



Government Digital
Sustainability Alliance

Circular Economy Working Group Hardware Lifecycle Management Toolkit

Lead Author: Gerry Hackett

Authors: Deborah Andrews, Steve Haskew, Astrid Wynne

Contributors: Barton Finn, Max Hillman, Mia Scott, Emily Watson-Breeze

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1. Introduction to Circularity

The basic principle of circularity is reuse – the reuse of whole items, the reuse of parts and the reuse of raw materials. The circular economy is the used or second-hand economy. This particularly applies to Information, communication technology (ICT) hardware products. Products should be used and reused for as long as possible in their original form. Various levels of repair, refurbishment or remanufacture may extend this period. At the end of product life, reusable parts should be harvested prior to industrial recycling to extract raw materials. These raw materials complete the circle by being reused in ‘new’ equipment.

1.1 ICT hardware circular principles

Always examine lower cost and lower carbon options:

- a) Continue with existing equipment in operation
- b) Refurbish and redeploy equipment within the organisation
- c) Source refurbished or remanufactured equipment externally
- d) Source new equipment efficiently manufactured with recycled raw materials (where possible)
- e) Source new equipment that operates efficiently, minimising carbon and other emissions
- f) Reuse unwanted functioning equipment through remarketing to 3rd parties
- g) At end-of-life, extract whole parts locally for reuse
- h) At end of life, reclaim raw materials for reuse through recycling locally (where possible)
- i) Repeat steps a to h

In the context of government, these principles of circularity can be amplified with an added stage of reuse – the reuse of equipment within other government departments. The UK government has prioritised UK based solutions for end-of-life material to improve control over recycled raw materials.

To help decision making when sourcing end-user devices, government should profile its users to establish what type of equipment they require. Cash and carbon can be saved at every level through smarter and more targeted purchasing.

We are not yet at the stage where the raw materials extracted from end-of-life products can be directly allocated to the manufacture of the same ‘new’ products. The extraction of these materials from recycled equipment, however, is clearly more environmentally friendly than mining, and they will be reused in other products.

The toolkit will highlight the benefits of these principles in cash and carbon terms, when properly implemented within government.

The adoption of more consistent, aggressive circular policies within government would have significant financial and environmental benefits for UK government.

Our initial work on the cash implications is very encouraging. We have used 2024 data from Computacenter Circular Services for product values, service charges and recycling raw material return. We have also assumed a very conservative change in approach to percentages of products being redeployed and used products being purchased. There is therefore significant room for increasing the benefits identified.

Across an End User Device (EUD) estate of 2.8 million assets within central government, replacing normal refresh activity every 4 years with a more circular approach, UK government would save £500 million and generate 5,000 tons of reusable raw materials over 5 years.

This excludes all Datacentre and Networking (DAN) equipment and infrastructure. It also excludes all assets managed by local and devolved government, the NHS and schools.

An additional area of work over the next few months is the carbon impact of all this activity.

2. Purpose and structure of the toolkit

2.1 ICT categories

The government categorisation of ICT technology is:

- hardware devices: end user devices, data centre and networking
- services: hardware lifecycle, cloud and hosting, network, profession
- software: applications, artificial intelligence (AI), collaborative tooling

This toolkit is focussed on the management of the hardware devices within government, outlined below (2.2 Hardware lifecycle).

There are 2 major categories of ICT equipment:

- End User Devices (EUD)
- Datacentre and Networking (DAN)

DAN is sometimes referred to as 'enterprise' or 'infrastructure', whilst EUD may be referred to as 'workplace computing'.

EUD are the ICT products that enable individual government workers to perform their jobs. DAN is the infrastructure product that creates the platforms on which government software tools and data reside. These platforms are accessed using the end user devices. Both EUD and DAN have several associated peripheral items, which need to be considered and managed, but not tracked individually, through the hardware lifecycle.

This toolkit examines the cash and carbon impact during the lifecycle of these 2 product categories EUD and DAN.

2.2 Hardware lifecycle

The management of ICT hardware can be broken down into 6 phases, which constitute the Hardware Lifecycle of all ICT equipment:

1. **Source** – Evaluate and negotiate purchase of ICT products.
2. **Deploy** – Configuration and rollout to government locations.
3. **Maintain** – Maintain functionality; swap faulty; repair reserve stock.
4. **Decommission** – Collect end of life product; audit and data-wipe.
5. **Reuse** – Redeploy used product within government; remarket used products to third parties.
6. **Recycle** – Harvest parts; recover raw material; report material mass balances.

Outside of the sourcing function, many activities within these lifecycle phases have been outsourced by government to a variety of third-party providers. This contracted work is

sometimes part of a larger managed service package or divided into different components. The provision of new equipment can be financed by one supplier, deployed by another and the end-of-life activity managed by a third.

Each of these phases has distinct operational characteristics with a mixture of technical and logistical services requiring a high degree of skilled coordination to achieve successful outcomes. The carbon and cash costs of these services can be reduced significantly through efficient planning and pro-active management.

In addition, a unique feature of the hardware lifecycle is the opportunity to generate significant carbon and cash savings, as well as major cash revenues from remarketing to third parties.

Functioning used equipment has a cash value which can be accessed through redeployment and savings or remarketing and revenue.

Used equipment also has the potential to reduce carbon impacts through reuse internally with redeployment or externally with remarketing.

This toolkit will help government to understand the dynamics of these processes and optimise the benefits that are available.

2.3 Government benefits

Government has an opportunity to lay down common policies throughout the whole of the hardware product lifecycle:

- reduction in procurement costs
- common sourcing contracts with no costly omissions
- structural incentives for good management
- start point for calculation of product carbon footprints
- increased revenues or reduced costs
- league tables to drive carbon reductions
- improved tech scrap reclamation and reporting of raw materials

One of the major benefits of renewing and refreshing government policy is that it will provide a boost to employment in this sector. The UK is a world leader in the provision of circular services, and the Information Technology Asset Disposition (ITAD) sector already employs 10,000's of employees across all parts of the country.

Growing the sector further and demanding UK based solutions will also support the government's [Critical Mineral Strategy](#), net zero target and strengthen supply chain resilience.

2.4 Building a circular strategy

The Toolkit begins with an outline of 6 key policy decisions to be made by government in this area. To underpin a successful implementation of a circular regime in government for the management of ICT hardware assets.

These are the building blocks of a circular strategy. The current methodologies produce hugely variable commentaries, in many cases unconnected to previous analyses and requiring costly redefinition and repetition.

Clear policy direction will enable meaningful comparisons across and between government departments. It will also provide a benchmark for the provision of hardware lifecycle services in the private sector, as it raises the bar to win government contracts.

It will also dictate the consistent realisation of cash benefits from the timely management of the hardware itself. This will reduce costs in terms of internal and external people resources.

The adoption of standards in product design to facilitate component swap outs and repairs would help to keep products operational for longer.

Last, but not least, policy direction can establish standards for the recycling of hardware at the end of its life. This is the final and, in the long term, the most important element of the circular economy. We can reuse equipment for a time, we can give it a second, even a third life, but eventually everything needs to be recycled.

There are some guidelines in this area within [ISO 59014](#). The standard sets out some of the main principles around traceability of secondary materials. In this document we outline basic reporting requirements which are possible now in the UK. Setting such policies as central elements of government circular strategy will improve the standard of the UK recycling industry.

This will increase control of raw materials and encourage the repatriation of industries utilising reclaimed materials, such as arc steel furnaces and copper refining.) This will also protect and grow a great variety of jobs, both skilled and unskilled.

After this section 3 on 'policy decisions', the toolkit then outlines the management of ICT hardware assets across the lifecycle outlined in 2.2 above.

Throughout this lifecycle journey, the toolkit will highlight the main considerations of each stage; indicate best practice; and outline the cash and carbon impacts of the choices available.

The key stage is the first – sourcing. This is when all elements of the hardware lifecycle services should be considered and appropriate plans adopted.

The toolkit has sections for 2 product areas:

- End User Devices (EUD)

- Datacentres and Networking (DAN)

There are clearly broad similarities across these 2 areas, but the toolkit highlights the key differences that these the management of these products entail. The intention is that these sections can be used as standalone guides for each product area.

At the back of the toolkit is a glossary of terminology and acronyms. There is also an additional reading list to provide more detailed analysis of some of the issues.

3.Key policy decisions

3.1 Policy Decision 1 – Government Product Asset Management System (GPAMS)

3.1.1 Creating a circular decision engine for government hardware

To make the best decisions at all stages of the hardware lifecycle, government needs to store and access a lot of product data. This is clearly an activity that is already being performed to varying degrees in many parts of government.

There are many threads of government thinking in motion right now - the upcoming Government Digital Sustainability Strategy, the forthcoming Circular Economy Plan, the draft Government Buying Standards and the 2025 to 2030 Greening Government Commitments. Now is a good time to direct a common approach to a product database for government ICT assets.

There are many versions of such products available, some of which are already in use within government.

A core product should be selected with a migration plan over a 5-year period to either move assets to the product or create interfaces to existing products. These interfaces would include links to data sets managed on behalf of government by all third-party suppliers – large and small.

Either way the central government database should contain all the asset data that government requires. This is an area where government should apply its buying power and demand the transfer of the requisite data in a timely fashion from its suppliers.

The main challenges with the provision of data are as follows:

- legacy product data take on
- timely addition or removal of products
- timely addition of impact of events – product failures and fixes, refurbished or remanufactured, end of life (within all these a logistics methodology)
- annual update to carbon and cash impacts levels

The system should record core data on every main ICT device deployed into government. The device types are listed below and range in value from hundreds of pounds to many thousands per device.

3.1.2 Product types

There are two main groupings of products. DAN hardware forms the backbone of the ICT infrastructure that manage application software and data storage. DAN hardware controls security and network access. EUD hardware consists of the devices that staff use to access the software applications/data files to perform their day-to-day job functions.

- DAN Infrastructure Hardware – servers, storage, networking and cooling
- EUD Hardware – desktops, laptops, monitors, printers, audio visual, tablets and phones

The hardware peripherals listed below the smaller items associated with the main DAN and EUD devices. They are important since they collectively represent a lot of weight and cost. They should be recorded as assumed volumes and weights attached to the device types, not as assets in their own right. The management of peripherals, from their acquisition through to end of life, should be included in every third-party contract.

These are the main types of peripherals:

- DAN Peripherals – Leads, Cables
- EUD Peripherals – Wearables, Headsets, Keyboards, Mice, Leads, Cables, Chargers.

3.1.3 Overview of datasets

The GPAMS should record a number of data points for each asset. This data will vary by product type. The list of data below provides an overview of the requirements. It is not an exhaustive list.

- Asset Device – Serial Number, Asset Number, Market Date, Purchase Date, Deployment Date, Reuse Dates, Recycled Date, Peripherals bundle
- Specification – Make, model, CPU, RAM, HDD (will vary by product, but should be standardised in format), standard peripherals (charger, keyboard, mouse, headphones)
- Location – Staff keeper, location, working from home (Yes or No)
- Lifecycle (all in months) – Expected life span, financial depreciation cycle, carbon amortization cycle
- Carbon footprint (all in CO²) – Manufacture (including raw materials extraction, shipping to UK, estimated in life usage per year, end of life processing, amortised carbon value at end of month)
- Construction (kgs) – weight, list of periodic elements with weight of each
- Financial – Purchased or leased, cost, monthly capital cost, monthly finance cost, depreciated book value at end of month, estimated actual value at end of month

- Product data reference tables – carbon avoidance, cash savings, logistics cost or carbon impacts, peripherals bundles. These would typically be reviewed and updated each year.

Much of this data can easily be provided by the vendor or reseller of the product at the sourcing stage. The rest of the data will be supplied by agreed government or departmental policy, asset activity data from both government and third-party service providers

The maintenance of the data within the GPAMS is the key to effective management and decision making. Changes to the asset data will spring from the following:

1. Bulk updates to GPAMS from mass refresh for ageing products – additions and updates to data for new and used products.
2. Updates to GPAMS for Starters and Leavers.
3. Updates to GPAMS for faulty product swap outs.

In harness with the other circular measures proposed below, the objective will be to produce a monthly statement of estate value and carbon footprint across government with relevant layers of departmental analysis.

Structured data and analysis will provide a common purpose and direction to decision making across government regarding the management of ICT devices.

3.1.4 Benefits

GPAMS is the foundation tool that enables effective management of the government's IT estate – reducing the cost and negative environmental impacts across the hardware lifecycle.

1. Meaningful analysis of environmental performance
2. Instant analysis of carbon footprint of government ICT estate
3. Instant analysis of the book or cash value of the government ICT estate
4. Ability to track the movements of the above across time and impacts of change
5. Savings from simplified contracts
6. Reduced costs – internal and external
7. Savings from reuse of products
8. Improved revenues from remarketing
9. Better measurement of recycling volumes and outcomes

3.2 Policy decision 2 - government amortisation on embedded carbon

3.2.1 Product lifecycles

This is a key decision which will provide a baseline method of recording the impact of embedded carbon in ICT devices – most of the carbon for EUD and a significant element of DAN.

Most workplace ICT equipment carries a 3-year warranty from the manufacturer. This is a historical thing which has been the basis of lifecycles and leasing periods over the years. It is at the low end of lifecycle estimates for most products.

DAN equipment carries similar warranties but are designed to last much longer and are normally covered by a comprehensive maintenance package supplied by the buyer or a service company.

In the cloud environment the hardware is managed and maintained by large third-party companies, and the monthly usage payments cover the original cost of the hardware and the ongoing maintenance.

We have settled therefore on an initial write down period of 3-years for EUD (including smartphones) and 5-years for DAN. In our assumptions, the full possible lifecycle for EUD we have extended to 6 years and to 10 years for DAN. This is not the definitive statement on the lifetime of these products, and there is a case for a shorter lifecycle on servers versus networking. It is more important to decide on the lifetimes and then measure.

For purchased assets it is a good idea to have the write down period for cash in step with the carbon write down. There is a well-established methodology for depreciation which carbon accounting can utilise for the amortisation of embedded carbon. 3 years should be the minimum period of initial usage with government for all EUD.

At the end of 3 years the product will be valued at 'zero' in the departmental accounts and count "zero" towards departmental carbon footprint in year 4.

These 2 'zero' points for cash and carbon are important for 2 reasons, beyond the fact that 3 years seems a reasonable period of elapsed time from acquisition.

Equipment that needs refurbishment or remanufacturing to prolong its life beyond the 3 years carries no embedded carbon at that point. Its comparison with a new device footprint will therefore be favourable – one third of embedded carbon (new) versus carbon cost of extension, refurbished and remanufactured (used).

Secondly, any cash value that the item still has is now a financial bonus for the owner since the full cost of acquisition has been written down. The full cost of a new device will be considerably more than the value of the used device, saving the difference for the departmental owner.

These are both real incentives to extend life beyond 3 years supported by a sensible 3 year write down policy.

With leased product the calculation is different. With leased equipment the 3-year period will have to be managed much more closely to avoid extension rentals and/or penalties. In financial terms the end-of-life bonus will probably be 'zero' since much of the residual value at 3 years will have been deducted from the initial product price, and the lessor will want it back. There might be opportunities to acquire the equipment at the end of the lease and these should be explored at the source phase.

The carbon accounting, however, will be similar and the embedded carbon should be written down in the same way over 3 years. If equipment is acquired as above, then the device will carry zero carbon.

Complexity of monthly calculations is inevitable whether you want to amortise over one year, 3 years or 6 years. It would be beneficial to embrace the issue now to reap the benefits later.

It is worth noting that the above policy recommendation is not currently the government approach to this issue, which writes down all the carbon in year one.

Some colleagues within the GDSA Circular Economy Working Group wished to clarify that this is an accounting methodology for the amortisation of the carbon, not the actual removal of the embedded carbon.

3.3 Policy decision 3 – government departmental financial structure

3.3.1 Departmental accounting

The GPAM system above will enable government departments individually to account for the cash and carbon impacts of their ICT asset management. Within a consistent framework, government departments should incur the costs of their decisions, as well as the carbon and cash benefits.

One of the major distortions within the contracting of IT Asset Disposition (ITAD) services over the past few years has been the policy of returning all funds from remarketing of used products to the treasury. The department whose product is being replaced has therefore been less concerned with the values being returned for decommissioned product. Instead, it has focussed on reducing fees for important security services, such as data-wiping, as well as logistics.

This combination rarely leads to good outcomes:

- a) Product fit for reuse within government is 'scrapped' with benefits to suppliers, not government
- b) Faulty goods are traded and exported, sometimes illegally, by suppliers to boost returns.
- c) Opportunities to remarket product along with associated revenues are lost
- d) Opportunities to redeploy, within and outside government, and potential huge savings are also lost
- e) Opportunities to manage the recycling of end-of-life product in UK are lost

One solution to this issue is to structure the management of departmental ICT estates as separate Profit and Loss (P&L) accounts, each with its associated GPAMS as in Section 2.

Each department purchases (see notes on leasing and cloud below) the ICT products required for its staff. The Government Product Asset Management System (GPAMS) will

provide a monthly statement of book value. When the time comes to refresh products, the hierarchy of actions and benefits is as follows:

Continue to use assets where they are:

- No additional cost in terms of cash
- Asset sits in GPAMS with zero carbon footprint
- Asset sits in GPAMS with zero cash book value, but with a real market value

Deploy assets within department:

- Low additional cash cost – collect, data-wipe, refurbish and deliver (charged to P&L)
- Asset sits in GPAMS with small carbon footprint from logistics and refurbish process
- Asset sits in GPAMS with zero cash book value, but with a real market value

Deploy assets elsewhere within government:

- Low additional cash cost – collect, data-wipe, refurbish and deliver (charged to P&L)
- 'Sale' revenue recorded at real market value (credited to P&L)
- Asset transferred to new department within GPAMS (charged to P&L)
- Small carbon footprint from logistics and refurbish process
- Cash book value of 'purchase' price
- Both carbon and cash are much lower than new
- Amortise/depreciate over 36 months

Remarket assets to third party

- Low additional cash cost – collect, data-wipe, store, deliver (charged to P&L)
- 'Sale' revenue recorded at real market value (credited to P&L)
- Asset removed from GPAMS

Recycle asset through third party

- Low additional cash cost – sort, dismantle, recycle, report (charged to P&L)
- Small carbon cost added to asset for step 1
- Asset removed from GPAMS

3.3.2 Note on donations

Government may decide that product is 'donated' from some departments to other areas when the product is being replaced. This should simply be managed as a redeployment within government. The donating department gets the benefit of the market value of the product, while the receiving department gets the benefit of the reduced price and carbon footprint versus a new product.

There may be opportunities to include refurbishment skills within government.

Donations outside government should be treated in the same way as a cash donation from departmental budgets.

3.3.3 Note on refurbished or remanufactured products

Government should evaluate the benefits of refurbished or remanufactured products alongside any other 'new' products at the sourcing stage. They should come with a guarantee that all embedded carbon was fully amortised when the refurbisher or remanufacturer acquired the product. The product carbon footprint (PCF) calculation should meet the same standards as a normal vendor with new products.

Such devices should bring significant cash and carbon benefits.

3.4 Policy decision 4 – government lifecycle assessment standard and carbon avoidance

3.4.1 Carbon footprint baseline

Measurement of carbon footprint at any scale of organisation requires agreement on the base line from which you are starting. The ICT carbon footprint is a key component of an overall footprint, but it can be tracked separately. The ICT footprint could be used to show trends and measure impact of product policies across time.

For any footprint to work it needs a baseline. The GDSA Scope 3 Working Group have laid out the principles of reporting a baseline in their [Digital Scope 3 Insights Report](#), applicable for any organisation, including government.

There are 2 main elements to the workplace ICT footprint:

- carbon from energy used to power equipment
- the embedded carbon from manufacture and shipping

For EUD the ratio is roughly 80% embedded versus 20% energy consumption.

3.4.2 Embedded carbon

ICT products are expensive to make and carry with them a significant embedded carbon footprint. For EUD most carbon equivalent emissions, which are attributable to a single device, is during its manufacture, roughly 5 to 6 times the amount consumed in energy whilst it is being used. Much of this manufacturing cost comes from the mining extraction and processing of raw materials (roughly 55 elements from the periodic table). The tracking of raw materials extracted from recycling at the end of a products life is the essence of circularity.

This embedded carbon figure is derived from a calculation that the manufacturers make concerning their own products called a Lifetime Carbon Assessment (LCA). The LCA should conform to ISO 14040 and 14044, but there is a lot of variation in the specific

calculations. Increasingly the manufacturers are diverging in their methods. Imperfect as it is, the LCA calculation is the only tool available to government to estimate the carbon impact of the acquisition of millions of ICT devices.

The LCA is typically divided into 4 sections:

- manufacture
- shipping
- in life usage
- end of life

As a whole, these figures are useful in comparing one potential new device against another (with the caveat about methods above). For embedded carbon, however, in-life usage will be tracked by the bills that government gets for its energy consumption. End-of-life impact should be tracked when equipment is decommissioned (the collection of assets from workers at home is a major factor here since COVID-19).

This leaves manufacturing and shipping as the elements of embedded carbon, which require accounting on acquisition by government (see section 2).

3.4.3 Embedded incentives

Combining this calculation of embedded carbon with the other policy decisions drives good behaviour. The reuse of products within government and the remarketing to third parties come with automatic reductions in carbon, as well as cost reductions and revenue generation. Making each department responsible for its own cash and carbon balance sheet, as well as the cash revenues and costs completes the picture.

3.5 Policy decision 5 – common government hardware procurement contract

The 6 lifecycle stages of hardware products are common across all ICT product areas.

They each contain services to manage ICT assets efficiently:

- **Source:** evaluate and negotiate the purchase of ICT products
- **Deploy:** configure products and roll them out to government locations
- **Maintain:** maintain functionality, replace faulty products and repair reserve stock
- **Decommission:** collect end-of-life products, audit assets and wipe data
- **Reuse:** redeploy used products within government and remarket used products to third parties
- **Recycle:** harvest parts, recover raw materials and report material mass balances

Government should mandate the use of a common procurement template for all products across government. The contract should address the issues arising from each stage of the

lifecycle. It should also include requirements to evidence compliance with the upcoming Government Buying Standards.

The GDSA toolkit below will provide an analysis of the main contractual issues as well as the key differences between the two main product areas:

- Workplace and End User Devices (EUD)
- Datacentre and Networking (DAN)

This approach will eliminate a huge amount of wasted time and resource in drawing up procurement requirements. It will also ensure that opportunities to save costs and generate revenue can be consistently realised, with no costly omissions.

The approach should include a commitment to a fair, and separate, assessment of service costs. This will avoid some of the distortions that suppliers can engage in to accommodate current policies.

A standard approach to contracting will draw on the current and historical data accumulated in the GPAM system. Managed well, the GPAM system will highlight successes and failings in the procurement process since it will be a continuous commentary on government ICT estate.

3.6 Policy decision 6 – government recycling processing and reporting

The effective management of the ICT waste stream is one of the most neglected areas when discussing the concept of circularity. Ultimately, every single item of hardware should be properly recycled. Far too much of this material, both from the private and public sectors, is traded illegally and shipped to developing countries where it is dangerously manually recycled, with residues dumped in unregulated landfill across the globe.

Much of this activity is financially driven to avoid the complicated and costly regulatory environment around waste. Many legislative elements of this landscape simply distort behaviour in a perverse and counter-productive manner to increase fee revenue – the designation of some forms of hazardous waste being a case in point. This area could be examined by government to encourage better, more productive conduct, and reduce the illegal export shipping of waste.

As it is, ICT waste from business-to-business activity represents around 11% of e-waste globally. Within this waste stream, there is a large quantity of metal and plastic which can be recovered. This material can be reused within the manufacturing supply chain. Currently, there is a very small amount of material re-allocated to the original ICT product manufacturing process. More of this may become possible, but do not think that this is a vital task, if the material is reused in some way.

Current processes within the UK enable over 65% of ICT waste material by weight to be recovered as raw material. The ultimate processing of this (mainly metal) recovered

product takes place outside the UK. Tata and British steel, are constructing Electric Arc Furnaces that will be able to use recycled steel in the UK, powered by electricity. This is an important factor in the UK's net zero planning.

The UK government should ensure that the first line of industrial processing of ICT waste should take place in the UK. In practice this will mean a ban on selling un-processed scrap ICT by weight, both in UK and to export markets.

The processing of this scrap material by UK recyclers should be subject to a test regime to examine the raw material output from all product types.

For each batch of scrap product shipped under the Waste Note for regimes in England, Wales, Scotland and Northern Ireland, the recycler should create a Material Mass Balance Report.

The report should give the actual weight and percentage for each of the following outcomes:

- materials recovered for reuse
- materials consumed as energy through incineration
- materials sent to landfill

For materials recovered for reuse, the report should give the weight and percentage separately for: ferrous, aluminium, copper, gold, silver, platinum, palladium, mercury, lead and plastic.

The list of materials recovered for reuse will be enlarged as new processes come online and are able to produce accurate reporting.

This data will enable government to measure the carbon impact of recycling raw materials against the impact of mining the raw materials. It will also provide a regular assessment of what critical raw materials may be available from the recycling supply chain. This in turn could lead to the development of UK based industry to exploit and utilise these resources. Expertise in this area could be a valuable opportunity for UK exports.

4. Other considerations

4.1 Ownership

All of this equipment may be bought outright by the government, or it may be leased or rented across a period of time, typically 3 years. For DAN equipment, government may choose the 'cloud' option where government pays for storage, access and processing power on a pay-as-you-go model. Leasing, cloud and purchase options have different cost profiles, both for carbon and cash, which we will highlight in the toolkit.

In situations where working capital is tight, there may be significant financial advantages to looking at leasing options for the acquisition of the equipment. Residual values at the end of the lease can reduce the sums borrowed to offset some of the interest costs. Additionally, end of life costs can be built into the monthly payments.

Within EUD, smartphones have traditionally been acquired under a lease model with monthly payments for the device and access to the phone network combined. Increasingly phones are being acquired purely as devices with network connections negotiated separately – this is the way forward.

4.2 Charity donations

Making product available to other government departments should be handled as a reuse through redeployment and should be actively promoted across government. It is not a cost-free exercise. However, and the 'donating' department should receive the financial credit for the transaction.

Regarding external donations, we have a divergence of views within the GDSA Circular Economy Working Group.

One school of thought says that government should stay well clear of external donations. If the donated equipment is old and of limited value, then the donation is a liability, not a gift. This equipment should be recycled in all cases

If the equipment is functioning and of value, then government should retain the benefit from this equipment through redeployment or remarketing and not give away taxpayers' money.

The alternative view is that donations of government ICT equipment, mainly laptops, form a useful tool to support charitable projects promoting digital inclusion. One issue with this option is the confusion over VAT which government should clarify. Another problem is the ad-hoc, subjective support for such schemes with very little analysis or measurement of benefits or effectiveness.

Our conclusion is that government should examine external donation proposals with open eyes and understand the immediate operational and cash implications, and the long-term investment in money and management required to make them work effectively.

5. End User Device (EUD) Toolkit

This part of the toolkit will take you through the 6 lifecycle stages for EUD hardware:

- **Source** – evaluate and negotiate purchase of ICT products
- **Deploy** – configuration and rollout to government locations
- **Maintain** – maintain functionality; swap faulty; repair reserve stock

- **Decommission** – collect end of life product; audit and data-wipe
- **Reuse** – redeploy used product within government; remarket used products to third parties
- **Recycle** – harvest parts; recover raw material; report material mass balances

For each stage, toolkit will provide an overview, outline best practice and analyse the carbon and cash impacts of the activities involved.

5.1 EUD – source stage of hardware lifecycle

The first critical stage is choosing what and when to buy (and by default what not to buy). This must be driven by the buying organisation and not the supplier network. First consider ‘what do the users of EUD need to do their job function?’.

There should be an understanding by the IT provisioning teams for EUD that perform a function for the user operationally – to over specify is a poor utilisation of public funds, and to under specify provides an inadequate user experience, and ultimately does not support the organisational needs of achieving best value.

This can only be established where the specification from the IT department is aligned to performance and persona based refresh – such as considering a product that could be 3 to 4 years old in technical terms being suitable for a certain persona, requiring access to common workplace apps like Microsoft 365, whereas a user requiring absolute power will likely need to use cutting edge technology with higher processing and GPU power requiring current technology.

The organisation should evaluate the environmental footprint of equipment options, including the benefits of utilising refurbished or remanufactured devices versus buying new, and comparing the sustainability of different new products. The sources of the sustainability benefits from both camps should come from a trusted and verified source, considering the physical carbon footprint of both the EUD as well as the organisational carbon reduction plan of the supply chain.

5.1.1 EUD source - best practice

You should examine reuse through redeployment, refurbished or remanufactured.

Before buying new, check firstly that you do not have any previously used EUD hardware that can be redeployed. Next, check if certified refurbished or remanufactured devices can meet requirements of the user environment – these dramatically cut embodied carbon and cost. The majority (80%+) of the carbon comes from the product manufacturing phase, and therefore to not have to reproduce from virgin materials will reduce the carbon impact and should reduce purchase costs versus new.

When considering an alternative to new devices, the buying organisation can specify the supply chain adhere to standards for compliance and governance. New standards from the British Standards Institution (BSI), for example, (soon to be adopted by ISO) in the BS8887 series clearly defines the product differences between refurbished and remanufactured EUD hardware from a cosmetic, quality and performance perspective.

Include environmental criteria in IT procurements (for example, require suppliers' Carbon Reduction Plans per [PPN 006](#), compliance with recognised Type 1 ecolabels, use of recycled materials, and take-back programs). Additionally, there needs to be consideration of the 'per unit' CO² footprint as well as from the supply organisation – in that many actors in the supply chain are not manufactures and pass through, with value added services.

Prefer products with sustainable integrity including being durable, upgradeable and repairable in design. Select hardware known for longevity (robust build, upgradeable components or extended warranty support). Opting for models with easy component replacement to enable future repairs or upgrades provide future resilience.

Choose suppliers or leasing providers that provide compliant end-of-life recovery (trade-in, recycling). Ensure warranties and support are aligned with longer use (3 to 5 plus years), see 'Decommission'.

5.1.2 EUD source – carbon impact

Sourcing EUD is where the largest Scope 3 emissions occur (embedded in the manufacturing phase of the device). Opting for redeployment, refurbished or remanufactured products with defined lower CO² impact, dramatically cuts those emissions.

5.1.3 EUD source – cash impact

Financially, acquisition costs can be reduced significantly through the redeployment of existing assets, as well as the procurement of refurbished or remanufactured equipment. Additionally, prolonging refresh cycles will reduce capital expenditure over time. Care must be taken to ensure that retained older equipment does not incur excessive energy or maintenance costs, but typically, the cost-benefit favours reuse or extended use. Other benefits include driving innovation and supporting UK job creation supporting UK suppliers of end-of-life services.

5.2 EUD – deploy stage of hardware lifecycle

Once equipment has been specified and procured, the deployment phase covers how it is delivered, installed, and brought into service for the organisation and the specific end user. Thoughtful logistics planning can reduce transportation, waste, carbon, and costs during this rollout.

5.2.1 EUD deploy - best practice

Schedule bulk equipment shipments to reduce trips. Use low-carbon transportation options where possible (sea freight for international, electric vehicles for local) and seek sustainable aviation fuels (SAF) in air freight where possible. Consider the 'mine to market' activity, and not just the 'last mile'.

Request minimal or bulk packaging. Recycle all packing materials (set up collection bins during installation). If available, return packaging to supplier for reuse, or ask the supplier to provide this as part of the contract for their own reuse, or recycling streams.

During redeployment, collect replaced old devices simultaneously. Maintain an inventory checklist so all EUD assets can be 'checked out of the organisation' and no old EUD asset is lost, forgotten or the cash value lost by the organisation.

Pre-configure devices centrally or remotely to shorten on-site work. Use 'zero-touch' deployment when feasible. This reduces the IT staff's travel to set up and ensures that packaging waste is handled centrally.

Proper planning in deployment improves user experience (seamless swap with minimal downtime) and reduces disruption, increasing efficiencies. One drawback to watch is scheduling large complex coordinated rollouts which may require careful project management which could impact cost if not considered ahead of an awarded contract.

Nonetheless, with clear checklists and supplier cooperation, public bodies can execute smooth and sustainable deployments.

5.2.2 EUD deploy – carbon impact

Deployment logistics mainly contribute indirect emissions via transportation (Scope 3, unless using owned vehicles, which would be Scope 1). Streamlining deliveries and avoiding duplicate trips reduces fuel use and emissions.

While relatively small compared to manufacturing emissions, these are still tangible savings, and the buying organisation should seek best practice.

5.2.3 EUD deploy – cash impact

Maintaining a planned 'roll in and roll out rhythm' will create efficiencies in logistics, reduction of shipping and labour costs - avoiding express (unplanned) shipments or multiple small deliveries that can save a significant sum on large projects.

Also, by capturing old devices promptly, the organisation can either redeploy them back into the business (saving on acquisition costs) or remarket them sooner (preserving any reduction in residual value).

5.3 EUD - maintain stage of hardware lifecycle

The maintain phase for EUD concerns the period when the product is actually being used by government employees in the office or at home. It lies between initial deployment and decommissioning at the end of first or second life.

5.3.1 EUD maintain - best practice

The main consideration at this stage of the hardware lifecycle is to keep the hardware functional to ensure that the user can work at all times. Normally government departments will contract external suppliers to operate a helpdesk line to answer general queries, provide advice on software issues, record hardware faults and initiate warranty repair and replacement for faulty products.

Maintenance contracts should cover all these corrective actions, along with agreements on service provision and timings for resolution. They should be targeted with keeping staff functioning as close to 100% of the time as possible.

In the event of hardware failure, the EUD should be repaired or replaced within a contracted period, depending on the criticality of the EUD role. The supplier should maintain a stockpile of parts and/or whole devices ready to deploy on request from the helpdesk.

5.3.2 EUD maintain – carbon impact

The main carbon impact during the Maintain phase comes from the actual energy consumed in the operation of the product. The manufacturer will supply a Lifecycle Carbon Assessment (LCA) for all EUD, part of which is an estimate of the energy consumption of the EUD across its lifetime. This data should be recorded in the GPAM system on acquisition.

The government should also track the actual consumption of energy as part of its normal audit of electricity usage in its offices and by staff at home.

Carbon is also consumed in the transportation of EUD and their components when repairing and replacing devices. The impact of this logistics activity should be logged in GPAM system to measure downtime impact of different products, from different suppliers.

5.3.3 EUD maintain – cash impact

Cash impacts in maintain stage concern the cost of the helpdesk and hardware support contracts and the efficient refresh of the repaired products.

5.4 EUD – decommission stage of hardware lifecycle

Decommissioning is the stage when equipment is taken out of active service. In a circular model, this phase is not the end, but a transition of assets to their next use (reuse, remarketing, or recycling). For the public sector, it's critical that this handover is done securely and efficiently.

5.4.1 EUD decommission - best practice

Before any device leaves the control of the organisation, a recognised and compliant IT Asset Disposal (ITAD) function needs to be employed: run certified data erasure or physically destroy data bearing media (least environmentally friendly). Keep certificates or logs of data destruction for compliance. Update the asset register.

When equipment is retired, transfer it to a secure storage or directly to an approved ITAD partner. Use asset tracking to log its chain of custody from user to removal and beyond. The ITAD partner should be vetted for accreditations. An example is ADISA and R2 accreditation. Many suppliers to the public sector offer ITAD as part of their service provision, requesting this service as part of the overall contract put the buying organisation in control of their redundant EUD estate.

Accumulate decommissioned devices and schedule pickups in batches to minimise transport runs. Use sealed containers for transporting sensitive hardware.

Document each decommissioned asset's journey (reused, sold or recycled) and ensure disposal follows the Waste Electrical and Electronic Equipment (WEEE) regulations and government information security standards published by the National Cyber Security Centre (NCSC).

Data protection compliance with General Data Protection Regulation (GDPR) is a non-negotiable element – proper decommissioning protects the organisation from any breaches from a security standpoint. On the flip side, a drawback might be the resource effort required to manage this process (staff time to track and coordinate). Many organisations mitigate that by using contracted specialists.

Finally, good decommissioning practices contribute to public sector sustainability targets and exemplify responsible governance – no hazardous e-waste ending up in landfills or developing countries, and maximum value extracted from assets at all times, which is a positive outcome for all stakeholders.

5.4.2 EUD decommission – carbon impact

The decommissioning stage has a small carbon footprint, mostly from transportation and any facility energy use for processing including data wiping, which might be Scope 1 or 2, if internal. The big impact is indirect: doing this stage diligently enables the downstream carbon savings of reuse or recycling.

Securely retrieving devices means they can be refurbished or remanufactured which avoids manufacturing of a new product, a Scope 3 reduction and Scope 4 avoided emission externally. Where EUD are beyond economic repair, then an authorised recycling route should be adopted to ensure the critical minerals and metals are extracted for repurposing or fuelling alternate supply chains. This avoids needless mining which has positive environmental impacts

5.4.3 EUD decommission – cash impact

The decommissioning of hardware has 2 main costs:

- logistics
- processing

Logistics charges have to be paid for transport provision to collect assets from offices and homes.

These costs will vary depending on the level of security required at point of collection, the physical size and weight of the hardware itself and the level of mixing that is permitted with other equipment during shipment.

These costs can be optimised by aggregating equipment for collection and the fees for bulk collections in the UK can be reduced to £5 to £10 per unit. Individual collections are more expensive in the range £25 to £50. These variations should be carefully analysed at Sourcing stage and have an increasing impact with the growth in home working.

Processing costs are incurred for the auditing and data wiping of hardware assets. These activities are clearly vital from a data security aspect, which is paramount for government.

They are also important to evaluate assets correctly in deciding what could or should happen next – redeploy, remarket or recycle.

The data gathered permits the removal of assets from maintenance and assets registers and the realisation of full value from redeployment and remarketing.

Depending on audit or data wiping requirements processing charges will range from £5 to £20 per unit.

5.5 EUD – reuse stage of hardware lifecycle

After a device is decommissioned and data-safe, the next question is does it have a useful life beyond first use. The reuse phase is about finding the best second life for equipment within the organisation or in the wider community or market – redeploy internally or remarket externally.

5.5.1 EUD reuse – best practice

To retain the already invested value, the question needs to be asked ‘can this device be redeployed to save buying a new one’. Advertise available retired equipment internally. Redeploy viable devices to other departments. This might involve refurbishment or remanufacturing services by specialist providers, to ensure the assets are in the best condition for reuse, and the employee experience is nothing but positive.

Use authorised resale partners or auctions for surplus assets. Aim to resell quickly while the hardware has the highest residual value.

Consider giving low value but working equipment to schools, charities, or digital inclusion programs. This supports community objectives and keeps hardware in use longer (ensure data is wiped and devices are cleaned). This helps close the digital divide to those not able to afford technology, which is ultimately empowering to a digitally connected UK. It is important that such schemes are evaluated for effectiveness, both from a social and financial perspective.

Additionally, donating equipment requires ensuring recipients will responsibly use or dispose of it later (so as not to merely defer a waste problem). There may also be a service and support provision that would need consideration – as the donor organisation might be responsible and under resourced to manage this.

If policy allows, offer ex-government devices to staff at market value after ensuring no internal reuse is needed. This can raise staff morale and extend device life.

Reuse contributes to circular economy goals and waste reduction targets (supporting commitments to resource efficiency). A potential drawback is the administrative effort to manage reuse streams and the possibility of flooding internal teams with outdated gear if not managed (hence the need for clear criteria on what is fit for reuse).

Overall, however, maximising reuse is an environmentally and socially responsible practice that public procurement should strive for at every opportunity.

5.5.2 EUD reuse – carbon impact

Reuse is one of the most powerful stages for carbon reduction. Every device redeployed or sold is essentially avoiding the CO² cost of manufacturing of a new device elsewhere – these avoided emissions (Scope 4) are substantial, effectively multiplying the impact of the public sector's actions beyond its own footprint. It keeps the carbon that was embedded in that device “active” over a longer life.

5.5.3 EUD reuse – cash impact

The cash impact of reuse options is significant. Reusing equipment internally saves having to buy replacement equipment and protects the value already invested in. With many new laptop products currently costing over £1,000, every 1,000 units redeployed could save over a £1 million off capital budgets.

Also remarketing functioning hardware to 3rd parties will generate direct cash revenues. To incentivise good management of hardware assets, government should make departments fully accountable for their expenditure and revenue – See 3.3 on Departmental Structure.

The values realised from remarketing can range from £15 to £200 per unit, depending on type and quality.

5.6 EUD - recycle stage of hardware lifecycle

Finally, when equipment truly reaches the end of its usable life, or is beyond economic repair, the last stage of the hardware lifecycle is recycling. The objective here is to recover materials and components to be fed back into manufacturing and repurposing, thus closing the loop and reducing the need for virgin resource extraction.

5.6.1 EUD recycle – best practice

Before recycling whole units, salvage useful components (memory, drives and AC adapters) for reuse in remaining systems or for the recycler to resell. This maximises resource recovery.

Send irreparable or unsellable electronics to accredited e-waste recyclers only. Verify they follow proper material recovery and do not landfill or export waste illegally. Ensure that the recycler processes all material initially in the UK – they should not be shipping whole, unprocessed units outside the UK.

Ensure the recycler recovers as much metal and plastics raw material as possible and is able to accurately report on the results of their processes, both direct and downstream. All shipments to recyclers should result in a ‘Materials Mass Balance’ report from the recycler.

This should record the weight of material shipped for recycling and the weight and percentage of each material recovery stream, as well as energy recovered and shipment to landfill. See 3.6 section ‘Government Recycling Process and Reporting’.

With some materials it is not currently possible to reduce landfill material to zero, but we can get close. It is important that recyclers identify the weight of such materials and work to eliminate it through better processing across time.

The primary benefits are environmental compliance and resource conservation. It also supports the development of the recycling industry and green jobs in the UK. A drawback is that recycling is energy-intensive and not 100% efficient – it's better than waste, but not as good as reuse. This is why this stage is the last resort. By the time you're recycling, you've hopefully extracted all possible reuses.

Emphasise within the organisation that recycling is good, but earlier circular strategies (reuse or repair) are better. As a broader thought, increasing recycling rates in IT also pressures manufacturers to improve product design for recyclability, such as design for disassembly and using recyclable plastic which closes the loop further. Public procurement can advocate for that by asking about recyclability at the sourcing stage.

5.6.2 EUD recycle – carbon impact

Recycling yields indirect carbon benefits by supplying raw materials, which require less energy than extracting virgin materials (for example, recycled aluminium uses around 95% less energy than new aluminium).

There are Scope 3 downstream benefits; some would categorize them as outside the organisation's direct footprint (Scope 4 avoided emissions globally). For the organisation itself, the act of recycling ensures compliance and avoids the potentially higher emissions of landfilling (which can cause methane or other pollution – negative to CO² reduction strategies).

5.6.3 EUD recycle – cash impact

Pure recycling usually does not make money for commodity electronics – often, any material value offsets the cost of proper recycling. In some cases, high-value components (RAM, Central Processing Units or CPUs) might recoup some cash, but generally, minimal revenue is expected at this final stage.

However, recycling prevents potential regulatory fines and disposal costs arising from improper handling. Additionally, many recyclers offer free collection if the equipment has enough recoverable value, making it cost-neutral to the organisation.

6. Datacentre and Networking (DAN) Hardware Toolkit

The toolkit will take you through the 6 lifecycle stages for DAN Hardware:

- **Source** – Evaluate and negotiate purchase of ICT products
- **Deploy** – Configuration and rollout to government locations
- **Maintain** – Maintain functionality; swap faulty; repair reserve stock
- **Decommission** – Collect end of life product; audit and data-wipe
- **Reuse** – Redeploy used product within government; remarket used products to third parties
- **Recycle** – Harvest parts; recover raw material; report material mass balances

For each stage, it will provide give a description, outline best practice and analyse the carbon and cash impacts of the activities involved.

6.1 DAN – source stage of hardware lifecycle

It is essential to consider design for circularity as part of the equipment sourcing process because up to 80% of environmental impact is determined during the design phase and design determines the level of circularity that can be achieved. Ask for details of design features that encourage circularity, for example, ease of upgrade and repair (to extend product life in service) and ease of disassembly to facilitate reuse, upgrade and recycling at end-of-life.

6.1.1 DAN source – best practice

Circular servers can be easily and economically repaired and upgraded so life in service can be extended until firmware becomes obsolescent or it is made open source. Compare Environmental Social and Governance (ESG) data sources to identify most circular products. Buy second life products that meet your requirements wherever possible to extend product life - this is a key criterion in circular economy.

6.1.2 DAN source – carbon impact

There are considerable variations in manufacturers' claims about embodied carbon because input data quality, scope and calculation methods vary and descriptions of criteria and calculations methodology often lack transparency. Design for circularity and embodied carbon are not necessarily linked. However, extending product life mitigates purchase of new products and therefore reduces embodied carbon across the product ecosystem.

Embodied carbon is determined by variables such as component specifications, materials content, energy source for manufacture and percentage of recycled materials. However, it is estimated that a 'typical' new enterprise server embodies about 900 to 950kg carbon.

6.1.3 DAN source – cash impact

Clearly identify your requirements and define specifications, and wherever possible purchase second-life products (with warranties) to extend product life. Price will vary according to generation of servers, availability and demand but it is fair to assume 50% saving over cost of new equipment.

6.2 DAN – deploy stage of hardware lifecycle

Once the most appropriate (circular) equipment has been sourced it will be securely implemented in the user's facility. Careful implementation planning for deployment can support circular practice by minimising the creation of waste, carbon, and costs during rollout. Key activities include:

- the packaging of items for shipment
- transportation of items from the manufacturer or vendor to the facility in which the items are being used
- the physical installation of items
- technical architecture development and deployment of items from a technical perspective (migrating workloads)
- decommissioning of kit being removed
- takeback of packaging utilised and removed kit

6.2.1 DAN deploy – best practice

Rationalise courier journeys and consider circularity and wider sustainability principles in logistics requirements involved in shipping new hardware. For example, plan logistics and routing efficiently - consolidate journeys to transport multiple items to the same or nearby locations to reduce mileage and use appropriately sized vehicles to minimise number of journeys. This will reduce associated financial and environmental impacts from wasted journeys and is particularly important for co-located enterprise hardware such as Crown Hosting.

Integrate supply chain management teams, tools and processes into the decision-making process to efficiently schedule and consolidate logistics for components and hardware with different lead times and from different suppliers or locations.

Consider the logistics providers' shipping methods: ensure that they and relevant third-party providers or sub-contractors use carbon-neutral or low CO² transport such as ground or sea as opposed to air freight to minimise environmental impacts.

Ensure that contractor and sub-contractors' minimise packaging to reduce potential waste and environmental impacts. Comply with Government Buying Standards to mitigate

environmental impacts through use of sustainable or recycled materials, removal or reuse of waste and packaging. Identify responsibility for waste management and include in deployment plans and supplier contracts and ensure compliance with penalties for non-conformance.

Employ circular logistics planning and circular packaging use by aligning all staff, sub-contractors and processes efficiently, for example, ensure that logistics carriers already on-site, no waste is left behind and all resources are optimised. Factor removal of 'old' hardware into deployment process and reuse packaging from 'new' or replacement equipment as part of this process.

Ensure efficient installation of equipment and minimise adverse impact to services by tagging and tracking assets in the requisite management databases. Plan ahead to ensure all resources are in place for efficient implementation to avoid wasted effort, time and resources.

Only deploy what is specifically needed and optimise existing resources before deploying new: plan for optimal use of hardware and ensure that solution architecture and equipment is the 'right size' and virtualise where possible, which will help to minimise scope 1,2 and 3 emissions. Ensure estate design includes potential to uplift and manage future usage rather than overprovisioning. Design a vendor agnostic approach that leaves decision making open to optimal sustainability decisions and fully justify hardware requirements from all aspects prior to deployment.

6.2.2 DAN deploy – carbon impact

In summary optimise deployment, delivery and shipping methods as described above to minimise embodied and operational carbon without compromising implementation and performance.

6.2.3 DAN deploy – cash impact

Avoid duplication of costs by optimising shipping, delivery, and removal processes as described above.

Installation costs may be embedded in the procurement contracts. Some original equipment manufacturers (OEMs) provide installation services as part of the contract for purchase of new equipment, which reduces cost of employing third-party installers. Installation costs for refurbished or second life equipment can be added to the contract at a reduced rate, but if not 'shop around' to find competitive rates and negotiate with third-party installers.

When deciding on support charges (covered further in maintenance section), for new kit, OEMs often provide 3-year initial support terms with the option of extending to 5 years (at an additional cost). The OEM 3-year support can be utilised in combination with procuring the additional support from a third party to optimise costs, as the third party will most likely offer cheaper additional support rates. If purchasing refurbished kit, the third-party support

will be the cheapest option, as the OEM will offer the same support rates as new at a 3-year rate.

Ensuring that hardware requirements and workloads are right sized to maximise usage in as few pieces of kit as possible and maximising efficiencies results in minimal cost expenditure in the usage of the hardware once installed and deployed.

6.3 DAN – maintain stage of hardware lifecycle

Maintenance of assets in the data centre includes service level agreements on hardware breakage and repair, related helpdesk support and engineers' input to implement asset repair and replacement. If the data centre is maintained by the buying organisation the inhouse staff can be trained to, for example, monitor equipment.

Maintenance is generally included in contracts for new equipment. It should be carried out by manufacturer accredited engineers as use of third parties can void the manufacturers' warranty. Contracts for refurbished equipment can be sourced from third party maintenance providers, who will also have accreditations but will not be aligned to one manufacturer. This is a good option for refurbished assets because their 3-year warranty will be issued by the secondary market provider, not the original manufacturer.

6.3.1 DAN maintain – best practice

When buying new hardware ask for reports about redundant (replaced) components. This should include information about the number of items that are repaired or processed for reuse and number of items that are recycled at end-of-life and – if possible - information about recycling technologies used.

Ask OEM and third-party maintenance contractors for information about the percentage of spares or upgrade components that they refurbished, this is becoming common practice. For example, Google claim that more than 50% of their spares and upgrade components are refurbished.

Software and hardware upgrades and maintenance are equally important. Check that third party maintenance suppliers have access to the latest firmware upgrades and security patches or ensure that they are available from the OEM. Note that it is now a [legal requirement that firmware upgrades are available on the open market](#) for at least 8 years after manufacture.

6.3.2 DAN maintain – carbon impact

Low carbon services should be employed wherever possible and carbon from diverse sources should be quantified. For example, use local transport providers with electric vehicles (EVs); reuse or use refurbished components. It is possible to calculate the benefits of reuse because some OEMs supply embodied carbon assessments for new equipment and components. As carbon is allocated to the first user, embodied carbon of

refurbished equipment is not counted but operational (energy) carbon for the refurbishment process should be sought and included.

Good third-party maintenance providers should provide advice on extending product life with upgrades on servers as opposed to a full refresh. This should reduce environmental and economic costs.

6.3.3 DAN maintain – cash impact

All new products from key vendors (for example, HPE, Dell, Pure) come with a warranty which typically lasts for 3 years although upfront purchase of upgrades to 5 years are becoming popular. The upgrade is for service level agreement (SLA) and includes for example critical support, 24 hour or next day repair or replacement.

At the end of the contract the customer has 4 choices:

- purchase a new (typically 12 month) contract
- refresh and purchase new equipment with a new warranty
- purchase a TPM (third party maintenance) contract
- have no maintenance

Product life can be easily extended through vendor contracts because they enable access to the vendor's vast global stock and engineering capabilities. Third-party contracts are available, but buyers and operators should ensure that stock levels of component parts are high and readily available.

Maintenance of second-life equipment by third-party providers is significantly cheaper than that by OEMs. OEMs often charge for the additional years past original warranty at a higher rate and/or for whole life cycle (such as from day one) of the asset if the asset does not have a maintenance contract when bought. However buyers can benefit from strong long-term relationships with OEMs, who may reduce maintenance costs of new equipment – a point for consideration when selecting an OEM or third-party maintenance provider.

Note that resellers with experience of both new and refurbished equipment will be able to help buyers to make the choice for equipment once it reaches the end of its first life.

6.4 DAN – decommission stage of hardware lifecycle

Decommissioning includes the secure removal of equipment from the first user's facility, which enables reuse of materials without risk of data leaks. Depending on the security level of this facility, different levels of processing will be applied. The process is as follows:

1. Migrate all vital workloads off servers before power down.
2. Remove servers, storage and networking equipment.
3. Asset tag all items.

4. Segregate all data bearing devices.
5. Destroy all data onsite through approved method on site or securely track and accompany transport of the items in a dedicated vehicle to approved service provider's facility.
6. Verify the asset register and send report to the customer.
7. Certify data destruction within 72 hours.
8. Provide report on percentage of equipment reused versus percentage recycled, calculate the recovered value and rebate within 20 days.

6.4.1 DAN decommission – best practice

Data sanitisation using software ensures that as many data storage products (for example HDDs and SSDs) as possible remain in use and that 100% materials are reused or recovered.

Shredding onsite or offsite should only be carried out if the devices no longer function, and materials should be recycling and recovered through high value recycling processes wherever possible.

6.4.2 DAN decommission – carbon impact

During decommissioning transport of materials and equipment can contribute a significant percentage of the overall carbon footprint. Use local decommissioning, transport and logistics agents with electric vehicles if possible. Request thorough reports about transport miles and/or initiatives to reduce associated emissions. Equipment and component reuse is less energy and carbon intensive than destruction, recycling and disposal; reuse has the potential to reduce the production rate of new devices, which have significant embodied carbon.

Many IT Asset Disposition (ITAD) providers issue carbon savings certificates which calculate carbon avoidance by comparing the embodied carbon of new and second life products. All the above support carbon reduction across the ecosystem.

6.4.3 DAN decommission – cash impact

Reuse is both environmentally and economically beneficial. IT Asset Disposition (ITAD) providers charge a processing fee per item but offer a rebate on fair market value for profit after processing. Reuse generates a higher cash return than destruction. For example, a secondary market Central Processing Units (CPU) will have a value between £12 and £4,000 on the open market depending on performance. The material content - silicon, plastics and copper- generates a less value (around 50p) from recycling. Buyers and operators should generate a comprehensive asset inventory and send to an ITAD provider who will provide accurate data on market value to support a business case that promotes product life extension through use.

6.5 DAN – reuse stage of hardware lifecycle

Reuse extends product life in service. It can be within a user's estate (cascading assets); component level upgrades or replacement and purchase of refurbished assets.

Suppliers of refurbished equipment will be able to show proof of:

- data sanitisation on data bearing assets
- performance testing with health score on hard disk drives
- installation of latest firmware
- factory reset of appropriate devices

Note that suppliers of enterprise equipment on the secondary market are supported by a wide network of other suppliers and processors. This means that larger orders can be delivered in a relatively short space of time by sourcing through partners.

6.5.1 DAN reuse – best practice

Equipment should be kept in use for as long as is technically and economically feasible and meets users' requirements: the adverse impact of energy use in servers that are about 3 years old will be far lower than the overall adverse impact of new servers.

Electronic equipment without moving parts does not degrade over time and therefore the performance of refurbished equipment with component level upgrades will be [comparable to that of new equipment](#).

The appropriate sizing of estates is vital to ensure sustainability best practice. The size and scope of workload should be provided so that hardware can be tailored towards this and alternatives compared for energy efficiency. Use Server Efficiency Rating Tool (SERT) by SpecPower to find a 'ballpark' figure on the relative efficiency of different types of servers at low and maximum power usage.

To future proof estates, these figures can be refined using other readily available software solutions that include the amount of memory and type of CPU or processor used.

The 'generations' of equipment influence operational efficiency. However, the decline of Moore's Law means that efficiency is a systems issue rather than just a CPU issue. CPU performance is significantly boosted by memory in more recent generations, and 3- to 5-year-old servers can be upgraded and life extended, which delays the need for full refresh, all of which saves cost, materials, carbon associated with the production of devices.

6.5.2 DAN reuse – carbon impact

Reuse is a good solution for maximising the value of the significant carbon spend associated with the production of devices. This is true of reuse between different areas of the data centre, purchase of refurbished devices from the secondary market and also the extension of server product life within the estate using component level upgrades. A basic configuration of a server with a low-level CPU and minimal memory is less performant than

a similar configuration the next generation. Upgrading the CPU and doubling the amount of memory makes that same older server 32% more performant than the later generation. The carbon cost of memory and CPU manufacture is significantly lower than that of a configured server, making upgrades a much less impactful option in carbon terms.

6.5.3 DAN reuse – cash impact

Ensuring that enterprise IT provision balances compute operations achieved against energy and material cost can generate significant cash savings as IT managers can purchase upgrades or refurbished alternatives rather than entire new estates. A fully configured server that has been refurbished is up to 80% less expensive than a new alternative. Upgrading older servers on site is even more attractive in cost terms; for example, servers typically cost tens of thousands of pounds while the cost of CPUs and memory is a lot lower.

6.6 DAN – recycle stage of hardware lifecycle

Recycling is the last stage in a product life cycle. In a circular economy materials are kept in circulation (reused) for as long as technically and economically feasible. They can be recycled or reclaimed and made into the same or similar components or products (closed loop) or made into different components or products with lower or different technical requirements (open loop).

Products should be disassembled and components and materials separated where possible. Many materials are processed thermally but some are recycled using chemical or bio-based processes. Metals, for example, steel, copper, aluminium, gold can be smelted, reclaimed and reused many times without losing inherent properties providing that they can be separated from other materials and metals.

Some plastics (thermoplastics and plastics that are not treated with fire-resistant coatings) can be recycled if sorted and separated by type. However they downgrade and lose inherent properties, but they can be combined with a percentage of virgin material to make the same or similar product; alternatively, they can be used to make products or components with lower technical performance or requirements.

Electronics are difficult to recycle economically. A few materials are reclaimed but many are dumped, landfilled or incinerated. Improved recycling processes are being developed to increase the range and volume of materials that can be reclaimed and reused.

6.6.1 DAN recycle – best practice

Once equipment no longer meets user requirements build an inventory and tag equipment to ensure tracking and tracing inside and beyond the estate. Equipment may be sold on to extend life via the secondary market but if repair or upgrade is no longer viable, it should be recycled to reclaim as many materials as economically and technically feasible.

HDDs and SSDs should be sanitised rather than shredded wherever possible to facilitate recycling. Prior to recycling ensure that data is destroyed securely by a certified processor / ITAD that complies with standards (BS EN15713, ISO 27001, BS 7858).

Identify legitimate recycling companies that reclaim as many materials as possible and ask for reports that detail what and how much material is reclaimed and how much and what is sent for incineration (with or without energy generation) or to landfill. Ensure that redundant equipment is collected and recycled by fully licenced organisations that comply with all WEEE Regulations and relevant standards including environmental (ISO 14001) and energy management (ISO 50001).

6.6.2 DAN recycle – carbon impact

As a rule of thumb recycled materials have a lower embodied impact than virgin materials because the extraction and initial processing phases are avoided. Although recycling processes demand resources (for example, energy, water or chemicals) the impact of formal or legal recycling is generally lower than that of extraction and increases materials reclamation and helps to reduce Scope 3 emissions. Carbon certificates and credits can be awarded for recycling: ask operators for details about where equipment or components are sent and what and how much material is reclaimed and reused. Include transport emissions in carbon assessment and use local services, electric vehicles and ocean transport if possible.

Unregulated or illegal recycling is invariably hazardous to health and can cause long term and extensive environmental damage so it should be avoided. It is also impossible to track process inputs, outputs, and materials associated with the processes and therefore to calculate Scope 1, 2 or 3 emissions which is bad for business.

6.6.3 DAN recycle – cash impact

Ensure that end of life equipment is collected and processed by a registered ITAD (IT 1, 2 and 3 calculations. Weight the tender accordingly.

7. Glossary

Term	Definition
Circularity	The principle of extending product life through first-use longevity, reuse (including redeployment), repair, refurbishment or remanufacture, harvesting whole parts, and recycling raw materials to minimize environmental and financial costs.

Term	Definition
Circular Economy	The 'used or second-hand economy,' where ICT products are used and reused in their original form as long as possible before parts harvesting and raw material recycling.
End User Devices (EUD)	ICT products used by individual government workers to perform their jobs (workplace computing), accessing platforms provided by DAN infrastructure; EUDs include devices like laptops and desktops and carry a high embedded carbon share relative to in-use energy.
Datacentre and Networking (DAN)	ICT infrastructure (for example, servers, storage, networking) that hosts software tools and data accessed by EUDs. Typically has longer design lifecycles and may be owned, maintained through service packages, or consumed via cloud models.
Workplace Computing	Alternate term for EUD—devices enabling staff to perform work and access government platforms.
Mobility (Smartphones)	EUD subcategory traditionally acquired through bundled lease plans; increasingly procured as devices with network access contracted separately.
GPAMS/ GPAM	Government Product Asset Management System—a centralised or common product database that stores asset, carbon, cash, and lifecycle data to support consistent circular decisions and monthly estate reporting.
Asset Device (dataset)	Core data record for each ICT device (for example, Serial Number, Asset Number, Market/Purchase/Deployment/Reuse/Recycled dates, peripheral bundle).
Specification (dataset)	Device technical attributes (for example, Make, Model, CPU, RAM, HDD/SSD) and standard peripherals (charger, keyboard, mouse, headphones) captured in standardised format.
Location (dataset)	Staff keeper and physical location of the device with a work from home (Yes or no) indicator.
Lifecycle (dataset)	Expected lifespan and accounting cycles for depreciation (cash) and carbon amortisation (months).

Term	Definition
Carbon Footprint (dataset)	Components recorded in CO ₂ e for manufacture (raw material extraction and processing), shipping to UK, estimated in-life energy usage, end-of-life processing, and the amortised carbon value monthly.
Carbon	The carbon associated primarily with manufacturing and shipping of an ICT device; for EUDs, manufacturing is roughly 5 to 6 times the in-use energy emissions; tracked and written down via policy over defined periods.
Lifetime Carbon Assessment (LCA)	Manufacturer's calculation of product carbon footprint, ideally conforming to ISO 14040/14044; typically segmented into manufacture, shipping, in-life usage, and end-of-life; used to compare devices despite methodological variability.
Product Carbon Footprint (PCF)	A standardised carbon footprint calculation for refurbished or remanufactured products that should meet the same standards as 'new' products when evaluated at sourcing.
Carbon Avoidance	A modelled metric within product data reference tables that reflects emissions avoided through reuse, redeployment, remarketing, and UK-based recycling actions.
Amortization (Carbon)	Accounting method to write down embedded carbon over time; initial policy suggests 3 years for EUD (including smartphones) and 5 years for DAN, aligned with cash depreciation where possible.
Depreciation (Cash)	Financial write-down of asset value over time; after the write-down period the book value is zero, though the device may retain real market value, incentivising reuse or redeployment.
Redeploy (within dept)	Reuse of a device internally, incurring logistics or refurbishment carbon and cash costs; asset remains in GPAMS with zero book value but real market value.
Redeploy (across gov)	Reuse of a device in another government department, with 'sale' revenue credited at real market value, transfer recorded in GPAMS, lower cash and carbon than new, and re-amortisation over 36 months.

Term	Definition
Remarket (to third party)	Sale of used assets externally with low additional cash costs (collect, data-wipe, store, deliver), recording revenue at market value and removing the asset from GPAMS.
Recycle	End-of-life processing to harvest whole parts and recover raw materials; government should prioritise UK-based first-line processing and require Material Mass Balance reporting for scrap shipments.
Material Mass Balance Report	A test report produced by UK recyclers for each scrap batch under Waste Note regimes, detailing material output by type (for example, ferrous, aluminium, copper, precious metals, plastics), used to measure recycling vs mining impacts.
Waste Note Regimes	England, Wales, Scotland and Northern Ireland regulatory frameworks governing scrap shipments for which recyclers should produce Material Mass Balance reports.
CO2e	Carbon dioxide equivalent units used to quantify and record emissions across the device lifecycle in GPAMS datasets.
WFH	Work From home indicator captured in the Location dataset to reflect usage context and potential in-use emissions considerations.
P&L	Departmental profit and loss accounts that accrue cash costs and benefits (for example, logistics, refurb, delivery charges; remarketing credits) to align incentives for reuse vs new purchases.
ITAD	IT asset disposal—services including secure decommissioning, data-wiping, logistics, and compliant trade/recycling of equipment; contract quality and incentive alignment affect outcomes.
Cloud (Pay-as-you-go)	Model for DAN where government pays for storage, access, and compute as a service; hardware is managed by providers, and monthly usage payments cover hardware and maintenance costs.
Peripherals	Non-primary hardware items (for example, chargers, keyboards, mice, headphones) tracked as assumed bundles of volumes/weights, not individually as assets, with management included in third-party contracts.

Term	Definition
UK-based Recycling	Policy preference that first-line processing of ICT waste occurs in the UK, with recovered materials feeding domestic industry and enabling more accurate carbon impact measurement.
Zero (Carbon/Book Value)	Post-amortization accounting concept where a device contributes zero to departmental carbon in the next period and has zero book value, while still retaining real market value that favours reuse over replacement.
Sourcing	The first lifecycle stage where contracts and policies should consider all downstream services (deploy, maintain, decommission, reuse, recycle) to unlock carbon and cash benefits.
Government Buying Standards (GBS)	Procurement requirement referenced in comments to evidence compliance in contracts governing lifecycle services; included to ensure consistent, high-quality outcomes.

8. Additional reading

- [The Waste Electrical and Electronic Equipment Regulations 2013](#)
- [EU Directive 2012/19/EU on waste electrical and electronic equipment \(WEEE\)](#)
- [Business to consumer \(B2C\) and business to business \(B2B\) EEE and WEEE guidance](#)
- [Regulation \(EU\) 2024/1781- establishing a framework for setting eco-design requirements for sustainable products](#)
- [Government standards for servers and data storage](#)
- Eco-servers review Phase 1
- [Eco-servers review Phase 2](#)
- [Greening Government Commitments 2021 to 2025](#)
- [Optimizing server refresh cycles](#)
- [TCO Certified circular electronics landscape to 2035](#)
- [Understanding impact of end-of-life decisions](#)
- [Share, reuse and collaborate guidance](#)
- [CFIT Framework for Circular and Fair ICT Procurement](#)
- [Reuse and recycling of ICT government devices - case study from Norway](#)
- [Measuring Circular Impact - An assessment of the consumer electronics industry](#)
- [Rethinking Mobile Phones - The business case for circularity](#)