Informing Energy Storage and Storage-Enabled Microgrid Project Decisions Using EPRI's DER-VET™

August Webinar Series

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August 2022

The Challenges of Storage, DER*, & Microgrid Modeling

- Today's storage, DER, and microgrid deployments demand robust analysis for strategic planning

- Valuation of storage requires project-level application and location analyses

- Complex co-optimization and decision-making process

*DER: Distributed Energy Resources

EPRI's DER-VET™ address these challenges

The Solution: EPRI's DER-VET™

Bridges industry gaps in project-level energy storage, DER, and microgrid analysis

Creates a common communication tool among all stakeholders

Evaluates various perspectives from customers values to grid values in any market

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

2022
EPRI DER-VET™ V1.2
1,000+ Users

www.der-vet.com

2016
EPRI StorageVET®

www.storagevet.com

Access **DER-VET** now at der-vet.com

2013
EPRI ESVT

Cost-Effectiveness of Energy Storage in California
https://www.epri.com/research/products/000000003002001164

2020
EPRI DER-VET Beta

202X
DER-VET User Group and Open-Source Developer Community

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Input and Output Examples in DER-VET
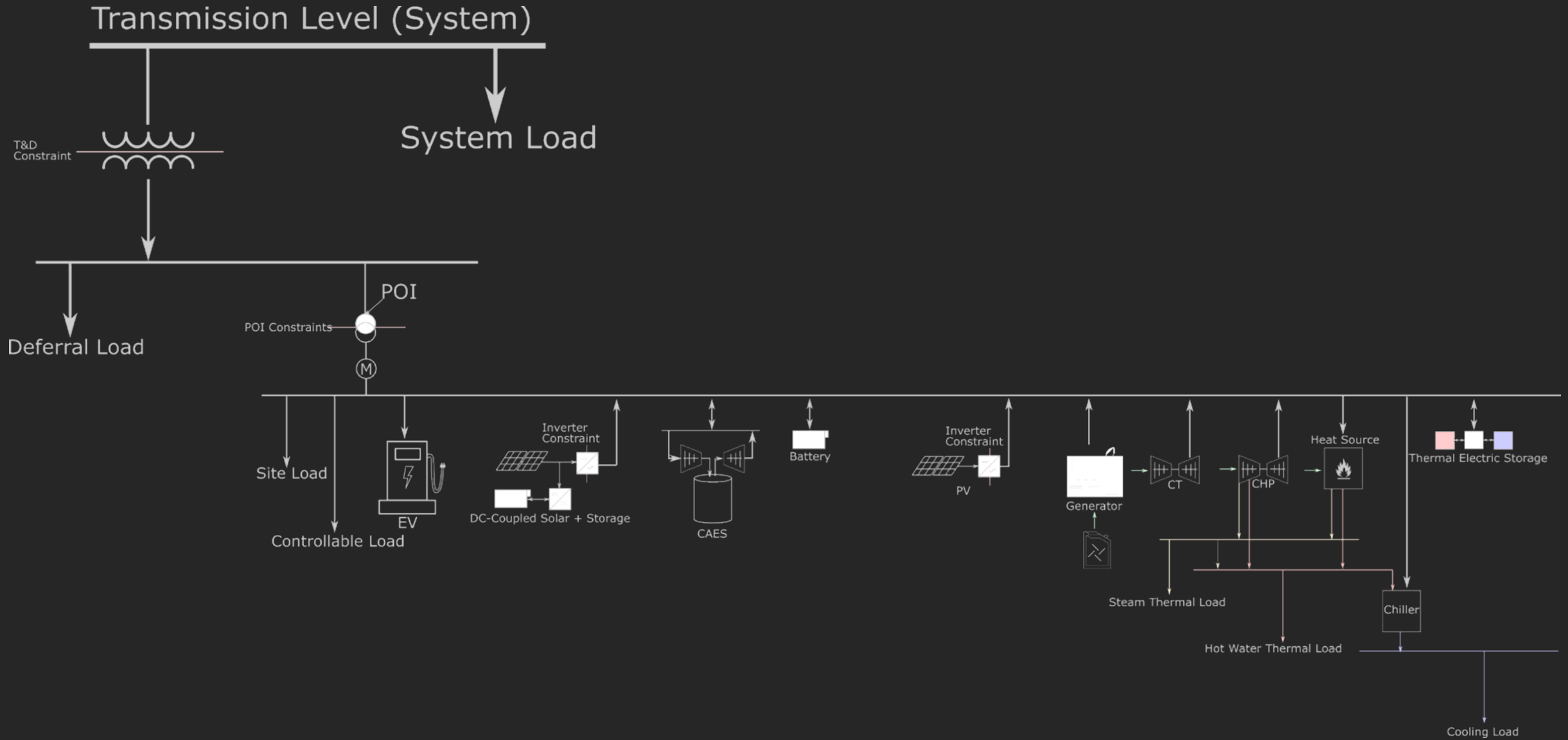
DER-VET Project Configuration Example

DER-VET Dispatch Results Example
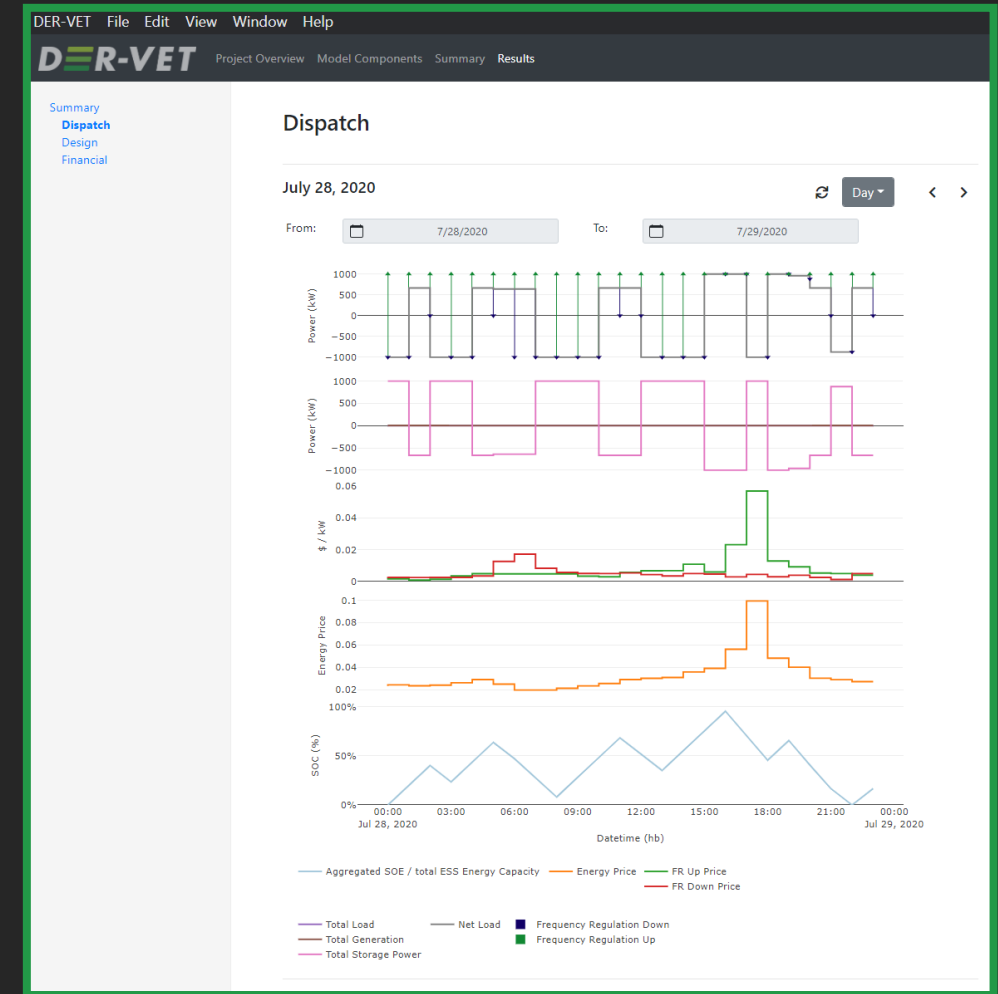
Technologies in DER-VET

Technologies in DER-VET: Today's Demonstration Focus
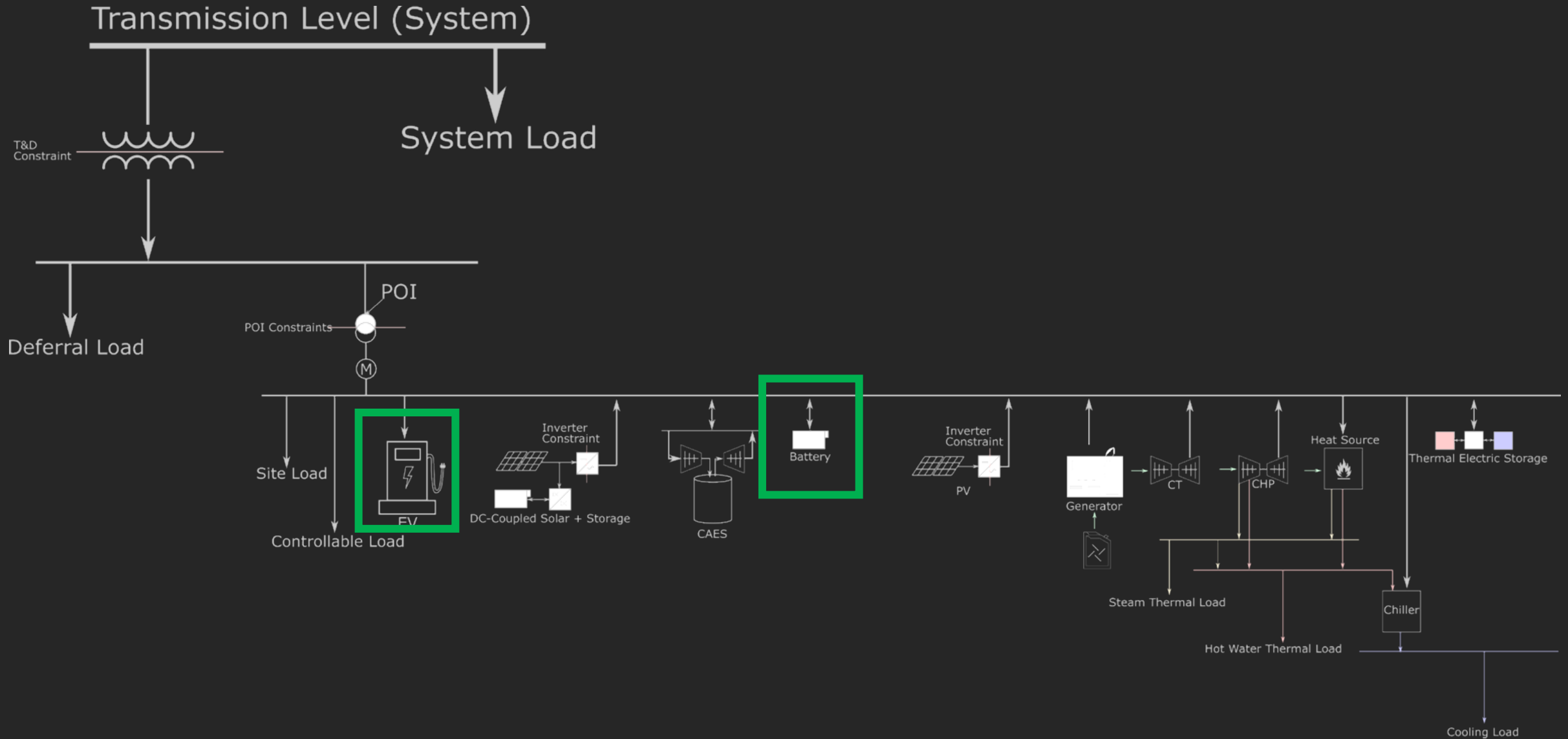
Services in DER-VET
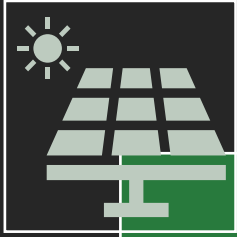
Bulk Market Services
- Energy Time Shift
- Load Following
- Frequency Regulation
- Spinning Reserves
- Non-spinning Reserves
- Resource Adequacy Capacity

T&D Services
- Upgrade Deferral
- Reliability/Resilience

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

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Services in DER-VET: Today's Demonstration Focus

Bulk Market Services

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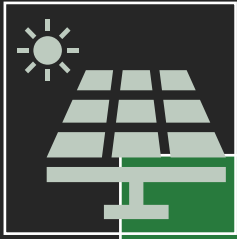- **Resource Adequacy Capacity**

T&D Services

- Upgrade Deferral
- Reliability/Resilience

Customer Services

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

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DER-VET Engagement

- Visit <u>www.der-vet.com</u>:
  - Download the tool for free
  - Reference case examples
  - Help forums, how-to videos, and documentation
  - Engage with monthly Public ESIC Task Force Web Meetings

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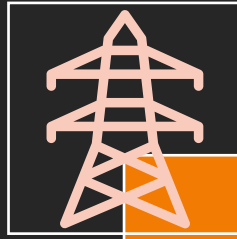
Long Duration Energy Storage (LDES) DER-VET Demo

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Project Configuration

Name

CESA LDES Demo

Start Year

2022

Year the project starts.

Analysis Window

Analysis Horizon Mode

- ● User-defined
- ○ The shortest DER lifetime
- ○ The longest DER lifetime

Define when to end cost benefit analysis. Choose it yourself, or by the lifetimes of your equipment

Analysis Horizon

20 years

The number of years the analysis will go for. The analysis will not consider equipment lifetime or anything else when determining the number of years to run for.

Time Series Data

Data Year (Baseline)

2022

Commonly the project start year. Data for additional years will be escalated from this value.

Timestep

60 minutes

What is the frequency of the time-series data?

Grid Domain

- ○ Generation
- ● Transmission
- ○ Distribution
- ○ Customer

Which grid domain or location the project will be connected to. Please refer to documentation for further guidance on which services are available in your selected domain.

Ownership

- ○ Customer
- ○ Utility
- ● 3rd Party

Who owns the assets?

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Services

Size equipment in microgrid
- ◯ Yes
- ⬤ No

Are there any microgrid components that you want to optimally size for?

Optimization Horizon

Optimization Window

[Months ▾]

We recommend:

- Month for Customer Services.

- Hours for Wholesale Services.

- Year to assume perfect forsight of an entire year.

Where do energy prices come from?

Energy Price Source

- ◯ Retail tariff, PPA, or other fixed contract (define energy price structure)
- ⬤ Wholesale energy market, production cost model, or other time-varying source (upload time series data)

Will the project be reducing energy charges on a retail electricity bill?

Day ahead energy time shift.

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Customer Services

☐ **Reliability**

Define a number of hours the site must be capable of covering a grid outage for. DER-VET will size and operate the DERs to guarantee coverage for outages of this duration.

☐ **Demand Charge Reduction**

Will the project be reducing demand charges on a retail electricity bill?

☐ **Backup**

Will a portion of energy always be reserved to be used in case of a grid outage?

☐ **Demand Response Program**

Will the assets be mindful of their energy consumption during certain hours of the year?

Wholesale/Bulk Services

☐ **Spinning Reserves**   ☐ **Non-Spinning Reserves**

☐ **Frequency Regulation**   ☐ **Load Following**

☑ **Resource Adequacy**

Grid Support

☐ **Deferral**

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Distributed Energy Resources (DERs)

0

Internal Combustion Engine (ICE) Generator Sets

Add

0

Diesel Generator Sets

Add

0

Solar Photovoltaic (PV) Sytems

Add

1

Battery Energy Storage Sytems (BESS)

Add

0

Single Electric Vehicle (EV)

Add

0

Fleet Electric Vehicle (EV)

Add

0

Controllable Loads (Demand Response)

Add

List of Technologies Added

Battery: Flow Battery	Deactivate 🗑

CalEnviroScreen

CalEnviroScreen is a mapping tool that helps identify California communities that are most affected by many sources of pollution, and where people are often especially vulnerable to pollution's effects. It uses environmental, health, and socioeconomic information to produce scores for every census tract in the state. To find the approximate impact of your project, enter your zip code below. For more information, please visit the CalEnviroScreen homepage.

Zip code [   ] [Go]

CalEnviroScreen scores for the census tracts in zip code **94304**:

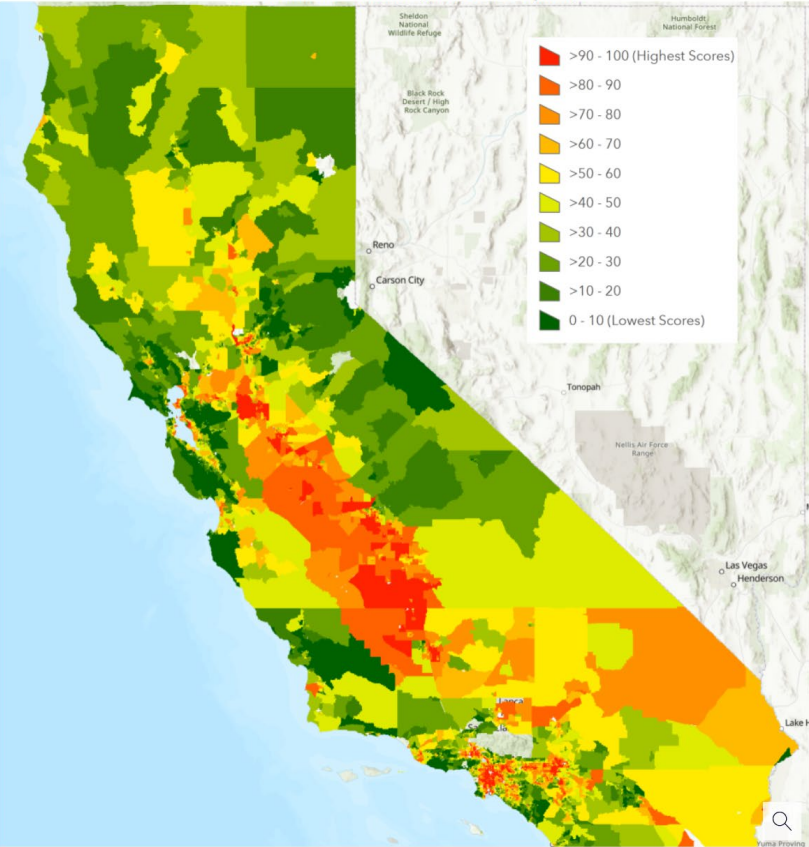| Census Tract	CES Score
6085511609	6.71
6085511705	4.72

CalEnviroScreen 4.0 Results (October 2021 Update)

Image from California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA)

Technology: Battery Storage

Component Name

Flow Battery

Energy Capacity Sizing

○ Have DER-VET size the Energy Capacity

● Known size

Energy Capacity

400000 kWh

What is the energy capacity of the battery storage?

Power Capacity Sizing

○ Have DER-VET size the Power Capacity

● Known size

Different Charge and Discharge Power Capacities?

○ Yes

● No

Power Capacity

50000 kW

What is the power capacity of the battery storage?

Roundtrip Efficiency

63 %

What is the AC roundtrip efficiency of the storage system? Only this single number is considered - no variable efficiency is modeled.

State of Charge

Upper SOC Limit

100 %

Energy Storage SOC upper bound

Target SOC

50 %

What state of charge should the battery storage system return to at the end of each optimization window?

Lower SOC Limit

0 %

Energy Storage SOC lower bound

Self-Discharge Rate

0 % / hour

What percent of the remaining stored energy will be wasted by the batteries every hour due to self-discharge?

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Limit Daily Cycling?

○ Yes
● No

Constrain the battery storage system's daily discharge energy. When selected, this input limits the amount of discharge energy a battery can do in any 24-hr period to a maximum of its rated energy capacity * daily cycle limit.

Cycle Degradation

Include degradation due to cycling?

○ Yes
● No

When selected, this will calculate degradation due to cycling based on the cycle life curve and combine this degradation with the calculated calendar degradation. * Note: Not compatible with deferral service.

Include Housekeeping Calculations?

○ Yes
● No

Include Housekeeping Power? – Apply a constant AC power consumption that does not discharge the battery directly. This is usually associated with HVAC requirements and keeping all equipment on.

Cost Function

Capital Cost

| 0 | $

Capital Cost per kW

| 768 | $ / kW

What is the capital cost per kW for the storage discharge power capacity?

Capital Cost per kWh

| 234 | $ / kWh

What is the capital cost per kWh for the storage energy capacity?

Fixed O&M Costs

| 11 | $ / kW-year

What is the cost of fixed operations and maintenance for the battery storage system?

Variable O&M Costs

| 0 | $ / MWh-year

What is the variable cost of operations and maintenance for the battery storage system?

Construction Year

| 2021 |

In what year will construction start?

Operation Year

| 2022 |

In what year will operation start (COD)?

Expected Lifetime	20 years	The number of years this technology will operate before new equipment is required to continue operation.
Replaceable?	○ Yes ● No	Will this technology be replaced at its end of lifetime or not?
Decomissioning Cost	0 $	The cost to decommission this technology when it reaches its expected lifetime end
Salvage Value	Sunk Co ⌄	Applies a financial benefit in the last year of the analysis window if the resource is not beyond its end of life. **Sunk Cost** means that there is no end of analysis value (salvage value = 0), **Linear Salvage Value** which will calculate salvage value by multiplying the technology's capital cost by (remaining life/total life), or **User Defined** to specify the exact salvage value of the technology.
Technology Escalation Rate	0 %	The rate at which this technology's cost increases or decreases in cost each year. A negative value indicates the technology is decreasing in cost over time. A value equal to the inflation rate indicates that the real cost of the technology is constant.
MACRS Term	15 ⌄ years	Which MACRS GDS category does this technology fall into?

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Services: Resource Adequacy

Number of Events	21 days	How many times will a resource be called on to fulfill its resource adequacy obligation in one year?
Duration of Events	4 hours	How long will a resource adequacy event last for?
Dispatch Mode	● Constrain power ○ Constrain energy	How should the DERs dispatch in response to the program?
Event Selection Method	○ Peak by Year ● Peak by Month ○ Peak by Month with Active Hours	Based on the system load, how are resource adequacy events selected?
Growth Rate of Resource Adequacy Awards	3 % / year	A per year increase from the baseline year. This is the project start year.

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Services: Day Ahead Energy Price

Growth Rate of Day Ahead Energy Prices

[3] % / year

A per year increase from the baseline year. This is the project start year.

Upload the **day ahead price ($/kWh)** as a `.csv` file that contains a reading for each timestep on a separate line. The selected data year is 2022 and selected data frequency is 60 minutes, so we require an input file with **8760** entries.

*Download a sample **DAPrice**.csv **file** with a 60-minute timestep for a year with 365 days (8,760 entries).*

Choose File	No file chosen

Remove Data

DA Price ($/kWh)

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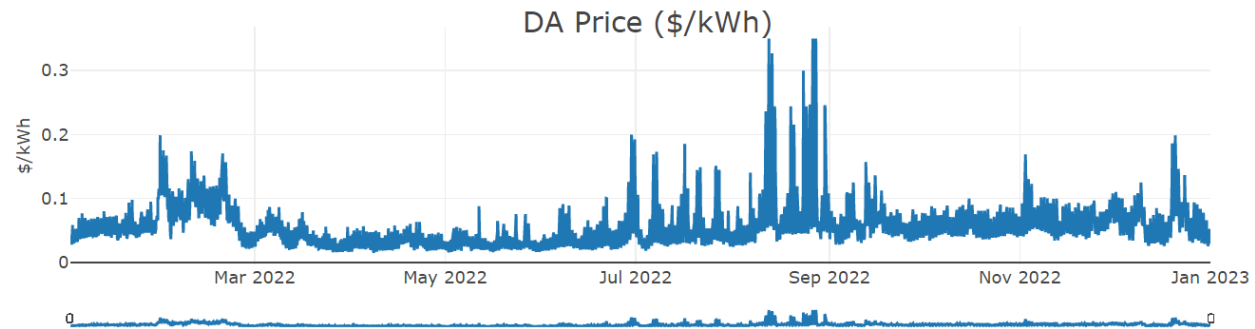
External Incentives

Specify by entering the external incentives one year at a time or by importing in bulk from an export file.

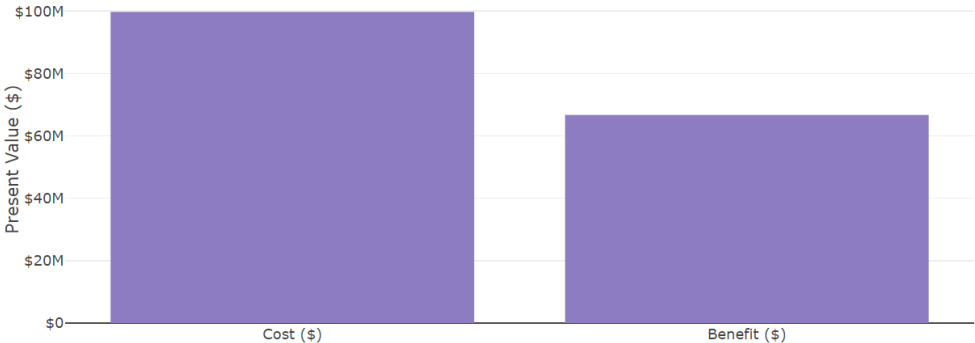| Year	Tax Credit (nominal $)	Other Incentive (nominal $)	🗑
2021	39600000	0	Edit | 🗑

Add External Incentives   ⬆ Import Incentives

⬇ Export Incentives

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Cost versus Benefit by Value Stream

Legend:
- State Tax Burden
- Resource AdequacyCapacity Payment
- Overall Tax Burden
- Federal Tax Burden
- DA ETS
- BATTERY: flow battery Variable O&M Cost
- BATTERY: flow battery Salvage Value
- BATTERY: flow battery Fixed O&M Cost
- BATTERY: flow battery Decommissioning Cost
- BATTERY: flow battery Capital Cost

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Li-Ion Comparison

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Technology: Battery Storage

Component Name

Li-ion Battery

Energy Capacity Sizing

○ Have DER-VET size the Energy Capacity

● Known size

Energy Capacity

400000 kWh

What is the energy capacity of the battery storage?

Power Capacity Sizing

○ Have DER-VET size the Power Capacity

● Known size

Different Charge and Discharge Power Capacities?

○ Yes

● No

Power Capacity

50000 kW

What is the power capacity of the battery storage?

Roundtrip Efficiency

86 %

What is the AC roundtrip efficiency of the storage system? Only this single number is considered - no variable efficiency is modeled.

Cost Function

Capital Cost
`0` $

Capital Cost per kW
`273` $ / kW
What is the capital cost per kW for the storage discharge power capacity?

Capital Cost per kWh
`216` $ / kWh
What is the capital cost per kWh for the storage energy capacity?

Fixed O&M Costs
`6` $ / kW-year
What is the cost of fixed operations and maintenance for the battery storage system?

Variable O&M Costs
`0` $ / MWh-year
What is the variable cost of operations and maintenance for the battery storage system?

Construction Year
`2021`
In what year will construction start?

Operation Year
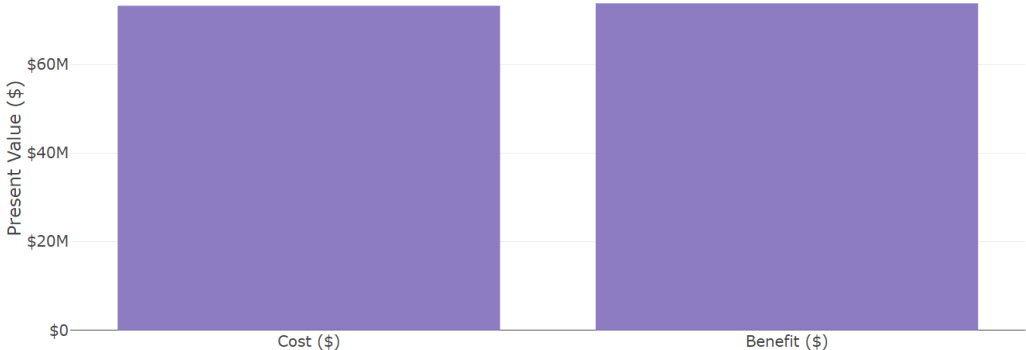`2022`
In what year will operation start (COD)?

Expected Lifetime
`15` years
The number of years this technology will operate before new equipment is required to continue operation.
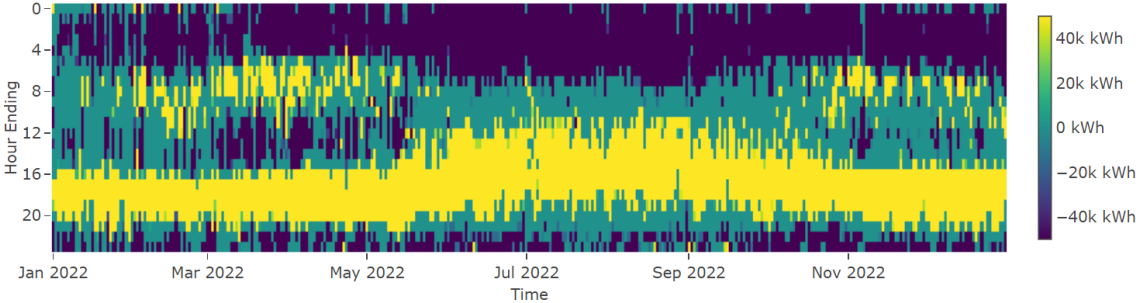
Financials Summary

Lifetime Present Value

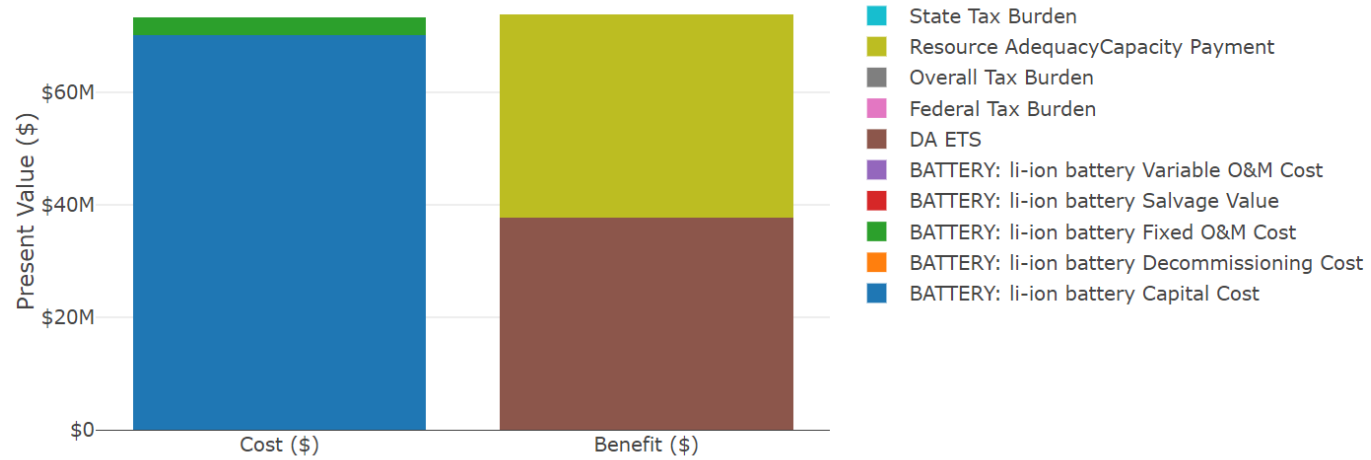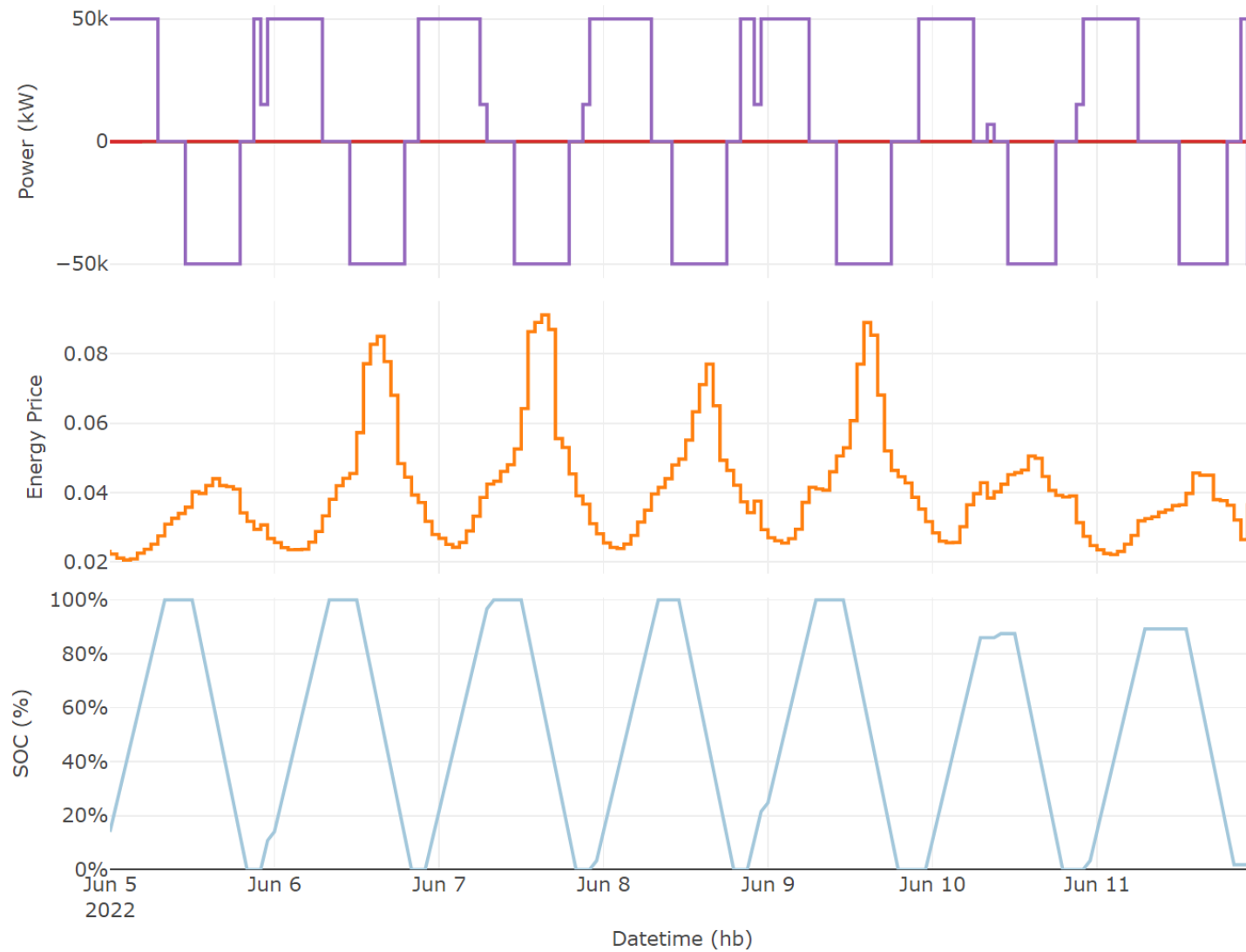**View Detailed Financials Results...**

Dispatch Summary

Battery Dispatch

View Detailed Dispatch Results...

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Cost versus Benefit by Value Stream

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Standalone Storage ITC

- 30% used in these cases

- More is possible with add-ons, such as if the project benefits disadvantaged communities, up to 50%

- These cases use reduced capital cost inputs to capture ITC, which does not fully capture tax implications

  – As the implementation is resolved, it may impact how ITC calculations are done in DER-VET

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DER-VET Engagement

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