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Energy Efficiency

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1.0 Introduction

An energy efficiency rating is a graph which indicates the property's current energy efficiency by taking into account the size of the property (m²), the amount of energy used and the amount of carbon dioxide emissions produced per year. Also, the graph will indicate the properties potential energy rating, which could be achieved by performing refurbishment works such as changing the lighting, insulation, heating, water systems and installing PV panels.

Energy rating certificates (ERC) are very important as they show the owner/future owner of a property the consumption currently used, therefore, this will give an indication of the utilities costs for the household. That is why, every property requires an EPC before it can be sold and if a landlord is to let their properties, an EPC is required by law.

2.0 Aim of Report

The aim of this report is to calculate the proposed refurbishment works to improve a detached property's current energy efficiency (37), so it can achieve its potential energy rating (73). After I have calculated cost for the four improvements, I will then calculate the cost of the energy consumption per year and the savings from the four improvements. Once this has been completed, I will work out the payback period duration for the costs to be recuperated for the improvements suggested.

2.0 Refurbishment Works**2.1 Changing lighting to LED**

The first refurbishment works proposed is to change all lighting in the property to LED. Using LED lights are becoming more popular as they have many benefits such as being up to 80% more efficient than fluorescent and incandescent lighting, this is due to only 5% of the light produced by a LED is wasted as heat. Also, LED lights can last up to 6 times longer than other lighting, resulting in lower maintenance costs. (Lighting, 2020). Using the construction drawings attached to the assignment, I calculated the amount of LED's required in each room by using the Charleston Lights website. As seen in Appendix A, I did a take off for the room sizes and the amount of watts and LED lights required for each room.

The total amount of LED's in the property is 61. After doing a research of 12w LED lights, I found they cost between £12-19. Therefore, taking an average of £15.50 and estimating it would take an electrician 4 hours to remove the existing lights and replace with LED. Using rates previously paid, the average for an electrician is £25 per hour. The calculations are shown in Appendix A.

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I have assumed that the lights are only element of works to be changed, there is to be no additional electrical works required to change to LED lighting.

2.2 Improving insulation to walls and ceilings

Ceilings

There are many methods to improve the ceiling insulation of an existing property. For example, one method is to remove the existing plasterboard ceilings, increase the amount of good quality insulation in the void, re-plasterboard, apply a plaster skim finish and then decorate. But this would take a long time and cost a lot of money. Another method is to overboard the existing ceiling with foiled insulated backing plasterboard. This example would also involve a plaster skim finish and decoration.

The method I am going to budget for is spray foam insulation. This is when the ceiling void is accessed at one point, and is pumped with high quality foam insulation, with the small holes produced to access the void is patched and decorated. This method is much quicker and entails a lot less remedial and decoration work. This spray foam, which is commonly Icynene, is sprayed between joists and rim joists to provide a highly effective insulation barrier.

Using the drawings given for this assignment, I calculated the ceiling areas to be 424.09m² (as shown in Appendix B). After in-depth research, I have found out that injection insulation to ceilings costs between £14-£20/m², therefore I will take the average of £17/m². This rate allows for all materials, plant and labour for the works. Therefore, the total cost of the ceiling insulation works is £7,209.60 – the calculation is shown in Appendix B.

During this section I have assumed that the ceiling insulation is to be improved to all basement, ground floor and first floor areas. Also, another assumption is that only an additional 150mm thick insulation is required.

Walls

Just like ceilings, there are many methods to improve the insulation of an existing properties wall. Some examples include pumping insulation into the cavity of external walls and over boarding the internal walls with foil backed insulated plasterboard then apply a plaster skim finish and decorate, similar to what can be done with ceilings. The method I am going to budget for is EWI, External Wall Insulation. This is applying a layer of insulation to the external wall and then covering with a reinforced and modern thin-coat of render. This EWI will also reduce the u-value of the existing property to 0.35 as a 100mm thick insulation will be installed, having calculated the existing property to have a u-value of 2.1, this is a reduction of 1.75.

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Having completed many EWI projects before, I can see that the cost of EWI works is £40/m². This is split into £23/m² for materials such as the insulation board, base coat and top coat render with the remaining £17/m² being labour costs (including plant) for the works. As I calculated a total external wall area of 452.08m², the total cost of EWI works was £18,083.38.

Calculations for the above are shown in Appendix C.

I have assumed that a 100mm insulation system is required and the materials used will be from the manufacturer Parex (construction detail is attached in the appendix below. Also, I have assumed there is no cavity walls, so the insulation has been applied from the external walls. Finally, I have measured through openings, such as windows and doors, to allow for wastage of materials.

2.3 Combined Gas and PV Panels

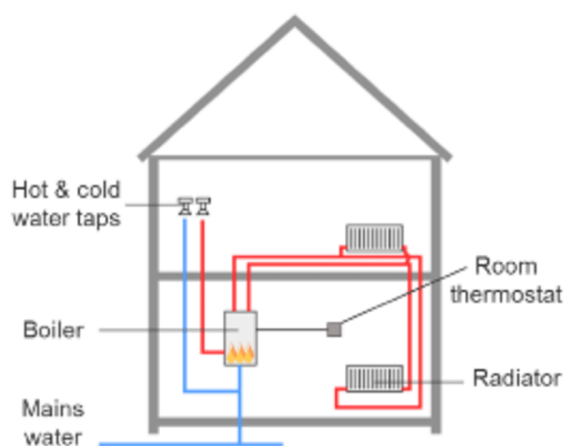
Combined Gas

The cost of converting from a heating and hot water system to a combined gas system depends on many of factors, which are detailed below:

- Location of old and new boilers
- The brand of boiler
- If any controls are required
- The complexity of the job

Assuming a standard boiler is required in this property, in the same location, I would budget £2,500 for the system to be converted.

Combination boilers are effective as they don't require a separate tank, like the previous system, therefore they save space and are cheaper to run. The below image, shows how a combination boiler works in a domestic property.



(Researchgate.net,2019)

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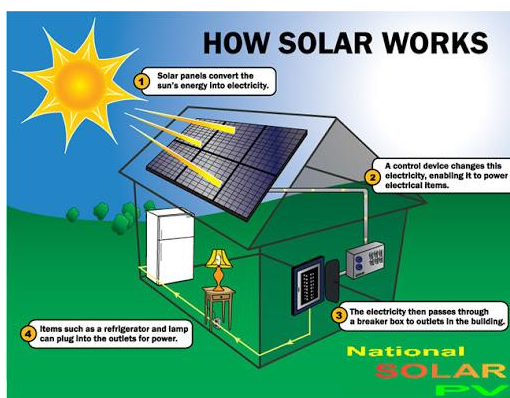
PV Panels

PV Panels are used to convert the sun's energy into electricity. The Solar panels produce a direct current of electricity which is run through an inverter to be transferred into an alternating current to create a direct current of electricity to be used by the household.

Assuming a 4kW PV Panel system is required for this property (as this is the most common system), I would budget £5,500 for these works as it can cost between £4,000-£7,000 due to other factors which are listed below:

- Type of kW system required
- Location of property – additional scaffolding etc

The budget of £2,500 was using the assumptions that the tilt angle of the property and its orientation is correct for this system. Also, the property is in a good location to get a high volume of sun light.



(pv, 2019)

3.0 The Cost of Energy Consumption

Before any refurbishment works were done, the total annual energy consumption was 40,000kWh, which consisted of 3,000kWh of lighting, 25,000 Heating + hot water and 12,000kWh for Appliances and others. Therefore, this would give an energy efficiency rating of 37, which is a low score (band F), resulting in high energy costs.

Using the U.K average for energy costs for electricity and gas of 15p/kWh for electricity and 4p/kWh for gas, this would mean the current annual cost of electricity in this property would be £3,250. This is assuming all appliances are from an electric source. However, if improvement 1 (LED lighting) was done, this would reduce the annual cost to £2,867.50, which is a saving of £382.50.

Also, working on the figures given in the brief, improvement 2 (changing insulation in ceiling and cavity wall), the cost of energy per annum is £2,850 which indicates a

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saving of £400 per annum. Whereas, improvement 3 (installing a combi boiler and PV panels) gives a saving of £200 per annum as the cost of energy is £3,050.

Finally, if all three improvements were done the total savings would be £982.50 per annum, resulting in a total energy cost of £2,267.50 per annum.

These calculations are showing in the Appendix D below.

Payback Period

The payback period is the amount of time to recoup the money spent on the refurbishment works, or to break-even. So this means that the lower the payback period, the better the investment. To calculate the payback period, the below calculation is used:

Cost of improvement works – savings per year = payback period (years)

Therefore, the improvements have the following payback periods:

- Improvement 1 = 2.7 years
- Improvement 2 = 63 years
- Improvement 3 = 40 years

These calculations are shown in the Appendix E below.

4.0 Conclusion

In Conclusion, the total cost to make all the three improvements is £34,338.48 which would create a saving of £982.50 per year on energy bills. Having said that, these three improvements have a payback period of 35 years to recoup the funds for the works. However, the energy efficiency rating of the property would increase highly to Band C.

5.0 References

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6.0 AppendicesAppendix A – LED LightingBasement Areas

<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>Height (m)</u>	<u>Watts Required</u>	<u>LED's Required</u>
Garage	8.40	6.64	2.63	77	8
Garage	5.85	10.50	2.63	85	9
Garage	3.15	11.95	2.63	52	6
Mechanical Room	3.35	3.76	2.63	17	2
Bathroom	1.74	2.01	2.63	6	1
Dressing Room	2.01	1.64	2.63	6	1
Staircase	2.50	3.71	2.63	3	1
				Total =	28

Ground Floor

<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>Height (m)</u>	<u>Watts Required</u>	<u>LED's Required</u>
Living/Dining Room	5.50	10.50	3.40	53	6
Internal Access	4.35	3.28	3.40	13	2
Toilet	1.50	3.15	3.40	4	1
Bedroom	3.46	3.02	3.40	9	1
Dressing Room	3.46	1.01	3.40	3	1
Bathroom	3.22	1.80	3.40	5	1
Kitchen	5.08	3.57	3.40	16	2

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Staircase					1
				Total =	15

First Floor

<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>Height (m)</u>	<u>Watts Required</u>	<u>LED's Required</u>
Bedroom 1	5.56	3.20	3.15	16	2
Bathroom 1	3.31	2.56	3.15	7	1
Dressing Room 1	2.19	2.56	3.15	5	1
Bedroom 2	3.65	3.76	3.15	12	2
Bathroom 2	3.23	2.46	3.15	7	1
Dressing Room 2	3.23	1.73	3.15	5	1
Bathroom 3	3.20	2.46	3.15	7	1
Dressing Room 3	3.11	1.73	3.15	4	1
Bedroom 3	3.37	3.76	3.15	11	2
Dressing Room 4	1.79	2.12	3.15	3	1
Bathroom 4	3.24	2.49	3.15	7	1
Bedroom 4	4.58	3.20	3.15	13	2
Corridor/Staircase	2.53	5.69	3.15	13	2
				Total =	18

	<u>Quantity</u>	<u>Unit</u>	<u>Rate</u>	<u>Total</u>
<u>Materials</u>				
LED Light (12w)	61	Number	£15.50	£945.50
<u>Labour</u>				
Electrician/Trade	4	Hours	£25/hr	£100
			Total =	£1,045.50

Appendix B – CeilingsCeiling Areas

<u>Basement</u>			
<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>M2</u>
Garage	8.40	6.64	55.78
Garage	5.85	10.50	61.43
Garage	3.15	11.95	37.64
Mechanical Room	3.35	3.76	12.60

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Bathroom	1.74	2.01	3.50
Dressing Room	2.01	1.64	3.30
Staircase	2.50	3.71	9.28
Total =			183.51

Ground Floor			
<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>M2</u>
Living/Dining Room	5.5	10.5	57.75
Internal Access	4.35	3.28	14.27
Toilet	1.5	3.15	4.73
Bedroom	3.46	3.02	10.45
Dressing Room	3.46	1.01	3.49
Bathroom	3.22	1.8	5.80
Kitchen	5.08	3.57	18.14
Total =			114.62

First Floor			
<u>Location</u>	<u>Length (m)</u>	<u>Width (m)</u>	<u>M2</u>
Bedroom 1	5.56	3.2	17.79
Bathroom 1	3.31	2.56	8.47
Dressing Room 1	2.19	2.56	5.61
Bedroom 2	3.65	3.76	13.72
Bathroom 2	3.23	2.46	7.95
Dressing Room 2	3.23	1.73	5.59
Bathroom 3	3.2	2.46	7.87
Dressing Room 3	3.11	1.73	5.38
Bedroom 3	3.37	3.76	12.67
Dressing Room 4	1.79	2.12	3.79
Bathroom 4	3.24	2.49	8.07
Bedroom 4	4.58	3.2	14.66
Corridor/Staircase	2.53	5.69	14.40
Total =			125.97

<u>Location</u>	<u>Total m2</u>	<u>Price/m2</u>	-
		£	£
Basement	183.51	17.00	3,119.64
		£	£
Ground Floor	114.62	17.00	1,948.51
		£	£
First Floor	125.97	17.00	2,141.44
Total =			£7,209.60

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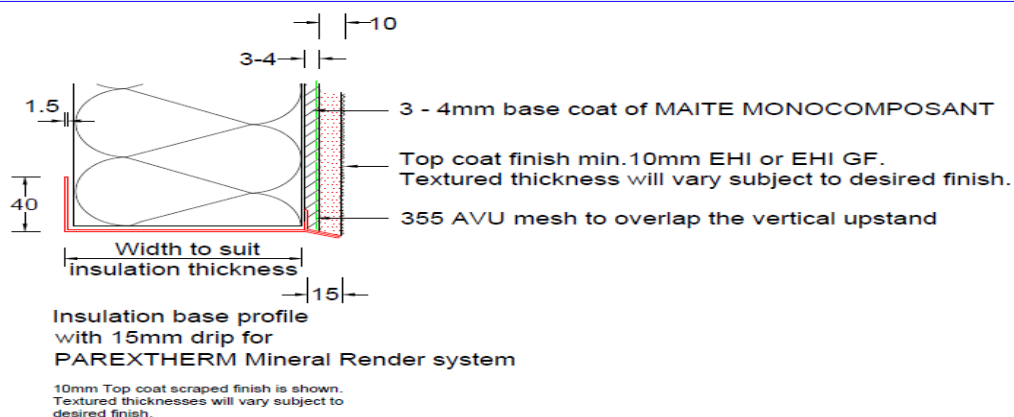
Appendix C – Walls

External Walls				
<u>Façade</u>	<u>Length (m)</u>	<u>Height (m)</u>	<u>m2</u>	<u>Total</u>
Front	11.15	7.35	81.95	119.29
	12.57	2.97	37.33	
Back	11.15	7.35	81.95	81.95
Left	14.6	7.35	107.31	124.93
	10.5	0.5	5.25	
	3.5	0.75	2.63	
	3.48	2.8	9.74	
Right	14.6	7.35	107.31	125.92
	10.18	1.57	15.98	
	3.5	0.75	2.63	

External Walls	
<u>Façade</u>	<u>m2</u>
Front	119.29
Back	81.95
Left	124.93
Right	125.92
Total =	452.08

EWI				
	<u>Quantity</u>	<u>Unit</u>	<u>Rate</u>	<u>Total</u>
<u>Materials</u>				
			£	£
Insulation boards	452.08	m2	11.50	5,198.97
			£	£
Base coat	452.08	m2	4.00	1,808.34
			£	£
Top coat render	452.08	m2	6.00	2,712.51
			£	£
Sundries/Fixings	452.08	m2	1.50	678.13
<u>Labour</u>				
Plasterer/Boarder including any plant required				
			£	£
	452.08	m2	17.00	7,685.44
				£
			Total =	18,083.38

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Appendix D – Cost Consumption

Original	kWh/year	Cost/kWh		
		£	£	
Lighting	3000	0.15	450.00	
		£	£	
Heating + hot water	25000	0.04	1,000.00	
		£	£	
Appliances and others	12000	0.15	1,800.00	Assuming all electric
			£	
		Total =	3,250.00	

Improvement 1	kWh/year	Cost/kWh		
		£	£	
Lighting	450	0.15	67.50	
		£	£	
Heating + hot water	25000	0.04	1,000.00	
		£	£	
Appliances and others	12000	0.15	1,800.00	Assuming all electric
			£	
		Total =	2,867.50	

Improvement 2	kWh/year	Cost/kWh		
		£	£	
Lighting	3000	0.15	450.00	
		£	£	
Heating + hot water	15000	0.04	600.00	
		£	£	
Appliances and others	12000	0.15	1,800.00	Assuming all electric
			£	
		Total =	2,850.00	

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Improvement 3	kWh/year	Cost/kWh	
		£	£
Lighting	3000	0.15	450.00
		£	£
Heating + hot water	20000	0.04	800.00
		£	£
Appliances and others	12000	0.15	1,800.00
			Assuming all electric
			£
		Total =	3,050.00

Improvement 2+3	kWh/year	Cost/kWh	
		£	£
Lighting	0	0.15	-
		£	£
Heating + hot water	4800	0.04	192.00
		£	£
Appliances and others	0	0.15	-
			Assuming all electric
			£
		Total =	192.00

<u>Savings</u>			
	£		£
Original cost	3,250.00	Original cost	3,250.00
	£		£
Improvement 1	2,867.50	Improvement 3	3,050.00
	£		£
Saving	382.50	Saving	200.00
	£		£
Original cost	3,250.00	Original cost	3,250.00
	£		£
Improvement 2	2,850.00	Improvement 2+3	192.00
	£		£
Saving	400.00	Saving	3,058.00

	£
Improvement 1	382.50
	£
Improvement 2	400.00
	£
Improvement 3	200.00
	£
Total =	982.50

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Appendix E – Payback Period

<u>Payback Period</u>	<u>Cost of refurbishment works</u>	<u>Savings/year</u>	<u>Payback period (years)</u>
	£	£	
Improvement 1	1,045.50	382.50	2.73
	£	£	
Improvement 2	25,292.98	400.00	63.23
	£	£	
Improvement 3	8,000.00	200.00	40
	£	£	
Total	34,338.48	982.50	34.95