The selected use case involves economic, power, energy, voltage and control actuation metrics. Overloads, outages and frequency deviations won’t occur in the use case as defined, but those teams exploring microgrid extensions may propose supplemental metrics in those areas. General and specific requirements for the base metrics are listed below; the PNNL Transactive Energy Simulation Platform satisfies all of them.

General requirements:

* Saved in a text format, JSON (preferred) or CSV
* Adjustable metrics interval, defaulting to 1 minute
* If the simulation time step is shorter than the metrics interval, include minimum, maximum and average values within each metrics interval. Integrated metrics (e.g. energy) are an exception
* Option to save all power flow data to CSV files, by manually inserting recorder statements in the GridLAB-D input file
* Able to separate solar, battery and load metrics at the same meter
* No time aggregation, as the use case covers a single day of operation
* Each metric should be associated to specific model components through metadata

Specific requirements for base metrics to include in the output:

1. Economic
   1. Wholesale price (defaults to the input LMP player file)
   2. Cleared price on the feeder
   3. Price, quantity, and status (accepted, not accepted) for each bid
   4. Revenue at each meter, separable by load and resource, see 4.e.m below
2. Substation
   1. Real and reactive power
   2. Real and reactive energy
   3. Real and reactive losses
3. At each feeder capacitor bank and voltage regulator
   1. Count of control actuations
4. At each meter (i.e. house)
   1. Voltage magnitude, line-to-neutral, averaged over all phases
   2. Voltage magnitude, line-to-line, averaged over all phases[[1]](#footnote-1)
   3. For three-phase loads only, line-to-line voltage unbalance as defined in ANSI C84.1: [%]
   4. Severity index for the fluctuation in *Vavg* on per-unit basis at uniform time step. Similar to an L2 norm; . This metric has also been used to quantify fluctuations in solar irradiance. IEEE Std. 1453 is less applicable because cloud-induced fluctuations are generally too slow.
   5. Violations of ANSI C84.1 voltage limits at the meter. The duration of time in each range should be accumulated. An event count occurs when the voltage transitions from normal to A Range, or from A Range to B Range.
      1. Total duration and event counts below 110 V (B Range)
      2. Total duration and event counts below 114 V (A Range)
      3. Total duration and event counts above 126 V (A Range)
      4. Total duration and event counts above 127 V (B Range)
      5. Total duration and event counts below 10 V (Outage; none expected)
   6. Total house load (real power)
   7. Total HVAC load (real power)
   8. Total water heater load (real power)
   9. Solar inverter real and reactive power
   10. Battery inverter real and reactive power
   11. House air temperature, and its deviation from scheduled set point
   12. Water heater temperature, and its deviation from scheduled set point
   13. Total bill, synchronized to the cleared market price[[2]](#footnote-2)

Additional metrics could be derived in post processing. One example is the “comfort metric” for thermostatically-controlled devices. There are several different comfort models, and they may also take account of building occupancy. GridLAB-D has an *occupancy\_fraction* that could be scheduled, but otherwise no occupancy model[[3]](#footnote-3). The time-dependent HVAC set point schedules might serve as a proxy for occupancy.

1. Because we’re using the balanced-secondary version of the IEEE 8500-node feeder, there won’t be any secondary voltage unbalance at single-phase loads. The normalized line-to-neutral and line-to-line voltage magnitudes will be equal. For such single-phase loads, *Vavg* should be defined on a 120-volt basis. [↑](#footnote-ref-1)
2. The 8500-node model as currently implemented assumes net metering, with DER disaggregation based on real power. An alternative would be to meter each DER separately from the house, so each could have its own tariff and bill. [↑](#footnote-ref-2)
3. EnergyPlus does have an occupancy model. [↑](#footnote-ref-3)