EGDC Case study: Flex Platform

April 2024

Case Study Methodology

Provided by: IBM

EUROPEAN GREEN DIGITAL COALITION

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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 to all other sectors.

The secretariat of the European Green Digital Coalition is managed by the consortium of the European Parliament Pilot Project for the EGDC, funded by the European Commission, namely the leading associations GeSI, the European DIGITAL SME Alliance, DIGITALEUROPE, ETNO and GSMA, working together with Carbon Trust, Deloitte, and Sustainable ICT Consulting.

This deliverable has been produced by the consortium of the European Parliament Pilot project for the EGDC.

Global Enabling Sustainability Initiative (Coordinator)

DIGITALEUROPE

European Telecommunications Network Operators' Association

European DIGITAL SME Alliance

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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 'Flex Platform' 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.

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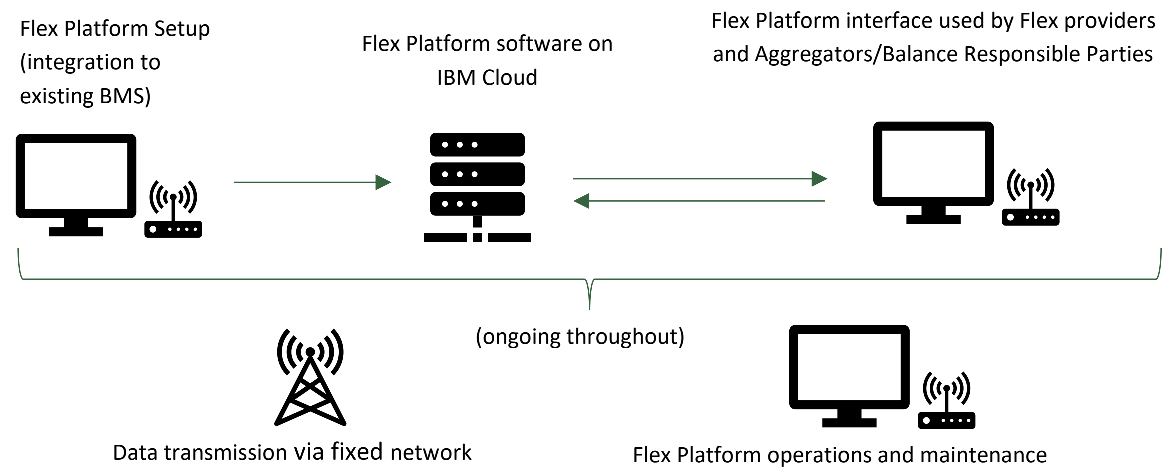
2 Methodology

Flex Platform	
Assessment Objective	The assessment intent is to understand the net carbon impact of the implementation of the IBM Flex Platform solution in municipal buildings in Copenhagen. The assessment will only consider one implementation context, which is ventilation assets in Copenhagen municipal buildings connected to the Flex Platform. The assessment will be ex-post, using data collected during the implementation of the solution in 2023.
Solution Description	The IBM Flex Platform is an intelligent grid optimisation solution which enables electricity consumers to connect their electrical assets (e.g. ventilation systems, comfort cooling, cold storage, heat pumps, EV charging stations) and offer their aggregate demand-side flexibility, helping balance the electricity grid at the transmission level and avoid bottlenecks at the distribution level. One of the impacts of demand-side flexibility enabled via the IBM Flex Platform is substituting the balancing capacity delivered by reserve power plants, which is the focus of this case study. Through this effect, the solution is expected to generate a positive impact in the power sector by reducing GHG emissions from reserve power plants. The IBM Flex Platform is designed to accommodate the need from the three primary actors in the market for flexibility services; an electricity consumer providing demand-side flexibility (Flex Provider), the Aggregator (incl. Balancing Responsible Party) and the electricity system operator that is receiving the flexibility (i.e. the Transmission System Operator (TSO) for ancillary services). The IBM Flex Platform has been designed and built to activate demand-side flexibility from electrical assets owned and managed by large commercial and public electricity consumers. The solution makes it possible for an electricity consumer (a Flex Provider) to make an agreement with an Aggregator (and their Balance Responsible Party when relevant) to control the demand-side flexible assets by temporarily reducing (or potentially increasing) the power consumption according to the balancing need in the power grid. This way, it reduces the need to use a regulating (often fossil fuelled) power plant to maintain the balance of power in the grid, thereby reducing GHG emissions. The Flex Platform is based on a configuration of the Internet of Things (IoT) Service, a set of trained and exposed Flex Asset Models implemented as part of the AI Service and a configured Blockchain Service for keeping track of agreements, forecasted, reserved, and delivered flexibility. The IoT Service is connecting the flexible assets to the Flex Platform by an integration layer, which is used for instrumenting and aggregating the flexible

	assets so they can be used as a flex portfolio. The IoT Service does not connect directly to the individual building assets, but through an existing Building Management System (BMS). The main technical limitation of the solution is that it requires an existing BMS to connect to. The solution has been initiated in Denmark, and this case study focuses on the deployment of the solution related to ventilation systems (37 in the data sample utilised) in City of Copenhagen office buildings. But the ambition is to expand quickly to the Nordic Countries and the rest of Europe. In the Nordics, the implementation of the Nordic Balancing Model will harmonise the regulation for selling and delivering ancillary services and the same is true across most European countries – with the implementation of MARI, PICASSO and TERRA markets. There are possibilities to expand in other geographies as long as there is electricity consumption, balancing needs and BMS/Control systems with which to integrate. The current focus has been on ancillary services (manual, automatic and frequency reserves) as these markets exist for trading flexibility. Other less mature markets that would have a good fit with the IBM Flex Platform capabilities include Network Congestion Services (in the distribution grid), Curtailment Services as well as using the platform for Spot Price and Tariff Optimisation.
Solution Boundary	The following components comprise the IBM Flex Platform: • BMS system(s) for assets onboarded to Flex Platform • **Flex Platform software including user interface** • **IBM Cloud to host software** • **Desktop computer and router to access interface** • **Data transmission network** • Electrical assets (ventilation systems) All components are digital technologies except for the electrical assets. ***Components in bold are not in the reference scenario and are therefore in scope for calculating 1st Order Effects. For hardware that was already in place (i.e. not specifically installed for the solution), only the use phase energy consumption of the component is considered in 1st Order Effects.***

High level overview of Flex Platform components and process flow:



Functional Unit	The chosen functional unit is kWh delivered per year. The function of the Flex Platform is to provide balancing capacity for the grid, which is achieved by aggregating capacity available in electrical assets connected to the platform and bidding into the balancing market. This function is fulfilled by reserve power plants in the reference scenario. The performance required is a balanced power grid throughout the year. The unit quantity is kWh delivered as that is the common unit between both the reference and solution scenarios.
Assessment Boundary	This assessment is for the deployment of the solution in City of Copenhagen, Denmark municipal buildings, specifically considering the impact of ventilation system assets that are connected to the IBM Flex Platform. Other types of electrical assets have different profiles for flexibility provision, therefore could result in different net carbon impacts. The assessment aimed to calculate the net carbon impact for the 2023 calendar year.
Reference scenario	The reference scenario for this case study is what typically happens in the ancillary services market (specifically for manual reserves (mFRR) in the DK2 market) in Denmark when there is a balancing need in the power grid, without the implementation of the IBM Flex Platform. Energinet, the Danish Transmission System Operator, defines the demand and timing of flexible energy (ancillary) services needed to maintain the balance of power in the grid. Various approved parties then bid to supply ancillary services to meet demand in each specific hour. For the manual reserves market, Energinet only buys upward regulation reserves and sorts the bids according to the price per megawatt (MW), generally covering its need by selecting bids according to increasing price.

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	Bidders for ancillary services can supply energy from renewable or non-renewable sources. IBM has indicated that, in the reference scenario, the weighted average emission factor for reserve power plants delivering flexibility is 0.8 metric tons CO2/MWh. This was agreed with Energinet.
Description of 1st order effects	The following components interact to produce first order effects as follows. (1) The Flex Platform software is hosted in an IBM data centre which results in electricity consumption and associated GHG emissions. (2) Users (Flex asset providers, aggregators/balance responsible parties, and operators & support team) access the Flex platform interface via their existing desktop computers and routers, which results in an increase in electricity consumption from these devices and associated GHG emissions. *(3)* The data that is transmitted between the assets, user devices and Flex Platform results in increased electricity use in the data transmission network and associated GHG emissions.
Categorisation of digital technologies (A) = ICT service (B) = Service specific building block (C) = Common ICT devices, services, infrastructure	• Flex Platform software including user interface – (A) • IBM Cloud to host software – (C) • Desktop computer and router to access interface - (C) • Data transmission network – (C)
Description of 2nd order effects	The IBM Flex Platform allows for electrical demand-side assets to react to the balancing needs demanded by the TSO, by reducing (or increasing) the power consumption of electrical assets to maintain the balance of power in the grid, similar to the way a regulating power plant is acting in the ancillary services market today. Therefore, the amount of flexibility delivered, in MW, by IBM Flex Platform assets substitutes flexibility otherwise delivered by reserve power plants. This results in carbon savings from avoiding the activation of reserve power plants.
Description of higher order effects	Two positive higher order effects were identified for this solution: Firstly, as fossil fuelled energy production continues to be replaced by renewables, production will fluctuate much more. As a result, the need for balancing resources will grow over the coming years. It is pivotal to engage with electricity consumers to help balance the grid if more renewables are to be phased into the energy system. Therefore, the IBM Flex Flatform can support the decarbonisation of the grid by enabling demand-side flexibility. Secondly, smart balancing solutions like the IBM Flex Platform can help avoid bottlenecks in the distribution grid and thereby can help avoid the resources (and associated emissions) needed to reinforce the grid to avoid bottlenecks.

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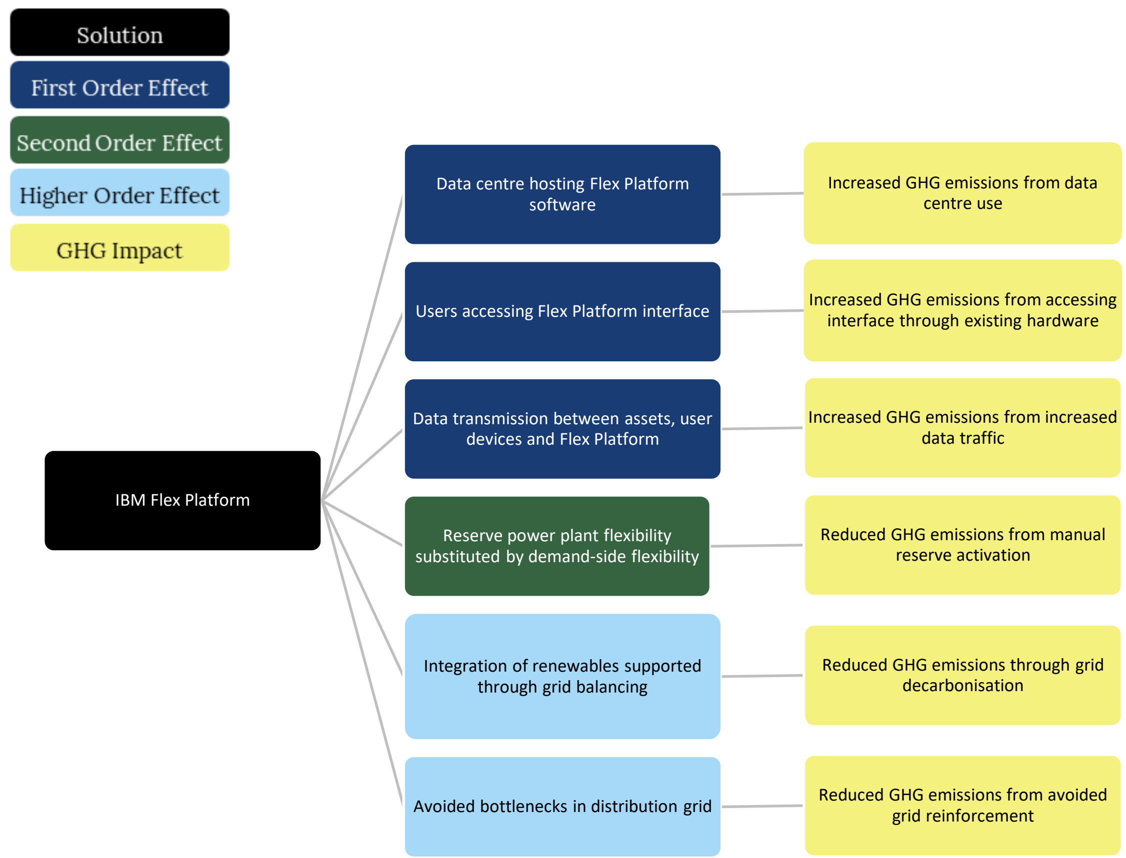
	These positive higher order effects were identified but not quantified in the calculator due to lack of data and excluding them makes the positive impact of the solution more conservative. No negative higher order effects have been identified.

Mapping of all effects



Description of calculation	All primary data provided for this case study is related to deployment of the solution in the city of Copenhagen, Denmark. **1st order effects:** The first order effects calculation includes the estimated emissions from the data centre, data transmission network and user device energy consumption associated with the Flex Platform's use for the city of Copenhagen.

	The Flex Platform software is hosted on IBM Cloud, specifically on 6 servers in 3 data centres in Germany (for Copenhagen deployment). The watt usage of relevant racks in the data centres was measured across a 4-week period to get an average watt usage estimate for each server (dividing the 4-week average watt usage per rack by number of devices per rack). For each of the 6 servers relevant to Copenhagen's use of the Flex Platform, the watt usage per server was multiplied by the data centre specific PUE and scaled up to get an annual kWh energy use estimate (i.e. multiplied by 8760 to reflect operation 24 hours a day/365 days a year). Based on this estimate of server energy use, energy use of storage and networking in the data centres are estimated based on an assumed distribution of power usage by hardware subsystem, supported by academic literature – see Figure 1.8 in The Datacenter as a Computer by Barroso, Luis André, et al. The total of server, storage and networking energy use make up the total energy use of the data centre related to the Flex Platform. The data centres run on renewable energy, therefore there are zero emissions associated with this layer of the solution. The data transmission network energy use is estimated by multiplying an average Western Europe fixed network energy intensity figure (0.0065 kWh/GB) by an estimate of the annual data transmission related to the solution for the Copenhagen deployment (4,250 GB). The network intensity figure, taken directly from a recent report on the Carbon impact of video streaming, is for the year 2020 therefore should provide a conservative estimate given expected annual improvements in network energy intensity. The emission factor applied to the network energy use estimate is an average of the lifecycle electricity grid factors for Germany and Denmark (2022) from the Association of Issuing Bodies. The user device energy use is estimated in two parts. First, desktop computer energy use is estimated by multiplying an estimated typical user profile (hours/year) for Flex providers, Aggregators/Balance Responsible Parties, and Operators & support team by the assumed power draw of a typical desktop computer (115 W). Second, router energy use for all the above users is estimated by multiplying the annual data transmission (4,250 GB) by an estimate of router energy intensity (0.025 kWh/GB, taken from the report Carbon impact of video streaming). Due to lack of data on enterprise router energy intensity, the router energy intensity used is for a 10 W home router. The emission factor applied to the total user device energy use is the lifecycle electricity grid factor for Denmark (2022) from the Association of Issuing Bodies. **2nd order effects:** The 2nd order effects calculation captures the GHG savings from substituting flexibility provided by reserve power plants with the demand-side flexibility enabled by the Flex Platform.

	A sample of hourly data from the Copenhagen deployment (37 unique ventilation assets, 70-day time series) was provided including the forecast and delivered flexibility per asset per hour. The forecast is an estimate of the flexibility that an asset could provide during a given hour (and is reserved), whilst the delivered flexibility is what was actually purchased in the market and delivered. Figures for three variables were derived from the data sample: the average kW flexibility reserved per asset per hour, the average number of hours per day that flexibility is reserved per asset, and the percentage of reserved flexibility that is delivered. These variables are used to develop a profile of an archetypal day in the year for ventilation assets in Copenhagen providing demand-side flexibility (in kWh). The flexibility delivered in an archetypal day is multiplied by 365 days in a year and the resulting annual flexibility delivered is multiplied by the emission factor for reserve power plants delivering flexibility in the reference scenario (0.8 tCO2e/MWh) to capture the total avoided emissions in the year. **Higher order effects:** No higher order effects were quantified. As the time frame for the identified higher order effects is medium-long term and the extent of the causal relationship between the solution and the effect needs further investigation, the data is not available to assess them quantitatively. However, excluding these positive effects makes the net carbon impact calculation more conservative. The net carbon impact is calculated by subtracting the emissions due to 1st order effects from the avoided emissions due to 2nd order effects.
Net Carbon Saving Impact of the Solution	**Total carbon saving impact** 3.4 tCO2e / year **1st order effects:** 0.1 tCO2e/year **2nd order effects:** 3.5 tCO2e/year **Savings from reference scenario (%)** Not applicable **Saving per functional unit** 0.001 tCO2e / kWh delivered / year
Qualitative data uncertainty and sensitivity analysis	The sensitivity analysis indicated that the net carbon impact results are most sensitive to the data related to the second order effect of displacing flexibility typically provided by reserve power plants. This applies to both the emission factor for power from reserve power plants and the activity data about how much flexibility is delivered by the Flex Platform to displace that reserve power. The uncertainty analysis, which qualitatively assesses the quality of the data inputs, highlighted that the data quality of the emission factor for power from

	reserve power plants was only 'fair' or 'poor' among the criteria of time, reliability and completeness. This should be a focus for improvement because it is a key determinant of the net carbon impact result. The other data inputs that had the greatest weaknesses against the quality criteria were the activity data related to the data transmission network and user devices; these were scored as 'fair' for the time, geography, reliability and completeness criteria. 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	• Assume assets can provide flexibility 365 days per year. • Assume the archetypal day derived from the sample data (covering 2.5 months in winter) is representative of an archetypal day for the whole year. IBM have indicated that the forecast and delivered flexibility for Copenhagen assets is likely to increase due to optimisations of the forecast logic being implemented and more ventilation assets being onboarded throughout the year. Therefore, the delivered flexibility in an archetypal day from the sample data is likely an underestimate, resulting in a conservative positive 2nd order effect. Due to this, no seasonal adjustment has been made to the resulting flexibility delivered in an archetypal day. • Assume users access the Flex Platform interface by using a desktop computer (115 W) and router (10 W). • Assume the estimated average watt per server based on measured rack data is an accurate estimate of the watt usage of the specific servers used for the Flex Platform's deployment in Copenhagen. • Assume that as more assets are onboarded onto the Flex Platform, the data centre energy consumption and data transmission energy consumption will not change materially. • Assume the fixed network energy intensity and router energy intensity figures are accurate substitutes for missing primary data.

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Data sources	Key data sources used in the calculations: • IBM provided primary data on flexibility delivered by ventilation assets in Copenhagen from Jan 1 to March 11, 2023. This data was exported from their software which logs all delivered flexibility. • IBM measured rack watt usage in the 3 data centres in Germany where there are servers used to operate the Flex Platform deployment in Copenhagen. This was used to calculate solution energy use. • IBM provided estimates of annual data transmission and user profiles (hours/year) based on their knowledge of the solution deployment. • IBM provided an estimate of the weighted average emission factor of reserve power plants, based on engagement with Energinet. • For estimating energy use of storage and networking in a datacentre: The Datacenter as a Computer: Designing Warehouse-Scale Machines, Third Edition | SpringerLink • For estimating the data transmission network energy use and user device energy use: Carbon impact of video streaming • Electricity grid emission factors were taken from: 2022 07 International Factors - release v1.0, Association of Issuing Bodies (AIB) 2022
Input adjustments and key considerations for usage of results	Key input adjustments are: • Average kW flexibility reserved per asset per hour • Average # of hours per day kW flexibility is reserved per asset • Percentage of reserved flexibility that is delivered • Emission factor of displaced reserve power (tCO2e/MWh) • Flex Platform Solution Data Centre Emission Factor (tCO2e/MWh) • Flex Platform Solution Data Network Transmission Emission Factor (tCO2e/MWh) • Flex Platform Solution End User Device Emission Factor (tCO2e/MWh) • IBM provided estimates of annual data transmission and user profiles (hours/year) Considerations for usage of results: • The calculator only considers ventilation assets in the context of office buildings – other types of assets, in other contexts, will have different flexibility profiles i.e. offer different quantities of kW flexibility at different hours. • The emission factor of displaced reserve power is entirely location dependent.

	• If the platform data centre was not running on renewable electricity, this would add a large negative emissions impact to the calculation, resulting in an overall negative net GHG impact for this deployment, if all other variables remain constant.
'Do no harm' criteria	No foreseen negative impacts on any of the EU Taxonomy's environmental nor social objectives, and strongly supports objective 1: Climate change mitigation.
Key areas for improvement	Within the scope of this case study, no verification of the data was undertaken, and the calculator is based on the assumption the data provided by IBM is correct. Key areas for improvement include: 1. To improve the data centre energy consumption calculation, the energy consumption of the exact servers hosting the Flex Platform should be measured (currently using an average per server estimate based on measured rack data). 2. The annual average kW flexibility delivered per asset is based on real data over a 2.5 month time period. This time period should be extended to get a more accurate annual average. In this case study, no adjustment has been made to correct for potential seaonality affecting the kW flexibility forecast and kW delivered when extrapolating the data to a one year time period. IBM has indicated that more ventilation systems have been onboarded to the platform, so delivered flexibility should increase over the course of the year, but this is not captured in the data sample provided. Therefore it is possible that this case study underestimates the positive second order effect in regard to the amount of flexibility that will be delivered during the year for this use case. 3. Evidence should be provided for the weighted average emission intensity of reserve power plants providing flexibility in the reference scenario.