DER-CAM+ DECISION SUPPORT TOOL FOR DECENTRALIZED ENERGY SYSTEMS

TOPOLOGY | ANALYTICS | PLANNING | OPERATIONS

Introduction to DER-CAM

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https://building-microgrid.lbl.gov/
https://gig.lbl.gov

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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

DER-CAM is not a …

- *transient power flow model*
- *simulation model*

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Two main branches

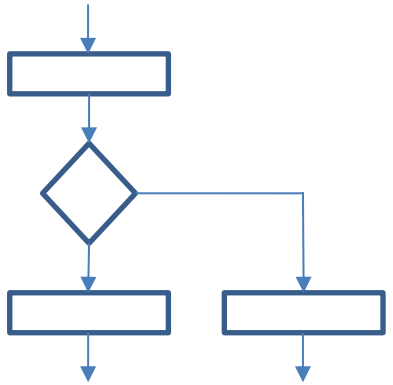
- **Investment and Planning (I&P) DER-CAM**
  - Considers hourly loads of representative day-types based in historic or simulated data
  - Finds optimal investment decisions for a representative year, or investment timeline up to 20 years in the future
  - Investment decisions are based in a bottom-up approach: optimized dispatch for representative day-types
  - Technologically neutral

- Operations DER-CAM (for Model Predictive Controllers)
  - Considers higher resolution time steps (1 min to 1 hour)
  - Finds optimal dispatch of local energy resources on a week-ahead basis
  - Uses existing load information and weather forecasts to forecast loads
  - Can be used to feed data to a building management system or SCADA

Optimization vs. Simulation

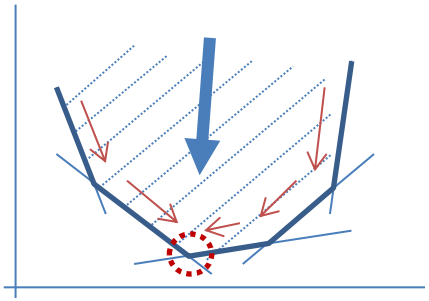
Simulation:

- Pre-defined set of rules
  If PV output > 0:
  If Load > 0: serve load;
  Else if Battery SOC < Max: Charge Battery
- Only one possible output per input (not optimal)
- Very fast



Optimization:

- Define boundaries for each variable
  0 <= PV output <= Cap * Irradiation * Eff
- Entire feasible region of possible output
- Define an objective function
  Total Cost = DER Inv. Cost + DER Op. Cost + Util. Cost
- Find the solution in the feasible region that optimizes the objective
- Problems may become very large and take time to solve



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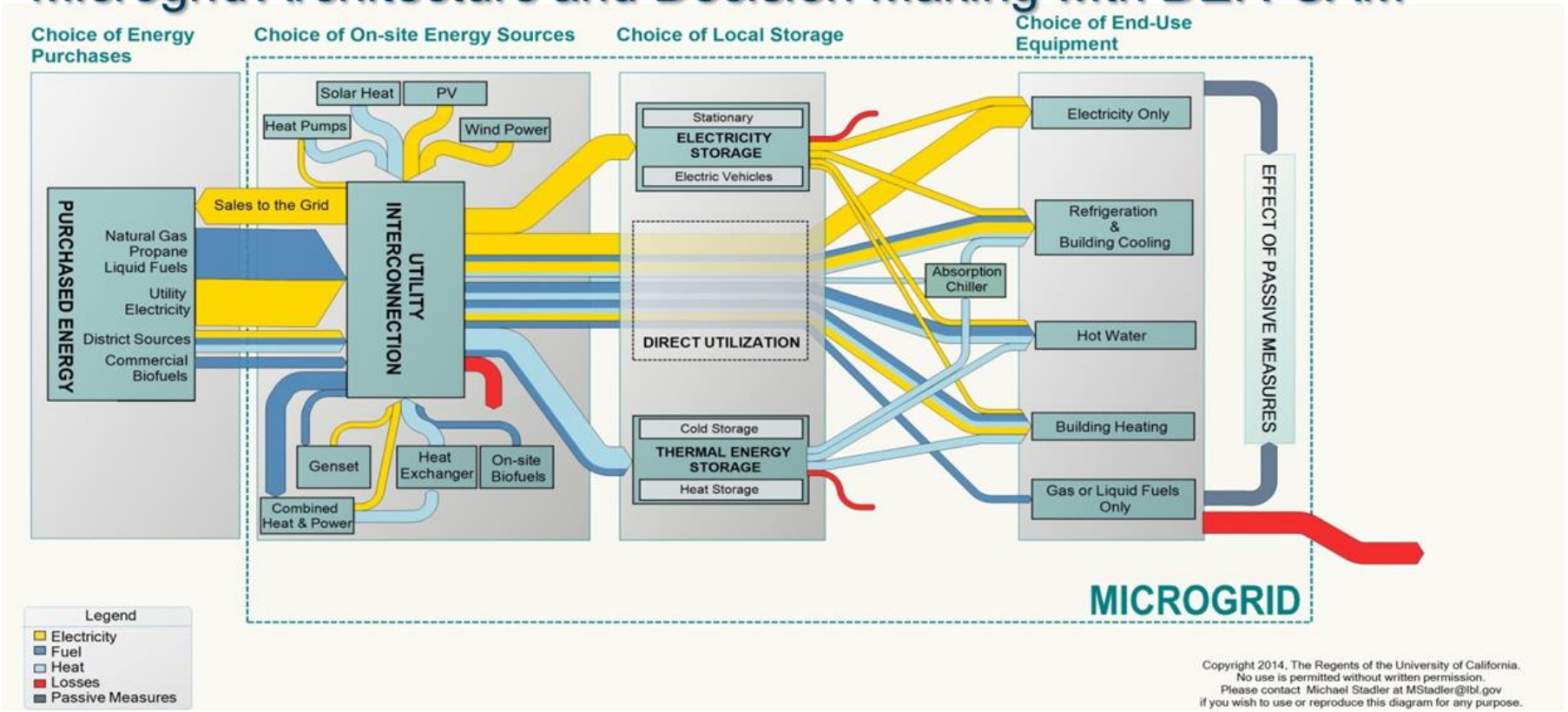
Microgrid Architecture and Decision Making with DER-CAM



DER-CAM handles complex interactions between different technologies, tariffs, loads, technical constraints (e.g. max. charging rate of batteries), and economic constraints (e.g. max. payback periods)

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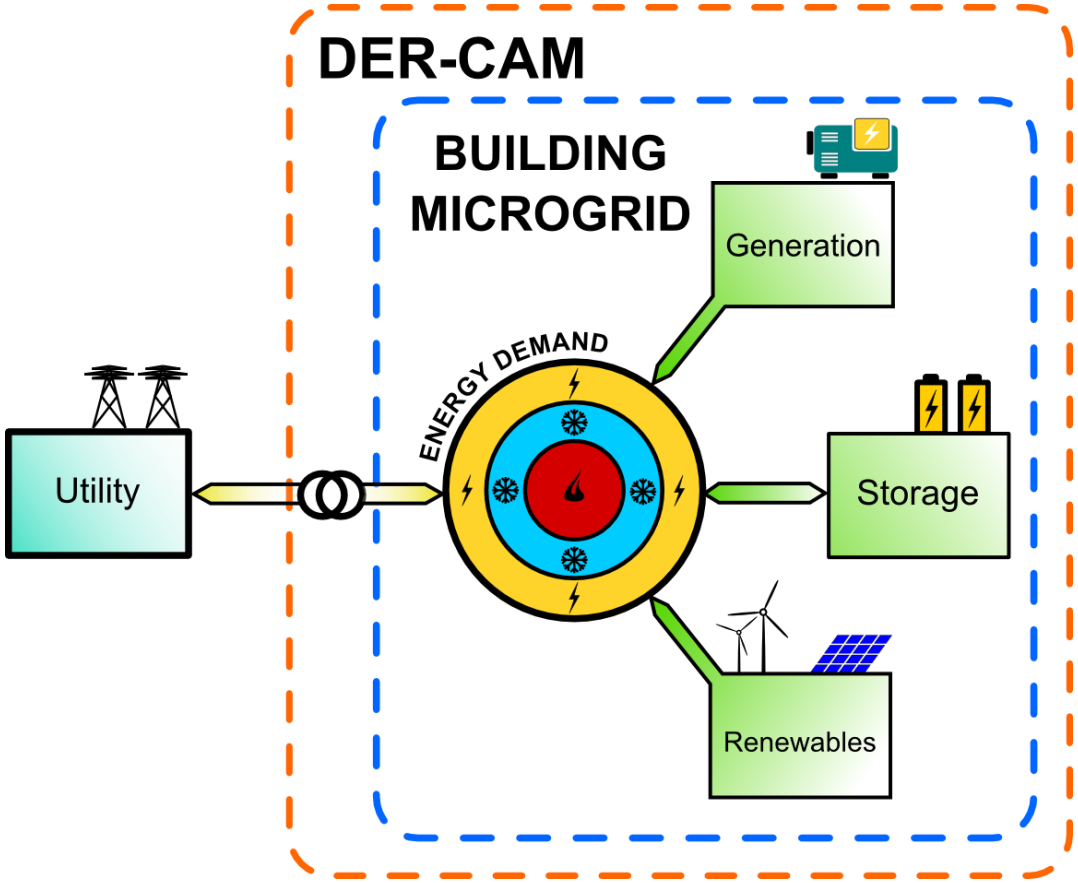

Main Features / Technologies

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)

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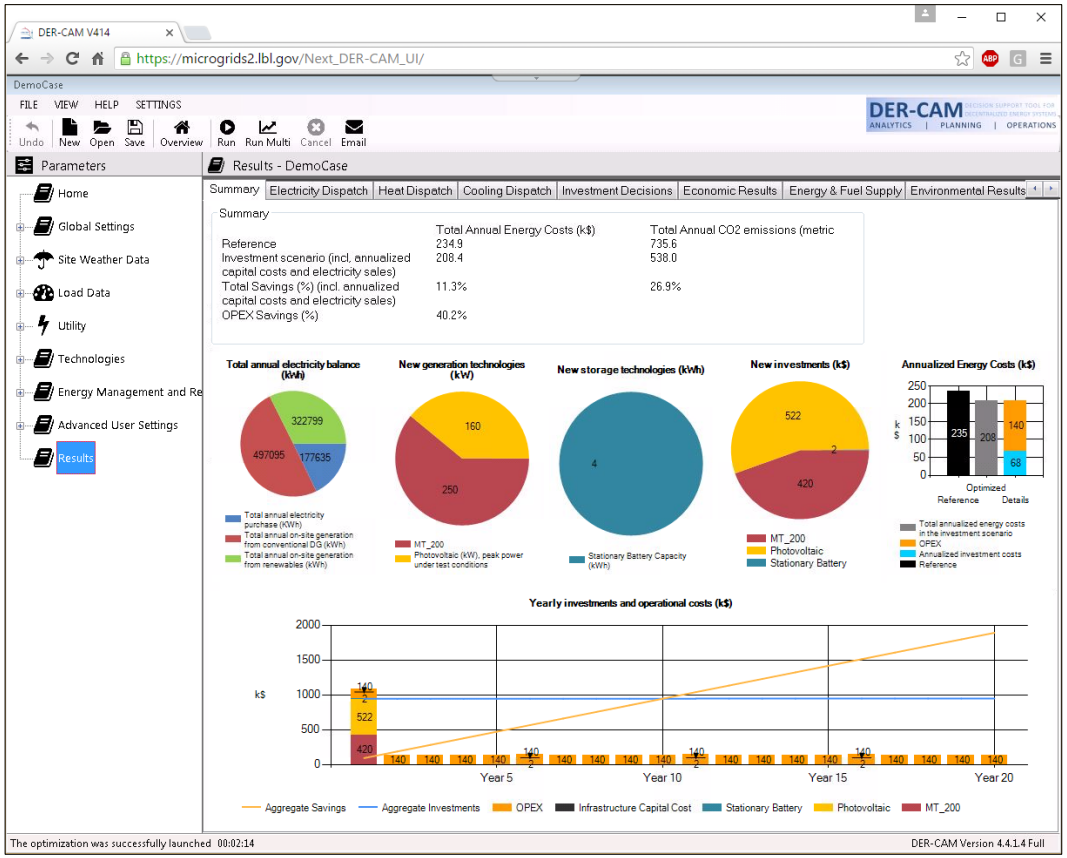
Graphical User Interface



Useful resources

- Load database
- Solar radiation database
- Tariff database
- Template DER data
- Graphical reports
- Investment timeline
- Hourly dispatch
- Breakdown of results

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

Roadmap

Recent developments

- Multiple location support (multi-node formulation)
- Electrical power and heat flow
- Fast cloud cover changes
- Ancillary services
- Tariff database

Work in progress

- Improved battery model
- Improved PV model
- …

EXAMPLE APPLICATION

Using ***Investment & Planning DER-CAM*** to assess microgrid DER considering prolonged outages

(DER-CAM v4.1.4; GUI v1.5.0)

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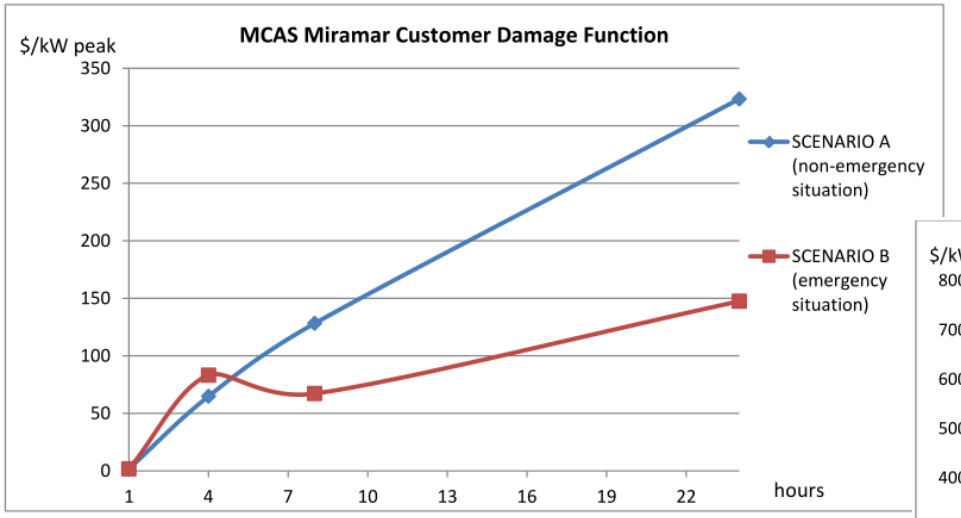
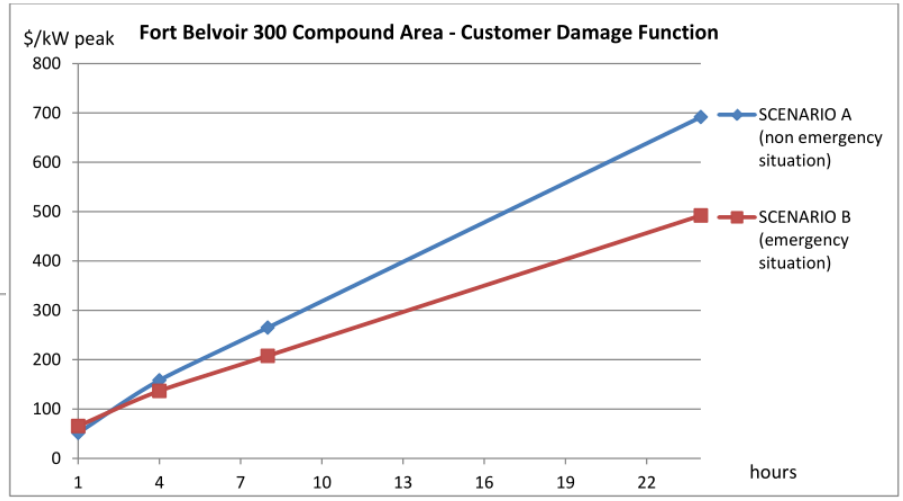
Establishing Value of Lost Load (VoLL) / Customer Damage Function (CDF)

VoLL / CDF used to estimate outage costs as a function of the outage duration.

*Outage Cost ~ Outage Duration * $/kW peak * Demand*





Source:
Valuing Energy Security: Customer Damage Function Methodology and Case Studies at DoD Installations, NREL

Example Large Office Building in Baltimore, Maryland

Procedure:

1) Simple Reference Case

2) Outage Reference Case
- 2 day blackout in August
- 25% Critical load (high priority); 50$/kW
- 75% Non-critical load:
  - 50% medium priority; 15$/kW
  - 25% low priority; 3$/kW

3) Resiliency Investment Case
- PV and Storage options

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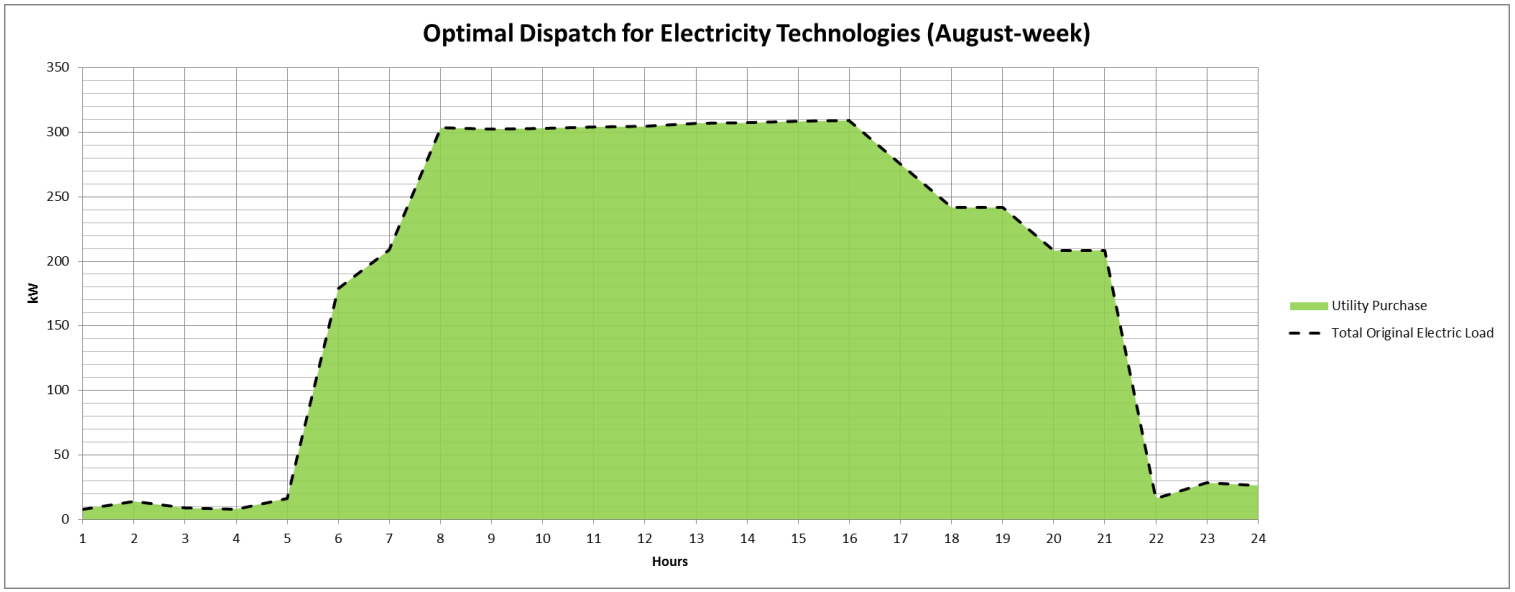
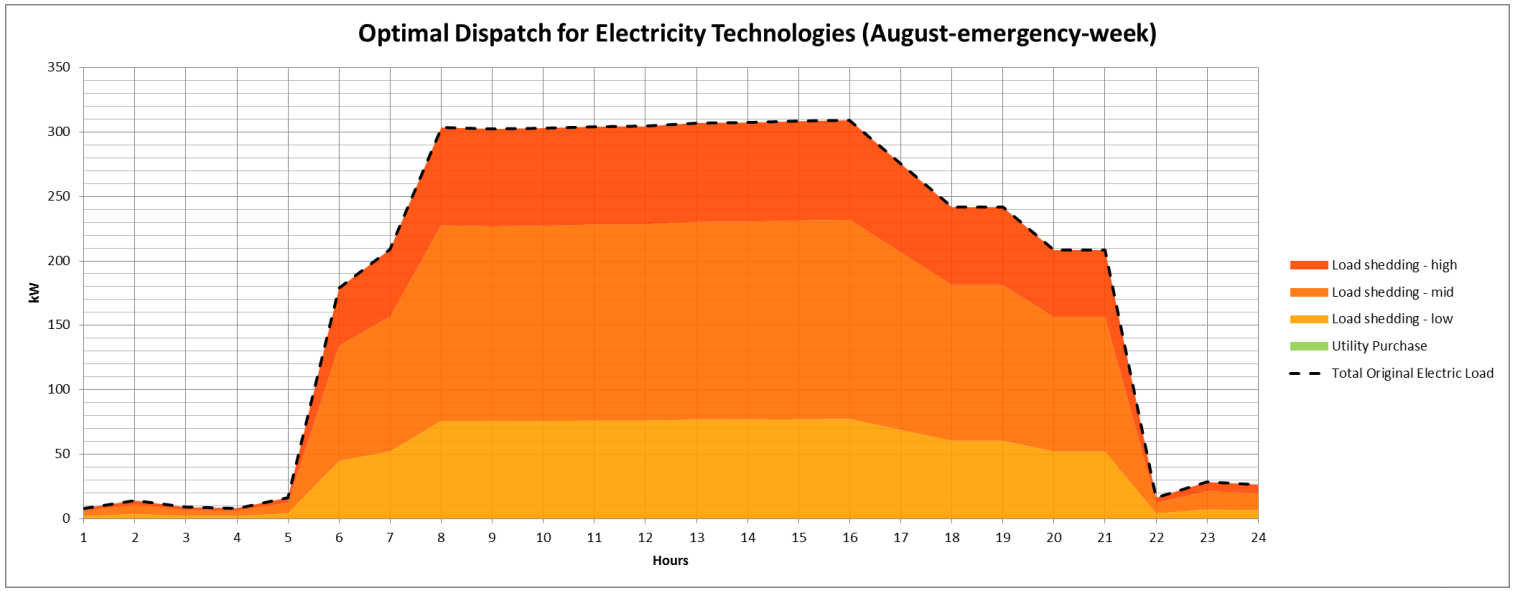
SCENARIO 1 Simple Reference Case

- Large Office Building in Baltimore, Maryland
- Annual energy costs ~ US$ 123k
- All needs are met by utility purchase



SCENARIO 2 *Outage* Reference Case

- Large Office Building in Baltimore, Maryland
- Annual energy costs ~ US$ 307k
- All load is curtailed



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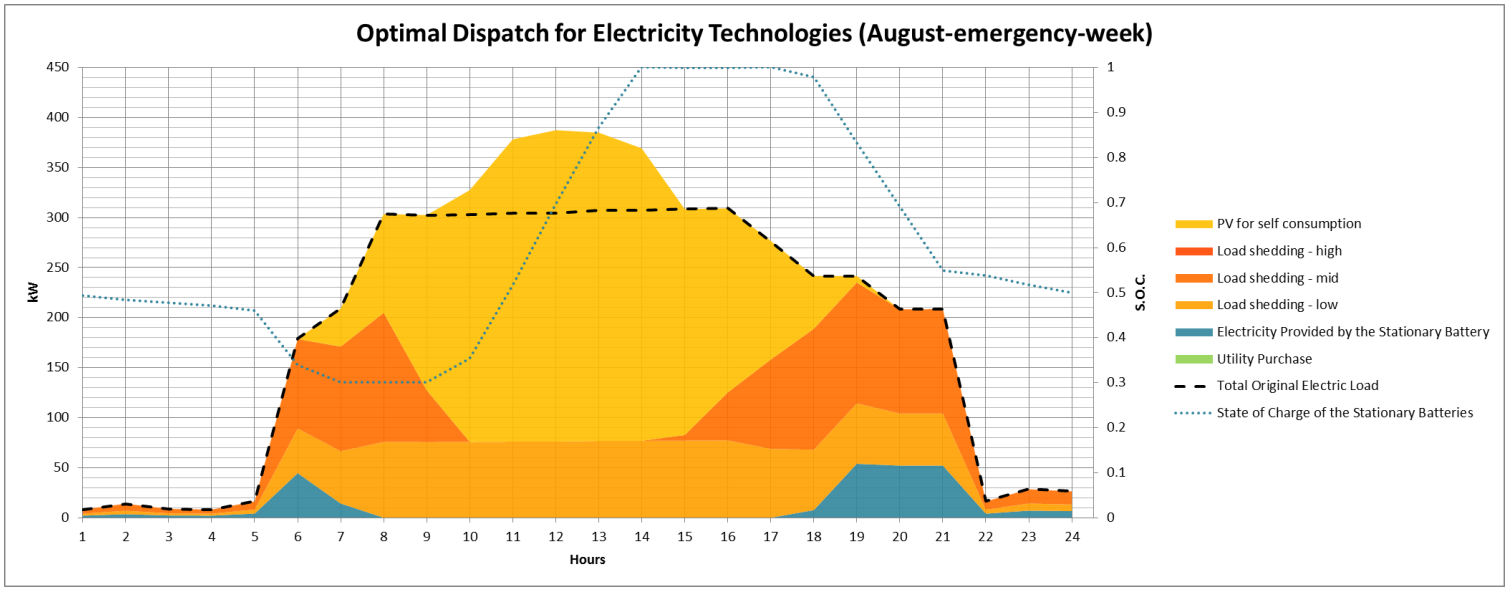
SCENARIO 3 Investment Case considering Outages

~400 kW PV
~400 kWh Battery

- Large Office Building in Baltimore, Maryland
- Annual energy costs ~ US$ 196k
- Some load is still curtailed in the event of a prolonged outage



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Questions?
Feedback?