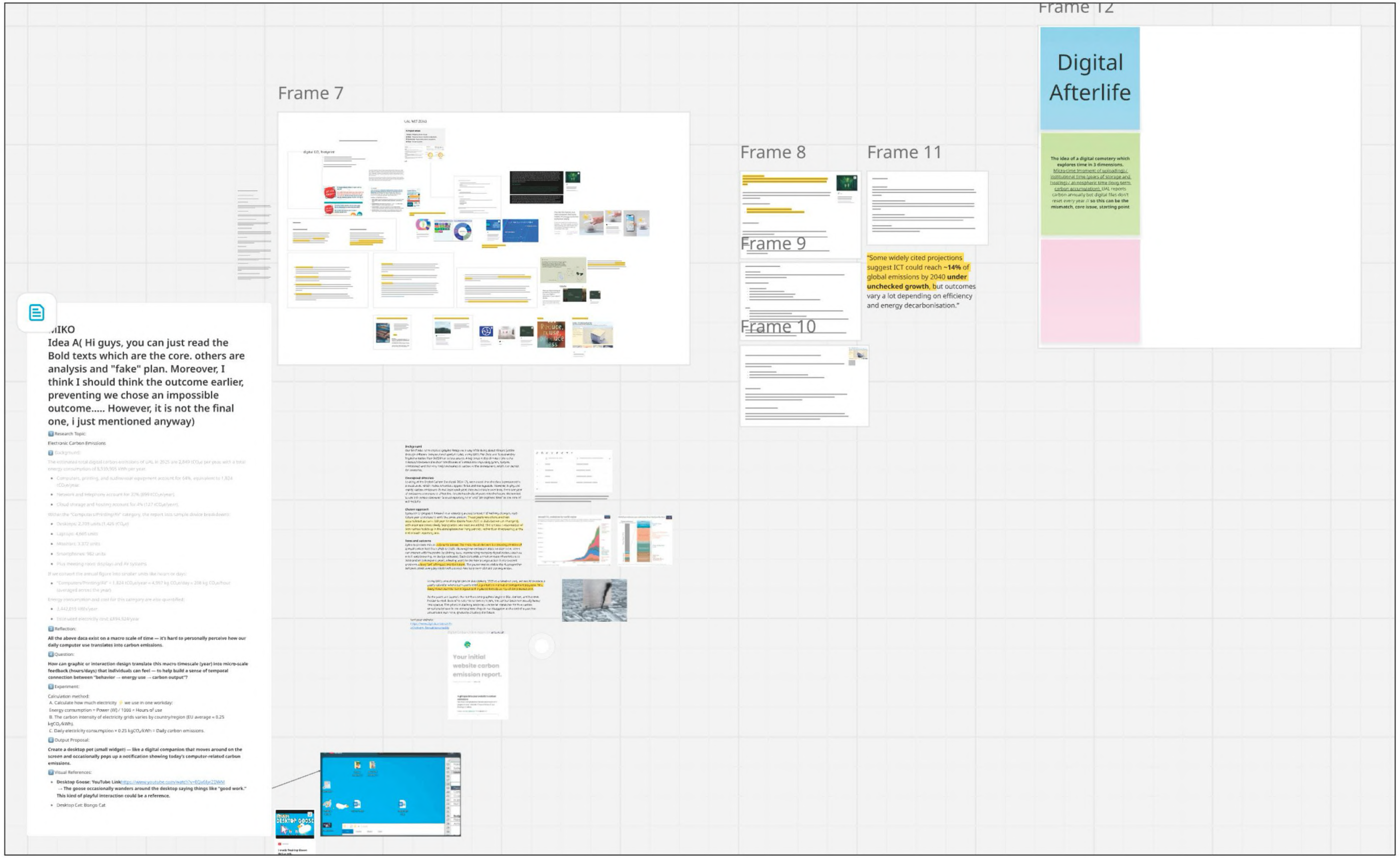
MAGCD Y1

Unit 1 Methods of Iterating

>Update time: Feb 20th   >Valerie Miko Tianyu Dasha

Brain Storming

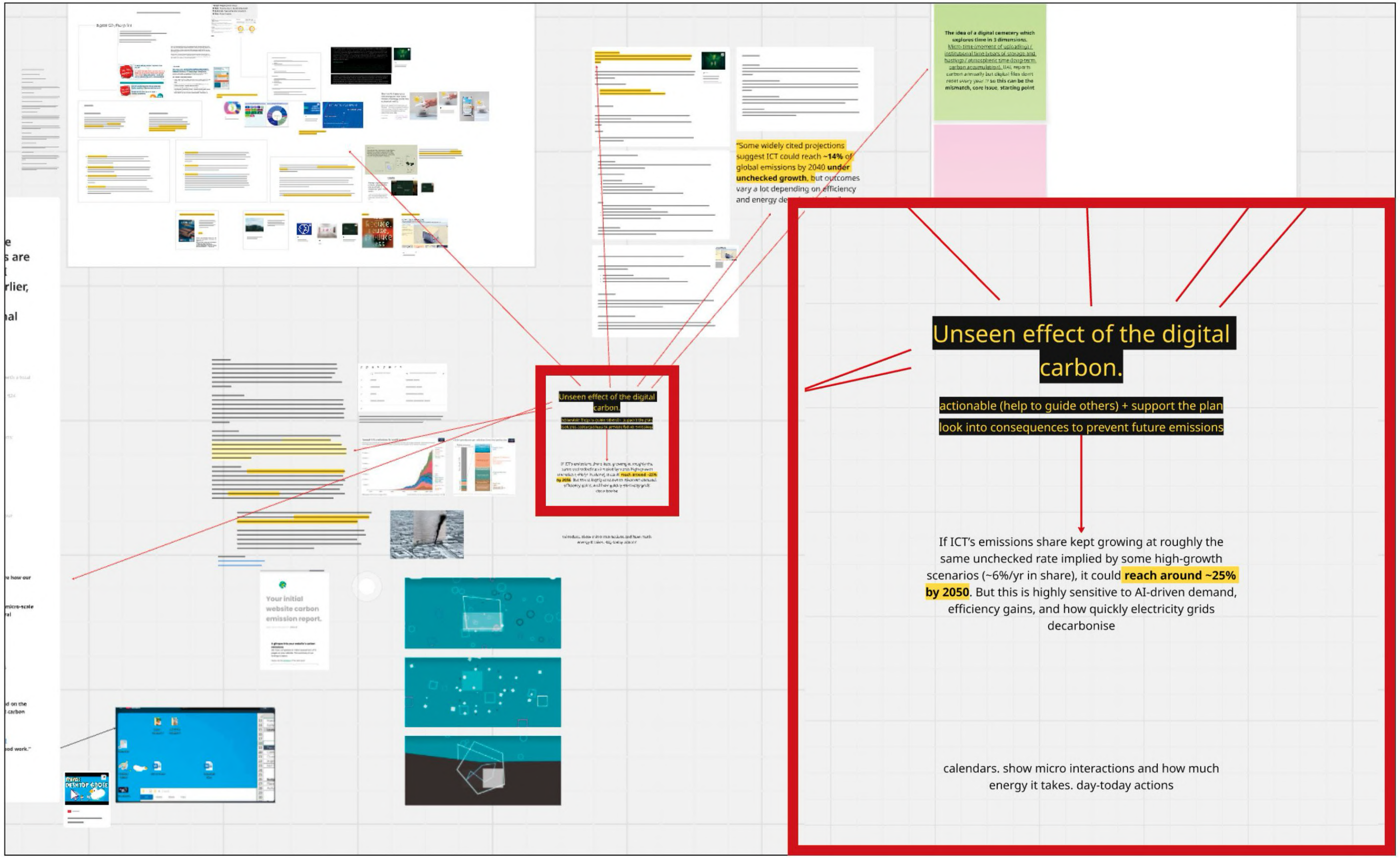
We each find the directions we're interested in and then bring them together.



[Miro Link]

Brain Storming

Through our discussion, we found that our thinking kept returning to the impact of digital carbon, so we chose this as our main focus.



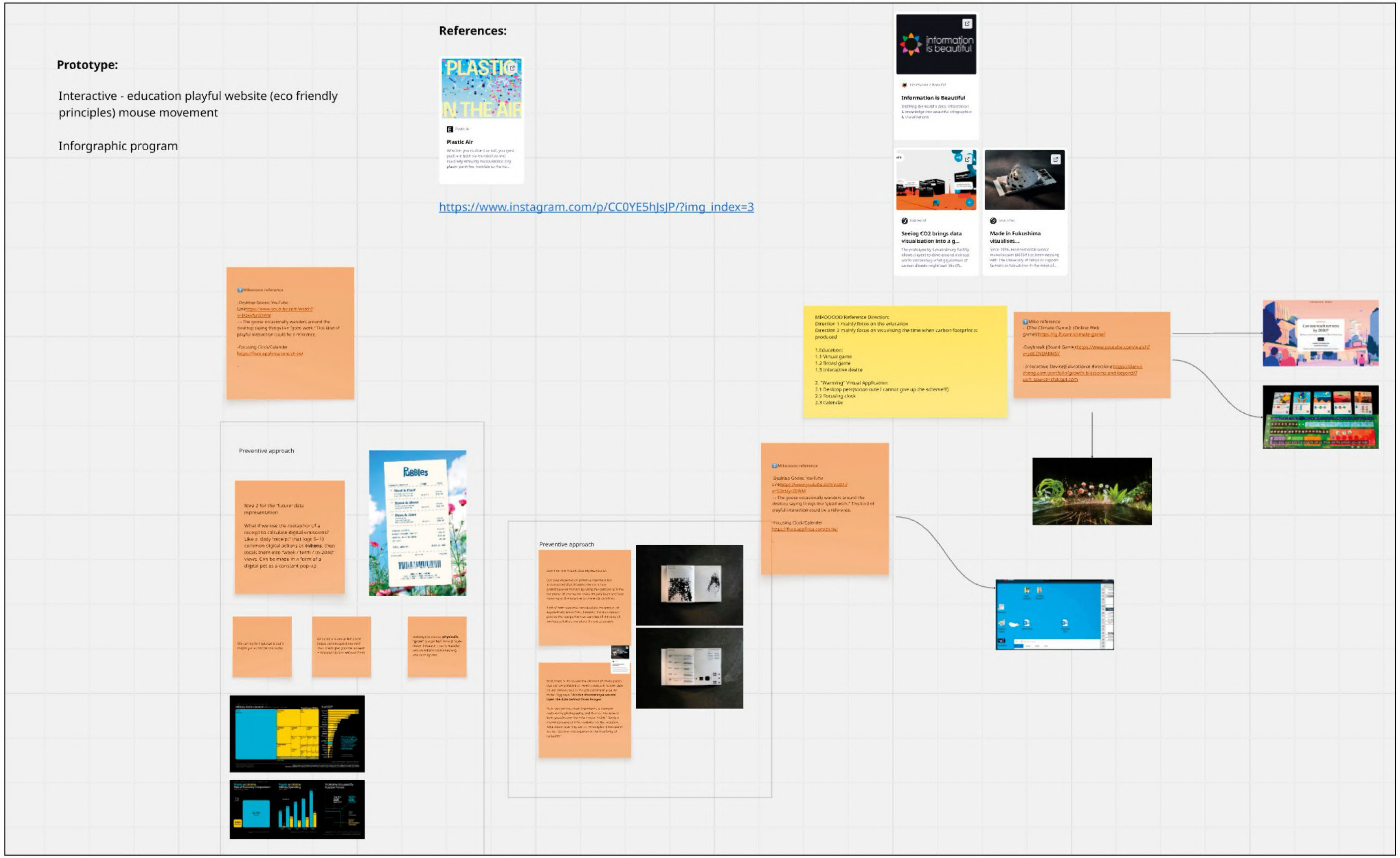
[Miro Link]

Brain Storming

We looked at some references related to the impact of digital carbon, to see how others have approached this topic, and to help us identify the questions we want to raise.

Yet these figures operate at the scale of institutions and the unit of years.

The gap between the data and the person is not one of quantity, but of perception.

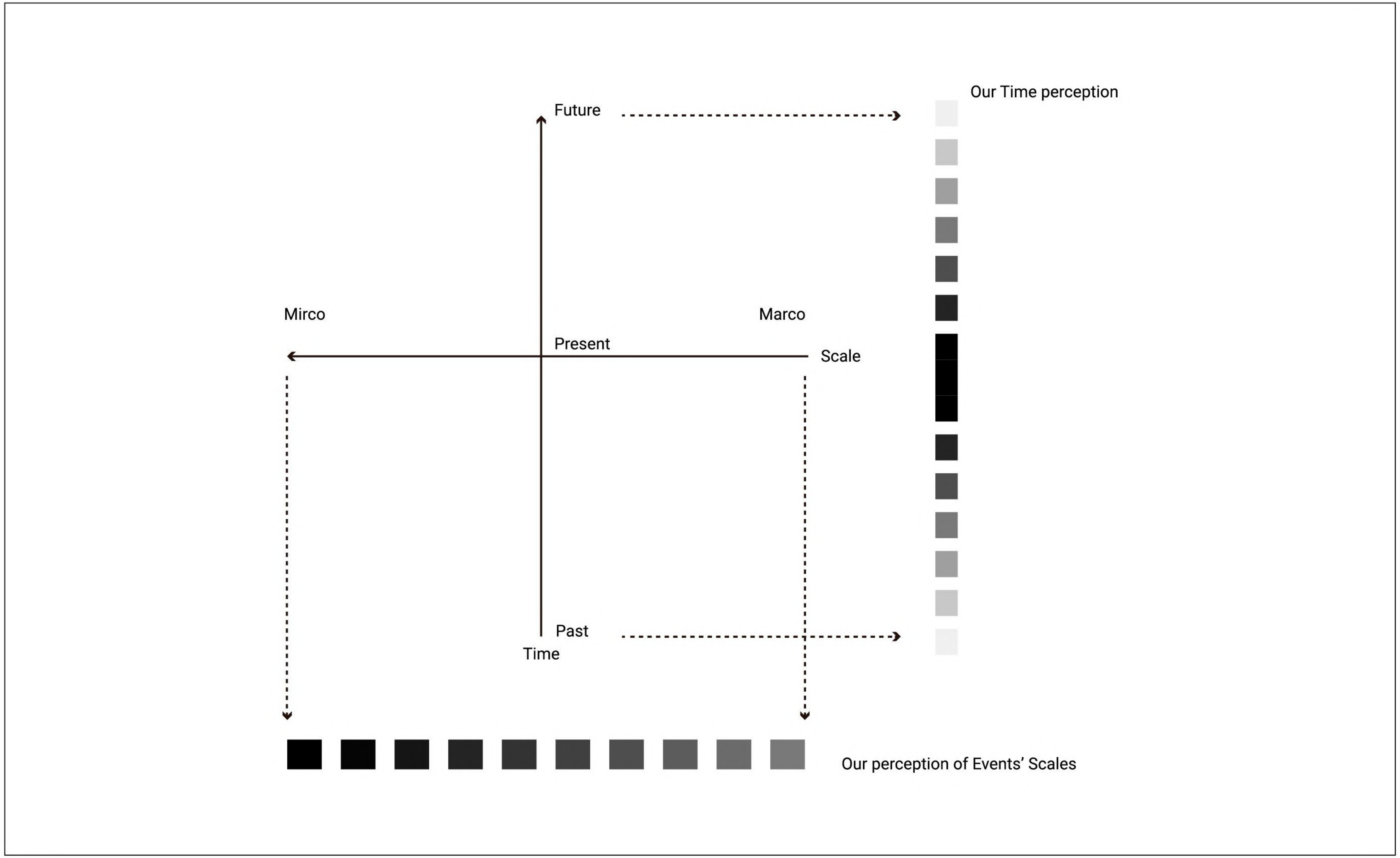


[Miro Link]

Assumption

Introducing a temporal axis — present, future — makes the problem more visible. Human perception is sharpest at the present moment.

Our sense of the past and the future is comparatively dim, and tends to remain so until anchored by a specific event, a concrete experience, or a tangible point of reference. Without that anchor, distant time remains distant.

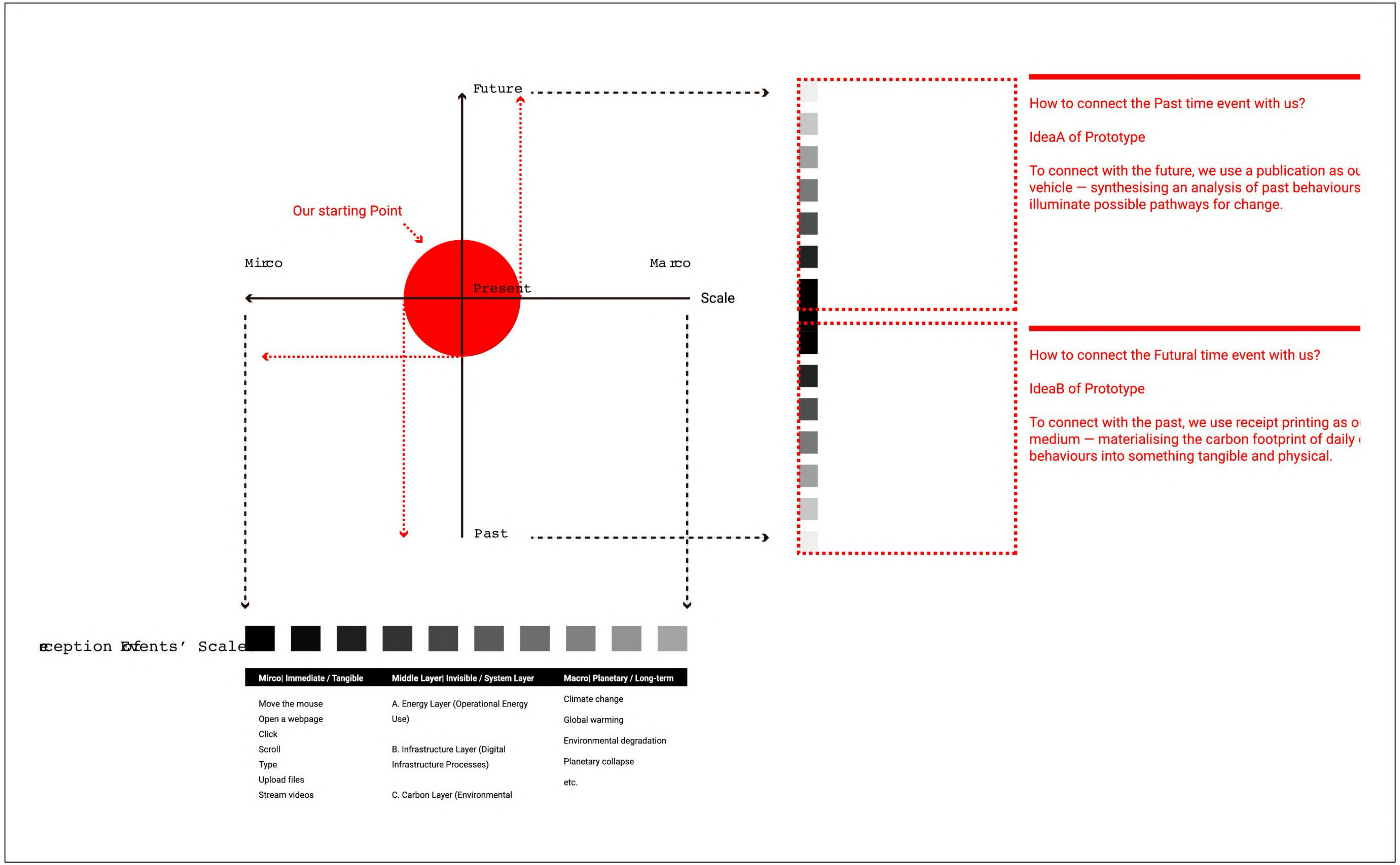


[Miro Link]()

Assumption

This brings us to a central question:

How can a design intervention make the hidden carbon cost of everyday digital habits visible and actionable across micro (daily) and macro (future) timescales at UAL?
And furthermore — what role can design play in this context?



[Miro Link]

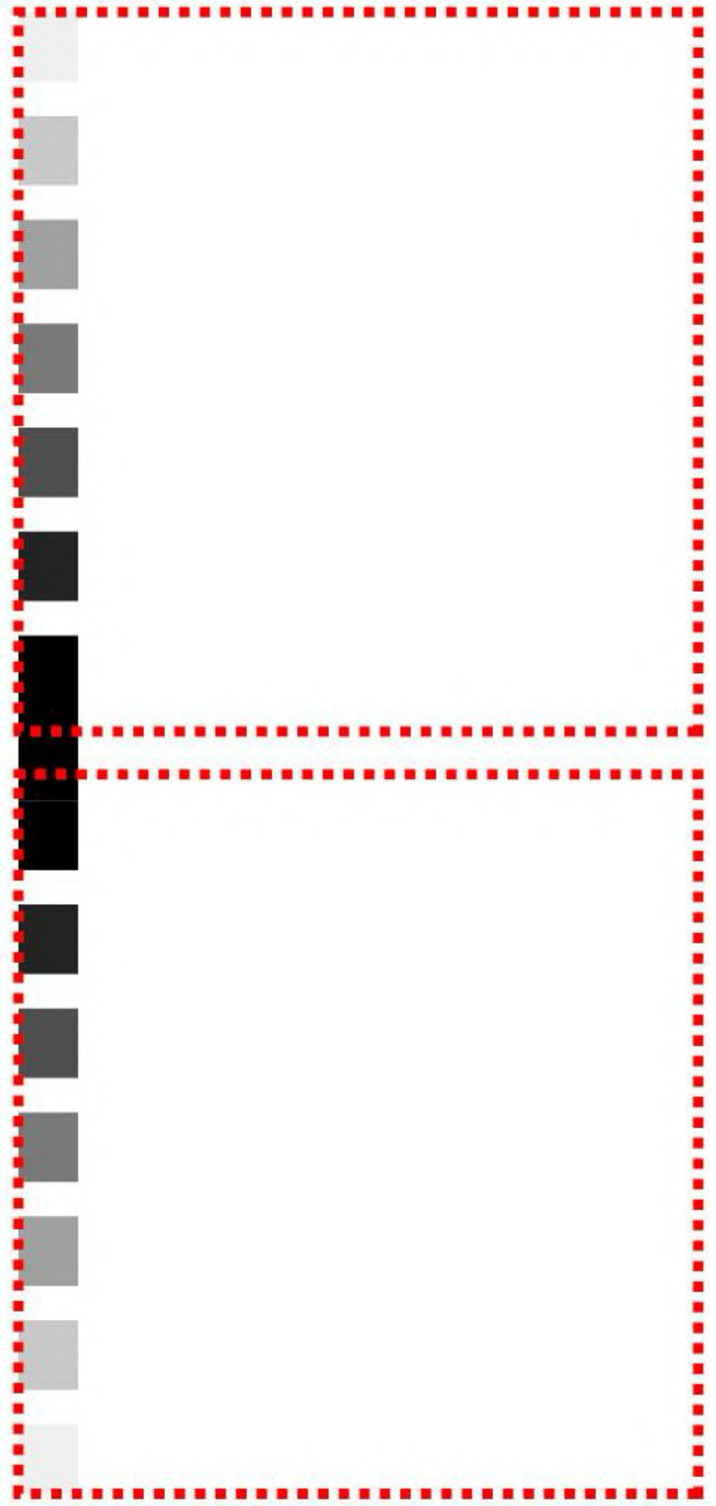
Ideas

To address this question, we decided to explore it from two dimensions:
(1) how we form meaningful connections with the past and the future, and
(2) how stronger connections can be created through a micro scale that we can more directly sense and experience.

Our perception Events' Scales

Mirco| Immediate / Tangible	Middle Layer| Invisible / System Layer	Macro| Planetary / Long-term
Move the mouse	A. Energy Layer (Operational Energy Use)	Climate change
Open a webpage	Electricity consumption	Global warming
Click	Energy usage	Environmental degradation
Scroll	Power demand	Ecosystem collapse
Type	Computational load	Planetary instability
Upload files	Server processing activity	Earth system disruption
Stream videos	Device energy draw	Planetary collapse
	B. Infrastructure Layer (Digital Infrastructure Processes)	
	Data transmission	
	Network traffic	
	Cloud storage operations	
	Data center operations	
	Server infrastructure load	
	Distributed computing processes	
	Bandwidth utilization	
	C. Carbon Layer (Environmental Output)	
	Carbon emissions	
	CO_2 emissions	
	Increased CO_2 output	
	Greenhouse gas emissions (GHG emissions)	
	Digital carbon footprint	
	Operational carbon footprint	
	Embodied carbon	
	Embodied energy	

OurTime perception



How to connect the Futural time event with us?

IdeaA of Prototype

To connect with the past, we use receipt printing as our medium — materialising the carbon footprint of daily digital behaviours into something tangible and physical.

How to connect the Past time event with us?

IdeaB of Prototype

To connect with the future, we use a publication as our vehicle — synthesising an analysis of past behaviours to illuminate possible pathways for change.

Miro Link

Prototype - PartA

-Data Physicalization: Receipt printer

This is a device that tracks every interaction a user has with their computer
— each keystroke, each trackpad gesture, each window opened, switched, or closed, each quiet movement within a browser(to be revised)

Within this system, time spent at the computer serves as the fixed quantity; user behaviour and carbon output become the dynamic variables made visible.

The past is no longer a number on a report.
It becomes something you can hold.

Receipt metaphor

Prototype - PartA

-Data Physicalization: Receipt printer

Our question:
How can we made inner working of the system exposed to the user? In what way we can calculate the power and eventually amount of carbon being used throughout the day of CSM student?

Throughout experimentation we used Python language to pull data from the computer apps to understand how much energy costs daily computer tasks.

•Every few seconds it checks which app is frontmost.

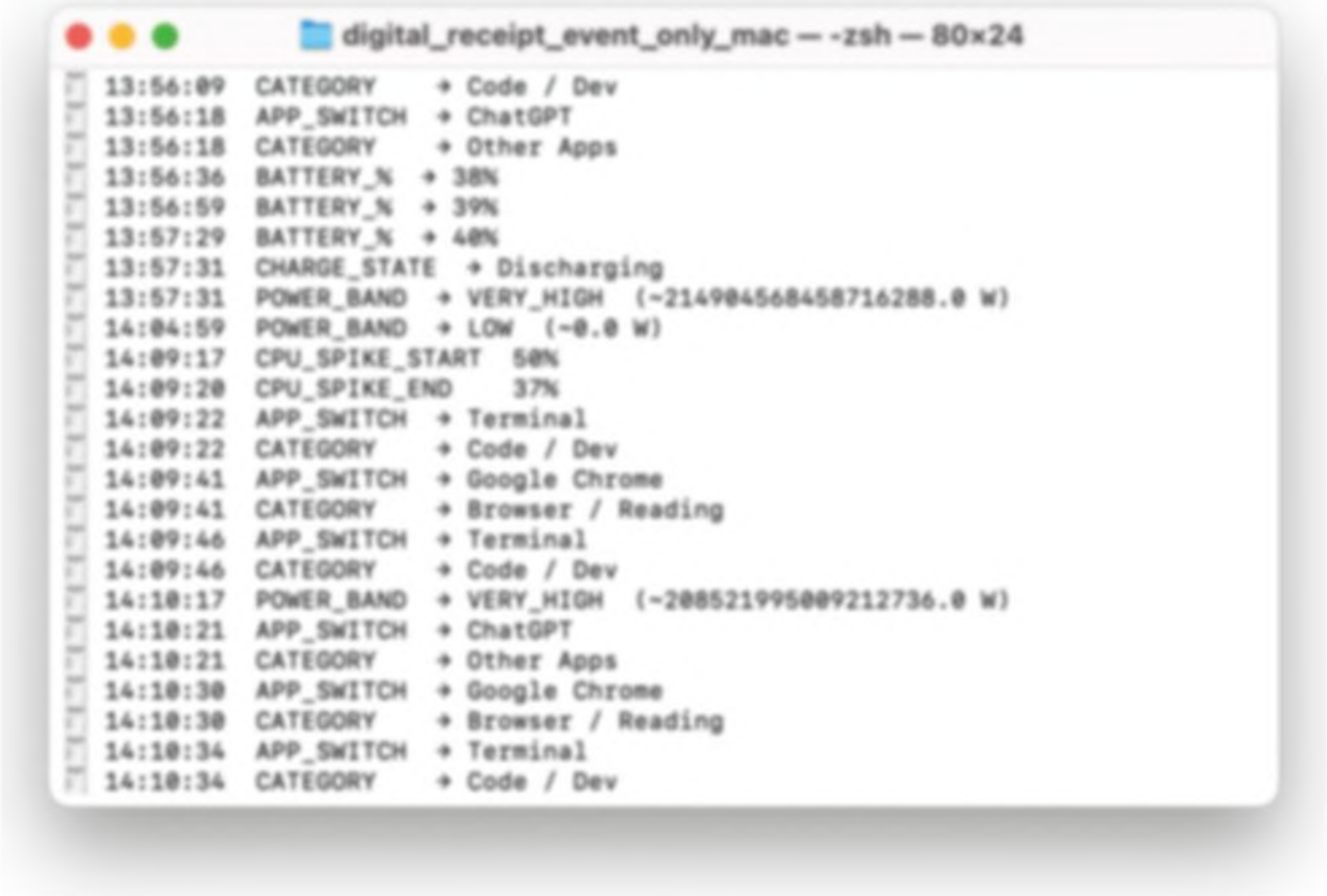
•It translates that app into one of 10 activity categories (Browser, Messaging, Code, etc.).

•When the category changes, it prints one row: time + a bubble code (1–10) + an energy estimate.

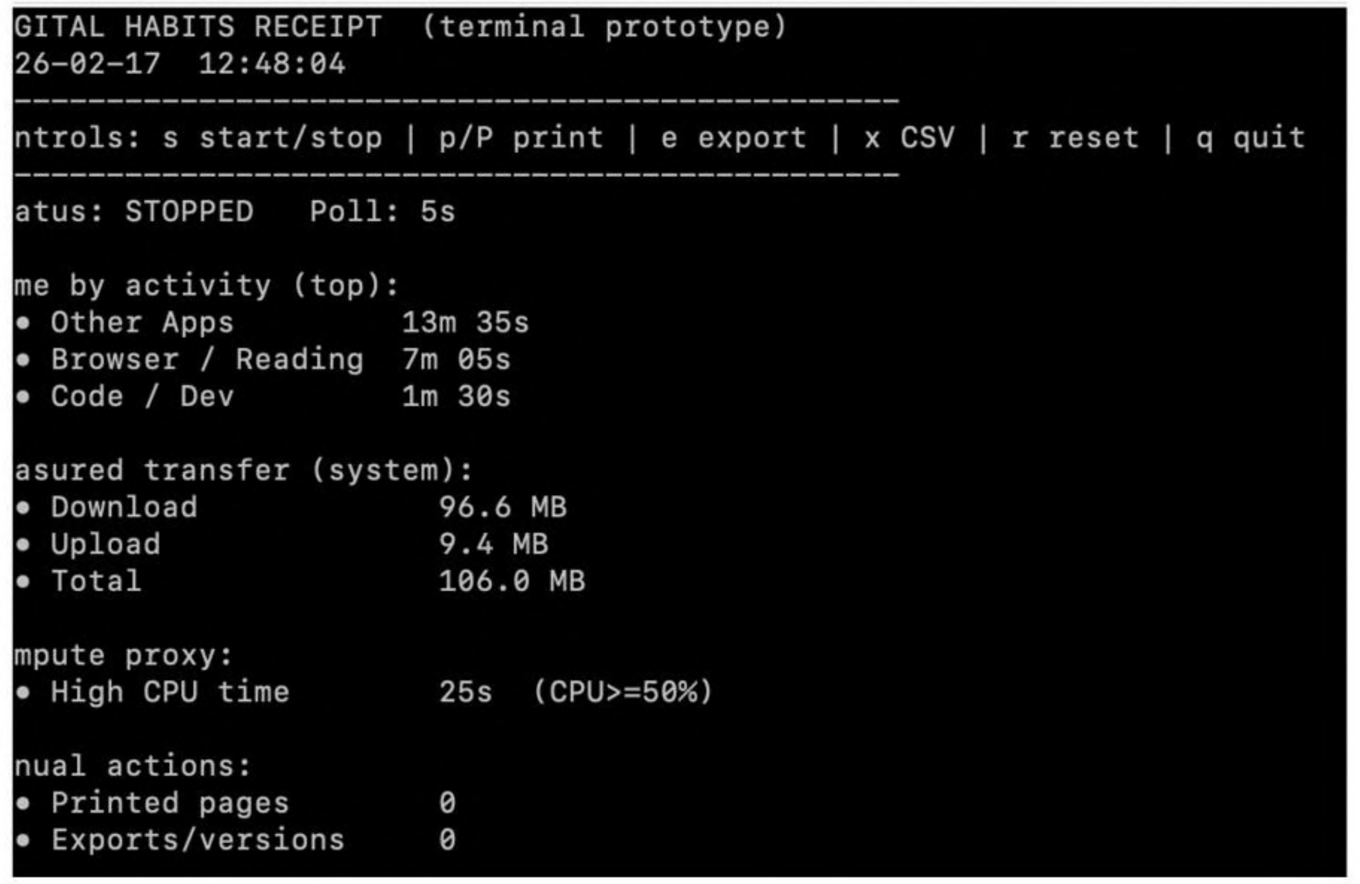
•The energy number is calibrated from my real battery drop.

Iterations

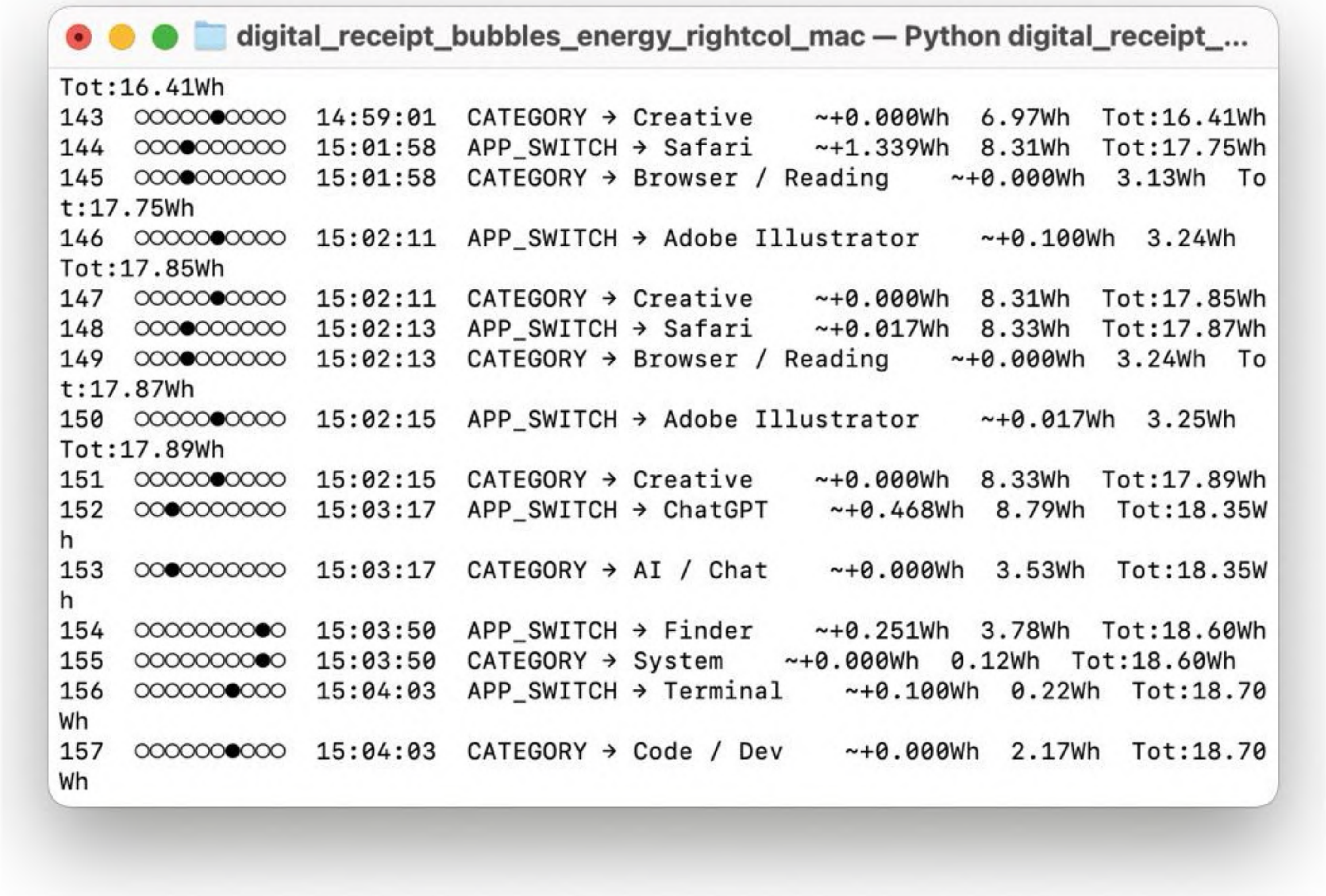
1



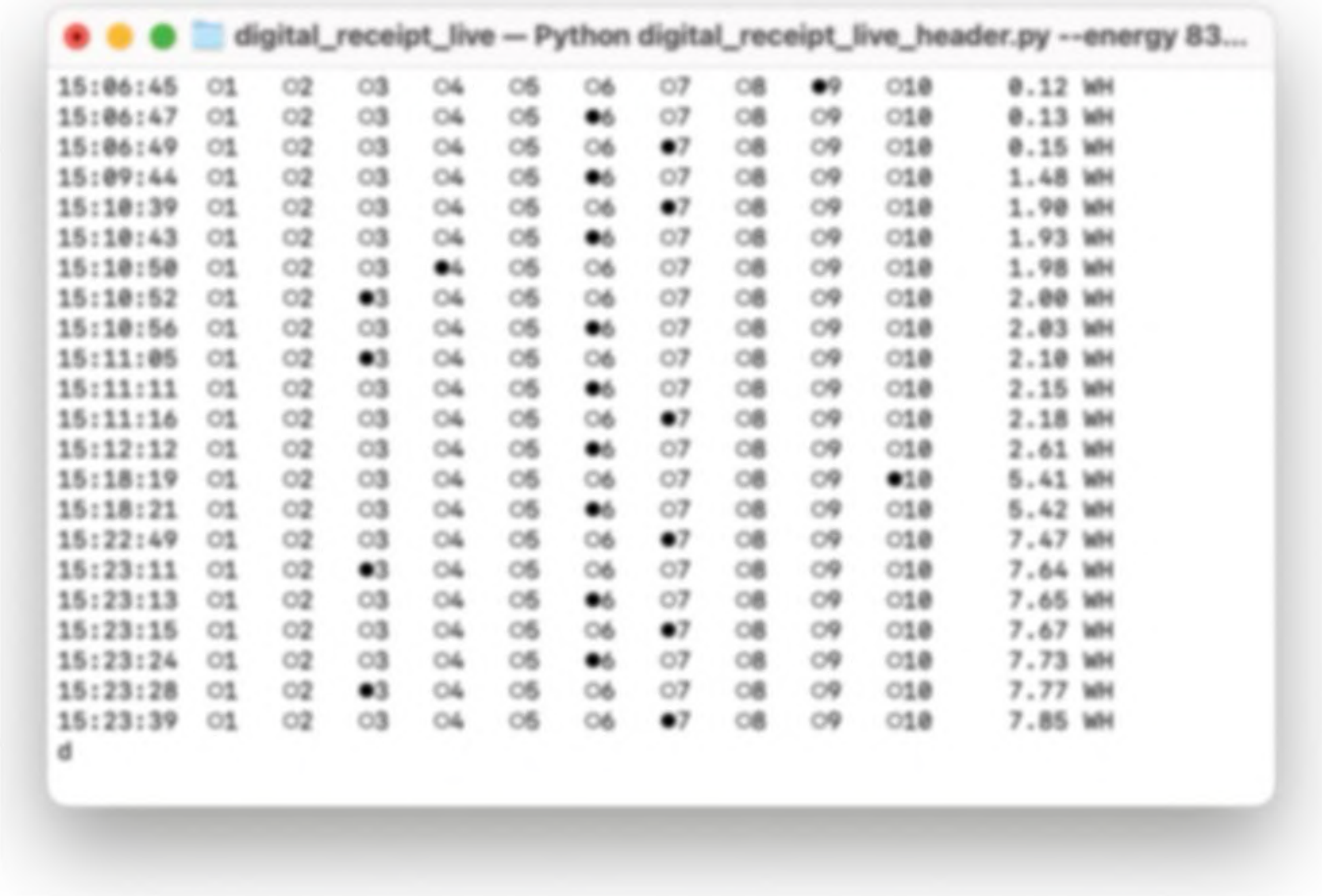
2



3



4

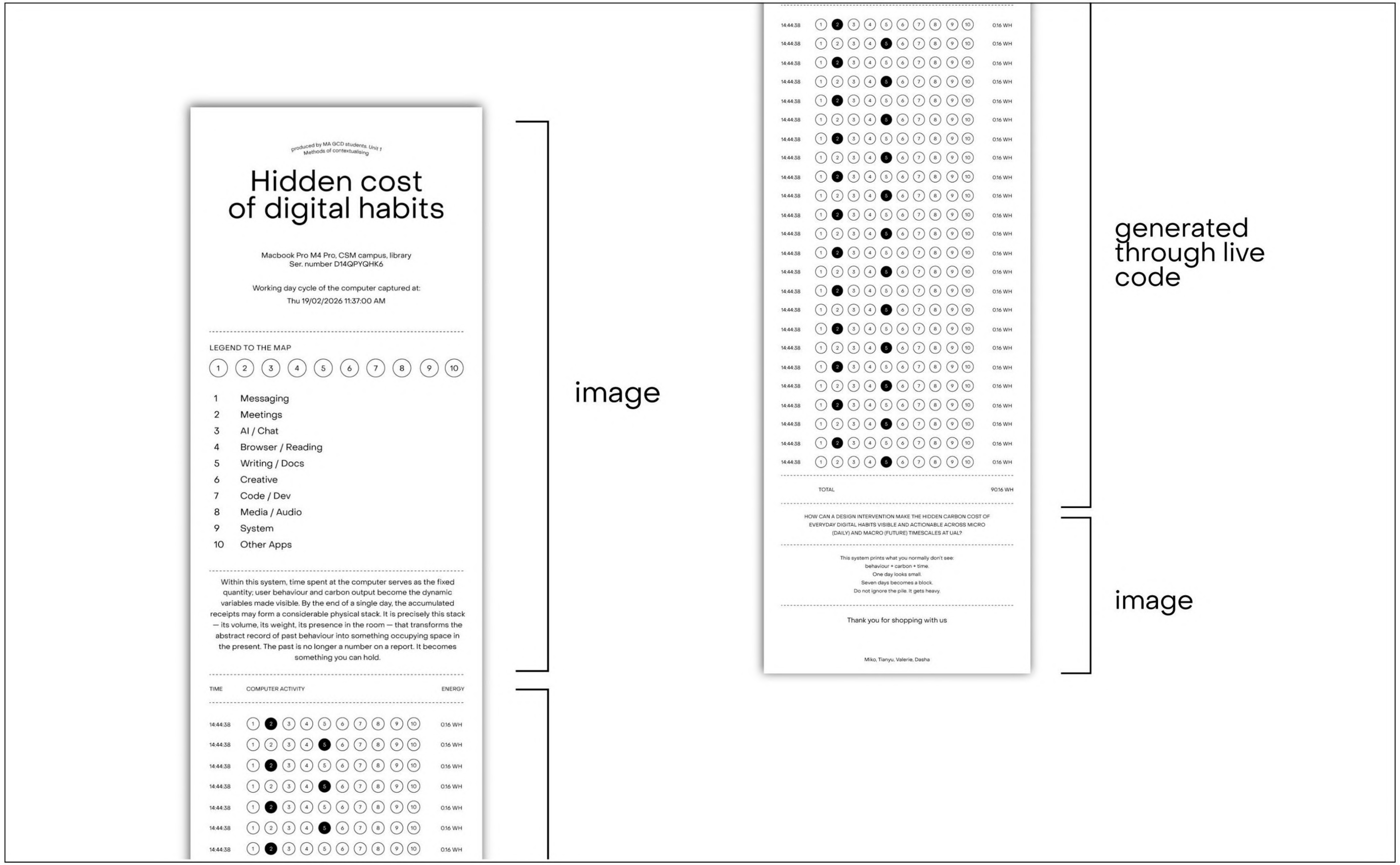


8.61 Wh / 0.333 h = ~25.8 W average

Prototype - PartA

-Data Physicalization: Receipt printer

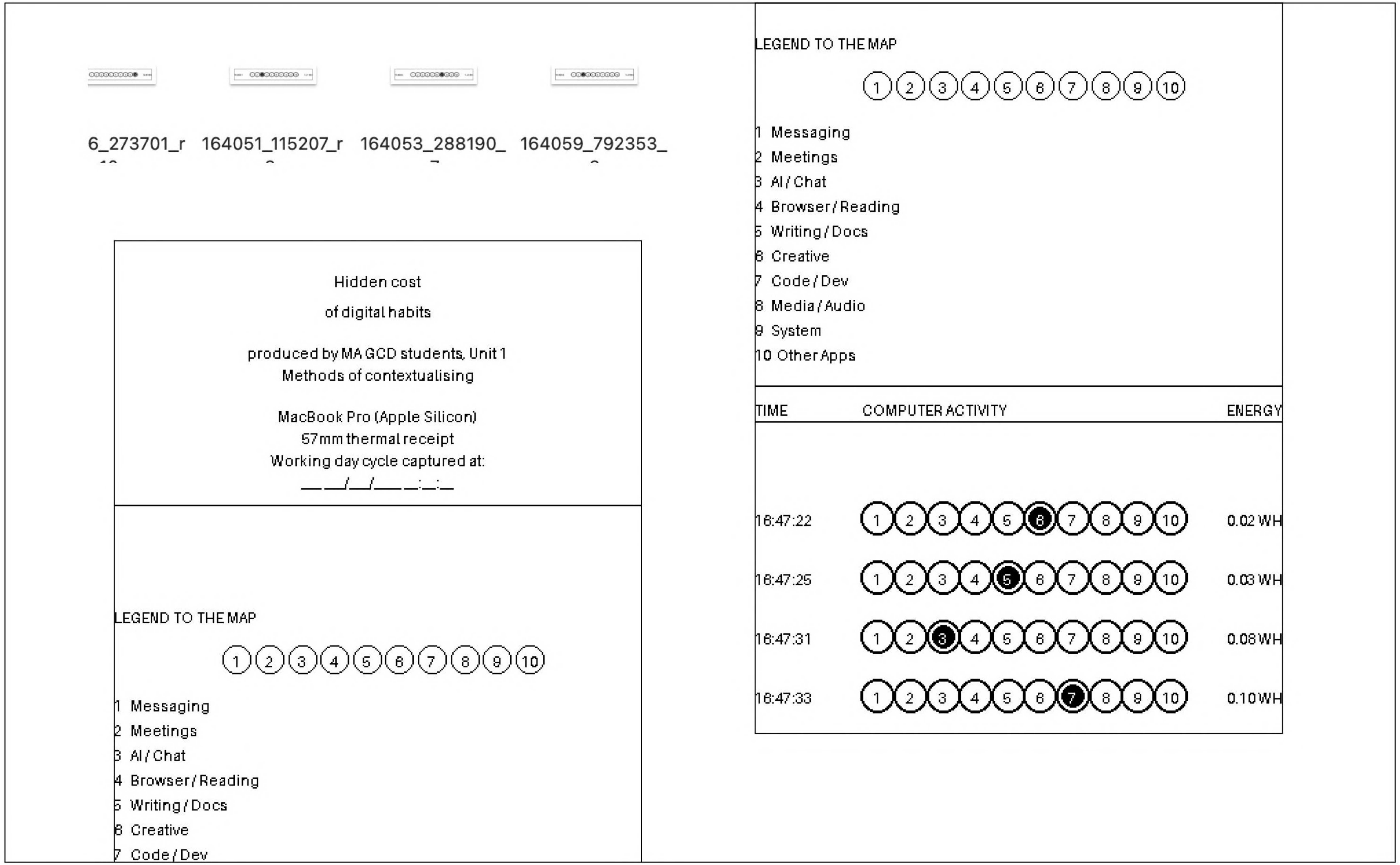
Visual style of the receipt
Plus considerations for tackling the printing through receipt machine to retain control over visuals



Prototype - PartA

-Data Physicalization: Receipt printer

Current Python iteration
Currently doesn't use the printer, so it just exists digitally



Prototype - PartB

Physical receipt insert

A printed receipt sample that documents everyday digital activity as a “cost” you can hold and review.

Introduction

Context for the project, intentions, and process — explaining why we chose a receipt printer as the format (familiar, immediate, transactional) and how the prototype works.

Infographic 1 — The concertina timeline

A long fold-out strip that visualises the tracked data over time, with a clear legend. It shows accumulated energy use and estimated carbon impact, plus how energy providers/grid intensity influence overall emissions.

Infographic 2 — Futures comparison (best vs worst case)

Two contrasting scenarios shown side-by-side (or printed double-sided): what this footprint could look like if practices improve versus if nothing changes.

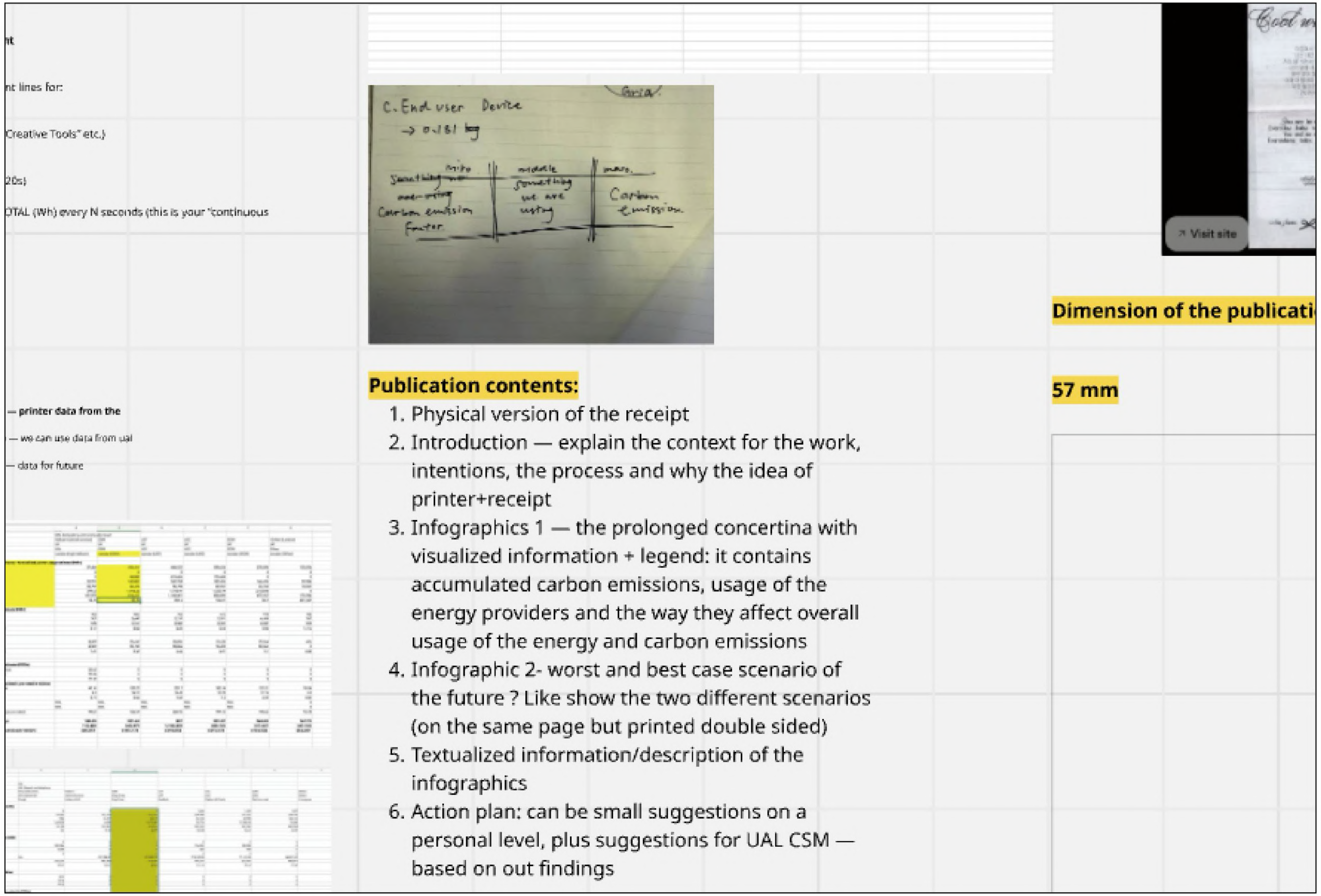
Explanatory text

Short, accessible descriptions that decode the infographics: what each element represents, how to read it, and what the key findings are.

Action plan

Practical recommendations at two levels:

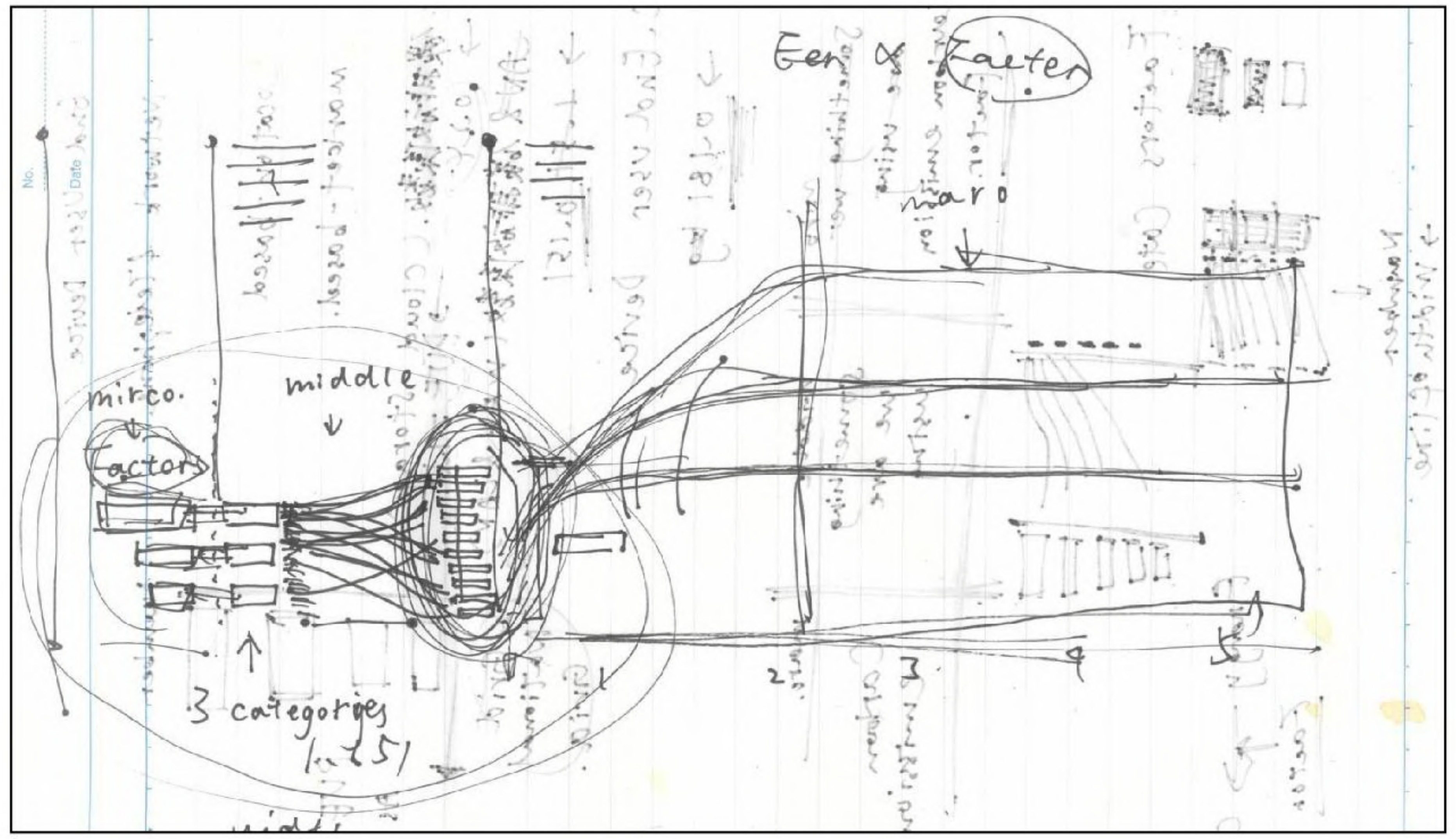
- Personal: small habit and settings changes that reduce impact.
- UAL / CSM: institutional suggestions informed by our findings (policies, design standards, procurement/IT choices, publishing practices).



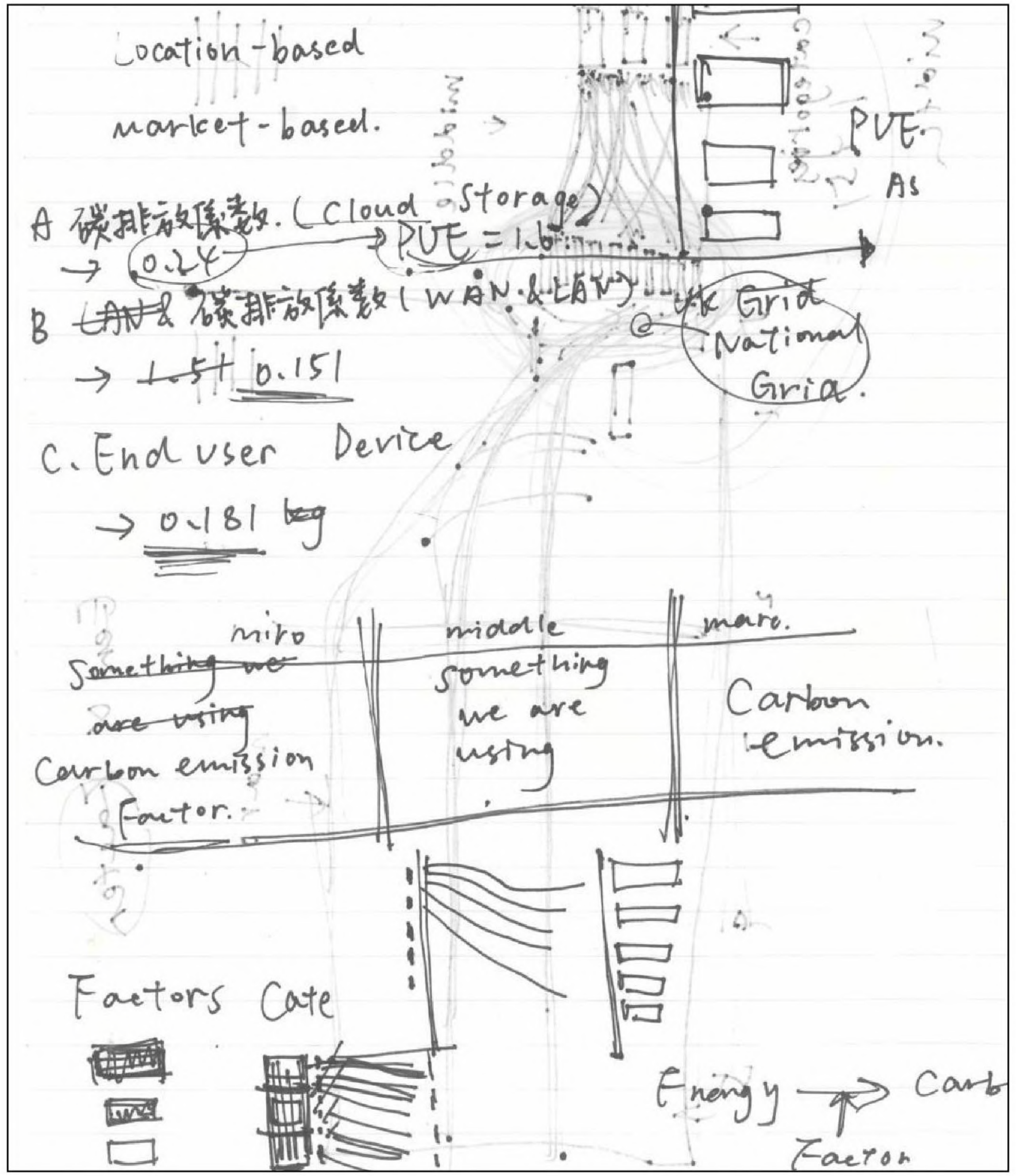
[Miro Link]

Prototype - PartB

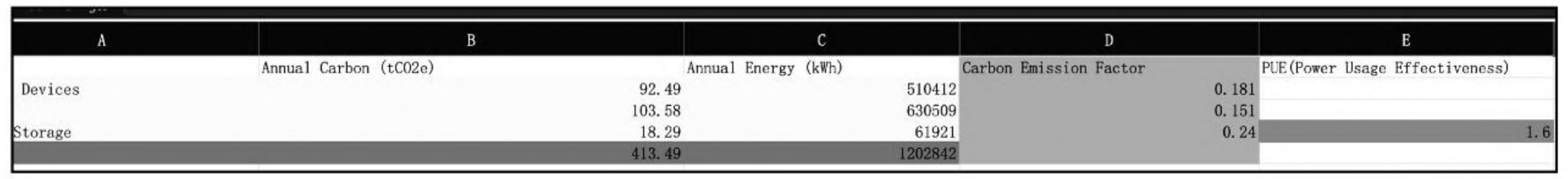
-Publication- the logic of Inforgraphic



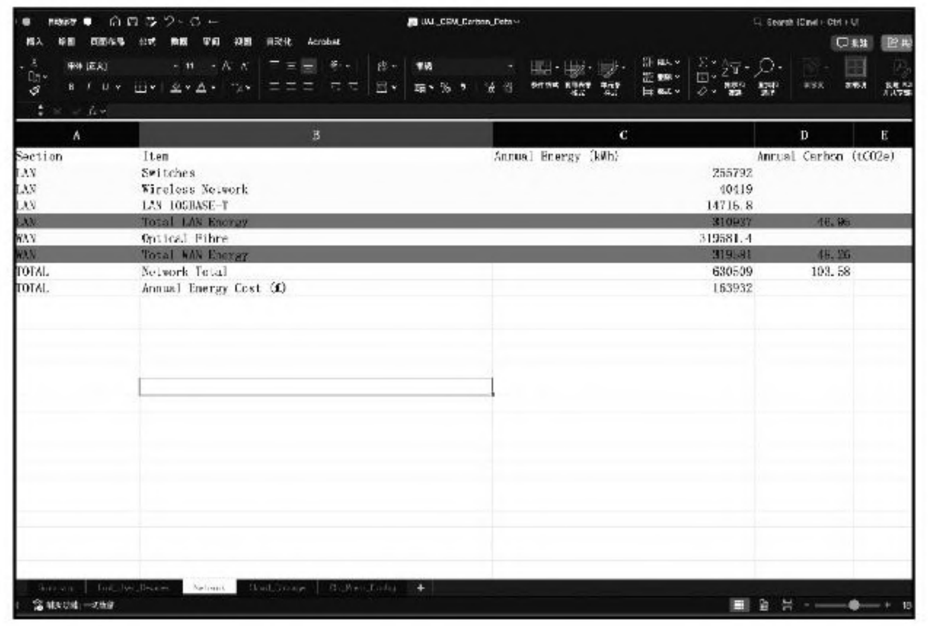
Sketch of Infrographic

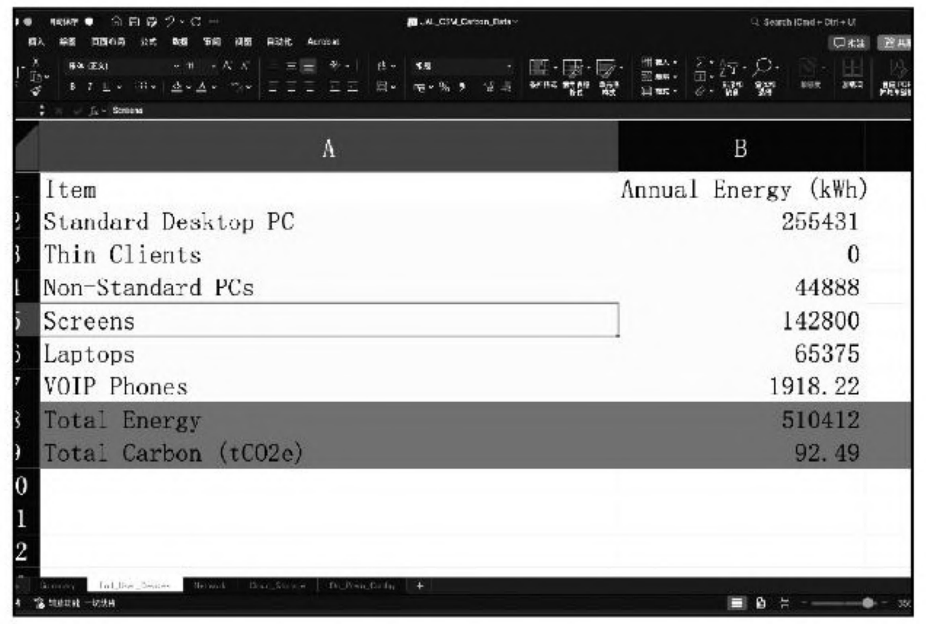


Analysis of Data

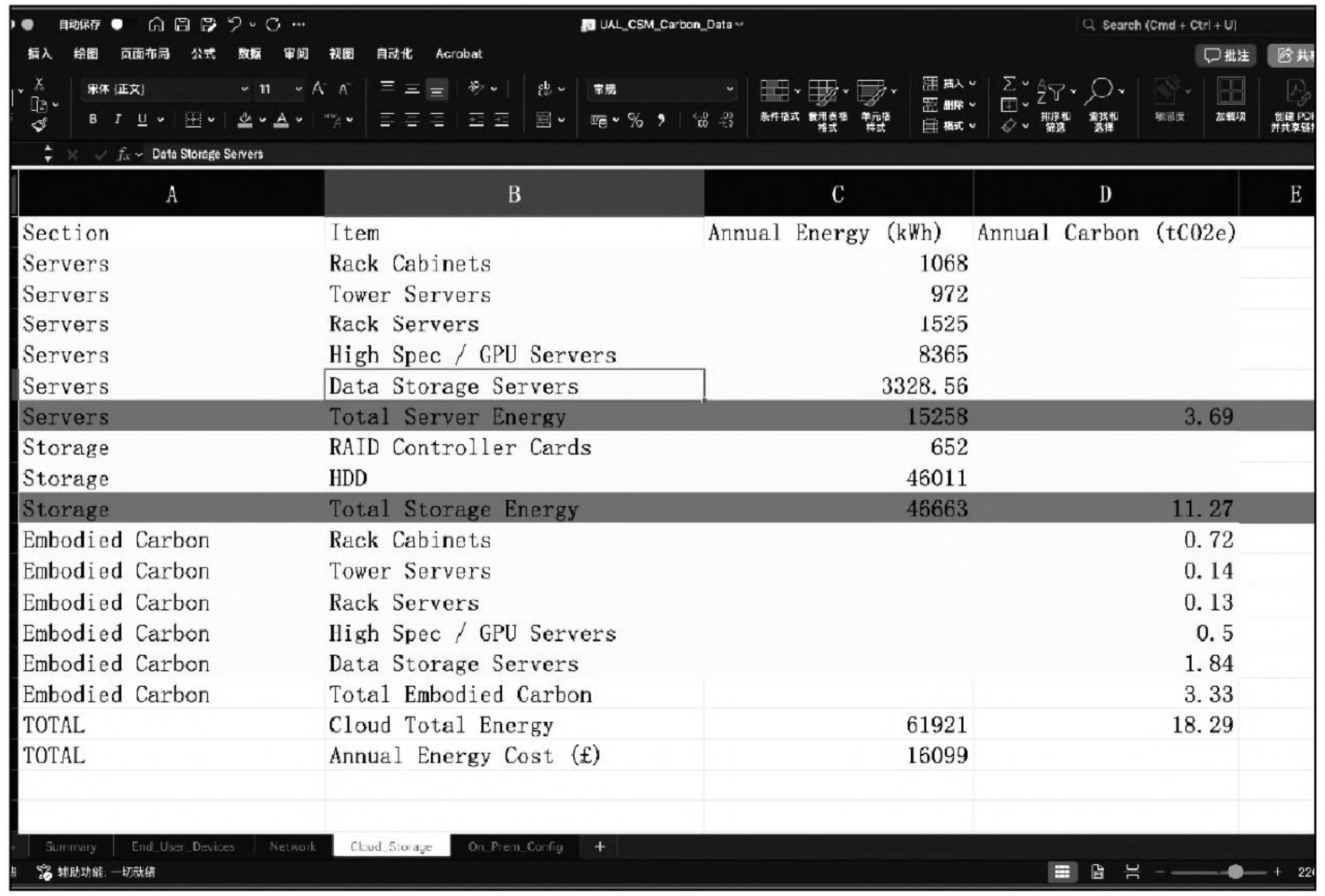


A	B	C	D	E
	Annual Carbon (tCO2e)	Annual Energy (kWh)	Carbon Emission Factor	PUE(Power Usage Effectiveness)
Devices	92.49	510412	0.181	
	103.58	630509	0.151	
Storage	18.29	61921	0.24	1.6
	413.49	1202842		





Item	Annual Energy (kWh)
Standard Desktop PC	256431
Thin Clients	0
Non-Standard PCs	44888
Screens	142800
Laptops	65375
VOIP Phones	1918.22
Total Energy	510412
Total Carbon (tCO2e)	92.49



Section	Item	Annual Energy (kWh)	Annual Carbon (tCO2e)
Servers	Rack Cabinets	1068	
Servers	Tower Servers	972	
Servers	Rack Servers	1525	
Servers	High Spec / GPU Servers	8365	
Servers	Data Storage Servers	3328.56	
Servers	Total Server Energy	15258	3.69
Storage	RAID Controller Cards	652	
Storage	HDD	46011	
Storage	Total Storage Energy	46663	11.27
Embodied Carbon	Rack Cabinets		0.72
Embodied Carbon	Tower Servers		0.14
Embodied Carbon	Rack Servers		0.13
Embodied Carbon	High Spec / GPU Servers		0.5
Embodied Carbon	Data Storage Servers		1.84
Embodied Carbon	Total Embodied Carbon		3.33
TOTAL	Cloud Total Energy	61921	18.29
TOTAL	Annual Energy Cost (£)	16099	

Prototype - PartB

-Publication- the draft of Inforgraphic

Mirco- Carbon Emission Factor

01 Micro Level — Carbon Emission Factor

The emission factor does not depend on how we use our devices, but on how electricity is sourced. It reflects the carbon intensity of the energy provider rather than individual behaviour. There are two accounting approaches:

Market-based
Users can choose energy suppliers. Some providers offer greener electricity with lower emission factors, though often at a higher cost.

Location-based
Emissions are calculated according to the regional grid average. This is the method adopted by our institution. While the value is relatively stable, there is limited flexibility in reducing it.

02 Why Cloud Emissions Are Higher

Cloud services have the highest emission factor.
Beyond the baseline UK grid factor (0.151), cloud emissions must also account for PUE (Power Usage Effectiveness). PUE measures the additional energy required to cool and maintain data centre infrastructure.

This means cloud emissions include:
- Operational electricity
- Cooling systems
- Supporting infrastructure

As a result, their total carbon intensity is higher.

03 Device Emission Factors

Device-related emission factors may slightly vary around the UK standard value (0.151).

These small differences occur because:
Different calculation models are used
Annual reporting methods may change
Some values are based on previous-year data
However, the UK grid average remains approximately 0.151

Middle-How Emissions Are Distributed in CSM

01 Sankey Diagram

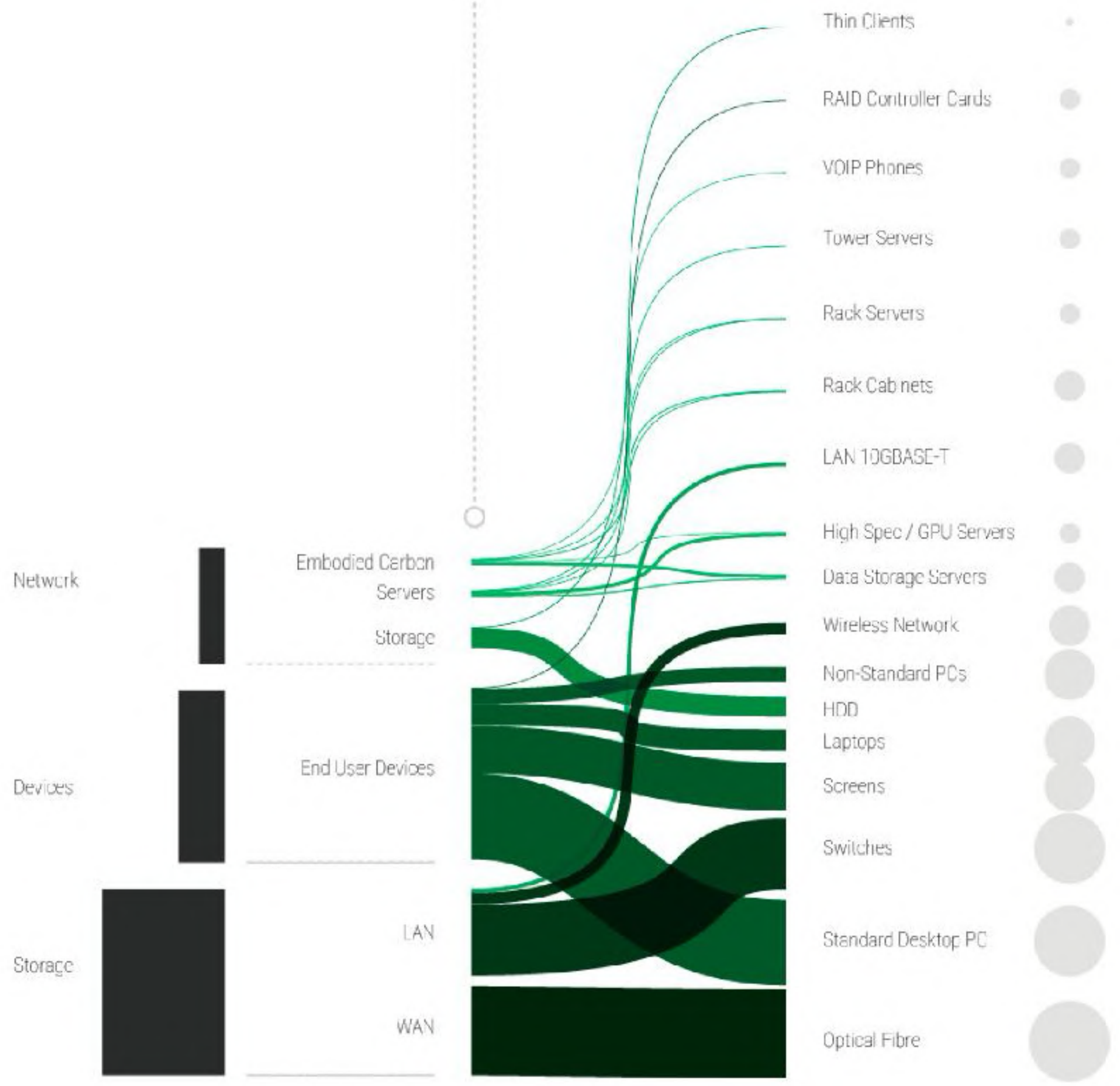
At the middle scale, emissions are analysed within CSM's digital infrastructure. They are grouped into three primary categories: Network, Devices, and Storage. Each category is further divided into subcategories to identify specific emission sources. The Sankey diagram visualises how these subcategories contribute to total emissions.

It shows where emissions originate and how they flow across the system. To clarify impact, all subcategories are arranged in descending order of carbon emissions. This ranking highlights which components contribute the most and where reduction efforts may be most effective.

02 Bubble Chart

The bubble chart following the Sankey diagram further illustrates the proportion of each subcategory within the total carbon emissions.

The size of each circle represents its relative share, allowing the weight of each component within the overall system to be compared more intuitively and at a glance.



Maro- The worse status "The Long-Tail Effect of CO_2"

At the macro level, we project UAL CSM's future digital carbon impact based on the 2024/25 dataset, and visualise a key property of CO_2: it does not disappear on a short timescale, but persists for decades to millennia.

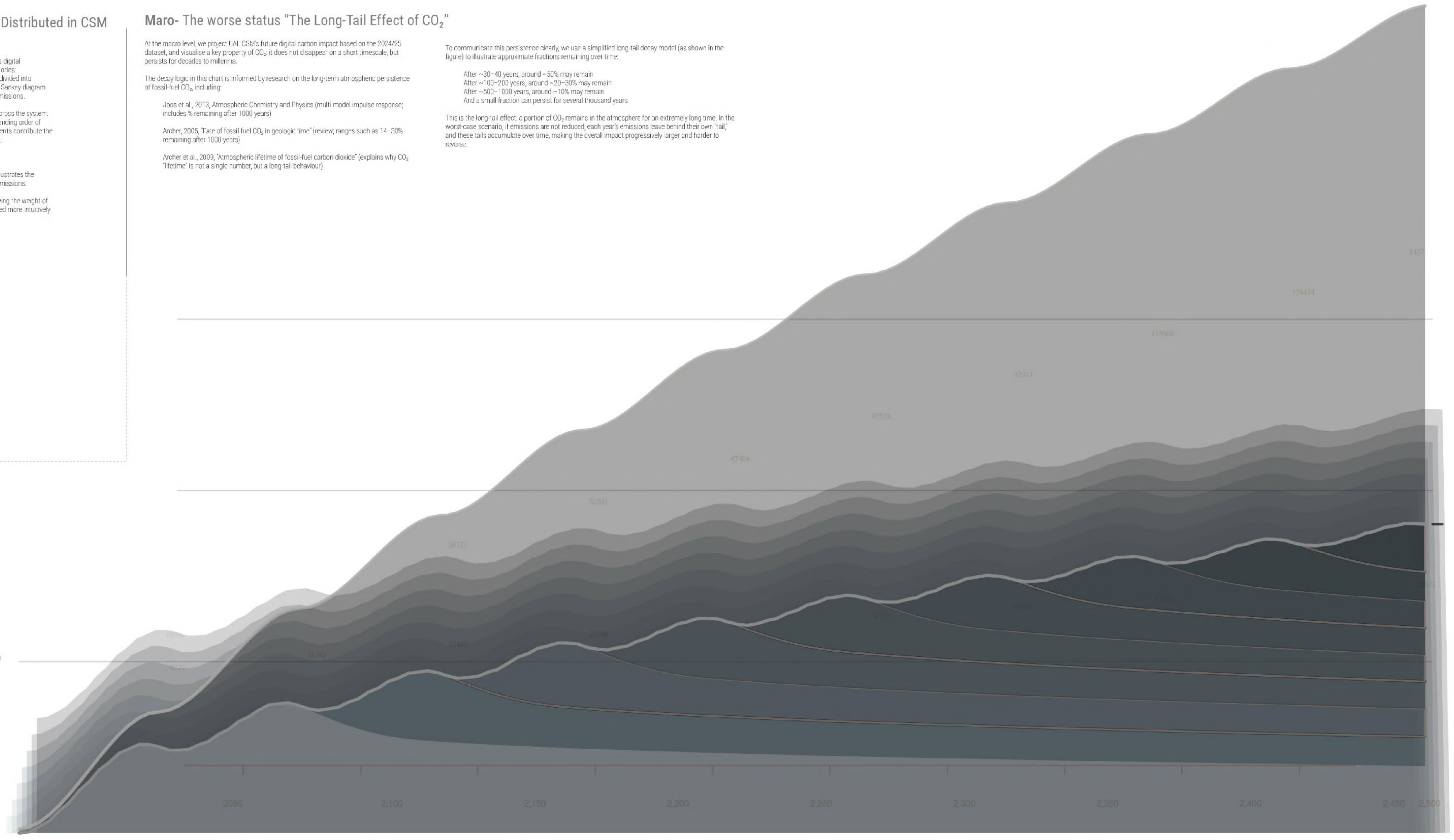
The decay logic in this chart is informed by research on the long-term atmospheric persistence of fossil-fuel CO_2, including:

- Joos et al., 2013, Atmospheric Chemistry and Physics (multi-model impulse response; includes % remaining after 1000 years)
- Archer, 2005, "Fate of fossil fuel CO_2 in geologic time" (review; ranges such as 14–30% remaining after 1000 years)
- Archer et al., 2009, "Atmospheric lifetime of fossil-fuel carbon dioxide" (explains why CO_2 "lifetime" is not a single number, but a long-tail behaviour)

To communicate this persistence clearly, we use a simplified long-tail decay model (as shown in the figure) to illustrate approximate fractions remaining over time:

- After ~30–40 years, around ~50% may remain
- After ~100–200 years, around ~20–30% may remain
- After ~500–1000 years, around ~10% may remain
- And a small fraction can persist for several thousand years

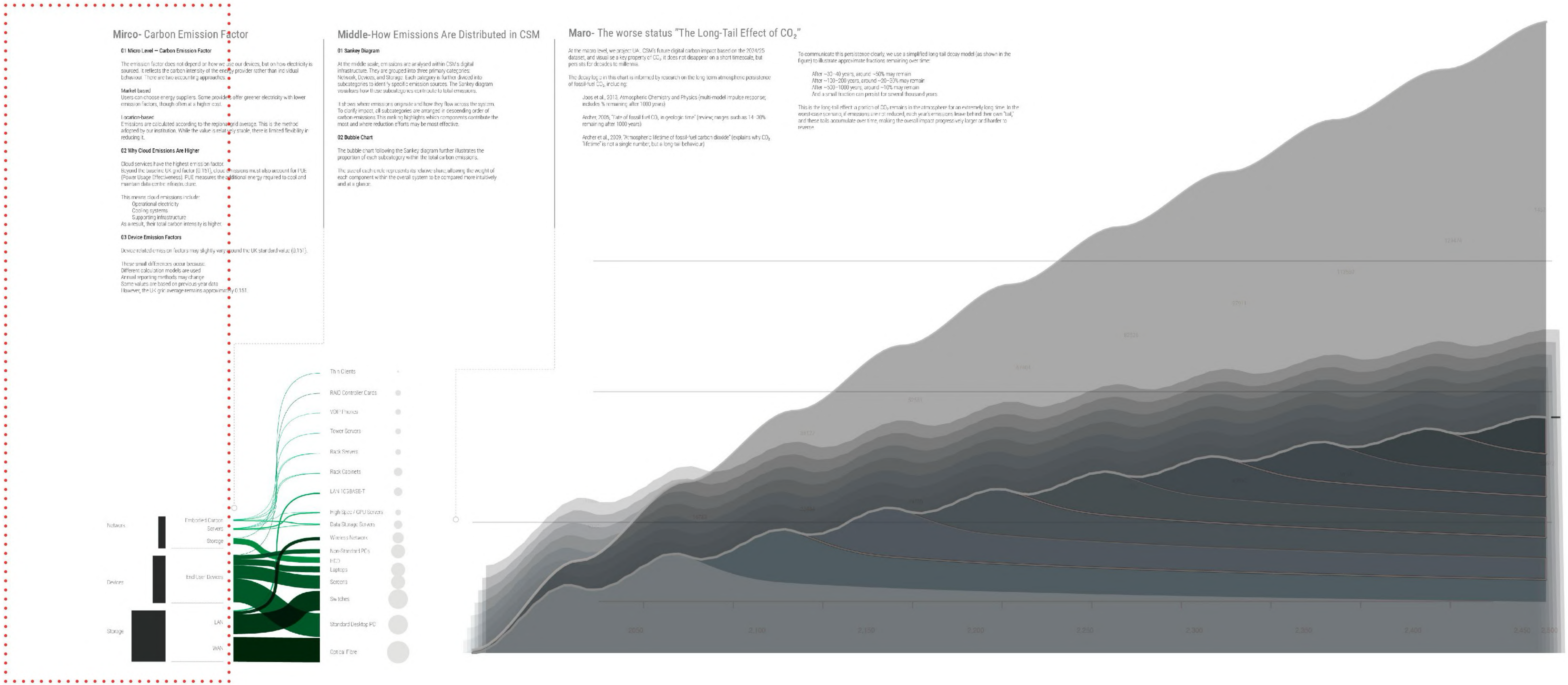
This is the long-tail effect: a portion of CO_2 remains in the atmosphere for an extremely long time. In the worst-case scenario, if emissions are not reduced, each year's emissions leave behind their own "tail," and these tails accumulate over time, making the overall impact progressively larger and harder to reverse.



Prototype - PartB

Infographic Part 1

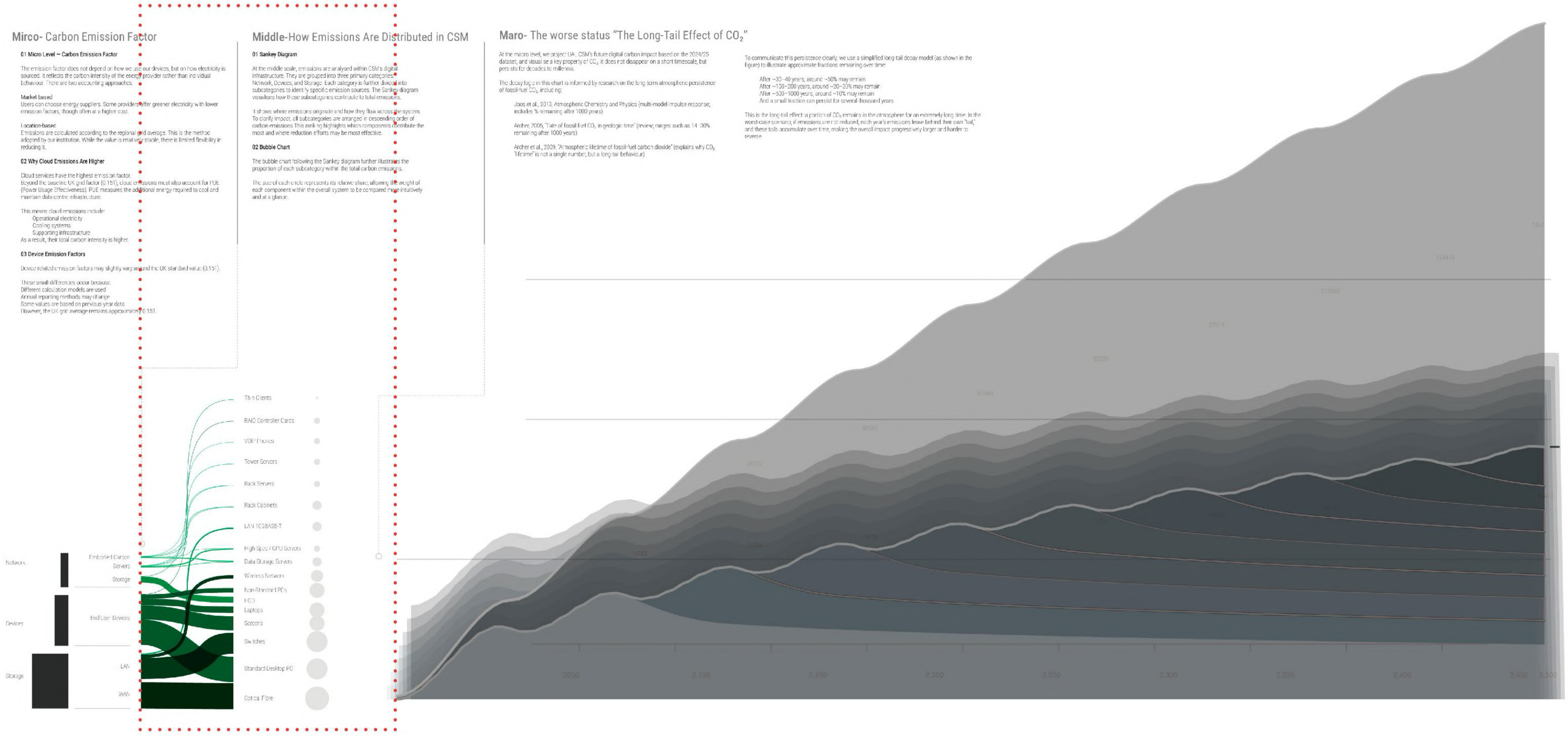
Micro Perspective: Carbon Emission Factor



Prototype - PartB

Infographic Part 2

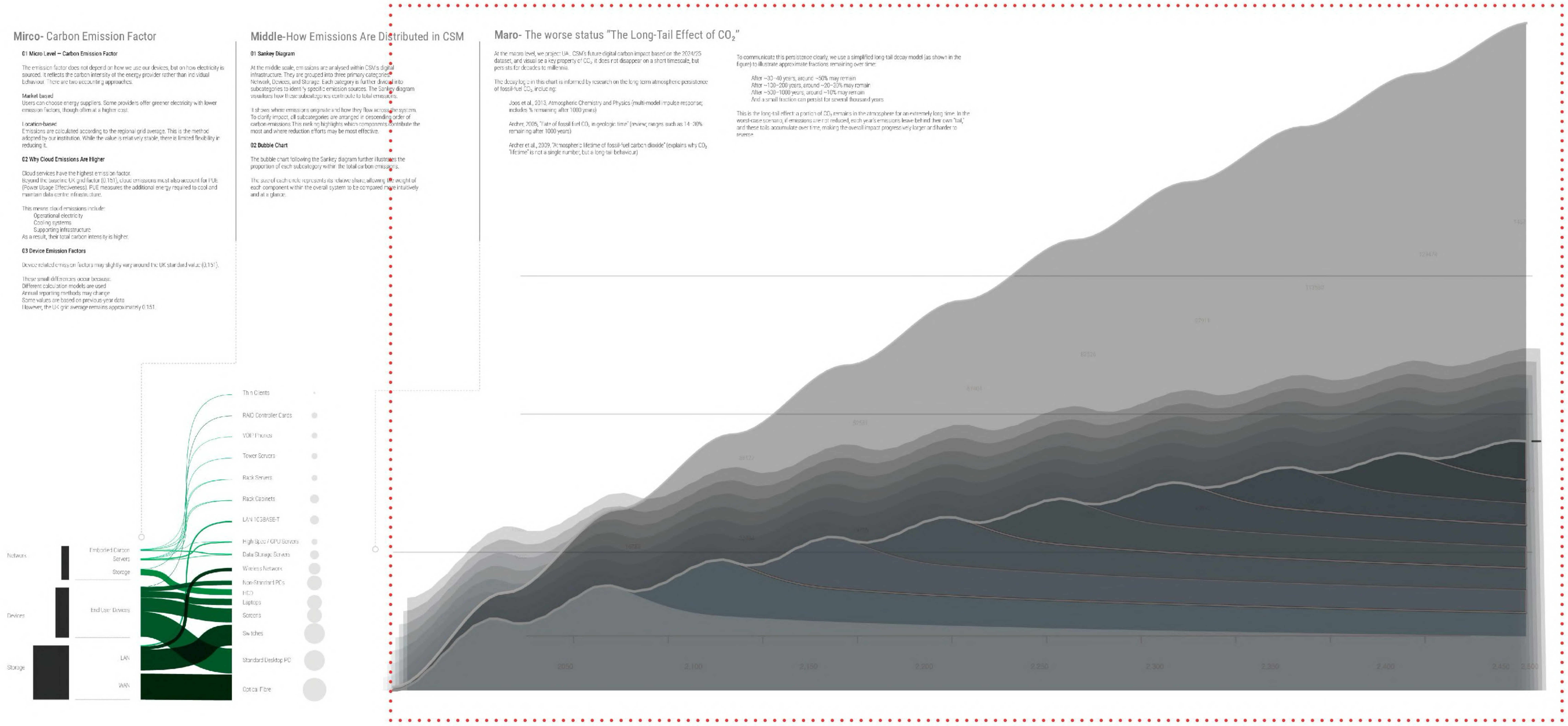
Middle Perspective: Sankey + Bubble Chart



Prototype - PartB

Infographic Part 3

Future Projection – Tail Effect

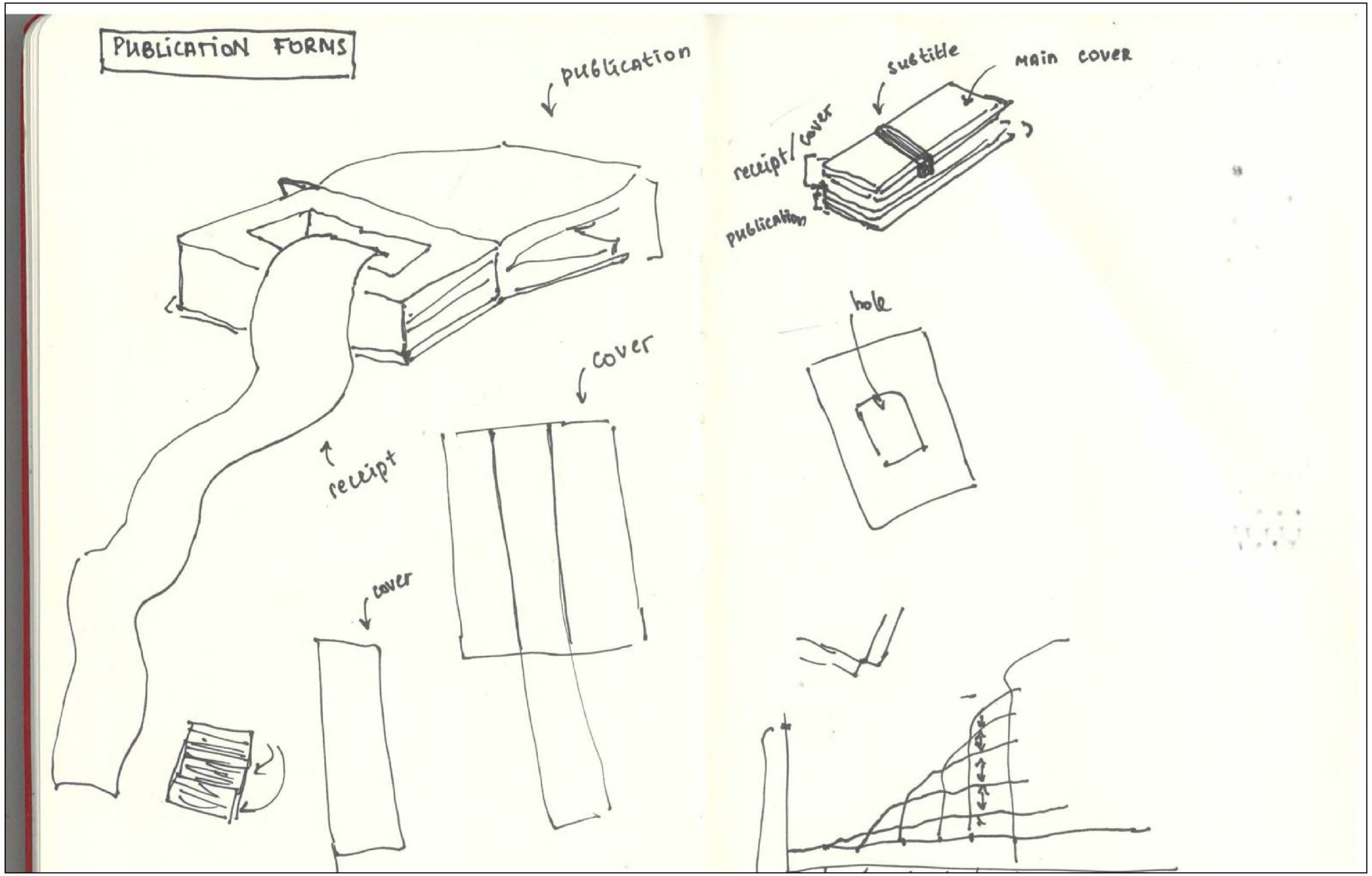


Prototype - PartB

Prototype of the structure of the publication

Pull-down format: Physical receipt insert
Tangible accumulation

Accordion fold (left–right expansion): Infographics

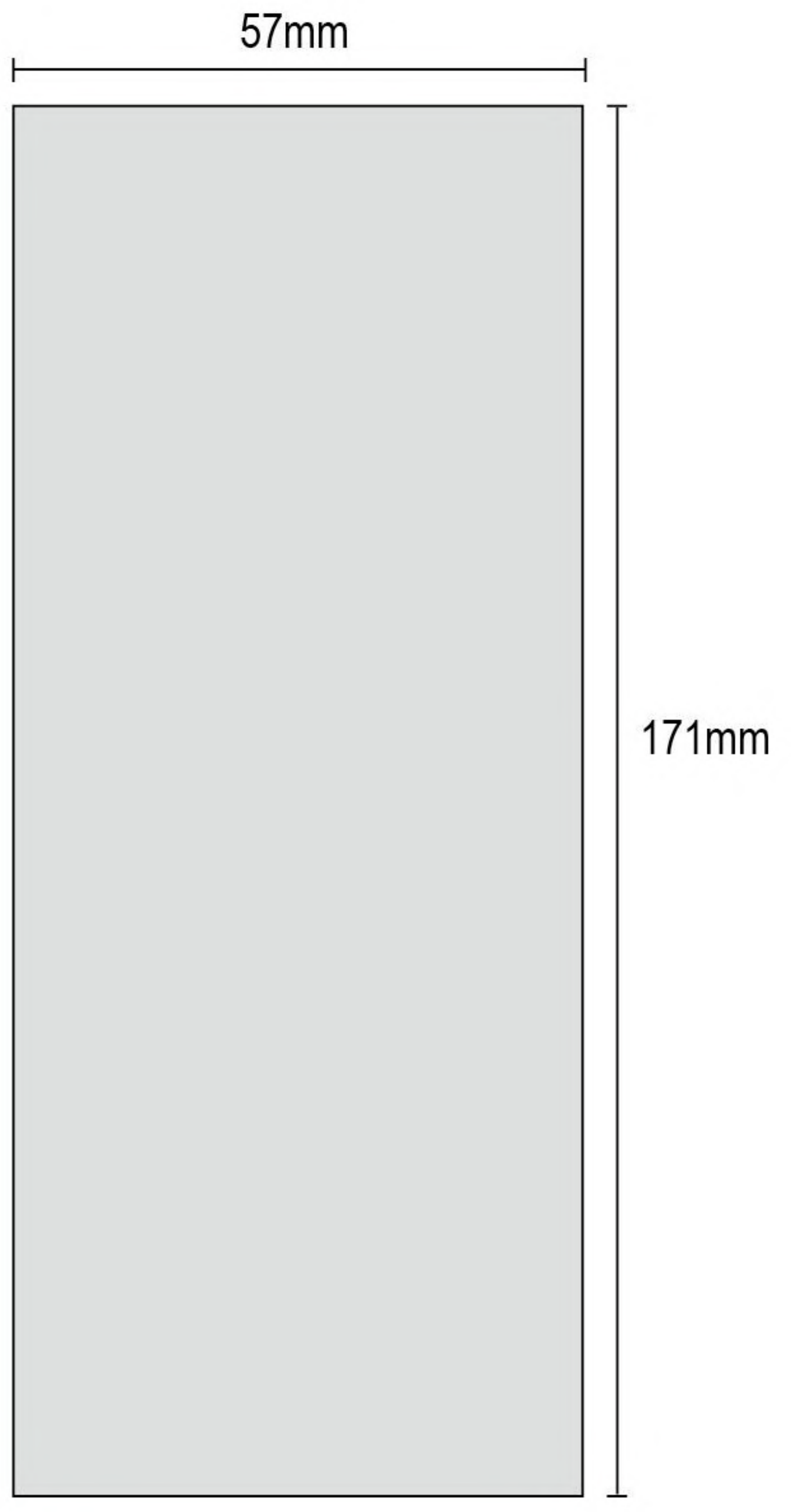


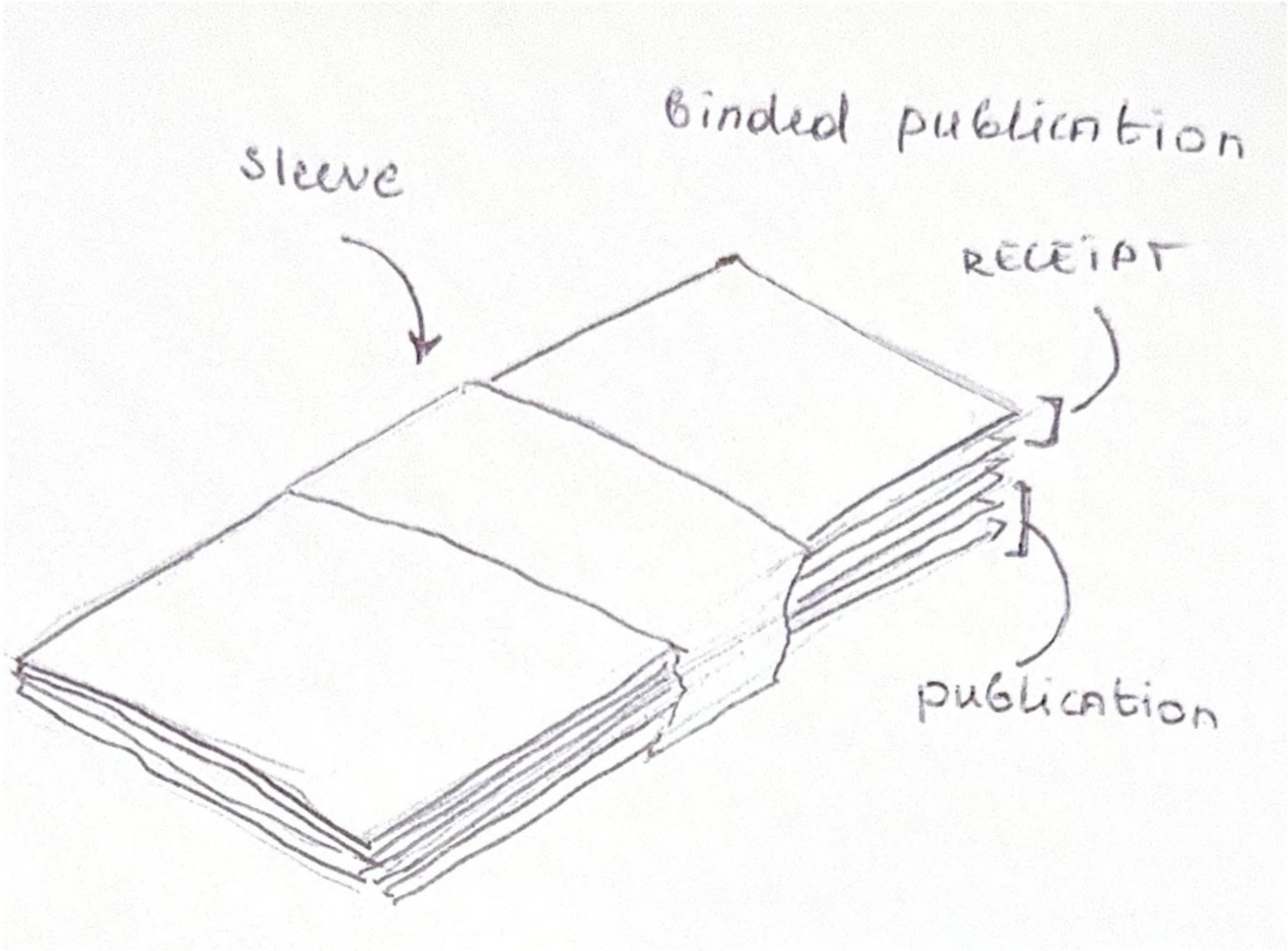
[Miro Link]

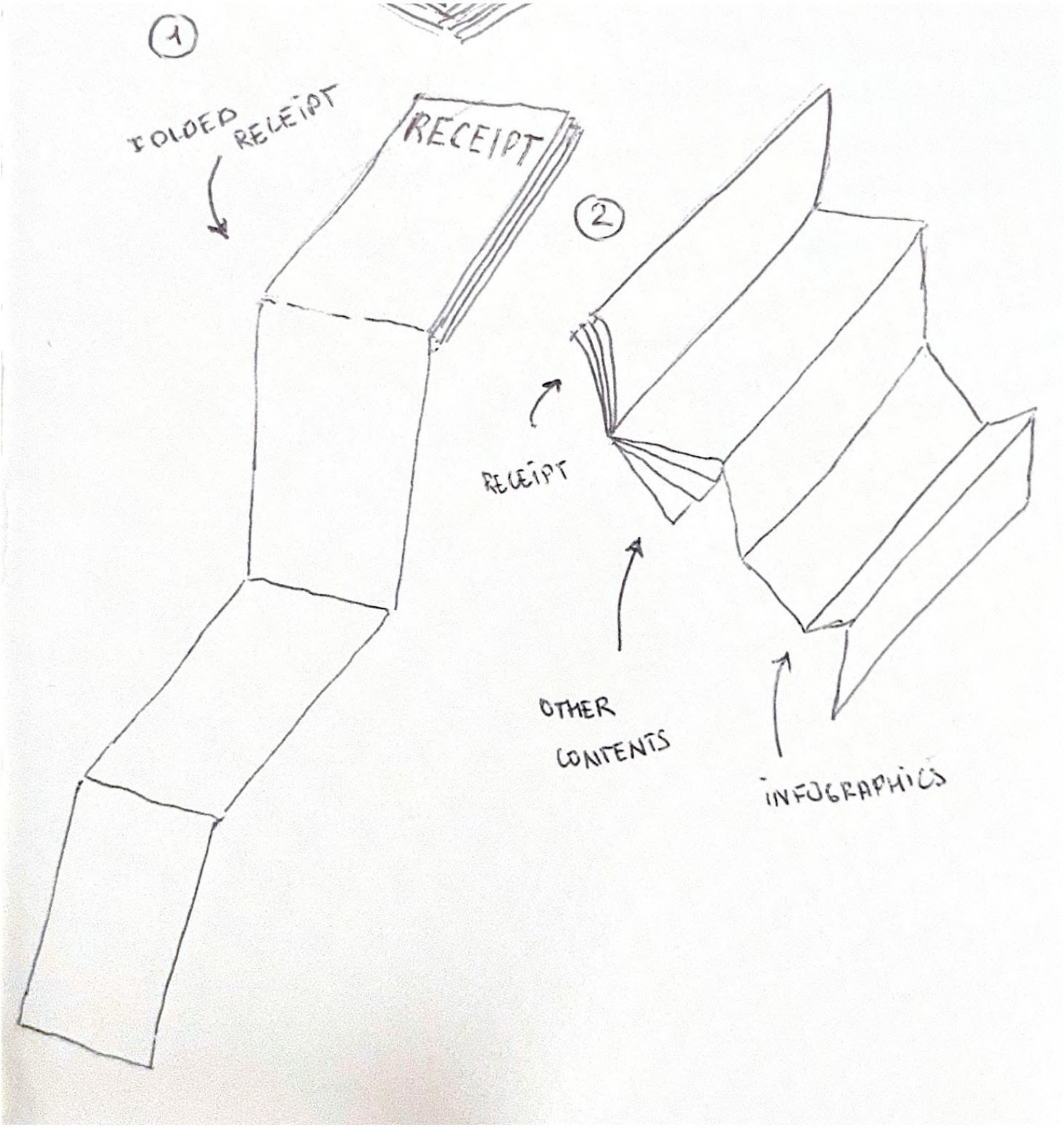
Prototype - PartB

-Publication-Design

Sketches of the final considerations of the publication's shape.
The publication is designed to match the width of a receipt.







[Miro Link]

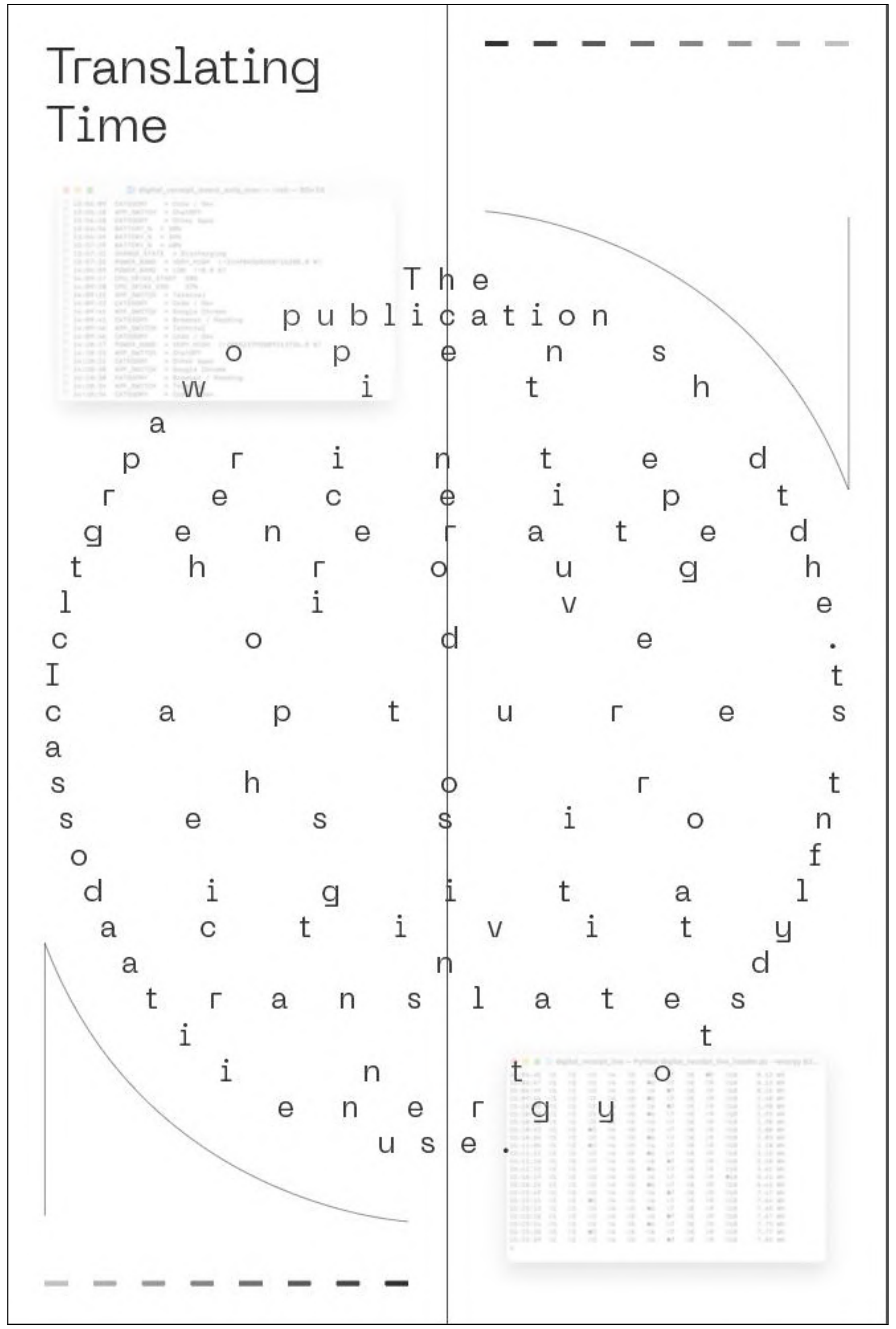
Prototype - PartB

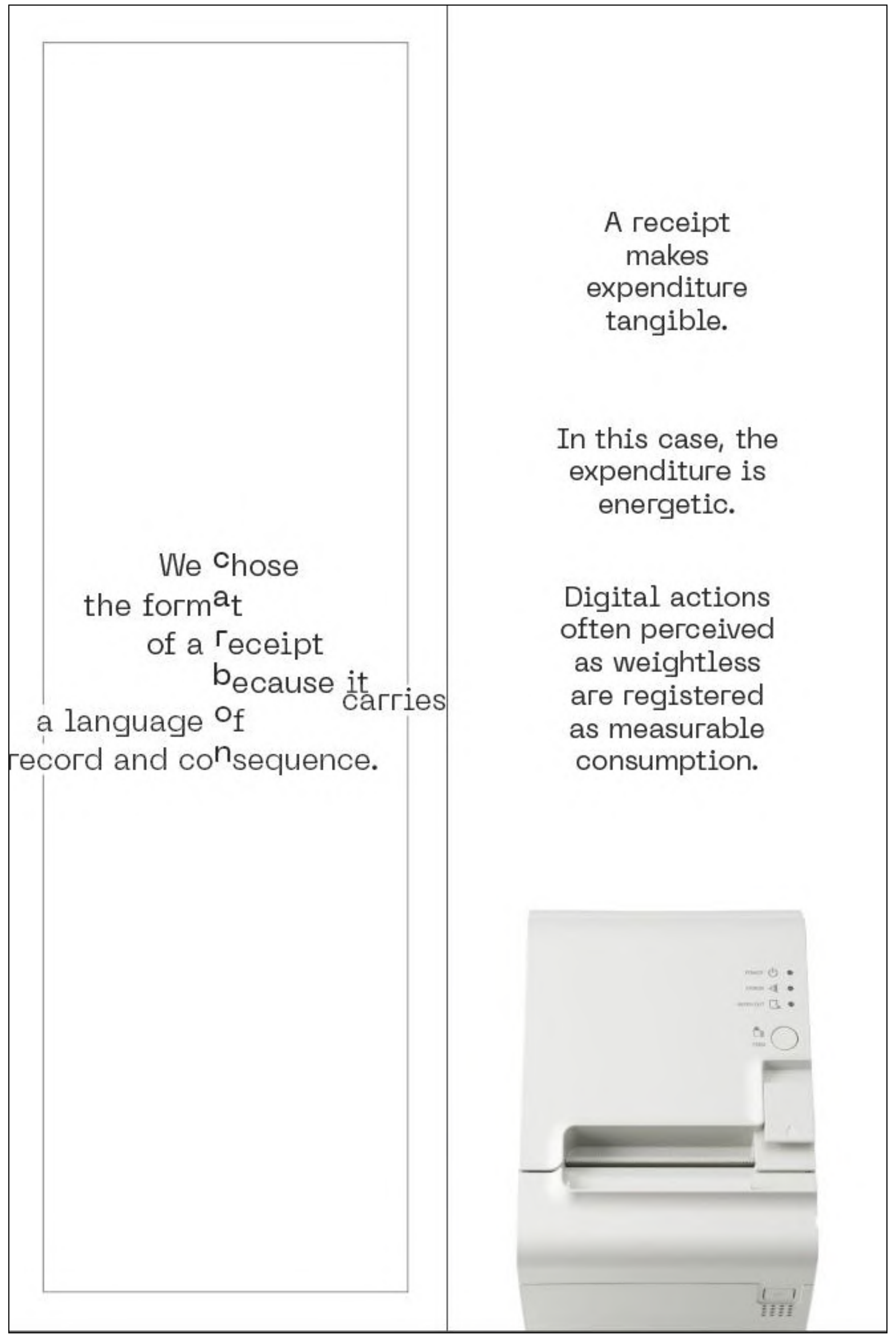
-Publication-Context-Inforgraphic

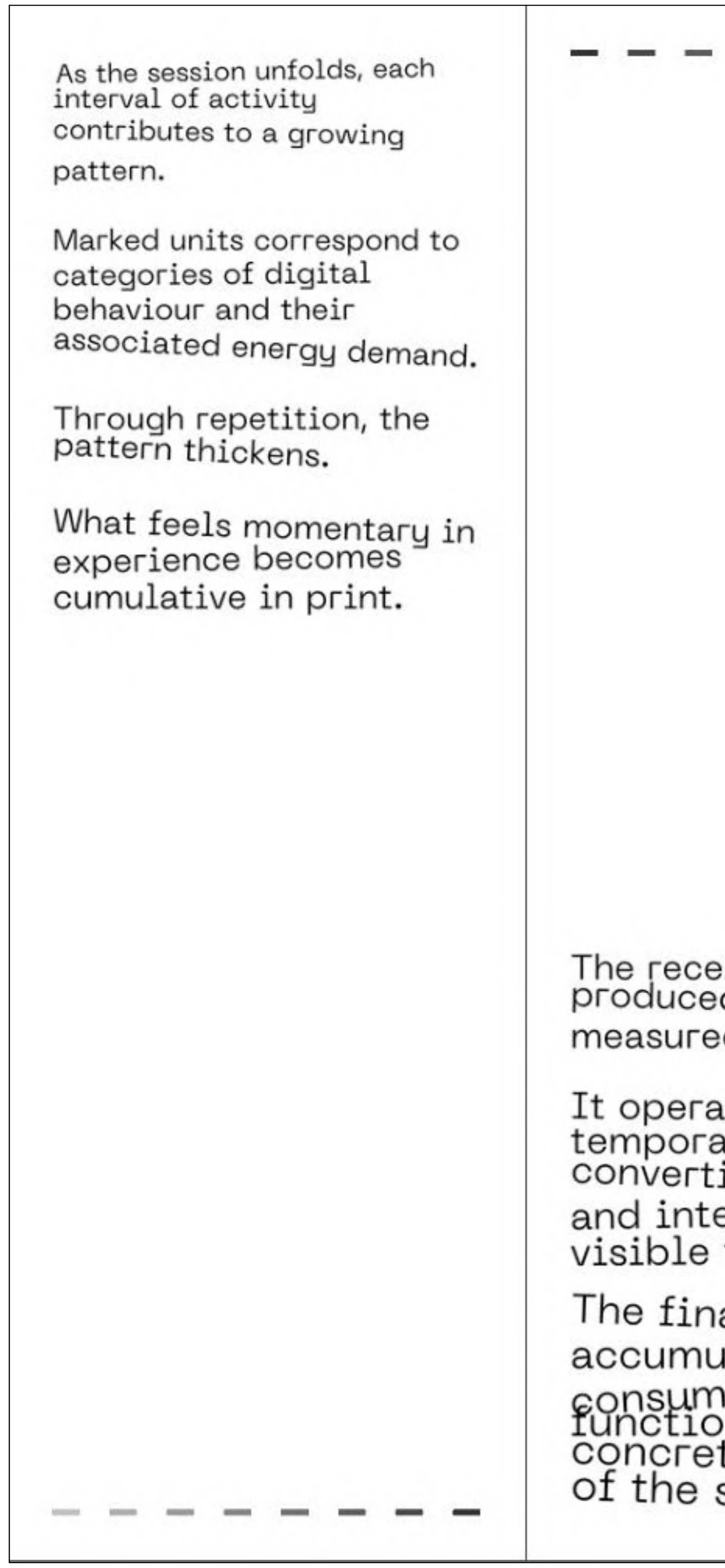
We chose a monochrome (black and white) layout.

Since digital carbon is difficult to visualise or perceive directly, we adopted a more abstract typographic approach.

At the same time, we limited the ink density to 85% black in order to reduce printing consumption.





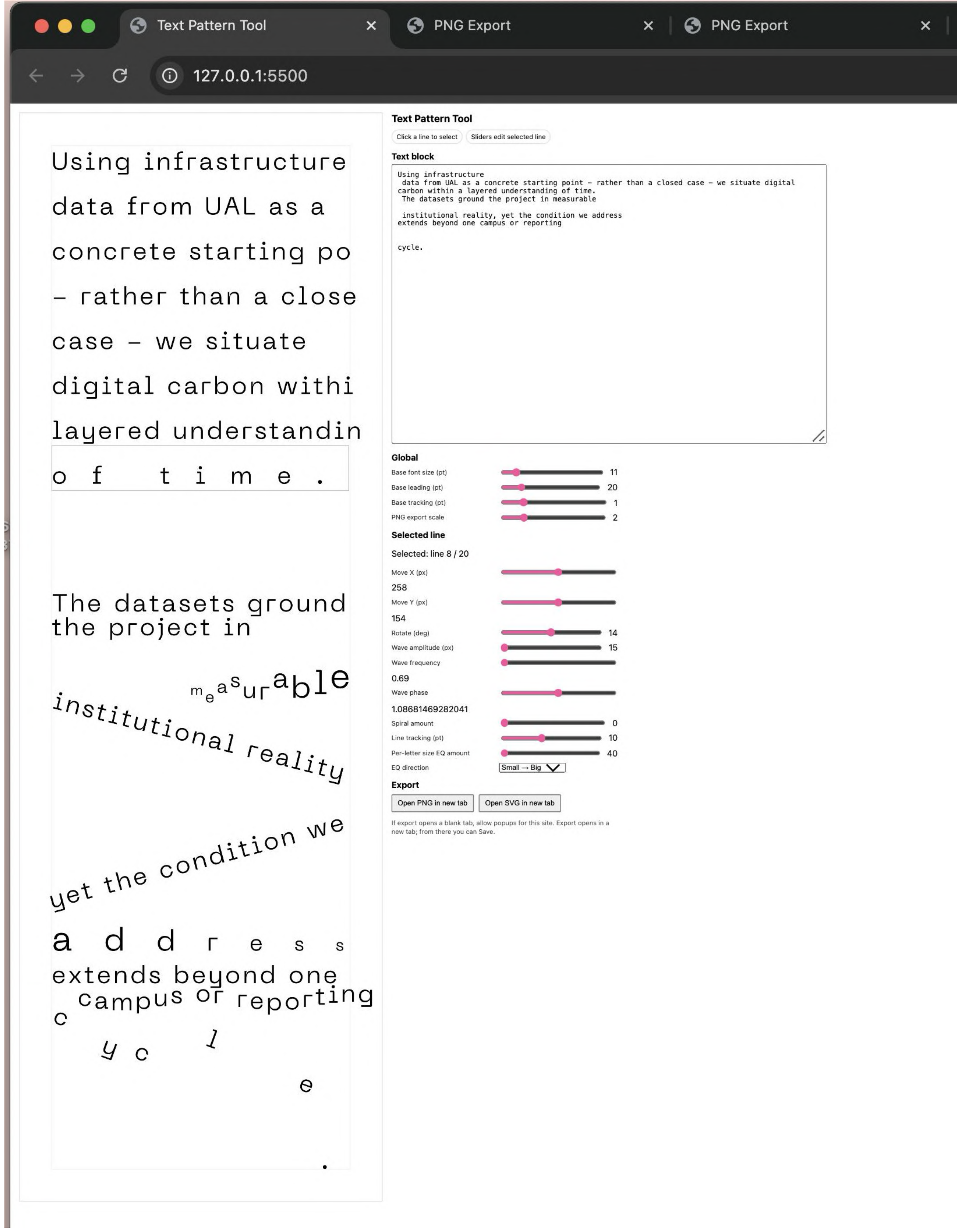


Prototype - PartB

To continue on the publication design we wanted the type itself to become a visual system.
The pattern created by the letters is intentional: it reflects the complexity and instability of digital carbon emissions where something that is invisible, abstract, and constantly shifting over time.

To explore this, we built a small browser-based tool using HTML and p5.js, a lightweight local web tool that allows me to generate and manipulate typographic patterns dynamically.

The idea is not to add digital weight, but to prototype and test how text can embody complexity rather than just describe it.

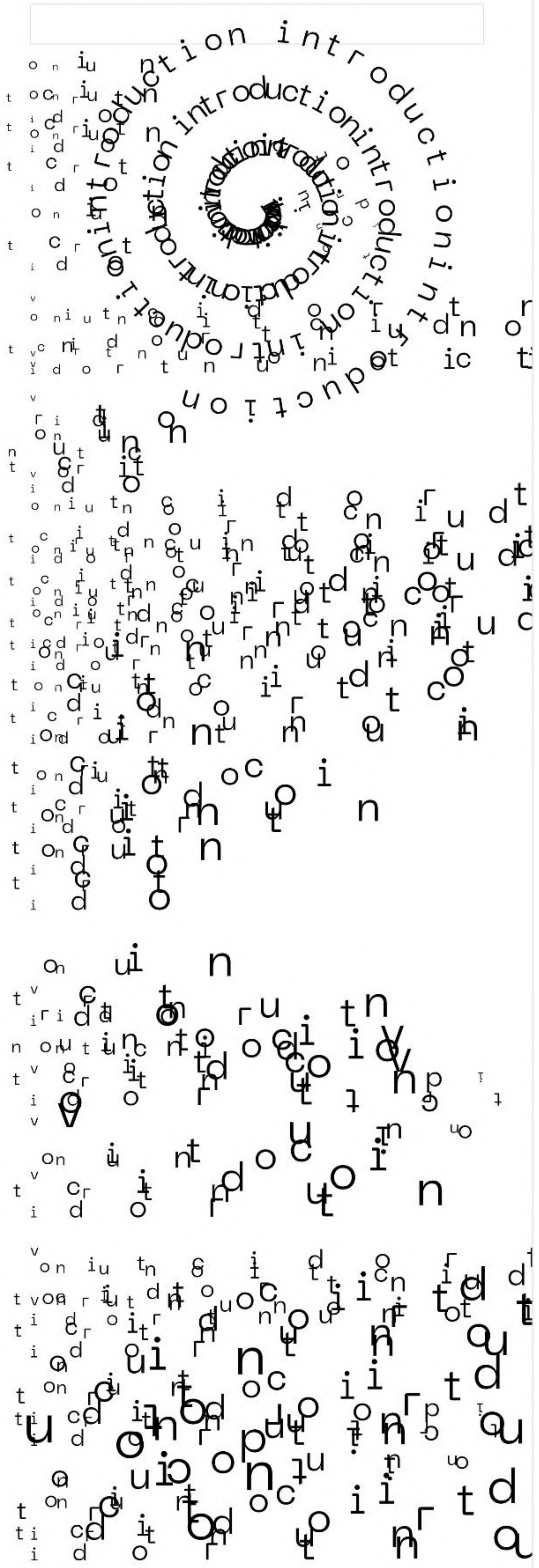


Prototype - PartB

This is still a WIP layout versions.

We're working toward patterns that are more sophisticated, but still readable because legibility remains essential.

The goal is to balance visual complexity with clarity, so the typography communicates both the data and the difficulty of visualising it.



The digital feels immediate. Yet beneath every click lies infrastructure: servers, networks, storage systems, and electricity grids that translate digital habits into energy demand and carbon emissions. Every digital action extends beyond its moment. Files remain stored for years. Servers continue running long after a document is forgotten. Electricity flows whether or not we are looking at the screen. Digital carbon emission does not disappear the session ends.

Digital carbon is often reported in annual summaries, institutional targets, and aggregated datasets. Yet digital infrastructure operates continuously. Single user behaviour unfolds in seconds. Atmospheric accumulation unfolds across decades. These temporalities rarely meet.

Using infrastructure data from UAL as a concrete starting po – rather than a close case – we situate digital carbon withi layered understandin of time.

The datasets ground the project in measurable institutional reality yet the condition we address extends beyond one campus or reporting cycle.

Digital carbon unfolds across three temporal dimensions: the immediacy of interaction, the institutional duration of storage and maintenance, and the atmospheric accumulation that exceeds both devices and annual targets. These scales rarely align. The gap between them is not only quantitative, it is perceptual. We feel the present and we rarely feel accumulation.

Thank you;-)

>Update time: Feb 20th >Valerie Miko Tianyu Dasha