EGDC Case study: High performance Building Management System

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Case Study Methodology

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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

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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 to 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 'High-Performance Building Management' case study calculator and provide 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 and Schneider Electric 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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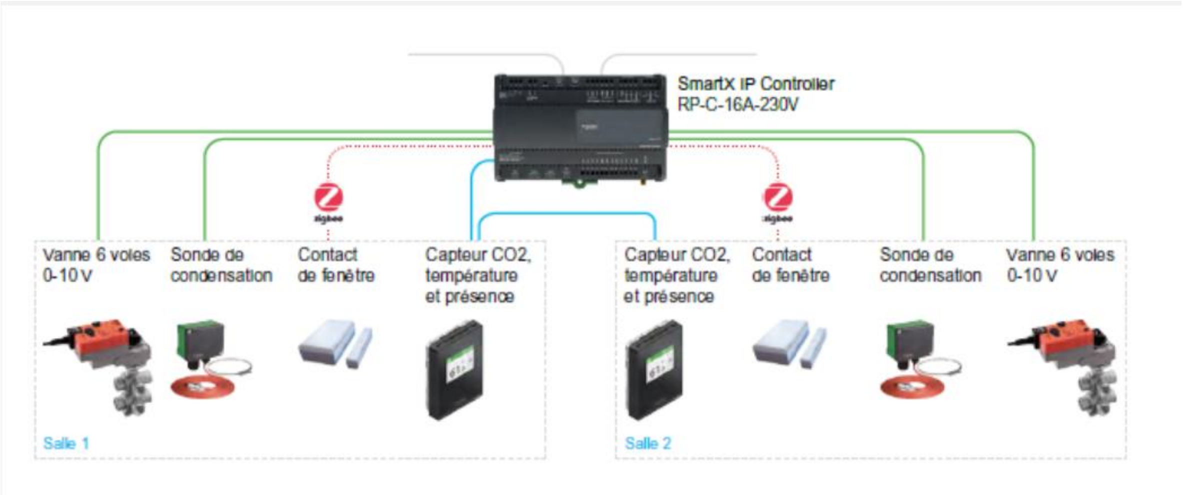
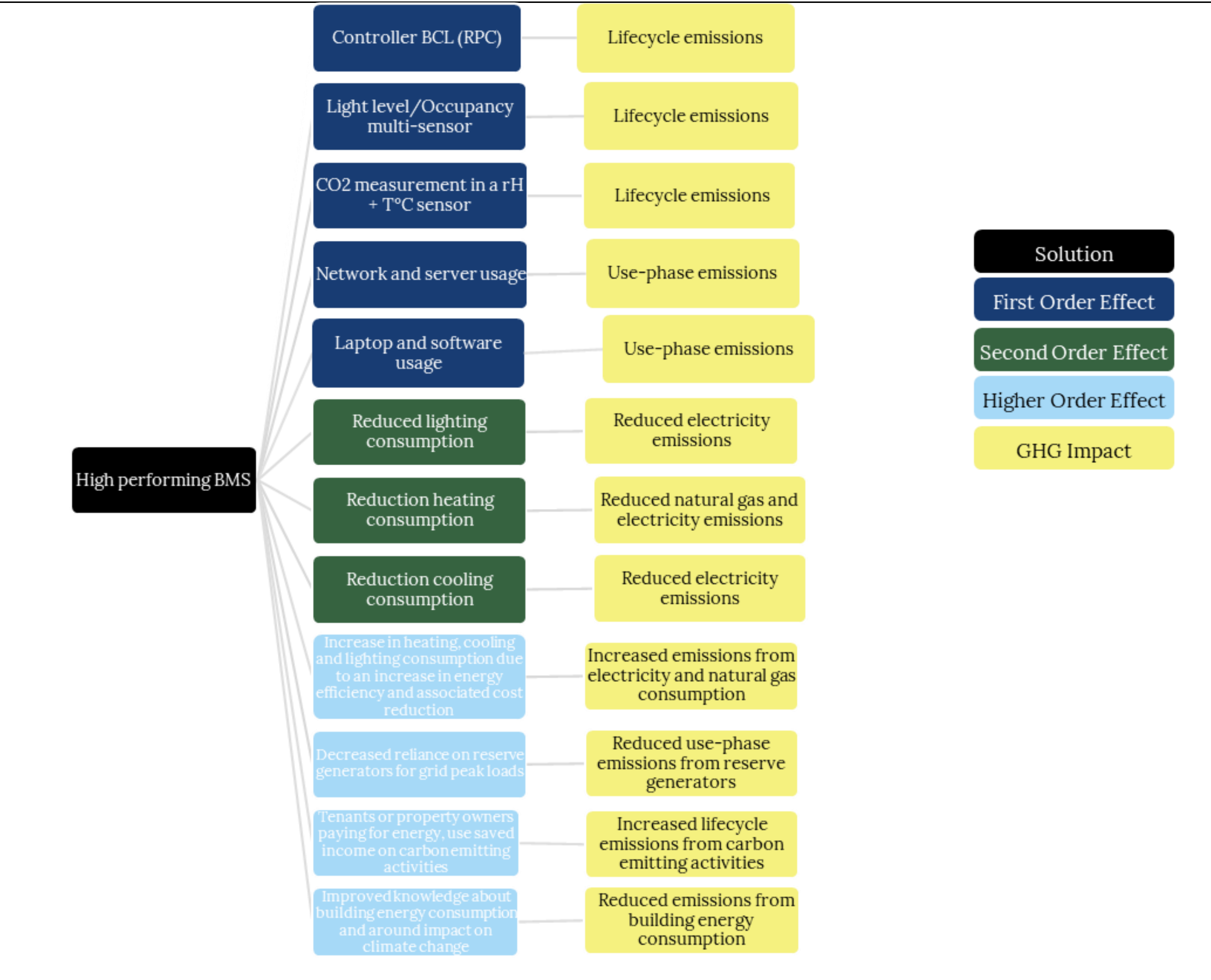
2 Methodology

High-Performance Building Management System	
Assessment Objective	The objective of this assessment is to determine to what extent the solution can have a net positive carbon impact on the buildings sector when implemented in multiple contexts across Europe. Furthermore, the aim of the assessment was also to test the EGDC ICT Guidance for Net Carbon Impact Assessments and identify sector-specific methodological considerations. The assessment aims to determine both the actual, ex-post impact of the solution in the Schneider Electric's Technopole building, as well as the ex-ante impact across commercial buildings in several European countries based on archetype data.
Solution Description	The High-Performance Building Management System allows for control of air quality, temperature, occupant comfort, lighting and heating in buildings. These commercial systems provide high levels of control which optimize space, time and energy use. It saves energy by heating, cooling and lighting, when and where it is needed in the building. The solution has been rolled out globally and can be rolled out across many different types of commercial buildings, in particular it is very relevant in buildings where you have sub-partitions such as hospitals, hotels and to a lesser extent education buildings. The solution requires network infrastructure to allow for data transmission, as well as existing HVAC equipment, metering infrastructure, valves, and dampers. Furthermore, the solution requires an understanding of energy management to ensure the solution is installed and operated correctly.
Solution Boundary	Digital components: - Controllers ○ Global controller ○ **Local controller BCL (RPC)*** ○ Remote control - Sensors ○ **Light level/Occupancy multi-sensor (Infrared motion detection sensor)** ○ **CO2 measurement in a rH + T°C sensor** - **IT infrastructure (Network and servers (on-site) used for data storage and trasmission)** - Only the in-use emissions from servers are considered as 1st order effects, as the embodied emissions were already in existence without the solution implementation - Usage of laptop devices and software required to operate the BMS

	- Metering o Electricity use and thermal energy meters Non-digital components: - Actuators o Valves o Dampers o Office Buildings o HVAC equipment (**Components in bold are not in the reference scenario and therefore 1st Order Effects)** *** Note:** The RPC Controller is not present in the Standard BMS Reference scenario, but is present in the Advanced BMS Reference Scenario
Components in the solution: 	
Functional Unit	The chosen functional unit is energy savings per square meter in an office building. The building control architecture is distributed and measured by ‘zone’, which is 17sqm. One zone is defined as the width of 2 window frames, equivalent to 4-6 desks, and consists of 1 combined light level/occupancy sensor, combined temperature relative humidity and CO_2 sensor, and 1 zone controller (RPC). This is a suitable functional unit as the floor area is often a key metric used to measure the energy intensity of buildings.
Assessment Boundary	There are two separate calculation boundaries for this assessment. Route 1 has a time boundary of one year and assesses the impact across several European countries. The buildings in this modelled scenario use electricity and gas. Route 2 has a time boundary of two years, comparing 2019 and 2021 building consumption at the Schneider Electric’s Technopole building in Grenoble, France. The building was completed in 2017 and occupies a total area of around 38,000 m2, which constitutes a mix of laboratories and tertiary activities. The building uses electricity and a heat pump for heating.

Reference scenario	There are two reference scenarios for this solution: Standard BMS (Ref I) and Advanced BMS (Ref II). Ref I is used for route 1 only, while Ref II is used for both route 1 and 2. Ref I: Standard BMS Reference scenario I is a standard BMS made up of a more basic BMS system that provides less savings than both an Advanced BMS and a High performing BMS solution. Under route 1, the actual reference scenario is unknown therefore the reference scenario needs to represent the market average approach for fulfilling the same function. This reference scenario reflects the basic type of BMS present in most office buildings and was deemed by Schneider Electric to represent the market average. Ref II: Advanced BMS The reference scenario II reflects a commonly implemented Advanced BMS system to showcase how the High performing BMS system supersedes it through additional carbon saving capabilities. Consequently, the High Performing BMS enables more carbon savings per sqm of a zone than an Advanced BMS. This reference scenario reflects an alternative option available in the market that is better than the basic type of BMS in Ref I. Under route 2, this reference scenario also reflects the actual reference scenario in place.
Description of 1st order effects	• Local controller BCL (RPC)* • Light level/Occupancy multi-sensor (Infrared motion detection sensor) • CO2 measurement in a rH + T°C sensor • IT infrastructure (Network and servers (on-site) used for data storage and trasmission) - Only the in-use emissions from servers are considered as 1st order effects, as the embodied emissions were already in existence without the solution implementation • Usage of laptop devices and software required to operate the BMS *** Note:** The RPC Controller is not present in the Standard BMS Reference scenario, but is present in the Advanced BMS Reference Scenario.
Categorisation of digital technologies (A) = ICT service (B) = Service specific building block	Category Active B (specific building block): • CO2 measurement in a rH + T°C sensor • Light level/Occupancy multi-sensor (Infrared motion detection sensor) • Local controller BCL (RPC)*

(C) = Common ICT devices, services, infrastructure	Category C (Generic building block): • IT infrastructure (Network and servers (on-site) used for data storage and trasmission) • Usage of laptop devices and software required to operate the BMS *For scenario comparing Standard BMS to Schneider Electric’s High Performing BMS Solution
Description of 2nd order effects	Energy reductions, and therefore GHG emissions, arise from the additional implementation and use of IoT sensors in the High Performing BMS. These sensors increase the efficiency of the occupancy, CO_2 monitoring, light and blind controls, while enabling HVAC and light demand to be controlled based on occupancy. The High Performing BMS allows for real-time monitoring of power consumption and uses, reductions in base consumptions and optimized energy control. Due to these capabilities, the High Performing BMS has a larger carbon saving impact in comparison to both the Advanced BMS and Standard BMS.
Description of higher order effects	Higher order effects that have not been considered in the calculations: • Direct rebound emissions from an increase in energy consumption due to an increase in energy efficiency and associated cost reduction – even though there could be a direct short-term impact, this higher order effect should be reflected in the percentage reduction of emissions based on energy consumption data and was therefore not considered seperately. • Decreased reliance on reserve generators for grid peak loads – this higher order effect is likely to have short-term, and could have a signficant emissions impact. However, a large number of buildings would need to be using the solution to achieve this impact. The combined impact of using this solution in multiple buildings has not been assessed. • Tenants or property owners paying for energy, use saved income on carbon emitting activities – the impact of this higher order effect is very uncertain, as saved income could be spent on very carbon intensive carbon activities or carbon saving activities. Furthermore, it will be difficult to establish a causal link between the saved income and the spend on certain activities and the associated emissions. • Improved knowledge about building energy consumption and around impact on climate change - the impact of this higher order effect is very uncertain, as it is unknown how the increased knolwedge will be turned into action and the magnitude of these actions. Furthermore, it will be difficult to establish a causal link between the increased knolwedge and any resulting carbon reduction actions.
Mapping of all effects	



Description of calculation	**1st order effects:** The solution emissions are obtained by adding the embodied and annual in-use emissions from electricity consumption of its components per zone (data transmissions and storage, Controller RPC, CO_2 sensor and two infrared motion detection sensors) and multiplying this by the total number of zones, based on the floor area. Embodied emissions include manufacturing, transportation and end-of-life, except for the sensors, which only include manufacturing emissions. Given that the end-of-life and transportation emissions for the controller contributes less than 1% to the total embodied emissions, and assuming they would be similar for the sensors, these emissions have been excluded for all three devices. The emissions from network and laptop/software usage have also been included based on the data quantity transmitted to servers over 1 year in ko and stored for 3 months, as well as assuming a consultation of the laptop for 30min per day through fixed network. **2nd order effects:** Two different calculation routes are available: Summary of Routes:

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Route 1 is based on DOE Building Archetype Data and Modelled Savings Derived from the Schneider Electric Sustainability Tool. Within this route there are two calculation options, detailed below.
Route 2 is based on measured reductions, comparing 2019 and 2021 building consumption at the Schneider Electric's Technopole building in Grenoble, France. Using their BEM Assessment Tool, 4 additional simulations were run, 'placing' the Technopole in 4 other cities in 4 other climate regions, to assess the impact varying climates have on the savings.

Route 1:
Route 1, Option 1: Annual Building consumption (kWh)

Inputs for country, office size, and reference scenario are chosen. Based on these parameters, default values are identified for floor area, average electricity consumption per year and average natural gas consumption per year. The enabled percentage reductions of electricity and gas consumption is determined by the input parameters, and these percentage reductions are applied to the consumption data to obtain annual kWh savings, which are then converted into kgCO$_2$e to get the total enabled reduction in gas and electricity emissions per year (kgCO2e/year). **This calculation route includes the option to manually override the default energy consumption input if primary data is available.** In addition, it is possible to override the Climate Region, which is based on different countries in Europe, broadly representing 6 different climate regions, as well as percentage of electricity consumption from onsite renewables.

Route 1, Option 2: Building area (m2)

Inputs for country, office size, and reference scenario are chosen. Based on these parameters, default values are identified for floor area, average electricity consumption per year and average natural gas consumption per year. The enabled percentage reductions of electricity and gas consumption is determined by the input parameters, and these percentage reductions are applied to the consumption data to obtain annual kWh savings, which are then converted into kgCO2e to get the total enabled reduction in gas and electricity emissions per year (kgCO2e/year). **This calculation route includes the option to manually override the default building area (sqm) input if primary data is available.** In addition, it is possible to override the Climate Region, which impacts the average energy used for heating and cooling throughout the year, as well as percentage of electricity consumption from onsite renewables.

Route 2:
This route is focused on comparing the reference scenario of Advance BMS to High Performing BMS, for buildings with electricity and heat pump heating. Inputs for country, annual electricity consumption for the building (kWh/year) and office floor area (m2) are added in to generate the savings. it is possible to override the Climate Region, which impacts the average energy used for heating and cooling throughout the year, as well as percentage of electricity consumption from onsite renewables.

Net GHG impact calculation:

	The solution emissions for the building are subtracted from the sum of the yearly enabled reductions of energy emissions to get the net avoided emissions. This figure is then divided by the building floor area to get the net enabled avoided emissions per m2.
Net Carbon Saving Impact of the Solution	Results will vary based on country. Ref I: Standard BMS for the EU (average) (using Route 1): **Large commercial buildings:** 1st order effect: 56 tCO2e/year 2nd order effects: 524 tCO2e/year Total carbon saving impact: 468 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 13% • % Gas savings: 29% Saving per functional unit: 0.01 tCO2e / m2 / year **Medium commercial buildings:** 1st order effect: 6 tCO2e/year 2nd order effects: 42 tCO2e/year Total carbon saving impact: 36 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 18% • % Gas savings: 28% Saving per functional unit: 0.007 tCO2e / m2 / year **Small commercial buildings:** 1st order effect: 0.6 tCO2e/year 2nd order effects: 4 tCO2e/year Total carbon saving impact: 3.4 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 20% • % Gas savings: 30% Saving per functional unit: 0.007 tCO2e / m2 / year Ref II: Advanced BMS for the EU (average) (using Route 1): **Large commercial buildings:** 1st order effect: 10 tCO2e/year 2nd order effects: 235 tCO2e/year Total carbon saving impact: 225 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 7% • % Gas savings: 11% Saving per functional unit: 0.005 tCO2e / m2 / year **Medium commercial buildings:**

	1st order effect: 1 tCO2e/year 2nd order effects: 18 tCO2e/year Total carbon saving impact: 17 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 9% • % Gas savings: 11% Saving per functional unit: 0.003 tCO2e / m2 / year **Small commercial buildings:** 1st order effect: 0.1 tCO2e/year 2nd order effects: 1.8 tCO2e/year Total carbon saving impact: 1.7 tCO2e / year Savings from reference scenario (%) • % Electricity savings: 10% • % Gas savings: 11% Saving per functional unit: 0.003 tCO2e / m2 / year
Qualitative data uncertainty and sensitivity analysis	The results are the most sensitive to the electricity percentage saving and the electricity emission factor. As the electricity savings are based on modelled savings, which take into account several parameters and are based on archetype data, there is some uncertainty around whether these saving percentages are translated into real world savings. Assuming the electricity savings are 5% as a minimum and 40% as a maximum, as indicated by other studies assessing the impact of BEMS, this would change the results by ~50% to +300% respectively. The gas percentage savings have a much lower impact on the overall net carbon impact as the gas consumption is much lower than electricity consumption for the buildings in this case study. While the data quality of the emissions factors is good to very good, the sensitivity to this parameter highlights how the results could vary across different countries, or in buildings that are using 100% renewable electricity, which would reduce the savings by nearly 100%. Although there is some uncertainty around the data quality of the first order effects, these tend to have a very minimal impact on the overall results and even a doubling of these emissions would reduce the overall net impact by no more than ~11%. 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	Key assumptions made in the calculations:

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	• 1 Controller RPC per zone, assume 10-year lifespan*,** • 1 CO2 sensor per zone, assume 10-year lifespan* • 2 infrared motion detection sensors per zone, assume 10-year lifespan* • Assume that the 5 countries selected are representative of their respective Climate Regions *Divided by 10 to acquire yearly attributable amount ** Only applicable when comparing the Standard BMS to the High Performing BMS scenarios
Data sources	Key data sources used in the calculations: • EN ISO standard 52120 1:2022 03 • Schneider Electric Primary Data & BEM AI Tool Analysis • Product Environmental Profile, SmartX IP Controller RP-C-16A-F-230V. Document Name: SXWRCF16A10003 ENVPEP1903003_V1 PEP ecopassport SCHN-00446-V01.01-EN • Schneider Electric LCA tool. Document Name: 'Adv. BMS Emissions Cost Assessment - DSA - Sept 2022' • Schneider Electric Internal Sustainability Tool • Schneider Electric BEM Assessment Tool • BEIS 2022 Emission Factors • Carbon Footprint Ltd, Country Specific Electricity Grid Greenhouse Gas Emission Factors, 2022 https://www.carbonfootprint.com/docs/2022_07_international_factors_-_release_10.xlsx
Input adjustments and key considerations for usage of results	List of things to consider if using results in other use cases: • Corresponding climate region • Onsite renewables (% of electricity consumption) • Office size (m2)) • Country selection – emission factors will need adjusting if location is not one of the defined options • Average consumption electricity per year depends on climate region and office size • Average consumption natural gas per year depends on climate region and office size
'Do no 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 Advanced BMS is scalable, while also having the potential to improve quality of life and human comfort.

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Key areas for improvement	In order to improve the calculator, more primary data should be used, like the case for the Grenoble building to confirm the results from the modelling of savings. Furthermore, widening the results to include different types of buildings, more countries, different energy sources, etc. could indicate the impact of the solution in different implementation contexts. Finally, an attempt to estimate the impact or magnitude of identified higher order effects could be made.

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