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Homestar Case Study

Cost Benefit Analysis

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1 EXECUTIVE SUMMARY

Auckland Council has commissioned this study to identify the costs and benefits of achieving 5, 6 and 7 Star Homestar above the NZBC standard. This study looks at hard cost benefits (energy and water) only; whilst there may be some soft cost benefits associated with the sustainable features (such as reduced health care cost) these are difficult to quantify. This study does not include the following costs that would be associated with Homestar:

- Materials selection;
- Site selection and ecology;
- Home management features;
- Waste minimisation and recycling features;
- Accreditation costs.

The Jasmx Homestar Cost-Scoring Appraisal gives more details on the cost of the above.

The Homestar rating is a tool which can be used to assess the level of sustainability in a house based on a scale of 1-10 Stars, with 10 Stars being the most sustainable. The average existing New Zealand house achieves 2 Stars and a new house based on NZBC standard would be expected to achieve 4 Stars. Higher Star rated buildings are less energy and water hungry and are also healthier to live in. 5, 6 and 7 Star ratings have been identified as being the most attainable for a standard NZ house and therefore 8 Stars and above have not been analysed here. An online rating tool is available for home owners should they wish to self-assess their house, but for certification a formal assessment must be carried out by an Assessor.

Energy saving features included in the analysis were:

- Increased insulation levels
- Low flow fittings which will assist with reducing hot water use
- Hot water heat pump
- Energy efficient lighting (CFLs or LEDs)

Water saving features included in the analysis were:

- Low flow fittings
- Rainwater storage

Table 1 presents the results of the cost benefit analysis. These results are based on a set of assumptions on the use of the house and in reality could be quite different and correlation with real data is recommend once that data is available from built 5, 6 and 7 Star rated buildings. The results of the analysis show that for 5 and 6 Star ratings paybacks are within the expected home ownership period, which is typically 7 years but we expect would be more likely to be more like 10 years given the comfort of these houses. The rates of returns seen for 5 and 6 Star Star ratings are much higher than current bank interests rates and therefore considered to be a very good investment. These figures do not take into account the added value to a property as a result of the features discussed here, which in reality could make these features look more favourable.

Table 1 Cost benefit analysis results for each scenario

Scenario	Capital Cost Investment (\$)	Annual Energy Savings (\$/yr)	Annual Carbon Savings (\$/yr)	Annual Water Cost Saving (\$/yr)	Annual Wastewater Cost Saving (\$/yr)	Total Hard Cost Saving (\$/yr)	Hard Cost Savings Simple Payback (yrs)	Hard Cost Savings 10yr NPV (\$)	Hard Cost Saving IRR (%)
NZBC	0	0	0	0	0	0	0.00	0	0
5 Star	2223	702	3	29	58	792	2.80	4032	31%
6 Star	5223	814	3	73	58	948	5.51	2286	31%
7 Star	14337	1293	5	73	58	1429	10.03	-2950	3%

Based on the results of this study we recommend that Homestar is adopted by Auckland Council and a minimum target of 6 Stars is set.

2 INTRODUCTION

2.1 Purpose of this report

The purpose of this report is to assist Auckland Council in quantifying the costs and benefits of achieving sustainable design levels identified using a Star Homestar rating. The four scenarios investigated are as follows:

1. NZBC Standard which is equivalent to a 4 Star Homestar rating
2. 5 Star Homestar rating
3. 6 Star Homestar rating
4. 7 Star Homestar rating

This report only analyses hard cost benefits (energy and water); however it should be recognised that there could also be soft cost benefits (health, sick days) although these are hard to quantify. For more detailed costs on all of the additional features for achieving 5, 6 and 7 Star Homestar ratings refer to the Jasmax Homestar Cost-Scoring Appraisal. This study does not include the following costs that would be associated with Homestar and are discussed in the Appraisal:

- Materials selection;
- Site selection and ecology;
- Home management features;
- Waste minimisation and recycling features;
- Accreditation costs.

2.2 Motivation for Sustainable Design

The Auckland Plan sets a target for reducing greenhouse gas emissions by 10-20% by 2020 and 50% by 2050. Including sustainable design features in homes will help to achieve this target. Sustainable design will help to make homes:

- More affordable to live by reducing energy and water use;
- Healthier as they are warmer, drier and have fewer toxic chemicals in them;
- Have a lower impact on the surrounding local environment, such as reduced stormwater flows;
- Reduce the need for infrastructure upgrades.

A two year study commissioned by the New Zealand Business Council for Sustainable Development concluded that by making homes warmer, drier and more energy and water efficient, the country could:

- Avoid sending 50 people a day to hospital with respiratory diseases (saving \$54m a year);
- Cut sick days off work by 180,000 a year (lifting production by \$17m a year);
- Cut household power bills by \$475m a year by using a combination of insulation and glazing; and
- Stop households wasting enough water a year to fill 9,200 Olympic swimming pools.

2.3 The Homestar Tool

The Homestar tool was developed by the NZGBC and BRANZ in order to assist home owners in making improvements to their homes that will conserve energy, conserve water, improve the health and thermal comfort of the house and lower its impact on the environment. Since its launch in 2010 there have been 23 houses certified. As well as the formal certification process there is a free online tool which can be used for a basic assessment by home owners. Several thousands of homes have been assessed through this online tool according to the NZGBC's records.

The Homestar tool assesses a home under the following categories:

- Energy
- Health and comfort

- Water
- Waste
- Home Management
- Site

In this study we only deal with the energy and water credits.

3 PRINCIPLE ENVIRONMENTAL FEATURES

3.1 Energy Use

3.1.1 Space Heating

Table 2 shows the insulation and glazing levels assumed in each scenario and their associated costs. It has been assumed there is no change to the air tightness of the building, as it is not common practise to check for this in home building presently. The Jasmax report assumed that resistive type heating was used in the NZBC, 5 Star and 6 Star models and a heat pump was used in the 7 Star model. In our experience heat pumps are fairly commonplace regardless of whether a house is Homestar rated, and therefore unlikely to be an additional cost on a standard new house specification, however we have assumed the inclusion of a heat pump for only the 7 Star scenario, to demonstrate the minimum capital cost of achieving each Star rating.

The space heating figures in this analysis were provided by the NZGBC using the Homestar space heating calculation. These space heating figures were calculated assuming heating for 24 hours to 20°C; however we would expect that this would typically be only between the hours of 4-10pm in reality. We have adjusted these figures to allow for the heat pump efficiency in the 7 Star case and have assumed an average COP of 3 over the heating period. Cooling has not been included in this analysis as it is not currently assessed under Homestar, however with heat pumps being fairly commonplace, the current trend for lots of glazing in houses and insulation levels increasing cooling loads are becoming more of a concern than heating loads.

Table 2 Insulation levels and glazing used in each scenario and associated costs

Scenario	Insulation Levels and Glazing	Additional Costs
NZBC	Insulation to code. R2.9 in roof, R1.9 in walls, R1.3 floor, R0.26 glazing.	\$0
5 Star	As above but with R4.2 in roof and full or edge insulation on the slab.	\$2,200
6 Star	As above.	\$2,200
7 Star	As above but with 140mm stud walls and R2.6 insulation. Exposed mass. No downlight penetrations in ceiling insulation. Heat pump.	\$7,874

3.1.2 Water Heating

Water heating savings can be made by using water efficient fittings. Details of the water efficiency of the fittings for each scenario are given in Table 4 below, the fittings important for hot water heating savings are the shower, kitchen tap, basin taps, washing machine, dishwasher, laundry tap and bath tap. Water efficiency values are based on those presented in the Jasmax report (2012).

Other water heating efficiency features investigated included a hot water heat pump which was included on the 7 Star Homestar rated building. All the other scenarios have a standard 250 Litre electric hot water cylinder. The additional cost of the hot water heat pump is \$3,300 and it is assumed to have an average COP of 3 over the year. In the NZBC standard scenario it is assumed that 160 Litre of hot water is used daily (based on the Plumbing Engineering Services Design Guide) and that the incoming water is 15°C and is heated to 60°C. Less hot water is used in the Homestar rated houses and the hot water use has been adjusted based on the water efficiency savings from the fittings. We have assumed there is no difference in the thermal performance of the cylinder or pipework, i.e. there is no difference in the levels of insulation.

The water heating has been adjusted to allow for a two week holiday during the year when hot water is not required.

3.1.3 Lighting and Appliances

Table 3 gives the types of lighting assumed for each scenario. The use of halogens (50W) and incandescents (100W) is still very common in new houses in New Zealand. However the availability of CFLs and LED alternatives is continually increasing and with this their costs are dropping. We have assumed that there is a mixture of 50% halogens and 50% incandescents in the NZBC standard house. For the 5 Star and 6 Star houses 70% of the lighting has been replaced with CFLs. The 7 Star house has 90% CFLs and LEDs. We have assumed the CFLs and LEDs

are 10W bulbs. Lighting is assumed to be used for 7 hours a day on average over the year and that 40% of the lights are on at any one time. We have assumed the same number of light fittings in each scenario.

Table 3 Lighting for each scenario

Scenario	Lighting	Additional Costs
NZBC	Halogens and incandescent lighting	\$0.00
5 Star	CFLs to 75% of internal lights and sensors on external lights	\$22.50
6 Star	As above	\$22.50
7 Star	CFLs/LEDs to 90% of internal lighting with exclusive fittings to 25%, sensors on external lights	\$162.50

Appliances have generally been ignored on this study as old ones are often used in new houses. With the Star ratings clearly given on all whiteware appliances these days it also makes it much easier for home owners to make an informed choice whether they are in a NZBC standard house or a 7 Star Homestar rated house.

3.2 Water Use

We have assumed that the house built to NZBC standards uses a typical daily water use of 400 Litres per day, based on the Plumbing Engineering Services Design Guide. Table 4 shows the water use rates of the fixtures and fittings assumed for each scenario, these has been based on Jasmox's report (2012). Comparing the 5 Star scenario with the NZBC standard scenario savings are made in the water use rates on the shower, kitchen tap, basin taps, toilet, laundry tap and bath tap. There is no change in water use rates for fixtures and fittings between the 5 Star, 6 Star and 7 Star scenarios. Table 5 shows the rainwater system details for each scenario, with NZBC standard and 5 Star having nothing and the 6 Star and 7 Star having a 4,000Litre tank. Table 5 also gives the expected non-potable water savings that could be achieved with the rainwater storage system available.

Table 4 Water use rates for each fitting and fixture for each scenario

Scenario	Shower (L/min)	Kitchen Tap (L/min)	Basin Taps (L/min)	Toilet (L/flush)	Washing Machine (L/Cycle)	Dishwasher (L/Cycle)	Laundry Tap (L/min)	Bath Tap (L/min)
NZBC	12	7.5	6	4	77	14	6.5	6
5 Star	9	4.5	4.5	3.5	77	14	4.5	4.5
6 Star	9	4.5	4.5	3.5	77	14	4.5	4.5
7 Star	9	4.5	4.5	3.5	77	14	4.5	4.5

Table 5 Rainwater storage for each scenario

Scenario	Rainwater Storage (L)	% Annual Non-Potable Water Supplied
NZBC	0	0%
5 Star	0	0%
6 Star	4000	61%
7 Star	4000	61%

4 VALUE CASE ASSUMPTIONS

4.1 Building Details

The house is located in Auckland. It is a three bedroom, two storey house with a total floor area of 180m². Rooms in this house are as follows:

1. Open plan living on ground floor
2. Toilet on ground floor
3. Double garage on ground floor
4. Master bedroom with ensuite on the first floor
5. Two bedrooms on first floor
6. Bathroom on first floor

The ensuite contains a shower, basin and toilet. The bathroom has a bath, separate shower, toilet and basin. There is a laundry area (washing machine and tub) located in the garage.

4.2 Capital cost investment for Energy and Water Conservation Features

The following capital cost investments in monetary terms have been estimated for the energy and water conservation features. Appliances (fridges, dishwasher, etc) have not been included in this analysis as energy star rated products are already widely available and therefore may not be purchased necessarily as a result of Homestar. It is also unlikely that developers would include appliances in their houses or that new appliances are bought with the new house.

Table 6 - Capital cost investment for 5, 6 and 7 Star Homestar Energy and Water Conservation Features

Costs (\$)	Space Heating	Water Heating	Lighting	Water Saving Features	TOTAL COST
NZBC	0.00	0.00	0.00	0.00	\$0
5 Star	2200.00	0.00	22.50	0.00	\$2,223
6 Star	2200.00	0.00	22.50	3000.00	\$5,223
7 Star	7874.00	3300.00	162.50	3000.00	\$14,337

4.3 Hard energy and water cost savings

Energy, water and wastewater costs of NZ\$0.2825 per kWh (Powerswitch, 2013), NZ\$1.1343 per m³ and NZ\$2.281 per m³ have been assumed respectively. These are based on Auckland figures only. Electricity prices have been obtained from the average electricity prices for a Low User profile (<8,000kWh/yr) for Contact, Meridian and Mercury from figures accessed on the Powerswitch website. Fixed charges (\$/day) for electricity have been excluded from this analysis as it is assumed that these do not change with energy use, which is a reasonable assumption in most cases. Water and wastewater charges are from Watercare's website assuming a metered house and exclude service charges (similar to the electricity fixed charge).

4.4 Discount rate

The value case uses a discount rate of 8 per cent per annum. This is in accordance with the Treasury's Cost Benefit Analysis Guide (2010).

4.5 Inflation rate

The inflation rate for electricity is assumed to be 4% per year. This has been calculated from the MED's energy costs for the last ten years and is thought to be conservative.

4.6 Carbon dioxide emission factor

The value case assumes an average carbon dioxide emission factor of 0.137 kgCO₂-e per kWh (Ministry for the Environment, 2011).

4.7 Cost of carbon

The value case uses the New Zealand Treasury price estimate of carbon of NZ\$8.27 per tonne at May 2012.

5 VALUE CASE RESULTS

Table 7 shows the savings made in energy, carbon, water and wastewater as a result of the different sustainability levels identified as 5 Star, 6 Star and 7 Star Homestar. Table 8 shows these savings in monetary terms. Table 9 shows the cost benefit analysis results for each scenario. This table identifies capital cost investment, hard cost savings, simple payback period, 10 year NPVs and internal rates of return (IRR). 10 year NPVs were used as we expect homeowners to stay in these homes for a period of 10 years, rather than the average 7 years, as they are more comfortable. Simple paybacks are 3, 6 and 10 years for 5 Star, 6 Star and 7 Star Homestar energy and water saving features respectively. Rates of returns for the 5 and 6 Star Homestar buildings are good and show a very worthwhile investment, the rates of return on the 7 Star is reasonable. These figures are based on modelled figures and assumptions and in reality paybacks and rates of return could be quite different.

Table 7 –Potential Homestar energy, carbon and water savings per year

Savings	Space Heating (kWh/yr)	Water Heating (kWh/yr)	Lighting (kWh/yr)	Total Energy (kWh/yr)	Carbon Emissions (kgCO2/yr)	Water (m3/yr)	Wastewater (m3/yr)
NZBC	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Star	434.00	614.91	1436.28	2485.18	340.47	25.63	25.63
6 Star	829.00	614.91	1436.28	2880.18	394.59	63.93	25.63
7 Star	471.33	2170.35	1934.50	4576.19	626.94	63.93	25.63

Table 8 – Potential Homestar energy and water cost savings per year

Saving (\$/yr)	Space Heating	Water Heating	Lighting	Total Energy	Carbon Emissions	Water Savings	Wastewater Saving	TOTAL SAVING
NZBC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 Star	122.59	173.69	405.70	701.98	2.82	29.08	58.47	792.35
6 Star	234.16	173.69	405.70	813.56	3.26	72.52	58.47	947.81
7 Star	133.14	613.05	546.43	1292.62	5.18	72.52	58.47	1,428.79

Table 9 Cost benefit analysis for each scenario

Scenario	Capital Cost Investment (\$)	Annual Energy Savings (\$/yr)	Annual Carbon Savings (\$/yr)	Annual Water Cost Saving (\$/yr)	Annual Wastewater Cost Saving (\$/yr)	Total Hard Cost Saving (\$/yr)	Hard Cost Savings Simple Payback (yrs)	Hard Cost Savings 10yr NPV (\$)	Hard Cost Saving IRR (%)
NZBC	0	0	0	0	0	0	0.00	0	0
5 Star	2223	702	3	29	58	792	2.80	4032	31%
6 Star	5223	814	3	73	58	948	5.51	2286	31%
7 Star	14337	1293	5	73	58	1429	10.03	-2950	3%

6 CONCLUSIONS

In this report we have investigated the costs and benefits for energy, carbon, water and wastewater saving features in the following scenarios:

1. NZBC Standard which is equivalent to a 4 Star Homestar rating
2. 5 Star Homestar rating
3. 6 Star Homestar rating
4. 7 Star Homestar rating

Energy saving features included in the analysis were:

- Increased insulation levels
- Low flow fittings which will assist with reducing hot water use
- Hot water heat pump
- Energy efficient lighting (CFLs or LEDs)

Water saving features included in the analysis were:

- Low flow fittings
- Rainwater storage

From the hard cost benefit analysis results we recommend that the Homestar rating is adopted by Auckland Council as means to improving the performance of new houses through:

- Lower energy costs
- Lower carbon costs
- Lower water costs
- Lower waste water costs

7 REFERENCES

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