Lucy Electric

Renewable Energy Solutions

engineering intelligent solutions

Why renewables?

Renewable energy sources such as solar, wind, tidal, biomass and biogas are critical for a sustainable future which addresses global CO2 reductions. Increases in population fuelling stronger electrical equipment demand combined with the evolution towards electric vehicles will lead to an increase in consumption of energy globally. Renewable energy is the ideal route to a greener and cleaner environment.

Contents

Renewable solutions

Wind farms, solar farms, battery storage substations, biomass and bio gas plants

Projects

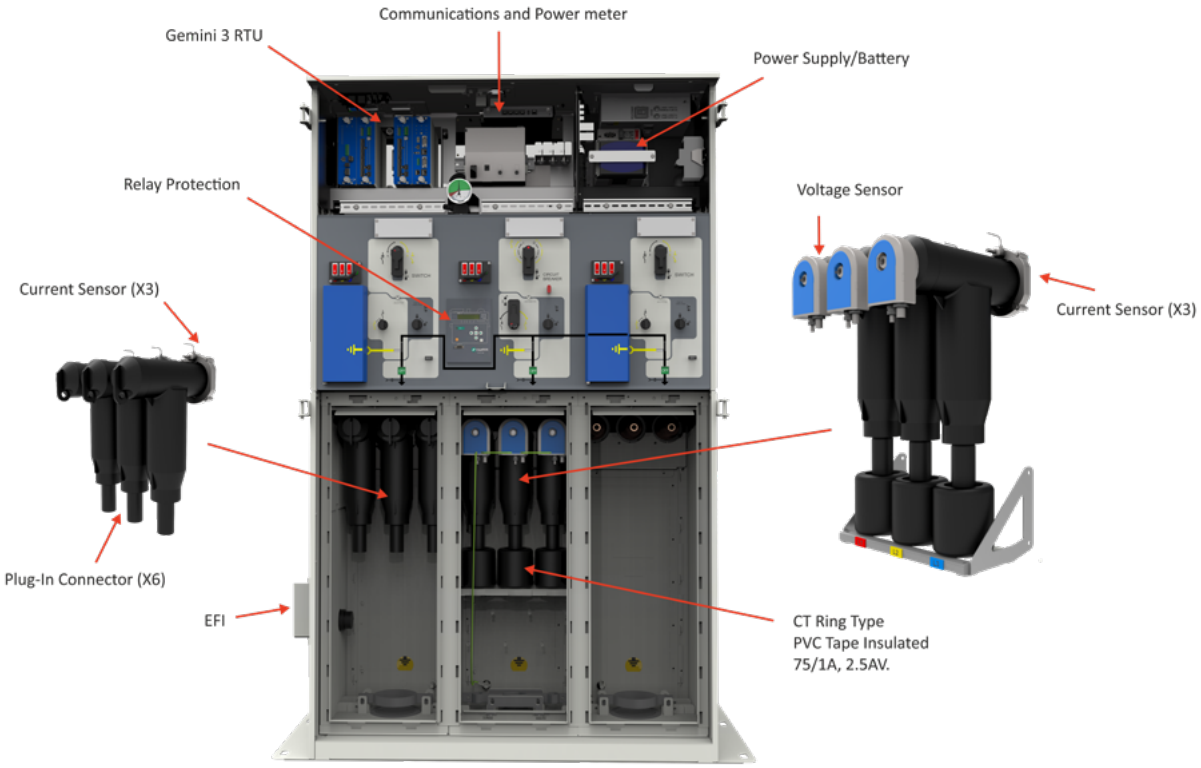
Our expertise in grid infrastructure and distribution control means we can ensure that the connection solution for your project is tailored to meet your needs and local infrastructure requirements. Below shows examples of up to 36KV solar and renewable projects:

Our engineers have extensive experience in supporting the connection of renewable generation.

Recent projects include the connection of wind farms in South Africa with total capacity of 250MW and solar PV farms with a capacity totalling 240MW in South Africa and South East Asia.

Solutions

Automated RMU

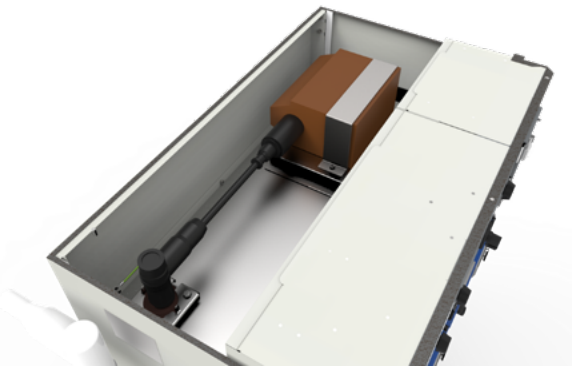


VT for aux power supply

VT with 110V or 220V AC output for auxiliary power supply

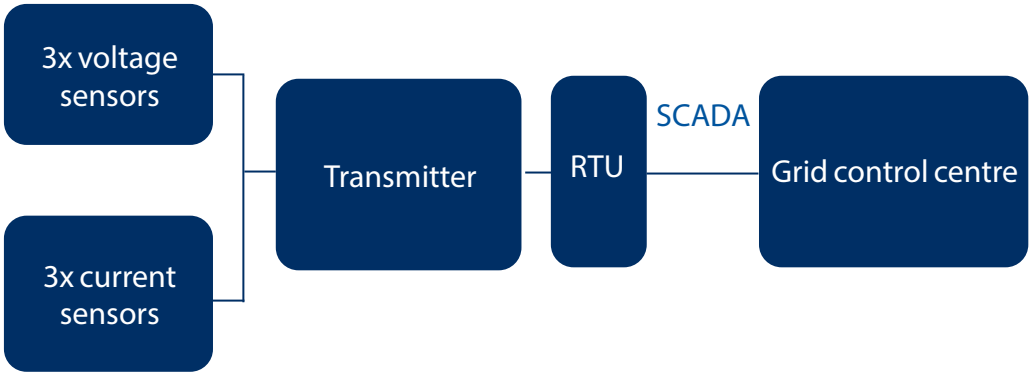
Aegis 36 with PT pannel (for auxiliary power supply)

Aegis Plus with busbar mounted VT for auxiliary power supply



Sensors and alarms

CT, VT sensors



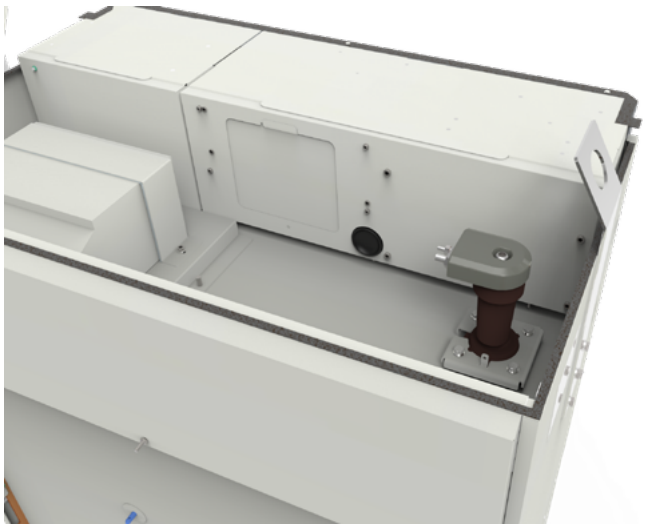
Network condition monitoring

- Real time information on
  - Voltage
  - Current
  - Power: active, reactive, and apparent
  - Power factor
  - Frequency

Load flow monitoring

- Maximum load
- Minimum load
- Mean values

Busbar mounted voltage sensor



IP54 Outdoor compact substation

The Lucy Electric IP54 outdoor compact substation comes with a range of features including the following:

Non –Extensible Ring Main Unit: Sabre VRN2a/ VRN6a

- SF6 gas insulated ring switches with Vacuum Circuit breaker, clean break technology, unrivalled levels of operator safety and low levels of maintenance.
- 12kV rated, 630 amp ring switches, 250A and 630 T-off CB variants
- Protection with TLF (Time Limit Fuse) or advanced self powered relays
- IP54 protection for indoor/outdoor installation
- Fully interlocked switches, to ESI 41-36, with padlocking for safe operation
- Extensible RMU, CB and disconnector Sabre options also available.

Transformer Mounted low voltage distribution cabinet: AcuTec

- Transformer mounted cabinets with either 800A or 1600A busbar ratings
- IP43 protection for indoor and outdoor installation
- Option for low voltage monitoring systems (GridKey) with communication platforms
- MCCB and ACB cabinets available for bulk distribution of energy
- Provision of generation connection for standby supplies
- Live current measurement and fuse test access facility per fuse handle

Transformers:

- A wide range of transformers to suit various application needs (typically 500,800,1000,1500,2000MVA, higher ratings on request).
- Extremely low noise making design to comply with the local requirements
- Highly energy efficient with very low eddy current and hysteresis losses
- Free breathing and hermetically sealed variants available
- Mineral oil (std) or high fire point fluids options (midel, silicone)
- ESI (unit type) or BEBS style transformers available
- Compact design and very low maintenance

IP54 outdoor containerised (metal enclosed) substations

Our containerised substations provide a range of solutions to meet your needs, working collaboratively with you to provide choice, flexibility and compliance with the latest standards for your market. These solutions include the following options:

Low voltage switchgear:

A fully customised low voltage cabinet with upto 2000A ratings available in the following combinations

- Air circuit-breaker (ACB)
- Moulded case circuit-breaker (MCCB)
- Low voltage fuse switch disconnector with DIN type fuses
- Instrumentation and metering options
- Low voltage monitoring systems (GridKey)

Distribution Transformers:

- Wide range of oil and dry type transformers up to 2000KVA ratings
- Extremely low noise design
- High energy efficiency with very low level of eddy current and hysteresis losses
- Available in free breathing, hermetically sealed and cast resin variants
- Compact design, virtually maintenance free.

Ring Main Units:

- Aegis
- Aegis Plus
- Sabre

Network connection and protection

The growth of renewable energy embedded on the traditional MV network has presented the electricity industry with new challenges. In order to overcome this Lucy Electric has developed new protection solutions suitable for use with either the Sabre or Aegis ring main units.

Neutral Voltage Displacement (NVD) Protection

In a healthy electrical system the neutral voltage will be negligible and close to earth. However, following a single phase to earth fault this can rise, in extreme conditions to line voltage. This phenomenon remains on the network even after the fault is cleared causing a potentially dangerous condition where an earth point is at a high touch potential. In order to prevent this, it is usual for NVD protection to be installed be the network operator at the point that embedded generation is fed onto their network. If the generation site suffers a fault resulting in the neutral voltage rising the network operator's breaker operates to disconnect the embedded generator from the main electricity network.

Lucy Electric have developed a number of solutions for this application. The system consists of a Ring Main Unit, metering unit and NVD protection panel. The metering unit is fitted with a 5 limb VT with the open delta tertiary winding used to detect the neutral voltage.

The NVD protection panel typically consists of an NVD relay, test block, transducer and flag relays indicating if a trip is initiated via the NVD or an external trip signal. The transducer is fed via a set of CTs around the metering unit outgoing bushings allowing the operator to understand and monitor the power flow from the site. The ring main unit is fully controlled by the network operator and fitted with a circuit breaker actuator which allows them to remotely reconnect once the neutral voltage is restored to zero.

Lucy Electric can either offer the NVD system as a combined unit with the protection panel mounted on the switchgear; this solution is fully integrated and tested within the factory. Alternatively, we can supply the NVD panel as a separate stand alone panel for floor or wall mounting.

The Lucy Electric NVD solution is fully approved for use on UK utility networks. Typical arrangements are shown below with bespoke designs being available on request.

G99 Protection (Generator and power grid connection regulation)

In order to protect the quality of power from embedded generation being exported to the network, the UK Electricity Network adopted ENA engineering recommendation of G99.

Lucy Electric are able to provide a bespoke protection solution on both the Aegis and Sabre switchgear ranges.

The G99 provides the following protections.

- Over current and earth fault
- Under and over voltage
- Under and over frequency
- Rate of Change of Frequency (ROCOF)
- Loss of mains power.

To achieve this the unit requires a voltage reference; this is provided by a VT mounted in a separate Air Metering unit (AMU) or PT cubicle directly coupled to the ring main unit.

Lucy Electric use a variety of relays to provide the voltage protection such as the ComAmp Mainspro and Siemens 7SR210. Capacitive screens within the bushings feed a voltage detection device to detect loss of mains, a lock out relay is provided in this circuit to prevent reconnection to the network until the mains are reconnected.

ATS (Automatic transfer switching)

In order to guarantee supplies on critical connections (such as hospitals), utilities will normally feed the site from two different primaries. When the supply from 1 was lost it was a manual switching process to isolate this feed and switch in the feed from primary 2. The process was then reversed once supply from the main primary was restored.

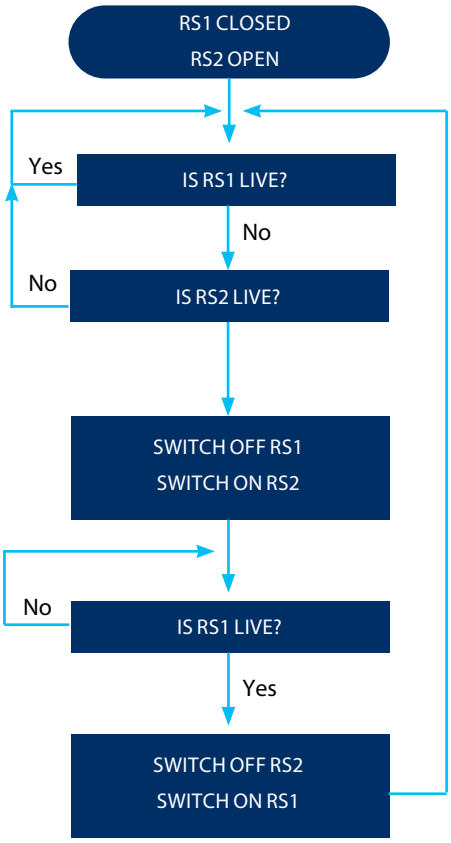
It is possible to achieve this automatically, using a single ring main unit feeding the site with the ring switches set as automatic transfer functions.

In this case each ring switch is connected to a different primary substation; it is important that both switches are never connected at the same time. Each ring switch has a VDS (voltage detection system device) and motor actuator fitted. There is an overall control panel fitted with PLCs such as the Siemens LOGO! 8 fitted on the unit.

The PLCs are connected to the VDS and programmed to give an operating sequence ensuring the power source is automatically changed if the main feed is disconnected.

The system starts with Ring Switch 1 closed and Ring Switch 2 open. It keeps checking to ensure the MV is connected to Ring Switch 1. If a loss of mains is detected on this side it checks to see if there is a healthy supply on the other side. If this is present a command is given to the actuator on Ring Switch 1 to open then a command to Ring Switch 2 to close. Note: it is important that RS1 is opened first in case the supply is restored.

As supply 1 is the preferred option the system keeps checking to see if power has restored. Once it is detected the Ring Switch2 actuator is opened and then the Ring Switch 1 closed.

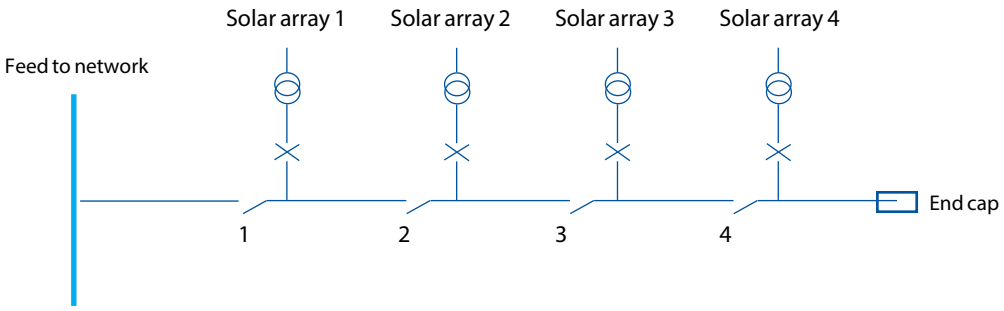


More complicated schemes may have the RMU feeding two transformers for greater resilience. Lucy Electric can also provide ATS schemes to facilitate the automatic transfer of load between this element of the network.

The ATS scheme would typically have a local / remote switch, to disable the scheme for switchgear maintenance, local indication lights highlighting which switches are live and communications back to SCADA for network visibility.

Sequential Closing

In order to understand the need for and benefits of sequential closing, consider the simple solar farm network shown below.

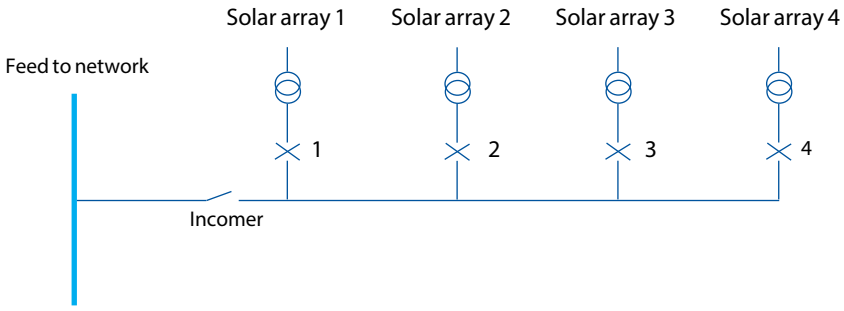


In normal operation all four solar arrays are running and exporting power to the network. The ring switches shown as 1, 2, 3 & 4 will be closed. The system can become detached from the network due to a protection trip – normally via the associated NVD or G99 protection operating. If the ring switches are left closed, when the source breaker / connection to the network is restored there would be a large inrush current. This in turn could cause the OC&EF protection to operate, tripping the breaker and disconnecting the solar farm from the network.

Sequential switching can overcome this issue.

The ring switches are fitted with a VDS device and motor actuator. When the network become disconnected the VDS devices will detect a loss of mains and a signal is sent to each associated actuator to open the ring switch (the network is now as shown in the diagram). When the network connection is restored the VDS at Switch 1 sees the power is restored so recloses the ring switch. This restores the power to the connection to switch 2. The VDS at 2 detects the restoration of power at this point and closes the associated ring switch. The sequence continues until all the arrays are switched back in. This scheme is used when the arrays are geographically spaced apart so cannot all be fed from a single unit.

An alternate arrangement is:



The incomer and four breakers may be supplied as a single unit.

The incomer is fitted with a VDS device, it may also have an actuator although this is not necessary. This switch is mainly supplied so that the feed to the solar array can be manually disconnected from the network.

The circuit breakers feeding the arrays are all fitted with actuators and a timer device. When the VDS detects a loss of mains all breakers are tripped. (At this point the ring switch at the incomer may be opened). When the mains is restored this is detected by the VDS and the breaker actuators given signals to reclose. The breaker actuator at 1 will be set to start closing immediately. The timer on breaker 2 will be set so the actuator does not start operating for 10 seconds, that at 3 after 20 seconds and finally 4 after 30 seconds. This will prevent all arrays simultaneously closing back in and reduce the inrush current.

Active Network Management

Active Network Management (ANM) is used to manage the load of a local network by integrating battery storage devices, renewable power generation source or small generators with electronics and software for monitoring and control.

ANM allows the generator to limit the power output and avoid excess energy into the network, which could have otherwise caused outage and system faults. ANM real time network measurement actively manages the energy demand and generation, while minimising the network losses along with stabilising the system and detects the faults.

Benefits of Active Network Management

- Easy system fault detection
- Prevents outages.
- Connects up to 10MW of renewable generation to the network
- Activate management of energy storage to balance the network load

Remote monitoring and control

Gemini 3

Gemini 3 is a compact and scalable RTU (remote terminal unit) platform providing advanced monitoring and control for medium voltage switchgear. Up to 4 SCADA interfaces are supported, allowing connection to the utility SCADA as well as local DER control systems for measurements, command and control. SCADA communication protocols supported include: -

- IEC 60870-5-101/104
- DNP 3.0

Gemini 3 also supports local integration of IEDs such as other RTUs and IEDs, using the following protocols: -

- Modbus
- DNP 3.0

AMM Module

The Analogue Measurement Module (AMM) which is an integral part of the Gemini 3 platform provides advanced measurement of power system currents, voltages, power, energy, power quality and directional fault passage indication.

The AMM supports traditional and non-conventional instrument transformers (NCTs). NCTs occupy less space in the switchgear, provide a much wider dynamic range than their conventional counterparts as well as being safe if accidently shorted or open circuited.

AMM order codes for AMM are: -

- AUT0004141: 110V VT, 1/5 A CT inputs
- AUT0004267: 4 V VT, 1 A CT inputs

The Gemini 3 RTU can be supplied as a freestanding device allowing it to integrate individual switchgear units. It is also available embedded with the Ring Main Unit or integrated as part of the marshalling box which would simplify procurement, supply and site installations.

Substation to substation intra communication

Gemini 3 RTUs support the IEC 61499 event driven programming language which allows both centralised and distributed processing. Using secure TCP/UDP communications between Gemini 3 RTUs allows the automatic co-ordination of switchgear at different locations, such as in a distributed transfer of source scheme (application note available for GX switch).

Products

Sabre

SF6 insulated with vacuum circuit breaker protection

Lateral and rear cable termination, SF6 gas insulated RMU, fully weather proof with IP54 for outdoor applications.

Characteristics

- Up to 24 kV and 630 A ratings
- Non extensible, extensible and modular range
- Switching functions enclosed in SF6 gas insulated stainless steel tank sealed for life
- Intuitive single line mimic diagram for simple and safe operation
- Integrated cable earth and test facility
- Choice of TLF (time limit fuses) or self / auxiliary powered relay protection
- Anti reflex mechanism to prevent load break switch opening under fault conditions
- Fully interlocked operation with padlocking facility for maximum operator protection
- Freestanding and transformer mounted units
- Actuators (motorised) for ring switches and circuit breakers
- IP54 for outdoor installation without requiring a kiosk
- Seamless integration with SCADA network for remote operation and control
- Maintenance free with 30 years life expectancy

Technical Data					
Rated voltage	kV	12	15.5	17.5	24
Rated current: ring switch	A	630	630	630 / 400	630
Rated current: vacuum circuit breaker	A	250 / 630	250 / 630	400 / 630	250 / 630
Impulse withstand voltage	kV	75	95	95	125 / 145
Short circuit making current	kA	50	50	54.6	40
Short circuit breaking current	kA	20	20	21	16
Internal arc rating	kA / 1sec	20	20	21	16

Range		Extensibility			
Product range	Description	Non extensible	Left hand extensible	Right hand extensible	Both ways extensible
Ring main units	2 ring switches and 250 A vacuum circuit breakers	✔	✔	✔	✔
Modular units	2 ring switches and 630 A vacuum circuit breakers	✔	✔	✔	✔
	250 A vacuum circuit breaker		✔	✔	✔
	630 A vacuum circuit breaker		✔	✔	✔
	630 A single ring switch		✔	✔	✔
	630 A double ring switch	✔	✔	✔	✔

Aegis Plus

SF6 insulated with vacuum circuit breaker or fuse switch protection

Front cable termination, SF6 insulated RMU with up to 5 switching functions in a single stainless steel enclosure

Characteristics

- 12, 17.5 and 24 kV with up to 630 A ratings
- Extensible and non extensible range with a wide choice of configurations
- Any combination of load break switches, vacuum circuit breakers or fuse switch available
- No on-site SF6 gas handling for installation
- AF, AFL and AFLR internal arc protection
- Intuitive single line mimic diagram
- Horizontal cable terminations with DIN 400 type C bushings
- Front access earth and test facility
- Integrated motorisation for remote control operation
- Vacuum circuit breaker protection with relays or TLF and fuse switch protection for transformers
- Suitable for Indoor (IP41) and outdoor (IP54) applications
- Integrated Gemini 3 RTU for easy SCADA connection, with optional automatic transfer scheme (ATS)
- Fully interlocked, anti-reflex mechanisms with padlocks
- Maintenance free with 30 years life expectancy

Technical Data				
Rated voltage	kV	12	17.5	24
Rated current: ring switch	A	630	630	630
Rated current: vacuum circuit breaker	A	250 / 630	250 / 630	250 / 630
Fuse Switch	A	200	200	200
Impulse withstand voltage	kV	75 / 85	95 / 110	125 / 145
Power frequency withstand voltage	kV	28 / 32	38 / 45	50 / 60
Short time withstand current	kA 3s	21	21	21
Short circuit making current	kA	52.5	54.6	52.5
Short circuit breaking current	kA		21	
Internal arc rating	kA 1s		21	

Range	Extensibility							
	Extensible					Non- extensible		
Configuration	1-way	2-way	3-way	4-way	5-way	3-way	4-way	5-way
Load break switch and/or 250 A circuit breaker	✔	✔	✔	✔	✔	✔	✔	✔
Load break switch and/or 630 A circuit breaker	✔	✔	✔	✔	✔	✔	✔	✔

Aegis[36]

SF6 insulated with vacuum circuit breaker protection

Front cable termination, SF6 insulated RMU with up to 4 switching functions in a single stainless steel enclosure

DV function: direct incomer with side cable entry

Characteristics

- 36 kV with up to 630 A ratings
- Extensible and non extensible range with a wide choice of configurations
- Any combination of load break switches and vacuum circuit breakers available
- No on-site SF6 gas handling for installation
- AF and AFLR internal arc protection
- Intuitive single line mimic diagram
- Horizontal cable terminations with DIN 400 type C bushings
- Front access earth and test facility
- Integrated motorisation for remote control operation
- Vacuum circuit breaker protection with relays
- Suitable for Indoor (IP41) and outdoor (IP54) applications
- Integrated Gemini 3 RTU for easy SCADA connection, with optional automatic transfer scheme (ATS)
- Fully interlocked, anti-reflex mechanisms with padlocks
- Maintenance free with 30 years life expectancy

Technical Data		
Rated voltage	kV	36
Rated current: ring switch	A	630
Rated current: vacuum circuit breaker	A	630
Impulse withstand voltage	kV	170/195
Power frequency withstand voltage	kV	200/220
Short time withstand current	kA 3s	50/62.5
Short circuit making current	kA	21 kA 3s/ 25 kA 1s
Short circuit breaking current	kA	
Internal arc rating	kA 1s	25

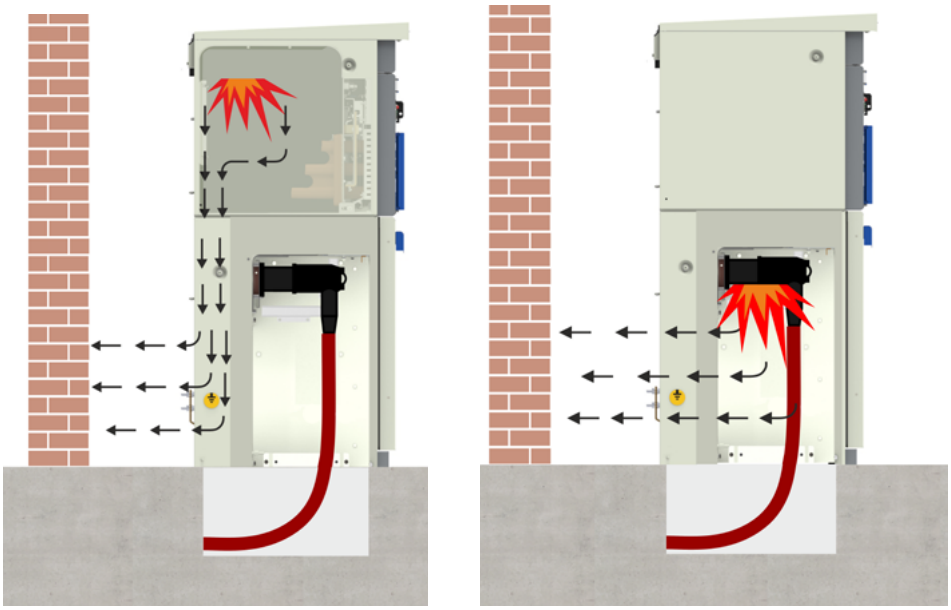
Range	Extensibility						
	Extensible				Non- extensible		
Configuration	1-way	2-way	3-way	4-way	2-way	3-way	4-way
Load break switch and/or 250 A circuit breaker	✔	✔	✔	✔	✔	✔	✔
Load break switch and/or 630 A circuit breaker	✔	✔	✔	✔	✔	✔	✔

Protection

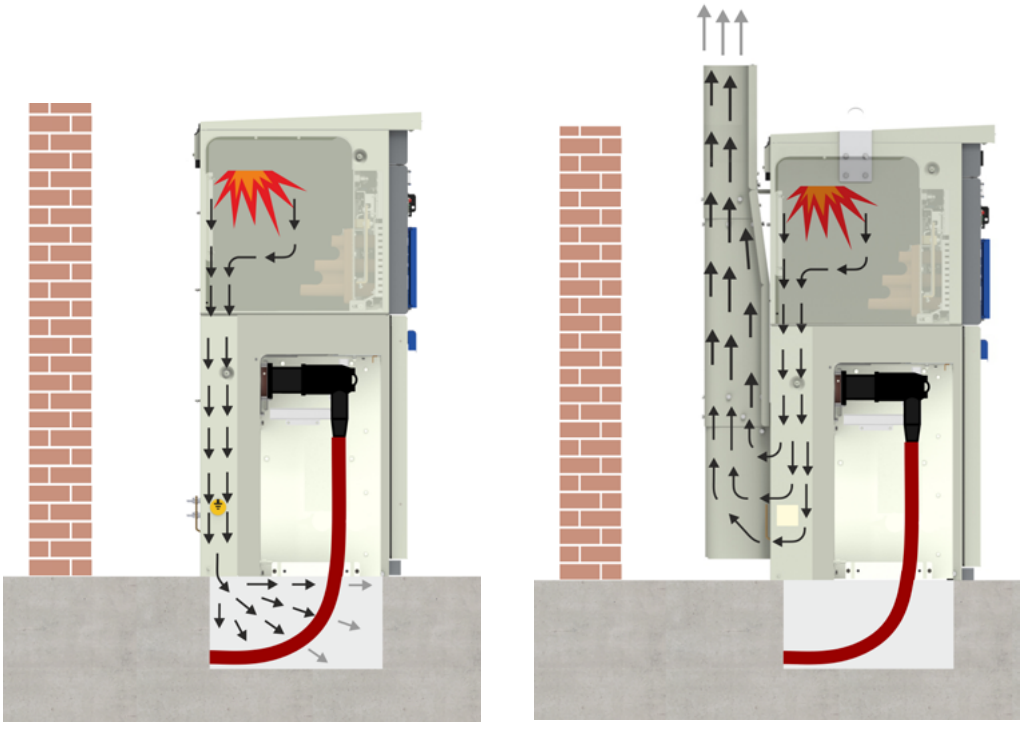
Internal arc

The Switchgear is tested to Internal Arc 20, 21 and 25kA 1s according to IEC 62271-200

AFL



AFLR



Lucy Electric worldwide offices

Lucy Electric Ltd.
Howland Road, Thame, Oxfordshire,
OX9 3UJ, United Kingdom
Tel: +44 1844 267 267 General
Tel: +44 1844 267 222 Sales
Fax: +44 1844 267 223
Email: salesuk@lucyelectric.com

Lucy Middle East FZE.
PO Box 17335, Jebel Ali, Dubai,
United Arab Emirates
Tel: +97 148 129 999
Fax: +97 148 129 900
Email: salesme@lucyelectric.com

Lucy Electric (Thailand) Ltd.
388 Exchange Tower, 37th Flr Unit 3702,
Sukhumvit Road, Klongtoey Sub district,
Klongtoey District, Bangkok,
10110, Thailand
Tel: +66 (02) 663 4290
Fax: +66 (02) 663 4293
Email: salesth@lucyelectric.com

Lucy Switchgear Arabia Co. Ltd.
Novotel Business Centre,
P.O. Box 35340, Dammam 31488,
Saudi Arabia
Tel: +966 138 147 910
Fax: +966 138 147 914
Email: salessa@lucyelectric.com

Lucy Electric (South Africa).
Unit 12 & 13, Block C,
Honeydew Business Park,
1503 Citrus Street, Laser Park,
Honeydew, 2170, South Africa
Tel: +27 11 025 7490
Fax: +27 11 794 3277
Email: salesza@lucyelectric.com

Postal Address:
P.O. Box 1078, Honeydew, 2040

Lucy Asia Pacific Sdn Bhd.
L17-05-06, PJX-HM Shah Tower,
No16A Jalan Persiaran Barat,
46050 Petaling Jaya, Selangor, Malaysia
Tel: +603 74910700
Fax: +603 79316923
Email: salesmy@lucyelectric.com

Lucy Equipamentos Elétricos Ltda.
Av. das Araucárias 2558
Thomaz Coelho, CEP 83707-067,
Araucária Paraná State, Brazil
Tel: +55 (41) 2106 2801
Email: salesbrazil@lucyelectric.com

Lucy Electric India Private Ltd.
F-10, MIDC, Ambad
Nasik 422010
India
Tel: +91 253 2381603
Fax: +91 253 2381247
Email: salesindia@lucygroup.com

engineering intelligent solutions

www.lucyelectric.com