MTFC Project Proposal 2025-26

Team Name	The Inventors
Team ID #	Team 8
Short Title for Proposal	Forecasting the Footprint: Modeling Data Centers’ Energy, Emissions, and Resource Demand for Smarter Climate Policy
Topic Category	Climate Change/Environment

Part 1: Project Definition *(Team's Topic)*

These prompts can be found on page 3 of the MTFC Project Proposal Prompts 2025-26. Additional information on Project Definition can be found in ***Step 1: Project Definition*** in the Actuarial Process Guide.
Team Responses:

#1: Identify the topic

- Response: We propose to model how current and projected AI workloads drive energy use, monetary costs, and natural resource demand, then translate those results into regional forecasts of CO_2 emissions and energy consumption and tailored mitigation recommendations. This topic matters because large-scale training and widespread inference are rapidly increasing compute demand, which can materially raise electricity consumption and supply-chain strain if left unchecked. Recent years have seen an abrupt rise in demand from large models and cloud GPU deployments, making forecasting and policy guidance urgent. The work affects technology companies, grid operators, energy companies, component producers, policymakers, the average consumer, and communities near data centers worldwide, and this links directly to energy policy, hardware supply chains, and climate mitigation strategies.
- *Note: we might change the consumption in general, depending on whether there is more data on data centers than just energy consumption (e.g., money)*

#2: Identify potential risks

In 3-5 sentences: Identify and describe 2-3 areas of risk for an individual, society, or organizations/industry/governmental groups related to your topic. Hypothetically, what could be a "best-case scenario" outcome for the risks identified? What could be a "worst-case scenario" outcome for the risks identified?

- Response: One area of risk is increasing energy costs and grid stress (availability of energy), and this risk impacts the following groups: local communities, utility providers, state and local governments, data-center companies, and AI companies. Increased carbon emissions from electricity production impact national and smaller level governments, environmental organizations, and the general public, who will suffer from increased carbon and carbon equivalent emissions. Increased water consumption for cooling puts the following groups at risk: residents near the used water sources, water companies, industries, and local ecosystems. The best-case scenario is that AI systems become far more efficient, data centers run effectively on clean electricity, and cooling technology shifts away from heavy freshwater use, allowing energy demand, carbon emissions, and water consumption to stay manageable while environmental impacts remain limited. The worst-case scenario is that there is no way to shift the electricity used by AI from carbon-heavy sources, the cooling systems will still use high amounts of freshwater, and the electricity consumption will continue to strain the grid.

#3: Identify a behavior change risk mitigation strategy

In 1-2 sentences describe: a specific behavior change risk mitigation strategy relevant to your topic that could mitigate (lessen the severity of) risks you identified associated with the topic. identify who (individual, society, organization/government, etc.) would be impacted by its implementation?

- Response: A relevant behavior-change risk-mitigation strategy would be requiring organizations that operate AI data centers to shift their practices toward using verified low-carbon electricity and low-water cooling methods, reducing the severity of energy, emissions, and water-use risks. This would primarily affect data-center operators and the governments regulating them, but it would also impact local communities that rely on shared energy and water resources.

#4: Identify a modifying outcomes risk mitigation strategy

- Response: A modifying-the-outcomes strategy would require governments, data-center companies, and AI companies to implement real-time monitoring and public reporting of electricity use, carbon intensity, and water withdrawals so that environmental impacts can be detected early, and adjustments in the distribution of energy and water can be planned accordingly. This would primarily affect data-center operators, government agencies, and AI companies, and it would also benefit local communities and environmental regulators who rely on accurate information to respond to emerging problems.

#5: Identify an insurance risk mitigation strategy

- Response: An insurance risk mitigation strategy requires AI companies to carry environmental liability insurance that compensates local communities, governments, and other groups at risk if excessive energy use, carbon emissions, or water overconsumption occurs, while also having the government provide incentives for environmentally friendly practices to reduce the likelihood of harm. This would primarily impact AI companies and would directly benefit society, local communities, governments, and ecosystems by ensuring that environmental damage is addressed without the public bearing the cost.

#6: Identify driving research questions for your topic

- Response:
  - How will global AI adoption trends affect electricity demand and carbon emissions over the next two decades?
  - What regional factors (energy mix, climate, infrastructure) most influence AI’s environmental footprint?
  - What policies or technological interventions can minimize AI’s negative climate and economic impacts while sustaining innovation?

Part 2: Data Identification & Assessment *(Team's Topic)*

These prompts can be found on page 4 of the MTFC Project Proposal Prompts 2025-26. Additional information on Data Identification and Assessment can be found in ***Step 2: Data Identification & Assessment*** in the Actuarial Process Guide.

Team Responses:

#7: Identifying the type of data you hope to find

Response: The ideal datasets would include insight into regional energy consumption in the U.S. and across the world, monthly energy consumption for data centers themselves, data on trends in water consumption and natural resource consumption, data that could show a correlation between data center energy consumption or model training to carbon emissions, and data on operational costs for data centers.

#8: Identify potential data sources for your topic

Response:

Fossil Fuel Consumption for Electricity Generation by Year, Industry Type and State (EIA-906, EIA-920, and EIA-923)[2]

U.S. Electric Power Industry Estimated Emissions by State (EIA-767, EIA-906, EIA-920, and EIA-923)[4]

Both datasets can be found with this link: https://www.eia.gov/electricity/data/state/

For each data source:

- Provide a 1-2 sentence description of the credibility and scope of the data sources and identify which one (or more than one) of the three categories of data from the Actuarial Process Guide (see section 2.1) for more details does the data source fall into.

The Monthly Consumption and Annual State Emissions datasets are highly credible, authoritative resources from the U.S. Energy Information Administration (EIA) that provide comprehensive, longitudinal tracking of energy metrics across all 50 states. The Monthly Consumption data falls into the Historical Trends and Separating Potential Outcomes categories by allowing for the granular analysis of recent demand spikes in specific sectors, while the Annual Emissions data primarily addresses the Severity of Potential Losses by quantifying the magnitude of the environmental impact in metric tons of carbon dioxide and other pollutants.

- In 1-2 sentences, describe what data summaries or visualizations your team would be able to do with this dataset in Phase 2: Projects. Examples could include charts, tables, or descriptive statistics (mean/standard deviation/frequency/range, etc).

For the Monthly Consumption of Fossil Fuels dataset, our team can create time-series line charts that overlay electricity demand in data-center-heavy states against the national average to visualize the localized "AI spike" in energy usage since late 2022, calculate descriptive statistics, such as year-over-year growth rates for independent power producers, and the mean fossil fuel consumption compared to the mean electricity generated. With the Estimated Emissions by State dataset, we can create scatter plots correlating rising natural gas consumption with CO2 output to determine the specific carbon intensity associated with the new demand, and we can produce bar charts displaying the changing pollutants by state to assess whether the AI boom hurts emissions.

Part 3: Mathematical Modeling *(Team's Topic)*

These prompts can be found on page 5 of the MTFC Project Proposal Prompts 2025-26. Additional information on Mathematical Modeling can be found in ***Step 3: Mathematical Modeling*** in the Actuarial Process Guide.

Team Responses:

#9: Modeling research on your topic

- Response: Through searching ""math model" on AI's effect on energy consumption, CO_2 emissions, and water usage," we were able to come up with results that encompassed a large portion of what we expected our topic to include. One of my results was a research article regarding the beneficial yields of AI on vegetation - LINK. We chose to look at this article specifically because it highlighted a contrasting approach to our mathematical concept, choosing the benefits over the faults. The model showed a non-linear relationship between AI and negative environmental effects, showing that as AI usage increased, negative environmental effects also increased. However, the article also identified the future possibility of AI usage benefiting the environment.

#10: Goals of a mathematical model in the project phase

- Response: The goal of this mathematical model is to determine and quantify the environmental effects of AI data centers. It should also be able to model the effects of a mitigation strategy in preventing the harmful environmental effects of AI data centers by using historical data and forecasting trends. The model should be able to detect harmful changes in the environment on factors such as energy consumption, water consumption, electricity generation, and CO_2 emissions, while accounting for other energy consumers like residential energy consumers and other energy-consuming giants. Probabilistic modelling, such as ARIMA, to forecast energy consumption patterns while using geospatial analysis to map data center locations against energy grids and heat map creation of the regional environmental impact of data centers.

#11: Assumption development

Assumptions:

1. AI models and training will continue to grow exponentially over the next 5-10 years through the increasing demand for generative AI and LLMs. The compute intensity per model will increase unless offset by efficiency gains.
2. Electricity prices and emissions factors remain relatively stable unless modeled under policy-change scenarios.
3. Other smaller environmental energy consumers have a negligible impact on the environment. The only environmental energy consumers/sources of energy consumption include water consumption, electricity generation, and nuclear power plants.
4. Assume that the datasets used in this study are a good representation of the energy consumption in general for America.
5. Assume that specific rates of efficiency improvements or hardware changes vary by **region**, not by state, as it will make things more complicated.
6. The only non-environmental factors that will have an imposing effect on the environmental effects of data centers are possible policy/political/social changes.

Part 4: Risk Analysis *(Team's Topic)*

These prompts can be found on page 6 of the MTFC Project Proposal Prompts 2025-26. Additional information on conducting a Risk Analysis can be found in ***Step 4: Risk Analysis*** in the Actuarial Process Guide.

Team Responses:

#12: Goals for mitigation strategy

- Response:

If no immediate changes are made, AI will soon ruin our environment. At the current rate of AI usage and growth, the effects on the environment and Earth as a whole are becoming irreversible. To combat this, the goal of our risk mitigation strategy is to provide recommendations on how to improve the effects of AI data centers on the environment.

Part 5: Recommendations *(Team's Topic)*

These prompts can be found on page 7 of the MTFC Project Proposal Prompts 2025-26. Additional information on making Recommendations can be found in ***Step 5: Recommendations*** in the Actuarial Process Guide.

Team Responses:

#13: Recommendation differences between mitigation strategies

- Response:
- Behavioral Strategies: The behavior change strategy focuses on direct operational compliance by mandating the use of low-carbon electricity and low-water cooling methods.
- Insurance: The insurance strategy is a market-based, financial mechanism that manages risk consequences and incentivizes change through premium discounts and incentives for adopting green technology, and it provides a financial hedge against climate-related operational risks.

#14: Audience for recommendations

- Response: The target of our recommendations is large software companies and governments, as these are the people with the largest influence over AI usage. Our recommendations rely on limiting the use of AI and changing how AI uses energy; to do this, groups with the largest influence over AI usage will have the greatest effect on changing the wastefulness of AI.

#15: Goals for situation improvement

- Response: We hope that under our recommendations, AI efficiency will increase and the deteriorating effects on the environment will decrease. Our project aims to recommend a mitigation strategy to decrease the water consumption and carbon emissions from AI, and it aims to increase energy efficiency. Ideally, we will recommend mitigation strategies that develop policies that can be upheld for a long time, so AI's effects on the environment will remain low.

Datasets

Helpful info on data:
Data centers emit a lot of carbon, need a lot of water for cooling, and use lots of electricity = hundreds of thousands of homes.
Breakdown of energy sources powering data centers (renewable, fossil fuels, nuclear, etc.).

- Data on energy usage from data centers in the US/worldwide
- Carbon dioxide equivalent data
- Power usage effectiveness
- Carbon intensity (The amount of carbon emissions produced per unit of energy generated or consumed)
- Carbon usage effectiveness (A metric similar to PUE but focused on carbon emission effectiveness. CUE measures the carbon emissions (CO2e) produced per unit of IT work performed in a data center, including both IT equipment and supporting infrastructure.
- Water usage effectiveness (WUE) (It compares the total water consumption of the facility to the water consumed by IT equipment, indicating water efficiency)
- Energy reuse effectiveness (ERE)
- ERE is a metric that evaluates the efficiency of energy reuse within a data center. It calculates the ratio of total energy used to the energy recycled or repurposed within the facility.
- Data on the physical effects of data centers themselves(for example, taking up too much land)
- Nuclear energy farms are being used for AI; find data on how widespread they are
- Data on how much money AI companies are spending
- We want the data on how much AI has been used on a global, country, statewide, and regional scale.
- Data on water consumption per state and per country
- Data on electricity consumption on a national, state, and regional level
- Data on CO2 emissions from data centers
- Different types of GPUs and CPUs, and other components, are being sold, and their energy consumption
- Cooling technologies and associated environmental impacts
- Stock market/money

- https://www.iea.org/reports/energy-and-ai/energy-demand-from-ai
- https://iee.psu.edu/news/blog/why-ai-uses-so-much-energy-and-what-we-can-do-about-it
- https://www.carbonbrief.org/ai-five-charts-that-put-data-centre-energy-use-and-emissions-into-context/
- https://www.polytechnique-insights.com/en/columns/energy/generative-ai-energy-consumption-soars/
- https://news.mit.edu/2025/explained-generative-ai-environmental-impact-0117
- https://www.integrityenergy.com/blog/the-shocking-truth-of-ai-energy-consumption/
- https://news.engin.umich.edu/2024/11/up-to-30-of-the-power-used-to-train-ai-is-wasted-heres-how-to-fix-it/
- https://ourworldindata.org/grapher/hardware-and-energy-cost-to-train-notable-ai-systems
- https://www.nature.com/articles/d41586-025-00616-z
- https://www.sciencedirect.com/science/article/pii/S2542435123003653
- https://www.sciencedirect.com/science/article/pii/S2210537923000124
- https://www.technologyreview.com/2025/05/20/1116327/ai-energy-usage-climate-footprint-big-tech/
- https://www.akamai.com/blog/cloud/ai-inference-hardware-decisions
- https://www.trgdatacenters.com/resource/gpu-vs-cpu-for-ai/

- https://cloud.google.com/blog/products/infrastructure/measuring-the-environmental-impact-of-ai-inference/
- https://hai.stanford.edu/ai-index/2025-ai-index-report
- https://www.kaggle.com/datasets/katerynameleshenko/ai-index
- https://www.atlanticcouncil.org/blogs/energysource/ground-zero-for-the-us-ai-energy-challenge-a-state-level-case-study/
- https://blogs.nvidia.com/blog/accelerated-ai-energy-efficiency/

Datasets:
- https://catalog.data.gov/organization/doe-gov Many datasets on energy consumption by state, region, sector for the U.S.
- https://www.kaggle.com/datasets/imaadmahmood/tech-and-ai-companies-market-data-2024 A small amount of data on the amount of money AI companies spend
- https://www.eia.gov/consumption/data.php
- https://www.congress.gov/crs_external_products/R/PDF/R48646/R48646.3.pdf
- https://www.epa.gov/ghgreporting/data-sets
- https://energy.ec.europa.eu/news/focus-data-centres-energy-hungry-challenge-2025-11-17_en
- https://cloud.google.com/blog/products/infrastructure/measuring-the-environmental-impact-of-ai-inference/
- https://www.frontiersin.org/journals/sustainability/articles/10.3389/frsus.2024.1507030/full
- https://www.americanactionforum.org/insight/ai-data-centers-why-are-they-so-energy-hungry/
- https://catalog.data.gov/dataset/monthly-and-annual-energy-consumption-by-sector Energy consumption by sector over the years
- https://arxiv.org/pdf/2302.08476

US Electricity Data
https://ember-energy.org/data/us-electricity-data/

How Americans View AI and Its Impact on People and Society
Statistic on more people being concerned about the use of AI than excited(can use for our hook/intro):
https://www.pewresearch.org/science/2025/09/17/how-americans-view-ai-and-its-impact-on-people-and-society/
MIT Research paper on our exact topic:
https://mit-genai.pubpub.org/pub/8ulgrckc/release/2
2024 U.S. Energy Usage(electricity) from data centers:
https://escholarship.org/uc/item/32d6m0d1
Data on New York water consumption over the years:
https://catalog.data.gov/dataset/water-consumption-and-cost-2013-2020
Data on AI usage in San Francisco
https://catalog.data.gov/dataset/san-francisco-ai-use-inventory-chapter-22j

Perplexity thread on research/data:
https://www.perplexity.ai/search/find-me-data-sources-on-this-p-qOVfw4HlQmm0ORc2AxGsog#5

10 useful websites for looking for data(via perplexity):

1. IEE: Institute of Energy and the Environment – Research articles and data on AI energy consumption.
2. MIT Technology Review – Analyses of AI’s energy footprint and trend forecasts.
3. MIT Sloan – Reports on data center costs and energy solutions for AI.
4. IBM – Future of AI and energy efficiency, including infrastructure data.
5. American Action Forum (AAF) – Summary of why AI data centers are energy-intensive.
6. Frontiers in AI – Forecasting methodologies and datasets for US data center CO_2 emissions.
7. Pew Research Center – Quantitative studies of US data center energy use in the AI era.
8. Carbon Brief – Charts and scenario analyses of global data center energy consumption and emissions.
9. Google Cloud – Tools and datasets to measure AI inference’s environmental impact.