HiPAS GridLAB-D

(EPC-18-046)
Deliverable 4.1.2 - Performance Evaluation

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Objective and Approach

Evaluate performance relative to the DOE version of GridLAB-D

- Metrics of performance
  - Simulation speed
  - Accuracy of results
  - Cost of operations
- Evaluation study
  - 2022 annual load forecast (2021 study baseline)
  - ICA analysis on utility feeders (no baseline available)

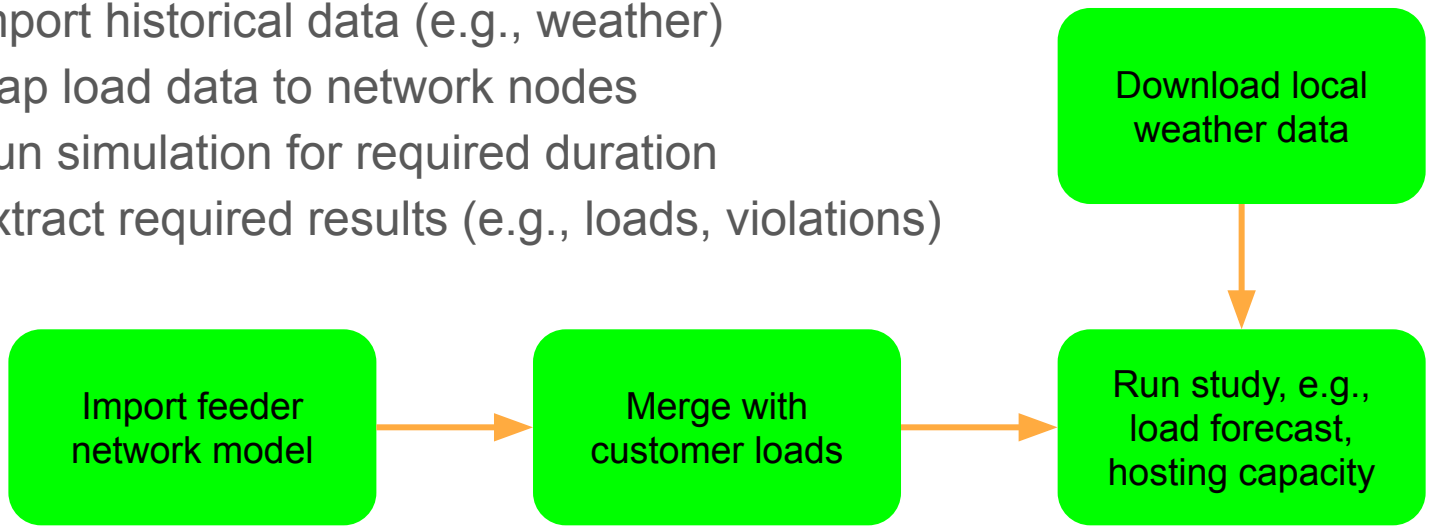
Performance Metrics

- Accuracy of result
  - Failed model conversions (manually fixed)
  - Changes from prior year's results
- Simulation speed
  - Time to completion
- Cost of operations
  - Storage requirements and costs
  - CPU requirements and costs

Performance Evaluation Study

For each of ~2000 feeders:

1. Convert CYME model to GLM
2. Import historical data (e.g., weather)
3. Map load data to network nodes
4. Run simulation for required duration
5. Extract required results (e.g., loads, violations)



Accuracy Results

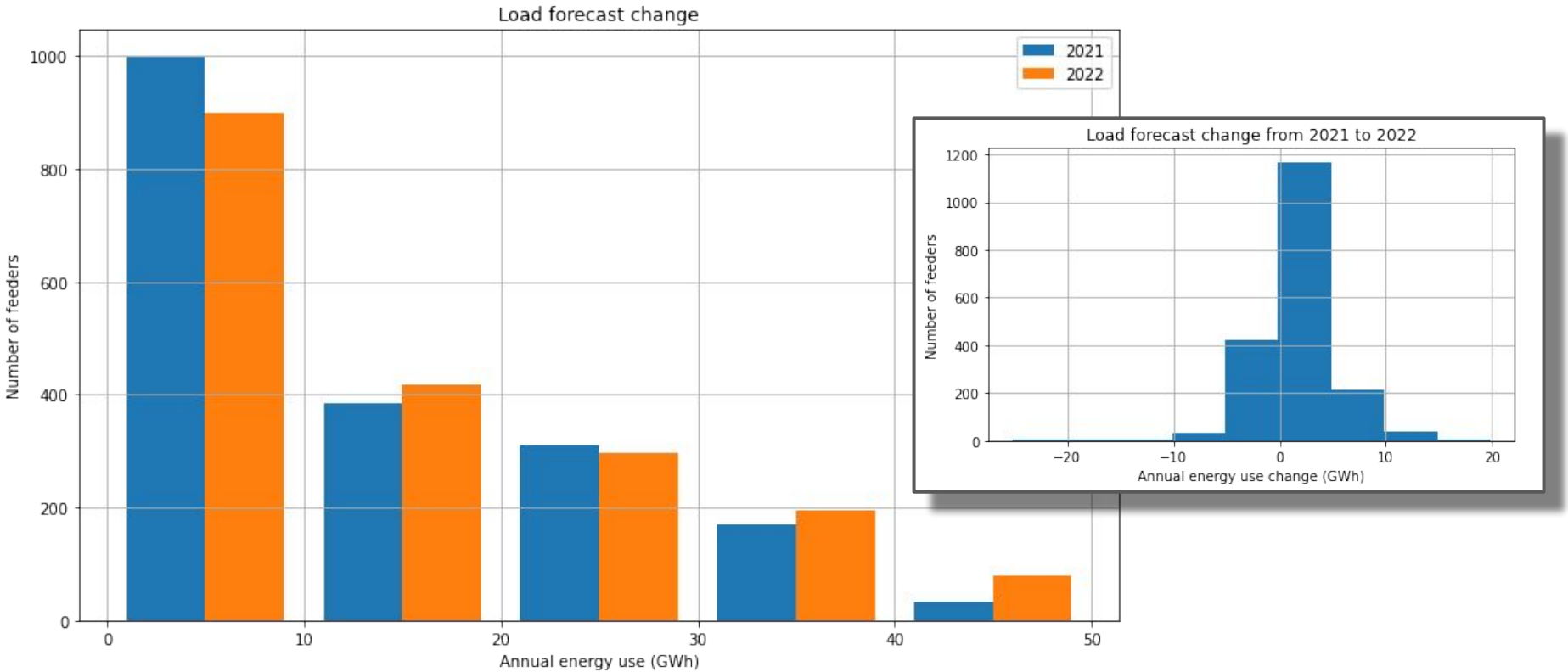
Feeder model conversion from CYME to GridLAB-D

1920 CYME feeder models received; 1871 converted ok to GLM (97.5% success)

Significant CYME→GLM conversion issues identified/corrected

- Nominal voltage of load objects may mismatch load bus
- Capacitors switches/phases/control settings may mismatch
- Regulator bandwidth units/values may be incorrect
- Load magnitudes may exceed reasonable values for phases
- PV generation on feeder may exceed hosting capacity limit
- Triplex lines are not modeled in CYME resulting loss discrepancy
- Loads may not be connected resulting in total kVA discrepancy
- Asset phases may mismatch
- Transformer model errors may resulting in incorrect secondary voltages

Comparison of annual energy use forecast



Simulation Speed

Test 1: 8760 hours load forecast

Server configuration: AWS c5a.24xlarge 96 vCPU (48 cores), 192 GB x 1 TB, Linux

2021 DOE GridLAB-D runtime on 7 servers: 114 hours

1248 feeder benchmark test:

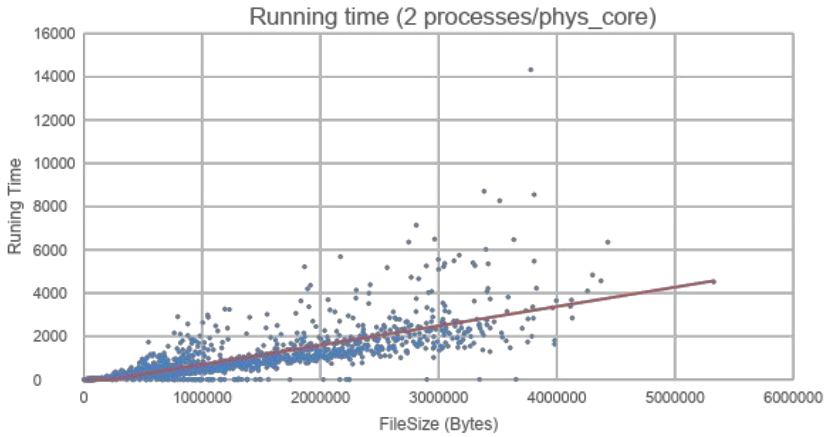
- HiPAS Runtime on 1 server: 3.44 hours

1871 feeder benchmark test:

- HiPAS Runtime on 1 server: 4.44 hours

HiPAS speed improvement: 180x faster

- Performance metric: 0.7 s/MB.wk



Test 2: Hosting capacity analysis (ICA)

Tests run on 25 DOE Taxonomy Feeders
(see https://github.com/hipas/gridlabd-benchmarks)

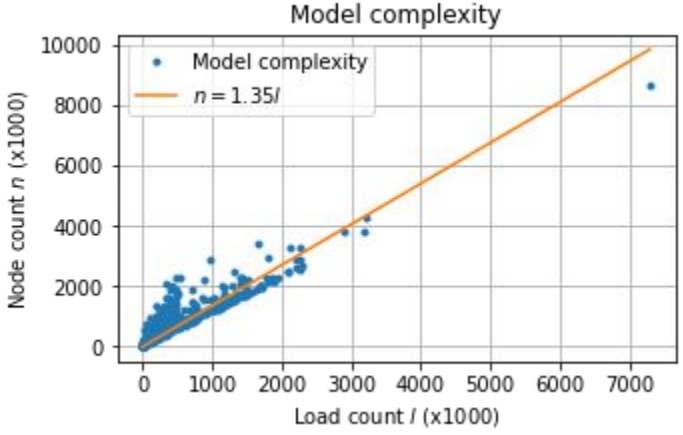
- Performance as a function of network size (1 *kn*=1000 nodes)

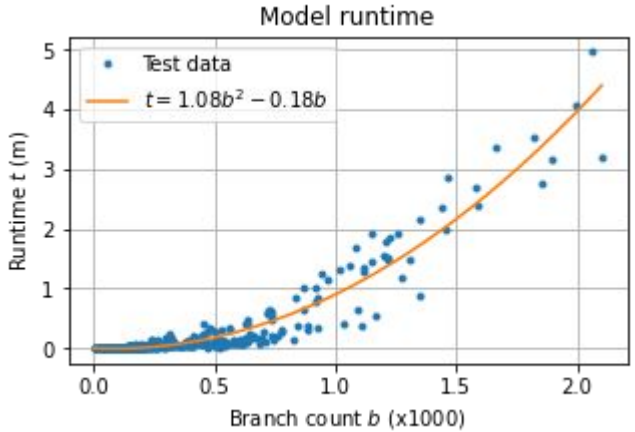
  $t = 52\ kn^2 - 4.9\ kn$ (s)

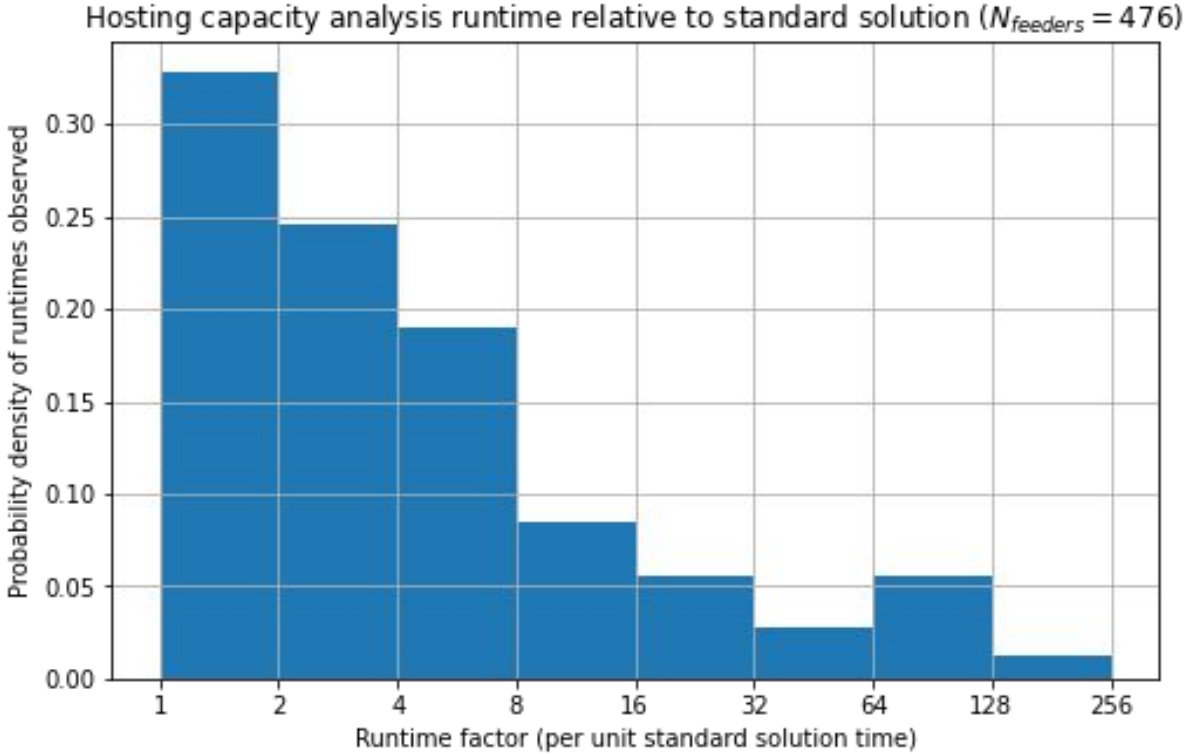
- Performance as a function of number of DERs (d)

  $t = 0.57\ d + 2.95$ (s)

Capacity analysis speed for utility feeders (*N*=1871)







Cost of Operations

Storage requirements and costs

DOE GridLAB-D: 17 TB storage

- Root cause: excessive warning messages

HiPAS GridLAB-D: 1.1 TB storage

- Solution 2: resolve warnings by fixing CYME-GLM converter
- Solution 1: suppressed remaining unneeded warnings

Resource requirements and costs

	Prior Method	HiPAS GridLAB-D
Average runtime	~ 25592 hours	4.44 hours
Average cost (AWS CPU)	~ $ 113,088	$20.25
Data size	17 TB	2 TB
Workflow	Sequential computing	Compute speed optimized with parallel computing
Hosting platform	AWS Windows	AWS Linux (c5a.24xlarge)

Open issues with performance analysis

1. ICA/HCA have no baseline results for comparison at this time
2. Resilience analysis is currently in progress at Southern California Edison
3. Tariff design and electrification performance analysis not done yet