≪Think of the environment, do not print this e-mail≫

The controversial role of technological innovation

Climate Change / Changing behaviors - Anne-Laure Ligozat - Cogmaster - 2020

Who am I?

Computer scientist

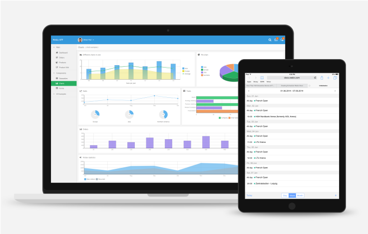
Research topic: environmental impact of ICT (Information and Communications Technology)

LIMSI (CNRS) /
LISN (CNRS, Université Paris Saclay)

+ EcoInfo

ENSIIE

How does technological innovation,
focusing on ICT,
influence climate change?



⇒ carbon footprint of ICT,
expressed in Global Warming Potential (GWP)
or Greenhouse Gases (GHG) emissions

ICT is non physical, right?

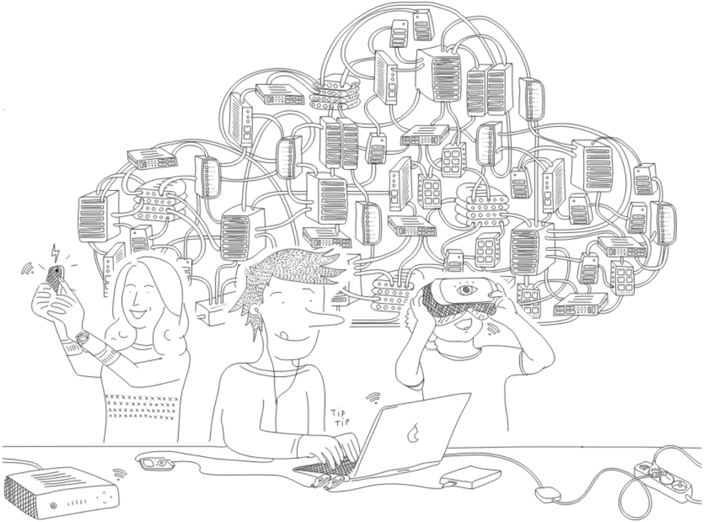
It avoids the use of paper, ink, planes...

User devices...

source: ADEME

+ Data centers and servers

+ Network infrastructure...



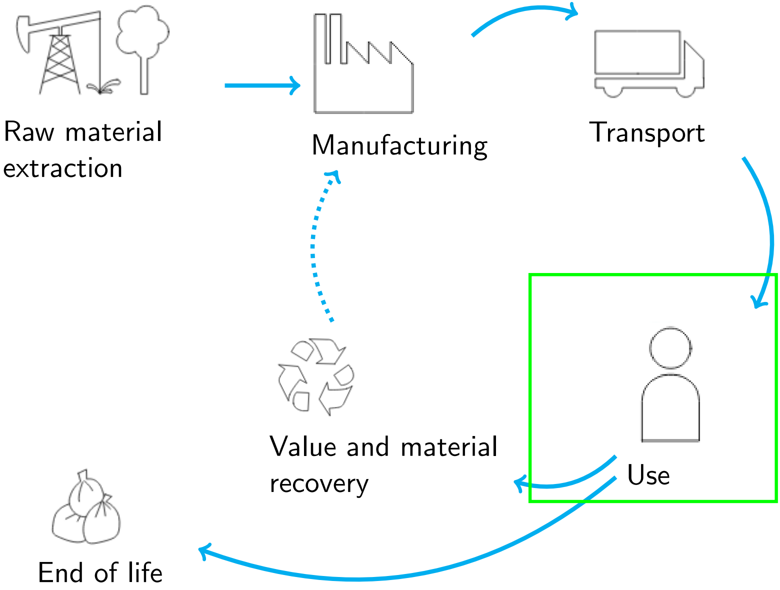
ICT, a non-polluting industry?

environmental footprint largely under-estimated by its users:

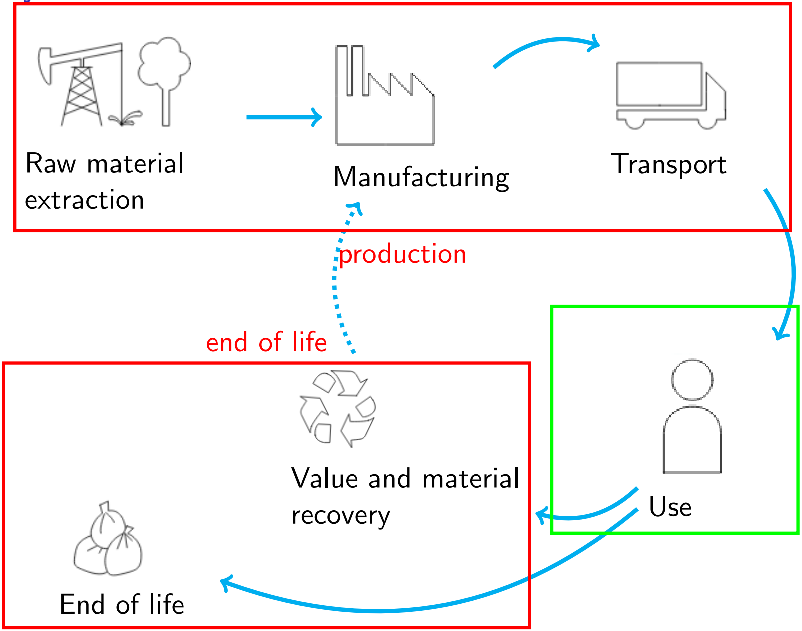
- "invisibility" of infrastructures
- cloud services
- miniaturization of devices

So let’s minimize
our consumption of energy?

Lifecyle of ICT



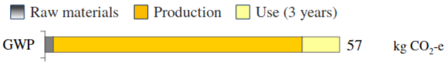
Lifecyle of ICT



Production phase

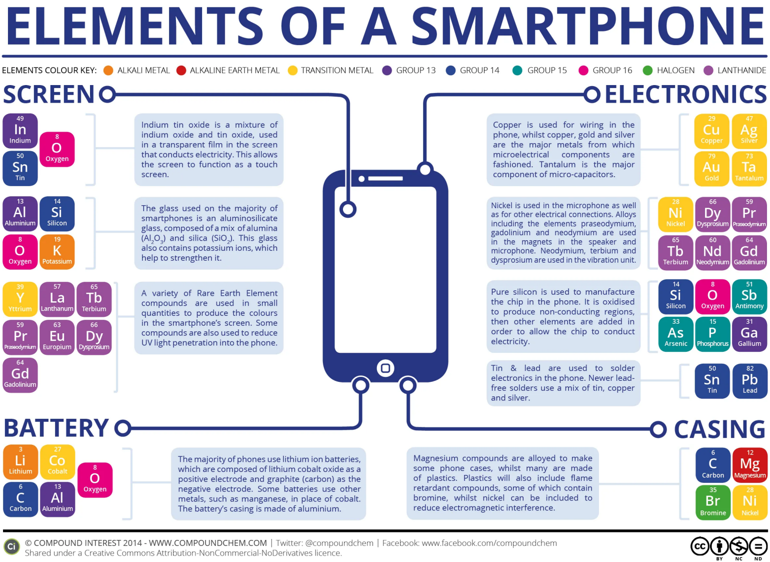
Smartphone:
$>$ 90% of its carbon footprint during production

(in France, excluding network usage)



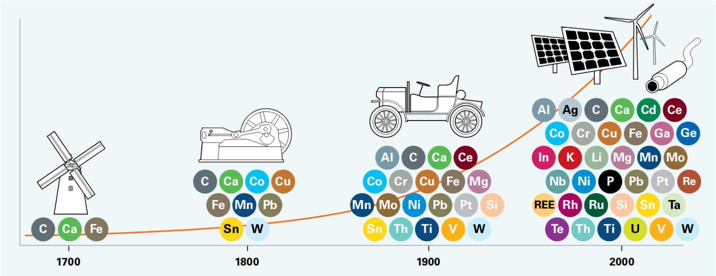
GWP of each lifecycle phase for a smartphone with a global electricity mix [Ercan et al., 2016]

Production phase



Production phase

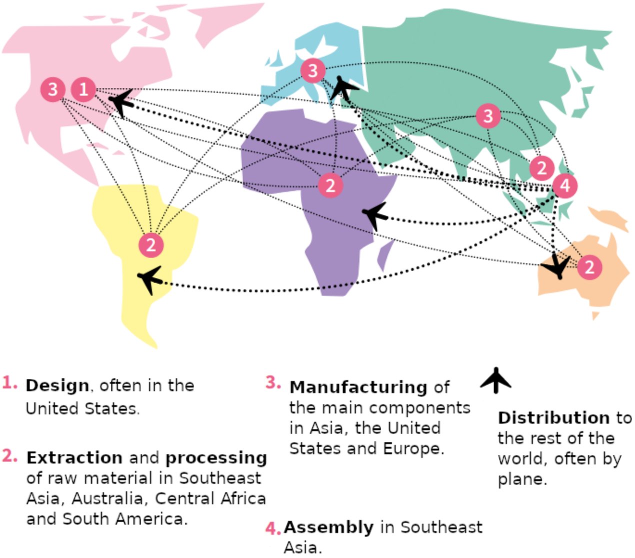
Material evolution



Elements widely used in energy pathways

Materials critical to the energy industry, Achzet et al., 2011

Production phase



source: ADEME and France Nature Environnement

End of life phase

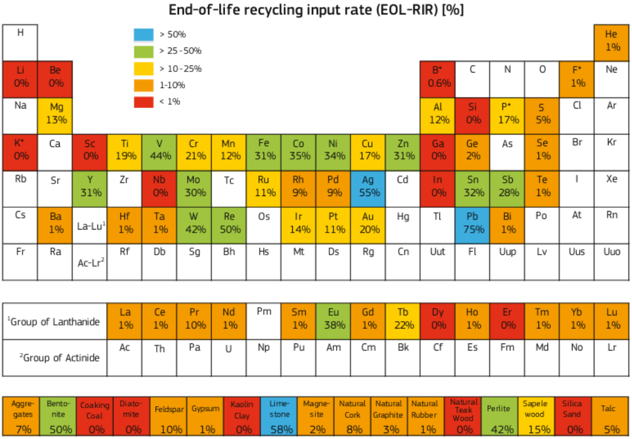
E-waste growth

source: E-waste monitor 2020

End of life phase

Recycling

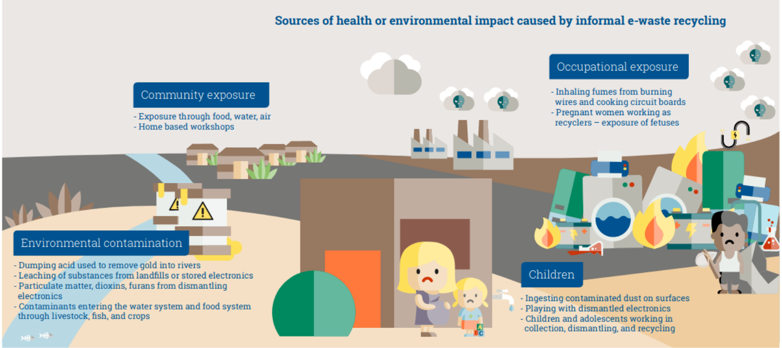
Figure 16.1: End-of-life recycling input rates (EOL-RIR) in the EU-28[170,171].



* F = Fluorspar; P = Phosphate rock; K = Potash, Si = Silicon metal, B = Borates.

source: [European Commission, Joint Research Centre, 2018]

E-waste health and environmental impact



source: E-waste monitor 2020

Environmental impact of ICT lifecycle

Global Warming Potential

Abiotic resource depletion

Blue water shortage

Human toxicity

...

civil aviation

2013

ICT

2018

automobile

2025

ICT $\approx$ 4% of global GHG

with an 8% annual growth!

GHG emissions

Digital share and trajectories compatible with a 2 degrees scenario

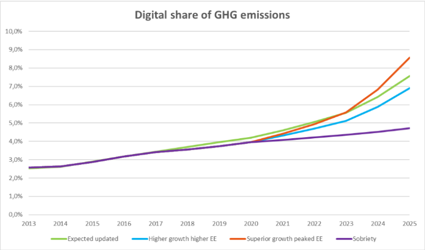


Figure 3: Evolution 2013-2025 of the share of digital technology in GHG emissions. The share of digital technology in GHG emissions. *[Source: [Lean ICT Materials] Forecast Model. Produced by The Shift Project from data published by (Andrae & Edler, 2015)*

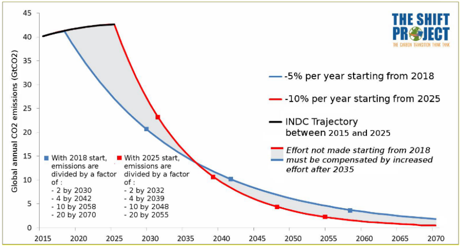


Figure 4: Emission trajectories compatible with a temperature increase limited to 2°C. [Source: The Shift Project, 2016]

Source : The Shift Project, 2018

But doesn't ICT help reduce GHG emissions?

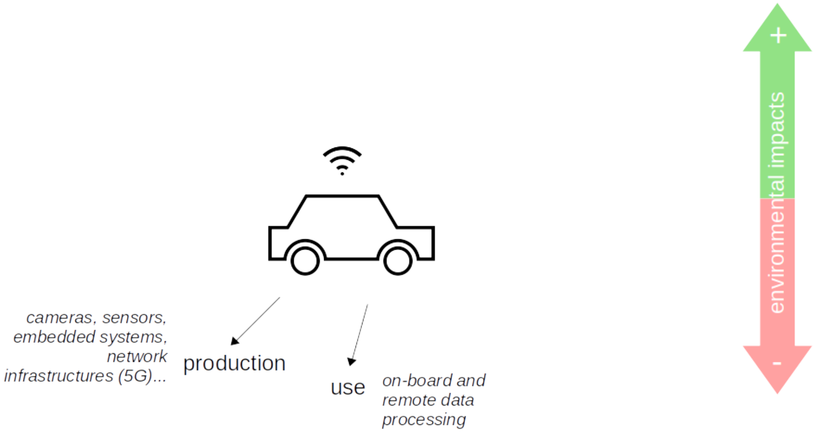
Types of ICT effects

type	perimeter	negative effects	positive effects
1 **direct** effects	technology	life cycle of ICT	n/a
2 **enabling** effects	application	induction	substitution
		obsolescence	optimization
3 **systemic** effects	economy & society	rebound effects	sustainable production and consumption
		emerging risks	

based on [Hilty, 2008, Hilty and Aebischer, 2014]

1st order effects

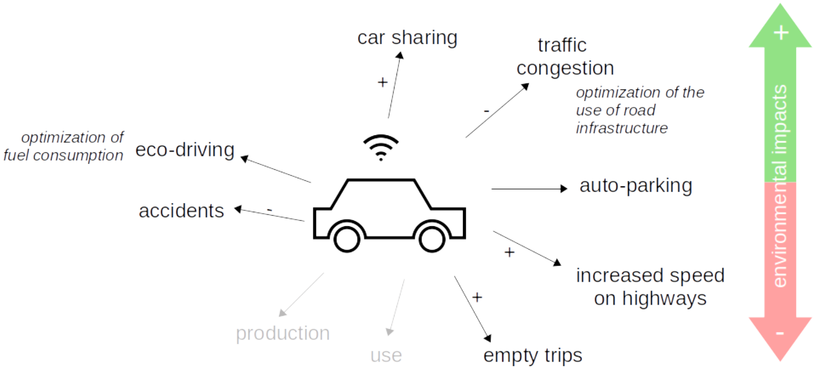
Autonomous vehicles



from Jacques Combaz and [Taiebat et al., 2019]

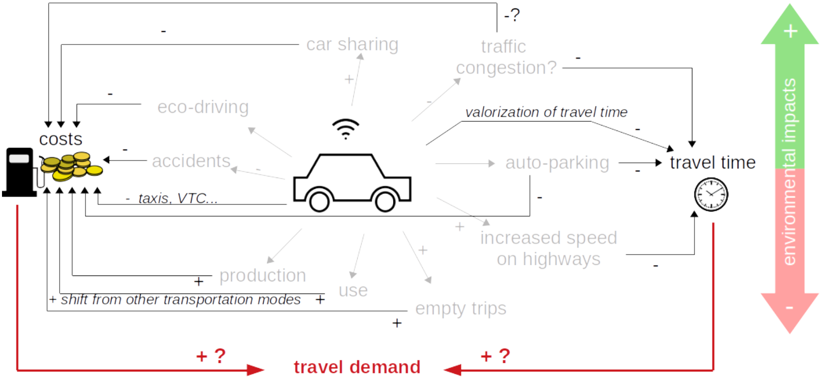
2nd order effects

Autonomous vehicles



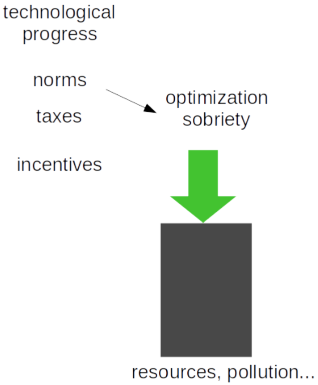
3rd order effects

Autonomous vehicles



The rebound effect

Or why ICT emissions (and others) keep growing nonetheless...



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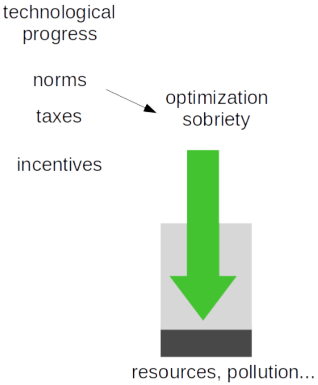

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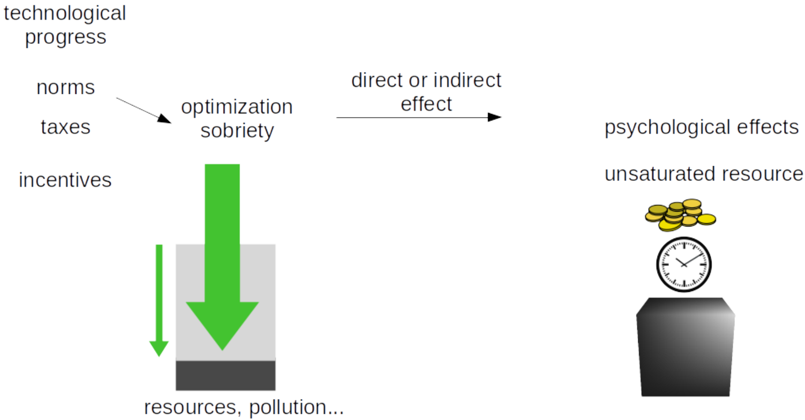

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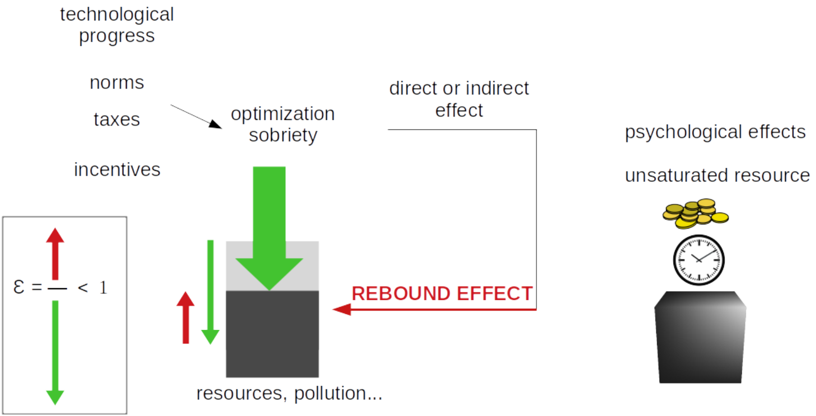

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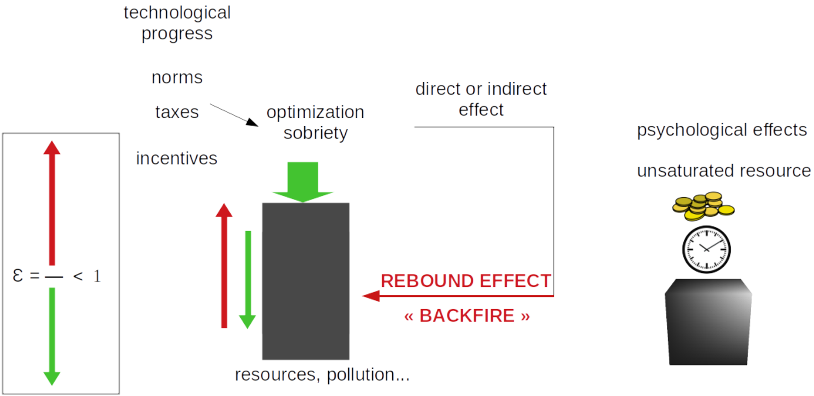
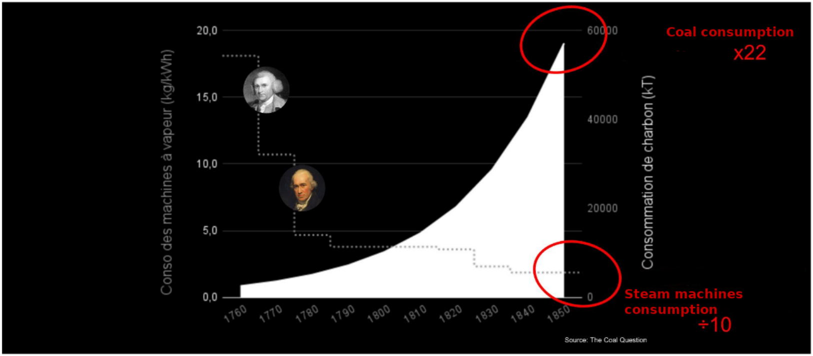
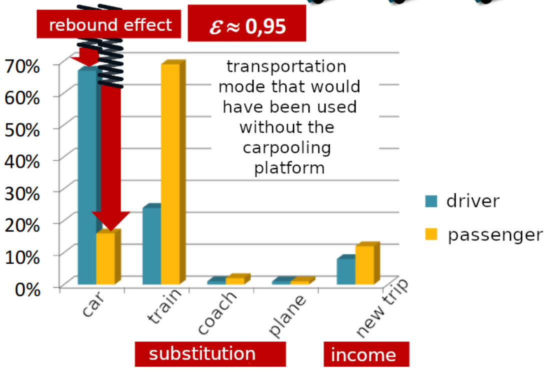


Jevons's paradox



Another example: Blablacar



Main motivations:

- savings 69 %
- socialization 87 %

source : Ademe, 2015

OK... So what about paper vs screen reading?


Je suis écolo, aucun arbre n'a été abattu pour faire mon livre !
Moi aussi, le mien ne contient aucun matériau polluant !
Emma.

Example: book vs e-reader

$\sim$ 1 to 3 kgCO2e

$\sim$ 40 to 170 kgCO2e

$\Rightarrow$ 3 to 35 books each year to make the e-reader more environmental friendly than books (with a 5 year lifetime for the e-reader)

sources: Base carbone Ademe and [Wells et al., 2012]

So back to an Amish lifestyle right?

Key notion with ICT

=

Sobriety

Why is digital sobriety difficult to promote?

- requires systemic changes
- linked to political visions of the future, and in particular the notion of progress

Do we have a choice?

Limits to growth

Technological

Limits to gains in efficiency e.g. Moore's law or Koomey's law

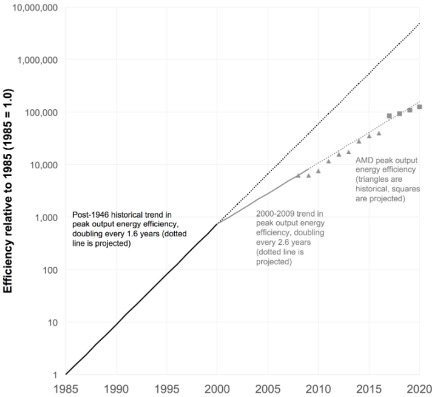


Figure 1: Peak output energy efficiency of computing, historical and projected

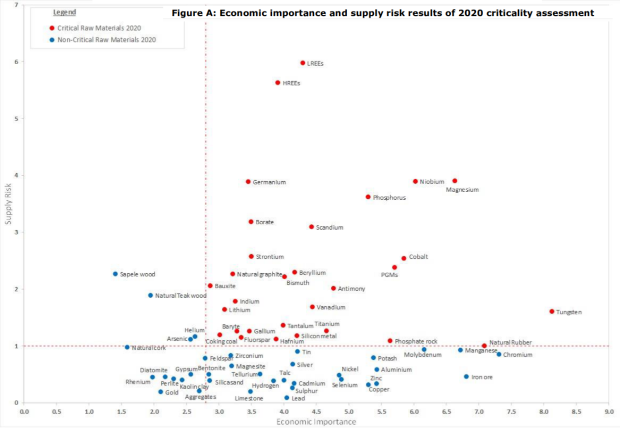
[Koomey and Naffziger, 2016]

Do we have a choice?

Limits to growth

Environmental

- resource (material and energy) depletion
- climate change...



source : [Blengini et al., 2020]

How to implement sobriety?

The Shift Project's recommendations for companies, organizations and governments

1. Adopt digital **sobriety as a principle of action**
2. **Inform** and spread awareness
3. Mobilize the lever of **public purchasing**
4. Allow companies and organizations to **manage the environmental dimension** of their digital transition
5. Carry out a **carbon balance of digital projects** to facilitate their prioritization
6. Improve consideration of the **systemic dimensions** of digital technology
7. Work at the **European scale** and with **international organizations**

How to implement sobriety?

As an individual

- acquisition
  - second-hand acquisition
  - use responsible criteria: repairability, recycling potential, energy use, local...

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  - material: buy less often, make equipments last longer, use responsible software...
  - energy: turn off equipments, use energy-saving modes...
  - data storage and transfer

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  - second-hand acquisition
  - use responsible criteria: repairability, recycling potential, energy use, local...
- use less
  - material: buy less often, make equipments last longer, use responsible software...
  - energy: turn off equipments, use energy-saving modes...
  - data storage and transfer
- end of life
  - donate equipment still in good condition, have it recycled by approved organizations

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