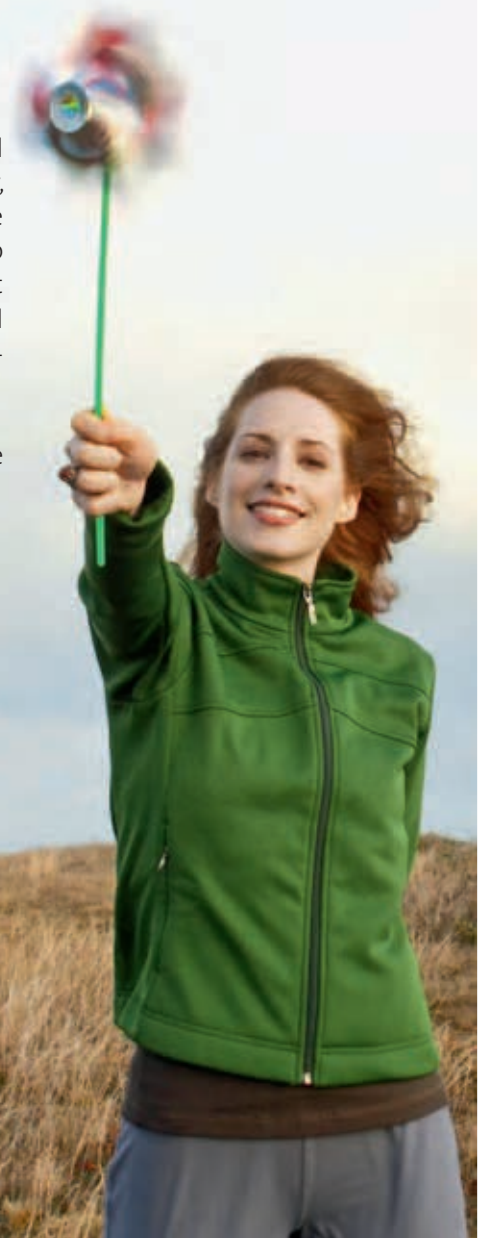


# POWER PLANTS

When we talk about power, it's impossible not to think about the world's demand for energy: currently, this stands at well over 100,000 Tera-Watt hours per year, and is likely to double by 2050. Around 85% of the world's energy demands are currently met by fossil fuels. However oil and coal resources are continuing to dwindle and what becomes scarce becomes expensive. This is why the largest shift in energy policy since the Industrial Revolution is taking place: the global trend towards renewable energies. The wind power industry in particular is seeing its share of the market increase.

BELFOR rides the tailwind and helps you overcome the problems that damage may cause to your business.





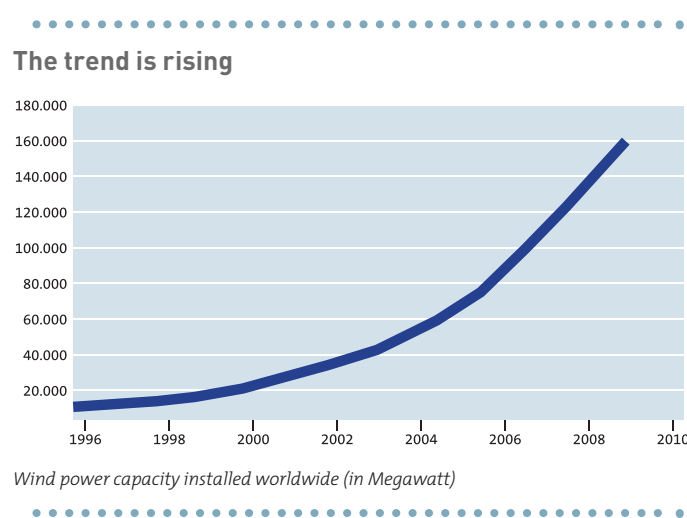
# Harnessing the power of the wind



Wind power can be used almost anywhere and is available in virtually unlimited quantities. It is clean and free from emissions. It also requires no fuel, creates jobs and drives the regional economy. So it's no wonder then that wind energy has the highest rate of growth - 30% - among the various forms of renewable energy.

## Making Watts out of thin air

The total amount of power generated by wind power turbines installed across the world is currently an impressive 160,000 MW. According to experts, this figure will multiply tenfold by the year 2020. 76 countries already use wind power as a factor in their economies. Since 2009, the USA has been the world's number 1 in terms of installed overall capacity. China takes first place for newly-installed wind power facilities, with growth rates of over 100% per annum. The European Union is also keen to increase its share of renewable energies used in the overall energy supply to its members to 20% by 2020. No matter where you look, wind power will be playing a key role in the energy mix of the future.



## Higher, faster, further!

The energy giants surpass themselves almost hourly with new, superlative reports on the achievements of their wind parks. The biggest "energy fish are caught where most of the wind is – out on the open ocean."

## Offshore

The current biggest offshore wind park is situated 30 km off the Danish North Sea coastline: "Horns Rev 2" has 91 2.3 MW wind turbines producing 209 Megawatts of power a year – enough for 200,000 homes. However this is not enough for its English neighbours: off the coast of Great Britain, "Gwynt y Môr", Welsh for "wind on the sea", soars skywards. The offshore wind park is expected to deliver 576 Megawatts of power for 400,000 households from 2014 onwards. However it is still nowhere near being a pretender to the crown of the world's largest wind park: close to Dogger Bank in the North Sea, there are already plans for a 9,000 Megawatt wind park. Its output is equivalent to that of seven nuclear power plants.

## Onshore

On the mainland, where there is not as much wind, engineers try to compensate for the lack of performance with more or taller wind turbines. The world's largest onshore wind park in Roscoe, Texas, generates 780 Megawatts of power from 627 wind turbines for more than 230,000 households. In the Belgian town of Estinnes, the tallest and most powerful wind turbines in the world are currently being erected: namely E-126 models from the German market leader Enercon. Each is 198.5 metres tall with a blade diameter of 127 metres, and has 6 Megawatts of rated capacity. To lift these giant blades skywards, the world's largest crawler crane was developed with a weight of 1,600 tonnes. It's perfectly clear that wind power unleashes other energies, providing a welcome boost to supplier industries too.

## The wind is turning

No matter where you look, the energy revolution is in full swing. Renewable energies are for the first time opening up the opportunity for mankind to fulfil a dream: to generate power in a way that is as climate-neutral as possible. The growing energy autonomy also offers emerging and developing countries the opportunity to raise their capacities to the energy level of the west in the foreseeable future. It's a win-win-win(d) situation for mankind, the economy and the environment.



Users of fossil fuels are facing strong headwinds – onshore and offshore



# Fighting the power of the wind



As well as valuable energy, the wind also brings with it extreme stresses. To utilise wind power efficiently long-term, it needs to be withstood effectively. BELFOR ensures that your blades will continue to turn, even after a little turbulence.

## Frequency of damage and downtime costs

As a rule, the larger the wind turbine, the more lucrative it is, but also the more prone it is to problems! Output classes below 1,000 kW (< 1 MW) register a damage frequency of one to two claims per year after two years of operation. Larger systems report around three claims a year in their first five years of operation. The average loss when an onshore system goes down is around € 1,500 per day, and around € 3,500 per day for an offshore system. Once the warranty period expires, downtimes, repair and failure costs are the responsibility of the operator. This is where property insurers provide special solutions. However, if things go wrong, both operators and insurers are dependent on a service team with short response times to keep downtimes and failure costs to a minimum. So who do they call? BELFOR!

## Repowering without any power loss

For around five years, the first wave of repowering has been in progress for onshore systems. This involves gradually replacing old systems with more powerful and more efficient systems or components. From 2014, onshore repowering is set to expand massively. The first major offshore repowering

project, due to offshore being a more recent development, is anticipated from 2022. Here, too, BELFOR can provide invaluable help for new beginnings.

## BELFOR never leaves you up in the air ...

Wind turbine operators value fast, smooth service, but most importantly independence. BELFOR gives you both – on land and at sea: for just under a decade, we have been successfully restoring on and offshore wind turbines. The average restoration time is just 2 weeks. Our many years' restoration experience from fire and water damage is of tremendous help to us for this, along with our expertise in ship restoration. (See page 28 et seq.) Our specialist teams of experts will assist you in the event of damage.

## ... because we hang around until the job is done

A wind power team generally comprises six staff, including three Alpine climbers who aren't afraid of heights, two trained restorers and one crew manager. This compact team offers the most flexibility with a minimal safety risk. All of the stages of the restoration project are agreed in close consultation with the operator and insurance provider and are documented from start to finish.

# BELFOR in action

## France – Clear course at the “Tower of Babel”

An 80-metre-high tower in which four languages are spoken is something unusual, even for BELFOR! However restoration means coordination and communication! This was certainly true for a case involving a French wind turbine, on which a cable fire had initially damaged the switching cabinets and spread contamination throughout the entire tower. Accordingly, BELFOR shared out the benefits of its international network: the manufacturer notified the German BELFOR Reletronic, and from here the message was relayed to French colleagues who pulled out all the stops to get a crew on site immediately. However, the term ‘immediately’ is relative when the nature and extent of the damage is – to put it mildly – “difficult”. The preparation work alone, for instance, took three weeks: specialist equipment had to be obtained, French team members specially trained and three platforms completely replaced. Six days a week, all of the members of the team worked for up to nine hours a day to meet an extremely tight deadline and while wearing heavy safety and protection equipment, but their efforts paid off. The “Tower of Babel”, where there was clear communication despite four different languages being spoken, will be back in operation at the start of the autumn.



Visible fire damage on the exterior of the tower

## Italy – no grid, but an international network

A second case study shows that it works the other way round too: when we can't resolve damage on site, then we simply “move” it to another location where we can. This is precisely what happened with a new, 2 Megawatt wind turbine. The electrical cable had burned out due to a technical defect, contaminating the entire tower and the nacelle with soot. Following an initial damage estimate, BELFOR took care of the major cleaning of the tower and nacelles on site.

## BELFOR's strengths: EXPERTISE

Whether it be levers or wheels, compressors or pumps, or even state-of-the-art wind turbines, mankind has been inventing machines and making them work for us since living memory. All round the world, 24 hours a day. When machines fail, equally good ideas are needed: and BELFOR DeHaDe has them – backed by over 30 years' experience in machine and system restoration. All combined with the nerve to work in all conditions, even at heights and in high winds.

### Our services

- ▣ Fire, oil damage, mould remediation
- ▣ Restoration of all electrical and electronic components
- ▣ Machine restoration and repair by BELFOR DeHaDe
- ▣ Replacement of cables, platforms, entire conductor rails and control wiring harnesses
- ▣ Cleaning of the inside of rotor blades
- ▣ Cleaning of tower exteriors and rotor blades
- ▣ Certified personnel capable of working at heights
- ▣ Project-specific restoration and recovery methods
- ▣ Short response times worldwide

### Your benefits

- ▣ No waiting thanks to 24-hour emergency response
- ▣ Fastest possible resolution and processing of the claim thanks to high location density and international presence
- ▣ Short downtimes
- ▣ Minimisation of financial losses
- ▣ Advantage of many years' experience and expertise
- ▣ Minimum coordination and organisation input required thanks to full service



A head for heights is essential: climbers in action

The severely contaminated nacelles were then partially dismantled, loaded onto transporters and taken to Germany, to BELFOR DeHaDe's main repair factory in Hamm (Westphalia). With specialist equipment and machinery restoration expertise at the factory, the nacelles were thoroughly cleaned and returned to the manufacturer.

### North Sea – “on time”, even offshore

The restoration of a wind turbine becomes even more complex if our experts not only have to “hang around”, but also have to work above water – such as on an offshore wind turbine in the North Sea. A technical fault had caused gear oil to leak and had damaged some of the nacelles as well as a number of the system's external parts. BELFOR was commissioned with cleaning the inside and outside of the tower to prevent oil leaking into the North Sea. Thanks to our maritime expertise and flawless collaboration with the customer, the entire system was fully restored in just three days – with not a single unnecessary drop of oil spilt.



In action on an offshore system

## The most common damage to wind turbines

### Causes

#### Mechanical stresses

- ▣ Unladen weight
- ▣ Mass acceleration
- ▣ Centrifugal forces
- ▣ Gyroscopic forces
- ▣ Mass imbalance
- ▣ Aerodynamic imbalance
- ▣ Natural vibrations

#### Weather-related stresses: e. g.:

- ▣ Storm/lightning strikes
- ▣ Frost, hail, ice
- ▣ Storms
- ▣ Sand storms
- ▣ Rain, condensation

For offshore systems, also: constant effects of water, salt and UV light

### Consequences

- ▣ Component wear
- ▣ Maintenance intervals (1 x per annum approx. 1 week)
- ▣ Downtimes for offshore systems: more cost-intensive maintenance, longer downtimes due to more complex installation and more difficult transport

- ▣ Voltage surge damage – short circuits
- ▣ Frequency fluctuations – corrosion
- ▣ Formation of mould
- ▣ Fluctuations in performance
- ▣ Vibrations
- ▣ Overload, overspeed (automatic system shutdown)
- ▣ Wear-related component damage
- ▣ Service interruptions
- ▣ Downtime
- ▣ Personal injury caused by ice falling from offshore systems: more costly maintenance and longer downtimes due to more complex installation and more difficult transport

#### Electronic damage

For offshore, also: damaged or torn marine cables

- ▣ Voltage/power fluctuations
- ▣ Control failure
- ▣ Fire
- ▣ Service interruptions
- ▣ Downtime

#### Material and processing damage: e.g.:

- ▣ Leaking oil
- ▣ Blade fracture
- ▣ Gear damage
- ▣ Generator damage
- ▣ Cracks in foundations
- ▣ Cracks in the rotor blade
- ▣ Faulty wheel bearings

- ▣ Maintenance and repair work
- ▣ Downtime
- ▣ Redress negotiations

#### Human and operating errors: e.g. during:

- ▣ Startup and shutdown
- ▣ Grid synchronisation
- ▣ Adjustment of the nacelle direction
- ▣ Blade angle adjustment
- ▣ Pole reversals

For offshore systems, also: collisions with ships (due to lack of manoeuvring ability, fog/navigational errors)

- ▣ Voltage fluctuations
- ▣ Power fluctuations
- ▣ Flickering
- ▣ Service failure
- ▣ Downtime

#### Transport, assembly and maintenance damage

- ▣ Delays to operation
- ▣ Interruptions to operation