

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
<input type="checkbox"/>	<input checked="" type="checkbox"/> The exact sample size (<i>n</i>) for each experimental group/condition, given as a discrete number and unit of measurement
<input checked="" type="checkbox"/>	<input type="checkbox"/> A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
<input checked="" type="checkbox"/>	<input type="checkbox"/> The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
<input checked="" type="checkbox"/>	<input type="checkbox"/> A description of all covariates tested
<input type="checkbox"/>	<input checked="" type="checkbox"/> A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
<input checked="" type="checkbox"/>	<input type="checkbox"/> A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
<input checked="" type="checkbox"/>	<input type="checkbox"/> For null hypothesis testing, the test statistic (e.g. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
<input checked="" type="checkbox"/>	<input type="checkbox"/> For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
<input checked="" type="checkbox"/>	<input type="checkbox"/> For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
<input checked="" type="checkbox"/>	<input type="checkbox"/> Estimates of effect sizes (e.g. Cohen's <i>d</i> , Pearson's <i>r</i>), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	The following software and codes are used for data collection in this study: 1. The climate data from 2024 to 2030: Meteonorm V8.2.0.24079 2. The grid data from 2024 to 2030: Regional Energy Deployment System (ReEDS) Model 2.0 3. The data center location and AI projection information data: Google Chrome 140.0.7339.208
Data analysis	The following software and codes are used for data analysis in this study: 1. Python 3.9.13: numpy: 1.21.5 pyomo: 6.5.0 csv: 1.0 cyipopt: 1.1.0 h5py: 3.12.1 pandas:2.2.3 scipy:1.13.1 2. Microsoft Excel for Microsoft 365 MSO (Version 22405 Build 16.0.17628.20006) 3. Specific codes and data are available in our GitHub repository: https://github.com/PEESEgroup/US-AI-Server-Analysis

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

All data and material used in the analysis are available in our GitHub repository: <https://github.com/PEESEgroup/US-AI-Server-Analysis>

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender This information has not been collected.

Reporting on race, ethnicity, or other socially relevant groupings This information has not been collected.

Population characteristics No human participants are involved in this study.

Recruitment Not applicable

Ethics oversight Not applicable

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description This study shows that the deployment of AI servers across the U.S. between 2024 and 2030 could contribute to an annual water footprint ranging from 731 to 1125 million cubic meters and additional annual carbon emissions of 24 to 44 Mt carbon dioxide equivalent between 2024 and 2030, depending on the scale of expansion

Research sample This study is constructed based on several datasets and verified simulation models. All involved dataset are listed below:
1. The climate data of each grid cell: Meteonorm V8.2.0.24079
2. Grid projection data: ReEDS model, <https://github.com/NREL/ReEDS-2.0>
3. Water use data: World Resources Institute, <https://www.wri.org/research/guidance-calculating-water-use-embedded-purchased-electricity>
4. Data center estimation model parameter data:
(1) Lei, N. & Masanet, E. Climate and technology-specific PUE and WUE estimations for US data centers using a hybrid statistical and thermodynamics-based approach. Resources, Conservation and Recycling 182, 106323 (2022).
(2) https://www.3m.com/3M/en_US/p/c/electronics-components/specialty-fluids/
5. Data center location data: <https://baxtel.com/>

Sampling strategy No sample size calculation method was used in this study. The sample size verification is listed as below:
1. Nvidia chip manufacture data is collected as the total AI server market data, considering it holds over 90% of the AI server market and is the dominant contributor for high-performance AI computing.
2. U.S. is selected as our research area considering its leading position in AI software and hardware development.
Detailed information can be found in method section and Supplemental Information

Data collection All data collection was performed by Tianqi Xiao under the supervision of Professor Fengqi You. The data are collected from the aforementioned resources.

Timing and spatial scale Data collection was conducted from September 2023 to Dec 2024. The timing and spatial scale of all datasets are listed as below:
1. The Nvidia manufacture data

(1) Timing scale: 2022 - 2030
 (2) Spatial scale: global.
 2. The climate data of the U.S.
 (1) Timing scale: 2024-2030
 (2) Spatial scale: U.S.
 3. Grid projection data:
 (1) Timing scale: 2024-2030
 (2) Spatial scale: U.S.
 4. Water use data:
 (1). Timing scale: 2024-2030
 (2). Spatial scale: U.S.
 5. Data center estimation model parameter data:
 (1). Timing scale: Current
 (2). Spatial scale: U.S.

Data exclusions

No data were excluded

Reproducibility

Our results and major findings can be easily reproduced following our reported data and code in <https://github.com/PEESEgroup/US-AI-Server-Analysis>.

Randomization

This research utilizes open-source data and verified simulation models to generate projections. Since there are no samples involved, randomization is not applicable or necessary for this study.

Blinding

This research utilizes open-source data and verified simulation models to generate projections. Since there are no human participants or real-world measures involved, blinding is not applicable or necessary for this study.

Did the study involve field work?

☐ Yes☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern
<input checked="" type="checkbox"/>	<input type="checkbox"/> Plants

Methods

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging

Plants

Seed stocks

Not applicable

Novel plant genotypes

Not applicable

Authentication

Not applicable