EGDC Case study – IBM LinuxONE
Server Energy efficiency case study

July 2026

Case Study Methodology

EUROPEAN GREEN DIGITAL COALITION

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1 Introduction

The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions on all other sectors.

The main aim of the EGDC is to maximise the sustainability benefits of digitalisation within the ICT sector, while supporting sustainability goals of other key sectors such as energy, transport, agriculture, and construction. The Coalition recognises the need for science–based methods to estimate the reduction and avoidance of greenhouse gas (GHG) emissions by specific Information and Communication Technology (ICT) solutions across sectors. This will accelerate the sustainability and circular transitions of these sectors while contributing to an innovative, inclusive, and resilient society.

To support the EGDC, a set of case study calculators are developed to provide a practical example of calculating the net carbon impact of a green digital solution in line with the European Green Digital Coalition (EGDC) methodology. This work aims to support the members of the EGDC with Action 2 of the EGDC Declaration.

This case study methodology accompanies the '*IBM® LinuxONE*" case study calculator and provides further details, additional context and transparency around the case study calculator to ensure the outcomes of the case study are interpreted and used correctly.

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Disclaimer for European Parliament Pilot Project – European Green Digital Coalition (EGDC) Case Studies

The following disclaimer is intended to provide clarity and context for the case studies prepared as part of the EP Pilot Project, which have showcased the net carbon impact of specific digital solutions using the EGDC ICT Methodology developed during the project:

1. **Purpose of the Case Studies:**

The case studies served multiple purposes, including:

- **Development of the Methodology:** They contributed to the development of the EGDC ICT Methodology. These case studies were conducted concurrently with the methodology's creation and served as a valuable testing ground for its initial formulation.
- **Application Examples:** They provided practical examples of how the methodology can be applied to real-life use cases. These case studies were essential in demonstrating the practicality and effectiveness of the methodology when applied to concrete situations.
- **Identification of Improvement Areas:** By conducting these case studies, we aimed to highlight parts of the calculation in need of improvement. They shed light on the challenges and limitations inherent in using available data and indicated the necessary steps to move towards best practices in assessing net carbon impacts.

2. **Data Quality as a Key Determinant:**

It is imperative to emphasise that data quality is a fundamental determinant of the quality and reliability of the case studies. The accuracy and completeness of the data used significantly influence the outcomes and findings of these case studies.
It is essential to acknowledge that the data available for each case study may differ in terms of accuracy, granularity, and coverage. As a result, the case studies may not necessarily represent the best practice application of the EGDC ICT Methodology. Instead, they reflect the application of the methodology at various stages of data availability.

3. **Liability for Errors/Omissions:**

While reasonable steps have been taken to ensure that the information contained within the case studies is correct, the EGDC gives no warranty and makes no representation as to its accuracy. We accept no liability for any errors or omissions that may be present in the case studies, methodology, or related information. Users and readers are advised to exercise their judgment and seek further clarification if needed, as the information provided may evolve over time and depend on external factors beyond our control.

4. **Appropriate Use of the Case Study Calculators:**

The case study calculators are intended for educational and informational purposes. They rely on certain assumptions and input data to generate results.
The results of the calculators are specific to the implementation of the ICT solution and may not be representative for other implementation contexts.
As such, it is imperative for users to refrain from directly extrapolating these results to ICT solutions or implementation contexts that may seem conceptually similar.
Instead, users are advised to use the calculators as a means to understand the practical application of the EGDC ICT Methodology, thereby equipping themselves with the knowledge required to develop customised calculators specifically tailored to their unique ICT solutions and implementation circumstances.

In conclusion, these case studies provide valuable insights into the calculation of the net carbon impact of digital solutions through the practical application of the EGDC ICT Methodology. However, it is vital to exercise caution when interpreting the results, considering the variances in data quality and the evolving nature of the methodology. The findings are indicative of the methodology's potential and its room for refinement as we work towards more accurate and comprehensive assessments of net carbon impacts.

2 Results

ICT Solution and assessment overview	Organisational contribution
IBM® LinuxONE is an enterprise-grade Linux platform that delivers high levels of scalability, energy efficiency, and security for mission-critical Linux workloads. The platform is designed to replace large numbers of conventional x86 servers by delivering equivalent computational workloads using significantly fewer processor cores, thereby reducing overall energy consumption and associated GHG emissions. The IBM LinuxONE emperor 5 Max 136 delivers an equivalent computational workload to 126 x86 servers with 5,376 cores in the case study.	IBM® is the designer and manufacturer of the LinuxONE emperor 5 Max 136 server. This aligns with A-level classification as defined by ITU-T L.1480 (contribution of implementing the integrated solution or the innovation of the solution).

Quantified impacts	
Assessment period:	5 years
Net carbon impact range:	-364 to -1,058 tCO2e
Net carbon impact:	-625 tCO2e
Net impact per delivery of the reference ICT workload to the same service level (SLA) over the study period:	-625 tCO2e

Other identified impacts
Reduction in energy use leads to significant cost savings of $67,918 USD annually. Over the full length of the case study assessment period of 5 years, this results in total savings of $339,590. Financial savings from the implementation of IBM LinuxONE solution are realised by the client and the client only. If all cost savings are invested by the client into similar business activity, it is estimated that this could result in an 10% reduction of the total net carbon impact due to the likely economic rebound effect from use of IBM LinuxONE.

3 Methodology

Name of solution	
Assessment Objective	The purpose of this assessment is to quantify the reduced energy consumption and associated avoided GHG emissions from the use of IBM LinuxONE in comparison with conventional x86 servers. The output of the assessment will demonstrate the solution's impact on energy consumption and GHG emissions reductions. The assessment will focus on a single implementation context: the replacement of 126 x86 servers with 5,376 cores in IBM's Poughkeepsie, N.Y. office with a single 136-core LinuxONE emperor 5 Max 136 server. In the assessment, all 136 cores of the LinuxONE server are in use. An ex-post assessment will be conducted, drawing on operational test data from conventional x86 servers and the LinuxONE server to establish a robust comparison of energy consumption.
Solution Description	With the IBM® LinuxONE solution, the delivery of enterprise computing workloads is consolidated onto a single high-capacity Linux server instead of being distributed across multiple x86 servers. The LinuxONE system is designed to run the same workloads to the same service level while using fewer physical machines and a more vertically integrated server architecture. The solution delivers equivalent computing output by running the same applications and workloads at the same performance and availability requirements, while reducing overall energy demand through higher utilisation, reduced infrastructure overheads, and more efficient system-level design. By consolidating workloads that would otherwise run across many x86

	servers, LinuxONE reduces the total power required for compute, memory, and associated data-centre support systems such as cooling and power distribution. The avoided GHG emissions mechanism is achieved by reducing electricity consumption associated with delivering the same ICT service. This lowers the GHG emissions linked to electricity generation for data-centre operations, while maintaining equivalent workload throughput and service quality. In addition, consolidation onto a single system can reduce peak power demand and associated infrastructure losses, contributing to more stable and efficient data-centre operation and further lowering the GHG emissions intensity of the computing service.
Solution Boundary	Components of the IBM LinuxONE platform solution: • Compute Hardware (CPC drawers, processors, and memory) • I/O hardware (PCIe+ I/O drawers, adapters) • Networking Redundant (Ethernet switches) • Power & cooling (Power supplies, fans, cooling assemblies) • Physical structure (Chassis, drawers, casing) • Management hardware (HMAs / Support Elements)
Functional Unit	Per delivery of the reference ICT workload to the same service level (SLA) over the 5-year study period.
Calculation Boundary	The calculation represents a 5-year assessment period in a test environment comparing 126 x86 servers with 5,376 cores to the IBM® LinuxONE Emperor 5 Max 136 server platform using all 136 cores. Both the reference and solution scenario are within IBM's Poughkeepsie, N.Y. office.
Reference scenario	In the reference scenario, delivering the same computational power as to the IBM® LinuxONE Emperor 5 Max 136 server requires 126 x86 servers with 5,376 cores.

	When tested, this consumes 495,932 kWh of electricity annually or 2,479,660 kWh over the full assessment period. Both the reference and solution scenario are within IBM's Poughkeepsie, N.Y. office to ensure fair comparison.
Description of 1st order effects	The first-order effects of the IBM® LinuxONE platform solution are related to the impacts arising from the manufacturing, transportation, non-energy related use phase, and end-of-life GHG emissions from the server. All GHG emissions values used in first order effects are assumed to be attributable to the entire 5-year assessment period. First order effects include: 1) **Manufacturing GHG emissions** • 31,100 kgCO2e • These emissions are calculated using IBM Systems Environment Estimator and consider all component and hardware emissions, including: ○ Compute Hardware (CPC drawers, processors, memory) ○ I/O hardware (PCIe+ I/O drawers, adapters) ○ Networking Redundant (Ethernet switches) ○ Power & cooling (Power supplies, fans, cooling assemblies) ○ Physical structure (Chassis, drawers, casing) ○ Management hardware (HMAs / Support Elements) 2) **Transportation GHG emissions** • 40 kgCO2e These emissions are calculated using IBM Systems Environment Estimator. 3) **Use phase GHG emissions** • 122,200 kgCO2e • 54,464kgCO2e if electricity emissions are removed, which they should be, as electricity consumption is part of second order effects. These emissions are calculated using IBM Systems Environment Estimator. 4) **End of life GHG emissions**

	• 490 kgCO2e These emissions are calculated using IBM Systems Environment Estimator.
Description of 2nd order effects	The 2nd order effect of the solution is the decrease in energy consumption achieved through running the same computational workload on fewer, more efficient cores. All energy consumption data from testing is within IBM's Poughkeepsie, N.Y. office to ensure fair comparison and consistency between both scenarios. The use of IBM LinuxOne achieves a 91% reduction in electricity consumption as compared to x86 servers. This is a saving of 452,788 kWh annually or 2,263,940 kWh over the 5-year test period. When converted to GHG emissions, this saving is equivalent to 711 tCO2e.
Description of higher order effects	Reduction in energy use leads to significant cost savings of $67,918 USD annually. Over the full length of the case study assessment period of 5 years, this results in total savings of $339,590. If all cost savings are invested into similar business activity for IBM's customer, it is estimated that this could result in an 10% reduction of the total net carbon impact. As all financial savings realised by IBM's clients, IBM does not have control over how it is invested or spend and therefore, the resulting rebound GHG emissions.
Mapping of 2nd order and higher order effects	

Assessing the impact of higher order effects	
Description of calculation	**1st Order Effects** The solution GHG emissions are calculated by IBM using [IBM Systems Environment Estimator.] This estimator calculates full lifecycle GHG emissions for a range of IBM systems from cradle to grave. For

	this assessment, cradle-to-grave GHG emissions (manufacturing; transportation; use-phase; and end-of-life) have been included. **2nd Order Effects** The second-order effects represent the GHG emissions avoided due to reduced energy consumption, achieved through running the same computational workload on fewer, more efficient cores. IBM compared energy consumption in a simulated production environment, comparing 5,376 x86 cores from 126 x86 servers (reference scenario) with one LinuxONE emperor 5 Max 136 with 136 cores (solution scenario) The energy consumption for both scenarios is multiplied by a grid emissions factor from [New York ISO - NYISO | Electricity Maps] to calculate reference and solution scenario GHG emissions. **Net Carbon Impact** The net carbon impact is calculated by subtracting the first-order GHG emissions generated by the solution itself from the second order effects. This ensures that the environmental benefit accounts for the GHG emissions embedded in the solution components and cloud usage, providing a more accurate measure of the net reduction in GHG emissions.
Net Carbon Saving Impact of the Solution	1st order effect (GHG emissions from solution components): 86.1 tCO_2e. 2nd order effect (avoided GHG emissions from reduced energy use): -710.9 tCO_2e over the 5-year assessment period. Total net GHG saving impact [tCO_2e]: -624.8 tCO_2e over the 5-year assessment period. **Other Savings from reference scenario:** % Energy savings through use of the solution: 91.3% per delivery of the reference ICT workload to the same service level (SLA) over the study period.

Uncertainty and sensitivity analysis	**Total GHG emissions savings enabled (tCO_2e):** Calculated Net Avoided GHG Emissions: -624.8 Lower uncertainty range: -364.4 Higher uncertainty range: -1,057.7 **Uncertainty & Sensitivity Analysis:** Uncertainty is primarily driven by grid GHG emissions factor uncertainty. Uncertainty is driven by the fact that data used in calculation is from a test environment across 5 years. A single grid emissions factor must be used to represent energy GHG emissions for both the reference and solution scenario over this 5-year test period, with temporal representativeness the key driver of this uncertainty. It should be noted that the analysis performed is not a quantitative uncertainty analysis. By providing a more granular view of data quality, which builds on the data quality assessment, this analysis highlights areas of uncertainty within the calculation using a qualitative assessment framework. It can however be used to feed into a quantitative uncertainty analysis using guidance from the Greenhouse Gas Protocol on Quantitative Inventory Uncertainty: https://ghgprotocol.org/sites/default/files/2022-12/Quantitative%20Uncertainty%20Guidance.pdf
Assumptions	**First order effects.** IBM LinuxONE is using full compute power of the server in this case study, meaning we account for the full first order effects of the IBM LinuxONE Emperor 5 Max 136 in use. There is an optional adjustment built into the calculator to adjust compute power usage to examine total net avoided GHG emissions in cases where the full compute of a LinuxONE server is not required. In the absence of full bill of materials and detailed life cycle assessment, it is assumed that first order effect GHG emissions as calculated by IBM using IBM Systems Environment Estimator are complete and accurate.

	Energy consumption. • Assume that testing environment is reflective of actual conditions for both the x86 servers and IBM® LinuxONE server for use in case study.
Data sources	**Data provided by IBM:** • Raw data on the annual energy consumption for x86 servers in the reference scenario. • Raw data on the annual energy consumption of the IBM® LinuxONE emperor 5 server in the solution scenario. **Other data sources:** • All secondary data sources used during calculations of the 2nd order effects have been linked within the calculator. • Open CEDA from watershed: Computer terminals and other computer peripheral equipment manufacturing: 0.1929 kgCO2e/$
Input adjustments and key considerations for usage of results	**List of things to consider if using results in other use cases:** • Country (for the electricity grid) • Location, city • Upstream lifecycle GHG emissions for first order effects. • Number of x86 cores being replaced in reference scenario and overall energy consumption. • In lower compute contexts, the share of IBM® LinuxONE compute being used may be less than the full server capacity, meaning you do not neccesarily account for full upstream GHG emissions within the first order effects.
'Do no significant harm' criteria	Do not foresee any negative impacts on any of the EU Taxonomy's environmental nor social objectives and strongly supports objective 1. Climate change mitigation. The IBM® LinuxONE could be deployed across different data centre or server contexts and improve energy efficiency in multiple use cases.
Key areas for improvement	1. The primary area for improvement lies in the assessment of first-order effects, as the analysis relied heavily on secondary research, assumptions, and estimates due to the limited availability of

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	primary data. This reliance introduces greater uncertainty into the calculated impact and highlights the need for more robust, directly sourced data in future assessments. 2. Analysis of higher order effects could also be improved by providing actual costs as the quantitative element of this is currently assessed using EEIO factors.