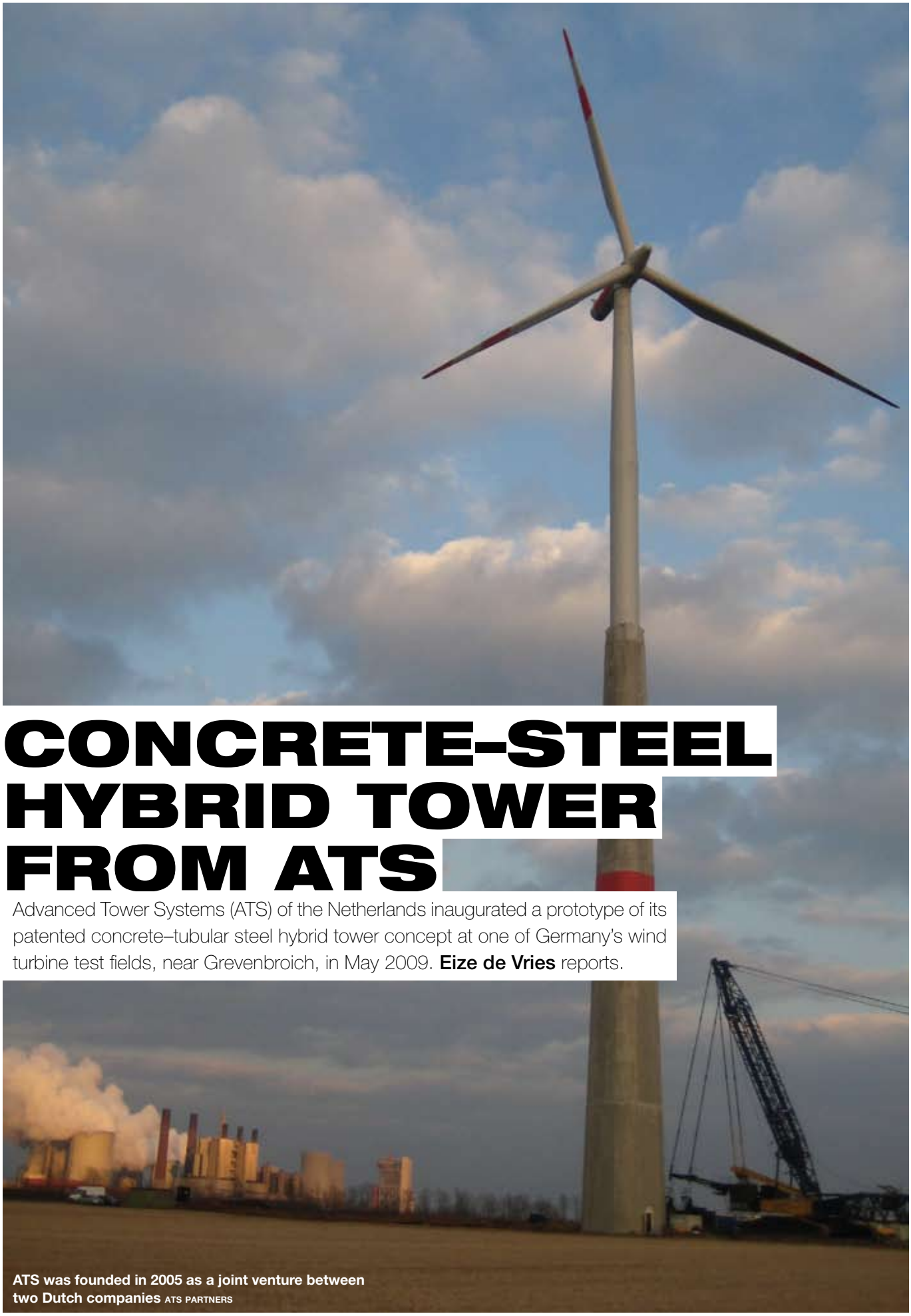

CONCRETE-STEEL HYBRID TOWER FROM ATS

Advanced Tower Systems (ATS) of the Netherlands inaugurated a prototype of its patented concrete–tubular steel hybrid tower concept at one of Germany's wind turbine test fields, near Grevenbroich, in May 2009. **Eize de Vries** reports.

ATS was founded in 2005 as a joint venture between two Dutch companies ATS PARTNERS

Sections of the ATS tower in Grevenbroich being assembled
ATS PARTNERS

As part of an inland wind energy project at Grevenbroich, Germany, a new prototype hybrid tower from Advanced Tower Systems (ATS) was combined with a 2.3 MW Siemens turbine, featuring a 93-metre rotor diameter. With its 133-metre hub height, the installation is clearly visible from some distance as it towers high above the landscape, which is characterized by gentle hills, partly wooded and partly agricultural. It's only from close up that the huge, gradually tapering concrete structure, square-sided with rounded corners, reveals its massive dimensions.

Founded in 2005, ATS was initially a joint venture between two Dutch companies, engineering consultancy Mecal BV and large general contractor Hurks BV – a company with concrete manufacturing expertise. German renewable energy project developer juwi Holding became the third ATS partner at the end of 2008, and already has plans to erect 34 turbines using these new towers.

For the Grevenbroich project the three ATS partners joined forces with a Siemens business-venture investment company. In its co-operation with ATS, Siemens Wind Power sees favourable opportunities for generating wind power at large hub heights.

ATS managing director Frans Brughuis explains the project background and future plans for the innovative wind turbine tower technology, recalling that the initial ATS tower concept ideas date back to 2002. 'We first commenced design calculations with a decagonal (10-sided) cross-sectional coning shape, but this concept was rejected later, for mainly visual reasons. A search for alternative options resulted in a coning circular shape. However, we found that this coning shape requires many different moulds, as sections of each new layer added have a reduced radius. That option therefore only proved viable for large series,' says Brughuis.

On-going research efforts aimed at finding an optimized shape suitable for manufacturing and other major objectives led to a triangular and, later, to the current square cross-section, Brughuis continues: 'A triangle proved suitable for sub-megawatt class power ratings, but is less suited for larger turbine capacities due to its comparatively small cross-sectional area, requiring a high materials input.'

STANDARD DESIGN

Enercon's prefabricated concrete towers also comprise multiple coning rings placed one above the other. By contrast, a prefabricated ATS tower consists of multiple slender elements 0.5–4 metres wide and 16 metres high which are transportable by road on standard trucks. Each cross-section comprises four identical cylindrical-shaped 90° corner elements and four flat coning elements that fit in between them. While these flat coning elements decrease in width with each additional 'layer' up the tower, the corner elements all have standard dimensions. At its foot, the sides of the Grevenbroich tower measure 8.3 metres each.

Brughuis explains that both this 'single mould' idea (standard corner elements made in one mould) and the actual tower segment dimensioning where the height is twice the width, are patent protected. He says: 'The application of a minimized number of tower construction elements in turn results in a minimum number of matching production moulds required.'

The tower solution is economically interesting for hub heights up to 150 metres and turbine power ratings of 1.5 MW and up, says ATS, although with the company's current tower concept there is no standard ratio between the total concrete and the tubular steel part lengths. Says Brughuis: 'A main criterion is that the maximum diameter

of the tubular steel part should for road transport-logistics reasons not exceed 4.3–4.4 metres.

Equally important, a bigger turbine results in increased maximum rotor loads and tower bending moments per unit of length. A major consequence is that in order to stay within the maximum diameter range, ATS-type towers for large turbines feature a shorter tubular steel section than ATS towers designed for smaller turbine equivalents.

With regard to concrete tower element transportation, the maximum allowable width of the flat coning sections is also restricted to about 4 metres. And, according to Brughuis, that may ultimately necessitate a switch to a pentagonal (five-sided) cross-section for future towers the company designs for 4–6 MW power ratings.

To accommodate the tubular steel tower, the concrete structure incorporates a square-shaped adaptor integrated into the top section. This steel-reinforced concrete component is 2.5 metres high, has sides of 5 metres each and a total mass of 50 tonnes. The adaptor height will be reduced to 1.75 metres in the series product, an optimizing measure that reduces component mass by 30%, ATS says. The tower bottom flange is attached to the adaptor with the aid of long studs passing right through the concrete and fastened from inside.

The bottom sections are assembled individually and each additional layer is partly assembled on the ground into two halves before hoisting. Total installation requires two to three weeks.

Brughuis commented: 'When installation of the concrete tower part is ready, the structure is post-tensioned with steel cables put in plastic tubing located inside the tower walls. With this prototype the tubes are filled with grout after the cable post-tensioning, but in future, grease will be applied as a corrosion protection measure.'

Another clever ATS design feature is that the tubular steel towers applied are also in fact standard serial manufactured products.

VIABLE SOLUTIONS

The introduction of the ATS product comes at a time when all major wind turbine suppliers are in search of economically feasible solutions to achieve hub heights in excess of 100 metres. Concrete towers built In-situ are not an option, believes Brughuis, and only with state-of-the-art prefab solutions can a constant production quality can be guaranteed and weather dependence simultaneously minimized. He says: 'At the moment we have one licensee for a segmented circular-shape tower, Inneo of Spain, which has already built 50 towers of 80 metres each. A second licensee, Postensa of Mexico, manufactures triangular-shape towers. As an indication of the huge interest in our tower solution, ATS is currently in contact with all major wind turbine suppliers except one, negotiating various options for them to use their technology.'

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