# HiPAS GridLAB-D

LF Energy Proposal
14 June 2022

David P. Chassin, SLAC National Accelerator Laboratory, Menlo Park, CA
(dchassin@slac.stanford.edu)

## Name

The project name is "HiPAS GridLAB-D".

## Mission statement

The mission of the HiPAS GridLAB-D project is to enable and support the commercial use of DOE's GridLAB-D technology by utilities, researchers, and vendors of smart grid, renewable energy, and climate-change mitigation technology with special attention to electric energy delivery systems.

## Project Description

GridLAB-D has emerged as an important open-source tool for utilities, researchers, and technology vendors in the development, maturation, and deployment of smart-grid and renewable energy resource integration technology. HiPAS GridLAB-D leverages these capabilities by delivering a more open and developer-friendly framework for addressing important use-cases identified by key industry stakeholders. These use-cases include (1) distributed energy resource hosting capacity, (2) tariff design, (3) end-use load electrification, (4) extreme weather resilience, (5) wildfire safety and protection, (6) peer-to-peer energy, and (7) advanced load modeling and forecasting.

GridLAB-D was originally developed for the US Department of Energy by a team of researchers at Pacific Northwest National Laboratory to address emerging electric power system engineering challenges associated with grid modernization and climate change response, mitigation, and adaptation. The first release of GridLAB-D was in 2008. Since then it has been used by the US Department of Energy for key electric power system studies, including conservation voltage reduction, dynamic pricing, peer-to-peer energy exchange, and fault-induced delayed voltage recovery.  For a more comprehensive list of journal articles, conference papers, and technical reports related to GridLAB-D, see http://gridlab-d.shoutwiki.com/wiki/Publications.

In 2018 the California Energy Commission authorized $6M of EPIC program funding for two open-source projects for SLAC National Accelerator Laboratory to create a commercially viable

version of GridLAB-D's back-end simulation engine and Hitachi America Labs to create a front-end for users in California's three largest utilities.  The front-end software is called GLOW (which stands for GridLAB-D Open Workspace), and the back-end software is called HiPAS GridLAB-D.

The projects are reaching final production status and will be completed in June 2023, at which time the products must support themselves financially. HiPAS GridLAB-D will continue to be developed and improved upon based on input from key stakeholders and it is expected to reach a level of maturity that requires a more structured and facilitated infrastructure for end-use support and ongoing development than can be provided by either original funding agency.

Hitachi has committed to supporting the open-source version of GLOW through high-end user subscriptions to premium versions.  However, SLAC National Accelerator Laboratory cannot engage in commercial activities using US Department of Energy facilities, nor can it create a separate legal entity to do so using .  As a national laboratory, SLAC can only engage in contract research and technical support for non-governmental entities under a so-called Strategy Partnership Program agreement, such as it currently has with Hitachi and would like to have with LF Energy under this proposed project.

### Is this a new project/working group/special interest group or an existing one?

This is an existing project based on a project initiated by the US Department of Energy in 2007. The current project was funded by the California Energy Commission in 2018 and ends in 2023.

### Current lead(s)

David P. Chassin, PhD, SLAC National Accelerator Laboratory operated by Stanford University (dchassin@slac.stanford.edu).

### Sponsoring organization(s), along with any other key contributing individuals and/or organizations

Current sponsors: California Energy Commission and US Department of Energy Cybersecurity Energy Security and Emergency Response Office.

Previous sponsors: US Department of Energy Office of Electricity and US Department of Energy Solar Energy Technology Office

Key organizations: Pacific Northwest National Laboratory (PNNL) operated by Battelle Memorial Institute, National Rural Electric Cooperative Association (NRECA)

Key contributors: David Chassin (SLAC), Jason Fuller (PNNL), Andy Fisher (PNNL), Alyona Teyber (SLAC), Nate Tenney (PNNL), Frank Tuffner (PNNL), Kevin Schneider (PNNL), David Pinney (NRECA)

## Existing community infrastructure

### *Github Repositories*

Primary GitHub repository: https://source.gridlabd.us/ (aka github:hipas/gridlabd)

Supporting resource repositories:

- https://github.com/hipas/gridlabd-models
- https://github.com/hipas/gridlabd-template
- https://github.com/hipas/gridlabd-converters
- https://github.com/hipas/gridlabd-library
- https://github.com/hipas/gridlabd-weather
- https://github.com/hipas/gridlabd-examples

### *Website and/or docs*

Main user documentation: https://docs.gridlabd.us/

Main develop documentation: https://source.gridlabd.us/wiki

AWS S3/DNS/EC2 Infrastructure: *.gridlabd.us, *.gridlabd.ca

### *Communication channels ( such as Mailing lists, Slack, IRC )*

**Slack**: https://hipas-gridlabd.slack.com/

Email: gridlabd@gmail.com

### *Social Media Accounts*

Twitter: @hipas_gridlabd

Slack: @hipas-gridlabd

## Are there any specific infrastructure needs or requests outside of what is provided normally by LF Energy (please refer to the lifecycle for project benefits)? If so please detail them.

None.

### Why would this be a good candidate for inclusion in LF Energy?

HiPAS GridLAB-D is an open-source energy infrastructure engineering tools used by researchers, industry, vendors, policy-makers, and regulators to identify and deliver the transformations of our energy infrastructure required to respond to the climate change challenge facing the 21st Century economies.

### How would this benefit from inclusion in LF Energy?

HiPAS GridLAB-D would benefit from inclusion in LF Energy in a number of important ways, including (1) increasing its visibility worldwide, (2) stabilizing the funding needed to support it in the mid-term, (3) receiving technical and market guidance from a broader group of experts and potential stakeholders, and (4) identifying and collaborating with other LF Energy projects in a mutually beneficial manner.

### Provide a statement on alignment with the mission in the LF Energy charter.

HiPAS GridLAB-D is a technical project related to the generation, transmission, distribution, and delivery of energy. The project requires funds for the technical resources that will ensure its open-source delivery model is sustainable in the mid-term while it transitions from the government agency research funding model it currently employs to the commercial funding model it requires in the long-term. As such, the HiPAS GridLAB-D project team believes the project is aligned with the mission of the LF Energy Charter, which states

> *The purpose of the Directed Fund is to raise, budget and spend funds in support of various open source and/or open standards projects relating to the generation, transmission, distribution and delivery of energy, including infrastructure and support initiatives related thereto (each such project, a "Technical Project").*

### What specific need does this project/working group/special interest group address?

HiPAS GridLAB-D addresses the needs of key stakeholders such as power system researchers, planners, operators, policy-makers and regulators. Specifically, this software provides an open-source advanced power system simulation engine capable of performing very large scale simulations of distribution systems that include a large fraction of so-called smart grid technology and distributed energy resources that the key stakeholders cannot obtain and/or afford to license from existing software vendors.

### Describe how this project/working group/special interest group impacts the energy industry.

HiPAS GridLAB-D has focused on tool integration and simulation use-cases that are not supported well by the current community of power distribution system software simulators. The earliest use-cases were instrumental in the development of technologies such as transactive

energy and microgrids. In addition, early versions also were used to demonstrate that conservation voltage reduction did not always work as anticipated and needed to be employed judiciously. The most recent release has focused on some key use-cases that will help increase the adoption rate among utilities that have hesitated to employ a new tell. These (1) include tariff design tools to evaluate the revenue impacts tariffs that consider the impact and variability of distributed energy resources; (2) electrification evaluation tools to evaluate the asset degradation impacts of decarbonizing the residential, commercial, and transportation sectors; (3) hosting capacity analysis tools to identify the distributed energy resource and end-use electrification carrying capacity of existing and planned distribution system infrastructure; and (4) resilience analysis to identify the impact of extreme weather events, wildfires, and flooding on existing and planned distribution system infrastructure.

### Describe how this project/working group/special interest group intersects with other LF Energy projects/working groups/special interest groups.

HiPAS GridLAB-D has been used to study data models, protocol design, and communication system performance on power distribution systems, with particular emphasis on data acquisition for machine-learning solutions and communication with behind-the-meter devices. Several of LF Energy projects are engaged the development and promulgation of such protocols, including the following:

- CDS: HiPAS GridLAB-D supports emissions impacts analysis, which depends in part on the availability of measured data quantifying actual emissions to validate and learn models of emissions for various generation resources.
- ComPAS: HiPAS GridLAB-D can simulate in real-time DERs, some of which use IEC 61850 for control.
- EVrest: HiPAS GridLAB-D simulates the control and operation of EV charging infrastructure and its impact on electric power distribution systems.
- FledgePower: HiPAS GridLAB-D simulates the impact of DERs, including industrial IoT assets, on electric power distribution systems.
- FlexMeasures: HiPAS GridLAB-D simulates the impact of demand response on utility operations and electric power distribution systems.
- Grid Capacity Map: One of the principal use-cases for HiPAS GridLAB-D is DER hosting capacity analysis.
- GXF: HiPAS GridLAB-D has been used extensively to simulate peer-to-peer energy technologies such as transactive energy, which is an exemplary use-case of GXF.
- Hyphae: HiPAS GridLAB-D has been used extensively to simulate the impact of extreme weather events on power distribution systems, including microgrids.

- OpenEEmeter: HiPAS GridLAB-D implements a wide variety of load modeling and forecasting tools used to estimate the impact of technologies on utility and customer costs.
- OpenGEH: HiPAS GridLAB-D has been used extensively to model transactive energy and peer-to-peer energy systems.
- openLEADR: HiPAS GridLAB-D is currently being used to simulate a transactive energy system in New England using OpenADR.
- OpenSTEF: HiPAS GridLAB-D uses machine learning technology to improve power solver performance and implement analysis methods for key use-cases such as extreme weather event and wildfire analysis, load modeling, and forecasting.
- PowSyBl: HiPAS GridLAB-D already incorporates multiple powerflow solvers, and is able to integrate new high-performance solvers with suitably designed APIs.
- Shapeshifter: HiPAS GridLAB-D supports simulating transactive energy systems.

### Who are the potential benefactors of this project/working group/special interest group?

Current HiPAS GridLAB-D is designed to serve the following key stakeholders:

- Researchers: these stakeholders are among the first to take an interest in GridLAB-D and have continued to be among the leading users. These include national laboratory scientists and engineers performing research projects for government agencies, academic researchers conducting research on smart grid technology impacts, and utilities and vendors assessing the potential impact of these technologies on electric power system performance and economics.
- Utility Planners: utility planners have started using GridLAB-D for long term load forecasting, resilience analysis, and climate change impact studies.
- Utility Operators: utility have been examining how GridLAB-D can support wildfire studies such as public safety power shutoffs (PSPS) optimization.
- Policy-makers: DOE has funded several large projects examining various policy/strategy reports such as conservation voltage reduction and distribution system operations with transactive energy.
- Regulators: The California Public Utility Commission has identified four key use-cases it would like to use GridLAB-D for, including tariff design, electrification impact studies, resilience analysis, and integration capacity analysis.

### What other organizations in the world should be interested in this project/working group/special interest group?

- Hitachi America Laboratories: the developer of GLOW, a simulation platform that uses HiPAS GridLAB-D as a core simulation engine.
- Pacific Northwest National Laboratory: the original developer of GridLAB-D.
- National Rural Electric Cooperative Association: NRECA uses GridLAB-D as part of the Open Modeling Framework (OMF).

### Plan for growing in maturity if accepted within LF Energy

The HiPAS GridLAB-D team would like to engage in road-mapping, case-studies, training video production, developer coaching and community building, increasing developer support capacity, other commercialization activities, and make the case for additional grant funding for special projects that support new and emerging use-cases for GridLAB-D.

### Questions for Technical Projects ONLY

- **Project license**

  GPL-3

- **Is the project's code available now? If so provide a link to the code location.**

  https://source.gridlabd.us/

- **Does this project have ongoing public (or private) technical meetings?**

  The Technical Advisory Committee meets publicly twice a year. The meetings are convened and materials curated by Gridworks.

- **Do this project's community venues have a code of conduct? If so, what is it?**

  Not explicitly as such. Currently contributions are restricted to individuals authorized by SLAC National Accelerator Laboratory, who are all bound by the Stanford University's code of conduct and the DOE operating contract for SLAC. This may be changed when the funding is no longer managed by the laboratory under the DOE operating contract. For more information about contributions see https://github.com/slacgismo/gridlabd/blob/master/CONTRIBUTING.md.

- **Describe the project's leadership team and decision-making process.**

  The project is currently managed by David P. Chassin, manager of the Grid Integration Systems and Mobility (GISMo) group at SLAC National Accelerator Laboratory. Decisions about research, development, and deployment of HiPAS GridLAB-D are made under a consensus process with the HiPAS and OpenFIDO project teams at SLAC, the GLOW project team at Hitachi America Laboratory, the project team at Pacific Northwest National Laboratory, and the CEC Advanced Grid Simulation Technical Advisory Committee.

- **Does this project have public governance (more than just one organization)?**

  No.

- **Does this project have a development schedule and/or release schedule?**

  Yes. The HiPAS GridLAB-D schedule was developed in consultation with the OpenFIDO and GLOW project teams, the Technical Advisory Committee, and approved by the California Energy Commission.

- **Does this project have dependencies on other open source projects? Which ones?**

  Yes. A significant number of open-source python and C++ libraries are used to build HiPAS GridLAB-D.  These include the following at this time:

  - Linux
  - Gnutools
  - Python
  - CensusData
  - Fiona
  - Pillow
  - PyGithub
  - Shapely
  - boto3
  - cfo
  - control
  - docker
  - elevation
  - folium
  - geocoder
  - geopandas

    - geopy
    - haversine
    - ipykernel
    - ipyplot
    - matplotlib
    - matplotlib_inline
    - metar
    - numpy
    - openpyxl
    - pandas
    - pandas_access
    - pysolar
    - pytz
    - scikit-learn
    - scipy
    - simplekml
    - timezonefinder
    - xlrd
    - Armadillo

- **Describe the project's documentation.**

  The user documentation is provided at https://docs.gridlabd.us/. The developer documentation is available at https://github.com/slacgismo/gridlabd/wiki. In addition, PNNL provided extensive technical support documentation at https://gridlabd.shoutwiki.org/.

- **Describe any trademarks associated with the project.**

  No.

- **Do you have a project roadmap? please attach [Are this project's roadmap and meeting minutes public posted?]**

  No.

- **Does this project have a legal entity and/or registered trademarks?**

  No.

- **Has this project been announced or promoted in any press?**

No.

- **Does this project compete with other open source projects or commercial products?**

  No. HiPAS GridLAB-D has been promoted as complementary with existing software simulations. Moreover, US government policy is to not develop technology that competes with commercial products.

---