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March 5, 2019

Ms. Debra Howland
Executive Director
New Hampshire Public Utilities Commission
21 S. Fruit Street, Suite 10
Concord, New Hampshire 03301-7319

NHPUC 6MAR'19AM11:36

RE: DE 16-576 Electric Distribution
Development of New Alternative Net Metering Tariffs and/or Other Regulatory Mechanisms and Tariffs for Customer-Generators

Dear Ms. Howland:

Enclosed please find an original and six copies of a study paper,

*"Why would a homeowner want to do that?"*
*A Homeowner Analysis of the Business Case for Distributed Residential PV + Energy Storage*

Best regards,

H. S. Archer, III

Herb Archer

“Why would a homeowner want to do that?”
A Homeowner Analysis of the Business Case for Distributed Residential PV + Energy Storage

by
Herbert Archer

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## 1) Executive Summary

This study takes a broad look at the business case for residential *distributed energy storage.*

Widespread adoption of *distributed energy storage* is in the public interest, offering utilities the potential of cost avoidance in the face of growing demand and seasonally-stressed grids. While technologies available for distributed energy storage come in many forms, the particular technology most available to a large cross-section of homeowners would be battery systems such as those offered by Tesla, SimpliPhi and others. Available for the price of a small car, these systems are compact and can be installed within a day or two, typically in combination with a Photovoltaic (PV) system.

Homeowners considering such a PV + Energy Storage investment will be keenly interested in the *payback period*: This study uses National Renewable Energy Lab (NREL) System Advisor Model (SAM) to answer the following two questions related to payback period:

1. Does the system pay for itself within the “warranty period” using simple payback calculations?
2. Or, longer term, does the system pay for itself within the “wear limit” period of the battery using discounted payback calculations?

The short answer to both questions is, unfortunately, "No," – even with the optimistic assumptions underlying this study, summarized below:

i) We selected the low end of the range of 10 $kW_{DC}$ PV system installation costs, $29K.
ii) We also assumed that the installation of $29K PV + $16K Energy Storage incurs no debt.
iii) The Federal tax credit incentive is assumed to be the current 30% allowance, and the New Hampshire incentive was set to $1,000. Future credits may not be so generous.
iv) We leveraged projections from multiple sources to lower the forward-going US inflation rate from 2.5% to 2.1% and the real discount rate of an alternate safe investment from 6.4% to 3.9%. Taken together, these make future savings more impactful in offsetting the initial investment, significantly accelerating payback.
v) Finally, this study case is of a home office for which power consumption is higher. Higher power consumption multiplied by these Time of Use (TOU) rate differentials gives a more robust cash flow which more quickly pays off the initial investment.

b) Even with these optimistic assumptions, none of the three notional Time of Use (TOU) rates led to payback before the warranty expired or batteries wore out. We therefore took the additional step of factoring into all cases a cost avoidance of $4.7K since, for many homeowners, batteries obviate the need for a home backup generator. Even with that cost avoidance the business case remains tenuous, insufficient for all but one of the cases analyzed.

c) In addition to the $4.7K generator cost avoidance
   i) To satisfy the business case for a tight TOU (T.TOU) with its peak periods highly focused around the historic peak periods of use, we needed an additional incentive of $6.9K. It would take combined allowances of $11.6K ($4.7K generator cost avoidance + $6.9K incentive) to make an energy storage investment financially attractive for the notional T.TOU.
   ii) To satisfy the business case for wide TOU (W.TOU), similar in concept to the current Eversource Residential TOD, we needed an additional incentive of $3K. It would take combined allowances of $7.7K ($4.7K generator cost avoidance + $3K incentive) to make the energy storage investment financially attractive for the W.TOU.

   As substantial as these amounts seem, these amounts are still less than the $16K implied incentive (free energy storage subsystem) that has already been used for the Liberty pilot.

d) If the rate is fixed, if battery scheduling is deterministic, and if the battery discharge rate into the grid is capped at a safe level, it's hard to envision significant added value brought by an aggregator. *Use of an aggregator should not be required* for accessing any new TOU rate.

e) Initial research underpinning this study pointed to the fact that there are many possible approaches to energy storage, including battery, pumped storage, ice-making, etc. The rate and incentive system ultimately adopted should therefore be *technology-agnostic.* Given the particular focus on battery technology in this study, an internet search turned up a half-dozen potential battery/inverter suppliers in this market. Some such as SimpliPhi even publish SAM models for their products. The rate and incentive system ultimately adopted should also be *vendor-agnostic*.

The lower graphs in Figure 1 illustrate the two business case goals (payback before warranty and wear-out) as vertical lines on a time-series cash flow chart. The computed payback periods are shown as milestones. Warranty for the Tesla Powerwall is always fixed at 10 years. The wear-out date varies with the battery dispatch schedule tied to each notional TOU, but should always be to the right of the warranty date. The business case is satisfied when payback milestones fall on or to the left of their respective warranty and wear-out lines.

Three cases are shown for notional tight, narrow, and wide TOU rates. Bottom line: For a homeowner contemplating adding Energy Storage to their anticipated PV purchase, a viable business case requires additional incentives and cost avoidance totaling from 29%-72% of the purchase price of the energy system.

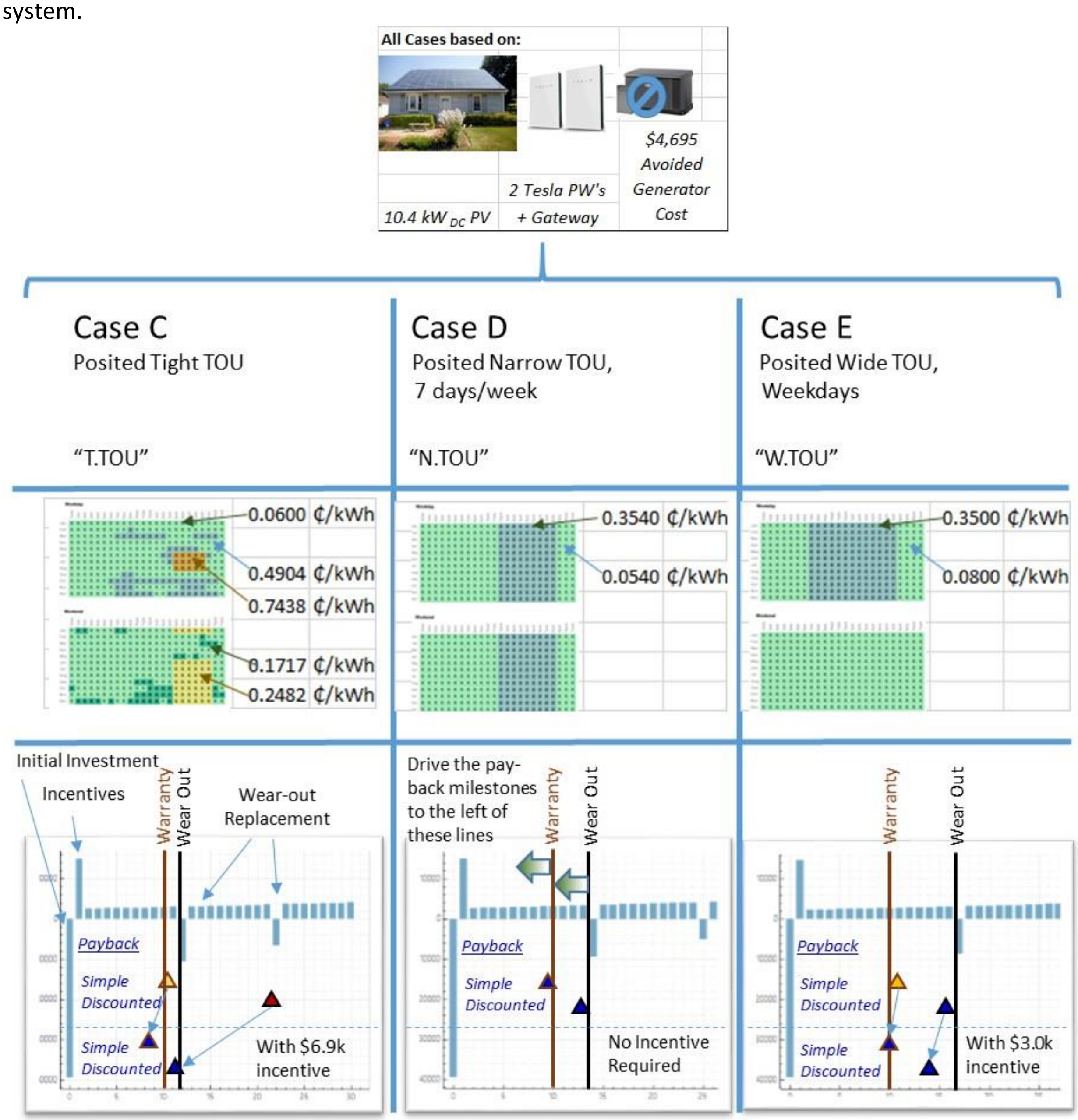



Figure 1

Achieving a *Simple Payback* before the Warranty Expires and *Discounted Payback* before Wear Out

## 1) Notional tight, narrow and wide TOU rates

**First – a caveat:**

> *The purpose of this study is to look at the business case for distributed residential energy storage - <u>not to design TOU rates</u>.* Rates used are *notional* solely for the purpose of performing this analysis.

Notional rates were developed with goals of simplicity, consistency, and "rate neutrality." Each of the T.TOU, N.TOU and W.TOU rates were then separately optimized to minimize their respective "simple" and "discounted" payback periods. Details of these rates are provided in Appendix C.

Design goals for two of these three rates included:

1. *<u>Simplicity</u>*:
   1.1. All rates have only one tier.
   1.2. No rates implemented demand charges.
   1.3. Rates N.TOU and W.TOU have only two levels: High (for peak) and Low (for non-peak).

2. *<u>Consistency</u>*: the N.TOU and W.TOU rates were designed to be consistent with past rate structures and also consistent with present rates used elsewhere in New Hampshire.
   2.1. We keep the meter/account charge the same as the current Eversource flat rate for all but case B, (the current Eversource TOD rate has a higher meter/account fee).
   2.2. The W.TOU rate periods are similar to the current Eversource TOD periods.
   2.3. The N.TOU rate periods are consistent across weekdays and weekends.
   2.4. For both the N.TOU and W.TOU rates, charges associated with peak rate periods fall between current Eversource charges and the Liberty pilot charges.

3. *<u>Rate neutrality</u>*:
   3.1. For all three notional rates, we forced the SAM output, "Electricity Bill Without the System," to match that of the current Eversource standard rate. Therefore, within the limitations of SAM, rates approached "neutral" in the case of the author's system.
   3.2. Beyond the scope of this paper is the fact that "rate neutrality" must be tested more broadly, taking into account growth across the customer base and, hopefully, future cost avoidance against the counterfactual case of zero growth in DG energy & storage.

4. *<u>Optimize Payback</u>*:
   4.1. We iteratively added/subtracted hours from the blocks of time while adjusting energy charges for the high and low periods, effectively doing a two-variable search to minimize the payback period within the constraint of neutrality (§3.1 above).
   4.2. Battery discharge periods were matched to the high rate periods, and the battery discharge rate was then pushed upward (forcing wear-out to happen sooner) subject to: 1) wear-out happening *after* the warranty period, 2) discounted payback period being tuned to happen just *before* the battery wears out.

## 2) Significant assumptions related to SAM models

This study relies on NREL SAM models for computing payback periods. In addition to the previously-discussed notional rates, these models are driven by other key assumptions, described below:

a) ***System design***

i) The SAM analysis reflects the author's residential 10.4 $kW_{DC}$ PV installation which features SE, S, and SW mounting planes shown in Appendix A.

Readers will note that this is but one specific case, probably representing on the order of 0.01% of the Eversource DG customer and production base. Yet, the sensibilities of this particular DG customer would likely be similar to that of other early adopters. This analysis is therefore indicative of the issues that would be facing a broader campaign to encourage homeowner investment in distributed PV + Energy Storage in the near term.

b) ***Battery***

i) After considering (and, in some cases, modeling) offerings from Tesla, Outback, Midnight, Solar Edge / LG Chem and SimpliPhi, the author settled on a pair of Tesla's Powerwall2 units for this analysis. The Tesla price is currently in the ballpark of the others in terms of $/kW for the required continuous and peak available power, and Tesla's price is superior to others in terms of $/ $kWh_{AC}$ for energy storage. The selection of Tesla for this study is also helpful for future comparison of these study results with those of the Liberty pilot.

ii) Tesla Powerwall2s were modeled per the NREL SAM discussion available the following link: https://sam.nrel.gov/node/74927. In the case of the SAM modeling done for this study, capacity parameters were doubled to reflect two Powerwall2s –vs- the single Powerwall in the SAM reference. Appendix B summarizes the parameters use for this selection.

c) ***Modeled costs for significant subsystems***

i) The author's own PV installation was installed with the help of fellow volunteers from the Hillsborough Area Renewable Energy Initiative (HAREI, https://www.harei.org/), however, this study was focused on the cost of a *professional* installation which would be the more typical case. Internet sources suggested that the average cost of a 10 kW installation in NH ranges from $29K to $35K. Given the downward trend of PV pricing, the author selected the lower end of that range, $29K, for the SAM runs in this study.

ii) The modeled cost associated with the battery system was identical to a Tesla quote for installing two Powerwall2 units plus a Gateway. Tesla's quote to the author was $16.2K – and although prices have since risen, they would be expected to drop back again as additional production capacity and competition come online.

iii) All cases also include the *avoided cost* of a whole house generator. Internet sources suggests generator and installation cost could range from $3,977 up to $5,072. For this modeling, we leveraged the cost of a generator $2600, plus installation $1,000, plus propane system installation including (but not purchase of) two size 120 propane tanks for $1,095. This totaled to $4,695, falling midway between the other prices found on the internet.

d) ***Financial parameters***

i) See Appendix D for financial values.

ii) Debt fraction is set to zero – a presumption that with rising interest rates, early adopters would self-fund this acquisition.

iii) The "Inflation" rate was reduced from the SAM default of 2.5% to 2.1% per year based on US inflation predictions from the United Nations and OECD.

iv) The "Real Discount" rate was reduced from the SAM default of 6.4% per year to 3.9% per year. This is the computed compounded rate of an alternate low risk investment (Vanguard VWINX), logging the investment gains in that fund over a long timeframe (3/1/1971 to 3/1/2019) and then backing out the effects of inflation over that same timeframe.

v) The combination of lower inflation and lower real discount rate drives the combined discount rate from the SAM default of 9.06% down to 6.08% per year, significantly accelerating the calculated payback period for the wear-out case.

e) ***Incentives***

i) These runs used the current 30% Federal Investment Tax Credit ("ITC" in SAM Model). This incentive is set to decline starting in 2020.

ii) These runs also included a $1000 New Hampshire Investment Based Incentive ("IBI" in SAM Model).

iii) When a particular run could not achieve payback criteria even accounting for $4.7K of avoided generator costs, an additional "Utility Incentive" was incrementally added until payback criteria were met. That required additional incentive ranged from $3K to $6.9K.

f) ***Electricity rates***

i) In addition to the three notional TOU rates described in the previous section and Appendix C, the study also included two baseline Cases, "A" and "B," using current PSNH residential standard and TOD rates. These were downloaded via SAM from the *Open EL Database:*

(1) Eversource Residential Standard

http://en.openei.org/apps/IURDB/rate/view/5988958a682bea7f0a7121bf

(2) Eversource Residential Time of Day

http://en.openei.org/apps/IURDB/rate/view/5988958a682bea7f0a7121c5

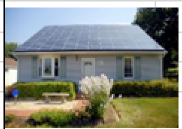
g) ***Electric loads***

i) See Appendix E for load values.

ii) The author used the "Calculate Load Data" SAM option whereby user-specified *monthly* consumption values are used to calibrate a nearby dataset of *hourly* consumption values.

iii) Rates reflect the author's actual Eversource power use for the two years prior to installing the PV system. These figures are reflective of a home office, with two workstations and a studio.

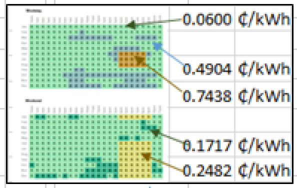
**All Cases based on:**

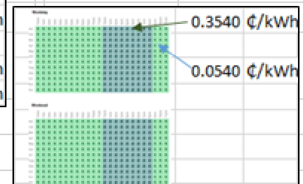


10.4 kW $_{DC}$ PV | 2 Tesla PW's + Gateway | *$4,695 Avoided Generator Cost*

***Current Rates***

Open EL E'source Std



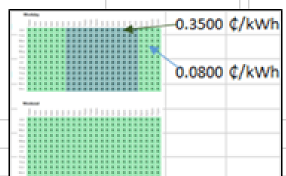




***Baseline Standard & Narrow TOU Cases***

| | Case: | A Standard | C T.TOU | with $6.85K Incentive | D N.TOU |
|---|---|---|---|---|---|
| Annual Energy (year 1) | kWh | 13,171 | 13,088 | | 13,170 |
| Capacity Factor (year 1) | | 14.5% | 14.4% | | 14.5% |
| Energy yield (year 1) | kWh/kW | 1,266 | 1,258 | | 1,266 |
| Performance (year 1) | | 0.79 | 0.79 | | 0.79 |
| Battery efficiency (incl. converter + ancillary) | | 87.65% | 87.86% | | 88.55% |
| Levelized COE (nominal) | ¢/kWh | 26.54 | 28.74 | | 27.94 |
| Levelized COE (real) | ¢/kWh | 21.19 | 22.56 | | 22.18 |
| Electricity Bill without system (year 1) | | **$3,953** | **$3,956** | | **$3,955** |
| Electricity Bill with system (year 1) | | $1,497 | $851 | | $668 |
| Net savings with system (year 1) | | $2,456 | $3,105 | | $3,287 |
| Net present value | | -$6,027 | $2,855 | | $7,244 |
| Simple payback period — Warranty 10 years | | 13.8 | 10.3 | 8.4 | 9.5 |
| Discounted payback period — Wear Out 13 years | | NaN | 20.6 | 11.0 | 12.9 |
| Net capital cost | | **$39,505** | **$44,200** | | **$34,105** |
| Equity | | $39,505 | $44,200 | | $34,105 |
| Debt | | $0 | $0 | | $0 |

***Baseline TOD & Wide TOU Cases***

Open EL E'source TOD




| | Case: | B TOD | E W.TOU | with $3K Incentive |
|---|---|---|---|---|
| Annual Energy (year 1) | kWh | 13,252 | 13,252 | |
| Capacity Factor (year 1) | | 14.5% | 14.5% | |
| Energy yield (year 1) | kWh/kW | 1,274 | 1,274 | |
| Performance (year 1) | | 0.8 | 0.8 | |
| Battery efficiency (incl. converter + ancillary) | | 88.98% | 88.98% | |
| Levelized COE (nominal) | ¢/kWh | 25.71 | 25.71 | |
| Levelized COE (real) | ¢/kWh | 20.40 | 20.40 | |
| Electricity Bill without system (year 1) | | a) **$4,289** | **$3,956** | |
| Electricity Bill with system (year 1) | | $1,772 | $1,022 | |
| Net savings with system (year 1) | | $2,517 | $2,934 | |
| Net present value | | -$2,235 | $4,828 | |
| Simple payback period — Warranty 10 years | | 13.0 | 10.8 | 10.0 |
| Discounted payback period — Wear Out 17 years | | 27.9 | 15.7 | 13.9 |
| Net capital cost | | **$39,505** | **$36,505** | |
| Equity | | $39,505 | $36,505 | |
| Debt | | $0 | $0 | |

Figure 2
Summary of SAM Modeling Results for Five Cases

## 3) Summary of SAM modeling results

Figure 2 summarizes the SAM outputs from two baseline cases of the current Eversource rates, and the three notional TOU cases - five cases in all. Regarding Figure 2:

- All cases are based on a professional installation of 10.4 $kW_{DC}$ PV array, two Powerwall2's & the associated gateway, and $4.7K of cost avoidance associated with not needing a conventional generator.
- Cases A and B were included as a baseline reference point, using OpenEL downloads of the Eversource standard and TOD rates.
- Case C uses a notional tight TOU rate crafted from analysis of ISO-New England – New Hampshire hourly costs by month, accumulated over the prior 12 months, separately analyzed for weekday and weekends. The actual rates associated with each period were directly scaled from ISO New England wholesale costs.
- Case D uses a notional narrow TOU rate that kicks in between 12:00PM and 8:00PM for both weekdays and weekends. The peak rate is similar to that of the recently-approved Liberty pilot.
- Case E uses a notional weekday wide TOU time period similar to the current Eversource TOD structure, but driven to a wider cost spread similar to rates selected for the recently-approved Liberty pilot.
- The blue-colored box demarking "Electricity Bill Without System" on both the upper and lower sections is an important feature of the study. In every case other than Case B, the rates were tuned to keep a constant value for this attribute in an attempt to enforce rate neutrality for this particular residential DG account.
    - In the particular situation of Case B we let the Eversource TOD rate float to its computed value which ends up being higher than the standard rate this DG customer is now paying.
- The computed simple and discounted payback periods are shown near the bottom of each data set, with titles highlighted in blue.
    - Within the data sets, if these calculated payback periods meet minimum business case criteria, they are highlighted in green. If they are within 25% of compliant, they are highlighted in yellow. Otherwise the fields are red.

Conclusions:

a) Even with a 30% Federal tax rebate, a $1K NH incentive, and optimistic assumptions, none of the three notional Time of Use (TOU) rates led to payback occurring before the warranty expired or batteries wore out.
b) Figure 2 already includes the additional step of a $4.7K cost avoidance for a generator. Even with this cost avoidance, the business case remains tenuous, insufficient for all but one of the cases analyzed (Case "D", N.TOU).
c) For a homeowner contemplating adding Energy Storage to their anticipated PV purchase, a viable business case therefore requires additional incentives and cost avoidance totaling from 29%-72% of the purchase price of the energy system. In practice, this could be a combination of incentives such as a purchase credit ($/kWh of storage), a "buy one get one free" battery arrangement, an unusually high TOU rate differential accounting for a more expansive calculation of avoided costs, or an exceptionally high sell rate for pre-arranged energy dumps to the grid.

# Appendix A – The particular PV system used for this study

| | |
|---|---|
| 10,400 | DC W |
| 13,393 | kWh |
| 35.2 | Simultaneous Amps |
| $2,181 | Dollars Saved per Yea |

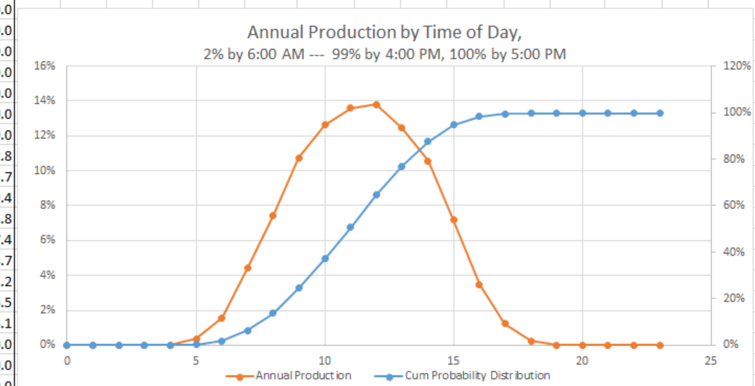

| | MP1 | | | MP2 | | | MP3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Garage SE Roof | | | Upstairs Flat Roof | | | MBR Attic SW Roof | | |
| Panels | ☑ | 14 | | ☑ | 8 | | ☑ | 10 | |
| W/panel | | 325 | | | 325 | | | 325 | |
| DC Watts | 4,550 | min | max | 2,600 | min | max | 3,250 | min | max |
| AC kWh/yr | 6,095 | 5,811 | 6,364 | 3,504 | 3,342 | 3,659 | 3,794 | 3,617 | 3,962 |
| % Hist Use | 30% | | | 17% | | | 19% | | |
| Max Amps | 15.8 | | 16.5 | 9.0 | | 9.4 | 10.9 | | 11.4 |
| Pk W / Panel | 270.8 | | 100% | 270.8 | | 100% | 261.4 | | 97% |
| Clip Hrs | 0.0 | | | 0.0 | | | 0.0 | | |

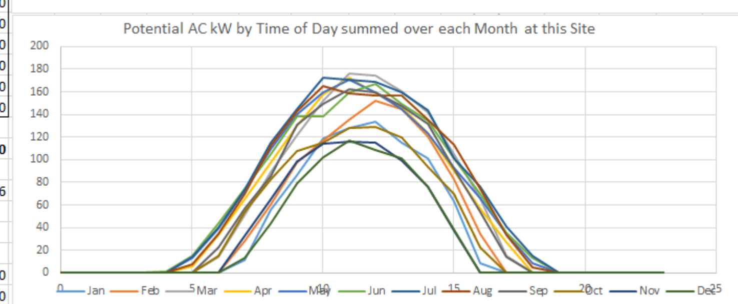
| | | |
|---|---|---|
| 290 | 290 | |
| 24 | 8 | |
| 6960 | 2320 | 9280 |
| | | 2.483 |

| Hour | Aggre | Annual F | Cum Probability |
|---|---|---|---|
| 0 | 0.0 | 0% | 0% |
| 1 | 0.0 | 0% | 0% |
| 2 | 0.0 | 0% | 0% |
| 3 | 0.0 | 0% | 0% |
| 4 | 0.0 | 0% | 0% |
| 5 | 1.3 | 0% | 0% |
| 6 | 5.7 | 2% | 2% |
| 7 | 16.0 | 4% | 6% |
| 8 | 27.0 | 7% | 14% |
| 9 | 38.9 | 11% | 25% |
| 10 | 45.7 | 13% | 37% |
| 11 | 49.2 | 14% | 51% |
| 12 | 49.9 | 14% | 65% |
| 13 | 45.1 | 12% | 77% |
| 14 | 38.2 | 11% | 88% |
| 15 | 25.9 | 7% | 95% |
| 16 | 12.7 | 3% | 98% |
| 17 | 4.5 | 1% | 99% |
| 18 | 0.9 | 0% | 100% |
| 19 | 0.0 | 0% | 100% |
| 20 | 0.0 | 0% | 100% |
| 21 | 0.0 | 0% | 100% |
| 22 | 0.0 | 0% | 100% |
| 23 | 0.0 | 0% | 100% |
| 24 | | 100% | |
| | Div by | 362 | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 1.5 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 6.2 | 13.6 | 15.3 | 13.8 | 7.8 | 0.5 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 14.4 | 33.4 | 39.3 | 44.0 | 40.2 | 34.2 | 22.8 | 14.8 | 0.0 | 0.0 |
| 7 | 11.6 | 28.0 | 50.8 | 65.3 | 72.2 | 74.2 | 73.8 | 70.1 | 57.2 | 54.2 | 32.4 | 12.8 |
| 8 | 55.7 | 60.5 | 89.3 | 97.8 | 109.1 | 104.6 | 115.5 | 112.2 | 85.9 | 82.9 | 65.1 | 43.7 |
| 9 | 86.3 | 97.2 | 122.0 | 130.3 | 140.0 | 138.1 | 145.2 | 143.1 | 130.7 | 107.6 | 98.0 | 79.4 |
| 10 | 118.4 | 117.1 | 152.5 | 157.6 | 159.9 | 138.1 | 172.7 | 164.7 | 149.5 | 115.1 | 114.0 | 101.8 |
| 11 | 127.7 | 135.9 | 176.2 | 172.6 | 170.8 | 159.3 | 171.0 | 158.3 | 162.0 | 127.8 | 116.2 | 117.4 |
| 12 | 133.9 | 151.8 | 174.4 | 158.9 | 159.7 | 166.9 | 169.1 | 157.2 | 159.6 | 129.4 | 115.0 | 108.7 |
| 13 | 115.2 | 145.1 | 160.6 | 147.0 | 144.7 | 149.4 | 159.9 | 156.4 | 147.4 | 119.9 | 99.1 | 101.2 |
| 14 | 101.2 | 120.2 | 141.9 | 123.7 | 123.5 | 135.0 | 143.5 | 135.5 | 131.7 | 93.8 | 76.5 | 76.5 |
| 15 | 63.2 | 82.4 | 105.1 | 89.9 | 93.0 | 101.4 | 101.0 | 113.7 | 92.3 | 69.5 | 37.2 | 38.1 |
| 16 | 8.3 | 34.1 | 66.2 | 56.9 | 66.4 | 69.9 | 76.5 | 74.5 | 53.6 | 22.2 | 0.0 | 0.0 |
| 17 | 0.0 | 0.0 | 14.8 | 26.7 | 34.6 | 35.3 | 40.8 | 34.0 | 14.0 | 0.0 | 0.0 | 0.0 |
| 18 | 0.0 | 0.0 | 0.0 | 0.3 | 8.5 | 13.6 | 15.3 | 4.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13,393 | | | 822 | 972 | 1268 | 1266 | 1336 | 1347 | 1439 | 1367 | 1207 | 937 | 754 | 680 |
| 20,480 | kWh | 2017-18 | 3273 | 2483 | 1775 | 1333 | 1269 | 1774 | 1416 | 1559 | 1267 | 1128 | 1137 | 2066 |
| 65% | Percent of Historical Use | | | | | | | | | | | | | |
| | Self-Supplied | $ 0.16 | 822 | 972 | 1268 | 1266 | 1269 | 1347 | 1416 | 1367 | 1207 | 937 | 754 | 680 |
| | Sell Back | $ 0.14 | 0 | 0 | 0 | 0 | 67 | 0 | 23 | 0 | 0 | 0 | 0 | 0 |



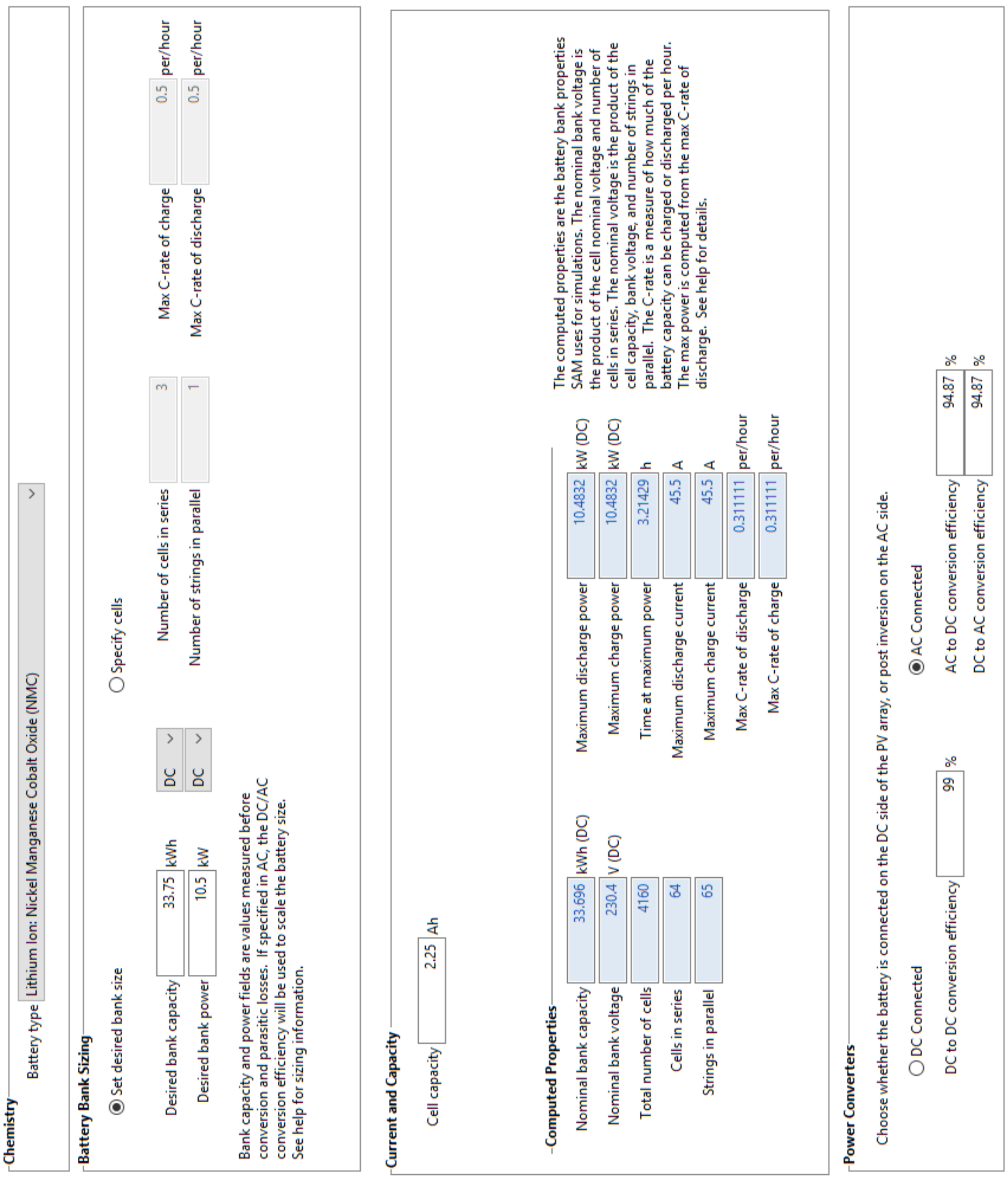



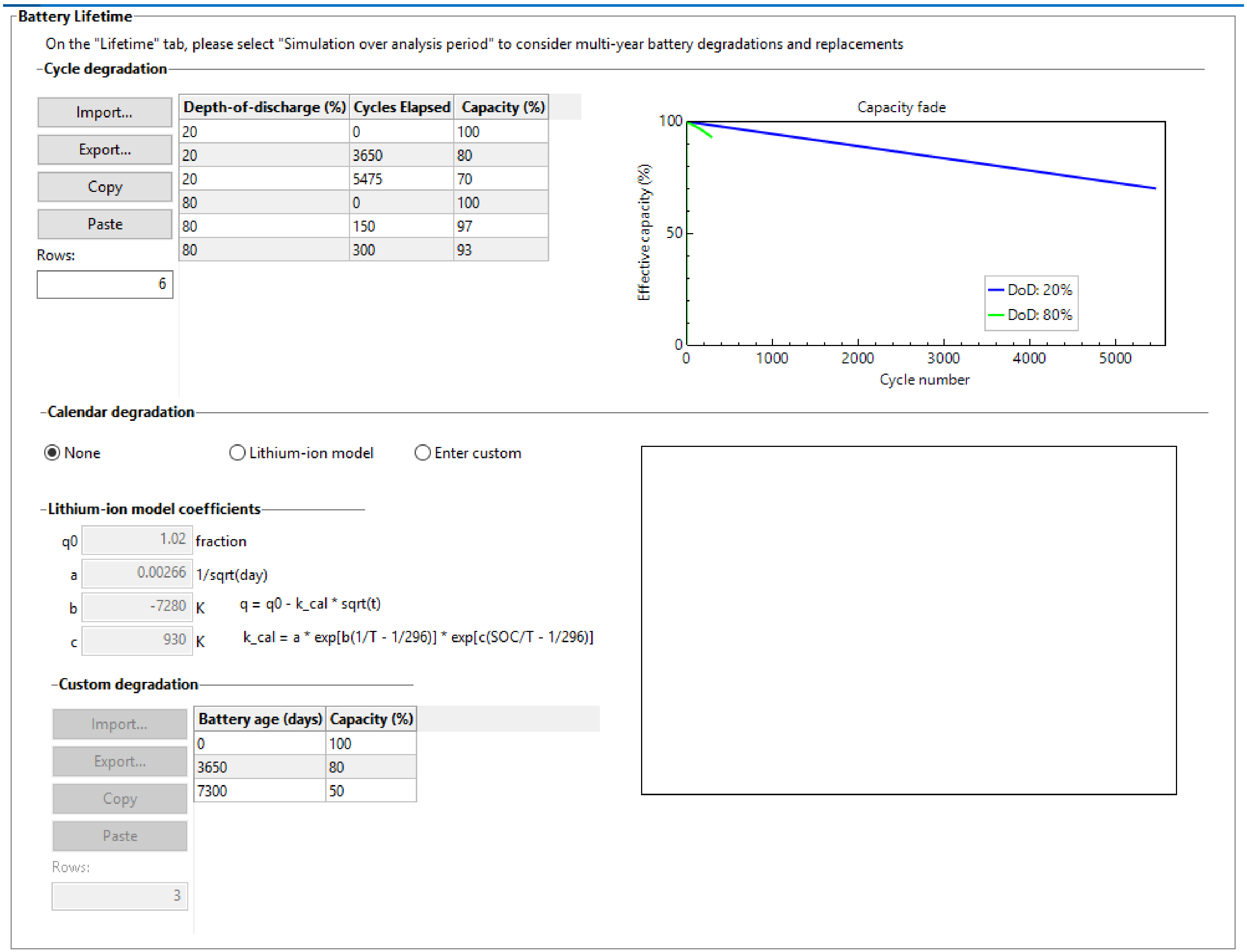
## Appendix B – SAM parameters for a pair of Tesla Powerwall2 energy storage units

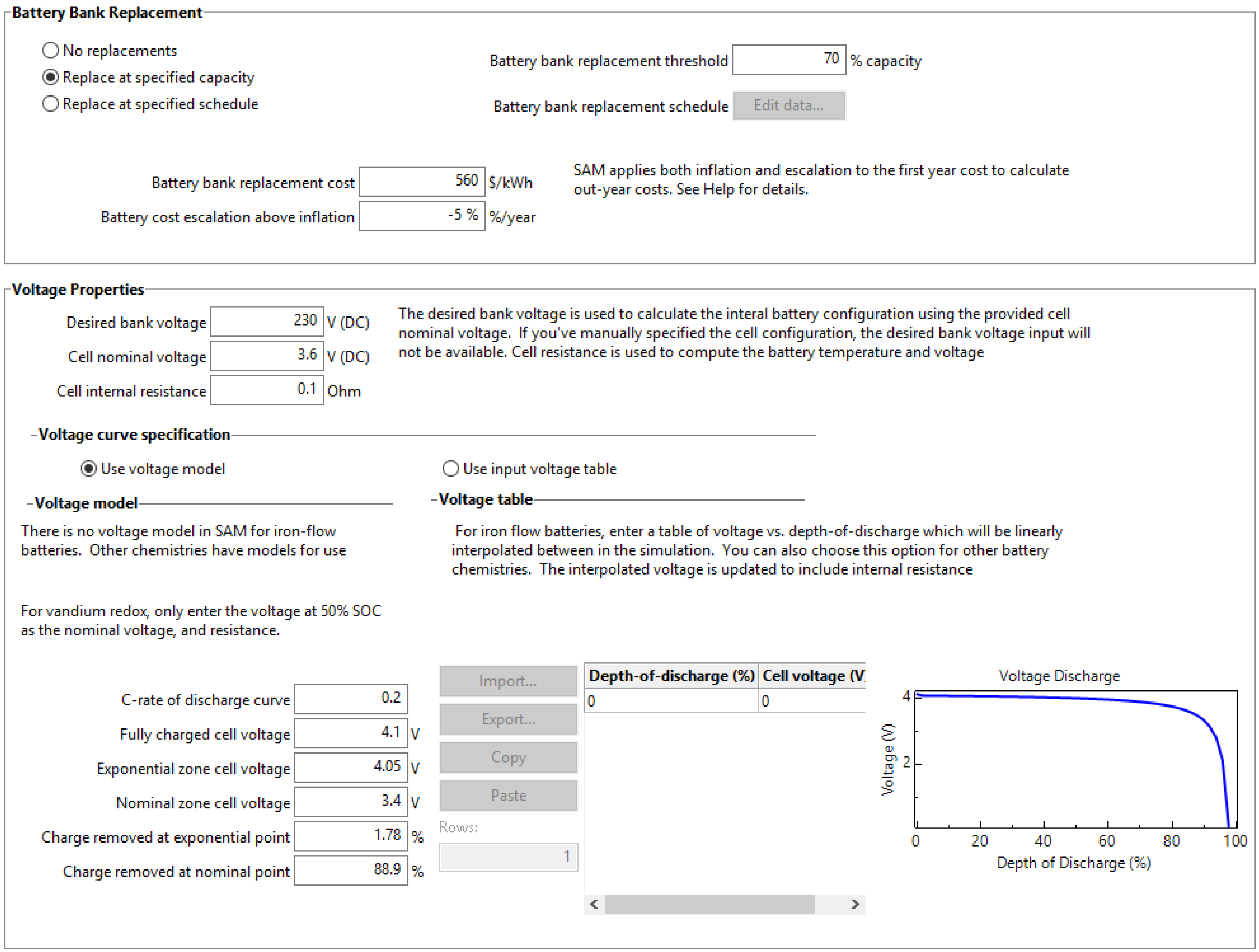
Note that specifications contained in the referenced thread are for a *single* Powerwall unit, and the SAM models use in these analysis specify *two* such Powerwalls.

Reference:

[https://sam.nrel.gov/node/74927](https://sam.nrel.gov/node/74927)




Battery Lifetime
On the "Lifetime" tab, please select "Simulation over analysis period" to consider multi-year battery degradations and replacements
Cycle degradation
Import...
Export...
Copy
Paste
Rows:
6
Depth-of-discharge (%) | Cycles Elapsed | Capacity (%)
20 | 0 | 100
20 | 3650 | 80
20 | 5475 | 70
80 | 0 | 100
80 | 150 | 97
80 | 300 | 93
Capacity fade
Effective capacity (%)
Cycle number
DoD: 20%
DoD: 80%
Calendar degradation
None
Lithium-ion model
Enter custom
Lithium-ion model coefficients
q0 1.02 fraction
a 0.00266 1/sqrt(day)
b -7280 K
c 930 K
q = q0 - k_cal * sqrt(t)
k_cal = a * exp[b(1/T - 1/296)] * exp[c(SOC/T - 1/296)]
Custom degradation
Import...
Export...
Copy
Paste
Rows:
3
Battery age (days) | Capacity (%)
0 | 100
3650 | 80
7300 | 50


Battery Bank Replacement
No replacements
Replace at specified capacity
Replace at specified schedule
Battery bank replacement threshold 70 % capacity
Battery bank replacement schedule
Edit data...
Battery bank replacement cost 560 $/kWh
Battery cost escalation above inflation -5 % %/year
SAM applies both inflation and escalation to the first year cost to calculate out-year costs. See Help for details.
Voltage Properties
Desired bank voltage 230 V (DC)
Cell nominal voltage 3.6 V (DC)
Cell internal resistance 0.1 Ohm
The desired bank voltage is used to calculate the interal battery configuration using the provided cell nominal voltage. If you've manually specified the cell configuration, the desired bank voltage input will not be available. Cell resistance is used to compute the battery temperature and voltage
Voltage curve specification
Use voltage model
Use input voltage table
Voltage model
There is no voltage model in SAM for iron-flow batteries. Other chemistries have models for use
For vandium redox, only enter the voltage at 50% SOC as the nominal voltage, and resistance.
Voltage table
For iron flow batteries, enter a table of voltage vs. depth-of-discharge which will be linearly interpolated between in the simulation. You can also choose this option for other battery chemistries. The interpolated voltage is updated to include internal resistance
C-rate of discharge curve 0.2
Fully charged cell voltage 4.1 V
Exponential zone cell voltage 4.05 V
Nominal zone cell voltage 3.4 V
Charge removed at exponential point 1.78 %
Charge removed at nominal point 88.9 %
Import...
Export...
Copy
Paste
Rows:
1
Depth-of-discharge (%)
Cell voltage (V
0
0
Voltage Discharge
Voltage (V)
Depth of Discharge (%)
0
20
40
60
80
100
2
4

**Ancillary Equipment Losses**

Specify additional hourly losses not captured by power conversion losses. Such losses might include pumps, heaters, or other equipment required by the battery system. For AC-connected batteries, the losses are applied on the AC side. For DC-connected batteries, the losses are applied on the DC side.

**Loss input**

◉ Enter average loss by operating mode

Charging mode [Edit values...] kW

Discharging mode [Edit values...] kW

Idle mode [Edit values...] kW

○ Enter time series

Time series [Edit data...] kW

Operation losses will be applied whenenver the battery is at that operational mode.

**Thermal Behavior**

Cp 1004 J/KgK

h 500 W/m2K

Room temperature 20 C

Model assumes battery with specific heat Cp sits in room of fixed temperature. Heat transfer to room proportional to heat transfer coefficient h

Import...

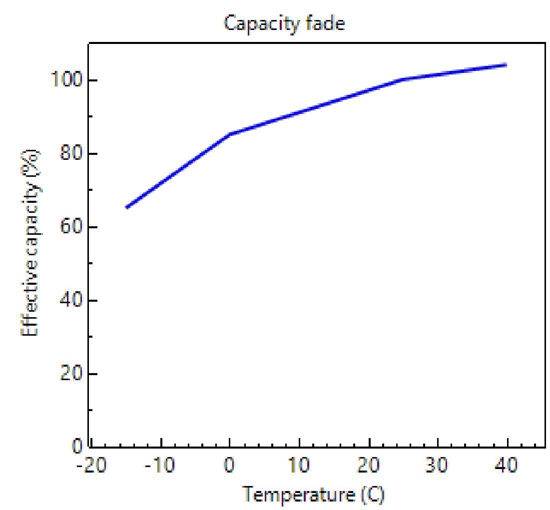
Export...

Copy

Paste

Rows: 4

| Temp (C) | Capacity(%) |
|---|---|
| -15 | 65 |
| 0 | 85 |
| 25 | 100 |
| 40 | 104 |




**Physical properties**

Specific energy per mass 197.33 Wh/kg

Specific energy per volume 501.25 Wh/L

Battery mass 170.76 kg

Battery volume 0.0672239 m3

This section does not model power used for thermal conditioning. If the battery requires operation of heating or cooling equipment, the associated electricity use can be entered in the 'Additional System Losses' section

## Appendix C – Notional T.TOU, N.TOU and W.TOU Rates

### a) Selection of T.TOU, N.TOU and W.TOU high rate periods

ISO New England - New Hampshire Total Cost

Workweek

| Index | Feb 2018 | Mar 2018 | Apr 2018 | May 2018 | Jun 2018 | Jul 2018 | Aug 2018 | Sep 2018 | Oct 2018 | Nov 2018 | Dec 2018 | Jan 2019 | Time of Day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 875 | 948 | 1149 | 653 | 694 | 883 | 853 | 805 | 940 | 1219 | 1010 | 1123 | 1:00:00 AM |
| 2 | 860 | 777 | 1155 | 557 | 737 | 837 | 815 | 830 | 938 | 1158 | 986 | 1106 | 2:00:00 AM |
| 3 | 804 | 736 | 1084 | 517 | 742 | 807 | 695 | 814 | 998 | 1154 | 1015 | 1055 | 3:00:00 AM |
| 4 | 802 | 752 | 1120 | 484 | 714 | 771 | 751 | 825 | 890 | 1156 | 988 | 1061 | 4:00:00 AM |
| 5 | 912 | 783 | 1176 | 519 | 683 | 774 | 756 | 833 | 957 | 1188 | 1017 | 994 | 5:00:00 AM |
| 6 | 989 | 937 | 1237 | 580 | 574 | 814 | 824 | 791 | 942 | 1336 | 1173 | 1132 | 6:00:00 AM |
| 7 | 1074 | 1028 | 1473 | 659 | 810 | 851 | 827 | 937 | 1213 | 1497 | 1449 | 1392 | 7:00:00 AM |
| 8 | 1149 | 1164 | 1612 | 939 | 906 | 927 | 891 | 1023 | 1533 | 1686 | 1639 | 1435 | 8:00:00 AM |
| 9 | 1038 | 1385 | 1429 | 807 | 861 | 983 | 932 | 1051 | 1279 | 1725 | 1400 | 1427 | 9:00:00 AM |
| 10 | 973 | 1188 | 1339 | 772 | 820 | 1020 | 978 | 1051 | 1111 | 1534 | 1112 | 1344 | 10:00:00 AM |
| 11 | 1003 | 958 | 1376 | 761 | 837 | 1052 | 1000 | 1039 | 1110 | 1604 | 1095 | 1328 | 11:00:00 AM |
| 12 | 924 | 921 | 1393 | 738 | 835 | 1131 | 1068 | 1067 | 1149 | 1593 | 1047 | 1288 | 12:00:00 PM |
| 13 | 874 | 896 | 1314 | 737 | 833 | 1131 | 1146 | 1126 | 1118 | 1493 | 998 | 1236 | 1:00:00 PM |
| 14 | 868 | 889 | 1271 | 736 | 866 | 1191 | 1361 | 1165 | 1071 | 1408 | 1064 | 1245 | 2:00:00 PM |
| 15 | 880 | 837 | 1193 | 674 | 869 | 1390 | 1565 | 1364 | 1092 | 1377 | 1110 | 1272 | 3:00:00 PM |
| 16 | 928 | 795 | 1110 | 888 | 895 | 1364 | 1500 | 1781 | 1093 | 1525 | 1215 | 1297 | 4:00:00 PM |
| 17 | 1000 | 812 | 1092 | 1023 | 891 | 1395 | 1641 | 2406 | 1161 | 1599 | 1348 | 1419 | 5:00:00 PM |
| 18 | 1110 | 890 | 1186 | 952 | 927 | 1486 | 1609 | 3818 | 1260 | 1803 | 1481 | 1682 | 6:00:00 PM |
| 19 | 1156 | 1001 | 1289 | 884 | 989 | 1378 | 1501 | 1993 | 1419 | 1689 | 1376 | 1741 | 7:00:00 PM |
| 20 | 1107 | 994 | 1347 | 852 | 926 | 1184 | 1317 | 1409 | 1381 | 1591 | 1300 | 1530 | 8:00:00 PM |
| 21 | 1025 | 975 | 1426 | 912 | 862 | 1029 | 1281 | 1258 | 1189 | 1606 | 1235 | 1401 | 9:00:00 PM |
| 22 | 960 | 979 | 1310 | 834 | 853 | 1037 | 1106 | 1074 | 1086 | 1506 | 1074 | 1291 | 10:00:00 PM |
| 23 | 915 | 921 | 1172 | 695 | 829 | 942 | 948 | 962 | 998 | 1179 | 1034 | 1149 | 11:00:00 PM |
| 24 | 747 | 828 | 1089 | 576 | 774 | 907 | 936 | 941 | 910 | 1069 | 1081 | 1083 | 12:00:00 AM |

| Mean | Std Dev | | | | Normalized | Rate |
|---|---|---|---|---|---|---|
| 1097 | 325.5 | 0.5 | Mean + 0.5 * Std Dev | 1260 | 251.9 | 0.49039 |
| | | 1.5 | Mean + 1.5 * Std Dev | 1585 | 317 | |
| | | 2.5 | Mean + 2.5 * Std Dev | 1911 | 382.1 | **0.74380** |

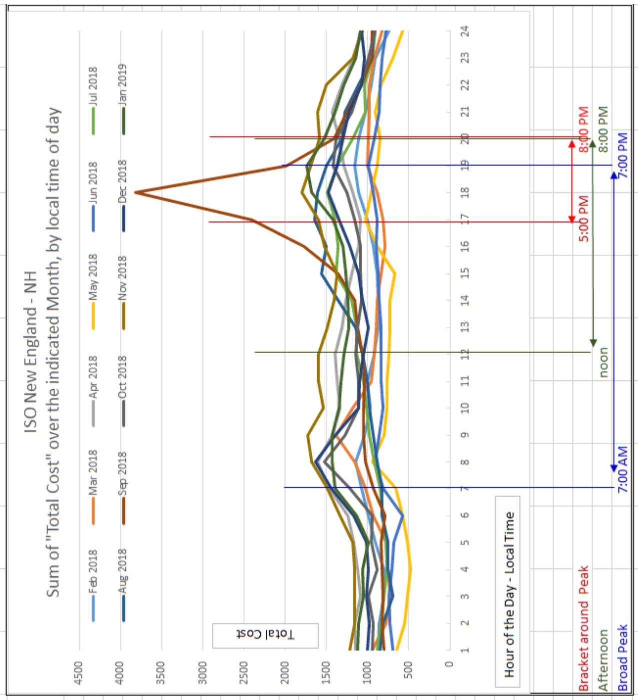



Figure 3

ISO New England – NH – Total cost by hour for each month, for the most recent 12 months, *Weekdays*

Weekends

| Index | Feb 2018 | Mar 2018 | Apr 2018 | May 2018 | Jun 2018 | Jul 2018 | Aug 2018 | Sep 2018 | Oct 2018 | Nov 2018 | Dec 2018 | Jan 2019 | Time of Day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 452 | 282 | 358 | 346 | 338 | 252 | 330 | 306 | 416 | 418 | 390 | 513 | 1:00:00 AM |
| 2 | 473 | 288 | 347 | 303 | 332 | 274 | 302 | 303 | 420 | 378 | 355 | 516 | 2:00:00 AM |
| 3 | 416 | 255 | 345 | 257 | 338 | 278 | 313 | 307 | 403 | 382 | 324 | 497 | 3:00:00 AM |
| 4 | 409 | 292 | 332 | 242 | 326 | 268 | 272 | 309 | 402 | 395 | 321 | 454 | 4:00:00 AM |
| 5 | 390 | 272 | 359 | 219 | 341 | 268 | 174 | 309 | 396 | 395 | 339 | 436 | 5:00:00 AM |
| 6 | 373 | 290 | 374 | 215 | 318 | 261 | 279 | 331 | 403 | 372 | 376 | 445 | 6:00:00 AM |
| 7 | 571 | 315 | 390 | 185 | 231 | 223 | 336 | 410 | 438 | 386 | 341 | 418 | 7:00:00 AM |
| 8 | 484 | 328 | 377 | 188 | 316 | 247 | 359 | 349 | 424 | 421 | 389 | 420 | 8:00:00 AM |
| 9 | 412 | 338 | 397 | 238 | 285 | 252 | 355 | 328 | 429 | 420 | 414 | 492 | 9:00:00 AM |
| 10 | 405 | 345 | 434 | 255 | 352 | 302 | 384 | 360 | 479 | 398 | 458 | 466 | 10:00:00 AM |
| 11 | 421 | 331 | 431 | 336 | 282 | 307 | 368 | 333 | 500 | 418 | 465 | 489 | 11:00:00 AM |
| 12 | 396 | 324 | 340 | 316 | 291 | 340 | 373 | 331 | 462 | 454 | 441 | 489 | 12:00:00 PM |
| 13 | 379 | 299 | 345 | 268 | 304 | 353 | 388 | 341 | 424 | 511 | 442 | 447 | 1:00:00 PM |
| 14 | 392 | 283 | 297 | 290 | 263 | 369 | 403 | 349 | 414 | 479 | 443 | 434 | 2:00:00 PM |
| 15 | 384 | 281 | 278 | 274 | 323 | 380 | 393 | 372 | 401 | 579 | 459 | 473 | 3:00:00 PM |
| 16 | 401 | 265 | 253 | 257 | 511 | 371 | 408 | 488 | 396 | 584 | 499 | 512 | 4:00:00 PM |
| 17 | 450 | 295 | 319 | 321 | 466 | 407 | 456 | 672 | 419 | 709 | 536 | 547 | 5:00:00 PM |
| 18 | 505 | 317 | 358 | 333 | 415 | 426 | 658 | 596 | 489 | 781 | 600 | 657 | 6:00:00 PM |
| 19 | 474 | 411 | 433 | 324 | 503 | 447 | 600 | 528 | 594 | 714 | 586 | 616 | 7:00:00 PM |
| 20 | 433 | 442 | 510 | 309 | 398 | 415 | 460 | 496 | 521 | 662 | 564 | 533 | 8:00:00 PM |
| 21 | 412 | 411 | 589 | 296 | 366 | 421 | 468 | 411 | 455 | 564 | 537 | 517 | 9:00:00 PM |
| 22 | 386 | 397 | 494 | 315 | 362 | 434 | 402 | 349 | 399 | 451 | 509 | 423 | 10:00:00 PM |
| 23 | 398 | 358 | 408 | 316 | 320 | 367 | 359 | 318 | 358 | 410 | 488 | 405 | 11:00:00 PM |
| 24 | 394 | 330 | 368 | 268 | 318 | 335 | 320 | 287 | 348 | 477 | 439 | 422 | 12:00:00 AM |

| Mean | Std Dev | | | | Normalized | Rate |
|---|---|---|---|---|---|---|
| 392 | 98.27 | 0.5 | Mean + 0.5 * Std Dev | 441 | 220.6 | 0.17171 |
| | | 1.5 | Mean + 1.5 * Std Dev | 539 | 269.7 | |
| | | 2.5 | Mean + 2.5 * Std Dev | 638 | 318.8 | 0.24823 |

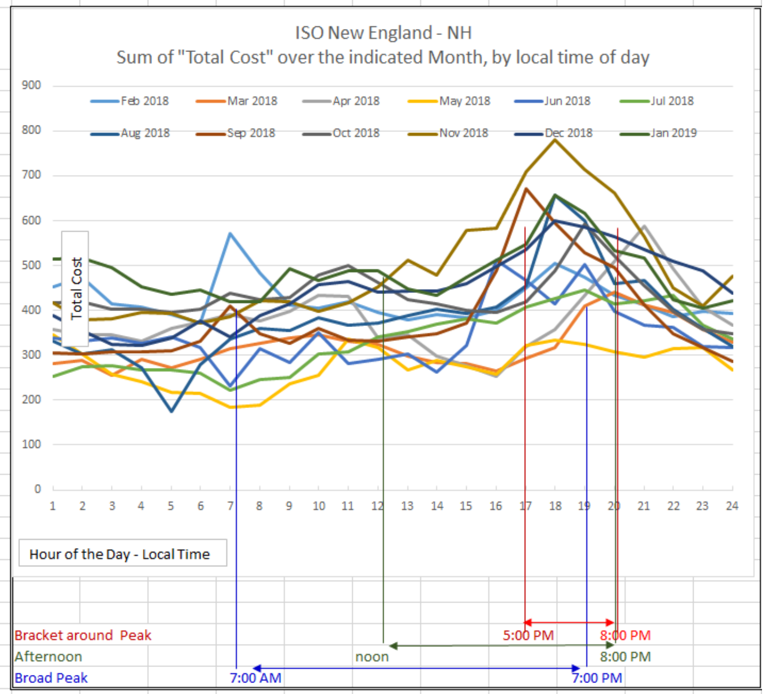



Figure 4

ISO New England – NH – Total cost by hour for each month, for the most recent 12 months, *Weekends*

The author's initial impulse was to tighten the peak periods around what has historically been peak costs of energy to NH from ISO-New England. The data in Figure 3 and 4 was a starting point for this approach – pulling ISO New England data for New Hampshire, summing the "Total Cost" figures for each hour of a given month, and then plotting the prior twelve months of these sums by time of day separately for weekdays and weekends. (Reference: [https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/whlsecost-hourly-newhampshire](https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/whlsecost-hourly-newhampshire)).

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 4 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Oct | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| Dec | 1 | 4 | 4 | 4 | 4 | 1 | 4 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |

**Rates for Energy Charges**

Import... Export... Copy Paste

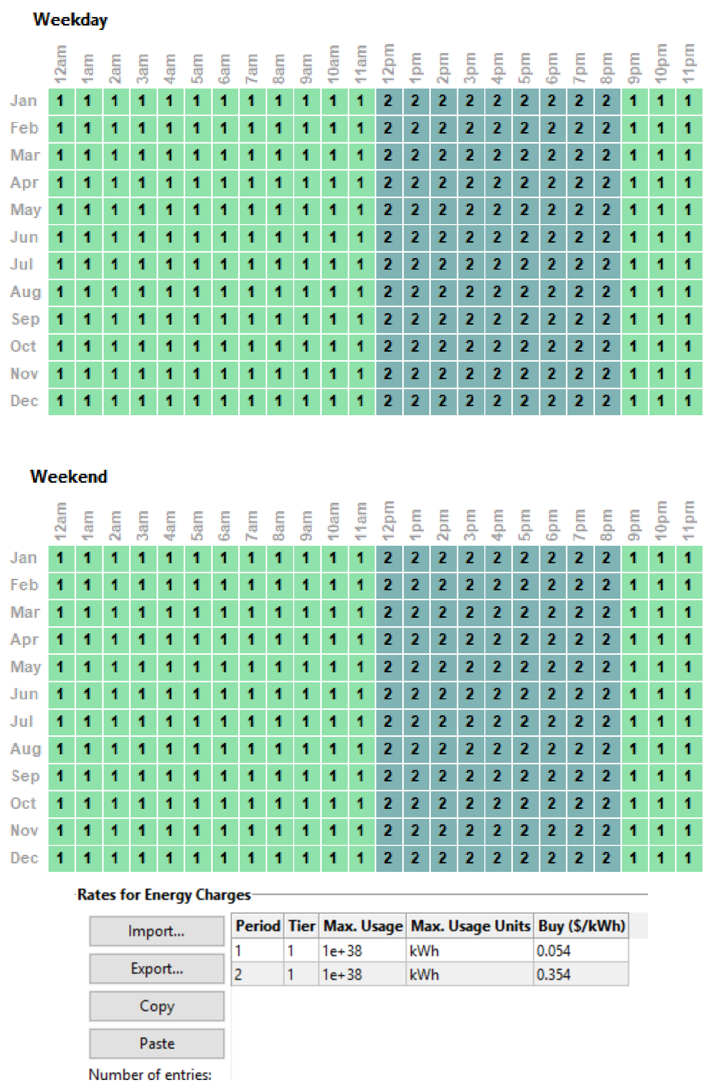
| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.06 |
| 2 | 1 | 1e+38 | kWh | 0.49039 |
| 3 | 1 | 1e+38 | kWh | 0.7438 |
| 4 | 1 | 1e+38 | kWh | 0.17171 |
| 5 | 1 | 1e+38 | kWh | 0.24823 |

Figure 5
Tight TOU (T.TOU) focused around prior year peak demands.

The chosen rates were directly scaled from the ISO New-England wholesale costs for each period.

Despite the seeming advantages of tightly bracketing the prior year peaks (red ranges in Figures 3 & 4), the payback was disappointing in the particular case of this customer's power consumption. Peak NH demand on ISO New England did not highly correlate with peak demand from our home and home office.

The second attempt at a TOU rate bracketed the afternoon and evening, from noon to 8:00 PM (green range on Figures 3 & 4). This captures the peaks for all seasons of the year, and does so with sufficient breadth to allow reasonable rate differential between the high and low periods. This ended up being the best choice, reflected in the data shown as "N.TOU", Case "D" in this study, and illustrated in Figure 6, below.



**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

**Rates for Energy Charges**

Import... Export... Copy Paste

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.054 |
| 2 | 1 | 1e+38 | kWh | 0.354 |

Number of entries:

Figure 6
Narrow TOU (N.TOU) focused on afternoon and evening demand

The third bracket, (blue range) goes from 7:00 AM to 7:00 PM.  This high period is similar to that offered in the current Eversource TOD, and has the advantage of capturing not only the summer high peaks but also the morning peaks in colder months.  This notional W.TOU is the basis for Case "E" in this study.  The resulting savings from this were not as significant as that of Case "D", but were still acceptable when coupled with generator cost avoidance and a purchase incentive.

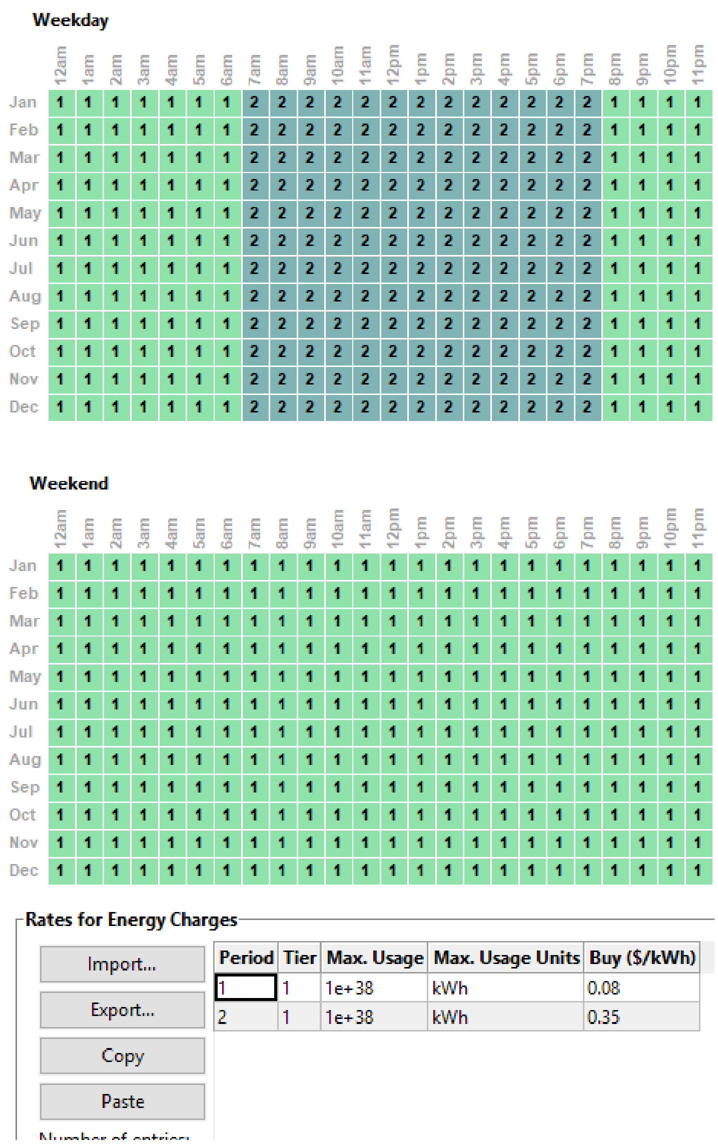



Figure 7

Wide TOU (W.TOU) Weekday Rate

# Appendix D – Financial parameters

### Inflation Rate

Annual rate of change of costs, typically based on a price index, expressed as a percentage. SAM uses the inflation rate to calculate the value of costs in years two and later of the project cash flow based on Year One dollar values that you specify on the System Costs page, Financial Parameters page, Electricity Rates page, and Incentives page.

The default value of 2.5% is based on consumer price index data from the U.S. Department of Labor Bureau of Labor Statistics, and is the average of the annual average consumer price index between 1991 and 2012.

The inflation rate may be either a positive or negative value.

### Real Discount Rate

A measure of the time value of money expressed as an annual percentage. SAM uses the real discount rate to calculate the present value (value in year one) of dollar amounts in the project cash flow over the analysis period and to calculate annualized costs.

SAM's financial model results are very sensitive to the real discount rate input. If you plan to use metrics like the net present value, levelized cost and PPA price, and internal rate of return, you should carefully consider the discount rate to use for your analysis. The default value is based on a reasonable guess for renewable energy projects in the United States. Because discount rates are very subjective and project developers are typically reluctant to share information about discount rates, published documents on renewable energy finance typically do not include detailed information about discount rates.

> Note. For projects with one of the PPA financial models, SAM includes both a discount rate and internal rate of return (IRR) in the analysis. For these projects, the discount rate represents the value of an alternative investment, and the IRR can represent a profit requirement or the risk associated with the project. For example, the IRR may be higher than the discount rate for a renewable energy project with higher risk than an alternative investment.

### Nominal Discount Rate

SAM calculates the nominal discount based on the values of the real discount rate and the inflation rate:

*Nominal Discount Rate = [ ( 1 + Real Discount Rate ÷ 100 ) × ( 1 + Inflation Rate ÷ 100 ) - 1 ] × 100*

For the purpose of these SAM runs:

1) Debt fraction is set to zero – a presumption that early adopters would self-fund this acquisition.
2) Inflation rate was reduced from the default of 2.5% per year to 2.1% per year based on projected US inflation data from the United Nations and OECD data sets.
3) Discount rate was reduced from the default of 6.4% peryear down to 3.9% based on the long range returns of an alternate investment (Vanguard VWINX). Its measured gain from 3/1/1971 to 3/1/2019 was equivalent to an annual compounded rate of 7.9%. When one backs out the effect of inflation over that same timeframe, the VWINX *real* gain was an annualized compounded rate of 3.9%, as shown in Figure 8 below.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Inflation since 1971 | | | | | | | | |
| $1 | | 1972 | | | | | | |
| $6.22 | | 2019 | | | | | | |
| | Gain | | Years | Compounded annual Gain | | | | |
| | 6.22 | | 47.00 | | | **4.0%** | | |
| VWINX | | | | | | | | |
| 10,000 | | 3/1/1971 | | | | | | |
| 398,774 | | 3/1/2019 | | | | | | |
| | Gain | | Years | Compounded annual Gain | | | | |
| | 39.88 | | 48.00 | | | **8.0%** | | |
| Real | 6.411 | | 48.00 | | | **3.9%** | | |

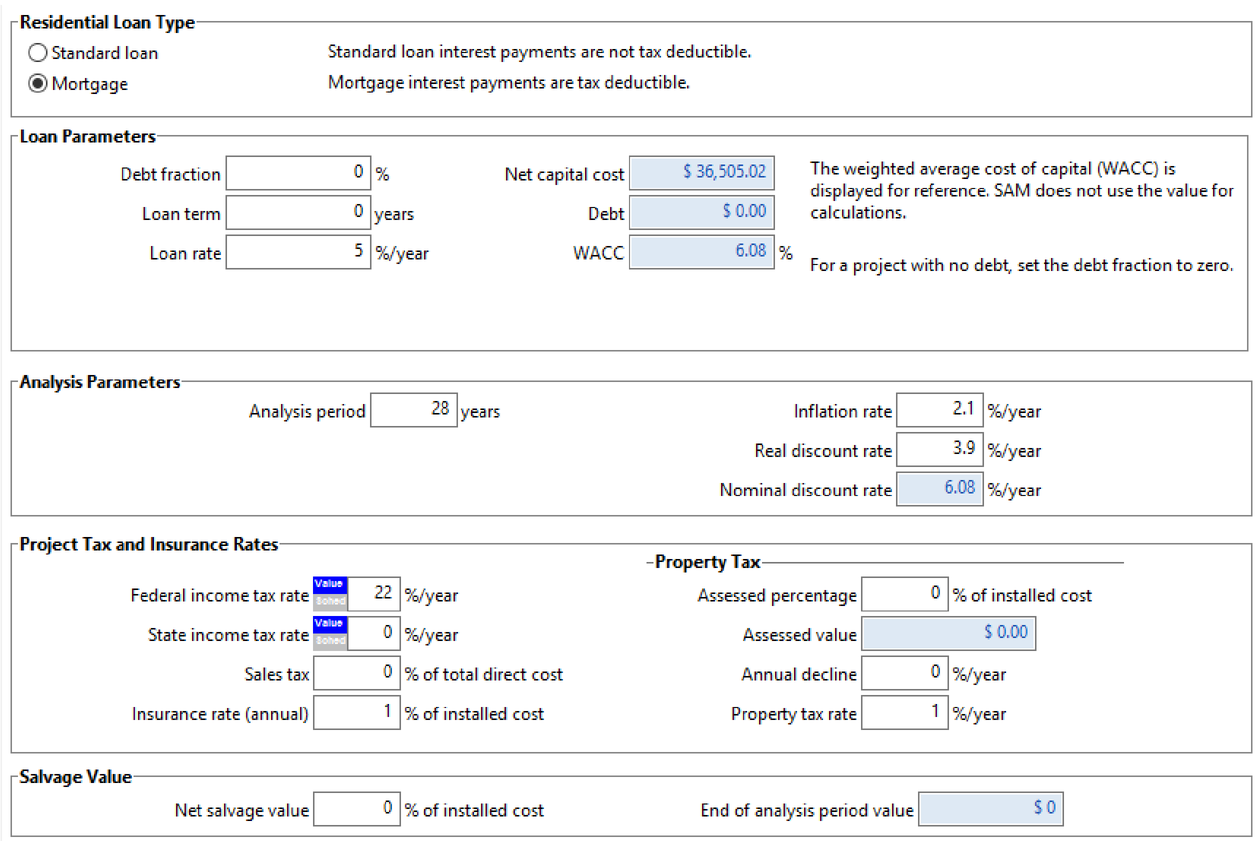



Figure 8

SAM Financial Model

## Appendix E – Electric loads

Rates reflect the author's approximated Eversource power use for the two years prior to installing the PV system. These figures include the load of an electric hot water heater, central forced-hot-air HVAC, and are reflective of a home office, with two workstations and a studio.

The more general case of a homeowner would likely have less power consumption.

### ▾ Calculate Load Data

The calculate load data option for residential buildings allows you to use monthly electric bill data and basic building energy parameters to calculate an hourly load profile. You can use this option to estimate load data when you do not have access to more accurate data.

### Building Energy Load Profile Estimator

#### To use the estimator

- Enter values and choose options to describe the residential building's basic energy performance.
- The occupancy and temperature schedules allow you to adjust the daily profile of the load. Click **Edit** to enter adjustment factors for each of the 24 hours in a day. (The 24 values should all be one for no adjustments.)
- Under **Monthly Load Data**, type monthly total electricity consumption values for one year's worth of electricity bills.
- Click **View load data** to open the time series data viewer with the 8,760 hourly load profile generated by the estimator.

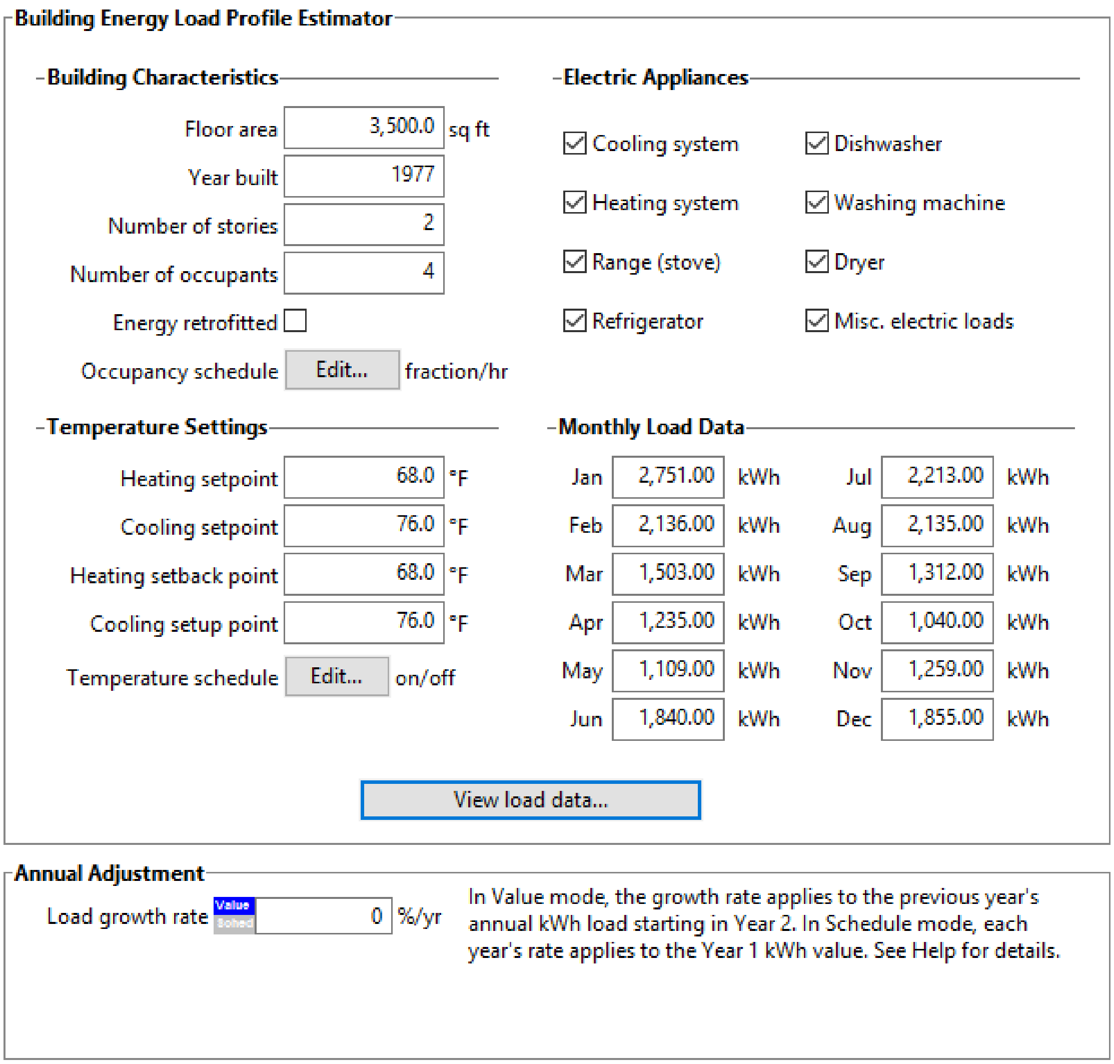



Figure 9
SAM Electrical Loads Monthly Inputs

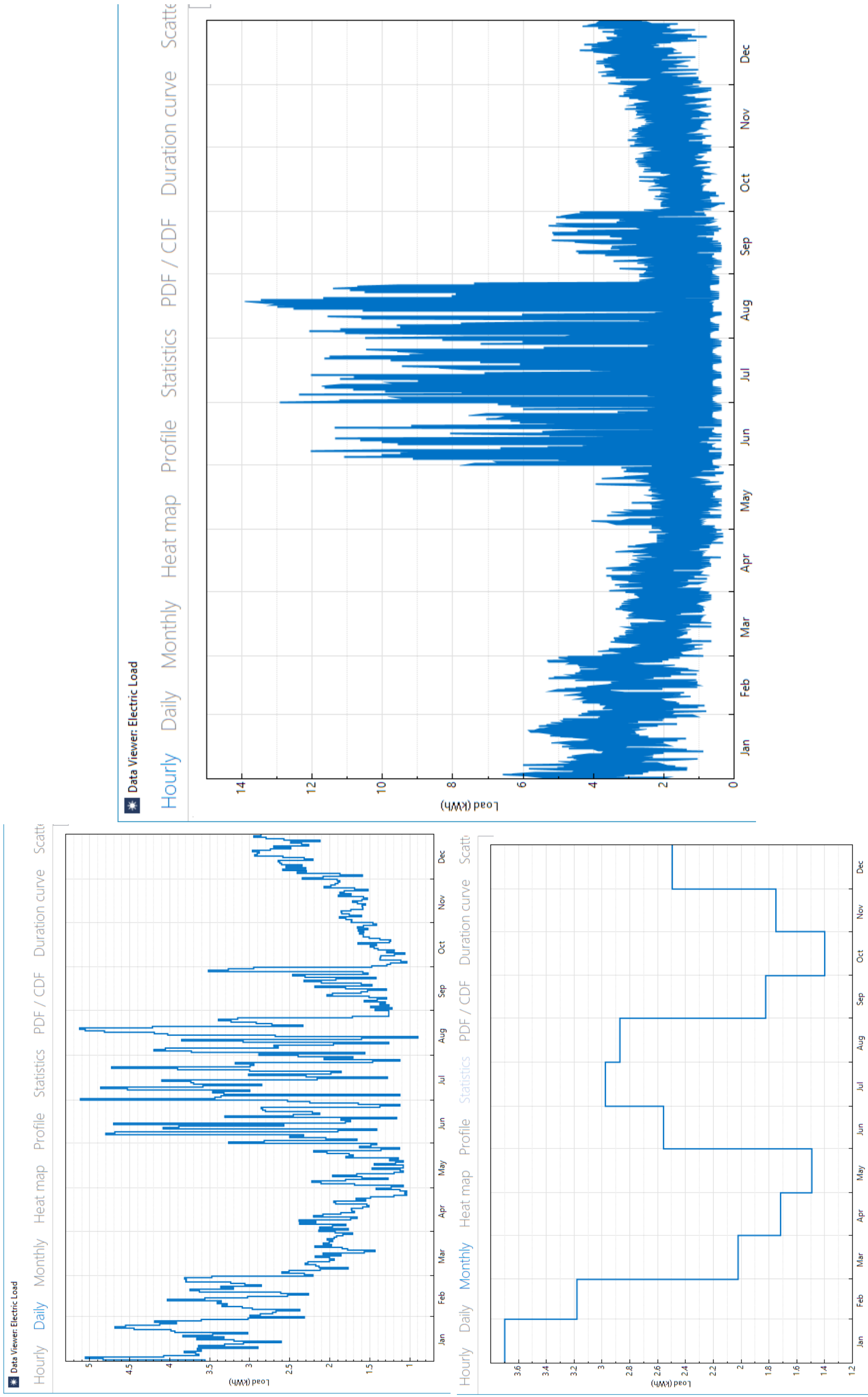



Figure 10
SAM Electrical Loads Model

## Appendix F, Case "A": *Open EI file of current Eversource standard residential rates*

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) | Sell ($/kWh) |
|---|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.18644 | 0 |

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Manual Dispatch Model**

| | Charge from PV | Charge from grid: Allow | Charge from grid: % capacity | Discharge: Allow | Discharge: % capacity |
|---|---|---|---|---|---|
| Period 1: | ☑ | ☑ | 25 | ☐ | 25 |
| Period 2: | ☑ | ☐ | 25 | ☐ | 25 |
| Period 3: | ☑ | ☐ | 25 | ☑ | 3.3 |
| Period 4: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 5: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 6: | ☐ | ☐ | 25 | ☐ | 25 |

To activate the manual dispatch model, choose Manual Dispatch under "Choose Dispatch Model" above. These inputs are inactive for the automated dispatch options.

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |

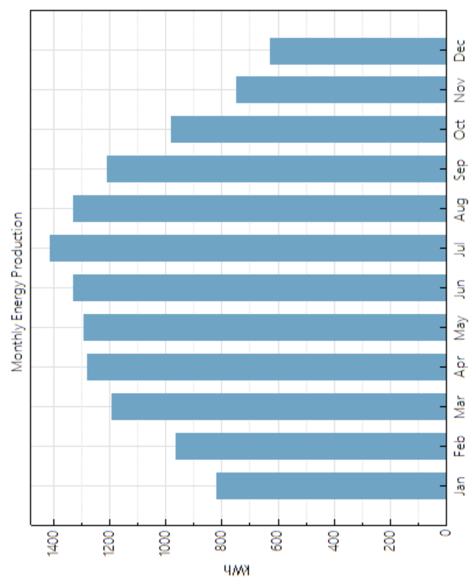
**Weekend**

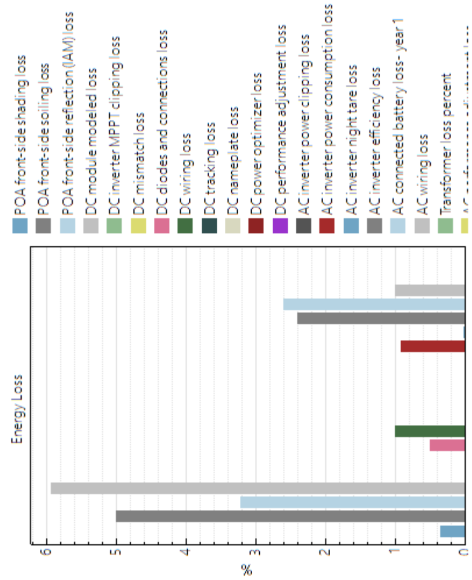
| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |

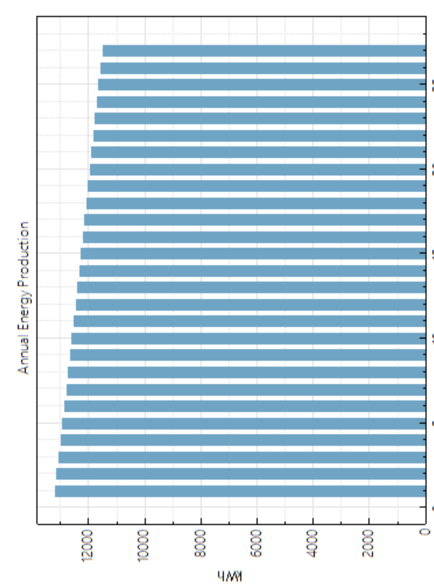
Figure 11

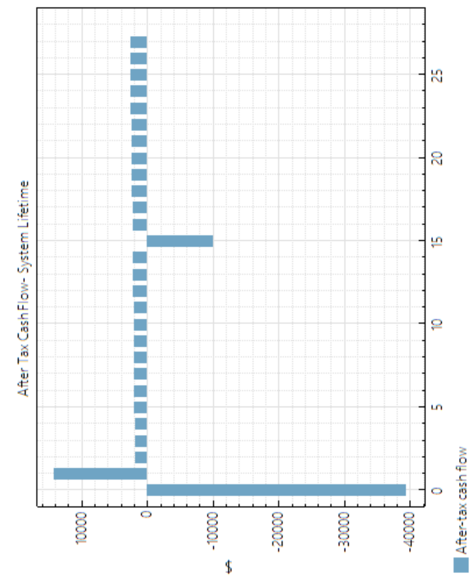
Case "A" Rate Structure and Manual Battery Dispatch Table

| Metric | Value |
|---|---|
| Annual energy (year 1) | 13,171 kWh |
| Capacity factor (year 1) | 14.5% |
| Energy yield (year 1) | 1,266 kWh/kW |
| Performance ratio (year 1) | 0.79 |
| Battery efficiency (incl. converter + ancillary) | 87.65% |
| Levelized COE (nominal) | 26.54 ¢/kWh |
| Levelized COE (real) | 21.19 ¢/kWh |
| Electricity bill without system (year 1) | $3,953 |
| Electricity bill with system (year 1) | $1,497 |
| Net savings with system (year 1) | $2,456 |
| Net present value | $-6,027 |
| Simple payback period | 13.8 years |
| Discounted payback period | NaN |
| Net capital cost | $39,505 |
| Equity | $39,505 |
| Debt | $0 |




**Tax Credits**

**Investment Tax Credit (ITC)**

| | Amount ($) |
|---|---|
| Federal | 0.00 |
| State | 0.00 |

| | Percentage (%) | Maximum ($) |
|---|---|---|
| Federal | 30 | 1e+38 |
| State | 0 | 1e+38 |

**Direct Cash Incentives**

**Investment Based Incentive (IBI)**

| | Amount ($) |
|---|---|
| Federal | 0.00 |
| State | 1,000.00 |
| Utility | 0.00 |
| Other | 4,695.00 |

Figure 12
Case “A” Incentive Table and Results

## Appendix F, Case “B”: *Open EI file of current Eversource residential TOD rates*

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.13832 |
| 2 | 1 | 1e+38 | kWh | 0.27706 |

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Manual Dispatch Model**

| | Charge from PV | Charge from grid: Allow | Charge from grid: % capacity | Discharge: Allow | Discharge: % capacity |
|---|---|---|---|---|---|
| Period 1: | ☑ | ☑ | 25 | ☐ | 25 |
| Period 2: | ☑ | ☐ | 25 | ☐ | 25 |
| Period 3: | ☑ | ☐ | 25 | ☑ | 3 |
| Period 4: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 5: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 6: | ☐ | ☐ | 25 | ☐ | 25 |

To activate the manual dispatch model, choose Manual Dispatch under "Choose Dispatch Model" above. These inputs are inactive for the automated dispatch options.

**Weekday**

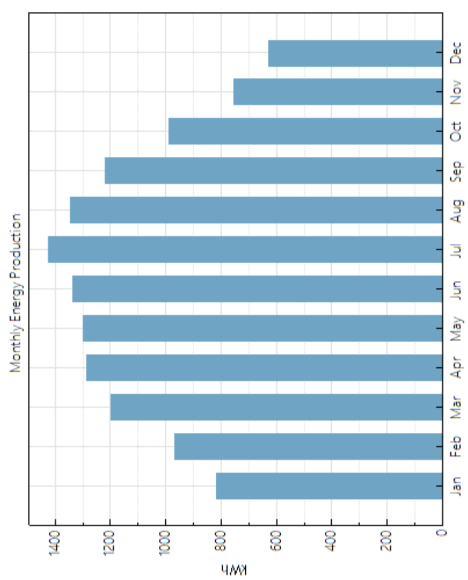
| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |

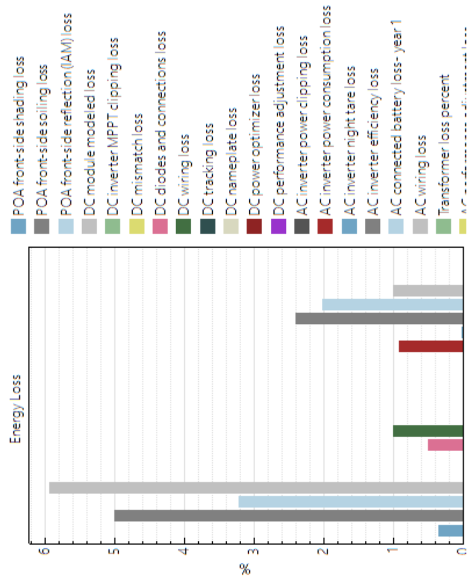
**Weekend**

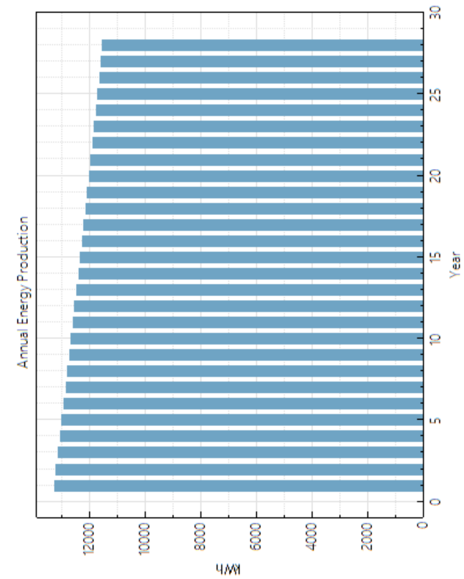
| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |

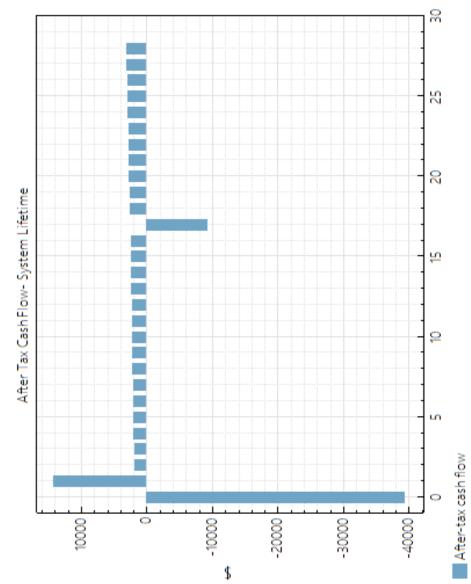
Figure 13
Case “B” Rate Structure and Manual Battery Dispatch Table

| Metric | Value |
|---|---|
| Annual energy (year 1) | 13,252 kWh |
| Capacity factor (year 1) | 14.5% |
| Energy yield (year 1) | 1,274 kWh/kW |
| Performance ratio (year 1) | 0.80 |
| Battery efficiency (incl. converter + ancillary) | 88.98% |
| Levelized COE (nominal) | 25.71 ¢/kWh |
| Levelized COE (real) | 20.40 ¢/kWh |
| Electricity bill without system (year 1) | $4,289 |
| Electricity bill with system (year 1) | $1,772 |
| Net savings with system (year 1) | $2,517 |
| Net present value | $-2,235 |
| Simple payback period | 13.0 years |
| Discounted payback period | 27.9 years |
| Net capital cost | $39,505 |
| Equity | $39,505 |
| Debt | $0 |



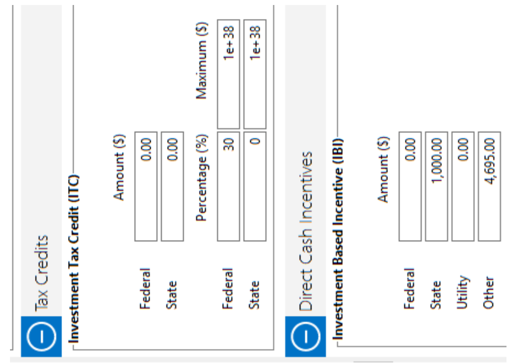




Figure 14
Case "B" Incentive Table and Results

## Appendix F, Case “C”: *Tight TOU with cost avoidance of generator*

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.06 |
| 2 | 1 | 1e+38 | kWh | 0.49039 |
| 3 | 1 | 1e+38 | kWh | 0.7438 |
| 4 | 1 | 1e+38 | kWh | 0.17171 |
| 5 | 1 | 1e+38 | kWh | 0.24823 |

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 4 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Oct | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| Dec | 1 | 4 | 4 | 4 | 4 | 1 | 4 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |

**Manual Dispatch Model**

| | Charge from PV | Charge from grid: Allow | Charge from grid: % capacity | Discharge: Allow | Discharge: % capacity |
|---|---|---|---|---|---|
| Period 1: | ☑ | ☑ | 25 | ☐ | 25 |
| Period 2: | ☑ | ☐ | 25 | ☑ | 4 |
| Period 3: | ☑ | ☐ | 25 | ☑ | 18 |
| Period 4: | ☐ | ☐ | 25 | ☑ | 2 |
| Period 5: | ☐ | ☐ | 25 | ☑ | 9 |
| Period 6: | ☐ | ☐ | 25 | ☐ | 25 |

To activate the manual dispatch model, choose Manual Dispatch under "Choose Dispatch Model" above. These inputs are inactive for the automated dispatch options.

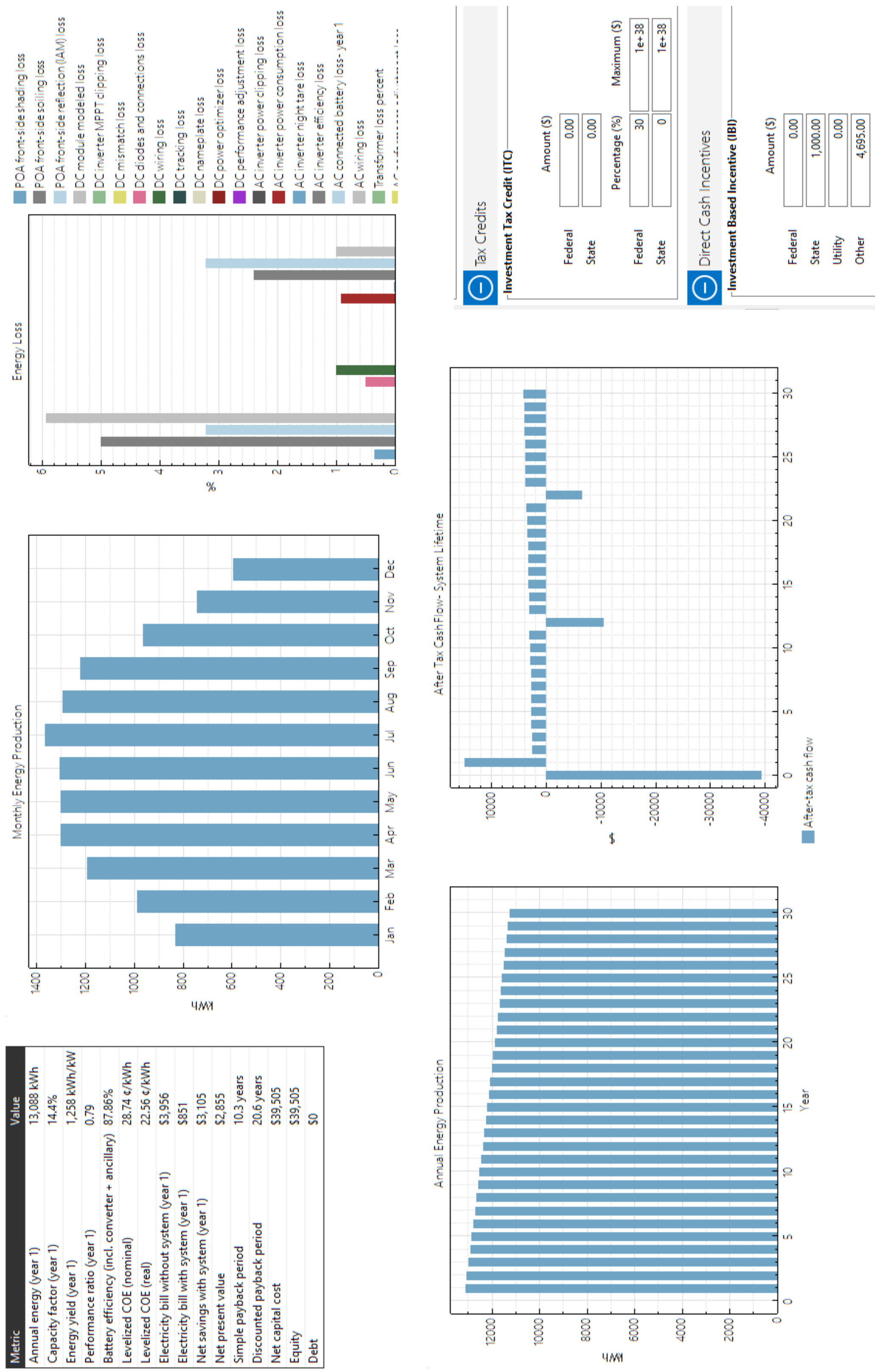
**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 4 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |
| Oct | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| Dec | 1 | 4 | 4 | 4 | 4 | 1 | 4 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 1 |

Figure 15
Case “C” Rate Structure and Manual Battery Dispatch Table




| Metric | Value |
|---|---|
| Annual energy (year 1) | 13,088 kWh |
| Capacity factor (year 1) | 14.4% |
| Energy yield (year 1) | 1,258 kWh/kW |
| Performance ratio (year 1) | 0.79 |
| Battery efficiency (incl. converter + ancillary) | 87.86% |
| Levelized COE (nominal) | 28.74 ¢/kWh |
| Levelized COE (real) | 22.56 ¢/kWh |
| Electricity bill without system (year 1) | $3,956 |
| Electricity bill with system (year 1) | $851 |
| Net savings with system (year 1) | $3,105 |
| Net present value | $2,855 |
| Simple payback period | 10.3 years |
| Discounted payback period | 20.6 years |
| Net capital cost | $39,505 |
| Equity | $39,505 |
| Debt | $0 |

Figure 16
Case "C" Incentive Table and Results

## Appendix F, Case "D": *Narrow TOU with cost avoidance of generator*

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.054 |
| 2 | 1 | 1e+38 | kWh | 0.354 |

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

**Manual Dispatch Model**

| | Charge from PV | Charge from grid: Allow | Charge from grid: % capacity | Discharge: Allow | Discharge: % capacity |
|---|---|---|---|---|---|
| Period 1: | ☑ | ☑ | 25 | ☐ | 25 |
| Period 2: | ☑ | ☐ | 25 | ☐ | 25 |
| Period 3: | ☑ | ☐ | 25 | ☑ | 4.35 |
| Period 4: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 5: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 6: | ☐ | ☐ | 25 | ☐ | 25 |

To activate the manual dispatch model, choose Manual Dispatch under "Choose Dispatch Model" above. These inputs are inactive for the automated dispatch options.

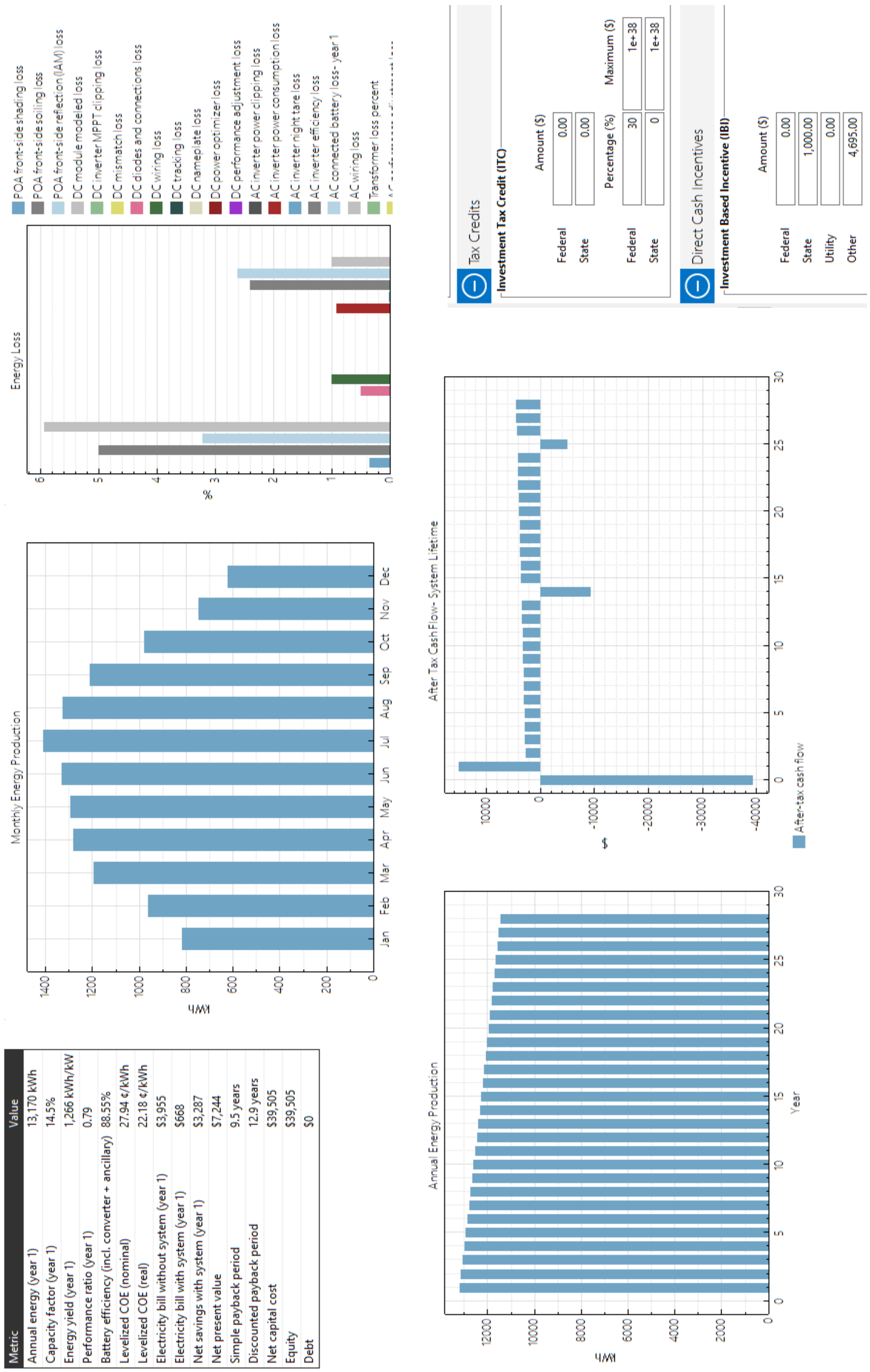
**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |

Figure 17
Case "D" Rate Structure and Manual Battery Dispatch Table




| Metric | Value |
|---|---|
| Annual energy (year 1) | 13,170 kWh |
| Capacity factor (year 1) | 14.5% |
| Energy yield (year 1) | 1,266 kWh/kW |
| Performance ratio (year 1) | 0.79 |
| Battery efficiency (incl. converter + ancillary) | 88.55% |
| Levelized COE (nominal) | 27.94 ¢/kWh |
| Levelized COE (real) | 22.18 ¢/kWh |
| Electricity bill without system (year 1) | $3,955 |
| Electricity bill with system (year 1) | $668 |
| Net savings with system (year 1) | $3,287 |
| Net present value | $7,244 |
| Simple payback period | 9.5 years |
| Discounted payback period | 12.9 years |
| Net capital cost | $39,505 |
| Equity | $39,505 |
| Debt | $0 |

Figure 18
Case "D" Incentive Table and Results

## Appendix F, Case "E": *Wide TOU with cost avoidance of generator*

| Period | Tier | Max. Usage | Max. Usage Units | Buy ($/kWh) |
|---|---|---|---|---|
| 1 | 1 | 1e+38 | kWh | 0.08 |
| 2 | 1 | 1e+38 | kWh | 0.35 |

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Manual Dispatch Model**

| | Charge from PV | Charge from grid: Allow | Charge from grid: % capacity | Discharge: Allow | Discharge: % capacity |
|---|---|---|---|---|---|
| Period 1: | ☑ | ☑ | 25 | ☐ | 25 |
| Period 2: | ☑ | ☐ | 25 | ☐ | 25 |
| Period 3: | ☑ | ☐ | 25 | ☑ | 3 |
| Period 4: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 5: | ☐ | ☐ | 25 | ☐ | 25 |
| Period 6: | ☐ | ☐ | 25 | ☐ | 25 |

To activate the manual dispatch model, choose Manual Dispatch under "Choose Dispatch Model" above. These inputs are inactive for the automated dispatch options.

**Weekday**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |

**Weekend**

| | 12am | 1am | 2am | 3am | 4am | 5am | 6am | 7am | 8am | 9am | 10am | 11am | 12pm | 1pm | 2pm | 3pm | 4pm | 5pm | 6pm | 7pm | 8pm | 9pm | 10pm | 11pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Apr | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Jul | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Aug | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Sep | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Oct | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Nov | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |
| Dec | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 |

Figure 19
Case "E" Rate Structure and Manual Battery Dispatch Table

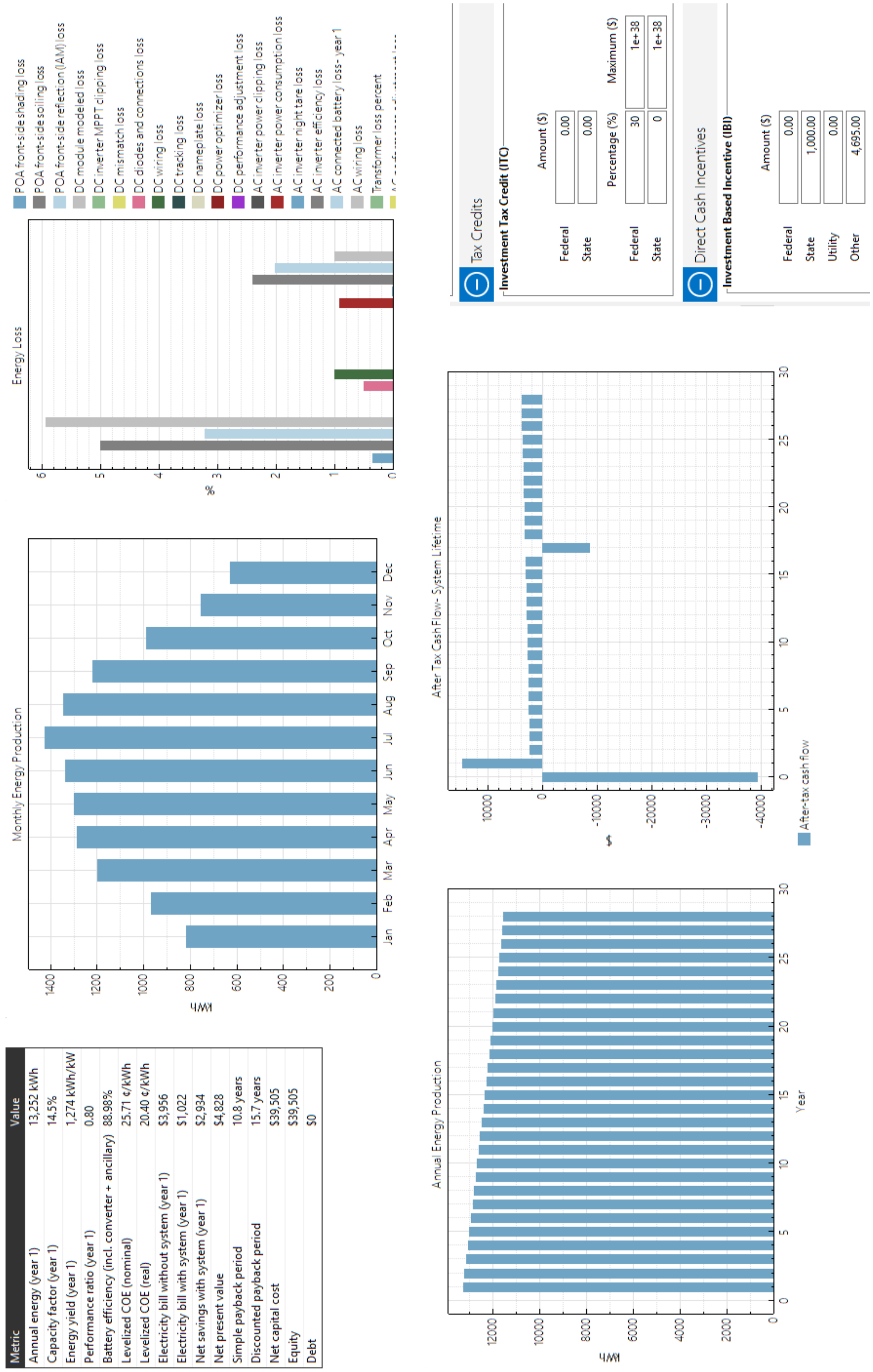



Figure 20
Case “E” Incentive Table and Results