

Assessment of the energy performance and sustainability of data centres in EU

First technical report

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1. Introduction

a. Purpose

This document represents the deliverable 'First Technical Report' for the project Study on Technical Assistance in support of implementing Article 12(5) of Directive 2023/1791 on the energy performance and sustainability of data centres, and has been produced by EY, AIT and Borderstep for the European Commission.

The technical report assesses data centre energy efficiency and sustainability, and the reporting scheme of the Delegated Regulation 2024/1364. It uses reported data, supplemented where necessary, and evaluates energy performance via sustainability and key performance indicators. The report also addresses data quality and completeness and proposes improvements for the reporting scheme, including in terms of the reported information and indicators and user experience.

b. Structure of this report

This document is structured as follows:

- Chapter 1 presents to report introduction.
- Chapter 2 revisits the project methodology of Task 1.
- Chapter 3 reports on the preliminary results.
- Chapter 4 concludes the report.

c. Version control

Version	Date	Description
1.0	April 4, 2025	Preliminary version of the First Technical Report
2.0	May 30, 2025	Second version of the First Technical Report
3.0	June 27, 2025	Final version of the First Technical Report

d. List of acronyms

Table 1 - List of acronyms

Acronym	
AIT	Austrian Institute of Technology
BAT	Best Available Technologies
CoC	Code of Conduct
DG ENER	Directorate-General for Energy
DCESS	Synergies between Data Centres and Energy Systems
EED	Energy Efficiency Directive
ERF	Energy Reuse Factor
EY	Ernst & Young
ICT	Information and Communication Technology
IT	Information Technology
KoM	Kick-off Meeting
KPI	Key Performance Indicator
LAU	Local Administrative Unit
MS	Member State

PUE	Power Usage Effectiveness
REF	Renewable Energy Factor
ToR	Terms of Reference
TRL	Technology Readiness Level
WUE	Water Usage Effectiveness

e. List of reference documents

Table 2 - List of reference documents

Source	Type	Name	Link	Summary
German Federal Government	Regulation	Draft Law on Increasing Energy Efficiency and Amending the Energy Services Act	Link	This draft law by the German Federal Government aims to enhance energy efficiency and amend the Energy Services Act. It sets ambitious energy efficiency targets for both primary and final energy consumption in Germany, aligning with the EU's climate goals for 2030. The law includes mandatory energy or environmental management systems for companies with high energy consumption and outlines specific energy-saving measures for public institutions.
European Commission	Technical report	Energy Consumption in Data Centres and Broadband Communication Networks in the EU	Link	It reviews and uses existing literature and public data sources to estimate the energy consumption of data centres and telecommunication networks in the EU.
Strive	White paper	he Future of Data Centres: Navigating Energy Efficiency Policies in the EU and APAC	Link	This whitepaper discusses the increasing energy consumption of data centres and the stricter energy efficiency regulations being introduced in the EU and APAC regions.
Oeko-Institut e.V.	Technical report	Development of an Energy Efficiency Label for Data Centres	Link	It proposes an energy efficiency label for data centres, developed within the PeerDC project commissioned by the German Federal Environment Agency.
European Commission	Study	Synergies between Data Centres and Energy Systems	Link	The study aims to reconcile the increasing energy consumption of data centres with their critical role in European digital transformation. The study emphasizes utilising waste heat and water generated from data centre operations to support local energy systems, contributing to the EU's Green Deal and Digital Decade goals of achieving highly energy-efficient and climate-neutral data centres by 2030.

Data Centre Map	Database	Explore The Leading Global Data Center Database	Link	The database is global, encompassing data centres worldwide, including those operated by data centre providers offering colocation, cloud, and connectivity services. It includes facilities ranging from hyperscale to edge data centres, spanning both smaller markets and major metropolitan areas. Listings are primarily submitted and maintained by operators, ensuring daily updates and continuous expansion with new data centres. The collected data provides access to a comprehensive research tool featuring industry-leading statistics and insights.
Uptime Institute	White paper	Tier Classification System	Link	Uptime Institute established the data centre Tier classification levels over 25 years ago, which continue to serve as the international standard for data centre performance. The Tier definitions outline the infrastructure requirements for data centre operations, with different classifications based on system availability needs. These classifications provide an objective and reliable method for comparing site infrastructure performance and aligning infrastructure investments with business objectives.
IEA-4E	Study	Energy efficiency of data centres	Link	Focus on improving energy efficiency by developing models, policies, and standards. It addresses challenges such as ICT energy consumption, lack of standardised metrics, and data limitations.
Climate Neutral Data Centre Pact	White paper	Climate Neutral Data Centre Pact presents new water metrics to European Commission	Link	The Climate Neutral Data Centre Pact (CNDCP) develops environmental metrics for data centres, recently proposing water conservation limits to the European Commission. It also works on monitoring, reporting, recycling, and energy efficiency to support climate neutrality.

2. Methodologies

a. Task 1 – Assessment of the sustainability of data centres in EU and of the respective reporting scheme

Aim and Objectives

Task 1 aims to assess the energy efficiency and sustainability of data centres in the EU, as well as the reporting scheme, the reported data and the user experience of the reporting entities. The task encompasses the first five objectives of the project as below with their corresponding sub-tasks:

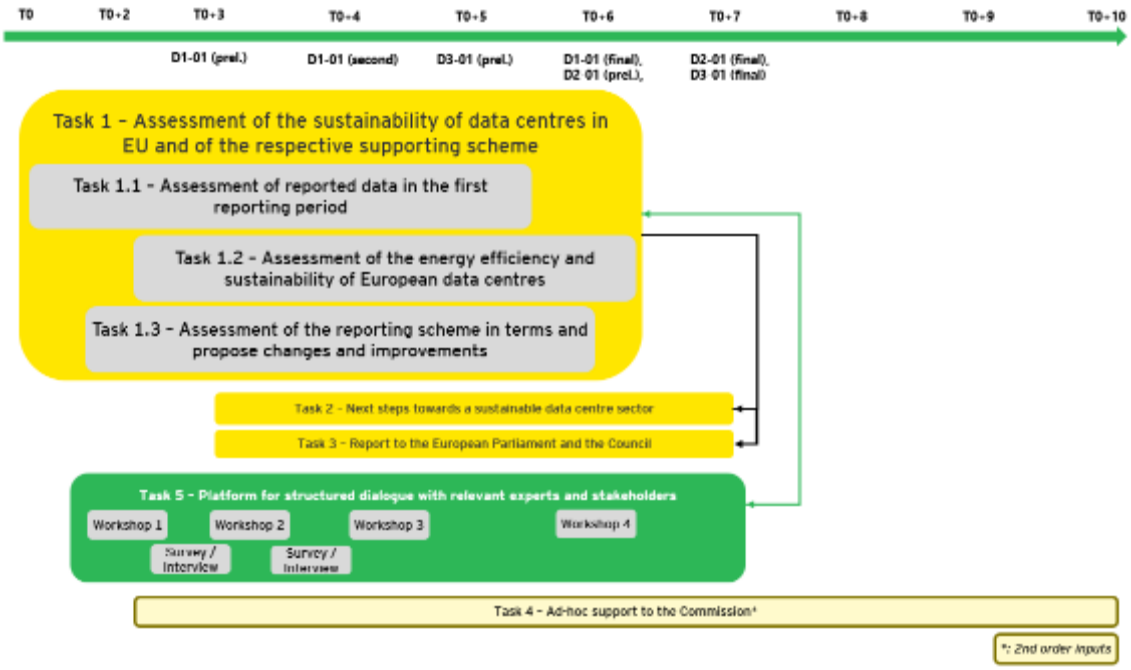
Table 3 - Project objectives and corresponding sub-tasks

Project objectives	Sub-tasks
Assess the reported data submitted in the first reporting period of 2024, in terms of both quality and completeness	Task 1.1 - Assess the reported data submitted in the first reporting period of 2024, in terms of both quality and completeness
Complement, if necessary, the reported data with data coming from other, trustworthy sources	

Assess the energy efficiency and sustainability of European data centres based on the reported and gathered data	Task 1.2 - Assess the energy efficiency and sustainability of European data centres based on the reported and gathered data
Assess the reporting scheme in terms of the information and indicators used and propose, if necessary, changes and improvements	Task 1.3 - Assess the reporting scheme in terms of the information and indicators used and in terms of user experience and management, and propose, if necessary, changes and improvements
Assess the reporting scheme in terms of user experience and management and propose, if necessary, changes and improvements	

The figure below provides an overview of the timeline and progress of Task 1, including the sub-tasks and the steps of the analysis, as well as the synergies with other tasks foreseen within this study.

Figure 1 - Overview of the timeline of Task 1



Data Collection

In order to obtain the necessary inputs for the assessment conducted under Task 1, the study team employed two steps of data collection as outlined below.

- **Desk research:**

  The desk research focuses on the prioritised KPIs for the analysis (see Table 9 below), with the aim to gather baseline information and supplement the reported data for the data completeness and quality analysis under Sub-Task 1.1.

  Additionally, extensive desk research was conducted to benchmark data centre energy efficiency and sustainability metrics computed based on the reported data against industry standards and thresholds to provide a comprehensive overview for the assessment under Sub-Task 1.2.

  The non-exhaustive list of sources consulted for the analysis are shown below.

Table 4 - Overview of sources for data centre baseline figures (non-exhaustive)

Types of sources	Sources
Academic journals	Research Gate
Dedicated portals for data centres	Data Center Map
	Data Center Dynamics
	Data Center Knowledge
	DataCenter-Insider
Trade and industry association websites, white papers and other publications	IEA (e.g. Efficient, Demand Flexible Network Appliances or 4E EDNA)[1]
	The Green Grid
	Uptime Institute (e.g. Tier Certification)[2]
	Oeko Insitut (e.g. Development of an energy efficiency label for data centres)[3]
	International Data Corporation (IDC)
	Gartner

- **Stakeholder engagement**

  Structured dialogue with relevant experts and stakeholders is crucial in consolidating, affirming and validating outputs from the work conducted within this study, in keeping with the current trends and dynamics within the industry. It should be noted that the stakeholder engagement activities are not only limited to Task 1 of this study, but also covering Task 2 on the next steps towards a sustainable data centres sector (see D2-01/02 Second Technical Report).

  Prior to the activities, the study team developed a list of relevant experts and stakeholders to be engaged throughout the study. The list has been expanded throughout the projects, for which a project landing page has been set up containing detailed information regarding the project and stakeholder engagement activities.[4]

  Overall, the stakeholder engagement activities will be divided into three activities:

  - **Survey:**

    The surveys aim to gather more general information on the current trends and dynamics from the data centre industry. The surveys were conducted in parallel with the interviews, while targeting a broader range of participants.

    The organisation of the survey was split into two phases as shown below.

Table 5 - Overview of surveys

Survey	Objectives	Target respondents	Time*	No. of answers
Survey 1	Gather industry average on the reported KPIs and collecting missing information from the reporting scheme for particular KPIs or MSs	• Data centre operators / owners • EU / National data centre associations or initiatives	February 20 – March 31, 2025	143
Survey 2	Ad-hoc survey regarding the user experience and data	• Data centre operators / owners	April 7 – June 13, 2025	54

[1] https://www.iea-4e.org/edna/tasks/energy-efficiency-of-data-centres/
[2] https://uptimeinstitute.com/tiers
[3] https://www.oeko.de/fileadmin/oekodoc/Oeko-Institut_energy-efficiency-label-for-data-centres.pdf
[4] https://www.borderstep.org/projekte/eudcear/

	management of the reporting scheme	• European Commission team and MS authorities managing the data		

**: Experts and stakeholders were free to provide ad-hoc inputs to the study team outside of the timeframe indicated.*

- **Interview:**

  Stakeholder interviews are aimed at gathering more detailed information and insights from a targeted group of experts and stakeholders to provide different perspectives and opinions on the matter. The study team foresaw two rounds of interviews, which were held in parallel with the surveys above.

Table 6 - Overview of interviews

Interview	Objectives	Target interviewees	Time*	No. of interviews
Interview 1	Gather industry average on the reported KPIs and collecting missing information from the reporting scheme for particular KPIs or MSs	• Data centre operators / owners • EU / National data centre associations or initiatives	April 7 – May 30, 2025	10
Interview 2	Ad-hoc survey regarding the user experience and data management of the reporting scheme	• Data centre operators / owners • European Commission team and MS authorities managing the data	May 5 – June 13, 2025	3

**: Experts and stakeholders were free to provide ad-hoc inputs to the study team outside of the timeframe indicated.*

- **Workshop:**

  The project includes four workshops, for which each workshop covers the presentation of findings from Tasks 1 and 2 of this study. Apart from presenting preliminary findings, the workshops have facilitated gathering inputs from participants to validate and refine the outcomes of the tasks.

  The table below presents the workshops and their objectives in conjunction with Task 1.

Table 7 - Overview of workshops

Workshop	Workshop objectives	Time*	No. of participants
Workshop 1	• Introduce the study, its objectives and methodology, work outline and timeline and set expectations for future workshops	February 11, 2025	35
Workshop 2	• Overview of data completeness and quality from the first reporting period • Preliminary energy efficiency and sustainability assessment	March 31, 2025	180
Workshop 3	• Overall energy efficiency and sustainability assessment	May 5, 2025	140

	• Overview of user experience and data management from the first reporting period		
Workshop 4	• Overview of user experience and data management from the first reporting period	June 18, 2025	142

i. Task 1.1 – Assess the reported data submitted in the first reporting period of 2024, in terms of both quality and completeness

Led by **EY**, supported by Borderstep.

The scope of the data collection and assessment will focus on the first reporting period as delineated under Article 12 of the EED Recast and the Delegated Regulation 2024/1364, for which the reporting will take place by May 15, 2024, and September 15, 2024, respectively, thus, covering data up to 2023.

The EU-wide reporting scheme for data centres was established through Article 12 of the Energy Efficiency Directive (EED) Recast of September 2023 on data centres, which mandates owners and operators of data centres in their territory with an installed IT power demand of at least 500 kW to make publicly available:[5]

- the name of the data centre, the owner and operators of the data centre, the date of entry into operation and the municipality where the data centre is based;
- the floor area of the data centre, installed power, annual incoming and outgoing data traffic and the amount of data stored and processed within the data centre;
- the performance of the data centre in the last full calendar years for the key performance indicators, including energy consumption, power utilisation, temperature set points, waste heat utilisation, water usage and use of renewable energy.

The information above shall be published by May 15, 2024, except for information subject to trade and business secrets and confidentiality or data centres providing services exclusively for defence and civil protection.

Simultaneously, as mentioned in Article 33 (3) of the EED Recast on delegated acts, the Delegated Regulation 2024/1364 of March 2024 sets out the key performance indicators to be reported on the European database of data centres by data centre operators with an installed IT power demand of at least 500 kW. The reporting will take place by September 15, 2024, and by May 15, 2025, and every year subsequently, and will be done through a national reporting scheme if already established or otherwise directly to the European database.[6]

The delegated regulation mandates data centre operators to report the following information:

- Information on the data centre: data centre name, owner and operator, location, type (i.e. enterprise, colocation or co-hosting data centre) and the year and month of entry into operation of the data centre.
- Information on the operation of the data centre: electrical and cooling infrastructure redundancy.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766
[6] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32024R1364#ntr2-L_202401364EN.000101-E0002

Meanwhile, the KPIs to be reported are as follows:

Table 8 - KPIs to be reported for the EU database on data centres under the delegated regulation 2024/1364

Types of indicators	Indicators
Energy and sustainability indicators	• Installed IT power demand • Data centre total floor area • Data centre computer room floor area • Total energy consumption • Total energy consumption of IT equipment • Electrical grid function • Average battery capacity • Total water input • Total potable water input • Waste heat reused • Average waste heat temperature • Average setpoint IT equipment intake air temperature • Types of refrigerants • Cooling degree days • Total renewable energy consumption • Total renewable energy consumption from Guarantees of Origin • Total renewable energy consumption from Power Purchasing Agreements • Total renewable energy consumption from on-site renewables
ICT capacity indicators	• ICT capacity for servers • ICT capacity for storage equipment
Data traffic indicators	• Incoming traffic bandwidth • Outgoing traffic bandwidth • Incoming data traffic • Outgoing data traffic

However, for the first reporting period (May and September 2024), data is expected to be missing at the Member State level and for certain industry segments, such as from smaller enterprise data centres close to the 500-kW threshold. The gap in reporting is also stipulated under Article 3 of the delegated regulation 2024/1364, for which data centre operators may omit from reporting the total energy consumption, total energy consumption of IT equipment, total water input, total potable water input, waste heat reused, average waste heat temperature, average setpoint IT equipment intake air temperature, total renewable energy consumption, total renewable energy consumption from Guarantees of Origin, total renewable energy consumption from Power

Purchasing Agreements and total renewable energy consumption from on-site renewables for the first reporting period, with reasonings given for the omission. Meanwhile, colocation data centres may provide an estimate of the ICT capacity for servers and for storage equipment for the first two reporting periods, when the necessary cannot be obtained.[7]

As part of this exercise, the consortium examines the completeness and quality of the reported data and complement it from other available sources, including industry reports, academic research and stakeholder inputs, among others. The work under this sub-task is split into two as below.

Assessment of the completeness reported data from the first reporting period of 2024

The study team has received from the Commission on an ad-hoc and "need to know" basis the data reported by data centre operators from the first reporting period. The study team has signed a "declaration of confidentiality" prior to accessing the data, in which access to the data is accompanied by a strong legal disclaimer from the side of the team.

The assessment does not encompass all KPIs included in the reporting scheme but is targeted on prioritised KPIs based on two main criteria, namely whether the KPIs are required for the assessment of the energy efficiency and sustainability of data centres under Task 1.2 and whether there are potential privacy issues. As the data is anonymised and made partially available to the consortium, this ensures that no sensitive information from the industry is disclosed.

The selected KPIs are as follows:

Table 9 - Prioritised KPIs for the analysis

Types of indicators	Indicators	Required for the assessment under Task 1.2	Potential privacy issues
Data Centre details	Location LAU code (country level)*	Yes	No
	Data centre type	Yes	No
	Year of entry into operation of the Data Centre	Yes	No
Energy and sustainability indicators	IT power demand	Yes	No
	Computer room floor area	Yes	No
	Total energy consumption	Yes	No
	Total energy consumption from back-up generators [kWh]	Yes	No
	Total consumption of IT equipment	Yes	No
	Total water input	Yes	No
	Waste heat reused	Yes	No
	Cooling degree days	Yes	No
	Total renewable energy consumption	Yes	No
	Total renewable energy consumption guarantees of origin	Yes	No
	Total renewable energy consumption from Power Purchasing Agreements	Yes	No

[7] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32024R1364#ntr2-L_202401364EN.000101-E0002

	Total renewable energy consumption from on-site renewables	Yes	No

**: Location LAU code is reported at the country level so no potential privacy issue is encountered as it is not directly identifiable to the reporting data centre operator/owner.*

Other KPIs from the reporting scheme may remain relevant for other parts of the study and the consortium may request these KPIs on an ad-hoc basis to the Commission whenever necessary.

After receiving the data, the team has examined the completeness of the reported data to check the gaps at the MS level to be aggregated to the EU level. Along the way, a database was built to check this completeness based on:

- The proportion of reporting data centres per MS;
- The overview of reported information and KPIs requested in the reporting scheme for the selected information and KPIs.

In that regard, the first step of this sub-analysis is to assess the proportion of reporting data centres from the total number of data centres in each MS, also divided by types and size of data centres whenever applicable. This exercise is useful in checking that all MSs are represented in the reporting scheme and that an adequate number of reporting data centres are participating in the reporting scheme out of the total number of data centres in any given MSs. If, for instance, no data centres from a specific MS are reporting their data or if only an insufficient number of data centres from one MS are recorded (e.g. fewer than 3 reporting data centres), the data for the specific MS is declared as incomplete and, thus, a further exploration to complete the data was undertaken as part of this sub-task.

The study team is utilising Data Centre Map[8] as the primary source on the total number of data centres per MS. Accounting for the fact that this source may be incomplete, the team has also consulted other relevant sources and reach out to national data centre associations or initiatives to gather this number as part of this sub-task.

The table below presents a sample for one country.

Table 10 - Sample overview of reporting data centres per MS

Country		Germany	
		Number of data centres[9]	**Number of reporting data centres**
Total		529	335
Data centre type	Enterprise data centre	158	95
	Co-location data centre	203	99
	Co-hosting data centre	168	36

Whenever possible, the data is also evaluated per data centre type (i.e. enterprise, co-location and co-hosting) and per size in terms of installed power (i.e. very small data centre (100-500 kW), small data centre (500-1 000 kW), medium size data centre (1-2 MW), large data centre (2-10 MW) and very large data centre (> 10 MW)). However, due to the lack of comprehensive data outside of the reporting period at the level of each type and size of data centres, this analysis has

[9] https://cloudscene.com/market/data-centers-in-germany/all

only been conducted for several MSs where data is available and, thus, no comprehensive outputs can be derived at the EU-level.

Thereafter, the second step is to examine the completeness for each information and KPIs as outlined above. The analysis has been logged in an MS Excel spreadsheet to provide an overview of the gaps for each information and KPI, which is included in Annex 1.

Table 11 - Sample overview of reported information and KPIs

Types of indicators	Indicators	Germany average
Energy and sustainability indicators	Installed IT power demand	2 931 kW
	Data centre computer room floor area	2 652 m2
	Total energy consumption	14 084 560 kWh
	Total energy consumption from back-up generators [kWh]	n.a.
	Total energy consumption of IT equipment	10 485 466 kWh
	Total water input	5 754 m3
	Waste heat reused	122 292 kWh
	Average waste heat temperature	20°C
	Cooling degree days	19
	Total renewable energy consumption	12 397 665 kWh
	Total renewable energy consumption from Guarantees of Origin	12 108 417 kWh
	Total renewable energy consumption from Power Purchasing Agreements	281 964 kWh
	Total renewable energy consumption from on-site renewables	7 284 kWh

Assessment of the quality reported data from the first reporting period of 2024 and complement the reported data with data coming from other, trustworthy sources

In order to perform the data quality assessment, the team has compiled baseline figures for each information and KPIs outlined above, including per category (i.e. enterprise, colocation and co-hosting) and per size (i.e. very small data centre (100-500 kW), small data centre (500-1 000 kW), medium size data centre (1-2 MW), large data centre (2-10 MW) and very large data centre (> 10 MW)) whenever possible.

The activities on compiling the baseline numbers have been as much as possible synergised with activities on complementing the reported data due to the similar nature of the exercises. The two activities encompass desk research from available sources of information and engagement activities with relevant experts and stakeholders from MS representatives, data centre operators and industry associations, among others, as described in more details in the previous sub-section.

For MSs and indicators where there is no reported data, the data collected under this exercise feeds into the database to represent the said MSs or indicators. Meanwhile, if there is already data reported by data centre operators as part of the reporting scheme, the data collected is used as a benchmark to examine the accuracy and reliability of the reported data. In that regard, the desk research and the surveys and interviews were designed to target more experts and stakeholders from MSs where there is limited or no reporting data based on the data completeness assessment.

The outcomes of the analyses are reported in the sections below.

ii. Task 1.2 – Assess the energy efficiency and sustainability of European data centres based on the reported and gathered data

Led by **EY**, supported by Borderstep.

As explained above, the selected information and KPIs from the first reporting period received from the Commission are used to compute the metrics to assess the energy efficiency and sustainability of data centres in the EU under Task 1.2. With the metrics in view, this enables determining which KPIs are crucial for the analysis, particularly with regards to the extent of the activities to complement the gaps with gathered data from desk research and stakeholder engagements.

The assessment focuses on the indicators on data centre energy efficiency and sustainability as delineated under Annex III of the delegated regulation 2024/1364.[10]

- **Power Usage Effectiveness (PUE):** ratio of total energy consumption to total energy consumption of IT equipment.

$$PUE = E_{DC}/E_{IT}$$

- **Water Usage Effectiveness (WUE):** ratio of total water input to total energy consumption of IT equipment.

$$WUE = W_{IN}/E_{IT}$$

- **Energy Reuse Factor (ERF):** ratio of waste heat reuse to total energy consumption.

$$ERF = E_{REUSE}/E_{DC}$$

- **Renewable Energy Factor (REF):** ratio of total renewable energy consumption to total energy consumption.

$$REF = E_{RES-TOT}/E_{DC}$$

It should be noted that some of the metrics above may have a different extent of availability. For instance, the figures for PUE and WUE, which are more established, are likely to be more easily obtainable, while this might not be the case for ERF.

The assessment is based on known standards and is focus on the Annex IV of the Delegated Regulation 2024/1364 and the data that needs to be published by the EU to benchmark the numbers to be computed for the indicators above, in alignment with the best practices outlined under the EU Code of Conduct for Data Centres. Although the CoC does not entail specific targets for each of the indicators, the document provides guides to help data centre operators to optimise their energy usage and work toward energy efficiency. Participants to the CoC are expected to report several indicators as part of their commitment to the initiative, including PUE, WUE, REF and ERF, among others. According to the COC's webpage, there are currently 178 data centre operators or owners registered as participants.[11]

Along the study, the metrics computed from the reported data have been benchmarked with other industry thresholds in order to measure the energy efficiency and sustainability of the EU data

[10] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32024R1364#ntr2-L_202401364EN.000101-E0002
[11] https://e3p.jrc.ec.europa.eu/node/575

centre sector. One of these is the Climate Neutral Data Centre Pact, which is a voluntary industry initiative where data centre operators signatories to the pact are committed to meet the agreed goals on energy efficiency, renewable energy, water conservation, circular economy and heat recovery and reuse through the Self-Regulatory Initiative. Some of the targets include a PUE target of 1.3 (or 1.4 in warmer climates) by 2025 for new data centres and by 2030 for existing data centres larger, a target of 75% renewable energy or hourly carbon-free energy matching by the end of 2025 and 100% by the end of 2030, a WUE target of 0.4 l/kWh by 2040.[12,13] Over 80 operators representing 90% of data centre capacity in Europe have signed up for the pact, for which 95% of the signatories passed the obligations of the scheme in the first reporting period.

Another example from the national level is the Energy Efficiency Law 2023 in Germany, which mandates data centres that start operating from July 2026 to have a PUE of 1.3 or lower in the first two years of operation, with an ERF of 10%. Meanwhile, data centres that start operating from July 2027 and 2028 shall have an ERF of 15% and 20%, respectively in the first two years of operations. For data centres starting operations before July 2026, the PUE target is lower at 1.5 or lower by July 2027 and 1.3 or lower by July 2030. Furthermore, data centres are obliged to match 50% of their electricity demand with unsubsidised electricity from renewable energies by 2024 and 100% by 2025.[14]

Along the study, the team is reviewing other existing industry benchmarks to be aggregated for each of the indicators to be measured in order to create a complete overview for the assessment of the energy efficiency and sustainability of data centres.

The assessment also takes into account other factors that may influence the energy efficiency and sustainability of data centres to add nuance to the numbers. For example, the targets would be relatively easier to reach for larger data centres than smaller ones due to a higher variability for energy efficiency. Similarly, a caveat for data centres in warmer locations shall be included due to the extra amount of energy required for operations. Lastly, the analysis considers the differences between newly built and existing data centres as it would be more challenging for existing data centres to meet the targets due to the needs to retrofit the facilities.

Another crucial consideration is the interdependencies between the indicators. For instance, the PUE, due to its dependency on the type of cooling, the quantity of water consumer or the extent of power usage, may affect the WUE. As such, besides looking at the indicators as a singular metric, the assessment also considers all indicators in a holistic way to measure the overall sustainability of the data centre sector. The limitations of each indicator will be factored in as well. For instance, the WUE may not distinguish between the water sources or the extent of local water stresses, while the ERF may not differentiate between the different types of heat produced by data centres.

Moreover, to produce more meaningful and granular findings, instead of merely reporting the average PUE or WUE of data centres, the reporting can be broken down by different types, sizes or years of construction of data centres to provide more context behind the figures.

Finally, the assessment should lead to useful conclusions and recommendations that can feed the work of decision and policy makers in both the public and private sectors. To this end, the assessment should identify whether and how the data centres sector adds stress to the energy and water systems of Europe, what are the ensuing risks, and how the sustainability of the sector can be improved. The recommendations for improvement should also consider the current projections for a significant increase in the capacity of data centres in the next few years.

[12] https://www.climateneutraldatacentre.net/working-groups/

[13] https://www.climateneutraldatacentre.net/2022/07/26/climate-neutral-data-centre-pact-presents-new-water-metrics-to-european-commission/

[14] https://www.bmwk.de/Redaktion/DE/Downloads/Gesetz/entwurf-enefg.pdf?__blob=publicationFile&v=6

The outputs from Task 1.2 are reported in the sections below.

iii. Task 1.3 – Assess the reporting scheme in terms of the information and indicators used and in terms of user experience and management, and propose, if necessary, changes and improvements

Led by **EY**, supported by Borderstep.

Task 1.3 aims to support the Commission in assessing the reporting scheme, both in terms of the information and indicators used, and the user experience of data centre operators and owners submitting the data and the data management from the side of the Commission, as well as propose any points of improvement and recommendations to be made following the assessment.

Assessment of the information and indicators used in the reporting scheme

The first step of the assessment takes into account the outcomes of the analyses done under Task 1.1. The reporting scheme is assessed based on the non-exhaustive criteria below:

- **Relevance:** whether the information and KPIs required for the reporting scheme align with the objectives set for the reporting scheme and if there are any missing indicators or indicators that are potentially overlapping with one another or overly complex for the scheme.
- **Comprehensiveness:** whether the reported data cover all MSs to an acceptable degree and the information and KPIs requested for the reporting scheme. For example, high rate of non-response to certain indicators may reveal issues with the specific indicators or the design of the scheme. Meanwhile, if the data reported for one MS only come from a limited number of operators or owners relative to the total number of data centres in that MS, this may lead to biased results.
- **Reliability and accuracy:** whether the reported data are in line with no significant discrepancies with known industry average and to ensure the consistency of the reporting across different MSs. Major discrepancies, for instance, can be explained through misunderstanding from the sides of the operators or owners regarding the indicators asked or data entry errors. Different MSs may have different ways of reporting as well, for which this will be investigated to ensure as much as possible a consistent reporting across the EU.
- **Timeliness:** whether the submission from data centre operators and owners were done within the annual deadlines in view of the dynamic and rapidly evolving nature of the sector.

The results of the assessment are reported in the sections below.

Assessment of the user experience from the reporting scheme

The second step of the analysis assesses the user experience perspective of the reporting scheme and entails the involvement of data centre operators or owners who have reported their information in the reporting scheme for the first reporting period.

As described in the previous sub-section, the study team has initiated a round of survey and interview targeting participating operators or owners regarding the user experience aspect from the reporting scheme. The survey questionnaire and interview guideline are included in Annex 2 below. The assessment criteria include among others the ease of reporting, accessibility, clarity and relevance of the information and KPIs requested, the length of the reporting, privacy and confidentiality matters and feedback opportunities.

Similar with the previous sub-analysis, the feedback from the respondents is reported in the sections below and compiled in a spreadsheet including common recurring themes from the feedback and any suggestions for improvement from the stakeholders.

Assessment of the data management from the reporting scheme

As part of the reporting scheme, data centre operators or owners shall communicate the requested information and KPIs into the European database. The reporting took places through a national reporting scheme if this has been established in the MSs where the data centres are based or directly into the database otherwise. As such, the assessment focuses on the national authorities involved responsible for the national reporting scheme or the team within the Commission in charge of the European database.

The assessment entails several criteria on data management, including the data collection, processing, storing and sharing, in addition to data integrity and privacy matters. Accordingly, the study team has organised a round of survey and interview targeting the team from the European Commission and MS authorities managing the data for the data management aspect. The survey questionnaire and interview guideline are included in Annex 2 below.

As above, feedback is collected and reported in the sections below, together with any suggestions for improvements from the interviewees.

3. Study developments and results

The preliminary results presented in this report provide a snapshot of the current energy usage and sustainability metrics across the European Union's data centres. These results, derived from reported data, highlight the preliminary trends for key performance indicators (KPIs), while acknowledging challenges in data completeness and quality. Notably, while the reporting is still ongoing, the preliminary results already provide valuable information to guide future improvements and contribute to the overall sustainability goals of the data centre sector in Europe.

The overall preliminary results from the reported data can be found in the table below, showing the EU median and average per KPI:

Table 12 - Results from reporting data centres of the first reporting period

Indicators	EU27 average	EU27 median	Unit
Installed IT power demand	17 075	1 287	kW
Data centre computer room floor area	3 670	1 593	m²
Total energy consumption	19 805 775	7 980 567	kWh
Total energy consumption from back-up generators	193 094**	-	kWh
Total energy consumption of IT equipment	15 457 020	5 378 639	kWh
Total water input	21 214	647	m³
Waste heat reused	4 046 667	693 792	kWh
Average waste heat temperature	24	23	°C
Cooling degree days	131	19	days
Total renewable energy consumption	16 835 139	5 299 610	kWh
Total renewable energy consumption from Guarantees of Origin	12 465 047	4 917 010	kWh
Total renewable energy consumption from Power Purchasing Agreements	5 322 448	0	kWh
Total renewable energy consumption from on-site renewables*	40 856	0	kWh

**: Some figures in the table show instances of unrepresentative data, as the "Total renewable energy consumption from Power Purchasing Agreements" indicator showing a stark contrast: the average is 5 322 448 kWh, while the median is 0 kWh. These discrepancies are largely driven by outliers or may be the result of a potential unit misinterpretation.*

***: Interview validation suggested that these figure is significantly misaligned with reality.*

a. Task 1.1 - Data quality and completeness assessment

i. Introduction to the data assessment

A comprehensive assessment of data centre reporting is essential to ensure accuracy, reliability and the promotion of sustainable practices. The assessment evaluates the quality and completeness of the reported data and the effectiveness of the reporting scheme. By addressing any gaps and shortcomings, the assessment can contribute to improving the accuracy and reliability of data reporting and promote the adoption of more sustainable practices in the data centre industry.

The assessment consists of two parts:

- **Data completeness assessment:** The assessment is crucial for identifying any gaps in the data reported by data centre operators. This assessment involves checking the proportion of reporting data centres per member state and the completeness of the reported information

and KPIs for each data centre. Any missing data can be identified and addressed through further exploration and stakeholder engagement.

- **Data quality assessment:** The assessment involves benchmarking the reported data against established standards, industry benchmarks and expert inputs. This can be done by comparing the reported data to baseline figures and performing plausibility checks to flag unrealistic values. Any inconsistencies or inaccuracies can be identified and addressed accordingly.

The data presented in this document is anonymised to ensure privacy and is used solely for analytical purposes. No individual or company-specific information is disclosed, including names or detailed geographical locations. Only selected indicators are made available to the study team based on priority and confidentiality assessment. The focus is on data centres with installed capacity higher than 500 kW, as participation in the reporting scheme is mandatory for them—though national laws may apply lower thresholds.

The data analysis is performed for data from the first reporting period as of June 20, 2025.

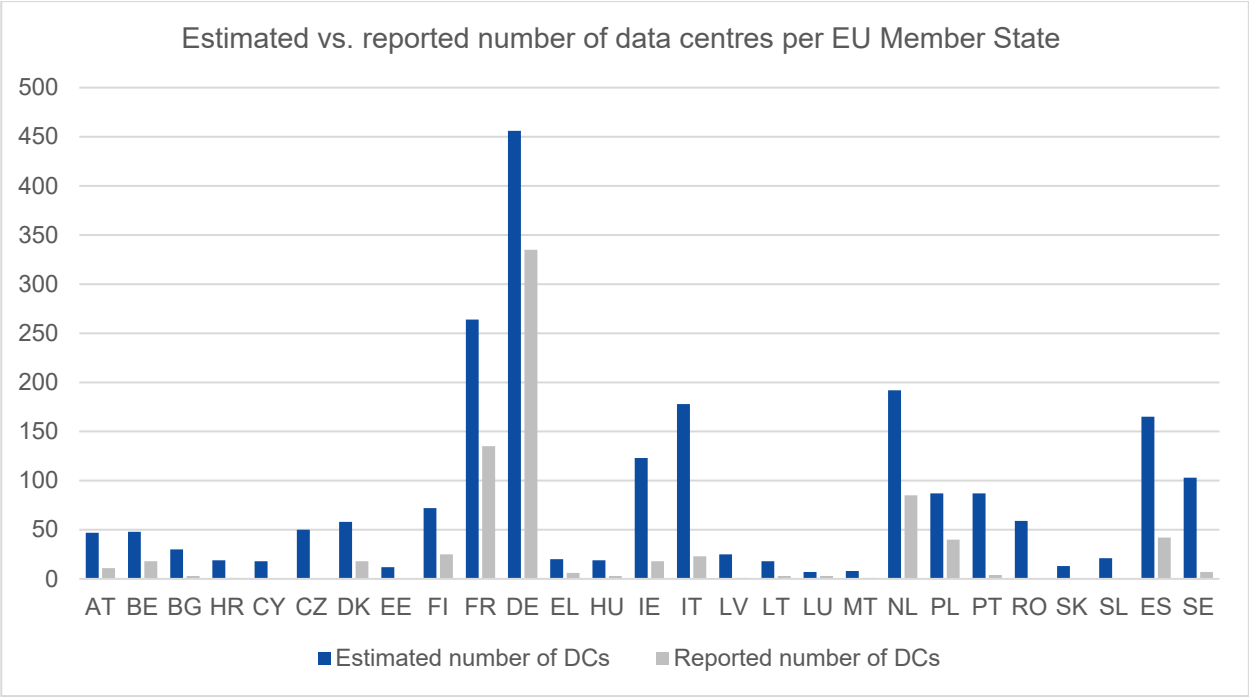
ii. Data completeness assessment

An evaluation was conducted to determine the extent of participation among data centre operators/owners in the reporting scheme, including measuring the proportion of reporting data centres whose data is reported and assessing the completeness of the KPIs provided. As mentioned above, the data collected is fully anonymised and used exclusively for analytical purposes, with no disclosure of individual or company-specific information. Only prioritised indicators are shared with the consortium. Based on the reporting requirements, this analysis focuses on data centres with an installed/rated capacity above 500 kW, for which EU reporting is mandatory. However, in certain cases, reporting is also mandatory for smaller data centres based on national legislations (e.g. for data centres above 300 kW in Germany following the Energy Efficiency Act of November 2023[15]). Inputs from those data centres with smaller installed capacity are retained in the analysis.

From the first reporting period, 36% of EU data centres reported their data, amounting to 770 data centres. There is no reported data for six Member States, while fewer than three data centres reported their KPIs in five MSs. The proportion across all Member States is illustrated in the figure below. This ratio is calculated based on the expected numbers according to sources such as datacentermap.com. The ratio of reported to total capacity (in MW) or reported energy consumption (in TWh) may be even lower given the wide variation in data centre sizes.

Figure 2 - Estimated vs. reported number of data centres per EU Member State

[15] Federal Republic of Germany, Gesetz zur Steigerung der Energieeffizienz in Deutschland (Energieeffizienzgesetz – EnEfG), BGBl. I S. 2806, 2023. Available at: https://www.gesetze-im-internet.de/enefg/BJNR1350B0023.html



The following table provides the proportion of reporting data centres per MS.

Table 13 - Estimated vs. reported number of data centres per EU Member State

Member States	Estimated total number of data centres	Number of reporting data centres from the scheme	Proportion
Austria	47	11	23%
Belgium	48	16	33%
Bulgaria	30	3	10%
Croatia	19	1	5%
Cyprus	18	0	0%
Czechia	50	0	0%
Denmark	58	17	29%
Estonia*	12	0	0%
Finland	72	25	35%
France	264	133	50%
Germany	456	335	73%
Greece	20	6	30%
Hungary	19	1	5%
Ireland	123	18	15%
Italy	178	23	13%
Latvia	25	1	4%
Lithuania	18	3	17%
Luxembourg	14	2	14%
Malta	8	1	13%
Netherlands	192	85	44%

Poland	87	36	41%
Portugal	42	4	10%
Romania	59	0	0%
Slovakia	13	0	0%
Slovenia	21	0	0%
Spain	165	42	25%
Sweden	103	7	7%
TOTAL	2 161	770	36%

**Estonia disclosed KPIs for three data centres, but those were not included in the study as they were data ranges rather than absolute numbers.*

To estimate the approximate number of data centres in Europe and per country that should report in the European database, multiple sources were consulted, including datacentermap.com[16] and inputs from national data centre associations and industry stakeholders during the consultation phase. It should be noted that datacentermap.com does not fully represent the entire data centre landscape. This limitation arises because participation in the database is voluntary, meaning that data centres are not obligated to share their information. As a result, the data captured in the database may not fully reflect the true number of data centres in operation, and there may be gaps in the information available for certain regions or operators. Subsequently, whenever available, the team has consulted other sources on the number of data centres per MS, on top of inputs from the stakeholder engagement activities.

Meanwhile, from the reported data, colocation data centres account for 54% of the total data centre population in the EU, while enterprise and co-hosting data centres represent 29% and 16%, respectively. In terms of installed power, approximately 35% of the facilities have an installed power capacity greater than 2 MW, while medium (1-2 MW) and small data centres (500 – 1 000 kW) form 24% and 18% of the population respectively. Lastly, 13% of the data centres fall below the mandatory reporting threshold of 500 kW according to reported data, while the remaining 9% did not disclose their installed power.

It should be noted that data centres with less than 500 kW of installed power capacity are still included for this analysis above, even though they may not be mandated to disclose their KPIs in most MSs. This has been accounted for in the energy efficiency and sustainability assessment under Task 1.2 below, where some results may be affected by the different parameters under which these very small data centres operate. There is a lack of available data sources on the number of data centres with installed power capacity over or below 500 kW, thus, it has not been feasible to provide a more accurate assessment of the scheme's success rate.

The table below presents the proportion of reporting data centres over 500 kW installed power capacity against all reporting data centres.

Table 14 - Reporting data centres over 500 kW installed power capacity as a proportion of all reporting data centres per EU Member State

Member States	Number of total reporting data centres from the scheme	Number of reporting data centres over 500 kW from the scheme	Proportion
Austria	11	8	73%
Belgium	16	13	81%
Bulgaria	3	3	100%

[16] Data Center Map, Global database of colocation data centres. Available at: https://www.datacentermap.com/

Croatia	1	1	100%
Cyprus	0	0	N/A
Czechia	0	0	N/A
Denmark	17	16	94%
Estonia*	0	0	N/A
Finland	25	24	96%
France	133	107	80%
Germany	335	264	79%
Greece	6	2	33%
Hungary	1	1	100%
Ireland	18	18	100%
Italy	23	21	91%
Latvia	1	1	100%
Lithuania	3	3	100%
Luxembourg	2	2	100%
Malta	1	1	100%
Netherlands	85	44	52%
Poland	36	27	75%
Portugal	4	4	100%
Romania	0	0	N/A
Slovakia	0	0	N/A
Slovenia	0	0	N/A
Spain	42	39	93%
Sweden	7	4	57%
TOTAL	770	597	78%

**: Estonia disclosed KPIs for three data centres, but those were not included in the study as they were data ranges rather than absolute numbers.*

There is a high variability across MSs, with an EU total of 78% reporting data centres above 500 kW from the first reporting period as a proportion of all reporting data centres. For MSs with more than 30 reporting data centres, there is also a high variability, with some high percentages observed in France, Poland and Spain and a slightly lower figure for Germany that can be attributed to the mandatory reporting for data centres above 300 kW. Although the Netherlands is one of the MSs with the highest number of data centres, there are a lot of non-reporting when it comes to the installed capacity, thus, reflected in the relatively low figure.

Meanwhile, the table below presents the complete breakdown of all reporting data centres across different size categories:

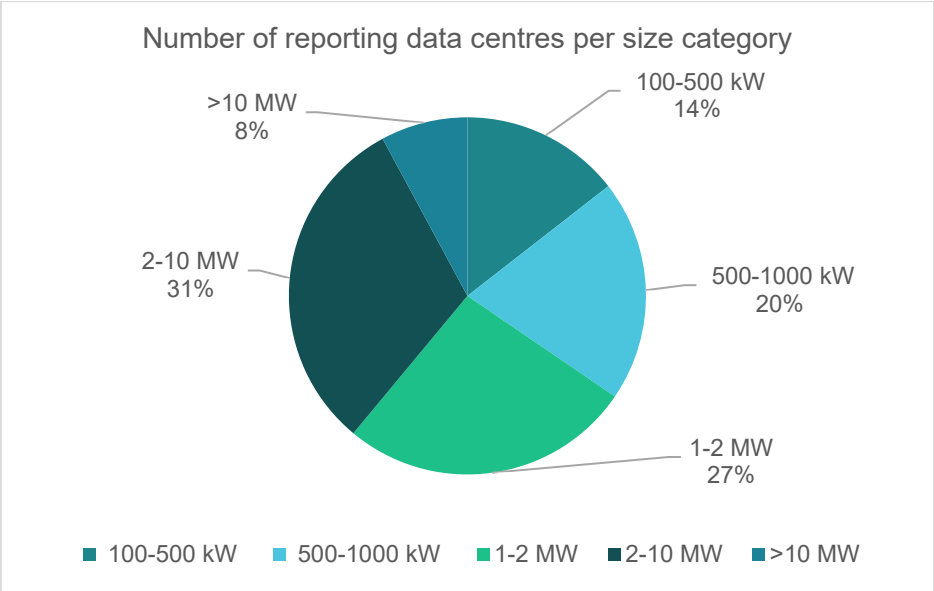
Table 15 - Reporting data centres per size category

Member States	Installed power capacity*					Number of total reporting data centres from the scheme
	Very small data centre (100 - 500 kW)	Small data centre (500 - 1 000 kW)	Medium size data centre (1 - 2 MW)	Large data centre (2 - 10 MW)	Very large data centre (> 10 MW)	
Austria	2	4	2	2	0	11

Belgium	2	4	3	5	1	16
Bulgaria	0	1	1	1	0	3
Croatia	0	1	0	0	0	1
Cyprus	0	0	0	0	0	0
Czechia	0	0	0	0	0	0
Denmark	1	6	2	6	2	17
Estonia**	0	0	0	0	0	0
Finland	1	2	12	8	2	25
France	17	13	22	56	16	133
Germany	57	64	103	75	22	335
Greece	2	2	0	0	0	6
Hungary	0	1	0	0	0	1
Ireland	0	1	3	10	4	18
Italy	1	2	8	8	3	23
Latvia	0	1	0	0	0	1
Lithuania	0	2	1	0	0	3
Luxembourg	0	0	1	0	1	2
Malta	0	1	0	0	0	1
Netherlands	10	16	9	18	1	85
Poland	5	9	10	8	0	36
Portugal	0	1	2	1	0	4
Romania	0	0	0	0	0	0
Slovakia	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0
Spain	3	9	6	17	1	42
Sweden	0	0	0	2	2	7
TOTAL	101	140	185	217	55	770

**: The number of reporting data centres from the scheme across size categories may not sum up to the total reporting data centres as some data centres did not disclose data on their installed power capacity.*
***: Estonia disclosed KPIs for three data centres, but those were not included in the study as they were data ranges rather than absolute numbers.*

Figure 3 - Reporting data centres per size category



From the table and figure above, large data centres (2-10 MW) represent the largest group in terms of size categories, followed by medium (1-2 MW) and small data centres (500-1 000 kW). It should be noted that very small data centres (100 – 500 kW) are technically not obligated to report their data, except in Germany with a 300 kW threshold, although around 100 data centres still participated in the first reporting period.

Even though reporting is mandatory for EU data centres above 500 kW and even lower in Germany, some have not submitted any data due to several factors, some have not submitted data due to several factors:

- **MS reporting:** At the national level, no country was able to supply full information regarding the total number of data centres operating within their respective borders. Additionally, key nations such as Germany (the largest data centre provider in the EU) and the Netherlands failed to submit their data in time, while Ireland struggled to implement the necessary systems for effective data collection. Those three nations alone represent 35.6% of the EU data centre ecosystem.
- **Colocation data centres:** The rationale behind the non-disclosure of data by certain data centres can be attributed to a variety of factors, one of them being data ownership. For instance, many colocation data centres (i.e. accounting for the majority of data centres across the EU) which provide physical space, power and cooling for clients' servers and infrastructure, may not have direct access to the full set of performance data or key performance indicators (KPIs) related to the operations of the servers they house. In these facilities, the clients can retain control over the data generated by their systems. As a result, colocation data centres may not be in a position to disclose certain information, as it is considered proprietary to their clients. This arrangement is typically governed by service-level agreements and confidentiality clauses, which protect the client's data and prevent third-party sharing without explicit consent. Additionally, some data centres may not have access to consolidated data for the entire facility, especially when the clients' infrastructure is highly fragmented or distributed across different providers.
- **Data collection:** Data centres may face challenges in tracking or gathering certain KPIs if the metrics required for the study are not consistently monitored or collected across all tenants. This lack of uniformity in data collection and reporting practices can make it difficult for data centres, particularly those with multiple clients, to aggregate and disclose the information requested.

- **First reporting period:** As the scheme is new, many operators submitted data late or faced technical issues, especially with bulk uploads. Additional submissions may still occur but were not available for this analysis.

This data gap underscores the challenges faced in achieving full transparency across the EU's data centre ecosystem. It is important to note that, despite these challenges, a sample size of approximately 1 in 3 still provides valuable insights into the overall landscape. Given the complexity and scale of the data centre sector, this sample offers a foundation for identifying key trends and patterns within the industry.

As described in the methodology section, the team already contacted national data centre associations or initiatives and authorities from who have not yet submitted any data or with limited reporting for the first reporting period, including through invitations to participate in surveys and interviews. However, only one reply has been received, albeit the data was not integrated into the analysis since only numerical ranges were provided. The survey that has been disseminated as part of the data completeness assessment is included in Annex 2.

Meanwhile, the table below provides insights into the EU average proportion of valid data points reported per KPI. The column labelled “Valid” indicates the percentage of data points that were either non-empty and/or non-zero, depending on whether the KPI in question can legitimately assume a value of zero. For example, while all reporting data centres in the EU successfully provided valid data for their respective year of entry into operation, only approximately 70% submitted valid (i.e. non-empty) data for the average Waste Heat Temperature KPI.

Table 16 – EU average proportion of valid data points per KPI

Types of indicators	Indicators	EU average	
		Valid	Invalid
Data centre details	Data centre type	93.1%	6.9%
	Year of entry into operation of the data centre	100.0%	0.0%
Energy and sustainability indicators	Installed IT power demand	92.3%	7.7%
	Data centre computer room floor area	98.6%	1.4%
	Total energy consumption	96.9%	3.1%
	Total energy consumption from back-up generators	79.2%	20.8%
	Total energy consumption of IT equipment	94.0%	6.0%
	Total water input	90.4%	9.6%
	Waste heat reused	92.1%	7.9%
	Average waste heat temperature	74.5%	25.5%
	Cooling degree days	83.3%	16.7%
	Total renewable energy consumption	92.9%	7.1%
	Total renewable energy consumption from Guarantees of Origin	91.7%	8.3%
	Total renewable energy consumption from Power Purchasing Agreements	84.4%	15.6%
	Total renewable energy consumption from on-site renewables	85.8%	14.2%

The proportion of valid data points per KPI for all EU MSs is included in Annex 1.

In parallel with stakeholder engagement activities, the study team conducted an extensive desk research effort to identify and validate different reporting KPIs. This research was designed to

complement the insights gathered through interviews and surveys and to fill critical data gaps in the dataset.

Through this process, the team identified and extracted some relevant KPIs for many important EU countries in terms of data centre infrastructure. Notably, the following metrics were often readily available and well-documented such as:

- Installed IT power - Different national studies from Mordor Intelligence[17]
- Cooling degree days - Eurostat[18]
- Total energy consumption - Energy Consumption in Data Centres and Broadband Communication Networks in the EU[19]

However, certain KPIs proved much more challenging to locate due to a lack of standardized definitions and inconsistent reporting across Member States. For instance, data for the total data centre computer room floor area was available for only a very limited number of countries, while no relevant information could be found for the remaining KPIs under consideration.

Overall, while this combined approach strengthened the dataset and improved the comprehensiveness of the results, the desk research showed limited results.

iii. Data quality assessment

Apart from the data completeness assessment, a data quality assessment was conducted to verify the plausibility, accuracy and internal consistency of the reported metrics. This step is essential to ensure the reliability of subsequent analyses and interpretations. To obtain relevant values, three different methodologies were applied: indicator comparison, ranges, and ratios.

Indicator comparison

Indicator comparison entails cross-checking certain indicators to identify inconsistencies and maintain data integrity. Any instance where the indicator surpassed the benchmark value was flagged as an outlier, signalling potential errors or inconsistencies in the reported data. Such anomalies may arise from incorrect data entry, making these data points unreliable and requiring further verification. The results are depicted below. There are instances where data centres did not report the full set of KPIs in the first reporting period, thus, the number of data points differs per indicator.

Table 17 - Data quality assessment - Indicator comparison

Indicators	Plausibility check	Data points	Reliable data
Installed IT power demand	Installed IT power demand ≤ Total energy consumption	741	94.9%
Data centre computer room floor area	Data centre computer room floor area ≤ Total floor area	757	99.7%
Total energy consumption	Total energy consumption ≥ Total energy consumption of IT equipment	738	99.7%
Total energy consumption from back-up generators	(Total energy consumption / 5) ≥ Total energy consumption from back-up generators	662	99.3%

[17] Mordor Intelligence. (2024). Belgium data center market. Mordor Intelligence. https://www.mordorintelligence.com/industry-reports/belgium-data-center-market

[18] Eurostat. (2024). Energy efficiency and greenhouse gas emissions in EU households and services – Data and analysis (Report No. 92378) [PDF]. Published by Eurostat. Retrieved June 26, 2025, from https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/92378.pdf

[19] European Commission Joint Research Centre. (2024). Module on energy efficiency in data centers (JRC135926_01). Luxembourg: Publications Office of the European Union. https://interactdc.com/static/images/documents/JRC135926_01.pdf

Total energy consumption of IT equipment	Total energy consumption ≥ Total energy consumption of IT equipment	741	99.7%
Total water input	Total water input ≥ Total potable water input	720	99.8%
Waste heat reused	Total energy consumption ≥ Waste heat reused	719	100.0%
Average waste heat temperature	15 ≤ Average waste heat temperature ≤ 60 degrees	641	100.0%
Total renewable energy consumption	Total energy consumption ≥ Total renewable energy consumption	731	95.9%
Total renewable energy consumption from Guarantees of Origin	Total renewable energy consumption ≥ Total renewable energy consumption from Guarantees of Origin	727	100.0%
Total renewable energy consumption from Power Purchasing Agreements	Total renewable energy consumption ≥ Total renewable energy consumption from Power Purchasing Agreements	671	100.0%
Total renewable energy consumption from on-site renewables	Total renewable energy consumption ≥ Total renewable energy consumption from on-site renewables	673	100.0%

The proportion of reliable data points per KPI for all EU MSs is included in Annex 1.

Ranges

The second filtering process entails assessing the arbitrary ranges of certain indicators, for which reported values were deemed unreliable if they fell outside the expected ranges or if they were not reported altogether. The filtering was done across a total of 770 data centres participating in the first reporting period. Overall, 70.1% of participating data centres are deemed to be reliable, implying that they reported consistent figures across the given metrics. The results of this data quality analysis are presented in the following table:

Table 18 – Sustainability metrics data quality check

Metric	% Reliable	# Potentially unreliable	Explanations for determining values potentially unreliable
Power density	89.6%	80	Predominantly zero or implausibly low values, e.g. 0.0048 kW/m²
Full load hours	76.2%	183	Many entries fall outside expected ranges, typically below 50 or above 8 760 hours
PUE	87.9%	94	Often reported as N/A or with unrealistically high values
WUE	94.7%	43	Often reported as N/A or exceeding realistic limits
Overall result	70.1%	232	Multiple unreliable values may be reported by a single data centre

The presence of values falling outside the expected range raises concerns regarding the accuracy and representativeness of the reported data. These outliers may indicate potential issues such as:

- Measurement errors: inaccurate power consumption or miscalculated facility metrics.
- Data entry errors: mistakes occurring during data input or reporting.
- Misinterpretation of units: incorrect conversion or application of measurement units.
- Unusual operational scenarios: While rare, extreme cases may exist but require further investigation to confirm validity.
- Limitation of the C_{serv}: the metric may have been too vague and could not capture the performance of GPU-based servers (see Chapter 3.3 for the suggestion for improvement).

Addressing these inconsistencies through further validation and stakeholder engagement is essential to improving the reliability of the dataset and ensuring a more accurate representation of energy usage within the EU data centre ecosystem.

Ratios

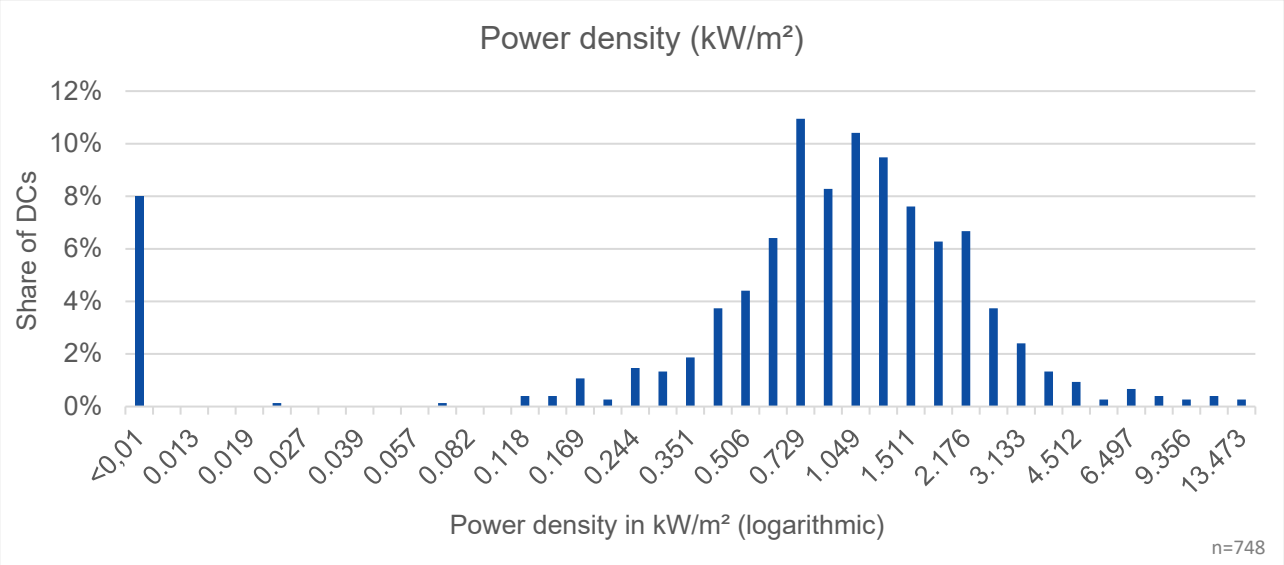
Finally, while not all KPIs quality could reliably be tested in the cited manners, ratios could be used to test the quality of data as well. The following example shows that ratios such as power density can be used to test the quality of new indicators (i.e. total computer floor area).

The figure below depicts the distribution of power density (kW/m²) across a sample of data centers. A realistic range for power density in data centers is generally considered to be between 0.02 kW/m² and 200 kW/m². This range accounts for variations in design, IT hardware, and utilization rates. Power density in a data centre is calculated as:

$$Power\ density = \frac{\text{ITPOWERDEMANDINSTALLED}}{\text{TOTALCOMPUTERROOMFLOORAREA}}$$

The histogram reveals a significant number of data points falling outside the established realistic range. Notably, a substantial portion of the data centers report power densities below 0.02 kW/m², as indicated by the prominent yellow bar.

Figure 4 - Power density of data centres from the reporting scheme

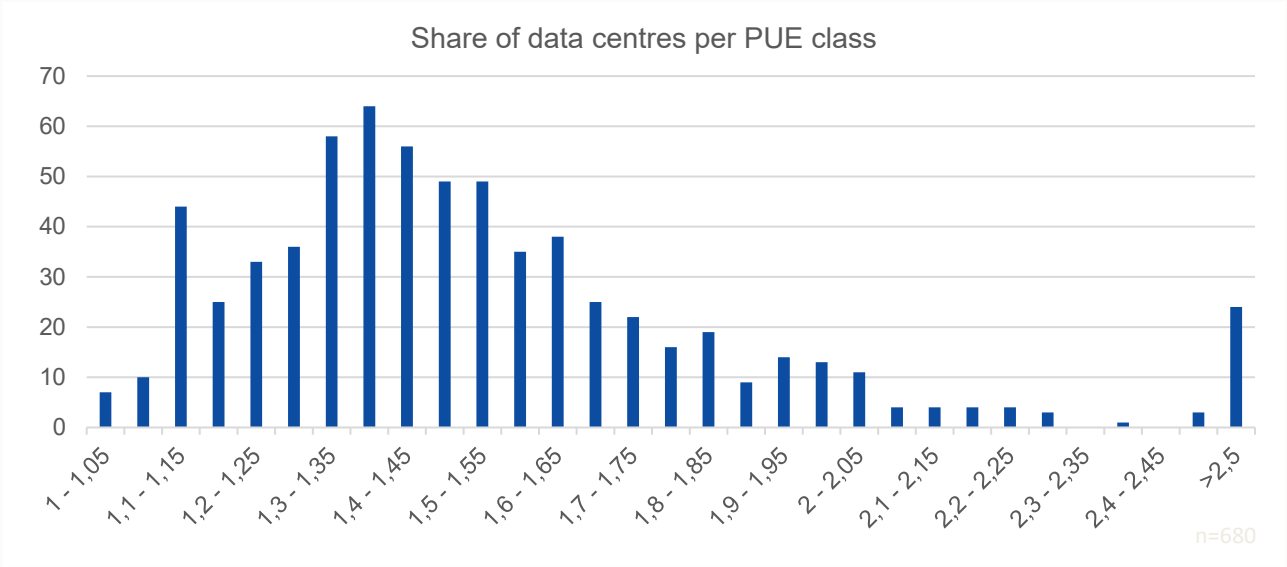


Hence, the data quality, as illustrated by the histogram and the presence of values outside the realistic range (0.02 - 200 kW/m²), is not fully satisfactory. These deviations indicate that the data may not accurately represent the true power density distribution in data centers. As a result, any analysis or conclusions derived from this dataset should be approached with caution. Outliers should be excluded from the study to ensure more reliable findings.

The PUE value represents another ratio, which can be considered as an indicator for data quality. Already at the indicator comparison, it is assured that IT energy consumption cannot be higher than total energy consumption of the data centre (which would be a PUE < 1).

In terms of PUE, the majority of data centres are concentrated in the 1.1 to 2.0 range (see **Error! Reference source not found.**), although it cannot be ruled out that data centres may be above or below this in individual cases. However, values below 1.05 and values above 2.50 need to be reviewed as they may not be plausible.

Figure 5 - Distribution of PUE of data centres from the reporting scheme



Some extreme cases in the data can be explained by the fact that the data centre was only in operation for a few months. Here, the building infrastructure such as cooling (e.g. for a test run) was presumably already started up and/or the batteries of the UPS were charged while there was still no or only a minimal amount of IT in the data centre. This can therefore be explained by further cross-comparisons, which is why such data can be recognised as plausible despite their extreme values, outside of the expected ranges. If such explanations are not possible from the wider context in the case of extreme values, the data must be critically reviewed and filtered out if necessary.

In conclusion, while preliminary figures were obtained regarding data quality with different methods, further analysis is required to obtain relevant values for the remaining indicators. A proposal for plausibility checks of the data when operators enter it into the EU database is currently in preparation and will be presented in the second technical report. With the help of such a plausibility check, warnings can be displayed to the operator as soon as the data is entered if the individual indicators or their relationship to other indicators are outside a certain range.

b. Task 1.2 - Energy efficiency and sustainability of European data centres

The assessment of data centre energy efficiency and sustainability in the EU is based on key performance indicators (KPIs) identified under Task 1.2 according to the Annex III of the Commission Delegated Regulation (EU) 2024/1364.[20] These include Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE), Energy Reuse Factor (ERF) and Renewable Energy Factor (REF), which are derived from the data reported under Task 1.1.

These metrics are computed using the reported data in order to draw conclusions on the energy efficiency and sustainability of the data centre sector in the EU. The outputs were benchmarked with industry thresholds for the given metrics, while accounting for other factors that may influence energy efficiency and sustainability and the interdependencies between the metrics.

Recognising the interdependencies between indicators, the analysis takes a holistic approach, considering factors like cooling systems, water sources and regional energy demands. To provide a nuanced view, the results are also be disaggregated by Member State and data centre size.

[20] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401364

It should be noted that all reported data is considered for the aggregated analysis at the EU-level. However, in line with Annex IV of the Delegated Regulation (EU) 2024/1364, when presenting the data per Member State, type of data centre and size category, the data is not shown when there are fewer than three reporting data centres. Furthermore, following Annex IV, the aggregation of energy efficiency and sustainability metrics is done with a weighted method, with total energy consumption as the weighting factor. All quantitative results are also presented in tables in Annexes 3 and 4.

The findings will inform policymakers and industry stakeholders on the sector's impact on Europe's energy and water systems, highlighting potential risks and opportunities for improving sustainability.

Other relevant results from the analysis are shown in Annexes 4 and 5 containing other available information in the European database on data centres in accordance with Annex IV of Delegated Regulation (EU) 2024/1364.

- **Power Usage Effectiveness (PUE):** ratio of total energy consumption to total energy consumption of IT equipment.

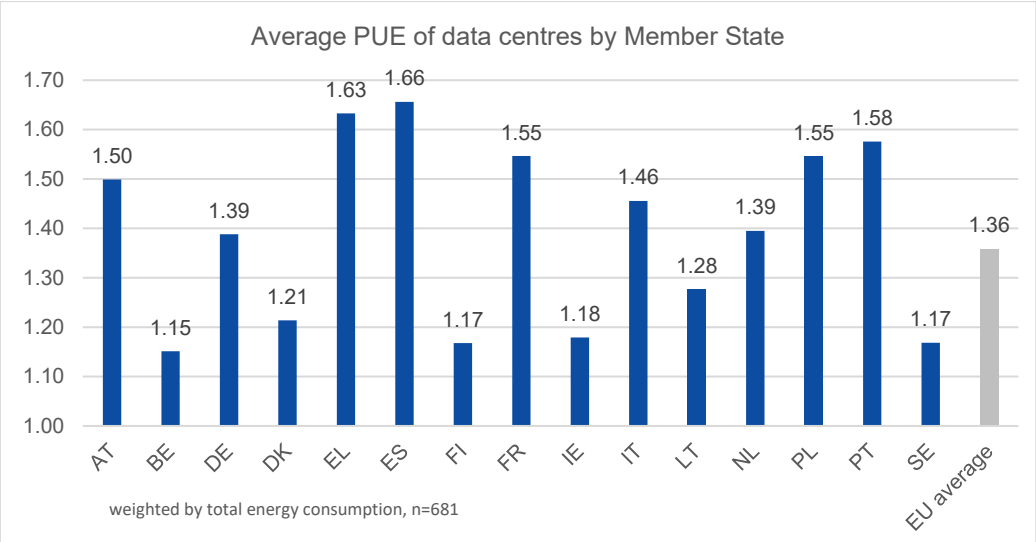
$$PUE = E_{DC}/E_{IT}$$

PUE is defined as the ratio of total facility energy consumption to the energy consumed by the IT equipment. Therefore, it represents the amount of energy (for cooling, power conversion, lighting, etc.) required to support the servers, storage and networking gear. PUE values typically range from about 1.0 (the theoretical ideal, in which every watt goes to IT equipment) up to around 2.0 in less efficient facilities. A lower PUE indicates better energy efficiency, while in practice, values below 1.2 are considered excellent, 1.2–1.5 good and anything above 1.5 reveals room for improvement. Values can vary between the years because of internal factors (e.g. optimisation/utilisation) and external factors (weather conditions).

The following diagram shows the average PUE of data centres across EU Member States, with the EU average as reference. In several Member States, fewer than three data centres reported their data, which may result in figures that are not representative. There is a high variability across Member States, with a lack of emerging pattern. However, in comparison with the PUE target of the Climate Neutral Data Centre Pact (CNDCP) of 1.3 for new data centres by 2030 in cool climates and 1.4 in warmer regions,[21] data centres from several Member States, such as Austria, France, Greece, Poland and Spain, are still markedly far from the target, according to the available data.

Figure 6 - Average PUE of data centres from the reporting scheme by Member State

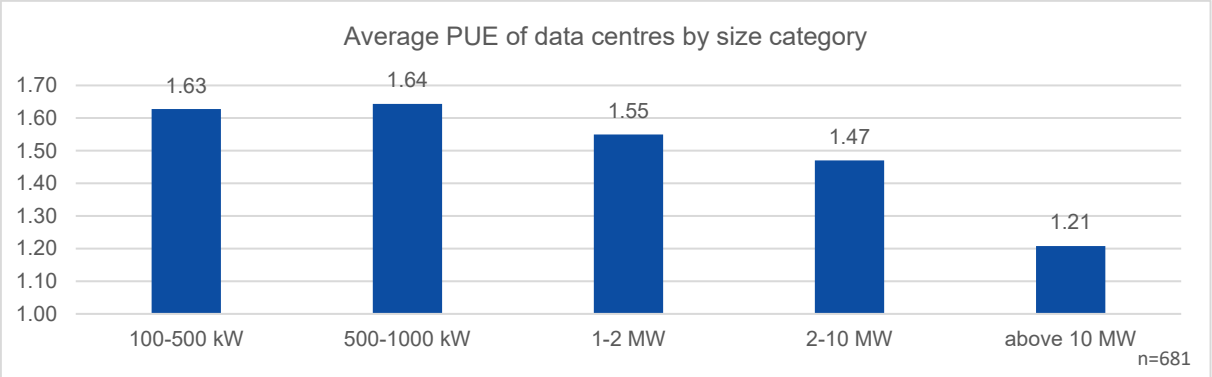
[21] Climate Neutral Data Centre Pact, *Working groups*. Available at: https://www.climateneutraldatacentre.net/working-groups/



The EU average PUE was further validated during the interactive session of the second workshop, in which stakeholders were asked for their expectations regarding the PUE averages—whether they should be higher, lower or remain the same. Over half of the participants agreed that the reported PUE averages were already within the range of their expectations, while 34% were in the opinion that the averages could be lower.

Lastly, the weighted PUE average is also shown by size of data centres as in the diagram below. It can be observed that as data centres increase in size, their energy efficiency generally improves, with the smallest facilities that are forced to report data (500-1 000 kW) having the highest PUE and those above 10 MW performing the best. This trend is the result of several factors, above all large data centres are often younger, more professionally managed and benefit from economies of scale in terms of efficiency.[22] Below the reporting threshold of 500 kW, the data is probably biased by the fact that voluntary reporting is done by more ambitious data centres. This trend usually continues until scale-related challenges set in for larger data centres.

Figure 7 - Average PUE of data centres from the reporting scheme by size category



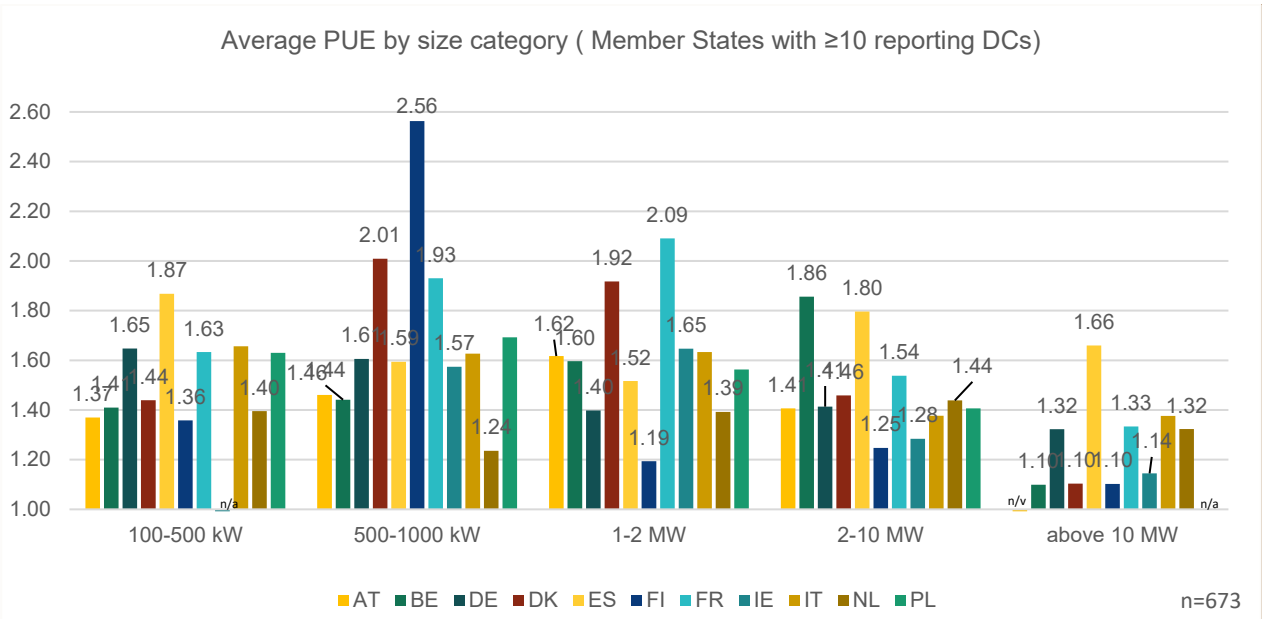
Efficiency is largely dictated by factors such as facility age, design and climate. Older buildings and poor insulation/roof albedo raise cooling loads, while cooler regions exploit free cooling and warmer ones depend on energy-hungry chillers, creating seasonal PUE swings. Under-utilisation of the infrastructure wastes power, whereas airflow optimisation, higher setpoint temperatures, modern chillers and routine maintenance restrain it.

[22] Uptime Institute, *Large data centers are mostly more efficient, analysis confirms*, 2024. Available at: https://journal.uptimeinstitute.com/large-data-centers-are-mostly-more-efficient-analysis-confirms/

Data indicates that as PUE increases, the number of centres falls, indicating that only a small cohort, mostly smaller facilities, operates at low efficiency. A few new or very large facilities reach PUE around 1.1, while values near 2.9 are rare. The smallest facilities that were required by the EED to report their data (500-1000 kW) have the highest PUE of 1.64, meaning they use energy less efficiently. The category below (100-500 kW), which contains mandatory data from the German Energieeffizienzgesetz (starting at 300 kW) and might be biased by voluntary reporters, that are more ambitious, or have on average a smaller redundancy, which reduces the overhead energy for cooling and uninterruptable power supply. The above 10 MW category performs the best, with the lowest PUE of 1.21.

For EU Member States with at least 10 reporting data centres, the average PUE per size class is presented in the figure below. This represents data from 673 data centres and thus more than 95% of the total reporting data centres. For some categories, the number of reporting data centres is very low (e.g. from Finland only two data centres in the range 500-1 000 kW reported) which can lead to some extreme figures (like the PUE of 2.56).

Figure 8 - Average PUE by size category of data centres in Member States with 10 or more reporting data centres



The overall trend looks similar: larger data centres are performing better (on average) compared to smaller ones. In many countries, the 100-500 kW category performs better compared to the 500-1 000 kW category. Again, this can be explained by the fact that those who have reported without being forced to do so probably have somewhat more ambitious sustainability requirements of their own accord.

It should be noted that in some MSs, there are only three or fewer reporting data centres per size category, which shall be taken as a disclaimer when presenting the figure. The table below presents the number of reporting data centre per MS by size category (only if reported on both: total energy use and IT energy use).

Table 19 – Average PUE – Number of reporting data centres per Member State by size category (only if reported on both: total energy use and IT energy use)

Member States	100 - 500 kW	500 - 1 000 kW	1 - 2 MW	2 - 10 MW	>10 MW	Total
Austria	2	4	2	2	0	10
Belgium	2	4	3	5	1	15
Bulgaria	0	1	1	1	0	3

Croatia	0	1	0	0	0	1
Denmark	1	6	2	6	2	17
Finland	1	2	12	8	2	25
France	17	13	22	56	16	124
Germany	57	64	103	75	21	319
Greece	2	2	0	0	0	4
Hungary	0	1	0	0	0	1
Ireland	0	1	3	10	4	18
Italy	1	2	8	8	3	22
Latvia	0	1	0	0	0	1
Lithuania	0	2	1	0	0	3
Luxembourg	0	0	1	0	0	1
Malta	0	1	0	0	0	1
Netherlands	10	16	9	18	1	54
Poland	5	9	10	8	0	32
Portugal	0	1	2	1	0	4
Spain	3	9	6	17	1	36
Sweden	0	0	0	2	2	4
Total	101	140	185	215	50	691

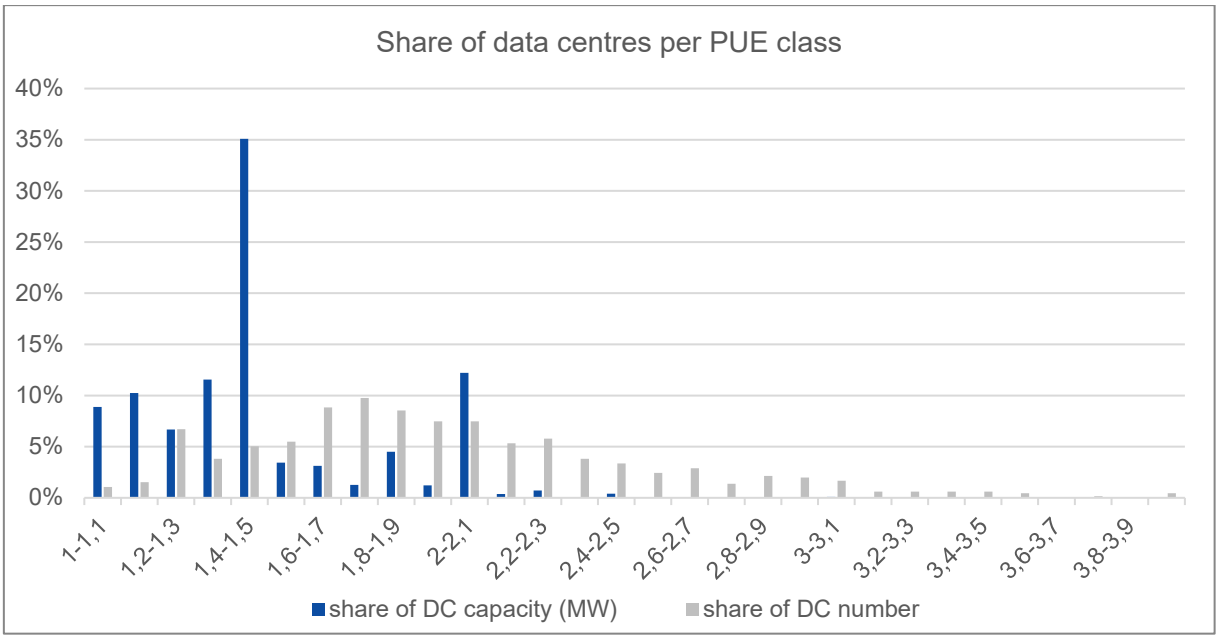
Indeed**, facility age and design** influence efficiency, with older infrastructures consuming more energy than modern, optimised layouts. **Building materials and insulation** affect cooling needs, while **local climate conditions** play a key role—cooler regions benefit from free cooling, whereas warmer climates require more energy-intensive systems due to the extra amount of energy needed predominantly for the cooling process. **Weather variability** can also cause seasonal PUE fluctuations. **IT equipment utilisation** is crucial, as underutilised servers waste energy, while **effective energy management** (i.e. airflow optimization and regular maintenance) helps maintain efficiency.[23]

In short, the data confirms what industry experts often observe—bigger data centres tend to be more energy-efficient, but once they reach a certain scale, other challenges may start to impact performance.

The following graph provides a clear picture of the energy efficiency distribution among data centres in the EU, measured by PUE.

Figure 9 - Share of data centres per PUE class

[23] https://www.flexential.com/resources/blog/power-usage-effectiveness-explained



Looking at all data centres, neglecting their size/capacity (grey bars), the most common efficiency level falls within the 1.6 to 1.9 range, as indicated by the tallest bars. This suggests that the majority of data centres operate at this efficiency level, making it the standard across the industry. Looking at the distribution, we see that data centres are concentrated in the mid-range PUE values (approximately 1.5 to 2.3). There are much fewer, but bigger facilities at the highly efficient values.

A noticeable trend emerges as PUE increases, the number of data centres decreases. This suggests that fewer and mostly smaller facilities operate at lower efficiency levels, reinforcing the idea that most data centres maintain moderate energy performance rather than being outliers at either end of the spectrum.

The highest-performing data centres, those with PUE values near 1.1, represent the most energy-efficient facilities. Their small number indicates that achieving such high efficiency remains a challenge which only large or very new data centres met. Conversely, the least efficient data centres, with PUE values closer to 2.9, are relatively rare, indicating that extremely poor energy performance is not widespread.

Overall, this graph offers valuable insights into the energy efficiency landscape of data centres in the EU. While most facilities operate within a reasonable efficiency range, the data highlights opportunities for further optimization and industry-wide improvements in sustainability. This distribution underscores the importance of continued improvements in energy efficiency, particularly in alignment with initiatives like the Climate Neutral Data Centre Pact (CNDCP), which sets a PUE target of 1.3 for new data centres by 2030 in cool climates and 1.4 in warmer regions.[24] While many data centres still operate above this threshold, industry-wide efforts toward optimisation and sustainability will be crucial in meeting these ambitious targets. Hence, further optimisation and investment will therefore be critical to meet these goals. In comparison, the global PUE average in 2023 remained relatively unchanged across the years with 1.58,[25] while the US reported a national average of 1.4 in 2023, reflecting an improving trend across the

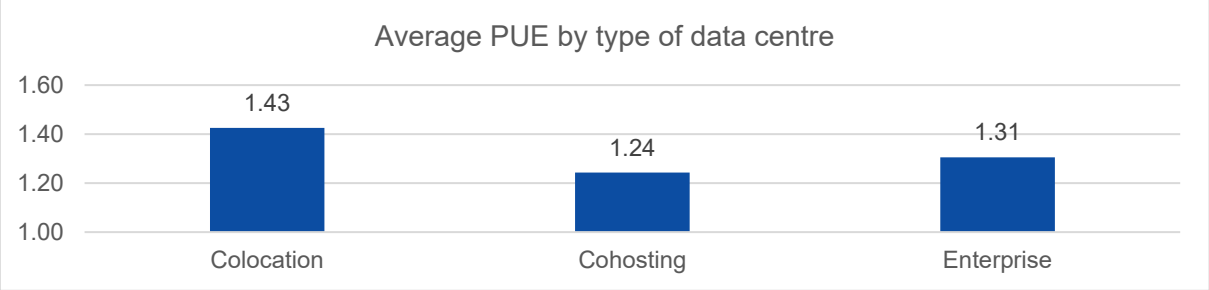
[24] https://www.procurri.com/2023/07/27/europes-climate-neutral-pact/
[25] Uptime Institute, Global PUEs: Are They Going Anywhere? 2023, https://journal.uptimeinstitute.com/global-pues-are-they-going-anywhere/

years.[26] Lastly, the Chinese government is targeting an average PUE of lower than 1.5 by the end of 2025.[27]

The next diagram shows the average PUE per type of data centre. While in the reported data, the operators could choose multiple operator models, here only the data is used for operators that chose only a single type:

- Colocation represents data centres that are reported solely as either "COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE" or "COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES" or a combination of those two.
- Co-Hosting represents data centres that are reported solely as either "CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE" or "CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES" or a combination of those two.
- Enterprise reperesents data centres that are reported solely as either "ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE" or "ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES" or a combination of those two.

Figure 10 - Average PUE from the reporting scheme by type of data centre



It is immediately apparent that co-hosting and enterprise data centres perform better than colocation data centres (on average). One of the reasons for this may be that operators of colocation data centres have no control over IT capacity utilisation and presumably often must maintain excess capacity for contractual reasons. In addition, existing colocation data centres have the problem that their central systems (cooling, power supply) are designed for the customer with the highest requirements, and this is often difficult to change at a later date due to long-term service level agreements (SLAs). This can lead to other IT that could be operated at higher temperatures or has low redundancy requirements being supplied with lower temperatures and possibly higher redundancy.

To sum up the PUE analysis, the interplay between PUE and other energy efficiency and sustainability metrics must be considered, in which these metrics should be perceived in a holistic way to measure the overall performance of data centres. As mentioned above, PUE itself depends on various factors, including the type of cooling and water and power consumption. Although PUE can already serve as a simplistic yet measurable metric for energy efficiency, improving the PUE could make other indicators worse off. For instance, if the improvement is achieved through shifting the cooling method to a more water-intensive one, this can worsen the Water Usage Effectiveness (WUE). Moreover, with respect to the Renewable Energy Factor (REF), high energy efficiency (thus, low PUE) would not guarantee a high REF if the energy source is not renewable.

[26] Lawrence Berkeley National Laboratory, United States Data Center Energy Usage Report, December 2024, https://eta-publications.lbl.gov/sites/default/files/2024-12/lbnl-2024-united-states-data-center-energy-usage-report.pdf

[27] The State Council of the People's Republic of China, China's Government Reports on Digital Infrastructure, 24 July 2024, https://english.www.gov.cn/news/202407/24/content_WS66a0b167c6d0868f4e8e96ba.html

Hence, the two metrics should be seen as complementary. Similarly, PUE is also not directly correlated with the Energy Reuse Factor (ERF), in which a data centre may have high energy efficiency but low ERF if the waste energy is not being reused. Nevertheless, PUE may still indirectly affect ERF through the selection of cooling techniques, which may be more energy efficient but less effective in dissipating waste heat to be reused.

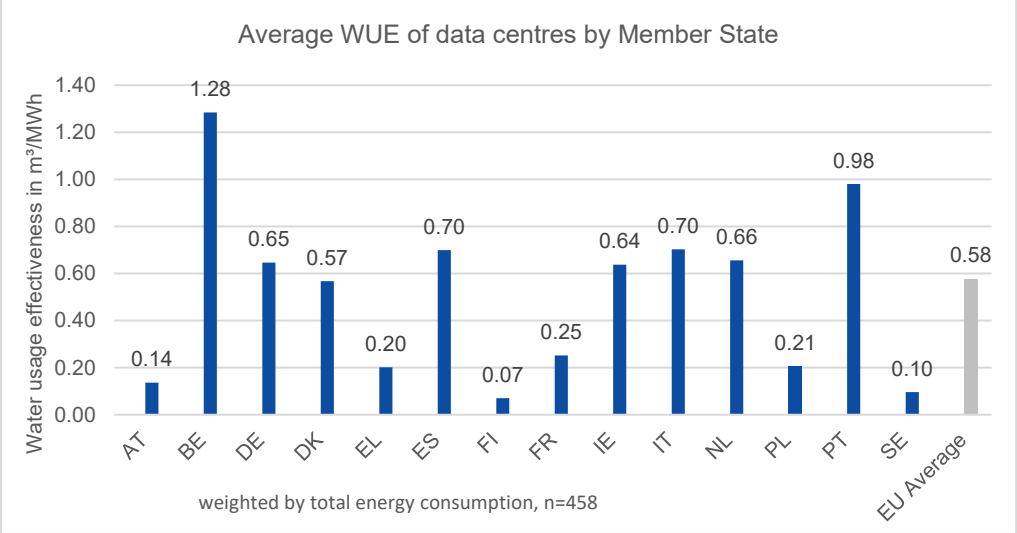
- **Water Usage Effectiveness (WUE):** ratio of total water input to total energy consumption of IT equipment.

$$WUE = W_{IN}/E_{IT}$$

WUE measures how efficiently a data centre uses water, expressed in litres per kilowatt-hour of IT equipment energy consumption (l/kWh). A lower WUE indicates higher water efficiency, meaning less water is used for the same level of computing power. Data centre water consumption depends primarily on the cooling technology employed: facilities that use water-based or evaporative systems consume significant water, whereas those relying on air-side or liquid-direct cooling can operate with little or no water.

However, there are relatively fewer data points to compute WUE since only those who reported numbers other than 0 for their total water consumption or IT energy consumption are considered. This results in only 458 data centres that can be considered. The following figure presents the average WUE of data centres across Member States. WUE measures how efficiently a data centre uses water, expressed in cubic metre per megawatt-hour of IT equipment energy consumption (m³/MWh).[28]

Figure 11 - Average WUE of data centres from the reporting scheme by Member State



In parallel, there is high variability across Member States. For a few Member States, such as Belgium, the WUE is dominated by inputs from only a few large operators with single facilities, thus, requiring higher water input. Indirect water consumption (e.g. by power plants for electricity generation) is not considered, as only water usage categories 1 and 2 according to EN 50600-4-9 are reported.[29]

The EU average above was presented during the interactive session of the second workshop, in which stakeholders were asked their expectations—whether it should be higher, lower or similar. The feedback was generally positive, though slightly less so than for PUE. Half of the participants

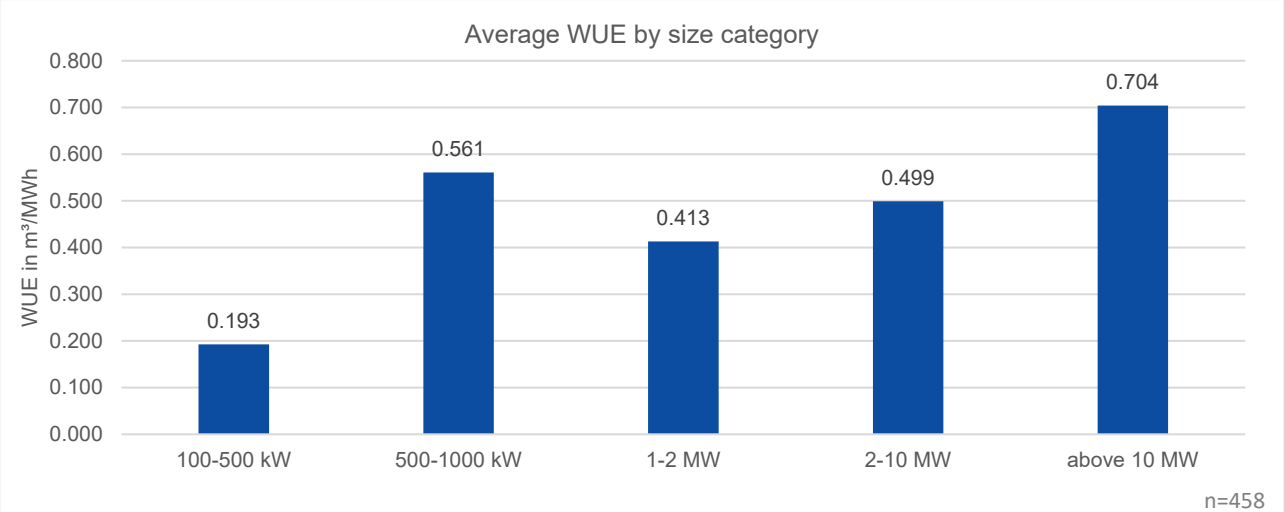
[28] m³/MWh can be replaced with L/kWh, but this report uses units in line with EN 506400-4.

[29] Category 1 of water usage includes potable water directly consumed by data centres, while category 2 covers non-potable water similarly used for operational purposes. Indirect water consumption is excluded from these categories.

agreed that the WUE average is within a realistic range, while 28% believed it should be lower and 22% felt it should be higher.

The figure below shows the average WUE values per size category of the data centres.

Figure 12 - Average WUE of data centres from the reporting scheme by size category



The data is segmented into five size categories, ranging from small data centres (100-500 kW) to the largest facilities (over 10 MW). The trends observed in the graph reveal a complex relationship between size and water efficiency. Smaller data centres (100-500 kW) demonstrate relatively low WUE values, which can easily be explained by the fact that evaporative cooling is not common in such small installation types. However, the next category (500-1 000 kW) experiences a significant increase in WUE, indicating higher water consumption. Interestingly, this trend reverses in the 1-2 MW range, where WUE decreases, reflecting improved water efficiency. Yet, as data centres grow beyond this range (2-10 MW and over 10 MW), WUE rises again, though not as sharply as in the smaller size brackets.

This variability highlights the challenges in optimising water efficiency across different facility sizes. In line with sustainability initiatives like the Climate Neutral Data Centre Pact (CNDCP), which sets a target of 0.4 L/kWh WUE by 2040,[30] improving water efficiency remains a key priority for the industry. Achieving responsible water management will be essential in meeting long-term sustainability commitments and ensuring efficient resource use across data centres of all sizes.

It is important to note that the graph only reflects data from facilities that reported their water usage. While this provides valuable insights into overall trends, it may not represent the full landscape of data centre water consumption across the EU.

Although Water Usage Effectiveness (WUE) is a useful efficiency metric, the number alone does not completely reflect the true environmental impact of water use. For example, it does not account for the source of the water, such as whether it is potable, recycled or rainwater, or the local water scarcity, both of which significantly affect sustainability. Other factors to be considered include the climatic differences (i.e. warmer climates would require higher water consumption for cooling), geographical dependencies (i.e. water-scarce regions or significant distance to water sources would encourage the adoption of water-efficient technologies) and technologies available for each data centre. Therefore, to understand a facility's water impact, context beyond the WUE number is required, including the source of the water, its location and operational choices.

[30] https://www.procurri.com/2023/07/27/europes-climate-neutral-pact/

Additionally, the interplay between WUE and other energy efficiency and sustainability metrics must be discussed to provide a holistic analysis. For example, as noted with PUE, data centres looking to improve their energy efficiency may consume more water if they switch to a more water-intensive cooling system, thus, worsening WUE. While the Renewable Energy Factor (REF) and Energy Reuse Factor (ERF) do not directly influence water consumption, REF could indirectly influence WUE through the type of renewable energy sources, which may differ in water intensity (e.g. hydropower). Conversely, WUE could indirectly affect ERF if the cooling techniques used are less water-intensive (thus, better WUE) but less effective in heat dissipation, thereby limiting the quantity and quality of waste heat available for reuse.

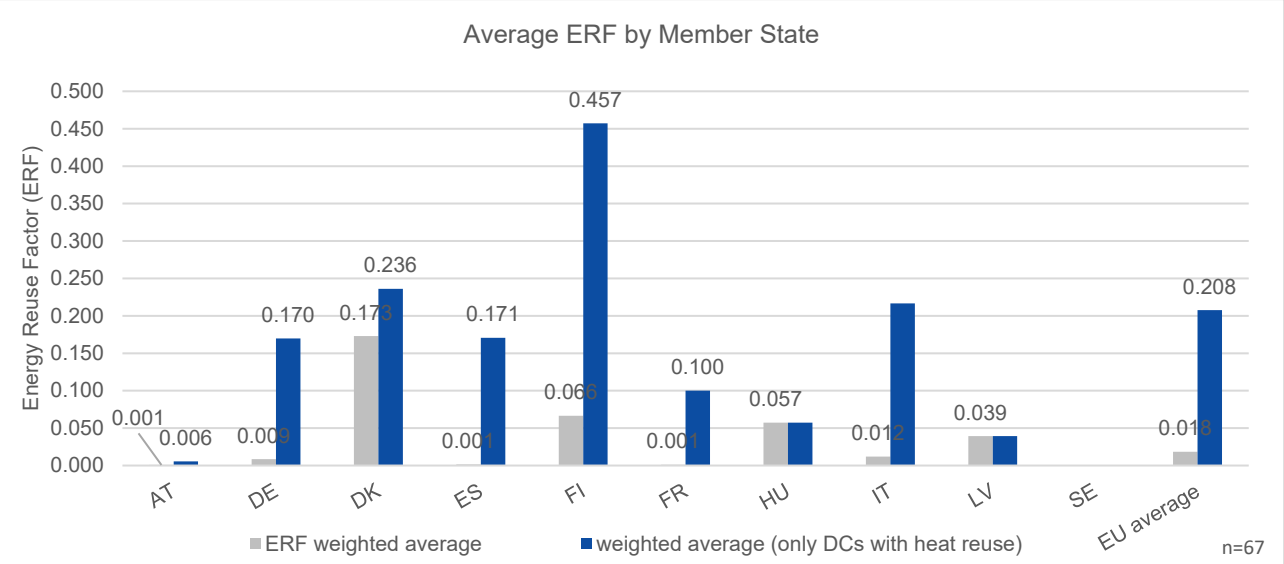
- **Energy Reuse Factor (ERF):** ratio of waste heat reuse to total energy consumption.

$$ERF = E_{REUSE}/E_{DC}$$

ERF can evaluate the energy efficiency of data centres by measuring how much energy (waste heat) can be reused for other purposes. It is typically expressed as a ratio between 0 and 1, where an ERF of 1 implies that all energy consumed by the data centre is being reused – although this is unrealistic due to energy losses or inefficiencies during the heat release or transport – while an ERF of 0 denotes that no energy is being reused. The analysis focuses on waste heat from data centres. Even in regions with high heating demand, the seasonality of heat demand remains a major barrier for high heat reuse rates.

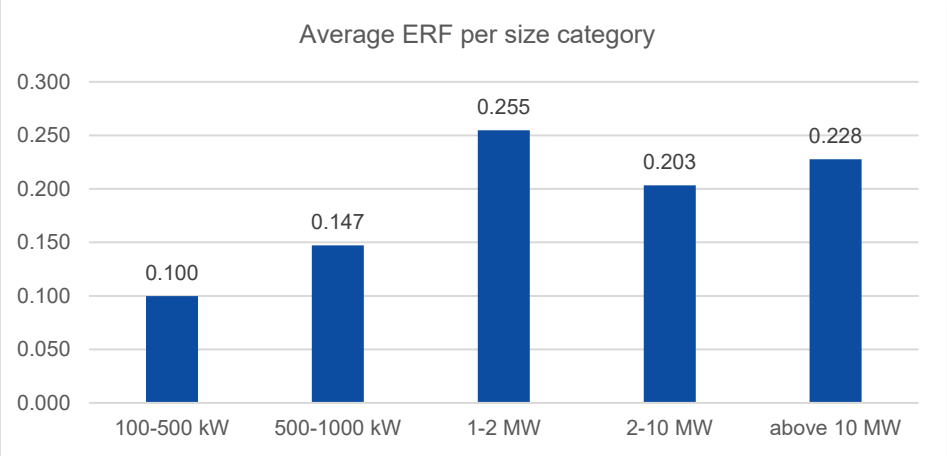
Unlike PUE and WUE, an ERF other than 0 can be calculated from the data of the first reporting period only for 67 data centres. Other data centres did not report a meaningful value or reported 0, which means they are not reusing their heat (ERF=0). For this reason, both the national ERF in relation to all data centres (grey) and the ERF only for the respective reporting data centres (yellow) are shown here. From the reported data, some computed values seem unrealistically high, although these could not be fully falsified. Moreover, although there are known heat reuse projects in some Member States, those same Member States have not reported any data centres on heat reuse, which shows that the figures below may not be representative of the full landscape of data centre heat reuse in the EU. In the available (reported) data, around 1.9% of all heat generated in data centres (theoretically based on the total energy consumption), is reused in the EU (which would mean an ERF of 0.019); if the reused energy is only divided by the energy consumption of those data centres which reuse the heat, the value is 23.5% (ERF of 0.235).

Figure 13 - Average ERF of data centres from the reporting scheme by Member State



Meanwhile, when presenting the average ERF by size of data centres, although the data points are similarly limited, it can be observed that data centres in the 1-2 and 2-10 MW categories have the highest ERF figures, while for smaller data centres, heat reutilisation was often not economically feasible in the past, thus, contributing to the lower ratio. Meanwhile, for the largest data centres (above 10 MW), it can be assumed that only small parts of the huge amount of waste heat are being reused. This could be explained at the fact, that there often are not many local offtakers which can take such enormous amounts of heat constantly.

Figure 14 - Average ERF of data centres from the reporting scheme by size category



Nevertheless, there is no particular industry threshold for ERF. One example is the German Energy Efficiency Act (EnEfG) of November 2023, which mandates new data centres over 300 kW to achieve a certain heat reutilisation ratio of: 0.1 for data centres that become operational after July 1st 2026, 0.15 for data centres that become operational after July 1st 2027 and 0.2 for data centres that become operational after July 1st 2028 (latest after two years of operation).[31] However, the demand side plays a very significant role in waste heat reuse, as data centres, once the infrastructure is set up, would want to release as much of the waste heat as possible because it is a waste product from their perspective. Therefore, targets should be designed with consideration for the heating demand from heat offtakers as well as the climatic and seasonal variations throughout the year. Moreover, special attention should be given to data centres in warmer climate zones, where the demand for heat reuse is practically non-existent. From the reported data, albeit limited, Nordic countries including Denmark and Finland have performed considerably well, while Italy and Spain, despite the warmer climates, have achieved satisfactory figures.

Finally, when discussing the interplay between ERF and other energy efficiency and sustainability metrics, it should be noted that ERF may not have direct influence. In a way, these metrics should be seen together to provide a holistic analysis as a high ERF does not necessarily translate to high energy or water efficiency. As mentioned for PUE and WUE, there may be an indirect correlation from the selection of cooling techniques, which may be more energy or water efficient but less effective in dissipating waste heat to be reused, thus affecting ERF. Correspondingly, ERF does not have a direct correlation with the Renewable Energy Factor (REF) either, for which the two metrics shall be seen as complementary in assessing the sustainability of data centres.

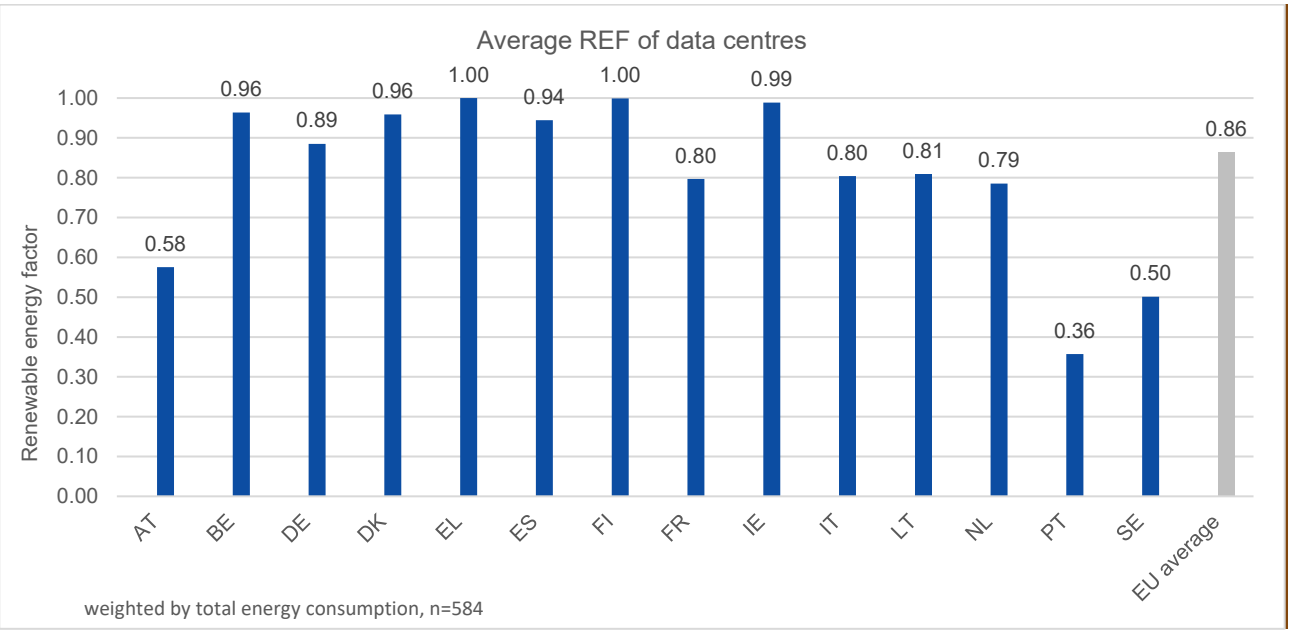
- **Renewable Energy Factor (REF):** ratio of total renewable energy consumption to total energy consumption.

$$REF = E_{RES-TOT}/E_{DC}$$

[31]Federal Republic of Germany, Energieeffizienzgesetz (EnEfG), Bundesgesetzblatt Jahrgang 2023 Teil I Nr. 309, 18 September 2023, https://www.gesetze-im-internet.de/enefg/BJNR1350B0023.html

REF assesses the proportion of energy consumption of a data centre from renewable sources. It is expressed as a ratio or percentage, in which a REF of 1.0 indicates that all energy consumption comes from renewable sources. Figure 15 Figure 15 presents the average REF of data centres across the EU. Many Member States achieve remarkably very high REF in data centres, with an EU-wide weighted average of 0.87, which is almost twice as high as the 45.3 % of the renewable power in gross electricity consumption in the EU.[32]

Figure 15 - Average REF of data centres from the reporting scheme by Member State

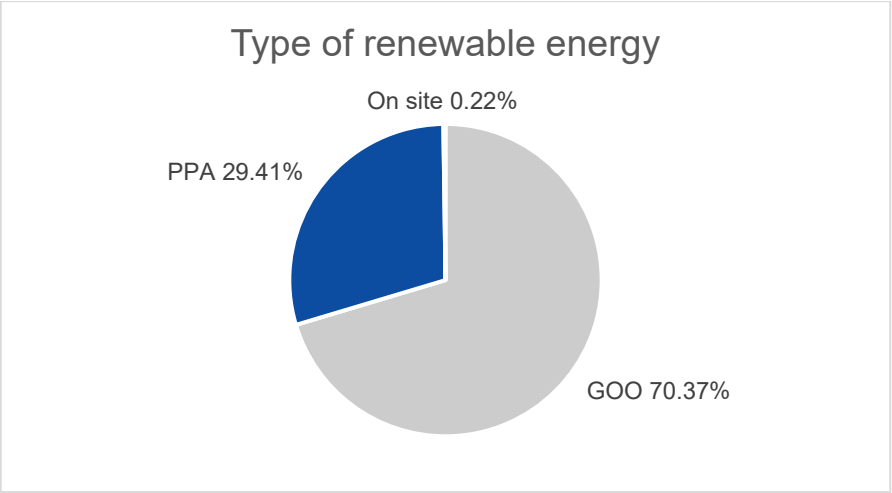


When presenting the outputs by the size of data centres, there is a linear trend with larger data centres achieving higher REF, which in turns leads to the overall high ratio above in the weighted average.

Regarding the types of renewable energy generation, around two thirds of the renewable energy comes from guarantees of origin (GOO), just under a third from green power purchase agreements (PPA) and only a very small proportion of less than one per cent from on-site generation (OS).Figure 16

Figure 16 - Shares of renewable energy types

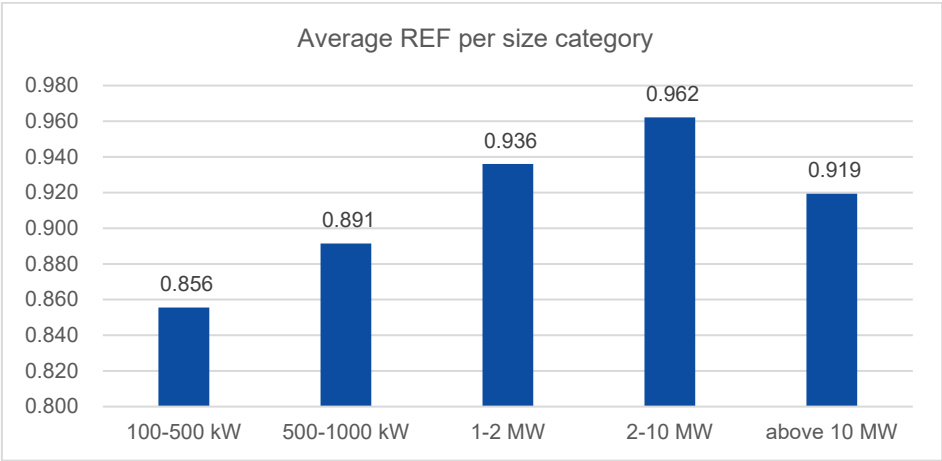
[32] https://ec.europa.eu/eurostat/de/web/products-eurostat-news/w/ddn-20250221-3



As guarantees of origin were more and more criticised in recent years[33], there is room to improve the supply of data centres with renewable energy. Green PPAs have a more direct impact on new installations of renewable production plants. On-site renewable production brings the power production closer to the consumer which is positive in terms of power transportation (and losses) in the power grid but also reduces the land consumption. A further step regarding system wide decarbonisation of the power sector can be achieved with hourly matching of green power production and consumption.[34]

When presenting REF by the size of data centres, there is a trend with larger data centres are being supplied by slightly higher shares of renewable energy, which in turns leads to the overall high ratio above in the weighted average.

Figure 17 - Average REF from the reporting scheme by size of data centres



The outputs above confirm that data centre owners/operators are already leaders in renewable energy sourcing. This echoes the commitments from large cloud operators which have already matched 100% of their electricity consumption in their data centres with renewable energy on an annual basis or are almost there. In parallel, signatories of the CNDCP have similarly committed

[33] E.g. https://industrydecarbonization.com/news/the-trouble-with-european-green-electricity-certificates.html, https://www.researchgate.net/publication/338174749_Is_guarantee_of_origin_really_an_effective_energy_policy_tool_in_Europe_A_critical_approach

[34] https://www.sciencedirect.com/science/article/pii/S2211467X24001950

to matching their electricity consumption with 75% renewable energy or hourly carbon-free energy by the end of 2025, and 100% by the end of 2030, under the Self-Regulatory Initiative.[35]

Finally, in relation to other energy efficiency and sustainability metrics, REF does not directly influence other metrics. When looking at WUE, the type of renewable energy sources may indirectly affect WUE, especially when hydropower is sourced. Furthermore, with respect to PUE and ERF, the relationships are seen more as complementary as high energy efficiency or high energy reuse ratio may not guarantee a high REF as they do not account for the source of energy. Hence, these metrics should be considered collectively to provide a comprehensive view of the sector's sustainability.

c. Task 1.3 - Reporting scheme user experience and data management assessment

i. Information and indicators used in the reporting scheme

This assessment entails evaluating the information and indicators used in the reporting scheme based on their relevance, comprehensiveness, reliability and accuracy and other criteria when relevant.

The data centre sector across the EU has witnessed significant growth, shaped by rising digitalisation, higher densities, and advances in equipment efficiency. To assess the effectiveness of the current reporting scheme, its design and implementation must be evaluated against four key criteria: **relevance, comprehensiveness, reliability and accuracy and timeliness.**

- **Relevance**

Under this criterion, the data and information are assessed whether they are related to energy efficiency and sustainability of data centres. The reporting scheme indeed captures a broad range of critical data and information essential for understanding the sector's environmental impact (see Table), including energy usage, water consumption, waste heat recovery and the adoption of renewable energy, among others. The selected indicators align closely with the scheme's objectives to increase transparency and to encourage sustainability and energy efficiency in the sector not only limited to reducing energy and water consumption but also the sourcing of renewable energy, waste heat reuse and increasing grid efficiency.[36] This is also in line with the Digital Decade and Green Deal goals of having extremely energy efficient and climate neutral data centres by 2030, in the context of the increasing energy consumption of data centres. Moreover, enhancing transparency will also be increasingly important with the significant and growing demand for installed IT power demand in EU data centres thanks to increasing digitalisation and data processing needs. According to one interviewee, they forecast annual growth rates from 2023 to 2030 of approximately 14% for colocation centres and around 10% for hyperscalers, with hyperscalers expected to reach roughly 5 GW of power demand by 2030.

Having said that, some indicators may be less relevant than others, especially when considering the energy efficiency and sustainability metrics prioritised by Annex III of the Commission Delegated Regulation (EU) 2024/1364,[37] namely Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE), Energy Reuse Factor (ERF) and Renewable Energy Factor (REF) (see Task 1.2). For instance, data traffic indicators (i.e. incoming and outgoing traffic bandwidth and incoming and outgoing data traffic), although useful in representing the workload and operational intensity of data centres, are not directly relevant in computing the four metrics above.

[35] Climate Neutral Data Centre Pact, *Working groups*, https://www.climateneutraldatacentre.net/working-groups/

[36] https://energy.ec.europa.eu/news/commission-adopts-eu-wide-scheme-rating-sustainability-data-centres-2024-03-15_en

[37] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401364

The inclusion and mandatory status for such indicators could be considered in future iterations of the scheme.

Additionally, some indicators may not be as easy to report for certain types of data centres. For example, whereas enterprise data centres operate across the entire technology stack, enabling visibility on the overall efficiency, colocation operators mainly focus on physical infrastructure and have limited control over this. Specifically, the reporting of ICT capacity indicators (i.e. ICT capacity for servers and storage equipment) may pose challenges for colocation centres that do not own client equipment. The scheme must account for these operational differences and tailor its indicators accordingly. This can be done, for instance, by distinguishing the reporting requirements for different types of data centres.

Lastly, in conjunction with the analysis under Task 1.2, external factors such as geographic location, climate, energy and water access, facility age and available technologies further complicate accurate measurement. In colder climates like the Nordics, ambient temperatures facilitate highly efficient cooling, resulting in low average Power Usage Effectiveness (PUE) values of 1.1–1.2. Conversely, southern regions such as Greece face higher temperatures and humidity, making such low PUE values more difficult to achieve. These climatic nuances must be factored into both the reporting framework and subsequent policy decisions.

- **Comprehensiveness**

The comprehensiveness criterion aims to assess the scope of the data and information collected and whether all relevant parameters are considered. The scheme itself is designed to encompass data centres of varying sizes and of different types across all EU Member States, thus, ensuring its inclusiveness and geographical coverage. Furthermore, the scheme asks for data and information pertaining to installed IT power demand, energy and water consumption and renewable energy use, among others (see Table), which enhances its comprehensiveness thanks to the variety of data and information collected. In view of the energy efficiency and sustainability metrics prioritised by Annex III of the Commission Delegated Regulation (EU) 2024/1364 above and the analysis under Task 1.2, these indicators are already adequate in computing these metrics.

However, the reported data from the first reporting period may not achieve the extent to which it is representative of the entire sector. As discussed in the data completeness analysis (see Table 13Table 13), around 36% of EU data centres participated in the first reporting period of the scheme. Although this sample size still provides valuable insights across various trends and patterns within the sector, there is room for improvement in terms of the participation rate, especially considering the mandatory nature of reporting for data centres above the 500 kW of installed power capacity threshold. Moreover, in some MSs, data has been sourced from only a limited number of data centres, with reporting proportion of under 10% denoted for Croatia, Hungary, Latvia, Portugal and Sweden with the exception of MSs with no reported data (see Table 13Table 13). Certain indicators such as waste heat reused and total water input also represent a relatively low proportion of reporting, thus, suggesting lower statistical significance and potential inconsistencies in reporting.

When looking at a more granular level, there are some gaps and opportunities for expansion foreseen. For example, while data centre operators and owners are already asked to report their total energy consumption, total energy consumption of IT equipment and renewable energy consumption, this has not been broken down by the specific energy types (e.g. electricity, hydropower, etc.). Moreover, as pointed out by one survey respondent, the indicators for waste heat reuse could also be expanded to reflect both its readiness and actual usage. Nevertheless, any expansion of such indicators must carefully balance the need for more detailed data with the risk of overburdening operators and owners, who have already invested significant effort in providing the current data.

- **Reliability and Accuracy**

The reliability and accuracy criterion refers to the data quality, standardisation and clarity across various types and sizes of data centres in all EU MSs. As underlined under the data quality analysis, there have been some invalid data inputs (see Table 16Table 16) and unreliable data points across the different indicators (see Table 17 Table 17 and Table 18Table 18). These inconsistencies often arise from differing national reporting standards, misunderstandings of indicators or errors in data entry. The scheme must then strive for greater clarity and consistency across borders, aligning definitions and methodologies to reduce confusion.

From inputs received from the stakeholder engagement activities, the effort to standardise and harmonise the reporting requirements across MSs and between the MS and EU-level emerge as a common suggestion to reduce inconsistencies. Furthermore, as already provided at the EU-level and in several MSs, open communication channels and regular interactions with stakeholders have been helpful in encouraging participation and enhancing clarity for operators and owners in filling in their data in the scheme. This can be supported with the provision of consistent and clear documentation and instructions on each KPI and the calculation method to obtain it to ensure that the operators and owners can fill in the information correctly. Within the scheme itself, another suggestion from stakeholders is the addition of user support and help options, including a dedicated assistance portal.

As part of the data quality analysis and from the stakeholder inputs, validation processes, including automated plausibility checks with soft/hard borders to minimise invalid inputs, can be implemented in future iterations. This approach can be combined with expert reviews for outliers and automated warnings for operators and owners to double-check their inputs in case they fall outside of the expected ranges.

- **Timeliness**

This criterion reviews the timeliness of the submission from data centre operators and owners with respect to the annual deadlines. Timeliness is especially critical considering the dynamic and rapidly evolving nature of the sector. This will enable the scheme to remain relevant in monitoring and guiding sustainability developments of the industry. As delineated under Article 12 of the EED Recast and the Delegated Regulation 2024/1364, the first reporting period was scheduled until May 15, 2024, and September 15, 2024, covering data from 2023. Despite these deadlines, data submissions have continued well beyond these dates, with new data still received as of June 2025. The extended submission period reflects practical challenges faced by operators in gathering, verifying and submitting the data, especially given that this is the first time such an EU-wide scheme is implemented.

The situation underscores the need for continued engagement from the data management side with data centre operators and owners to encourage timely participation for future iterations. From inputs received from stakeholders, several MS authorities are currently maintaining open communication channels, while also organising frequent stakeholder events for continued interactions.

Additionally, with respect to the complexity of the indicators to be reported, for which certain indicators may be too cumbersome and risk longer collection time, a greater understanding of the indicators and the scheme itself, together with refinements proposed for the indicators from the explanations on the relevance, comprehensiveness and reliability and accuracy of the scheme above, will help the timeliness of reporting.

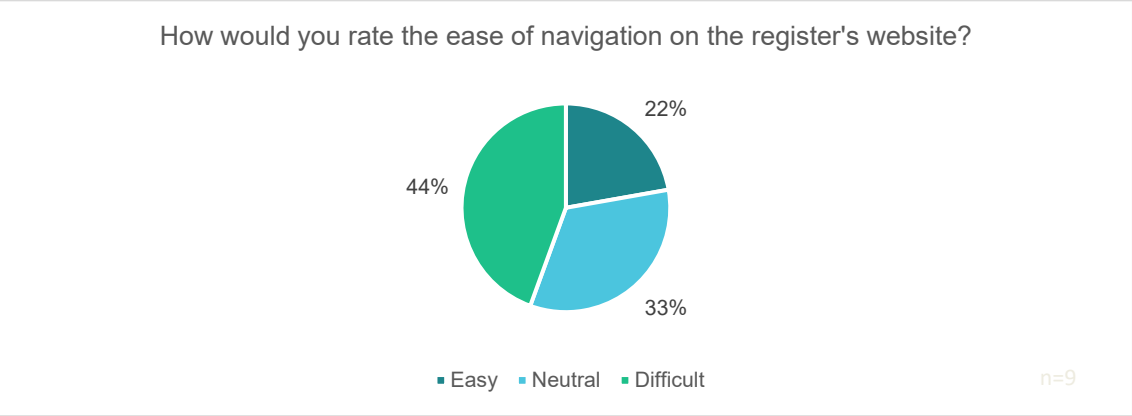
ii. User experience of the reporting scheme

As part of the second survey campaign, stakeholders responsible for reporting—such as data centre operators and owners—shared valuable insights and observations regarding their experience with the reporting portals. These comments covered both the EU-level reporting portal and the national-level platforms developed by individual member states. The survey questions are included in Annex 2.

A total of 20 respondents participated in the survey, representing different EU MSs, with countries such as Belgium, Finland, Germany and Spain having three respondents in the survey. Nevertheless, in line with the focus on the user experience, only 12 answers are considered for the analysis as other respondents did not participate in the scheme itself.

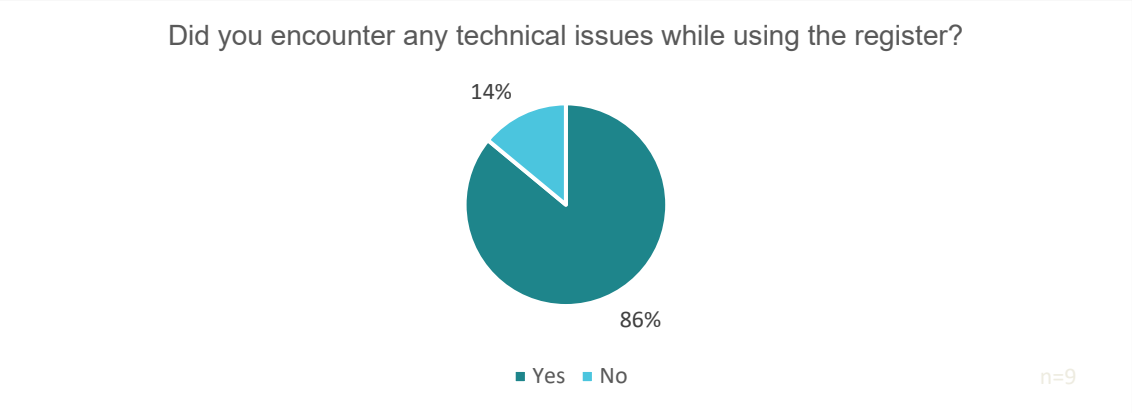
Feedback from data centre owners and operators revealed a range of user experiences. As presented below, over 40% found the system difficult to navigate, while around 30% found it easy.

Figure 18 – User experience survey results – Reporting scheme ease of navigation



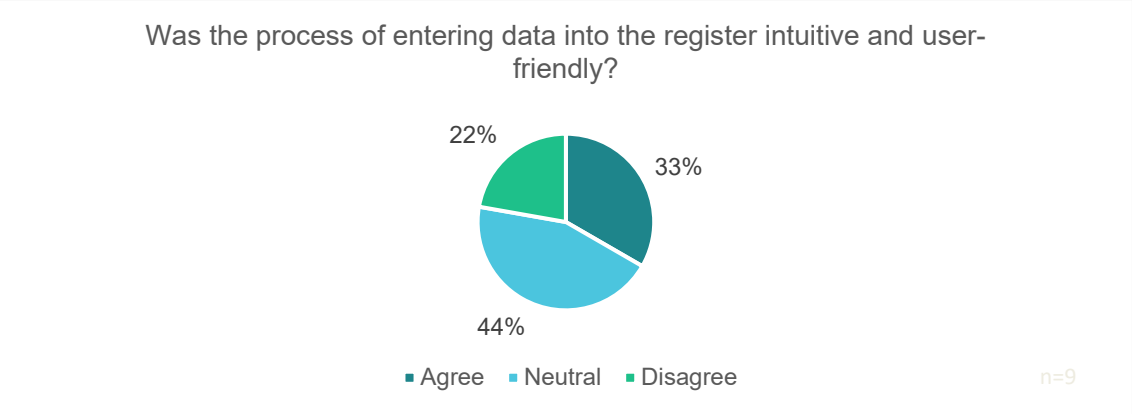
Additionally, the database also faced other criticism, with about 85% of users reporting technical issues such as missing interface elements in browsers like Firefox, login reauthentication problems and limited characters for data fields related to energy information. The data entry process was often perceived as unclear, and many users felt the platform lacked intuitiveness.

Figure 19 - User experience survey results – Reporting scheme technical issues



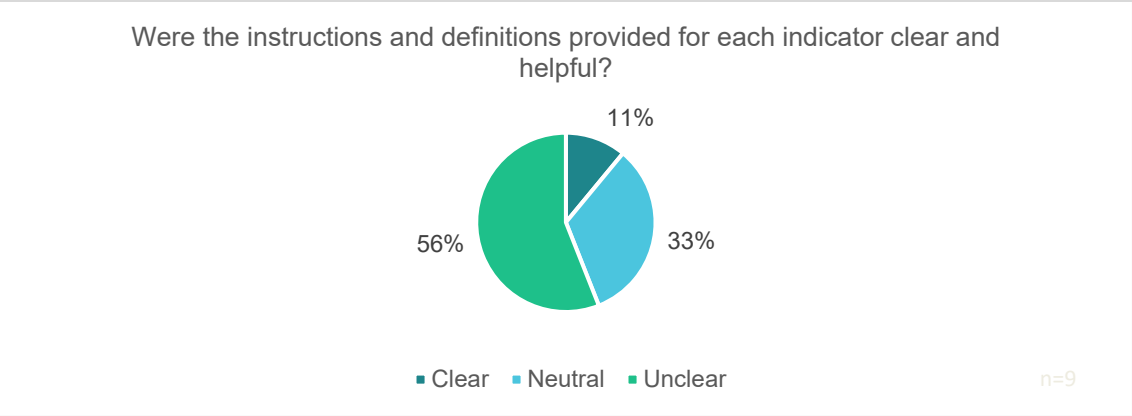
Meanwhile, over 40% of the respondents neither agree or disagree that the process of entering data into the register to be intuitive and user-friendly, although around 30% of respondents indicating that the register is already intuitive and user-friendly.

Figure 20 - User experience survey results – Reporting scheme intuitiveness and user-friendliness



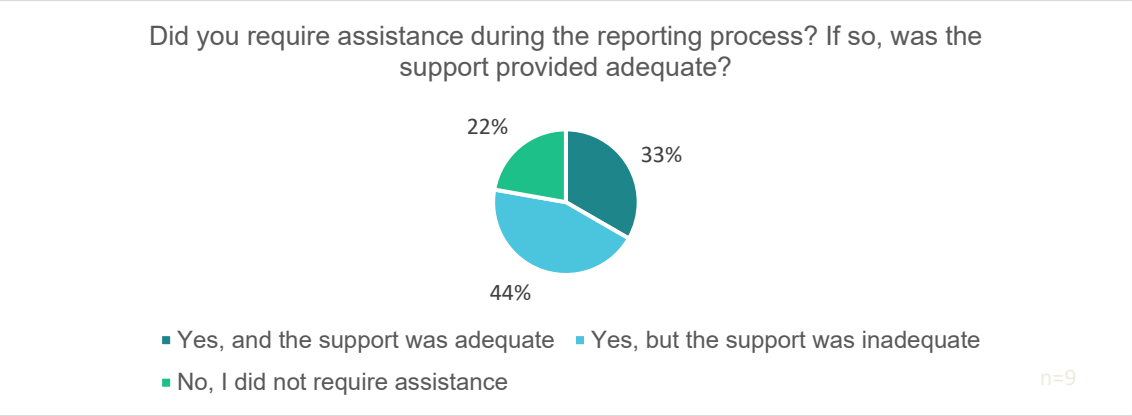
Over half of the responded considered the instructions and definitions provided for each indicator as part of the reporting scheme to be inadequate. This highlights a room for improvement to add clarity on what ought to be inputted per indicator to avoid discouraging data centres to report certain data points and further inaccuracies with the figures reported.

Figure 21 - User experience survey results – Reporting scheme instructions



Lastly, with respect to the assistance provided during the reporting period, around 40% of respondents indicating requesting assistance, although they deem it to be inadequate, reflecting the needs to improve the quality of assistance provided.

Figure 22 - User experience survey results – Reporting scheme assistance provided

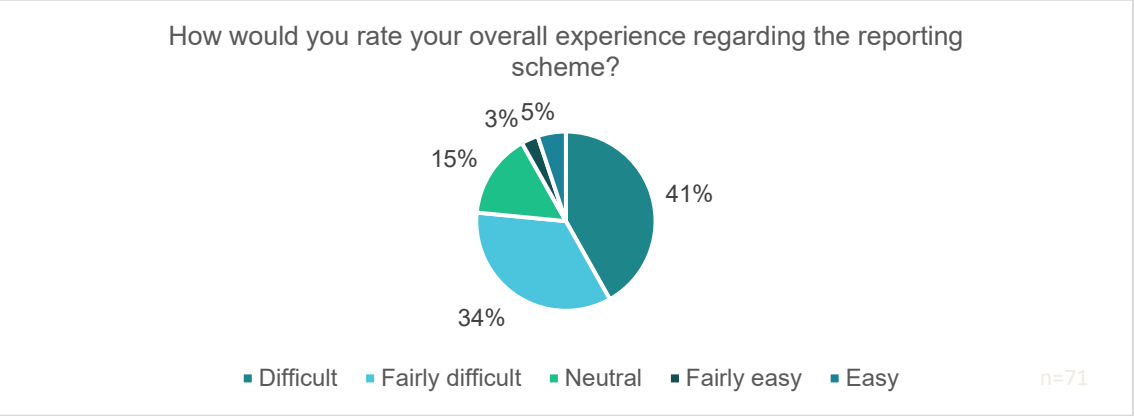


When reviewing the list of respondents to the survey, almost all respondents reported needing to upload data for more than one data centres, with 44% of the respondents indicating filling in data for more than five data centres. For those who reported for more than one data centre, a half of them indicated that the reporting portal is already efficiency in inputting data for multiple data

centres, with only one denoting that the process was inefficient. Meanwhile, completion times range from under two hours for around 40% of respondents to over eight hours for another 40% of respondents, indicating a high variability depending on data volume and technical difficulties.

Besides the survey, an interactive session was conducted during the second workshop where one of the topics discussed was to assess user experience regarding the data center reporting scheme. The findings revealed that the majority of participants encountered challenges in navigating the reporting process, with a strong tendency toward difficulty, as shown in the figure below:

Figure 23 - User experience of reporting scheme during the second workshop



The results showed that 41% of respondents rated the reporting scheme as "Difficult," making it the most common response. When combined with the 34% who found it "Fairly Difficult," a total of 75% of participants faced challenges in completing the reporting requirements. In contrast, only a small proportion of users reported a positive experience, with 7% rating it as "Easy" and 3% as "Fairly Easy," totaling just 10% positive feedback. Meanwhile, 15% of respondents had a "Neutral" experience, indicating neither strong dissatisfaction nor ease but still reflecting limited positive sentiment. These findings highlight a critical need for improvements in the usability of the reporting scheme.

The high proportion of users experiencing difficulties suggests potential underlying issues, including:

- Complexity of the Reporting Process – The steps involved may be too intricate or lack clarity.
- User Interface Design – The system may not be intuitive, making navigation cumbersome.
- Data Requirements – The information required for reporting may be difficult to collect or interpret.
- Training and Support – A lack of adequate training and user assistance may contribute to the challenges faced.

At the end of the survey, respondents were asked suggestions to improve the user experience, which was also asked during the second workshop of the study. The compiled list of suggestions are as follows:

- **Simplification:**
  - In certain instances, to consider removing customer-related metrics such as IT specifications and network/storage indicators as operators and owners may not have access to these metrics.
  - Eliminate redundant data traffic indicators.

  - Harmonise requirements across Member States to reduce national-level inconsistencies.
- **Improved tools and processes:**
  - Introduce application programming interfaces (APIs) to support automated reporting and data submission.
  - Allow data import/export in common formats such as MS Excel, CSV and JSON.
  - Add user support and help options, including a dedicated assistance portal.
  - Provide clear documentation and instructions on each KPI and its calculation to ensure users fully understand the process.
  - Add possibility to reuse data from the previous period, especially for metrics that may be very static.
  - Continuously gathering user feedback to identify pain points and refine the system accordingly.
- **Transparency and public access:**
  - Create public dashboards to share regional data centre information with citizens.
  - Maintain confidentiality protections for sensitive business information.
- **Better coordination:**
  - Strengthen collaboration between national contact points and EU-level authorities.
  - Standardise definitions and methodologies across all Member States.
- **Enhanced metrics:**
  - Include the age of IT systems to provide context in performance evaluations.
  - Expand heat reuse reporting to reflect both readiness and actual usage.
- **Special considerations:**
  - Differentiate reporting requirements for different types of data centres.
  - Adapt thresholds to account for the limitations of older or smaller facilities.

iii. Data management of the reporting scheme

The data management aspect of the data centre reporting scheme both at the Member State and EU-level remains a key area of interest within the ongoing research activities. This assessment focuses on the national authorities involved responsible for the national reporting scheme and the team within the European Commission in charge of the European database and entails several criteria on data management, namely data collection, processing, storing and sharing, in addition to data integrity and privacy matters.

The information gathering was conducted primarily through a series of targeted interviews. In total, three in-depth interviews were carried out. These interviews provided valuable firsthand perspectives on the current practices and challenges related to data management within the scheme.

To complement the insights obtained from the interviews, a dedicated survey was also designed and launched. This survey aimed to collect comprehensive and detailed information on data management procedures from a broader group of stakeholders involved in the operation, oversight and compliance aspects of the reporting framework. A total of 34 replies were received, for which only 10 replies were considered for the analysis due to the completeness of the responses.

Both the survey and interview guidelines utilised for this sub-task are provided in Annex 2 for reference.

Data and insights were gathered at both the Member State ad EU-level, ensuring a holistic view of the reporting landscape. This dual-level approach allowed for the identification of common trends, as well as distinctions in practices and procedures across different governance scales.

- **Reporting Guidelines and Support:**

EU level: Data centre operators were provided with clear reporting guidelines through a delegated regulation, supplemented by webinars and an EU-wide FAQ to ensure consistent understanding across Member States. Multiple workshops (3-4) were held before and during the portal launch to explain procedures and provide guidance. A dedicated contact email supports both platform issues and reporting content questions. Individual inquiries from operators have been addressed directly, while FAQs serve as ongoing soft guidance on specific indicators.

National level: Operators typically receive comprehensive reporting guidelines prior to participation, including FAQs, detailed datapoint guides, webinar sessions and explanatory documents outlining regulatory obligations and reporting procedures. A dedicated contact point or helpdesk is maintained to handle questions and technical support requests. Automated responses to frequently asked questions help manage the volume of inquiries, with the goal of gradually reducing the need for direct intervention.

- **Communication Channels:**

EU level: Two dedicated mailboxes handle platform support and policy-related queries. EU MSs authorities and industry associations act as intermediaries and multipliers to manage the large number of operators, disseminating information and invitations.

National level: Regular communication channels such as emails, webinars and stakeholder meetings are used to maintain operator engagement and encourage timely reporting. Associations and industry groups often assist in disseminating information and invitations to operators. While direct incentives may be limited, some frameworks include penalties for non-compliance, serving as a motivation to submit reports on time. Continuous dialogue with operators through workshops, professional unions and forums supports compliance and fosters collaboration.

- **Measures to Encourage Reporting:**

EU level: To boost timely participation, reminders of reporting deadlines are regularly sent. Outreach to associations helps spread invitations to operators. Workshops, events, and ongoing discussions with operators maintain engagement and awareness. However, challenges remain due to limited identification of all operators, as no comprehensive registry exists across countries.

National level: Data collection is generally facilitated through national or regional reporting platforms aligned with overarching EU requirements. Operators may submit data directly via secure portals or through batch uploads managed by data authorities. Validation processes include automated plausibility checks with hard limits to prevent invalid inputs, complemented by expert reviews for outliers. There is interest in expanding these checks to include soft borders and automated alerts to prompt operators to verify entries that fall outside expected ranges.

- **Data Processing and Validation:**

EU level: The in-house developed reporting software currently lacks automated validation, but plans are underway to introduce multi-level plausibility checks, including syntax verification, logical tests and soft/hard borders to flag inconsistent inputs. Future improvements aim to incorporate built-in notifications for operators when inconsistencies are detected.

National level: Reported data is stored in secure national or regional databases, with access controls such as two-factor authentication and encryption safeguarding sensitive information. Data retention policies often follow national legal frameworks, with typical retention periods extending up to 10 years. Systems vary in their ability to maintain audit trails or historical logs of data changes and account approvals, which poses challenges for traceability and version control.

- **Data Storage and Security:**

EU level: Data is stored securely within the European Commission's cloud environment, with access controls restricting users and MSs to only their own data. A high-level retention policy indicates data may be deleted after 10 years.

National level: Reported data is stored in secure national or regional databases, with access controls such as two-factor authentication and encryption safeguarding sensitive information. Data retention policies often follow national legal frameworks, with typical retention periods extending up to 10 years. Systems vary in their ability to maintain audit trails or historical logs of data changes and account approvals, which poses challenges for traceability and version control.

- **Feedback and Potential Improvements:**

EU level: Users report the platform can be confusing; developers are working to improve navigation, filtering, and overall user-friendliness. Proposed enhancements include allowing multiple data import formats (while keeping the system simple), better operator identification to reduce inconsistencies across Member States and more automated, customised landing pages. Future iterations may also support machine-to-machine data exchange or simpler Excel-based uploads to accommodate user preferences.

National level: Operators face complexity in account creation, especially regarding requirements for personal versus generic email addresses, which complicates data ownership and transfer when personnel changes occur. Hybrid reporting models combining individual operator submissions and bulk uploads raise concerns about data overwriting or loss. Current platforms lack comprehensive notification systems to alert authorities and operators of modifications or inconsistencies.

There is a clear demand for enhanced platform features, including:

- Historical logs to track changes and approvals for better traceability.
- Automated validation with real-time error or inconsistency alerts during data entry.
- Expanded comment fields to allow operators to explain measurement issues or corrective actions directly within the platform.
- Improved communication tools integrated within the reporting system to replace reliance on email correspondence.
- Fields identifying where data is publicly available, supporting transparency and compliance with public reporting requirements.

A unified EU-wide FAQ and clear definitions of data points would promote consistency in reporting across Member States. Some technical datapoints currently included in reporting frameworks may require revaluation for relevance and clarity. Providing operators with clear overviews of valid data ranges and interpretation guidance would reduce confusion and improve data quality.

4. Conclusion

The report presents the assessment on the energy efficiency and sustainability of data centres in the EU in conjunction with the first reporting period of the European database on data centres in line with Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364. The analysis also touches upon the assessment of the reporting scheme itself, the reported data and the user experience of the reporting entities. Along the way, the report contributes to the ongoing effort to enhance the energy efficiency and sustainability of the sector.

In the first reporting period, approximately 36% of eligible EU data centres or around 770 facilities participated in the reporting scheme, highlighting both the potential and the challenges in securing comprehensive sector-wide transparency. Encouragingly, around 80% of these reported data is deemed to be accurate and reliable. Nevertheless, technical issues and usability challenges were commonly cited by reporting data centre operators and owners, with many respondents finding the system difficult to navigate and encountering technical issues such as browser incompatibility and unclear data entry processes. From the data management perspective, the scheme involves coordinated efforts at the Member State and EU-level, with authorities overseeing the reporting and providing guidelines and assistance to operators. Clearer guidance and improvements to the platform are recommended to ensure consistent, high-quality reporting across the Union.

When assessing the reporting scheme itself, the indicators chosen are highly relevant to the sector's sustainability goals the EU's Digital Decade and Green Deal objectives. However, some indicators may be less directly tied to energy efficiency and operational differences between data centre types can make reporting certain indicators challenging. The scheme, though comprehensive in covering various data centre types and collecting diverse information, faced significant variation of response rate across Member States, while data reliability and accuracy were sometimes compromised by inconsistent national standards, unclear definitions and data entry errors, underscoring the need for harmonisation and improved user support. Timeliness is also an issue, as many operators struggled to meet deadlines due to the novelty and complexity of the scheme, emphasising the need for ongoing engagement, clearer guidance and streamlined indicators in future reporting cycles.

Additionally, energy efficiency and sustainability were assessed using four key metrics, namely Power Usage Efficiency (PUE), Water Usage Effectiveness (WUE), Energy Reuse Factor (ERF) and Renewable Energy Factor (REF). Many data centres still operate above the widely accepted PUE benchmark of 1.3-1.4, while WUE results still vary significantly across data centres around the industry threshold of 0.4 L/KWh, highlighting that further optimisation and investment will therefore be critical to meet these targets. Meanwhile, the high REF values recorded across the EU reflect an already commendable commitment to renewable energy sourcing. Conversely, ERF data, though limited, also displayed considerable regional variation, suggesting that national or local policies may be better suited in addressing heat reuse. Lastly, interdependencies between these metrics, together with other factors such as facility age and climate or seasonal variations, must be considered when drawing conclusions to create a nuanced and comprehensive view of the sector.

a. Recommendations to improve the reporting scheme

From the various assessments done on the reporting scheme and the data and information collected within the scheme, the study team has compiled several recommendations to improve the scheme in future reporting cycles.

- Reconsider the inclusion of indicators not directly relevant to data centre energy efficiency and sustainability to streamline the reporting required for operators and owners.
- Differentiate the reporting requirements for different types of data centres (i.e. colocation, enterprise and co-hosting data centres) as operators of certain types may not have access to the full metrics.

- Maintain open communication channels and organise regular stakeholder engagement activities with operators to encourage participation in the reporting scheme.
- Standardise and harmonise the reporting standards across EU MSs and between the MS and EU-level to reduce reporting inconsistencies and misunderstandings from operators.
- Provide clear documentation and instructions on obtaining each KPI to operators to ensure more accurate and reliable reporting, including user support and help options within the reporting platform itself.
- Incorporate automated plausibility checks and warning alerts for potentially inaccurate inputs on the reporting platform to minimise invalid inputs.
- Improve the overall user-friendliness and navigation of the reporting platform.
- Allow data import/export in more common formats (e.g. Excel) to streamline the data submission process.

Annex 1 - Data quality assessment and valid data points per KPI

Table 20 - Data quality assessment - Indicator comparison

Indicators	Plausibility check	Member States																										EU average		
		AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LV	LT	LU	MT	NL	PL	PT	RO	SK	SL	ES	SE	Reliable	Unreliable	Data points
Data centre type	n.a.	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	n.a.	n.a.	n.a.
Year of entry into operation of the data centre	n.a.	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	n.a.	n.a.	n.a.
Installed IT power demand	Installed IT power demand >= Total energy consumption	100 %	75%	67%	100 %	N	N	94%	N	96%	93%	98%	100 %	100 %	100 %	96%	100 %	100 %	100 %	100 %	96%	89%	100 %	N	N	N	93%	100 %	95%	5%	741
Data centre computer room floor area	Data centre computer room floor area >= Total floor area	100 %	100 %	100 %	100 %	N	N	94%	N	100 %	100 %	99%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	757
Total energy consumption	Total energy consumption >= Total energy consumption of IT equipment	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	94%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	738
Total energy consumption from back-up generators	(Total energy consumption / 5) >= Total energy consumption from back-up generators	91%	100 %	100 %	100 %	N	N	94%	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	99%	1%	662
Total energy consumption of IT equipment	Total energy consumption >= Total energy consumption of IT equipment	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	94%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	741
Total water input	Total water input >= Total potable water input	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	99%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	97%	100 %	N	N	N	100 %	100 %	100%	0%	720
Waste heat reused	Total energy consumption >= Waste heat reused	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	719
Average waste heat temperature	15 >= Average waste heat temperature >= 60 degrees (https://datacenter-group.com/en/news-stories/article/waste-heat-recovery-from-data-centers/)	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	641
Cooling degree days	Cooling degree days <= 842 (https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20230227-2)	100 %	94%	100 %	100 %	N	N	100 %	N	96%	98%	100 %	100 %	100 %	100 %	87%	100 %	100 %	50%	100 %	98%	100 %	100 %	N	N	N	100 %	100 %	96%	4%	718
Total renewable energy consumption	Total energy consumption >= Total renewable energy consumption	100 %	94%	100 %	100 %	N	N	100 %	N	96%	100 %	99%	83%	100 %	94%	91%	100 %	100 %	100 %	100 %	88%	100 %	75%	N	N	N	98%	100 %	96%	4%	731
Total renewable energy consumption from Guarantees of Origin	Total renewable energy consumption >= Total renewable energy consumption from Guarantees of Origin	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	727
Total renewable energy consumption from Power Purchasing Agreements	Total renewable energy consumption >= Total renewable energy consumption from Power Purchasing Agreements	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	671
Total renewable energy consumption from on-site renewables	Total renewable energy consumption >= Total renewable energy consumption from on-site renewables	100 %	100 %	100 %	100 %	N	N	100 %	N	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	N	N	N	100 %	100 %	100%	0%	673

Table 21 - EU average proportion of valid data points per KPI

Types of indicators	Indicators	Member States																										EU average	
		AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LV	LT	LU	MT	PL	PT	RO	SK	SL	ES	SE	Valid	Invalid
Data centre details	Data centre type	64%	100%	100%	100%	n.a.	n.a.	67%	n.a.	100%	99%	100%	67%	100%	100%	100%	100%	100%	100%	100%	100%	73%	n.a.	n.a.	n.a.	86%	100%	93%	7%
	Year of entry into operation of the data centre	100%	100%	100%	100%	n.a.	n.a.	100%	n.a.	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	n.a.	n.a.	n.a.	100%	100%	100%	0%
Energy and sustainability indicators	Installed IT power demand	91%	94%	100%	100%	n.a.	n.a.	100%	n.a.	100%	95%	97%	67%	100%	100%	96%	100%	100%	100%	100%	66%	89%	n.a.	n.a.	n.a.	88%	57%	92%	8%
	Data centre computer room floor area	91%	100%	100%	100%	n.a.	n.a.	100%	n.a.	100%	94%	100%	100%	100%	100%	96%	100%	100%	100%	100%	95%	100%	n.a.	n.a.	n.a.	95%	100%	99%	1%
	Total energy consumption	91%	69%	67%	100%	n.a.	n.a.	100%	n.a.	96%	90%	98%	100%	100%	100%	91%	100%	100%	100%	100%	66%	83%	n.a.	n.a.	n.a.	88%	100%	92%	8%
	Total energy consumption from back-up generators	91%	69%	0%	100%	n.a.	n.a.	88%	n.a.	72%	70%	100%	50%	100%	67%	52%	100%	100%	100%	100%	100%	69%	n.a.	n.a.	n.a.	60%	100%	79%	21%
	Total energy consumption of IT equipment	82%	100%	100%	100%	n.a.	n.a.	100%	n.a.	96%	88%	99%	100%	100%	94%	87%	100%	100%	100%	100%	55%	83%	n.a.	n.a.	n.a.	88%	100%	94%	6%
	Total water input	91%	94%	67%	100%	n.a.	n.a.	100%	n.a.	88%	93%	97%	100%	100%	100%	78%	100%	33%	100%	100%	100%	69%	n.a.	n.a.	n.a.	88%	100%	90%	10%
	Waste heat reused	91%	88%	100%	100%	n.a.	n.a.	88%	n.a.	92%	94%	98%	100%	100%	100%	70%	100%	67%	100%	100%	100%	78%	n.a.	n.a.	n.a.	69%	100%	92%	8%
	Average waste heat temperature	82%	81%	33%	100%	n.a.	n.a.	71%	n.a.	92%	51%	100%	33%	100%	89%	74%	100%	33%	50%	100%	100%	44%	n.a.	n.a.	n.a.	74%	57%	75%	25%
	Cooling degree days	100%	88%	67%	100%	n.a.	n.a.	88%	n.a.	92%	88%	100%	33%	100%	94%	96%	100%	0%	50%	100%	100%	69%	n.a.	n.a.	n.a.	83%	100%	83%	17%
	Total renewable energy consumption	91%	88%	100%	100%	n.a.	n.a.	88%	n.a.	100%	89%	100%	100%	100%	94%	91%	100%	100%	50%	100%	100%	69%	n.a.	n.a.	n.a.	90%	100%	93%	7%
	Total renewable energy consumption from Guarantees of Origin	91%	75%	100%	100%	n.a.	n.a.	88%	n.a.	100%	86%	100%	100%	100%	100%	91%	100%	100%	50%	100%	99%	81%	n.a.	n.a.	n.a.	90%	100%	92%	8%
	Total renewable energy consumption from Power Purchasing Agreements	91%	88%	100%	100%	n.a.	n.a.	88%	n.a.	100%	61%	100%	50%	100%	50%	70%	100%	100%	50%	100%	99%	72%	n.a.	n.a.	n.a.	79%	100%	84%	16%
	Total renewable energy consumption from on-site renewables	91%	88%	100%	100%	n.a.	n.a.	88%	n.a.	100%	59%	100%	50%	100%	50%	70%	100%	100%	50%	100%	99%	69%	n.a.	n.a.	n.a.	88%	100%	86%	14%

Annex 2 – Surveys/Interviews

- **Survey 1**

Aim

The European Commission's Directorate for energy matters (DG ENER) has launched a tender for a new study in the domain of the energy efficiency and sustainability of data centres. This study's major goal is to assess the energy-efficiency of data centres, in line with the objectives of the Green Deal and the Digital Decade to have climate-neutral data centres, and to propose potential additional measures such as the establishment of a common Union rating scheme vis-à-vis the sustainability of data centres. This survey therefore consists of two types of questionaries: one for Task 1 and one for Task 2.

The survey on Task 1 focuses on specific indicators that data centres with an installed IT power demand of at least 500 kW will have to provide to the respective EU register in order to ensure compliance with Regulation (EU) 2024/136414.

As per the regulation, data centres need to report the following indicators:

Energy and sustainability indicators	ICT capacity indicators	Data traffic indicators
• Installed IT power demand • Data centre total floor area • Data centre computer room floor area • Total energy consumption • Total energy consumption of IT equipment • Electrical grid function • Average battery capacity • Total water input • Total potable water input • Waste heat reused • Average waste heat temperature • Average setpoint IT equipment intake air temperature • Types of refrigerants • Cooling degree days • Total renewable energy consumption • Total renewable energy consumption from Guarantees of Origin • Total renewable energy consumption from Power Purchasing Agreements • Total renewable energy consumption from on-site renewables	• ICT capacity for servers • ICT capacity for storage equipment	• Incoming traffic bandwidth • Outgoing traffic bandwidth • Incoming data traffic • Outgoing data traffic

The objective of this survey is to contribute to the **assessment of the completeness of the reported data** from the first reporting period of 2024.

The survey on Task 2 will focus on comprehensive understanding of the practical challenges and industry readiness for potential adopting a new EU-wide rating scheme and establishment of minimum performance standards as stated in the Directive (EU) 2023/1791 Article 12(5).

The objective of this survey is to contribute to the development and implementation of effective measures that will **drive the data centre sector towards enhanced sustainability.**

The questionnaire for Task 1 will be split into two versions, one for data centre operators/owners and another for EU/national data centre associations and other types of stakeholders. The questionnaire for Task 2 will be common for all types of stakeholders, with the option to answer only question relevant for the respective stakeholder.

Task 1 questionaire: Data Centre Energy Performance and Sustainability KPIs

General information (Page 1/5)

Which type of stakeholder group do you represent?

The following choice will define which set of questions the respondent will answer for Survey 1.

[ ] Data centre operators/owners

[ ] EU/National industry associations and initiatives

[ ] Others

Data centre operators/owners

General information (Page 2/5)

Which data centre operator/owner do you represent? (optional)

_____

In which Member States is/are the data centre(s) located? Please select the Member State where the data centre you wish to provide feedback on is located. You can start another survey if you would like to provide responses for data centre(s) located in other Member States.

Dropdown menu with all Member States + Others (please name the country)

_____

Facilities information (Page 3/5)

For which type of data centre would you like to reply to the questionnaire? *Please select the type of the data centre you wish to provide feedback on. You can start another survey if you would like to provide responses for other types of data centres.*

[ ] Colocation data centre

[ ] Co-hosting data centre

[ ] Enterprise data centre

[ ] Others (please name the type): _____

What is the year of entry into operation of your data centre?

_____

What is the installed power of your data centre?

[ ] Very small data centre (100-500 kW)

[ ] Small data centre (500 -1 000 kW)

[ ] Medium size data centre (1-2 MW)

[ ] Large data centre (2-10 MW)

[ ] Very large data centre (> 10 MW)

What is the computer room floor area in square metres for your data centre?

[ ] <1 000 m^2

[ ] 1 000 – 2 000 m^2

[ ] 2 000 – 5 000 m^2

[ ] 5 000 – 10 000 m^2

[ ] > 10 000 m^2

[ ] N/A

[ ] Please specify the figure if available: _____

Key performance indicators (Page 4/5)

Have you reported your key performance indicators as part of the first reporting period of the European database on data centres Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364?

[ ] Yes

[ ] No

The performance indicators requested are valid for the last full calendar year. Preferably, the data should be sourced from 2023, but if available, 2024 data may be considered.

Energy consumption

What is the total energy consumption in kWh of the data centre(s) you operate/own?

[ ] < 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the total energy consumption from back-up generators in kWh of the data centre(s) you operate/own? (optional)

[ ] 0 - 1 000 kWh

[ ] 1 000 – 10 000 kWh

[ ] 10 000 – 100 000 kWh

[ ] 100 000 – 1 000 000 kWh

[ ] > 1 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the total energy consumption of IT equipment in kWh of the data centre(s) you operate/own? (optional)

[ ] < 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

Use of renewable energy

What is the total renewable energy consumption in kWh of the data centre(s) you operate/own?

[ ] 0 kWh

[ ] 1 - 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the total renewable energy consumption from guarantees of origin in kWh of the data centre(s) you operate/own? (optional)

[ ] 0 kWh

[ ] 1 - 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the total renewable energy consumption from Power Purchasing Agreements in kWh of the data centre(s) you operate/own? (optional)

[ ] 0 kWh

[ ] 1 - 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the total renewable energy consumption from on-site renewables in kWh of the data centre(s) you operate/own? (optional)

[ ] 0 kWh

[ ] 1 - 1 000 000 kWh

[ ] 1 000 000 – 5 000 000 kWh

[ ] 5 000 000 – 10 000 000 kWh

[ ] 10 000 000 – 20 000 000 kWh

[ ] 20 000 000 – 50 000 000 kWh

[ ] > 50 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

Waste heat utilisation

What is the waste heat utilisation in kWh in the data centre(s) you operate/own?

[ ] 0 kWh

[ ] 1 000 – 10 000 kWh

[ ] 10 000 – 100 000 kWh

[ ] 100 000 – 1 000 000 kWh

[ ] > 1 000 000 kWh

[ ] N/A

[ ] Please specify the figure if available: _____

What is the average waste heat temperature in degree Celsius in the data centre(s) you operate/own? (optional)

[ ] < 10 °C

[ ] 10 - 20 °C

[ ] 20 - 30 °C

[ ] 30 - 40 °C

[ ] > 40 °C

[ ] N/A

[ ] Please specify the figure if available: _____

How many cooling degree days did your data centre(s) observe in the last full calendar year? (optional)

[ ] < 25 days

[ ] 25 – 100 days

[ ] 100 – 200 days

[ ] 200 – 500 days

[ ] 500 – 1 000 days

[ ] > 1 000 days

[ ] N/A

[ ] Please specify the figure if available: _____

Water usage

What is the water usage in cubic metres of the data centre(s) you operate/own?

[ ] < 100 m³

[ ] 100 – 250 m³

[ ] 250 – 500 m³

[ ] 500 – 1 000 m³

[ ] 1 000 – 2 000 m³

[ ] 2 000 – 5 000 m³

[ ] 5 000 – 10 000 m³

[ ] 10 000 – 25 0000 m³

[ ] 25 000 – 50 0000 m³

[ ] 50 000 – 100 0000 m³

[ ] > 100 0000 m³

[ ] N/A

[ ] Please specify the figure if available: _____

What is the potable water usage in cubic metres of the data centre(s) you operate/own? (optional)

[ ] < 100 m³

[ ] 100 – 250 m³

[ ] 250 – 500 m³

[ ] 500 – 1 000 m³

[ ] 1 000 – 2 000 m³

[ ] 2 000 – 5 000 m³

[ ] 5 000 – 10 000 m³

[ ] 10 000 – 25 0000 m³

[ ] 25 000 – 50 0000 m³

[ ] 50 000 – 100 0000 m³

[ ] > 100 0000 m³

[ ] N/A

[ ] Please specify the figure if available: _____

AoB (Page 5/5)

Would you be interested in participating in an in-depth interview to discuss the points above? In case you are interested, our study team will contact you with further details.

( ) YES

( ) NO

If you are interested, please provide us with an email address for further communication.

_____

Thank you for your contribution! For any questions or requests for further information, please do not hesitate to contact the study team at EUDCEAR@be.ey.com.

EU/National industry associations and initiatives + Others

General information (Page 2/5)

Which organisation do you represent? (optional)

_____

Which Member State do you and/or your organisation represent? *In case you and/or your organisation represent more than one Member States, please select the Member State in which you have the highest amount of data centres. You can start another survey if you would like to provide responses for data centres located in other Member States.*

Dropdown menu with all Member States + Others (please name the country)

_____

Facilities information (Page 3/5)

What is the aggregated installed power in MW for the data centre(s) in the Member States that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

What is the number of data centre(s) in the Member States that you represent or for the data centre(s) that you represent in case of non-national associations above 500 kW?

_____

For national associations, what percentage of the total data centre market (in terms of the number of data centres) are you covering in the Member State that you represent? (optional)

_____

What is the typical computer room floor area in square metres for the selected type of data centre(s)?

_____

Key performance indicators (Page 4/5)

The performance indicators requested are valid for the last full calendar year. Preferably, the data should be sourced from 2023, but if available, 2024 data may be considered.

Energy consumption

What is the average total energy consumption in GWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

What is the average total energy consumption from back-up generators in GWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

What is the average total energy consumption of IT equipment in GWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

Use of renewable energy

What is the average total renewable energy consumption in kWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

What is the average total renewable energy consumption from guarantees of origin in kWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

What is the average total renewable energy consumption from Power Purchasing Agreements in kWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

What is the average total renewable energy consumption from on-site renewables in kWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

Waste heat utilisation

What is the average waste heat utilisation in kWh for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

What is the average waste heat temperature in degree Celsius for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

How many cooling degree days did the data centre(s) in the Member State that you represent or the data centre(s) that you represent in case of non-national associations observe in average in the last full calendar year? (optional)

_____

Water usage

What is the average water usage in cubic metres for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations?

_____

What is the average potable water usage in cubic metres for the data centre(s) in the Member State that you represent or for the data centre(s) that you represent in case of non-national associations? (optional)

_____

AoB (Page 5/5)

Would you be interested in participating in an in-depth interview to discuss the points above? In case you are interested, our study team will contact you with further details.

( ) YES

( ) NO

If you are interested, please provide us with an email address for further communication.

_____

Thank you for your contribution! For any questions or requests for further information, please do not hesitate to contact the study team at EUDCEAR@be.ey.com.

- **Interview 1**

The European Commission's DG ENER has launched a study to support the assessment of data centre energy efficiency and to propose additional measures in conjunction with refining the already established EU-wide rating scheme for the sustainability of data centres under Article 12 of the Energy Efficiency Directive (EED) Recast on data centres, and the Delegated Regulation (EU) 2024/1364 on the first phase of the establishment of a common Union rating scheme for data centres.

As per the regulation, data centres with an installed power demand of at least 500 kW are mandated to report the following indicators:

The objective of this interview is two-fold. First, the interview aims to contribute to the assessment of the completeness and quality of the reported data from the first reporting period by benchmarking the figures from the reporting scheme with inputs from the industry and complementing the data whenever applicable. Second, the interview also aims to assess the energy efficiency and sustainability of data centres in Europe in the transition towards a sustainable data centre sector.

General information

- Could you please introduce yourself and your role in your organisation?

Topic 1 - Assessment of the sustainability of data centres in EU and of the respective reporting scheme

- How has the installed IT power demand in data centres evolved in recent years? The median value across the EU from the reporting scheme is 2 339 kW − do you think this is representative of the sector, or are you observing significantly different values? Please specify the figures if available.

- Are data centres expanding in physical size or is there a shift towards more compact, high-density designs? The median value for computer room floor area across the EU from the reporting scheme is 2 679 m^2 with a median power density (IT power installed/total computer room floor area) of around 1 kW per m^2. Would this figure be representative of most data centres today? Please specify the figures if available.

- What are the key factors driving changes in total energy consumption across data centres? The median energy consumption from the reporting scheme is 14 413 954 kWh − does this align with what you observe from the data centres that you own/operate or represent, or are there significant variations? Please specify the figures if available.

- Has reliance on backup generators decreased in recent years? The EU median from the reporting scheme is 80 303 kWh or 0.56% of the total energy consumption − does this reflect typical backup generator usage, or do you see deviations? Please specify the figures if available.

- Are IT equipment energy demands rising due to increasing workloads or are efficiency improvements balancing consumption? Given the median from the reporting scheme

of 6 593 420 kWh or a little less than half the total energy consumption, does this seem realistic based on your experience? Please specify the figures if available.

- How is water consumption evolving in data centres? The EU median from the reporting scheme is 891 m^3 − do you think this accurately represents water usage trends, or are there large discrepancies? Please specify the figures if available.

- To what extent are data centres reusing waste heat? The median amount reused from the reporting scheme is 15 290 kWh or about 0.1% of total energy consumption − does this figure reflect actual practices in the sector, or do you observe higher or lower values? Please specify the figures if available.

- Are there variations in waste heat temperature trends? The EU median from the reporting scheme is 25 degrees Celsius − do you see significant deviations, or is this a typical waste heat temperature? Please specify figures if available.

- How are the climatic conditions across different EU regions impacting cooling requirements for data centres? With a EU median of 293 cooling degree days, does this match what you observe in your region?

- Is the adoption of renewable energy growing across the data centre sector? Do you think it representative to say that around 50% of the energy consumed (i.e. EU median of 6 350 771 kWh) by data centres originates from renewable energy? Please specify figures if available.

- How important are Guarantees of Origin (GOs) in data centre renewable energy strategies? Would you say that there is a significant reliance on GOs in terms of the ratio with the total renewable energy consumption, or do you see a shift towards other mechanisms? Please specify the figures if available.

- Are Power Purchase Agreements (PPAs) becoming more popular in the sector? What renewable energy ratio would come to your mind as representative of the EU? Does the EU median of 3 947 067 kWh from the reporting scheme (i.e. 62% of total renewable energy consumption) make sense to you? Please specify the figures if available.

- How feasible is on-site renewable energy generation for data centres? According to inputs from the reporting scheme, it represents 1/60th (i.e. a median figure of 9 094 kWh from the reporting scheme) of the renewable energy consumed by data centre in the EU. Does this suggest limited uptake, or do you see an increasing trend in on-site generation? Please specify the figures if available.

- **Survey 2**

User experience of the reporting scheme

We would like to invite you to participate in a survey for the study European Union Data Centre Energy Efficiency Assessment and Reporting Scheme (EUDCEAR) commissioned by the European Commission's DG ENER. The survey seeks to gather insights on the user experience perspective of the first reporting period of the European database on data centres

Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364.

The questionnaire contains 15 questions, for which some of the questions are optional, and will take approximately 15 minutes to complete. Please find the survey in the next few pages.

General information (page 2/5)

Which data centre operator/owner do you represent? (optional)

_____

Which Member State do you and/or your organisation represent? *In case you and/or your organisation represent more than one Member States, please select the Member State in which you have the most amount of data centres. You can start another survey if you would like to provide responses for data centres located in other Member States.*

Dropdown menu with all Member States + Others (please name the country)

_____

Have you reported your key performance indicators as part of the first reporting period of the European database on data centres Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364?

( ) Yes

( ) No

NOTE: If yes, the respondents can continue to the next questions. If no, either we stop the survey or we redirect the respondents to the general feedback section.

Which register did you use to report the indicators?

( ) EU Register for data centres

( ) National register for data centres

( ) All options above

( ) None

User experience and support (page 3/5)

How would you rate the ease of navigation on the register's website?

( ) Very easy

( ) Easy

( ) Neutral

( ) Difficult

( ) Very difficult

Did you encounter any technical issues while using the register? If yes, please specify.

( ) Yes

( ) No

Was the process of entering data into the register intuitive and user-friendly?

( ) Strongly agree

( ) Agree

( ) Neutral

( ) Disagree

( ) Strongly disagree

Were the instructions and definitions provided for each indicator clear and helpful?

( ) Very clear

( ) Clear

( ) Neutral

( ) Unclear

( ) Very unclear

Did you require assistance during the reporting process? If so, was the support provided adequate?

( ) Yes, and the support was adequate

( ) Yes, but the support was inadequate

( ) No, I did not require assistance

How much time did it take you to complete the reporting process?

( ) Less than 2 hours

( ) 2 to 4 hours

( ) 4 to 8 hours

( ) More than 8 hours

Did the reporting portal provide an efficient way to report multiple data centres' indicators, if applicable?

( ) Yes, very efficient

( ) Somewhat efficient

( ) Neutral

( ) Somewhat inefficient

( ) No, not efficient at all

Feedback and Improvements (page 4/5)

What aspect of the reporting portal could be improved to enhance your reporting experience?

_____

Do you have any suggestions for additional features or functionalities that could be added to the reporting portal?

_____

AoB (page 5/5)

Would you be interested in participating in an in-depth interview to discuss the points above? In case you are interested, our study team will contact you with further details.

( ) YES

( ) NO

If you are interested, please provide us with an email address for further communication.

Thank you for your contribution! For any questions or requests for further information, please do not hesitate to contact the study team at EUDCEAR@be.ey.com.

- **Data management of the reporting scheme**

We would like to invite you to participate in a survey for the study European Union Data Centre Energy Efficiency Assessment and Reporting Scheme (EUDCEAR) commissioned by the European Commission's DG ENER. The survey seeks to gather insights on the data management perspective of the first reporting period of the European database on data centres Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364.

The survey is intended for national authorities responsible for the national reporting scheme or the team within the European Commission in charge of the European database.

The questionnaire contains 15 questions, for which some of the questions are optional, and will take approximately 15 minutes to complete. Please find the survey in the next few pages.

General information

Which organisation do you represent? (optional)

_____

In which Member State is your organisation located? *In case of representatives from the European Commission or other third-party organisations, please select "Others" and indicate the organisation.*

Dropdown menu with all Member States + Others (please name the country)

_____

Which register did you manage as part of the first reporting period?

( ) EU Register for data centres

( ) National register for data centres

( ) I did not manage any sorts of data centre register (End of survey)

Data management (page 3/5)

Data collection

Were reporting guidelines or similar documents provided to data centre operators prior to participating in the reporting scheme?

( ) Yes, please describe

( ) No

_____

Did you have a dedicated coomunication channel where data centre operators can ask questions or request for more information?

( ) Yes

( ) No

Did you implement any measures to encourage timely participation from data centre operators? If yes, please describe. (E.g. reminders, follow-ups, incentives, etc.)

( ) Yes, please describe

( ) No

_____

Data processing

Which tools or software did you use to handle the reported indicators from data centres? (E.g. data management systems, analytical software, etc.)

_____

Have there been (automated) validation or plausibility checks in place for the indicators submitted by data centres to ensure the accuracy and consistency of the reported indicators? If yes, please describe.

( ) Yes, please describe

( ) No

_____

Data storage and protection

Where is the reported indicators stored? (E.g. cloud storage, national databases, European databases, etc.)

_____

What measures are in place to ensure the security of the reported indicators during storage? (E.g. encryption, access controls, etc.)

_____

How long is the reported indicators retained and what is the policy for archiving or deleting data?

_____

Feedback and Improvements (page 4/5)

What aspect of the reporting portal could be improved in terms of data management?

_____

Do you have any suggestions for additional features or functionalities that could be added to the reporting portal?

_____

AoB (page 5/5)

Would you be interested in participating in an in-depth interview to discuss the points above? In case you are interested, our study team will contact you with further details.

( ) YES

( ) NO

If you are interested, please provide us with an email address for further communication.

_____

Thank you for your contribution! For any questions or requests for further information, please do not hesitate to contact the study team at EUDCEAR@be.ey.com.

- **Interview 2**

The European Commission's Directorate-General for Energy (DG ENER) has launched a study in the domain of the energy efficiency and sustainability of data centres. This study's major goal is to assess the energy-efficiency of data centres, in line with the objectives of the Green Deal and the Digital Decade to have climate-neutral data centres, and to propose potential additional measures such as the establishment of a common Union rating scheme vis-à-vis the sustainability of data centres.

Part of the study focuses on data management. This interview guide is therefore designed to gather feedback on the data management perspective from the first reporting period of the European database on data centres under Article 12 of the Energy Efficiency Directive (EED) Recast and the Delegated Regulation (EU) 2024/1364. Its purpose is to facilitate consistent and comprehensive data collection, ensure alignment with reporting requirements, and support effective collaboration between national and EU-level stakeholders.

General information

- Could you please introduce yourself and your role in your organisation?

Data collection

- Were reporting guidelines or similar documents provided to data centre operators prior to participating in the reporting portal?
- Do you maintain an open channel where data centre operators can ask questions or request for more information?
- Did you implement any measures to encourage timely participation from data centre operators? If yes, please describe. (E.g. reminders, follow-ups, incentives, etc.)

Data processing

- Which tools or software did you use to handle the reported indicators from data centres? (E.g. data management systems, analytical software, etc.)
- Have there been (automated) validation or plausibility checks in place for the indicators submitted by data centres to ensure the accuracy and consistency of the reported indicators? If yes, please describe.

Data storage and protection

- Where are the reported indicators stored? (E.g. cloud storage, national databases, European databases, etc.)
- What measures are in place to ensure the security of the reported indicators during storage? (E.g. encryption, access controls, etc.)
- How long are the reported indicators retained and what is the policy for archiving or deleting data?

Feedback and improvement

- What aspect of the reporting portal could be improved in terms of data management?
- Do you have any suggestions for additional features or functionalities that could be added to the reporting portal?

Annex 3 – Further Union level results according to Annex IV of the Delegated Regulation (EU) 2024/1364

In accordance with Annex IV of the Delegated Regulation (EU) 2024/1364 on the first phase of the establishment of a common Union rating scheme for data centres, the following data points shall be reported at Union level:

- number of reporting data centres (see Chapter 3);
- distribution of reporting data centres by size categories;
- total installed information technology power demand (PDIT) of all reporting data centres (see Table 22);
- total energy consumption (EDC) of all reporting data centres (see Table 22);
- total water consumption (WIN) of all reporting data centres (see Table 22);
- average PUE for all reporting data centres in the Union territory, average PUE per type of data centre, average PUE per size category (see Chapter 3);
- average WUE for all reporting data centres in the Union territory, average WUE per type of data centre, average WUE per size category (see Chapter 3 and Figure 24 for average WUE per type of data centre);
- average ERF for all reporting data centres in the Union territory, average ERF per type of data centre, average ERF per size category (see Chapter 3 and Figure 25 for average ERF per type of data centre);
- average REF for all reporting data centres in the Union territory, average REF per type of data centre, average REF per size category (see Chapter 3 and Figure 26 for average REF per type of data centre).

Table 22 - EU totals for installed power, energy consumption and water consumption

	Total installed information technology power demand (PDIT) of all reporting data centres (in MW)	Total energy consumption (EDC) of all reporting data centres (in GWh)	Total water consumption (WIN) of all reporting data centres (in m³)
EU	3 738.86	14 088	6 223 391

Table 23 – Average PUE, WUE, ERF and ERF per type and size category of data centres

	Averages of all reported	Average value per type of data centres[38]	Average value per size category of data centres

[38] Colocation includes the categories: COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE and COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES,
Co-hosting includes the categories: CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE and CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES,
Enterprise includes the categories: ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE and ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES
The following (mixed) categories are not considered: COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_CO_HOSTING_SERVICES, COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE_WITH_CO_HOSTING_SERVICES, CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE_WITH_COLOCATION_SERVICES, CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_COLOCATION_SERVICES.

	data centres	Colocation	Co-hosting	Enterprise	100-500 kW	500-1000 kW	1-2 MW	2-10 MW	above 10 MW
PUE	1.36	1.43	1.24	1.31	1.63	1.64	1.55	1.47	1.21
WUE	0.58	0.56	0.17	0.83	0.193	0.561	0.413	0.499	0.705
ERF	0.205	0.20	0.02	0.24	0.147	0.255	0.203	0.228	0.147
REF	0.86	0.95	0.99	0.97	0.856	0.891	0.936	0.962	0.919

PUE only considers data centres that reported on both: Total energy consumption and IT equipment energy consumption (n=681). WUE considers only data centres with a reported water consumption other than 0 (n=457). The ERF considers only data centres that report >0 on waste heat reused (n=66). The REF only considers data centres that report on renewable energy >0 (n=583). The total energy consumption is used as weighting factors for all aggregated metrics.

Additionally, the figures below represent the average WUE, ERF and REF per type of data centres. Other relevant figures pertaining these metrics are shown in Chapter 3.2.

Figure 24 – Average WUE by type of data centre

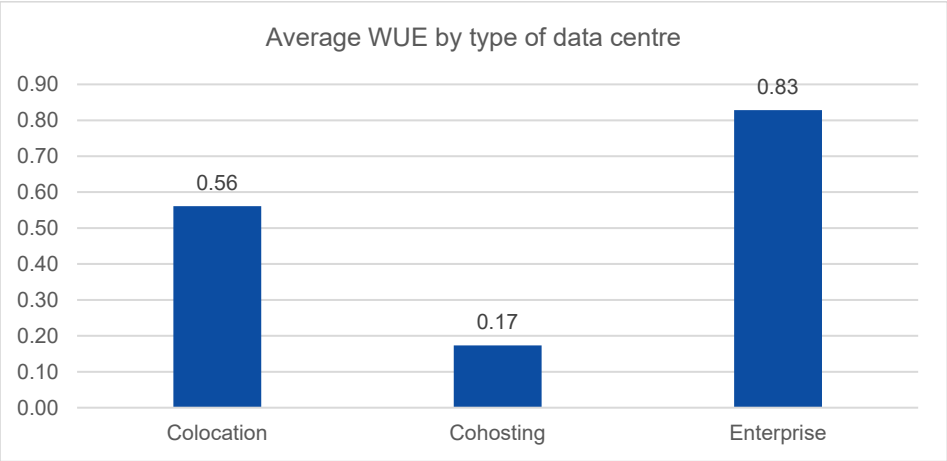


Figure 25 - Average ERF by type of data centre

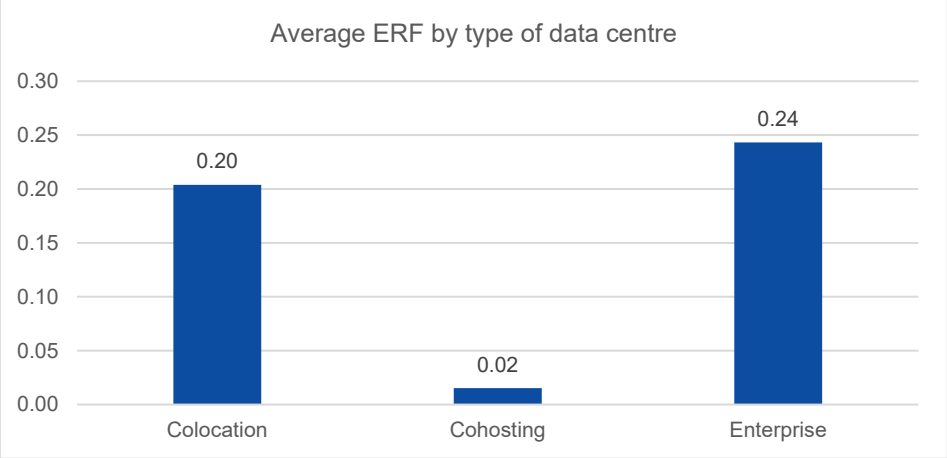
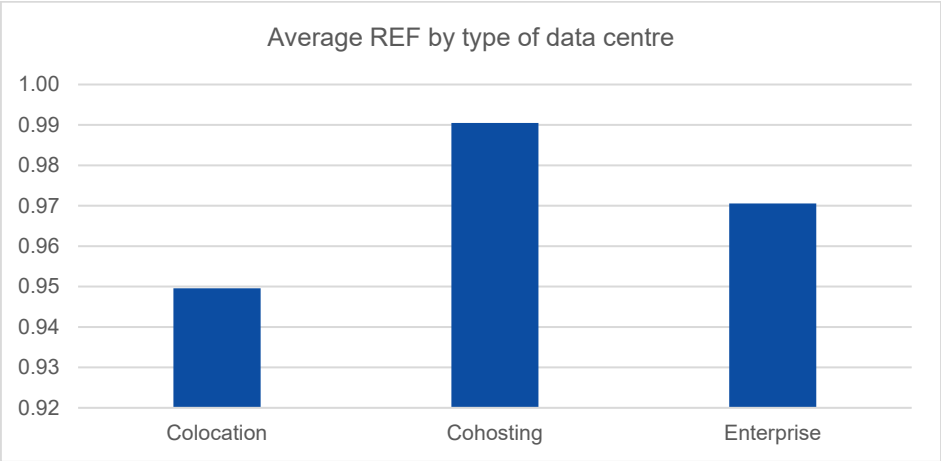


Figure 26 – Average REF by type of data centre


Average REF by type of data centre
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
Colocation
Cohosting
Enterprise

Annex 4 – Further MS level results according to Annex IV of the Delegated Regulation (EU) 2024/1364

Data points to be reported an MS level:

- number of reporting data centre (see Chapter 3ii);
- distribution of reporting data centres by size categories (see Chapter 3);
- total installed information technology power demand (PDIT) of all reporting data centres (see Table 24);
- total energy consumption (EDC) of all reporting data centres (see Table 24);
- total water consumption (WIN) of all reporting data centres (see Table 24);
- average PUE for all reporting data centres in the MS territory, average PUE per type of data centre, and average PUE per size category (see Table 25, Table 24 and Chapter 33.b);
- average WUE for all reporting data centres in the MS territory, average WUE per type of data centre, and average WUE per size category (see Table 26 and Chapter 33.b);
- average ERF for all reporting data centres in the MS territory, average ERF per type of data centre, and average ERF per size category (see Table 27 and Chapter 33.b);
- average REF for all reporting data centres in the MS territory, average REF per type of data centre, and average REF per size category (see Table 28 and Chapter 3).

No data centres reported data in the following countries: Cyprus, Czechia, Estonia,[39] Romania, Slovakia and Slovenia.

The table below presents the overview of IT installed power demand, energy consumption and water input across EU MSs based on the reported data of the first reporting period.

Table 24 - Member State data on total IT power, energy consumption and water input

Member State	Total installed information technology power demand (PDIT) of all reporting data centres (in MW)	Total energy consumption (EDC) of all reporting data centres (in GWh)	Total water consumption (WIN) of all reporting data centres (in m^3)
AT	16.14	111.10	6 288
BE	236.13	1 070.95	1 240 048
BG	4.11	20.14	4 601
DE	946.87	4 608.53	1 841 262
DK	193.74	731.28	330 801
EL	1.78	36.90	4 879
ES	101.03	603.63	214 501
FI	219.67	1091.18	8 599
FR	1 311.43	2416.90	399 147
HR	0.88	7.71	280

[39] Estonia disclosed KPIs for three data centres, but those were not included in the study as they were data ranges rather than absolute numbers.

HU	0.53	6.52	0
IE	315.92	1 411.76	626 594
IT	92.02	350.24	78 351
LT	2.30	18.00	0
LU	11.20	53.22	12 279
LV	0.70	6.30	60
MT	0.64	7.95	0
NL	102.76	574.87	1 356 210
PL	59.05	276.55	20 359
PT	7.67	48.75	27 919
SE	114.30	635.53	51 213

Meanwhile, the table below presents the average PUE per type and size categories of data centres filtered with threshold of minimum three data centres per category. The total energy consumption is used as a weighting factor for all aggregated metrics.

Table 25 - Average PUE per type of data centre and per size category

Member State	Average PUE per Member State	Average PUE per type of data centre[40]			Average PUE per size category				
		Colocation	Co-hosting	Enterprise	100-500 kW	500-1000 kW	1-2 MW	2-10 MW	above 10 MW
AT	1.50	1.44	*	*	*	1.46	*	*	*
BE	1.15	1.88	*	1.12	*	1.44	1.60	1.86	*
BG	1.46	*	*	*	*	*	*	*	*
DE	1.39	1.38	1.25	1.48	1.65	1.61	1.40	1.41	1.32
DK	1.21	*	*	1.53	*	2.01	*	1.46	*
EL	1.63	1.77	*	*	*	*	*	*	*
ES	1.66	1.67	*	1.66	1.87	1.59	1.52	1.80	*
FI	1.17	1.22	1.12	1.13	*	*	1.19	1.25	*
FR	1.55	1.48	*	1.71	1.63	1.93	2.09	1.54	1.33
HR	1.38	*	*	*	*	*	*	*	*
HU	2.00	*	*	*	*	*	*	*	*
IE	1.18	1.28	*	1.15	*	*	1.65	1.28	1.14
IT	1.46	1.41	*	1.53	*	*	1.63	1.38	1.38
LT	1.28	*	*	*	*	*	*	*	*
LU	1.37	*	*	*	*	*	*	*	*
LV	1,40	*	*	*	*	*	*	*	*

[40] Colocation includes the categories: COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE and COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES,
Co-hosting includes the categories: CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE and CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES,
Enterprise includes the categories: ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE and ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES
The following (mixed) categories are not considered: COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_CO_HOSTING_SERVICES, COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE_WITH_CO_HOSTING_SERVICES, CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE_WITH_COLOCATION_SERVICES, CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_COLOCATION_SERVICES.

MT	1.40	*	*	*	*	*	*	*	*
NL	1.39	1.39	*	1.32	1.40	1.24	1.39	1.44	*
PL	1.55	*	*	*	1.63	1.69	1.56	1.41	*
PT	1.58	*	*	*	*	*	*	*	*
SE	1.17	*	*	*	*	*	*	*	*

**: Below threshold of 3 data centres in this category.*

The table below presents the average WUE per type and size categories of data centres filtered with threshold of minimum three data centres per category. The total energy consumption is used as a weighting factor for all aggregated metrics. This analysis includes only data centres that have reported a number other than 0 on water input.

Table 26 - Average WUE per type of data centre and per size category

Member State	Average WUE per Member State	Average WUE per type of data centre[41]			Average WUE per size category				
		Colocation	Co-hosting	Enterprise	100-500 kW	500-1000 kW	1-2 MW	2-10 MW	above 10 MW
AT	0.14	*	*	*	*	0.501	*	*	*
BE	1.28	0.037	*	1.334	*	0.038	0.035	0.084	*
BG	0.32	*	*	*	*	*	*	*	*
DE	0.65	0.707	0.173	0.939	0.257	0.669	0.374	0.662	0.758
DK	0.57	*	*	1.565	*	0.233	*	0.239	*
EL	0.20	0.306	*	*	*	*	*	*	*
ES	0.70	1.005	*	0.847	0.138	1.262	0.183	0.454	*
FI	0.07	0.054	*	*	*	*	0.021	0.057	*
FR	0.25	0.264	*	0.278	0.037	0.433	0.169	0.204	0.341
HR	0.05	*	*	*	*	*	*	*	*
HU	No data	*	*	*	*	*	*	*	*
IE	0.64	1.045	*	0.510	*	*	2.004	1.286	0.515
IT	0.70	0.689	*	*	*	*	0.302	0.508	1.600
LT	No data	*	*	*	*	*	*	*	*
LU	0.32	*	*	*	*	*	*	*	*
LV	0.01	*	*	*	*	*	*	*	*
MT	No data	*	*	*	*	*	*	*	*
NL	0.66	0.641	*	*	0.081	0.036	0.641	0.898	*

[41] Colocation includes the categories: COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE and COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES,
Co-hosting includes the categories: CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE and CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES,
Enterprise includes the categories: ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE and ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES

The following (mixed) categories are not considered: COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_CO_HOSTING_SERVICES, COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE_WITH_CO_HOSTING_SERVICES, CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE_WITH_COLOCATION_SERVICES, CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_COLOCATION_SERVICES.

PL	0.21	*	*	*	0.232	0.058	0.028	0.428	*
PT	0.98	*	*	*	*	*	*	*	*
SE	0.10	*	*	*	*	*	*	*	*

**: Below threshold of 3 data centres in this category*

The table below presents the average ERF per type and size categories of data centres filtered with threshold of minimum three data centres per category. The total energy consumption is used as a weighting factor for all aggregated metrics. This analysis includes only data centres that have reported a number other than 0 on waste heat reused.

Table 27 - Average ERF per type of data centre and per size category

Member State	Average ERF per Member State	Average ERF per type of data centre[42]			Average ERF per size category				
		Colocation	Co-hosting	Enterprise	100-500 kW	500-1000 kW	1-2 MW	2-10 MW	above 10 MW
AT	0.006	*	*	*	*	*	*	*	*
BE	no data	*	*	*	*	*	*	*	*
BG	no data	*	*	*	*	*	*	*	*
DE	0.170	*	*	0.183	0.157	0.121	0.238	0.156	0.157
DK	0.236	*	*	*	*	*	*	*	*
EL	no data	*	*	*	*	*	*	*	*
ES	0.171	*	*	*	*	*	*	*	*
FI	0.457	0.424	*	*	*	*	0.440	0.461	*
FR	0.100	*	*	*	*	*	*	*	*
HR	no data	*	*	*	*	*	*	*	*
HU	0.057	*	*	*	*	*	*	*	*
IE	no data	*	*	*	*	*	*	*	*
IT	0.217	*	*	*	*	*	*	*	*
LT	no data	*	*	*	*	*	*	*	*
LU	0.000	*	*	*	*	*	*	*	*
LV	0.039	*	*	*	*	*	*	*	*
MT	no data	*	*	*	*	*	*	*	*
NL	0.068	0.067	*	*	*	*	*	0.053	*
PL	0.000	*	*	*	*	*	*	*	*
PT	0.006	*	*	*	*	*	*	*	*
SE	no data	*	*	*	*	*	*	*	*

[42] Colocation includes the categories: COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE and COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES,
Co-hosting includes the categories: CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE and CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES,
Enterprise includes the categories: ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE and ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES

The following (mixed) categories are not considered: COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_CO_HOSTING_SERVICES, COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE_WITH_CO_HOSTING_SERVICES, CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE_WITH_COLOCATION_SERVICES, CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_COLOCATION_SERVICES.

**: Below threshold of 3 data centres in this category*

The table below presents the average REF per type and size categories of data centres filtered with threshold of minimum three data centres per category. The total energy consumption is used as a weighting factor for all aggregated metrics. This analysis includes only data centres that have reported a number other than 0 on total renewable energy consumption.

Table 28 - Average REF per type of data centre and per size category

Member State	Average REF per Member State	Average REF per type of data centre[43]			Average REF per size category				
		Colocation	Co-hosting	Enterprise	100-500 kW	500-1000 kW	1-2 MW	2-10 MW	above 10 MW
AT	0.58	*	*	*	*	*	*	*	*
BE	0.96	1.000	*	1.000	*	*	*	*	*
BG	1.00	*	*	*	*	*	*	*	*
DE	0.89	0.912	0.991	0.893	0.847	0.959	0.917	0.970	*
DK	0.96	*	*	0.932	*	*	*	*	*
EL	1.00	1.000	*	*	*	*	*	*	*
ES	0.94	0.999	*	1.000	*	*	*	*	*
FI	1.00	0.999	*	*	*	*	1.000	0.997	*
FR	0.80	0.989	*	0.989	*	*	*	*	*
HR	0.00	*	*	*	*	*	*	*	*
HU	0.00	*	*	*	*	*	*	*	*
IE	0.99	0.983	*	1.000	*	*	*	*	*
IT	0.80	0.999	*	*	*	*	*	*	*
LT	0.81	*	*	*	*	*	*	*	*
LU	0.25	*	*	*	*	*	*	*	*
LV	0.84	*	*	*	*	*	*	*	*
MT	0.00	*	*	*	*	*	*	*	*
NL	0.79	0.939	*	*	*	*	*	0.938	*
PL	0.59	*	*	*	*	*	*	*	*
PT	0.36	*	*	*	*	*	*	*	*
SE	0.50	*	*	*	*	*	*	*	*

**: Below threshold of 3 data centres in this category*

[43] Colocation includes the categories: COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE and COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES,
Co-hosting includes the categories: CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE and CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES,
Enterprise includes the categories: ENTERPRISE_DATA_CENTRE_SINGLE_STRUCTURE and ENTERPRISE_DATA_CENTRE_GROUP_OF_STRUCTURES

The following (mixed) categories are not considered: COLOCATION_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_CO_HOSTING_SERVICES, COLOCATION_DATA_CENTRE_SINGLE_STRUCTURE_WITH_CO_HOSTING_SERVICES, CO_HOSTING_DATA_CENTRE_SINGLE_STRUCTURE_WITH_COLOCATION_SERVICES, CO_HOSTING_DATA_CENTRE_GROUP_OF_STRUCTURES_WITH_COLOCATION_SERVICES.

Annex 5 – List of contributing stakeholders

Table 29 - List of contributing stakeholders

Stakeholder category	Representatives
National data centre associations / initiatives	• Austrian Data Center Association • Bitkom (Germany) • Dutch Data Center Association • Estonian Association of Information Technology and Telecommunications (ITL) • Finnish Data Center Association • German Data Center Association • IT Infrastructure and Data Center Sector (SITIP) – ICT Association of Slovenia (ZIT) • Swedish Data Center Association
Data centre operators / owners and service providers	• A1 Telekom Austria • Adam Ecotech • Amazon Web Services • Aruba • Carbon3IT • Cisco • Colt Data Centre Services • Cosmote • Croatian Telecom • CyrusOne • Danfoss • DATEV eG • Deutsche Telekom • Digital Realty • Equinix • Fujitsu • Global Switch • Google • Hewlett Packard Enterprise (HPE) • Huawei

Stakeholder category	Representatives
	• IBM Corporation • Infineon Technologies • Intel • Ipcore • Iron Mountain • Kevlinx • LCL Data Centers (Belgium) • Magyar Telekom • Makedonski Telekom • Meta • Microsoft • Mitsubishi Electric • Nabiax • NEC Europe • Nixval • NTT Global Data Centers • NVIDIA • Orange • OVHcloud • Oxigen DC • SAP • Schneider Electric • SopraSteria • Telefonica • T-Mobile Austria • T-Mobile Germany • T-Mobile Poland • T-Systems International • Uptime Institute • Vantage Data Centers • Vertiv • Vodafone

Stakeholder category	Representatives
Industry associations / initiatives	• Anitec-Assinform (Italy) • CCIA Europe • CISPE • Connect Europe • Data Centre Alliance • DIGITALEUROPE • eco – Association of the Internet Industry • EUDCA • GIMELEC • Polish Chamber of Commerce for Electronics and Telecommunications (KIGEiT) • techUK • The Shift Project • Sustainable Digital Infrastructure Alliance (SDIA)
Research institutions and academia	• CSC – IT Center for Science • European Journal of Industrial Engineering (EJIE) • Istanbul Technical University • Kajaani University of Applied Sciences • KAMK University of Applied Sciences • Politecnico di Milano - Data Center Observatory • Roegen Centre for Sustainability • TU Wien • University of Bristol • University of East London • University of Nottingham • University of Stuttgart
Regulatory and policy authorities	• Autorité de Régulation des Communications Électroniques, des Postes et de la Distribution de la Presse (ARCEP) (France) • Danish Energy Agency • E-Control (Austria) • Energy Authority of Finland

Stakeholder category	Representatives
	• Federal Ministry for Economic Affairs and Climate Action Germany • Ministry for the Ecological Transition and the Demographic Challenge Spain • Ministry of Climate and Enterprise Sweden • Ministry of Climate Estonia • Ministry of Ecological Transition France • Ministry of Economy Croatia • Ministry of Economy France • Ministry of Economy Luxembourg • Ministry of Economy Slovakia • Ministry of Energy France • Ministry of Energy Lithuania • Ministry of Energy Commerce and Industry Cyprus • Ministry of Environment and Energy Greece • Ministry of Industry and Trade Czech Republic • Ministry of Justice and Digital Affairs of Estonia • Direction Générale de l'Energie et du Climat • Statistics Estonia • Sustainable Energy Development Agency Bulgaria
Energy and environmental stakeholders	• Aqua Publica Europea • Bruxelles Environnement • European Integrated Hydrogen Project (EIHP) • European Partnership for Energy and the Environment (EPEE) • Green Web Foundation • Nordic Swan Ecolabel • Oeko-Institut e.V. • Water Europe
Public affairs representatives	• APCO • Flint Global • Rud Pedersen Public Affairs

Stakeholder category	Representatives
Others (consultancies, IT companies or providers, legal representatives, etc.)	• Acton Consulting • Airbus • Atman • Banco Santander • Bechtle • Bird & Bird • Bjumper • BMGi • Bureau Veritas • CaixaBank • Capitoline • Chemours • CIS - Certification & Information Security Services • CoreStack • Conova communications • Cullen International • Data Center Excellence • Datwyler IT Infra • DCONGREEN • E+H Rechtsanwalte • EnBW Cyber Security • EPI Europe • Eurovent • Fibratel • Frauscher Consulting • Grow Energy • Hoval • Infineon Technologies AG • Insentis • Lazzari • Legrand • Merlin Properties

Stakeholder category	Representatives
	• MiCiM OI • MINUTE MANTENIMIENTO AIE • Netze BW • Northshore • PwC Belgium • Schneider Electric • SpiNNcloud Systems • Xylem • Zaunergroup

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