Feedback from design meeting regarding initial discussion of the possibility of roof mounted turbines being configured to a stadium roof

Attendees: Stephen Appleton (Director of Ramboll Building services and Renewables), Mark Boyle (Director of Ramboll Structural engineering, Stephen Crosher (Product Design Director for Quiet Revolution), Lynda Garman (Business Development Manager)

Venue: Ramboll London office, Newman street, London

Date: 15.30, June 3rd 2009.

My thoughts regarding the initial design concept for the layout of turbines detailed in the agenda document, was a good example of not what to do, but had its place to be able to start discussing what could be achieved in reality.

In relation to a football club committing to a full array after a pilot study has been carried out (this being the maximum they could possibly apply from the two types of turbines) to an existing or new build roof, I think the obvious issues related to my initial concept design configuration were:

For Proven -

- two rows of Proven would create shadowing and banking - therefore this idea would be ruled out leaving only one row, which would half the expected amount of Proven turbines from 56 to 28 (i.e. 14 on the west side and 14 on the East side of stadium like Middlesborough's, where the predominant wind flow is West to East. This configuration best suits a HAWT's efficiency to gain wind yield in yaw from the windward flow.
- could try and stagger them so the back row would not be directly behind the front row of Proven, however I think the issue of cast shadows of the turbines on the pitch would present another problem, if a second row was positioned closer to the inner edge. So for this reason I think one row would probably best suit;
- apart from that you probably don't want any additional weight on a cantilever stadium roof from the second back row, to be too far down the cantilever arms. As mentioned in the meeting the risk of the wind dynamics moving across the surface of the roof will have a significant impact on the bending moment of this row more so than the first front row, due to the back row being further away from the outer edge of the stadium.

For Quiet Revolution -

- I feel the opportunity for Quiet Revolution is probably a better potential being that it operates best in skewed flow it could take advantage of both the laminar flow created from the windward side of the stadium roof West to East, whilst also being positioned along the North and South side making use of the tri-dimensionality design by gaining wind yield from an opni-directional flow of wind in skewed flow. So it doesn't need to rely on the predominant wind flow flowing from West to East as much as the Proven HAWTs would need to.

- For this reason I think potentially we could still create a large amount of yield from a combined configuration using the types of turbines, but would probably be more suitable to conversely use more Quiet revolution turbines than Proven.

Suggesting that an estimate of positioning a row of 20 along the outer edge of the West side of stadium like Middlesborough (which is 200 metres in length for the West and East side, and 150 metres for the North and South side), and a further 20 along the outer edge of the East side of the stadium (assuming they need to be each - 10 metres apart)

This would give an estimate of the total no. being: (28 Proven - i.e. a row of 14 approx. in the middle of the West side and 14 in the middle of the East side) + (20 QR - i.e. a row on the outer edge of the West side and 20 QR on the East side) + (15 QR - i.e. a row on the outer edge of the North side and 15 QR - i.e. a row on the outer edge of the South side)

Total being = 98 turbines x 6kW each equates to 594kW potential from 1 stadium. If the average household requires 4kW of electricity at peak capacity, then the stadium when not using the generation for it's own use, could have the potential to power 149 houses within a housing estate.

Further thoughts:

Following our meeting earlier in the week, I have given thought to the prospect of retrofitting turbines to existing football clubs.

I think realistically this could create an opportunity for bigger and quicker rewards for all involved.

However, I think Quiet Revolution's VAWT type presents more ease of application and less affect on the structural system having to be adjusted, as it merely needs to be applied to the outer edge rather than like Proven's 6 kW array which would need to be positioned further into the middle of the roof to make best use of its natural functionality of a HAWT operating best efficiency in yaw flow rather than in skew flow which would occur if they were positioned at the outer edge.

Retrofitting a row of Proven's HAWTs within the middle of an existing stadium roof may prove to have more design and installation problems on the existing structural system's loading, due to an existing structural system for a stadium possibly not being able to account for the excessive wind loading and wind excitation. However, a minimum amount could potentially be retrofitted if the structural engineering was correctly calculated.

From a new build perspective, there is no reason why the structural limits of static and dynamic loadings for a large no. of Proven HAWTs (say a row on West and East side) are to be inclusively calculated within the overall structural stadium's roof structural limits from the start of the design. This could then prove that a large no. of Proven HAWTs can be applied to the middle of the roof making best use of their efficiency through being able to get the optimum laminar windward flow from being positioned at this location.

My thinking would be to pursue two avenues:

1. Focus on pitching the retrofit scenario to existing football clubs predominantly using the Quiet Revolution's 6kW array around the outer edge of a stadium roof, and possibly a small no. of Proven 6kW turbines located at the middle of both the West and East sides of a stadium. (Assuming the prevailing wind flow is blowing West to East at a given stadium site.

2. Focus on pitching an integrated collaborative arrangement involving both QR and Proven's 6kW array appropriately to a new build stadium scenario.

My conclusion

There is more scope for QR's 6kW roof mounted turbines being attached to a stadium roof, (even though QR's VAWTs have less wind swept area than Proven's 6kW HAWTs due to Proven's rotors being larger, so therefore has less potential than Proven's 6 kW to produce the most wind yield).

However, Proven's 6kW presents the issues of being more:

- obtrusive, unsure of having an impact of shadow flicker on pitch;
- more design and installation complications for Proven if attached in middle of roof rather than outer edge (in which it will need to be located at middle of roof, to avoid vortices created by skewed wind at the outer edge (unlike VAWTs which are better positioned at outer edge as they work better in skewed flow);
- being attached in middle of roof will involve more complex structural system design to combat against wind excitation, and vibration.

Proven's HAWT type is associated with being more efficient by being positioned in the prevailing windward yaw flow, which is ideally perpendicular to the nature of its functionality, (irrespective of its turbine design turning on its axis to the direction of a skewed flow). This means that it can function in skew flow but doesn't mean that it functions more efficiently and effectively than a Quiet Revolution VAWT, (as QR VAWTs are made to naturally function in skew flow efficiently). Conversely, QR's VAWTs could be foreseen as being a lot less efficient than Proven's HAWTs if positioned in the middle of the roof within a windward yaw flow, as a HAWT is proved scientifically that it performs better at this location of a roof and in a windward yaw flow, whilst also having a larger rotor diameter to achieve a high wind-swept area to produce higher wind yield.

QR's VAWTs could be used in a more versatile way, being applied to the North and South location in the skewed flow, and also at the West and East side being able to function also in the predominant windward yaw flow from the prevailing wind at the outer edge of the stadium roof.