Offshore and onshore wind farm solutions
Proven, reliable, innovative
As the wind blows, **power flows**

Wind – an infinite source of energy that society is harnessing more and more. Wind generated energy is forecast to increase from 158 GW in 2009 to 410 GW in 2014.

Wind power, now a mainstream energy technology, benefits people and society at large. It plays a pivotal role in combating climate change and reducing our fossil fuel dependence.

As cutting edge solutions are critical to reliable wind power generation and network integration, operators need the skills and experience of Alstom Grid, a world leader in electricity transmission.
Proven

Over 28,000 Alstom Grid employees in more than 100 countries bring our global expertise to your doorstep. Our “Customer First” culture makes us your ideal trusted partner.

Thanks to 120 years of expertise and continuous R&D, Alstom Grid is a major player in the evolving power transmission industry. Our expertise encompasses all aspects of a wind farm’s electrical system – from network consulting, design, project management, products and systems to installation and service.

Reliable

Products and know-how contributing to reliable wind farm operations.

You can depend on our solutions. They comply with national, international and customer-specific standards. They ensure reliable power supply and efficient grid connection from wind farms. Our advanced energy management further ensures power transmission reliability.

Equally dependable is our know-how in feasibility studies, power connection design and power quality solutions – STATCOM and SVC. This all adds up to reliable delivery of energy to the networks.

Innovative

Compact, modular and intelligent solutions.

Alstom Grid brings you a complete range of reliable high voltage equipment, well adapted to wind farm applications. Our innovative solutions for offshore wind farm grid connection are tailored to the project requirements. We help you from the start to design the solution most suited to your needs.

For onshore wind farms, we deliver complete MV/HV substations for switching, controlling and managing your transmission systems and contributing to a rapid return on investment.

When designing your renewable generation wind farm, you can count on Alstom Grid to be your ecological partner. Alstom Grid is a front runner in the concept of eco-design, meaning that ecological considerations are taken into account right from the design stage to reduce a product’s or component’s ecological footprint.

Alstom Grid capabilities

Grid Connection

- Turnkey MV/HV substation
- Innovative offshore platform solutions for HVDC and HVAC
- Complete range of HV products: circuit breakers, disconnectors, instrument transformers, gas-insulated-switchgear
- Power transformers

Solutions for equipment health monitoring

- Automation solutions and wind power management systems
- Electrical system protection and control
- Dynamic overhead line rating
- Renewables fleet management

Power system design and grid studies

- Power quality
  - Reactive power compensation system designs
  - Static and dynamic var compensation (FACTS)

Service

- Full palette of services to maximise the production, availability and reliability of the wind farms
Offshore wind is the next frontier for the development of wind power. Large wind farms can be constructed in areas that are remote from centres of population and where strong persistent winds exist. Turbines of up to 5 MW and above have rotor dimensions far larger than the largest wingspans of existing commercial planes.

The potential for offshore wind seems unlimited. In the European North Sea alone, offshore wind power’s potential is set to reach 2,600 TWh by 2020, equal to between 60% and 70% of projected electricity demand. Offshore wind installed capacity is expected to exceed 45 GW in 2020. Increasingly, connecting such wind farms to the grid requires the installation of an offshore electrical substation, a challenge that Alstom Grid has risen to enthusiastically.

Offshore Wind Farms

Alstom Grid has been pioneering the way for offshore wind farm grid connections with the design and construction of the first offshore substations in the UK and Germany. Since then, we have constantly improved the design of our solutions, learning from the execution of multiple contracts.

Alstom Grid capabilities
Alstom Grid, together with its partners, has designed and supplied several types of offshore substations. For the first wind farms, which were relatively small (<100 MW), the solution adopted was a simple topside of a pallet or a frame and modules installed on top of or within it. It was intended to be unmanned and visited infrequently.

As projects have increased in size and the location of substations has become further offshore, the solution design has evolved. Alstom Grid has therefore ensured that "form follows function" by co-operating with project developers and suppliers of other elements of the projects. From these collaborations have come both fully integrated topside solutions installed upon monopole and jacket structures and also self-floating and self-installing solutions that remove the need for the mobilisation of scarce and expensive marine crane spreads.

The weight of such platforms can range from 400 tons for simple solution to up to more than 4000 tons for 400 MW floating, self-installing platforms.

Hermetic power transformers

Hermetically sealed power transformers are ideally suited for the harsh environment of offshore platforms. They have neither a conservator, nor any dehydrating breather. Oil expansion is absorbed by the specially-designed tank and radiators. Moreover, the on-load tap changer, when used, is fitted with vacuum contact chambers which prevents oil decomposition due to the switching operation.

Benefits

- Substantially longer service life
- Reduced maintenance thanks to lower oil ageing, no dehydrating breather and no hydro-compensator

Characteristics

- Up to 245 kV, 200 MVA or 170 kV, 250 MVA
HVDC MaxSine

For offshore wind farms that are remote (>50 km) from the coastline, direct current often provides the best techno-economic solution for transmission of power to the shore. For this purpose, Alstom Grid has developed the HVDC MaxSine technology, which combines its extensive knowledge of HVDC systems and Voltage Source Converters, using chain link (or multi-level) technology.

MaxSine technology

Each link (or level) in the converter consists of a DC capacitor and an IGBT switch. By switching in the correct sequence, the VSC can generate a voltage waveform of controlled magnitude and phase angle. This gives the MaxSine converter the ability to control the power flow from the wind farm to the onshore network and also control the reactive power flow on both sides of the HVDC system.

Key benefits of HVDC MaxSine solution

- Precise control of real and reactive power
- Compact site area, which is well adapted to offshore platforms
- No harmonic filtering is required
- Standard grid transformers can be used
- Able to operate down to zero MW power flow
- Able to “black start” the offshore station
- Ideal for multi-terminal applications due to the ability to block DC side faults
- Suitable for hybrid applications with “classic” LCC HVDC interconnectors

Ratings of HVDC MaxSine

- Scalable technology able to operate up to 300/320 kV using XLPE cables, or up to 500 kV using MIND cables
- DC current rating up to 1250 A
- Symmetrical monopole or bi-pole arrangements
Pioneering the way in offshore wind farm connection

**ROBIN RIGG – UK**
> Client & operator: E.ON UK Solway Offshore Ltd and E.ON UK Offshore Resources Ltd.
> Project scope: 180 MW offshore wind farm total with 60 wind turbine generators (Vestas V90/3.0 MW)
> Completed Spring 2009

**VEJA MATE, GERMANY**
> Substation built in Mobile Offshore Application Barge (MOAB)
> 400 MW
> Under construction

**GLOBAL TECH I, GERMANY**
> Self floating, self installing solution
> 400 MW
> Under construction

**SHERINGHAM SHOAL, UK**
> Double topside substations, including topside fabrication
> 315 MW
> Under construction

**BORKUM WEST II, GERMANY**
> Including topside fabrication
> 400 MW
> Under construction

**ALPHA VENTUS – GERMANY**
> Client & operator: DOTI GmbH (EWE AG, E.ON Climate & Renewables - Central Europe GmbH und Vattenfall Europe Windkraft GmbH)
> Project scope: 60 MW offshore wind farm with 12 wind turbine generators (6x AREVA Multibrid M5000 & 6x REpower 5M)
> Completed September 2008
Onshore wind is one of the most ancient and mature renewable energy technologies. Successful wind generation needs integrated, flexible systems that can cope with difficult operating conditions and stringent standards.

**HV air-insulated equipment**

Alstom Grid manufactures a complete range of high voltage air-insulated equipment, up to 1100 kV: live and dead tank circuit breakers, disconnectors (centre break, vertical break...), current and voltage transformers. If space is a constraint, we have developed a cost-effective compact switchgear, the Hypact, combining disconnectors, current transformers and a circuit breaker in a single SF6 insulated tank (one module per phase). Non-conventional instrument transformers (optical) are also available.
Electrical system delivery

By choosing Alstom Grid, you gain the collective skills and knowledge of our people, plus the experience of host network standards and practices. We have in depth knowledge of electrical system operator requirements and provide environment, health and safety training that is aligned to local standards. Our management of the interfaces between equipment solutions and the civil works, logistics and utilities required to create an operating asset benefits our customers. Alstom Grid’s adapted electrical solutions take into account the scope and performance of different wind turbines.

We take the weight off our customers’ shoulders by filling missing skills gaps and assuring delivery programmes (proven project delivery management processes certified to international standards). Being your electrical system delivery partner with a solid balance sheet, Alstom Grid can reliably and efficiently translate your wind farm design requirements into a sustainable asset that delivers return-on-investment.

Substation automation solution

Alstom Grid is a world leader providing complete protection and control systems for wind farm electrical networks. They range from electrical protection relays in the substation and the turbine switchgear through to bay controllers, gateways and all the necessary control and configuration software tools.

Benefits
- **Security**: dedicated to substation automation
- **Reliability**: proven systems worldwide
- **Expertise**: in-depth knowledge based on wind park projects around the world
- **Economy**: natively scalable IEC 61850 solutions tailored to real demands and supported by cutting edge engineering tools

Characteristics
- Scalable functions: protection, extended protection for wind farm grid connection: basic control, remote control and supervision
- Scalable architecture:
  - Simple/redundant, centralised/distributed
  - New substations/retrofit schemes
- Scalable communication:
  - Based on standards (IEC 61850, IEC 60870, DNP, MODBUS)
  - Ring, star, WAN
  - Ethernet switch redundancy and integration with less than 1 ms switchover

e-terra: smart solutions to manage wind power

In its portfolio of smart grid solutions, Alstom Grid offers the latest e-terra renewable solution management systems for wind farms, combining wind generation forecasting with real-time monitoring, control and simulation.

Benefits
- Cutting-edge wind farms management system with superior monitoring and control capabilities
- Improved knowledge of current production
- Reduced uncertainty on future production
- Optimised resources dispatch, including minimised reserve and control actions
- Improved grid reliability with look-ahead network security analysis

Characteristics
- New I&C architectures for renewable generation
- Scalable architecture, plus hierarchical supervision of wind generation portfolio
- Modern information management applications
- Advanced user interface
- Interfacing with multiple wind forecast solutions
- Control based on signals from supra-control and monitoring organisation
- Leverage of Alstom Grid generation automation technology
- Advanced visualisation tools
- Service oriented architectures for plant I&C integration in the business infrastructure
Power quality

Alstom Grid provides turnkey reactive power compensation and harmonic filtering to satisfy power quality requirements.

Reactive power and harmonics are the most important parameters for grid owners, while frequency range, voltage unbalance and voltage range are the primary parameters influencing wind turbine operation. On the other hand, real power loss optimisation inside the wind farm is critical to developers and owners. It is crucial to take into account grid code requirements, network dynamics at the interconnection point and wind farm characteristics in order to design the right reactive power compensation and harmonic filtering system.

Our service

We offer a full palette of services to maximise wind farm production, availability and reliability.

Asset management and preventive maintenance

Our services range from exclusive framework contracts to full-scope maintenance programmes and remote monitoring, including erection and commissioning, scheduled inspections and replacement parts programmes.

Corrective maintenance

To minimise the impact of unscheduled emergency maintenance, a spare parts stock can be stored at the wind farm, or a conveniently located warehouse. Our local presence combined with our global expertise helps you solve problems fast.

Predictive maintenance

Alstom Grid offers predictive maintenance such as oil analysis, vibration measurements, thermographs etc., which anticipate potential, slowly-developing issues, not detectable in normal operation.

Training

Our customised training programmes help your employees handle your operations more effectively. Our “hands-on courses for hands-on application” enable your staff to apply their new expertise from day one. Most training programmes are certified by national institutions and carry the ISO 9001 Certification.
**Worldwide presence in wind energy**

- **France**
  The e-terra solution from Alstom Grid manages the nation portfolio of renewables.

- **Germany**
  A large part of onshore wind parks connected to HV network are furnished with Alstom Grid equipment.

- **Denmark**
  The whole Distributed Generation of Denmark (Wind and CHP) is managed by e-terra platform from Alstom Grid.

- **Turkey**
  In Turkey, after successfully delivering turnkey solutions for four wind farm projects, Alstom Grid is recognised as a preferred partner.

- **Greece**
  Alstom Grid has connected the largest wind farms in Greece.

- **Brazil**
  Alstom Grid connected more than a third of the wind farms in Brazil.

- **Australia**
  Alstom Grid successfully completed the electrical balance-of-plant civil and electrical works of many wind farms in Australia, such as the 75 MW Studland Bay and the 159 MW Lake Bonney Stage 2 farms.

**What our customers say...**

- **“Alstom Grid was instrumental in helping Roaring 40s to develop the Studland Bay wind farm in northwest Tasmania. The level of professionalism and dedication to the job demonstrated by the Alstom Grid personnel on site was excellent, and the solutions developed helped Roaring 40s maximise the value of the overall project.”**
  **David Pollington**, General Manager Construction Roaring 40’s Renewable Energy in Hobart, Australia

- **“The quality of Alstom Grid’s manufactured materials and its experience in construction of electrical systems for wind farms have been demonstrated once again. It’s been a pleasure to work with Alstom Grid, and we hope to work with them again in the near future.”**
  **Gökhan Andi**, Wind Energy Coordinator, SANKO Holding, Turkey

- **“We expect an absolute adherence to delivery dates from our suppliers. Ventotec has implemented several substation projects together with Alstom Grid, who have proved themselves to be highly competent partners both in consultation and execution. In Alstom Grid we have found a truly reliable partner for our wind farm projects.”**
  **Ralf Heinen**, General Manager of Ventotec GmbH, Leer, Germany