The challenge of TIC regulations for Green IT

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Objective

- Technics alone does no good…

…think Green IT politically as well as technically

- Imagine what could be Green IT regulations…

…regulations that consider IT equipment as more than complex lumps of complex material

Summary

- Sustainable development, IT, Green IT

technology

- Sustainable development, IT, Green IT

politics

The technology of Green IT

Green IT = Sustainable development of IT

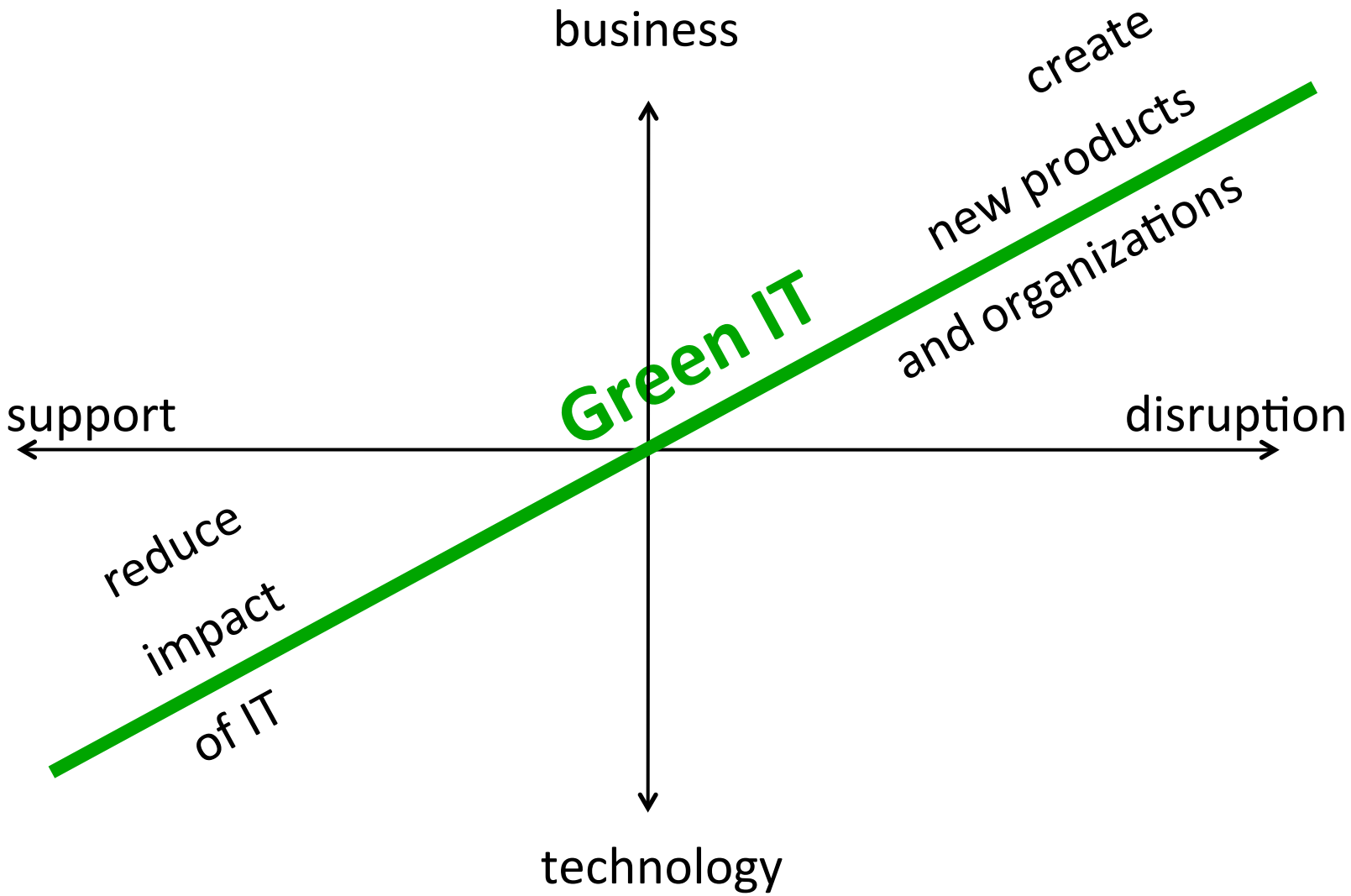
- 3 pillars
  - environment, economy and society
- 1 condition
  - education and transparency
- Tools
  - life cycle assessment
  - monitoring
  - regulations

A bias for energy issues

- The environmental pillar is more popular than the two others
- Energy issues are over-popular among the environmental issues

E3 - RSD

Technology vs politics

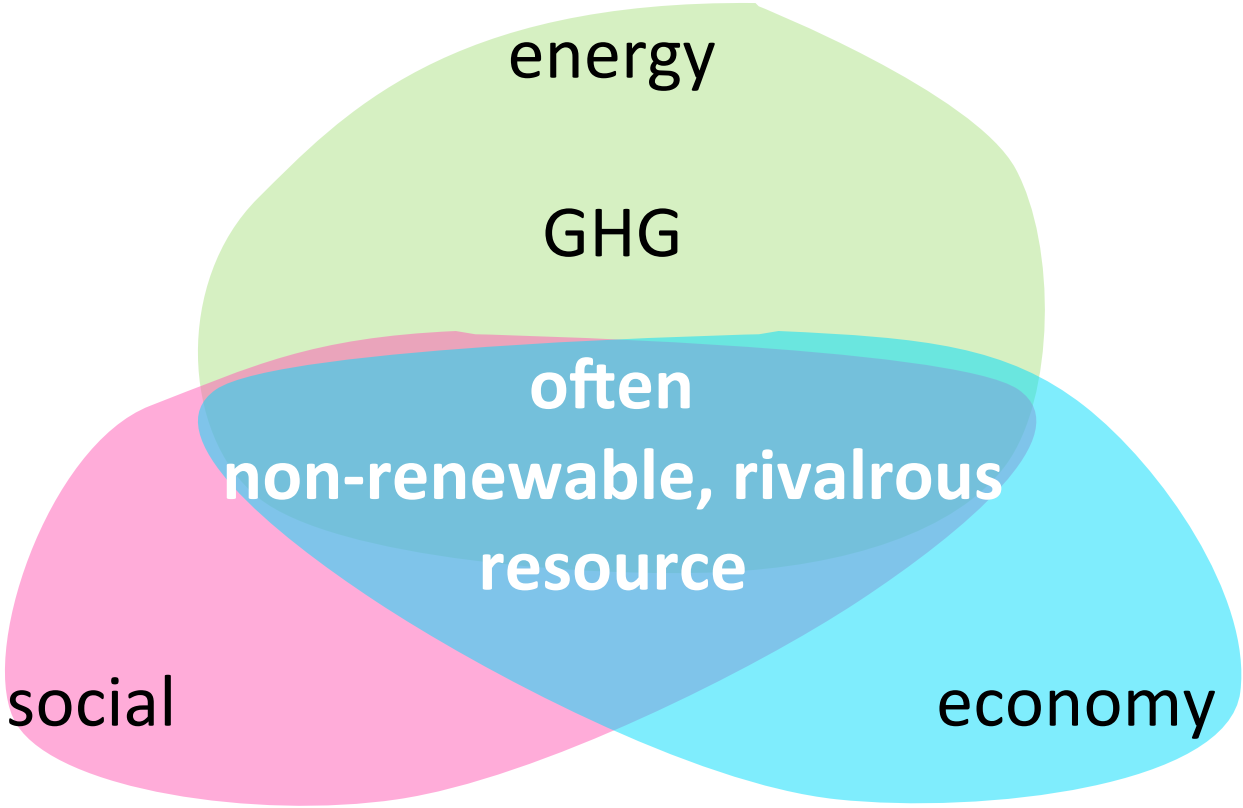


Why is energy an issue?

- Environmental impact, GHG
- Limited nonrenewable resource
- Rivalrous resource

- Other resources share these properties
- Energy, easier to grasp, to measure?

Energy as an issue



Renewability as an issue

- Pré-industrial water-mills exploit a
  - non-rivalrous source of energy?
  - renewable source of energy?

- Revalry between water-mills,
  and between water-mills and other users

Copper is an issue too

- Copper is a critical resource
  - 42% used for IT,
  - only mildly recyclable,
  - limited reserves,
  - Chile possesses more than 30% of resource

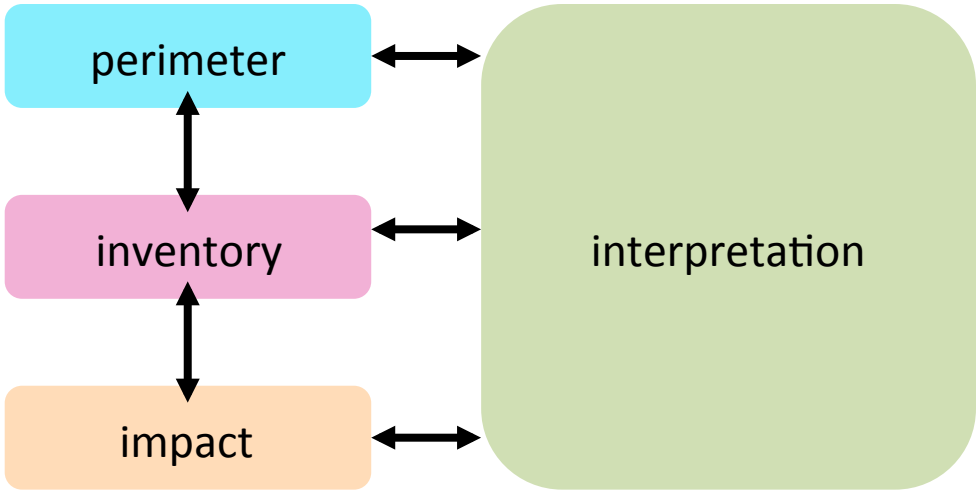
- Copper mining uses lots of water in areas where it is rare…

…impact on an Indian reserve in Arizona

Platinum too…

- Platinum is a critical resource
  - used for hard drives and fiber,
  - RSA possesses more than 75% of reserves
- 4 months strike for better wages
  - prices raise from $20 to $1500 /oz

A tool: life cycle assessment



- LCA
  - definition of perimeter: functional unit
  - inventory et quantitative study
  - analyse of impact
  - interpretation of results

Functional unit (1)

- Unit of end-user service
- **Normalized** for easy comparison
  - (extra-)urban driving cycle
  - energy class of home appliances
- Difficult to design for IT systems

Functional unit (2)

- Too often, improvements target measures that do not refer to a functional unit
  - **PUE**

    $$\text{power usage effectiveness} = \frac{\text{total power}}{\text{computing power}}$$

  - peak energy efficiency $= \frac{\text{max FU}}{\text{power}}$

    proportionality?

Hardware improvements vs software

- Often, hardware improvements do not go through to the end-user…

…software dampens improvement

$$\frac{\text{power}}{\text{op}} \searrow \quad \text{but} \quad \frac{\text{op}}{\text{FU}} \nearrow\nearrow \quad \text{hence} \quad \frac{\text{power}}{\text{FU}} \nearrow$$

…lack of precise software LCA

Technology improvement wants political guidance

- Improvements in life cycle may have undesired indirect impact
  - rebound effect when improvement augments usability more than it augments efficiency
  - move problems somewhere else
  - parasitic behaviour of a component
- Requires political control

Rebound effects (1)

- Jevons: steam-engine consumption ↘ though coal consumption ↗

  (#steam engine ↗↗)

- In IT: flat display consumption ↘ though total consumption ↗

  (total area ↗↗)

Rebound effects (2)

- Moore law: computation consumption ↘ though computers consumption ↗

  (#computers ↗↗)

- Internet: consumption per bit ↘ though total consumption ↗

  (#bits ↗↗)

Rebound effects (3)

- A prediction
- IoT: unit consumption ↘ though total consumption ↗

(#connected objects ↗↗)

Displacing the problem

- In IT: flat display usage consumption ↘ though total consumption ↗

  (manufacture consumption ↗↗)

- Externalization: client consumption ↘ though total consumption ↗

  (servers and network ↗↗)

Parasitic behaviour

- Software bloat: energy per instruction ↘ though energy per UF ↗

(#instruction per UF ↗↗)

The politics of Green IT

A political objective
Reduction of environmental footprint

- Reduction from **4** to **10** according to authors
- $$\frac{\text{production}}{\text{consumption}} = \text{efficiency} \nearrow$$

consumption ↘ ? or production ↗ ?

or even production ↗↗ ?

with rebound effect

- **Needs regulations**

IT regulations today

- WEEE and Basel Convention
- RoHS
- Energy certifications
- Electromagnetic emissions
- Grenelle II - RSE

Not really IT specific…

…IT peripheral!

…IT as machines!

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WEEE

- Waste of Electric and Electronic Equipment
- European directive 2003…

…implemented by member states

- Producer Responsibility Principle
- Recycle at least 85% of WEEE by 2016
- Reverse logistics

RoHS

- Restriction of Hazardous Substances
- European directive 2003
- Declaration of conformity
- Ban of 10 hazardous substances
  - lead (Pb), mercury (Hg), cadmium (Cd), brominated products, …
  - batteries under Battery Directive 2006
  - many exemptions: ex. solar cells…
- IT: soldering and flame retardant

Electromagnetic emissions

- Safe to work with !

- Ozone emission
- Electric hazard

…

Grenelle II - RSE

- Sustainable development at the company scale
- ISO 26000

Basel Convention

- Control of Transboundary Movements of Hazardous Wastes and Their Disposal
- International Treaty 1989-1992
- Basel Ban Amendment 1995
  - EU adheres
- WEEEs leak through as "commodities"
- Basel Action Network
  - e-Stewards initiative

Energy certifications

- 80 plus: efficiency in power supply 2006
  - > 80 % energy efficiency
  - do not say 90 plus! …say 80 plus Platinum!
  - does not cope with standby power
- Energy Star 1992
  - voluntary labeling program
  - includes 80 plus 2007

Regulations in real life

- Fishery management in watts
- WEEE directive
  - < 1000 Volt (AC) or 1500 Volt (DC)
  - large equipment > 50 cm
  - screen area > 100 cm^2
  - collection rate in 2016 > 45 %
- Displacement of engines > 49,9 cm^3
- RoHS bans lead solder

Simplistic, arbitrary, ahead on technology

In summary

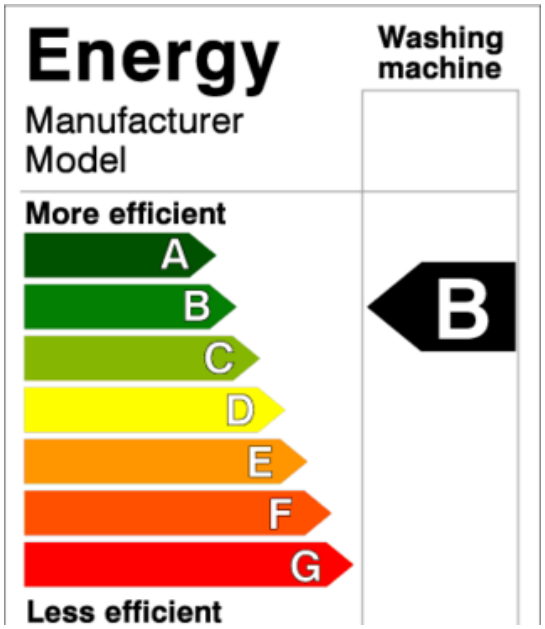
- IT systems considered like electric kettles

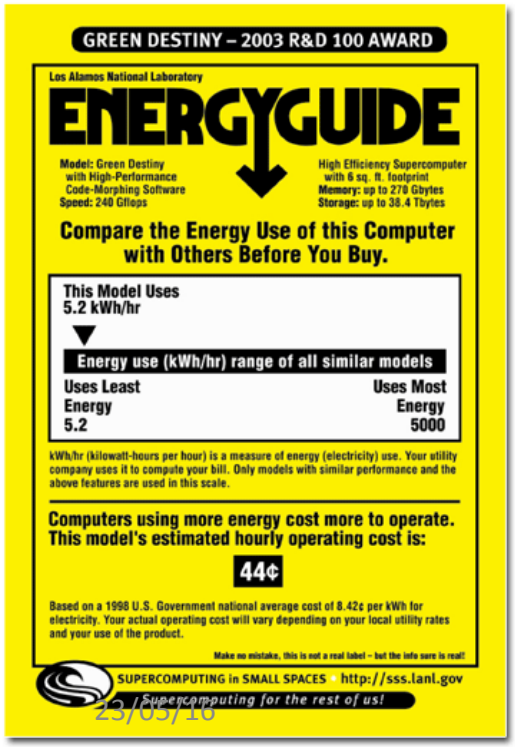
  a complex lump of complex materials

- No consideration for the IT behaviour of IT systems

Imagine IT specific Green regulations

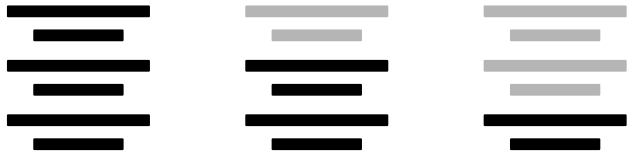
- Measure and display Green IT indicators
- Constrain IT equipment into categories
- Constrain software





Green IT indicators

- Display energy efficiency
  - benchmarked
  - or online



  - reuse the bar system of wireless communication systems

- Display LCA results

Constrain IT systems into power categories

- Form power categories
  - e.g. personal computer < 10 W

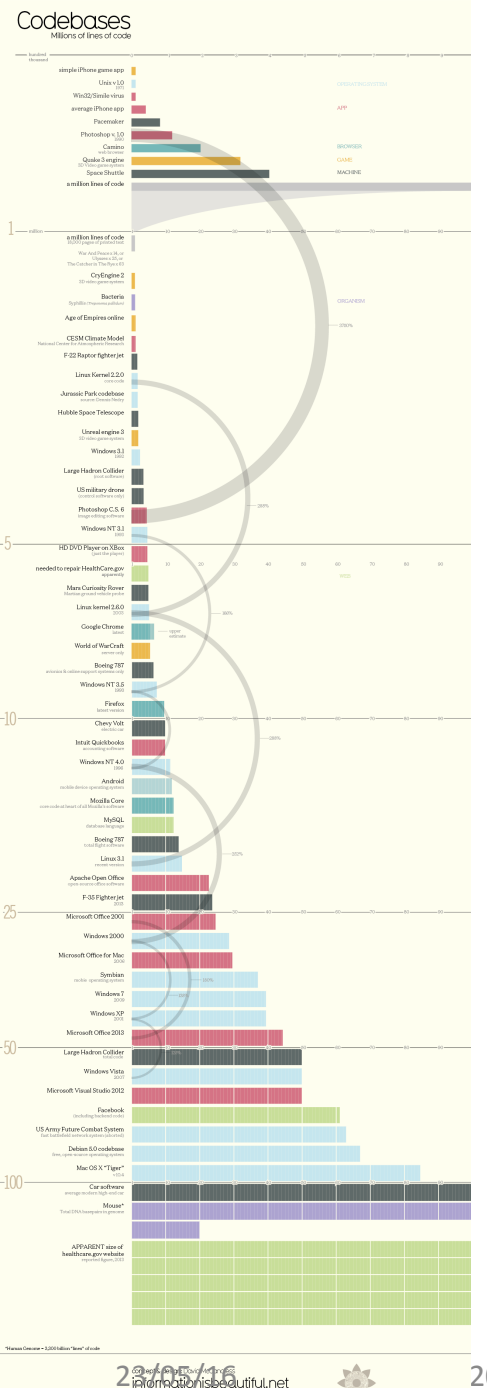
arbitrary, simplistic and ahead of technology

- Stress on **innovative design**

Power constrained projects

- USB objects : 2,5 W
- DOE's Exascale initiative : 20 MW

- All autonomous embedded IT systems



Constrain software into size categories

- Battle against software bloat
- A software and all its versions should belong to the same category

Too easy to fiddle with size metrics?

- Seems a poor metric because of compression
- Not so poor!
  - **nloc metrics** (infamous but used in real life)
  - **Kolmogorov complexity** (respected) well approximated by compression

Distribute compressed execute expanded

- Bennett **logical depth**
  - time consumption of the shortest algorithm

- A simplistic constraint with a formal meaning!

Tools exist for agressive size control

- Compilation, JIT
- Optimization
- Partial evaluation

- E.g. Google Web Toolkit

agressive
Java ⟶ JavaScript
translation

A real life example

- FCC (Federal Communications Commission) bans wifi routers open to 3rd party programs
- Linksys explains why its routers can remain open

  the RF data are protected and not subject to modification by 3rd party firmware

- Not yet a Green IT example,

  but still a IT-as-a-system regulation example

Brute force is not enough

- Need planning
- Need **software LCA** and **green design patterns**
- Need also **internet/web LCA**

- Transient systems
- Self-referencing systems
  - bootstrapped, but imagine ironworks without iron

Conclusion

- Regulations are required to reap the benefits of technical improvements
- Regulations may also stimulate technical innovation
- Public regulations are often **simplistic, arbitrary and ahead of state-of-the-art**
- Need software LCA and green patterns
- It is our job too!

Warning (1)

- In the past IT people have often objected regulations on the ground of being so different
  - immaterial information
  - virtual worlds, avatars,…
  - free clones, free copies…
  - Turing completeness, Universal Turing Machine, data = program…
  - Gödel, incompleteness, non-decidability…

Warning (2)

- We know now that it is an illusion
  - IT is made of **real materials**
  - IT lives on **real energy**

Green IT is a kind of rematerialization

- IT must also model real-life constraints
  - Bitcoin / Blockchain