DER-VET Task Force

ESIC Working Group 1: Grid Services and Analysis

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Giovanni Damato | EPRI

October 1, 2020

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ELECTRIC POWER RESEARCH INSTITUTE

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Agenda

- Announcements
- Sequential Load Shedding
- Battery Degradation
- (more) Advanced Benefit-Cost Analysis

Announcements

DER-VET Task Force Presentations and Recordings Moved

- www.der-vet.com/esictf

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

DER-VET™ | ESIC Task Force | Help | Forums

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Energy Storage Integration Council (ESIC)
Working Group 1 DER-VET™ Task Force Meeting Recordings

DER-VET™ Task Force : Presentations

- 2020-07-02 Meeting: PDF | recording
- 2020-06-04 Meeting: PDF | recording
- 2020-05-07 Meeting: PDF | recording
- 2020-04-02 Meeting: PDF | recording
- 2020-03-05 Meeting: PDF | recording
- 2020-02-06 Meeting: PDF | recording
- 2020-01-09 Meeting: PDF | recording
- 2019-12-05 Meeting: PDF | recording

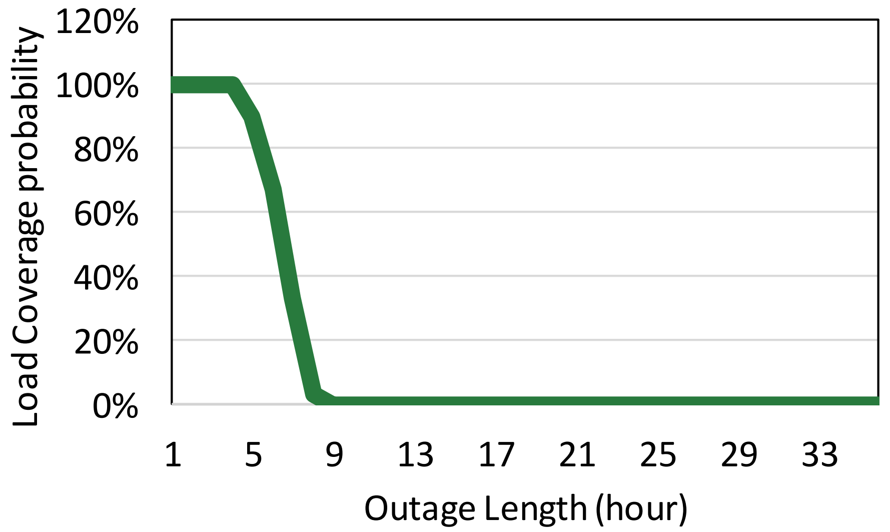
DER-VET™ Task Force : Office Hours

- 2020-04-23 Office Hours: recording
- 2020-04-16 Office Hours: recording

Sequential Load Shedding

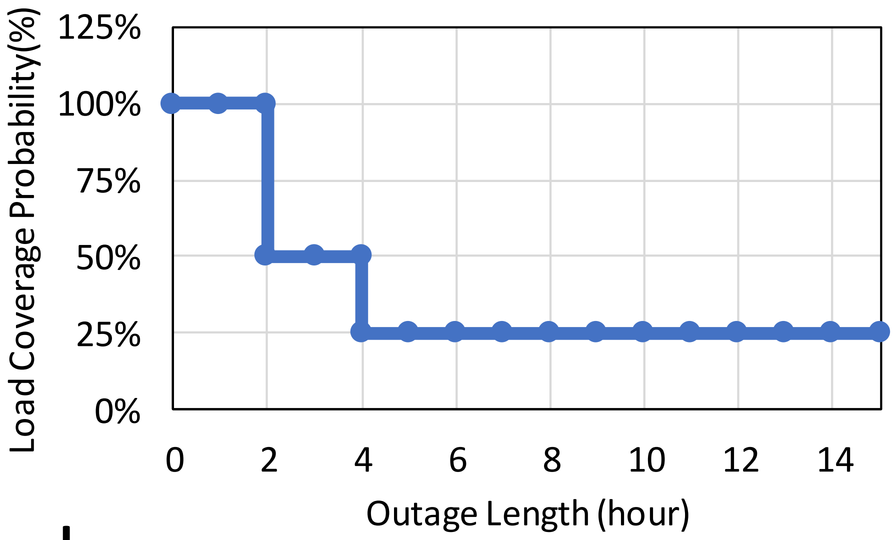
Customer Reliability Calculation - Overview

- For any given outage scenario,
  - If total generation (from all DER sources) >= net critical load
    - then the scenario is considered as a success
    - else it is a failure
- Similarly all the outage scenarios are evaluated, and load coverage probability curve is calculated
  - Percentage of success scenarios Vs Outage length



Customer Reliability Calculation with Load Shedding

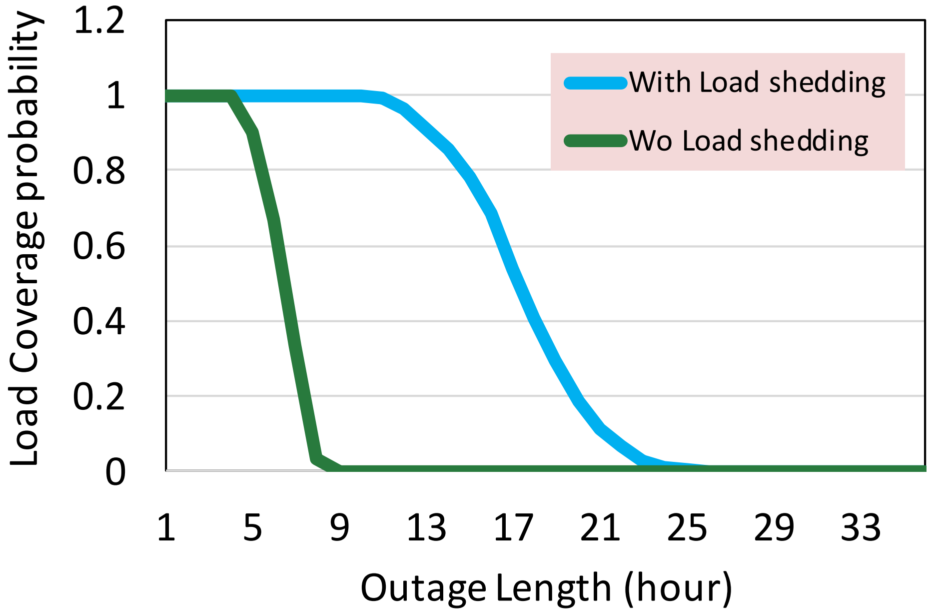
- Default option - 100% critical load is served during the outage length duration
- With load shedding option, user can define the logic e.g.,
  - 100% load coverage < 2 hour
  - 50% load coverage 2-3 hour (50% of the loads are shed)
  - 25% load coverage >= 4 hour (75% of the loads are shed)



- DER-VET does not disaggregate loads, so it is up to the user to determine appropriate %s to use.

Customer Reliability - Load Coverage Probability

- Load coverage probability for a given microgrid with and without the load shedding option is calculated below



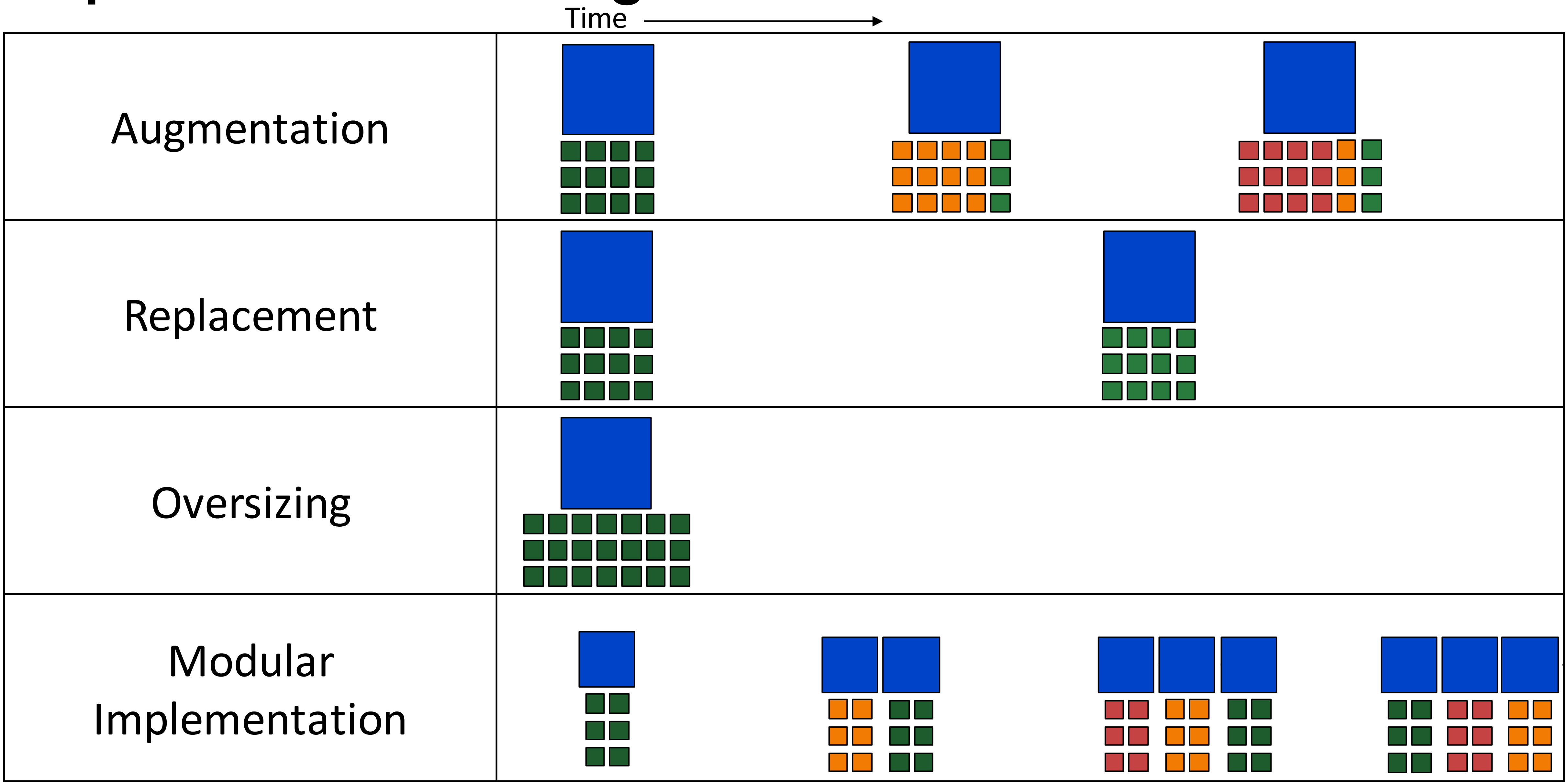
The possibility of shedding some of the critical load improved the load coverage probability metrics

Battery Degradation

Degradation Topics

- Kinds of degradation
  - Energy capacity fade
  - Power capacity fade
  - Efficiency
- Drivers of degradation
  - Time
  - Cycling
  - SOC
  - Temperature
- Type/chemistry-specifics
- Augmentation
- Replacement
- Oversizing
- Modular Implementation
- Performance guarantees/warranties
  - Limits on use (SOC, cycles)
- Tradeoffs with value
  - aux power
  - Service participation

Implementation Strategies

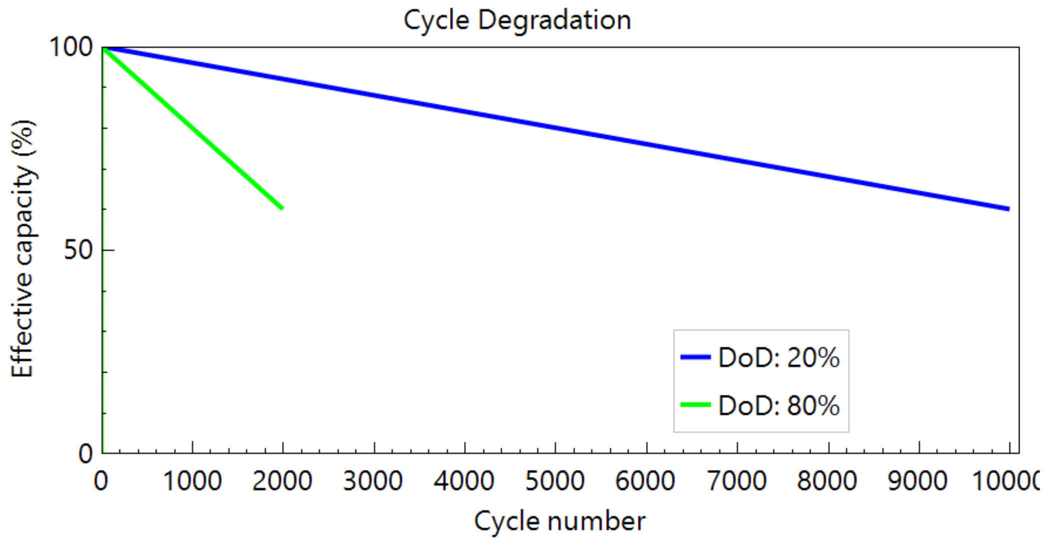


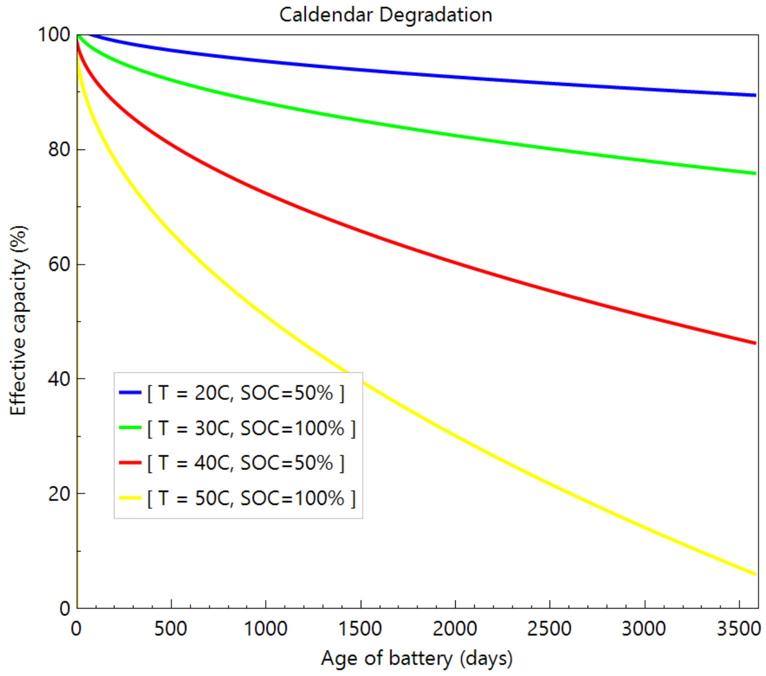
Modeling Degradation

- Little good information about standalone ESS degradation in the field, which differs from cell-level lab testing due to
  - Non-ideal conditions (temperature, etc.)
  - Differential degradation between cells/modules
  - Non-ideal use (lab duty cycle may not perfectly mimic real operation)
- Validating degradation models of fielded systems will take a long time

Degradation in DER-VET

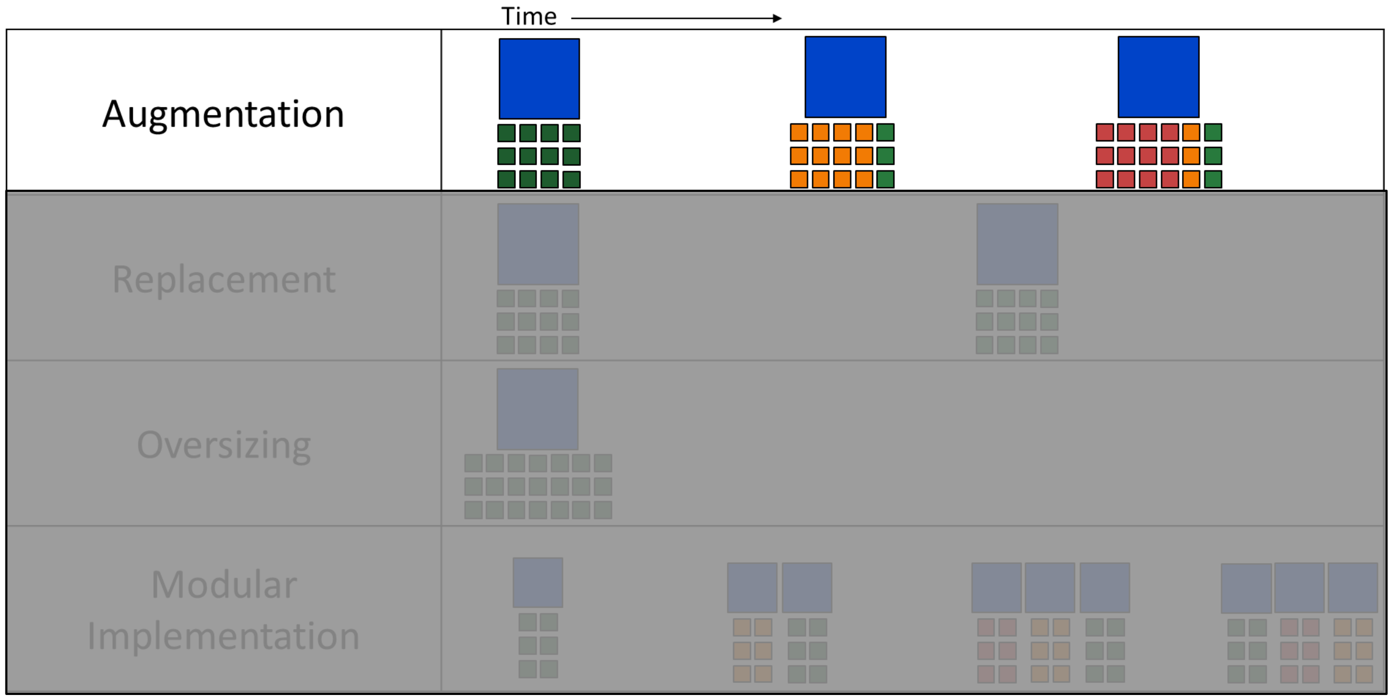
- Only consider calendar and cycling degradation of energy capacity with no compounding stress factors
- Cycle life curve input and %/yr calendar degradation input
- Images from NREL's SAM tool (very similar degradation model)





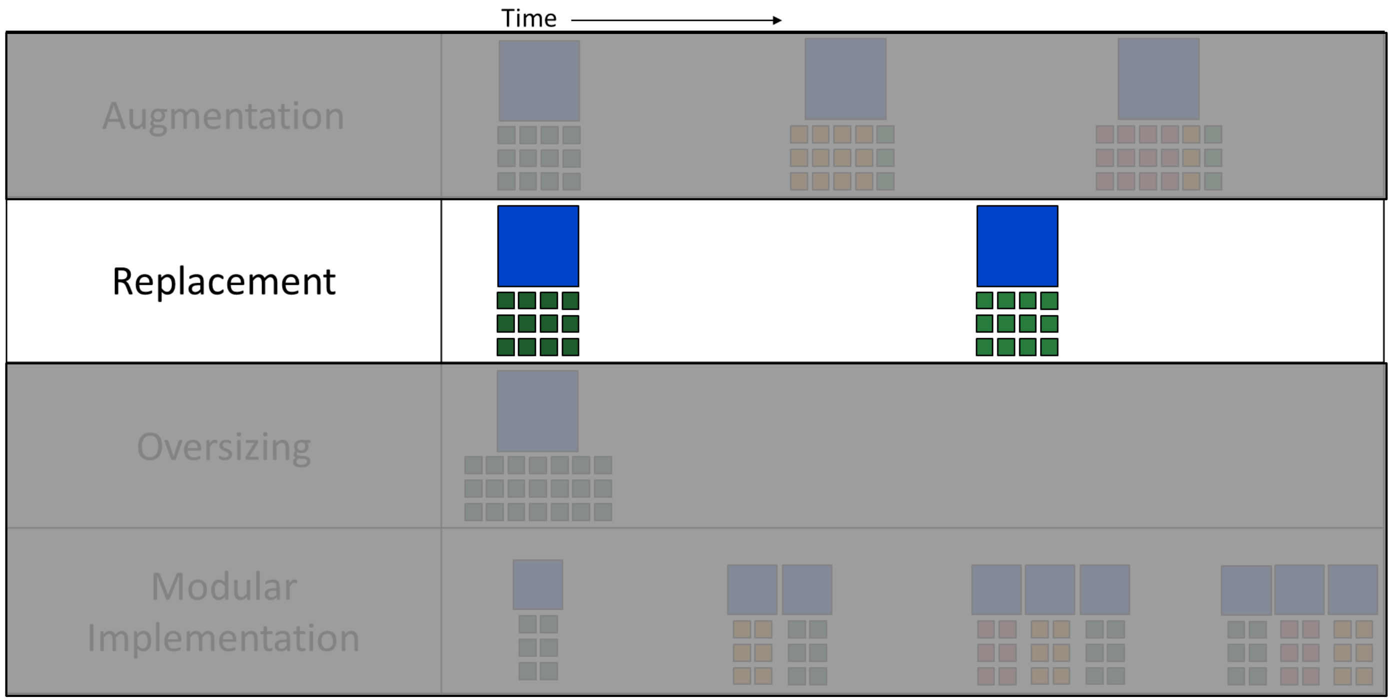
Augmentation in DER-VET

- Default DER-VET mode is to assume the system is under a performance guarantee/warranty
  - No perceived degradation for system life
  - Yearly fixed cost



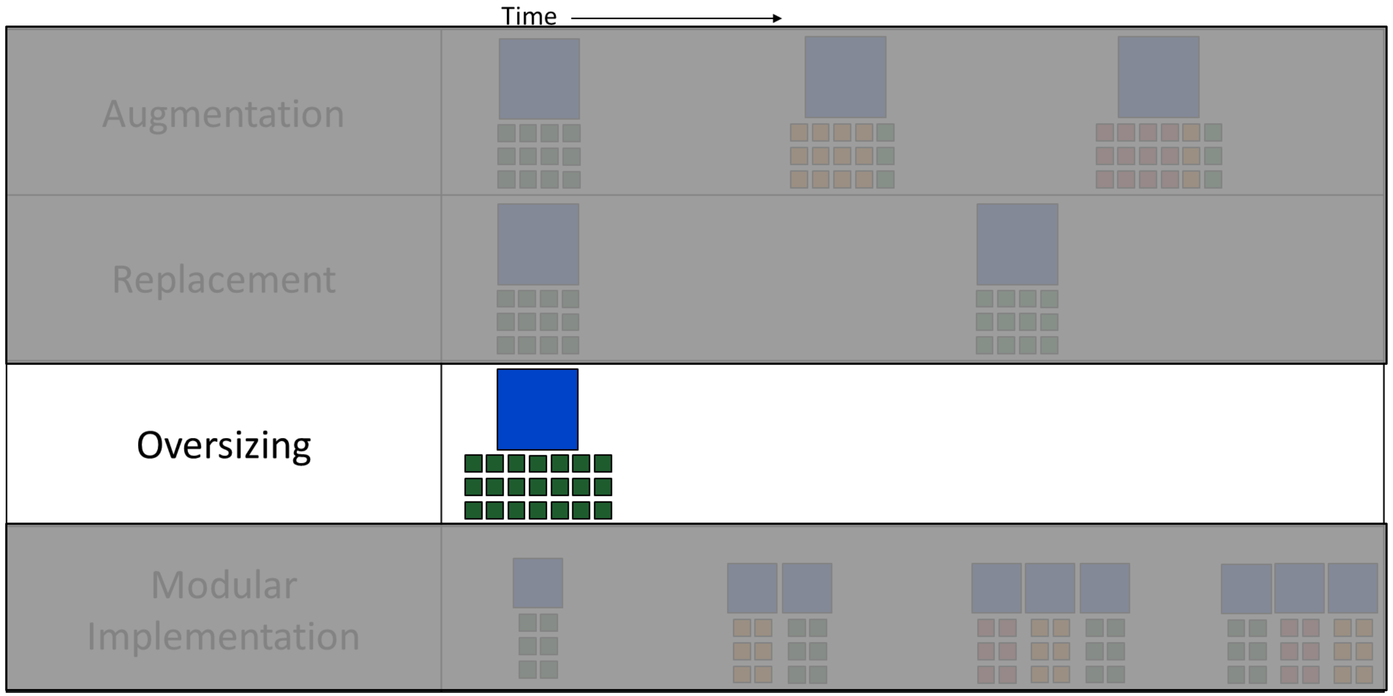
Replacement in DER-VET

- Two separate battery system inputs.
- The 2nd battery becomes operational when the 1st reaches end of life
- Each battery employs ‘oversizing’ within their own life



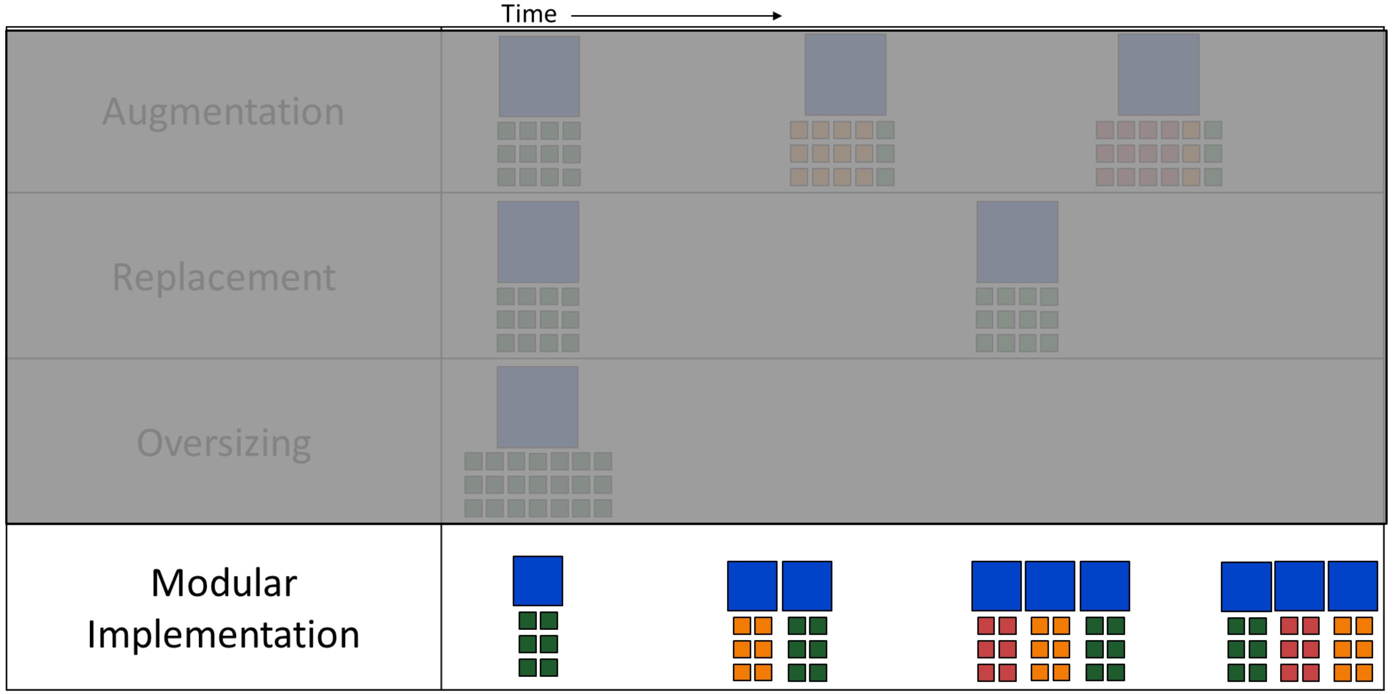
Oversizing in DER-VET

- Functionally identical to Augmentation
- Higher capital cost but no ongoing degradation cost



Modular Implementation in DER-VET

- Suitable for a growing need for storage (e.g. distribution deferral with load growth)
- New modules are installed and replaced as needed to meet growing requirements



ECC, Another Option in DER-VET

- Translate all costs into a single annualized number
  - Includes degradation
  - Includes technology escalation rate (price learning curve)
    - Negative for battery energy storage
    - Roughly keeps up with inflation for established technology

Implementation

- Oversizing
  - Leave degradation off
  - Set lifetime appropriately
  - Limit cycles to 1/day or similar

1	yearly_degrade	0	
1	incl_cycle_degrade	0	
1	cycle_life_filename	.\storagevet\Data\Battery_Cycle_Life.csv	

Implementation

- Augmentation
  - Leave degradation off
  - Set lifetime appropriately
  - Limit cycles to 1/day or similar
  - Include yearly fixed O&M cost to include augmentation cost
    - Terms depend strongly on the case

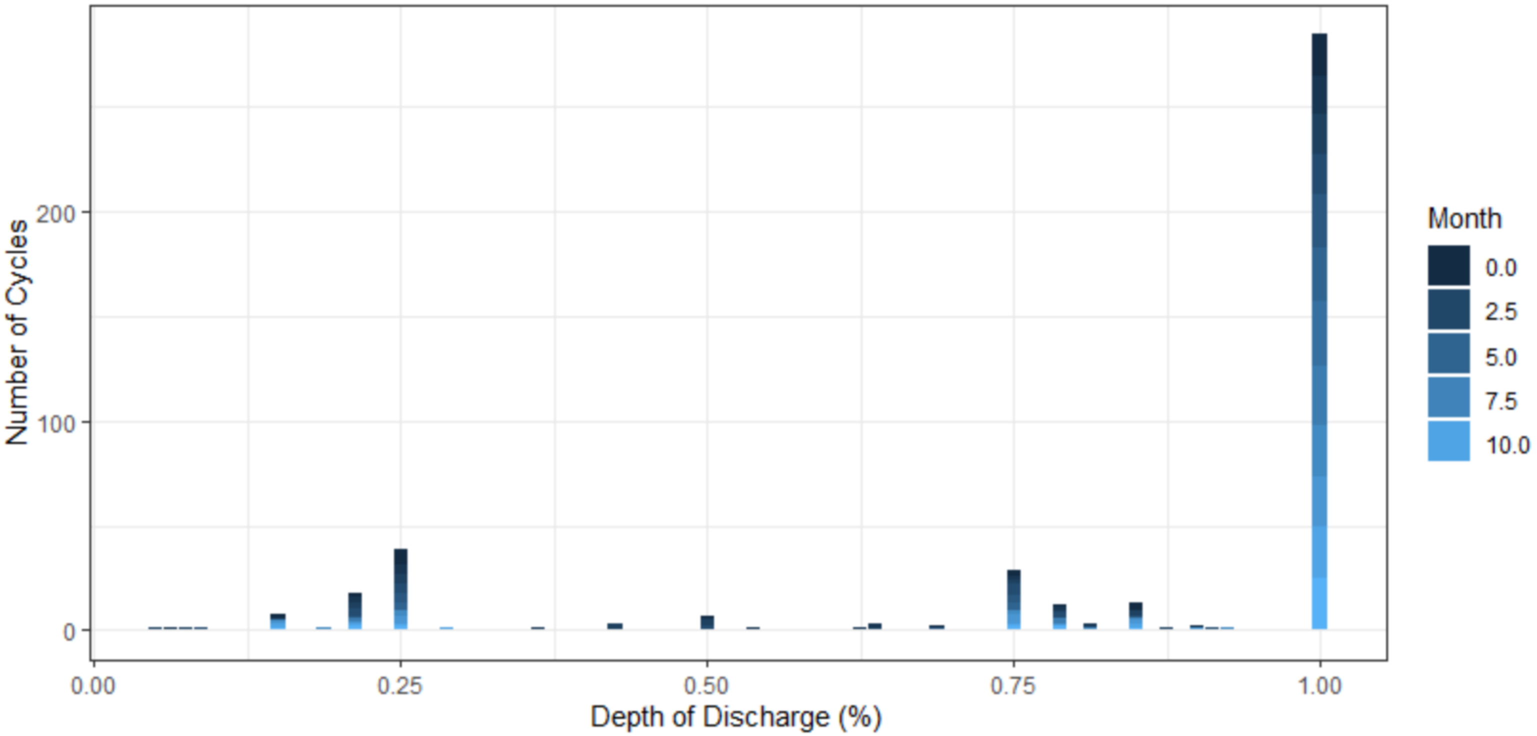
1	startup		0	N/A
1	fixedOM		20	$/kW-yr

1	yearly_degrade		0
1	incl_cycle_degrade		0
1	cycle_life_filename	.\storagevet\Data\Battery_Cycle_Life.csv	

Implementation

- Replacement
  - Turn degradation on
  - Set replacement cost based on projected price
- DER-VET's degradation calculation will validate (or not) expected lifetime input
- Output includes cycle count (see plot) and associated energy capacity degradation

1	yearly_degrade	3
1	incl_cycle_degrade	1
1	cycle_life_filename	.\storagevet\Data\Battery_Cycle_Life.csv

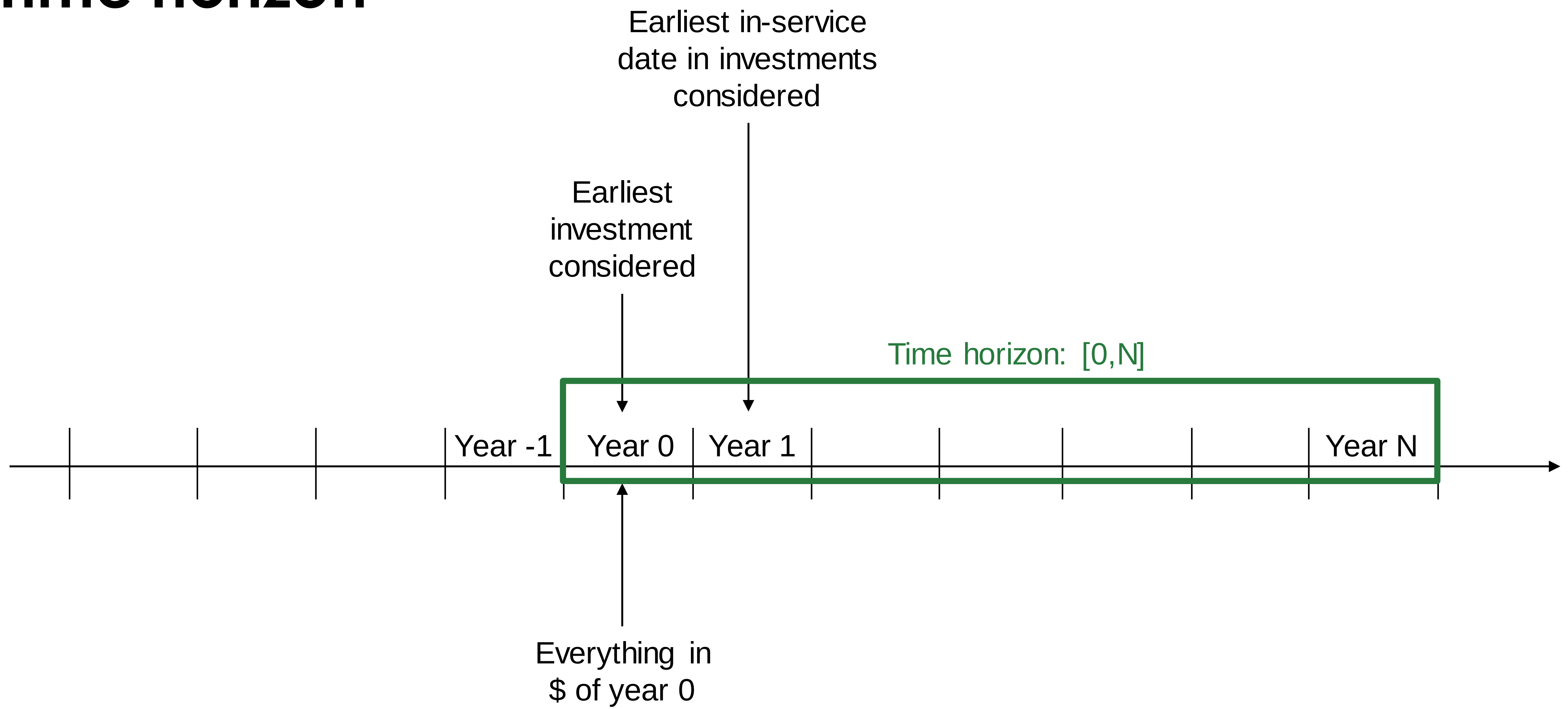


Implementation

- Modular Implementation
  - Multiple battery systems with different operation dates
  - Battery lifetimes overlap
  - Each battery can be oversized, replaced, augmented, etc.
  - Each battery's inputs are identical to the above cases

Benefit-Cost Analysis

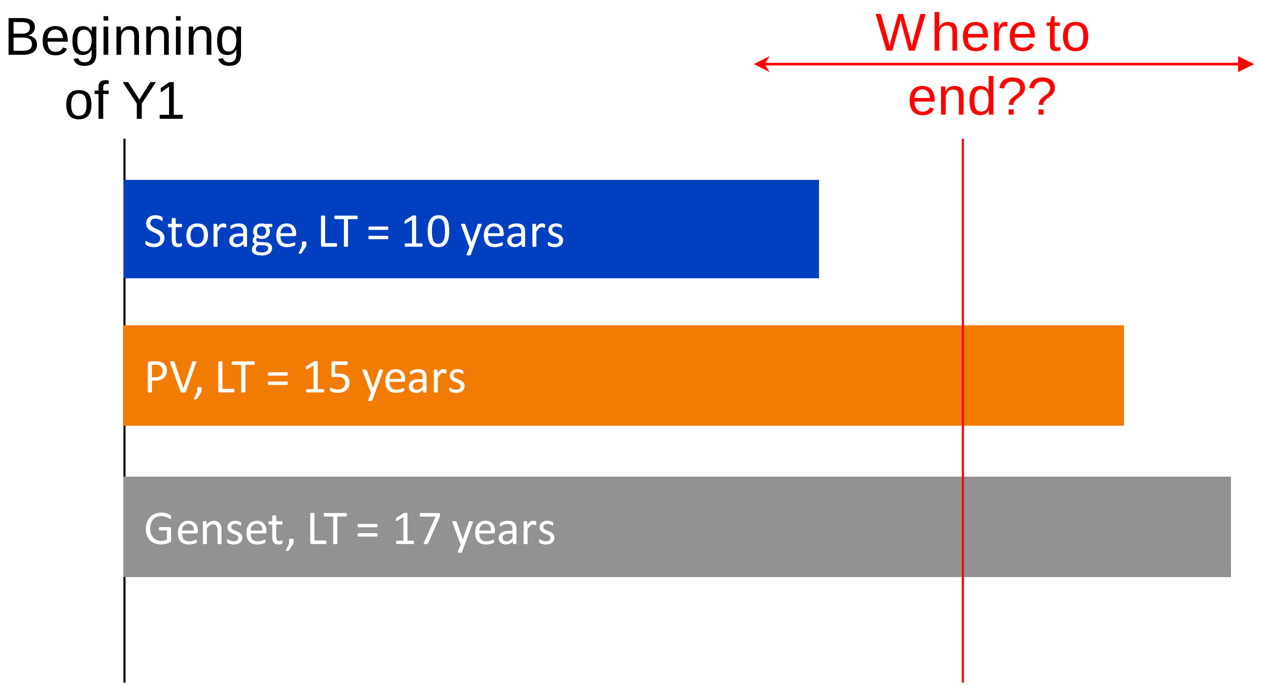
Time horizon



Slide Credit: Tanguy Hubert, EPRI

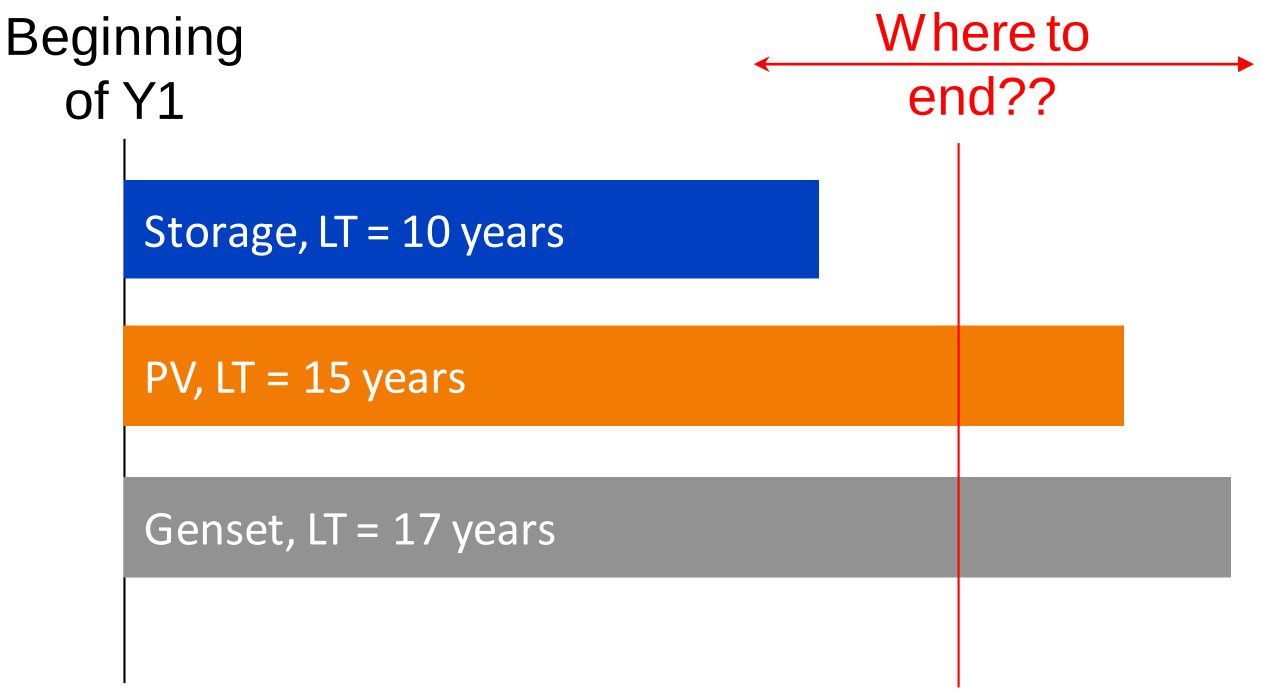
Time Horizon Issue

- How to set time horizon when several assets have different life times?



Slide Credit: Tanguy Hubert, EPRI

Time Horizon Issue Solution



- Analysis end time
  - Shortest lifetime of all assets
  - Longest lifetime of all assets
  - Something else user-defined
- Replacement
  - User can turn automated replacement on or off
- Remaining value/cost at end of analysis
  - Sunk cost (0$, do not consider)
  - Salvage value (linear decline over life or customized)
  - Decommissioning cost
- Annualize everything (ECC)

Slide Credit: Tanguy Hubert, EPRI

Next Meeting

Regularly-Scheduled Meetings

- Next Meeting – **Thursday November 5, 11:00 am Pacific Time**

Together…Shaping the Future of Electricity