eCubed Building Workshop Ltd

energy
environment
engineering

Homestar Value Case Study

Cost Benefit Analysis

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Disclaimer:

1.0 EXECUTIVE SUMMARY

The New Zealand Green Building Council has commissioned this study to identify the cost benefits of achieving 6, 7 and 8 Star Homestar above the NZBC standard. This study is an expansion and revision of the 2013 Homestar Value Case Study originally commissioned by Auckland Council as an add-on to the Jasmax Homestar Cost-Scoring Appraisal.

This study looks at direct 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. There are also other indirect costs beyond the site boundary that affect NZ society in general and should also be considered by the government as part of its "guardianship" role. We understand that an economic analysis of the soft costs and indirect costs / externalities is currently being undertaken by others, however have provided a brief discussion on this for context in Section 6.0.

The Homestar rating is an approach which can be used to assess the level of sustainability in a house with higher star rated buildings being less energy and water hungry and also healthier homes in which to live. The rating tool has recently undergone an extensive revision. The current version (Version 4) allows for homes to be rated on a scale of 6-10 Stars, with 10 Stars being the most sustainable. A new house built to minimum NZBC standards would not typically be expected to attain a rating under Version 4 of the tool. Ratings of 6-8 Stars have been identified as being the most attainable for a standard NZ house and therefore ratings of 9 and 10 Stars have not been analysed by this report. 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 a Homestar Accredited Assessor.

Energy saving features included in the analysis were:

- Increased insulation levels and higher performance glazing
- Low flow fittings which will assist with reducing hot water use
- Heat pump heating in main living space
- Hot water heat pump

Water saving features included in the analysis were:

- Low flow fittings
- Rainwater storage

It is important to note that savings in water use, currently only result in actual hard cost savings in Auckland as neither Wellington nor Christchurch Council charge for water based on volumetric metering and therefore no actual dollar savings can be made as a result of water saving measures implemented for Homestar. We would expect that in future all local councils would consider a move to volumetric charges.

The tables which follow show the hard savings made in energy, carbon, water and wastewater as a result of the different sustainability levels identified as 6 Star, 7 Star and 8 Star Homestar in each of the three main centres – Auckland Wellington and Christchurch. We note that these results are based on a set of assumptions on the use of the house that in reality could be quite different depending on how residents choose to use and occupy their residence

Table 1: Potential annual savings for Auckland

Specification	Annual Energy Savings ($/yr)	Annual Carbon Savings ($/yr)	Annual Water Cost Savings ($/yr)	Annual Wastewater Cost Savings ($/yr)	Total Hard Cost Savings ($/yr)
NZBC	-	-	-	-	-
6 Star	355	5	39	66	465
7 Star	1888	29	88	110	2115
8 Star	1891	29	64	110	2094

Table 2: Potential annual savings for Wellington

Specification	Annual Energy Savings ($/yr)	Annual Carbon Savings ($/yr)	Annual Water Cost Savings ($/yr)	Annual Wastewater Cost Savings ($/yr)	Total Hard Cost Savings ($/yr)
NZBC	-	-	-	-	-
6 Star	464	7	-	-	471
7 Star	2291	35	-	-	2325
8 Star	2438	37	-	-	2475

Table 3: Potential annual savings for Christchurch

Specification	Annual Energy Savings ($/yr)	Annual Carbon Savings ($/yr)	Annual Water Cost Savings ($/yr)	Annual Wastewater Cost Savings ($/yr)	Total Hard Cost Savings ($/yr)
NZBC	-	-	-	-	-
6 Star	461	7	-	-	468
7 Star	1589	24	-	-	1613
8 Star	1742	26	-	-	1768

For the 6 Star cases the annual hard cost savings are broadly similar in all locations at approximately $450-500. There is no significant difference in hard cost savings between the 7 and 8 Star case in any of the locations. For the 7 and 8 Star cases the annual hard cost savings are approximately $2000-2100 in Auckland, $2300-2500 in Wellington and $1600-1800 in Christchurch.

It is important to note that 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. The results from the annual Homestar / realestate.co.nz survey as summarised in the table below show a rising market preference for high levels of insulation and orientation for sun. Figures correspond to the percentage of survey respondents rating features as 'important' or 'very important'

Table 4: Relative Importance of Home Features as per the Annual Homestar / realestate.co.nz Survey

Home Feature	2014 results	2013 results	2012 results
Orientated to maximise the sun	91%	86%	87%
High level of insulation	90%	82%	76%
Off-street parking	76%	75%	73%
Ample storage space	76%	72%	71%
Located on a quiet street	74%	69%	69%
Covered car parking (garage/carport)	73%	73%	74%
Energy-efficient features - e.g. LEDs, double glazing	72%	49%	51%
Number of bedrooms (3 or more)	69%	74%	74%
Indoor-outdoor flow	69%	69%	70%
Outdoor entertaining area	63%	65%	65%
Open-plan living	58%	55%	55%
A large section/garden with room for fruit and vegetables	54%	55%	53%
Close to amenities, e.g. schools, medical care, supermarket etc	50%	47%	48%
A home built with sustainable or environmentally friendly materials	48%	36%	33%
Attractive updated or gourmet kitchen	47%	51%	51%
Renewable energy, e.g. solar PV panels or solar water heating	45%	n/a	n/a
Close to public transport	42%	29%	31%
Large or walk-in wardrobes	41%	42%	44%
Water-saving features e.g. rain water tank	37%	29%	26%

2.0 INTRODUCTION

2.1 Purpose of this Report

The purpose of this report is to assist The New Zealand Green Building Council in quantifying the costs and benefits of achieving 6 and 7 Star Homestar ratings in each of the three main city centres (Auckland, Wellington and Christchurch).

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. There are also other indirect costs beyond the site boundary that affect NZ society in general and should also be considered by the government as part of its "guardianship" role.

We understand that an economic analysis of the soft costs and indirect costs / externalities is currently being undertaken by others, however have provided a brief discussion on this for context in Section 6.0.

2.2 Motivation for Sustainable Design

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 polls.

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 around 500 houses certified.

The Homestar tool assesses a home under six categories:

- Energy, Health and Comfort
- Water
- Waste
- Management
- Materials
- Site

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

3.0 PRINCIPLE ENVIRONMENTAL FEATURES

3.1 Energy Use

The calculated energy use savings are presented in the table below. Further details on how this was determined is presented in the sub sections which follow

Table 5: Energy Use Savings and Additional Costs

Location	Specification	Space Heating & Cooling Savings (kwh/yr)	Hot Water Heating Savings (kWh/yr)
Auckland	NZBC	-	-
	6 Star	107.5	1244.5
	7 Star	1579.1	5606.4
	8 Star	1586.5	5606.4
Wellington	NZBC	-	-
	6 Star	520.4	1244.5
	7 Star	3113.0	5606.4
	8 Star	3674.5	5606.4
Christchurch	NZBC	-	-
	6 Star	511.1	1244.5
	7 Star	3895.7	2151.7
	8 Star	4478.9	2151.7

3.1.1 Space Heating & Cooling

The space heating and cooling energy use figures were calculated via thermal simulation. The thermal simulations were carried out by eCubed Building Workshop using Energy Plus v8.6 software via a Design Builder front-end. Full details of the modelling including the inputs and assumptions are not included in this report, but can be provided on request.

The table which follows shows the insulation levels, glazing and heating systems assumed in each scenario and their associated costs. It has been assumed the there is no change to the air tightness of the building, as it is not common practice to check for this as part of home building in New Zealand.

Electric resistive type heating was used in the main living space for the NZBC and 6 Star models and a heat pump was used for the 7 Star and 8 Star model in all locations. 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. The modelling allows for the heat pump efficiency in the 7 Star and 8 Star scenario only and we have assumed an average COP of 3 over both the heating and cooling period.

The modelling assumes comfortable temperatures are maintained for 24 hours the living space and bedrooms. In reality actual use is highly dependent on the behaviour of the occupants and we would expect that the operation of heating and cooling systems might be more limited in practise.

Table 6: Insulation Levels, Glazing and Heating Systems Used in Each Scenario and Associated Costs

Location	Specification	Insulation Levels	Glazing	Heating Systems
Auckland	NZBC	R3.2 Ceiling Insulation R2.0 Wall Insulation Slab-on-grade ground floor	Standard clear double glazing in aluminium frames	Electric panel heater in open plan living space
	6 Star	R4.0 Ceiling Insulation R2.4 Wall Insulation Slab-on-grade with EPS waffle pods	As above	As above
	7 Star	R6.0 Ceiling Insulation R2.8 Wall Insulation Slab as above plus 30mm edge insulation	Upgrade to clear low e double glazing in aluminium frames	Heat pump in open living space
	8 Star	As Above	Upgrade to clear low e double glazing with argon core in thermally broken frame	Heat pump in open living space

Wellington	NZBC	R3.2 Ceiling Insulation R2.0 Wall Insulation Slab-on-grade ground floor	Standard clear double glazing in aluminium frames	Electric panel heater in open plan living space
	6 Star	R5.0 Ceiling Insulation R2.4 Wall Insulation Slab-on-grade with EPS waffle pods and 30mm edge insulation	As above	As above
	7 Star	R6.0 Ceiling Insulation R3.2 Wall Insulation, 140mm frames Slab as above	Upgrade to clear low e double glazing with argon core in aluminium frames	Heat pump in open living space
	8 Star	Double layer of ceiling insulation: R2.6 insulation between rafters and R3.2 insulation on top of rafters R4.0 Wall Insulation, 140mm frames Slab-on-grade with 50mm underslab insulation and 30mm edge insulation	Upgrade to clear low e double glazing with argon core in thermally broken frames	Heat pump in open living space
Christchurch	NZBC	R3.6 Ceiling Insulation R2.2 Wall Insulation Slab-on-grade ground floor	Standard clear double glazing in aluminium frames	Electric panel heater in open plan living space
	6 Star	R5.0 Ceiling Insulation R2.4 Wall Insulation Slab-on-grade with EPS waffle pods and 30mm edge insulation	As above	As above
	7 Star	R6.0 Ceiling Insulation R3.2 Wall Insulation, 140mm frames Slab as above	Upgrade to clear low e double glazing with argon core in aluminium frame	Heat pump in open living space
		Double layer of ceiling insulation: R2.6 insulation between rafters and R3.2 insulation on top of rafters R4.0 Wall Insulation, 140mm frames Slab-on-grade with 50mm underslab insulation and 30mm edge insulation	Upgrade to clear low e double glazing with argon core in thermally broken frames	Heat pump in open living space

3.1.2 Water Heating

Water heating savings are made by using water efficient fittings. Details of the water efficiency of the fittings for each scenario are given in the table below, with the same water saving measures are assumed for each of the three locations. The fittings important for hot water heating savings are the shower, kitchen tap and basin taps. While there are other uses of hot water in a typical household such as washing machines, dishwashers and laundry taps, we have excluded analysis of these fittings from the value case as no efficiency measures are proposed to these fittings as part of the Homestar framework.

Further offset in water heating energy use is achieved via a hot water heat pump which was included on the 7 Star and 8 Star Homestar rated building in Auckland and Wellington. All the other scenarios have a standard 180 Litre electric hot water cylinder. Heat pump hot water heating is not recommended in Christchurch due to the low ambient temperatures and hence we have excluded this from the Christchurch value case.

The energy use calculations assume that the cold incoming water is 15°C and is heated to 60°C in the hot water cylinder. 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 fittings. Details of assumptions regarding water efficient fitting are noted in Section 3.2.1. 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 and that in all cases the cylinder is located indoors.

The hot water heat pump is assumed to be of the split system type with an average COP as 2.0 which is a conservative estimate in line with the findings from the BRANZ study report on heat pump water heaters (Pollard, 2010) and takes into account standing losses in the cylinder.

Table 7: Water Efficient Fittings and Hot Water Heating Systems Used in Each Scenario and Associated Costs

Location	Specification	Fittings	Hot Water Heating Systems
Auckland / Wellington	NZBC	Shower – 12L/min Kitchen Tap – 7.5L/min Basin Taps – 6L/min	180L Electric Storage Cylinder

	6 Star	Shower – 9L/min Taps as above	As above
	7 Star	Shower – 7.5L/min Kitchen Tap – 6L/min Basin Taps – 4.5L/min	Heat Pump Hot Water Cylinder
	8 Star	As above	As above
Christchurch	NZBC	Shower – 12L/min Kitchen Tap – 7.5L/min Basin Taps – 6L/min	180L Electric Storage Cylinder
	6 Star	Shower – 9L/min Taps as above	As above
	7 Star	Shower – 7.5L/min Kitchen Tap – 6L/min Basin Taps – 4.5L/min	As above
	8 Star	As above	As above

3.1.3 Lighting and Appliances

We have excluded analysis of lighting and appliances fittings from the value case as no additional efficiency measures are proposed as part of the Homestar Value Case outline specification with energy efficient LED lighting assumed to be standard in all new home builds.

3.2 Water Use

The calculated water use and wastewater savings are presented in the table below. Further details on how this was determined is presented in the sub sections which follow

Table 8: Water Use and Wastewater Savings

Location	Specification	Water Use Savings (m3/yr)	Wastewater Savings (m3/yr)
Auckland / Wellington / Christchurch	NZBC	-	-
	6 Star	26.1	26.1
	7 Star	59.5	43.5
	8 Star	43.5	43.5

Note that the while the savings in water use are the same in all three locations, currently this only results in added hard cost savings in Auckland as neither Wellington nor Christchurch Council charge for water based on volumetric metering and therefore no dollar savings can be made as a result of water saving measures implemented for Homestar.

3.2.1 Water Efficient Fittings

Water use savings are made by using water efficient fittings. The fittings specified for water savings as part of the Homestar framework are the shower, toilets, kitchen and basin taps. While there are other uses of water in a typical household such as washing machines, dishwashers and laundry taps, we have excluded analysis of these fittings from the value case as no efficiency measures are proposed to these fittings as part of the Homestar framework.

Table 9: Water Efficient Fittings Used in Each Scenario and Associated Costs

Location	Specification	Shower	WC	Kitchen Tap	Basin Taps
Auckland / Wellington / Christchurch	NZBC	12L/min	6/3 dual flush	7.5L/min	6L/min
	6 Star	9L/min	4.5/3 dual flush	As above	As above
	7 Star	7.5L/min	As above	6L/min	4.5L/min
	8 Star	As above	As above	As above	As above

We have calculated daily water use for the key water saving fittings as per the following assumptions. The calculated water use is presented in the table which follows. For reference we have also provided the findings from the BRANZ Water Use & Efficiency Project (WEEP) and water use calculated using the Homestar V4 calculator.

- Showers – 0.7 showers per person per day with an average duration of 7.8 minutes

- Toilets – 5 flushes per person per day with an average flush volume of 1 full flush to 4 half flushes
- Taps –10 litres fixed use in kitchen plus 5 uses per person per day with an average duration of 30 seconds
- Outdoor – Average use of 29 L/person/day in accordance with the findings from the WEEP study

Table 10: Calculated Water Use for Water Efficient Fittings (L/person/day)

End Use	WEEP	Homestar V4 Assumptions				Value Case Assumptions			
		NZBC	6 Star	7 Star	8 Star	NZBC	6 Star	7 Star	8 Star
Toilets	33.4	18.0	16.5	16.5	16.5	18.0	16.5	16.5	16.5
Showers	45.1	84.0	63.0	52.5	52.5	65.5	49.1	41.0	41.0
Taps	23.5	24.7	24.7	21.7	21.7	26.9	26.9	23.1	23.1
Outdoor	29.1	1.25	1.25	1.25	1.25	29.1	29.1	29.1	29.1

We can see in the table that the toilet use is much lower than that recorded during the WEEP study, which is to be expected as the average flush volume recorded during the study was approximately 6.2 L/flush compared with an average of 3.6L/flush for a more efficient 6/3 dual flush toilet. Our shower water use assumptions provide a reasonable approximation which is broadly similar to that recorded in the WEEP study, but notably lower that the estimate in the Homestar V4 calculator.

As outdoor water is such a highly variable water use it is difficult to estimate with certainty hence we have referred to the findings from the WEEP study. The Homestar V4 Calculator allows for much less irrigation water by default, although this can be overridden in the data entry.

3.2.2 Rainwater Offset

Further offset in water use is achieved via a 2,000 Litre rainwater storage tank which was included on the 7 Star Homestar rated houses in all locations to offset the water used for outdoor uses (irrigation) and toilet flushing. The rainwater tank is an additional capital cost of $1,050. We note however that no rainwater harvesting system is assumed for the 8 Star rated houses as advised by NZGBC.

Space would obviously need to be found for the tank and there are a number of space efficient options/designs for residential applications.

The expected non-potable water savings that could be achieved via the rainwater system were calculated using and in-house calculator developed by eCubed BuIlding Workshop using 10 year averaged daily rainfall data for the Auckland region.

Table 11: Rainwater Offset for Irrigation and Toilet Flushing

Location	Specification	Toilets & Outdoor (L/p/day)	Toilets & Outdoor (L/day)	Rainwater Offset for Toilets & Outdoor (%)	Rainwater Offset for Toilets & Outdoor (L/day)
Auckland / Wellington / Christchurch	NZBC	47.1	188.2	0.0	0.0
	6 Star	45.6	182.2	0.0	0.0
	7 Star	45.6	182.2	89%	43.7
	8 Star	45.6	182.2	0.0	0.0

4.0 VALUE CASE ASSUMPTIONS

4.1 Building Details

The house is a three-bedroom (four person), two storey houses with a total gross floor area of 180m^2.

4.2 Hard Energy and Water Cost Savings

Electricity costs are estimated as NZ$0.2627, NZ$0.2785 and NZ$0.2645 per kWh for Auckland, Wellington and Christchurch respectively. Average electricity prices have been estimated using data obtained from six common energy retailers for a low user profile (<8,000kWh/yr for Auckland and Wellington, <9000kWh/yr for Christchurch). Fixed charges ($/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. The six retailers were Contact, Genesis, Meridian, Mercury, Powershop and Trustpower.

Water and wastewater charges for Auckland are taken as NZ$1.480 per m^3 and NZ$2.535 per m^3 respectively. These charges are based on the current Watercare pricing as of 1 July 2017 assuming a metered house and exclude service charges (similar to the electricity fixed charge).

Currently neither Wellington nor Christchurch Council charge for water based on volumetric metering and therefore no dollar savings can be made as a result of water saving measures implemented for Homestar.

4.3 Carbon Dioxide Emission Factor

For the value case in this report we have used a *marginal* carbon dioxide emission factor of 0.19 kgCO2-e per kWh for purchased electricity.

We note that this figure is slightly higher than the *average* carbon dioxide emission factor of 0.119 kgCO2-e per kWh as based on data from the 2014 calendar year (Ministry for the Environment, 2016). Average carbon emissions are calculated using the total carbon emissions and total amount of electricity generated. However, in reality as electricity is saved the reduction in generation is not spread across each generator. The reduction occurs in one plant – the marginal generator. As such the use of a *marginal* carbon dioxide emission factor is more appropriate for determining the impact of an offset or reduction project, because it is designed to take into account the change in electricity generation at the margin.

We have estimated the marginal emissions factor for New Zealand using an average of the current marginal plant (natural gas[1]) and likely future marginal plant (geothermal, wind and solar PV). This estimate is broadly in line with the UNFCC methodology for calculating the emission factor. We acknowledge that currently there are 5 different future scenarios as proposed by MBIE for future energy generation each with different implications for marginal plant, however in general the trend which we are already seeing is a move away from older less efficient technologies (gas and coal) and a move to cheaper and cleaner technologies (geothermal, wind and solar PV).

4.4 Cost of Carbon

The value case uses a very conservative estimate of carbon of NZ$21 per tonne as based on the current market price. The main reason we have used the current carbon price rather than a future price estimate is because, as shown in the next section, the simple payback periods for the 6 and 7 Star value cases are less than 10 years and changes to the carbon market may not come into effect in such a short timeframe. However, it is worth bearing in mind that this is a conservative estimate when interpreting the results

As shown in the figure below carbon prices doubled during 2016 and are forecast to increase further, largely due the phase out of the government one-for-two subsidy. The chart below as taken from the Carbon Forest Services website shows approximate prices of New Zealand Units (NZUs). There currently is a government cap at NZ$25

[1] As Genesis Energy has already announced that its last coal burning generators in Huntly will be closed by the end of 2018, coal has not been included as part of the current marginal plant.

which is due to remain in place until 2021, however recent reporting by the Productivity Commission has noted that for New Zealand to move to a "low-emissions" economy by 2050, the carbon price will need to increase from $21 to between $75 and $152 per tonne; and for New Zealand to go further and reach "net-zero emissions" the price of carbon needs to increase to between $200 and $250 per tonne.

Figure 1: Indicative Carbon Prices - NZUs (Carbon Forest Services, 2018)

5.0 VALUE CASE RESULTS

The tables below show the hard savings made in energy, carbon, water and wastewater as a result of the different sustainability levels identified as 6 Star, 7 Star and 8 Star Homestar in each of the three locations.

Note that the while the savings in water use are the same in all three locations, currently this only results in added hard cost savings in Auckland as neither Wellington nor Christchurch Council charge for water based on volumetric metering and therefore no dollar savings can be made as a result of water saving measures implemented for Homestar. We would expect that in future all local councils would consider a move to volumetric charges.

For the 6 Star cases the annual hard cost savings are broadly similar in all locations at approximately $450-500. There is no significant difference in hard cost savings between the 7 and 8 Star case in any of the locations. For the 7 and 8 Star cases the annual hard cost savings are approximately $2000-2100 in Auckland, $2300-2500 in Wellington and $1600-1800 in Christchurch. We note that these results are based on a set of assumptions on the use of the house that in reality could be quite different depending on how it is used and operated.

Table 12: Potential Homestar energy, carbon and water savings per year

Location	Specification	Energy Savings (kWh/yr)	Carbon Savings (kgCO2/yr)	Water Savings (m3/yr)	Wastewater Savings (m3/yr)
Auckland	NZBC	-	-	-	-
	6 Star	1352.0	256.9	26.1	26.1
	7 Star	7185.4	1365.2	59.5	43.5
	8 Star	7197.8	1367.6	43.5	43.5
Wellington	NZBC	-	-	-	-
	6 Star	1765.0	335.3	26.1	26.1
	7 Star	8719.4	1656.7	59.5	43.5
	8 Star	9280.8	1763.4	43.5	43.5
Christchurch	NZBC	-	-	-	-
	6 Star	1755.6	333.6	26.1	26.1
	7 Star	6047.4	1149.0	59.5	43.5
	8 Star	6630.6	1259.8	43.5	43.5

Table 13: Potential Homestar energy, carbon and water savings per year in monetary terms

Location	Specification	Energy Savings ($/yr)	Carbon Savings ($/yr)	Water Savings ($/yr)	Wastewater Savings ($/yr)	TOTAL SAVINGS ($/yr)
Auckland	NZBC	-	-	-	-	-
	6 Star	355.2	5.4	38.6	66.2	465.4
	7 Star	1887.6	28.7	88.1	110.4	2114.7
	8 Star	1890.9	28.7	64.4	110.4	2094.4
Wellington	NZBC	-	-	-	-	-
	6 Star	463.7	7.0	-	-	470.7
	7 Star	2290.6	34.8	-	-	2325.4
	8 Star	2438.1	37.0	-	-	2475.1
Christchurch	NZBC	-	-	-	-	-
	6 Star	461.2	7.0	-	-	468.2
	7 Star	1588.6	24.1	-	-	1612.8
	8 Star	1741.9	26.5	-	-	1768.3

As noted in the previous section, the value case uses a very conservative estimate of carbon of NZ$21 per tonne. If the carbon price were to increase to $200 per tonne per recent reporting from the Productivity Commission, the total monetary savings would increase by approximately 10-15% across the board or between $50-60 for 6 Star and $200-300 for 7 and 8 Star.

6.0 DISCUSSION ON INDIRECT COSTS / EXTERNALITIES

The value case provided by this report deals only with the direct costs attributed to a typical house and its occupants. There are other indirect costs beyond the site boundary that affect NZ society in general and should also be considered by the government as part of its "guardianship" role. A brief summary of some of the key externalities which are indirectly impacted as a result of credits and categories in the Homestar accreditation framework is given below

Health and Wellbeing

National health statistics show that on average 20 children die and 30,000 are hospitalised every year from preventable, housing-related diseases like asthma, pneumonia and bronchiolitis. There is strong international evidence that effective heating, insulation and ventilation can directly reduce illness, by helping maintain a minimum air temperature; and can indirectly reduce illness by controlling relative humidity, lowering dampness, and inhibiting the growth of mould and fungi. New Zealand-based research has shown that improving housing quality improved self-rated health, self-reported wheezing, days off school and work, fewer visits to general practitioners, and fewer hospital admissions for respiratory conditions; and children with asthma significantly reduced their symptoms, days off school and healthcare visits.

Greenhouse Gases

The Ministry for the Environment estimates a fiscal liability of between $3.5-7.5 billion over the 2021-2030 period in order to meet our Paris commitment. We also note that this figure assumes an international carbon price of $25-50 per tonne which is lower than more recent forecasting predicts. The Commission on Carbon Prices, a group of 13 leading economists supported by the World Bank, report that in order to achieve the Paris Agreement target carbon prices would need increase to US$40-$80 per tonne by 2020 (NZ$60-120), and US$50-$100 per tonne by 2030 (NZ$70-150).

Climate Change

The Insurance Council of New Zealand reports that extreme weather events in 2017 cost over $242m which is five times that reported for 2016. Provisional costs for 2018 are already over $100m.

Droughts are projected to become more frequent and more intense under climate change and represent a significant cost to the agricultural sector of the New Zealand economy. Economic impacts due to notable drought events in recent years include:

- The Treasury estimated the cost of the 2012-13 droughts at 0.7% of GDP, or around $1.5 billion
- The 2007-2008 drought cost the economy approximately $2.8 billion in lost production
- The 1997-98 / 1998-99 droughts cost the economy $618 million (0.9% GDP) and $539 million respectively
- A drought-induced electricity shortage in 1992 caused a drop in GDP of 1.5%

Waste

New Zealand industries and households send over 3 million tonnes of construction and demolition debris to landfills and cleanfills every year. Averaged across the population, this represents about one tonne per person. The current waste disposal levy, as introduced under the Waste Minimisation Act 2008, is $10 per tonne on all waste sent to landfill. Extrapolating from this figure, the cost of construction and demolition waste alone is over $30m per annum.

Transport

New Zealanders have one of the highest vehicle ownership rates in the world, and most of our travel is by car. The emissions released by motor vehicles on the road can be both harmful to the environment and human health, particularly in areas where there are high traffic and congestion rates. The 2012 Health and Air Pollution in New Zealand (HAPINZ) report found that harmful emissions from vehicles cause 256 premature deaths (with social costs of $934 million) annually in New Zealand

Urban Design

Sustainable buildings can also contribute significantly towards urban design. A 2005 report commissioned by the Ministry for the Environment - 'The Value of Urban Design' reached the following broad conclusions about the benefits of urban design in a New Zealand context.

- Good urban design can offer significant benefits to the community; conversely, poor design can have significant adverse effects on the urban environment, society and economy.
- While good urban design sometimes costs more upfront, this is not necessarily the case; moreover, long-term costs can be avoided.
- Communities value the better quality of life that good urban design can deliver.
- Urban design can affect people's ability and willingness to undertake physical exercise: good design can offer health benefits.
- Urban design can help make towns and cities safer and more secure.
- Urban design elements are interconnected: urban design is most effective when a number of elements come together (e.g. mixed use, density and connectivity).
- Ignoring these significant indirect costs and benefits which accrue to society when making decisions about long term investments such as leased government buildings could be considered to be short sighted.

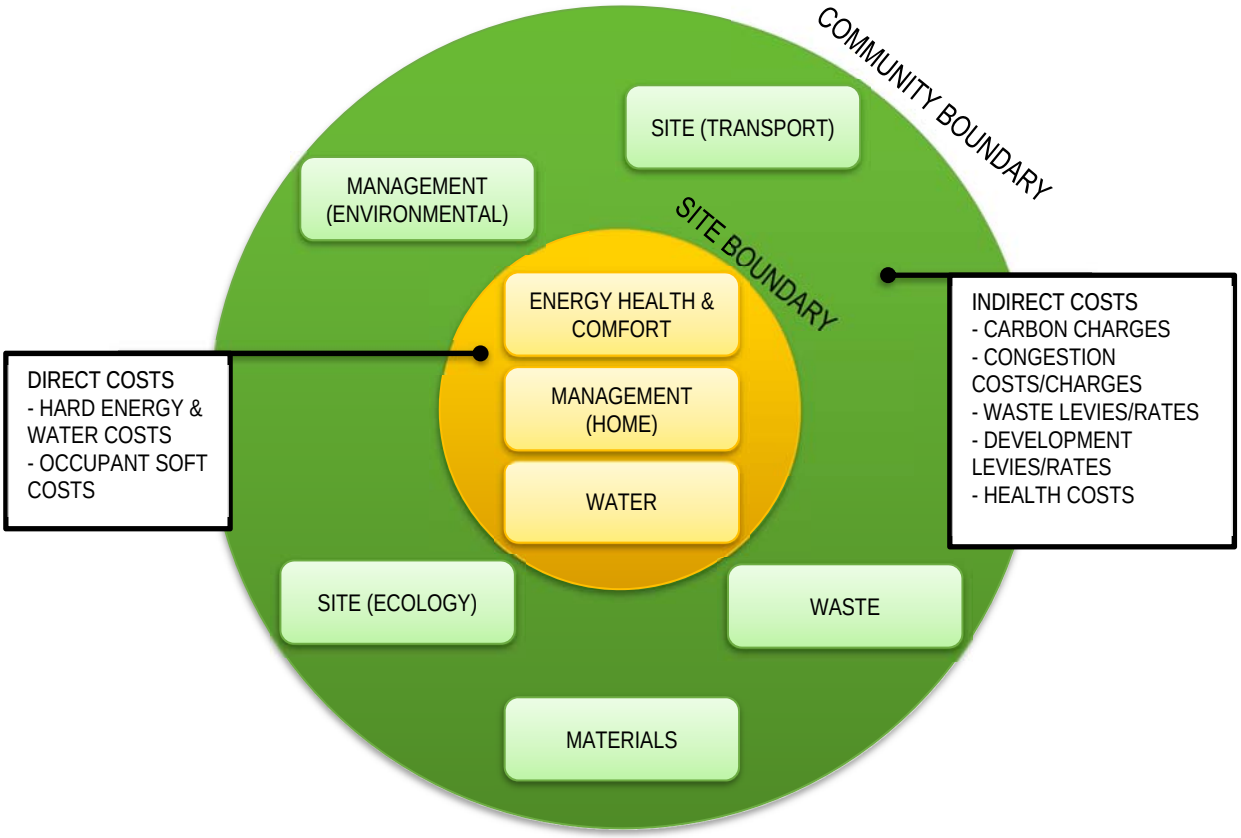

Figure 2: Homestar Categories & Direct and Indirect Costs

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