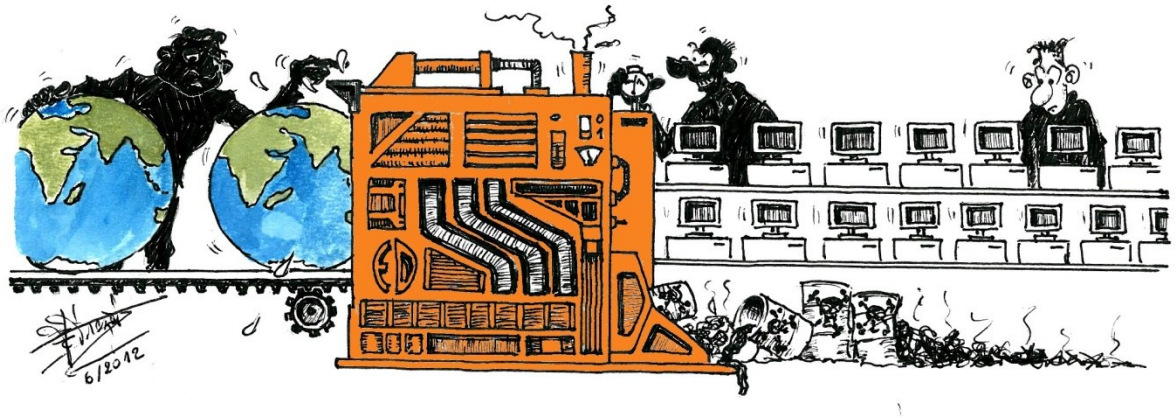
# Information and Communication Technologies,

Behind a dematerialized image…

…the real impacts

# Plan



- Introduction
- The « Big Data »
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- The lifetime decrease
- The key role of OS and software
- The increase of impacts
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  - The war of water
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  - Electronic wastes
  - Recycling
- Low cost production
- Conclusion

# Introduction

- ICT[1]: from the image…
  - Dematerialization
  - Clean technology
  - Cloud

- … to reality :
  - Billion of electronic equipments
  - Toxic products , resources, wastes, energy, water
  - Social aspects


(1) Information and Communication Technologies

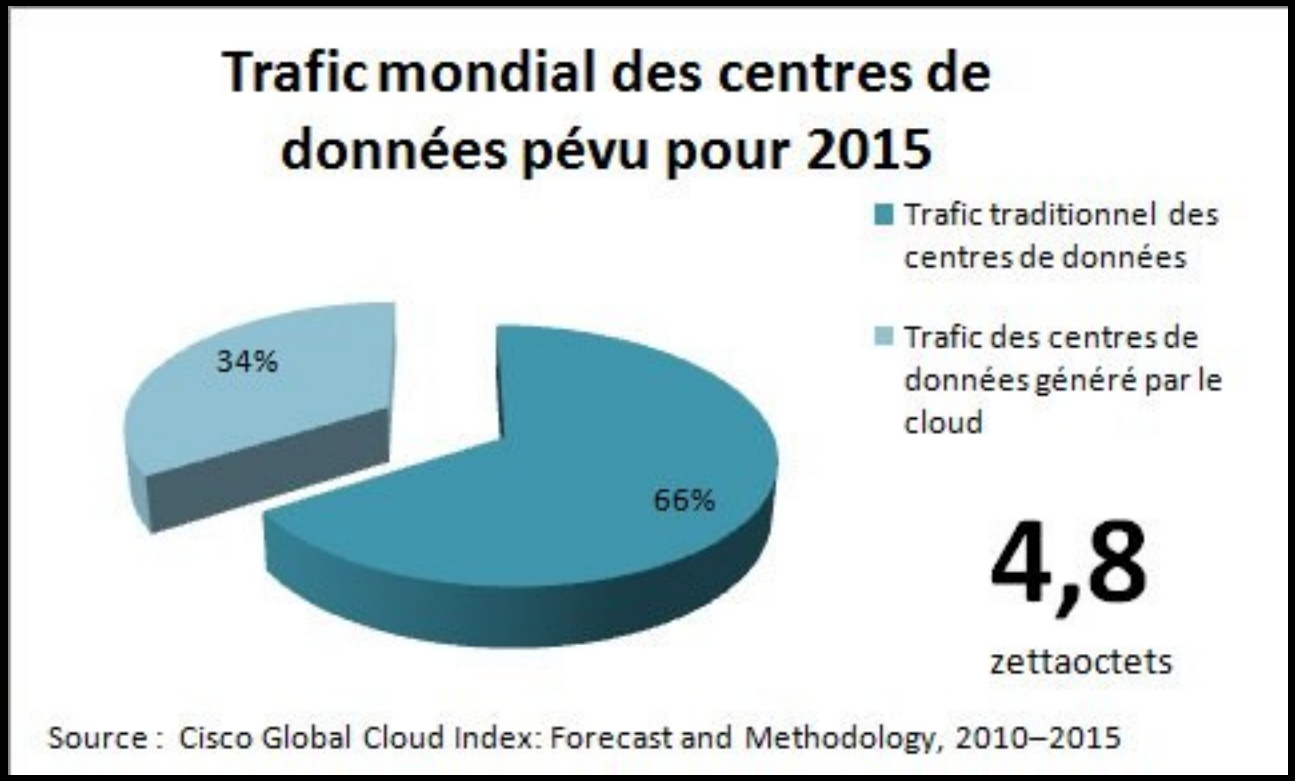
# The « Big data »


- Huge increase of datacenters
- 3150 billion of Google queries / year (level of beginning of 2012)
- + more than a 1/3 of the world population has an access to Internet
- Facebook : 1 billion users

< Datacenter

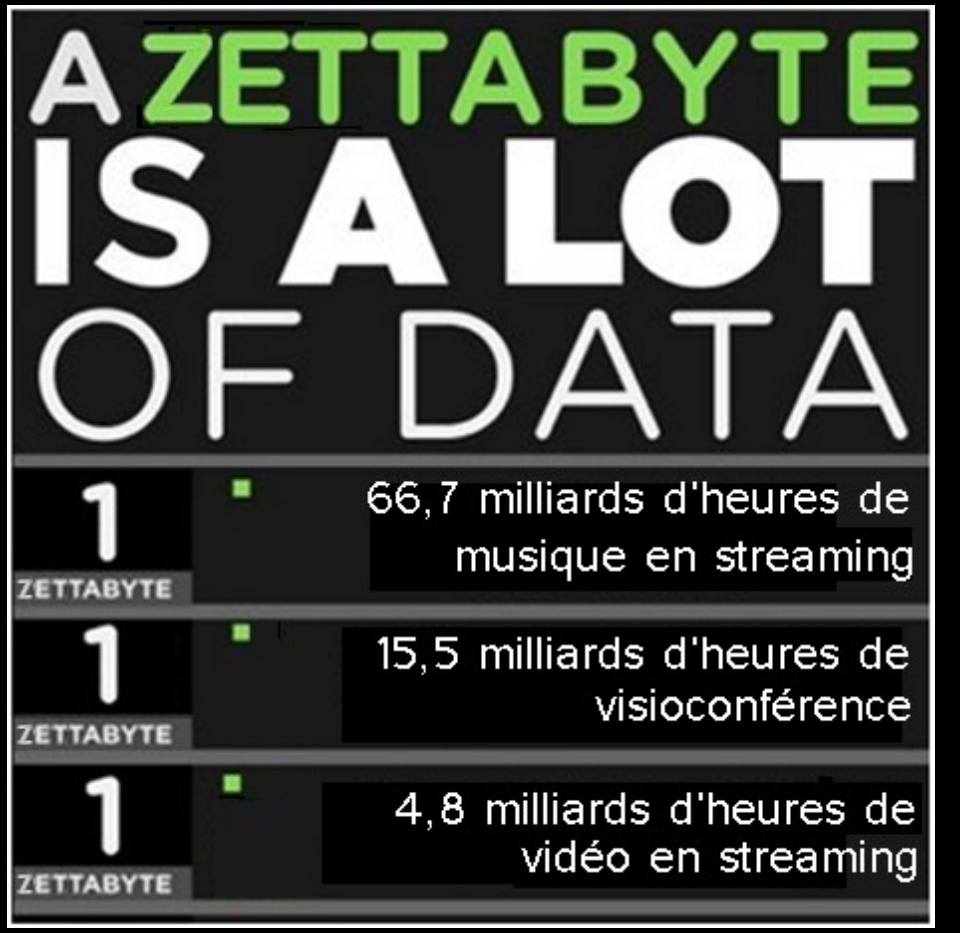
# The « Big data »

- Data world traffic evolution between 2010 and 2015 :



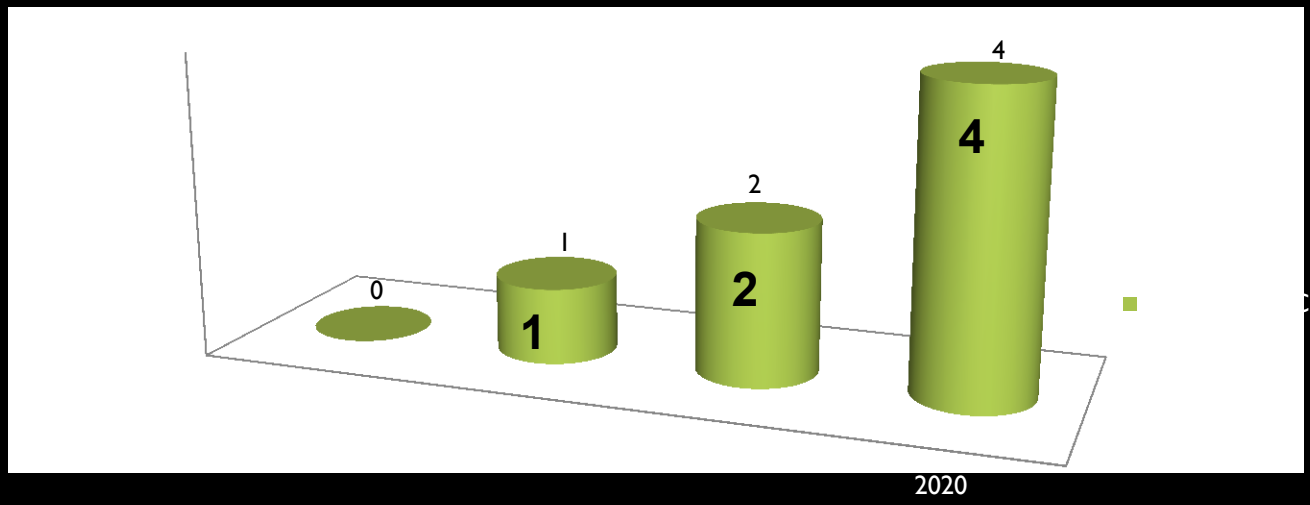
# The « Big data »

- Explosion of data :
  - 1 Kb = $10^3$ bytes
  - 1 Mb = $10^6$ bytes
  - 1 Gb = $10^9$ bytes
  - 1 Tb= $10^{12}$ bytes
  - 1 Pb = $10^{15}$ bytes
  - 1 Eb = $10^{18}$ bytes
  - 1 Zb = $10^{21}$ bytes
  - 1 Yb = $10^{24}$ bytes



# The increase of demand

- Demand ⇗ 12,6%/year in volume on 45 years[1]

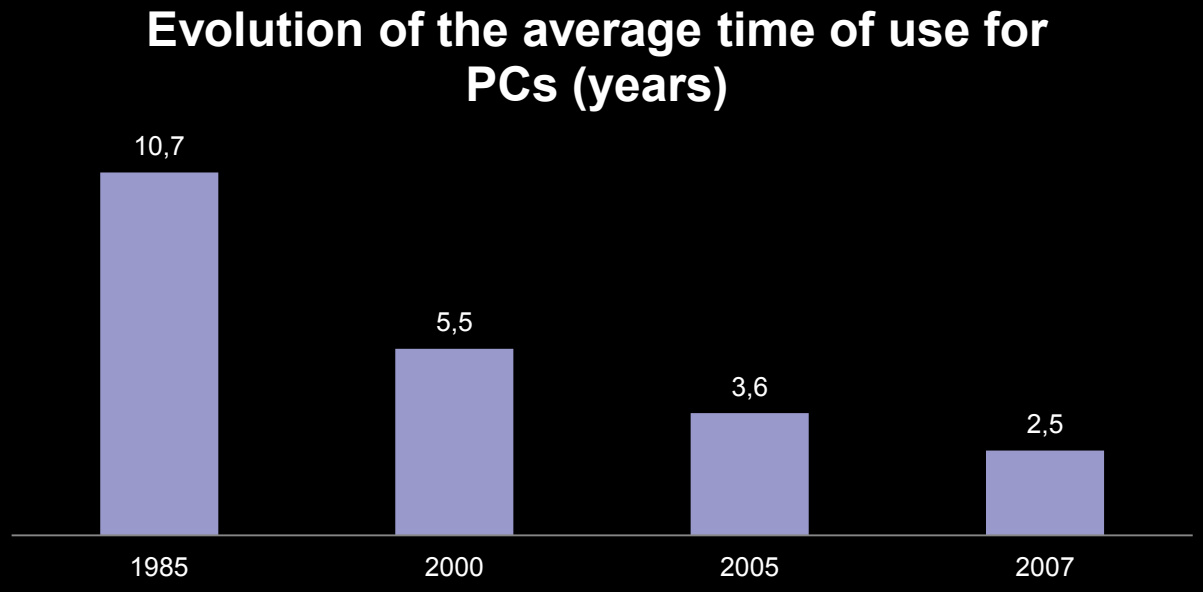



- super-exponential increase :
  - 28 years to reach the 1st billion of PC
  - 7 years to reach the second one
  - 5 years to double again

(1) Source : INSEE - La consommation des ménages en TIC depuis 45 ans (09/2006)
(2) Source : GESI – rapport Smart 2020 - http://www.smart2020.org/

# The lifetime decrease

- Lifetime of electronic equipments decreases[1]



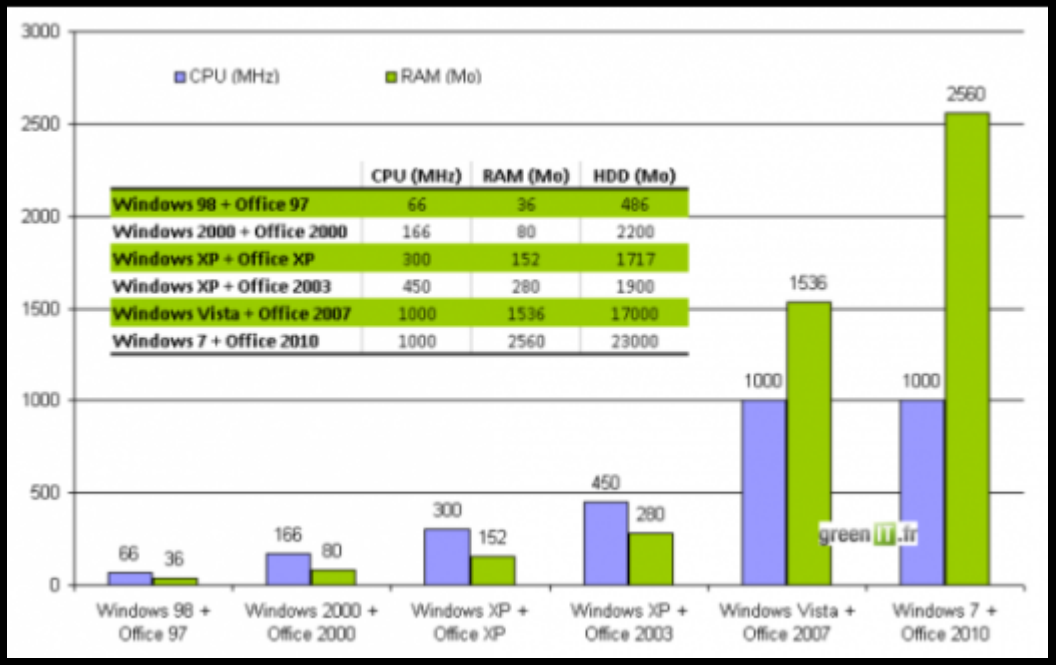

Obsolescence is a key word in electronics industry

For mobile phones the average time of use 1,5 year

(1) Bordage (2010 ) GreenIT.fr, Compilation de 3 études scientifiques (E. Williams, EPA, et Seikatsu Jouhou Center: Tokyo, 2002)

# The key role of OS and software

- The evolution of Windows and Office from 95 to 7[1]




| | CPU (MHz) | RAM (Mo) | HDD (Mo) |
|---|---|---|---|
| Windows 98 + Office 97 | 66 | 36 | 486 |
| Windows 2000 + Office 2000 | 166 | 80 | 2200 |
| Windows XP + Office XP | 300 | 152 | 1717 |
| Windows XP + Office 2003 | 450 | 280 | 1900 |
| Windows Vista + Office 2007 | 1000 | 1536 | 17000 |
| Windows 7 + Office 2010 | 1000 | 2560 | 23000 |

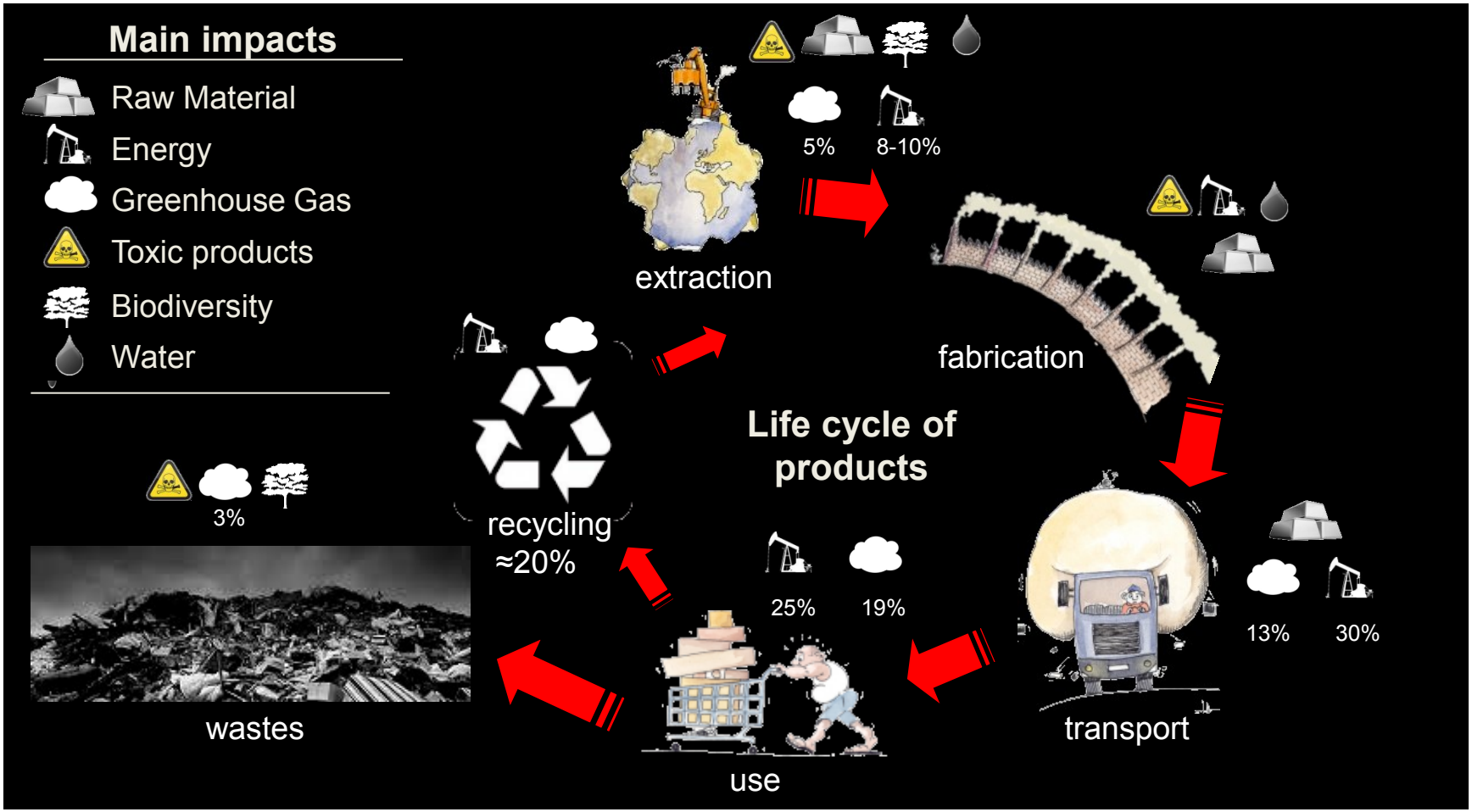
The power needed to write a text increases every 2 or 3 years[1]

Change for a new release often leads to

**increase of resources**

(1) Bordage (2010). GreenIt.fr. Logiciel : la clé de l'obsolescence programmée du matériel informatique

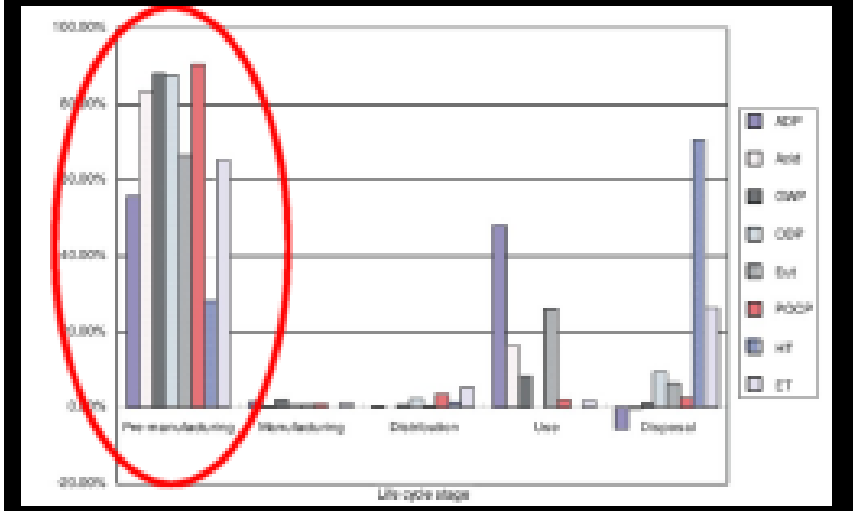
# The increase of impacts



# The increase of impacts

**The extraction and fabrication of the materials for a PC**

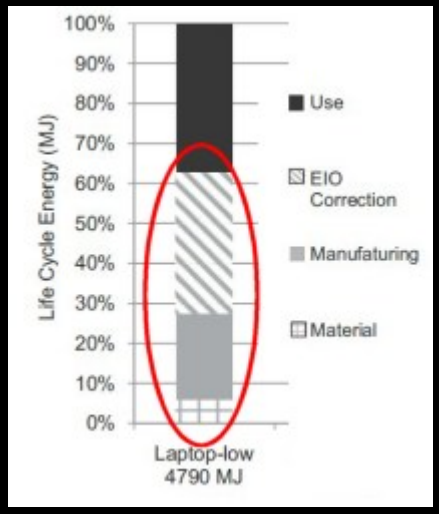
- This is the phase producing the major impacts[1]



To lower the impacts…

**The energy consumption of a laptop**

- + 60% is dedicated to the conception phase [2] (USA)



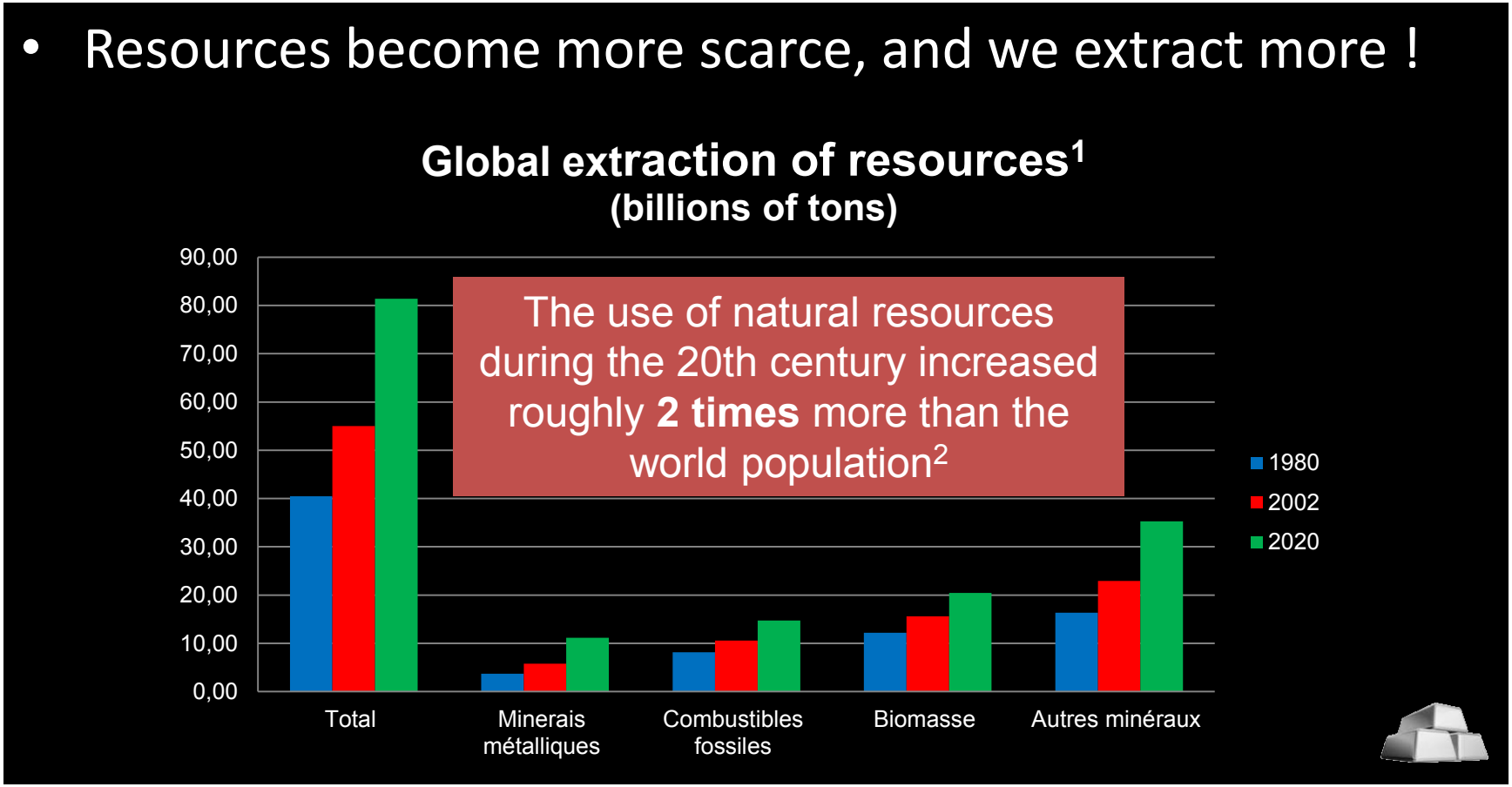

… increase the lifetime

(1) Choi & all, 2005, « Life Cycle Assessment of a Personal Computer and its Effective Recycling Rate"

(2) Deng, Babbitt, Williams, 2011

# Resources scarcity

- Resources become more scarce, and we extract more !




(1) Perspectives de l'environnement de l'OCDE à l'horizon 2030, OCDE, 2008

(2) Découpler l'utilisation des ressources naturelles et les impacts environnementaux de la croissance économique, PNUE, 2010

# Resources scarcity

- A mobile phone contains about sixty different metals, some of them rare


The solicitation of rare metals in Mendeleev's table increased from 10 in the 80ies to

**60**

in 2010[1]

(1) OPESCT (2011), Les enjeux des métaux stratégiques : le cas des terres rares

# Resources scarcity

- Geological scarcity is not the only subject : critical access of materials used in ICT[1] is also a problem :

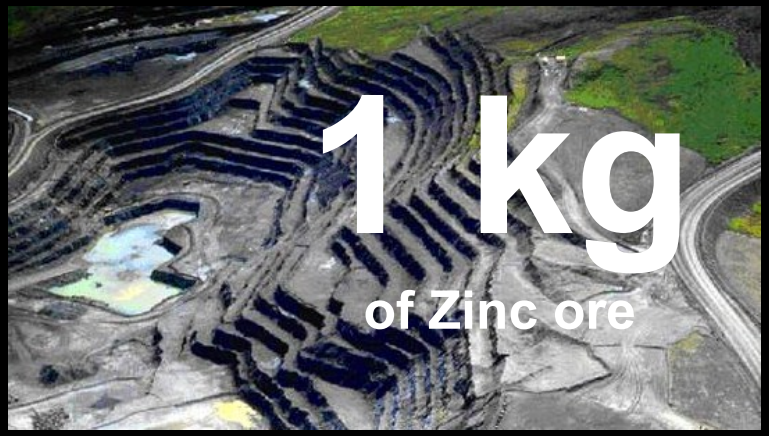
| TIC | Ag Argent | Cu Cuivre | In Indium | Ga Gallium | Ge Germanium | Li Lithium |
|---|---|---|---|---|---|---|
| Use | Contacts | Wires | Screens | Leds | Wifi | Batteries |
| % World prod. | 21% | 42% | >50% | 40% | 15% | 20% |
| Reserves (years) | 15-30 | 40 | | | | High |
| Recycling | >50% | >50% | | | | |
| Substitution | Low | Low | Org. Mat. | Low | Si | Ni,Zn,Cd,Pb |
| 1st producer | Peru | Chile | | | | Chile |
| % World prod. | 18% | 34% | 52% | N/D | 67% | 35% |

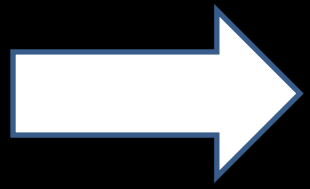
(1) « Impacts écologiques des TIC », EcoInfo, 2012

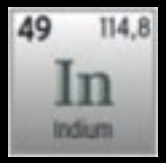
# Resources scarcity

- Easy deposits are over : metal concentration in ores is decreasing ⇨ energy and material needed ⇗.

  Ex: Indium used in flat screens






From 1 to 100 mg of indium[1]

A 15,4 inch LCD screen needs 39 mg of indium[2]

- For most of the elements of Mendeleev's table the estimated reserves are between 30 and 60 years[3]

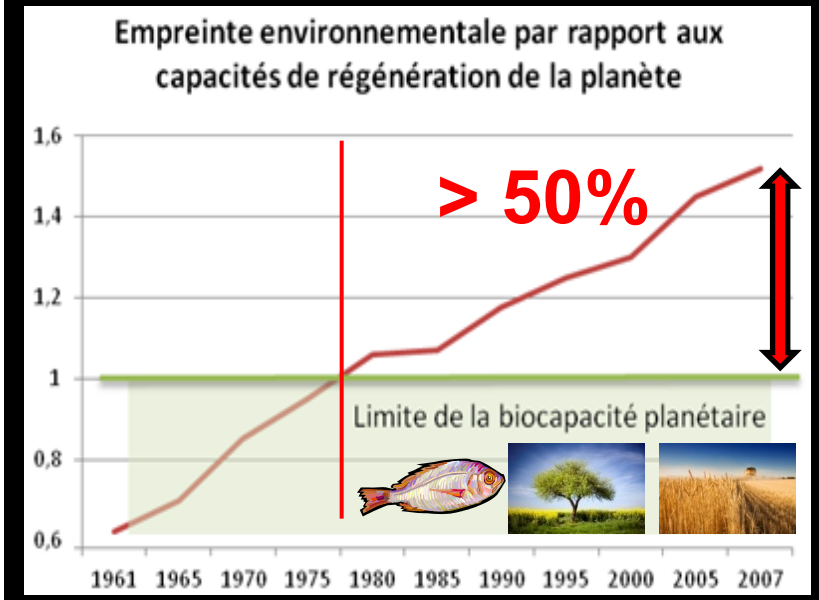
(1) Tolcin, 2012. Indium (USGS)

(2) Prakash, 2011 cité dans Öko-Institut e.V., 2012. *Recycling critical raw materials from waste electronic equipment*

(3) « Critical raw materials for the EU », 2010

# Resources scarcity

- Ecological footprint : surface of land needed to sustain current consumption level of resources and wastes production[1]




Ecological footprint = (hag)

Productive capability of one hectare[2] with an average world productivity

$$\text{Biocapacity} = \frac{\text{Bioproductive surface}}{\text{World population}}$$

(1) Wackernagel M. (1994). *Ecological Footprint and Appropriated Carrying Capacity: A Tool for Planning Toward Sustainability*.University of British Columbia

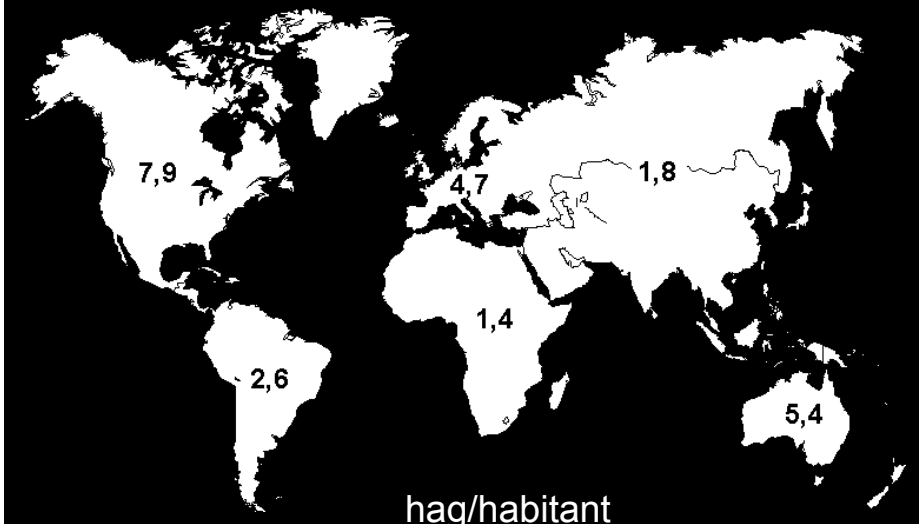
(2) one hectare = 10 000m$^2$

# Resources scarcity

- Evolution of overshoot days of world biocapacity[1] :

| 1992 | 2002 | 2012 | 2022 |
|---|---|---|---|
| 21 October | 3 October | 22 August | ? |

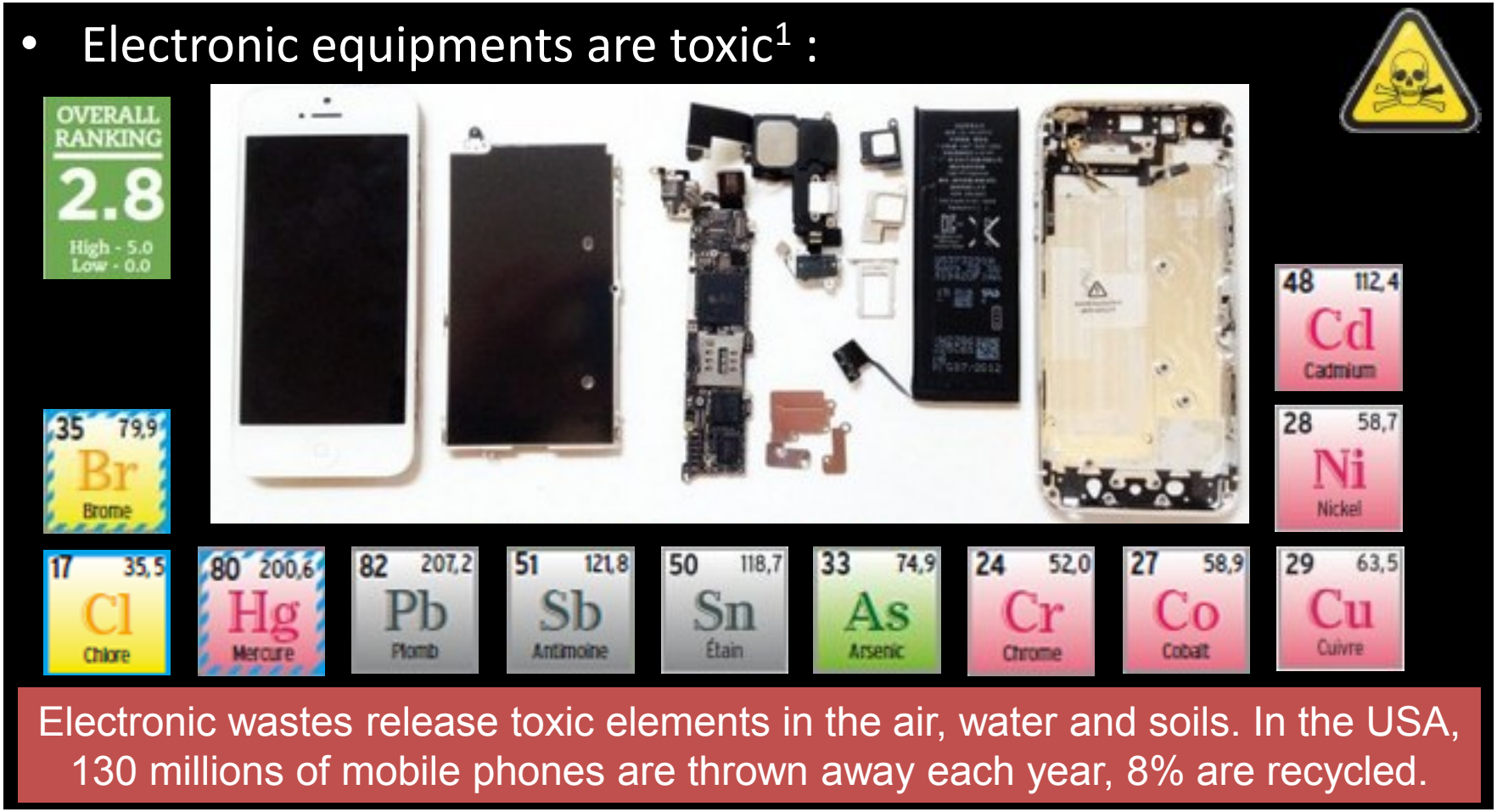
- Hag for continents, countries and cities[2] :




(1) *Global Footprint Network (http://www.footprintnetwork.org)*
(2) *Le dessous des cartes « L'empreinte écologique » (Arte, 2011)*

# Toxic products

- Electronic equipments are toxic[1] :




Electronic wastes release toxic elements in the air, water and soils. In the USA, 130 millions of mobile phones are thrown away each year, 8% are recycled.

(1) Sources : iFixit.org et HealthyStuff.org – Etude d'Octobre 2012

# Energy problems

- Most of the world economy rely on fossil energies

Oil production peak by human[1] **1979**

Conventional oil production peak[2] **2006**

Global oil production peak[3] **2015**

78% of world production electricity will rely on gas, oil and coal (87% in 2008)[4] **2030**

(1) Rifkin (2012) « La troisième révolution industrielle », citant une étude réalisée par BP
(2) International Energy Agency (2010) (3) Jancovici (2009) « C'est maintenant » (4) Etude de BP citée dans Ecoinfo (2012) « Impacts écologiques des Technologies de l'Informationet de la Communication »

# Energy problems

The production of a single micro chip of 2 g


1600 g fossil energy[1]

The world datacenters consume the production of

30 nuclear plants[2]

(1) Williams (2002) The 1.7 Kilogram Microchip: Energy and Material Use in the Production of Semiconductor Devices.

(2) New York Times (10/2012)

# The war of water


- The amount of drinking water that can be used by ecosystems and humanity doesn't exceed **1%**[1]

Global warming
+ 1°C
⇨
Humidity retention in the atmosphere
+ 7%

⇨ More heavy rains, lower frequency → flooding, drought[2]

- In the XXth century, water withdrawals have increased **x 2** faster than world population[3]
- Countries under water stress or shortage[4]: **28** in 1998, **56** in 2025
- Mining, paper, electronics industries need high levels of water, often in water stressed areas
- Water recycling is improving but not enough facing the increase of the global water demand (rebound effect)

(1) UN Water (2012). Statistics : Graphs & Maps : Water Resources. Untited Nations
(2) Rifkin (2012) « La troisième révolution industrielle »
(3) Meadows (2012) « Les limites à la croissance »
(4) Shiva (2003) « La guerre de l'eau »

# Deforestation

- The role of forest is crucial…

$CO_2$

Sanctuary of biodiversity and indigenous peoples

Soil protection

**1,6**

Billion people live from forest resources[1]

Tank and water filter

- …however, it is decimated


Borneo[3]

More than **60%** of extracted materials come from surface mines [2]

World production of paper in 2010 : **16,41** kg/inhab (+25% since 1990)

(1) FAO (2010) Évaluation des Ressources Forestières Mondiales – Rapport Principal
(2) « L'industrie minière: Impacts sur la société et l'environnement ». Mouvement Mondial pour les Forêts Tropicales (2004)
(3) Courrier international - Bornéo défigurée par les mines à ciel ouvert (mars 2010)

# Electronic wastes

**2010**
20 to 50 millions of tons[1]

Annual world production of WEEE

**2015**
40 to 70 millions of tons[1]

- In Europe, the increase is around **5**% / year[1]

Informal channels :

- Pollution of water, air, soil, health problems
- Low yield

- Around **50%** to 80% of WEEE collected in industrialized countries are exported in China, Ghana, Pakistan, India, Vietnam and Philippines, and are recycled in informal chanels[2]
  ⇨ huge problems of pollution and health

(1) Trends in sustainable development - UN, 2010
(2) UNEP, 2005 cité dans Wong et al., 2007

# Recycling

- Recycling levels of iron and steel : **70-90%**
- Recycled Al : **4-5%** of energy needed from bauxite[3]

World production of EEE in 2011 contained :

320 t

of gold (7,7% of gold production) and 7 500 tons of silver


- Recycling rates of rare metals[2] is **< 1%**[3]
- Extract ore ⇨ **more and more energy**
- High tech : ultra pure metals ⇨ **recycled metals disqualified**[4]
- **Losses in recycling** (Aluminum : 1 to 2%)

(1) Le Monde : Une mine d'or et d'argent ignorée dans les déchets électroniques (07/2012)
(2) Lithium, béryllium, bore, scandium, vanadium, gallium, germanium, arsenic, sélénium, strontium, yttrium, zirconium, indium, tellure, baryum, hafnium, tantale, osmium, thallium, bismuth, lanthane, cérium, praseodymium, néodyme, samarium, europium, gadolinium, terbium, thulium, ytterbium, lutétium
(3) « Metals Recycling Report » UNEP, 2011
(4) « Quel futur pour les métaux ? » Bihouix et de Guillebon, 2010

# Low cost production

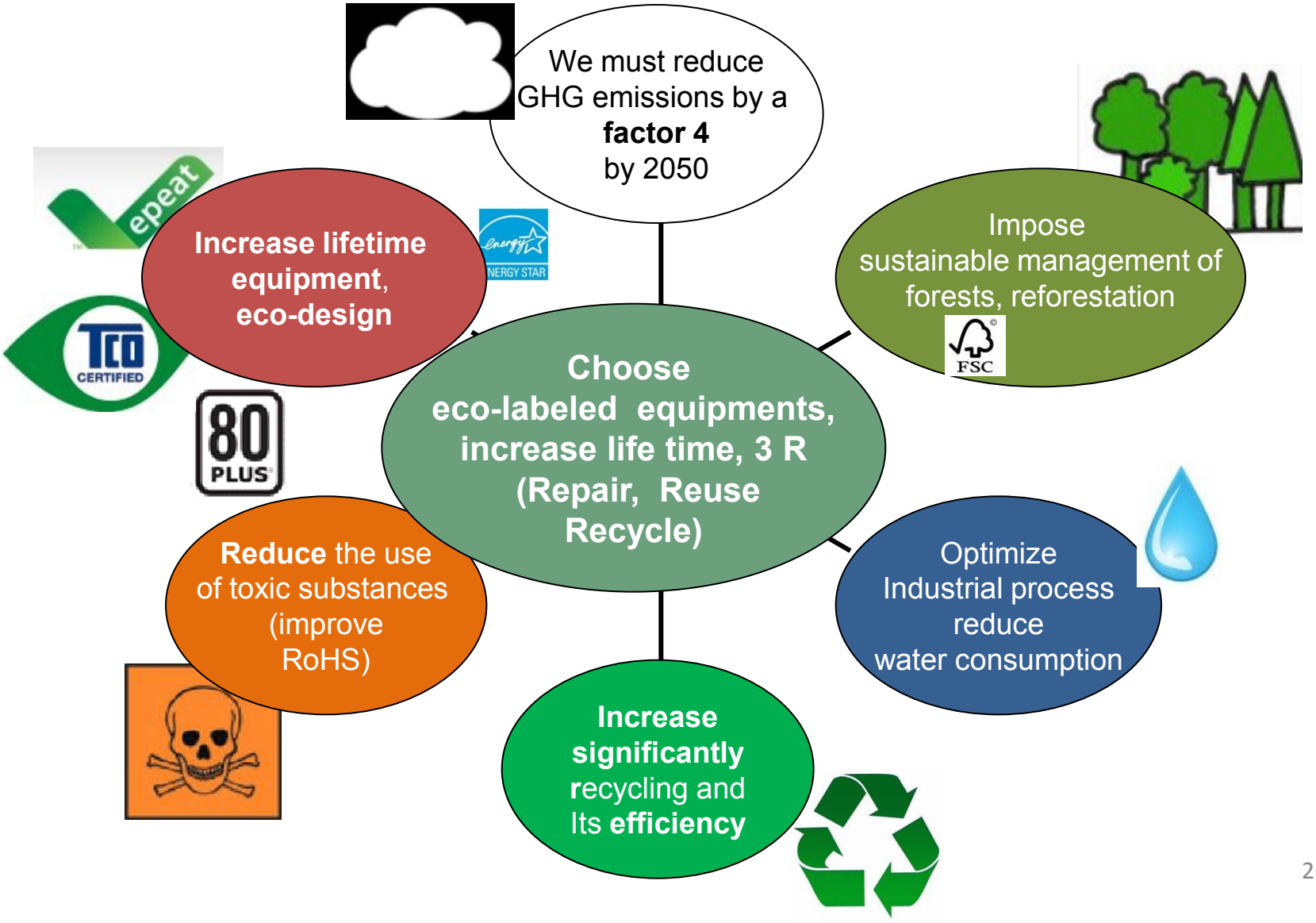
Products purchased in emerging countries are inexpensive

- Rebound effect : we buy more, we **change more often**, even if the equipment is still functional
- **Repair is disqualified** because repair cost > production cost
- Manufacturers prefer to produce products with a **short life span** (= non-repairable)

It gives work local populations

- The lack of regulation has consequences :
  - **Social** (exploited workers, professional illnesses, suicides)
  - **Environnmental** : pollutions, greenhouse gas emission

# Conclusion


We must reduce GHG emissions by a **factor 4** by 2050
**Increase lifetime equipment, eco-design**
Impose sustainable management of forests, reforestation
**Choose eco-labeled equipments, increase life time, 3 R (Repair, Reuse Recycle)**
**Reduce** the use of toxic substances (improve RoHS)
Optimize Industrial process reduce water consumption
**Increase significantly** recycling and Its **efficiency**
epeat
ENERGY STAR
TCO CERTIFIED
80 PLUS
FSC