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California's AI Energy Problem

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Core Competencies Demonstrated:

- **Policy Research & Analysis**: Identified a critical gap in state energy planning by synthesizing and contrasting public-sector forecasts (CAISO) with private-sector projections (Goldman Sachs).
- **Governance Framework Design**: Proposed a novel, 4-principal policy framework, "Blueprint for Powering California's AI Future (BP2030)," to mitigate the identified risks.
- **Strategic Recommendation**: Defined actionable policy recommendations, including "Partnership & Transparency", "Measurement & Ratings" (via a sample "AI Energy Rating" guide), and a continuous "Learning Loop".
- **Phased Rollout Planning**: Designed a detailed, multi-year "BP2030 Recommendation Milestones" timeline with specific, dated deliverables for each year from 2025 to 2030.

Policy Brief - *December 2024*

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INTRODUCTION

Attention: *California Governor, CA Energy Commission, and CA Public Utilities Commission.*

There is an urgent need to ensure that California's energy plans can support the electricity demands of Artificial Intelligence (AI). The energy forecasts and planning conducted by the California Air Resources Board and the California Independent System Operator, in 2022 and 2023 respectively, may not account for AI's growing energy demands.

Recent increases in AI adoption and its high energy requirements may result in inadequate forecasts, potentially undermining California's clean energy plans and the state's economic growth. California must consider policies to facilitate AI energy transparency for long-term energy planning and investments. This policy brief outlines the AI environment, the risks, and potential solutions to mitigate California's AI energy problem.

KEY TAKEAWAYS

California is the fifth-largest economy in the world and a leader in big tech. AI is expected to have a $400 billion benefit to the state's economy. AI and data centers use enormous amounts of energy and could require over 4% of all electricity in California. California's long-term energy forecasts made in 2021 & 2023 may not include the recent AI boom in 2023. Additionally, there is a lack of data and transparency from the private sector on AI energy consumption due to a lack of explicit policies and the protection of trade secrets.

Policy Solutions

California should develop new policies to support AI energy transparency and planning. This brief proposes a policy solution framework called **Blueprint for Powering California's AI Future (BP2030).** The recommended framework outlines key principles, including:

- **Partnerships & Transparency:** Promote voluntary sharing of AI energy consumption data between AI developers, electric companies, and state agencies.
- **Measurement & Ratings:** Develop measurement ratings for AI algorithm efficiency that are shared publicly to enable developers to evaluate their own AI's efficiency.
- **Innovation:** Provide incentives for AI companies to develop AI systems that require less energy to reduce the strain on the energy grid.
- **Efficiency & Learning:** Leverage data and insights to ensure accurate planning and optimize the energy grid.

CALIFORNIA'S TECH ECONOMY

Big Tech

California is the fifth-largest economy in the world and is a hub of big tech.[1] Many of the largest tech companies in the world are headquartered in California, including Apple, Google, Meta, Cisco, Oracle, Intel, Netflix, and OpenAI. OpenAI, which is based in San Francisco, helped kickstart the recent AI boom with the release of ChatGPT-3 in late 2022.[2] The tech industry employs over 150 million Californians.[3] In addition to its big tech presence, California also has a significant number of data processing and hosting companies, accounting for 22% of the sector's revenue in the United States, with 285 data center sites.[4]

AI's Potential

AI is becoming a vital part of California's economy, potentially having a $400 billion benefit by 2030.[5] It is estimated that nearly half of new AI startups are based in California.[6] California businesses, in general, are adopting AI as part of their business strategies. Businesses that have indicated that they have a propensity to use AI are concentrated in the Bay Area, Silicon Valley, San Diego, and Riverside areas.[7] Companies are also investing heavily in AI, and with this investment comes hardware purchases. Both Meta and Google have announced significant investment plans for their AI infrastructures.[8] Additionally, recent record sales from NVIDIA, which is also based in California, indicate that many companies are purchasing hardware to support longer-term AI needs.[9]

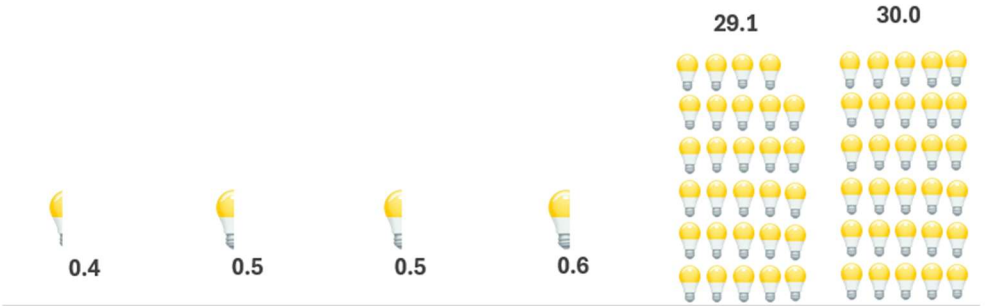
[1] State of California (2024). Provides a comprehensive breakdown of the world's economies compared to California's economy.
[2] ChatGPT (2022). Details the development of OpenAI's artificial intelligence technologies.
[3] High Tech—California Governor's Office of Business and Economic Development.
[4] See MyIBISWorld 2024 and Data Center Map from USA Data Centers (2024_.
[5] Nava (2020, page 6). From the Little Hoover Commission, examines AI's benefits and risks to California.
[6] High Tech—California Governor's Office of Business and Economic Development.
[7] McElheran et. al. (2024, page 390). see full article on ai adoption and interest by geographic area and industry.
[8] See blog posts from Meta and Google: Lee et. al. 2023; Vahdat and Lohmeyer 2023 for more information on their investments.
[9] Megaw and Kinder (2024). See article for more information on Nvidia's sales.

ENERGY PROBLEMS WITH AI

AI's Enormous Appetite

AI algorithms, including generative AI (GenAI) and large language models (LLM), consume a significant amount of electricity. It is estimated that a GenAI text search request requires up to ten to thirty times more electricity compared to traditional text search methods.[10] Additionally, it is estimated that OpenAI's ChatGPT requires 564 MWh per day[11], which is roughly the equivalent energy use of 50,000 households. This would be the equivalent of powering all the households in the city of Thousand Oaks, CA, which has a population of over one hundred and twenty-three thousand people.[12] For some context on what this energy consumption really means, to create 100 GenAI images, data centers consume as much electricity as a 10-watt LED bulb for 29 hours (see Figure 1).

Figure 1 – Number of Hours to Power One 10-Watt LED Bulb Using the Same Electricity as 100 AI Requests[13]



	AI Object detection	AI Text generation	AI Text Summarization	AI Image captioning	AI Image generation	AI LLM Search Request
Energy Per 1 Request (Wh)	0.038	0.047	0.049	0.063	2.907	3.000

Sources:
Luccioni, S., Jernite, Y., & Strubell, E. (2024), page 88

With the use of AI growing, AI requests in datacenters will increase along with their energy consumption. The hardware required for AI has high electricity demands. A popular Graphic Processing Unit (GPU) used for AI in data centers, the NVIDIA H100, is estimated to consume as much energy as an American household.[14] By 2030, AI could require a sizable portion of total energy consumption in California. Some estimates predict that AI energy use could increase by 160% by 2030 compared to 2022.[15] This means that data center electricity could increase from 2% of total electricity to 4% by 2030.[16]

[10] For more information, refer to Luccioni, Jernite, and Strubell (2024, p. 88) for AI request energy usage.
[11] Wells (2023). Provides details on projections of ChatGPT energy use.
[12] U.S. Census Bureau -Thousand Oaks city, CA. (2022)
[13] Luccioni, Jernite, Strubell (2024, page 88).
[14] Shilov (2023). For more information GPU energy use.
[15] See Goldman Sachs (2024) for more information on private sector projections for data center energy consumption.
[16] et al.

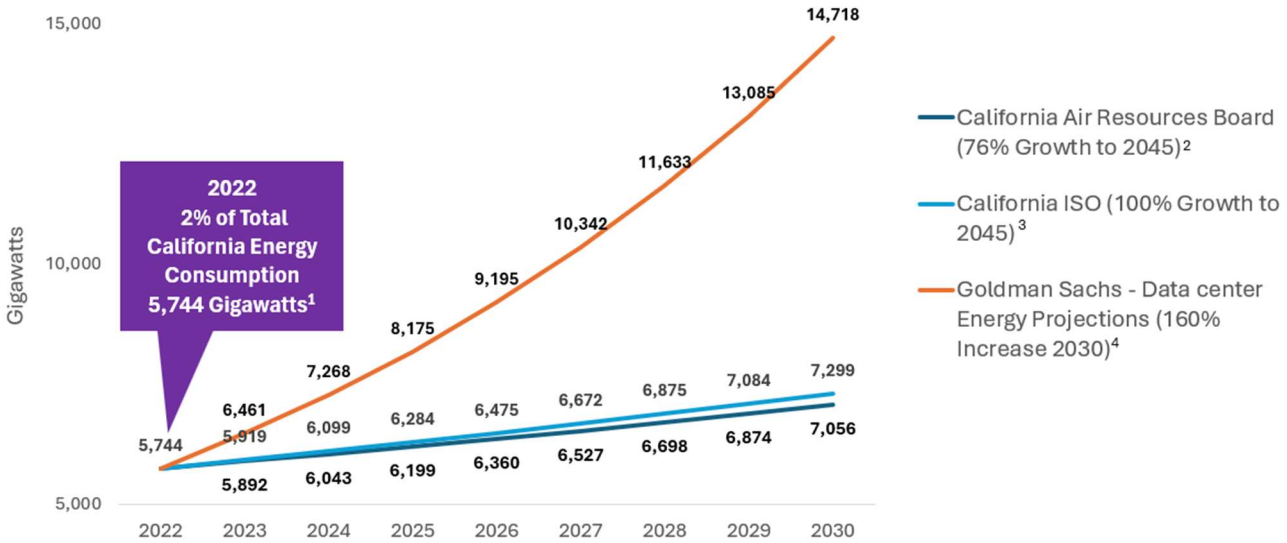
Lack of Transparency

In a recent study by the US Department of Energy, with focus groups from policymakers and industry experts, one major theme that emerged was the need for transparency in energy use and reporting.[17] Creating accurate forecasts for AI energy demands is challenging due to a lack of transparency from private big tech and AI sectors. AI developers and tech companies treat data on how much energy their AI solutions take to develop and deploy as confidential information. California Regulators and the California Department of Energy need data to properly forecast energy demands.

Forecasting Challenges for California

California's longer-term energy forecasts may not account for the recent surge in AI usage. The California Air Resources Board projected that total electricity demand will only increase in the state by 76% by 2045 (relative to demand in 2022), while the California Independent System Operator (CAISO) projected that total energy demand should double by 2045.[18][19] These projections are at odds with estimates coming from the private sector who are estimating a much larger energy demand.

Figure 2 – Data Center Energy Growth Projections



Sources:
[1] Nyberg 2022.
[2] Hohbein and Aczel 2024, page 25.
[3] California ISO - 2023-2024 Transmission plan
[4] Goldman Sachs 2024.

As mentioned previously, data centers use approximately 2% of California's energy. In 2022, 2% of California's energy consumption is estimated to be equivalent to 5,744 Gigawatt-hours.[20] When growth rates from the California Air Resources Board and CAISO are compared to those from Goldman Sachs' projections, there is a significant difference in the results.[21] This data illustrates the risks of inaccurate assumptions, which could lead to substantial differences and impacts if AI energy consumption is under-projected.

[17] See Recommendations on Powering Artificial Intelligence and Data Center Infrastructure (2024) for more information on key issues in energy planning.
[18] See Hohbein and Aczel (2024, p. 25) for projection data from the California Air Resources Board.
[19] See CAISO (2023) report for projection data.
[20] Refer to Nyberg (2022) for California's total energy consumption.
[21] See Goldman Sachs (2024) for more information on private sector projections for data center energy consumption.

CURRENT POLICY TRENDS

Policies that specifically address the energy use of AI in California are currently limited and are not adequate to support energy projection planning.

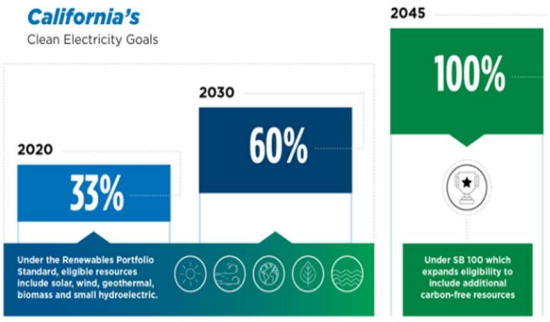
CA SB253:

Passed into law in 2023, this policy requires companies that do business in California and have over $1 billion in annual revenue to disclose greenhouse gas emissions to the California Air Resources Board (CARB) agency.[22] This policy does make steps toward transparency, but there are limitations in this policy. SB253 does not require these corporations to disclose their energy use. Additionally, this policy is limited to only companies with over $1 billion in revenue, while smaller companies could also have significant energy consumption.

CA SB100:

Passed into law in 2018, this policy requires that by 2045, all electricity will be powered by renewable and zero-carbon energy sources.[23] The policy increases the requirement over time, with 60% of energy sources being 'green' in 2030 and 100% by 2045 (see Figure 3). SB100 plans are reviewed every four years. The last update to SB100 was made in 2021 and did not include the AI boom, which started in 2023; however, the SB100 plans are set to be reviewed in 2025.

Figure 3 – SB100 Rollout Plan



CA SB887:

This policy requires the California Energy Commission to provide annual energy projections to retail electric companies (e.g., PG&E, SoCal Edison) for grid management and planning. This policy, implemented in 2022, is part of long-term energy planning activities related to the larger SB100 policies. However, this policy does not require any estimates or projections around the specific needs of AI.[24]

CA SB1006:

The California Energy Commission requires that power companies investigate technologies to maximize the capacity and efficiency of the power grid.[25] This policy recently passed in September 2024 and would require an initial report by January 1, 2026. This policy encourages the use of AI for balancing energy loads in the power grid, which could potentially be applied to using AI to forecast energy demands.

[22] See state bill SB253 for full details.
[23] See California Energy Commission's SB100 Joint Agency Report 2021for full details.
[24] See state bill SB887 for full details.
[25] See state bill SB1006 for full details.

POLICY OPTIONS TO CONSIDER

Energy Transparency

At the federal level, senators in US Congress are proposing a new policy for transparency on AI energy use by developers. The proposed law, the **US Artificial Intelligence Environmental Impacts Act of 2024**, recommends voluntary reporting of energy consumption at all stages of the AI lifecycle (i.e., design, development, deployment).[26] This information would be extremely helpful to the California Energy Commission in planning activities. Ideally, this information should be required rather than voluntary, but in these initial stages of AI development and evolution, any data is valuable for planning purposes.

Energy Efficiency Ratings

An interesting approach proposed in academia is to have energy efficiency ratings for every AI model.[27] These energy efficiency ratings could function much like the Energy Guide appliance ratings, comparing the energy consumption of the AI application to the average energy consumption in the same product category (see Figure 4).[28] Having energy efficiency rating standards would provide a baseline for AI developers to work towards and would help encourage innovation/discovery of more energy-efficient techniques in their AI models.

Figure 4 – ENERGYGUIDE Label

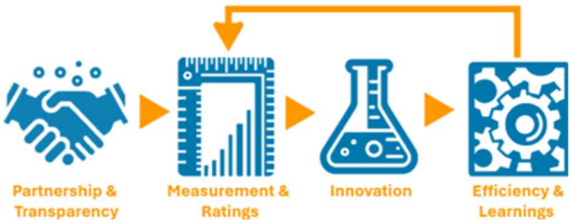
RECOMMENDATIONS

By the end of 2030, California must consider developing methods to support long-term AI energy transparency to protect the state's tech industry, energy grid, and environment. Without this data, the California energy grid will face challenges in planning, which may result in insufficient energy to support California's Tech/AI economy. To this end, it is recommended that California develop and new policy framework for AI energy. This new policy framework, codenamed ***Blueprint for Powering California's AI Future (BP2030)***, aims to support the need for long-term goals in green energy, bolster the AI economy, and solidify California's energy planning.

Key Principles of the Proposed Blueprint Framework

The proposed framework has four key principles that would enable better energy planning for California: Partnership & Transparency, Measurement & Ratings, Innovation, Efficiency & Learning.

Figure 5—BP2030 Framework Process



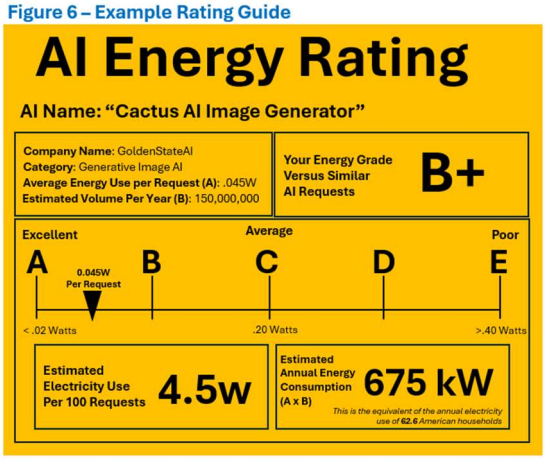
[26] Refer to Markey (2024) to see full details of the proposed Artificial Intelligence Environmental Impacts Act of 2024.
[27] Luccioni et. al. (2024) Light bulbs have energy ratings—So why can't AI chatbots?
[28] Federal Trade Commission - Energy Guide Label 2022.

BP2030 - Principles Detail

- **Partnership & Transparency:** BP2030 recommends developing partnerships that will enable the free sharing of information between AI developers (e.g., Google, Meta, Apple, etc.), electric companies (e.g., PG&E, SoCal Edison, etc.), and state agencies, including the CA Energy Commission (CAEC) and the CA Public Utilities Commission (CAPUC). These partnerships aim to collaborate and ensure energy support for AI. This collaboration would be beneficial to all parties, enabling better and more efficient systems. AI developers would voluntarily share data on their energy consumption to train, develop, and deploy their AI models. The AI energy consumption data would be used to create energy standards and help forecast energy demands. This sharing should not be limited to only large companies but should include AI developers of all sizes. The data to be shared for AI should include at minimum AI Application Purpose/Type, Average Energy Use per Request, and Estimated Volume of Requests Per Year.

- **Measurement & Ratings:** BP2030 recommends developing measurement ratings for AI algorithm efficiency. These ratings would function much like Energy Star-appliance ratings, evaluating AI against an average in the same category (e.g., image generation). These ratings would enable tech companies to see how efficient their AI models are and identify areas for improvement. Figure 6 shows an example of what an energy rating could look like and how an AI Energy Rating guide could be used to compare an AI model to the average.

Figure 6 – Example Rating Guide



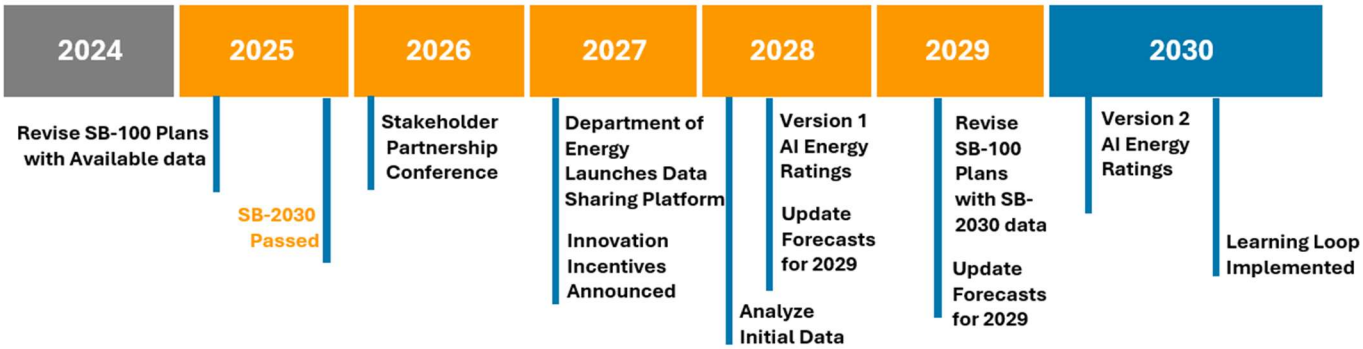
- **Innovation:** The State of California wants its businesses to be successful and innovative. BP2030 recommends tax credit or energy credit incentives for AI companies to identify and share energy-efficient techniques that could benefit other tech companies and reduce the strain on the energy grid caused by inefficient data models. BP2030 does not wish to eliminate any competitive advantage that tech companies have but aims to promote the free sharing of knowledge and learnings for the benefit of society.

- **Efficiency & Learning:** BP2030's goal is to make AI efficient and use energy resources as effectively as possible. BP2030 recommends improving the energy grid using data shared through the partnership and new insights gained through Innovation incentives. As AI evolves, our understanding and planning for AI will change over time. BP2030 recommends the development of a Learning Loop framework that will enable California and the energy grid to learn from data and innovations, facilitating flexible planning of energy resources. This learning loop would be continuous and integrated into the State of California's annual energy planning activities.

BP2030 Recommendation Milestones & Timing

To achieve the goals of BP2030, a phased rollout plan with key milestones each year is essential. While sharing information may sound simple, it requires a proper rollout plan to capture, understand, validate, and execute on stakeholder feedback. A proposed milestone plan for BP2030 is outlined below:

Figure 5 – Proposed BP2030 Timeline



- **2025:** California must review the SB100 plans and compare them to current AI projections from the private sector and academia. The report was last updated in 2021[29]. The 2025 edition of the report should start to consider the ramifications of this new surge in electricity consumption from the tech sector. ***BP2030*** should be passed and funded by the state legislature by the end of 2025.
- **2026:** Develop a partnership and stakeholder outreach program. Host a conference or symposium to gather feedback from key stakeholders in both the tech and energy sectors. The conference will serve as the foundation for establishing the free sharing of information and discussions on energy rating principles in 2027. The stakeholder feedback must include what is being measured and how often the data is being shared.
- **2027:** Launch the data-sharing platform on the California Department of Energy's website. This program will allow AI developers to share their energy usage data. The submission process must be easy and straightforward. Companies are not required to share full algorithm details, but are encouraged to share information that they feel is relevant. By the end of 2027, all interested parties will be able to access the information.
- **2028.** AI Energy Data will be analyzed by energy companies and the California State Department of Energy in early 2028. This information will be used to update forecasts and plans for 2029. Additionally, Version 1 of the AI Energy Rating will be released.
- **2029:** The annual energy forecasts provided by the Department of Energy, as well as the longer-term plans for ***SB100***'s green energy initiatives, will be revised using data gathered by ***BP2030***.
- **2030:** Version 2 of the AI Energy Ratings will be released, and changes will reflect the feedback from stakeholders and data provided by tech companies. Additionally, the Learning Loop for 2030 will be fully automated and integrated into the California Department of Energy's planning.

[29] California Energy Commission - SB100 Joint Agency Report 2021

CONCLUSION

Addressing AI's energy demand requires multiple approaches to ensure that California can not only address the growing demands but also create a market for the AI sector to continue to thrive, benefiting the state's economy. Through the proposed ***BP2030*** or a similar approach, California can encourage AI energy consumption disclosures from companies. This transparency will enable better forecasting for the power grid and help ensure ***SB100's*** 100% green energy source plans are successful.[30] With AI's potential $400 billion benefit to the state[31], it will be crucial to foster an environment that promotes transparency, efficiency, and sustainability. The California Governor, CA Energy Commission (CAEC), CA Public Utilities Commission (CAPUC) supporting the recommendations in this policy brief will help stabilize California's energy grid, protect its position as a global leader in the tech industry, and maintain its economic power. Policymakers should act swiftly to adopt ***BP2030's*** recommendations to ensure that we can power California's future.

[30] California Energy Commission - SB 100 Joint Agency Report 2021
[31] Nava (2020, page 6). From the Little Hoover Commission, examines AI's benefits and risks to California.

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