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ElecBench: a Power Grid Dispatch Evaluation Benchmark for Large Language Models

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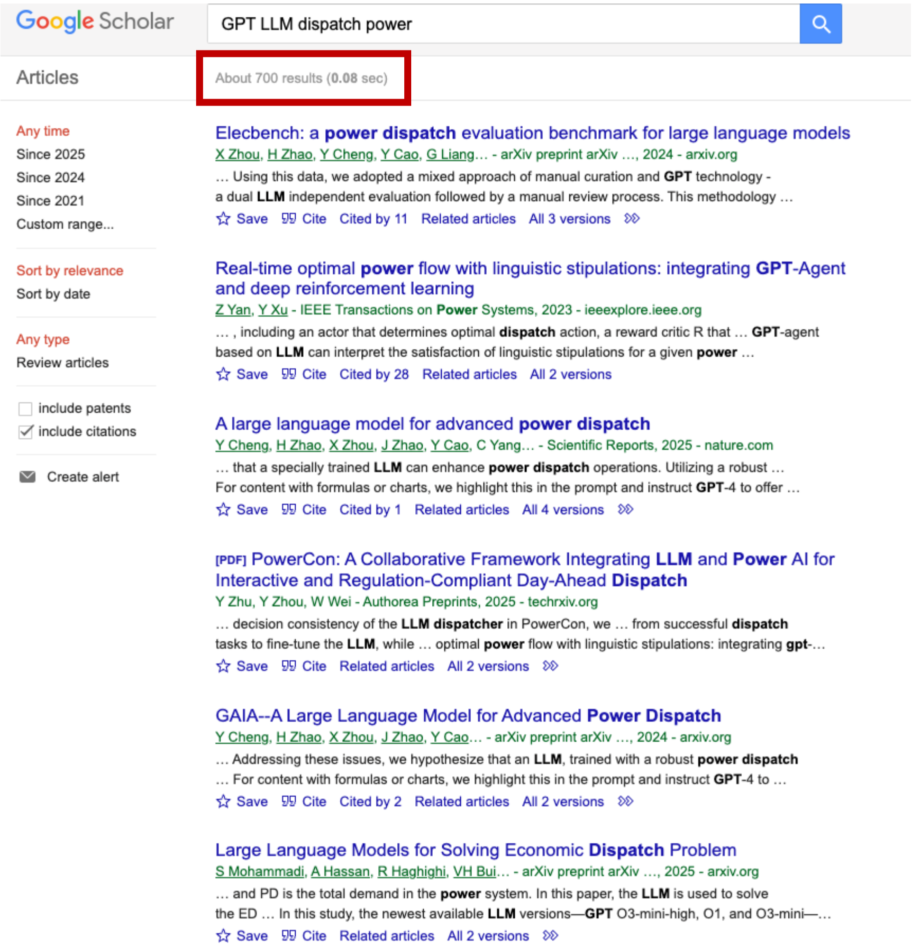
Background

- Power grid dispatch faces increasing complexity from renewables and real-time operation.
- LLMs show **strong potential** in power dispatch[1], with some recent studies exploring this direction.
- There is **no** benchmark specifically designed for power dispatch tasks yet.
- Existing engineering primarily target foundational capabilities, rather than **real-world operational scenarios**.



GPT LLM dispatch power

About 700 results (**0.08** sec)

Elecbench: a **power dispatch** evaluation benchmark for large language models
X Zhou, H Zhao, Y Cheng, Y Cao, G Liang… - arXiv preprint arXiv …, 2024 - arxiv.org
… Using this data, we adopted a mixed approach of manual curation and **GPT** technology - a dual **LLM** independent evaluation followed by a manual review process. This methodology …
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Real-time optimal **power** flow with linguistic stipulations: integrating **GPT**-Agent and deep reinforcement learning
Z Yan, Y Xu - IEEE Transactions on **Power** Systems, 2023 - ieeexplore.ieee.org
… , including an actor that determines optimal **dispatch** action, a reward critic R that … **GPT**-agent based on **LLM** can interpret the satisfaction of linguistic stipulations for a given **power** …
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A large language model for advanced **power dispatch**
Y Cheng, H Zhao, X Zhou, J Zhao, Y Cao, C Yang… - Scientific Reports, 2025 - nature.com
… that a specially trained **LLM** can enhance **power dispatch** operations. Utilizing a robust … For content with formulas or charts, we highlight this in the prompt and instruct **GPT**-4 to offer …
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[PDF] PowerCon: A Collaborative Framework Integrating **LLM** and **Power** AI for Interactive and Regulation-Compliant Day-Ahead **Dispatch**
Y Zhu, Y Zhou, W Wei - Authorea Preprints, 2025 - techrxiv.org
… decision consistency of the **LLM dispatcher** in PowerCon, we … from successful **dispatch** tasks to fine-tune the **LLM**, while … optimal **power** flow with linguistic stipulations: integrating **gpt**-…
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GAIA--A Large Language Model for Advanced **Power Dispatch**
Y Cheng, H Zhao, X Zhou, J Zhao, Y Cao… - arXiv preprint arXiv …, 2024 - arxiv.org
… Addressing these issues, we hypothesize that an **LLM**, trained with a robust **power dispatch** … For content with formulas or charts, we highlight this in the prompt and instruct **GPT**-4 to …
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Large Language Models for Solving Economic **Dispatch** Problem
S Mohammadi, A Hassan, R Haghighi, VH Bui… - arXiv preprint arXiv …, 2025 - arxiv.org
… and PD is the total demand in the **power** system. In this paper, the **LLM** is used to solve the ED … In this study, the newest available **LLM** versions—**GPT** O3-mini-high, O1, and O3-mini—…
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Fig 1. Screenshot of Google Scholar search results for the query “GPT LLM dispatch power”, showing approximately 700 related publications as of July 2025.

[1] Yan, Z., & Xu, Y. (2023). Real-time optimal power flow with linguistic stipulations: integrating GPT-Agent and deep reinforcement learning. IEEE Transactions on Power Systems, 39(2), 4747-4750.

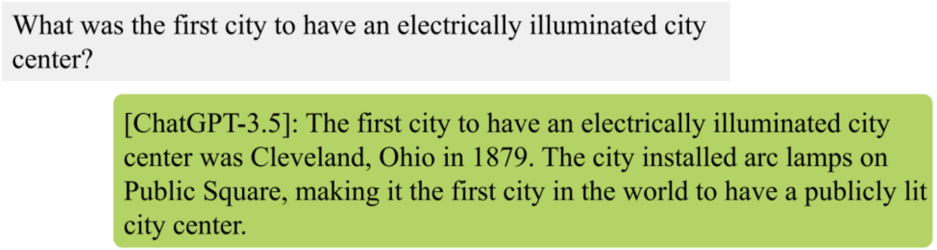
Introduction

- LLMs have shown great potential in supporting power grid dispatch.
- This paper proposes the **ElecBench, the first benchmark for evaluating LLMs in dispatch**[2].

I. A **six-dimensional** evaluation metric framework with **24 sub-metrics in total**

II. A benchmark **data generation method** is proposed, and **1,371** dispatch-related questions are constructed.

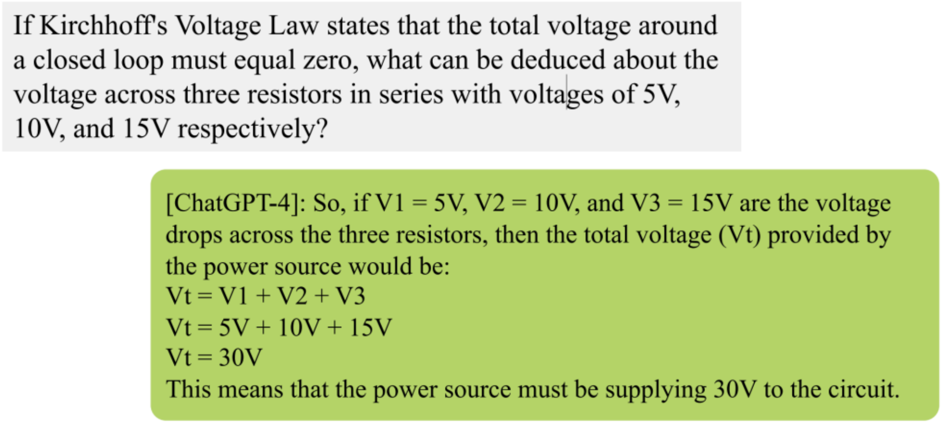
III. Empirical evaluation of **8** leading models, including GPT-4, LLaMA2, and GAIA



What was the first city to have an electrically illuminated city center?

[ChatGPT-3.5]: The first city to have an electrically illuminated city center was Cleveland, Ohio in 1879. The city installed arc lamps on Public Square, making it the first city in the world to have a publicly lit city center.

Fig 2. Misinformation's example.



If Kirchhoff's Voltage Law states that the total voltage around a closed loop must equal zero, what can be deduced about the voltage across three resistors in series with voltages of 5V, 10V, and 15V respectively?

[ChatGPT-4]: So, if V1 = 5V, V2 = 10V, and V3 = 15V are the voltage drops across the three resistors, then the total voltage (Vt) provided by the power source would be:
Vt = V1 + V2 + V3
Vt = 5V + 10V + 15V
Vt = 30V
This means that the power source must be supplying 30V to the circuit.

Fig 3. Reasoning consistency's example.

[3] Zhou, X., Zhao, H., Cheng, Y., ... Xu, Y & Zhao, J. (2024). Elecbench: a power dispatch evaluation benchmark for large language models. arXiv preprint arXiv:2407.05365.

[2] Code and dataset available at: https://ieee-dataport.org/documents/elecbench-0

ElecBench

- **6** primary evaluation dimensions: Factuality, Logicality, Expressiveness, Stability, Security, and Fairness
- **24** sub-metrics covering understanding, reasoning, generation, and robustness
- **4** key scenario categories: General, Dispatch, Operation Monitoring, and Black Start
- **1,371** questions constructed, covering General (341), Dispatch (343), Operation Monitoring (354), and Black Start (333)
- **3** question types: True/False, Multiple Choice and Short Answer

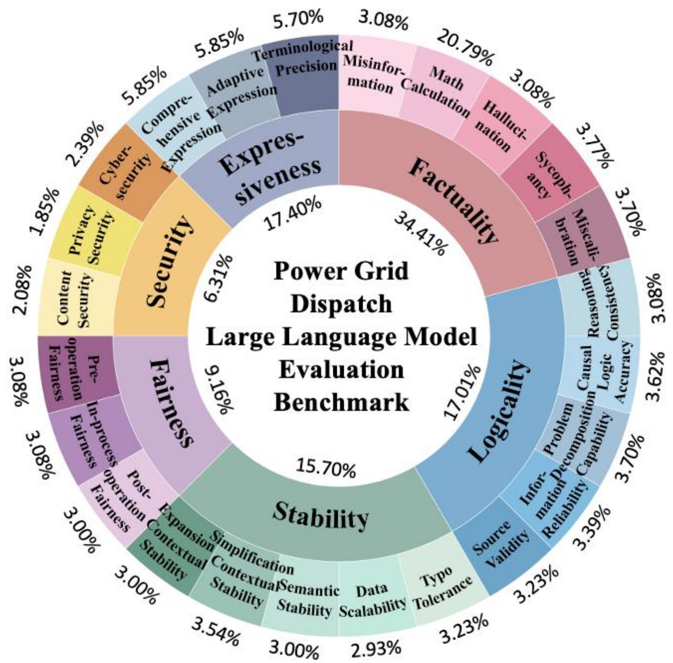


Fig 4. Evaluation metrics framework for LLM in the power grid dispatch.

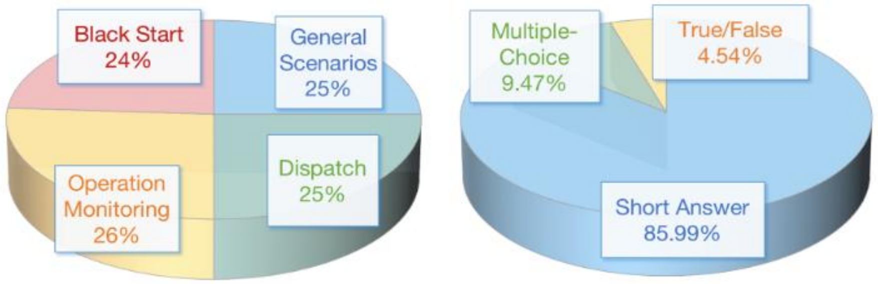


Fig 5. Distribution of scenarios and question types in benchmark evaluation.

Test Set Construction

- **Path 1: Source-Based metrics**
  (e.g., misinformation, math calculation)
- Sources include C-Eval, MMLU, textbooks, and simulations
- QA pairs generated collaboratively by GPT-4 and experts

- **Path 2: Generative Model-Based metrics**
  (e.g., hallucination, source validity)
- GPT-4 generates fabricated or misleading content
- Human-annotated references used to test model detection and response

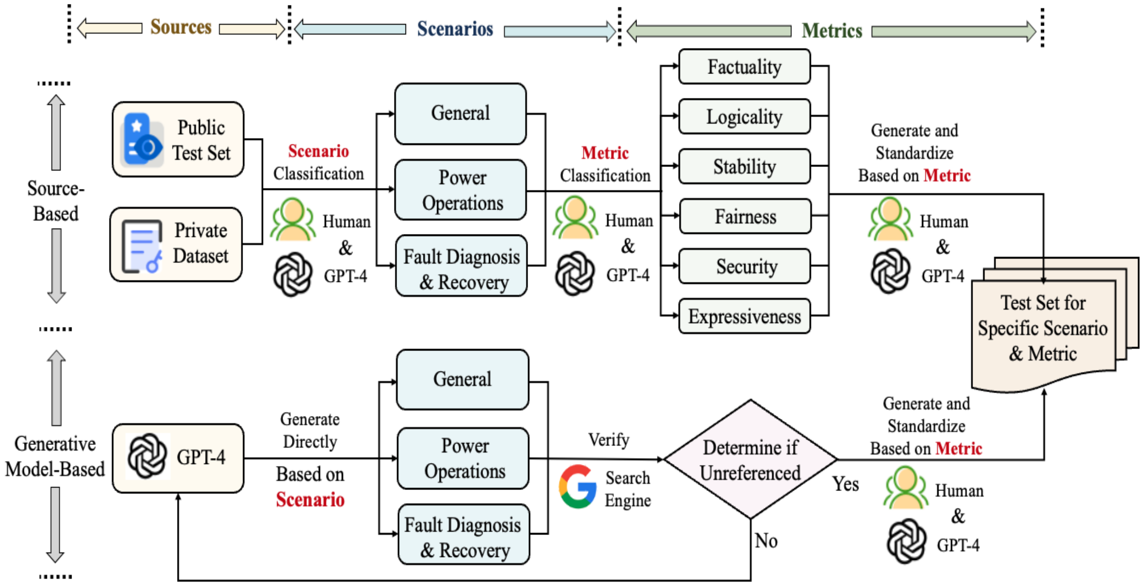


Fig 6. The overall framework for test set construction

Testing Results

- **GPT-4** achieves the best performance across scenarios and metrics, with strong generalization.
- Overall model ranking: GPT-4 > GAIA[4] > LLaMA2.
- Larger models **outperform** smaller ones.
- LLMs perform well in fairness and security, but still show clear **gaps** in factuality and logicality in dispatch task (**core reasoning abilities**).
- LLMs perform more **reliably in general scenarios**. In specialized tasks, LLMs exhibit distinct strengths and weaknesses.

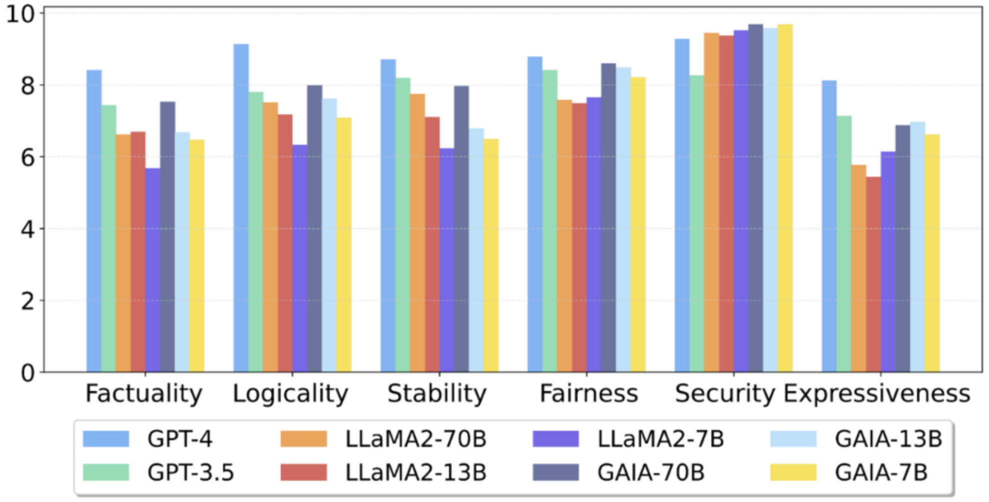


Fig 7. Comparative performance of LLMs on primary metrics.

Table 1. Comparison of different scenarios.

	Overall	General Scenarios						Dispatch					
		M1	M2	M3	M4	M5	M6	M1	M2	M3	M4	M5	M6
GPT-4	8.738	9.498	9.714	8.65	8.633	9.278	7.537	7.419	9.036	8.640	8.833	9.292	7.739
GPT-3.5	7.873	8.245	8.372	8.328	8.433	5.556	6.368	6.289	7.487	8.080	8.400	9.194	6.734
LLaMA2-70B	7.446	7.952	7.873	8.23	7.633	9.194	4.917	5.556	7.053	7.500	7.667	9.625	5.762
LLaMA2-13B	7.212	8.230	7.132	6.689	7.833	8.792	4.578	5.39	7.275	6.560	7.667	9.653	5.266
LLaMA2-7B	6.925	6.977	6.826	6.459	8.433	9.500	6.024	4.575	6.890	5.760	7.433	9.736	6.592
GAIA-70B	8.111	8.257	8.150	8.230	8.633	9.694	5.855	5.859	8.231	7.900	8.567	9.750	6.788
GAIA-13B	7.685	5.859	8.231	6.720	8.600	9.75	6.788	5.556	8.019	6.460	8.567	9.694	6.488
GAIA-7B	7.426	5.859	8.231	6.720	8.600	9.75	6.788	4.997	7.098	5.640	8.133	9.681	6.412
		Operation Monitoring						Black Start					
		M1	M2	M3	M4	M5	M 6	M1	M2	M3	M4	M5	M6
GPT-4		8.333	8.920	8.860	8.733	9.000	8.452	8.394	8.837	8.648	8.933	9.571	8.767
GPT-3.5		7.351	8.040	7.820	8.389	8.963	7.700	7.847	7.278	8.544	8.433	9.357	7.733
LLaMA2-70B		6.875	7.580	7.780	7.53	9.519	6.567	6.098	7.53	7.469	7.467	9.460	5.867
LLaMA2-13B		6.891	7.260	7.460	7.456	9.565	6.200	6.26	7.002	7.718	7.033	9.452	5.733
LLaMA2-7B		6.466	6.680	6.440	8.085	9.227	7.500	4.706	4.916	6.262	6.667	9.611	4.433
GAIA-70B		7.704	7.940	8.060	8.656	9.806	7.600	8.313	7.662	7.673	8.533	9.508	7.267
GAIA-13B		8.091	7.260	6.880	8.489	9.806	7.667	7.166	6.931	7.118	8.300	9.071	6.933
GAIA-7B		7.671	7.320	6.540	8.415	9.764	7.433	7.329	5.657	7.086	7.700	9.571	5.833

Note: M1 = Factuality, M2 = Logicality, M3 = Stability, M4 = Fairness, M5 = Security, M6 = Expressiveness

[4] Cheng, Y., Zhao, H., Zhou, X., Zhao, J., Cao, Y., Yang, C., & Cai, X. (2025). A large language model for advanced power dispatch. Scientific Reports, 15(1), 8925.

Conclusions and Future Works

- Introduced ElecBench, the **first** benchmark for LLMs in power dispatch.
- Evaluation **reveals gaps** in core abilities (e.g., factuality and logicality).
- Provides guidance for LLM **training and improvement** in power dispatch tasks.
- Future work will expand tasks and cover broader **knowledge and domain scenarios**.

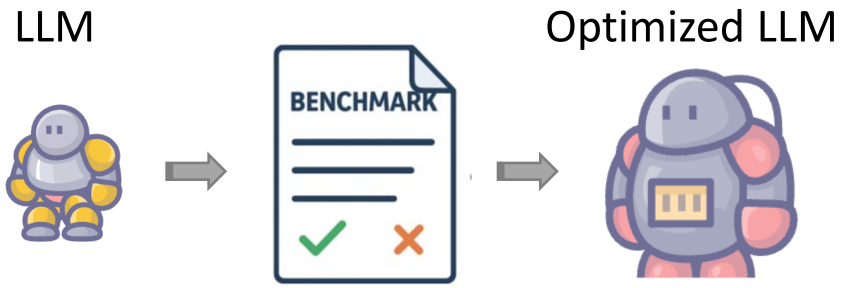


Fig 8. Illustration of how benchmark informs the optimization of LLM capabilities.

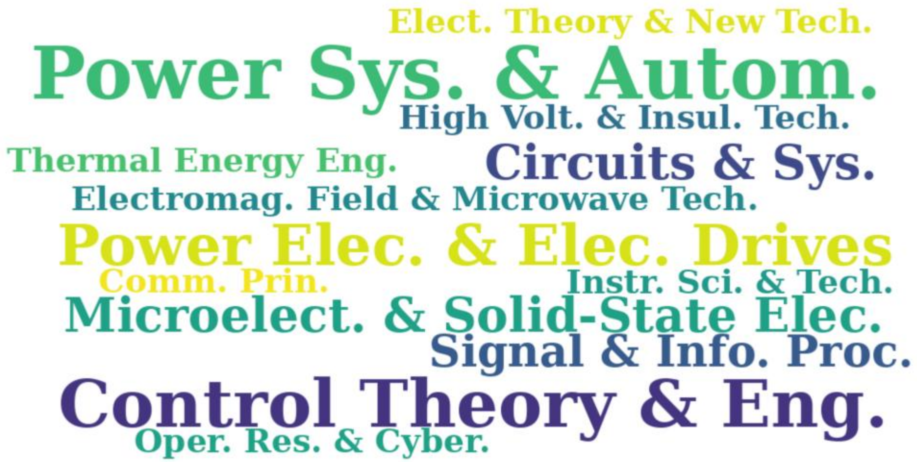


Fig 9. Word cloud of future domain areas planned for ElecBench coverage.