DOE-OE Energy Storage Technology Advancement Partnership (ESTAP) Webinar

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

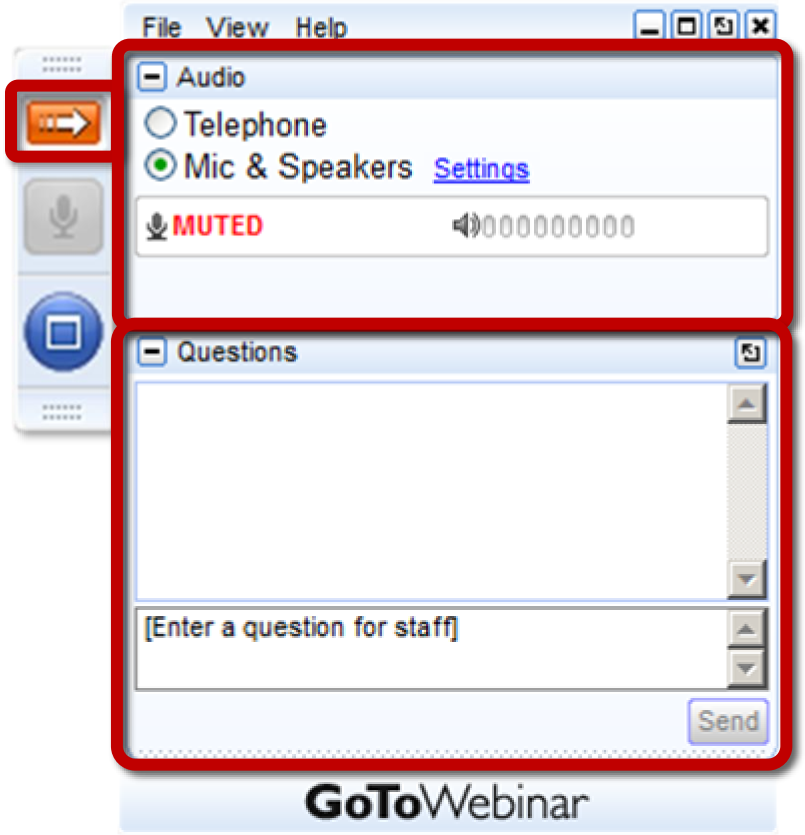
August 24, 2022

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

Clean Energy States Alliance

Webinar Logistics



Join audio:

- Choose Mic & Speakers to use VoIP
- Choose Telephone and dial using the information provided

Use the orange arrow to open and close your control panel

Submit questions and comments via the Questions panel

This webinar is being recorded. We will email you a webinar recording 48 hours. This webinar will be posted on CESA's website at www.cesa.org/webinars

CleanEnergy States Alliance

State of California Energy Commission

Connecticut Green Bank SM

Department of Energy & Environment

Energy Trust of Oregon

IPA Illinois Power Agency

Governor's Energy Office (Maine)

Maryland Energy Administration

Massachusetts Clean Energy Center®

EGLE Michigan Department of Environment, Great Lakes, and Energy

mn Commerce Department

State of New Hampshire Department of Energy

BPU New Jersey Board of Public Utilities

New Jersey's cleanenergy program™ njcleanenergy.com

New Mexico emnrd Energy, Minerals and Natural Resources Department

NYSERDA

State of Rhode Island Office of Energy Resources

SMUD™ Powering forward. Together.

Vermont Department of Public Service Clean Energy Development Fund

Virginia Energy

Washington State Department of Commerce

OEI Wisconsin Office of Energy Innovation

Connecticut Energy Environment

Illinois Commerce Commission ICC

Inclusive Prosperity Capital

DOER Massachusetts Department of Energy Resources

MassDEP

NREL National Renewable Energy Laboratory

Commissioner Stephanie Garcia Richard New Mexico State Land Office

OPC-DC Office of the People's Counsel Advocacy | Education | Protection

Oregon Department of Energy

Prairie Island Indian Community in the State of Minnesota

Rhode Island Commerce Corporation

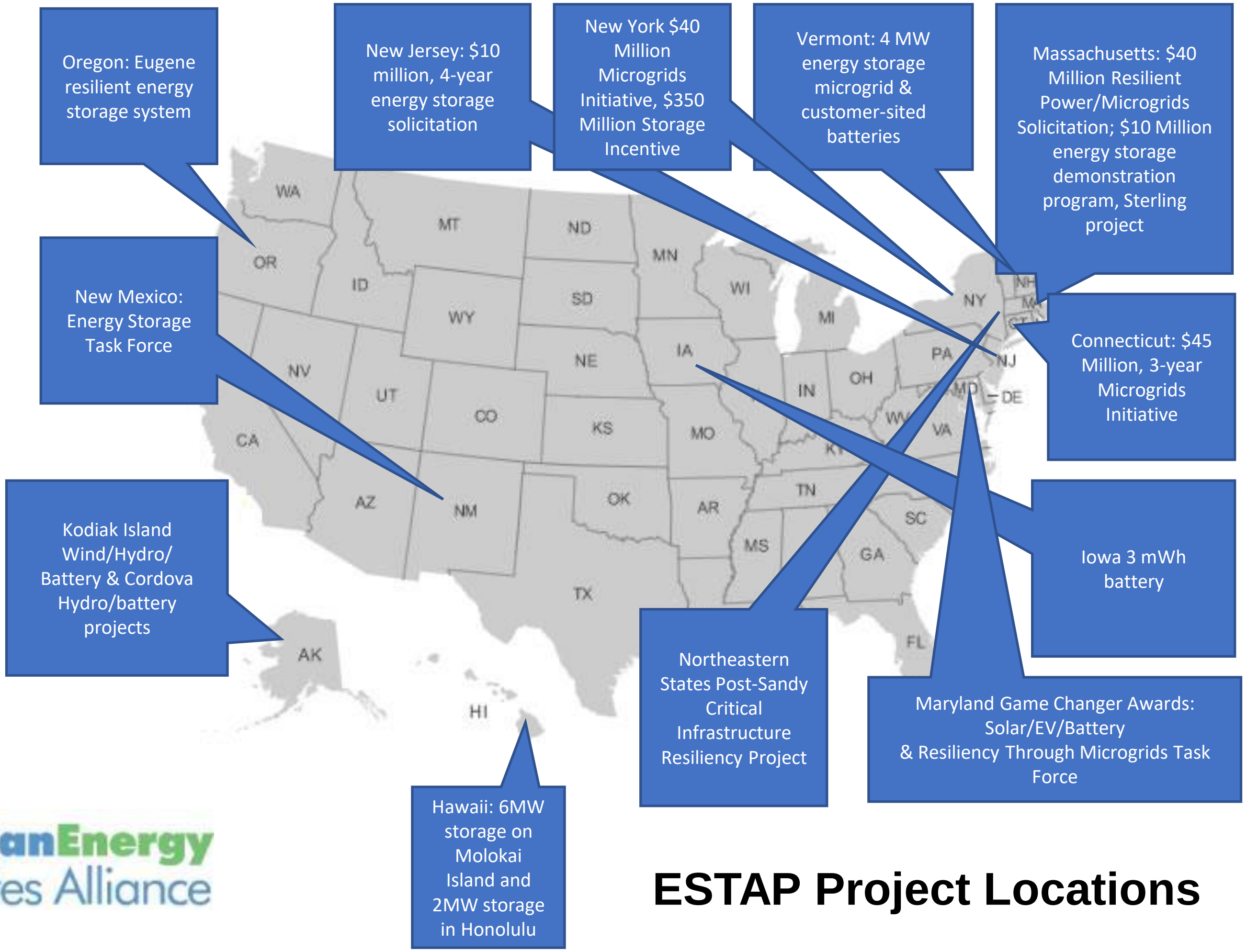
Smart Electric Power Alliance

DOE-OE Energy Storage Technology Advancement Partnership

The Energy Storage Technology Advancement Partnership (ESTAP) is a US DOE-OE funded federal/state partnership project conducted under contract with Sandia National Laboratories.

ESTAP Key Activities:

1. Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment
2. Disseminate information to stakeholders
   - ESTAP listserv >5,000 members
   - Webinars, conferences, information updates, surveys.
3. Support state energy storage efforts with technical, policy and program assistance



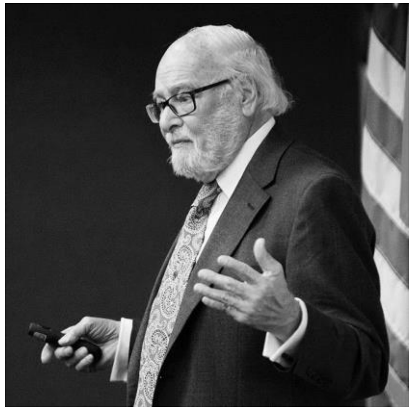
ESTAP Project Locations

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

CleanEnergy States Alliance

Thank You!



Dr. Imre Gyuk
Director, Energy Storage Research,
U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

Dan Borneo
Engineering Project/Program Lead,
Sandia National Laboratories

Sandia National Laboratories

Webinar Speakers

- **Mike Gravely**, California Energy Commission
- **Hatice Gecol**, California Energy Commission
- **Giovanni Damato**, Electric Power Research Institute
- **Ramakrishnan Ravikumar**, Electric Power Research Institute
- **Miles Evans**, Electric Power Research Institute
- **Andrew Etringer**, Electric Power Research Institute
- **Anna Adamsson**, Clean Energy States Alliance (moderator)

CALIFORNIA ENERGY COMMISSION

ELECTRIC POWER RESEARCH INSTITUTE

Clean Energy States Alliance

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

CESA Webinar

Giovanni Damato, EPRI
Miles Evans, EPRI
Andrew Etringer, EPRI
Ram Ravikumar, EPRI

August 24, 2022

The Challenges of Storage, DER*, & Microgrid Modeling

- Today's storage, DER, and microgrid environment demands 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

EPRI

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

2013
EPRI ESVT

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

2016
EPRI StorageVET®

www.storagevet.com

2020
EPRI DER-VET Beta

2022
EPRI DER-VET™ V1.2
1,000+ Users

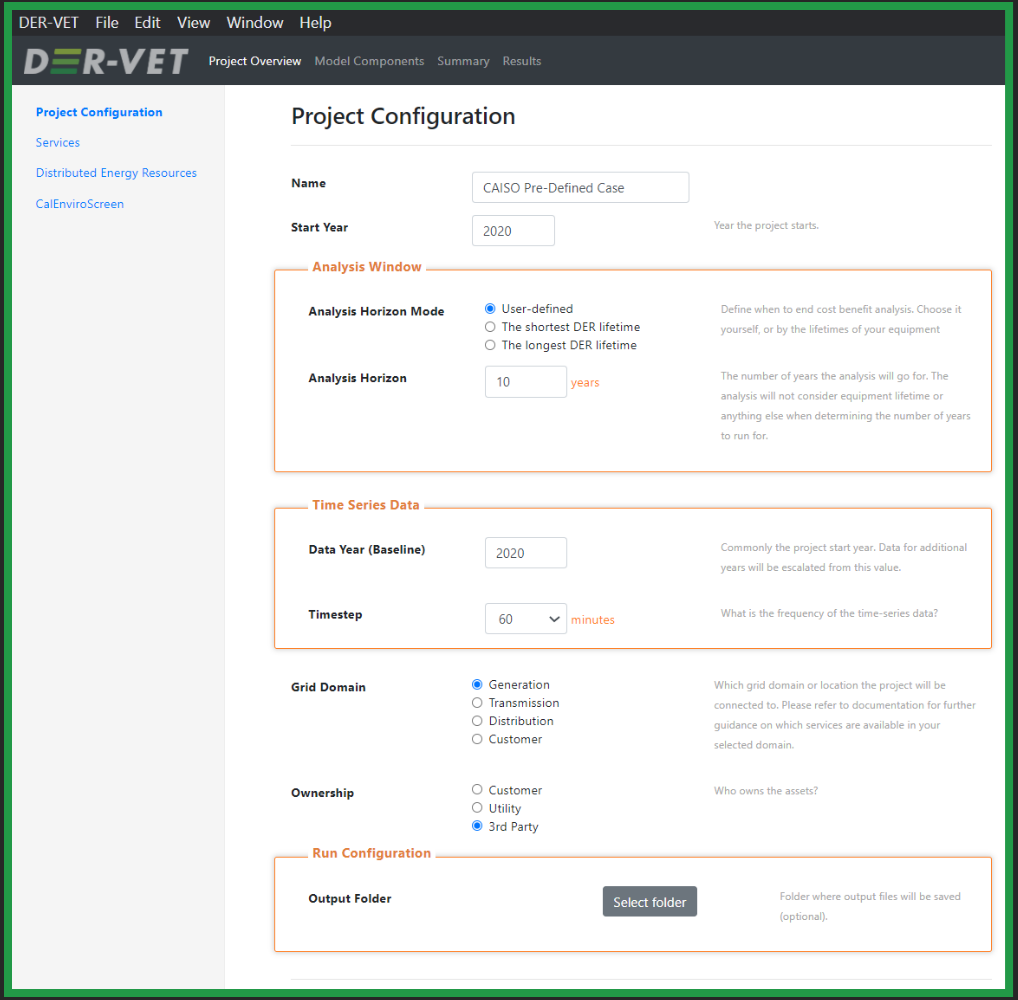
www.der-vet.com

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

Access DER-VET now at der-vet.com

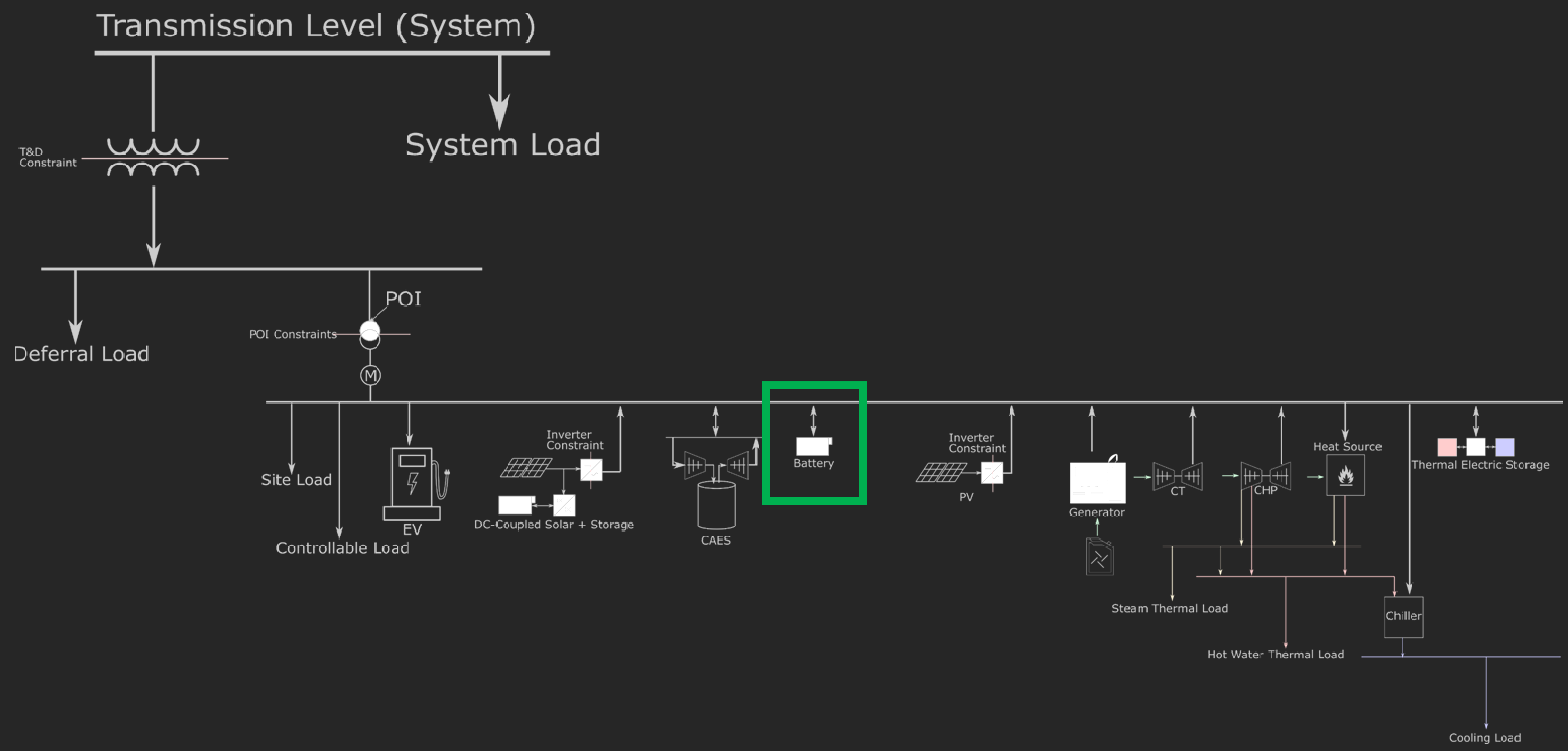
Input and Output Examples in DER-VET

DER-VET Project Configuration Example



DER-VET Dispatch Results Example

Technologies in DER-VET



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

DER-VET Engagement

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

Long Duration Energy Storage (LDES) DER-VET Demo

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?

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.

Customer Services

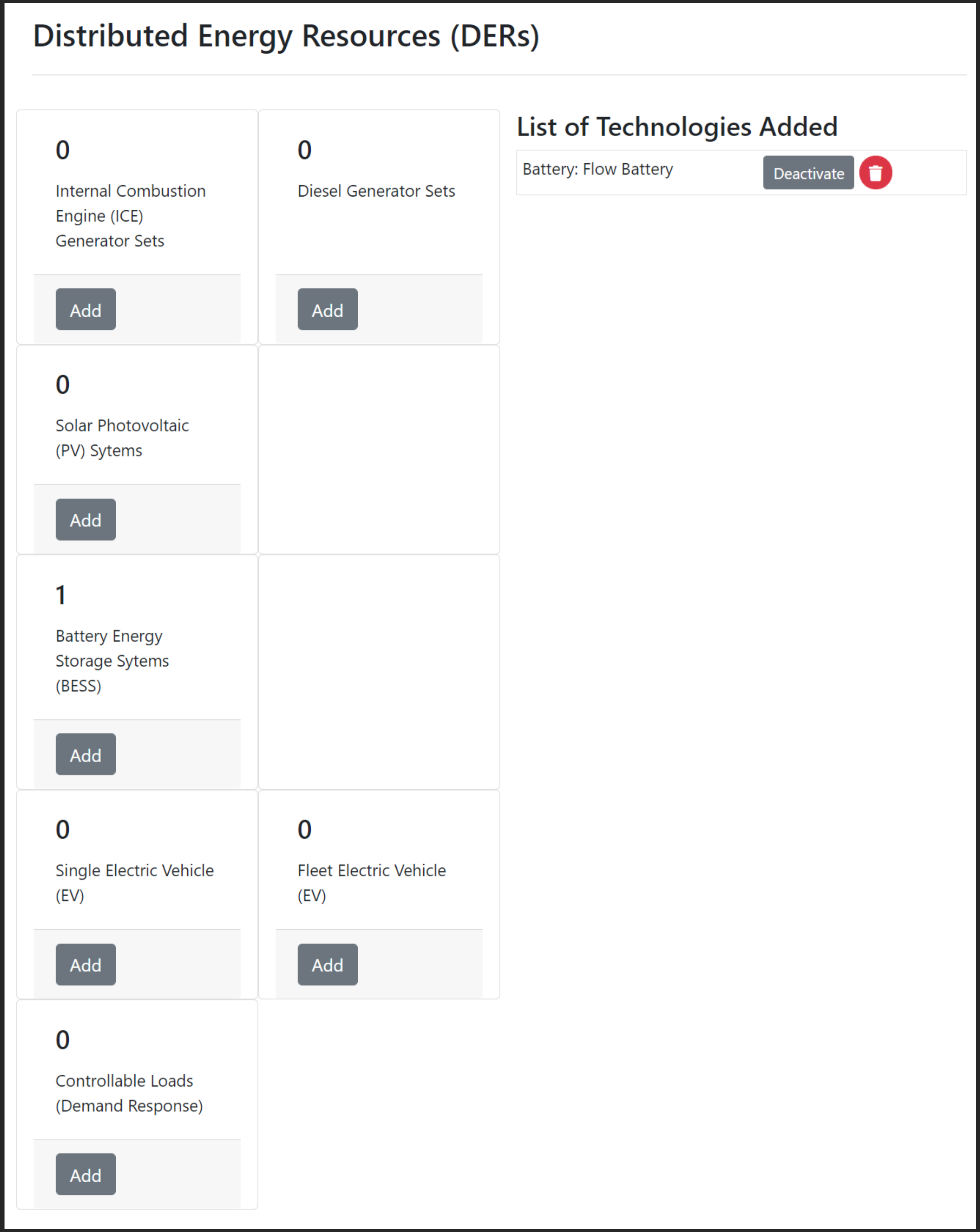
- [ ] **Reliability** — Define a number of hours the site must be capable of covering a grid outage for. DER-VET will size and operate the DERs to guarantee coverage for outages of this duration.
- [ ] **Demand Charge Reduction** — Will the project be reducing demand charges on a retail electricity bill?
- [ ] **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**
- [x] **Resource Adequacy**

Grid Support

- [ ] **Deferral**


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)

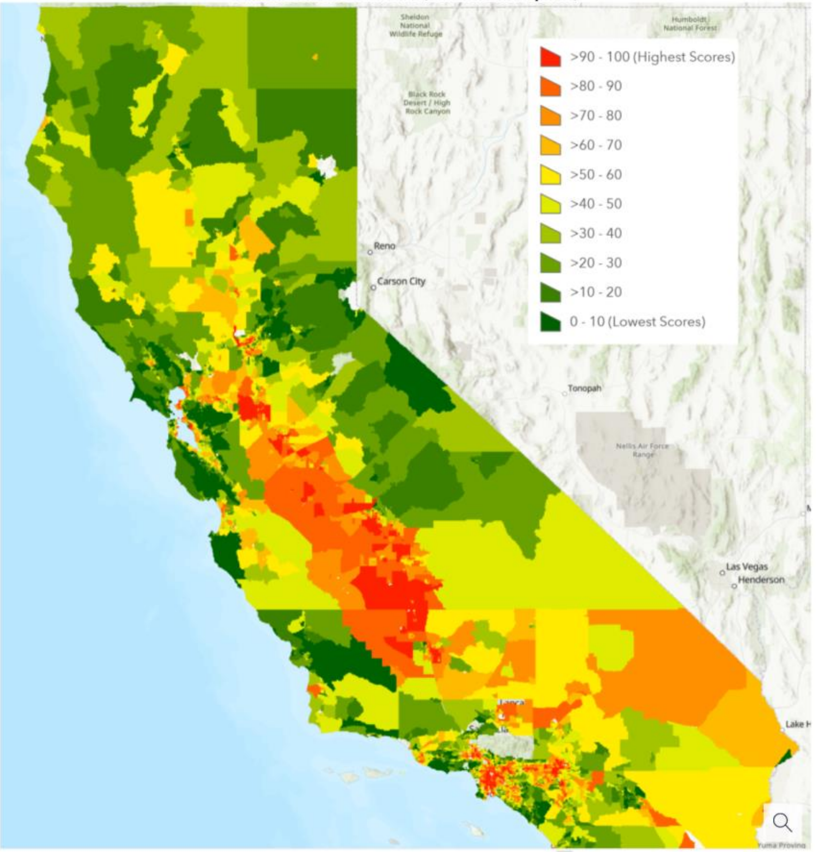


Image from California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA)

Define Components

Technologies

Battery: Flow Battery

Services

Site Information

System Information

Resource Adequacy

Day Ahead Pricing

Financial

Miscellaneous Inputs

External Incentives

Done Defining Components

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?

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?

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.

Services: Day Ahead Energy Price

Growth Rate of Day Ahead Energy Prices 3 % / year

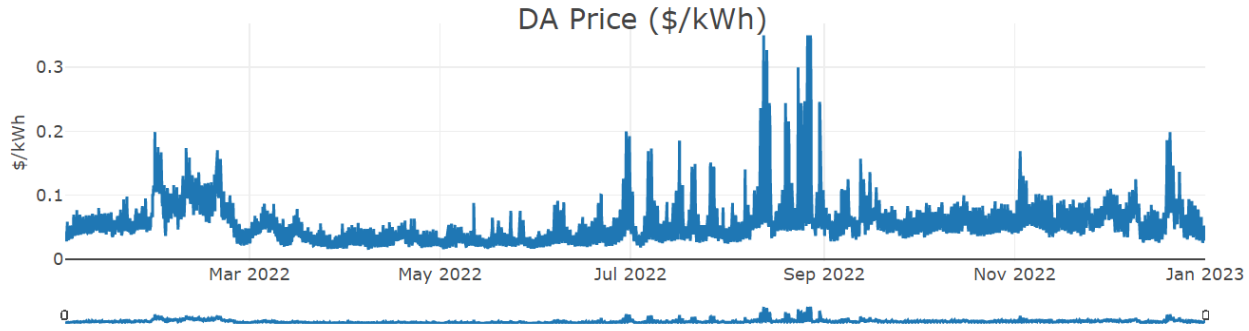
A per year increase from the baseline year. This is the project start year.

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



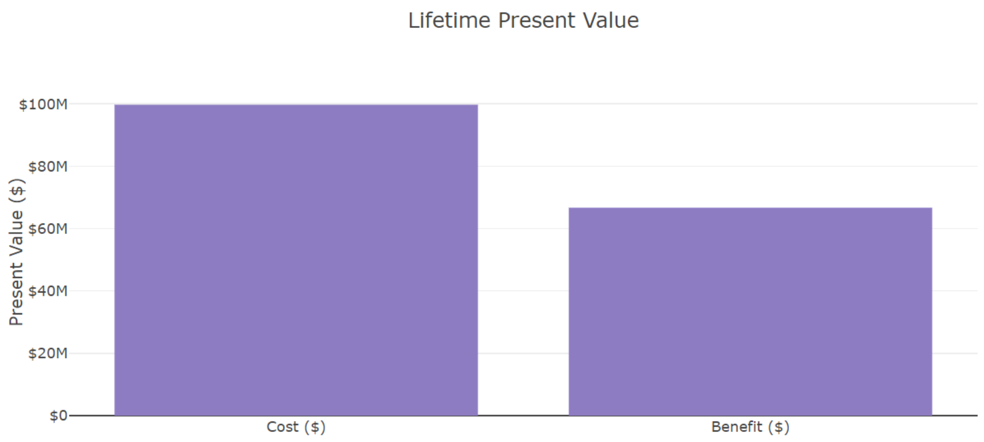
External Incentives

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 |

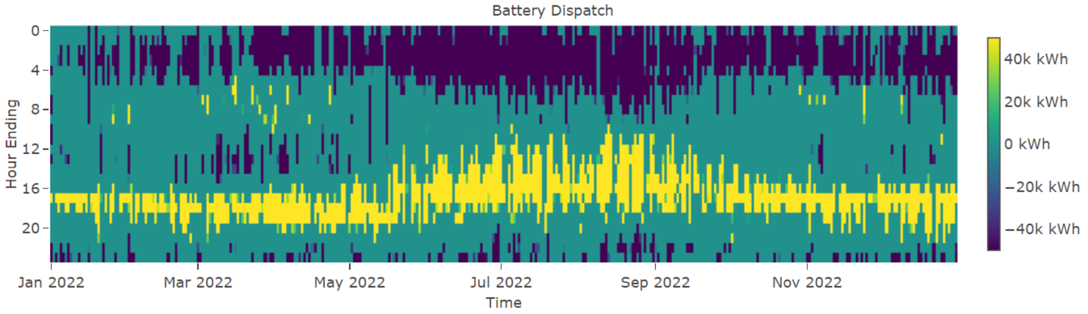
Add External Incentives | Import Incentives | Export Incentives

Financials Summary

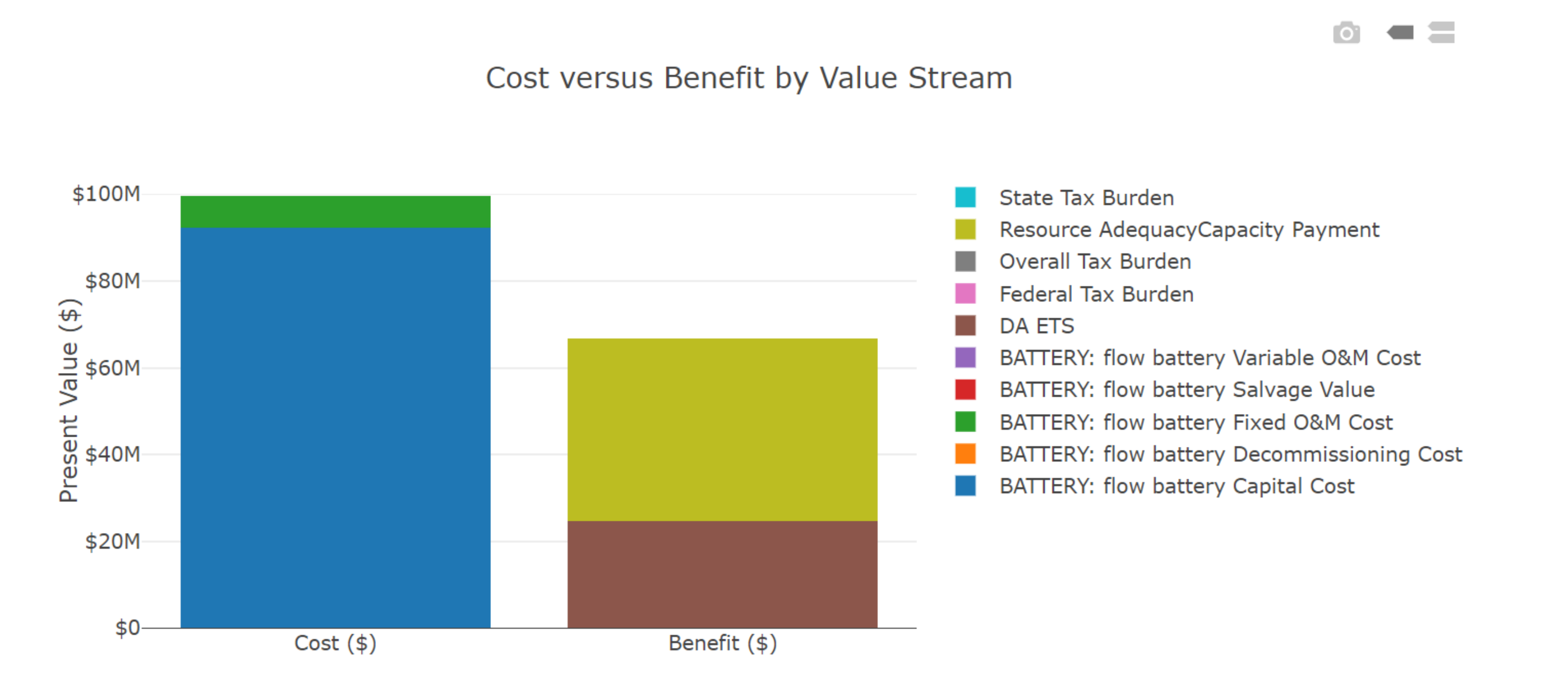


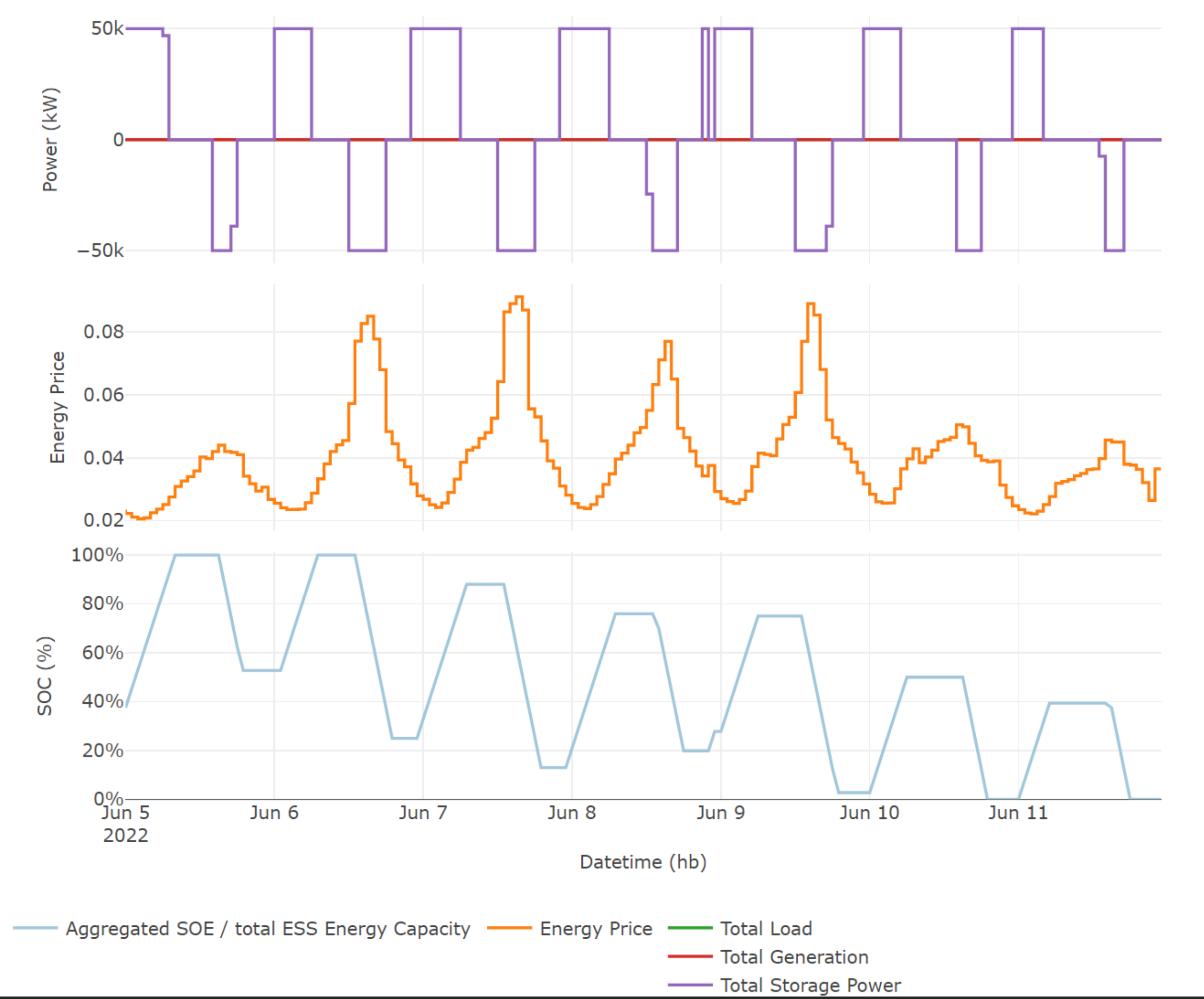
View Detailed Financials Results...

Dispatch Summary

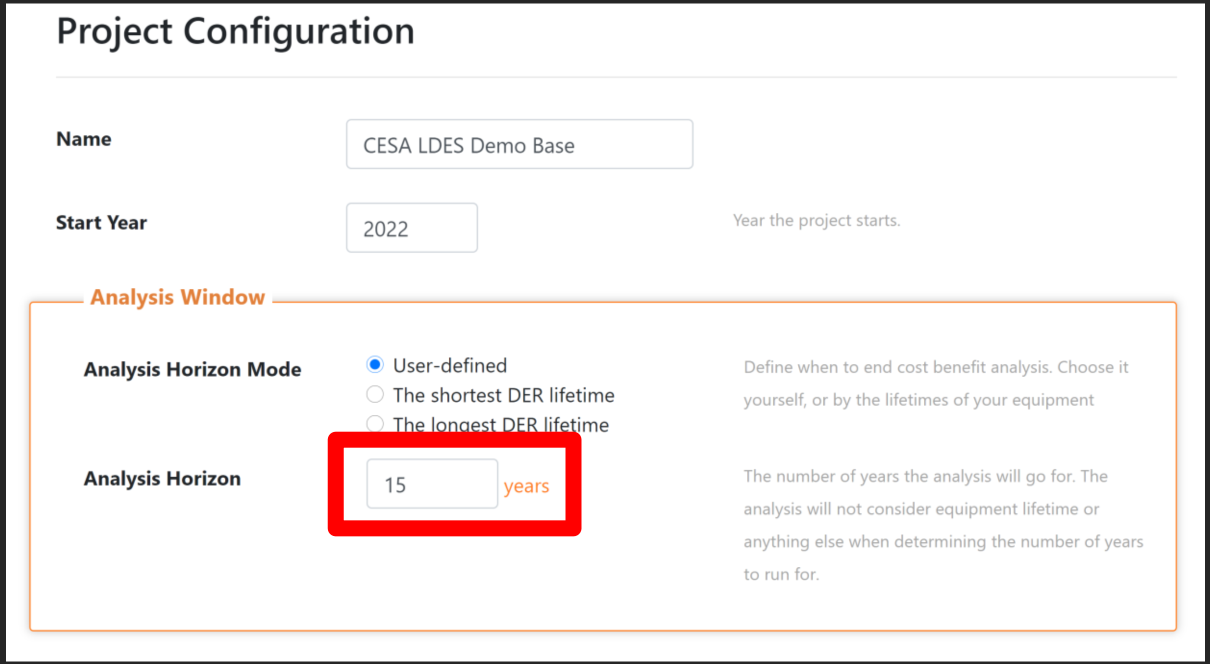


View Detailed Dispatch Results...


Cost versus Benefit by Value Stream
$100M
$80M
$60M
$40M
$20M
$0
Present Value ($)
Cost ($)
Benefit ($)
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


50k
0
−50k
Power (kW)
0.08
0.06
0.04
0.02
Energy Price
100%
80%
60%
40%
20%
0%
SOC (%)
Jun 5
2022
Jun 6
Jun 7
Jun 8
Jun 9
Jun 10
Jun 11
Datetime (hb)
Aggregated SOE / total ESS Energy Capacity
Energy Price
Total Load
Total Generation
Total Storage Power

Li-Ion Comparison


Project Configuration
Name
CESA LDES Demo Base
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
15
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.

Technology: Battery Storage

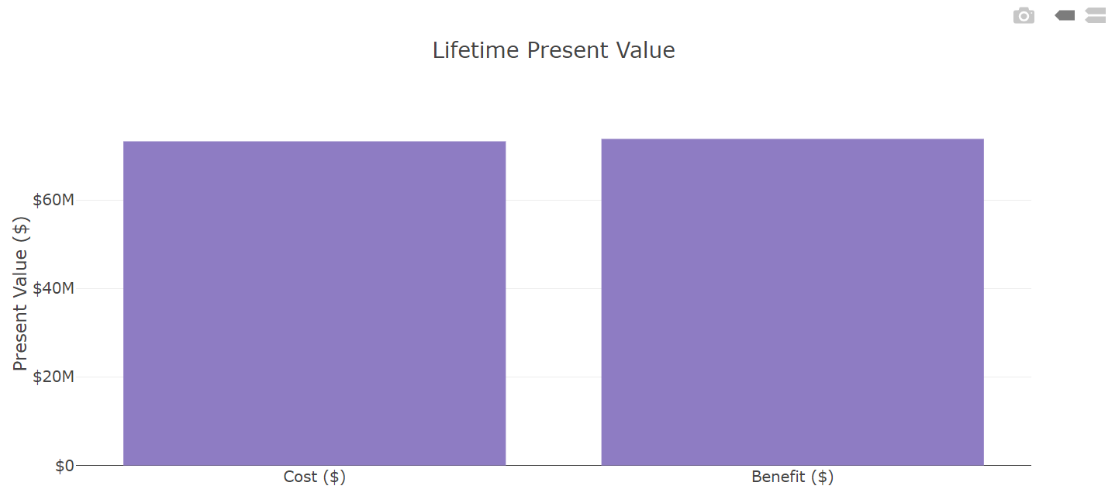
Component Name	Li-ion Battery		
Energy Capacity Sizing	○ Have DER-VET size the Energy Capacity ● Known size		
Energy Capacity	400000	kWh	What is the energy capacity of the battery storage?
Power Capacity Sizing	○ Have DER-VET size the Power Capacity ● Known size		
Different Charge and Discharge Power 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.

requirements and keeping all equipment on.

Cost Function

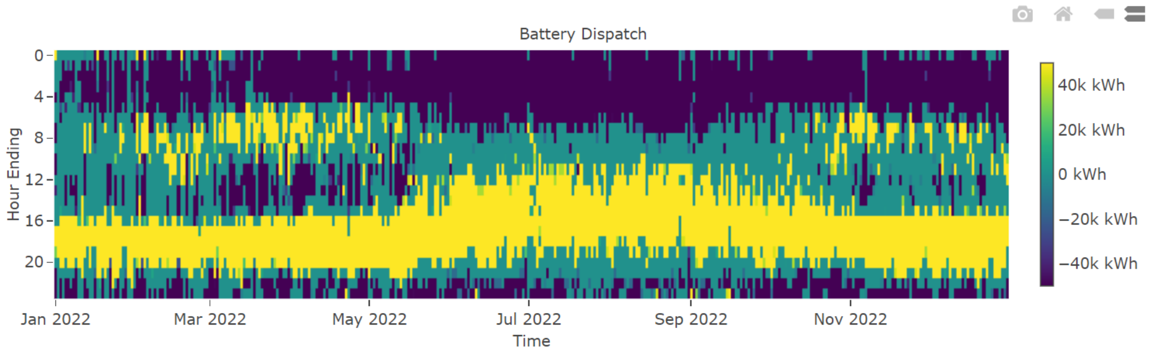
Capital Cost	0 $	
Capital Cost per kW	273 $ / kW	What is the capital cost per kW for the storage discharge power capacity?
Capital Cost per kWh	216 $ / kWh	What is the capital cost per kWh for the storage energy capacity?
Fixed O&M Costs	6 $ / kW-year	What is the cost of fixed operations and maintenance 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

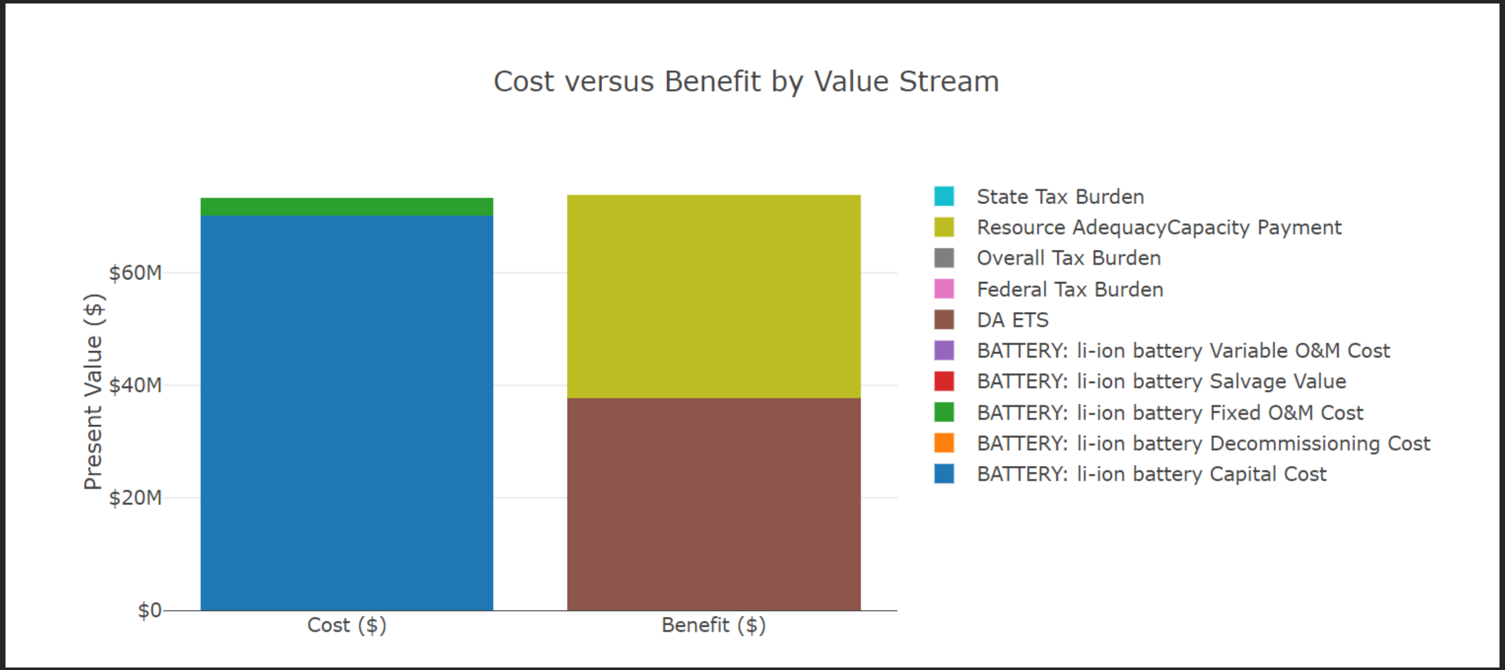


View Detailed Financials Results...

Dispatch Summary



View Detailed Dispatch Results...


Cost versus Benefit by Value Stream
Present Value ($)
$60M
$40M
$20M
$0
Cost ($)
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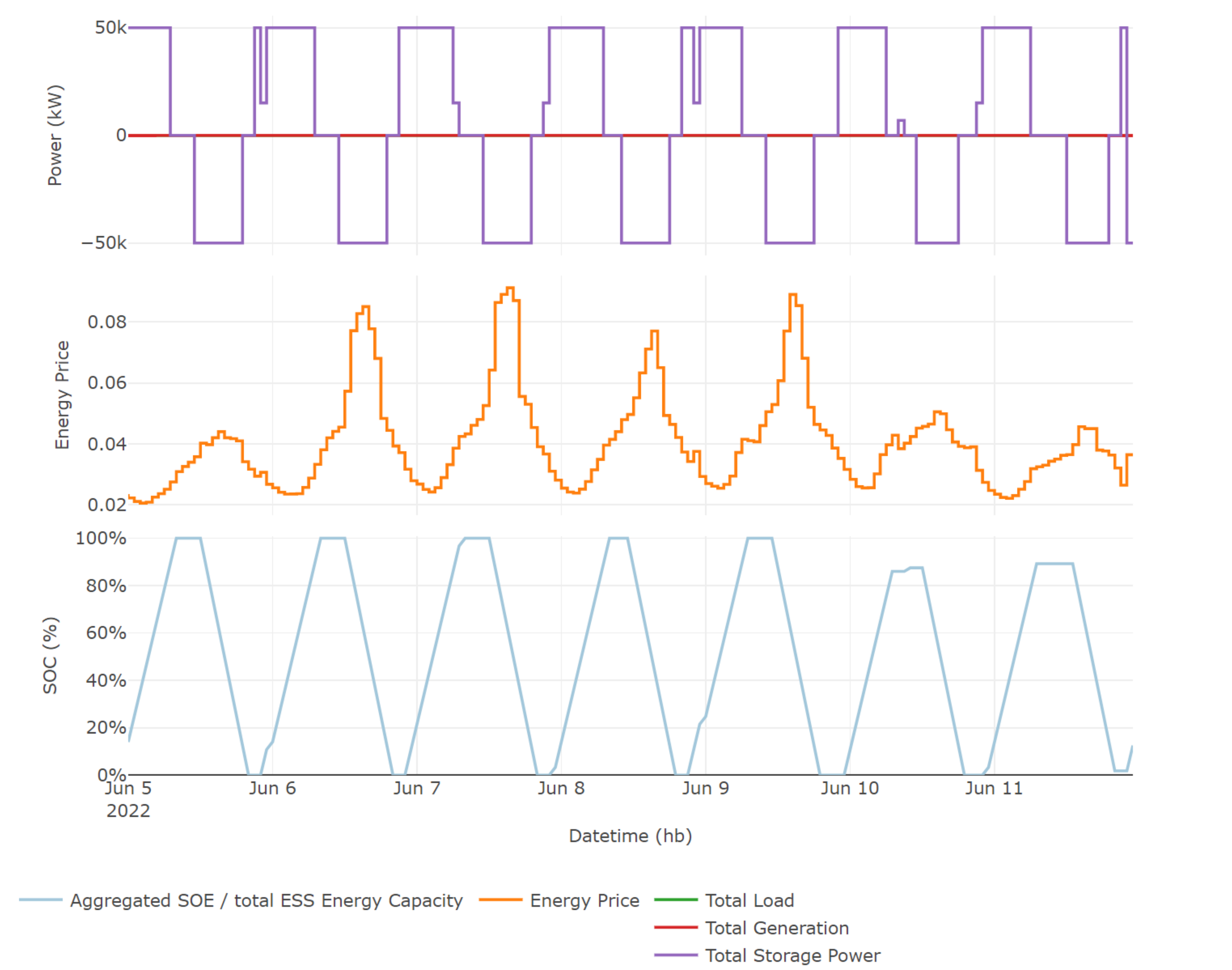
BATTERY: li-ion battery Decommissioning Cost
BATTERY: li-ion battery Capital Cost


Power (kW)
50k
0
−50k
Energy Price
0.08
0.06
0.04
0.02
SOC (%)
100%
80%
60%
40%
20%
0%
Jun 5
2022
Jun 6
Jun 7
Jun 8
Jun 9
Jun 10
Jun 11
Datetime (hb)
Aggregated SOE / total ESS Energy Capacity
Energy Price
Total Load
Total Generation
Total Storage Power

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

DER-VET Engagement

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

Together…Shaping the Future of Energy™

This webinar was presented by the DOE-OE Energy Storage Technology Advancement Partnership (ESTAP)

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ESTAP Website: https://cesa.org/projects/energy-storage-technology-advancement-partnership/

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Upcoming Webinars

- **Glad Tidings: How a California Congregation Is Pioneering a New Model by Building a Clean Energy Hub with Solar and Electric Vehicles** (8/31/22)
- ***ESTAP Webinar:* Commissioning an Energy Storage System: Lessons Learned in the Field** (9/7/22)
- **Advancing Solar for Manufactured Homes through Community Solar** (9/14/22)

Read more and register at: www.cesa.org/webinars