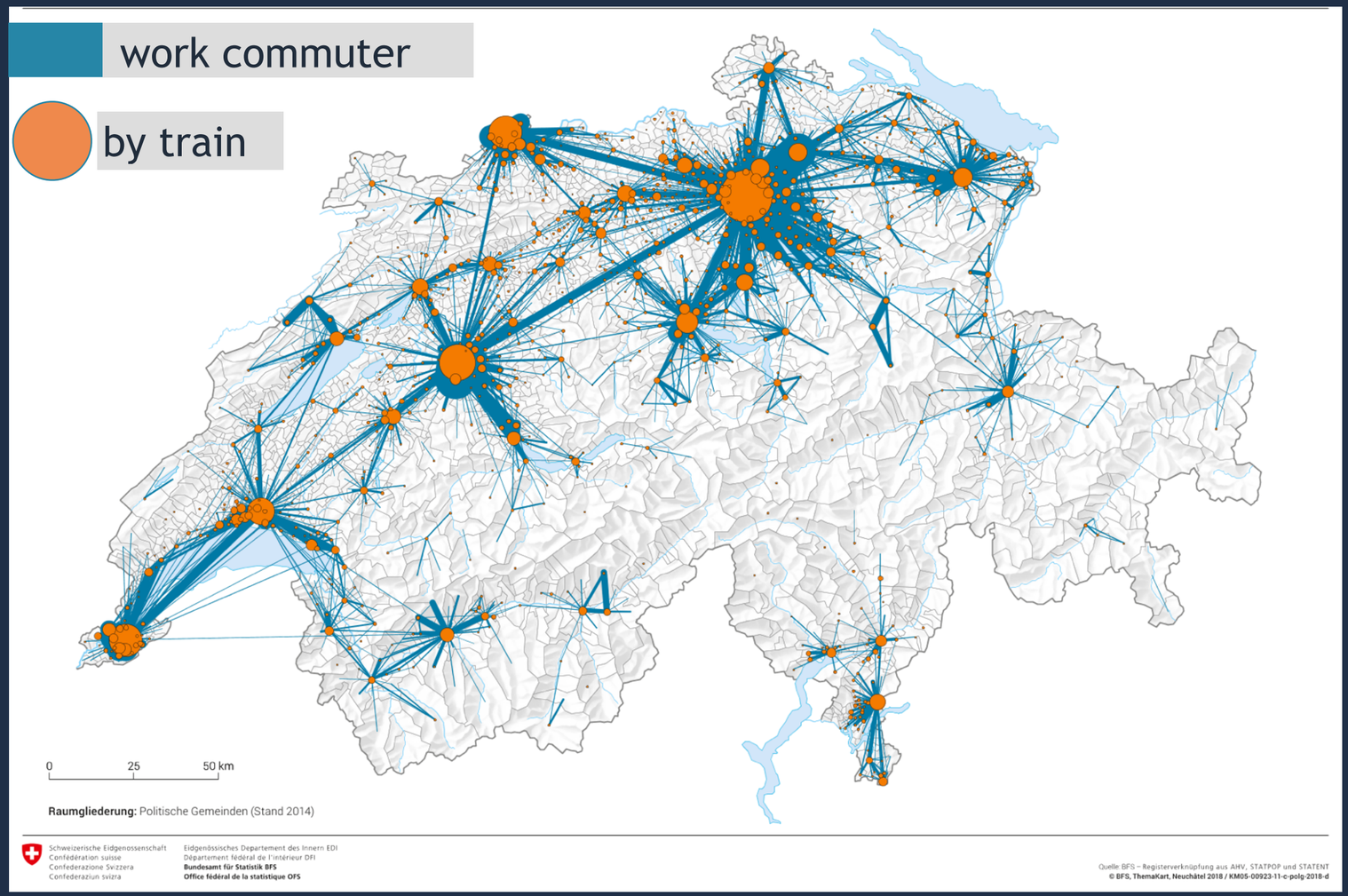
How can digital systems help saving energy and carbon?

Digitalization and the Rebound Effect - Seminar HS2019

Fabian Müller

Daily Work Commuter



4.0 million people travel to work (avg. 15.0 km)

52% travel by car

utilization:
1.14 pers./car

Federal Statistical Office, 2014

Commuter: Improvement Ideas

less emissions

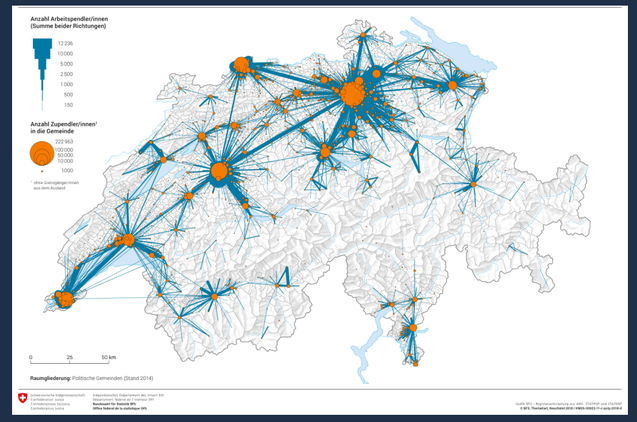
less travel

Where?

car sharing

How?

home office



modern
company policy

Where to
allocate?

digital system

How to
measure?

direct
consequences

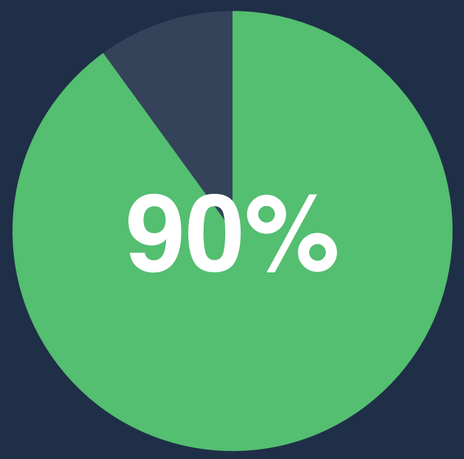
wider relations

Digitalization

—> growing application of IT across the economy

Facts: Sensors & Data

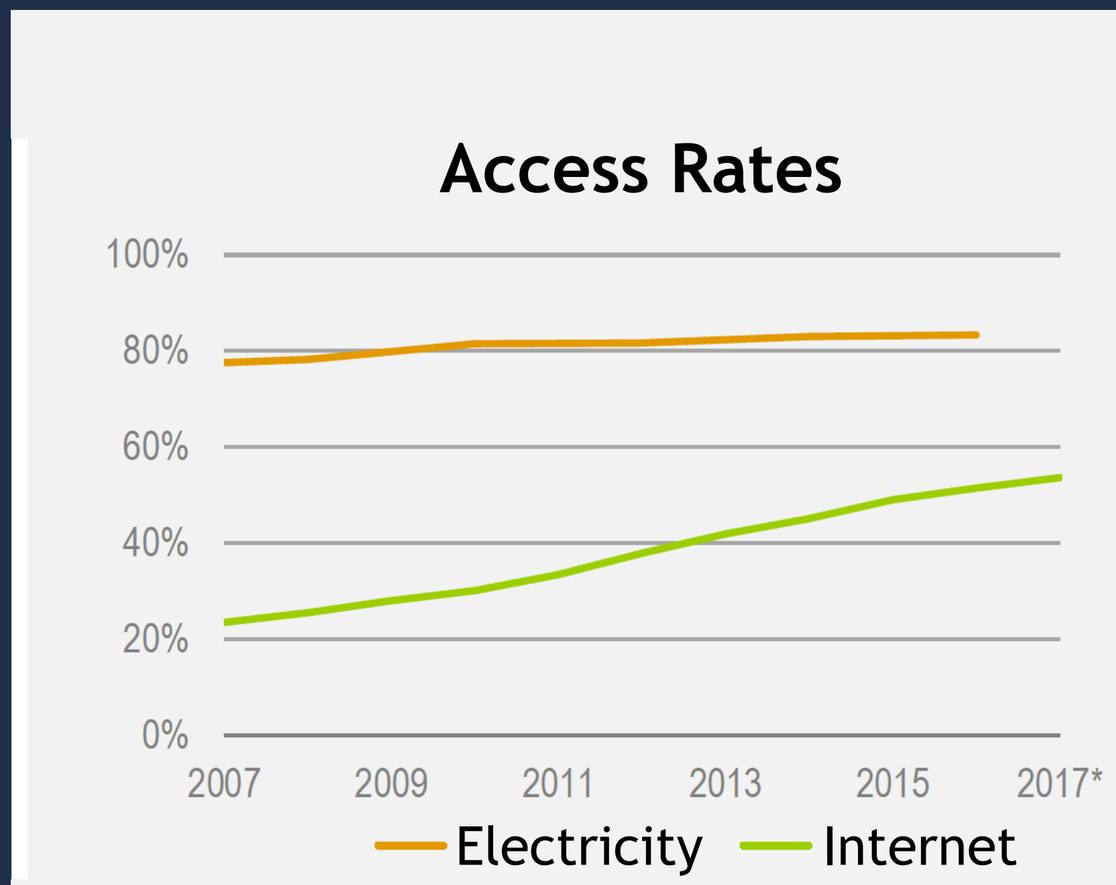
8.4 billion IoT devices in 2017

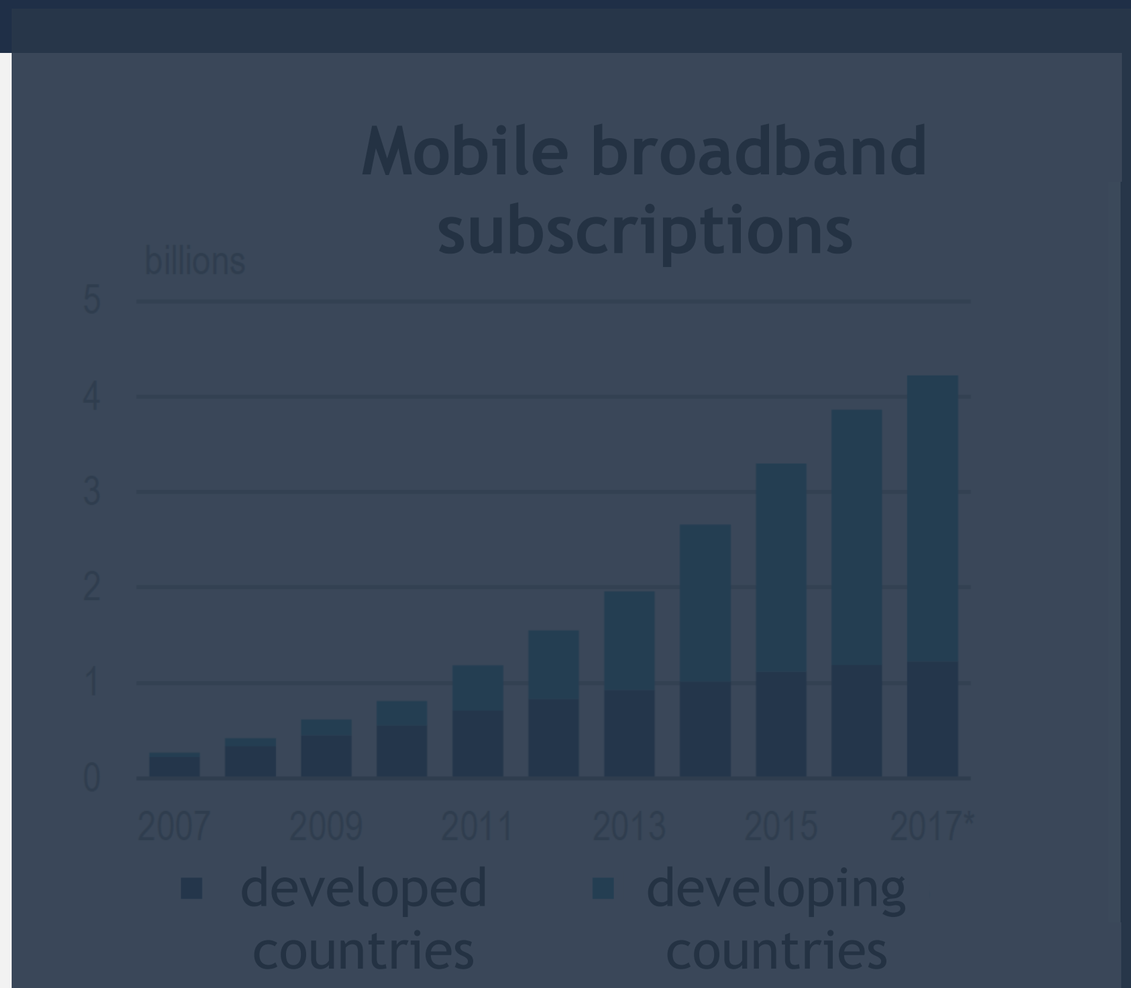


worldwide data younger than 2 years

Source: IEA, Digitalization & Energy, 2017

Facts: Global Connectivity

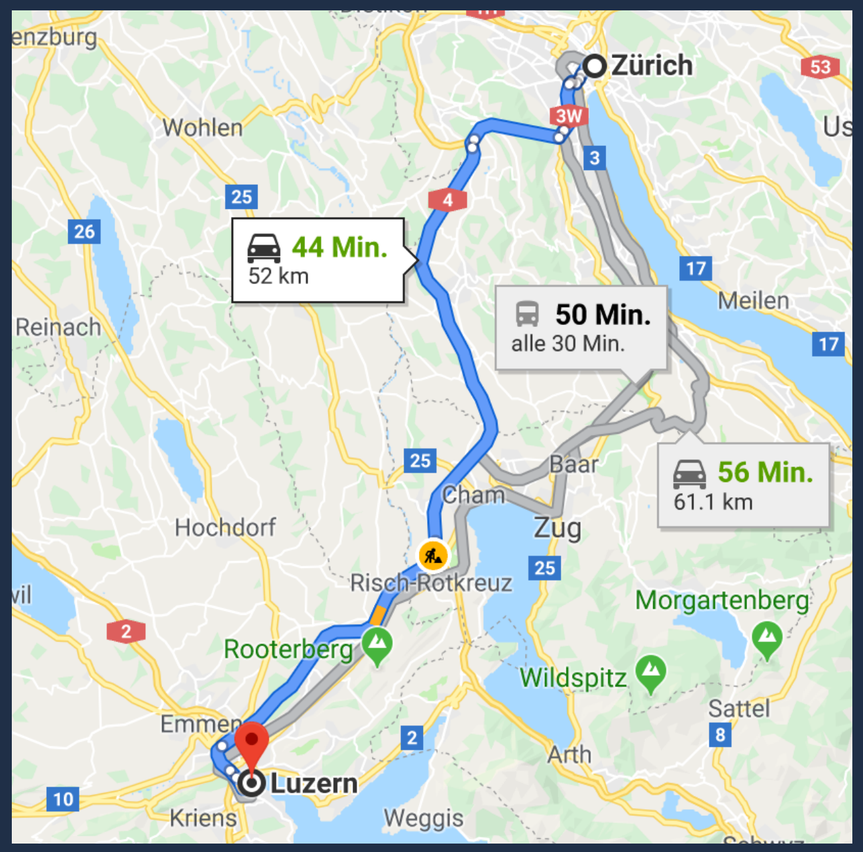




Source: IEA, Digitalization & Energy, 2017

Promising solutions: Transport

Navigation



Source: maps.google.com

Autonomous cars

Shared mobility

Promising solutions: Buildings

Smart heating

Energy storage

Online shopping

—> less physical stores needed

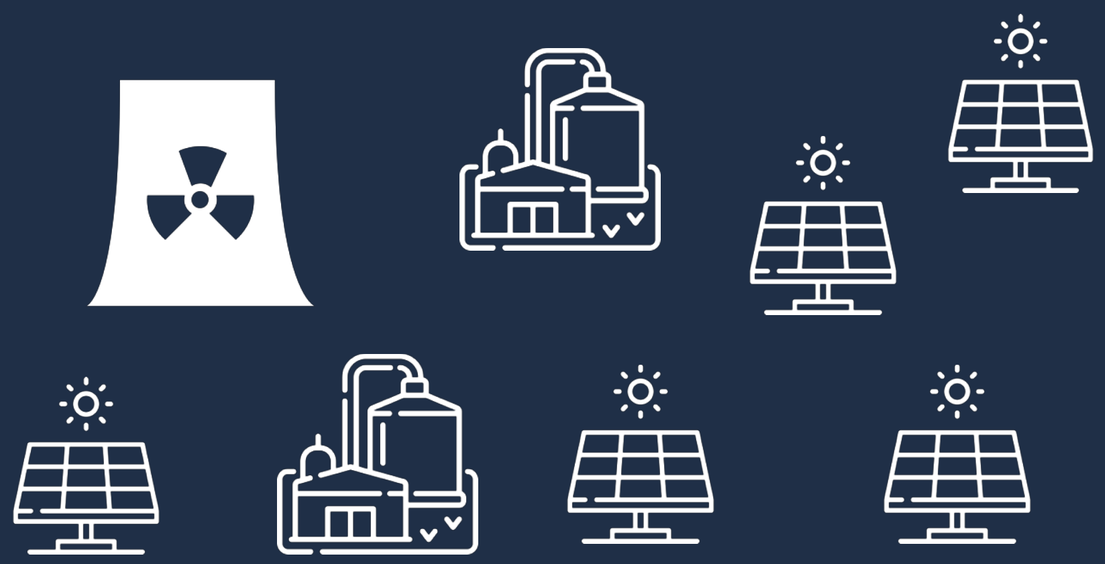
Promising solutions: Industry

Smart logistics

Sharing economy

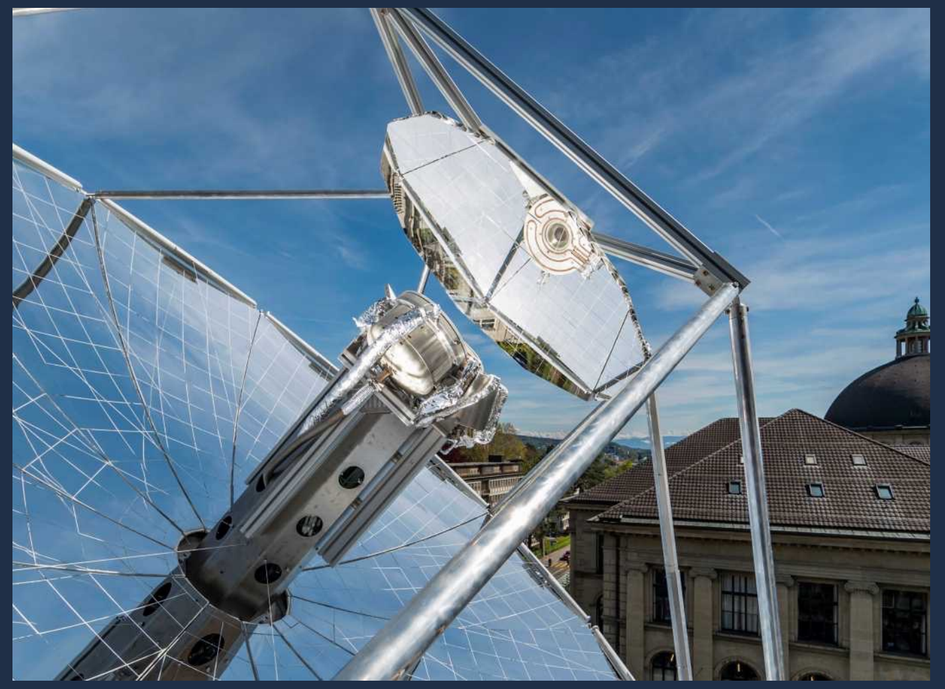
Promising solutions: Energy Production

Smart grid



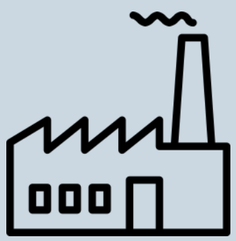
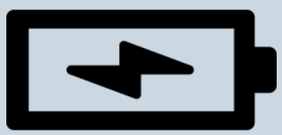
- distributed generation
- bidirectional flow

Carbon-neutral fuel



Source: prec.ethz.ch

Savings through ICT: mechanisms vs. sectors

iea International Energy Agency	Substitution / Dematerialization	Increased Efficiency	Awareness and decision support
	Virtual conference	Autonomous car Shared mobility	Real-time navi
	Online shopping	Smart heating Energy storage	normative feedback
	Electronic media	Smart logistics	Sharing economy
	Carbon-neutral fuel	Power grid	Gas leakage discovery

Where to invest?

Initiatives

We need to define:

- Measurement
- Quantization
- Reporting
- Verification

We need to develop:

- Tools
- Methods

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Mission Innovation

- global initiative: focus on clean energy
- launched in 2015 with 25 countries
- together: 75% of world’s CO2 emissions from electricity
- over 80% of the world's clean energy R&D investment

Source: obamawhitehouse.archives.gov,"Announcing Mission Innovation"

Mission Innovation: Solution Framework

Who:

- Research Institutes of Sweden (RISE)
- Swedish Energy Agency
- WWF
- EIT Climate-KIC (EIT: European Institute of Innovation and Technologies, KIC: Knowledge and Innovation Community)

Goal:

- accelerate the innovation of low-carbon solutions

—> introduce framework and method for **measuring** ***avoided emissions***

Problem Statement

Investors

Governments

Companies

Stakeholders

…

Tools
Methods

demonstrate

positive impact

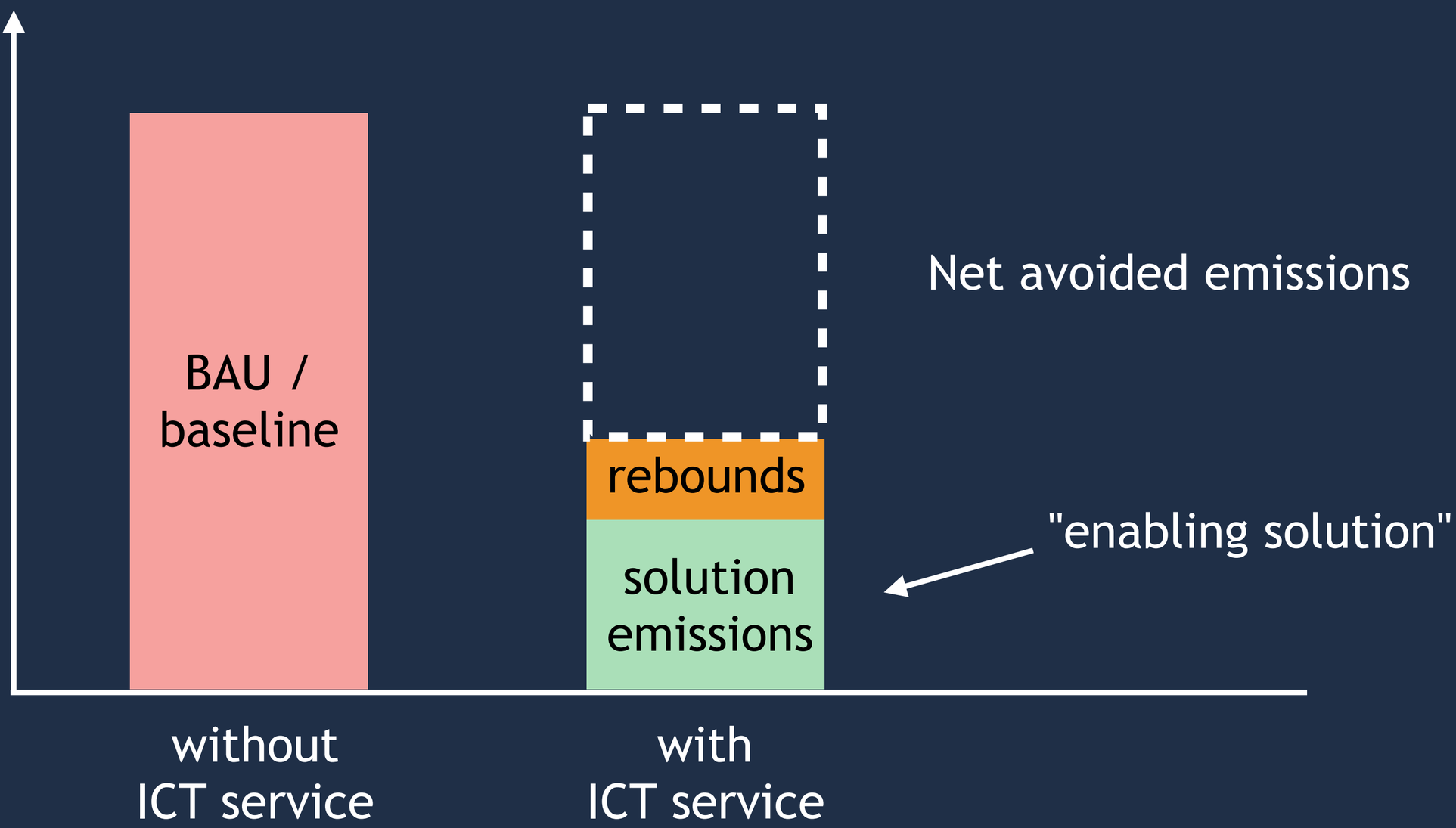
Solution
Providers

Companies

Research Groups

…

"Avoided Emissions"

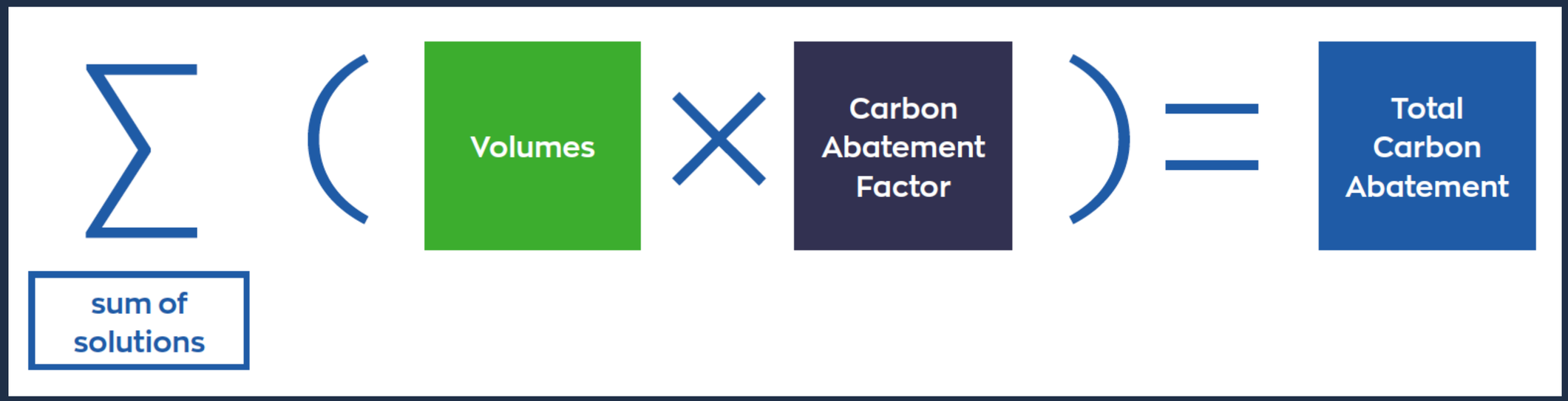


Calculation Method

- carbon abatement factor (net avoided emissions per unit of solution)
- volume (total number of units)

Example: video conference

- avoided emissions per video conference (kgCO2e)
- number of video conferences instead of flights

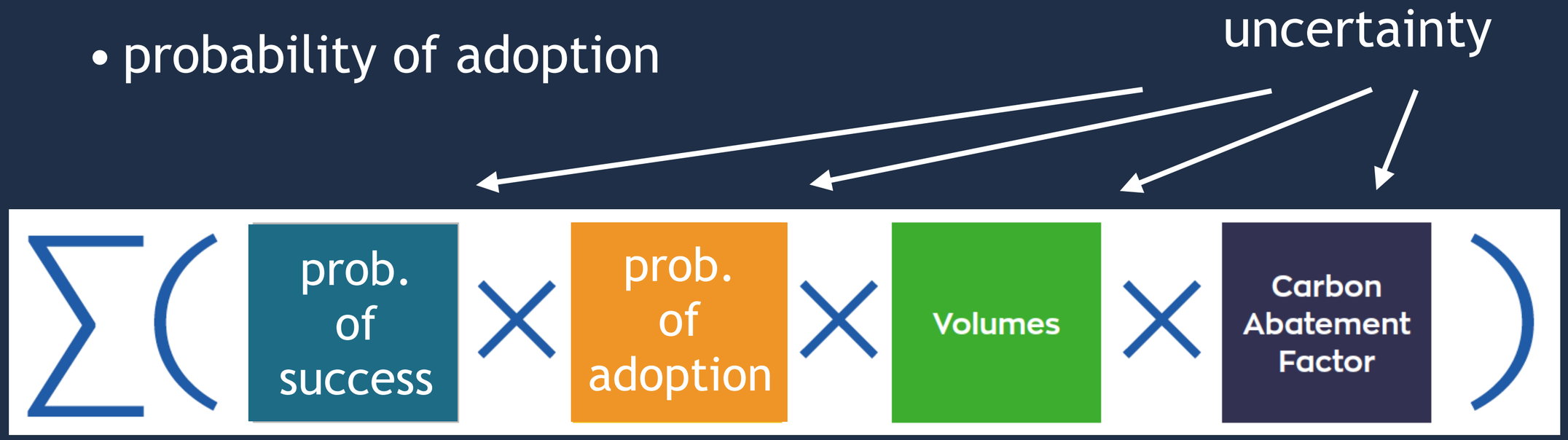


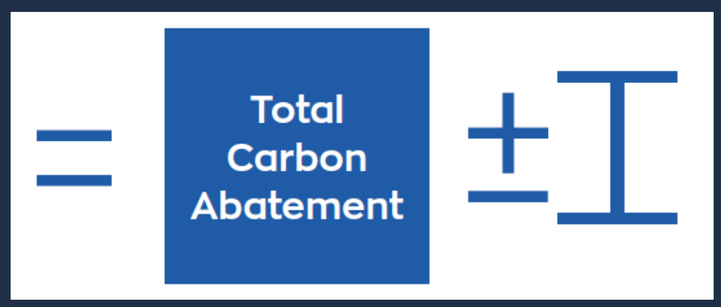
Source: Mission Innovation, Solution Framework, v2018-1

Calculation Method: potential scenarios (future)

- probability of success
- probability of adoption

uncertainty





Source: Mission Innovation, Solution Framework, v2018-1

Calculation Method: Simple Example

Smartphone App: "Save Energy by using your smartphone less"

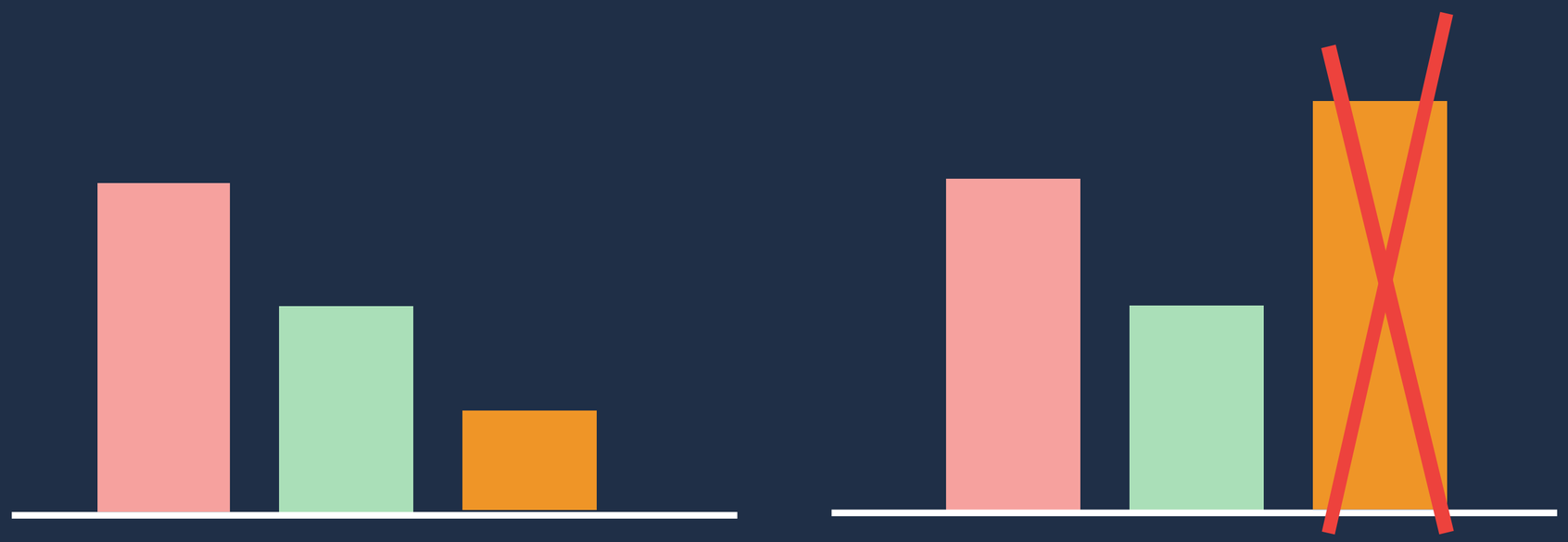
- prob. of success: 90%
- prob. of adoption: 1%
- Volumes: 5’000’000 (smartphone users in CH)
- carbon abatement factor: 10 kgCO2e per year

Avoided emissions = 0.9 * 0.01 * 5’000’000 * 10

= 450’000 kgCO2e per year

Challenges: Identification

Principle of materiality:



Expected avoided emissions

Calculation effort

Idea:

- start at high level scope
- identify largest contributors
- get into more details

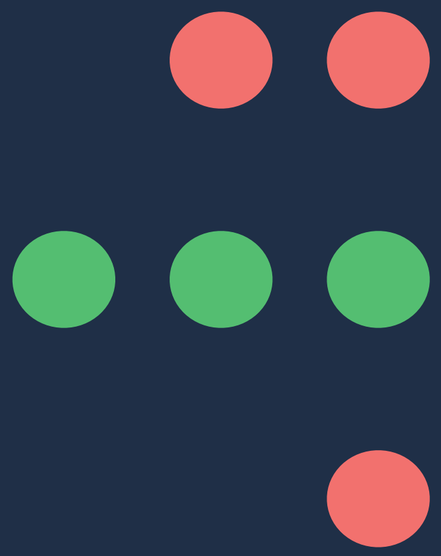
Challenges:
System Boundary

- Assessment: What is included, what is excluded?

LCA

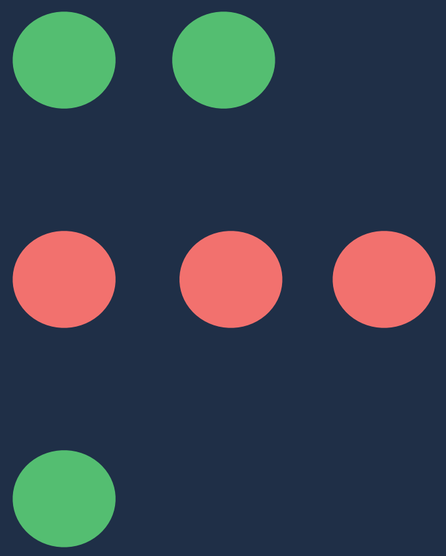
Transport

Suppliers



Production & Material
Electric car emissions
Recycling

Production & Material
Petrol car emissions
Recycling



Challenges:
Data quality

Sources

Industry

- up-to-date
- might be biased

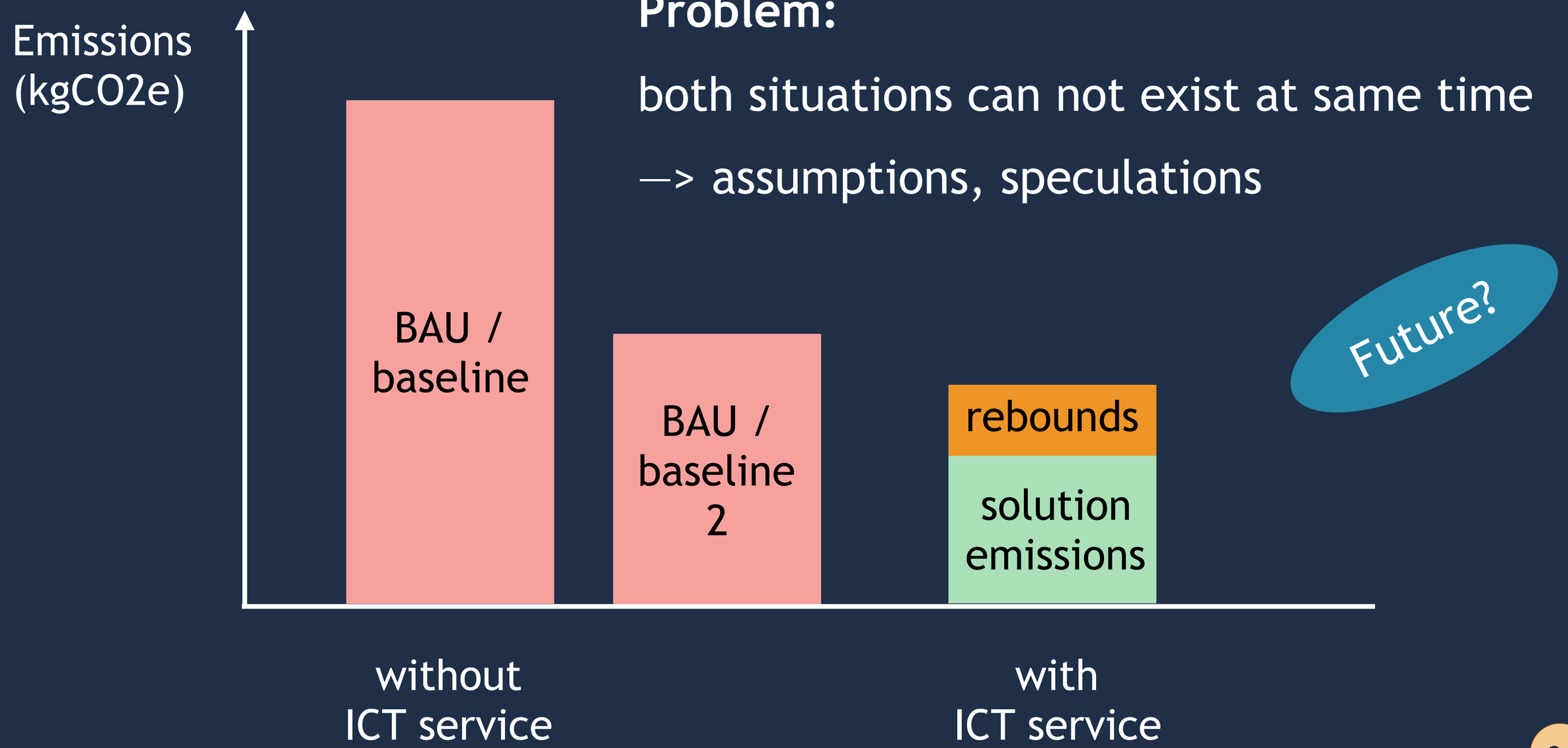
Research Studies

- often theoretically

Uncertainties

- Errors in data
- Assumptions in data generating process
- Lack of data

Challenges:
Baseline



Problem:

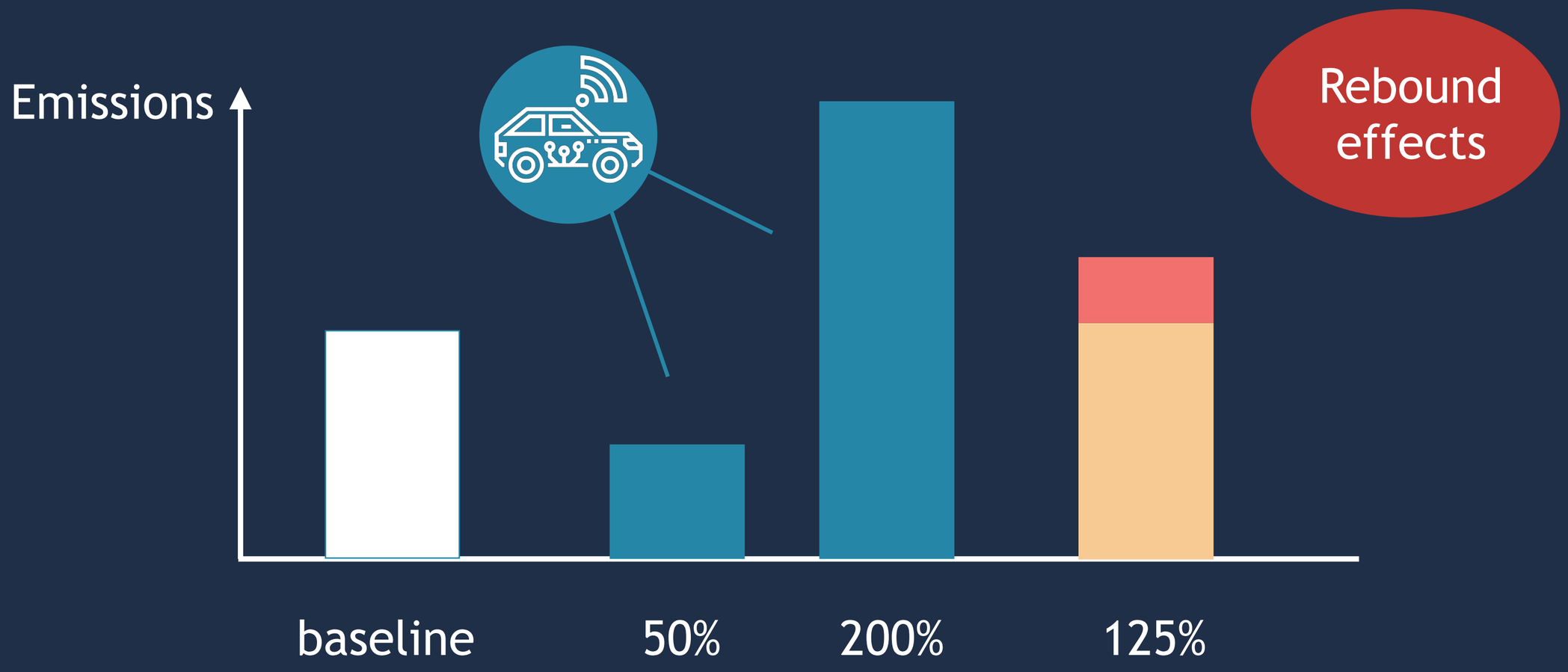
both situations can not exist at same time

—> assumptions, speculations

Challenges:
Solution potential estimation

Often hard: vague assumptions, speculations

Example: IEA report "Digitalization & Energy", 2017



Challenges:
Allocation & Double Counting

Where to allocate?

#SMARTer2030

- GeSI: Global e-Sustainability Initiative
- strategic partnership of ICT companies and industry associations
  —> AT&T, Dell, Huawai, Samsung, Swisscom
- Goal:"… **create and promote technologies** and practices that foster […] sustainability and drive economic growth and productivity."

Source: GeSI, Smart2020, 2008

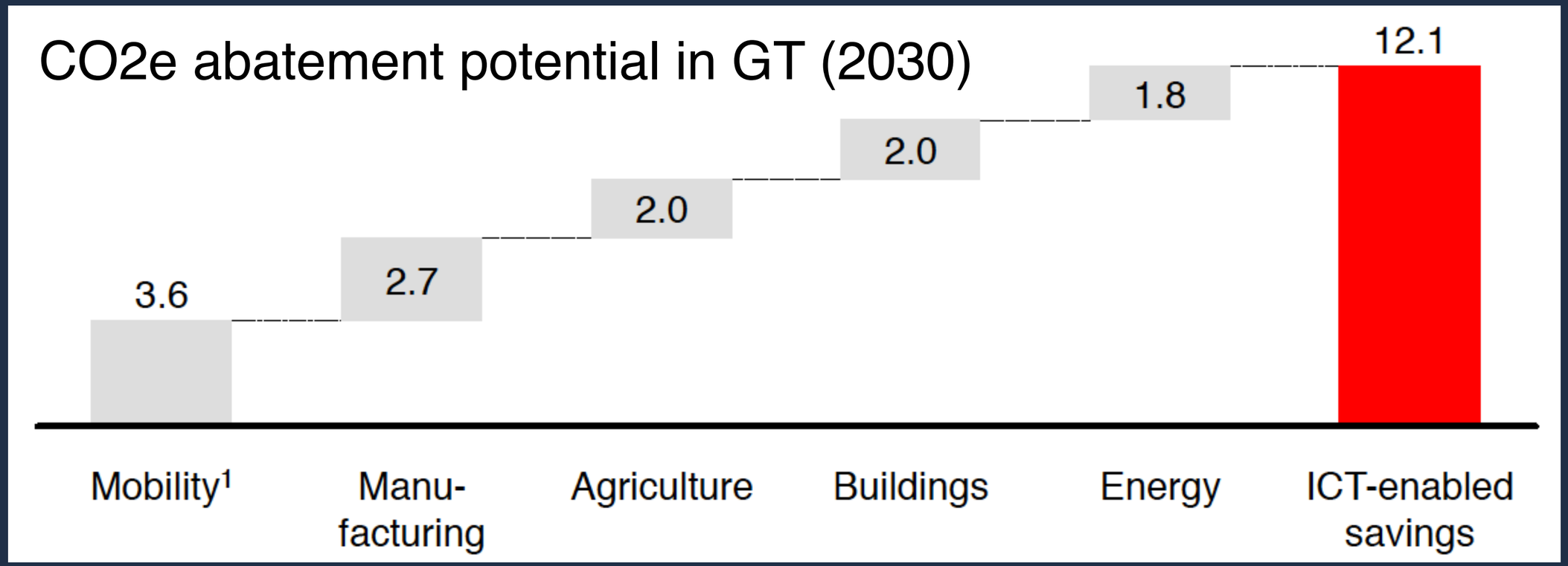
#SMARTer2030

Method: 3 main variables

input data	*adoption rates*	*sustainability impact*
(e.g. population in 2030)	(e.g. # smart households)	(energy savings)

Source: GeSI, #SMARTer2030, 2015

#SMARTer2030



—> 20% reduction of global CO2e emissions by 2030

Source: GeSI, #SMARTer2030, 2015

#SMARTer2030

Appendix: Rebound effect

Potential Rebound effect for:

Smart Logistics: 20%
E-Health, E-Banking, E-Learning, Connected Private Transport: 7%
Smart Building and Traffic Control: 10%
….

Calculations **without rebound effects** because:

- "The science behind rebound is generally tricky and a matter of debate."
- "Neither SMART2020 nor SMARTer2020 calculated expected rebound effect."

Source: GeSI, #SMARTer2030, 2015

Summary

- There are **enough ideas**
- There are some tools, but **no common standards** to quantify and report solutions
- Innovations in development: Focus must be **equally** on possible **positive and negative** outcomes

Thank you!