Solutions

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How we cracked it

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The challenge: To design a building where onsite power generation was integral to the design
The solution: An aerofoil shape and a spine of wind turbines
Architect: Waugh Thistleton
Services engineer: XCO2
Site: Ramsgate Street, London
Project type: Mixed use

Step 1 The challenge ▼

Ramsgate Street is a mixed-use scheme in Dalston providing private and affordable flats and houses, in addition to office space. A key requirement of our brief from the Metropolitan Housing Trust was to meet or exceed mayor Ken Livingstone's target on renewable energy sources, whereby 10% of the building's carbon emissions should be offset by the use of renewable energy technologies. Our aim was to offset 13-15%.

We wanted the energy producing/saving mechanics of the building to be an integral part of the design, rather than an afterthought. Wind turbines on the roof or solar panels on the elevations too often look tokenistic and offer a sop to energy generation. Our approach was to integrate the power generation within the building as a first principle of its design, as important as the structure and the weatherproofing.

Step 2 Developing ideas ▼

We ran through a checklist of technologies looking at which solution was most appropriate given both the use and context of the building.

The site at Ramsgate Street, which allowed for a tall building in the context of relatively low buildings, suggested the opportunity for wind generation. Wind speeds gradually increase with height. As wind energy is proportional to the wind speed cubed, a small increase in speed gives a large increase in energy out.

The design team investigated how to use the height and form of the building to optimise the capture of the wind energy. Further, the shape of the site began to suggest the form of an aerofoil. So we developed a plan of the building in the form of an aerofoil facing the predominant winds, a form that could suit the use of the turbines.

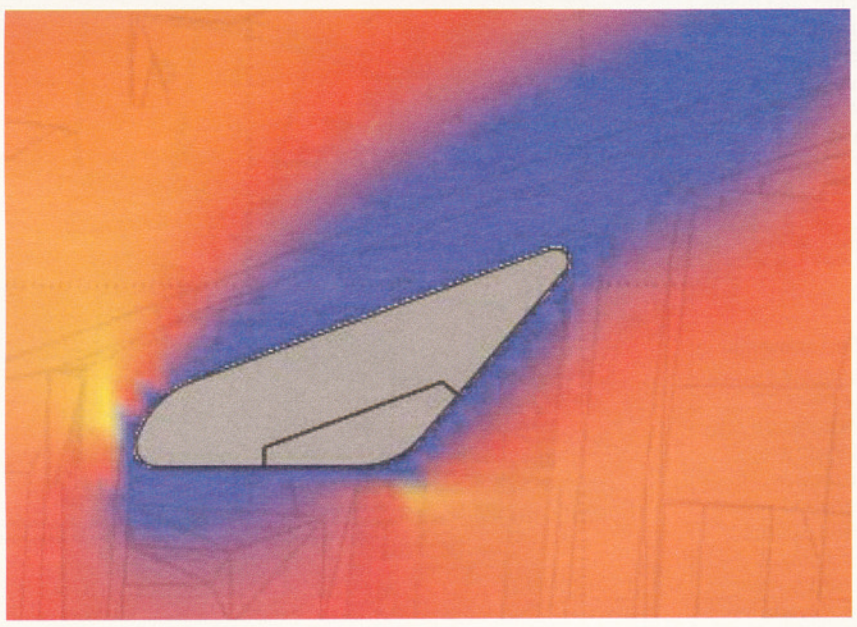
Site plan

Step 3 Finding the right form ▼

Computational fluid dynamics analysis was used to look at the speed-up effect due to the form and orientation of the tower. We took advantage of the Bernoulli effect, where wind speeds increase in order to pass round an object, especially where the shape is streamlined.

It was found that the southerly corner, when streamlined rather than orthogonal, formed an excellent wind speed "hotspot". The wind here can be up to double the prevailing wind speeds, leading to a maximum instantaneous power output increase of eight times. To capture that energy, our design proposes the use of four helical wind turbines, placed vertically down the spine of the building on the southern side

Next, we looked at the surface wind resistance of various forms of cladding. In the end, we opted for glazed terracotta tiles as they will give minimal surface resistance. The tiles also reflect ambient light from the sky, illuminating the north-facing facade.



An image from the computational fluid dynamics analysis of the structure. In plan, the building's streamlined shape behaves like a wing.

Step 4 Integrating the wind turbines ▼

The "quietrevolution" wind turbine (pictured right) developed by low-carbon energy consultant XCO2 takes advantage of wind conditions around buildings. Its vertical axis design and triple-helix form enables it to take advantage of varying wind directions, essential for use in towns and cities.

Also, unlike the common propeller-type turbines, the helical turbine virtually eliminates noise and vibration. The tips of a propeller slice through the air at a greater speed than the rest of the blade, creating noise and vibration. But the blades of the helical turbine move at uniform speed across their length, so any small vibration is taken up by the bearings and support bracket at either end of the machine.

The building has a reinforced concrete spine that houses

the lift and stair core and provides the rigidity in the structure. The turbines are attached to the structure on steel brackets at the top and bottom of each turbine.

Step 5 Energy predictions ▲

On average over the year, the installation is expected to generate 1.5 times as much energy as would be generated by turbines installed in clear air at the same height. Dependent on wind speed, the four quietrevolution turbines will generate around 40,000kW hours a year. This is enough to power the lighting, computers, phones, faxes, printers and servers of an 80-person office, or the electrical energy requirement of more than 40 flats. This will save approximately 7 tonnes of CO_2 a year.

● **Andrew Waugh is a partner at Waugh Thistleton.**