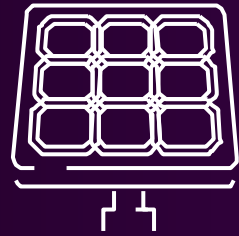


Tucson Electric Power Resource Aggregation and Integration Network Project RAIN

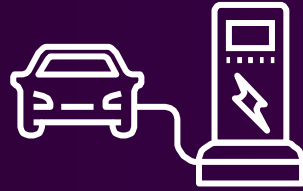
Director, Emerging Technology and Innovation
Tucson Electric Power



Five Different DER Technologies



PV System



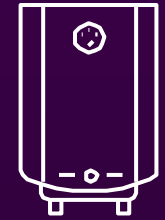
Electric
Vehicle
Charging



Battery



Thermostat

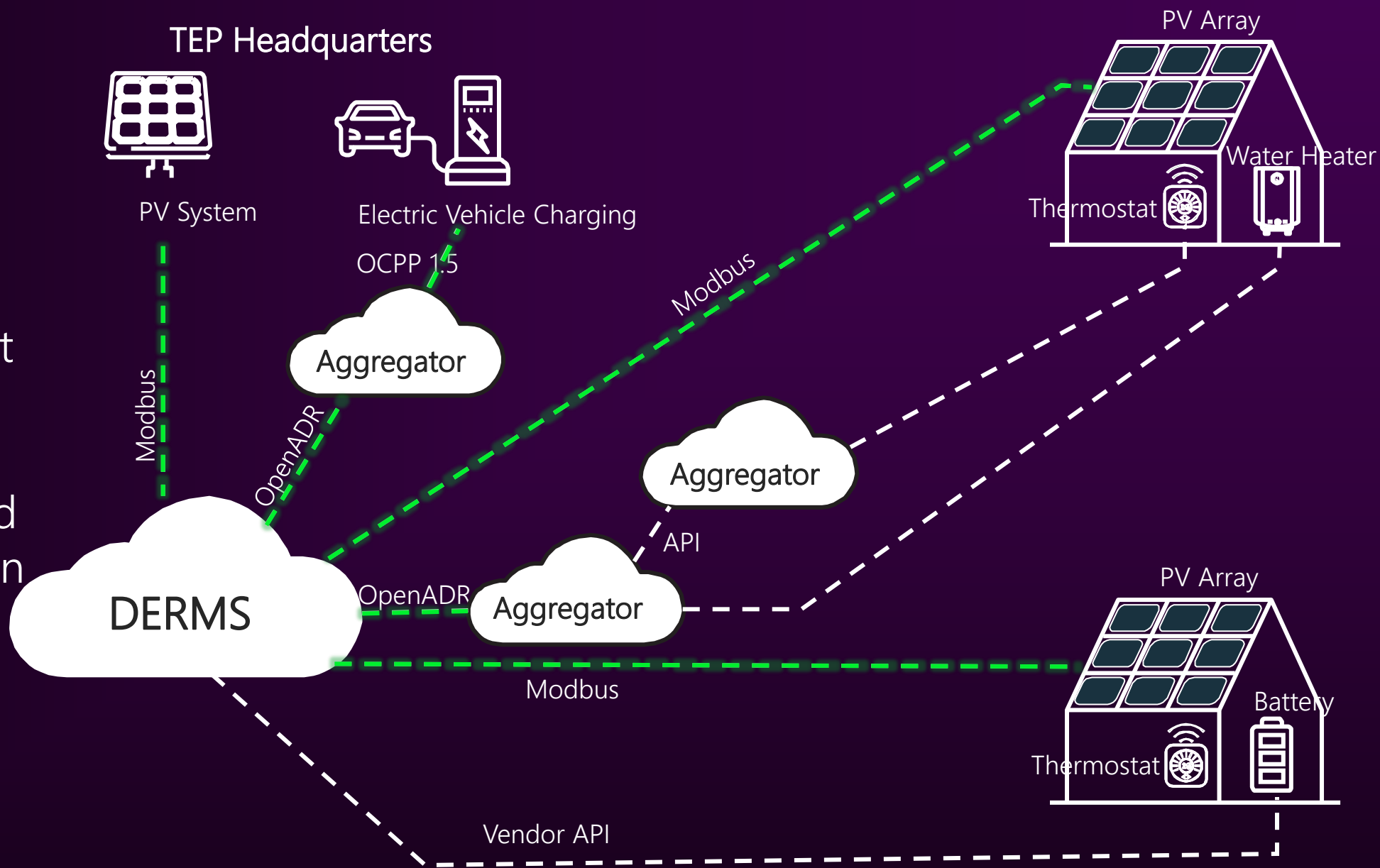


Water
Heater

Five Different
DER
Technologies

Three Different
Aggregators

Open Standard
Communication
Protocols

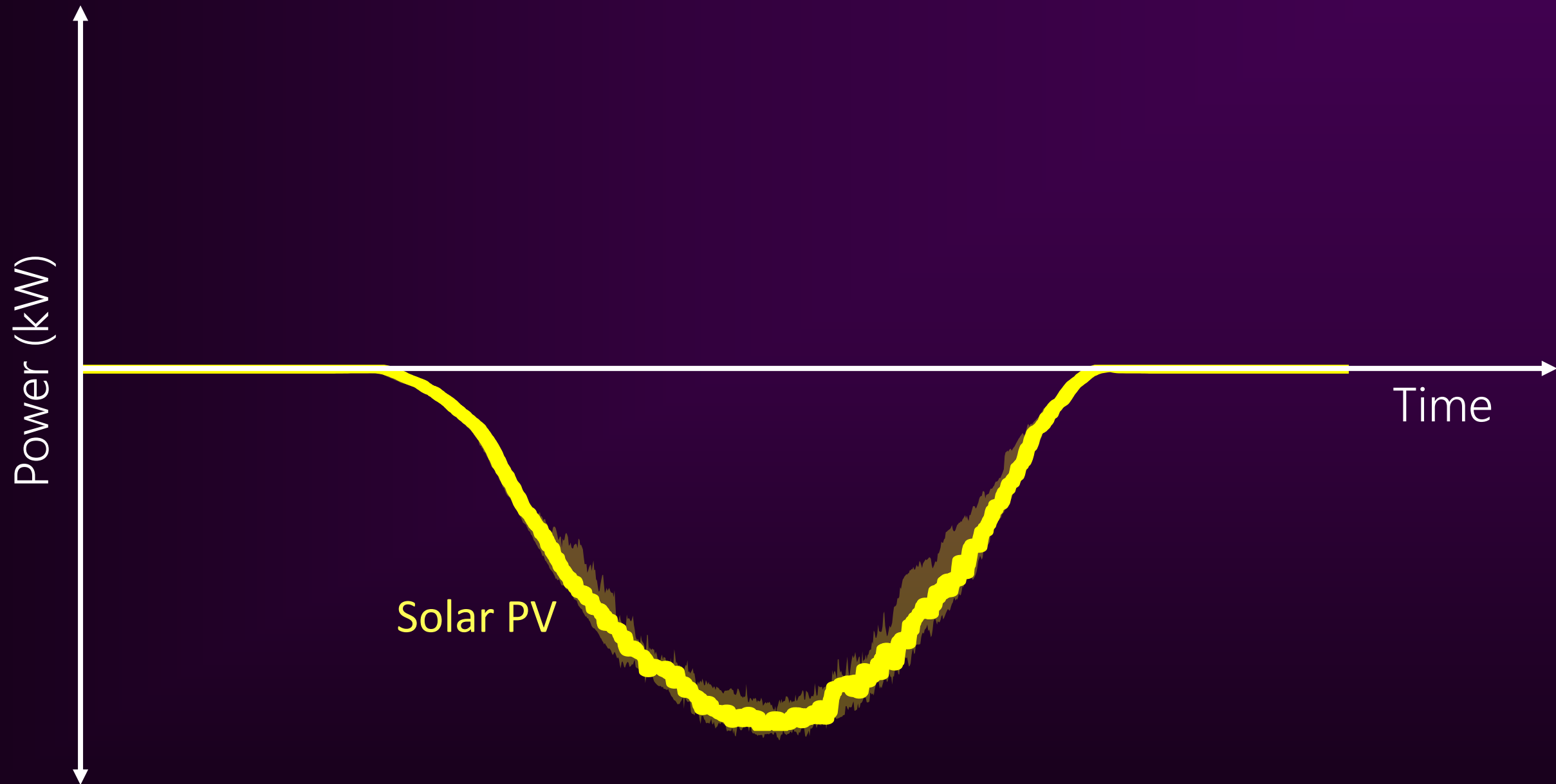


Normal Load and Generation Behavior

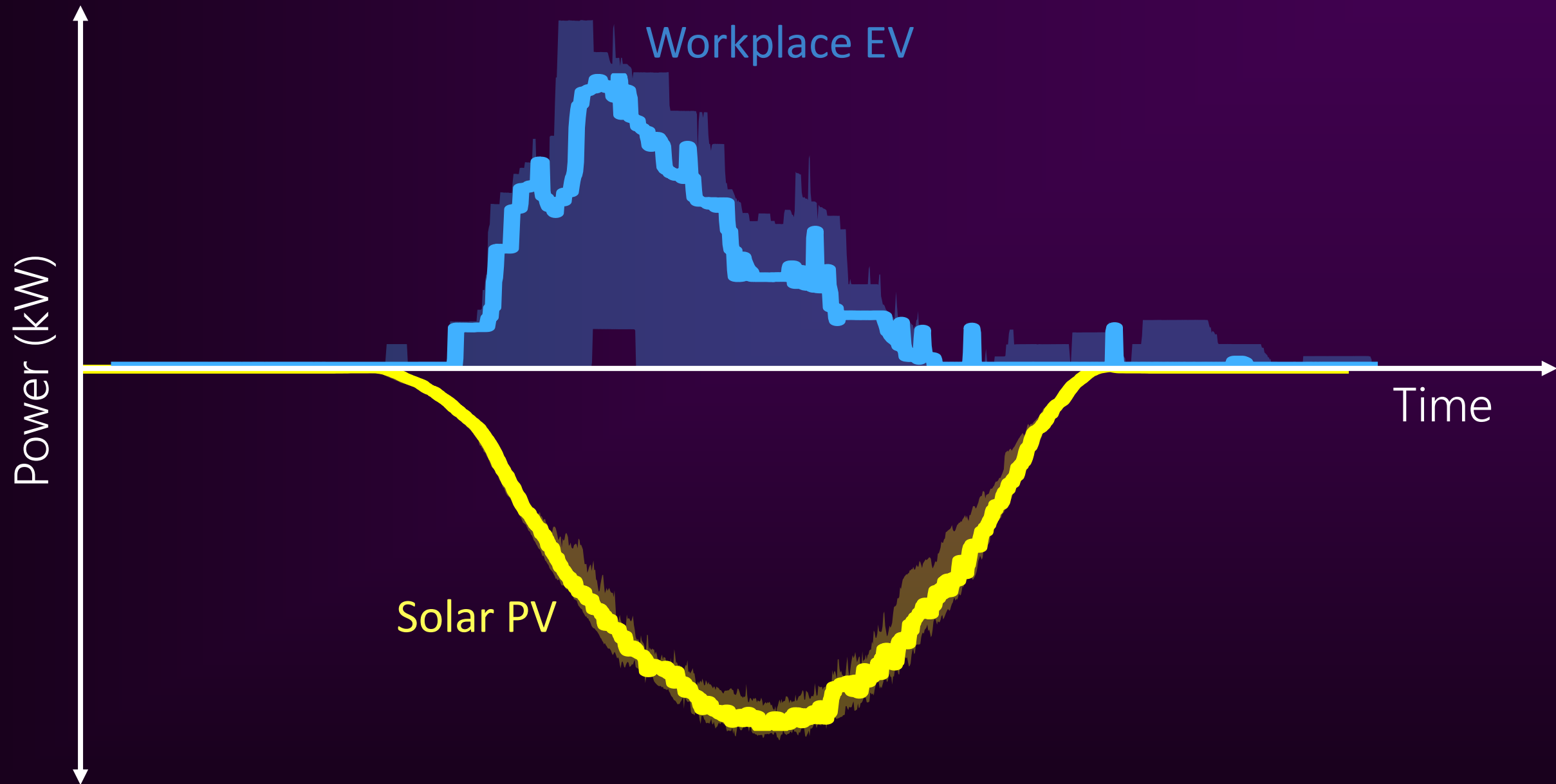
Normal Load and Generation Behavior



Normal Load and Generation Behavior



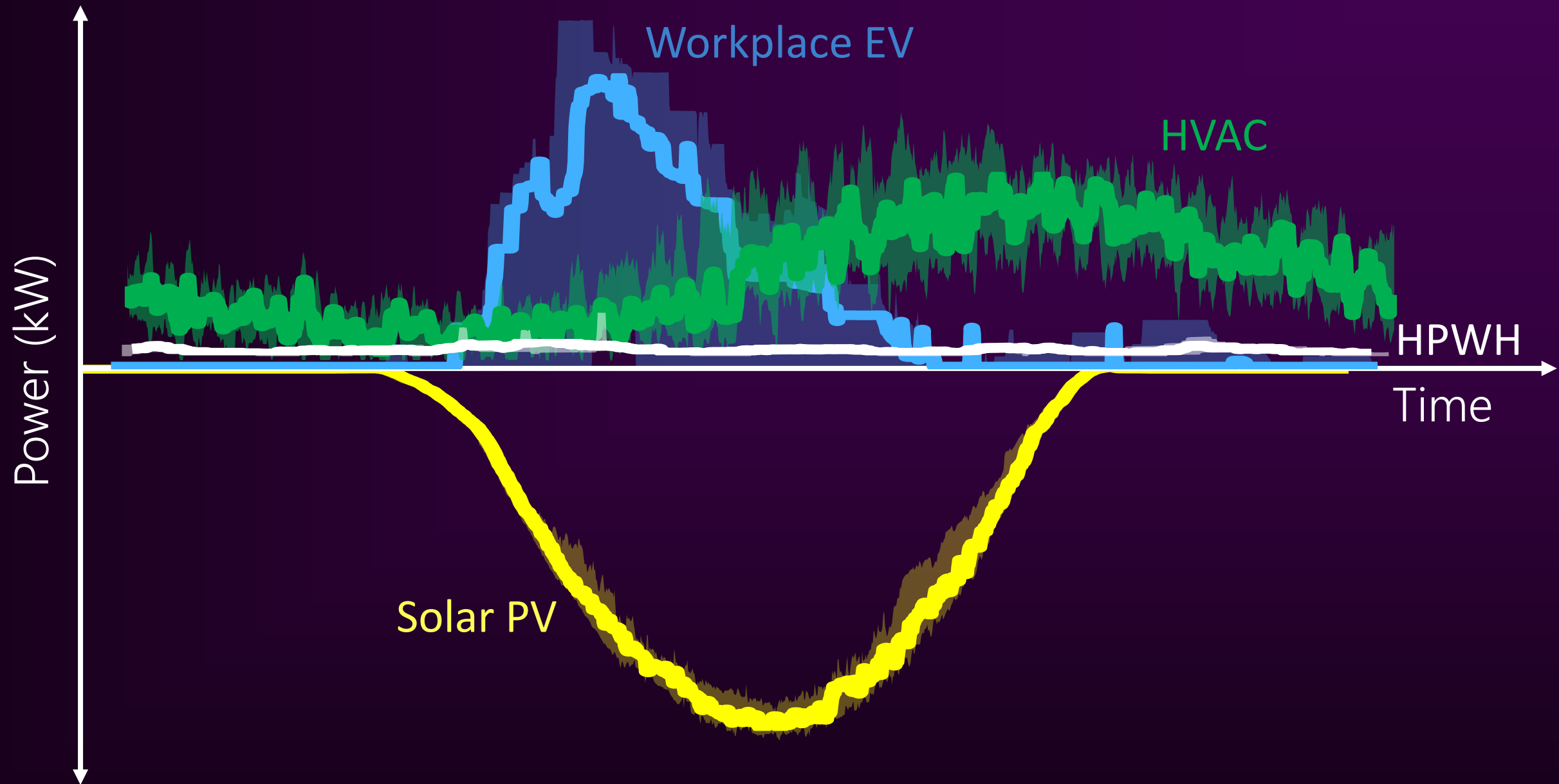
Normal Load and Generation Behavior



Normal Load and Generation Behavior

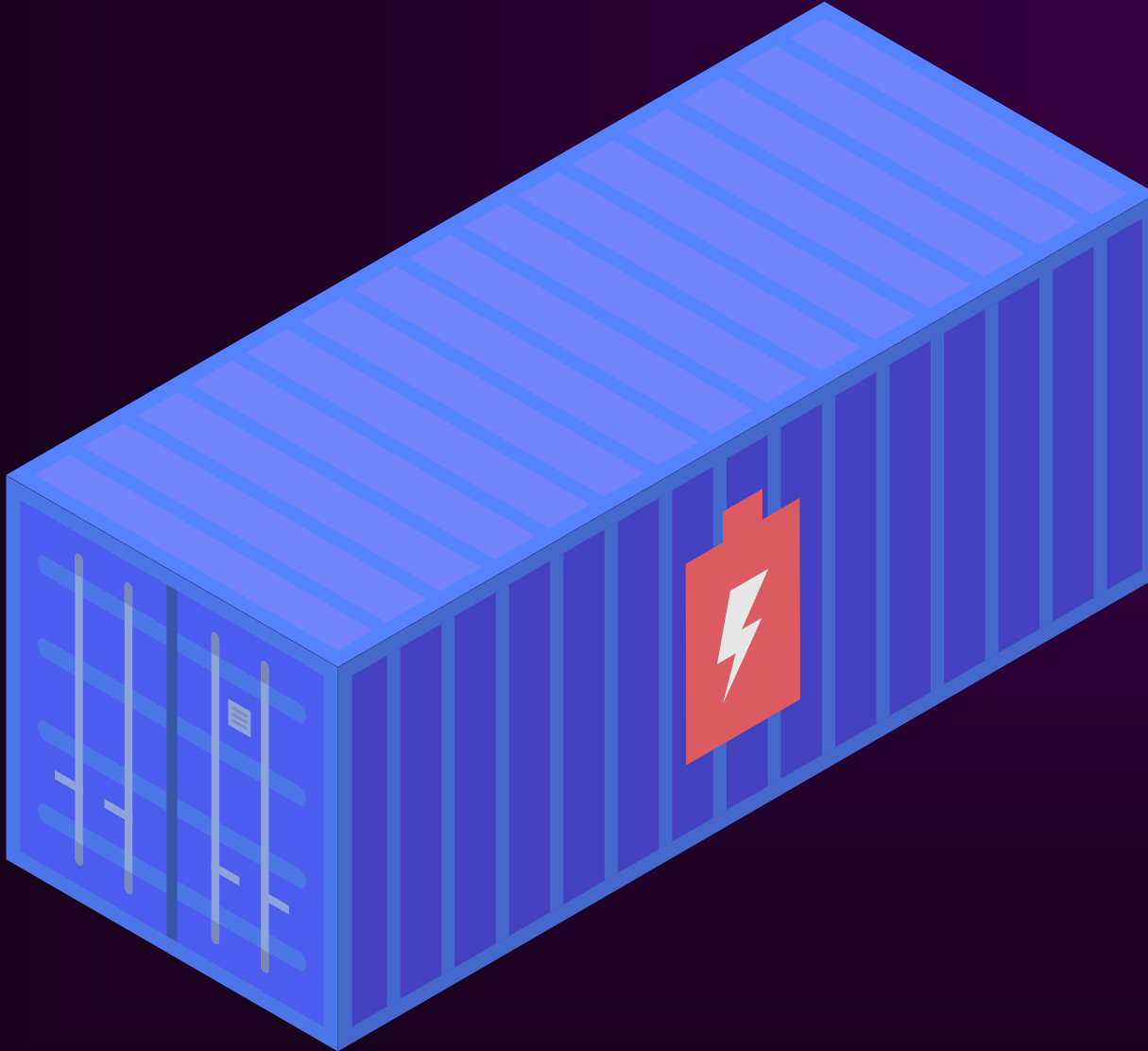


Normal Load and Generation Behavior



Device Characteristics

Battery Energy Storage System



Can be dispatched in either direction or any time

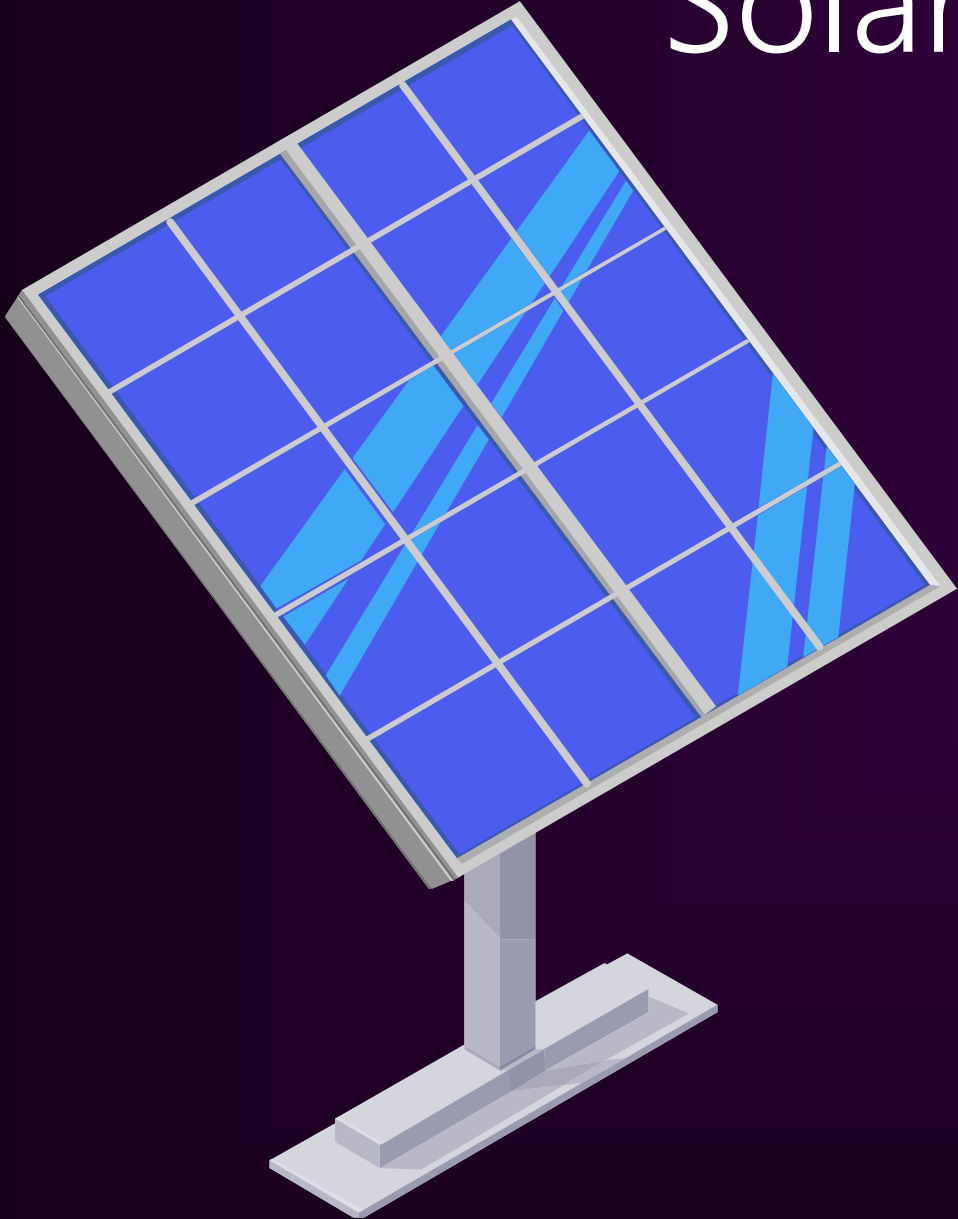


Minimal comfort impact



Must be aware of state of charge

Solar Photovoltaics



No comfort impact

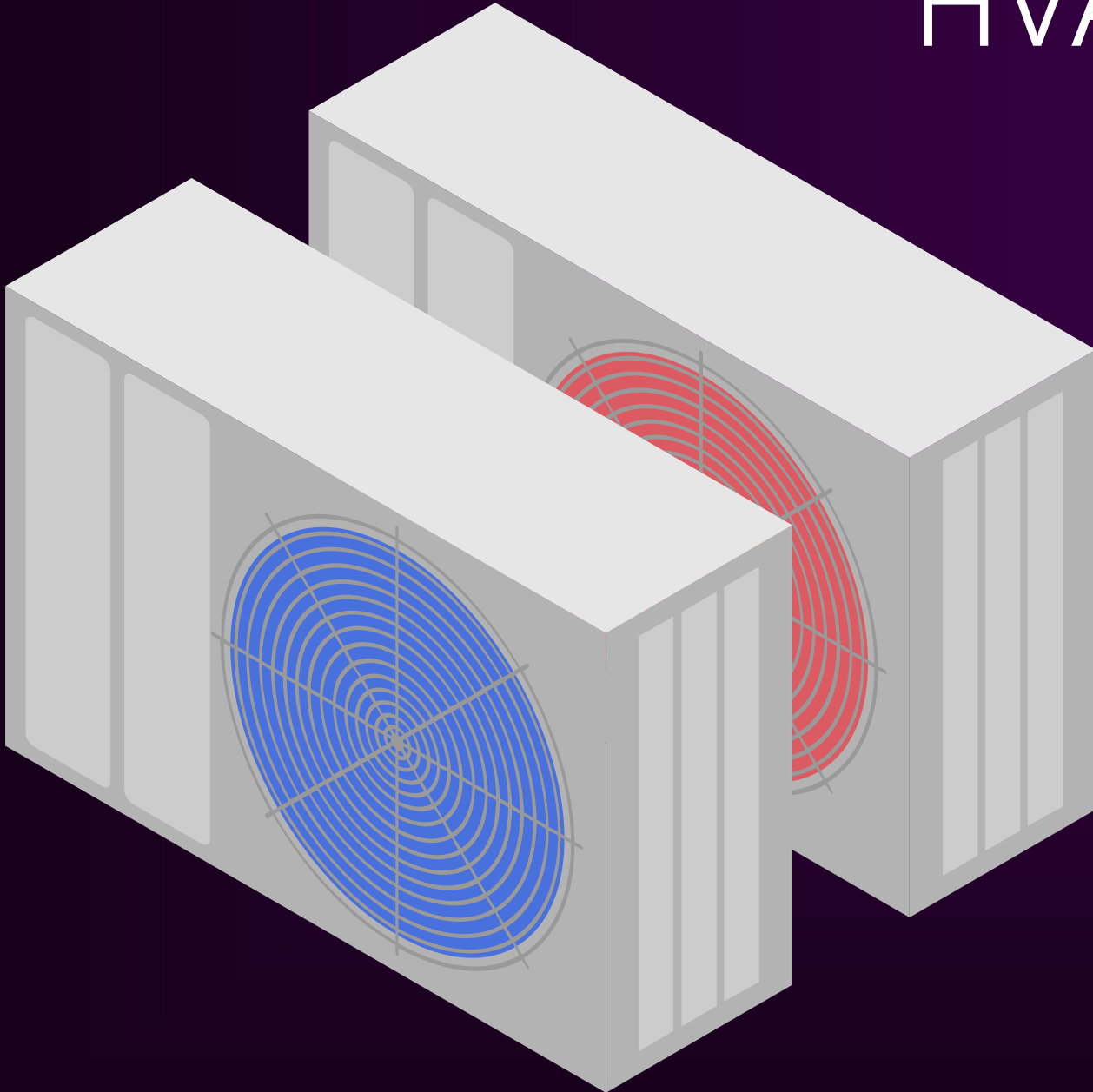


Can only curtail
(increasing load)



Peak does not
correlate with utility
peak

HVAC



40% of customer load on average



Peak HVAC correlates with peak utility load

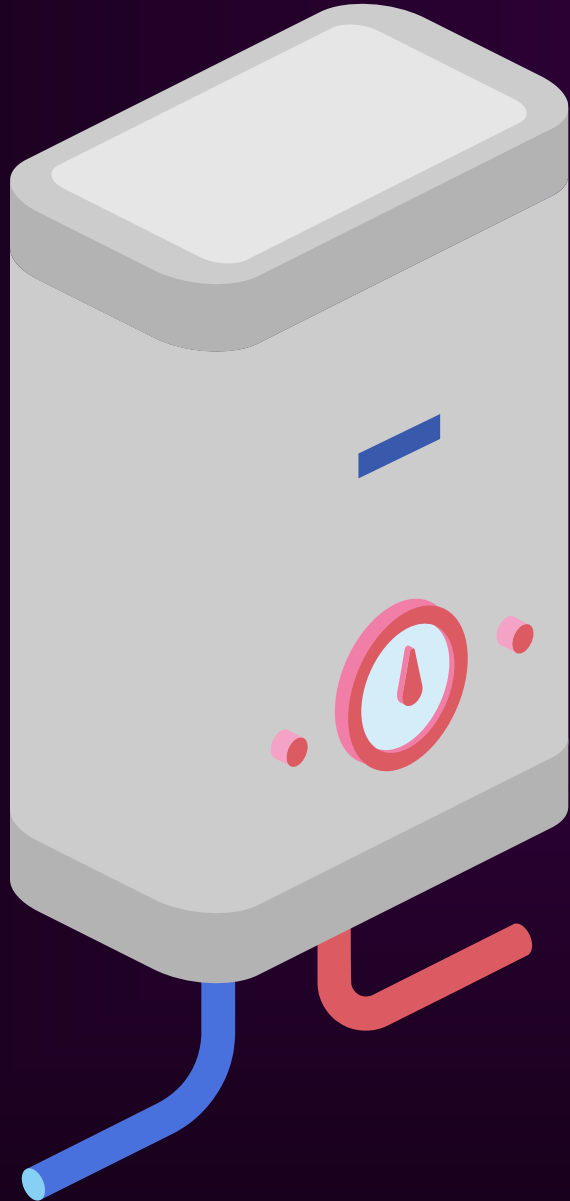


High customer impact



Impact fades as degree target reached

Heat Pump Water Heater



Minimal comfort
impact

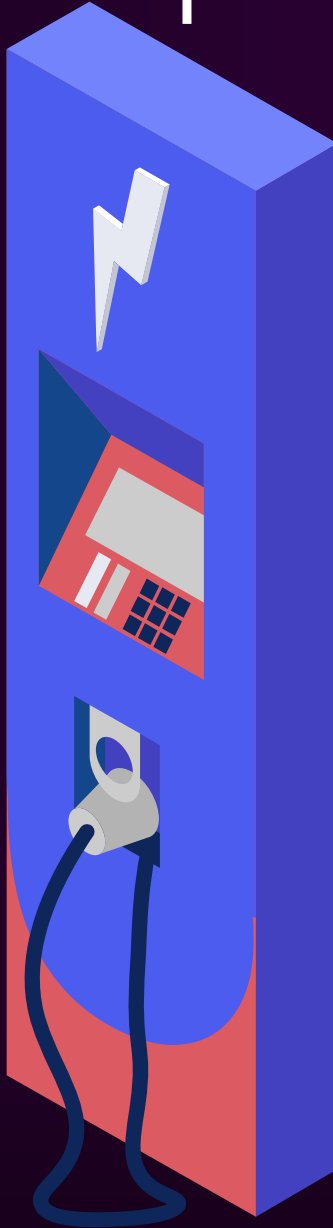


Unpredictable usage
pattern



2.5% of customer's
load on average

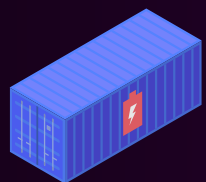
Workplace EV Charging Station



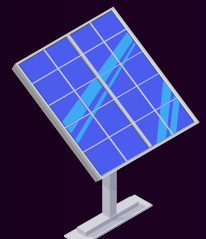
Use aligns well with
PV generation



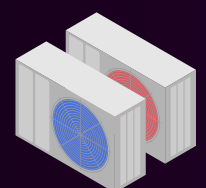
Not available to
reduce evening peak



BESS



PV



HVAC



Water
Heater



EV
Charger

Increase Load

Decrease Load

Load Up

Shed

Critical Shed

Grid Emergency

Charge at 60%

Discharge
30%

Discharge
60%

Discharge
100%

Curtail to 50%

Full 100% production

Lower setpoint 6°F

Relax
setpoint 3 °F

Relax
setpoint 6 °F

Turn off
HVAC

Max water temp

Maintain lower
water temp

Maintain min.
water temp

Turn off water
heater

Charge Normally

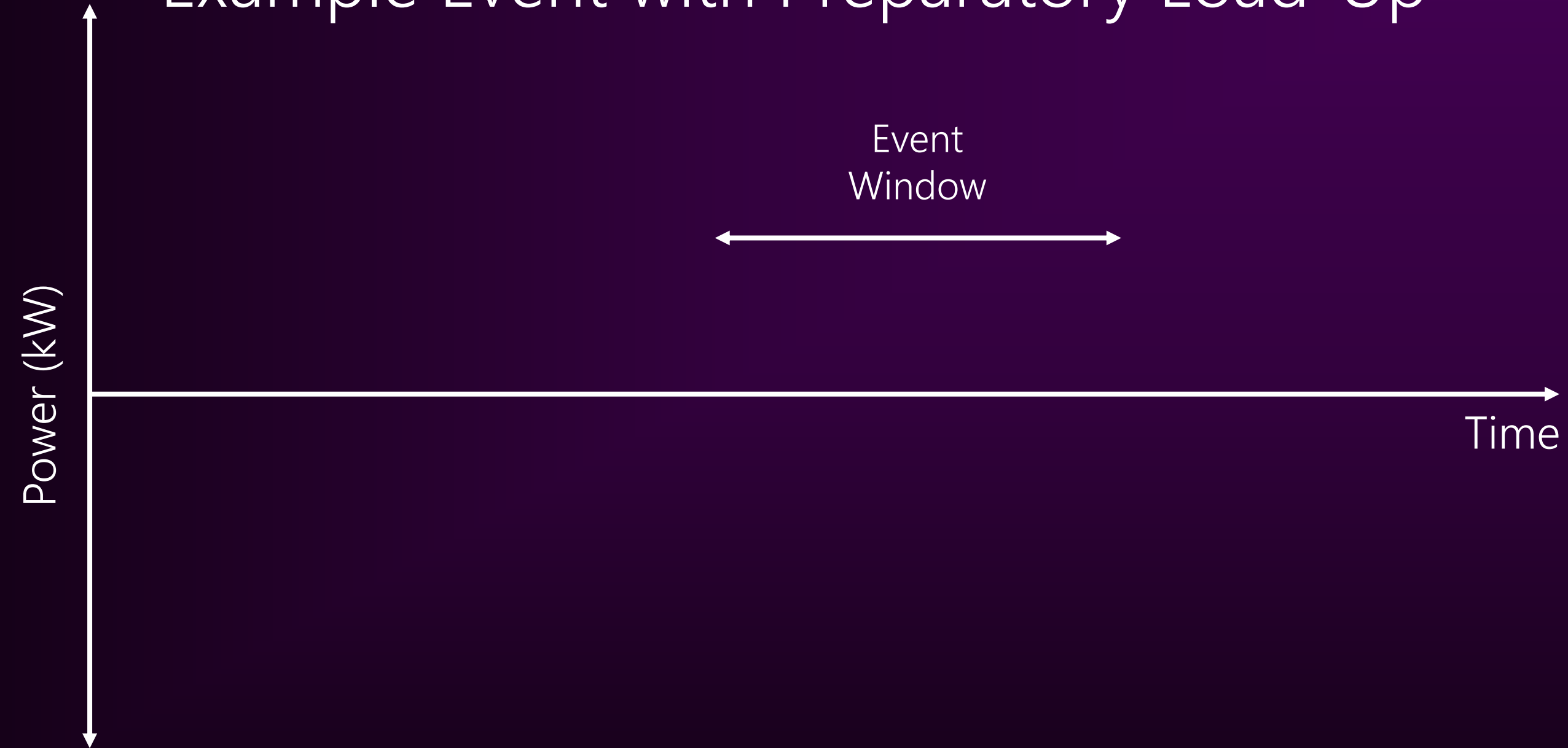
Limit
charge rate
to 60%

Limit
charge rate
to 30%

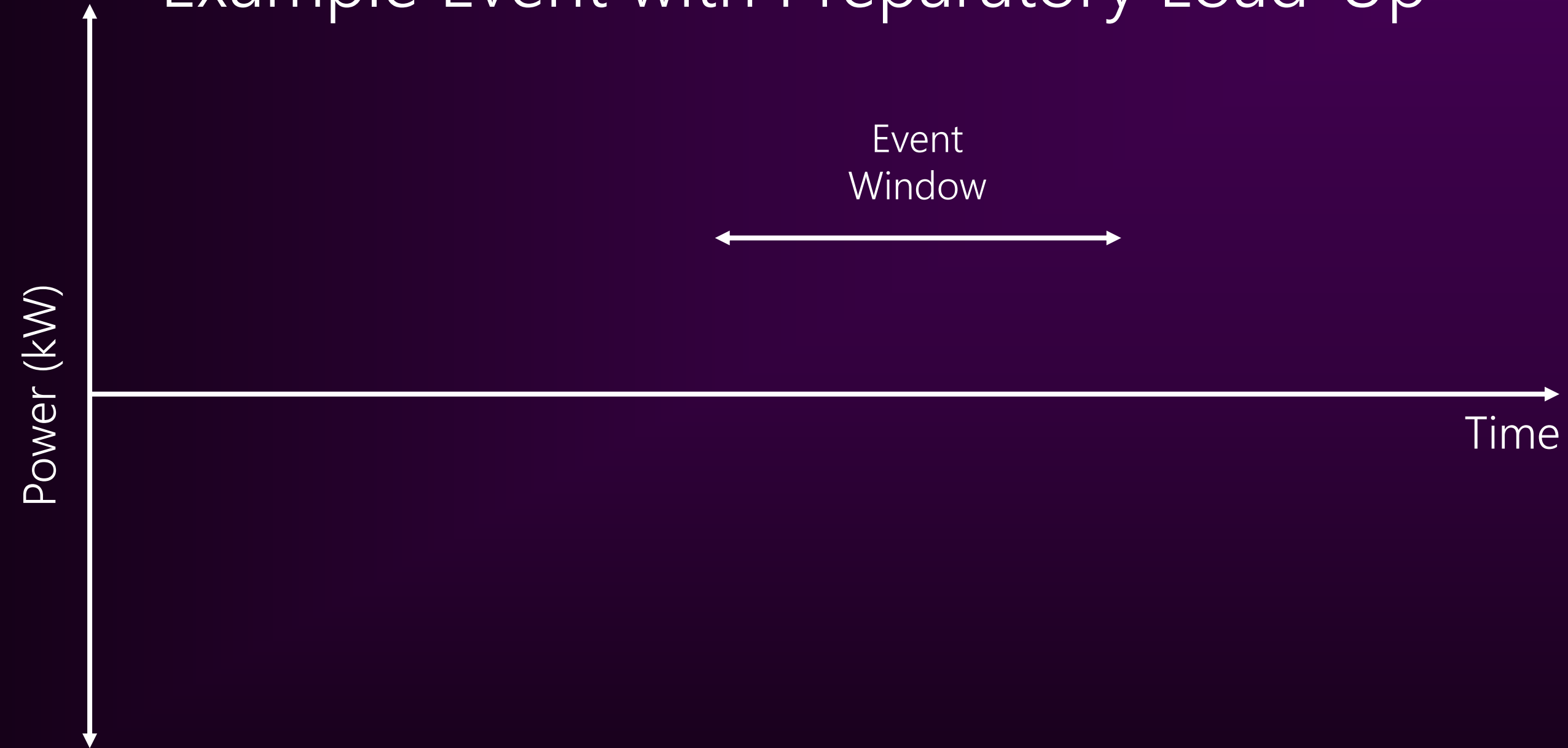
Stop
charging

Example Event with Preparatory Load-Up

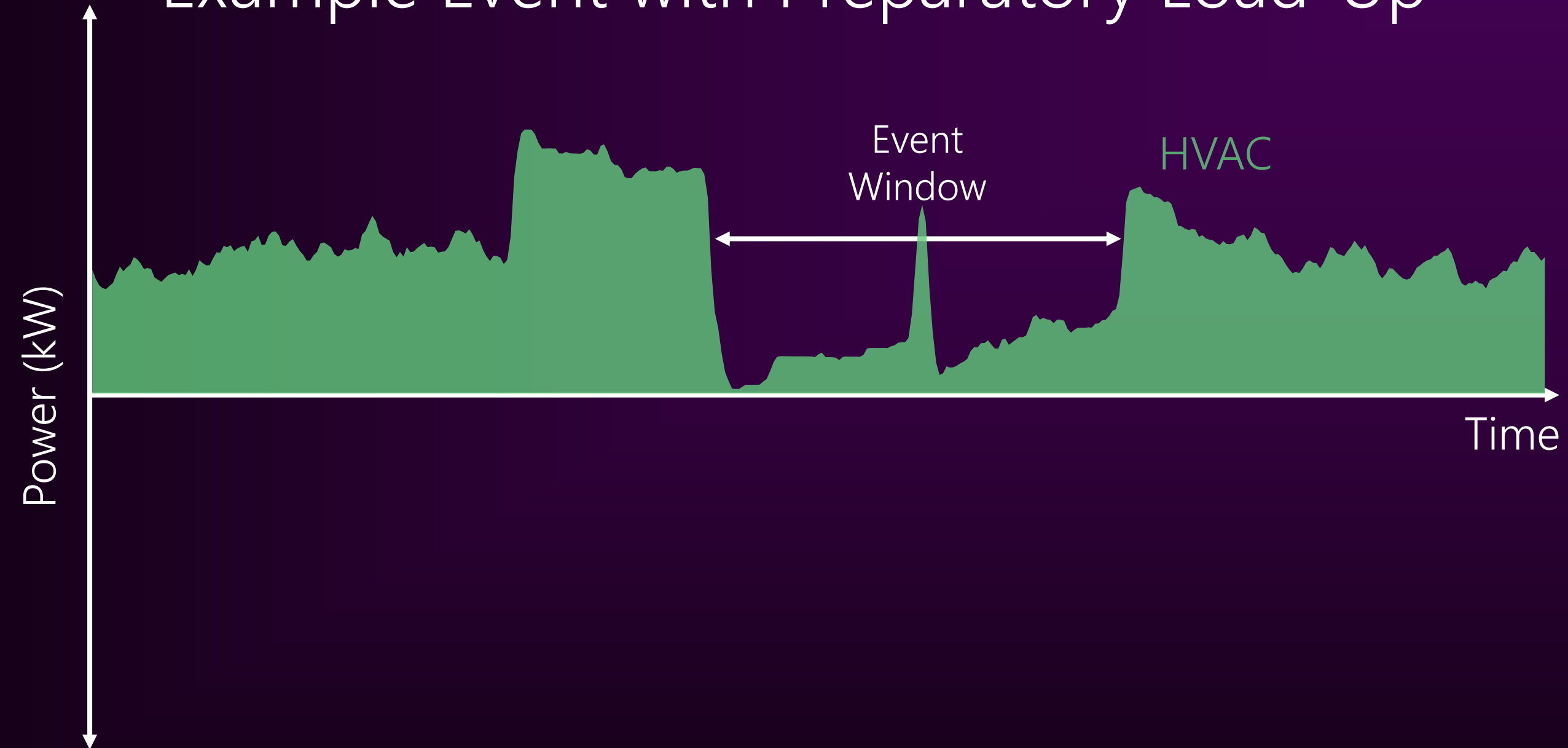
Example Event with Preparatory Load-Up



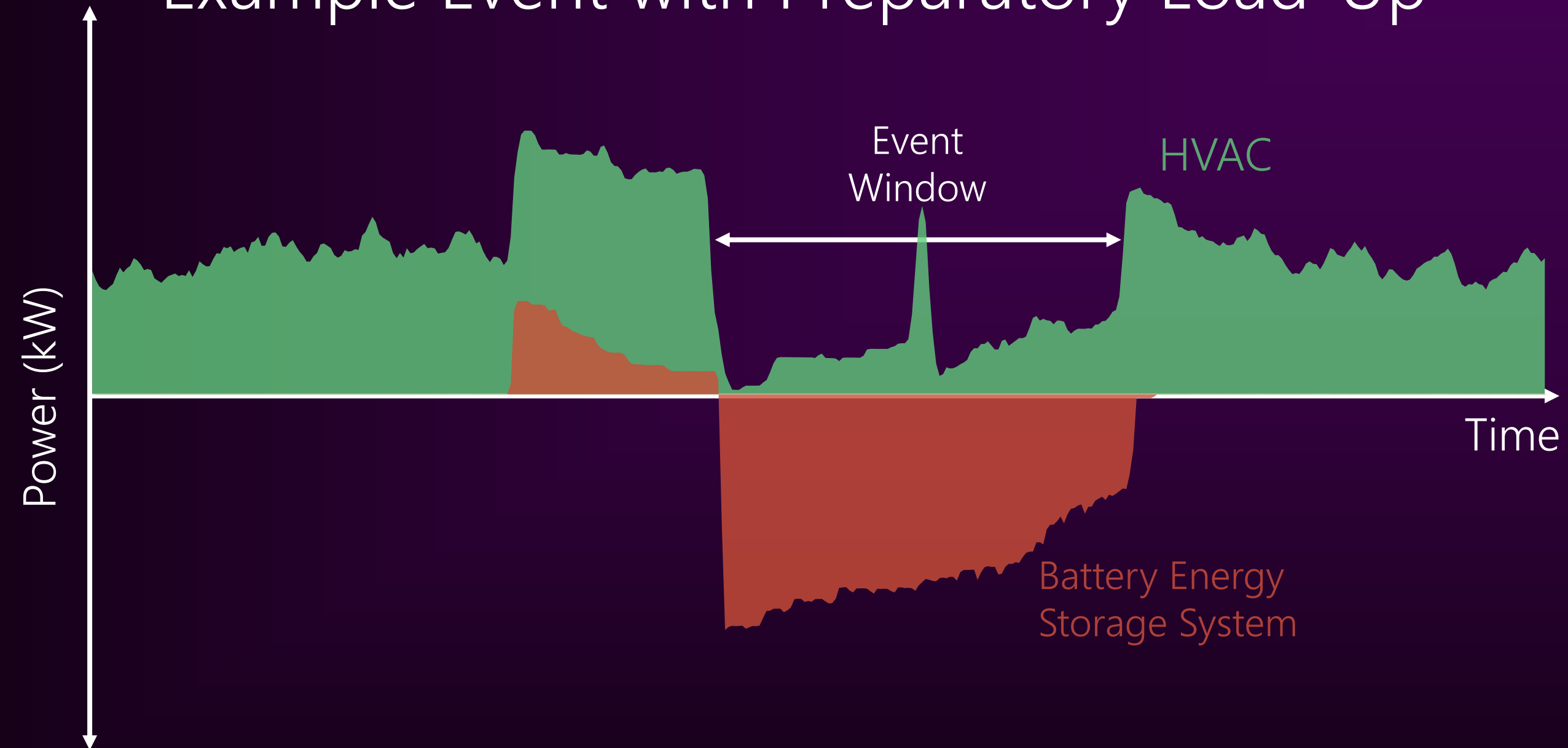
Example Event with Preparatory Load-Up



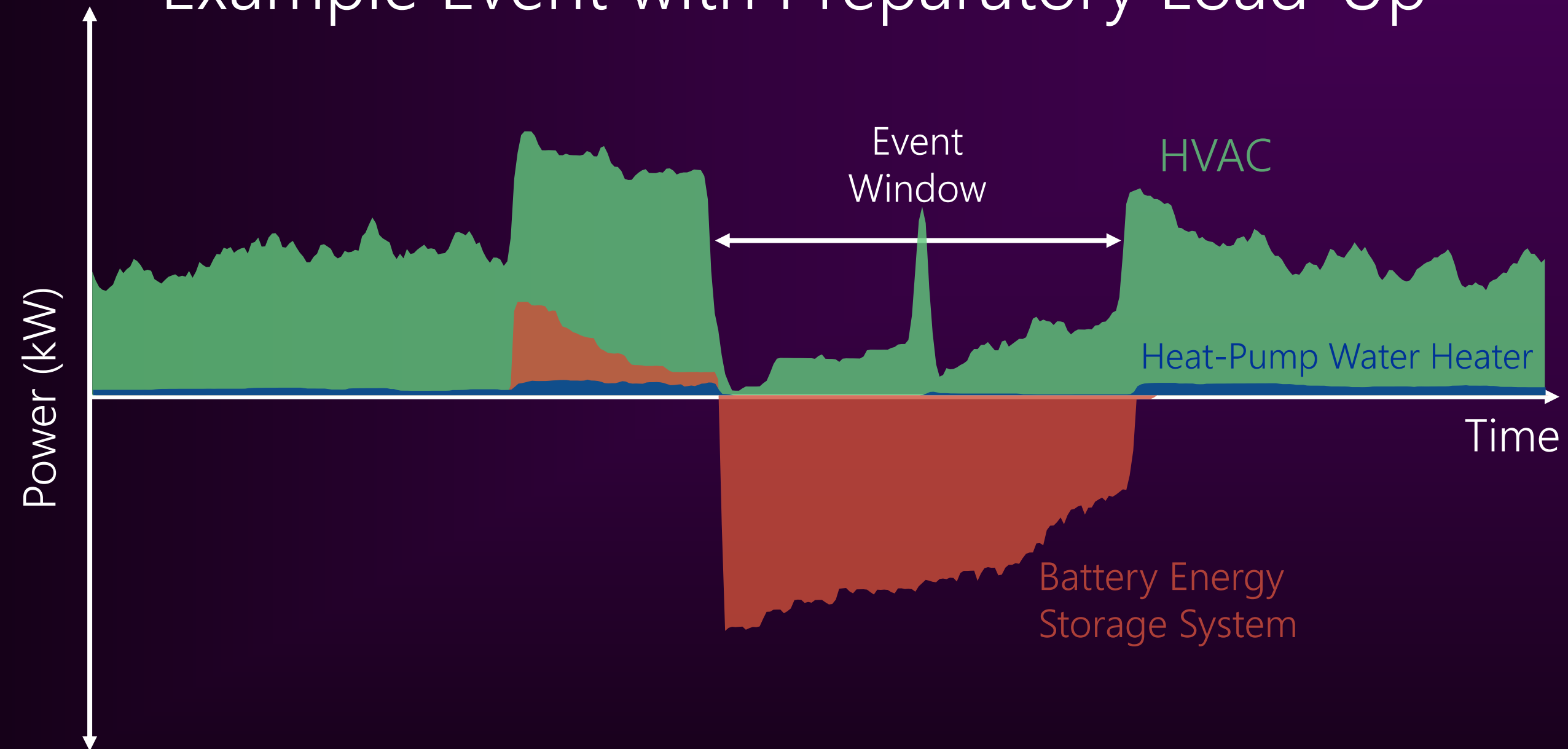
Example Event with Preparatory Load-Up



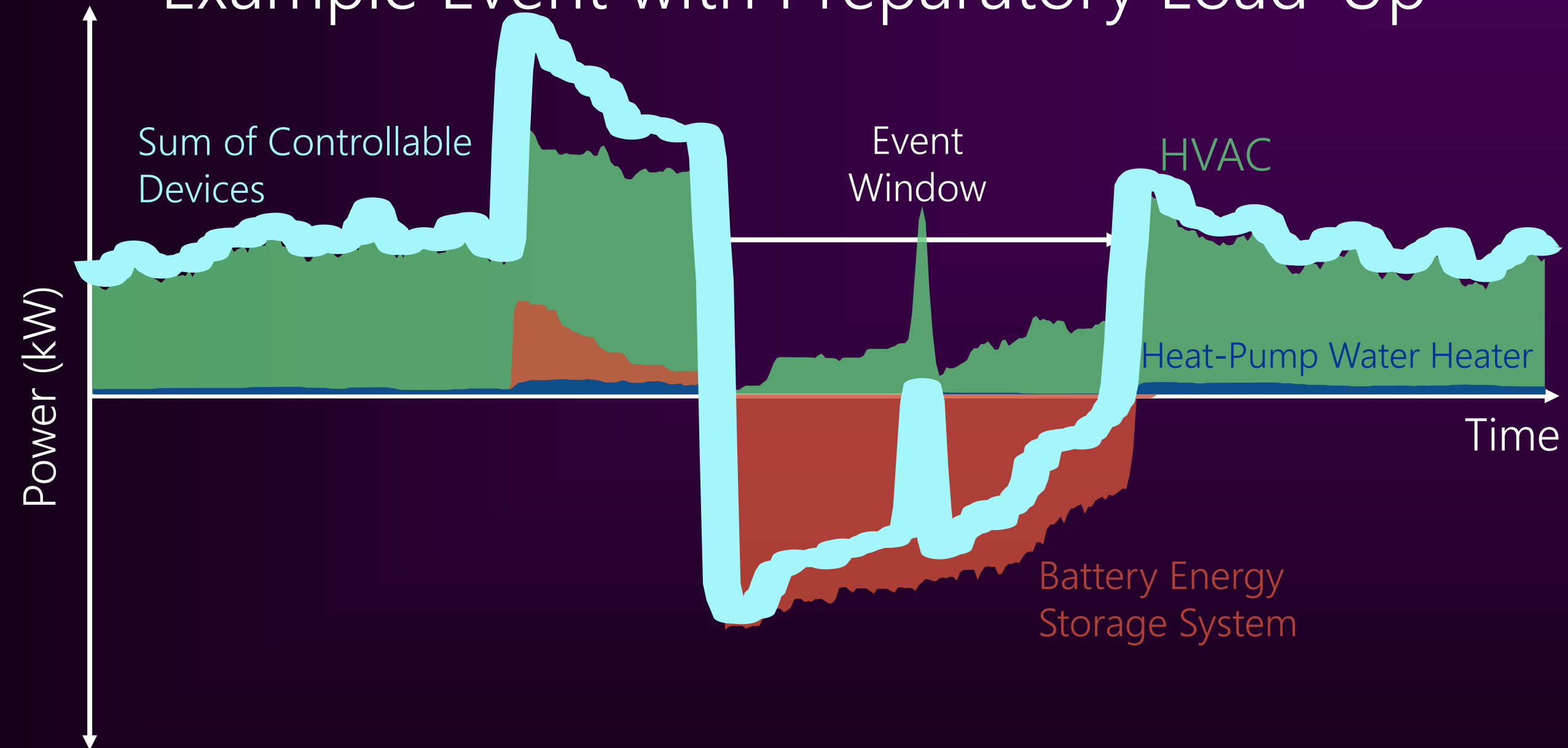
Example Event with Preparatory Load-Up



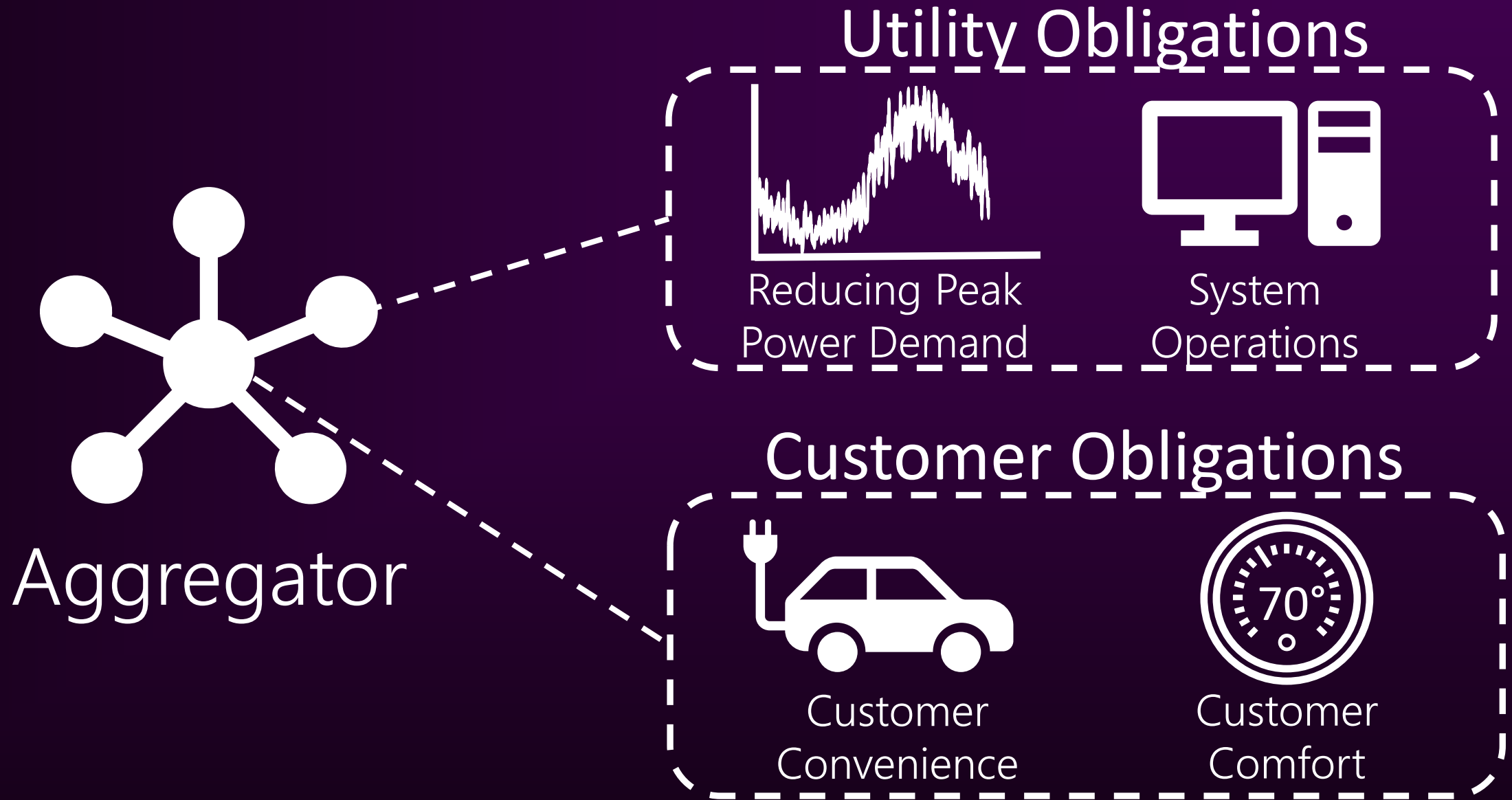
Example Event with Preparatory Load-Up



Example Event with Preparatory Load-Up



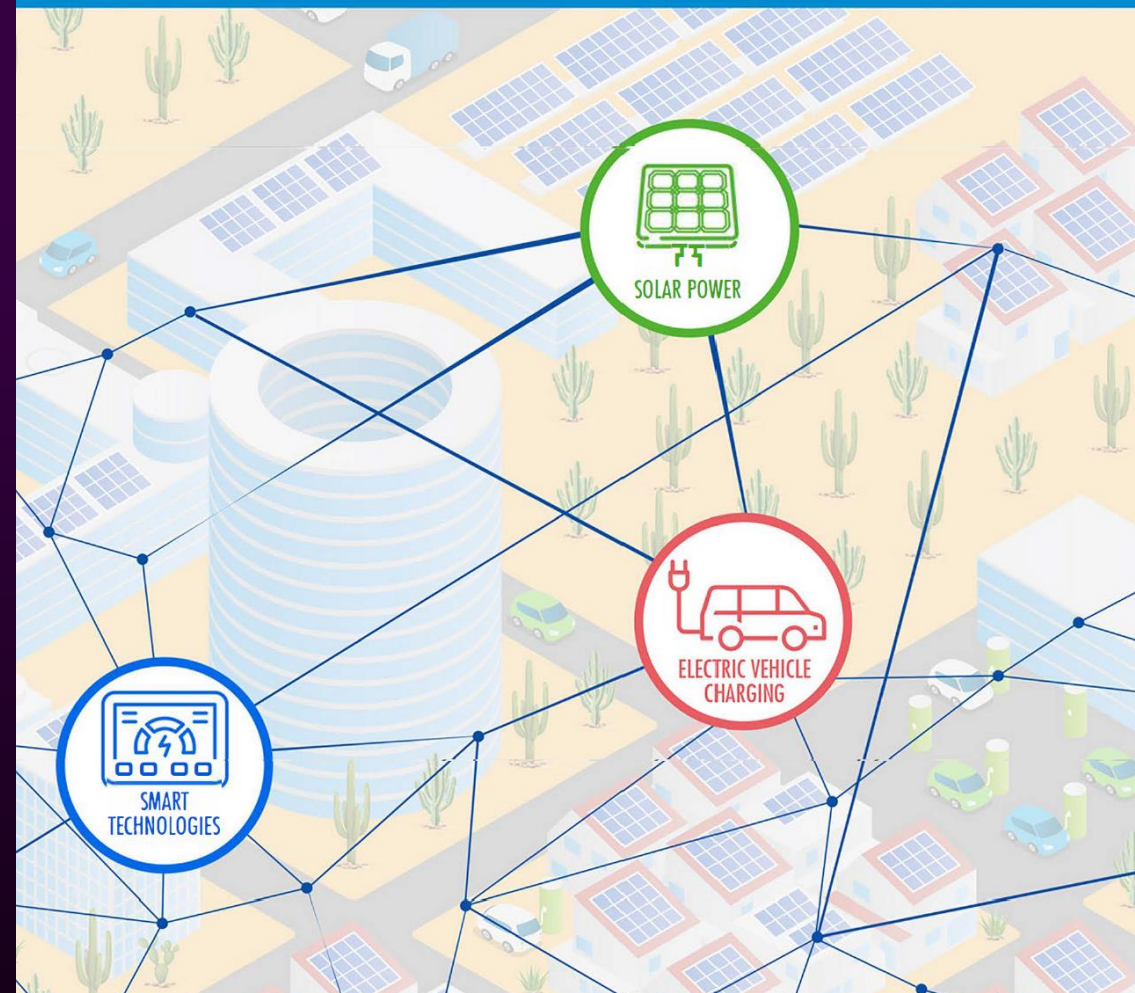
Philosophical Gaps



Tech Transfer

TUCSON ELECTRIC POWER PROJECT RAIN

FINAL UPDATE – OCTOBER 2019



Tech Transfer

October 2018
Update



February 2019
Update



October 2019
Final Update

