CEDaCI Circular Economy
for the Data Centre Industry

The business case for refurbished equipment

D2.1 - Preparatory Phase

Circular Economy
for the Data Centre Industry

Interreg
North-West Europe
CEDaCI
European Regional Development Fund

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Abstract

This report constitutes the CEDaCI deliverable D2.1 “Preparatory Phase – The business case for refurbished equipment” which analyses refurbishment cases, exploiting feedback from Work Package 4 “Situational Analysis & Network Building” and more specifically, the publication of the Situational Analysis and Review Document, publicly available for download on the project website.

The report further covers a market analysis of the Data Centre and Refurbishment, Hardware (HW) information review, feasibility and case studies overview and identified gaps, primary considerations and strategies for enabling the decision making model and finally a “put to market strategy” including CAPEX or OPEX based solutions.
As such, the main objective of this report is a starting point for providing guidelines and foundation for a Circular Economy (CE) approach for refurbished equipment.

About CEDaCI

Circular Economy for the Data Centre Industry (CEDaCI) is a five year, Interreg North-West Europe-founded project across the UK, Germany, Netherlands and France. CEDaCI will create a robust Circular Economy for the Data Centre Industry by adopting a whole-life-cycle approach to the problem of sectoral e-waste.

The Data Centre Industry has grown rapidly and generates a large volume of WEEE. The current infrastructure for dealing with this waste is underdeveloped and consequently, there is a real and urgent need to address this now. CEDaCI is bringing together stakeholders from all equipment life cycle stages to turn this waste into a valuable resource and support the ongoing rapid growth of the DCI.

Project Delivery Team

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List of Acronyms

CE	Circular Economy
CRM	Critical Raw Materials
DC	Data Centre
DCI	Data Centre industry
EC	European Commission
EU	European Union
EU CoC	EU Code of Conduct
GDPR	General Data Protection Regulation
ICT	Information and Communication Technology
MRA	Metropolitan Region of Amsterdam
OCP	Open Compute Project
OEM	Original equipment manufacturer
LCM	Life Cycle Management

Introduction

According to the latest research by Paolo Bertoldi from the EU Joint Research Centre, we are acknowledging an exponential and rapid growth in Data Centre (DC) energy consumption in the European Union (EU): from 56 TWh (in 2013) to an anticipated 104 TWh in 2020[1]. DCs are the backbone of our digital economy, where our use of digital services generates huge data traffic, which continues to rise every year, despite the use of more virtualisation and cloudification. As such, to keep up with the latest technology, DC equipment is facing an extensive decommissioning process. It is estimated that servers, batteries, storage and network equipment have a lifespan between 3 and 5 years.

These challenges lie at the heart of the CEDaCI project and are the reason why we need to implement a Circular Economy (CE) for the Data Centre industry (DCI). There is also an urgency to tackle waste management and integrate a real strategy of Life Cycle Management (LCM) for DC equipment.

The CE is an economic system that promotes sustainability by mimicking nature's ability to design out waste and pollution, keep products and materials in use, and regenerate natural systems[2]. Sustainability and CE are driving business opportunities and are uncovering new impactful activities. This is a driver for change and transformation, and we need to embrace these concepts to transition towards new legacy systems. Unfortunately, a recent report shows us that the world is only 8.6 % circular[3], meaning that, according to the organisation Circle Economy:

"the global economy is consuming 100 billion tonnes of materials a year for the first time ever, but the cycling rate of resources has gone into reverse."

With the growing digitisation, comes many new innovative features. Netherlands, and the Metropolitan Region of Amsterdam (MRA) has developed an internationally important and ever-growing ICT (Information and Communication Technology) and DC industry. At the same time, many organisations also are aware of the sustainability challenges that this brings about e-Waste, resource scarcity, health, and environmental issues related to the use of data centre IT hardware. Circular IT and refurbishment/reuse of IT equipment are growing, and many new initiatives have started. However, there is still much unknown. In addition, refurbished equipment is still underestimated in data centres.

1. H2020 CATALYST project - D8.6 Green DC Energy Efficiency Roadmap
2. Ellen Macarthur Foundation
3. Circule Economy - Our World Is Now Only 8.6% Circular

Introduction

What are the different strategies for enabling a CE?

What is the role of the refurbishment strategy in a CE?

What are the primary considerations for the business case for refurbished equipment?

One of the objectives of this report is to get a handle on the misconception surrounding refurbishment and recycling that means the market has only made small investments which is not a suitable and viable economic model. There are numerous case studies, companies and an ever-growing demand for this equipment.

Market analysis

Data centre market

This section will outline the key information about the characteristics of the data centre market. We will present information on the prism of refurbishment and e-waste. Data centres operate in a fast-paced environment, where innovations are answering business operation and geographical challenges. As such, data centre decommissioning is an important part of managing a data centre.

Market characteristics

Data centres are complex spaces, involving internal and external dynamics that have direct and indirect effects on the different set of factors.
Growth in the sector teaches us that 90% of the world's data was created in the last two years. As such, 6.8 ZB[4] was the annual global data centre IP traffic in 2016. In 2021, the IP traffic is expected to reach 20.6 ZB. This shows that the industry is growing at an exponential rate.

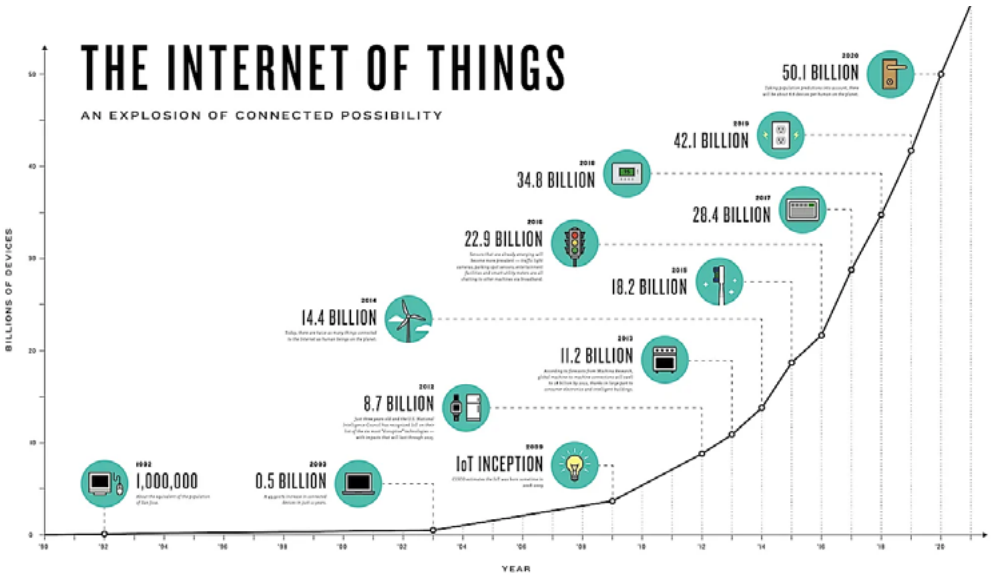

Figure 1. IoT, an explosion of connected possibility

4. Dutch Data Centre Association Publications: State of the Dutch Data Centers 2019 – Digital Awareness is Near

Legislations and current governmental policies

The data centre landscape is changing and therefore, new legislations and policies are constantly adapting. In this section, we will focus on the most important and relevant policies used in the sector.

The coordination group on Green Data Center (CENELEC)

CENELEC is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field[5]. They are the principal member of the Coordination Group on Green Data Centers[6] and are responsible for the development of the EN 50600 series of standards. It represents the first European standard that uses a holistic approach to make comprehensive specifications for the new construction and operation of a DC. It defines requirements for building construction, power distribution, environmental control, telecoms cabling, security systems, management and operations. In particular, EN 50600 series cover design standards (EN 50600 2-x), operational standards (EN 50600-3-x), and resource efficiency and management (EN 50600-4-x)[7]. CENELEC produces also Technical Reports (TRs), which are much more flexible than a formal standard and can be developed and approved far more quickly. A TR is essentially a toolkit of recommended practices. TRs can cover all sorts of things, from HR to security. CLC/TR 50600-99-1 is focused on energy management in DCs and CLC/TR 50600-99-2 on recommended practices for environmental sustainability, and are based on the EU Code of Conduct for Data Centers.

Certified Energy Efficient Data Centre Award (CEEDA)

CEEDA is an energy efficiency assessment framework addressing best practices which directly impact OPEX, providing a globally applicable certification and guidance on optimizing deployment of labour and CAPEX to maximize performance. The framework is progressive in terms of sophistication of best practices applied – reflecting the complex and holistic nature of data centre operations- and is based on specifications drawn from ASHRAE, Energy Star, ETSI, EU CoC and The Green Grid.

EU Code of Conduct for Data Center

The EU Code of Conduct (EU CoC) is the first government-led set of best practices intended to drive good energy management in the DC sector. Initially developed by members of the British Computer Society, it was adopted by the Joint Research

5. https://www.cenelec.eu/aboutcenelec/whoweare/index.html
6. https://www.cen.eu/work/Sectors/Digital_society/Pages/GreenDataCentres.aspx
7. http://project-catalyst.eu/wp-content/uploads/2019/01/CATALYST.D2.2.GIT_.WP2_.V1.0.pdf

Council (JRC) of the European Commission. The Code is available on a voluntary basis and is updated yearly.

It comprises 150+ best practices for a data centre entity to adopt to reduce energy and thus carbon emissions, it also comprises some sustainability best practices. Since 2016, the best practices have also been included in the EN50600 series of data centre design, build and operate standards as a technical report, EN50600 TR99-1, subsequently the sustainability elements have been collated as a separate technical report and published as EN50600 99-2.

International Telecommunication Union (ITU)

ITU[8] is the United Nations specialized agency for information and communication technology – ICT. It was founded in 1865 with the objective to facilitate international connectivity in communication networks, by developing technical standards and seek to improve access to ICT to underserved communities worldwide. Their members, ranging from public and private sectors, are working together to help shape the future ICT policy and regulatory environment, global standards, and best practices to help spread access to ICT services.

ITU has three main areas of activity organized in 'Sectors' which work through conferences and meetings. Among the three, there is the ITU's Telecommunication Standardization Sector (ITU-T). Standardization work is carried out by the technical Study Groups (SGs), one of which is: SG5- Environment and Circular Economy. This SG will be detailed in "ITU-T Study Group 5- Environment and circular economy" on page 15.

PESTEL analysis

In this section, we will detail the different factors influencing the data centre market, related to refurbished IT equipment. The goal of this table is to highlight the main gaps for the refurbishment market and the influence between the constant need for innovation versus the replacement of servers.

The PESTEL analysis is a tool used to conduct an external analysis of the business environment of any industry. The analysis provides valuable insight into the operating challenges that any company in the industry appears to face, and so the company in question may face as well.

8. https://www.itu.int/en/about/Pages/default.aspx

Table 1. PESTEL analysis of data centre market

Political	Government and their respective policies and priorities have an impact on the sector. Granting the permission to design, build and operate a data centre in a specific city or region is attracting not only investments and jobs but is a driver for the digital expansion and recognition of our cities and societies. The FLAP market has witnessed the first ever halt for new build data centres. Indeed, the City of Amsterdam put a year-long stop on new data centre builds before collectively designing a smarter strategy for this ever-growing market.
Economical	The FLAP market is a growing market, with 24% increase in 2019[9]. This level of growth must be put in parallel with market confidence in these economies. According to Gartner, worldwide IT spending is projected to total $3.74 trillion in 2019, an increase of 0.6% from 2018[10].
Social	Indirect factors are numerous and concern mostly the working conditions and the supply chain: conflict materials, exposure to hazardous metals and e-waste at end-of-life. Though these aspects do not impact directly on the 3 most important aspects of a DC- performance, availability, and security- they need to be considered.
Technological	The number of data centres is incrementally rising. 18.5% is the average growth by the Dutch data center hub in the last 8 years[11] , and so too do the volumes of hardware within these infrastructures increase. As such, the constant need for innovation and business demands are responsible for the upgrade of equipment in data centres. The sector witnessed a shift from on-premise IT owned assets to (public) cloud computing with increasing numbers of servers, network equipment and data storage. High operational demand for data processing and storage devices are linked to the sharewww of data centre operators which are decommissioning their hardware equipment every 3 to 5 years, “if not sooner”[12].
Environmental	Environmental concerns for data centres can be grouped in two main categories: level of energy consumption and environmental impact of hardware refresh. Considering the number of servers in a data centre, it represents one of the biggest energy costs, as well as material costs, composed mainly of plastics, aluminum, steel and CRM. The percentage of data centre waste is divided into 15% buildings and facilities (60 years) and 85% from IT equipment (3-5 years).
Legal	New laws and regulations or modifications of existing ones influence the DCI to better pave the way for a greener and a more circular sector. Policies and regulations are one of the most important drivers for change.

9. https://data-economy.com/european-colocation-take-up-surpasses-200mw-for-the-first-time-in-q4-2019/
10. https://www.gartner.com/en/newsroom/press-releases/2019-10-07-gartner-says-global-it-spending-to-grow-06-in-2019
11. Dutch Data Centre Association Publications: State of the Dutch Data Centers 2019 – Digital Awareness is Near
12. https://15tyiy1j6r1m26d5mxyq74md-wpengine.netdna-ssl.com/wp-content/uploads/sites/2/2019/05/global-data-center-decommissioning-white-paper.pdf

Market analysis

Refurbishment market

This section details the rationale for the refurbishment market, providing information on the market characteristics, an analysis of the stakeholders, the different legislations in place and a PESTEL-GS analysis as a way of summarising the collected input.

Market characteristics

According to the Situational Analysis report[13] made by our partners in France, they defined refurbishment as the "the expansion of the product lifespan". The international standard NSF[14] defined refurbishment as the functional or aesthetic maintenance or repair of a product to restore to original or upgraded functional state. Refurbishment is part of a Circular Economy model. But refurbishment is only one stage in the Circular Economy process. Different steps are also necessary and are intertwined with concepts such as recycling and reuse.

Recycling can be defined as operations by which products, components, materials, or waste are processed and converted into raw materials for use in the production of new products or in processes, not including energy recovery or disposal.
Where reuse is the concept of using again, equipment or components for the originally intended purpose, a similar purpose, or in an upgraded state, possibly after refurbishment, repair or hardware upgrading.
The Ellen MacArtur Foundation visualised abovementioned processes in a circular economy system diagram[15], commonly known as butterfly diagram, which summarises the different strategies and steps towards achieving a CE.

Based on the Situational Analysis report, the secondary market of refurbished equipment is quite developed in Europe, presenting different actors (brokers, spare parts providers or remanufacturers). IT equipment is re-used after being traded by brokers.

In NWE, it is estimated that 133 brokers dealing with data servers operate in UK (64), Germany (29), Netherlands (24) and France (16)[16] . Remanufacturing in Europe

13. WeLoop Situational Analysis Report
14. National Sanitation Foundation
15. Ellen MacArtur Foundation Butterfly Diagram
16. "The Broker Site," 2019.

represents an important turnover of $6,900 billion, compared to $2,700million in US. Spare parts providers get complete equipment, dismantle it and sell the components (under the requirements for spare parts) to third party maintainers who service and upgrade existing equipment. Some business models are already based on secondary market equipment, e.g. ITRenew (USA), who works with hyperscale centres.

Specific data for the DCI in Netherlands is available in the Green IT Report: Circular Data Servers, where it is estimated that more than 184k server units are scrapped every year in Amsterdam alone. 11% are refurbished, 24% recycled and the remaining portion is exported out of The Netherlands. From the recycled fraction, it was estimated that 81% of the materials are recovered, while 15% is valorised (incineration with energy recovery or using residues as stuffing), with only 4% lost in the process. The export of servers for reuse is estimated to be >50%.

A podcast published by Martin Thompson from Free ICT Europe (reference) spoke with Astrid Wynne of Techbuyer on IT's role in the Circular Economy on January 16, 2020. Wynne confirmed that even though some numbers are available, it is still difficult to assess the market size. Refurbishment can vary between 10 and 20% of the market. The main problem is that equipment is not necessarily tracked when leaving its first use. Meaning that some equipment can be lost and go off-radar.

Lifecycle analysis of a network product

Upgrades in an infrastructure environment are often happening because the current generation of equipment reaches its end-of-life and is no longer supported by the OEM.

End-of-Sale:
The last day to order the product through the OEM point of sale mechanisms (vendors often still provide support after this date).

End-of-Life:
Indicates that a product is at the end of its useful life (from the OEM's point of view), and a vendor stops marketing, selling, or sustaining it. Support and replacements become unavailable.After the initial End-of-Sale date, the maintenance and support costs are increased, and the user is nudged to implement a newer model. From here the cycle resets until the current model reaches the same status.

Proof of concept phase:
Usually when a new product is introduced, it takes about 2 years until the reliability, support and newer features stabilise. This happens after a few software updates and patches.

Deployment:
This is the optimal period to use in production according to OEMs. Usually after the period of 3 years, a new product line is introduced with better performance or new features and focus shifts to upgrading the infrastructure.
Often this means that users are in an endless loop of transitioning to in-life equipment, even if their current equipment suits their requirements.

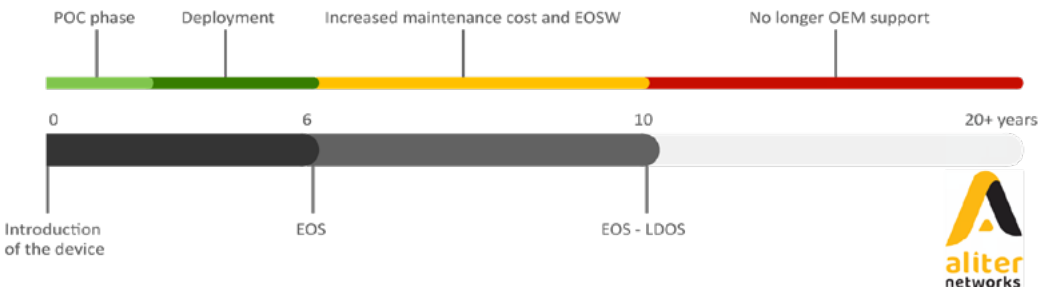

Figure 2. Lifecycle of a product from 0 to 20+

Legislations and current governmental policies

A number of national and European drivers have an influence on the e-waste market, including refurbishment, recycling and end-of-life scenarios. The main ones are included in the following section.

EN 50600 TR-99-2 Sustainability Best Practices

EN 50600 represents the first European standard using a holistic approach to make comprehensive specifications for the new construction and operation of a data centre. It defines requirements for the construction, power supply, air conditioning & ventilation, cabling, security systems, and defines criteria for the operation of data centres.

In the latest document, there are various recommended practices for environmental sustainability and for embodied impact of ICT equipment that are interesting for the CEDaCI project.

In the category "Utilization, Management and Planning: General policies", section 7.9 Hardware end-of life processes, it says "Implement e-waste and reuse policies which ensure ICT equipment is resold, recycled, donated, or disposed of based on legislative, ethical, and sustainability considerations. Management of potential data security risks shall be considered. Measurement of share of Used Electrical and Electronic Equipment and Waste Electrical and Electronic Equipment which is recovered and responsibly disposed of can help identify opportunities for improvement. The Green Grid describes an Electronics Disposal Efficiency metric.

ITU-T Study Group 5 - Environment and circular economy

ITU-T Study Group 5 (SG5) is responsible for studies on methodologies for evaluating ICT effects on climate change and publishing guidelines for using ICT in an eco-friendly way. Under its environmental mandate SG5 is also responsible for studying design methodologies to reduce ICT and e-waste's adverse environmental effects, for example, through recycling of ICT facilities and equipment[16].

Circular Economy Action Plan

The new EU Circular Economy Action Plan[17] was published in March 2020, with a focus on electronics and ICT equipment, as a key product value chain. The

17. https://www.itu.int/en/ITU-T/about/groups/Pages/sg05.aspx
18. https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf

report aims to set directions for the sector to promote longer product lifetimes by including regulatory measures for electronics and ICT under the Ecodesign Directive. It also sets priorities for devices to be designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling. Moreover, there is a focus on electronics and ICT as a priority sector for implementing the 'right to repair', including a right to update obsolete software.

Our digital age and the green transition are also enabling factors for the circular economy and the development of new business models. As such, the EC plans to update and propose an Intellectual Property Strategy to ensure laws support EU businesses' competitiveness.

Conflict Minerals Regulation

On the 1st of January 2021, a new law will apply across the EU – the Conflict Minerals Regulation[18].

It aims to help stem the trade in four minerals – tin, tantalum, tungsten and gold - which sometimes finance armed conflict or are mined using forced labour. The regulation will mean changes at different business levels, whether it is an importer of minerals or metals, a smelter or refiner of them, or the owner of a due diligence scheme.

It aims to boost corporate transparency and performance, as well as encourage companies to embrace a more sustainable approach.

WEEELABEX

This standard was introduced in 2011 in the framework of a project co-financed by the European Commission's LIFE+ programme. It sets out a coherent, continent-wide and comprehensive set of technical requirements with respect to e-waste operations. Compliance is voluntary.

The requirements laid down in WEEELABEX are embedded in Directive 2002/96/EC and its transposing legislation. WEEELABEX comprises three documents: collection, logistics and treatment. It is available in seven languages.

19. https://trade.ec.europa.eu/doclib/docs/2017/march/tradoc_155423.pdf

PESTEL analysis

The benefits of using and buying refurbished equipment are very straightforward. In this section, we will summarise the different factors influencing the refurbishment market and the requirements for paving the way to a business case for refurbished equipment. As such, adopting data centre circular economy principles can be divided into different categories.

Table 1. PESTEL analysis of data centre market

Political	Political aspects are not always used in a put to market strategy but in this business case for refurbished equipment, they are quite important to acknowledge. By being able to extend the lifecycle and reduce the need for new products, we can reduce the dependence of countries with unstable governments where many CRMs are mined. For e-Waste, which is the fastest-growing waste stream in the world, by remarketing equipment, we reduce the electronic waste stream to countries unable to recycle these materials.
Economical	Refurbished equipment maximise the financial value in the form of the lifetime value of IT hardware assets and therefore, maximises sustainability. By making use of refurbished equipment, organisations can save 50-90% on their OPEX spending, creating additional IT budgets for CAPEX and therefore more opportunity to innovate. Whether you are a hyperscaler decommissioning your IT hardware and want to maximise the financial value or a small-scale data centre constrainted by budget and want to free up budget for other things, refurbished equipment is a relevant and economical alternative.
Social	A common practice for OEM suppliers is to use a Vendor lock in model. In short, if you are tied to a certain vendor, even a cloud vendor- and you want to change direction- it's going to cost time and money. Usually the buyer of equipment will be tied to multiple year hardware and support contracts. When making use of refurbished equipment from an independent supplier, more freedom can be created on which products to keep in the network. Brand name recognition is also a factor for refurbished equipment because the consumer can now afford to buy a product from a branded manufacturer, even if it is reconditioned, acquire knowledge and experience about circular IT purchase As a society, we should all care about the sustainable impact of IT hardware, even if data centres are quite often hidden from the public eye.

Technological	When equipment is refurbished, it will be tested, repaired and supported by a company in order to ensure that it works as new. In many cases this equipment can be more reliable than new equipment due to the Bathtub curve. Due to better availability in the market, it is also often easily replaceable and better to support on short notice. Additionally, the software on devices which have been around for a longer period often already have multiple bugfixes and software updates, resulting in a more stable product compared to new units that are still in proof of concept phase.
Environmental	Adopting data centre circular economy approaches maximise sustainability: moving from the linear principle of take/make/dispose to a model that is circular, generating multiple loops of lives for equipment and deferring negative impact of new manufacturing. Hence, reducing CO2 emissions, sectoral waste, and the need for new products, and so fewer primary materials are used in the production/consumption/loss.
Legal	More and more new legislative and regulatory measures are being developed, and old ones are being updated to better-fit the challenges of the sector. What was valid 10 years ago is no longer valid in our fast-paced economy. A great example of this is the new Circular Economy Action Plan in which the European Commission (EC) recognised the lack of sustainability and is the reason why the Circular Economy Action Plan features so prominently in the European Green Deal.

Explanation of the bathtub curve in electronic equipment containing PCBs:

The bathtub curve consists of three periods: an infant mortality period with a decreasing failure rate followed by a normal life period (also known as “useful life”) with a low, relatively constant failure rate and concluding with a wear-out period that exhibits an increasing failure rate.

Figure 3. illustrates the well-known bathtub curve shape of failure rate changes over time. In the initial period, some equipment or installations have a high initial rate of failure, the portion of the curve is called the burn-in or infant mortality phase, in which the defects developed during initial manufacture of a component cause failures. After these defects are eliminated, the curve levels into the second zone, called the constant failure zone which reflects the phase where random accidents maintain a fairly constant failure rate.

Mean time between failure (MTBF) refers to the average amount of time that a

20. https://www.sciencedirect.com/topics/engineering/bathtub-curve

device or product functions before failing. This unit of measurement includes only operational time between failures and does not include repair times, assuming the item is repaired and begins functioning again.

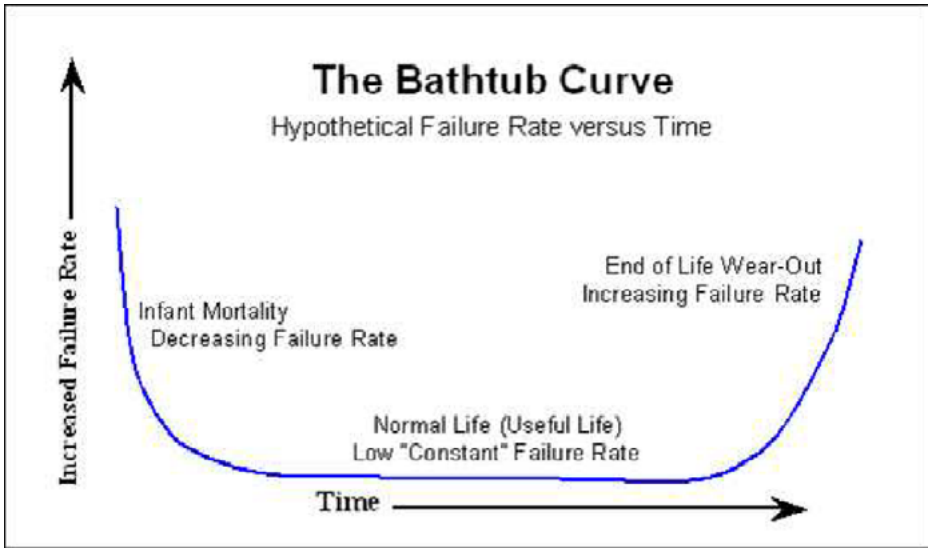

Figure 3. The bathtub curve reliability model

Example:

The 3750X series is still in use with many organizations. The series was introduced in 2010 and the EOS (end of sales) date is 30 October 2016.

For a 3750X-24T switch, the MTBF can be found in the datasheet.

Mean Time Between Failure (MTBF) Hours	
3750X-24T	189,704
3750X-24P	167,198
3750X-24U	238,070
3750X-48T	171,846

Table 3. Mean Time Between Failure Hours

In hours this means (/24) 8.279 days and (/365) over 22 years of continuous running time.

After 3-5 years of use it is recommended to upgrade to a newer model as the current one is no longer supported by the OEM.

The Technical performance of the device still allows it to function properly for another 17 to 19 years according to the above data.

The advantage of making use of pre-owned hardware here means that the equipment has passed the “burn-in” phase with its relatively high failures, and instead performs in the flat area of the bathtub curve with its relatively low failure rate.

Hardware Information Review

Current situation

In the Data Centre Industry, there is a strong focus on power usage. The energy consumption including the ongoing need for improvement in the hardware for higher speed connectivity required by the biggest hardware buyers in the data centre industry (hyperscalers) like Google, AWS, Microsoft, Facebook is the main driver for OEMS to keep innovating their products at a rapid pace.

The growth in absolute numbers of users worldwide and the data consumption which flows out of this is one of the reasons why the hyperscalers are in need of better, faster and scalable products/ solutions. The legacy hardware manufactured by the OEMS are not specific to any given industry and are not scalable in the way the hyperscalers want. The time taken for the OEMS to move from R&D to mass production and delivery, is a further reason why the biggest purchasers of hardware are looking to design their own hardware to ensure self-reliance, meaning they can produce based on their own specific needs, adapt quicker, and work in a more scalable way like OCP (Open Compute Project). Facebook has been one of the pioneers in the Open Compute Project and there are fully operational data centres completely running on OCHW.

Average lifecycle legacy hardware (OEM) per customer category:

Customer category	Average lifecycle legacy hardware
Hyperscaler	3-4 yr
Enterprise	4-5 y
SMB	5-6 yr

Table 4. Average lifecycle legacy hardware (OEM) per customer category.

Cloud is growing every day and the cloud providers are the main driver behind the push for ever improving hardware. Most of the hardware in the current DCs/Colos and on-premise (enterprise) solutions, is coming from the OEMs. Legacy hardware (routers, switches, storage, servers and all its parts and components) is sold in the second-hand market and widely accepted across the globe.

Products coming from a first user are being assessed from a technical and commercial point of view before they are resold. They can flow down layer by layer, from hyperscaler to Telco to Enterprise to SMB based on (for example) the usage where the hardware is needed most. However, it could also be redeployed in their own supply chain.

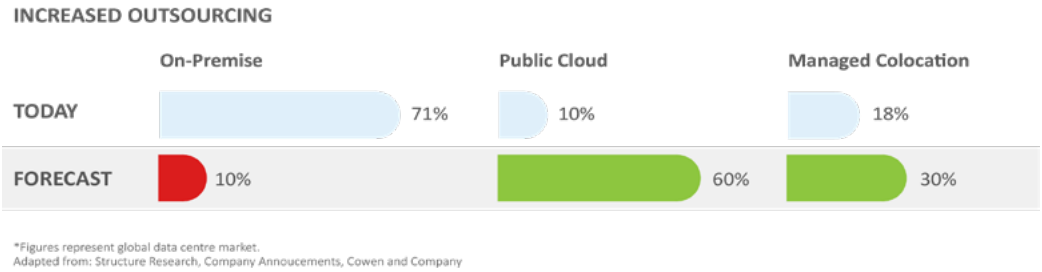

Figure 4. Increased outsourcing for data centre market

What is the future?

Looking at the current landscape of the Data Centre Industry, where a lot of hardware is still running on premise with SMB's and Enterprises with the strong shift to cloud, it is likely that the cloud providers (hyperscalers) will become the biggest suppliers of data centre products to the second user market for legacy hardware as well as OCP hardware. Where hyperscalers are designing products themselves based on their specific needs/ requirements it will become a challenge to reuse their hardware as a whole product and will most likely go into parts harvesting/componentry reuse where possible. In some cases, the owner of the material wants it recycled from a data protection point of view, in other cases the components are just too specific for others to reuse them. The hyperscalers don't necessarily want to become designers/manufacturers but they want to have their needs fulfilled until OEMS will take care of it

.

This specific hardware is not broadly accepted/wanted by the "smaller" data centres and is a niche compared to the current situation where legacy hardware (OEM) is more accepted by the second user market.

Momentarily whole racks with OCP hardware are being refurbished and put back into the market. However, this is still just in the beginning phase and needs time before the market has accepted this major shift.

Based on the above assumptions more material will need to be recycled after component harvesting which comes down to either better extraction solutions for the CRM out of this material or more mining, which is in conflict with all sustainability goals.
Changes from OEM legacy hardware to user-defined OCP hardware and design can bring great opportunities when all stakeholders collaborate throughout the lifecycle from the design phase through to reclamation at its end-of-life.

Feasibility studies overview

This section will detail three feasibility case studies that we have been working on in the past year. The three cases studies will be described and analysed. The first part of each section will be an analysis to explain the different objectives and outcomes of the case study. The second part will highlight various gaps that we uncover in order to facilitate the design and implementation of the Pilot activity.

Case study 1:

Closing the Loop

Analysis

The business model of Closing the Loop is set up from a socio-economic point of view. It offers users, buyers and resellers in countries without proper recycling facilities a solution to make these end-of-life mobile devices, phones and tablets, material-neutral and waste-free instead of ending up at landfill for precious metal extraction through burning by minorities and underaged children.

Closing the Loop pays a fixed fee per phone to collect it at specific points in a country. This results in less impact on the environment and a safer environment for the people who used to burn the product for reclamation of the CRM.

Closing the Loop gathers all devices in a country until they have a container-load. When the container is filled it is shipped to their partner in Belgium, Umicore, who is a smelter and reclaims CRM via a proper process. Working directly with a smelter as a company like Closing the Loop is quite unique as smelters normally only collaborate with recycling companies which bring in volume and better separated material than complete phones. By keeping the lines as short as they do and the volume Closing the Loop collects in the countries they operate in, it is commercially interesting for all stakeholders on a sustainability basis.

For this case study, there are numerous gaps that we can highlight:

- LME prices
- Data breaches (GDPR)
- Local wage increases
- CRM in the older devices vs current models
- Corruption
- Country-specific regulation changes
- Transport price fluctuations
- Device as a Service (DaaS)

Case study 2:

(R)eStructure

Analysis

The (R)eStructure initiative focused on an area within the ICT sector which is generally not visible or known to the average person; yet is highly present in our daily digital lives: the ICT related infrastructure for the data centre. This includes server, storage and network equipment and related products such as racks, cabinets, cables etc. The aim of (R) eStructure was to gain insight into the chains that play a role in the reuse of IT hardware that is disposed of at its end-of-life by a data centre or IT department, but that can be used for new applications.

The (R)eStructure business model was developed based on supply chain collaboration, transparency and adoption of Circular Economy principles while sharing responsibility and benefits. It was created as an 'open adoption' model. Its design is based on the premise of flexibility, scalability and the ability to absorb new knowledge about circular aspects relevant to data centre equipment.

(R)estructure makes the hardware more easily recycled and reallocatable with appropriate business models, based on the principles of the Circular (ecosystem) model, which simultaneously reduces negative impacts and enhances positive impacts. We focused on the chain with a focus on the creation of practical cases. This requires a support infrastructure that - depending on the wishes and needs of a customer - can always be different. For each case study, we questioned (chain) partners in facilitating an appropriate business model.

The (R)estructure project aims to facilitate a circular ecosystem model that supports (services) infrastructure and can be delivered easily and quickly based on a business model where all chain partners have a share (Income and responsibilities) in it.

This will be the foundation of Pilot B and especially the Deliverable 2.3 – The business case for refurbished equipment pilot.

The Dutch pilot aims to validate opportunities, demonstrate impact in the market and provide examples that include the various potential circular scenarios from the model. The pilot will work in incremental steps to continuously improve this, by organising a Transnational pilot and collaborating with other countries in the market that are looking to adopt circular principles. More information on the pilot will be available in the second report Deliverable 2.2: Preparatory Phase – Analysis of the Tested Business Model.

21. (Re)structure - Towards a truly Circular Model for Data Centre Equipment. Initiative and project report December 2018

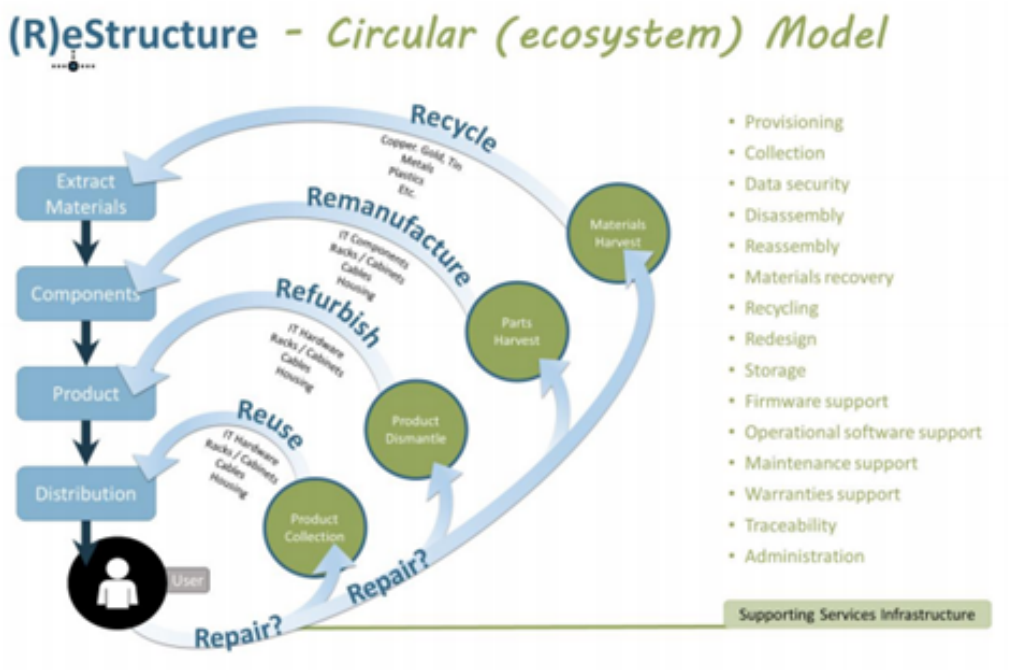

Figure 5. (R)eStructure Circular (ecosystem) model

Gaps

As part of the CEDaCI pilot deliverables (Work Package 6), this model will be used and the gaps in the previous (R)structure project will be established and solved.. As such, a launching customer – a user of refurbished hardware – and engage them for our Business case for refurbished equipment pilot.

The launching customer is a purchaser, as in, an organisation participating as a buyer of recycled hardware. The other customer will be a batch provider, an organisation that offers a batch of hardware that is used for reuse. The main benefits and return values for the customers are very diverse.

First of all, the purchaser will acquire knowledge and experience about circular IT purchase and as such, receive purchasing support. Ultimately, the pilot activity will contribute to company's targets for sustainability, circular economy and innovative procurement. There is also an important recognition aspect – the company will be a "prosumer" in initiating such change. Prosumers have a large impact on design and use and therefore, creating enormous change in the industry. Financially speaking, buying second-hand IT hardware generates lower investment costs through the pay-for-use structure.

Case study 3:

Circular Equipment

In this section, an example business case in which refurbished equipment was better than a new solution will be presented:

The details:

- Industry: systems integration
- Location: Austria and Germany
- Company size: approx. 30 employees

A contracted systems integrator for a major international US bank installs IT systems for their client's ATM machines and other electronic payment services. This includes bank statement printers, self-service terminals, cash register systems and networks.

The challenge:

ATM machines need to be connected 24/7, 365 days per year, and the router is the key element that keeps everything up and running. To meet their US client's needs, the company needed to find high quality, budget-friendly integrated service routers. For safe operations of an ATM, 3G routers suffice, so the desire was to source the Cisco 800 3G wireless series. Unfortunately, these were discontinued and replaced by a 4G model at a significantly higher price point.

The solution:

Fortunately, because Aliter works with pre-owned equipment, the company was able to refurbish Cisco 800 3G routers and guarantee their supply to the systems integrator. The routers turned out to be a perfect solution for the company – from both a quality and performance perspective, as well as an economic standpoint.

"It is great to save such a large amount of money",

says the company's IT Manager.

"But with the line of work we are in, performance and reliability are even more important. Since working with Aliter Networks, we've only had to replace one single 3G card out of approximately 1000 of the routers we've purchased. This speaks for the quality that they deliver."

Refurbished IT products:

1000x Cisco 800 Series (3G wireless) integrated services routers.

Difference made:

- Established a long lasting, trustworthy business relationship
- Provided high quality refurbished IT networking equipment with lifetime guarantee
- Saved the company €350.000 over the course of 5 years

Preliminary Decision-making model

In February 2020, a Community of Practice (CoP)- including Fairphone, Circle Economy, Sustainable Finance Lab- released a report called Tracking Value . The report followed the launch of the Fairphone 3. One of the key learning that we wanted to highlight for the introduction of this section is the following sentence: "Collecting insights about usage and performance of assets enables the entrepreneur to improve the product and further increasing the product lifespan". This sentence details perfectly the rationale behind the objective of our Decision-Making Tool (DMT).

Route 1:

Refurbishment

Process and steps taken, how to track, and how testing works:

First, we start with an example on asset recovery. When an organisation is upgrading their network infrastructure Aliter can offer to process the old equipment and reduce electronic waste. With the devices that can still be reused (for organisations that don't have the highest requirements) value will be generated.

After securely packing and transporting the equipment to the warehouse, all is unpacked and will be received into Aliter's system by assigning a barcode and serial number to each device. This is used to trace each product as it moves through the building and after repurposing.

First each device is visually inspected for any damages, alterations and original serial numbers. If it does not qualify for further testing it will be separated here from the rest of the equipment for dismantling (in cases of larger modular equipment) and recycling.

Next, it is moved over to the testing environment where engineers clear all the equipment of old configurations and data. Each testing station is suited to connect and simulate a network environment to check if the equipment still works as originally described. Then each port is tested individually on maximum data throughput, power, PoE, fans and overall performance. Test logs are created, and the image version and active licenses are identified.

If performance testing and quality process is successful, the equipment is moved over to our final stage. Cleaning and Packing. Here, stickers and small scratches are removed and repainted. Any dust accumulation inside is thoroughly removed, there is a final check on airflow and blanks are reassembled where needed.

After this process, the product is proven to work and looks as new, now it is ready for packing or kept on stock for future projects.

Route 2:

Dismantling

After thorough testing it can be that some defects occur within a whole unit. When it turns out that refurbishment is (partially) not possible, the components within a whole unit can still be harvested.

For example , when a motherboard is (partially) not functioning, the effort for replacing the motherboard instead of harvesting the useful components, is commercially not interesting for a refurbisher. The following components are, amongst others, easy to harvest and reuse: CPU, RAM, FANs, GPU, PSU, Rails.

Stripping down a unit upon a component level is essential for service providers, end users and distributors. Looking at the future where OCP hardware is the trend, reusing components is a big sustainable advantage.

Route 3:

Recycling

When a product is completely stripped of the commercially interesting components, it is ready for recycling and shredding in order to reclaim the CRM in the leftovers of the assets disposed.

Recyclers are collaborating closely with smelters in order to reclaim at least the commercially interesting CRM. It would benefit circularity if recyclers were working strongly together with OEMS in the design phase with the end in mind.

Put to market strategy

The process and the model

As long as there will be a relatively short lifecycle of equipment within fast changing organisations, there will also be a market for used equipment and organisations with lower requirements.

One of the potential outcomes of the CEDaCI project is the development of an online decision-making tool. Organisations like data centres and enterprises would be able to find information and compare cost analysis on new versus reusing equipment.
This platform could be supported by a network of suppliers and researchers with a focus on sharing and improving the knowledge base:

- Creating a base of trust for organisations that are new to reuse
- Make use of a network of different stakeholders
- Raise more awareness of the amount of waste generated and solutions for reuse
- Facilitate new opportunities and business models in an ecosystem of collaboration
- A more transparent system of the supply chain
- Sharing of documents and good practices

OPEX or CAPEX solutions

On average the end user organisations that we collaborate with spend 80% on OPEX:

- Support contracts of equipment
- Energy
- Subscription licenses

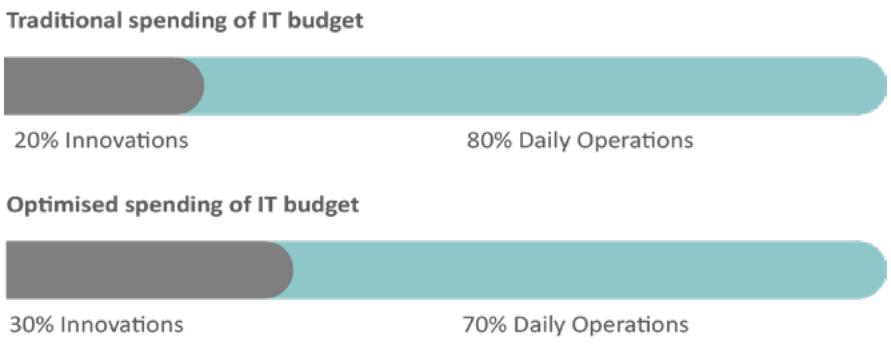

Figure 6. Traditional versus Optimized IT budget spending

When equipment that is not supported anymore by the OEM fails, the organisation is forced to upgrade the whole network instead of replacing that device. This increases

their capital expenses as well without the innovations that the organisation might want to focus on.

By self-sparing and third-party support this is preventable and can keep the infrastructure working properly, intact for as long as the end user wishes. This can save a lot of budget over time.

When an organisation needs to upgrade or expand their network to the latest models they might need to allocate €100,000, plus a further €50,000 for licenses and support contracts (often recurring costs every few years).

Aliter often approach the analysis of the current network on a case-by-case basis, checking what is really necessary now and in the near future.

Functionality of previous generations of equipment is compared and if suitable, recommended for this environment.

As previous generations are well available due to other organisations having to upgrade as well. Even going back one generation can save around 70% and licenses are often not subscription based yet. The price for a pre-owned device is often much lower than a support contract on a new device, here it makes sense to keep an extra unit in stock for quick replacement if needed. The lifetime warranty covers all the acquired devices.
Total costs of this setup that functions in the same way is now €25,000, and without any recurring expenses. Over time and other upgrades, this way of thinking can save a lot of budget while extending the lifetime of equipment that still functions properly.

Conclusion and Future work

The business model of using refurbished equipment has a solid foundation and there are many organizations that thrive by making use of this. However, for organizations that have no experience in this area, it can be challenging.

This preparatory report, as well as the next one, the D2.2, paves the way for the maximization of the economic and environmental life of hardware in the data center environment. Recycling, refurbishing and dismantling of equipment are truly viable pathways, aiming to extend the lifetime of hardware for years.

While hyperscalers are proven to have short refresh cycles of servers, a different method is needed to assess the financial and environmental value of circular IT equipment.
In the next report, we will address a comprehensive data collection sets to analyse the hardware preparation for dispatching based on the 3 scenarios for the DMT: design, refurbish, recycle. We will base our results on economic data to validate the business case for refurbished equipment.