GridChat: Leveraging GenAI for Smarter Power Distribution Modeling with Arras Energy

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Welcome and Introductions

Arras Energy and GridLAB-D

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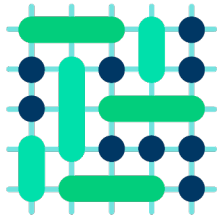
Energy Delivery Systems Simulation

Arras Energy is a commercial release of HiPAS GridLAB-D developed by the California Energy Commission

→ Make the US Department of Energy's agent-based electricity delivery system simulator available to California utilities

→ Support emerging use-cases in California

- Hosting capacity analysis
- Extreme event resilience
- Deep electrification
- Modern tariff design.



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ARRAS

Arras Energy - 21st Century Electricity System Analysis Tools for 21st Century Electricity Utilities

https://arras.energy/

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Timeline of Arras Energy development

2002 - PNNL creates PDSS, an agent-based solver technology demonstration

2007 - DOE funds development of GridLAB-D based on PDSS

2008 - First version of GridLAB-D released as free open-source software

2018 - CEC funds SLAC to develop HiPAS GridLAB-D

2022 - LF Energy adopts HiPAS GridLAB-D and renames it Arras Energy

Available Solvers

Distribution Systems

3-phase unbalanced solvers

- Newton-Raphson current injection
- Kersting's method
- Transient dynamics (experimental)
- CYME converter available

Detailed asset models

- Cable geometry/configuration
- Transformers, relays, switches, etc.
- Pole failure due wind, ice, vegetations
- Distribution generation and storage

Load models by sector (R/C/I/A)

- Physics based (residential w/appliances)
- Data-driven (all)

Transmission Systems

Positive sequence solver (pypower)

- PSS/E converter available

Aggregate asset models

- Powerline composition
- Transformer, relays
- Generators, including costs for OPF
- Loads

Geodata

- Weather
- Loadshapes
- Other parameters that vary regionally

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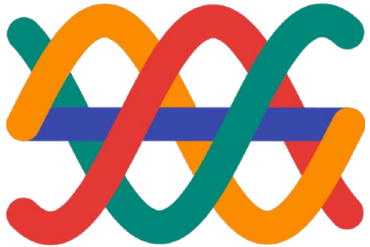
Other Useful Modules

Modeling

- Behavior
- Connection
- Powernet
- Reliability
- Resilience
- Revenue
- Tariff
- Transactive

Support

- Assert
- Influxdb
- Mysql
- Tape
- Optimize



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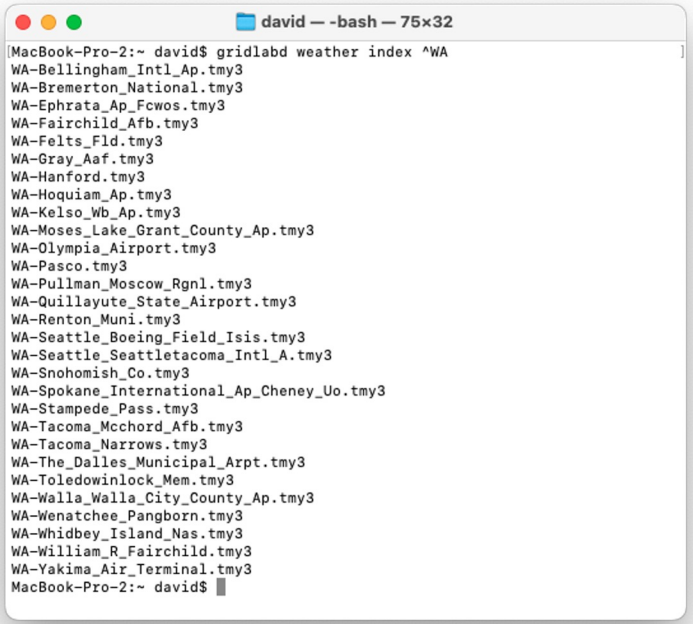
GridLAB-D Subcommands

Building - generate load models from data
Convert - file format converters (to/from)
Geodata - manipulate geographic data
Library - manipulate asset libraries
Loaddata - manipulate load datasets
Model - download example/test models
Plot - generate plots from models
Python - access python environment
Server - control gridlabd servers
Template - access analysis templates
Timezone - access timezone database
Version - control gridlabd version
Weather - access weather libraries



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GridLAB-D Tools

create_* - create submodels (ductbanks, filters, meters, poles, schedule, etc.)
fire_* - get fire reports and fire danger for location and date
fit_filter - fit a *z*-transform to data and generate a gridlabd filter
group - identify potential islands in a gridlabd model
market_* - access market data and generate market models
noaa_forecast - access NOAA weather data (realtime)
nsrdb_weather - access historical weather data from NREL

Python Integration

Module-level

- Full python access
- All global variables
- Model construction (before initialization)
- Model access (after initialization)
- Event handlers
  - Initialization
  - Precommit
  - Presync/sync/postsync
  - Commit
  - Finalize
  - Terminate

Class/Object-level

- Class event handlers
- Object event handlers
- Full object property access
- Automatic unit conversion
- Fast property accessors

Other Python Integrations

- Require tool adds python modules
- Python/shell subcommands access venv
- OpenFIDO access to pipelines/workflows

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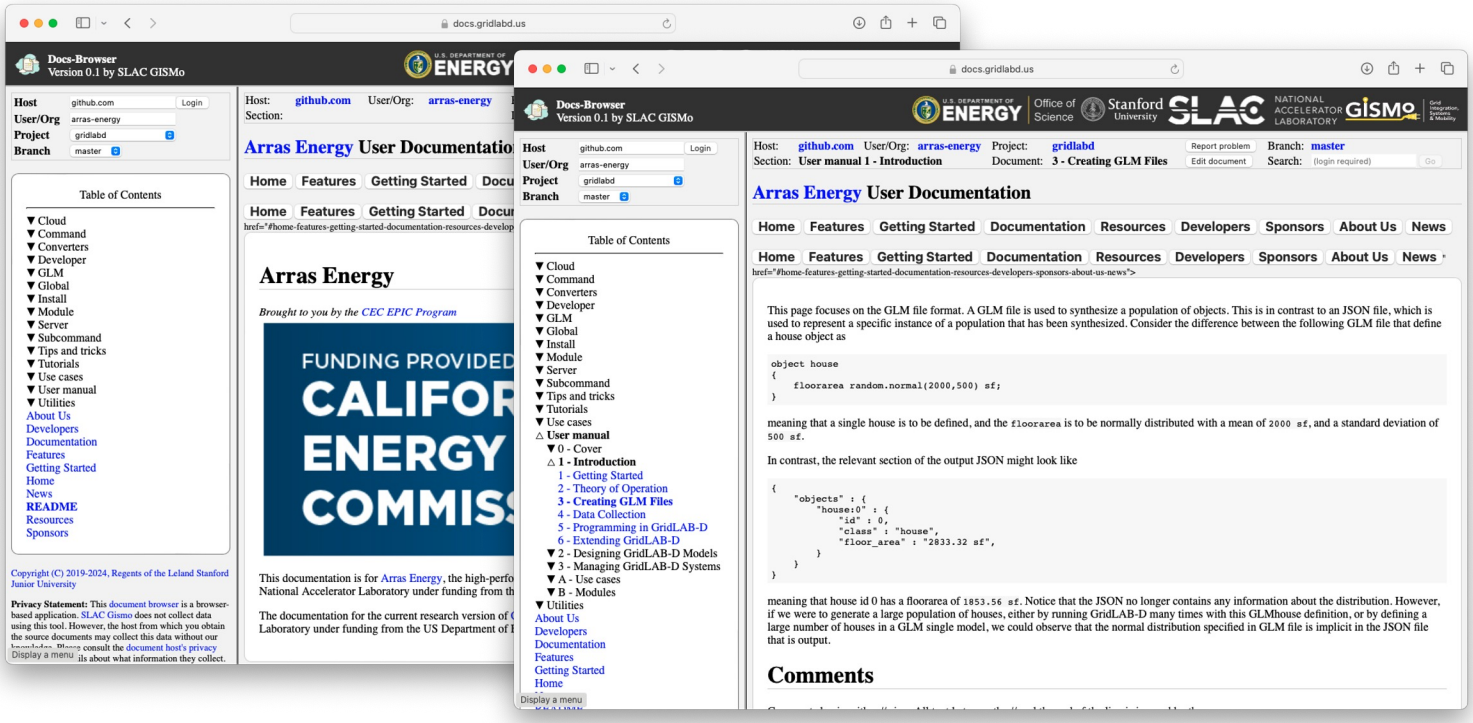
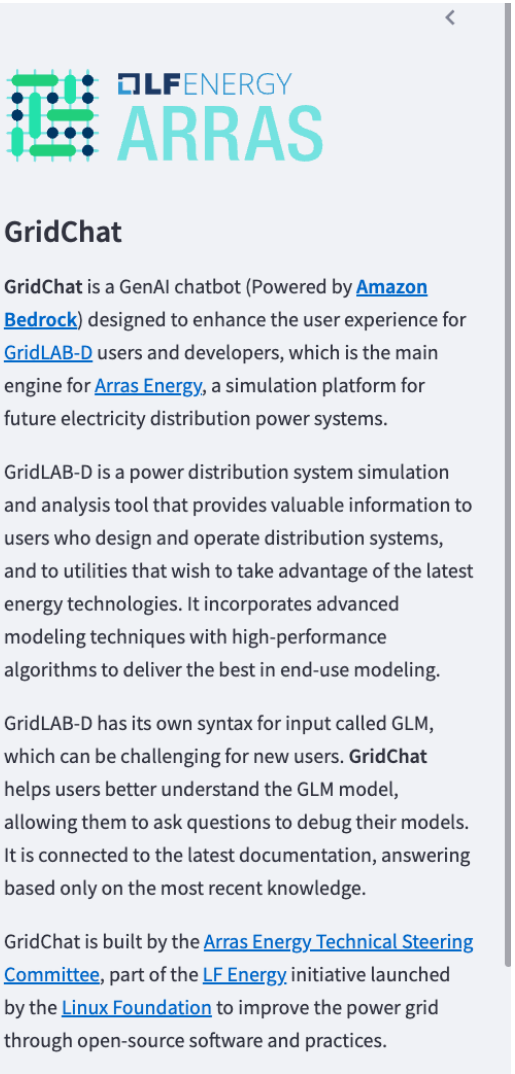
Online Documentation



User Interfaces

- **GitHub Projects**
  - Easy setup and management of GridLAB-D models and simulation results
  - Ready-to-run template projects with github actions workflows
  - Online tutorials/howtos
- **OpenFIDO**
  - Developed by SLAC National Accelerator Laboratory
  - Funded by CEC as an open grid analysis environment for utilities and regulators
- **Marimo Notebook**
  - Developed by Akshay Agrawal, Stanford PhD student of Stephen Boyd
  - Funded by GISMo at SLAC and US Department
- **Hitachi GLOW**
  - Developed by Energy Solutions Lab, Hitachi America Ltd.
  - Funded by CEC as a commercial front-end to HiPAS GridLAB-D

What is GridChat?



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The Technology Behind GridChat

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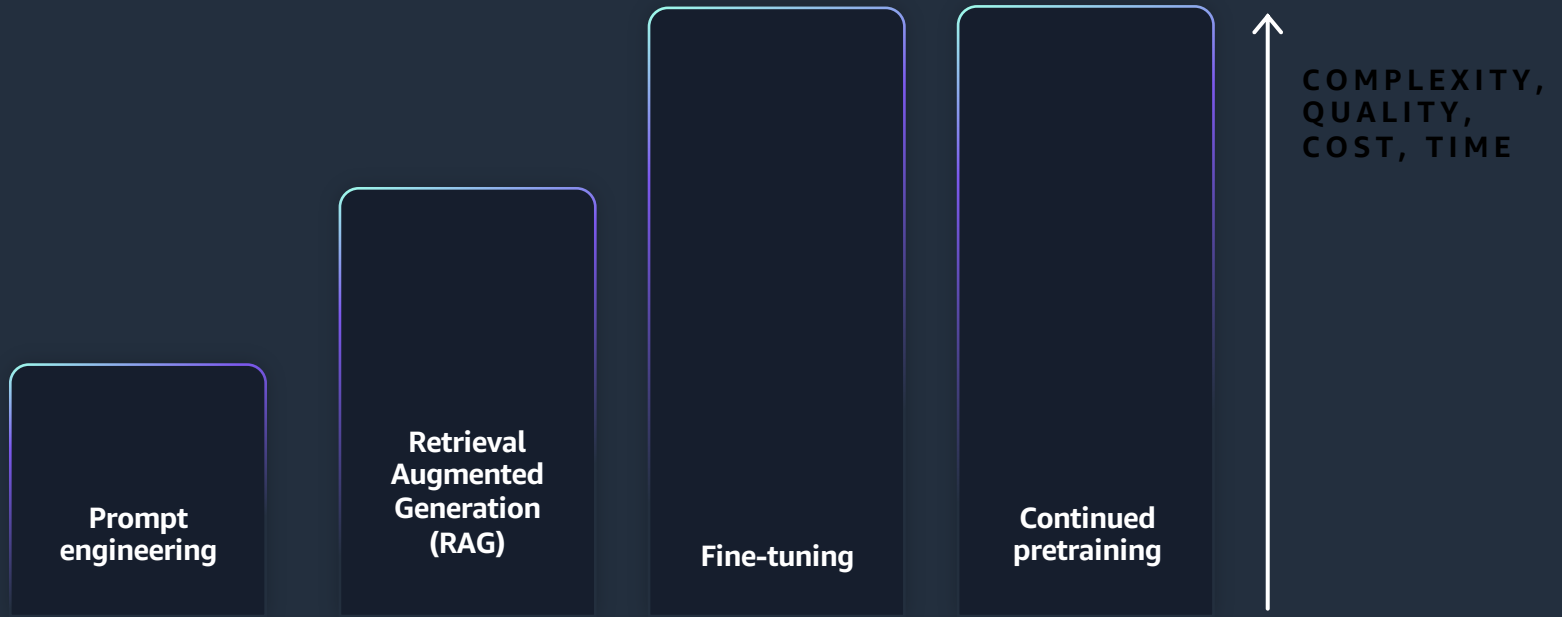
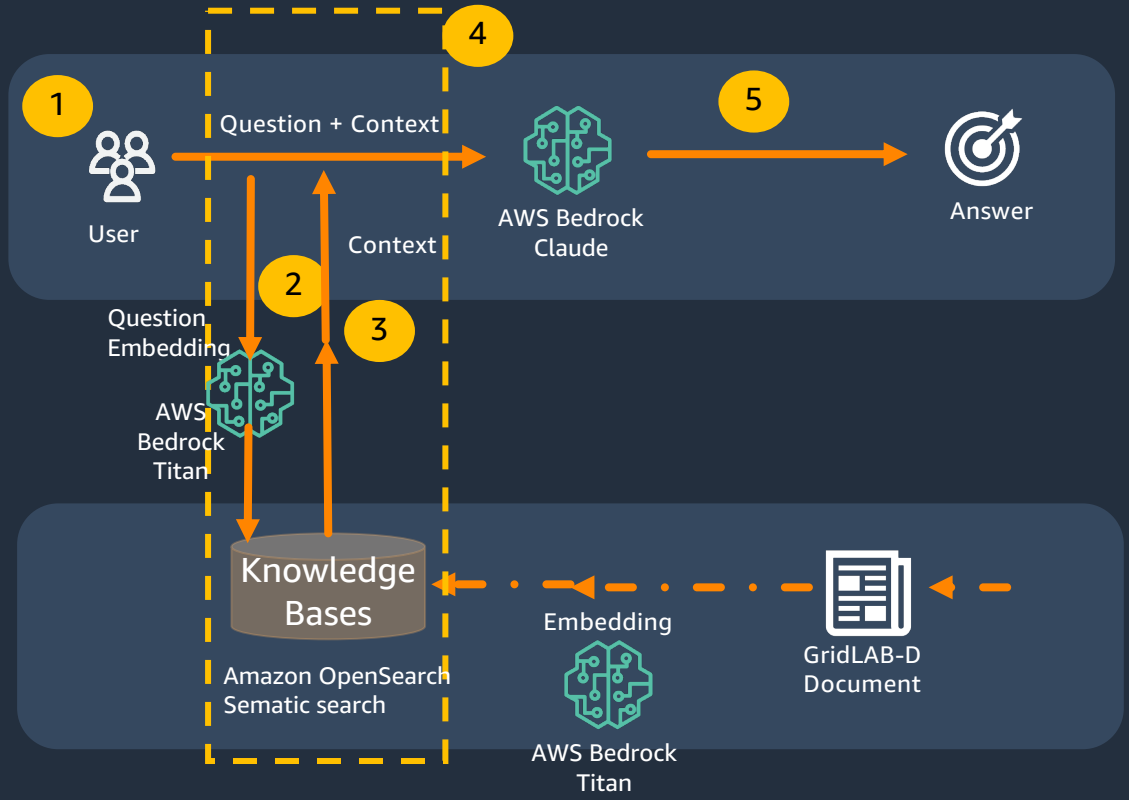
Common approaches for customizing FMs





Amazon Bedrock

The easiest way to build and scale generative AI applications with powerful tools and foundation models

- Choice of leading FMs through a single API
- Model customization
- Retrieval Augmented Generation (RAG)
- Agents that execute multistep tasks
- Security, privacy, and data governance

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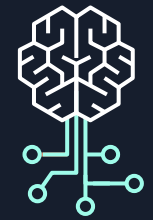
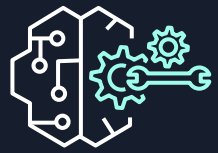
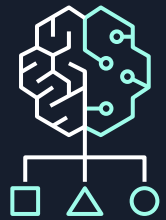
Amazon Bedrock **simplifies**



Choice



Customization

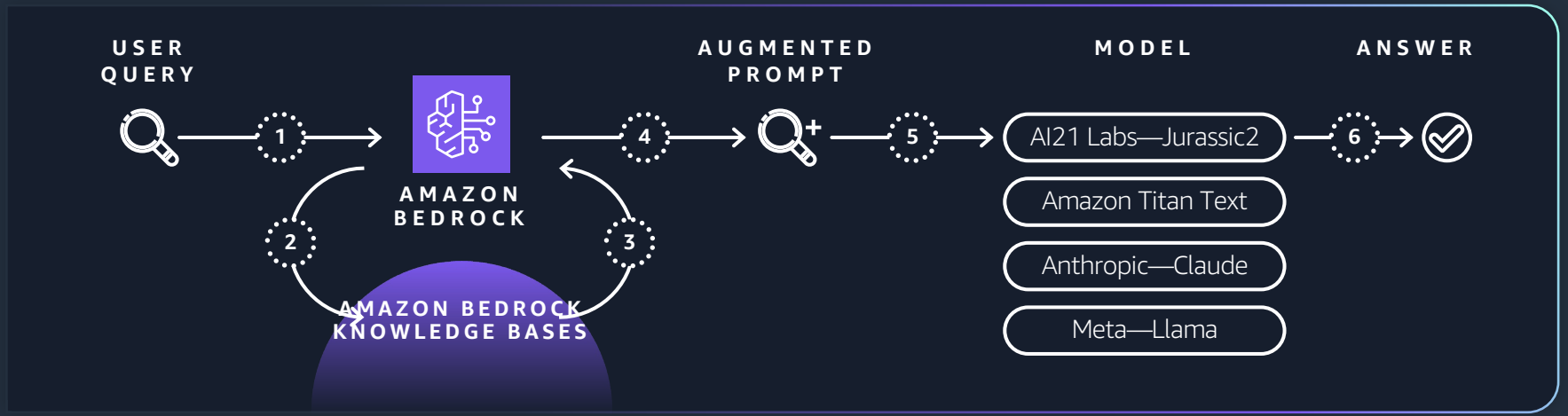


Integration

Security and governance

Amazon Bedrock Knowledge Bases

NATIVE SUPPORT FOR RAG



Securely connect FMs to data sources for RAG to deliver more relevant responses

Fully managed RAG workflow including ingestion, retrieval, and augmentation

Built-in session context management for multiturn conversations

Automatic citations with retrievals to improve transparency

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Anthropic Claude Models on Bedrock

CHOOSE THE EXACT COMBINATION OF INTELLIGENCE, SPEED, AND COST TO SUIT YOUR NEEDS

		Claude 3.5 Sonnet	Claude 3 Haiku	Claude 3 Sonnet	Claude 3 Opus
Use case		Most intelligent, built for high-volume use cases	Fastest performance at the lowest cost	Balance between intelligence, speed, and cost	Second-most intelligent overall; most intelligent in Claude 3 family
Context		200K	200K	200K	200K
Vision		✓	✓	✓	✓
Cost*	Input:	$0.003	$0.00025	$0.003	$0.015
	Output:	$0.015	$0.00125	$0.015	$0.075

*Per 1K tokens

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Demo

https://gridchat.gridlabd.us/

Example: Conversations

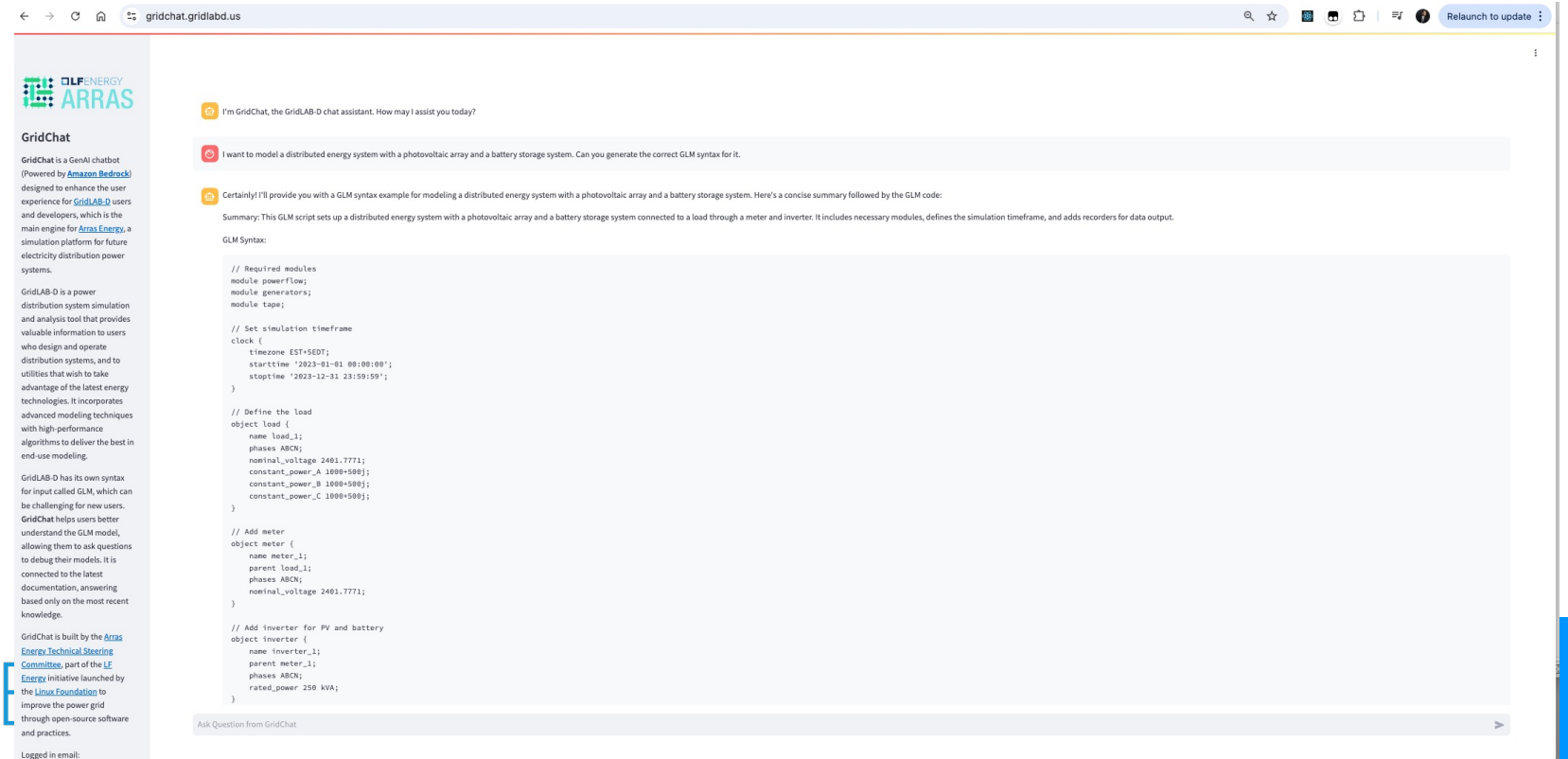
Explain the role of the clock object in GridLAB-D. Can you also provide a working example for a simulation starting at 8 AM on January 1st?

Example--Troubleshooting

My simulation results show abnormal voltage swings at node 12. What could be causing this, and how do I debug the issue?

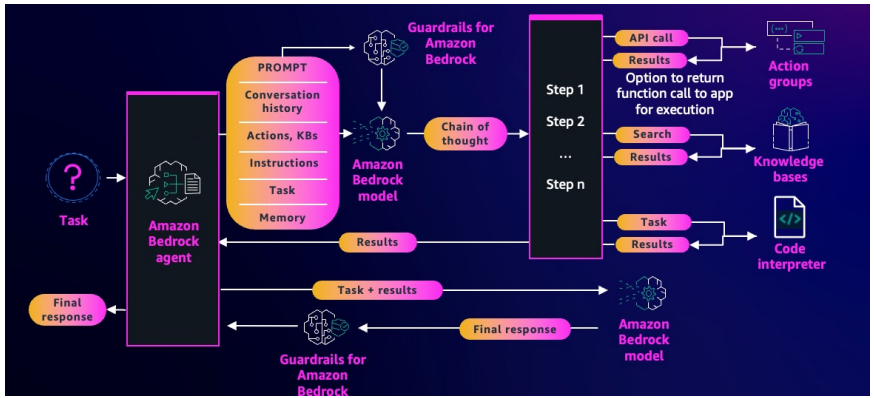
Example--Advanced Simulation

I want to model a distributed energy system with a photovoltaic array and a battery storage system. Can you generate the correct GLM syntax for it.



Future Plans

- Expanding GridChat's capabilities
- Introducing agentic features for autonomous tool execution



- Collaboration opportunities with the community

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Q&A

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