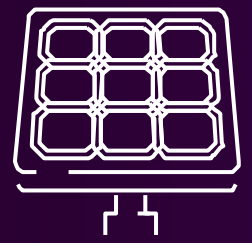
Tucson Electric Power
Resource Aggregation and Integration Network
Project RAIN

Director, Emerging Technology and Innovation
Tucson Electric Power

TEP Tucson Electric Power

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Five Different DER Technologies

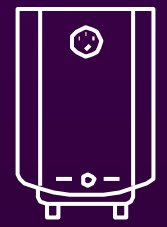


PV System

Electric Vehicle Charging

Battery

Thermostat

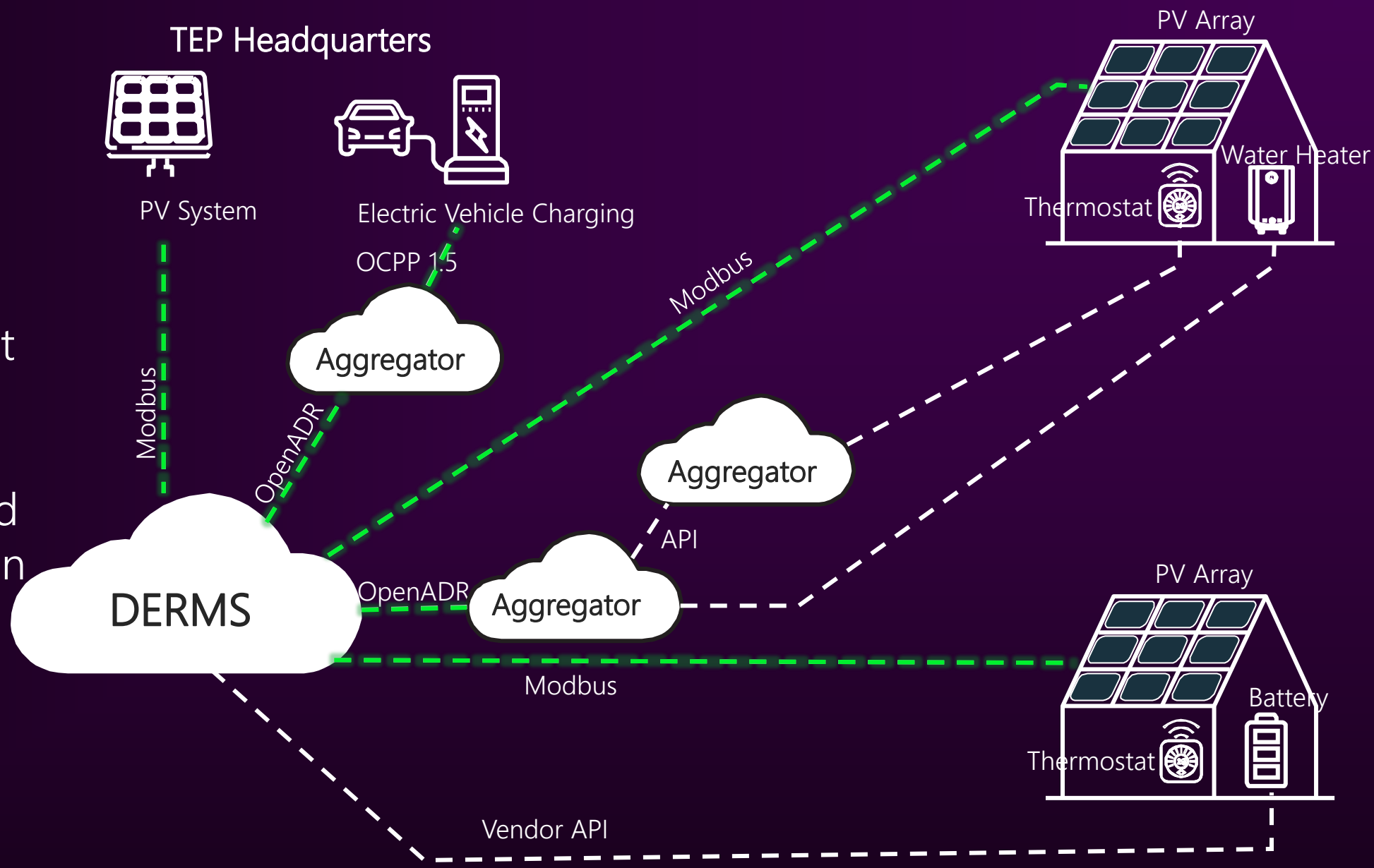


Water Heater

Five Different DER Technologies

Three Different Aggregators

Open Standard Communication Protocols



Normal Load and Generation Behavior

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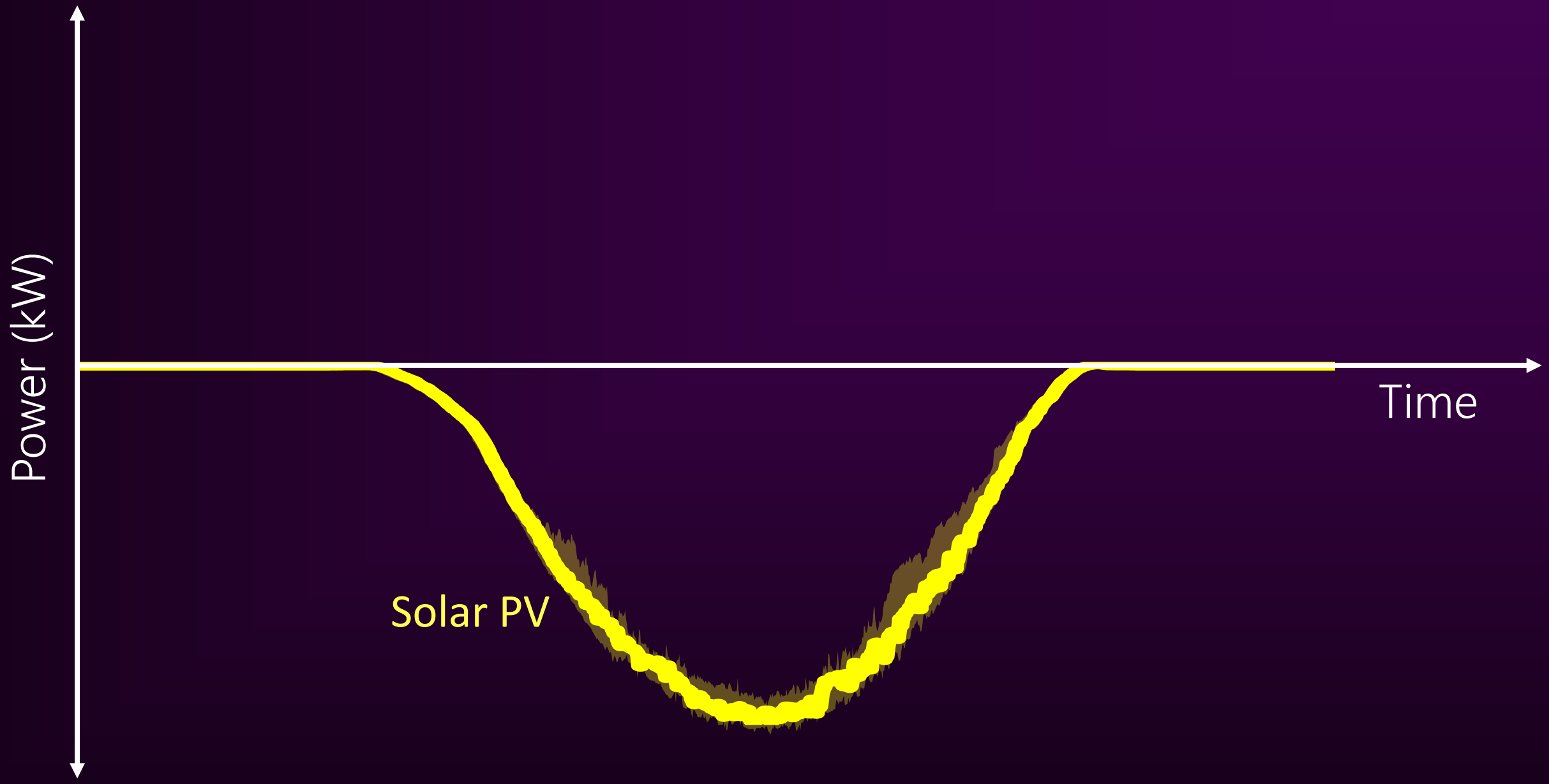
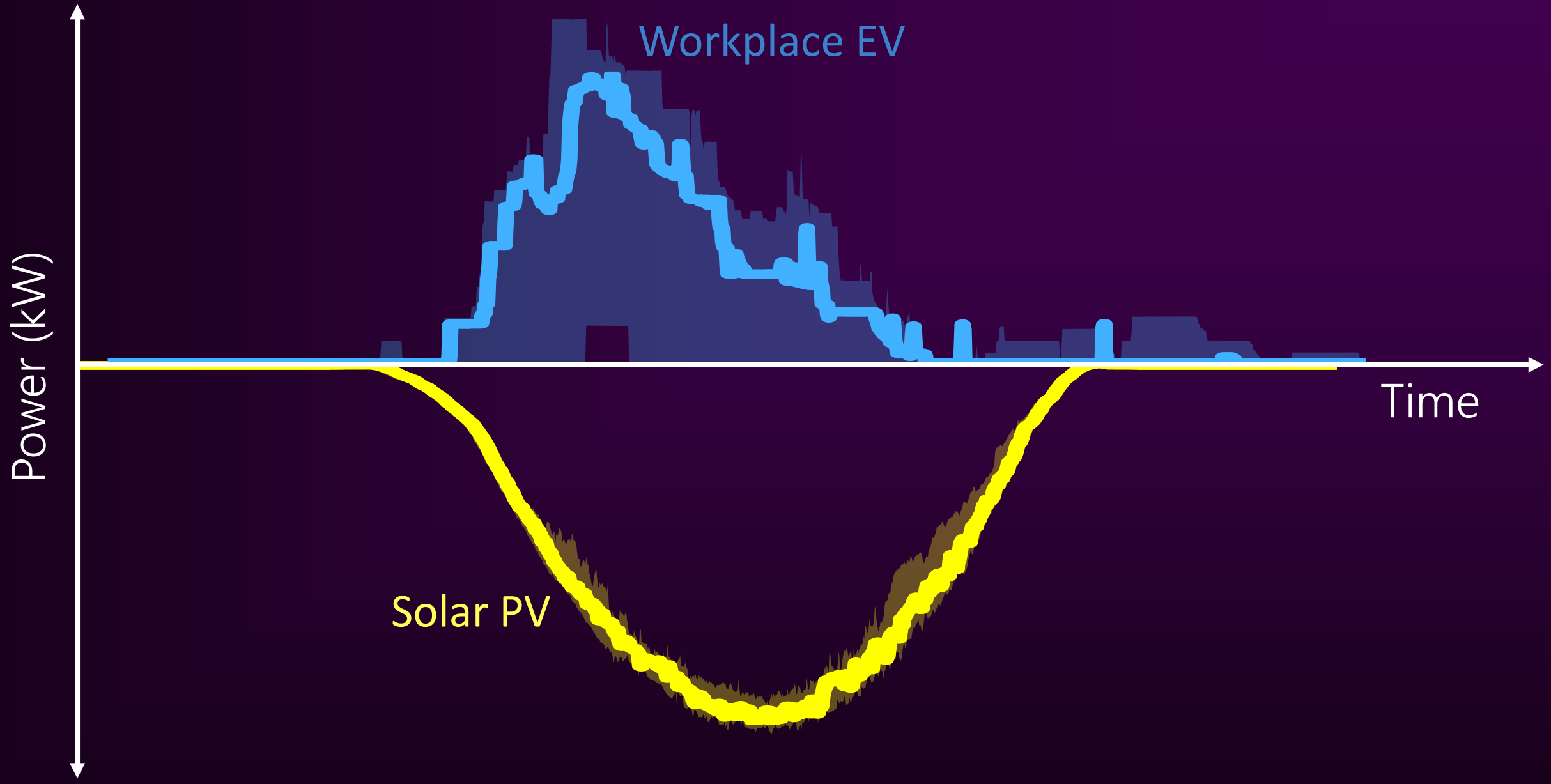


Normal Load and Generation Behavior



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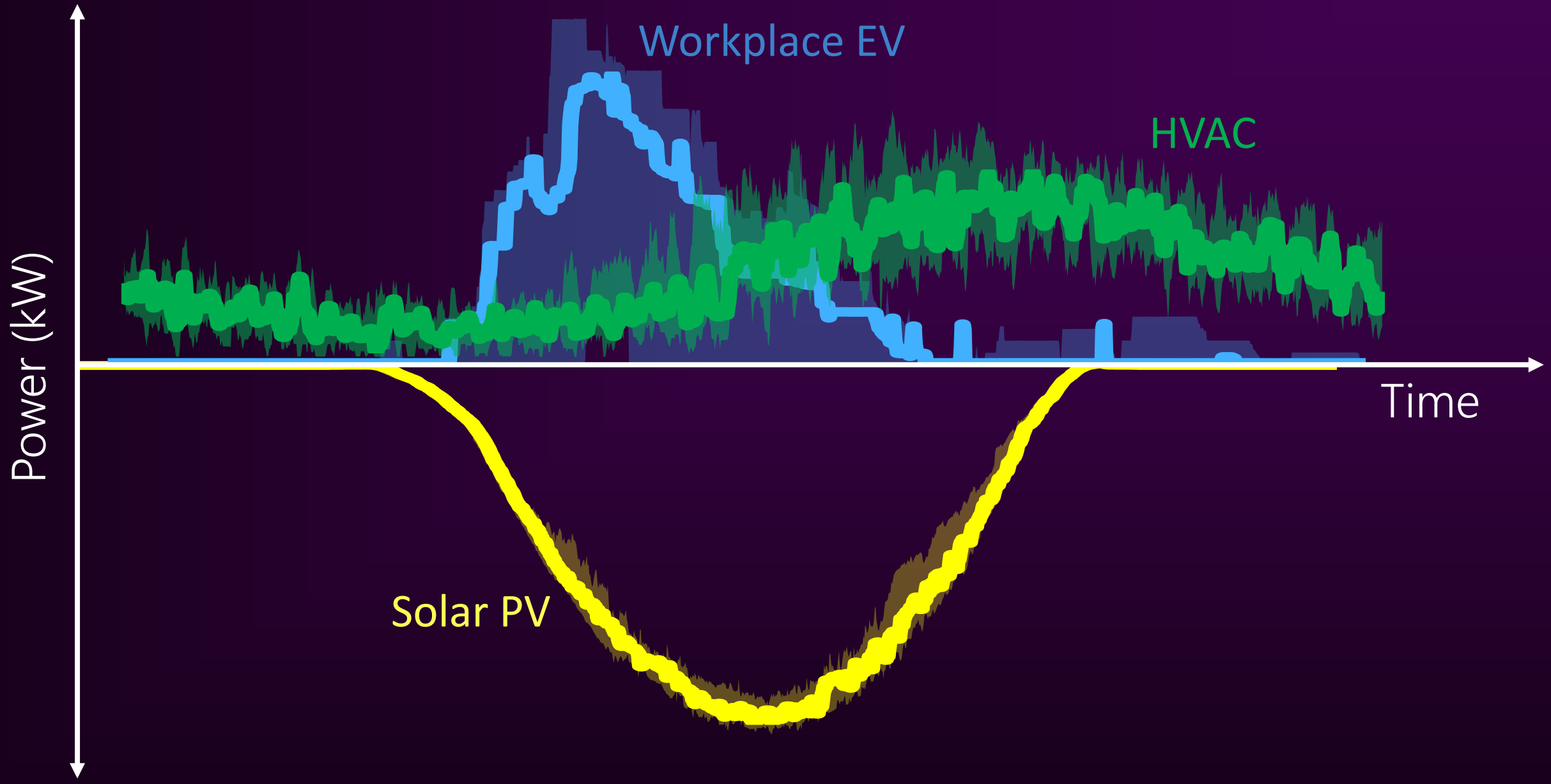
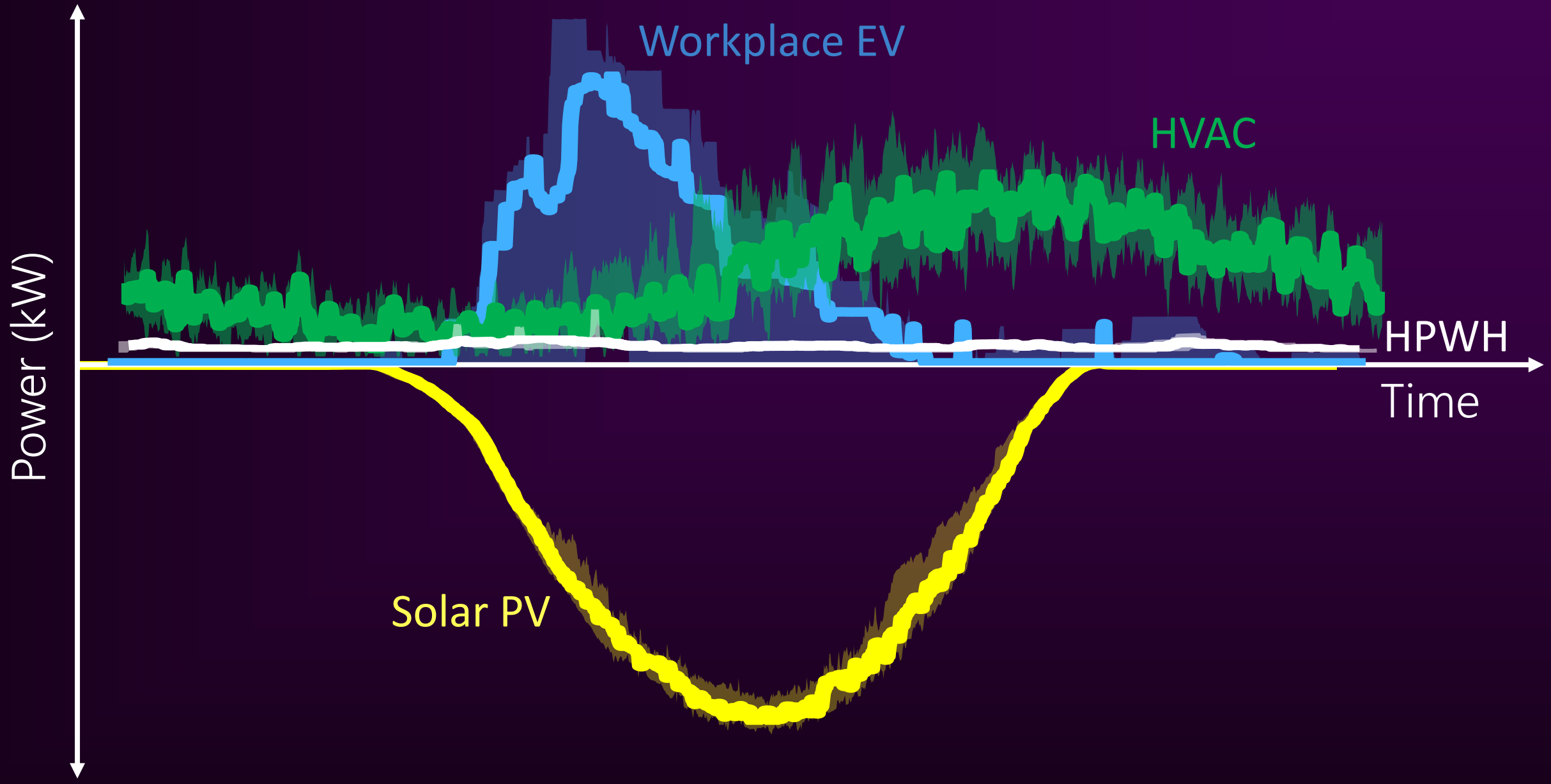
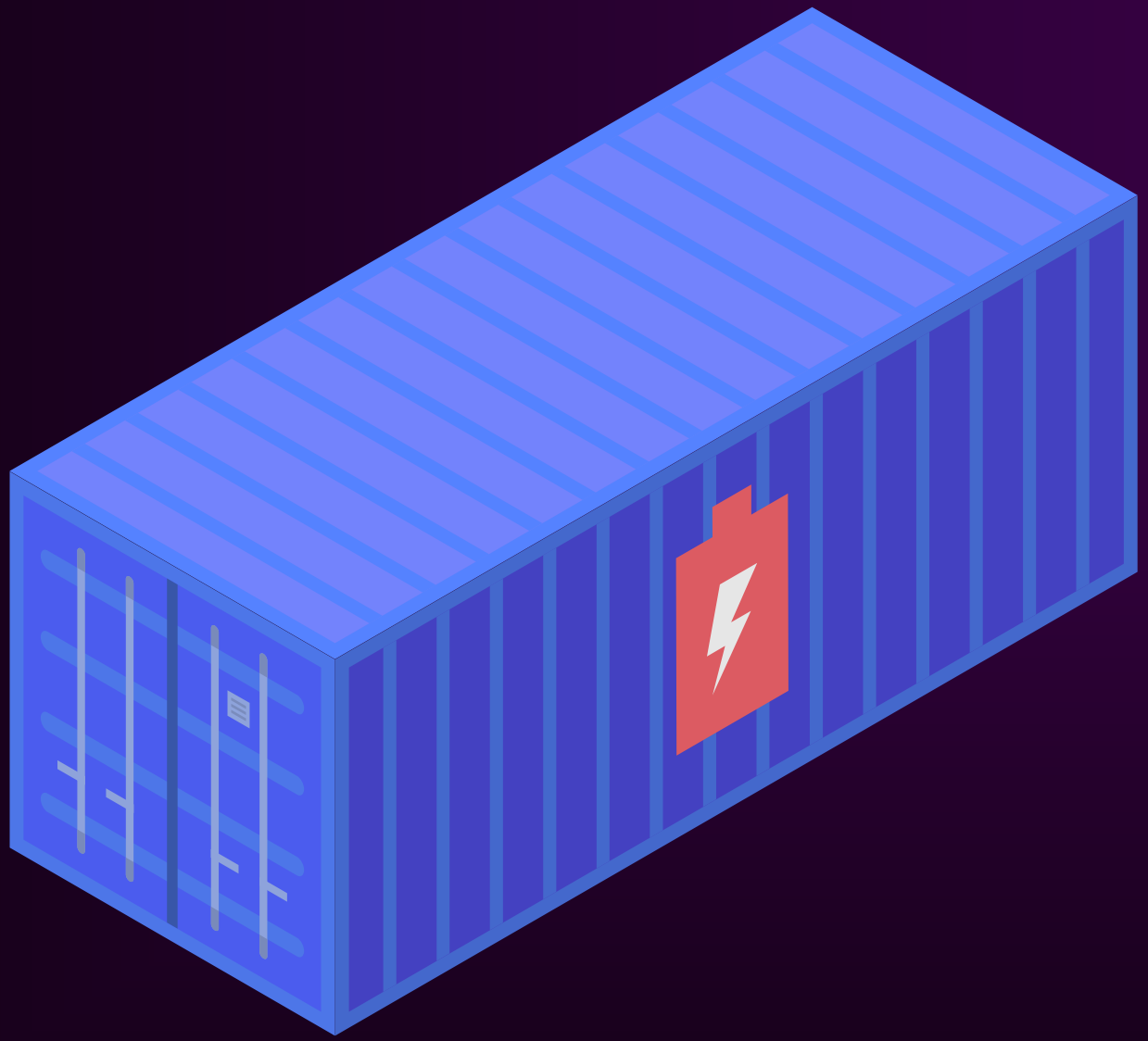


Normal Load and Generation Behavior



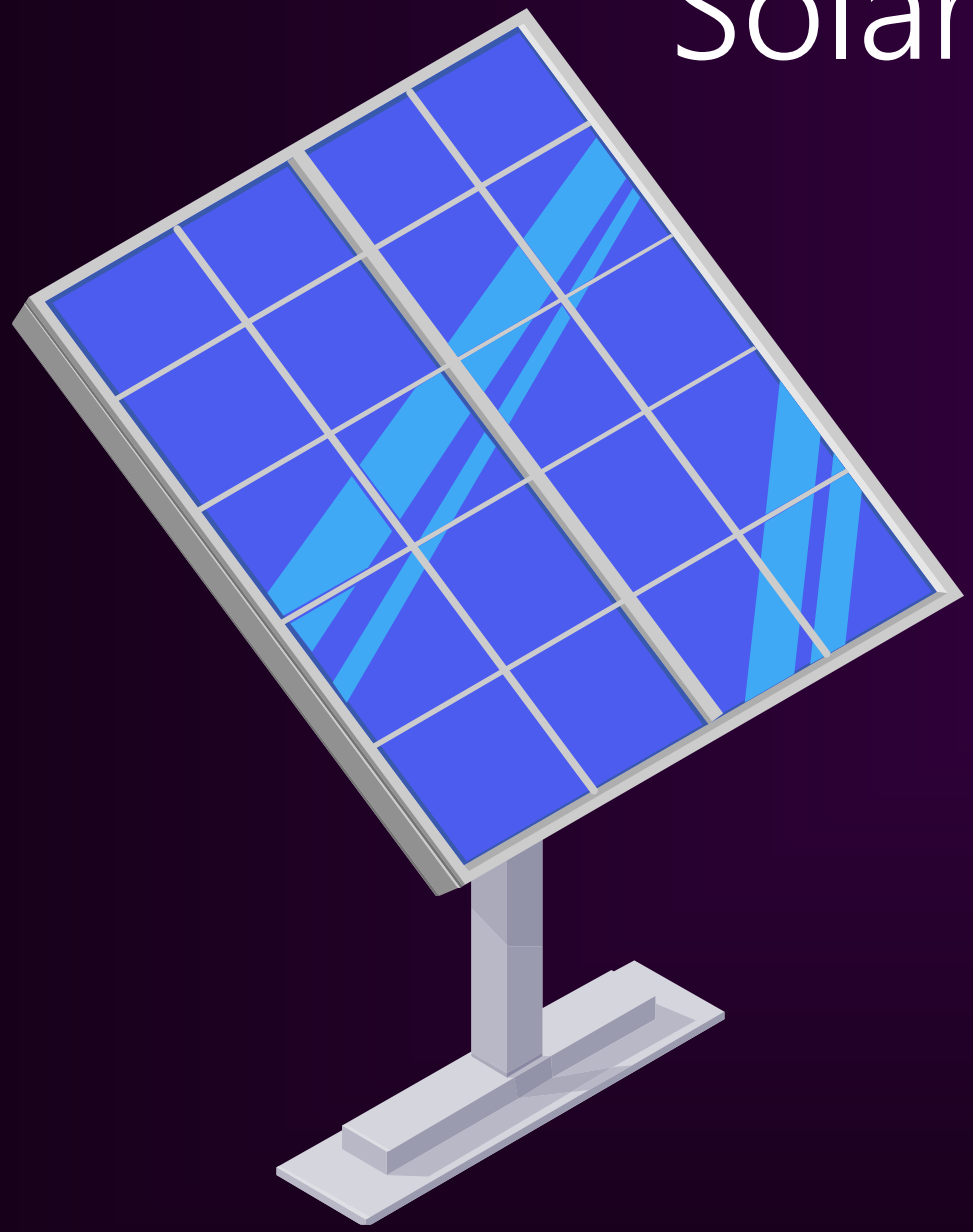
Device Characteristics

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

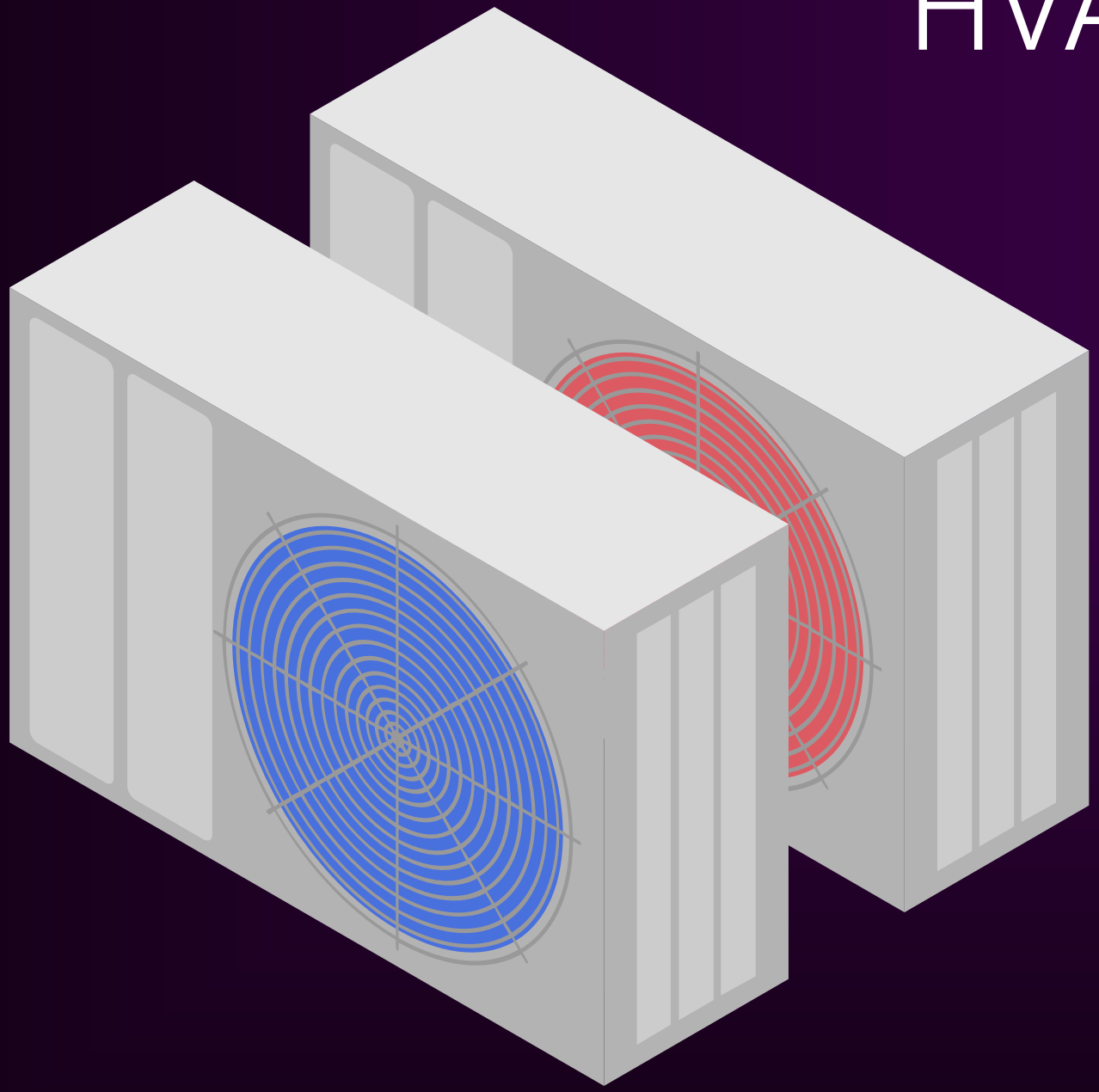


No comfort impact

Can only curtail (increasing load)

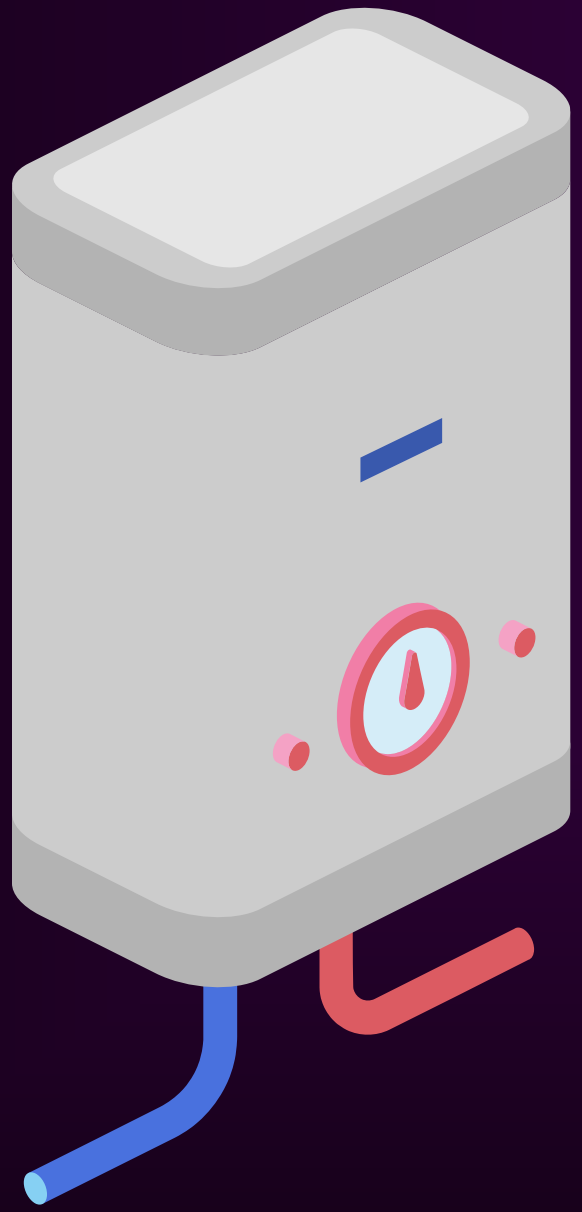
Peak does not correlate with utility peak

HVAC



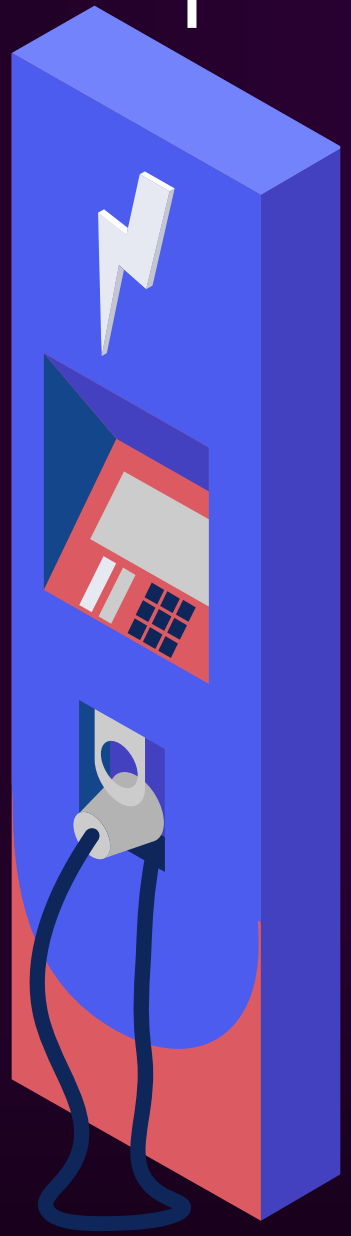
- 40% of customer load on average
- Peak HVAC correlates with peak utility load
- High customer impact
- Impact fades as degree target reached

Heat Pump Water Heater



- Minimal comfort impact
- Unpredictable usage pattern
- 2.5% of customer’s load on average

Workplace EV Charging Station

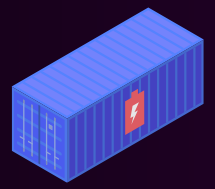
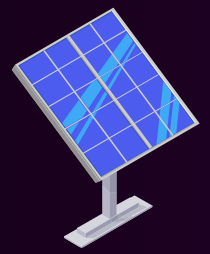
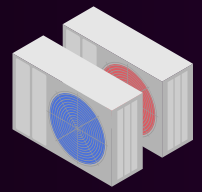
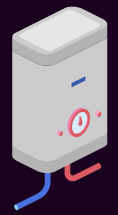


Use aligns well with PV generation

Not available to reduce evening peak

Increase Load

Decrease Load

	Load Up	Shed	Critical Shed	Grid Emergency
 BESS	Charge at 60%	Discharge 30%	Discharge 60%	Discharge 100%
 PV	Curtail to 50%	Full 100% production		
 HVAC	Lower setpoint 6°F	Relax setpoint 3 °F	Relax setpoint 6 °F	Turn off HVAC
 Water Heater	Max water temp	Maintain lower water temp	Maintain min. water temp	Turn off water heater
 EV Charger	Charge Normally	Limit charge rate to 60%	Limit charge rate to 30%	Stop charging

Example Event with Preparatory Load-Up

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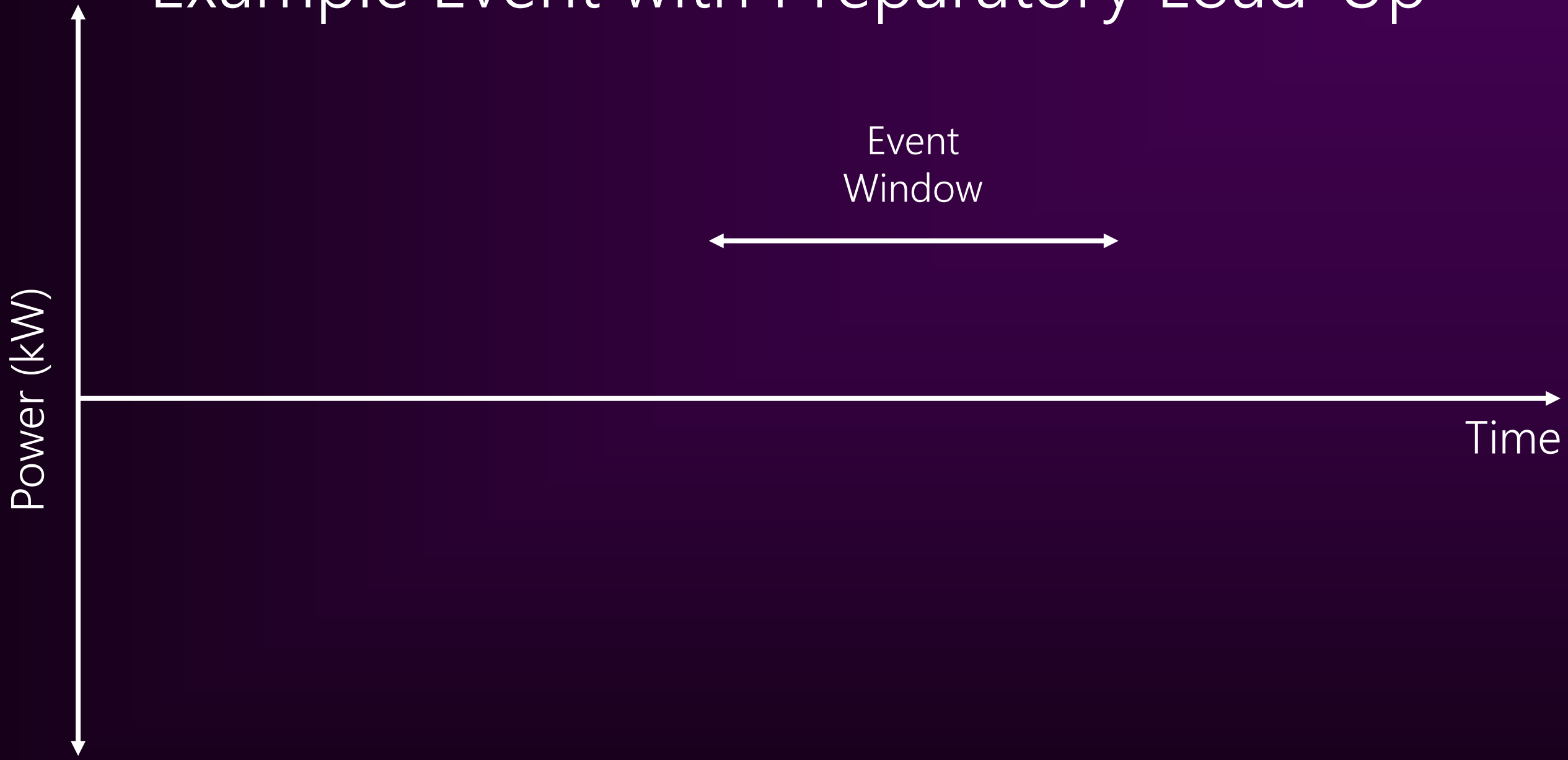
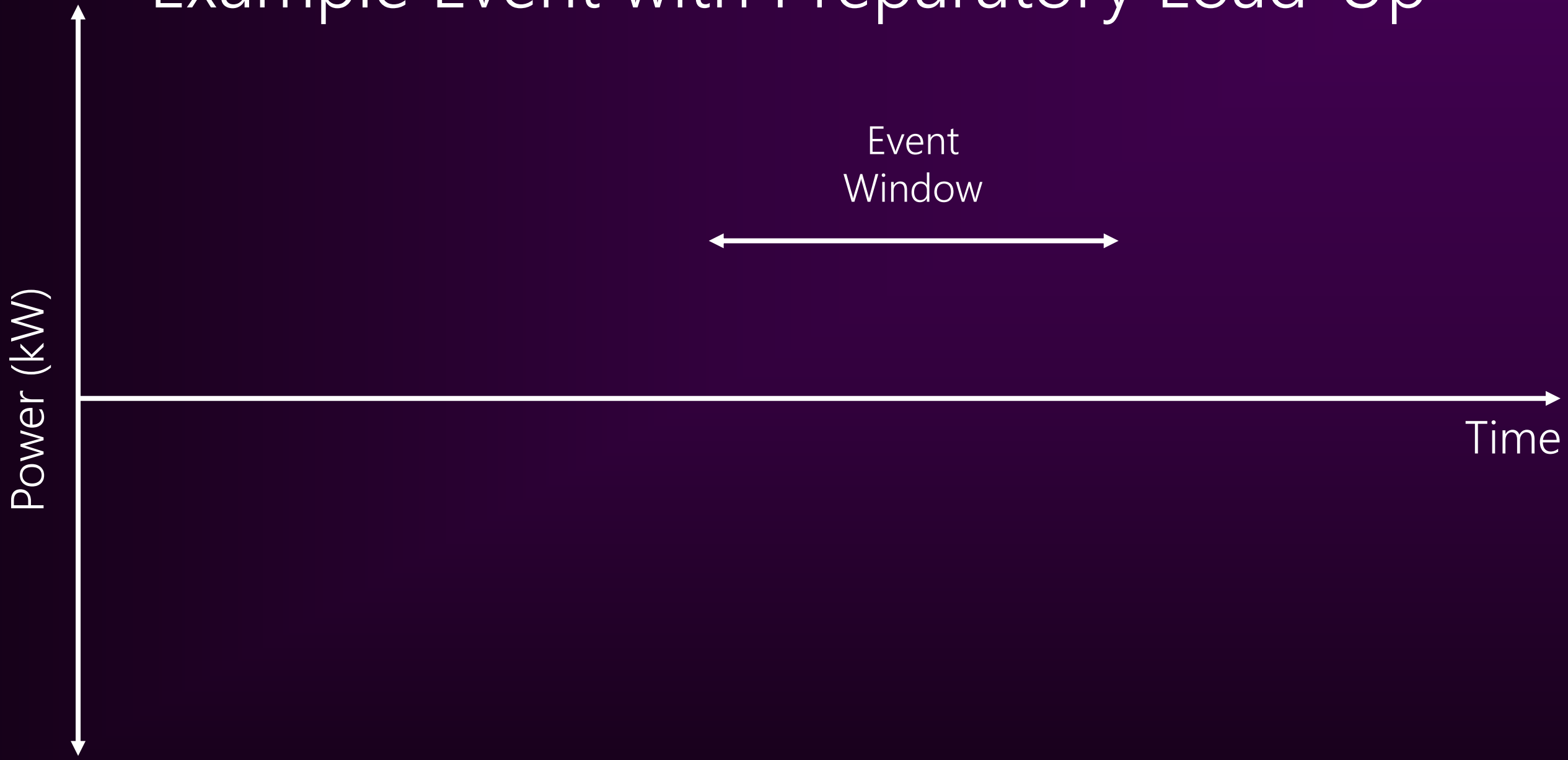
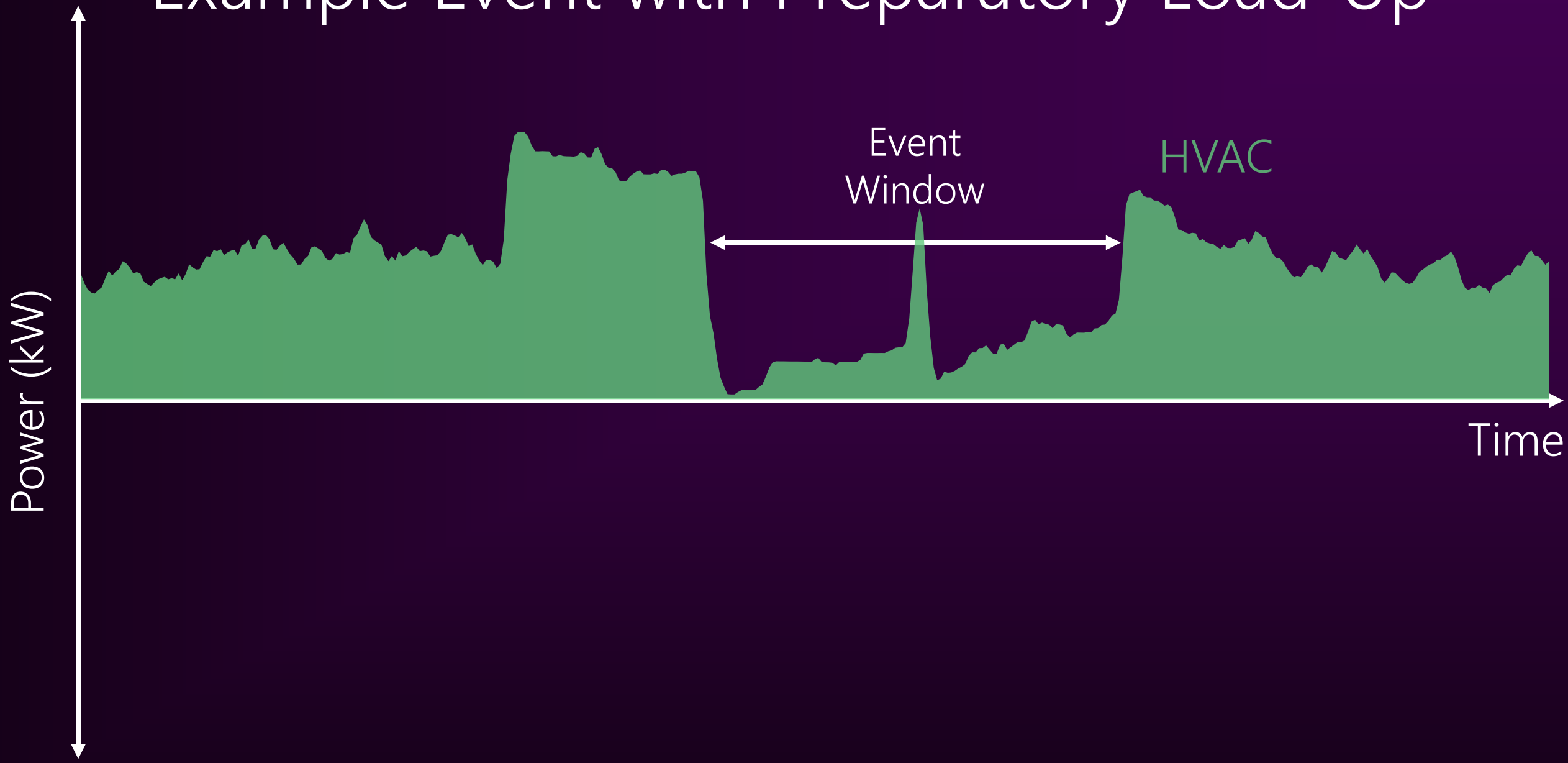


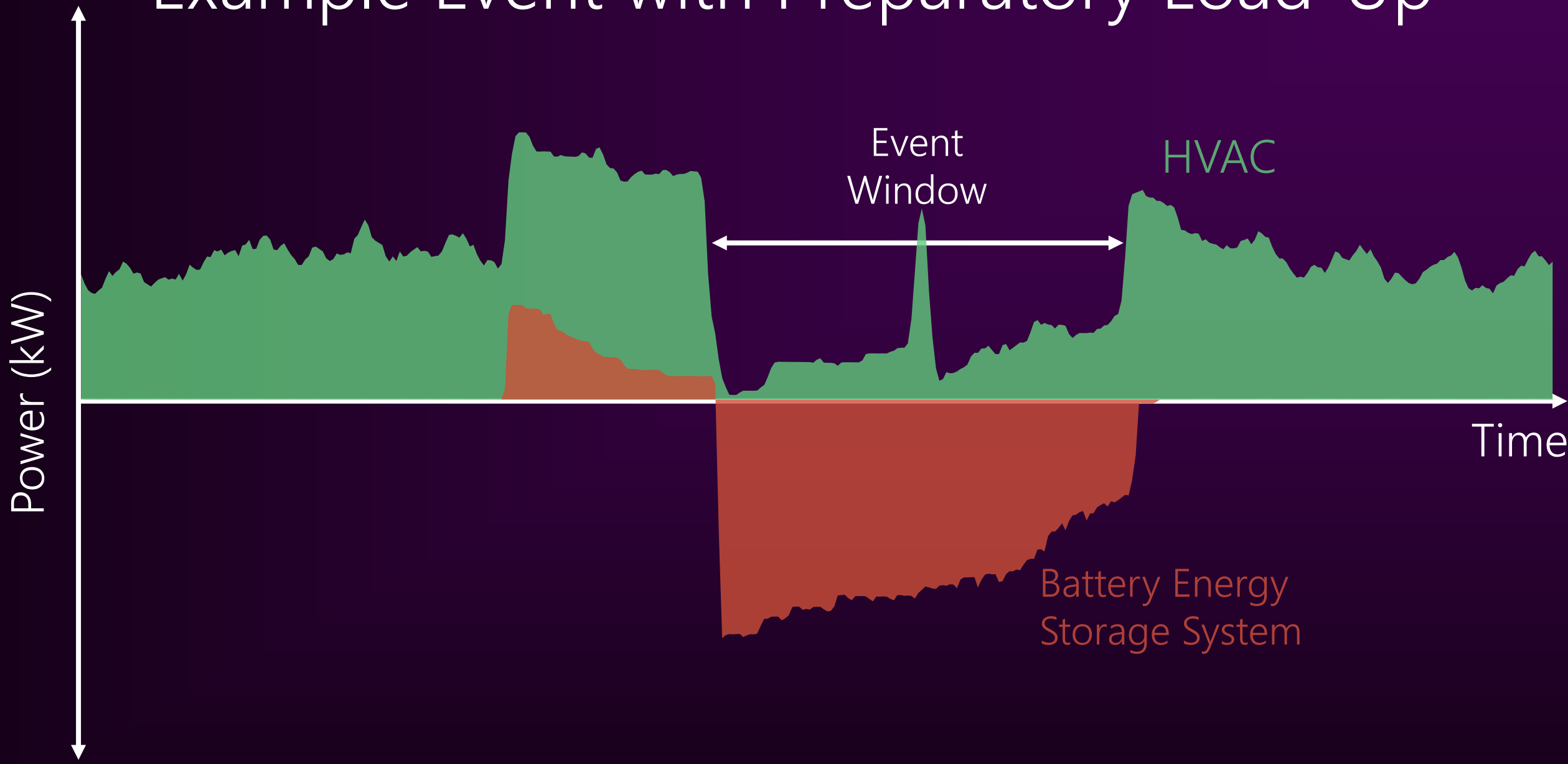
Example Event with Preparatory Load-Up



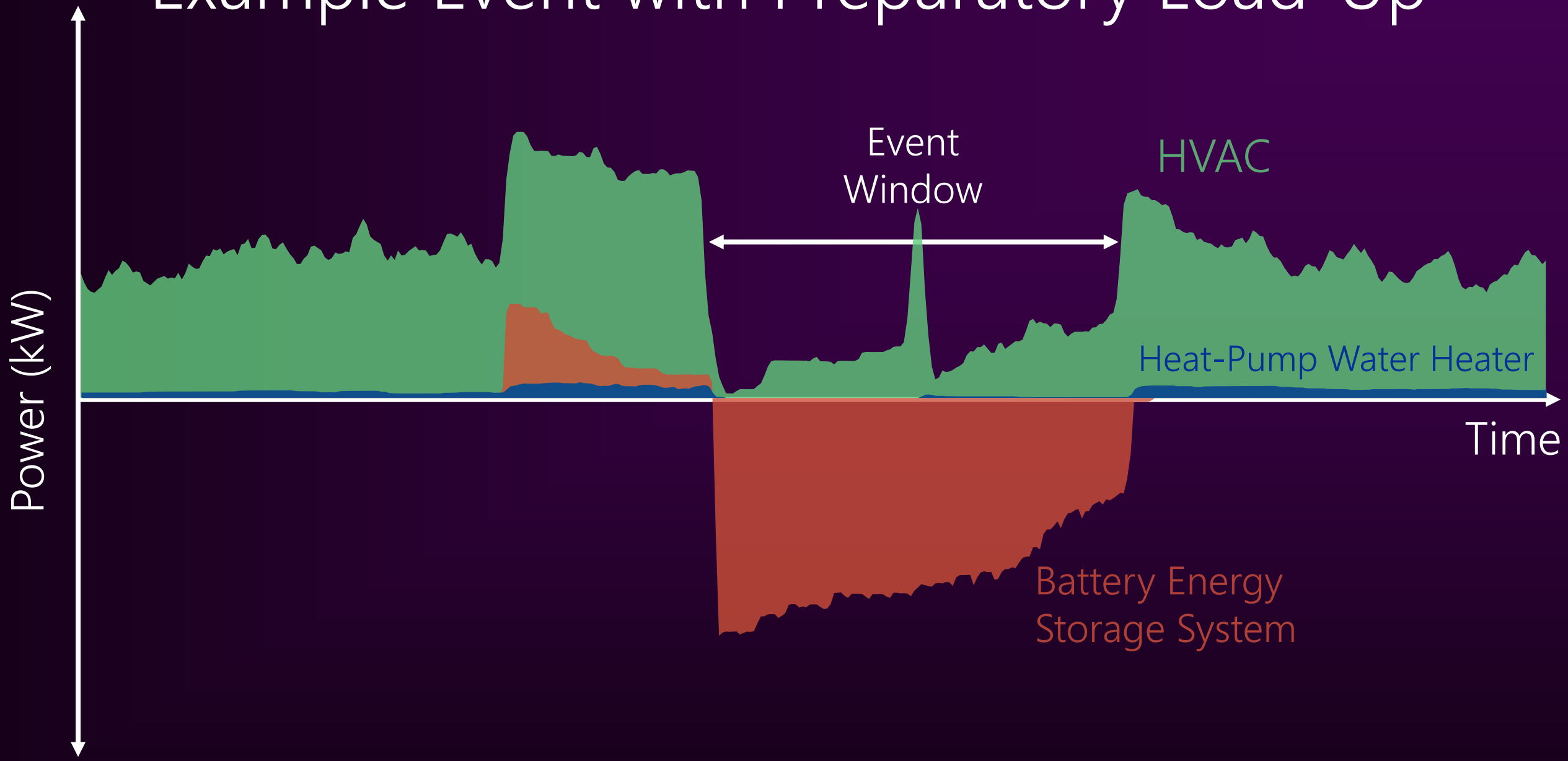
Example Event with Preparatory Load-Up



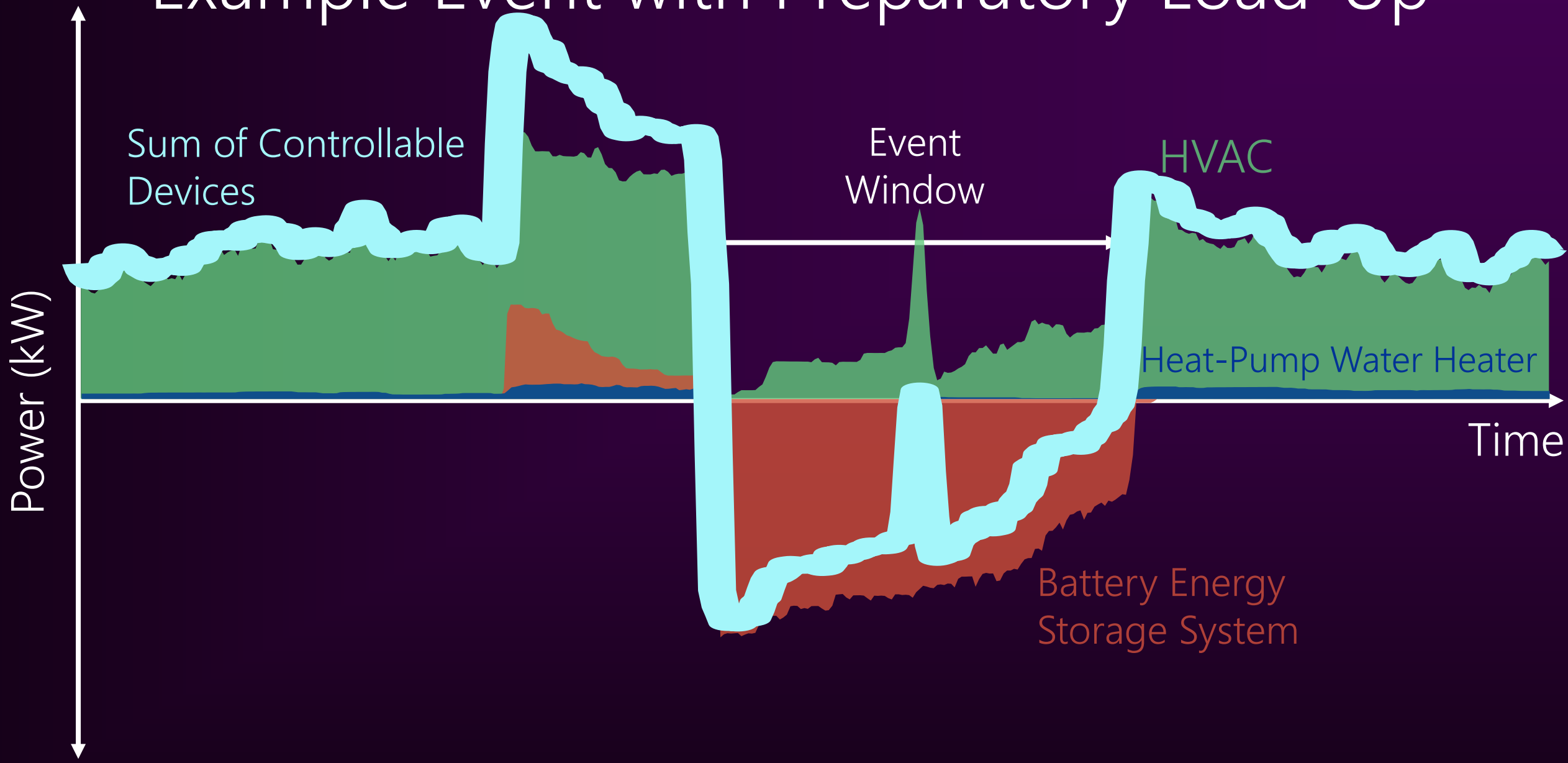
Example Event with Preparatory Load-Up



Example Event with Preparatory Load-Up

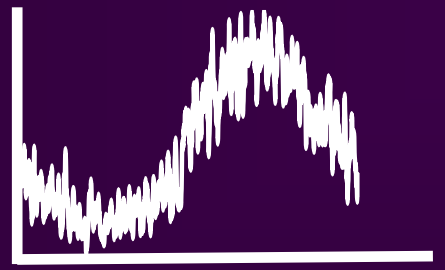


Example Event with Preparatory Load-Up



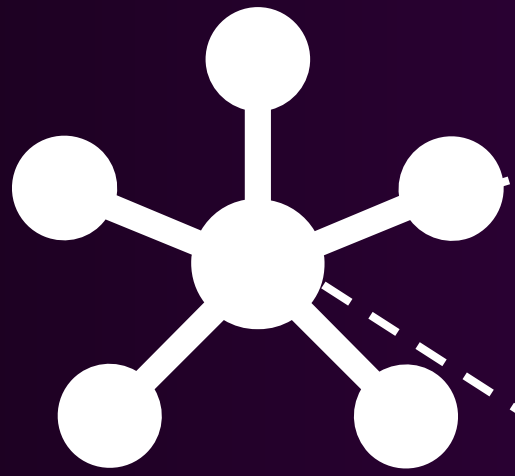
Philosophical Gaps

Utility Obligations



Reducing Peak Power Demand

System Operations



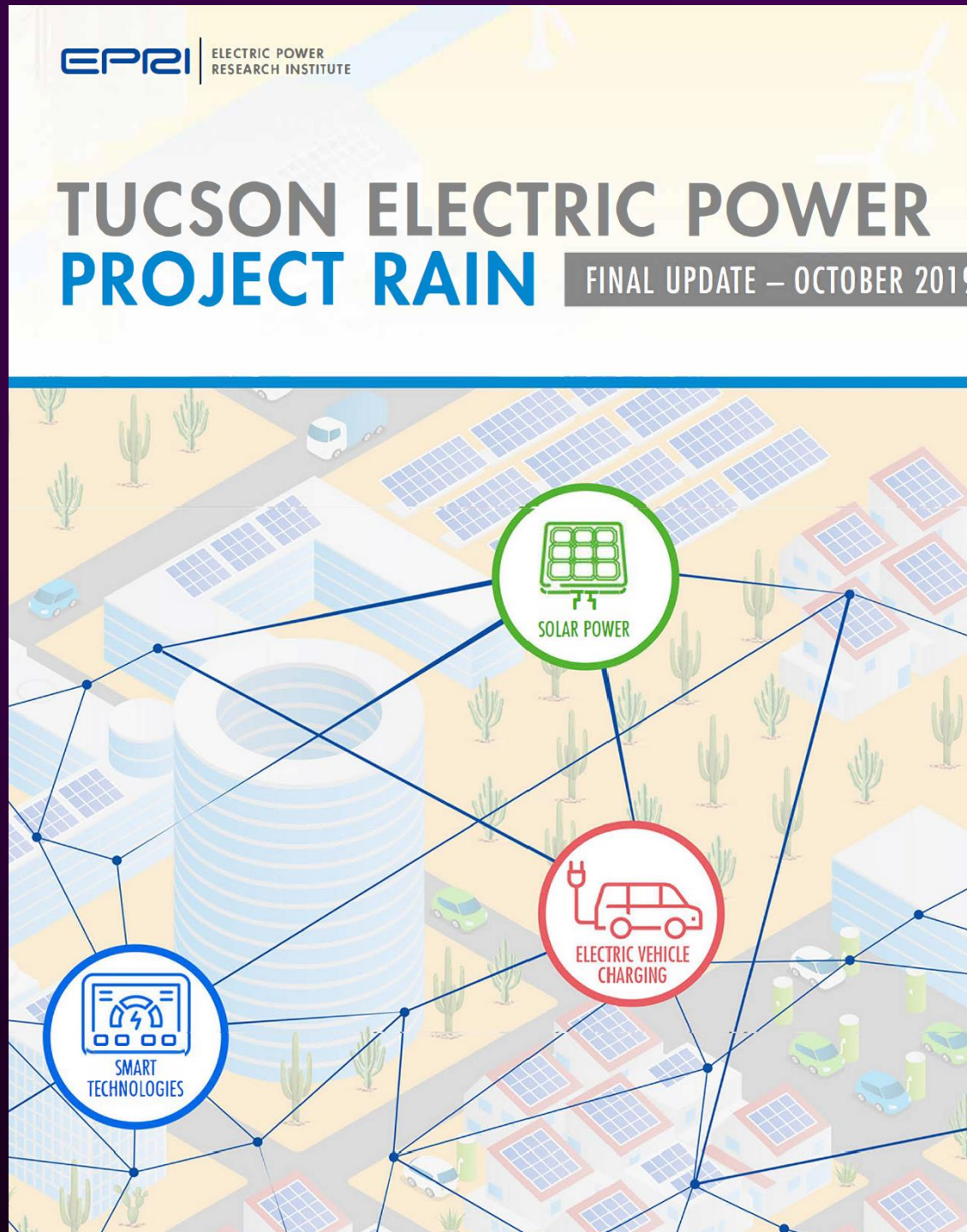
Aggregator

Customer Obligations

Customer Convenience

Customer Comfort

Tech Transfer



Tech Transfer

October 2018 Update

February 2019 Update

October 2019 Final Update