CEC GridLAB-D Modeling Program

GLOW, OpenFIDO, and HiPAS SLAC Requirements Analysis

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U.S. DEPARTMENT OF ENERGY
Office of Science

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Overview

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- **Current GridLAB-D usage review**
  - California-based projects that use GridLAB-d
- **Code review**
  - Findings from GridLAB-D 4.0 code review
- **User interviews**
  - User interviews synopsis
- **General requirements identification**
  - Requirements identified from usage/code reviews and interviews

Current GridLAB-D Usage Review

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Projects reviewed

1. VADER (DOE)
2. Powernet (CEC)
3. GRIP (DOE)

Visual Analytics for Distributed Energy Resources (VADER)

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- **Uses simulation engine for scenario modeling**
- **Relies on utility models, AMI and SCADA data**
- **Analytics supported:**
  - Solar disaggregation
  - Switch status detection
  - Machine learning-based power flow

PowerNET (DOE) and PowerNET With Markets (CEC)

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- **Simulation to estimate control system impacts**
- **Data and model sources**
  - Cyme network models and tariff/DR/DER control models
  - Semi-aggregated AMI and SCADA data (AWS MySQL/Mariah RDS)
- **Analytics implemented:**
  - Advanced load control performance evaluation
  - Demand response performance evaluation
  - Distributed energy resource performance impacts
  - Cost and revenue impacts

Grid Resilience Intelligence Project (GRIP)

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- **Utility resilience anticipation/absorption tools**
- **Data and model sources**
  - Cyme network and DMS control models
  - AMI and SCADA data
- **Analytics supported:**
  - Pole failure impacts
  - Absorption strategy performance evaluation

Advanced Load Modeling

- **NERC load composition for planning studies**
- **Relies on data collected from utilities**
  - Feeder load measurements
  - AMI data
- **Analysis of data to validate load composition**
  - Weather sensitivity
  - Filling in gaps in data coverage
  - Verification of default value
  - Managing datasets used in planning studies

Code Review

Topic areas covered by code review

1. Data formats
2. Core structure
3. Platform dependencies
4. Data handling

Area 1: Data formats

- **Support for new/modern data formats, e.g.,**
  - JSON (widely used by python-based software)
  - CIM (new standard for network modeling)
  - OpenADR (new standard for DR/DER controls)
  - Emerging standards for tariff modeling

Area 2: Core structure

- **Separate core from data, UX and module APIs**
  - Main: platform, module and solver management
  - APIs: UX, module, solver and host access libraries
- **Reentrancy for scenarios analysis**
  - Main needs to be run multiple cores in a single process
  - Session stream/copy needed for scenario processing

Area 3: Platform-level dependencies

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- **Standardized deployment hosts**
  - Docker
  - Amazon Web Services (AWS)
  - Google Cloud
  - Microsoft Azure
- **Embedding in open-source languages**
  - Python 3 module
  - Others (e.g., Julia, R)?

Area 4: Data-handling

- **Standardize data handling APIs**
  - Credential management for cloud-based data access
  - Download caches for using remote data
  - Support data pipelines used in analysis methods
  - Uploading, reviewing, and publishing data & results
- **Scenario-based data management**
  - Provide access to data based on scenario parameters
- **Data processing**
  - Standardized data cleaning, previewing, and output formatting

User Interviews

Types of interviews

1. Government (state and federal)
2. Utilities (TSO/DSO, public/private)
3. Service provides (data analytics)
4. Researchers (academic, government)

Government

- **Tariff analysis**
  - Customer revenue and resource cost impacts at distribution level
  - Tariff parameter sensitivity analysis on revenue and costs
- **ICA analysis**
  - Implementation of a standard integrated capacity analysis method
- **LNBA analysis**
  - Implementation of a standard locational net-benefit analysis method
- **Resilience analysis**
  - Asset vulnerability assessment
  - Large-scale rare event impacts analysis

Utility

- **ICA, LNBA analysis**
  - Validation of ICA and LNBA on utility test models
- **Tariff design**
  - Validation of tariff design tools on utility test models
- **Resilience planning**
  - Demonstrate asset vulnerability and extreme event analysis method
- **Resource procurement modeling**
  - Load modeling and load forecasting
  - Distributed energy resource modeling
  - Demand response modeling

Service/analytics providers

- **Custom analysis implementation and deployment**
  -
- **Automate access to public data repositories**
  - Weather data collection/processing/delivery
  - Standard grid, building, and tariff models libraries
- **Data import and export**
  - Automatic data format recognition and handling
  - Data cleaning, time-standardization, identification

Researchers

- **Documentation**
  - Current internals documentation is needed for all analytic methods
- **Training resources**
  - User cases with step-by-step instruction online as videos
- **Valid agents for all system components**
  - Code snippets, standardized units, parameter ranges, good defaults
  - E.g., distribution grids, households, buildings, renewable resources
- **Data-driven res/com building models**
  - CEUS/RBSA data for residential and commercial building models
- **Optimization solvers**
  - Update optimization module to support new methods

Identified Requirements

Categories of identified requirements

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- **Usability**
  - Improve GridLAB-D user experience and support GLOW UX design
- **Speed**
  - Enable multicore, multihost, and cloud scale simulations
- **Flexibility**
  - Enable user-defined data pipelines, scenarios, and modules
- **Validation**
  - Enable user-defined model validation tools
- **Reproducibility**
  - Enable high-reproducibility simulation capabilities

General issue: Usability

- **Need a well-designed UX**
  - Data access
  - Simulation hosting
- **Data access UX**
  - Plug-and-play import, cleaning, viewing and export tools
- **Simulation hosting UX**
  - Individual and organization credential management system
  - Local, organizational, and cloud simulation management system

General issue: Speed

- **Parallelization for internal loops**
  - Many potentially parallel internal loops
  - Parallel loops exist at every level of simulation
- **Access and control of external hosts**
  - Configuration of multiple host pools
  - Scalable job control
  - Share resource management (e.g., input data, intermediate results)
  - Automatic dispatch of processing pipeline

General issue: Flexibility

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- **User-defined scenario design**
  - Model selection/customization
  - Scenario-based data selection
- **Scenario execution**
  - Scalable hosting of processing
  - Resource usage/cost tracking/management
- **Scenario result analysis**
  - Collection of scenario output results
  - Preview and output formatting (e.g., collation, tabulation, plotting)

General issue: Validation

- **Validation of methods and tools**
  - Integrated capacity analysis (ICA)
  - Locational Net-Benefit Analysis (LNBA)
  - Tariff design
  - Resilience analysis (asset vulnerability, rare large event impacts)
- **Focus on canonical test and results**
  - Standard test cases must be implemented
  - Results must be matched to a predetermined error margin
  - Incorporated into main build validation procedure

General issue: Reproducibility

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- **Stochastic model reproducibility**
  - Local entropy sources
  - Saving/restoring entropy state in model save/load
- **Variables and properties**
  - Latent variable implementation
  - Cross-correlated properties
  - Uncertainty propagation

Questions & Discussion

Sources and Interviews

Sources

- Leigh Tesfatsion (Iowa State University)
- GridLAB-D (GitHub)
- VADER (DOE)
- GRIP (DOE)
- PowerNET (DOE)
- PowerNET Mkts (CEC)

Interviews

- CPUC
- Utilities
- CCAs
- Vendors