Integrating Life Cycle Management for a more Circular Data Centre Industry

• Dr. Naeem ADIBI   n.adibi@weloop.org

www.weloop.org
www.nweurope.eu/cedaci

@cedaci_project

https://www.linkedin.com/company/cedaci-circular-economy-for-the-data-center-industry/

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

Sustainability metrics based on Life Cycle Approaches.

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

Awareness raising and training to support sustainability implementation.

Support communication based on sustainability performances.

www.weloop.org
Contact: info@weloop.org
03 21 13 51 88-9
Our expertise and multi-sectorial experience

Building and construction

Metallurgy

R&D – Innovation

Plastics

Food & retail

Textile
Context

Connectivity – very rapid growth at global level

**DIGITAL AROUND THE WORLD IN 2018**

- **Total Population**: 7.593 Billion
- **Internet Users**: 4.021 Billion
- **Active Social Media Users**: 3.196 Billion
- **Unique Mobile Users**: 5.135 Billion
- **Active Mobile Social Users**: 2.958 Billion

**Urbanisation**: 55%

**Penetration**:
- Internet: 53%
- Social Media: 42%
- Mobile: 68%
- Social Media: 39%
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

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%

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

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
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

<table>
<thead>
<tr>
<th>Critical Raw Materials (CRMs) (European Commission, 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
</tr>
<tr>
<td>Baryte</td>
</tr>
<tr>
<td>Beryllium</td>
</tr>
<tr>
<td>Bismuth</td>
</tr>
<tr>
<td>Borate</td>
</tr>
<tr>
<td>Cobalt</td>
</tr>
<tr>
<td>Coking coal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power generation</th>
<th>Component</th>
<th>CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium Ion Batteries</td>
<td>HDD</td>
<td>Co</td>
</tr>
<tr>
<td>SSD</td>
<td>Si</td>
<td></td>
</tr>
<tr>
<td>(CRM found in PCB)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Servers, storage equipment (SSD), Network equipment</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB</td>
<td>PGM</td>
</tr>
<tr>
<td></td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td>Ni</td>
</tr>
<tr>
<td></td>
<td>Mg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Servers</th>
<th>Connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td>Be</td>
</tr>
<tr>
<td></td>
<td>Co</td>
</tr>
<tr>
<td></td>
<td>Pd</td>
</tr>
<tr>
<td></td>
<td>Si</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

We Loop
Interreg North-West Europe
CEDaCI
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

### "Basic building brick" server

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

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

CEDaCI project. WeLOOP
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)

- Human health impacts
- Environmental Impacts
- Losses of resources (Economic impact)
## 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
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
Circular Economy/LCM in DCI

NWE
- High economic importance
- Large market

DC Equipment
- High replacement rates
- High value

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

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

Circular Economy
- Ecodesign
- Recycle
- Reuse/repair

Extend life of products: Economic and environmental benefits
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 B Refurbishment/ reuse and business models

Pilot A Ecodesign and manufacture

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
Application to join CEDaCI network
Application via Online Survey: [https://fr.surveymonkey.com/r/CEDaCI](https://fr.surveymonkey.com/r/CEDaCI)

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?

Application via Online Survey: [https://fr.surveymonkey.com/r/CEDaCI](https://fr.surveymonkey.com/r/CEDaCI)

- Dr. Naeem ADIBI  n.adibi@weloop.org
  www.weloop.org
  www.nweurope.eu/cedaci

- @cedaci_project