Distribution Grid Locational Performance Modeling

Developing a Foundational Integrated Modeling Tool for Regulators

Proof of Concept

Overview

Develop a **prototype software framework** to *illustrate potential outcomes of developing a fully integrated modeling tool for regulators*.

"Answer locational and tariff questions related to the integration of behind-the-meter DER in the distribution system that can be used by regulators to support decision-making in the regulatory framework"

Proof of Concept

Approach

- Develop software prototype
    - Use DER-CAM as optimization backend
    - Develop new capabilities, e.g. support Tiered Tariffs
    - Integrate with distribution power flow models
    - Upgrade DER-CAM server and develop new specific APIs, e.g. automated analysis of tariff modifications
    - Develop new data visualization capabilities – GUI

- Carry out representative case study
    - Analyze impact of TOU rate modifications

DER-CAM

What is DER-CAM?

Decision support tool for decentralized energy systems

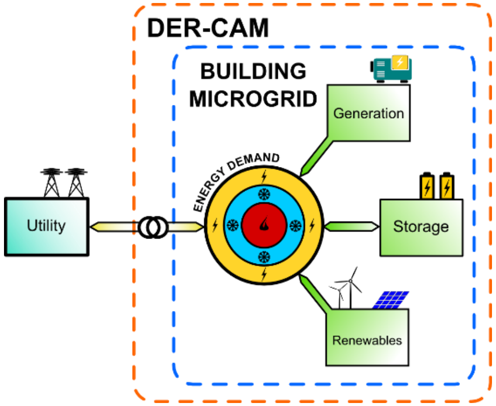
- Optimal energy supply solutions for buildings and microgrids
- Optimal dispatch of existing energy supply technologies in buildings and microgrids

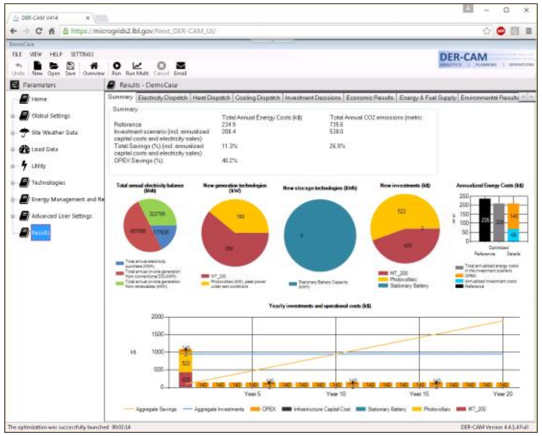
DER-CAM is…

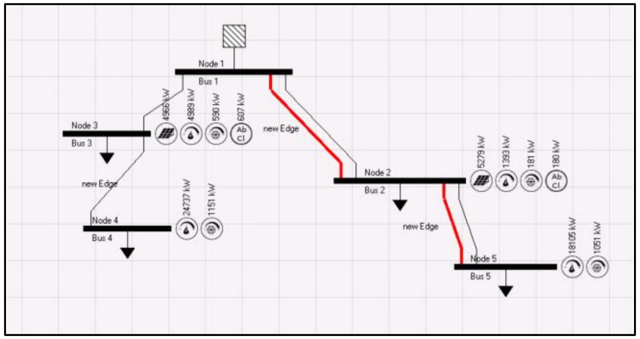
- *A physically-based* ***(economic) optimization model***
  - Find most cost-effective mix of generation and storage + dispatch that minimizes costs / CO_2 emissions
  - Decisions consider load management options such as load shifting, load scheduling, load shedding
  - Constrains force energy balance and technology behavior
  - Takes into account power flow constrains

https://building-microgrid.lbl.gov/projects/der-cam

DER-CAM







Features / Technologies

- Distributed Generation

Combustion engines, fuel cells, micro-turbines, CHP, photovoltaic, solar thermal panels, wind turbines

- Energy Storage

Stationary storage, electric vehicles, heat storage, cooling storage

- Energy Management

Demand response, load shifting, load shedding

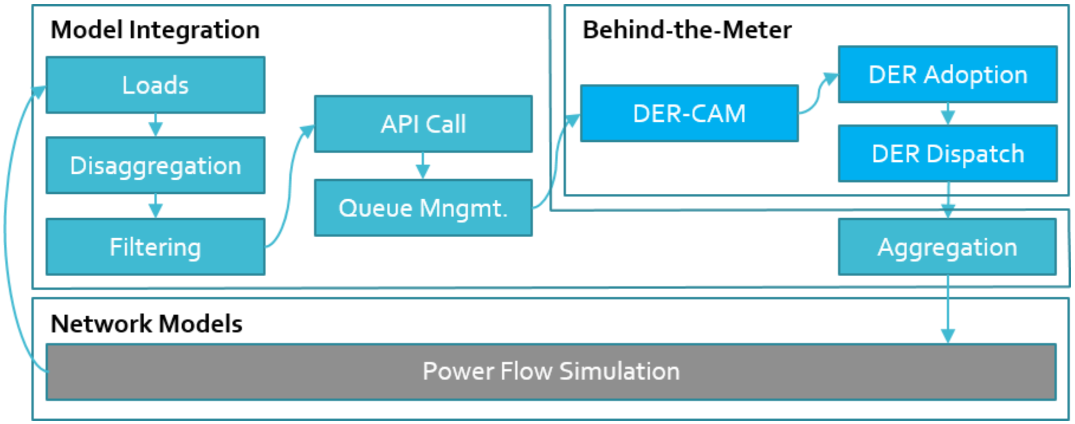
- Passive technologies

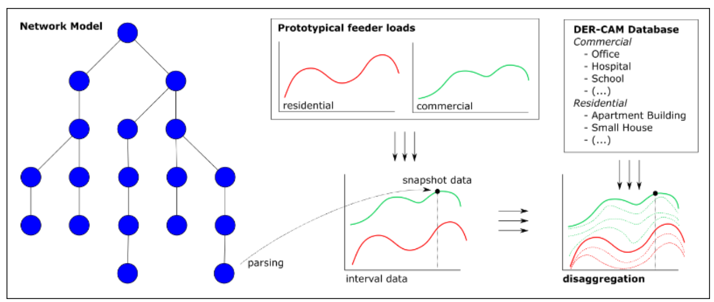
  Building shell replacements (windows, doors, insulation)

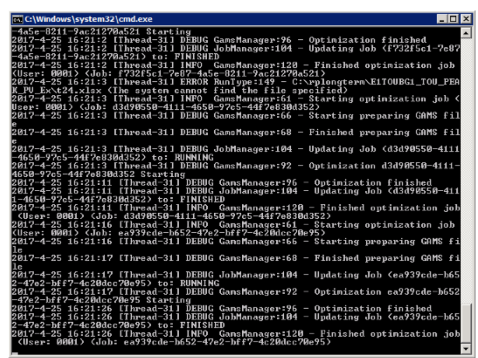
Proof of Concept

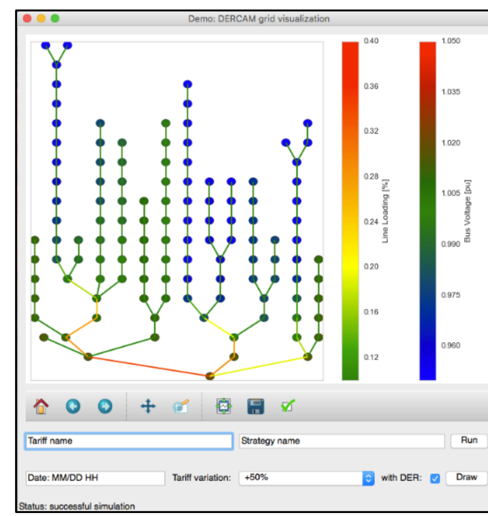
Integrated software platform prototype

- Integrate DER-CAM with distribution level power flow models
- Generate and visualize both nodal and system level results





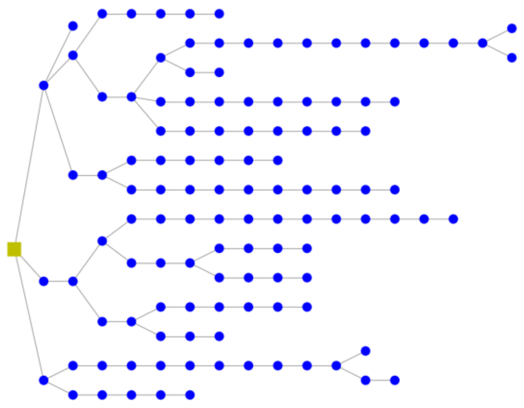




Proof of Concept

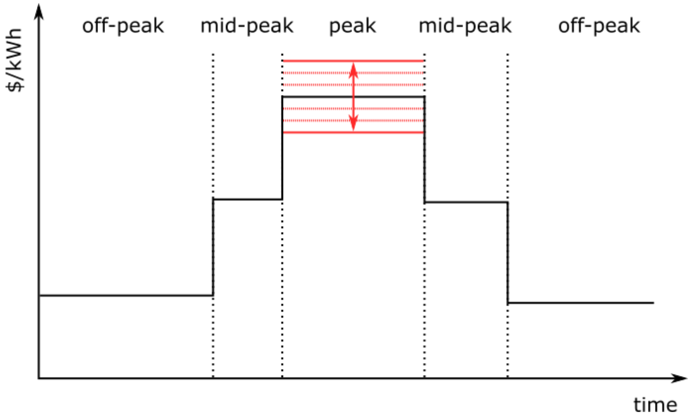
Datasets

- Standard test feeder (radial 119 bus)
- DoE building energy load datasets
  - Residential Energy Consumption Survey
  - Commercial Reference Building Models
- CBECS and U.S. Census data
- TMY weather data
- DER techno-economic data
- California IOU tariffs



Case Study

- DER Investment cases:
  - PV Only
  - PV and Storage
  - PV, Storage and CHP
- Sensitivity to TOU (peak)

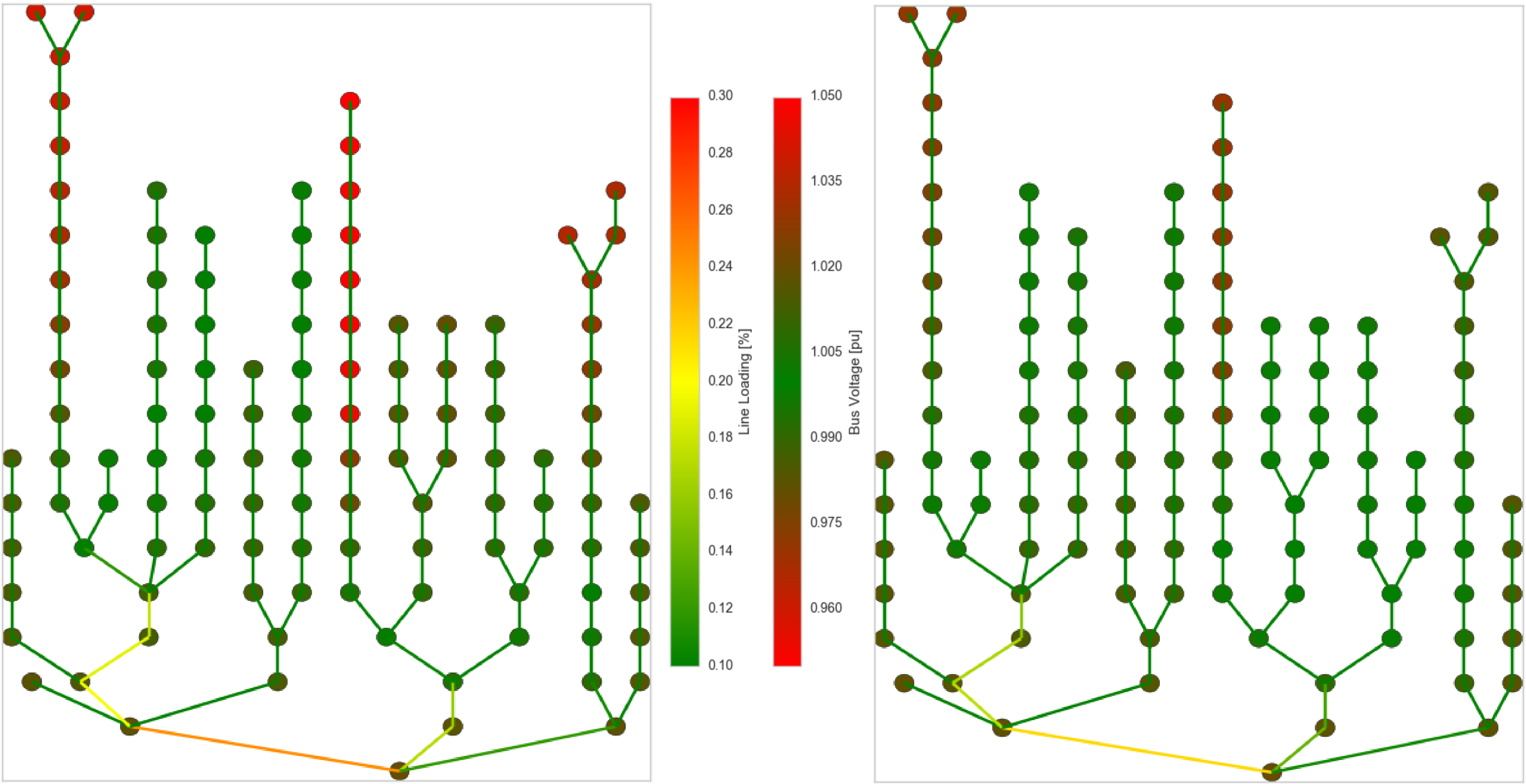


Proof of Concept

Understanding Results

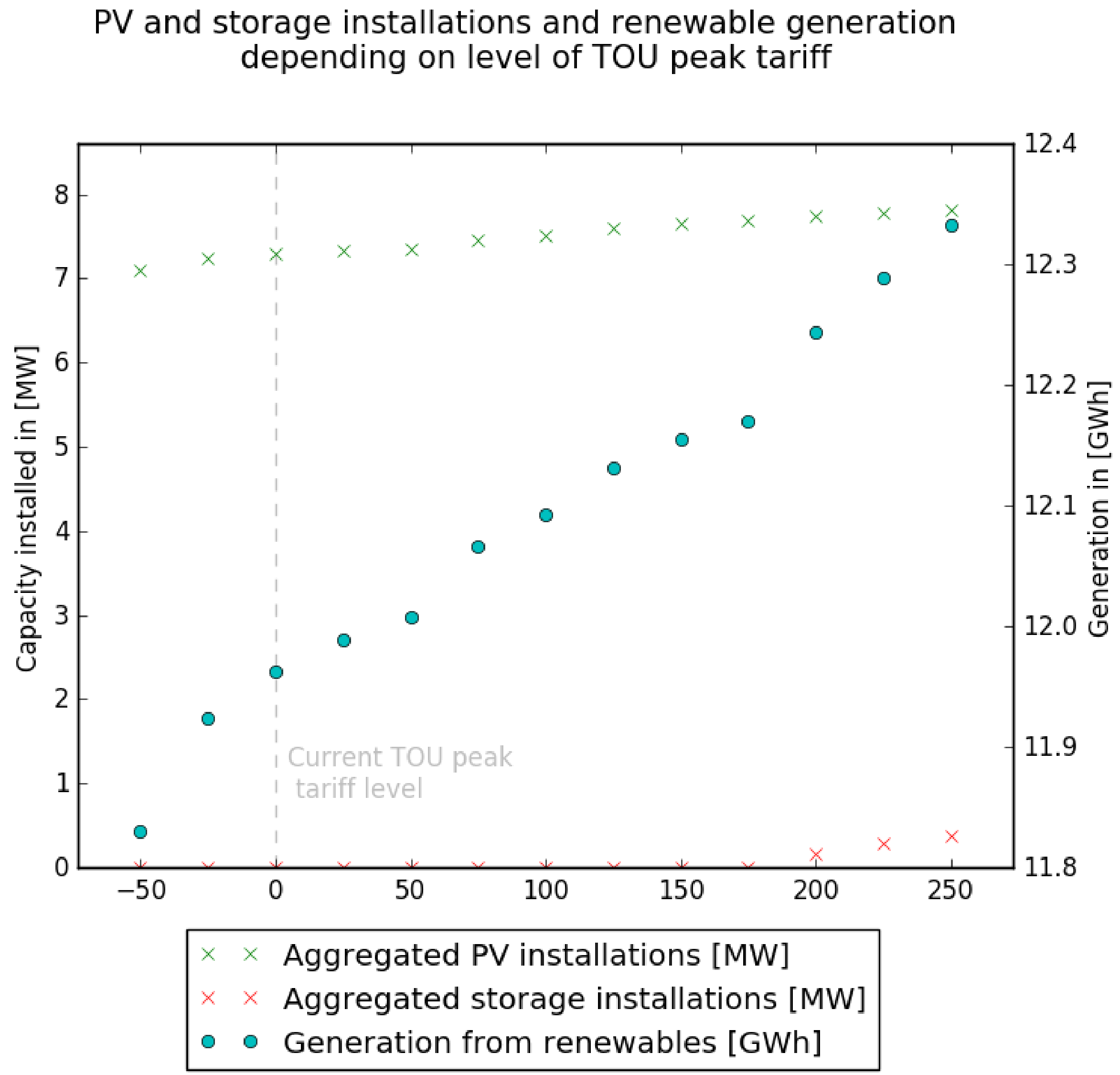
- Determine, for each tariff modification, cost-effectiveness of different DER investment options for each customer segment
- Aggregate the customer level results to each node
- Run power flow analysis of the distribution circuit with net loads calculated for each tariff modification (transformer level)
  - Identify e.g. line loading, voltage, backfeeding
- Further aggregating results to the system level
  - Total installed PV capacity
  - Total renewables generation
  - Max voltage drop / increase

No DER **With DER investments**



System-level visualization of grid impact on voltage levels, line loading

Results


PV and storage installations and renewable generation depending on level of TOU peak tariff
Capacity installed in [MW]
Generation in [GWh]
0
1
2
3
4
5
6
7
8
11.8
11.9
12.0
12.1
12.2
12.3
12.4
−50
0
50
100
150
200
250
Current TOU peak tariff level
Aggregated PV installations [MW]
Aggregated storage installations [MW]
Generation from renewables [GWh]

Conclusion

Final Remarks

- First step towards incorporating consumer cost-benefit analysis in wider system planning
- Provide visibility to behind-the-meter DER adoption decisions
- Provide guidance for hosting capacity analysis

Moving forward

- Investment deferral, operation costs
- Long term technology adoption
- Optimal rate design
- Integrate with transmission level models