Business Unit Grid Integration
Portfolio overview | July 2020
Grid integration
We deliver lifecycle value and lower risks with our system solutions

Plan
Unparlelled integrated systems knowledge
>90 years of market-leading innovation and >500 engineers and consultants in grid integration systems

Build
Proficient execution with no compromise on HSE or Quality
>500 system packages and turnkey solutions delivered every year to our customers in the 5 continents

Operate
Global services on a local basis
>60 local operating offices provide 24/7 support for thousands of customer assets

Customer benefits

Highest Lifecycle Value

Lowest Risk Factor
Grid Integration
Plan
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Grid integration
Leveraging our unique domain expertise to solve customer challenges

- **Systems studies and analysis**: AC and DC power systems analysis
- **Asset/power systems assessment**: Audits, diagnosis and failure assessment
- **Training**: Standard/tailor-made courses
  - **Cyber security**: Cyber security diagnosis and assessment
  - **Analytical tools**: Software and support
  - **Economical studies**: Technical and economical system optimization
Transcription systems

- Power generation interconnection
- Transmission constraints mitigation
- Dynamics and control
- Insulation co-ordination
- HVDC and FACTS
- Protection and control systems

Distribution systems

- Planning
- Reliability analysis
- Protection and control systems
- Spatial load forecasting
- Distributed generation interconnection
- Plug-in electric vehicle integration
Grid integration
Comprehensive consulting solutions, tailored for specific needs

**Industrial systems**
- Motor behavior
- System protection
- Transient/harmonic analysis
- Filter design
- Co-generation integration
- Islanding and load shedding schemes
- Energy efficiency
- Audits

**Renewable systems**
- Feasibility/stability studies
- Compensation determination
- Reliability analysis
- System perturbation
- Voltage protection design
- Economic efficiency
- System layout and equipment dimensioning
- Neutral grounding and network protection
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Grid integration
Our solutions portfolio

Generator Connections
- Solar plant
- Wind plant
- Thermal plant

Power Transmission (HVDC)
- Grid interconnectors
- Offshore wind connections
- City infeeds
- Power from shore
- Remote loads and generators

Power Quality (FACTS)
- Fixed Series Compensators
- Thyristor Controlled Series Capacitors
- Static Var Compensators
- Static Compensators
- Static Frequency Converters

Substations
- AIS substations
- GIS substations
- Digital substations
- Hybrid and mobile solutions

Hybrid and mobile solutions
- Ports and ships
- Datacenters
- Industrial sites

Power Supply
- e-Bus
- Rail
Grid Integration
Generator connections
**Technical**

- Adaptation to meet grid codes
- Ancillary services for renewable energy
- Grid integration
- Plant control
- Digitalization and smart grids

**Commercial**

- Fast track installations
- New business setups
- Competition with other energy sources
- Demand management
1. The WTGs are supplied by the WTG OEM, ABB products are sold directly to the OEM
2. Ring main units could be installed inside or outside the tower
3. Medium voltage collection
4. Substation
5. Overhead lines (OHL)
6. Transmission lines
7. Storage and FACTS
Generator connections
Structure of solar farm, from grid to solar generator

1. Substation
2. Overhead lines (OHL)
3. Transmission lines
4. Storage and FACTS
Grid Integration
Power Transmission (HVDC)
Power transmission (HVDC)

Applications

Connecting remote generation
Interconnecting grids
Offshore wind connections
DC links in AC grids

Power from shore
City center infeed
Connecting remote loads
Upgrades / life cycle services
High voltage electricity is converted from *alternating current (AC)* to *direct current (DC)* and vice versa in a converter station.

Power flow in both directions
Power transmission (HVDC)
The unique advantages

More power
HVDC can provide more power per square meter than the alternatives.

Long distances
Distance presents minimal challenge to HVDC transmission.

Higher efficiency
Overhead, underground or underwater; more power reaches the consumer.

[Note: In the title, we’ve replaced “transmissions” with “transmission” to be coherent with previous slides]
Grid Integration
Power Quality (FACTS)
Power quality (FACTS)
Solution overview

Generation
- Increasing energy production
- Integration of renewables
- Distributed generation

Consumers
- Increasing power consumption
- New grids in emerging markets
- Faster and stronger transportation systems

Transmission
- Aging infrastructure
- Changing regulations grid code compliance
- Energy trading between regions
- Reversible power flow

Need for good power quality
Power quality is a quantifiable measure of how effectively power is utilized and supplied in terms of its availability, quality and efficiency. Good power quality is important along the whole energy value chain:

The benefits of good power quality

- Supply network reliability and availability
- Increase Industrial productivity
- Lower environmental impact
- Energy efficiency
Power quality (FACTS)
Serving all markets

Utility
- Increased power transfer
- Stable power supply
- Grid code compliance
- Enhancing inertia and network strength

Industry
- Increased productivity
- Grid code compliance

Renewables
- Grid stability
- Increase in reliability
- Grid code compliance

Railway
- Powering the trackside supply
- Frequency conversion
- Load balancing
- Grid code compliance
Utilities
Effective power transmission and distribution

As the global demand for power increases there is a corresponding demand for greater power transmission capacity.

The traditional approach is simply to build more lines of ever greater power capacity. This can involve considerable capital investment as well as long planning delays in obtaining wayleaves, together with meeting environmental objections.

The smarter way is make more effective use of the infrastructure that is already in place.
Heavy industrial plants often take their power directly from sub-transmission or transmission networks, at 110 kV or higher. Power utilities usually impose maximum limits on the active and reactive power demand. If these limits are exceeded, a penalty fee can be imposed. Heavy industry can therefore put a price on reactive power.

Furthermore, heavy industrial users can present significant challenges to their grid supply, such as voltage fluctuations, harmonic distortion, and asymmetry between phases. This is more pronounced the larger the relationship between the installed power and the fault level of the feeding grid.
Renewable energy
Integration of renewable energy in AC networks

When wind farms are connected to power grids, it is vital that they do not impair grid reliability and stability. Transmission system operators (TSOs) have responded by strengthening their Grid Code requirements, especially for reactive power, voltage control, and fault ride-through capability.

To ensure full compliance with Grid Codes, wind farms often require dynamic reactive power compensation equipment such as an SVC and/or STATCOM.
Railway
Grid integration of railway traction systems

Thyristor driven locomotives fed by AC supplies have a large and varying consumption of reactive power. At the same time, railways are often located far from generation facilities. This can cause fluctuating or even sagging catenary voltages. Harmonic distortion is generated, and if not contained, there will be a deterioration in power quality at the point of common connection.
Grid Integration

Substations
Substations
AIS – Air Insulated Substations

Portfolio
- Live Tank Circuit Breakers 36–1,000 kV
- Dead Tank Circuit Breakers 72–800 kV
- Instrument transformers 36–800 kV
- Disconnectors 72–800 kV
- Eco-efficient solutions available
- Utilizes IEC 61850

A reliable choice
A versatile concept for all applications and environments. ABB has global expertise in all types of AIS installations
Substations
GIS – Gas Insulated substations

Portfolio
- Factory modules, pre-assembled and tested
- Customization and final assembly in our factories
- Structured factory acceptance test (FAT) process
- Fast and efficient delivery, installation and commissioning
- Utilizes IEC 61850

A reliable choice
- Up to 90% space savings are possible compared to air-insulated switchgear
- Reduced environmental impact, more eco-efficient with less SF$_6$-gas
Substations
Hybrid switchgear

Portfolio
- Plug and Switch System PASS 72.5–420 kV
- Multi Functional Modules MFM 72.5–420 kV
- Utilizes IEC 61850

A reliable choice
- Integration of functions enables a reduced substation footprint
- Fast erection and commissioning with minimum civil works
- Flexibility of configuration facilitates the use of various combinations of busbar and cable connections to suit different site needs

* Property of ABB. Should be changed after day 1
Substations
Digital substation – solution offering overview

From high voltage to medium voltage, AIS and GIS

- Utility communication on MPLS/TP and existing SDU networks with FOX615
- Relay room with process bus based protection
- Cyber security on substation borders, systems level and in the electronic devices
- FOCS optical CTs: free-standing or integrated in DCB*
- GIS w.NCIT for U&I smart local control cubicle with MSM switchgear monitoring
- SAM600 to digitize bushing CT measurements
- CoreTec transformer monitoring with CoreSense
- Transformer
- Unigear digital MV switchgear with NCITs
- Operator workspace
- Mobile workforce management
- SDM600 data manager
- FOXMAN NMS
- Asset health center
- Intelligent substation HMI
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Substations
Digital substation – solution benefits

Conventional

Digital

IEC 61850 Station Bus

Interface to field

IEC 61850 Process Bus

Thousands of hardwired point-point connections

Process bus reduces cabling and distributes information efficiently
Substations
Digital substation – solution benefits

Safety and Security
- Eliminate risk by replacing copper wires that carry high currents with safe optical fibers
- Secure systems against internal and external threats

Footprint
- Fully integrated factory-assembled modules save on land, civil and operating costs and open up new possibilities for future locations

Maintenance
- Combine asset health monitoring with high-speed data communication, software verification of control and protection equipment

Outage reduction

Network dynamic loading and stability

Operation

Superior benefits

Lead time
- Accelerate grid readiness for renewable generation with ABB Ability – gain second-by-second analysis and control
- Reduce project lead times by a typical 7 months

Longevity of equipment

HITACHI ABB POWER GRIDS
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Grid Integration
Power Delivery
The portfolio for traction power supply systems covers:

- Consulting services, such as system studies and traction power simulations
- Traction substations for AC and DC applications; complete electrification projects
- Reversible DC traction substations; wayside energy storage systems
- FACTS (flexible AC transmission systems) static frequency converter and load compensation equipment
- Network management systems

### Full system integrator

### Operator

- Signalling and train control systems
- Tolling and ticketing
- Depot
- Power supply and distribution
- Telecoms
- Platform screen doors
- Power and operations SCADA
- Track works
- Trains / rolling stock
- OHS, 3rd Rail
- Civil construction

### ABB offering
Power delivery
Rail – offering scope

Multidisciplinary projects
Complete electrification projects covering a variety of different domains:
- Bulk power substations, AC or DC traction substations, passenger station power distribution, wayside equipment, energy storage systems, SVC, SCADA, civil construction, etc.

Traction substations
- AC traction substations for 1AC and 2AC applications
- DC traction substations
- Frequency converter stations

Modules
- Pre-fabricated and factory tested 1AC and 2AC indoor and outdoor module including protection and control

Products
- Circuit breakers and switches
- Air or gas insulated switchgear
- Protection and control relays

Module: Electrical switchgear and control equipment

Complexity
Engineered packages and turnkey systems
System integration scope

Value creation
The TOSA concept uses the on-board converter to provide a simple, reliable interface for efficient battery charging. It can also recuperate energy generated during braking.
Power delivery
eBus TOSA – solution benefits

World’s fastest connection
in less than 1 second

Full system view
of energy needs from smart grid to on-board batteries

Simple interface
between bus and wayside charger improves reliability and saves time

Only system available
for electrification of high capacity high frequency lines

A common system
for all lines and all buses in a city
The ship’s power load is transferred to the shore side power supply without disruption to onboard services.

Emissions to the local surroundings are eliminated.

Ships can shut down their engines while berthed and plug into an onshore power source.

Main incoming station  Power cables  Shore-side substation  Berth terminal  On-board installation
Power delivery
Shore-to-ships – solutions benefits

Shore-to-ship power benefits
- No polluting emissions at port
- No noise and vibrations from auxiliary engines
- Low operating costs for ship owners

Impact on stakeholders
- Reduced health problems/costs
- Improved public image
- Green ports and green operators
- Clean air = happier citizens
- Gain aesthetic credits
- Cost savings for ship owners
- Reduction of negative externalities
- Enhanced reputation

Smart Port Vision
- Overall port development
- Positive impact on tourism/commerce

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Highest Lifecycle Value
Lowest Risk Factor
Services
Solutions portfolio

Rapid response
We guarantee fast and flexible response to maximise your equipment uptime.

Operational excellence
We work together with you to manage your assets, operations and risk to deliver strategic business results.

Performance improvement
We optimize creativity, reliability and efficiency of your assets to increase speed and productivity.

Lifecycle management
We employ powerful tools and knowledge to optimize and extend your equipment life.
Service
Rapid response

24/7 phone
Direct access to grid integration experts
– Available 24/7
– Prompt response times
– Expert support a phone call away

24/7 remote
Increased availability by remote access
– Troubleshoot from a secure network
– Immediate start of troubleshooting
– Reduced downtime

24/7 support
On-site support
– Corrective Maintenance support
– On-site support in case of an emergency
– Support during difficult maintenance operations
Service
Operational excellence

Software update

Keep your systems up to date

- Update packages to make older installations new
- Improve reliability, functionality, spare part availability and increased performance

Maintenance

Preventative maintenance

- Ensure the availability and reliability of your grid assets throughout their entire lifetime
- Expert maintenance to identify problems, at planned intervals

Cyber security

Keep your system secure

- System assessments
- Patch tracking / validation / installation
- Supports compliance with national and international rules and regulations
Service
Performance improvement

Training
Ensure the right knowledge
– Available 24/7
– Prompt response times
– Expert support a phone call away

Simulation models
Simulate the live systems
– Replicas for large scale system simulation and testing of new functionality
– Real time models and simulation

Condition assessment
Assessment of your asset
– Analysis of the grid asset to provide a summary and evaluation of the condition of the actual equipment
– Reduced unplanned maintenance costs
Spare Parts
The right part at the right place and time
- Spare parts management
- Inventory of most critical components

Partial Upgrades
Partial protection and control upgrade
- Using the latest MACH computers
- Modular system allows flexibility
- Step-by-step upgrade with controlled certainty of costs

Upgrades
Reason to upgrade
- Extend operational life
- New technical functionality
- Changes in grid and increase loads
Conclusion
System Lifecycle Partner
Grid integration
Delivering system solutions across the entire lifecycle journey

1. Plan | Strategic planning partner
   - Network and asset analysis
   - Project development
   - FEED (Front End Engineering Design)

2. Build | System integrator
   - Engineered sub-system packages
   - Engineered system packages
   - Turnkey solutions

3. Operate | Lifecycle service partner
   - Assessments
   - Operation and maintenance
   - Upgrades

Digital – Enabling more together

Connectivity Solutions  Digital Twin  Digital Applications  Cyber Security