Analysing ICT in prospective scenarios to help reveal undone computer science

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Computer science is often mentioned as a solution to solve climate change (e.g. [Rolnick et al., 2019]). But at the same time, it is now acknowledged that ICT has it own environmental impacts. Several authors have tried to estimate future information and communication technologies (ICT) energy consumption and carbon footprint [Andrae, 2019, Malmodin and Lundén, 2018]. The projections depend on two main variables: efficiency of IT and demand for ICT (via possible rebound effects) [Freitag et al., 2021].

From these opposite observations, it seems legitimate to question which research topics computer scientists should tackle and maybe not tackle from a sustainability perspective. Defining research questions that have not yet been addressed or collectively deciding which research need to be pursued or reconsidered requires to envision desired futures of the ICT sector. To that end, we have started studying the connection between digital technologies in prospective scenarios, current research trends and undone computer science. The first objective is to observe the place of digital technologies in future narratives and analyze how ICT in prospective studies relates to today's development of digital technologies. The second objective aims at identifying if existing scenarios for ICT give space to known unknowns, and consider sunset or sunrise of technologies [Hess, 2015].

To understand the link between possible futures and current research on ICT, we have therefore analyzed the place of ICT in several prospective studies. In the climate change context, many prospective studies have been proposed in the past years to develop imagination and drive ecological transition. They describe the future in very different formats: some are purely narratives, while others rely on quantitative models. Scenarios result from different societal or technical hypotheses, each scenario being shaped by many variables: economic growth, well-being, sobriety, low-carbon energy, population, uncertain events. We reviewed 14 prospective studies [Ademe, 2021, négaWatt, 2021, RTE, 2022, Ministère de la Transition écologique et solidaire, 2020, The Shift Project, 2020, Millot et al., 2018, European Commission, 2019, European Environment Agency, 2021, IPCC, 2022, Arup, 2019, Danish Design Center, 2020, Creutzig et al., 2022, CNIL,

2021, Deron and McDonald, 2022] and their corresponding 35 scenarios, targeting the evolution of digital technologies and their areas of applications. We do not pretend to have made an exhaustive review of existing scenarios. However, we have tried to cover various scenario types, from narrations only to more quantitative ones, positive or negative. We observed that all scenarios consider that ICT will be present in the future. Yet, evolution of ICT sector and its role towards other sectors vary between scenarios.
Through this talk, we first propose to highlight common points and differences between scenarios in order to answer the following questions: What ICT is present in the scenarios? i.e. which infrastructure, quantity of data and technologies?; What applications relying on ICT are described?; How is ICT used for the environmental transition?

In a second step, we will show that many known unknowns are absent from all scenarios, with very few technical or scientific revolution, few changes in our relation to digital technologies, and some missing applications. We will discuss challenges that should be addressed as research questions to enable or avoid the scenarios, considering aspects such as systemic view of ICT, correlation with physical reality and access to critical resources, resilience and geopolitical aspects.

Finally, we will argue that designing prospective studies for ICT with sustainability perspective is probably itself an undone computer science that needs to be done to i) offer a more diverse and systemic view of the future of digital technologies; ii) highlight the need for discussing, structuring or funding other computer science research topics currently undone. From different prospective scenarios for Quebec in 2040, the study [Deron and McDonald, 2022] found 33 milestones to reach a desire future of digital technologies. This study is the result of co-design workshops where participants had to imagine the future of ICT in the context of predefined visions of the future of ICT. The milestones show samples of which social and industrial movements, funding, and research are needed for a desirable sustainable ICT.

Keywords— future of ICT, prospective scenario, sustainable ICT

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