Évaluer les impacts environnementaux du numérique : Open Source contre opacité

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Votre serviteur

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Recherche ⇒ 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

Périmètre

Mutli-steps

Multi-perimeters

Périmètre

Mutli-steps

End-user equipments

Network

On-prem infra

Cloud

Périmètre

End-user equipments

Network

On-prem infra

Cloud

Manufacture

Transport

Use

Waste

Pourquoi faire de la mesure un commun ?

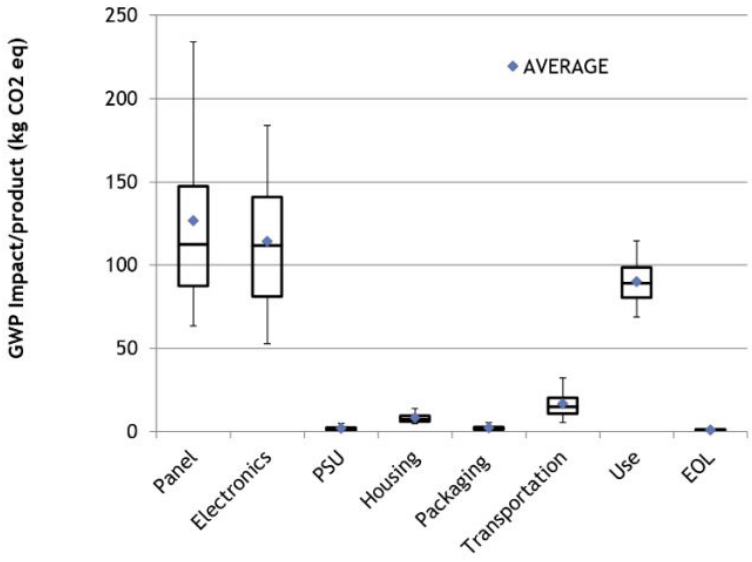
Parce que c’est une nécessité démocratique

“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 **(kgCO2e/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

Dell E2219HN Monitor



Des maaaaaaaaaarges 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

End-user equipments

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Cloud (As a service)

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Waste

Données constructeurs

Fopen-data

PAIA

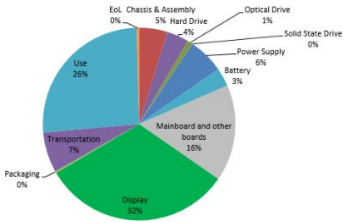
PCR - Product carbon footprint

Lenovo Product Carbon Footprint (PCF) Information Sheet

PC/Notebook/Monitor/Tablet

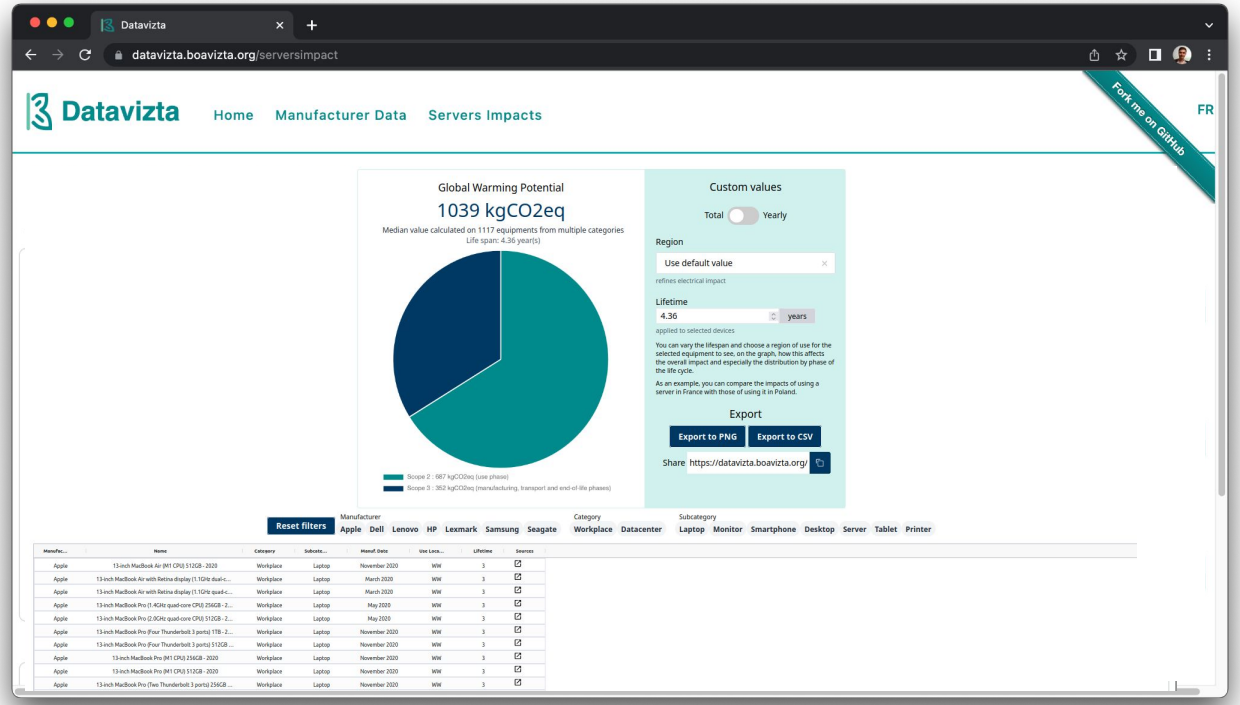
Commercial Name	Lenovo E41-45
Model Number	81BK, 82BF
Issue Date	2020/03/17

Product Environmental Attributes	
(a) Product Carbon Footprint Value:	**336 kg of CO_2e (see Note 1 below)**
(b) Product Picture:	**(c) Life Cycle Detail by Component & Life Stage (Pie Chart):**



Note 1:

DEMO



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Datacenter

Perimeter

End-user equipments

Network

On-prem infra

Cloud (As a service)

Manufacture

Transport

Use

Waste

Consommation électrique du datacenter

Open-methodologies

Open-Source

Physique

Mesure logiciel

PowerAPI

Modélisation

Joular

Perimeter

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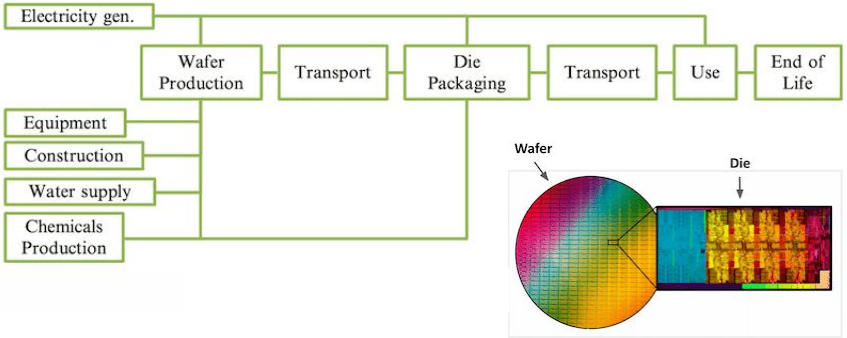
Approche boavizta

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



Impact de la fabrication d’un CPU

$$I_{CPU} = (\textbf{core\_units} \times \textbf{die\_size\_per\_core} + 0.491) \times MANUF\_DIE + MANUF\_BASE$$

Source : Etapes du cycles de vie d’un circuit intégré - Sarah Boyd

Crowdsourcing

Open-data

WikiChip
Chips & Semi

Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

ARCHIVES OUVERTES HAL

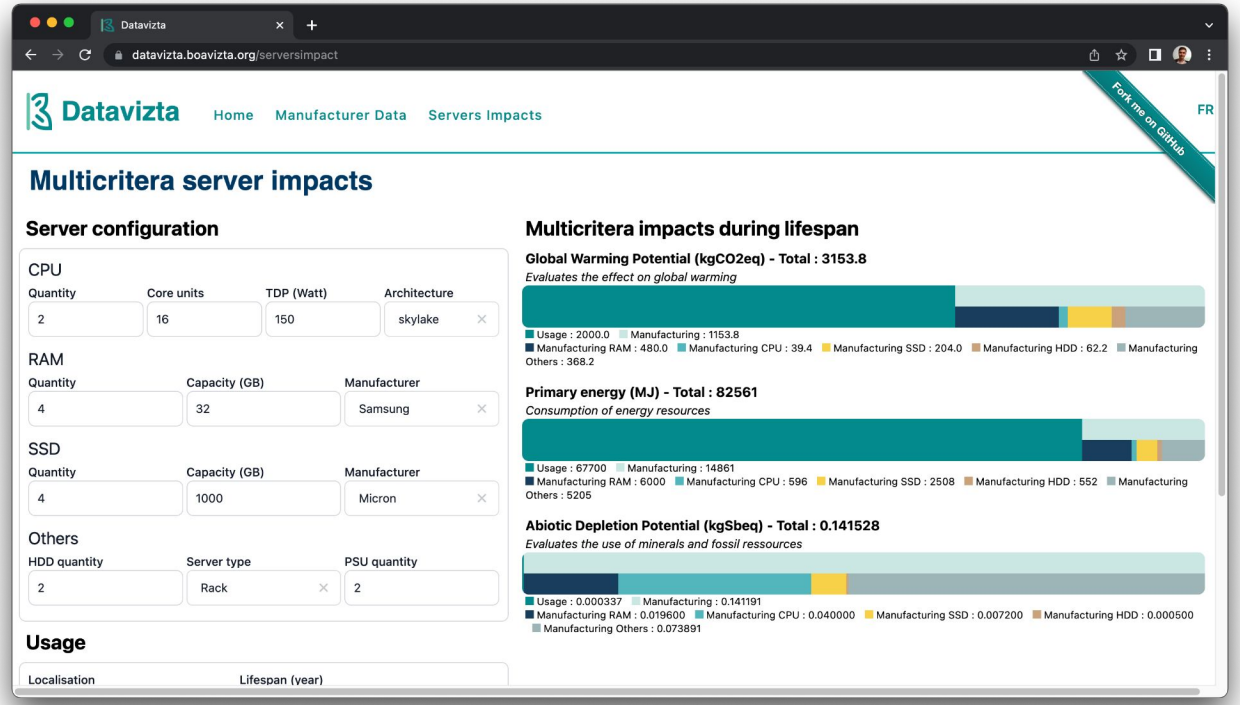
ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

UCLouvain

Open-source

BoaviztAPI
Boagent

DEMO



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Et dans le cloud ?

Perimeter

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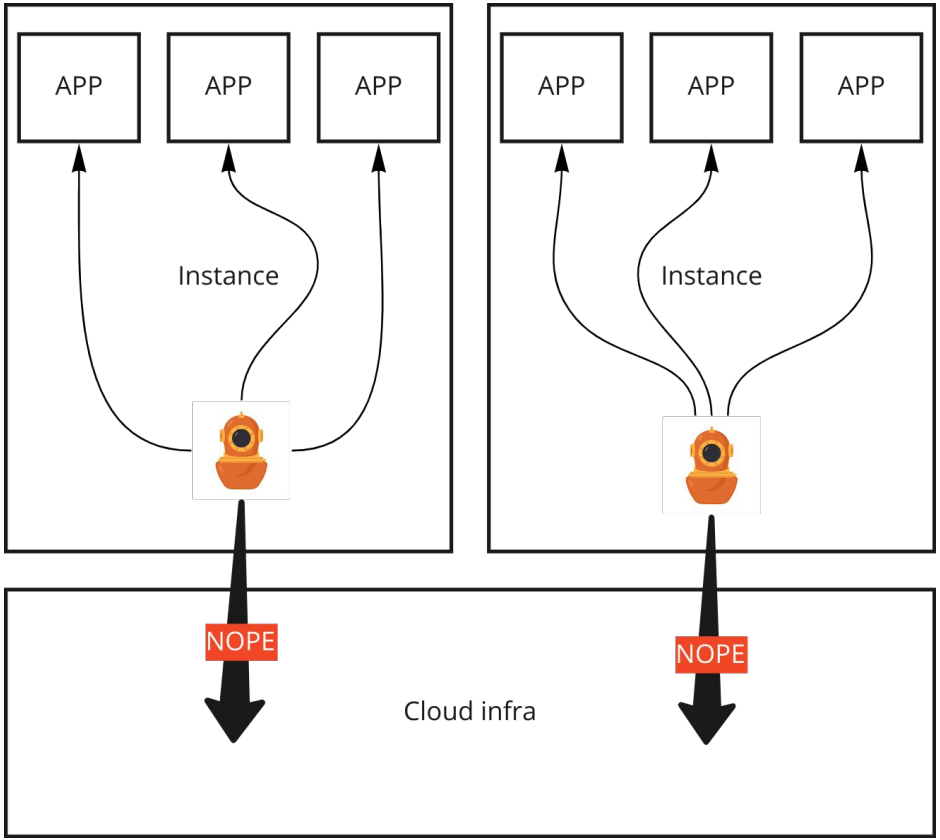
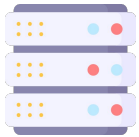
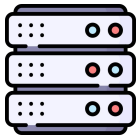
Où brancher mon wattmètre ?



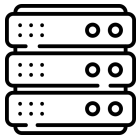
Energizta



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



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



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

Open-science

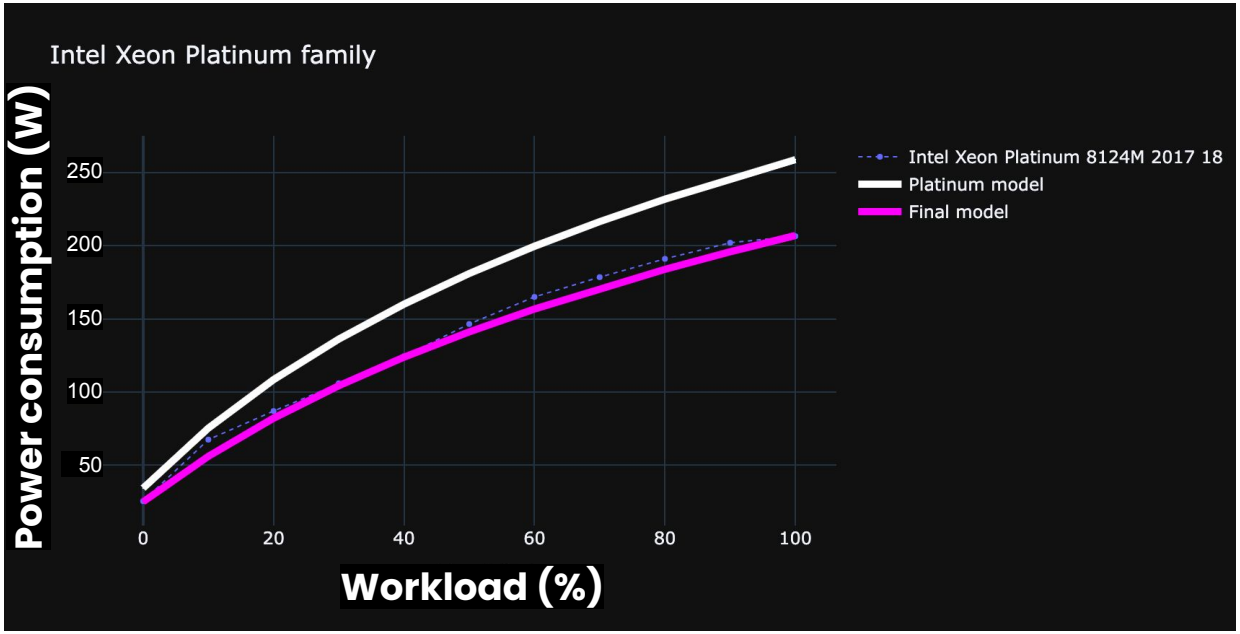
- ❑ Analyser les méthodes de mesures de la conso
- ❑ Profils de consommations
- ❑ Trouver les caractéristiques dimensionnant
- ❑ ...

Credits to Benjamin Davy (Teads), Samuel Rince & Boavizta

Exemple pour un CPU

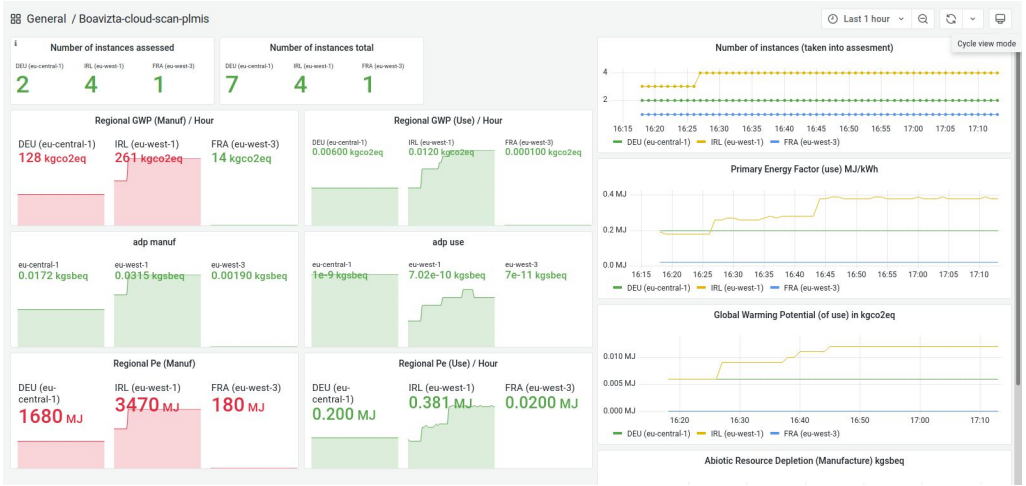
$$f(\text{workload}) \rightarrow \textbf{power}$$

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



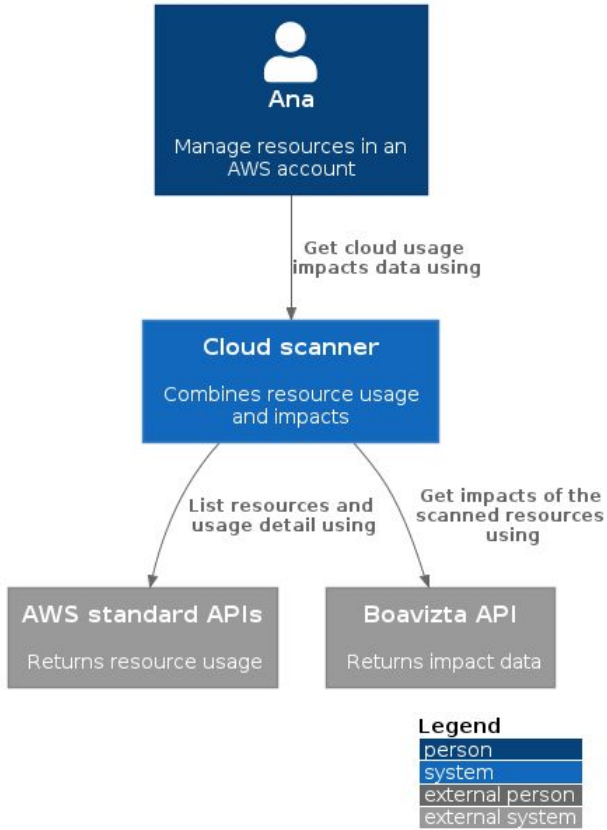
Credits to Olivier de Meringo & Boavizta

Cloud-scanner



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

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



Le réseau

Ou comment poser les bonnes questions

Perimeter

	 *End-user equipments*	 *Network*	 *On-prem infra*	 *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 bilion	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
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
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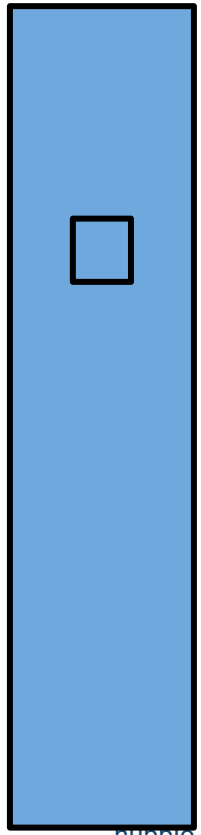
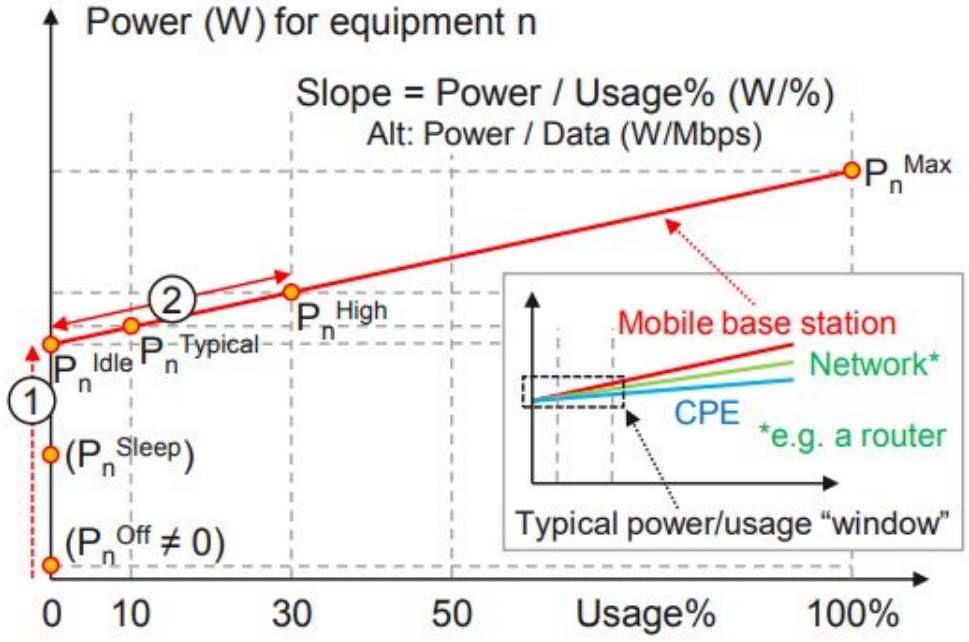


Approche conséquentielle court-terme

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



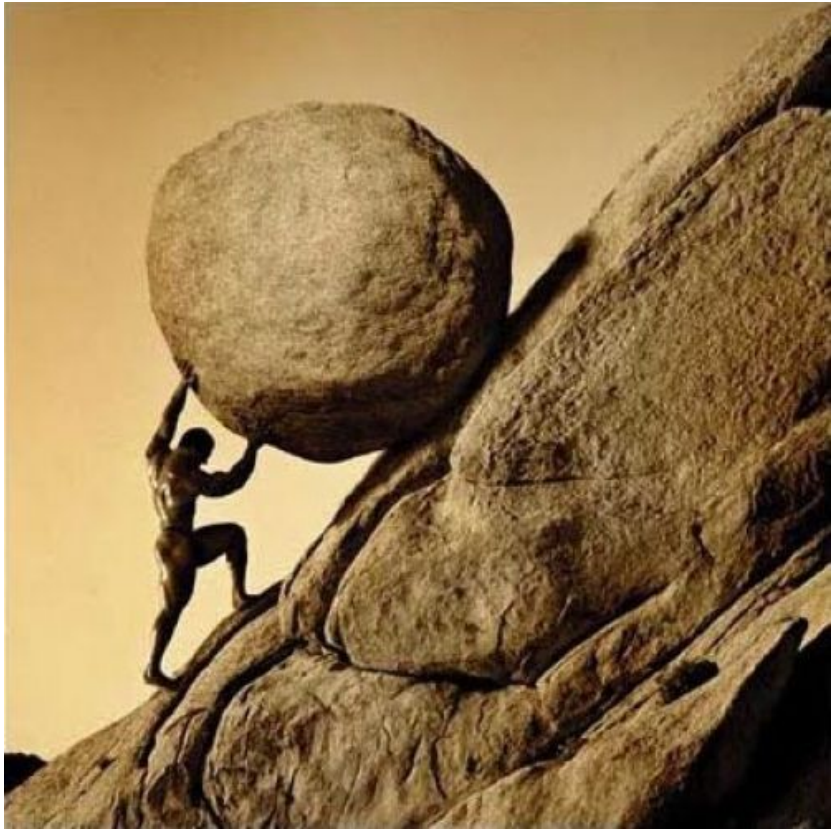
Approche conséquentielle long terme

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

End-user equipments

Network

On-prem infra

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 bilion	Photo-chemical ozone formation - human health - mg NMVOC eq.	Raw materials - kg	Waste production - kg	Primary energy consump-tion - MJ	Final energy consump-tion (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 bilion	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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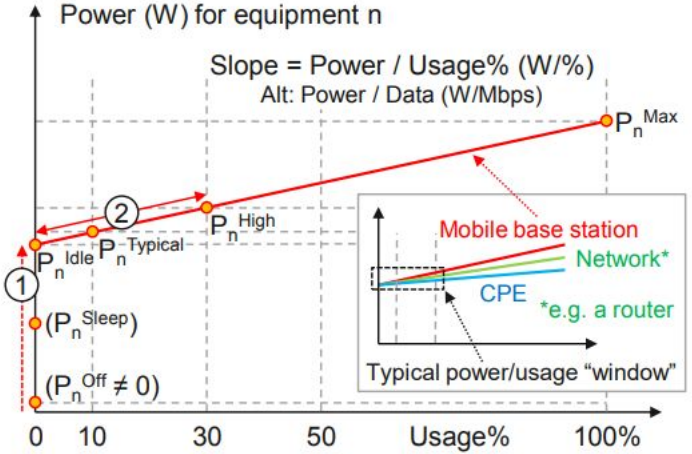
By marginal cost

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

Node1(x) = a1.x+b1

Reduce the impacts of ICT

GREEN IT

IPAT

Impact = Population * Affluence * Technology

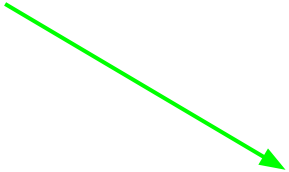
Number of users

Quantity of technology consumed

Impact of a unit of technology

Optimize

Impact = Population * Affluence * Technology



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

Beware of the rebound effect

Impact = Population * Affluence * Technology

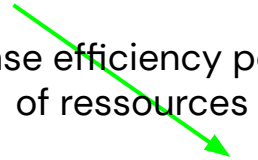
🏛️ Increase in the population or affluence due to a reduction in technology cost

🕒 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

Impact = Population * Affluence * Technology



Increase efficiency per unit of ressources

🪙⚙️ **Increase in people accessing hosted services**

🪙⚙️ **Increase in resource unit consumption**

🪙 **Reduce cost per unit of ressource**

⚙️ **Reduce deployment complexity**

Reduce the impact with ICT

IT 4 Green

ICT 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