Integrating Life Cycle Management for a more Circular Data Centre Industry

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The 9th International Conference on Life Cycle Management
1st – 4th September 2019, Poznan, Poland
LCM, Circular Economy and sustainability strategy.

Eco-design to implement sustainability. Key Performance Indicators for progress.

Sustainability metrics based on Life Cycle Approaches.

Support communication based on sustainability performances.

Awareness raising and training to support sustainability implementation.

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Our expertise and multi-sectorial experience

- Building and construction
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- Plastics
- Food & retail
- Textile
Context

Connectivity – very rapid growth at global level
What are data centers?

DC industry - emphasis on 24/7 operation & uninterrupted performance

reducing operational energy consumption

~ 8.6 million data centres globally
~ 63,000 in EU - 66% in UK, France, Germany & Netherlands

Predicted growth – 300% by 2025 / 500% by 2030
Context

Embodied impact - building life 60 years
15% - from building and facilities / 85% - from IT equipment
20 million servers etc = 0.56 million tonnes materials
CEDaCI – objectives

✓ Create stable and secure materials supply chain for DC sector
✓ reduce sectoral waste and environmental impact by......

• Increasing recycling / reclamation of CRM
• Improving design for disassembly/ manufacturing
• Extending product life – refurbishing
• Base CE in NWE Europe to grow business
Project steps

- **Situational Analysis** and **Network Building**
- **EcoDesign** / **Design for Circular Economy** prototype products and Guidelines
- **Co-creation** activities, Tool Development and Testing and EcoDesign Guideline Finalisation
- Improved **Recycling** methods and process for increased recycling and reclamation of CRM
- **Refurbishment** business and Decision Making models
- **Communication** / **Long Term strategy**
Situational Analysis and Network Building

Characterization of DC equipment (age, technology, etc.)

Inventory of stakeholders/case studies/BM

Building a network of the stakeholders

Screening Life Cycle Assessment
Data Centres in NWE

C: Colocation DC; E: Enterprise DC; MSP: Managed Service Providers; % Share in Europe

UK
- C: 450, 20.32%
- E: 11500, 19.10%
- MSP: 25, 16.45%

FRANCE
- C: 270, 12.19%
- E: 8700, 14.45%
- MSP: 20, 13.16%

NETHERLANDS
- C: 250, 11.29%
- E: 5600, 9.30%
- MSP: 15, 9.87%

GERMANY
- C: 410, 20.32%
- E: 13200, 21.92%
- MSP: 30, 19.74%

Data Centre Life Cycle

- Circular economy initiatives between use and end-of-life
- Not enough collaboration among stakeholders (GreenIT Report: Circular Data Servers, 2018)
- GAP between end-of-life and design stakeholders
## Equipment composition

<table>
<thead>
<tr>
<th>Power generation</th>
<th>Lifespan (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninterruptible power supply (UPS)</td>
<td>20</td>
</tr>
<tr>
<td>Transformers</td>
<td>20</td>
</tr>
<tr>
<td>Switch gear</td>
<td>20</td>
</tr>
<tr>
<td>Backup generators</td>
<td>20</td>
</tr>
<tr>
<td>Power distribution units (PDUs)</td>
<td>20</td>
</tr>
<tr>
<td><strong>Batteries</strong></td>
<td><strong>3-5</strong></td>
</tr>
<tr>
<td>Power cables</td>
<td>20</td>
</tr>
<tr>
<td><strong>Servers</strong></td>
<td><strong>3-8</strong></td>
</tr>
<tr>
<td><strong>Storage equipment</strong></td>
<td><strong>3-5</strong></td>
</tr>
<tr>
<td><strong>Network equipment (switches, routers, etc.)</strong></td>
<td><strong>3-5</strong></td>
</tr>
<tr>
<td>Chassis</td>
<td>20</td>
</tr>
<tr>
<td>Network cables</td>
<td>20</td>
</tr>
<tr>
<td>Chillers</td>
<td>20</td>
</tr>
<tr>
<td>Computer room air conditioning units (CRACs)</td>
<td>20</td>
</tr>
<tr>
<td>Direct expansion air handler</td>
<td>20</td>
</tr>
<tr>
<td>Pumps</td>
<td>20</td>
</tr>
<tr>
<td>Cooling towers</td>
<td>20</td>
</tr>
<tr>
<td>Heat exchange systems</td>
<td>20</td>
</tr>
<tr>
<td>Reservoir storages for collecting rain water</td>
<td>20</td>
</tr>
<tr>
<td><strong>Security system</strong></td>
<td><strong>20</strong></td>
</tr>
<tr>
<td>Fire-suppression system</td>
<td>20</td>
</tr>
<tr>
<td>Video-cameras</td>
<td>20</td>
</tr>
<tr>
<td><strong>Building structure</strong></td>
<td><strong>20</strong></td>
</tr>
<tr>
<td>Lighting, infrastructure, etc.</td>
<td>20</td>
</tr>
</tbody>
</table>

- **Batteries, storage equipment and network equipment** need replacement every 3-5 years and **servers** every 3-8... and often earlier!
- Technology changes through the time

**JRC. (2015). Environmental Footprint and Material Efficiency Support for product policy, analysis of material efficiency requirements of enterprise servers**
## Critical Raw Materials (CRM) in DCs

### Critical Raw Materials (CRMs) in DCs (European Commission, 2017)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Component</th>
<th>CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power generation</td>
<td>Lithium Ion Batteries</td>
<td>Co</td>
</tr>
<tr>
<td>Storage equipment</td>
<td>HDD</td>
<td>Dy</td>
</tr>
<tr>
<td></td>
<td>SSD</td>
<td>Nd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tb</td>
</tr>
<tr>
<td>Servers, storage equipment (SSD), Network equipment</td>
<td>SSD</td>
<td>Si (CRM found in PCB)</td>
</tr>
<tr>
<td></td>
<td>PCB</td>
<td>PGM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Si</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ga</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mg</td>
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<tr>
<td></td>
<td></td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Co</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Si</td>
</tr>
</tbody>
</table>

- **Beryllium, Germanium:** Natural graphite, Silicon metal
- **Bismuth, Hafnium:** Natural rubber, Tantalum
- **Borate, Helium:** Niobium, Tungsten
- **Cobalt, HREEs:** PGMs, Vanadium
- **Coking coal, Indium:** Phosphate rock
CRM in Europe

Supply Risk

- Import reliance
- Geopolitical situation of providers
- Number of countries (providers)
- Recycling rate
- Substitution index

Economic importance

- Link to industry supply chains
- Modern technology
- Environmental applications

CRM in data servers

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity in server (g)</th>
<th>Material</th>
<th>Quantity in server (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sb</td>
<td>4,44</td>
<td>Si metal</td>
<td>11,22</td>
</tr>
<tr>
<td>Be</td>
<td>0,03</td>
<td>REEs</td>
<td></td>
</tr>
<tr>
<td>Co</td>
<td>9,27</td>
<td>Nd</td>
<td>14,63</td>
</tr>
<tr>
<td>Mg</td>
<td>0,004</td>
<td>Dy</td>
<td>3,60</td>
</tr>
<tr>
<td>Pd</td>
<td>0,40</td>
<td>Pr</td>
<td>3,60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tb</td>
<td>0,75</td>
</tr>
</tbody>
</table>

**NETHERLANDS**

*(GreenIT Report: Circular Data Servers, 2018)*

- **184.000 scrapped server units per year**, only in Amsterdam
- **11% refurbished**
- **24% recycled** with 81% of its mass recovered, 15% valorised and 4% lost in the process

These values depend on the technology and age of the equipment

Need to characterise different equipment to set strategies

Every year in NWE

~ 250 t

CRM are scrapped

- Environmental Footprint and Material Efficiency Support for product policy, analysis of material efficiency requirements of enterprise servers, 2015
- Ecodesign Technical Assistance Study on Standards for Lot 9 Enterprise Servers and Enterprise Data Storage, Intertek
Waste Electrical and Electronic Equipment (WEEE)

- Toxic materials: need special treatment
- **WEEE Directive 2012/19/EU**
  - Obligation to dismantle hazardous components
    - Printed Circuit Boards
    - Batteries
    - External cables
    - Capacitors with PCBs
  - Objectives:
    - Reduce amount of waste (**Reuse, Refurbish**)
    - Avoid landfilling
    - Proper treatment, managing toxic materials
    - Avoid illegal exports to less developed countries (Asia, Africa)

Source image: stephenleahy.net
# Data centre equipment recycling

<table>
<thead>
<tr>
<th>Component with CRM</th>
<th>Industrial recycling process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium Ion Batteries</td>
<td>Yes</td>
</tr>
<tr>
<td>HDD</td>
<td>No</td>
</tr>
<tr>
<td>SSD</td>
<td>No</td>
</tr>
<tr>
<td>PCB</td>
<td>Yes</td>
</tr>
<tr>
<td>Connectors</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**High recovery**
- Co
- Platinum Group metals
- Precious metals
- Iron
- Aluminium
- Plastics (incineration)
- Copper
- Lead

**Very low recovery**
- Ta
- Rare Earths
- Be
- Ge
- Ga
- Si

**Low recycling rates: low collection, lost in the process**

**Materials with best recovery rates from electronic products**

- Not economically viable processes
- Small concentrations
- Lost in the recycling process
Recycling of CRM

<table>
<thead>
<tr>
<th>CRM in data servers</th>
<th>EU Import reliance Primary material (European Commission, 2018)</th>
<th>Recycling rate from end-users (European Commission, 2018)</th>
<th>Use in servers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sb</td>
<td>100%</td>
<td>28%</td>
<td>Flame retardant in PCBs</td>
<td>Not from PCBs!</td>
</tr>
<tr>
<td>Be</td>
<td>100%</td>
<td>0%</td>
<td>Contacts as alloying element in Cu alloys</td>
<td>Lost in the process</td>
</tr>
<tr>
<td>Co</td>
<td>32%</td>
<td>35%</td>
<td>Cathode in LIB (PSU and PCB)</td>
<td>Rates are supposed to increase with EV development</td>
</tr>
<tr>
<td>Mg</td>
<td>100%</td>
<td>13%</td>
<td>Alloying element for Al alloys</td>
<td>Recycled as an alloy element with aluminium</td>
</tr>
<tr>
<td>PGM</td>
<td>100%</td>
<td>11%</td>
<td>Found in capacitors, HDD and coatings to enhance conductivity</td>
<td>Lots of losses!</td>
</tr>
<tr>
<td>REE</td>
<td>100%</td>
<td>6-7%</td>
<td>Nd and Dy in magnets of HDD</td>
<td>Not from old scrap!</td>
</tr>
<tr>
<td>Si metal</td>
<td>64%</td>
<td>0%</td>
<td>Connectors and Transistors NAND memories, SDD and PCBs</td>
<td>Not from old scrap!</td>
</tr>
<tr>
<td>Ta</td>
<td>100%</td>
<td>1%</td>
<td>Capacitors from PCBs</td>
<td>Not from old scrap!</td>
</tr>
</tbody>
</table>

Only 1% of CRM recovery from WEEE
CRM Recovery, 2014

Work Package 6 (October 2019 – March 2021) Recycling pilot case
Recycling of CRM

Economically non-viable (yet) for all the CRM

- Very small concentrations of CRM in products
- Composition of equipment is unknown
- Destruction of data (Data sanitation) and it’s influence on recycling
- Electronic products are complex: costly dismantling operations of the components (PCBs, drives, capacitors, etc.) and separation of materials
- Complex processes are required (high CAPEX)
- Volatile prices of CRM

Improve the design
- Research & Development in recycling
- Extend lifetime by reusing and refurbishing

CRM Recovery, 2014
Circular Economy/LCM in DCI

NWE
- High economic importance
- Large market

DC Equipment
- High replacement rates
- High value

Circular Economy
- Ecodesign
- Reuse/repair
- Recycle

Extend life of products: Economic and environmental benefits

Materials
- High amount of Critical Raw Materials
- Need of secure supply chain
- Very low recovery rates

WEEE
- High toxicity
- Low recycling rates
- Societal and environmental impacts
Conclusion and perspectives

1. Improve communication among stakeholders
2. Increase efficiency of end-of-life strategies
3. Increase awareness about CRM
4. Create secure supply chain
Map of CEDaCI Pilots

Pilot A: Ecodesign and manufacture

Pilot B: Refurbishment/ reuse and business models

Pilot C: WEEE recycling and reclamation of CRM
Application to join CEDaCI network
Application via Online Survey: https://fr.surveymonkey.com/r/CEDaCI

Join the multi-professional network
✓ Receive innovative insights towards circularity solutions
✓ Share ideas within a multi-professional network, e.g. designers, manufacturers, business actors related to refurbishing, remanufacturing, and recycling, DCI operators & users, public authorities, scientists from several disciplines, policy and communication experts
✓ Test, develop and use a circular business model
✓ Enlarge your national and European business network

More information: www.cedaci.org and info@cedaci.org
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Level of integration
- Working Group France
- Working Group UK
- Working Group Netherlands
- Working Group Germany
- Broader network

Key topics
- Eco-design
- Refurbishing
- Recycling
- Socio-economic impact

Life Cycle (LC) stages (selection)
- Supplier
- Design
- Manufacturing
- R&D Design
- Installation & Dismantling
- Transport
- Data destruction
- Reuse
- Refurbishing
- Recycling
Thank you for listening – any questions?

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