# Finding the Least Cost Mix of Renewables, and Storage with CHP

Andrew Kruse

Business Development Manager

UL Renewables

CampusEnergy2020
THE POWER TO CHANGE
FEBRUARY 10-14 ▲ SHERATON DENVER DOWNTOWN ▲ DENVER, CO

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

# The Evolution of the grid

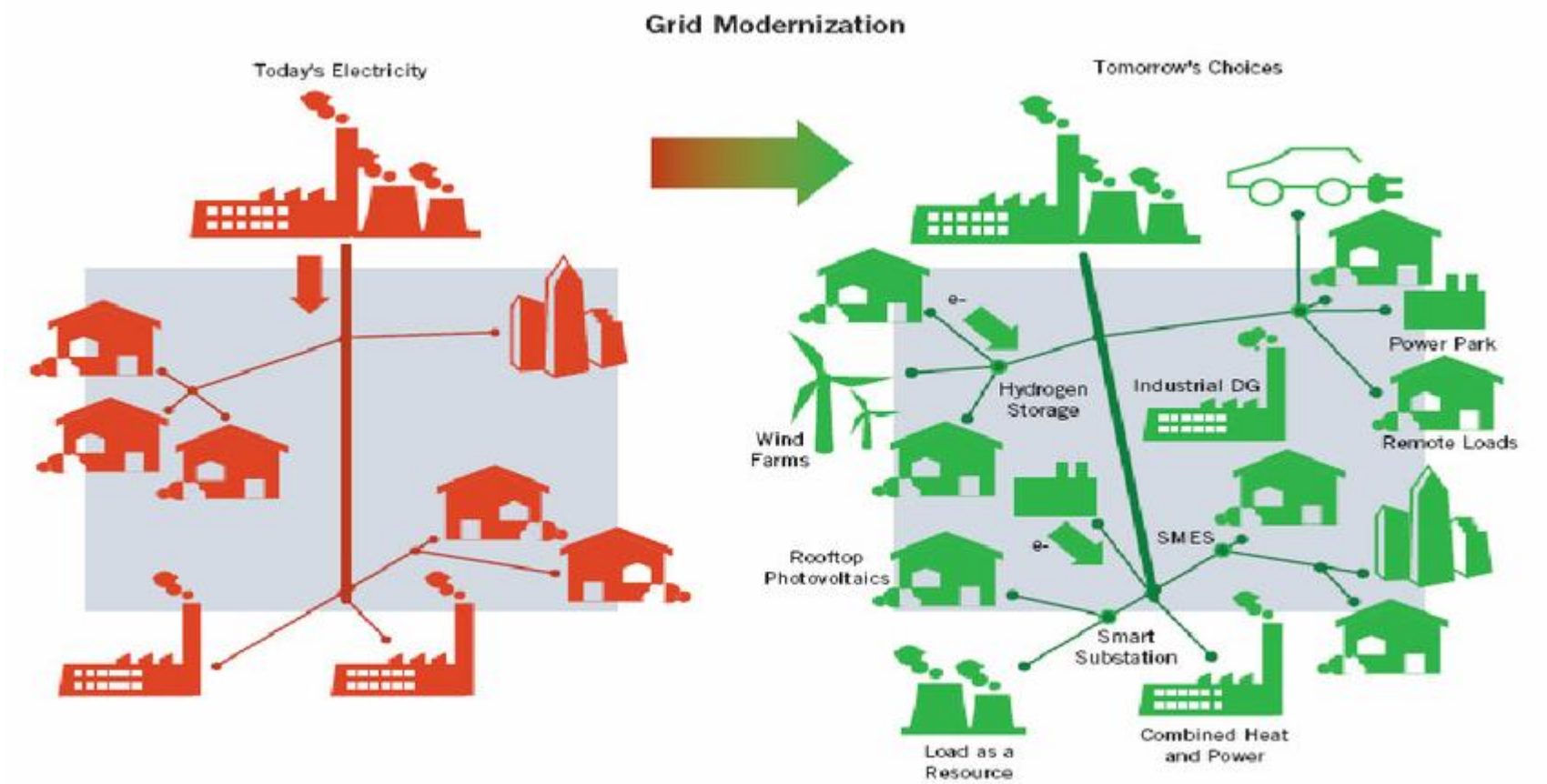
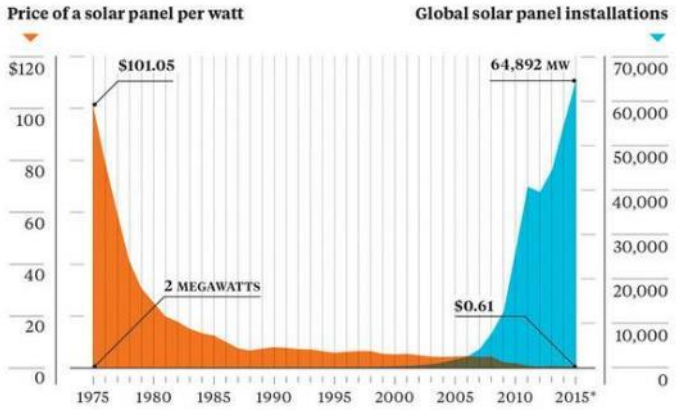


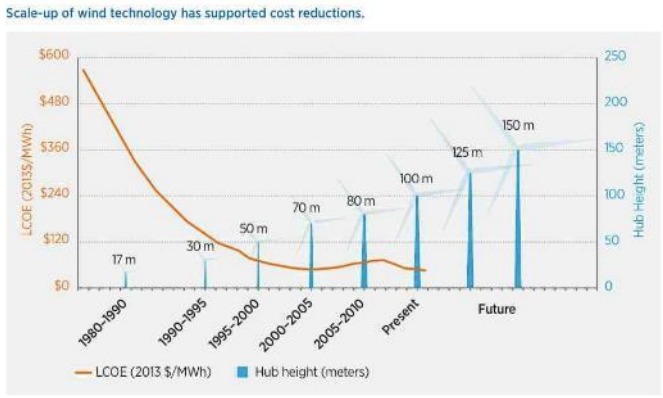

**Fig. 1. The IEEE's version of the Smart Grid involves distributed generation, information networks, and system coordination, a drastic change from the existing utility configurations.**

# Renewables & Storage are the Disruptors for Modern Microgrids

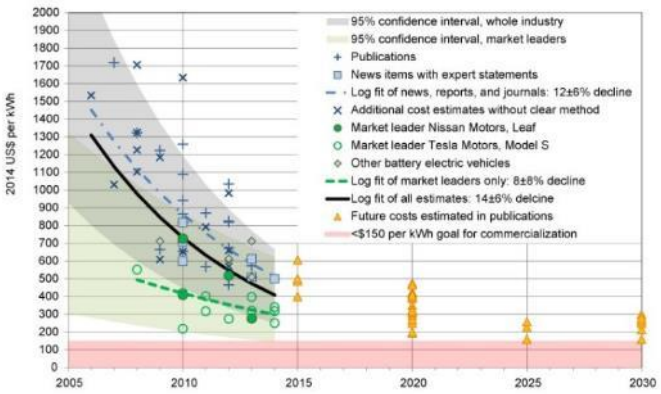
Hybrid microgrids and DER's are growing today because of one primary reason: **Economics**




SOLAR




WIND




STORAGE

In the last decade, the cost of solar and wind have declined by as much as 80% and storage over 50%. They are fast becoming mature, bankable technologies.

# The Potential Impact of Solar+Storage on CHP

- Solar plus storage is having an impact on most forms of I.C. engines used in electricity generation.
- Within this presentation, sensitivities were run on projected future costs of energy storage to better understand the impact of solar plus storage
- This is a simulated example of a small hotel in Massachusetts using HOMER Grid simulation software

# Modeling Process

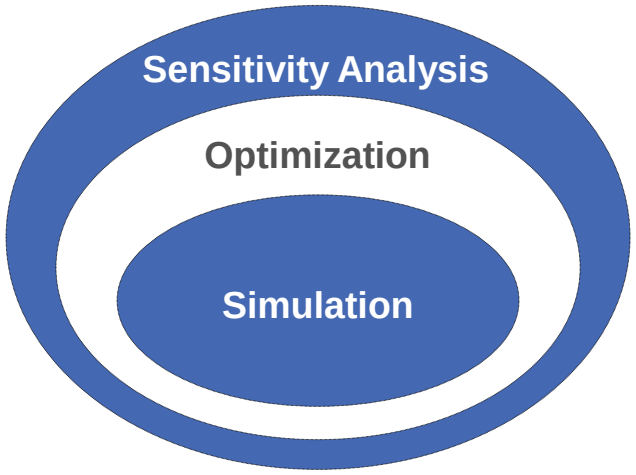
**Project Inputs**

Load Profile

Site-Specific Resources

System Components

**Analysis**




**Results**

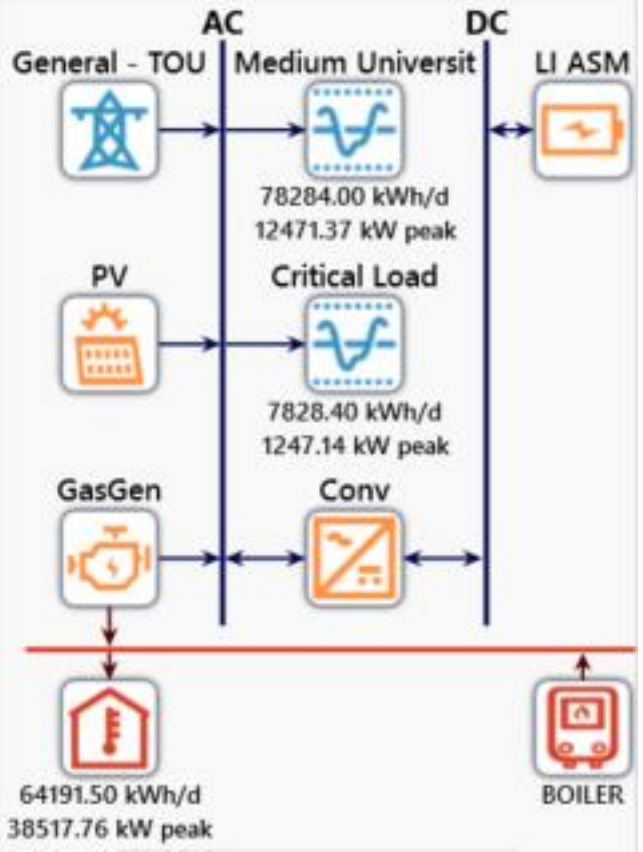
**Economic & Engineering**

System Sizing

Performance Details

Financials

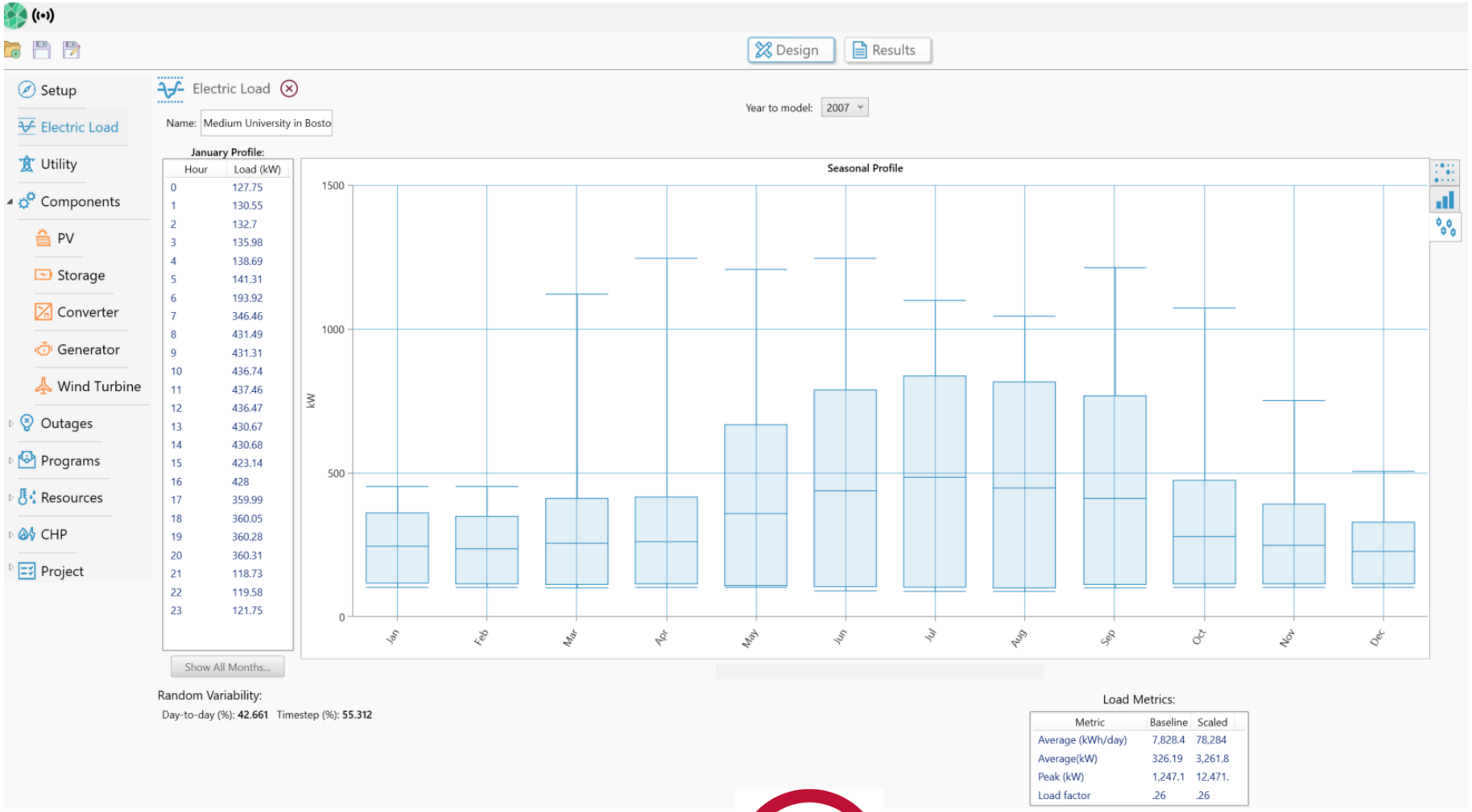
Various Reports




# Architecture

The image is used for demonstration purposes only. This system was not actually built.

# Load Profile of the Hotel

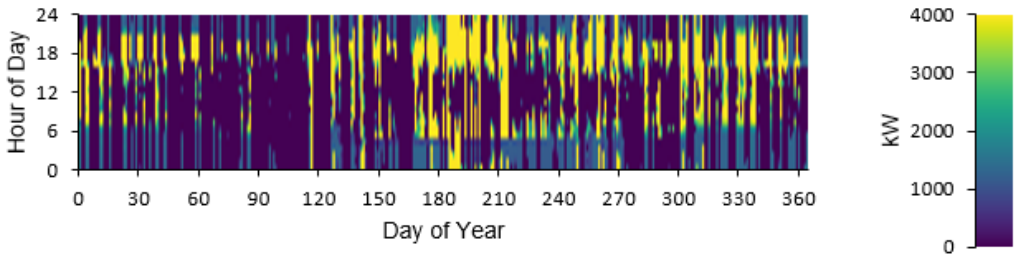


# Breakdown of Components (CHP)

Generator: Generic Gas Microturbine with CHP (size-your-own) (Natural Gas)

Power output from the Generic generator system, rated at 4,000 kW using Natural Gas as fuel, is 8,796,645 kWh/yr.

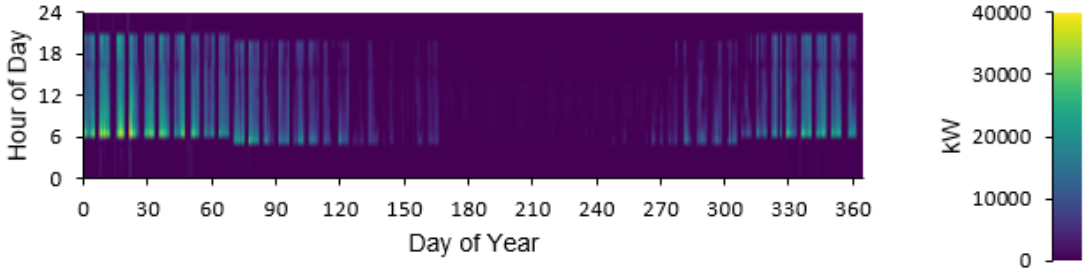
| | | | |
|---|---|---|---|
| Capacity | 4,000 kW | Generator Fuel | Natural Gas |
| Operational Life | 25.7 yr | Generator Fuel Price | 0.200 $/m³ |
| Capital Cost | $6.00M | Maintenance Cost | 140,160 $/yr |
| Fuel Consumption | 2,262,233 m³ | Electrical Production | 8,796,645 kWh/yr |
| Thermal Production | 8,125,745 kWh/yr | Hours of Operation | 3,504 hrs/yr |




Boiler: Generic Boiler

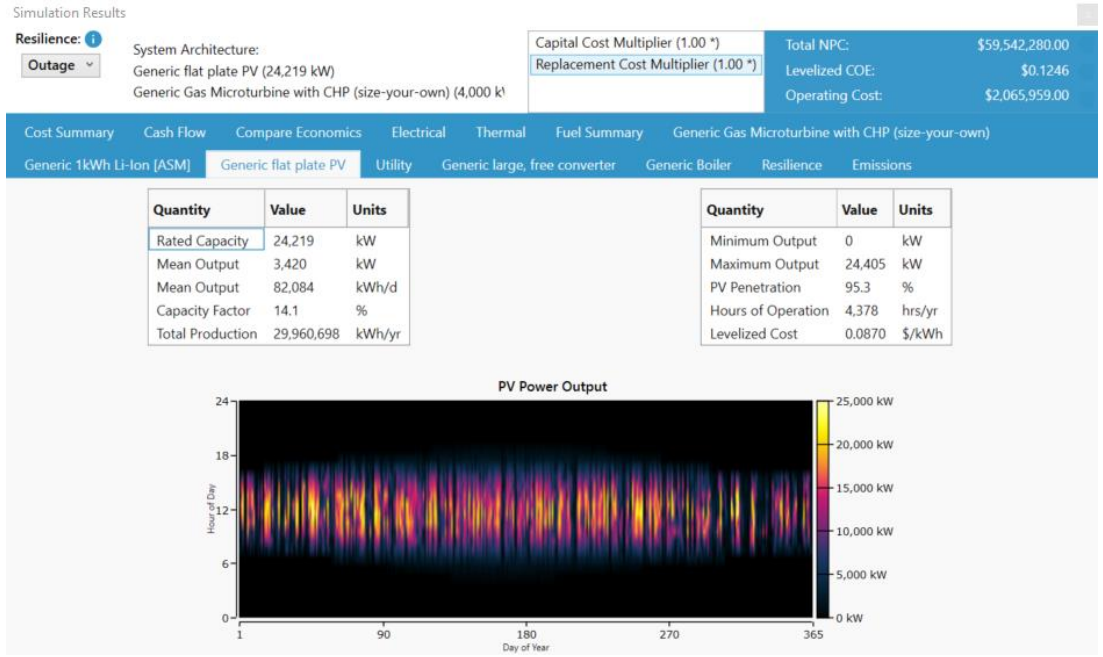
Power output from the Generic boiler system is 20,438,139 kWh/yr.

| | | | |
|---|---|---|---|
| Total production | 20,438,138 kWh/yr | Hours of operation | 6,052 h/yr |
| Boiler Fuel | Natural Gas | Boiler Fuel Price | 0.200 $/m³ |
| Boiler Fuel Consumption | 2,434,924 m3/yr | | |




Model using a .25 capital cost multiplier. Suggested component sizes will vary with changes to model

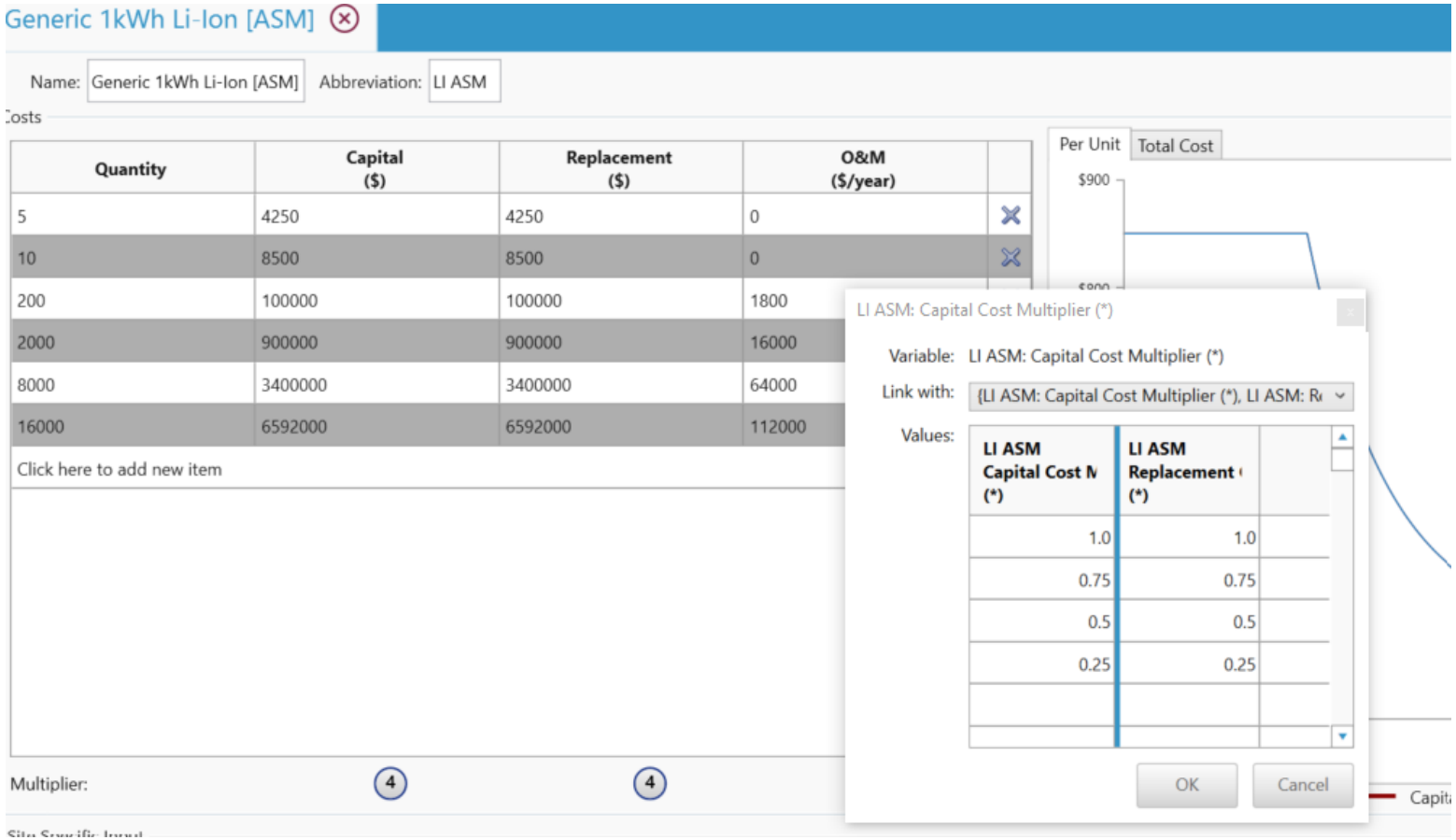
# Cost Breakdown of Components (Solar + Storage)





Model using a .25 capital cost multiplier. Suggested component sizes will vary with changes to model

# Energy Storage Sensitivities



# Model One - .25 multiplier for storage

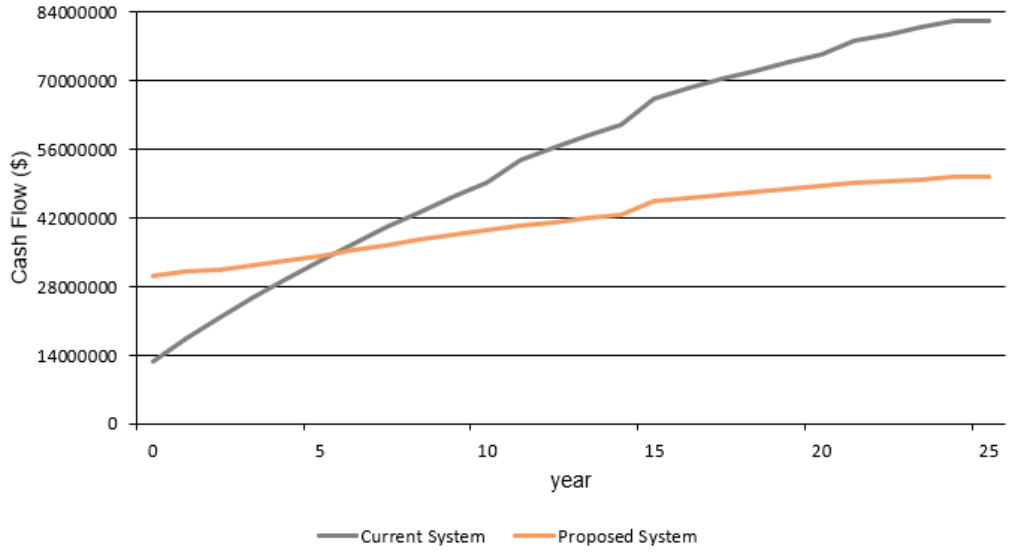
**CURRENT SYSTEM**

The electric needs of 1 Cambridge St, Boston, MA 02114, USA are met with a grid connection. You currently spend $2.57M on your utility bill per year. 26% of your utility bill are demand charges.

**PROPOSED SYSTEM**

We propose adding 25,116 kW of PV. This would reduce your annual utility bill to $261,571. Your investment has a payback of 4.43 years and an IRR of 22.12%.

| | | | |
|---|---|---|---|
| Simple payback: | 4.43 yr | Net Present Value: | $32.1M |
| Return on Investment: | 17.7 % | Capital Investment: | $30.1M |
| Internal Rate of Return: | 22.1 % | Annualized Savings: | $3.79M |



# Model Two- .50 multiplier for storage

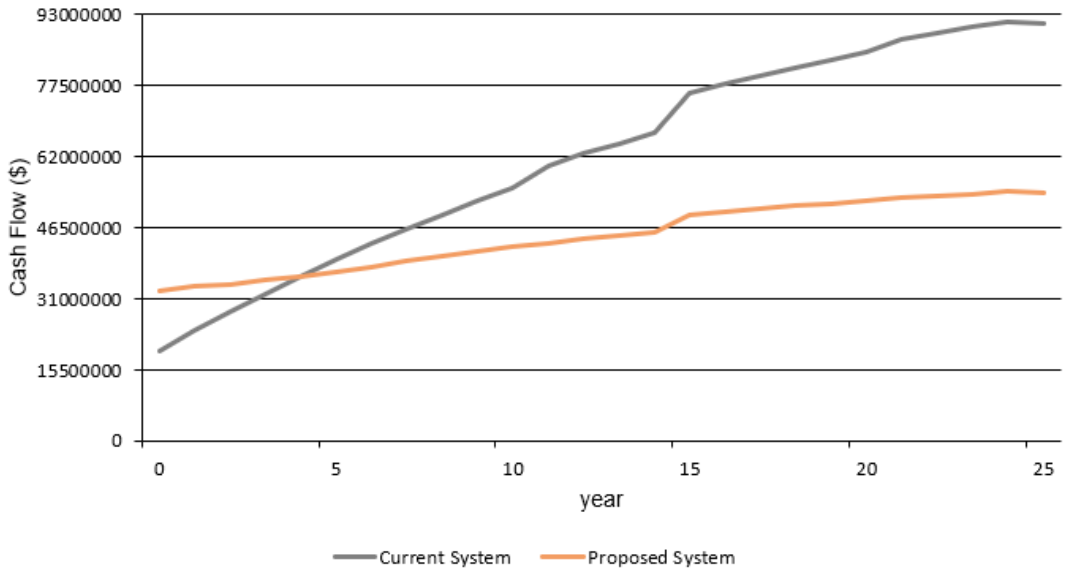
**CURRENT SYSTEM**

The electric needs of 1 Cambridge St, Boston, MA 02114, USA are met with a grid connection. You currently spend $2.57M on your utility bill per year. 26% of your utility bill are demand charges.

**PROPOSED SYSTEM**

We propose adding 26,881 kW of PV. This would reduce your annual utility bill to $378,685. Your investment has a payback of 3.42 years and an IRR of 28.70%.

| | | | |
|---|---|---|---|
| Simple payback: | 3.42 yr | Net Present Value: | $37.1M |
| Return on Investment: | 25.0 % | Capital Investment: | $32.9M |
| Internal Rate of Return: | 28.7 % | Annualized Savings: | $3.86M |



# Model Three - .75 multiplier for storage

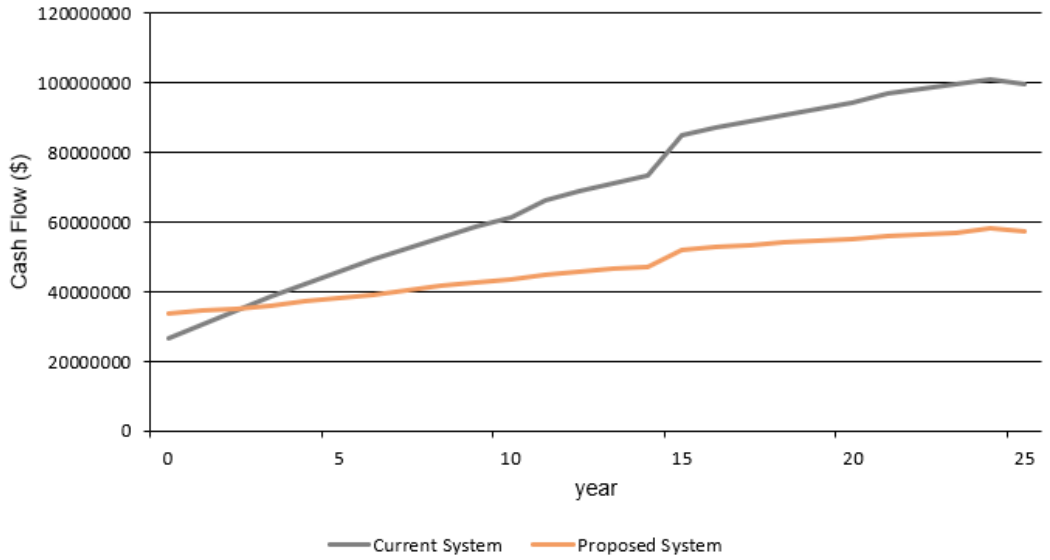
**CURRENT SYSTEM**

The electric needs of 1 Cambridge St, Boston, MA 02114, USA are met with a grid connection. You currently spend $2.57M on your utility bill per year. 26% of your utility bill are demand charges.

**PROPOSED SYSTEM**

We propose adding 26,013 kW of PV. This would reduce your annual utility bill to $467,026. Your investment has a payback of 1.93 years and an IRR of 49.76%.

| | | | |
|---|---|---|---|
| Simple payback: | 1.93 yr | Net Present Value: | $42.8M |
| Return on Investment: | 48.7 % | Capital Investment: | $33.7M |
| Internal Rate of Return: | 49.8 % | Annualized Savings: | $3.85M |



# What was not Considered in this Model

- Property constraints for the solar PV
- Balance of system, permitting and construction costs
- No assumptions were made for the decrease in the cost of solar PV
- Other CHP technologies may have improved cost efficiency curves.
- This model is specific to the Northeastern Untied States. Location will have an impact on the economics

# Conclusions

- The falling cost of solar plus storage will have an impact on future CHP plants

- CHP can demonstrate capabilities that are beyond solar and storage. These include:
  - Energy density (footprint) of a CHP plant
  - Solar PV is not practical for campus heating

- Solar and storage without fossil fuel generation such as CHP has limited resilience capability when long term outages are expected

- CHP remains an excellent solution for critical backup

# Thank You!

**Andy Kruse**

**Business Development Manager**

**Underwriters Laboratories**

**Andy.Kruse@UL.com**

**www.homerenergy.com**