DER-VET Task Force

ESIC Working Group 1: Grid Services and Analysis

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Miles Evans | EPRI
Giovanni Damato | EPRI

November 5, 2020

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Agenda

- Announcements
- Implementation of Solar PPA Cost Calculation
- DERVET– External Software Integration Scenario Analysis
  - Distribution analysis with OpenDSS

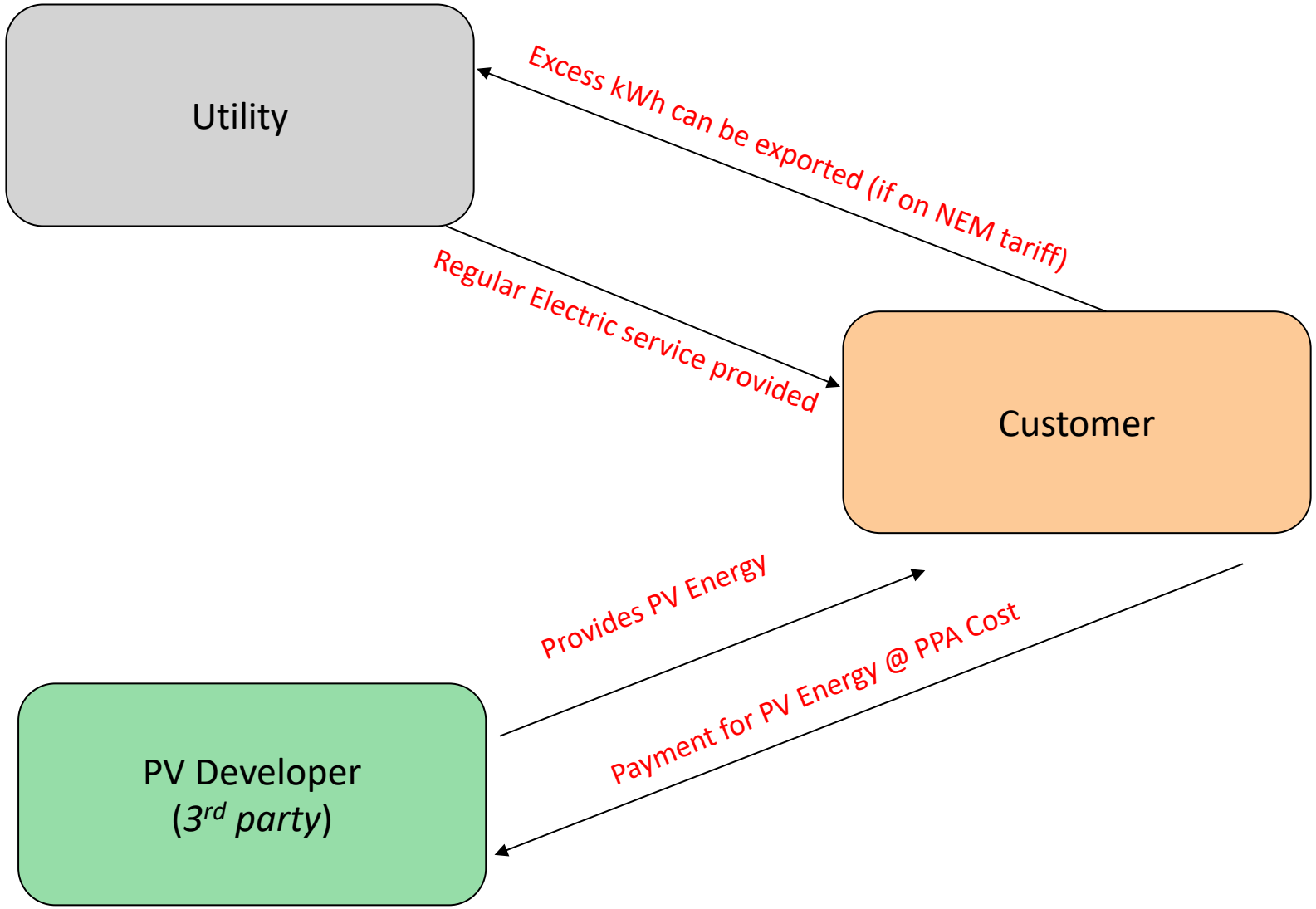
Solar Power Purchase Agreements (PPAs)

- A Solar PPA is a bilateral financial agreement between a customer and a PV project developer (*3rd party*), in which the developer facilitates the design, financing and installation of a PV system at the customer's location for a cost
- The solar PPA cost is typically calculated based on the annual PV generation profile (kWh) on a ($/kWh) basis

Advantages to the customer:

- No upfront capital cost required
- Developer is responsible for guaranteeing PV system performance
- Long-term "Predictable" energy price as compared to utility rates
- Maximize tax credits

Role of Various Stakeholders in a Solar PPA Arrangement



Note: There are multiple DER ownership models that can be modeled in DER-VET. The solar PPA model is one of them.

Solar PPA Modeling in DER-VET

- The annual solar PPA cost in DER-VET is calculated based on:
  - Annual PV Production (kWh)
  - PPA Cost ($/kWh)
  - PPA Cost Escalation Factor (if any)

For a given year,

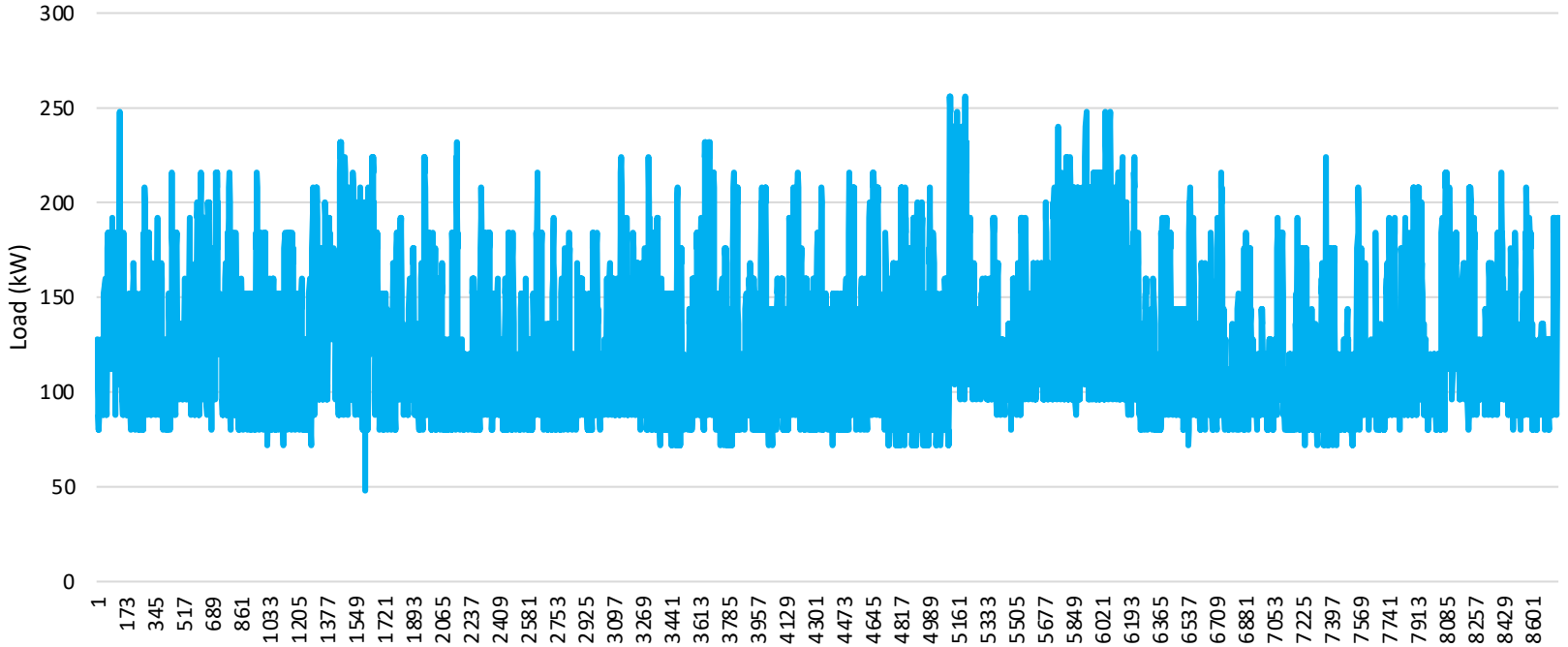
Annual PPA Cost ($) = Annual PV Production (kWh) * PPA Cost ($/kWh)

Note: PV system degradation can also be included in the model

Use Case Description

- A Commercial customer installs a co-located PV+ES system with the objective of bill reduction (energy cost & demand charges)
- Customer is subjected to a NEM tariff
- ES and PV sizes are predefined
- ES owned and operated by the customer
- PV operated by the customer. Owned by a 3rd party developer. Customer pays the 3rd party developer an annual cost as defined by the PPA

Load Profile and Utility Tariff



Energy Charges:

Season	On Peak	Mid Peak	Off Peak
Winter	-	$0.062/kWh	$0.054/kWh
Summer	$0.262/kWh	$0.086/kWh	$0.049/kWh

Demand Charges:

Season	All Periods
Summer & Winter	$7.016/kW

DER Specification

PV Specification:

Parameter	Value
PV Nameplate Rating	250 kW
Annual PV Degradation	0.5%/year

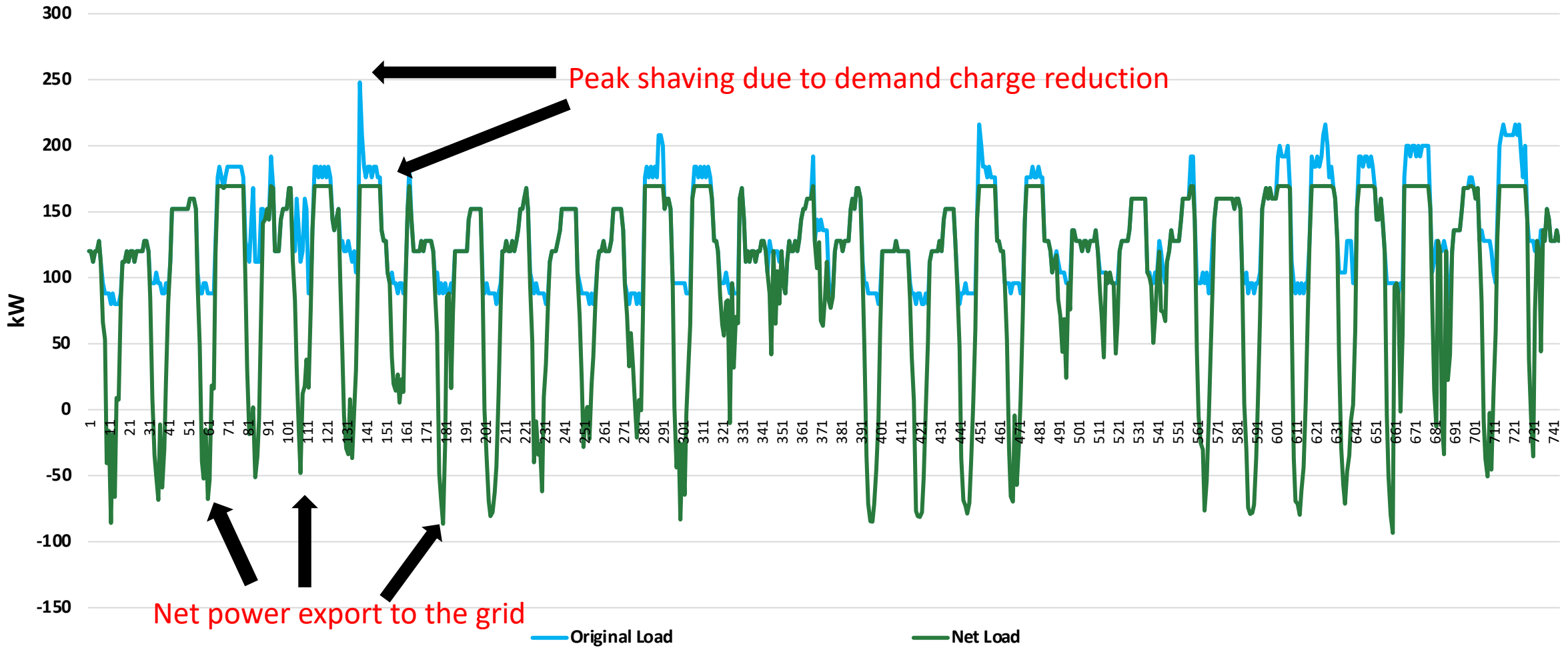
ESS Specification:

Parameter	Value
ES Size	250 kW, 500 kWh
ES RT Efficiency	85%
ES Cost	$100/kW + $500/kWh
ES Technology Escalation Rate	-5%/year
No. of ES replacements	1 (Year 9)

Financial Assumptions

Parameter	Value
Project Analysis Horizon	10 Years
Inflation	2%
Discount Rate	5%
Solar PPA Cost	$0.07/kWh **(Year 1)**
Solar PPA Escalation Rate	2%/year

Load Profile Comparison (January)



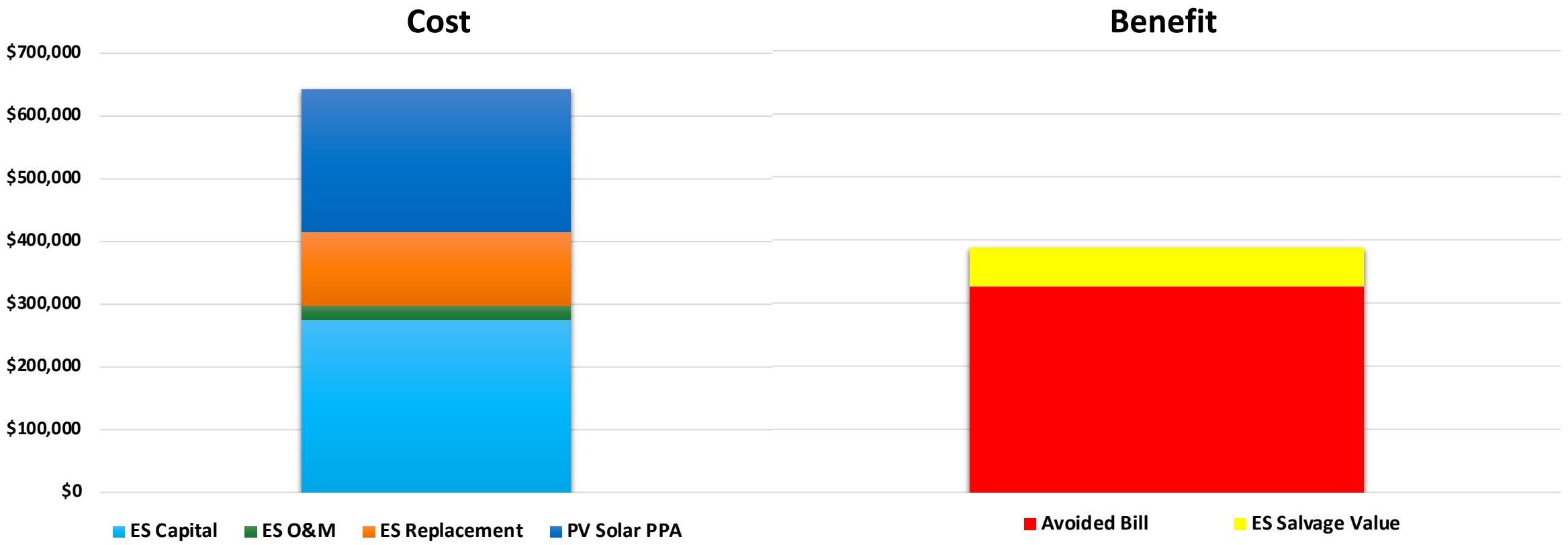
Pro Forma Results

Year	Avoided Bill	ES CAPEX	ES O&M	ES Replacement	ES Salvage Value	Solar PPA Cost
Year 0	$0	($275,000)	$0	$0	$0	$0
Year 1	$44,745	$0	($2,676)	$0	$0	($27,726)
Year 2	$43,614	$0	($2,764)	$0	$0	($28,139)
Year 3	$43,345	$0	($2,802)	$0	$0	($28,558)
Year 4	$42,493	$0	($2,839)	$0	$0	($28,984)
Year 5	$41,580	$0	($2,875)	$0	$0	($29,415)
Year 6	$41,049	$0	($2,913)	$0	$0	($29,854)
Year 7	$40,265	$0	($2,953)	$0	$0	($30,299)
Year 8	$40,080	$0	($2,994)	$0	$0	($30,750)
Year 9	$42,764	$0	($3,166)	($182,441)	$0	($31,208)
Year 10	$42,145	$0	($3,238)	$0	$99,039	($31,673)

Annual bill savings reduces with time due to PV and ES degradation

Cost Benefit Analysis

Project Analysis Horizon: 10 years
Discount Rate: 5%
Inflation Rate: 2%



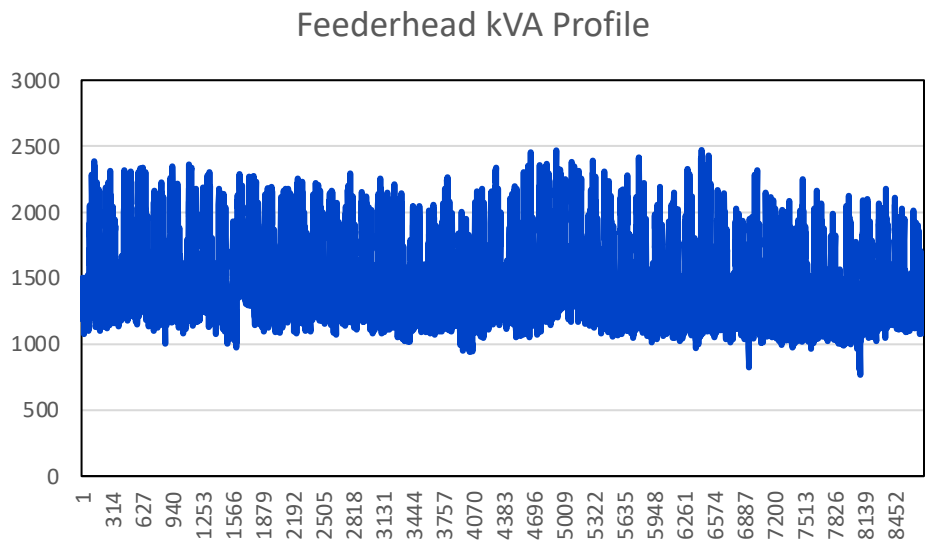
DERVET External Software Integration - Distribution Analysis

1. DERVET Analysis + Distribution analysis to study grid impacts
   - DERVET optimizes size and DER dispatches
   - Provide DERVET output to distribution power flow software (OpenDSS)

2. Distribution analysis to study grid impacts + DERVET Analysis
   - For a given DER size, find DER dispatch limits to avoid grid violations
   - DERVET optimizes DER dispatches within grid specified limits

1. DERVET + Distribution Analysis - Software Integration

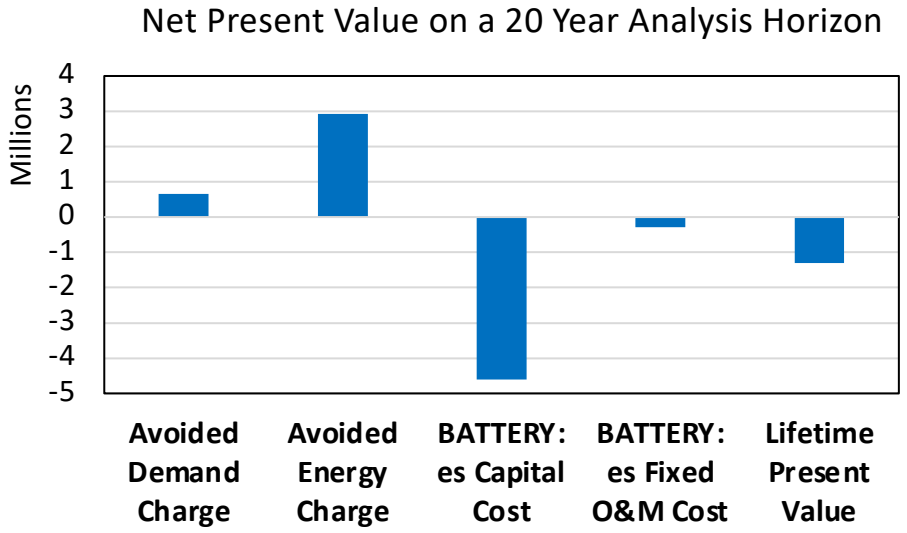
- DERVET Data Input
  - Peak load ~2.5MW
  - Energy storage - 2 MW 6 hr
  - Utility tariff rate/Market structure
  - DERVET objective:
    - Maximize customer bill reduction

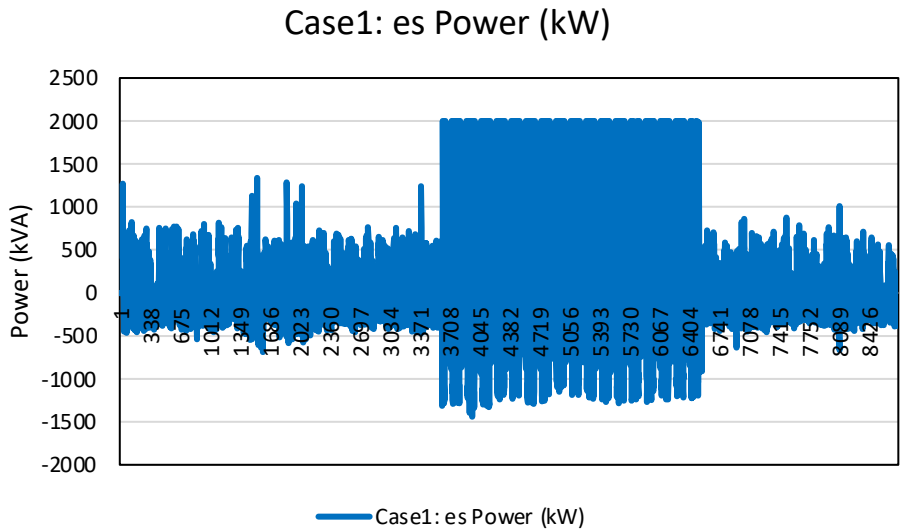


Summer			Winter		Demand Charge
On Peak	Mid Peak	Off Peak	Mid Peak	Off Peak	
$0.262392/kWh	$0.086152/kWh	$0.049672/kWh	0.062392/kWh	$0.054152/kWh	$7.016/kW

1. DERVET + Distribution Analysis - Software Integration

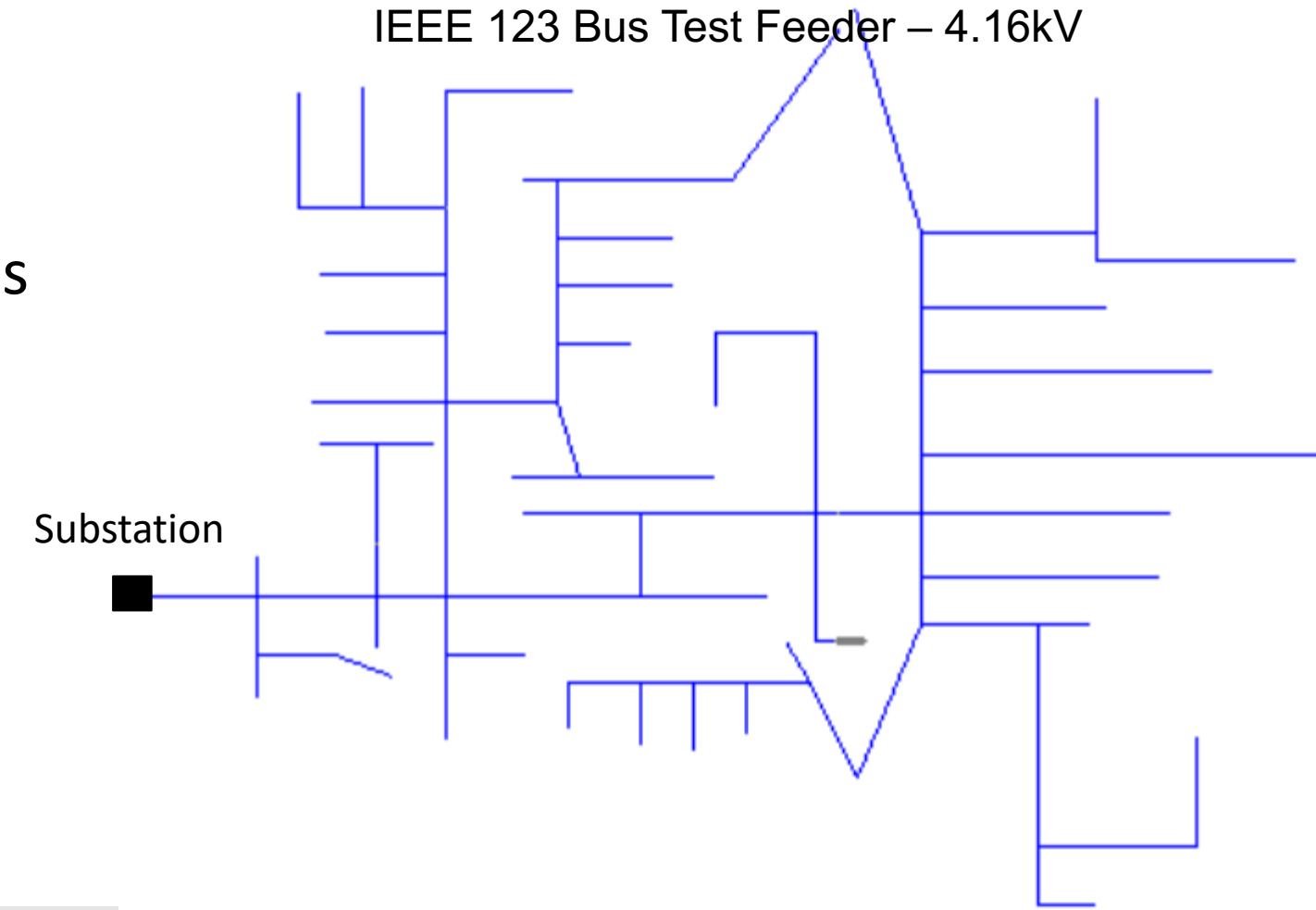
- DERVET Data Output
  - ES dispatch optimization to max bill reduction benefits



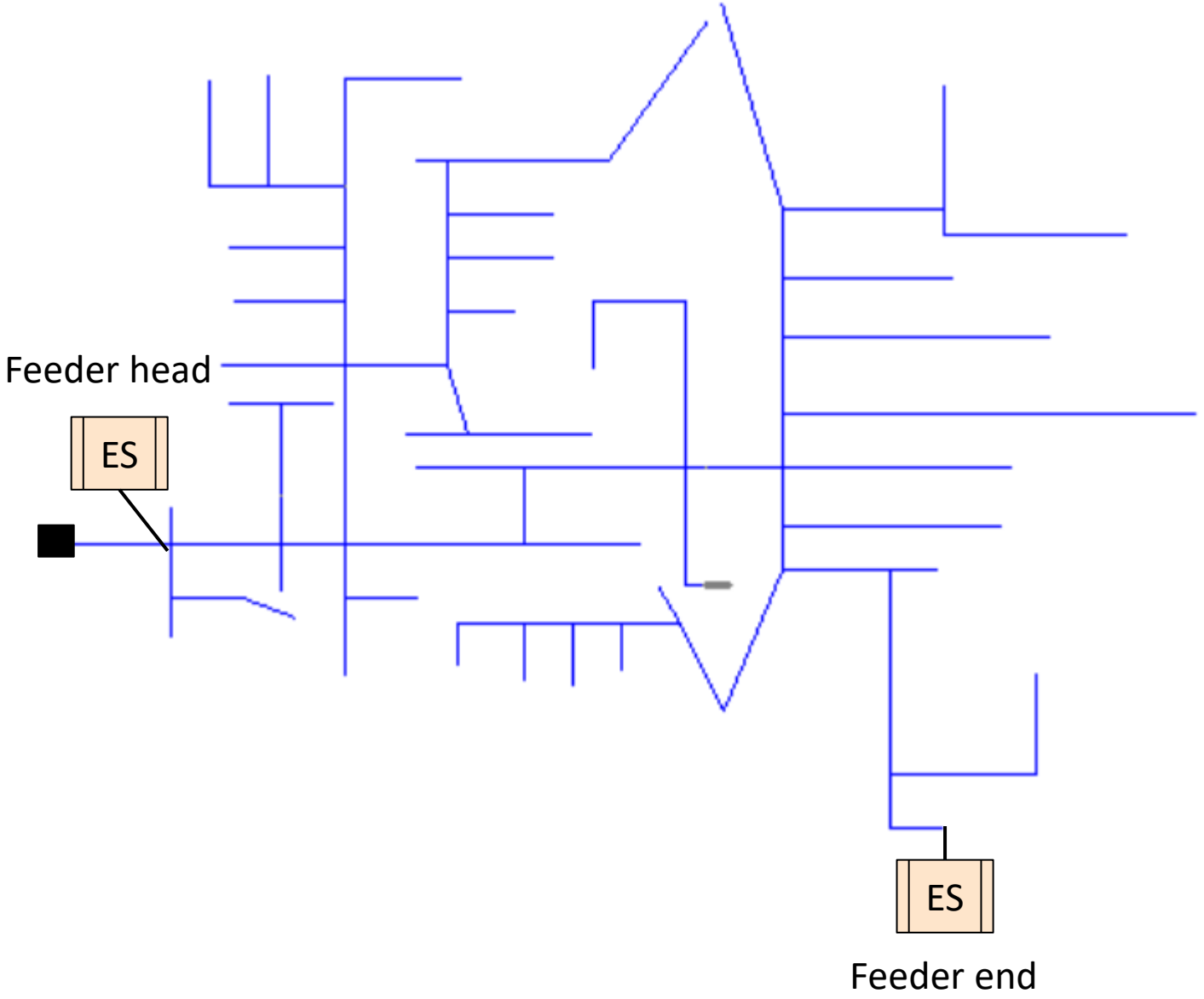


1. DERVET Optimization + Distribution Analysis

- Distribution Analysis- Time series power flow analysis
  - Inputs
    - Circuit model
    - Load profile for each load
    - DER sizes and DER dispatches
  - Outputs
    - Excel files output
      - Violation report csv files



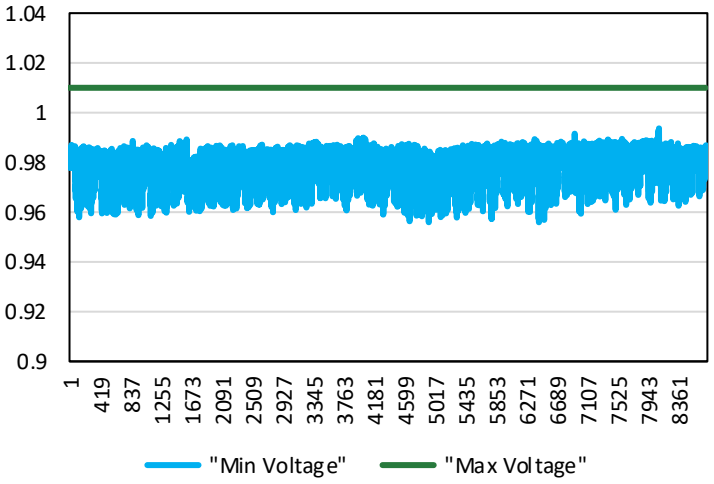
Distribution Analysis is Location Specific



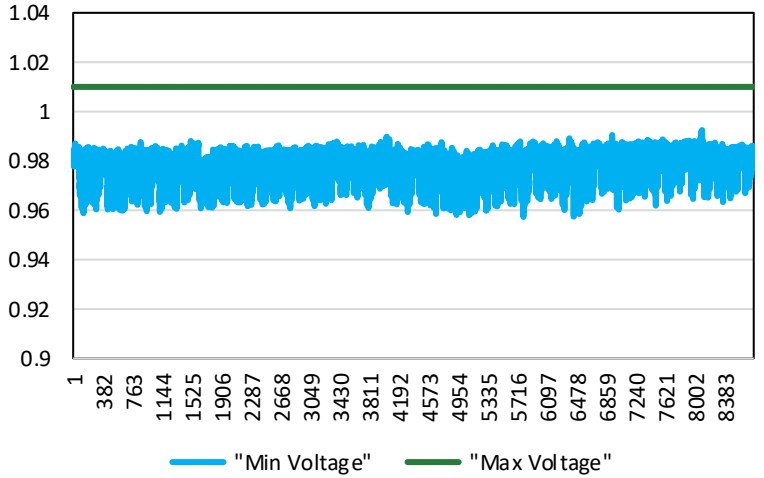
Distribution Grid Impacts – Without and With ES

- Min and Max Voltage across the feeder

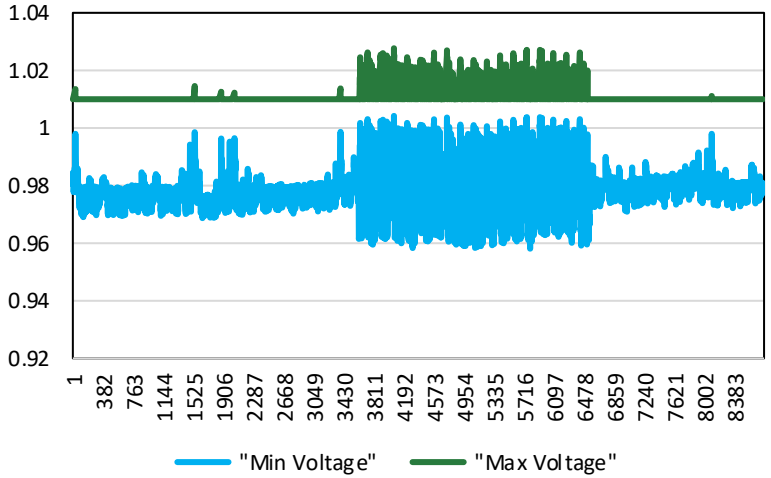
Basecase



Feeder Head ES



End of the Feeder ES

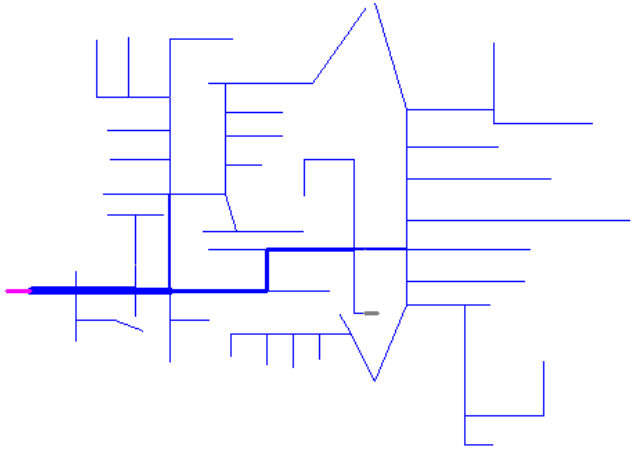


Voltage profile is within limits for all three cases

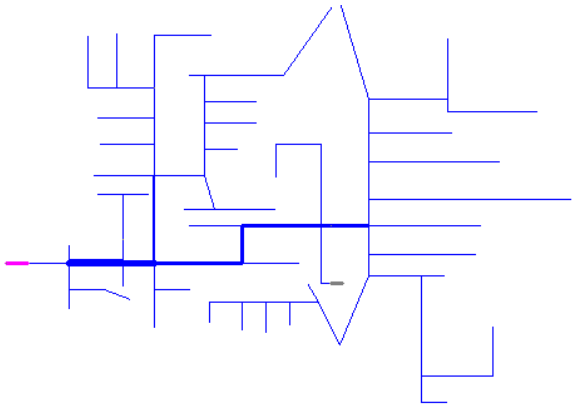
Distribution Grid Impacts – Without and With ES

- Line overload analysis

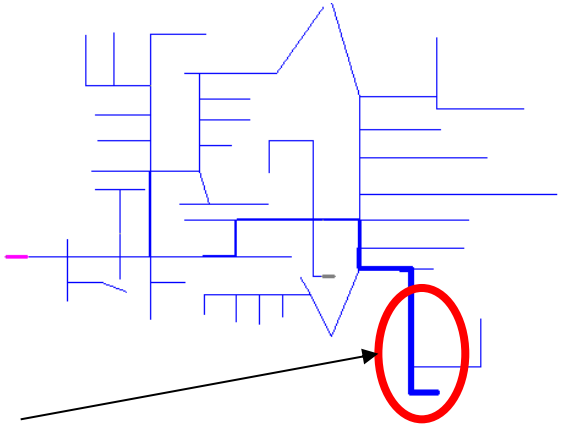
Basecase



ES at Feederhead



ES at Feeder end

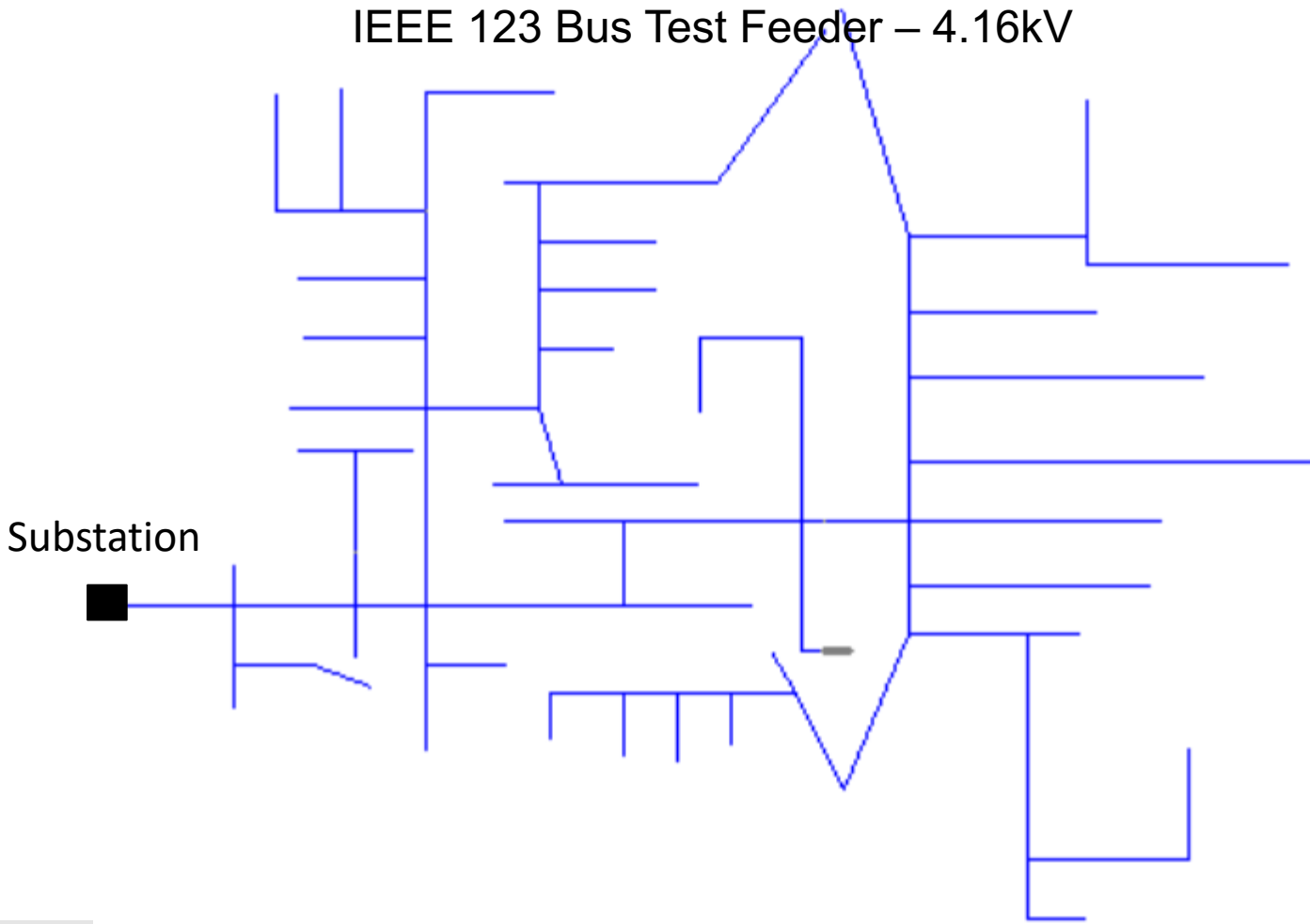


Because of new generation, there is overload at some lines. Line rating = 200A. With ES Line current is overloaded by 38%

Few Dx lines are overloaded when ES is at Feeder end

2. Distribution Analysis+ DERVET Optimization

- Distribution Analysis- Time series power flow analysis
  - Inputs
    - Circuit model
    - Load profile for each load
  - Outputs
    - Hosting capacity
    - time-series charge and discharge limits



2. DERVET + Distribution Analysis - Software Integration

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  - Utility tariff rate/Market structure
  - Time-series charge and discharge limits
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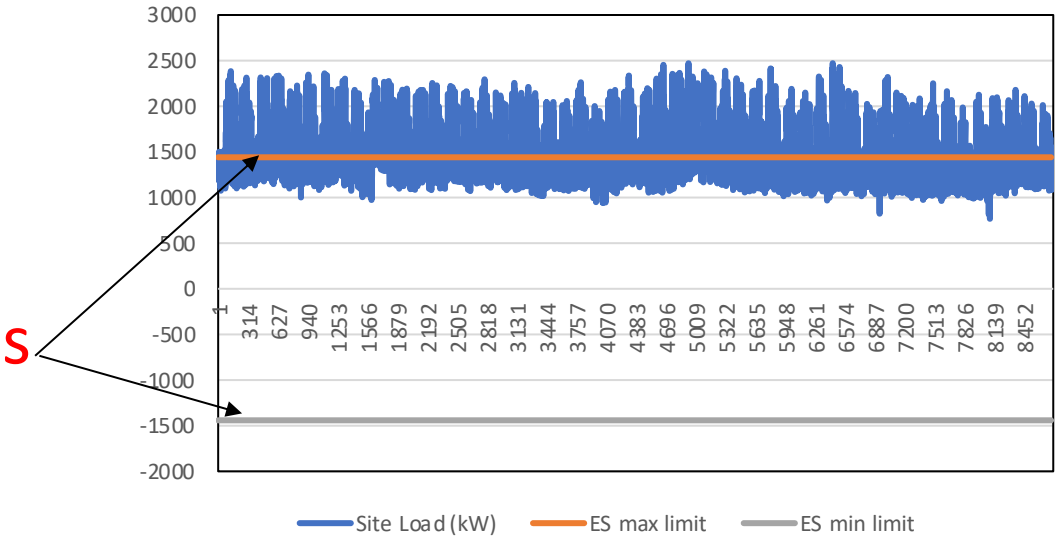
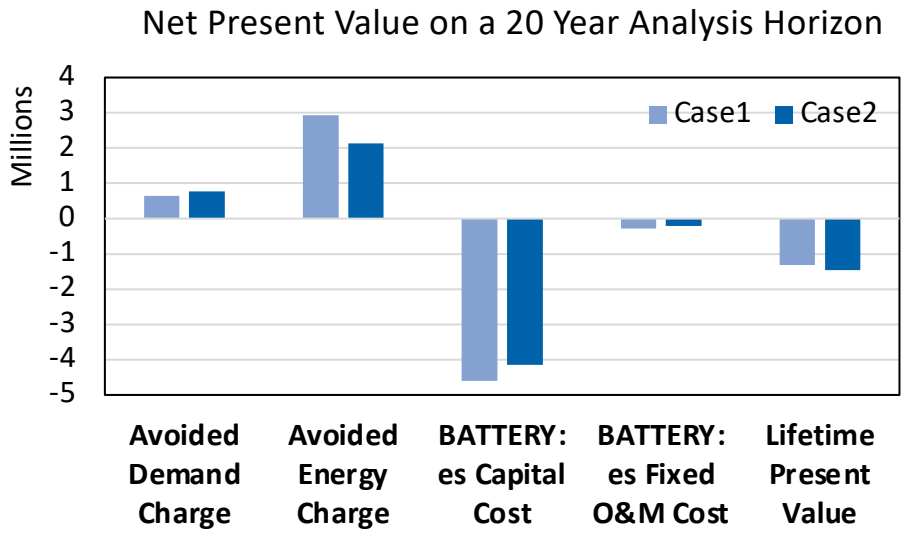
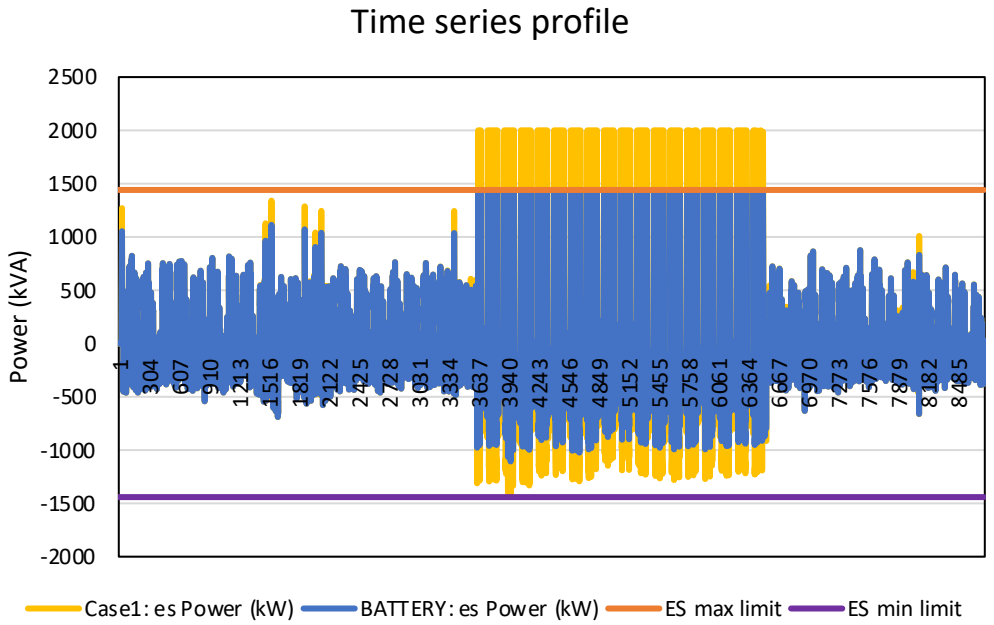


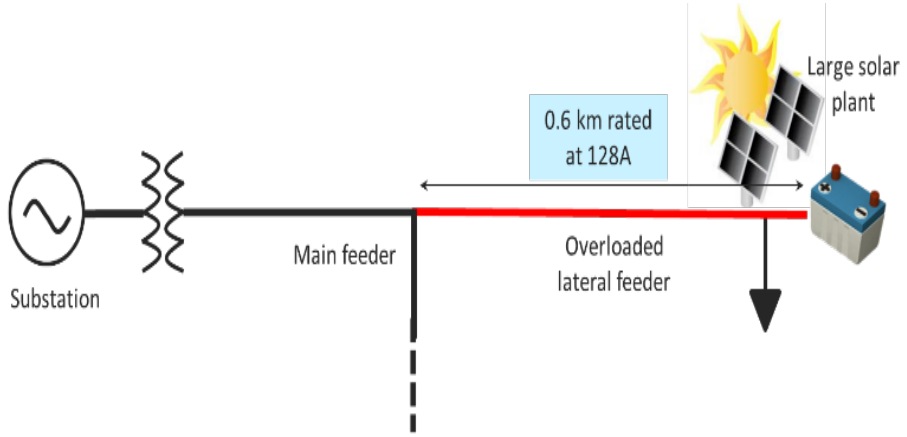
Case 1 and 2 Comparison

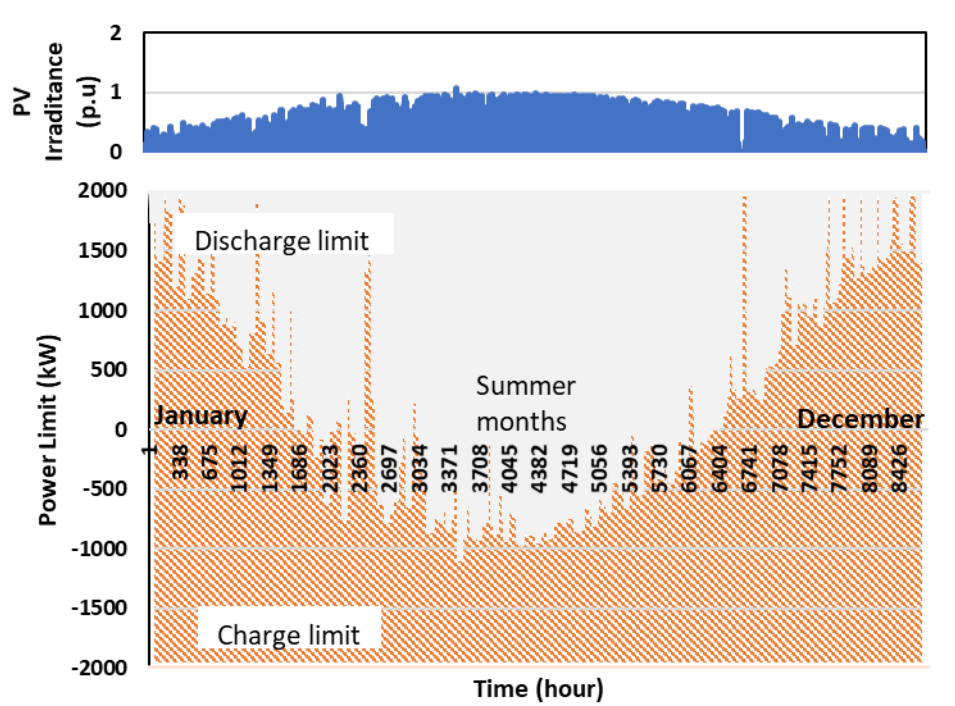
- DERVET Data Output
  - ES dispatch optimization to max bill reduction benefits





Energy storage – With Other DERs





PV Irradiance profile and Energy storage charge and discharge limits for a year starting with January

Detailed Analysis is required in the presence of other DERs

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