Civil Engineering Contributions to Harvest Wind Energy: From Aeolos Era to Future Cities

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Wind turbines create controversy almost everywhere they are built: people don't like the size, the noise, the threat to birds and the despoiling of the countryside.

Yet, along with solar power, large-scale harvesting of wind energy is vital if we want to create a sustainable future.

On- and off-shore wind farms are here to stay for now – and turbines as lofty as 300 metres will be built by 2020 – but there are also simpler, viable alternatives to large, risky and expensive structures, such as every new home being built with its own wind turbine that is noiseless and small enough to be hidden away in a 'cupboard'.

Dr Charalampos (Lambis) Baniotopoulos, Professor of Sustainable Energy Systems at the School of Civil Engineering, is one of Europe's leading academics on wind energy technology infrastructure. Over the past 15 years, he has worked with groups across the Continent to find ways of making existing towers more robust and cost-efficient – through, for example, using high strength steel, innovative component-joining techniques and different foundation solutions – while at the same time exploring alternatives to wind farms.

This month, it was confirmed he had won a four-year COST (European Cooperation in Science and Technology) Action grant to explore new ideas on using wind for power.

When he arrived at the University earlier this year, Lambis joined what was already one of the foremost wind engineering research groups in the world, headed by Professor Chris Baker.

'I come from a structural engineering background, so we are combining our expertise to go one step further and become a world leader in wind energy structures,' he explains.

Human beings have tried to tame the wind from time immemorial, and it was this topic Lambis chose for his EPS Inaugural Lecture, entitled Civil Engineering contributions to harvesting wind energy: From Aeolos era to future cities, on November 13.

In ancient Greek mythology, Aeolos was known as the Treasurer of Gods because he was able to dominate the wind. Ever since then, from the ancient windmills of Mesopotamia to the turbines of today, wind has been an important way to generate power.

Over the past two decades, the need to harness the wind has become more urgent due to modern cities' huge energy demands, as well as the oil-price crisis and environmental concerns.

'Civil engineers have contributed significantly to the enhancement of wind energy technology research and development with innovations that made the relevant designs smarter, safer, more serviceable, more sustainable and more economic,' says Lambis. 'This has produced the technology for higher and lighter wind turbine towers, innovative connections to improve their erection, more sustainable foundations and more daring and challenging structural systems.'

Lambis, who is Chair of Sustainable Energy Systems and Director of the Birmingham Centre for Resilience Research and Education, was born in Thessaloniki, Greece's second-largest city. He enjoyed a full academic career at the Aristotle University of Thessaloniki, rising to Professor and Director of the Institute of Steel Structures within the Department of Civil Engineering. Fluent in four languages, he also spent several years in Europe, mainly in Germany, where he was twice awarded the Alexander von Humboldt Research Fellowship.

After being invited to take part in the design of Greece's highest-ever steel towers, which stand at 50m, Lambis's interest became focused on the structural design of sustainable energy systems, in particular wind turbine towers. He has written no fewer than 250 papers on the subject as well as two (out of a total of 11) books.

'One of the very few top interests for society is energy needs,' he explains. 'It's a typical interdisciplinary area, and among those who contribute to the advances being made in its application are civil engineers. We started with wind towers of a few metres high and now we design towers of 300m. It's a challenge for structural engineers, with a lot of issues for future investigation with reference to foundations, joints and bolts to be used and the real mechanical problems like buckling, taking into account the higher you go, the more the cost increases. So we have to optimise the design.'

Those designs already include skyscrapers in Asia, China and London that incorporate medium or large turbines within the buildings.

'What is interesting now is that there are a lot of new building projects where small turbines are completely hidden: you don't see them and you don't hear them,' says Lambis.

'Wind farms are very expensive: Offshore turbines are particularly costly and also come with a lot of risks, such as corrosion. So we are trying to find alternative solutions – such as building higher, using lighter materials – that are better for the environment and also safer and more economic.

'On the other hand, we have to look at harvesting wind in a more simple way. If each one of our small houses had a turbine, hidden and with no noise, with a small solar cell, they would be self-powered. Ten years ago, there was no industry for these products, but in Britain now there are lots. So it's about bringing people round to the idea in order for our future cities to be cleaner – therefore healthier – and more sustainable.'

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