CEC Advanced Simulation Program

GridLAB-D Technical Advisory Committee (TAC) Meeting

September 9, 10:00 am - 12:00 pm PDT

Meeting ID: 856 953 6132

Passcode: California

Join Zoom Meeting

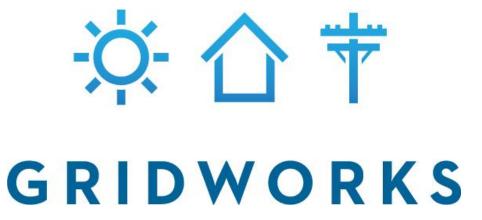












Convene, educate, and empower stakeholders working to decarbonize electricity grids.

Meeting Objectives

- Present project development updates
 - a. OpenFIDO (EPC 17-047)
 - b. HiPAS (EPC 17-046)
 - c. GLOW (EPC 17-043)
- Present GLOW user interface and three use cases (ICA, Grid Resilience, Electrification), get feedback and discuss the future development and support needs of the platform
- 3. Secure collaboration from TAC members on ongoing GLOW development and upcoming Testing Group
- 4. Discuss cloud hosting costs and how to manage them



Meeting Agenda

- 1. **Introduction** (5 minutes) -- Gridworks
- 2. **GLOW Update** (30 minutes) -- Hitachi
 - a. Project Plan Overview
 - b. Demonstrating Use Cases
 - c. GLOW Beta Release and Live Demo
 - d. Launching Beta Test, Confirming TAC member participation
- 3. **Updates on HiPAS** (30 minutes) -- SLAC
 - a. Status update
 - b. Use Cases: Electrification, Tariff design, and Resilience
 - c. Technology Transfer
- 4. Updates on OpenFIDO (30 minutes) -- SLAC
 - a. Status Update
 - b. CYME converter demo
 - c. Vegetation/Wildfire analytics
- 5. Open Questions to TAC



Questions for the Technical Advisory Committee

 What suggestions do you have to refine tool capabilities through beta testing?

• What opportunities and challenges should the team anticipate in commercializing the tools after the conclusion of this project? Long-term support funding model?



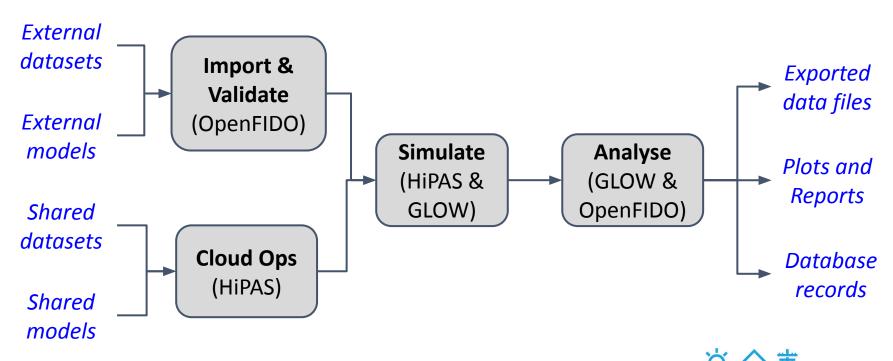
Program Overview

Three project will be discussed today

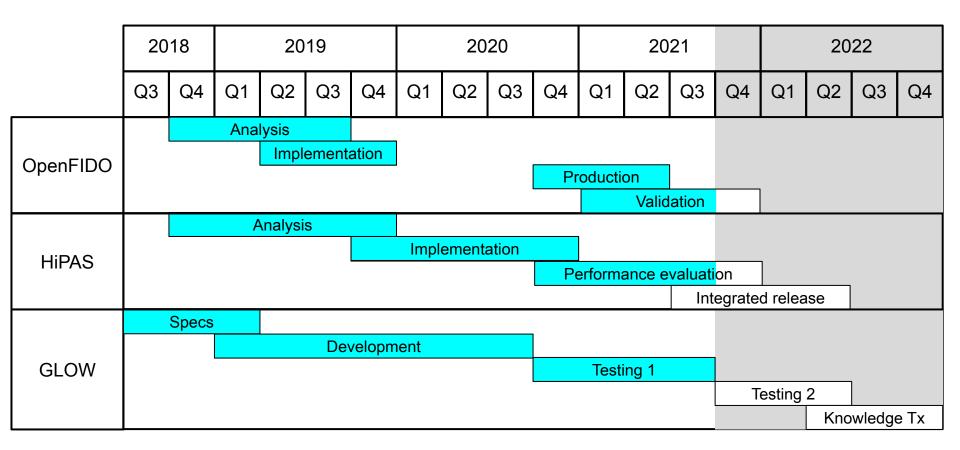
- GLOW (CEC EPC-17-043)
 - A user interface for GridLAB-D focusing on a key distribution system analysis use-case in California
- HiPAS (CEC EPC-17-046)
 - A project to enhance GridLAB-D for major grid simulation use-cases identified by this committee
- OpenFIDO (CEC EPC-17-047)
 - A tool to support data exchange between tools in the program and tools used by California utilities



Program Overview



Program Progress Update



HiPAS GridLAB-D (EPC-17-046)

Sept 9, 2021





Project status overview

SLAC

Technical results

- 1. Data integration
 - a. Weather
 - b. Geodata
 - c. External sources
- Libraries
 - Powerlines
 - b. Power poles
- 3. Templates
 - a. Use-cases (👷)
- 4. Solvers
 - a. ML powerflow (👷)
- 5. Loads
 - a. Multi-family (***)
 - b. Industrials
 - C. Data-driven

Use-Cases

- 1. Tariff design (👷)
- 2. Electrification ()
- 3. Resilience (👷)

Technology Transfer

- 1. Releases this year
- 2. Training program roll-out
- 3. Commercialization plan

g: available but under active development

: not available to users at this time

SLAC

Weather subcommand:

- Manages local copies of weather data
- Provides direct access to online data
- OpenFIDO converter automatic import

Example 1: Shell access

\$ gridlabd weather index CA-San_Fran

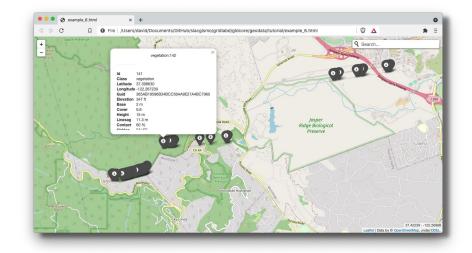
CA-San_Francisco_Intl_Ap.tmy3

Example 2: GLM file access

#weather get CA
#input "CA-San_Francisco_Intl_Ap.tmy3"

Geodata subcommand:

- Creates and merges GIS data
- Multiple packages: e.g., address, census, elevation, utility, powerline, vegetation
- Converter for mapping (folium)



Data integration from external sources

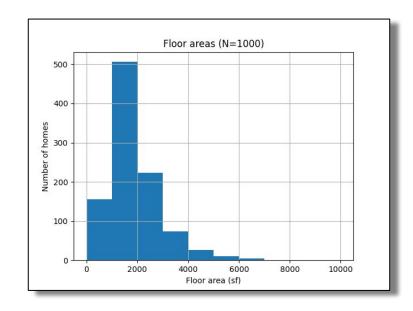


Delivers in-line data analytics support using numpy, scipy, or pandas

Example: create 1000 homes using RECS data

```
#begin python
import eia_recs, numpy
fips = eia_recs.Microdata.get_division("CA")
codes = eia_recs.Microdata.get_codes(**fips)
recs = eia_recs.Microdata()
data = recs[recs["DIVISION"]==codes["division"]]
avg = numpy.log(data["TOTSQFT_EN"]).mean()
std = numpy.log(data["TOTSQFT_EN"]).std()
#end

object house:..1000
{
    floor_area random.lognormal ${PYTHON avg},${PYTHON std});
}
```



- Delivers pre-packaged libraries
 - O Libraries located at http://library.gridlabd.us//CA/<organization>/<name>.glm
- Current libraries available
 - Overhead line conductors (for powerflow and powerline sag analysis)
 - Pole configurations (for resilience analysis)
- Subcommand to manage libraries:
 - Shell command:

```
$ gridlabd library get overhead_line_conductors.glm
```

GLM file:

```
#library get overhead_line_conductors.glm
#include "overhead_line_conductors.glm"
```

- Delivers pre-packaged analysis templates, e.g., for major use-cases
 - Templates located at http://template.gridlabd.us/
 - Designed to be run on unmodified GLM models
- Subcommand to manage templates:
 - Shell management:

```
$ gridlabd template get ica_analysis
$ gridlabd my_model.glm --template ica_analysis
```

O GLM file access:

```
module powerflow;
object { ... } ...
#template get ica_analysis
#option template ica_analysis
```

GridLAB-D load model upgrades



Physics-based load models

Residential

- Gas end-uses
- Updated loadshapes (EIA, RBSA)
- Multi-family buildings (apartments ///)

Commercial

- Commercial buildings (office/retail ///)
- Parking structures with EV chargers

Industrial

NAICS based ZIP loads (pg)

<u>Data-driven load models</u>

Residential

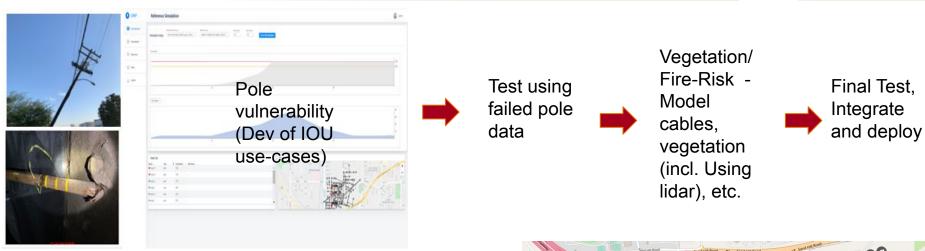
- RBSA
- RECS (2015)

Commercial

- CEUS
- CBECS (2018 ///)

Resilience Use-case overview





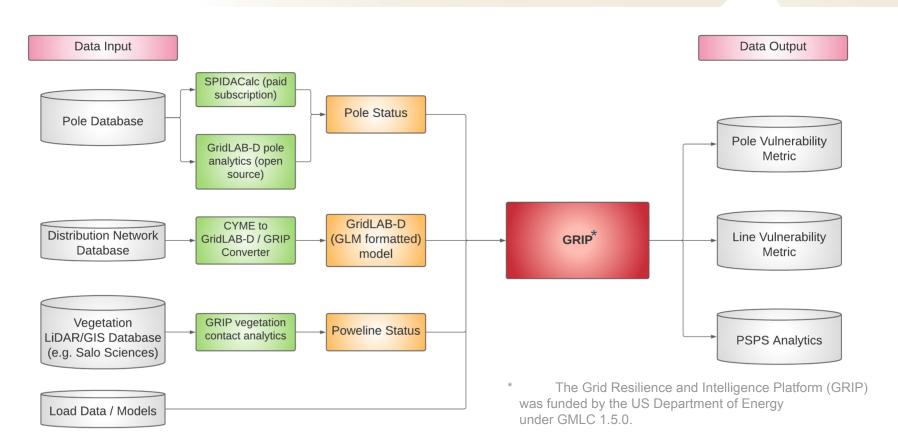
Features added this year:

- Reformulation of the pole vulnerability assessment in HiPAS GridLAB-D power flow module
 - Line-dependent pole failure vs node-dependent pole failure
 - Ease of integration with IOUs pole databases
- Addition of vegetation geodata module for line vulnerability forecasting



Resilience analysis





- Built directly into the power flow module within GridLAB-D source code
 - Pole object
 - Pole configuration
 - Pole mount
- Child of the overhead line object
- Allows for integration with pole databases that map lat/long information onto distribution network models.
- Calculates the moments on the pole and translates into the vulnerability metric for resilience.
- Available under an open-source license.
- Alternatively, pole stresses can be populated through other commercially available (paid) software
 - SPIDA implemented
 - Powerlines Pro future work
 - Others future work

```
object pole
    pole status "OK";
    tilt angle "0 deg";
   tilt direction 0 deg";
   weather "<climate-object>";
    configuration "<pole-configuration-object>";
    install year "1970";
    repair time "24 h";
    wind speed 0.0 m/s;
   wind direction 0.0 deg;
    wind gusts 0.0 m/s:
    pole stress "0 pu";
    pole stress polynomial a "0 ft*lb";
    pole stress polynomial b "0 ft*lb";
    pole stress polynomial c "0 ft*lb";
    susceptibility "0 pu*s/m";
                                      object pole configuration {
    total moment "0 ft*lb";
                                        pole type "WOOD";
    resisting moment "0 ft*lb";
                                       design ice thickness 0.25;
    pole moment "0 ft*lb";
                                       desing wind loading 4.0;
    pole moment nowind "0 ft*lb";
                                       design temperature 15.0;
    equipment moment "0 ft*lb";
                                       overload factor vertical 1.9;
    equipment moment nowind "0 ft*
                                       overload factor transverse general 1.75;
    critical wind speed "0 m/s";
                                       overload factor transverse crossing 2.2;
    guy height "0 ft";
                                       overload factor transverse wire 1.65;
                                       overload factor longitudinal general 1.0;
                                        overload factor longitudinal deadend 1.3;
                                        strength factor 250b wood 0.85;
                                        strength factor 250b support 1.0;
```

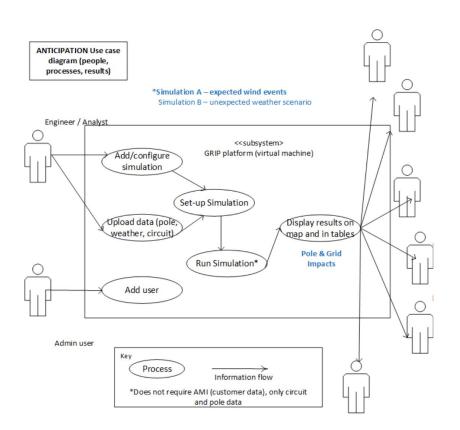
pole_length 45.0;
pole depth 4.5;

ground diameter 32.5/3.14;

treatment method "CRESOTE";

top_diameter 19/3.14;
fiber strength 8000;

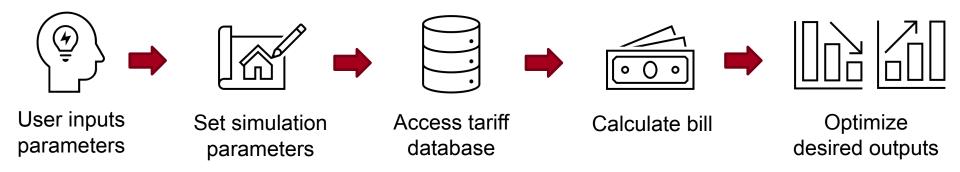
```
object pole_mount
{
    equipment link_id;
    height 0.0 ft;
    offset 0.0 ft;
    direction 0.0 deg;
    weight 0.0 lbs;
    area 0.0 ft;
}
```



Identified use-cases:

- 1. Which poles to replace?
- 2. Assess system stability
- 3. Identify fire-risk areas where poles may fall
- 4. Where to stage field crew
- Where are poles likely to fail day of events.
- Maximizing stability during a wind storm

- Development of electrical tariff simulation template for HiPAS GridLAB-D
- Focus on residential tariffs for California IOUs
- Leveraging an open-source world-wide tariff database, OpenEi (NREL)

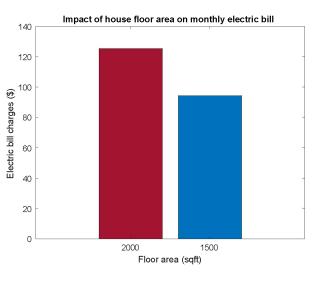


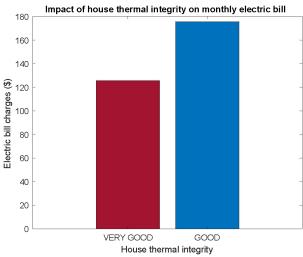
Tariff Design - sample output

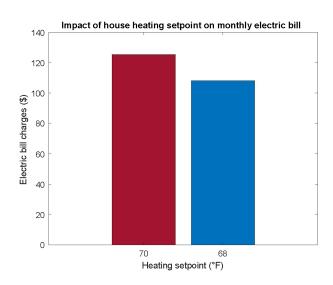


Simulation Parameters:

- Jan 1, 2021 Feb 1, 2021
- 1 house in San Francisco
- PG&E E-TOU-C3 Region R

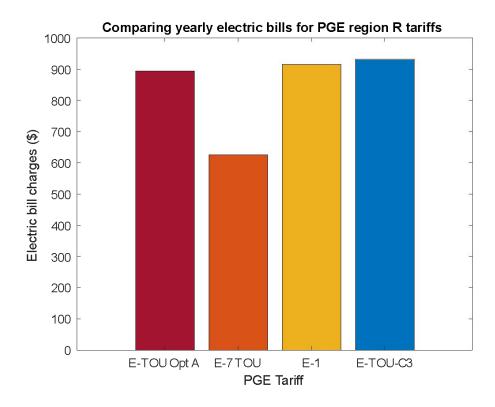






Simulation Parameters:

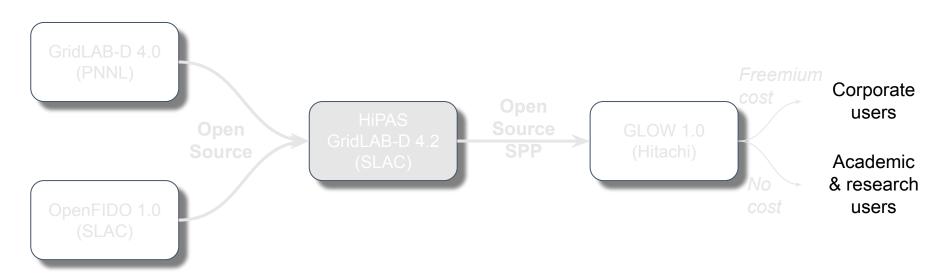
- Jan 1, 2020 Jan 1, 2021
- 1 house in San Francisco
- Very good thermal integrity
- Water heater, dryer, and range gas end uses
- Heat pump heating system
- 70 F heating set point



HiPAS GridLAB-D tagged release series

SLAC

- Bi-weekly "beauharnois" releases of 4.2 for beta builds
 - First release a year ago
 - Current release: Beauharnois-26
 - Maintained by GitHuB + Docker Hub
- Highlights of new capabilities:
 - Subcommands: template, library, geodata, weather, plot, pandas, convert, job, openfido
 - Converters: GLM, JSON, CSV, MDB, TMY3, TXT, PNG, HTML, ...
 - Tutorials: Geodata, RECS, weather, ...
- Starting in October 2021 "chiba" release of 4.2 for final builds
 - Frequency of releases will likely decrease to about monthly



- No cost operations on all supported on-premise/workstation platforms
- Support for cloud operations using commercial platforms
- Super-user/sys-admin/developer training by SLAC on cost-recovery basis

HiPAS GridLAB-D training program roll-out





APPLIED ENERGY DIVISION

HiPAS GridLAB-D Training

SLAC National Accelerator Laboratory provides training to academic, industry, and vendors that wish to use the High-Performance Agent-based Simulation (HiPAS) version of GridLAB-D in their research, development, and operations. Staff in the Grid Integration Systems and Mobility group are experts on the design, development, and use of GridLAB-D, and related tools.

Training courses cower a range of topics from introductory material for newcomers to the world of agent-based power system simulation, intermediate topics on specific modules, including power systems, buildings loads, transportation infrastructure, and distributed energy resource integration, and advanced topics, include data handling, cloud computing, module development, and core development. Attenders will learn how to use GridLAB-D to simulate grid behaviour under deep electrification, DER integration, and tariff design. In addition, special topics may be addressed by request.

Instructors are highly experienced electrical and mechanical engineers who have worked with and developed tools using GridLAB-D for many years. Training courses are offered in 1/2-day or 1-day modules, depending on the topic and can be delivered on-line using Zoom, on-site at SLAC National Accelerator Laboratory, or off-site at a hosting facility. Off-site courses include GSA per-diem costs, unless instructors' travel. Good, and todaing are prepaid.

About the Instructors *

David P. Chassin, PhD



David has more than 30 years experience in energy system modeling and simulation. He manages the Grid Integration Systems and Mobility at SLAC. He is the original developer of

GridLAB-D and leads the development of the California Energy Commission EPIC projects to commercialize GridLAB-D for California's investor-owned utilities.

Alyona Teyber, MASc



Alyona has 7 years experience modeling and simulating power systems using GridLAB-D, as well as developing tools and applications based on GridLAB-D technology. Alyona

leads research projects in grid resilience, distribution system electrification, and the integration of renewable resources in distribution system operations.





Scan this QR code to get a copy of the training application form or use the following link:

https://tinyurl.com/2mk56vn3

A U.S. Department of Energy Research Facility Operated Under Contract by Stanford University

^{*} Please note that instructors may change depending on the course date and location.

Postdocs:

Fuhong Xie

PhD Students:

- Siobhan Powell
- Lily Buechler
- Gustavo Cezar
- Marie-Louise Arlt

Research assistants:

- Sara Borchers
- Adithya Antonysamy

Summer interns:

- Jewel Newman ('20, '21)
- Johnson Hsiung ('21)
- Wonseok Choi ('21)
- Jorge Higuera ('21)

OpenFIDO (EPC-17-047)

Sept 9, 2021





Project status overview

Technical results

- Operational status
- Alpha release issues
- Beta release status

Online documentation

- http://help.openfido.org/
- https://auth.openfido.org/apidocs/
- https://api.openfido.org/apidocs/

Demonstration

CYMF data extraction

Upcoming work

Vegetation analysis

Commercialization

Commercial partnerships



9: available but under active development

inot available to users at this time

SLAC

Online/cloud platform (AWS)

- Registered/invited users only
- https://app.openfido.org/

On-premise/private cloud platform

Available but not substantially tested ()

Local/private workstation platform

- Deployed via OpenFIDO CLI
- Available to general public
- https://github.com/openfido/cli

Pipeline status

- 1. NERC load composition data generator
- 2. CYME extractor
- 3. GridLAB-D input/output converters
- 4. General numerical processing (numpy)
- 5. Integration Capacity Analysis ()
- 6. GRIP Anticipation (👷)
- 7. Data cleaning (///)
- 8. General data processing (pandas *i*//)
- 9. General data analysis (scipy ///)
- 10. Vegetation/wildfire analytics (GRIP-2 ///)

Identified issues

- Pipeline start dialog
 Lacks clear guidance as to what data/files
 are required to successfully run pipeline
- Visualization dialog
 Needs options to handle various forms
 CSV outputs (e.g., transpose)
- 3. Lack of clear diagnostic outputs

 Output messages do not provide guidance
 on how to fix the problem found

Plan for beta release

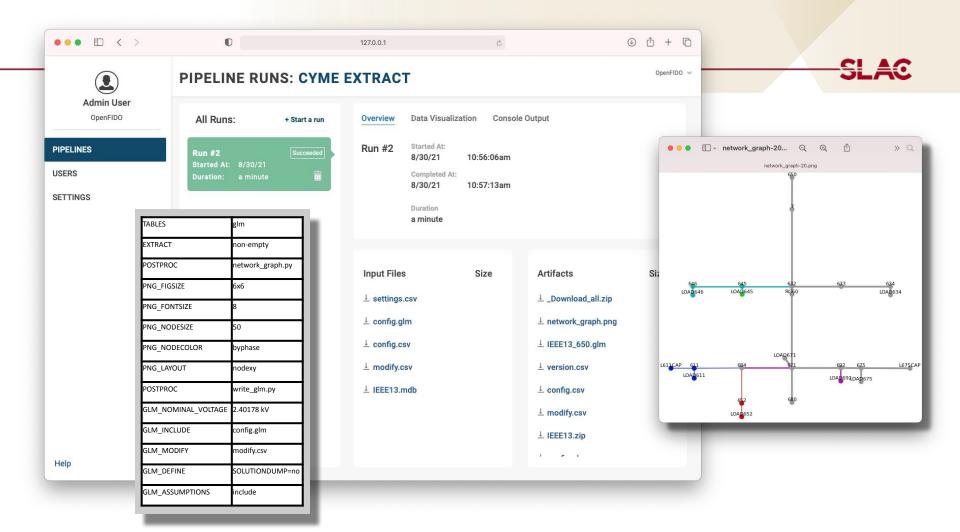
- Form-based pipeline start dialog ()
 Pipelines can present input form that generates files needed to run
- 2. Upgraded visualization dialog ()

 Visualization dialog will support

 additional CSV read options and plot
 formats
- 3. Improved diagnostic output (***)

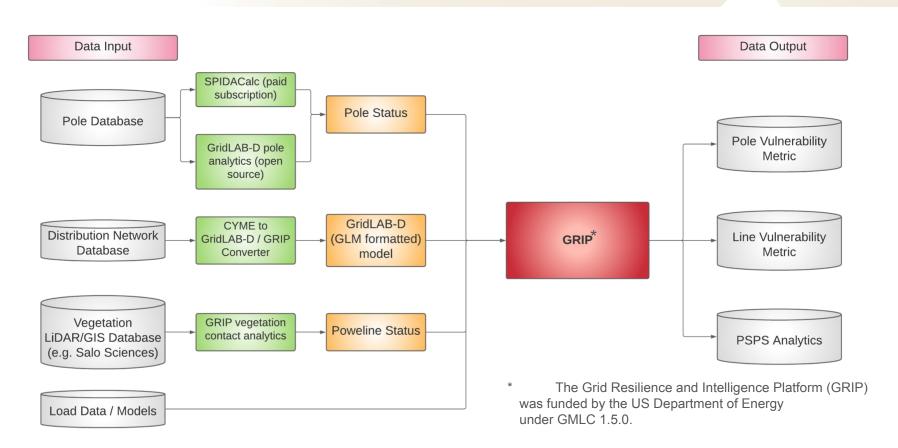
 Pipelines will be required to follow error

 message guidelines for troubleshooting



Vegetation/wildfire analytics





GRIP - Grid resilience and Intelligence Platform

SLAC

Platform for databases relevant for resilience Develop a metric to determine asset vulnerability

- Pole vulnerability (pg)
- Conductor vulnerability (sep
- Analytics to support de-energization and DER support (

Uses HiPAS GridLAB-D as the solver for resilience

Integrates with OpenFIDO

- CYME converter for network models
- Pole database converters
- Load models

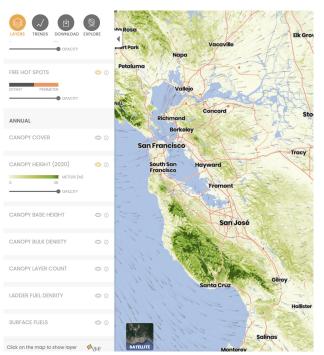
Next steps:

Forecasting grid status at near-term in the context of wildfire resilience

Typical Datasets for Resilience



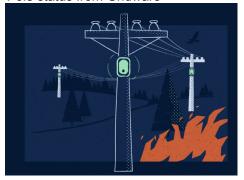
Vegetation (LiDAR / Satellite) from Salo Sciences



Pole stress assessment from SPIDA



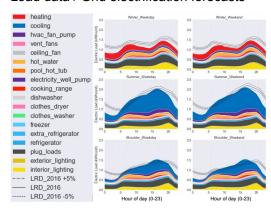
Pole status from Gridware



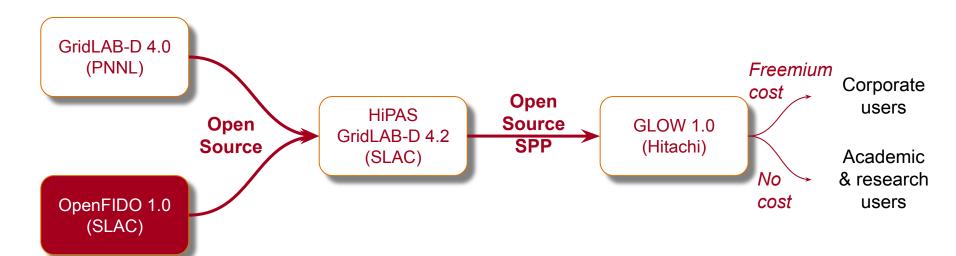
Census data



Load data / Grid electrification forecasts



- Builds on data-driven approach to resilience
- Integrates vegetation and elevation data to build forecasts and determine the probability of contact
- Develop optimization and controls for PSPS events for distribution feeder
 - Incorporates census data for DER placement
 - Electrification data for both building and transportation sector



- No cost operations on-premise and workstation
- Demonstration and training on https://app.openfido.org/