

Supplementary

Supplementary Table S1. Prisma Ckecklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	p. 1, Title.
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p. 1, Abstract.
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	pp. 2–3, Introduction.
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p. 3, Introduction.
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	pp. 4–5, Section 2.3; pp. 7–9, Sections 2.8–2.9.
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	pp. 3–4, Section 2.2; Supplementary Tables S1–S2.
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	pp. 3–4, Section 2.2; Supplementary Tables S1–S2.
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p. 5, Section 2.4.
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	pp. 5–6, Section 2.5.
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	pp. 4 and 6, Sections 2.3 and 2.5.
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p. 6, Section 2.5.

Section and Topic	Item #	Checklist item	Location where item is reported
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p. 7, Section 2.7; Supplementary Tables S6A–S6B.
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	pp. 6 and 8, Sections 2.5 and 2.8.
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	pp. 7–9, Sections 2.8–2.9.
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	p. 6, Section 2.5; p. 8, Section 2.8.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	pp. 8–9, Sections 2.8–2.9.
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	pp. 7–8, Section 2.8.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	pp. 7–8, Section 2.8.
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	p. 8, Section 2.8.
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Not reported.
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	p. 9, Section 2.10.
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	pp. 9–10, Section 3.1 and Figure 1.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	p. 9, Section 3.1.
Study characteristics	17	Cite each included study and present its characteristics.	pp. 10–14, Sections 3.2–3.3 and Table 1; Supplementary Tables S3 and S7.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	pp. 19–20, Section 3.8 and Figure 6;

Section and Topic	Item #	Checklist item	Location where item is reported
			Supplementary Tables S6A–S6B.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	pp. 15–19, Sections 3.4–3.7, Tables 2–4 and Figures 3–5; Supplementary Tables S5 and S8.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	pp. 17–20, Sections 3.6–3.8.
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	pp. 15–19, Sections 3.4–3.7.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	pp. 7–8 and 17–18.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	p. 16, Section 3.5.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not reported.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	p. 21, Section 3.9.
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	pp. 21–23, Sections 4.1–4.3.
	23b	Discuss any limitations of the evidence included in the review.	p. 24, Section 4.5.
	23c	Discuss any limitations of the review processes used.	p. 24, Section 4.5.
	23d	Discuss implications of the results for practice, policy, and future research.	pp. 23–25, Sections 4.4 and 4.6; p. 25, Conclusions.
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p. 3, Section 2.1 (PROSPERO registration CRD420261502966)

Section and Topic	Item #	Checklist item	Location where item is reported
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p. 3, Section 2.1.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not reported.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p. 26, Funding.
Competing interests	26	Declare any competing interests of review authors.	p. 26, Conflicts of Interest.
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	pp. 25–26, Supplementary Materials and Data Availability Statement.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

Supplementary Table S2. Full database search strategies: PubMed, Embase, Scopus, Web of Science.

Database	Search strategy	Records retrieved
PubMed	<pre>("data center"[Title/Abstract] OR "data centers"[Title/Abstract] OR "data centre"[Title/Abstract] OR "data centres"[Title/Abstract] OR "server farm"[Title/Abstract] OR "server farms"[Title/Abstract]) AND ("Air Pollution"[Mesh] OR "Air Pollutants"[Mesh] OR "Environmental Pollution"[Mesh] OR "Environmental Exposure"[Mesh] OR "Environmental Monitoring"[Mesh] OR "Noise"[Mesh] OR "Water Supply"[Mesh] OR "Water Resources"[Mesh] OR pollution[Title/Abstract] OR emission*[Title/Abstract] OR exhaust[Title/Abstract] OR "air pollution"[Title/Abstract] OR "air pollutant*"[Title/Abstract] OR "air quality"[Title/Abstract] OR "particulate matter"[Title/Abstract] OR PM2.5[Title/Abstract] OR PM10[Title/Abstract] OR NOx[Title/Abstract] OR "nitrogen dioxide"[Title/Abstract] OR ozone[Title/Abstract] OR noise[Title/Abstract] OR "environmental noise"[Title/Abstract] OR "waste heat"[Title/Abstract] OR "thermal pollution"[Title/Abstract] OR "heat island"[Title/Abstract] OR "urban heat island"[Title/Abstract] OR "water use"[Title/Abstract] OR "water consumption"[Title/Abstract] OR "water withdrawal"[Title/Abstract] OR "water scarcity"[Title/Abstract] OR "water stress"[Title/Abstract] OR diesel[Title/Abstract] OR "diesel generator"[Title/Abstract] OR "diesel generators"[Title/Abstract] OR "backup generator"[Title/Abstract] OR "backup generators"[Title/Abstract] OR "gas turbine"[Title/Abstract] OR "gas turbines"[Title/Abstract] OR "land use"[Title/Abstract] OR "land-use"[Title/Abstract] OR "land use change"[Title/Abstract] OR "environmental justice"[Title/Abstract] OR "environmental inequality"[Title/Abstract] OR "environmental inequity"[Title/Abstract])</pre>	252
Embase	<pre>('data center':ti,ab OR 'data centers':ti,ab OR 'data centre':ti,ab OR 'data centres':ti,ab OR 'server farm':ti,ab OR 'server farms':ti,ab) AND ('air pollution'/exp OR 'air pollutant'/exp OR 'environmental exposure'/exp OR 'environmental monitoring'/exp OR 'noise'/exp OR 'water supply'/exp OR 'water resource'/exp OR pollution:ti,ab OR emission*:ti,ab OR exhaust:ti,ab OR 'air pollution':ti,ab OR 'air pollutant*':ti,ab OR 'air quality':ti,ab OR 'particulate matter':ti,ab OR PM2.5:ti,ab OR PM10:ti,ab)</pre>	313

	OR NOx:ti,ab OR 'nitrogen dioxide':ti,ab OR ozone:ti,ab OR noise:ti,ab OR 'environmental noise':ti,ab OR 'waste heat':ti,ab OR 'thermal pollution':ti,ab OR 'heat island':ti,ab OR 'urban heat island':ti,ab OR 'water use':ti,ab OR 'water consumption':ti,ab OR 'water withdrawal':ti,ab OR 'water scarcity':ti,ab OR 'water stress':ti,ab OR diesel:ti,ab OR 'diesel generator':ti,ab OR 'diesel generators':ti,ab OR 'backup generator':ti,ab OR 'backup generators':ti,ab OR 'gas turbine':ti,ab OR 'gas turbines':ti,ab OR 'land use':ti,ab OR 'land-use':ti,ab OR 'land use change':ti,ab OR 'environmental justice':ti,ab OR 'environmental inequality':ti,ab OR 'environmental inequity':ti,ab)	
Web of Science	TI=("data center" OR "data centers" OR "data centre" OR "data centres" OR "server farm" OR "server farms") AND TS=(pollution OR emission* OR exhaust OR "air pollution" OR "air quality" OR noise OR "environmental noise" OR "waste heat" OR "thermal pollution" OR "heat island" OR "urban heat island" OR "water use" OR "water consumption" OR "water withdrawal" OR "water scarcity" OR "water stress" OR diesel OR "diesel generator*" OR "backup generator*" OR "gas turbine*" OR "land use" OR "land use change" OR "environmental justice" OR "environmental inequality"))	1,248
Scopus	TITLE ("data center" OR "data centers" OR "data centre" OR "data centres" OR "server farm" OR "server farms") AND TITLE-ABS-KEY (pollution OR emission* OR exhaust OR "air emissions" OR "air pollution" OR "air quality" OR noise OR "environmental noise" OR "waste heat" OR "thermal pollution" OR "heat island")	1,838

	OR "urban heat island" OR "water use" OR "water consumption" OR "water withdrawal" OR "water scarcity" OR "water stress" OR "water resources" OR diesel OR "diesel generator*" OR "backup generator*" OR "gas turbine*" OR "land use" OR "land use change" OR "environmental justice"
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Supplementary Table S3. Google Scholar supplementary search strategies and prespecified stopping rule.

Environmental exposure domain	Data-center search terms	Domain-specific search terms	Stopping rule
Air pollution and emissions	"data center" OR "data centre" OR "server farm"	"air pollution" OR pollution OR emissions OR "air emissions" OR exhaust OR "air quality" OR "air pollutant" OR diesel OR "diesel generator" OR "backup generator" OR "gas turbine"	Two consecutive results pages without a new potentially eligible study
Water use and water stress	"data center" OR "data centre"	"water use" OR "water consumption" OR "water withdrawal" OR "water scarcity" OR "water stress" OR "water resources"	Two consecutive results pages without a new potentially eligible study
Environmental noise	"data center" OR "data centre"	noise OR "environmental noise"	Two consecutive results pages without a new potentially eligible study
Waste heat and thermal effects	"data center" OR "data centre"	"waste heat" OR "thermal pollution" OR "heat island" OR "urban heat island"	Two consecutive results pages without a new potentially eligible study
Land use and environmental justice	"data center" OR "data centre"	"land use" OR "land-use" OR "land use change" OR "environmental justice" OR "environmental inequality"	Two consecutive results pages without a new potentially eligible study

Supplementary Table S4. Study-design and health-related analytical categories by geographical region (study-level counts).

Study design	North America	Latin America & Caribbean	Europe	Sub-Saharan Africa	Middle East & North Africa	Asia-Pacific	Multi-region / Global	Not reported	Total
Ecological study	1	0	0	0	0	0	0	0	1
Environmental epidemiology study (other design)	1	0	0	0	0	0	0	0	1
Health Impact Assessment (HIA)	3	0	0	0	0	0	0	0	3
Exposure assessment study	9	1	3	0	1	2	3	1	20
Quantitative modelling study (public health implications)	4	0	2	0	0	2	3	0	11
Total	18	1	5	0	1	4	6	1	36

Note. Design categories with zero eligible studies are omitted.

Supplementary Table S5. Exposure domain by endpoint category (study-level counts)

Exposure domain	Mortality	Respiratory disease	Modelled human health/toxicity impact	DALYs	Environmental inequalities	Assessment-type outcome only	Domain total (unique studies)
Air pollution / atmospheric emissions	3	0	1	0	2	4	6
Greenhouse gas emissions / climate change	0	0	0	0	0	12	12
Diesel backup generators / gas turbines	2	0	0	0	0	3	4
Environmental noise	0	0	0	0	0	5	5
Waste heat / local heat-island effects	0	0	0	0	0	6	6
Water use / withdrawal / scarcity / stress	0	0	0	0	0	12	12
Land-use change	0	0	0	0	0	3	3
Environmental justice related to environmental exposures	0	0	0	0	1	0	1
Multiple exposure domains	1	1	2	1	0	1	4
Total (unique studies)	4	1	2	1	3	34	36

Note. Only outcome categories with at least one contributing study are shown; cells are not mutually exclusive.

Supplementary Table S6. Extracted quantitative estimates from the included studies (n = 112 estimates).

Effect ID	Exposure domain	Pathway	Health outcome	Measure type	Estimate	Unit	Direction	Evidence link level
Al Kez, 2022_CARBON	GHG emissions	Indirect	Not applicable	Absolute/descriptive	9.74	Mt CO2/year	Not applicable	Pressure only
Al Kez, 2022_LAND	Land-use change	Indirect	Not applicable	Absolute/descriptive	110.1	km ²	Not applicable	Pressure only
Al Kez, 2022_WATER	Water use / scarcity	Indirect	Not applicable	Absolute/descriptive	77.13	million m ³ /year	Not applicable	Pressure only
Alnuaimy, 2022_NOISE_RANGE	Environmental noise	On-site	Not applicable	Absolute/descriptive	65.0–82.7	dB(A)	Not applicable	Population exposure
Baniata, 2021_AHF	Waste heat	On-site	Not applicable	Normalized	0.00417	W/m ²	Not applicable	Pressure only
Baniata, 2021_HEAT	Waste heat	On-site	Not applicable	Absolute/descriptive	1720.51	MW	Not applicable	Pressure only
Batterman, 2010_SERVER_OFFICE_BDE_AIR	Air pollution	On-site	Not applicable	Absolute/descriptive	855–1340	pg/m ³	Not applicable	Population exposure
Bux, 2025_GWP_BASELINE	GHG emissions	Multiple	Not applicable	Modelled	0.677724	Mt CO2e	Not applicable	Pressure only
Bux, 2025_GWP_SCENARIO1	GHG emissions	Multiple	Not applicable	Modelled	0.602197	Mt CO2e	Not applicable	Pressure only
Bux, 2025_GWP_SCENARIO2	GHG emissions	Multiple	Not applicable	Modelled	0.526677	Mt CO2e	Not applicable	Pressure only
Bux, 2025_GWP_SCENARIO3	GHG emissions	Multiple	Not applicable	Modelled	0.686575	Mt CO2e	Not applicable	Pressure only
Chakraborty, 2026_DCHI_ANNUAL	Waste heat	Multiple	Not applicable	MD	0.95	°C	Not applicable	Pressure only
Chakraborty, 2026_DCHI_SUMMER	Waste heat	Multiple	Not applicable	MD	1.44	°C	Not applicable	Pressure only
Chakraborty, 2026_NDVI_ANNUAL	Land-use change	Multiple	Not applicable	MD	-0.145	NDVI	Not applicable	Pressure only
Chakraborty, 2026_NDVI_SUMMER	Land-use change	Multiple	Not applicable	MD	-0.163	NDVI	Not applicable	Pressure only
Chakraborty, 2026_POP_2020	Multiple domains	Multiple	Not applicable	Absolute/descriptive	20	million residents	Not applicable	Population exposure
Chakraborty, 2026_POP_2030	Multiple domains	Multiple	Not applicable	Absolute/descriptive	21.1	million residents	Not applicable	Population exposure
Chen, 2023_CUE	GHG emissions	Indirect	Not applicable	% change	-11	%	Not applicable	Pressure only
Chen, 2023_WSUE	Water use / scarcity	Multiple	Not applicable	% change	-14.7	%	Not applicable	Pressure only
Chen, 2023_WUE	Water use / scarcity	On-site	Not applicable	% change	-22.4	%	Not applicable	Pressure only

Chen, 2026_NONURBAN_MORT_2023	Air pollution	Indirect	Environmental inequalities	Modelled	0.27	deaths/100,000 popula...	Unclear/mixed	Modelled health impact
Chen, 2026_O3_MORT_2023	Air pollution	Indirect	Mortality	Modelled	137	deaths/year	Not applicable	Modelled health impact
Chen, 2026_PM25_EXPOSURE_2023	Air pollution	Indirect	Not applicable	Absolute/descriptive	0.02–0.08	µg/m³	Not applicable	Population exposure
Chen, 2026_PM25_MORT_2023	Air pollution	Indirect	Mortality	Modelled	513	deaths/year	Not applicable	Modelled health impact
Chen, 2026_TOTAL_MORT_2023	Air pollution	Indirect	Mortality	Modelled	650	deaths/year	Not applicable	Modelled health impact
Conaway, 2024_CAMPUS_RES_NOISE	Environmental noise	On-site	Not applicable	Absolute/descriptive	59	dB(A)	Positive	Population exposure
Conaway, 2024_DC1_RES_NOISE	Environmental noise	On-site	Not applicable	Absolute/descriptive	53	dB(A)	Not applicable	Population exposure
Conaway, 2024_DC2_RES_NOISE	Environmental noise	On-site	Not applicable	Absolute/descriptive	63	dB(A)	Positive	Population exposure
Dandres, 2017_DALY	Multiple domains	Indirect	DALYs	Other	1.69e-06	DALY/kWh	Not applicable	Modelled health impact
Dandres, 2017_GHG	GHG emissions	Indirect	Not applicable	Other	0.85	kg CO2e/kWh	Not applicable	Pressure only
Eslami, 2025_CO2_ELECTRICITY	GHG emissions	Indirect	Not applicable	Absolute/descriptive	0.037668	Mt CO2/year	Not applicable	Pressure only
Eslami, 2025_NOX_BACKUP	Backup generators	On-site	Not applicable	Absolute/descriptive	12	t NOx/year	Not applicable	Pressure only
Eslami, 2025_NOX_CONSTRUCTION	Air pollution	Multiple	Not applicable	Absolute/descriptive	8–30	t NOx/site	Not applicable	Pressure only
Eslami, 2025_PM_BACKUP	Backup generators	On-site	Not applicable	Absolute/descriptive	0.05	t PM/year	Not applicable	Pressure only
Eslami, 2025_PM_CONSTRUCTION	Air pollution	Multiple	Not applicable	Absolute/descriptive	0.5–3.0	t PM/site	Not applicable	Pressure only
Han, 2026 (A)_ASTHMA_2028_HIGH	Multiple domains	Multiple	Respiratory disease	Modelled	600000	asthma symptom cases/...	Not applicable	Modelled health impact
Han, 2026 (A)_GEO_INEQUALITY_2023	Air pollution	Multiple	Environmental inequalities	Other	7	× national average	Unclear/mixed	Modelled health impact
Han, 2026 (A)_HEALTHCOST_2028_HIGH	Multiple domains	Multiple	Modelled human health / t...	Modelled	20.9	billion 2023 USD/year	Not applicable	Modelled health impact

Han, 2026 (A)_SCOPE1_MORT_2023	Backup generators	On-site	Mortality	Modelled	32	deaths/year	Not applicable	Modelled health impact
Han, 2026 (A)_SCOPE2_MORT_2023	Air pollution	Indirect	Mortality	Modelled	401	deaths/year	Not applicable	Modelled health impact
Han, 2026 (A)_TOTAL_MORT_2028_HIGH	Multiple domains	Multiple	Mortality	Modelled	1262	deaths/year	Not applicable	Modelled health impact
Han, 2026_B_CAPACITY_BASELINE	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	697–1451	million gal/day	Not applicable	Pressure only
Han, 2026_B_CAPACITY_OPTIMISTIC	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	227–604	million gal/day	Not applicable	Pressure only
Han, 2026_B_CONSUMPTION_2030	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	60–110	billion gal/year	Not applicable	Pressure only
Han, 2026_B_LOUDOUN	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	20–50	million gal/day	Not applicable	Pressure only
Han, 2026_B_PEAKING_FACTOR	Water use / scarcity	On-site	Not applicable	Normalized	6 (often); >10 (sometimes)	peak/average ratio	Not applicable	Pressure only
Han, 2026_B_WITHDRAWAL_2030	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	80–150	billion gal/year	Not applicable	Pressure only
Hankendi, 2026_GHG_LIFETIME	GHG emissions	Multiple	Not applicable	Modelled	2.8	Mt CO2e	Not applicable	Pressure only
Hankendi, 2026_WATER_LIFETIME	Water use / scarcity	On-site	Not applicable	Modelled	56	billion L	Not applicable	Pressure only
Herrera, 2025_BAU2050	Water use / scarcity	Multiple	Not applicable	Modelled	28.11	billion L/day	Not applicable	Pressure only
Herrera, 2025_MOD2050	Water use / scarcity	Multiple	Not applicable	Modelled	8.36	billion L/day	Not applicable	Pressure only
Herrera, 2025_SUST2050	Water use / scarcity	Multiple	Not applicable	Modelled	1.38	billion L/day	Not applicable	Pressure only
Hu, 2026_5X_TA	Waste heat	Multiple	Not applicable	Absolute/descriptive	1.98	°C	Not applicable	Pressure only
Hu, 2026_CA_POP_HEAT	Waste heat	Multiple	Not applicable	Absolute/descriptive	0.72	million residents	Not applicable	Population exposure
Hu, 2026_LA_TA	Waste heat	Multiple	Not applicable	Absolute/descriptive	0.35	°C	Not applicable	Population exposure
Hu, 2026_SANTACLARA_TA	Waste heat	Multiple	Not applicable	Absolute/descriptive	0.8	°C	Not applicable	Population exposure
Jalilzadeh, 2014_LAEQ1H	Environmental noise	On-site	Not applicable	Absolute/descriptive	71.83	dB(A)	Not applicable	Population exposure
Jerleus, 2024_GHG	GHG emissions	Indirect	Not applicable	Absolute/descriptive	0.13	Mt CO2e/year	Not applicable	Pressure only

Jerleus, 2024_WATER	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	42	million m³/year	Not applicable	Pressure only
Jia, 2026_SO2_DID_T1	Backup generators	On-site	Not applicable	Beta	0.09	ppb	Positive	Population exposure
Jia, 2026_SO2_MORT_T1	Backup generators	On-site	Mortality	Modelled	7.2	additional deaths	Positive	Modelled health impact
Jiang, 2025_SEVERE_SCARCITY_2022	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	71.9	% of national computi...	Not applicable	Pressure only
Jiang, 2025_TEI_2050	Water use / scarcity	Multiple	Not applicable	Modelled	85.7	billion m³/year	Not applicable	Pressure only
Jiang, 2025_TOTAL_WF_2022	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	15.7	billion m³/year	Not applicable	Pressure only
Jiang, 2025_WSF_2022	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	13.4	billion m³/year	Not applicable	Pressure only
Karimi, 2022_WATER_PHOENIX_MAX	Water use / scarcity	Multiple	Not applicable	Modelled	24	million m³/year	Not applicable	Pressure only
Karimi, 2022_WATER_PHOENIX_MIN	Water use / scarcity	Multiple	Not applicable	Modelled	7.5	million m³/year	Not applicable	Pressure only
Karimi, 2022_WUE_DC1	Water use / scarcity	Multiple	Not applicable	Normalized	3.1	L/kWh	Not applicable	Pressure only
Karimi, 2022_WUE_DC2	Water use / scarcity	Multiple	Not applicable	Normalized	9.11	L/kWh	Not applicable	Pressure only
Li, 2025_GPT3_INFERENCE	Water use / scarcity	Multiple	Not applicable	Normalized	16.904	mL/request	Not applicable	Pressure only
Li, 2025_GPT3_TRAIN_SCOPE1	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	0.708	million L	Not applicable	Pressure only
Li, 2025_GPT3_TRAIN_SCOPE2	Water use / scarcity	Indirect	Not applicable	Absolute/descriptive	4.731	million L	Not applicable	Pressure only
Liang, 2026_DIRECT_WATER	Water use / scarcity	On-site	Not applicable	Absolute/descriptive	8.658	million m³/year	Not applicable	Pressure only
Liang, 2026_DROUGHT	Water use / scarcity	Indirect	Not applicable	Absolute/descriptive	9.47505	million m³/year	Not applicable	Pressure only
Liang, 2026_INDIRECT_WATER	Water use / scarcity	Indirect	Not applicable	Absolute/descriptive	7.44726	million m³/year	Not applicable	Pressure only
Liang, 2026_TOTAL_WF	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	16.10526	million m³/year	Not applicable	Pressure only
Marinoni, 2026_LST_4_5KM	Waste heat	On-site	Not applicable	Absolute/descriptive	1	°C	Not applicable	Pressure only
Marinoni, 2026_LST_MEAN	Waste heat	On-site	Not applicable	MD	2.07	°C	Not applicable	Pressure only
Marinoni, 2026_POP_10KM	Waste heat	On-site	Not applicable	Absolute/descriptive	343	million residents	Not applicable	Population exposure

Miljkovic, 2016_NOISE_SPATIAL	Environmental noise	On-site	Not applicable	Absolute/descriptive	80.3	dB(A)	Not applicable	Population exposure
Miljkovic, 2016_NOISE_TEMPORAL	Environmental noise	On-site	Not applicable	Absolute/descriptive	79.4	dB(A)	Not applicable	Population exposure
Molla, 2026_EJ	Environmental justice related to environmental exposures	Multiple	Environmental inequalities	Rate	12.99	% below poverty line	Positive	Population exposure
Molla, 2026_LST	Waste heat	On-site	Not applicable	Absolute/descriptive	39.74	°C	Positive	Population exposure
Molla, 2026_NDVI	Land-use change	Multiple	Not applicable	Absolute/descriptive	0.15	NDVI	Positive	Pressure only
Muller, 2026_LAP_DAMAGE_2025	Air pollution	Indirect	Mortality	Modelled	4.59	billion 2025 USD/year	Positive	Modelled health impact
Muller, 2026_PM25_EXPOSURE_2025	Air pollution	Indirect	Not applicable	Modelled	0–0.035	µg/m³	Positive	Population exposure
Ngata, 2025_NOISE	Environmental noise	On-site	Not applicable	Other	28	dB	Positive	Population exposure
Ni, 2024_CO2_2021	GHG emissions	Indirect	Not applicable	Absolute/descriptive	135.01	Mt CO2/year	Not applicable	Pressure only
Ni, 2024_CO2_2050_BAU	GHG emissions	Indirect	Not applicable	Modelled	430	Mt CO2/year	Not applicable	Pressure only
Ni, 2024_CO2_2050_NETZERO	GHG emissions	Indirect	Not applicable	Modelled	10.6	Mt CO2/year	Not applicable	Pressure only
Olaguer, 2016_NO2	Backup generators	On-site	Not applicable	Modelled	50	ppbv	Positive	Population exposure
Olaguer, 2016_PM	Backup generators	On-site	Not applicable	Modelled	5	µg/m³	Positive	Population exposure
Sailor, 2026_Aligned	Waste heat	On-site	Not applicable	MD	0.7	°C	Positive	Population exposure
Sailor, 2026_CyrusOne_August	Waste heat	On-site	Not applicable	MD	0.5	°C	Positive	Population exposure
Sailor, 2026_CyrusOne_June	Waste heat	On-site	Not applicable	MD	0.8	°C	Positive	Population exposure
Sailor, 2026_DigitalRealty	Waste heat	On-site	Not applicable	MD	1	°C	Positive	Population exposure
Sailor, 2026_NTT	Waste heat	On-site	Not applicable	MD	0.9	°C	Positive	Population exposure
Siddik, 2021_GHG	GHG emissions	Indirect	Not applicable	Absolute/descriptive	31.5	million tons CO2e/year	Not applicable	Pressure only
Siddik, 2021_WATER	Water use / scarcity	Multiple	Not applicable	Absolute/descriptive	513	million m³/year	Not applicable	Pressure only

Siddik, 2021_WSF	Water use / scarcity	Multiple	Not applicable	Modelled	1.29	billion m³ US-eq	Not applicable	Pressure only
Whitehead, 2015_CARCI NOGENS	Multiple domains	Multiple	Modelled human health / t...	Modelled	162	Pt	Not applicable	Modelled health impact
Whitehead, 2015_HUMAN_HEALTH	Multiple domains	Multiple	Modelled human health / t...	Modelled	391.23	Pt	Not applicable	Modelled health impact
Whitehead, 2015_RESP_INORG	Air pollution	Indirect	Modelled human health / t...	Modelled	154	Pt	Not applicable	Modelled health impact
Xiao, 2025_GHG_2030	GHG emissions	Indirect	Not applicable	Modelled	26.8	Mt CO2e/year	Not applicable	Pressure only
Xiao, 2025_WATER_2030	Water use / scarcity	Multiple	Not applicable	Modelled	860.1	million m³/year	Not applicable	Pressure only
Zhou, 2024_GHG_2025	GHG emissions	Indirect	Not applicable	Modelled	168	million tons CO2/year	Not applicable	Pressure only
Zhou, 2024_GHG_2030	GHG emissions	Indirect	Not applicable	Modelled	234.7	million tons CO2/year	Not applicable	Pressure only
Zhou, 2024_GHG_2060	GHG emissions	Indirect	Not applicable	Modelled	196.6	million tons CO2/year	Not applicable	Pressure only
Zhou, 2024_NET_2060_BASELINE	GHG emissions	Indirect	Not applicable	Modelled	-26.2	million tons CO2/year	Not applicable	Pressure only
Zhou, 2024_NET_2060_HIGH	GHG emissions	Indirect	Not applicable	Modelled	-53.16	million tons CO2/year	Not applicable	Pressure only
Zhou, 2026_CARBON_FLOW_2030	GHG emissions	Indirect	Not applicable	Modelled	41.45	Mt CO2	Not applicable	Pressure only
Zhou, 2026_EDWC_2060	GHG emissions	Indirect	Not applicable	% change	-77.6	%	Inverse	Pressure only

Note. Each row represents one extracted effect. “Not applicable” under Health outcome indicates an environmental pressure or exposure estimate without a health endpoint. Ninety-five percent confidence intervals were reported for 11 of 112 effects and are not shown in this table. Additional extraction details, including confidence intervals, adjustment status, statistical significance, and verbatim source data, are retained in the study extraction database.

Supplementary Table S7A. QualSyst study-level appraisal: Q1–Q14 + scores

First Author, year	Study type	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Raw score	Max applicable score	Standardized score
Al Kez, 2022	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	16	18	0.889
Alnuaimy, 2022	Occupational noise exposure assessment / direct monitoring	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Partial	Partial	Partial	No	N/A	Yes	Partial	13	20	0.650
Baniata, 2021	Quantitative environmental modelling	Yes	Partial	Partial	Yes	N/A	N/A	N/A	Partial	N/A	Partial	Partial	N/A	Yes	Partial	12	18	0.667
Batterman, 2010	Occupational indoor-air exposure assessment / direct monitoring	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	Partial	Yes	Yes	N/A	Yes	Yes	19	20	0.950
Bux, 2025	Life cycle assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	No	N/A	Yes	Yes	16	18	0.889
Chakraborty, 2026	Satellite-based exposure assessment / geospatial observational analysis	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	Yes	Yes	Partial	Partial	Yes	Partial	19	22	0.864
Chen, 2023	Quantitative environmental modelling / exposure assessment	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Yes	N/A	Yes	Yes	18	18	1.000
Chen, 2026	Health Impact Assessment /	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Yes	N/A	Yes	Yes	18	18	1.000

	coupled power-air-quality-health modelling																	
Conaway, 2024	Acoustical exposure assessment / receptor-level noise modelling	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Partial	N/A	Yes	No	N/A	Yes	Yes	14	18	0.778
Dandres, 2017	Quantitative modelling study (public health implications)	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	No	N/A	Yes	Yes	16	18	0.889
Eslami, 2025	Quantitative environmental modelling / emissions inventory / scenario analysis	Yes	No	Partial	Partial	N/A	N/A	N/A	Partial	N/A	No	No	N/A	Yes	Partial	8	18	0.444
Han, 2026 (A)	Health Impact Assessment / quantitative public health modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Han, 2026 (B)	Exposure assessment / quantitative water-demand and capacity modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Hankendi, 2026	Life cycle / whole-systems quantitative environmental modelling	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	15	18	0.833
Herrera, 2025	Quantitative environmental modelling / scenario analysis	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Yes	N/A	Yes	Yes	18	18	1.000

Hu, 2026	Exposure assessment with quantitative urban-climate modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Yes	N/A	Yes	Yes	18	18	1.000
Jalilzadeh, 2014	Occupational noise exposure assessment / direct monitoring	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Yes	Partial	Yes	No	N/A	Yes	Yes	16	20	0.800
Jerleus, 2024	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Partial	N/A	Yes	No	N/A	Yes	Yes	15	18	0.833
Jiang, 2025	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Karimi, 2022	Exposure assessment with quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	Partial	Yes	Yes	Partial	Yes	Yes	20	22	0.909
Li, 2025	Quantitative environmental modelling / AI water-footprint assessment	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Partial	N/A	Yes	No	N/A	Yes	Yes	15	18	0.833
Liang, 2026	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	16	18	0.889
Marinoni, 2026	Satellite-based exposure assessment / geospatial	Yes	Partial	Partial	Yes	N/A	N/A	N/A	Partial	Yes	Partial	Partial	Partial	Yes	No	14	22	0.636

	before-after analysis																	
Miljkovic, 2016	Occupational environmental noise exposure assessment	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Yes	Partial	Yes	No	N/A	Yes	Partial	15	20	0.750
Molla, 2026	Ecological spatial study / geospatial observational analysis	Yes	Yes	Partial	Partial	N/A	N/A	N/A	Partial	Partial	Yes	No	No	Yes	Yes	14	22	0.636
Muller, 2026	Health Impact Assessment / integrated air-pollution damage modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Ngata, 2025	Exposure assessment study	Yes	Partial	Partial	Partial	N/A	N/A	N/A	Partial	No	No	No	No	Partial	Partial	8	22	0.364
Ni, 2024	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Olague, 2016	Quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	No	N/A	Yes	Yes	16	18	0.889
Sailor, 2026	Exposure assessment study	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Yes	Partial	Partial	No	Partial	Yes	Partial	15	22	0.682
Siddik, 2021	Exposure assessment / quantitative environmental modelling	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	16	18	0.889
Whitehead, 2015	Life cycle assessment / quantitative	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Yes	N/A	Yes	Yes	18	18	1.000

	environmental modelling																	
Xiao, 2025	Quantitative environmental modelling / scenario analysis	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes	N/A	Yes	Partial	N/A	Yes	Yes	17	18	0.944
Zhou, 2024	Quantitative environmental modelling / scenario analysis	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	15	18	0.833
Zhou, 2026	Quantitative environmental modelling / scenario analysis	Yes	Yes	Partial	Yes	N/A	N/A	N/A	Partial	N/A	Yes	Partial	N/A	Yes	Yes	15	18	0.833

Note. QualSyst items were scored as Yes = 2, Partial = 1, and No = 0; items considered not applicable to the study design were excluded from the maximum possible score. The standardized score was calculated as the raw score divided by the maximum applicable score. Items Q5–Q7 (randomization and blinding) were not applicable to the non-interventional environmental studies. Q9 was applied to 10 empirical studies for which sample-size adequacy could meaningfully be assessed, and Q12 to six observational comparative studies in which confounding was conceptually relevant. For Q11, Partial was assigned when uncertainty or sensitivity was quantitatively characterized without a formal variance estimate. Standardized scores were used descriptively and were not interpreted as directly comparable risk-of-bias measures across heterogeneous study designs.

Supplementary Table S7B. JBI appraisal of Jia 2026

First Author, year	J1	J2	J3	J4	J5	J6	J7	J8	J9	Overall_Appraisal
Jia, 2026	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Include

Note. J1–J9 correspond to the nine items of the 2020 JBI Critical Appraisal Checklist for Quasi-Experimental Studies. Items were rated as Yes, No, Unclear, or Not applicable. The overall appraisal was classified as Include, Exclude, or Seek further information.

Supplementary Table S8. Technical and operational characteristics of the included studies.

First Author, year	IT capacity / load	Cooling system	Backup-power type	Backup operating assumptions	Electricity source / grid mix	PUE	WUE	Water-stress context
Al Kez, 2022	NR	NR	NR	NR	2020 global and country-specific electricity generation mixes	NR	NR	NR
Alnuaimy, 2022	NR	NR	NR	NR	NR	NR	NR	NR
Baniata, 2021	NR	NR	NR	NR	NR	Google 1.10; Azure 1.25; Amazon 1.14	NR	NR
Batterman, 2010	NR	NR	NR	NR	NR	NR	NR	NR
Bux, 2025	5 MW IT capacity; 85% (4.25 MW)	Baseline: chilled water; Scenario 2: DX CRAC	Baseline: diesel; Scenario 2: natural gas	Scenario operating assumptions as extracted: baseline 8000 h/year; Scenario 2 8760 h/year	Italian electricity mix	NR	NR	NR
Chakraborty, 2026	UPS metadata available for some facilities; not a direct measure of actual utilization.	NR	NR	NR	NR	NR	NR	NR
Chen, 2023	0.4 MW IT capacity; 400 kW IT load	CRAH-based chilled-water system; airside and/or water-side economization scenarios	NR	NR	US regional electricity grid	1.51–1.59 across modelled U.S. locations	1.85–2.30 L/kWh onsite across modelled U.S. locations	NR
Chen, 2026	2023 U.S. data-center load modelled as near-continuous; 171.0 TWh attributable generation.	NR	On-site backup generation excluded from analysis	On-site backup generation excluded from analysis	U.S. grid; marginal supply dominated by natural gas and coal in several regions.	NR	NR	NR
Conaway, 2024	NR	Air-cooled chillers; 32, 134 and 64 units across Data Centers #1–#3.	Backup generators	Routine testing; load-shedding operation considered.	NR	NR	NR	NR
Dandres, 2017	66% of capacity	NR	NR	NR	Canadian/U.S. grid	NR	NR	NR

Eslami, 2025	10 MW IT capacity; Reference calculation assumes a 10 MW continuously operating facility (87,600 MWh/year); statewide future scenarios use ERCOT load forecasts.	Air-cooled, water-cooled and direct-expansion systems considered; emerging immersion cooling discussed.	Diesel backup generators (reference 2.5 MW units); alternatives discussed include natural gas, hydrogen fuel cells and battery storage.	100 h/year per generator in the main reference calculation; 50–150 h/year described as a typical testing/maintenance range.	ERCOT mixed grid (natural gas, wind, coal, nuclear and solar); average grid emission factor used in calculations.	1.3–1.5 (typical optimized Texas facilities)	NR	Texas drought/water-availability constraints are discussed for cooling-system choice but are not quantitatively assessed as an exposure.
Han, 2026 (A)	U.S. data-center electricity consumption: 176.39 TWh in 2023; 325 TWh (low) to 580 TWh (high) projected for 2028.	NR	Diesel backup generators (onsite; Scope 1)	Reference case assumes actual generator emissions at 10% of permitted annual levels; maintenance commonly 10–20 h/year; up to 50 h/year non-emergency use may be allowed under specified conditions.	Regional U.S. electricity grids/power plants across 14 AVERT electricity regions; mixed generation including fossil fuels.	NR	NR	NR
Han, 2026 (B)	National IT-load growth scenarios; operator-level IT energy used to derive baseline water intensity.	Evaporative cooling, cooling towers, and dry cooling with evaporative assistance; dry cooling considered as alternative.	NR	NR	NR	NR	WUE trajectories incorporated as modelling assumptions; no single summary value extracted	Capacity constraints, summer peaks, heatwaves and drought-sensitive water supplies.
Hankendi, 2026	50–80% modelled server utilization	NR	NR	NR	Country-specific grid electricity: predominantly hydropower in Norway; mixed grid including coal in Germany; substantial	1.2	0.2	NA

					wind/renewables in Denmark			
Herrera, 2025	Baseline server electricity consumption in 2025 modelled as $N(\text{mean } 1.0 \times 10^9, \text{SD } 0.1 \times 10^9)$ kWh/day	Multiple cooling technologies considered conceptually; forecast incorporates cooling efficiency through WUE rather than explicit facility-level cooling-system shares	NR	NR	Electricity-related water intensity represented through EWIF; specific generation mix not reported	NR	WUE incorporated in the probabilistic model and sensitivity analysis; no single summary value extracted	NR
Hu, 2026	3 GW installed utility power; 100% load assumed as upper-bound scenario.	NR; main model assumes sensible heat; latent-heat sensitivity analysis included.	Backup diesel generators excluded from heat inventory	Excluded from main heat inventory	California grid; Scope 2 attributed to supplying power plants by balancing authority.	NR	NR	NR
Jalilzadeh, 2014	NR	Room-based cooling with air conditioners and rack/server fans.	NR	NR	NR	NR	NR	NR
Jerleus, 2024	NR	NR	NR	NR	Mixed grid: hydro, wind, nuclear, solar and thermal; zone-specific	NR	1.8	Low overall; county WEI 0.06–4.5%, highest in Stockholm (4.5%) and Skåne (4.2%)
Jia, 2026	Facility size varies; median estimated electricity demand in heterogeneity analysis was 7.64 MW.	NR	Diesel backup generators; confirmed in 421/694 facilities.	Commissioning and routine testing; exact runtime not observed.	Not applicable to primary onsite exposure pathway	NR	NR	NR

Jiang, 2025	Facility-level IT load estimated from server-room floor area and data-center-type-specific IT load intensity; future computing scale modelled using provincial rack capacity	Open-loop indirect cooling assumed in the modelling; cooling water requirement = 1.8 m3/MWh	NR	NR	Province-specific grid mixes including thermal/coal, nuclear, photovoltaic, wind and hydropower	1.51	1.8 m3/MWh	Strong spatial overlap with water scarcity; 71.9% of computing capacity in severe water-scarcity prefectures and 84.9% in severe or more extreme scarcity
Karimi, 2022	DC1 54 MW; DC2 34.5 MW (88.5 MW total); Phoenix-wide scenarios modelled 707 MW IT capacity	DC1: air-cooled chillers; DC2: water-cooled chillers plus direct evaporative cooling	NR	NR	SRP electricity supply	DC1 1.84; DC2 1.63	Source WUE: DC1 3.10; DC2 9.11 L/kWh	High
Li, 2025	NR	NR	NR	NR	Location-specific electricity-grid fuel mixes used to estimate off-site water consumption	Annualized/location-specific PUE incorporated into the water-footprint model; no single summary value extracted	Annualized/location-specific WUE incorporated into the water-footprint model; no single summary value extracted	Freshwater scarcity and competition for water resources considered conceptually
Liang, 2026	550 MW IT capacity; Aggregate operational IT load ~550 MW; facility estimates range from 60 to 180 MW for the four named operators	Predominantly evaporative cooling; mixed cooling for aggregated other operators	NR	NR	Brazilian/São Paulo electricity mix used for baseline and drought scenarios; specific generation shares not extracted	1.5	1.8 L/kWh	High-to-critical water stress in the Alto Tietê watershed; watershed supplies >20 million people
Marinoni, 2026	NR	NR	NR	NR	NR	NR	NR	NR
Miljkovic, 2016	Low utilization of computing resources	Separate cabinet cooling systems plus HVAC/air-conditioning; server and equipment cooling fans	NR	NR	NR	NR	NR	NR

Molla, 2026	NR	NR	NR	NR	NR	NR	NR	NR
Muller, 2026	About 251 TWh/year under the default 55% load-factor scenario.	NR	NR	NR	eGRID subregion-average U.S. generation mix.	NR	NR	NR
Ngata, 2025	NR	NR	Diesel	NR	NR	NR	NR	NR
Ni, 2024	NR	NR	NR	NR	Chinese regional electricity grids; strong dependence on coal, with regional variation in generation mix	NR	NR	NR
Olague, 2016	NR	NR	Diesel RICE and natural gas-fired RICE	2h	Not applicable to grid mix; onsite diesel and natural-gas backup-generation scenarios	NR	NR	NR
Sailor, 2026	Facility-specific capacities reported for NTT PH1 (36 MW) and CyrusOne (169 MW); capacities for the other two sites not reported	Air-based cooling	NR	NR	NR	1.3	NR	NR
Siddik, 2021	NR	NR	NR	NR	US grid; power-plant-specific generation mix linked through power control areas	NR	NR	Mixed
Whitehead, 2015	13 MW IT capacity; 30% average utilization; idle power assumed at 50% of peak	Direct air-side free cooling; redundant chilled-water and condenser-water systems; DX cooling for UPS rooms	Generator sets plus UPS batteries	NR	UK grid electricity mix	1.17	NR	NR
Xiao, 2025	2030 annual AI-server shipment capacity: 17.6 GW	Specific cooling configurations unknown; state-	NR	NR	State- and balancing-area-specific	State-specific PUE values modelled using a hybrid	State-specific WUE values modelled using a hybrid	State-level water scarcity incorporated;

	lowest, 21.9 GW mid-case, 33.7 GW highest; model assumes 30% training and 70% inference capacity, with utilization rates of 72% and 25%, respectively	specific PUE/WUE estimated using a hybrid climate/thermodynamic model; advanced liquid cooling assessed as a mitigation scenario			projected US electricity mixes modelled using ReEDS	climate/thermodynamic model; no single summary value extracted	climate/thermodynamic model; no single summary value extracted	severe scarcity concentrated particularly in western states including California, Nevada, Arizona, Utah and New Mexico
Zhou, 2024	NR	NR	Diesel	NR	National grid; fossil and nonfossil electricity with scenario-specific future shares	1.3	NR	NR
Zhou, 2026	Scenario-dependent IT load utilization; policy scenario target = 65%, LurS scenario = 80%	NR	NR	NR	Province- specific grid electricity	policy scenario east 1.25, west 1.20; PueS progressively to 1.10	NR	NR

Note. Technical information was consolidated across the structured extraction fields and study-level notes or limitations when a single dedicated field could not capture multiple, site-specific, or modelled values. NR indicates not reported. Statements such as “excluded from analysis” or “not applicable” are retained when they represent an explicit study assumption. PUE, power usage effectiveness; WUE, water usage effectiveness.

Supplementary Table S9. Within-study environmental and health-related changes associated with alternative technical or system-level configurations.

First Author, year	Technical or system-level contrast	Outcome	Reference → alternative	Relative change vs reference	Source of percentage
Bux, 2025	Extended IT refresh interval	Lifecycle GHG emissions	0.677724 → 0.602197 Mt CO ₂ e	−11.1%	Derived
Bux, 2025	Efficient physical infrastructure	Lifecycle GHG emissions	0.677724 → 0.526677 Mt CO ₂ e	−22.3%	Derived
Bux, 2025	Alternative electricity mix	Lifecycle GHG emissions	0.677724 → 0.686575 Mt CO ₂ e	1.30%	Derived
Chen, 2023	Combined economization	Operational carbon emissions	Study-reported contrast	−11.0%	Reported
Chen, 2023	Economization	On-site water use	Study-reported contrast	−22.4%	Reported
Chen, 2023	Combined economization	Water-scarcity impact	Study-reported contrast	−14.7%	Reported
Karimi, 2022	DC2 vs DC1 cooling configuration	PUE	1.84 → 1.63	−11.4%	Derived
Karimi, 2022	DC2 vs DC1 cooling configuration	Source WUE	3.10 → 9.11 L/kWh	+193.9% (2.94-fold)	Derived
Liang, 2026	Drought electricity-grid scenario	Indirect water consumption	7.44726 → 9.47505 million m ³ /year	27.2%	Derived
Jiang, 2025	Combined PUE, WUE and electricity decarbonization	Projected water footprint	Study-reported contrast	−51.5% to −58.3%	Reported
Xiao, 2025	Combined best-practice scenario	Water footprint	Study-reported contrast	Up to −86%	Reported
Xiao, 2025	Combined best-practice scenario	Carbon emissions	Study-reported contrast	Up to −73%	Reported
Han, 2026 (A)	Health-informed workload shifting	Modelled health costs	Study-reported contrast	Approximately −25%	Reported
Zhou, 2026	East Data West Computing policy scenario	CO ₂ emissions in 2060	Study-reported contrast	−77.6%	Reported

Negative values indicate a lower environmental or health-related burden relative to the study-specific reference scenario; positive values indicate an increase. Derived percentages were calculated only when both reference and alternative values were explicitly available in the extracted data. Reported percentages were retained when directly provided by the original study. These contrasts should not be interpreted as pooled effect estimates or directly compared as measures of intervention effectiveness because study settings, system boundaries, and outcomes differed.