The material cost of the digital sector and how to constrain it

Adrien Luxey-Bitri

30 MINUTES OF SCIENCE

8th October 2024

The menu

Hello my name is ...

Datacenter primer

ICT's lifecycle

Open research questions

Who am I?

Teacher–Researcher–Activist

PhD (Rennes'19): Dist. Systems

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- Dist. systems
- Privacy
- Mobile platforms
- Environment
- Philosophy
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I want to be a **generalist**!

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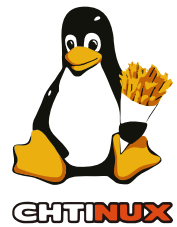
Digital freedoms activist



Build convivial tools:

- Home-hosting
- On old hardware
- Democratically

Serve the people:

- Offer public utility services
- Help the public
- Advocate, spread knowledge

What is Spirals?

We study
the adaptation of distributed software systems

- Soft. development
- Maintenance & evolution
- Privacy-protection, security
- Sobriety, resilience

Section 2

Datacenter primer

What is a datacenter?

Constraints :

- Connectivity
- Security
- Availability

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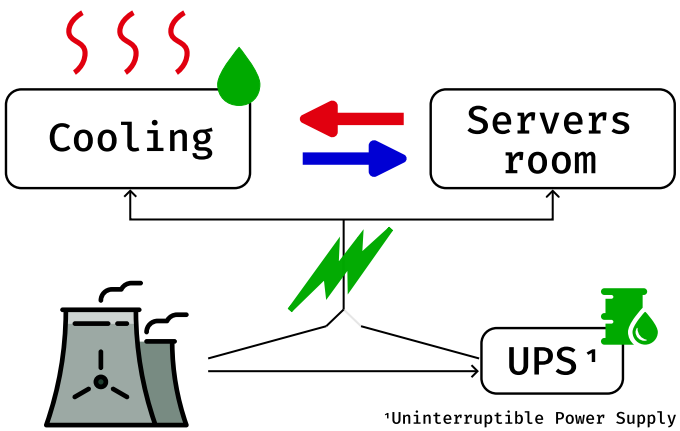

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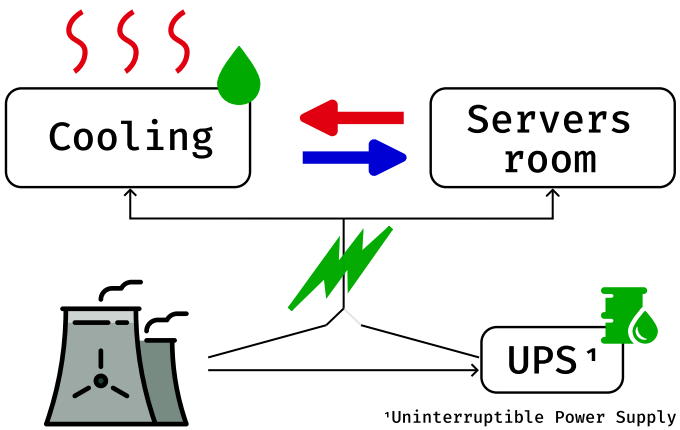
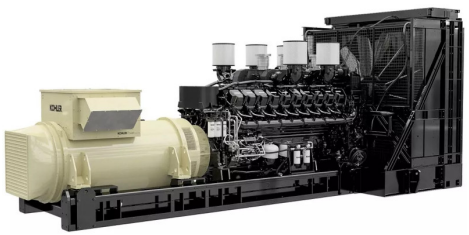


Uninterruptible Power Supply

- Regulates electricity
- Takes over if grid is KO



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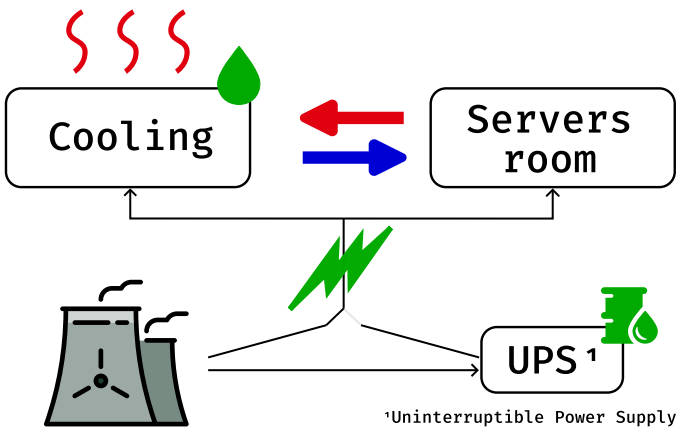

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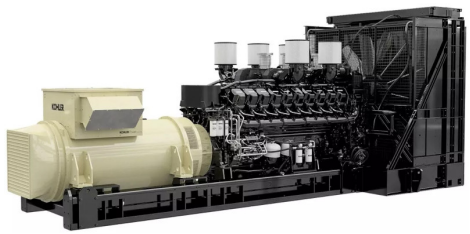

Cooling

- **Coolant** fluid (air, water, oil...)
- Heat dissipated through water

Cool kids mind their PUE

Power Usage Effectiveness (PUE) $= \frac{\text{Whole datacenter power input}}{\text{Servers power input}}$
Closest to 1, the better.

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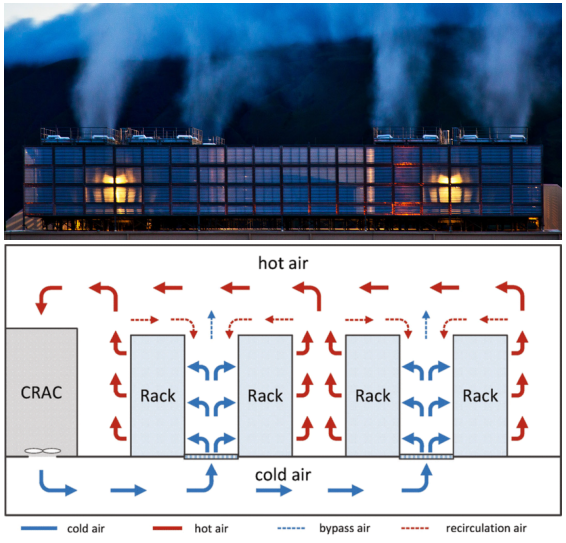
Air cooling: lame



PUE around 1.5

Most datacenters

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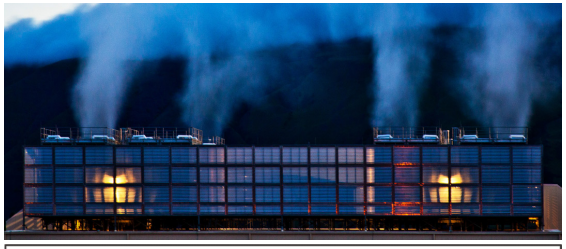

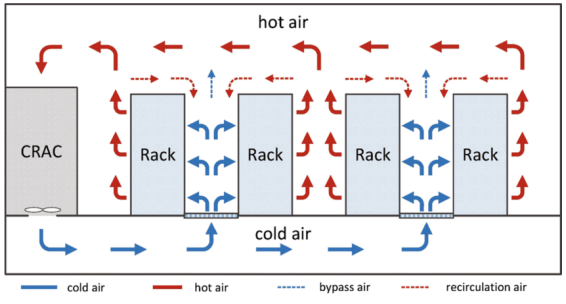

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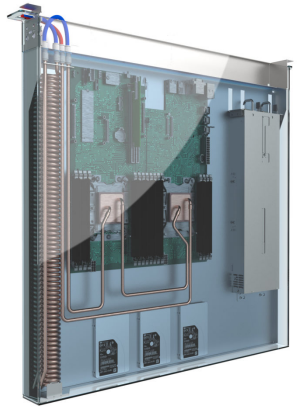
Liquid cooling: nice



PUE around 1.2

OVHCloud does this

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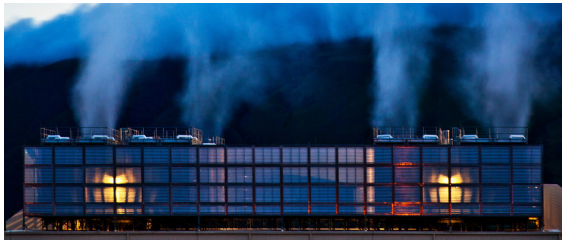

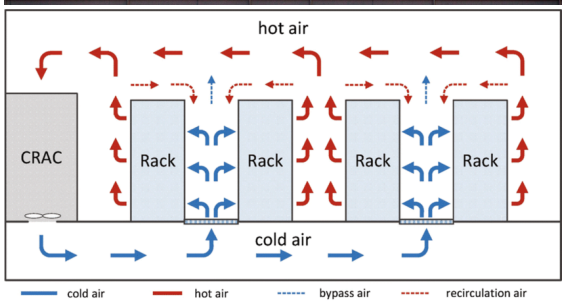

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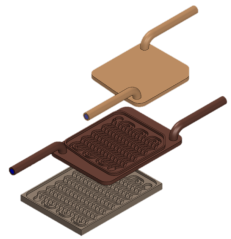
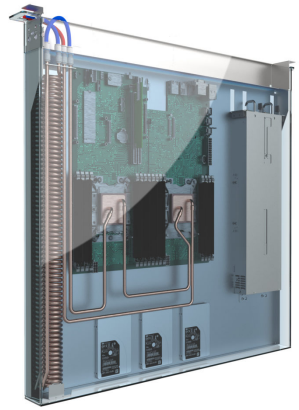
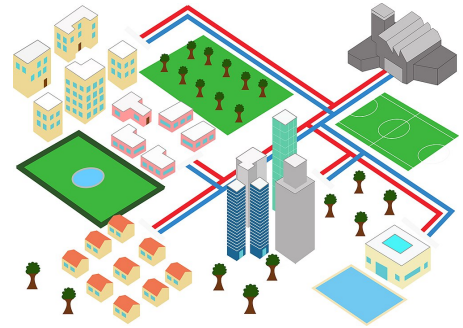




PUE around 1.2

OVHCloud does this

Heat networks: best



Heat as *resource*

Qarnot does this

Microsoft's solution

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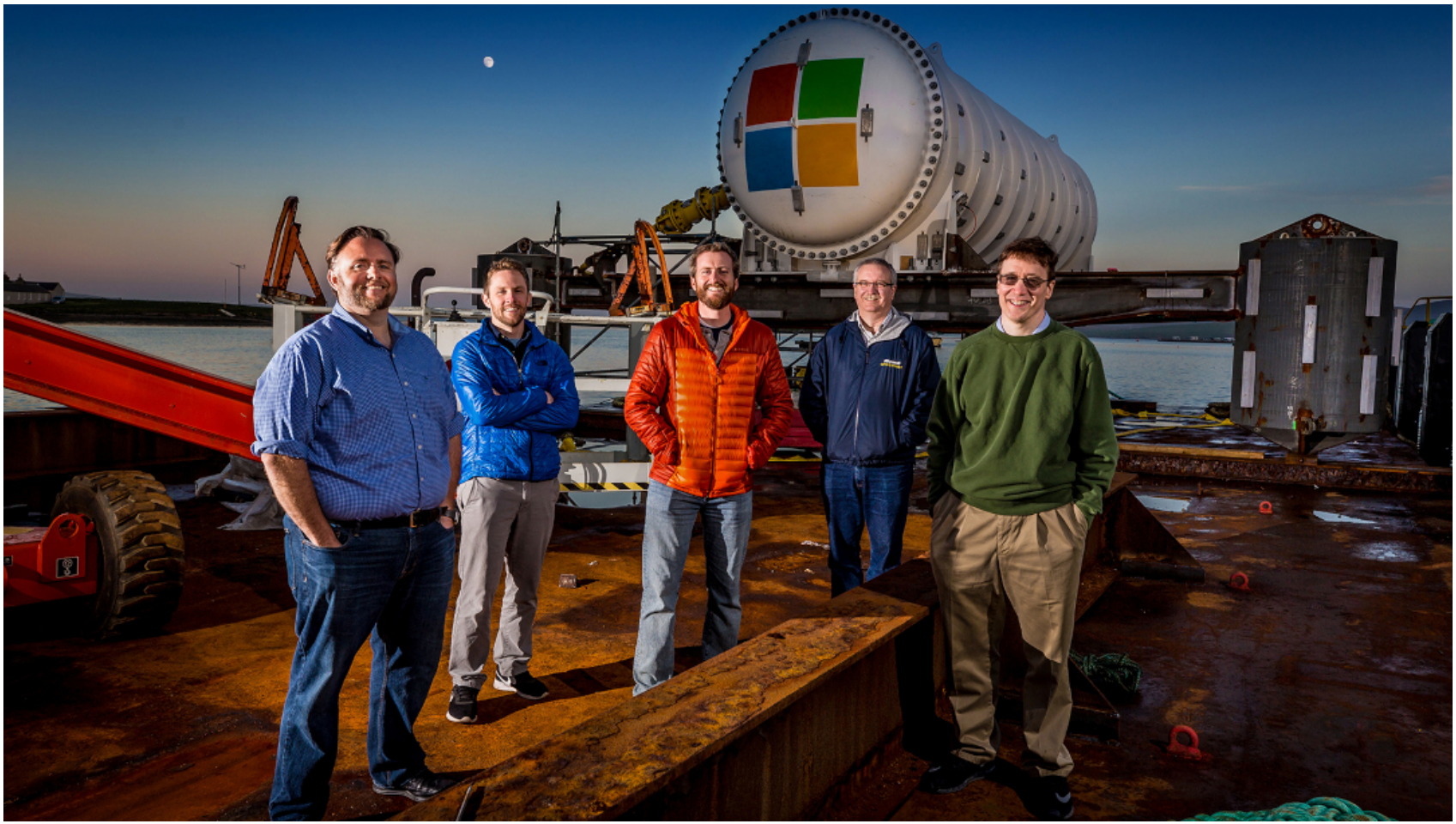
Dump the servers into the ocean



PUE of 1!

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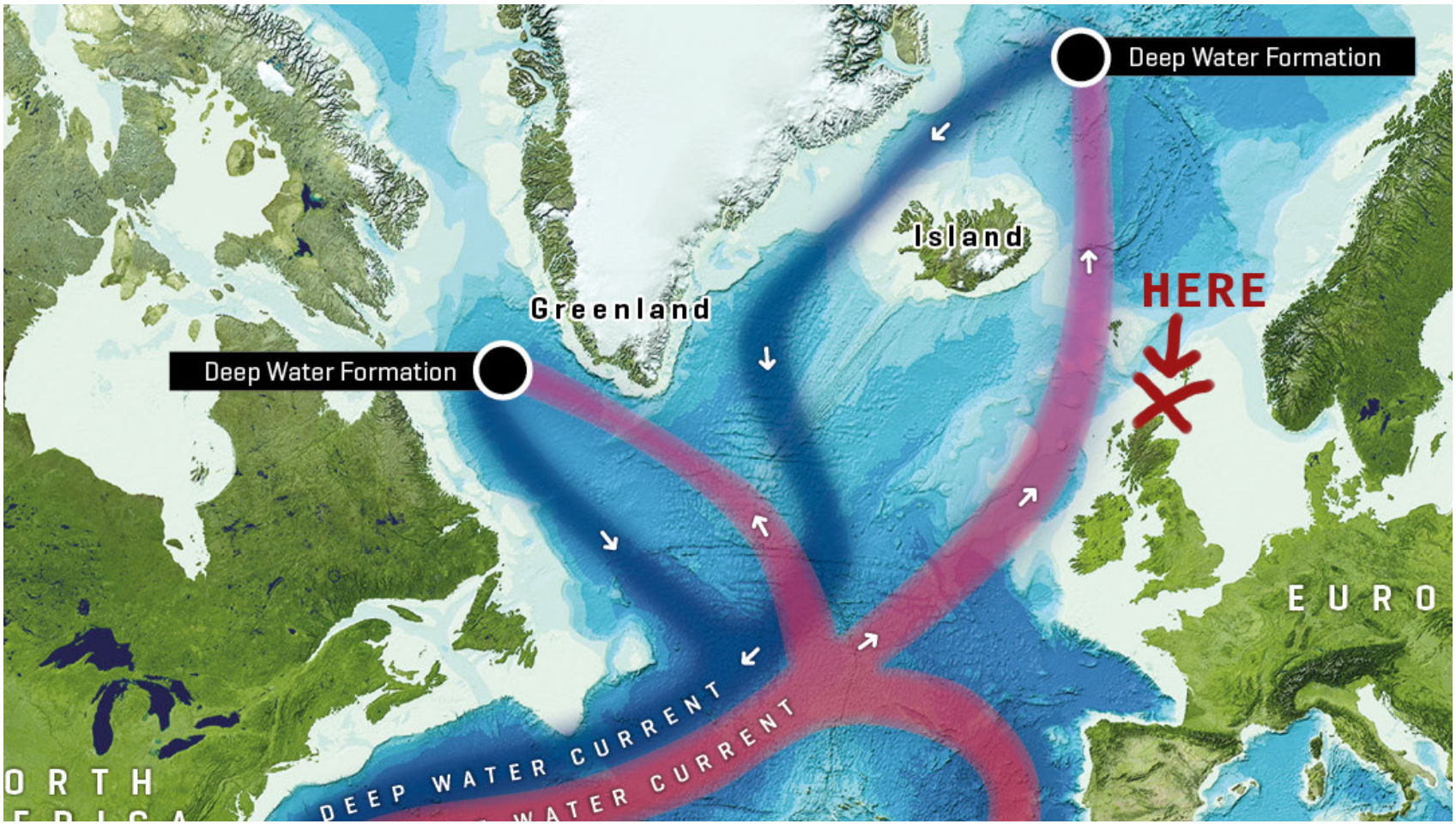

Microsoft's solution

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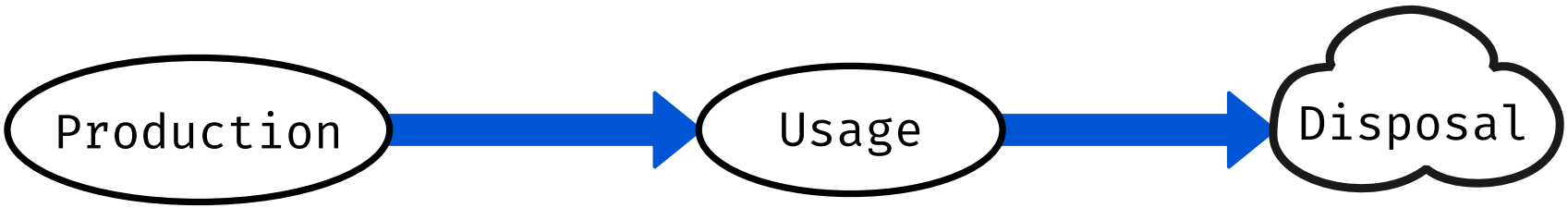
Think in systems!

J. de Rosnay, The Macroscope, 1974

Section 3

ICT's lifecycle

Lifecycle of digital goods



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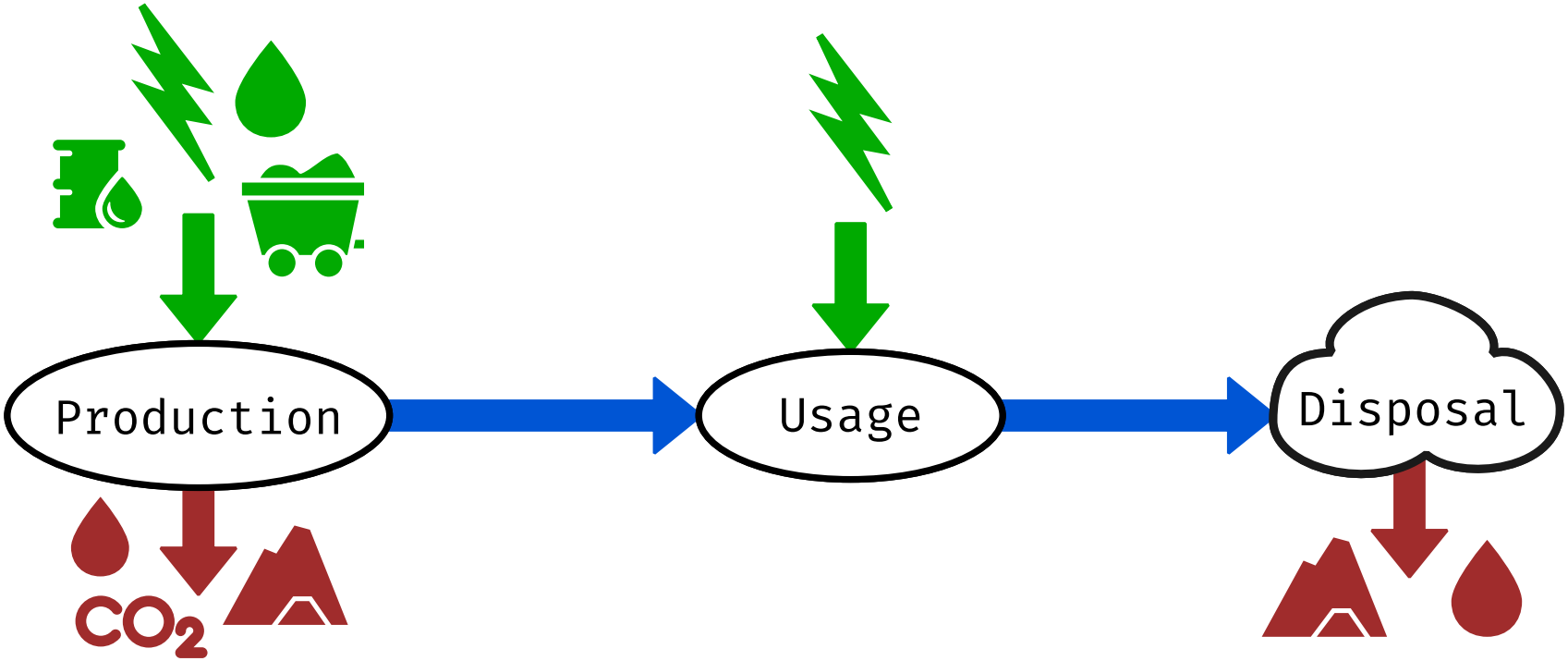

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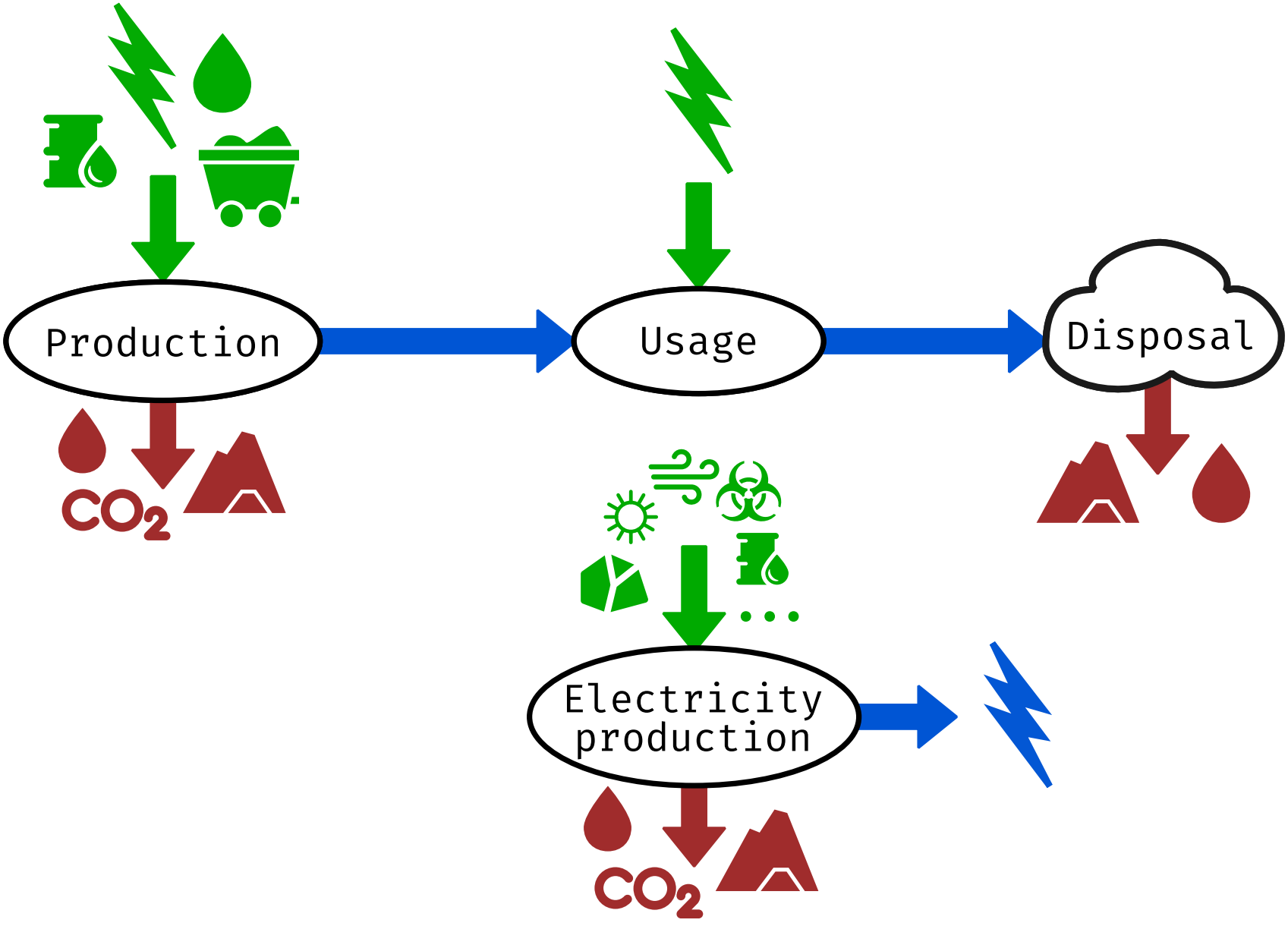

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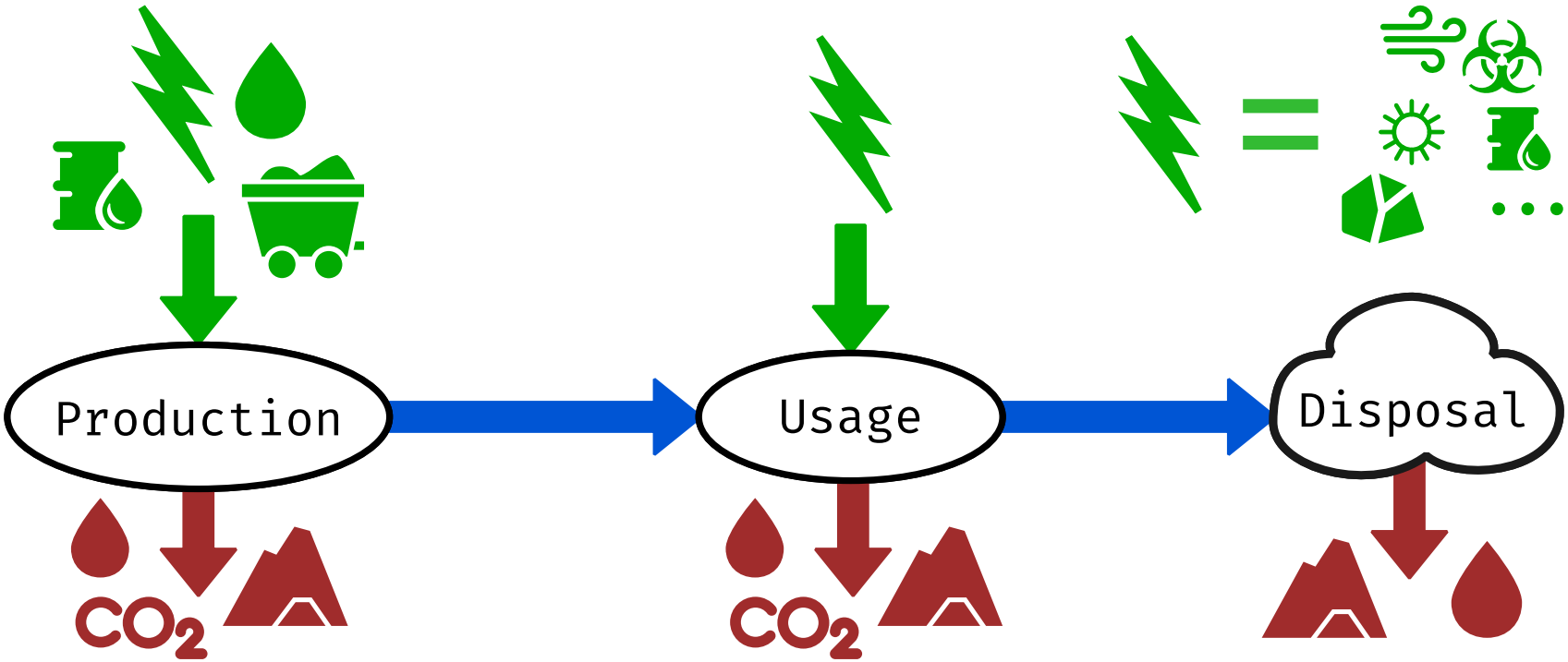
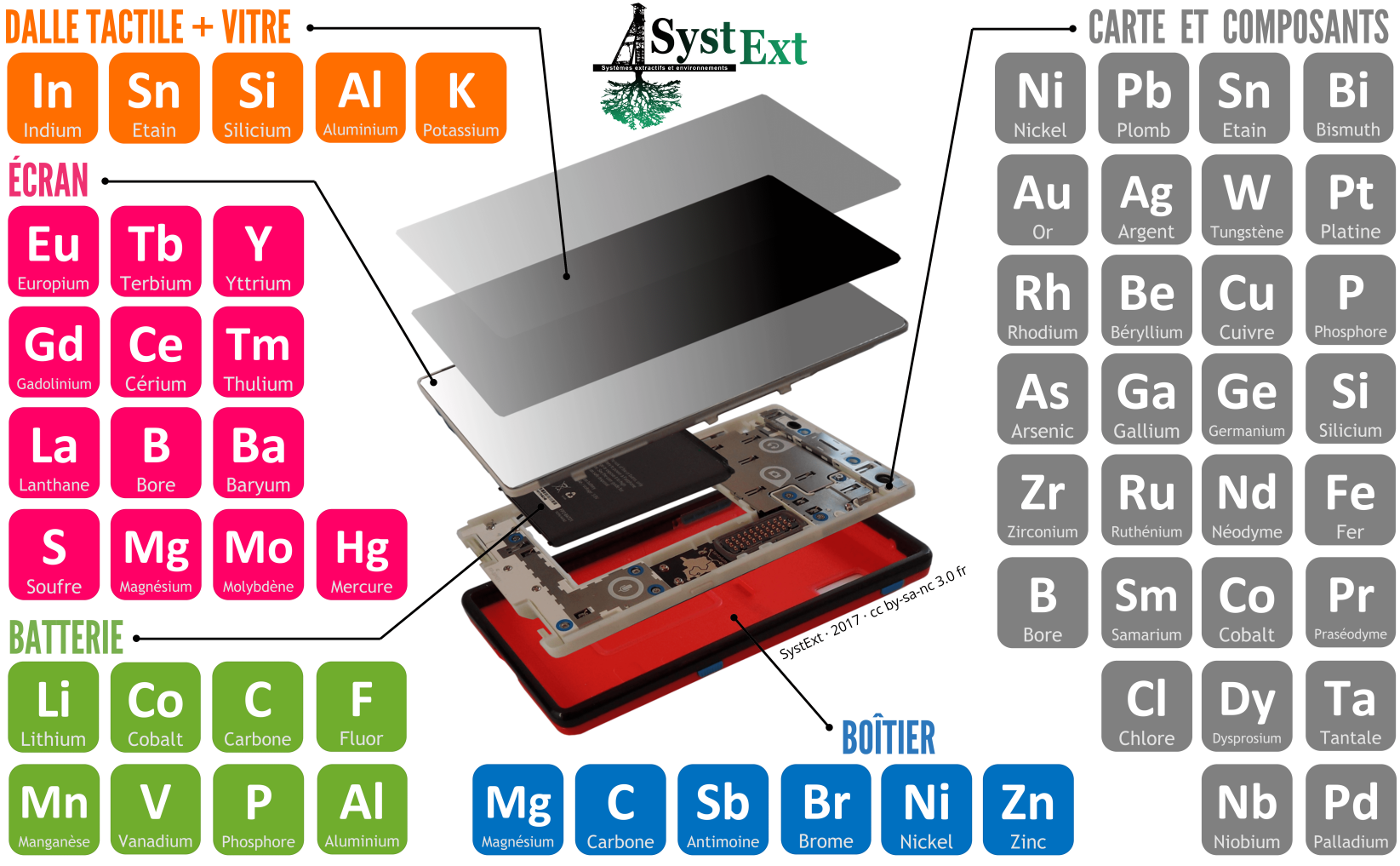


Production: inflows



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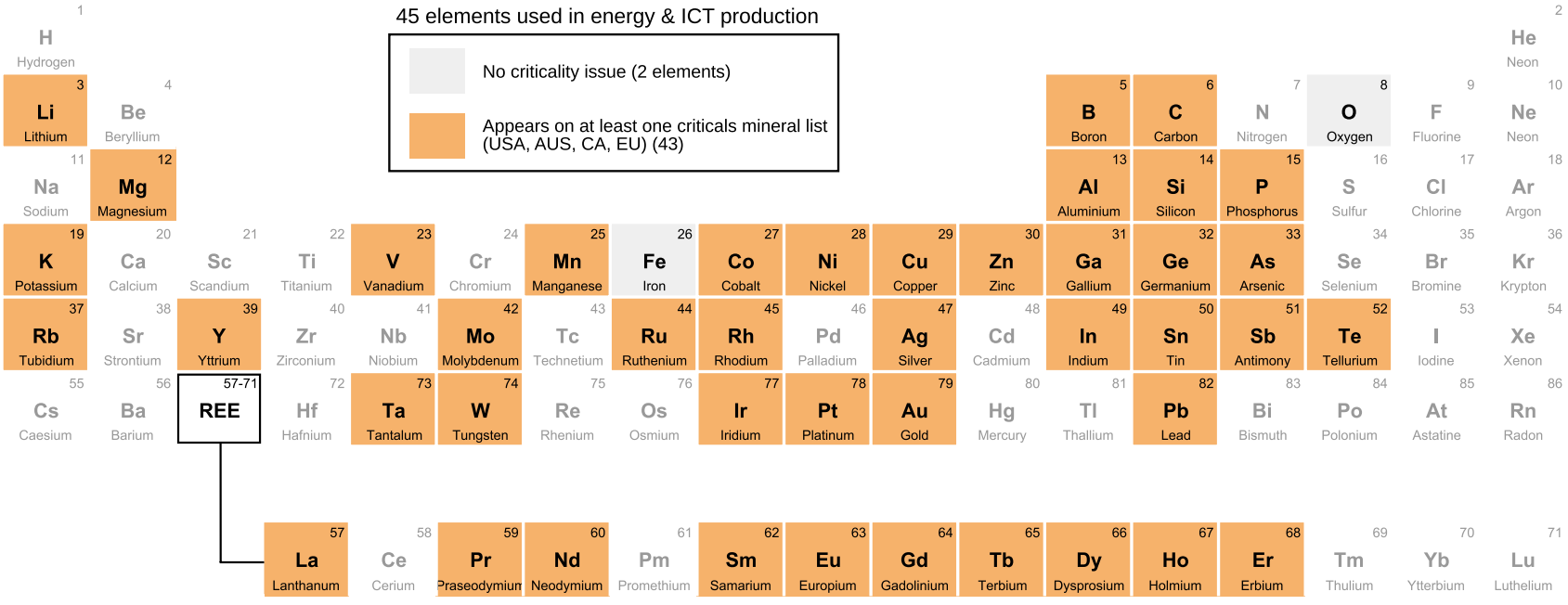
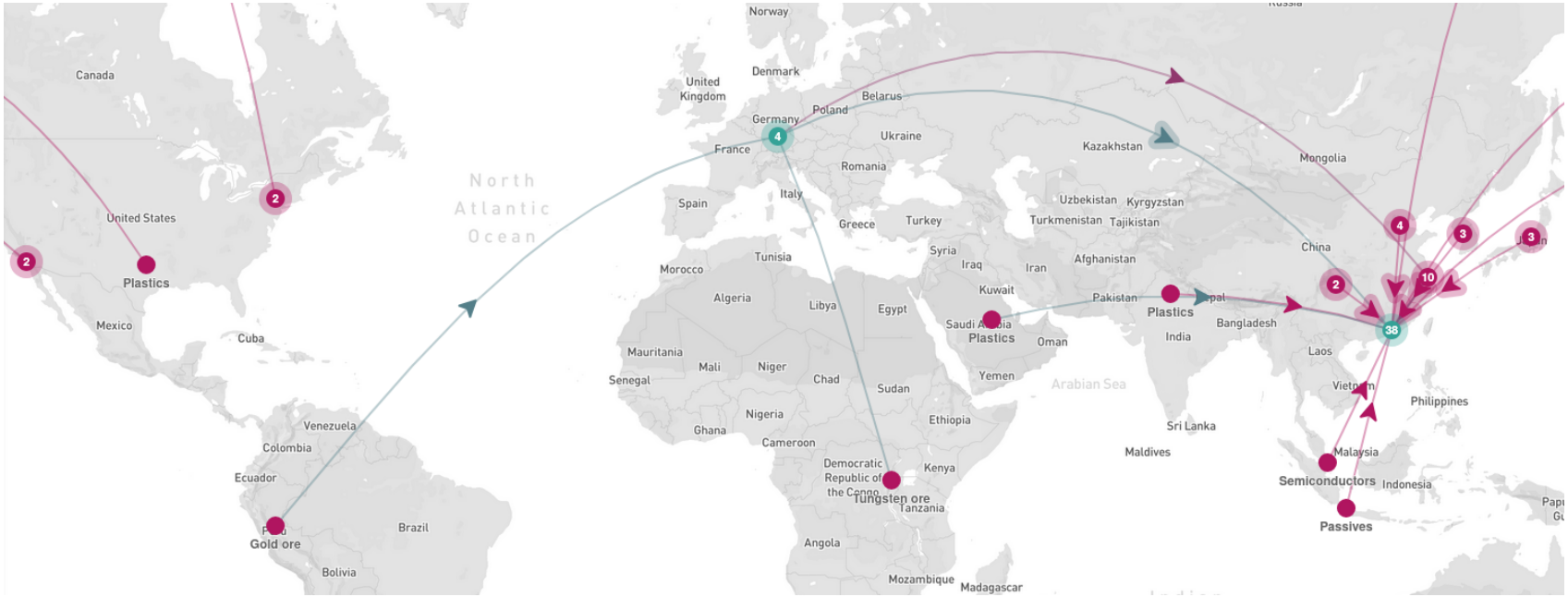


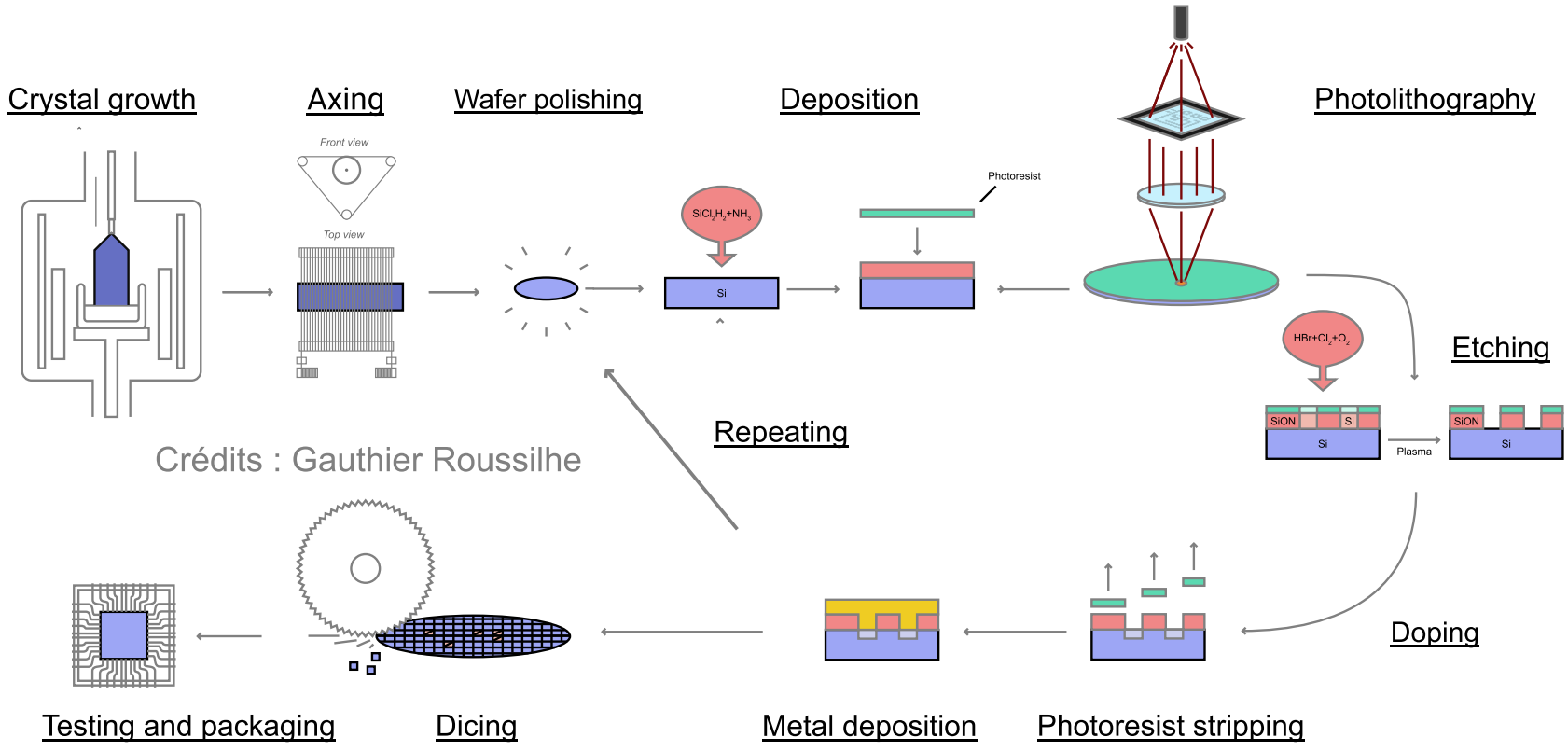
Over-solicitation of the periodic table

Production: a worldwide endeavour



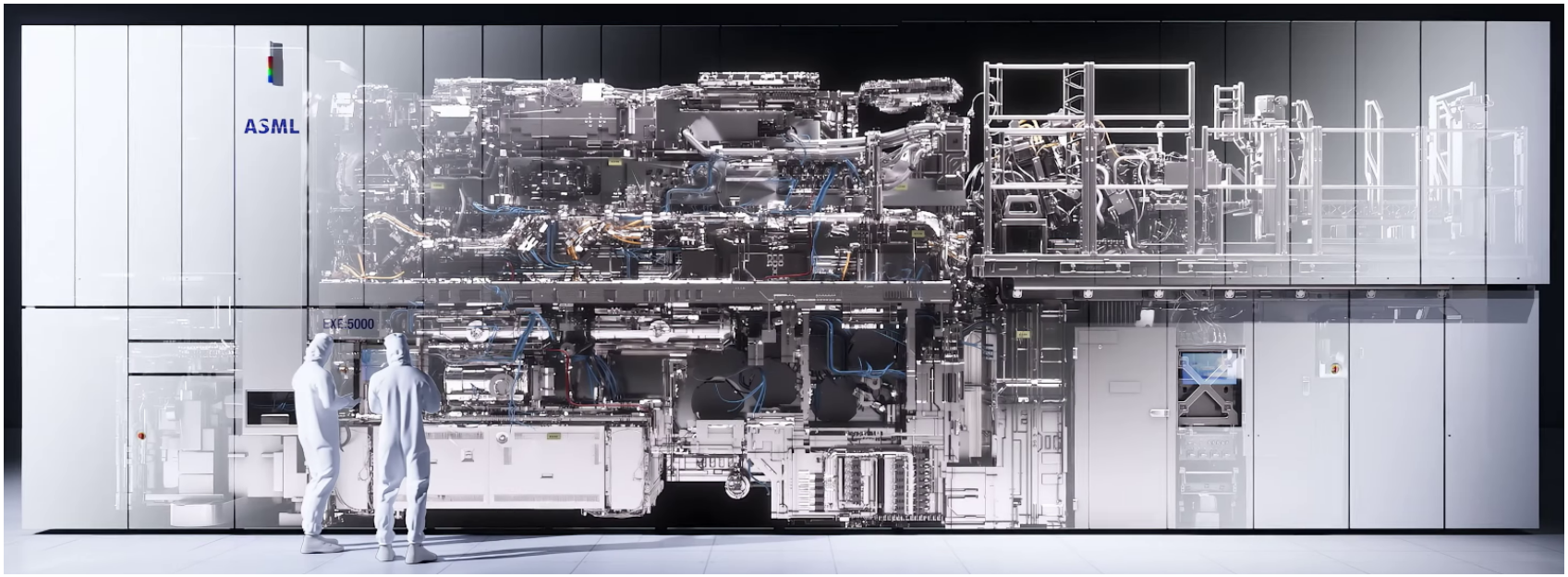
Example of the Fairphone 4 supply chain

Production: Microchip manufacture



Materials, power & water intensive

Prodution: an expensive production infrastructure

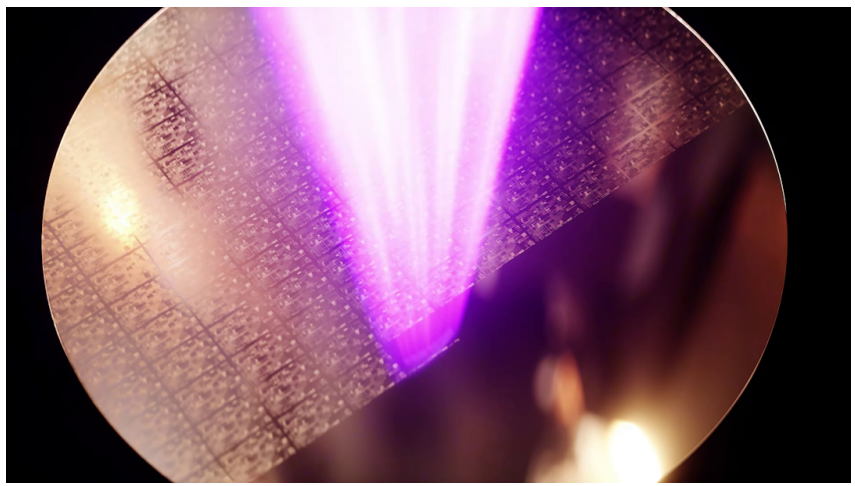


ASML High-NA EUV lithography system

Less than 3 nm resolution

Price: 380M $

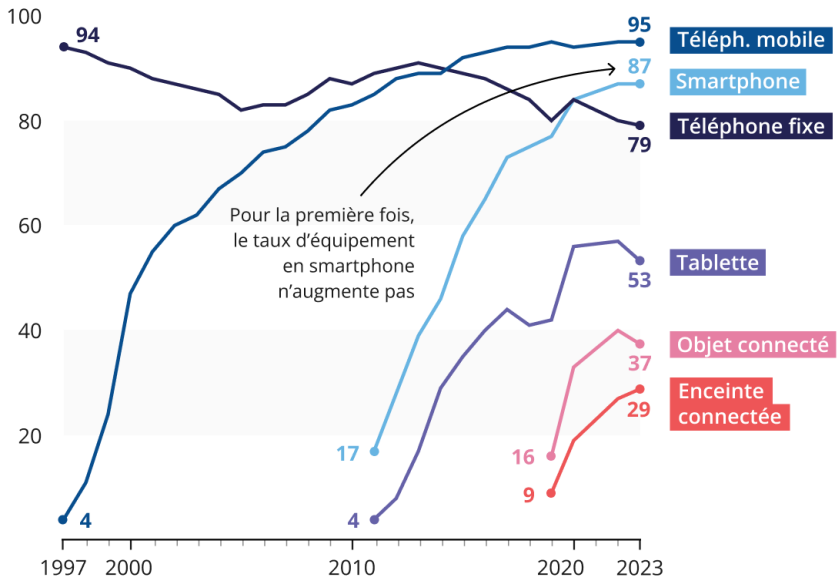
Now you need to sell...



Usage: inflows

Consumer market

Evolution du taux d'équipement des répondants (%)



ARCEP (fr), May 2024

- TVs & phones saturated
- Computers may be receding
- New "things" hit market

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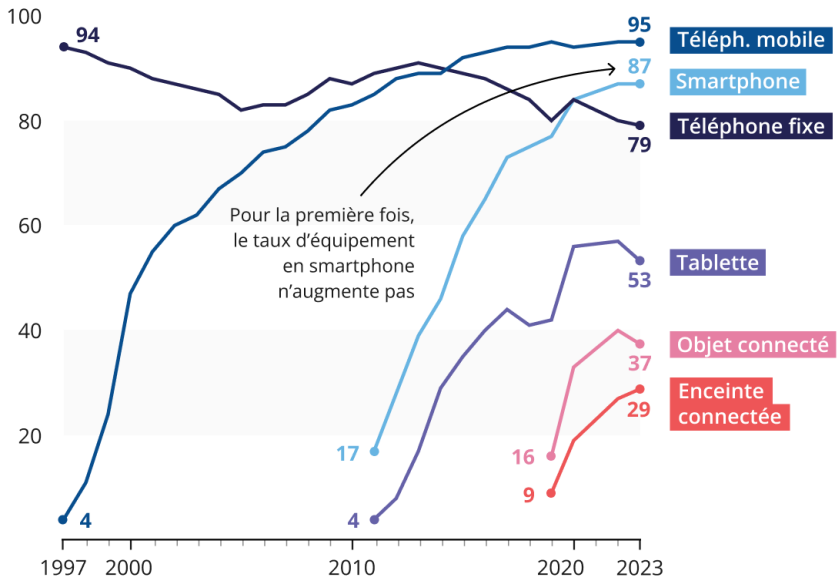

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Growth nevertheless

- Obsolescence
- Ubiquitous things

Only 20 % of data is produced by individuals

- Datacenter market boom
- AI

Disposal: a sink, not a loop

The industrial way

17 % e-waste globally **collected**

Preprocessing:
Complex evolving hardware flow

Processing:
Few minerals worth (low qty)

The artisanal way

Welcome to Sodom, Documentary, 2024

Agbogbloshie, Accra, Ghana (until 2021)

- Meticulous craftsmanship
- Black market, undocumented

Section 4

Open research questions

Quantify our environmental footprint

Political issues require scientific instruction.

(Y. Bréchet)

- Material inputs and outputs of the digital sector

- Quantify goods & services' sobriety & sustainability
  What metrics? How to avoid rebound effects?

Software engineering within limits

- Embed material limits in soft. abstractions
  Think IP-stack (knows kb/s), not Kubernetes (*data volume*)
  We need better abstractions.

- Turn waste back into functional computers
  Who actually understands mainstream mobile firmware?
  What if: moratory on hardware production?

Reconcile cybersecurity and the environment

Cybersecurity is a driver of hardware replacement.
It's an *arms race*.

- How to keep old hardware secure?

- Is "secure-by-design" a pipe dream?
  Are we doomed by game theory foerever?

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That's all folks

- Slides on `https://luxeylab.net`
- Class "Enjeux environnementaux et société" (M2-Info, fr) :
  - Last week's slides on `https://luxeylab.net`
  - Tomorrow's class "Matières premières et eau" at 8h (C15 006) and 10h15 (M5 A09)
- Expo "Le numérique en eaux troubles" (fr) from 11th Oct. to 10th Nov. (Forum des Sciences, V. d'Ascq.)
- Read [Cer+23]!