Framework for conducting Life Cycle Analysis (LCA) of Datacenters

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Objectives of the TGG study

- Give **framework and rules** for conducting studies on environmental aspects of datacenters.

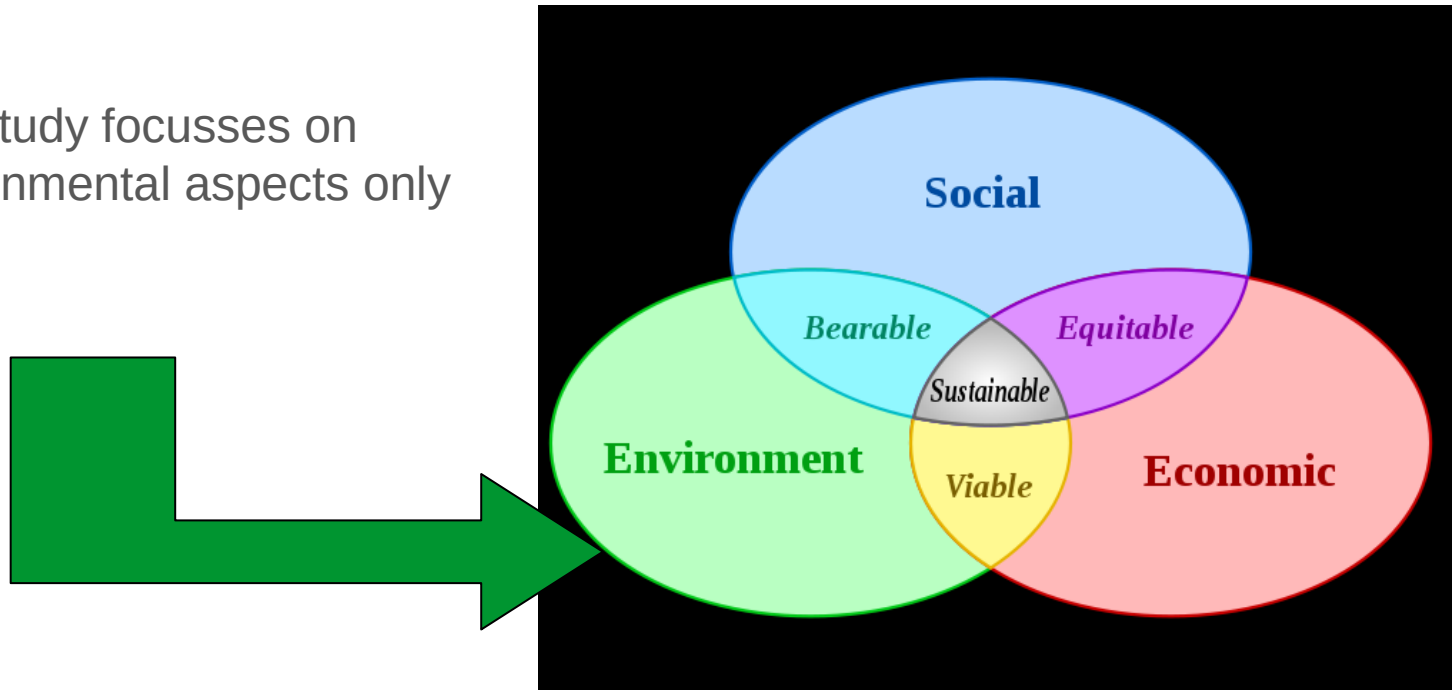
- **Not calculate numbers**
- **Not a list of best practices**

- Make proposals for next studies, anticipate future developments in this area

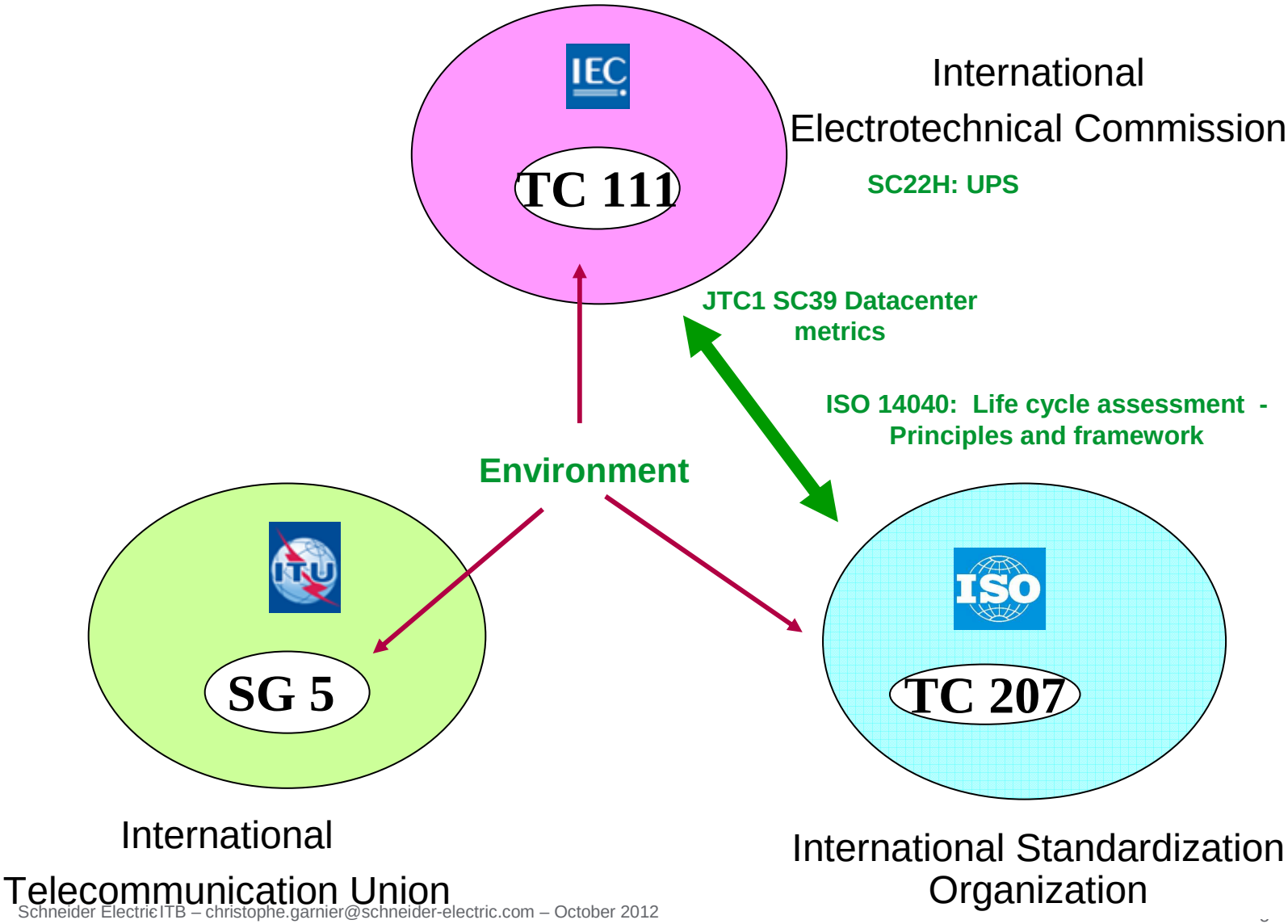
The 3 pillars of sustainability

Sustainability = meet the needs of the present without compromising the ability of the future generations to meet (Brundtland Report, 1987)

This study focusses on environmental aspects only



International standardization bodies

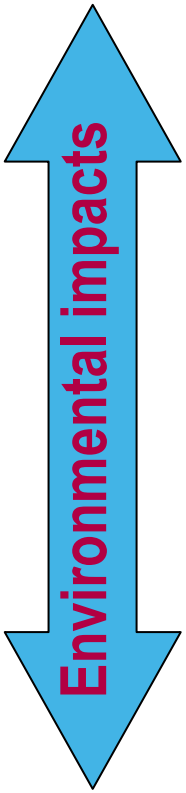


Existing studies: Various scopes, goals, organizations,…

- Environmental impacts
  - Single impact: GHG Protocol Data Centre Chapter
  - Multi impacts: ISO 14040 Life Cycle Analysis
- Product phase
  - Most of the time, only “Use phase”
  - 2 phases embedded/use, several
- Product scope
  - All products in scope: ISO 14040
  - Data Center only: GHG Protocol
- Geographical scope
  - WW: ISO, IEC, ITU
  - Europe: EU methodology,
  - Singapore: SS564
  - No visible activity in US and Asia for the moment
- Product, organization, or service?
  - A data center can be considered as a product, an organization, or a service
- Focused on reduction
  - Calculate progress, and not current number
- Standards or consortia
  - IEC, ISO, ITU,…
  - GHG Protocol, TGG, …

Life cycle assessment principles

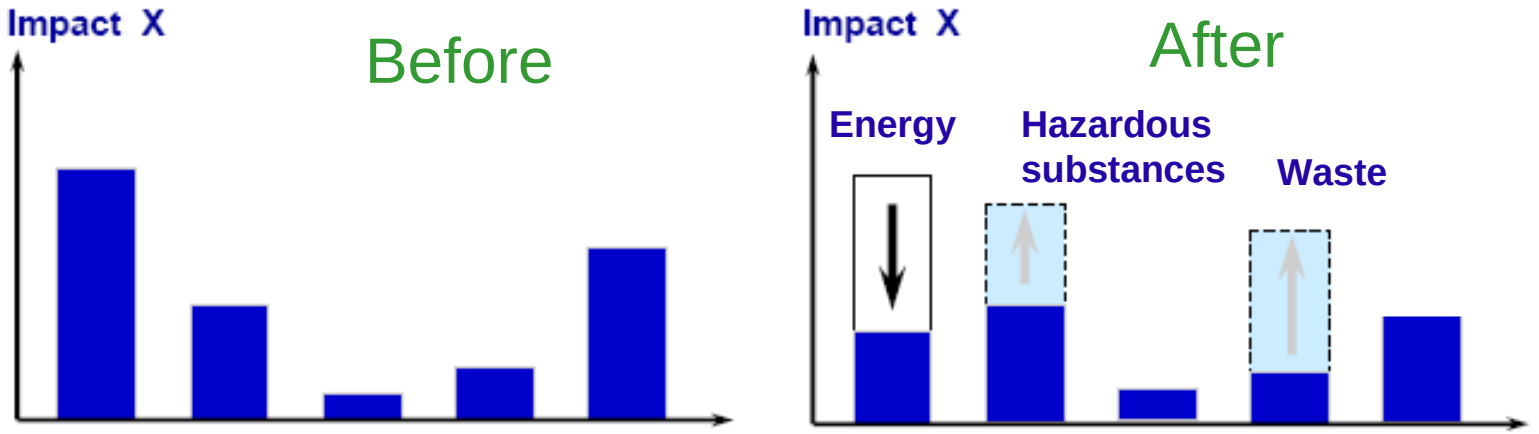
- Complete life cycle + all environmental impacts



	Manufacturing Construction	Transport	Use	Maintenance Upgrade	End of life
Raw material					
Air					
Water					
Energy					
Global Warming (CO2)					
Ozone					
Toxic Waste					
Substances					
Recycling					
Biodiversity					
Noise					
…					

Life cycle assessment principles

- Avoid pollution shift: do not transfer burden from one environmental impact category to another



For instance, what is the global environmental benefit if you reduce energy consumption and increase hazardous substances and waste?

?

LCA Principles

- **System boundaries**: what is in/out the study
- **Functional unit**: Unit of reference
- **Life cycle perspective**: Consider Complete life cycle
- **Comprehensiveness**: all aspects of natural environment, human health and resources

System boundaries

- Set of criteria specifying which unit processes are **part of a product system** (ISO 14040)

- Description of what is IN and OUT of the DC
- There no unique definition of a DC. **Each study can have its own boundaries but clearly defined**
- Required to compare, measure evolution, or aggregate data
- Use ratio when Datacenter is part of a building with other functions

System boundaries

Roads, parking

Lightning

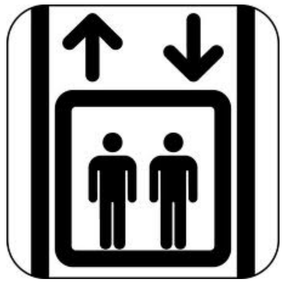
Is this Equipment part of the Data Center?

Submarine cables

Satellites

Fire system

Photovoltaic panels



Lifts

Employee offices

Functional unit

- **Quantified description of performance** of a product system for use as a reference unit (ISO 14040)
- Defines what is being studied. All subsequent analyses are then relative to that functional unit

- What is measured in the DC?
  - Per compute basis = very complex
    - Calculation capacity, Storage capacity, Transactions per second, …+ System availability, geographical area,…
  - **Per-kW of computing per-year basis**

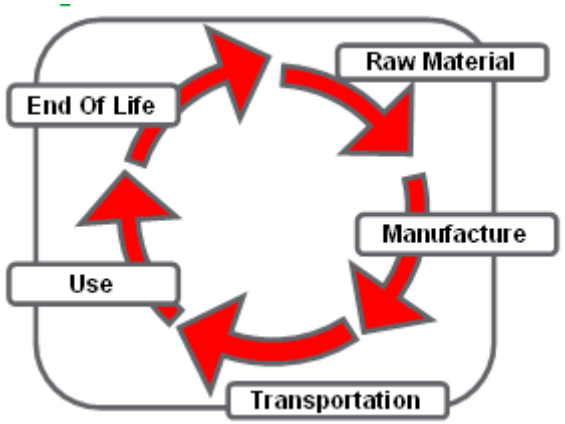
Functional unit

- Year 1: datacenter A, Year 2: same datacenter A with 50% less activity. PUE is better. Datacenter is more efficient?
- Datacenter A is Tier 1, datacenter B is Tier 4 with same activity. A is more efficiency than B?
- Assessment of impact for 1 year usage. Divide “life time impact” by “expected life time” of equipment

Life cycle

- Consecutive and interlinked **stages** of a product system, from raw material acquisition or generation from natural resources to final disposal (ISO 14040)

- Life Cycle Phases for a datacenter:



Building and components

Use, upgrade, maintenance

Construction

Comprehensiveness

- LCA considers **all aspects** of natural environment, human health and resources. By considering all aspects, potential ***trade-offs*** can be identified and assessed (ISO 14040)

- Environmental impacts
  - Energy consumption
  - Water usage / pollution
  - Air pollution
  - Carbon footprint
  - Hazardous substances
  - Waste
  - Noise
  - Biodiversity
  - …

Impact shifting

Through such a systematic overview and perspective, the **shifting** of a potential environmental burden between life cycle stages can be identified and possibly avoided

- Refresh equipment every year with top of the class
  - More efficient ⚖ Recycling and Packaging waste
- Move to a carbon neutral building
  - New carbon neutral building ⚖ dismantling existing building
- Using water from river
  - Save drinkable water ⚖ warm the river
- Electronic documentation
  - Save paper ⚖ use IT
- Photovoltaic panels
  - Save energy ⚖ raw material, hazardous/rare substance

Rebound effect

- Smaller/cheaper -> shorter life time
- More devices -> same function in several devices
- More powerful -> more use (video,…)
- More flexible -> more upgrade

Limits of LCA

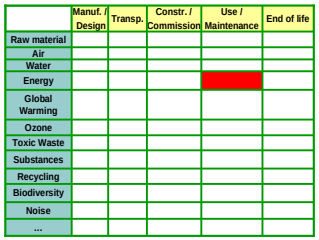
- Expertised people is required
- Resources: time and money
- Data collection
  - no data, no result
  - Uncertainty
    - Primary data: measure or collected data
    - Secondary data:Data derived from other sources such as literature or database

- Impact categories:
  - Carbon is the most recognized and documented
  - And also water, air, ozone, biodiversity, …

LCA Trend: what to measure?

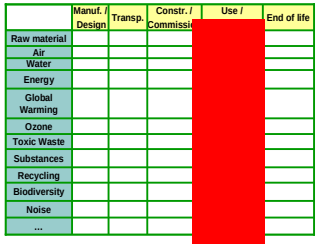
- From single criteria to global assessment

YESTERDAY



1 phase x 1 impact
=
PUE

TODAY



1 phase x all impacts
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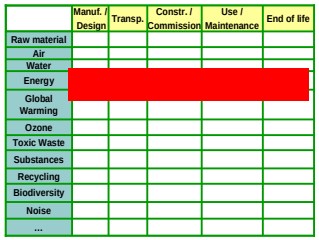
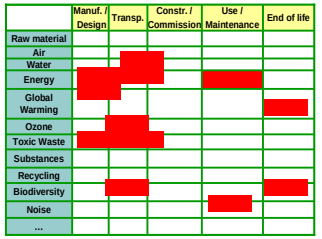
PUE, CUE, WUE, xUE,…



all phases x 1 impact
=
Carbon footprint

TOMORROW



all phases x all impacts
=
Focus on main impacts

LCA Trend: how to measure?

- Many methodologies under development
  - ITU/ETSI, IEC, GHG Protocol, EU JRC
- Compatible, similar results…
  - Good for identification of main impacts
- But too much uncertainty
  - GW from 20 to 50 substances
  - CO2 conversion not always the same
- At the end
  - Comparison is not possible
  - Regulation cannot be implemented
- Standardization of KPIs
  - ISO/IEC JTC1 SC39

Thanks - Merci