Energy Storage System Performance Impact Evaluation

Appendices

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Appendix A Supporting detail on survey methods

This appendix describes the methods utilized for both secondary and primary data collection and analysis to develop market characterization and assessment results for Evaluation Year Two.

A.1. Overview and limitations

A.1.1. Market adoption – Methods overview

The analysis team sourced NY-Sun program data that included projects entered into the database through December 2022, and attempted to fill gaps in understanding through evaluation of primary data.[1] In total, there were 27 market adoption topic area responses to the installer web survey (including both full and partial responses):four responses from energy storage installers, 14 from solar plus storage installers, and nine from solar PV installers based on interconnection data classification.

A.1.1.1. Limitations

- The analysis team reviewed available secondary data (e.g., NYSERDA program data, utility interconnection data, etc.) that could inform development of New York State-specific market adoption rates. Identifying market trends for incentivized versus non-incentivized systems was difficult as there was no unique identifier to match interconnection data (all systems) to NYSERDA program data (incentivized systems).
- The in-depth interviews and web surveys were administered to a selected sample, and the results presented reflect the responses of that sample. As with all surveys, the results of this study depend on the accuracy of the information provided by survey respondents.

A.1.2. Balance of system and soft costs – Methods overview

The team developed this study's cost stacks in line with the cost stacks that appear to be the default method for presenting system costs. The NREL *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks* studies served as the main secondary data source for this evaluation.

This assessment of system costs in New York utilized the results of an in-depth survey effort that stratified the respondent population into a variety of segments to develop cost stacks for each segment. Additionally, there were 25 balance of system/soft cost topic area responses (both full and partial responses) that provided data to the installer web survey: three from energy storage

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[1] Throughout this report, NY-Sun data includes Green Jobs Green NY financing in addition to NY-Sun program data.

installers, 13 responses from solar plus storage installers, and nine from solar PV installers based on interconnection data classification. Though some energy storage installers responded to the survey, none installed storage systems in 2021, resulting in a lack of insight into the current balance of system (BOS)/soft costs of energy storage systems located in New York. Further, the majority of respondents did not provide any cost data, and some respondents did not provide sufficient data to generate a full cost stack. Survey respondent data is therefore likely to be non-representative of BOS/soft costs in New York State and often reflects the data provided by a single, non-market driving installer for a given system type and customer segment.

A.1.2.1.   Limitations

- BOS and soft costs are, by their nature, difficult to estimate. The installer web survey was distributed to a representative sample, and the results presented reflect the responses of that sample. As with all surveys, the results of this study depend on the accuracy of the information provided by survey respondents. The analysis team worked to minimize inaccuracies in survey responses through a variety of means, further described in the primary data methodology below (Section A-3).
- Prior to beginning primary data collection, the analysis team conducted a wide-ranging review of available secondary data (e.g., NYSERDA program, NREL, etc.) that could inform development of New York state-specific cost stacks. The NYSERDA program data were not sufficiently granular to develop cost stacks comparable to the chief secondary data sources, and were not comprehensive across all system types, including capturing sufficient cost information for non-incentivized systems and providing comparable breakdowns across cost categories for different system types.
- The analysis team's aim for the initial installer web survey was to support establishing a baseline of costs by system type, segment, and geography. Given the survey data received to date, it is not possible to establish a baseline as originally planned. An alternative methodology is needed to collect the types of data that can inform an effective baseline and, upon subsequent survey iterations, yield results that could grant NYSERDA insight into how system costs, including BOS and soft costs, evolve over time, and how this evolution compares to broader, national-level cost trends.

A.2. Secondary data methodology

The analysis team collected and analyzed the secondary data sources listed in Table A-1.

Table A-1. Documents reviewed for secondary data

Secondary Data	Source	Summary Content
NY-Sun and Energy Storage program data files (Salesforce data pulls)	NYSERDA	Project-level data for completed/incentivized solar PV, energy storage, and combined systems
Interconnection, Open NY, and DER data	NYSERDA	Project-level data for completed solar PV, energy storage, and combined systems
CEF Regulatory Filings, Commission Orders	NYSERDA	CEF Compiled Investment Plan, quarterly reports, L-SFA market barriers study, E-SFA analysis of standard offer versus competitive solicitation
US community solar market outlook H1 2022	Wood Mackenzie	National survey of customer acquisition costs reported by leading community solar developers
U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021	NREL	National-level benchmarks for cost elements across wide array of system types and sizes
State of Storage system cost data survey responses	NYSERDA	Cost data, by cost element, provided as survey responses for some standalone storage systems

The analysis team mined these secondary data sources to:

- Examine sector level market characteristics by system type.
    a. NY-Sun and Energy Storage program data, sourced from Salesforce NYSERDA data shared with the analysis team, differentiates data between the residential and non-residential sectors. To avoid using incomplete data, or fields where customer sector level remained blank, the analysis team used project site record type solicitation to categorize projects at the sector level. In this report, residential/small commercial projects, as referenced in NY-Sun Salesforce data, are referred to as 'residential'. Commercial/Industrial projects referenced in NY-Sun and Energy Storage are referred to as 'non-residential'.
- Evaluate solar PV and energy storage penetration in NY State, either standalone or in combination, both incentivized and non-incentivized.
    a. Interconnection data encompasses both incentivized and non-incentivized projects, but it does not differentiate by sector.
    b. The team used NY-Sun and Energy Storage program data to estimate the total number and capacity of program participants (incentivized systems) and used interconnection data to estimate total number and capacity of all systems (both incentivized and non-incentivized).
- Investigate standalone energy storage adoption barriers.
- Obtain national-level benchmark data against which New York State-specific data could be compared.

- Provide sources for system cost data elements that were not captured through the survey.

As with the market adoption study, the analysis team utilized primary data to build upon understanding gained through secondary data with a focus on NY State. For the evaluation of BOS and soft costs, primary data collection informed the bulk of the analysis team's efforts to develop cost stacks, though secondary data from NREL served as the basis for cost elements that were not captured through the survey.

A.3. Primary data methodology

Note: The analysis team provided NYSERDA with a separate memorandum that describes the sampling strategy for the installer population. [2]

A.3.1.   Program staff interviews

Interviews were conducted with various members of NYSERDA program staff to understand the current state of programs, data sets, changes to rules, incentives, and efforts undertaken to advance relevant CEF initiatives. Interviews were conducted with NYSERDA staff representing the Retail and Bulk Storage programs, the NY-Sun program, including CDG and SFA, Clean Energy Siting and Soft Cost Reduction, Standards & Quality Assurance, Clean Energy Communities, and NYGB. To support subsequent evaluation years, the analysis team intends to interview NYSERDA staff representing Renewables Optimization and continue engagement with previously interviewed program staff.

A.3.2.   Installer engagement interviews

To engage solar PV and energy storage installers, the analysis team designed an installer engagement interview to (a) identify the correct respondent for each section of the web survey, (b) gather information from CDG installers about their CDG projects and subscriber information, and (c) collect performance data for the solar persistence study.

The team conducted in-depth telephone interviews with 49 installers of 80 attempted (61% response rate) using the following process:

Soft launch. First, the analysis team conducted outreach to seven installers who were identified from previous program evaluation efforts to provide feedback as part of a soft launch. Two of these initial seven organizations were not included in the sample strategy memorandum. Of the other five organizations, two were identified in the sample strategy as sample, one was identified

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[2] DNV, *NYSERDA Solar PV and Energy Storage Market and Impact Evaluation Sample Strategy Memo*, August 2022.

as backup, and two were not selected as sample or backup.[3] All five organizations were contacted prior to other respondents from the sample population.

Finalize installer sample. Following the soft launch effort, the analysis team referred to the sample strategy memorandum to identify the target interview population of 70 developers in addition to 10 back-up developers—50 who installed combined solar PV and energy storage projects, 16 who installed solar PV projects, and 14 who installed standalone energy storage projects. Of those 80 total installers, six solar PV-only installers and four standalone energy storage installers were identified as back-ups from the sample frame. When possible, the analysis team obtained contact information from NYSERDA's program database. Where program data did not contain contact information, the analysis team completed ZoomInfo lookups to identify email and/or phone information.[4]

Full launch. The analysis team begin engagement interviews with the full sample of installers in July 2022 and continued through December 2022. The team attempted to reach each installer at least four times or until a final disposition (e.g., interview completion or refusal) was reached. Additionally, the analysis team collaborated with NYSERDA program staff to determine if a more suitable contact was available for organizations that were non-responsive after four attempts. Of the 80 contacted installer organizations, the analysis team completed an engagement interview with 49 respondents to achieve a 61% response rate. Table A-2Table A-2 provides a disposition summary from the installer engagement interviews.

Table A-2. Installer engagement interview disposition

Disposition	Count
Number of Contacts Emailed/Called	80
Interview Completions	49
Referral or Company Merger/Change	4
Non-responsive	15
Refused/Declined	7
Bad Number or Email/Wrong Number or Email	5

A.3.2.1.   Installer CDG subscriber lists

During in-depth interviews with installers, the analysis team inquired as to whether each CDG installer were willing and able to share their subscriber list(s). For each developer that indicated they or someone else at their company might be able to provide their list(s), the analysis team

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[3] For more detail, see *NYSERDA Solar PV and Energy Storage Market and Impact Evaluation Sample Strategy Memo*, August 2022.

[4] https://www.zoominfo.com/

provided a NYSERDA-branded partnership opportunity document for their review.[5] After exhaustive outreach to installers (at least four attempts for each respondent) the analysis team was able to obtain one subscriber list that included subscriber counts and addresses, but not subscriber types.

A.3.3.   Installer web surveys

The analysis team developed a detailed installer web survey to gain insight into market adoption, BOS/soft costs, and system performance for both NYSERDA-incentivized and non-incentivized projects. The web survey asked installers to respond to market adoption and BOS/soft cost questions for each system type they installed, including solar PV, combined solar PV and energy storage, and standalone energy storage.

Sampling. The analysis team contacted 66 of the 80 installer organizations that made up the sample for the installer engagement interview. The 14 organizations not invited to respond to the web survey were not traditional developers, were not open to sharing information, refused to participate, or the analysis team was unable to reach an appropriate contact (bad or incorrect number or email). Of the 66 developers who were invited to respond, interconnection data indicated 16 installed solar PV-only projects, 11 installed standalone energy storage projects, and 39 installed combined solar PV and energy storage projects. The analysis team invited respondents from the engagement IDIs to take the web survey on a rolling basis, as each interview was completed. The analysis team provided the initial interview respondent with a link to the web survey and asked the respondent to identify the person from their organization best suited to answer questions pertaining to the three main sections of the survey: market adoption, BOS/soft costs, and system performance. If the initial respondent identified contacts besides themself, the team sent links to the newly identified contacts.

Survey fielding. The analysis team fielded the web survey from September 2022 through January 2023. The team attempted to contact each installer at least four times or until a final disposition (e.g., survey completion or refusal) was reached. In an attempt to increase response rate, the analysis team offered respondents the opportunity to be entered into a drawing for one of ten $50 gift cards. Of the 66 contacted installer organizations, the analysis team received completed surveys from 18 respondents (including eight solar PV installers, eight combined solar PV and

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[5] Refer to Appendix B to review the partnership opportunity document.

energy storage installers, and two standalone energy storage installers), for a 27% response rate. Table A-3Table A-3 provides a disposition summary from the installer web survey.

Table A-3. Installer web survey disposition

Disposition	Count
Number of Contacts Emailed/Called	66
Full Survey Completion	18
Partial Survey Completion	15
No Response	26
Refused / Declined	7

A.3.4.   Community solar (CDG) subscriber web survey

The analysis team developed a web survey for CDG subscribers to assess several aspects of their experience with CDG, including how they decided to enroll; if they saved money on their electricity bill as a result of subscribing to CDG and if so, how much; and their levels of satisfaction with CDG. The survey also gathered demographic and firmographic information.

Sampling. The analysis team obtained CDG subscriber data from NYGB, receiving a total of 12,014 unique subscriber addresses. After the soft launch, the analysis team geolocated the NYGB CDG subscriber dataset, and proceeded to use unique addresses that were successfully, physically matched to a street address, reducing the number of usable records from 12,014 to 9,501.

Soft launch. The team soft-launched the survey to 200 subscribers (100 residential and 100 non-residential) randomly selected from the data provided by NYGB. Due to missing or incomplete addresses, the analysis team pulled additional records (129 residential and 236 non-residential, in total) to reach the soft launch target of 200 subscribers.

Full launch. For the full launch, the analysis team attempted a census for all remaining non-residential records with valid mailing addresses (a total sample of 909 – including the 100 from the soft launch). For the residential records, the team filtered the NYGB dataset for projects categorized as "completed" (3,059) and attempted a census for these subscribers. Finally, the team filtered the residential dataset for projects categorized as "pipeline" (5,533) and selected a simple random sample of 2,500 subscribers, resulting in a total residential sample of 5,659 including the 100 from the soft launch.

Survey fielding. The team began fielding the CDG survey in September 2022 and continued through January 2023. For each contact in the sample, the team mailed a letter to the address

provided in NYGB data. The analysis team performed additional follow-up activities to boost the survey response rate.

For the soft launch, the analysis team attempted to identify email addresses through ZoomInfo lookups and sent email reminders to those subscribers with found email addresses (53 for residential and 59 for non-residential). To further boost the response rate for non-residential subscribers, the analysis team also conducted phone call follow-ups for cases in the soft launch. Members of the analysis team offered to complete the web survey via phone with these contacts.

For the full launch, the analysis team sent follow-up email reminders to subscribers with a valid email address in the NYGB subscriber dataset. Additionally, the analysis team sent out postcard reminders to 200 randomly selected subscribers (100 residential and 100 non-residential) from the full launch sample to determine the effect on response rate to aid in planning for outreach during future evaluation years. Fourteen residential postcards and 27 non-residential postcards were returned as undeliverable. Zero additional survey completions were gathered for residential subscribers, and two additional survey completions were gathered for non-residential subscribers. The analysis team was able to complete the survey with 338 residential respondents representing a 6% response rate, and 26 non-residential respondents for a 3% response rate. Table A-Table A-4 provides a disposition summary from the community solar subscriber web survey.

Table A-4. CDG subscriber web survey disposition

Disposition	Count – Residential	Count – Non-residential
Number of Contacts Mailed/Emailed/Called	5,659	909
Survey Full Completions	338	26
Online Completion	338	21
Phone Complete from Phone Outreach Test	0	5
Partial Complete	23	1
Total survey completions	361	27
Undeliverable Letter	616 (11%)	222 (24%)

A.3.4.1.   Weighting – Community solar subscriber web survey

To weight the CDG web survey responses back to the population sampled, the analysis team defined case weights based on the four strata shown in Table A-5.

Strata were created with the expectation that response rates between Residential/Non-Residential and located in a DAC/not located in a DAC would vary between groups and therefore were weighted accordingly. In 13 cases, 9 residential and 4 non-residential, survey responses contradicted the original sector assignment (residential/non-residential). Based on their responses, the analysis team reassigned these respondents to the opposite subscriber sector.

To determine case weights, the team divided the population, N, by the respondents, n, for each stratum. These weights were then applied to the subscriber responses to extrapolate the survey results to the population. The strata and corresponding case weights can be found in Table A-5.

Table A-5. Case weight by stratum

Strata	Sample Frame (Population)	Survey Completes	Weight
Non-Residential, Not Located in a DAC	644	18	35.8
Non-Residential, Located in a DAC	270	9	30.0
Total Non-Residential	**914**	**27**	
Residential, Not Located in a DAC	6255	311	20.1
Residential, Located in a DAC	2332	50	46.6
Total Residential	**8587**	**361**	
Total Population			**9501**

A.4. Number and type of CDG subscribers

This calculation assumes that the average capacity of a Green Bank subscriber is similar to all other CDG subscribers. The sector is a driving factor in the average capacity and therefore this analysis inherently assumes that NYGB has a similar ratio of residential to non-residential subscribers as the rest of the state. This assumption must be made because the team can determine the residential and non-residential split in the NYGB data, but not at the population level.

Reviewing the NYGB data for projects which were determined to be completed at the time of this evaluation, the team found that the residential sector makes up 90% of the subscribers and non-residential subscribers comprise 10%.

The team collected 12,014 unique CDG customer mailing addresses from NYGB, representing 35 projects. Following geolocation, 9,517 physical mailing addresses were matched. Before weighting, a total of 364 subscribers were surveyed, including 338 residential and 26 non-residential subscribers. When weighted to the geocoded population, respondents represented 8,597 residential (90%) and 920 non-residential (10%) NYGB CDG subscribers.

The total installed capacity of CDG projects collected from NYGB was 132.48 MW. This total installed capacity was divided by the lower bound (9,517) as well as the upper bound (12,014) of CDG addresses received to produce an average capacity per subscriber, 0.01392 for the low bound and 0.01103 for the upper bound. This represented the average capacity subscribed per customer.

- The total MW capacity of projects with a CDG metering type (including RC) from utility interconnection data from January 1, 2015, to November 30, 2022 (1,746 MW) was then divided by the average capacity subscribed per customer to produce an estimate of a low

bound of 125,000 subscribers and an upper bound of 158,000 subscribers to statewide CDG projects.

- Similarly, the total MW capacity of projects with a CDG metering type from NY-Sun program data (1,476 MW) was divided by the average capacity subscribed per customer to produce an estimate of a low bound of 106,000 subscribers and an upper bound of 134,000 subscribers to incentivized CDG projects.

Appendix B Partnership opportunity document

NYSERDA Evaluation on NY-Sun: Partnership Opportunity and Request for Participating Developers

Overview

NYSERDA is conducting an evaluation of the NY-Sun program. The purpose of this evaluation is to better understand the impacts of recent community distributed energy (CDG) projects in New York State, including community solar projects and energy storage projects that received NYSERDA incentives. NYSERDA has contracted with independent research firms DNV, APPRISE, and Industrial Economics to conduct this study.

For this evaluation, NYSERDA is requesting your organization's partnership for three research activities described below. NYSERDA values your organization's efforts to advance clean energy solutions in New York and would appreciate your assistance in helping to understand how to improve NY-Sun program offerings.

Request #1 – **Complete Web Survey**

To better understand the experiences of solar and storage project developers and managers, NYSERDA will be conducting an online survey with questions about solar and storage projects completed in New York since 2018. The survey will ask about topics including your projects in development or completed since 2018, solar and storage project types and subscriber models, system costs, system performance, and satisfaction with NYSERDA.

This important survey will be available to complete online and should take approximately 20 minutes to complete. The survey can be completed by one individual familiar with each of the topics, or different sections can be completed by the appropriate person in your organization familiar with that topic area.

Next Step: NYSERDA is planning to email you this survey in <u>September 2022</u>. If you have questions about the survey, please let us know.

Request #2 – **Partnership in Subscriber Survey**

NYSERDA will also be conducting a survey with community solar subscribers. The survey will include a sample of residential subscribers and of non-residential subscribers. The purpose of this survey is to collect information from subscribers about their reason for subscribing for community solar, their satisfaction with their experience, and their demographic or firmographic characteristics.

NYSERDA would like to partner with you as a co-sponsor of the subscriber survey. For your support in helping to contact subscribers about the survey, NYSERDA would share aggregated, anonymous results from the survey with you so that you can view and use the results.

Subscribers selected for the survey would be invited to participate in this voluntary survey. The survey would be available to complete online, by mail, or by phone and should take approximately 5 to 10 minutes to complete.

Next Step: The Evaluation Team can share additional information about the survey with you. To help co-sponsor this survey, NYSERDA requests the following:

1. Information on the number of current residential and non-residential subscribers for each active community solar project in New York,

2. Subscriber contact information to allow NYSERDA to send a sample of your subscribers the survey invitation request (via a mailed letter or email),

3. Your support in contacting subscribers to confirm the survey and encourage their participation

*Request #3 – **Partnership in Confirming Subscriber Locations***

To help NYSERDA assess progress in supporting community solar projects that benefit disadvantaged communities through the Solar Energy Equity Framework, NYSERDA will also be analyzing the geographic location of community solar subscribers.

NYSERDA requests you support in identifying the geographic locations of your current subscribers. NYSERDA will use this to identify the portion of subscribers located in designated Disadvantaged Communities (DACs). NYSERDA will share the results with you.

Next Step: NYSERDA requests your support using one of the two options described below:

> Option 1. Provide Subscriber Address Information (Street, City, and Zip Code) to the Evaluation Team.

> Option 2. Provide the Count of residential and non-residential Subscribers by Census Tract (APPRISE can provide information on tools available to identify census tracts based on individual addresses)

How will Information be Protected and Secure?

You can provide the requested information directly to NYSERDA's contractors, APPRISE and DNV, in Microsoft Excel or other formats. The analysis will only use summary level data and

will not identify individual subscribers or solar developers. APPRISE can assist you with securely transferring the information.

As contractors to NYSERDA, APPRISE and DNV are required to store data securely and to maintain strict data protection procedures. All information will be kept confidential to the extent permitted by law including but not limited to the Freedom of Information Law (FOIL). The analysis will only use summary level data and will not identify individual respondents (developers or subscribers).

NYSERDA understands the importance of your relationship with your subscribers and partners, and the Evaluation Team can work with you to discuss outreach approaches, address concerns, or develop data sharing solutions.

If you have any questions about this evaluation, you can contact the NYSERDA evaluation lead:

Dana Nilsson

NYSERDA Market Characterization and Evaluation Team

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What will be the outcome of this evaluation?

NYSERDA will publish a report describing the evaluation findings once the evaluation is complete. The report will not identify individual organizations, projects, or subscribers.

Once the Evaluation Team completes the subscriber survey or the geographic analysis of your subscribers, the team will share the aggregated results with you.

Appendix C Uncertainty bounds methodology

C.1. Introduction

Measuring the performance of energy storage systems and/or characterizing the system's operation requires collecting many thousands of data points related to several metrics, across multiple distributed sites, over a defined period. In this study, system performance is characterized by *revenue metrics* – including VDER revenue, site impacts (from demand charge reduction) – and *operational metrics* – including cycles per year, average state of charge, and others. Large data sets like these inherently contain some level of data validation issues due to the unavoidable presence of data gaps, data anomalies, and outliers. These data validation issues, in turn, cascade into uncertainty in the analyses that rely on the dataset.

The purpose of this memo is to describe the evaluation team's methodology for quantifying data uncertainty across all sites and data fields used in an energy storage impact evaluation. Note that the evaluation team chose the term "*uncertainty*" (analogous to, but different from, statistical uncertainty) to provide an indicative representation of the measure of data completeness and consistency.

C.2. Objective

The objective of this exercise was to develop a standardized framework to be used for categorizing energy storage system performance. The framework includes three levels of uncertainty – low, moderate, and high – that can be applied to all site impact metrics. Ultimately, this uncertainty metric will increase the transparency behind the results in and help contextualize the report's recommendations related to data collection. While the uncertainty bounds are currently applied only to *revenue metrics*, they could be applied to other *operational metrics* in the future too.

C.3. Validation rules

First, the evaluation team will perform a set of data validation exercises, including:

- Null check (e.g. Identifying all data points that are null).
- Values flagged by data cleaning rules (e.g., solar generation at night, battery discharge idling at 10-100 kW).
- Outlier validation rules (e.g., load delta from phantom generation).

C.4. Analysis considerations

As there is an enormous and varied set of data across sites. The evaluation team developed the following considerations that inform the data uncertainty analysis:

- Three data streams – Battery kW, solar kW, facility kW – will be included in the analysis. (*Note*: The evaluation team combined Battery Charge and Discharge into one metric so as not to over-weight validation issues in battery data vis-a-vis solar generation or facility load).
- 60-minute interval data (rather than 15-minute).
- All three years of battery operational data are considered in the analysis. i.e., systems with initial poor data coverage will be impacted even if they have subsequently addressed the data issues.

Exclusions

The following data attributes will be excluded from the data uncertainty analysis:

- State of charge, as it does not directly factor into the site impact.
- Data gap in solar generation when the site has a standalone storage system.

Uncertainty bounds

The three data validation exercises will be synthesized into one uncertainty grade containing three tiers. Grades will be assigned at the site-level and the evaluation team will incorporate them into the report by adding the count of sites by grade to the report's figures.

Low uncertainty

- n =21
- <5 % records with any validation issue
- <2% records in peak window with any validation issue

Moderate uncertainty

- n =8
- [5-10] % records with some validation issue (OR)
- [2-5] % of records in peak window with some validation issue

High uncertainty

- n =13
- >10% records with any validation issue
- >5% records in peak window with any validation issue

Note: Peak window will be defined as the ICAP Alternative 2 window - June 24 to August 31 (~100 days)