Reforming the Energy Vision

Demonstration Project Q2 2016 Report

CONFIDENTIAL

Flexible Interconnect Capacity Solution

AVANGRID

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1.0 Executive Summary

The Flexible Interconnect Capacity Solution (FICS) demonstration project tests a new model for interconnecting large-scale Distributed Energy Resources (DERs) to the distribution grid. Flexible interconnection is enabled by utilizing Active Network Management (ANM), a technology that allows the utility to manage the delivery of electricity generated by a DER to the grid to provide a less expensive, potentially faster interconnection alternative to traditional network infrastructure upgrades. ANM hold the potential to reduce DER interconnection costs, aiding economic viability, and the potential to accommodate greater penetration of DER than otherwise.

Two proposed DERs in the New York State Electric and Gas Corporation (NYSEG) service territory have been targeted as the demonstration sites for the initial FICS scope. Using ANM, a portion of the interconnection cost for each participating DER will be deferred by managing network constraints identified in AVANGRID's interconnection screening. The targeted DERs include a 2 MW solar photovoltaic (PV) farm and a 450 kW farm waste biodigester.

During Q2 2016, the project team advanced engagement with the two chosen developers, developing supplemental agreements to the New York State Standardized Contract for Interconnection of New Distributed Generation Units for each DER. The agreements lay out FICS participation terms, detailing expected production impact, technical requirements, cost deferral, and operating provisions. The project team has executed a supplemental agreement with one of the two developers, with the second developer currently reviewing participation terms to finalize its interconnection option.

During Q2 2016, the project team also advanced technical implementation of the ANM platform, completing system design and commencing build/configuration activities. The design finalized normal and fail-safe operational configurations for ANM operations, communications infrastructure needed to provide connectivity between ANM system components, and technical requirements to securely integrate the ANM system into NYSEG's existing operations technology platform.

The following report provides a progress update on the tasks, milestones, checkpoints, and lessons learned to date.

2.0 Demonstration Highlights Since the Previous Quarter

Activity and results during Q2 2016 include:

- Completed initial modeling of FICS capacity and control based on feeder load and DER generation profiles for each constrained network area.
- Deployed monitoring capabilities to capture interval feeder-level loading data in each constrained network area, finalizing initial FICS capacity and control modeling.
- Developed agreements on FICS participation terms with the developers of the two targeted DERs.
- Developed design specification for the core ANM system and two proposed ANM schemes.
- Developed acceptance test specification for the core ANM system.

2.1 Activity Overview

2.1.1 Activity: Developed FICS participation agreements with two DER developers

In Q2 2016, the project team developed supplemental agreements to the New York State Standardized Contract for Interconnection of New Distributed Generation Units for each DER targeted for participation in the initial FICS demonstration. The project team has executed a supplemental agreement with one of the two developers, with the second developer currently reviewing participation terms to finalize its interconnection option.

The agreements detail the following FICS participation terms:

- Methodology and results of FICS capacity and control modeling, with projections of ANM-related operational impact on the DER during both normal and fail-safe configurations;
- Technical requirements for each developers' generation facilities to interface with the ANM system;
- Terms of interconnection cost deferral based on each DER's Coordinated Electric System Interconnection Review results (which represent firm interconnection cost and requirements);
- Principles of Access governing future DER interconnections to the constrained network areas where the two participating DERs are sited;
- Operating provisions between AVANGRID and each developer during ANM operations, including data sharing such that the DER developer may distinguish ANM-related generation curtailment.

FICS DER #1

[redacted]2 MW [redacted] project was identified through AVANGRID's interconnection screening process as contributing to low voltage conditions at two locations on the adjacent circuit of NYSEG's Mason Corners substation. To alleviate this potential issue, and as an alternative to installing additional in-line voltage regulators, AVANGRID proposed that ANM be utilized to adjust the voltage set point of the load tap changer (LTC) at the Mason Corners substation during low voltage excursions. The voltage at the PV's point of common coupling (PCC) will also be monitored for overvoltage separately, with generation curtailment instructions issued as needed to maintain acceptable PCC voltage. These control points are coupled in one ANM scheme.

AVANGRID developed a cost estimate for interconnecting the PV as part of the project's CESIR, presented in Table 1:

Table 1: FICS DER #1 CESIR Cost Estimate for Firm Interconnection

Requirement	**Cost**
PCC Recloser Installation w/ SCADA commun	[redacted]
2 Sets of Single Phase Line Regulator Installations	[redacted]
Substation LTC Reverse Control Upgrade	[redacted]
Engineering Support	[redacted]
Overheads & Contingency	[redacted]
Total	[redacted]

[redacted] has paid the total amount presented in Table 1 in full. AVANGRID and [redacted] have agreed that the ANM scheme will be commissioned in conjunction with the PV, and will operate for a demonstration period of one year. Operational data from the ANM scheme will be collected and logged by AVANGRID to measure the occurrence of low voltage excursions at the two metered locations and the performance of tap change operations in resolving excursions. Should the project team determine that ANM resolves observed low voltage excursions, AVANGRID will refund the in-line voltage regulator cost paid by [redacted] at the conclusion of the demonstration period, and will keep the ANM scheme operational moving forward.

FICS DER #2

[redacted] 450 kW farm waste biodigester, proposed at [redacted], was identified through AVANGRID's interconnection screening process as exceeding the hosting capacity limit for NYSEG's Aurora substation. No additional distributed generation can presently be accommodated at the proposed PCC without network upgrades, namely an upgraded substation transformer bank. Furthermore, AVANGRID determined that the

biodigester may cause high-voltage conditions outside ANSI criteria on the local Aurora substation circuit under light loading. Consequently, additional in-line voltage regulators are required to interconnect the generator.

The project team offered three options to EnviTec Biogas to interconnect the biodigester:

1. Do not participate in FICS and upgrade the Aurora substation transformer bank;
2. Participate in FICS, with the biodigester managed by ANM to address the thermal capacity constraint at the Aurora substation transformer bank. Install new distribution line regulation to prevent high-voltage conditions.
3. Participate in FICS, with the biodigester managed by ANM to address the thermal and voltage constraints.

The costs for these three options are detailed in Tables 2-4:

Table 2: FICS DER #2 CESIR Cost Estimate for Firm Interconnection (Option 1)

Requirement	**Cost**
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted][1]	[redacted]
[redacted]	[redacted]
Total Cost	[redacted]

Table 3: FICS DER #2 Developer Cost Responsibility for Option 2

Requirement	**Cost**
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
Total Cost	[redacted]

[1] Pursuant to PSL §66-j(3)(c)(ii), AVANGRID may not require a customer-generator proposing to install farm waste electric generating equipment with a nameplate rated capacity up to 1,000 kW per farm to contribute more than $5,000 in interconnection costs for transformers or other safety equipment needed to interconnect the generator in order to protect the safety and adequacy of electric service provided to other customers. The [redacted] cost limitation includes CESIR cost. The balance presented in Tables 2-4 reflects the applicable costs already paid by [redacted], and the total costs presented in Tables 2-4 reflect applicability to other requirements included in the CESIR.

Table 4: FICS DER #2 Developer Cost Responsibility for Option 3

Requirement	Cost
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
Total Cost	[redacted]

[redacted] has indicated preliminary interest to implement two ANM applications, thermal and voltage mangement, in a local ANM scheme. Presented as Option 3 above, the output from the biodigester would be monitored and controlled such that reverse power flow through the substation transformer bank adheres to AVANGRID's System Planning threshold requirements. ANM would also monitor the output from the biodigester and the voltage on the local Aurora substation circuit to subject the generator, as needed, to real power curtailment to maintain acceptable voltage.

For Option 3, [redacted] would need to pay AVANGRID a one-time platform-as-a-service fee of [redacted], which reflects the incremental hardware and licensing costs for ANM to perform both thermal and voltage management.

Per both developers' request, AVANGRID will institute Last In First Off Principles of Access for each ANM scheme. Principles of Access define a customer's rights to access network capacity where ANM is implemented. Additional interconnections proposed off the Mason Corners and Aurora substations that are subject to a Coordinated Electric System Interconnection Review (above 50 kW and up to 5 MW) will have the option to either join the scheme on a Last In First Off basis or pay the necessary network upgrade costs to resolve the thermal capacity interconnection constraint.[2]

Under the Last In First Off principles, any binding network constraint is resolved by curtailing all generators in the order in which they applied for interconnection to the network. In this way, generators are insulated against greater curtailment caused by the interconnection of later generation. AVANGRID will be responsible for holding and maintaining a register of all qualifying DERs that propose interconnection to the two constrained network areas, ensuring that all subordinate DERs on the register shall be subject to the ANM scheme parameters.

[2] The Coordinated Electric System Interconnection Review requirements are defined in the New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators 5 MW or Less Connected in Parallel with Utility Distribution Systems.

2.1.2 Activity: Developed ANM design specifications

In Q2 2016, the project team advanced technical implementation of the ANM platform, completing system design and commencing build/configuration activities. The design determined normal and fail-safe operational configurations for ANM operations, communications infrastructure needed to provide connectivity between ANM system components, and technical requirements to securely integrate the ANM platform into NYSEG's existing operations technology platform.

Figure 1 presents the field components to be included in the ANM scheme for DER #1. The ANM scheme includes SGS connect devices at the Mason Corners substation and the [redacted] site, along with communications-enabled voltage transducers at the two voltage constraint locations on the adjacent circuit. The ANM Scheme hardware at the four locations will have communications connectivity provided by AVANGRID. AVANGRID will also provide communications connectivity between the ANM scheme and the core ANM system components to be installed at AVANGRID's Energy Control Center in Vestal, NY.

Figure 1: DER Site #1 ANM Scheme Components

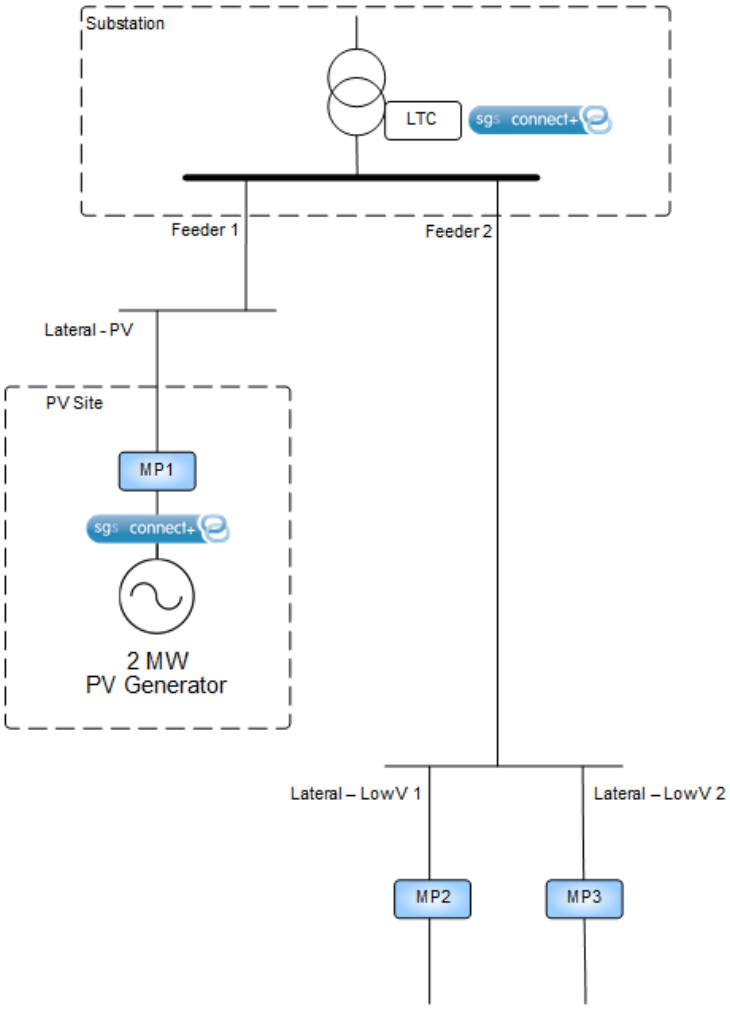
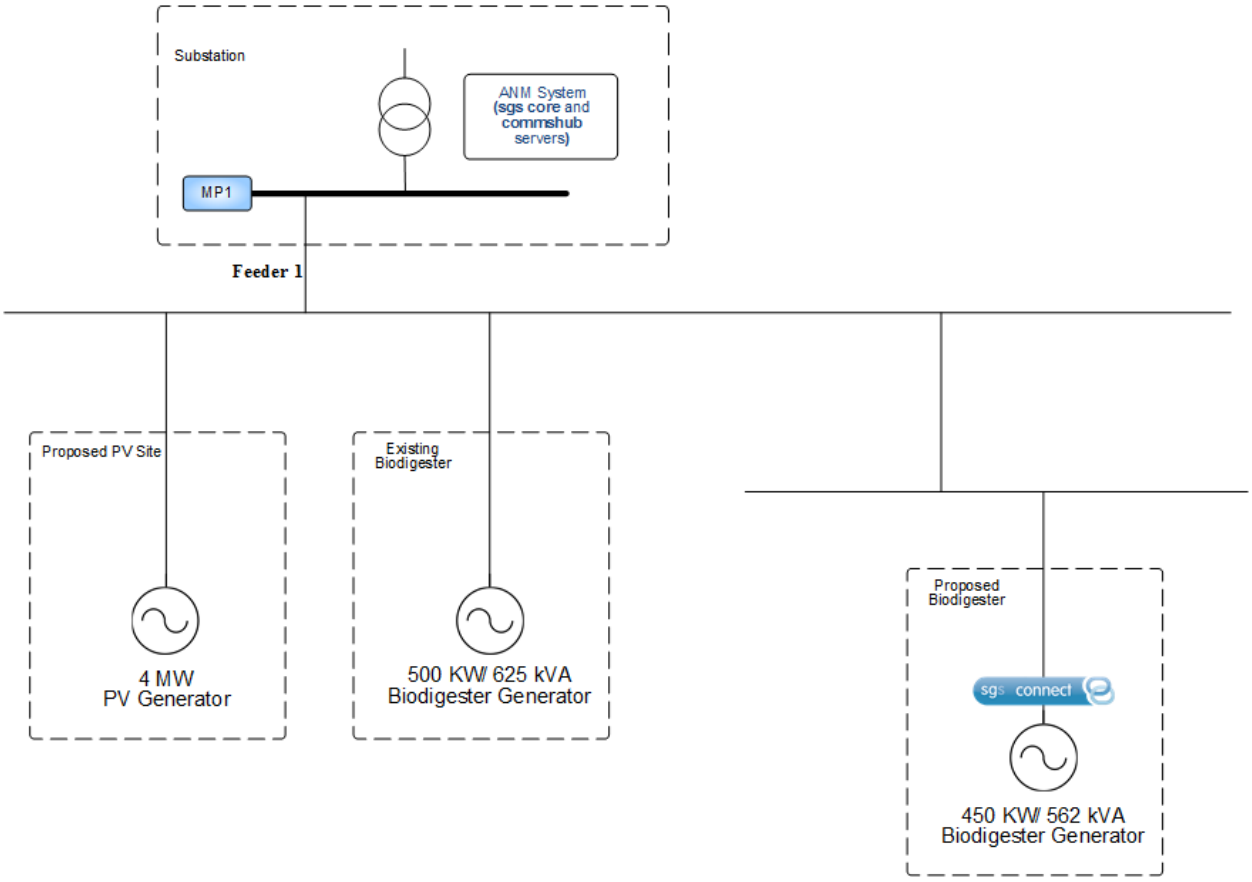


Figure 2 presents the field components to be included in the ANM scheme for DER #2. Under Option 3, the ANM scheme includes an SGS connect device at the [redacted] biodigester site, along with a communications-enabled current transducer at the Aurora substation transformer bank and a communications-enabled transducer on the local Aurora substation circuit. The ANM scheme hardware at the three locations will have communications connectivity provided by AVANGRID. AVANGRID will provide communications connectivity between the Aurora ANM Scheme and the core ANM system components to be installed at AVANGRID's Energy Control Center.

Figure 2: DER Site #2 ANM Scheme Components



2.2 Tasks Completed & Milestone Progress

Table 5: Implementation Plan Milestones by Project Task

Project Task	Milestone for Task Completion	IP Target	Status
Kickoff	Smarter Grid Solutions delivers Project Initiation document to AVANGRID	Q4 2015	Complete
Stakeholder Engagement	AVANGRID signs off on ANM requirements specifications	Q1 2016	Complete
Modeling	Developer reviews simulated capacity analysis and signs off to proceed with data gathering	Q1 2016	Complete
Data Gathering and Analysis	Developer accepts projected capacity analysis produced by Smarter Grid Solutions	Q1 2016	Complete
Initial Design	AVANGRID and Developer accept draft ANM design specification, interconnection contract executed	Q2 2016	1 of 2 Complete
Final Design	Pre-production and production acceptance test specifications finalized	Q2 2016	In Progress
Build and Configure	Pre-production and production factory acceptance test	Q3 2016	In Progress
Installation and Testing	Site acceptance test, ANM system go live	Q4 2016/ Q1 2017	At Risk
Highlighted cells indicate changes from Q1 2016 report.			

The Project Tasks Initial Design and Final Design are completed for DER #1. The completion of Initial Design and Final Design for DER #2 is pending execution of the FICS participation agreement by the developer.

2.3 Checkpoints

The FICS Implementation Plan included six progress checkpoints. As detailed in the Implementation Plan, certain checkpoints are dependent on milestones to be completed later in 2016. Sufficient progress has been made to provide an update on the following checkpoints:

Selection of the FICS Option

The expected target in the FICS Implementation Plan was that at least two DER developers in the NYSEG and/or RG&E service territory will elect the FICS option during the demonstration term. The project team has executed a supplemental agreement with one of the two developers, with the second developer currently reviewing participation terms.

Interconnection Cost

The measure in the FICS Implementation Plan included the total utility infrastructure cost per MW interconnected and the avoided cost of system reinforcement that would otherwise be required. The total cost per MW interconnected will be finalized following completion of each

interconnection, expected for the two targeted DERs in Q4 2016 and Q1 2017 respectively. Based on current estimates, the total expected avoided cost of network reinforcement for the two candidate DERs is approximately $4.11 million, or $1.68 million per MW managed, assuming Option 3 for DER #2.

Total FICS Utility Revenue

As stated in the FICS Implementation Plan, the area of commercial development for the "platform-as-a-service" business model is a primary focus for testing, with the project team's expected target to obtain robust lessons learned of revenue opportunities for FICS.

As discussed in the Q1 2016 update, due to the characteristics of remotely net metered solar PV projects, the project team foresees challenges obtaining meaningful platform-as-a-service fees in the short term with current DER penetration levels in the NYSEG and RG&E service territories.

The developer of FICS DER #1 has expressed that there is insufficient financial incentive to participate in FICS unless they are able to retain the expected interconnection savings in full following the demonstration term. The developer has obtained financing for the full interconnection cost without FICS.

The developer of FICS DER #2 has agreed to pay AVANGRID a one-time platform-as-a-service fee of [redacted], which reflects the incremental hardware and licensing costs for ANM to perform both thermal and voltage management in Option 3.

External Engagement

Following the broad external outreach conducted in Q1 2016, in Q2 2016 the project team focused on engagement with the developers of two candidate DERs to move the demonstration scope into implementation.

3.0 Work Plan

3.1 Budget Review

Through Q2 2016, project spend is below the quarterly projections included in the FICS Implementation Plan:

	2015	2016	2016	Total to Date
	Q4	Q1	Q2	
Projected Budget	[redacted]	[redacted]	[redacted]	[redacted]
Actual Spend	[redacted]	[redacted]	[redacted]	[redacted]
Variance	[redacted]	[redacted]	[redacted]	[redacted]

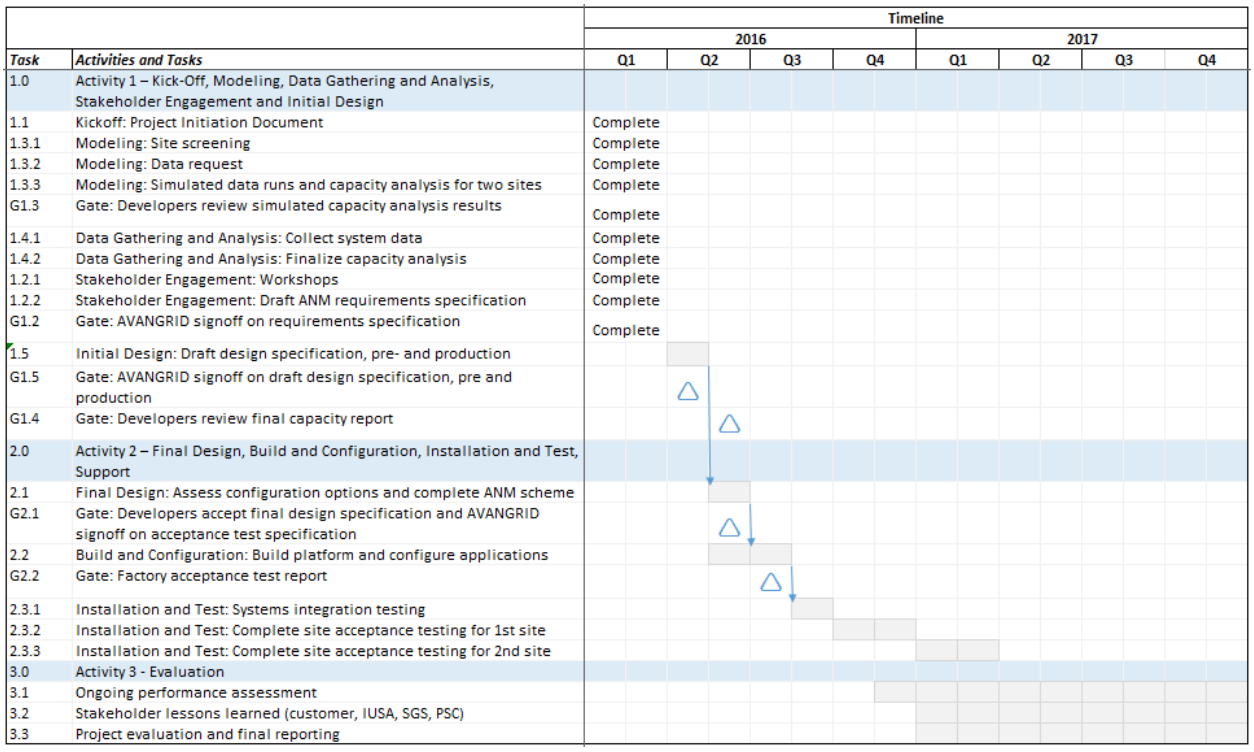
3.2 Updated Work Plan

As discussed in the Q1 2016 progress update, the project team expected to commission the first FICS site in Q4 2016 and the second FICS site expected in Q1 2017, with demonstration operations running through 2017 in order to capture sufficient operating experience and data for final reporting.

On July 21, AVANGRID received notice of a permitting issue with DER #1 which may delay the project several months. AVANGRID is looking for alternative sites for the FICS demonstration while continuing to pursue DER #1. In addition to seeking alternative sites for FCS demonstration, AVANGRID will move to make ANM a standard component of our interconnection alternatives analyses in the future.

These are target dates, which may be subject to change based on interconnection milestones being met, as well as the development of other DER ahead in the queue.

Figure 3: FICS Schedule



3.3 Next Quarter Planned Activities

In Q3 2016, the project team aims to complete the following tasks for DER #2:

> Initial Design: AVANGRID and Developer accept draft ANM design specification, interconnection contract executed.
>
> Final Design: Pre-production and production acceptance test specifications finalized.

The project team also aims to complete the following task, which will support DER #1 and DER #2:

> Build and Configure: Build and configuration of the ANM platform and applications. Conduct factory acceptance testing against approved test specification.

4.0 Conclusion

4.1 Lessons Learned

- The portability of solar PV development continues to pose challenges to developing meaningful platform-as-a-service fees under ANM in the short term.
- Additional FICS candidate selection is inhibited by queued project characteristics. Monitoring DER development activity from Q4 2015 through Q2 2016, applications are concentrated among a few developers with substantial PV capacity cleared for interconnection.

As discussed in the Q1 2016 FICS update report, portability is a major factor in the current solar PV domain under the SIR. With remote net metering and community DG development, PV developers have the ability to move project siting at low cost to avoid large interconnection expenses, thus voiding the large interconnection cost avoidance opportunities that ANM could provide.

The project team reviewed 541 DER applications proposed between October 2015 and May 2016 to identify additional FICS candidates and to advance the FICS revenue test. The 541 applications encompass 1051 MW of total generation capacity, 99.5% of which is PV, proposed by 24 different developers.[3] These projects are subject to the SIR; the following figures do not take into account proposed DER capacity smaller than 50 kW. Reviewing the Preliminary Technical Reviews and CESIRs (when available) for these projects, the project team produced several findings:

[3] 95% of the applications reviewed were greater than 1.9 MW in size.

1. Only 15% (159 MW) of the total proposed capacity has been moved into the CESIR phase, while an additional 18% of the total proposed capacity (101 MW) has been tentatively greenlit for interconnection but not moved into the CESIR phase by developers.[45]

2. The 97 MW with CESIRs completed to date had an average total interconnection cost of $96,000 per MW. Developer feedback gathered in Q4 2015 and Q1 2016 indicated the average 2 MW remotely-net metered PV project in the NYSEG and Rochester Gas and Electric Corporation (RG&E) service territories requires a total interconnection cost of $125,000 per MW to be economically viable.

3. The top two developers (in terms of proposed DER capacity) account for 79% of the total proposed capacity reviewed. The top four developers account for 87% of the total proposed capacity.

4. The top developer, who accounted for 48% (504 MW) of the total proposed capacity, has moved 22 MW into the CESIR phase. To date, the developer has 20 MW of cleared capacity, meaning a project with a completed CESIR and a total interconnection cost under $250,000, with an average $89,000 per MW firm interconnection cost. The developer has an additional 56 MW of capacity tentatively greenlit for interconnection.

5. The second-highest developer, who accounted for 33% (350 MW) of the total proposed capacity, has moved 96 MW into the CESIR phase. To date, the developer has 37 MW of cleared capacity, with an average $108,000 per MW firm interconnection cost. The developer has an additional 50 MW of reviewed capacity tentatively greenlit for interconnection.

In addition to the two DERs targeted for FICS participation in the initial demonstration scope, there are seven PV projects proposed in Q4 2015 and Q1 2016 that meet FICS candidacy criteria based on proposed local capacity in interconnection queue. These seven projects are proposed by the top two developers described above. The developers are proposing community DG projects, where they will aggregate offtake customers, and have yet to move any capacity to construction.

Considering the cleared capacity and the tentatively greenlit capacity for each developer, the developers do not currently have a value proposition to move the FICS candidate sites into construction, with generation capacity subject to potential curtailment. Instead, as they secure

[4] "Tentatively greenlit" refers to projects with no line or substation upgrade requirements identified in the Preliminary Technical Review (due to network capacity ratings) that have yet to move into the CESIR phase.

[5] 30% (221 MW) of the total proposed capacity did not meet basic requirements for interconnection viability, meaning that projects were either sited outside of the NYSEG and RG&E service territories (5%) or sited on single phase line more than 1200 feet to the nearest three-phase electric service (25%).

offtake customers the developers can focus on constructing the capacity with minimal upgrades required.

4.2 Conclusions

Through Q2 2016, the project team advanced engagement with the two chosen DER developers, developing supplemental agreements to the New York State Standardized Contract for Interconnection of New Distributed Generation Units for each DER. The project team also advanced technical implementation of the ANM platform, completing system design and commencing build/configuration activities.