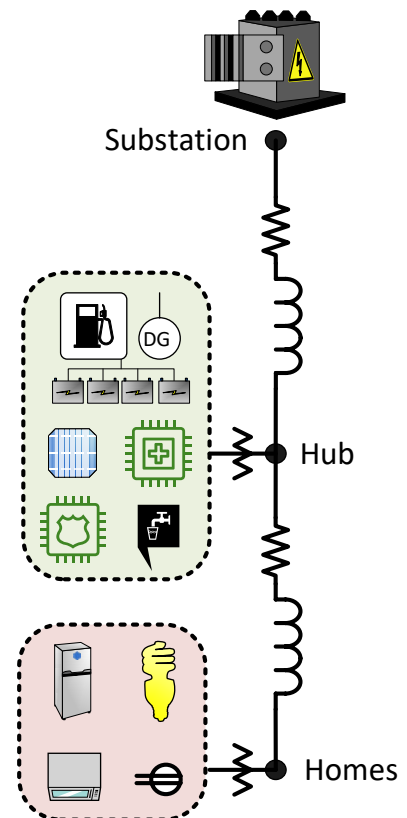
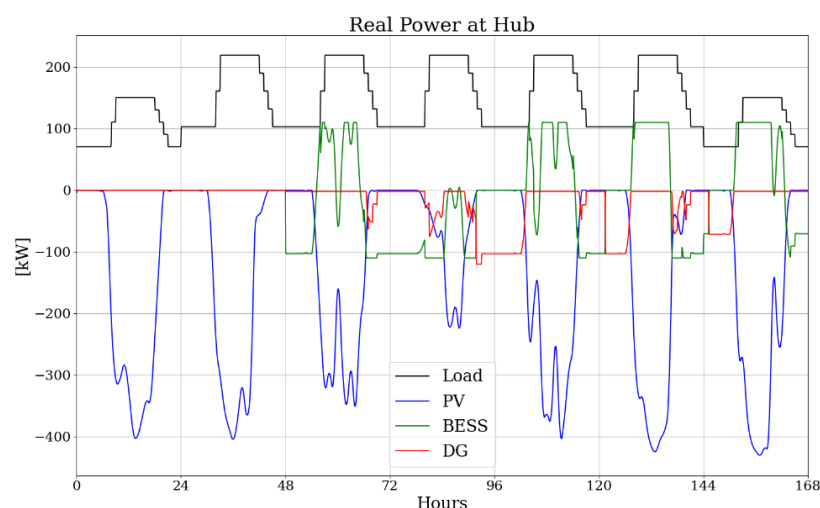


**Socio-Grid Co-simulation (SOCO) Example:** This example uses GridLAB-D, HELICS, and a new SOCO Python agent to simulate blue-sky conditions and a black-sky event. It simulates seven days in August, using typical weather data and end-use load profiles, with realistic impedances that could be estimated from maps, field visits, billing data, interviews, etc. The five black-sky cases represent a five-day loss of utility service. In the baseline, a diesel generator (DG) serves the hub load and essential home loads, e.g., refrigeration, if residents will curtail other loads. A larger PV helps with decarbonization and local environmental goals. The battery energy storage system (BESS) has a small effect on DPM, by reducing overall losses. The smaller diesel case combines the BESS with extreme load reduction to reduce the DG energy to near zero.

Case	Homes [5-day kwh]	Hub Energy [7-day kwh]	PV Energy [% of hub]	DPM [lbs]	DG Cost [\$]
Blue Sky, 50 kW PV	174626	23877	9.2%	0	\$ -
Baseline	33015	23877	9.2%	8124	\$ 18,380
No Home Refrig.	2924	23877	9.2%	3757	\$ 8,500
500 kW PV	33015	23877	91.8%	5354	\$ 12,114
Add 24-Hour BESS	33015	23877	91.8%	5198	\$ 11,761
Smaller Diesel	2924	23877	91.8%	624	\$ 1,411



The plot shows that a large BESS can serve the hub load at hour 48 (midnight), but not at hour 96 because PV output couldn't recharge the BESS on days 3 and 4. The BESS charge recovers by hour 168. Granular load modeling supports ties to other infrastructure layers and many more equity metrics. The Python agent handles load prioritization, behavior, and resource dispatch.

SOCO applies to design of a single resilience hub. The Sandia/NREL tool called ReNCAL applies to optimization of a cluster of hubs, e.g., 22 hubs for New Orleans to 80 hubs for Puerto Rico (<https://www.osti.gov/servlets/purl/1880920>). SOCO details the “zero-distance effort” term in (4) of <https://doi.org/10.2172/1846088>, and offers customization of the social burden calculation. As a possible extension to SOCO, the “pairwise efforts” of ReNCAL are simpler to evaluate for one hub per community.