

A low-angle, close-up shot of a wind turbine against a clear blue sky. The large, curved blade of the turbine dominates the upper left portion of the frame, extending diagonally. In the background, the rest of the turbine, including the nacelle and another blade, is visible, slightly out of focus. The overall color palette is a range of blues, from deep navy to a lighter, hazy blue near the horizon.

Safe working  
environments,  
lower costs,  
greater  
reliability

**COTES**



“There is no sign of corrosion, condensation or any problem of that kind. Inside, our wind turbines and the electrical installations are pretty much in as good a state as the day they were commissioned.”

**JESPER NIELSEN**

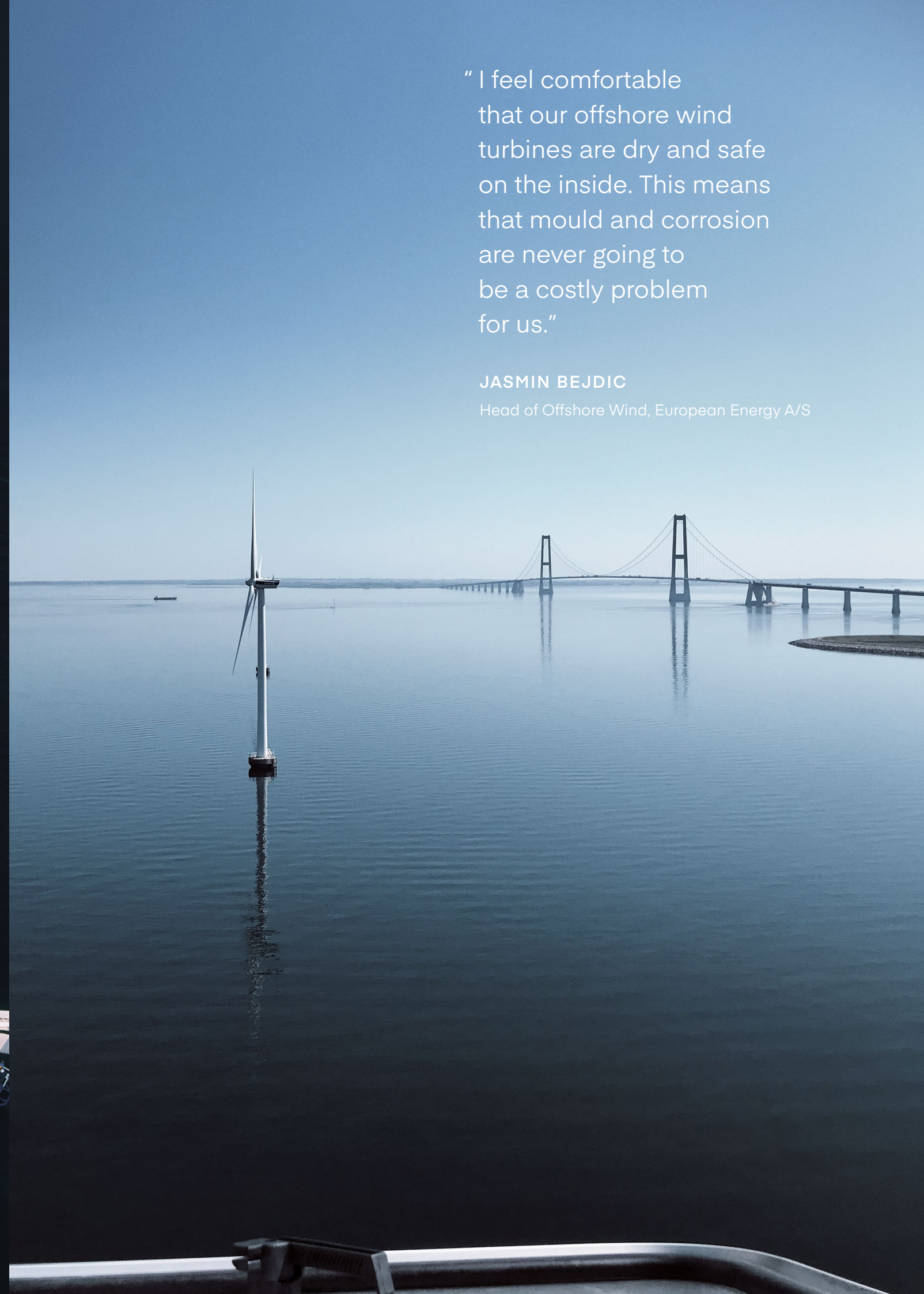
Manager for the Nysted Offshore Wind Farm,  
DONG Energy (now Ørsted)



“I feel comfortable that our offshore wind turbines are dry and safe on the inside. This means that mould and corrosion are never going to be a costly problem for us.”

**JASMIN BEJDIC**

Head of Offshore Wind, European Energy A/S





Problems arise if nothing is done

## Mould and toxic gases

—harmful to people

## Condensation and corrosion

—harmful to electronics and installations



# Doing nothing is risky and expensive

### Your installation will be damaged

It's an unfortunate fact of offshore wind farm operations that air laden with a corrosive mix of salts and moisture is going to enter the nacelles and towers from outside through all the many gaps and openings. This then results in constantly corrosive environments around everything inside.

If you don't take appropriate measures, the conditions inside will end up extremely harmful to the equipment and structures as well as for the people who have to undertake inspections, service and repairs inside them.

### Toxic working conditions

High, uncontrolled humidity gives rise to mould growths that are hazardous to health. Gases like hydrogen, hydrogen sulphide and ozone from below ground and given off by materials, equipment and battery packs are also harmful to anyone working inside the turbine.

In such conditions, health and safety regulations often require the use of cumbersome respiratory equipment that makes work procedures slow and ineffective—and therefore costly.

### Facts

- \* Humidity gives rise to uncontrolled mould growth
- \* Mould is not allowed in working environments
- \* Health-hazard gases get trapped and accumulate
- \* Up to 25% of all faults are directly or indirectly caused by the corrosive combination of airborne humidity and salts
- \* Compliance with ISO 9223 corrosion class C4 or C5 will be needed

### Cost perspective

Seen from a cost perspective, it's extremely expensive to just do nothing to deal with these challenges.

- \* Lost revenue from breakdowns amounts to up to €15,000 per day
- \* Effective mould removal costs up to €30,000 per turbine—each time
- \* Complying with C3 or C2 corrosion standards rather than C5 or C4 saves up to 50% on component costs

# Prevention is easy and safe

## Facts

These kinds of problems are actually easy to solve. All you have to do is create a slight overpressure of air that's dry and free from salts.

- \* No risk of condensation
- \* No risk of mould
- \* No risk of corrosion
- \* No risk of EHS issues from toxic gases and mould
- \* Any gases from underground, batteries or other sources are vented out
- \* Air inside is safe to work in

## Cost perspective

From a cost perspective, it makes good commercial sense.

- \* Turbines can be spec'd and built much cheaper
- \* CAPEX from €3,000
- \* No risk of extra costs to combat or remove mould
- \* Cost savings as a result of ISO 9223 C2 or C3 classification
- \* Breakdowns and downtime reduced by up to 25%
- \* Preventing just *one* breakdown during a 25-year service life pays for the whole installation
- \* EHS compliance provides big savings on servicing and repairs



Block Island  
Wind Farm



Preventive planning  
makes for increased  
uptime and longer  
service life



# What you should do if you are ...

## ... set to purchase offshore turbines

**PURCHASING DECISIONS**  
Designed-in capabilities provide commercial advantage

It's very likely a good idea to consider the long-term risk of extra costs and lost revenue due to breakdowns and maintenance, especially for the long stretch after the OEM warranty expires.

- Cotes recommends specifying the following in a tender or purchase contract:
- Effective venting of gases
  - Relative humidity never above 55%
  - Effective, reliable salt filtration

Cotes has worked with many of the world's leading wind turbine manufacturers to co-develop a common standard for surface treatment inside turbine towers. All the major manufacturers have now implemented this, and use it when developing new tower designs.

## ... a decision-maker at a wind turbine manufacturer

**PLANNING DECISIONS**  
Preventive planning makes for increased uptime and longer service life

Cost and risk are probably prime concerns, because your company will be directly responsible for repairs, mould removal and breakdowns for at least first five years, as part of the OEM guarantee.

In this key period, there's a big likelihood of unscheduled operating costs that amount to more than double your initial investment.

There are substantial savings to be had on the internals in the tower, and if the nacelle components can be spec'd to normal industrial standards, rather than having to comply with the more rigorous and more expensive offshore specification levels.

These big savings are, of course, on top of being able to tell your customers that they'll be free of all concerns about durability and reliability issues or safety due to air conditions inside the wind turbines you're supplying.

## ... designing a wind turbine

**DESIGN AND CONFIGURATION**  
Design your way out of corrosion and mould problems

You are almost certainly well aware that airborne humidity and salts make up a nastily corrosive cocktail. You probably also know that gases from below ground—and elsewhere—are harmful.

The obvious solution lies in over-specifying to try to be on the safe side. But this is haphazardly risky as well as expensive, and slices into any project's planned profit margins.

The real solution is actually quite straightforward. Instead of engineering preventively for an aggressive environment, it's possible to transform the conditions inside nacelles and towers into a safer, protective environment.

This then opens up a new world of opportunities, because you can now use standard industrial components in your design and configuration work. These involve less risk and lower cost, and are much easier to source all over the world.

## ... a technician entering an offshore wind turbine

**WORKING CONDITIONS**  
Less bother, safe working conditions

You already know that mould and gases like hydrogen, hydrogen sulphide and ozone can be harmful as well as dangerous.

To see if the turbine is infected with mould, keep a watchful eye open for green or black stains—usually seen on the tower wall. Mould growths are easy to see, and if they are there, you should report this to your superiors, and require appropriate safety equipment until the mould and its spores are removed.

It's not quite as easy with gases, because they're usually invisible and often odourless. If the turbine is fitted with some kind of ventilation system, it's *probably* safe. If not, you'll need to keep the door open for a while before entering, as well as taking all other mandated precautions.

**But if there's a Cotes combined dehumidifier and desalter fitted, you know you'll be safe and can work without special safety gear.**

## ... taking over turbines when the OEM warranty expires

**TAKING OVER RESPONSIBILITY**  
Keep structures, surfaces and equipment in good condition

If the manufacturer's warranty on the wind turbine expires soon, you should check for any signs of mould and corrosion. It might also be a good idea to install sensors inside the turbine to determine the humidity level. If relative humidity is above 55% for significant periods, there's a good chance you'll face problems in the long run. Uncertainty and risk can be expensive.

You should also inspect carefully for corrosion, especially in electrical cabinets, power converters, on olts and on doors. If you see any such signs, the wind turbine's remaining service life is probably relatively limited.

**If there is no ventilation system, you should almost certainly consider getting one installed, because the risk of harmful working conditions inside the nacelle or tower will soon become your problem.**

Bear in mind, however, that traditional ventilation is really only moving different bodies of salt-laden moist air around. You need a solution that actually does something to remove the humidity and airborne salts—effectively and reliably.

## ... already facing mould or hazardous gases

**DEALING WITH MOULD**  
Prevention is better than just fixing

Experience tells us that most onshore wind turbines and many offshore wind turbines are currently having problems with mould, hazardous gases or both.

If your wind turbines are plagued by mould, you'll have to start the cleaning up process by removing any existing growths. However, it can be extremely expensive to tackle growths of this kind, so be careful how you get it done and by whom. Simply using chemicals is never enough.

**You also have to prevent the mould problems from coming back. The most cost-effective, reliable way to do this is by installing a combined dehumidifier and desalter.**

There's also the big advantage that you can use the same equipment to get rid of any health-hazard gases, and to prevent future problems with corrosion and electrical faults.



# Designed to help you and your operations

## Combined dehumidifier and desalters

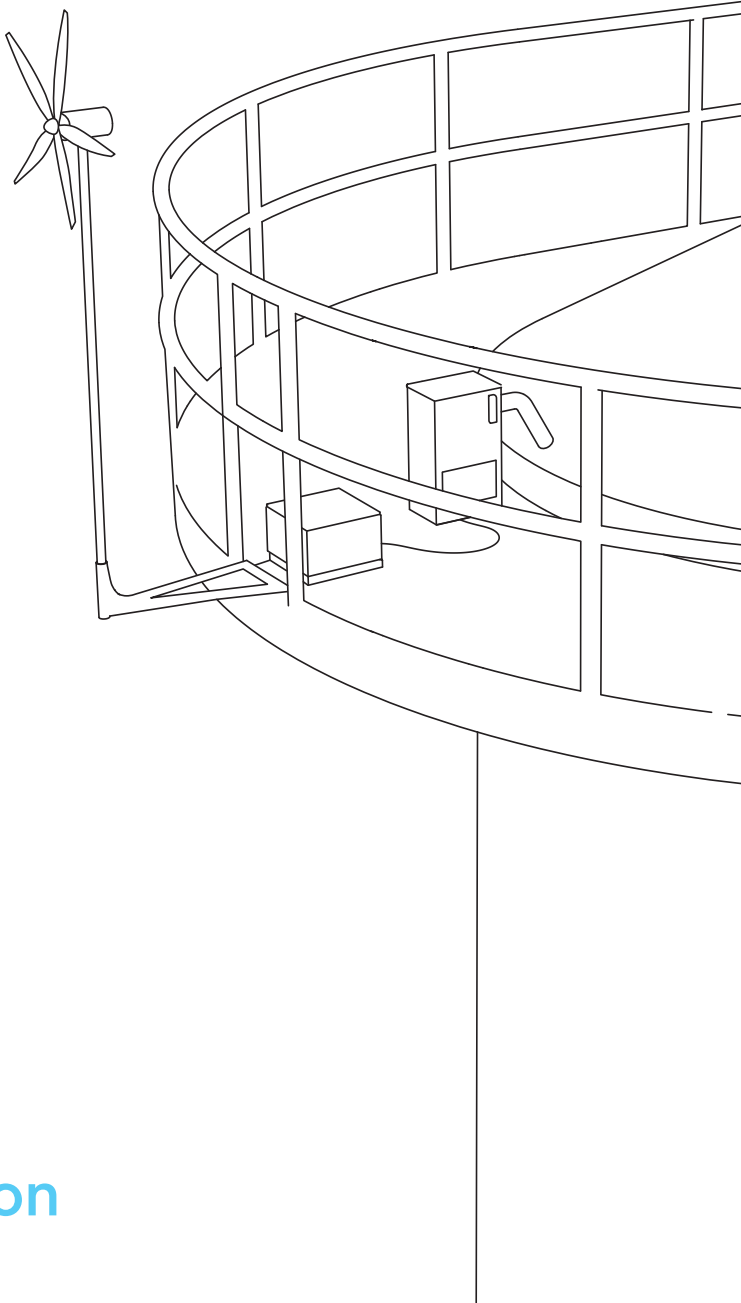
Cotes combined dehumidifier and desalters are the only safe, reliable solutions on the market. They filter away any salts, and remove most of the humidity. They blow a protective flow of dry, clean air into the tower, creating an overpressure so that this air protects the installations and people working there.



Scan this QR code to see how it works

## Combined dehumidifier and desalter, for off-grid installation

Many offshore wind farms face problems with mould during construction—well before they're connected to a national grid or some other form of shore power. Dehumidifiers cannot run without electricity, so Cotes has developed a small, practical solution to deal with this situation. It is basically a compact combined dehumidifier and desalter, powered by a micro wind turbine and a small diesel-run heater. These off-grid units require very little maintenance and Cotes can monitor them remotely, if required.



## Keeping transition pieces in best possible condition until completion



TPs and other equipment risk getting plagued by mould problems in the period before they can be connected to the grid —because traditional protection systems require electrical power. A Cotes off-grid system is the ideal solution.

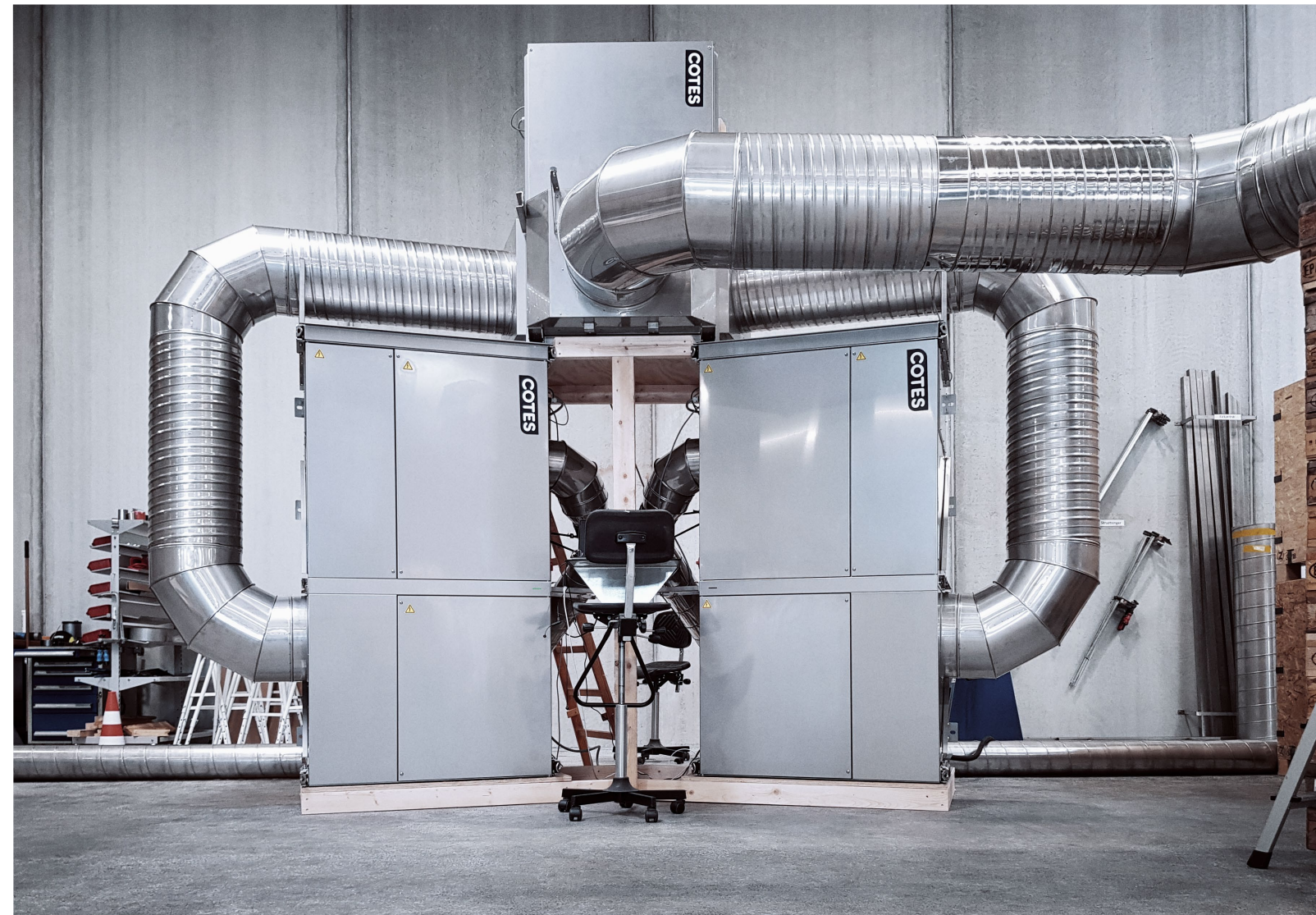


# Reference successes

We've delivered more than 30,000 dehumidifiers for use in offshore and onshore wind turbines, making Cotes the only supplier with the technology, know-how and experience to help you protect your assets and the people working in them.

We wish we could reveal all the customer references and success stories we've built up. But we can say that we supply dehumidifiers to most of the world's top eight wind turbine manufacturers. And that Cotes systems are installed in 75% of all the offshore wind turbines in service today.

We're here to help. The first step is contact.











PurePrint® by KLS  
Produced 100% biodegradable  
by KLS PurePrint A/S



We apply Cotes humidity management technology and know-how to help manufacturers, operators and owners eliminate key practical challenges to the take-up of wind energy — via greater efficiency, better safety, lower cost and improved reliability.

Put our  
expertise  
to your  
advantage

We're here to help. The first step is contact.

Call	+45 5819 6322
Email	<a href="mailto:sales@cotes.com">sales@cotes.com</a>
Read	<a href="http://cotes.com">cotes.com</a>
Download	<a href="http://cotes.com/downloads">cotes.com/downloads</a>

