

Energy efficiency and sustainable materials

ACBA5012



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Quantity Surveying

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Introduction

I have been asked to undertake an exercise in order to analyse the energy consumption in a detached house with a basement area below. (Figure 1 and 2). Energy efficiency is a big talking point at the moment with people trying to focus on renewable energy and not wasting the energy we already have. All occupied buildings must now have an energy efficiency rating

Aim

I will look to effectively price the stipulated methods of improvement. Once this has been completed I will calculate the energy consumption currently and then with the said improvements and compare.

Improvement recommended are;

- Changing all lighting to LED
- Improving insulation of cavity walls and ceiling
- Change heating and water system to combined gas and PV Panels

Cost of the different refurbishment works

Lighting to LED

In order to do this, I have had to make assumptions regarding the number of lights in the house. See figures 3-5 for presumed locations of lights. I have also assumed that one light would be sufficient to light the full room. The cost of one LED bulb is £1.29 (Energy Saving Online, n.d.)

The material element costs us £104.75 for the 5W LED GLS. We would also need to consider the labour for changing the lights although it is minimal. I have used the average rate for an apprentice electrician at £6.80 (Payscale, n.d.) to calculate the labour amount and we have allowed a full days work of 7.5 hours.

Total = £186.00

Improving insulation of cavity and ceiling

As it is not a new build, to improve the cavity wall insulation we would have to use a retrofit system like 'Expanded Polystyrene Beads (EPS)' (Cavitech, 2019) which is a high performance, injected, blown grey bead that can reduce the energy consumption in the build. We would have to assess the suitability of the brick work to ensure it is structural sound prior.

Cost for this system is £1,500 for a detached four bedroom house (Cavitech, 2019)

To improve the insulation in the ceilings would take more work, see breakdown of rates in appendix. I have had to utilise labour for plaster boarder plus the cost of material in order to formulate a cost for these items.

Totals cost for improving insulation to the ceiling = £3,467.88

Total: £4,967.88

Changing heating and hot water system to combined gas and PV panels

From the information provided we know that there already is a gas heating and hot water system so we only require a price for fitting PV panels to the existing build. As per appendix quotation for 28m² is £6,000. (Price your Job, 2017) The logistics and setting out of the 28m² area would be best facing south so would be best to pack top left corner of build if possible.

Total cost of refurbishment works: £11,153.88

Current cost of energy consumption per year

The average cost of electricity is 14.33 p/kWh in the UK

The average cost of gas is 3.63 p/kWh in the UK (British Gas, 2020)

Total GIFA: 486.15

The total cost for energy consumption per year for the household based on the above figures is £46,779.74. This is extraordinarily high and wouldn't normally be expected from a current UK household

Savings for each intervention

To change your lights to led based on calculations seen in the appendix is £8,150.84 per year which shows in this case it would be extremely beneficial to the homeowner.

The improvement of improving insulation to cavity and the ceiling areas also creates a big saving for the homeowner. The calculated cost of this £5,717.71 Per year! which is massive for a house like this.

The third scenario is adding in a PV system to the current hot water system and using this as a hybrid. To just install this system it somehow creates a bigger energy consumption than the hot water system alone and causes us a loss of £1,958.84 Per year! This shows that it would not be a good investment as we would actually spending more every year on by making an investment.

However if you couple both points 2 + 3 there is a dramatic decrease in expenditure for the year resulting in huge cost savings. To implement both methods we would save £10,482.47 Per year!

Payback Period

To return on your initial investment on the LED bulbs it would only take 8.34 days. This is because of the huge energy savings associated with changing the bulbs.

To return on you investment of improving the insulation to the build it would take 221.45 days. This is also a brilliant return for an investment which shouldn't take longer than two weeks.

Based on the results installing solely a PV system to run the heating and hot water system would have no return on your initial investment and would actually increase your expenditure for the year which would not be recommended.

When we look at the associated costs of combining both the improved insulation and PV panels we see a healthy return on investment despite the initial cost of £9,467.88. This would be returned in 329.66 days which is very quick turn around for such investments.

Conclusion

To conclude it is extremely important that we know that this exercise is hypothetical as the values used in this assignment are significantly different to what we would expect of a regular UK household. Although, values gathered show a trend that we can analyse and shows the benefit of changing to LED bulbs and that can demonstrate a huge saving every year on electricity not to mention the life of an LED bulb compared to a filament. Everyone should now be using these bulbs to save massive amounts of money.

With upgrading our insulation, this is a big task compared to the other methods and a number of things need to be considered in order to be considered for the exercise, house must not be susceptible to wind driven rain for example and brick wall must meet requirements. It is also a lot of work internally to deal and dispose of the old plasterboard and put in new materials. However the return on this investment shows that is extremely worthwhile for people willing to consider it.

From our results we can tell that installing purely PV panels would be of no benefit to us unless coupled with improving insulation to the walls. We can draw from this that there is no point having new renewable resources to give energy to our homes unless we can keep it in using insulation measures.

To conclude, all measures show massive savings for the homeowners when used properly and should used when they can in all homes.

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Appendixes

Energy consumption

Total Energy Consumption: 1,233 kWh/m²

Lighting: 148 kWh/m²

Heating and Hot Water: 752 kWh/m²

Appliances and others: 333 kWh/m²

The average cost of electricity is 14.33 p/kWh in the UK

The average cost of gas is 3.63 p/kWh in the UK (British Gas, 2020)

GIFA of House

Total GIFA: 486.15

Basement level: 192.15

Ground Floor: 147.0

First Floor: 147.0

(a) Cost of the refurbishment works

1. Changing all lighting to led

The lights that we will be using for a comparison are;

- 40W GLS pearl filament bulb £1.29

- 5W LED GLS at £5.40 (Energy Saving Online, n.d.)

Material

Number of lightbulbs = 25

25 x £4.19 = £135

Labour

Number of hours allowed (1 day) 7.5 Hours

Apprentice Electrician rate = £6.80

7.5 x £6.80 = £51.00

Total: £186.00

2. Improving insulation of cavity walls and ceiling

Cavity Wall Quotation for labour and materials

£1,500.00 (Cavitech, 2019)

Insulation to ceilings as follows

Labour

Cost Of boarder = £12.35 (Payscale, n.d.)

- (1) 2 Men x 1 day to rip down ceiling above basement
- (2) 2 Men x 1 day to rip down ceiling above Ground Floor
- (3) 2 Men x 1 day to fit noggins between joist and lay Knauf Eko Roll insulation above basement
- (4) 2 Men x 1 day to fit noggins between joist and lay Knauf Eko Roll insulation above basement
- (5) 2 Men x 1 day to lay Knauf Eko Roll insulation in attic space
- (6) 2 Men x 1 day to board ceiling above basement
- (7) 2 Men x 1 day to board ceiling above Ground floor

- (1) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (2) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (3) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (4) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (5) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (6) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$
- (7) $2 \times 7.5 \text{ hours} \times £12.35 = £185.25$

Sub Total of labour: £1,296.75

Materials

Knauf Eko Insulation £19 roll covering 8.3m² (B&Q, 2020)
 $19/8.3 = £2.29\text{m}^2$

m² required = 486.15

Cost = $486.15 \times £2.29 = £1,113.28$

Treated Rough sawn Whitewood spruce Timber
2.4m = £2.37 (B&Q, 2020)

30 lengths = £68.10

Plasterboard

7.63 a sheet covering 2.88m² (B&Q, 2020)
 $7.63/2.88 = £2.65\text{m}^2$

m² required = 339.15

Cost = $339.15 \times £2.65 = 989.75$

Sub total of materials: £2,171.13

Total: £3,467.88

(3) Changing heating and hot water system to combined gas and PV panels

PV Quotation for installation and materials

£6000 to cover 28m² with a 4Kw system size

(b) Current cost of the energy consumption per year and the expected savings

1. Current cost of energy consumption

The average cost of electricity is 14.33 p/kWh in the UK

The average cost of gas is 3.63 p/kWh in the UK (British Gas, 2020)

GIFA = 486.15

Total energy consumption: 1,233kWh/m²

Lighting: 148 kWh/m²

Heating and Hot Water: 752 kWh/m²

Appliances and others: 333 kWh/m²

Electricity:

Lights

$148 \times 486.15 = 71950.2 \text{ kWh}$

$71950.2 \times 0.1433 = £10,310.46$

Appliances and others

$333 \times 486.15 = 161887.95 \text{ kWh}$

$161887.95 \times 0.1433 = £23,198.54$

Sub Total: £33,509.00

Gas: $752 \times 486.15 = 365584.8 \text{ kWh}$

$365584.8 \times 0.0363 = £13,270.73$

Sub Total: £13,270.73

Total cost of energy consumption without refurbishment = £46,779.73

2. Expected savings with each intervention

a) Improvement 1 = changing lighting to LED

Cost of electricity with LED lights

$31 \times 486.15 = 15070.65 \text{ kWh}$

$15070.65 \times 0.1433 = £2,159.62$

Cost of electricity with current lighting

= £10,310.46

Savings for this element = £10,310.46 - £2,159.62

= £8,150.84 per year!

b) Improvement 2 = Improving cavity walls and ceiling

Cost of Gas with improved insulation

$428 \times 486.15 = 208072.2 \text{ kWh}$

$208072.2 \times 0.0363 = £7,553.02$

Cost of Gas currently

= £13,270.73

Savings for this element = £13,270.73 - £7,553.02

= £5,717.71 Per year!

c) Improvement 3 = Combined gas and PV system

Cost of Gas with Pv system

$863 \times 486.15 = 419547.45 \text{ kWh}$

$419547.45 \times 0.0363 = £15,229.57$

Cost of Gas currently

= £13,270.73

Savings for this element = £13,270.73 - £15,229.57

= - £1,958.84 Per year!

d) Improvement 4 = Combination of PV and cavity insulation

Cost of Gas with Pv system and improved insulation

$158 \times 486.15 = 76811.7 \text{ kWh}$

$76811.7 \times 0.0363 = £2,788.26$

Cost of Gas currently

= £13,270.73

Savings for this element = £13,270.73 - £2,788.26

= £10,482.47 Per year!

Payback period

1) LED lighting

Cost of implementing the change = £186.00

Saving per year = £8,150.84 per year

$\text{£}8,150.84 / 365 = \text{£}22.33$ per day saving

$\text{£}186.00 / 22.33 = 8.34$ days to repay your investment

2) Improving Cavity and ceiling insulation

Cost of implementing the change = $\text{£}3,467.88$

Saving per year = $\text{£}5,717.71$ per year

$\text{£}5,717.71 / 365 = \text{£}15.66$ per day saving

$\text{£}3,467.88 / 15.66 = 221.45$ days to repay your investment

3) PV panels

No return on investment, not a worthwhile purchase.

4) Insulation plus installing a PV system

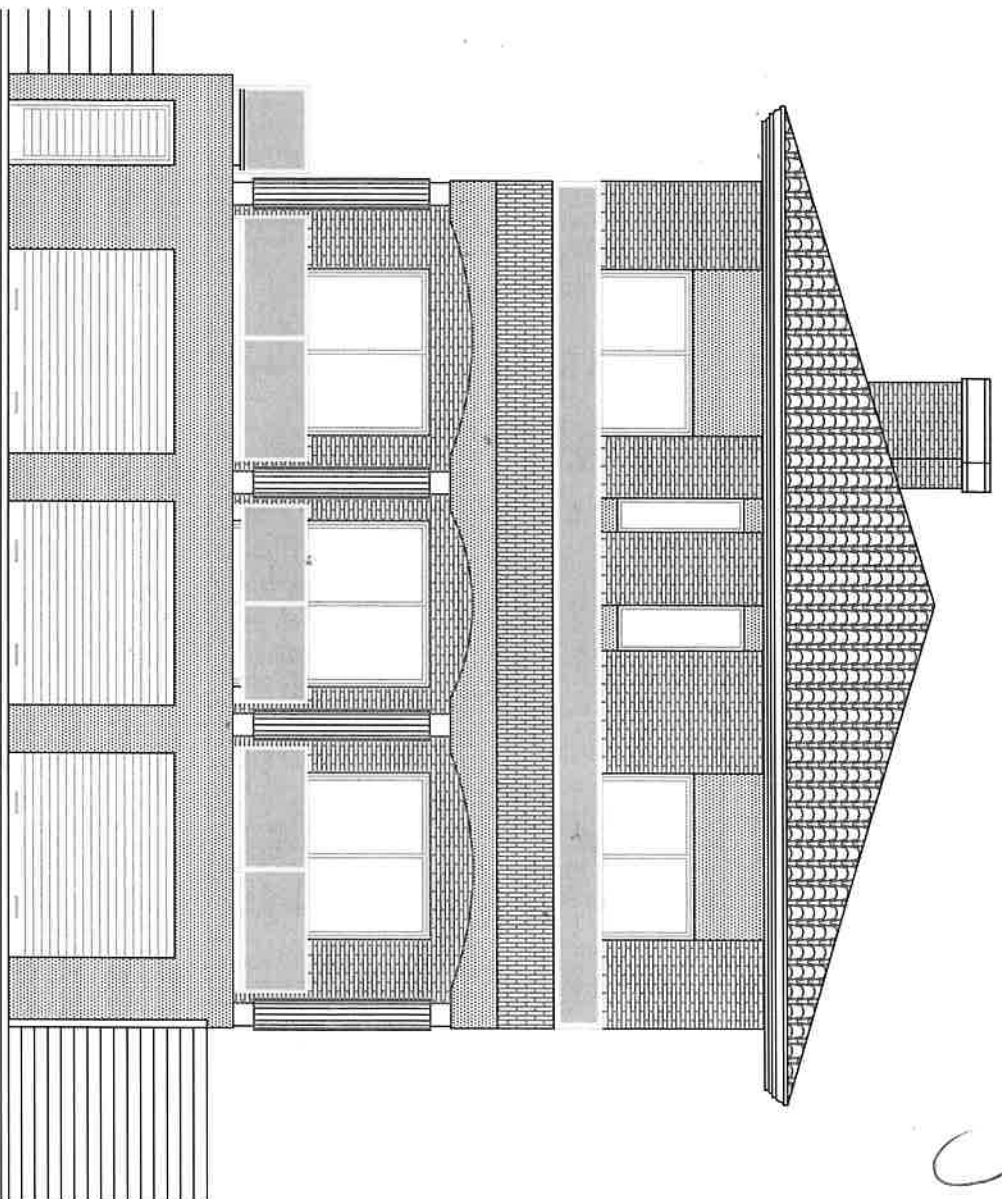
Cost of implementing the change = $\text{£}6,000.00 + \text{£}3,467.88 = \text{£}9,467.88$

Saving per year = $\text{£}10,482.47$ per year

$\text{£}10,482.47 / 365 = \text{£}28.72$ per day saving

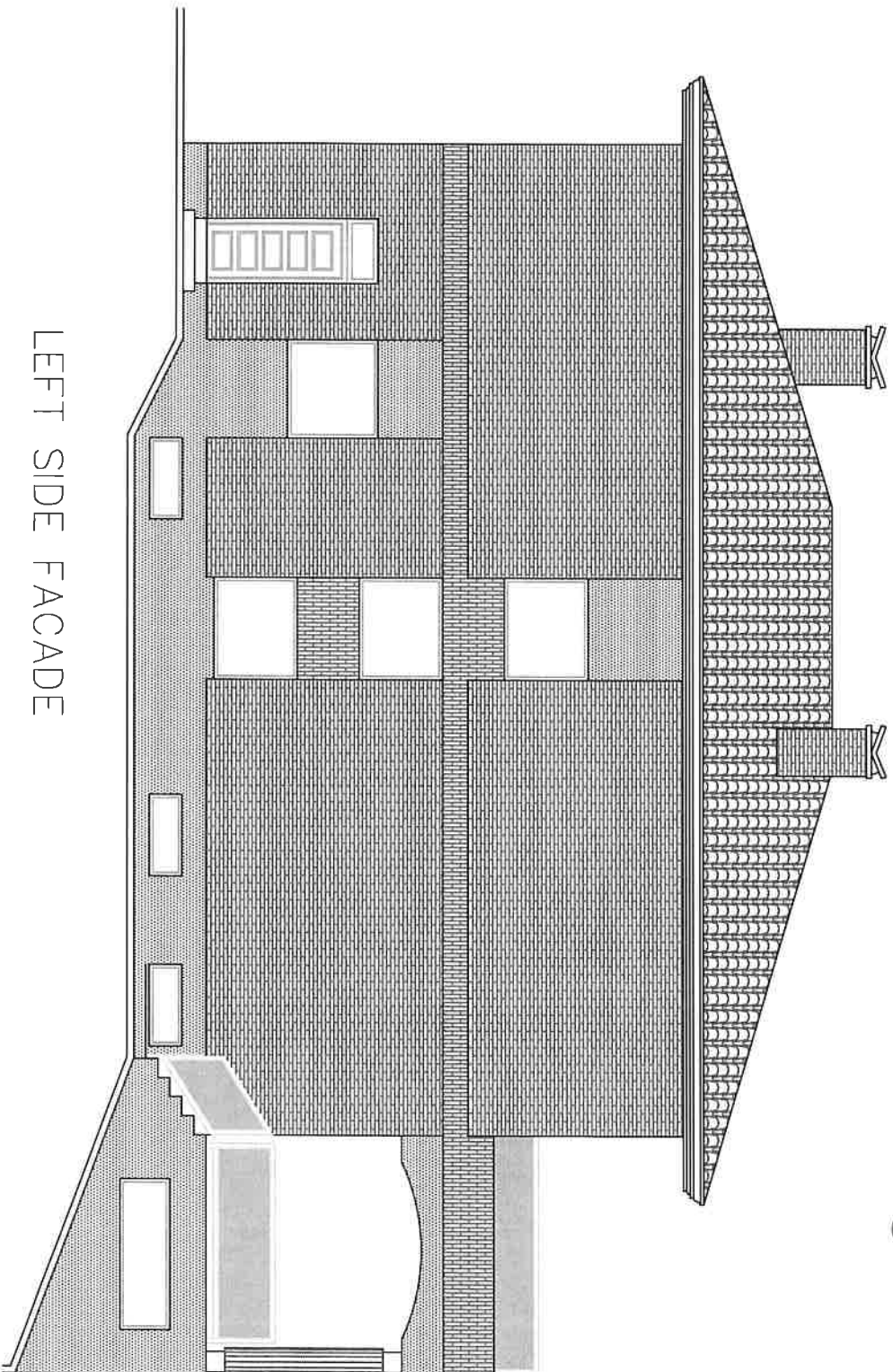
$\text{£}9,467.88 / 28.72 = 329.66$ days to repay your investment

Figure 1



FRONT FACADE

Figure 2



LEFT SIDE FACADE

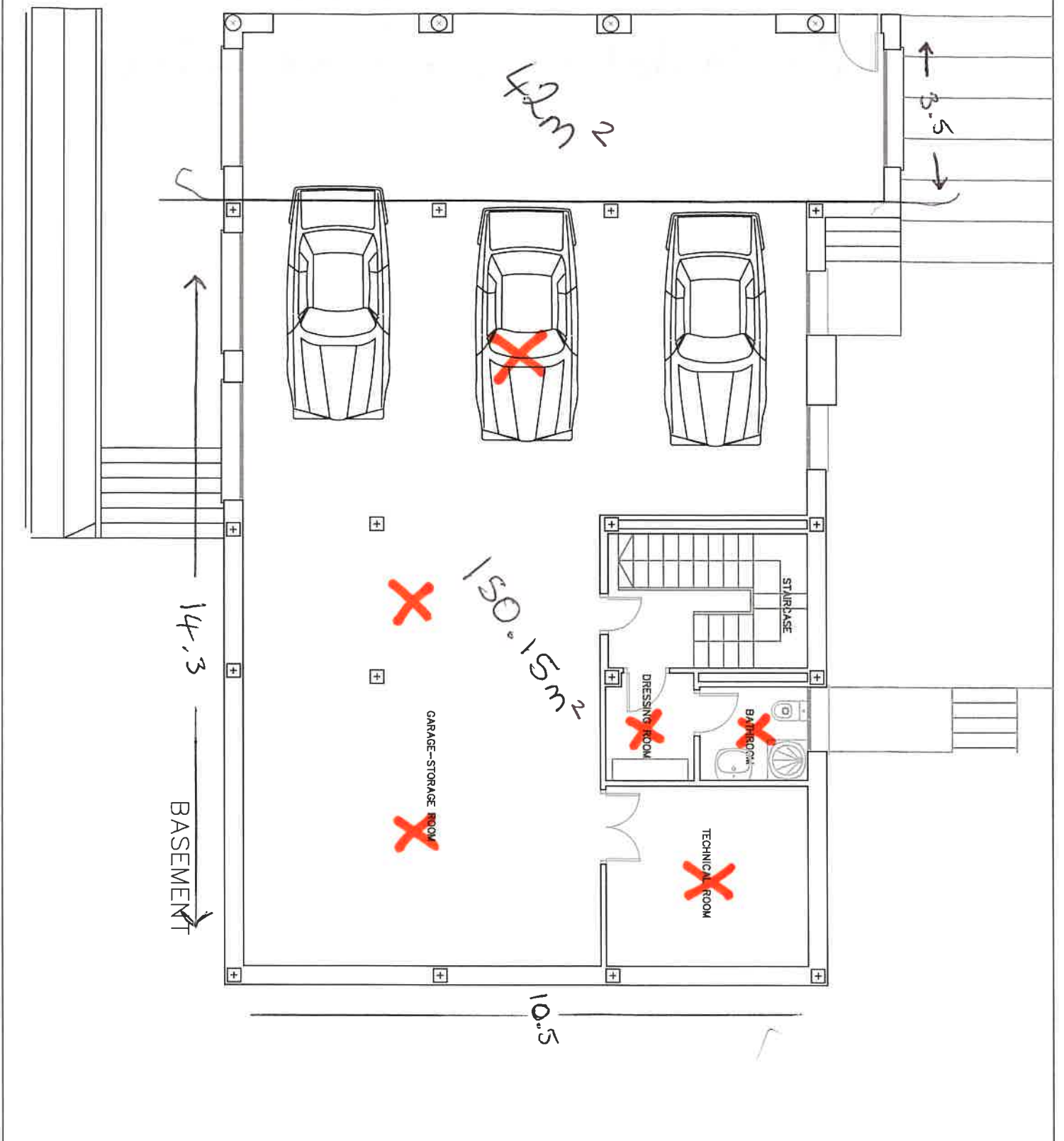


Figure 3

Total
= 192.15

BASEMENT
FLOOR DISTRIBUTION

SCALE 1/100

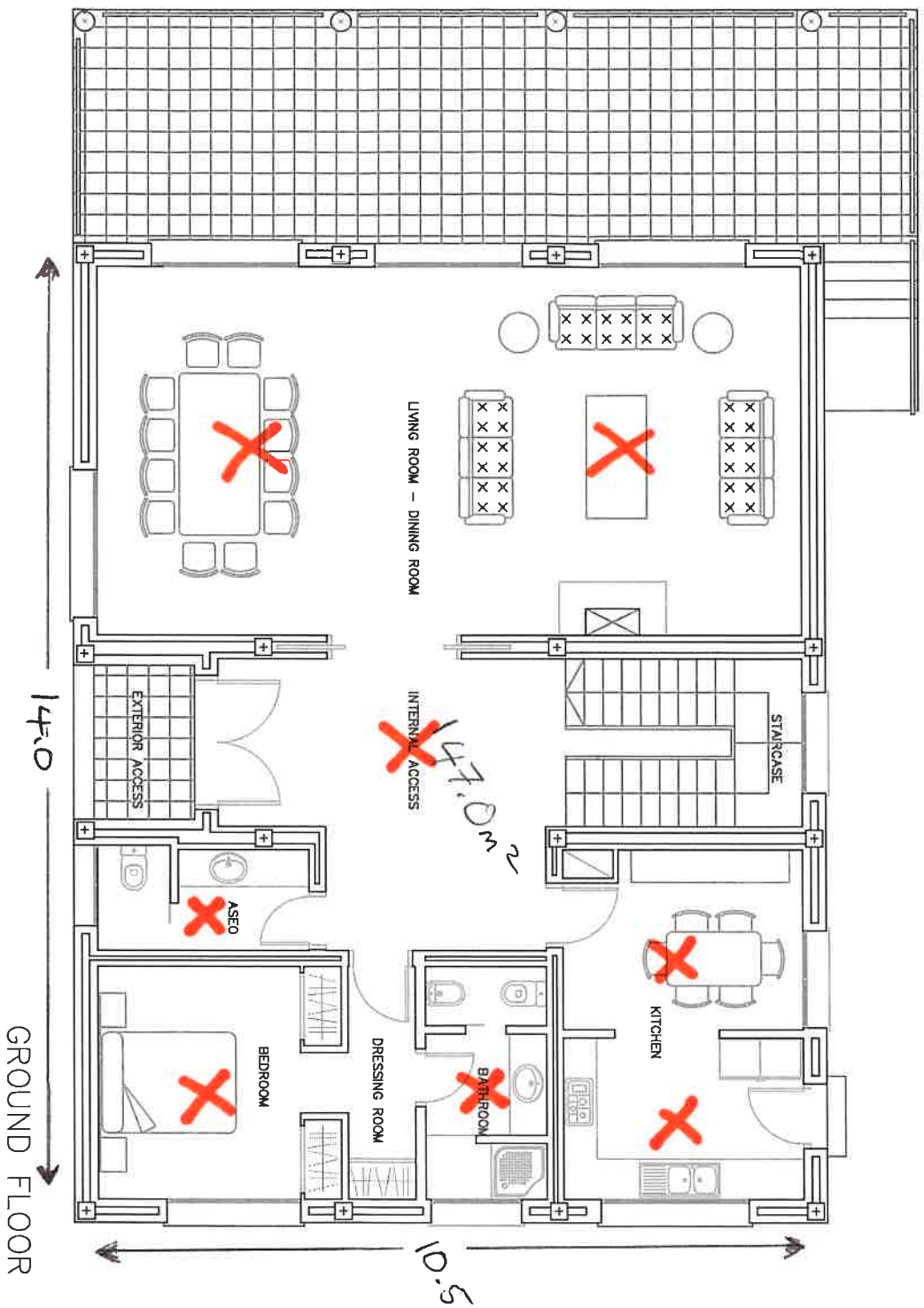


Figure 4

Total
= 147.0

GROUND FLOOR
FLOOR DISTRIBUTION
SCALE 1/100

Figure 5

Total
= 147.0

FIRST FLOOR
FLOOR DISTRIBUTION
SCALE 1/100

