CASE STUDY

Winds of change – Acciona Energia takes the next step in power system reliability and operational efficiency

In this case study, we take a deep dive into a future-proof protection, control and monitoring solution delivered to Acciona Energia – a leader in providing sustainable solutions for infrastructure and renewable energy projects.

A substation near the Anabaru wind farm in the state of Karnataka in India is now effectively monitored locally and controlled from the control center in Spain. It is also the home of the first Smart Substation Control and Protection SSC600 device in the wind power segment in India.

ABB's smart solution is providing cost savings and improved operational efficiency, easier operation and maintenance, and flexibility to adapt as the substation and the grid evolve.

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A world in transition to clean energy
India is rapidly on the way

Wind energy is one of the earliest energy sources used by mankind and is today a well-established and effective source of renewable energy. Overall, wind energy has less environmental consequences than several other energy sources and may also decrease the dependence on quantity of electricity generation from fossil fuels, resulting in lower air pollution and CO_2 emissions – a key enabler on the road to net zero.

In India, wind power generation capacity has significantly increased in recent years. As of 1 July 2022, the total installed wind power capacity was 40.788 GW, which ranks India as number four in the global wind power installed capacity index [1]. Wind power capacity is mainly spread across the southern, western and north-western regions of the country [2].

The Government of India is supporting wind power in the entire country via various fiscal and financial incentives and has also established laws, initiatives, and a flexible environment to attract international investments with the target to expand the country's presence in the renewable energy industry [3].

In this case study, we take a deep dive into the Hiremallanahole substation at Acciona Energia's Anabaru wind farm in India to learn how ABB's future-proof protection, control and monitoring solution is bringing cost savings and improved operational efficiency.

Acciona Energia's Anaburu wind farm

Background

Acciona is a global leader in the development, construction, operation and maintenance of wind power facilities. The company began operations in India in 2006 and has four operational wind farms in the state of Karnataka today [4].

The Anaburu onshore wind farm is in the Davangere district of the state of Karnataka in the south-western part of India. There are ten wind turbines (diameter 82 m) and total nominal power of 16.5 MW [5]. The site has been commissioned and is in operation since September 2008.

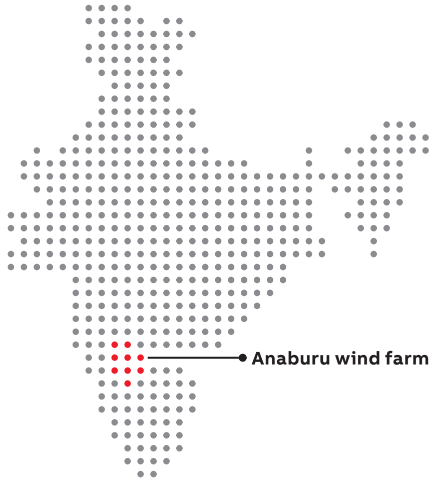

Fig 1. The Anaburu wind farm is in the Davengere district in the state of Karnataka in India.

The electricity generated at the Anaburu wind farm is supplied to the Hiremallaholle 66/33kV substation, which is owned by Karnataka Power Transmission Corporation Limited (KPTCL), the state transmission utility, from there the electricity is further supplied to the state grid and onwards to the consumers.

Acciona Energia has executed a Power Purchase Agreement (PPA) with the Bangalore Electricity Supply Company Limited (BESCOM), for the sale of the generated electricity, who has taken over the responsibility from KPTCL for the distribution of electricity in the districts. Metering is done monthly on the 66kV side, jointly by BESCOM, KPTCL and Acciona Energia through an electronic tri-vector meter installed at the Hiremallanahole substation.

Acciona Energia's requirements and needs

The most important requirement for equipment in substations is safety and reliability, that is, ensuring the power supply in a safe and controlled manner. To enable the 16.5 MW of power to flow from the Anabaru wind farm, Acciona identified the need to automate the power system infrastructure with a future-proof protection and control solution that would meet the demands of fast changes in the protection requirement that arise, for example, with bidirectional power flow and generation fluctuations. Simply put, we cannot ensure that the wind blows 24/7, yet power companies need to ensure reliable operation with systems that can handle the intermittency that comes with renewable energy resources.

To make significant improvements in reliability and robustness and enhance the efficiency of the Hiremallanahole substation, Acciona wanted to automate the power system infrastructure both in existing (brownfield) and new (greenfield) installations with IEC 61850 standard-based digital communication and GOOSE (Generic Object Oriented Substation Event) messaging. IEC 61850-enabled devices and horizontal GOOSE communication enable faster reaction times for the power system's protection scheme and still maintain power protection selectivity. This will minimize the amount and duration of unplanned interruptions due to network faults.

Acciona had also identified the need for a SCADA (Substation Automation and Data Acquisition) system to be able to monitor the switchgear/ substation at the local level from the Bangalore office in India, yet have the control from the control center in Spain. With this setup, Acciona has the possibility to control the export of the power generated.

ABB’s solutions

To meet Acciona’s requirements, ABB supplied and commissioned a solution with Smart Substation Control and Protection SSC600 – the first installation of this technology in a wind power substation in India. Amongst many other benefits, SSC600 offers the gateway connectivity to Acciona’s control center in Spain.

For protection, control and measurement, ABB’s Relion® protection and control relays from the 615 and 620 series, types REF615 and RET620, were installed in the 33 kV switchgear at the Hiremallanahole substation. As the SCADA system with energy management, analytics, and reporting, ABB supplied ZEE600.

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Fig 2. Hiremallaholle substation, 66/33kV, 2x16MVA in the district of Karnataka, India.

ABB Ability™ Smart Substation Control and Protection for electrical systems SSC600

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Fig 3. Smart Substation Control and Protection SSC600

Smart Substation Control and Protection SSC600 is a novel approach to protection and control in distribution networks – centralizing all protection and control functionality into one single device on the substation level. The ability to protect and control a wide variety of applications with a single device allows convenient station-wide visibility, minimal engineering, and easy and cost-efficient process management. SSC600 is IEC 61850 standard-compliant and offers unprecedented flexibility throughout the substation's entire lifetime. Fully modular software allows it to change with the evolving grid and up to 15 percent savings in substation life cycle costs can be achieved as SSC600 can handle new network functionalities as required.

Compared to a conventional RTU (Remote Terminal Unit) -based solution, ABB's SSC600 offers many benefits and in specifically in this case, the extended capabilities offered to form a custom protection and control solution with the Relion protection relays, as well as the gateway functionality needed all in one device.

The winning qualities for Acciona were:

1. The ability to view and monitor processes on substation level

With SSC600 you receive increasingly more data about the current state and operation of the substation. With this data you can react, before bigger problems develop. Clear visualizations of single line diagrams and new power distribution process information supports faster and better decision-making.

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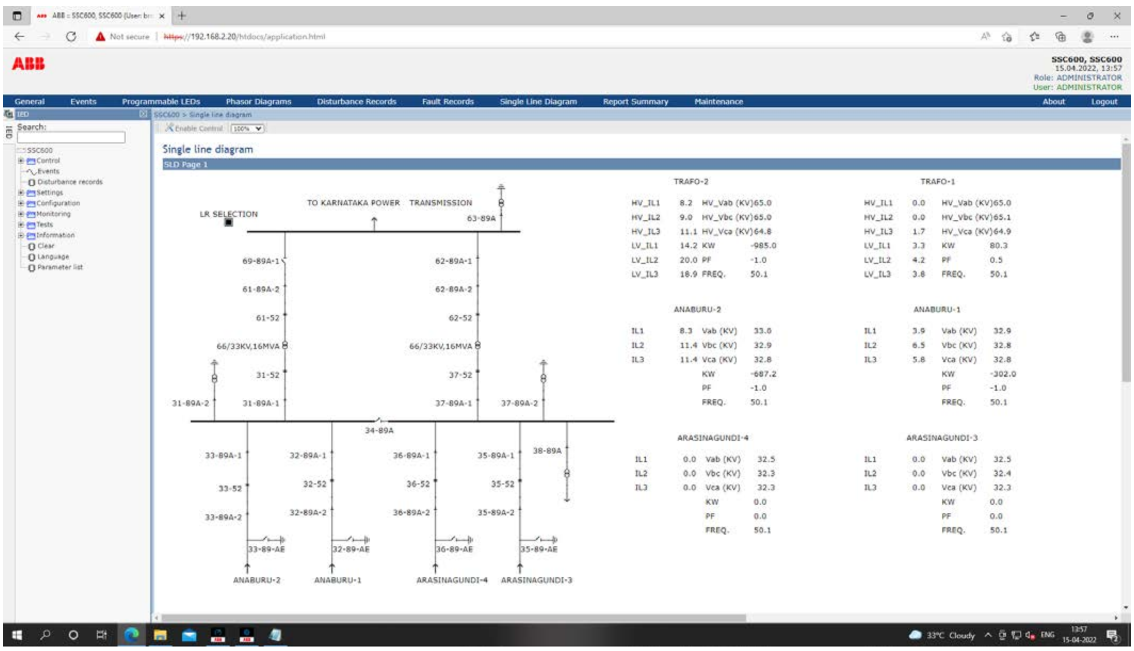
Fig 4. SSC600 webHMI: Single Line Diagram (SLD) – View from Bangalore and Spain locations.



2. Centralized access to control and monitoring functionality via a single human-machine interface (HMI)

All control and monitoring functions are available on one page in SSC600's web-HMI, which brings increased situational awareness and ease of use. Local or remote location of the HMI is enabled, with the control allowed only from dedicated interfaces, whereas from other interfaces only monitoring is allowed – and control access is securely managed.

3. Centralized event recording

Event logs no longer need to be gathered from many different devices, as they are centrally available in the SSC600.

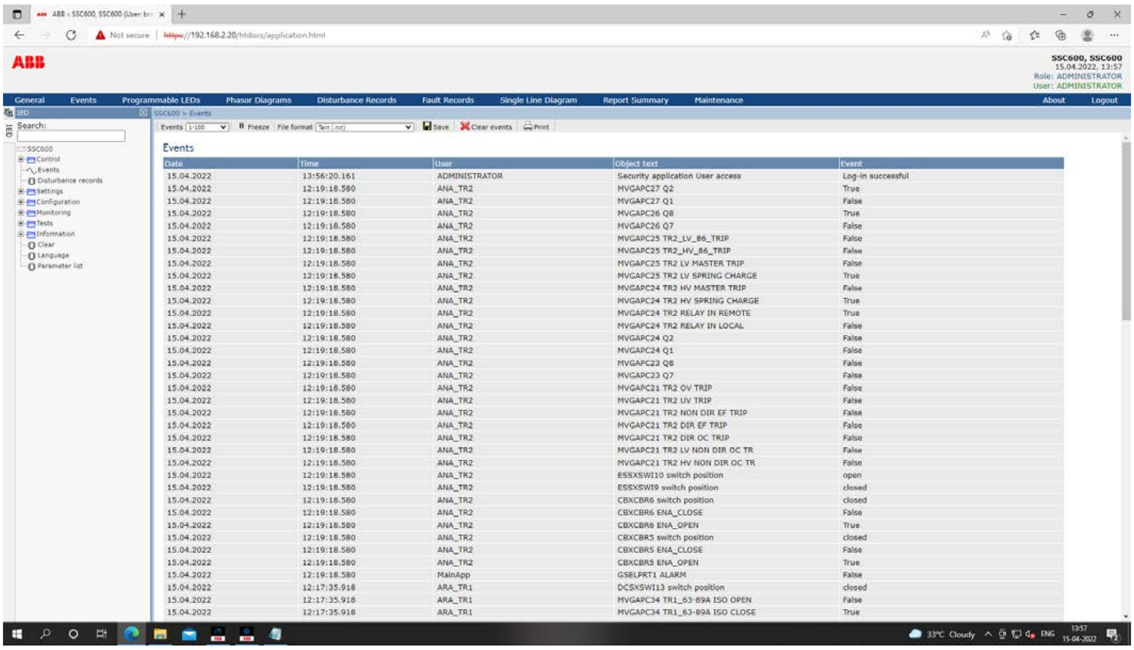


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Fig 5. SSC600 webHMI: Sequence of Events (SoE) – View from Bangalore and Spain locations.

4. Fault analysis for the whole substation

Centralized fault recordings enable comprehensive analysis, as the needed data is available in a single view.

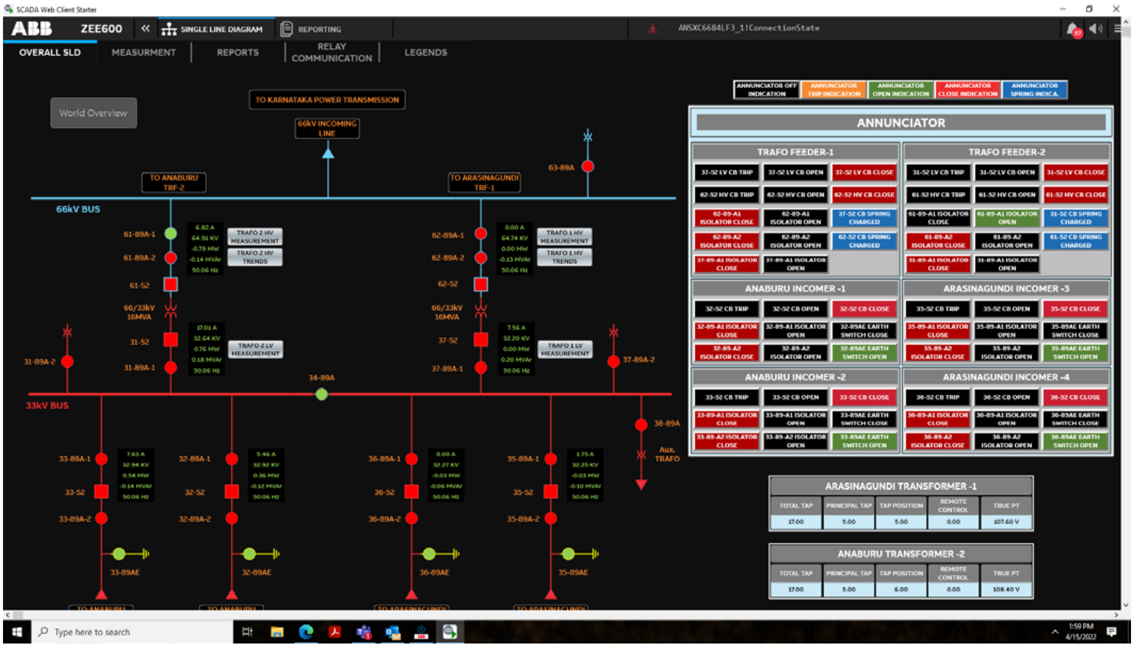
5. In-built gateway functionality over IEC 60870-5-104

Direct communication to the control center in Spain is possible with IEC 61850 or IEC 60870-5-104, without a set-up with an external gateway in-between.

6. SSC600 for feeder protection

At the Hiremallaholle substation, SSC600 can act as back-up protection for the feeders. This is an option that Acciona may take into use at a later stage.

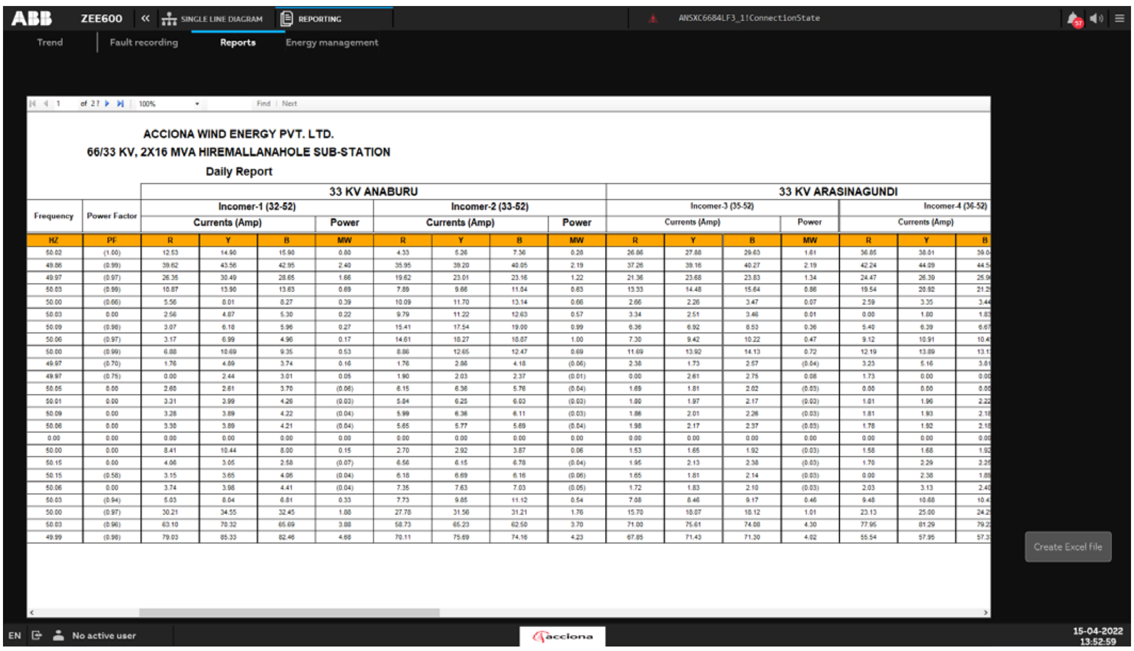
ABB Ability™ Electrification Monitoring and Control for distribution substations ZEE600



— Fig 6. ZEE600: Annunciation of critical signals.

The ZEE600 supplied provide energy management, analytics, and reporting. It also takes on the role of integrator – some of the existing switchgear panels do not have IEC 61850 -compliant devices, such as the Remote Tap Changer device and the multi-function meters (MFM), and these devices were also easily integrated into the system with the ZEE600.

With the Excel-based reporting – generated hourly, daily, monthly and quarterly – Acciona can monitor the energy parameters 24/7. With these reports of alarms and annunciation of critical signals, Acciona gets data for decision-making and can improve operational efficiency.



— Fig 7. ZEE600: Customized energy reports.

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Fig 8. ZEE600: Real time trends and historical data view of the feeders.

ABB's Relion® protection and control relays

There are six of ABB's Relion protection relays installed and commissioned as a part of the power system protection in the substation. The purpose of the protection relays is to detect problems in the power system, ideally as early as possible, and to either eliminate the problems or significantly reduce their impact, i.e., prevent or reduce damage to personnel and/or equipment. When a short circuit fault is detected, the protection relay closest to the fault must trip and prevent other relays in the network from tripping by utilizing fast GOOSE peer-to-peer communication. As a result, fast operation times and good selectivity are achieved in the network.

From the Relion protection relay family there are two types of relays installed, REF615 and RET620, and they are used for protection, control, measurement and supervision. The REF615 is used as the feeder protection and control relay and RET620 is used for transformer management. RET620 can be used for both power and step-up transformers, including power generator-transformer blocks and is also ideal for voltage regulation. Both types are suitable for both utility and industrial power distribution systems – with or without distributed power generation.

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Fig 9. ABB's Relion protection and control relays were installed in the 33 kV switchgear at the Hiremallanahole substation.

Solution implementation

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Fig 10. Solution implementation.

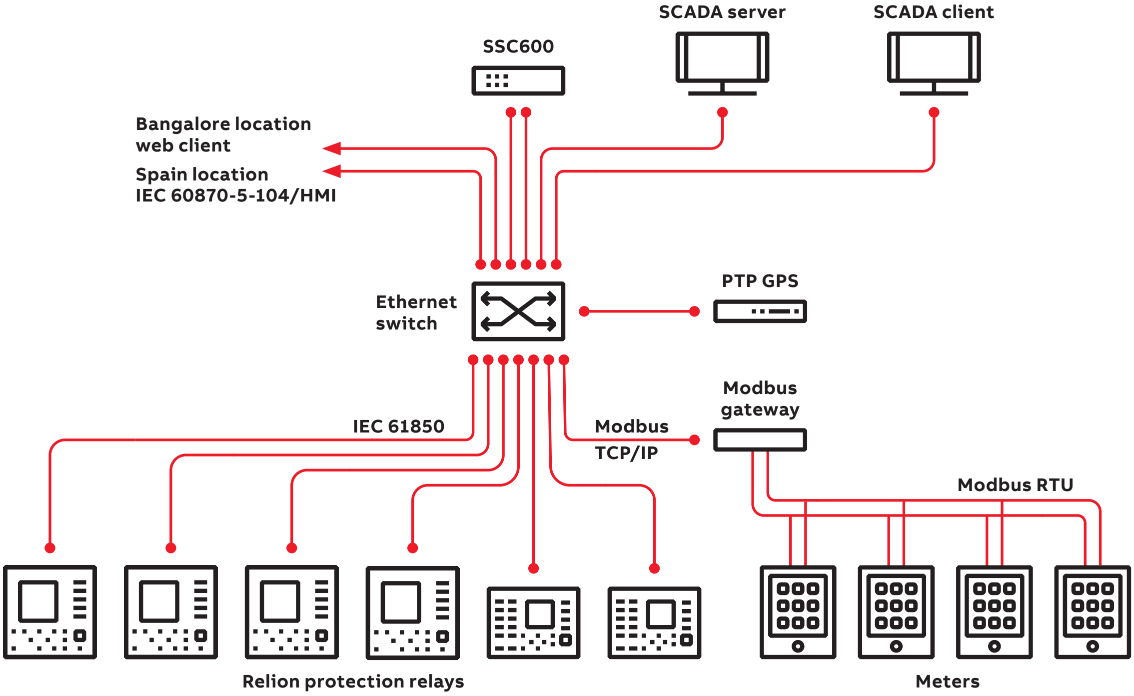

Figure 10 outlines the solution implemented at the Hiremallanhole substation.

The Relion protection relays are connected to the Ethernet switch (ES), forming a star topology over IEC 61850 communication. A Precision Time Protocol (PTP) GPS receiver is used for time synchronization of all the network devices connected to the respective Ethernet switches.

With this solution, hardwiring is minimized. In a conventional approach, a full-fledged switchgear panel would be needed to accommodate the devices such as RTU, Ethernet switches, GPS device, and the cabling (hardwired and communication cables) coming in and out of the switchgear. With the use of SSC600 and Relion protection relays the hardwiring in the switchgear is minimized, as the communication is based on IEC 61850 – GOOSE and MMS (Manufacturing Message Specification), which only need the one communication cable in the switchgear.

SSC600 – How is it implemented?

An overview of how SSC600 is implemented is provided in table 1.

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Table 1. Overview of how SSC600 is implemented.

Function	Monitoring	Control
Object monitoring of bay feeders	Via binary GOOSE, are supervised	Circuit breaker control via binary GOOSE is controlled
Measurement data of the protection relays	Via analog GOOSE, are supervised	–
Single Line Diagram (SLD) and object control	Via webHMI (in-built feature)	Via webHMI (in-built feature)
Gateway/ RTU functionality	Configured and made available via IEC 60870-5-104	configured and made available via IEC 60870-5-104
Events, fault records, disturbance records and parameter list	Via webHMI (in-built feature)	Via webHMI (in-built feature)

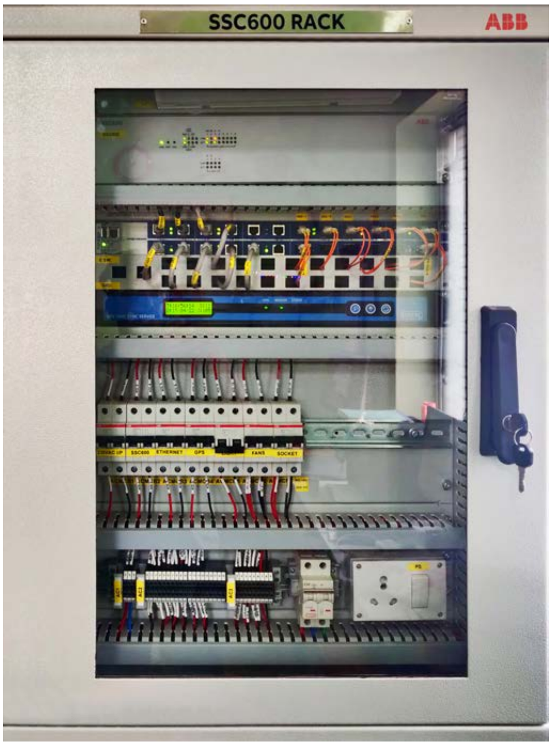

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Fig 11. SSC600 network rack.

SSC600 is housed together with Ethernet switches and the GPS device. The overall dimensions of this wall-mount type network rack are 600 (width) × 600 (depth) × 800 (height) mm. The dimensions of the rack used provided compactness and easy mounting options, allowing for optimized use of the available space in the substation.

ZEE600 – How is it implemented?

An overview of how ZEE600 is implemented is provided in table 2.

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Table 2. Overview of how ZEE600 is implemented.

Function	Monitoring	Reporting
	non-IEC 61850 devices	
Digital annunciation of legacy/older devices, which do not support IEC 61850 communication	Utilizing Modbus TCP/IP profiles for visualization of equipment, e.g., MFM, tap changer status	Via Modbus TCP/IP communication
Excel-based reporting, hourly, daily, monthly, and quarterly	Via Modbus TCP/IP communication	Via Modbus TCP/IP communication

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Fig 12. ABB's ZEE600.

Solution benefits and key findings

ABB's solution offers the remote monitoring and control Acciona was looking for – the substation is connected locally to the office in Bangalore (monitoring only) and also to the central control center in Spain (with control). This gives Acciona the possibility to continuously monitor and control the switchgear/substation, which gives them better data to support decision-making and improve operational efficiency.

The main benefits of the solution include:

1. The control center gets more processed information from the substation

With a conventional approach you would get information that to a large extent is coming from binary change of the status of equipment for the major objects, such as circuit breakers and isolators (either hardwired or via legacy communication protocols). However, with an SSC600-based approach, the object status is monitored utilizing IEC 61850 GOOSE-based communication, where all binary inputs and binary outputs are supervised and communicate utilizing GOOSE and MMS profiles. Any communication loss is recorded in terms of Sequence of Event (SoE) and the same is reported to the operator in real-time.

2. Easier operation and maintenance with asset simplification

Acciona's personnel does not need to maintain a range of different tools, hardware and spares, as all the equipment now comes from same product portfolio. They can use the same tool, Protection and control IED manager PCM600, for efficient management and configuration of the Relion protection relays and the SSC600.

In a conventional approach, the relay software and hardware are different to the RTU/gateway software and hardware. This means that the operator needs to keep and maintain spares/hardware and software throughout their different lifecycles – and continuously monitoring to stay on top of changes done by the different OEMs.

3. Future-proof protection, control and monitoring solution

A system built on IEC 61850 beings flexibility and ensures Acciona is prepared for the future and to meet evolving needs. As technology continues to advance and new applications develop, so too does the standard.

With SSC600 new protection functionality can be easily activated when requirements change. The modular software and the continuous access to new software developments allow easy customization and adaptation to changing protection requirements for the lifetime of the substation. The advantage of only having to modify one device instead of all bay-level protection and control devices makes upgrading the entire substation system easier than ever.

The P&C solution is based on IEC 61850 standard-based digital communication and GOOSE messaging. IEC 61850-enabled devices and horizontal GOOSE communication will enable faster reaction times for the power system's protection scheme and still maintain power protection selectivity. This will minimize the amount and duration of unplanned interruptions due to network faults.

IEC 61850 allows digitalization of the power system in a way that it allows integration of existing equipment and systems and collaboration with other digital entities, such as a power management system (PMS). Further, standard-compliant devices supplied by different manufacturers can communicate with each other without any engineering-intensive complications in the same power system.

4. Informative reports to support decision-making

With this solution, informative reports are prepared in a graphical format, which makes simultaneous evaluation of both historical data and live data clear and straightforward – providing the load information in an easy to digest format to support decision-making.

5. Gateway over IEC 60870-5-104

Via this gateway, the SSC600 is fully controllable from Acciona's control center in Spain. They can monitor and switch on/off any of the circuit breakers utilizing IEC 60870-5-104 communication.

6. Significant cost savings

The cost savings with this set-up are significant and reaches approximately 35% compared to a conventional solution. This is achieved thanks to functionality included in the SSC600. This means there is no need for a RTU device for tap change control or gateway functionality over IEC 60870-5-104. There is no need for a disturbance recorder nor a dedicated computer for local HMI with phasor, controls and SLD. Further, there is no need for dedicated software for GOOSE monitoring nor licenses for web-HMI multi-client monitoring as these are built-in features of SSC600. Additionally, hardwiring is significantly reduced with digital communication, bring additional substantial savings.

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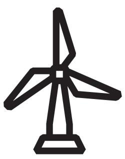
Table 3. Overview of cost saving items.

Conventional solution	SSC600 solution
RTU	Included in SSC600
Tap changer control	Included in SSC600/EMS
Gateway functionality IEC 60870-5-104	Included in SSC600
Dedicated computer for local HMI with phasor, controls, SLD	Included in SSC600
Dedicated software for GOOSE monitoring	Included in SSC600
Web-HMI for multi-client monitoring	Induced in SSC600



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"Acciona wanted to integrate a 13-year old substation with modern SCADA control. ABB's SSC600 has all the features for communication & control needed for our team in Spain, as well as the possibility to operate it locally, which made it an ideal choice."

Acciona Wind Energy Pvt Ltd. (AWEPL)

What's next?

Acciona has now installed the first SSC600-based system – the first installation in the wind power segment in India – and they are now benefiting from an efficient solution.

The company can reap several benefits now – they do not need to use separate dedicated communication gateways or conventional RTUs, nor do they need allocate resources towards maintaining separate hardware such as gateways/ RTUs, as the all-in-one SSC600 device provides seamless integration possibility, which is not only limited to protection of feeders, but it is also the same product for the upward gateway communication to the central SCADA.

The multi-client monitoring, which is now enabled via the easy-to-use webHMI, ensures that Operation and Maintenance personnel can quickly take actions and make decisions based on events occurring in the system.

Any future changes to the substation are easy to make with SSC600. With a software-based approach it is easy to update and modify functionality as requirements change. And any future bay expansion need is easily managed via adding merging units or Relion protection relays.

Acciona took the new solution into use in April 2022 and is now learning about this new technology firsthand. The switch from a conventional design (P&C per bay) to a centralized approach naturally involves changes and a learning curve. With a stepwise introduction to the technology, Acciona has the opportunity to take the next steps to gain the full benefit from a centralized P&C system in the future, as the substation continues to evolve.

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Fig 13. Anaburu wind farm in the district of Karnataka, India.

List of abbreviations

BESCOM	Bangalore Electricity Supply Company Limited
EMS	Energy Management System
ES	Ethernet Switch
GOOSE	Generic Object Oriented Substation Event
GPS	Global Positioning System
GW	Gateway
HMI	Human-Machine Interface
IED	Intelligent Electronic Device
KPTCL	Karnataka Power Transmission Corporation Limited
MFM	Multi-Function Meters
MMS	Manufacturing Message Specification
OEM	Original Equipment Manufacturer
P&C	Protection and Control
PPA	Power Purchase Agreement
PTP	Precision Time Protocol
RTU	Remote Terminal Unit
SCADA	Substation Automation and Data Acquisition
SoE	Sequence of Events
SLD	Single Line Diagram
TCP/IP	Transmission Control Protocol / Internet Protocol

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