femto-st SCIENCES & TECHNOLOGIES

New generation of data centers

ANR-SOCLOUD: a Sober and Open Cloud

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19th Scheduling for large-scale systems workshop
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UNIVERSITÉ MARIE & LOUIS PASTEUR

SUP MICRO TECH

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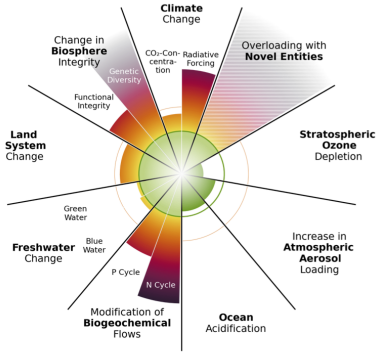
[1] 4 years project that has been funded last june by the french research agency – ANR

The Environnemental crisis

Planetary limits

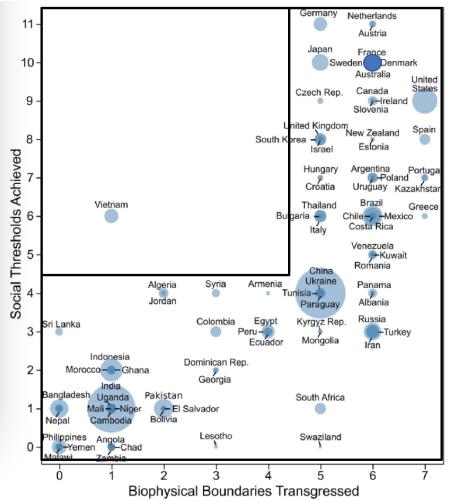


The Doughnut

Kate Rayworth 2017

Evolution in modern times

- In most countries, living standards have risen at the cost of ever-increasing energy consumption.
- At what price?



ICT in the crisis

Two opposing directions can be distinguished:
ICT as a solution to mitigate the crisis and ICT as an aggravating factor.

The tough question is **how to estimate the ICT sector overall impacts**

positive side:

- ICT4green/HPC4green (HPC for applied to virtuous actions)
- GreenICT/GreenHPC (reduce –optimize– the footprint of applications and infrastructures or compute on renewable energies).

negative side:

- electricity consumption, exponential growth of GHG emissions, water, metals

`https://edge-intelligence.imag.fr/trajectory_app.html`

ICT sector in figures

- In 2023, data centers in Ireland accounted for **21%** of total electricity consumption – more than urban households
- Marseille's massive DC expansion has created electricity shortages for decarbonization projects
- Near Paris, the Data4 campus (23 DCs, 110 ha, 250 MW) consumes **1.3 TWh/year** – equivalent to Lyon or Toulouse
- In 2014, Google used **32 TWh**—equal to Ireland's annual electricity production
- Google Gemini AI prompts consume only 5 drops of water per query, yet totaled **12,000 Olympic pools** in 2024 (**+28%** vs. 2023)
- RTE forecasts France DC electricity demand will **triple by 2035**
- ADEME projects the ICT sector share of electricity use will rise to **8%** (from 2% today)

Possible levers of GreenICT/GreenHPC/GreenAI

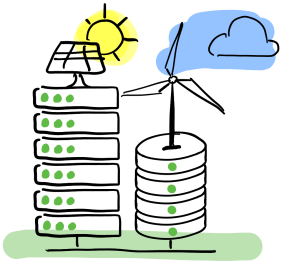
An HPC/DC platform is not restricted to its hardware components!

A 3-fold pattern:

- Processors, memory, networks
  For modern (interactive, in situ) applications or AI, we should add: sensors, IoT, terminals, displays, etc.
- Software stack, resource manager
- Users

The interactions are not easy to determine, for instance a more efficient hardware or software may lead to increase usage

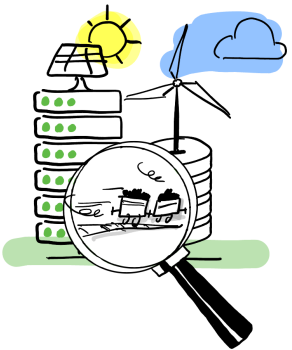
Is cloud powered by renewable energy really green?



Is cloud powered by renewable energy really green?

We need the full assessement for an attributional LCA.

Not completed yet!



GreenICT is not enough

- Energy *efficiency* corresponds to improve the footprint of existing methods, materials or tools
- For 10 years, the question of efficiency has been addressed from many sides
- Remarkable progress has been realized component by component
- However, Efficiency does not allow to address systemic effects

⚠ Because of indirect effects like **rebound**[2]

This is sobriety

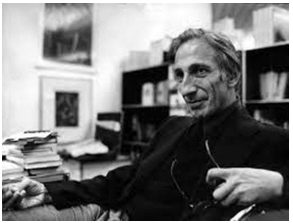
[2] it is the negative effect of an increase in the number of users or features of an application following an improvement in technology.

Beyond efficiency

Guidelines for a new way for deal with BigTech

The convivial approach

- What does BigTech sobriety mean according to Illich's pillars?
  - Ensuring sustainability with limited footprint
  - Question the usefulness of needs
  - Anticipating for resilience
  - Restoring control of tools
  - Acceptance by everyone leading to equity
- For users:
  As a consequence, we should agree conscientiously to degrade, postpone or even renounce in some occasions.



And now ?

How to imagine a new generation of data centers that takes into account a decade of experience in energy efficiency ?

ANR SOCLOUD

Sobriety/Sufficiency rather than Efficiency

SOCLOUD (ANR-25-CE25-2651)

Since being more efficient will never be not enough to reduce DC impacts, we propose sobriety as a new ICT design paradigm.

- Designing a user-centered decision making approach
- Making the data center concrete and its energy consumption visible
- Developing *convivial*, open and low-energy tools
- Making these tools/indicators understandable by users in order to:
  - Give to the user the power to choose whether and how to access resources
  - Provide indicator to help the user to appreciate imperative nature of each request

SOCLOUD

Objective 1

- Identifying human and technical conditions to implement sobriety/sufficiency in the cloud

Objective 2

- Designing frugal algorithms to operate this sufficiency-based resilient and sustainable cloud
- Allowing equitable and responsible access to the resources

SOCLOUD: 4 challenges

Challenge 1: Sobriety/sufficiency vs efficiency

- Has been presented before
- What sufficiency and/or sobriety means in the ICT domain ? (degrade, delay, renounce or maintain the request)
- The idea is to follow the guidelines at all the levels, namely, hardware, algorithms/workflows, software stack

Challenge 2: Usage hierarchy

- How prioritize the access to resources and reward virtuous behavior, for example when resources are available and powered by renewable energies?
- How can access to resources be limited without using quotas, but by encouraging users to regulate their own needs?

SOCLOUD: 4 challenges

Challenge 3: measures and metrics

- Defining score to help the user make his/her virtuous decision
- How to react when we face with an energy load shedding?
- Taking the rebound effect into account

Challenge 4: Open and resilient decisions

- Designing algorithms that are a white box in spite of black box
- Designing frugal algorithms to manage the datacenter (ICT and energy sides)

SOCLOUD: 4 technical work-packages

WP 1: Management

WP 2: Identifying lever of digital sobriety/sufficiency and their implications

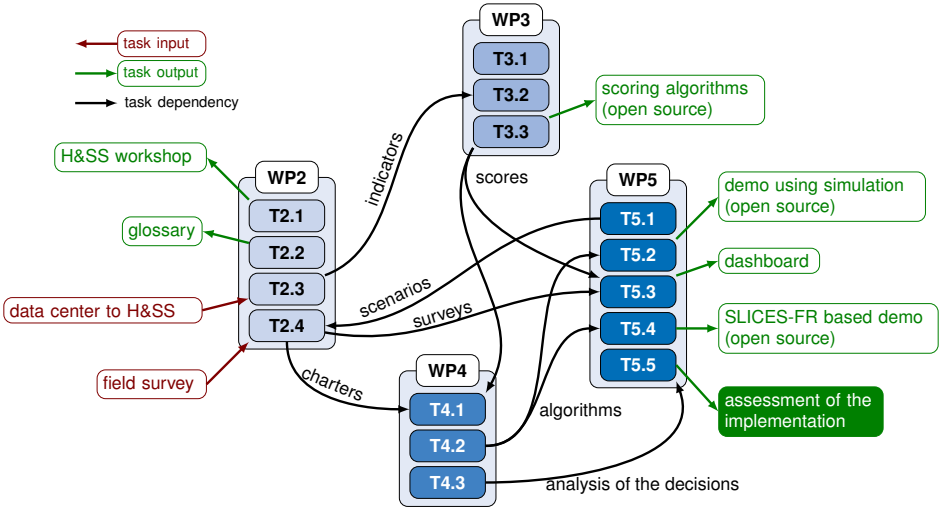
WP 3: Design of metrics and scoring approaches

WP 4: Design of frugal and convivial algorithms for decision-making

WP 5: Implementation of the SOCLOUD proof of concept

WP 6: Dissemination

SOCLOUD: technical work-packages and tasks



Conclusion

- The environmental crisis is urgent, and ICT and AI are part of it
- Energy efficiency is only a stopgap measure
- The most important point is to limit the exponential growth of usage
- We need to rethink everything from scratch