



Évaluer les impacts environnementaux du numérique : Open Source contre opacité

Aristote - 13 avril 2023

Votre serviteur



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Recherche \Rightarrow Action

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Boavizta



<https://boavizta.org/>

Groupe de travail

**Entreprises
Chercheurs
Freelances**

Thématiques

**Référentiel de données
Mesure du cloud
Méthodes de calcul
Convictions top management
Outils open-source**



Les impacts environnementaux du numérique

L'analyse de cycle de vie

Analyse de Cycle de Vie

ISO 14040

ISO 14044

Multi-critères



Mutli-steps

Multi-perimeters

Périmètre



End-user equipments



Network



On-prem infra



Cloud

Mutli-steps

Périmètre



End-user equipments



Network



On-prem infra



Cloud



Manufacture



Transport



Use



Waste



Pourquoi faire de la mesure un commun ?



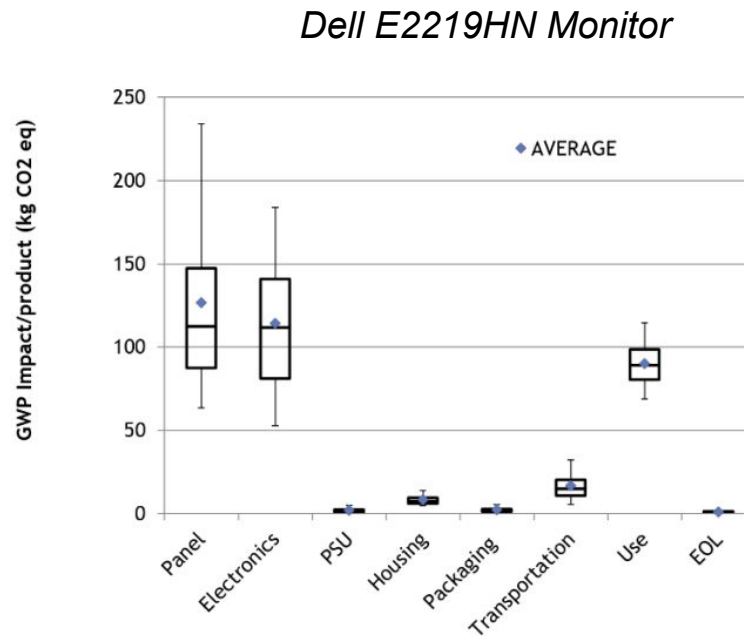
Parce que c'est une nécessité démocratique



“On va envoyer un mail avec une pièce jointe rigolote et on va consommer beaucoup d'énergie” *Agnès Pannier-Runacher*

Parce que les mesures sont de mauvaise qualité

Impact carbone moyen des écrans d'ordinateurs (kgCO ₂ e/inch)	
Dell (PAIA)	11,4 to 26,7
Lenovo (PAIA)	5,7 to 24,5
HP (Other)	3,3 to 8,6
NegaOctet	2,94
Base Impacts (ADEME)	≈ 2,7



Des maaaaaaarges d'erreurs



Parce que le chemin est plus important que l'arrivé

Quelques bénéfices de la démarche de mesure indépendant du résultat :

- Expliquer les chiffres
- Stimuler l'action collective
- Comprendre les dynamiques d'impacts
- Comprendre les postes d'impacts
- Questionner les résultats existants
- ...



Terminaux utilisateurs

Perimeter



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Données constructeurs

Fopen-data

PAIA

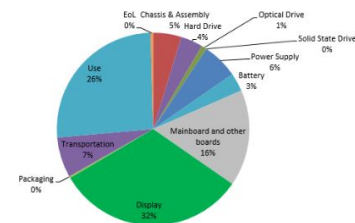
PCR - Product carbon footprint

Lenovo Product Carbon Footprint (PCF) Information Sheet PC/Notebook/Monitor/Tablet

Commercial Name	Lenovo E41-45	
Model Number	81BK, 82BF	
Issue Date	2020/03/17	

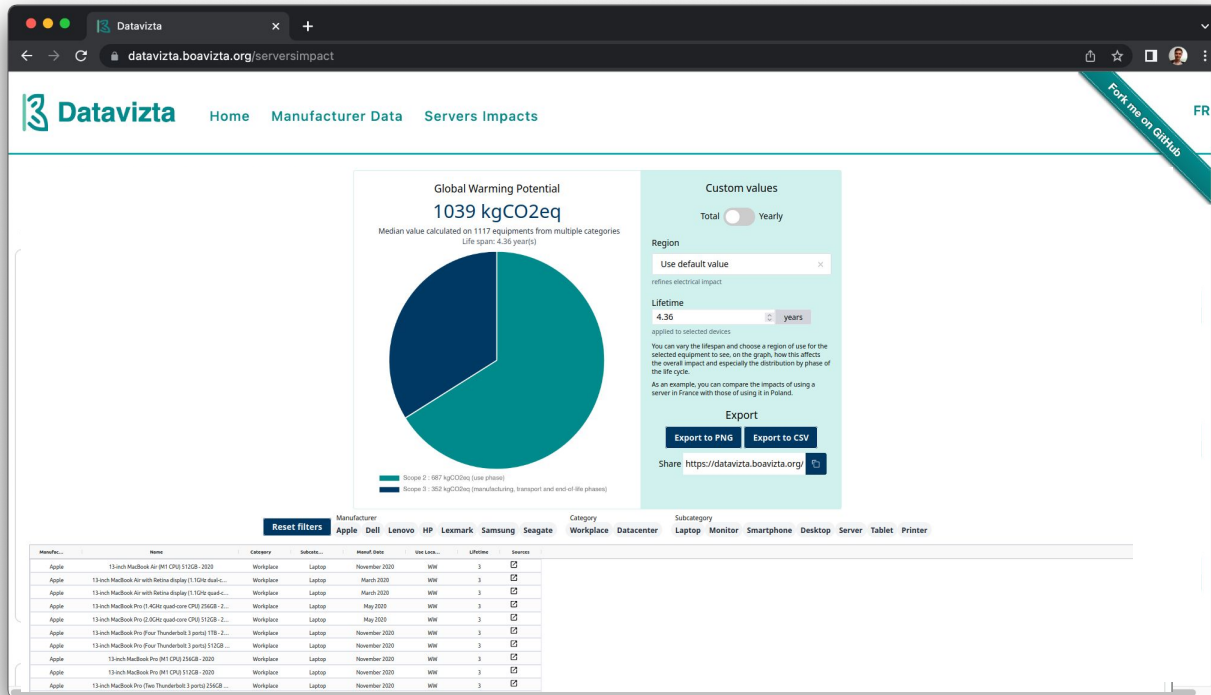
Product Environmental Attributes

(a) Product Carbon Footprint Value:	336 kg of CO ₂ e (see Note 1 below)
(b) Product Picture:	(c) Life Cycle Detail by Component & Life Stage (Pie Chart):



Note 1:

DEMO



The background features two large, thin blue circles that overlap each other. One circle is positioned on the left side, and the other is on the right side, with their intersection in the center.

Datacenter

Perimeter



End-user equipments



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Consommation électrique du datacenter

Open-methodologies

Physique

Mesure logiciel

Modélisation

Open-Source



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Transport



Use

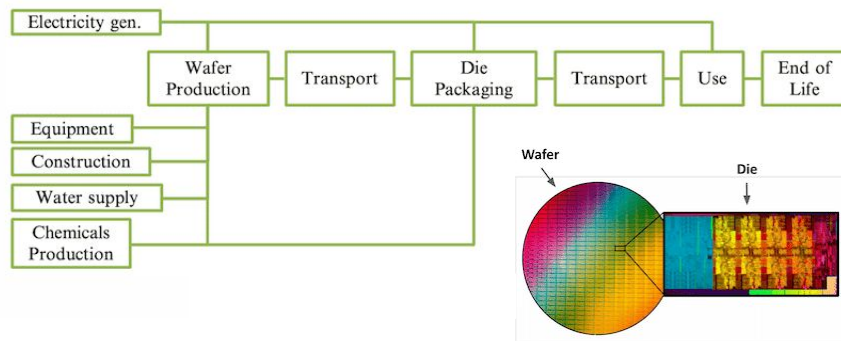


Waste



Approche boavizta

À partir des études ACV on déduit des “proxy” pour calculer les impacts d’autres produits.



Impact de la fabrication d’un CPU

$$I_{\text{CPU}} = (\text{core_units} \times \text{die_size_per_core} + 0.491) \times \text{MANUF_DIE} + \text{MANUF_BASE}$$

Crowdsourcing

Open-data



Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit



UCLouvain

Open-source



BoaviztAPI
Boagent

The screenshot displays the Datavizta website interface. At the top, there is a navigation bar with the logo and links for 'Home', 'Manufacturer Data', and 'Servers Impacts'. A 'FR' language selector and a 'Fork me on GitHub' button are also visible. The main content area is titled 'Multicriteria server impacts' and is divided into two main sections: 'Server configuration' and 'Multicriteria impacts during lifespan'.

Server configuration

CPU

Quantity	Core units	TDP (Watt)	Architecture
2	16	150	skylake

RAM

Quantity	Capacity (GB)	Manufacturer
4	32	Samsung

SSD

Quantity	Capacity (GB)	Manufacturer
4	1000	Micron

Others

HDD quantity	Server type	PSU quantity
2	Rack	2

Usage

Localisation	Lifespan (year)
--------------	-----------------

Multicriteria impacts during lifespan

Global Warming Potential (kgCO2eq) - Total : 3153.8
Evaluates the effect on global warming

Category	Value
Usage	2000.0
Manufacturing	1153.8

Primary energy (MJ) - Total : 82561
Consumption of energy resources

Category	Value
Usage	67700
Manufacturing	14861

Abiotic Depletion Potential (kgSbeq) - Total : 0.141528
Evaluates the use of minerals and fossil resources

Category	Value
Usage	0.000337
Manufacturing	0.141191

Global Warming Potential Breakdown:

- Usage : 2000.0
- Manufacturing : 1153.8
- Manufacturing RAM : 480.0
- Manufacturing CPU : 39.4
- Manufacturing SSD : 204.0
- Manufacturing HDD : 62.2
- Manufacturing Others : 368.2

Primary energy Breakdown:

- Usage : 67700
- Manufacturing : 14861
- Manufacturing RAM : 6000
- Manufacturing CPU : 596
- Manufacturing SSD : 2508
- Manufacturing HDD : 552
- Manufacturing Others : 5205

Abiotic Depletion Potential Breakdown:

- Usage : 0.000337
- Manufacturing : 0.141191
- Manufacturing RAM : 0.019600
- Manufacturing CPU : 0.040000
- Manufacturing SSD : 0.007200
- Manufacturing HDD : 0.000500
- Manufacturing Others : 0.073891



Et dans le cloud ?

Perimeter



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Transport



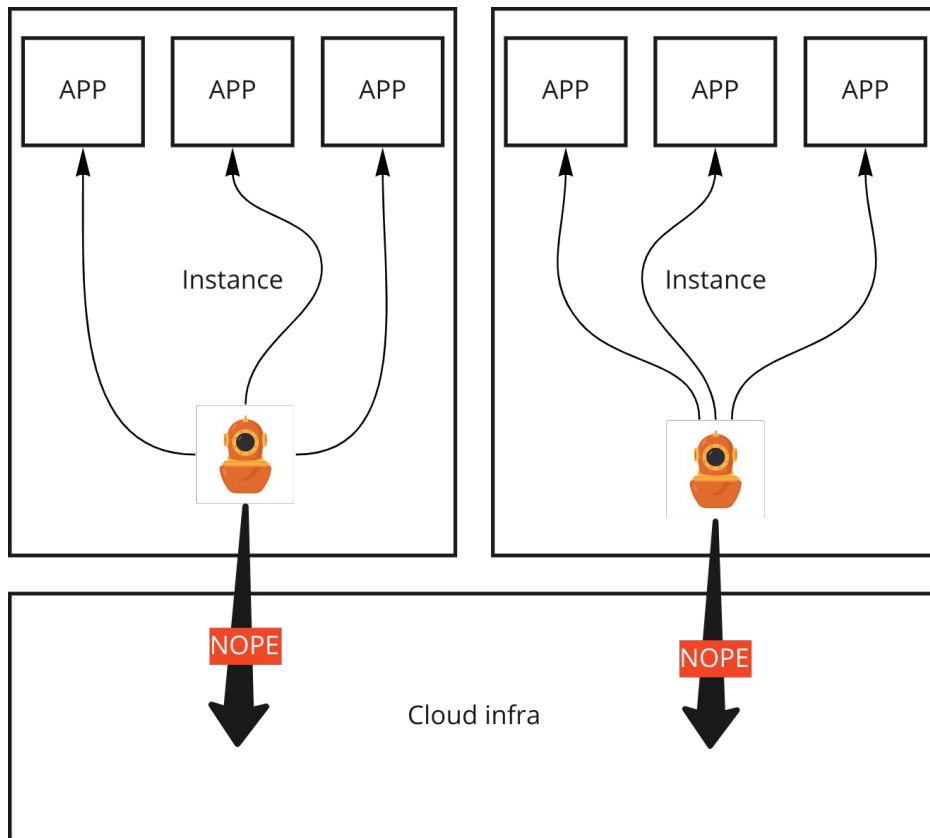
Use



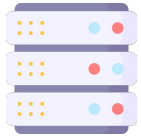
Waste



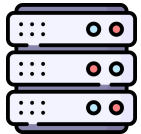
Où brancher mon wattmètre ?



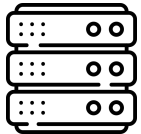
Energizta



- Caractéristique techniques
- États : [(power, load, I/O,...)]



- Caractéristique techniques
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- Caractéristique techniques
- États : [(power, load, I/O,...)]



Open-science

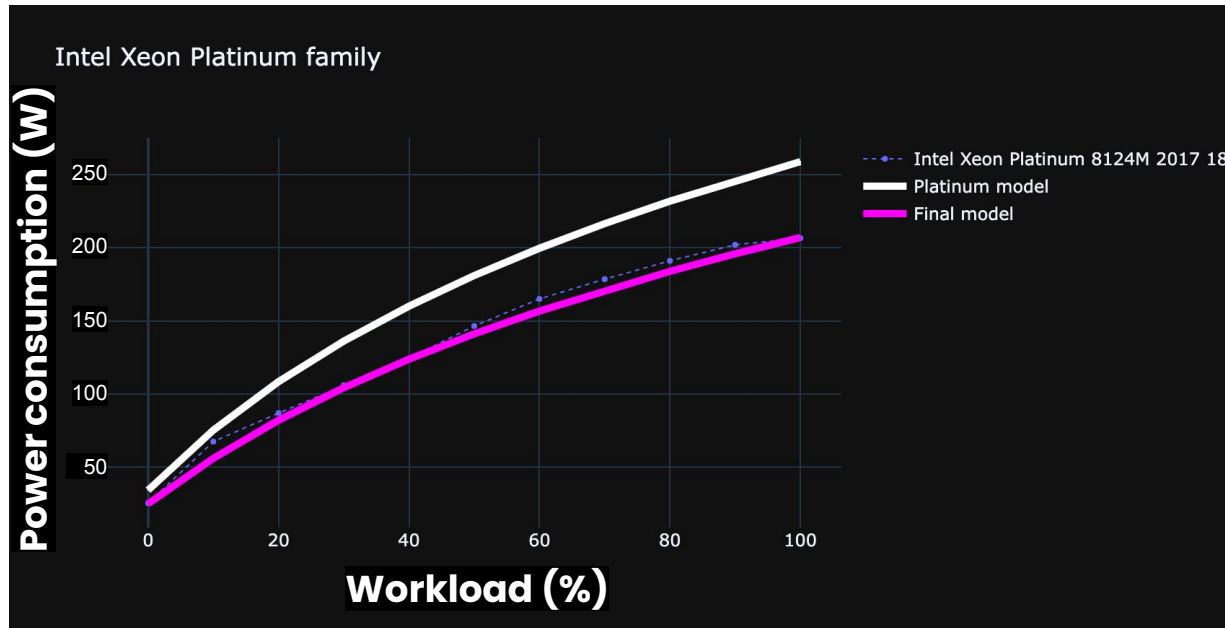


- ❑ Analyser les méthodes de mesures de la conso
- ❑ Profils de consommations
- ❑ Trouver les caractéristiques dimensionnant
- ❑ ...

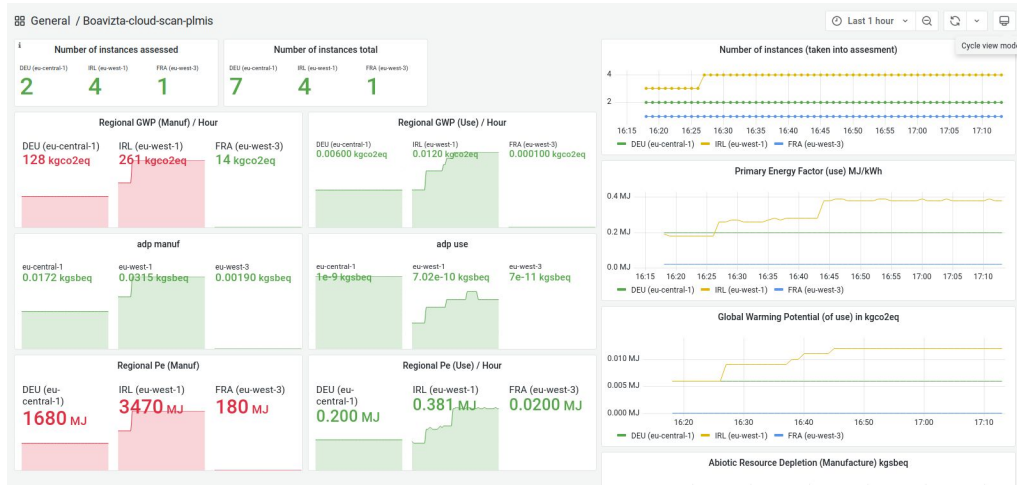
Exemple pour un CPU

$$f(\text{workload}) \rightarrow \text{power}$$

Modélisation de la puissance d'un **CPU Intel Xeon Platinum**

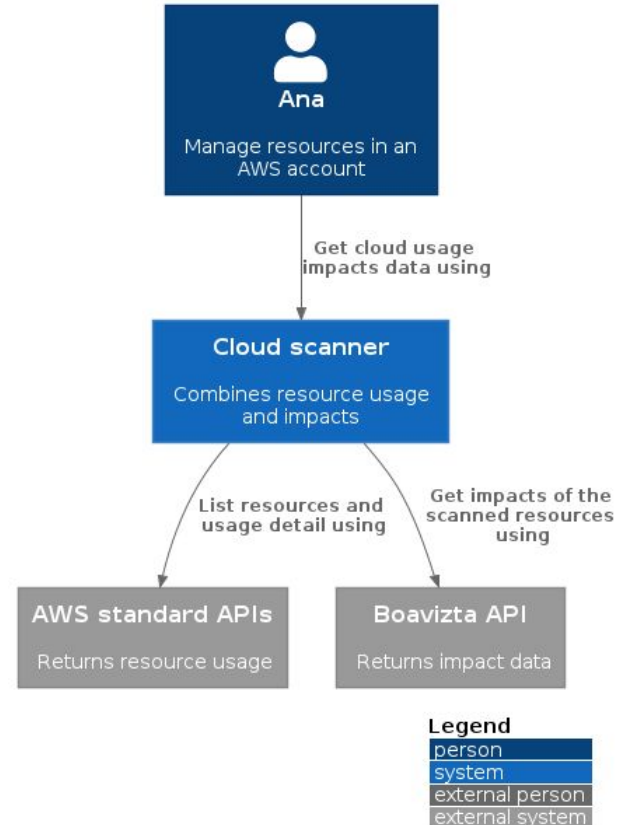


Cloud-scanner



⇒ Scan de l'usage du cloud AWS (AWS API)

⇒ Modélise les impacts à l'usage et à la fabrication (BoaviztaAPI)



The background features several large, thin blue circles that overlap each other, creating a network-like pattern. One large circle is centered on the left side, another on the right, and a third one overlaps them from the top. The text is centered within the space between these circles.

Le réseau

Ou comment poser les bonnes questions

Perimeter



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Cloud (As a service)



Manufacture



Transport



Use



Waste



Question

Question : Quelles sont les impacts réseaux d'un service consommant 1 Go ?

Approche attributionnelle

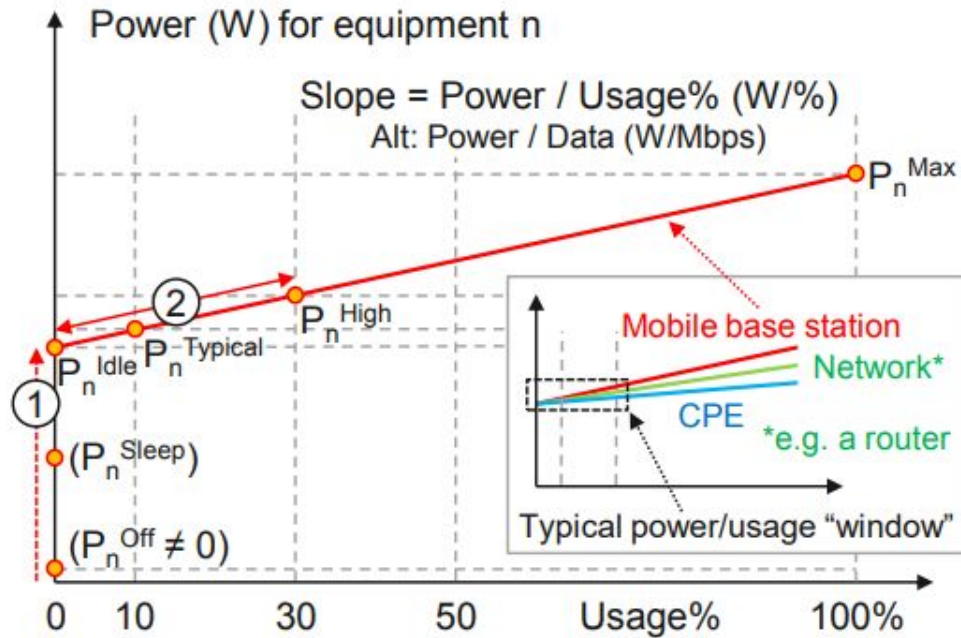
Question : Quelle part des impacts du réseau, je peux attribuer à 1 Go ?

		Resource use, minerals and metals - mg Sb eq.	Resource use, fossils - MJ	Acidification - mol H+ eq.	Eco-toxicity, freshwater -CTUe	Climate change - kg CO ₂ eq.	Ionising radiation, human health - kBq U235 eq.	Particulate matter - Disease occurrence per 1 billion	Photo-chemical ozone formation - human health - mg NMVOC eq.	Raw materials - kg	Waste production - kg	Primary energy consumption - MJ	Final energy consumption (use) - MJ
Per subscriber	Fixed-line network	1,470	2,040	0.533	1,160	81.20	151	3,820	197,000	266	40.4	2,400	654
	Mobile network	87.3	252	0.0645	135	9.85	16.4	469	23,300	27.8	3.27	299	87.6
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Approche conséquentielle court-terme

Question : Quel est l'impact marginal d'un Go sur un réseau ?



Approche conséquentielle long terme

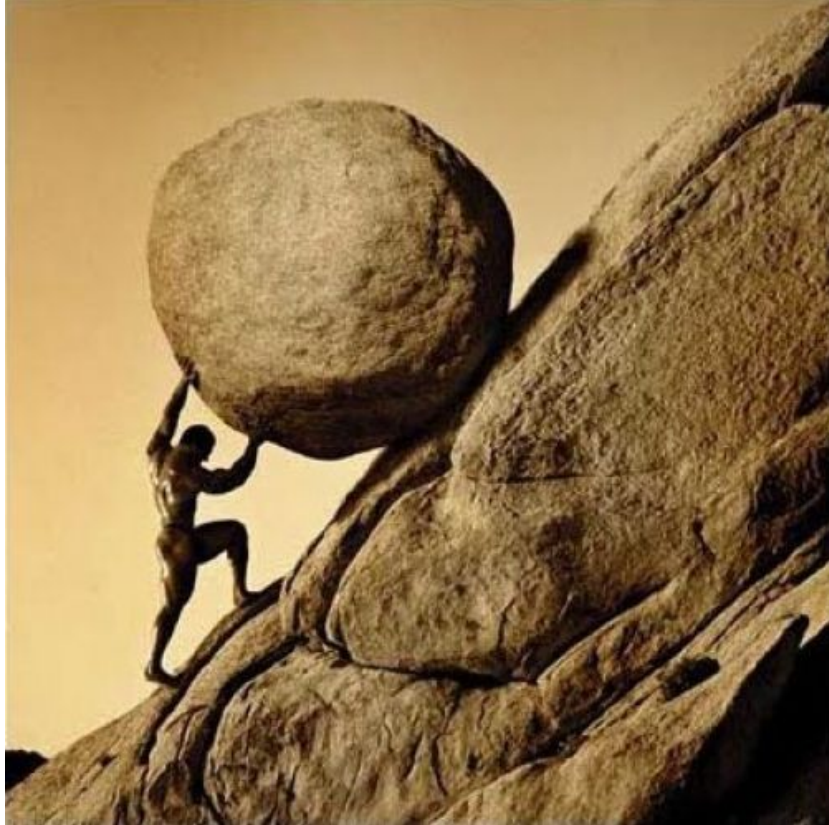
Question : Quel est l'impact du réseau à la suite de la généralisation du service ?

Les effets à considérer :

- Effets rebonds
- Effets d'empilement
- Transformation sociales
- Transformation économiques
- Substitution
- ...



Félicitations ! Vous avez une mauvaise évaluation



En attendant

1. Refusez
2. Réduisez
3. Réutilisez
4. Recyclez
5. Rendez

ANEXES



Mesurer les impacts du réseau



Perimeter



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Cloud (As a service)



Manufacture



Transport



Use



Waste



Per GB

Open-data

		Resource use, minerals and metals - mg Sb eq.	Resource use, fossils - MJ	Acidification - mol H+ eq.	Eco-toxicity, freshwater -CTUe	Climate change - kg CO ₂ eq.	Ionising radiation, human health - kBq U235 eq.	Particulate matter - Disease occurrence per 1 billion	Photo-chemical ozone formation - human health - mg NMVOC eq.	Raw materials - kg	Waste production - kg	Primary energy consumption - MJ	Final energy consumption (use) - MJ
Per GB of transferred data	Fixed-line network	0.557	0.773	0.000202	0.439	0.0307	0.0572	1.45	74.5	0.101	0.0153	0.909	0.248
	Mobile network	0.851	2.460	0.000629	1.320	0.096	0.16	4.57	227	0.271	0.0318	2.910	0.853

Per line

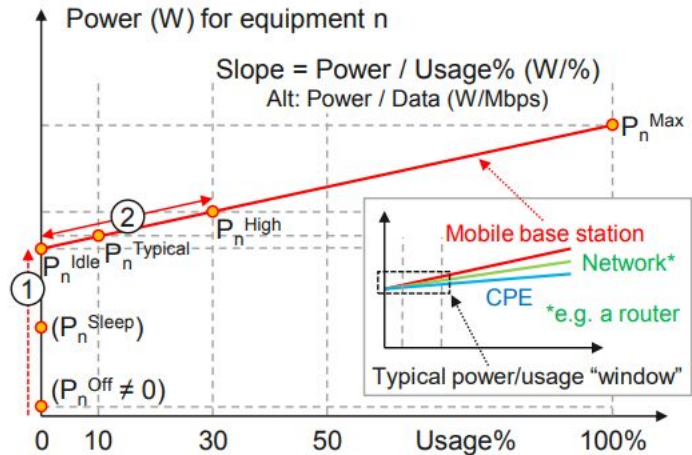
Open-data

		Resource use, minerals and metals - mg Sb eq.	Resource use, fossils - MJ	Acidification - mol H+ eq.	Eco-toxicity, freshwater -CTUe	Climate change - kg CO ₂ eq.	Ionising radiation, human health - kBq U235 eq.	Particulate matter - Disease occurrence per 1 billion	Photo-chemical ozone formation - human health - mg NMVOC eq.	Raw materials - kg	Waste production - kg	Primary energy consumption - MJ	Final energy consumption (use) - MJ
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	Mobile network	87.3	252	0.0645	135	9.85	16.4	469	23,300	27.8	3.27	299	87.6

By marginal cost

Open Science

Let's build it together !



Type de noeud	Impact fixe - fab, maintenance, idle (/ligne)	Impact variable (/go)
Node1	b1	a1
Node2	b2	a2
Node3	b3	a3

$$\text{Node1}(x) = a1.x+b1$$

Reduce the impacts of ICT

GREEN IT



IPAT

$$\text{Impact} = \text{Population} * \text{Affluence} * \text{Technology}$$

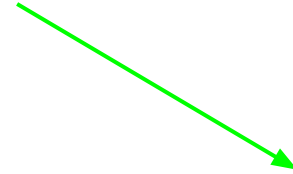
↓
Number of users

↓
Quantity of
technology
consumed

↓
Impact of a unit
of technology

Optimize

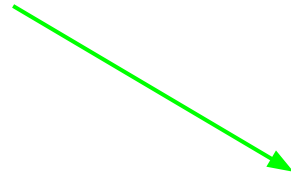
$$\text{Impact} = \text{Population} * \text{Affluence} * \text{Technology}$$



- Reduce the energy consumption per unit of technology
- Reduce the use of resources per unit of technology
- ...

Beware of the rebound effect

$$\text{Impact} = \text{Population} * \text{Affluence} * \text{Technology}$$



Increase in the population or affluence due to a reduction in technology cost



Increase in the population or affluence due to an reduction in time consumption





Increase in the population or affluence due to a reduction of complexity

Rebound effect in cloud context

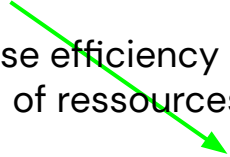
$$\text{Impact} = \text{Population} * \text{Affluence} * \text{Technology}$$



  Increase in
people accessing
hosted services



  Increase in
resource unit
consumption



Increase efficiency per unit
of ressource

 Reduce cost per
unit of ressource


 Reduce deployment
complexity

Reduce the impact with ICT

IT 4 Green




Substitution

 Shifting to a less polluting process per unit of service



Optimization


 Reduction of the impact of a process by introducing a new technical element



Beware of the rebound effect

Substitution





 Increase in the number of books read (Affluence)

Partial substitution

Optimization



 Purchase of new goods with fuel economy

 New uses with time saved

Boavizta schémas globale

