

Regrowing a greener web.

# A master thesis

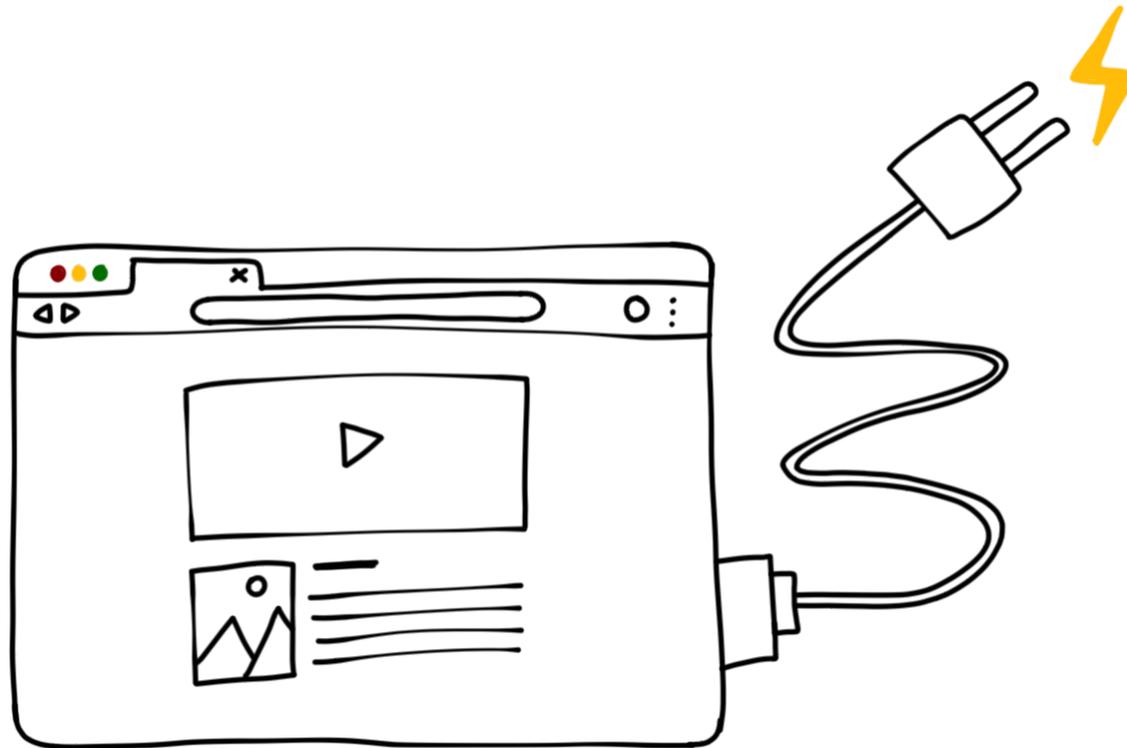
Investigating how interaction design can aid to make the web less polluting

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Oslo School of Architecture and Design

Did you know that websites demand energy? In fact the bigger they are, the more they demand. And the average website is huge! This project will bring about experiments and tests to see how interaction designers could help slim down the internet. Because the more weight we lose, the less energy we produce. Which equals fewer carbon emissions in our atmosphere.



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I have chosen to work with carbon emissions associated with webdesign, because I see it as a new norm in the near future and want to learn how it affects us designers and the IT industry.

If you wish to discuss my master thesis or digital emission in general, then feel free to reach out.  
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## **Abstract**

The digital world is intertwined with our daily lives and will continue to do so in the future, but it has a hidden cost to the ozone layer that many aren't aware of. This master thesis is a proposal to how we might shine a light on the subject and investigate how some of our existing services might change if designed with digital emissions in mind. Reading this paper will make you discover sustainability trends happening in the IT industry and give you a good idea about where our future as digital designers should go.

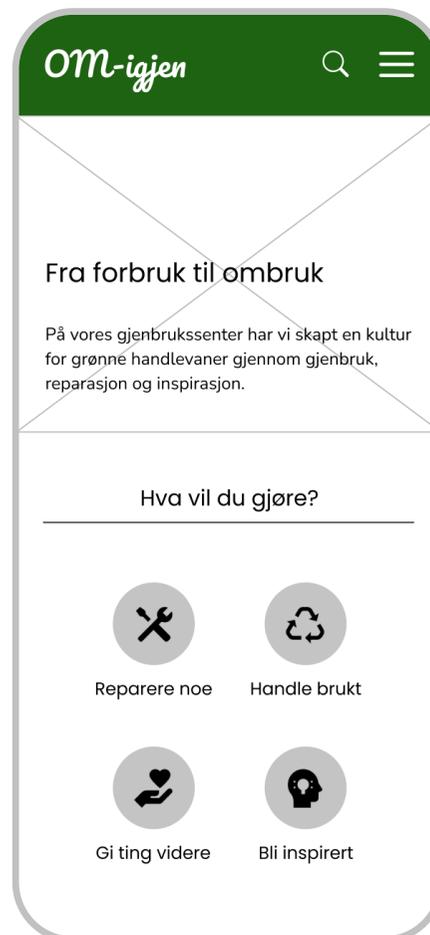
Calculating the carbon emissions of digital content is a fairly new concept and new discoveries are made every day. The ideas and prototypes in this paper have been made with the current best practice (fall, 2023) of designing for fewer emissions.

## Background

Digital emissions was introduced to me while working for Asker municipality. I joined the project omigjen, which is a collection of shops that sell environmentally friendly products. My roles was to gather insight, facilitate workshops and create mock-ups of the website to-be.

From an early stage it was decided that the website should have the lowest carbon footprint possible. This became a challenge for me. Because exactly how to do that, was not obvious, at the time, from googling and/or asking experts. But it was a fun challenge and the result was a what-do-you-need format that will let people find answers quickly so they spend less time online, meaning a smaller carbon footprint

Omigjen peaked my interest for digital emissions. Regrowing a greener web is in many ways a selfish project, where the goal is simply to learn more. But also an investment in the future, as designing services with low carbon footprints, will become a more common wish from sustainability conscious clients.



Mock-up by me for the omigjen website



Final website was designed and developed by Netlife for Asker municipality.

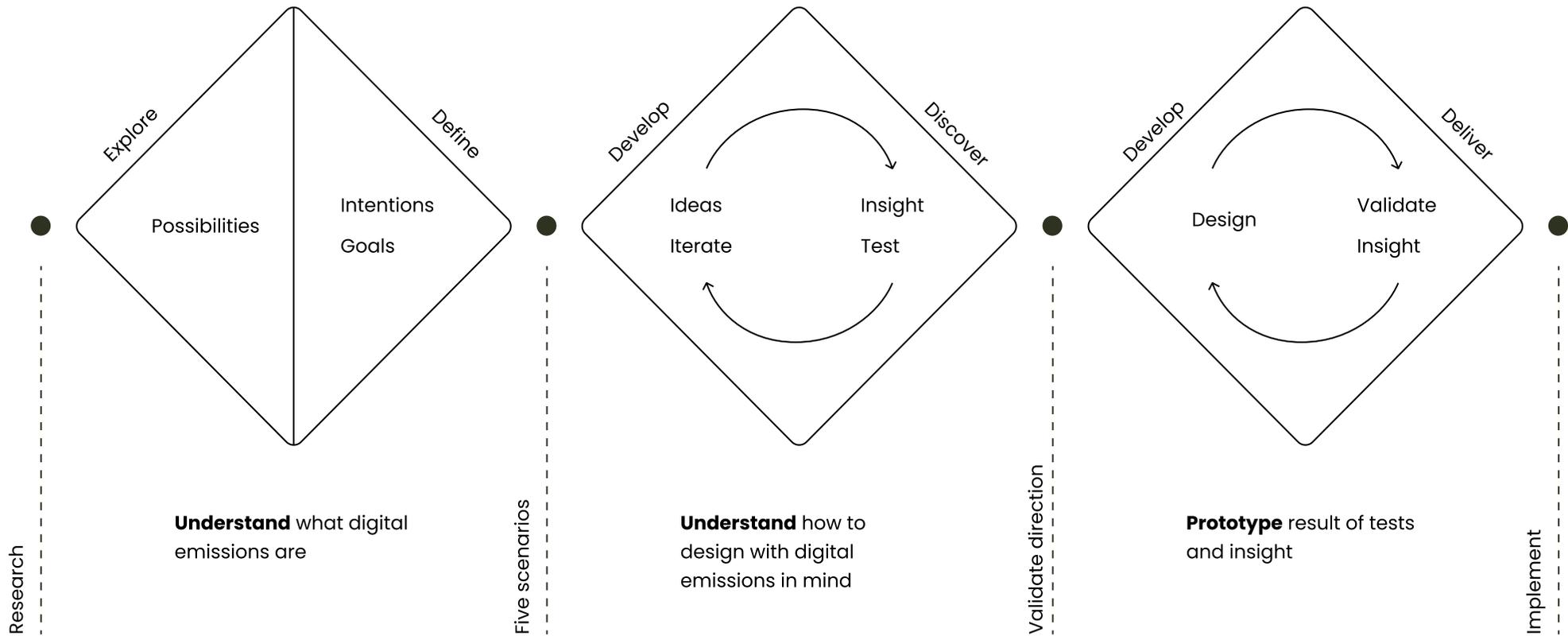
# Thesis statement

An investigation on what digital emission are

An exploration on how we can inform people about digital emissions

An experiment on how some existing services would change, if designed with digital emissions in mind.

The project has followed a triple diamond approach with each chapter representing a diamond.



# Methods

## **Design through research**

The project is based in exploring and experimentation and a natural effect of that is to learn through creating. All experimentations have been made with the intention to speak with an expert or research on a specific topic of interest.

## **Behavioural design - Design Behaviour Intervention model**

Designing for positive chance is a key word for the project, therefore I have utilized the Design Behaviour Intervention model. The model is made with a physical product in mind, but much of the content is easily transferable to the digital media.

## **Semi-structured interviews**

The interviews of users have consisted of showing existing services and/or the projects ideas, this was done deliberately to inspire conversation through visual aid. Because the topic is complex and has many angles. It proved to be valuable and sparked much conversation. To my surprise, the smallest of visual objects can become the biggest conversation starters.

## **Co-creating with experts**

Digital emissions is a new topic with many challenges, but it has the most open community of enthusiasts. Some of which have joined workshopping with me.

## **Strategic narrative: The five C's**

The delivery and project structure is loosely based on the 5C's systemic narrative as introduced by lecturer and designer Jonathan Romm:

- Common ground
- Complications
- Concern
- Course of action
- Conclusions

it is a useful model to create a narrative on complex problems. It has created a red thread for the project to follow and inspired how the presentation is made.

# Chapter 1

## The state of the web

This chapter will explore what digital emissions are as well as the current trends for sustainable IT development.

## The ICT sector

Information and Communication Technology (ICT) is a broad term covering telecommunications, radio, internet services, satellite systems, network infrastructure, and more. It includes technologies and services facilitating communication, data management, and information sharing, encompassing both hardware and software in the digital world. (Wikipedia Contributors, 2019)

## ICT and sustainability

Data is often perceived as something apart from the physical world, perhaps due to terms like 'cloud' and 'digitizing documents' which conveys a sense of lightness. But data and bytes are very much physical and demands energy to be made, accessed, and stored. All energy has a carbon footprint and this is what we call 'digital emissions'. In recent years, it has become more known that data is connected to energy, thanks to collaborative efforts by companies, research institutions, and certain individuals. As our understanding deepens so does the availability of tools to save on digital emissions increase. Yet much remains unknown.

Understanding digital emissions begins with examining the Information and Communications Technology (ICT) industry. ICT encompasses networking components, applications, devices and systems facilitating digital media. Emissions within ICT can be classified in two ways.

- Direct ICT emissions
- Indirect ICT emissions

The terms used to define ICT emissions are my interpretation of multiple sources:

(Frick, 2022)

(Freitag et al., 2021)

(Malmodin and Lundén)

## Direct ICT emissions

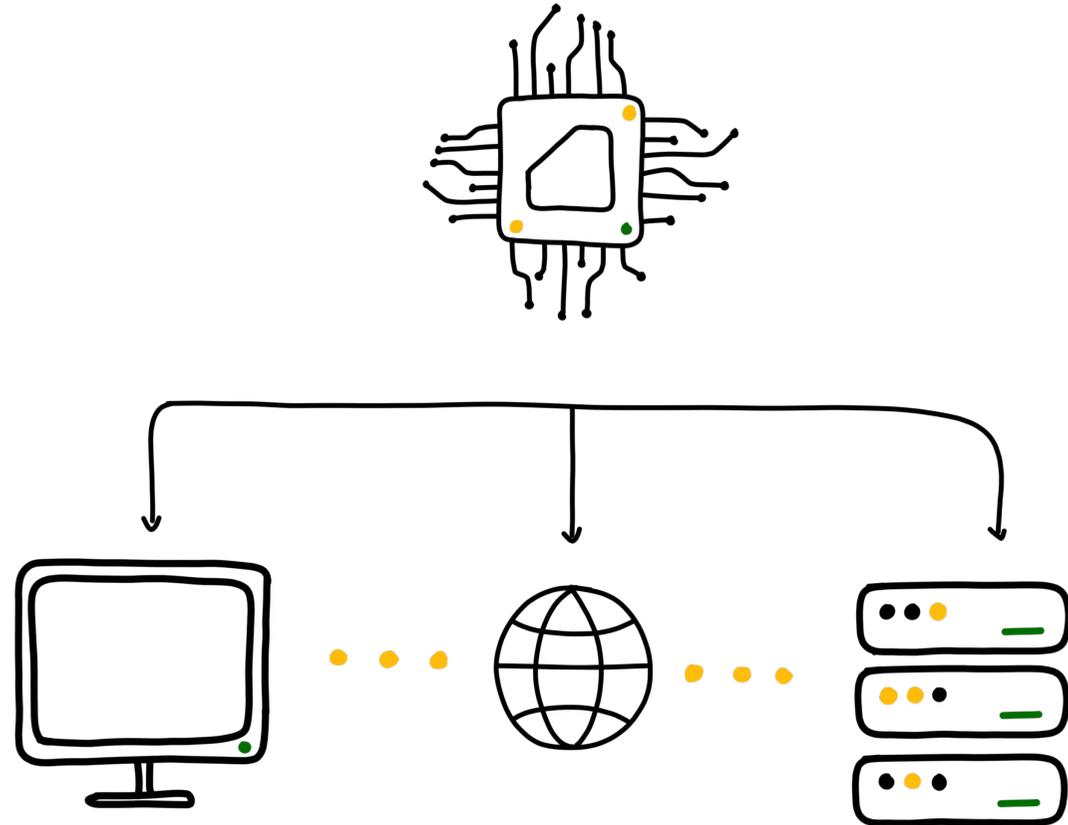
All emissions associated with products or services in the ICT sector, can be categorized in embodied and digital emissions.

### Embodied emissions

The extraction of raw materials, the manufacturing of the product, the packaging and transportation of equipment and devices.

### Digital emissions

The carbon emitted from digital activities such as accessing a website, streaming videos, and messaging. The Major factors of digital emissions include; power usage of the client device(phone, tablet, pc, laptop, etc.), network energy usage (data transfer between server and device), and data centers (the energy consumption of powering and cooling down servers).



## Indirect ICT emissions

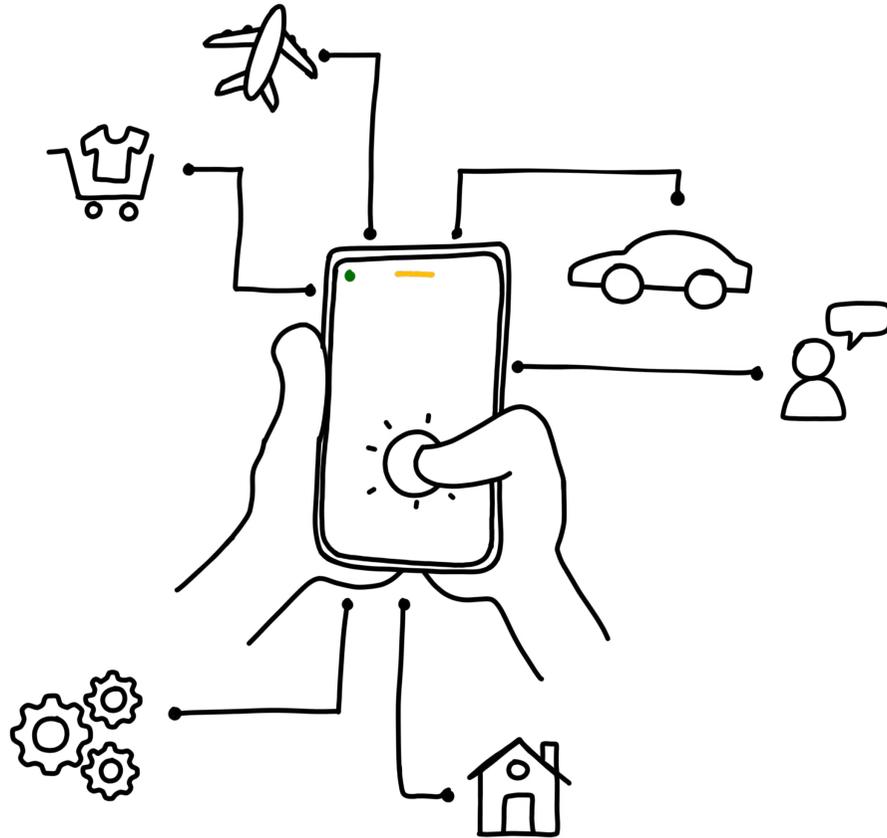
The ICT sector influences many other industries and can act as the pivoting factor for sustainability in a business.

### Decreasing emissions

Conducting a virtual meeting rather than flying to meeting location or using 5G and IoT to make factories more energy efficient.

### Increasing emissions

When websites use deceptive patterns to push an unnecessary purchase or when companies design products with planned obsolescence.



This project has made definitions for the sources of emissions in the ICT sector, based on a collection of studies and research papers. In the hope to create understandable differentiations. This has been a consequence of the current terminology which is often confusing without clear distinctions

This project have specifically explored how designers can play a crucial role in mitigating **digital emissions**. and will address global perspectives on the ICT sector, focusing on how companies, municipalities, and communities engage in sustainable IT development. It does so in order to create an image of what the industry looks like today, and how it might change in the future. From this imagery there will be presented experimental ideas to change online behavior, the goal of this project is to investigate rather than implement and should be viewed accordingly.

The ICT stands for 2–5% of global GHG.  
Surpassing the aviation industry of 1.9%

(Ritchie and Roser)  
(Freitag et al.)  
("Press Corner")

## **The ICT's global GHG**

The ICT sectors global GHG's is an incredibly complex calculation. Experts and scholars trying to understand how polluting the industry is, will take liberties by theorizing to the best of their capability. This creates many contradictions where the differences are often binary. It is difficult to evaluate which study is more true as they all show a degree of; lack of honesty, conflicts of interest or limited scope that does not fully fathom the extent of ICT.

to understand the ICT's GHG we must break it down in three categories; Efficiency, renewable energy and the ICT sectors impact on other industries.

# Efficiency

Efficiency in IT technologies have improved rapidly and has been doing so according to “Kooomey’s Law” since the 1940’s. The law describes that energy efficiency of computing has doubled every 1.6 years and every 2.7 years since 2000. Following this law has helped keep data centers total energy consumption the same since 2015 to 2021. Despite internet traffic tripling in the same time frame ( Kamiya).

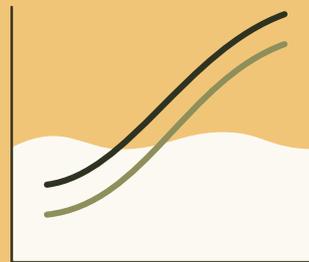
Network traffic has also seen its share of efficiency improvements. For example Ericsson did a study showing that by changing radio towers from 4G to 5G, they managed to reduce the power consumption by 52%. The two factors were better equipment and smarter systems, which gave better feedback on current energy consumption and enabled sleep mode during low traffic periods (Jonsson et al.).

One might conclude that by consistently increasing efficiency we might be able to decouple increased carbon emissions from increased data usage.

But can efficiency keep up with demand? Blockchain, IoT, 5G, machine learning and XR are expected to accelerate data transfer demand in the next few years. In a discussion with digital emissions expert Eivind Skogen, it was noted that while 5G is more energy-efficient than 4G, its ability to handle 20 times more data will lead to increased overall data transmission. The sustainability gains in networks and data centers don’t necessarily translate to more sustainable consumer behavior. A phenomenon known as the rebound effect or Jevons paradox. Kris de Decker echoes these concerns, that one must only look to the past which shows that despite efficiency improvements in the last years, the ICT’s direct emissions have risen as well as contributing to more resource-intensive consumption patterns (Decker).

Scenario 1

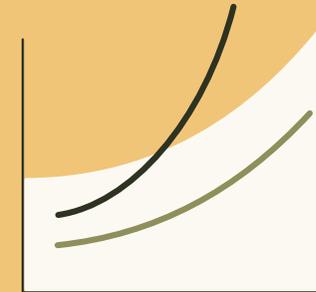
## ICT energy efficiency



- Energy & CO<sup>2</sup>
- Energy efficiency
- Demand

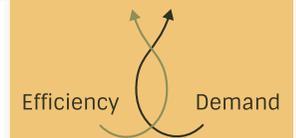
Scenario 2

## ICT energy efficiency

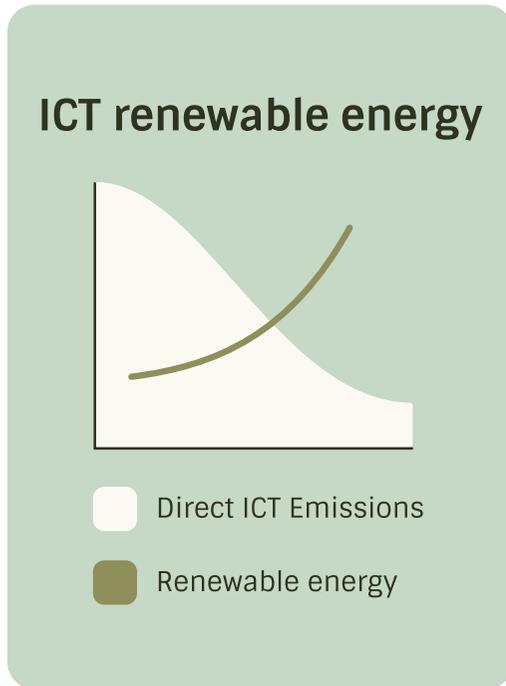


- Energy & CO<sup>2</sup>
- Energy efficiency
- Demand

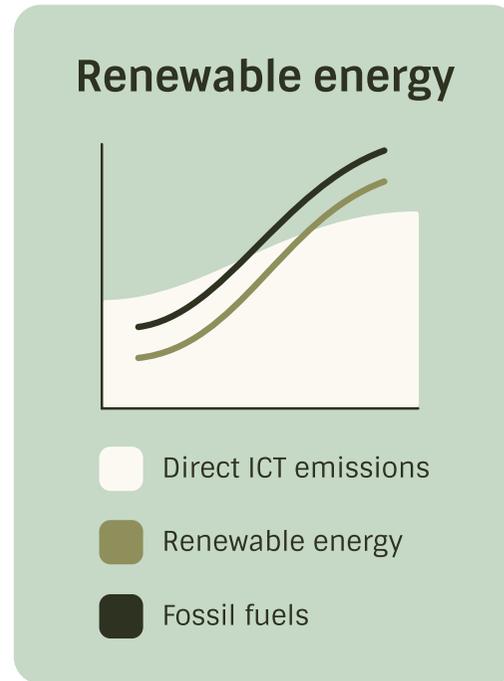
### Jevons paradox



Scenario 1



Scenario 2



## Renewable energy

Ericsson argues that achieving 100% renewable energy for the ICT sector could cut its carbon footprint by over 80%, making it potentially so low that growth concerns become obsolete (Malmodin and Lundén).

Additionally, in response to rising energy prices, some ICT companies are investing in independent renewable energy production, aiming for sustainability and resilience against price shocks and energy disruptions (Jonsson et al.).

Some studies show that the ICT sector not only invests but also constructs renewable energy plants, arguing that their direct emissions are relatively insignificant compared to the emissions they save from expansion (Freitag et al.).”

Kris de Decker, who is behind Low Tech Magazine, argues that studies claiming the ICT sector can be carbon-free with green energy, forget to include the embodied emissions of power plants. Even if they remembered, the bigger problem lies in the fact that the way things are going now, renewable energy does not replace non-renewable sources, they just pile up. (Decker, “How (Not) to Resolve the Energy Crisis”). Additionally studies show that producing on renewable energy does not equal infinite expansion (Freitag et al.).

*“We don’t have an energy production problem. We do have an energy consumption problem.”*

(McGovern)

## ICT's potential impact on other industries

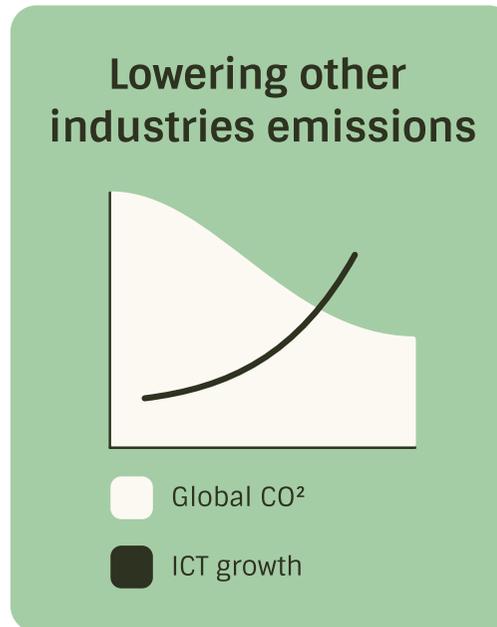
The global carbon emissions are significantly influenced by the ICT sector. with its role to adopt energy-efficient technologies and the overall growth of other industries.”

The ICT sector holds promise in cutting global carbon emissions by 15%. Innovations such as AI and IoT facilitate energy optimization across various sectors. Additionally, practices like telecommuting and video conferencing substitute physical travel with virtual interactions, mitigating carbon emissions linked to flying and driving. Industries are also moving towards dematerialization, emphasizing software and services over physical products, coupled with online training courses and documents, with the potential to significantly reduce global emissions (Malmodin and Lundén).”

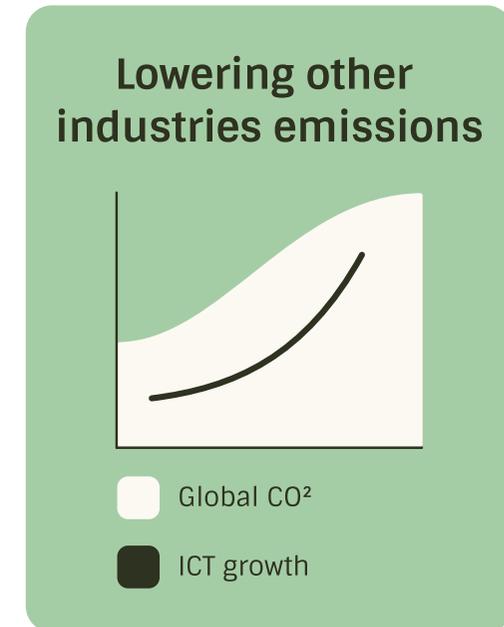
On the other hand, studies claim that it is more likely that ICT creating efficiency in other industries will lead to growth and higher demand, and in turn more GHG emissions - a phenomenon akin to Jevons paradox (Decker).

Some studies emphasize that ICT opportunities lead to carbon savings in other industries only if they entirely replace carbon-intensive activities, rather than supplementing them. For instance, video communication has not replaced transportation but has been added to it since travel has only increased, possibly due to more access to it coupled with targeted ads and websites with persuasive patterns. (Freitag et al.)

Scenario 1



Scenario 2



## Conclusion

The impact of the ICT sector on global carbon emissions is a complex issue. While it has the potential to increase emissions, it also offers opportunities to reduce them. It is crucial for the industry to prioritize sustainability and embrace environmentally friendly practices to ensure a reduction in global carbon emissions.

Currently the approach to lowering the ICT's emissions is to optimize energy efficiency or change to renewable energy. As Gerry McGovern says, we need to focus on the consumption of energy rather than the production of it. So let us discover how to reduce digital emissions by lowering the consumption of data.

*“Currently our grid is not 100% clean and we can't wait for that tech to come. so start optimizing now.”*

Conversation with Fershad Irani

## Concern for the future

People are often encouraged to live more sustainably by changing certain patterns or actions in their life, e.g. shop locally, insulate their home or separate trash, but there will always be certain limits to what individuals may do. People in industrialized countries are often locked into unsustainable behavior, for example it is increasingly more difficult to navigate the city without a smartphone connected to the internet. The smartphone is established as a necessity and as such an individual can choose to buy and use it in a way to reduce energy consumption, but they have no control over the fact that it expires and cannot be repaired after a certain amount of years.

### We can't do it ourselves

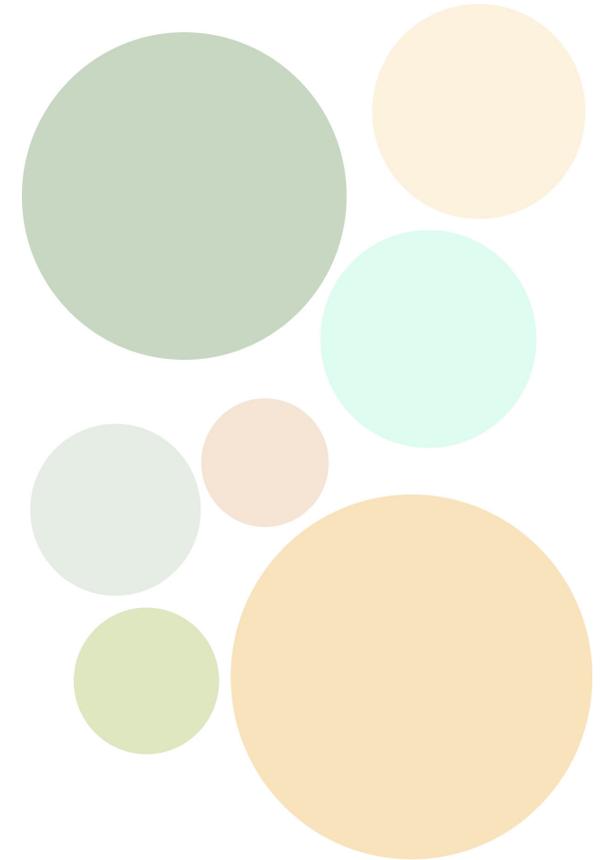
Neither do individuals have the power to reduce the increasing bit rates on the internet, they may try to consume as little as possible, but he or she shouldn't expect much impact because the dominant economic system requires content providers to "innovate" in order to stimulate growth.

By placing responsibility and guilt on the individuals, our attention is deflected away from the institutions structuring the foundation for our actions. We should stop holding the consumer responsible for making sustainable decisions and look beyond that, towards the politicians and economic actors as the biggest contributors to sustainable behavior (Decker, "We Can't Do It Ourselves").

### Complacent designers

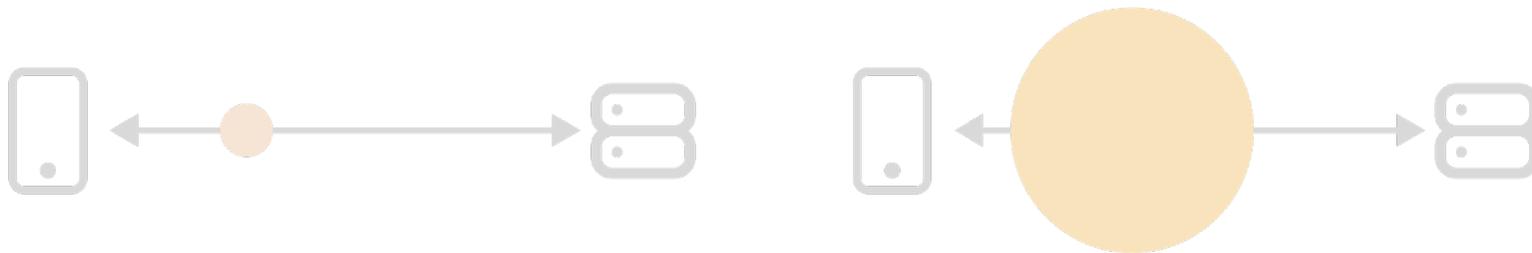
The internet has undergone significant advancements in recent years, with faster connectivity and improved technologies giving web designers more extensive opportunities to craft complex and visually stunning websites. Regrettably, these advancements have also created design complacency with efficiency taking a back seat (Greenwood). A result of this is that the average webpage has since 2010 grown to be 5 times heavier ("HTTP Archive: Page Weight"). Łukasz Mastalerz is a seasoned developer and green software researcher, in an interview with him he explained how; in the past developers had to count the bits because of limited technology, but with increased internet speeds, many have stopped prioritizing efficiency, resulting in overburdened sites with unnecessary animations, high-resolution images, and large video files. This affects website loading speed, leading to poor user experience. Moreover, search engines factor in website speed when ranking search results, making a slow-loading website unfavorable. Web designers must start prioritizing efficient and effective design that places user experience at the forefront, avoiding the temptation to create sophisticated and decorative websites that compromise speed and frustrate users. Designing websites with less impact does not mean making bare and stark webpages, it just means that every content needs to be justifiable (Greenwood).

The average webpage has since 2010 grown to be 5 times heavier



Data consumption per month will in  
2028 have grown 4 times in size

(Jonsson et al.)



## Digital responsibility – Challenging the industry

On the 15th of February 2023, I attended a seminar hosted by the Norwegian organization GoForIT, which focused on digital responsibility. GoForIT is a new organization that advocates for the same values as Corporate Digital Responsibility (CDR), and aims to create a community for sharing knowledge and pushing the agenda of how sustainability and digitization can be combined (karine). The organization has a close relationship with Rob Price, the founder of CDR. Together, they have translated the CDR manifesto into Norwegian, and while doing so they changed the term “corporate digital responsibility” into “digital responsibility to society” or “digitalt samfunnsansvar” in Norwegian. Their reason for doing so is to remind us of the responsibility we have to create useful IT solutions for our neighbors, friends and family. In essence. For people. Rather than for businesses or profit. Though this argument has two sides to it, because it may be that individuals behind and participating at the GoForIT seminar were very enthusiastic about discovering ways to create for digital responsibility, their companies/stakeholders main concern will always be for their business to stay afloat in todays market. But the common understanding between people at the seminar is that the only way to stay afloat, is to design with responsibility and sustainability in mind. The main takeaway of that day is knowing that the awareness of such practices is spreading its roots in large organizations, meaning that the perceived responsibility on individuals fades away.



Attending workshop hosted by Bouvet and GoForIT, Honored guest was Rob Price who is behind CDR. Image used by courtesy of Bouvet.

“Reducing energy demand is not a matter of persuading individuals to cut back on their consumption, nor is it a question of making cars, freezers and heating systems more efficient. Instead radical demand reduction is about shaping the ways in which energy-demanding practices develop over time.”

(Centre)

### Worlds first regulation on digital emissions

France have passed the worlds first law to regulate digital emissions. it aims to lower the environmental footprint of French telecom operators. The laws author is Patrick Chaize and he based in on a study made by Arcep (Pollet) Chaize explains that the finalized law proposal has been trimmed down compared to its original format, whereas the original proposal included a system for multiannual commitments by operators to ensure their progress(Pollet). The reason for trimming it down was to make it more pragmatic, but this now means that the law lacks a good measure to follow up and punish uncorrect behaviour with. It might be added here that any reasoning for making a more optimistic or radical law would prove to be very difficult, as the topic of direct ICT emissions is a new and complex. Nevertheless this proves governmental action to make the internet sustainable is possible.



Study which pushed the French regulations. Made by Arcep, a french independent research group. ("Publications")

## Governmental in-house action

Asker municipality in Norway has calculated their digital emissions and begun to lower the emissions of their website and a handful of internal systems.

Sophus Aarnæs, the digital consultant responsible for leading the process, explained how digital emissions is not currently associated with the municipalities total GHG.

The municipality work to reduce their GHG with 67% by 2030, so as Aarnæs adds, it is very attractive for them to see new tools to calculating and/or explaining digital and embodied emissions to the decision makers of the municipalities sustainability plan.

**Utslipp fra digitale enheter**

Enhet	Antall	Produksjonsutslipp (Kg CO2)		Bruksutslipp (kg CO2/år)	Produksjonsutslipp pr år (kg Co2/år)
			Total levetid (år)		
Chromebook R11	16000	300	6	194083	800000
Andre bærbare PCer	4000	300	4,5	64694	266667
Skjermer < 50"	6230	400	15	50381	166133
Stasjonær PC	1000	300	4,5	80868	66667
Svitsjer	638	25	5	84314	3190
Aksesspunkter (15 W)	2750	25	5	54349	13750
Mobiletelefon	3800	60	4,5	5775	48000
Printer	473	300	6	16631	23650
Aksesspunkter (25 W)	800	25	5	25667	4000
Nye fysiske servere	20	1300	5	11871	5200
Gamle fysiske servere	15	1333	10	10267	2000
<b>Total</b>	<b>35526</b>			<b>598900</b>	<b>1 399 256</b>

...det er fordi at utslippene relatert til produksjonen av utstyret er så høyt sammenlignet med bruksutslippet. For å regne ut bruksutslippet regner vi om strømførbruk til utslipp. Akkurat den faktoren er et fagfelt i seg selv og kan gjøre det vanskelig å sammenligne tall på tvers av studier. Vi har brukt en parameter som prøver å ta hensyn til energimiksen i Europa vi er en del av.

**Sophus**

**Oscar Frank**

Slide showing emissions calculation of software and hardware in municipality. Screenshot from conversation.

### Eco warriors

IT communities that focus on implementing ethical and sustainable practices in digital services are becoming more common.

These communities can be referred to as Eco Warriors, because they are actively creating momentum toward a sustainable future for the internet.

# Netlife

#### Netlife

Design bureau producing manifestos, spreading knowledge and practicing best practice for lowering emissions in their projects.



#### Climate action tech

Tech focused actions for sustainable IT. Mostly developers and engineers.



#### Green software foundation

Community that builds standards and best practices



#### Sustainable UX network

Sustainability community for designers.



#### The green web foundation

aims for a fossil free internet by 2030. Authors of Branch magazine which is about a sustainable and ethical internet.



#### W3C

Develops standards for the web. Has a subgroup focused solely on sustainability.

## **Research reflection**

The research have taught me that the IT industry is very focused on designing with sustainability in mind, both with indirect and direct ICT emissions. So the future of design will most definitely evolve to work with digital emissions as common practice in the future.

This creates opportunities for the project to explore new ideas on designing with sustainability as the main building block.

## Chapter 2

# Designing with digital emissions in mind

## **Project position**

### **Interaction design**

The ICT and the internet is both large complex systems and one might go about reducing their emissions from many angles, depending on professional field or association.

I am an interaction designer and has solved it as such, by experimenting with solutions on a scale fit for individuals and businesses.

### **The world wide web**

The internet is the main subject of this diploma due to it being the most researched topic of digital emissions and it having many opportunities to change for the better. The internet is most commonly viewed in mobile but I have choosen to work mostly with desktop solutions as websites are often better viewed on desktop.

### **Regrowth**

The internet is giving our society amazing opportunities and is here to stay. The project focuses on regrowing our digital content rather than removing or pushing users to practice abstinence.

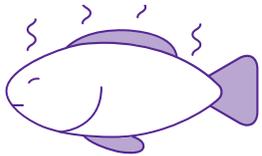
## Expert co-creation

With a thorough understanding of the climate change of the ICT sector and emerging trends, I invited Eivind Skogen to do a co-creation session on how designers can create ideas for lowering digital emissions.

Eivind Skogen is a Netlife employee and is an expert on digital emissions, with many years of experience. He also helped lead the OMigjen project (page 07).

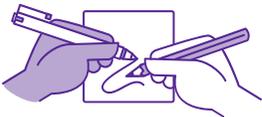
The goal of the co-creation was to voice fears and hopes surrounding carbon emissions of the digital world and think smart on how we could design for positive change.

### Methods used in co-creation:



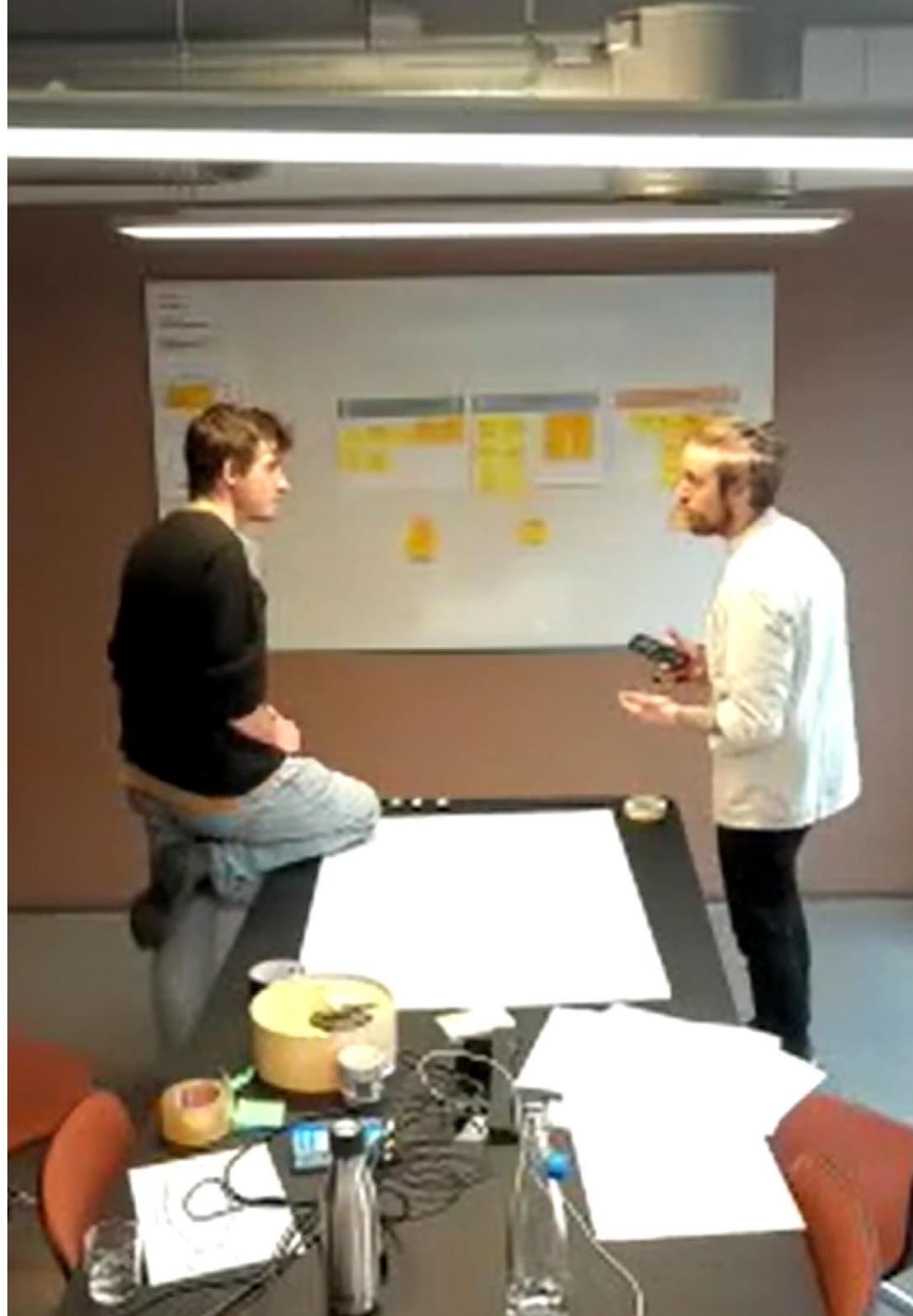
("Stinky Fish")

The stinky fish was used for its fun and collaborative way of voicing fears for the future. It started the day well to put worries up on the wall for both of us to see.



("Mash-up Innovation")

Mash-up innovation is an idea generation method well made for collaboration. I made it simpler than the source refers to, so it would work for two and in a small time frame.



## Result from co-creation

Many small ideas were illustrated and discussed but one idea came to take the most focus. Which is to visualize the total digital emissions of a persons day. The main takeaways of that concept is:

### Nudge though numbers

By measuring first we can make conscious choices and also give people a reason to why things must change

### Give numbers context

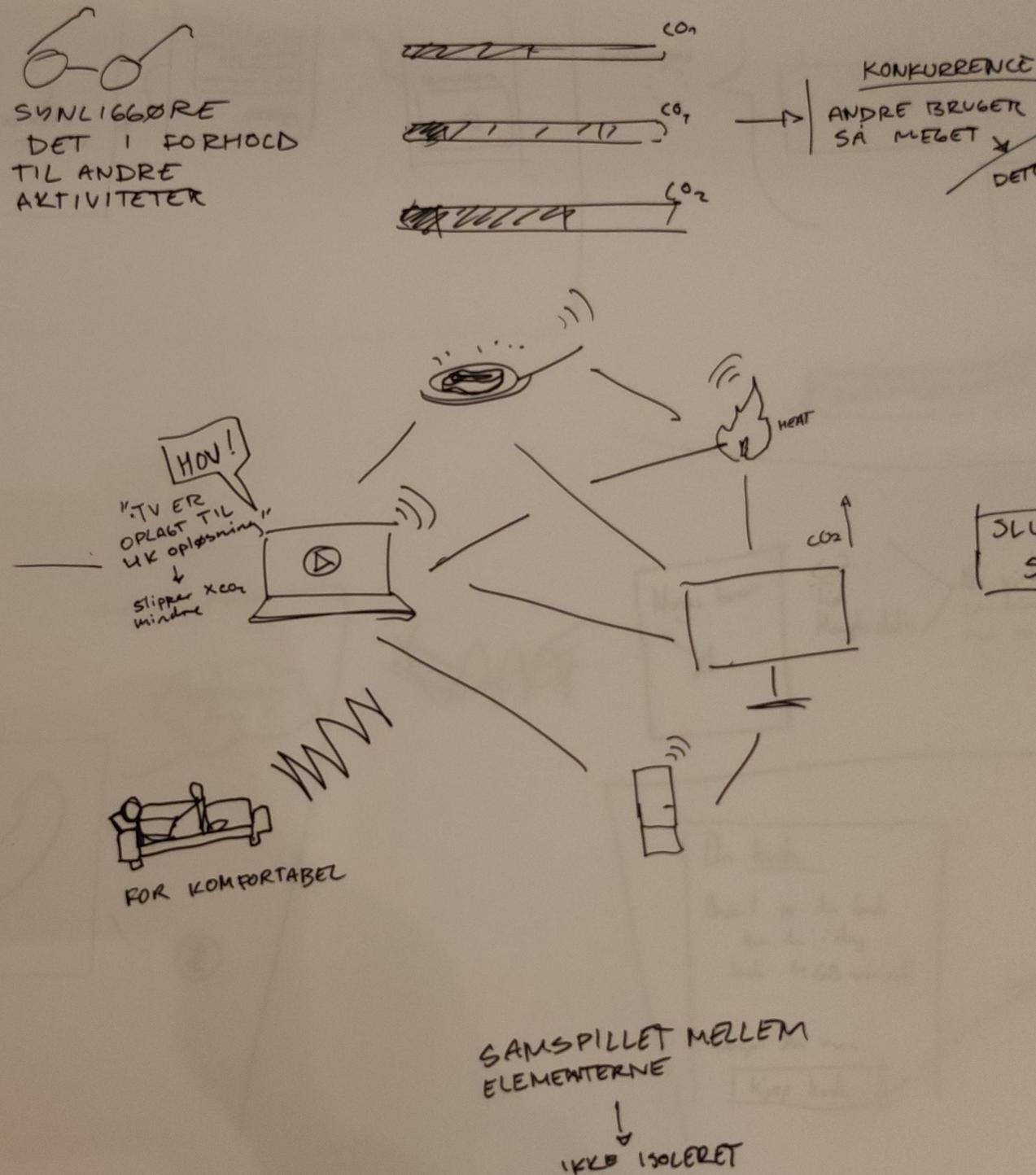
Nothing is more confusing than what CO2 actually is. So give it context; how many trees are needed to offset the CO2? How good are you compared to others? How good are you compared to yesterday?

### Don't just think individual

The tool might be for the individual person, but the message must be to push service owners to decrease the digital emissions of their products.

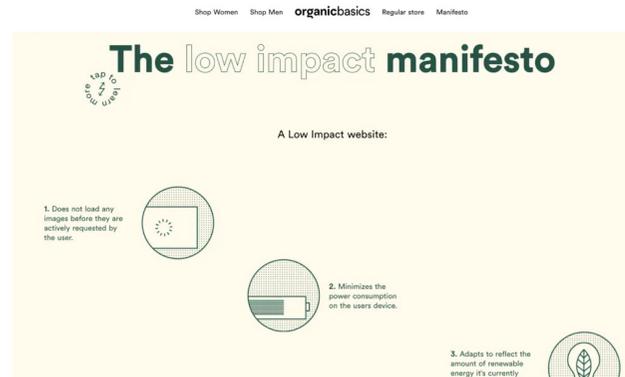
## Reflection

It was valuable to create with and expert because it created a place where I could voice personal concerns with the topic and possible directions. Some of which Eivind himself has experienced. The result which is an idea to calculate a persons total digital emissions in a day is a major undertaking. One too large for a thesis. But rather it served as a source of inspiration.



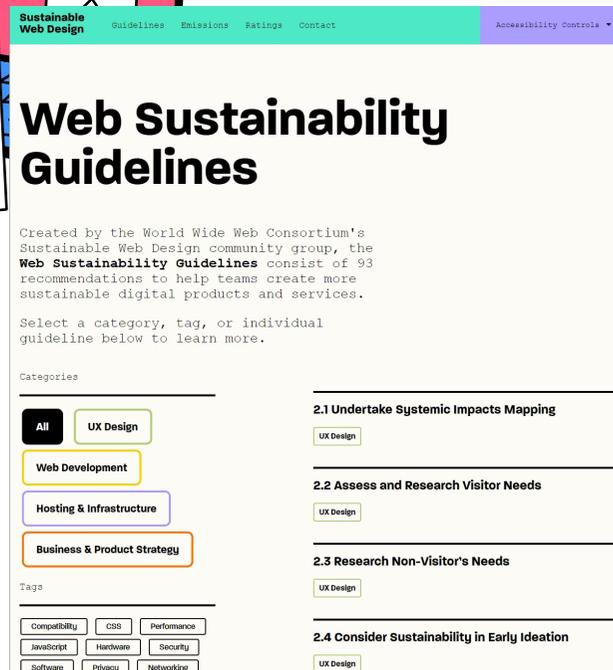
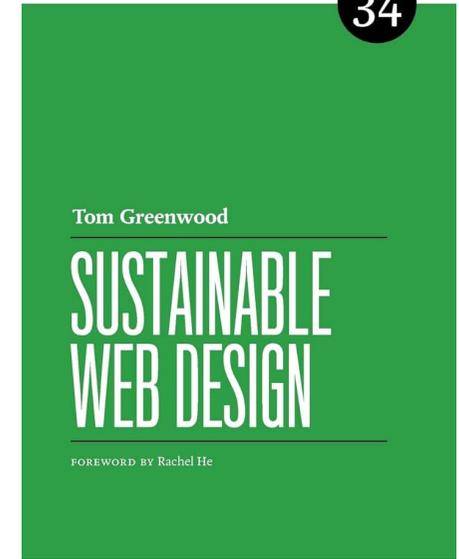
# Green web design best practice

- Manifestos
- Blogs
- Guidelines and standards
- Examples



A BOOK APART

Nº 34



## Blog

Search the Blog



## Introducing the Web Sustainability Guidelines

Posted by [Tim Frick](#) in [Business Strategy](#), [Sustainability](#), [UX Design](#), [Web Development](#) tagged with [Corporate Digital Responsibility](#), [Sustainable Web Design](#)  
Last Modified: 09.28.2023

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- [SEO and SEM Strategy](#)
- [Events and Workshops](#)

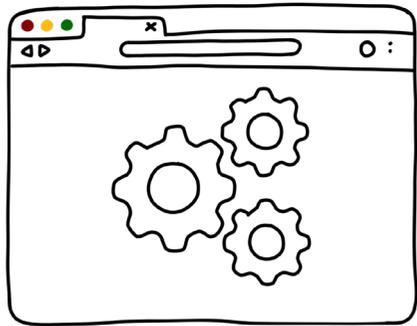
## INTRODUCING THE WEB SUSTAINABILITY GUIDELINES



W3C Sustainable Web Design (SustyWeb)

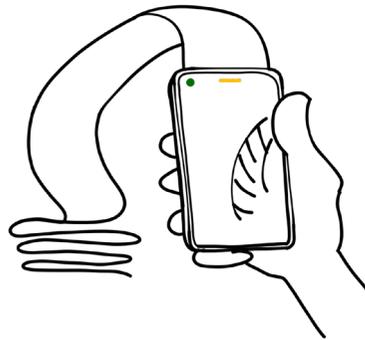
(Skogen)  
(Frick)  
(Basics)  
(Greenwood, "Sustainability Guidelines Archive")  
(Greenwood)

# Green web design summed up



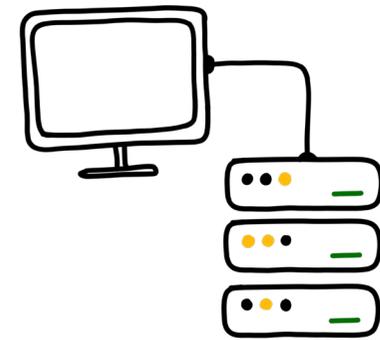
## Web performance optimization

How quickly does the site download to a user's device?



## Clicks and content

How many clicks before users find the content they need? And how useful is that content once it's found?



## Green web hosting

Are the servers hosting your digital products and services powered by renewable energy?

# Five scenarios

Exploration is needed to truly understand what designing for low emissions means. So five scenarios were created and used as conversation stimulus with experts on sustainable IT.



## E-commerce

*Experiment 1*

We've become complacent to create large websites to push cheap clothes made in unethical and non-sustainable ways, our approach is to sell more and screw the repercussions. What if we made an online clothing brand that went so far in their brand story, that they build their whole service around a low carbon website.



## Image hoarding

*Experiment 2*

It is much easier to upload and forget than it is to sort and delete. Our cloud is full of unnecessary content. What if our personal cloud storages focused on lowering digital emissions by helping people delete the images and videos we do not need.



## Municipality websites

*Experiment 3*

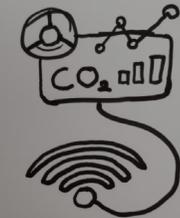
Municipalities websites are sadly poor managed and as a result becomes a place to dump new information. What if all municipality websites had the same website origin and replicated generic information. Then we might lower the CO2 emissions tenfold.



## Website rating

*Experiment 4*

The average website grows every year in size which causes an obese internet. What if we rated every website based on their CO2 emissions and gave consumers an overview how the websites performance. Perhaps we can push websites owners to slim down their products.



## Carbon report

*Experiment 5*

The internet has become a world wide waste bin and the average web user has no chance to understand how much carbon their consumption actually produces. What if we gave the consumer a carbon emission report on their personal usage of the web.

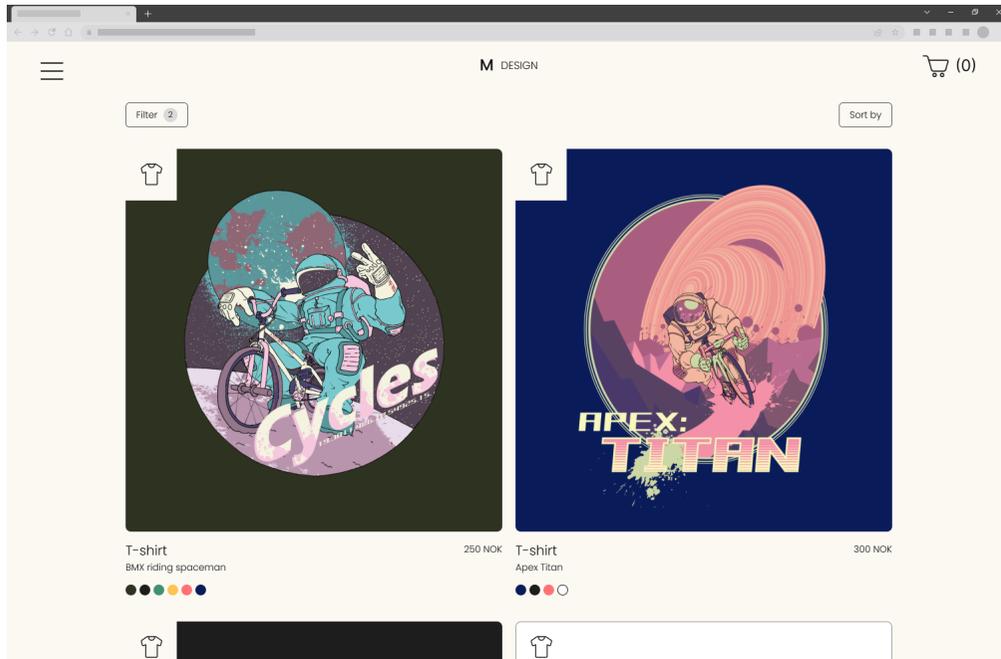
Experiment 1

# E-commerce Webshops

The project has investigated how an emerging brand could stand out, by designing their service to accommodate low digital emissions.

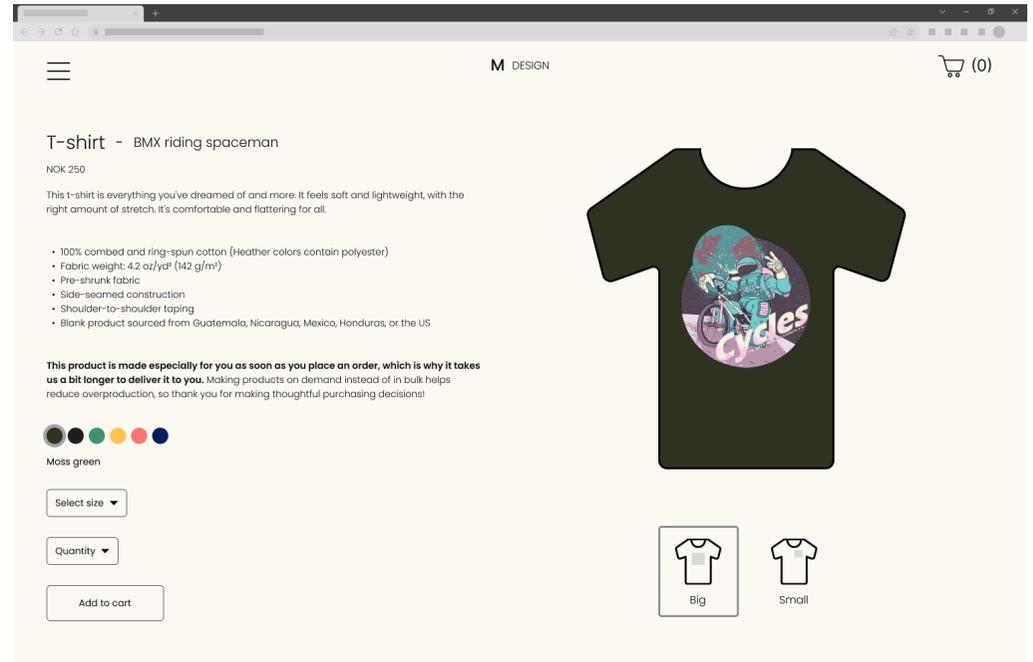
**Hypothesis**

Illustration weigh less than images. Can we design a functional online clothing store, which relies heavily on showcasing their products in high quality images, using only illustrations?



“A t-shirt is a T-shirt” Consumer picks the color and illustration.

Choose the placement of illustration on T-shirt.





Fershad Irani, developer and consultant for Green Web Foundation

Are illustration less heavy than images?  
*"Depends on the image or illustration, AVIF is usually the lightest but not always"*

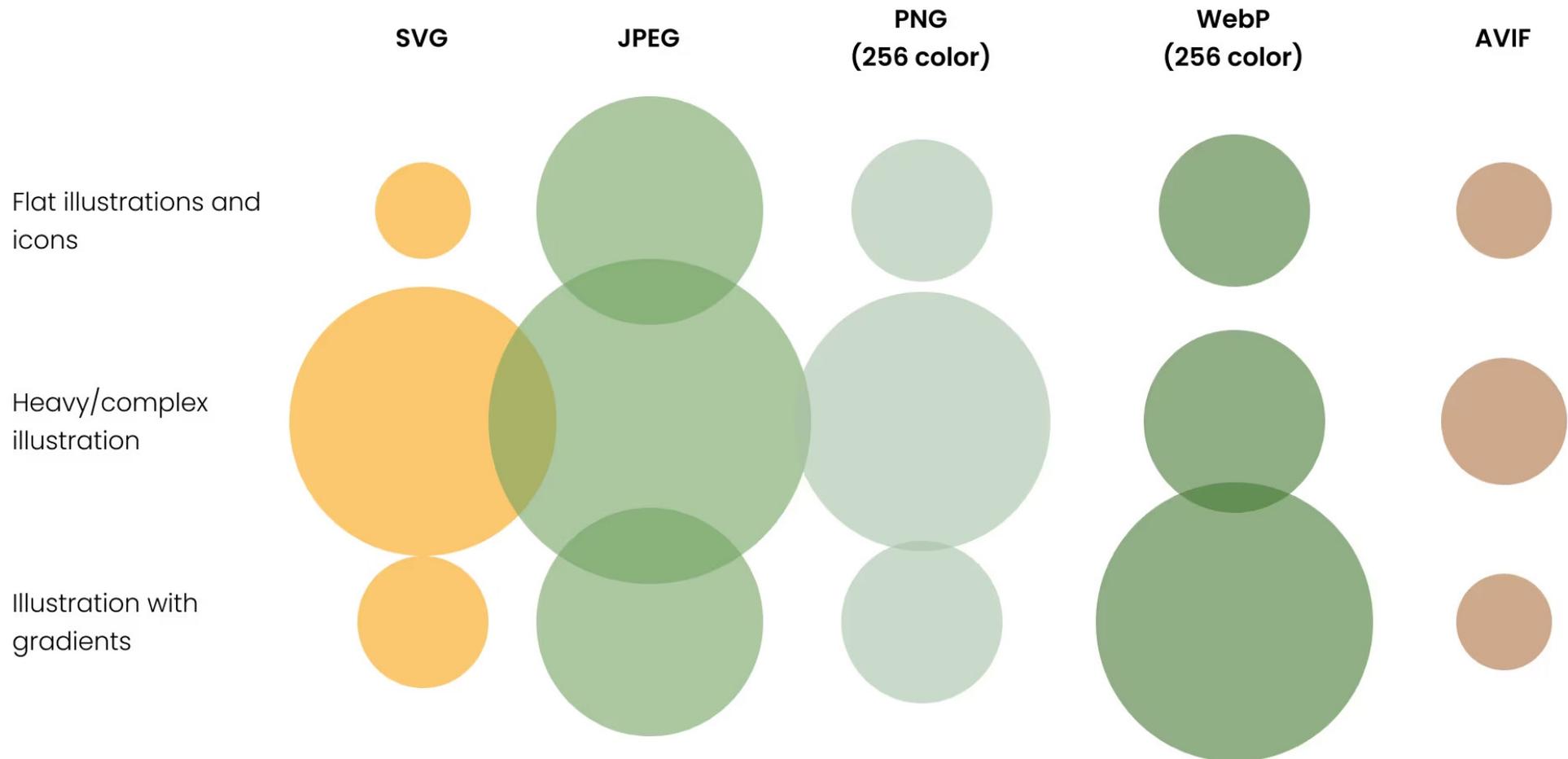
*"Are you guaranteeing that the financial performance will stay the same?"*



Rob Price, IT guru and founder of CDR

## Illustration optimization

Model based on a study made by Jake Archibald(Archibald) It shows that AVIF is the superior file format. All illustrations used in prototype(and this paper) has been compressed to AVIF. Though this will change in unique examples.



# MADE BY NATURE DESIGNED FOR THE STREETS

Shop clothing made with natural materials and explore sustainable products in need of embrace

Save our leftovers



We've succesfully climate compensated 78 pct of our clothing! With the help of local farmers and our 10 carbon commandments

[Found out how and what's next!](#)



- SHIRTS
- TANK TOPS
- HOODIES
- CAPS
- SHORTS

## Simple clothing ASTRONAUT COLLECTION

Get started



## Simple clothing ASTRONAUT COLLECTION

Get started



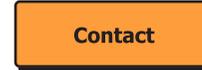
Apex Titan	3.312 kg CO <sub>2</sub>	Spacewhip	3.702 kg CO <sub>2</sub>	Space ADV	1.312 kg CO <sub>2</sub>
300 NOK		320 NOK		180 NOK	
250 NOK		275 NOK			

## OUR 10 CARBON COMMANDMENTS

We compiled best practices to make the meanest, leanest and keenest carbon mission for our brand

Discover how we did it

**A LOW IMPACT WEBSITE**  
only 0.48g of CO<sub>2</sub> is produced every time someone visits this web page



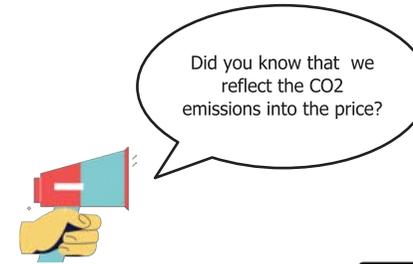
# SHOP



## ALL our products are designed with sustainability in mind

At natural fashion we believe in complete transparency in our products. That is why we've, besides creating a sustainable product journey, also created a green website for our products to be sold at.

[Discover here what that means.](#)



Astronaut collection ▾

▾ Filter



Apex Titan 3.312 kg CO<sub>2</sub>

300 NOK  
 250 NOK



Spacewhip 3.702 kg CO<sub>2</sub>

320 NOK  
 275 NOK



Space ADV 1.312 kg CO<sub>2</sub>

180 NOK



## Experiment 2

# Image hoarding Backing up the cloud

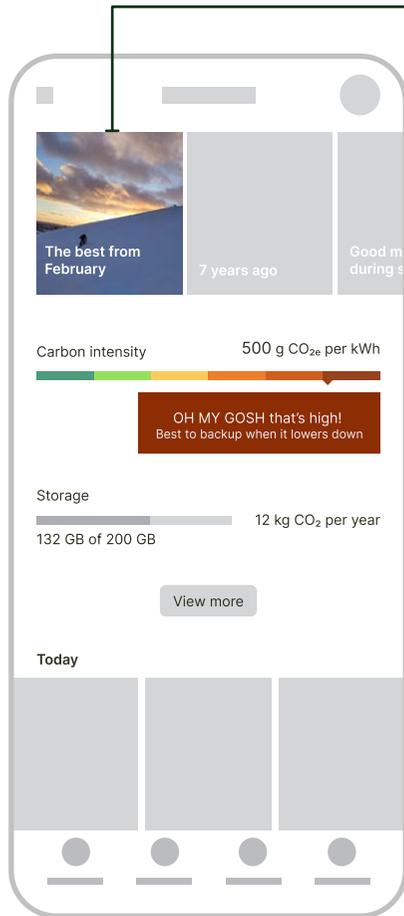
Back ups to the cloud are automatic processes that results in a mess of images and videos. The mess must be cleaned.

## Hypothesis

Cloud storage filled up with unnecessary images that passively demand energy. We need to clean it up as it is a waste of resources.

“Spend energy on the content that matters”

Conversation with Eivind Skogen



CO2 emissions of storage



Keep the good images

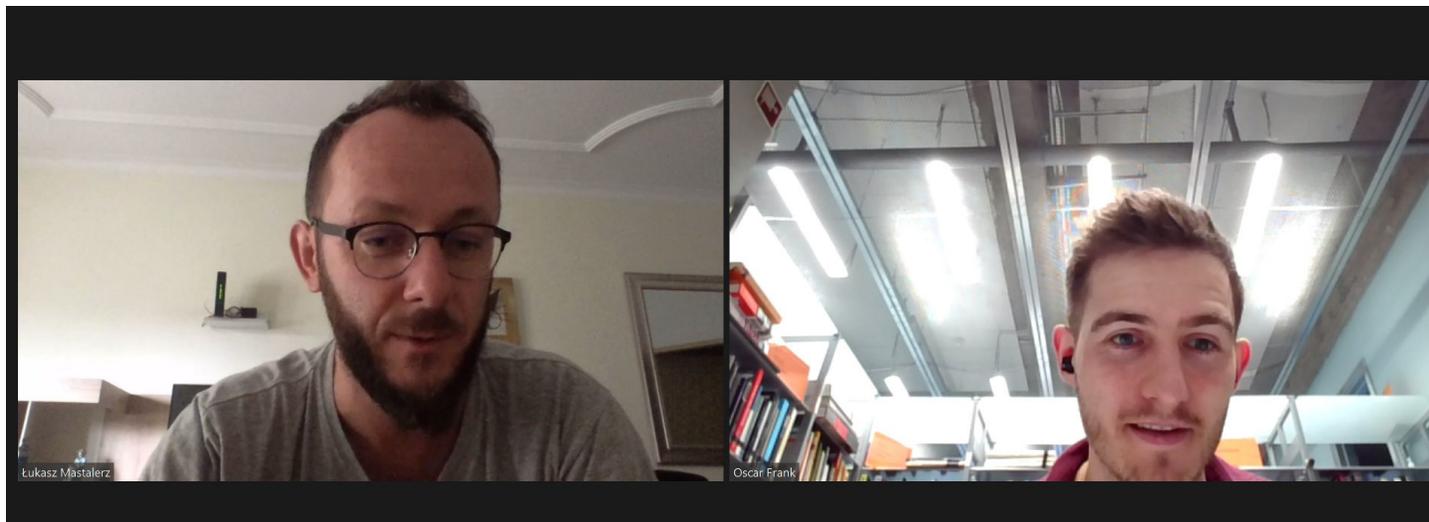


Delete the images you do not need



Remove duplicates, keep the good ones

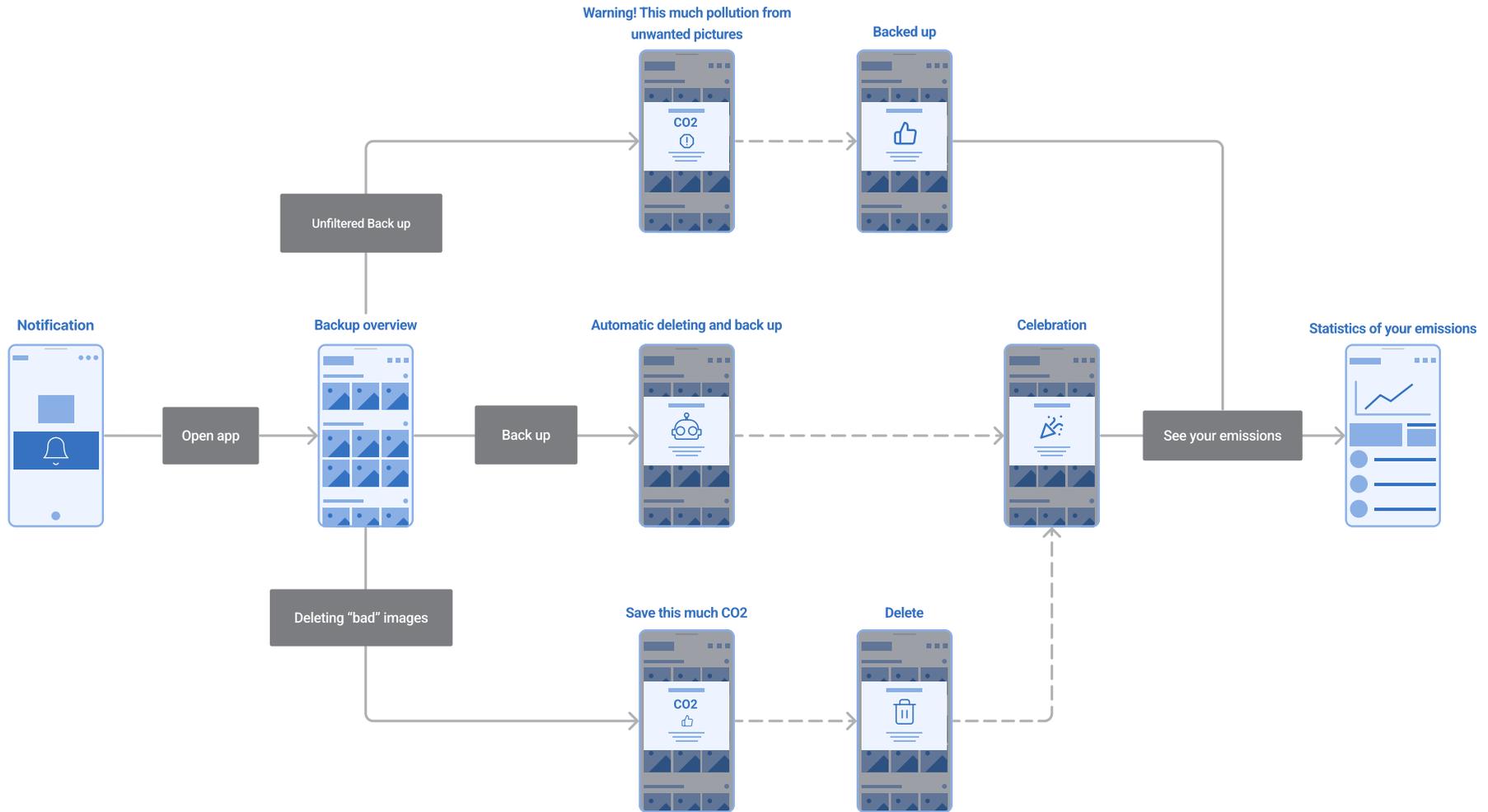
*“Most of the **energy usage comes from transferring to and from the cloud**, so it would be more interesting to avoid unnecessary uploads instead of deleting afterwards”*

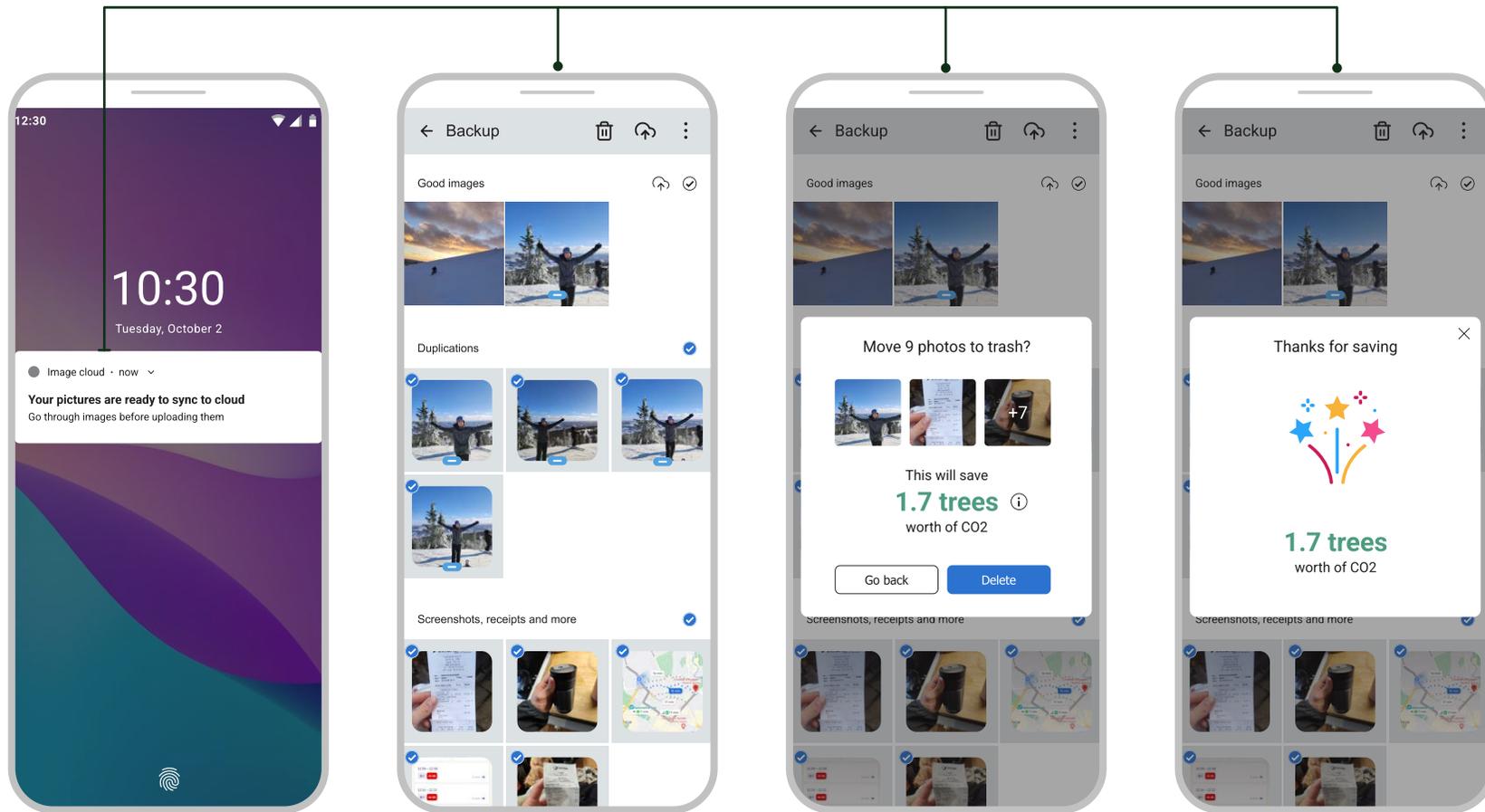


Łukasz Mastalerz, data architect and green software researcher

# Mapping user touchpoints

Instead of cleaning up the cloud, how might we reduce unnecessary uploads?





Notification

Automatically sorting the unnecessary images

"Save this many trees of CO2" - giving numbers context

Celebration

## Main takeaway

Most large cloud services, for private use, runs on renewable energy. Additionally they have become so efficient at storing data that the energy usage is very small. However when it comes to uploading or downloading from a cloud service then energy usage is much higher, due to it being spread out across the network and user device (Google) ("The Cloud"). If one were to avoid digital emissions from the cloud, it would be more effective to decrease the amount of data being transferred rather than stored.

Furthermore Ericsson claims one should mostly account for the energy of the client device, since network usage is fairly constant and is only set to rise in peak hours to accommodate expected demand (Malmodin and Lundén). Though decreasing data traffic is still relevant as lowering everyones data usage can lower the average network energy usage.

## Experiment 3

# Municipality websites

When looking to decrease digital emissions on the internet, it becomes interesting to investigate websites that serve many purposes and is run by many people. Because the result is often an overflow of information and a website that becomes a graveyard of old data.

I have experience working at Asker municipality which gave me insight into how they run their website, I have seen the tremendous job they have done to increase the UX experience and decrease digital emissions of their website.

### Design case

Citizens using Askers website mostly uses the chatbot Kommune-Kari instead of navigating the website, according to Øyvind Moen, the lead web editor at Asker municipality. In a conversation with him he explained how Kommune-Kari works much like a duplication of the website and therefore almost doubles the energy usage when used.

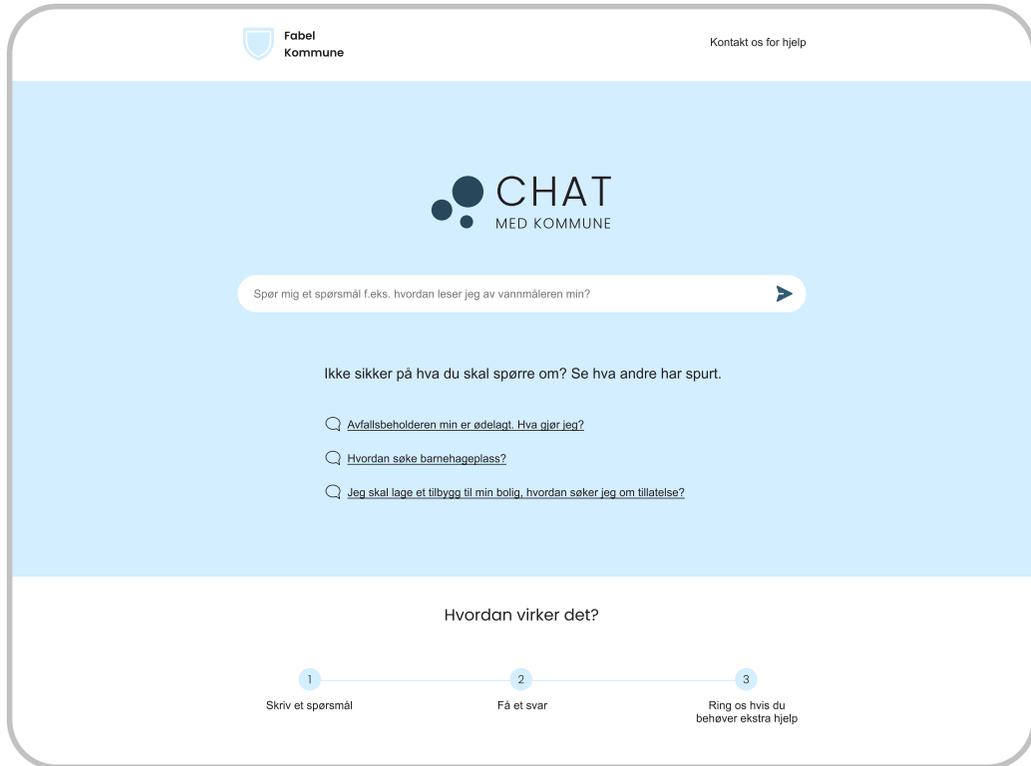
If we want to decrease the energy usage of a website we must lower the clicks and content of pages. If we made municipalities main feature a chatbot could we then lower its digital emissions because it would only be a chat interface?



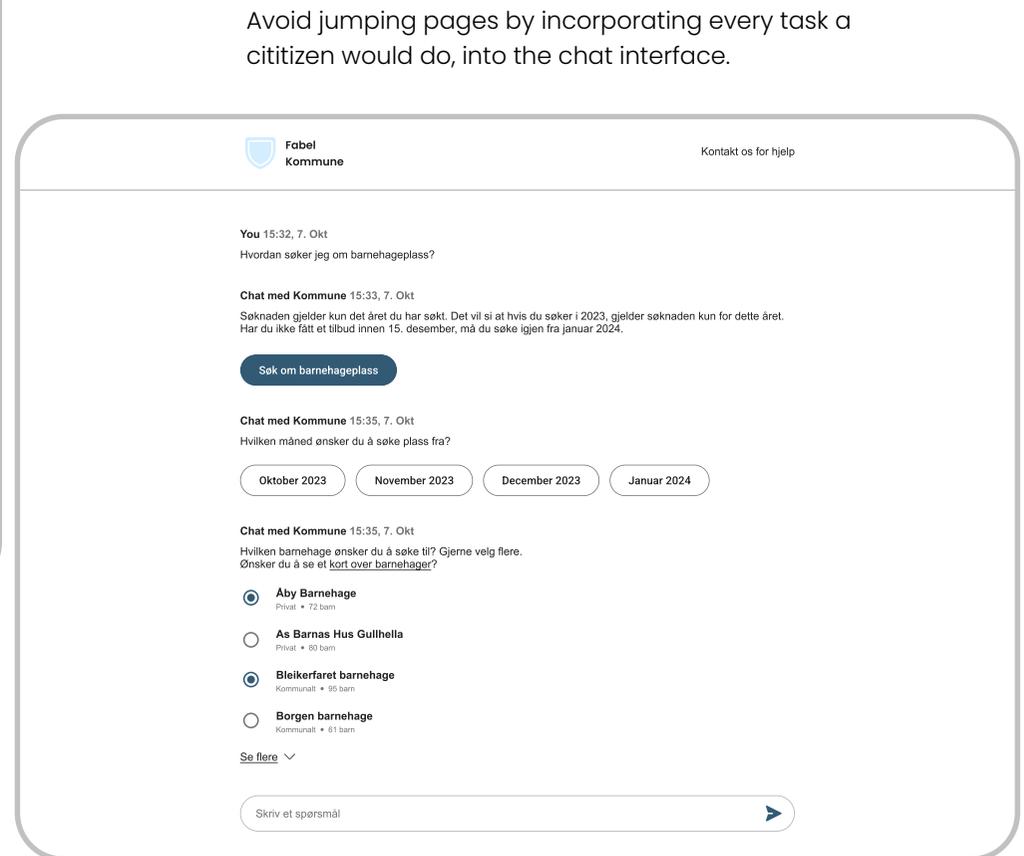
### Kommune-Kari

Chatbot designed for municipality websites.

Will answer all questions municipality related.



Municipality website front page. intelligent chatbot(or LLM). Answers all questions related to the local municipality and national topics of interest.



Avoid jumping pages by incorporating every task a citizen would do, into the chat interface.

## Findings

- Kommune-Kari is the citizens preferred navigation
- The chatbot is great as a system but demands a large administrative work
- Kommune-Kari is a copy of the website. Meaning when you use the chatbot, you use double the energy necessary.

## Reflection

The chatbot is great for making a more convenient website. But for lowering digital emissions it is quite the opposite. Current chatbot uses double the energy needed versus a normal navigation or a google search.

Another source claims that if one looks at ChatGPT, we see that a search query consumes the same energy as a 5W LED bulb running for 1hr and 20min. Versus a google search which is 3min (Zodhya).

The source is questionable as it calculates feeding the machine and simplifies a few things. But goes to show that for effective use of a chatbot, we would need to optimize their energy usage.

The screenshot displays the Asker kommune website. At the top, there is a navigation menu and a search bar with the text "Jeg leter etter...". Below the search bar is a grid of service categories, each with an icon and a brief description:

- Vaksining**: Koronavirusvaksining, oppfriskningsdoser og influensavaksining.
- Samfunnsutvikling i Asker**: Stedsutvikling, strategiske planer, byggeprosjekter, folkehelse.
- Plan, bygg og eiendom**: Kommuneplan, arealplaner, byggesak, insyn, dataesk, kart, oppmåling, seksjonering, brannvern.
- Barn, unge og familie**: Hjelp, rådgivning og støtte til barn, unge og familier. Barnevern, Barne- og familietjenesten, helsestasjoner, foster hjem.
- Barnehage**: Oversikt barnehager, søk plass, sammenlig barnehager, om opptak, Åpen barnehage, priser, informasjon til private barnehager, Biskudd.
- Skole og utdanning**: Felleinformasjon om Asker-skolen, Skoleskysa, Skolehelsetjenesten, permisjoner, skolerute, skoler og SFO, spesialundervisning m.m.
- Helse og omsorg**: Helse tjenester, omsorg, rehabilitering, demens, pårørendestøtte, tannhelse, rehabilitering, opptrening, bo- og omsorgssenter, psykisk helse.
- Bolig og sosiale tjenester**: Bostøtte, startlån, kommunale boliger, økonomisk rådgivning/zjeldrådgivning.
- Integrering, innvandrere og flyktninger**: Om integrering av innvandrere og flyktninger i Asker.

An inset window titled "Kommune-Kari" shows a chatbot interface with the following text:

For og smittesmittet før 01.01.2020 kan du bestille sporenebriva her.

Bestill sporenebriva

Du mottar besvret i din digitale postkasse (ev. følgende adresse) Regn med noe saksbehandlingstid.

Gjelder det perioden etter 01.01.2020, må du kontakte lederen din.

Skriv her, unngå personlig info

Conversation with Julie, the responsible for kommune-Kari in Asker municipality.

#### **Experiment 4**

## **Website ranking**

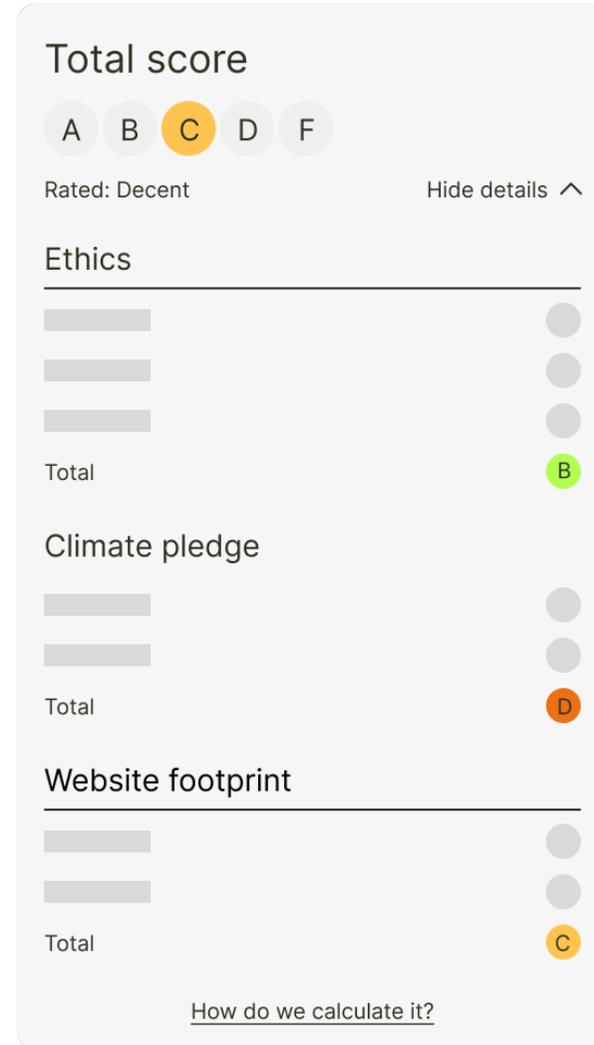
Earlier in the paper it was discovered that data traffic and website is constantly getting bigger. The increase in data consumption is unnecessary, and therefore we must look for ways to make it attractive for website owners to create less data heavy websites.

#### **Design case**

Might we make website owners more inclined to reduce the weight of their sites, by creating a system to rate websites based on how sustainable they are?

**Concept**

An online certificate that shows how ethical and sustainable their business is and the digital carbon footprint of their service. This concept is heavily inspired by the efforts of Ecosia and could be viewed as a further interpretation of their service.



### Findings

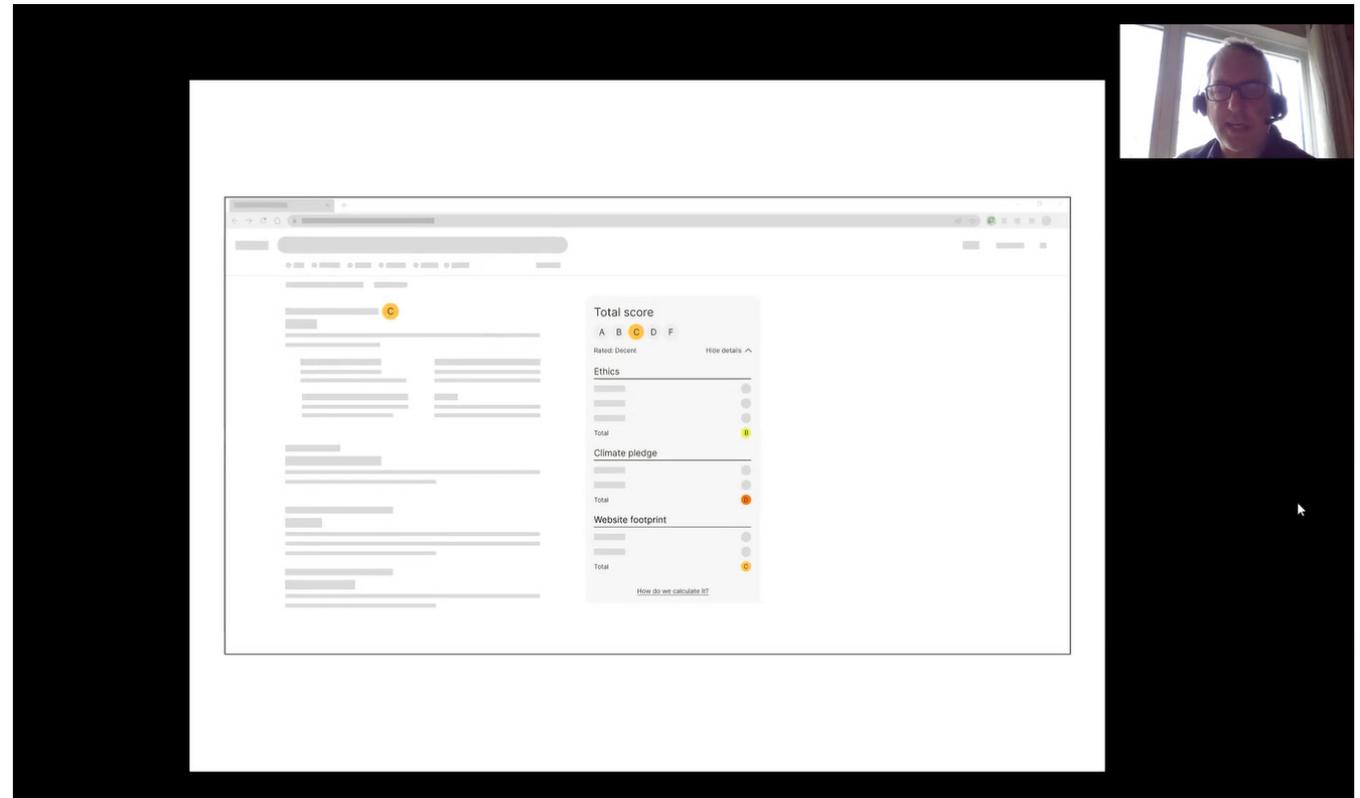
There is a potential to make this process automatic by utilizing existing grading systems like Ethics Answer or the website carbon calculator by Wholegrain digital.

Certificates have a potential to give the brand a competitional edge.

### Reflection

Having an online retail store that doesn't show images of models or of the clothes, might not be financially sustainable. But having official certificates to show costumers the sustainable actions they take, might be the edge needed to make the competitionally more attractive on the market. During this fall; Wholegrain Digital in collaboration with Mightybytes released a full rating system from A+ to F. (Digital)

This goes to show how the topic has momentum and will most likely become more common knowledge in the near future.



Screenshot from conversation with Rob Price

## Experiment 5

# Carbon report

“[Digital emissions] can get pretty nerdy and technical so finding ways to make it understandable to non-tech savvys would be very beneficial”

Conversation with Lukasz Mastalerz

### **Design scope**

Modern homeowners use apps by electrical companies to give an overview of their electric consumption. It helps people save on resources and their energy bill. The apps give people the necessary tools to lower their energy usage which often gets users engaged to buy products with a lower energy demand, which pushes product suppliers to create more sustainable solutions.

Can we make digital emissions understandable for users and engage them to want to lower their digital emissions, and as an effect, push website owners to create less polluting digital solutions?

Carbon report is an extension to a browser and can connect to multiple devices. A dashboard will give the user an overview of their digital emissions and let them know how to help push services to lower the carbon of their websites.



**Findings**

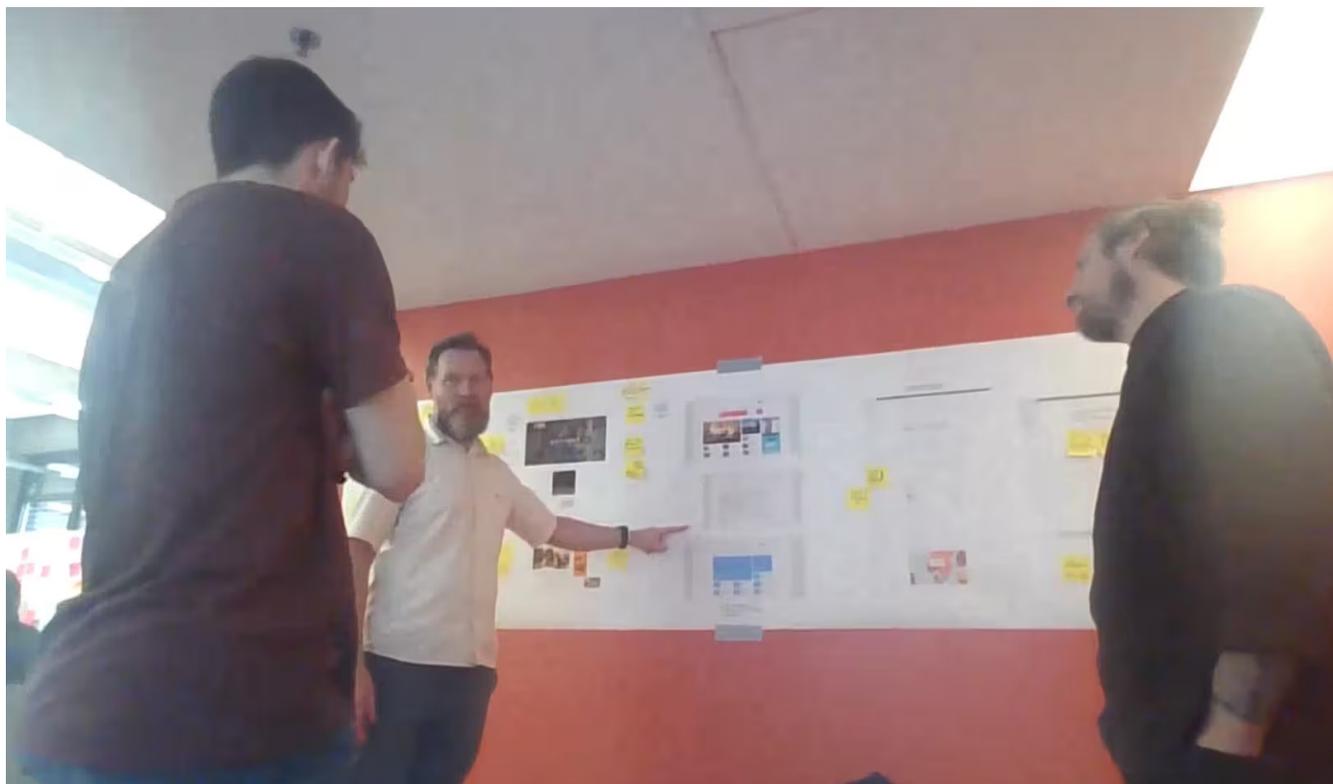
Greenifying the web will not be impactful enough to “save the world” but an important step to optimize our products.

There is currently not enough knowledge on digital emissions to fetch data on each persons usage. So the concept has to be placed within a future scope. Could be interesting to see the breakdown of user device energy usage, this could be an opportunity to show the impact of the three factors of digital emissions(device, network and data center).

**Reflection from feedback**

The topic is still very undiscovered so even though it can be easy to think of what to measure, it will be very difficult to actually collect the data.

This whole idea is about visualizing the invisible, but also has potential to visualize what we do not know.



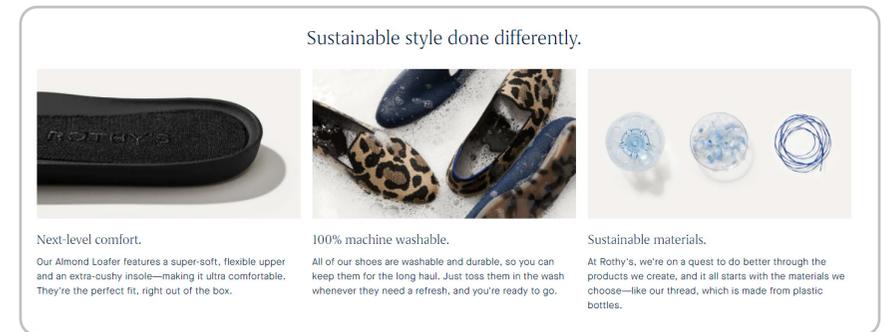
Screenshot from camera recording. Co-creating with senior developer Svale Fossåskaret and Eivind Skogen.

## Concern

I was concerned that user engagement for digital emissions would be difficult. As seen with any product designed for sustainability, it seems that people need to make an extra effort and therefore it is less attractive. Even though said people actually care about being pro-environmental. This is known as the value-action gap. (Decker, "We Can't Do It Ourselves")

# Testing existing services

In order to address the concern of a value-action gap. The project used current digital services that had similar attributes to the five scenarios. Testing was done with a variety of users between 25-60.



1. product labels. Does it affects purchases?

2. Sustainable brand story. Do consumers care?

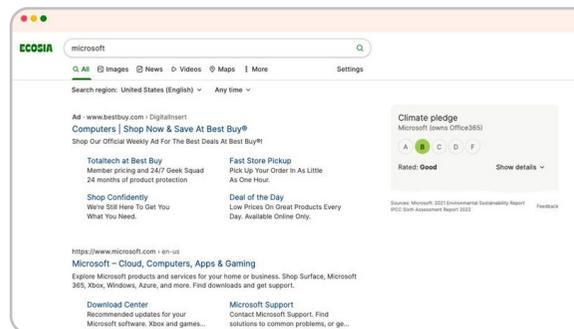
1. ("Oversigt over Produktmærkninger")

2. ("Black")

3. ("Greenwashing or Real Commitment? Introducing Our Climate Pledge Rating")

4. ("Veganmisjonen")

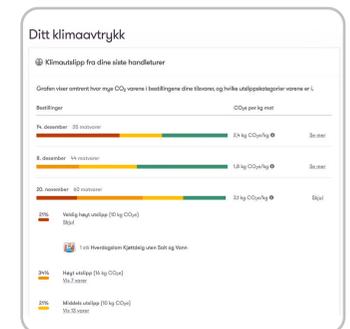
5. ("Klimaavtrykk for Matvarer – Bærekraft Hos Oda.com")



3. Ecosia. Search engine which rates companies climate pledge. Does it consumers choices?



4. low carbon label. Is this attractive for consumers?



5. Oda carbon report of consumers shopping. How does it affect future shopping habits?

## Takeaway

- Saving on energy in the household is the most common and understandable way of saving energy.
- People are split between buying items based on sustainability. It is seen that it is mostly young parents who care much about the "right" items.
- Money is the biggest motivator for saving on energy usage.

## Reflection

Most people are interested in being sustainable and often has a job or study where sustainability is a factor. But applying it to their daily lives is often experienced as being unmanageable. That being said, it was observed that every participant had a good deal of knowledge on sustainability. Meaning that even though they do not act sustainable in every aspect of their life. They still learn from services and products on how to do it.

So perhaps my concepts do not need to be successful in use engagement, but rather as a tool for visualizing and informing about digital emissions.



## Conclusion of chapter 2

- Images are a vital part of a website, but will fill most data if not careful. Always consider its value and compress to AVIF if used.
- Storing data is not an issue as first perceived (that is if you are storing on efficient and green servers like google). It is data transfer because its travel demands device and network energy.
- Engaging users to use the carbon report as an active tool is too optimistic. Better to use it as an informative tool used occasionally.

# Chapter 3

## An eco-conscious browser

This chapter will explore the final concept and conclude the process.



## Crossroad – Carbon counter and eco mode

In order to better inform users of digital emissions, I made an eco mode for browsers that would be connected to the carbon report. This symbiosis could potentially inspire people to want to be carbon-friendly online, which could push website owners to accommodate that need.



## Explaining eco mode

### It is a

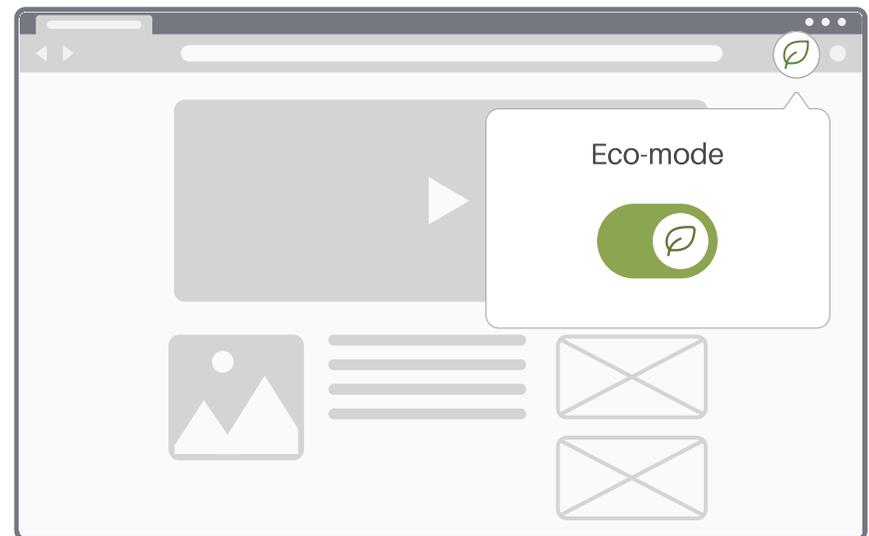
start to solving a complex problem, which is how to reduce the environmental footprint of all digital services. Eco mode for browsers is intended as a way to illuminate the invisible emissions of the web.

### It is for

The website owner and average web user, to understand what digital emissions are. It functions as a visual aid to see the changes needed to save energy.

### It is beneficial

To empower the average web user, so they gain control on their digital emissions, seeing as the only control they have today is abstinence. Furthermore it has proven to increase user experience for some websites.



## Inspiration

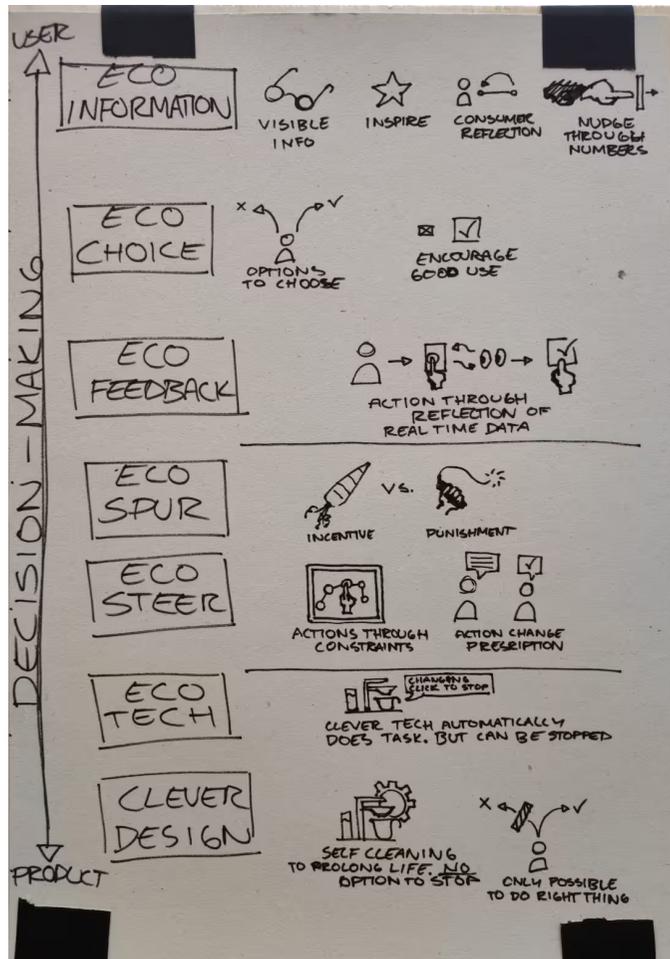
The idea of an eco mode is inspired from a workshop by Mozilla. They explain how an eco mode for Firefox might empower users and promote a more sustainable internet (“Firefox Eco-Mode Brainstorming: How Can the Internet Tackle the Climate Emergency”).

The way I have tackled it is by trying to engage users through empowerment and enlightenment. The eco mode being the power to control digital emissions and the carbon report, the light to shine on the pollution.

These next pages will explain the thought process behind the idea.



(“Archivo:Mozilla Logo.svg - Wikipedia, La Enciclopedia Libre”)

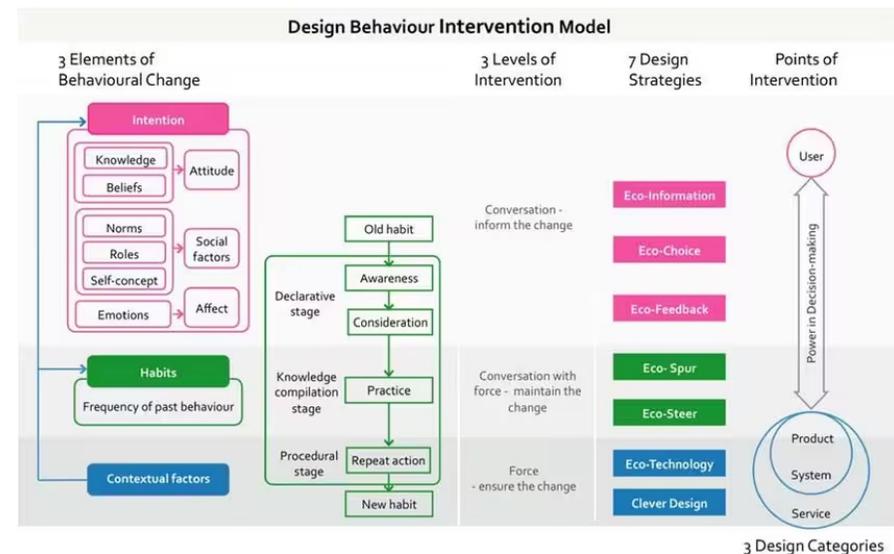


My interpretation of the 7 design strategies

## Design intervention

Behavioural design has been used as a best practice to design with engagement in mind. The model best suited for the project was the Design Behaviour Intervention model, due to it being about how to create pro-environmental choices in products.

The model is made with a physical product in mind, but much of the content is easily transferable to digital media. It was mostly used for inspiring new ideas.



Design Behaviour Intervention Model Diagram (Michie et al.)

# Designing dashboard VI

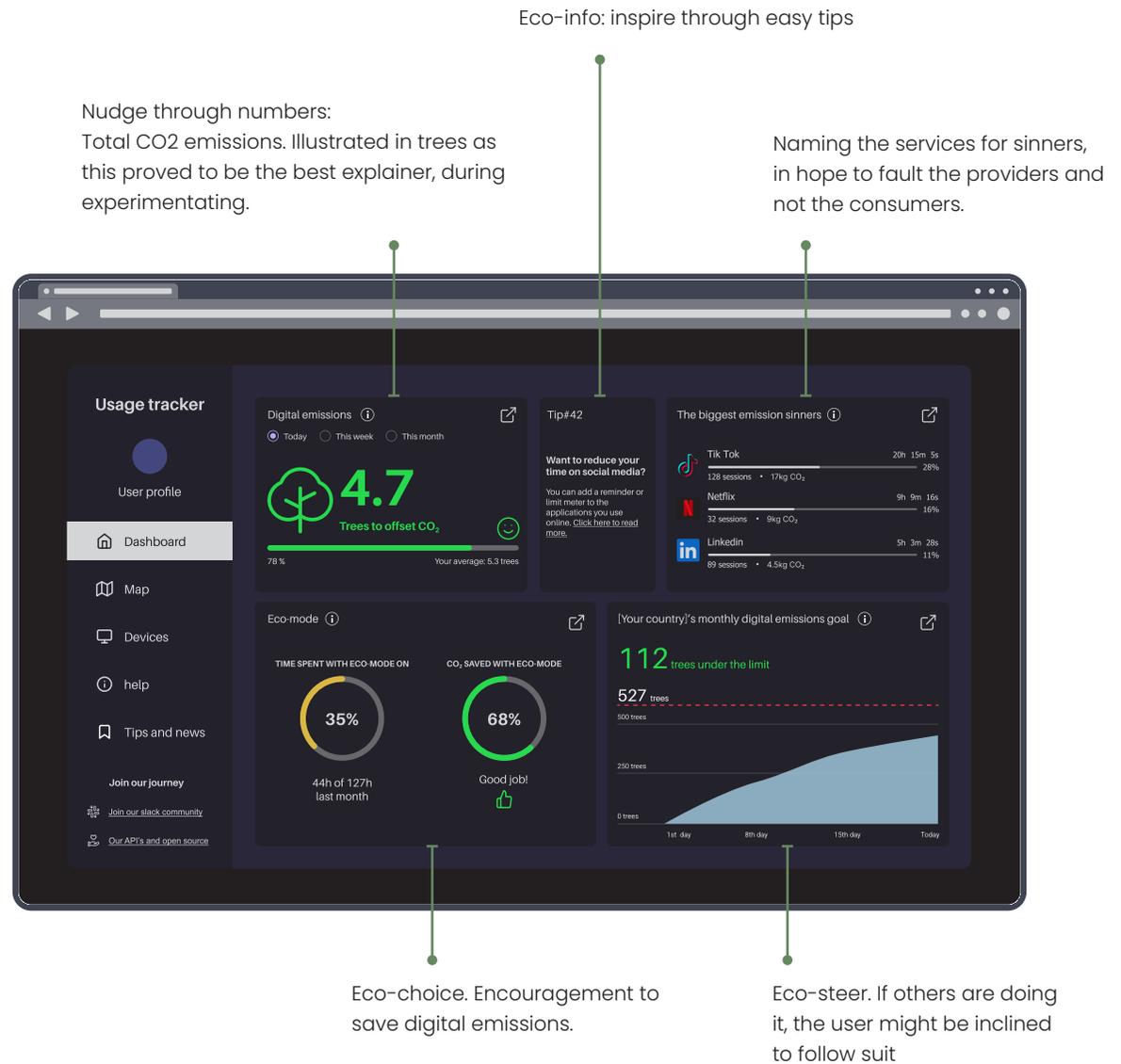
The dashboard is intended to be easy to understand and engage people to come back.

Though when asking friends in informal conversations, this is not the case of VI, as they would understand it through an explanation. But not as a stand alone dashboard.

## Does dark mode save energy?

It has been made in dark mode because I assumed this would be more energy efficient, though this is only true for OLED and AMOLED screens, not LCD. Additionally in some cases there is a rebound effect as some users increase brightness under dark mode. (Braun)

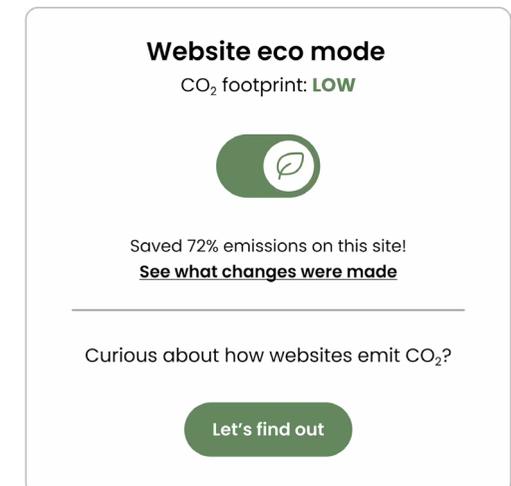
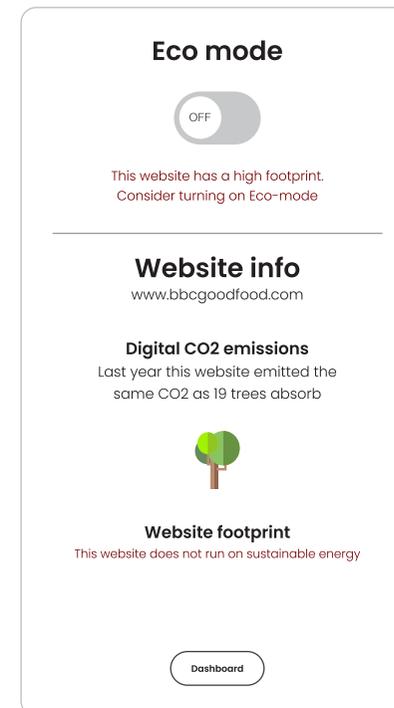
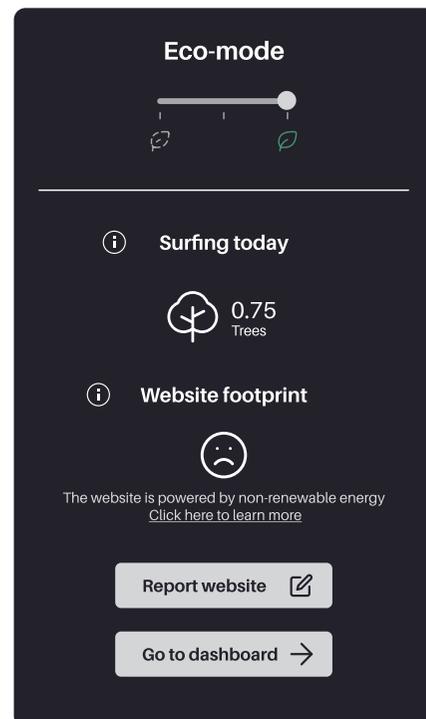
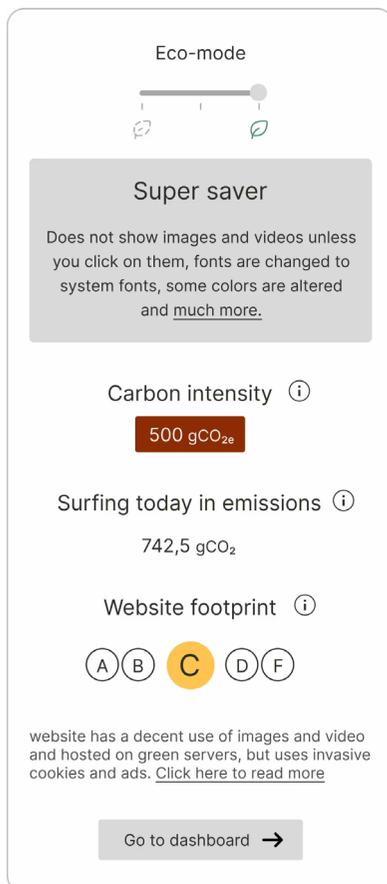
It was acknowledged after making the design, that dark mode should not be standard but rather the users choice and follow preset preferences.



## Designing Eco mode

Several design were made, each clearer than the other. The Design Behaviour Intervention model dictates that pro-environmental choices are often made when things are simplified.

Continous testing was done in informal interviews with fellow students and friends. And much like version 1 of the dashboard, the comments were often that it was not clear enough without an explanation. So the result is an eco mode with just enough information to make you want to try turning it on.



# Designing dashboard V2

Dark mode has been abandoned as this was concluded to best be a preference set by the user. Data has been boiled down to the most important.

Trees, car miles and household energy usage. Were among the most familiar contexts when testing existing services.

Most important number has been highlighted

Option to change into "enthusiast" mode, to see more data.

**Digital carbon emissions**  
**88.2 kg of CO2**

**4.2 trees**  
It's roughly the same amount of carbon that 4.2 trees absorb in a year.

**169.3 km**  
It's equivalent to driving a petrol car 169.3 km.

**1.1 Apt.**  
It's the same as heating 1.1 apartments in Oslo for a month.

**Your emission sinners**

Category	Percentage
Social media	42%
Messaging	14%
Entertainment	31%
Shopping	3%
Other	10%

**Social media platforms**

Platform	Percentage of emissions
Tik Tok	38%

**Norways' monthly digital emissions**

Time Period	Emissions (kg of CO2)
Start of Aug	~1000
1st week	~1500
2nd week	~2500
3rd week	~3500
End of Aug	~4000

Digital emissions sinner have been categorized into most common type of websites

See your countries digital emissions and compare it with others.

## Visit to Netlife

I participated in Netlife's weekly "Pils & Proto" which is an arena for showcasing ideas and receiving feedback from a variety of developers, designers, content managers and others. This was an opportunity to test my concepts in a crowd of experts.

### Takeaway

- It is unnecessary for the average person to know their digital emissions.
- The dashboard should be considered in other contexts as it is not believed to be possible to create enough engagement with users.
- Eco mode works well as a tool to show clients easy steps to improve website.

### Reflection

Many participants knew of digital emissions from before, but explaining them my process and concepts managed to make them aware of new challenges and opportunities. The format invited people to drink, which helped ease tensions and proved to be an ally when discussing a heavy topic such as sustainability and IT.



## Dashboard in another context

As mentioned earlier, I have worked in Asker municipality. I realized that an asset management system for their digital products and service could prove useful for them, as they are working to make digital emissions known to politicians and decision makers (mentioned on page 26).

The digital asset management system could become a standard in municipality and large businesses.



Made with Askers logo, so that testing it as their system is more apparent.

## A need for a digital asset management system?

Testing idea with digital consultant i Asker municipality  
Sophus Aarnæs agreed that such a system is very beneficial to them.

### Ideas for further development:

- Need an easy way to find the “sinners” like duplicated files and old unused documents.
- Should have an option to print out a report on the CO2 emissions. One that could be shown to politicians and in the case if digital emissions becomes a law to disclose.

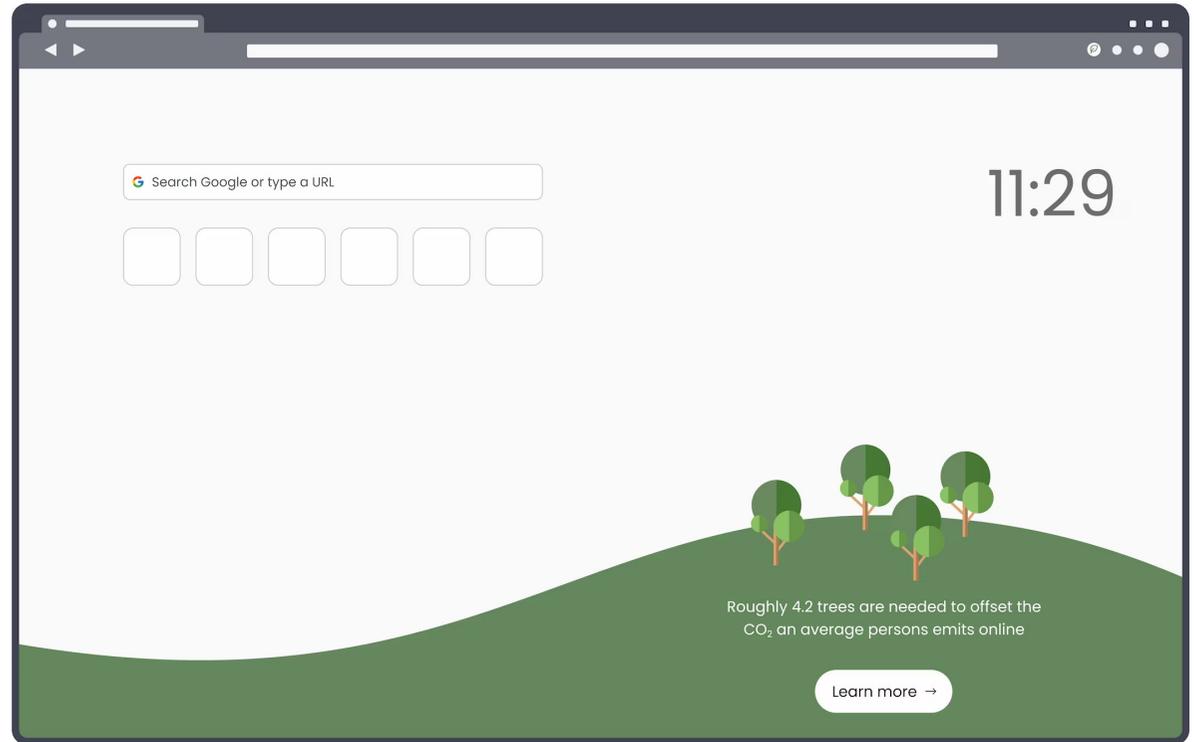


Screenshot of conversation with sophus Aarnæs

## Decoupling Eco mode from dashboard

The dashboard has proven from testing with users and experts that it is not valuable. However we might consider using the data in a smaller setting.

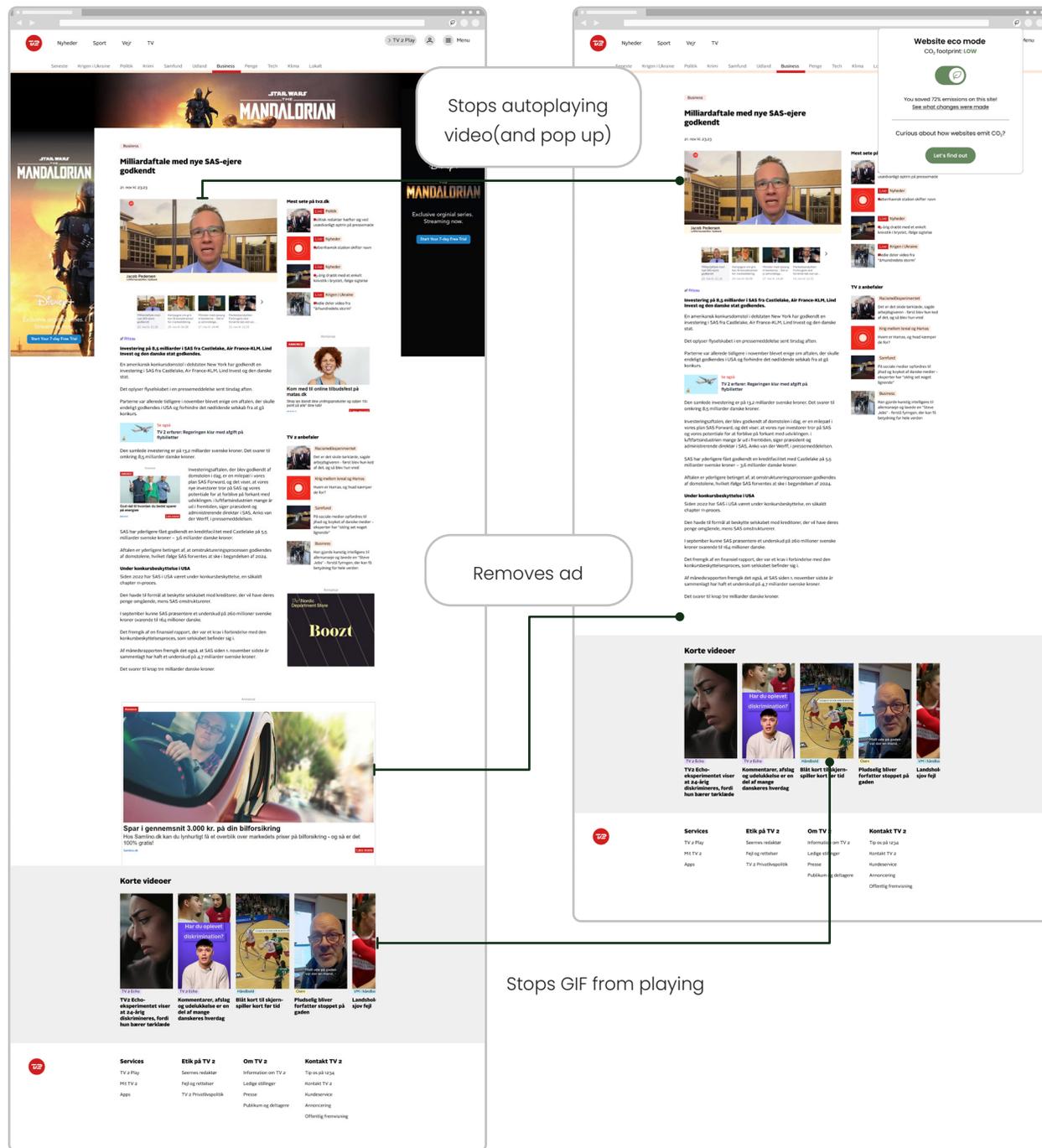
Eco mode could be installed with a dedicated homepage which will show fun facts about sustainability and the internet.



Browser homepage. The fact is made up, but not far from the truth

# Example

through informal conversations about digital emissions, it was often mentioned how videos popping up and media moving in the background is the most annoying experience when going into a site. This example shows the danish TV2 before and after eco mode. The result is a much cleaner and digestible format. This was done to create a scenario where eco mode is not only good for the environment, but also the user experience.



# Example

This time showing an example looking for recipes. A common and tedious task when bombarded with ads.

## Reflection on removing ads

Many of the experts I have spoken with are concerned about removing ads. Because the internet runs on it. The worry is that I am removing the economic benefit of making free services. My answer is that eco mode is a tool to show polluting elements and ads are on the top. Not only do they often consist of autoplaying videos or GIF's but they also push people to buy unnecessary stuff. Increasing indirect ICT emissions. Perhaps the internet should not have to run on ads? I do not have the answer but I wish to empower users with the choice.

The screenshot shows the Good Food website interface for the recipe 'Easy paella'. The page is annotated with several callouts:

- Removes GIF ad:** Points to a BOMBAS socks advertisement at the top of the page.
- No autoplay:** Points to a video player for 'How To Make Easy Paella' which has a play button overlay.
- Removed GIF ads and pop up ads:** Points to several advertisements including a Tide detergent ad, a Starbucks 'SIP SIP GO' ad, and a 50% off shoe sale ad.

The recipe details include:

- Easy paella** by Jane Horley, 164 ratings, 65 comments.
- Prep:** 10 mins, **Cook:** 30 mins, **Easy**, **Serves 4**.
- Nutrition per serving:**

	kcal	fat	saturates	carbs	sugars	fibre	protein	salt
	431	5g	1g	66g	5g	3g	34g	2.1g
- Ingredients:** 1 tbsp olive oil, 1 onion, 1 tsp each hot smoked paprika and dried thyme, 300g paella or risotto rice, 3 tbsp dry sherry or white wine, 400g can chopped tomatoes with garlic, 900ml chicken stock, 400g frozen seafood mix, 1 lemon, 1/2 juiced, 1/2 cut into wedges, handful of flat-leaf parsley, roughly chopped.
- Method:** STEP 1: Heat the olive oil in a large frying pan or wok. Add the onion and saute for 5 mins. STEP 2: Add the smoked paprika, thyme and paella rice, stir for 1 min, then splash in the sherry. If using, Once evaporated, stir in the chopped tomatoes and chicken stock. STEP 3: Season and cook, uncovered, for about 15 mins, stirring now and again until the rice is almost tender and still surrounded with some liquid. STEP 4: Stir in the seafood mix and cover with a lid. Simmer for 5 mins, or until the seafood is cooked through and the rice is tender. Squeeze over the lemon juice, scatter over the parsley and serve with the lemon wedges.

# Eco mode effects

The changes made by eco mode are as following:

- Remove ads
- Change to a web-safe font
- Change images to next gen formats like AVIF or Webp.P will be cached to save energy on next visit.
- Videos and GIF do not autoplay and caps video resolution
- Blocks unwelcome cookies

The changes are quite small considering the many possibilities to change websites. But the point is to show quick and easy changes that can save a lot of loading time and emissions.

The user is also shown a “click-to-learn-more” slide which is intended to send them to a site with best practice guidelines.

### Removed ads



Ads can be quite energy-intensive for websites to run and might interrupt the users experience of the website. Additionally they can slow down loading speeds, especially GIF's and auto playing videos. Which are among the most energy-intensive. Ads on websites are not welcome if they make tasks impossible or unnecessarily tedious.

[Our top tooltips for sustainable usage of ads](#)

1 of 6 >



## Validating eco mode

Tested positive that eco mode is a clear and understandable concept. Some noted that they honestly do not think they would use eco mode but think it is interesting enough as a concept.

Would like to see eco mode as a normal part of browsers, rather than as an extension you must now about before downloading.

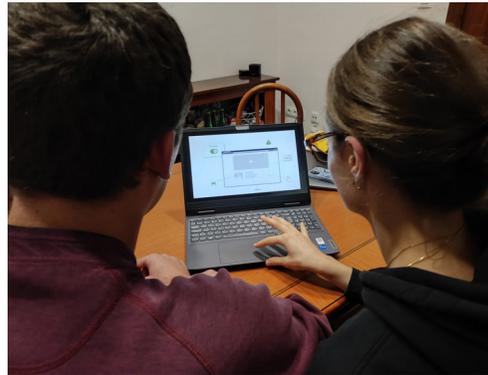
Illustrations worked well to explaining the changes to a site. But should add the positive effects of the change as well

### Reflection

Tests and interviews with couple prove to be very effective as participants will keep each other honest and conversation runs more smoothly and less like a series of questions.

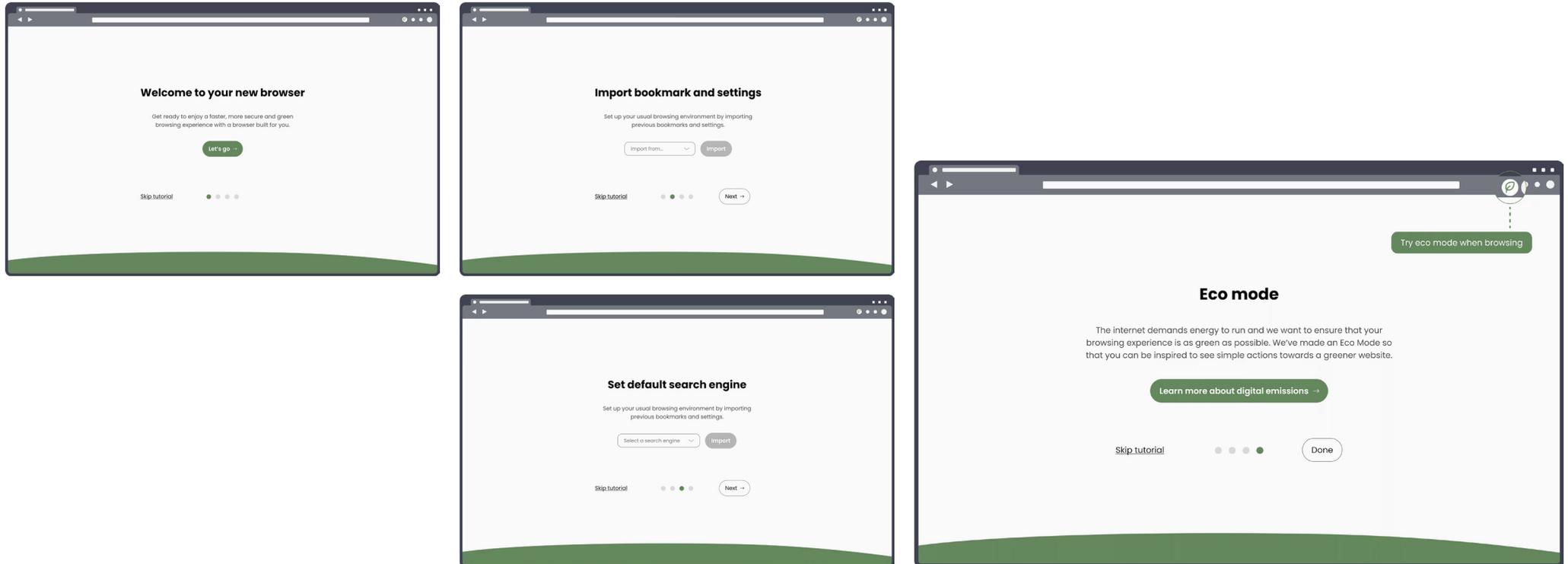
Eco mode proves to be a good tool to shine a light on what digital emissions are and even if it was just used once, the idea would stick with participants.

Eco mode as an extension makes it difficult to actually inform people about the service, but as a participant mentioned, having it be an integral part of a browser could prove to be a good solution.



# An eco-conscious browser

The future versions could be to investigate how eco mode could be an integral part of a browser. Mozilla Firefox did come up with the idea about an eco mode so perhaps they could work as drivers for bringing it to light. further iterations would also have to support more tips and guidelines on how to design for low emissions, as this has been a neglected part in the project. Additionally eco mode must be tested on a browser.



## Conclusion

Through the project I have investigated what digital emissions are, experimented on how to work with them as a designer and explored how to inform people about them. The result is the knowledge acquired from experts and the prototype of an eco mode for browsers. Designing with digital emissions in mind proved to be a fun experience as it opened up conversations with people who burn for creating a sustainable internet. During the last months of this project, the Norwegian news channel NRK had posted a few articles about the pollution of websites. This sparked new conversations with people I know. Spreading the news is the first step and it seems that this is happening with or without an eco mode. But I am certain that an eco mode could help push it even further. Because it will give a direct feedback on what surfing the internet could be like, without unnecessary filling. That being said it is important to remember that the concept is not intended to be used as a new way to be online, but rather a push to get website owners started on making websites with fewer emissions.

## Personal reflection

My personal goal was to learn more about digital emissions and that is the case. Looking back now there is a few things I would have done differently, for example I would have pushed to make the eco mode a functional prototype by coding a simple browser extension and I would have tested more with users as my project lacked a steady stream of user insights. But the result is something I can say challenged me and evolved me as an interaction designer.



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