EGDC Case study - heata

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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 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 'heata' 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.

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 emphasize 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 customized 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.

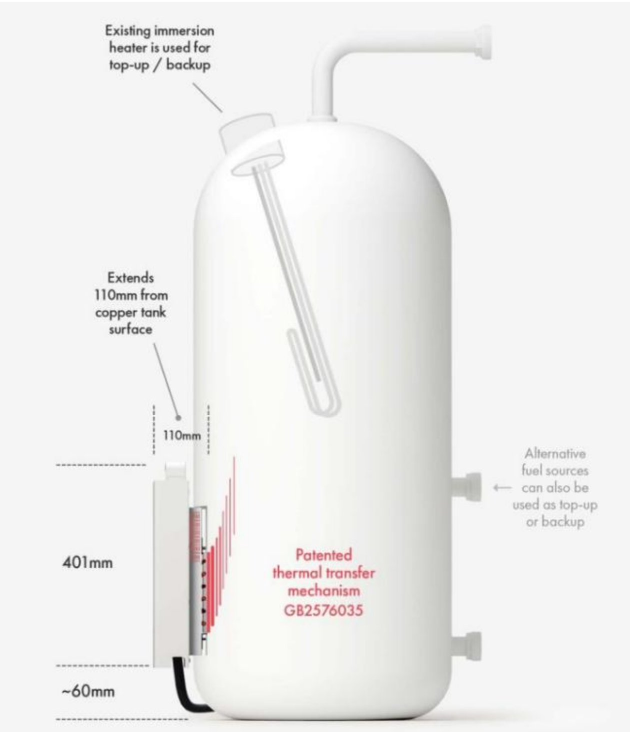
2 Impact Assessment

The case study's objective was to assess the impact a heata unit can have by using waste heat from cloud servers to provide free hot water for homes on the associated greenhouse gas emissions.

ICT Solution and assessment overview

heata reimagines the data centre as a network of distributed cloud-computing servers (heata units) inside homes which are mounted to domestic hot water cylinders and connected to heata's network forming a 'virtual data centre'. heata uses this virtual data centre to provide cloud services, with the resulting heat warming the water in the cylinder.

This case study is an ex-post assessment of heata units installed in homes in 2025 using gas for hot water heating.



Impact

> **"By using energy 'twice' (once for processing, once for heating) heata avoids the need for energy-intensive cooling systems found in data centres and energy consumption in the home for hot water."**

The heata system has a net carbon impact of -0.38 kgCO2e per kWh of compute. For heata's deployed compute in 2025 the system has a:

- Net carbon impact range of -70 to -148 tCO2e
- Net carbon impact of -101 tCO2e
- Net carbon impact including rebound effects of -96 tCO2e

Reduction in home gas consumption leads to cost savings for the homeowner which can help address fuel poverty. The rebound effect considered above is a scenario where all cost savings are spent on typical UK carbon-intensive activities.

Organisational contribution

heata are the innovator, developer, and deployer of the solution. This aligns with A-level classification as defined by ITU-T L.1480.

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3 Methodology

Assessment Objective

The primary aim of this assessment is to assess the carbon impact from the implementation of a heata network of distributed cloud-computing servers. Other potential environmental and social impacts will be identified.

This assessment compares the energy consumption for home hot water heating and data centre cooling required when using a typical cloud-computing data centre versus the heata network.

The assessment considers a single heata network implemented in 45 homes in Surrey in the UK. An ex-post assessment will be conducted, based on field trial data collected from heata units switched from 'active' to 'idle' at various times over the course of the trial to establish a robust comparison.

Solution Description

heata reimagines the data centre as a network of distributed cloud-computing servers (heata units) inside homes which are mounted to a domestic hot water cylinder and connected using fibre to heata's network forming a 'virtual data centre'. heata uses this virtual data centre to provide cloud services, with the resulting heat warming the water in the cylinder.

By using energy 'twice' (once for processing, once for heating) heata avoids the need for energy-intensive cooling systems found in data centres and energy consumption in the home for hot water

In normal circumstances you have two discrete systems:

1) a data centre with server racks, providing IT services (compute, data storage etc.). These servers are cooled by water, air or immersion cooling systems that consume additional energy which in a typical data centre can makes up ~30% of the power demand. The full power demand of each server is ultimately converted to heat which is then vented into the atmosphere. A 100MW data centre will vent roughly 100MW of heat.

2) a domestic hot water system typically powered by gas or electricity (gas boiler, heat pump).

In normal circumstances, there is no way for the heat from (1) to offset the heat from (2), so the systems are independent of one another. The heata system combines these two discrete systems to make the compute waste heat useful for home hot water heating.

The avoided emissions mechanisms are achieved by reducing gas demand for home hot water heating and electricity demand for data centre cooling.

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Solution Boundary

The solution consists of network of heata units installed in homes and connected via the internet to form a network by integrating the following components:

Digital components:

- heata unit
- Thermal bridge and heat pipe
- Power supply unit
- Power sub-meter
- Networking

Functional Unit

CO_2 emissions per kWh compute

This functional unit was selected as it relates to the service heata sell to their customers and allows the impact to be scaled according to the customer compute demand.

Calculation Boundary

The calculation represents a one-year period (although this can be adjusted by the use). The annual value is extrapolated from field trial data of 45 heata units.

The geographic boundary of the solution is limited to Surrey, United Kingdom

Reference scenario

In the reference scenario, home hot water heating is achieved from natural gas boilers (not combi boilers) and data centre cooling is achieved by a typical European air-cooled data centre.

First order effects

The first-order effects of the heata network are related to the direct GHG emissions arising from the deployment and operation of the network. These include:

- heata installations: Life cycle emissions from the heata unit, thermal bridge and heat pipes, power supply unit, and power sub-meter.
- Networking: Emissions from use-phase electricity consumption of network infrastructure

heata installations

Embodied and end of life emissions are calculated based on the bill of materials weights / estimated weights, material type, and associated emissions factors.

The heata units and data centre servers' electricity consumption are equal as the kWh compute is equivalent between the scenarios and so heata unit use-phase emissions are not calculated.

Use-phase emissions from the power supply unit, and power sub-meter are calculated using the maximum rated power, time in use, and relevant electricity emissions factor.

Networking

The use-phase emissions due to the connectivity network for the heata units are also not assessed as these are assumed to be equal to data centre connectivity network use for the equivalent amount of computation.

Total first-order emissions are obtained by summing up the contributions from all hardware, networking and installation emissions.

Second order effects

The second order effects of the solution are the decrease in gas consumption for home hot water heating and the avoided electricity demand of data centre cooling thereby lowering the associated CO_2 emissions from gas combustion and electricity generation.

The reduced gas consumption per heata unit was assessed by heata in field trials carried out with heata units installed in 45 homes across Surrey in the UK. The trial was completed in partnership with BRE and provided in a report titled "SAP *Appendix Q –Stage 5b (Scoping Study) Report for Heata unit*". The results of the field trial were an average gas saving of 9.7 ± 0.61 kWh/day across a 12-month period.

The assessment used the lower bound of the gas saving for a conservative impact (e.g. 9.7 – 0.61 = 9.09 kWh/day). The trial was carried out at 100% server utilisation, which provided 7.2 kWh compute per day allowing the summer and winter gas savings to be calculated per kWh of compute. The relevant UK natural gas emission factor is then used to calculate the GHG emissions reduction.

The avoided data centre cooling demand is calculated by considering the data centre server electricity consumption to be equivalent to the heata unit electricity consumption over the time period of the assessment (1 year). The avoided cooling electricity demand is estimated by considering the average PUE of data centres in the Europe. As $\text{PUE} = \text{Total facility energy consumption} / \text{IT energy consumption}$, cooling electricity consumption can be estimated by:

$$\text{Cooling electricity consumption} = \text{IT electricity consumption} \times (1 - \text{PUE})$$

Non-IT energy consumption in a data centre is for cooling, power distribution, lighting, and other building services, not all of which is electricity and not all for cooling. However, as cooling electricity represents 90% of all other energy demand in the data centre [1] this estimation was deemed suitable.

[1] Data Centers and Their Energy Consumption - Congress.Gov

Higher order effects

By reducing the hot water heating required for homes each heata unit reduces homeowner energy costs by up to an estimated £148 per year for gas consumers delivering a social benefit by reducing fuel poverty.

If households spend their savings on other carbon-intensive activities the emissions avoided by the heata network would be reduced. The impact of this rebound effect was assessed by consideration of the UK consumption emissions per person, and average annual spend of a UK household as shown in the table below. This could reduce the total net carbon impact by 5%.

Please note that all possible higher order effects are as of now assumed and have not yet been proven.

Effect	Quantitative Assessment		Magnitude	Likelihood	Mitigation
Cost savings due to reduced gas consumption	**Gas consumption**		4.3% of total net impact	Highly likely to occur however the impact will vary significantly on the heata homeowner. In cases where the heata unit address fuel poverty, the impact is likely to be reduced.	
	-7,860	kWh			
	Cost of gas in UK:				
	£0.0629				
	Annual savings:				
	-£494				
	UK Consumption emissions 2022:				
	560	MtCO2e			
	UK population 2022:				
	67,636,134	people			
	UK consumption emissions per capita				
	8,280	kgCO2e / person			
	UK average household spend				
	£34,444				
	UK emissions per £ spent				
	0.24	kgCO2e/£			
	Potential rebound emissions				
	118.84	kgCO2e			

Consequence tree

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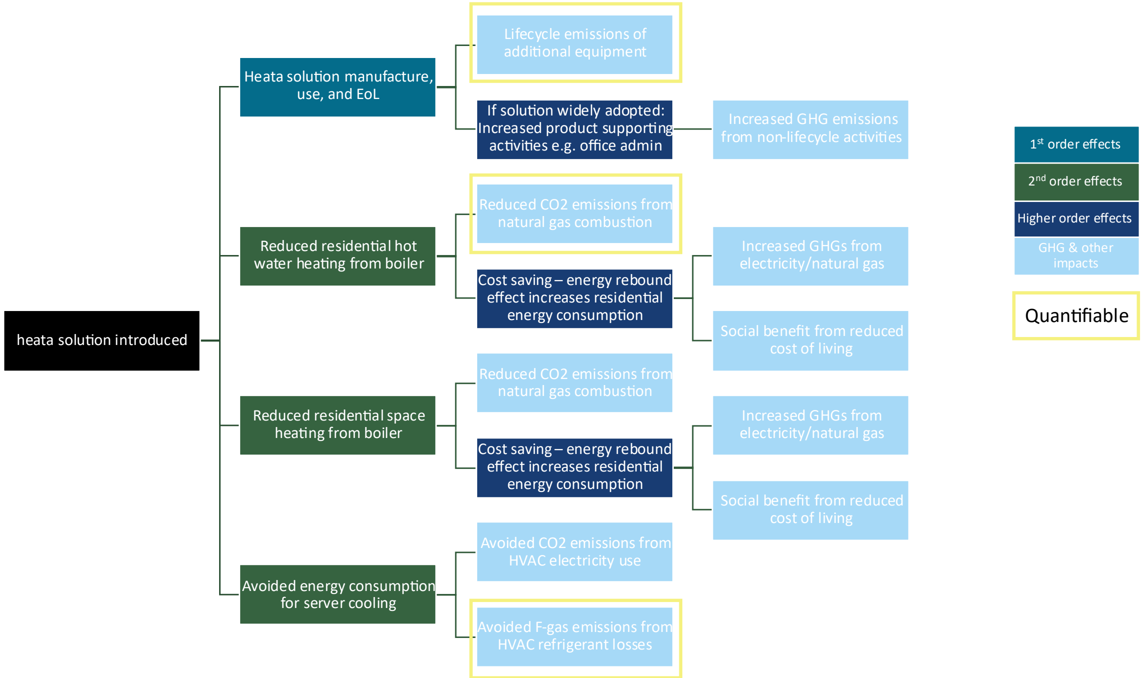


Data sources

Data provided by heata:

- SAP Appendix Q –Stage 5b (Scoping Study) Report for Heata unit
- Bill of material of the heata unit including quantities and weights (Heata MVP BOM - v1.5 - Carbon Trust)
- Heata unit energy consumption and other data points (Impact Calculator_Carbon Trust)

Secondary data sources:

- All secondary data sources used during calculations of the 1st order effects have been linked within the calculator
- Data centre PUE – Uptime institute 2024
- UK Government emission factors – BEIS 2024 & 2025
- All sources are linked directly in the calculator

Assumptions

Bill of Materials and Component Weights

- The weights of individual components have been assumed based on available specifications for comparable products.
- Where exact data was not available, the Bill of Materials (BOM) was either estimated based on background research or excluded as negligible for small components.
- All sources and technical references used for these assumptions are

stored within the calculator and can be consulted if needed.

Lifetime of Devices and Components

- All lifetimes were specified by heata

Estimation Methodology

- All assumptions regarding hardware components and BOM are based on secondary data sources available in the calculator.
- Energy consumption calculations were extrapolated by multiplying the reported rated power by the number of days in the time period

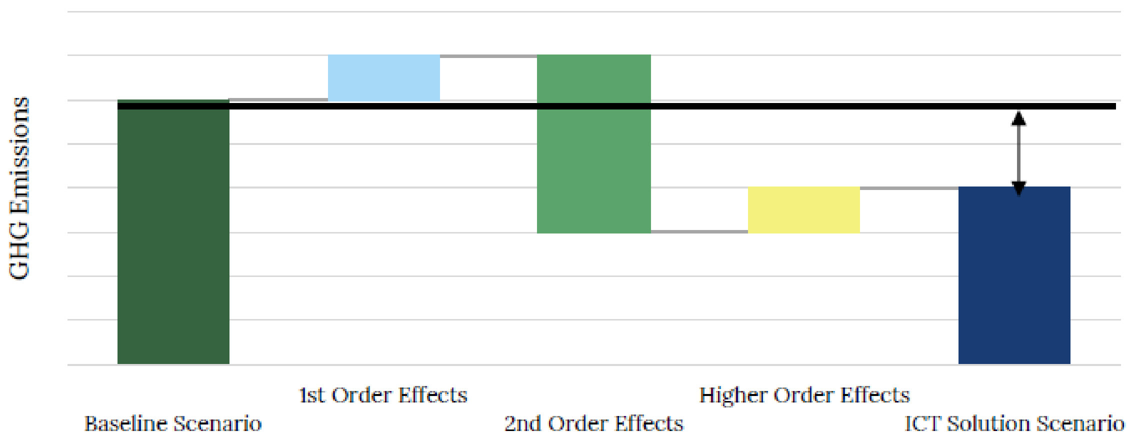
Key areas for improvement

1. Improving the estimation of avoided cooling by collecting primary / secondary data on cooling demand per kW of server power use.
2. Including an estimation of avoided fugitive emissions from data centre cooling systems

4 Results

Net Carbon Impact

Net carbon impact is calculated by a summation of the emissions from first-order, second order, and higher order effects generated by the solution:



This ensures that the net carbon impact accounts for the emissions associated with the implementation and use of the solution (first order effects), as well as accounting for both beneficial effects of the solution implementation and unintended consequences (second and higher order effects).

Net Carbon Impact of the Solution

Net carbon impact per kWh of processing compute:	**-0.38 kgCO2e**
1st order effects:	0.02 kg CO2e
2nd order effects:	-0.41 kg CO2e
Total net carbon impact of heata network deployed in 2025 (average 30 kW compute)**:**	**-96 tCO2e**
Excluding rebound effects:	-101 tCO2e
Gas savings from avoided heating	-331,785 kWh
Electricity savings from avoided data centre cooling electricity use	-141,168 kWh

Data quality assessment and uncertainty analysis

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Total net carbon impact (lower range)	-70	tCO2e
Total net carbon impact (higher range)	-148	tCO2e

Data centre cooling electricity consumption is the main driver of uncertainty in the assessment as a result of the use of a European average PUE to estimate the avoided data centre cooling which had a low data quality score.

Sensitivity analysis

The quantity of avoided home hot water gas consumption and gas consumption emission factor have the highest impact on the assessment outcome, but these data points have high data quality as they were collected by an SAP survey field trials and from the government UK emissions factor database respectively.

Data centre cooling electricity consumption and emissions factors are the second most significant data points on the assessment outcome. The data centre cooling electricity consumption has low data quality and therefore, is the key source of uncertainty in the assessment.

All first order effects have very low sensitivity on the outcome of the assessment.

'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 heata solution is scalable, delivers cost savings, which can address fuel poverty with the potential to improve quality of life.

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