Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Mathematics and Statistics RAS 2023

91946 Interpret and apply mathematical and statistical information in context

EXEMPLAR

Excellence TOTAL 07

Section A

First Bullet point:
Comparing the 2 trend lines you can see that there is an overall increasing trend for both homes and businesses while the prices for “Homes” electricity per kW/hour has a steeper gradient and increase more as it increased by 21 cents over the last 32 years compared to businesses which increased by only 6.5 cents over the last 32 years. If you compare the 2 prices over the last 6 years you can also see that they have both become more stable and not rising as much per year lately and that they followed the same similar trend of increasing prices during 1999-2012 and have also both had a similar stable trend since 2016 onwards too. On average business kW/hour price rises 0.20 cents per year while compared to “homes” which rose 0.66 cents a year on average. You can also see business cent per kWh become cheaper from 1990-1999 before rising again compared to homes which has consistently been rising since 1990 as you can see through the trend line. They were also both the same price around 1994 which is when they intersected in cents per kWh as they both costed around 11 cents/ kWh. You can tell by the graph that businesses cents per kWh are cheaper than homes and this could be due to more demand from businesses meaning the fixed costs are more spread out and also because individual businesses can negotiate with the electricity provider.

Second bullet point: As you can see through recourse 1 graph.“Home” prices for Kw/hour has been increasing the last 32 years as it has increased by 21 cents over the last 32 years per kW/H as it started at 9 cents per kWh but rose to 30 cents per kWh. If you also look at recourse 2A and 2B you can see that the home expenditure (amount spent) per household has still increased a tiny bit on average in price. As of 2013 Q4 it was $479 for 1698 kw/hour compared to 2021 Q4 which was $504 for 1654 kw/hour. So you can see the price has increased even if the kw/ hour usage has decreased. The usage has decreased for a variety of reasons such as electricity appliances getting more and more efficient with energy thus using less electricity and people not being at home as often. The price for average overall expenditure has also increased a tiny bit over the years. As if you compare Q3 average home expenditures over the years 2018, 2019, 2020 and 2021 which respectfully costs $639.25, $646.67, $654.54 and $695.83 you can see how the price moved in an upward trend as the price for power becomes more expensive as well.You can also see that it peaks last year in price (2021 Q3 at $695.83 average) which shows how price has been increasing but this could also be due to covid meaning a lot more people stayed at home thus using more electricity as well but even so it still shows price has increased as there was similar usage level in 2015 Q3 (2373.71), 10 kw/ hour less but the price has still increased in 2021 Q3 compared to 2015 Q3 by $50. Which confirms the theory of prices increasing over the years.These claims can be supported because as you can see through the graph from recourse 1, the price for power has been increasing per kW/hour constantly over the last 32 years and through recourse 2B you can see even with the reduced fixed costs and efficient electricity tools the home expenditure is still slightly increasing too which shows how the price of power has been increasing. These claims can also be supported as there are enough values in order as there is a wide range of years in order to make an accurate claim.

Third bullet point: Looking at the graphs if we analyse graph 2A you can see a seasonal trend as it peaks during the winter (as homes use more electrical appliances because of the cold) and dips during the summer (less need for electrical appliances as it's already hot) which means that you can conclude that it peaks during Q3 and dips during Q1 and it hasn't changed throughout the years as every year they always mark the maximum and minimum average expenditure costs. Also there is no noticeable seasonal variation throughout the years so using both these points of information we can conclude the weather and the season has an effect on the amount of electricity used and money spent thus affecting the average home expenditure for each home every year and that the price doesn't vary too much year to year. It also peaked in price during 2021 Q3 as you can see through recourse 2B that the price and usage amount was the highest during that quarter. This could be due to covid but even so the usage levels weren't abnormally high so it shows the price has been steadily increasing over the years and how world events can change the amount of electricity used as well. You can also conclude also from graph 2B that the average price of electricity per kWh has gone up over the years as in 2013 Q2 it was $509 for 1824 kwH while in 2022 Q2 it was $546 for 1736 kWh which shows that the average price has gone up as you've used less electricity usage but the prices average for home expenditure has still increased. You can also make the conclusion that there isn't too much need for concern about price rising and becoming unaffordable as even though it spiked in 2021 Q3 this was due to covid so a one off event and in recourse 2A you can see that the following seasons didn't variate too much from the past few seasons so you can conclude that average home expenditure prices won't be getting more and more expensive every year yet and the overall trend is stable. You can also see through recourse 2A that there hasn't been too much of an increase in price even in the last 9 years which shows that power companies have been keeping the price to steady level even with inflation which also shows how they're keeping up with technological change and even when changing the price per kWh they aren't increasing the overall home expenditure by that much.

Fourth Bullet point: First of all medium sized NZ households should choose their electricity company based on what time they use electricity and how much electricity they use. If you look at a medium-sized NZ household in New Zealand, the amount of electricity they use and what time then I think the best option should be Shout electricity provider. Every household is different though so they should be choosing it based on the times they are using electricity and how much they are using it. Shout is a very good for medium sized household as it provides $100 credit which can help with bills especially in the economy and inflation that NZ has now and also because the anytime rate and off peak night and day rate are very low at $0.1675 / kWh. This isn't the cheapest compared to each individual plan for example night rate being cheaper with Equator energy ($0.1196/ kWh) so if a household is using electricity more often at night this may be a better option but overall if the household is using electricity a lot and often Shout would be cheaper in the long term as it has cheaper day rates as well as anytime rate compared to the other 3 plans. The daily charge matters a lot though as well as if you aren't home often, plans with high daily charge wouldn't be a good plan. The daily charge is quite high at $2.5070/ day for Shout compared to the cheapest option which is Equator energy at $1.7502/ day daily charge so choosing a electricity company is dependant

on each family but on average in making this conclusion I'm assuming that medium sized households do use electricity often especially when kids come home from school and watch TV, do homework and stuff like that so I still think Shout would still be the best option but if a medium sized family doesn't use electricity too much or too often then they should make their decision based off of that instead. In making this conclusion I'm assuming that families use a lot of electricity and are using it all the time and also that the medium sized typical NZ family would be 2 kids and 2 adults. Some families might not use electricity at night or morning so may not get the added benefits of cheaper off-peak plans provided by Shout and I'm also assuming that a medium sized family wouldn't want a renewable option instead or any add ons as there aren't any included in the Shout plan/contract and no mention of renewable energy as well. There is also the added assumption that they are at home often as sometimes I noticed in real life that some medium sized families might not be at home too often, as the kids have school and the parents have work so the family members are not home during the day to really take advantage of Shout. Some limitations in choosing a power company and making this conclusion would be that if they were to be away from their house or are not using a lot of electricity and want to switch power companies. It would take 3-4 days to complete. So if you want to switch to a cheaper or better deal, it may take some time and for a lot of families every dollar counts so even if it is open term you can't just switch whenever you feel like or whenever the situation calls for instantly. It would mean it would take planning in advance to switch if you go on a vacation or are not going to be using a lot electricity for a time period or something. Another limitation is that not every power company is available everywhere in NZ so even if this is the best option for a medium sized family in NZ it may not be available to their home location if the power companies haven't set up the resources to deliver power to your home location which prevents you from choosing this plan. Overall because it is an open term plan meaning that there aren't a lot of restrictions on if you want to change the plan compared to Wired 4 Power which gives you some room for change in the future if something happens, and also because of the cheaper rates and selling point I think that Shout would be the best electricity plan for typical medium sized households in NZ as it provide you with that option and gives you a cheap deal. It also has the best customer rating out of the 4 options at 8 which shows just how pleased the customers who have used this power company before is, and could be a good representation of the quality of the service which may appeal for some families in NZ which makes it an even better and more reliable option as you NZ families should check the reviews beforehand on each power company before making their decision as some companies may not be as good and reliable in real life compared to how it looks on paper.

Section B

First bulletpoint: The electricity method that creates the most environmental impact would be coal as you can see through graph 6 that it generates the most kg's of Co2 per annum (2.508 billion) even though it only accounts for 5 percent of NZ operating capacity which shows that it is an extremely inefficient generation method and extremely bad for the environment as it creates the most emissions which harms the environment by far even though it is used so less

in comparison to the other generation methods.Also because the unaccounted for damage such as mining and habitat destruction in order to use coal takes a toll on the environment too so coal is just overall inefficient and harmful for the environment.

Second bulletpoint: This claim could become true and is on track too as you can see through recourse 5B that the planned capacity consists of mostly renewable sources and only 1% percent non renewable. But this one percent planned capacity hinders NZ from reaching 100% as there would still be non renewable plants still operating and most likely won't close as soon as they are just opening so the companies need to make back their money first and if the government were to intervene it would take a massive investment as well. You can also see from recourse 4 shows that NZ still needs to cut down 0.25 GW of energy and replace them per year (as 20% of energy created is non renewable as of right now) in order to help NZ be on 100% renewable energy by 2030 but it is going in the right direction by making the planned power capacity 99 percent renewable sources (such as wind) but genesis energy who own the huntly steam power plant would need to shut the remaining 2/4 units as they consist of 500 MW of power by themselves. Which is run on a non renewable source and is powered by coal which is the most harmful generation method too and produces the most emissions as you can see through the top graph on recourse 6. Even if genesis energy switched those power plants to natural gas even though it would be better than coal, it would still not be completely non renewable and still would need to shut down completely in order to have NZ 100% renewable by 2030. You can also see through recourse 5A that there are still a dozen power plants operating and more planned non renewable sources (which is only 1% though; as Others* is specified on the website directed by the link too mean biomass oil and other non renewable sources) which hinder NZ's goals of 100% renewable energy. So in order to reach the goal these new power plants planned would have to be shut down as well. If the government does follow through with all these things there would be some consequences of closing down these power plants which would have to be dealt with, such as a power shortage. As the power sources have been shut down meaning more power plants would need to be built in the future to make up for the energy gap (have to still be renewable sources too in order to reach the 100% renewable goal). Also thinking about what to do with the abandoned powerplants as leaving them sitting there not doing anything isn't good for the environment either. So in conclusion this claim could become true but it would require a large investment and effort from the government as well as commitment in making sure that they don't open any non renewable powerplants and that they try to close the old operating powerplants as well. You can see by the graph such as recourse 5B that they have attempted too make this transition and are trying to accomplish this goal but some little things like opening those 2 non renewable powerplants seen on recourse 5A could hinder there overall progress.

Third bulletpoint: There are many solutions in order to be Zero Carbon emissions by 2050 but one possible effective solution would be to ban or restrict fossil fuel usage overtime and eventually try to completely minimise the use of fossil fuels and non-renewable sources by 2050. This is because fossil fuels account for the majority of electricity, transport and

manufacturing emissions created. So by restricting the usage of it you can save billions of billions of emissions being produced and released into the atmosphere as you can see by the bottom graph of recourse 6 that transport accounts for 14.131 billion kg of Co2 produced. So by implementing these restrictions and switching to a more green option like electric cars would reduce emissions by an extreme amount if everybody co-operates. Also since it would be expensive for a lot of families, investing in public transport would help NZ too as you can see for other countries such as Great Britain, the better the public transport the less overall transport emissions created as there are less cars on the road releasing emissions. For electricity we are already heading in the right direction as you can see that most of the planned capacity through the pie chart on recourse 5B is non renewable and NZ is on track to reach the 100% renewable goal by 2030. But to completely reduce it to near 0 carbon emissions you would have to shut down non renewable operating power plants as well as not planning anymore too. So the laws that restrict fossil fuels will help that as it forces companies to try to make the change for a more renewable energy source which in the end will help NZ get closer to achieving the "Zero Carbon emissions by 2050" goal but it won't reduce emissions completely for electricity as geothermal and cogen sources still release 1.047 billion kg of CO2 so also trying to make those more energy efficient too could help the environment and decrease electricity emissions too. By restricting the fossil fuels like coal and oil through laws and other restricting methods you automatically reduce the amount of manufacturing emissions created as when you are transporting and creating buildings using a green way such as driving an electric car instead of using gas and oil it automatically decreases emissions produced on its own. In addition to these restrictions, planting a lot of trees and starting sustainable farming will help NZ actually become 0 carbon emissions by 2050 a lot more efficiently and easily. As you can see in the bottom graph on recourse 6 that forestry, land use and land use change accounts for 2.74 billion kg of CO2 so by planting trees you automatically decrease the amount of forestry emissions in general and trees can help the additional emissions created as well. This lowers NZ's overall emissions per annum as well. Even if there is a little bit of carbon emissions produced NZ could still be net zero emissions as zero carbon emissions definition means to produce only what emissions the atmosphere can release sustainably. So even though we can't control the methane emissions produced by cows, if we try to control what we can, like by switching to renewable energy (through ecocity wind, hydro and solar) we can reduce the emissions produced so much that the environment can deal with those uncontrollable factors that are created. There are some limitations in this plan though such as the fact that even if you switch to renewable powerplants or electric cars they both still have their own effects on the environment even if they don't release emissions, such as land change when creating these new renewable powerplants such as a hydro dam. Also the batteries used in electric cars aren't great for the environment either and can have a lasting impact overtime. They are still better than the alternative non renewable methods we are using right now so using it will still have an overall positive effect and help NZ to reach its 0 carbon emissions goal. It would take a large effort from everybody though as you can through recourse 4 that other companies such as genesis energy own large non renewable power plants and would need to shut down such power plants in order to reduce emissions but this would hurt their profit so some companies might not co operate unless stricter laws are put in place. It also leave room for more power

plants needed to be created, in order to fill the energy needs of the country left by the non renewable powerplants closing. The laws and restrictions required would also take a large investment from the government in terms of money and time and would need to go through a lot of different processes to be official and in action as well. In the end this plan will be worth it though as it helps NZ to reach its zero carbon emissions goal by 2050.

Excellence

Subject: Mathematics and Statistics

Standard: 91946

Total score: 07

Grade score	Marker commentary
E7	A good response to Section B (iii) that drew on the resources and 'real world views.' Apart from Section B (ii) – a detailed and accurate script.

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EXEMPLAR

Excellence TOTAL 07

Section A:

- For homes and businesses, the average prices for electricity per kW/hour both follow an increasing overall trend, from 1990 to 2022. The average electricity rate for homes starts at 9 cents per kW/hour and follows a steady increase until 1998, while for businesses it is around 12 cents per kW/h in 1990, this price decreases slightly until 1998. From 1994, after both average prices were 11 cents per kW/hour, prices for homes began to be more expensive than businesses and continued this way up to 2022. Both average prices for homes and businesses began increasing in around 2001, this begins to stop in 2012 for businesses and 2015 for homes. In 2022, prices for homes were 30 cents per kW/h, while for businesses it was around 18.5 cents per kW/h. Homes have been paying more money per kW/hour since 1994 on average, and this could be because businesses have deals with power companies as they use more energy and more frequently, being open during the day. While homes may require and use less electricity, with less or no people being there during the day, so would not be using lights/electricity.

- I agree with the claim that the price of power has been increasing for NZ homes customers being able to be supported. The average electricity rate follows an overall increasing trend, shown in Resource 1, while in Resource 2A the average home expenditure follows a slightly increasing trend, while showing a seasonal pattern. In 1998 the average electricity rate was around 14 cents per KWh, and increased to 28.5 cents per kWh in 2015. Since then, until 2022 the average rates follow a slightly increasing trend, with the average rate in 2022 being around 30 cents per kWh. In Resource 2A and 2B, in 2013 the highest average home expenditure was $633.41(Q3 - winter) on electricity per household, while the lowest average was $432.32 (Q1 - summer). In 2021, the highest average home expenditure was $695.83 (Q3 - winter), the highest average from 2013 Q2 and 2022 Q2 as well, while the lowest was $452.14 (Q1 - summer). The average home expenditures in NZ follow a slight increase.

- A conclusion we could make from this is that the average home expenditures per household in NZ follow a seasonal trend from 2013 Q2 to 2022 Q2 due to less usage of electricity per household on average. In Resource 2A, in the 4th quarter of every year the average home expenditures is the peak within that year, as shown in the year 2013 and 2022. Then, the average home expenditure reaches its lowest price within that year in the first quarter. This is because of less energy usage, as shown in Resource 2B. In the first quarter of a year, the average home usage is always less than in the last quarter. For example, in 2014, the average home usage of electricity per household was 1493.44 kW/h and the average home expenditure was $432.32 while in the last quarter it was 1721.30 kw/hour, around 200kW/h more and the average home expenditure was $496.87, around $70 more. Resource 2A and B covers 37 quarters, so is above the minimum sample size, so there is enough data to make conclusions about the quarters.

- However, this information may not be as useful as it only goes up to the second quarter of 2022. While that is relatively recent data, it is best to have an updated set to make conclusions, so up to 2023 Q2.
- Resource 1 proves less electricity is used in summer than in winter. This could be because in winter, heaters are used rather than aircons being used in summer, with heaters costing more on average. In summer, it is the long holiday where people go on vacation for a long time and so don't use as much electricity, but prices don't drop as low to around $0 average home expenditure because it is not for the whole quarter/summer and electricity is still required when no one is home (like for a refrigerator). So, from Resource 2A and B, we can see there is a seasonal pattern, but something that may affect our prediction of this seasonal pattern for prices and usage for the future, could be power cuts. This would lower the average home electricity usage, and so will lower home expenditure during that time. Global warming/climate change has also become an increased issue over the years, and so could influence the use of heaters and air conditioners. Inflation has also been occurring in New Zealand and so could affect prices, making them increase. Another pandemic may happen, forcing people to stay in their homes during lockdown, increasing the energy usage and so increasing prices. A suggestion I would make is to include/get data up to 2023, the second quarter.
- Another conclusion that can be made from Resources 2A and 2B are that the COVID-19 pandemic has had an effect on the average home expenditures. The lockdown of the pandemic occurred in the years 2020 and 2021. The average home expenditure in the 3rd quarter of 2021 has peaked and was around $50 more on average than the 3rd quarter of 2020. The higher prices are related to the seasonal pattern for average home expenditures, but this data suggests that average home expenditures have gone up in the Winter of lockdowns. This could be because people are staying at home, and not going to work, so are using more energy. Students are doing online learning and so are using their devices more frequently, as well as being home all day allows for usage of lights and other equipment being used for longer periods of time than it would've when they were not in lockdown. However, it is possible that it is just another winter with higher average home expenditures.

- Assuming a typical household has around 4 members, with 2 working adults and 2 children/students, the household should choose their electricity company based on customer ratings and prices for off-peak plans, if it is offered. In resource 3, it shows that there are many different things to consider, other things like contract terms, add-ons, anytime rates, day rate and night rate for off-peak plans, or even if a company has an off-peak plan for their customers, and daily charge.
- A typical household should focus on customer satisfaction because it sums up how households work with a certain energy company. This average rating would come from many different types of families and so is more typical to a household. From this you could see how it works for typical families as plans may not always be easy to figure out. They should also choose their electricity company based on rates. An off-peak plan is a better choice than an anytime rate because homes that mainly use

power at night will likely make savings on their power bills. It is better to spend less money on energy. Time families may use electricity after around 9pm is when charging their devices, and possibly using lamps over the night. They may use fans or heaters overnight too, as well as some students doing work after 9pm, the typical time for a night rate to start. This high energy usage after 9pm can save them more money if they were to choose a company that offers a more expensive anytime rate or no off-peak plan. They should choose an off-peak plan with the cheapest day and night rates possible, while considering other factors like customer satisfaction and daily charge, etc. A typical family is also away during the day with students at school and adults working.

- With this knowledge, with the options of companies in Resource 3, a company a household should choose Equator energy as they have the cheapest night rate ($0.1196/kWh) compared to other companies like Shout, which has no off-peak plan so has a night and day rate price of $0.1675/kWh, and Rhythm energy which has a night rate of $0.1779/kWh, and a day rate of $0.2113/kWh. Equator energy also has a customer satisfaction rating of 7.9/10, and is a close second to Shout with 8/10. Meanwhile Rhythm Energy has 6.4/10 and Wired 4 Power has 3.7/10. Additionally, Equator energy uses 100% renewable energy and is open term, so makes it easy for families to change companies. This is good as households need to know the plan that works for them, so may need to try different plans. Day rates tend to be more expensive than anytime rates, as shown in Resource 3. For Equator energy, the day rate is $0.2146/kWh, so is more expensive than their anytime rate of $0.2028/kWh. Another example of this is for Wired 4 Power, they have a day rate of $0.2240/kWh, which is more expensive than their anytime rate of $0.2146/kWh.

- However, in Resource 3 there is only information about 4 energy companies in NZ, and does not show whether these companies may offer different sorts of plans for certain families or whether they have any deals. So this may limit my recommendation of how a household may choose their electricity company as it does not offer all the information for the companies' plans. My assumption of a typical household may impact this recommendation too. This is as some households may not require as much energy during the night, with adults working at home during the day, and so may use a lot of energy during the day, increasing the price they would need to pay. So then an anytime rate may suit them more.Some households may not be willing to change their habits that may not suit an off-peak plan to ones that do.

Section B:

- The electricity generation method of coal creates the most environmental impact In Resource 6, you can see that per primary fuel source per annum, Coal creates 2.508 billion kg of carbon emissions, while other sources of thermal generation like gas creates 1.573 billion kg of carbon emissions, and another example is geothermal generation creating 0.735 billion kg of carbon emissions.

- I agree with this claim, New Zealand is on track to reach 100% renewable energy by 2030, which is in 7 years. Shown in Resource 5B, 74% of New Zealand's 9683 MW of operating capacity is renewable energy, with 57% of that being hydro. New Zealand also has a planned capacity of 1564 MW, none of those being for the power generated from gas or coal, and 78% being planned for wind. 99% of the planned capacity is for renewable energy.
- However, it does not specify the date/year of when this data was collected. By now, there may have been a significant change of plans, cancellation of certain planned power plants or new planned power plants, and a certain change in the operating capacity. Because of this, it is not certain that they have 74% renewable energy capacity and 99% of planned capacity being renewable.
- This is assuming that what Resource 5A and 5B specifies as 'Other,' are non-renewable types of energy. There are also some obstacles that they may face including the public being against this idea, as these changes from non-renewable energy to renewable energy may cause supply disruptions. The public may not be happy about the economic side, like changes to power plans and to costs of energy.

- Because, as shown in Resource 6, over 50% of carbon energy emissions per annum come from transport (14.131 billion kg of carbon energy emissions), less usage of transport creating carbon emissions can aid in NZ reaching their goal of Zero Carbon Emissions by 2050. The government could encourage usage of other types of transport like biking, walking, buses, and using a scooter and using less gas cars. This would therefore aid in the decrease of carbon emissions per annum if more people were to drive less. They can also do this by discouraging long road trips, driving on a particular day of the week, using certain types of vehicles, particularly ones that release a higher quantity of carbon emissions than standard vehicles, e.g. a large truck, having to carry a heavy load of items. All of these would be part of encouraging Kiwis to use/require gas cars less. This would be an entire movement of making New Zealand more accessible, and so can encourage others to use other forms of transport that don't produce or produce less carbon emissions. Over time, this can aid in their goal of reaching zero carbon emissions by 2050. If the government makes New Zealand a better place for transport other than vehicles, this does help.
- However, since this is more of a social movement, having to get the public on board may be an issue. This is also assuming that gas cars are the main source of carbon emissions for transport. There has been an issue regarding taxes, with businesses having to pay a large amount. Many people are not liking this and may not be in support of the banning of certain vehicles and driving on certain days because those are critical for businesses (e.g. transporting supplies). Some people may not live close to areas that they need access to, so are in places where things are not very accessible, may not like this idea as they may be very dependent on vehicles to get by. Because of this, I think that is why New Zealand should have the accessibility of places for residents involved in this plan.

- Although, there is a good chance people will get on board as other forms of transport like biking and walking are healthier and it all works towards a big goal of reaching net zero carbon emissions, especially with other environmental issues becoming increasingly more alarming. This is why they should do this plan. The government should get an updated set of data, the data shown in Resource 6 regarding NZ's carbon emissions per annum is from November of 2017. An updated set of data will help New Zealand see what they can focus on in order to reach their goal, as many things can happen in 4-5 years.

Excellence

Subject: Mathematics and Statistics

Standard: 91946

Total score: 07

Grade score	Marker commentary
E7	A good response to Section A (iv). The candidate considers what is important to a family when deciding “how” to choose an electricity provider. They use evidence from the resources and consider limitations and assumptions in the context.