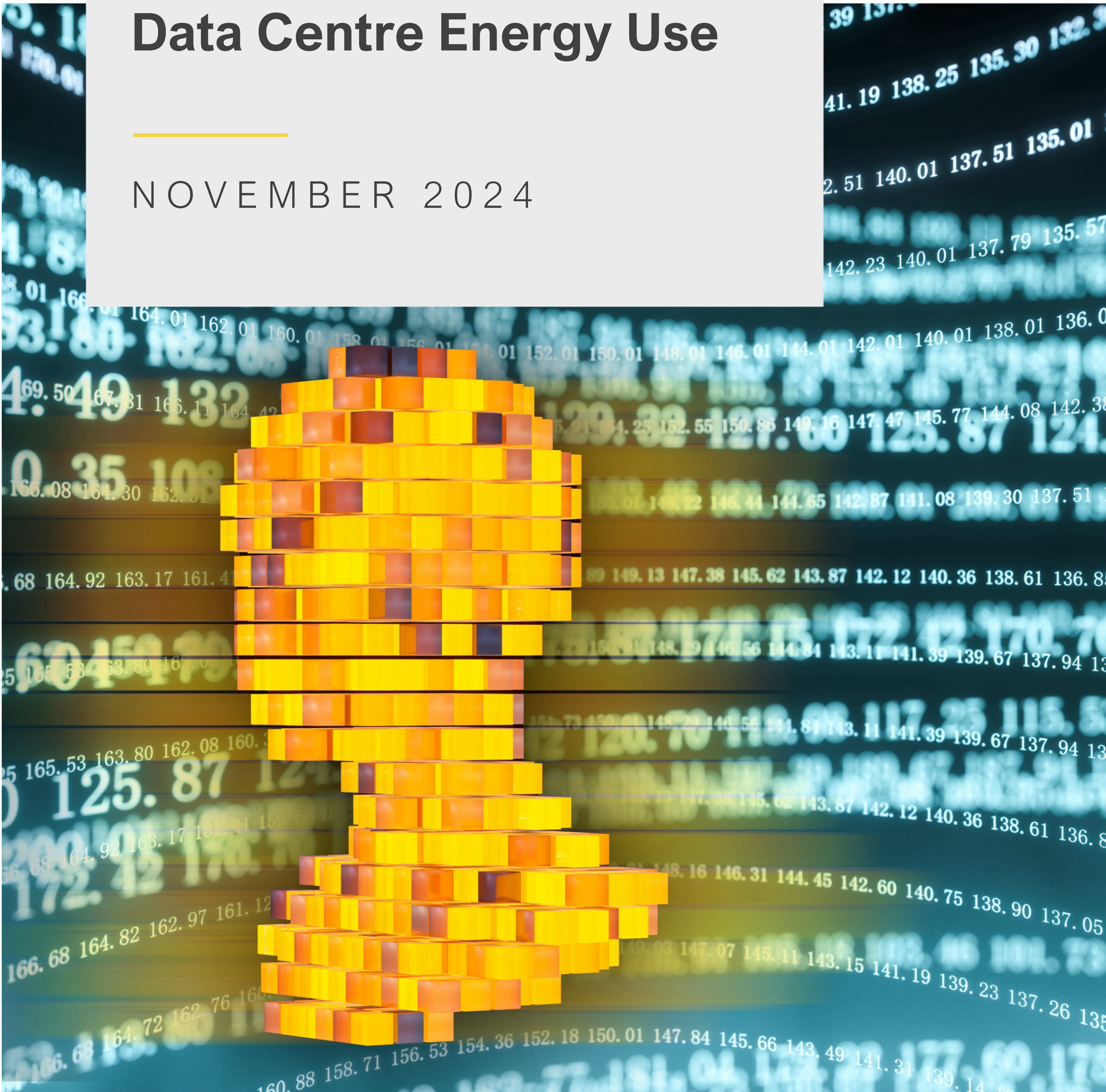
Efficient, Demand Flexible Networked Appliances EDNA

Public Data on Data Centre Energy Use

NOVEMBER 2024



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Energy Efficient End-use Equipment
International Energy Agency

The Technology Collaboration Programme on Energy Efficient End-Use Equipment (4E TCP), has been supporting governments to co-ordinate effective energy efficiency policies since 2008.

Fourteen countries and one region have joined together under the 4E TCP platform to exchange technical and policy information focused on increasing the production and trade in efficient end-use equipment. However, the 4E TCP is more than a forum for sharing information: it pools resources and expertise on a wide a range of projects designed to meet the policy needs of participating governments. Members of 4E find this an efficient use of scarce funds, which results in outcomes that are far more comprehensive and authoritative than can be achieved by individual jurisdictions.

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The Efficient, Demand Flexible Networked Appliances Platform of 4E (EDNA) provides analysis and policy guidance to members and other governments aimed at improving the energy efficiency and demand flexibility of connected devices and networks.

Further information on EDNA is available from: **www.iea-4e.org/edna**

PUBLIC DATA ON DATA CENTRE ENERGY USE

Collation and analysis

Fiona Brocklehurst, Ballarat Consulting

November 2024

for: IEA's Energy Efficient End-Use Equipment Technology Collaboration Programme Efficient, Demand Flexible Networked Appliances

Public data on data centre energy use

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Version 1, November 2024

Executive summary

The objectives of this study were to gather and analyse publicly available data on energy use by data centres.

Information was available within building energy benchmarking schemes that published data. There is one national policy, in France, which has published data for 2021 aggregated by building type. 159 *Servers & IT* sites reported a combined floor area of 800,000m^2 and energy use of 1.9TWh, 99% of which was electricity. *Servers & IT* was the building category with the highest Energy Use Intensity (EUI - energy use divided by floor area), with a mean EUI of 2477 kWh/m^2.

There are over fifty state, province, county and city energy benchmarking schemes in North America, some of which publish site data. It was found that 12 of these published data in enough detail to allow analysis and where at least one data centre or equivalent[1] had reported. They were (in order of state then city/county alphabetically): California, Boston MA, Brisbane CA, Cambridge MA, Chicago IL, Evanston IL, Lexington MA, Montgomery County MD, New York City NY, San Francisco CA, Seattle WA and Washington DC. Only a few data centres reported in each jurisdiction in a given year, except for California and New York City.

These data were cleaned and added together to give overall statistics for data centres for these U.S. schemes which are shown in the table below.

Year	2014	2015	2016	2017	2018
Number of sites reporting	5	11	11	15	45
Total energy reported (TWh)	0.030	0.217	0.224	0.285	1.527
Total floor area reported (m^2)	54,768	217,920	208,444	265,762	769,297
Year	**2019**	**2020**	**2021**	**2022**	**2023**
Number of sites reporting	98	111	118	78	1
Total energy reported (TWh)	2.192	2.582	2.659	2.916	0.006
Total floor area reported (m^2)	1,373,248	1,490,568	1,450,490	1,169,277	3,748

North American energy benchmarking schemes - Total energy use and floor area reported by data centres

The data were also analysed to look for variations in energy use over time, by jurisdiction and by floor area. As most sites only reported energy and floor area EUI is the only available metric for comparison. There were no clear relationships between EUI and place or floor area or over time in any jurisdiction. There were wide variations in EUI within each jurisdiction. Some of these variations are thought to be due to limitations in reporting under these schemes. For example, poor reporting compliance; sites did not report consistently from year to year. This means that there is a changing population of sites over time. Others are thought to be intrinsic to trying to use data from a multi-purpose building energy benchmarking schemes to derive information on data centres. These

[1] All the North American schemes used ENERGY STAR® Portfolio Manager to gather building energy data. This has two site categories which seem relevant: data centres and Other – Technology/Science sites. As it is unclear whether these categories are equivalent or distinct they were analysed separately.

reports do not collect data centre specific information such as IT installed power, type of operation (enterprise or colocation) or % utilisation, all of which have an effect on data centre energy use.

Analysis of reported data from building energy benchmarking schemes has to be done jurisdiction by jurisdiction and year by year; it is very time intensive and would be difficult to automate. Given that the information generated is of limited value it is suggested that this process is repeated, if at all, only for jurisdictions with a higher number of sites reporting such as California and New York City.

There are data centre specific schemes in the EU to collect and publish information on energy use which are expected to yield more information on energy performance. However these had not reported at the time of this analysis.

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Glossary

Term	Description
DC	Data Centre
EED	The EU's 2023 recast of the Energy Efficiency Directive which includes a requirement for data centres with a capacity of 500kW or greater to report energy use
EUI	Energy Use Intensity – energy use divided by floor area (kWh/m^2)
ENERGY STAR® Portfolio Manager	Tool provided by the US Environmental Protection Agency to report building performance. Used by all the North American building energy performance reporting schemes found in this research
GHG	Green House Gas
OTS	Other – Technology/Science. A site category in ENERGY STAR® Portfolio Manager which sometimes overlaps with data centres
PUE	Power Usage Effectiveness – a measure of infrastructure energy efficiency for data centres defined as $\frac{(IT\ equipment\ energy\ use + infrastructure\ energy\ use)}{IT\ equipment\ energy\ use}$
TEM	EDNA Total Energy Model : a quantitative global model of the 'total energy use' of connected devices. More information here.

1 Background and introduction

EDNA has a workstream on policy measures for energy efficiency of data centres. The goal of this workstream is to provide policy makers with information and evidence-based recommendations for policy measures to improve the energy efficiency of data centres, including the impact of these measures and suggestions for implementation.

Work to date has examined possible metrics for data centre energy efficiency, trends in data centre energy efficiency, assessing the availability of data, a review of existing or proposed policies on efficiency and data centre reporting and possible energy savings from the adoption of energy efficiency measures.

Worldwide energy use by data centres is already thought to be significant. Estimates for 2024 vary between between 250TWh[2] and over 500TWh[3] per year. One source forecasts energy use rising sharply in the next few years, to between 600 and 1000TWh in 2026.[4] At present policy makers have limited information on where data centres are, how much energy they use and how efficient they are. This makes it difficult for them to formulate effective policies on data centre energy efficiency.

A recent report for EDNA[5] showed that several public registries are being set-up for data centre energy related data. EDNA are considering taking up the role of collecting public data from these registries to provide a general overview of data centre (energy) data, e.g. collating and publishing on the EDNA website. This study examines what data (on individual data centres) is already publicly available and how this can be collected, stored and presented. The objectives of this task are to:

- Examine what data (on individual data centres) is already publicly available and how this can be best collected, stored and presented (on a regular basis).
- Collect the (public) data from registries to provide a general overview of data centre energy data.
- Devise which data could / should be displayed on the EDNA website.
- Investigate any intellectual property issues.
- Collate / parse data for publishing on EDNA website.
- Suggest a process and timeframe for updating the data on a regular basis.
- Report on the activity.

2 Methodology

2.1 Search for national schemes

A search had been made for (public) data registration schemes in selected countries in a previous project for EDNA[6]. The search focused on countries considered most suitable for new data centres with 22 countries included. For this work, the focus was primarily on IEA 4E TCP member countries, namely:

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[2] Brocklehurst (2024) Policy development on energy efficiency of data centres, EDNA
[3] IEA (2024) Electricity 2024; Analysis and forecast to 2026
[4] Ibid
[5] Brocklehurst (2024) Policy development on energy efficiency of data centres, EDNA
[6] Ibid

- EU
- Australia
- Austria
- Canada
- China
- Denmark,
- France
- Korea
- Netherlands
- New Zealand
- Sweden
- Switzerland
- United Kingdom
- United States

India and Malaysia were also included as they were known to have data centre energy labelling schemes.

An internet search was undertaken using variations of search terms. However, no additional data registration schemes were found in the original or new jurisdictions.

2.2 Search for North American state, province and city schemes

Previous work on registration schemes in North America took a targeted approach– searching for schemes in areas where data centres were known to be concentrated. For this study a comprehensive approach was taken. This was practicable because the Institute for Market Transformation[7] (IMT), a U.S. nonprofit organisation, tracks which cities, counties, states and provinces have adopted mandatory building energy benchmarking and transparency policies for existing buildings. IMT presents this information by category in maps for the U.S.[8] and Canada[9] and a matrix[10] which compares the requirements of commercial building energy benchmarking and transparency policies in cities and states around the U.S. These are updated periodically – the versions that were published in April 2024 were the most recent available and were used for this research. It was assumed that the matrix and maps are complete and up to date and no search for other schemes was undertaken.

IMT provide information on whether schemes publish data or not. Information on each scheme IMT identified as publishing data was sought using an internet search. Schemes were classified by the type of data they publish; where detailed data was available this was downloaded and analysed as described in the next section.

2.3 Analysis of data from North American building energy benchmarking schemes

Data was downloaded from the respective website for each jurisdiction where it was available. Generally, data was published by calendar year; in some cases (Chicago, San Francisco and

[7] https://imt.org/
[8] https://imt.org/resources/map-u-s-building-benchmarking-policies/
[9] https://www.imt.org/resources/canadian-policies-for-existing-buildings-benchmarking-transparency-and-beyond/
[10] https://imt.org/resources/comparison-of-commercial-building-benchmarking-policies/

Washington DC) data for all years was in one file. In each case, sites in the relevant categories were selected and copied into a separate workbook, by year.

The data was checked for quality, using quality flags where supplied and internal checks (such as whether the calculated EUI matched the published one). The quality checks used varied by jurisdiction and are described in Appendix 2 for each jurisdiction. Data which was suspected of being poor quality was not included in the analysis. A standard set of statistics were calculated for each year of data. Where possible these were:

- Number of sites reporting
- Number of sites reporting with robust data
- Total area of sites with robust data
- Total energy use of sites with robust data
- Average EUI of all sites reporting that year – calculated from the above
- Mean and median of the individual site EUIs (These differ from the overall EUI, above, which is weighted by floor area)
- Where there was significant use of fuels other than electricity, the number of sites using other fuels and the use as a percentage of the total.

In years and jurisdictions where there were sufficient sites for the analyses to be meaningful (20 or more sites) more detailed statistical analyses of the distribution of site EUIs were undertaken (calculating the deciles and quartiles) and presented using box and whisker graphs.

In some jurisdictions two further analyses were undertaken where there was robust data for many sites:

1. The EUI of sites which had robust reported data for several years were extracted and plotted. The graphs showed that there was a wide variation in performance. This was not found to be very informative so were not undertaken for most jurisdictions.
2. EUI was plotted against floor area for several sites and years to see if there was a correlation. There did not appear to be a strong correlation, so this analysis was not undertaken for most jurisdictions.

The results of these analyses are presented in detail by jurisdiction in Appendix 2. The headline results for North America are compared with each other and those published for France in section 5 (The data in France is also from building based energy reporting so is, in principle, comparable).

3. National and supranational schemes

National and supranational schemes that were identified are summarised in Table 1. The schemes are outlined in Appendix 1.

Table 1 National and supranational data collection and benchmarking schemes.

Jurisdiction	Policy name	deadline for data submission	Date data published	Type of data published
EU	Energy Efficiency Directive (recast)	1st 15/9/24 then 14/5 each year	Not known	Aggregate only
France	ELAN	30/9 starting 2022	2021 data published in June 2024. Future dates unknown.	Aggregate only
Germany	Energy efficiency law	1st 15/8/24 then 15/5 each year	1st 15/8/24 then 15/5 each year	For each DC

North American schemes which had published data in sufficient detail to allow analysis are summarised in Table 2. The schemes are outlined, along with the analysis of the data, in Appendix 2.

Table 2 North American state, province and cities' building energy benchmarking schemes, area thresholds and dates of application

Jurisdiction	Threshold area for reporting (m^2)	Applies from
California	4645	2018
Boston MA	3252 1858	2014 2021
Brisbane CA	929	2019
Cambridge MA	2323	2015
Chicago IL	4645	2014
Evanston IL	1858	2017
Lexington MA	4645	2022
Montgomery County MD	2323	2015
New York City NY	4645 2323	2015 2018
San Francisco CA	929	2011
Seattle WA	1858	2015
Washington DC	4645	2012

There are a handful of schemes which publish data in spreadsheet form and include detailed property type[11] and EUI but limited other data – no energy data and generally no floor area. These are described in Table 3. As there was limited information and it was not possible to check the quality of these data, it was decided not to include them in the analysis.

Table 3 North American state, province and cities schemes which publish property type and EUI but limited other data.

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
Ontario	Energy and water reporting	2018	≥ 4,645 m^2	Annual data published[12] in spreadsheet 2019-2022, with OTSs

[11] Other schemes use only six or so broad categories so it isn't possible to identify data centres.

[12] https://data.ontario.ca/dataset/energy-and-water-usage-of-large-buildings-in-ontario

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
Austin TX	Energy Conservation and Disclosure (ECAD) Ordinance	2008	≥ 929 m^2	Annual spreadsheet data[13] from 2014 to 2017 with DCs
Orlando FL	Building Energy & Water Efficiency Strategy	2016	Commercial ≥ 4645 m^2 Public/Government ≥ 929 m^2	Spreadsheet[14] for 2023 (2022 data?).. One DC, one OTS.
Reno NV	Energy and Water Efficiency Program	2019	Commercial ≥ 2787 m^2 Public/Government ≥ 929 m^2	Annual spreadsheets for 2021-2022[15]. Only weather normalised EUI and floor area. No DCs or OTSs in 2022 data.

There were a number of state and city schemes which had either been recently introduced or the web page to access the data was not available at the time of the analysis (June-July 2024). These were noted as they may be a source of public data in future. These are summarised in Table 4 and outlined in Appendix 3.

Table 4 North American state, province, and cities - Building energy benchmarking schemes where public data may become available.

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
Colorado	Building Performance Program	1st yr reporting 2021	≥ 4,645 m^2	Yes but not available yet
Massachusetts	Act Driving Clean Energy and Offshore Wind	2024	≥ 1858 m^2	Yes but not available yet
Minnesota	Building Energy Use Benchmarking Program	2023	≥ 9,290 m^2 2024 data then ≥ 4,645 m^2 2025 on	Yes but not available yet
New Jersey	Energy Benchmarking	2018 – 1st reporting year 2023	Commercial ≥ 2322 m^2	Unclear – in any case not yet available
Washington State	Clean Buildings Performance Standard	Adopted 2022, 1st reporting not until 2026	≥ 20,439 m^2 then 9,290 m^2	Unclear – in any case not yet available
Chelsea MA	Building Energy Reporting and Disclosure Ordinance (BERDO).	2022	≥ 1858 m^2	Unclear – in any case not yet available
Detroit, MI	Building Benchmarking Policy	2023	≥ 9290 then 2323 m^2	Not clear – no data yet
Philadelphia PA	Building Energy Performance Program	2013	Commercial ≥ 4645 m^2	Webpage not available[16]

[13] https://data.austintexas.gov/browse?q=ecad
[14] https://data.cityoforlando.net/dataset/BEWES-Building-Data/f63n-kp6t/about_data
[15] https://www.reno.gov/community/sustainability/energy-and-water-efficiency
[16] https://www.phillybuildingbenchmarking.com/

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
			Public/Government ≥ 929 m^2	

The remaining North American schemes either had not published detailed data or, in the case of new schemes, did not state the intention of publishing data. These are summarised in Table 5.

Table 5 North American state, province and cities - Data collection and benchmarking policies with no published data

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
Ann Arbor MI	Energy & Water Benchmarking Ordinance	2021 – 1st reporting 2024	≥ 1858 m^2	Not mentioned
Aspen CO	Building IQ	2022	≥ 929 m^2	Aggregate data in a report only
Atlanta GA	Building Efficiency	2015	Commercial ≥ 2323 m^2 Public/Government ≥ 929 m^2	Map[17] with EUI range only. 2DCs listed.
Berkeley CA	Building Emissions Saving Ordinance (BESO)	2012	≥ 1394 m^2	Annual spreadsheet up to 2022[18] but only 6 property types so not possible to identify DCs
Bloomington MN	Large building benchmarking program	2021	≥ 6968 m^2	Data on map and 1 DC but only EUI range shown
Boulder CO	Building Performance Ordinance	2015	Commercial ≥ 1858 m^2 Public/Government ≥ 465 m^2	Data on map and 1 DC but only EUI range
Chula Vista CA	Building Energy Saving Ordinance	2021	≥ 1858 m^2	Yes but not energy use and only 8 property types so not able to pick out data centres
Columbus OH	Energy and Water Benchmarking and Transparency Policy	2020	≥ 4,645 m^2	Data on map and only EUI range
Denver CO	Energize Denver Benchmarking	2017	≥ 2323 m^2	Aggregate report and data on map - only EUI range. DCs and OTSs reporting.
Des Moines IA	Benchmarking DSM	2019	≥ 2323 m^2	Yes via a map[19] but can only select by location and no info available

[17] https://gis.atlantaga.gov/CBEEO/
[18] https://data.cityofberkeley.info/Energy-and-Environment/BESO-Building-Energy-Data-and-Compliance-Status-15/5vy5-rwja/data
[19] https://maps.dsm.city/portal/apps/dashboards/1711d57c661e420492f539ac003eb15a

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
Edina MN	Efficient Buildings Ordinance-	2019	≥ 2323 m^2 from 2024	Yes and one DC but only range of energy intensity
Fort Collins CO	Building Energy and Water Scoring	2018	465-4645 m^2	Yes via map but only range of EUI and no DCs
Honolulu HI	Better Buildings Benchmarking	2022	Commercial ≥ 2323 m^2 Public/Government ≥ 929 m^2	Yes but only EUI via map
Indianapolis IN	Thriving Buildings	2021	Commercial ≥ 4645 m^2 Public/Government≥ 2323 m^2	No
Kansas City MO	Energy Benchmarking/ Energy Empowerment Ordinance	2015	Commercial ≥ 4645 m^2 (from 2024 on) Public/Government ≥ 929 m^2	Yes, via map but only GHG emissions and ENERGY STAR™ score
Los Angeles CA	Existing Buildings Energy and Water Efficiency (EBEWE) ordinance	2017	Commercial ≥1858 m^2, Public/Government ≥ 697 m^2	Yes but no property type and only EUI and GHG emissions
Madison WI	Building Energy Savings Program	2023	2024 ≥ 9290 m^2 2025 ≥ 4645m^2 2026 ≥ 2323 m^2	No
Miami FL	Building Efficiency 305 (BE305) program	2021	≥ 200,000 m^2 (for June 2023) ≥ 9290 m^2 (for Oct 2023) ≥ 4645 m^2 (for 2024) ≥ 1858 m^2 (for 2025)	Yes, via map with data type and EUI range only
Minneapolis MN	Energy Benchmarking	2013	Comm ≥ 4645 m^2 Public/Gov't ≥ 2323 m^2	Yes but by individual address and only EUI and GHG emissions
Oak Park IL	Building benchmarking	2023	≥ 929 m^2	No
Pittsburgh PA	Building Benchmarking	2016	Comm ≥ 4645 m^2, all Public/Gov't	Yes in theory but none published[20]
Portland ME	Energy Benchmarking	2016	Comm ≥ 1858 m^2 Public/Gov't ≥ 465 m^2	Yes but only EUI and GHG and no property type.
Portland OR	Commercial Building Energy Reporting	2015	≥ 1858 m^2	Yes via map[21] but only EUI. Map won't load.
Salt Lake City UT	Energy Benchmarking and Transparency Ordinance	2017	Comm ≥ 2323 m^2 Public/Gov't ≥ 279 m^2	No

[20] https://pittsburghpa.gov/dcp/reports-and-datasets
[21] https://www.portlandmaps.com/

Jurisdiction	Policy name	Date of introduction	Threshold (total building area)	Energy data published
San Diego CA	Building Energy Benchmarking Ordinance	2019	≥ 4645 m^2	Yes via map[22]? But not working
San Jose CA	Energy and Water Building Performance Ordinance	2018	≥ 4645 m^2	No
St. Louis MO	Building Energy Awareness Ordinance	2017	≥ 4645 m^2	Publish annual report (most recent 2018) with aggregate data
St. Louis Park MN	Efficient Building Benchmarking Ordinance	2019	≥ 2323 m^2	Yes via map, in most recent 2022, 1DC, but only EUI range
St. Paul MN	Energy Benchmarking Ordinance	2020	Comm ≥ 4645 m^2 Public/Government ≥ 2323 m^2. Partial disclosure possible - not to share energy data.	Yes via map, in most recent 2022, 1DC, but only EUI range
Vancouver BC	Annual Greenhouse Gas and Energy Limits Bylaw	Adopted July 2022, for 2023 on (rep deadline 1 June 2024)	area ≥ 9,290 m^2 then ≥ 4,645 m^2 2024 on	No, voluntary only

There are two or three different formats of maps used by the schemes that present data in maps. Some of these allow sites to be selected based on type; in some cases these are very broad types e.g. commercial, multi-residential. In others all the types in ENERGY STAR® Portfolio Manager (the software used by all the North American schemes to gather building energy performance data; hereafter abbreviated as Portfolio Manager) are presented. The most commonly displayed data for selected sites are EUI – Energy Use Intensity – in three ranges and the ENERGY STAR® score[23] – again in three ranges.

4. Overview of published data

4.1 Limitations of energy benchmark data

The building energy reporting schemes which are included in this review are designed to cover all large building types[24] and lack information specific to data centres. An energy reporting scheme designed specifically for data centres, such as the scheme introduced in the EU under the recast of the Energy Efficiency Directive (See section 2.1 and Appendix 1) would collect data on the data centre's IT capacity, the type of data centre (colocation or enterprise, as this may influences its energy use) and IT equipment energy use (separately from that used on infrastructure). It would also, where possible, record the energy used in the data centre separately from other uses in the same building, such as an office.

[22] https://www.sandiego.gov/sustainability-mobility/climate-action/bd/benchmarking/map
[23] An indication of the building energy efficiency
[24] ENERGY STAR® Portfolio Manager includes 18 main categories and, within those, more than 80 choices for building type.

Generic building energy reporting schemes do not provide these data. In particular, the floor area of the building is the only indicator of size; the concentration of equipment in a data centre could vary significantly so this may be a poor proxy of data centre size. Furthermore, a specific feature of these published data is that, for building with multiple uses, Portfolio Manager requires the area of each use to be entered, but this is not always published[25]. To provide consistent data the **total** building floor area had to be used in all cases, which means that floor area will be less representative in general. The most common co-use with data centres was parking, which would be expected to have a much lower EUI than data centres.

A further complication in comparing energy performance for sites in different jurisdictions is that the floor area threshold for requiring reporting varies in place (by up to a factor of five) and in some cases in time. This means that different populations of sites are sampled in each jurisdiction. The details for each North American scheme are in Table 2.

The French Decree n° 2019-771 relating to obligations for actions to reduce final energy consumption in buildings for tertiary use, French building energy marking and obligation regulation, abbreviated as ELAN, sets requirements on data centres based on floor area with six categories, as shown in Table 6. These classifications were applied to each North American site. These data are reported by size class in Appendix 2.

Table 6 Data centre size categories in the French building energy marking and obligation regulation - ELAN

Classification	Minimum area m^2	Maximum area in m^2
Server room	20	100
Mini data centre	100	500
Small data centre	500	1000
Medium data centre	1000	5000
Large data centre	5000	10000
Very large data centre	10000	

4.2 North American building energy benchmarking schemes

All the building energy benchmarking schemes that have been researched in this work require sites to report in calendar years. The deadline to submit reports varies somewhat – it may be as early as April or as late as July of the following year, with additional time generally allowed at the beginning of the scheme. Data is generally published more than a year later; only one jurisdiction, San Francisco, had published 2023 data when the data analysis was undertaken, in July 2024. All the schemes require building owner/operators to report using the U.S. Environmental Protection Agency's ENERGY STAR® Portfolio Manager[26]. (Sometimes additional data are required which are reported separately.) This has the advantage that most of the input data for all the schemes are common; however, as will be seen later, what each jurisdiction chooses to publish varies widely. Portfolio Manager is used for other purposes – including providing input data for calculating the ENERGY STAR® score for a building and enabling owners/operators to track and improve their building energy use. The former means that it is possible to enter data which is specific to the building category; for example, for data centres these include the PUE and IT energy use. However,

[25] Even in jurisdictions where it is published, it is generally only available for the most recent years of data.
[26] https://www.energystar.gov/buildings/benchmark

the energy benchmarking regulations do not require owners/operators to fill in these sections, few schemes include them in the data they publish and when they do it is only for a few sites.

4.3 Particular issues for North American energy benchmarking data

Site categorisation was found to be an unexpected complication for the analysis of the data from North American building energy benchmarking schemes. Portfolio Manager allows the user to specify the primary site category (for example, office or data centre) but also assigns a category which may be the same or different. How Portfolio Manager assigns a category is not stated. In some jurisdictions both values were published and differed for some sites. In all cases where it was published the Portfolio Manager assigned category was used in this analysis.

When screening the data initially it was noted that data centres were commonly included as a property use/category alongside other, primary uses/categories such as offices, shops and hospitals. These sites might be server rooms, or could be stand-alone data centres, but were not the largest building use by floor area. As it was not possible to extract floor area or energy use by building use these were not included in this analysis.

Another issue came to light in the course of the analysis: in two jurisdictions, Boston and New York City, there was a large increase in the number of sites categorised as data centres reporting in 2022. In both cases it was found that at least some of the data centre sites had reported in previous years but under a different category called Other – Technology/Science (OTS). To be consistent sites which were categorised as data centres in 2022 were re-categorised as data centres in previous years. In addition, data on Other – Technology/Science sites were collated and analysed in the same way as for data centres, but separately, for all jurisdictions. In some jurisdictions the energy performance of sites in the two categories, as measured by the EUI, appeared to be distinct (e.g. in California); in others there was considerable overlap (e.g. in Boston and New York City).

In some jurisdictions the number of data centres and Other – Technology/Science sites was similar (for California and Cambridge) but generally fewer of the latter reported data. There were several jurisdictions where no "Other – Technology/Science" sites were reported (e.g. in Chicago, Montgomery, Seattle and Washington DC) and two (in Evanston and Lexington), where only the latter were reported.

Portfolio Manager allows, and the energy benchmarking ordinances require, many parameters to be entered for reporting sites. In most cases only a small proportion of these parameters were published. In some cases around 20 parameters were included, for example the scheme in Brisbane. At the other extreme, New York City publishes a large number of the Portfolio Manager parameters for each site and a number of data quality checks – 254 parameters in total, although many of these are category specific so only a proportion of these are reported for any one site. Some of the 'basic' parameters, such as the total energy use, are not always included or energy use by fuel type is given only as a percentage of the total energy. This means that some elementary data quality checks cannot be done. Generally the weather normalised EUI (discussed below) is published even when the base EUI (calculated from total energy use and floor area) is not published but not all jurisdictions include the weather normalised EUI.

Other variations in reporting make the analysis more challenging. Where data for each calendar year is published separately the published parameters can change over time, which makes it more difficult to analyse data year by year. Another factor is the units used; in general reporting follows the

Portfolio Manager convention of using square feet for area and kilo British thermal unit (kBtu) for energy. However some jurisdictions use kWh or Therms[27] for some forms of energy.

6. Results and their interpretation

6.1 French results

The first publication of building energy performance data under ELAN was in June 2024[28]. This provided a summary of data reported for 2021 by building type. 159 *Servers & IT* (the category which includes data centres) sites reported data for 2021. These sites had a combined floor area of 800,000m^2 and energy use of 1.9TWh, 99% of which was electricity. The *Servers & IT* category had the highest EUI (with a mean EUI of 2477 kWh/m^2). The next highest category was *Laundry* (with a mean EUI of 829 kWh/m^2, around a third of the mean *Server & IT* EUI). The building energy performance data in the ELAN report (2024) includes some statistics on the distribution of EUI which are presented in Table 7.

Table 7 2021 Building energy performance data in ELAN (France) for Server & IT

	Mean	**D1 (10%)**	**Q1 (25%)**	**Median**	**Q3 (75%)**	**D9 (90%)**
EUI (kWh/m^2)	2477	265	828	1805	2817	5784

where D1 is 1st decile, Q1 is 1st quartile, Q3 is 3rd quartile and D9 is 9th decile.

6.2 North American results

Table 8 gives an overview of the North American data analysed. In most jurisdictions robust energy data was only reported for a handful of sites. The exceptions were California (for data centres and "Other – Technology/Science sites") and New York City (for data centres).

Table 8 Overview of data reported in North American province, state and city, building energy benchmarking schemes-

Jurisdiction	**Years of data analysed**	**Maximum No. of DCs reporting robust data (in a given year)**	**Maximum No. of OTSs reporting robust data (in a given year)**
California	From 2018 to2022	56 (2022)	28 (2022)
Boston MA	From 2014 to 2022 (lower area threshold from 2021)	8 (2021 and 2022)	2 (2021 and 2022)
Brisbane CA	2021 only	1 (2021)	1 (2021)
Cambridge MA	From 2015 to 2022	4 (2015 and 2022)	5 (2022)
Chicago IL	From 2014 to 2020 (DCs only reported from 2019)	4 (2019 and 2022)	None
Evanston IL	2018 and 2019	None	1 (2018)
Lexington MA	2022 only	None	3 (2022)
Montgomery County MD[29]	From 2015 to2022 (only public buildings 2015, DCs only reported from 2019)	4 (2022)	None

[27] a non SI unit of heat, equivalent to 100 kBtu
[28] PERFORMANCE ÉNERGÉTIQUE DU PARC TERTIAIRE Quel bilan de l'utilisation de la plateforme OPERAT en 2022-2023 ? Analyses et enseignements (ENERGY PERFORMANCE OF THE TERTIARY ESTATE What is the assessment of the use of the OPERAT platform in 2022-2023? Analysis and lessons), 2024, ADEME.
[29] Includes Rockville and Takoma Park MD which also have building energy benchmarking schemes.

Jurisdiction	Years of data analysed	Maximum No. of DCs reporting robust data (in a given year)	Maximum No. of OTSs reporting robust data (in a given year)
New York City NY	From 2015 to 2022 (lower threshold from 2018)	61 (2019)	5 (2018)
San Francisco CA	From 2011 to-2023 (DCs only reported from 2019)	1 (2018, 2019, 2023)	2 (From 2018 to 2023)
Seattle WA	From 2015 to2022	3 (2021)	None
Washington DC	From 2012 to 2022	1 (From 2012 to 2014, and 2018)	None

The number of data centres reporting robust data by year and jurisdiction is shown in Figure 1 and the number of Other – Technology/Science sites is shown in Figure 2. Robust data means data which was considered valid after data cleaning. The procedures for cleaning the data for each jurisdiction are described in Appendix 2.

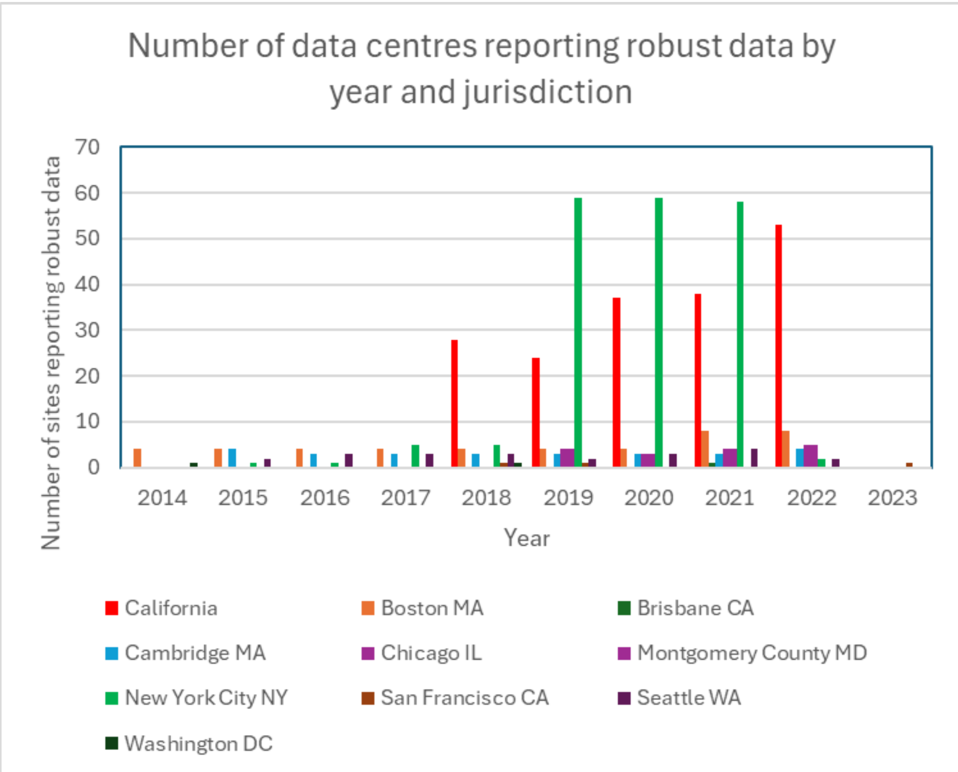

Figure 1 Number of data centres reporting robust data by year and jurisdiction

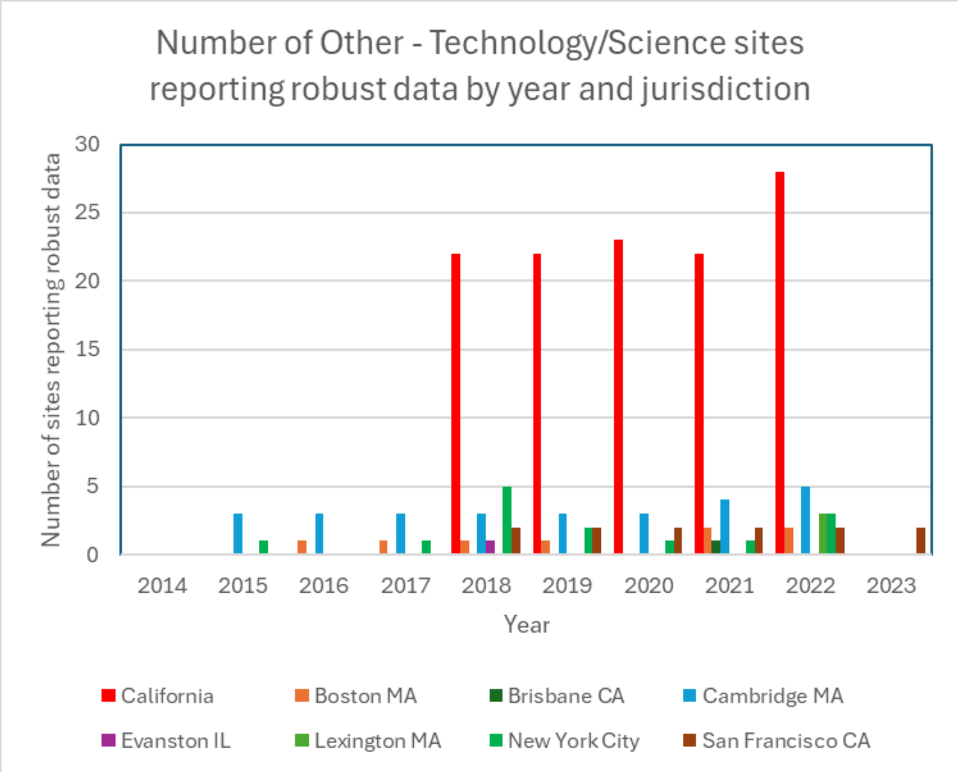

Figure 2 Number of Other – Technology/Science sites reporting robust data by year and jurisdiction

The total energy and floor area reported by year for all the jurisdictions combined is shown in Table 9 for data centres and for OTSs it is shown in Table 10. In both cases the data are for sites which reported robust data.

Table 9 North American energy benchmarking schemes- total energy use and floor area reported by data centres (robust data only)

Year	**2014**	**2015**	**2016**	**2017**	**2018**
Number of sites reporting	5	11	11	15	45
Total energy reported (TWh)	0.030	0.217	0.224	0.285	1.527
Total area reported (m^2)	54,768	217,920	208,444	265,762	769,297
Year	**2019**	**2020**	**2021**	**2022**	**2023**
Number of sites reporting	98	111	118	78	1
Total energy reported (TWh)	2.192	2.582	2.659	2.916	0.006
Total area reported (m^2)	1,373,248	1,490,568	1,450,490	1,169,277	3,748

The floor area and the energy reported increase year by year from 2014 to 2021. In 2022 the number of data centre sites in New York City which reported robust data decreased substantially reducing the overall totals. In 2023 data was available for only one jurisdiction at the time of analysis. There was a notable change in the number of sites, energy and floor area in 2018, when data for more jurisdictions became available. Also there was a sudden increase in data centres reporting in New York City between 2018 and 2019.

The area and energy reported for these North American jurisdictions collectively in 2021 is greater than that in France under the ELAN regulation.

Table 10 North American energy benchmarking schemes- total energy use and area reported by Other – Technology/Science sites (robust data only)

Year	**2014**	**2015**	**2016**	**2017**	**2018**
Number of sites reporting	0	4	4	5	34
Total energy reported (TWh)	0	0.014	0.027	0.028	0.377
Total floor area reported (m^2)	0	26,009	39,324	41,658	458,787
Year	**2019**	**2020**	**2021**	**2022**	**2023**
Number of sites reporting	30	29	32	43	2
Total energy reported (TWh)	0.250	0.225	0.224	0.266	0.009
Total floor area reported (m^2)	323,183	350,232	392,143	415,086	5,286

The pattern for the number of sites reporting robust data, the area and energy reported for Other-Technology/Science sites is similar to that for data centres although noticeably smaller in all respects.

The EUI is the only metric that is universally available for all the data analysed. So, while it has limitations, it is used to compare the energy performance of sites over time and between jurisdictions. These are compared with French results for context. Figure 3 and Figure 4 are bubble graphs of the mean site EUIs by year for data centres (or *Servers & IT* in France) and Other – Technology/Science sites, respectively. The two graphs are plotted using the same scale on the y-axis so the data centre and Other Technology values can be compared more easily. Note that there are fewer Other – Technology/Science sites in all cases, so the bubble sizes scale is different between the two figures. The range of mean EUIs by jurisdiction is greater for data centres than for Other – Technology/Science sites.

When comparing the U.S. and French results it is important to bear in mind the different in coverages of the different schemes:

- Those in the U.S schemes are for sites above the individual jurisdiction's floor area threshold and for sites where the primary building use is as a data centre or Other – Technology/Science.
- In France building operators are required to report data centre energy use whether this is for a dedicated data centre or a building with an IT (server) room.

Data centres and Other – Technology/Science sites have similar EUIs in some jurisdictions. This is true for New York City and Boston (where sites that had been categorised as Other – Technology/Science were re-categorised as data centres in 2022, as described above) while in other jurisdictions (California and San Francisco) the mean EUI values are noticeably higher for data centres than for Other – Technology/Science.

There are no clear trends in mean EUI values over time in most jurisdictions, the exception being the single data centre which reported in San Francisco, which showed a decrease in EUI over time. The variations in mean EUI over time are generally less than the difference in mean between jurisdictions. The range of mean EUIs by jurisdiction is greater for data centres than for Other – Technology/Science sites.

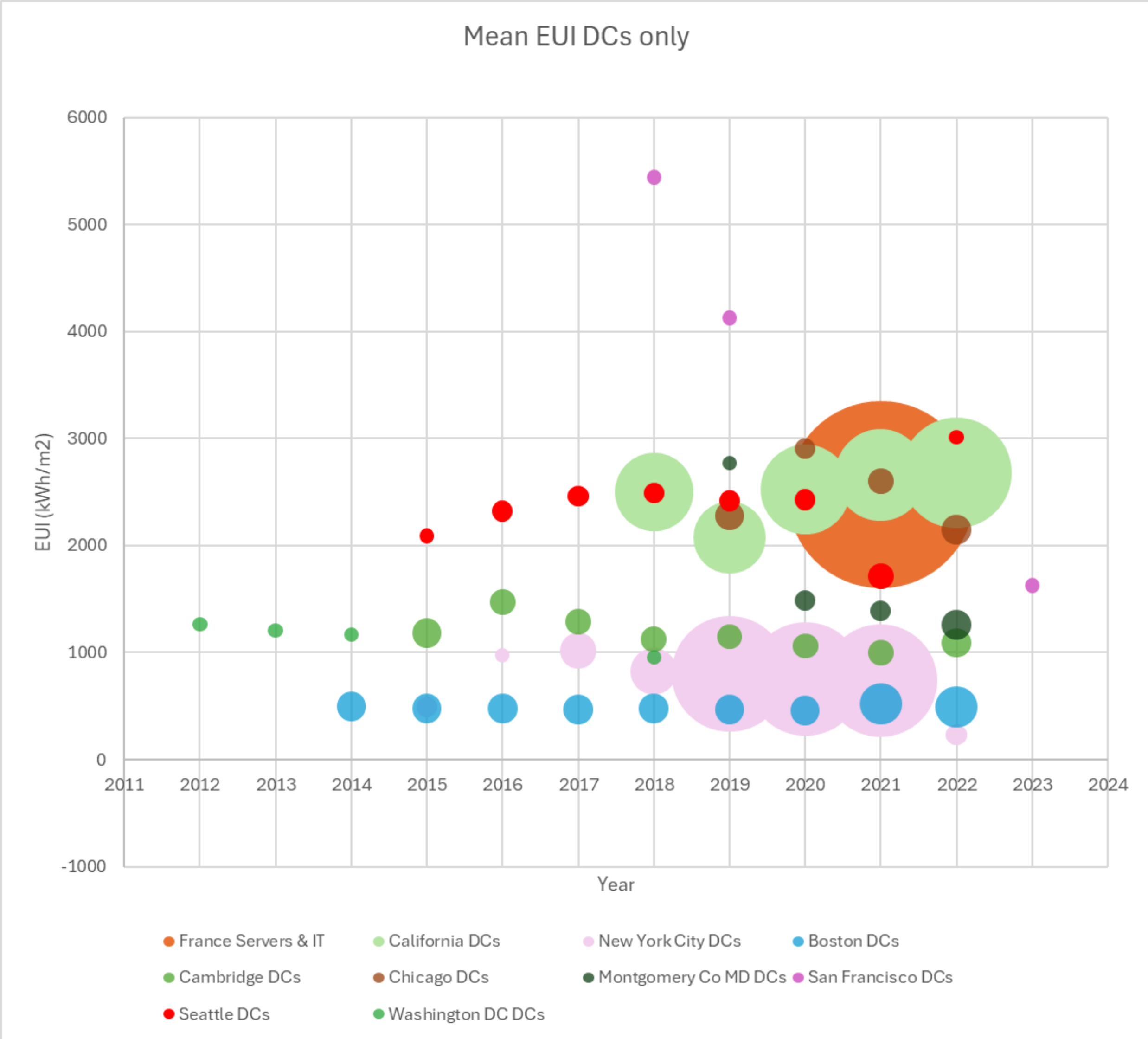

Figure 3 Mean site EUI for data centres across all jurisdictions by year. Size of bubble indicates the number of sites reporting robust data.

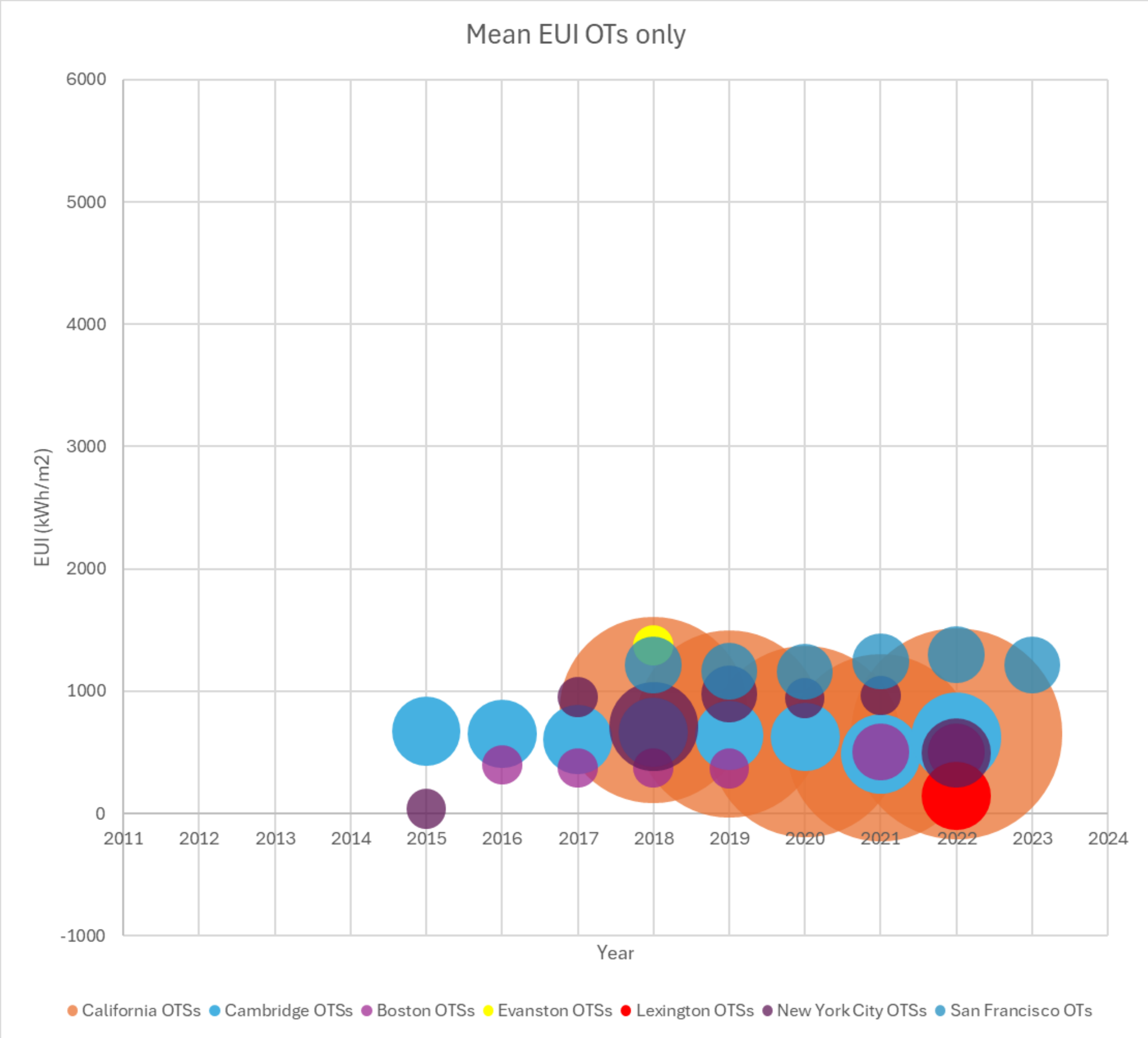

Figure 4 Mean site EUI for Other- Technology/Science sites across all jurisdictions by year. Size of bubble indicates the number of sites reporting robust data.

Figure 5 and Figure 6 are bubble graphs of the median site EUIs by year for data centres (and *Servers & IT* in France) and Other – Technology/Science sites respectively, with the same y-axis scale so that they can be compared. The range of mean EUIs by jurisdiction is greater for data centres than for Other – Technology/Science sites. Similar patterns between jurisdictions, between data centres and Other – Technology/Science and over time apply as for the means.

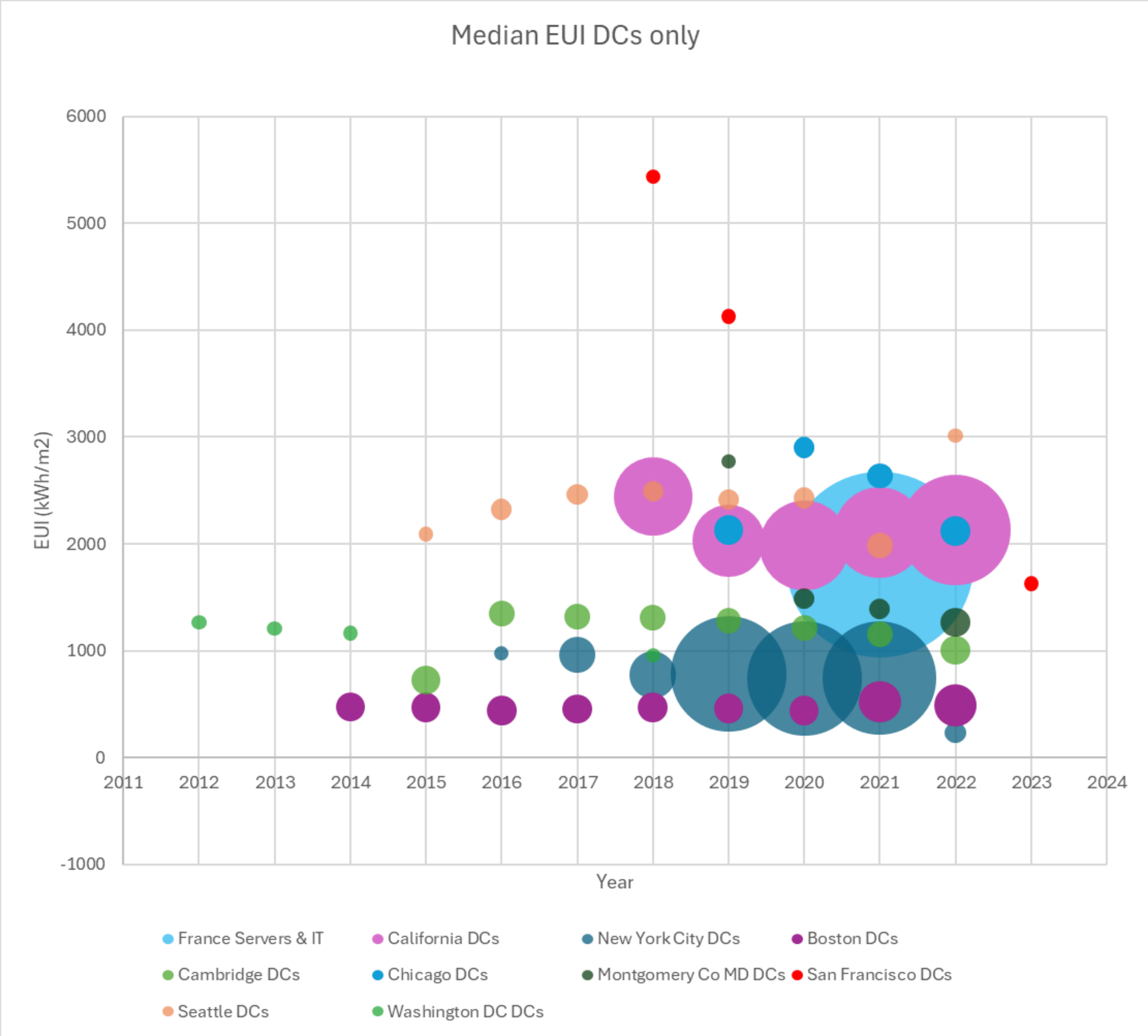

Figure 5 Median site EUI for data centres across all jurisdictions by year. Size of bubble indicates the number of sites reporting robust data

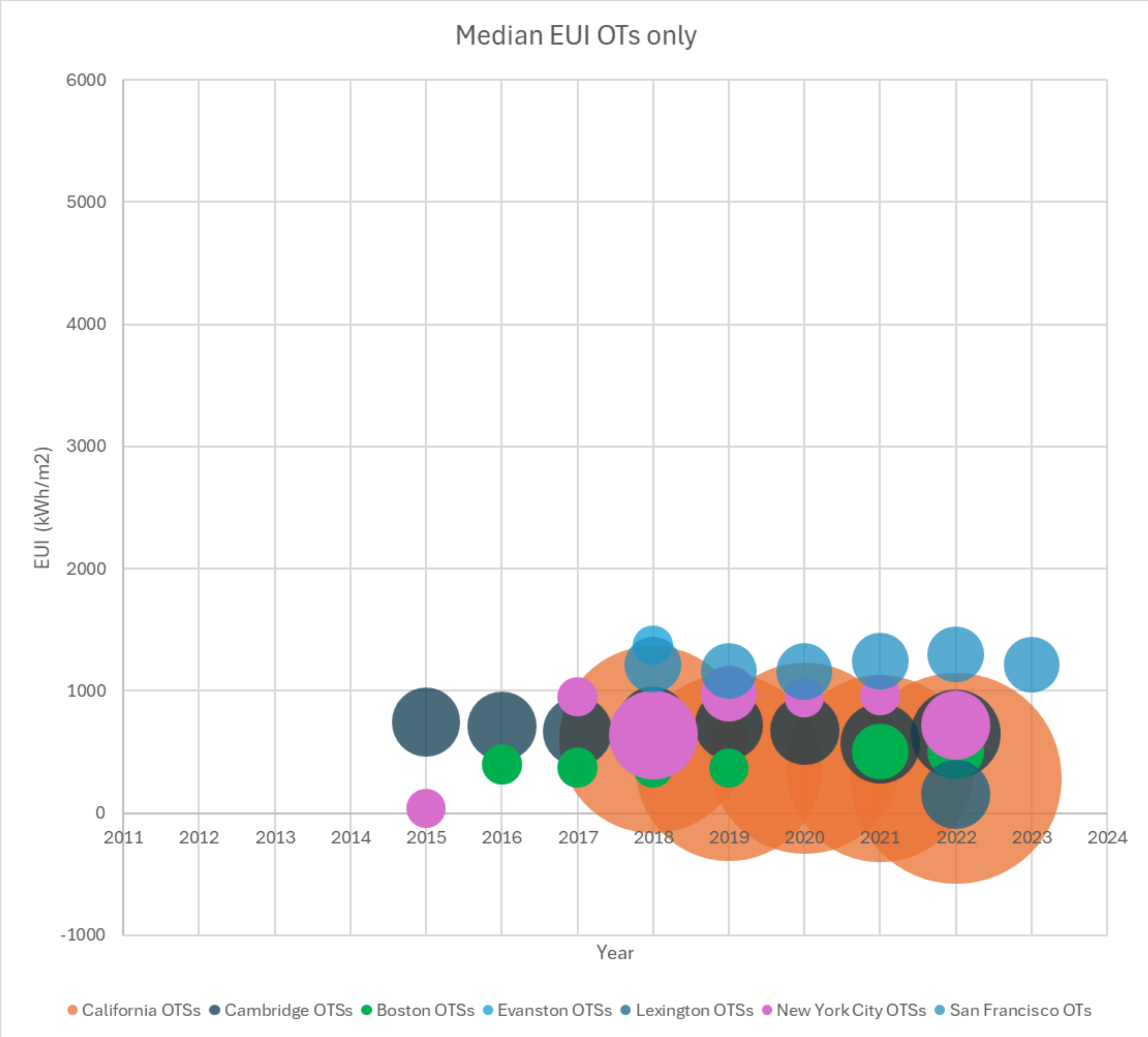

Figure 6 Median site EUI for Other- Technology/Science sites across all jurisdictions by year. Size of bubble indicates the number of sites reporting robust data.

Focusing only on average EUI values might be misleading as there are large variations in EUI in all jurisdictions within each year. This is demonstrated by the range of EUI seen in two North American jurisdictions with enough reporting sites to make centile analysis valid, California and New York City, shown in Figure 7 alongside the results for France in 2021.

The data for New York City shows the lowest variation between the first and ninth deciles in absolute terms; this could be because the median EUI values are lower. However, it is also true in terms of the ratio to median, as shown in Figure 8. This could be because one contributor to the variation in EUI by site is climate and there is less climate variation within a single city than within a U.S. state (California) or a country (France). Some of the range of variation in France may be due to the fact it includes data from server rooms, as well as buildings where the primary function is a data centre.

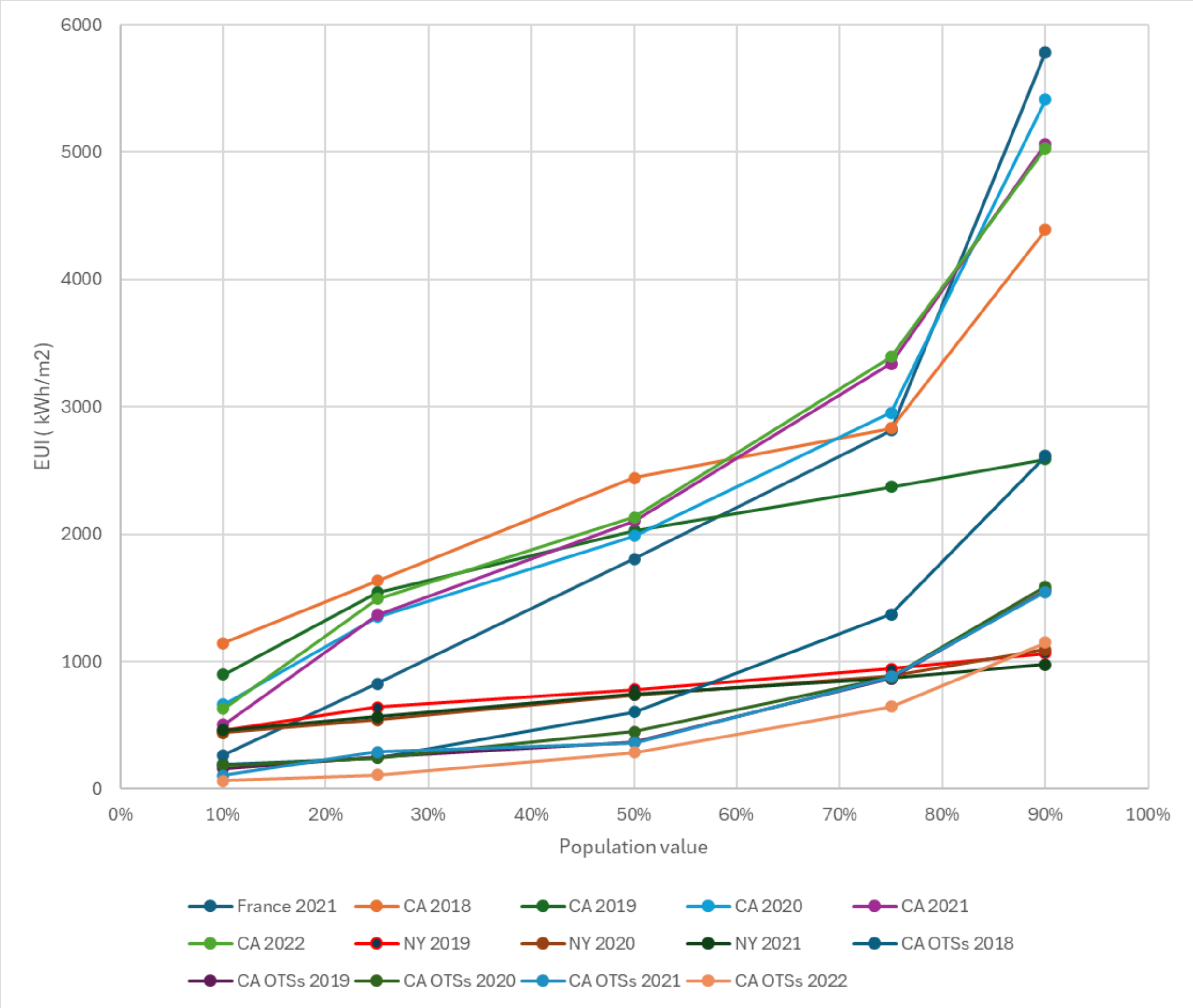

Figure 7 Variation in EUI by jurisdiction and year for selected jurisdictions.

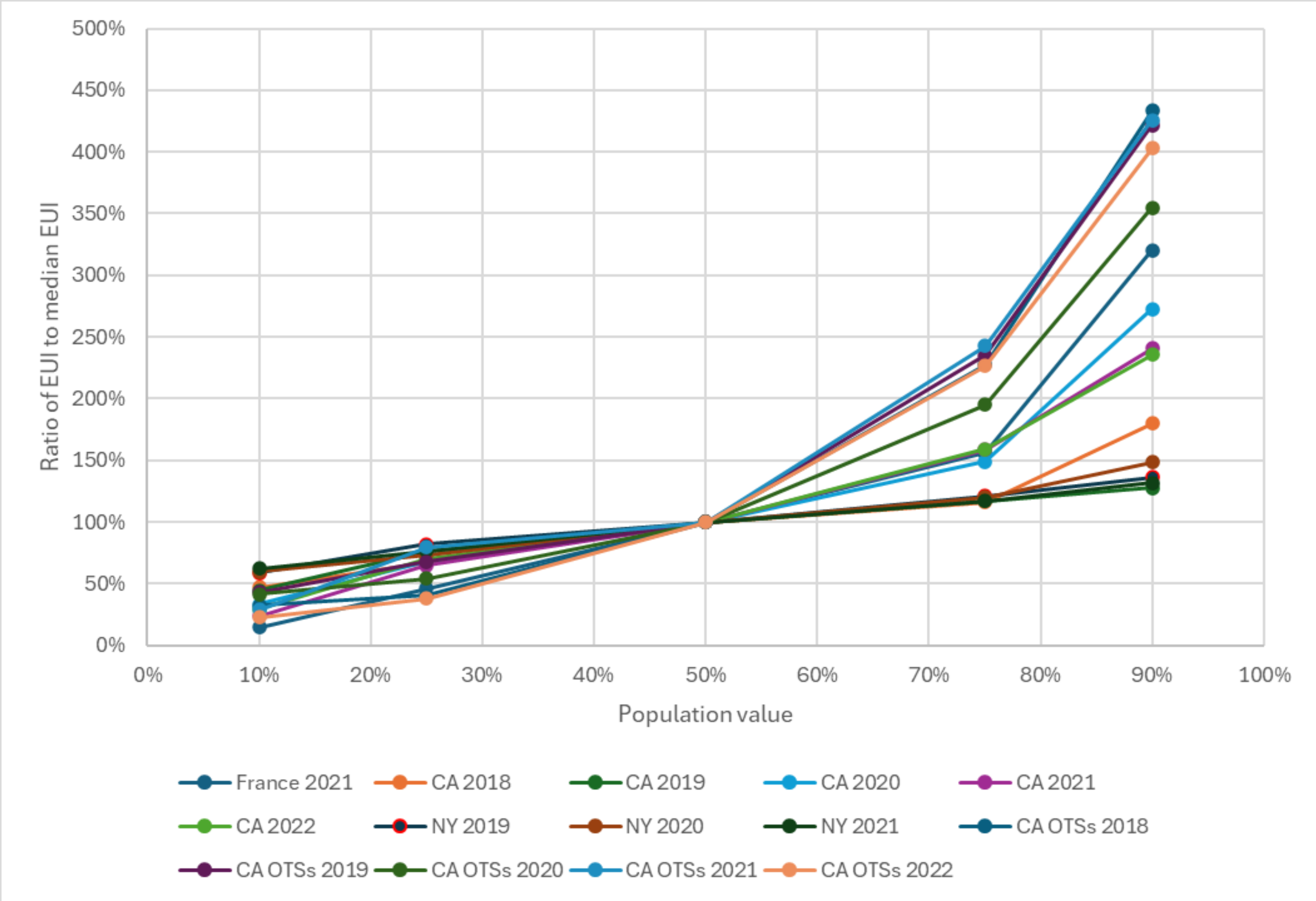

Figure 8 Distribution of EUI as a proportion of median EUI for selected jurisdictions

The sources of variations in EUI by data centre and how and to what extent they could be addressed by better and broader data collection is discussed in the next section.

6.2 Sources of variations in the North American data

As described above the EUI values showed large variations. There are several reasons for this, some of which could be lower compliance and poor quality of reporting for data centres, and some which are intrinsic to the data. These are discussed separately below.

Variations due to the quality of the reporting

Better compliance means that all eligible sites would report robust data every year. In two jurisdictions (Cambridge and San Francisco) all sites were included in the annual report whether they had provided a compliant report or not. This means that it is possible to distinguish between a site that had not reported previously because it was new and one that should have reported and did not. The latter appeared to be common; in any year in most jurisdictions some sites which had reported previously were missing and in many cases then reported in following years. This meant that the sites had not changed usage but their data were missing because they had not reported. Equally it was not possible to distinguish between sites which were reporting for the first year because they were new, or because this was the first year that they had complied. The latter seemed likely in some cases, such as the increase in data centres reporting in New York City between 2018 and 2019.

The poor continuity of site reporting suggests that compliance rates are low and that the responsible authorities are not enforcing the regulation vigorously. This is the case even though all of the schemes include fines for not reporting in a given year. Moreover, governments have lists of buildings, with information on their floor areas and owners for the purposes of collecting local taxes and enforcing other regulations, therefore, it should seem feasible, if time consuming, to enforce the regulations.

This churn in the data means that the population of sites reporting changes when the population of sites which should be reporting does not. The variation in reporting could mask any real trends in number of reporting sites, energy use and EUI. This is a large effect:

- in California only 11% of Other – Technology/Science sites and 24% of data centres reported for all five years of published data.
- in New York City 93% of the data centres reported for four years or less and only one site (1.5%) reported for the possible maximum of 13 years. Of the Other – Technology/Science 13 sites which reported in total; there were only 17 sets of site reports –only two sites reported for more than one year.

Another source of inconsistency is the changes in site categorisation. In two jurisdictions a mass re-categorisation occurred for the data reported in 2022. Sites which had been listed as Other – Technology/Science in previous years were 'rebranded' as data centres. It is unclear why this happened, but as it happened in two jurisdictions in the same year it is possible that this was due to a change in Portfolio Manager. The fact that re-categorization occurred suggests that the categories are not applied consistently. If sites are wrongly categorised then this will be another source of variation in the data.

Some jurisdictions undertook error checking and provided the results so it was possible to use these checks to exclude sites with less robust data from the analysis. In other cases, sufficient data was published to allow the identification of questionable data using simple checks. In yet other cases it was not possible to clean the data and it had to be accepted as it was. If some of these are poor quality data points this will add variations (errors) to the results.

Secondary or tertiary sites uses were reported for some of the sites but it wasn't possible to take account of this in the analysis, as this wasn't reported consistently. If some sites have significant energy use outside the primary use, i.e., as data centre or as Other – Technology/Science sites, then this will add to the noise in the data.

Variations intrinsic to the data

When the threshold for floor area for a building to report is changed more buildings become eligible and should report, which increases and changes the population of sites reporting. This may change the distribution and averages of the EUI; however the effect is explicit and the effects can be identified.

One inevitable source of variation in the energy use data reported will be the effect of the weather. Most data centres have a PUE of greater than 1.5. This means that at least a third of energy use is in infrastructure, most of which is used in air conditioning and so is at least partially weather dependent. Portfolio Manager attempts to account for this situation by calculating the "weather normalised energy use". This takes into account the type of building energy use by fuel type, and the number of cooling and heating days in a year compared to the climate average. The process is described in more detail in Appendix 4. Where the weather normalised EUI was included in the published data this was compared to the EUI calculated from the energy use and the floor area. The weather normalised EUI was not used in this analysis, predominantly because it was not always published. However, it is not clear whether the normalisation has been customised to the particular energy performance of data centres and Other – Technology/Science sites. If the weather normalisation has not been customised then the variation of energy use due to changing weather year by year would be a remaining source of variation in the data, even if the weather normalised EUI was used.

As a significant proportion of data centre energy is used for cooling the climate would be expected to have an effect on the EUI. In principle it would be possible to combine data on climate (for example cooling degree days) and location to adjust for this although it would be complex. Ideally data on the proportion of energy used in infrastructure, expressed as PUE, would also be used. This is not included in the published energy benchmarking data. The effect of climate remains embedded in the data.

Finally there are some variations of energy use which are particular to data centres:

1. Different types of data centres, for example small enterprise and large cloud data centres, may have different energy intensities. If the data centre type and size (in IT capacity) were reported then these data could be analysed separately.
2. To some extent the energy use of a data centre depends on the 'work' it does – the data analysed, stored or transmitted, but they also use a significant portion of energy when in idle. If the time in idle, or a parameter which related to it, such as % utilisation, were to be reported then it would be possible account of this in the analysis.
3. Data centres are frequently modified and upgraded with new servers and/or data storage and/or networking equipment installed. These may be replacement or additional equipment, and in the latter case, may not need increased floor space. Thus, while occupying the same floor area and operating under the same organisation, a data centre may change in form and energy use substantially over time. If the total IT power/IT load was reported it may be possible to account for this in the analysis of the energy use.

6.3 Energy use by fuel type

At the start of this work it was expected that the vast majority of energy use by data centres would be electricity. It was thought that this could be supplemented by the use of diesel fuel at a low level, consistent with use for back-up power supply and occasional use to check the systems functioned correctly. This is reported to be the case in the ELAN data from France; 99% of the reported energy use in 2021 by *Servers & IT* was electricity. However, in many North American jurisdictions several sites consistently reported the use of natural gas across a number of years. It was possible that natural gas was used as back-up power, analogous to the use of diesel. Taking the data on diesel use as an example it was assumed that if usage was below 5% a year natural gas was being used as back-up. The number of sites reporting significant natural gas use, above 5%, was counted for each year and it was found to be substantial.

From the California data centres data it became apparent that natural gas is being used to generate a large portion of the electricity for some sites, and even at one site in 2019 it was used to generate extra electricity which was exported to the grid (109%). This was consistent with the same site reporting no use of electricity from the grid in other years. An online search was made to investigate the use of natural gas by data centres. Technical providers and news sites report the use of natural gas to generate electricity for data centres, both as back-up power[30] and, as the supply for fuel cells,

[30] "Powering Data Centers with Natural Gas - A Report on the Benefits of Natural Gas for Data Center Backup Power". Black & Veatch, 2020. https://www.bv.com/perspectives/powering-data-centers-natural-gas-report-

to displace grid supplied electricity[31]. The reasons given for using fuel cells are the difficulty and delays in getting an electricity grid connection at the required capacity and to reduce the cost of energy. Another advantage is quoted as being a minimal footprint or infrastructure at the location of the data centre.

In one jurisdiction, New York City, several fuels other than electricity were reported at significant levels (>5% of energy use) for multiple sites over a number of years. These were fuel oil, diesel, natural gas and district steam (details in Appendix 2.9). It is assumed that fuel oil, diesel and natural gas were used to generate electricity, supplementing that from the grid. It is not clear how steam could be used in data centres, where the predominant energy demand is for cooling rather than heating. An internet search on this topic failed to find any results.

7 Summary and conclusions

7.1 Data availability and quality

The period of this analysis (May to July 2024) was ahead of the deadline for data centres to report energy data under any of the data centre specific reporting obligations. These obligations are all in EU countries. Some countries, Germany and the Netherlands, have stated their intention to make data public soon after their submission. (This seems ambitious and is very different to the practice in the building energy benchmarking schemes, where there is generally a delay of at least a year between the reporting deadline and data publication.) When analysed these data should provide insight on data centre performance in a way that the broad building energy benchmarking schemes cannot, as they lack data on metrics which are particular to data centres. Also the selection of the data which are published may be more consistent than in the building energy benchmark schemes which vary widely by jurisdiction.

At present data are only available from the building energy benchmarking schemes: one in France and twelve U.S. schemes at state, county or city level. The main metric for all of these is Energy Use Intensity (EUI). EUI has limited utility for data centres, even with building floor area also provided, as it does not give a clear indication of the size or the type of operation of the data centre.

The French scheme, ELAN, presents aggregated data from a considerable number of Server & IT sites, around three times that of any of the individual U.S. schemes to date. The first publication only included data by building type for 2021 but there is a commitment that data will be published for subsequent years. Energy reporting is one aspect of a broader policy (outlined in Appendix 1.2), which also places an obligation to reduce carbon emissions by a given percentage by target dates, the first being 2030. It is hoped that this will mean that building owners/operators will report data consistently, so that year on year comparisons of performance are meaningful. The data are presented in a single report so are easy to collect.

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benefits-natural-gas-data-center-backup-power/#:~:text=Natural%20gas%20supply%20and%20delivery,startup%20time%20for%20emergency%20power.

[31] "Data centers and fuel cells", Peter Gross, PMG Associates, Data Center Dynamics. February 2023. https://www.datacenterdynamics.com/en/opinions/data-centers-and-fuel-cells/
and
"Microsoft planning 170MW gas power plant at Dublin campus". Dan Swinhoe. Data Center Dynamics, December 2022. https://www.datacenterdynamics.com/en/news/microsoft-planning-170mw-gas-power-plant-at-dublin-campus/.

Data availability is less homogeneous for the benchmarking schemes in North America. Some jurisdictions do not publish any data, some only publish aggregate data, with data centres not being reported separately. Many jurisdictions only publish the data on an interactive map. Of the 58 schemes investigated in the course of this research only 16 currently publish individual site records in spreadsheets – so that they are accessible for analysis and of these four only report EUI. There is the prospect of newly adopted schemes publishing data in the next few years, some of which are for states and this could increase the number of reports of data centres considerably. However, some of these may publish the data in a form which is not suitable for analysis.

Twelve jurisdictions published detailed data, including floor area and energy use. It was reasonably straightforward to download the data in a Comma Separate Value or Excel spreadsheet format, generally year by year. However, while data are submitted using a common format (in Portfolio Manager) the data is published in different forms by jurisdiction and in some cases from year to year. Different combinations of data are published. In some cases little or no data cleaning had been done; when this was undertaken some or many sites' data had to be excluded from the analysis.

In summary, the inconsistencies in the data (for example use of different metrics) and variable data quality meant that a lot of effort had to be spent cleaning the data and the analysis couldn't be standardised. With this situation it is difficult to see how data collection and analysis could be automated effectively in further studies. Analysis of data jurisdiction by jurisdiction and year by year, as it was done in this first study, is very time intensive.

7.2 Insights from the data centre energy data

The combined energy use reported from all the U.S. energy benchmarking schemes was about 3 TWh in 2022 (see Table 9), of the same order as that reported for the French *Servers & IT* category in 2021, which was 2 TWh. This compares with projections for global data centre energy use of around 200 TWh in 2021[32] or from the analysis done using TEM for EDNA[33] of about 220 TWh in 2024; this suggests that the collected data represents a small fraction of the total. This seems in line with the relatively limited geographic coverage. This indication of the total energy use in these jurisdictions is the most useful figure from the analyses.

No useful information on energy efficiency is available from the U.S. schemes because of the limitations of the data. These are:

- There are two site categories in Portfolio Manager which may apply to data centres: data centre and Other- Technology/Science. In two jurisdictions sites which had been categorised as Other-Technology/Science were re-categorised as data centres. There does not appear to be a clear distinction between the two categories of sites, as demonstrated by the re-categorisation from Other – Technology/Science to data centres in two jurisdictions, and also by the similar EUI values in some jurisdictions. For this study data on both categories have been analysed separately using the most recent categorisation for previous years where applicable. While the number of Other- Technology/Science sites relative to data centres is small, this creates both uncertainty and more work in collecting and analysing the data.
- There is poor consistency in reporting - sites drop in and out of reporting in most jurisdictions. This implies that, in general, compliance is low. Also, in most jurisdictions reports did not list sites which should have reported but did not. This means it isn't possible to distinguish between sites

[32] Kamiya, G. and Kvarnström, O. (2019). Data centres and energy – from global headlines to local headaches? IEA

[33] Brocklehurst, F. (2024).Policy Development on Energy Efficiency of Data Centres, EDNA.

that have changed their activity or new sites from those which have not reported in a given year from sites which have not reported. This churn in reporting makes it difficult to identify any trends in the data, as the population of sites being analysed in any one year keeps changing.

- For the published data of the jurisdictions included in this analysis, information about compliance rates did not seem to be published.[34] If it is not possible to include all sites in a report whether they comply or not compliance rate information by building category by year would be helpful to give an indication of how much data are missing.
- The threshold of the floor area for reporting varies by jurisdiction, and in some cases over time, so the population is different by jurisdiction. Data centres with smaller floor areas are obliged to report in some jurisdictions whereas in others they aren't; the comparisons are between different populations.

These limitations of the data mean it is difficult to extract useful information from it.

Further, as all the data comes from building energy benchmarking schemes EUI has to be used as the metric of energy intensity. EUI has limitations for analysis of energy use of data centres. Both data centres and Other – Technology/Science sites reported a wide range of EUIs in each jurisdiction which means that trying to track trends over time using average values is of limited value, but at this point and with this reported data, is the only practical option.

The average EUI values (see Figure 3, Figure 4, Figure 5 and Figure 6) show a wide range across jurisdictions. In general the average is distinct for each jurisdiction over time and, in most cases, did not show a trend over time. Whenever several sites reported in a given year there was a wide range of EUIs and the range of EUIs overlapped between jurisdictions (as shown in Figure 7).

It was possible to extract the energy use and EUI for a given site which reported robust data for several years, for the sites which reported robust data, but it was found that there were no insights to be gained from this.

One unexpected finding was that a number of data centres used significant amounts of natural gas (greater than 5% of total energy use). This was the case for sites in four of the jurisdictions i.e., California, Boston, Montgomery County and New York City. The same was the case for Other – Technology/Science sites in five jurisdictions (California, Cambridge, Lexington, New York City and San Francisco). Also significant use of district steam was reported in New York City for some data centres and Other – Technology/Science sites and in Boston for one Other – Technology/Science site.

7.3 Display of data on EDNA website

One of the objectives of this study was to consider whether and how to make public data on data centre energy use available on the EDNA website. As the data collected to date has not proven to be informative the proposal is not to do this at present.

7.4 Process and timeframe for updating the data on a regular basis

The timeframe for publication of data centre energy performance in the EU under the EED or separate Member State regulations (like the Energy Efficiency Law in Germany) is uncertain so it is not possible to comment on this at this time.

[34] In jurisdictions which published information on maps or aggregated in reports this information was more common.

The process for reporting of aggregate energy data under ELAN in France is still being developed; it is hoped that now the first publication by building category has taken place data for 2022 onwards will be published soon and a schedule for future years will become established.

Most of the U.S. building energy benchmarking schemes allow owners six months after the end of the calendar year to report and publish the data 15 to 18 months after that. Based on this it seems sensible that a round of data collection and analysis take place in the first quarter of the year after the year end – that is for 2023 data checking in January to March 2025.

For new U.S, schemes (listed in Table 4 and described in Appendix 3) the delay between data collection and publication is likely to be longer – probably it is only worthwhile checking if data is available and if so in what form in early 2026.

For most jurisdictions only a handful of sites report, which means few results for almost the same effort of collecting, compiling and analysing the data as for larger datasets. If resources are limited then it makes sense to focus on the jurisdictions where the most sites report: as a first cut these would be California and New York City, in a second cut, adding Boston, Cambridge and Chicago. Five of the new schemes are for states rather than counties or cities so they could include many data centres, depending on what data are published.

Appendix 1 Description of national and supranational data collection schemes

In alphabetical order of country or jurisdiction.

A1.1 EU: Energy Efficiency Directive 2023 and data centre registry delegated regulation 2024

Short description

Article 12 of the recast EED, EU/2023/1791, (entered into force September 2023) places an obligation on Member States to require owners and operators of eligible data centres in their territory to make a set of information publicly available, except for information subject to Union and national law protecting trade and business secrets and confidentiality via Article 33 paragraph 3.

The COMMISSION DELEGATED REGULATION (EU) 2024/1364 of 14.3.2024 on the first phase of the establishment of a common Union rating scheme for data centres was published in the Official Journal of the EU on 17 May 2024.

By 15 September 2024, then by 15 May 2025, and every year thereafter, reporting data centre operators shall communicate to the European database the information and key performance indicators listed below.

Scope

Data centres with a power demand of the installed information technology (IT) of at least 500kW, are included.

Data centres used for, or providing their services exclusively with the final aim of, defence and civil protection are excluded.

Data collected (published)

The data to be gathered annually is:

1. **Information on the reporting data centre**
   a) the name of the data centre,
   b) the name and contact details of the owner and operators of the data centre,
   c) Location of the data centre (Local Administrative Unit Code (LAU code))
   d) Type of data centre (choice of ‘enterprise data centre’, ‘colocation data centre’ or ‘co-hosting data centre’. If a colocation data centre also offers co-hosting services or if a co-hosting data centre also offers colocation services, this shall be indicated.)
   e) Year and month of entry into operation;
2. **Information on the operation of the reporting data centre**
   a) Redundancy level of the electrical infrastructure
   b) Redundancy level of the cooling infrastructure
3. **Energy and sustainability indicators**
   a) Installed information technology power demand (‘PDIT’, in kW),
   b) Data centre total floor area (‘SDC’, in square metres).
   c) Data centre computer room floor area (“SCR”, in square meters)
   d) Total energy consumption (‘EDC’, in kWh)
   e) Total energy consumption of information technology equipment (‘EIT’, in kWh)

f) Electrical grid functions
g) Average battery capacity ('CBtG', in kW)
h) Total water input ('WIN', in cubic metres)
i) Total potable water input ('WIN-POT', in cubic metres)
j) Waste heat reused ('EREUSE', in kWh)
k) Average waste heat temperature ('TWH', in degree Celsius)
l) Average setpoint information technology equipment intake air temperature ('TIN', in degree Celsius)
m) Types of refrigerants used
n) Cooling degree days ('CDD', in degree-days)
o) Total renewable energy consumption ('ERES-TOT', in kWh)
p) Total renewable energy consumption from Guarantees of Origin ('ERES-GOO', in kWh)
q) Total renewable energy consumption from Power Purchasing Agreements ('ERES-PPA', in kWh)
r) Total renewable energy consumption from on-site renewables ('ERES-OS', in kWh)

4. **ICT capacity indicators**
    a) ICT capacity for servers ('CSERV')
    b) ICT capacity for storage equipment ('CSTOR', in petabytes)
5. **Data traffic indicators**
    a) Incoming traffic bandwidth ("BIN", in gigabytes per second)
    b) Outgoing traffic bandwidth ("BOUT", in gigabytes per second)
    c) Incoming data traffic ("TIN", in exabytes)
    d) Outgoing data traffic ("TOUT", in exabytes)
6. **Sustainability Indicators**
    a) Power Usage Effectiveness (PUE)
    b) Water Usage Effectiveness (WUE)
    c) Energy Reuse Factor (ERF)
    d) Renewable Energy Factor (REF)

Member States are to require owners and operators of data centres in their territory to make this information publicly available, except for information subject to Union and national law protecting trade and business secrets and confidentiality.

The information, and key performance indicators, communicated to the European database, and the data centre sustainability indicators, shall be made public in an aggregated manner, at Member State and Union level.

Hardware and software used for collection

The European database shall apply a common user interface as well as a common application programming interface ensuring that all reporting data centres are able to communicate, in the same way, the information and key performance indicators.

References:

- DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on energy efficiency and amending Regulation (EU) 2023/955 (recast), July 2023
- COMMISSION DELEGATED REGULATION (EU) 2024/1364 of 14 March 2024 on the first phase of the establishment of a common Union rating scheme for data centres

A1.1.1 Netherlands: National publication of data

On 3 June 2024 the Dutch Government announced how they would meet the EED requirement publishing a web page and a (spreadsheet) template which operators are to use to report data (which is in line with the EU requirements listed above). The powers to require data centre operators to do this were introduced by Regulation no. WJZ/45659628, 2024.

Points to note are:

- Data reporting opens on the 17th June; the deadline for reporting is 15 July (for subsequent years 15 May)
- Data reporting is via a spreadsheet template available on the Government web site in Dutch and English
- Reports will be published within 14 days of submission
- The expectation is that all data is published. Operators are to make a case for why data should not be published under Open Government Act, article 5.1.1c.

References

- Decree of April 26, 2024 amending the Decree on living environment activities, STB 122
  https://zoek.officielebekendmakingen.nl/stb-2024-122.html#d17e73
- Regulation of the Minister for Climate and Energy of 6 June 2024, no. WJZ/45659628, amending the Environmental Regulation in connection with the implementation of Article 12 of Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) (OJ EU 2023, L 231)
  No. 18837, 13 June 2024
  https://zoek.officielebekendmakingen.nl/stcrt-2024-18837.html
- Web page: Reporting obligation for energy efficiency data centres, https://www.rvo.nl/onderwerpen/energiebesparingsplicht/eed-auditplicht/rapportageplicht-datacentra

A1.1.2 Austria: national collection of data

A specific web page has been set up to gather the information that data centres need to submit to comply with the EED. This is a development of the existing electronic reporting platform for the Federal Energy Efficiency Act.

A1.2 France: obligations for actions to reduce final energy consumption in buildings for tertiary use (ELAN) 2019

Short description

The decree No 2019-771 relating to the Obligations for actions to reduce final energy consumption in buildings for tertiary use was adopted in 2019 and the first deadline for entering data for was 30 September 2022. (30 September is the deadline for entering data for the previous calendar year.)

Scope

The scope is defined by floor area, with a threshold of 1000 m^2. This applies to all tertiary buildings. Building operators will need to report data centre energy use whether this is for a dedicated data centre or a building with an IT (server) room.

Data collected (published)

Each owner or tenant will have to report their energy consumption data annually for the previous year. The floor area by category or sub-category (data centres are a sub-category) is also reported. Only collated data – the energy performance of a sector for a given year, is published. In addition the online platform will allow each organisation to see how their energy performance compares to those made by organisations with buildings in the same category.

The first report of aggregate performance data was published in June 2024. The report gives headline data (total floor area and energy reported) for the reference year and 2020 to 2022.. In addition for each property type for 2021 the report lists:

- The total energy use
- The floor area
- The % use by fuel type
- Statistics on the energy use intensity: the mean; first decile; first quartile; median, third quartile and ninth decile.

Hardware and software used for collection

Data is reported via an online IT platform called OPERAT.

References:

- OPERAT presentation 25 January 2023
- PERFORMANCE ÉNERGÉTIQUE DU PARC TERTIAIRE Quel bilan de l'utilisation de la plateforme OPERAT en 2022-2023 ? Analyses et enseignements (ENERGY PERFORMANCE OF THE TERTIARY ESTATE What is the assessment of the use of the OPERAT platform in 2022-2023? Analysis and lessons), 2024, ADEME

A1.3 Germany: Energy Efficiency Law 2023

Short description

The act entered into force in November 2023 at the latest.

The first date of entering data into the national register and publishing the data is:

- 15 August 2024 (2023 data) for data centres > 500kW. Thereafter 15 May in the subsequent year.
- 1 July 2025 for data centres ≥ 300kW and < 500kW. Thereafter 15 May in the subsequent year.

The German Federal Government is establishing an energy efficiency register for data centres in which the information transmitted by the data centres is stored and transferred to a European database on data centres.

Most recent information (May 2024)[35] is that it is not clear when and how the data will be published, in any case not before September 15. Aggregation level, etc. is still to be decided.

Scope

In the law a data centre is defined as:

a) A structure or group of structures for the central housing, central connection and central operation of information technology and network telecommunications equipment to provide data storage, data processing and data transport services with a non-redundant rated electrical connected load from 300 kilowatts and up.

b) All facilities and infrastructure for power distribution, for environmental control and for the required level of resilience and security required to provide the desired service availability, with a non-redundant nominal electrical connected load of 300 kilowatts or more.

Data centres that serve to connect or connect other data centres and which predominantly do not have any data processing are exempt.

Data collected (published)

Operators of data centres are obliged to submit and publish information about their data centre to the Federal Government (deadlines above). The publication obligation can be fulfilled by granting approval for the publication of the required data in the efficiency register for data centres[36].

The requirements under the German Law are:

1. General data centre information for publication

a) Name of the data centre,
b) Name of the owner
c) Name of the operator of the data centre
d) Size class by rated information technology load (<500 kW; < 1MW, < 5MW; <10MW, <50MW; <100 MW; >= 100 MW),
e) Postcode at which the data centre is located
f) Data centre total floor area
g) Category of operator type (voluntary information) from the following options: Federal administration, state administration, local administration, educational institution (e.g., university or university of applied sciences), research organisation, private sector, other.
h) Rated information technology load (in kW)
i) Non-redundant rated electrical load (in kW)
j) Ecologically relevant certification (voluntary information). Selectable ecologically relevant certifications are “The Blue Angel”, EMAS, ISO 50001 and CEN/CENELEC EN 50600

2. General data on the operation of the data centre in the last full calendar year for publication:

k) Total energy consumption in kWh (covers the use of electricity, fuels and other energy sources used for cooling. electricity consumption including own generation, total electricity purchase and Power feedback into the supply network)
l) Electricity consumption for systems that are used exclusively for the thermal upgrading of waste heat from the data centre (in kWh)

[35] Personal communication between Hans-Paul Siderius, RVO NL and Paul Papenbrock, Bundesministerium für Wirtschaft und Klimaschutz May 2024
[36] FAQ doc March 2024 page 3

m) Total renewable energy consumption as set out in the CEN/CENELEC EN 50600-4-3, the sum of three indicators:
   a. Total renewable energy consumption from Guarantees of Origin (“ERES-GOO”, in kWh)
   b. Total renewable energy consumption from Power Purchasing Agreements (“ERESPPA”, in kWh)
   c. Total renewable energy consumption from on-site renewables (“ERES-OS”, in kWh)
n) Amount of waste heat released into the air, water or ground (in kWh)
o) Average waste heat temperature (“T_{WH}”, in degree Celsius)
p) Waste heat reused (“EREUSE”, in kWh) ground
q) Data traffic indicators
   a. Incoming traffic bandwidth (“BIN”, in gigabytes per second)
   b. Outgoing traffic bandwidth (“BOUT”, in gigabytes per second)
   c. Incoming data traffic (“TIN”, in exabytes)
   d. Outgoing data traffic (“TOUT”, in exabytes)
r) Power Usage Effectiveness (PUE)
   a. Total energy consumption of information technology equipment (“EIT”, in kWh)
s) Cooling Efficiency Ratio (CER) (calculated automatically by the system)
   a. Electrical energy used by the cooling system for the data centre (“ECooling” in kWh)
t) Water Usage Effectiveness
   a. Total water input (“WIN”, in cubic meters)
   b. Amount of non-industrially reused water (“Wre,nid”, in cubic meters) (voluntary information)
u) Energy Reuse Factor defined in CEN/CENELEC EN 50600-4-6 (ERF)

3. Additional information that data centres covered by the EU Energy Efficiency Directive delegated regulation[37], that is with IT power ≥ 500kW, are also required to submit (but presumably not published as not included above):

- Contact details of the owner of the reporting data centre
- Contact details of the operator of the reporting data centre
- Location of the data centre (Local Administrative Unit Code (LAU code))
- Type of data centre (choice of ‘enterprise data centre’, ‘colocation data centre’ or ‘co-hosting data centre’. If a colocation data centre also offers co-hosting services or if a co-hosting data centre also offers colocation services, this shall be indicated.)
- Year and month of entry into operation
- Redundancy level of the electrical infrastructure and the cooling infrastructure
- Data centre computer room floor area (“SCR”, in square meters)
- Electrical grid functions
    - Average battery capacity (“CBtG”, in kW)
- Total potable water input (“WIN-POT”, in cubic meters)
- Average setpoint information technology equipment intake air temperature (“TIN”, in degree Celsius)

[37] Note that when this was published the text was available in the version adapted by the European Commission, but had not yet been published in the Official Journal of the European Union so it possible that there are difference which would be adjusted in revisions of the guidance.

- Type of refrigerant
- Cooling degree days ("CDD", in degree-days) for the location of the reporting data centre during the last calendar year. The number of cooling degree days will be calculated automatically by the system.
- ICT capacity indicators
    - ICT performance for servers ("CSERV")
    - ICT capacity for storage equipment ("CSTOR", in petabytes)

Hardware and software used for collection

According to a recent presentation by the German Federal Government:

- The Federal Office for Energy Efficiency (Bundesstelle für Energieeffizienz, BfEE), part of the Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA) have created a Register [38] (Energieeffizienzregister für Rechenzentren RZReg) for data centre owners/operators to input the required data. They are responsible for administering the register.
- The BfEE are also responsible for transferring these data to the EU.
- There will be a publicly accessible platform for information on essential energy consumption data from data centres (although no details are available yet).

References:

- Guide to the data points in the data centre register (DCReg); Information for operators of data centres in accordance with §§ 13, 14 Energieeffizienzgesetz Version 1.0 April 2024 https://www.bmwk.de/RZReg/Downloads/guide-data-points-in-data-centre-register.pdf?__blob=publicationFile&v=5

- Launch of the Energy Efficiency Register for Data centers – Timeline update 19 March 2024 – Berlin, Paul Papenbrock – Speaker IIA6 (BMWK) and Robert Leonards (BfEE)

[38] Should have been possible to enter data from end April 2024

Appendix 2 Description of North American building energy benchmarking schemes and results of analysis of published data

Schemes are listed first by state then smaller jurisdiction, in alphabetical order.

A2.1 California: Building Energy Benchmarking Program

Short description

First reporting year was 2018. The deadline for annual submission is 1 June and most recent data is 2022. Note that properties required to report under county or city regulations are not covered by the regulation[39]. In addition to the two city regulations included below there are several cities in California which require reporting but do not publish data in full. They are: Berkeley, Chula Vista, Los Angeles, San Diego, and San Jose.

Scope is buildings with (1) more than 50,000 square feet (≥ 4645 m^2) of gross floor area and (2) either no residential units or 17+ residential units are required to report energy use annually. Data is published. Portfolio Manager is used for data collection.

Overview of data

At the time of analysis (July 2024) data was available for five years: 2018 to 2022. The number of buildings with a primary use identified as "Data Center" has fluctuated from year to year. Some of the sites which reported in the earlier years did not report in later years and some sites have not reported energy data which is considered robust to date. The same applied to Other – Technology/Science sites.

The data were cleaned by separating data centres where the energy data might not be robust using three indicators:

1. No electricity use reported
2. Flagged as using estimated data
3. Flagged as not for a full twelve months of data or a flag is raised ('Possible Issue' or 'Unable to Check (not enough data)' in the column "Alert - Energy Meter has less than 12 full calendar months of data")

Also one data centre with an area below the reporting threshold reported in 2018; it also had an anomalously high EUI so it was considered an error and not included in the analysis.

If one or more of these indicators existed the data was separated out from the main analysis. The proportion of entries where this was the case varies by year. In some years there were sites where the energy data appeared to be robust but no value for Weather Normalized Site EUI was presented – these were included in the analysis.

When comparing the calculated and weather normalised EUI (see section below) three sites had anomalous values in 2022 and were also removed from the analysis.

[39] https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program/exempted-local-benchmarking

The data do not include the name of the property owner or operator.

The total number of data centres which have reported for at least one year is 92, of which 19 have not reported robust energy data. In 2022 the greatest number of data centres reported, 68, of which 53 had robust energy data. 22 (24%) data centres reported in all five years of which 16 (17%) reported robust data in all five years. Some data centres reported in one year and then not in subsequent years. The number of data centres reported which at all or with robust energy year by number of years reporting is shown in Figure 9.

The total number of Other – Technology/Science sites reporting was 70, of which 18 have not reported robust energy data. The maximum reporting in one year was 33 (in 2019) of which 22 had robust data. 8 (11%) of Other – Technology/Science sites reported in all five years of which 7 (10%) reported robust data in all five years. The number of these sites which reported at all or with robust energy by number of years reporting is shown in Figure 10.

It is not known if the turnover in sites reporting is due to new sites being built and sites changing use or due to variations in whether the owner or operator reported energy use. In some cases it is clearly due to a lack of reporting in one year as they report before and after this year. The California Energy Commission do not appear to publish information on reporting compliance rates.

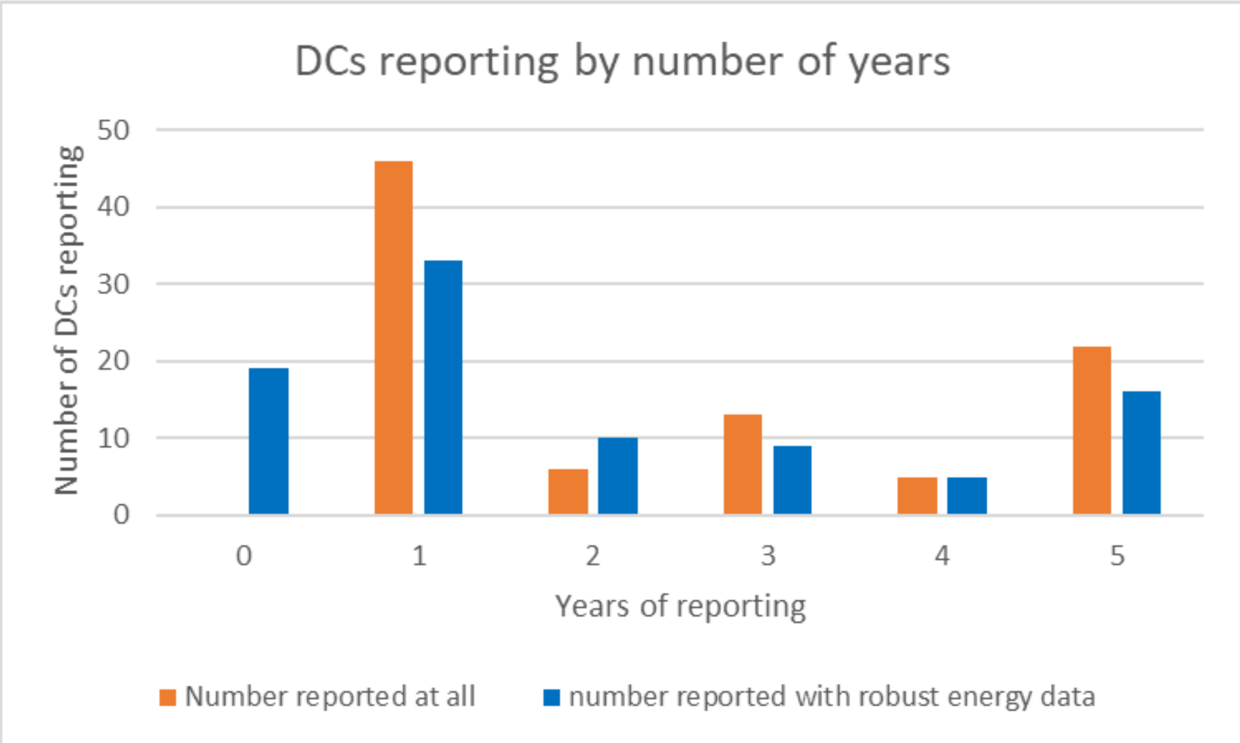

Figure 9 Data centre reporting in California by number of years of reporting

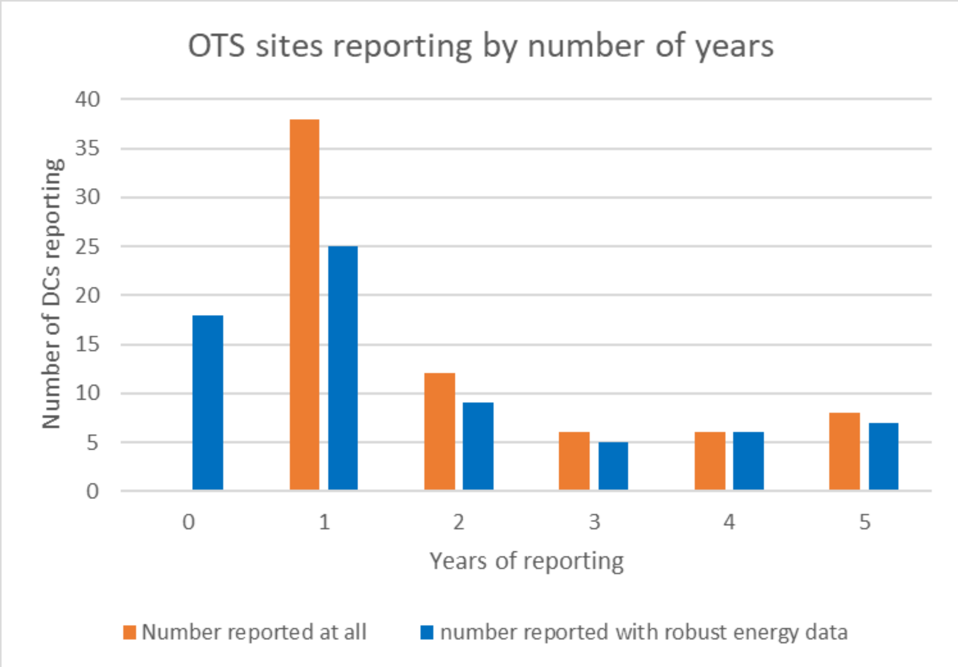

Figure 10 Other – Technology/Science sites reporting in California by years of reporting

The headline statistics for data centres reporting by year are in Table 11. Except for the first row all values are for sites with robust energy data only.

Table 11 Overview of data centres reporting in California by year.

Parameter	2018	2019	2020	2021	2022
Number of DCs reporting	36	34	47	42	68
Number of DCs reporting robust energy data	28	24	37	38	53
Total area of DCs with energy data (m^2)	524,239	462,041	585,766	530,744	744,497
Total energy use of DCs (MWh)	1,249,919	1,021,322	1,475,879	1,520,879	2,156,620
Mean energy use per data centre	44,640	42,555	39,889	40,023	40,691
Mean Energy Use Intensity (EUI, kWh/m^2)	2383	2209	2518	2864	2895
Number of medium DCs reporting	0	1	2	4	5
Number of large DCs reporting	7	7	14	15	19
Number of very large DCs reporting	21	16	21	19	29

The number and size of reporting data centres, as measured by total floor area and energy use, fluctuate from year to year but appear to increase significantly in 2022. Data for 2023 would be needed in order to clarify whether this is a trend or a random fluctuation.

The headline statistics for Other – Technology/Science sites reporting by year are in Table 12. Except for the first row all values are for sites with robust energy data only.

Table 12 Overview of Other – Technology/Science sites reporting in California by year.

Parameter	2018	2019	2020	2021	2022
Number of OTSs reporting	27	33	27	26	31
Number of OTSs reporting robust energy data	22	22	23	22	28
Total area of OTSs with energy data (m^2)	303,110	232,539	303,669	304,368	278,652
Total energy use of OTSs (MWh)	256,681	169,820	179,425	164,114	182,007
Mean energy use per data centre	11,667	7,719	7,801	7,460	6,500
Mean Energy Use Intensity (EUI, kWh/m^2)	846	730	590	539	653
Number of medium OTSs reporting	2	3	3	2	2
Number of large OTSs reporting	9	12	9	10	20
Number of very large OTSs reporting	11	7	11	10	6

The number and floor area of Other – Technology/Science sites reporting is roughly half that of data centres and the average EUI is lower resulting in proportionately lower energy use.

Energy use by fuel type

The California data includes energy use by the following fuel types:

- Electricity Use Grid Purchase
- Electricity Use – Generated from Onsite Renewable Systems and Used Onsite
- Fuel Oil #2[40] Use
- District Steam Use
- Diesel Use
- Propane Use
- District Hot Water Use
- District Chilled Water Use
- Natural Gas Use

The reports do not include a value for total energy use, summed across all fuel types. This addition was done in this analysis.

Most data centres reported only electricity use. Two sites across all five reporting years reported renewable electricity use. In every year a handful of sites reported diesel use, generally at a level of 1% or less of total energy use reported, which seems consistent with the use of diesel for back up power supply and occasional use to check the systems functioned correctly, although in a couple of cases diesel use was 5% or 6% of the total. The number of sites reporting significant (> 5%[41] of total) gas use was counted for each year. The data on gas use by year are in Table 13.

[40] This is the term used in the published data

[41] This threshold was chosen as in most cases diesel use was less than 5%.

Table 13 Data centres with significant natural gas use by year

Parameter	2018	2019	2020	2021	2022
Number of DCs with significant gas use	3	1	3	2	8
% of DCs with significant gas use	11%	4%	8%	5%	15%
Maximum proportion of gas use by a single site	96%	109%	85%	76%	77%
gas use as % of total energy use	6%	2%	2%	1%	4%

From these data it was apparent that natural gas (methane) is being used to generate electricity for the data centres and in one case (the 109% in 2019) to export electricity to the grid (this was confirmed by the fact that the site reported negative grid electricity use). The three sites that reported significant gas use and which reported for more than one year all reported significant gas use every year they reported. Eleven sites reported significant gas use over the five years.

A web search was made to investigate this further. Technical providers and news sites report the use of natural gas to provide electricity for data centres both as back-up power[42] and, using fuel cells, as the main energy supply[43]. The reasons given for using gas fuel cells are the difficulty and delays in getting an electricity grid connection at the required capacity and to reduce the cost of energy. Another advantage is quoted as being a minimal footprint or infrastructure at the location of the data centre.

Most (between 65 and 73%) Other – Technology/Science sites reported significant gas use in all years, up to 90% in a year. A few sites reported using onsite renewable electricity but no other fossil fuel use was reported.

Energy use intensity

The Energy Use Intensity (EUI) for each site was calculated by adding the energy use from all fuel types and dividing by the floor area. The mean and median of site EUIs for data centres and Other – Technology/Science sites and the overall mean (total energy use divided by total floor are) by year are shown in Figure 11.

[42] "Powering Data Centers with Natural Gas A Report on the Benefits of Natural Gas for Data Center Backup Power", Black & Veatch, 2020, https://www.bv.com/perspectives/powering-data-centers-natural-gas-report-benefits-natural-gas-data-center-backup-power/#:~:text=Natural%20gas%20supply%20and%20delivery,startup%20time%20for%20emergency%20power.

[43] "Data centers and fuel cells", Peter Gross, PMG Associates, Data Center Dynamics, February 2023, https://www.datacenterdynamics.com/en/opinions/data-centers-and-fuel-cells/
and
"Microsoft planning 170MW gas power plant at Dublin campus", Dan Swinhoe, Data Center Dynamics, December 2022, https://www.datacenterdynamics.com/en/news/microsoft-planning-170mw-gas-power-plant-at-dublin-campus/

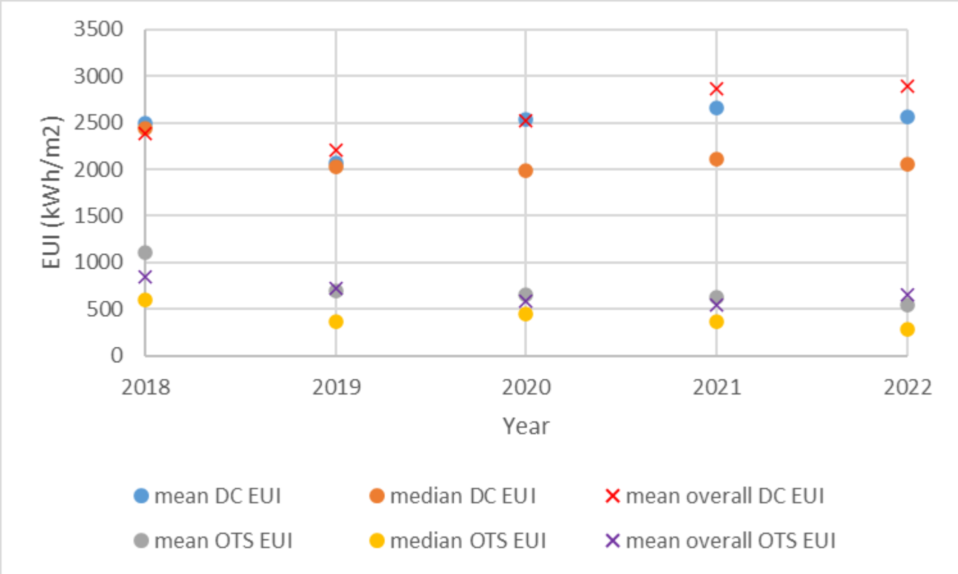

Figure 11 Mean and median EUI for data centres and Other – Technology/Science sites in California by year

The EUIs for data centres are several times higher than for Other – Technology/Science sites. There are no strong temporal trends in EUI.

The distributions of EUI by year for data centres are shown in Figure 12 (x indicates mean, line in block is the median, block is 1st to 3rd quartile, whiskers are 1.5 times the interquartile range, points are outliers).

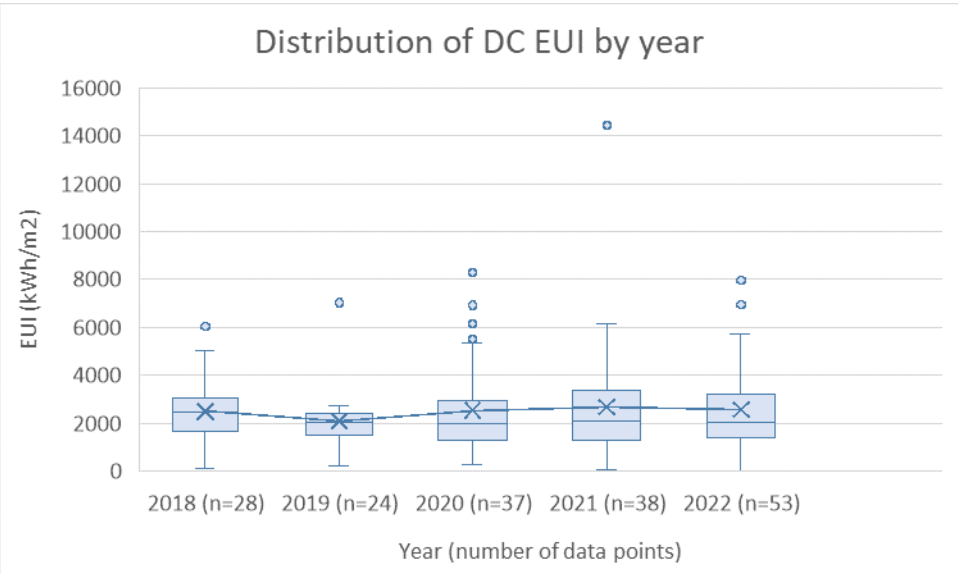

Figure 12 Distribution of EUI for data centres by year in California .

There is a big range of values in each year and the range varies by year. The data centre with the outlier in 2021 only reported in that year. The averages (mean and median) vary less by year. There does not appear to be a trend to these values over time. This may be because of the varying populations of reporting sites.

The distributions of EUI by year for Other – Technology/Science sites are shown in Figure 13. (x indicates mean, line in block is the median, block is 1st to 3rd quartile, whiskers are 1.5 times the interquartile range, points are outliers).

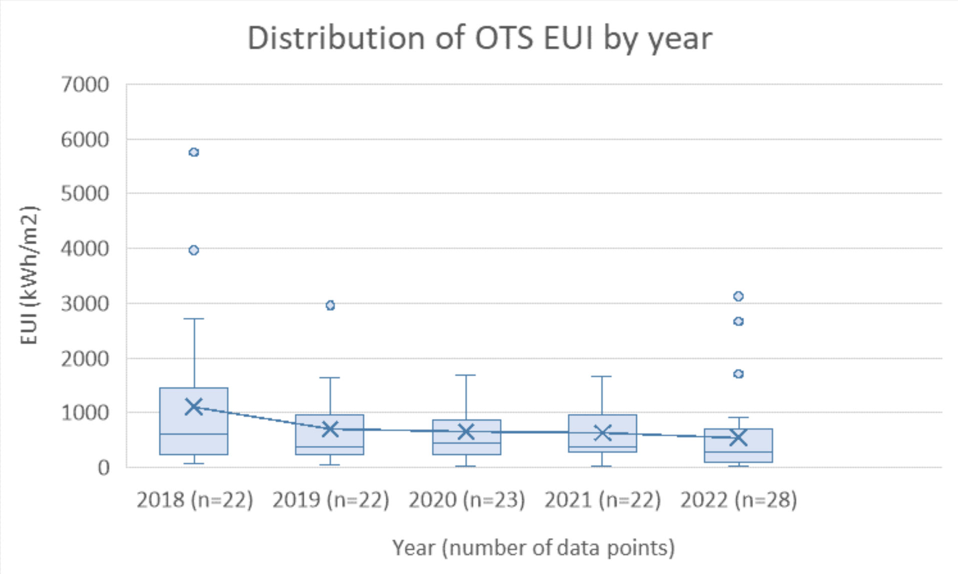

Figure 13 Distribution of EUI for Other – Technical/Science sites by year in California

The average (mean and median) EUI value appears to be decreasing with time, although it is not possible to be certain given the varying population of reported data.

Data for each data centre was collated so that comparisons could be made on a site by site by year basis. There were 15 sites which reported robust energy data for five years. The EUI by year for these sites is shown in Figure 14.

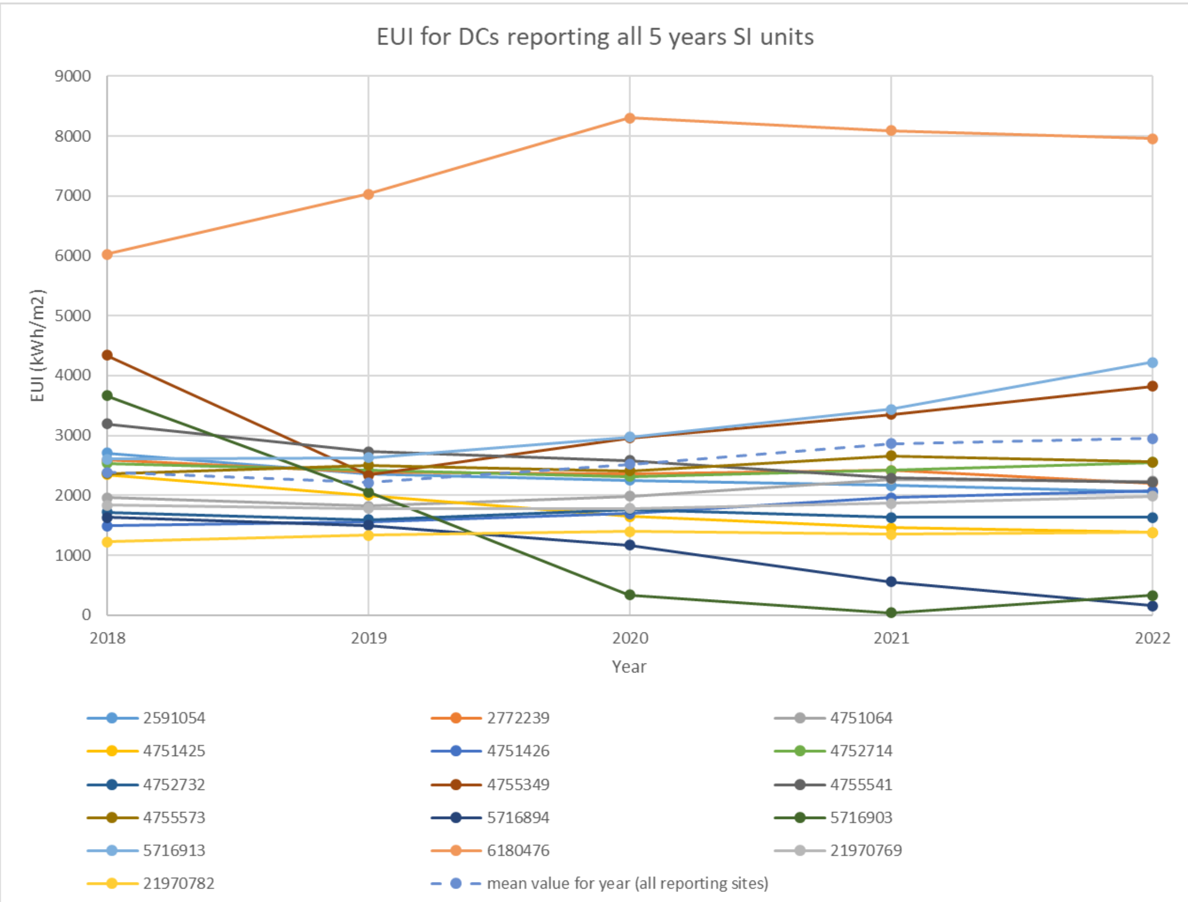

Figure 14 EUI by site for the 15 data centres which reported robust energy data for all five years in California

There does not appear to be a trend to these data.

This analysis was not repeated for California Other - Technology/Science sites.

Energy use intensity relationship to floor area

The only information on the size of a data centre in the benchmark data is floor area. This is not expected to be a good indicator of size of a data centre as the concentration of IT equipment can vary greatly. Nevertheless the relationship between floor area and EUI was examined to see if any correlation could be seen. A graph showing the variation of EUI with floor area is in Figure 15 (the data have not been converted to SI units as it is their variation, rather than absolute values, that is of interest).

Most sites reported the same floor area every year they reported but there were some exceptions:

- Four sites changed their area by less than 1%
- One site increased by 6% then decreased then increased again
- One site decreased the area by 44% from 2018 to 2019 and then stopped reporting.

The variation of EUI with floor areas is shown in Figure 15. (Data has not been converted to SI units as the variation rather than the absolute values are of interest). Any correlation of EUI with area appears to be weak.

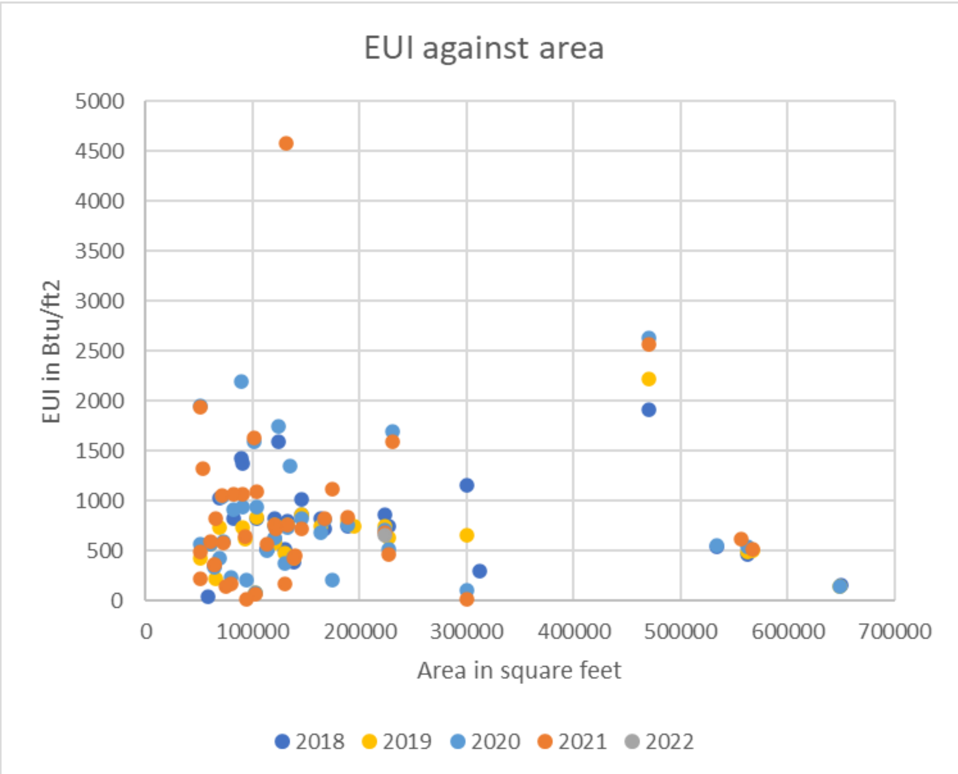

Figure 15 Variation in EUI by area for California data centres.

The data as supplied includes property uses other than the primary one for all years. (For data centres the most common other use is parking, followed by office). A new feature in the 2022 data is that, where relevant, area occupied by the other property uses is included. Of the 56 sites with robust energy data:

- 23 sites had no other use listed

- 3 sites had office listed as other use and the area was included in the total area. The office areas were between 44 and 53% of the total area.
- 30 sites had parking as the other use and the parking area was not included in the total area (and not used in the analyses above). The parking area varied from less than 1% to 98% of the data centre area, with a mean value of 44% and a median value of 39%. It seems reasonable to assume that users have not included the parking area in the reporting area because the EUI of the parking areas is low as the energy services provided are likely only lighting and security.

This analysis was not repeated for California Other - Technology/Science sites.

Weather normalized energy use intensity

Most values of weather normalized EUI differ little from the EUI calculated in these analyses (from the total energy and the reported floor area); for data centres they are in the range 95% to 106%. There are three outlier data centres in 2023 where the weather normalized EUI is much lower than the calculated EUI: 65 to 69%. One of these sites reported for the first time in 2022. The two other sites also reported robust data in 2020 and 2021. The EUI for both these sites in 2020 and 2021 were similar to the other years and very different from that in 2022. The 2022 data appeared to be in error data from all three sites were excluded from analysis.

References:

- California Energy Commission Building Energy Benchmarking Program https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program

A2.2 Boston (Massachusetts): Building Energy Reporting and Disclosure Ordinance (BERDO).

Short description

The reporting requirement applied to non-residential buildings that are 35,000 square feet or larger (≥ 3252 m^2) from 2014. Smaller non-residential buildings, that are 20,000 square feet or larger (≥ 1858 m^2) began reporting their energy in 2022 (2021 usage). Buildings owned by the City of Boston and Boston Housing Authority are also required to report.

The reporting deadline is 15 May. Portfolio Manager is used for reporting.

Overview of data

Data by year is available to download in spreadsheets. The data included has varied from year to year, gradually becoming more complete over time. Of particular relevance for this analysis is that an unambiguous identifier for each site, the BERDO ID, was only included from 2021. Prior to this the address was the best identifier but in later years several addresses were included: the building address and the parcel address. The building owner name was only included from 2021.

At the time of analysis (July 2024) data is available for nine years: 2014 to 2022. Sites were identified as Data Centres in 2014 and 2015, then until none until 2022. However sites at the same addresses had all reported in previous years, the larger sites (> 35,000 ft^2) from 2014 and the smaller sites in 2021. The property owners listed in 2021 and 2022 were also the same (two communications companies: New England Tel * tel co and NE Tel & Tel co of NY). All these sites were categorised in previous years reports as “Other - Technology/Science” which is defined by ENERGY STAR® Portfolio

Manager[44] as "Other – Technology/Science refers to buildings used for science and technology related services other than Laboratories and Data Centers". In this analysis these sites have been classified as data centres and their energy use included for all the years they have reported, not just for 2022.

All data centres sites reported electricity use and reported as being compliant and for calculated energy use and EUI matched declared for all sites and years (that is, all sites reported robust data). The same four data centres reported in every year with the addition of four sites with lower floor area (above the new threshold of 20,000 square feet or larger (≥ 1858 m^2) in 2021 onwards. No site has stopped reporting.

The headline statistics for data centres by year are in Table 14.

Table 14 Overview of data centres reporting in Boston MA

Parameter	2014	2015	2016	2017	2018
Number of DCs reporting	4	4	4	4	4
Total area of DCs (m^2)	51572	51572	51572	51572	51572
Total energy use of DCs (MWh)	26,102	25,290	25,365	25,106	25,807
Mean energy use per data centre	6,525	6,322	6,341	6,277	6,452
Mean Energy Use Intensity (EUI, kWh/m^2)	506	490	492	486	500
Number of medium DCs reporting	0	0	0	0	0
Number of large DCs reporting	1	1	1	1	1
Number of very large DCs reporting	3	3	3	3	3

Parameter	2019	2020	2021	2022
Number of DCs reporting	4	4	8	8
Total area of DCs (m^2)	51572	51572	61138	61138
Total energy use of DCs (MWh)	25,067	24,490	28,192	28,163
Mean energy use per data centre	6,267	6,122	3,524	3,520
Mean Energy Use Intensity (EUI, kWh/m^2)	486	475	461	460
Number of medium DCs reporting	0	0	4	4
Number of large DCs reporting	1	1	1	1
Number of very large DCs reporting	3	3	3	3

From 2016 on at least one site categorised as Other – Technology/Science was reported which was not identified as a data centre in another year. These were analysed separately from data centres.

44 https://portfoliomanager.energystar.gov/pm/glossary?_gl=1*4zfju0*_ga*MTU3MjUxMDc0Ny4xNjg0MzMzMjk4*_ga_S0KJTVVLQ6*MTcyMDE4MDg0Mi4xMi4wLjE3MjAxODA4NDIuMC4wLjA.#OtherTechnologyScience

From 2016 to 2021 one site reported; in 2020 the report did not include a value for EUI so the data was not analysed. In 2022 an additional site reported. The headline statistics for Other – Technology/Science sites are in Table 15. Except for the first row all values are for sites with robust energy data only.

Table 15 Overview of Other – Technology/Science sites reporting in Boston MA

Parameter	2016	2017	2018	
Number of OTSs reporting	1	1	1	
Number of OTSs reporting robust data	1	1	1	
Total area of OTSs (m^2)	15,003	15,003	15,003	
Total energy use of OTSs (MWh)	5,995	5,618	5,576	
Mean energy use per data centre	5,995	5,618	5,576	
Mean Energy Use Intensity (EUI, kWh/m^2)	1	1	1	
Number of medium OTSs reporting	0	0	0	
Number of large OTSs reporting	0	0	0	
Number of very large OTSs reporting	1	1	1	
Parameter	**2019**	**2020**	**2021**	**2022**
Number of OTSs reporting	1	1	2	2
Number of OTSs reporting robust data	1	0	2	2
Total area of OTSs (m^2)	15,003	0	26,737	26,737
Total energy use of OTSs (MWh)	5,526	0	13,089	13,131
Mean energy use per data centre	5,526	0	6,545	6,565
Mean Energy Use Intensity (EUI, kWh/m^2)	368	0	489	491
Number of medium OTSs reporting	0	0	0	0
Number of large OTSs reporting	0	0	0	0
Number of very large OTSs reporting	1	0	2	2

Energy use by fuel type

All four of the larger data centre sites reported significant (>5% of total) gas use from 2014 to 2017. One site stopped using gas in 2018; none of the smaller sites have reported significant gas use. The maximum proportion of gas use by a single site varied from 21% to 25%.

The Other – Technology/Science site which reported from 2015 reported significant (7 to 13%) steam use each year. The other site reported significant gas use (41-42%) in 2021 and 2022.

Energy use intensity

Energy Use Intensity (EUI), calculated by adding the energy use from all fuel types and dividing by the floor area, was included in the downloaded data. Figure 16 shows the variation in mean and median EUI by year and site category.

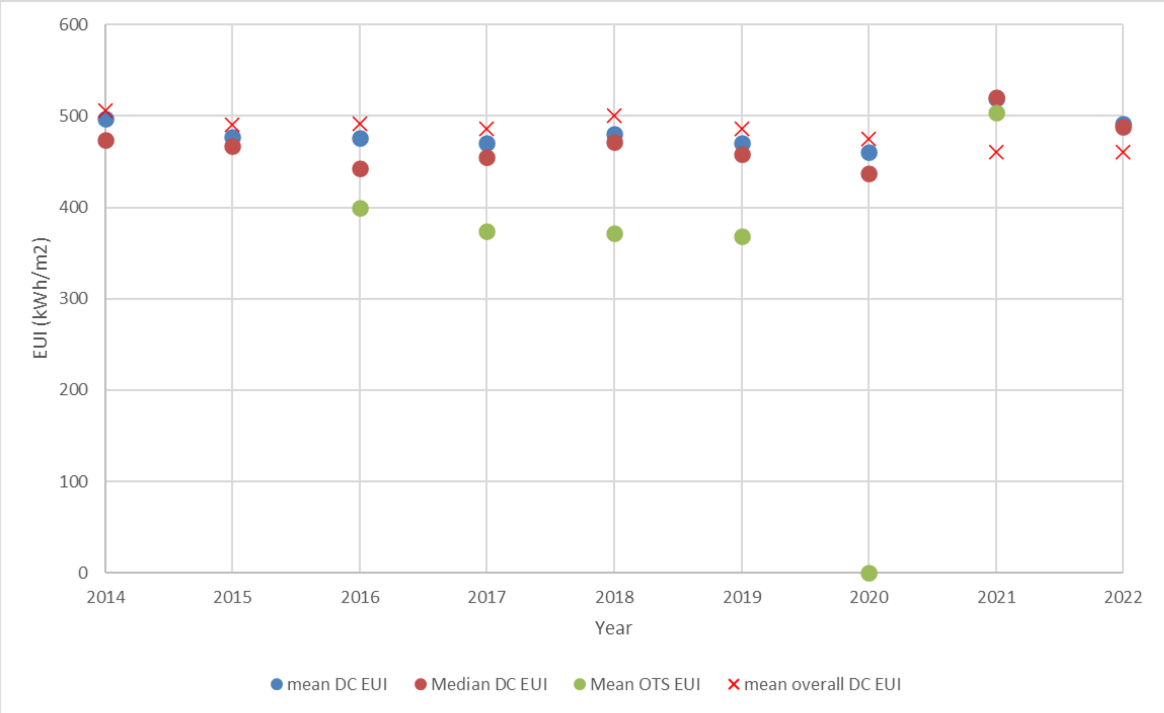

Figure 16 Average of EUI for Boston DCs and OTSs by year

The EUIs for the four data centre sites which reported for nine years is shown in Figure 17.

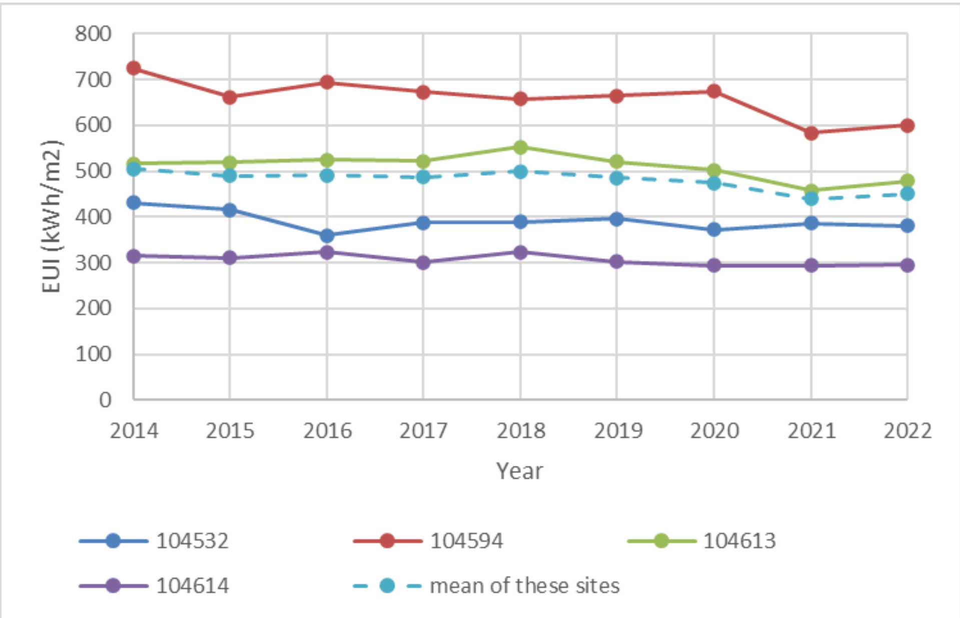

Figure 17 EUI by year for four Boston sites which reported for nine years

The variations in EUI are small. There does not appear to be a consistent trend in EUI over time. The EUI values are much smaller than the averages of the data reported in California – by about a factor of four.

Energy use intensity relationship to floor area

All the sites reported a consistent floor area year to year. The variation of EUI against floor area for data centres is shown in Figure 18. There does not appear to be a correlation between these values, although this may be due to the fact there are so few data points.

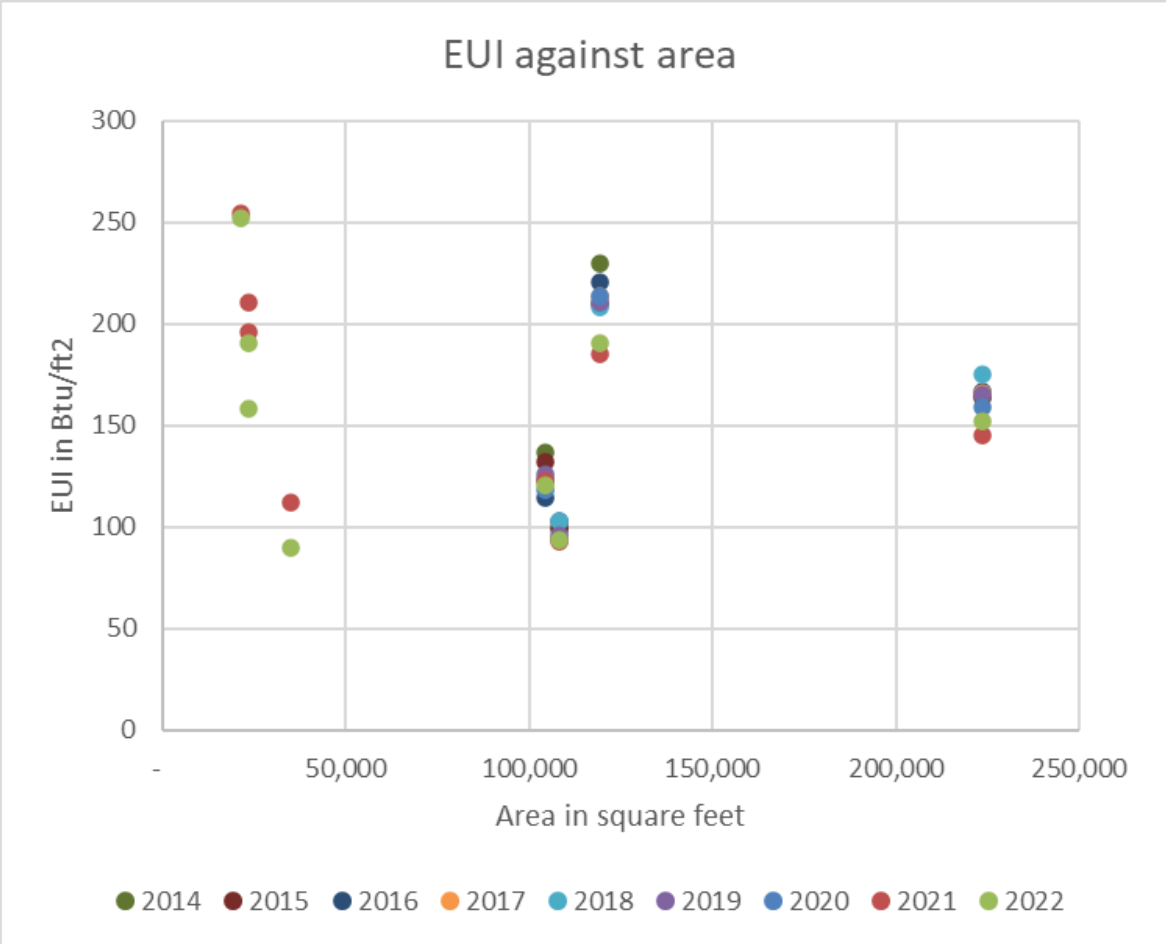

Figure 18 Variation of EUI with floor area:for Boston data centres

Weather normalized energy use intensity

Weather normalized EUI is not published in the Boston datasets.

References:

- Cortex, BERDO 101: Everything Building Owners need to know, July 18, 2022 https://get.cortexintel.com/berdo-101-everything-building-owners-need-to-know/#:~:text=BERDO%201.0%20was%20initially%20enacted,(GHG)%20and%20energy%20use.
- BERDO (Building Emissions Reduction and Disclosure Ordinance) 2.0 101 webinar May 2022
- Data can be downloaded from https://data.boston.gov/dataset/building-emissions-reduction-and-disclosure-ordinance#:~:text=previous%20calendar%20year.-

,The%20City%20of%20Boston%20is%20required%20to%20annually%20disclose%20BERDO,or%2025%20units%20or%20above.

A2.3 Brisbane CA: Building Efficiency Program

Short description

The scheme was introduced in 2019. The scope is commercial and multi-family buildings with more than 10,000 square feet (≥ 929 m^2) of gross floor area and municipal offices with more than 2,000 square feet (186m^2) floor area.

A map of data is published annually. In addition a spreadsheet of data for 2021 is available for download.

Portfolio Manager is used for reporting.

Overview of data

As of the time of this analysis (July 2024) data for 2021 was published. This includes one data centre and one Other – Technology/Science site. The published data does not include owner name or floor area or energy sources other than electricity and gas. The key data for these sites are shown in Table 16.

Table 16 2021 energy data reported on data centre and Other – Technology/Science site in Brisbane

Type of site	**EUI (kWh/m^2)**	**Weather normalised EUI (kWh/m^2)**	**Energy use (MWh) (assuming energy use from fuels other than electricity and natural gas not significant)**	**Electricity use**	**Natural gas use**
Data centre	291	288	668.3	43%	57%
Other – Technology/Science	907	907	309.6	100%	0%

The gas use by the data centre is significant (that is > 5%). The EUI values are in the low range of those reported elsewhere.

References:

- https://www.brisbaneca.org/bbep
- https://dpwbrisbane.maps.arcgis.com/apps/instant/portfolio/index.html?appid=121423bf27c64a8da65a198a332a8f21

A2.4 Cambridge MA: Building Energy Use Disclosure Ordinance

Short description

The scheme was Introduced in 2014. The scope Is non-residential buildings with more than 25,000 square feet (≥ 2323 m^2) of gross floor area and municipal offices with more than 10,000 square feet (929m^2) floor area.

The reporting deadline is 1 May. Portfolio Manager used for reporting

Overview of data

At the time of analysis (July 2024) data was available for nine years: 2015 to 2022. The data included whether a site had submitted a report or not so it was possible to distinguish new sites from sites which had existed before but not reported. There were no compliance or quality check data. For this study the sum of energy use by fuel was compared against the reported total energy use and the stated and calculated site EUIs were compared as quality checks. The data for all the sites were robust against these checks.

Four sites were categorised as data centres in 2015. Of these three reported every year to 2022, one reported again only in 2022. The property owner name was included in the published data. The owner of the very large data centre, which was the one which reported sporadically, was listed as AT&T Corp (one of the U.S.'s main telephone and communications companies).

The headline statistics by year for data centres are in Table 17.

Table 17 Overview of data centres reporting in Cambridge MA

Parameter	**2015**	**2016**	**2017**	**2018**
Number of DCs reporting	4	3	3	3
Total area of DCs (m^2)	26,628	13,807	13,807	13,807
Total energy use of DCs (MWh)	13,492	11,856	10,430	9,163
Mean energy use per data centre	3,373	3,952	3,477	3,054
Mean Energy Use Intensity (EUI, kWh/m^2)	506	858	755	663
Number of medium DCs reporting	2	2	2	2
Number of large DCs reporting	1	1	1	1
Number of very large DCs reporting	1	0	0	0
Parameter	**2019**	**2020**	**2021**	**2022**
Number of DCs reporting	3	3	3	4
Total area of DCs (m^2)	13,807	13,807	13,807	26,628
Total energy use of DCs (MWh)	9,336	8,663	8,162	19,860
Mean energy use per data centre	3,112	2,888	2,721	4,965
Mean Energy Use Intensity (EUI, kWh/m^2)	676	627	591	745
Number of medium DCs reporting	2	2	2	2
Number of large DCs reporting	1	1	1	1
Number of very large DCs reporting	0	0	0	1

Several sites were categorised as “Other – Technology/Science” in the data: three sites from 2015 to 2020, five sites in 2021 and 2022. The two additional sites which reported in 2021 and 2022 appeared to be new sites (they were not listed in previous years as not having submitted a report). Two of the sites which reported throughout the period were listed as being owned by New England Telephone & Telegraph Co.

There was one site which consistently had a difference in total energy use between that stated and calculated from the declared energy sources; in most cases this was less than 2% so the data was included in the analysis. In 2021 it was more than 7% so the data were excluded.

The headline statistics by year for Other – Technology/Science sites are in Table 18.

Table 18 Overview of Other – Technology/Science sites reporting in Cambridge MA

Parameter	**2015**	**2016**	**2017**	**2018**
Number of OTSs reporting	3	3	3	3
Number of OTSs reporting robust data	3	3	3	3
Total area of OTSs (m^2)	24,322	24,322	24,322	24,322
Total energy use of OTSs (MWh)	13,492	20,704	20,157	21,188
Mean energy use per OTS	4,497	6,901	6,719	7,063
Mean Energy Use Intensity (EUI, kWh/m^2)	554	851	828	871
Number of medium OTSs reporting	1	1	1	1
Number of large OTSs reporting	1	1	1	1
Number of very large OTSs reporting	1	1	1	1
Parameter	**2019**	**2020**	**2021**	**2022**
Number of OTSs reporting	3	3	5	5
Number of OTSs reporting robust data	3	3	4	5
Total area of OTSs (m^2)	24,322	24,322	37,633	50,911
Total energy use of OTSs (MWh)	20,318	20,310	20,780	36,612
Mean energy use per OTS	6,773	6,770	5,195	7,322
Mean Energy Use Intensity (EUI, kWh/m^2)	835	835	552	719
Number of medium OTSs reporting	1	1	1	1
Number of large OTSs reporting	1	1	1	1
Number of very large OTSs reporting	1	1	2	3

The area and the energy used in the OTSs is greater than in the data centres in all years but in 2015 by a considerable margin. The mean overall EUIs are of the same order for both categories of site.

Energy use by fuel type

One data centre site reported gas use but this was not significant (less than 1% in all cases and zero in 2022). All the Other – Technology/Science sites reported significant (>5%) natural gas use with one site reporting gas use at 60% or greater in all years. One site reported a small amount of kerosene use in most years replaced by diesel in 2022.

Energy use intensity

Energy Use Intensity (EUI), calculated by adding the energy use from all fuel types and dividing by the floor area, was included in the downloaded data. Figure 19 shows the variation in mean and median EUI of each site for data centres and for Other – Technology/Science sites.

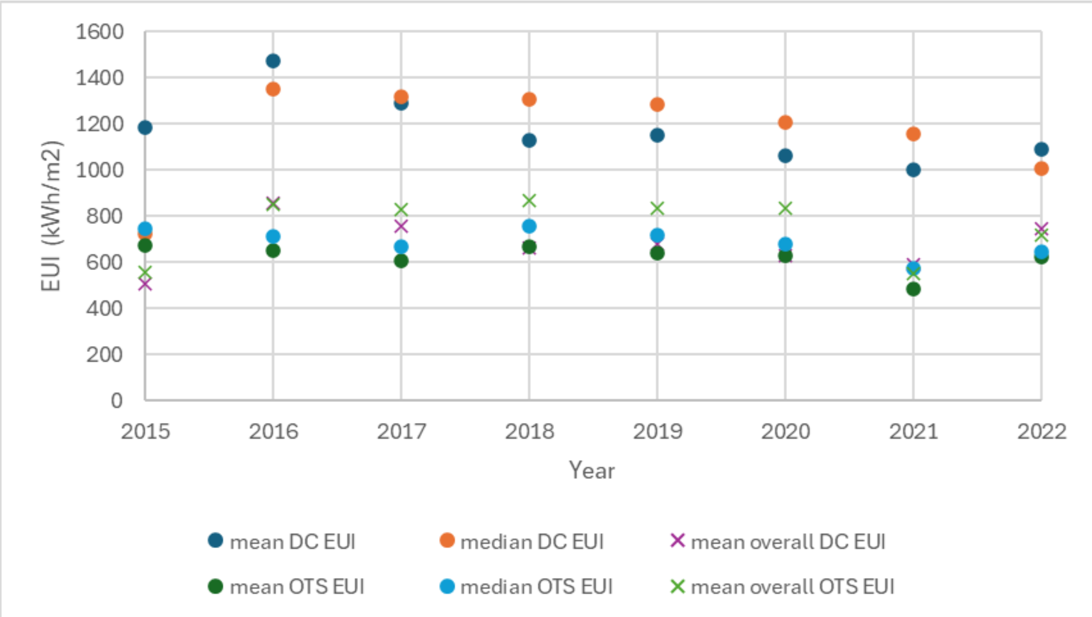

Figure 19 Annual variation in EUI for data centres and for Other – Technology/Science sites for Cambridge MA

The mean and medians of site EUIs for Other – Technology/Science sites are noticeably lower than for data centres.

The variation in EUI for the three data centres which reported in all eight years is shown in Figure 20.

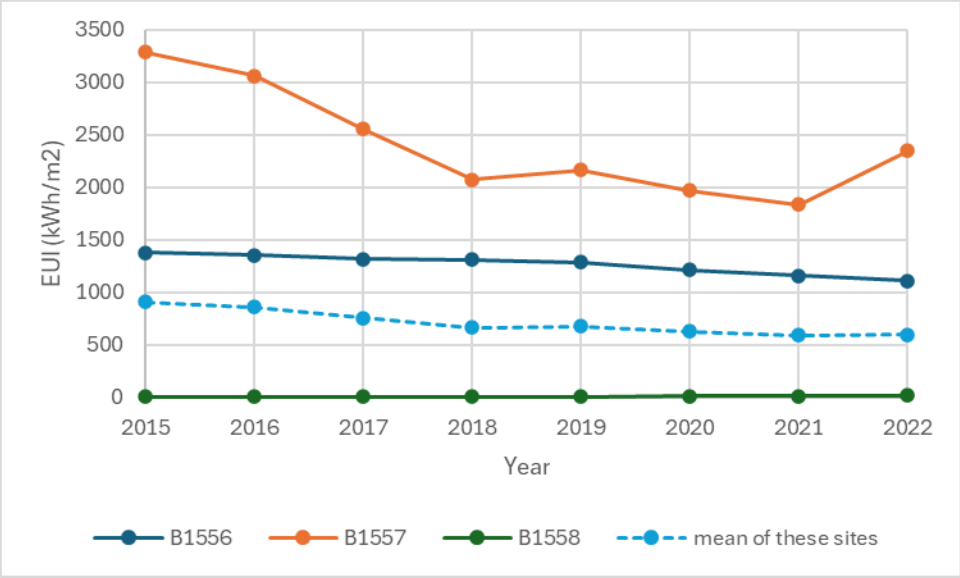

Figure 20 EUI by year for three sites in Cambridge MA which reported in all eight years

The EUI of one site was very low, towards the lower than the usual range for data centres reported elsewhere.

Energy use intensity relationship to floor area

All the sites of both types reported a consistent floor area year to year. Also one data centre site had an additional use and a separate area for this use (as parking). No analysis of variation of EUI with areas was undertaken given the small number of sites.

Weather normalized energy use intensity

The weather normalized EUI was very close to the base EUI (< 1%) for all data centre sites for all years with one exception. The site which only reported in 2015 and 2022; in 2015 the weather normalized EUI was 13 times the base EUI (which was similar to that reported in 2022). This appears to be an error.

For Other – Technology/Science sites the weather normalized EUI was very close to the base EUI (< 1% difference) except for one site where the base EUI weather was less than the normalised EUI by a greater margin – 2 to 8%.

References:

- https://www.cambridgema.gov/CDD/zoninganddevelopment/sustainabledevelopment/buildingenergydisclosureordinance
- Data available from: https://www.opendatanetwork.com/dataset/data.cambridgema.gov/72g6-j7aq

A2.5 Chicago IL: Building Energy Benchmarking

Short description

The scheme was adopted 2013 with first year of reporting 2014. The scope is existing commercial, institutional, and residential buildings larger than 50,000 square feet (4645m^2).

The reporting deadline is 1 June. A report is published annually with aggregated data on energy use, ENERGY STAR® scores, water use and GHG emissions.

Portfolio manager is used for reporting.

Overview of data

At the time of analysis (July 2024) data was available for nine years: 2014 to 2022. Sites with the primary property type of data centres started reporting in 2019, with the maximum number of data centre sites, 5, reporting in 2022. Of these three reported every year to 2022, one missed 2020, one reported only in 2022. The property owner/operators name was not published.

No reporting sites were categorised as "Other – Technology/Science".

The energy use types reported were: gas, electricity, district steam use, district chilled water use and all other fuel use. The total energy use was calculated from the addition of these and the EUI by site by year was calculated to compare with the reported values. In most cases these values matched closely. However for one site in 2020, 2021 and 2022 the calculated value was about half the reported value. While the site EUI was reasonably consistent year to year the data for these years were omitted from the analyses.

The headline statistics by year are shown in Table 19. Except for the first row all values are for sites with robust energy data only.

Table 19 Overview of data centres reporting in Chicago

Parameter	2019	2020	2021	2022
Number of DCs reporting	4	3	4	5
Number of DCs with robust energy data	4	2	3	4
Total area of DCs (m^2)	154736	132122	143371	160093
Total energy use of DCs (MWh)	481,874	445,029	495,956	545,845
Mean energy use per data centre	120,468	222,514	165,319	136,461
Mean Energy Use Intensity (EUI, kWh/m^2)	3112	3366	3457	3407
Number of medium DCs with robust energy data	0	0	0	0
Number of large DCs with robust energy data	1	0	1	1
Number of very large DCs with robust energy data	3	2	2	3

Energy use by fuel type

Only one site reported gas use and this was not significant (less than 1%). One site reported use of district steam and district chilled water – the latter was significant – at around 30% in all four years.

Energy use intensity

Energy Use Intensity (EUI was included in the downloaded data. Figure 19 shows the variation in mean and median EUI of each site.

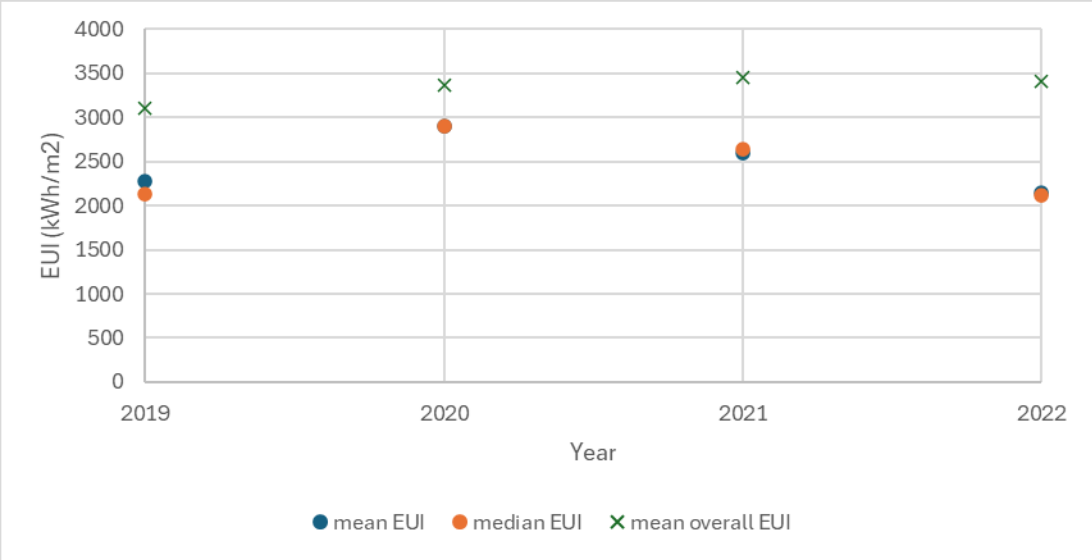

Figure 21 Annual variation in EUI for Chicago IL

Energy use intensity relationship to floor area

One site reported the floor area almost doubling between 2019 and 2020 but then remained constant. This was the site where the calculated and reported energy use was different from 2020 to 2022 and these data were omitted from the analyses.

No analysis of variation of EUI with areas was undertaken given the small number of sites.

Weather normalized energy use intensity

The weather normalized EUI was very close to the base EUI (< 1% difference) for all sites for all years with one exception. One site for one year did not report a weather normalized EUI.

References:

- Chicago Energy Benchmarking Homepage
  https://www.chicago.gov/city/en/progs/env/building-energy-benchmarking---transparency.html
- Chicago Energy Rating System
  https://www.chicago.gov/city/en/progs/env/ChicagoEnergyRating.html
- Chicago Energy Benchmarking Benchmarking Guide v2 2021
- Chicago Energy Benchmarking 2020 Report, City of Chicago
- Data available from
  https://data.cityofchicago.org/Environment-Sustainable-Development/Chicago-Energy-Benchmarking/xq83-jr8c/about_data

A2.6 Evanston IL: Benchmarking Ordinance

Short description

The scheme was introduced in 2016. The scope is commercial and multi family residential buildings with more than 20,000 square feet (≥ 1858 m^2) and public/govt 10,000 (929 m^2) of gross floor area.

Data overview

As of time of analysis (July 2023) there were reported data for 2018 and 2019. No sites categorised as a data centre were reported in these years. One site categorised as Other – Technology/Science reported in 2018 only, which was classified as large. No quality checks were recorded, however the EUI calculated for this analysis was very close (99.99%) to the reported EUI so the data were considered robust. Both electricity and natural gas use were recorded with the latter being 66% of the total. The owner's name was not published.

References:

- https://www.cityofevanston.org/government/departments/community-development/building-inspection-services/benchmarking-ordinance

A2.7 Lexington MA: Building Energy Use Disclosure

Short description

The scheme was introduced in 2022. The scope Is commercial and multi family residential buildings with more than 50,000 square feet ≥ 4645 m^2, public/Gov't ≥10,000 (929 m^2) of gross floor area.

Data overview

As of time of analysis (July 20234 there were reported data for 2022. No sites were categorised as a data centre. Three sites were categorised as Other – Technology/Science; two were classified by floor area as medium sized, one as large. No energy quality checks were recorded, however the calculated EUI was very close to the reported EUI so all the data were considered robust. The data are summarised in Table 20. Weather normalised EUI was not published. No owner names were published.

Table 20 Overview of Other – Technology/Science sites reporting in Lexington MA

Parameter	**2022**
Number of OTSs reporting	3
Total area of OTSs (m^2)	15334
Total energy use of OTSs (MWh)	1863
Mean energy use per OTS (MWh)	621
Mean overall Energy Use Intensity (EUI, kWh/m^2)	122
Mean site EUI (kWh/m^2)	145
Median site EUI (kWh/m^2)	151

Energy use by fuel type

All three sites reported substantial natural gas use – between 54 and 99% of total energy use.

References:

- https://www.cityofevanston.org/government/departments/community-development/building-inspection-services/benchmarking-ordinance

A2.8 Montgomery County MD: Building Energy Benchmarking

Short description

The scheme was Introduced in 2014, the first year of reporting was 2015. The current scope is commercial buildings with more than 25,000 square feet (≥ 2323 m^2) of gross floor area and all public/govt more than 10,000 square feet. The scheme also covers Rockville MD and Takoma Park MD. Montgomery County MD is adjacent to Washington DC.

The reporting deadline is 1 June.

Data overview

At the time of analysis (July 2024) data was available for eight years: 2015 to 2022 with coverage gradually increasing as shown in Table 21. (gsf is an abbreviation of Gross Square Feet.)

Table 21 Reporting requirements by year for Montgomery MD

Group	Building Coverage	First Calendar Year Benchmarking Period
County	County-owned buildings > 50k gsf	2014
Group 1	Commercial buildings > 250k gsf	2015
Group 2	Commercial buildings 50k – 250k gsf	2016
Group 3	Commercial buildings 25k – 50k gsf;	2022
Group 4	Multifamily residential buildings > 250k gsf	2022

Data centres started reporting in 2019[45], with the maximum number of data centre sites, 4, reporting in 2022. The data centres which reported in 2019 continued to report through to 2022. The building owner of record was included in the published data up to 2019. In 2019 the Benchmarking Report Status of one of the data centres was "Data Incomplete/Under DEP Review" so data for this site was omitted for this year.

No reporting sites categorised as "Other – Technology/Science" in any year[46].

The headline statistics by year are shown in Table 22. Except for the first row all values are for sites with robust energy data only.

Table 22 Overview of data centres reporting in Montgomery County MD

Parameter	2019	2020	2021	2022
Number of DCs reporting	2	2	2	4
Number of DCs with robust energy data	1	2	2	4
Total area of DCs (m^2)	8,489	28,446	28,446	42,399
Total energy use of DCs (MWh)	23,564	31,077	30,181	48,925
Mean energy use per data centre	23,564	15,538	15,090	12,231
Mean Energy Use Intensity (EUI, kWh/m^2)	2774	1092	1060	1153

[45] Some sites had the self selected property type 'data centre' before this date but the EPA calculated categorisation was used in all the analyses for consistency.
[46] Some had self selected property type Other – Technology/Science

The two sites that reported in 2021 were large and very large; the additional sites in 2022 were medium and very large.

Energy use by fuel type

Only the two sites which reported in 2022 reported natural gas use. In both cases it was just significant, at 5.1% and 6.2% of total energy use. Otherwise all energy use was electricity only.

Energy use intensity

Energy Use Intensity (EUI), calculated by adding the energy use from all fuel types and dividing by the floor area, was included in the downloaded data. Figure 22 shows the variation in mean and median EUI of each site by year.

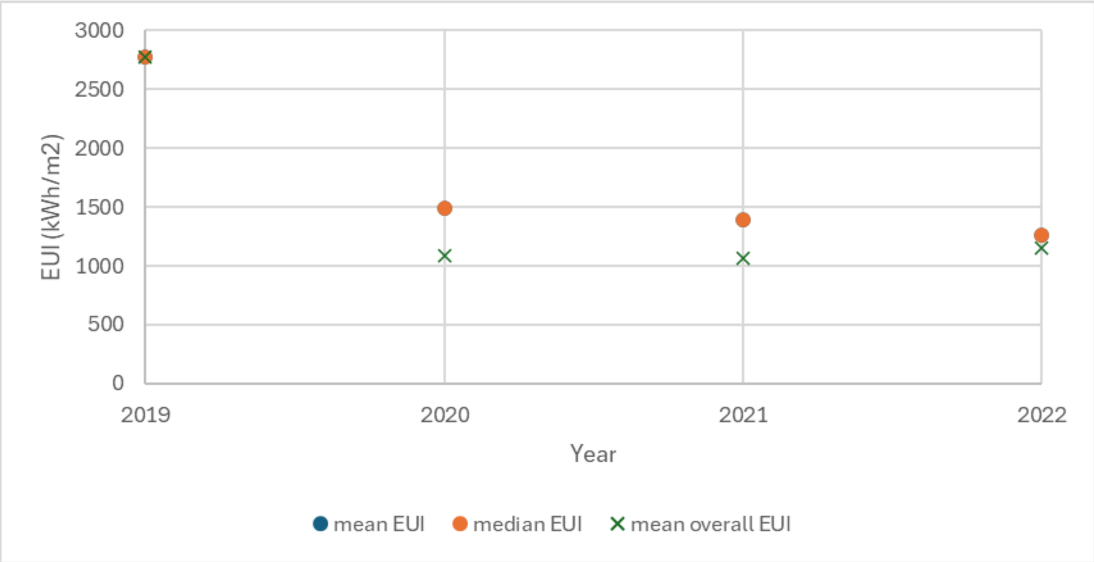

Figure 22 Annual variation in EUI for data centres in Montgomery County

Energy use intensity relationship to floor area

The area of each site did not change over time. No analysis of variation of EUI against floor area was undertaken given the small number of sites.

Weather normalized energy use intensity

The weather normalized EUI was very close to the base EUI (< 1% difference) for all sites for all years.

References:

- https://www.montgomerycountymd.gov/dep/energy/commercial/energy-benchmarking.html#:~:text=Montgomery%20County's%20Energy%20Benchmarking%20Law,every%20three%20years%20thereafter%2C%20and
- Data from https://www.montgomerycountymd.gov/DEP/energy/commercial/disclosed-data-reports.html

A2.9 New York City NY: Building Energy Benchmarking

Short description

The scheme was introduced in 2009. The initial requirement was for buildings larger than 50,000 square feet (4645 m^2) to report. The threshold was reduced to of 25,000 square feet (2323 m^2) in a 2016 amendment with the smaller buildings to report energy use from 2018.

Portfolio Manager is used for reporting.

Overview of data

Low numbers of sites identified as data centres reported in all years up to 2022 when the number went up to 59 (from three or four in previous years). It was found that most of the sites which were categorised as data centres in 2022 had reported in previous years categorised as "Other - Technology/Science", as discussed for Boston. The 2022 data report includes a column for 'Property notes'. For all the sites which had previously been categorised as "Other - Technology/Science" the contents of this column reads "*This building houses networking and technology equipment that is not sub-metered. It is not a datacenter, but does have a high energy intensity due to the equipment.*"

Nevertheless it was decided to recategorise sites which were tagged as data centres in 2022 but as "Other - Technology/Science" when they reported in previous years (in common with the approach taken with the Boston data). Sites which were consistently categorised as Other - Technology/Science were analysed separately.

The total number of data centres which reported for at least one year is 75 of which 7 have not reported robust energy data. The maximum number of sites reported was 61, in 2019.

The data do not include the name of the property owner or operator.

Data from 2010 to 2013 does not include any quality check information. Quality check information was reported from 2014 onwards and was used to clean the data. The checks reported varied somewhat by year, those in the most recent reported data, 2022, and the reasons for not including sites are in Table 23.

Table 23 Error flags in the 2022 New York City energy benchmarking report

Title	**Value to reject**
Default Values	TRUE
Temporary Values	TRUE
Estimated Values - Energy	Yes or Unable to Check (not enough data)
Alert - Energy Meter has less than 12 full calendar months of data	Yes or Unable to Check (not enough data)
Alert - Energy Meter has gaps	Yes or Unable to Check (not enough data)
Alert - Energy Meter has overlaps	Yes or Unable to Check (not enough data)
Alert - Energy - No meters selected for metrics	Yes or Unable to Check (not enough data)
Alert - Energy Meter has single entry more than 65 days	Yes or Unable to Check (not enough data)

Title	Value to reject
Alert - Property has no uses	Yes or Unable to Check (not enough data)
Alert - Gross Floor Area is 0 ft2	Yes or Unable to Check (not enough data)
Estimated Data Flag - Electricity (Grid Purchase)	Yes or Unable to Check (not enough data)
Estimated Data Flag - Natural Gas (where relevant)	Yes or Unable to Check (not enough data)

The number of data centres reported at all or with robust energy data by number of years reporting is shown in Figure 23.

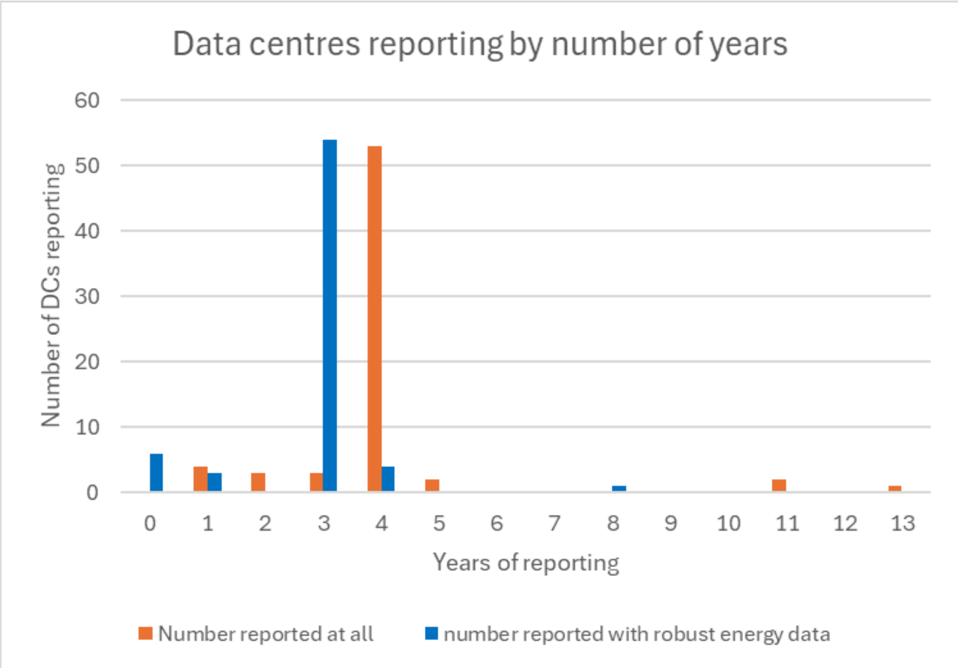

Figure 23 Number of data centres reporting any or robust data for New York City

Most of the site reports (57 out of 59) from 2022 were not considered robust. Most of these (55 out of 57) were flagged as including default values. It seems likely that this is an error however other categories of properties were not flagged as reporting default values in 2022 so if it is an error then it is particular to data centres.

The number of data centres reporting in each year to 2014 are shown in Table 24. Headline statistics for subsequent years (where quality checking data was provided) are shown in Table 25. Except for the first row all values are for sites with robust energy data only.

Table 24 Overview of data centres reporting in New York City by year 2010 to 2014.

Parameter	2010	2011	2012	2013	2014
Number of DCs reporting	3	4	3	4	4
Number of DCs with robust energy data	0	0	0	0	0

Table 25 Overview of data centres reporting in New York City by year from 2015

Parameter	2015	2016	2017	2018
Number of DCs reporting	4	5	7	5
Number of DCs with robust energy data	1	1	5	5
Total area of DCs with energy data (m^2)	99828	99828	157145	129497
Number of sites with floor area < 50,000ft^2	0	1	0	2
Total energy use of DCs with (MWh)	94,530	97,610	159,881	130,628
Mean energy use per data centre	94,530	97,610	31,976	26,126
Mean Energy Use Intensity (EUI, kWh/m^2)	946	977	1017	1008
Number of medium DCs	0	0	0	2
Number of large DCs	0	0	1	1
Number of very large DCs	1	1	4	2
Parameter	**2019**	**2020**	**2021**	**2022**
Number of DCs reporting	60	59	59	59
Number of DCs with robust energy data	59	59	58	2
Total area of DCs with energy data (m^2)	635,618	635,618	619,841	131,178
Number of sites with floor area < 50,000ft^2	10	10	10	0
Total energy use of DCs with robust energy data (MWh)	529,291	507,634	484,091	106,598
Mean energy use per data centre	8,971	8,604	8,346	53,299
Mean Energy Use Intensity (EUI, kWh/m^2)	832	798	780	812
Number of medium DCs	11	11	11	0
Number of large DCs	29	29	29	0
Number of very large DCs	19	19	18	2

It is not known if the turnover in data centres reporting is due to new data centres being built and old ones being taken out of service or due to variations in whether the owner or operator reported. The sudden increase in data centres reporting in 2019 is noticeable. It doesn't seem to be related to the reduction in size threshold for reporting that took effect in 2018, as most of the 'new' sites were larger than the previous threshold (50,000 ft^2). There was an increase in the total number of buildings (of all types) reporting between 2018 and 2019 but this was much smaller – around 15%. The sudden increase in data centres reporting seems to be more likely to be due to increased compliance. The City of New York do not appear to publish information on rates of reporting compliance.

Fewer Other – Technology/Science sites reported in any year. There was low continuity of sites, 13 reported but only two reported for more than one year (one for two years, one for four years). The overview of reported data is in Table 26. Except for the first row all values are for sites with robust energy data only.

Table 26 Overview of Other – Technology/Science sites in New York City by year from 2015

Parameter	2015	2016	2017	2018
Number of OTSs reporting	1	1	1	7
Number of OTSs with robust energy data	1	0	1	5
Total area of OTSs with energy data (m^2)	1,687	0	2,334	103,139
Total energy use of OTSs with robust energy data (MWh)	66	0	2,223	73,022
Mean energy use per data centre	66	0	2,223	14,604
Mean Energy Use Intensity (EUI, kWh/m^2)	39	0	952	708
Number of medium OTSs with robust energy data	1	0	1	0
Number of large OTSs with robust energy data	0	0	0	1
Number of very large OTSs with robust energy data	0	0	0	4
Parameter	**2019**	**2020**	**2021**	**2022**
Number of OTSs reporting	2	1	1	3
Number of OTSs with robust energy data	2	1	1	3
Total area of OTSs with energy data (m^2)	46,034	16,955	16,955	38,166
Total energy use of OTSs with robust energy data (MWh)	45,332	15,982	16,354	23,455
Mean energy use per data centre	22,666	15,982	16,354	7,818
Mean Energy Use Intensity (EUI, kWh/m^2)	984	942	964	614
Number of medium OTSs with robust energy data	0	0	0	0
Number of large OTSs with robust energy data	0	0	0	1
Number of very large OTSs with robust energy data	2	2	1	2

Energy use by fuel type

Most data centres reported only electricity use however a greater variety of fuel types were reported than in other jurisdictions with four other fuels being used at a significant level (>5% of total) at at least one site. The data for the three years with the greatest number of sites reporting robust data are shown in Table 27.

Table 27 Data centres reporting significant fuel use (> 5% of total) by in New York City 2019-2022

Parameter	2019	2020	2021
No of sites with natural gas use	18	17	19
Max gas use as % of total	66%	60%	49%
No of sites with fuel oil use	16	14	16
Max fuel oil as % of total	49%	30%	42%
No of sites with diesel use	9	8	9
Max diesel as % of total	15%	12%	12%
No of sites with district steam use	6	6	6
Max district steam as % of total	18%	17%	19%

In all years there were some data centres which used a substantial amount of other fuels. The use of district steam is notable; it is not clear how these data centres usef district steam.

There was less diversity of fuel use in the Other – Technology/Science sites although some sites used substantial steam energy too (42%).

Energy use intensity

Energy Use Intensity was included in the downloaded data. Figure 24 shows the variation in mean and median EUI by year for data centres and Other – Technology/Science sites. The EUIs for the two different types of sites were similar. There is greater variation year to year for the latter than for data centres, probably due to the fact that fewer sites reported.

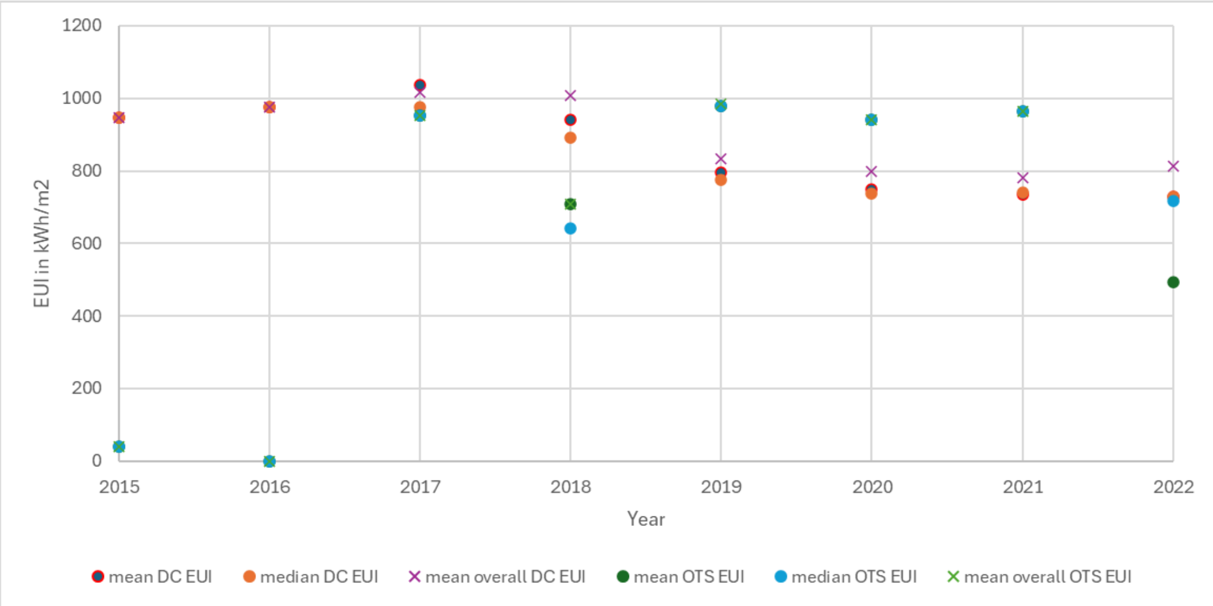

Figure 24 Mean and median EUIs for data centres and Other – Technology/Science sites in New York City

A more detailed analysis of the distribution of EUI values for data centres was possible for the three years where a greater number of sites reported. The results are shown in Figure 25 (x indicates mean, line in block is the median, block is 1st to 3rd quartile, whiskers are 1.5 times the interquartile range, points are outliers).

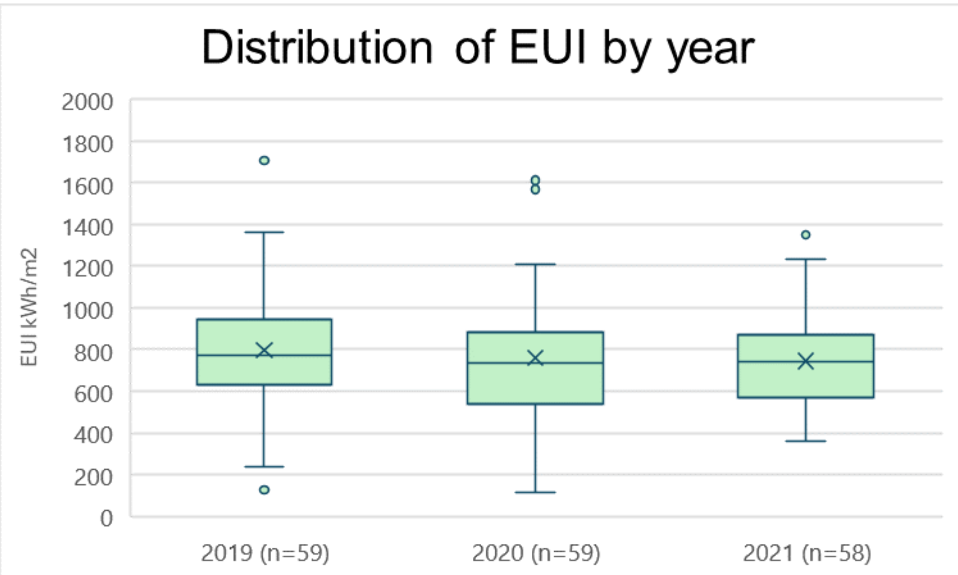

Figure 25 Distribution of EUI by year for data centres reporting in New York City .

There is a big range of values in each year and these vary widely by year. The averages (mean and median) vary less by year. The range of values is lower in 2021.

Analysis of the EUI by site by year in other jurisdictions has not been informative and the number of years that a large number of data centres reported is limited so it was decided not to repeat this analysis for New York.

Energy use intensity relationship to floor area

The variation of EUI with floor areas for the three years with multiple data centres reporting (2019-2021) is shown in Figure 26 (Data has not been converted to SI units as the variation rather than the absolute values are of interest) and again with the high area outlier removed in Figure 27. The latter suggests that there may be a correlation between EUI and area, albeit with an offset and a high degree of scatter.

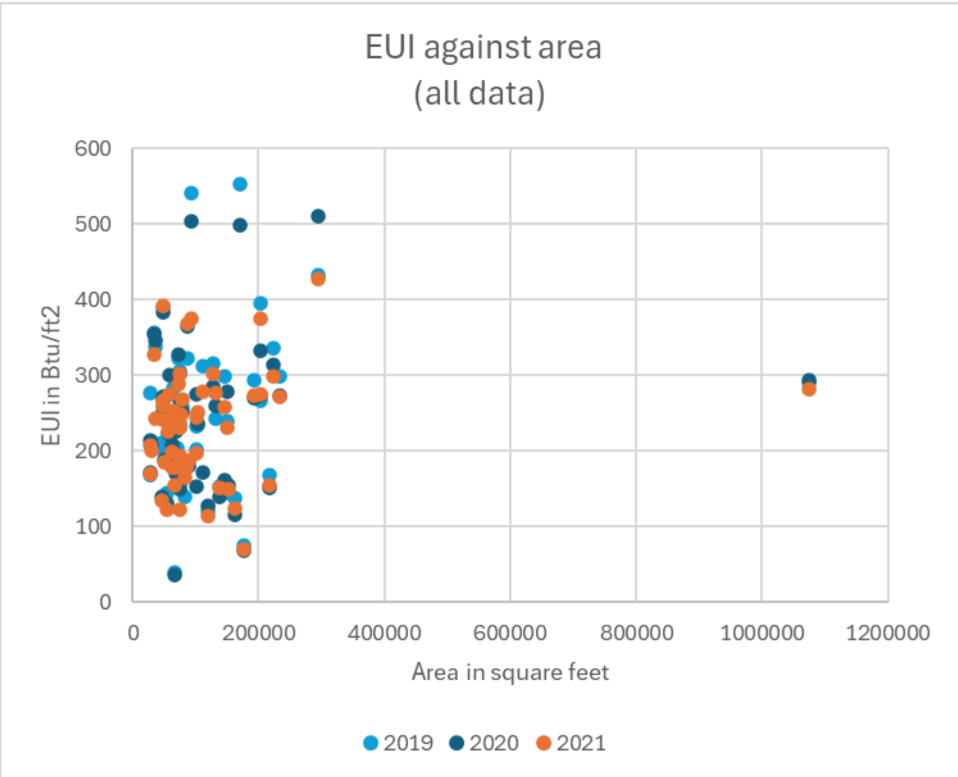

Figure 26 Variation in EUI by area for data centres 2019-2022, all data, New York City

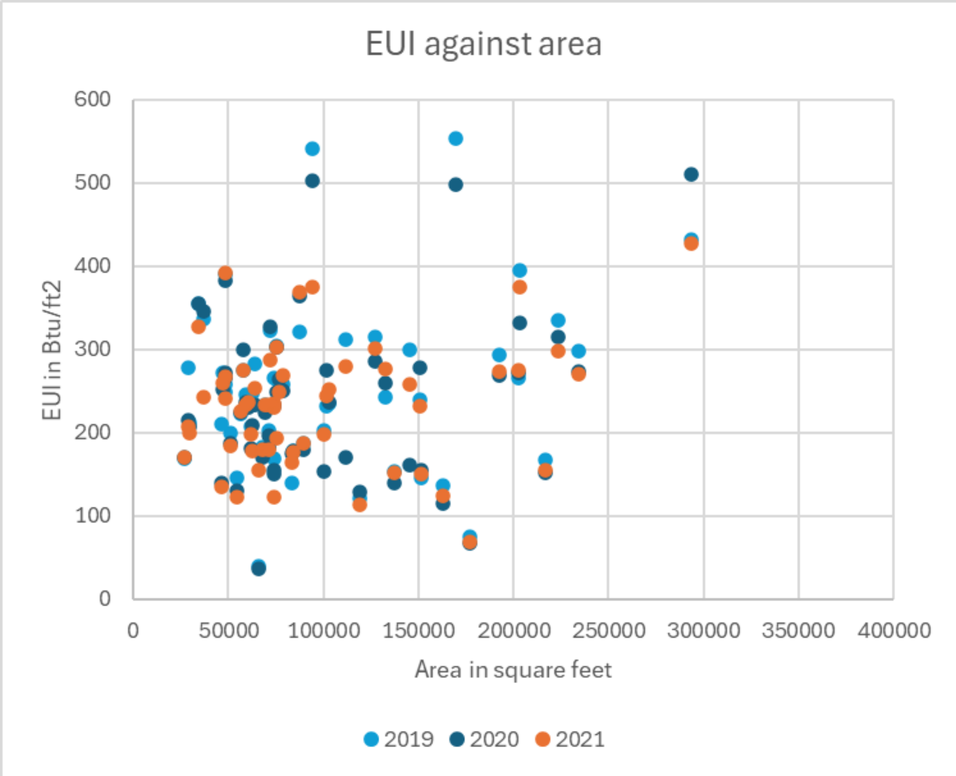

Figure 27 Variation in EUI by area for data centres2019-2022, high area outlier removed, New York City

Weather normalized energy use intensity

The ratios of the base EUI to the weather normalized EUI for data centres reporting in New York City are shown in Table 28.

Table 28 Variations in the ratio of base EUI to weather normalised EUI by year for New York City

Parameter	**2015**	**2016**	**2017**	**2018**
Mean	100.00%	100.71%	98.35%	99.89%
Median	100.00%	100.71%	99.24%	100.00%
Max	100.00%	100.71%	101.28%	101.26%
Min	100.00%	100.71%	94.16%	98.23%
Parameter	**2019**	**2020**	**2021**	**2022**
Mean	100.23%	99.57%	99.99%	99.85%
Median	100.15%	100.00%	99.90%	99.85%
Max	101.50%	102.66%	106.41%	100.25%
Min	99.47%	95.46%	95.23%	99.45%

There was much greater variation in the ratio for some years, for example 2017 and 2021, compared to the other years.

References:

- Benchmarking and Energy Efficiency Rating home page https://www.nyc.gov/site/buildings/codes/benchmarking.page
- NYC Buildings 2022 Local Law 33 Data Disclosure for CY2021 Reporting
- Reported overview data at: https://www.nyc.gov/site/finance/property/nyc-energy-benchmarking-report.page

- Detailed data at: https://data.cityofnewyork.us/browse?q=building+energy

A2.10 San Francisco CA: Building Energy Benchmarking

Short description

The first year of reporting was 2011. The scope is commercial and public/government buildings with more than 10,000 square feet (≥ 929 m^2) of gross floor area.

The deadline for reporting is 1 May. Reporting uses Portfolio Manager.

Overview of data

Data was available for 2011 to 2023. However not all the years' data were suitable for analysis as follows:

- For most sites from 2011 and 2012 the only related data was whether the sites complied or not
- For all sites from 2013 to 2017 the site EUI was added but no direct energy data was published so this was not included in the analysis
- From 2018 onwards total energy use and electricity, gas and district steam use were included. No other fuels were included but a cross check showed that in all cases the sum of the declared fuels was very close (< 2% difference) to the declared total.

There was a flag in all cases whether the site complied or not. Sites which were listed as not complying did not include energy data and were not included in this analysis. A cross check on the data for the remaining sites was performed by calculating the EUI and comparing that with the stated value. If the values differed by more than 1% then the data entries were not included in the analysis. This applied to two data centres in all the reporting years. The Other – Technology/Science sites passed this quality test in all years.

Unlike most other data sets the same sites were included in the dataset in every year whether they complied or not, from 2011 to 2023. This makes the data easier to interpret than other datasets – it is clear that the eligible sites did not change but in some years the sites did not comply with the reporting requirements.

Owner information was not published.

Data was analysed for sites categorised as data centres and Other - Technology/Science sites separately.

The statistics for data centres and for Other Technology/Science sites reporting 2011 to 2017 are shown in Table 29.

Table 29 Overview of data centres and Other – Technology/science reporting in San Francisco by year 2011 to 2017.

Parameter	2011	2012	2013	2014	2015	2016	2017
Number of DCs reporting	3	3	3	3	3	3	3
Number of DCs reported as compliant	1	1	1	3	3	3	3
Number of DC with robust energy data	0	0	0	0	0	0	0
Parameter	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Number of OTSs reporting	2	2	2	2	2	2	2
Number of OTSs reported as compliant	0	1	2	2	2	2	2
Number of OTSs with robust energy data	0	0	0	0	0	0	0

The overall statistics from 2018 to 2023 for data centres are shown in Table 30. Except for the first two rows all values are for sites with robust energy data only.

Table 30 Overview of data centres reporting in San Francisco by year from 2018

Parameter	2018	2019	2020
Number of DCs reporting	3	3	3
Number of DCs complying	3	3	2
Number of DCs with robust energy data	1	1	0
Total area of DCs with energy data (m^2)	3,748	3,748	0
Total energy use of DCs with robust energy data (MWh)	20,406	15,490	0
Mean energy use per data centre	20,406	15,490	0
Mean overall Energy Use Intensity (EUI, kWh/m^2)	5441	4130	0
Mean of site EUIs (kWh/m^2)	5441	4130	0
Parameter	**2021**	**2022**	**2023**
Number of DCs reporting	3	3	3
Number of DCs complying	2	2	3
Number of DCs with robust energy data	0	0	1
Total area of DCs with energy data (m^2)	0	0	3,748
Total energy use of DCs with robust energy data (MWh)	0	0	6,103
Mean energy use per data centre	0	0	6,103
Mean overall Energy Use Intensity (EUI, kWh/m^2)	0	0	1627
Mean of site EUIs (kWh/m^2)	0	0	1628

The energy use and EUI for the site reporting robust data dropped significantly between 2018 and 2019 and also between 2019 and 2023. The site was medium size.

The overall statistics from 2018 to 2023 for Other Technology/Science sites shown in Table 31. Except for the first two rows all values are for sites with robust energy data only.

Table 31 Overview of Other Technology/Science sites reporting in San Francisco by year from 2018

Parameter	2018	2019	2020
Number of OTSs reporting	2	2	2
Number of OTSs complying	2	2	2
Number of OTSs with robust energy data	2	2	2
Total area of OTSs with energy data (m^2)	5,286	5,286	5,286
Total energy use of OTSs with robust energy data (MWh)	9,361	9,070	8,893
Mean energy use per data centre	4,681	4,535	4,446
Mean overall Energy Use Intensity (EUI, kWh/m^2)	885	857	841
Mean of site EUIs (kWh/m^2)	1213	1166	1159
Parameter	**2021**	**2022**	**2023**
Number of OTSs reporting	2	2	2
Number of OTSs complying	2	2	2
Number of OTSs with robust energy data	2	2	2
Total area of OTSs with energy data (m^2)	5,286	5,286	5,286
Total energy use of OTSs with robust energy data (MWh)	9,050	9,217	8,749
Mean energy use per data centre	4,525	4,609	4,374
Mean overall Energy Use Intensity (EUI, kWh/m^2)	855	871	827
Mean of site EUIs (kWh/m^2)	1243	1300	1214

The two reporting sites were medium sized.

Energy use by fuel type

None of the reporting data centres used a significant amount of natural gas. Both of the Other Technology/Science sites did, although in both cases this decreased between 2018 and 2023: for one site from 83% to 62%; the other from 64% to 17%.

Given the small number of sites reporting robust data no other analyses were undertaken.

References:

- Description of scheme
  https://www.sfenvironment.org/existing-buildings-energy-performance-ordinance
- Data from:
  https://data.sfgov.org/Energy-and-Environment/Existing-Buildings-Benchmark-Reports/4ua7-5sfx/about_data
  https://data.sfgov.org/browse?q=building+energy

A2.11 Seattle WA: Building Energy Benchmarking

Short description

The scheme was Introduced in 2012. The scope is non residential and multi family residential buildings with more than 20,000 square feet (≥ 1858 m^2). Portfolio Manager is used for data reporting.

Overview of data

As of time of analysis (July 2024) there were published data for 2015 to 2022. There were no sites categorised as Other Technology/Science.

In all years there was an entry for compliance status (compliant or non compliant). For 2013 to 2017 there was an additional entry for Default data (Yes/No). From 2018 to 2022 there was an additional entry Compliance Issue (No issue or issue listed). If any of these flags were set the data for the site was not included in the analysis. In addition:

- If there was no value for EUI or energy use
- the EUI was calculated from the site area and energy use and compared with the reported EUI; if they were significantly different (in practice they either agreed to 0.1% or differed by 50%)

then the data was not included in this analysis.

There was one site which reported in most years but which never reported robust data.

Sites dropped in and out of the data.

Data on site ownership were not published.

There was one site for which the category under 'largest property type' was always data centre but which in some years under the 'EPA Property Type' was Mixed use and in some was data centre. The data for this site was included in all the analyses as a data centre.

The overall statistics for Seattle data centres are shown in Table 32. Except for the first two row all values are for sites with robust energy data only.

Table 32 Overview of data centres reporting in Seattle

Parameter	2015	2016	2017	2018
Number of DCs reporting	2	3	3	3
Number of DCs with robust energy data	2	3	3	3
Number of DCs reported as compliant	1	2	2	2
Total area of DCs with energy data (m^2)	39,893	43,238	43,238	43,238
Total energy use of DCs with robust energy data (MWh)	83,486	89,305	90,001	88,467
Mean energy use per data centre	83,486	44,652	45,001	44,233
Mean overall Energy Use Intensity (EUI, kWh/m^2)	2091	1032	1040	1022
Mean of site EUIs (kWh/m^2)	2091	2324	2462	2492
Median of site EUIs (kWh/m^2)	2091	2324	2462	2492
Parameter	**2019**	**2020**	**2021**	**2022**
Number of DCs reporting	2	3	4	2
Number of DCs reported as compliant	2	2	4	1
Number of DCs with robust energy data	2	2	3	1
Total area of DCs with energy data (m^2)	43,238	43,238	48,488	3,345
Total energy use of DCs with robust energy data (MWh)	86,314	89,004	90,489	10,094
Mean energy use per data centre	43,157	44,502	30,163	10,094
Mean overall Energy Use Intensity (EUI, kWh/m^2)	997	1029	622	3016
Mean of site EUIs (kWh/m^2)	2419	2430	1714	3016
Median of site EUIs (kWh/m^2)	2419	2430	1989	3016

The data centres which reported robustly in most years were classified as medium and very large sized. A large data centre reported robust data in one year.

There do not appear to be any trends in energy use intensity.

None of the reporting data centres used a significant amount of natural gas.

Weather normalised EUI was not reported.

Given the small number of sites reporting robust data no other analyses were undertaken.

References:

- Scheme information: https://www.seattle.gov/environment/climate-change/buildings-and-energy/energy-benchmarking
- Data from: https://www.seattle.gov/environment/climate-change/buildings-and-energy/energy-benchmarking/data-and-reports#individualbuildingdata

A2.12 Washington DC: Building Energy Benchmarking

Short description

The scheme was introduced in 2008. The first reporting year was 2012. The scope is commercial and multi family residential buildings with a floor area of more than 50,000 square feet (≥ 4645 m^2) and Public/Government buildings with a floor area of more than 10,000 square feet (929m^2).

The submission deadline is generally 1 April but for 2024 it was extended to 1 July.

Overview of data

As of time of analysis (July 2024) there were reported data for 2012 to 2022. One site was categorised as a data centre; classified by floor area as medium sized. This reported from 2012 to 2014 and in 2018. There were no sites categorised as Other Technology/Science. No quality checks were recorded, however the calculated EUI was very close (99.99%) to the reported EUI so the data were considered robust. The only fuel use reported was electricity. The owner of record was reported as the Government of the District of Columbia Department of General Services.

References:

- Scheme description
  https://dc.beam-portal.org/helpdesk/
- Data from
  https://opendata.dc.gov/datasets/DCGIS::building-energy-benchmarking/about

Appendix 3: New North American energy benchmarking schemes where data may become available

A3.1 Colorado: Building Performance Program

2021 was the first year of energy data reported (by end of 2022, thereafter by 1 June following year).

NB if cities are covered by separate city ordinances the building is required to meet city **and** state requirements.

The scope is buildings with more than 50,000 square feet (≥ 4645 m^2) of gross floor area unless:

a) a building in which more than half of the gross floor area is used for manufacturing, industrial, or agricultural purposes; or

b) a single-family home, duplex, or triplex

Eligible buildings are required to report energy use annually. Data is to be published. It is unclear at present if building use type will be published.

"Benchmarking data for all covered buildings that have reported will be made publicly available through a digitally interactive online map on Building Performance Colorado's website. The publicly available data will not include any contact information for a covered building that is not otherwise publicly available. The map will include basic benchmarking information such as the square footage, ENERGY STAR® Score, Energy Usage Intensity (EUI), and GHG emissions, where applicable."
The digital map not available as of 10 May 2024.
Portfolio Manager is to be used for data collection and then online reporting.

References:

- Benchmarking FAQ https://co.beam-portal.org/helpdesk/kb/building-performance-colorado/20/

A3.2 Massachusetts: Act Driving Clean Energy and Offshore Wind

The Act was signed in August 2022, the requirement goes into effect on July 1, 2024, but the Department of Energy Resources (DOER) has an additional year (until July 1, 2025) to draft implementing regulations and establish the parameters of the reporting programme. It applies to buildings in the state (except in cities which have adopted their own ordinances – such as Boston and Cambridge – see A2.2 and A2,4) with floor area of 20,000 square feet or more (≥ 1858 m^2) initially but DOER may lower that threshold by regulation.

There is no information yet on what energy data will be required. Once the program is up and running, the data will be made publicly available on DOER's website on a building-by-building basis.

It is not yet known how data will be collected. It seems likely to use Portfolio Manager in line with other U.S. schemes.

References:

- Massachusetts to Require Disclosure of Energy Usage from Large Buildings, Kathleen Brill, Law & the environment, 2022 https://www.lawandenvironment.com/2022/08/24/massachusetts-to-require-disclosure-of-energy-usage-from-large-buildings/

A3.3 Minnesota Benchmarking Energy Use Data

This scheme was introduced in 2023. 2024 will be first year of energy data reported (in 2025, buildings with a smaller area reporting 2025 data in 2026).

The scope is buildings with more than 50,000 square feet (≥ 4645 m^2) of gross floor area unless:

a) a building in which more than half of the gross floor area is used for manufacturing, industrial, or agricultural purposes; or

b) a single-family home, duplex, or triplex

Buildings are required to report energy use annually. Data is to be published.

Beginning in late 2025, the responsible Department will post on its website:

- Annual summary statistics on energy use for all covered properties;
- Annual summary statistics on energy use for all covered properties, aggregated by covered property class, city, and county;
- The percentage of covered properties in each building class that are in compliance with benchmarking requirements; and
- For each covered property, the address, total energy use, energy use intensity, annual greenhouse gas emissions, and an energy performance score, if available.

Portfolio Manager will be used for reporting.

References:

- https://mn.gov/commerce/energy/consumer/energy-programs/benchmarking-energy-use.jsp

A3.4 New Jersey: Clean Energy Act Energy Benchmarking

The first year of data to be reported is 2022, submission required by October 2023.

The scope is commercial buildings[47] larger than 25,000 square feet (2323 m^2). Other building operators or owners can choose to report, without charge.

The data collected will include water and energy use. Portfolio Manager is to be used for data collection.

Data will be published but the format is to be decided.

[47] Data centres are explicitly included, see https://www.njcleanenergy.com/commercial-industrial/programs/benchmarking/energy-benchmarking-signup/?vs=&r=&b=Data%20Center&s=Commercial

References:

- New Jersey's Clean Energy Program CEA Benchmarking https://njcleanenergy.com/commercial-industrial/programs/cea-benchmarking
- New Jersey Energy and Water Benchmarking, Stakeholder meeting, NJ Board of Public Utilities, December 2022.

A3.5 Washington State: Clean Buildings Performance Standard

The regulation was adopted in 2022; first reporting is to be in 2026.

The scope is buildings with an area ≥ 20,439 m^2 2026, then 9,290 m^2, then from June 1, 2028 more than 50,000 sq. ft. (4645 m^2).

It is not yet clear what data will be published.

Portfolio Manager will be used for reporting.

References:

- https://www.commerce.wa.gov/growing-the-economy/energy/buildings/

A3.6 Chelsea MA: Building Energy Reporting and Disclosure Ordinance (BERDO)

The ordinance was adopted in 2022, with the first reporting year to be 2023. For 2023, public city buildings and commercial and industrial buildings at least 50,000 sq. ft. (4645 m^2) are required to comply. From 2024 all properties including multi family dwellings of ≥20,000 sq. ft (1858 m^2).

It is not yet clear what data will be published

Portfolio Manager is used for data collection.

References:

- https://touchstoneiq.com/chelsea-energy-benchmarking

A3.7 Detroit MI: Building Benchmarking Policy

The policy was adopted in 2023, with 2023 the first reporting year, and 2025 the first transparency year.

For 2023, commercial, industrial and multi family buildings with a floor area of at least 100,000 sq. ft. (9290 m^2) are required to comply. From 2024 all properties ≥25,000 sq. ft (2323 m^2).

It is not yet clear what data will be published

Portfolio Manager is used for data collection.

References:

- https://detroitmi.gov/government/mayors-office/office-sustainability/energy-and-water-benchmarking-ordinance/how-benchmark#:~:text=The%20Detroit%20Benchmarking%20Ordinance%20requires,to%20begin%20reporting%20in%202025.

A3.8 Philadelphia PA: Building Energy Performance Program

The program was introduced in 2013. Commercial and multi family residential buildings with more than 50,000 square feet (≥ 4645 m^2), and public/Government buildings of greater than 10,000 square feet (929 m^2) of gross floor area have to report.

The program publishes information on a map but website has not been available over the period of this analysis (June to July 2024)

References:

- https://www.phila.gov/programs/building-energy-performance-program/#:~:text=The%20Building%20Energy%20Performance%20Program,non%2Dresidential%20buildings%20in%20Philadelphia.
- https://www.phillybuildingbenchmarking.com/

Appendix 4 ENERGY STAR® portfolio manager weather normalised EUI

Portfolio Manager calculates the Weather normalized EUI. This is defined as “the energy your building would have used under average conditions”. This is described in an ENERGY STAR® Portfolio Manager Technical Reference, ‘Climate and Weather’ (version dated August 2023)[48]. ENERGY STAR® uses the Global Surface Summary of the Day (GSOD) dataset to calculate key weather metrics used in Portfolio Manager, including the actual average monthly temperature, Heating Degree Days (HDD), and Cooling Degree Days (CDD). The U.S. National Center for Environmental Information maintains a dataset of climate normals that is updated every 10 years. The most recent set expresses the average conditions experienced between 1991 and 2020.

To adjust energy values to the climate normal the U.S. Environmental Protection Agency (EPA) use the latitude/longitude coordinates of the daily weather stations and the U.S. ZIP Codes to determine which weather station is closest to each ZIP code. This weather station is assigned to any properties located in that ZIP code. In addition, based on the experience of ENERGY STAR® partners benchmarking in coastal and mountainous regions with unique weather patterns, they have performed an additional manual review of some ZIP codes to identify areas where the closest station may not provide a good representation of the weather. Fewer than 1.5% of ZIP codes in the U.S. are mapped to a weather station other than the closest station.

To account for the fact that different fuels will cover different loads in a building, the normalization process is performed separately for each fuel that is present (i.e. electricity, natural gas, district steam, etc.). The normalized values for each fuel are added together to get the normalized value for the property.

The reference reports that the normalization process requires monthly data in order to determine the relationship between monthly energy consumption and monthly temperature. If monthly data is not supplied then “you will not be able to receive accurate normalization for that fuel.” This may be an explanation for why there are not values for weather normalised EUI for sites which appear to be robust otherwise.

[48] https://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-technical-reference-climate-and-weather#:~:text=ENERGY%20STAR%20Score.&text=The%20ENERGY%20STAR%20score%20accounts,score%20better%20and%20vice%20versa.