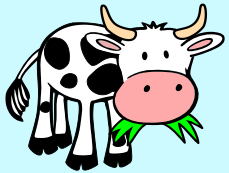
Effets environnementaux « indirects » du numérique

Jacques COMBAZ
Jacques.Combaz@univ-grenoble-alpes.fr
ecoinfo.cnrs.fr

écosphère

technosphère

impacts environnementaux



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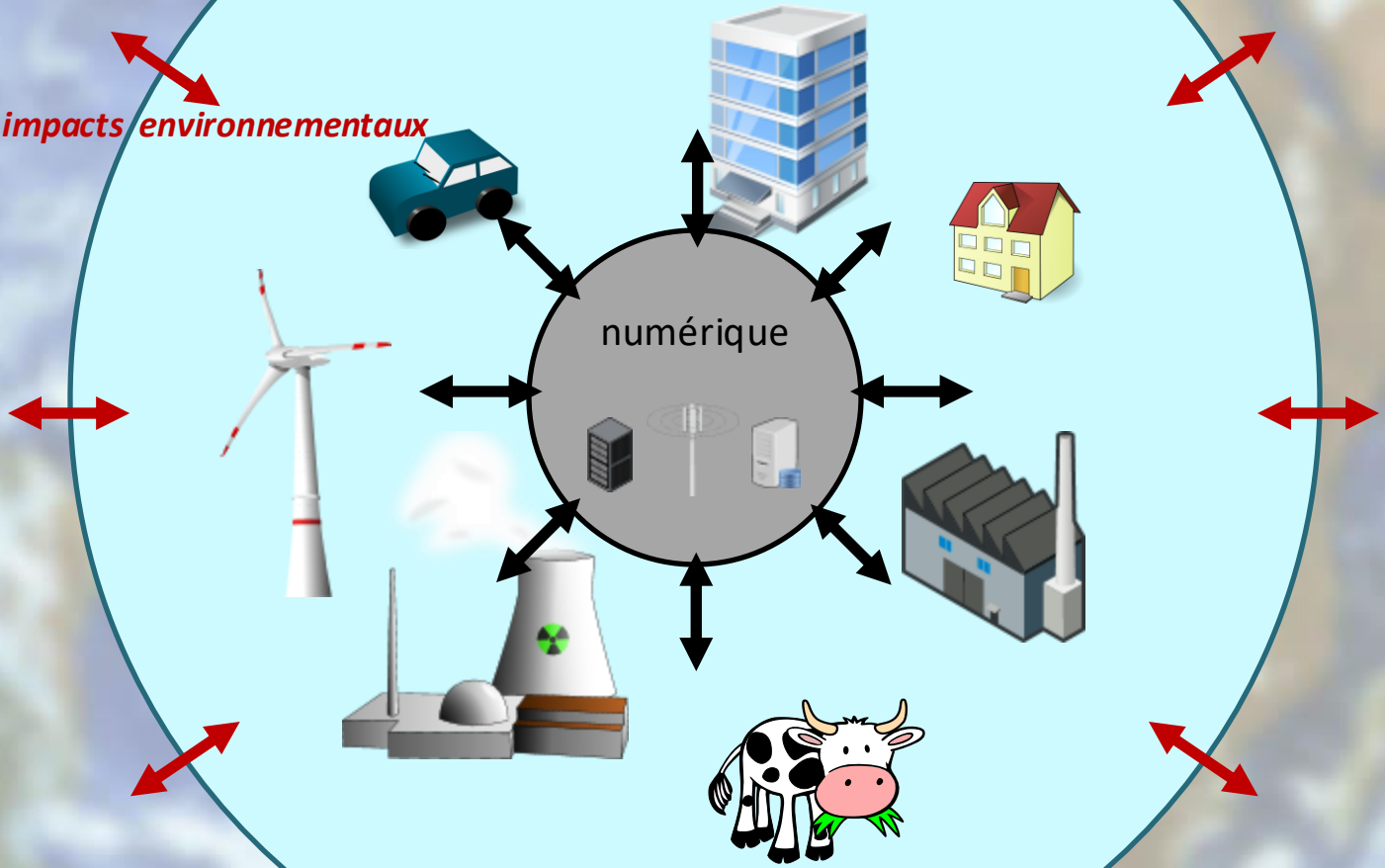

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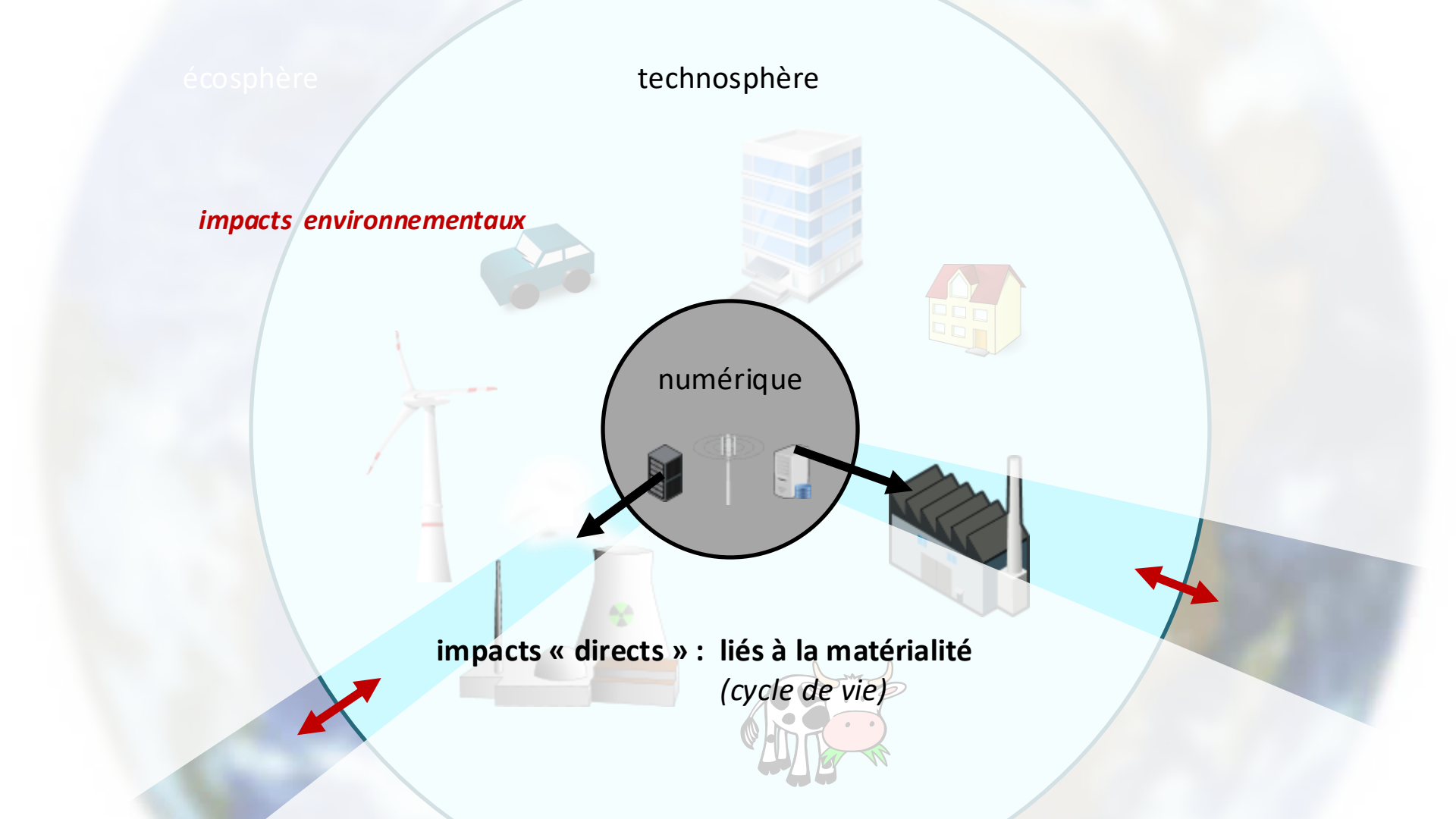
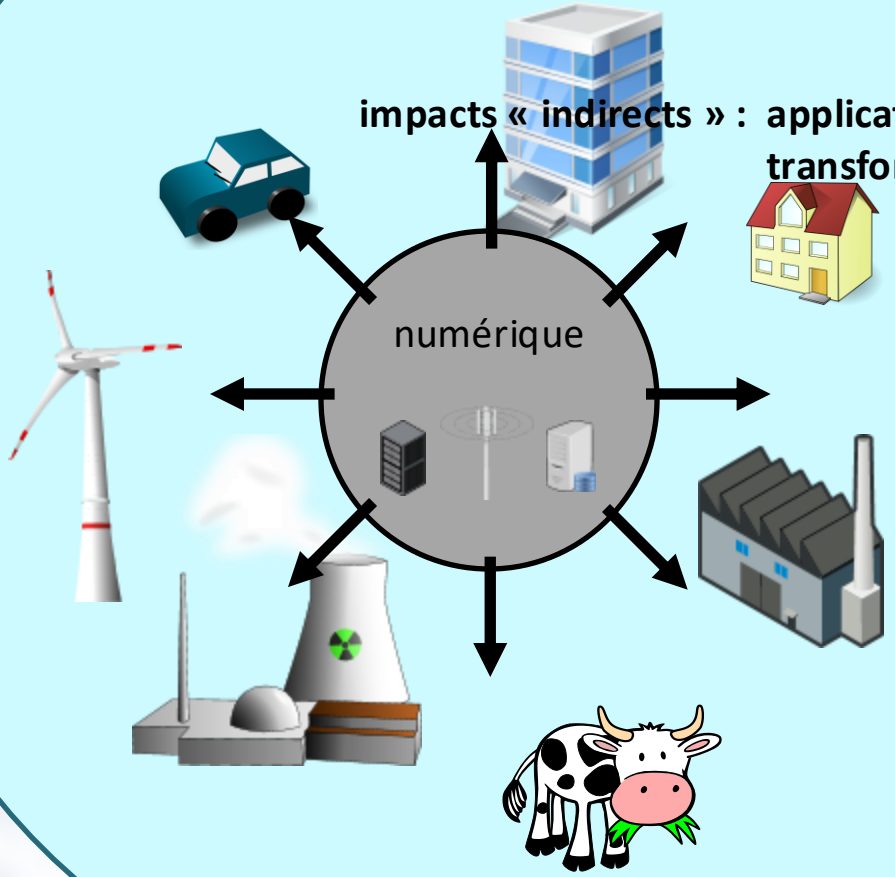


impacts « directs » : liés à la matérialité
(cycle de vie)

écosphère

technosphère

impacts « indirects » : applications numériques transforment la société



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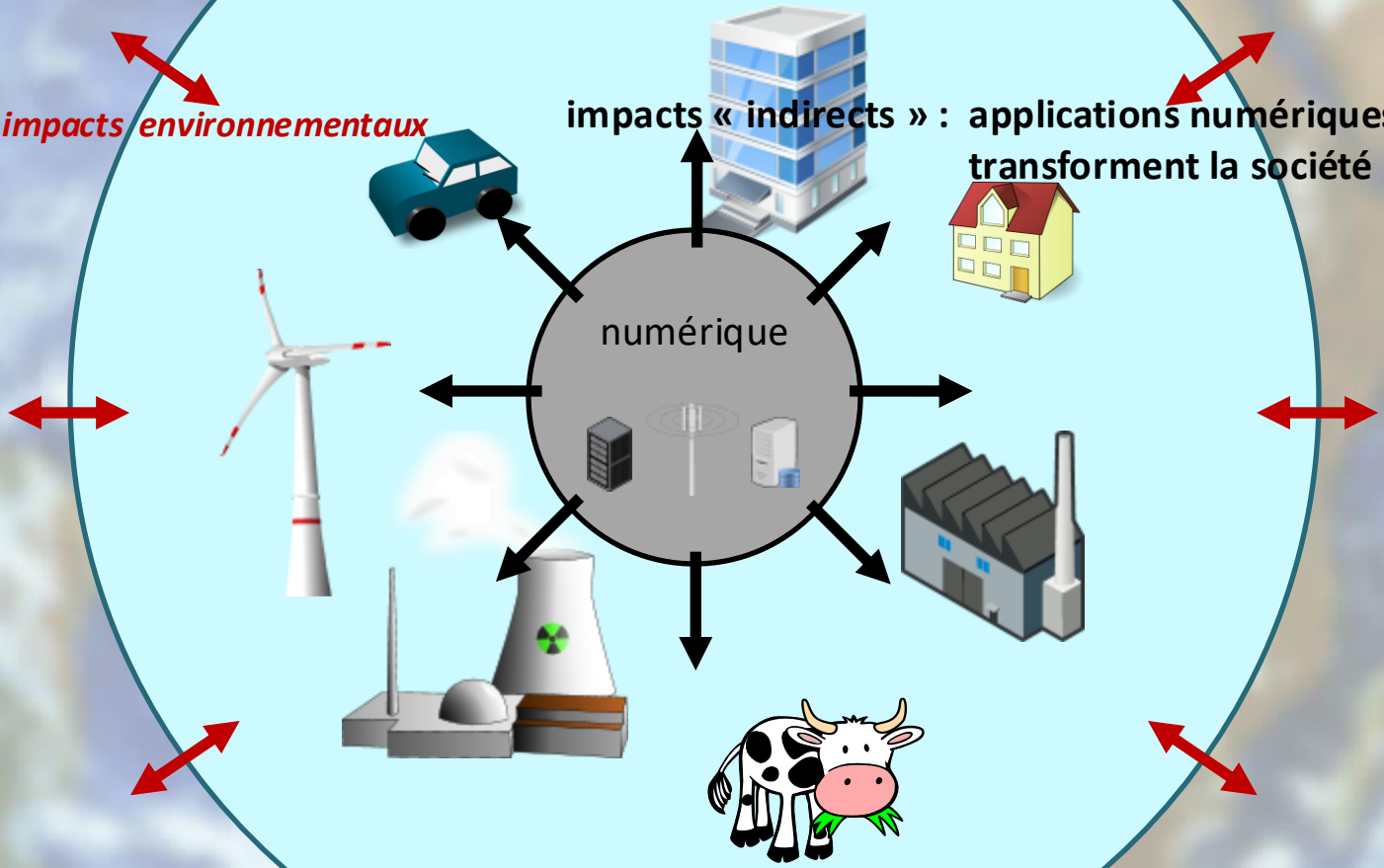
impacts environnementaux

impacts « indirects » : applications numériques transforment la société



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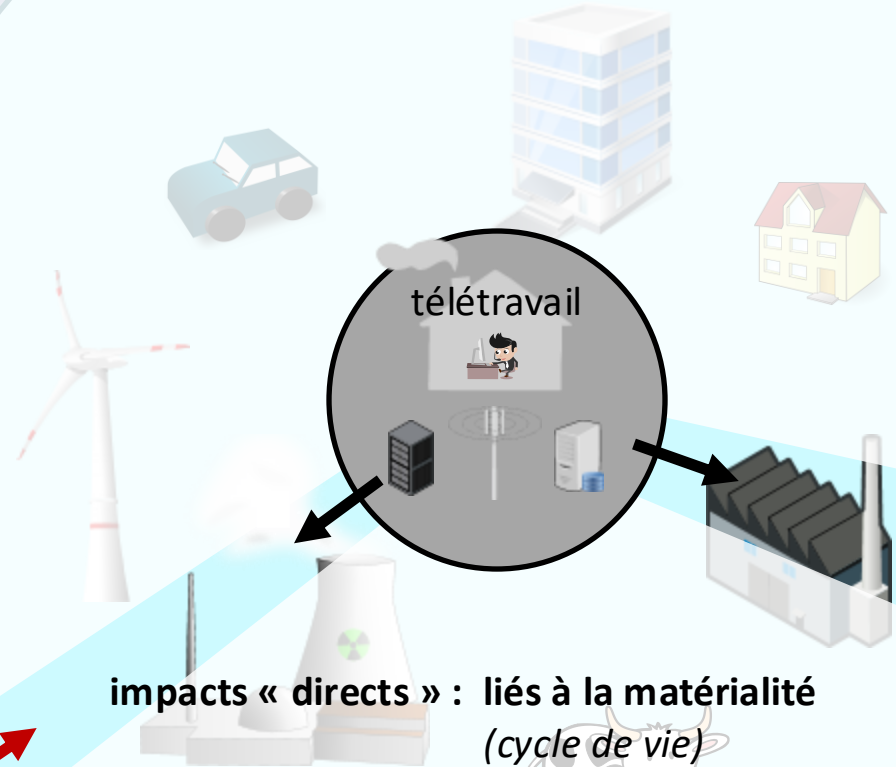


impacts « directs » : liés à la matérialité

(cycle de vie)

écosphère

impacts environnementaux

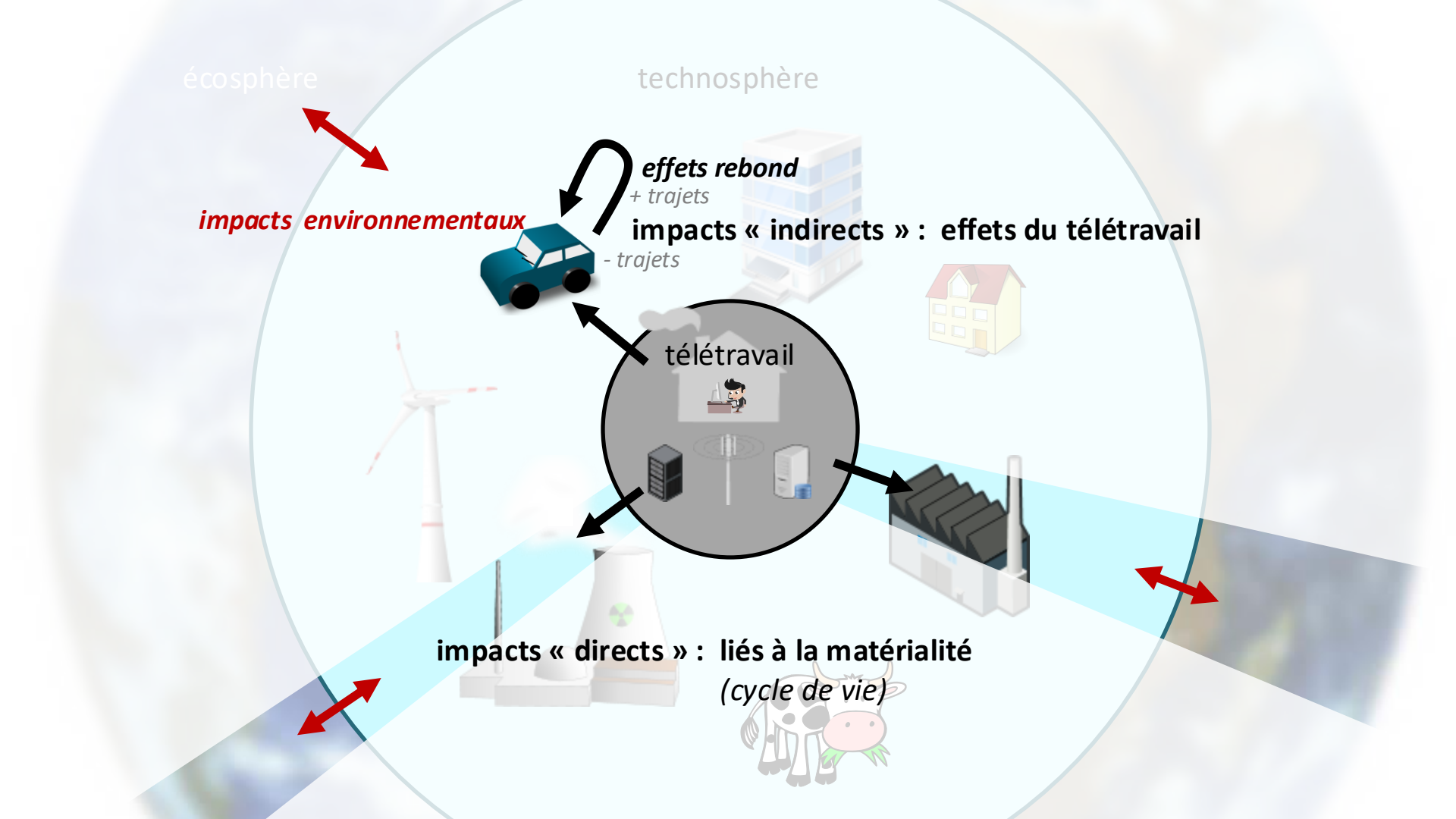
impacts « indirects » : effets du télétravail

- trajets

télétravail

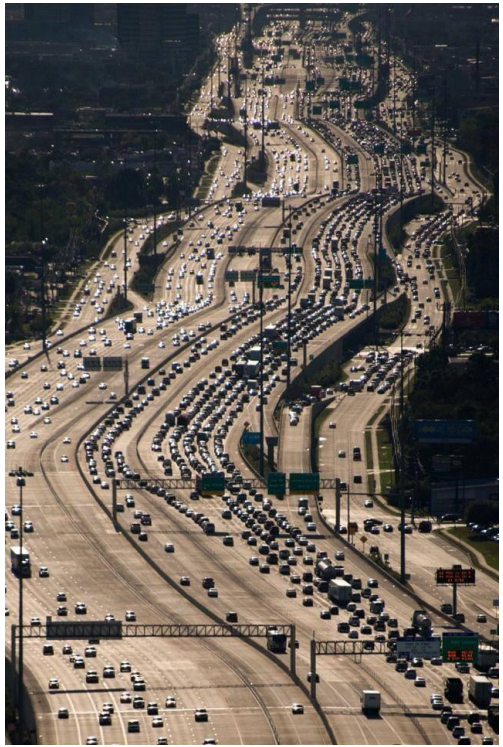
impacts « directs » : liés à la matérialité

(cycle de vie)


écosphère
technosphère
impacts environnementaux
effets rebond
+ trajets
- trajets
impacts « indirects » : effets du télétravail
télétravail
impacts « directs » : liés à la matérialité
(cycle de vie)

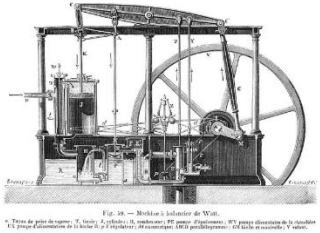
Quelques exemples d'effets rebond

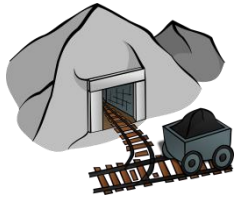
- Trafic induit

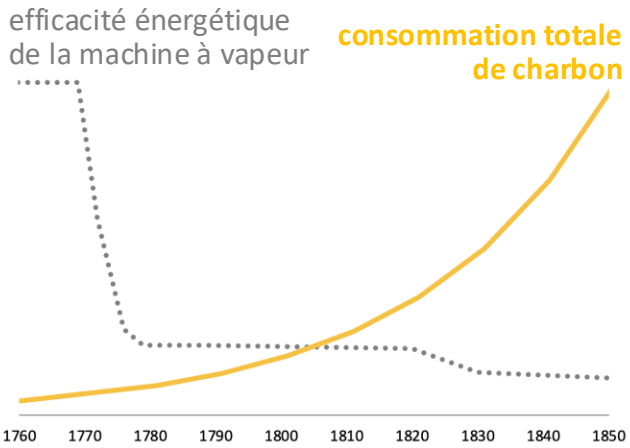


Houston I-10 Katy Freeway

- Paradoxe de Jevons

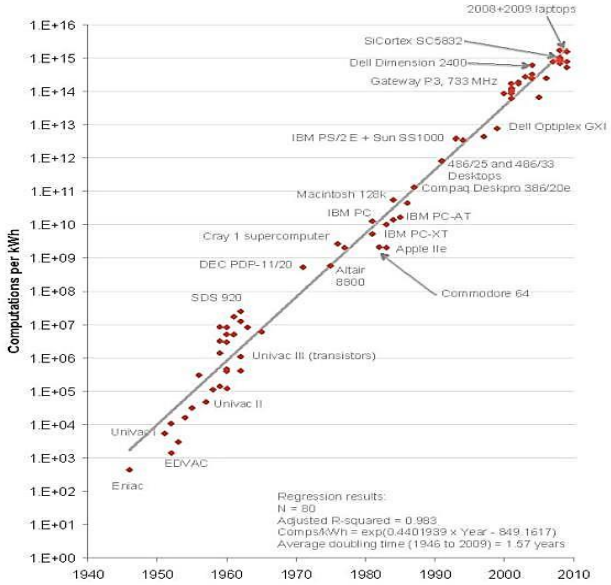




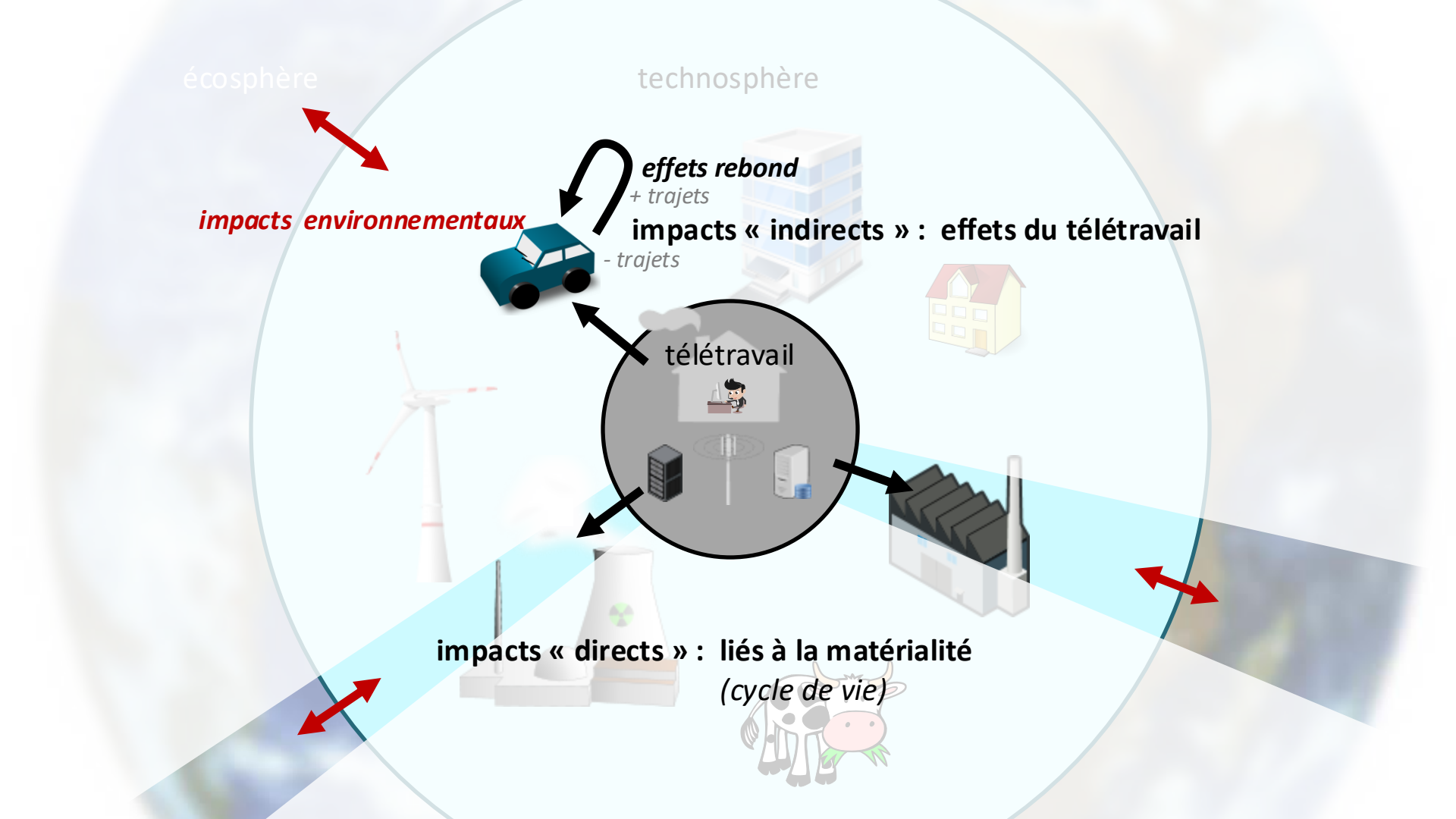


source : à partir de The Coal Question, *Jevons* (1865)

- Consommation énergétique du numérique



source : Wikipedia, loi de Koomey


écosphère
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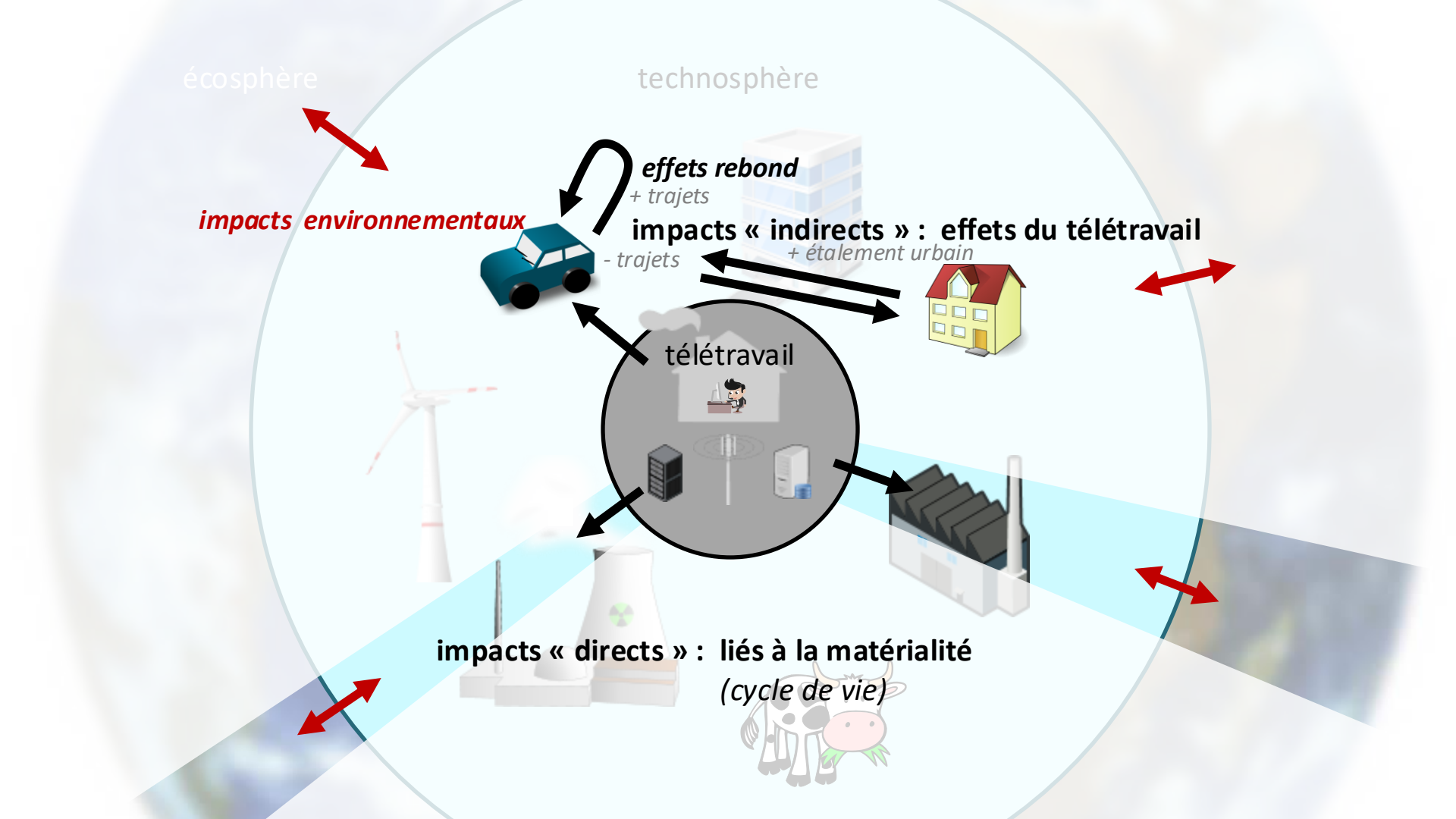
impacts environnementaux
effets rebond
+ trajets
- trajets
impacts « indirects » : effets du télétravail
télétravail
impacts « directs » : liés à la matérialité
(cycle de vie)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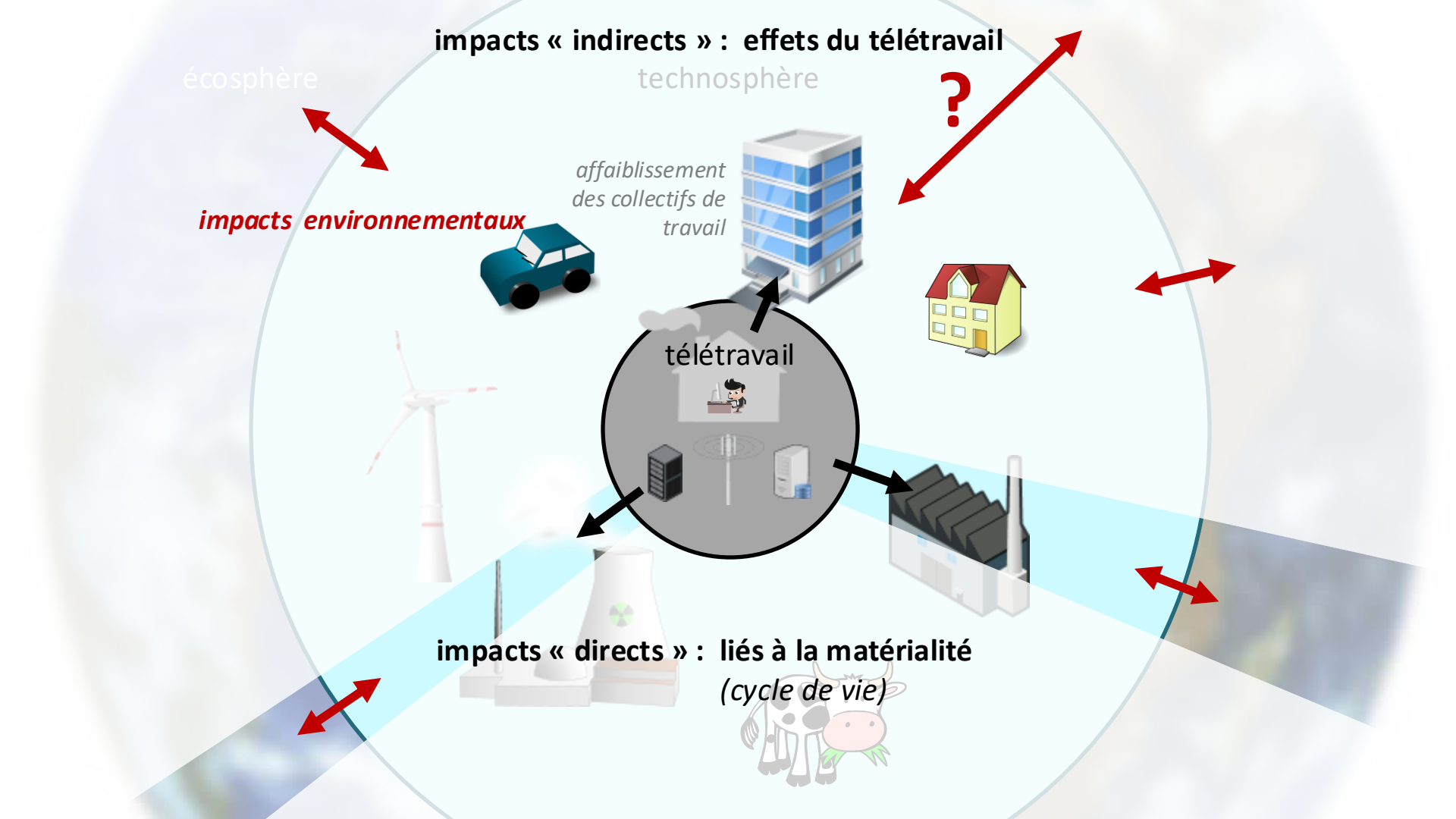
effets rebond
+ trajets
impacts environnementaux
impacts « indirects » : effets du télétravail
- trajets
+ étalement urbain
télétravail
impacts « directs » : liés à la matérialité
(cycle de vie)


impacts « indirects » : effets du télétravail
écosphère
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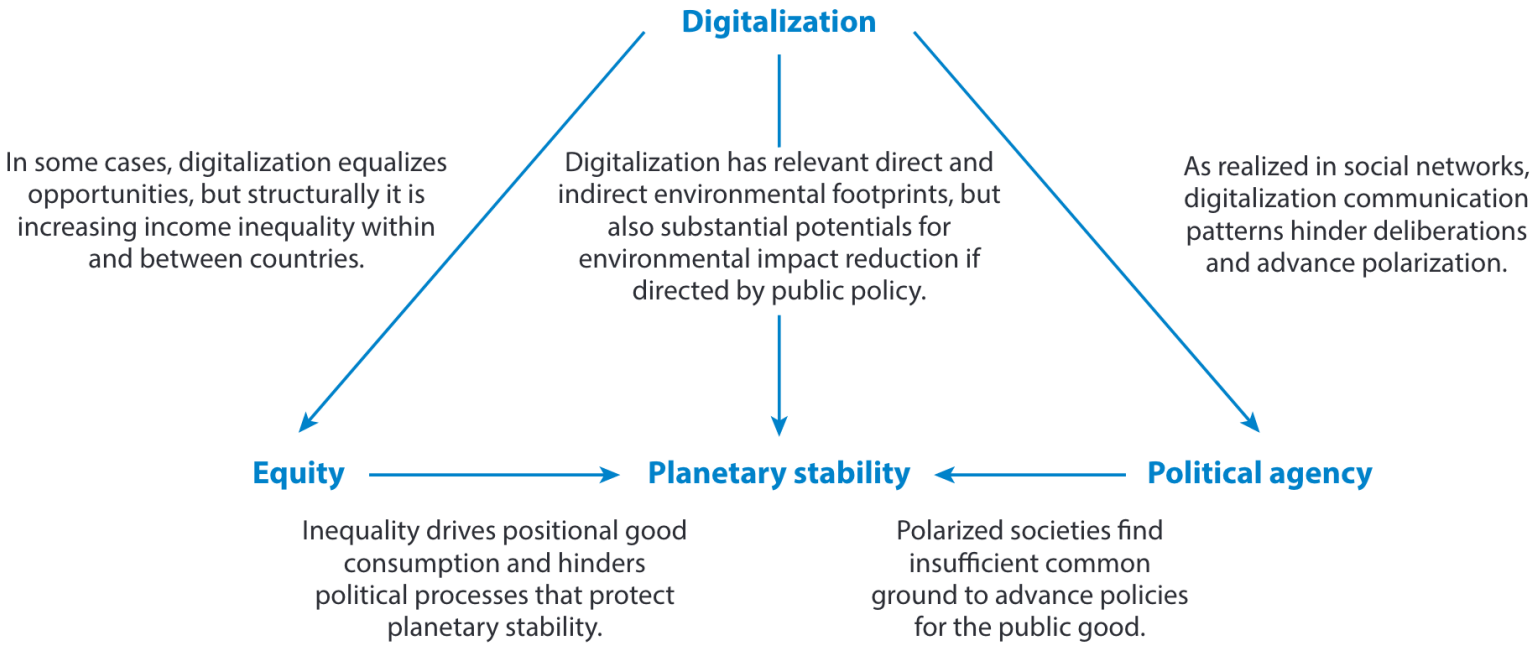
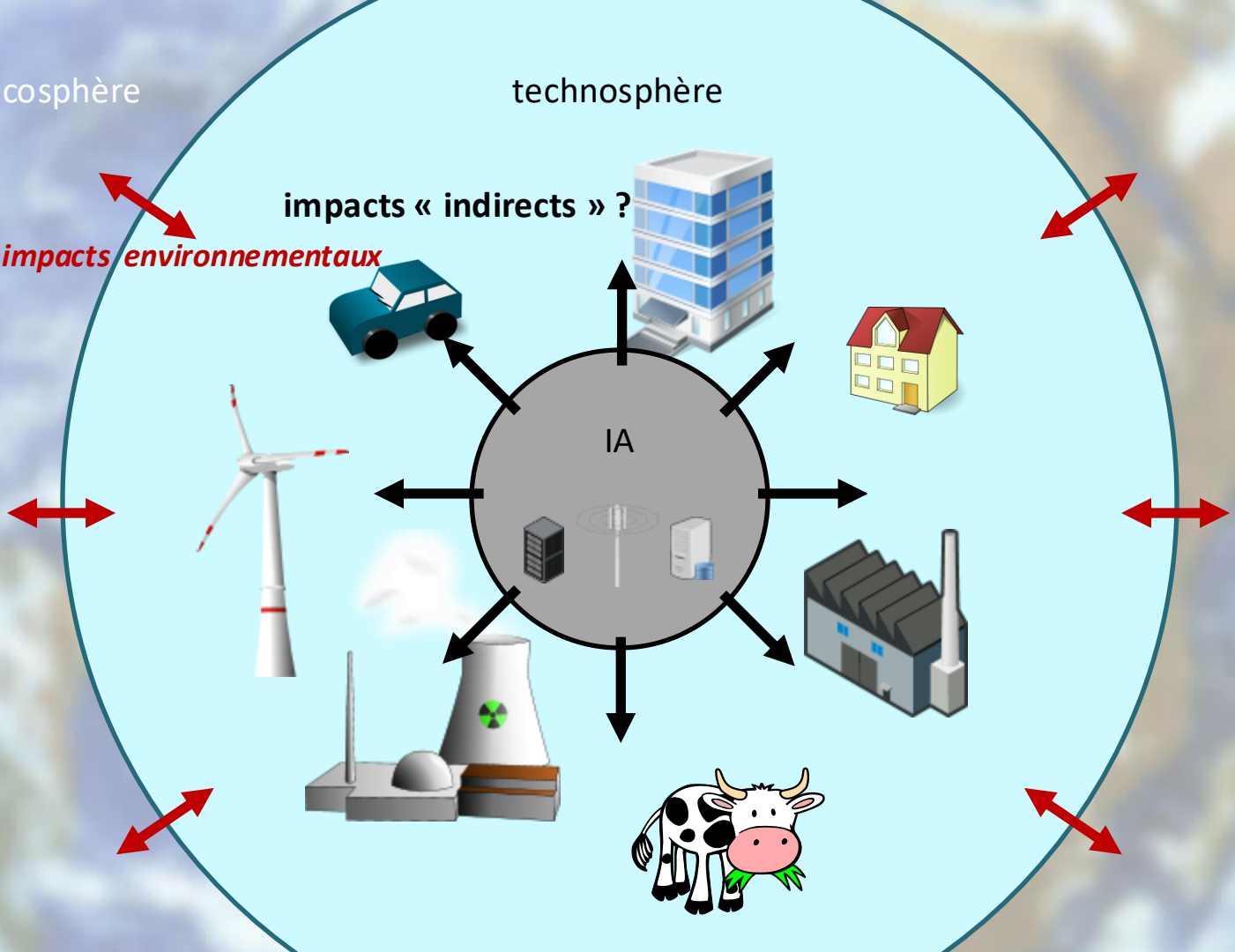
affaiblissement des collectifs de travail
impacts environnementaux
télétravail
impacts « directs » : liés à la matérialité
(cycle de vie)

Exemples de visions alternatives



source : Digitalization and the Anthropocene, Creutzig et al. (2022)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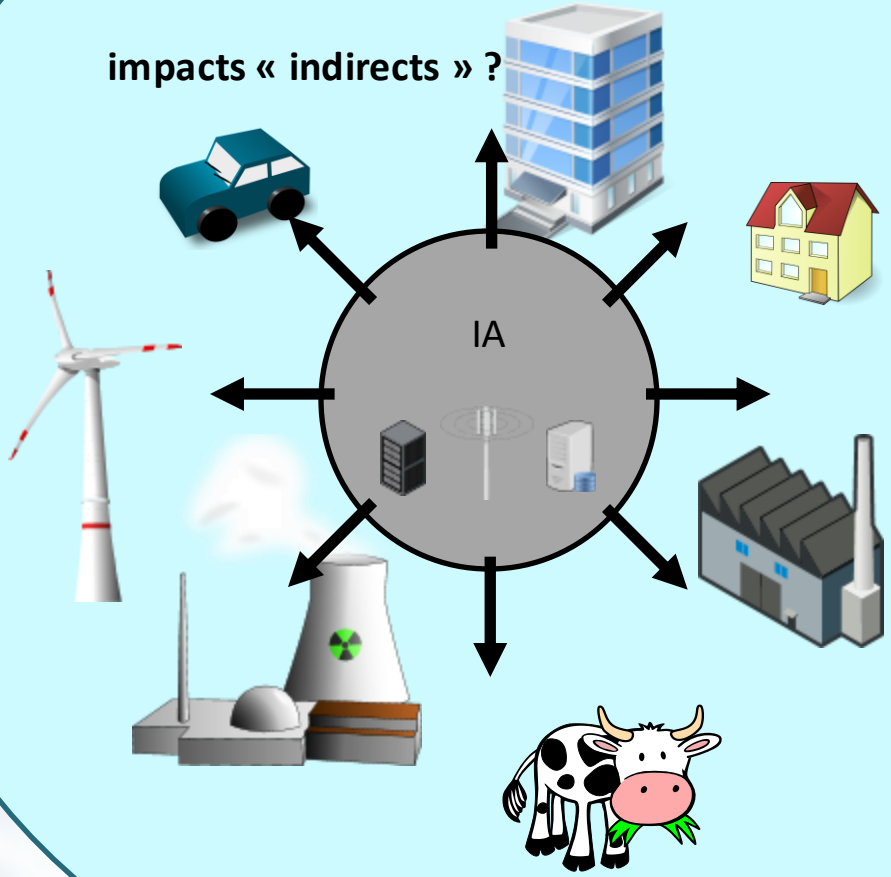
impacts « indirects » ?



Taxonomy described in this paper			Alternate taxonomies			
Effect	**Scope**	**GPS System Example**	**Hilty**	**Berkhout & Hertin**	**Williams**	**Rattle**
Embodied energy	Direct	Energy to produce a GPS system	1st-order	Direct effects	ICT infrastructure and devices	
Operational energy		Energy to operate a GPS system				
Disposal energy		Energy to dispose of a GPS system at end-of-life				
Efficiency	Indirect: Single-service	More efficient traffic flow due to GPS-enhanced routing	2nd-order	Indirect effects	Applications	Optimization
Substitution		Replacement of paper-based maps				Substitution
Direct rebound		More travel due to lower cost of traffic congestion	3rd-order	Structural & behavioral effects	Effects on economic growth and consumption patterns	Induction
Indirect rebound	Indirect: Complementary services	Energy consumed during time saved by more efficient travel				Supplement-ation
Economy-wide rebound (Structural change)	Indirect: Economy-wide	GPS enables autonomous vehicles and causes growth of intelligent transportation system manufacturing				Creation
Systemic Transformation	Indirect: Society-wide	Autonomous vehicles alter patterns in where people choose to live and work			Systemic effects on technology convergence & society	

source : Known unknowns: indirect energy effects of information and communication technology, Horner et al. (2021)

International Telecommunication Union

ITU-T

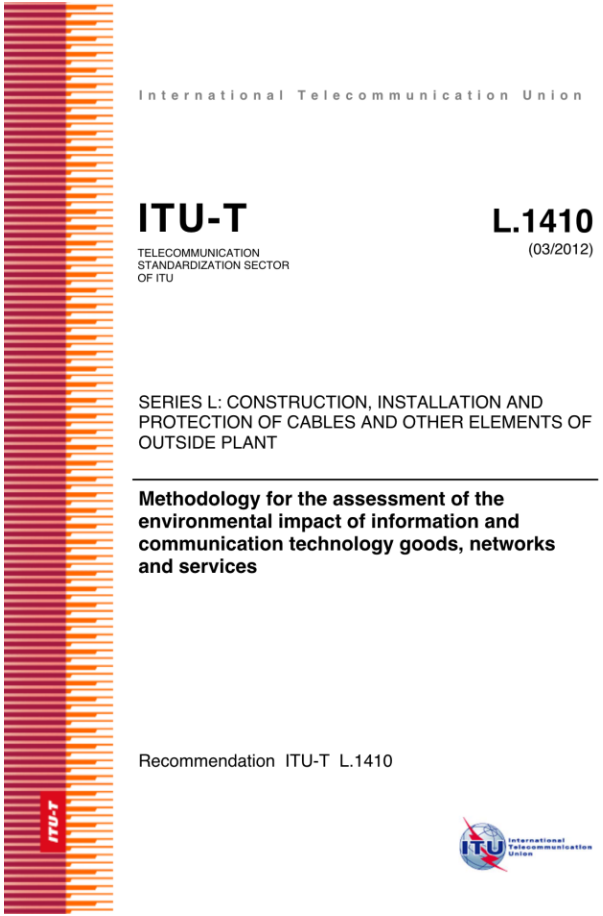
TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

L.1410
(03/2012)

SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Methodology for the assessment of the environmental impact of information and communication technology goods, networks and services

Recommendation ITU-T L.1410



«Unlike many products and services [...], ICT distinguishes itself by its double-edged nature. On the one hand, ICTs have an environmental impact at each stage of its life cycle [...]. On the other hand, ICTs can enable vast efficiencies in lifestyle and in all sectors of the economy [...]. »

« Different levels of impact are acknowledged in some academic literature as the three order effects of ICTs:

- *First order effects (or the environmental load of ICTs): the impacts created by the physical existence of ICTs and the processes involved*
- *Second order effects (or the environmental load reduction achieved by ICTs): the impacts and opportunities created by the use and application of ICTs*
- *[Third order] effects: may include [...] the aggregated effects on societal structural changes by using ICTs; [...] additional impacts are often defined as "rebound effects". »*

« [Third order] effects await further exploration due to the many uncertainties involved. »

« The first order effect [...] can be quantified by performing a life cycle assessment (LCA). The second order effect (or environmental load reduction achieved by ICT) can be quantified by the comparison of LCA results between the ICT goods, networks and services product system and the reference product system performing the same function. »

source : Methodology for the assessment of the environmental impact of information and communication technology goods, networks and services, International Telecom Union (2012)

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Methodology for the assessment of the environmental impact of information and communication technology goods, networks and services

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Unlike many products and services sold in the world today, ICT distinguishes itself by its double-edged nature. On the one hand, ICTs have an environmental impact at each stage of its life cycle, e.g., from energy and natural resource consumption to e-waste. On the other hand, ICTs can enable vast efficiencies in lifestyle and in all sectors of the economy by the provision of digital solutions that can improve energy efficiency, inventory management and business efficiency by reducing travel and transportation, e.g., tele-working and video conferencing and by substituting physical products for digital information, e.g., e-commerce.

These different levels of impact are acknowledged in academic literature as the three order effects of ICTs:

- First order effects (or the environmental load of ICTs): the impacts created by the physical existence of ICTs and the processes involved, e.g., energy consumption and GHG emissions, e-waste, use of hazardous substances and use of scarce, non-renewable resources.
- Second order effects (or the environmental load reduction achieved by ICTs): the impacts and opportunities created by the use and application of ICTs. This includes environmental load reduction effects which can be either actual or potential, such as travel substitution[1], transportation optimization, working environment changes, use of environmental control systems, use of e-business, e-government, etc.
- Other effects:
  - may include the impacts and opportunities created by the aggregated effects on societal structural changes by using ICTs;
  - may, for some ICT services such as tele-working or video conferencing, include the time gained by an end user using an ICT service which then may cause additional impact e.g., a leisurely drive and economic activities, which are difficult to track. Such additional impacts are often defined as "rebound effects".

[1] e.g., if an ICT service offers a reduced need for transport, the travel substitution replacing transport by car is actual – the car does not run – whereas the reduced need for travel by public transport is potential – the plane, train or metro is still running if the timetable has not changed. However, the large scale deployment of video conferencing and tele-working (telecommuting) in the future will likely change lifestyles and impact on social structure, and while it is expected to substantially reduce traffic volume, further research is required to assess what the full impact (including rebound effects) will be.

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Most of the benefits of ICTs lie in the second order effects via increased efficiency, transparency, speed of transactions, rapid market-clearing, long-tail effects and so on. There are environmental impacts associated with the first order: environmental impact of ICT goods, networks and services (hereafter "ICT GNS") such as resource consumption and carbon emissions during manufacturing and the disposal of hardware. Other effects await further exploration due to the many uncertainties involved. While these other effects may be critical in constructing a more sustainable society, much more research on this remains to be done. Thus, this Recommendation focuses on the first and second order effects. Further research in the area of other effects is encouraged.

In constructing a sustainable society from an environmental viewpoint, the negative aspects of ICTs should be minimized and the positive ones should be maximized, as summarized in Figure 1.

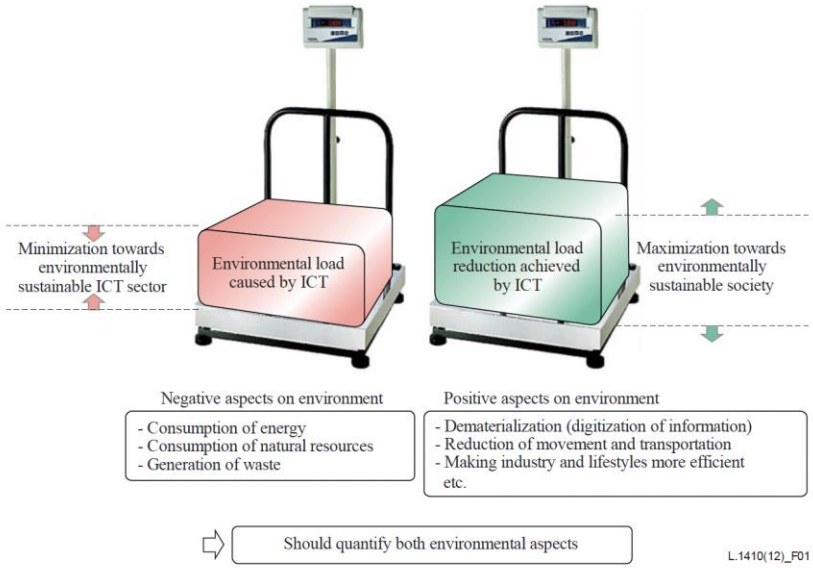


Figure 1 – Schematic model for the environmental assessment of ICT goods, networks and services

The first order effect (or environmental load caused by ICT) can be quantified by performing a life cycle assessment (LCA). The second order effect (or environmental load reduction achieved by ICT) can be quantified by the comparison between the ICT GNS product system and the reference product system performing the same function.

1er ordre

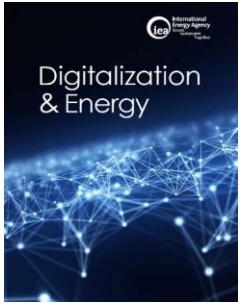
Où sont les impacts « indirects » du cycle de vie ?

« Indeed, social conflicts has emerged because of environmental impacts of mining activities and can destabilize some communities. [...] Also, more than social impacts, health related impacts, political and geopolitical issues need to be explained to understand local mining situations. There we found some indirects [...] impacts of ICT coming from those direct effects [...]. »

source : Design of an interdisciplinary evaluation method for multi-scaled sustainability of computer-based projects. A work based on the Sustainable Computing Evaluation Framework (SCEF), Grimal et al. (2021)

2ème ordre

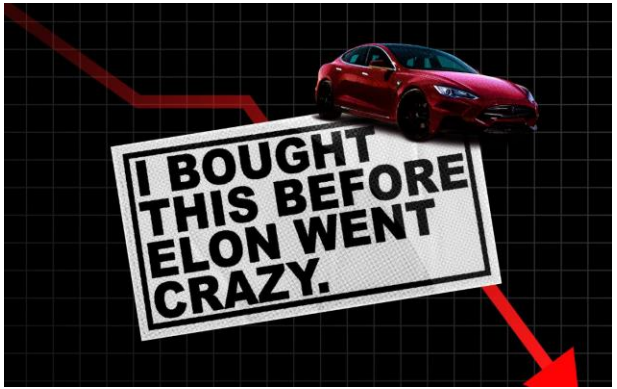
Impacts « indirects »



- Les applications semblent ne relever que de l'IT4Green ?
  → où est e.g. l'IT4Bad ?
  - grâce au numérique **+5%** sur les réserves fossiles exploitables, soit **10 ans** de consommation !
  - « *The battle for a safer future climate […] is not merely a push to mitigate the effect of technological development, but also a battleground of ideology and power played out over trillions of network nodes, through billions of screens, and into billions of human minds.* »

source : Treadmill of information, Simpson et al. (2019)

- On parle d'« effets » [« non comportementaux »] :
  - théorique ? désiré ?
  - raisonnement iso-fonctionnel : quelle référence ?
  → présupposé sur les comportements



©Crédit Photographie : Valentine Michel ©Bonpote

3ème ordre

Impacts « indirects »

- Assimilation structurel, systémique, macro, long-terme, comportemental :
  → il existe des effets micro comportementaux (e.g. effets rebond et micro-économie)

- Les effets rebond sont vus comme contre-intuitifs, indésirables :
  → contredit la littérature sur le sujet :
  – Le paradoxe de Jevons n'en est pas un : *« It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth. » — W.S. Jevons (1865)*
  – Postulat de Khazzoom-Brookes (années 80)
  – Schneider (2009) : stratégies/politiques de croissance = stratégies/politiques de rebond

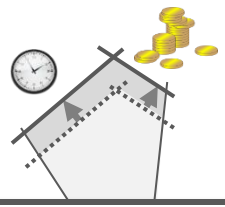
L’effet rebond selon Schneider

L’amélioration technologique ...

... ou la sobriété (la suffisance) ...

effets rebond

... ce qui rend possible l’**intensification d’usages** existants ou le développement de **nouveaux usages**



« L'effet rebond peut être défini comme « l'augmentation de la consommation liée à la suppression de limites à l'utilisation d'une technologie ». Ces limites peuvent être de nature monétaire, temporelle, sociale, physique, énergétique, spatiale, et organisationnelle. La notion fondamentale de limites nous amène à l'idée de facteurs limitant et à l’idée de capacité. » — F. Schneider

ressources : Schneider et al., *Sur l'importance de la décroissance des capacités de production et de consommation dans le Nord global pour éviter l'effet rebond* (2009)
Schneider, *ECO-INFOSOCIETY: Strategies for an Ecological Information Society* (2001)

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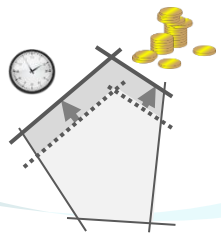


… repousse des limites …

- *économiques (prix, revenues, …)*
- *physiques, techniques (temps, espace, ressources, infrastructures, compétences, …)*
- *psychologiques (désire, morale, danger, …)*
- *sociologique (habitudes, pratiques, normes, …)*
- *réglementaires, …*

ressources : Schneider et al., *Sur l'importance de la décroissance des capacités de production et de consommation dans le Nord global pour éviter l'effet rebond* (2009)
Schneider, *ECO-INFOSOCIETY: Strategies for an Ecological Information Society* (2001)

En résumé

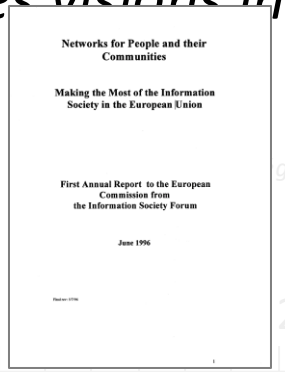
- Approche technicienne des liens numérique – société – environnement :
  - parler « d'impact/effet indirect d'une application numérique » est déjà cadrant :
    - contexte + application → effet/impact
    - le numérique vu comme force majeure de transformation ; où sont les acteurs ?
    - vision issue des sciences de la nature (mécaniste, déterministe)
  - l'ACV et la quantification occupent une place centrale.

- Nombreux angles morts

- Pourrait s'expliquer par le contexte de production scientifique :
  - background des auteurs (ICT4S)
  - perméabilité entre les sphères académiques, normatives, et grises (auteurs, méthodologies, études)
  - influences : découplage, la société de l'information, le développement durable.

Contexte historique

Des visions industrielles et institutionnelles optimistes


Networks for People and their Communities

Making the Most of the Information Society in the European Union

First Annual Report to the European Commission from the Information Society Forum

June 1996

1990 2000 2010 2020

Rapport de l'ISF à l'UE

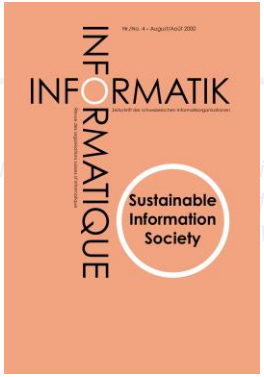
« Most experts do not think that sustainable development is realistically attainable without information technologies, but nor are they sure it is guaranteed with them. Much depends on the framework in which they are used. There is a risk of a "rebound" effect whereby they could stimulate new demands for material consumption. »

ressources : Évaluation environnementale des effets directs et indirects du numérique pour des cas d'usage — État de l'art des méthodologies existantes, ADEME (2024)
Enquête sur le processus sociotechnique européen de constitution de savoirs relatifs aux impacts environnementaux du numérique, Mémoire de recherche de Master 2, Béchadergue (2021)

Contexte historique

Du côté académique

Towards a Sustainable Information Society (Hilty, Ruddy)



« The counter-intuitive trends that can be observed in traffic development and paper consumption are examples of a phenomenon known as the rebound effect.

[…]

information technology contributes a necessary, but not sufficient condition for attaining the goal of sustainable development. As developments up to now have clearly shown, there is a risk that this technology may in fact induce more material and energy throughput through the economic system than it saves.»

ressources : Évaluation environnementale des effets directs et indirects du numérique pour des cas d'usage — État de l'art des méthodologies existantes, ADEME (2024)
Enquête sur le processus sociotechnique européen de constitution de savoirs relatifs aux impacts environnementaux du numérique, Mémoire de recherche de Master 2, Béchadergue (2021)