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Developing a Circular Economy for the Data Centre Industry – how the CEDaCI project contributes to sustainable decision making

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Abstract. Data centres (DCs) house data processing and storage equipment. The data centre industry (DCI) is evolving rapidly, as society is becoming more dependent on digital technologies. Currently, there are 7.2 million DCs globally and provision is predicted to grow fivefold by 2030. The sector already utilises millions of tonnes of resources, including Critical Raw Materials, and the demand will only increase. DCI is based on a linear economy; recycling and materials reclamation infrastructure are also inadequate. At the end-of-life, many materials are either lost to landfill, incinerated, or unaccounted for. Furthermore, many virgin materials are located in geopolitically sensitive locations, which poses a threat to the supply chain that the sector relies on. The CEDaCI project aims to increase overall sectoral sustainability by addressing the various technical, cultural, and behavioural barriers across the DCI, such as fragmentation and sole focus on the energy efficiency. This paper describes the whole-systems approach and CEDaCI project outputs, including bespoke Eco-design guidelines, strategies, and digital tools to extend product life and recycling, and enable better decision-making to increase circularity in the DCI, prepare and support implementation of the EU Circular Economy Action Plan and ensure a secure, sustainable resource supply chain.

1 Introduction

Data Centres (DCs) form one of the most essential pillars of modern infrastructure, designed to process and manage digital data in almost every part of our world. The Data Centre Industry (DCI) is a unique sector, and one of the major contributors to the economy. Since the introduction of the World Wide Web in the early 1990s and increasing dependence of numerous different sectors on digital technology and services, DCI has grown very rapidly. Currently, there are 7.2 million DCs worldwide. [1] Growth is ongoing and by 2030, it is predicted that global provision will increase fivefold as more people and objects become connected (via the Internet of Things). In Europe, the DCI is mainly concentrated in the UK, Germany, France, and Netherlands. [2] There are different types of Data Centres with

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different business models, for example: colocation, hyperscale or enterprise – and all differ in size. Hyperscale data centres are run by the big tech giants and house thousands, even millions, of servers. Hyperscale Data Centre owners generally carry out their equipment design, refurbishment, and upgrades in-house, which makes them more circular in practice, although their server refresh rates can be as short as 9 months. On the other hand, Enterprise Data Centres are much smaller and procure their equipment from the major IT hardware manufacturers and often opt out for buying new servers at the end of the service agreement (which is 3-5 years on average) rather than refurbish and reuse the existing machines. Colocation DC model is based on providing data centre facilities for rental and can host both hyperscale and enterprise customers at the same time. Hence, these data centres can vary in size, but would typically host thousands of servers.

Servers are an integral part of the Data Centre infrastructure and are chiefly high spec computers full of complex electronics designed for data processing and storage. On average, servers weigh between 25–35 kg and so millions of tonnes of resources including Critical Raw Materials (CRM) are already utilised by the sector in manufacturing of the equipment and demand will only increase in the future as the sector expands rapidly.

The prime focus of hardware design, so far, has been on operation and performance. At present, enterprise server design allows for general repair and remanufacturing as some parts can be replaced. The design itself differs significantly from model to model and between generations. Such approach does not fit well into circularity and does not allow for the maximum reuse of the equipment to avoid excessive manufacturing.

Average server refresh rates are 3 to 5 years but can be annual, which significantly contributes to the production of e-waste, which is already growing rapidly. At the end-of-life (EoL) data centre equipment undergoes several mechanical and chemical separation processes in which a high volume of material is being lost. Currently, only Precious Metals (PM) and a limited number of CRM are being recovered from the e-waste. [3] Current recycling practice is not sustainable because the existing recycling and materials reclamation infrastructure are inadequate. According to The Global E-waste Monitor 2020, only 17.4% of the global e-waste generated in 2019, which added up to 53.6 Mt, was officially recycled. [4] Because of the low recycling rates and lacking infrastructure, millions of tonnes of materials are either lost to landfill, incinerated or are unaccounted for at the end-of-life. In addition, many virgin materials are situated in geo-politically sensitive locations, the combined impact of which poses a threat to the supply chain and therefore the DCI activities that rely on it unless the approach is altered on every stage of the equipment life cycle. [5]

2 CEDaCI and its contributions toward a Circular Economy

CEDaCI – A Circular Economy for the Data Centre Industry – is a 5-year Interreg-funded project that runs across 7 countries in North-Western Europe (NWE): UK, France, Netherlands, Germany, Belgium, Luxembourg, and Ireland.

The CEDaCI project is unique and is led by London South Bank University (LSBU) in the UK. It was exclusively initiated to support DCI transitioning to Circular Economy by introducing a whole-systems approach in an industry where all 10 sub-sectors are operating in silos.

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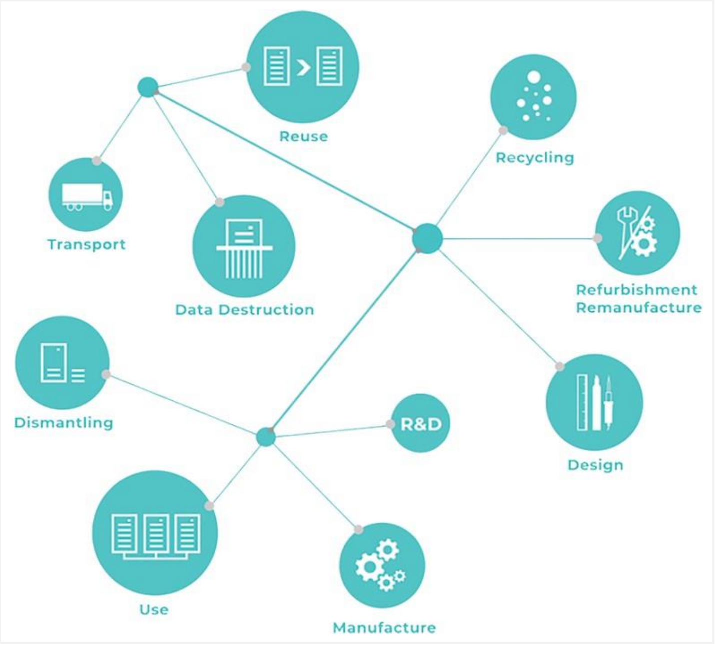

Fig. 1. DCI Sub-sector diagram.

A whole-systems approach is essential because it allows for the interconnection and collaboration between all of the relevant industry stakeholders and supports joint decision making at each life cycle stage, leading to the outcomes that are in line with the Circular Economy (See Figure 1). CEDaCI project is focusing on sustainable design thinking and holistic design methods, which underpin the project's structure ensuring that it delivers what the sector needs when dealing with the problem of the industry generated e-waste and CRM recovery.

CEDaCI is actively promoting DCI stakeholder collaboration and its sector-wide approach through various channels such as co-creation workshops, webinars, training, publications, and network building – all aimed at sharing the experience and research outcomes with the industry representatives.

The whole-systems approach advocated by CEDaCI is addressing all life cycle stages of the data centre equipment starting right at the beginning with the design & manufacture. The implementation of sustainable design thinking at this stage leads to product life extension and increased recycling and material reclamation later on – at the end-of-life of the equipment (See Figure2).

In this context, various project outputs were initiated and piloted by different project partners across NWE to support sustainable decision making within DCI. For example, in the UK, London South Bank University (LSBU) is involved in the design of the server that fits a circular economic model based on the assessment of the design, material content and manufacturing techniques of the existing equipment, as well as the assessment of the current eco-design regulations and other sustainable recommendations. The research team have also prepared the inventory data sets for the existing equipment, which will feed into the life cycle assessment (LCA) models built by the French partners – WeLOOP, Terra Nova

Dévelopment, TEAM2 – and UK partner Operational Intelligence; LSBU also supports the construction of the DC equipment LCA databases. Additionally, the French partners are developing the technology to increase equipment recycling and CRM reclamation from its e-waste. The UK partners are also working with the policy advisors on the Eco-design guidelines with the aim to extend the recommendations with CEDaCI supplementary guidelines and strategies based on the empirical data collected from the assessment of the different server models, which will help the industry to adopt circularity as an essential business format, and to extend product life and increase recycling.

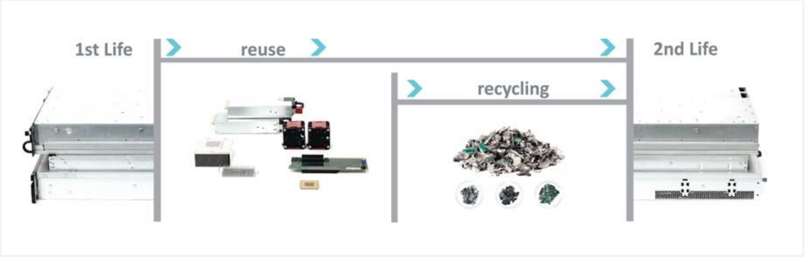

Fig. 2. Server life cycle stages in a Circular Economy.

Partners from Green IT and SDIA in Netherlands are focusing on the reuse and refurbishment of the DC equipment, and its economic and energy related factors. They are working together with sub-partners: TechBuyer (UK), Aliter Networks and Sims Recycling (Netherlands) who are providing valuable data sets that also feed into CEDaCI LCA model and database that will be later shared with the industry representatives.

One of the important but often overlooked aspects of product life cycle is its social impact. CEDaCI partner Wuppertal Institute for Climate Environment and Energy, in Germany, is working on the Social LCA model (SLCA) in collaboration with other partners involved in the life cycle assessment of the DC equipment, and LSBU (UK) is leading the life cycle costing and economic models. Collaboration and diverse expert input is ensuring that the LCA models and data sets compiled by CEDaCI reflect the full effect of the equipment on the environment, society, and the economy. The outcomes from these deliverables complete the life cycle sustainability assessment model.

Another significant output to support DCI transition to circularity is the Circular Data Centre Compass (CDCC) – an online decision-making tool based on a multi-step life cycle assessment method, which is built on unique CEDaCI LCA data collaboratively generated and assessed by the project partners. The tool is designed to help industry stakeholders proactively engage in transitioning towards a Circular Economy. CDCC comprises 3 sections: Compare, Evaluate and End-of-Life. Users can assess all the life cycle stages of their equipment and receive detailed easy to understand graphic feedback and an extended comprehensive PDF report (See Figure 3).

Overall, the CEDaCI project includes 20+ expert partner team from academia and industry across 7 countries in NWE; over 100 members have also joined the CEDaCI multi-disciplinary network across the sector. Project partners delivered trans-sectoral learning through multiple Co-creation Workshops actively promoting extended product life through second use and refurbishment. As from April 2022, partners from Ireland and Luxembourg (Host in Ireland & Free ICT Europe respectively) will be joining CEDaCI. The partners will be involved in reaching out to the Small and Medium Enterprises (SMEs) by setting up networks in Belgium, Ireland, and Luxembourg to support SMEs in the implementation of the Circular Economy solutions developed by CEDaCI.

Cross-sector expert collaboration pioneered by CEDaCI has already raised awareness of the challenges associated with the life cycle and circularity of DC hardware among the industry stakeholders. CEDaCI's unique 'whole-systems' approach has also linked various DCI sub-sectors who have not communicated previously, encouraging sustainability within the industry.

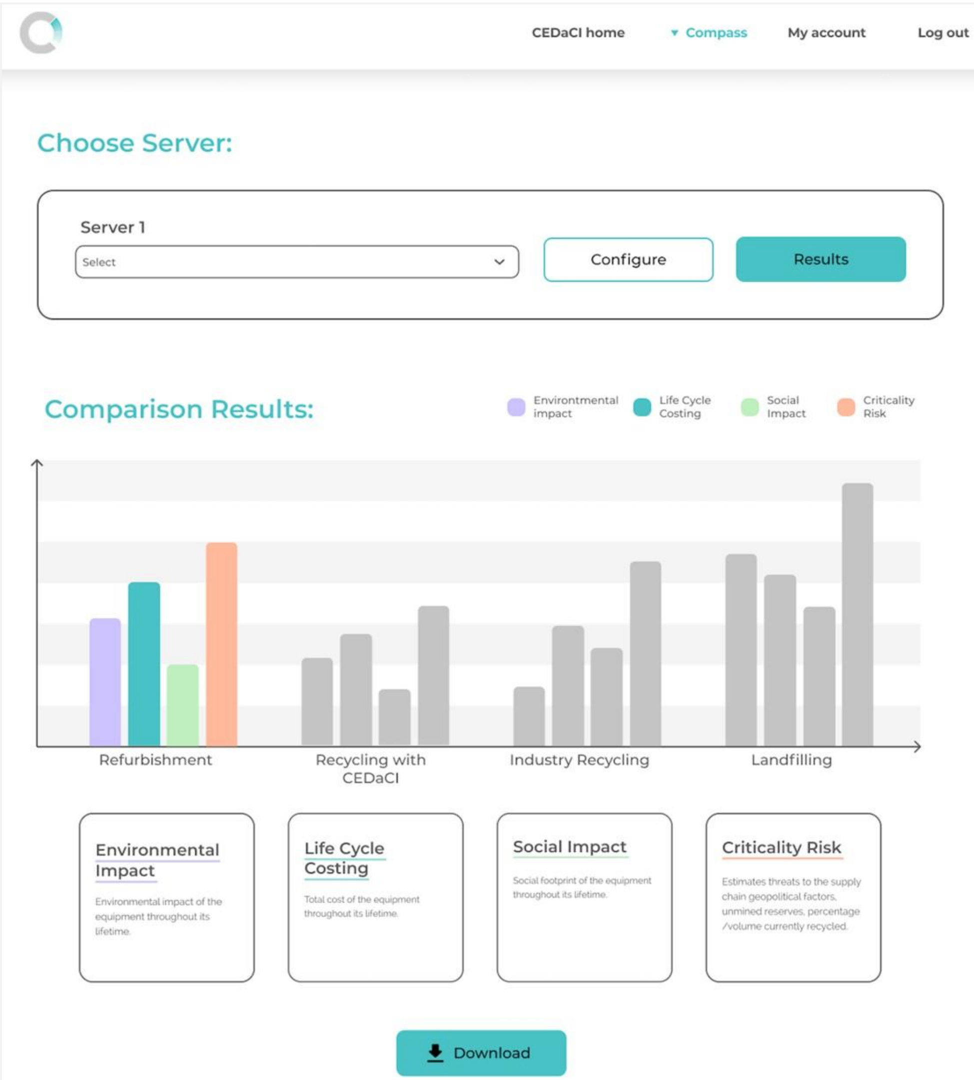

Fig. 3. CDCC graphic feedback webpage view.

3 Conclusion

Reducing the environmental impact of the growing e-waste stream arising from redundant DC equipment is essential in the implementation of the Circular Economy. CEDaCI's whole-systems approach contributes to better decision-making for the sector, prepares and supports implementation of the EU Circular Economy Action Plan. It also enables increased sectoral material recovery from DCI waste streams and reduced virgin materials use, which in turn will develop a secure and economically viable CRM supply chain.

To achieve this CEDaCI works as a catalyst for bridging the gaps in communication between different DCI sub-sectors involved in the design, manufacturing, refurbishment, recycling, use and procurement – helping bring together various stakeholder groups who otherwise would have not interacted to achieve a common goal of an effective implementation of the Circular Economy. Although DCI representatives were already involved in circular practices, they were often working in silos – limited to introducing circular measures within their own businesses. This had no effect on the rest of the industry as a Circular Economy encompasses joint co-operation and collaboration across the whole sector, involving every stakeholder throughout the whole life cycle of a product. Working groups and co-creation workshops facilitated by CEDaCI enabled cross-sectoral interaction creating an opportunity for effective communication between representatives from all life cycle stages, and most importantly experience exchange. This in turn helps to eliminate the sectoral trend of silo-operation, creates cross-sectoral sustainability orientated partnerships, and brings the implementation of the Circular Economy within the industry closer to becoming a reality.

All the data collected through the research that CEDaCI works on are shared with the industry stakeholders to give a more detailed picture of the industry's pinch points. The database is fed into CEDaCI multi-step LCA online decision-making tool – CDCC, that contributes to sustainable decision making when it comes to designing, procuring or end-of-life scenarios of the equipment. Further training sessions offered by CEDaCI will expand stakeholder knowledge about the tool and will continue to foster a positive trend of whole life cycle thinking when it comes to DCI business strategies in the future. This makes CEDaCI a key enabler of the Circular Economy within Data Centre Industry. By bringing stakeholders together, CEDaCI is reinforcing the viability of circularity within the sector.

References

1. K. Mlitz, *Number of data centers worldwide 2015-2021* | Statista [Internet]. Statista. (2021) [cited 10 October 2021]. Available from: https://www.statista.com/statistics/500458/worldwide-datacenter-and-it-sites/

2. *CEDaCI – Circular Economy for the Data Centre Industry* [Internet]. Nweurope.eu. (2018) [cited 8 October 2021]. Available from: https://www.nweurope.eu/projects/project-search/cedaci-circular-economy-for-the-data-centre-industry/

3. *Electronic Waste and the Circular Economy* – Environmental Audit Committee – House of Commons [Internet]. Publications.parliament.uk. (2020) [cited 8 October 2021]. Available from: https://publications.parliament.uk/pa/cm5801/cmselect/cmenvaud/220/22008.htm

4. V. Forti, C.P. Baldé, R. Kuehr, G. Bel, *The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential*, United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam (2020)

5. D. Andrews, B. Whitehead. *Data Centres in 2030: Comparative Case Studies that Illustrate the Potential of the Design for the Circular Economy as an Enabler of Sustainability*, LSBU Open Research [Internet]. Openresearch.lsbu.ac.uk. (2019) [cited 8 October 2021]. Available from: https://openresearch.lsbu.ac.uk/item/8675q