



Industry Briefing

REFCL Isolating Transformers in New Estates

24 March 2022

AusNet
services

REFCL Isolating Transformers - Agenda

- 1 5 mins – Welcome and introduction.
- 2 5 mins – Safety conversation – Reporting Asset Hazards.
- 3 20 mins – Background – How REFCL works and where it is mandated.
- 4 50 mins – The need for Isolating transformers, design, placement and overview.
- 5 10 mins – Wrap up and close.

Housekeeping

We all want to get the best out of our session today, so we've put some guidelines and requests in place.

There is a lot to cover today.

A copy of the slides and written responses to any FAQs or questions we don't have time to cover will be sent out after the session.



Time

Arrive or join on time for the meeting start time
Return on time after any breaks



Mute

Mute your microphone when you aren't speaking



Raise your virtual hand

If you have a question, please use the Raise Your Hand button



Contribute

Please share your thoughts and ideas with the group

Q&A

Questions

Feel free to use team chat for any questions



Monitor

Keep an eye on the on-line chat for answers to your questions



Record of meeting

We will be recording today's session, for internal use only

The AusNet team

Customer Projects



Gareth Downes
Customer Projects Manager
(Acting)



Craig Velt
Delivery Partner Compliance Manager



Andrew Webber
Design Compliance Specialist - Central



Ross Morgan
Lead Compliance Specialist



Brian Morrison
Compliance Specialist

Customer Experience



Rachael Quigley
Experience & Research Manager



Lucy Holder
Customer Engagement Manager



Sacha Albert
Research & Engagement Coordinator

Objectives of today's session

To provide participants with an understanding of:

- **Overview** of the REFCL program and why it has been mandated by Government
- The **need for REFCL** Isolating Transformers (ISO's)
- **Geographic coverage** of RECFL system in AusNet area
- Technical & Engineering **challenges** of REFCL
- Selecting Isolating Transformer **locations**
- **Types** of Isolating Transformers
- Isolating transformer **reserve requirements** for housing estates
- Construction **responsibilities**
- **Cost implications** on HV rebates
- Construction timing and issue of **Statement of Compliance (SOC)**
- **Aesthetic** considerations

Safety Conversation



Reporting Assets Hazards

AusNet Faults and Emergencies Line

Electricity 131 799

Gas 136 707

For all other queries, please call 1300 360 795 (8am-5pm, Monday to Friday).
Remember, always treat fallen lines as live and keep a safe distance.

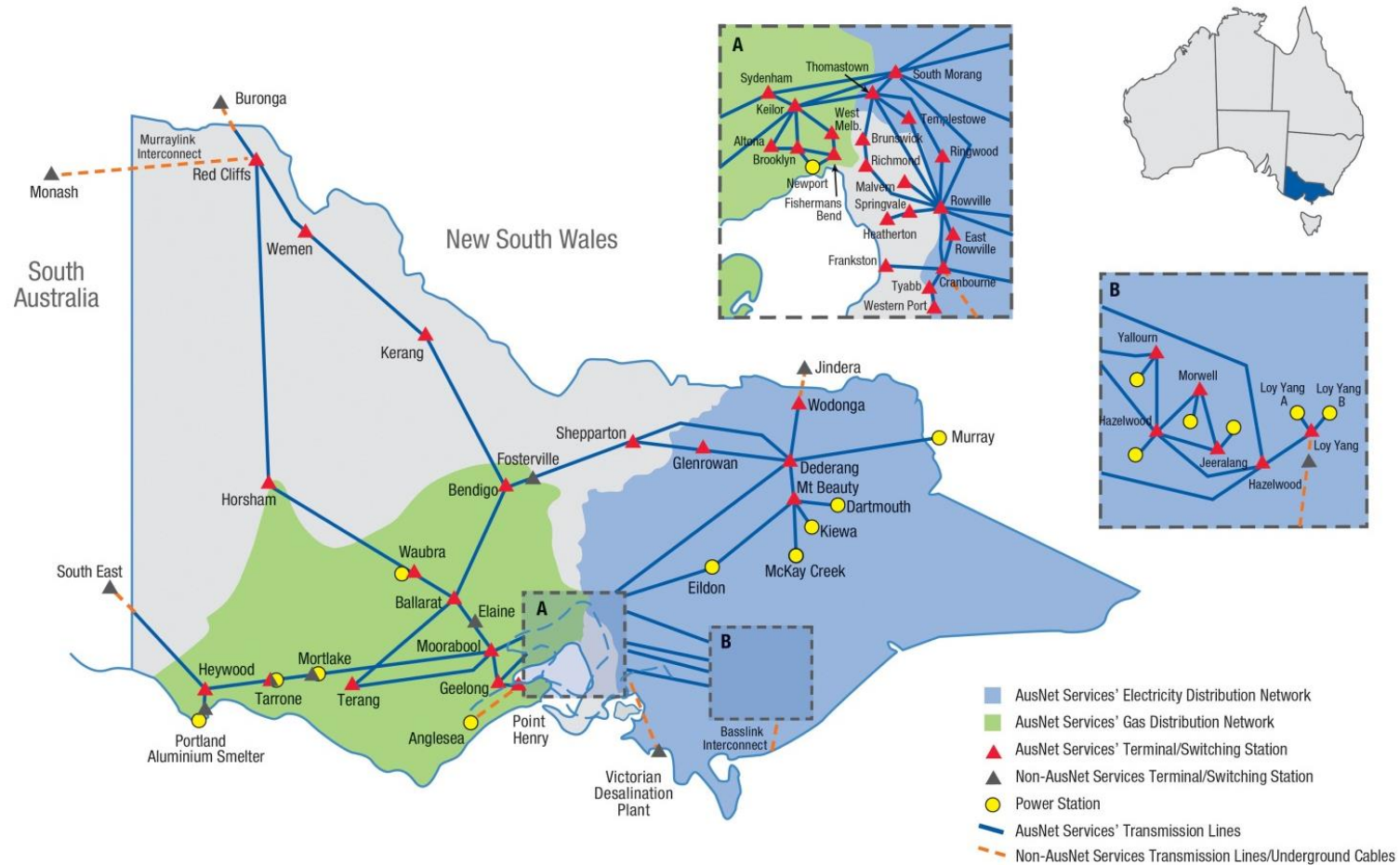


REFCL - Background



AusNet

Our Network



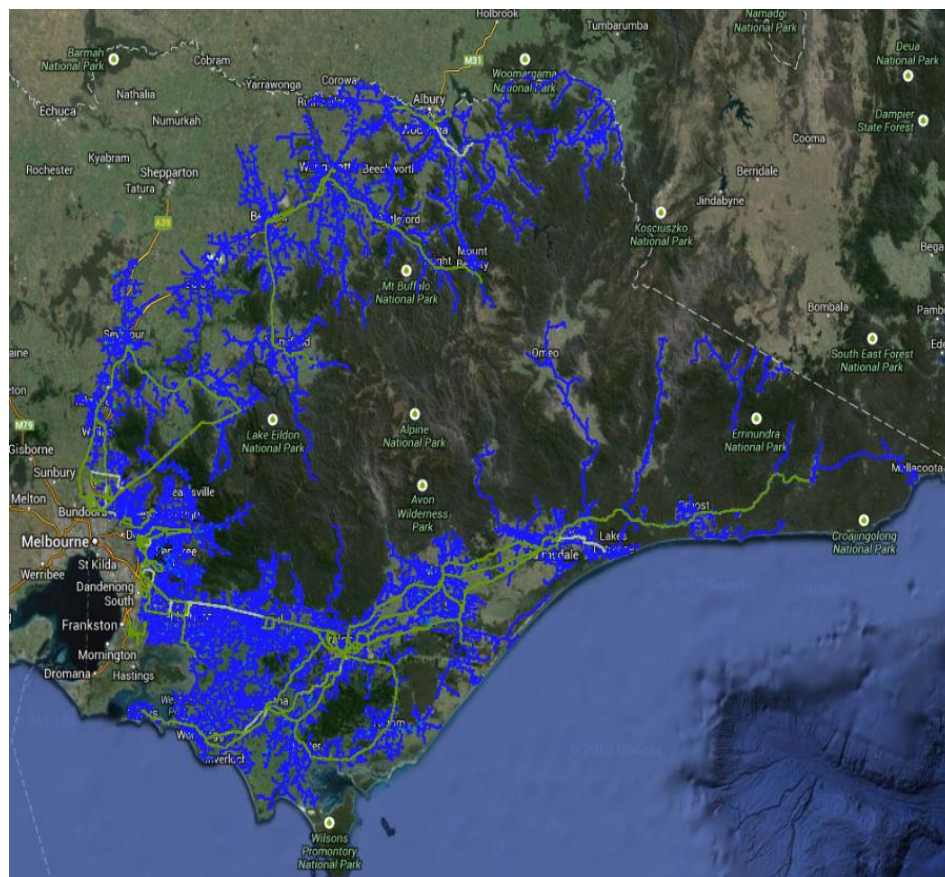
AusNet own, operate and control critical energy delivery infrastructure in Victoria.

AusNet

Unique characteristics of our distribution network

Key statistics:

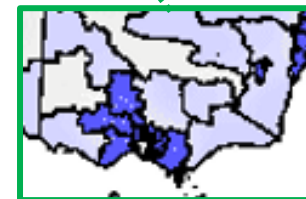
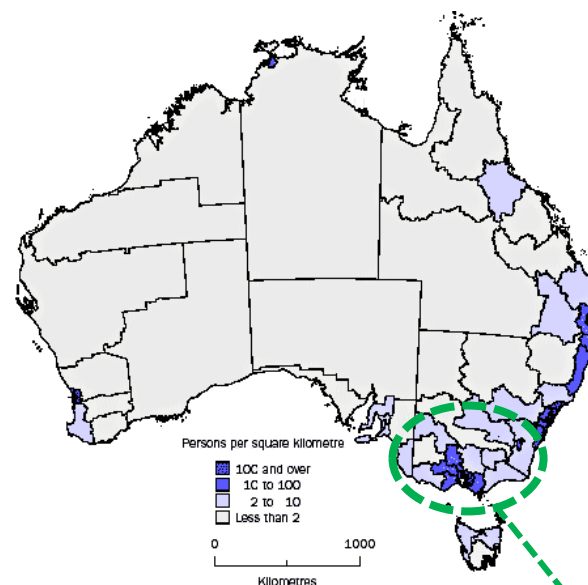
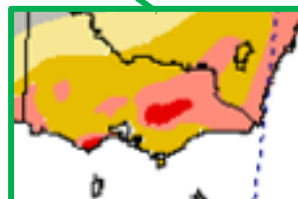
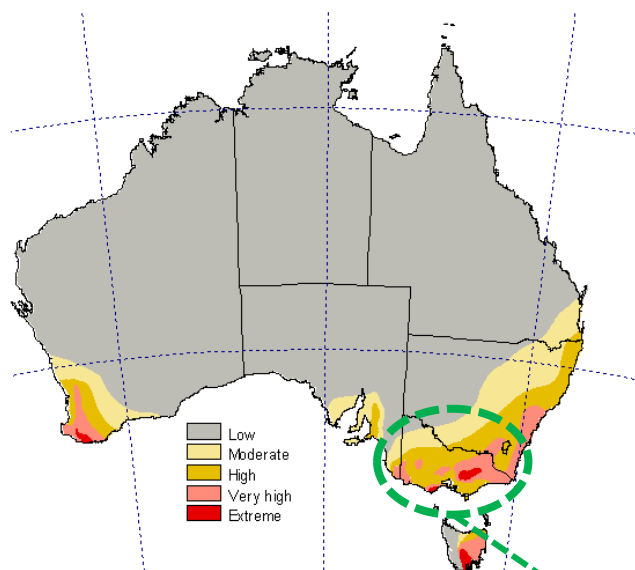
- › 80,000 km² service area
- › 40,000 km overhead lines
- › 6,400km underground lines
- › 4000,000 poles
- › 700,000+ premises supplied
- › Approx. 8,000 network faults per annum



AusNet customer base is more heavily weighted towards residential than any other Victorian distributor

AusNet

Our bushfire risk profile

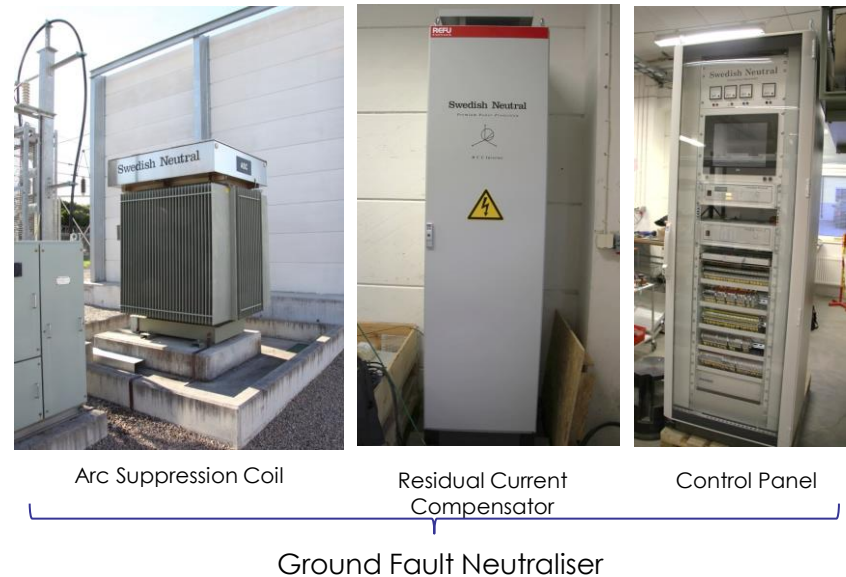


AusNet's network operates in a unique geographical location with high bushfire risk and high population density.

Introduction to AusNet REFCL

What is a Rapid Earth Fault Current Limiter?

- REFCL stands for '**Rapid Earth Fault Current Limiter**'
- A REFCL is a type of **electricity network protection device** that operates as a large safety switch on AusNet's electricity network, reducing fault current caused by damaged powerlines
- It **rapidly limits the electricity** that is released in certain types of powerline faults, known as earth faults
- A REFCL device **protects the 22kV network** from phase to ground earth faults
- It was originally developed for its reliability benefits in Europe. In Victoria, however, it will be used to **help reduce the risk of bushfires**.
- The REFCL technology is the **most suitable for bushfire safety** and is known as a Ground Fault Neutraliser.
- It is made up of **3 main components**.



Introduction to AusNet REFCL

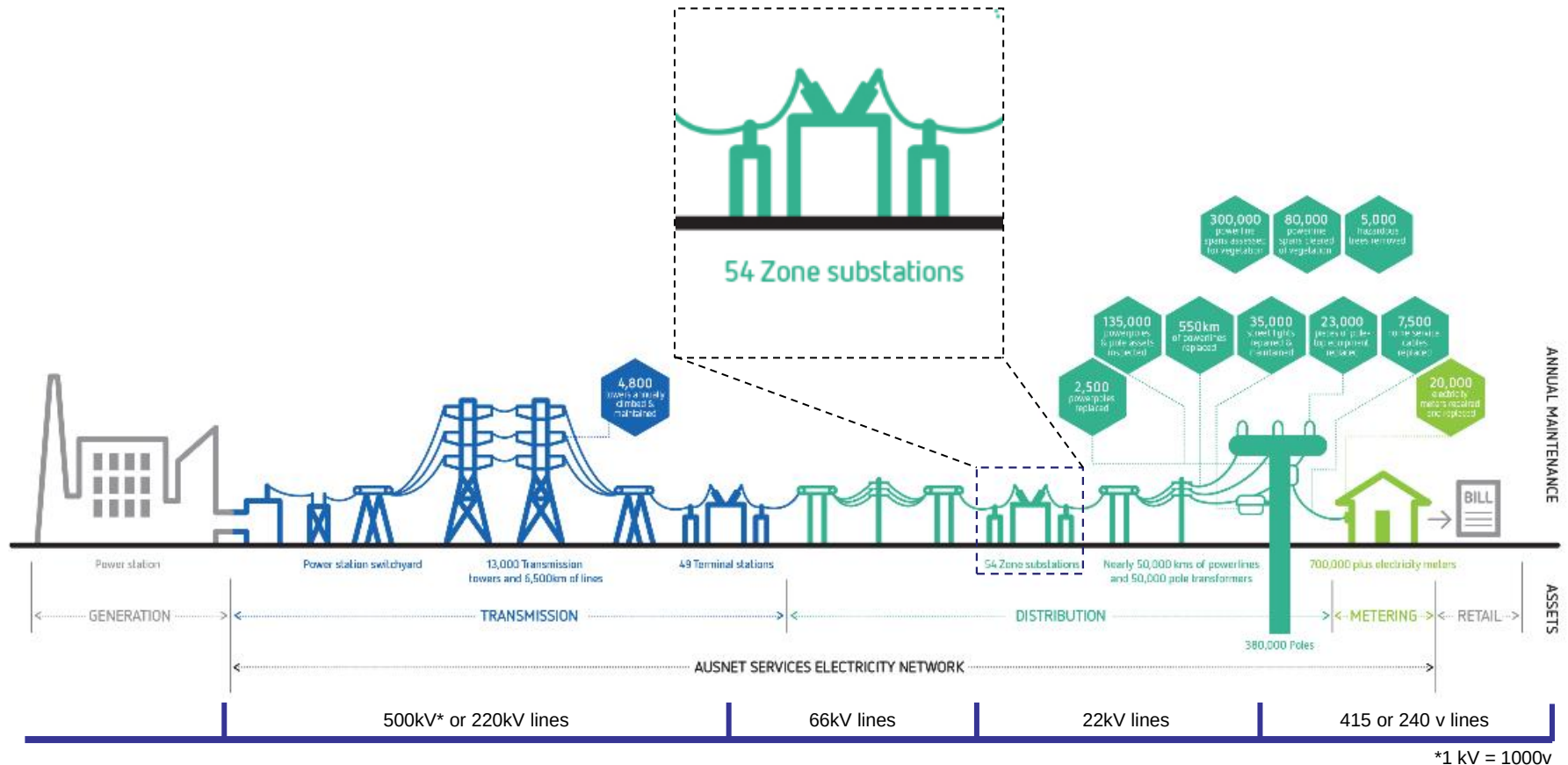
Why are we installing REFCL's?



- The 2009 Victorian Bushfires Royal Commission recommendations were accepted by the Victorian Government.
- One of the recommendations has led to changes in Regulations.
- The installation of REFCLs is predicted to halve the risk of powerlines starting bushfires.
- REFCLs will also prevent the occurrence of transient faults.
- AusNet to deploy REFCL technology in 22 zone substations by 2023.

Introduction to AusNet REFCL

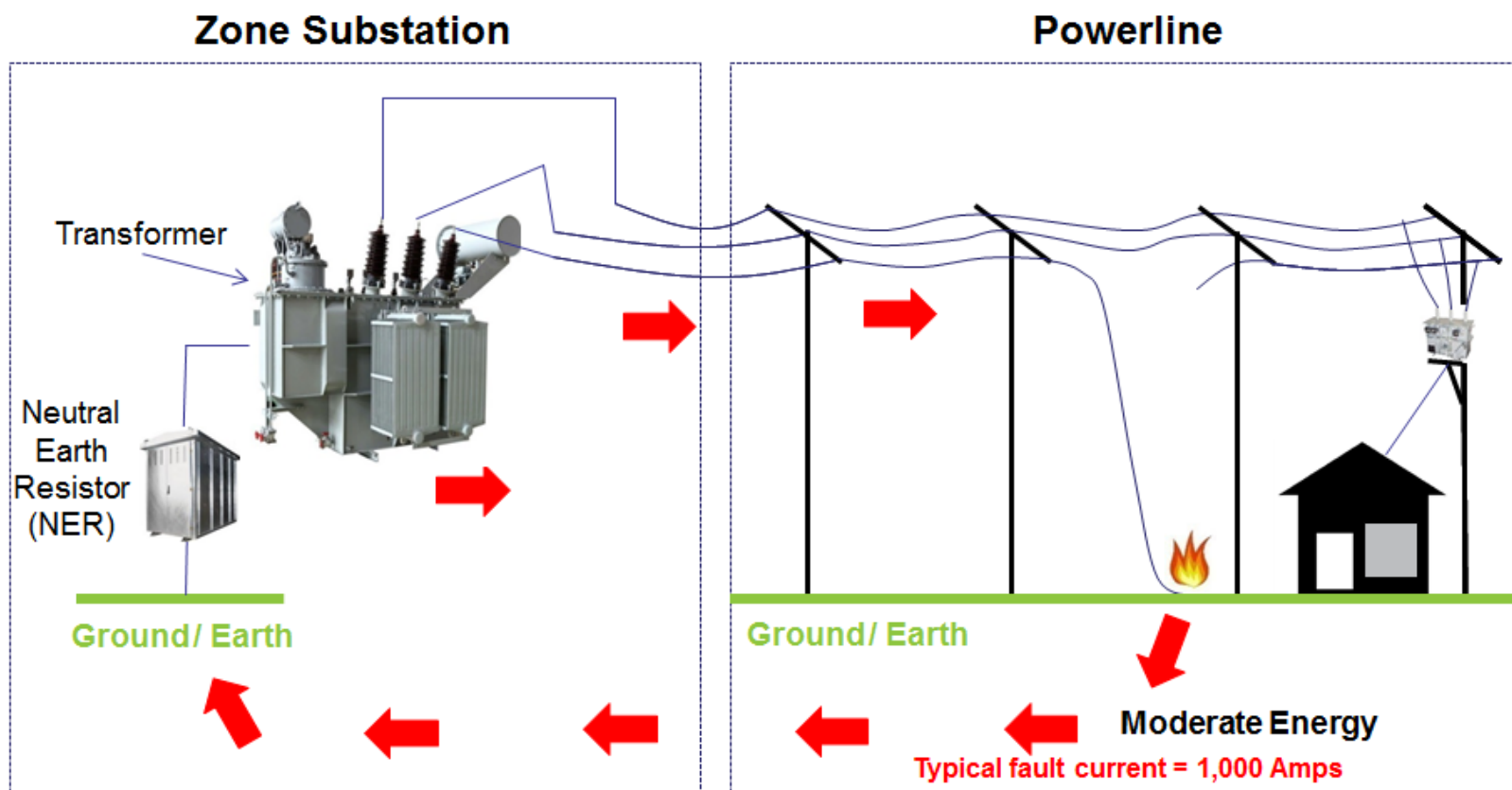
Where do they fit on the network?



The REFCL is installed in the Zone Substations. They work by constantly monitoring the surrounding 22kV high voltage powerlines to detect if there is an earth fault current.

Introduction to AusNet REFCL

An earth fault on a typically protected network without a REFCL

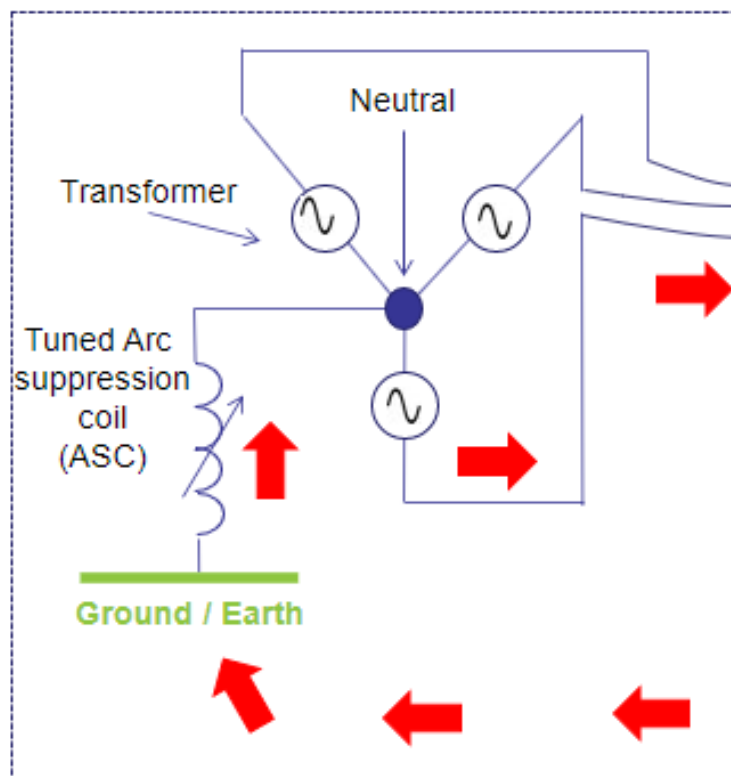


When an earth fault occurs without the REFCL, the energy at the point where the fallen powerline touches the ground, can still be enough to ignite a fire

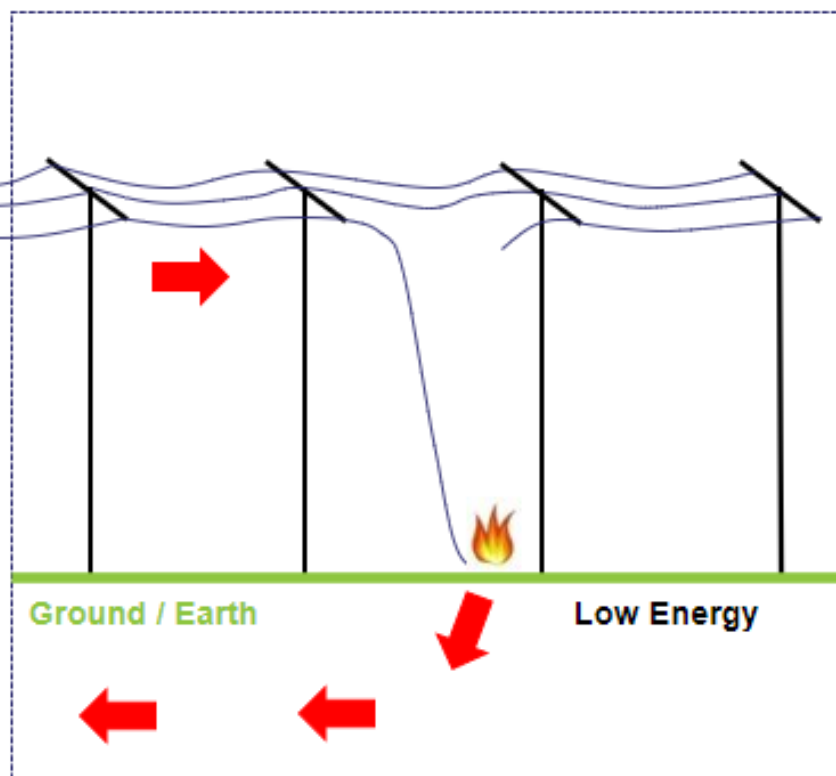
Earthing System

Resonant Earthing – Arc Suppression Coil

Zone Substation



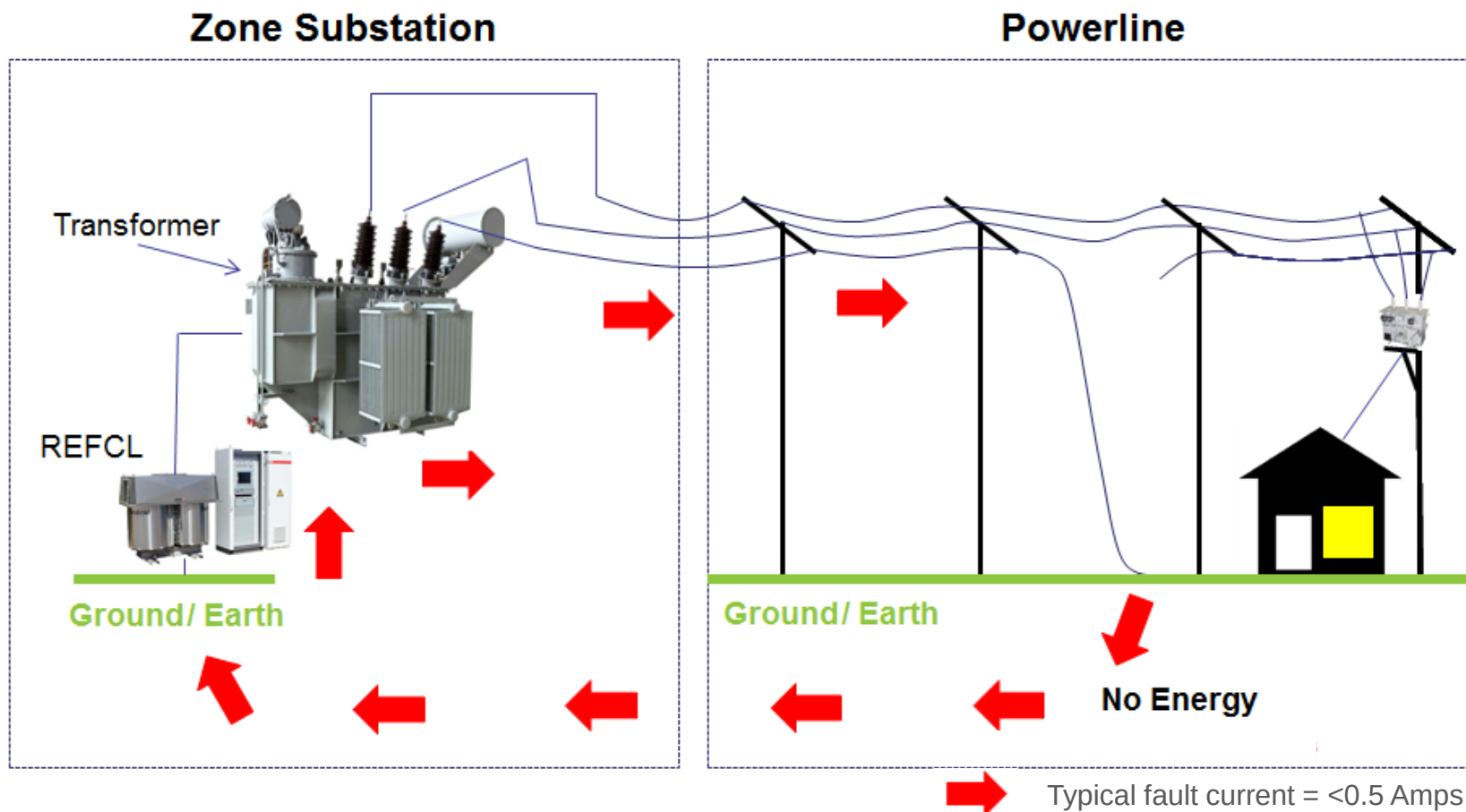
Powerline



 Typical fault current = <25 Amps

Introduction to AusNet REFCL

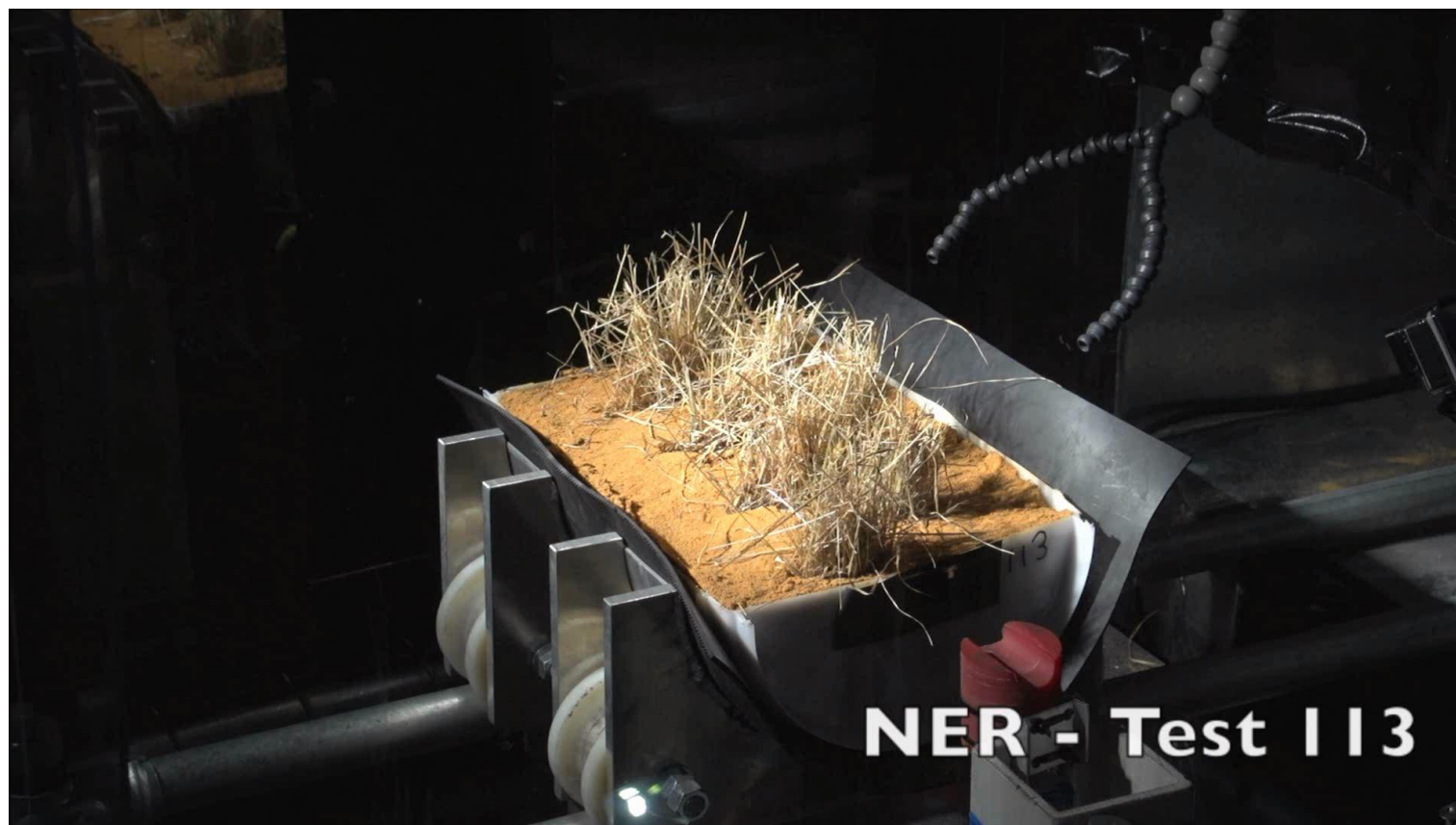
An earth fault on a typically protected network with a REFCL



When an earth fault occurs a REFCL detects and cuts the energy flow within milliseconds on the powerline that has the fault. This reduces the possibility of a fire being started.

Introduction to AusNet REFCL

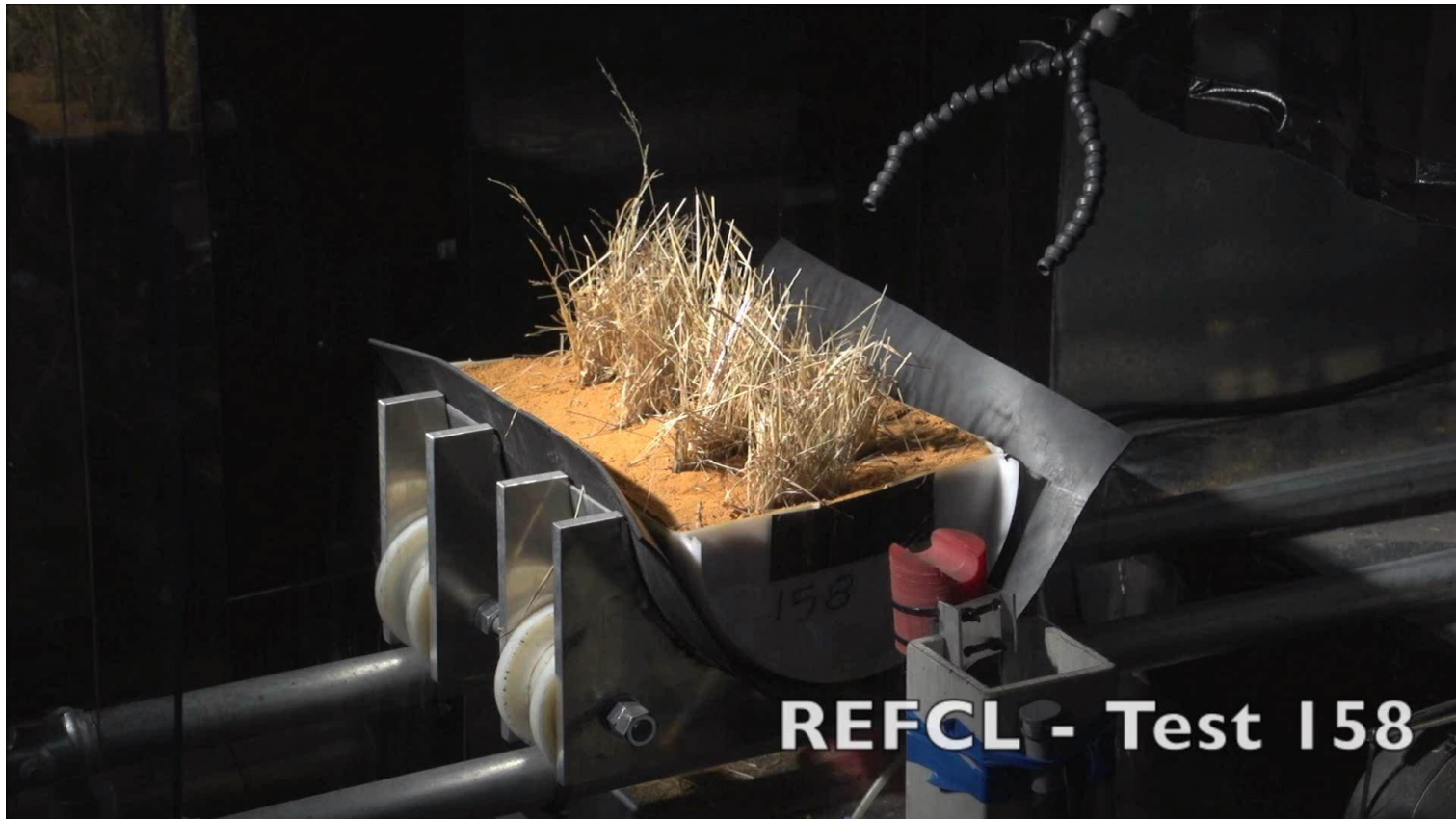
An earth fault on a typically protected network without a REFCL



When an earth fault occurs without the REFCL, within 0.9 of a second, sufficient current would be flowing into the ground to cause ignition of very dry vegetation.

Introduction to AusNet REFCL

Earth fault on a typically protected network with a REFCL



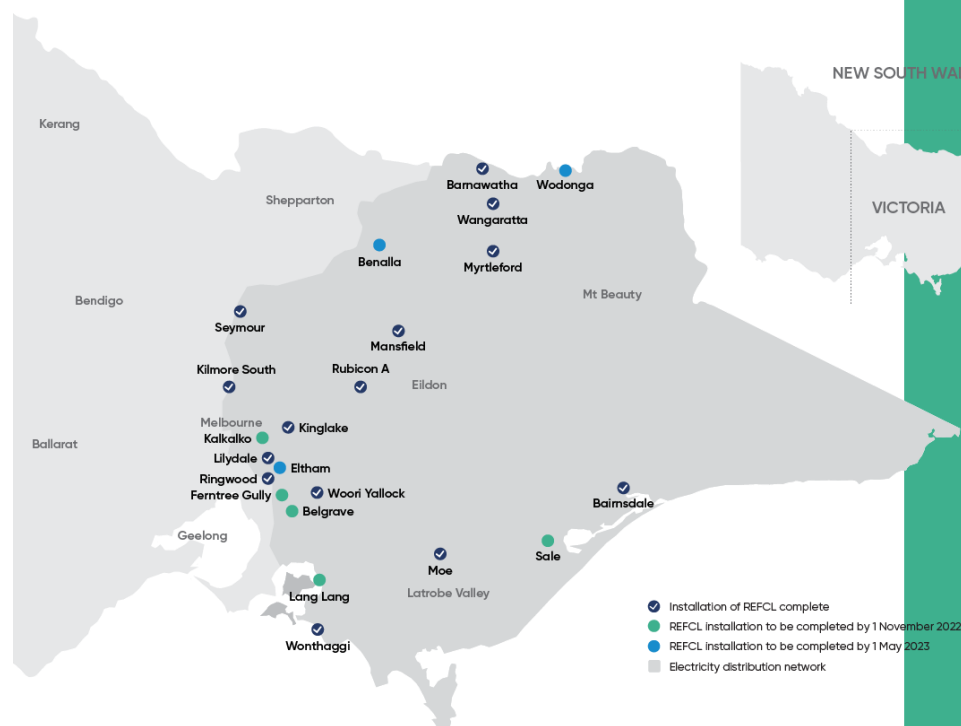
When an earth fault occurs with the REFCL, within milliseconds there was a clear absence of high energy current



The need for Isolating Transformers, design, placement and overview



Zone Substation REFCL Implementation timeframes



The Government mandated REFCL (Rapid Earth Fault Current Limiting) program, will require the introduction of Isolating transformers in front of Housing estates on REFCL affected feeders:

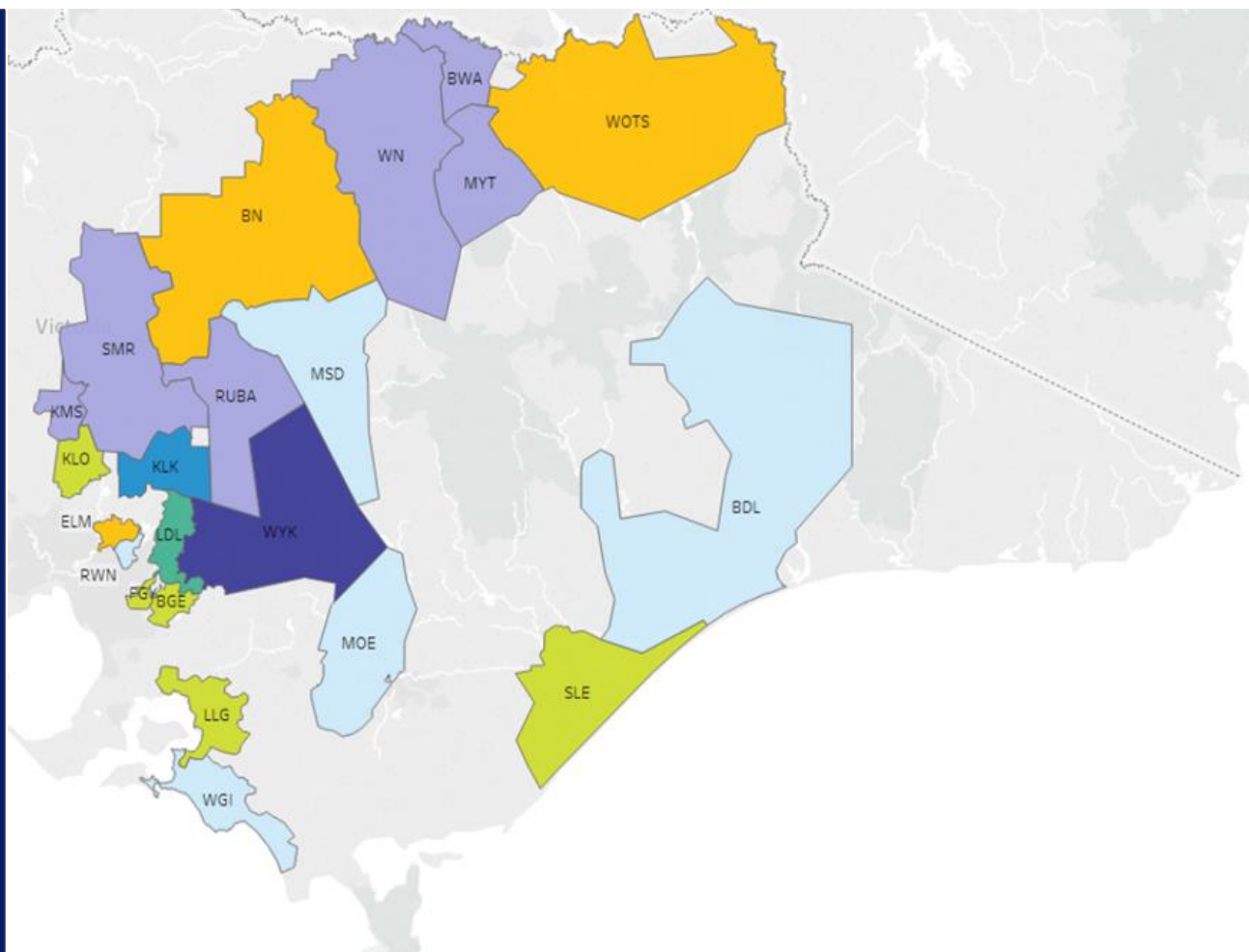
- REFCL systems require low capacitance levels to operate within legislated requirements.
- HV underground cables such as those used in housing estates introduce high capacitance that needs to be mitigated to ensure the REFCL operates properly.
- Isolating transformers mitigate capacitance with designs and enclosure sizes nearing finalisation for introduction onto the network.

Working through the technical requirements for these systems is a priority for AusNet

REFCL Geographic Coverage

Installation locations

AusNet will install
REFCL's in
22 locations
in outer
Melbourne and
across northern
and eastern
Victoria.



Feedback from Developer Consultative Committee - DCC

It would be good to see **consultation with developers** for major changes like this

What are the options for **locations** of installation?

Will these fixtures become **redundant** in the future?

What is the **estimated cost** of installation of these units and associated rebates?

Is the **industry prepared** for this?
Will the required number be available?

Requested to see a **drawing of the transformers** once available

The REFCL Challenge

Three key challenges

1. Capacitive balance

- REFCL sense phase to ground faults on the 22kV network by detecting changes in the neutral voltage.
- REFCLs cannot distinguish between these faults and network imbalance. To achieve the required sensitivity or capacitive balance, the capacitance of each of the three phases on each feeder must be equal.

2. Total capacitance limit

- To achieve legislated REFCL performance requires limiting the network size in terms of capacitance.
- The limits are set by the sensitivity equation. The arc suppression coil (ASC) sizing policy defines the sensitivity equation in terms of parameter limits (see REF 30-04 22kV/ $\sqrt{3}$ ASC Sizing Policy)
- Use the REF 40-07 Capacitive balancing tool for Lines Design to determine a design's effect on total capacitance.
- Potential solutions to exceeding the ASC coil limit include, but are not limited to, installing a **zero-sequence isolating transformer** or installing additional REFCLs.

3. Design considerations

- Technical exemptions from the REFCL legislative obligations are required for each section of the 22kV network downstream of the secondary terminals of the isolation transformers. In order to remain compliant with the particulars of the technical exemptions, the following rules apply to the network downstream of isolation transformers:
 - ❖ Do not install additional 22kV network
 - ❖ You may replace like for like, for example for maintenance
 - ❖ Existing transformers may be upgraded as long as total installed capacity in the isolated section is in line with normal design/planning considerations
 - ❖ No LV ties are to be established on isolated transformers due to vector shift.
- These rules safeguard our compliance.

The Need for Isolating Transformers (ISO's)

Mitigating capacitance

- AusNet has a **responsibility to operate** the REFCL system in accordance with government directives.
- In order for the REFCL system to operate correctly during high fire danger periods the **total capacitance limit** cannot be exceeded
- High Voltage underground cables have **very high capacitance**
- Housing Estate supply requires large quantities of High Voltage underground cables that **need to be isolated** from the network
- Low capacitance cables were introduced to the network to help **mitigate against capacitance increase**, however, these cables still have relatively high capacitance when compared to an overhead network.
- Isolating transformers **mitigate high capacitance** by electrically isolating the capacitance from being seen by the REFCL protection system. This enables the system to perform to specifications.

Selecting Isolating Transformer (ISO) locations

Considerations

- **Lines beyond the ISO must remain insulated** ie. NO bare wire overhead lines are allowed beyond the ISO as they must remain protected by the REFCL system
- **Large estates with multiple stages** are expected to be covered by a single large ISO at the start of the estate and there should be no need for multiple ISO's to be provided to each stage once the initial ISO is installed
- **Timely planning** of overall estate layouts is critical in REFCL areas to identify the need for a new REFCL ISO.
- **Isolation transformer reserves** will be required to be provided in the development in the same way it occurs for Kiosk substations now
- Where possible, **for smaller estates**, AusNet will try to identify remote locations for an ISO to offset the capacitance increase of the new estate HV cabling. ie. the ISO may not be necessarily built in development.
- **AusNet needs to maintain the ISO's** so will endeavour to minimise the number required as far as is practicable.

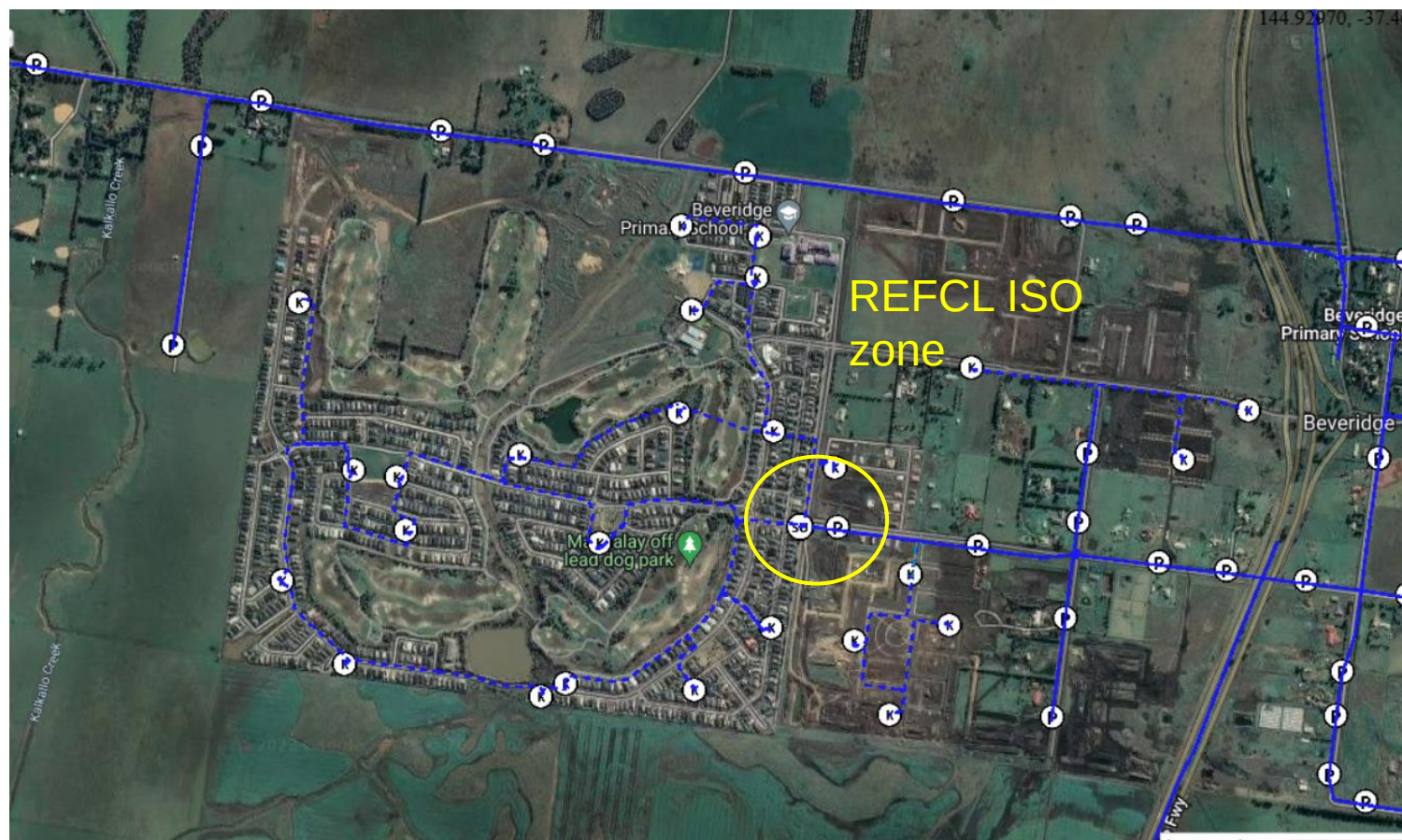
Selecting Isolating transformer locations

Small developments



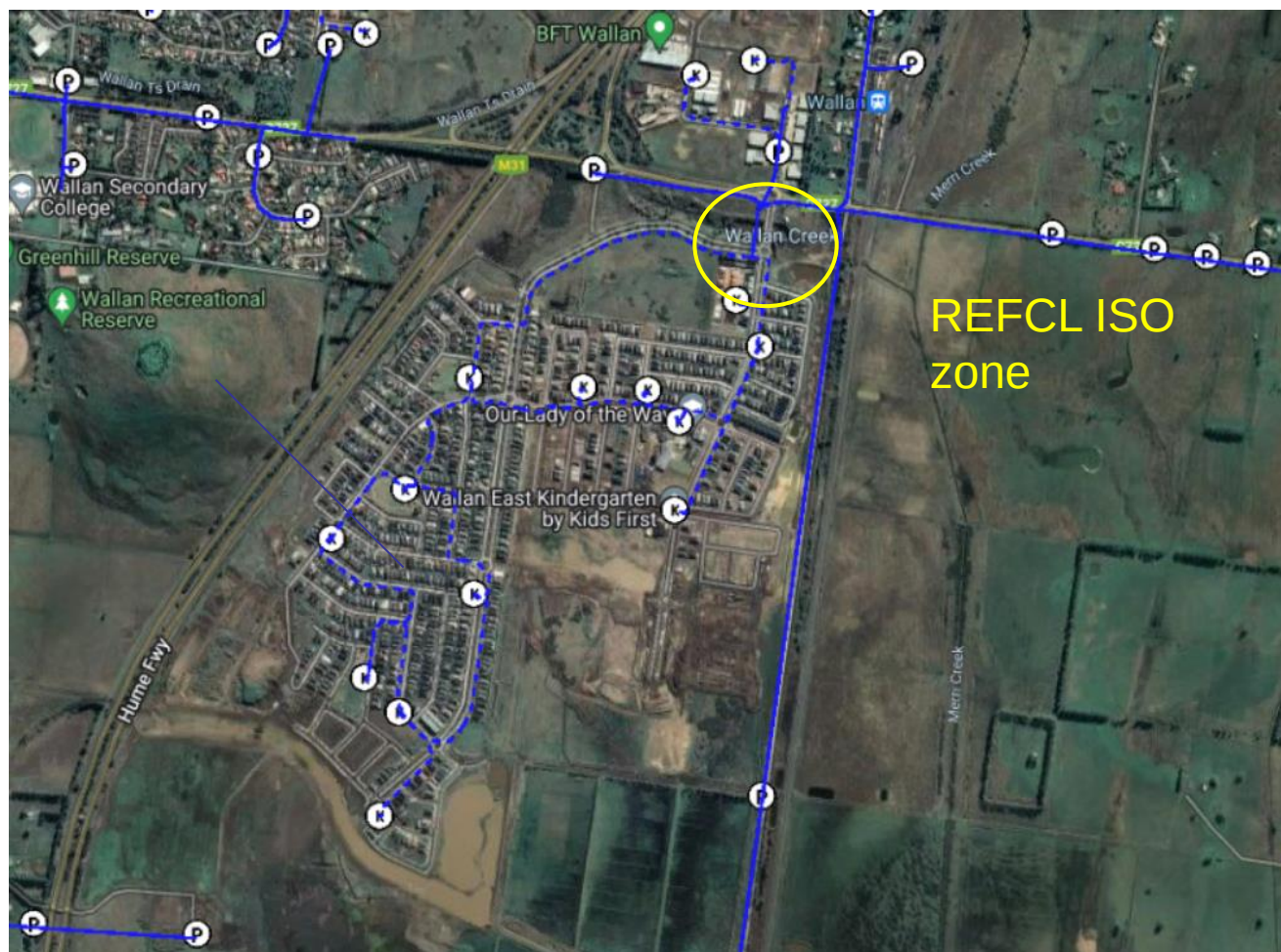
Selecting Isolating transformer locations

Larger developments



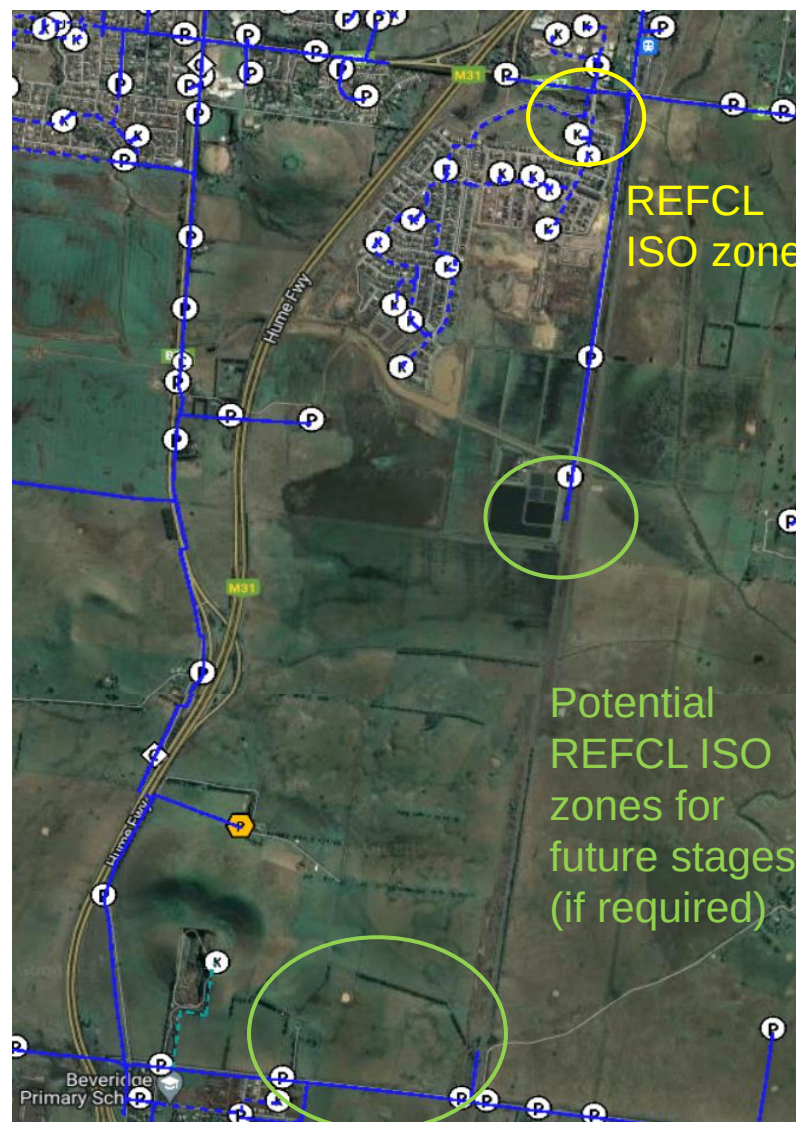
Selecting Isolating transformer locations

Isolated estate placement



Selecting Isolating transformer locations

Connected estate placement



Types of Isolating Transformers

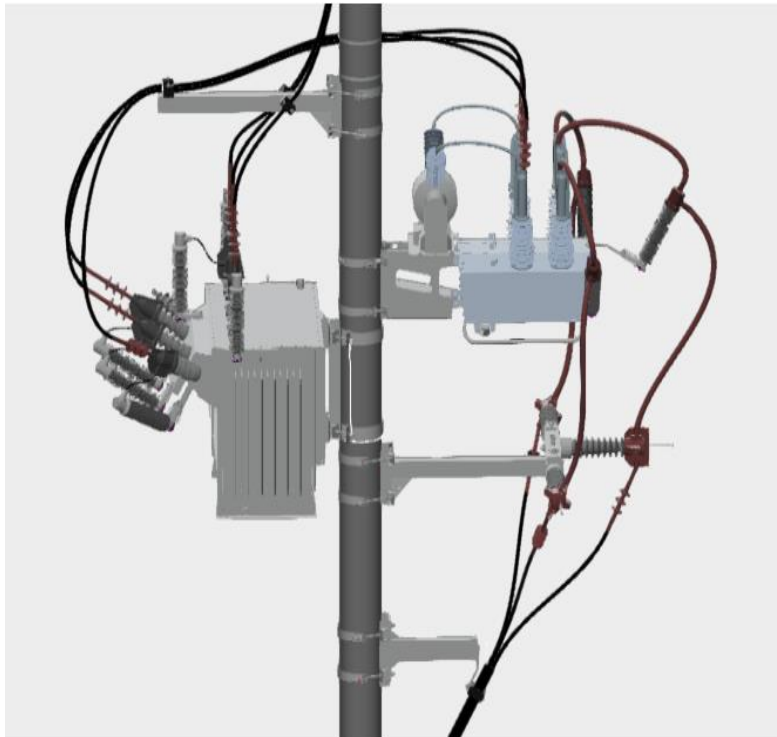
Pole Mounted

- 300 kVA - Single pole with ACR
- 1 MVA - Two pole with ACR
 - Special Footing
 - Expensive, in the order of \$100k

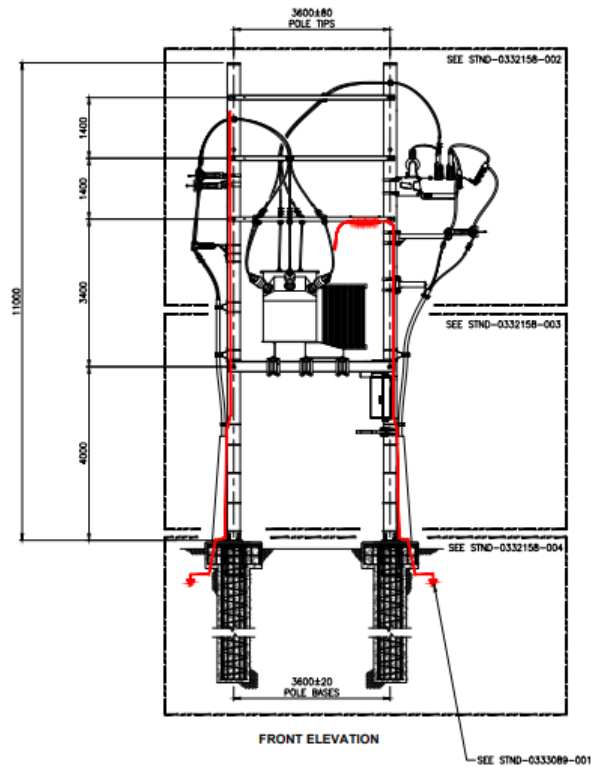
Gound Mounted

- 1 , 2 , 3 or 5 MVA
 - Physically Large - ie. up to 3.5 x 6m x 3.5 m high
 - Reserve size – potentially In the order of 10m x 12m
 - Heavy – up to 15 tonne
 - Special footings required
 - Very expensive, in the order of \$200 - 500k

Pole mounted Isolating Transformer 300kVA



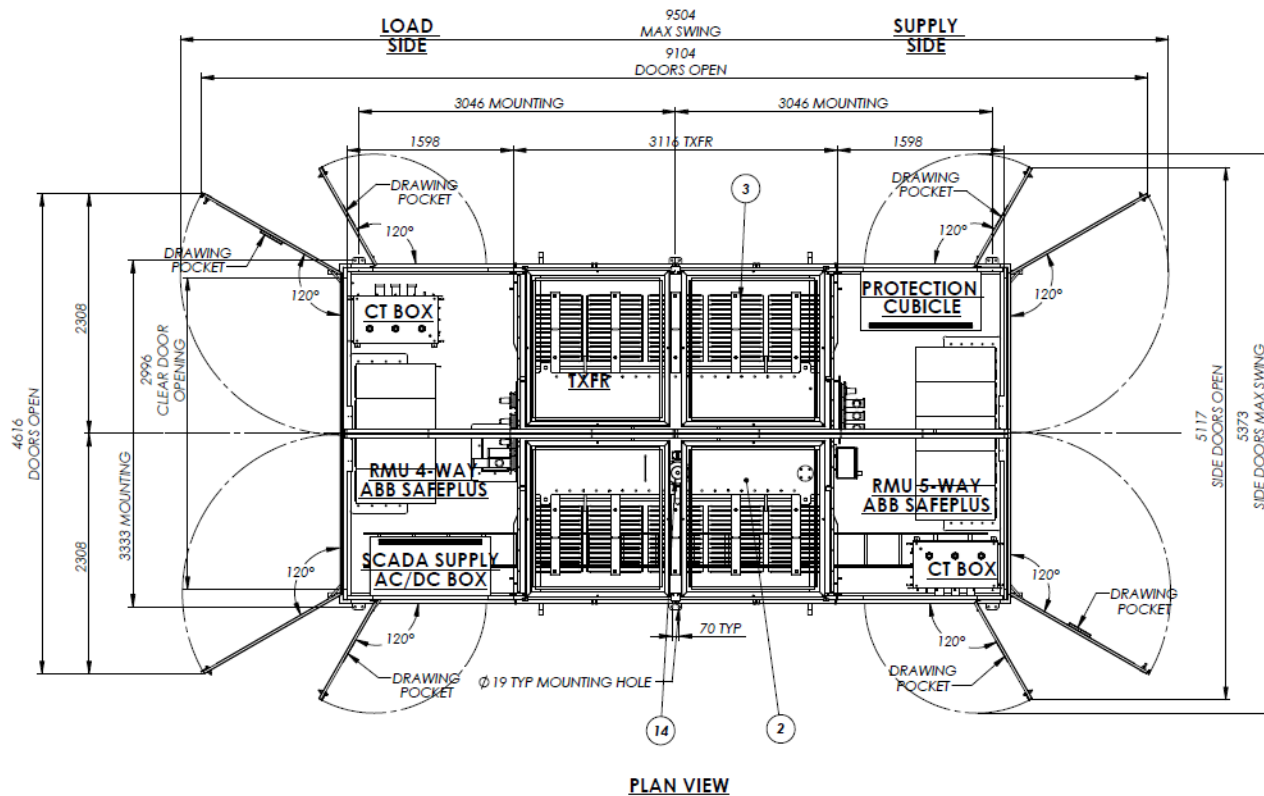
2 Pole mounted Isolating Transformer 1000 kVA



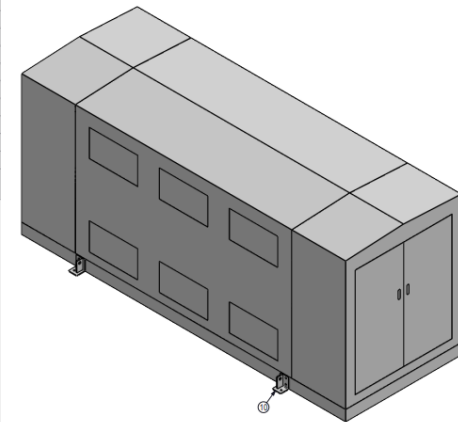
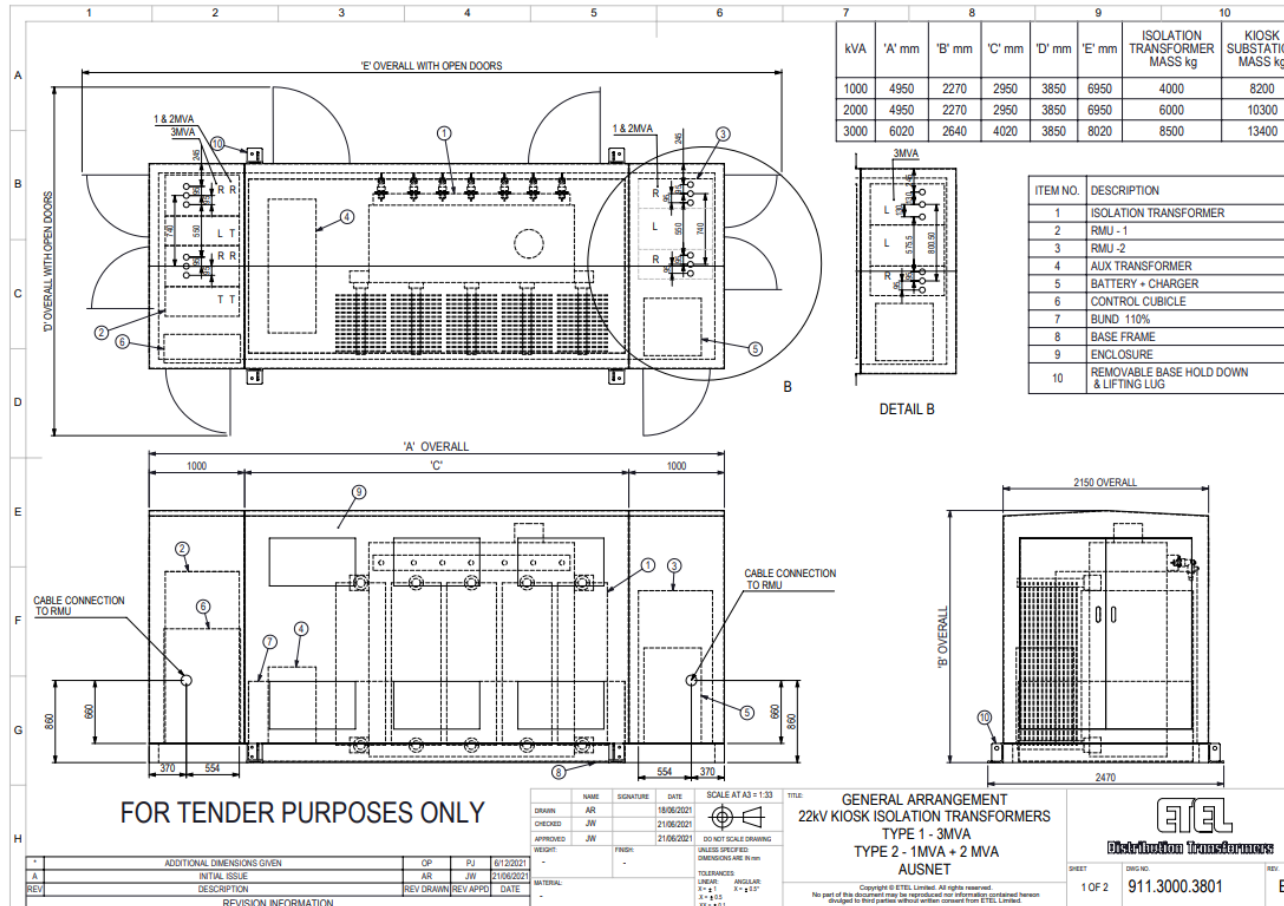
Ground mounted Isolating Transformer – 5MVA



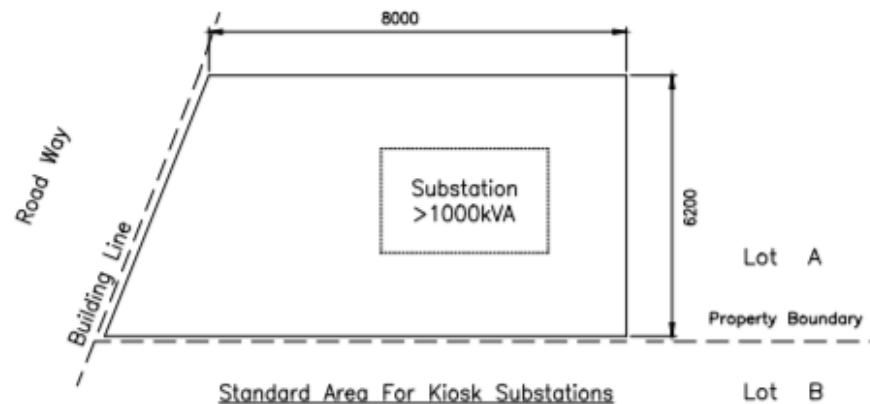
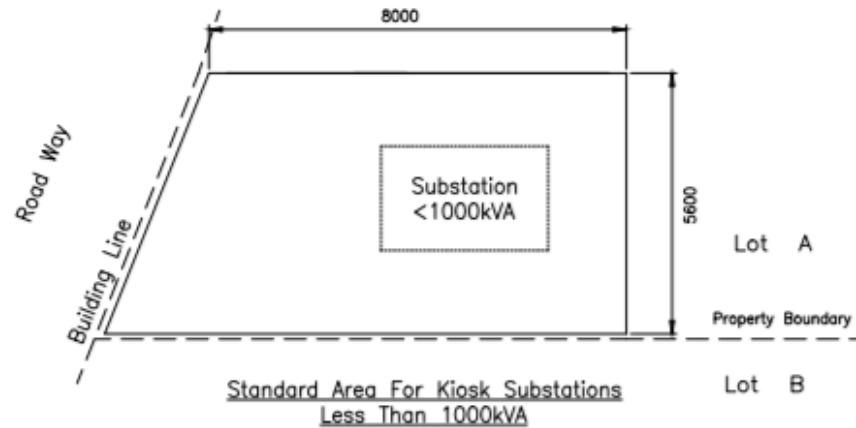
Ground mounted Isolating Transformer >5MVA



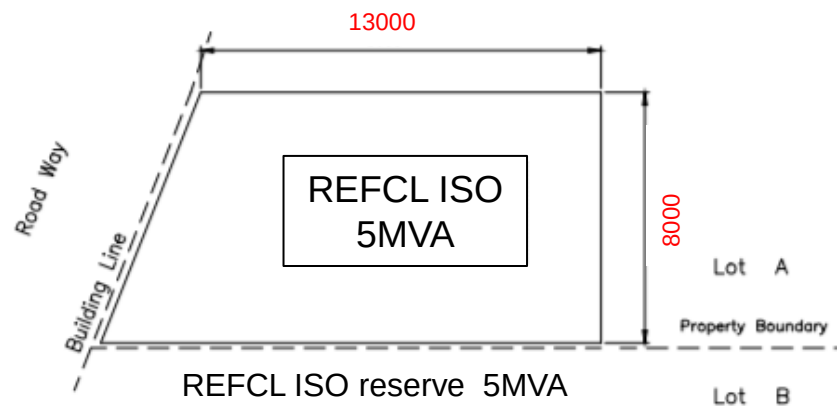
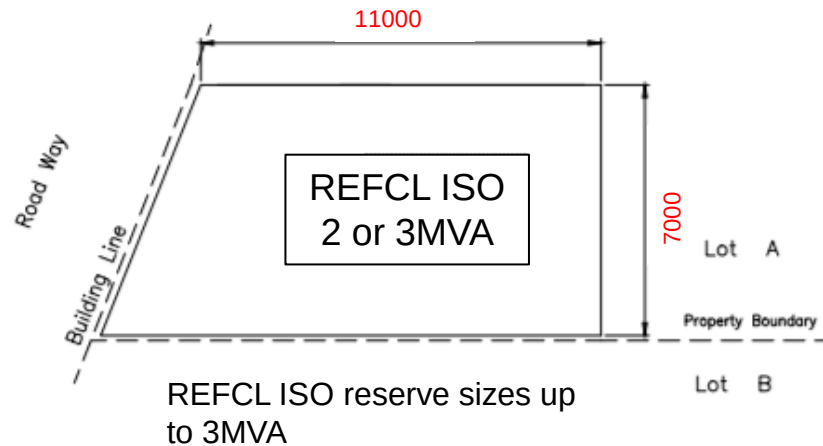
Ground mounted Isolating Transformer 1-3MVA



Current Kiosk Reserve sizes in Estates



Isolating Transformer Reserve size in Estates

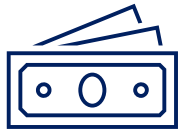


Requirements

A double brick (or similar) fire rated boundary wall 1.8m high is required where the reserve boundary abuts a residential allotment. **

Crushed rock base or asphalt surrounding ISO.

** without fire rated walls reserve size would need to be increased by at least 3m in all directions



Cost implications on HV rebates

- The installation cost of Isolating transformers will be **funded by AusNet** with funding via regulated tariff mechanisms from the EDPR approved by the Australian Energy Regulator (AER).
- The impact on **customer contribution** of the regulatory price reset has been calculated with revised HV re-imbursement schedules having taken effect for all offers issued from 1 March 2022.
- For estates constructed in **non REFCL areas** HV reimbursement schedules will received a modest increase of approximately 2.5%.
- For estates supplied from **REFCL area** zone substations HV reimbursements schedules have reduced to be 18.5% less that for non REFCL areas.
- **Provision of space** for a REFCL Isolating Transformer reserve (if required) will be determined in early planning with reserves to be provided by developers in the same way as for kiosk reserves.
- **Construction of fire proof barrier** for the REFCL Isolating Transformer reserve (if required) will be considered as part of civil work responsibilities of the developer.



Construction timing and SOC

- Construction of REFCL Isolating transformers will be **performed by AusNet.**
- **Option 2 Contestable Construction** for all other network assets to service the development will remain as per current practices.
- **Designs will need to take into account the REFCL Isolating Transformer** and if additional developer constructed HV assets are needed, HV rebates will be made for these.
- **Current lead times** for REFCL Isolation transformer manufacture and delivery is 32-40 weeks. This makes early planning vital to establish the need for the estate.
- The construction also requires **site specific footing and earthing design** to be undertaken, which can add to lead times.
- Due to the long **construction delivery lead times** and depending capacitance levels, some estate stages may be delayed for energisation until the Isolating Transformer can be put into service. We are anticipating this to be rare but needs to be considered.
- In such cases, AusNet will work with the developer to explore **Statement of Compliance options** which may include the need to enter into a section 173 agreement if early SOC is deemed necessary.



Aesthetic considerations

- AusNet recognises that the REFCL Isolating transformers are **considerably larger than any kiosk substation** used to date.
- AusNet also recognises the need for estate entries to be **attractive to the public**.
- AusNet is willing to **work with the industry** to find ways to enhance the look of these necessary assets and incorporate them into estates in a sensitive way.



Wrap up and close





Thank you

