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# BANGOR UNIVERSITY

## ENVIRONMENTAL IMPACT AND VALUE OF SEARCH ENGINES

## FINAL REPORT

## SPETEMBER 2023

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** Numbers in the tables may not equal to the total due to rounding.*

# EXECUTIVE SUMMARY

As part of the '25 by 25 – Your Voice' campaign, Verity Edward Scott (Undergraduate from the School of Medical & Health Sciences) made the following suggestion that was shortlisted:

*"I believe Ecosia should be made the default search engine for all university campus computers."*

The Vice Chancellor awarded funding for a research project within the Bangor Business School on this subject.

When users search the web using Ecosia, the search engine generates revenue through ads, just like other search engines. However, instead of keeping all the profits, Ecosia uses 80% of its revenue to fund tree-planting projects. The search engine is committed to making a positive impact on the world.

Student organizations and clubs at universities around the world have promoted Ecosia and encouraged their members to use it as their default search engine as part of their sustainability and environmental initiatives. Ecosia Campus allows universities and schools to track the number of trees planted by their students and staff, as well as customize the Ecosia homepage with their institution's logo and branding. As of March 2023, there are 30 university campuses (for example University of Edinburgh and University of St Andrews) using Ecosia alongside with 300 student-led campaigns and 300,000 student users.

The findings in this report indicate that Ecosia is the best search engine for basic searches as it has the least amount of carbon emission. Ecosia has no shortcomings when it comes to performing weather, definition, and local searches. Moreover, these searches are less carbon intensive. Therefore, transitioning from Ecosia to Google will not only maintain the advantages of utilizing these practical functions but also contribute positively to the environment.

**RECOMMENDATIONS**

This report recommends Bangor University adopts Ecosia as its default search engine for all university campus computers.

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# 1. INTRODUCTION

The 25 by 25 is the University's sustainability campaign (launched in November 2022) which aims to reduce 25% of the University's carbon dioxide equivalent emissions by 2025. The campaign has three key target areas:

- Energy,
- Waste, and
- Travel.

The University will examine how it uses all types of power and fuel, the waste we throw away, the way we travel, the water we use and just about anything and everything that creates a greenhouse gas emission.

The campaign was launched with '25 by 25 – Your Voice' when both students and staff were asked to submit ideas on how the University could meet this ambitious target. Over 40 ideas were submitted from across the University and each idea was reviewed and discussed with the relevant departments. A shortlist was put together based on each idea's potential to progress, and what funding they may require.

Verity Edward Scott (Undergraduate from the School of Medical & Health Sciences) made the following suggestion that was shortlisted:

"*I believe Ecosia should be made the default search engine for all university campus computers.*"

The Vice Chancellor awarded funding for a research project within the Bangor Business School on this subject. The results of this research will allow an evidence-based decisions on whether the University moves from Google to an arguably more environmentally friendly, Ecosia.

# 2. OPPORTUNITY

The funding has enabled a systematic literature review of academic and non-academic reports on the environmental impacts and values of search engines. Ecosia (www.ecosia.org) is a not-for-profit search engine company that dedicates 100% of its profits to the planting and protection of trees. By collaborating with local communities, it has planted more than 160 million trees all over the world. While a search engine that plants trees does have sustainability benefits, both Google and Microsoft search engines both do lots to make their operations more sustainable.

There is an opportunity for the University to contribute to tree-planting and restoration projects by making Ecosia the default search engine for all university campus computers,

The internet has transformed the way we live, work, and communicate. It has become an integral part of our daily lives, with billions of people around the world using it to access information, connect with others, and conduct business. As the internet's popularity has grown, so too has its impact on the environment. The energy required to power data centres, networks, and personal devices has led to a significant increase in carbon emissions. Some estimates suggest that the internet and related technologies account for as much as 3-4% of global greenhouse gas emissions, a figure that is expected to grow as more people come online and digital technologies continue to evolve.

The environmental impact of the internet is complex and multifaceted. It includes both direct emissions from energy use, such as electricity consumption by data centres and network infrastructure, as well as indirect emissions from the production and disposal of devices and the impact of online activities such as e-commerce and social media. Search engines, which are utilized daily by most internet user, can have substantial negative environmental impact. Search engines constitute 93% of all web traffic and 5.06 billion people use search engines that process approximately 2.2 trillion search queries annually.[1]

[1] https://www.businessdit.com/search-engines-usage-statistics/

# 3. ANALYSIS

## 3.1 SEARCH ENGINES

Performing massive amount of different search queries necessitates operating many data centres equipped with powerful computing hardware which requires significant energy consumption. This issue was first recognized in 2009 by a renowned Harvard physicist, Alex Wissner-Gross, who claimed that a Google search query produces 7 grams of carbon dioxide (CO2) that is equivalent to the half CO2 produced via boiling a kettle for a cup of tea.[2] Google disputed Wissner-Gross by claiming that a search query only produces 0.2 grams of CO2 and it is insignificant compared to carbon-intensive activities like driving, as well as further arguing that without Google people would have driven to the library for finding information.[3] Another study found that on average, the carbon impact for all search engines is 0.106 gEqCO2, and Google's carbon impact is 0.108 gEqCO2, equivalent to the carbon impact of one meter carried out in a light vehicle.[4] Furthermore, Google has faced criticism for its $82 million private jet terminal exclusively reserved for the company's top executives.[5] Also, The Center for Countering Digital Hate have revealed that Google is helping major oil companies by providing advertisement space that are used for “greenwashing” and making millions from climate misinformation.[6]

The environmental accusations pointed at Google followed by antitrust cases against the company, impairing their brand name on the eyes of millions of internet users. Data privacy has also become a concern for Google and they regularly failed to protect the data of users. In 2015, BrainTest Malware infected up to 1 million Android devices and another malware, Gooligan, did the same in 2016.[7] The most notorious fiasco occurred in December 2018 where a bug exposed the data of 52.5 million Google+ accounts. All of these data privacy failures, combined with the environmental accusations, has deteriorated Google’s reputation and accelerated the emergence of alternative search engines.

Many of the new and novel search engines embrace environmental and social concerns and constitute viable alternative to Google. Nevertheless, they hardly disrupted Google’s search engine market share

[2] https://archive.nytimes.com/www.nytimes.com/external/idg/2009/01/12/12idg-Google-disputes.html?pagewanted=print
[3] https://qz.com/1267709/every-google-search-results-in-co2-emissions-this-real-time-dataviz-shows-how-much
[4] https://greenspector.com/en/search-engines/
[5] https://www.fastcompany.com/3023502/check-out-googles-new-82-million-corporate-jet-facility
[6] https://counterhate.com/research/greenwashing-google-big-oil/
[7] https://firewalltimes.com/google-data-breach-timeline/

and Google maintains its dominant position in the UK and globally. Table 1 summarizes the most notable examples of novel search engines.

## 3.2 ECOSIA: AN ENVIRONMENTALLY FRIENDLY SEARCH ENGINE

Ecosia is a search engine that is making waves in the tech industry for its focus on sustainability and environmental impact. Founded in 2009 by Christian Kroll, Ecosia is based in Berlin, Germany, and operates as a social business. Its mission is to help reforest the planet and fight climate change through its search engine service. Eocisa utilizes Microsofot Bing technology, and it works like any other search engine, but the company uses its profits to fund tree-planting projects around the world. When users search the web using Ecosia, the search engine generates revenue through ads, just like other search engines. However, instead of keeping all the profits, Ecosia uses 80% of its revenue to fund tree-planting projects. To ensure that the trees are planted where they are needed most, Ecosia partners with local organizations in countries around the world. These partners are responsible for identifying areas where reforestation is most needed, and for planting and maintaining the trees. Ecosia also provides regular updates on its website about its tree-planting projects and the impact they are having.

Ecosia's commitment to sustainability and reforestation has led to some impressive environmental impact statistics. Since its launch in 2009, Ecosia has planted over 135 million trees in countries such as Brazil, Burkina Faso, Indonesia, Madagascar, and Spain. The company estimates that these trees have removed over 6 million tons of CO2 from the atmosphere. In addition to its tree-planting projects, Ecosia is also committed to reducing its own carbon footprint. The company uses renewable energy sources to power its servers and data centers, and it has also implemented measures to reduce energy consumption and carbon emissions.

Aside from its positive environmental impact, there are several other reasons to consider using Ecosia as a search engine of choice. Ecosia is a privacy-friendly search engine that doesn't track or store user data. It also has a user-friendly interface that is easy to navigate, and it provides accurate search results just like other popular search engines. Another distinguishing feature of Ecosia is that it is a social business, meaning that it operates with a social and environmental purpose in mind. This contrasts with many other technology companies that prioritize profit over social and environmental responsibility. Many of the users cherish their Ecosia experience with the perception of supporting a company that is committed to making a positive impact on the world.

**Table 1 – Description of novel search engines**

| Search Engine | Release Date | Focus | Key Features | Social/Environmental Initiatives | Ownership | Funding Model |
|---|---|---|---|---|---|---|
| Ecosia | 2009 | Environmental Sustainability | Plants trees with ad revenue, 100% renewable energy for servers | Tree planting, reforestation projects | Public Benefit Corporation | Ad revenue |
| GreenMaven | 2008 | Environmental Sustainability | Results prioritized by environmental impact, news and resources on sustainable living | Eco-friendly lifestyle, sustainable products and services | Private | Ad revenue |
| OceanHero | 2020 | Ocean Conservation | Removes plastic from oceans with ad revenue, carbon-neutral servers | Plastic pollution reduction, ocean conservation projects | Private | Ad revenue |
| GiveWater | 2009 | Clean Water Initiatives | Funds clean water initiatives with ad revenue, carbon-neutral servers | Clean water access, sanitation, hygiene projects | Private | Ad revenue |

| Search Engine | Release Date | Focus | Key Features | Social/Environmental Initiatives | Ownership | Funding Model |
|---|---|---|---|---|---|---|
| Lilo | 2015 | Social and Environmental Causes | Allows users to support various causes with searches, ad revenue donated to chosen cause | Range of social and environmental initiatives | Cooperative | Ad revenue |
| Goodsearch | 2005 | Social Causes | Donates portion of ad revenue to user-chosen causes | Range of social causes, education, animal welfare | Private | Ad revenue |
| Blackle | 2007 | Energy Conservation | Uses black background to save energy, powered by renewable energy | Energy conservation, carbon emissions reduction | Private | Ad revenue |
| Ekoru | 2019 | Ocean Conservation and Carbon Offsetting | Donates majority of ad revenue to ocean conservation and carbon offsetting, carbon-neutral servers | Ocean conservation, carbon offsetting projects | Public Benefit Corporation | Ad revenue |
| WolframAlpha | 2009 | Education and Knowledge-Sharing | Computational search engine offering information on a wide range of topics | Educational resources, knowledge-sharing | Private | Paid subscriptions |

| Search Engine | Release Date | Focus | Key Features | Social/Environmental Initiatives | Ownership | Funding Model |
|---|---|---|---|---|---|---|
| SearchScene | 2020 | Social and Environmental Causes | Donates majority of profits to user-chosen social and environmental causes | Range of social and environmental initiatives | Private | Ad revenue |
| Znout | 2010 | Privacy | Does not track users, encrypts all searches, no targeted ads | User privacy protection | Private | Ad revenue |
| Benefind | 2021 | Social Causes | Donates portion of ad revenue to user-chosen social causes, results prioritize social impact | Range of social causes, education, poverty alleviation | Private | Ad revenue |

Another distinguishing feature is Ecosia's commitment to protect user privacy. Ecosia's data privacy policies are different from Google's, as Ecosia is committed to protecting user privacy and does not collect or store user data in the same way that Google does. When you use Ecosia, your search query is encrypted and anonymized before it is sent to the search engine that Ecosia uses (currently Bing). This means that Ecosia cannot see or collect any identifiable information about you or your searches. Ecosia does not sell or share any user data with third parties, and they are transparent about how they use data for their own operations, such as improving their search results.

## 3.3 CURRENT USERS

There are several universities that use Ecosia as their default search engine or encourage their students and faculty to use it. Examples include:

- University of East Anglia
- University of Glasgow
- University of Brighton
- University of Plymouth
- University of Bristol
- University of Stirling
- University of Sheffield
- University of Leeds
- University of the West of England, Bristol
- University of St Andrews
- University of Edinburgh
- Ohio State University
- University of Lausanne
- University of Göttingen
- Leiden University
- University of Antwerp

In addition, student organizations and clubs at universities around the world have promoted Ecosia and encouraged their members to use it as their default search engine as part of their sustainability

and environmental initiatives. For instance, University of Cambridge's student union is currently campaigning along with many others.

It's also worth noting that Ecosia offers a tool called Ecosia Campus, which is specifically designed for educational institutions. Ecosia Campus allows universities and schools to track the number of trees planted by their students and staff, as well as customize the Ecosia homepage with their institution's logo and branding.

According to Ecosia's website, as of March 2023, there are 30 university campuses using Ecosia alongside with 300 student-led campaigns and 300,000 student users. It is estimated that more than 27 million searches have been made in Ecosia by the students. Moreover, according to the student campaigner testimonials published in Ecosia's website and each of them has reported overwhelmingly positive feedback from the students.[8] The testimonials highlight the fact that students love seeing the "tree counter" on their screen that showed how many trees have been planted as a direct result of their searches (see Figure 1). Furthermore, the ability to perform quick searches in Google Scholar via using Ecosia's "#gs function" is cherished by students.[9]

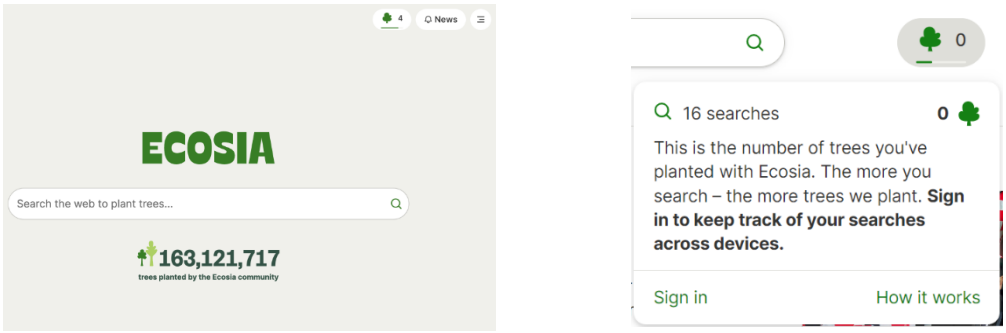


**Figure 1 - Ecosia's main page where users could observe the total planted trees in the center and their contribution to that number via the tree-counter at the top right**

[8] All of the testimonials are coming from UK universities. These are Herriot-Watt University, University of Sussex, University of East Anglia, University of Glasgow and University of East Anglia.
https://www.dropbox.com/s/b3skzhyymfh9ub3/Campaigner%20testimonials.pdf?dl=0

[9] This is a quick shortcut to make searches in Google Scholar from the Ecosia search box. For instance, if user searches "#gs the impact of economic shocks on small businesses", she will be automatically directed to a Google Scholar page which includes the search results for "the impact of economic shocks on small businesses".

## 3.4 SEARCH PERFORMANCE

When comparing the performances of search engines, several factors come into play. Search engine performance refers to the effectiveness and efficiency of a search engine in delivering relevant search results to users. But also, the carbon impact is another importance metric that should be considered while comparing the performance search engines.

### 3.4.1 Carbon impact of search queries

In this section, we summarize the empirical findings regarding search engines' carbon impact. Figure 2 shows the carbon impact of a basic and URL search. A basic search refers to a simple and straightforward search conducted using a search engine or search bar to find information on the internet. It is the most popular search type. For instance, typing and entering "Bangor University" into Google is a basic search. On the other hand, A URL search refers to performing a search query within a specific URL or website. It involves entering specific keywords or phrases into the search bar provided by a website or within the URL itself to find relevant information within that particular website or webpage. For example, if you want to search within a website, i.e., typing "blue pen" in websites such as Amazon and ebay, you will be performing a URL search.

The findings indicate that Ecosia is the best search engine for basic searches as it has the least amount of carbon emission. It outperforms Yahoo, Google and even its environmentally friendly rival - Lilo. A basic search impact in Ecosia comes with a 13% carbon reduction when compared to Google that has an emission of 0.192 gEqCO2. However, Ecosia's superior performance fades away in URL searches. Google and Lilo has better performance in this category. Nevertheless, Ecosia dominates the remaining alternatives (Binge, Qwant, DuckDuckGo etc.). Given that internet users mostly conduct basic searches rather than URL searches, Ecosia's relative underperformance in URL search is negligible due to its vast superiority in basic searches.

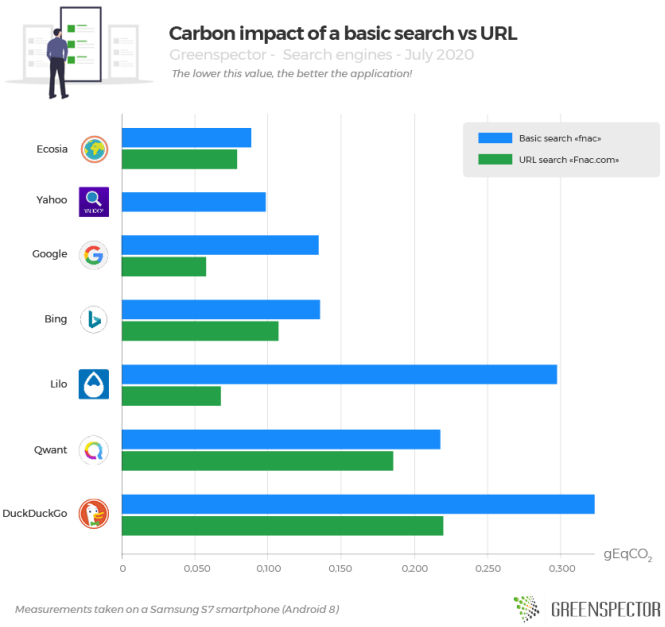


**Figure 2 - Carbon Impact of a basic search vs URL (source: Greenspector)**

Local search refers to a search query that is focused on finding information, products, or services within a specific geographical location. The purpose of a local search is to help users discover businesses, events, or resources that are relevant and accessible within their immediate vicinity. For instance, if you want to explore the restaurants in Bangor, you can type “Bangor Italian restaurants” into your search engine and easily obtain a list of popular Italian restaurants in Bangor (see Figure 3). Local search has become increasingly important with the rise of mobile devices and the growing emphasis on personalized and location-based experiences. Figure 4 shows the carbon impact of local searches. In this comparison, Ecosia, again, secures another victory with a wide margin. The carbon impact of local search engine is Ecosia (0.055 gEqCO2) is almost less than one third of Google’s (0.178 gEqCO2), indicating that using Ecosia instead of Google will lead to a 69% reduction in carbon emissions.

Weather searches refers to the act of using a search engine to obtain weather information for a specific location or to check the forecast for a particular region. It involves entering a search query related to weather conditions, such as the name of a city or a specific location, along with the term "weather" or "forecast," to retrieve the current or future weather details. For instance, you can type “London weather” and quickly obtain the weather conditions in London for that day and week (see Figure 5). In terms of weather search, Ecosia (0.062 gEqCO2) ranks 2$^{nd}$, just after Lilo. Google is ranked as the third worst search engine, underperforming with a significant margin. Figure 6 demonstrates the performance of search engines for weather search.

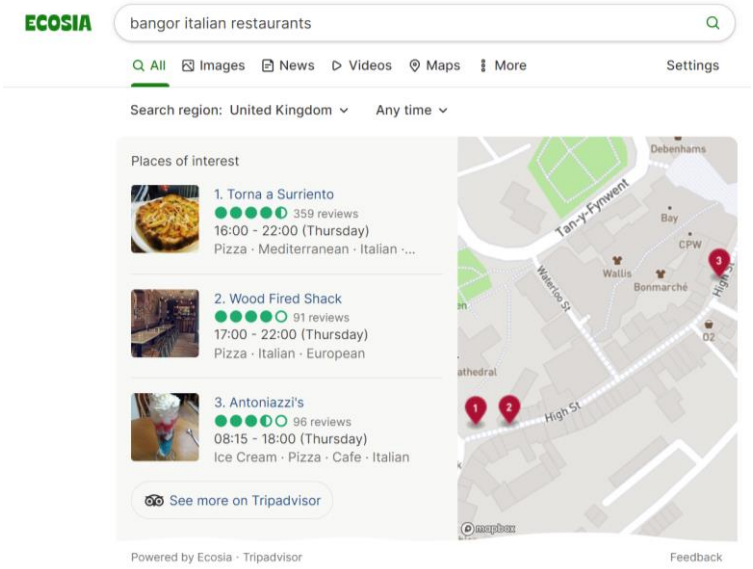


**Figure 3 - An example of a local search in Ecosia**

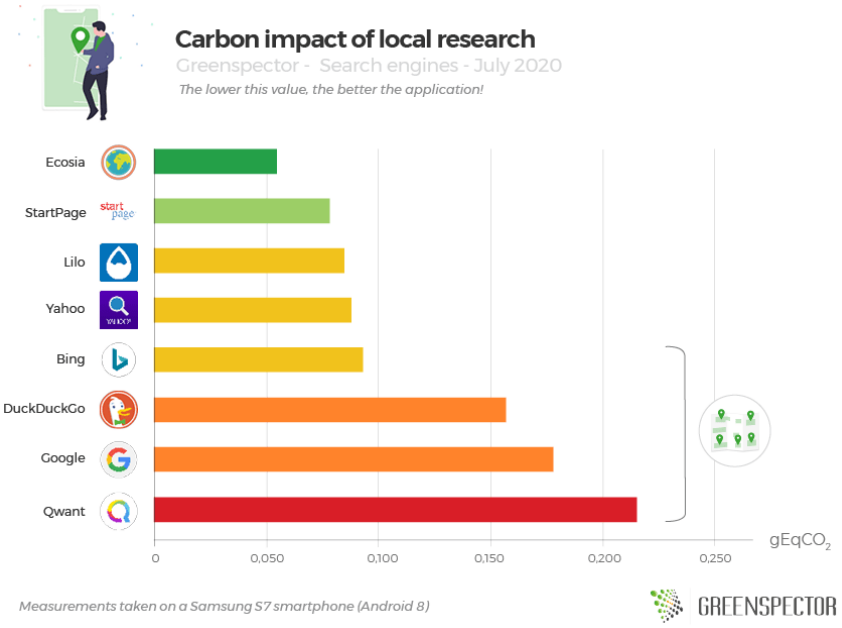


**Figure 4 - Carbon Impact of Local Research (source: Greenspector)**

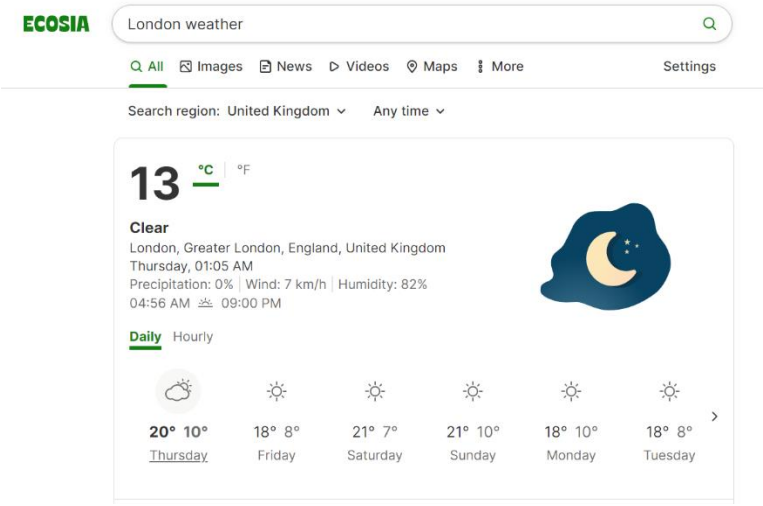


**Figure 5 - An example of a weather search in Ecosia**

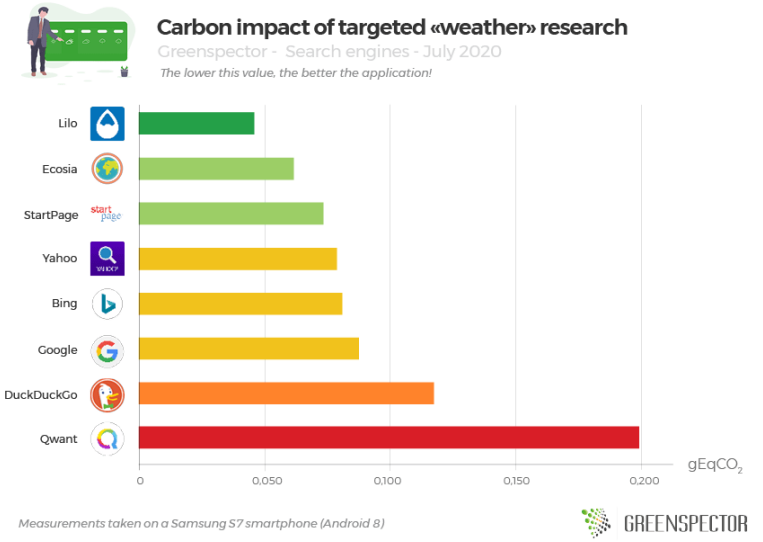


**Figure 6 - Carbon Impact of Weather Search (source: Greenspector)**

A basic definition search involves utilizing a search engine to discover the definition or significance of a specific word, phrase, or idea. This process entails inputting the term or phrase into the search engine's search bar to acquire a brief explanation or definition. When conducting a basic definition search, the search engine typically presents a direct answer or snippet at the top of the search results page, providing a brief definition or explanation of the term in question. This snippet is often extracted from a reliable and authoritative source. For instance, you can type “define democracy” in your search engine and instantly obtain the definition. An example of a basic definition search is displayed in Figure 7 which also compares Google and Ecosia in terms of the accuracy of the search results. Since they both use Oxford Languages, they retrieve the same definition and yield an identical result. In terms of carbon impact of a basic definition search, Ecosia (0.068 gEqCO2) ranks 2nd with a very slight margin behind Lilo (0.065 gEqCO2) whereas Google underperforms Ecoisa by an almost double carbon emission. Figure 8 shows the carbon impact of search engines for basic definition searches.

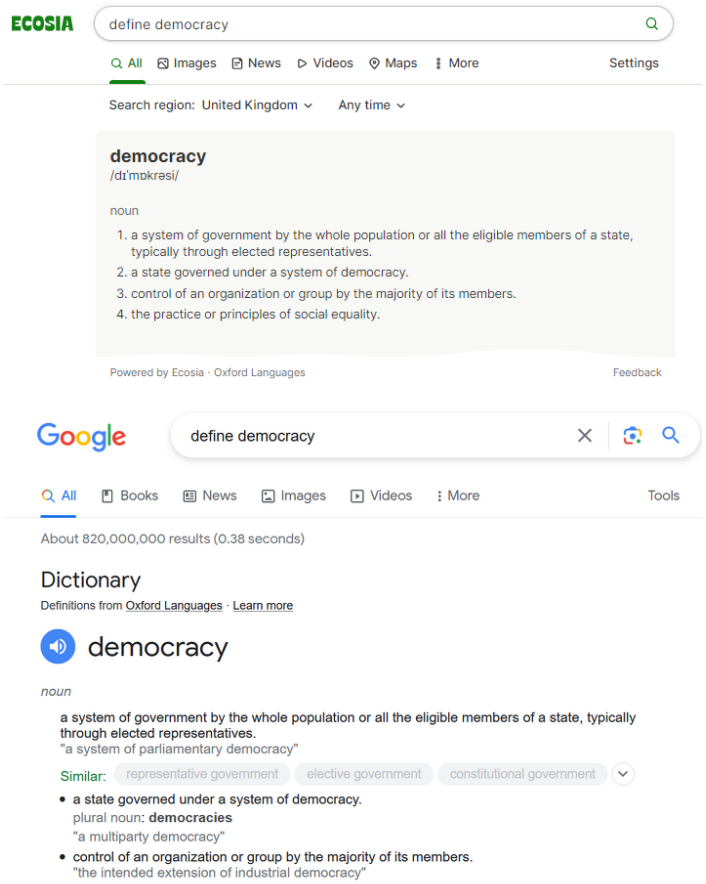


**Figure 7 - An example and comparison of a basic search: Ecosia vs Google**

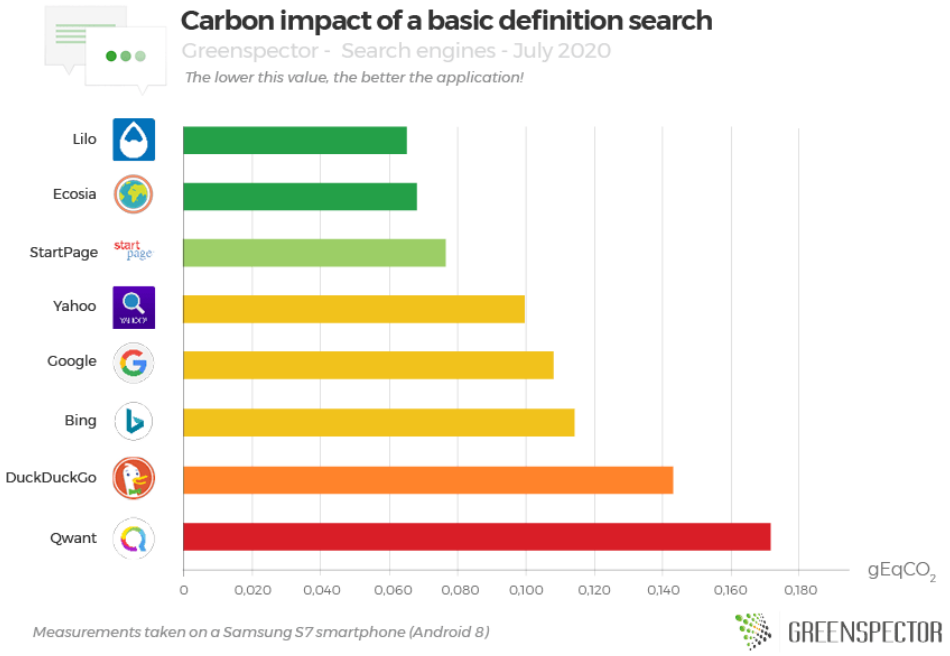


**Figure 8 - Carbon Impact of a basic definition search**

### 3.4.2 Practical functions

One of the practical functions of search engines is their unit conversions. This functionality simplifies the process of converting units, provides immediate and reliable results, and facilitates seamless communication across different measurement systems. For instance, users can perform quick conversions, such as from miles to kilometres or Celsius to Kelvin. Ecosia and Google both perform unit conversions in an efficient and user-friendly manner.

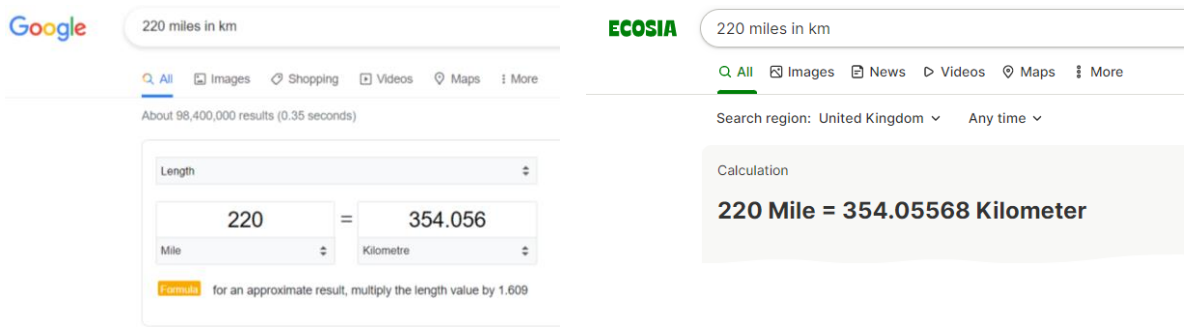


**Figure 9 - Unit Conversion Ecosia and Google**

Distance calculations in search engines refer to the algorithms and techniques used to calculate the proximity or distance between two locations or objects. It involves determining the spatial or

geographic distance between points, typically using latitude and longitude coordinates. Since Ecosia does not have an associated mapping application, such as Google Maps, it cannot perform distance calculations. However, Ecosia users could still use this function by visiting Google Maps (with an additional time cost of one more click).

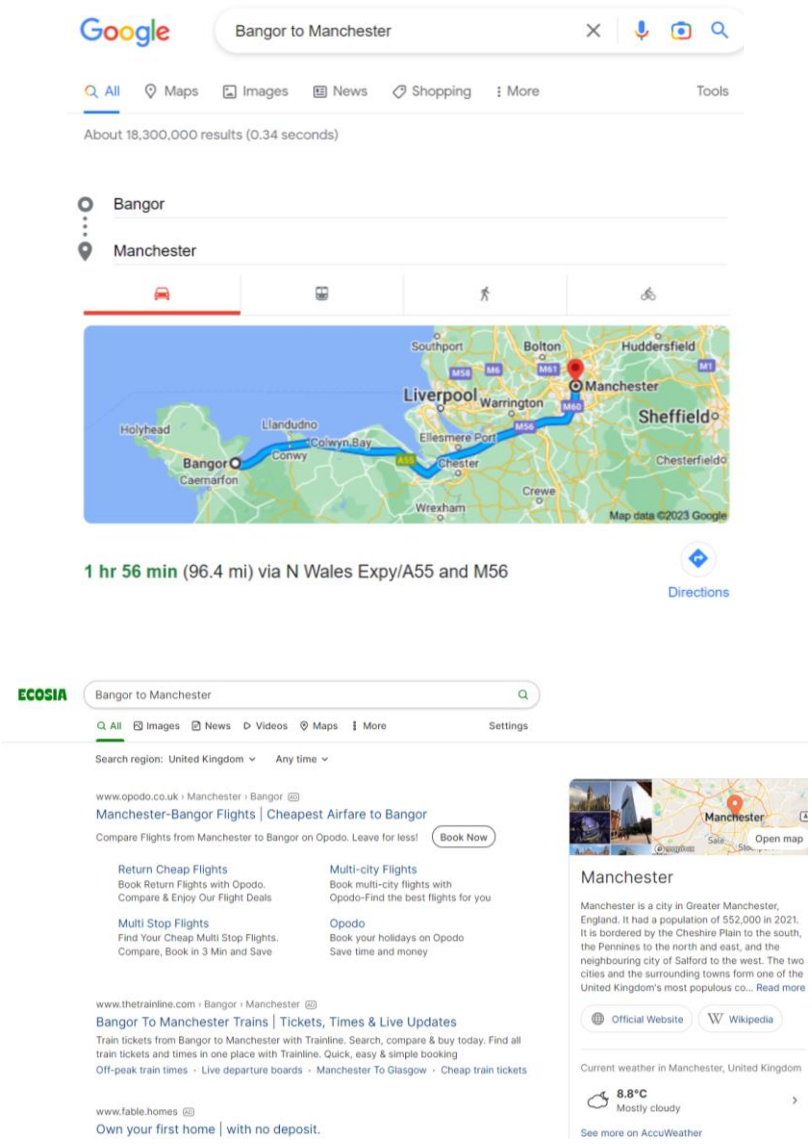


**Figure 10 - Distance Calculations in Ecosia and Google**

### 3.4.3 Custom search experiment: Ecosia vs Google

This sub-section demonstrates the findings from a custom search that we have conducted. Our main goal is to identify whether the search results are similar in Ecosia and Google. Many people are satisfied with Google's search performance, and we expect that many of them will be reluctant to

switch to Ecosia due to concerns regarding accuracy and relevancy of the search results. With this in mind, we formulate a search experiment with two different basic search queries and compare Ecosia's results with Google's. The first search query is "History of Wales", and this should reveal their search performance regarding a short query that consists of few words. In the second search query, we aim to identify their search performance regarding a longer and complex query that consists of 13 words: "What are the long-term impacts of heavy drinking on mental and physical health?". The results for the search query are displayed in Table 2 while the later one is shown in Table 3. The common results are highlighted in different colours.

The Tables show that Ecosia and Google retrieve more or less similar results for the custom search queries that we have executed. For instance, for the "History of Wales", they both bring Wikipedia as the top result. They have two common results in Britannica, one in BBC and one in Visit Wales. The Google search displays two Amazon links (to relevant books) which is not shown in Ecosia. On the other hand, Ecosia displays History Extra (BBC History Magazine) and Conversation (an UK-based credible independent news and analysis platform) which do not exist in Google. For the second and longer search query, Ecosia's 5 (out of 8) results are shared with Google. However, the similarity and rankings of the search results are not as identical in the previous comparison. Nevertheless, all of the Ecosia's search results are relevant with the search query, and it retrieves a highly cited research report about the subject that is not shown in Google (see Ecosia's #5 in Table 3).

**Table 2 - Search Results Comparison for "History of Wales"**

| # | Google | Link | Ecosia | Link |
|---|---|---|---|---|
| 1 | Wikipedia | https://en.wikipedia.org/wiki/History_of_Wales | Wikipedia | https://en.wikipedia.org/wiki/History_of_Wales |
| 2 | Britannica | https://www.britannica.com/summary/Wales | BBC | https://www.bbc.co.uk/wales/culture/sites/aboutwales/pages/history.shtml |
| 3 | Britannica | https://www.britannica.com/place/Wales | Britannica | https://www.britannica.com/place/Wales |
| 4 | Britain Express | https://www.britainexpress.com/wales/history/index.htm | Britannica | https://www.britannica.com/place/Wales/History |
| 5 | Amazon | https://www.amazon.co.uk/History-Wales-John-Davies/dp/0140284753 | Visit Wales | https://www.visitwales.com/info/history-heritage-and-traditions/wales-incredible-history |
| 6 | Amazon | https://www.amazon.co.uk/Best-Sellers-History-of-Wales/zgbs/books/4117761 | BBC | https://www.bbc.co.uk/wales/history/ |
| 7 | BBC | https://www.bbc.co.uk/wales/culture/sites/aboutwales/pages/history.shtml | Wikipedia | https://en.wikipedia.org/wiki/Timeline_of_Welsh_history |
| 8 | Visit Wales | https://www.visitwales.com/info/history-heritage-and-traditions/wales-incredible-history | History Extra | https://www.historyextra.com/period/modern/wales-welsh-history-language-culture-differences-england-industry-coal-independence/ |
| 9 | Goodreads | https://www.goodreads.com/en/book/show/409696 | The Conversation | https://theconversation.com/how-the-people-of-wales-became-welsh-82192 |

**Table 3 - Search Results Comparison for "What are the long-term impacts of heavy drinking on mental and physical health?"**

| # | Google | Link | Ecosia | Link |
|---|---|---|---|---|
| 1 | CDC | https://www.cdc.gov/alcohol/fact-sheets/alcohol-use.htm | Alcohol Change | https://alcoholchange.org.uk/alcohol-facts/fact-sheets/alcohol-and-mental-health |
| 2 | Mental Health | https://www.mentalhealth.org.uk/explore-mental-health/a-z-topics/alcohol-and-mental-health | NHS | https://www.nhs.uk/conditions/alcohol-misuse/risks/ |
| 3 | NHS | https://www.nhs.uk/conditions/alcohol-misuse/risks/ | Mental Health | https://www.mentalhealth.org.uk/explore-mental-health/a-z-topics/alcohol-and-mental-health |
| 4 | Alcohol Think Again | https://alcoholthinkagain.com.au/alcohol-your-health/alcohol-and-long-term-health/ | IAS | https://www.ias.org.uk/wp-content/uploads/2020/12/The-physical-and-mental-health-effects-of-alcohol.pdf |
| 5 | American Addiction Centres | https://americanaddictioncenters.org/alcoholism-treatment/mental-effects | Drink Aware | https://www.drinkaware.co.uk/facts/health-effects-of-alcohol/effects-on-the-body/alcohol-and-the-brain |
| 6 | Priory Group | https://www.priorygroup.com/blog/the-short-and-long-term-effects-of-alcohol-consumption-on-the-body | Health.com | https://www.health.com/condition/alcoholism/effects-of-alcohol-on-the-brain |
| 7 | nidirect | https://www.nidirect.gov.uk/articles/how-alcohol-affects-your-health | Webmd | https://www.webmd.com/mental-health/addiction/what-to-know-about-alcohol-and-mental-health |
| 8 | Webmd | https://www.webmd.com/mental-health/addiction/addiction-heavy-drinking | NHS | https://www.nhs.uk/live-well/alcohol-advice/the-risks-of-drinking-too-much/ |
| 9 | Alcohol Change | https://alcoholchange.org.uk/alcohol-facts/fact-sheets/alcohol-and-mental-health | BUPA | https://www.bupa.co.uk/newsroom/ourviews/alcohol-and-mental-health |

# 4. RECOMMENDATION AND RATIONALE

Ecosia is a search engine that is leading the way in terms of sustainability and environmental impact. Its commitment to reforestation and carbon reduction has led to impressive results, and the company's dedication to privacy and social responsibility make it an attractive alternative to other search engines. Ecosia enables its user to make a positive impact on the planet and support a company that is dedicated to making a difference.

**RECOMMENDATIONS**

This report recommends Bangor University adopts Ecosia as its default search engine for all campus computers.

When users search the web using Ecosia, the search engine generates revenue through ads, just like other search engines. However, instead of keeping all the profits, Ecosia uses 80% of its revenue to fund tree-planting projects. Student organizations and clubs at universities around the world have promoted Ecosia and encouraged their members to use it as their default search engine as part of their sustainability and environmental initiatives. Ecosia Campus allows universities and schools to track the number of trees planted by their students and staff, as well as customize the Ecosia homepage with their institution's logo and branding.

## 4.1 ALTERNATIVES

There are two possible alternatives to adopting Ecosia as a default search engine.

Alternative #1

A possible option for Bangor University is to continue using its current default search engine. While this option eliminates any issues around adaptability of new technology by staff and students, it does not contribute to the Universities ’25 by 25’ goals. **Not a viable option.**

Alternative #2

Another option for Bangor University is to adopt an alternative search engine that promotes sustainability and reduces its impact on their environment. This report has considered alternative search engines and found Ecosia to be the best in terms of search capabilities and impact on the environment. **Not a viable option.**

## 4.2 RISKS

Ecosia is a proven search engine that has been available since 2009. It has been successfully implemented at other Universities and the tests performed in this report found minimal differences in results compared with using Google.

There is a risk that staff and students will be unfamiliar with Ecosia. However, this risk is considered minimal and can be mitigated by providing user information through the staff bulletin and to the student community. In addition, staff and students will always have the option of continuing to use Google if they desire despite Ecosia being the default search engine.

Given the rise of Artificial Intelligence (AI) tools there is uncertainty over the future of search engines. This is discussed further in Appendix B. However, based on the current situation with search engines, the adoption of Ecosia is a viable option.

## 4.3 IMPLEMENTATION

Implementation of Ecosia will be done by Bangor University Digital Services team.

# APPENDIX A – SELECTED LITERATURE

| Report title | Year & URL | Academic / Non-academic | Search engines discussed | Main findings |
|---|---|---|---|---|
| The environmental impact of search engines apps | 2020 **Link** | Non-academic | Bing, DuckDuckGo, Ecosia, Google, Lilo, Qwant, StartPage, and Yahoo | • Ecosia outperform Google in basic search, weather search, local search and basic definition search<br><br>Compared to other engines, Ecosia has a very low carbon impact, often ranking in the top or second place |
| Every Google search results in CO2 emissions. This real-time data viz shows how much | 2018 Link | Non-academic | Google | • By handling 3.5 billion search queries per day, Google is globally responsible for approximately 40% of the total carbon emissions attributed to the internet.<br><br>With an approximate average of 47,000 requests per second, the platform generates an estimated 500 kg of CO2 emissions every second. |
| Green Search Engine Usage - A Qualitative Study Exploring Why German Millennials Use the Green Search Engine Ecosia | 2021 Link | Academic | Ecosia | German millennials prefer Ecosia due to six reasons: : (1) the perception of it being easy to adopt, (2) the desire for an environmentally-friendly lifestyle, (3) the positive beliefs associated with the behaviour, (4) social influence and internalization, (5) a favourable perception of the organization, and (6) Ecosia's tree-counter feature. |

| Report title | Year & URL | Academic / Non-academic | Search engines discussed | Main findings |
|---|---|---|---|---|
| The Carbon Footprint of Search | 2023<br>Link | Non-academic | Google, Bing and DuckDuckGo | • The carbon emission of a single search:<br>○ Google (0.11g)<br>○ Bing (0.12 g)<br>○ DuckDuckGo (0.14g) |
| Values-based Business Model Innovation–the Case of Ecosia and Its Business Model | 2022<br>Link | Academic | Ecosia | Ecosia's business model is considered an innovative and sustainable approach due to its positive environmental impact resulting from various components, such as redirecting revenues towards tree planting. This demonstrates a sustainable business model innovation (BMI). |
| Switch your search engine to Ecosia, a not-for-profit that makes a big impact | 2023<br>Link | Non-academic | Ecosia | • Ecosia, as a carbon-negative search engine, actively removes 0.5 kg of CO2 from the atmosphere with each user's search by planting trees and offsetting its energy consumption through renewable sources<br>• If Ecosia were as large in scale as Google, it would have the capacity to offset approximately 15% of the total global CO2 emissions. |

| Report title | Year & URL | Academic / Non-academic | Search engines discussed | Main findings |
|---|---|---|---|---|
| Ecosia: The Green Search Engine That Plants Trees | 2023<br>Link | Non-academic | Ecosia | • Over 500 different native tree species planted<br>• Transparent governance with disclosure of monthly financial reports f<br>• Solar panels generate twice the amount of energy needed for conducting user searches |
| Google disputes Harvard fellow's pollution estimate | 2009<br>Link | Non-academic | Google | • Wissner-Gross claims that A single Google search produces approximately 7 grams of carbon dioxide (CO2), which is slightly less than half the amount of CO2 emissions generated from boiling a kettle to make a cup of tea.<br>• Google's Senior VP counters this argument by claiming that it is only 0.2 grams |

# APPENDIX B – FUTURE OF SEARCH ENGINES

The rise of Artificial Intelligence (AI) chatbots is set to have a profound impact on the future of search engines as evident by the fact that ChatGPT just becomes the fastest-growing application of all time.[10] These intelligent conversational agents can transform the way users interact with search engines and revolutionize the search experience in several ways:

1. **Improved user engagement:** AI chatbots enable more interactive and conversational search experiences. Instead of relying on traditional keyword-based queries, users can engage in natural language conversations with chatbots to express their needs more precisely. This enhances user engagement and encourages a deeper exploration of search topics, leading to a more satisfying and informative search experience.

2. **Personalized and contextualized results:** AI chatbots can leverage user preferences, browsing history, and contextual information to provide personalized search results. By understanding the user's intent, chatbots can refine search queries, ask clarifying questions, and tailor the search results to match individual needs. This personalized approach ensures that users receive more relevant and contextually appropriate information.

3. **Natural language understanding and assistance:** AI chatbots are equipped with advanced natural language processing capabilities, allowing them to understand and interpret user queries more effectively. These chatbots can comprehend complex language structures, handle ambiguous queries, and extract meaning from unstructured data. By offering accurate and comprehensive responses, they enhance the search engine's ability to understand user intent and deliver precise results.

4. **Intelligent recommendations:** AI chatbots can provide intelligent recommendations based on user preferences and behaviour. By analysing user interactions and historical data, chatbots can suggest relevant search queries, related topics, or even recommend products and services. These personalized recommendations enhance the overall search experience, offering users valuable insights and saving time in the search process.

[10] https://www.reuters.com/technology/chatgpt-sets-record-fastest-growing-user-base-analyst-note-2023-02-01/

5. **Conversational commerce:** AI chatbots have the potential to transform search engines into powerful platforms for conversational commerce. By integrating with e-commerce systems, chatbots can assist users in product searches, provide recommendations, answer questions about products or services, and even facilitate transactions directly within the chat interface. This seamless integration of search and commerce streamlines the user journey and enables frictionless shopping experiences.

6. **24/7 availability and instant assistance:** AI chatbots provide round-the-clock availability and instant assistance, ensuring that users can access search engine services and support at any time. Whether it's answering queries, providing guidance, or offering troubleshooting assistance, chatbots offer immediate responses, reducing wait times and improving customer satisfaction.

7. **Multilingual support:** AI chatbots can support multiple languages, breaking down language barriers and expanding the reach of search engines to a global audience. Users can interact with chatbots in their preferred language, making search engines more inclusive and accessible to diverse populations worldwide.

8. **Continuous learning and improvement:** AI chatbots can learn from user interactions, feedback, and ongoing training, allowing them to continuously improve their understanding and responses. By leveraging machine learning techniques, chatbots can adapt to changing user preferences, refine their knowledge base, and provide increasingly accurate and helpful search results over time.

9. **Enhanced voice search:** AI chatbots can enhance the capabilities of voice search, enabling users to perform hands-free searches and receive voice-based responses. By leveraging speech recognition and synthesis technologies, chatbots can understand and generate natural language speech, providing a more intuitive and convenient search experience for users who prefer voice interactions.

10. **Human-like conversations:** As AI chatbot technologies advance, they become more capable of generating human-like conversations. This enables chatbots to engage in dynamic and nuanced interactions with users, fostering a sense of natural conversation. By understanding context, employing empathy, and generating coherent responses, chatbots create more immersive and satisfying search experiences.

It is important to note that while AI chatbots offer numerous benefits, they also pose challenges related to privacy, data security, and ethical considerations. Safeguarding user data, ensuring transparency in decision-making processes, and addressing potential biases are safeguarding user data, ensuring transparency in decision-making processes, and addressing potential biases are critical aspects that need to be carefully managed. Ongoing research and collaboration between AI developers, search engine providers, and regulatory bodies are necessary to establish best practices, standards, and guidelines for the ethical and responsible use of AI chatbots in search engines. By addressing these challenges, search engines can harness the potential of AI chatbots while upholding user privacy, transparency, and fairness, ensuring that the future of search engines is not only innovative but also socially beneficial.