

Royal Holloway Materialities of Media

From Refuse to Refusal:

A media ecology of digital waste



[Tim Cowlishaw / 3rd year \(part time\) / BAU Centre Universitari d'Arts i Disseny / PRS Europe May 2023](#)

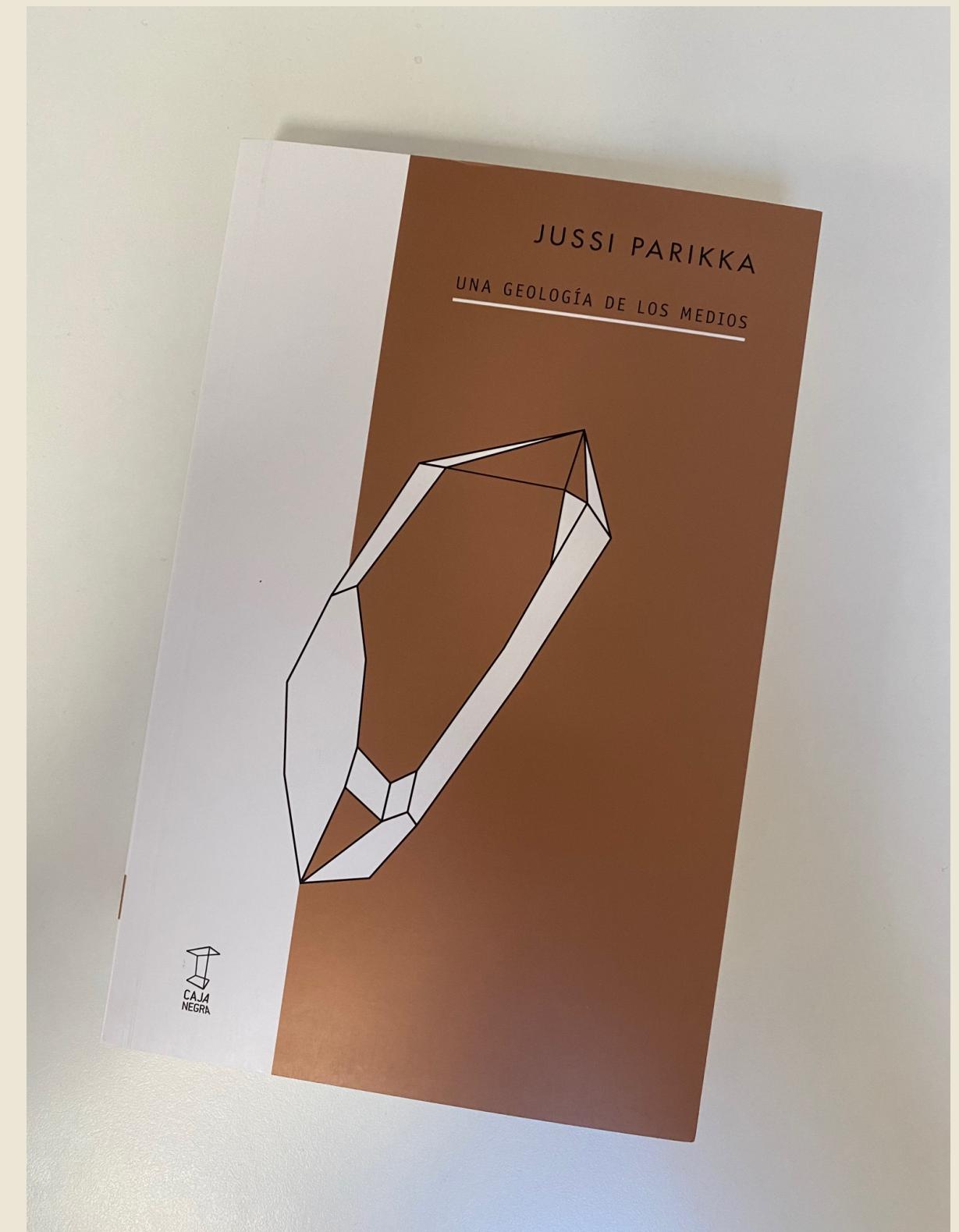
"The Cloud" and the environment

Critical Studies of the Cloud

The idea for this project – [Critical Studies of the Cloud](#) – emerges from Dr. [Mél Hogan](#)'s (University of Calgary) decades long research into 'the cloud', and the belief that the field has not yet fully grappled with the intervention **artists** have made, and are making, via the **data center** – as object, cultural image, sociotechnical imaginary, site, metaphor, and concept – alongside all the other material manifestations of the internet.

The collection/compilation on this site is ongoing (and updated it fits and starts). The artworks are presented in no particular order – just as the come in. The point of sharing this collection is simply to make transparent some of the art referenced in various academic research writing projects over the years – it is not a definitive or comprehensive list, nor a statement as to who or what counts as "data center art" or "critical studies of the cloud". I hope it's useful to others!

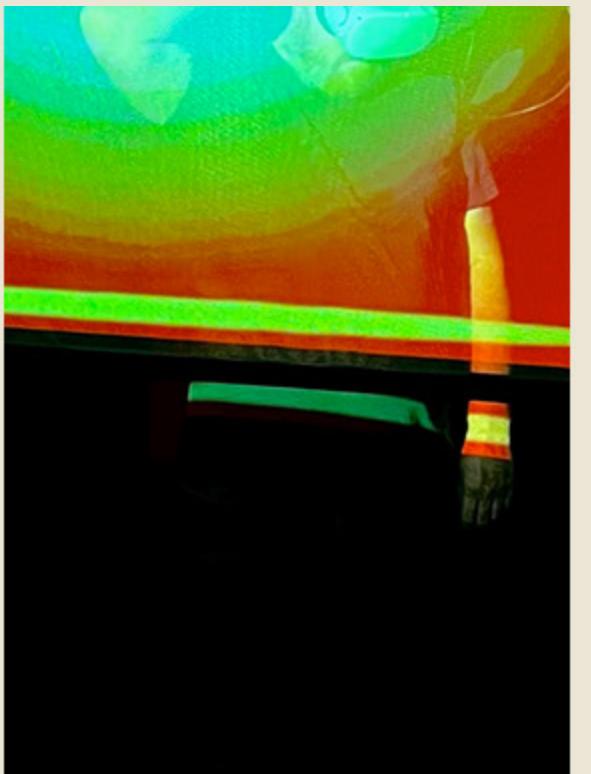
In 2020, the [Environmental Media Lab \(EML\)](#) interviewed 10 artists about their work investigating the data center. Interviews were led by [Crystal Chokshi](#), Associate Director of the [EML](#), and [CMF](#) doctoral student



Research Questions:

- On what material resources (be it energy, physical materials, or labour) does the accumulation of digital waste depend?
- What part does my practice as both an interaction designer and computer user play in contributing to the material impact of digital media?
- **(Can this impact be mitigated through my research, and reflective practice?)**

My 'practice':



Structured search - Find case law

ALPHA This is a new service – your **feedback** will help us to improve it.

You are in: [Find case law](#) > Structured search



Structured search

[How to search](#)

Search

Neutral citation

For example [2021] EWCA Crim 1785

Containing specific keywords

From specific courts or tribunals

- United Kingdom Supreme Court
- Court of Appeal Civil Division
- Administrative Court
- Chancery Division of the High Court
- Senior Courts Costs Office
- Intellectual Property Enterprise Court
- Patents Court
- Technology and Construction Court
- Family Court

- Privy Council
- Court of Appeal Criminal Division
- Admiralty Court
- Commercial Court
- Family Division of the High Court
- Mercantile Court
- King's / Queen's Bench Division of the High Court
- Court of Protection
- Upper Tribunal Immigration and Asylum Chamber



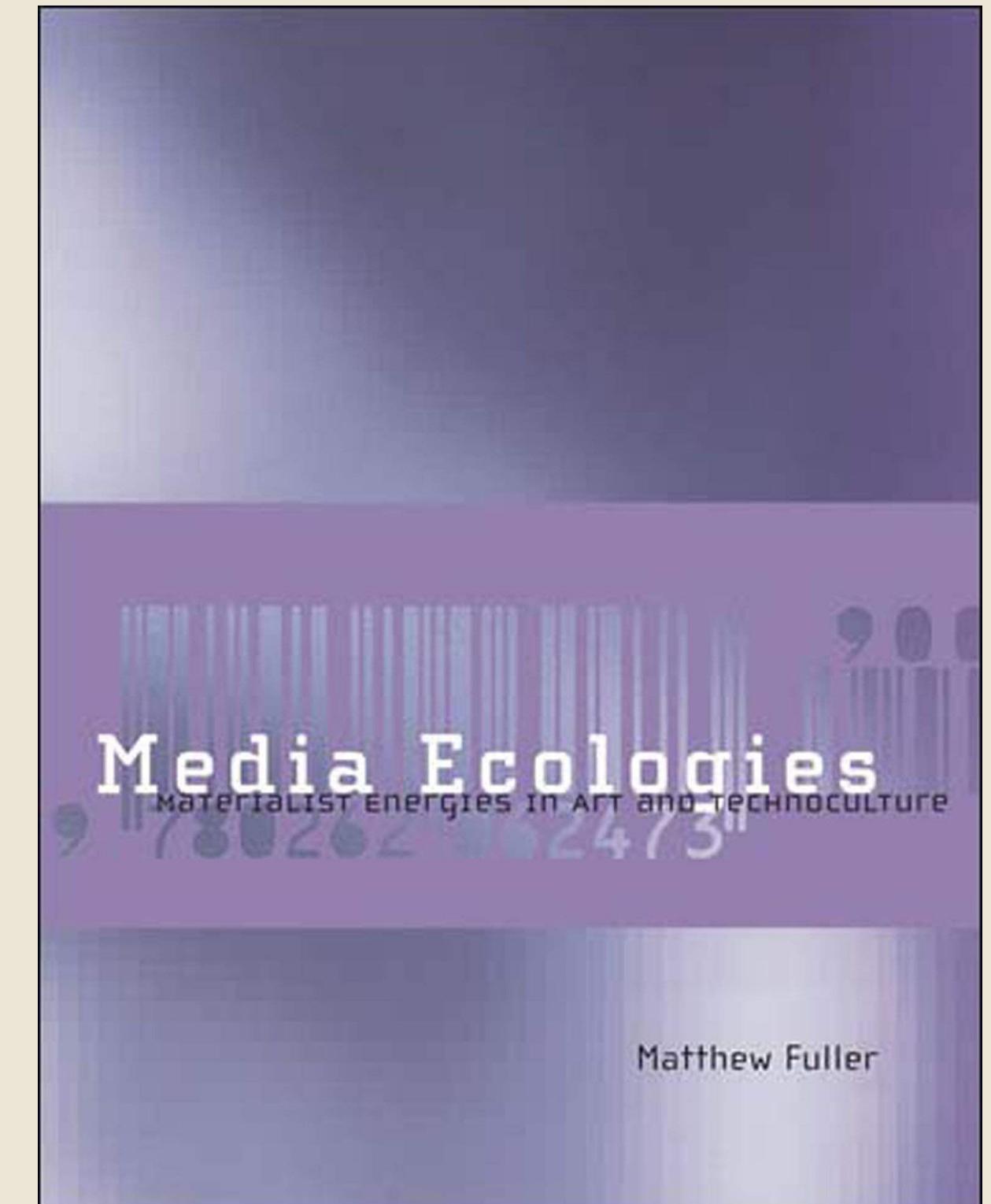
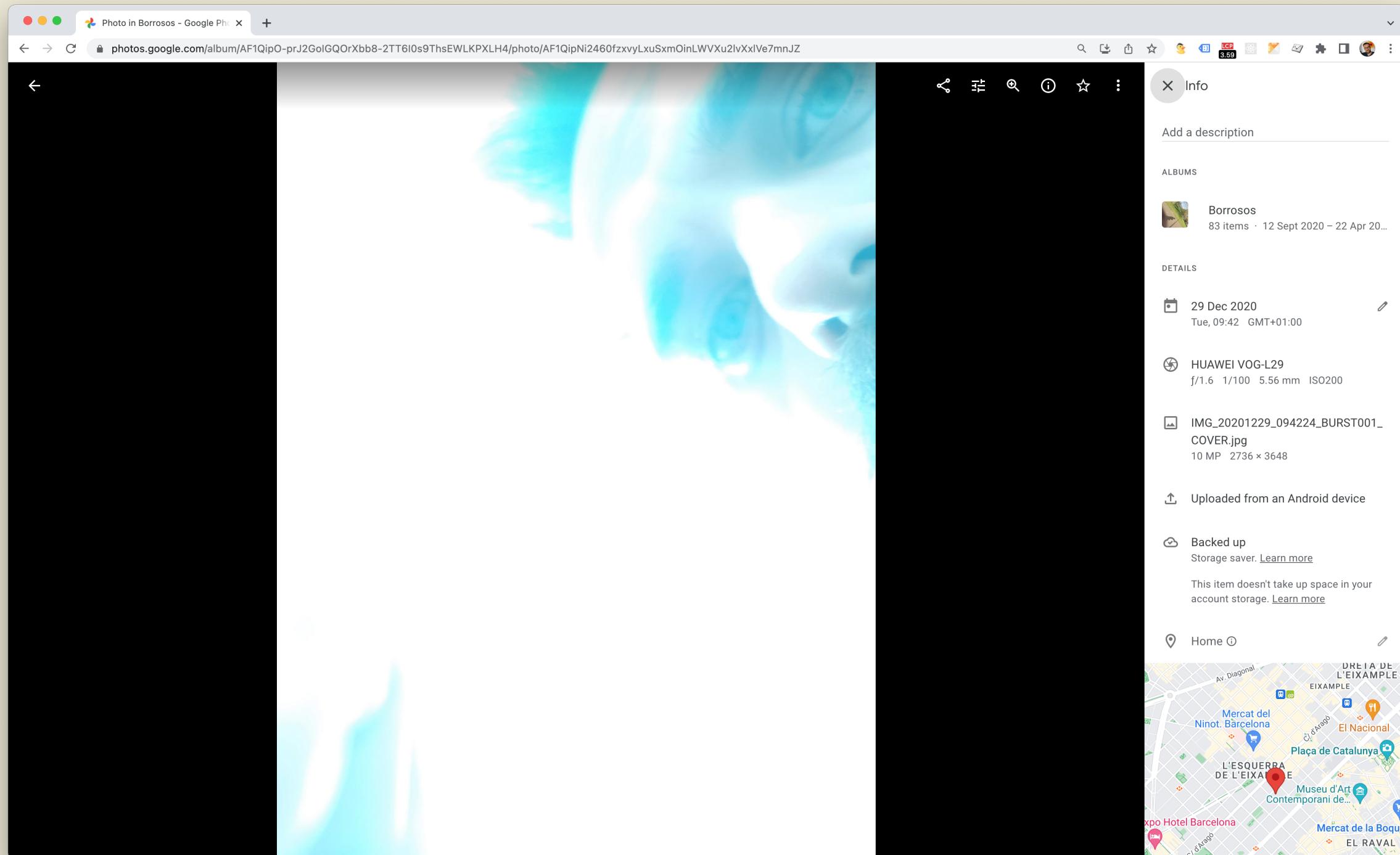
The screenshot shows the homepage of the parla app. At the top, there's a navigation bar with icons for search, refresh, and other browser functions. The address bar shows the URL https://app.myparla.com. Below the header, the word "parla" is written in a large, lowercase, sans-serif font. A quote is displayed: "Although it is not always clear, I trust that I am on the right path to reach my dreams." To the right of the quote is a red button labeled "Journal". Below the quote are three white rectangular boxes with orange icons: "Chat" (two speech bubbles), "News" (a newsfeed icon), and "Experts" (a person icon). To the left of these boxes is a large, semi-transparent orange circle. Below this section is a horizontal line with the text "MEDITATIONS" above it. There are four small images with corresponding labels: "Meditations: Positivity" (yellow flowers), "Meditations: Relaxation" (a close-up of a plant), "Gratitude and self love" (a single red leaf), and "Meditations: Letting go" (a woman with a headscarf). To the right of these images is an orange button labeled "Explore all >". Below this is another horizontal line with the text "HEALTH GUIDES" above it. There are three small images: a dandelion, a plant with yellow flowers, and a book. The bottom right corner features a circular icon with a white "a" inside.



Outline:

- Experiment 1: What is a JPG made of?
- Experiment 2: Compression vs Corruption
- Experiment 3: Writing a thesis, materially

What is a JPG made of?



What is a JPG made of?

- Where is this image?
- How much space does it use up?
- What does it rely on for its continued existence?

What is a JPG made of?

GR Gauthier Roussilhe

Gauthier Roussilhe Articles Ressources EN

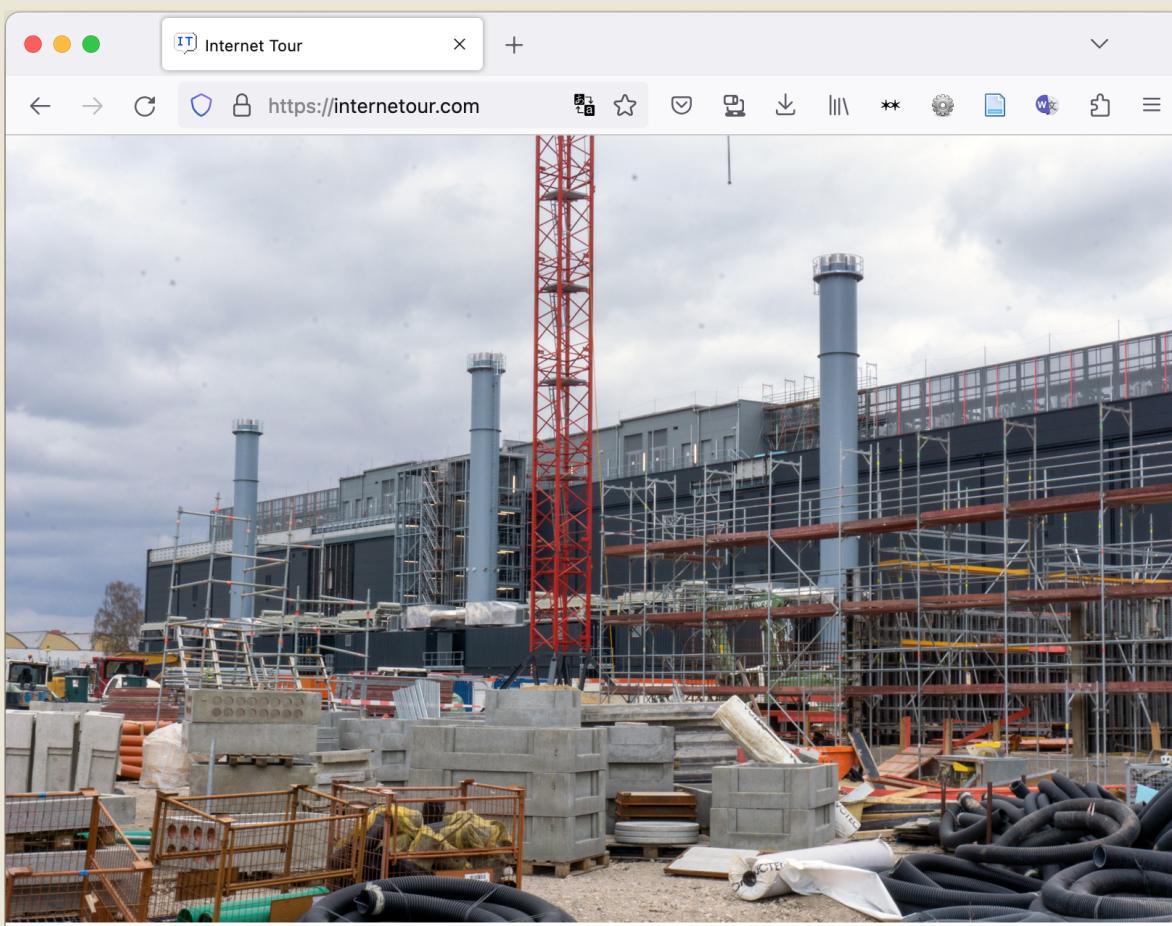
Explorer les écosystèmes numériques possibles dans un monde soutenable

Trajectoire suivie pour 2100 (données 2021): +2.7°C

Nous devons faire des choix inédits pour nous adapter à moyen et long terme à la crise environnementale. Nous sommes ainsi tenus d'organiser une décrue de notre empreinte matérielle et énergétique et tous les secteurs sont concernés. Face à cet effort de transformation la place du secteur numérique n'est pas encore déterminée.

Internet Tour

https://internetour.com



Internet Tour is an open and replicable tour operator focused on the phenomenon of tele-technologies. A journey through the physical Internet infrastructure, a lost route of non-touristic places.

LC RM Low Carbon Methods

lowcarbonmethods.com/research

LOW CARBON RESEARCH METHODS

Served from a solar powered server in Peterborough, Canada

Today's weather: clear sky

Tomorrow's weather: broken clouds

Battery Charge: 52.0%

Anne Pasek is the Canada Research Chair in Media, Culture, and the Environment at Trent University. She studies how carbon becomes communicable to different communities, to different social and material effects. She is the convener of the Low-Carbon Research Methods Group.



19.3W
17.2W
8.2W
5.1W
4.3W
4.1W
3.6W
2.7W
0.7W

-24 hrs -12 hrs 09:35 PM

What is a JPG made of?

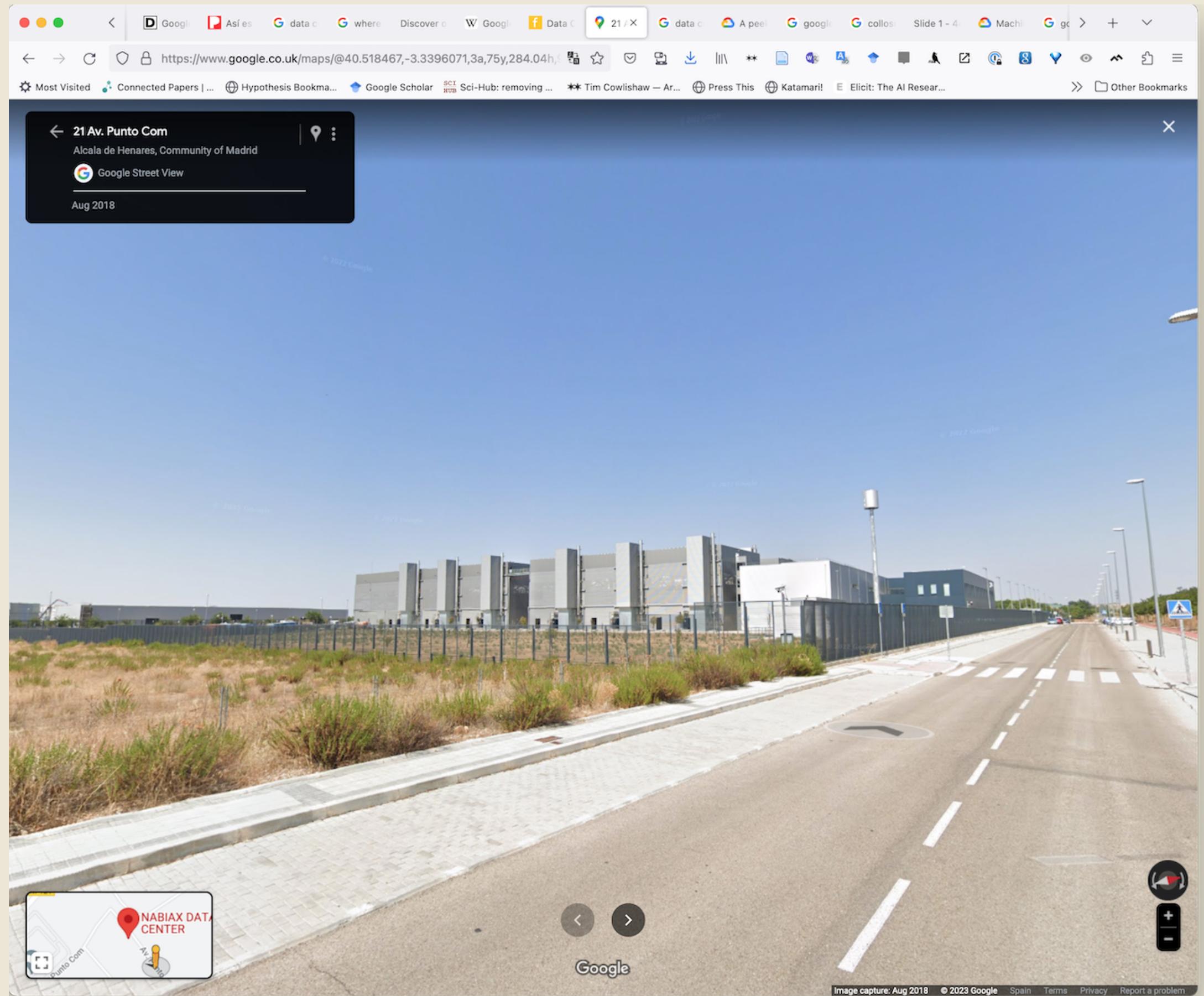
```
om/line/142.250.200.129
-bash: http://ip-api.com/line/142.250.200.129: No such file or
directory
[09:32:25] [tim@Tims-MacBook-Pro /Users/tim] $ curl http://ip-
api.com/line/142.250.200.129
success
Spain
ES
MD
Madrid
Madrid
28001
40.4168
-3.70379
Europe/Madrid
Google LLC
Google LLC
AS15169 Google LLC
142.250.200.129
[09:32:32] [tim@Tims-MacBook-Pro /Users/tim] $ host lh3.google
usercontent.com
lh3.googleusercontent.com is an alias for googlehosted.l.google
usercontent.com.
googlehosted.l.googleusercontent.com has address 142.250.200.1
29
googlehosted.l.googleusercontent.com has IPv6 address 2a00:145
0:4003:80f::2001
[09:32:42] [tim@Tims-MacBook-Pro /Users/tim] $ curl http://ip-
api.com/line/142.250.200.129
success
Spain
ES
MD
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28001
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-3.70379
Europe/Madrid
Google LLC
Google LLC
AS15169 Google LLC
142.250.200.129
[09:32:45] [tim@Tims-MacBook-Pro /Users/tim] $
```

(0) tim@Tims-MacBook-Pro.local< 5:thesis- 6:web 7:bash*09:38

The collage consists of several overlapping and adjacent screenshots:

- Top Left:** A screenshot of a Mac OS X desktop showing multiple browser tabs open. The main window displays a large green title "What is a JPG made of?". Other tabs include "Google", "Data C", "NAI X", "data c", "A peel", "YouTube", and "How r".
- Top Center:** A screenshot of a YouTube video player. The video shows the interior of a modern data center with a large server rack. The title "IT ROOM" and "15,000M2" are overlaid on the image. Below the video, a thumbnail for a video titled "Telefónica inaugura 'Alcalá Data Center'" is shown.
- Top Right:** A screenshot of a Google Cloud page showing a server rack.
- Middle Left:** A screenshot of a Google+ reviews page for "Alcalá de Henares". It features reviews from users Ziyang Zhang, Julio Bleda López, and Sergio Cavero, each with a star rating and a short comment.
- Middle Center:** An aerial satellite view of a data center complex. The buildings are labeled "Av. Punto Com". A "Layers" button is visible in the bottom left corner of the map.
- Middle Right:** A screenshot of a news article from elpais.com titled "Así es el primer Data Center de Google en España". The article discusses Google's investment in Spain and includes a large image of the Google logo.
- Bottom Right:** A screenshot of a charitywater.org advertisement featuring a cartoon character holding a water glass.

Infrastructures, inside and outside



Infrastructures, inside and outside

A screenshot of a Google Maps search result for "nabiax data centre alcala de hen". The map shows a large, modern industrial building with multiple dark grey cylindrical tanks or cooling towers. The building is situated on a paved area next to a road. The road is labeled "Av. Punto Com" and has several cars parked along it. To the right of the building is a large, open field with some sparse vegetation and dirt paths. The map interface includes a sidebar with saved locations like "Alcala de Henares" and "Adam", and a review section for "Salva Martínez" which reads:

★★★★★ a year ago
Llevo trabajando con ellos 7 años y no puedo estar más descontento con ellos. Por un lado su constante intento de borrar la palabra Telefónica en el edificio. Tengo dudas de que cumplan el Tier IV como tal, los protocolos son muy lentos, la eficacia de entrada paupérrima, la facilidad de poner consignas nula, posibilidad de comer durilla y si te lo traen búscalos tú sin posibilidad de gestionar bien el tiempo durante la crisis que tengas. A nivel técnico un mes para que pasen cableado entre armarios, 1 meses de provisionado y etiquetados de componentes incorrectos, ágiles no son. Todo subcontratado, (los chicos de seguridad amables y correctos, xo algunos técnicos de servicio poco cualificados y/o desganados (no todos y algunos muy buenos). Una vez dentro, irse es complicado si tienes servicios 24/7, pero poco a poco se consigue. Cada vez hay más racks vacíos... El centro como tal de instalaciones está bien, xo si gestión da mucho que desear...

[See translation](#)

The map also shows other nearby buildings and roads, with a "Layers" button and a scale bar indicating 20 meters.

Infrastructures, inside and outside

"Today, we're excited to announce that our new Google Cloud region in Madrid is officially open," the company announced this week. "Designed to help meet the growing technology needs of Spanish businesses, the new Madrid region (europe-southwest1) provides low-latency, highly available cloud services with high international security and data protection standards — all on the cleanest cloud in the industry."

The new region was first announced in [June 2020](#) and is delivered in partnership with Telefónica.

Google said the Madrid region is launching with three cloud zones to prevent service interruptions, and its standard set of products, including Compute Engine, Google Kubernetes Engine, Cloud Storage, Persistent Disk, CloudSQL, and Cloud Identity.

This is the company's first region in Spain. Google currently has nine cloud regions across Europe, with more due to launch in Turin and Berlin in the future. The Grace Hopper subsea cable landed in September 2021 in Bilbao, connecting Spain and the UK with the United States.

This is the second GCP region to open this week, after Google launched a new location in [Columbus, Ohio](#).

It's not clear exactly what facilities Google's new Madrid region is located in, but Telefónica operates the [Tier IV Alcalá CDG facility](#) on the outskirts of Madrid; the facility was built in 2013 and spans 23 data halls, each measuring 681 sqm, and [offers up to 100MW of capacity](#).

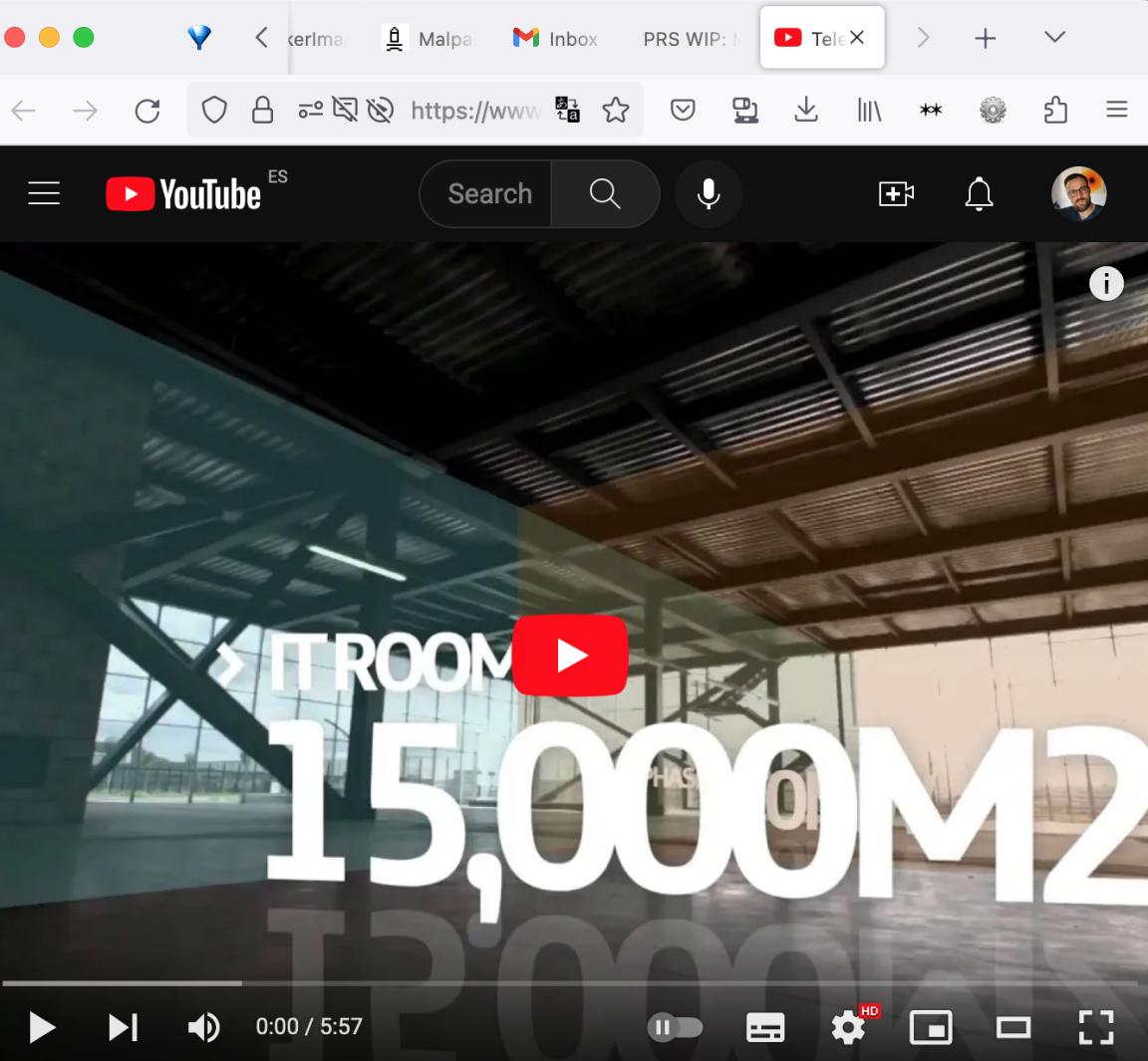
In 2020 Microsoft announced plans for a Spanish Azure region in Madrid in partnership with Telefónica, but hasn't shared a go-live date. Oracle has also [previously partnered](#) with the telco to host an upcoming cloud region in Madrid due to go live this year.

AWS is due to launch a Spanish region [in Aragon](#) in mid-2022.

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Got it!



Telefónica inaugura 'Alcalá Data Center'

Telefónica 34.3K subscribers

Subscribe

146 likes

Share

0:00 / 5:57

35K views 10 years ago

La operadora inaugura su mayor centro de datos que albergará los servicios digitales más avanzados. Alcalá Data Center será un referente internacional en tamaño, seguridad y eficiencia energética. [Show more](#)

All From Telefónica Data center Listenable Recently uploaded

How Does a Data Center Work? Discovering Data Centers 2:45

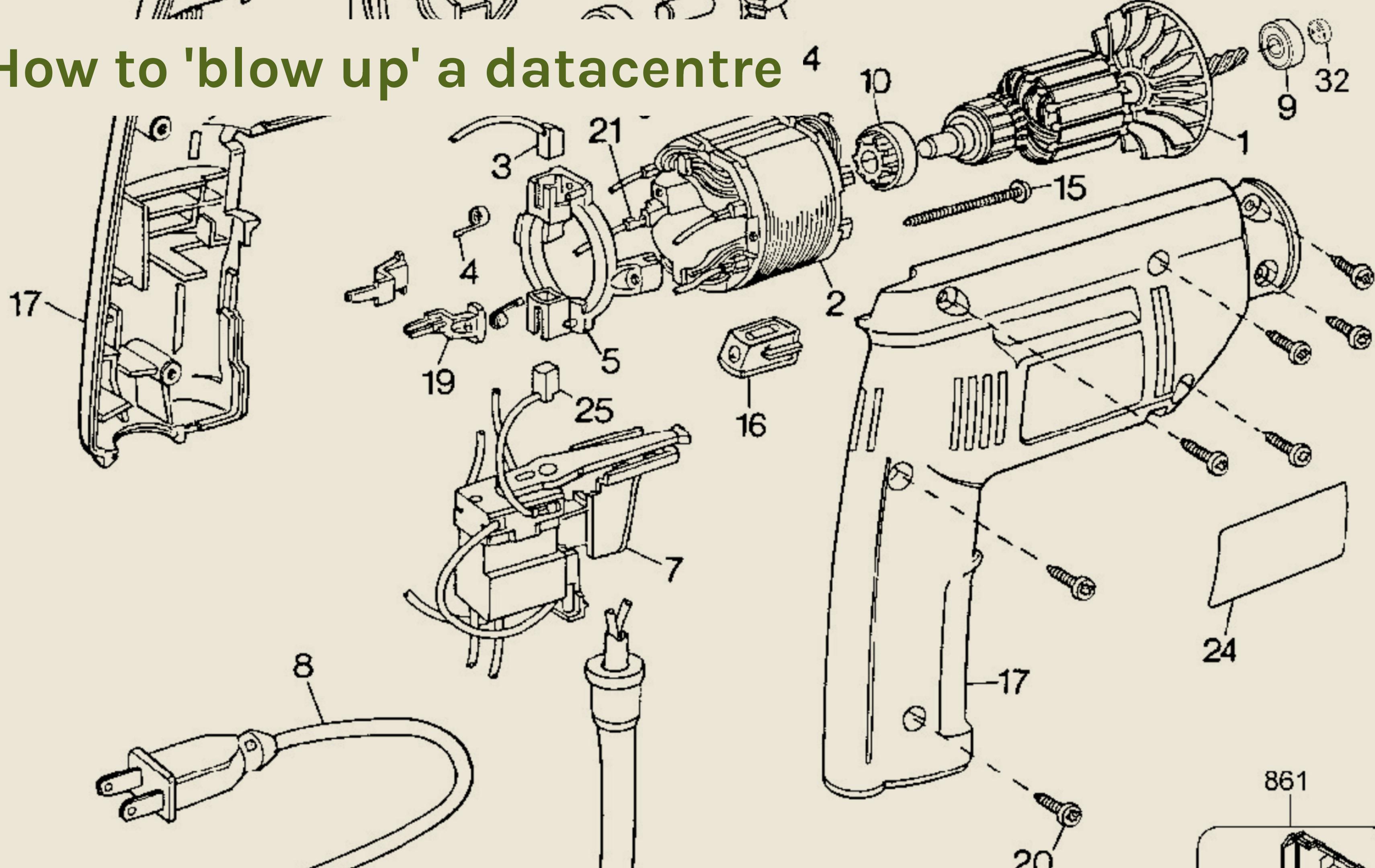
What is a Data Center? Google Cloud Tech 186K views • 2 years ago

PODCAST Pantomima Full

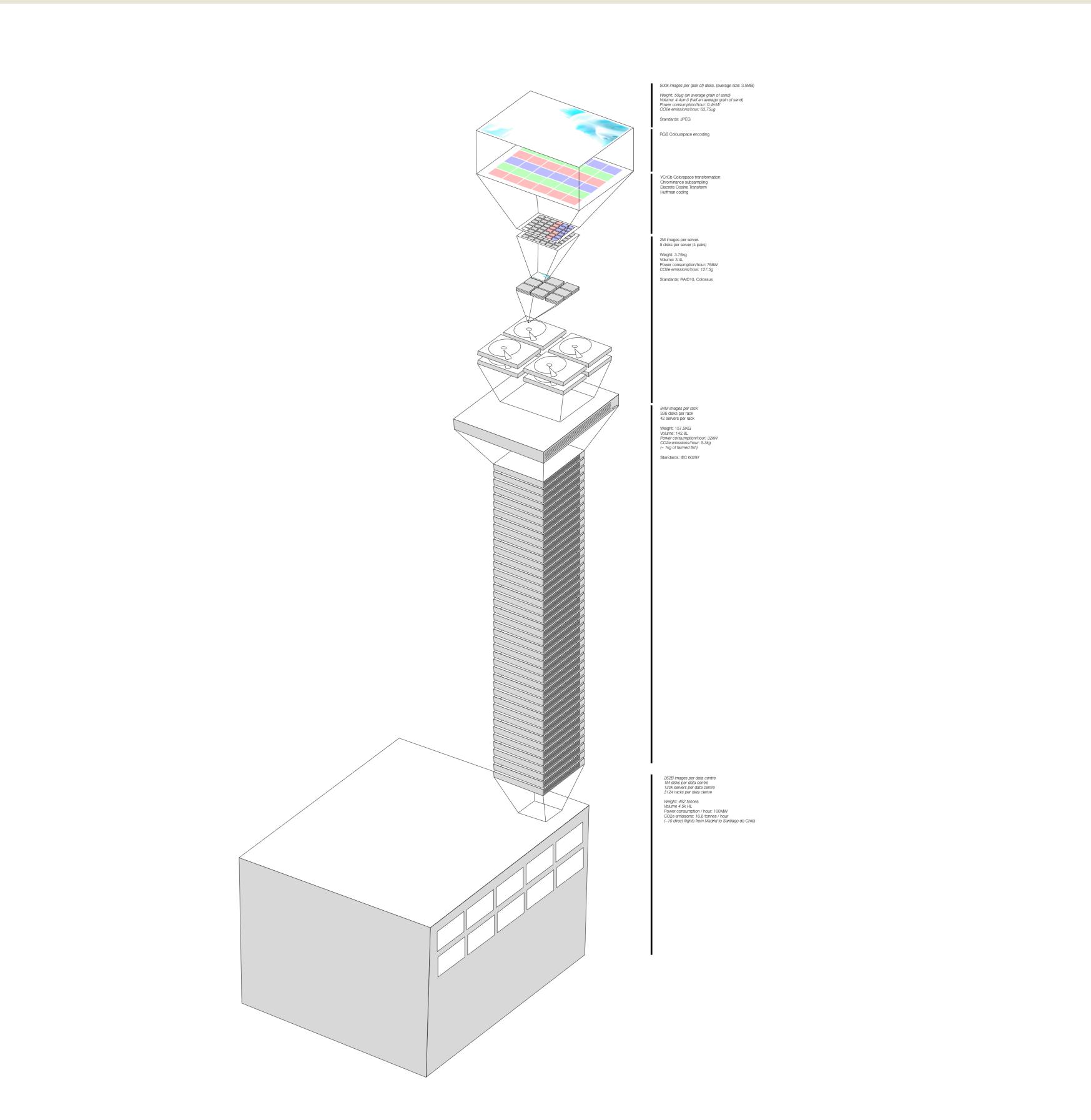


Specification	EA-STORAGE-10	EA-GPU-T4
Processor	16 core CPU, 64GB RAM	NVIDIA T4 GPU, 16 core CPU, 64GB RAM
Storage	8x 2TB SSDs. Usable storage is 7.2 TB using RAID10.	4x 2TB SSDs. Usable storage is 3.6 TB using RAID10.
Networking	2x 10GBASE-T RJ45, 2x 1GbE RJ45	
Shipping weight	13.6 kg (30 lbs)	
Dimensions	Height: 43 mm (1.7 in.), width: 209 mm (8.2 in.), depth: 376 mm (14.8 in.)	
Mounting options	Horizontal or vertical orientation. Bookshelf mount (3 servers), DIN rail wall mount, ceiling mount, 1U rack mount (2 servers), 2U short-depth rack mount (2 servers). Available locking bezel with dust filter.	

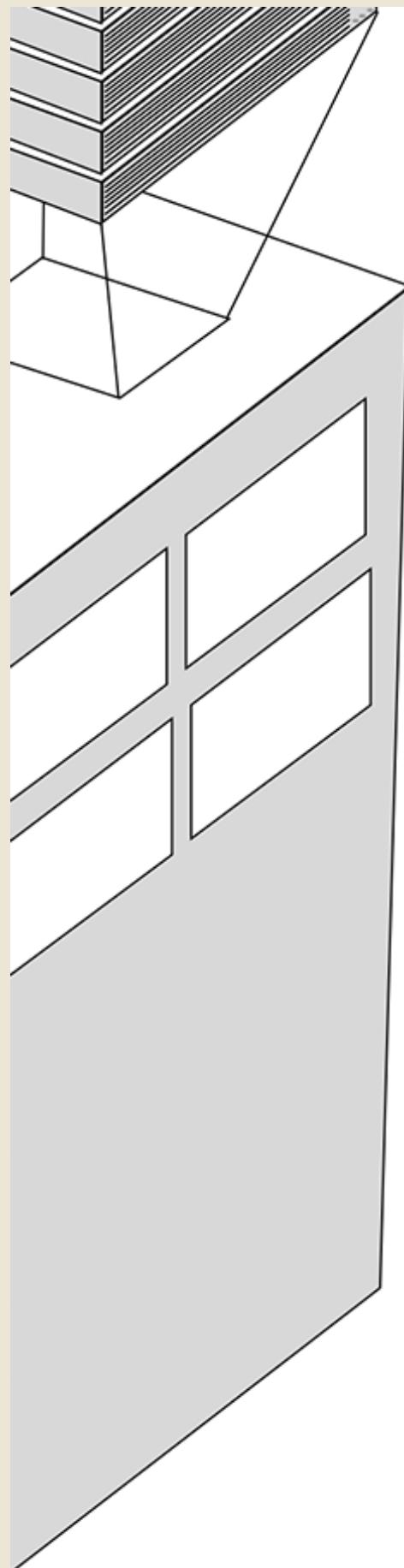
How to 'blow up' a datacentre



How to 'blow up' a datacentre

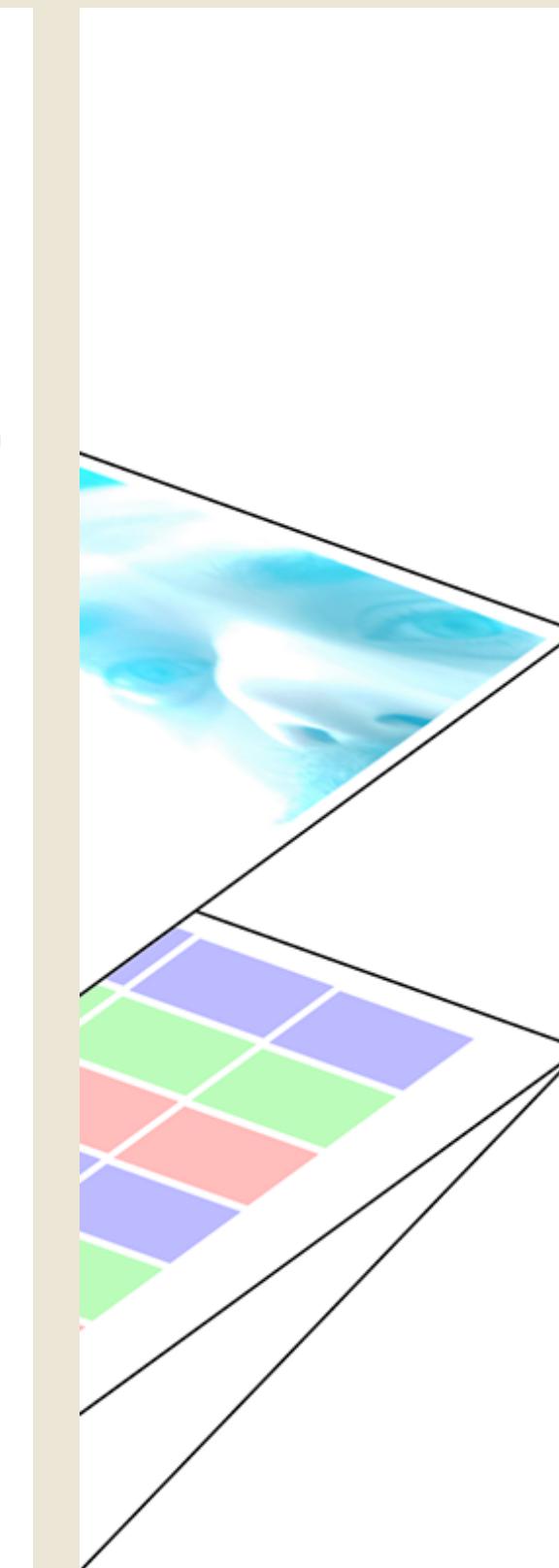


From Refuse to Refusal



262B images per data centre
1M disks per data centre
130k servers per data centre
3124 racks per data centre

Weight: 492 tonnes
Volume 4.5k HL
Power consumption / hour: 100MW
CO2e emissions: 16.6 tonnes / hour
(~10 direct flights from Madrid to Santiago de Chile)



500k images per (pair of) disks. (average size: 3.5MB)

Weight: 50µg (an average grain of sand)
Volume: 4.4µm³ (half an average grain of sand)
Power consumption/hour: 0.4mW
CO2e emissions/hour: 63.75µg

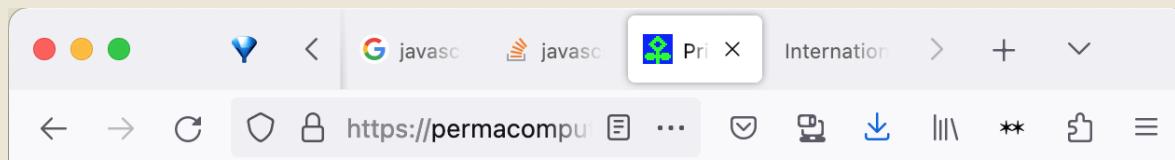
Standards: JPEG

RGB Colourspace encoding

YCrCb Colorspace transformation
Chrominance subsampling
Discrete Cosine Transform
Huffman coding

2M images per server.
8 disks per server (4 pairs)

From Refuse to Refusal



permacomputing/ Principles

[Edit](#) [RecentChanges](#) [Preferences](#) [?Discussion](#)

These **design principles** have been modeled after those of **permaculture**.

These are primarily design/practice principles and not philosophical ones, so feel free to disagree with them, refactor them, and (re-)interpret them freely.

Permacomputing is not prescriptive, but favours instead situatedness and awareness of the diversity of context. Said differently, its design principles can be as much helpful as a way to guide practice in a specific situation, as it can be used as a device to help surface systemic issues in the relationship between computer technology and ecology.

Care for life

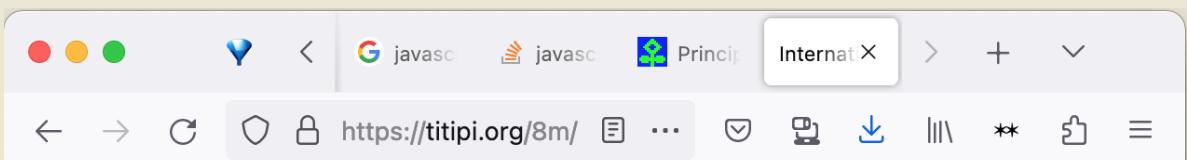
This is the ethical basis that permacomputing builds on. It refers to the permacultural principles of "care for the earth" and "care for people", but can be thought of as the basic axiom for all choices.

Create low-power systems that strengthens the biosphere and use the wide-area network sparingly. Minimize the use of artificial energy, fossil fuels and mineral resources. Don't create systems that **obfuscate waste**.

Care for the chips

Production of new computing hardware consumes a lot of energy and resources. Therefore, we need to **maximize the lifespans** of hardware components - especially **microchips**, because of their low material **?recyclability**.

- Respect the quirks and peculiarities of what already exists and **?repair** what can be repaired.
- Create new devices from **salvaged components**.
- Support local **time-sharing** within your community in order to avoid buying redundant stuff.
- Push the industry towards **Planned longevity**.
- Design for disassembly.



INTERNATIONAL TRANS★FEMINIST DIGITAL DEPLETION STRIKE

[english](#) [español](#) [catalan](#) [français](#) [Deutsch](#) [Nederlands](#) [português](#) [ελληνικά](#)
[română](#) [italiano](#) [slovensky](#) [Türkçe](#) [Danish](#) [한국어](#) [ქართული](#)

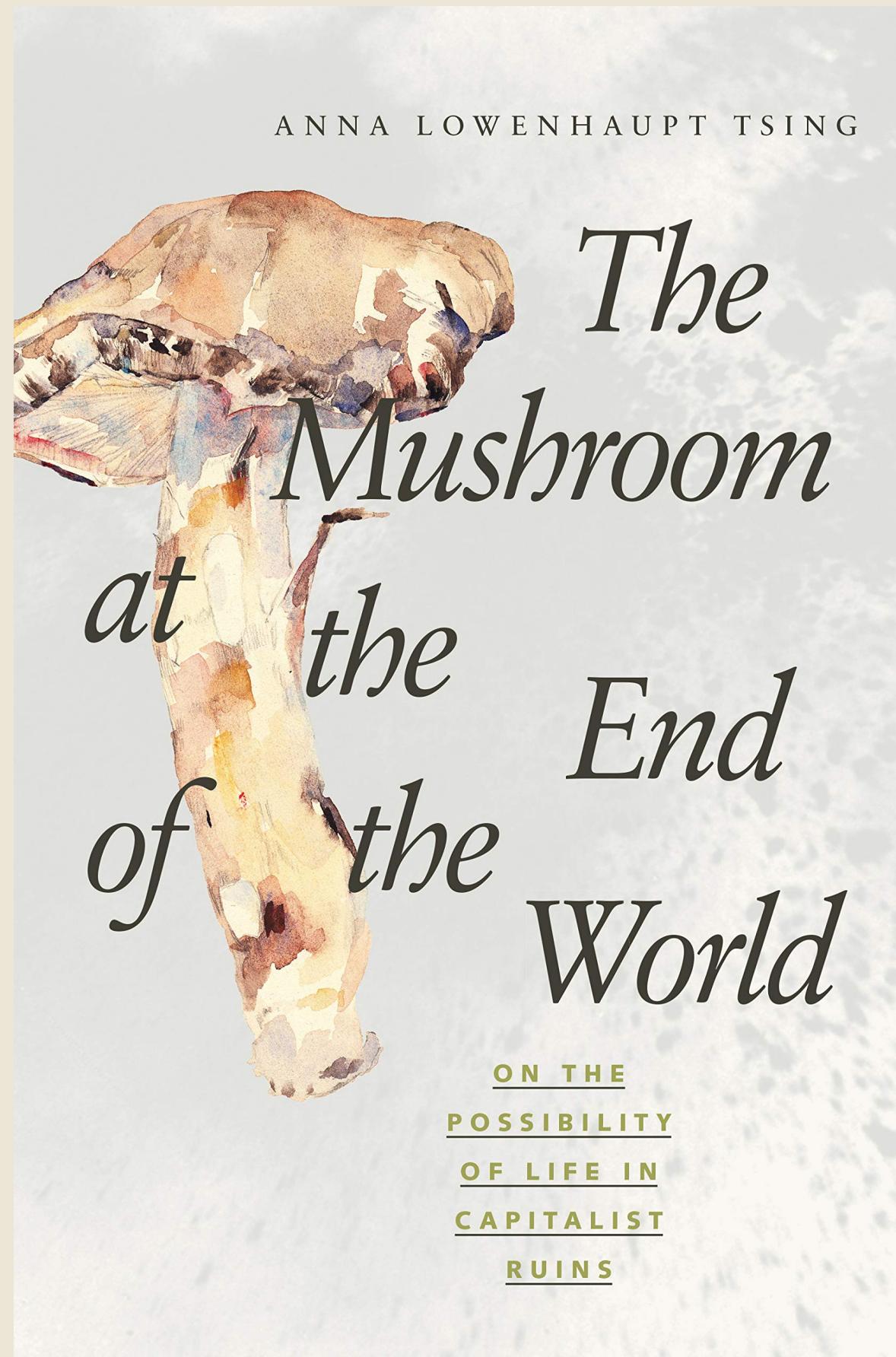
WEDNESDAY 8 MARCH 2023 ✨

On 8th of March 2023, we call for a Counter Cloud Action Day.

On this day, we will try to withhold from using, feeding, or caring for The Big Tech Cloud. The strike calls for a hyperscaledown of extractive digital services, and for an abundance of collective organising. We join the long historical tail of international feminist strikes, because we understand this fight to be about labour, care, anti-racism, queer life and trans★feminist techno-politics.

Too many aspects of life depend on The Cloud. The expansionist, extractivist and financialized modes of Big Tech turn all lively and creative processes into profit. This deeply affects how we organise, and care for resources. Many public institutions such as hospitals, universities, archives and schools have moved to rented software-as-a-service for their core operations. The interests of Big Tech condition how we teach, make accessibility, learn, know, organise, work, love, sleep, communicate, administrate, care, and remember.

Especially now our dependency on Big Tech Cloud seems intractable, it is time

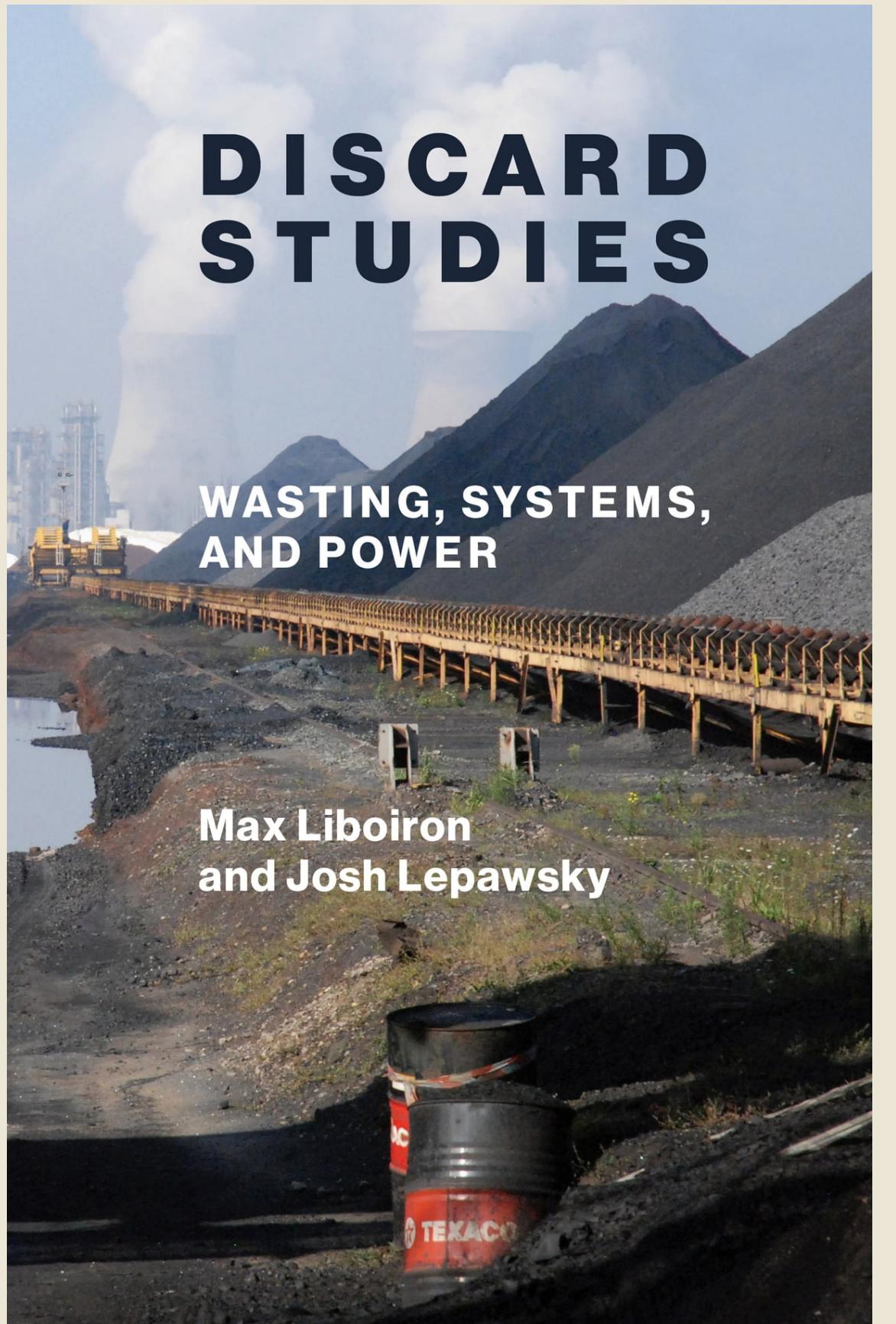


ANNA LOWENHAUPT TSING

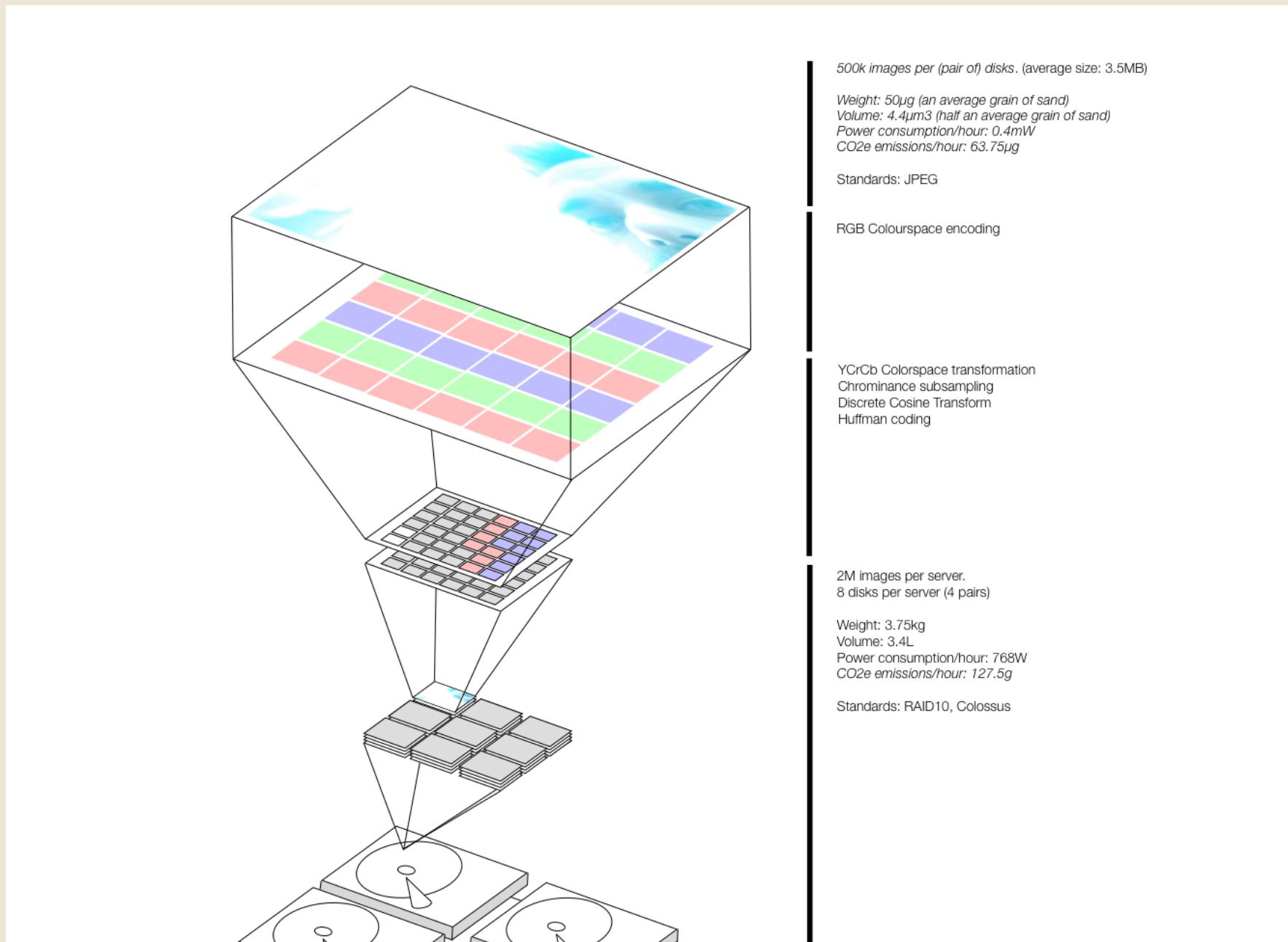
*The
Mushroom
at the
End
of the
World*

ON THE
POSSIBILITY
OF LIFE IN
CAPITALIST
RUINS

"Discarding well"



Software as infrastructure

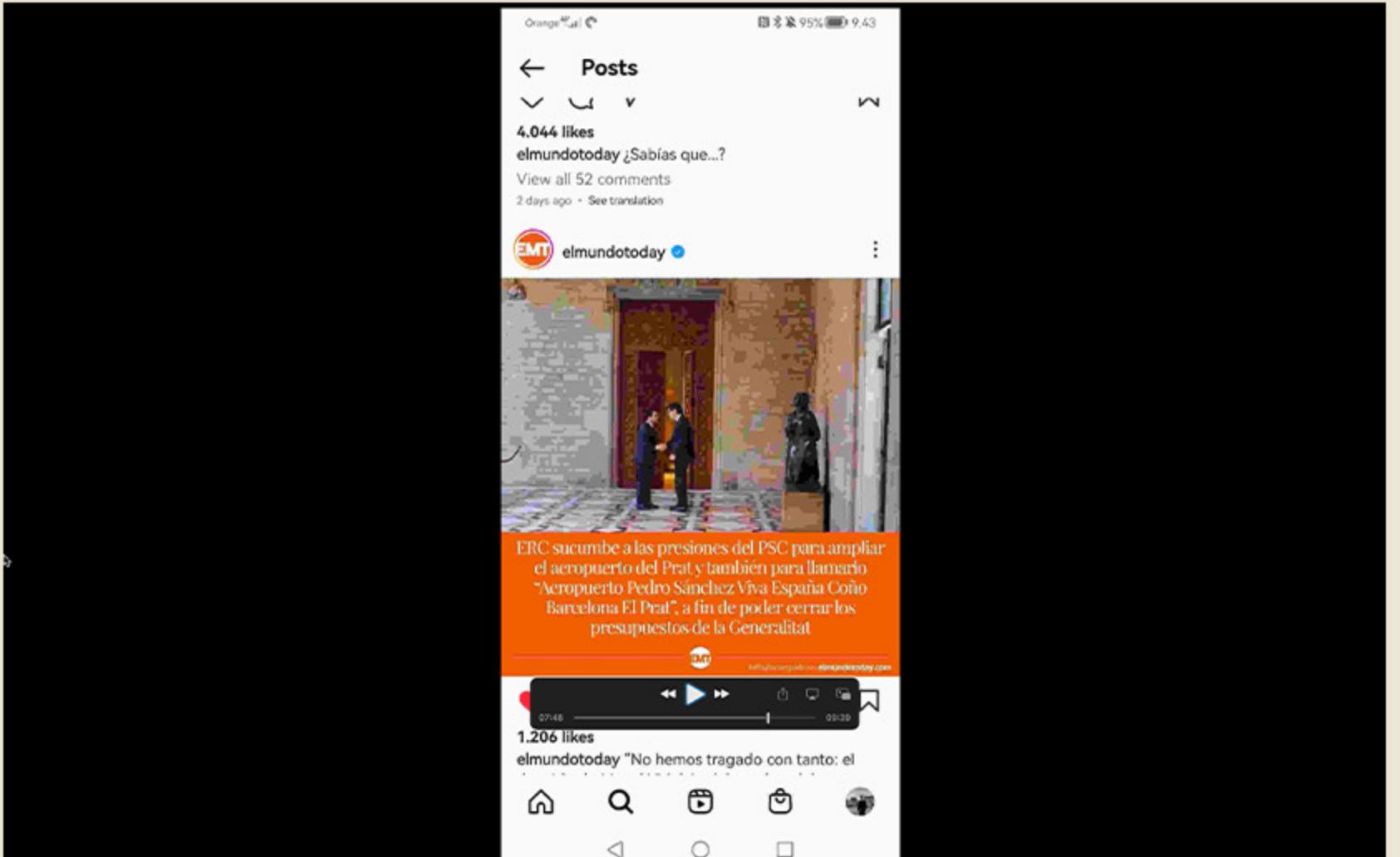


Corruption vs Compression



Reframing her questions in the context of *Saturation Trails* leads us to consider not just the interconnected equipment within the laboratory as a holistic apparatus but the FAST Lab and Clean Room's existence within a research unit which attracts considerable funding and can therefore afford to devote time to "continuing the quest for lateral, non-linear ideas" (ORC website). We might also look to Winchester School of Art's merger with a University whose primary focus is science and engineering as a key component of the apparatus that enabled the collaborations at the heart of this research project. Barad's expansive conception of the research apparatus has some confluence with Gilbert Simondon's concept of the technical ensemble, of which he offers the laboratory as a higher-level example. However, unlike Barad, Simondon distinguishes the bounds of the ensemble from its milieu, so for him, the funding environment would be part of the laboratory's milieu rather than part of the ensemble itself.

Combining Barad's expanded definition of the apparatus with Simondon's definition of the technical ensemble, we can conceptualise the meeting of my Panasonic Lumix compact camera and the Coherent Mira laser oscillator as a hinge between the apparatus of optoelectronic research and the technical ensemble of the consumer camera. The laser assay then provides an instance of feedback between these two mutually reliant domains. The image sensor, whose uptake as a consumer device relies on its claim to objectivity garnered through its use in research

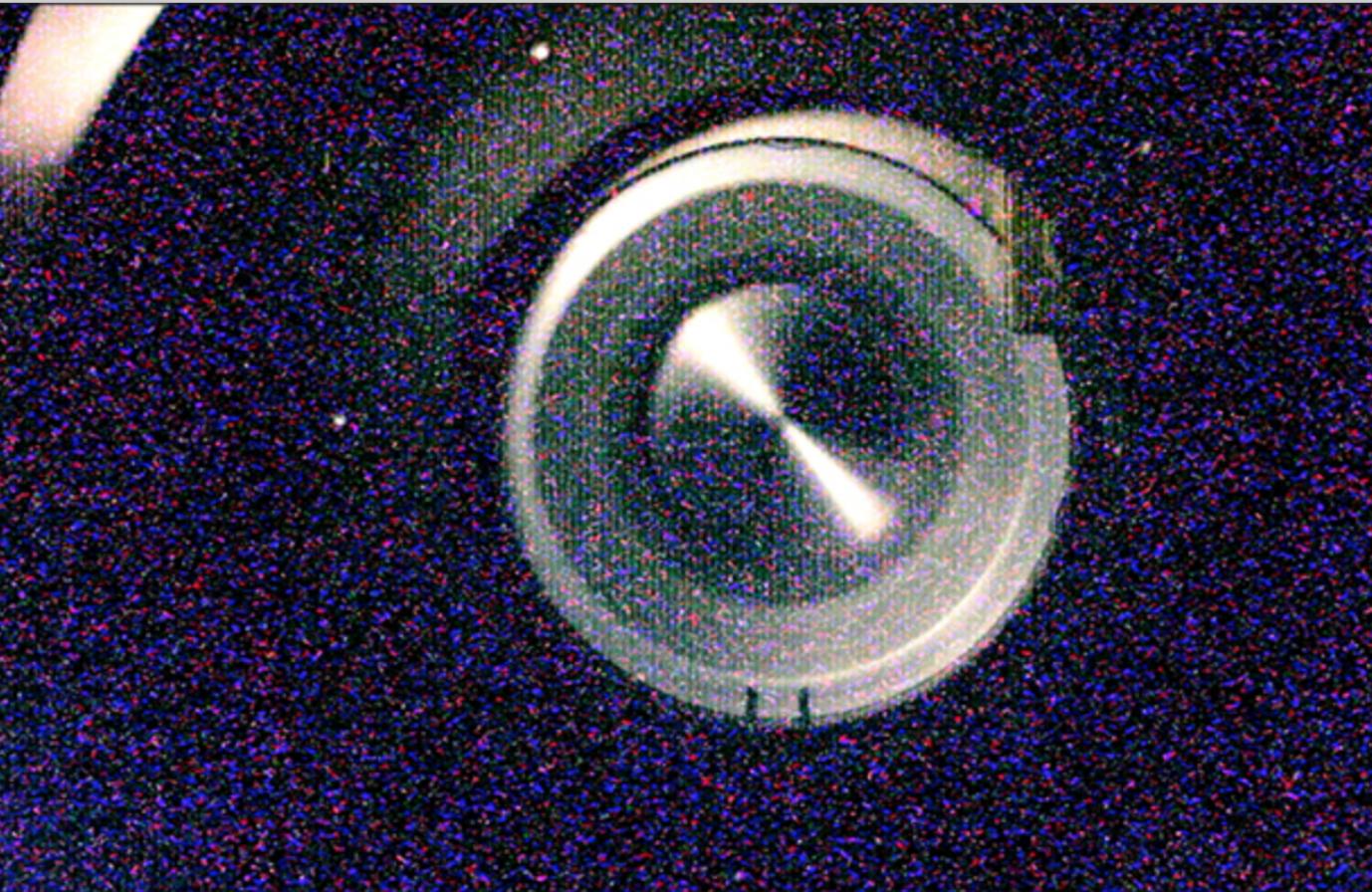


Corruption vs Compression

Stephen
Cornford

blog
works
discs
texts
info

Saturation Trails [X-ray] (2017)



Saturation Trails seeks to reveal the architecture of the digital image through direct material interaction with image sensor ubiquitous photosensitive semiconductors which transduce light into voltage in our digital cameras. The project appropriates techniques from optoelectronic manufacture and testing: pulsed lasers, acid etching and X-ray radiation.

The X-ray assay exposed the image sensors from two commercial cameras, one HD and one SD, to an incremental dose of radiation. While the duration of these exposures was not sufficient to do permanent damage, it was imaged in both cases to reveal a coloured noise pattern, and caused other artifacts to be produced in the image. In exhibition these videos are shown alongside appropriated footage from the internal investigation of the primary containment vessel of Fukushima Daiichi, Unit 2 (still images of which can be seen below). Here the endoscopic camera produces an involuntary record of the radiation inside the reactor.

VIDEO: X-ray Assay #2



**Unraveling
the JPEG**

May 1, 2019

Created by
[Omar Shehata](#)

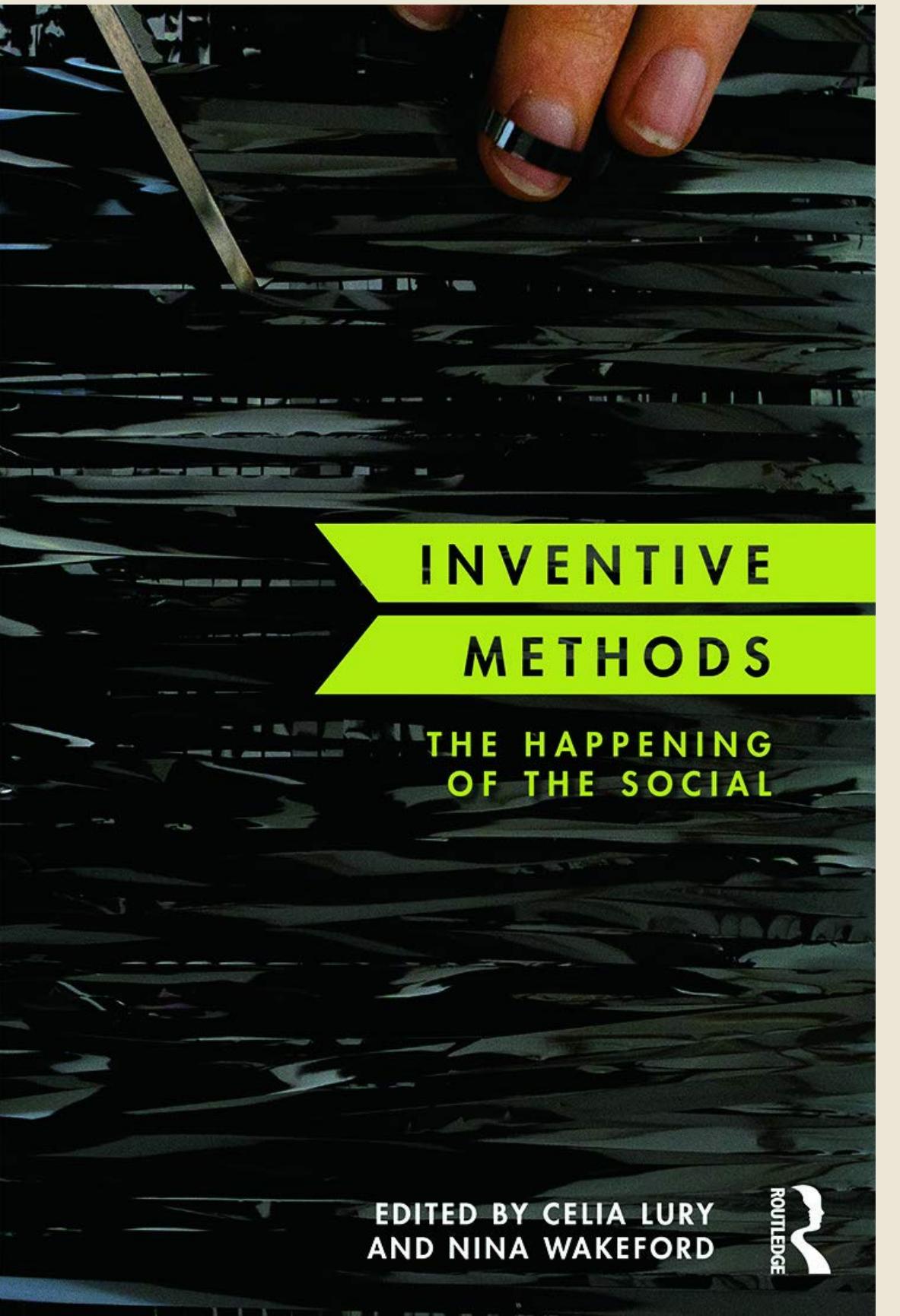
Metadata
[Source Code](#)
[Offline Archive](#)
[DOI](#)

Unraveling the JPEG

JPEG images are everywhere in our digital lives, but behind the veil of familiarity lie algorithms that remove details that are imperceptible to the human eye. This produces the highest visual quality with the smallest file size—but what does that look like? Let's see what our eyes can't see!

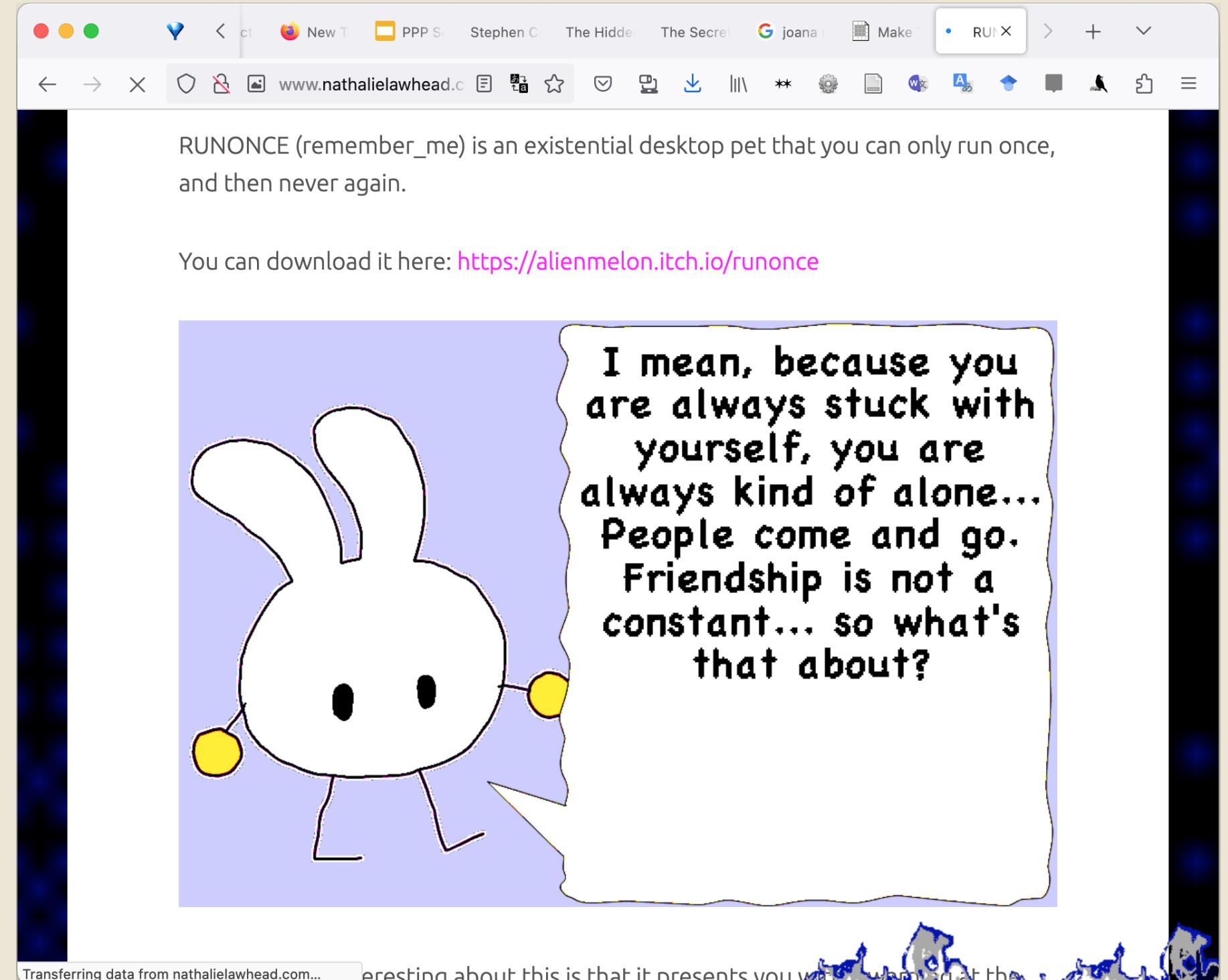
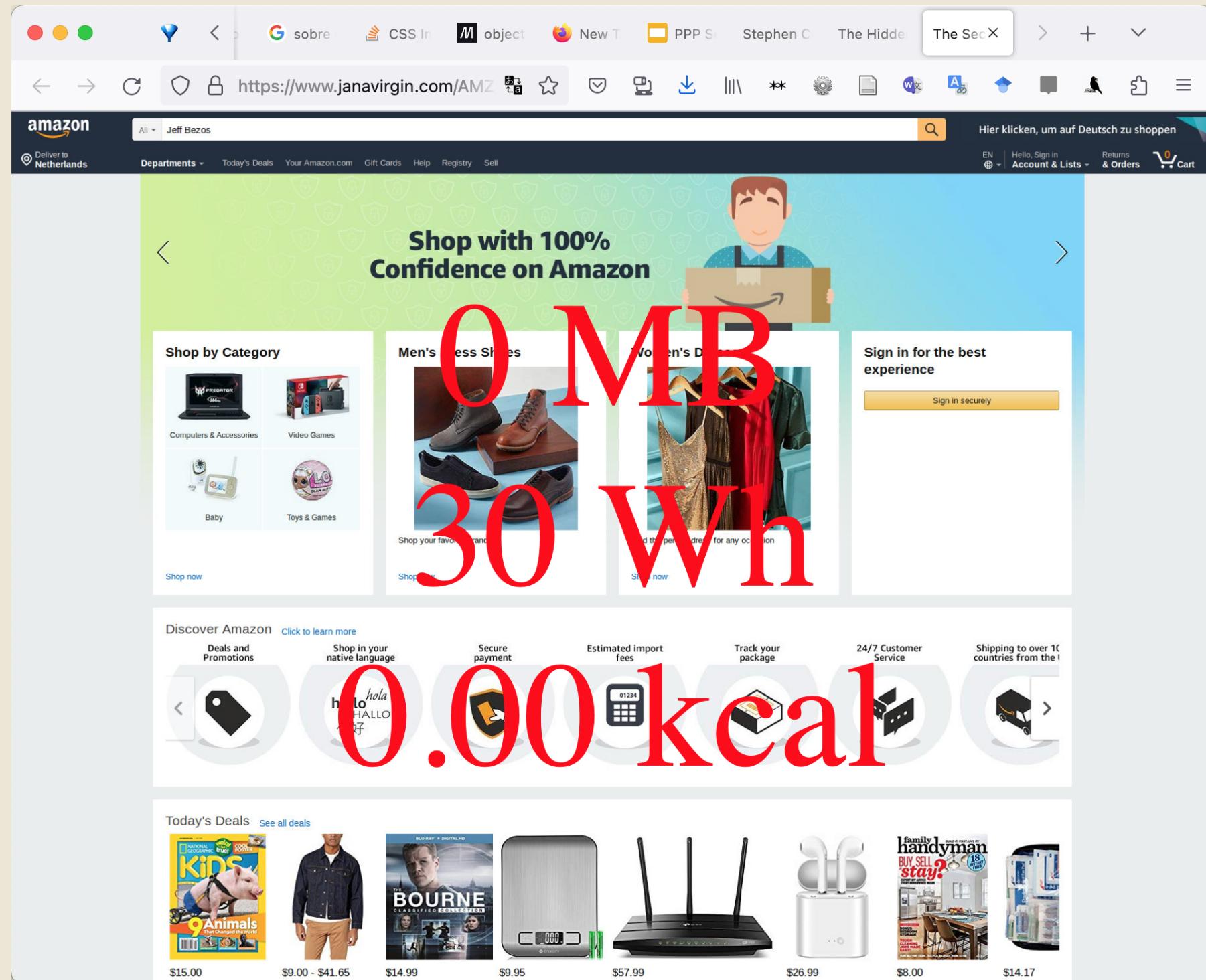
It's easy to take for granted that you can send a picture to a friend without worrying about what device, browser, or operating system they're using, but things weren't always this way. By the early 1980s, computers could store and display digital images, but there were many competing ideas about how best to do that. You couldn't just send an image from one computer to another and expect it to work.

Speculative software interventions



BEYOND
SPECULATIVE
DESIGN:
PAST -
PRESENT
- FUTURE

Speculative software interventions



Writing a thesis, materially.

This is, (or will be) my doctoral thesis - currently a work in progress. It is hosted entirely on an old laptop which was headed for the scrapheap - when that laptop goes offline this site will disappear. The text below is an incomplete draft. To watch my progress (on both the text and the thesis-laptop as a material object) have a look [here](#).

1.5 How to read this thesis.

TO DO Supertext, references, experiments, etc.

CHAPTER 2: ON THE MODE(S) OF EXISTENCE OF DIGITAL WASTES

Digital objects, digital wasting and the pre-materiality of digital wastes

2.1 Introduction

Up until now, I've treated *digital waste* as a term with an obvious, apparent definition. However in order to continue this inquiry, we will need to place this definition on a firmer footing, and in doing so, interrogate the relationship between digital wastes, other digital objects, digital infrastructures, and their users. In popular usage, *digital waste* is commonly used to mean two distinct things - discarded digital devices, and the wastes produced in their manufacture and ongoing use (also known as e-waste), and discarded virtual objects - the data, files, media or messages that inhabit our computer trash cans or sit forgotten about on phones, desktops, or servers, and which, as discussed in the previous chapter, are experienced in multiple ways, exist at multiple scales, and have multiple materialities.

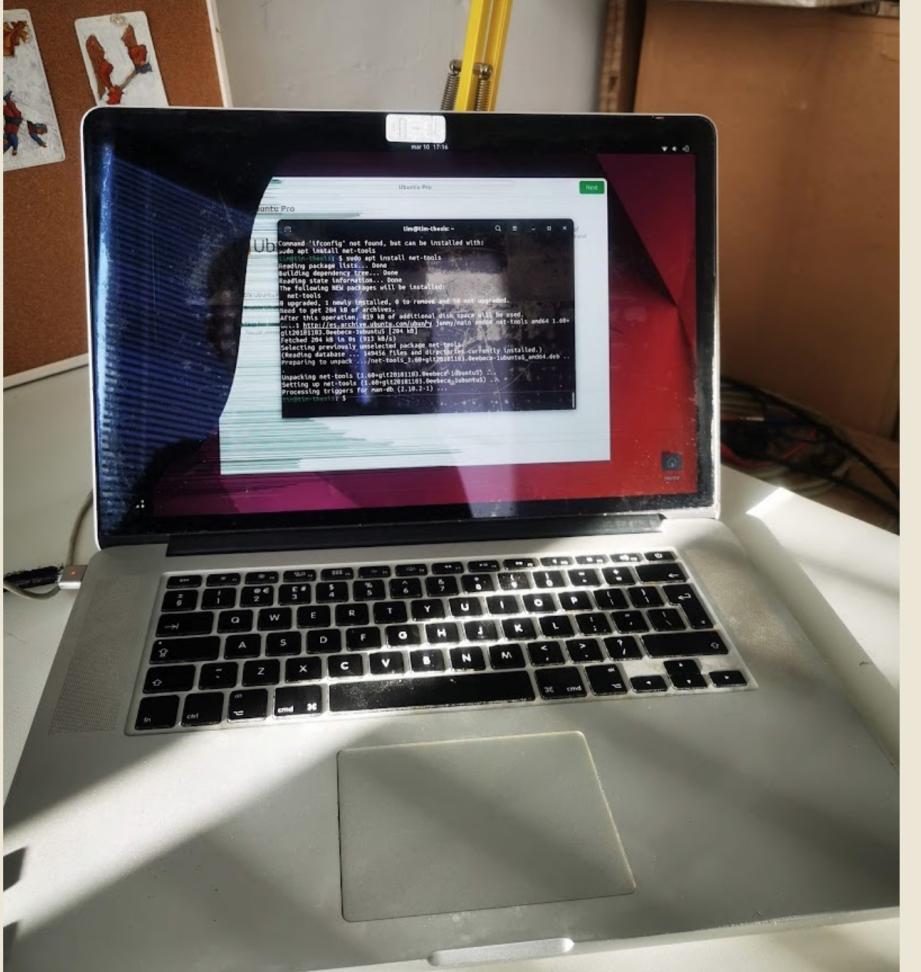
While the former meaning - *physical* digital wastes, or discarded electronic devices has been the subject of study in multiple fields - notably the field of *Discard Studies* (Lepawsky, 2018; Akese, 2019) - the latter - which I will provisionally term *virtual* digital wastes, while an issue of concern in technology journalism and popular writing (Beck, 2012; Godoy, 2021), so far lacks more sustained study in an academic context: save its analysis as a behavioural phenomenon (Sweeten, Sillence and Neave, 2018; Neave et al., 2019), or a medical condition (van Bennekom et al., 2015). The goals of this thesis are to argue that virtual digital wastes, as objects which are present in our digital lives in multiple ways merit more sustained analysis, and that such analysis can both be carried out *through* design practice, and has important consequences for such practice - topics which will be the subject of later chapters.

However, while I have begun to identify some of the ways in which these digital

Ecologies of Excess

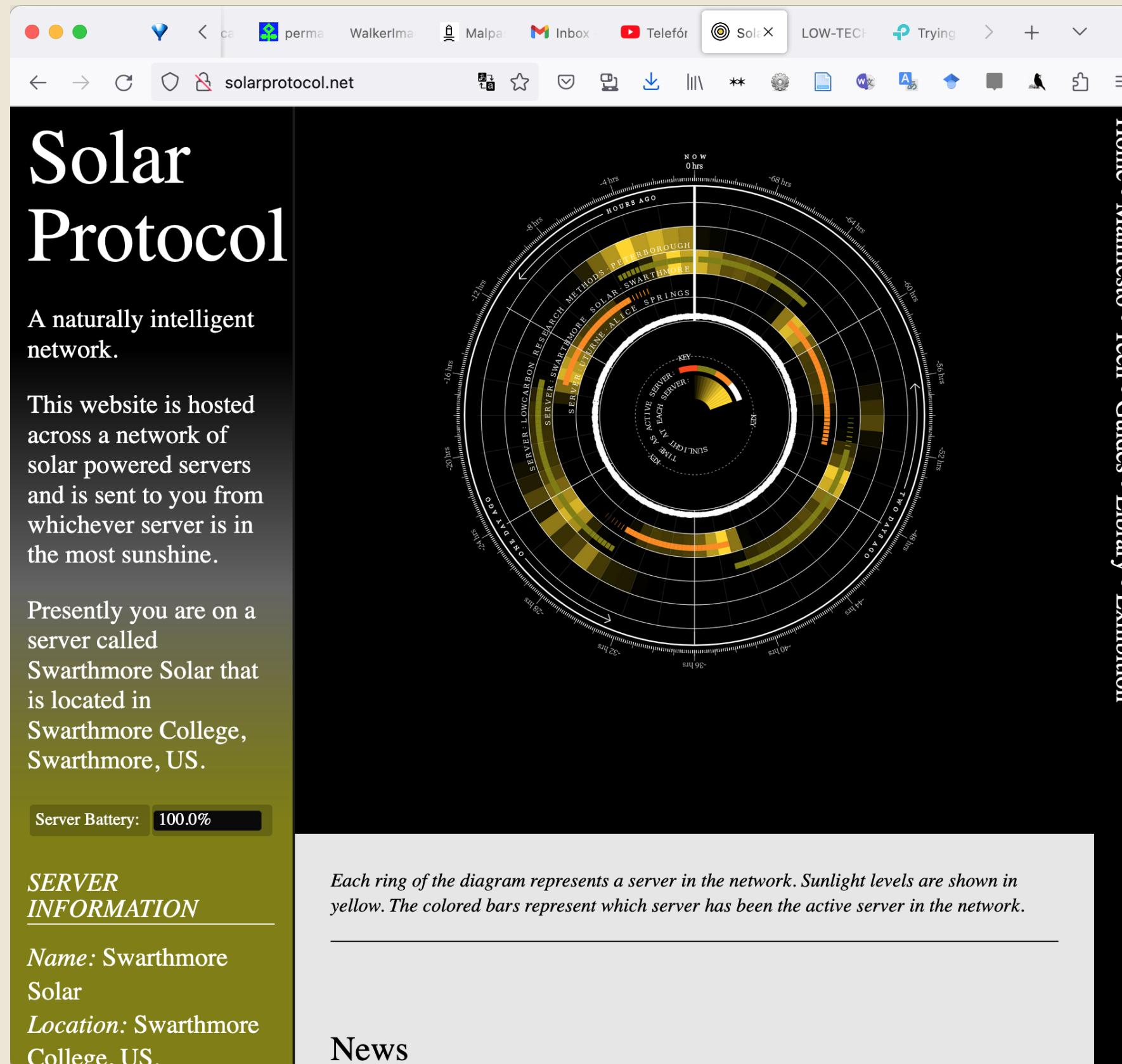
← Back

COLOPHON

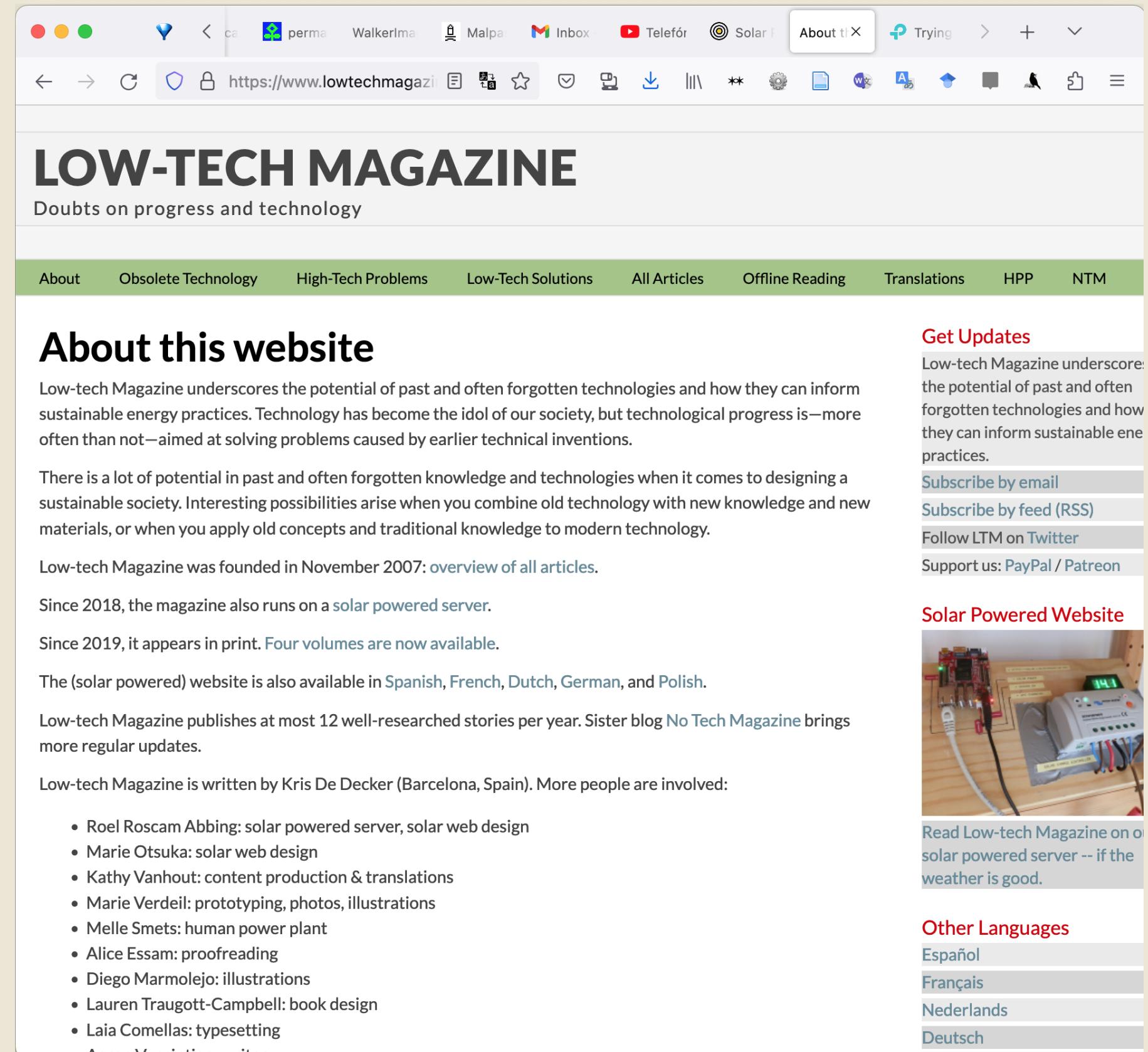


This thesis is hosted on a 2014 MacBook Pro with a cracked screen, a battery that won't hold charge for more than about 20 minutes, and which I had left at the bottom of a box of miscellaneous 'gadgets' for the best part of the last three years, after the stained portion of the screen finally got too big for it to be useful as a laptop.

Writing a thesis, materially.



The screenshot shows the homepage of the Solar Protocol website. The main feature is a large circular diagram representing a network of servers. The diagram has multiple concentric rings, each representing a different server. The rings are color-coded, with yellow indicating active servers. The diagram is overlaid with various text labels such as "HOURS AGO", "PEPPERBROOK", "SWARTHMORE SOLAR", "ALICE SPRINGS", "LOWCARBON RESEARCH METHODS", "SUNLIGHT LEVELS", "ACTIVE SERVER", and "TIME AS EACH SERVER". Below the diagram, there is a text block explaining its purpose: "Each ring of the diagram represents a server in the network. Sunlight levels are shown in yellow. The colored bars represent which server has been the active server in the network." On the left side of the page, there is a sidebar with the title "Solar Protocol" and a sub-section titled "A naturally intelligent network." It also contains a text block about the website's hosting and a section titled "SERVER INFORMATION" with details about the server's name, location, and battery status (100.0%).



The screenshot shows the "About" page of the Low-Tech Magazine website. The page features a large title "LOW-TECH MAGAZINE" and a subtitle "Doubts on progress and technology". Below the title is a navigation bar with links to "About", "Obsolete Technology", "High-Tech Problems", "Low-Tech Solutions", "All Articles", "Offline Reading", "Translations", "HPP", and "NTM". To the right of the main content area, there is a sidebar titled "Get Updates" with links to "Subscribe by email", "Subscribe by feed (RSS)", "Follow LTM on Twitter", and "Support us: PayPal / Patreon". There is also a small image of a solar-powered website setup. The main content on the page discusses the magazine's mission to highlight forgotten technologies and their potential for sustainable energy practices. It also mentions the magazine's history, publication frequency, and writing staff.

Conclusions

- The environmental harms of cloud technologies are *systemic*, the result of a pervasive *logic of scalability*.
- For this reason, focusing on individual choice and behaviour is marginal. This presents a challenge for design practice.
- Responding to this challenge involves taking an *ecological* view of digital media, and enlarging the purview of design away from the interface.

Thank you!

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