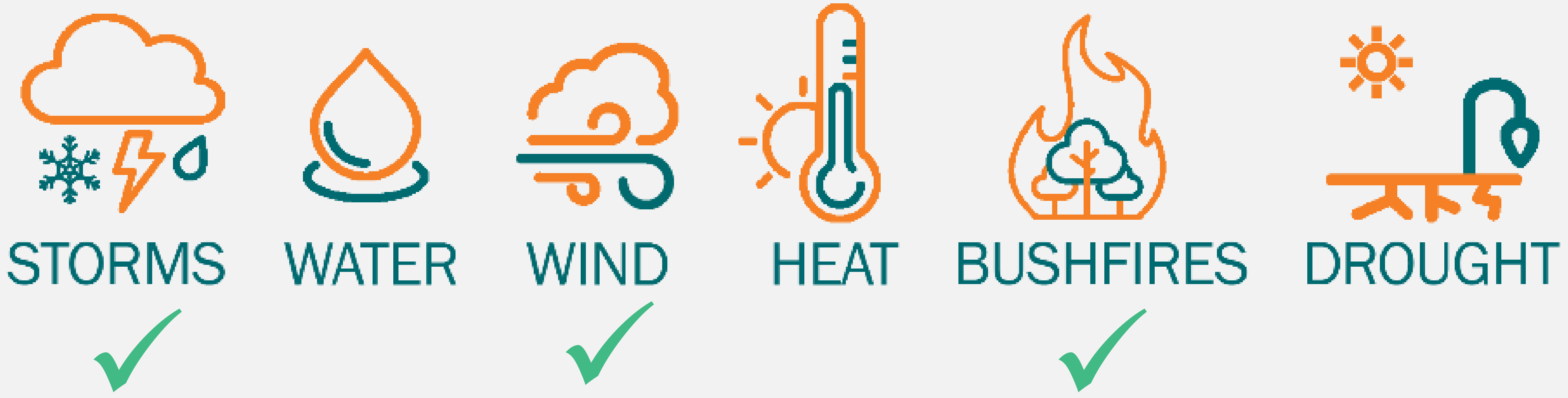
REVIEW AND INVESTIGATION OF FIRE STARTS ATTRIBUTED TO THE NETWORK
identify asset and human factors that contribute to network initiated fires and identify controls to correct them.

TARGETED STAFF TRAINING RELATING TO BUSHFIRE AND BLACK START PROTOCOLS
Staff knowledge is refreshed on the restrictions and governance required on total fire ban days and black start events.

ASSET RISK AND VALUATION FRAMEWORKS TO ASSESS NETWORK INVESTMENT PROGRAMS
Evaluation structure to determine the value delivered by investment programs when safety, reliability, fire start, reputational risk, environmental and financial consequences are considered

Resilience Programs Underway - Composite poles

- ☑ 2.5 times more expensive to buy, but 10% cheaper to install
- ☑ Light weight, multi-piece with pre-drilled holes
- ☑ Fireproof and immune to rot, termites and corrosion
- ☑ Longer life (70 years versus 50 years for wooden poles)
- ☑ Less expensive to maintain
- ☑ Made in Australia (Singleton and Toowoomba)
- ☑ Reusable if removed carefully and technology for recycling is evolving

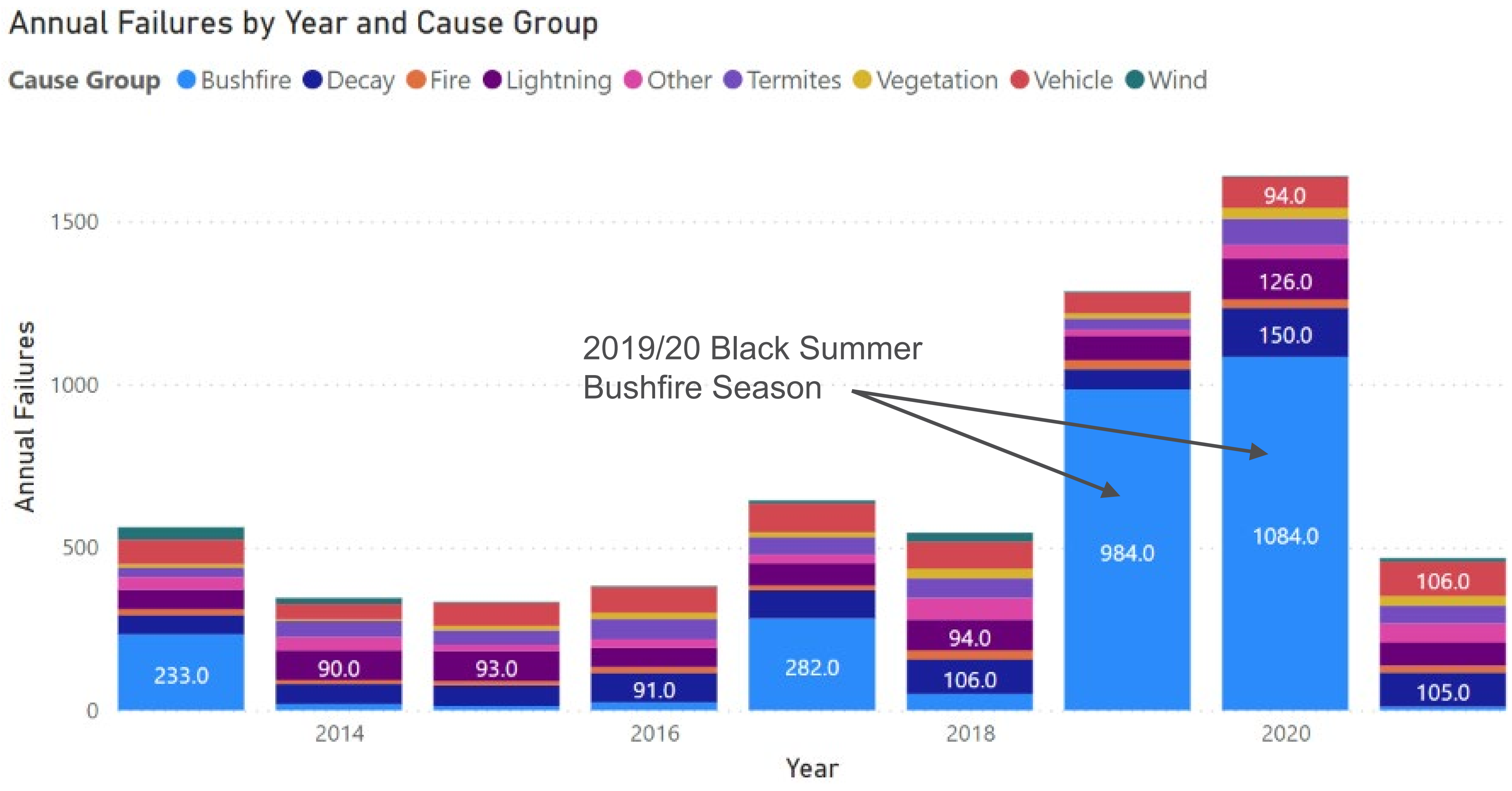


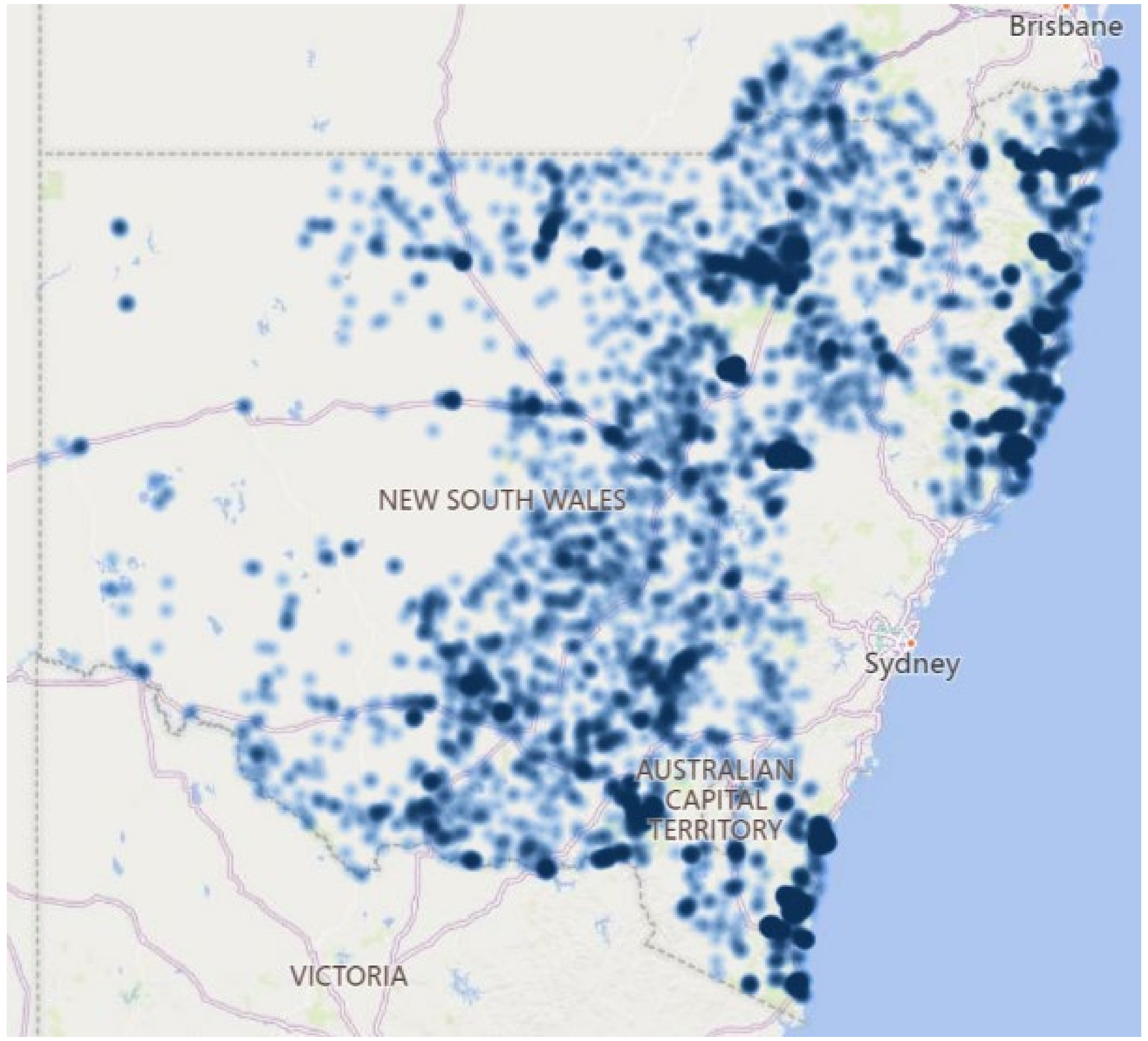
Reduced risk of failure and resistance to fire speeds up recovery efforts

Kosciusko National Park

Composite poles – Approach

- To quantify the benefit that composite poles give, the risk of EE's current timber pole fleet was first considered
- All functional pole failure data from 2013 – 2021 was studied
- Failures were grouped based on the main cause descriptions for pole failures
- Average of **689 pole failures p.a.**





Functional Pole Failure Geographic Distribution (2013 – 2021)

Undergrounding (New Program to Commence FY25)

Safety | Affordability | Reliability & Resilience | Good customer service and communication | Future focused

Key facts

- All new residential network additions are undergrounded
- Undergrounding costs 6 to 12 times more than overhead
- About 5% (10,000 km) of our network is underground
- Underground assets are inspected every 10 years (overhead 4 ½ years)

STORMS	WATER	WIND	HEAT	BUSHFIRES	DROUGHT
✓		✓	✓	✓	

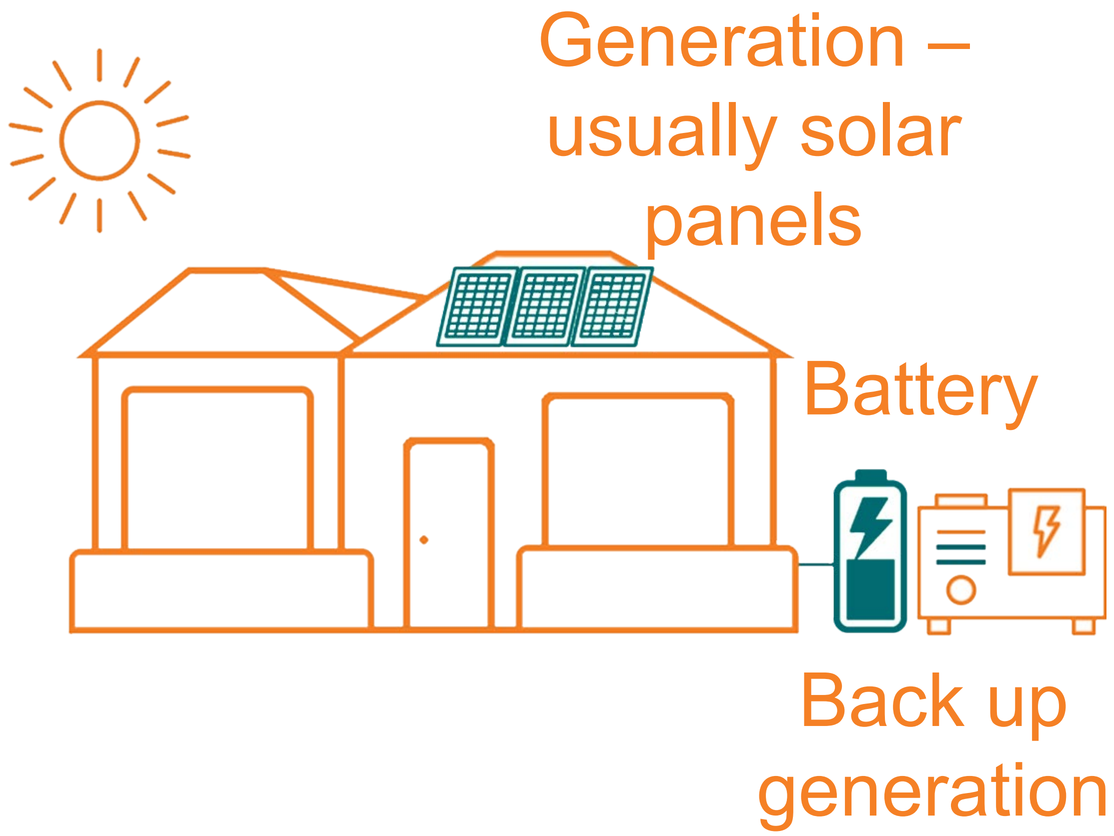
Underground networks resist some climate events by virtue of being buried underground

Alternative solutions – Stand-Alone Power Systems (SAPS)

Safety | Affordability | Reliability & Resilience | Good customer service and communication | Future focused

Key facts

- We have undertaken one longer term SAPS trial
- We trialled 12 SAPS to restore power for remote bushfire affected customers and critical infrastructure assets
- We've identified 1,200 sites where SAPS provide a better solution



- ☑ A solution for **hard to access and high cost-to-serve customers** currently connected to the network
- ☑ Serve one or just a handful of customers
- ☑ Improve reliability and resilience for the SAPS customer(s)
- ☑ Lower costs for all Essential Energy's customers
- ☑ Offer the same customer experience as being connected to the network

Stand-Alone Power Systems (SAPS) Example

SAPS Overview

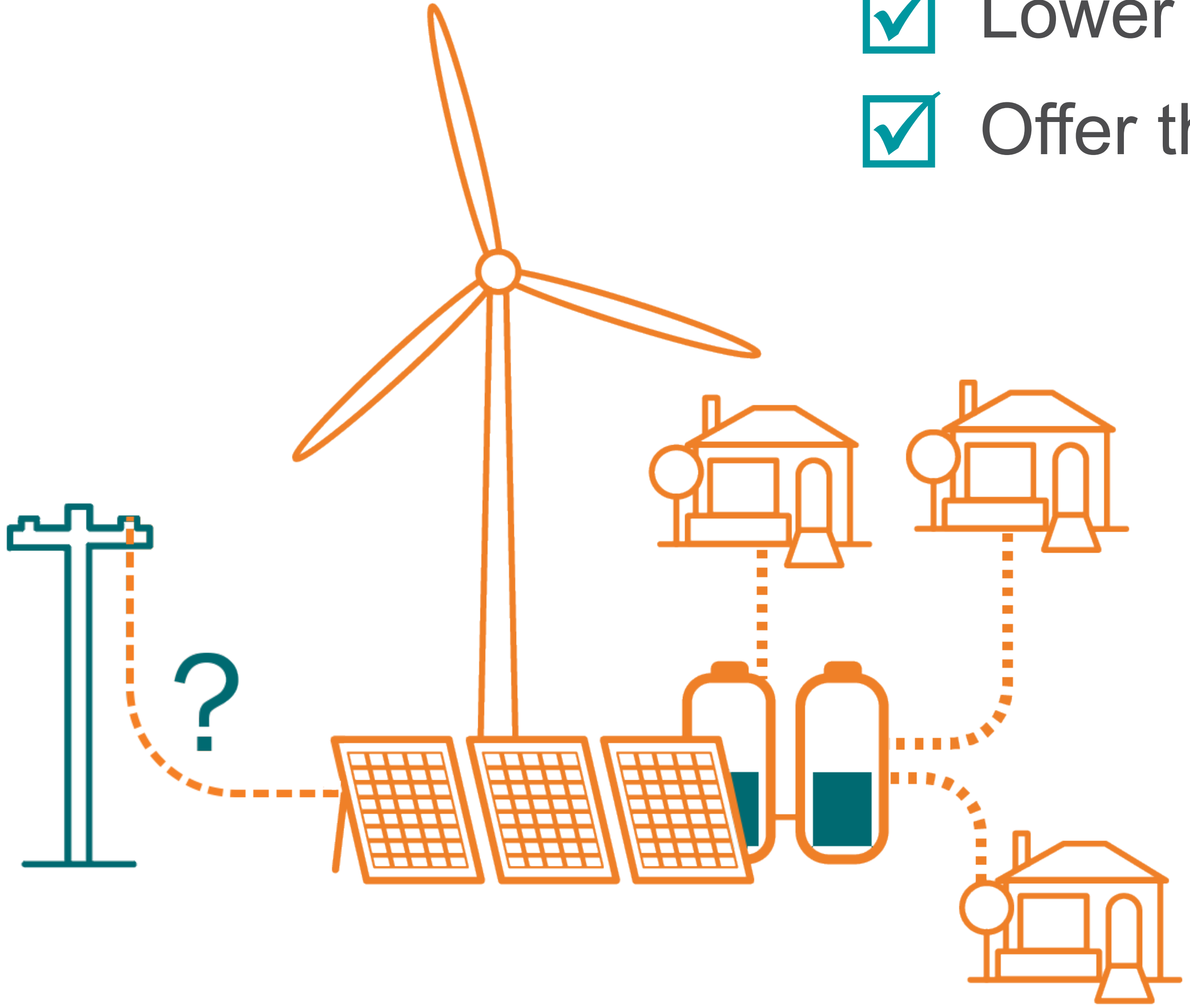
- ~ 0.5% of our customer base require around 17% of the length of the installed network
- Benefits of SAPS not limited to remote customers
  - Areas with high maintenance costs, like vegetation are also ideal SAPS candidates
  - High bushfire start risk
  - Difficult to access sites e.g. roads regularly washed out, flooded

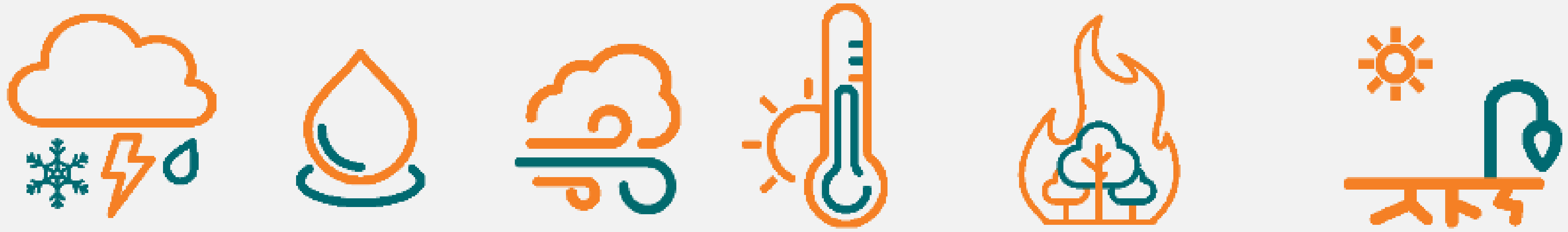
Why site was chosen for a SAPS

- 5.5km spur line traversing National Park and flood plains
- Very dense vegetation, P1 Bushfire Zone
- Multiple creek crossings
- Regular incidence of natural disasters
- Low consumption residential site

Alternative solutions – Microgrids

- ☑ A large SAPS that services a community of customers
- ☑ A solution **where remoteness creates reliability issues** for communities
- ☑ Improve reliability and resilience for the microgrid customers
- ☑ Lower costs for all Essential Energy's customers
- ☑ Offer the same customer experience as being connected to the network



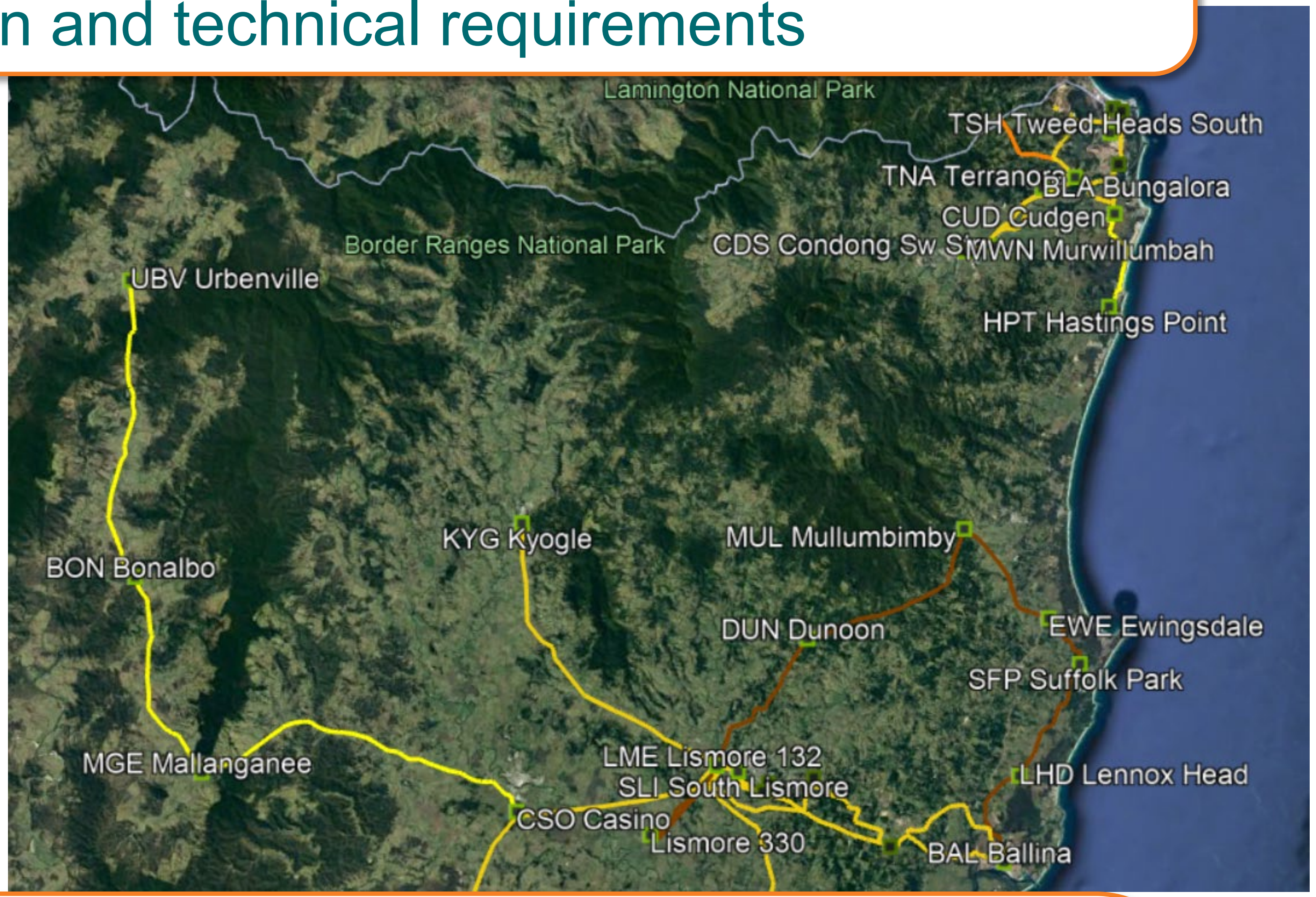


STORMS	WATER	WIND	HEAT	BUSHFIRES	DROUGHT
✓		✓	✓	✓	

Customers are less impacted by these elements as the impacts of being served by long sections of wires is removed

Microgrid Example

Islandable Microgrids are only suitable for a small segment of zone substations which meet location and technical requirements



Location Specific

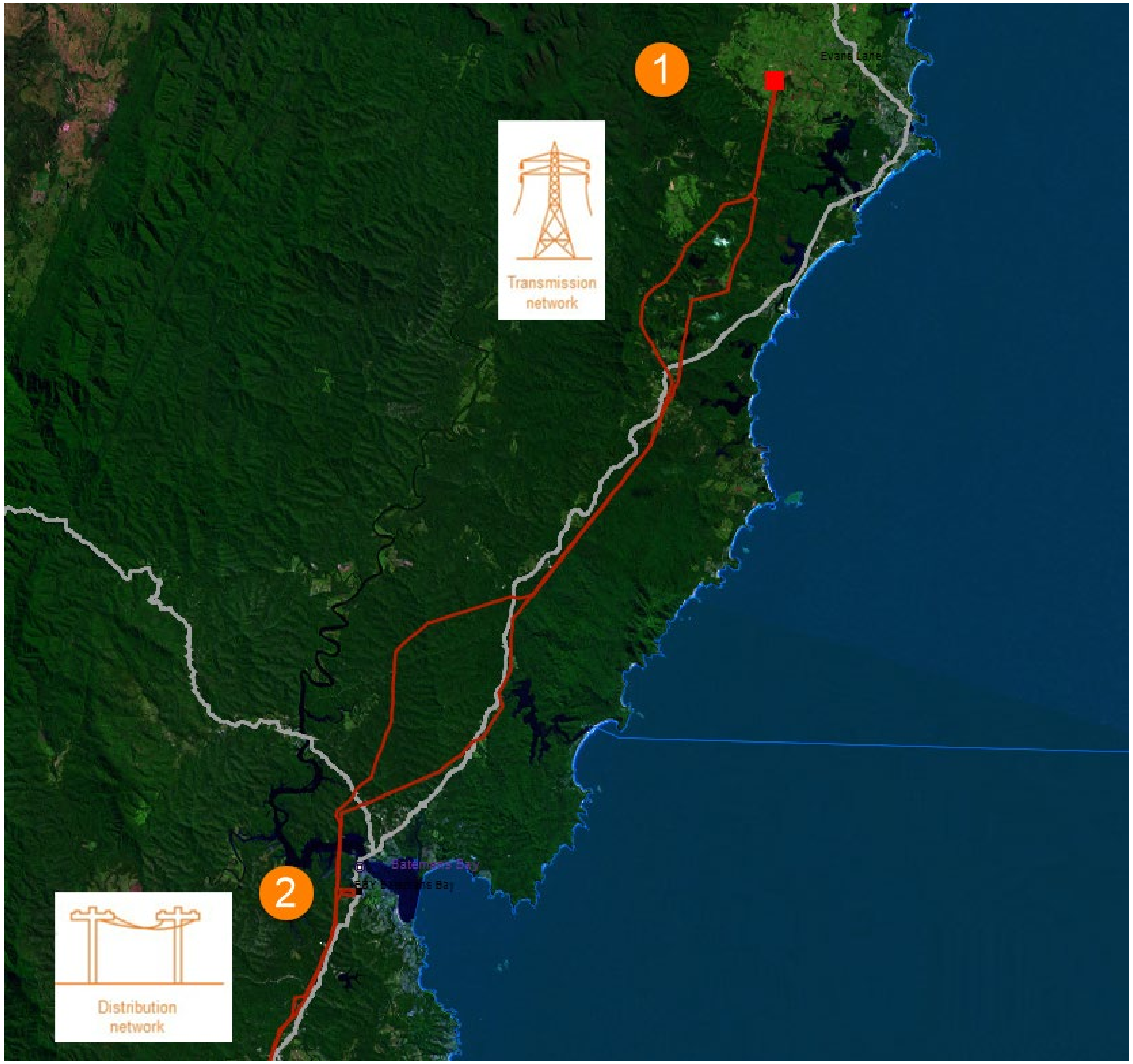
- To supply small electrical networks
- Installed at zone substations
- Zone subs are supplied by long radial lines
- Not suitable for interconnected grids
- Prioritise zone subs with poorer reliability and resilience

Technical Limitations

- Cost of batteries ~$1,000,000 per MWH
- Can only support low loads
- Have limited short duration capacity
- Requires diesel generators for support
- Significant protection and operating systems required

- Urbenville Zone Sub supplies 616 customers
- Long radial sub transmission network (>90km)
- Low load in the vicinity of 0.5MW
- Experienced poorer reliability due to length of line and vegetation impacts in difficult terrain

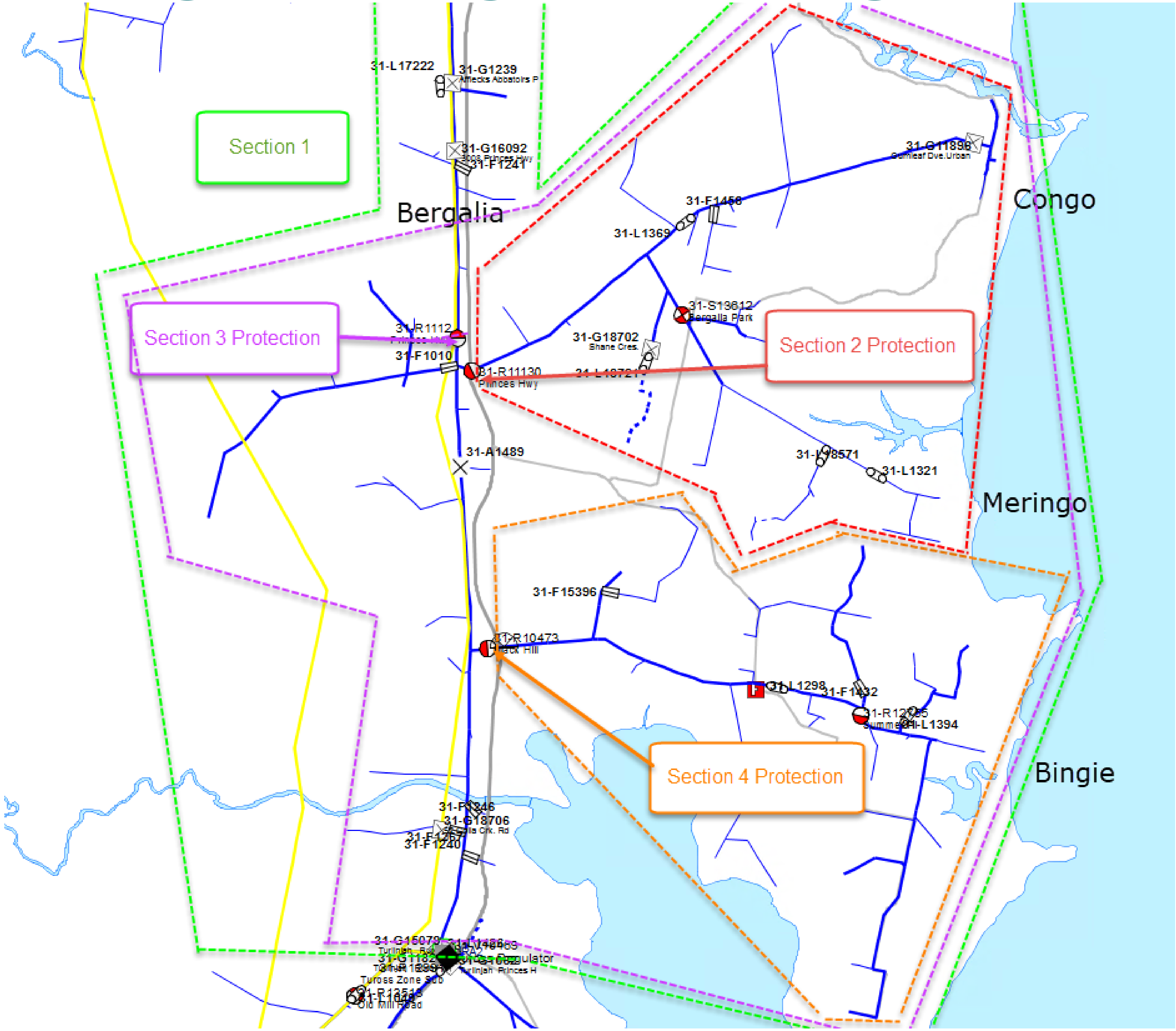
Eurobodalla Network



1. **Eurobodalla power supplied from Ulladulla**
   - North of Termeil operated and maintained by Endevour Energy
   - 2 Feeds – 1 into Bateman Bay & 1 into Moruya
   - 132K Volts
2. **Essential Energy Batemans Bay Zone Substation**
   - Essential Energy High Voltage distribution feeders supply local towns and communities
   - 33KV, 11KV and Low Voltage (400V/230V)

Batemans Bay	Moruya	Narooma
Mogo	Broulee	Congo
Malua Bay	Bodalla	Mystery Bay
Rosedale	Nerrigundah	Tilba Tilba
North Durras	South Durras	Nelligan
Tomakin	Potato Point	Dignams Creek

Congo / Bergalia / Bingie Network



HV protection overview

- Fed From Moruya Town Zone Substation
- Some areas of the network are capable of being backfed from Tuross Zone Sub

Section 4 Reliability

April 22 – April 23

Target SAIDI – **779 mins**
Target SAIFI – **4.86**

Measured SAIDI – **1 & 17 mins**
Measured SAIFI - **0.01 & 0.26**

Section 3 Reliability

April 22 – April 23

Target SAIDI – **779 mins**
Target SAIFI – **4.86**

Measured SAIDI – **-0 mins**
Measured SAIFI - **0**

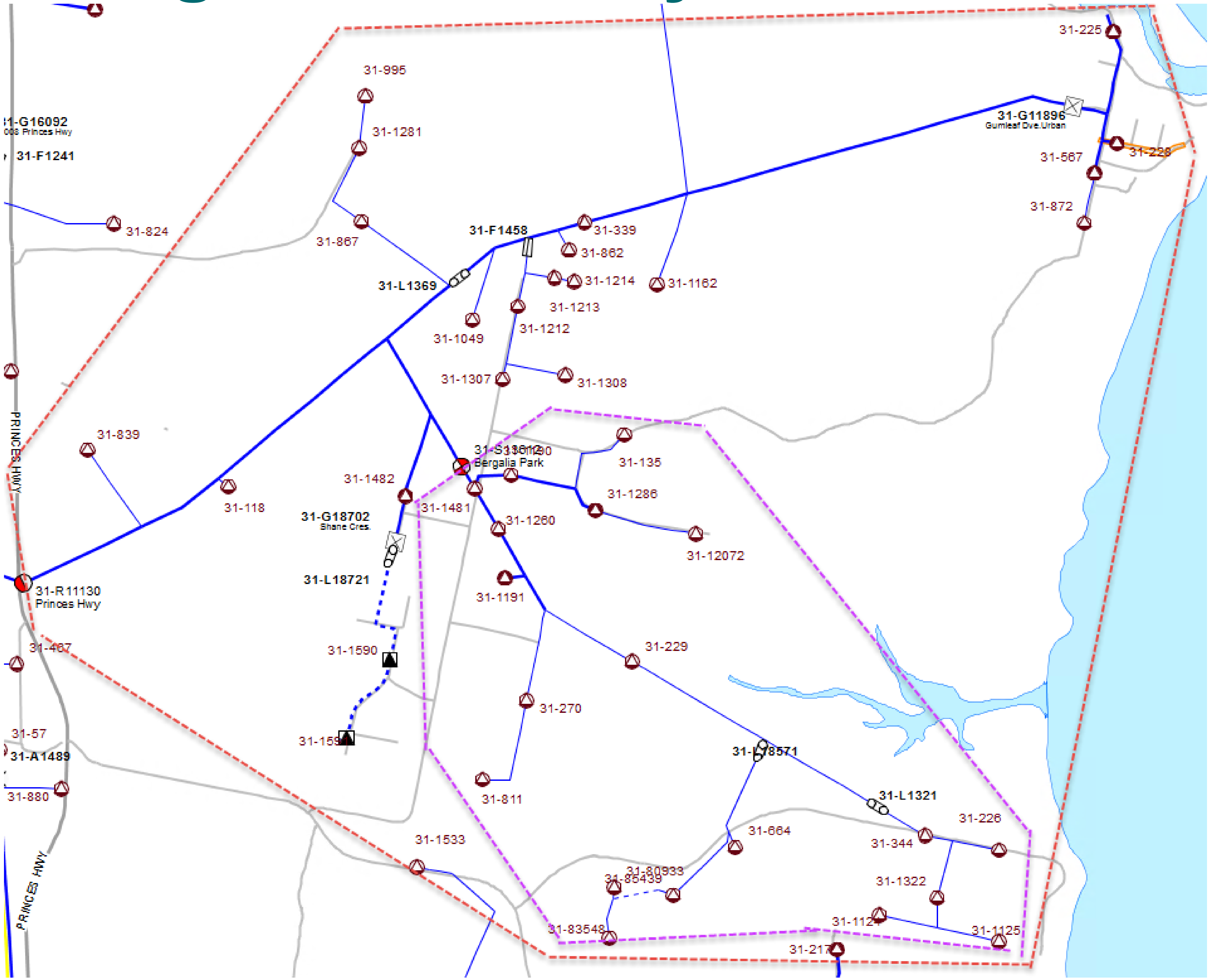
Section 1 Reliability

April 22 – April 23

Target SAIDI – **779 mins**
Target SAIFI – **4.86**

Measured SAIDI – 8 **mins**
Measured SAIFI - **0.3**

Congo Community Network



HV protection overview

- If there is a HV fault on the main line within the purple area a protection device may operate and isolate Bergalia Park and Meringo without isolating Congo.
- If there is a HV fault on the main line is upstream of the purple area Bergalia, Congo and Meringo will be isolated.
- If the protection device operates no back feed is available

Section 2 Reliability

April 22 – April 23

Target SAIDI – **779 mins**
Target SAIFI – **4.86**

Measured SAIDI – **1 mins**
Measured SAIFI - **0**

Section 3 Reliability

April 22 – April 23

Target SAIDI – **779 mins**
Target SAIFI – **4.86**

Measured SAIDI – **0 mins**
Measured SAIFI - **0**

Q&A

Outline

Australian National University

Battery Storage and Grid Integration Program

An initiative of The Australian National University

1. What are microgrids and where are they being used?

2. Why aren't they being used in the Eurobodalla?

3. How might they contribute to a better energy future for the Eurobodalla and regional Australia?

What is a Microgrid?

Australian National University

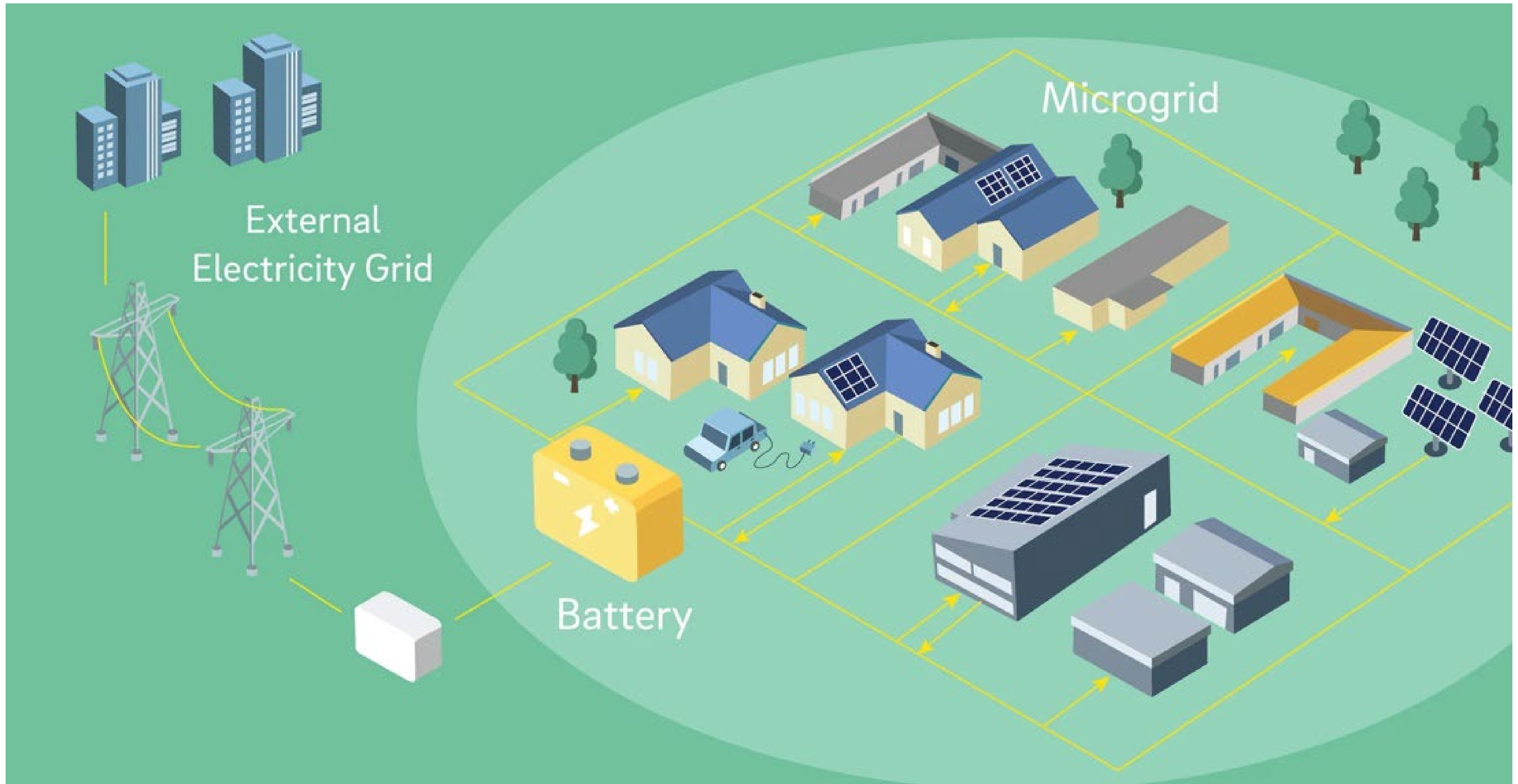
Battery Storage and Grid Integration Program

An initiative of *The Australian National University*

A relatively small, bounded electricity system that can run independently.

What is a Microgrid?

- A grid (connecting customers and electrical equipment)
- Electrical loads (appliances etc.)
- Generation sources (solar panels, wind turbines, diesel generators)
- Energy storage (batteries, pumped hydro)



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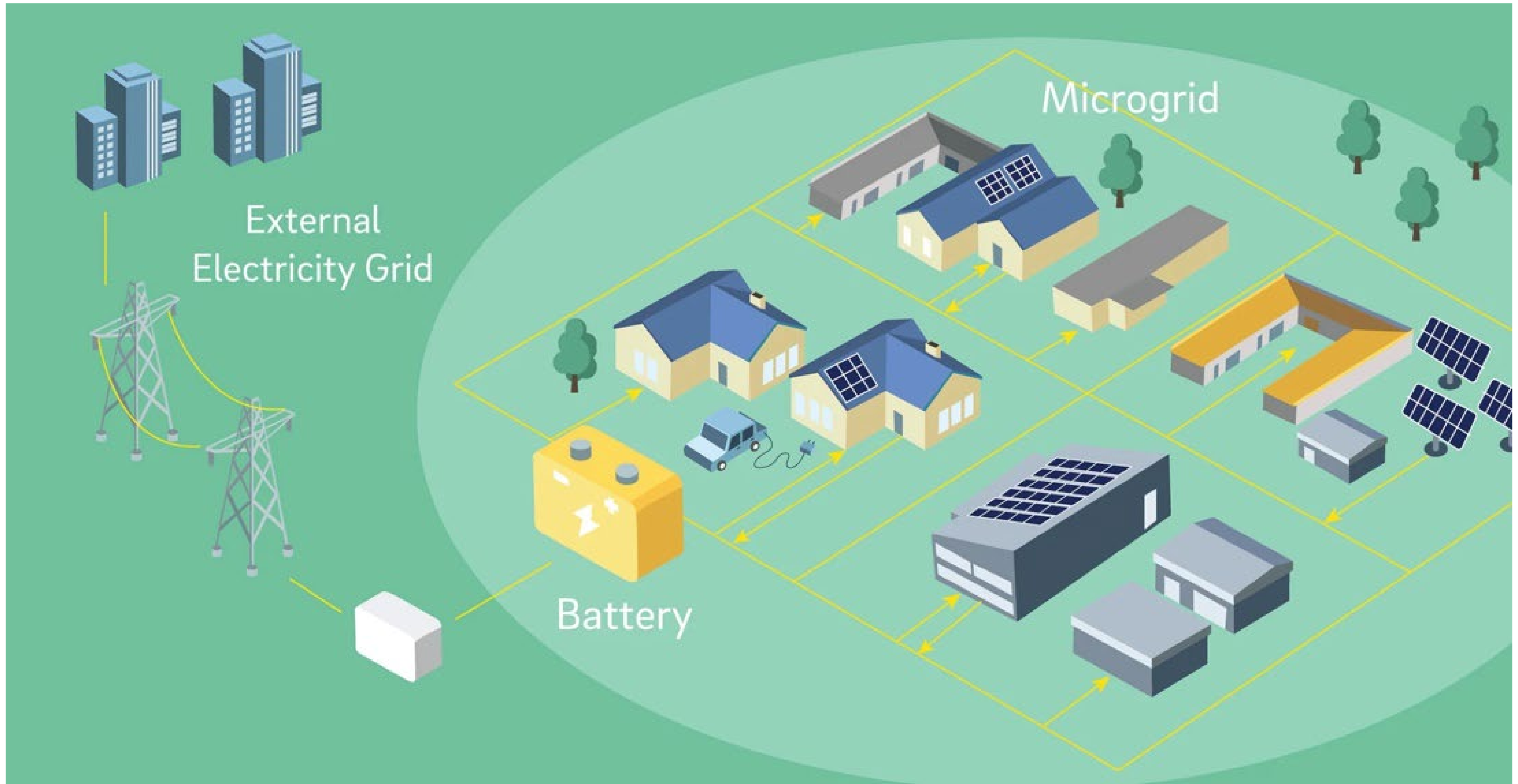
- **Control system** (to balance supply and demand)



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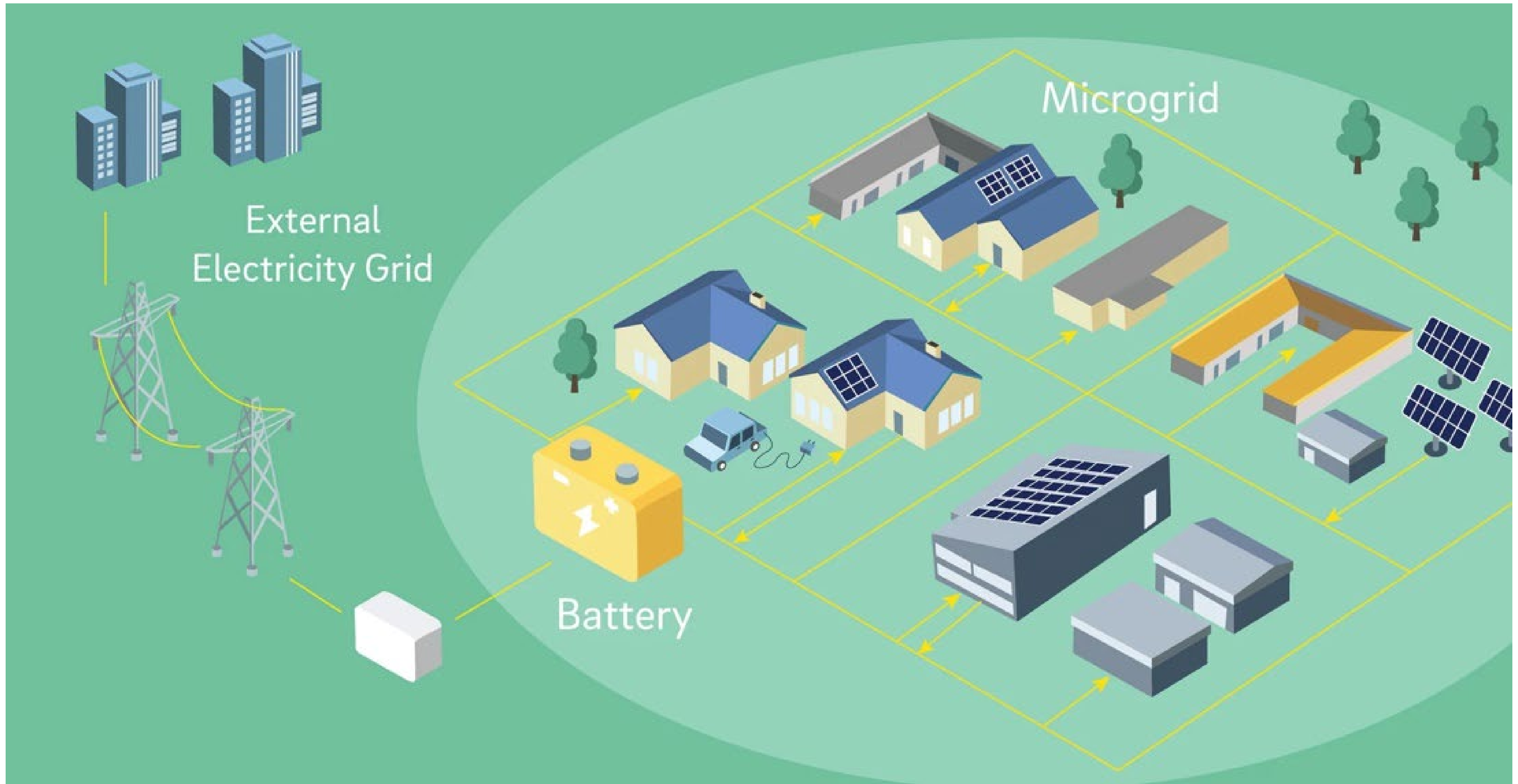
- **Control system** (to balance supply and demand)
- **Governance arrangement** (roles, rules and processes)



What is a Microgrid?

A relatively small, bounded electricity system that can run independently.

Much more involved & complex than a single asset, like a solar farm or battery.

Raises many governance issues of customer engagement & equity, business models, regulation.

Onslow (in northern WA)

Australian National University

Battery Storage and Grid Integration Program

An initiative of The Australian National University

- 850-person town has always been an islanded microgrid (run on gas) with an integrated state-owned utility

- In 2021 ran on 100% renewables for 80 minutes using solar (45% on roofs) and 1MW battery

Mooroolbark (in Melbourne)

- 18 households (14 with solar), one 10kWh battery (18 kW)
- Ran independently, on 100% solar and battery power, for 22hrs (AC used up battery)
- Trial conditions – did not consider business or governance issues

Outline

1. What are microgrids and where are they being used?

2. Why aren't they being used in the Eurobodalla?

3. How might they contribute to a better energy future for the Eurobodalla and regional Australia?

The barriers to microgrids

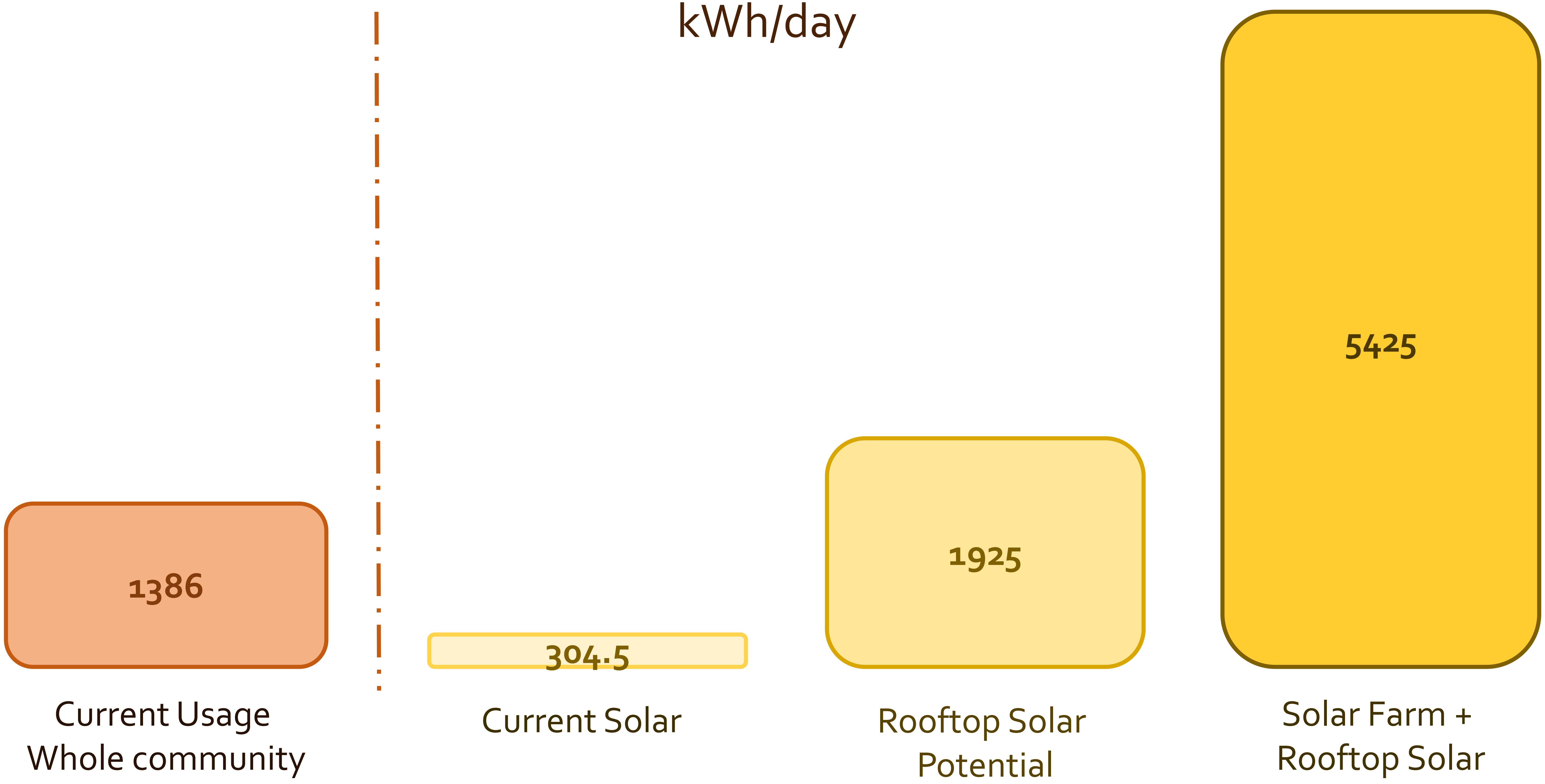
- Microgrids are expensive. $1-7m for Congo.
- Extreme weather events are (relatively) rare.
- Microgrids provide many values to many stakeholders, none of which are sufficiently motivated to make the investments (on their own).

Potential values of microgrids

Value	Accessible	Stakeholder
Reliability	Yes, but not serious problem in Congo	Essential Energy
Resilience	No	Shared
Reducing emissions	Yes (but only partly)	Shared
Reducing customer bills	No	Customers
Energy generation/storage (market services)	Yes	Asset owner
Local economic benefits	No	Community
Local control of energy system	No	Community

Solar and Microgrid potential supply

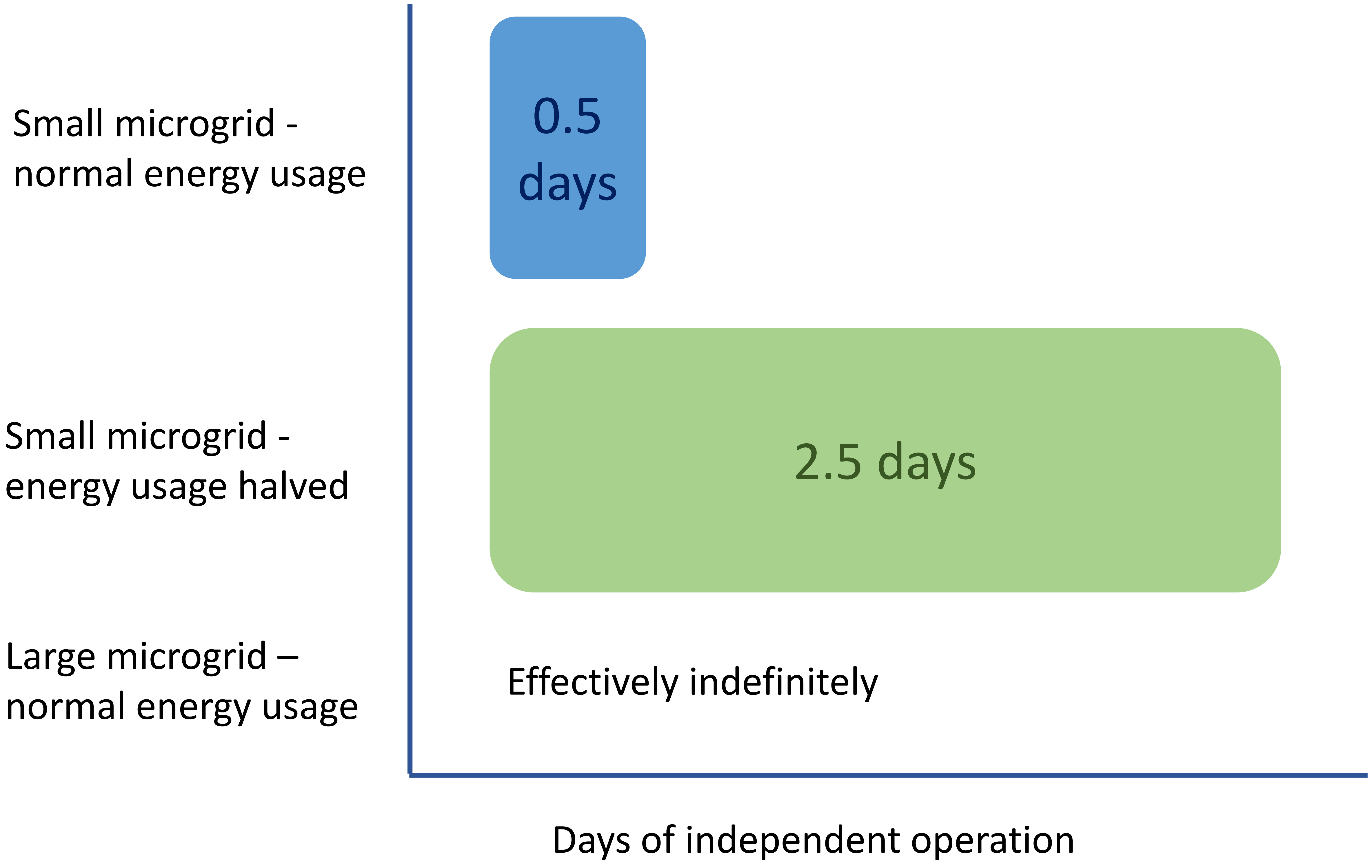
kWh/day



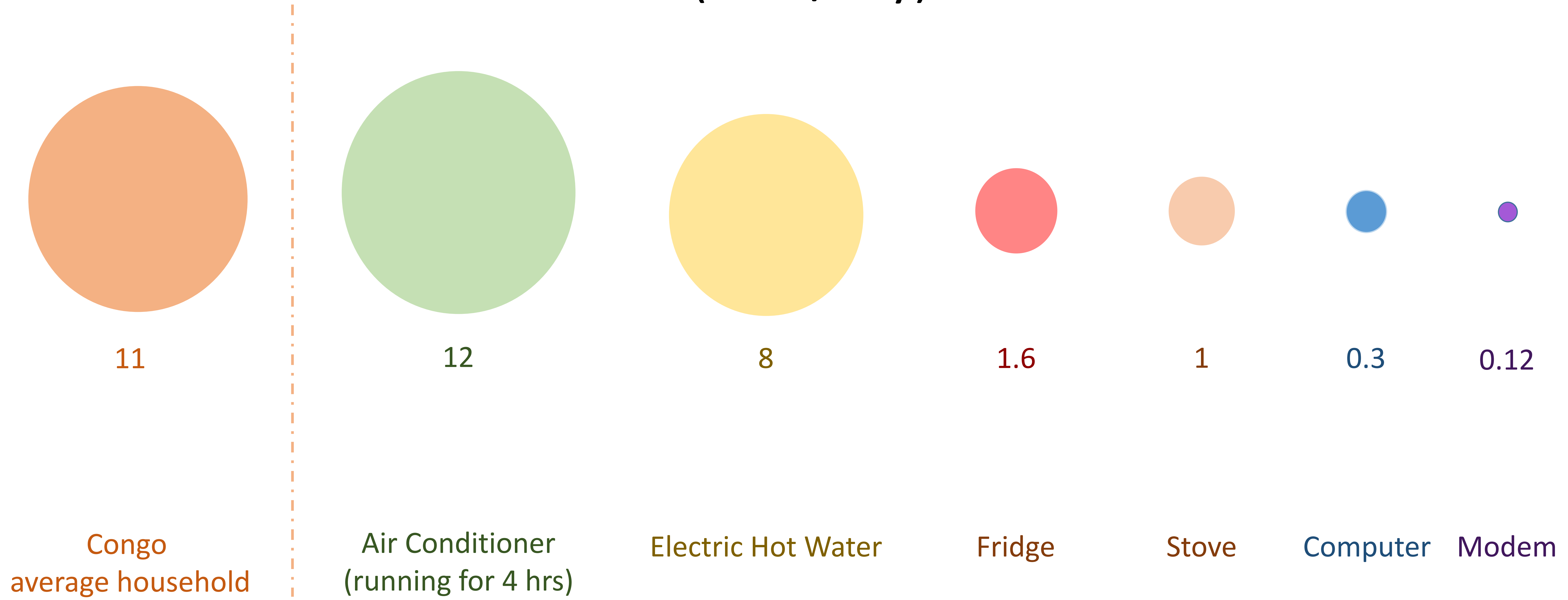
Congo

Congo

Average time microgrid can run independently



Energy consumption of appliances (kWh/day)



Outline

1. What are microgrids and where are they being used?

2. Why aren't they being used in the Eurobodalla?

3. How might they contribute to a better energy future for the Eurobodalla and regional Australia?

SuRF identified issues

- Business models must combine many values, some of which are context specific
- Resilience for the Eurobodalla can't be solved by one technology (needs reg change, more resources, coordination at different levels, community input)
- Not efficient/equitable for every community to have a microgrid
- Many operational issues that the sector struggles with - maintenance, customer engagement, consumer protections, system safety
- Ownership – Public expectations versus current options
- Challenges of MG for resilience (effects of smoke, vulnerability of infrastructure to fires, lack of suitable location etc)

SuRF Project Activities

Perspectives

- Interviews & forums across Eurobodalla – *like this one*
- Interviews with industry, government, regulators

Possibilities

- Conceptual designs & costings for small & large microgrids
- Feasibility reports for eight communities

Process

- Governance / process by which microgrids should be explored/evaluated/etc

Register to receive project outputs by emailing **ciska.white@anu.edu.au**

SμRF

Q&A

Register to receive project outputs by emailing ciska.white@anu.edu.au

Coffee Break

Register to receive project outputs by emailing ciska.white@anu.edu.au

Part 2

Discussion

RENEWABLES

SuRFProject - Congo

ENGINEERING | STRATEGY | ANALYTICS | COMPLIANCE

SuRF Concept Designs

Concept designs are split into large and small microgrids.

Large:

- Solar Farm
- Co-located Battery Energy Storage System (BESS)

Small:

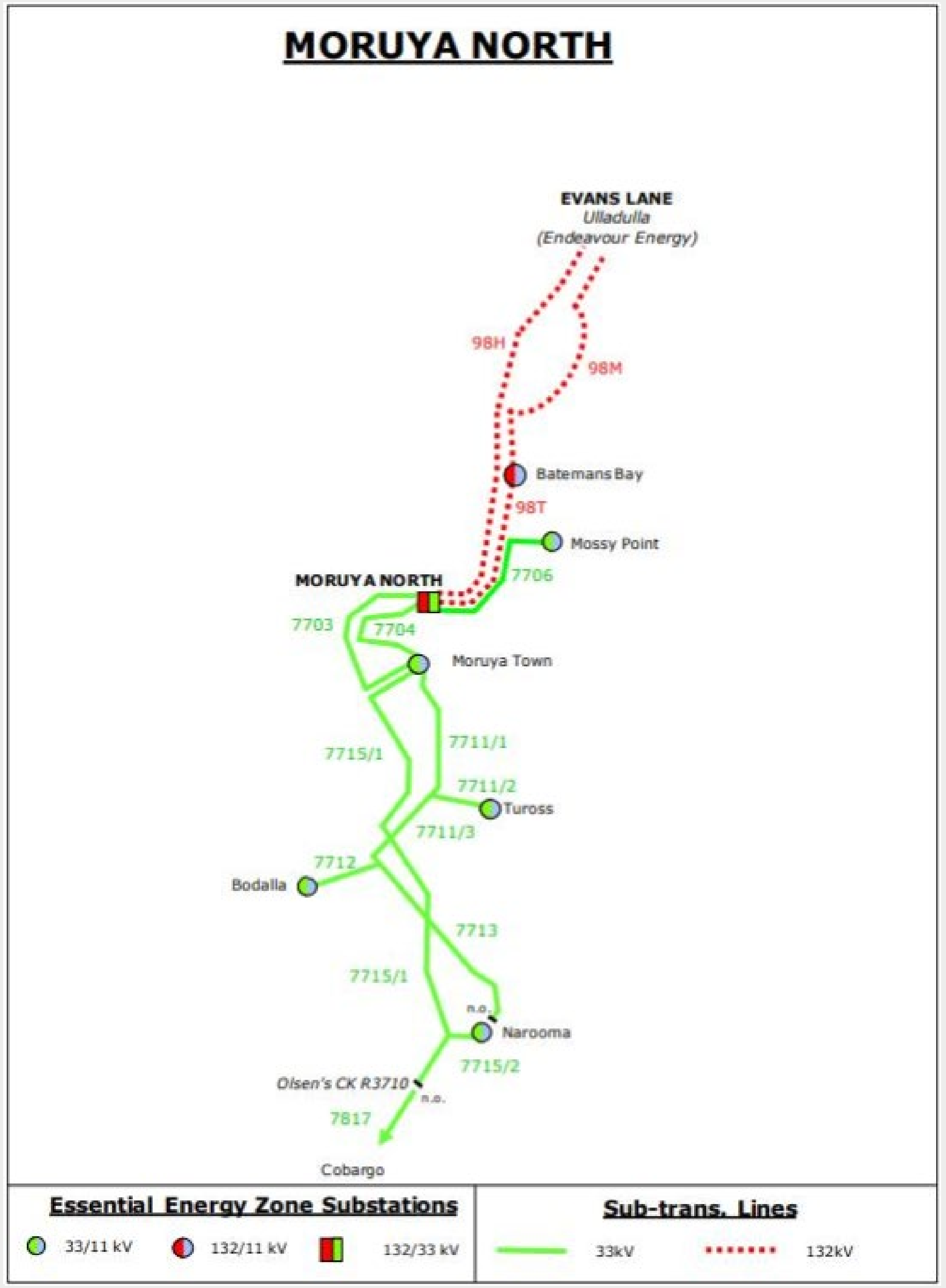
- Community BESS (with rooftop solar)

SuRF Concept Designs

Inputs for concept design development:

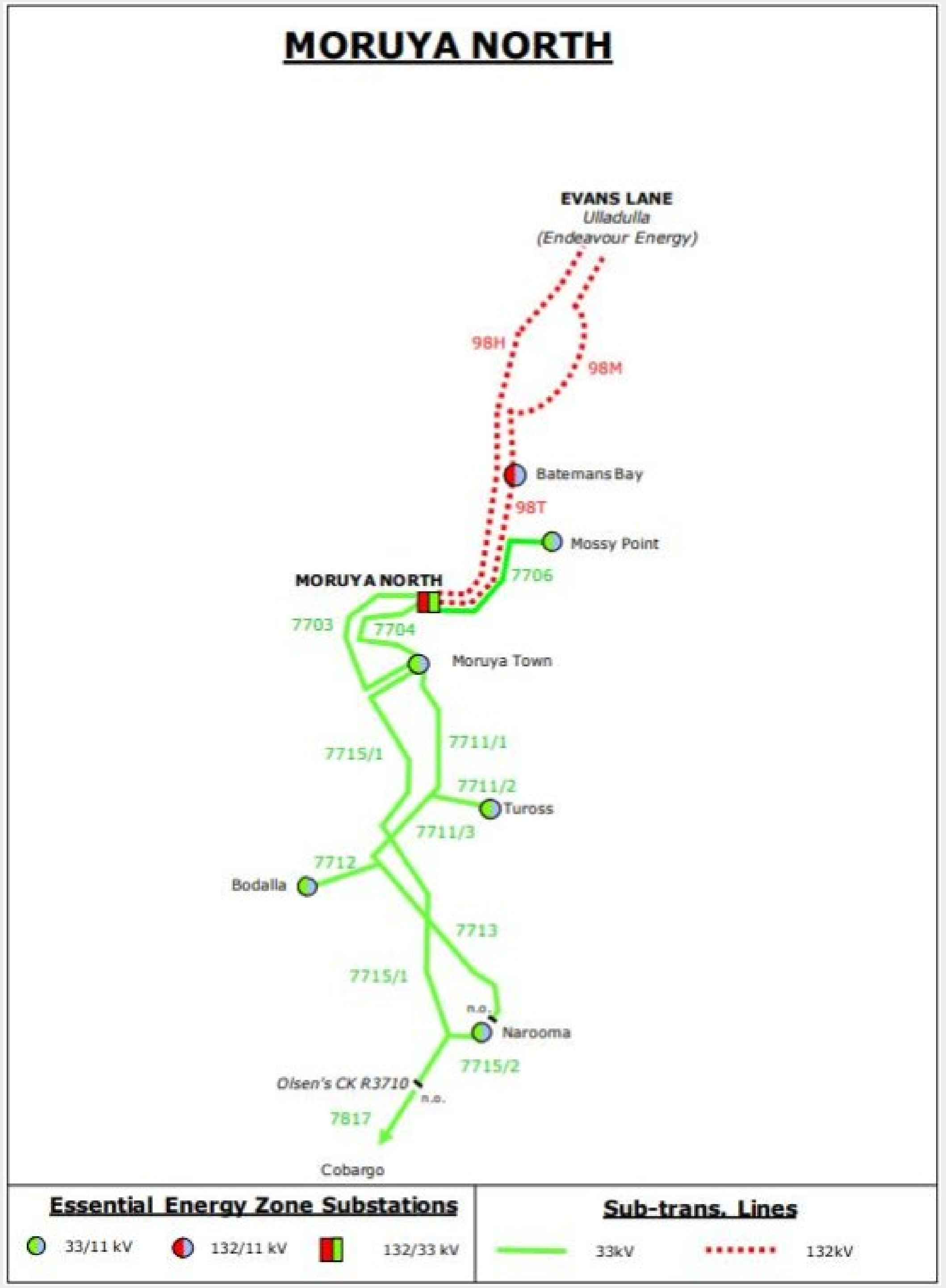
- Sizing information provided by the ANU
- 11/33kV line constraints
- Zone substation constraints
- Essential Energy/AEMO connection application constraints

Congo Introduction



- Four Zone Substations supply the SuRF central analysis region; MPT (Mossy Point), MYT (Moruya Town), TUR (Tuross) and BOD (Bodalla).
- These Zone Substations are supplied at 33kV on 7711 Bodalla T - Moruya Town T from Moruya North substation, itself supplied at 132kV on 98T Batemans Bay – Moruya North and 98H Evans Lane – Moruya North emanating from the Endeavour Energy network.

Congo Introduction



- Moruya North substation is rated to 30/45MVA
- 7711 Bodalla T - Moruya Town T is rated to 22MVA
- MYT ZS is rated to 10/16MVA with 4.4MW embedded generation – no constraints
- 2.3MVA 11kV transfer limit to Congo (Almond 6/1/2.50 ACSR/GZ @ 65°C)

SuRF Concept Designs - Congo

Congo concept design:

Topology	Generator Sizing
Large microgrid	550 kW rooftop solar + 1000 kW solar farm (PEG) + 1250 kW/2500 kWh battery
Small microgrid	550 kW rooftop solar + 350 kW/350 kWh battery
Diesel Only	350 kVA

SuRF Concept Designs

Appropriate technologies chosen for:

- System scale
- Use cases/flexibility
- Track record
- Ease of procurement

Technology - BESS

Technology – PV Array

Technology – Inverters and Power Conditioning

Congo Proposed Site

Congo Site Introduction – Large Microgrid

Congo Site Introduction – Small Microgrid

Congo General Arrangement

SuRF Concept Design Costing

Concept designs costed based on detailed costing model:

- 63 inputs
- Fixed and capacity-proportional development costs

SuRF Concept Design Costing

Component	Projected Cost – Large Microgrid	Projected Cost – Small Microgrid	Projected Cost – Diesel Only
Development Works	*$278,000*	*$75,000*	*$278,000*
EPC Procurement	*$80,000*	*$80,000*	*$80,000*
Design & Construction -Principal	*$681,000*	*$81,000*	*$81,000*
Design & Construction -EPC	*$4,950,000*	*$1,264,000*	*$376,000*
EPC Margin and Contingency	*$617,000*	*$241,000*	*$23,000*
Total Projected Cost	*$6,606,000*	*$1,741,000*	*$838,000*

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