Team 1015

How much electrical power will be required due to New Zealanders adopting the use of generative AI?

Abstract:
The purpose of this report was to calculate how much electrical power would be required due to New Zealand adopting the use of generative Artificial Intelligence. We decided to first use a logistic function to model the percentage of people using AI over time. We then used a linear graph to model the New Zealand population over time. We decided to calculate the population that used generative AI at the point when 85% of the New Zealand population are adopted to it. We calculated the amount of power used to run ChatGPT per person and used that to find the amount of electrical power needed for 85% of the New Zealanders. Through mathematical modelling and calculations we found that the amount of electrical power required at the point that New Zealanders had adopted the use of generative AI is 3863000W.

Introduction:
AI is found frequently in our everyday lives and promises to transform our futures. Generative AI tools are rapidly infiltrating our frequent internet usage with their expansive range of functions to automate so many aspects of our everyday lives. Artificial intelligence is capable of generating imagery, text, audio and synthetic data. Generative tools such as these have been curated as early as the 1960s but the more publicly available forms we accept today were released between 2014 and the present in varying degrees. The Generative AI functions through a learned course of algorithms that can make connections from the key words of a provided prompt to produce the requested content. Coinciding with the rise of total technology usage across New Zealand, more New Zealanders are inclined to adopt these generative tools to conform to this increasingly automated world. We are looking to quantify the power required to support New Zealanders future usage of generative AI tools.

Definition and interpretation of question:
Generative AI is a type of artificial intelligence that can rapidly generate content from different inputs. This output can be text, imagery, audio, animation, 3D models and other data. Examples of this are ChatGPT, Bard, Stable Diffusion, Midjourney. Electric power is the rate at which electrical energy is transferred by an electric circuit. The SI unit of power is the watt, one joule per second. We are measuring an approximation of the electrical power used by New Zealand's population once the use of generative AI has been adopted. We will be following the trend of people in New Zealand using generative AI from the introduction to now.

Adoption - We consider the tool of generative AI to be adopted at a point at which 85% of the New Zealand population has used it in their life or is an active user. We chose this percentage as it highlights the point at which the tool would be both widely understood and used. At this point, it has comfortably entered mainstream use and has become a regular part of most people's everyday lives.
New Zealanders - For New Zealanders, we will be using recent population data from 2023 onwards. We are considering all residents of New Zealand as New Zealanders (citizens, permanent/temporary residents, etc)
Electrical power - the pace at which an electrical circut transfers electrical energy. It is therefore measures in joules of energy per second Js^{-1}or in Watts (W).

Use of AI - We are defining the use of AI as the text generating AI in which a prompt of key words will initiate a long answer or short answer text response.
Generative AI - We are focusing on the AI tool of Chat GPT (Generative Pre-trained Transformer) which is a conversational text generative tool. It is capable of forming text responses based off of requests and key words and can incorporate further information into its original answer proceeding user feedback.

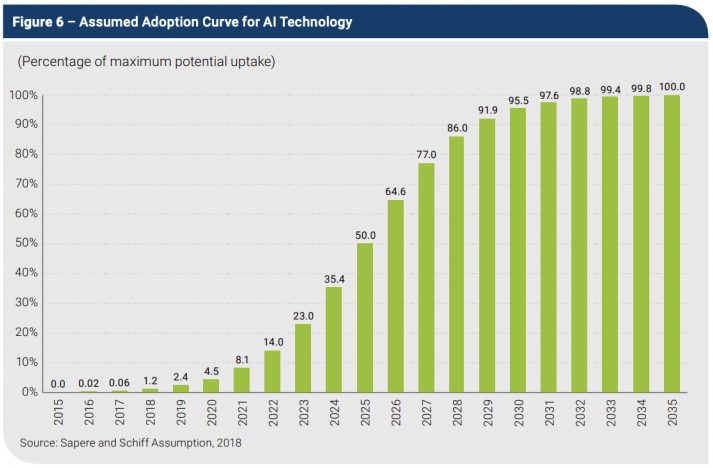
Assumptions:

- Electrical power used per person for generative AI is constant
- Not 100% of New Zealanders will ever be using AI at any given time in the present or future
- That the entire population of New Zealand are considered New Zealanders (to be considered in the set of data)
- New Zealand has officially 'adopted' generative AI when the majority of individuals who use the internet use it.
- Each person is using generative AI on only one device at a time
- As the amount of New Zealanders to begin using the internet plateaus, the amount of New Zealanders beginning to adopt generative AI tools will continue to increase.
- That all Generative AI tools use similarly comparable amounts of energy to run as each other

Our first assumption is that the electrical power used per person for generative AI is the same. The second assumption is that not all of New Zealanders will be using AI at any given time in the present or future. This is rational as there will always be individuals who don't trust AI or are too old or too young to use it. We decided that New Zealand has officially 'adopted' generative AI when 85% of New Zealanders use it. We chose this percentage as it highlights the point at which the tool would be both widely understood and used. At this point, it has comfortably entered mainstream use and has become a regular part of most people's everyday lives. The assumption that each person is using generative AI on only one device at a time is because people generally would not be using generative AI on more than one device at once.

Modelling approach:

Mathematic modelling for Logistic Function of Adoption Curve for AI Technology/Generative AI:



(*Shaping a Future New Zealand*, n.d.)

We chose to model the assumed adoption curve for AI technology/Generative AI off of a curve titled - 'Assumed Adoption Curve for AI Technology' - as the trend observed in the data resembles that approximated by the logistic function. In order to mathematically model the trend and predict the date of 'adoption', a function must be chosen. The characteristics of the logistic function is the most accurate to the data collected from the report. A logistic function models the feasibility of an event occurring within a given population. We created an expression that we could visualise as a graph; of the increase of New Zealanders using generative AI technology overtime.

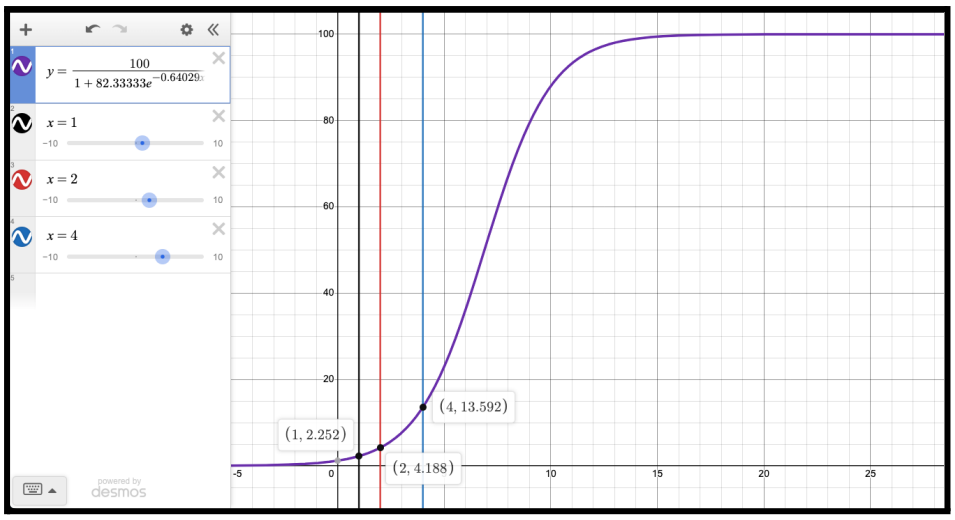
The general formula for a logistic function is $y = \frac{L}{1+be^{-kt}}$. The t in our model will be the time in years, starting from 2018 being t=0. The y in our model will be the percentage of the people using AI. The L in the general formula stands for the fucntion's maximum value, the maximum percentage of people using AI is 100 therefore L is 100. Therefore,our formula is $y=\frac{100}{1+be^{-kt}}$. We decided to select two sets of data from our source. One set being t=0 and y=1.2 (year 2018 and adoption rate 1.2%) and another set being t=5 and y=23 (year 2023 and adoption rate 23%). The reason we chose these is because 2018 is the year when generative AI started rising and 2023 is the current year. These two timepoints are the most relevant to the trend we are determining.

By substituting t=0 and y=1.2, we get:

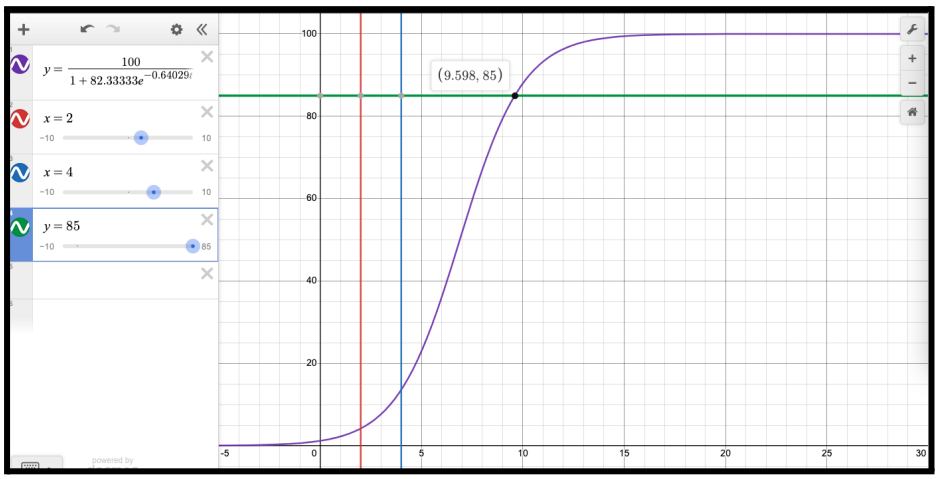
$1.2=\frac{100}{1+be^{0}}$
$1.2=\frac{100}{1+b}$
$1.2+1.2b=100$
$1.2b=98.8$
$b=\frac{98.8}{1.2}$
$b=82.3333$

We've got b, therefore our formula is $y=\frac{100}{1+82.333e^{-kt}}$
By substituting t=5 and y=23, we get:
$23=\frac{100}{1+82.333e^{-5k}}$
$23+1893.6667e^{-5k}=100$
$1893.6667e^{-5k}=77$
$e^{-5k}=\frac{77}{1893.6667}$
$k=\frac{ln(77/1893.6667)}{-5}$
$k=0.640493$

Therefore we have the values of k and b, and we can form our formula for the adoption curve of AI, $y=\frac{100}{1+82.33333e^{-0.640493t}}$.

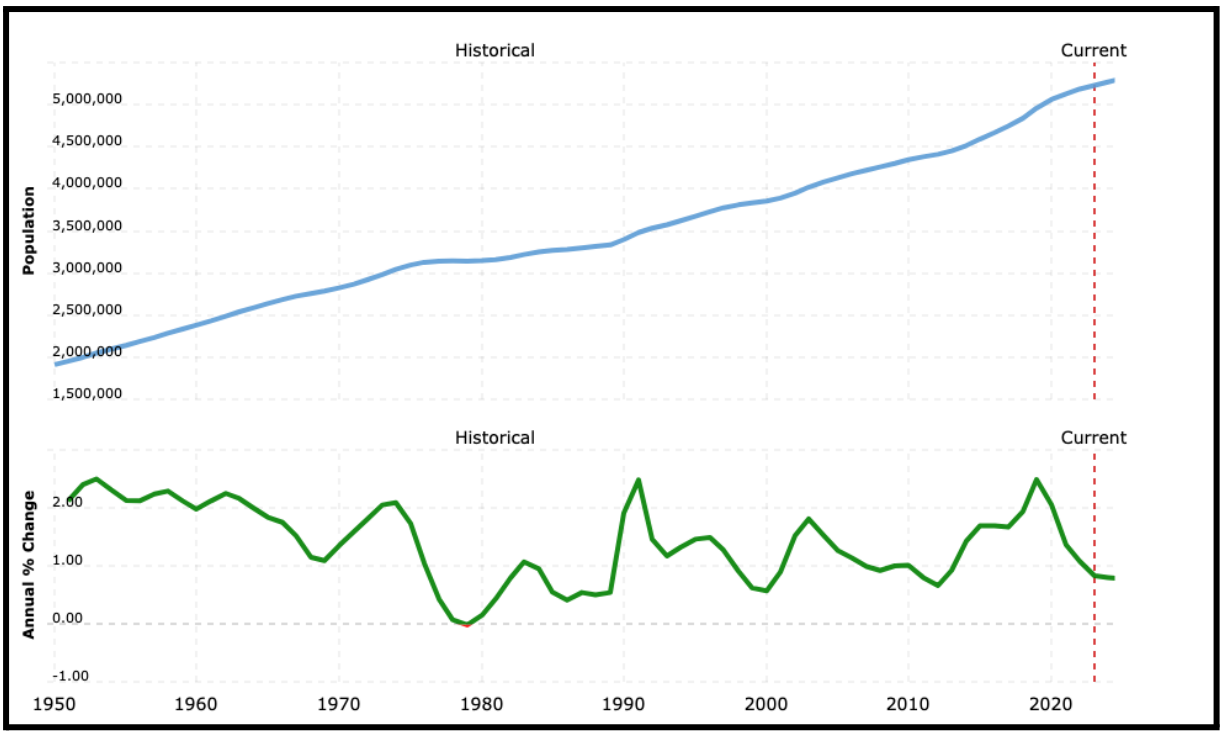


These points correspond to the data we found in our source. In our source, in 2019 (x=1), the adoption rate is 2.4% and in our model, at x=1, y=2.252, which is very similar. In our source, in 2022 (x=4), the adoption rate is 14% and in our model, at x=4, y=13.592, which is also very similar. Therefore we can claim that our logistic model can predict the AI adoption rate in the future.



With this data we can find the year when generative AI has been officially adopted by New Zealanders - as adoption in this report is regarded as the time instance when the majority of the population is an active user or has used generative AI in the past.
We have set 85% as a majority of our population. When 85% of the NZ population is using or has used generative AI, we can state that New Zealanders as a whole have adopted generative AI. When $y = 85$, t is equal to 9.598. $2018 + 9.598 = 2027.598$, if we round it up, the time when the majority of the New Zealanders are adopted to the use of generative AI will be 2028.

<u>Mathematic Modelling for New Zealand Population Growth:</u>
The New Zealand population in 1950 was 1911608 and the population in 2023 is 5228100. The trend in the change of the population over time can be simplified down to a linear graph in the form of $y = m * t + c$. The t in our model will be time in years starting from 1950 being t=0.



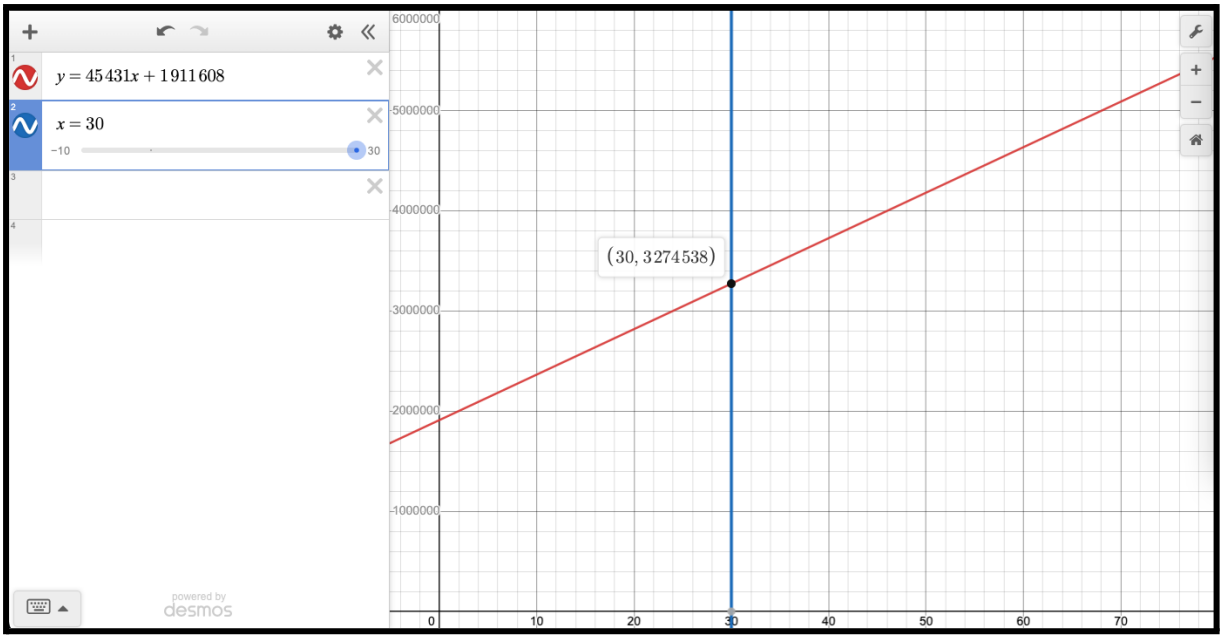
We decided to use two sets of data for our linear model. One set is t=0 and y=1911608 and the other set from 2023, so t=73, y=5228100.

Substituting t=0 and y=1911608 into $y = m * t + c$, we get:
$1911608 = m * 0 + c$
c=1911608

Therefore we get c=1911608.

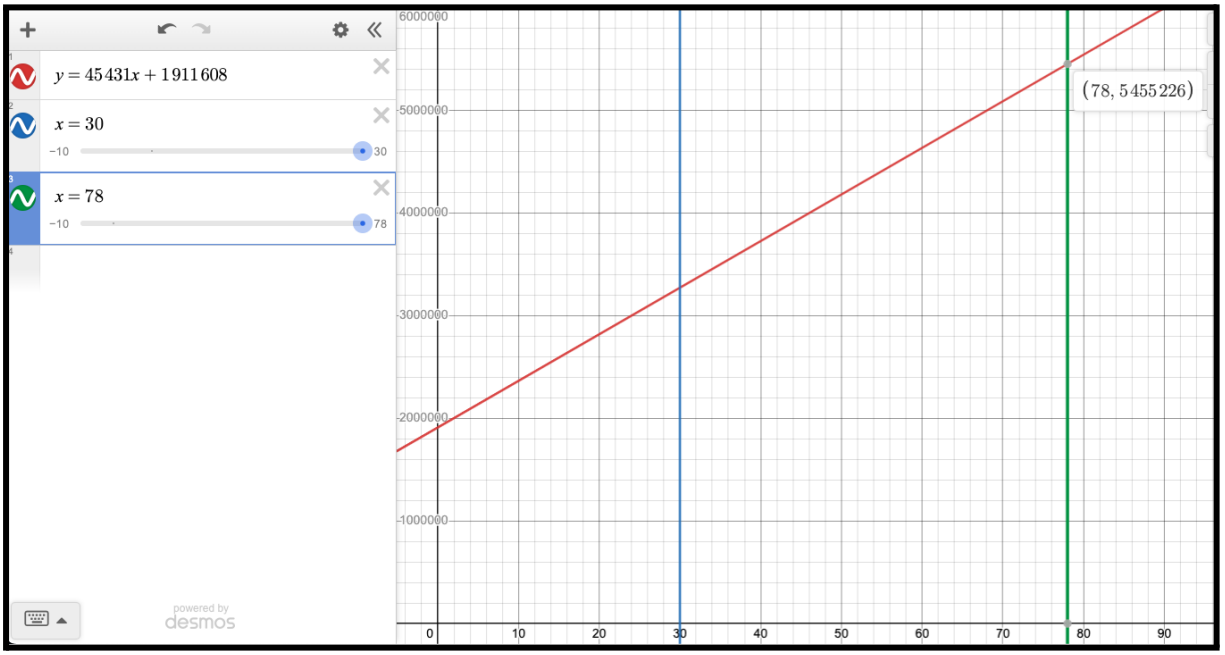
Substituting t=73, y=5228100 and c=1911608, we get:
$5228100 = m * 73 + 1911608$
3316492=73m
m=$\frac{3316492}{73}$
m=45431

Thus y = 45431t+1911608



The population that our model shows for t=30 (year 1980) is 3274538, which is quite close to the population of 1980 being 3147168. Therefore our model can be used to predict the future.

Now we can use our model to predict the population in 2028.



The population in 2028 is 5455226, we can round it to 4 significant figures being 5455000 people.

<u>Amount of electrical power used per New Zealander:</u>

We made the assumption that people would not access more than one generative AI at one time. A perfect example of generative AI is ChatGPT. On ChatGPT, each question asked by a user uses $0.000833kWh$ of energy. We can divide this number by 1 hour to calculate the power of asking each question, which is 0.833W. We are assuming that the energy per question includes the associated power to run the program in this time. Therefore the electrical power for using ChatGPT is 0.833W.

In 2028, 85% of New Zealanders will adopt the use of generative AI (this is represented by ChatGPT), and by 2028, New Zealand will have a population of 5455000. 85% of 2028's population is $5455000 \times 85\% = 4637000$.

4637000 people using ChatGPT at the same time means a power of
$4637000 \times 0.833 = 3863000W$

Conclusion:
Based on our calculations from our mathematical models we can expect that the amount of electrical power required due to New Zealanders adopting the use of generative AI is $3863000W$. This is an approximation of the electrical power used for generative AI by New Zealand's population once the use of generative AI has been adopted. Our model tells us that we will have 'adopted' generative AI by 2028, and at that point we will require $3863000W$. This answer was deduced from the assumed adoption rate of AI and the rate of population growth in New Zealand.

Discussion and limitations:
Through our research we came upon many limitations that would act as additional variables to affect the amount of power consumed by New Zealanders using generative AI. There was a large limitation on the resources available. Although we were quickly able to find information about our nation's usage of internet and generative AI tools, we struggled finding credible sources to state the electrical power usage of generative AI tools. We didn't take into consideration the power used by the peripherals of the device. We also had difficulty finding information about different generative AI tools other than ChatGPT and the comparable power consumption.We overcame these limitations by using our best judgement with sources and their credibility when using their stated power quantities. We also decided to assume that all forms of generative AI tools require comparable amounts of energy to run and that differences in these requirements would be negligible. Another limitation we faced was the influence of human nature and individual use of the generative AI tools. Every person may use these tools for different purposes and the power used for different purposes may be different. From this we had to generalise a large deal of our calculations such that our value is representative of the population as a whole rather than attempting to predict individual behaviour.

We decided to make the judgement that generative AI is considered 'adopted' when it is used by 85% of the total population at that time. At the point at which 85% of a population has participated in an activity, it has entered the mainstream and will become commonly accepted, thus it has become socially 'adopted'. This value also accounts for those without access to the internet or who are incapable of using extensions such as generative AI (children, elderly, etc).

We made the big assumption that power required for generative AI can be reduced to the data provided about ChatGPT because there was limited information available regarding the electrical power use of the other generative AIs. Additionally, the information regarding the power of chatgpt is likely to be similar to that of other AIs. Differences may occur due to generating audio, videos, images or other more complicated output, but that data is difficult to account for.

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