Universiteit Utrecht DATAWERKPLAATS

Green E-Government

Research Report

Daniela Tinca & Albert Meijer

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Need for Green E-Government

Reducing environmental impact has become a key priority in the public sector and limiting the carbon footprint is increasingly present in organisational objectives. At the same time, in a digitalized world, public organizations are using digital technologies to improve efficiency and productivity, leading to a drastic increase in ICT equipment and operations. This has resulted in a significant rise in energy consumption and greenhouse gas emissions. To provide the broader picture, ICT accounts for 3.6% of global greenhouse gas emissions, and its digital carbon footprint grows by 8% annually (Belkhir and Elmeligi, 2018; Freitag and Berners-Lee, 2020 in Lokshin & Widmar, 2023). E-government is only a small part of global ICT use but given the growth in ICT operations within public institutions, highlighted by the 5% annual increase in ICT procurement spending (Gartner, 2022 in Lokshin & Widmar, 2023), it is crucial to address the environmental impact of ICT.

ICT has an environmental impact throughout its entire life cycle—from the use of rare metals in manufacturing to energy-intensive operations and the resulting e-waste at the end of its life. Focusing on Green ICT practices is essential for limiting environmental impacts. Green ICT refers to practices that minimize the environmental impact of ICT throughout its life cycle—production, usage, and disposal—by addressing both IT infrastructure and human management to reduce emissions, e-waste, and improve energy efficiency (e.g., Molla et al., 2009 in Lokshin & Widmar, 2023). A focus on Green ICT in the public sector, which we refer to as Green E-Government, can also provide a broader contribution to a sustainable future by setting an example for private and non-profit organizations.

While the awareness of the need for Green E-Government has grown, many organizations are struggling with the question of what they need to do to minimize their environmental impacts. Which aspects of e-government do they need to address to reduce the environmental effects? How can they formulate an organizational strategy for Green E-Government? Many organizations are struggling with these questions but answers are not readily available. Our empirical exploration in four organizations highlights that while sustainability is recognized as important, a common challenge exists: there are few actionable Green E-Government (Green ICT) strategies. This is why the Data Workshop decided to investigate Green E-Government to present recommendations to government organizations, focusing both on short-term actions and long-term strategies

This report builds upon the (limited) literature on the topic and empirical research in four organisations. Our theoretical perspective builds upon the Green Government IT Index developed by Lokshin & Widmar (2023). The empirical research was conducted in four Datawerkplaats partners (Province of South Holland, Province of Utrecht, Municipality of Utrecht, and Municipality of Amersfoort). The five interviews in these four organizations revealed an increasing focus on Green E-Government, with both small steps and long-term

goals being implemented, but still at an early stage. Combined, the theoretical framework and the empirical research provide the basis for recommendations and practical Green E-Government solutions.

Green E-Government Framework: Five Pillars

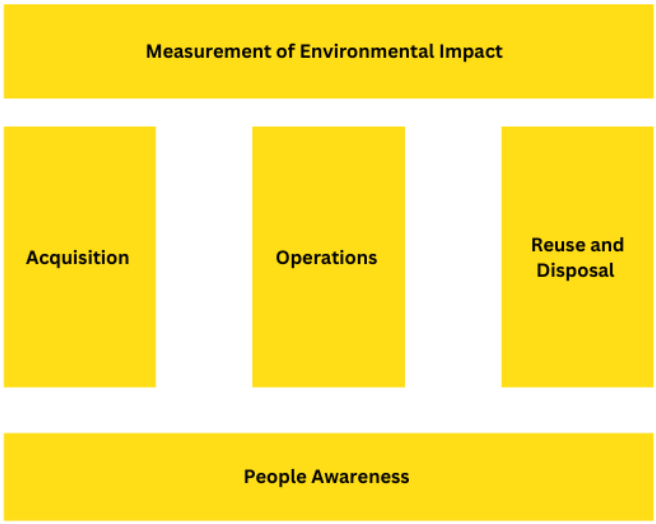
There is little literature on Green ICT in the public sector addressing the specific characteristics, challenges, and needs of public institutions. Lokshin & Widmar (2023) from the World Bank provide the Green Government IT Index to measure the environmentally responsible use of ICT by government institutions. It offers institutions an overview of their ICT sustainability and identifies areas for improvement. The index is designed for cross-comparison between public organizations, using a simple, single measurement. Considering factors such as budgetary constraints, bureaucratic and legal regulations, and multiple layers of decision-making authority, Lokshin & Widmar (2023) developed a sector-specific tool with both conceptual and mathematical foundations that enable cross-comparison between organizations. Based on this tool, we used three pillars of Green E-Government as a starting point: 'acquisition' of ICT equipment, 'operations,' and end-of-life 'disposal.'

We extended the Lokshin & Widmar (2023) model by adding two pillars based on other literature on Green IT. The fourth pillar, 'people awareness', is linked to Lago and Jansen's (2011) research on environmental awareness. This pillar focuses on raising awareness of environmental footprints through ICT use, such as by using applications providing real-time feedback on energy consumption to encourage more resource-efficient behavior. This pillar regards general employees as ICT end-users and IT departments responsible for operations. Awareness is a crucial precondition for the other three pillars (acquisition, disposal and operations).

Awareness by itself does not suffice: taking action to reduce environmental impacts also requires information. Lago & Jansen, (2011) argue for measuring the greenness of services. 'Green metrics' and 'feedback services' provide end-users with information on the carbon footprint of services. Consequently, a fifth pillar, 'measuring environmental impact' through energy consumption and CO2 monitoring, was added to the framework.

The extended framework can be labelled as 3+2: Green E-Government entails targetted action in three domains (acquisition, disposal and operations) and these actions are stimulated by people's awareness and informed by measuring environmental impact.

Figure 1: Pillars of Green E-Government



Pillar One: Purchasing Strategy

The first pillar of Green E-Governance is 'acquisition' of ICT equipment. It assesses whether an organization adopts practices that consider environmentally sustainable hardware and software acquisition standards (Lokshin & Widmar, 2023). For example, it evaluates whether sustainability is a key factor in purchasing decisions and how organizations address it. In our research, we found that government organizations are aware of the need to consider the sustainability impacts when purchasing ICT, even though more focus is placed on budget constraints, security, and performance than on sustainable procurement.

Organizations can significantly influence sustainability by including eco-friendly criteria in the purchasing phase. The Municipality of Utrecht aims to maximize its impact by incorporating sustainability standards in tenders. This approach was evident in the ongoing End-use and Hardware tender, where they partnered with a smaller company high on the R-ladder (Reduce, Reuse, Recycle) for hardware procurement. This company, more focused on circularity than large multinationals, promotes local reuse by donating repurposed hardware within the region instead of exporting it.

Additionally, Utrecht aims to reduce hardware by minimizing devices per employee, switching to laptops over desktops, eliminating landline phones, and transitioning to cloud-only operations. The Province of South Holland is also moving towards a wireless environment, reducing hardware needs and upgrading infrastructure with more Wi-Fi points and automated systems such as light switches. This not only supports sustainability goals but also delivers financial benefits.

Therefore, the purchasing stage presents an opportunity to implement more sustainable practices by researching market offerings and selecting providers that prioritize sustainability. Measures such as reducing hardware and cable usage contribute to greener operations. Various measures can be implemented but there is an overall need for a comprehensive strategy for green e-government acquisition which is integrated in all purchasing decisions.

Pillar Two: Operations

The second Pillar refers to the daily operations of ICT. It asses the extent to which sustainability is integrated into the day-to-day organisational ICT practices, for example, in matters regarding Cloud/On-Premises operations, data centres, and endpoint devices (laptops, phones). In our research, we found various practical examples of how the environmental impacts of operations can be reduced.

The first part of the Operations Pillar concerns the data centres. The participant representing the Province of South Holland mentioned that energy consumption primarily concerns computer operations and the data centre. For the data centre, they replaced the spinning drives with SSD drives (storage on ‘chips’, ‘solid-state drives’), and now it is consuming significantly less energy. Since they use less energy, there is also less heat produced. Therefore, less energy is needed for air conditioning of the data centre. In the past decade, the energy consumption of data centres has been reduced by approximately 50% since the replacement of spinning discs. The disc gets 'fuller' towards the end of the lifetime, leading to more energy consumption. The chip storage’s energy consumption is linear during its life cycles and uses less energy. However, there is a need to find ways to shut it down when possible to reduce the energy consumption.

The literature review revealed that specialised Data Centres that public organisations use can be more environmentally friendly than keeping on-premises storage within the organisation, even if the data centre has a higher ecological footprint (Lokshin & Widmar, 2023). That is mainly because modern and specialised Data Centres have advanced strategies to measure and manage the environmental impact, strategies which on-premises data centres of public institutions often lack due to limited resources and expert knowledge. One of the participant organisations in this study mentioned that their Data Centre will be relocated with a specialised

company. The company is giving a lot of attention to their ecological footprint and provided the organisation with reports containing information on how it procures its energy, how much it uses, and how it manages energy consumption. For instance, the Municipality of Utrecht decided to outsource their data centre to a specialised third-party provider in Amsterdam. The municipality inquired about its environmental strategies, visited the facility, and reviewed its cooling tools and overall green initiatives. Notably, the provider utilizes heat produced by its data centre to warm nearby households.

The second part of the Operations Pillars addresses Cloud and On-Premises Operations. All the participating organisations use a hybrid system of on-premises and cloud storage and operations, mentioning that the trend is to move towards mostly Cloud Services. One of the participants from the Municipality of Amersfoort shed light on the technicalities regarding managing the power consumption of cloud operations. In their organisation, 50% of the current line of business applications are on Cloud and 50% are on-premises. In the Cloud model, you can choose to put the application in sleep mode at night, which saves up energy and money. However, it depends on the type of Cloud model. For instance, in PaaS (platform as a service) and IaaS (infrastructure as a service), saving energy saves money, while in SaaS (software as a service), the price stays the same, regardless of energy usage. Therefore, there is no incentive for the organisation to put applications in sleep mode unless the provider can reduce the overall costs of the services. In their opinion, such an incentive from the provider's side would make a difference in the way the organisation manages power consumption. Alternatively, identifying how to shut down applications when not needed, requires future exploration.

Another aspect discussed in the interviews is the issue of bad storage practices of end-users who tend to create duplicates of the same document in the Cloud. One participant mentioned that the storage allocated per employee is 1 TB, which is rarely used at its maximum capacity. In Microsoft SharePoint, documents are saved multiple times, and duplicates take up unnecessary space. The municipal department uses a lot of large files such as maps and geographical system data; when employees send the file instead of the link to the files, it results in multiple duplicates saved in SharePoint. In terms of technically managing the storage to reduce energy consumption, the participants mentioned that storage can be done in tiers, primary and secondary, which saves energy. Additionally, paying more attention to how end-users utilise the storage space and avoiding duplicating data would result in less needed storage and therefore less environmental impact. If they buy less data storage, they also gain financially.

Lastly, another important category of the Operations Pillar regards end-point devices (phones, laptops, computers). Organisations introduced the Fairphone, a more eco-friendly mobile option, though its adoption is limited by cost and performance factors, leading some organizations to discontinue its use. Additionally, they aim to extend the lifespan of laptops and computers, averaging 4-5 years. All organizations conduct ICT maintenance through the

providers from which the hardware was acquired, for as long as it is supported by the manufacturer. A green practice shared by the Province of South Holland is an in-house repair at the end of the ICT devices' lifecycle, replacing broken hardware to meet the circularity goals.

Other green practices discussed focused on building operations. For example, by transitioning to a wireless environment, the Province of South Holland reduces hardware and cables. End-users also minimize streaming communication, avoid unnecessary emails, and limit excessive AI use—hidden energy consumers—though this is further addressed in the People Awareness Pillar.

Overall, Pillar Two reveals that organizations are already taking significant steps to reduce their carbon footprint by adopting green practices, such as relocating data centres to specialized providers and extending the lifetime of end-point devices through in-house repairs once manufacturer support ends. The variety of measures identified can form the basis for a comprehensive strategy for green e-government operations.

Pillar Three: Disposal (and Reuse) Strategy

The disposal pillar evaluates the end-of-life practices of reusing and recycling waste from Electrical and Electronic Equipment (WEEE)/e-waste. Through this pillar, we assess the sustainable measures organizations take regarding the produced e-waste to contribute to the circular economy. In this context, circularity refers to repurposing devices at the end of their lifetime. The research showed that some measures are already taken.

Organizations do not repurpose old devices internally mainly because those devices no longer receive support from the manufacturer and, therefore, lack software updates, which hinders performance and security levels. Participants from the Province of South Holland and Gemeente Amersfoort mentioned they send their equipment for recycling in accordance with contracts with the third parties who sold them the equipment. Another participant from Gemeente Amersfoort mentioned they repurpose their old equipment by sending it to schools. The municipality of Utrecht also repurposes old devices locally, rather than donating internationally, through the support of the provider. As they mentioned, this was an important factor for them when considering partnering with that provider.

In sum, organizations are already adopting circular practices regarding their e-waste. Addressing the goal of supporting a circular economy, repurposing old devices contributes significantly to reducing the use of primary materials. Notably, doing so locally rather than internationally also reduces the carbon footprint associated with transportation. The next step needs to be that a reuse perspective on ICT equipment is integrated into the organisation’s green e-government strategy, possibly from the early procurement phase.

Pillar Four: Measuring The Environmental Impact

Pillar four addresses the extent to which organizations measure the environmental impact of ICT. This includes measuring CO2 production or energy consumption per device or similar units of output (e.g., computers). This information does not directly reduce environmental impacts but it is a crucial precondition for the three previous pillars: information about the sustainability impacts of various products and activities forms the basis for rational organizational decision-making.

The Province of Utrecht uses the CO2 Performance Ladder, a tool developed by The Foundation for Climate Friendly Procurement and Business (in Dutch: SKAO), to manage and reduce their CO2 emissions. Since it measures the overall CO2 emissions of the organization, the Performance Ladder highlights the main polluters (e.g., construction work) and energy consumers, while ICT practices have a significantly smaller carbon footprint. As such, the organization is understandably focused on tackling the main polluters. While the Province of Utrecht already takes extensive steps towards greening their ICT services, it is important for anyone using similar measuring tools to remember that ICT, although not a main polluter, can easily be addressed and, therefore, should not be overlooked.

The municipality of Utrecht employed a different strategy, engaging CE Delft to analyze the climate impact and resource depletion caused by the municipality's annual procurement, including ICT equipment. This analysis helped the municipality prioritize efforts to reduce CO2 emissions in different procurement segments. In 2022, total municipal expenditure contributed to approximately 92.5 kilotons of CO2 equivalent emissions, comparable to the annual emissions of 4,900 Dutch households. ICT procurement accounted for about 5% (4.9 kilotons CO2 eq.) of this impact, highlighting it as a significant area for improvement in the municipality's sustainability initiatives.

Therefore, measuring the environmental impact of ICT provides important insights into how it contributes to the organization's carbon footprint. This can be done by utilizing tools from external providers, as seen in the two cases above. Another aspect to consider, which organizations are not currently addressing, is finding ways to monitor energy consumption per device or for overall ICT operations to identify the main energy consumers and, therefore, pinpoint areas for intervention.

Pillar Five: People Awareness

The fifth pillar addresses the extent to which organizations take action to raise the awareness of their employees regarding how their daily practices impact the carbon footprint of the organization, while also sharing knowledge on green practices they can easily adopt. This pillar involves both end-user employees and specialized IT department employees.

There is a growing need for increased awareness among employees about how their data storage and device usage can reduce their carbon footprint. IT department employees, in particular, need to be more proactive in implementing greener ICT practices, as they are the experts responsible for driving change. While there are existing initiatives, such as workshops and training programs like the IT Circle Nederland, which address sustainable IT practices like cloud computing and energy-efficient data centres, more enthusiasm and effort are required to make a significant impact.

Moreover, the method used to communicate with employees and encourage sustainable practices is important. For example, the Province of Utrecht organized a spring cleaning event to help employees optimize their devices by cleaning storage space. The municipality of Utrecht shared a success story in which they communicated the environmental impact of email reduction through relatable messages, such as ‘sending fewer emails saves trees’. Employees responded better to this approach than to formal policy communications. Their SharePoint environment also includes thematic folders with practical advice on email management, interactive quizzes, and engaging activities, such as encouraging birthday greetings in person rather than by email. These resources help employees actively reduce their digital footprint.

Other respondents indicated that employees are encouraged to adopt simple practices, such as regularly deleting old emails and reconsidering the necessity of large email attachments like logos, which take up valuable storage space. Additionally, switching to environmentally friendly search engines like Ecosia, using streaming communication only when absolutely necessary, and raising awareness of the carbon footprint associated with AI usage are steps employees can take. The challenge lies in fostering collective responsibility for sustainability, as the actions needed to reduce environmental impact are often straightforward and should involve everyone in the organization.

Therefore, this pillar focuses on individual-level green practices and aims to encourage employees to actively reduce their carbon footprint by adopting simple practices and engaging in knowledge-sharing activities on sustainability. Research has been conducted on the importance of Environmental Awareness (Lago & Jansen, 2011), which emphasizes raising individuals' awareness of their environmental footprints through the use of ICTs. For instance, this can be achieved through service-based applications that offer real-time feedback on energy consumption, encouraging users to adopt more resource-efficient behaviors. While this is not yet implemented, it can have a significant impact.

The Road Ahead- Green ICT Recommendations

Based on insights from our interviews and the theoretical model developed around the five pillars of Green E-Government, we propose that organizations adopt the Five Pillar model to shape their green E-Government Strategies. This model provides a holistic and integrated approach, enabling organizations to minimize their environmental impact by taking targeted actions within each pillar. The five pillars can be added as a chapter to the organizational ICT strategy to take the step from intentions (minimizing environmental impacts) to concrete actions. This model should be supported by strong leadership to ensure its successful implementation. Effective leadership is essential for setting clear goals, mobilizing resources, and maintaining organizational commitment to sustainability. The table below offers an overview of Green E-Government recommendations for each pillar, which organizations can consider for implementation. We highlight the focus of each pillar and present some concrete suggestions.

Figure 2: Green E-Government Recommendations

Green E-Government Strategies and Recommendations				
Overall strategy				
Acquisition	**Operations**	**Disposal**	**Measuring the Environmental Impact**	**People Awareness**
Include sustainability criteria in decisions about and tendering processes for ICT hardware	*Minimize sustainability impacts in all daily ICT-operations (ICT use, data storage, etc.)*	*Develop end-of-life practices of reusing and recycling ICT-hardware*	*Measure energy use and CO2 emissions per unit of output*	*Improve user awareness of all energy-saving practices (acquisition, operations, disposal)*
Some specific recommendations				
Expand knowledge of sustainable devices by researching market offerings that balance costs, performance levels and sustainability	Relocate data centers to sustainable facilities that reuse excess heat to warm residential areas or greenhouses.	Repurpose old devices by donating locally (e.g. donate to schools)	Measure energy consumption per device to identify high-usage equipment. Explore scalable solutions to assess consumption across networks.	Use interactive platforms like SharePoint for engaging information on sustainability practices.
Purchase refurbished devices	Adopt eco-conscious apps (e.g., Ecosia) and mobile options (e.g. Fairphone)		Consider using specialized tools to measure environmental impact internally or collaborate with external institutions that conduct assessments.	Encourage IT teams to engage in Green IT knowledge-sharing initiatives.
	Minimize streaming and AI usage to reduce energy usage.			
	Transition to wireless environments to minimize cable usage.			
	Shut down IT devices and applications at night and during inactivity			

Figure 3: Resources to explore

If you would like to know more about the mentioned organisations, please refer to the following links:

Pillar Four: Measuring Environmental Impact

- CO2 Performance Ladder, developed by SKAO: https://www.co2-prestatieladder.nl/
- CE Delft: https://ce.nl/

Pillar Five: People Awareness

- IT Circle Nederland: https://www.itcircle-nederland.nl/en/

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