The University Of Sheffield.

Mini-project report

Sustainable Refurbishment: A case of the Crookesmoor Building

Faisal Abubakar – dtp11fha@sheffield.ac.uk

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Supervisor: Dr Hasim Altan

ASSIGNMENT COVER SHEET 2010/2011

A completed copy of this sheet MUST be attached to coursework contributing towards theme 2 assessment.

Name :	Faisal Abubakar
Degree Course:	**E-Futures DTC**
Supervisor:	**Dr Hasim Altan**
Signature:	

I declare that this work is my own and that I have made appropriate reference to any sources used. I am aware of the handbook section on 'Plagiarism' and declare that this work is consistent with those guidelines.

Mini-Project Mark Sheet

Student: **Grade:** fail/satisfactory/good/very-good/excellent

Supervisor:

Feedback:

	Excellent	**Good**	**Average**	**Poor**	**Very Poor**	**Not Done**	**Not applicable**
Introduction to the problem / subject							
Statement of aims							
Experimental description							
Presentation of results / findings							
Quality and depth of discussion / interpretation							
Relevance of conclusions							
Quality of English							
Use of reference material							
Evidence of external reading							
Quality of presentation							
Use of figures							

Comments:

INTRODUCTION

The UK and EU have fairly ambitious emission reduction targets. The UK is aiming to reduce GHG emissions by 34% (2020) and 80% (2050) (Climate Change Act, 2008). The EU is targeting a of greenhouse gases emissions reduction of 20% by 2020 (Europe 2020).

Energy use in buildings accounts for a large amount of total world energy consumption ranging from 30% in smaller countries to around 40% in Europe and the United States (EU, 2012). Current political issues such as growing energy import dependency as well as global warming or climate change and their associated environmental impacts has led to many countries taking big steps to cut down on fossil fuel consumption. In order to reduce the environmental and economic impacts of energy consumption in buildings, the European Union EU issued directives such as Energy Certificates Directive 2002/91/EC and Energy Performance of Buildings Directive 2010/31/EU (EPBD).

It is estimated that 80% of the buildings that we will be occupying in 2050 have already been built (Institute for Building & urban Design, 2012). This means these buildings need to be upgraded if these targets are to be met. Refurbishment could be a solution. However, the refurbishment needs to be sustainable. This suggests the solutions have to be sensible, affordable and bring comfort to the users of the building

This study looks at the refurbishment of the Crookesmoor Building. It is a continuation of an earlier project on the energy performance of University of Sheffield buildings undertaken by my colleague James Douglas. The aim is to gather as much data as possible on the refurbishment plan. This involves getting all data missing from the initial project. The data would then be used it in a dynamic simulation model of the building. The proposed plans can then be compared with modelled results.

THE CASE FOR REFURBISHMENT

Refurbishment offers building owners a means of significantly improving the performance of the existing buildings as well as the appearance and value. The economic and environmental costs related with new building construction can be avoided with refurbishment. There are many refurbishment options. Factors such as the aims for refurbishing, building type, the state of the existing fabric, technical and operational constraints such as not interrupting activities within the building and the budget affect the choice of solution.

Energy efficiency, reduction of bills: The UK has very huge emissions reduction targets and it is estimated that between 30-40% emissions in the UK come from buildings. Solutions are therefore needed. Building refurbishment can offer a more efficient building. The use of insulation, fitting energy efficient appliances and double glazed windows can cut bills while also making a building more eco-friendly.

Opportunity to change and improve the functionality of a building: A building can offer a lot of space but often advantage is not taken of this space. Refurbishment can allow the chance to change the design and function of a building, thereby making the most of space.

Increases in value of the property: Refurbishing can be seen as a good investment since making a building more attractive and a nicer place to work in will add value to it. It could also increase income from rent and may even encourage added interest from possible tenants. This third advantage does not apply to Crookesmoor because it is a public building and is used for academic purposes only.

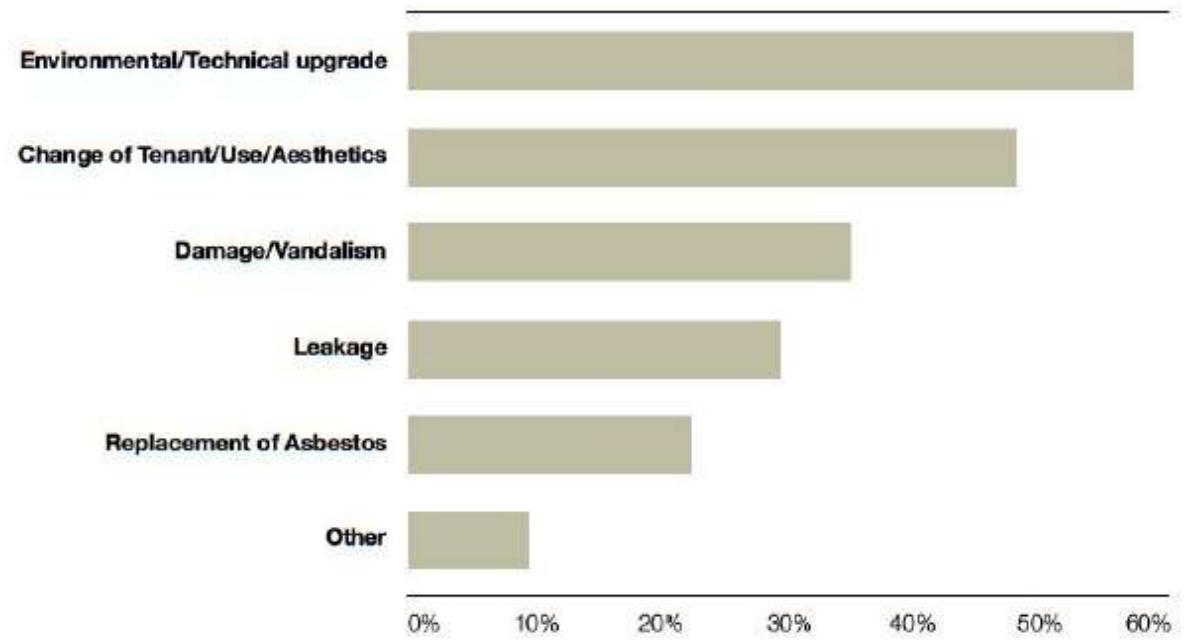


Figure 1: Reasons for refurbishment (Corus, 2001)

The chart above illustrates the main reasons for refurbishment. As can be clearly seen, technical and environmental factors are the main reasons cited.

BACKGROUND ON CROOKESMOOR

The Crookesmoor Building is located on the western extremity of the campus in a predominantly residential area and not close to student facilities such the student union, eateries or school libraries. Before its present closure, it was home to the school of Architecture and landscape architecture. It once housed the school of law and when the planned refurbishment works are complete, it will be the new management school.

The building was constructed in the 1970s. It has a very small entrance considering the number of students the building accommodates. Also there are narrow corridors and tends to get overcrowded. The building use consists of offices as well as lecture halls and ICT facilities. More space is allocated to lecturers and seminars.

Figure 2: Crookesmoor Building Front view

PRESENT CROOKESMOOR ENERGY SITUATION

The building is old. Most of the energy systems have outgrown their usefulness. The heating services: the heating system is past its working life. There is no flexibility of control and energy efficiency levels.

The windows are old fashioned mostly single glazed throughout the building. Some of the offices are double glazed, hence the need for more heating, especially during the colder months and evenings.

Figure 3: Large single-glazed windows interior view and exterior view

Figure 4: top floor single-glazed windows

Figure 5: corridor window

The single glazed windows also allow for a high amount of damp and condensation to affect the building. There is obvious heat-loss potential.

The building is also very damp. This can be felt when coming in contact with the walls almost all round the building. It is more evident towards the right of the building. This section is partly underground and there is a lot of moisture.

Similarly, the building exhibited very poor insulation and in some places there was none.

Figure 6: poor pipe insulation

Figure 7: Water tank with no insulation

Figure 8: No roof insulation

Figure 9: the roof with no insulation

The cooling system in the computer lab of the school of Landscape was open. Instead of being an enclosed space, the cooling was lost to other parts that didn't need it. This obviously meant that the cooling was not being used efficiently and also other places were cooler than would be ideal and hence the need for more heating. Pictures below show the vacated computer lab from different angles. The lack of demarcation can be clearly seen.

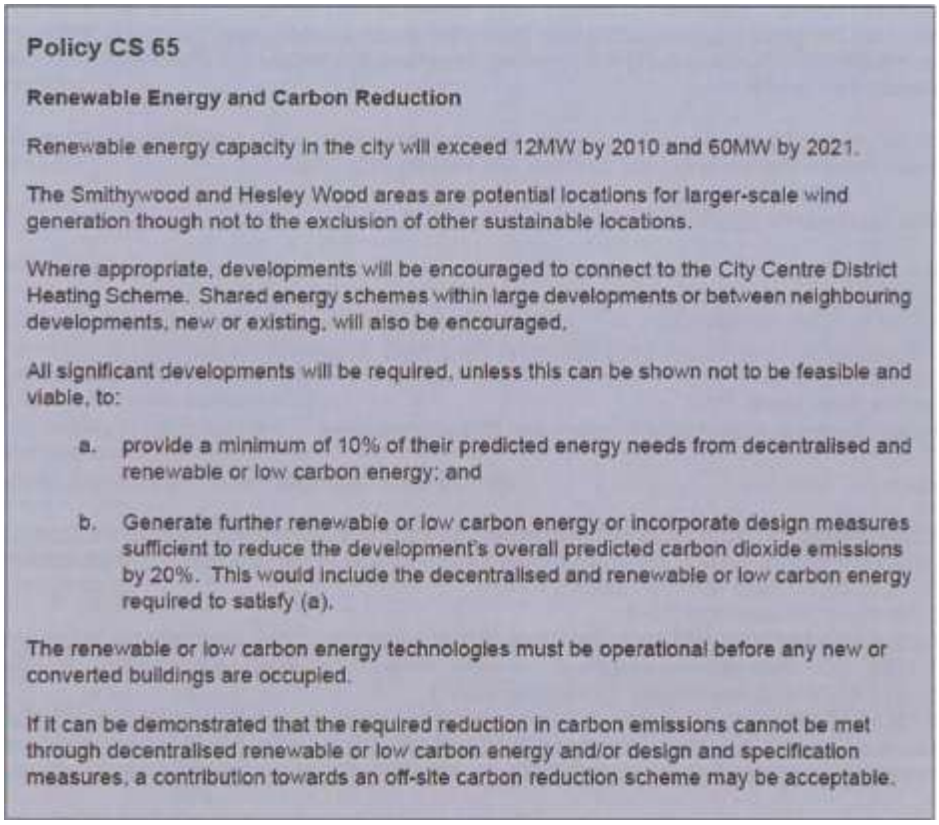
Figure 10: Open computer room (a)

Figure 11: Open computer room (b)

Figure 12: Open computer room (c)

THE PROPOSAL

There are many regulations that people have to abide by when building or refurbishing. However, the regulation that caught our interest was the Sheffield Council policy on energy and emissions. It is shown below.



Policy CS 65

Renewable Energy and Carbon Reduction

Renewable energy capacity in the city will exceed 12MW by 2010 and 60MW by 2021.

The Smithywood and Hesley Wood areas are potential locations for larger-scale wind generation though not to the exclusion of other sustainable locations.

Where appropriate, developments will be encouraged to connect to the City Centre District Heating Scheme. Shared energy schemes within large developments or between neighbouring developments, new or existing, will also be encouraged.

All significant developments will be required, unless this can be shown not to be feasible and viable, to:

a. provide a minimum of 10% of their predicted energy needs from decentralised and renewable or low carbon energy; and

b. Generate further renewable or low carbon energy or incorporate design measures sufficient to reduce the development's overall predicted carbon dioxide emissions by 20%. This would include the decentralised and renewable or low carbon energy required to satisfy (a).

The renewable or low carbon energy technologies must be operational before any new or converted buildings are occupied.

If it can be demonstrated that the required reduction in carbon emissions cannot be met through decentralised renewable or low carbon energy and/or design and specification measures, a contribution towards an off-site carbon reduction scheme may be acceptable.

Figure 14: Sheffield Council Regulation CS65 (Stage D Report).

The above policy requires a building such as the size and nature of Crookesmoor to source 10% of its energy requirements from low carbon energy sources. Additionally, it entails a 20% reduction in emissions.

In an attempt to meet the above requirements, the Stage D report started by predicting the energy consumption as well as emissions coming from Crookesmoor. The predictions were based on benchmark data and looking at similar buildings. The emissions were calculated using conversion factors of 0.544 KgCO2/KWh for Grid Electricity and 0.184 KgCO2/KWh for gas.

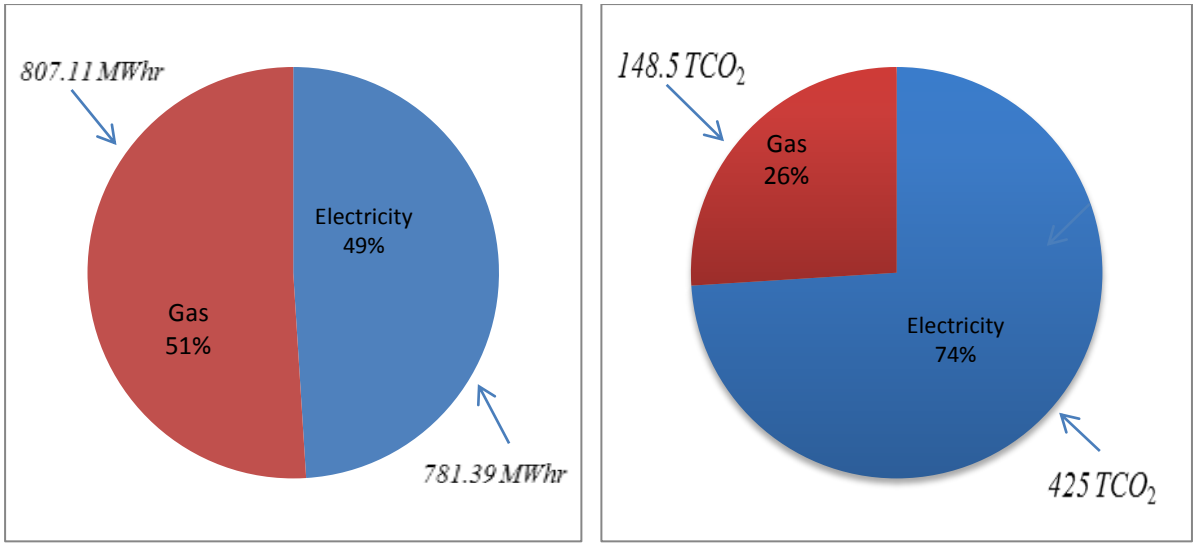


Figure 15: Predicted Consumption & Emissions for Crookesmoor

Figure above show the energy consumption predictions as well as emissions. They assume that consumption of gas and electricity are almost the same proportion. It can also be seen that electricity is presumed to be the highest emitter. If the Sheffield council policy is to be met the following would need to done:

10% reduction of building's predicted energy consumption = 158.9 MWhr/Annum

20% reduction of building's predicted energy consumption = 317.79 MWhr/Annum

Based upon these predictions, they then looked at the possibility of a couple of renewable energy options. Some of them are as follows.

Solar PV's or solar cells: The panels are mounted usually on rooftops and they absorb sunlight and convert it to electricity. It could be good for Crookesmoor since the building would be used mostly during at the time of electricity generation given favourable weather conditions. Major problems are intermittency of the sunlight, the cost of the cells and the long payback periods. Photovoltaics are however eligible for funding through the feed-in-tariff programme.

Biomass: biomass could be used at the Crookesmoor building to provide heating and hot water. It has the advantage of being carbon neutral. The problem associated with biomass is the large space required for storage and also the need for a back-up system for when the biomass system is cooling down. Crookesmoor building location in a residential area would not be ideal for big truck deliveries of biomass.

Combined Heat and Power (CHP), Air Source Heat Pump (ASHP) and solar thermal were also suggested. The Report concluded that a combination of ASHP and CHP would be the best option but would not meet the target.

DISCUSSION

We have looked at and confirmed the reasons for the inefficient nature of the Crookesmoor Building. We have been fortunate to visit the building and see first-hand the situation of the building. Heat loss has been identified as the main cause.

From the previous study of university buildings, we have the actual energy consumption figures for the surveyed buildings. We find that the proposal chose to use predictions rather than actual consumption figures that are available. They did not even use figures from the display energy certificates. Using the same calculation methods and conversion factors we calculate emissions. There is a great difference between the predictions and the actual figures. The charts below show the actual energy consumption and emissions figures for Crookesmoor.

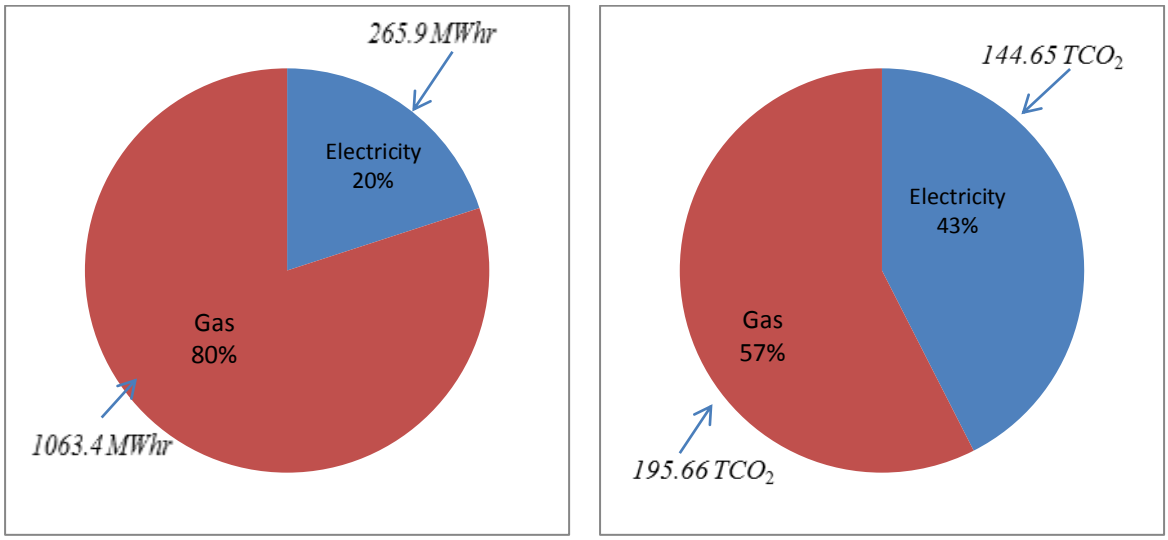


Figure 18: Actual Energy Consumption & Emissions for Crookesmoor

It is clear that the predictions overestimate electricity use and subsequently underestimate gas use. Gas for heating is the main energy source used in Crookesmoor most likely due to potential heat loss. Therefore emissions from gas are higher than that of electricity. If the Sheffield council policy is to be met the following would need to done:

10% reduction of building's predicted energy consumption = 132.9 MWhr/Annum

20% reduction of building's predicted energy consumption =265.86 MWhr/Annum

The targets are now lower than predicted. This may make it easier to meet. Efforts should be geared towards the reduction in consumption of gas for heating rather than electricity. Measures like giving people more control over heating and behavioural studies could be a costless way of achieving set targets.

Communication difficulties are a major obstacle to the successful carrying out of the project.This has been due to the long time it took to get any information from the Estates and Facilities department of the University of Sheffield and also the short-term nature of the mini-project.

CONCLUSION

The estimates used in the stage D report were very different from the actual consumption and emissions figures. The figures have significant implications on the amount of energy generation, emissions reduction as well as renewable energy sources chosen. The refurbishment is unlikely to meet the Sheffield council target and the technology employed would depend on the overall budget.

This study has been able to gather additional data on the Crookesmoor building. This data in the form of the Stage D and E reports give detailed information on the proposed refurbishment works on the Crookesmoor Building. The information ranges from electrical, mechanical to architectural design and even cost elements. This data gathered can be used as a scenario for comparism after the intended dynamic simulation models are carried out.

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REFERENCES

CIBSE (2008), *Guide F, Energy Efficiency in Buildings, London: Chartered Institute of Building Services Engineers*

Committee on Climate Change, (2010), *The Fourth Carbon Budget | Reducing emissions through the 2020s.*

Corus, (2011), *Refurbishment solutions to non-domestic buildings.*

Douglas, J. (2012), *Energy performance of university buildings mini project report*

Estates and Facilities Management EFM (2011*), Relocation of the University of Sheffield Management School, Crookesmoor Building Stage D Report: University of Sheffield.*

Estates and Facilities Management EFM (2011*), Relocation of the University of Sheffield Management School, Crookesmoor Building Stage E Report: University of Sheffield.*

http://www.montagumaintenance.co.uk/services/three-important-reasons-to-have-a-building-refurbishment/