Summary

With research and mathematical calculations, we found that no, we could not avoid building a new power station, but using energy efficient steps, we could delay the need for a new power station for 5 years.

First of all, we researched on the internet how much electricity was used per year. We put this data into tables to make graphs which presented our data in a visual form.

We found that the period from 2001 to 2007, 33,348 – 38,545 GWh (gigawatt hours) of electricity was used by New Zealand in total, and that 11,306 – 12,731 GWh were used by residential dwellings from the period 2001 to 2007[1]. The total electricity production from the same period was 38,341 to 42,277 GWh[2].

As the question asked about avoiding another power station construction, we kept the total electricity produced level at 42,277 GWh through to 2020. For the residential and total electricity used in New Zealand, we used Microsoft Excel to project the increasing trend of the totals for the years from 2008 – 2020. This allowed us to know when and if the electricity use would be greater than the electricity produced.

The electricity used would be greater than the electricity produced by 2012. This meant that the need for another power station has been met in 2012.

From further research on the internet, we found that an energy efficient home could reduce its energy use by 35%. We modelled our 35% on 4 main ways of cutting down electricity. These were insulating the home, using low energy light bulbs, turning the heating down by just one degree and by turning appliances off at the wall. This totals to around 40%, but we appreciated that these changes in every household will not be 40%, so, we lowered the change to a more realistic goal of 35%, as was stated by information.org[3].

By assuming that every year 50% more houses become energy efficient from 2009, then by 2020, the total electricity used by residential homes will be 35% less than if energy improvements hadn't been made.

By plotting this data on a graph, we discovered that the energy used would exceed the energy produced by 2017, meaning that New Zealand could not save enough electricity via energy efficiency improvements in home to avoid New Zealand requiring an additional power station being constructed.

Introduction

Looking at the question "could New Zealanders save enough electricity via energy efficiency improvements in homes to avoid New Zealand requiring an additional power station being constructed?" we looked at the total energy use by New Zealand and residential dwellings, and the total production of energy in New Zealand. We took this to mean that if all New Zealand homes became energy efficient, then would another power station ever need to be built. We decided how much electricity could be saved by implementing various energy efficiency measures in New Zealand homes and calculated, using a model, if this saving would be enough to avoid needing a new power station. We made various assumptions which would allow the model to work. Our model was based on the residential power consumption usage as a percentage of the total power consumption versus the total power production of New Zealand with and without energy efficiency measures.

Main Part

First of all, we researched the energy production and usage figures on the internet. We found that from 2001 to 2007 the amount of energy used by residential dwellings increased from 11,306 GWh (gigawatt hours) to 12,731 GWh, and the increase of total energy use in New Zealand increased from 33,348 GWh to 38,545 GWh from 2001 to 2007. The energy produced from 2001 to 2007 increased from 38,341 GWh to 42,277 Gwh.

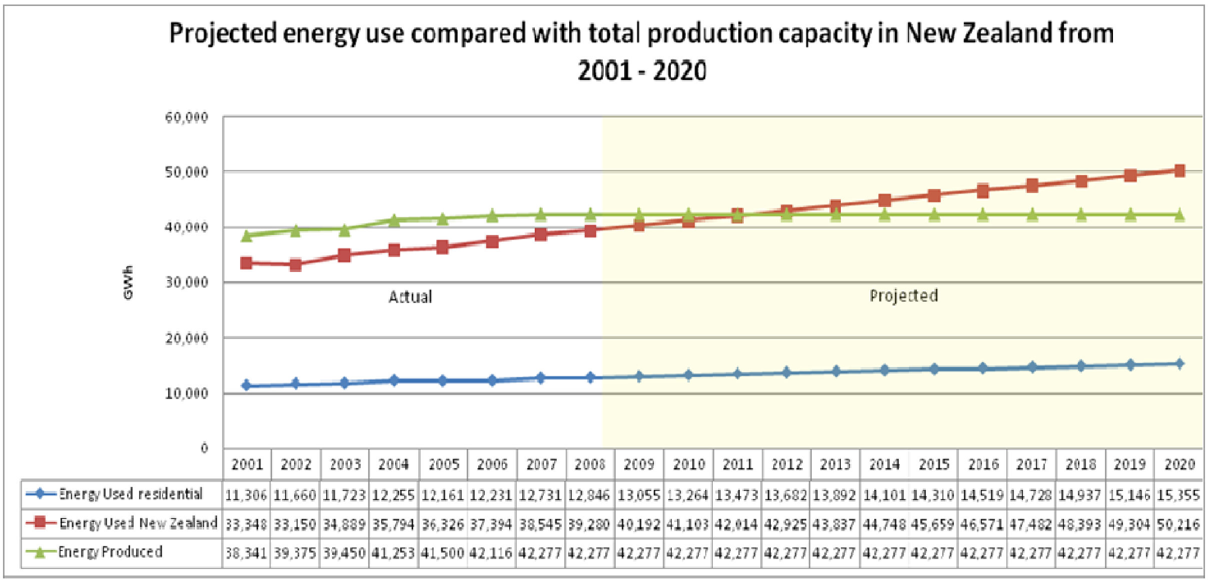
Year	Energy Used Residential[1]	Energy Used New Zealand[1]	Energy Produced[2]
2001	11,306	33,348	38,341
2002	11,660	33,150	39,375
2003	11,723	34,889	39,450
2004	12,255	35,794	41,253
2005	12,161	36,326	41,500
2006	12,231	37,394	42,116
2007	12,731	38,545	42,277

This is shown on this table, using figures from two different sources.

After finding these figures, we extrapolated the energy used residential and energy used New Zealand, through to 2020. This was done on excel and gave us figures that increased steadily from year to year. As the question wanted, we added no extra power production to the energy produced, because no further power plants were being constructed, so no additional energy could be produced. We also assumed that the energy produced, from 2008 – 2020 was the maximum capacity of possible production. After extrapolating the data, this gave us more figures –

Year	Energy Used Residential[1]	Energy Used New Zealand[1]	Energy Produced[2]
2001	11,306	33,348	38,341
2002	11,660	33,150	39,375
2003	11,723	34,889	39,450
2004	12,255	35,794	41,253
2005	12,161	36,326	41,500
2006	12,231	37,394	42,116
2007	12,731	38,545	42,277
2008	12,846	39,280	42,277
2009	13,055	40,192	42,277
2010	13,264	41,103	42,277
2011	13,473	42,014	42,277
2012	13,682	42,925	42,277
2013	13,892	43,837	42,277
2014	14,101	44,748	42,277
2015	14,310	45,659	42,277
2016	14,519	46,571	42,277
2017	14,728	47,482	42,277
2018	14,937	48,393	42,277
2019	15,146	49,304	42,277
2020	15,355	50,216	42,277

This also gave us a graph, which gave a visual representation of the data, showing the year that the energy used exceeded the energy produced.



As we can deduce from the data, a new power station would be needed by 2012 to meet the demands of the New Zealand market.

To possibly solve this, we needed to reduce the power consumption residential dwellings by implementing energy efficiency measures to save enough electricity to get below the green line.

With further research, we found that a reasonable power saving by households would be around 35%. We modelled this by using 4 major energy efficiency improvements. These are insulating the home (you can reduce your home's heating and cooling costs by as much as 30% through proper insulation and air sealing techniques[4]) which means that (because roughly 50% of home electricity use is for space heating[5]) insulation can save 15% of electricity usage; using low energy light bulbs (traditional light bulbs use 80% more energy, mostly making heat, not light[6]) which saves 8% of electricity usage (artificial lighting makes up about 15% of a household's electricity use[7]); turning the heating down by just one degree saves 10% of electricity (this can save up to 10% of your overall electricity bill[8]) and by turning appliances off at the wall (appliances left on stand-by mode can draw an average of 5 – 10% of household energy use[9]) then around 7.5% of electricity usage can be saved. This totals around to 40%, but we realised that every house adhering to these rules would not make a saving of 40%, so we lowered this saving to 35%, which was backed up by a quote from information.org - Energy efficient homes use 35% less energy than standard homes[10].

An assumption we made was that every year, 50% less houses would remain non-energy efficient (energy efficient meaning electricity usage has decreased by 35%), so that almost all houses become energy efficient by 2020. This was modelled by the equation: percentage of energy saved = 0.35 x (0.5 (to the power of the number of years after 2009) + 0.5 (to the power of the number of years after 2009 minus one) + 0.5 (to the power of the number of years after 2009 minus two))...etc, or S=0.35(0.5^n+0.5^(n-1)+0.5^(n-2)+0.5^(n-3)) and so on until n=0, where S=percentage of energy saved, and n=number of years after 2009.

Putting this formula into excel and placing it against figures, we were able to find out the percentage of amount of electricity saved. This gave us a new table:

Year	Energy used residential	Energy saved (% total)
2009	13,055	17.50%
2010	13,264	26.25%
2011	13,473	30.63%
2012	13,682	32.81%
2013	13,892	33.91%
2014	14,101	34.45%
2015	14,310	34.73%
2016	14,519	34.86%
2017	14,728	34.93%
2018	14,937	34.97%
2019	15,146	34.98%
2020	15,355	34.99%

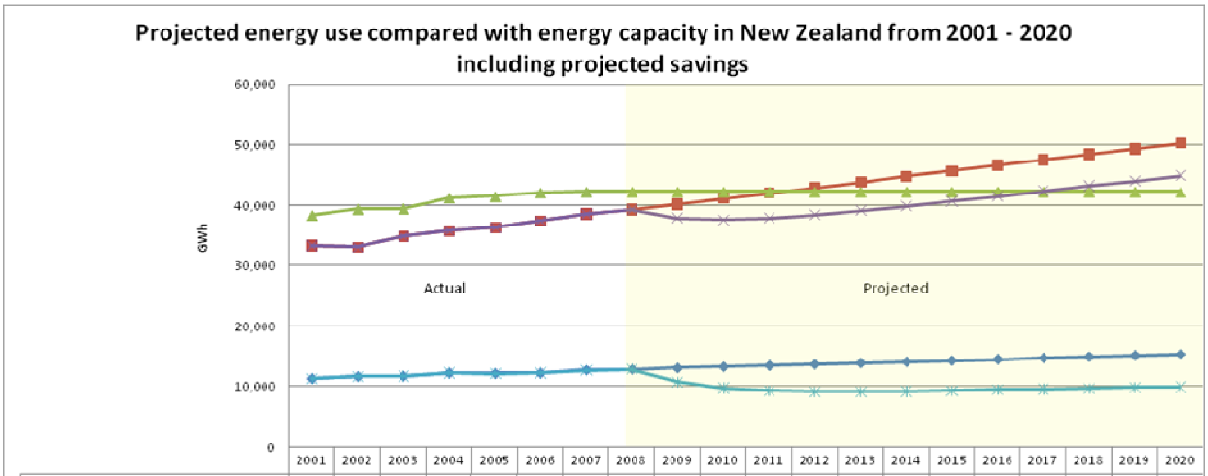
After doing this, we could multiply the percentage of energy saved by the energy used residential. This formula was $E_s=E_u*(1-S)$, where E_s=Energy after savings, and E_u=Energy used before savings. This gave us the table of:

Year	Energy used residential	Energy saved (% total)	Energy Used After Savings	Energy Saved
2009	13,055	17.50%	10,770	2,285
2010	13,264	26.25%	9,782	3,482
2011	13,473	30.63%	9,347	4,126
2012	13,682	32.81%	9,193	4,489
2013	13,892	33.91%	9,182	4,710
2014	14,101	34.45%	9,243	4,858
2015	14,310	34.73%	9,341	4,969
2016	14,519	34.86%	9,457	5,062
2017	14,728	34.93%	9,583	5,145
2018	14,937	34.97%	9,714	5,223
2019	15,146	34.98%	9,847	5,299
2020	15,355	34.99%	9,982	5,373

From this data, we were able to see how much energy per year was used in total, and plot that against the power produced, by subtracting the power saved from the total power used per year

Year	Energy Used residential	Energy Used New Zealand	Energy Produced	Projected Energy Use after savings	Projected Residential Use after savings
2001	11,306	33,348	38,341	33,348	11,306
2002	11,660	33,150	39,375	33,150	11,660
2003	11,723	34,889	39,450	34,889	11,723
2004	12,255	35,794	41,253	35,794	12,255
2005	12,161	36,326	41,500	36,326	12,161
2006	12,231	37,394	42,116	37,394	12,231
2007	12,731	38,545	42,277	38,545	12,731
2008	12,846	39,280	42,277	39,280	12,846
2009	13,055	40,192	42,277	37,907	10,770
2010	13,264	41,103	42,277	37,621	9,782
2011	13,473	42,014	42,277	37,888	9,347
2012	13,682	42,925	42,277	38,436	9,193
2013	13,892	43,837	42,277	39,126	9,182
2014	14,101	44,748	42,277	39,890	9,243
2015	14,310	45,659	42,277	40,690	9,341
2016	14,519	46,571	42,277	41,509	9,457
2017	14,728	47,482	42,277	42,337	9,583
2018	14,937	48,393	42,277	43,170	9,714
2019	15,146	49,304	42,277	44,006	9,847
2020	15,355	50,216	42,277	44,843	9,982

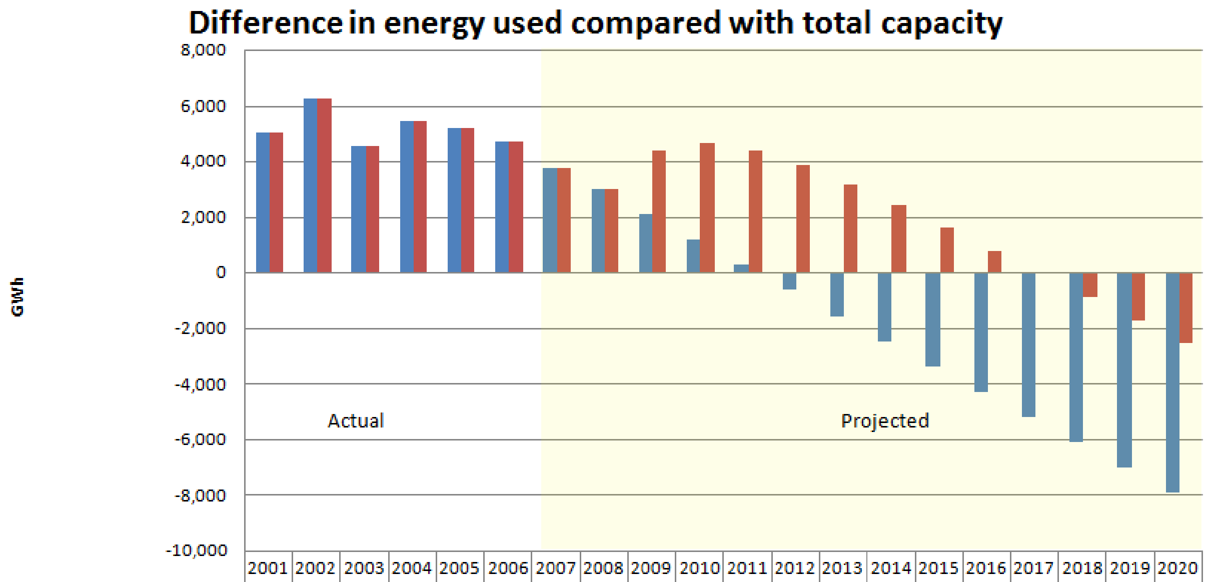
This data gave us the most important graph, which gave a visual representation of the power produced and the power used.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy Used residential	11,306	11,660	11,723	12,255	12,151	12,231	12,731	12,846	13,055	13,264	13,473	13,682	13,892	14,101	14,310	14,519	14,728	14,937	15,146	15,355
Energy Used New Zealand	33,348	33,150	34,889	35,794	36,326	37,394	38,545	39,280	40,192	41,103	42,014	42,925	43,837	44,748	45,659	46,571	47,482	48,393	49,304	50,216
Energy Produced	38,341	39,375	39450	41,253	41,500	42,116	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277	42,277
Projected Energy Use after savings	33,348	33,150	34,889	35,794	36,326	37,394	38,545	39,280	37,907	37,621	37,888	38,436	39,125	39,890	40,690	41,509	42,337	43,170	44,006	44,843
Projected Residential Use after savings	11,306	11,660	11,723	12,255	12,151	12,231	12,731	12,846	10,770	9,782	9,347	9,193	9,182	9,243	9,341	9,457	9,583	9,714	9,847	9,982

This graph allowed us to see the effects of energy efficiency savings on the total amount of energy required. The year that a new power station was needed was only delayed by 5 years.

This means that no, New Zealanders cannot save enough electricity via energy efficiency improvements without needing an additional power station to be constructed. However, as the next graph shows, the requirement for a power station which produces a large amount of energy is not needed, as the amount of electricity required after energy efficiency improvements is only low.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Difference Before Savings	4,993	6,225	4,561	5,458	5,174	4,722	3,732	2,996	2,085	1,174	262	-649	-1,56	-2,47	-3,38	-4,29	-5,20	-6,11	-7,02	-7,94
Difference After Savings	4,993	6,225	4,561	5,458	5,174	4,722	3,732	2,996	4,370	4,655	4,388	3,840	3,150	2,386	1,586	767	-61	-894	-1,73	-2,56

In researching this topic, we had to make assumptions to allow the models to work. These assumptions were:

- Because no further power plants are being built, we will assume that the energy production will be the same, based on 2007 levels. This was in order to allow us to know when the amount of energy required exceeded the level of energy produced, and to comply with the guidelines of the question (requiring an additional power station – therefore no extra power is being produced)

- All houses are energy inefficient before 2009. This means that the amount of energy saved could be less than actual, because some houses are already energy efficient, and are therefore unable to reduce their power consumption by a further 35%, however this may be offset by extremely inefficient houses which would be able to reduce their power consumption by more than 35%.

- All houses are powered by electricity supplied from the national grid. This is to make the model easier to work with, but it also lowers the amount of energy saved because some houses are or could be made self-sustainable.

- In the model, 50% of energy inefficient houses will become energy efficient every year after 2009. This may not happen, for cultural, economic or viability reasons, so this again reduces the amount of energy saved. However this assumption was again designed to comply with the guidelines of the question (“could...” – therefore the question is implying that it should be assumed that energy efficient measures will be taken by all houses). This figure could easily be changed and still work in the model.

Conclusion

From the graphs, we found that, without any energy efficient measures being taken, New Zealand would need another major power station by 2012. If energy efficient measures were taken, then the need for another major power station would be offset by 5 years until 2017 (not indefinitely). Therefore no, New Zealanders could not save enough electricity via energy efficiency improvements in homes to avoid New Zealand requiring and additional power station being constructed.

To enhance our answer, our research would need to be more indepth. This would include finding the number of houses that are not energy efficient, the projected growth of New Zealand, the real maximum capacity of power stations in New Zealand, and have a model that better represents all factors. We would also want to look at the economics of making energy efficiency improvements in homes and determine what percentage of home could realistically afford this, and if it is more economic to build a power station instead of implementing these measures. We could also look at other ways of improving energy efficiency in the home, and how much could be realistically saved in the long term.

Appendix

1. http://www.mfe.govt.nz/rma/central/nps/generation/submissions/118-ohariu-preservation-society.pdf
2. http://www.med.govt.nz/templates/MultipageDocumentTOC____41150.aspx
3. http://www.energy.govt/insulationairsealing.htm
4. http://ww.hydro.com.au/handson/sustliv/homenrgy.htm
5. http://www.energysavingtrust.org.uk/energy-saving-products/energy-saving-lightbulbs-and-fittings/frequently-asked-questions
6. http://www.energywisepa.org/category/fact-sheet-categories/electric/daylighting-0
7. http://energy-conservation.suite101.com/article.cfm/save_energy_cut_electricity_bills
8. www.sciencedirect.com
9. http://news.bbc.co.uk
10. http://www.informaction.org/cgi-bin/gpage.pl?menu=menua.txt&main=energy_gen.txt&s=energy