ikg Consulting

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Chester Fire Station – Enhancing the Green Credentials

Background

1. Given concerns about climate change and in light of expectations about reducing CO_2 an exercise was commissioned to establish the potential to improve the sustainability credentials of the new fire station.

2. The proposed design for Chester Fire Station, which is currently under construction was developed some eighteen months ago, and has been "on the shelf" due to the delays securing planning permission. In general terms the design was a good "low carbon" design for the time it was prepared. However, construction technologies and processes have evolved to an extent that it could now be improved. This paper rehearses the changes that could be made and assesses their cost and impact.

3. It seems likely that in the future the Fire Authority will be required to upgrade its estate to reduce energy consumption/CO_2 production. Whilst Chester as a newer station will be a lot better than those constructed in the 1960s and 1970s, it will still require an upgrade if completed to the current design.

4. Given the delays to the construction of the new Fire Station, there is a small window of time, available to amend some elements of the fabric to improve the building significantly during the construction period at a much lower cost than would be the case for retrofitting.

5. These measures include improvements to the thermal efficiency of the building fabric and the addition of photovoltaic panels. The target standards set have been driven by the proposals for the new Crewe Fire Station. However in some cases, as will be seen from the proposals below, it is not considered to be feasible to achieve these in all elements.

Proposals

Enhanced Roof Coverings:
Chester Design – Contract U Value: 0.16 W/m2K
Crewe Design – Proposed U Value: 0.12 W/m2K
Chester Proposed Enhancement: 0.12 W/m2K

6. Following review, it is possible through a change of insulating material to improve the U value of the roof at Chester to achieve that proposed at Crewe. The cost to make this change is to be finalised.

External Wall Insulation:
Chester Design – Contract U Value: 0.22 W/m2K
Crewe Design – Proposed U Value: 0.15 W/m2K
Chester Proposed Enhancement: 0.18 W/m2K

7. Following review, it is not possible to achieve a U value of 0.15 at Chester without increasing the width of the external wall cavities. Unfortunately to do this, at this stage, would involve redesigning the foundations and adjusting the orders for pre manufactured materials such as concrete reinforcing bars. Whilst this is possible, it is felt that this would be cost prohibitive and consequently has not been pursued.

8. However, it is possible within the existing cavity to increase the thickness of the insulating material to achieve an improvement in the U Value to 0.18W/m2K. The cost to make this change is to be finalised.

Ground Floor Insulation:
Chester Design – Contract U Value: 0.20 W/m2K
Crewe Design – Proposed U Value: 0.15 W/m2K
Chester Proposed Enhancement: 0.15 W/m2K

9. Following review, it is possible through an increase in the thickness of the insulating material to improve the U value of the floor at Chester to achieve that proposed at Crewe. The cost to make this change is to be finalised.

10. The above cost, includes additional excavation and removal of spoil from site as this thickens the floor slab construction by 30mm.

Windows, Doors and Curtain Walling: (Not Appliance Bay Doors)

Chester Design – Contract U Value: 1.60 W/m2K	Contract G Value: 0.4
Crewe Design – Proposed U Value: 1.40 W/m2K	Proposed G Value: 0.4
Chester Proposed Enhancement: 1.40 W/m2K	Proposed G Value: 0.3

11. Following review, it is possible through a change in the proposed window system to improve both the U value and G Value of the windows at Chester to achieve that proposed at Crewe. The cost to make this change is to be finalised.

12. A second option to enhance the U value of the windows only, to a level of 0.8 W/m2K has been identified. This will require the proposed double glazing to be enhanced to triple glazing at a further additional cost which is to be finalised. This has not been analysed further in the energy modelling, as it is an additional improvement beyond the target for Crewe.

Air Tightness:
Chester Design – Contract Air Tightness: 7
Crewe Design – Proposed Air Tightness: 3
Chester Proposed Enhancement: 5

13. Following review, it is not possible to achieve an air tightness of 3 without substantial change to the proposed designs and construction methods. It is thought that this would incur a significant additional cost as it will increase the contract period and the associated overheads and staffing costs would therefore be payable.

14. However, it is possible to enhance the air tightness using the existing construction methodology to a level of 5. ISG have agreed to amend the contract to this revised level at NIL cost.

Photo Voltaic Panels to the Roof:

15. The addition of Photo Voltaic (PV) Panels to the roofs to generate electricity is, by far, the easiest and quickest way to enhance further the reduction in the carbon consumption of the proposed building, however it is also one of the most expensive.

16. At present the building is designed with no roof access, however if PV Panels are added then builders work is required to the following, in addition to the addition of the PV Panels:

- Additional roof beams to carry the additional weight
- The addition of a "man safe" system. (This will also require maintenance thus increasing the operating costs.)

NB: A number of options for safe maintenance access have been considered, but as this is effectively a retro fit to an existing design, the design team have advised that this is the most cost effective and least obtrusive option available.

Three options have been considered for the installation of PV Panels:
1. Installation to the low level roof only, at a cost to be finalised
2. Installation to all roofs, at a cost to be finalised
3. As Option 2 with the addition of storage batteries, at a cost to be finalised

17. The design team have advised that Option 3 is not viable, due to the size and weight of the batteries. This has therefore not been considered further.

Summary

18. To help understand the effect of implementing the above proposals on the carbon consumption of the building a BRUKL energy model of two options has been undertaken to compare against the current design proposal.

19. The two options considered are:

Option 1: Enhance Roof, Walls, Floor and Double Glazed Windows. Increase Air Tightness to 5 and install PV Panels to the low level roof only.

Option 2: Enhance Roof, Walls, Floor and Double Glazed Windows. Increase Air Tightness to 5 and install PV Panels to all roofs.

The table below sets out to compare the BRUKL results for each option, the proposed design and the current proposals for Crewe.

Criteria	Chester FS: As Submitted to Planning	Chester FS: As Designed	Chester FS: Enhanced Option 1	Chester FS: Enhanced Option 2	Crewe FS: Draft Feasibility
Building Emission Rate (kgCO2/m2/annum)	48.2	37.2	26.8	1.6	-0.1
Energy Consumption (kWh/m2)	92.83	71.73	60.73	60.73	68.76
Area of PV Proposed (m2)	NIL	NIL	99.6	637.4	600
Energy Produced by PV (kWh/m2)	NIL	NIL	9	57.62	68.91
Electrical Energy to be Purchased from Grid (kWh/m2)	92.83	71.73	51.73	3.11	-0.15
Additional Capital Cost:	NIL	NIL	Cost to be finalised	Cost to be finalised	N / A
Annual Running Electricity Cost (Regulated Energy only). Based on 0.135pence per KwH (current price) - 1370m2		£ 132.66	£ 95.67	£ 5.75	
Annual Saving			£ 36.99 (27.9%)	£ 126.91 (95.7%)	

NB. These consumption figures are in respect of REGULATED ENERGY ONLY, i.e. energy used in the building for heat, light, ventilation and hot water. It does not include end user energy consumption e.g. Computers, Charging Fire Engines, Charging Cars.
The costs shown will not reflect actual electricity bills as the bills include all electricity consumed on the premises.

Further Work and Summary

20. Following the receipt of the above results, further modelling has been undertaken to assess the implications of adding triple glazing and further PV panels.

21. The design team have determined that adding triple glazing will result in a reduction in the Building Emission Rate from 1.6 kgCO2/m2/annum to 1.3 which is still some way from “zero carbon”. A possible side effect of doing this, is that the potential overheating of the building on a hot day may get worse, as hot air will get trapped in, rather than be allowed to escape.

22. As will be seen in the next paragraph, it is possible to obtain “Zero Carbon” for a lower cost than the triple glazing option. As a consequence of the above the design team do not recommend progressing with this option.

23. The design team have calculated that the addition of a further 35m2 of PV panels would convert Option 2 to a “zero carbon” option, in respect of regulated energy.

24. Therefore, by enhancing Option 2 with additional PV panels the Fire Authority can deliver a zero carbon building for an additional £ 270,232.00 (subject to caveats below).

25. In order to test if a cheaper option is available we have also considered if “zero carbon” can be achieved by omitting the building fabric improvements and just doing additional PV panels. This option however would require a total of 795 m2 of PV panels. By rule of thumb, this would require approximately 1000m2 of roof, which is far in excess of the building size. This therefore isn’t a viable option.

26. The design team therefore recommend that the “best value option” to enhance the green credentials of Chester Fire Station sufficiently to meet the “Climate Emergency Declaration” of the local authorities would be to adopt Option 2, with the additional PV for a sum of £270,232.00

27. This option will produce a zero carbon building through a combination of the use of PV Panels and Building Fabric Enhancements.

28. There are three steps which will need to be taken before the zero carbon option could be delivered: firstly, further design work will be required to ensure that the photo voltaic panels can be orientated for the best effect and so as not to impact upon neighbouring properties; secondly, an approach will be required to Scottish Power concerned with the discharge of spare energy into the grid; and thirdly, the current planning permission will need to be amended.