STUDY REPORT

SR 230 (2010)

Higher Than NZBC Thermal Insulation in New Housing Cost-Benefit Analysis

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Preface

This report examines the costs and benefits of installing insulation at the minimum New Zealand Building Code (Code) level compared to higher than Code levels for new housing. It examines the performance of non-solid timber-framed construction in 16 climate locations throughout New Zealand. Three houses were analysed (small, medium and large, all clay brick, steel roof, concrete slab floor), but the main focus is on the medium-sized house. A variety of heating appliances (back-to-back air-source heat pumps, electric resistance heaters, solid fuel wood burners, night stores, pellet burners and gas) were considered in the analyses. Heat pump, electric, and gas heating types are the focus of the main parts of this report.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for designers, major builders, developers and officials.

Higher Than NZBC Thermal Insulation in New Housing Cost-Benefit Analysis

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Abstract

Thermal modelling was carried out for typical new houses to identify the conditions under which higher than Code “schedule method” insulation levels are cost-effective in new housing. Generally current Code levels are considered cost-optimal, but a number of situations were identified where extra insulation is worthwhile. These included polystyrene insulation under the concrete slab, and the provision of a thermal mass wall with whole-house heating. The type of heating appliance was found to have a significant effect on the cost-effectiveness of additional insulation. The base case heating schedule was 21°C from 5pm to 10pm during winter in the living/family rooms and spaces open to them (i.e. open-plan living, kitchen and dining room).

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1. SUMMARY

This report examines the costs and benefits of installing insulation at the minimum Code level compared to higher than Code levels for new housing. The base case is the insulation levels as set out in the schedule method in NZBC Acceptable Solution H1/AS1. This work examines the performance of non-solid construction in 16 climate locations throughout New Zealand. Three houses were analysed (small, medium, and large and all clay brick, steel roof, concrete slab floor), but the main focus is on the medium-sized house.

Insulation combination levels are detailed in Table 1 and Table 2 as follows:

- Insulation Level 1 ("Level 1") in Climate Zones 1 and 2 is equivalent to the minimum Code insulation requirements
- Level 1 in Climate Zone 3 is slightly above minimum Code insulation with the floor above minimum Code (minimum Code is plain concrete slab), and Level 1 in Climate Zone 3 is equivalent to Level 2 in Climate Zone 1 and 2.

In 2009 for the South Island, about half of all concrete slab floor houses had some kind of polystyrene insulation installed under the slab (BRANZ 2009). Here lies the reason for modelling Level 1 in Zone 3 with 50 mm EPS polystyrene perimeter insulation under the slab instead of just plain concrete slab. R-4.5 in wall insulation is considered a potential upper limit in R-values using high-density technology. Note R-values are insulation material R-values.

Table 1. Zone 1 and 2 insulation combinations (North Island apart from Taupo)

Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
Level 1	90mm stud wall plain slab	2.2	3.2
Level 2	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 3	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 4	50mm eps full cover	2.8	4.6
Level 5	100mm eps full cover	4.5	5

Table 2. Zone 3 insulation combinations (South Island and Taupo)

Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
Level 1	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 2	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 3	50mm eps full cover	2.8	4.6
Level 4	100mm eps full cover	4.5	5

The main results are shown in Table 3, where Level 2 and above are insulation levels above minimum Code. The net financial benefits depend on a number of factors including the type of heating, and how much of the house is heated.

Table 3. Main findings of medium-sized house

Medium house cost benefit summary against base case "insulation level 1 without thermal mass wall"					
		Below are insulation levels more cost effective than base case "insulation level 1 without thermal mass wall"			
Heating appliance	**Climate Zone**	**Part house heated (level 1 is *without* thermal wall)**	**Part house heated with thermal mass wall (level 1 is *with* thermal wall)**	**Entire house heated (level 1 is *without* thermal wall)**	**Entire house heated with thermal mass wall (level 1 is *with* thermal wall)**
Electric resistance (Winter heating)	**Zone 1**	level 2	none	levels 2 to 4	levels 1 to 4
	Zone 2	levels 2 and 3 Rotorua: levels 2 to 4	level 2 Rotorua: levels 2 to 3	All levels	All levels
	Zone 3	none	none	none	Taupo, West Coast, Christchurch: levels 1 to 2 Lower SI: levels 1 to 3 Nelson: none
Heat Pump (Summer cooling and Winter heating)	**Zone 1**	none	none	levels 2 to 3	levels 1 to 3
	Zone 2	Rotorua, Hamilton, Wellington: level 2 Other Zone 2: none	none	Rotorua, Hamilton, Wellington: levels 2 to 4 Other Zone 2: levels 2 to 3	Rotorua, Hamilton, Wellington: levels 1 to 4 Other Zone 2: levels 1 to 3
	Zone 3	none	none	none	Central Otago, Cromwell: levels 1 to 2 Other Zone 3: level 1
Gas (Winter heating) Natural gas in North LPG gas in South	**Zone 1 (Natural Gas)**	level 2	none	Auckland: levels 2 to 4 Northland: levels 2 to 3	levels 1 to 3
	Zone 2 (Natural Gas)	level 2 Rotorua: levels 2 to 3	Rotorua: level 1 Other Zone 2: none	levels 2 to 4 Rotorua: All levels	levels 1 to 4 Rotorua: All levels
	Zone 3 (LPG)	none	none	none	Lower SI, Christchurch: levels 1 to 3 West Coast: levels 1 to 2 Taupo: level 1 Nelson: none
The above table shows the net financial benefits of insulation level designs (Levels 2 to 5) against base Level 1 for a specific medium-sized house (brick veneer walls, steel roof and timber framing). Options considered are:					
1. The default heating case was partial house heating referred to as "Heated Area 1". These are the living/family room and any spaces open to this room (i.e. open-plan living, kitchen and dining room).					
2. Entire house heating is referred to as "Heated Area 2". These are the living/family room and spaces open to this room (i.e. open-plan living, kitchen and dining room), and bedrooms, hallways.					
3. The medium house has a built-in thermal mass wall as an option for both Heated Area 1 and Heated Area 2. The wall covers the interior walls inside the living room, with orientation of the living room facing north for optimal solar exposure....					
.... to maximise solar gains. This scenario has two insulation Level 1's (Level 1 without thermal mass wall and Level 1 with thermal mass wall). Benefit-cost ratios are against the base case which is Level 1 without the thermal mass wall.					
Other parameters:					
Heating at 21 degrees celcius over winter (Apr to Oct) from 5pm to 10pm, Heat pump cooling at 19 degrees celcius over summer (Dec to Feb) from 9am to 4pm					
Orientation is North facing sun, 241sqm house					
Economic analysis: 30 year period, 5% discount rate, 1 % escalation rate					

The main conclusions are:

- EPS polystyrene insulation under concrete floor insulation is the main energy savings contributor and higher wall and ceiling insulation make minimal difference for this particular designed house (medium house). This explains why without a thermal mass wall, Climate Zone 1 and 2 regions (with its base case as Level 1 which is plain concrete slab) had cost-effective options above the base case, and how Zone 3 regions had no cost-effective options above the base case.
- Thermal mass wall is-cost effective when the whole house is heated, but not partly-heated. Partly-heated with this wall consumes more energy than without it, whereas entirely heated with this wall consumes less energy than without it. The initial cost of the thermal mass wall was low-cost, therefore not having too much effect on the total initial costs which are mainly insulation costs.
- With heat pump heating, more insulation is cost-effective in only a few situations because energy costs are lower

Part-house heating

- Under this heating arrangement with either electric or gas heating, it is cost-beneficial to design at Level 2 for Zones 1 and 2.
- Heat pumps are only marginally cost-effective in Rotorua, Hamilton and Wellington (benefit-cost ratios just above 1.0). New Plymouth and East Coast were very close with ratios between 0.90 to 0.99.
- It is cost-beneficial designing at Levels 2 to 4 in Zone 3 due to small proportional energy savings and higher insulation costs compared with Level 1 for these options.

Whole-house heating

- Under this heating arrangement in Zones 1 and 2 under any of electric, heat pump or gas heating, it is cost-beneficial to design at Levels 2 or 3 and some at Levels 4 and 5. Zone 3 shows that no insulation options above Level 1 are cost-effective.
- About twice as much energy is used when heating the entire house than heating part of the house. This means larger margins/differences between energy costs of Levels 2 to 5 against Level 1. This overall has resulted in increasing the cost ratios, therefore more cost-beneficial insulation options.
- It is not cost-beneficial designing at Levels 2 to 4 in Zone 3 due to small proportional energy savings and higher insulation costs compared with Level 1 for these options.

Part-house heating with thermal mass wall

- Apart from Rotorua, heating with either gas or electric, this option is not cost-beneficial as energy consumption rises up by 3-20% with the thermal wall when the house is partly-heated. This can be explained by the thermal mass requiring a certain amount of energy to heat it up. When heating only part of the house, the rear of the wall is facing onto cooler temperatures, thus leading to heat being lost out the back and cooling being transferred into the heated areas. This would not happen to the same degree with a hollow internal wall, as the air gap acts like insulation. The thermal wall is not cost-effective if heating only part of the house. The better option is not to have a thermal mass wall if heating part of the house.

Whole-house heating with thermal mass wall

- Apart from in Nelson heated with either gas or electric heating, this option is cost-effective as energy consumption decreases by 5-16% with the thermal wall when the house is entirely heated. The thermal wall acts as a temperature moderator. With high enough insulation, the thermal wall will maintain the temperatures of the spaces backing onto it, releasing the heat slowly when active heating is removed. This then reduces the size of the increase in temperature required to get it back up to temperature when heating is turned back on. Note that this may not be as effective if the heating is only done for short periods. The thermal wall is cost-effective if heating the entire house.

2. INTRODUCTION

This report examines the costs and benefits of having greater insulation levels for three different-sized new house designs (clay brick veneer wall cladding, corrugated steel roof, slab foundation). These houses were modelled for:

- thermal performance (using thermal performance modelling software SUNREL, refer to Appendix 1); and
- their costs of insulation and energy use during winter heating and summer cooling (summer cooling only if heating appliance is heat pump).

The main focus is analysis on the medium-sized house.

A variety of heating appliances (back-to-back air-source heat pumps, electric resistance heaters, solid fuel wood burners, night stores, pellet burners and gas) were considered in the analyses. Heat pump, electric and gas heating types are the focus of the main parts of this report. Electric resistance heaters in new housing are not as common as the other forms of heating, but they gave the higher cost-benefits due to their higher energy cost rates. Heat pump and gas are the most common types of heating. Benefit-cost ratios and Present Values (PVs) of the main heating appliances analysed and the other types of heating are in Appendix 2.

Throughout the report, Level 1 in Zones 1 and 2 is equivalent to Code insulation minimum requirements. However Level 1 in Zone 3 (equivalent to Level 2 in Zones 1 and 2) is slightly above Code insulation, with the floor type above Code (minimum Code is plain concrete slab).

Analysis in this report covers the cost-benefits of insulation level designs (Levels 2 to 5) against Level 1 under the heated area arrangement and thermal mass wall scenarios:

1. All three different-sized houses are only partly-heated (referred to as Heated Area 1). These are the living/family room and any spaces open to this room (e.g. often the kitchen and dining room in new houses).
2. The medium house is entirely heated (referred to as Heated Area 2). These are the living/family room and spaces open to this room (i.e. open-plan living, kitchen and dining room) and bedrooms, hallways.
3. The medium house has a built-in thermal mass wall in the initial design for both “Heated Area 1” and “Heated Area 2”. The analysis of this scenario changes the insulation combinations to those set out in Table 4 below.

Table 4. Zone 1 and 2 insulation combinations – thermal mass wall

Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
level 1 (no thermal wall)	90mm stud wall plain slab	2.2	3.2
Level 1 (with thermal wall)	90mm stud wall plain slab	2.2	3.2
Level 2 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 3 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 4 (with thermal wall)	50mm eps full cover	2.8	4.6
Level 5 (with thermal wall)	100mm eps full cover	4.5	5

Table 5. Zone 3 insulation combinations – thermal mass wall

Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
level 1 (no thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 1 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 2 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 3 (with thermal wall)	50mm eps full cover	2.8	4.6
Level 4 (with thermal wall)	100mm eps full cover	4.5	5

Note: Scenarios 2 and 3 were reduced to medium house analysis due to project constraints.

The houses were modelled with the following as base case parameters:

- Insulation at Level 1. In Zones 1 and 2, this is the insulation level of minimum requirements as set out in H1/AS1. In Zone 3, Level 1 is slightly above minimum Code insulation; with the floor R-value above Code (Code is plain concrete slab).
- Heating regime for all heating appliances set in the evening at 21°C over winter (referred to as "Eve21" in parameter tables). Heat pump has extra summer cooling during the day over summer at 19°C (referred to as "Day19, Eve21" in parameter tables). The winter period is from April to October, whereas the summer period is from December to February. Over winter, house heating starts from 5pm until 10pm. Over summer, cooling with heat pump starts at 9am until 4pm.
- Economic analysis over a period of 30 years, with discount rate of 5% per annum, energy escalation at 1% per annum.
- Orientation of living/family room facing north for optimal solar exposure to maximise solar gains.

The house model variables can be defined by the parameter table below:

Variable	Options
House type(s)	Small, Medium, Large
Schedule	Eve21 or Eve22 for all heaters apart from heat pump. For Heat pump: Summer (Day19,Eve21) or (Day20,Eve22)
Heated area	1 or 2
Themal Mass wall?	None or Yes
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	N, NE, E, SE, S, SW, W, NW
Heater	Electric, Nitestor, Gas, Pellets, Solid fuel, Heat pump

The selected options on the right-hand column are the ones analysed/simulated.

Throughout this report in the cost-benefit ratio tables, highlighted pink areas are benefit-cost ratios of greater than 1.0, meaning the insulation level is more cost-effective than the initial design of a house with Insulation Level 1. Cost-benefit ratios are explained in Section 4: "Method: Present Value (PV) and Benefit-Cost Ratio".

For the basic house designs, pricing on insulation and appliances, assumptions, parameters, thermal performance modelling software and references refer to Appendix 1.

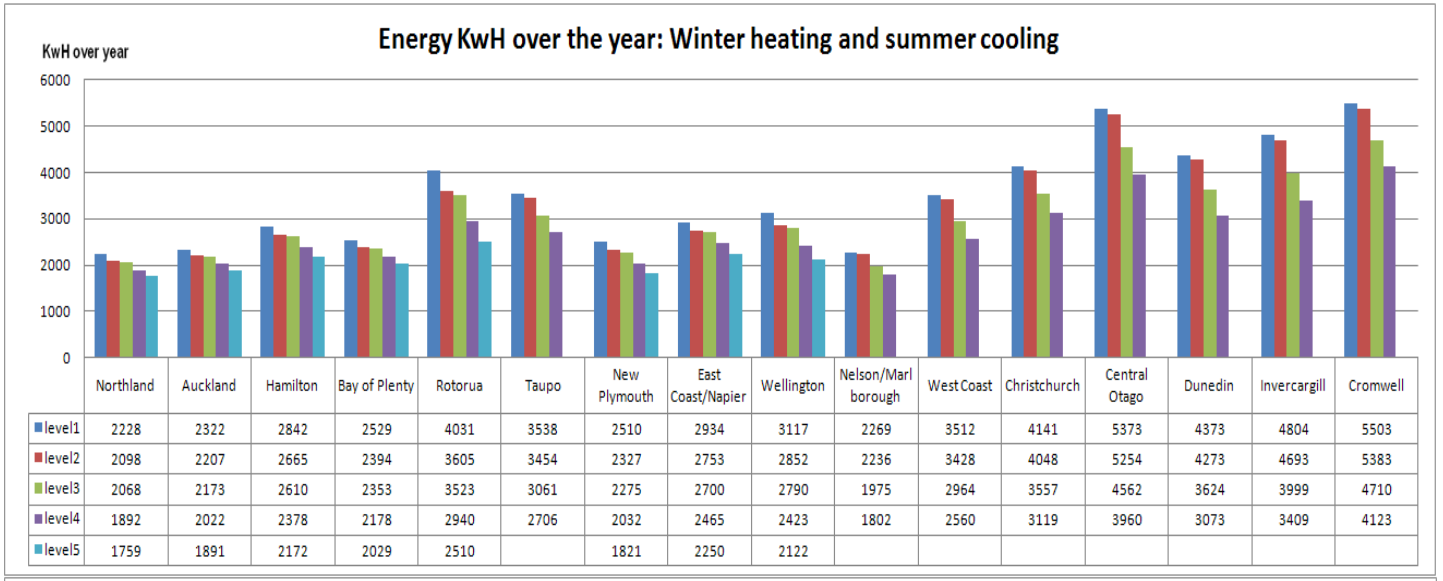
3. MAIN RESULTS

3.1 Part-house heating Heated Area 1 results – all three house types

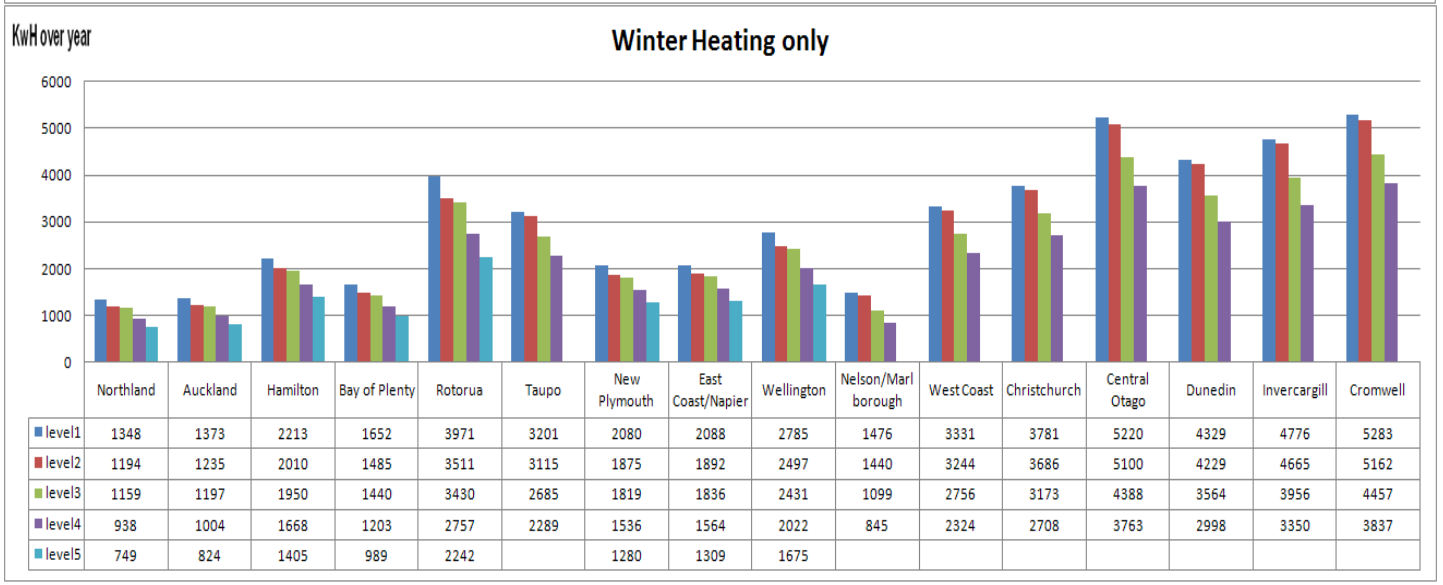
What are the cost-benefits of above Level 1 options for part-house heating Heating Area 1? (This is the living or family room and any spaces open to this room, e.g. open-plan living, kitchen and dining room.) Below shows the three house types with the parameters modelled.

House model parameters

Variable	Options selected
House type(s)	Small, Medium, Large
Schedule	Eve21 for all heaters apart from heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	1
Themal Mass wall?	None
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Nitestor, Gas, Pellets, Solid fuel, Heat pump

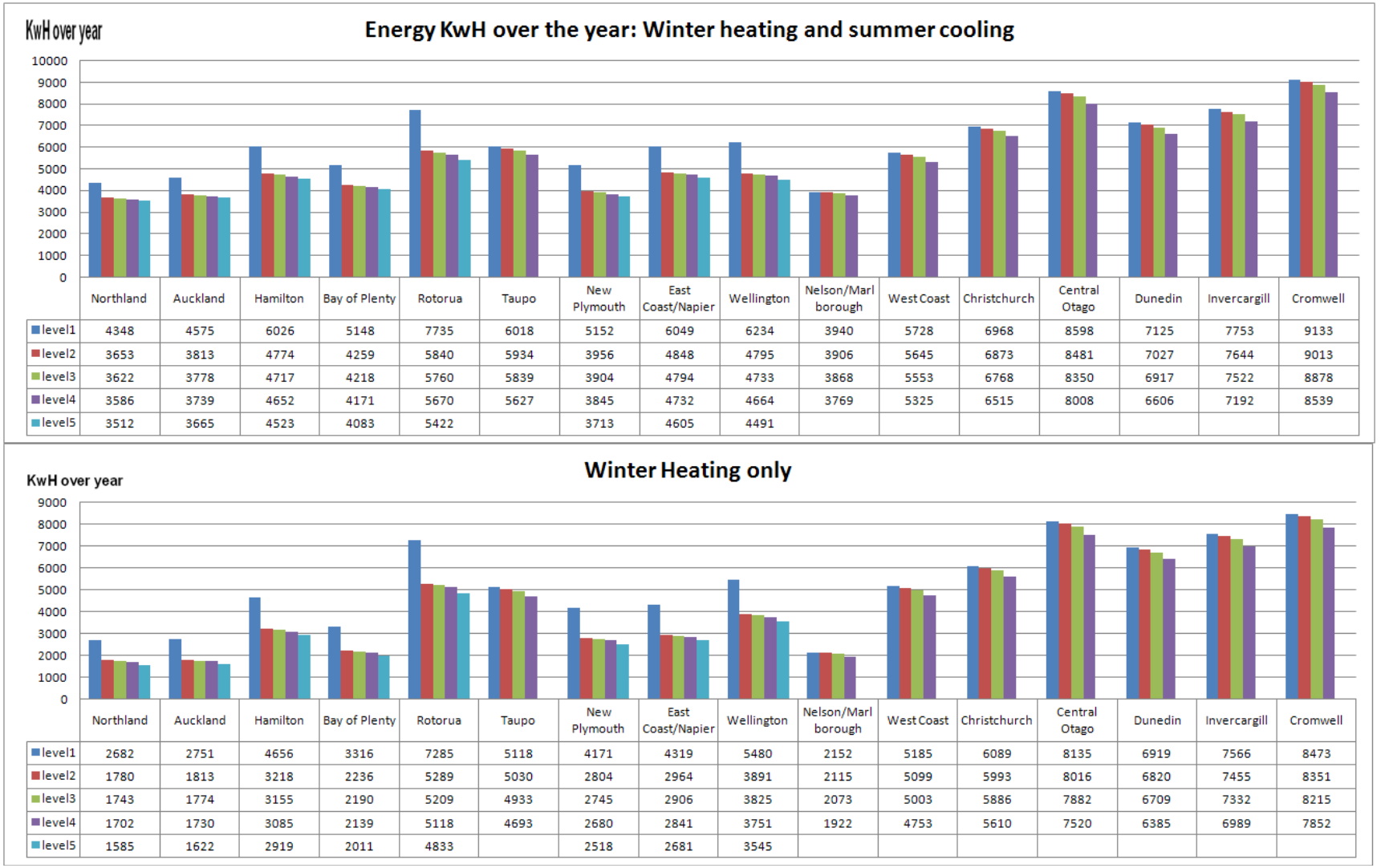


	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	2228	2322	2842	2529	4031	3538	2510	2934	3117	2269	3512	4141	5373	4373	4804	5503
level2	2098	2207	2665	2394	3605	3454	2327	2753	2852	2236	3428	4048	5254	4273	4693	5383
level3	2068	2173	2610	2353	3523	3061	2275	2700	2790	1975	2964	3557	4562	3624	3999	4710
level4	1892	2022	2378	2178	2940	2706	2032	2465	2423	1802	2560	3119	3960	3073	3409	4123
level5	1759	1891	2172	2029	2510		1821	2250	2122							



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	1348	1373	2213	1652	3971	3201	2080	2088	2785	1476	3331	3781	5220	4329	4776	5283
level2	1194	1235	2010	1485	3511	3115	1875	1892	2497	1440	3244	3686	5100	4229	4665	5162
level3	1159	1197	1950	1440	3430	2685	1819	1836	2431	1099	2756	3173	4388	3564	3956	4457
level4	938	1004	1668	1203	2757	2289	1536	1564	2022	845	2324	2708	3763	2998	3350	3837
level5	749	824	1405	989	2242		1280	1309	1675							

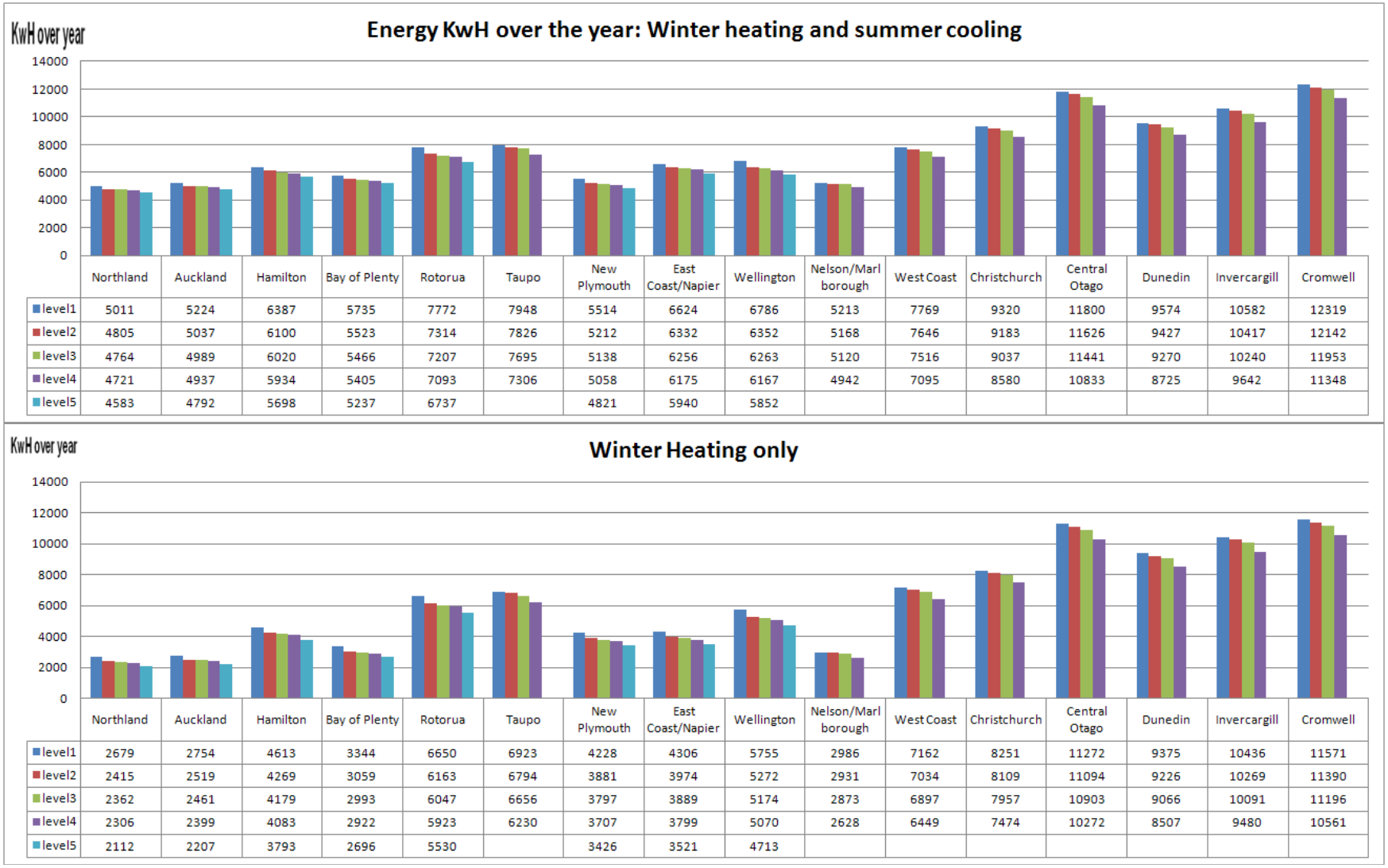
Figure 1. Small house energy usage over a year – part-house heating without thermal mass wall



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	4348	4575	6026	5148	7735	6018	5152	6049	6234	3940	5728	6968	8598	7125	7753	9133
level2	3653	3813	4774	4259	5840	5934	3956	4848	4795	3906	5645	6873	8481	7027	7644	9013
level3	3622	3778	4717	4218	5760	5839	3904	4794	4733	3868	5553	6768	8350	6917	7522	8878
level4	3586	3739	4652	4171	5670	5627	3845	4732	4664	3769	5325	6515	8008	6606	7192	8539
level5	3512	3665	4523	4083	5422		3713	4605	4491							

	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	2682	2751	4656	3316	7285	5118	4171	4319	5480	2152	5185	6089	8135	6919	7566	8473
level2	1780	1813	3218	2236	5289	5030	2804	2964	3891	2115	5099	5993	8016	6820	7455	8351
level3	1743	1774	3155	2190	5209	4933	2745	2906	3825	2073	5003	5886	7882	6709	7332	8215
level4	1702	1730	3085	2139	5118	4693	2680	2841	3751	1922	4753	5610	7520	6385	6989	7852
level5	1585	1622	2919	2011	4833		2518	2681	3545							

Figure 2. Medium house energy usage over a year – part-house heating without thermal mass wall



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	5011	5224	6387	5735	7772	7948	5514	6624	6786	5213	7769	9320	11800	9574	10582	12319
level2	4805	5037	6100	5523	7314	7826	5212	6332	6352	5168	7646	9183	11626	9427	10417	12142
level3	4764	4989	6020	5466	7207	7695	5138	6256	6263	5120	7516	9037	11441	9270	10240	11953
level4	4721	4937	5934	5405	7093	7306	5058	6175	6167	4942	7095	8580	10833	8725	9642	11348
level5	4583	4792	5698	5237	6737		4821	5940	5852							

	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	2679	2754	4613	3344	6650	6923	4228	4306	5755	2986	7162	8251	11272	9375	10436	11571
level2	2415	2519	4269	3059	6163	6794	3881	3974	5272	2931	7034	8109	11094	9226	10269	11390
level3	2362	2461	4179	2993	6047	6656	3797	3889	5174	2873	6897	7957	10903	9066	10091	11196
level4	2306	2399	4083	2922	5923	6230	3707	3799	5070	2628	6449	7474	10272	8507	9480	10561
level5	2112	2207	3793	2696	5530		3426	3521	4713							

Figure 3. Large house energy usage over a year – part-house heating without thermal mass wall

Tables 6 and 7 show cost-benefit ratios of “Insulation Levels 2 and 3” against “Insulation Level 1” of the houses under ‘electric heating’ and ‘gas’. Highlighted pink areas are benefit-cost ratios of greater than 1.0, meaning the insulation level is more cost-effective than the base design of the house (i.e. “Insulation Level 1”).

Table 6. Part-house heating – benefit-cost ratios at Levels 2 and 3 under electric heating

Part house heating, benefit cost ratio of Insulation level 2 and 3				
Electric			House Type	
Region	Insulation level	SMALL	MEDIUM	LARGE
Northland	level2	0.8	2.0	0.6
	level3	0.4	0.9	0.3
Auckland	level2	0.7	2.1	0.5
	level3	0.4	1.0	0.3
Hamilton	level2	1.0	3.2	0.8
	level3	0.6	1.5	0.4
Bay of Plenty	level2	0.8	2.4	0.6
	level3	0.5	1.1	0.3
Rotorua	level2	2.3	4.5	1.1
	level3	1.2	2.1	0.6
Taupo	level2	0.3	0.2	0.2
	level3	0.9	0.2	0.1
New Plymouth	level2	1.0	3.1	0.8
	level3	0.6	1.4	0.4
East Coast/Napier	level2	0.998	3.1	0.7
	level3	0.6	1.4	0.4
Wellington	level2	1.5	3.6	1.1
	level3	0.8	1.6	0.6
Nelson/Marlborough	level2	0.1	0.1	0.1
	level3	0.6	0.0	0.1
West Coast	level2	0.3	0.1	0.2
	level3	0.9	0.1	0.2
Christchurch	level2	0.3	0.2	0.2
	level3	0.9	0.1	0.2
Central Otago	level2	0.5	0.2	0.3
	level3	1.4	0.2	0.2
Dunedin	level2	0.4	0.2	0.3
	level3	1.3	0.1	0.2
Invercargill	level2	0.4	0.2	0.3
	level3	1.4	0.2	0.2
Cromwell	level2	0.5	0.2	0.3
	level3	1.4	0.2	0.2

Table 7. Part-house heating – benefit-cost ratios at Levels 2 and 3 under gas heating

Part house heating, benefit cost ratio of Insulation level 2 and 3				
Gas Heater			House Type	
Region	Insulation level	SMALL	MEDIUM	LARGE
Northland	level2	0.4	1.0	0.3
	level3	0.2	0.5	0.2
Auckland	level2	0.4	1.1	0.3
	level3	0.2	0.5	0.2
Hamilton	level2	0.5	1.7	0.4
	level3	0.3	0.8	0.2
Bay of Plenty	level2	0.4	1.3	0.3
	level3	0.2	0.6	0.2
Rotorua	level2	1.2	2.3	0.6
	level3	0.6	1.1	0.3
Taupo	level2	0.2	0.1	0.1
	level3	0.4	0.1	0.1
New Plymouth	level2	0.5	1.6	0.4
	level3	0.3	0.7	0.2
East Coast/Napier	level2	0.5	1.6	0.4
	level3	0.3	0.7	0.2
Wellington	level2	0.8	1.9	0.6
	level3	0.4	0.8	0.3
Nelson/Marlborough	level2	0.2	0.1	0.1
	level3	0.7	0.1	0.1
West Coast	level2	0.4	0.2	0.3
	level3	1.1	0.1	0.2
Christchurch	level2	0.4	0.2	0.3
	level3	1.2	0.2	0.2
Central Otago	level2	0.5	0.2	0.4
	level3	1.6	0.2	0.3
Dunedin	level2	0.4	0.2	0.3
	level3	1.5	0.2	0.2
Invercargill	level2	0.5	0.2	0.3
	level3	1.6	0.2	0.3
Cromwell	level2	0.5	0.2	0.4
	level3	1.6	0.2	0.3

Under electrical heating

- The small house with insulation at Level 2 is cost-effective in most Zone 2 regions. For the lower South Island (Central Otago, Cromwell, Invercargill, Dunedin), Level 3 is more cost-effective than Level 1, mainly because energy savings per year at Level 3 compared with base case Level 1 (15-18%) were much greater than energy savings at Level 2 with base case Level 1 (2%).
- The medium house with insulation at Level 2 and/or 3 is cost-effective in the north apart from Taupo which is a Zone 3 region.
- The large house only shows Rotorua and Wellington with cost-benefits at Level 2.
- Wellington and Rotorua were cost-effective for all houses at Level 2.

Under gas heating

- The small house with insulation at Level 2 is cost-effective only for Rotorua. For the lower south island (Central Otago, Cromwell, Invercargill, Dunedin), Level 3 is more cost-effective than Level 1, mainly due to energy savings per year at Level 3 compared with base case Level 1 (15-18%) were much greater than energy savings at Level 2 with base case Level 1 (2%). The medium house with insulation at Level 2 is cost-effective in the north apart from Taupo which is a Zone 3 region.
- No cost-benefits against Level 1 were found for the large house.

In general

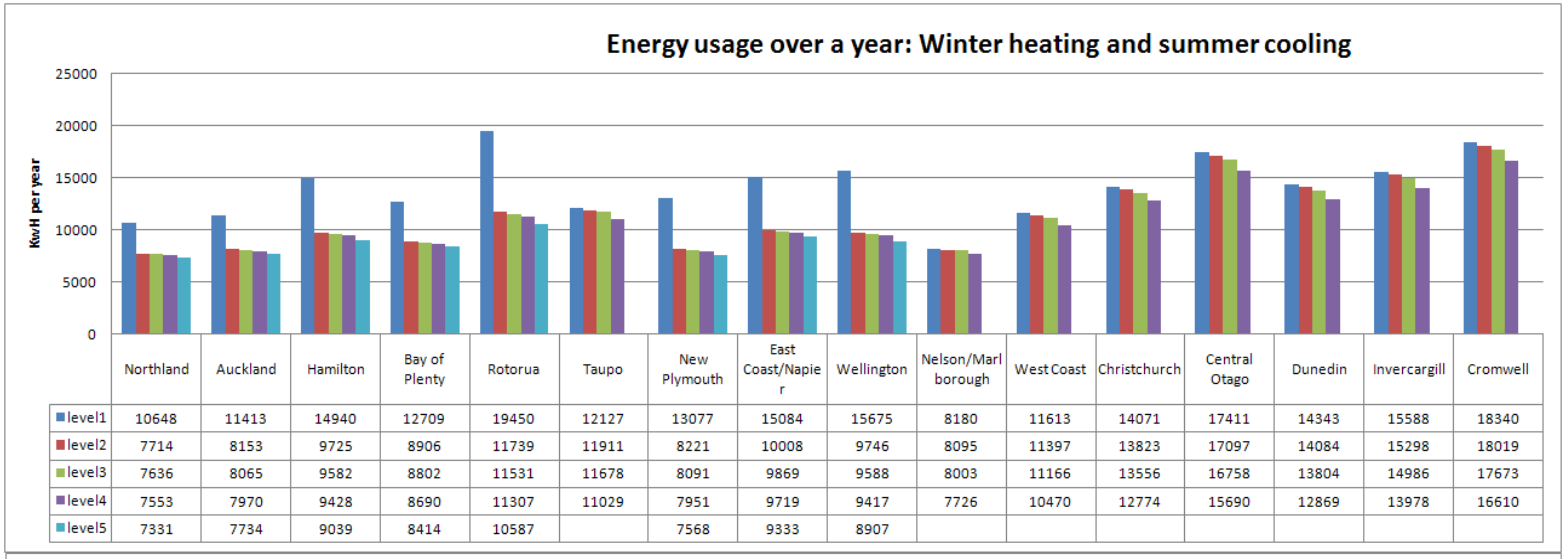
- Although heat pumps are the most common heaters, extra insulation is not cost-effective (even including summer cooling energy savings) except in Hamilton, Rotorua and Wellington. Hamilton and Rotorua have colder winters, and Wellington has high wind speeds. Refer to Appendix 2 Sections 10.1.2, 10.1.8, 10.1.14.
- In most cases, it is not cost-beneficial designing houses at Levels 4 and 5.
- In most cases, it is not cost-beneficial designing at above Level 1 for houses in Zone 3 due to small proportional energy savings and higher insulation costs compared with Level 1 for these options.

3.2 Entire house heating Heated Area 2 results – medium house

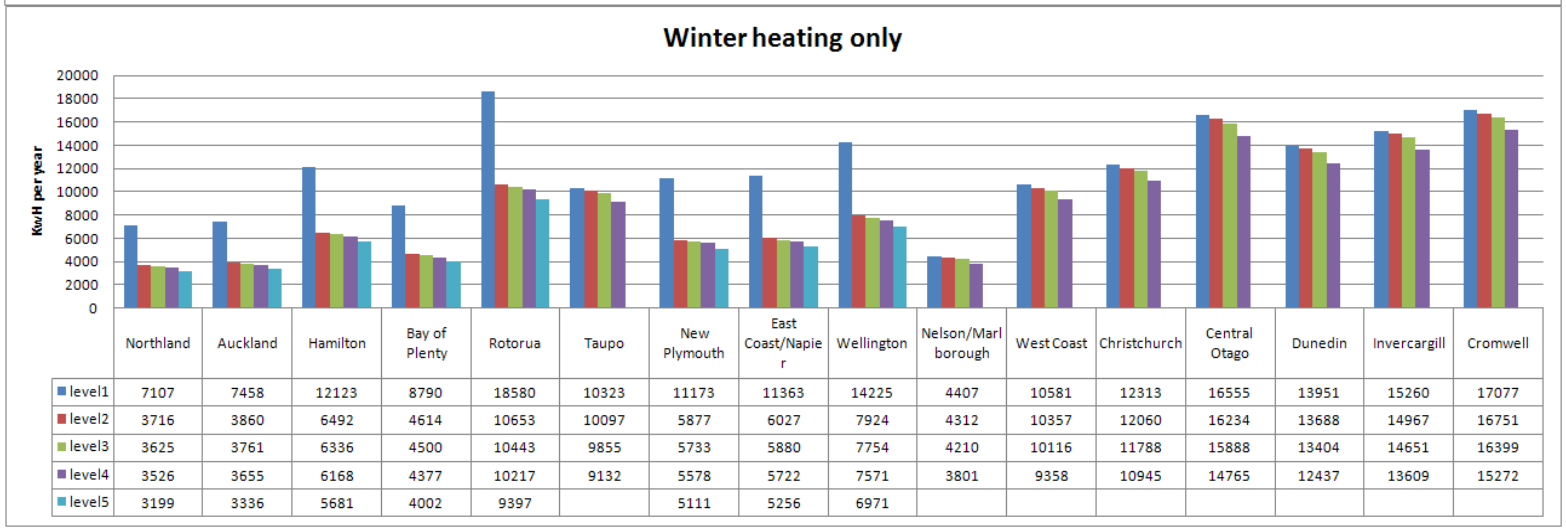
What are the cost-benefits of above Level 1 options for entire house heating Heating Area 2? (This is the living and/or family rooms and spaces open to this room, bedrooms, kitchen, dining, hallways.) See below which shows the medium house with the parameters modelled.

House model parameters

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	2
Themal Mass wall?	None
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Heat pump, Gas



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	10648	11413	14940	12709	19450	12127	13077	15084	15675	8180	11613	14071	17411	14343	15588	18340
level2	7714	8153	9725	8906	11739	11911	8221	10008	9746	8095	11397	13823	17097	14084	15298	18019
level3	7636	8065	9582	8802	11531	11678	8091	9869	9588	8003	11166	13556	16758	13804	14986	17673
level4	7553	7970	9428	8690	11307	11029	7951	9719	9417	7726	10470	12774	15690	12869	13978	16610
level5	7331	7734	9039	8414	10587		7568	9333	8907							



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	7107	7458	12123	8790	18580	10323	11173	11363	14225	4407	10581	12313	16555	13951	15260	17077
level2	3716	3860	6492	4614	10653	10097	5877	6027	7924	4312	10357	12060	16234	13688	14967	16751
level3	3625	3761	6336	4500	10443	9855	5733	5880	7754	4210	10116	11788	15888	13404	14651	16399
level4	3526	3655	6168	4377	10217	9132	5578	5722	7571	3801	9358	10945	14765	12437	13609	15272
level5	3199	3336	5681	4002	9397		5111	5256	6971							

Figure 4. Medium house energy usage over a year – entire house heating without thermal mass wall

Tables 8, 9, 10 below show cost-benefit ratios against Level 1 of the medium house under electric heating, heat pump, gas heater for heating the entire house Heated Area 2.

Table 8. Entire house heating – benefit-cost ratios at Levels 2 and 3 under electric heating

Entire house heating benefit cost ratios Electric Heater Region	Insulation level level2	level3	level4	level5
Northland	7.6	3.4	1.8	0.9
Auckland	8.0	3.7	1.9	0.9
Hamilton	12.6	5.7	3.0	1.5
Bay of Plenty	9.3	4.2	2.2	1.1
Rotorua	17.7	8.1	4.3	2.1
Taupo	0.4	0.3	0.3	n/a
New Plymouth	12.0	5.4	2.9	1.4
East Coast/Napier	12.1	5.4	2.9	1.4
Wellington	14.2	6.4	3.4	1.7
Nelson/Marlborough	0.2	0.1	0.1	n/a
West Coast	0.4	0.3	0.3	n/a
Christchurch	0.4	0.3	0.3	n/a
Central Otago	0.6	0.5	0.5	n/a
Dunedin	0.5	0.4	0.4	n/a
Invercargill	0.5	0.4	0.4	n/a
Cromwell	0.6	0.5	0.5	n/a

Table 9. Entire house heating – benefit-cost ratios of all levels under heat pump

Entire house heating benefit cost ratios Heat Pump Region	Insulation level level2	level3	level4	level5
Northland	2.3	1.1	0.6	0.3
Auckland	2.6	1.2	0.6	0.3
Hamilton	4.2	1.9	1.0	0.5
Bay of Plenty	3.0	1.4	0.7	0.4
Rotorua	6.2	2.8	1.5	0.7
Taupo	0.1	0.1	0.1	n/a
New Plymouth	3.9	1.8	0.9	0.5
East Coast/Napier	4.1	1.8	1.0	0.5
Wellington	4.8	2.1	1.2	0.6
Nelson/Marlborough	0.0	0.0	0.0	n/a
West Coast	0.1	0.1	0.1	n/a
Christchurch	0.1	0.1	0.1	n/a
Central Otago	0.2	0.2	0.2	n/a
Dunedin	0.2	0.1	0.1	n/a
Invercargill	0.2	0.1	0.2	n/a
Cromwell	0.2	0.2	0.2	n/a

Table 10. Entire house heating – benefit-cost ratios of all levels under gas heating

Entire house heating benefit cost ratios Gas Heater Region	Insulation level level2	level3	level4	level5
Northland	3.9	1.8	0.9	0.5
Auckland	4.2	1.9	1.0	0.5
Hamilton	6.5	3.0	1.6	0.8
Bay of Plenty	4.8	2.2	1.2	0.6
Rotorua	9.2	4.2	2.2	1.1
Taupo	0.2	0.2	0.2	n/a
New Plymouth	6.2	2.8	1.5	0.7
East Coast/Napier	6.2	2.8	1.5	0.7
Wellington	7.4	3.3	1.8	0.9
Nelson/Marlborough	0.2	0.1	0.2	n/a
West Coast	0.4	0.4	0.4	n/a
Christchurch	0.5	0.4	0.4	n/a
Central Otago	0.6	0.5	0.5	n/a
Dunedin	0.5	0.4	0.4	n/a
Invercargill	0.6	0.5	0.5	n/a
Cromwell	0.7	0.5	0.5	n/a

Under electrical heating

- For Zone 1 regions, there are cost-benefits for all levels apart from Level 5 design
- For Zone 2 regions, there are cost-benefits for all levels
- For Zone 3 regions, there are no cost-benefits

Under heat pump

- For Zone 1 regions, there are cost-benefits at Levels 2 and 3
- For Zone 2 regions, there are cost-benefits at Levels 2 and 3 and some at Level 4
- For Zone 3 regions, there are no cost-benefits

Under gas heating

- For Zone 1 regions, there are cost-benefits at Levels 2, 3 and Auckland at Level 4
- For Zone 2 regions, there are cost-benefits at Levels 2, 3 and Rotorua at Level 4
- For Zone 3 regions, there are no cost-benefits

In general

- Over winter, Heated Area 2 consumes about twice the amount energy as Heated Area 1 due to the extra space heated
- Larger margins/differences between energy costs of Levels 2 to 5 against Level 1. This overall has resulted in increased benefit-cost ratios
- In most cases, it is not cost-beneficial designing at Levels 2 to 4 for houses in Zone 3 due to small proportional energy savings and higher insulation costs compared with Level 1 for these options.

3.3 Thermal mass wall – medium house

What are the cost-benefits against Level 1 if a thermal mass wall is included in the initial design of the medium house with electrical heating, heat pump, or gas? The wall covers the interior walls inside the living room, starting from the sitting room outer wall continuing along through to the study room outer wall. Orientation of the living room is facing north for optimal solar exposure to maximise solar gains. Refer to Appendix 1 for further details on extra costs for thermal mass wall. The tables below show the new insulation options.

Please note that as mentioned before there are two Level 1 options: Level 1 *without* thermal mass wall and Level 1 *with* thermal mass wall.

Insulation combinations in floor, wall and ceiling for houses in Zones 1 and 2

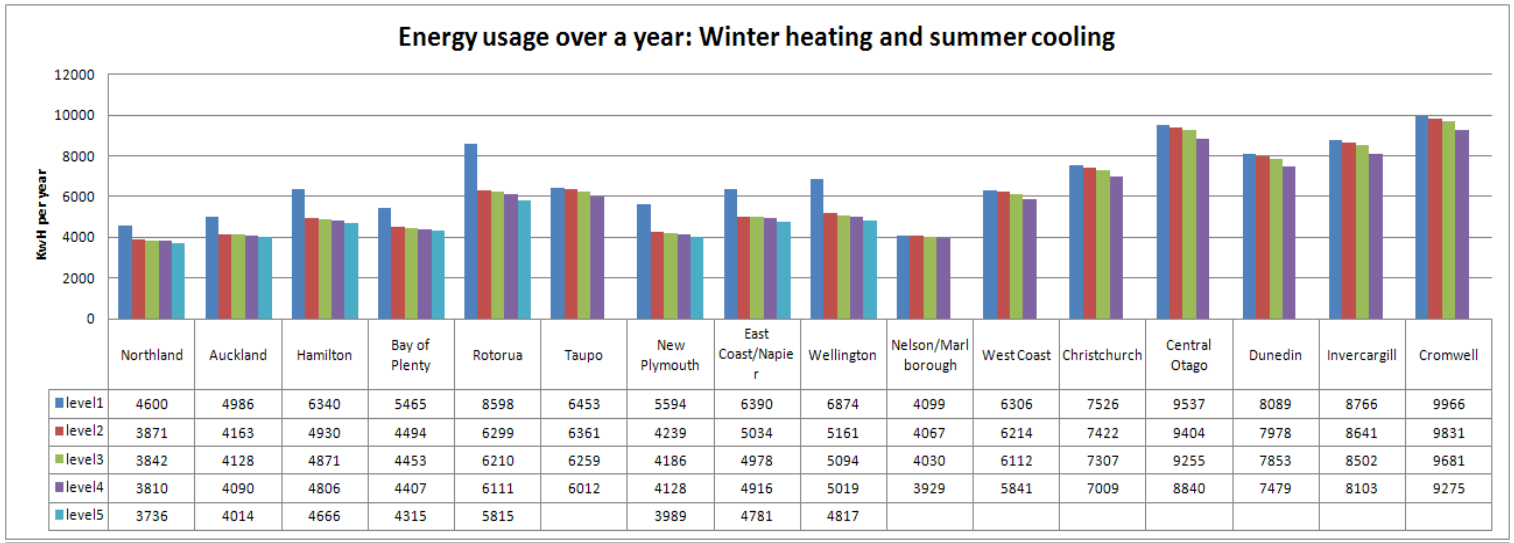
Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
level 1 (no thermal wall)	90mm stud wall plain slab	2.2	3.2
Level 1 (with thermal wall)	90mm stud wall plain slab	2.2	3.2
Level 2 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 3 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 4 (with thermal wall)	50mm eps full cover	2.8	4.6
Level 5 (with thermal wall)	100mm eps full cover	4.5	5

Insulation combinations in floor, wall and ceiling for houses in Zone 3

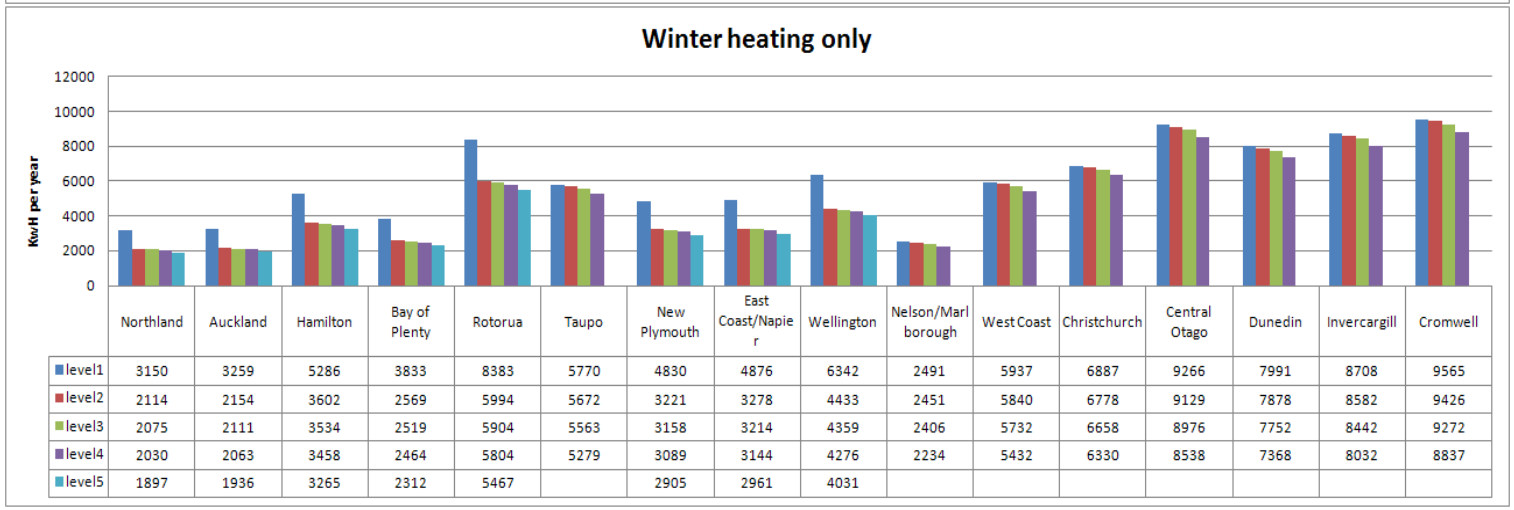
Insulation level	*Floor type*	*Wall Ins R-value*	*Ceiling Ins R-value*
level 1 (no thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 1 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.4	3.6
Level 2 (with thermal wall)	1.2m X 50mm eps perimeter insulation under slab	2.6	4
Level 3 (with thermal wall)	50mm eps full cover	2.8	4.6
Level 4 (with thermal wall)	100mm eps full cover	4.5	5

3.3.1 Thermal mass wall when part of house (Heated Area 1) is heated

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	1
Themal Mass wall?	Yes
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Heat pump, Gas



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	4600	4986	6340	5465	8598	6453	5594	6390	6874	4099	6306	7526	9537	8089	8766	9966
level2	3871	4163	4930	4494	6299	6361	4239	5034	5161	4067	6214	7422	9404	7978	8641	9831
level3	3842	4128	4871	4453	6210	6259	4186	4978	5094	4030	6112	7307	9255	7853	8502	9681
level4	3810	4090	4806	4407	6111	6012	4128	4916	5019	3929	5841	7009	8840	7479	8103	9275
level5	3736	4014	4666	4315	5815		3989	4781	4817							



	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	3150	3259	5286	3833	8383	5770	4830	4876	6342	2491	5937	6887	9266	7991	8708	9565
level2	2114	2154	3602	2569	5994	5672	3221	3278	4433	2451	5840	6778	9129	7878	8582	9426
level3	2075	2111	3534	2519	5904	5563	3158	3214	4359	2406	5732	6658	8976	7752	8442	9272
level4	2030	2063	3458	2464	5804	5279	3089	3144	4276	2234	5432	6330	8538	7368	8032	8837
level5	1897	1936	3265	2312	5467		2905	2961	4031							

Figure 5. Medium house with thermal mass wall – part-house heating

Tables 11, 12 and 13 are the benefit-cost ratios of Levels 1 and 2 *with* thermal wall against Level 1 *without* thermal wall under electric heating, heat pump and gas heating.

Please note there are two Level 1 options: Level 1 *without* thermal mass wall and Level 1 *with* thermal mass wall.

Table 11. Part-house heating – benefit-cost ratios of Levels 1 and 2 with thermal wall against Level 1 without thermal wall – under electric heating

Part house heating with Thermal mass wall, benefit cost ratios		
Electric Heater	Insulation level	
Region	level1	level2
Northland	-2.4	0.9
Auckland	-2.7	0.9
Hamilton	-3.3	1.7
Bay of Plenty	-2.7	1.2
Rotorua	-5.7	2.0
Taupo	-1.9	-0.6
New Plymouth	-2.0	1.2
East Coast/Napier	-1.7	1.3
Wellington	-2.6	1.3
Nelson/Marlborough	-1.0	-0.3
West Coast	-2.3	-0.7
Christchurch	-2.4	-0.7
Central Otago	-4.6	-1.2
Dunedin	-4.4	-1.2
Invercargill	-4.7	-1.3
Cromwell	-4.5	-1.2

Table 12, Part-house heating – benefit-cost ratios of Levels 1 and 2 with thermal wall against Level 1 without thermal wall – under heat pump

Part house heating with Thermal mass wall, benefit cost ratios		
Heat Pump	Insulation level	
Region	level1	level2
Northland	-0.5	0.3
Auckland	-0.8	0.2
Hamilton	-0.6	0.6
Bay of Plenty	-0.6	0.4
Rotorua	-1.6	0.8
Taupo	-0.5	-0.1
New Plymouth	-0.5	0.4
East Coast/Napier	-0.4	0.5
Wellington	-0.7	0.5
Nelson/Marlborough	-0.2	0.0
West Coast	-0.6	-0.2
Christchurch	-0.6	-0.2
Central Otago	-1.4	-0.4
Dunedin	-1.4	-0.4
Invercargill	-1.5	-0.4
Cromwell	-1.2	-0.3

Table 13. Part-house heating – benefit-cost ratios of Levels 1 and 2 with thermal wall against Level 1 without thermal wall – under gas heating

Part house heating with Thermal mass wall, benefit cost ratios		
Gas Heater	Insulation level	
Region	level1	level2
Northland	-1.3	0.5
Auckland	-1.4	0.5
Hamilton	-1.7	0.9
Bay of Plenty	-1.4	0.6
Rotorua	-3.0	1.0
Taupo	-1.0	-0.3
New Plymouth	-1.0	0.6
East Coast/Napier	-0.9	0.7
Wellington	-1.3	0.7
Nelson/Marlborough	-1.2	-0.4
West Coast	-2.8	-0.8
Christchurch	-2.9	-0.9
Central Otago	-5.1	-1.4
Dunedin	-4.9	-1.3
Invercargill	-5.2	-1.4
Cromwell	-5.0	-1.3

Under electrical heating

- There are see cost-benefits at Level 2 only for Zone 2 regions.
- Energy consumption rises up by 10-20% with the thermal wall when the house is heated in Heated Area 1. Therefore this makes the thermal wall not cost-beneficial if only heating part of the house.

Under heat pump

- There are no cost-benefits when heated with a heat pump.
- Energy consumption rises up by 3-15% with the thermal wall when the house is heated in Heated Area 1. Therefore this makes the thermal wall not cost-beneficial if only heating part of the house.

Under gas heating

- Only Rotorua at Level 2 is cost-beneficial.
- Energy consumption rises up by 10-20% with the thermal wall when the house is heated in Heated Area 1. Therefore this makes the thermal wall not cost-beneficial if only heating part of the house.

In general

- Apart from Rotorua, the thermal wall option is not cost-beneficial as energy consumption rises up by 3-20% with the thermal wall when the house is heated in Heated Area 1. Therefore this makes the thermal wall not cost-beneficial to install if only heating part of the house. The better option is not to have a thermal mass wall if heating part of the house.

3.3.2 Thermal mass wall when entire house (Heated Area 2) is heated

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	2
Themal Mass wall?	Yes
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Heat pump, Gas

	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	8992	9745	12743	10805	17066	10464	11233	12899	13607	7100	10198	12133	15226	12870	13884	15857
level2	6618	7109	8396	7695	10448	10282	7180	8693	8597	7032	10015	11925	14957	12647	13636	15585
level3	6552	7033	8270	7605	10257	10085	7064	8571	8455	6958	9816	11698	14665	12405	13367	15290
level4	6480	6950	8133	7507	10051	9551	6938	8439	8300	6736	9237	11053	13769	11618	12522	14408
level5	6299	6759	7803	7281	9404		6609	8113	7854							

	Northland	Auckland	Hamilton	Bay of Plenty	Rotorua	Taupo	New Plymouth	East Coast/Napier	Wellington	Nelson/Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
level1	6318	6586	10777	7803	16631	9194	9891	10083	12649	4159	9519	10929	14714	12660	13747	15089
level2	3398	3495	5941	4216	9830	9000	5352	5509	7257	4077	9325	10712	14438	12434	13497	14810
level3	3314	3404	5797	4110	9637	8790	5218	5374	7101	3987	9115	10477	14138	12188	13225	14507
level4	3221	3305	5641	3996	9427	8181	5074	5227	6932	3630	8473	9768	13192	11375	12353	13563
level5	2926	3020	5207	3661	8693		4655	4812	6396							

Figure 6. Medium house with thermal mass wall – entire house heating

Tables 14, 15 and 16 are the benefit-cost ratios of all levels *with* thermal wall against Level 1 *without* thermal wall, under electric heating, heat pump and gas.

Please note there are two Level 1 options: Level 1 *without* thermal mass wall and Level 1 *with* thermal mass wall.

Table 14. Entire house heating – benefit-cost ratios of all levels with thermal wall against Level 1 without thermal wall – under electric heating

Entire house heating with Thermal mass wall, benefit cost ratios					
Electric Heater	Insulation level				
Region	level1	level2	level3	level4	level5
Northland	4.1	5.8	3.2	1.8	0.9
Auckland	4.6	6.2	3.4	1.9	0.97
Hamilton	7.0	9.7	5.3	3.0	1.5
Bay of Plenty	5.2	7.2	3.9	2.2	1.1
Rotorua	10.2	13.7	7.4	4.2	2.2
Taupo	3.4	1.5	0.8	0.5	n/a
New Plymouth	3.8	7.5	4.4	2.7	1.4
East Coast/Napier	3.8	7.5	4.4	2.7	1.4
Wellington	4.7	9.0	5.3	3.2	1.7
Nelson/Marlborough	0.7	0.3	0.2	0.2	n/a
West Coast	3.2	1.3	0.8	0.5	n/a
Christchurch	4.2	1.7	0.9	0.6	n/a
Central Otago	7.6	2.7	1.4	0.8	n/a
Dunedin	5.3	1.9	1.0	0.6	n/a
Invercargill	6.2	2.2	1.2	0.7	n/a
Cromwell	8.2	2.8	1.5	0.9	n/a

Table 15. Entire house heating – benefit-cost ratios of all levels with thermal wall against Level 1 without thermal wall – under heat pump

Entire house heating with Thermal mass wall, benefit cost ratios					
Heat Pump	Insulation level				
Region	level1	level2	level3	level4	level5
Northland	3.1	2.3	1.2	0.7	0.3
Auckland	3.1	2.4	1.3	0.7	0.4
Hamilton	4.1	3.7	2.0	1.1	0.6
Bay of Plenty	3.6	2.8	1.5	0.9	0.4
Rotorua	4.5	5.0	2.7	1.6	0.8
Taupo	1.8	0.7	0.4	0.2	n/a
New Plymouth	2.0	2.7	1.6	0.96	0.5
East Coast/Napier	2.3	2.9	1.7	1.0	0.5
Wellington	2.2	3.3	1.9	1.2	0.6
Nelson/Marlborough	1.2	0.4	0.2	0.1	n/a
West Coast	1.5	0.6	0.3	0.2	n/a
Christchurch	2.1	0.8	0.4	0.2	n/a
Central Otago	3.2	1.1	0.6	0.3	n/a
Dunedin	2.2	0.8	0.4	0.2	n/a
Invercargill	2.5	0.9	0.5	0.3	n/a
Cromwell	3.6	1.2	0.6	0.3	n/a

Table 16. Entire house heating – benefit-cost ratios of all levels with thermal wall against Level 1 without thermal wall – under gas heater

Entire house heating with Thermal mass wall, benefit cost ratios					
Gas Heater	Insulation level				
Region	level1	level2	level3	level4	level5
Northland	2.1	3.0	1.6	0.9	0.5
Auckland	2.4	3.2	1.7	0.998	0.5
Hamilton	3.6	5.0	2.7	1.6	0.8
Bay of Plenty	2.7	3.7	2.0	1.2	0.6
Rotorua	5.3	7.1	3.9	2.2	1.1
Taupo	1.7	0.8	0.4	0.3	n/a
New Plymouth	2.0	3.9	2.3	1.4	0.7
East Coast/Napier	2.0	3.9	2.3	1.4	0.7
Wellington	2.4	4.6	2.7	1.7	0.9
Nelson/Marlborough	0.9	0.4	0.3	0.2	n/a
West Coast	3.9	1.6	0.9	0.6	n/a
Christchurch	5.1	2.1	1.2	0.7	n/a
Central Otago	8.4	2.9	1.6	0.9	n/a
Dunedin	5.9	2.1	1.1	0.7	n/a
Invercargill	6.9	2.4	1.3	0.8	n/a
Cromwell	9.0	3.1	1.7	0.96	n/a

Under electric heating

- For Zone 1 regions, there are cost-benefits for all levels apart from Level 5 design
- For Zone 2 regions, there are cost-benefits for all levels
- For Zone 3 regions, there are cost-benefits at Levels 1 and 2, and some at Level 3 (lower south Island only). Installing a thermal mass wall in Nelson/Marlborough is not cost-effective.

Under heat pump

- For Zone 1 regions, there are cost-benefits at Levels 1 to 3
- For Zone 2 regions, there are cost-benefits at Levels 1 to 3 and some at Level 4
- For Zone 3 regions, there are cost-benefits at Level 1 and some at Level 2.

Under gas heating

- For Zone 1 regions, there are cost-benefits at Levels 1 to 3
- For Zone 2 regions, there are cost-benefits at Levels 1 to 4, Rotorua to Level 5
- For Zone 3 regions, there are cost-benefits at Levels 1 and 2, and some at Level 3. Not cost-effective to install thermal mass wall in Nelson/Marlborough for all levels.

In general

- Energy consumption decreases by 5-16% with the thermal wall when the house is heated in Heated Area 2. Therefore this makes the thermal wall cost-effective only when heating the entire house.

3.4 Orientation

What are the optimal/worst orientations by region of a house with electrical heating, heat pump or gas heating? Below is the medium house modelled.

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-Heat pump types. For Heat pump: Summer (Day19,Eve21)
Heated area	1
Themal Mass wall?	None
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	All 8
Heater	Electric, Heat pump, Gas

The results from the tables below show that for most regions, the optimal orientation lies in the quadrant of north to north-west, and the worst orientation in the east to south quadrant. Note: heat pump is utilised all year round, therefore has higher energy consumption than the other heater types.

Table 17. Best and worst orientations – heat pump

			Margin energy kWh per year between optimal and worst					Cost savings per year				
	Orientation		(optimal orientation level k - worst level k)					(optimal orientation level k - worst level k)				
	Optimal	Worst	Insulation level					Insulation level				
			Level1	Level2	Level3	Level4	Level5	Level1	Level2	Level3	Level4	Level5
Northland	W	E	154	185	185	186	186	$ 11	$ 13	$ 13	$ 13	$ 13
Auckland	NW	E	187	197	197	196	194	$ 13	$ 14	$ 14	$ 14	$ 13
Hamilton	NW	SE	154	179	180	181	183	$ 11	$ 12	$ 12	$ 12	$ 13
Bay of Plenty	W	E	175	213	213	214	214	$ 12	$ 15	$ 15	$ 15	$ 15
Rotorua	N or NW	S or SE	361	316	316	315	315	$ 25	$ 22	$ 22	$ 22	$ 22
Taupo	NW	SE	223	223	224	227		$ 15	$ 15	$ 15	$ 16	
New Plymouth	NW	E or SE	269	273	273	273	273	$ 19	$ 19	$ 19	$ 19	$ 19
East Coast/Napier	NW	E	156	198	199	200	203	$ 11	$ 14	$ 14	$ 14	$ 14
Wellington	NW	SE	220	207	206	206	205	$ 15	$ 14	$ 14	$ 14	$ 14
Nelson/Marlborough	W	E	198	199	200	201		$ 13	$ 13	$ 13	$ 13	
West Coast	NW	SE	391	391	390	389		$ 25	$ 25	$ 25	$ 25	
Christchurch	NW	SE	331	331	331	329		$ 21	$ 21	$ 21	$ 21	
Central Otago	N	S	623	619	616	604		$ 44	$ 44	$ 44	$ 43	
Dunedin	N	S	405	403	401	393		$ 29	$ 29	$ 28	$ 28	
Invercargill	NW	S	436	435	434	427		$ 31	$ 31	$ 31	$ 30	
Cromwell	N	S	447	445	443	436		$ 32	$ 32	$ 31	$ 31	

Table 18. Best and worst orientations – electric resistance heater

			Margin energy kWh per year between optimal and worst					Cost savings per year				
	Orientation		(optimal orientation level k - worst level k)					(optimal orientation level k - worst level k)				
	Optimal	Worst	Insulation level					Insulation level				
			Level1	Level2	Level3	Level4	Level5	Level1	Level2	Level3	Level4	Level5
Northland	N	SE	238	255	255	256	258	$ 46	$ 49	$ 49	$ 49	$ 50
Auckland	N	SE	299	309	308	308	309	$ 58	$ 60	$ 60	$ 60	$ 60
Hamilton	N	S	352	349	348	348	349	$ 68	$ 67	$ 67	$ 67	$ 67
Bay of Plenty	N	S or SE	323	334	334	334	337	$ 62	$ 64	$ 64	$ 65	$ 65
Rotorua	N	S	492	465	464	464	461	$ 95	$ 90	$ 90	$ 89	$ 89
Taupo	N	S	437	436	436	435		$ 84	$ 84	$ 84	$ 84	
New Plymouth	N	SE	424	434	435	435	438	$ 82	$ 84	$ 84	$ 84	$ 85
East Coast/Napier	N	S	385	380	380	380	383	$ 74	$ 73	$ 73	$ 73	$ 74
Wellington	N	S	422	396	395	394	392	$ 81	$ 76	$ 76	$ 76	$ 76
Nelson/Marlborough	N	SE	293	294	294	296		$ 53	$ 53	$ 53	$ 53	
West Coast	NW	SE	508	508	508	508		$ 91	$ 91	$ 91	$ 92	
Christchurch	N	S	496	495	494	492		$ 89	$ 89	$ 89	$ 89	
Central Otago	N	S	815	813	810	804		$ 162	$ 162	$ 161	$ 160	
Dunedin	N	S	504	503	503	500		$ 100	$ 100	$ 100	$ 100	
Invercargill	N	S	526	525	524	520		$ 105	$ 105	$ 104	$ 103	
Cromwell	N	S	684	683	683	681		$ 136	$ 136	$ 136	$ 135	

Table 19. Best and worst orientations – gas heater

			Margin energy kWh per year between optimal and worst					Cost savings per year				
	Orientation		(optimal orientation level k - worst level k)					(optimal orientation level k - worst level k)				
	Optimal	Worst	Insulation level					Insulation level				
			Level1	Level2	Level3	Level4	Level5	Level1	Level2	Level3	Level4	Level5
Northland	N	SE	238	255	255	256	258	$ 24	$ 26	$ 26	$ 26	$ 26
Auckland	N	SE	299	309	308	308	309	$ 30	$ 31	$ 31	$ 31	$ 31
Hamilton	N	S	352	349	348	348	349	$ 35	$ 35	$ 35	$ 35	$ 35
Bay of Plenty	N	S or SE	323	334	334	334	337	$ 32	$ 33	$ 33	$ 33	$ 34
Rotorua	N	S	492	465	464	464	461	$ 49	$ 47	$ 46	$ 46	$ 46
Taupo	N	S	437	436	436	435		$ 44	$ 44	$ 44	$ 43	
New Plymouth	N	SE	424	434	435	435	438	$ 42	$ 43	$ 44	$ 44	$ 44
East Coast/Napier	N	S	385	380	380	380	383	$ 39	$ 38	$ 38	$ 38	$ 38
Wellington	N	S	422	396	395	394	392	$ 42	$ 40	$ 40	$ 39	$ 39
Nelson/Marlborough	N	SE	293	294	294	296		$ 64	$ 65	$ 65	$ 65	
West Coast	NW	SE	508	508	508	508		$ 112	$ 112	$ 112	$ 112	
Christchurch	N	S	496	495	494	492		$ 109	$ 109	$ 109	$ 108	
Central Otago	N	S	815	813	810	804		$ 179	$ 179	$ 178	$ 177	
Dunedin	N	S	504	503	503	500		$ 111	$ 111	$ 111	$ 110	
Invercargill	N	S	526	525	524	520		$ 116	$ 116	$ 115	$ 114	
Cromwell	N	S	684	683	683	681		$ 150	$ 150	$ 150	$ 150	

4. METHOD: PRESENT VALUE (PV) AND BENEFIT-COST RATIO

The cost-benefit technique used in this study is used to convert all costs to the PV. This is based on the idea that $1 expenditure in the future costs less than the same expenditure now. Whereas in the second case $1 is needed now, in the first case a lesser amount can be set aside now to earn interest so that it amounts to $1 in five years' time. The amount to set aside now is that which, when compounded at the appropriate interest rate (or discount rate), will exactly equal $1 in five years' time.

The compound factor is given by:

$(1+r)^5 = 1.611$ for r=10%.
Hence, the amount to be set aside now is only $1/1.611 = 62 cents. Or, in other words, an expenditure of $1 in five years' time is only worth 62 cents in today's values.

In this study:

Total PV = (Initial cost Insulation Level k) + (Initial cost thermal mass wall) + (PV heating appliance) + (PV energy at Insulation Level k)

Where:

- Initial cost thermal mass wall is zero if there is no wall built-in. The cost is a marginal cost i.e. the additional cost of the wall compared to a timber-framed wall. Refer to Section 9.1.6: "Thermal mass wall costs, rates, groupings".

- PV Heating appliance = $\sum H/(1 + r)h$
  H is the cost of the heating appliance at year t=0 and allowing for replacement at year h. The life spans of the heating appliances are 15 years (electric heater and heat pump), 20 years (night store and gas), and 30 years (solid fuel and pellets).

- PV energy at Insulation Level k, heating appliance energy rate j
  $= C_1/(1+r) + C_2/(1+r)^2 + C_3/(1+r)^3 + \ldots + C_n/(1+r)^n$
  for k = 1, 2, 3, 4, 5, and j = electric, heat pump, gas, night store, solid fuel, pellets.
  C_1, C_2, C_3 … + C_N are space heating energy in year 1, 2, 3 … N. For this study the energy costs are allowed to escalate at a rate of 1% per year above the rate of general inflation. Energy rates vary according to heating appliance utilised. Refer to Section 9.1.7: "Appliance costs, life of appliance, energy rates, and groupings".

r= discount rate.
N = period of analysis, years.
The base case parameters were:
30 year analysis period.
5% discount rate.

The benefit-cost ratio at k, j ("BCR k, j") is:

1. (PV energy at Insulation Level 1) minus (PV energy at Insulation Level k) at heating appliance energy rate j , divided by
2. (Insulation Level k) minus (Insulation Level 1) plus additional cost for thermal mass wall if applicable.

In words, the BCR is the PV of energy cost savings divided by the additional insulation costs and additional thermal mass wall cost (which is zero if no wall) using Insulation Level 1 as base case. PV of heating appliance has no effect on the ratio, as the heater arrangement is the same in all insulation design levels. If "BCR k, j" is greater than 1.0, then Insulation Level k is more cost-beneficial than Insulation Level 1. Likewise if "Total PV at Level k, heater j" is

less than “Total PV at Level 1, heater j”, then Insulation Level k is more cost-effective than Level 1.

5. SENSITIVITY ANALYSIS

5.1 Temperature change – winter heating only

What energy savings are to be gained when the heating thermostat over winter is changed? Winter heating (April to October) is scheduled is 5pm to 10pm. Figure 7 below shows energy savings range from 5-18% when the medium house is insulated at Level 1 and heated in part of the house at 21°C as opposed to 22°C. Heating the entire house gives similar results as found in Figure 8.

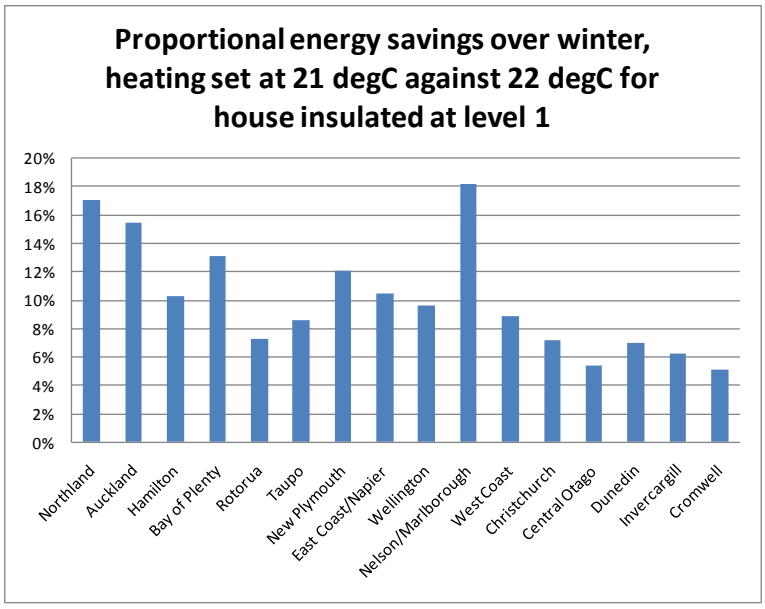


Figure 7. Energy savings when heater set at 21°C against 22°C in Heated Area 1

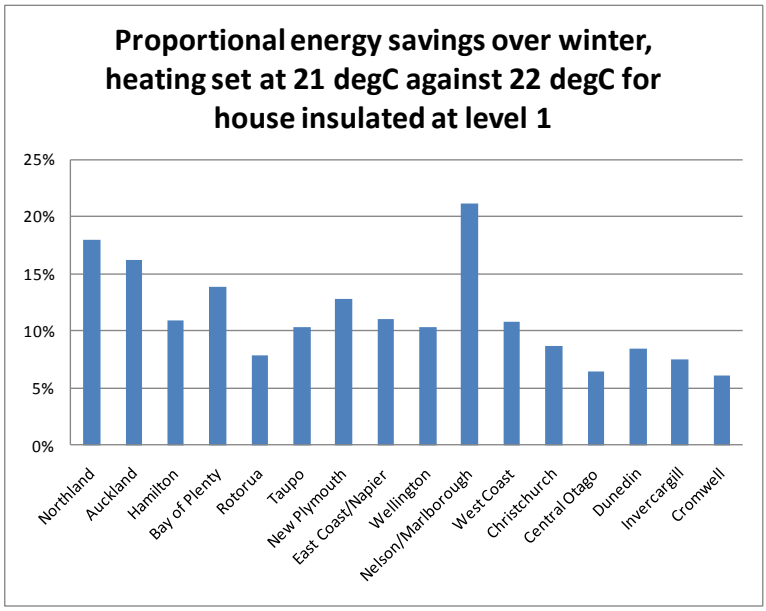


Figure 8. Energy savings when heater set at 21°C against 22°C in Heated Area 2

5.2 Financial factors

What effect does changing the financial factors have when considering the cost-effectiveness of insulation options? A sensitivity analysis is performed on the base case medium house and financial factors (economic life of 30 years, money discount rate at 5% per annum, energy escalation at 3% per annum) with the economic scenarios:

1. Discount rate at 3% per annum
2. Discount rate at 7% per annum
3. Economic analysis of 10 years
4. Economic analysis of 50 years
5. Energy escalation at 3% per annum

	Base case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
House type(s)	Medium	Medium	Medium	Medium	Medium	Medium
Schedule	Eve21	Eve21	Eve21	Eve21	Eve21	Eve21
Heated area	1	1	1	1	1	1
Themal Mass wall?	None	None	None	None	None	None
Life cycle years	30	30	30	10	50	30
Discount rate	5%	3%	7%	5%	5%	5%
Energy price escalation	1%	1%	1%	1%	1%	3%
Orientation(s)	North	North	North	North	North	North

5.2.1 Electrical heater

Part house heating, benefit cost ratios Electric Heater		Base case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
House type(s)		Medium	Medium	Medium	Medium	Medium	Medium
Schedule		Eve21	Eve21	Eve21	Eve21	Eve21	Eve21
Heated area		1	1	1	1	1	1
Themal Mass wall?		None	None	None	None	None	None
Life cycle years		30	30	30	10	50	30
Discount rate		5%	3%	7%	5%	5%	5%
Energy price escalation		1%	1%	1%	1%	1%	3%
Orientation(s)		North	North	North	North	North	North
Northland	level2	2.0	2.6	1.6	0.9	2.5	2.6
	level3	0.9	1.2	0.7	0.4	1.2	1.2
	level4	0.5	0.6	0.4	0.2	0.6	0.6
	level5	0.3	0.3	0.2	0.1	0.3	0.3
Auckland	level2	2.1	2.7	1.7	1.0	2.6	2.7
	level3	1.0	1.2	0.8	0.5	1.2	1.3
	level4	0.5	0.7	0.4	0.2	0.6	0.7
	level5	0.3	0.3	0.2	0.1	0.3	0.3
Hamilton	level2	3.2	4.2	2.6	1.5	4.0	4.2
	level3	1.5	1.9	1.2	0.7	1.8	1.9
	level4	0.8	1.0	0.6	0.4	1.0	1.0
	level5	0.4	0.5	0.3	0.2	0.5	0.5
Bay of Plenty	level2	2.4	3.1	1.9	1.1	3.0	3.1
	level3	1.1	1.4	0.9	0.5	1.4	1.4
	level4	0.6	0.8	0.5	0.3	0.7	0.8
	level5	0.3	0.4	0.2	0.1	0.4	0.4
Rotorua	level2	4.5	5.8	3.6	2.1	5.6	5.8
	level3	2.1	2.7	1.6	1.0	2.6	2.7
	level4	1.1	1.4	0.9	0.5	1.4	1.4
	level5	0.6	0.7	0.4	0.3	0.7	0.7
Taupo	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2
New Plymouth	level2	3.1	4.0	2.5	1.4	3.8	4.0
	level3	1.4	1.8	1.1	0.7	1.8	1.8
	level4	0.8	1.0	0.6	0.4	1.0	1.0
	level5	0.4	0.5	0.3	0.2	0.5	0.5
East Coast/Napier	level2	3.1	4.0	2.4	1.4	3.8	4.0
	level3	1.4	1.8	1.1	0.7	1.7	1.8
	level4	0.8	1.0	0.6	0.4	0.9	1.0
	level5	0.4	0.5	0.3	0.2	0.5	0.5
Wellington	level2	3.6	4.6	2.9	1.7	4.5	4.7
	level3	1.6	2.1	1.3	0.8	2.0	2.1
	level4	0.9	1.2	0.7	0.4	1.1	1.2
	level5	0.4	0.6	0.4	0.2	0.6	0.6
Nelson/Marlborough	level2	0.1	0.1	0.0	0.0	0.1	0.1
	level3	0.0	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.0	0.0	0.1	0.1
West Coast	level2	0.1	0.2	0.1	0.1	0.2	0.2
	level3	0.1	0.1	0.1	0.1	0.1	0.1
	level4	0.1	0.1	0.1	0.0	0.1	0.1
Christchurch	level2	0.2	0.2	0.1	0.1	0.2	0.2
	level3	0.1	0.2	0.1	0.1	0.2	0.2
	level4	0.1	0.1	0.1	0.1	0.1	0.1
Central Otago	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2
Dunedin	level2	0.2	0.2	0.1	0.1	0.2	0.2
	level3	0.1	0.2	0.1	0.1	0.2	0.2
	level4	0.1	0.2	0.1	0.1	0.2	0.2
Invercargill	level2	0.2	0.3	0.2	0.1	0.2	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2
Cromwell	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2

5.2.2 Heat pump

Part house heating, benefit cost ratios Heat Pump		Base case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
House type(s)		Medium	Medium	Medium	Medium	Medium	Medium
Schedule		Eve21	Eve21	Eve21	Eve21	Eve21	Eve21
Heated area		1	1	1	1	1	1
Themal Mass wall?		None	None	None	None	None	None
Life cycle years		30	30	30	10	50	30
Discount rate		5%	3%	7%	5%	5%	5%
Energy price escalation		1%	1%	1%	1%	1%	3%
Orientation(s)		North	North	North	North	North	North
Northland	level2	0.6	0.7	0.4	0.3	0.7	0.7
	level3	0.3	0.3	0.2	0.1	0.3	0.3
	level4	0.1	0.2	0.1	0.1	0.2	0.2
	level5	0.1	0.1	0.1	0.0	0.1	0.1
Auckland	level2	0.6	0.8	0.5	0.3	0.8	0.8
	level3	0.3	0.4	0.2	0.1	0.4	0.4
	level4	0.2	0.2	0.1	0.1	0.2	0.2
	level5	0.1	0.1	0.1	0.0	0.1	0.1
Hamilton	level2	1.0	1.3	0.8	0.5	1.2	1.3
	level3	0.5	0.6	0.4	0.2	0.6	0.6
	level4	0.2	0.3	0.2	0.1	0.3	0.3
	level5	0.1	0.2	0.1	0.1	0.2	0.2
Bay of Plenty	level2	0.7	0.9	0.6	0.3	0.9	0.9
	level3	0.3	0.4	0.3	0.2	0.4	0.4
	level4	0.2	0.2	0.1	0.1	0.2	0.2
	level5	0.1	0.1	0.1	0.0	0.1	0.1
Rotorua	level2	1.5	2.0	1.2	0.7	1.9	2.0
	level3	0.7	0.9	0.6	0.3	0.9	0.9
	level4	0.4	0.5	0.3	0.2	0.5	0.5
	level5	0.2	0.2	0.2	0.1	0.2	0.2
Taupo	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.0	0.0	0.1	0.1
New Plymouth	level2	1.0	1.2	0.8	0.5	1.2	1.3
	level3	0.4	0.6	0.4	0.2	0.5	0.6
	level4	0.2	0.3	0.2	0.1	0.3	0.3
	level5	0.1	0.2	0.1	0.1	0.1	0.2
East Coast/Napier	level2	1.0	1.3	0.8	0.5	1.2	1.3
	level3	0.4	0.6	0.4	0.2	0.6	0.6
	level4	0.2	0.3	0.2	0.1	0.3	0.3
	level5	0.1	0.2	0.1	0.1	0.1	0.2
Wellington	level2	1.2	1.5	0.9	0.5	1.4	1.5
	level3	0.5	0.7	0.4	0.2	0.7	0.7
	level4	0.3	0.4	0.2	0.1	0.4	0.4
	level5	0.1	0.2	0.1	0.1	0.2	0.2
Nelson/Marlborough	level2	0.0	0.0	0.0	0.0	0.0	0.0
	level3	0.0	0.0	0.0	0.0	0.0	0.0
	level4	0.0	0.0	0.0	0.0	0.0	0.0
West Coast	level2	0.0	0.1	0.0	0.0	0.1	0.1
	level3	0.0	0.1	0.0	0.0	0.0	0.1
	level4	0.0	0.0	0.0	0.0	0.0	0.0
Christchurch	level2	0.1	0.1	0.0	0.0	0.1	0.1
	level3	0.0	0.1	0.0	0.0	0.1	0.1
	level4	0.0	0.0	0.0	0.0	0.0	0.0
Central Otago	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.0	0.0	0.1	0.1
Dunedin	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.0	0.1	0.0	0.0	0.1	0.1
Invercargill	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.0	0.0	0.1	0.1
Cromwell	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.0	0.0	0.1	0.1

5.2.3 Gas heating

Part house heating, benefit cost ratios Gas Heating		Base case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
House type(s)		Medium	Medium	Medium	Medium	Medium	Medium
Schedule		Eve21	Eve21	Eve21	Eve21	Eve21	Eve21
Heated area		1	1	1	1	1	1
Themal Mass wall?		None	None	None	None	None	None
Life cycle years		30	30	30	10	50	30
Discount rate		5%	3%	7%	5%	5%	5%
Energy price escalation		1%	1%	1%	1%	1%	3%
Orientation(s)		North	North	North	North	North	North
Northland	level2	1.0	1.4	0.8	0.5	1.3	1.4
	level3	0.5	0.6	0.4	0.2	0.6	0.6
	level4	0.3	0.3	0.2	0.1	0.3	0.3
	level5	0.1	0.2	0.1	0.1	0.2	0.2
Auckland	level2	1.1	1.4	0.9	0.5	1.4	1.4
	level3	0.5	0.6	0.4	0.2	0.6	0.7
	level4	0.3	0.3	0.2	0.1	0.3	0.3
	level5	0.1	0.2	0.1	0.1	0.2	0.2
Hamilton	level2	1.7	2.2	1.3	0.8	2.1	2.2
	level3	0.8	1.0	0.6	0.4	1.0	1.0
	level4	0.4	0.5	0.3	0.2	0.5	0.5
	level5	0.2	0.3	0.2	0.1	0.3	0.3
Bay of Plenty	level2	1.3	1.6	1.0	0.6	1.6	1.6
	level3	0.6	0.7	0.5	0.3	0.7	0.8
	level4	0.3	0.4	0.2	0.1	0.4	0.4
	level5	0.2	0.2	0.1	0.1	0.2	0.2
Rotorua	level2	2.3	3.0	1.8	1.1	2.9	3.0
	level3	1.1	1.4	0.8	0.5	1.3	1.4
	level4	0.6	0.7	0.5	0.3	0.7	0.7
	level5	0.3	0.4	0.2	0.1	0.4	0.4
Taupo	level2	0.1	0.2	0.1	0.1	0.1	0.2
	level3	0.1	0.1	0.1	0.0	0.1	0.1
	level4	0.1	0.1	0.1	0.0	0.1	0.1
New Plymouth	level2	1.6	2.1	1.3	0.7	2.0	2.1
	level3	0.7	0.9	0.6	0.3	0.9	0.9
	level4	0.4	0.5	0.3	0.2	0.5	0.5
	level5	0.2	0.3	0.2	0.1	0.2	0.3
East Coast/Napier	level2	1.6	2.0	1.3	0.7	2.0	2.1
	level3	0.7	0.9	0.6	0.3	0.9	0.9
	level4	0.4	0.5	0.3	0.2	0.5	0.5
	level5	0.2	0.3	0.2	0.1	0.2	0.3
Wellington	level2	1.9	2.4	1.5	0.9	2.3	2.4
	level3	0.8	1.1	0.7	0.4	1.1	1.1
	level4	0.5	0.6	0.4	0.2	0.6	0.6
	level5	0.2	0.3	0.2	0.1	0.3	0.3
Nelson/Marlborough	level2	0.1	0.1	0.1	0.0	0.1	0.1
	level3	0.1	0.1	0.0	0.0	0.1	0.1
	level4	0.1	0.1	0.1	0.0	0.1	0.1
West Coast	level2	0.2	0.2	0.1	0.1	0.2	0.2
	level3	0.1	0.2	0.1	0.1	0.2	0.2
	level4	0.1	0.2	0.1	0.1	0.2	0.2
Christchurch	level2	0.2	0.2	0.2	0.1	0.2	0.2
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.1	0.2	0.1	0.1	0.2	0.2
Central Otago	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.2	0.2	0.1	0.2	0.3
	level4	0.2	0.2	0.1	0.1	0.2	0.2
Dunedin	level2	0.2	0.3	0.2	0.1	0.2	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2
Invercargill	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.2	0.1	0.1	0.2	0.2
	level4	0.2	0.2	0.1	0.1	0.2	0.2
Cromwell	level2	0.2	0.3	0.2	0.1	0.3	0.3
	level3	0.2	0.3	0.2	0.1	0.2	0.3
	level4	0.2	0.2	0.1	0.1	0.2	0.2

6. HEATER EVALUATION UNDER LEVEL 1 – MEDIUM HOUSE

The 'most cost-beneficial heaters' under each region are highlighted in pink with the lowest total PV. The 'least cost-beneficial heaters' under each region' are highlighted in orange with the highest total PV. Refer to Section 4: "Method: Present Value (PV) and Benefit-Cost Ratio".

6.1 Heater evaluation – part-house heating

Medium House, Insulation level 1

Part house heating	Period =	30 years
Best and worst heating	Disct rate =	5%
No thermal wall	Energy esc =	1%
North Orientation	Winter heating degC =	21

Best heater highlighted in pink, worst heater in orange for each region

Total PVs

	Northland	Auckland	Hamilton	BOP	Rotorua	Taupo	New Plymouth	East Coast/ Napier	Wellington	Nelson/ Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
Electric	15903	16134	22522	18028	31338	25456	20795	21290	25185	15023	24509	27337	36865	32660	34897	38034
Heat pump	15232	15504	17243	16191	19293	18617	16095	17170	17392	15784	17772	19151	23490	21673	22448	24150
Gas	17396	17516	20826	18497	25393	23012	19882	20138	22157	22346	33940	37396	47695	43046	45519	48986
Night store	13151	13310	17712	14616	23787	20164	16491	16832	19516	12637	18697	20504	29097	26096	27692	29930
Solid fuel	12736	12856	16166	13837	20734	18352	15222	15479	17497	13199	18469	20040	24094	21981	23105	24681
Pellets	13770	13878	16857	14761	20968	18963	15998	16228	18045	14325	19068	20482	24681	22779	23791	25209
Lowest PV	12736	12856	16166	13837	19293	18352	15222	15479	17392	12637	17772	19151	23490	21673	22448	24150
Highest PV	17396	17516	22522	18497	31338	25456	20795	21290	25185	22346	33940	37396	47695	43046	45519	48986

6.2 Heater evaluation – entire house heating

Medium House, Insulation level 1

Entire house heating	Period =	30 years
Best and worst heating	Disct rate =	5%
No thermal wall	Energy esc =	1%
North Orientation	Winter heating degC =	21

Best heater highlighted in pink, worst heater in orange for each region

Total PVs

	Northland	Auckland	Hamilton	BOP	Rotorua	Taupo	New Plymouth	East Coast/ Napier	Wellington	Nelson/ Marlborough	West Coast	Christchurch	Central Otago	Dunedin	Invercargill	Cromwell
Electric	31409	32584	48230	37051	69882	43576	44944	45580	55176	22741	42052	47468	66867	57864	62389	68673
Heat pump	27227	28145	32374	29699	37780	30385	30039	32445	33154	24942	28759	31493	40287	36502	38037	41433
Gas	25085	25694	33800	28008	45019	32055	32049	32379	37351	30964	54567	61187	79880	69927	74930	81877
Night store	23377	24187	34969	27265	49890	32192	32673	33111	39724	17142	29479	32940	49870	43447	46676	51160
Solid fuel	20425	21034	29141	23348	40359	27396	27389	27719	32691	17116	27845	30854	38724	34200	36474	39632
Pellets	20690	21238	28534	23321	38631	27102	26948	27244	31719	17851	27506	30214	37847	33776	35823	38665
Lowest PV	20425	21034	28534	23321	37780	27102	26948	27244	31719	17116	27506	30214	37847	33776	35823	38665
Highest PV	31409	32584	48230	37051	69882	43576	44944	45580	55176	30964	54567	61187	79880	69927	74930	81877

7. DISCUSSION AND CONCLUSIONS

The three different house designs varied in energy consumption due to size, perimeter area, window sizes, size of living areas, and depth of living areas. The large-sized house had a much larger living area than the other two houses.

Regional energy consumption varied according to climate zone. Zone 3 regions (lower South Island the coldest) used more energy than Zone 2 and Zone 1 regions. The exceptions were Nelson, which has similar energy patterns to Zone 1 regions, and Rotorua which is close to Taupo and is borderline Zone 3 but is excluded according to the Code.

The main conclusions of the medium-house analyses:

- EPS polystyrene insulation under concrete floor is the main energy savings contributor, and higher wall and ceiling insulation make minimal difference for this particular designed house. This explains why: without a thermal mass wall, Zone 1 and 2 regions (with its base case as Insulation Level 1, Zone 1 and 2, which is plain concrete slab) had cost-beneficial options above the base case; and how Zone 3 regions (with its base case as Insulation Level 1, Zone 3, which consists of EPS polystyrene perimeter insulation under the slab) had no cost-beneficial options above the base case.

- Thermal mass walls are very cost-effective when the house is heated entirely, but not partly-heated. Partly-heated with this wall consumes more energy than without it, whereas entirely heated with this wall consumes less energy than without it. Also the marginal cost of the thermal mass wall was cost-effective, therefore not having too much effect on the total initial costs which are mainly insulation costs.

- Of the main heating appliances, in Zone 1 and 2 electric heating gave the highest cost-benefit ratios followed by gas and then heat pump. In Zone 3, gas heating gave highest cost-benefit ratios followed by electric heating and then heat pump.

Part-house heating with thermal mass wall

- Energy consumption rises up by 3-20% with the thermal wall when the house is heated in Heated Area 1. This can be explained due to the thermal mass requiring a certain amount of energy to heat it up. When heating only part of the house, the rear of the wall is facing onto cooler temperatures, thus leading to heat being lost out the back and cooling being transferred into the heated areas. This would not happen to the same degree with a hollow internal wall, as the air gap acts like insulation. The thermal wall is not cost-effective if only heating only part of the house. The better option is not to have a thermal mass wall if heating part of the house.

Entire house heating with thermal mass wall

- Energy consumption decreases by 5-16% with the thermal wall when the house is heated in Heated Area 2. The thermal wall acts as a temperature moderator. With high enough insulation, the thermal wall will maintain the temperatures of the spaces backing onto it, releasing the heat slowly when active heating is removed. This then reduces the size of the increase in temperature required to get it back up to temperature when heating is turned back on. Note that this may not be as effective if the heating is only done for short periods. The thermal wall is cost-effective if heating the entire house.

  The generally low cost-effectiveness of additional insulation in most locations is probably because 2007 Code changes to Clause H1 and insulation levels were forward looking. The changes at the time were designed to have favourable net benefits, assuming

energy prices continued to escalate above general inflation and that households would be looking to improve comfort levels. This in fact has occurred and Code requirements are now generally more cost-optimal with the 2007 insulation changes.

8. REFERENCES

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9. APPENDIX1: ASSUMPTIONS, DESIGNS, PARAMETERS, REFERENCES

9.1.1 SUNREL

Sunrel is thermal modelling software utilised to generate theoretical heating and cooling energy consumption of a given model. It is an hour-by-hour simulation, and should not be expected to be entirely accurate nor reflective of reality due to being based on average weather files for a given region, assumptions and calculations.

9.1.2 Climate Zones

Regions	Climate zone
Northland	1
Auckland	1
Hamilton	2
Bay of Plenty	2
Rotorua	2
Taupo	3
New Plymouth	2
East Coast/Napier	2
Wellington	2
Nelson/Marlborough	3
West Coast	3
Christchurch	3
Central Otago	3
Dunedin	3
Invercargill	3
Cromwell	3

9.1.3 Basic house designs

The table below shows the basic house design details of the three types of houses modelled at Level 1 (which is the base case designs). Insulation levels above minimum Code are a change in the wall and ceiling insulation thickness R-value.

Building Feature	Small house	Medium	Large
Floor area (sqm)	103	241	250
Heated area 1 (sqm) -living/family room and any spaces open to this room (i.e. Open-plan living, kitchen and dining room).	40	53	92
Heated area 2 (sqm) -living/family room and spaces open to this room (i.e. Open-plan living, kitchen and dining room), and bedrooms, hallways.	not required in analysis	127	not required in analysis
Wall Insulation area (sqm)	67	188	195
Ceiling Insulation area (sqm)	90	217	226
Floor Insulation area (sqm)	90	217	226
Wall cladding	Clay brick	Clay brick	Clay brick
Roof cladding	Corr Iron	Corr Iron	Corr Iron
Floor	Zone1&2 plain slab, Zone3 eps perimeter	Zone1&2 plain slab, Zone3 eps perimeter	Zone1&2 plain slab, Zone3 eps perimeter
Wall Insulation R-value	Zone1&2 R2.2, Zone3 R2.4	Zone1&2 R2.2, Zone3 R2.4	Zone1&2 R2.2, Zone3 R2.4
Ceiling Insulation R-value	Zone1&2 R3.2, Zone3 R3.6	Zone1&2 R3.2, Zone3 R3.6	Zone1&2 R3.2, Zone3 R3.6
Structure	Timber Non-solid	Timber Non-solid	Timber Non-solid

Number of heaters required in medium house for part-house heating arrangement Heated Area 1

Heated area 1	Small	Large	Medium
Part house	# req	# req	# req
Elect	1	2	2
Night store	1	1	1
Solid fuel	1	1	1
Pellets	1	1	1
Gas	1	2	2
Heat pump	1	1	1

Number of heaters required in medium house for entire house heating arrangement Heated Area 2

Heated area 2	Small	Large	Medium
Entire house	# req	# req	# req
Elect	1	3	3
Night store	1	1	1
Solid fuel	1	1	1
Pellets	1	1	1
Gas	1	2	2
Heat pump	1	2	2

9.1.4 Inclusion of concrete thermal mass wall on the medium house details

- Covers the interior walls inside the living room, starting from the sitting room outer wall continuing along through to the study room outer wall
- Wall dimensions: length 16.7 m, height 2.4 m, 150 mm thick.

9.1.5 Insulation costs, rates, groupings

1. All costs and rates are GST exclusive.
2. All wall and ceiling insulation $/sqm rates are Pink Batts Fibreglass from Rawlinsons (2008) excluding:

    i) wall batts R-2.4 – this rate is estimated
    ii) ceiling batts R-4.6 – this rate is estimated
    iii) polyurethane sheet from Foremans– one rate is applied to all 16 regions and is one-third of the actual rate obtained from them due to expected economies of scale with increased usage.

Rawlinsons has four main rates from the main centres of New Zealand. Regions have been arbitrarily partitioned into the following $/sqm rate groups:

A. Auckland $/sqm Rawlinsons rate: Northland, Auckland, Hamilton, Bay of Plenty, Rotorua
B. Wellington/Christchurch/Dunedin $/sqm Rawlinsons rate: Taupo, New Plymouth, East Coast/Napier, Wellington, Nelson/Marlborough, West Coast, Christchurch, Central Otago, Dunedin, Invercargill, Cromwell (note that Wellington, Christchurch and Dunedin rates were very similar and only differed by $0.25/sqm)

3. Polystyrene floor insulation $/sqm rates are quotes from New Zealand builders. One rate is applied to all 16 regions.

Insulation rates		
Wall	**Auck**	**Wgtn/ChCh/Dune**
Batts 2.2	11.75	11.50
Batts 2.4	14.71	14.46
Batts 2.6	16.25	16.25
Batts 2.8	21.00	20.75
Polyurathene 4.5	51.84	51.59
Ceiling	**Auck**	**Wgtn/ChCh/Dune**
Batts 3.2	15.50	15.25
Batts 3.6	17.00	16.75
Batts 4.0	19.25	19.00
Batts 4.6	22.00	21.75
Batts 5.0	24.50	24.25
Floor Insul	**Auck Insul rate**	**Insul rate**
100mm full cover polystyrene	21.0	20.7
50mm full cover polystrene	13.0	12.7

Insulation levels initial costs
Insulation level options, Zone 1 & 2

	Small			Large			Medium	
Insulation level	**Auck**	**Wgtn/ChCh/Dune**		**Auck**	**Wgtn/ChCh/Dune**		**Auck**	**Wgtn/ChCh/Dune**
Level1	$ 2,184	$ 2,145		$ 5,798	$ 5,693		$ 5,576	$ 5,475
Level2	$ 2,851	$ 2,804		$ 7,331	$ 7,212		$ 7,075	$ 6,959
Level3	$ 3,708	$ 3,665		$ 9,172	$ 9,078		$ 8,964	$ 8,870
Level4	$ 4,895	$ 4,821		$ 12,630	$ 12,442		$ 12,167	$ 11,987
Level5	$ 7,907	$ 7,833		$ 21,020	$ 20,833		$ 20,247	$ 20,066

Insulation level options, Zone 3

Zone 3	Small			Large			Medium	
Insulation level	**Auck**	**Wgtn/ChCh/Dune**		**Auck**	**Wgtn/ChCh/Dune**		**Auck**	**Wgtn/ChCh/Dune**
Level1	$ 2,851	$ 2,804		$ 7,331	$ 7,212		$ 7,075	$ 6,959
Level2	$ 3,708	$ 3,665		$ 9,172	$ 9,078		$ 8,964	$ 8,870
Level3	$ 4,895	$ 4,821		$ 12,630	$ 12,442		$ 12,167	$ 11,987
Level4	$ 7,907	$ 7,833		$ 21,020	$ 20,833		$ 20,247	$ 20,066

Insulation costs groups

Regions	Insulation Costs group
Northland	Auck
Auckland	Auck
Hamilton	Auck
Bay of Plenty	Auck
Rotorua	Auck
Taupo	Wgtn/ChCh/Dune
New Plymouth	Wgtn/ChCh/Dune
East Coast/Napier	Wgtn/ChCh/Dune
Wellington	Wgtn/ChCh/Dune
Nelson/Marlborough	Wgtn/ChCh/Dune
West Coast	Wgtn/ChCh/Dune
Christchurch	Wgtn/ChCh/Dune
Central Otago	Wgtn/ChCh/Dune
Dunedin	Wgtn/ChCh/Dune
Invercargill	Wgtn/ChCh/Dune
Cromwell	Wgtn/ChCh/Dune

9.1.6 Thermal mass wall costs, rates, groupings

The extra costs for the inclusion of a thermal mass wall is calculated as the difference in $/sqm rates (Rawlinsons 2008) of the initial design of timber frame and the solid filled reinforced concrete block masonry wall.

Extra costs for thermal mass wall of medium house

Medium House Thermal Mass Wall				Timber Framing			
thick	0.15	Vol m3	sqm	thick	0.1	Vol m3	sqm
height	2.4	6.0	40.1	height	2.4	4.0	40.1
length	16.7			length	16.7		
		Rawlinsons					
		Auck	Wgtn	ChCh	Dune		
	Hollow Conc blocks, p71 S4.3, sqm	$ 145	$ 150	$ 146	$ 145		
	Interior Wall, p85 S10.1, sqm	$ 129	$ 122	$ 120	$ 124		
		$ 16	$ 28	$ 26	$ 21		
	Difference (Extra cost for Mass Wall)	$ 641	$ 1,122	$ 1,042	$ 842		

Rawlinsons has four main rates from the main centres of New Zealand. Regions have been arbitrarily partitioned into the following $/sqm rate groups:

A. Auckland $/sqm rate: Northland, Auckland, Hamilton, Bay of Plenty, Rotorua
B. Wellington $/sqm rate: Taupo, New Plymouth, East Coast/Napier, Wellington
C. Christchurch $/sqm rate: Nelson/Marlborough, West Coast, Christchurch
D. Dunedin $/sqm rate: Central Otago, Dunedin, Invercargill, and Cromwell.

Thermal mass wall costs groups

Regions	Thermal Wall costs group
Northland	Auck
Auckland	Auck
Hamilton	Auck
Bay of Plenty	Auck
Rotorua	Auck
Taupo	Wgtn
New Plymouth	Wgtn
East Coast/Napier	Wgtn
Wellington	Wgtn
Nelson/Marlborough	ChCh
West Coast	ChCh
Christchurch	ChCh
Central Otago	Dun
Dunedin	Dun
Invercargill	Dun
Cromwell	Dun

9.1.7 Appliance costs, life of appliance, energy rates, and groupings

Appliance costs are grouped either A or B of the table below.

	Initial appliance costs						
Regions	**Elect**	**Nitestor**	**Solid fuel**	**Pellets**	**Gas**	**Heat pump**	**Group**
Northland	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Auckland	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Hamilton	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Bay of Plenty	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Rotorua	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Taupo	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
New Plymouth	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
East Coast/Napier	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Wellington	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Nelson/Marlborough	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
West Coast	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Christchurch	$ 450	$ 1,000	$ 2,500	$ 4,000	$ 2,600	$ 3,000	A
Central Otago	$ 600	$ 1,500	$ 3,000	$ 5,000	$ 3,500	$ 4,000	B
Dunedin	$ 600	$ 1,500	$ 3,000	$ 5,000	$ 3,500	$ 4,000	B
Invercargill	$ 600	$ 1,500	$ 3,000	$ 5,000	$ 3,500	$ 4,000	B
Cromwell	$ 600	$ 1,500	$ 3,000	$ 5,000	$ 3,500	$ 4,000	B
life years	15	20	30	30	20	15	

Energy rates vary depending on which heating device is used. Energy $/kWh (kilowatt hours) rates are from Meridian Energy as at March 2009.

Energy rates $/kWh

	energy costs $/kWh					
Regions	**Elect**	**Nitestor**	**Solid fuel**	**Pellets**	**Gas**	**Heat pump**
Northland	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Auckland	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Hamilton	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Bay of Plenty	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Rotorua	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Taupo	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
New Plymouth	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
East Coast/Napier	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Wellington	$ 0.19	$ 0.13	$ 0.10	$ 0.09	$ 0.10	$ 0.07
Nelson/Marlborough	$ 0.18	$ 0.12	$ 0.10	$ 0.09	$ 0.22	$ 0.06
West Coast	$ 0.18	$ 0.12	$ 0.10	$ 0.09	$ 0.22	$ 0.06
Christchurch	$ 0.18	$ 0.12	$ 0.10	$ 0.09	$ 0.22	$ 0.06
Central Otago	$ 0.20	$ 0.14	$ 0.10	$ 0.09	$ 0.22	$ 0.07
Dunedin	$ 0.20	$ 0.14	$ 0.10	$ 0.09	$ 0.22	$ 0.07
Invercargill	$ 0.20	$ 0.14	$ 0.10	$ 0.09	$ 0.22	$ 0.07
Cromwell	$ 0.20	$ 0.14	$ 0.10	$ 0.09	$ 0.22	$ 0.07

Energy rates groups

	Rates groupings					
Regions	**Elect**	**Nitestor**	**Solid fuel**	**Pellets**	**Gas**	**Heat pump**
Northland	E1	N1	S1	P1	G1	H1
Auckland	E1	N1	S1	P1	G1	H1
Hamilton	E1	N1	S1	P1	G1	H1
Bay of Plenty	E1	N1	S1	P1	G1	H1
Rotorua	E1	N1	S1	P1	G1	H1
Taupo	E1	N1	S1	P1	G1	H1
New Plymouth	E1	N1	S1	P1	G1	H1
East Coast/Napier	E1	N1	S1	P1	G1	H1
Wellington	E1	N1	S1	P1	G1	H1
Nelson/Marlborough	E2	N2	S1	P1	G2	H2
West Coast	E2	N2	S1	P1	G2	H2
Christchurch	E2	N2	S1	P1	G2	H2
Central Otago	E3	N3	S1	P1	G2	H3
Dunedin	E3	N3	S1	P1	G2	H3
Invercargill	E3	N3	S1	P1	G2	H3
Cromwell	E3	N3	S1	P1	G2	H3

Gas rates are higher in the South Island than the North Island because the former is LPG, while the latter is natural gas.

10. APPENDIX 2: FINANCIAL ANALYSIS OF ALL SCENARIOS, PART-HOUSE HEATING AND ENTIRE HOUSE HEATING WITH AND WITHOUT THERMAL MASS WALL

This section includes detailed results (benefit-cost ratios, Present Values (PVs), Net Present Values (NPV), energy KWh per year, number of heaters required, PV heaters including replacement, PV energy, insulation cost, thermal wall cost if applicable) of all scenarios. All three houses were included for part-house heating Heated Area 1 without thermal mass wall. Only the medium house was analysed for the other scenarios. Only the three main heaters (electric, heat pump, gas) were analysed when medium house is with thermal mass wall.

Under each table, explanations are given for:

1. Benefit-cost ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using Insulation Level 1 without thermal wall as the base case
2. Total Present Value = PV heater including replacements + PV energy + insulation cost + thermal wall extra cost
3. NPV is for Insulation Level 1 (without thermal wall) as base case
4. If heat pump, summer cooling energy consumption is included
5. PV of energy costs is over an analysis period of 30 years
6. Insulation cost = cost of floor type + wall insulation type + ceiling insulation type
7. Extra cost of thermal mass wall compared with timber wall.

10.1 Part-house heating Heated Area 1 results – all three different-sized house types – under all heater types

Variable	Options selected	
House type(s)	Small, Medium, Large	
Schedule	Eve21 for all heaters apart from heat pump. For Heat pump: Summer (Day19,Eve21)	
Heated area	1	
Themal Mass wall?	None	
Life cycle years	30	
Discount rate	5%	
Energy price escalation	1%	
Orientation(s)	North	
Heater	Electric, Nitestor, Gas, Pellets, Solid fuel, Heat pump	

10.1.1 Small House – Electric resistance

Small House

Part house heating
Electric heating
No thermal wall
North Orientation

Period = 30 years
Discount rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
Level1		7371		1348	15	1	666	4520	2184	n/a
Level2	0.8	7520	-150	1194	15	1	666	4003	2851	n/a
Level3	0.4	8262	-891	1159	15	1	666	3888	3708	n/a
Level4	0.5	8706	-1336	938	15	1	666	3145	4895	n/a
Level5	0.4	11084	-3713	749	15	1	666	2511	7907	n/a
Auckland										
Level1		7455		1373	15	1	666	4604	2184	n/a
Level2	0.7	7660	-206	1235	15	1	666	4143	2851	n/a
Level3	0.4	8388	-934	1197	15	1	666	4014	3708	n/a
Level4	0.5	8927	-1473	1004	15	1	666	3366	4895	n/a
Level5	0.3	11337	-3883	824	15	1	666	2764	7907	n/a
Hamilton										
Level1		10271		2213	15	1	666	7420	2184	n/a
Level2	1.0	10257	13	2010	15	1	666	6740	2851	n/a
Level3	0.6	10914	-643	1950	15	1	666	6540	3708	n/a
Level4	0.7	11156	-885	1668	15	1	666	5594	4895	n/a
Level5	0.5	13284	-3013	1405	15	1	666	4711	7907	n/a
Bay of Plenty										
Level1		8391		1652	15	1	666	5540	2184	n/a
Level2	0.8	8496	-105	1485	15	1	666	4978	2851	n/a
Level3	0.5	9204	-814	1440	15	1	666	4830	3708	n/a
Level4	0.6	9594	-1203	1203	15	1	666	4033	4895	n/a
Level5	0.4	11889	-3498	989	15	1	666	3316	7907	n/a
Rotorua										
Level1		16166		3971	15	1	666	13315	2184	n/a
Level2	2.3	15293	873	3511	15	1	666	11775	2851	n/a
Level3	1.2	15877	289	3430	15	1	666	11502	3708	n/a
Level4	1.5	14808	1358	2757	15	1	666	9247	4895	n/a
Level5	1.0	16092	74	2242	15	1	666	7519	7907	n/a
Taupo										
Level1		14204		3201	15	1	666	10734	2804	n/a
Level2	0.3	14776	-572	3115	15	1	666	10445	3665	n/a
Level3	0.9	14493	-289	2685	15	1	666	9006	4821	n/a
Level4	0.6	16175	-1971	2289	15	1	666	7676	7833	n/a
New Plymouth										
Level1		9787		2080	15	1	666	6976	2145	n/a
Level2	1.0	9759	28	1875	15	1	666	6288	2804	n/a
Level3	0.6	10431	-644	1819	15	1	666	6100	3665	n/a
Level4	0.7	10637	-850	1536	15	1	666	5150	4821	n/a
Level5	0.5	12790	-3003	1280	15	1	666	4291	7833	n/a
East Coast/Napier										
Level1		9813		2088	15	1	666	7002	2145	n/a
Level2	1.0	9815	-1	1892	15	1	666	6344	2804	n/a
Level3	0.6	10487	-674	1836	15	1	666	6156	3665	n/a
Level4	0.7	10733	-920	1564	15	1	666	5246	4821	n/a
Level5	0.5	12888	-3075	1309	15	1	666	4389	7833	n/a
Wellington										
Level1		12151		2785	15	1	666	9339	2145	n/a
Level2	1.5	11844	307	2497	15	1	666	8373	2804	n/a
Level3	0.8	12485	-334	2431	15	1	666	8153	3665	n/a
Level4	1.0	12266	-116	2022	15	1	666	6779	4821	n/a
Level5	0.7	14116	-1965	1675	15	1	666	5617	7833	n/a
Nelson/Marlborough										
Level1		8087		1476	15	1	666	4617	2804	n/a
Level2	0.1	8836	-749	1440	15	1	666	4505	3665	n/a
Level3	0.6	8925	-838	1099	15	1	666	3438	4821	n/a
Level4	0.4	11143	-3056	845	15	1	666	2644	7833	n/a
West Coast										
Level1		13888		3331	15	1	666	10417	2804	n/a
Level2	0.3	14478	-591	3244	15	1	666	10147	3665	n/a
Level3	0.9	14106	-218	2756	15	1	666	8619	4821	n/a
Level4	0.6	15766	-1878	2324	15	1	666	7267	7833	n/a
Christchurch										
Level1		15297		3781	15	1	666	11827	2804	n/a
Level2	0.3	15860	-563	3686	15	1	666	11529	3665	n/a
Level3	0.9	15411	-114	3173	15	1	666	9924	4821	n/a
Level4	0.7	16969	-1672	2708	15	1	666	8470	7833	n/a
Central Otago										
Level1		21743		5220	15	1	889	18051	2804	n/a
Level2	0.5	22186	-443	5100	15	1	889	17633	3665	n/a
Level3	1.4	20881	862	4388	15	1	889	15172	4821	n/a
Level4	1.0	21733	10	3763	15	1	889	13012	7833	n/a
Dunedin										
Level1		18661		4329	15	1	889	14968	2804	n/a
Level2	0.4	19176	-515	4229	15	1	889	14623	3665	n/a
Level3	1.3	18032	629	3564	15	1	889	12323	4821	n/a
Level4	0.9	19088	-427	2998	15	1	889	10366	7833	n/a
Invercargill										
Level1		20208		4776	15	1	889	16516	2804	n/a
Level2	0.4	20683	-475	4665	15	1	889	16130	3665	n/a
Level3	1.4	19390	819	3956	15	1	889	13680	4821	n/a
Level4	1.0	20305	-96	3350	15	1	889	11583	7833	n/a
Cromwell										
Level1		21960		5283	15	1	889	18268	2804	n/a
Level2	0.5	22400	-440	5162	15	1	889	17847	3665	n/a
Level3	1.4	21121	840	4457	15	1	889	15411	4821	n/a
Level4	1.0	21988	-28	3837	15	1	889	13267	7833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.2 Small House – Heat Pump

Small House

Part house heating
Heat Pump
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		9298		2228	15	1	4443	2671	2184	n/a
Level2	0.2	9809	-511	2098	15	1	4443	2515	2851	n/a
Level3	0.1	10631	-1332	2068	15	1	4443	2480	3708	n/a
Level4	0.1	11606	-2308	1892	15	1	4443	2268	4895	n/a
Level5	0.1	14459	-5161	1759	15	1	4443	2109	7907	n/a
Auckland										
Level1		9412		2322	15	1	4443	2784	2184	n/a
Level2	0.2	9940	-529	2207	15	1	4443	2646	2851	n/a
Level3	0.1	10756	-1344	2173	15	1	4443	2605	3708	n/a
Level4	0.1	11762	-2350	2022	15	1	4443	2424	4895	n/a
Level5	0.1	14617	-5206	1891	15	1	4443	2267	7907	n/a
Hamilton										
Level1		10035		2842	15	1	4443	3408	2184	n/a
Level2	0.3	10490	-455	2665	15	1	4443	3196	2851	n/a
Level3	0.2	11280	-1245	2610	15	1	4443	3129	3708	n/a
Level4	0.2	12189	-2154	2378	15	1	4443	2851	4895	n/a
Level5	0.1	14954	-4919	2172	15	1	4443	2604	7907	n/a
Bay of Plenty										
Level1		9659		2529	15	1	4443	3032	2184	n/a
Level2	0.2	10164	-504	2394	15	1	4443	2870	2851	n/a
Level3	0.1	10972	-1312	2353	15	1	4443	2821	3708	n/a
Level4	0.2	11949	-2290	2178	15	1	4443	2611	4895	n/a
Level5	0.1	14782	-5123	2029	15	1	4443	2432	7907	n/a
Rotorua										
Level1		11461		4031	15	1	4443	4833	2184	n/a
Level2	0.8	11616	-156	3605	15	1	4443	4322	2851	n/a
Level3	0.4	12375	-914	3523	15	1	4443	4224	3708	n/a
Level4	0.5	12862	-1402	2940	15	1	4443	3524	4895	n/a
Level5	0.3	15359	-3898	2510	15	1	4443	3009	7907	n/a
Taupo										
Level1		11488		3538	15	1	4443	4241	2804	n/a
Level2	0.1	12249	-761	3454	15	1	4443	4141	3665	n/a
Level3	0.3	12934	-1446	3061	15	1	4443	3670	4821	n/a
Level4	0.2	15520	-4032	2706	15	1	4443	3244	7833	n/a
New Plymouth										
Level1		9597		2510	15	1	4443	3009	2145	n/a
Level2	0.3	10037	-440	2327	15	1	4443	2790	2804	n/a
Level3	0.2	10836	-1239	2275	15	1	4443	2728	3665	n/a
Level4	0.2	11699	-2102	2032	15	1	4443	2436	4821	n/a
Level5	0.1	14459	-4862	1821	15	1	4443	2183	7833	n/a
East Coast/Napier										
Level1		10105		2934	15	1	4443	3517	2145	n/a
Level2	0.3	10548	-443	2753	15	1	4443	3301	2804	n/a
Level3	0.2	11345	-1240	2700	15	1	4443	3237	3665	n/a
Level4	0.2	12219	-2113	2465	15	1	4443	2955	4821	n/a
Level5	0.1	14973	-4867	2250	15	1	4443	2697	7833	n/a
Wellington										
Level1		10325		3117	15	1	4443	3737	2145	n/a
Level2	0.5	10666	-341	2852	15	1	4443	3419	2804	n/a
Level3	0.3	11453	-1128	2790	15	1	4443	3345	3665	n/a
Level4	0.3	12169	-1844	2423	15	1	4443	2905	4821	n/a
Level5	0.2	14820	-4495	2122	15	1	4443	2544	7833	n/a
Nelson/Marlborough										
Level1		9770		2269	15	1	4443	2523	2804	n/a
Level2	0.0	10595	-825	2236	15	1	4443	2487	3665	n/a
Level3	0.2	11460	-1691	1975	15	1	4443	2196	4821	n/a
Level4	0.1	14279	-4509	1802	15	1	4443	2003	7833	n/a
West Coast										
Level1		11153		3512	15	1	4443	3906	2804	n/a
Level2	0.1	11920	-767	3428	15	1	4443	3812	3665	n/a
Level3	0.3	12560	-1407	2964	15	1	4443	3296	4821	n/a
Level4	0.2	15123	-3970	2560	15	1	4443	2847	7833	n/a
Christchurch										
Level1		11852		4141	15	1	4443	4604	2804	n/a
Level2	0.1	12609	-757	4048	15	1	4443	4501	3665	n/a
Level3	0.3	13219	-1368	3557	15	1	4443	3955	4821	n/a
Level4	0.2	15744	-3893	3119	15	1	4443	3469	7833	n/a
Central Otago										
Level1		15357		5373	15	1	5924	6629	2804	n/a
Level2	0.2	16071	-714	5254	15	1	5924	6482	3665	n/a
Level3	0.5	16373	-1016	4562	15	1	5924	5628	4821	n/a
Level4	0.3	18642	-3285	3960	15	1	5924	4885	7833	n/a
Dunedin										
Level1		14123		4373	15	1	5924	5395	2804	n/a
Level2	0.1	14861	-738	4273	15	1	5924	5272	3665	n/a
Level3	0.5	15215	-1093	3624	15	1	5924	4470	4821	n/a
Level4	0.3	17548	-3425	3073	15	1	5924	3791	7833	n/a
Invercargill										
Level1		14655		4804	15	1	5924	5926	2804	n/a
Level2	0.2	15378	-723	4693	15	1	5924	5789	3665	n/a
Level3	0.5	15679	-1024	3999	15	1	5924	4934	4821	n/a
Level4	0.3	17963	-3308	3409	15	1	5924	4206	7833	n/a
Cromwell										
Level1		15517		5503	15	1	5924	6789	2804	n/a
Level2	0.2	16230	-712	5383	15	1	5924	6641	3665	n/a
Level3	0.5	16556	-1038	4710	15	1	5924	5811	4821	n/a
Level4	0.3	18843	-3326	4123	15	1	5924	5086	7833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.3 Small House – Gas

Small House

Part house heating
Gas heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
Level1		8106		1348	20	1	3580	2342	2184	n/a
Level2	0.4	8505	-399	1194	20	1	3580	2074	2851	n/a
Level3	0.2	9302	-1196	1159	20	1	3580	2014	3708	n/a
Level4	0.3	10104	-1998	938	20	1	3580	1630	4895	n/a
Level5	0.2	12787	-4681	749	20	1	3580	1301	7907	n/a
Auckland										
Level1		8150		1373	20	1	3580	2385	2184	n/a
Level2	0.4	8577	-428	1235	20	1	3580	2147	2851	n/a
Level3	0.2	9368	-1218	1197	20	1	3580	2080	3708	n/a
Level4	0.2	10219	-2069	1004	20	1	3580	1744	4895	n/a
Level5	0.2	12919	-4769	824	20	1	3580	1432	7907	n/a
Hamilton										
Level1		9609		2213	20	1	3580	3845	2184	n/a
Level2	0.5	9923	-314	2010	20	1	3580	3492	2851	n/a
Level3	0.3	10676	-1067	1950	20	1	3580	3388	3708	n/a
Level4	0.3	11373	-1765	1668	20	1	3580	2899	4895	n/a
Level5	0.2	13928	-4319	1405	20	1	3580	2441	7907	n/a
Bay of Plenty										
Level1		8635		1652	20	1	3580	2871	2184	n/a
Level2	0.4	9010	-376	1485	20	1	3580	2580	2851	n/a
Level3	0.2	9790	-1156	1440	20	1	3580	2503	3708	n/a
Level4	0.3	10564	-1930	1203	20	1	3580	2090	4895	n/a
Level5	0.2	13205	-4570	989	20	1	3580	1718	7907	n/a
Rotorua										
Level1		12663		3971	20	1	3580	6899	2184	n/a
Level2	1.2	12532	131	3511	20	1	3580	6101	2851	n/a
Level3	0.6	13247	-584	3430	20	1	3580	5960	3708	n/a
Level4	0.8	13266	-603	2757	20	1	3580	4791	4895	n/a
Level5	0.5	15382	-2719	2242	20	1	3580	3896	7907	n/a
Taupo										
Level1		11945		3201	20	1	3580	5562	2804	n/a
Level2	0.2	12657	-711	3115	20	1	3580	5412	3665	n/a
Level3	0.4	13067	-1121	2685	20	1	3580	4666	4821	n/a
Level4	0.3	15390	-3445	2289	20	1	3580	3977	7833	n/a
New Plymouth										
Level1		9339		2080	20	1	3580	3614	2145	n/a
Level2	0.5	9642	-303	1875	20	1	3580	3258	2804	n/a
Level3	0.3	10405	-1066	1819	20	1	3580	3161	3665	n/a
Level4	0.4	11069	-1730	1536	20	1	3580	2668	4821	n/a
Level5	0.2	13636	-4297	1280	20	1	3580	2223	7833	n/a
East Coast/Napier										
Level1		9353		2088	20	1	3580	3628	2145	n/a
Level2	0.5	9671	-318	1892	20	1	3580	3287	2804	n/a
Level3	0.3	10434	-1082	1836	20	1	3580	3190	3665	n/a
Level4	0.3	11119	-1766	1564	20	1	3580	2718	4821	n/a
Level5	0.2	13687	-4334	1309	20	1	3580	2274	7833	n/a
Wellington										
Level1		10564		2785	20	1	3580	4839	2145	n/a
Level2	0.8	10722	-159	2497	20	1	3580	4338	2804	n/a
Level3	0.4	11469	-905	2431	20	1	3580	4225	3665	n/a
Level4	0.5	11913	-1349	2022	20	1	3580	3513	4821	n/a
Level5	0.3	14323	-3759	1675	20	1	3580	2910	7833	n/a
Nelson/Marlborough										
Level1		12027		1476	20	1	3580	5643	2804	n/a
Level2	0.2	12751	-724	1440	20	1	3580	5506	3665	n/a
Level3	0.7	12603	-576	1099	20	1	3580	4202	4821	n/a
Level4	0.5	14644	-2617	845	20	1	3580	3231	7833	n/a
West Coast										
Level1		19116		3331	20	1	3580	12732	2804	n/a
Level2	0.4	19647	-531	3244	20	1	3580	12402	3665	n/a
Level3	1.1	18935	181	2756	20	1	3580	10534	4821	n/a
Level4	0.8	20294	-1178	2324	20	1	3580	8882	7833	n/a
Christchurch										
Level1		20839		3781	20	1	3580	14455	2804	n/a
Level2	0.4	21335	-497	3686	20	1	3580	14091	3665	n/a
Level3	1.2	20530	309	3173	20	1	3580	12129	4821	n/a
Level4	0.8	21765	-927	2708	20	1	3580	10353	7833	n/a
Central Otago										
Level1		27579		5220	20	1	4819	19956	2804	n/a
Level2	0.5	27978	-399	5100	20	1	4819	19494	3665	n/a
Level3	1.6	26413	1166	4388	20	1	4819	16773	4821	n/a
Level4	1.1	27037	542	3763	20	1	4819	14385	7833	n/a
Dunedin										
Level1		24171		4329	20	1	4819	16548	2804	n/a
Level2	0.4	24649	-478	4229	20	1	4819	16166	3665	n/a
Level3	1.5	23263	908	3564	20	1	4819	13623	4821	n/a
Level4	1.0	24112	59	2998	20	1	4819	11460	7833	n/a
Invercargill										
Level1		25882		4776	20	1	4819	18259	2804	n/a
Level2	0.5	26316	-434	4665	20	1	4819	17832	3665	n/a
Level3	1.6	24764	1118	3956	20	1	4819	15124	4821	n/a
Level4	1.1	25457	424	3350	20	1	4819	12806	7833	n/a
Cromwell										
Level1		27819		5283	20	1	4819	20196	2804	n/a
Level2	0.5	28214	-396	5162	20	1	4819	19730	3665	n/a
Level3	1.6	26677	1141	4457	20	1	4819	17037	4821	n/a
Level4	1.1	27319	500	3837	20	1	4819	14667	7833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.4 Medium House – Electric resistance

Medium House

Part house heating
Electric heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		15903		2682	15	2	1333	8995	5576	n/a
Level2	2.0	14376	1528	1780	15	2	1333	5968	7075	n/a
Level3	0.9	16141	-238	1743	15	2	1333	5844	8964	n/a
Level4	0.5	19206	-3303	1702	15	2	1333	5706	12167	n/a
Level5	0.3	26896	-10993	1585	15	2	1333	5317	20247	n/a
Auckland										
Level1		16134		2751	15	2	1333	9226	5576	n/a
Level2	2.1	14489	1645	1813	15	2	1333	6081	7075	n/a
Level3	1.0	16246	-112	1774	15	2	1333	5949	8964	n/a
Level4	0.5	19302	-3168	1730	15	2	1333	5802	12167	n/a
Level5	0.3	27017	-10883	1622	15	2	1333	5438	20247	n/a
Hamilton										
Level1		22522		4656	15	2	1333	15614	5576	n/a
Level2	3.2	19198	3324	3218	15	2	1333	10791	7075	n/a
Level3	1.5	20878	1644	3155	15	2	1333	10581	8964	n/a
Level4	0.8	23847	-1324	3085	15	2	1333	10346	12167	n/a
Level5	0.4	31367	-8845	2919	15	2	1333	9787	20247	n/a
Bay of Plenty										
Level1		18028		3316	15	2	1333	11120	5576	n/a
Level2	2.4	15905	2123	2236	15	2	1333	7497	7075	n/a
Level3	1.1	17642	386	2190	15	2	1333	7345	8964	n/a
Level4	0.6	20675	-2646	2139	15	2	1333	7174	12167	n/a
Level5	0.3	28323	-10294	2011	15	2	1333	6743	20247	n/a
Rotorua										
Level1		31338		7285	15	2	1333	24429	5576	n/a
Level2	4.5	26144	5194	5289	15	2	1333	17737	7075	n/a
Level3	2.1	27765	3573	5209	15	2	1333	17467	8964	n/a
Level4	1.1	30665	673	5118	15	2	1333	17165	12167	n/a
Level5	0.6	37789	-6450	4833	15	2	1333	16209	20247	n/a
Taupo										
Level1		25456		5118	15	2	1333	17164	6959	n/a
Level2	0.2	27072	-1616	5030	15	2	1333	16869	8870	n/a
Level3	0.1	29861	-4405	4933	15	2	1333	16541	11987	n/a
Level4	0.1	37138	-11682	4693	15	2	1333	15739	20066	n/a
New Plymouth										
Level1		20795		4171	15	2	1333	13988	5475	n/a
Level2	3.1	17694	3102	2804	15	2	1333	9402	6959	n/a
Level3	1.4	19409	1386	2745	15	2	1333	9206	8870	n/a
Level4	0.8	22309	-1513	2680	15	2	1333	8989	11987	n/a
Level5	0.4	29843	-9047	2518	15	2	1333	8444	20066	n/a
East Coast/Napier										
Level1		21290		4319	15	2	1333	14483	5475	n/a
Level2	3.1	18233	3057	2964	15	2	1333	9941	6959	n/a
Level3	1.4	19949	1342	2906	15	2	1333	9745	8870	n/a
Level4	0.8	22845	-1555	2841	15	2	1333	9526	11987	n/a
Level5	0.4	30390	-9100	2681	15	2	1333	8991	20066	n/a
Wellington										
Level1		25185		5480	15	2	1333	18378	5475	n/a
Level2	3.6	21340	3845	3891	15	2	1333	13048	6959	n/a
Level3	1.6	23029	2156	3825	15	2	1333	12826	8870	n/a
Level4	0.9	25899	-714	3751	15	2	1333	12579	11987	n/a
Level5	0.4	33286	-8101	3545	15	2	1333	11887	20066	n/a
Nelson/Marlborough										
Level1		15023		2152	15	2	1333	6731	6959	n/a
Level2	0.1	16817	-1794	2115	15	2	1333	6614	8870	n/a
Level3	0.0	19802	-4779	2073	15	2	1333	6482	11987	n/a
Level4	0.1	27411	-12388	1922	15	2	1333	6012	20066	n/a
West Coast										
Level1		24509		5185	15	2	1333	16217	6959	n/a
Level2	0.1	26152	-1642	5099	15	2	1333	15948	8870	n/a
Level3	0.1	28968	-4459	5003	15	2	1333	15649	11987	n/a
Level4	0.1	36266	-11757	4753	15	2	1333	14867	20066	n/a
Christchurch										
Level1		27337		6089	15	2	1333	19045	6959	n/a
Level2	0.2	28948	-1610	5993	15	2	1333	18744	8870	n/a
Level3	0.1	31728	-4391	5886	15	2	1333	18408	11987	n/a
Level4	0.1	38945	-11608	5610	15	2	1333	17546	20066	n/a
Central Otago										
Level1		36865		8135	15	2	1777	28129	6959	n/a
Level2	0.2	38363	-1498	8016	15	2	1777	27716	8870	n/a
Level3	0.2	41018	-4152	7882	15	2	1777	27254	11987	n/a
Level4	0.2	47845	-10979	7520	15	2	1777	26001	20066	n/a
Dunedin										
Level1		32660		6919	15	2	1777	23924	6959	n/a
Level2	0.2	34228	-1568	6820	15	2	1777	23581	8870	n/a
Level3	0.1	36960	-4300	6709	15	2	1777	23196	11987	n/a
Level4	0.1	43922	-11262	6385	15	2	1777	22078	20066	n/a
Invercargill										
Level1		34897		7566	15	2	1777	26161	6959	n/a
Level2	0.2	36426	-1529	7455	15	2	1777	25778	8870	n/a
Level3	0.2	39116	-4219	7332	15	2	1777	25352	11987	n/a
Level4	0.2	46008	-11111	6989	15	2	1777	24165	20066	n/a
Cromwell										
Level1		38034		8473	15	2	1777	29297	6959	n/a
Level2	0.2	39524	-1490	8351	15	2	1777	28876	8870	n/a
Level3	0.2	42169	-4135	8215	15	2	1777	28405	11987	n/a
Level4	0.2	48994	-10961	7852	15	2	1777	27151	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.5 Medium House – Heat Pump

Medium House

Part house heating
Heat Pump
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy	Heater	# heaters	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$	kWh/ year	life years	in house	$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		15232		4348	15	1	4443	5213	5576	n/a
Level2	0.6	15898	-666	3653	15	1	4443	4380	7075	n/a
Level3	0.3	17749	-2517	3622	15	1	4443	4342	8964	n/a
Level4	0.1	20910	-5678	3586	15	1	4443	4300	12167	n/a
Level5	0.1	28901	-13669	3512	15	1	4443	4211	20247	n/a
Auckland										
Level1		15504		4575	15	1	4443	5485	5576	n/a
Level2	0.6	16089	-585	3813	15	1	4443	4571	7075	n/a
Level3	0.3	17937	-2433	3778	15	1	4443	4530	8964	n/a
Level4	0.2	21093	-5589	3739	15	1	4443	4483	12167	n/a
Level5	0.1	29084	-13580	3665	15	1	4443	4394	20247	n/a
Hamilton										
Level1		17243		6026	15	1	4443	7224	5576	n/a
Level2	1.0	17242	1	4774	15	1	4443	5724	7075	n/a
Level3	0.5	19062	-1819	4717	15	1	4443	5655	8964	n/a
Level4	0.2	22188	-4945	4652	15	1	4443	5577	12167	n/a
Level5	0.1	30112	-12869	4523	15	1	4443	5422	20247	n/a
Bay of Plenty										
Level1		16191		5148	15	1	4443	6172	5576	n/a
Level2	0.7	16624	-433	4259	15	1	4443	5106	7075	n/a
Level3	0.3	18464	-2273	4218	15	1	4443	5056	8964	n/a
Level4	0.2	21611	-5420	4171	15	1	4443	5001	12167	n/a
Level5	0.1	29585	-13394	4083	15	1	4443	4895	20247	n/a
Rotorua										
Level1		19293		7735	15	1	4443	9274	5576	n/a
Level2	1.5	18519	774	5840	15	1	4443	7002	7075	n/a
Level3	0.7	20313	-1020	5760	15	1	4443	6906	8964	n/a
Level4	0.4	23408	-4115	5670	15	1	4443	6798	12167	n/a
Level5	0.2	31190	-11897	5422	15	1	4443	6500	20247	n/a
Taupo										
Level1		18617		6018	15	1	4443	7215	6959	n/a
Level2	0.1	20427	-1810	5934	15	1	4443	7114	8870	n/a
Level3	0.0	23430	-4813	5839	15	1	4443	7001	11987	n/a
Level4	0.0	31256	-12638	5627	15	1	4443	6747	20066	n/a
New Plymouth										
Level1		16095		5152	15	1	4443	6177	5475	n/a
Level2	0.97	16146	-51	3956	15	1	4443	4743	6959	n/a
Level3	0.4	17993	-1898	3904	15	1	4443	4680	8870	n/a
Level4	0.2	21040	-4945	3845	15	1	4443	4610	11987	n/a
Level5	0.1	28961	-12866	3713	15	1	4443	4452	20066	n/a
East Coast/Napier										
Level1		17170		6049	15	1	4443	7252	5475	n/a
Level2	0.97	17215	-45	4848	15	1	4443	5813	6959	n/a
Level3	0.4	19060	-1891	4794	15	1	4443	5747	8870	n/a
Level4	0.2	22103	-4933	4732	15	1	4443	5673	11987	n/a
Level5	0.1	30030	-12861	4605	15	1	4443	5521	20066	n/a
Wellington										
Level1		17392		6234	15	1	4443	7474	5475	n/a
Level2	1.2	17151	241	4795	15	1	4443	5749	6959	n/a
Level3	0.5	18988	-1596	4733	15	1	4443	5675	8870	n/a
Level4	0.3	22022	-4630	4664	15	1	4443	5592	11987	n/a
Level5	0.1	29893	-12501	4491	15	1	4443	5384	20066	n/a
Nelson/Marlborough										
Level1		15784		3940	15	1	4443	4381	6959	n/a
Level2	0.0	17657	-1873	3906	15	1	4443	4344	8870	n/a
Level3	0.0	20732	-4948	3868	15	1	4443	4302	11987	n/a
Level4	0.0	28701	-12917	3769	15	1	4443	4192	20066	n/a
West Coast										
Level1		17772		5728	15	1	4443	6369	6959	n/a
Level2	0.0	19591	-1819	5645	15	1	4443	6278	8870	n/a
Level3	0.0	22605	-4833	5553	15	1	4443	6175	11987	n/a
Level4	0.0	30430	-12658	5325	15	1	4443	5921	20066	n/a
Christchurch										
Level1		19151		6968	15	1	4443	7748	6959	n/a
Level2	0.1	20957	-1806	6873	15	1	4443	7643	8870	n/a
Level3	0.0	23956	-4805	6768	15	1	4443	7526	11987	n/a
Level4	0.0	31754	-12603	6515	15	1	4443	7245	20066	n/a
Central Otago										
Level1		23490		8598	15	1	5924	10607	6959	n/a
Level2	0.1	25257	-1767	8481	15	1	5924	10463	8870	n/a
Level3	0.1	28212	-4721	8350	15	1	5924	10301	11987	n/a
Level4	0.1	35869	-12379	8008	15	1	5924	9879	20066	n/a
Dunedin										
Level1		21673		7125	15	1	5924	8790	6959	n/a
Level2	0.1	23463	-1790	7027	15	1	5924	8669	8870	n/a
Level3	0.1	26445	-4772	6917	15	1	5924	8534	11987	n/a
Level4	0.0	34140	-12467	6606	15	1	5924	8150	20066	n/a
Invercargill										
Level1		22448		7753	15	1	5924	9565	6959	n/a
Level2	0.1	24224	-1776	7644	15	1	5924	9430	8870	n/a
Level3	0.1	27190	-4742	7522	15	1	5924	9280	11987	n/a
Level4	0.1	34862	-12414	7192	15	1	5924	8872	20066	n/a
Cromwell										
Level1		24150		9133	15	1	5924	11267	6959	n/a
Level2	0.1	25913	-1763	9013	15	1	5924	11119	8870	n/a
Level3	0.1	28863	-4713	8878	15	1	5924	10953	11987	n/a
Level4	0.1	36524	-12374	8539	15	1	5924	10534	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.6 Medium House – Gas

Medium House

Part house heating
Gas heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$				$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		17396		2682	20	2	7160	4660	5576	n/a
Level2	1.0	17327	69	1780	20	2	7160	3092	7075	n/a
Level3	0.5	19152	-1756	1743	20	2	7160	3028	8964	n/a
Level4	0.3	22284	-4888	1702	20	2	7160	2956	12167	n/a
Level5	0.1	30161	-12765	1585	20	2	7160	2755	20247	n/a
Auckland										
Level1		17516		2751	20	2	7160	4780	5576	n/a
Level2	1.1	17386	130	1813	20	2	7160	3151	7075	n/a
Level3	0.5	19207	-1691	1774	20	2	7160	3082	8964	n/a
Level4	0.3	22333	-4818	1730	20	2	7160	3006	12167	n/a
Level5	0.1	30224	-12708	1622	20	2	7160	2817	20247	n/a
Hamilton										
Level1		20826		4656	20	2	7160	8090	5576	n/a
Level2	1.7	19826	1000	3218	20	2	7160	5591	7075	n/a
Level3	0.8	21607	-781	3155	20	2	7160	5482	8964	n/a
Level4	0.4	24688	-3862	3085	20	2	7160	5361	12167	n/a
Level5	0.2	32478	-11652	2919	20	2	7160	5071	20247	n/a
Bay of Plenty										
Level1		18497		3316	20	2	7160	5761	5576	n/a
Level2	1.3	18119	378	2236	20	2	7160	3885	7075	n/a
Level3	0.6	19930	-1433	2190	20	2	7160	3806	8964	n/a
Level4	0.3	23044	-4547	2139	20	2	7160	3717	12167	n/a
Level5	0.2	30900	-12403	2011	20	2	7160	3494	20247	n/a
Rotorua										
Level1		25393		7285	20	2	7160	12658	5576	n/a
Level2	2.3	23425	1969	5289	20	2	7160	9190	7075	n/a
Level3	1.1	25175	219	5209	20	2	7160	9050	8964	n/a
Level4	0.6	28221	-2827	5118	20	2	7160	8894	12167	n/a
Level5	0.3	35805	-10412	4833	20	2	7160	8398	20247	n/a
Taupo										
Level1		23012		5118	20	2	7160	8893	6959	n/a
Level2	0.1	24771	-1758	5030	20	2	7160	8741	8870	n/a
Level3	0.1	27717	-4705	4933	20	2	7160	8571	11987	n/a
Level4	0.1	35381	-12369	4693	20	2	7160	8155	20066	n/a
New Plymouth										
Level1		19882		4171	20	2	7160	7248	5475	n/a
Level2	1.6	18990	892	2804	20	2	7160	4871	6959	n/a
Level3	0.7	20800	-918	2745	20	2	7160	4770	8870	n/a
Level4	0.4	23804	-3922	2680	20	2	7160	4657	11987	n/a
Level5	0.2	31601	-11719	2518	20	2	7160	4375	20066	n/a
East Coast/Napier										
Level1		20138		4319	20	2	7160	7504	5475	n/a
Level2	1.6	19270	868	2964	20	2	7160	5151	6959	n/a
Level3	0.7	21079	-941	2906	20	2	7160	5049	8870	n/a
Level4	0.4	24082	-3944	2841	20	2	7160	4936	11987	n/a
Level5	0.2	31884	-11746	2681	20	2	7160	4658	20066	n/a
Wellington										
Level1		22157		5480	20	2	7160	9522	5475	n/a
Level2	1.9	20880	1277	3891	20	2	7160	6761	6959	n/a
Level3	0.8	22676	-519	3825	20	2	7160	6646	8870	n/a
Level4	0.5	25664	-3508	3751	20	2	7160	6518	11987	n/a
Level5	0.2	33385	-11228	3545	20	2	7160	6159	20066	n/a
Nelson/Marlborough										
Level1		22346		2152	20	2	7160	8227	6959	n/a
Level2	0.1	24113	-1767	2115	20	2	7160	8083	8870	n/a
Level3	0.1	27070	-4724	2073	20	2	7160	7923	11987	n/a
Level4	0.1	34574	-12229	1922	20	2	7160	7348	20066	n/a
West Coast										
Level1		33940		5185	20	2	7160	19821	6959	n/a
Level2	0.2	35523	-1583	5099	20	2	7160	19493	8870	n/a
Level3	0.1	38273	-4333	5003	20	2	7160	19126	11987	n/a
Level4	0.1	45396	-11457	4753	20	2	7160	18171	20066	n/a
Christchurch										
Level1		37396		6089	20	2	7160	23277	6959	n/a
Level2	0.2	38940	-1543	5993	20	2	7160	22910	8870	n/a
Level3	0.2	41645	-4249	5886	20	2	7160	22499	11987	n/a
Level4	0.1	48671	-11275	5610	20	2	7160	21445	20066	n/a
Central Otago										
Level1		47695		8135	20	2	9638	31097	6959	n/a
Level2	0.2	49149	-1454	8016	20	2	9638	30641	8870	n/a
Level3	0.2	51755	-4060	7882	20	2	9638	30130	11987	n/a
Level4	0.2	58449	-10755	7520	20	2	9638	28745	20066	n/a
Dunedin										
Level1		43046		6919	20	2	9638	26448	6959	n/a
Level2	0.2	44577	-1532	6820	20	2	9638	26069	8870	n/a
Level3	0.2	47269	-4223	6709	20	2	9638	25644	11987	n/a
Level4	0.2	54113	-11067	6385	20	2	9638	24408	20066	n/a
Invercargill										
Level1		45519		7566	20	2	9638	28921	6959	n/a
Level2	0.2	47007	-1488	7455	20	2	9638	28499	8870	n/a
Level3	0.2	49652	-4133	7332	20	2	9638	28027	11987	n/a
Level4	0.2	56419	-10900	6989	20	2	9638	26715	20066	n/a
Cromwell										
Level1		48986		8473	20	2	9638	32389	6959	n/a
Level2	0.2	50432	-1446	8351	20	2	9638	31923	8870	n/a
Level3	0.2	53027	-4041	8215	20	2	9638	31402	11987	n/a
Level4	0.2	59721	-10734	7852	20	2	9638	30016	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.7 Medium House – Night store

Medium House

Part house heating
Night store heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
Level1		13151		2682	20	1	1377	6198	5576	n/a
Level2	1.4	12564	587	1780	20	1	1377	4113	7075	n/a
Level3	0.6	14368	-1217	1743	20	1	1377	4027	8964	n/a
Level4	0.3	17476	-4325	1702	20	1	1377	3932	12167	n/a
Level5	0.2	25287	-12136	1585	20	1	1377	3664	20247	n/a
Auckland										
Level1		13310		2751	20	1	1377	6358	5576	n/a
Level2	1.4	12643	668	1813	20	1	1377	4191	7075	n/a
Level3	0.7	14441	-1131	1774	20	1	1377	4100	8964	n/a
Level4	0.4	17543	-4232	1730	20	1	1377	3998	12167	n/a
Level5	0.2	25371	-12061	1622	20	1	1377	3747	20247	n/a
Hamilton										
Level1		17712		4656	20	1	1377	10760	5576	n/a
Level2	2.2	15888	1825	3218	20	1	1377	7436	7075	n/a
Level3	1.0	17633	80	3155	20	1	1377	7292	8964	n/a
Level4	0.6	20674	-2962	3085	20	1	1377	7130	12167	n/a
Level5	0.3	28368	-10656	2919	20	1	1377	6745	20247	n/a
Bay of Plenty										
Level1		14616		3316	20	1	1377	7663	5576	n/a
Level2	1.7	13618	997	2236	20	1	1377	5167	7075	n/a
Level3	0.8	15403	-787	2190	20	1	1377	5061	8964	n/a
Level4	0.4	18488	-3873	2139	20	1	1377	4944	12167	n/a
Level5	0.2	26270	-11655	2011	20	1	1377	4647	20247	n/a
Rotorua										
Level1		23787		7285	20	1	1377	16835	5576	n/a
Level2	3.1	20674	3113	5289	20	1	1377	12223	7075	n/a
Level3	1.4	22378	1409	5209	20	1	1377	12037	8964	n/a
Level4	0.8	25373	-1585	5118	20	1	1377	11828	12167	n/a
Level5	0.4	32794	-9006	4833	20	1	1377	11170	20247	n/a
Taupo										
Level1		20164		5118	20	1	1377	11828	6959	n/a
Level2	0.1	21872	-1708	5030	20	1	1377	11625	8870	n/a
Level3	0.1	24763	-4599	4933	20	1	1377	11399	11987	n/a
Level4	0.1	32289	-12125	4693	20	1	1377	10846	20066	n/a
New Plymouth										
Level1		16491		4171	20	1	1377	9639	5475	n/a
Level2	2.1	14815	1676	2804	20	1	1377	6479	6959	n/a
Level3	1.0	16591	-100	2745	20	1	1377	6344	8870	n/a
Level4	0.5	19558	-3067	2680	20	1	1377	6194	11987	n/a
Level5	0.3	27262	-10771	2518	20	1	1377	5819	20066	n/a
East Coast/Napier										
Level1		16832		4319	20	1	1377	9980	5475	n/a
Level2	2.1	15187	1645	2964	20	1	1377	6851	6959	n/a
Level3	1.0	16963	-131	2906	20	1	1377	6716	8870	n/a
Level4	0.5	19928	-3096	2841	20	1	1377	6564	11987	n/a
Level5	0.3	27639	-10807	2681	20	1	1377	6196	20066	n/a
Wellington										
Level1		19516		5480	20	1	1377	12664	5475	n/a
Level2	2.5	17328	2188	3891	20	1	1377	8992	6959	n/a
Level3	1.1	19086	430	3825	20	1	1377	8839	8870	n/a
Level4	0.6	22032	-2516	3751	20	1	1377	8669	11987	n/a
Level5	0.3	29635	-10119	3545	20	1	1377	8192	20066	n/a
Nelson/Marlborough										
Level1		12637		2152	20	1	1377	4300	6959	n/a
Level2	0.0	14472	-1836	2115	20	1	1377	4225	8870	n/a
Level3	0.0	17505	-4869	2073	20	1	1377	4142	11987	n/a
Level4	0.0	25284	-12648	1922	20	1	1377	3841	20066	n/a
West Coast										
Level1		18697		5185	20	1	1377	10361	6959	n/a
Level2	0.1	20436	-1739	5099	20	1	1377	10189	8870	n/a
Level3	0.1	23361	-4664	5003	20	1	1377	9998	11987	n/a
Level4	0.1	30941	-12244	4753	20	1	1377	9498	20066	n/a
Christchurch										
Level1		20504		6089	20	1	1377	12168	6959	n/a
Level2	0.1	22223	-1719	5993	20	1	1377	11976	8870	n/a
Level3	0.1	25124	-4620	5886	20	1	1377	11761	11987	n/a
Level4	0.1	32653	-12149	5610	20	1	1377	11210	20066	n/a
Central Otago										
Level1		29097		8135	20	1	2065	20072	6959	n/a
Level2	0.2	30713	-1616	8016	20	1	2065	19777	8870	n/a
Level3	0.1	33500	-4403	7882	20	1	2065	19447	11987	n/a
Level4	0.1	40685	-11589	7520	20	1	2065	18554	20066	n/a
Dunedin										
Level1		26096		6919	20	1	2065	17071	6959	n/a
Level2	0.1	27762	-1666	6820	20	1	2065	16826	8870	n/a
Level3	0.1	30604	-4509	6709	20	1	2065	16552	11987	n/a
Level4	0.1	37886	-11790	6385	20	1	2065	15754	20066	n/a
Invercargill										
Level1		27692		7566	20	1	2065	18667	6959	n/a
Level2	0.1	29330	-1638	7455	20	1	2065	18395	8870	n/a
Level3	0.1	32142	-4450	7332	20	1	2065	18090	11987	n/a
Level4	0.1	39375	-11682	6989	20	1	2065	17243	20066	n/a
Cromwell										
Level1		29930		8473	20	1	2065	20905	6959	n/a
Level2	0.2	31541	-1611	8351	20	1	2065	20605	8870	n/a
Level3	0.1	34321	-4391	8215	20	1	2065	20269	11987	n/a
Level4	0.1	41506	-11575	7852	20	1	2065	19374	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.8 Medium House – Solid Fuel

Medium House

Part house heating
Soild Fuel heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$				$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		12736		2682	30	1	2500	4660	5576	n/a
Level2	1.0	12667	69	1780	30	1	2500	3092	7075	n/a
Level3	0.5	14492	-1756	1743	30	1	2500	3028	8964	n/a
Level4	0.3	17624	-4888	1702	30	1	2500	2956	12167	n/a
Level5	0.1	25502	-12765	1585	30	1	2500	2755	20247	n/a
Auckland										
Level1		12856		2751	30	1	2500	4780	5576	n/a
Level2	1.1	12726	130	1813	30	1	2500	3151	7075	n/a
Level3	0.5	14547	-1691	1774	30	1	2500	3082	8964	n/a
Level4	0.3	17674	-4818	1730	30	1	2500	3006	12167	n/a
Level5	0.1	25564	-12708	1622	30	1	2500	2817	20247	n/a
Hamilton										
Level1		16166		4656	30	1	2500	8090	5576	n/a
Level2	1.7	15166	1000	3218	30	1	2500	5591	7075	n/a
Level3	0.8	16947	-781	3155	30	1	2500	5482	8964	n/a
Level4	0.4	20028	-3862	3085	30	1	2500	5361	12167	n/a
Level5	0.2	27818	-11652	2919	30	1	2500	5071	20247	n/a
Bay of Plenty										
Level1		13837		3316	30	1	2500	5761	5576	n/a
Level2	1.3	13460	378	2236	30	1	2500	3885	7075	n/a
Level3	0.6	15270	-1433	2190	30	1	2500	3806	8964	n/a
Level4	0.3	18385	-4547	2139	30	1	2500	3717	12167	n/a
Level5	0.2	26241	-12403	2011	30	1	2500	3494	20247	n/a
Rotorua										
Level1		20734		7285	30	1	2500	12658	5576	n/a
Level2	2.3	18765	1969	5289	30	1	2500	9190	7075	n/a
Level3	1.1	20515	219	5209	30	1	2500	9050	8964	n/a
Level4	0.6	23561	-2827	5118	30	1	2500	8894	12167	n/a
Level5	0.3	31145	-10412	4833	30	1	2500	8398	20247	n/a
Taupo										
Level1		18352		5118	30	1	2500	8893	6959	n/a
Level2	0.1	20111	-1758	5030	30	1	2500	8741	8870	n/a
Level3	0.1	23057	-4705	4933	30	1	2500	8571	11987	n/a
Level4	0.1	30721	-12369	4693	30	1	2500	8155	20066	n/a
New Plymouth										
Level1		15222		4171	30	1	2500	7248	5475	n/a
Level2	1.6	14331	892	2804	30	1	2500	4871	6959	n/a
Level3	0.7	16140	-918	2745	30	1	2500	4770	8870	n/a
Level4	0.4	19144	-3922	2680	30	1	2500	4657	11987	n/a
Level5	0.2	26941	-11719	2518	30	1	2500	4375	20066	n/a
East Coast/Napier										
Level1		15479		4319	30	1	2500	7504	5475	n/a
Level2	1.6	14610	868	2964	30	1	2500	5151	6959	n/a
Level3	0.7	16420	-941	2906	30	1	2500	5049	8870	n/a
Level4	0.4	19422	-3944	2841	30	1	2500	4936	11987	n/a
Level5	0.2	27225	-11746	2681	30	1	2500	4658	20066	n/a
Wellington										
Level1		17497		5480	30	1	2500	9522	5475	n/a
Level2	1.9	16220	1277	3891	30	1	2500	6761	6959	n/a
Level3	0.8	18016	-519	3825	30	1	2500	6646	8870	n/a
Level4	0.5	21005	-3508	3751	30	1	2500	6518	11987	n/a
Level5	0.2	28725	-11228	3545	30	1	2500	6159	20066	n/a
Nelson/Marlborough										
Level1		13199		2152	30	1	2500	3739	6959	n/a
Level2	0.0	15044	-1846	2115	30	1	2500	3674	8870	n/a
Level3	0.0	18088	-4889	2073	30	1	2500	3601	11987	n/a
Level4	0.0	25906	-12708	1922	30	1	2500	3340	20066	n/a
West Coast										
Level1		18469		5185	30	1	2500	9009	6959	n/a
Level2	0.1	20230	-1762	5099	30	1	2500	8860	8870	n/a
Level3	0.1	23180	-4712	5003	30	1	2500	8694	11987	n/a
Level4	0.1	30825	-12357	4753	30	1	2500	8259	20066	n/a
Christchurch										
Level1		20040		6089	30	1	2500	10581	6959	n/a
Level2	0.1	21784	-1744	5993	30	1	2500	10414	8870	n/a
Level3	0.1	24714	-4674	5886	30	1	2500	10227	11987	n/a
Level4	0.1	32314	-12274	5610	30	1	2500	9748	20066	n/a
Central Otago										
Level1		24094		8135	30	1	3000	14135	6959	n/a
Level2	0.1	25798	-1703	8016	30	1	3000	13928	8870	n/a
Level3	0.1	28682	-4588	7882	30	1	3000	13695	11987	n/a
Level4	0.1	36132	-12038	7520	30	1	3000	13066	20066	n/a
Dunedin										
Level1		21981		6919	30	1	3000	12022	6959	n/a
Level2	0.1	23720	-1739	6820	30	1	3000	11850	8870	n/a
Level3	0.1	26643	-4662	6709	30	1	3000	11657	11987	n/a
Level4	0.1	34161	-12179	6385	30	1	3000	11095	20066	n/a
Invercargill										
Level1		23105		7566	30	1	3000	13146	6959	n/a
Level2	0.1	24824	-1719	7455	30	1	3000	12954	8870	n/a
Level3	0.1	27726	-4621	7332	30	1	3000	12740	11987	n/a
Level4	0.1	35209	-12104	6989	30	1	3000	12143	20066	n/a
Cromwell										
Level1		24681		8473	30	1	3000	14722	6959	n/a
Level2	0.1	26381	-1699	8351	30	1	3000	14511	8870	n/a
Level3	0.1	29260	-4579	8215	30	1	3000	14274	11987	n/a
Level4	0.1	36710	-12028	7852	30	1	3000	13644	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.9 Medium House – Pellets

Medium House

Part house heating
Pellets heating
No thermal wall
North Orientation

Period = 30 years
Discount rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		13770		2682	30	1	4000	4194	5576	n/a
Level2	0.9	13858	-87	1780	30	1	4000	2783	7075	n/a
Level3	0.4	15690	-1919	1743	30	1	4000	2725	8964	n/a
Level4	0.2	18828	-5058	1702	30	1	4000	2661	12167	n/a
Level5	0.1	26726	-12956	1585	30	1	4000	2479	20247	n/a
Auckland										
Level1		13878		2751	30	1	4000	4302	5576	n/a
Level2	1.0	13911	-33	1813	30	1	4000	2836	7075	n/a
Level3	0.5	15739	-1861	1774	30	1	4000	2774	8964	n/a
Level4	0.2	18873	-4995	1730	30	1	4000	2706	12167	n/a
Level5	0.1	26783	-12904	1622	30	1	4000	2536	20247	n/a
Hamilton										
Level1		16857		4656	30	1	4000	7281	5576	n/a
Level2	1.5	16107	750	3218	30	1	4000	5032	7075	n/a
Level3	0.7	17899	-1042	3155	30	1	4000	4934	8964	n/a
Level4	0.4	20992	-4135	3085	30	1	4000	4825	12167	n/a
Level5	0.2	28811	-11954	2919	30	1	4000	4564	20247	n/a
Bay of Plenty										
Level1		14761		3316	30	1	4000	5185	5576	n/a
Level2	1.1	14571	190	2236	30	1	4000	3496	7075	n/a
Level3	0.5	16389	-1628	2190	30	1	4000	3425	8964	n/a
Level4	0.3	19513	-4752	2139	30	1	4000	3345	12167	n/a
Level5	0.1	27391	-12630	2011	30	1	4000	3144	20247	n/a
Rotorua										
Level1		20968		7285	30	1	4000	11392	5576	n/a
Level2	2.1	19346	1622	5289	30	1	4000	8271	7075	n/a
Level3	1.0	21110	-142	5209	30	1	4000	8145	8964	n/a
Level4	0.5	24172	-3204	5118	30	1	4000	8004	12167	n/a
Level5	0.3	31805	-10837	4833	30	1	4000	7559	20247	n/a
Taupo										
Level1		18963		5118	30	1	4000	8004	6959	n/a
Level2	0.1	20737	-1774	5030	30	1	4000	7867	8870	n/a
Level3	0.1	23700	-4737	4933	30	1	4000	7714	11987	n/a
Level4	0.1	31406	-12442	4693	30	1	4000	7340	20066	n/a
New Plymouth										
Level1		15998		4171	30	1	4000	6523	5475	n/a
Level2	1.4	15344	654	2804	30	1	4000	4384	6959	n/a
Level3	0.7	17163	-1166	2745	30	1	4000	4293	8870	n/a
Level4	0.4	20178	-4181	2680	30	1	4000	4192	11987	n/a
Level5	0.2	28004	-12006	2518	30	1	4000	3938	20066	n/a
East Coast/Napier										
Level1		16228		4319	30	1	4000	6754	5475	n/a
Level2	1.4	15595	633	2964	30	1	4000	4636	6959	n/a
Level3	0.7	17415	-1186	2906	30	1	4000	4544	8870	n/a
Level4	0.4	20429	-4200	2841	30	1	4000	4442	11987	n/a
Level5	0.2	28259	-12030	2681	30	1	4000	4193	20066	n/a
Wellington										
Level1		18045		5480	30	1	4000	8570	5475	n/a
Level2	1.7	17044	1001	3891	30	1	4000	6085	6959	n/a
Level3	0.8	18851	-807	3825	30	1	4000	5981	8870	n/a
Level4	0.4	21853	-3808	3751	30	1	4000	5866	11987	n/a
Level5	0.2	29609	-11565	3545	30	1	4000	5543	20066	n/a
Nelson/Marlborough										
Level1		14325		2152	30	1	4000	3365	6959	n/a
Level2	0.0	16177	-1852	2115	30	1	4000	3307	8870	n/a
Level3	0.0	19228	-4903	2073	30	1	4000	3241	11987	n/a
Level4	0.0	27072	-12747	1922	30	1	4000	3006	20066	n/a
West Coast										
Level1		19068		5185	30	1	4000	8108	6959	n/a
Level2	0.1	20844	-1777	5099	30	1	4000	7974	8870	n/a
Level3	0.1	23811	-4743	5003	30	1	4000	7824	11987	n/a
Level4	0.1	31499	-12432	4753	30	1	4000	7433	20066	n/a
Christchurch										
Level1		20482		6089	30	1	4000	9523	6959	n/a
Level2	0.1	22242	-1761	5993	30	1	4000	9372	8870	n/a
Level3	0.1	25191	-4709	5886	30	1	4000	9204	11987	n/a
Level4	0.1	32839	-12357	5610	30	1	4000	8773	20066	n/a
Central Otago										
Level1		24681		8135	30	1	5000	12722	6959	n/a
Level2	0.1	26405	-1724	8016	30	1	5000	12535	8870	n/a
Level3	0.1	29313	-4632	7882	30	1	5000	12326	11987	n/a
Level4	0.1	36825	-12144	7520	30	1	5000	11759	20066	n/a
Dunedin										
Level1		22779		6919	30	1	5000	10820	6959	n/a
Level2	0.1	24535	-1756	6820	30	1	5000	10665	8870	n/a
Level3	0.1	27478	-4699	6709	30	1	5000	10491	11987	n/a
Level4	0.1	35051	-12272	6385	30	1	5000	9985	20066	n/a
Invercargill										
Level1		23791		7566	30	1	5000	11831	6959	n/a
Level2	0.1	25529	-1738	7455	30	1	5000	11659	8870	n/a
Level3	0.1	28452	-4662	7332	30	1	5000	11466	11987	n/a
Level4	0.1	35995	-12204	6989	30	1	5000	10929	20066	n/a
Cromwell										
Level1		25209		8473	30	1	5000	13250	6959	n/a
Level2	0.1	26930	-1721	8351	30	1	5000	13060	8870	n/a
Level3	0.1	29833	-4624	8215	30	1	5000	12846	11987	n/a
Level4	0.1	37345	-12136	7852	30	1	5000	12279	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.10 Large House – Electric resistance

Large House

Part house heating
Electric heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
Level1		16114		2679	15	2	1333	8983	5798	n/a
Level2	0.6	16762	-648	2415	15	2	1333	8098	7331	n/a
Level3	0.3	18426	-2312	2362	15	2	1333	7921	9172	n/a
Level4	0.2	21695	-5581	2306	15	2	1333	7732	12630	n/a
Level5	0.1	29434	-13320	2112	15	2	1333	7081	21020	n/a
Auckland										
Level1		16365		2754	15	2	1333	9234	5798	n/a
Level2	0.5	17110	-745	2519	15	2	1333	8446	7331	n/a
Level3	0.3	18757	-2392	2461	15	2	1333	8252	9172	n/a
Level4	0.2	22009	-5644	2399	15	2	1333	8046	12630	n/a
Level5	0.1	29753	-13388	2207	15	2	1333	7400	21020	n/a
Hamilton										
Level1		22601		4613	15	2	1333	15470	5798	n/a
Level2	0.8	22980	-379	4269	15	2	1333	14316	7331	n/a
Level3	0.4	24519	-1918	4179	15	2	1333	14014	9172	n/a
Level4	0.3	27653	-5053	4083	15	2	1333	13691	12630	n/a
Level5	0.2	35072	-12471	3793	15	2	1333	12719	21020	n/a
Bay of Plenty										
Level1		18344		3344	15	2	1333	11213	5798	n/a
Level2	0.6	18923	-579	3059	15	2	1333	10259	7331	n/a
Level3	0.3	20542	-2199	2993	15	2	1333	10037	9172	n/a
Level4	0.2	23763	-5420	2922	15	2	1333	9800	12630	n/a
Level5	0.1	31393	-13050	2696	15	2	1333	9040	21020	n/a
Rotorua										
Level1		29432		6650	15	2	1333	22301	5798	n/a
Level2	1.1	29331	101	6163	15	2	1333	20667	7331	n/a
Level3	0.6	30784	-1352	6047	15	2	1333	20279	9172	n/a
Level4	0.4	33825	-4393	5923	15	2	1333	19863	12630	n/a
Level5	0.2	40898	-11466	5530	15	2	1333	18545	21020	n/a
Taupo										
Level1		31762		6923	15	2	1333	23217	7212	n/a
Level2	0.2	33194	-1433	6794	15	2	1333	22784	9078	n/a
Level3	0.2	36096	-4335	6656	15	2	1333	22321	12442	n/a
Level4	0.2	43057	-11295	6230	15	2	1333	20891	20833	n/a
New Plymouth										
Level1		21204		4228	15	2	1333	14179	5693	n/a
Level2	0.8	21560	-355	3881	15	2	1333	13015	7212	n/a
Level3	0.4	23144	-1939	3797	15	2	1333	12733	9078	n/a
Level4	0.3	26206	-5002	3707	15	2	1333	12431	12442	n/a
Level5	0.2	33653	-12449	3426	15	2	1333	11487	20833	n/a
East Coast/Napier										
Level1		21467		4306	15	2	1333	14442	5693	n/a
Level2	0.7	21870	-403	3974	15	2	1333	13326	7212	n/a
Level3	0.4	23453	-1986	3889	15	2	1333	13042	9078	n/a
Level4	0.3	26515	-5048	3799	15	2	1333	12740	12442	n/a
Level5	0.2	33974	-12507	3521	15	2	1333	11808	20833	n/a
Wellington										
Level1		26324		5755	15	2	1333	19299	5693	n/a
Level2	1.1	26225	99	5272	15	2	1333	17681	7212	n/a
Level3	0.6	27762	-1438	5174	15	2	1333	17352	9078	n/a
Level4	0.3	30777	-4452	5070	15	2	1333	17002	12442	n/a
Level5	0.2	37969	-11645	4713	15	2	1333	15804	20833	n/a
Nelson/Marlborough										
Level1		17883		2986	15	2	1333	9338	7212	n/a
Level2	0.1	19579	-1696	2931	15	2	1333	9168	9078	n/a
Level3	0.1	22761	-4878	2873	15	2	1333	8986	12442	n/a
Level4	0.1	30386	-12503	2628	15	2	1333	8220	20833	n/a
West Coast										
Level1		30945		7162	15	2	1333	22401	7212	n/a
Level2	0.2	32410	-1465	7034	15	2	1333	21999	9078	n/a
Level3	0.2	35345	-4400	6897	15	2	1333	21570	12442	n/a
Level4	0.2	42336	-11391	6449	15	2	1333	20170	20833	n/a
Christchurch										
Level1		34351		8251	15	2	1333	25806	7212	n/a
Level2	0.2	35773	-1422	8109	15	2	1333	25362	9078	n/a
Level3	0.2	38662	-4312	7957	15	2	1333	24887	12442	n/a
Level4	0.2	45541	-11190	7474	15	2	1333	23375	20833	n/a
Central Otago										
Level1		47964		11272	15	2	1777	38975	7212	n/a
Level2	0.3	49214	-1249	11094	15	2	1777	38359	9078	n/a
Level3	0.2	51920	-3956	10903	15	2	1777	37701	12442	n/a
Level4	0.3	58129	-10165	10272	15	2	1777	35519	20833	n/a
Dunedin										
Level1		41407		9375	15	2	1777	32418	7212	n/a
Level2	0.3	42756	-1349	9226	15	2	1777	31901	9078	n/a
Level3	0.2	45568	-4162	9066	15	2	1777	31349	12442	n/a
Level4	0.2	52026	-10619	8507	15	2	1777	29416	20833	n/a
Invercargill										
Level1		45075		10436	15	2	1777	36086	7212	n/a
Level2	0.3	46364	-1289	10269	15	2	1777	35509	9078	n/a
Level3	0.2	49112	-4037	10091	15	2	1777	34892	12442	n/a
Level4	0.2	55388	-10313	9480	15	2	1777	32778	20833	n/a
Cromwell										
Level1		48999		11571	15	2	1777	40010	7212	n/a
Level2	0.3	50239	-1240	11390	15	2	1777	39384	9078	n/a
Level3	0.2	52933	-3934	11196	15	2	1777	38713	12442	n/a
Level4	0.3	59126	-10128	10561	15	2	1777	36516	20833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.11 Large House – Heat Pump

Large House

Part house heating
Heat Pump
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy	Heater	# heaters	PV heater	PV energy	Insulation	Thermal mass wall extra cost
		$	$	kWh/ year	life years	in house	inc replace $	$	cost $	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		16249		5011	15	1	4443	6008	5798	n/a
Level2	0.2	17535	-1287	4805	15	1	4443	5761	7331	n/a
Level3	0.1	19327	-3078	4764	15	1	4443	5712	9172	n/a
Level4	0.1	22733	-6484	4721	15	1	4443	5660	12630	n/a
Level5	0.0	30958	-14710	4583	15	1	4443	5495	21020	n/a
Auckland										
Level1		16504		5224	15	1	4443	6263	5798	n/a
Level2	0.1	17813	-1309	5037	15	1	4443	6039	7331	n/a
Level3	0.1	19596	-3092	4989	15	1	4443	5981	9172	n/a
Level4	0.1	22992	-6488	4937	15	1	4443	5919	12630	n/a
Level5	0.0	31208	-14704	4792	15	1	4443	5745	21020	n/a
Hamilton										
Level1		17899		6387	15	1	4443	7658	5798	n/a
Level2	0.2	19087	-1188	6100	15	1	4443	7313	7331	n/a
Level3	0.1	20833	-2934	6020	15	1	4443	7217	9172	n/a
Level4	0.1	24188	-6289	5934	15	1	4443	7115	12630	n/a
Level5	0.1	32294	-14396	5698	15	1	4443	6831	21020	n/a
Bay of Plenty										
Level1		17117		5735	15	1	4443	6876	5798	n/a
Level2	0.2	18395	-1278	5523	15	1	4443	6621	7331	n/a
Level3	0.1	20168	-3051	5466	15	1	4443	6553	9172	n/a
Level4	0.1	23554	-6436	5405	15	1	4443	6481	12630	n/a
Level5	0.0	31741	-14624	5237	15	1	4443	6278	21020	n/a
Rotorua										
Level1		19559		7772	15	1	4443	9318	5798	n/a
Level2	0.4	20543	-983	7314	15	1	4443	8768	7331	n/a
Level3	0.2	22256	-2697	7207	15	1	4443	8641	9172	n/a
Level4	0.1	25577	-6018	7093	15	1	4443	8504	12630	n/a
Level5	0.1	33541	-13982	6737	15	1	4443	8078	21020	n/a
Taupo										
Level1		21183		7948	15	1	4443	9529	7212	n/a
Level2	0.1	22903	-1719	7826	15	1	4443	9382	9078	n/a
Level3	0.1	26111	-4927	7695	15	1	4443	9225	12442	n/a
Level4	0.1	34035	-12852	7306	15	1	4443	8759	20833	n/a
New Plymouth										
Level1		16747		5514	15	1	4443	6611	5693	n/a
Level2	0.2	17903	-1157	5212	15	1	4443	6249	7212	n/a
Level3	0.1	19681	-2934	5138	15	1	4443	6160	9078	n/a
Level4	0.1	22950	-6203	5058	15	1	4443	6065	12442	n/a
Level5	0.1	31056	-14309	4821	15	1	4443	5780	20833	n/a
East Coast/Napier										
Level1		18077		6624	15	1	4443	7942	5693	n/a
Level2	0.2	19246	-1169	6332	15	1	4443	7592	7212	n/a
Level3	0.1	21021	-2944	6256	15	1	4443	7500	9078	n/a
Level4	0.1	24288	-6211	6175	15	1	4443	7403	12442	n/a
Level5	0.1	32397	-14320	5940	15	1	4443	7121	20833	n/a
Wellington										
Level1		18271		6786	15	1	4443	8135	5693	n/a
Level2	0.3	19271	-1000	6352	15	1	4443	7616	7212	n/a
Level3	0.2	21029	-2758	6263	15	1	4443	7508	9078	n/a
Level4	0.1	24279	-6008	6167	15	1	4443	7394	12442	n/a
Level5	0.1	32292	-14021	5852	15	1	4443	7016	20833	n/a
Nelson/Marlborough										
Level1		17452		5213	15	1	4443	5798	7212	n/a
Level2	0.0	19268	-1816	5168	15	1	4443	5747	9078	n/a
Level3	0.0	22579	-5127	5120	15	1	4443	5693	12442	n/a
Level4	0.0	30771	-13319	4942	15	1	4443	5495	20833	n/a
West Coast										
Level1		20294		7769	15	1	4443	8639	7212	n/a
Level2	0.1	22024	-1730	7646	15	1	4443	8503	9078	n/a
Level3	0.1	25243	-4949	7516	15	1	4443	8358	12442	n/a
Level4	0.1	33166	-12872	7095	15	1	4443	7890	20833	n/a
Christchurch										
Level1		22019		9320	15	1	4443	10364	7212	n/a
Level2	0.1	23733	-1714	9183	15	1	4443	10212	9078	n/a
Level3	0.1	26935	-4916	9037	15	1	4443	10049	12442	n/a
Level4	0.1	34817	-12798	8580	15	1	4443	9541	20833	n/a
Central Otago										
Level1		27692		11800	15	1	5924	14557	7212	n/a
Level2	0.1	29344	-1652	11626	15	1	5924	14343	9078	n/a
Level3	0.1	32481	-4788	11441	15	1	5924	14114	12442	n/a
Level4	0.1	40121	-12429	10833	15	1	5924	13364	20833	n/a
Dunedin										
Level1		24947		9574	15	1	5924	11811	7212	n/a
Level2	0.1	26631	-1684	9427	15	1	5924	11630	9078	n/a
Level3	0.1	29802	-4855	9270	15	1	5924	11436	12442	n/a
Level4	0.1	37520	-12574	8725	15	1	5924	10764	20833	n/a
Invercargill										
Level1		26190		10582	15	1	5924	13054	7212	n/a
Level2	0.1	27852	-1662	10417	15	1	5924	12851	9078	n/a
Level3	0.1	30999	-4810	10240	15	1	5924	12633	12442	n/a
Level4	0.1	38652	-12462	9642	15	1	5924	11895	20833	n/a
Cromwell										
Level1		28333		12319	15	1	5924	15197	7212	n/a
Level2	0.1	29981	-1648	12142	15	1	5924	14980	9078	n/a
Level3	0.1	33113	-4780	11953	15	1	5924	14746	12442	n/a
Level4	0.1	40756	-12423	11348	15	1	5924	13999	20833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.1.12 Large House – Gas

Large House

Part house heating
Gas heating
No thermal wall
North Orientation

Period = 30 years
Discr rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		17612		2679	20	2	7160	4655	5798	n/a
Level2	0.3	18687	-1075	2415	20	2	7160	4196	7331	n/a
Level3	0.2	20436	-2824	2362	20	2	7160	4104	9172	n/a
Level4	0.1	23796	-6184	2306	20	2	7160	4006	12630	n/a
Level5	0.1	31849	-14237	2112	20	2	7160	3669	21020	n/a
Auckland										
Level1		17742		2754	20	2	7160	4784	5798	n/a
Level2	0.3	18867	-1125	2519	20	2	7160	4376	7331	n/a
Level3	0.2	20608	-2865	2461	20	2	7160	4276	9172	n/a
Level4	0.1	23959	-6216	2399	20	2	7160	4169	12630	n/a
Level5	0.1	32014	-14272	2207	20	2	7160	3834	21020	n/a
Hamilton										
Level1		20973		4613	20	2	7160	8016	5798	n/a
Level2	0.4	21908	-935	4269	20	2	7160	7418	7331	n/a
Level3	0.2	23593	-2620	4179	20	2	7160	7261	9172	n/a
Level4	0.1	26883	-5910	4083	20	2	7160	7094	12630	n/a
Level5	0.1	34770	-13797	3793	20	2	7160	6590	21020	n/a
Bay of Plenty										
Level1		18767		3344	20	2	7160	5810	5798	n/a
Level2	0.3	19806	-1039	3059	20	2	7160	5315	7331	n/a
Level3	0.2	21533	-2765	2993	20	2	7160	5201	9172	n/a
Level4	0.1	24868	-6100	2922	20	2	7160	5078	12630	n/a
Level5	0.1	32864	-14097	2696	20	2	7160	4684	21020	n/a
Rotorua										
Level1		24513		6650	20	2	7160	11555	5798	n/a
Level2	0.6	25199	-687	6163	20	2	7160	10709	7331	n/a
Level3	0.3	26839	-2326	6047	20	2	7160	10507	9172	n/a
Level4	0.2	30081	-5568	5923	20	2	7160	10291	12630	n/a
Level5	0.1	37789	-13276	5530	20	2	7160	9609	21020	n/a
Taupo										
Level1		26401		6923	20	2	7160	12030	7212	n/a
Level2	0.1	28043	-1642	6794	20	2	7160	11805	9078	n/a
Level3	0.1	31167	-4766	6656	20	2	7160	11565	12442	n/a
Level4	0.1	38817	-12416	6230	20	2	7160	10824	20833	n/a
New Plymouth										
Level1		20199		4228	20	2	7160	7347	5693	n/a
Level2	0.4	21115	-916	3881	20	2	7160	6744	7212	n/a
Level3	0.2	22835	-2636	3797	20	2	7160	6597	9078	n/a
Level4	0.1	26043	-5844	3707	20	2	7160	6441	12442	n/a
Level5	0.1	33945	-13746	3426	20	2	7160	5952	20833	n/a
East Coast/Napier										
Level1		20335		4306	20	2	7160	7483	5693	n/a
Level2	0.4	21276	-941	3974	20	2	7160	6904	7212	n/a
Level3	0.2	22995	-2660	3889	20	2	7160	6758	9078	n/a
Level4	0.1	26203	-5868	3799	20	2	7160	6601	12442	n/a
Level5	0.1	34111	-13776	3521	20	2	7160	6118	20833	n/a
Wellington										
Level1		22852		5755	20	2	7160	9999	5693	n/a
Level2	0.6	23532	-680	5272	20	2	7160	9161	7212	n/a
Level3	0.3	25228	-2376	5174	20	2	7160	8991	9078	n/a
Level4	0.2	28411	-5559	5070	20	2	7160	8809	12442	n/a
Level5	0.1	36181	-13329	4713	20	2	7160	8188	20833	n/a
Nelson/Marlborough										
Level1		25785		2986	20	2	7160	11414	7212	n/a
Level2	0.1	27443	-1658	2931	20	2	7160	11205	9078	n/a
Level3	0.1	30585	-4800	2873	20	2	7160	10982	12442	n/a
Level4	0.1	38039	-12255	2628	20	2	7160	10047	20833	n/a
West Coast										
Level1		41750		7162	20	2	7160	27378	7212	n/a
Level2	0.3	43125	-1375	7034	20	2	7160	26888	9078	n/a
Level3	0.2	45965	-4216	6897	20	2	7160	26363	12442	n/a
Level4	0.2	52645	-10895	6449	20	2	7160	24652	20833	n/a
Christchurch										
Level1		45913		8251	20	2	7160	31541	7212	n/a
Level2	0.3	47236	-1323	8109	20	2	7160	30999	9078	n/a
Level3	0.2	50020	-4107	7957	20	2	7160	30418	12442	n/a
Level4	0.2	56563	-10650	7474	20	2	7160	28570	20833	n/a
Central Otago										
Level1		59938		11272	20	2	9638	43088	7212	n/a
Level2	0.4	61123	-1184	11094	20	2	9638	42407	9078	n/a
Level3	0.3	63760	-3822	10903	20	2	9638	41679	12442	n/a
Level4	0.3	69739	-9800	10272	20	2	9638	39268	20833	n/a
Dunedin										
Level1		52689		9375	20	2	9638	35839	7212	n/a
Level2	0.3	53983	-1295	9226	20	2	9638	35267	9078	n/a
Level3	0.2	56737	-4049	9066	20	2	9638	34657	12442	n/a
Level4	0.2	62991	-10303	8507	20	2	9638	32520	20833	n/a
Invercargill										
Level1		56744		10436	20	2	9638	39894	7212	n/a
Level2	0.3	57972	-1228	10269	20	2	9638	39256	9078	n/a
Level3	0.3	60655	-3911	10091	20	2	9638	38574	12442	n/a
Level4	0.3	66708	-9964	9480	20	2	9638	36237	20833	n/a
Cromwell										
Level1		61082		11571	20	2	9638	44232	7212	n/a
Level2	0.4	62256	-1174	11390	20	2	9638	43540	9078	n/a
Level3	0.3	64879	-3797	11196	20	2	9638	42799	12442	n/a
Level4	0.3	70841	-9759	10561	20	2	9638	40370	20833	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2 Entire house heating "Heated Area 2" results, Medium house, under all heater types

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	2
Themal Mass wall?	None
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Nitestor, Gas, Pellets, Solid fuel, Heat pump

10.2.1 Medium House – Electric resistance

Medium House

Entire house heating
Electric heating
No thermal wall
North Orientation

Period = 30 years
Discf rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
Level1		31409		7107	15	3	1999	23834	5576	n/a
Level2	7.6	21536	9873	3716	15	3	1999	12462	7075	n/a
Level3	3.4	23119	8290	3625	15	3	1999	12155	8964	n/a
Level4	1.8	25991	5419	3526	15	3	1999	11824	12167	n/a
Level5	0.9	32973	-1563	3199	15	3	1999	10726	20247	n/a
Auckland										
Level1		32584		7458	15	3	1999	25009	5576	n/a
Level2	8.0	22020	10564	3860	15	3	1999	12945	7075	n/a
Level3	3.7	23578	9006	3761	15	3	1999	12614	8964	n/a
Level4	1.9	26423	6161	3655	15	3	1999	12256	12167	n/a
Level5	0.9	33435	-851	3336	15	3	1999	11188	20247	n/a
Hamilton										
Level1		48230		12123	15	3	1999	40655	5576	n/a
Level2	12.6	30847	17384	6492	15	3	1999	21772	7075	n/a
Level3	5.7	32212	16018	6336	15	3	1999	21249	8964	n/a
Level4	3.0	34852	13378	6168	15	3	1999	20685	12167	n/a
Level5	1.5	41296	6934	5681	15	3	1999	19050	20247	n/a
Bay of Plenty										
Level1		37051		8790	15	3	1999	29476	5576	n/a
Level2	9.3	24548	12503	4614	15	3	1999	15474	7075	n/a
Level3	4.2	26054	10997	4500	15	3	1999	15090	8964	n/a
Level4	2.2	28844	8207	4377	15	3	1999	14677	12167	n/a
Level5	1.1	35666	1385	4002	15	3	1999	13420	20247	n/a
Rotorua										
Level1		69882		18580	15	3	1999	62307	5576	n/a
Level2	17.7	44798	25084	10653	15	3	1999	35724	7075	n/a
Level3	8.1	45985	23897	10443	15	3	1999	35021	8964	n/a
Level4	4.3	48431	21451	10217	15	3	1999	34264	12167	n/a
Level5	2.1	53758	16124	9397	15	3	1999	31512	20247	n/a
Taupo										
Level1		43576		10323	15	3	1999	34617	6959	n/a
Level2	0.4	44731	-1155	10097	15	3	1999	33862	8870	n/a
Level3	0.3	47033	-3458	9855	15	3	1999	33047	11987	n/a
Level4	0.3	52688	-9112	9132	15	3	1999	30622	20066	n/a
New Plymouth										
Level1		44944		11173	15	3	1999	37470	5475	n/a
Level2	12.0	28668	16275	5877	15	3	1999	19710	6959	n/a
Level3	5.4	30096	14848	5733	15	3	1999	19226	8870	n/a
Level4	2.9	32692	12252	5578	15	3	1999	18705	11987	n/a
Level5	1.4	39206	5738	5111	15	3	1999	17140	20066	n/a
East Coast/Napier										
Level1		45580		11363	15	3	1999	38106	5475	n/a
Level2	12.1	29172	16408	6027	15	3	1999	20213	6959	n/a
Level3	5.4	30589	14991	5880	15	3	1999	19719	8870	n/a
Level4	2.9	33173	12407	5722	15	3	1999	19187	11987	n/a
Level5	1.4	39691	5889	5256	15	3	1999	17626	20066	n/a
Wellington										
Level1		55176		14225	15	3	1999	47702	5475	n/a
Level2	14.2	35531	19646	7924	15	3	1999	26572	6959	n/a
Level3	6.4	36872	18304	7754	15	3	1999	26003	8870	n/a
Level4	3.4	39376	15801	7571	15	3	1999	25390	11987	n/a
Level5	1.7	45442	9734	6971	15	3	1999	23376	20066	n/a
Nelson/Marlborough										
Level1		22741		4407	15	3	1999	13782	6959	n/a
Level2	0.2	24356	-1615	4312	15	3	1999	13486	8870	n/a
Level3	0.1	27153	-4411	4210	15	3	1999	13166	11987	n/a
Level4	0.1	33953	-11212	3801	15	3	1999	11888	20066	n/a
West Coast										
Level1		42052		10581	15	3	1999	33093	6959	n/a
Level2	0.4	43262	-1210	10357	15	3	1999	32392	8870	n/a
Level3	0.3	45623	-3571	10116	15	3	1999	31637	11987	n/a
Level4	0.3	51333	-9281	9358	15	3	1999	29268	20066	n/a
Christchurch										
Level1		47468		12313	15	3	1999	38510	6959	n/a
Level2	0.4	48589	-1120	12060	15	3	1999	37719	8870	n/a
Level3	0.3	50855	-3386	11788	15	3	1999	36869	11987	n/a
Level4	0.3	56296	-8828	10945	15	3	1999	34231	20066	n/a
Central Otago										
Level1		66867		16555	15	3	2666	57241	6959	n/a
Level2	0.6	67668	-801	16234	15	3	2666	56132	8870	n/a
Level3	0.5	69590	-2723	15888	15	3	2666	54937	11987	n/a
Level4	0.5	73785	-6919	14765	15	3	2666	51054	20066	n/a
Dunedin										
Level1		57864		13951	15	3	2666	48239	6959	n/a
Level2	0.5	58865	-1001	13688	15	3	2666	47329	8870	n/a
Level3	0.4	61001	-3137	13404	15	3	2666	46349	11987	n/a
Level4	0.4	65736	-7872	12437	15	3	2666	43004	20066	n/a
Invercargill										
Level1		62389		15260	15	3	2666	52764	6959	n/a
Level2	0.5	63288	-898	14967	15	3	2666	51752	8870	n/a
Level3	0.4	65313	-2924	14651	15	3	2666	50661	11987	n/a
Level4	0.4	69788	-7398	13609	15	3	2666	47056	20066	n/a
Cromwell										
Level1		68673		17077	15	3	2666	59048	6959	n/a
Level2	0.6	69456	-782	16751	15	3	2666	57920	8870	n/a
Level3	0.5	71355	-2682	16399	15	3	2666	56703	11987	n/a
Level4	0.5	75537	-6864	15272	15	3	2666	52806	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2.2 Medium House – Heat Pump

Medium House

Entire house heating
Heat Pump
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy	Heater	# heaters	PV heater	PV energy	Insulation	Thermal mass
		$	$	kWh/ year	life years	in house	inc replace $	$	cost $	wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		27227		10648	15	2	8886	12765	5576	n/a
Level2	2.3	25209	2018	7714	15	2	8886	9248	7075	n/a
Level3	1.1	27006	222	7636	15	2	8886	9155	8964	n/a
Level4	0.6	30108	-2881	7553	15	2	8886	9055	12167	n/a
Level5	0.3	37922	-10694	7331	15	2	8886	8789	20247	n/a
Auckland										
Level1		28145		11413	15	2	8886	13683	5576	n/a
Level2	2.6	25736	2409	8153	15	2	8886	9775	7075	n/a
Level3	1.2	27519	626	8065	15	2	8886	9669	8964	n/a
Level4	0.6	30608	-2463	7970	15	2	8886	9555	12167	n/a
Level5	0.3	38405	-10260	7734	15	2	8886	9272	20247	n/a
Hamilton										
Level1		32374		14940	15	2	8886	17911	5576	n/a
Level2	4.2	27620	4753	9725	15	2	8886	11659	7075	n/a
Level3	1.9	29339	3035	9582	15	2	8886	11488	8964	n/a
Level4	1.0	32357	16	9428	15	2	8886	11304	12167	n/a
Level5	0.5	39970	-7596	9039	15	2	8886	10837	20247	n/a
Bay of Plenty										
Level1		29699		12709	15	2	8886	15237	5576	n/a
Level2	3.0	26638	3061	8906	15	2	8886	10677	7075	n/a
Level3	1.4	28403	1296	8802	15	2	8886	10553	8964	n/a
Level4	0.7	31472	-1772	8690	15	2	8886	10418	12167	n/a
Level5	0.4	39221	-9521	8414	15	2	8886	10088	20247	n/a
Rotorua										
Level1		37780		19450	15	2	8886	23318	5576	n/a
Level2	6.2	30035	7746	11739	15	2	8886	14074	7075	n/a
Level3	2.8	31675	6105	11531	15	2	8886	13825	8964	n/a
Level4	1.5	34610	3170	11307	15	2	8886	13556	12167	n/a
Level5	0.7	41825	-4045	10587	15	2	8886	12692	20247	n/a
Taupo										
Level1		30385		12127	15	2	8886	14540	6959	n/a
Level2	0.1	32036	-1651	11911	15	2	8886	14280	8870	n/a
Level3	0.1	34874	-4488	11678	15	2	8886	14001	11987	n/a
Level4	0.1	42176	-11790	11029	15	2	8886	13223	20066	n/a
New Plymouth										
Level1		30039		13077	15	2	8886	15678	5475	n/a
Level2	3.9	25702	4337	8221	15	2	8886	9856	6959	n/a
Level3	1.8	27457	2582	8091	15	2	8886	9701	8870	n/a
Level4	0.94	30406	-367	7951	15	2	8886	9533	11987	n/a
Level5	0.5	38025	-7987	7568	15	2	8886	9073	20066	n/a
East Coast/Napier										
Level1		32445		15084	15	2	8886	18084	5475	n/a
Level2	4.1	27844	4601	10008	15	2	8886	11998	6959	n/a
Level3	1.8	29588	2857	9869	15	2	8886	11832	8870	n/a
Level4	0.99	32525	-80	9719	15	2	8886	11652	11987	n/a
Level5	0.5	40142	-7697	9333	15	2	8886	11190	20066	n/a
Wellington										
Level1		33154		15675	15	2	8886	18793	5475	n/a
Level2	4.8	27530	5624	9746	15	2	8886	11685	6959	n/a
Level3	2.1	29251	3903	9588	15	2	8886	11495	8870	n/a
Level4	1.2	32163	991	9417	15	2	8886	11291	11987	n/a
Level5	0.6	39630	-6476	8907	15	2	8886	10678	20066	n/a
Nelson/Marlborough										
Level1		24942		8180	15	2	8886	9096	6959	n/a
Level2	0.0	26758	-1817	8095	15	2	8886	9002	8870	n/a
Level3	0.0	29773	-4831	8003	15	2	8886	8900	11987	n/a
Level4	0.0	37543	-12602	7726	15	2	8886	8591	20066	n/a
West Coast										
Level1		28759		11613	15	2	8886	12914	6959	n/a
Level2	0.1	30430	-1671	11397	15	2	8886	12674	8870	n/a
Level3	0.1	33289	-4530	11166	15	2	8886	12417	11987	n/a
Level4	0.1	40595	-11836	10470	15	2	8886	11643	20066	n/a
Christchurch										
Level1		31493		14071	15	2	8886	15647	6959	n/a
Level2	0.1	33128	-1635	13823	15	2	8886	15372	8870	n/a
Level3	0.1	35948	-4455	13556	15	2	8886	15075	11987	n/a
Level4	0.1	43158	-11665	12774	15	2	8886	14205	20066	n/a
Central Otago										
Level1		40287		17411	15	2	11848	21479	6959	n/a
Level2	0.2	41810	-1523	17097	15	2	11848	21091	8870	n/a
Level3	0.2	44509	-4222	16758	15	2	11848	20674	11987	n/a
Level4	0.2	51271	-10984	15690	15	2	11848	19357	20066	n/a
Dunedin										
Level1		36502		14343	15	2	11848	17694	6959	n/a
Level2	0.2	38093	-1591	14084	15	2	11848	17375	8870	n/a
Level3	0.1	40865	-4363	13804	15	2	11848	17030	11987	n/a
Level4	0.1	47791	-11289	12869	15	2	11848	15876	20066	n/a
Invercargill										
Level1		38037		15588	15	2	11848	19230	6959	n/a
Level2	0.2	39591	-1554	15298	15	2	11848	18873	8870	n/a
Level3	0.1	42323	-4285	14986	15	2	11848	18488	11987	n/a
Level4	0.2	49158	-11121	13978	15	2	11848	17244	20066	n/a
Cromwell										
Level1		41433		18340	15	2	11848	22626	6959	n/a
Level2	0.2	42948	-1515	18019	15	2	11848	22230	8870	n/a
Level3	0.2	45637	-4203	17673	15	2	11848	21802	11987	n/a
Level4	0.2	52406	-10972	16610	15	2	11848	20491	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2.3 Medium House – Gas

Medium House

Entire house heating
Gas heating
No thermal wall
North Orientation

Period = 30 years
Discr rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		25085		7107	20	2	7160	12349	5576	n/a
Level2	3.9	20692	4393	3716	20	2	7160	6457	7075	n/a
Level3	1.8	22422	2663	3625	20	2	7160	6298	8964	n/a
Level4	0.9	25454	-369	3526	20	2	7160	6126	12167	n/a
Level5	0.5	32964	-7879	3199	20	2	7160	5558	20247	n/a
Auckland										
Level1		25694		7458	20	2	7160	12958	5576	n/a
Level2	4.2	20942	4751	3860	20	2	7160	6707	7075	n/a
Level3	1.9	22660	3034	3761	20	2	7160	6536	8964	n/a
Level4	1.0	25678	16	3655	20	2	7160	6350	12167	n/a
Level5	0.5	33204	-7510	3336	20	2	7160	5797	20247	n/a
Hamilton										
Level1		33800		12123	20	2	7160	21065	5576	n/a
Level2	6.5	25516	8285	6492	20	2	7160	11281	7075	n/a
Level3	3.0	27134	6667	6336	20	2	7160	11010	8964	n/a
Level4	1.6	30045	3755	6168	20	2	7160	10718	12167	n/a
Level5	0.8	37277	-3477	5681	20	2	7160	9871	20247	n/a
Bay of Plenty										
Level1		28008		8790	20	2	7160	15272	5576	n/a
Level2	4.8	22252	5756	4614	20	2	7160	8017	7075	n/a
Level3	2.2	23943	4065	4500	20	2	7160	7819	8964	n/a
Level4	1.2	26932	1076	4377	20	2	7160	7605	12167	n/a
Level5	0.6	34360	-6352	4002	20	2	7160	6953	20247	n/a
Rotorua										
Level1		45019		18580	20	2	7160	32283	5576	n/a
Level2	9.2	32744	12275	10653	20	2	7160	18510	7075	n/a
Level3	4.2	34270	10749	10443	20	2	7160	18146	8964	n/a
Level4	2.2	37081	7938	10217	20	2	7160	17753	12167	n/a
Level5	1.1	43734	1285	9397	20	2	7160	16328	20247	n/a
Taupo										
Level1		32055		10323	20	2	7160	17936	6959	n/a
Level2	0.2	33575	-1519	10097	20	2	7160	17545	8870	n/a
Level3	0.2	36270	-4214	9855	20	2	7160	17123	11987	n/a
Level4	0.2	43092	-11037	9132	20	2	7160	15867	20066	n/a
New Plymouth										
Level1		32049		11173	20	2	7160	19414	5475	n/a
Level2	6.2	24331	7717	5877	20	2	7160	10212	6959	n/a
Level3	2.8	25992	6057	5733	20	2	7160	9962	8870	n/a
Level4	1.5	28839	3210	5578	20	2	7160	9692	11987	n/a
Level5	0.7	36107	-4058	5111	20	2	7160	8881	20066	n/a
East Coast/Napier										
Level1		32379		11363	20	2	7160	19744	5475	n/a
Level2	6.2	24592	7786	6027	20	2	7160	10473	6959	n/a
Level3	2.8	26247	6131	5880	20	2	7160	10217	8870	n/a
Level4	1.5	29088	3290	5722	20	2	7160	9942	11987	n/a
Level5	0.7	36358	-3980	5256	20	2	7160	9133	20066	n/a
Wellington										
Level1		37351		14225	20	2	7160	24716	5475	n/a
Level2	7.4	27887	9464	7924	20	2	7160	13768	6959	n/a
Level3	3.3	29503	7848	7754	20	2	7160	13473	8870	n/a
Level4	1.8	32302	5049	7571	20	2	7160	13155	11987	n/a
Level5	0.9	39338	-1987	6971	20	2	7160	12112	20066	n/a
Nelson/Marlborough										
Level1		30964		4407	20	2	7160	16845	6959	n/a
Level2	0.2	32513	-1549	4312	20	2	7160	16483	8870	n/a
Level3	0.1	35239	-4274	4210	20	2	7160	16092	11987	n/a
Level4	0.2	41755	-10791	3801	20	2	7160	14529	20066	n/a
West Coast										
Level1		54567		10581	20	2	7160	40447	6959	n/a
Level2	0.4	55621	-1054	10357	20	2	7160	39591	8870	n/a
Level3	0.4	57814	-3248	10116	20	2	7160	38668	11987	n/a
Level4	0.4	62998	-8431	9358	20	2	7160	35772	20066	n/a
Christchurch										
Level1		61187		12313	20	2	7160	47067	6959	n/a
Level2	0.5	62131	-944	12060	20	2	7160	46101	8870	n/a
Level3	0.4	64208	-3021	11788	20	2	7160	45062	11987	n/a
Level4	0.4	69063	-7877	10945	20	2	7160	41838	20066	n/a
Central Otago										
Level1		79880		16555	20	2	9638	63282	6959	n/a
Level2	0.6	80564	-684	16234	20	2	9638	62055	8870	n/a
Level3	0.5	82359	-2480	15888	20	2	9638	60734	11987	n/a
Level4	0.5	86145	-6266	14765	20	2	9638	56441	20066	n/a
Dunedin										
Level1		69927		13951	20	2	9638	53330	6959	n/a
Level2	0.5	70832	-905	13688	20	2	9638	52324	8870	n/a
Level3	0.4	72865	-2938	13404	20	2	9638	51240	11987	n/a
Level4	0.4	77246	-7319	12437	20	2	9638	47542	20066	n/a
Invercargill										
Level1		74930		15260	20	2	9638	58332	6959	n/a
Level2	0.6	75721	-792	14967	20	2	9638	57213	8870	n/a
Level3	0.5	77632	-2702	14651	20	2	9638	56007	11987	n/a
Level4	0.5	81726	-6796	13609	20	2	9638	52021	20066	n/a
Cromwell										
Level1		81877		17077	20	2	9638	65279	6959	n/a
Level2	0.7	82540	-663	16751	20	2	9638	64032	8870	n/a
Level3	0.5	84311	-2434	16399	20	2	9638	62686	11987	n/a
Level4	0.5	88082	-6205	15272	20	2	9638	58378	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2.4 Medium House – Night store

Medium House

Entire house heating
Night store heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		23377		7107	20	1	1377	16424	5576	n/a
Level2	5.2	17040	6338	3716	20	1	1377	8588	7075	n/a
Level3	2.4	18718	4659	3625	20	1	1377	8377	8964	n/a
Level4	1.3	21692	1685	3526	20	1	1377	8148	12167	n/a
Level5	0.6	29015	-5638	3199	20	1	1377	7392	20247	n/a
Auckland										
Level1		24187		7458	20	1	1377	17234	5576	n/a
Level2	5.5	17373	6814	3860	20	1	1377	8921	7075	n/a
Level3	2.5	19034	5153	3761	20	1	1377	8692	8964	n/a
Level4	1.3	21990	2197	3655	20	1	1377	8446	12167	n/a
Level5	0.6	29334	-5147	3336	20	1	1377	7710	20247	n/a
Hamilton										
Level1		34969		12123	20	1	1377	28016	5576	n/a
Level2	8.7	23456	11513	6492	20	1	1377	15004	7075	n/a
Level3	3.9	24984	9985	6336	20	1	1377	14643	8964	n/a
Level4	2.1	27799	7170	6168	20	1	1377	14255	12167	n/a
Level5	1.0	34752	217	5681	20	1	1377	13128	20247	n/a
Bay of Plenty										
Level1		27265		8790	20	1	1377	20312	5576	n/a
Level2	6.4	19115	8150	4614	20	1	1377	10663	7075	n/a
Level3	2.9	20740	6525	4500	20	1	1377	10399	8964	n/a
Level4	1.5	23659	3606	4377	20	1	1377	10114	12167	n/a
Level5	0.8	30871	-3606	4002	20	1	1377	9248	20247	n/a
Rotorua										
Level1		49890		18580	20	1	1377	42937	5576	n/a
Level2	12.2	33070	16820	10653	20	1	1377	24618	7075	n/a
Level3	5.5	34475	15415	10443	20	1	1377	24134	8964	n/a
Level4	2.9	37156	12733	10217	20	1	1377	23612	12167	n/a
Level5	1.4	43339	6550	9397	20	1	1377	21716	20247	n/a
Taupo										
Level1		32192		10323	20	1	1377	23855	6959	n/a
Level2	0.3	33582	-1390	10097	20	1	1377	23335	8870	n/a
Level3	0.2	36137	-3946	9855	20	1	1377	22774	11987	n/a
Level4	0.2	42545	-10354	9132	20	1	1377	21102	20066	n/a
New Plymouth										
Level1		32673		11173	20	1	1377	25821	5475	n/a
Level2	8.2	21919	10754	5877	20	1	1377	13582	6959	n/a
Level3	3.7	23496	9176	5733	20	1	1377	13249	8870	n/a
Level4	2.0	26254	6419	5578	20	1	1377	12890	11987	n/a
Level5	1.0	33255	-582	5111	20	1	1377	11812	20066	n/a
East Coast/Napier										
Level1		33111		11363	20	1	1377	26260	5475	n/a
Level2	8.3	22265	10846	6027	20	1	1377	13929	6959	n/a
Level3	3.7	23836	9275	5880	20	1	1377	13589	8870	n/a
Level4	2.0	26586	6525	5722	20	1	1377	13222	11987	n/a
Level5	1.0	33589	-478	5256	20	1	1377	12146	20066	n/a
Wellington										
Level1		39724		14225	20	1	1377	32873	5475	n/a
Level2	9.8	26647	13077	7924	20	1	1377	18311	6959	n/a
Level3	4.4	28166	11558	7754	20	1	1377	17919	8870	n/a
Level4	2.4	30860	8864	7571	20	1	1377	17496	11987	n/a
Level5	1.1	37552	2172	6971	20	1	1377	16109	20066	n/a
Nelson/Marlborough										
Level1		17142		4407	20	1	1377	8805	6959	n/a
Level2	0.1	18863	-1722	4312	20	1	1377	8616	8870	n/a
Level3	0.1	21776	-4634	4210	20	1	1377	8412	11987	n/a
Level4	0.1	29038	-11896	3801	20	1	1377	7595	20066	n/a
West Coast										
Level1		29479		10581	20	1	1377	21143	6959	n/a
Level2	0.2	30942	-1463	10357	20	1	1377	20695	8870	n/a
Level3	0.2	33576	-4097	10116	20	1	1377	20213	11987	n/a
Level4	0.2	40142	-10663	9358	20	1	1377	18699	20066	n/a
Christchurch										
Level1		32940		12313	20	1	1377	24603	6959	n/a
Level2	0.3	34345	-1406	12060	20	1	1377	24098	8870	n/a
Level3	0.2	36919	-3979	11788	20	1	1377	23555	11987	n/a
Level4	0.2	43313	-10373	10945	20	1	1377	21870	20066	n/a
Central Otago										
Level1		49870		16555	20	1	2065	40846	6959	n/a
Level2	0.4	50989	-1119	16234	20	1	2065	40054	8870	n/a
Level3	0.3	53253	-3383	15888	20	1	2065	39201	11987	n/a
Level4	0.3	58562	-8691	14765	20	1	2065	36430	20066	n/a
Dunedin										
Level1		43447		13951	20	1	2065	34422	6959	n/a
Level2	0.3	44708	-1262	13688	20	1	2065	33773	8870	n/a
Level3	0.3	47125	-3678	13404	20	1	2065	33073	11987	n/a
Level4	0.3	52818	-9371	12437	20	1	2065	30686	20066	n/a
Invercargill										
Level1		46676		15260	20	1	2065	37651	6959	n/a
Level2	0.4	47864	-1188	14967	20	1	2065	36928	8870	n/a
Level3	0.3	50202	-3526	14651	20	1	2065	36150	11987	n/a
Level4	0.3	55709	-9033	13609	20	1	2065	33577	20066	n/a
Cromwell										
Level1		51160		17077	20	1	2065	42135	6959	n/a
Level2	0.4	52265	-1105	16751	20	1	2065	41330	8870	n/a
Level3	0.3	54513	-3354	16399	20	1	2065	40461	11987	n/a
Level4	0.3	59812	-8652	15272	20	1	2065	37680	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2.5 Medium House – Solid Fuel

Medium House

Entire house heating
Soild Fuel heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		20425		7107	30	1	2500	12349	5576	n/a
Level2	3.9	16032	4393	3716	30	1	2500	6457	7075	n/a
Level3	1.8	17763	2663	3625	30	1	2500	6298	8964	n/a
Level4	0.9	20794	-369	3526	30	1	2500	6126	12167	n/a
Level5	0.5	28305	-7879	3199	30	1	2500	5558	20247	n/a
Auckland										
Level1		21034		7458	30	1	2500	12958	5576	n/a
Level2	4.2	16282	4751	3860	30	1	2500	6707	7075	n/a
Level3	1.9	18000	3034	3761	30	1	2500	6536	8964	n/a
Level4	1.0	21018	16	3655	30	1	2500	6350	12167	n/a
Level5	0.5	28544	-7510	3336	30	1	2500	5797	20247	n/a
Hamilton										
Level1		29141		12123	30	1	2500	21065	5576	n/a
Level2	6.5	20856	8285	6492	30	1	2500	11281	7075	n/a
Level3	3.0	22474	6667	6336	30	1	2500	11010	8964	n/a
Level4	1.6	25385	3755	6168	30	1	2500	10718	12167	n/a
Level5	0.8	32617	-3477	5681	30	1	2500	9871	20247	n/a
Bay of Plenty										
Level1		23348		8790	30	1	2500	15272	5576	n/a
Level2	4.8	17592	5756	4614	30	1	2500	8017	7075	n/a
Level3	2.2	19283	4065	4500	30	1	2500	7819	8964	n/a
Level4	1.2	22272	1076	4377	30	1	2500	7605	12167	n/a
Level5	0.6	29700	-6352	4002	30	1	2500	6953	20247	n/a
Rotorua										
Level1		40359		18580	30	1	2500	32283	5576	n/a
Level2	9.2	28085	12275	10653	30	1	2500	18510	7075	n/a
Level3	4.2	29610	10749	10443	30	1	2500	18146	8964	n/a
Level4	2.2	32421	7938	10217	30	1	2500	17753	12167	n/a
Level5	1.1	39074	1285	9397	30	1	2500	16328	20247	n/a
Taupo										
Level1		27396		10323	30	1	2500	17936	6959	n/a
Level2	0.2	28915	-1519	10097	30	1	2500	17545	8870	n/a
Level3	0.2	31610	-4214	9855	30	1	2500	17123	11987	n/a
Level4	0.2	38433	-11037	9132	30	1	2500	15867	20066	n/a
New Plymouth										
Level1		27389		11173	30	1	2500	19414	5475	n/a
Level2	6.2	19672	7717	5877	30	1	2500	10212	6959	n/a
Level3	2.8	21332	6057	5733	30	1	2500	9962	8870	n/a
Level4	1.5	24179	3210	5578	30	1	2500	9692	11987	n/a
Level5	0.7	31447	-4058	5111	30	1	2500	8881	20066	n/a
East Coast/Napier										
Level1		27719		11363	30	1	2500	19744	5475	n/a
Level2	6.2	19932	7786	6027	30	1	2500	10473	6959	n/a
Level3	2.8	21587	6131	5880	30	1	2500	10217	8870	n/a
Level4	1.5	24428	3290	5722	30	1	2500	9942	11987	n/a
Level5	0.7	31699	-3980	5256	30	1	2500	9133	20066	n/a
Wellington										
Level1		32691		14225	30	1	2500	24716	5475	n/a
Level2	7.4	23227	9464	7924	30	1	2500	13768	6959	n/a
Level3	3.3	24843	7848	7754	30	1	2500	13473	8870	n/a
Level4	1.8	27642	5049	7571	30	1	2500	13155	11987	n/a
Level5	0.9	34678	-1987	6971	30	1	2500	12112	20066	n/a
Nelson/Marlborough										
Level1		17116		4407	30	1	2500	7657	6959	n/a
Level2	0.1	18863	-1746	4312	30	1	2500	7492	8870	n/a
Level3	0.1	21801	-4685	4210	30	1	2500	7315	11987	n/a
Level4	0.1	29170	-12054	3801	30	1	2500	6604	20066	n/a
West Coast										
Level1		27845		10581	30	1	2500	18385	6959	n/a
Level2	0.2	29366	-1521	10357	30	1	2500	17996	8870	n/a
Level3	0.2	32063	-4218	10116	30	1	2500	17576	11987	n/a
Level4	0.2	38826	-10981	9358	30	1	2500	16260	20066	n/a
Christchurch										
Level1		30854		12313	30	1	2500	21394	6959	n/a
Level2	0.2	32325	-1472	12060	30	1	2500	20955	8870	n/a
Level3	0.2	34969	-4116	11788	30	1	2500	20483	11987	n/a
Level4	0.2	41583	-10729	10945	30	1	2500	19017	20066	n/a
Central Otago										
Level1		38724		16555	30	1	3000	28765	6959	n/a
Level2	0.3	40077	-1353	16234	30	1	3000	28207	8870	n/a
Level3	0.2	42593	-3869	15888	30	1	3000	27607	11987	n/a
Level4	0.2	48721	-9997	14765	30	1	3000	25655	20066	n/a
Dunedin										
Level1		34200		13951	30	1	3000	24241	6959	n/a
Level2	0.2	35654	-1454	13688	30	1	3000	23784	8870	n/a
Level3	0.2	38278	-4077	13404	30	1	3000	23291	11987	n/a
Level4	0.2	44676	-10476	12437	30	1	3000	21610	20066	n/a
Invercargill										
Level1		36474		15260	30	1	3000	26515	6959	n/a
Level2	0.3	37876	-1402	14967	30	1	3000	26006	8870	n/a
Level3	0.2	40444	-3970	14651	30	1	3000	25458	11987	n/a
Level4	0.2	46712	-10238	13609	30	1	3000	23646	20066	n/a
Cromwell										
Level1		39632		17077	30	1	3000	29672	6959	n/a
Level2	0.3	40975	-1344	16751	30	1	3000	29105	8870	n/a
Level3	0.2	43480	-3849	16399	30	1	3000	28494	11987	n/a
Level4	0.2	49602	-9970	15272	30	1	3000	26535	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.2.6 Medium House – Pellets

Medium House

Entire house heating
Pellets heating
No thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV $	NPV $	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace $	PV energy $	Insulation cost $	Thermal mass wall extra cost $
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
Level1		20690		7107	30	1	4000	11114	5576	n/a
Level2	3.5	16886	3804	3716	30	1	4000	5811	7075	n/a
Level3	1.6	18633	2058	3625	30	1	4000	5668	8964	n/a
Level4	0.8	21681	-991	3526	30	1	4000	5514	12167	n/a
Level5	0.4	29249	-8559	3199	30	1	4000	5002	20247	n/a
Auckland										
Level1		21238		7458	30	1	4000	11662	5576	n/a
Level2	3.8	17112	4126	3860	30	1	4000	6037	7075	n/a
Level3	1.7	18846	2392	3761	30	1	4000	5882	8964	n/a
Level4	0.9	21883	-645	3655	30	1	4000	5715	12167	n/a
Level5	0.4	29464	-8226	3336	30	1	4000	5217	20247	n/a
Hamilton										
Level1		28534		12123	30	1	4000	18958	5576	n/a
Level2	5.9	21228	7306	6492	30	1	4000	10153	7075	n/a
Level3	2.7	22873	5661	6336	30	1	4000	9909	8964	n/a
Level4	1.4	25813	2721	6168	30	1	4000	9646	12167	n/a
Level5	0.7	33130	-4596	5681	30	1	4000	8883	20247	n/a
Bay of Plenty										
Level1		23321		8790	30	1	4000	13745	5576	n/a
Level2	4.4	18291	5030	4614	30	1	4000	7216	7075	n/a
Level3	2.0	20001	3320	4500	30	1	4000	7037	8964	n/a
Level4	1.0	23012	309	4377	30	1	4000	6844	12167	n/a
Level5	0.5	30505	-7184	4002	30	1	4000	6258	20247	n/a
Rotorua										
Level1		38631		18580	30	1	4000	29055	5576	n/a
Level2	8.3	27734	10897	10653	30	1	4000	16659	7075	n/a
Level3	3.8	29296	9335	10443	30	1	4000	16331	8964	n/a
Level4	2.0	32145	6485	10217	30	1	4000	15978	12167	n/a
Level5	1.0	38942	-311	9397	30	1	4000	14695	20247	n/a
Taupo										
Level1		27102		10323	30	1	4000	16143	6959	n/a
Level2	0.2	28661	-1559	10097	30	1	4000	15790	8870	n/a
Level3	0.1	31397	-4295	9855	30	1	4000	15411	11987	n/a
Level4	0.1	38346	-11244	9132	30	1	4000	14280	20066	n/a
New Plymouth										
Level1		26948		11173	30	1	4000	17473	5475	n/a
Level2	5.6	20150	6797	5877	30	1	4000	9191	6959	n/a
Level3	2.5	21836	5112	5733	30	1	4000	8966	8870	n/a
Level4	1.3	24709	2238	5578	30	1	4000	8723	11987	n/a
Level5	0.6	32059	-5111	5111	30	1	4000	7993	20066	n/a
East Coast/Napier										
Level1		27244		11363	30	1	4000	17770	5475	n/a
Level2	5.6	20385	6859	6027	30	1	4000	9426	6959	n/a
Level3	2.5	22066	5179	5880	30	1	4000	9195	8870	n/a
Level4	1.4	24934	2310	5722	30	1	4000	8947	11987	n/a
Level5	0.7	32285	-5041	5256	30	1	4000	8219	20066	n/a
Wellington										
Level1		31719		14225	30	1	4000	22245	5475	n/a
Level2	6.6	23350	8369	7924	30	1	4000	12391	6959	n/a
Level3	3.0	24996	6723	7754	30	1	4000	12126	8870	n/a
Level4	1.6	27826	3893	7571	30	1	4000	11840	11987	n/a
Level5	0.8	34967	-3248	6971	30	1	4000	10901	20066	n/a
Nelson/Marlborough										
Level1		17851		4407	30	1	4000	6891	6959	n/a
Level2	0.1	19613	-1763	4312	30	1	4000	6743	8870	n/a
Level3	0.1	22570	-4719	4210	30	1	4000	6583	11987	n/a
Level4	0.1	30010	-12159	3801	30	1	4000	5944	20066	n/a
West Coast										
Level1		27506		10581	30	1	4000	16547	6959	n/a
Level2	0.2	29066	-1560	10357	30	1	4000	16196	8870	n/a
Level3	0.1	31805	-4299	10116	30	1	4000	15819	11987	n/a
Level4	0.1	38700	-11194	9358	30	1	4000	14634	20066	n/a
Christchurch										
Level1		30214		12313	30	1	4000	19255	6959	n/a
Level2	0.2	31730	-1516	12060	30	1	4000	18860	8870	n/a
Level3	0.2	34421	-4207	11788	30	1	4000	18434	11987	n/a
Level4	0.2	41181	-10967	10945	30	1	4000	17115	20066	n/a
Central Otago										
Level1		37847		16555	30	1	5000	25888	6959	n/a
Level2	0.3	39256	-1409	16234	30	1	5000	25386	8870	n/a
Level3	0.2	41833	-3985	15888	30	1	5000	24846	11987	n/a
Level4	0.2	48156	-10308	14765	30	1	5000	23090	20066	n/a
Dunedin										
Level1		33776		13951	30	1	5000	21817	6959	n/a
Level2	0.2	35275	-1499	13688	30	1	5000	21405	8870	n/a
Level3	0.2	37948	-4172	13404	30	1	5000	20962	11987	n/a
Level4	0.2	44515	-10739	12437	30	1	5000	19449	20066	n/a
Invercargill										
Level1		35823		15260	30	1	5000	23863	6959	n/a
Level2	0.2	37276	-1453	14967	30	1	5000	23405	8870	n/a
Level3	0.2	39899	-4076	14651	30	1	5000	22912	11987	n/a
Level4	0.2	46348	-10525	13609	30	1	5000	21281	20066	n/a
Cromwell										
Level1		38665		17077	30	1	5000	26705	6959	n/a
Level2	0.3	40065	-1400	16751	30	1	5000	26195	8870	n/a
Level3	0.2	42631	-3967	16399	30	1	5000	25644	11987	n/a
Level4	0.2	48948	-10283	15272	30	1	5000	23882	20066	n/a

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.3 Part house heating "Heated Area 1" results, Medium house with Thermal mass wall, under Electric heating, Heat Pump, Gas

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	1
Themal Mass wall?	Yes
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Heat pump, Gas

10.3.1 Medium House with Thermal mass wall – Electric resistance

Medium House

Part house heating
Electric heating
With thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
level 1 (without wall)		15903		2682	15	2	1333	8995	5576	0
Level1	-2.4	18114	-2211	3150	15	2	1333	10564	5576	641
Level2	0.9	16139	-236	2114	15	2	1333	7090	7075	641
Level3	0.5	17896	-1992	2075	15	2	1333	6957	8964	641
Level4	0.3	20951	-5047	2030	15	2	1333	6809	12167	641
Level5	0.2	28583	-12679	1897	15	2	1333	6362	20247	641
Auckland										
level 1 (without wall)		16134		2751	15	2	1333	9226	5576	0
Level1	-2.7	18478	-2343	3259	15	2	1333	10928	5576	641
Level2	0.9	16274	-139	2154	15	2	1333	7225	7075	641
Level3	0.5	18017	-1882	2111	15	2	1333	7078	8964	641
Level4	0.3	21059	-4924	2063	15	2	1333	6917	12167	641
Level5	0.2	28712	-12578	1936	15	2	1333	6491	20247	641
Hamilton										
level 1 (without wall)		22522		4656	15	2	1333	15614	5576	0
Level1	-3.3	25277	-2755	5286	15	2	1333	17727	5576	641
Level2	1.7	21129	1393	3602	15	2	1333	12080	7075	641
Level3	0.9	22789	-267	3534	15	2	1333	11851	8964	641
Level4	0.6	25739	-3217	3458	15	2	1333	11597	12167	641
Level5	0.3	33171	-10649	3265	15	2	1333	10950	20247	641
Bay of Plenty										
level 1 (without wall)		18028		3316	15	2	1333	11120	5576	0
Level1	-2.7	20402	-2374	3833	15	2	1333	12852	5576	641
Level2	1.2	17665	363	2569	15	2	1333	8616	7075	641
Level3	0.7	19386	-1358	2519	15	2	1333	8448	8964	641
Level4	0.4	22403	-4375	2464	15	2	1333	8261	12167	641
Level5	0.2	29974	-11945	2312	15	2	1333	7753	20247	641
Rotorua										
level 1 (without wall)		31338		7285	15	2	1333	24429	5576	0
Level1	-5.7	35664	-4326	8383	15	2	1333	28114	5576	641
Level2	2.0	29150	2188	5994	15	2	1333	20101	7075	641
Level3	1.1	30737	601	5904	15	2	1333	19798	8964	641
Level4	0.7	33604	-2265	5804	15	2	1333	19462	12167	641
Level5	0.4	40555	-9217	5467	15	2	1333	18334	20247	641
Taupo										
level 1 (without wall)		25456		5118	15	2	1333	17164	6959	0
Level1	-1.9	28765	-3309	5770	15	2	1333	19350	6959	1122
Level2	-0.6	30347	-4891	5672	15	2	1333	19021	8870	1122
Level3	-0.2	33098	-7642	5563	15	2	1333	18656	11987	1122
Level4	0.0	40225	-14769	5279	15	2	1333	17704	20066	1122
New Plymouth										
level 1 (without wall)		20795		4171	15	2	1333	13988	5475	0
Level1	-2.0	24127	-3331	4830	15	2	1333	16197	5475	1122
Level2	1.2	20216	579	3221	15	2	1333	10802	6959	1122
Level3	0.8	21917	-1121	3158	15	2	1333	10591	8870	1122
Level4	0.5	24801	-4006	3089	15	2	1333	10359	11987	1122
Level5	0.3	32263	-11467	2905	15	2	1333	9742	20066	1122
East Coast/Napier										
level 1 (without wall)		21290		4319	15	2	1333	14483	5475	0
Level1	-1.7	24280	-2990	4876	15	2	1333	16350	5475	1122
Level2	1.3	20408	882	3278	15	2	1333	10994	6959	1122
Level3	0.8	22105	-815	3214	15	2	1333	10779	8870	1122
Level4	0.5	24984	-3694	3144	15	2	1333	10542	11987	1122
Level5	0.3	32449	-11159	2961	15	2	1333	9928	20066	1122
Wellington										
level 1 (without wall)		25185		5480	15	2	1333	18378	5475	0
Level1	-2.6	29197	-4012	6342	15	2	1333	21267	5475	1122
Level2	1.3	24280	905	4433	15	2	1333	14865	6959	1122
Level3	0.8	25942	-757	4359	15	2	1333	14617	8870	1122
Level4	0.5	28783	-3598	4276	15	2	1333	14341	11987	1122
Level5	0.3	36039	-10854	4031	15	2	1333	13517	20066	1122
Nelson/Marlborough										
level 1 (without wall)		15023		2152	15	2	1333	6731	6959	0
Level1	-1.0	17126	-2103	2491	15	2	1333	7792	6959	1042
Level2	-0.3	18910	-3887	2451	15	2	1333	7665	8870	1042
Level3	-0.1	21886	-6863	2406	15	2	1333	7524	11987	1042
Level4	0.0	29428	-14405	2234	15	2	1333	6987	20066	1042
West Coast										
level 1 (without wall)		24509		5185	15	2	1333	16217	6959	0
Level1	-2.3	27904	-3395	5937	15	2	1333	18570	6959	1042
Level2	-0.7	29511	-5002	5840	15	2	1333	18266	8870	1042
Level3	-0.3	32289	-7780	5732	15	2	1333	17928	11987	1042
Level4	-0.1	39429	-14919	5432	15	2	1333	16988	20066	1042
Christchurch										
level 1 (without wall)		27337		6089	15	2	1333	19045	6959	0
Level1	-2.4	30873	-3536	6887	15	2	1333	21539	6959	1042
Level2	-0.7	32445	-5108	6778	15	2	1333	21200	8870	1042
Level3	-0.3	35184	-7847	6658	15	2	1333	20823	11987	1042
Level4	-0.1	42238	-14900	6330	15	2	1333	19797	20066	1042
Central Otago										
level 1 (without wall)		36865		8135	15	2	1777	28129	6959	0
Level1	-4.6	41619	-4753	9266	15	2	1777	32040	6959	842
Level2	-1.2	43055	-6189	9129	15	2	1777	31566	8870	842
Level3	-0.5	45643	-8778	8976	15	2	1777	31037	11987	842
Level4	-0.1	52209	-15343	8538	15	2	1777	29524	20066	842
Dunedin										
level 1 (without wall)		32660		6919	15	2	1777	23924	6959	0
Level1	-4.4	37209	-4548	7991	15	2	1777	27630	6959	842
Level2	-1.2	38729	-6068	7878	15	2	1777	27239	8870	842
Level3	-0.5	41409	-8749	7752	15	2	1777	26803	11987	842
Level4	-0.1	48160	-15500	7368	15	2	1777	25475	20066	842
Invercargill										
level 1 (without wall)		34897		7566	15	2	1777	26161	6959	0
Level1	-4.7	39689	-4791	8708	15	2	1777	30111	6959	842
Level2	-1.3	41164	-6266	8582	15	2	1777	29674	8870	842
Level3	-0.5	43796	-8899	8442	15	2	1777	29190	11987	842
Level4	-0.1	50457	-15559	8032	15	2	1777	27772	20066	842
Cromwell										
level 1 (without wall)	0.0	38034		8473	15	2	1777	29297	6959	0
Level1	-4.5	42650	-4617	9565	15	2	1777	33072	6959	842
Level2	-1.2	44082	-6048	9426	15	2	1777	32593	8870	842
Level3	-0.5	46665	-8632	9272	15	2	1777	32059	11987	842
Level4	-0.1	53239	-15206	8837	15	2	1777	30554	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.3.2 Medium House with Thermal mass wall – Heat Pump

Medium House

Part house heating
Heat Pump
With thermal wall
North Orientation

Period = 30 years
Discount rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$				$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
level 1 (without wall)		15232		4348	15	1	4443	5213	5576	0
Level1	-0.5	16175	-943	4600	15	1	4443	5514	5576	641
Level2	0.3	16800	-1568	3871	15	1	4443	4641	7075	641
Level3	0.2	18655	-3423	3842	15	1	4443	4606	8964	641
Level4	0.1	21819	-6587	3810	15	1	4443	4568	12167	641
Level5	0.0	29811	-14579	3736	15	1	4443	4480	20247	641
Auckland										
level 1 (without wall)		15504		4575	15	1	4443	5485	5576	0
Level1	-0.8	16638	-1135	4986	15	1	4443	5978	5576	641
Level2	0.2	17150	-1646	4163	15	1	4443	4991	7075	641
Level3	0.1	18998	-3494	4128	15	1	4443	4950	8964	641
Level4	0.1	22156	-6652	4090	15	1	4443	4904	12167	641
Level5	0.0	30144	-14640	4014	15	1	4443	4813	20247	641
Hamilton										
level 1 (without wall)		17243		6026	15	1	4443	7224	5576	0
Level1	-0.6	18261	-1018	6340	15	1	4443	7601	5576	641
Level2	0.6	18070	-826	4930	15	1	4443	5910	7075	641
Level3	0.3	19889	-2645	4871	15	1	4443	5840	8964	641
Level4	0.2	23014	-5771	4806	15	1	4443	5763	12167	641
Level5	0.1	30926	-13682	4666	15	1	4443	5594	20247	641
Bay of Plenty										
level 1 (without wall)		16191		5148	15	1	4443	6172	5576	0
Level1	-0.6	17212	-1021	5465	15	1	4443	6552	5576	641
Level2	0.4	17547	-1356	4494	15	1	4443	5388	7075	641
Level3	0.2	19387	-3196	4453	15	1	4443	5338	8964	641
Level4	0.1	22536	-6345	4407	15	1	4443	5284	12167	641
Level5	0.1	30505	-14314	4315	15	1	4443	5173	20247	641
Rotorua										
level 1 (without wall)		19293		7735	15	1	4443	9274	5576	0
Level1	-1.6	20968	-1675	8598	15	1	4443	10308	5576	641
Level2	0.8	19712	-419	6299	15	1	4443	7552	7075	641
Level3	0.5	21494	-2201	6210	15	1	4443	7445	8964	641
Level4	0.3	24578	-5285	6111	15	1	4443	7326	12167	641
Level5	0.2	32302	-13009	5815	15	1	4443	6971	20247	641
Taupo										
level 1 (without wall)		18617		6018	15	1	4443	7215	6959	0
Level1	-0.5	20261	-1644	6453	15	1	4443	7737	6959	1122
Level2	-0.1	22062	-3444	6361	15	1	4443	7626	8870	1122
Level3	0.0	25056	-6438	6259	15	1	4443	7504	11987	1122
Level4	0.0	32839	-14222	6012	15	1	4443	7208	20066	1122
New Plymouth										
level 1 (without wall)		16095		5152	15	1	4443	6177	5475	0
Level1	-0.5	17746	-1651	5594	15	1	4443	6706	5475	1122
Level2	0.4	17607	-1512	4239	15	1	4443	5082	6959	1122
Level3	0.3	19454	-3359	4186	15	1	4443	5019	8870	1122
Level4	0.2	22501	-6406	4128	15	1	4443	4949	11987	1122
Level5	0.1	30414	-14319	3989	15	1	4443	4783	20066	1122
East Coast/Napier										
level 1 (without wall)		17170		6049	15	1	4443	7252	5475	0
Level1	-0.4	18701	-1531	6390	15	1	4443	7661	5475	1122
Level2	0.5	18560	-1390	5034	15	1	4443	6035	6959	1122
Level3	0.3	20404	-3234	4978	15	1	4443	5968	8870	1122
Level4	0.2	23446	-6276	4916	15	1	4443	5894	11987	1122
Level5	0.1	31363	-14194	4781	15	1	4443	5732	20066	1122
Wellington										
level 1 (without wall)		17392		6234	15	1	4443	7474	5475	0
Level1	-0.7	19281	-1889	6874	15	1	4443	8241	5475	1122
Level2	0.5	18713	-1321	5161	15	1	4443	6188	6959	1122
Level3	0.3	20542	-3151	5094	15	1	4443	6107	8870	1122
Level4	0.2	23569	-6177	5019	15	1	4443	6017	11987	1122
Level5	0.1	31407	-14015	4817	15	1	4443	5776	20066	1122
Nelson/Marlborough										
level 1 (without wall)		15784		3940	15	1	4443	4381	6959	0
Level1	-0.2	17003	-1219	4099	15	1	4443	4558	6959	1042
Level2	0.0	18878	-3094	4067	15	1	4443	4522	8870	1042
Level3	0.0	21954	-6170	4030	15	1	4443	4482	11987	1042
Level4	0.0	29920	-14136	3929	15	1	4443	4369	20066	1042
West Coast										
level 1 (without wall)		17772		5728	15	1	4443	6369	6959	0
Level1	-0.6	19457	-1685	6306	15	1	4443	7012	6959	1042
Level2	-0.2	21265	-3494	6214	15	1	4443	6910	8870	1042
Level3	-0.1	24268	-6496	6112	15	1	4443	6796	11987	1042
Level4	0.0	32047	-14275	5841	15	1	4443	6495	20066	1042
Christchurch										
level 1 (without wall)		19151		6968	15	1	4443	7748	6959	0
Level1	-0.6	20814	-1663	7526	15	1	4443	8369	6959	1042
Level2	-0.2	22609	-3458	7422	15	1	4443	8254	8870	1042
Level3	-0.1	25597	-6446	7307	15	1	4443	8125	11987	1042
Level4	0.0	33346	-14195	7009	15	1	4443	7795	20066	1042
Central Otago										
level 1 (without wall)		23490		8598	15	1	5924	10607	6959	0
Level1	-1.4	25491	-2001	9537	15	1	5924	11766	6959	842
Level2	-0.4	27237	-3747	9404	15	1	5924	11601	8870	842
Level3	-0.1	30171	-6680	9255	15	1	5924	11418	11987	842
Level4	0.0	37738	-14247	8840	15	1	5924	10906	20066	842
Dunedin										
level 1 (without wall)		21673		7125	15	1	5924	8790	6959	0
Level1	-1.4	23704	-2032	8089	15	1	5924	9979	6959	842
Level2	-0.4	25478	-3805	7978	15	1	5924	9842	8870	842
Level3	-0.2	28441	-6768	7853	15	1	5924	9688	11987	842
Level4	0.0	36059	-14386	7479	15	1	5924	9227	20066	842
Invercargill										
level 1 (without wall)		22448		7753	15	1	5924	9565	6959	0
Level1	-1.5	24540	-2092	8766	15	1	5924	10815	6959	842
Level2	-0.4	26296	-3848	8641	15	1	5924	10660	8870	842
Level3	-0.2	29241	-6793	8502	15	1	5924	10489	11987	842
Level4	0.0	36828	-14380	8103	15	1	5924	9996	20066	842
Cromwell										
level 1 (without wall)	0.0	24150		9133	15	1	5924	11267	6959	0
Level1	-1.2	26020	-1870	9966	15	1	5924	12295	6959	842
Level2	-0.3	27764	-3614	9831	15	1	5924	12128	8870	842
Level3	-0.1	30695	-6545	9681	15	1	5924	11943	11987	842
Level4	0.0	38274	-14124	9275	15	1	5924	11442	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.3.3 Medium House with Thermal mass wall – Gas

Medium House

Part house heating
Gas heating
With thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$				$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
level 1 (without wall)		17396		2682	20	2	7160	4660	5576	0
Level1	-1.3	18851	-1455	3150	20	2	7160	5474	5576	641
Level2	0.5	18550	-1154	2114	20	2	7160	3674	7075	641
Level3	0.3	20370	-2974	2075	20	2	7160	3605	8964	641
Level4	0.2	23497	-6100	2030	20	2	7160	3528	12167	641
Level5	0.1	31344	-13948	1897	20	2	7160	3296	20247	641
Auckland										
level 1 (without wall)		17516		2751	20	2	7160	4780	5576	0
Level1	-1.4	19039	-1523	3259	20	2	7160	5662	5576	641
Level2	0.5	18619	-1103	2154	20	2	7160	3743	7075	641
Level3	0.3	20433	-2917	2111	20	2	7160	3667	8964	641
Level4	0.2	23553	-6037	2063	20	2	7160	3584	12167	641
Level5	0.1	31411	-13895	1936	20	2	7160	3363	20247	641
Hamilton										
level 1 (without wall)		20826		4656	20	2	7160	8090	5576	0
Level1	-1.7	22562	-1737	5286	20	2	7160	9185	5576	641
Level2	0.9	21135	-309	3602	20	2	7160	6259	7075	641
Level3	0.5	22906	-2080	3534	20	2	7160	6140	8964	641
Level4	0.3	25978	-5152	3458	20	2	7160	6009	12167	641
Level5	0.2	33721	-12896	3265	20	2	7160	5674	20247	641
Bay of Plenty										
level 1 (without wall)		18497		3316	20	2	7160	5761	5576	0
Level1	-1.4	20036	-1539	3833	20	2	7160	6659	5576	641
Level2	0.6	19340	-843	2569	20	2	7160	4464	7075	641
Level3	0.3	21143	-2645	2519	20	2	7160	4377	8964	641
Level4	0.2	24249	-5752	2464	20	2	7160	4281	12167	641
Level5	0.1	32065	-13568	2312	20	2	7160	4017	20247	641
Rotorua										
level 1 (without wall)		25393		7285	20	2	7160	12658	5576	0
Level1	-3.0	27944	-2550	8383	20	2	7160	14567	5576	641
Level2	1.0	25291	102	5994	20	2	7160	10415	7075	641
Level3	0.6	27024	-1630	5904	20	2	7160	10258	8964	641
Level4	0.4	30052	-4659	5804	20	2	7160	10084	12167	641
Level5	0.2	37547	-12154	5467	20	2	7160	9499	20247	641
Taupo										
level 1 (without wall)		23012		5118	20	2	7160	8893	6959	0
Level1	-1.0	25267	-2255	5770	20	2	7160	10026	6959	1122
Level2	-0.3	27008	-3996	5672	20	2	7160	9856	8870	1122
Level3	-0.1	29935	-6923	5563	20	2	7160	9666	11987	1122
Level4	0.0	37521	-14509	5279	20	2	7160	9173	20066	1122
New Plymouth										
level 1 (without wall)		19882		4171	20	2	7160	7248	5475	0
Level1	-1.0	22149	-2267	4830	20	2	7160	8392	5475	1122
Level2	0.6	20838	-956	3221	20	2	7160	5597	6959	1122
Level3	0.4	22640	-2758	3158	20	2	7160	5488	8870	1122
Level4	0.2	25636	-5754	3089	20	2	7160	5368	11987	1122
Level5	0.1	33396	-13514	2905	20	2	7160	5048	20066	1122
East Coast/Napier										
level 1 (without wall)		20138		4319	20	2	7160	7504	5475	0
Level1	-0.9	22228	-2090	4876	20	2	7160	8472	5475	1122
Level2	0.7	20938	-799	3278	20	2	7160	5696	6959	1122
Level3	0.4	22737	-2599	3214	20	2	7160	5585	8870	1122
Level4	0.3	25731	-5593	3144	20	2	7160	5462	11987	1122
Level5	0.2	33492	-13354	2961	20	2	7160	5144	20066	1122
Wellington										
level 1 (without wall)		22157		5480	20	2	7160	9522	5475	0
Level1	-1.3	24776	-2620	6342	20	2	7160	11019	5475	1122
Level2	0.7	22944	-787	4433	20	2	7160	7702	6959	1122
Level3	0.4	24726	-2569	4359	20	2	7160	7573	8870	1122
Level4	0.3	27699	-5543	4276	20	2	7160	7431	11987	1122
Level5	0.2	35352	-13195	4031	20	2	7160	7004	20066	1122
Nelson/Marlborough										
level 1 (without wall)		22346		2152	20	2	7160	8227	6959	0
Level1	-1.2	24685	-2339	2491	20	2	7160	9523	6959	1042
Level2	-0.4	26440	-4094	2451	20	2	7160	9368	8870	1042
Level3	-0.2	29385	-7039	2406	20	2	7160	9196	11987	1042
Level4	0.0	36808	-14462	2234	20	2	7160	8540	20066	1042
West Coast										
level 1 (without wall)		33940		5185	20	2	7160	19821	6959	0
Level1	-2.8	37858	-3918	5937	20	2	7160	22696	6959	1042
Level2	-0.8	39397	-5457	5840	20	2	7160	22325	8870	1042
Level3	-0.3	42100	-8160	5732	20	2	7160	21912	11987	1042
Level4	-0.1	49031	-15091	5432	20	2	7160	20763	20066	1042
Christchurch										
level 1 (without wall)		37396		6089	20	2	7160	23277	6959	0
Level1	-2.9	41486	-4090	6887	20	2	7160	26325	6959	1042
Level2	-0.9	42983	-5586	6778	20	2	7160	25911	8870	1042
Level3	-0.4	45639	-8242	6658	20	2	7160	25450	11987	1042
Level4	-0.1	52464	-15067	6330	20	2	7160	24196	20066	1042
Central Otago										
level 1 (without wall)		47695		8135	20	2	9638	31097	6959	0
Level1	-5.1	52861	-5166	9266	20	2	9638	35421	6959	842
Level2	-1.4	54247	-6552	9129	20	2	9638	34897	8870	842
Level3	-0.5	56779	-9085	8976	20	2	9638	34313	11987	842
Level4	-0.1	63185	-15490	8538	20	2	9638	32639	20066	842
Dunedin										
level 1 (without wall)		43046		6919	20	2	9638	26448	6959	0
Level1	-4.9	47985	-4940	7991	20	2	9638	30546	6959	842
Level2	-1.3	49464	-6418	7878	20	2	9638	30114	8870	842
Level3	-0.5	52098	-9053	7752	20	2	9638	29632	11987	842
Level4	-0.1	58709	-15663	7368	20	2	9638	28163	20066	842
Invercargill										
level 1 (without wall)		45519		7566	20	2	9638	28921	6959	0
Level1	-5.2	50727	-5208	8708	20	2	9638	33288	6959	842
Level2	-1.4	52156	-6637	8582	20	2	9638	32806	8870	842
Level3	-0.6	54737	-9218	8442	20	2	9638	32271	11987	842
Level4	-0.1	61248	-15729	8032	20	2	9638	30702	20066	842
Cromwell										
level 1 (without wall)	0.0	48986		8473	20	2	9638	32389	6959	0
Level1	-5.0	54001	-5015	9565	20	2	9638	36562	6959	842
Level2	-1.3	55382	-6396	9426	20	2	9638	36032	8870	842
Level3	-0.5	57909	-8923	9272	20	2	9638	35443	11987	842
Level4	-0.1	64325	-15338	8837	20	2	9638	33779	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.4 Entire house heating "Heated Area 2" results, Medium house with Thermal mass wall, under Electric heating, Heat Pump, Gas

Variable	Options selected
House type(s)	Medium
Schedule	Eve21 for Non-heat pump. For Heat pump: Summer (Day19,Eve21)
Heated area	2
Themal Mass wall?	Yes
Life cycle years	30
Discount rate	5%
Energy price escalation	1%
Orientation(s)	North
Heater	Electric, Heat pump, Gas

10.4.1 Medium House with Thermal mass wall – Electric resistance

Medium House

Entire house heating
Electric heating
With thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio	Total PV	NPV	Energy kWh/ year	Heater life years	# heaters in house	PV heater inc replace	PV energy	Insulation cost	Thermal mass wall extra cost
		$	$				$	$	$	$
	(1)	(2)	(3)	(4)				(5)	(6)	(7)
Northland										
level 1 (without wall)		31409		7107	15	3	1999	23834	5576	0
Level1	4.1	29404	2005	6318	15	3	1999	21187	5576	641
Level2	5.8	21112	10297	3398	15	3	1999	11396	7075	641
Level3	3.2	22717	8692	3314	15	3	1999	11112	8964	641
Level4	1.8	25611	5798	3221	15	3	1999	10803	12167	641
Level5	0.9	32701	-1292	2926	15	3	1999	9813	20247	641
Auckland										
level 1 (without wall)		32584		7458	15	3	1999	25009	5576	0
Level1	4.6	30304	2280	6586	15	3	1999	22087	5576	641
Level2	6.2	21436	11148	3495	15	3	1999	11720	7075	641
Level3	3.4	23019	9565	3404	15	3	1999	11414	8964	641
Level4	1.9	25890	6694	3305	15	3	1999	11082	12167	641
Level5	1.0	33015	-431	3020	15	3	1999	10127	20247	641
Hamilton										
level 1 (without wall)		48230		12123	15	3	1999	40655	5576	0
Level1	7.0	44358	3872	10777	15	3	1999	36141	5576	641
Level2	9.7	29640	18591	5941	15	3	1999	19924	7075	641
Level3	5.3	31045	17184	5797	15	3	1999	19441	8964	641
Level4	3.0	33726	14504	5641	15	3	1999	18918	12167	641
Level5	1.5	40347	7883	5207	15	3	1999	17460	20247	641
Bay of Plenty										
level 1 (without wall)		37051		8790	15	3	1999	29476	5576	0
Level1	5.2	34385	2666	7803	15	3	1999	26168	5576	641
Level2	7.2	23853	13198	4216	15	3	1999	14138	7075	641
Level3	3.9	25389	11662	4110	15	3	1999	13784	8964	641
Level4	2.2	28208	8843	3996	15	3	1999	13400	12167	641
Level5	1.1	35164	1887	3661	15	3	1999	12277	20247	641
Rotorua										
level 1 (without wall)		69882		18580	15	3	1999	62307	5576	0
Level1	10.2	63987	5895	16631	15	3	1999	55771	5576	641
Level2	13.7	42680	27202	9830	15	3	1999	32964	7075	641
Level3	7.4	43922	25960	9637	15	3	1999	32317	8964	641
Level4	4.2	46422	23460	9427	15	3	1999	31614	12167	641
Level5	2.2	52038	17844	8693	15	3	1999	29151	20247	641
Taupo										
level 1 (without wall)		43576		10323	15	3	1999	34617	6959	0
Level1	3.4	40912	2664	9194	15	3	1999	30831	6959	1122
Level2	1.5	42175	1401	9000	15	3	1999	30183	8870	1122
Level3	0.8	44587	-1011	8790	15	3	1999	29478	11987	1122
Level4	0.5	50622	-7046	8181	15	3	1999	27435	20066	1122
New Plymouth										
level 1 (without wall)		44944		11173	15	3	1999	37470	5475	0
Level1	3.8	41767	3177	9891	15	3	1999	33170	5475	1122
Level2	7.5	28028	16916	5352	15	3	1999	17947	6959	1122
Level3	4.4	29491	15453	5218	15	3	1999	17499	8870	1122
Level4	2.7	32123	12821	5074	15	3	1999	17015	11987	1122
Level5	1.4	38797	6147	4655	15	3	1999	15609	20066	1122
East Coast/Napier										
level 1 (without wall)		45580		11363	15	3	1999	38106	5475	0
Level1	3.8	42408	3171	10083	15	3	1999	33812	5475	1122
Level2	7.5	28556	17024	5509	15	3	1999	18475	6959	1122
Level3	4.4	30013	15567	5374	15	3	1999	18021	8870	1122
Level4	2.7	32637	12943	5227	15	3	1999	17529	11987	1122
Level5	1.4	39326	6254	4812	15	3	1999	16138	20066	1122
Wellington										
level 1 (without wall)		55176		14225	15	3	1999	47702	5475	0
Level1	4.7	51015	4161	12649	15	3	1999	42419	5475	1122
Level2	9.0	34418	20758	7257	15	3	1999	24337	6959	1122
Level3	5.3	35805	19371	7101	15	3	1999	23813	8870	1122
Level4	3.2	38354	16822	6932	15	3	1999	23246	11987	1122
Level5	1.7	44635	10541	6396	15	3	1999	21447	20066	1122
Nelson/Marlborough										
level 1 (without wall)		22741		4407	15	3	1999	13782	6959	0
Level1	0.7	23010	-269	4159	15	3	1999	13009	6959	1042
Level2	0.3	24663	-1922	4077	15	3	1999	12751	8870	1042
Level3	0.2	27499	-4757	3987	15	3	1999	12471	11987	1042
Level4	0.2	34462	-11720	3630	15	3	1999	11354	20066	1042
West Coast										
level 1 (without wall)		42052		10581	15	3	1999	33093	6959	0
Level1	3.2	39773	2280	9519	15	3	1999	29772	6959	1042
Level2	1.3	41078	974	9325	15	3	1999	29166	8870	1042
Level3	0.8	43538	-1485	9115	15	3	1999	28509	11987	1042
Level4	0.5	49608	-7556	8473	15	3	1999	26501	20066	1042
Christchurch										
level 1 (without wall)		47468		12313	15	3	1999	38510	6959	0
Level1	4.2	44181	3287	10929	15	3	1999	34180	6959	1042
Level2	1.7	45414	2054	10712	15	3	1999	33503	8870	1042
Level3	0.9	47796	-327	10477	15	3	1999	32768	11987	1042
Level4	0.6	53658	-6189	9768	15	3	1999	30550	20066	1042
Central Otago										
level 1 (without wall)		66867		16555	15	3	2666	57241	6959	0
Level1	7.6	61345	5522	14714	15	3	2666	50878	6959	842
Level2	2.7	62299	4568	14438	15	3	2666	49921	8870	842
Level3	1.4	64378	2489	14138	15	3	2666	48884	11987	842
Level4	0.8	69187	-2320	13192	15	3	2666	45613	20066	842
Dunedin										
level 1 (without wall)		57864		13951	15	3	2666	48239	6959	0
Level1	5.3	54243	3621	12660	15	3	2666	43776	6959	842
Level2	1.9	55371	2493	12434	15	3	2666	42993	8870	842
Level3	1.0	57638	227	12188	15	3	2666	42143	11987	842
Level4	0.6	62904	-5039	11375	15	3	2666	39330	20066	842
Invercargill										
level 1 (without wall)		62389		15260	15	3	2666	52764	6959	0
Level1	6.2	58001	4389	13747	15	3	2666	47534	6959	842
Level2	2.2	59045	3344	13497	15	3	2666	46668	8870	842
Level3	1.2	61221	1168	13225	15	3	2666	45727	11987	842
Level4	0.7	66287	-3897	12353	15	3	2666	42713	20066	842
Cromwell										
level 1 (without wall)		68673		17077	15	3	2666	59048	6959	0
Level1	8.2	62639	6034	15089	15	3	2666	52173	6959	842
Level2	2.8	63585	5089	14810	15	3	2666	51207	8870	842
Level3	1.5	65654	3019	14507	15	3	2666	50160	11987	842
Level4	0.9	70472	-1798	13563	15	3	2666	46898	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.4.2 Medium House with Thermal mass wall – Heat Pump

Medium House

Entire house heating
Heat Pump
With thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21
Summer cooling degC = 19

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
level 1 (without wall)		27227		10648	15	2	8886	12765	5576	0
Level1	3.1	25884	1344	8992	15	2	8886	10780	5576	641
Level2	2.3	24537	2691	6618	15	2	8886	7934	7075	641
Level3	1.2	26347	881	6552	15	2	8886	7855	8964	641
Level4	0.7	29464	-2236	6480	15	2	8886	7769	12167	641
Level5	0.3	37326	-10099	6299	15	2	8886	7552	20247	641
Auckland										
level 1 (without wall)		28145		11413	15	2	8886	13683	5576	0
Level1	3.1	26787	1358	9745	15	2	8886	11684	5576	641
Level2	2.4	25125	3020	7109	15	2	8886	8523	7075	641
Level3	1.3	26923	1222	7033	15	2	8886	8431	8964	641
Level4	0.7	30028	-1883	6950	15	2	8886	8333	12167	641
Level5	0.4	37877	-9732	6759	15	2	8886	8103	20247	641
Hamilton										
level 1 (without wall)		32374		14940	15	2	8886	17911	5576	0
Level1	4.1	30381	1993	12743	15	2	8886	15278	5576	641
Level2	3.7	26668	5705	8396	15	2	8886	10066	7075	641
Level3	2.0	28407	3967	8270	15	2	8886	9915	8964	641
Level4	1.1	31445	928	8133	15	2	8886	9751	12167	641
Level5	0.6	39130	-6756	7803	15	2	8886	9356	20247	641
Bay of Plenty										
level 1 (without wall)		29699		12709	15	2	8886	15237	5576	0
Level1	3.6	28057	1642	10805	15	2	8886	12954	5576	641
Level2	2.8	25828	3871	7695	15	2	8886	9226	7075	641
Level3	1.5	27609	2090	7605	15	2	8886	9117	8964	641
Level4	0.9	30695	-996	7507	15	2	8886	9000	12167	641
Level5	0.4	38504	-8805	7281	15	2	8886	8730	20247	641
Rotorua										
level 1 (without wall)		37780		19450	15	2	8886	23318	5576	0
Level1	4.5	35564	2216	17066	15	2	8886	20461	5576	641
Level2	5.0	29128	8652	10448	15	2	8886	12526	7075	641
Level3	2.7	30790	6991	10257	15	2	8886	12298	8964	641
Level4	1.6	33745	4035	10051	15	2	8886	12050	12167	641
Level5	0.8	41049	-3268	9404	15	2	8886	11274	20247	641
Taupo										
level 1 (without wall)		30385		12127	15	2	8886	14540	6959	0
Level1	1.8	29513	872	10464	15	2	8886	12545	6959	1122
Level2	0.7	31206	-821	10282	15	2	8886	12327	8870	1122
Level3	0.4	34086	-3701	10085	15	2	8886	12091	11987	1122
Level4	0.2	41526	-11141	9551	15	2	8886	11451	20066	1122
New Plymouth										
level 1 (without wall)		30039		13077	15	2	8886	15678	5475	0
Level1	2.0	28950	1089	11233	15	2	8886	13467	5475	1122
Level2	2.7	25576	4463	7180	15	2	8886	8608	6959	1122
Level3	1.6	27347	2692	7064	15	2	8886	8469	8870	1122
Level4	1.0	30313	-274	6938	15	2	8886	8318	11987	1122
Level5	0.5	37998	-7959	6609	15	2	8886	7924	20066	1122
East Coast/Napier										
level 1 (without wall)		32445		15084	15	2	8886	18084	5475	0
Level1	2.3	30947	1498	12899	15	2	8886	15464	5475	1122
Level2	2.9	27390	5055	8693	15	2	8886	10422	6959	1122
Level3	1.7	29154	3291	8571	15	2	8886	10276	8870	1122
Level4	1.0	32112	333	8439	15	2	8886	10117	11987	1122
Level5	0.5	39801	-7356	8113	15	2	8886	9727	20066	1122
Wellington										
level 1 (without wall)		33154		15675	15	2	8886	18793	5475	0
Level1	2.2	31797	1357	13607	15	2	8886	16314	5475	1122
Level2	3.3	27275	5879	8597	15	2	8886	10307	6959	1122
Level3	1.9	29015	4139	8455	15	2	8886	10136	8870	1122
Level4	1.2	31946	1208	8300	15	2	8886	9951	11987	1122
Level5	0.6	39491	-6337	7854	15	2	8886	9417	20066	1122
Nelson/Marlborough										
level 1 (without wall)		24942		8180	15	2	8886	9096	6959	0
Level1	1.2	24783	159	7100	15	2	8886	7895	6959	1042
Level2	0.4	26618	-1676	7032	15	2	8886	7819	8870	1042
Level3	0.2	29652	-4710	6958	15	2	8886	7737	11987	1042
Level4	0.1	37485	-12543	6736	15	2	8886	7490	20066	1042
West Coast										
level 1 (without wall)		28759		11613	15	2	8886	12914	6959	0
Level1	1.5	28228	531	10198	15	2	8886	11341	6959	1042
Level2	0.6	29935	-1176	10015	15	2	8886	11137	8870	1042
Level3	0.3	32830	-4071	9816	15	2	8886	10915	11987	1042
Level4	0.2	40266	-11507	9237	15	2	8886	10272	20066	1042
Christchurch										
level 1 (without wall)		31493		14071	15	2	8886	15647	6959	0
Level1	2.1	30380	1113	12133	15	2	8886	13492	6959	1042
Level2	0.8	32059	-566	11925	15	2	8886	13260	8870	1042
Level3	0.4	34924	-3431	11698	15	2	8886	13009	11987	1042
Level4	0.2	42286	-10793	11053	15	2	8886	12292	20066	1042
Central Otago										
level 1 (without wall)		40287		17411	15	2	11848	21479	6959	0
Level1	3.2	38433	1853	15226	15	2	11848	18784	6959	842
Level2	1.1	40012	275	14957	15	2	11848	18452	8870	842
Level3	0.6	42769	-2482	14665	15	2	11848	18092	11987	842
Level4	0.3	49742	-9455	13769	15	2	11848	16986	20066	842
Dunedin										
level 1 (without wall)		36502		14343	15	2	11848	17694	6959	0
Level1	2.2	35526	976	12870	15	2	11848	15877	6959	842
Level2	0.8	37162	-660	12647	15	2	11848	15602	8870	842
Level3	0.4	39981	-3479	12405	15	2	11848	15304	11987	842
Level4	0.2	47089	-10587	11618	15	2	11848	14333	20066	842
Invercargill										
level 1 (without wall)		38037		15588	15	2	11848	19230	6959	0
Level1	2.5	36778	1260	13884	15	2	11848	17128	6959	842
Level2	0.9	38383	-345	13636	15	2	11848	16823	8870	842
Level3	0.5	41167	-3130	13367	15	2	11848	16491	11987	842
Level4	0.3	48204	-10166	12522	15	2	11848	15448	20066	842
Cromwell										
level 1 (without wall)		41433		18340	15	2	11848	22626	6959	0
Level1	3.6	39211	2222	15857	15	2	11848	19562	6959	842
Level2	1.2	40786	647	15585	15	2	11848	19226	8870	842
Level3	0.6	43539	-2106	15290	15	2	11848	18862	11987	842
Level4	0.3	50531	-9098	14408	15	2	11848	17775	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall

10.4.3 Medium House with Thermal mass wall – Gas

Medium House

Entire house heating
Gas heating
With thermal wall
North Orientation

Period = 30 years
Disct rate = 5%
Energy esc = 1%
Winter heating degC = 21

Insulation level & region	Benefit Cost ratio (1)	Total PV $ (2)	NPV $ (3)	Energy kWh/ year (4)	Heater life years	# heaters in house	PV heater inc replace $	PV energy $ (5)	Insulation cost $ (6)	Thermal mass wall extra cost $ (7)
Northland										
level 1 (without wall)		25085		7107	20	2	7160	12349	5576	0
Level1	2.1	24355	730	6318	20	2	7160	10978	5576	641
Level2	3.0	20781	4304	3398	20	2	7160	5905	7075	641
Level3	1.6	22523	2562	3314	20	2	7160	5758	8964	641
Level4	0.9	25566	-481	3221	20	2	7160	5597	12167	641
Level5	0.5	33133	-8048	2926	20	2	7160	5085	20247	641
Auckland										
level 1 (without wall)		25694		7458	20	2	7160	12958	5576	0
Level1	2.4	24821	872	6586	20	2	7160	11444	5576	641
Level2	3.2	20949	4745	3495	20	2	7160	6073	7075	641
Level3	1.7	22679	3014	3404	20	2	7160	5914	8964	641
Level4	1.0	25711	-17	3305	20	2	7160	5742	12167	641
Level5	0.5	33295	-7602	3020	20	2	7160	5247	20247	641
Hamilton										
level 1 (without wall)		33800		12123	20	2	7160	21065	5576	0
Level1	3.6	32103	1697	10777	20	2	7160	18726	5576	641
Level2	5.0	25199	8601	5941	20	2	7160	10323	7075	641
Level3	2.7	26839	6962	5797	20	2	7160	10073	8964	641
Level4	1.6	29771	4030	5641	20	2	7160	9802	12167	641
Level5	0.8	37095	-3294	5207	20	2	7160	9047	20247	641
Bay of Plenty										
level 1 (without wall)		28008		8790	20	2	7160	15272	5576	0
Level1	2.7	26936	1072	7803	20	2	7160	13559	5576	641
Level2	3.7	22201	5807	4216	20	2	7160	7325	7075	641
Level3	2.0	23907	4101	4110	20	2	7160	7142	8964	641
Level4	1.2	26912	1097	3996	20	2	7160	6943	12167	641
Level5	0.6	34409	-6401	3661	20	2	7160	6361	20247	641
Rotorua										
level 1 (without wall)		45019		18580	20	2	7160	32283	5576	0
Level1	5.3	42274	2745	16631	20	2	7160	28897	5576	641
Level2	7.1	31956	13063	9830	20	2	7160	17080	7075	641
Level3	3.9	33510	11509	9637	20	2	7160	16745	8964	641
Level4	2.2	36349	8670	9427	20	2	7160	16380	12167	641
Level5	1.1	43152	1867	8693	20	2	7160	15104	20247	641
Taupo										
level 1 (without wall)		32055		10323	20	2	7160	17936	6959	0
Level1	1.7	31216	839	9194	20	2	7160	15975	6959	1122
Level2	0.8	32791	-735	9000	20	2	7160	15639	8870	1122
Level3	0.4	35543	-3487	8790	20	2	7160	15274	11987	1122
Level4	0.3	42563	-10507	8181	20	2	7160	14215	20066	1122
New Plymouth										
level 1 (without wall)		32049		11173	20	2	7160	19414	5475	0
Level1	2.0	30943	1105	9891	20	2	7160	17187	5475	1122
Level2	3.9	24540	7508	5352	20	2	7160	9299	6959	1122
Level3	2.3	26219	5830	5218	20	2	7160	9067	8870	1122
Level4	1.4	29085	2964	5074	20	2	7160	8816	11987	1122
Level5	0.7	36436	-4387	4655	20	2	7160	8087	20066	1122
East Coast/Napier										
level 1 (without wall)		32379		11363	20	2	7160	19744	5475	0
Level1	2.0	31276	1102	10083	20	2	7160	17519	5475	1122
Level2	3.9	24814	7564	5509	20	2	7160	9573	6959	1122
Level3	2.3	26489	5889	5374	20	2	7160	9337	8870	1122
Level4	1.4	29351	3027	5227	20	2	7160	9082	11987	1122
Level5	0.7	36710	-4331	4812	20	2	7160	8362	20066	1122
Wellington										
level 1 (without wall)		37351		14225	20	2	7160	24716	5475	0
Level1	2.4	35736	1615	12649	20	2	7160	21979	5475	1122
Level2	4.6	27851	9499	7257	20	2	7160	12610	6959	1122
Level3	2.7	29491	7860	7101	20	2	7160	12339	8870	1122
Level4	1.7	32313	5037	6932	20	2	7160	12045	11987	1122
Level5	0.9	39461	-2110	6396	20	2	7160	11113	20066	1122
Nelson/Marlborough										
level 1 (without wall)		30964		4407	20	2	7160	16845	6959	0
Level1	0.9	31061	-97	4159	20	2	7160	15900	6959	1042
Level2	0.4	32657	-1692	4077	20	2	7160	15585	8870	1042
Level3	0.3	35430	-4466	3987	20	2	7160	15242	11987	1042
Level4	0.2	42145	-11181	3630	20	2	7160	13877	20066	1042
West Coast										
level 1 (without wall)		54567		10581	20	2	7160	40447	6959	0
Level1	3.9	51549	3018	9519	20	2	7160	36388	6959	1042
Level2	1.6	52720	1847	9325	20	2	7160	35648	8870	1042
Level3	0.9	55033	-467	9115	20	2	7160	34845	11987	1042
Level4	0.6	60658	-6091	8473	20	2	7160	32390	20066	1042
Christchurch										
level 1 (without wall)		61187		12313	20	2	7160	47067	6959	0
Level1	5.1	56937	4249	10929	20	2	7160	41776	6959	1042
Level2	2.1	58020	3167	10712	20	2	7160	40948	8870	1042
Level3	1.2	60238	949	10477	20	2	7160	40049	11987	1042
Level4	0.7	65607	-4421	9768	20	2	7160	37339	20066	1042
Central Otago										
level 1 (without wall)		79880		16555	20	2	9638	63282	6959	0
Level1	8.4	73686	6194	14714	20	2	9638	56247	6959	842
Level2	2.9	74539	5340	14438	20	2	9638	55189	8870	842
Level3	1.6	76509	3371	14138	20	2	9638	54042	11987	842
Level4	0.9	80972	-1093	13192	20	2	9638	50426	20066	842
Dunedin										
level 1 (without wall)		69927		13951	20	2	9638	53330	6959	0
Level1	5.9	65835	4092	12660	20	2	9638	48396	6959	842
Level2	2.1	66881	3047	12434	20	2	9638	47530	8870	842
Level3	1.1	69057	870	12188	20	2	9638	46591	11987	842
Level4	0.7	74026	-4099	11375	20	2	9638	43480	20066	842
Invercargill										
level 1 (without wall)		74930		15260	20	2	9638	58332	6959	0
Level1	6.9	69989	4940	13747	20	2	9638	52550	6959	842
Level2	2.4	70942	3988	13497	20	2	9638	51592	8870	842
Level3	1.3	73019	1911	13225	20	2	9638	50553	11987	842
Level4	0.8	77766	-2836	12353	20	2	9638	47220	20066	842
Cromwell										
level 1 (without wall)		81877		17077	20	2	9638	65279	6959	0
Level1	9.0	75117	6760	15089	20	2	9638	57678	6959	842
Level2	3.1	75961	5916	14810	20	2	9638	56611	8870	842
Level3	1.7	77920	3957	14507	20	2	9638	55453	11987	842
Level4	1.0	82393	-516	13563	20	2	9638	51847	20066	842

(1) Ratio = [PV energy savings] : [additional insulation + additional thermal wall (if included)], using insulation level 1 without thermal wall as base case
(2) Total Present Value = PV heater inc replacements + PV Energy + Insulation cost + thermal wall extra cost
(3) NPV is for insulation level 1 (without thermal wall) as base case
(4) If Heat Pump, summer cooling energy consumption is included
(5) PV of energy costs over analysis period
(6) Cost of floor type, wall insulation, ceiling insulation
(7) Extra cost of thermal mass wall compared with timber wall