Solar and Storage Industries Institute

Modeling the Revenue Impacts of “Flexible Interconnection” on New York Community Solar Projects

An Executive Summary for Policy-Makers

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The Promise of "Flexible Interconnection"

The process of connecting clean energy projects to the electric distribution system, known as interconnection, is extraordinarily complex and has become a major barrier to clean energy deployment. The number of interconnection applications is increasing, wait times are rising, and in turn the costs to interconnect distributed energy resources (DER) are rising. And while many state policy measures have encouraged the growth of community solar projects -- DER projects that inject power into the grid and provide savings to multiple customers in the form of bill credits -- based on their larger size of the DER spectrum, these projects often run into the thorniest interconnection challenges.

Very often a reason cited for delaying community solar projects is the need to upgrade the grid itself. Substation upgrades, line upgrades or reconductoring, and transformer replacements are expensive and time consuming. To realize the full promise of a clean energy future, the nation's distribution grids will need significant additional investment. But new tools may hold tremendous promise for connecting more community solar projects to these grids while awaited upgrades are in the works.

One tool is flexible interconnection (FIX). FIX is more accurately described as a suite of different tools that optimize project injections based on grid conditions. These tools range from something as simple as fixed project import export limits, to more advanced distributed energy resource management systems (DERMS) that monitor real time grid conditions and automatically curtail community solar project output when certain operational thresholds are reached. FIX solutions could allow more projects to be connected while still maintaining reliability and avoiding expensive upgrade costs.

But how often would that curtailment occur? For community solar project developers, understanding the likely frequency of curtailment and its subsequent impact on project revenue is a very important business consideration. Answers to these questions can make or break a project. Another important question involves timing. Does it make more sense to wait for a grid upgrade or accept some form of voluntary curtailment as part of a flexible interconnection arrangement? Our project intended to find these answers.

Project Background

The Solar and Storage Industries Institute (SI2), in partnership with the Coalition for Community Solar Access (CCSA), Smarter Grid Solutions, Solar Energy Industries Association (SEIA), National Grid, and Nexamp, proposed this study as part of the U.S. Department of Energy's Interconnection Innovation Exchange (i2x) Technical Assistance Program. With detailed modeling work and project management conducted by Pacific Northwest National Laboratory (PNNL), this effort aimed to model the impacts of flexible interconnection on community solar project output and revenue. The project also aimed to understand to what extent using flexible interconnection tools would allow more large projects to be sited on the distribution system to connect in accordance with state energy goals. And we sought to understand the timing of whether it made more sense to wait for expensive network upgrades to be constructed or move ahead with flexible interconnection right away.

Study Parameters

In an ideal analysis, this effort would be based on actual historical utility system data, but given that much of that data is not readily available or subject to certain restrictions, this project relied on a 9,500 node model feeder developed by the PNNL team to simulate grid conditions. Furthermore, community solar project profiles were provided by Nexamp based on actual community solar sites located in New York State.[1] Project compensation was based on the New York's Value of Distributed Energy Resources (VDER) tariff using a calculator developed by the New York State Energy Research and Development Authority.[2]

There were three FIX scenarios modeled in this project to compare how project outcomes and revenue will change.

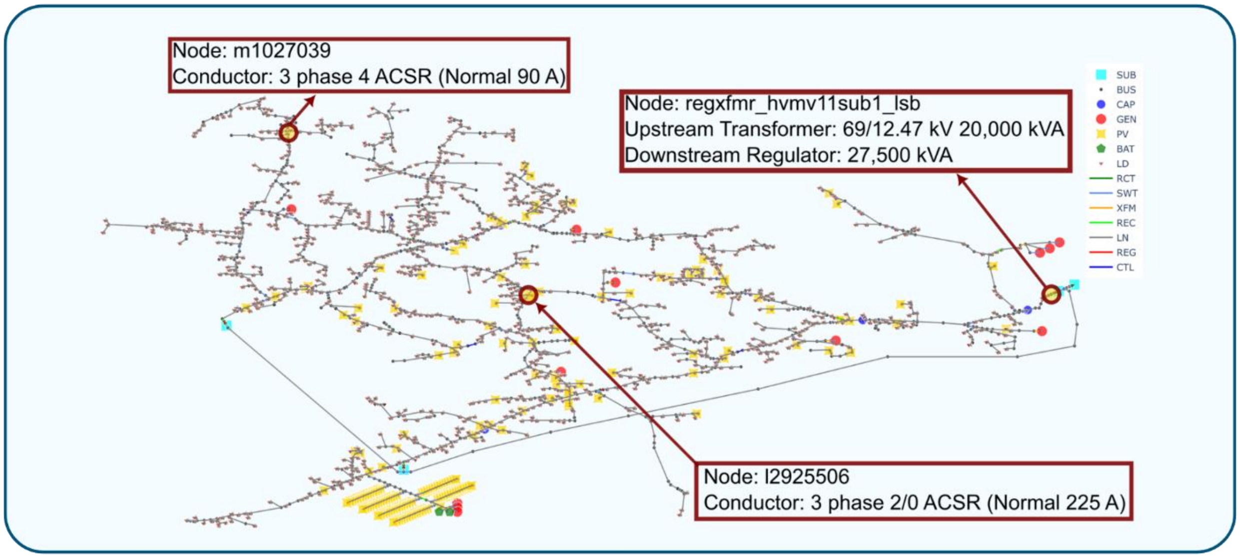
- The "conventional" interconnection scenario, where the capacity of the community solar plant is limited to the minimum hosting capacity of the surrounding grid.
- The "solar only" interconnection scenario, where the solar plant is sized greater than the minimum hosting capacity.
- The "solar plus storage scenario", where the same capacity as the solar only scenario is used, but with a battery energy storage system.

Factored into this modeling is the deferred upgrade analysis, which considers the question of whether it makes sense to interconnect quickly or whether it is better to wait for a grid upgrade to be completed and produce with zero curtailment from the beginning.

To model variation on the grid itself, and recognizing that hosting capacity varies considerably across sections of the distribution grid, the community solar projects modeled were placed in different locations with varying distances from substations. The locations of the projects are seen in the figure below. It's worth noting that the node in the upper left (node m1027039) most closely matches the situation of many community solar projects today. This has the most variable hosting capacity given that it is farther away from the substation. For many community solar projects in development today, ideal sites with ample hosting capacity are increasingly rare.

[1] Solar output data was taken from NREL reVX Tool. See: https://www.nrel.gov/gis/rev-disclaimer.html

[2] See: https://www.nyserda.ny.gov/All-Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources/Value-Stack-Calculator



I2X TA Report Figure 19: Locations under investigation on the 9500-node feeder. The substations can be seen as light blue squares in the figure.

Study Results

The results are based on the variability of hosting capacity and the community solar location relative to the substation. For the key case where hosting capacity is highly variable, which most closely matches the circumstances of many community solar projects today, the NPV analysis over the lifetime of the project, seen in Figure 21 below, shows that FIX is very beneficial.

The "solar only" FIX scenario achieves preferable results to the conventional scenario, and the solar plus storage scenario, with an NPV ratio of 2.75 versus the conventional scenario, or 176% more revenue over the lifetime of the project when compared with the conventional scenario. The analysis further demonstrates that in the solar plus storage scenario, the capital costs for storage do not necessarily justify the curtailment savings.[3]

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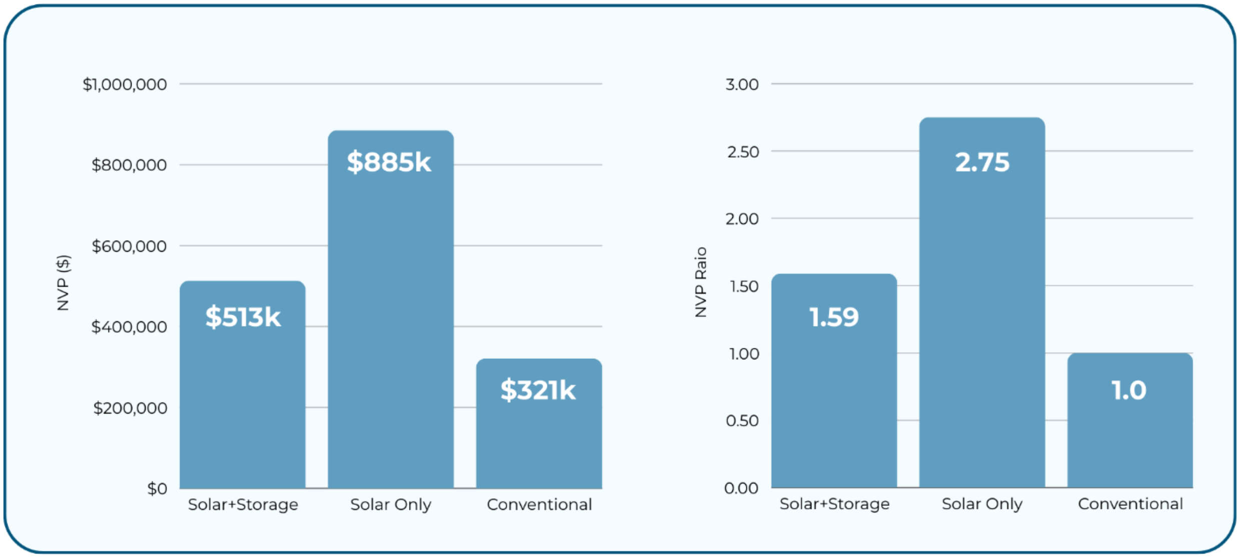
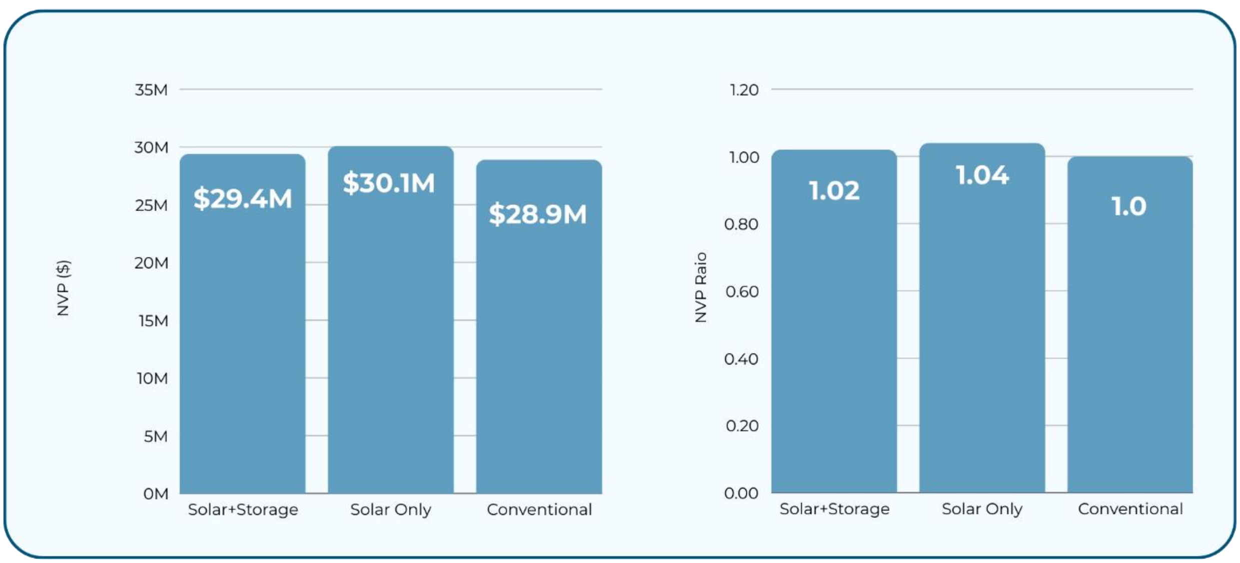
[3] There could be other market reasons for installing storage that are not captured in this analysis, for example, access to wholesale market revenue streams or other state incentives.



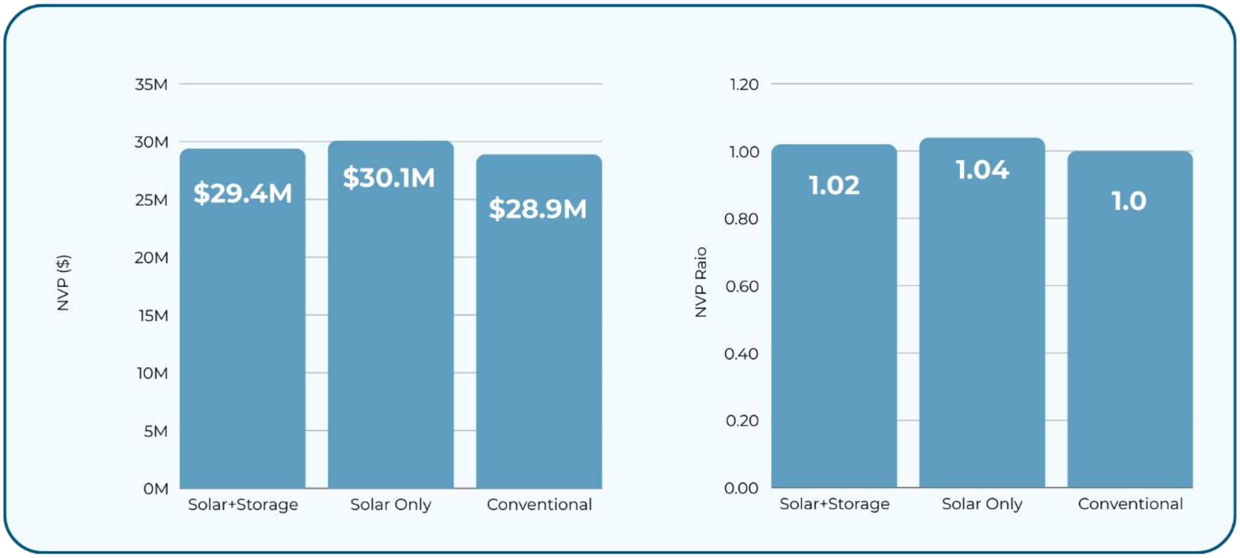
I2X TA Report Figure 21: Net present value for three different scenarios at node m1027039 showing advantage for flexible interconnection. The right panel shows the NPV ratio with respect to conventional interconnection.

The location closer to the substation is connected via a higher capacity conductor and has a stronger connection. The NPV analysis for this case, seen in the figure below, shows that FIX is still beneficial, but the lower variability in the hosting capacity makes it less spread between the different scenarios, which makes FIX look less appealing.



I2X TA Report Figure 27: NPV for three scenarios at node I2925506 showing reduced spread due to smaller hosting capacity variability. The right panel shows the NPV ratio with respect to conventional interconnection.

For the location closest to the substation, or the strongest connection point, hosting capacity limits derive from thermal restrictions as opposed to voltage limits. The NPV analysis, seen in the figure below, shows that FIX is somewhat beneficial here, and given the similarities in capacity, it is not surprising that NPVs are close together. Therefore, this analysis shows that most upgrades are worthwhile for this case, but flexible interconnection while awaiting an upgrade is always worthwhile.



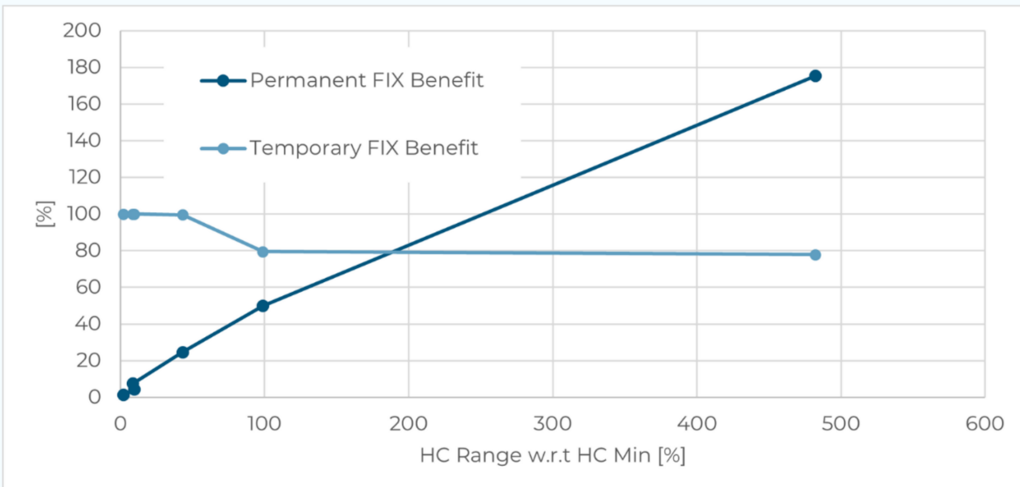
I2X TA Report Figure 31: Net present value for the three scenarios at the substation node. The right panel shows the NPV ratio with respect to conventional interconnection.

Key Takeaways and Conclusion

This analysis showed the limited number of curtailment events for flexible interconnection in the modeled scenarios. For the key case, where the substation is the furthest away, curtailment was only 10% of yearly exported MWhs. This limited number of curtailment events and the subsequent NPV analysis demonstrates that FIX will likely not impact project revenue.

The benefits of temporary flexible interconnection are always better than waiting for a major upgrade. The nodes that were further from the substation would benefit the most from indefinite flexible interconnections, and those closest to substation benefit most from temporary flexible interconnections as they wait for an upgrade.

The figure below shows that as hosting capacity variability increases, the permanent FIX benefit increases, while as hosting capacity variability decreases, temporary FIX benefit decreases. Flexible interconnection is meant to provide options to the conventional capped output method at a particular point of interconnection and not necessarily to compare at various interconnection points. But this analysis shows that all systems benefit from flexible interconnection, and it is therefore very important to consider the role of flexible interconnection as a solution to interconnection challenges.



I2X TA Report Figure 34: Hosting capacity variability and its relationship to the benefit of flexible interconnection.

Given the high cost of upgrades, and the rising demand for interconnection in distribution networks, flexible interconnection is a solution to help address these issues. Both permanent and temporary flexible interconnection have benefits to the system, and therefore policymakers should consider encouraging its use as both a permanent and temporary interconnection solution.