Digitalisation and Energy Savings

Digitalisation and the Rebound Effect – Seminar HS2020

ETH Zürich

Estimations show that digitalisation could save energy in different sectors

Overview of High-level Industry Examples

Transportation

Self-driving, connected vehicles

Avoided emission: 2.6Gt CO_2

40 Gt CO_2/ year

Energy

Smart energy

Energy savings: 6300 TWh

140 000 TWh /year

Industry examples show that digitalisation could save energy and carbon in different sectors

Sources: Global e-Sustainability Initiative. #SMARTer 2030 report, 2015. | Our World in Data, CO2 and Greenhouse Gas Emissions, report, 2020
Our World in Data, Energy, report, 2018.

Agenda

1. **Definition of digitalisation**
2. **Digital solutions in various sectors**
   - **Buildings**
   - **Industry**
   - **Transportation**
   - **Energy**
3. **Assessment challenges**
4. **Conclusion**

Definition of digitalisation

There are various definitions of digitalisation

Definitions of Digitalisation

Digitalisation

Public

*"The process of using **ICT** to solve real life problems"*
- Student at ETH

*"Digitalisation is the **'organisational process'** or 'business process' of the **technologically-induces change** within industries, organisations, markets and branches."*
- Wikipedia

The International Encyclopedia of Communication Theory and Philosophy

Digitisation
"…as the material process of converting analog streams of information into digital bits…"

Digitalisation
"…as the way many domains of social life are restructured around digital communication and media infrastructures…"

How would you define digitalisation?

Sources: J. Scott Brennen, Daniel Kreiss. 2016. Digitalization. In The International Encyclopedia of Communication Theory and Philosophy, K.B. Jensen, E.W. Rothenbuhler, J.D. Pooley, and R.T. Craig (Eds.). 1–11. https://doi.org/10.1002/9781118766804. wbiect111

Digital solutions in various sectors

Estimated energy savings due to digitalisation in the buildings sector 10%

Digital Solutions Buildings

Today

Environmental impact

- **33%** of global energy consumption
- **55%** of global electricity demand

Going forward

Digitalisation

- Smart thermostat
- Smart lighting

Estimated energy savings

10%

Sources: International Energy Agency. Digitalisation & Energy, report, 2017

Energy usage in the transportation sector could halve or more than double due to digitalisation

Digital Solutions Transportation

Today

Environmental impact

- **28%** of global energy consumption
- **23%** of global CO_2 emission

Going forward

Digitalisation

- Sensors on planes and ships
- Revolutionary change?

Estimated energy savings

Best-case scenario: energy savings up to **50%**

Worst-case scenario: energy consumption increases with **100%**

Sources: International Energy Agency. Digitalisation & Energy, report, 2017

Energy savings in industry sector due to digitalisation primarily from 3D printing and robots

Digital Solutions Industry

Today

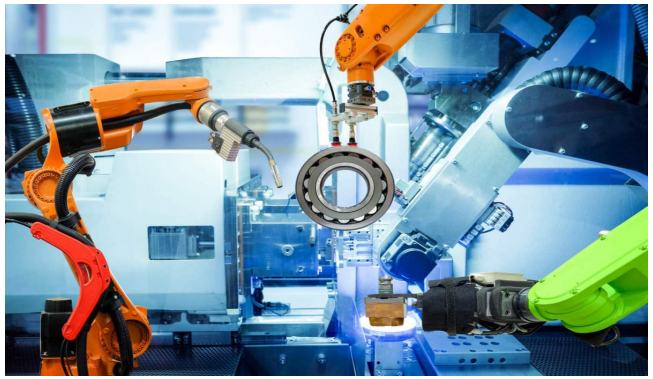
Environmental impact

- **38%** of global energy consumption
- **24%** of global CO_2 emission

Going forward

Digitalisation

- 3D printing
- Industrial robots



Estimated environmental impact

Example: US aircraft fleet

Avoid
20 kt metal use/ year

Reduced fuel use
6.4%

Sources: International Energy Agency. Digitalisation & Energy, report, 2017

Energy savings in energy sector due to digitalisation primarily from integrating renewables

Digital Solutions Industry

Today

Energy Landscape

- Petroleum products 36%
- Natural gas 21%
- Solid fossil fuels 15%
- Renewable energy 15%
- Nuclear energy 13%

Going forward

Digitalisation

- Integrating **renewables**

Estimated energy savings

30

Mt CO_2 emission (EU)

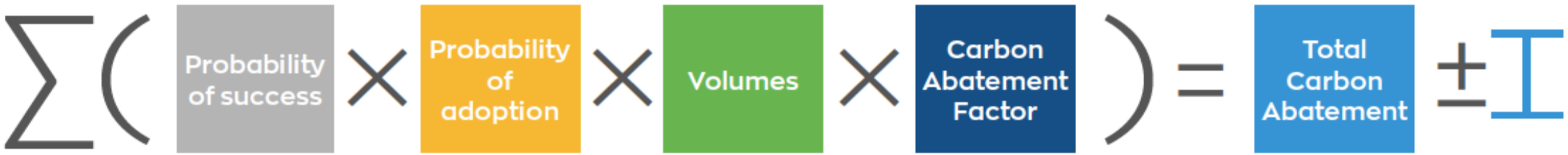
40 Gt CO_2/ year

Sources: International Energy Agency. Digitalisation & Energy, report, 2017
European Commission. Shedding light on energy in the EU, 2018, https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-2a.html

Assessment challenges

Formula show how to quantify energy savings in theory

The Formula

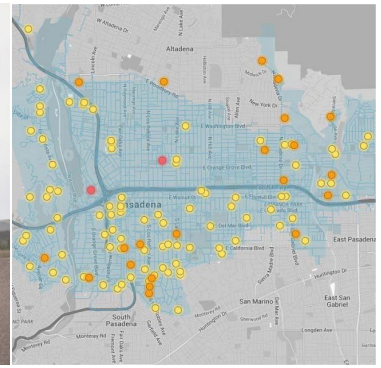


The formula is not easy to apply in practice

Sources: A. Stephens, V. Thieme. Framework for Assessing Avoided Emissions, Accelerating innovation and disruptive low- and zero-carbon solutions. Part 2: Draft methodology for calculating avoided emissions, report, 2020

Case study shows that there are challenges in quantifying avoided emissions

Background



- Smart system for gas detection

EDF ENVIRONMENTAL DEFENSE FUND — Finding the ways that work

Google Earth Outreach

Assumptions and approximations

- Pipes replaced blockwise → 8160 segments
- 25% to reduce emissions → 2040 segments
- Traditional methods could have caught 50% → ICT → additional 1020 segments
- One replacement, one leakage → 1020 segments
- Average leak flow 6.41 kg/ day → 2340 kg NG/ (year and leak)

Avoided emissions

2400 t NG/ year

60 kt CO_2 eq/ year

It is possible to do estimations! However, there are a lot of **uncertainties**

Sources: V. Coroama, M. Höjer. Assessing GHG Benefits Induced by ICT Services in Practice: A Case Study and Resulting Challenges, 2016

First challenge in quantifying energy savings

Finding the Baseline

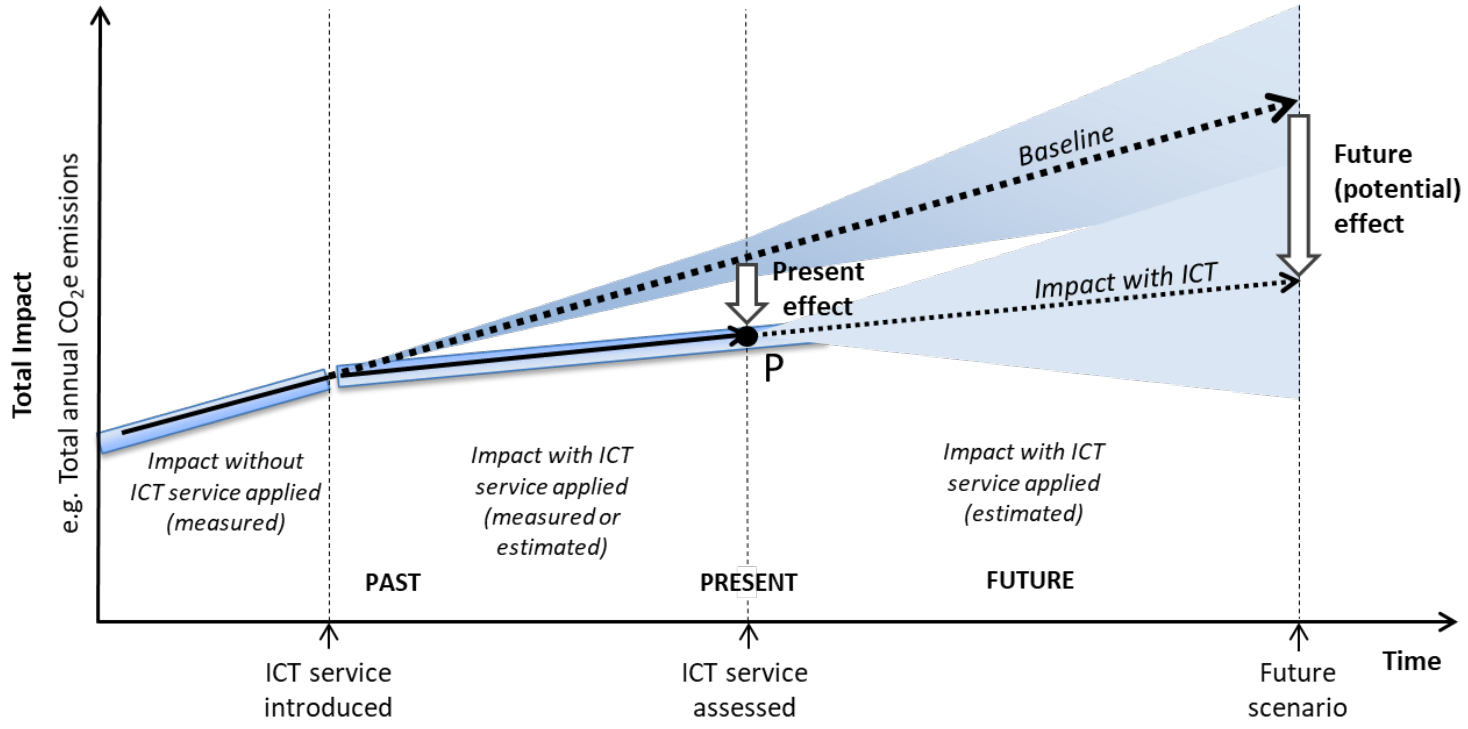
What is the baseline?

- **No implementation of digital service**
- **Case to compare with**

Challenges

- Uncertainties
- The baseline will affect the magnitude

One Approach for Finding the Baseline



Sources (including graph): V. Coroama, P. Bergmark M. Höjer, J. Malmodin. A Methodology for Assessing the Environmental Effects Induced by ICT Services: Part I: Single Service, Proceedings of ICT for Sustainability (ICT4S) 2020, pp. 36-45, 2020

Second challenge in quantifying energy savings

Data Quality

Challenges
• Uncertainties • Assumptions • No primary data • Reliable sources

Sources: A. Stephens, V. Thieme. Framework for Assessing Avoided Emissions, Accelerating innovation and disruptive low- and zero-carbon solutions. Part 2: Draft methodology for calculating avoided emissions, report, 2020

Third challenge in quantifying energy savings

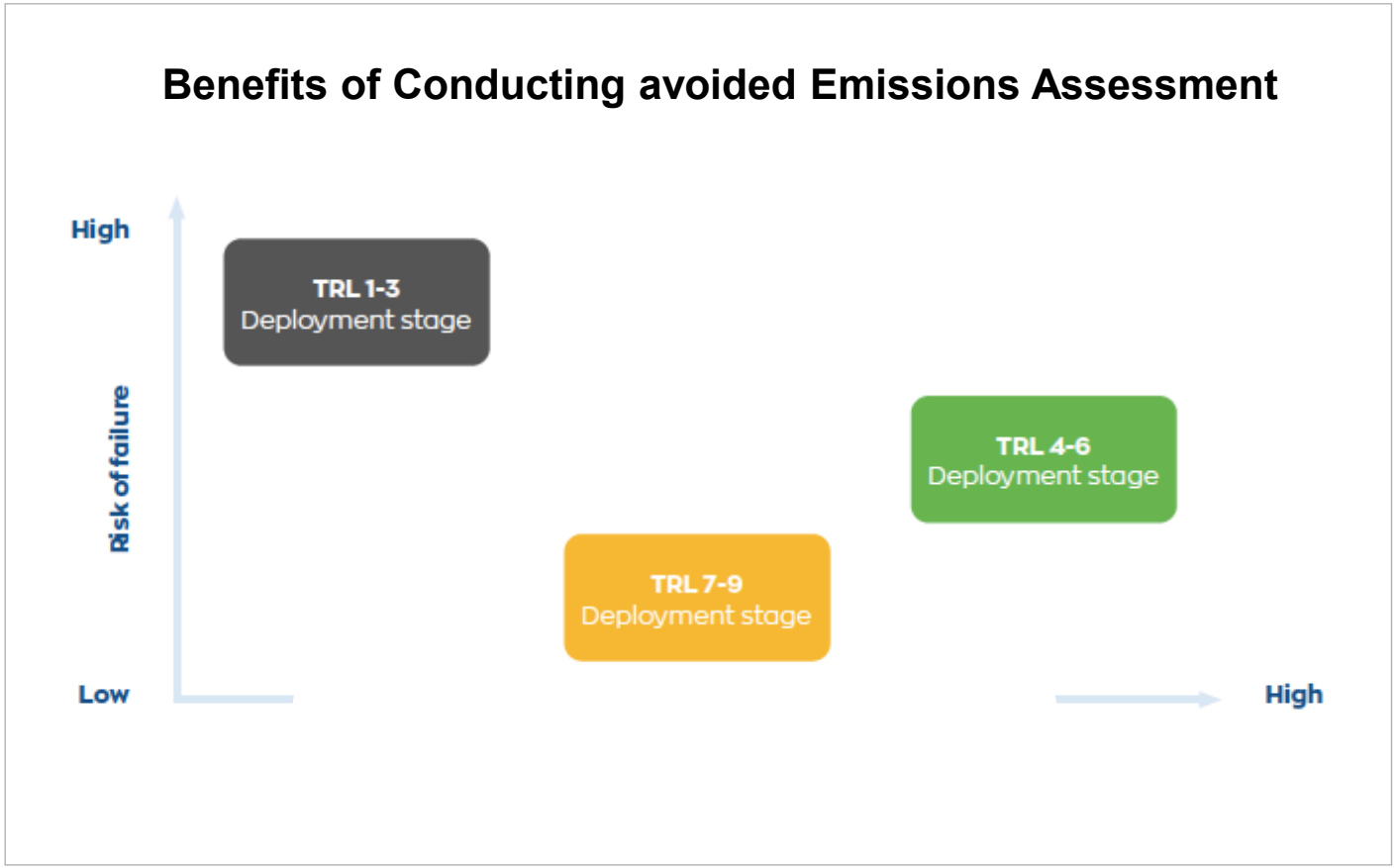
Forecasting Digital Solutions

Technical readiness level

In which stage of development is the product or service?

Challenges

- Success in development of product or service
- Adoption in market
- Environmental impact per use



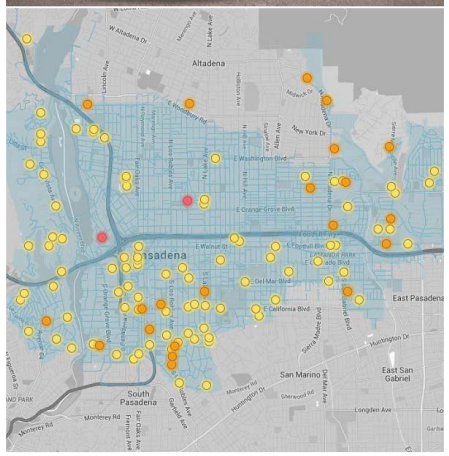
Sources: A. Stephens, V. Thieme. Framework for Assessing Avoided Emissions, Accelerating innovation and disruptive low- and zero-carbon solutions. Part 2: Draft methodology for calculating avoided emissions, report, 2020

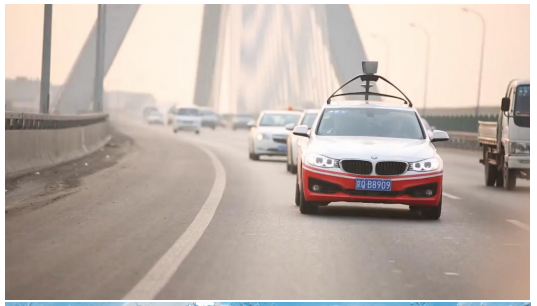
Fourth challenge in quantifying energy savings

Generalising Individual Cases

Challenges

- Different systems, different products and services
- Adoption
- Effect per use
- Conservative assumptions and approximations





Sources: V. Coroama, M. Höjer. Assessing GHG Benefits Induced by ICT Services in Practice: A Case Study and Resulting Challenges, 2016

Fifth challenge in quantifying energy savings

Anticipating Rebound Effect

What is the rebound effect?

When CO_2 emissions increases due to use of the digital enabler

Challenges

- Predicting the markets response
- Large impact on the result

In many reports, the rebound effect is not included in the estimations of energy savings or avoided emissions

Sources: V. Coroama, P. Bergmark M. Höjer, J. Malmodin. A Methodology for Assessing the Environmental Effects Induced by ICT Services: Part I: Single Service, Proceedings of ICT for Sustainability (ICT4S) 2020, pp. 36-45, 2020

Conclusion

There are 3 key takeaways

Conclusion

1 Uncertainties

Digitalisation could help save energy, or not

2 Assessment challenges

- *Several challenges*
- *The formula*

3 Industry reports

Many reports written within the industry, ignoring possible negative effects

Sources: V. Coroama, P. Bergmark M. Höjer, J. Malmodin. A Methodology for Assessing the Environmental Effects Induced by ICT Services: Part I: Single Service, Proceedings of ICT for Sustainability (ICT4S) 2020, pp. 36-45, 2020

Thank you

Pictures: https://merculexenergy.com/celebrating-world-environment-day/ | https://eitrawmaterials.eu/expert-forum-digitalisation-in-the-raw-materials-sector/ | https://asiatimes.com/2020/08/us-china-both-lag-badly-in-industrial-robot-race/ | https://aqualith-park.nl/smart-lighting-showdown-bluetooth-smart-vs-wi-fi-vs-zigbee/ | https://www.azocleantech.com/article.aspx?ArticleID=1094 | https://www.bizjournals.com/sanfrancisco/news/2017/04/19/self-driving-car-baidu-china.html | https://www.photowall.com/us/world-map-detailed-without-roads-wallpaper |