Indirect effects of digitalization on the environment

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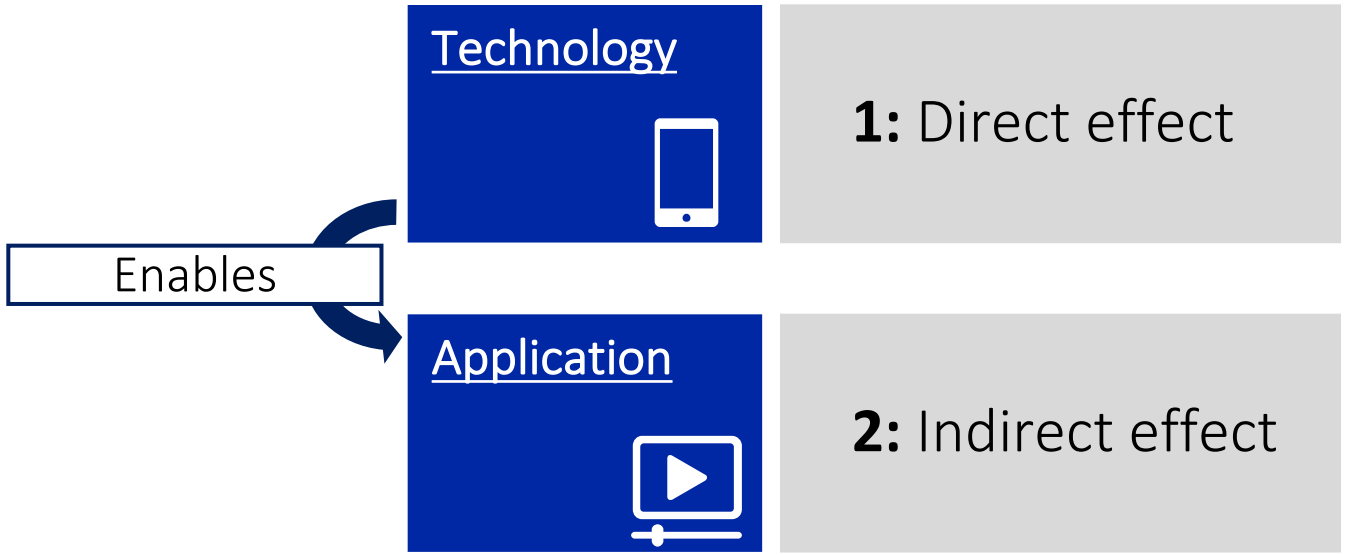
LCA Discussion Forum, 21 November 2019

Environmental effects of ICT

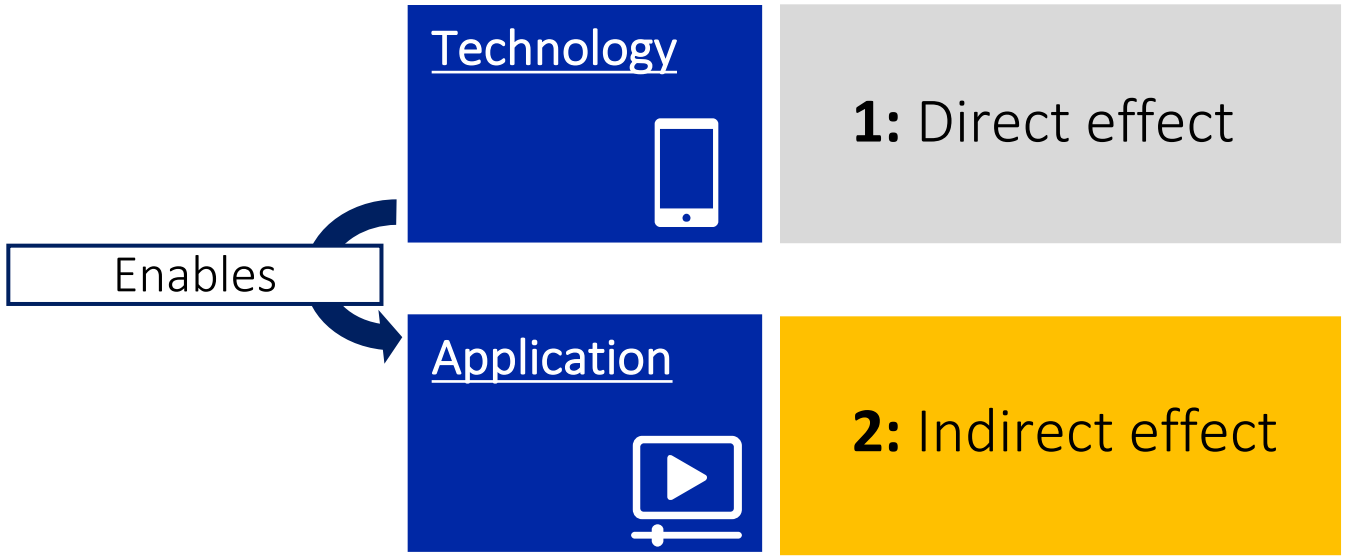


1: Production, use and disposal of ICT requires resources and creates emissions to the environment

2: Environmental effects of ICT application, examples:

- e-book reader replaces paper-based book
- less heating required in a smart home
- printer stimulates use of paper

Focus of this presentation: Indirect environmental effects of ICT



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Agenda

1. What are ICT applications?
2. How are environmental effects of ICT applications assessed?
3. What are methodological challenges in the assessment?

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1. **What are ICT applications?**
2. How are environmental effects of ICT applications assessed?
3. What are methodological challenges in the assessment?

Assessments focus on various ICT use cases in various application domains.

Application Domain	Description	Example Use Cases
Virtual goods	Replacing physical goods with ICT-based services	– E-books – Music and video streaming
Shared goods	Coordinating access to goods, increasing utilization	– Sharing platforms
Virtual mobility	Replacing physical travel with ICT-based remote action	– Video conferencing – Remote maintenance
Smart transport	ICT-enabled change of the process of transporting people or goods	– Route optimization – Traffic flow management
Smart production	ICT-enabled change of the processes and business models of production	– Automation of production processes
Smart energy	ICT applications in the energy sector	– Smart metering – Demand side management
Smart buildings	Change of building management enabled by ICT	– Smart heating – Smart lighting

Source: [1]

Agenda

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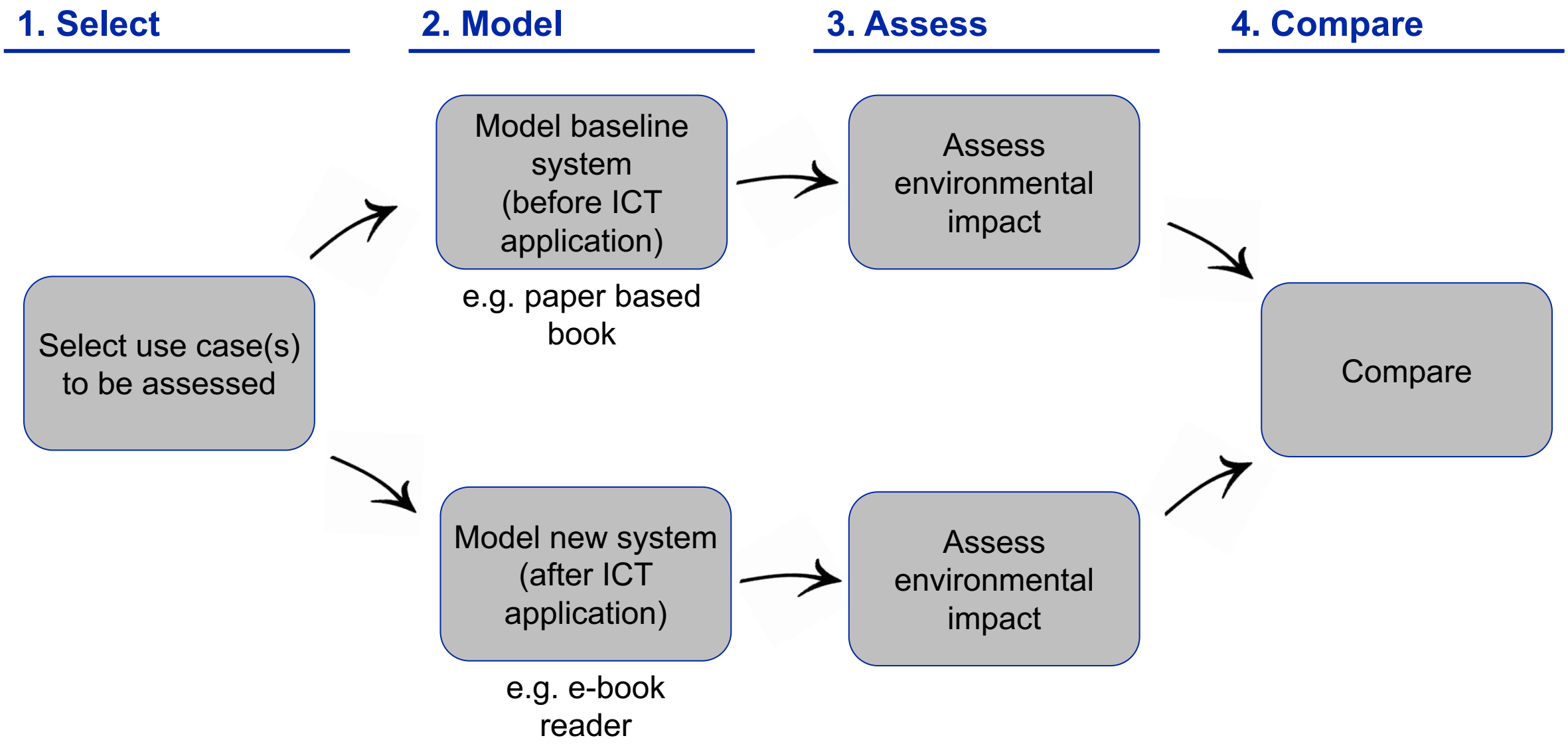
2. **How are environmental effects of ICT applications assessed?**
3. What are methodological challenges in the assessment?

General assessment approach



Based on: [1]

Various assessment methods are applied.

Approach	Advantages	Challenges
LCA		
Rough estimation method		

LCA is used to compare two product systems with each other – before and after ICT application.

Approach	Advantages	Challenges
LCA	– Compare two product systems with each other and assess complexities of use cases – Used to improve design of an ICT solution or derive policy recommendation at product level	– Less focus on changes of consumption patterns – Difficult to consider (dynamic) rebound effects – High effort and data requirements → usually applied to few ICT use cases
Rough estimation method		

Source: [1]

Exemplary LCA study: Paper-based books vs. e-book reader

Paper-based book

Direct effect

- Global warming potential of 1 book read:
  1.3 kg CO_2e
- Production emissions increase with each printed book

Source: [2], [3]

Exemplary LCA study: Paper-based books vs. e-book reader

Paper-based book

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- Global warming potential of 1 book read:
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E-book reader

- Global warming potential of 1 e-book read:
  0.87 kg CO_2e
- The more book reads, the less emissions per read

Source: [2], [3]

Exemplary LCA study: Paper-based books vs. e-book reader

Direct effect

Paper-based book

- Global warming potential of 1 book read: **1.3 kg CO_2e**
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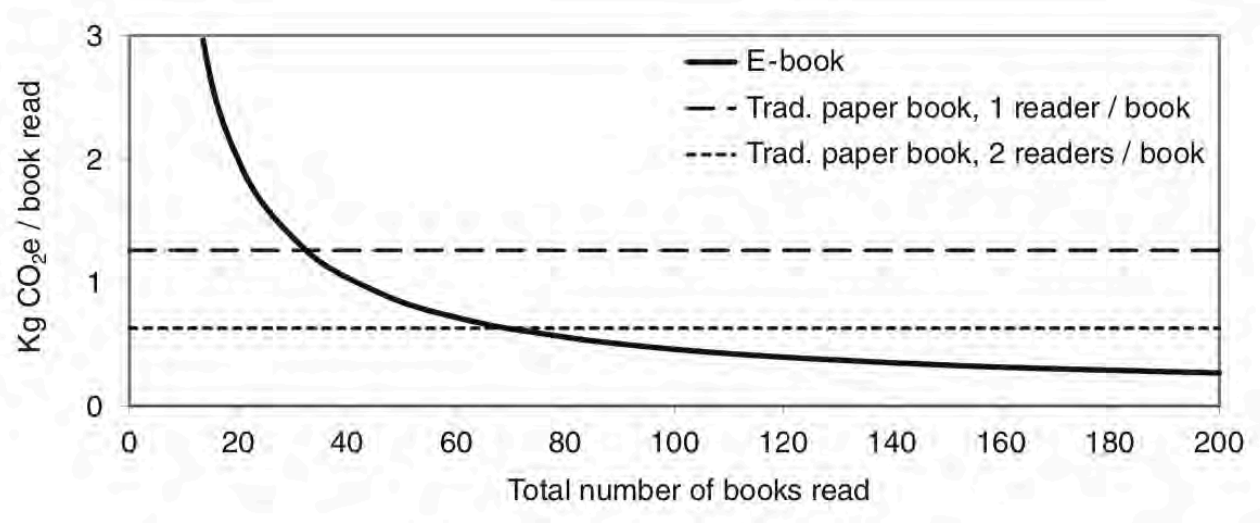
vs.

E-book reader

- Global warming potential of 1 e-book read: **0.87 kg CO_2e**
- The more book reads, the less emissions per read

Indirect effect

- **Substituting** paper-based books with an e-book reader



E-book readers are environmentally sustainable if they avoid production of 30-40 paper-based books.

Source: [2], [3]

Rough estimation methods are applied for comparison of ICT use cases across application domains.

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Rough estimation method	– Rough comparative assessments of ICT use cases across application domains – Low effort and few data per use case required	– Assessments of various use cases often neglect interaction among use cases – Difficult to consider (dynamic) rebound effects – No insights into complexities of ICT use case

Source: [1]

Exemplary estimation study: GeSI SMARTer 2030

Study goal

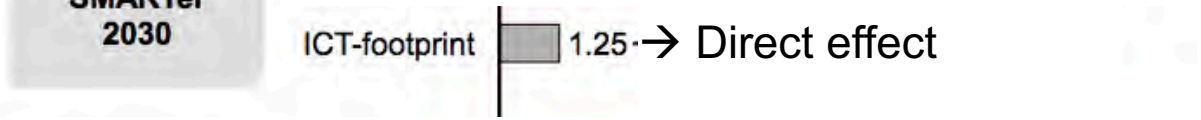
1. Assessment of GHG footprint of global ICT sector
2. Assessment of global GHG abatement potential of 12 ICT use cases (e.g. intelligent heating, route optimization,…)

Source: [4]

Exemplary estimation study: GeSI SMARTer 2030

Global ICT-enabled GHG abatement potential vs. GHG footprint of the ICT-sector

In Gt CO_2e/year



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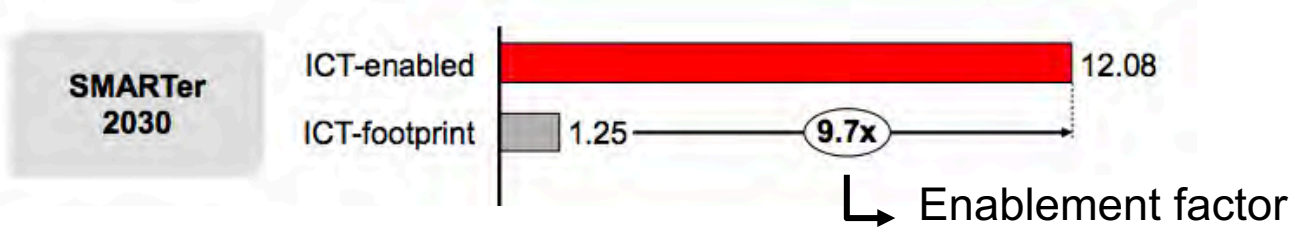

Source: [4]

Exemplary industry estimation studies:
Enablement factors of telecommunication service providers

Company	Status-quo	Target	Company	Status-quo	Target
swisscom	1.2x ‘17	2x ‘25	中国移动 China Mobile	6.5x ‘08	10x ‘20
T	1.7x ‘17	n/a	NTT	9.5x ’18	10x ‘31
BT	2.2x ’17/’18	3x ’17/’18	verizon	1.5x ’16/’17	2x ‘22
vodafone	2.1x ‘18	n/a	AT&T	n/a	10x ‘25

Source: Sustainability reports and websites

Exemplary estimation study:
Switzerland 2025

Global ICT-enabled GHG abatement potential vs. GHG footprint of the ICT-sector

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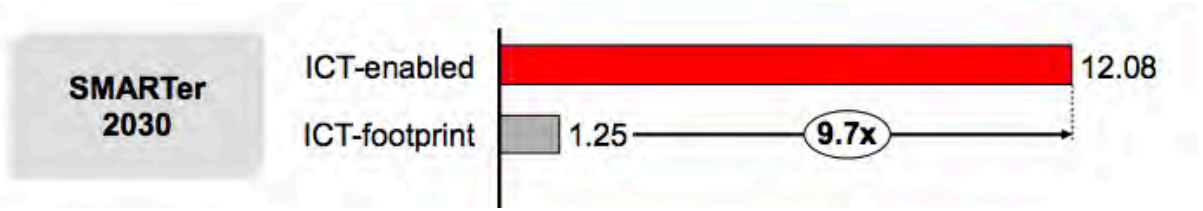

Question

- Are the assumptions valid and do they apply to Switzerland?

Source: [4]

Exemplary estimation study:
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Global ICT-enabled GHG abatement potential vs. GHG footprint of the ICT-sector

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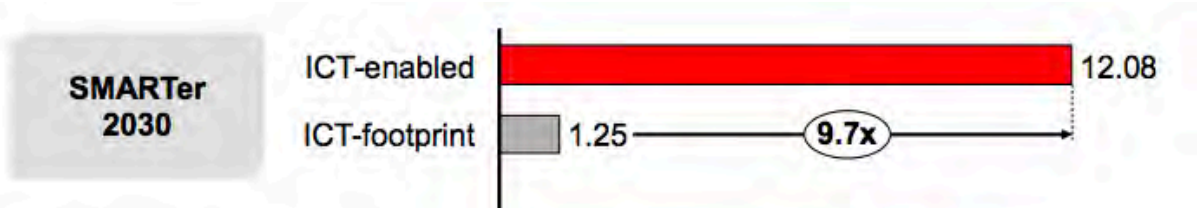


Question

- Are the assumptions valid and do they apply to Switzerland?

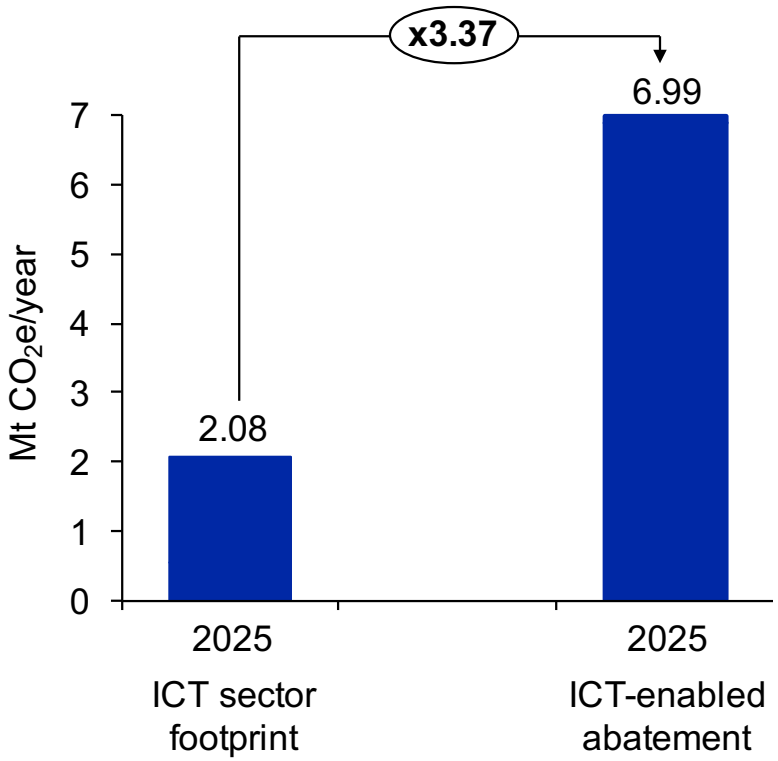
Approach

- We used the same calculation as the SMARTer 2030 study
- We re-assessed their assumptions about actual impacts of ICT, adoption rates of ICT solutions and rebound effects
- We adapted the used figures to Switzerland in 2025

In Switzerland in 2025, ICT can avoid up to 3.37 more GHG emissions than its own footprint.

ICT-enabled GHG abatement potential vs. GHG footprint of the ICT-sector in Switzerland (optimistic scenario)

In Mt CO_2e/year

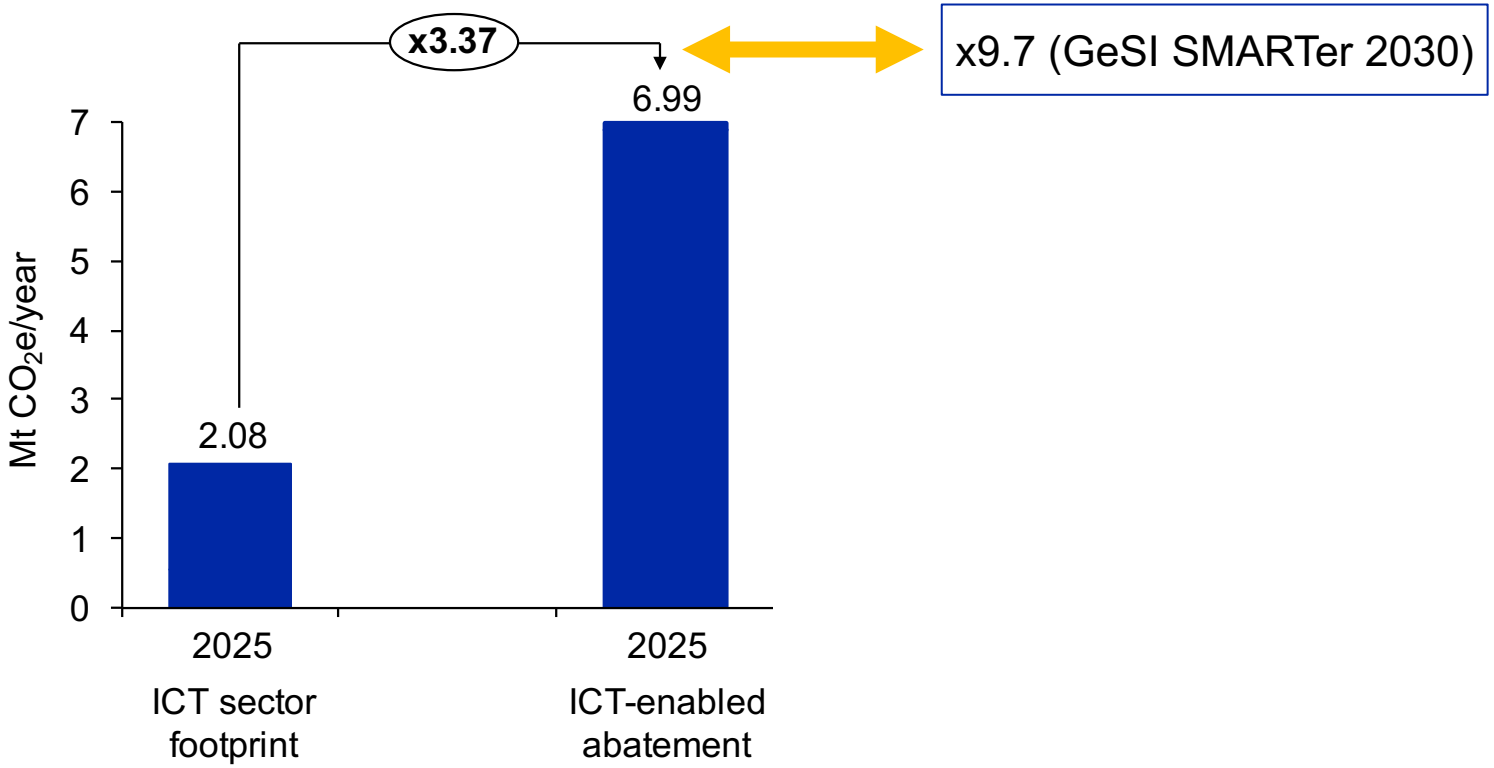


Source: [6]

This factor is almost 3 times lower than the factor estimated in the SMARTer 2030 study.

ICT-enabled GHG abatement potential vs. GHG footprint of the ICT-sector in Switzerland (optimistic scenario)

In Mt CO_2e/year



University of Zurich[UZH]

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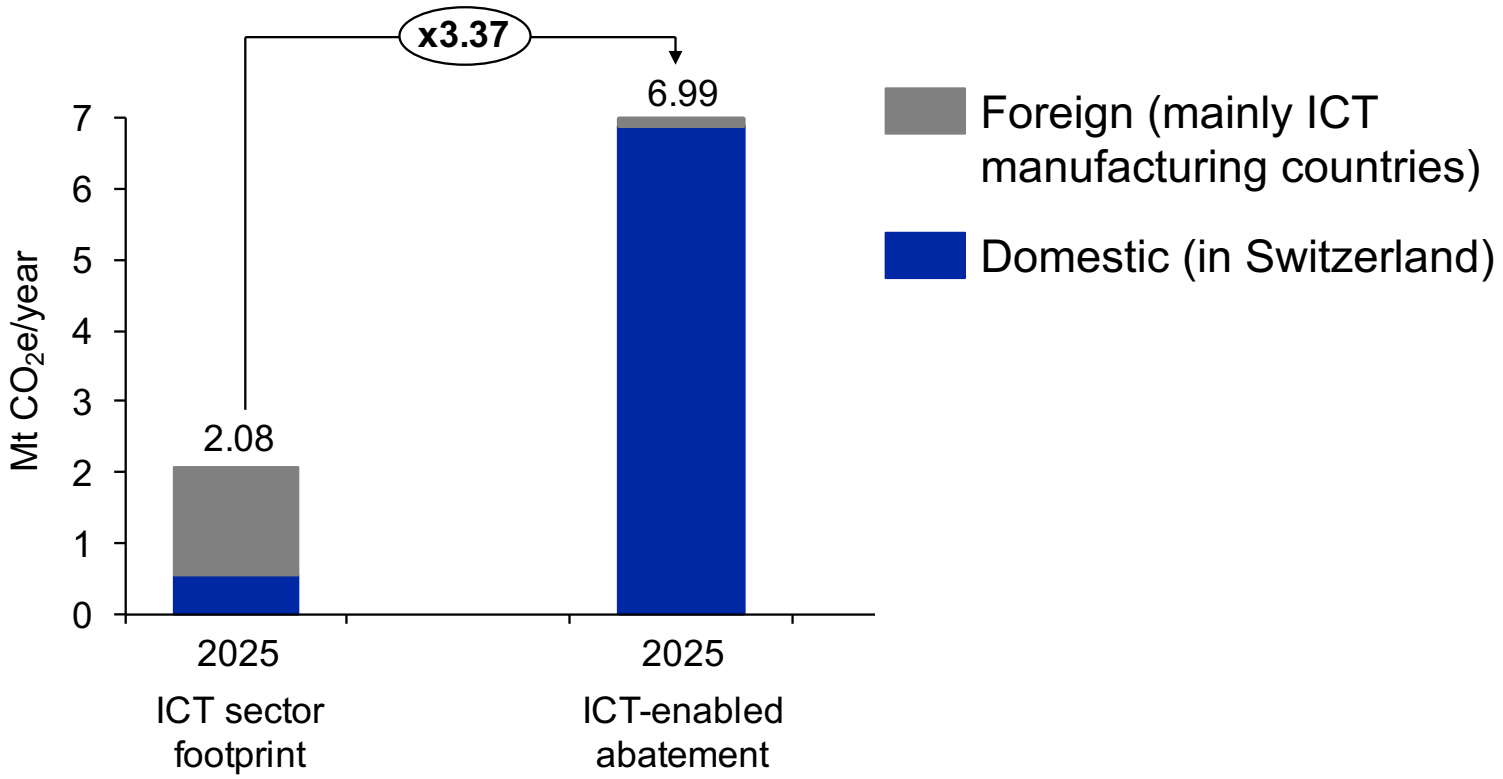
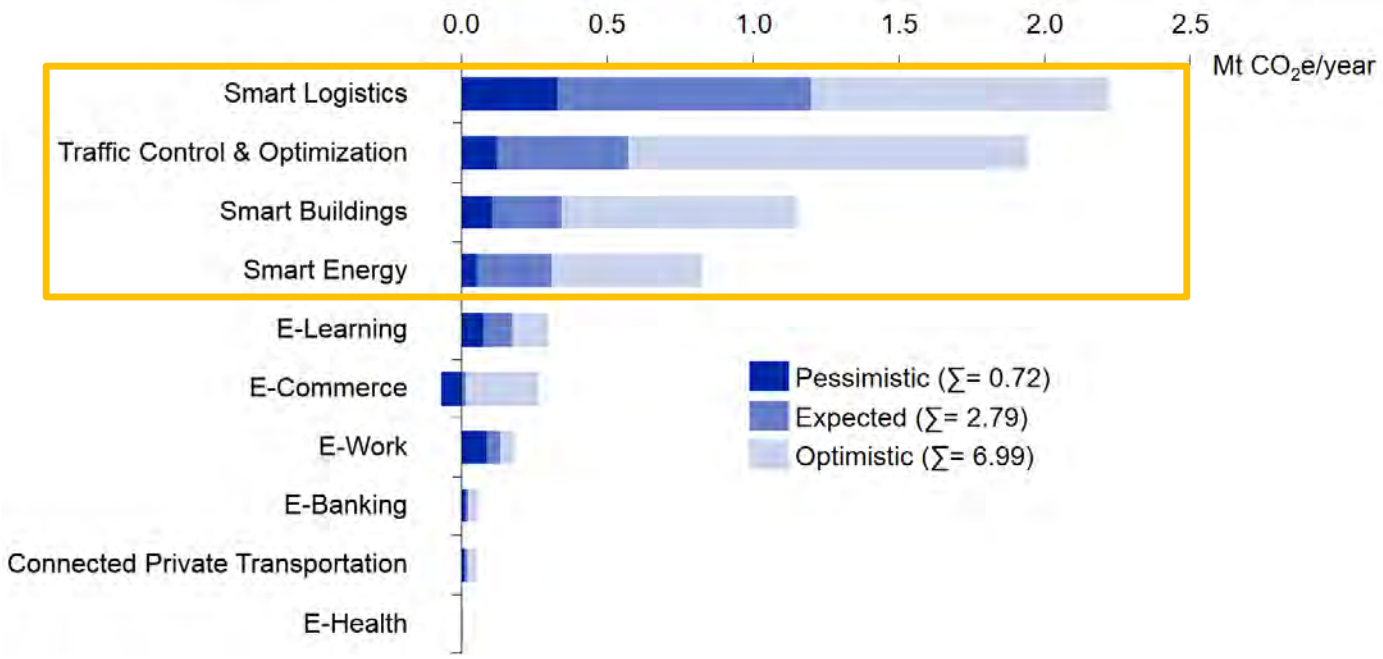


Source: [6]

Largest ICT-enabled potentials to avoid GHG emissions in Switzerland are in the transport, building and energy sector.

ICT-enabled GHG abatement potential in Switzerland in 2025 by use case

In Mt CO_2e/year



Most effective ICT applications to reduce GHG emissions in Switzerland

1. Less tonne and person kilometers (e.g. through virtual mobility)
2. More efficient use, heating and cooling of buildings (e.g. intelligent heating)
3. Flexibilization of electricity demand to increase share of renewable energies in electricity grid (e.g. demand side management)

Source: [6]

Rough estimation methods are applied for comparison of ICT use cases across application domains.

Approach	Advantages	Challenges
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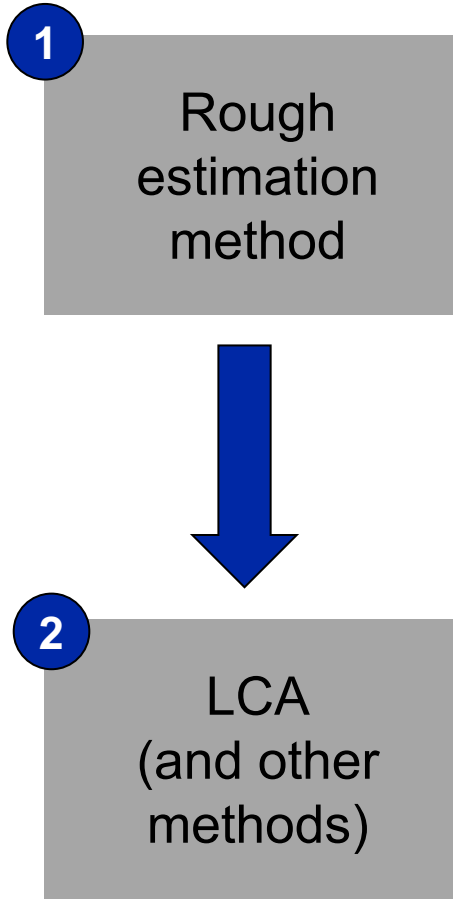
Rough estimation methods should be used to identify opportunities and risks – LCA to improve specific ICT solutions.



Use for identifying opportunities and risks of digitalization and prioritize fields of action.

Use to design/improve products and policies which harness opportunities and mitigate risk in high-priority fields.

Source: [1]

Agenda

1. What are ICT applications?
2. How are environmental effects of ICT applications assessed?
3. **What are methodological challenges in the assessment?**

Assessments of such kind face various methodological challenges.

1 Selection of use cases	Assessments focus on a (limited) selection of ICT use cases	→	How do we make sure our selection is unbiased?
2 Consumption perspective	ICT use changes consumption patterns	→	How do we account for changes in consumer behavior?
3 Systemic impacts	ICT use cases are embedded in complex socio-economic systems	→	How do we account for dynamic system interactions?
4 Rebound effects	ICT-enabled efficiency improvements can trigger additional consumption	→	Which rebound effects exist and how large are they in my specific study setting?

These (and more) challenges need to be considered in the assessment of indirect effects.

Source: [5]

Conclusions.

1. Indirect environmental effects of ICT are environmental effects of ICT application.
2. Assessments use different methods and face various methodological challenges.
3. Choice of method and consideration of methodological challenges influences results and their comparability.
4. Use rough estimations to prioritize fields of action. Use LCA (in combination with other methods) to show how we can realize the potentials on a product level.

Thank you for your kind attention!

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References

[1] Bieser, J., & Hilty, L. (2018a). Assessing Indirect Environmental Effects of Information and Communication Technology (ICT): A Systematic Literature Review. *Sustainability*, *10*(8), 2662. https://doi.org/10.3390/su10082662

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[3] Coroama, V. C., Moberg, Å., & Hilty, L. M. (2015). Dematerialization Through Electronic Media? In *Advances in Intelligent Systems and Computing 310*. *ICT Innovations for Sustainability* (S. 405–421). Switzerland: Springer International Publishing.

[4] GeSI. (2015). *#SMARTer2030. ICT Solutions for 21st Century Challenges*. Brussels, Belgium.

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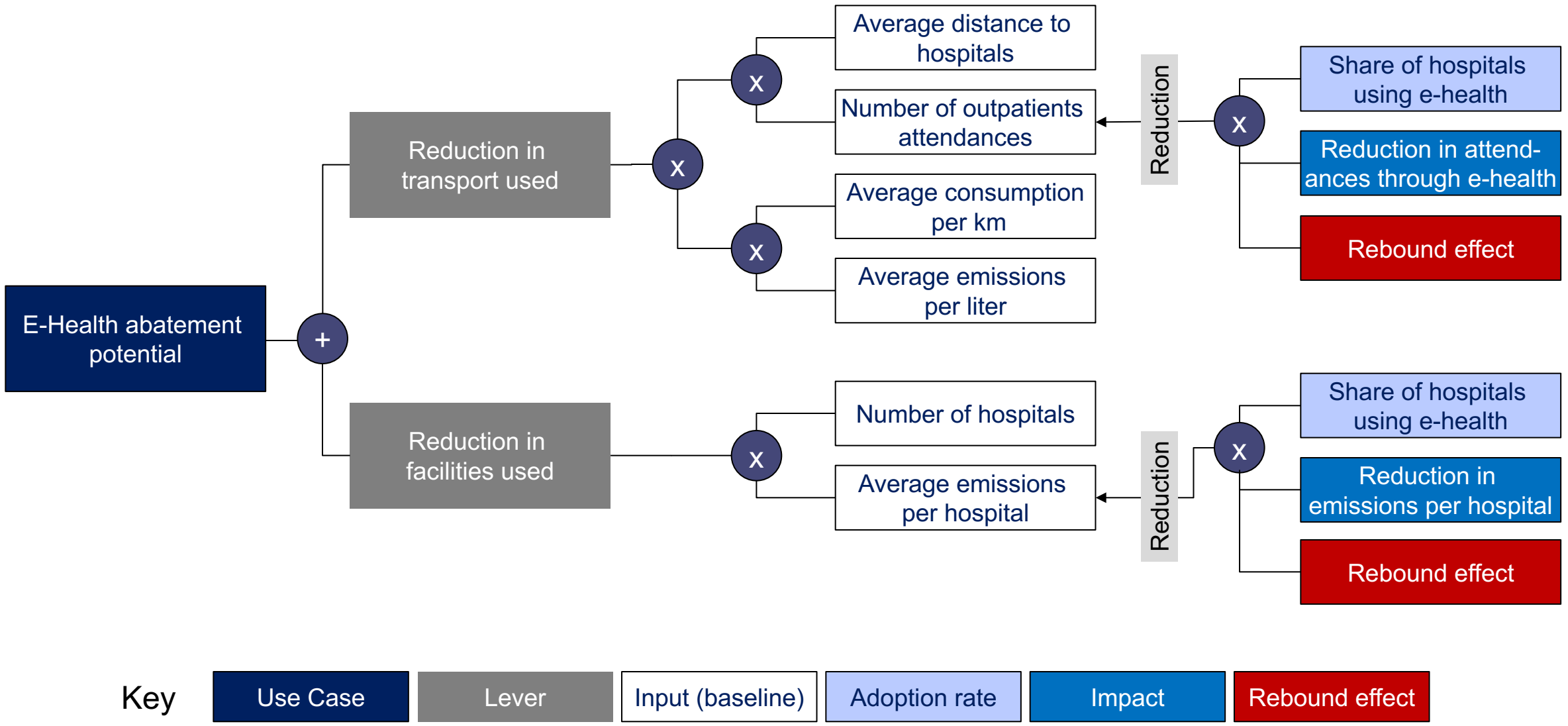
[6] Hilty, L., & Bieser, J. (2017). *Opportunities and Risks of Digitalization for Climate Protection in Switzerland*. Abgerufen von University of Zurich, website: http://www.zora.uzh.ch/id/eprint/141128/1/ Study_Digitalization_Climate_Protection _Oct2017.pdf

[7] Hilty, L., Arnfalk, P., Erdmann, L., Goodman, J., Lehmann, M., & Wäger, P. (2006). The relevance of information and communication technologies for environmental sustainability – A prospective simulation study. *Environmental Modelling & Software*, *21*(11), 1618–1629. https://doi.org/10.1016/j.envsoft.2006.05.007

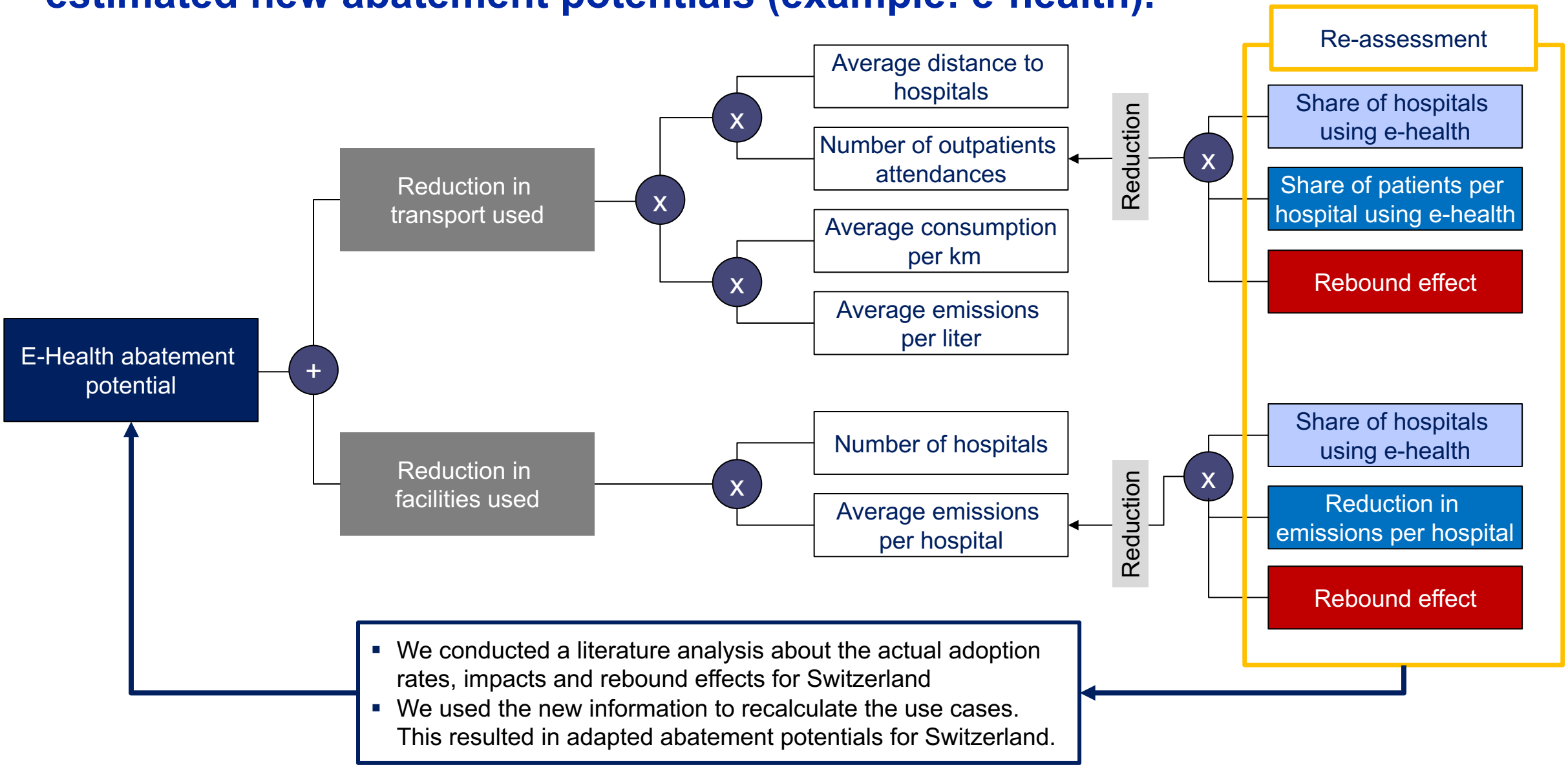
Backup

GeSI calculation of abatement potential, example use case: e-health



Source: [5]

We challenged the adoption rate, impacts and rebound effects and thereby estimated new abatement potentials (example: e-health).



- We conducted a literature analysis about the actual adoption rates, impacts and rebound effects for Switzerland
- We used the new information to recalculate the use cases. This resulted in adapted abatement potentials for Switzerland.

Source: [5]