



CUSTOMER PRESENTATION

UniPack-S

Steel Compact Secondary Substation (CSS)



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Introduction and product information

Introduction

What is ABB's Compact Secondary Substation (CSS)?

- CSS is a type-tested substation containing:
 - Medium voltage (MV) switchgear
 - Distribution transformers
 - Low voltage (LV) switchboard
 - Connections and auxiliary equipment to supply low voltage energy from medium voltage systems
- CSS is for energy transformation in secondary distribution network from MV to LV or LV to MV
- CSS is typically installed in locations accessible to the public and should ensure protection for all people according to specified service conditions
- All CSS components shall be type- and routine-tested per their relevant product standards



Complete CSS portfolio

UniPack

ABB offering

The UniPack family is a factory type-tested prefabricated assembly containing:

- Enclosure with natural ventilation and several layouts
- Medium voltage switchgear
- Distribution transformers
- Low voltage switchboard

- Enclosure material
 - Galvanized steel
 - Marine grade aluminum material - optional
 - Stainless steel - optional

ABB components

- Gas or air insulated MV switchgear up to 40.5 kV
- Oil or dry transformers up to 3500 kVA
- Various number and ratings of outgoing feeders available

Standards

- Fully type-tested according to the latest edition of IEC62271-202, with high reliability and safety
- Arc classification (IAC-AB) test

Typical applications

CSS applications

- **Distribution** - transformation and public distribution
- **Operation** - operation at medium voltage level
- **Supply** - supply to satellite stations
- **Customer supply** - supply to major electricity customers
- **Feeding** - connection of decentralized power plant to the public network
- **Networks** - substations for radial and ring connections



Product overview

- Up to 3500 kVA, 40.5 kV
- Type tested as per IEC 62271-202 Ed. 2.0
- Internal arc tested for operator and public safety
- Design of wall elements prevents water penetration into CSS
- Highly flexible layouts for applications and logistics
- Lighter and lower cost to ship greater distances
- Oil collection pit integrated in the foundation
- Designed for safety, system continuity and environmental friendliness



Main concept

UniPack-S

Walls, roof, doors and other components are made of galvanized sheet steel

- Pre-galvanized material ensures higher corrosion protection than painted black steel
- UniPack CSS design combined with different steel thicknesses ensures sufficient mechanical stability and robustness for handling, installation and service
- 2 point door locking system as standard, 3 point as an option
- Other materials in different thicknesses available on request



Components of UniPack-S

Main components

- Medium voltage secondary switchgear
 - SafeRing/SafePlus
 - SafeRing Air/AirPlus
 - UniSec
 - SafeLink 2
 - SafeLink CB
- Distribution transformers
 - Oil type, hermetically sealed
 - Dry type
- Low voltage switchboard
 - UniPack LVS
- Automation



Typical layouts

UniPack-S

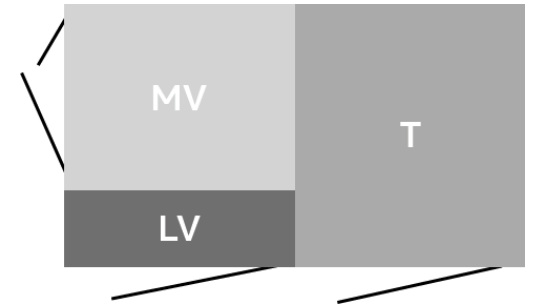
Charon



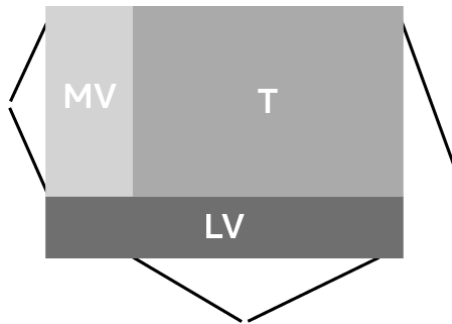
Mercury



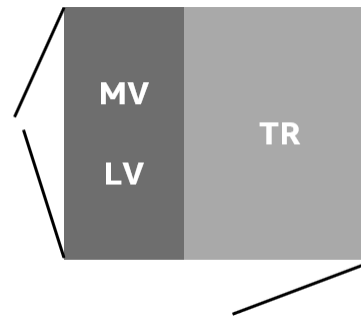
Mars



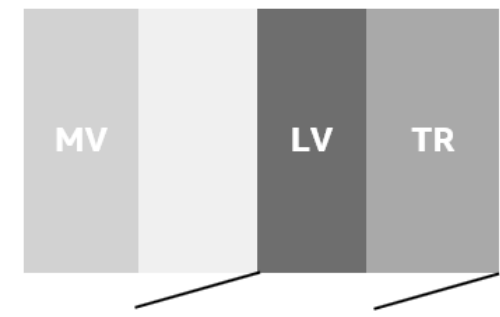
Terra



Pluto



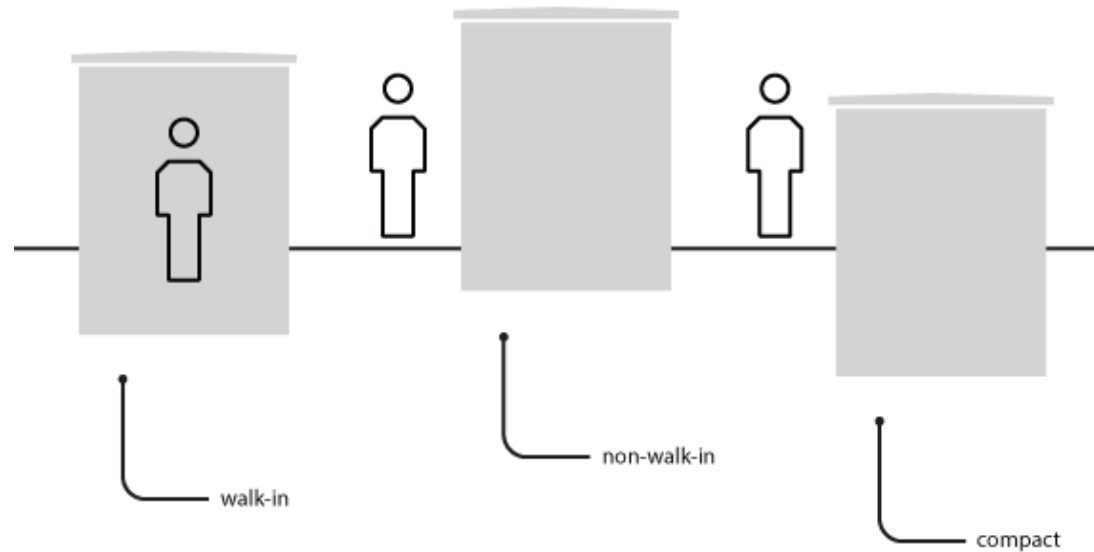
Jupiter



Common enclosure types

UniPack

- A "walk-in" type CSS is situated at ground level or partially buried and operated by entering the CSS
- A "non-walk-in" type CSS is situated at ground level and operated from outside
- A "compact" type CSS is situated partially below ground level and operated from outside



Segments

Compact Secondary Substations are often used in the following segments

Utility

Industries

Solar and wind

E-mobility

Data center

Small generation

Mining & oil and gas

Food & Beverage

Energy Storage

Infrastructure/ports

Rail



Product features

CSS foundation material

UniPack-S platform has different foundations available:

- Compact – concrete foundation benefits are integrated oil pit and detachable cover plates
 - Cover plates are made of 2 mm galvanised sheet steel with a high zinc content to avoid corrosion due to direct contact with foundation and ground
 - Thicker zinc layer is needed for corrosion protection at ground level due to higher soil humidity
 - Cable entries with inlet are available as an option
- Steel - galvanized steel frame benefits are lighter and have high corrosion resistance



Product features

Design features

- Double layer door
 - Provides strength and robustness to doors and design
- No corner elements
 - Allows efficient space utilization in equipment compartments
- Double roof in MV and LV areas (optional)
 - Reduce solar radiation effect inside the CSS and prevent water dripping to the equipment
- Optimized material thicknesses
 - Type tested design available in different material thickness, starting from 1mm
- Different roof slope
 - For snowy or heavy rain areas
- Ingress Protection (IP Class)
 - Up to IP 54 for MV and LV compartment
- Locking device prepared for padlock or cylinder lock available



Customer benefits

Customer benefits

Customer benefits



1. High safety

- Provides safety to equipment, personnel and environment
- Internal arc fault tested



2. Reliability

- Type tested and factory test products



3. Long lifetime of internal components

- Zinc coated plates in foundation
- Effective ventilation



4. Easy and fast installation

- Pit type foundation allows for faster installation
- Complete factory-delivered solution with only external connection to be done at site



5. Ease of maintenance

- Compartmented roof
- Wide door opening
- Limited number of moving parts

1. High safety

Features and benefits

- 2 point locking (3 point - optional)
 - Increased safety to prevent unauthorized entry to CSS
- Internal arc tested design
 - Provides high safety to public and service personnel
- High protection degree
 - Increased safety level and prevents animal entry
- Compartmented design
 - Provides higher safety for service personnel and containment for arc gas
 - Prevents access between compartment
- Oil pit
 - Prevents oil leakage to the environment



Safe for operator and public

Safety



Arc-proof CSS



Non-arc-proof CSS



Internal Arc Classified per IEC 62271-202 Ed. 2.0

- Operator - A
- Public – B
- UniPack is rated IAC AB, 20 kA for 1 sec as a standard

Safe for operator and public

Internal Arc Classification (IAC)

Safety

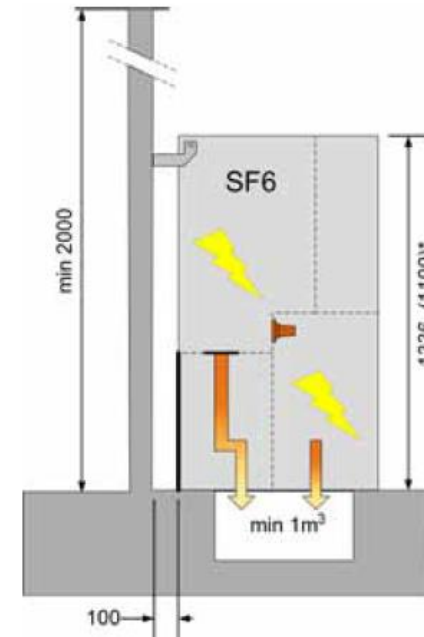
Arc proof MV switchgear inside CSS does not mean that CSS is arc tested

MV switchgear need to be tested when installed inside CSS due to:

- Overpressure inside CSS
- Overpressure on RMU covers
- Hot gases escaping the CSS

Hot gases escape from MV SWG need to be controlled by CSS design

Arc proof SWG



Non-arc proof CSS



Safe for equipment installed inside

UniPack-S and UniPack-G

Transformer lifetime comparison

Classified CSS – 10K

- Lower top-oil and hot-spot temperature
- Higher lifetime of transformer
- Capability for temporary overloading

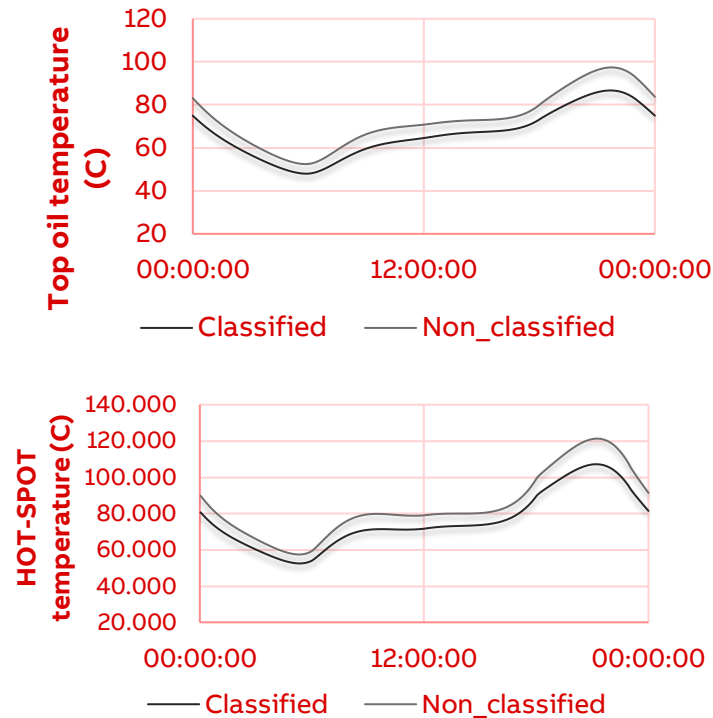
Not classified CSS

- Higher temperatures on oil and hot-spot
- Lower lifetime of transformer
- Risks of failures on the insulation caused by high temperatures on the hot-spot.

In Classified CSS transformer lifetime is 4 times more

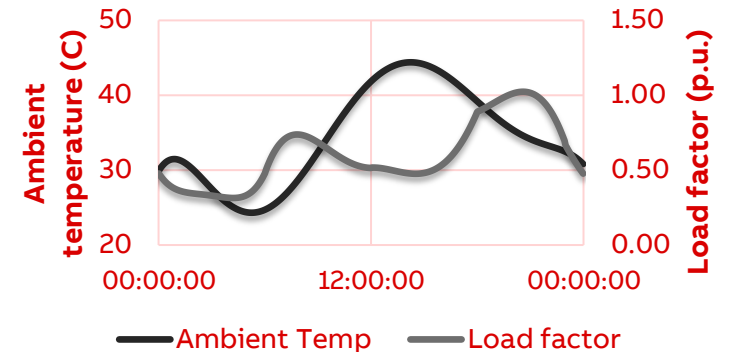
- Loss of lifetime calculation based on IEC 60076-7
- Not classified CSS equivalent to 25K for this simulation

Trends



Conditions

35 °C daily average, 45 °C maximum
60/65 transformer, Utility load profile



Tested according to IEC 62271-202 Ed.2

– Mandatory type tests on CSS:

- Dielectric tests
- Temperature rise tests
- Short time and peak withstand current of main and earthing circuits
- IP tests (degree of protection)
- Mechanical stress tests (IK, roof load, wind pressure)

– Mandatory tests where applicable:

- Internal arc fault test (if IAC classification is required)
- EMC test

– Optional type test on CSS:

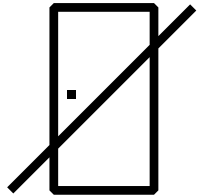
- Sound level test (to be agreed between manufacturer and user)
- EMF (test or calculation)



2. Reliability

Features and benefits

- Robust design, factory routine tested and type tested products so the performance and function will not be insensitive to variance
- Double layer door
 - Provides strength and robustness to doors and design
- Optimized material thicknesses
 - Type tested design available in different material thickness, starting from 1mm



3. Long lifetime of internal components

Features and benefits

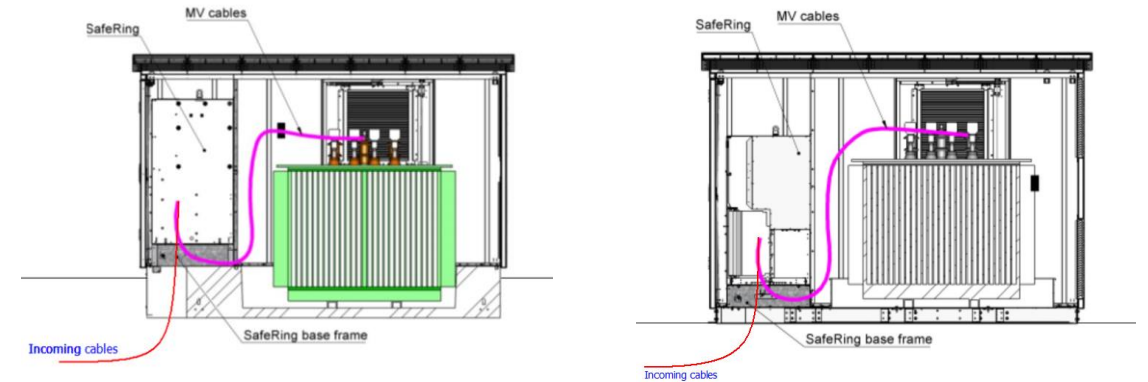
- Zinc coated plates in foundation
 - Thicker zinc layer is needed for corrosion protection at ground level due to higher soil humidity
- Prevents water penetration between frame and enclosure
- Optimized ventilation
 - UniPack platform ventilation provides efficient air flow and better cooling which increase transformer life time, even with high degree IP protection (up to IP45 for ventilation grid)
- Stainless steel hinges
 - High resistance to corrosion
- Double roof (optional)
 - Reduce solar radiation inside the CSS and prevent water dripping to the equipment



4. Easy and fast installation

Features and benefits

- Foundation
 - Available both concrete and steel
 - integrated oil pit and detachable cover plates
 - Removable cover plates allows easy installation on site
 - Galvanized steel frame - lighter and corrosion resistant
- Lightweight, optimized transportation allow for ease of installation



5. Ease of maintenance

Features and benefits

- Main components from ABB
 - Domain expertise
- Optimized number of components
 - Reduces repair time and spare parts
- Compartmented roof
 - Possibility to work in compartments while keeping other station parts stays in operation
- Hinges
 - Simple and robust construction allows easy service
- Wide door opening
 - Provides more space for maintenance and service activities
- Limited number of moving parts
 - Increase reliability and allows to optimize stock





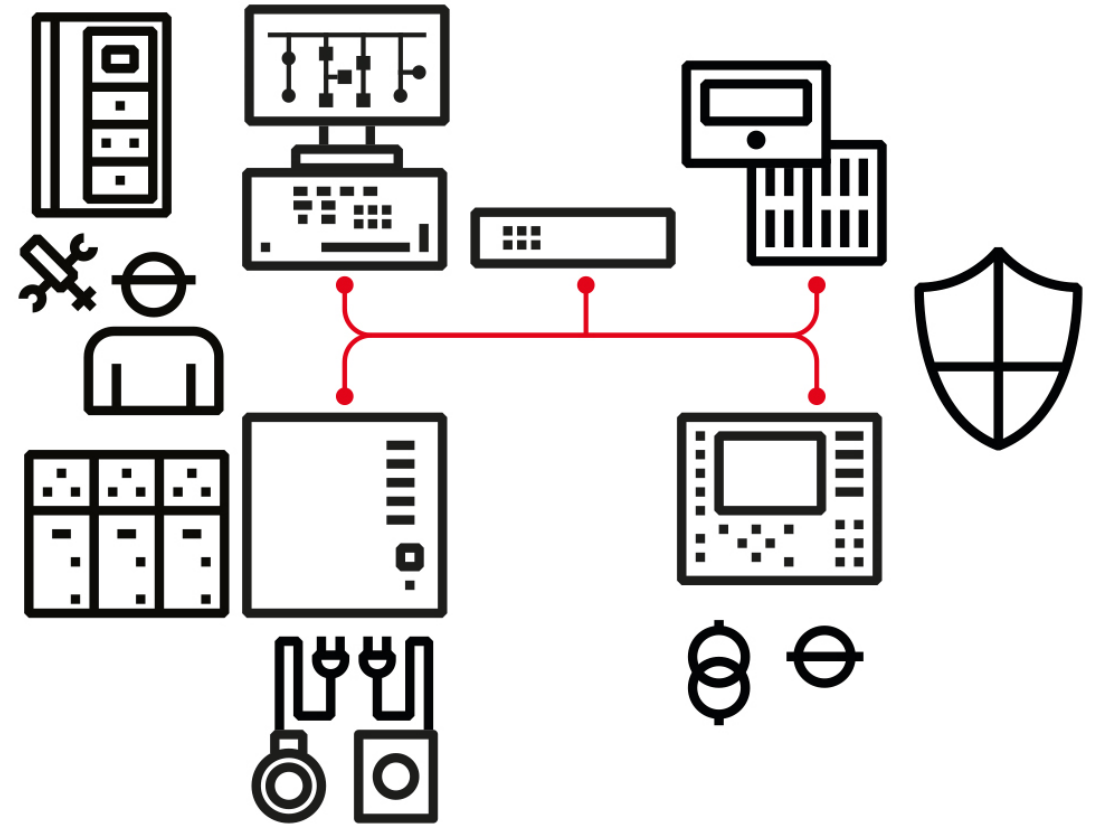
Digitalization

Market trends

Increasing levels of automation are expanding into secondary substations. These need to be connected for distributed applications and for SCADA and DMS applications.

There are various levels of digitalization, from basic communication to implementation of a station-level self-healing strategy.

Centralized, self-healing capabilities maximize distribution circuits' reliability and require automation of switching points and communications platforms.



Digitalization

Benefits and features

Flexible, modular and well integrated solutions

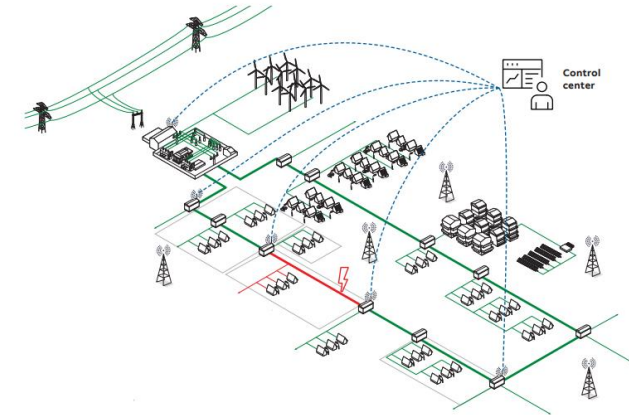
- A wide portfolio of solutions to cover the basic demand of monitoring and control to more demanding solutions for the diverse and evolving power distribution grids including fault management and protection selectivity
- Fully integrated and tested in the factory to minimize time on site

Bringing your asset within reach

- With secure and cost effective connectivity over public wireless networks the communication will be managed with the control center from the CSS to maximizing uptime and availability

State of the art fault passage indication

- ABB's unique, multifrequency admittance-based earth-fault detection algorithm for fault passage indication (FPI) is now able to detect all types of earth faults with unequalled accuracy, irrespective of the type of distribution network

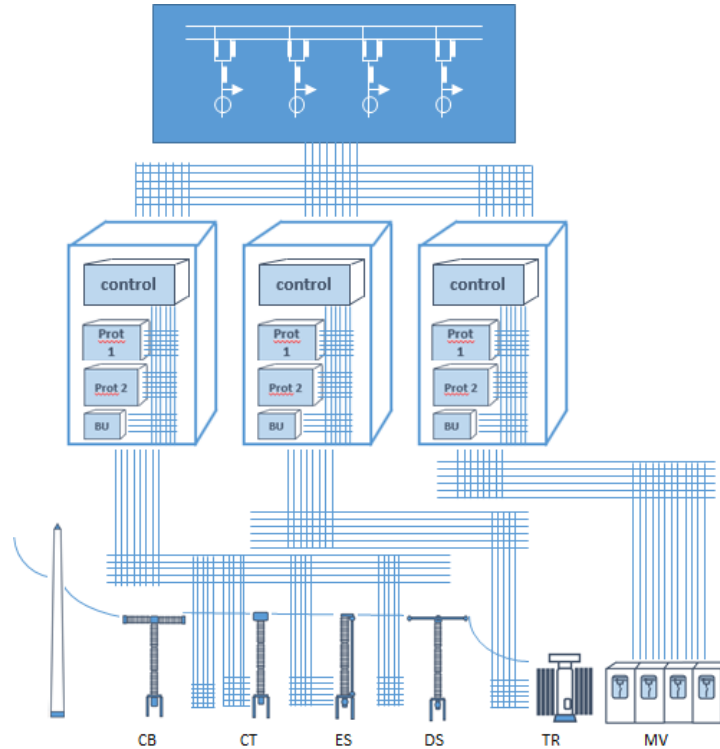


Smart CSS

Conventional compared to Digital

Conventional substation (example MV)

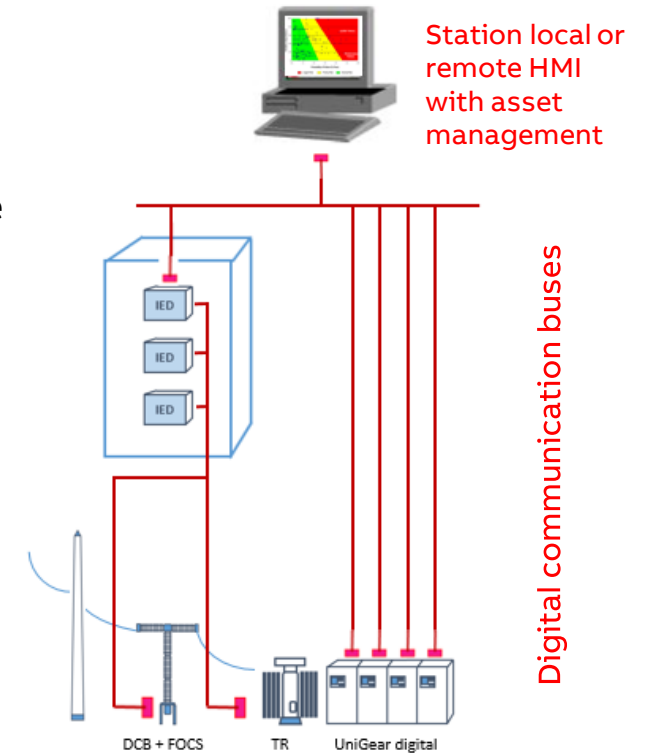
Primary components stand alone



Digital substation (example MV)

Small foot-print integration

- 80% copper reduction
- 40% shorter installation time
- 50% less space required
- Operational cost reduction
- 50% outage time reduction

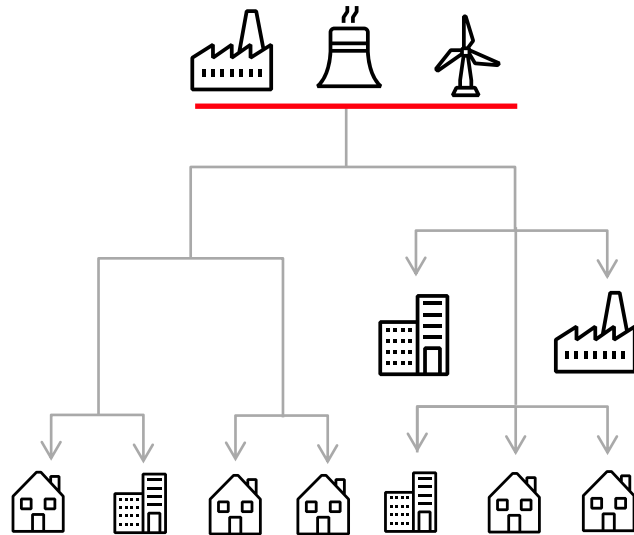


Smart CSS - key elements in a Smart Grid

The evolving grid

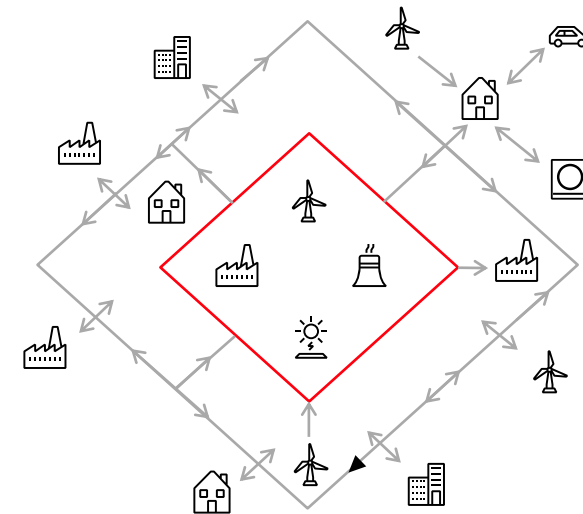
From traditional to smart grids – Smart CSS a key element

Traditional grid



- Centralized power generation
- One-directional power flow
- Generation follows load
- Top-down operations planning
- Operation based on historical experience

Smart grid



- Centralized and distributed generation
- Multi-directional power flow
- Intermittent renewable generation
- Consumption integrated in system operation
- Operation based on real time data

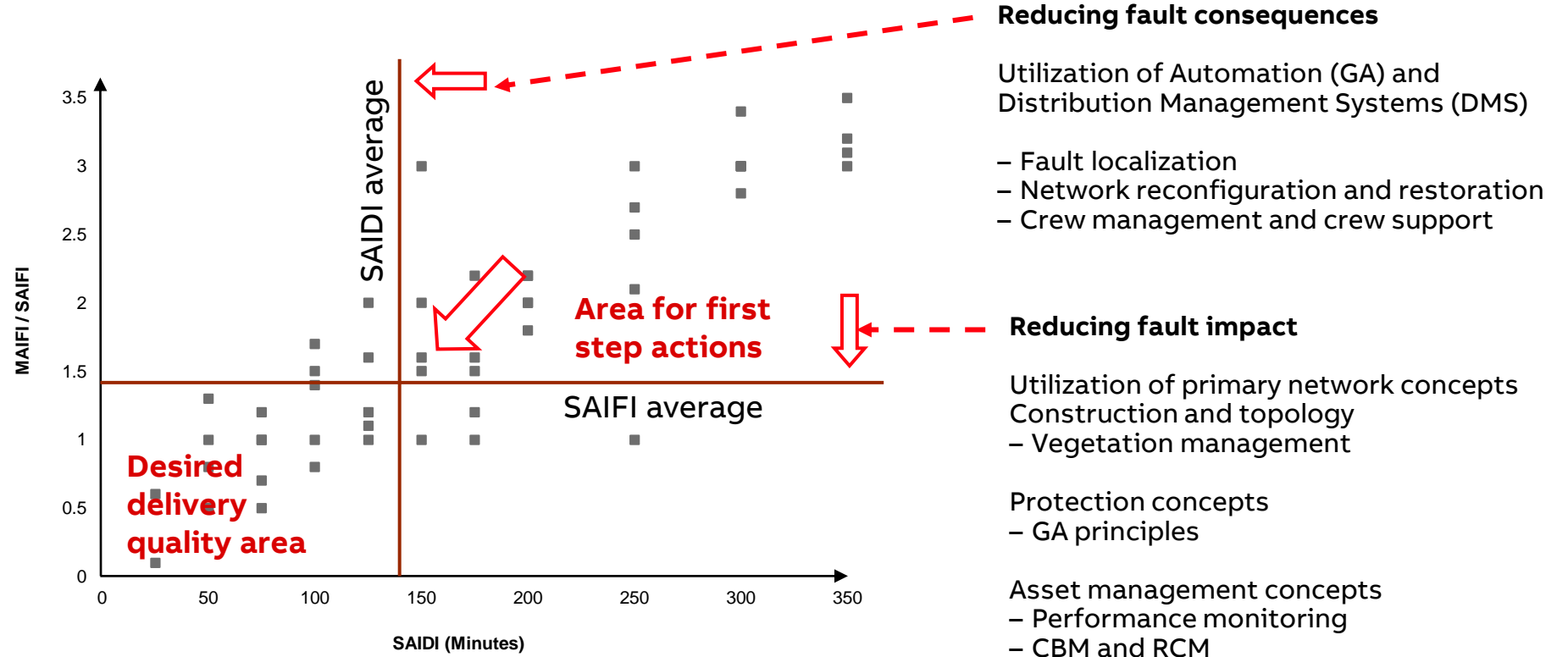
Smart CSS for grid automation

Digitalization can help reduce the number of outages and the duration

– SAIFI
= System Average
Interruption
Frequency Index

– SAIDI
= System Average
Interruption
Duration Index

– MAIFI
= Momentary
Average
Interruption
Frequency Index





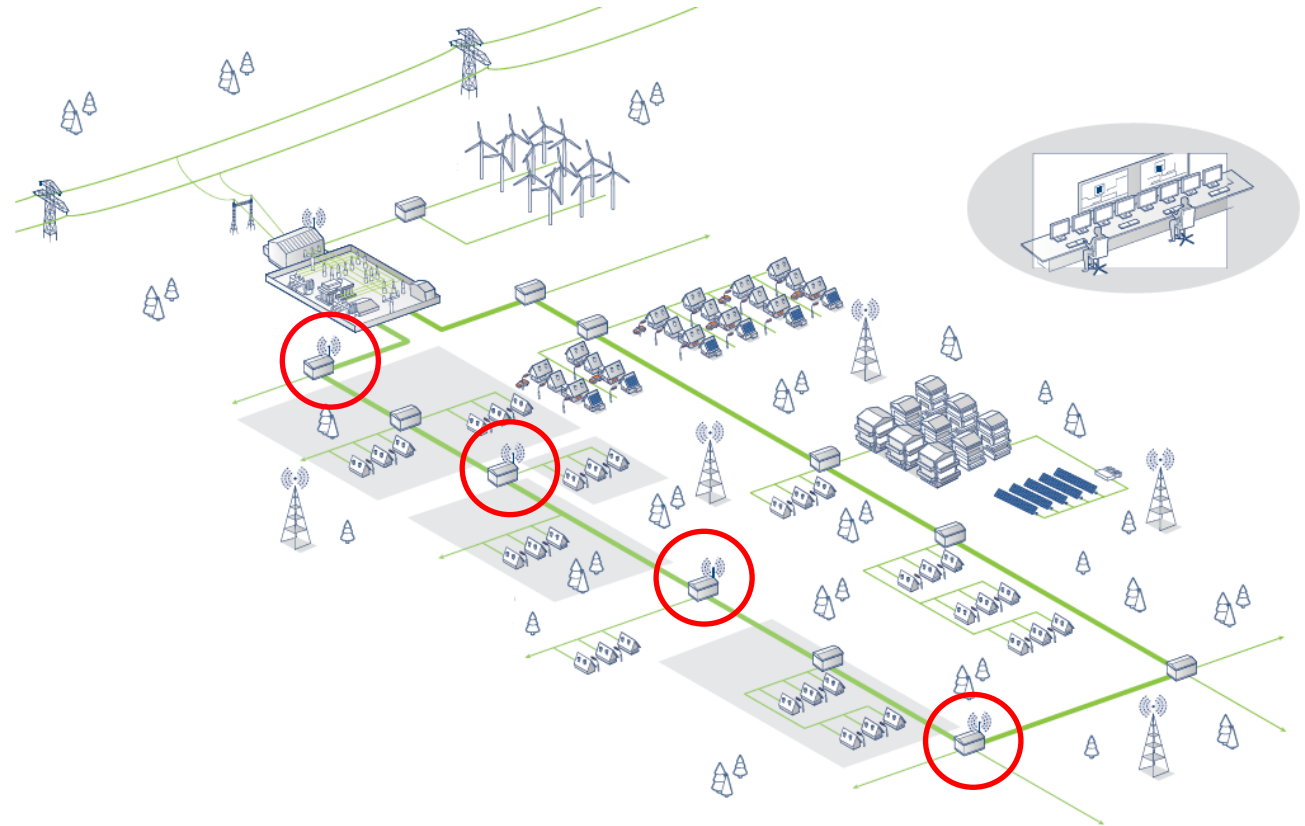
How a Smart CSS is working in a Smart Grid

Digitalization - The zone concept

Fault management

Example

- Open ring cable network with **coupling points** from other feeders/rings
- Compensated network
- Feeder is divided to zones
- Protection in primary switchgear
- **Fault passage indicators** in secondary substations
- **DMS controls automatically the restoration** process in case of fault

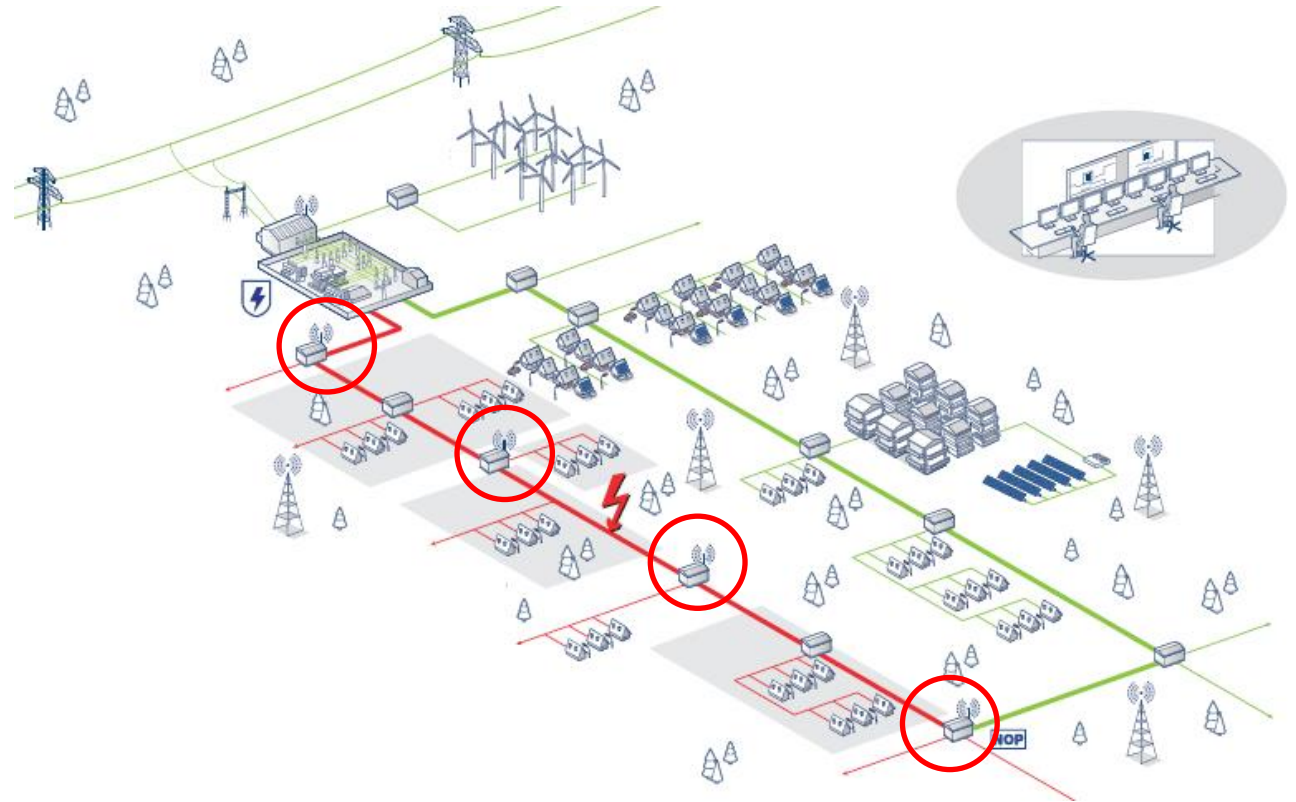


Digitalization - The zone concept

Fault management

Example, protection

- When an over current or earth fault occurs in the feeder protection in the primary substation trips the feeder

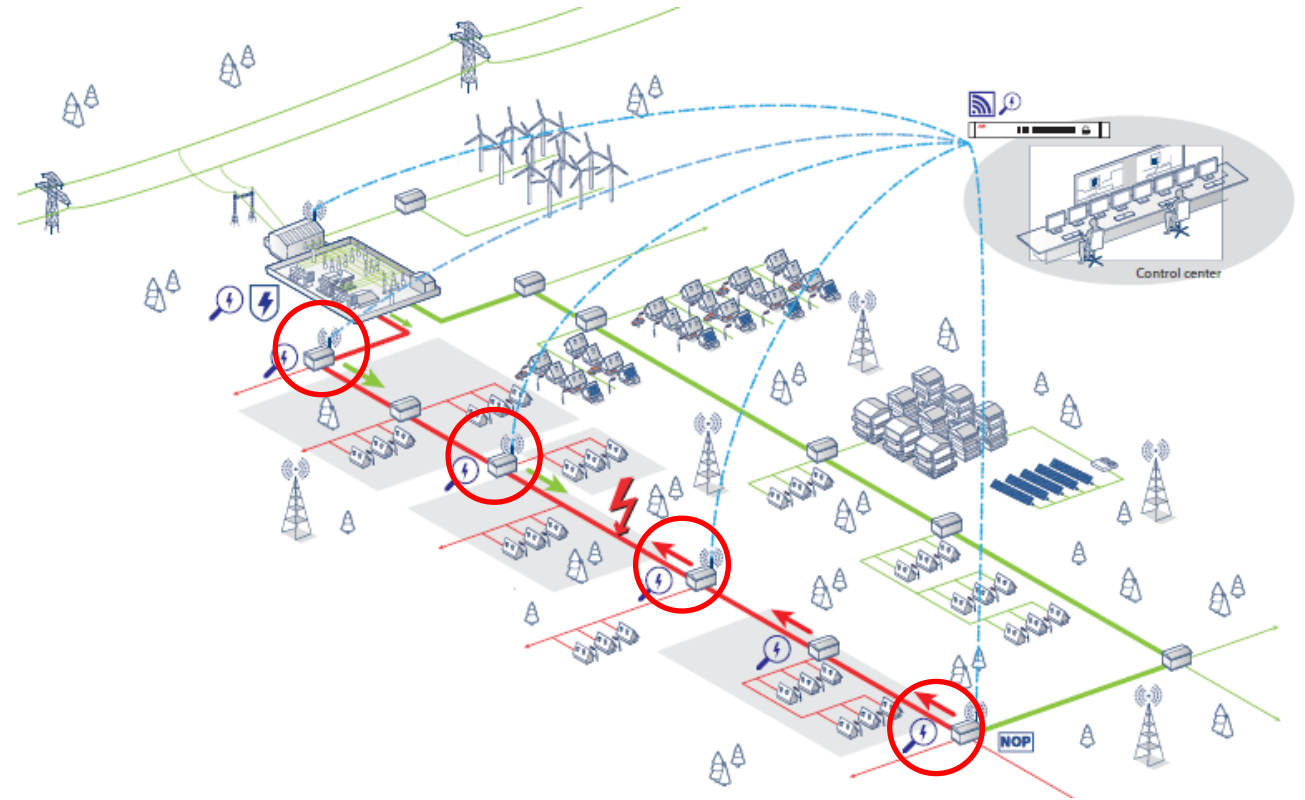


Digitalization - The zone concept

Fault management

Example, indication

- Fault passage indicators installed between zones **indicate the direction of the fault**
- Fault information from each node is **communicated to DMS**
- In case of over current fault protection relay can calculate distance to fault (Primary Substation)

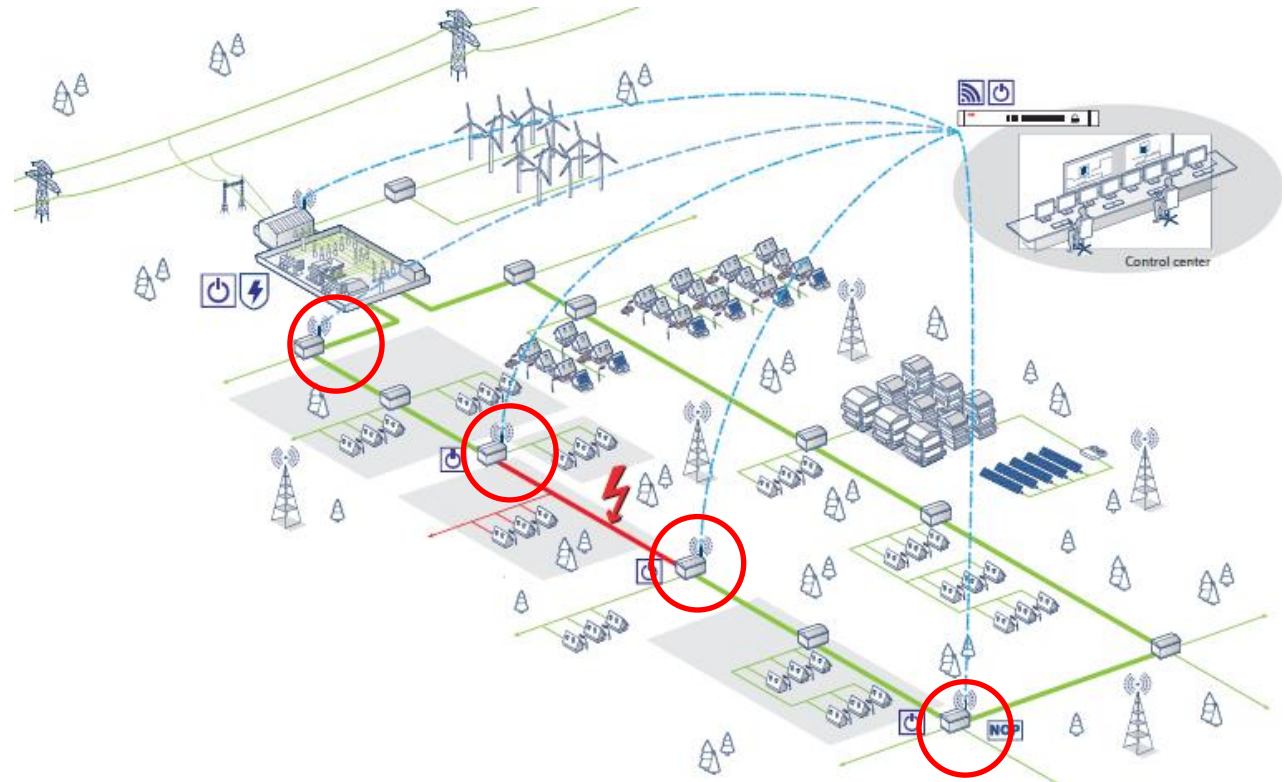


Digitalization - The zone concept

Fault management

Example, restoration

- Based on received fault information **DMS locates the fault**
- **Controlling remotely** the primary equipment limits the affected area
- **Rest of the network is restored** in fast manner



Smart CSS configuration and customer value add

Smart CSS

Typical challenges by segment

Utility typical challenges

- Large and complex MV distribution grid
- Cable and overhead line
- Large distance between CSS
- Outages at consumers cause penalties \$\$\$
- Hard to localize and clear the fault
- Outages may affect multiple CSS

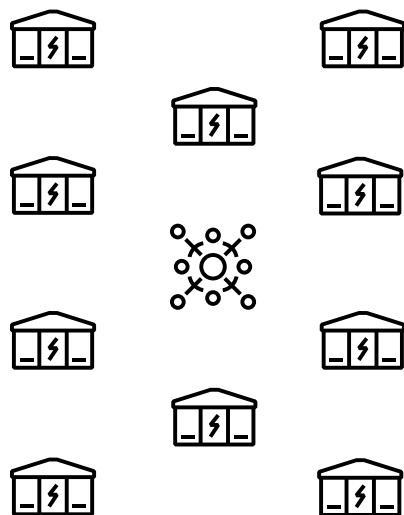


ABB advantages

- Alarms of potential issues, enabling action prior to outage for circuit breakers and transformers as well as auxiliary equipment
- Fast and accurate protection to minimize damage for the power system
- Remote control provides flexibility from control room and minimizes site visits
- Advanced earth Fault location (FLIR)
Automatic network reconfiguration in case of line fault to minimize outage time
- Predictive maintenance based on MV Switchgear, transformer or low voltage switchgear condition

Digitalization Packages - simplify the selection of advanced functions and logics with group of packages able to satisfy requirements by market segments and applications

Smart CSS

Typical challenges by segment

Solar, small generation and industry challenges

- High power utilization
- Lifetime and health of equipment is critical
- Downtime cause loss of \$\$\$
- Need to minimize energy cost and carbon footprint
- Need to implement generator plant protection and comply to the grid code

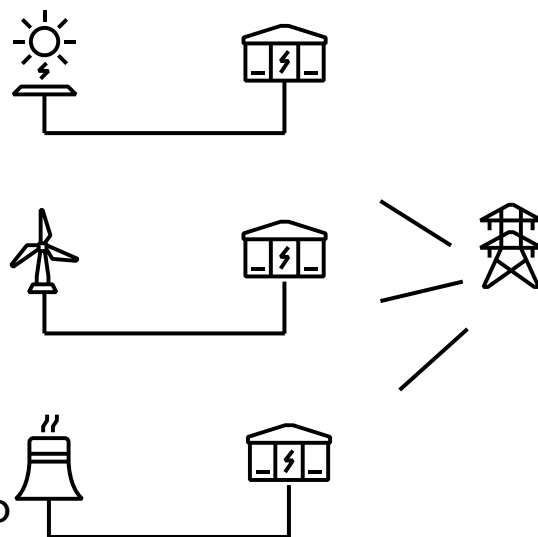








ABB advantages

- Alarms of potential issues, enabling action prior to outage for circuit breakers and transformers as well as auxiliary equipment
- Provides information for more efficient maintenance, minimizing costs
- Fast and accurate protection to minimize damage for the power system
- Improves uptime and capital allocation
- User generation plant protection disconnects when ever grid voltage and frequency are out of range prescribed by local connection standards

Digitalization Packages - simplify the selection of advanced functions and logics with group of packages able to satisfy requirements by market segments and applications

Smart CSS

Utility

		<u>MV</u>	<u>Transformer</u>	<u>LV & Enclosure</u>	
Remote Access 	 Cloud	- Predictive maintenance		- Predictive maintenance	<ul style="list-style-type: none"> ✓ Trending data to identify weak links ✓ Improves uptime and capital allocation
	 SCADA interface	<ul style="list-style-type: none"> - Advanced earth Fault location (FLIR) - Automatic network reconfiguration 	<ul style="list-style-type: none"> - Alarm handling - Monitor status 	<ul style="list-style-type: none"> - Monitor status - Alarm handling - Remote control - Product condition 	<ul style="list-style-type: none"> ✓ Fast network restoration ✓ Minimize outage time ✓ Maintenance data for better efficiency ✓ Crew mgt. & support improved
Protection & Control 	 Field devices	<ul style="list-style-type: none"> - Directional and Non-Dir. O/C protection - Auto reclosing - Fault Location - Advanced earth fault indication - Automatic transfer switch - Remote open/close 	<ul style="list-style-type: none"> - Over temp protection - Over pressure protection 	<ul style="list-style-type: none"> - Overcurrent protection - Remote open/close 	<ul style="list-style-type: none"> ✓ Fast and accurate protection to minimize damage for the power system ✓ Selective coordination minimizes outage scope ✓ Remote control provides flexibility from control room and minimizes site visits
Monitoring 		Signals: <ul style="list-style-type: none"> - Switch/CB status - Fuse blown - Spring charged - SF6 low - Basic Fault passage indication - Local/remote switch position - Remote reset of fault 	<ul style="list-style-type: none"> - Winding Temp (dry TR) 	Ekip digital combo: <ul style="list-style-type: none"> - LV analog values (U, I, cos phi etc.), data logger, synchrocheck Signals: <ul style="list-style-type: none"> - LV breaker status - Aux. Supply battery replacement notification - Battery charger failure - CSS Door open - Smoke detector alarm 	<ul style="list-style-type: none"> ✓ Easy access to CSS status from communicating field devices ✓ Alarms of potential issues, enabling action prior to outage for circuit breakers and transformers as well as auxiliary equipment ✓ Event data speeds troubleshooting and reduces outage time ✓ Provides information for more efficient maintenance, minimizing costs.

Smart CSS Medium voltage

Basic range

REJ 603

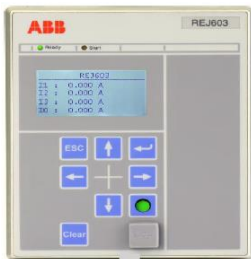


REJ603 V 1.5

Self powered feeder protection relay with CTs
HMI as an option

51, 50, 51N, 50N, 68, 49

REJ 603 V3.0

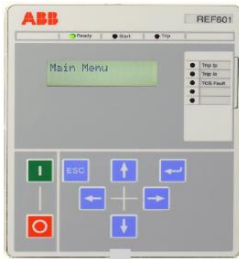


REJ603 V3.0

Self powered feeder protection relay with conventional CTs + front port comm

51, 50, 51N, 50N, 68, 49

REF 601



REF601

Feeder protection relay with breaker control

51, 50, 51N, 50N, 68, 49

REF 611



611 series

Protection relay with breaker control, current and voltage functions (up to 4I+4U + 8BI)
+IEC61850 Ed.1+2
+PRP/HSR comm

50/51/49/67/67N/46/59G/68

...

REF 615



615 series

Advanced feeder protection and control, current and voltage, advanced communication with GOOSE, IEC61850, IEC60870-5-103, Modbus

50/51/49/67/67N/46/59G/68

...

Smart CSS

Levels of digitalization

Benefits of levels



Level 1 - Monitoring

- MV Fault and switch indications
- LV Measurements

Benefits

- Faster fault localization
- Network switching status information



Level 3 - Measurements

- Accurate measurements (U, I, f, P, Q, S, $\cos\phi$)
- Advanced fault indication algorithms

Benefits

- Network power flow status
- Trustworthy fault indication



Level 2 - Control

- Remote switch operations

Benefits

- Fast fault isolation and power restoration



Level 4 - Protection

- Advanced protection algorithms

Benefits

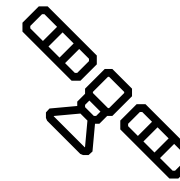
- Selective protection
- Integration of distributed generation

Communication solutions for Smart Grids

Communication alternatives

- Public wireless is the most cost efficient solutions for bringing in a large amount of nodes to the NCC
- Our products have integrated support for the most common ones: fiber-optic and public wireless
- We also support all other communication alternatives through interface modems

Wireless



Satellite

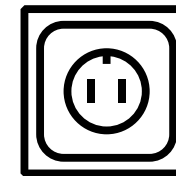


Private wireless

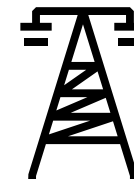


Public wireless

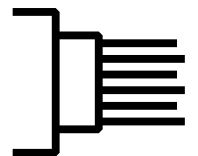
Wireline



Copper wire



Power line





Resources

Compact Secondary Substation

Key reference projects

1. GRP wind segment, Brazil project - provided 69 units of special material CSS to withstand high temperatures in NE Brazil

2. Universal Studios in China- delivered full set of CSS for this high end project in CN

3. UK wind farm: UniPack-G used for power collection in the wind farm in a very harsh environment

4. Major utilities in Finland – automated CSS for the cabling projects around Finland. All units are tested, including SCADA connection testing in the factory for quick installation.

5. Major utilities in Norway – automated CSS for the distribution network in Norway.



6. Egypt utilities – CSS for distribution network for major Utilities and EPC in the development of the new cities

7. UAE, QA, OM, & KW Steel and GRP CSS for the O&G industries in the region for both infrastructure and well site electrification

8. VN Solar projects- large Solar plant using integrated Skid solutions with central inverter

9. Solar projects- Several projects in renewables with UniPack-G in European countries (DE, HR, DK, HU)

10. Santos Australia – More than 200 secondary solutions delivered across different stages for gas collection areas

11. Saudi Solar– large solar plant using integrated skid solutions with central inverter

12. Smart cities in India– several projects for the Smart cities development in IN

Global presence

ABB secondary solution factories

7 cites in 7 countries

- Skien, NO
- Buenos Aires, AR
- Cairo, EG
- Nashik, IN
- Beijing, CN
- Johannesburg, ZA
- Hanoi, VN
- Auckland, NZ



Summary

UniPack-S



Safety and reliability – Internal arc classified for both operators and public, UniPack ensures the highest levels of safety



Service and support - Global reach, local service presence provides you with access to global experience and knowledge with customized local service support based on your needs



Ease of maintenance – Compartmented design and isolated compartment with padlockable doors for easy access, with remote monitoring



Ease of installation – Lightweight, optimized transportation and foundation allow for efficient installation, while different steel thicknesses ensure stability and robustness for handling and installation

ABB