Digital technology and the environment

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Abstract:
Juxtaposing in a single sentence "digital" and "environmental" is not neutral. Our societies believe in the quasi magical power of information and communications technology (ICT) to solve environmental problems. True, we are more or less aware that we should not turn a blind eye to the consumption of energy by digital technology, nor to the related wastes. However this does not change one iota our collective belief, nor our actions. Between a fuzzy vocabulary, bits of utterly simplified information, "alternative facts" and fixed ideas, it is hard to form an accurate idea about the state of current knowledge on ICT's environmental impact. Let us return to the facts and avoid rushing into a new environmental catastrophe. While seeing digital technology as a tool for assisting the environmental transition, we should remain aware of the problems that will crop up in a digital society. A critique of four false ideas provides the opportunity to review critical information about ICT's negative effects.

The information society has a negligible environmental footprint

Dematerialization, virtualization, the cloud, networks, information, data, simulations, avatars, virtual reality, smart grids, e-devices, e-mail… all so many words from ICT's lexicon.[1] These words, tinted with intelligence, evidently draw us away from physical, tangible reality even as they draw on real material resources that produce definitely nonvirtual forms of pollution. In fact, the electricity consumed by ICT is estimated at about 10% of worldwide consumption, a percentage approximately spread out as follows: 30% for data centers, 30% for end-user terminals (mostly computers) and 40% for telecommunication networks. According to predictions, electricity consumption will continue rising around 7% per year. The increasing percentage consumed by data centers and networks is mainly due to the proliferation of services in the "cloud" (in particular for storing data) and the equipment used for this purpose. Greenhouse gas emissions from ICT are not lagging behind: they now account for 2%-5% of all such emissions on the planet — more than civil aviation.

Besides, a product's or service's environmental footprint is not restricted to questions related to energy and the impact on the climate during the period when it is in use. The ICT industry relies on equipment and an infrastructure with a high added value and two relatively constant characteristics.

FIRST OF ALL, ICT has a heavy environmental footprint owing to the use of several minerals that are scarce or critical in the geological, economic and geopolitical senses of this word. For instance, an ordinary smartphone concentrates a few dozen different metals, seventeen of which will, at the end of the product's life cycle, undergo recycling to the point of recuperating the metals. The other metals will be lost, dispersed.

[1] This article has been translated from French by Noal Mellott (Omaha Beach, France). The translation into English has, with the editor's approval, completed a few references.

Table 1: Metals used in information and communications technology (ICT)								
	Silver	*Copper*	*Indium*	*Gallium*	*Germanium*	*Lithium*	*Tantalum*	*Rare-earths*
Uses:	*Contacts*	*Cables*	*Monitors*	*LEDs*	*Wi-Fi*	*Batteries*	*LCDs, capacitors*	*LCDs, magnets*
World production for ICT	21%	42%	>50%	40%	15%	20%	66%	20%
Years of reserves	15-30	40	10-15	10-15	10-15	Many	150	Many
Recycled	>50%	>50%	<1%	<1%	<1%	<1%	<1%	<1%
Sources: www.ecoinfo.cnrs.fr . DREZET 2012; VIDAL 2016.								

Geologists estimate that silver, indium, gallium or germanium deposits will last for approximately fifteen years at the current rate of consumption. In Table 1, a reserve deposit represents a geologically identified quantity that can be extracted using existing technology given both the metal's current price and the price estimated on the basis of current and foreseeable consumption patterns. These values should be handled with caution. Currently however, the average concentration of metals (such as copper, gold and silver) in newly discovered deposits is diminishing. These metals are a major issue for ICT.

SECONDLY, according to a scenario based on average use, the phase of manufacturing the equipment necessary for processing and transmitting data (smartphones, computers, storage equipment, etc.) accounts for somewhere between a quarter and more than three quarters of ICT's environmental impact. The transportation phase has a heavy footprint too because of air freight. Estimates of the recycling phase are still of poor quality, even in an industrialized land such as France; the data are missing or tarnished by a high degree of uncertainty. In contrast, considerable progress has, it should be pointed out, been made in evaluating the phase of use. Nonetheless, we observe no overall reduction in electricity consumption, since the volume of data is swelling, the number of applications is proliferating, and software programs keep swelling as does our need for them.

From these remarks, I would like to draw three preliminary conclusions. First of all, it is more than ever worthwhile to pay attention to the trees that hide the forest. Secondly, it is urgent to prolong the use of ICT devices and equipment in order to reduce the levy on nonrenewable resources and the impact due to the manufacturing and recycling phases. Finally, rebound and side effects that increase consumption by pushing back the limits on using the technology (for example: as prices or energy consumption per device decrease) risk canceling the expected benefits from the advances made.

Telework (telecommuting) reduces the carbon footprint

An apparently excellent way to act in favor of the environment is to limit commuting by car, since using ICT to work at home seems more economical. This argument keeps quiet about the many negative effects that cancel part of the hoped-for benefits:

— Working at home means heating the house, having a place to work (an additional room) and, therefore, increasing the environmental impact attributable to housing.

— It is neither imagined nor desirable for wage-earners to spend 100% of their worktime at home but, instead, something like two days out of five. However this would not significantly reduce the environmental impact, neither the room for workspace nor the energy consumed.

— Many wage-earners who "telework" (or "telecommute") choose an environment offering a better quality of life. They move farther from their workplace and thus increase the commuting distance for the days they have to work at the plant or office.

— Secondary trips (for shopping, school, etc.) become "primary" on the days spent teleworking, whence greenhouse gas emissions.

In all, taking into account the conditions and side-effects, as analyzed in several studies, the benefits of telework turn out to be much lower than they seem. Depending on the scope, hypotheses, scenarios and countries in these studies, the potential gain on greenhouse gas emissions is from 0.1% to 0.5%. In other words, given our current state of knowledge and the uncertainty of the data used in these studies, we are unable to conclude that ICT's contribution to the development of telework is environmentally friendly. Attention also has to be paid to the problems stemming from the permeability of the bounds between work and home life and from the risk of work teams losing cohesion.

We are now recycling 80% of electric and electronic wastes.

This statistic is deceptive, since it depends on what "recycling" means. Under the EU WEEE directive[2] and according to ADEME[3], 80% of ICT equipment in France is being recycled as prescribed. But a closer look lets us see what this statistic covers. This percentage is based on the ratio of the tonnage of electrical and electronic wastes that have undergone "depollution" (and then grinding and sorting) to the total tonnage collected. Before discussing recycling itself, I would like to point out, for us to bear in mind, that only about 45% of these wastes are currently being collected.

In addition, the output of the recycling operations performed on these wastes is normally separate batches of plastic (sorted as a function of the waste's physical and chemical properties), of chip-cards or of ferrous and of nonferrous materials. The waste is labeled as "recycled" once these batches leave the plant. However there is a big difference between these batches and the materials that re-enter the manufacturing process, in particular for plastics and several metals present in very small quantities in this equipment. Recycling a batch of plastic does not necessarily mean that the plastic is retrieved to manufacture plastic. Even for the metals that are rather easy to recycle, the process results in sizeable loses — to take aluminum as example: a loss of approximately 5% (in weight). So, the statistic on recycling does not describe what consumers might imagine. Worse yet, we do not know (not even in France) how to precisely measure the retrieval rate of electronic wastes at the end of the chain.

Two conclusions are to be added to the preceding remarks:

— As users of electrical and electronic equipment — and thus as producers of wastes — we should utilize the facilities set up (in stores, public areas and waste collection centers) for retrieving ICT equipment, even small devices.

— The recycling, as prescribed, of electronic devices does not mean that the materials produced by recycling will be used to make new equipment. We are still far from a circular economy in the handling of the life cycle of ICT equipment.

[2] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE). Texts of European Union law are available via http://eur-lex.europa.eu/legal-content/FR/TXT/?uri=CELEX%3A02006R1907-20140410.

[3] ADEME, *Équipements électriques et électroniques, rapport annuel*, 2005 available at http://www.ademe.fr/sites/default/files/assets/documents/registre-eee-donnees-2015-201610-rapport-annuel.pdf.

Figure 1: A product's life-cycle from the mining and extraction of ores to the end. A very small fraction of the material used to build new equipment comes from recycling.

ICT will save the equivalent of ten times its environmental impact by 2030

Several prospective studies published in recent years have moved politicians and industrialists to boost the deployment of digital tools and techniques. These studies draw the conclusion that this deployment can significantly reduce (by a factor ranging from five to ten) the greenhouse gases emitted by branches of the economy other than ICT.[4] Most of these studies compare the current situation with projections for 2020 or 2030 in matters of: *a)* the environmental footprint due to the direct negative effects of (part of) the ICT industry, mainly the end-user part (computers, telephones) along with data centers and networks; and *b)* the environmental footprint due to the indirect positive effects of ICT being used for various purposes or in various branches of the economy: "dematerialization", transportation, buildings, energy networks, or even industry and agriculture.

A closer look at these studies catches sight of important limits and major points of uncertainty. These studies are exploratory; they are not robust prospective analyses. Taking account of their findings in decision-making (for policies and strategies) is betting on a future — a risk all the greater insofar as it is poorly evaluated.

[4] I might cite as example the study by the Fédération Fançaise des Télécoms, Alliance TICS and Fédération des Industries Électriques, Électroniques et de Communication or the following: The Climate Group, *Smart 2020: Enabling the Low Carbon Economy in the Information Age*, 87p., a report on behalf of the Global eSustainability Initiative (GeSI), (Creative Commons 2008), available at https://www.theclimategroup.org/news/smart2020.

Let us remark a few critical limitations of these studies. Only the indicator of potential global warming is assessed, while other environmental indicators, such as the depletion of nonrenewable resources, are overlooked. Moreover, certain phases in the product life-cycle have been omitted or but partially brought under consideration. Such is the case of the phases of procurement/manufacturing and end of life. In addition, the scenarios are based on a model that evolves without environmental and biophysical constraints. The hypotheses formulated correspond to an aggregation of information as it comes in from varied sources (public agencies, industrialists, reports on studies, international organizations, claims by experts, etc.). Sectoral data have often been extrapolated from other geographical areas, without any analysis of how robust they are. Negative side effects and rebound effects, whether positive or negative, are left out of the picture. These limitations weaken the conclusions, all the more so since, according to the 2017 climate report by the think tank I4CE,[5] the carbon footprint per capita in France in 2015 was the same as in 1995, but with a reversal of the shares of CO_2 produced by France and of the CO_2 imported in France in the form of manufactured goods: 35% was imported in 1995 as compared with 55% in 2015. This suggests a transfer — instead of a reduction — of pollution.

Conclusion

The purpose of debunking these four misleading arguments is to show how the circulation of simplified messages, the diffusion to decision- and policy-makers of not very robust findings from exploratory studies, and the choice of a vocabulary in line with a mind-set that deliberately purges reality of its material grounds make us collectively unaware of the consequences of this choice. Digital technology could well be a lever for the environmental transition, under condition that we shine light — not just as a function of our desires and impulses — on users' behavior patterns and manufacturers' marketing strategies so that everyone's knowledge become enlightened.

[5] M. Baude, F.X. Dussud, M. Ecoiffier, J. Duvernoy & C. Vailles, *Chiffres clés du climate. France et monde 2017* (Institute for Climate Economics,I4CE, 2017) available at: http://www.statistiques.developpement-durable.gouv.fr/fileadmin/documents/Produits_editoriaux/Publications/Datalab/2016/chiffres-cles-du-climat-edition2017-2016-12-05-fr.pdf.