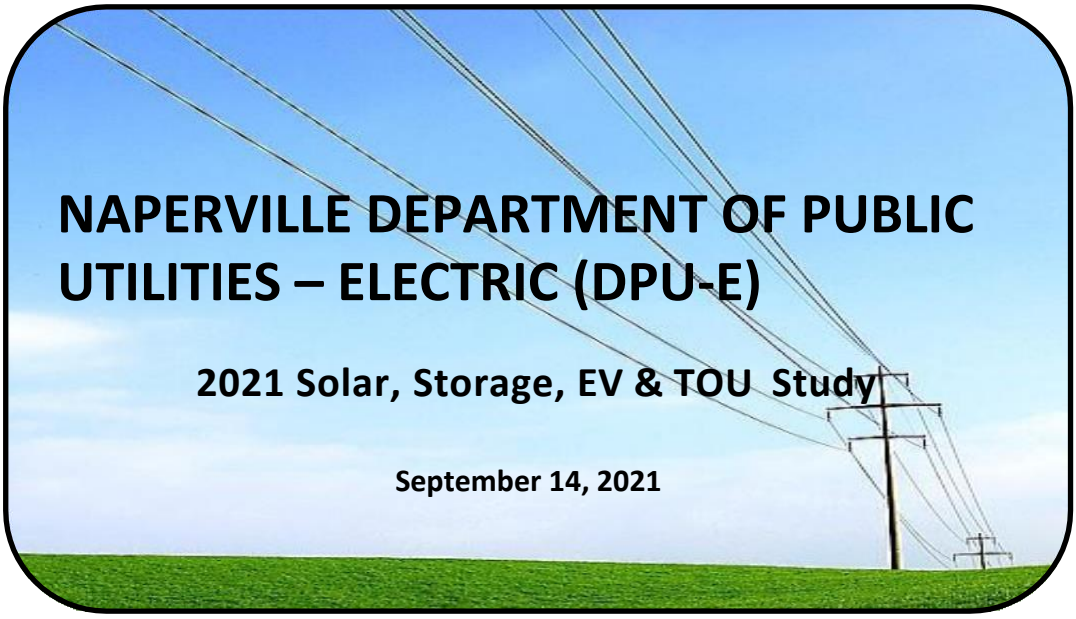

NAPERVILLE DEPARTMENT OF PUBLIC UTILITIES – ELECTRIC (DPU-E)

2021 Solar, Storage, EV & TOU Study

September 14, 2021

Naperville

UFS UTILITY FINANCIAL SOLUTIONS, LLC

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Introduction

This report was prepared to provide guidance on the valuation of solar generation (with and without storage), electric vehicle (EV) rate for residential and alternative time of use (TOU) (with and without demand) rates for the Naperville Department of Public Utilities – Electric (DPU-E). UFS used a short-run marginal cost valuation (avoided cost / utility savings) methodology to calculate the values. The savings were calculated by estimating the power supply cost savings from IMEA billing when a customer installs one of the above resources. The purpose of this report is to identify the value of electricity produced for each of the resources to guide in metering, billing and crediting methods for DPU-E customers electing to install the respective generation resource. Energy savings were based on timing of production compared to IMEA energy and energy cost adjustments. The Demand value was calculated by comparing solar with storage and its' ability of the respective combined resource to reduce the DPU-E monthly system peak. There were two solar values calculated. One was for the expected energy only + losses (solar without storage). The second was for solar with storage and it included energy, demand + losses. The reason for this is that solar is an intermittent generation resource dependent on weather and sun. For this reason, solar alone is not predictable nor reliable as a consistent generation resource. However, with appropriately sized and configured storage, solar can become more reliable, predictable and valuable. For now, a reduction in DPU-E's monthly peak should result in lower IMEA demand billing.

(Study assumed full (energy, demand, + system losses) solar credit with properly sized and configured battery storage. Study assumed energy only + system losses credit for solar without storage.)

Summary Assumptions and Findings

- Naperville Department of Public Utilities – Electric (DPU-E) retained Utility Financial Solutions to conduct a marginal cost (avoided cost / utility savings) determination for the value of solar with and without storage
- The study was conducted using DPU-E's recent historical IMEA billing
- Solar production profile was based on irradiance data for the DPU-E area obtained from NREL.gov System Advisor Model.
- Average distribution system loss of 3.35% (from eCOS)
- The calculated values of solar assumes a buy-all-sell-all or equivalent metering and billing methodology. Other metering and billing methods may result in utility cost under recovery.
- The value of solar with storage (fixed roof mount) was calculated to be 5.845 cents per kWh
- The value of solar without storage (fixed roof mount) was calculated to be 4.374 cents per kWh
- Large installs should be valued on a per case basis and generally use a buy all sell all method similar to a PURPA rate that generally tracks with variable energy value
    - An alternative approach could be to use net billing with a value of solar considering only the final avoided energy value per kWh for larger installs and/or customers on a demand kW retail rate (for example for solar a credit value of 4.374 cents per kWh)

- For TOU & Demand rate alternatives please see rate design file attached by reference: “NAP TOU RD 09-14-2021 - Final.pdf”.
- It is recommended that any residential customer be eligible to opt into the “OPTIONAL Rate Design Summary for Residential TOU with Demand” rate. This should account for residential customer with or without solar (with or without storage) and customers with or without EV.
- UFS has provided a solar and storage right sizing model under separate attachment file: “UFS Solar and Storage Sizing 09-14-2021 Naperville - Final.xlsx”. This file can be used to prequalify customers adding solar and/or storage.

Summary Avoided Cost Results

- A summary of results is listed in the tables below. The detail calculations and assumptions used in the analysis are listed in the subsequent sections of this report. **This study was conducted using DPU-E supplied power supply costs and detailed hourly solar production data was from NREL. Solar produced and used immediately on premise behind the customer meter would increase in value due to the savings from the distribution system losses being avoided. Average distribution system loss of 3.35% (from eCOS)**

Table 1 fixed array: Avoided Cost

	Off Peak	On Peak	Annual Average
Solar only (Energy only + Losses)	$ 0.04374	$ 0.04374	$ 0.04374
Solar with Storage (Energy, Demand + Losses)	$ 0.04878	$ 0.09164	$ 0.05845

Solar Production

The solar production projected was from National Renewable Energy Laboratory (NREL) System Advisor Model. Fixed roof mount solar production would have an annual capacity factor of 13.5%. For example, a 5 kW fixed array on average would produce 5,930 kWh's over one year's time (1,186 kWh per kW DC of installed fixed roof mount solar).

Solar and Storage Considerations

- **Calculated values**
  - Valuation: (calculated values assume a buy-all-sell-all or equivalent – see TOU attachment for TOU differentials)
    - **5.845 cents per kWh for a fixed roof mount array with storage**
    - **4.374 cents per kWh for a fixed roof mount array without storage**
    - **Large installs should be valued on a per case basis**
      - An alternative approach could be to use net billing with a value of solar considering only the final avoided energy value per kWh for larger install s and/or customers on a demand kW retail rate (for example for solar a credit value of 4.374 cents per kWh)
- **Periodic review and update of values** – DPU-E should review and update the value of solar and implementation methods as significant assumptions change. This will **typically mirror general (annual) rate making timing**
- **Eventual move for all customers toward rate structures having a demand / TOU component**
- **Right sizing -** (within allowed sizing of DPU-E's interconnection policy, consider any required State and Federal policy, consider IMEA full requirement contract)
  - Example: allow solar install **up to lesser of**:
    - 100% of a customer's peak demand "before solar"
    - Or 100% of a customer's average annual kWh usage "before solar" (net zero)
    - Storage sizing minimum 50% of peak demand for 1 hour configured in power quality or blended mode.
- **System verification** – As outlined in DPU-E's interconnection policy
- **Metering & billing**
  - Final metering and billing options selected by DPU-E is ultimately based on their Management and Board preferences. It is often based on a combination of philosophy preference as well as metering and billing capabilities of DPU-E. Many utilities are adopting multiple approaches depending on the size of distributed generation resource install.
  - The most common method for smaller, rooftop solar installations is net billing.
  - The most common method for larger solar installations is buy-all-sell-all – (This is the closest to provide services at cost of service .)
    - An alternative approach could be to use net billing with a value of solar considering only the final avoided energy value per kWh for larger installs and/or customers on a demand kW retail rate (for example for solar a credit value of 4.374 cents per kWh)
  - Many utilities are moving toward a more robust rate structure. At a minimum , all rates (including residential rates) should evolve to include one or more demand component(s).
  - For TOU & Demand rate alternatives please see rate design file attached by reference: "NAP TOU RD 09-14-2021 - Final.pdf".
  - It is recommended that any residential customer be eligible to opt into the "OPTIONAL Rate Design Summary for Residential TOU with Demand" rate. This should account for

residential customer with or without solar (with or without storage) and customers with or without EV.

- UFS has provided a solar and storage right sizing model under separate attachment file: "UFS Solar and Storage Sizing 09-14-2021 Naperville - Final.xlsx". This file can be used to prequalify customers adding solar and/or storage.
- In general, the closer DPU-E can get their kWh retail rate to match their avoided cost, DPU-E should be more indifferent to customer-installed generation.

TOU & Demand Considerations (EV rates)

General observation

UFS proposes that DPU-E publish the time of use rate with demand as an option for any customer. This will likely attract only winners to the rate but it would provide useful information to the utility when preparing to implement on a large scale. It will send an appropriate price signal to all customers including potential new EV and solar customers (with or without storage). For progression, we would prefer demand charges on all rate classes to collect distribution system costs with TOU after that. The mandatory demand charge helps reduce energy charges and set more appropriate rates for all customers including EV and solar customers.

- **TOU**
  - Immediate optional opt in offering to customers to move to TOU & Demand rate as outlined in attached TOU rate file.
  - Build history of metering and billing data along with proof of concept for customers that opt in to TOU & demand rate.
  - Consider eventual movement of all rates to TOU energy.
  - Phase out non TOU rates as all rate classes phase to TOU. The rates would then be mandatory for all – no longer opt in with no opt out.
- **Demand**
  - Move to optional opt in TOU & demand rate as outlined above.
  - Move all rate classes as soon as possible to include at least a distribution demand charge. This will be the respective customer's monthly peak kW demand billed.
  - Phase out all non-demand rates as new demand rates phase in. The rates would then be mandatory for all – no longer opt in with no opt out.

Potential progression

Step 1: Publish an Optional TOU + Demand rates
Step 2: Implement monthly retention of each meters kW and On/Off peak data (eventually key to setting rates and informing customers of historical usage)
Step 3: Add kW and On/Off peak data to customer bill ($0 charge and after internal data verification) Step 4: Identify steps and phase in of a mandatory distribution demand charge (utilize billing data to identify demand progression)
Step 5: Implement a mandatory TOU + Demand rate for all classes

TOU Periods

In review of TOU periods and seasons with DPU-E staff, it was agreed that a single season with an On Peak and Off Peak time periods would be best for initial implementation. This would have the same time of use hours each day, all year long. There are no differences for holidays, weekends or seasonal differences. The On Peak hours have been defined as staring at 2 PM and ending through 9:59 PM. All other hours are Off Peak.

Start Time	End Time	Hour Ending	Annual
12:00 AM	12:59 AM	100	Off Peak
1:00 AM	1:59 AM	200	Off Peak
2:00 AM	2:59 AM	300	Off Peak
3:00 AM	3:59 AM	400	Off Peak
4:00 AM	4:59 AM	500	Off Peak
5:00 AM	5:59 AM	600	Off Peak
6:00 AM	6:59 AM	700	Off Peak
7:00 AM	7:59 AM	800	Off Peak
8:00 AM	8:59 AM	900	Off Peak
9:00 AM	9:59 AM	1000	Off Peak
10:00 AM	10:59 AM	1100	Off Peak
11:00 AM	11:59 AM	1200	Off Peak
12:00 PM	12:59 PM	1300	Off Peak
1:00 PM	1:59 PM	1400	Off Peak
2:00 PM	2:59 PM	1500	On Peak
3:00 PM	3:59 PM	1600	On Peak
4:00 PM	4:59 PM	1700	On Peak
5:00 PM	5:59 PM	1800	On Peak
6:00 PM	6:59 PM	1900	On Peak
7:00 PM	7:59 PM	2000	On Peak
8:00 PM	8:59 PM	2100	On Peak
9:00 PM	9:59 PM	2200	On Peak
10:00 PM	10:59 PM	2300	Off Peak
11:00 PM	11:59 PM	2400	Off Peak

Metering and billing options defined

Buy-all-sell-all

(This is the closest to provide services at cost of service. This method is common for larger installations.)

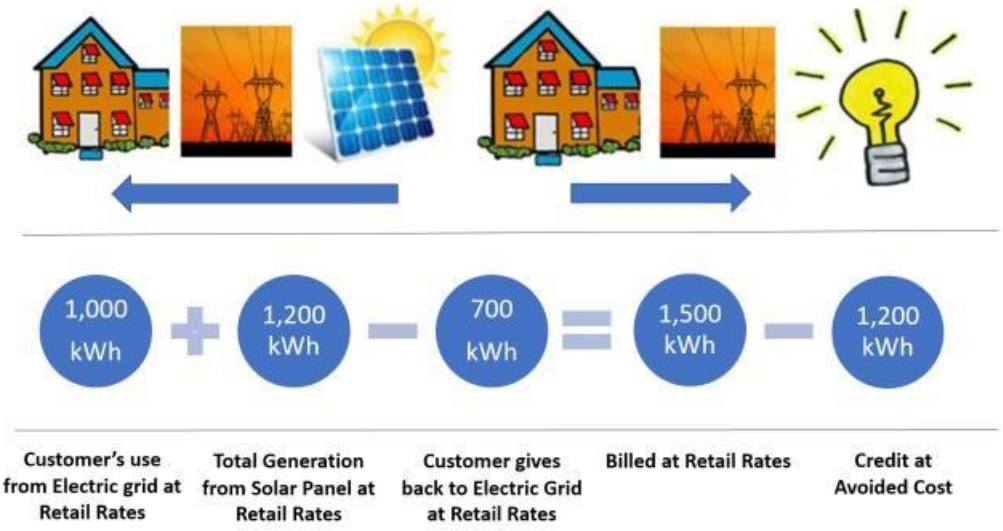
Under a buy-all-sell-all metering and billing scenario, two meters are required. All power consumed by the customer will be billed at regular retail rates from the utility. The consumed power will be the total power used by the customer from both the utility and the solar production. Solar production is metered by the second meter. All solar production will be credited at the current avoided cost. This option is occasionally used for larger solar installs. This option is typically not used for residential solar since a second meter is required to accurately measure the actual solar production . However, this option can also be done on a "theoretical buy-all-sell-all" agreement where the billing is netted on the customer bill. This allows the customer to keep as much of their solar production behind their meter as possible.

Buy-all-sell-all summary

Metering: Two meters are required with a buy-all-sell-all scenario. One (dual register) meter is for tracking power supplied by the utility to the customer and excess customer solar pushed back to the grid. A second meter is used for tracking solar production generated by the customer.

Solar Production: All solar production gets credited to the customer at the avoided cost .

Billing: The utility bills all the power consumed by the customer at the normal retail rates. This includes all power supplied by the utility and all solar production used by the customer.



Summary: Customer billed on total customer consumption at retail - Utility credits customer on the total solar production at avoided cost.

Metering required:

- Meter on facility (tracking customer's use from the electric grid and custo mer gives back to electric grid)
- Meter on solar unit

Net metering

(not recommended unless required by statute)

Under a net metering scenario only one meter will be required. Net metering can be done under two different metering options. The first option is a meter that "spins both ways". This type of meter will spin forward when power is being used from the utility. This meter will then spin in reverse when excess solar production is being sent back to the utility. The second option is a meter that tracks the "in and out" separately. The utility supplied power in will be tracked and the solar production excess sent back to the utility is tracked separately. These two numbers can be netted for billing at the current normal utility rates. Both metering options under net metering will yield the same customer bill. At the end of the billing cycle the net usage will be billed at the current normal utility rates. If there is a billing cycle that there is more power sent back to the utility than power supplied by the utility, the excess solar production will be credited at the current normal utility rates. This option is generally only used if mandated by state or local requirements. Some utilities will limit the dollar amount and/or number of months that an over-production of solar will be allowed to be credited.

Net metering summary

Metering: Only one meter is required with a net metering scenario. One meter is for power supplied by the utility to the customer. The same meter is used for solar production sent back to the utility by the customer. The two most typical single net meter options are a meter that spins both ways or a meter that tracks the in and out separately. Both meters should allow for the same customer bill to be calculated.

Solar Production: Only excess solar production gets sent back to the utility. The customer only uses power supplied by the utility when solar production does not meet their usage needs .

Billing: The utility sells all the power to the customer at the normal rate. The utility buys the excess solar production at the normal rate. (Net usage based on two metering options above). The customer is credited at retail rates (or avoided cost if allowed by statute) if more solar production is sent to the utility then used from the utility.

Summary: Customer billed on total net customer usage at retail - Utility credits customer on the excess solar production at retail (if customer gives back more than they used from electric grid in a given month (over-production)).

Metering required:

- Meter on facility (tracking customer's use from the electric grid and customer gives back to electric grid)

Net billing

(Common method for smaller residential rooftop solar installs)

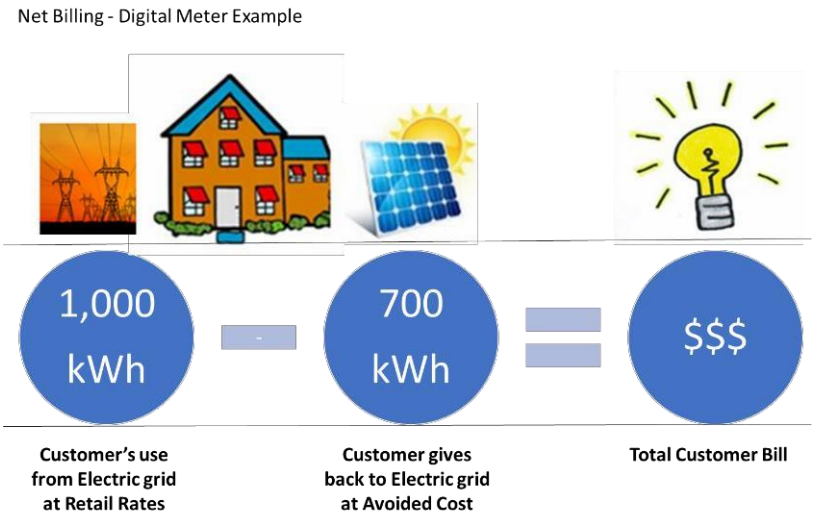
Under a net billing scenario only one (dual register) meter is required. For a utility that has bi-directional (dual register) digital meters, the utility generated kWhs are billed at retail while the customer excess generated kWhs pushed back to the grid are credited at the current avoided cost. This option is generally used for smaller solar installs. Some utilities will elect this method for smaller installs while using a buy-all-sell-all method for larger installs.

Net billing summary

Metering: Only one meter (dual register) is required with a net billing scenario. The first register is used for tracking power supplied by the utility to the customer. The same meter (register two) is used to track solar production sent back to the utility by the customer.

Solar Production: Only excess solar production gets sent back to the utility. The customer only uses power supplied by the utility when solar production does not meet their usage needs.

Billing: The utility sells all the utility delivered power to the customer at the normal retail rate. The utility buys the excess solar production pushed back to the grid at the avoided cost.



Summary: Customer billed on customer usage from the utility at retail - Utility credits customer on the excess solar production pushed back to the grid at avoided cost.

Metering required:

- Dual register, bi-directional meter on customer facility (tracking customer's use from the electric grid and excess customer gives back to electric grid)