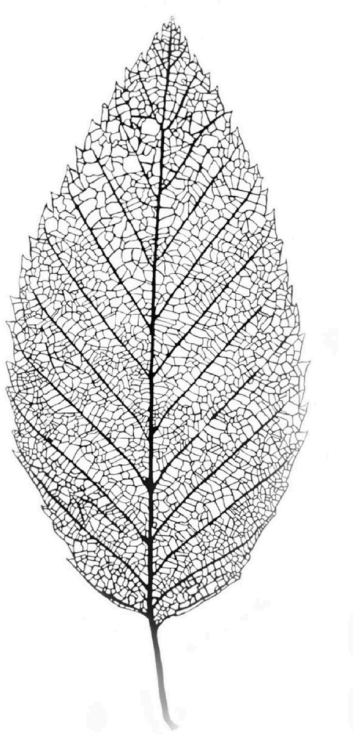
Michael Culture Association

Cultural Heritage for digital, societal, and environmental transformation



Recommendations for environmental friendly practices in Digital Cultural Heritage

Written by Michael Culture Association. May 2026.

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1. Introduction

The environmental footprint of information and communication technology (ICT) is no longer a marginal concern. ICT now accounts for an estimated 2-4% of global greenhouse gas emissions, and this share is accelerating sharply with the expansion of cloud computing, data-intensive services and, most recently, Generative Artificial Intelligence, whose training and inference workloads place fast-growing demands on data centres, electricity grids and water resources. The cultural sector cannot treat this as someone else's problem. As an industry built on long-term stewardship and public trust, it has both the responsibility and the credibility to lead.

Calculating the precise environmental impact of digital cultural heritage is difficult: data is fragmented, methodologies vary, and the sector has only recently begun to measure systematically. But we know we have to act as a sector and we know how we can do it. The Europeana Climate Action Community chaired by Michael Culture Association since 2024 published recently a survey study of over 100 institutions across 30 countries: it found that while 78% recognise environmental responsibility as important, only 42% have a formal environmental strategy, just 14% measure the carbon footprint of their digital services, and only 3% consider environmental factors when buying ICT equipment. The gap between awareness and action is wide, and closing it is a matter of cultural leadership as much as technical practice.

In the present document we propose five practical guidelines for heritage professionals applying Green ICT principles, ordered from most to least impactful, followed by steering recommendations for the Common European Data Space for Cultural Heritage. The work draws on and gratefully acknowledges the research of Murzyn and the Europeana Climate Action Community, Pendergrass and colleagues, Goldman and Paschalidou and colleagues. All the main references for these guidelines are listed at the end of this document.

2. Green ICT Guidelines for Cultural Heritage Institutions

1. Extend the lifespan of your IT Hardware

Around 80% of the total carbon footprint of a typical laptop is already embedded in the way it is build: the mining of raw materials, the manufacturing of components, the energy used to assembly, the global shipping that gets it to the buyer are the most impactful elements in the lifecycle of devices, both in terms of environmental and social impact. Over 50 million tonnes of electronic waste are generated worldwide each year. Only around 22% is formally recycled. Much of the rest is exported to countries with weaker environmental protections, where it is broken down in hazardous conditions by communities that did not benefit from the original use of the devices.8 Equipment from US school districts, government agencies and museums has been documented in informal e-waste processing sites in Ghana, China, India and Pakistan.9

The most impactful dissection an institution can make in their ICT Green strategy is to keep in service as long as possible the piece of equipment they currently have. This encompasses computers, portable computers, working smartphones, external screens, servers hardwares, chargers, et cetera.

Extending a laptop's working life from four years to seven amortises its annual environmental impact by nearly half, with no other change needed, while also reducing costs up to 30% for the institution.

What to do:

- Before replacing any device or hardware, ask whether it can be repaired, upgraded or given a second use elsewhere in the institution. Replacement should be the last option.
- Set a target service life that goes beyond the industry default. Some baselines are: 7 years for computers, 10 years for servers
- Train at least one person on site in basic hardware maintenance (replacing RAM, swapping a hard drive for an SSD, changing a laptop battery…). These small operations can add several years to a device's useful life at very low cost.
- For older computers no longer supported by systems like Windows or MacOS, consider switching to Linux distribution (Linux Mint and Ubuntu are good starting points that will fulfill the main requirement for everyday work).

Useful tool

- iFixit (ifixit.com): free repair guides by a strong community for almost every consumer device
- TCO Certified (tcocertified.com): independent sustainability certification for IT production, useful both for buying and for assessing existing equipment.
- Linux Mint, Ubuntu LTS: free operating systems that extend the life of older computers no longer supported by other operative systems.

2. Strategize before digitizing, prioritize among contents, formats and qualities

Every digital file an institution creates carries a long environmental tail. It will need to be stored, backed up multiple times, checked for integrity, migrated to new formats, served to users, more and more accessed by crawling bots training AI systems, and eventually retired. All of this consumes electricity, networking capacity and hardware. A digitization choice made today commits the institution to those downstream costs for years or decades. Resolution choices matter especially: the energy cost of storing, transmitting and delivering a file scales with its size and digital cameras and scanners now routinely produce files much larger than any actual use case requires. File format choices have a similarly large effect: the "Regenerative Digital Transformation" report shows that PDF and JPG together account for around a third of digital heritage collections, despite the existence of more efficient alternatives. A reduction in average file size translates directly and proportionately into a reduction in storage cost, and this can be achieved by changing JPG files to JPEG XL or WebP. A purpose-driven strategy in digitization would focus on how each data will be reused and in which context, defining in that way the type of format or resolution that could be used.
Heritage data providers already face many challenges in digitizing collections, mainly in terms of budget, human resources and skills. The objective should not be to stifle digitization processes in heritage collection. Having a clear sense of purpose, quality and scope could also help the institutions in these processes, while noticeably impacting on the related emissions of keeping a digitized collection.

What to do:

- Starting a digitization project, start by asking the question: What are digitizing for? Who will actually use the result? What level of quality does that use require? The answer to this question should not be conservative, but rather realistic. You will be able to set resolution levels through the relevant digitization technology based on purpose, influencing also how many copies of each digital asset you actually need and the formats;
- Where digitisation projects are funded externally, build environmental considerations into the project plan from the start (scope, formats, retention), you will be able to embed them through every step of the way;
- When no prioritisation in terms of content is feasible or applicable, focus on digitizing well once, at appropriate quality, in formats that will not need to be redone;
- For preservation masters, use uncompressed or lossless formats (TIFF, FLAC, WAV, PDF/A), while for access copies use modern efficient formats (JPEG XL, WebP, AVIF for images, Opus for audio, AV1 for video, TXT for text)
- Audit existing access derivatives, to check if those active are old oversized files and formats and if they be re-encoded at scale to lighter formats without an user-visible difference

Useful tools:

- The Europeana Publishing Framework (https://pro.europeana.eu/post/publishing-framework): a practical guidance on metadata and content level for online publication of heritage, which could help shape appropriate effort strategies
- Federal Agencies Digital Guidelines Initiative (https://www.digitizationguidelines.gov): for a look on practices outside Europe, these are well-documented imaging guidelines that distinguish levels of capture by purpose,
- Ffmpeg (https://ffmpeg.org): the open-source toolchain for audio and video transcoding, able to manipulate the most ancient formats,
- ImageMagick (imagemagick.org) or : the open source tool for batch image conversation.

3. Reduce Dark Data

Studies estimate that around half of all stored organisational data is “dark data”. This type of data is collected, kept, but never used. In heritage institutions, the falling cost of storage has reinforced what the “Regenerative Digital Transformation” report calls a “save everything” reflex. Institutions accumulate redundant scans, abandoned project files and unused backups, all of which require continuous energy to host, making it also harder to care for the entirety of the digital collection well. Deciding wherever materials belong at full preservation or not, reflecting the lifecycle of digital assets, with appropriate community input, is good stewardship. Small institutions can make meaningful progress in this area: a dark data audit does not require a sustainability officer, a budget, or new technology, but the willingness and little time to set up.

What to do:

- Run regularly (every 2-3 years) a “dark data audit”, identifying digital files that have not been accessed for at least 3 years and are not legally or culturally required to be kept. Review them

in the light of at risk heritage and representativeness in your collection and decide what to do with them;
- Use a three-tier model to match preservation effort to value:
    - Tier 1 - Full preservation, for rare, unique, at risk assets, with regular integrity checks
    - Tier 2 - Moderate preservation, for important assets, with less frequent checks
    - Tier 3 - Basic Documentation, for items of marginal use, keeping the catalogue record and not the necessary file
- Identify and switch off "Zombie servers", machines that are still powered up but no longer doing any useful work, costing real electricity for no benefit
- Where possible, involve user communities and communities surrounding the heritage institution in decisions about what is genuinely worth keeping at full preservation level.

Useful tools
- Archivematica (https://www.archivematica.org/en/): a web- and standards-based, open-source application which allows your institution to preserve long-term access to trustworthy, authentic and reliable digital content and supports configurable lifecycle workflows;
- TreeSize Free (Windows), WinDirStat (Windows), ncdu (Linux/macOS): show at a glance which folders are taking up the most space, and how old the contents are.

4. Choose ICT and Cloud Services with sustainability in mind

Considering environmental factors when buying ICT is one of the largest unrealised opportunities in the whole field. Procurement decisions determine the environmental footprint of a piece of equipment for its entire service life. Cloud services especially are often invisible, but the energy and water demands of cloud data centres are very real. The carbon intensity of running the same workload can vary by a factor of seventy or more depending on which country the data centre is in, because national electricity grids vary so much in how clean they are. Major cloud providers also differ significantly in their environmental commitments and reporting. These differences are knowable and should help institutions in their choices for hosting their data.
When small institutions, for example, are subscribing to a cloud service, they can ask sensible questions before implementing one specific option: visibility on this issue is the first step, then comes the institutional choice.

What to do:
- Add environmental criteria to every ICT purchase decision. As a minimum: repairability score, manufacturer commitment to spare parts for a defined number of years, energy efficiency certification, recycled content, and supply chain transparency;
- For cloud services, ask the provider direct questions before signing: where are the data centres located, what is the carbon intensity of the local grid, what proportion of their energy is renewable, what is the data centre's PUE (power usage effectiveness), and is the supplier transparent about its overall emissions? If the cloud service is a mainstream one, such as Google, IBM or Amazon, these information are usually accessible online (even if the transparency issue is present for these large providers);
- Where your institution's regulatory environment allows you to choose your electricity supplier, check whether you can switch to a renewable energy contract.

- For storage specifically, consider tiered approaches: keep frequently-used material on fast online storage, and move less-frequently-used material to slower, lower-power storage. Tape and other "powered-down" media can be a good fit for archival content that does not need instant access.

Useful tools:

- The Green Web Foundation directory (thegreenwebfoundation.org): a free way to check whether a given website or cloud service is hosted on grids using renewable energy.
- Cloud Carbon Footprint (cloudcarbonfootprint.org): open-source tool for estimating emissions from AWS, Azure and Google Cloud services.
- EPEAT (epeat.net): Electronic Product Environmental Assessment Tool registry, with Bronze, Silver and Gold tiers.

5. Measure, build staff skill and engage your community

When institutions are committed to environmental sustainability, they tend to focus on energy use in physical buildings, waste and staff travels, but very few monitor the carbon footprint of their digital services. As digital services take on a larger and larger share of what institutions actually do, this blind spot grows. You cannot manage what you do not measure: none of the other recommendations in this document can be evaluated for effectiveness without some kind of baseline.

If the obstacle to implementing all these steps is perceived financial barriers, it is good to know that most of the practices recommended in this document save money over time. The deeper barrier could be the knowledge gap. Free resources exist; what is often missing is institutional permission for staff to spend time on them. Granting that permission is one of the cheapest, most effective things an institution can do. Community engagement plays a parallel role. Users can tell institutions which materials they actually use, can accept delivery delays when the reasoning is explained, and can hold institutions accountable for stated sustainability commitments in ways internal governance often cannot.

What to do:

- Start measuring, picking one digital service, usually the institutional website is the easiest starting point, and estimate its annual carbon footprint using one of the free tools listed below. From there, you can go to measuring your digital collections platforms and the cloud services;
- Be transparent and publish what you measure, including the methodology and the limitations: it will show your commitment to sustainability, while also attracting feedback on your methodology;
- Include digital sustainability in staff training plans. Much of the relevant material is free, but staff need time to engage with it;
- Join sector networks. The Europeana Climate Action Community, the Climate Action Tech community and the Digital Preservation Coalition's sustainability working group are all free, and the knowledge sharing happens in both directions.
- Engage your user communities in conversations about sustainability, as they can be partners in deciding what to preserve, allies in accepting lower-impact delivery, and ambassadors for the institution's wider environmental commitments.

Useful tools

- Website Carbon Calculator (websitecarbon.com): quick first estimate of a website's per-visit carbon footprint;
- The Europeana Climate Action Community (https://pro.europeana.eu/page/climate-action-community) , the sector's main network for digital sustainability in heritage;
- The Linux Foundation's "Green Software for Practitioners" (https://training.linuxfoundation.org/blog/new-course-brings-environmental-consciousness-to-software-development/): a free training course on how to develop green software.

3. Strategic recommendations for the DS4CH

The Common European Data Space for Cultural Heritage (DS4CH) plays a role no individual European institution can play. By steering how cultural heritage data is described, harvested, aggregated and accessed across Europe, it helps setting the standards that thousands of contributing institutions then will follow. This is why it is important to make the DS4CH a reference point of regenerative practices in digital cultural heritage. The following steps could be implemented to fulfill the public mission of the Data Space.

Commitment to 100% renewable energy

This is the same principle proposed in Guideline 4 for individual institutions: the cleanliness of the underlying electricity grid is one of the single largest factors in any digital service's environmental footprint, applied at the infrastructural scale where DS4CH operates. To commit to renewable energy, the DS4CH could:

- Partner exclusively with service providers that use 100% renewable energy sources for hosting, aggregation infrastructure, and cloud-based services on which the data space depends.
- Implementing energy-efficient technologies and practices within DS4CH's own operations, from data centre selection criteria to the design of harvesting and indexing workflows.

Optimisation of resource-intensive digitisation and aggregation processes

This connects directly to Guidelines 1 and 2: the same logic that asks an individual institution to extend hardware lifespans and to digitise deliberately applies, with greater leverage, to the shared infrastructure that handles aggregated material at European scale.

- A comprehensive analysis of hardware requirements for DS4CH's operations, balancing environmental costs against operational benefits. This includes critical review of whether all redundancy, all replication, and all derivative generation currently performed are genuinely necessary, and whether any can be rationalised or made conditional on actual use.
- Prioritising the use of energy-efficient hardware across DS4CH's infrastructure, with hardware lifecycle thinking (repair, refurbishment, extended service life) embedded in procurement and operations from the start.

These actions could be implemented strategically across the consortium putting into place the Data Space, with a common agreement on how to procure hardware sustainably.

Comprehensive environmental impact assessment and transparency

This is the principle of Guideline 5 applied at infrastructural scale. Through the help of an external party, with an expertise in digital sustainability, the DS4CH could:

- Perform detailed environmental impact assessments focusing on energy consumption, carbon emissions, and resource use associated with the hardware and data centre operations supporting the actions of the Data Space.
- Develop and implement mitigation strategies for identified impacts, with progress reported publicly and aligned with the EU's climate neutrality goals.

A published environmental assessment by DS4CH would establish a sector benchmark, provide methodology that contributing institutions could reuse, and demonstrate the transparency the data space asks of its participants.

4. To go further: readings

This deliverable is a synthesis and is meant to be an accessible document for concrete steps to be put into practice. The thinking behind it draws on a small number of recent academic works that any heritage professional interested in digital sustainability will find worth reading in full:

- Murzyn and the Environmental Sustainable Practices Task Force (2025), "Regenerative Digital Transformation" (Europeana CAC): The sector's most current and most directly relevant document. Combines a survey of over 100 European institutions with concrete case studies (POLIN, the National Library of Finland, L'Internationale) and frames practical recommendations for institutions of every size. The starting point for anyone working on this in a European heritage context.
- Pendergrass, Sampson, Walsh and Alagna (2019), "Toward Environmentally Sustainable Digital Preservation". The most influential academic article on the topic. Argues that environmentally sustainable preservation requires rethinking three areas: what we appraise, how permanently we preserve, and how immediately we make material available.
- Goldman (2018), "It's Not Easy Being Green(e)." Returns to the older archival literature on appraisal (Greene, Ham) and asks what its lessons mean in a climate-aware era. Particularly useful for thinking about the cultural dimension of preservation choices.
- Paschalidou et alii (2019), "A Strong Sustainability Framework for Digital Preservation of Cultural Heritage: Introducing the Eco-Sufficiency Perspective". This research shows that the understanding of the sustainability of digitalisation is not fully developed. Strong sustainability is hardly applied in practice, even though an inherent tendency for sufficiency especially in the appraisal stage was identified. It highlights the need for extensive stakeholder networks for advancing the sustainability of digital preservation

Other academic sources

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- Rosário, A. T., & Dias, J. C. (2022). "Sustainability and the Digital Transition: A Literature Review." Sustainability, 14(7).
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