Sustainable ICT Research

IGEL OS reduces end user computing carbon footprint

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Executive Overview

The research objective is to determine environmental and financial benefits enabled by using IGEL OS to extend the useful lifespan of end user computing (EUC) devices. Values calculated include reductions to product and use phase carbon footprint, e waste, electricity consumption, utility and hardware procurement costs. To achieve the objective two studies are conducted. The first focuses on an average 5,000 user EUC environment and the repurposing of devices facing replacement due to impending Windows 10 end of life. The second examines an organisation moving all 5,000 devices from a 4 year retention policy to 8 years to improve product longevity and reduce carbon footprint and long term costs.

The results determine that faced with a 27% device replacement due to Windows 10 end of life, the purchase of 1,355 new devices is 100% displaced by installing IGEL OS on existing computers. Extending the device lifespan by a further 3 years, immediately avoids anticipated new device supply chain greenhouse gas (GHG) emissions of 316,528 kgCO_2e and replacement hardware costs of £827,045.

Taking this circular approach, 3,076 kg of e waste is also avoided as the existing computers continue useful operation. Plus, ongoing electricity consumption is reduced by 22% due to improved device energy efficiency. This is caused by IGEL OS requiring less power draw than comparative operating systems during active use. During the extended period, the new efficiency saves a further £7,123 in utility costs and avoids 8,274 kgCO_2e of scope 2 (electricity) GHG emissions.

In the second study, when enabled to transition from a 4 year retention policy to 8 years by installing IGEL OS, the research shows that 44% of the total lifespan carbon footprint for 5,000 EUC devices is avoided. In context, the 1,236,014 kgCO_2e GHG reduction is equivalent to emissions generated by driving a petrol engine car 182 times around the Earth's circumference. As 85% of EUC device carbon footprints are derived from the supply chain, the environmental improvement assists with sustainability reporting compliance too. New legislation requires organisations to report annual supply chain emissions and specifically the carbon footprint of capital goods purchased. Therefore, the reduction of GHG emissions is a compelling outcome as it reduces operational environmental impact.

The same policy also delivers a 48% reduction in combined procurement and utility costs, saving £3,125,963 during the 8 year period.

In conclusion, all determined values indicate that IGEL OS enables organisations to positively improve Planet, Profit and Policy outcomes. Doing so enables responsible consumption strategies that save money and ultimately drive climate action.

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Introduction

Information communications technology (ICT) is responsible for as much as 3% of annual global greenhouse gas emissions [1]. In context, if ICT were a country then it would rank as the world's fifth highest emitter just behind Russia and ahead of Japan. The source of emissions is a combination of ICT hardware production, distribution, use and end of life (EOL) services associated with end user computing (EUC), networking and data centres.

EUC devices account for more than a third of all ICT emissions [2] due to increasing global digitisation driving end point popularity. As an example, over 4.2 billion users consume electricity each day as they use devices such as tablets, notebooks, desktops and monitors [3]. This creates what are known as scope 2 GHG emissions caused by electricity purchased for use. In turn, digitisation creates new product demand causing the production of over 665 million new EUC devices each year [3]. This activity generates what are known as scope 3 GHG emissions caused by the product supply chain.

On average, the carbon footprint of EUC devices is predominantly generated by the supply chain stage. This accounts for approximately 75-85% of a device's total lifespan GHG emissions depending on factors such as hardware type and how many years the computer is used for [4]. Research shows that this supply chain percentage will increase in the future [5]. This is because devices are becoming more energy efficient and electricity grids across the world are transitioning away from electricity generated by carbon intensive fossil fuel to low carbon renewable energy sources [4]. Therefore, as electricity supplies decarbonise the contribution of scope 2 (electricity) emissions will logically decline moving forward.

Consequently, because new product production contributes so highly, research also shows that to reduce long term EUC device carbon footprints, the best strategy is to keep computers and monitors for as long as possible [2-7]. As an example, keeping devices for just 4 years means that during a 12 year period, every user will receive 3 new computers. While increasing retention periods to 6 years, the users will only receive 2 new computers within the same time frame. Therefore, without much effort both EUC ICT carbon footprint and procurement costs have been reduced by one third.

The strategy is called useful lifespan extension and displacement. This is because the device remains in use for longer periods and replacement product procurement occurs less frequently. The need to implement approaches such as this are emphasised by the United Nations sustainable development goals (SDGs) [10] that form part of a wider framework designed to help humanity create a more sustainable future.

Goal 12 positions that achieving responsible production at a manufacturing level and responsible consumption at a consumer level will drive goal 13, climate action, as associated GHG emissions decline.

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While legislation and standards continue to evolve to ensure manufacturers reduce their new product carbon footprints [3], research shows that on average commercial, public and third sector organisations refresh EUC devices every 4 to 5 years [7]. As this retention period can be considered relatively short, the current practice offers an opportunity for lifespan extension and displacement to be adopted to achieve responsible consumption.

Impetus to do so is also being heightened by the introduction of new legislation designed to curb excess ICT hardware consumption [3]. As an example, from 2024 onwards, over 50,000 organisations across Europe are now required to report supply chain GHG emissions [3]. The new reporting requirement includes emissions created by purchased and capital goods. ICT is included within this category and therefore the supply chain carbon footprint attributed to all ICT hardware must be accounted for within such reports. Consequently, if EUC devices could be kept for longer periods, then these reported annual values will decline accordingly. This helps to address both compliance and responsible consumption.

However, the current average retention policy for EUC devices is driven by a mixture of decision making criteria. At the top of the list is operating system obsolescence and device performance reduction [3]. These two key drivers relate to devices becoming unable to effectively interact with evolving business applications and experiencing security issues as operating system updates become no longer available [3].

Examples of operating system obsolescence can be extreme in some cases and when experienced at scale, the impact to both planet and profit is significant. As an example, reports suggest that approximately 240 million devices will be rendered obsolete when Microsoft ends Windows 10 support in 2025 [8]. This will create over 57 billion kgCO_2e in new product supply chain emissions and in excess of 600 million kg of electronic waste [9] if the affected devices are replaced with new devices.

In context, that's equivalent to average annual GHG emissions generated by 28.2 million combustion engine cars [9]. From a cost perspective the impact is vast too. Replacing 240 million notebooks, desktops and tablets will cost over £148 billion [9].

Consequently, it's reasonable to suggest that to change current EUC device replacement behaviours and cycles, a credible alternative is required. IGEL OS offers such potential by installing the new operating system on existing EUC equipment being considered for replacement.

This is because IGEL OS is designed to create an updated and secure endpoint for a variety of EUC computing strategies including desktop as a service (DaaS) solutions such as AWS, Citrix and Microsoft W365, plus, Virtual Desktop Infrastructure (VDI) solutions. As all of these approaches offload processing to inside the data centre, concerns relating to device performance degradation and application compatibility are removed. This means that devices destined for replacement can continue to operate productively and securely.

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To determine the positive impact to both planet and profit delivered by IGEL OS when extending device lifespans, this paper scientifically calculates two scenarios. The first study focuses on an average 5,000 users environment repurposing those devices facing Windows 10 device obsolescence. The second, examines an organisation moving all 5,000 devices from a 4 year retention policy to 8 years by using IGEL OS.

Methodology

The objective of the research is to substantiate metrics associated with avoiding early replacement of end user computing (EUC) devices. The metrics include carbon footprint (annual, total, scope 2 and 3), e waste, electricity consumption, utility and hardware procurement costs. GHG emissions data for carbon footprint metrics are presented in kilograms of carbon dioxide equivalent (kgCO2e) in accordance with international GHG accounting protocol. E waste is calculated in kilograms (kg) and electricity consumption in kilowatt hours per year (kWh/y). Concomitant scope 2 use-phase GHG emissions are calculated using a European average carbon intensity conversion factor [9]. Procurement and utility costs are based upon averages experienced in the United Kingdom [9].

All device related metrics are extracted from the Px^3 sustainable ICT applications platform database [9]. Device types included within the study are desktop, integrated desktop (also known as All-in-One or AIO), thin client desktop, workstation desktop, notebook, mobile workstation, mobile thin client and tablet computers.

To generate average proportional representation by computer type, asset data including 3.2 million devices captured during Px^3 commercial, public and third sector EUC carbon footprint reporting is used [9]. This enables the number of devices of each type within an average 5,000 computer user environment to be determined.

For the Windows 10 study, Px^3 EUC carbon footprint reports conducted within the last 12 months including 310,000 devices in commercial, public and third sector organisations are used to generate percentages of device types that will require replacement due to Windows 10 support expiring [9]. The identification of such devices is based upon the criteria outlined in the results section as part of the discussion. The results include the total avoided metrics delivered by implementing IGEL OS in favour of device replacement.

For the wholesale replacement study, the same device type proportional representation data is applied to a 5,000 user group [9]. In this instance, the reported metrics are based upon extending the existing devices' useful lifespan from 4 years to 8 years by installing IGEL OS on all devices. The results include total carbon footprint, e waste and cost reductions plus annual improvements to enable comparison and highlight changes.

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Results

The results section first examines the Windows 10 replacement scenario, followed by the 5,000 user group extension study. Analogous values are used throughout to ensure the results can be contextualised into familiar equivalents to enhance understanding of the environmental impact in each instance. This includes computer GHG emissions translated to emissions caused by driving combustion engine cars. Plus the relevant size of mature forests required to remove the resulting carbon from the atmosphere.

Study 1: IGEL OS and Windows 10 EOL

Replacing Windows 8.1, Microsoft released Windows 10 in July 2015. Six years later, Windows 11 was released with a free upgrade available to computers meeting the new operating system's requirements. Next year, in October 2025, Microsoft will no longer provide security updates or technical support for Windows 10 devices. This means that devices not meeting the Windows 11 requirements must be replaced or an alternative strategy, such as implementation of IGEL OS, must be sought.

To successfully upgrade existing Windows 10 devices to Windows 11 and avoid operating system obsolescence, existing hardware must meet the upgrade criteria. While memory and storage drives can in many cases be increased in capacity to meet the 4 gigabytes (GB) and 64 GB minimum, the barrier to compatibility focuses on two key requirements. Firstly, the device must have a central processing unit (CPU) of 1 gigahertz (GHz) or faster, with 2 or more cores on a compatible 64-bit processor or System on a Chip (SoC). Secondly, the Trusted Platform Module (TPM) that provides hardware based security function must be version 2

In the case of the TPM, it is feasible to update the version in some instances. As such, whether a device can or cannot be upgraded to Windows 11 predominantly lies with the CPU model. From an Intel perspective, this means that any EUC device such as a notebook or desktop computer, must have a processor that is 8th generation or above. Considering this, it's reasonable to suggest that computers manufactured before 2018 cannot be upgraded to Windows 11.

To corroborate this perspective, notebook model releases from the Dell Latitude range were examined for compatibility with a Windows 11 upgrade [11]. As anticipated, all models 2017 and older are not listed by Dell as upgradable to Windows 11 [11]. While all models from 2018 onwards with an 8th generation Intel CPU or newer can be upgraded [11]. To test this, an attempt was made to upgrade the operating system of one of the last 2017 releases from Dell, a Latitude 5480 notebook, to Windows 11. Unsurprisingly, it was not possible as expected and a new device replacement was automatically suggested.

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Consequently, organisations with Windows 10 EUC devices manufactured before 2018 face three choices:

- *Continue with Windows 10*
    - In this scenario, users can simply carry on using the devices at the risk of new applications incompatibility, limited hardware and OS security and eventual obsolescence. As an example, Microsoft states that while Windows 10 devices will obviously continue to operate, Microsoft 365 apps will not be supported on Windows 10 after October 2025. This is because the OS will no longer meet the system requirements for Microsoft 365 apps.

- *Buy a replacement device*
    - To remain supported, an upgrade to Windows 11 must be undertaken which in this instance can only occur by buying an appropriate replacement device. Therefore in this scenario, users must replace devices manufactured before 2018 if they wish to continue using Microsoft OS and applications.

- *Repurpose the device with IGEL OS*
    - Organisations with Windows 10 devices that do not meet the Windows 11 upgrade requirements have the option of installing an alternative operating system such as IGEL OS. By doing so the device's useful lifespan is extended as users can once again use the existing hardware as a secure endpoint for a variety of EUC computing strategies including SaaS, DaaS, and VDI. This includes Microsoft applications.

It's reasonable to suggest that option 1 is impractical in business environments as it will undermine security of operations plus impact user productivity. Therefore, if option 2, the replacement strategy, is selected then additional environmental and financial costs will be incurred.

Examining asset data for 310,000 end user computing devices installed at commercial, public and third sector organisations [9], it was found that as much as 27% of devices do not meet the Windows 11 upgrade requirements. Particular device types were exposed as being affected more than others. As an example, 55% of desktop workstations, 31% of mobile workstations and 27% of integrated desktop computers (AIO) did not meet the CPU specification.

In the context of a 5,000 user computer workplace, this means that as shown in table 1, 1,355 computers will require strategic intervention before October 2025.

Should a replacement device strategy be followed then the new product supply chain carbon footprint generated will be 316,528 kgCO_2e (Table 1). In context, this is equivalent to emissions generated by a combustion engine car being driven 47 times around Earth

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circumference. Arguably more compelling, to remove the resulting carbon by photosynthesis from the atmosphere requires 14,400 mature trees.

Additionally, on average the replacement will also create 3,076 kg of avoidable e waste. Now the fastest growing solid waste stream in the world, e waste produces over 62 million tons per year and is predicted to reach 82 million by 2030. This growth is being accelerated by short electronic product life cycles [12].

While the planet impact is significant, even within this single 5,000 user environment financial benefits generated by extending device lifespans is compelling. Specifically, replacing the computers not able to upgrade to Windows 11 will cost the organisation approximately £827,000 in new hardware costs (Table 1). As such, depending upon company stakeholder role based interest and needs, there is both a planet and profit case to be made in favour of strategy 3. In this scenario, the existing computers can be repurposed using IGEL OS meaning that no devices are replaced.

While the obvious avoidance of both new product carbon footprint, e waste and hardware cost is positive, an additional benefit is realised. Research shows that IGEL OS is capable of reducing device electricity consumption by 22% [5]. This is achieved by the operating system requiring less power draw when in the active mode than comparable operating systems [5].

Pragmatically, EUC devices affected by Windows 10 EOL will be at least 6 years old. Therefore, these devices fall outside of the average 4-5 year retention period determined by research. As such, it is reasonable to suggest that the extension of lifespans in this situation, will not be double the average policy. Instead, it is assumed that a further 3 years of use will be gained from the existing equipment by repurposing with IGEL OS.

Consequently, by adopting IGEL OS and avoiding replacement of an average number of devices (1,355) without an upgrade path to Windows 11 in a 5,000 user organisation, a business can expect to achieve the following:

- **Planet:**
    - **Avoid 316,528 kgCO_2e in supply chain GHG emissions (scope 3) by not buying new products**
    - **Avoid 3,076 kg of e waste by not buying new products**
    - **Avoid 8,274 kgCO_2e in electricity GHG emissions (scope 2) by improving existing device energy efficiency**
- **Profit:**
    - **Displace £827,000 in new hardware costs by not buying new products**
    - **Reduce electricity consumption by 27,396 kWh and utility costs by £7,122 by improving existing device energy efficiency**

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In total, the avoided carbon footprint is 324,802 kgCO_2e and the cost savings £834,168 (Table 1). Beyond the considerable financial savings, the GHG emissions avoided are equivalent to a combustion engine car travelling to the Moon five times.

Calculated as a per capita value, the 'IGEL OS for Win 10 strategy' avoids 240 kgCO_2e of GHG emissions per user. Research shows that 9 out of 10 employees would support sustainable ICT strategies if the resulting climate action was tangible to them [4]. In this example, emissions avoided per user are equivalent to the same user avoiding a 1,400 km journey in a combustion engine car. Similarly, to sequester the resulting carbon from the atmosphere requires 11 mature trees.

Table 1. Planet and Profit impacts for Windows 10 EOL scenario

Number of IGEL OS End Points per 5,000 users	Avoided Scope 3 GHG Emissions (kgCO_2e)	Avoided E-Waste (kg)	Procurement Cost Saving (£)	Avoided Scope 2 GHG Emissions (kgCO_2e)	Electricity Consumption Reduction (kWh/y)	Electricity Cost Saving (Currency)	Total Avoided Carbon Footprint (kgCO_2e)	Total Cost Saving (£)
1,355	316,528	3,076	£827,045	8,274	27,396	£7,123	324,802	£834,168

At both an organisational and individual level, it is evident that the triple bottom line of Planet, Profit and People that acts as the foundation of Environmental, Social, and Governance (ESG) and Corporate Social Responsibility (CSR) frameworks is supported by extending device lifespans.

With Windows 10 EOL approaching, organisations ought to be compelled to investigate the strategy and to calculate the benefits available by decoupling operating system obsolescence from device replacement decision making. By doing so goal 12, responsible consumption can be meaningfully achieved and climate action realised via sustainable ICT with IGEL OS.

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Study 2: IGEL OS and Device Lifespan Extension

The following study expands upon the concept of device lifespan extension using IGEL OS. In this scenario, planet and profit metrics are compared between an existing 5,000 endpoint environment with a retention policy of 4 years and the same devices being extended to a retention period of 8 years using IGEL OS installed from the 5th year onwards.

IGEL OS and Device Life Span Extension

Using data compiled from over 3 million EUC devices included in carbon footprint reports and sustainable ICT strategies conducted by Px[3], metrics for an average EUC environment for 5,000 users is generated [9]. This includes all device types represented by the average percentage that they appear in the workplace. Table 2 details the carbon footprint, e waste, electricity consumption, utility and procurement costs associated with this endpoint estate.

When kept for 4 years, the total lifespan carbon footprint is 1,404,709 kgCO_2e (Table 2). This is generated by an 85% contribution from supply chain GHG emissions (scope 3) and 15% use-phase (scope 2) GHG emissions (Table 2). As the value includes 4 years of use, the annualised carbon footprint that would be recorded each year to meet GHG legislation reporting requirements is 351,177 kgCO_2e (Table 2). Therefore the annual carbon footprint per user is 70 kgCO_2e.

In context, the total is equivalent to a combustion engine car driving 206 times around the Earth's circumference. Annually, a 1.65 km^2 forest is required to remove the carbon from Earth's atmosphere.

E waste is 12,739 kg (Table 2), creating an average of 2.56 kg per user and an annual value of 3,185 kg.

Total costs are £3.27 million (Table 2) made up of 94% procurement and 6% electricity costs (Table 2) during the devices' useful life span. Electricity consumption for the 4 year period is 716,137 kWh/y (Table 2) meaning that each year the EUC estate consumes 179,034 kWh/y at a cost of £46,549 per annum.

Table 2. Planet and Profit impacts for an average 5,000 EUC device environment with a 4 year retention policy

Existing EUC Device Metrics 4 Year Policy										
Number of EUC Devices	Total Scope 3 GHG Emissions (kgCO_2e)	Total E-Waste (kg)	Total Procurement Cost (£)	Total Scope 2 GHG Emissions (kgCO2e)	Total Electricity Consumption (kWh/y)	Total Electricity Cost (Currency)	Total Carbon Footprint (kgCO2e)	Annual Carbon Footprint (kgCO2e)	Total Cost (£)	Annual Cost (£)
5,000	1,188,436	12,739	£3,085,000	216,273	716,137	£186,196	1,404,709	351,177	£3,271,196	£817,799

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Comparatively, if the same 5,000 device environment is extended to an 8 year lifespan using IGEL OS, the metrics logically change to reduce both the planet and profit metrics. With all lifespan extension models, the key metrics used to compare differing retention policies are the annualised values. This is because the total lifespan values include electricity carbon footprint and costs as a sum for the period and are therefore not comparable. For example, a 4 year period includes the impact of as many years of electricity consumption, while an 8 year period includes double this.

When kept for 8 years, the annualised total carbon footprint value decreases by 44% from 351,177 kgCO_2e to 196,675 kgCO_2e (Table 3). Therefore the annual carbon footprint per user also declines by the same percentage from 70kgCO_2e to 39 kgCO_2e.

This is caused by two factors. Firstly, supply chain emissions are spread over twice as many years. In the original 4 year retention policy, the organisation will purchase 5,000 further devices to replace the original computers in year 5. While this will not occur in the 8 year retention policy. As such, demand for 5,000 new devices during the 8 year period has been avoided entirely.

Secondly, as previously noted, IGEL OS reduces device energy consumption by approximately 22% [5]. Consequently, during the 5 to 8 year period (inclusive) electricity consumption and concomitant scope 2 GHG emissions will decline from 179,034 kWh/y and 54,068 kgCO_2e per annum to 139,646 kWh/y and 42,173 kgCO_2e as shown in table 3.

Annual E waste is reduced by 50% from 3,185 kg to 1,592 kg (Table 3), creating an average of 0.32 kg per user per annum.

Annualised total costs reduce by 48% from £817,799 to £427,054 as assets are sweated across twice the original retention policy and electricity consumption falls by on average 11% across the entire period. Specifically, annual electricity consumption reduces from 179,034 kWh/y to 159,340 kWh/y (Table 3).

Table 3. Annual Planet and Profit impacts for an average 5,000 EUC device environment with a 8 year retention policy and IGEL OS

Annual Metrics Compared								
Policy	Annual Scope 3 GHG Emissions (kgCO2e)	Annual E-Waste (kg)	Annual Procurement Cost (£)	Annual Scope 2 GHG Emissions (kgCO2e)	Annual Electricity Consumption (kWh/y)	Annual Electricity Cost (Currency)	Annual Total Carbon Footprint (kgCO2e)	Total Cost (£)
Existing 4 Years	297,109	3,185	771,250	54,068	179,034	46,549	351,177	£817,799
IGEL OS 8 Years	148,554	1,592	385,625	48,121	159,340	41,429	196,675	£427,054
Reduction	50%	50%	50%	11%	11%	11%	44%	48%

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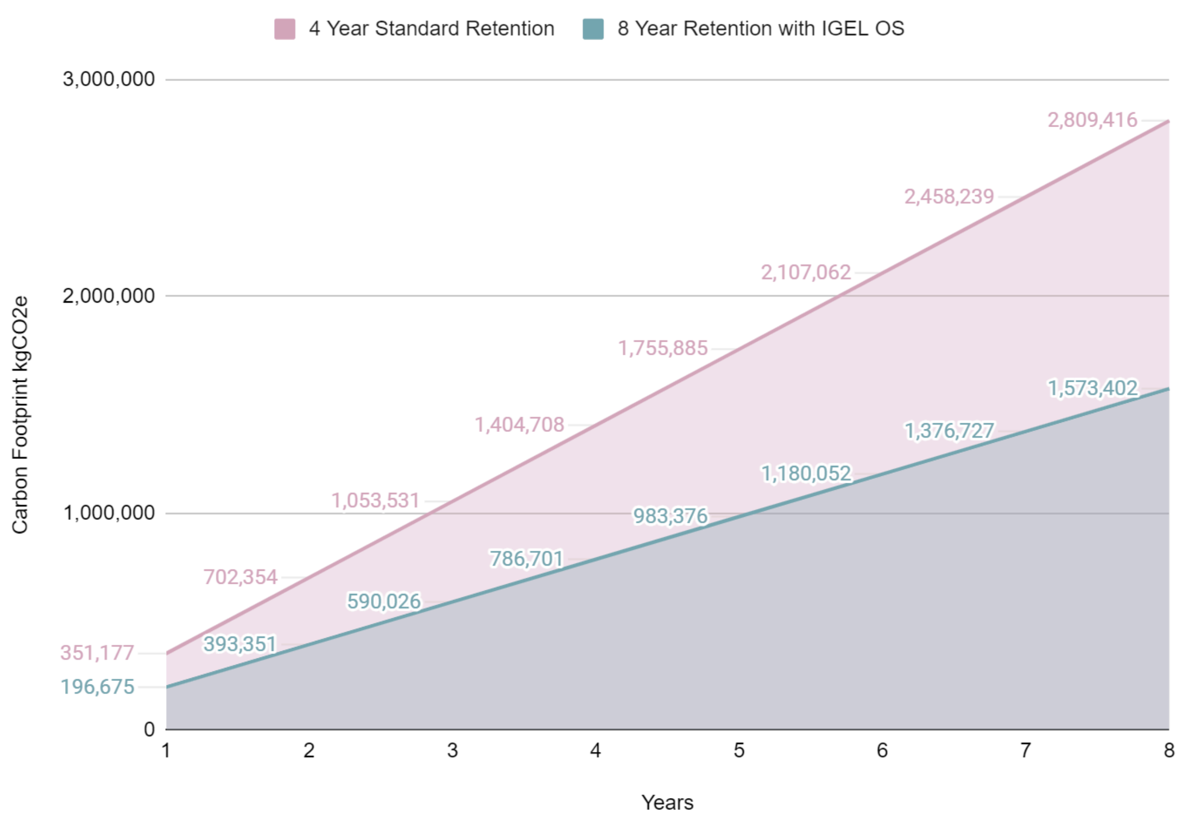
To understand the cumulative impact of both retention policies, the annualised values are compared across an 8 year period. As noted, for the 4 year retention cycle, 10,000 devices will be required. While for the IGEL OS 8 year cycle only 5,000 devices are required. The impact is as follows:

- **Planet:**
    - **Figure 1 shows that at the end of an 8 year period, an organisation adopting IGEL OS will have reduced the cumulative carbon footprint by 44% from 2,809,416 kgCO_2e to 1,573,402 kgCO_2e**
    - **This means that 1,236,014 kgCO_2e of GHG emissions has been avoided**
    - **In context, this is equivalent to emissions generated by driving 7.3 million km in a combustion engine vehicle or 182 times around the Earth circumference**
    - **Left unabated, the emissions would require over 7,000 trees every year to remove the associated carbon from our atmosphere**

Figure 1. Cumulative Planet metrics for an average 5,000 EUC device environment compared with an 8 year retention policy and IGEL OS



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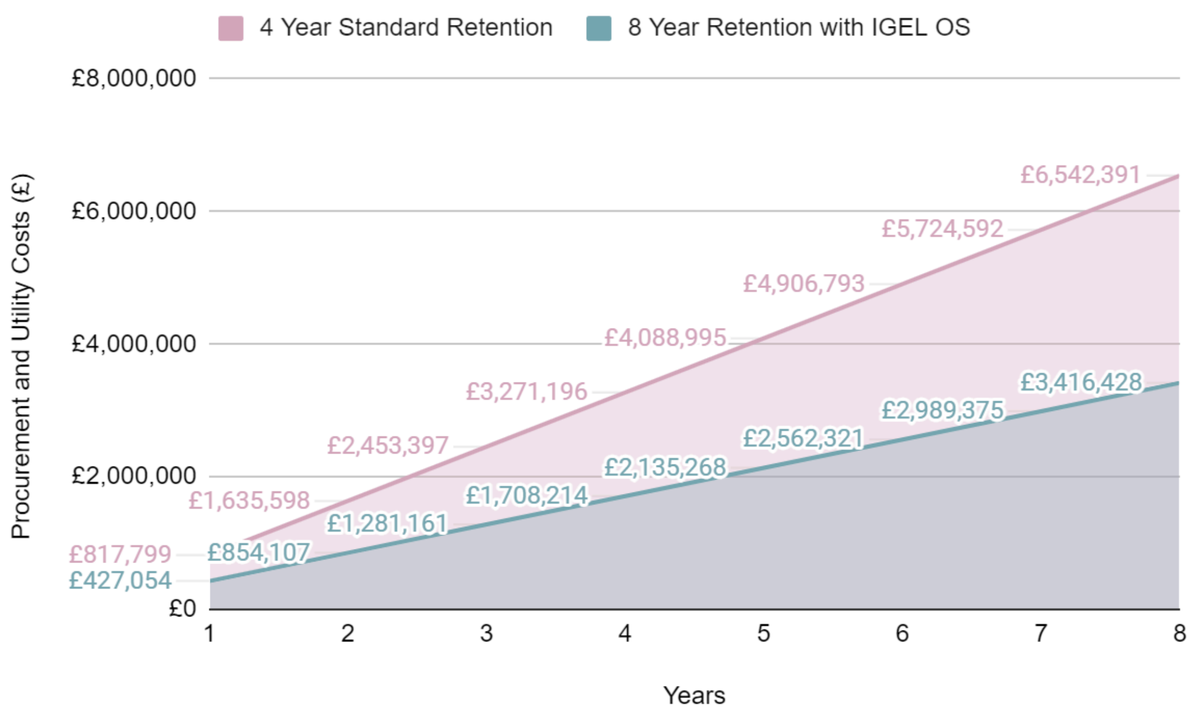
- **Profit:**
    - **Figure 2 shows that at the end of an 8 year period, an organisation adopting IGEL OS will have reduced the cumulative hardware procurement and utility costs by 48% from £6,542,391 to £3,416,428**
    - **This means that £3,125,963 of capital and operational expenditure has been avoided**

Figure 2. Cumulative Profit metrics for an average 5,000 EUC device environment compared with an 8 year retention policy and IGEL OS



Similar to the Windows 10 to IGEL OS strategy, the device lifespan extension policy using IGEL OS delivers significant planet and profit improvements. Research shows that when planning sustainable ICT strategies, appealing to all stakeholders by role based needs and interests is key to success [13].

Looking beyond the CxO board that will be satisfied with both the planet and profit outcomes, from a people perspective, in this example the lifespan per capita impact reduces by 44% from 562 kgCO_2e per user to 315 kgCO_2e. Showing again that on an individual and organisational level responsible consumption and ultimately climate action can be achieved via sustainable ICT and IGEL OS.

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Summary

Sustainability is the principle of ensuring our current actions do not limit the economic, social, and environmental options of future generations.

The seventeen United Nations Sustainable Development Goals act as a framework to encourage development that works for all people [10]. With over 8 billion people living on Earth, goal 12, responsible consumption and production, is key to long term success. The goal focuses upon transitioning to a circular economy by achieving product longevity, repairability, and recyclability. Doing so protects resource depletion and minimises waste. It also contributes meaningfully to goal 13, climate action as lifespan product carbon footprints are reduced.

Research shows that certain barriers often prevent widespread diffusion of sustainability strategies that can deliver change within the realm of ICT consumption [13]. The positive impact of transitioning to sustainable ICT strategies are in fact often highly underestimated and incorrectly perceived as costly [13].

Findings in this paper show that in fact, sustainable ICT strategies, such as device lifespan extension and new product displacement deliver significant improvements environmentally and financially.

Faced with device replacement due to Windows 10 end of life, the purchase of 1,355 new devices is displaced by transitioning to IGEL OS in study 1. Extending the device lifespan by a further 3 years, immediately avoids 100% of the anticipated new device supply chain emissions (316,528 kgCO_2e) and replacement hardware costs (£827,045).

Taking this circular approach, 3,076 kg of e waste is avoided as the existing computers continue their useful life. Plus, ongoing electricity consumption is reduced by 22% due to improved device energy efficiency [5], saving a further £7,123 and avoiding 8,274 kgCO_2e.

Applying the concept of EUC device lifespan extension to all endpoints in a 5,000 device environment using IGEL OS in study 2, further substantiates the positive impact of responsible consumption. Enabled to transition from a 4 year retention policy to 8 years, the model shows that 44% (1,236,014 kgCO_2e) of combined supply chain and use-phase product GHG emissions are avoided. While 48% (£3,125,963) of combined procurement and utility costs are avoided too.

The environmental and financial values are compelling and will appeal to stakeholders with diverse role based interests and performance indicators. Quite simply, if money can be saved and GHG emissions meaningfully avoided then sustainable ICT strategies such as this are to be embraced by business leaders.

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From a policy perspective, stakeholders concerned with governance and reporting will also be satisfied. For several years organisations have been subject to energy focused GHG emissions annual reporting [4]. As ICT consumes over 10% of all commercial electricity [1], this area has provided a rich source of concomitant scope 2 GHG emissions reduction [2-7].

More recently, to support national, regional and global GHG abatement targets, further legislation has been introduced requiring organisations to annually report supply chain carbon footprints [3]. As ICT equipment is included within this approach, opportunities to reduce long term scope 3 emissions by as much as 44% cannot be overlooked if organisations are to show that they are capable of achieving responsible consumption.

Ultimately, the planet metrics generated by sustainable ICT strategies support climate action via GHG emissions reduction. This is because the excessive production of GHG emissions causes global warming.

In 2017, 1.0°C sustained global warming became a reality [14]. More recently, 2023 represented the first 12 month period to experience a consistent 1.5°C rise in temperature with ongoing permanence predicted with high confidence by 2030 [14].

To avoid a 2°C rise by 2060, scientists calculate a 45% reduction in global GHG emissions generation coupled with 55% sequestration by both natural and mechanical processes is required [14].

Ahead of successful long term diffusion of global infrastructure and transport strategies such as 100% low carbon energy and electric vehicle transition, the United Nations indicates that existing technology must be examined to reduce current emissions and bridge the gap [15]. With 4.2 billion end user computing devices, this area of ICT offers a promising source of abatement to support this target [3].

As such, it is concluded that based upon the findings, lifespan extension using IGEL OS is capable of meaningfully contributing to sustainability and abatement strategies as it represents the opportunity to reduce EUC device GHG emissions by an average of 44%.

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About Px³

A scientific ICT carbon footprint report by sustainable ICT experts Px³.

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Founded in 2013, Px³ is a world leading sustainable ICT research and consulting organisation. Working globally for leading ICT manufacturers, eco certification labels, governments, commercial, public and third sector organisations, our aim is to drive climate action via the adoption of sustainable ICT.

This is achieved by combining our research and consulting skills with our unique sustainable ICT applications platform. The Px³ sustainable ICT cloud-based applications platform is the only solution of its kind in the world to be validated by science.

Already being used by organisations responsible for millions of computer users, the platform was researched, developed and peer reviewed during PhD research conducted at the world leading University of Warwick Computer Science Faculty. Consequently, the data produced is compliant with GHG accounting protocols, international Life Cycle Analysis (LCA) and electronic equipment energy testing standards and sustainable procurement legislation.

The Px³ applications platform enables organisations to create baseline ICT carbon footprint and energy consumption baseline reports. Then to model strategic policy changes such as selecting low carbon footprint devices and extending device lifespans to significantly reduce ICT GHG use phase and supply chain emissions, e-waste, electricity consumption, utility and procurement costs.

Research Lead

Dr Justin Sutton-Parker holds a PhD in computer science in the field of sustainable ICT and a MBA in sustainability. As Chief Scientist for Px³ and a Research Fellow for the University of Warwick, Dr Sutton-Parker's findings advance and influence global ICT manufacturing, procurement and user behaviours designed to reduce the carbon footprint of ICT.

Dr Sutton-Parker is widely published in scientific journals, a regular public speaker and sustainable ICT editor for the world's leading ethics and sustainability magazine My Green Pod. Editions include the first dedicated sustainable ICT magazine series for the UN COP sessions.

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