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Opportunities and Risks of Digitalization for Climate Protection in Switzerland

Executive Summary

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Executive Summary

Information and Communication Technology (ICT) is an important enabler for a low-carbon economy in Switzerland. ICT has the potential to avoid up to 3.37 times more greenhouse gas (GHG) emissions than the amount of emissions caused by the production, operation and disposal of ICT devices and infrastructures used in Switzerland in 2025. In absolute terms, ICT will enable the Swiss economy to save up to 6.99 Mt CO_2-equivalents (CO_2e) per year, with an own carbon footprint of 2.08 Mt CO_2e per year (see Figure 1).

This opportunity for the ICT sector to contribute to climate protection, however, can only be realized under optimistic assumptions. In particular, it is necessary that the existing technological and economic potentials are systematically exploited by taking ambitious and targeted actions. Such actions can be especially effective in the transportation, building and energy sectors, which have the highest potential for ICT-enabled ("smart") solutions to reduce GHG emissions. At the same time, the carbon footprint of the ICT sector itself must be reduced by 17%, which is technologically and economically feasible due to efficiency gains.

Measurement and projections of the ICT footprint are based on a consumption-based view, i.e., the footprint of ICT hardware and services consumed in Switzerland includes emissions occurring in other countries, such as the emissions caused by the production of imported ICT hardware ("embedded emissions"). For the estimation of the ICT-enabled GHG abatement, effects on emissions in foreign countries are also taken into account. As shown in Figure 1, a substantial part of the ICT sector GHG footprint occurs abroad, whereas almost the entire ICT-enabled GHG abatement happens in Switzerland.

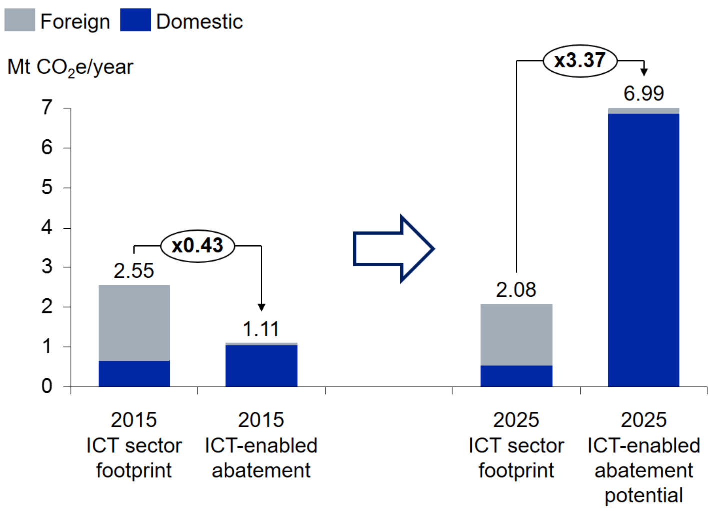

Figure 1: The Swiss ICT sector causes greenhouse gas emissions both in Switzerland and abroad. At the same time, the application of ICT in Switzerland contributes to greenhouse gas emission abatement in sectors other than ICT. Projection from 2015 to 2025.

The study reported here investigated opportunities and risks of digitalization for climate protection in Switzerland by focusing on the two aspects:

– the ICT sector's own footprint (direct effects of ICT on GHG emissions) and
– the abatement potential of ICT (indirect effects of ICT on GHG emissions).

The ICT sector's own footprint:

Our study found that the largest share of the ICT sector's GHG emissions comes from end-user devices. Currently, roughly ⅔ of the consumption-based GHG emissions of ICT in Switzerland are caused by desktop, laptop and tablet computers, smartphones and printers, while ⅓ of the emissions are caused by telecommunication network operators and datacenters (numbers from 2015).

Figure 2 shows how annual emissions are distributed over device types. It can be seen that phasing out stationary desktop computers ("traditional PCs") and replacing them by mobile devices, which are constrained in weight and power demand for reasons of convenience, provides an opportunity to reduce emissions both during production and use of the devices. Mobile devices (laptops, tablets, smartphones) could even be called "energy-sufficient" because their power consumption is kept at a low level in absolute terms to enable long battery life with small batteries. Thus, there is an opportunity to reduce the per-capita emissions caused by ICT consumption while improving user experience. With this shift to light and energy-sufficient mobile devices, the relative share of the production phase increases, which implies that it becomes more important for the ICT sector to engage in "greening" the supply chain and avoid "embedded" emissions, i.e., emissions that happen in the countries where the hardware is manufactured and the raw materials are mined. It is essential that the use of fossil energy is reduced over the entire life cycle of the products.

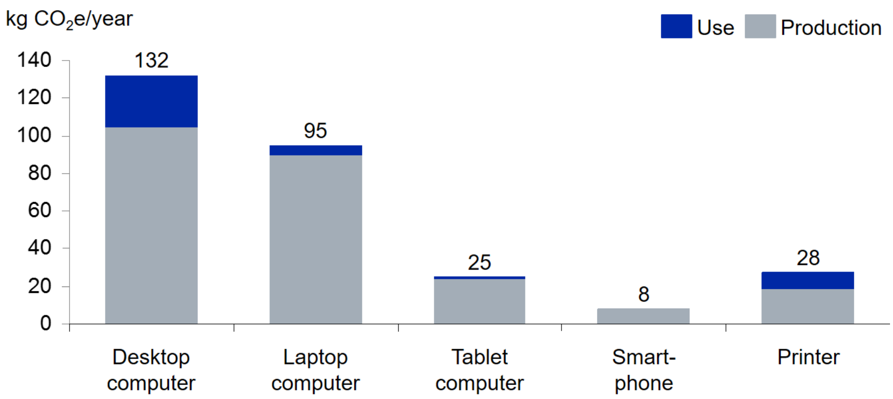

Figure 2: Average annual greenhouse gas emissions per end-user device during production and use by device type. The annual values of production emissions (grey) are based on current average useful lives of the devices.

The main risk for the development of the ICT sector's own footprint is that this positive trend is compensated or even overcompensated for by an increasing number of devices per capita and decreasing service lifetimes of the devices. The worst case would be a prevalent throw-away mentality with regard to digital electronics. This would substantially increase the footprint of the ICT sector, even under conditions of the well-established Swiss recycling system for waste electrical and electronic equipment. If the same amount (or even larger amounts) of scarce raw materials are distributed among larger numbers of devices, the dissipation of many scarce metals will increase. Resource depletion and the efforts to recover scarce material resources (also in terms of energy and GHG emissions), will grow as a consequence. A second risk is that Internet traffic, in particular machine-to-machine traffic, might grow faster than the energy efficiency of the infrastructure in the future, resulting in growing emissions of the large parts of the global Internet which will still be powered by non-renewable energies.

The GHG abatement potential of ICT:

Our study examined ten use cases discussed in literature, re-estimating adoption and impact parameters needed for our projection to 2025. We calculated three scenarios to reflect both, data uncertainty and the fact that the future is still to be shaped (Figure 3). The darkest parts of the bars in Figure 3 show the findings for the pessimistic scenario, resulting in a total abatement potential of 0.72 MT Mt CO_2e per year. For the optimistic scenario, the abatement potential amounts to 6.99 Mt CO_2e per year. The scenario which is to be expected under "business as usual" conditions yields 2.79 Mt CO_2e per year. All scenarios are based on use cases that could be realized with technologies already available and would provide a financial benefit to their users.

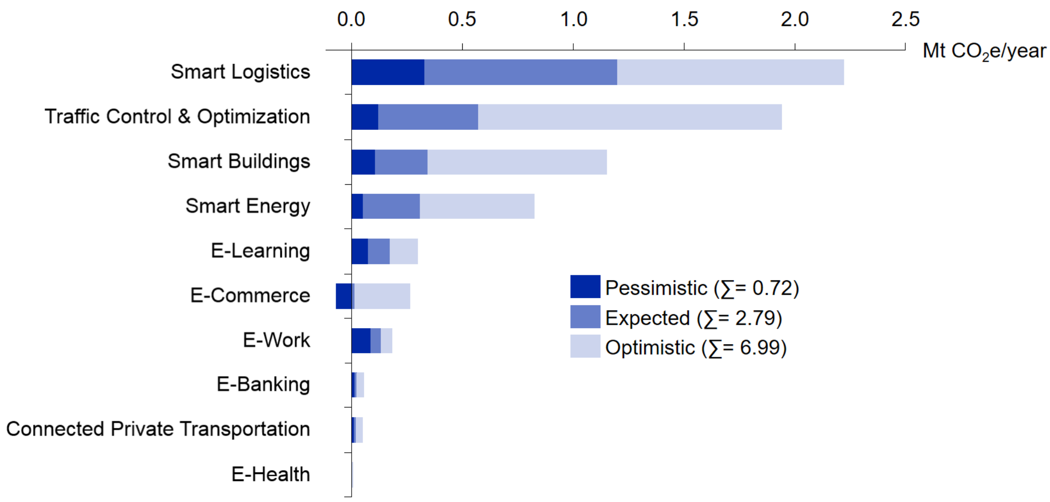

Figure 3: GHG abatement potential in 2025 in a pessimistic, expected and optimistic scenario by use case.

There is an unprecedented opportunity to take ambitious and targeted actions to implement ICT-based ("smart") low-carbon solutions, both in terms of technologies and business models, within less than one decade. This can mainly be done by further developing smart solutions in logistics, traffic control and optimization, buildings, and electric energy. Unleashing this GHG abatement potential would make a significant contribution to the Swiss GHG reduction goals.

The main risk for the contribution of ICT to climate protection is that the abatement potential could not be unleashed because the solutions will not be adopted by businesses and end consumers, resulting in the pessimistic scenario. ICT-based ("smart") solutions are only acceptable if businesses and end consumers can use them straightforward, safe, and be sure that the enormous amounts of data generated and processed are not used against their interests by anyone, including the government, competitors, and cybercriminals. In some application areas, rebound effects (i.e., increasing demands due to lower cost) compensating for the abatement, pose an additional risk.

Case studies on promising use cases:

To deepen the understanding of the drivers and barriers relevant to ICT-enabled GHG abatement, we analyzed five examples in detail:

– Collaborative logistics (example of smart logistics): ICT-based sharing of logistic assets among companies in road freight transport can increase the utilization of assets and reduce GHG emissions per ton kilometer. Flexible use of logistic assets can be a part of the "Industry 4.0" vision. Policies are needed to avoid an increase of demand for transport as a reaction to lower cost (rebound effect).
– Intelligent heating (example of smart buildings): Intelligent heating systems can reduce energy consumption by households significantly, without reducing the comfort of the residents. For buildings built before 1980 and one-family buildings, intelligent heating can be considered the "low-hanging fruit" of energy saving. The ICT sector and the heating industry as well as utility companies should cooperate to standardize and simplify the use of intelligent heating technology.
– Demand side management (DSM) in electricity consumption (example of smart energy): DSM supports the integration of renewable energies into the electricity grid and increases capacity utilization of existing infrastructure. For example, the operation of dishwashers could be postponed to shift the power consumption to times of lower demand or higher supply. Technical and regulatory standards are needed to enable adoption.
– Coworking (example of e-work): ICT is continuously increasing the portion of work that can be done independent of location. Active utilization of office space is low on the average, while the GHG emissions associated with building space are high. Coworking spaces can increase office space utilization, reduce commuting

distances and provide advantages compared to home-office work, such as the possibility to have physical meetings.

– Car sharing (example of connected private transportation): The leading role of Switzerland in car sharing could be used as a starting point to develop innovative car sharing schemes, such as free-floating car sharing. Cooperation between public authorities, public transport companies and car sharing providers is necessary to extend coverage of innovative car sharing schemes.

A comparison among these five examples shows a high potential for demand-side management if we assume that it plays a crucial role in the transformation of the energy system towards electricity from solely renewable sources. Collaborative logistics and intelligent heating both can make substantial contributions to the transition to a low-carbon economy. In direct comparison, the abatement potentials of coworking and car-sharing are smaller, but still worth exploring.

System boundaries:

This study provides quantitative results only for GHG emissions as one of several relevant environmental indicators, such as the depletion of scarce resources and toxicity. However, we show qualitatively that including the other indicators would not change the essential implications of our results.

The study does not take into account changes to the electricity mix (except in use cases where integration of renewables is the lever for the GHG abatement potential). We were using a constant electricity mix to show the impact of ICT as clearly as possible. The transition towards a higher share of renewable energy in the Swiss electricity mix has several effects on our results. In particular, it can decrease the use-phase emissions of end-user devices, telecommunication networks and data centers. A larger effect for climate protection, however, would result from a transition to low-carbon energy in countries where ICT hardware is produced.

Regarding the enabling effect of ICT, this study focused on use cases where a GHG abatement potential can be expected. It is possible that use cases exist where ICT enables or supports activities with high GHG emissions, thus bearing induction potentials (as opposed to abatement potentials). Induction potentials were excluded from the system under study.

Several developments in the ICT sector had to be excluded as well because predicting them would go beyond the scope of this study. This includes the general trend towards the "Internet of Things" (as far as direct effects are concerned) and applications of Artificial Intelligence such as self-driving cars and autonomous robots.

Taking the resulting uncertainty into account, we can derive the following robust recommendations from our results.

Recommendations:

- Swiss households and businesses can influence the direct environmental impacts by using mobile devices (laptops, tablets, smartphones) instead of old stationary devices and using them as long as possible.
- Swiss households and businesses should evaluate their individual benefit of adopting ICT-based ("smart") solutions in areas where investment in such solutions provides a substantial GHG abatement potential: Solutions such as demand-side management, intelligent heating, car sharing or the sharing of other assets can have substantial positive effects, but their impact is context-dependent and must be evaluated in each individual case.
- Swiss ICT companies including telecommunication network operators should consistently reduce their carbon emissions, both locally and by using their purchasing power to influence the supply chain for imported equipment in the direction of green and fair procurement.
- Swiss ICT companies including telecommunication network operators should use their potential to develop and provide ICT-based low-carbon solutions to their B2B and B2C customers in areas with high GHG abatement potential.
- Policy makers should develop framework conditions that enable and encourage safe and privacy-respecting ICT solutions.
- Policy makers should encourage the development of open technical standards and create incentives for the adoption of ICT-based low-carbon solutions, especially in areas with high GHG abatement potential (transportation, smart buildings, smart energy).