Energy Storage, DER, and Microgrid Project Valuation

EPRI DER-VET™ Analysis in Action

Eva Gardow
evgardow@epri.com
Technical Executive | EPRI

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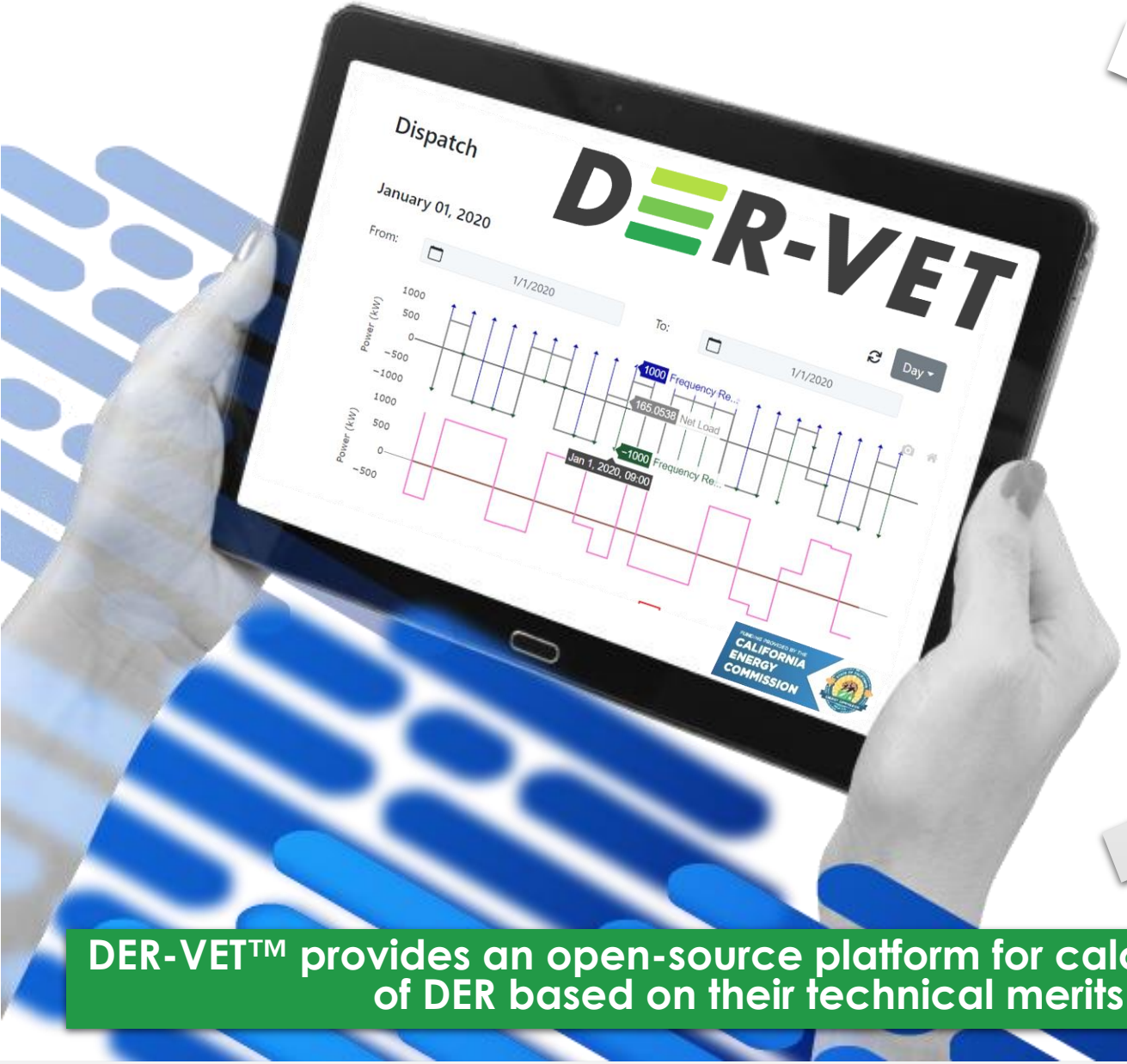
The Challenges of Storage, DER*, & Microgrid Modeling

- Today's energy storage, DER, and microgrid deployments demand robust analysis for strategic planning
- Valuation of energy storage requires project-level analyses for specific applications and locations
- This is a complex co-optimization, decision-making process

*DER: Distributed Energy Resources

EPRI's Distributed Energy Resources Value Estimation Tool, DER-VET™ addresses these challenges

The Solution: EPRI's DER-VET™



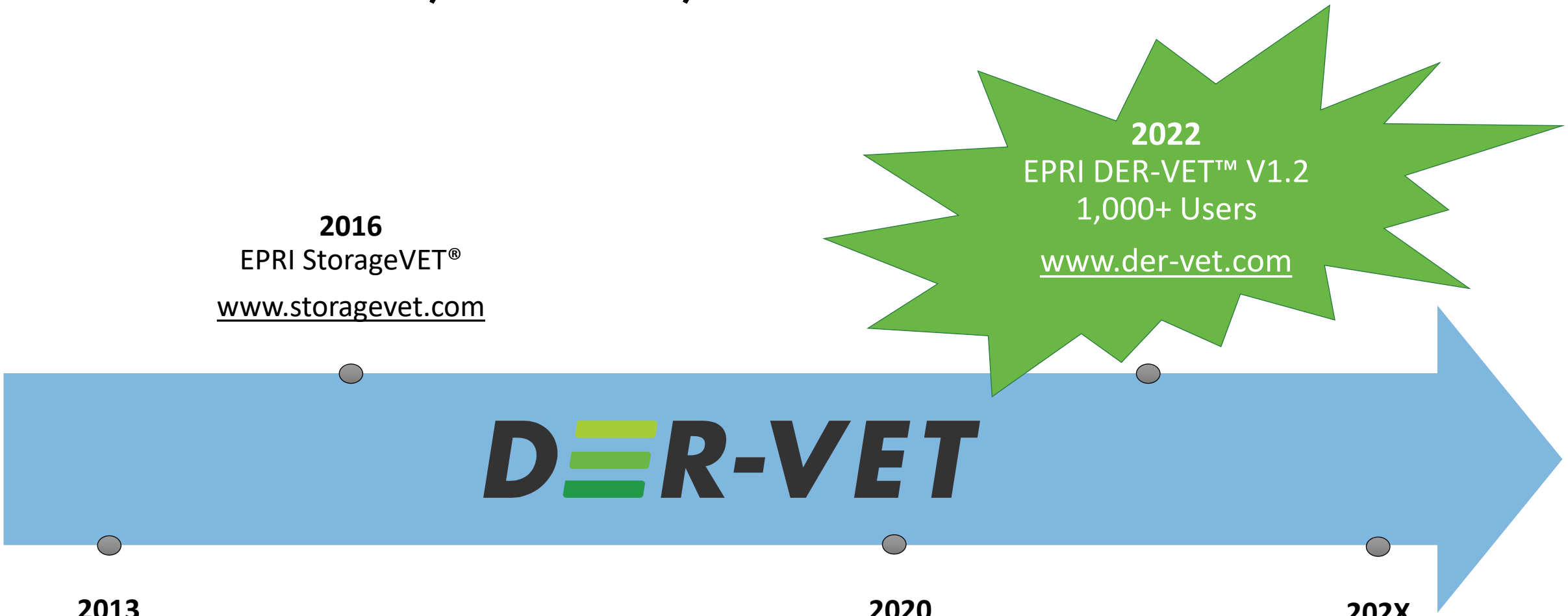
Bridges industry gaps in project-level energy storage, DER, and microgrid analysis with a publicly available tool and methodology

Creates a common and consistent communication tool among stakeholders

Evaluates various perspectives from customers values to grid values in any market; estimates benefits and costs of energy storage and other DER

DER-VET™ provides an open-source platform for calculating, understanding, and optimizing the value of DER based on their technical merits and constraints: www.der-vet.com

DER-VET's Past, Present, and Future



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Distributed Energy Resource Value Estimation Tool (DER-VET™)

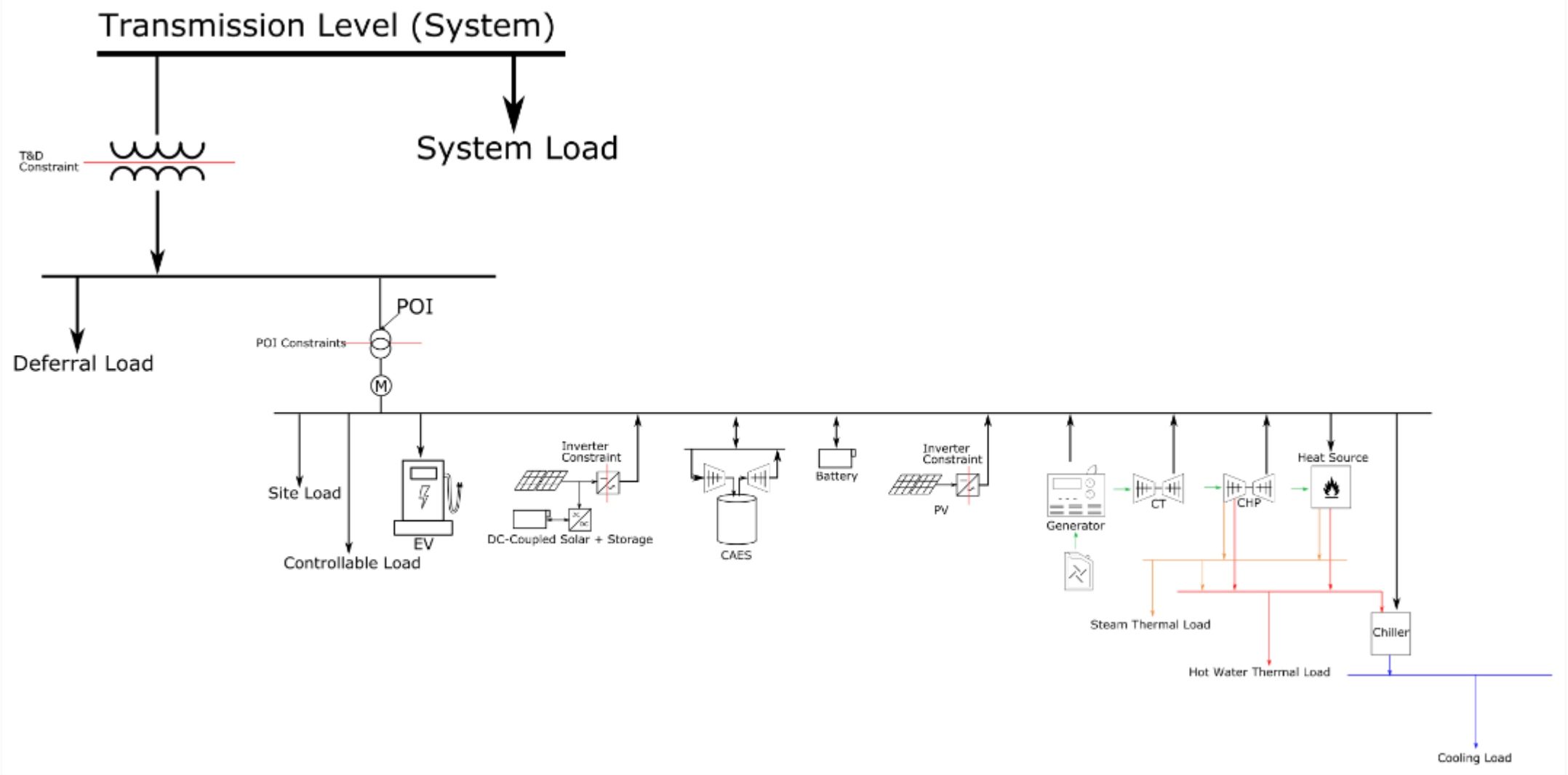
DER-VET™ | Software | Reference Cases | ESIC Task Force | Help | Forums

To download DER-VET, go to https://www.der-vet.com/

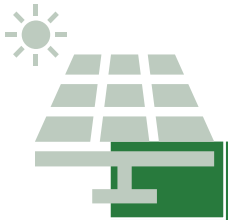
- Download the tool for free as it was developed with California Energy Commission funding
- **Software Release: DER-VET™ Version 1.2 (Updated July 11, 2022)**
- **DER-VET™ Overview Presentation (September 2022)**
- **DER VET User Guide**

- **Get Involved**
  - Engage with monthly Public ESIC Task Force Web Meetings. The Energy Storage Integration Council (ESIC), an open technical forum. More info can be found at **www.epri.com/esic**.
  - ESIC Working Group 1 DER-VET™ Task Force Meeting Recordings can be found at **www.der-vet.com/esictf**
  - The ESIC collaboration site contains live draft user documentation from the ESIC DER-VET™ Subgroup at **collab.epri.com/esic**.

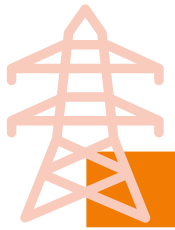
Technologies in DER-VET



Services in DER-VET



- Energy Time Shift
- Load Following
- Frequency Regulation
- Spinning Reserves
- Non-spinning Reserves
- Resource Adequacy Capacity

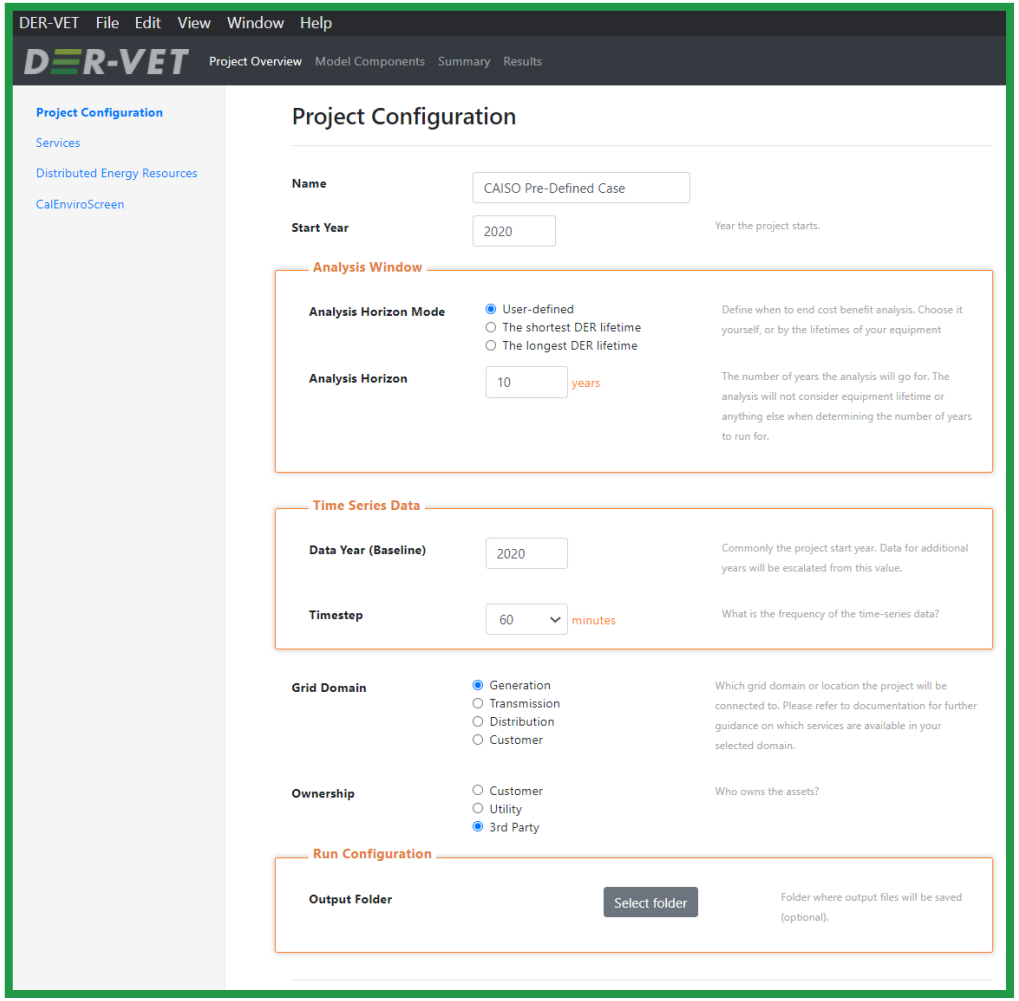


- Upgrade Deferral
- Reliability/Resilience

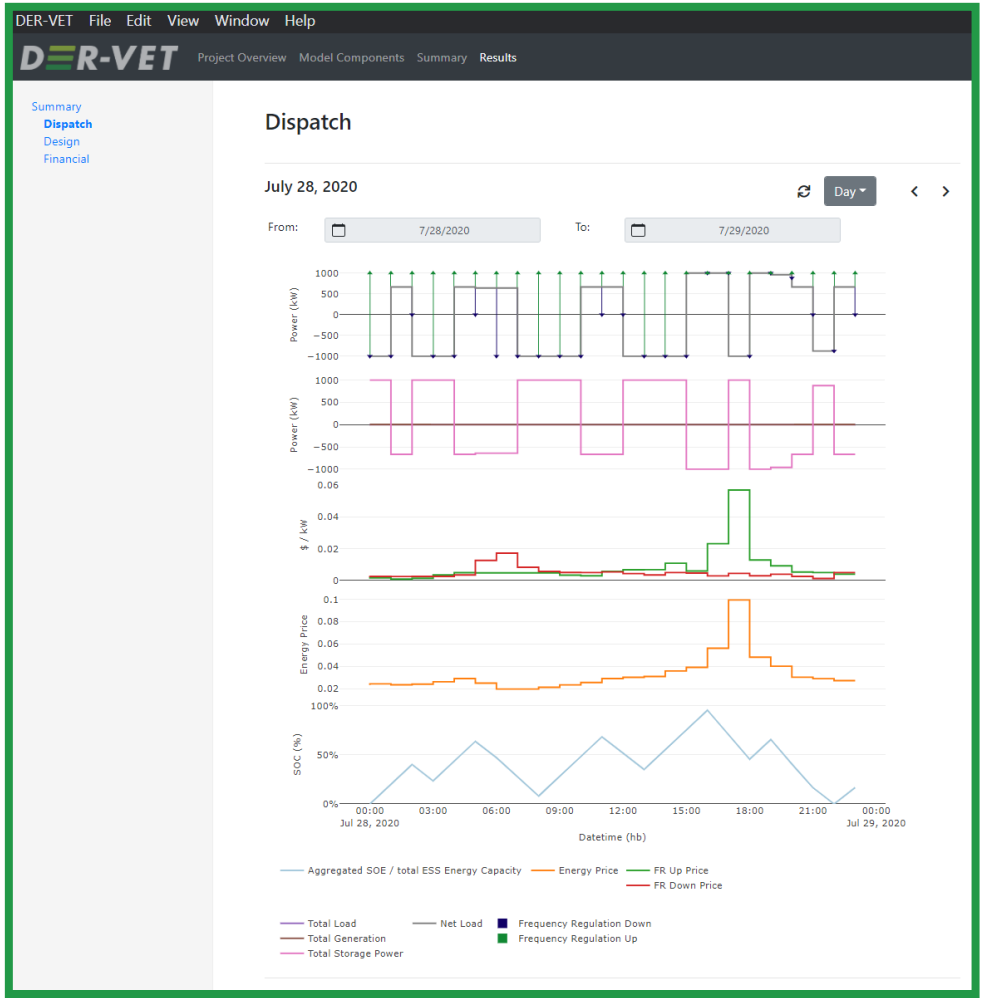
- Retail Energy Time Shift
- Demand Charge Reduction
- Demand Response
- Reliability/Resilience

Input and Output Examples in DER-VET

DER-VET Project Configuration Example

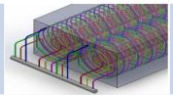
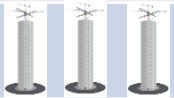


DER-VET Dispatch Results Example



Long Duration Energy Storage Case Study

Long Duration Energy Storage (LDES) DER-VET Analysis

Type	Technology	Acronym	TRL
	Concrete Thermal Energy Storage	CTES	4
	Electro-Thermal Energy Storage	ETES	3
	Gravitational Energy Storage	GES	6
	Liquid Air Energy Storage	LAES	6
	Lithium-Ion Battery Storage	Li-Ion	9

Base

- All technologies were run using the original pricing curves in each region for 4h for Li-Ion Benchmark as well as 6, 8, and 10h

Sensitivities

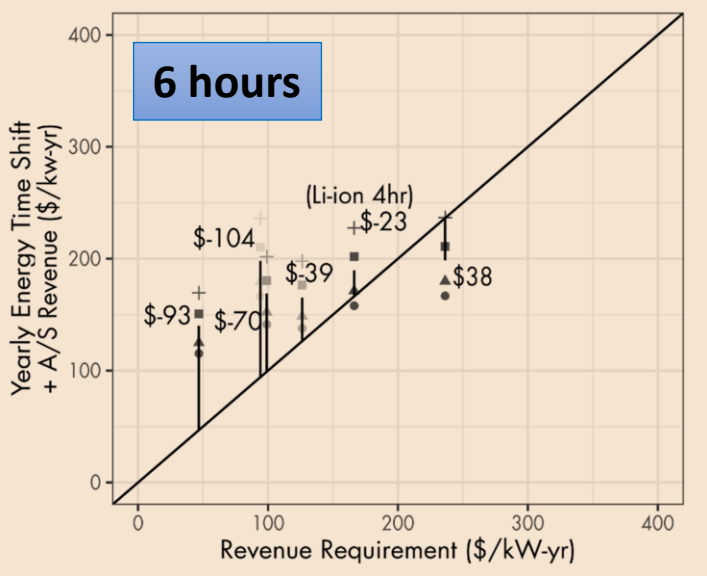
- Capital costs were adjusted +10% / -30%
- Energy prices were modified (mod) from their original (orig)
- RTE was adjusted +/- 5% points

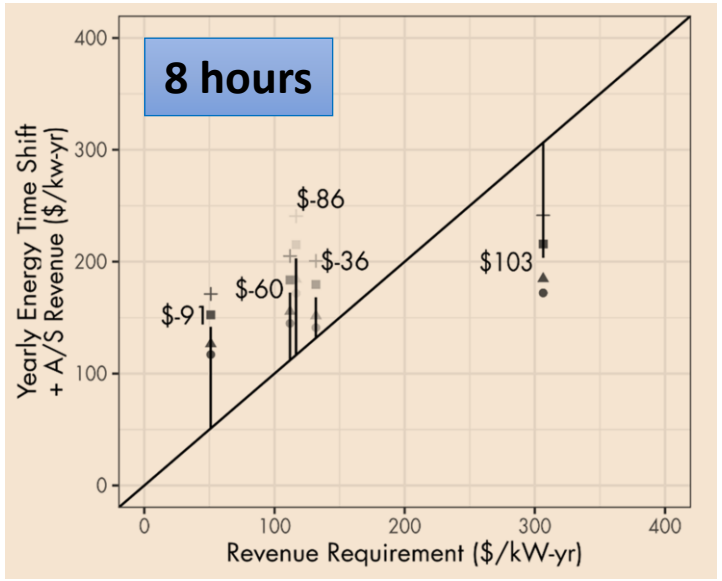
Pricing	Orig	Orig	Orig	Orig	Orig	Orig	Orig	Orig	Orig
RTE	Base	Base	Base	High	High	High	Low	Low	Low
Costs	Base	High	Low	Base	High	Low	Base	High	Low

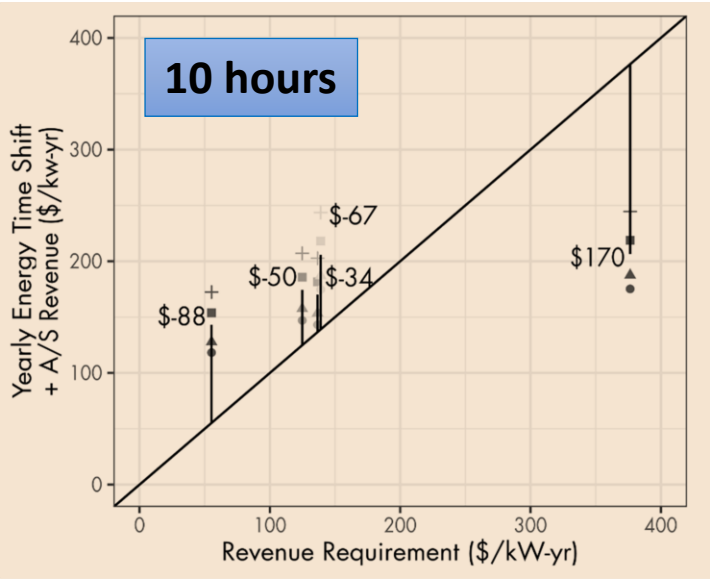
Pricing	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod	Mod
RTE	Base	Base	Base	High	High	High	Low	Low	Base
Costs	Base	High	Low	Base	High	Low	Base	High	Base

Significant number of DER-VET cases: 1728 total

DER-VET Results: Tech Duration vs. Revenue Requirements







Duration, hours	LDES A	LDES B	LDES C	LDES D	Li-ion
4	---	---	---	---	-23
6	-93	-39	-104	-70	38
8	-91	-36	-86	-60	103
10	-88	-34	-67	-50	170

Technology cost forecast is a key driver for LDES analysis

Transmission Solar + Energy Storage Case Study

LADWP Energy Storage + Solar Project

- Los Angeles Department of Water and Power (LADWP) required to study and procure energy storage

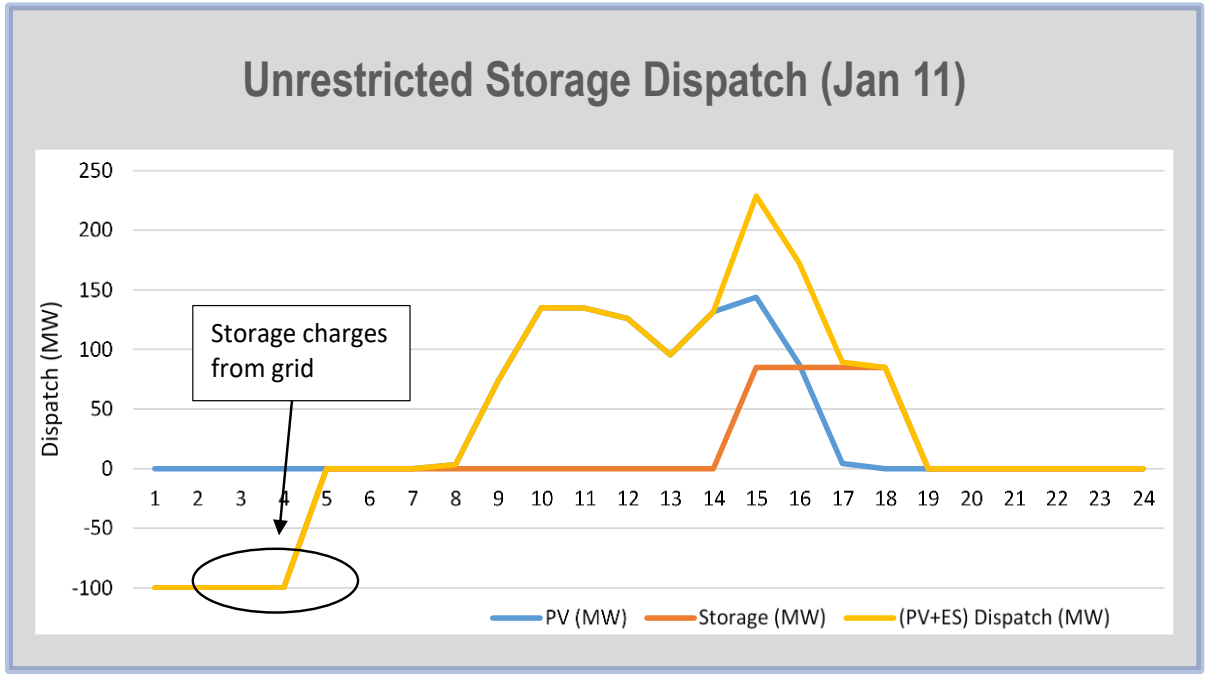
- 100 MW, 4-hour battery energy storage system
- 200 MW solar PV
- Power Purchase Agreement (PPA) able to claim Federal Investment Tax Credit (FITC) incentive

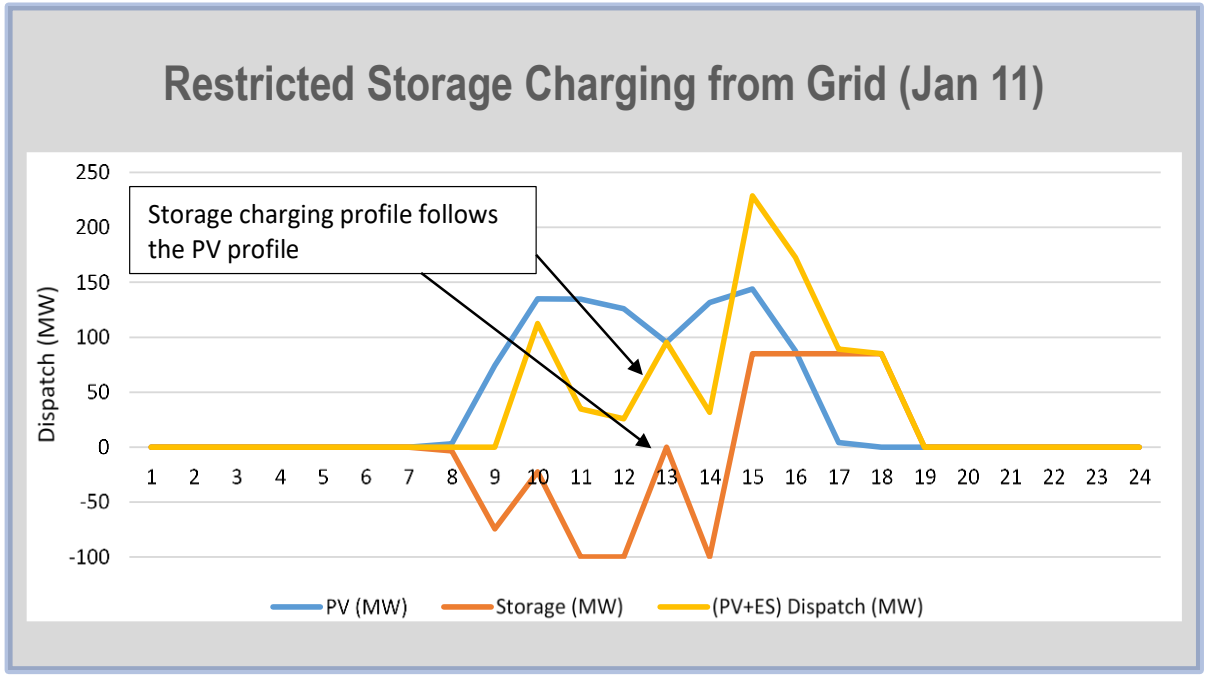
	Provide Energy Time Shift and Spinning Reserve	Restrict Charging from Grid	Restrict Charging from Grid and Discharge Min	Provide Frequency Response
Case #1	✓		✓	
Case #2	✓		✓	✓
Case #3	✓	✓		
Case #4	✓	✓		✓

LADWP Full Report: *Integrating Energy Storage System with Photovoltaic Generation: Analysis within Los Angeles Department of Water and Power (LADWP) Service Territory to Meet SB801 Requirements* at http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002013007

LADWP Case Results - Dispatch

- Impact of grid charging constraints:

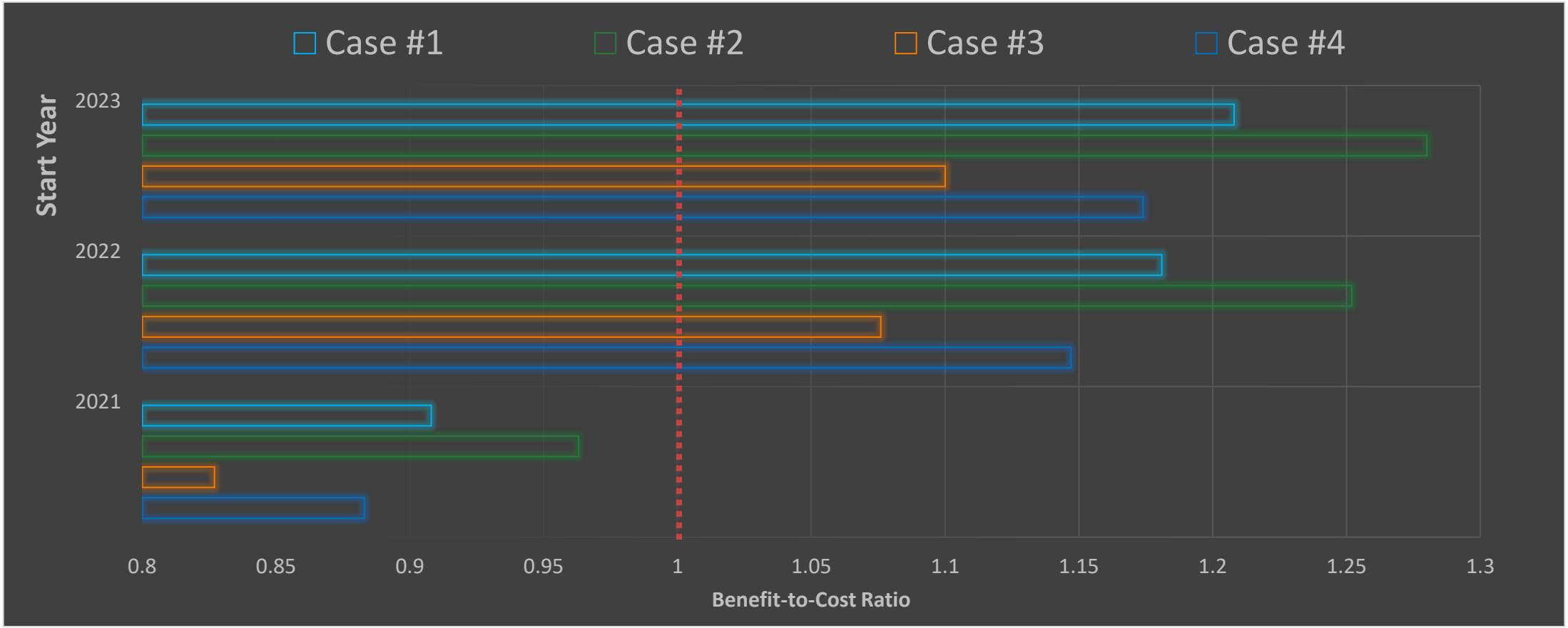




DER-VET Optimized Dispatch Outputs

LADWP Case Results - CBA

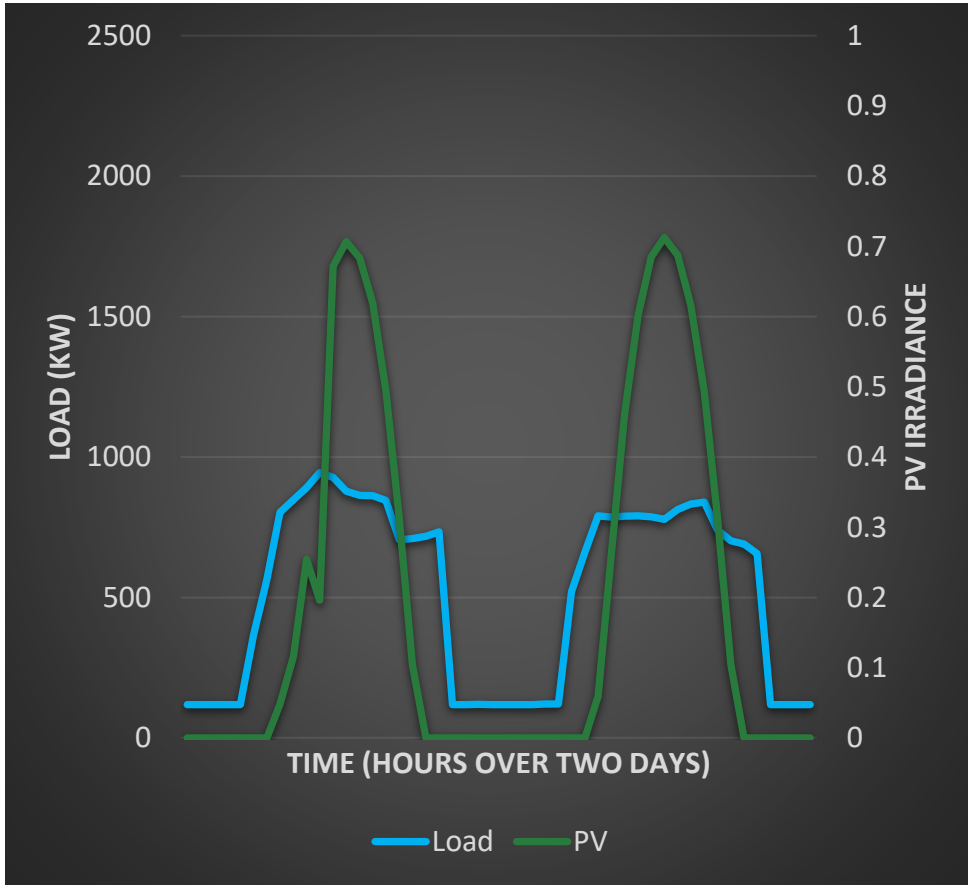
- Several cases resulted in benefit-cost ratios greater than one for project start years after 2022 as illustrated in the graph below



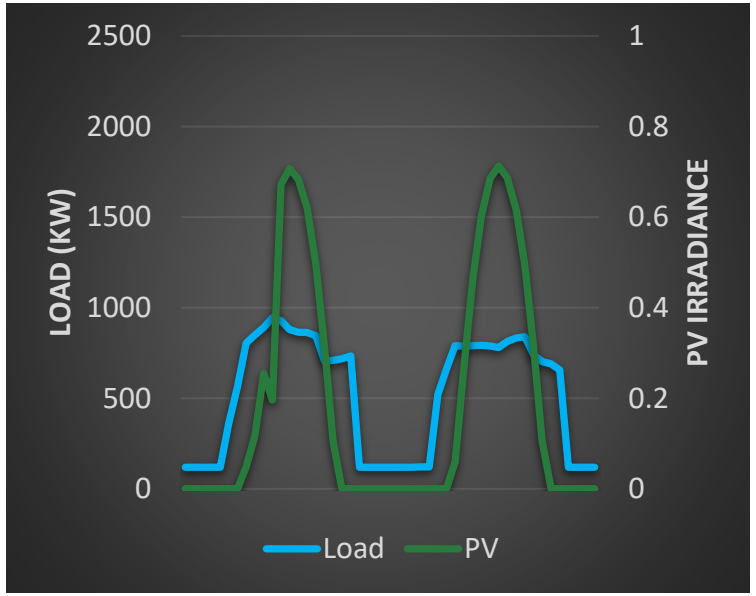
Microgrid Design for California Public Service Power Shutoffs (PSPS) Events

Microgrid Design - DER-VET Modeling Assumptions

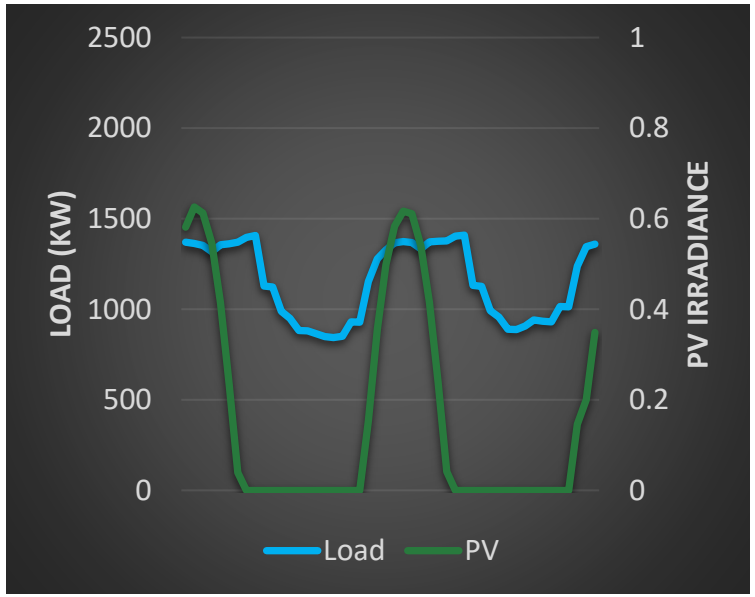
- Identify potential Public Safety Power Shutoff (PSPS) planned events and duration in California
- Solar PV plus battery energy storage microgrid technologies
- Initial storage state of charge at the start of outage event is 100% with advanced PSPS notifications



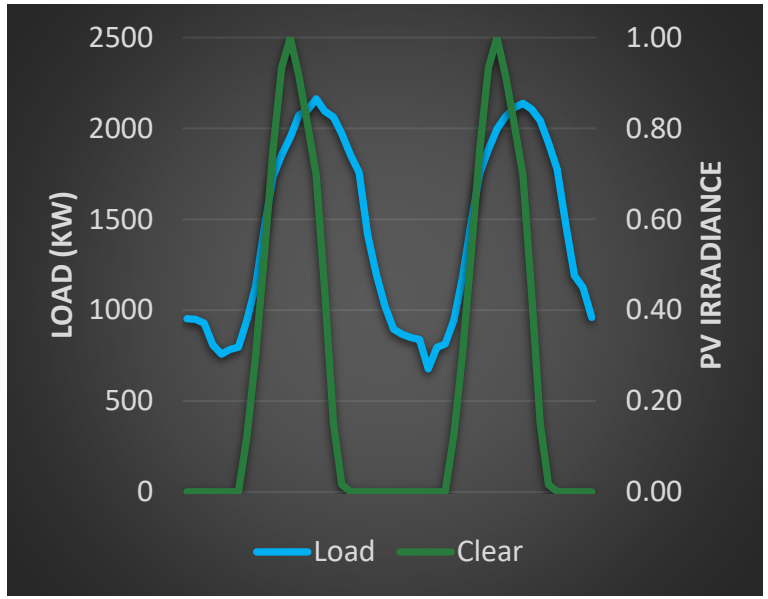
Load and PV Profile



Peak load – 0.9 MW
24hr load requirement – 13MWh
36hr load requirement – 18MWh
48hr load requirement – 25MWh



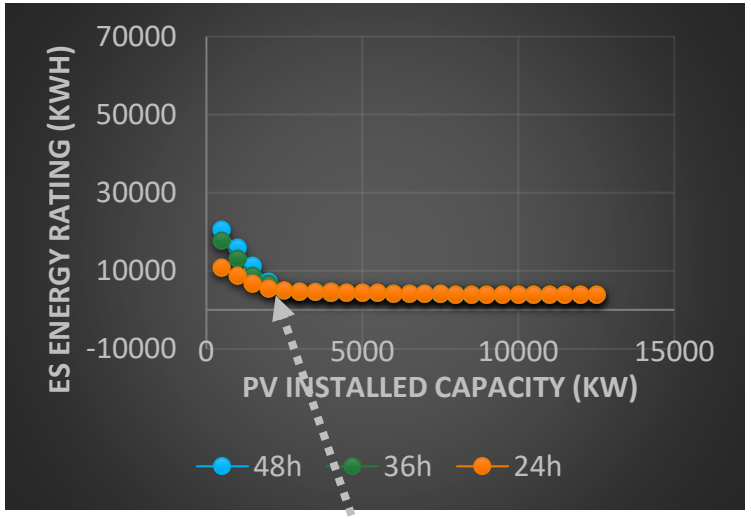
Peak load – 1.4 MW
24hr load requirement – 28MWh
36hr load requirement – 43MWh
48hr load requirement – 55MWh



Peak load – 2.16 MW
24hr load requirement – 35MWh
36hr load requirement – 48MWh
48hr load requirement – 76MWh

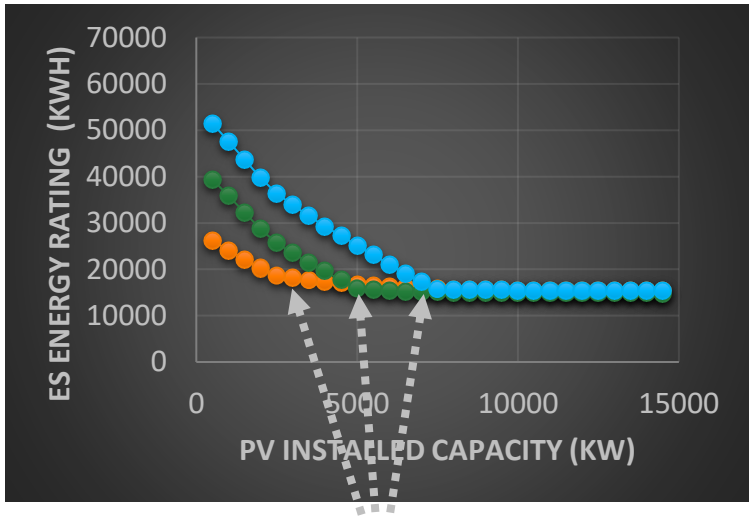
Microgrid Sizing Results

LA – Sec School



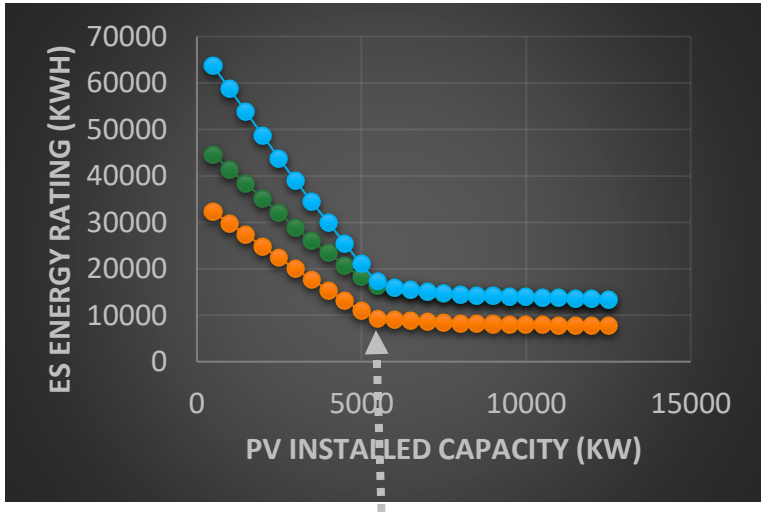
2.5MW PV +
0.735MW/4.9MWh ES

LA - Hospital



24h – 3.5MW PV+1.4MW/17MWh ES
36h – 5MW PV+1.6MW/15MWh ES
48h – 7.5MW PV+3MW/15MWh ES

SCE Feeder

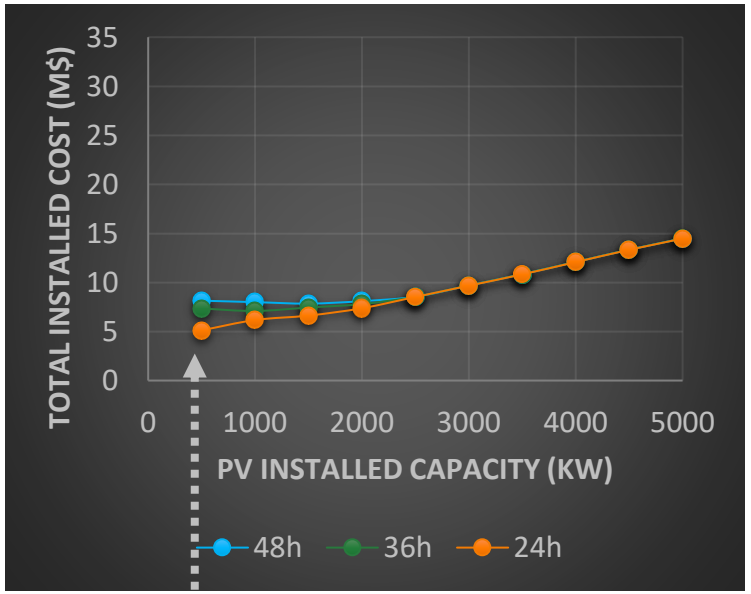


24h – 5.5MW PV+1.9MW/9.2MWh ES
36h– 5.5MW PV+1.9MW/17.2MWh ES
48h – 5.5MWPV +2 MW/17.2MWh ES

The energy storage and PV size corresponding to the knee point. Knee-point is a point where adding more PV does not affect the size of energy storage significantly.

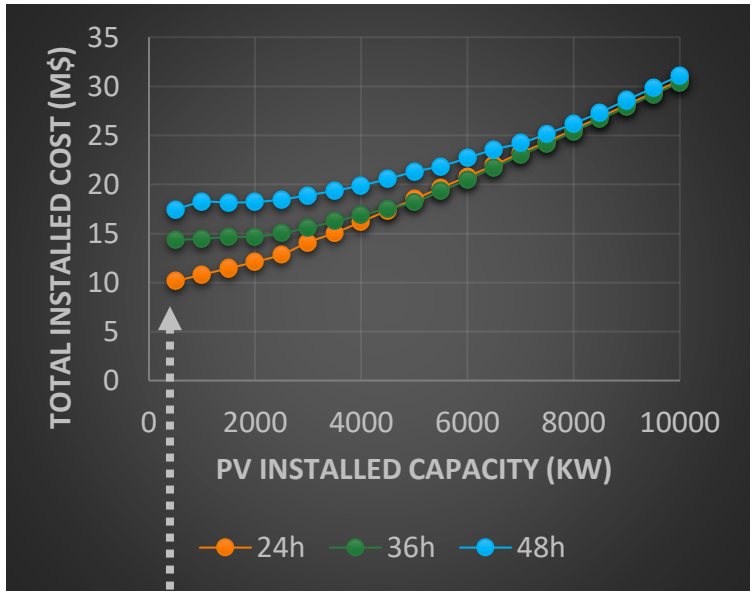
Microgrid Cost Summary

LA – Sec School



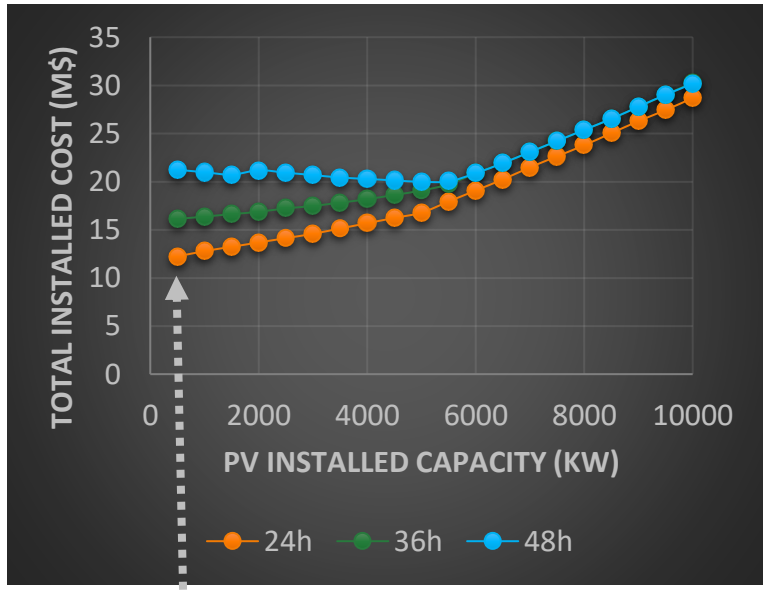
Min Cost of covering 24, 36, and 48hr outage – **$5M, $7M, and $8M**

LA - Hospital



Min Cost of covering 24, 36, and 48hr outage – $**10M, $14M, and $18M**

SCE Feeder



Min Cost of covering 24, 36, and 48hr outage – $**12M, $16M, and $22M**

Together...Shaping the Future of Energy®