



# Sustainable Energy Advantage, LLC

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## Memorandum

To: Rhode Island Office of Energy Resources and Distributed Generation Board

From: Jim Kennerly, Sustainable Energy Advantage, LLC

Date: April 8, 2021

Re: **Revised Scope of Services and Budget Request for 2022 Renewable Energy Growth (REG) Program Support**

## Background & Summary of Budget Request

In November and December of 2020, the Rhode Island Office of Energy Resources (OER) requested that Sustainable Energy Advantage, LLC (SEA) develop a budget proposal surrounding its support and assistance to OER and the DG Board during the development of the 2022 REG program year (PY) Ceiling Prices and (if requested) the development and/or evaluation of Public Policy Adders. This memorandum (revised following our April 5, 2021 meeting with the PUC) is intended to detail the proposed scope of these services, as well as the various cost options for these services.

SEA requests funding of **\$205,854** for its “core scope” (for Tasks 0-7 below), plus an additional **\$49,898 in budgetary headroom** to cover certain activities (described in Task 8) that are contingent on decisions that may be made by National Grid and the Rhode Island General Assembly.<sup>1</sup> The request is shown in Table 1 below.

**Table 1: Task Budget Summaries (Including Solar+Storage Support Options)**

Task	Total Budget (Option A – With Solar+Storage Support)	Total Budget (Option B – With Solar+Storage Support)
Task 0: Contracted Ceiling Price Analysis <sup>2</sup>	\$65,000	\$65,000
Task 1: Incremental Ceiling Price Assistance <sup>3</sup>	\$54,703	\$54,703
Task 2: Carport Adder Support	\$38,975	\$38,975
Task 3: Low Income Adder or Program Evaluation/Development	\$0 <sup>4</sup>	\$0 <sup>5</sup>
Task 4: Solar+Storage Adder Investigation	\$14,835	\$0
Task 5: Stakeholder Engagement	\$13,954	\$9,304
Task 6: Incremental PUC Support	\$12,901	\$9,644
Task 7: Client Communication/Project Management	\$5,486	\$5,486
Task 8: Efforts Contingent Upon National Grid Decisions and/or Enactment of New Laws and Policies	\$49,898	\$49,898
<b>Total “Core Scope” (Tasks 0-7)</b>	<b>\$205,854</b>	<b>\$183,112</b>
<b>Total “Not-to-Exceed” (Including Task 8)</b>	<b>\$255,752</b>	<b>\$233,010</b>

<sup>1</sup> These requests may be as shown in the column for “Option B” if a decision is made not to pursue a Public Policy Adder for paired solar and energy storage projects.

<sup>2</sup> Represents current contracted SEA scope of services.

<sup>3</sup> Represents activities closely related to Ceiling Price development, but not immediately within contracted scope of services.

<sup>4</sup> Currently set at \$0 but may be revised based on PUC proposal regarding Low Income CRDG (see Task 3 description herein).

<sup>5</sup> Ibid.

We describe each of these tasks and itemize the effort by subtask in the remaining sections of this memorandum.

## Proposed 2022 Renewable Energy Growth Program Support Tasks and Budget Values

### Task 0: Ceiling Price Development

This task encompasses SEA’s annual Ceiling Price support.

**Table 2: Task 0 Budget Summary**

Tasks/Subtasks	Total
<b>Task 0 Total</b>	<b>\$65,000</b>

### Task 1: Incremental Ceiling Price Assistance (Under Existing Laws and Rules)

The purpose of these tasks is to provide support that goes beyond the typical changes to Ceiling Prices that occur from year to year, but that do not require changes to federal or state law or policy. We detail the proposed scope for this assistance below.

#### Task 1.1: Feasibility of Incorporating Single-Axis Tracking into 2023 PY Ceiling Prices

During 2020, several larger-scale distributed solar projects using single-axis tracking were selected in the Connecticut Shared Clean Energy Facilities (SCEF) program at substantially lower per kWh prices over 20 years than typical fixed-axis projects of similar sizes. Under this Task, SEA would investigate if single-axis tracking should be assumed for all or part of the population of Medium, Commercial or Large Solar projects for the 2023 program year, and whether doing so would balance ratepayer benefit with technical feasibility and market development. Activities under this task will include liaising with stakeholders to determine whether trackers can bear snow load, or whether projects utilizing trackers can be sited on disturbed parcels (or other parcels with atypical siting characteristics) or parcels with more unevenness or slope than what has been technically possible for single-axis tracker installations historically. In addition, SEA would examine the cost of land acquisition for such projects as well.

#### Task 1.2: Sensitivity Analysis of Residential Ceiling Prices by Tilt/Azimuth

Certain REG stakeholders have raised the possibility of changing the DC capacity factor-based formula for calculating the size of Small Solar projects, arguing that the current 14% value assumed by National Grid is insufficient for sizing a system to offset the state law-mandated threshold of 100% of a residential or small commercial customer’s on-site load. These stakeholders have proposed changing the 14% value to a value based on a matrix of tilts and azimuths. In response to this request, National Grid has proposed a potential approach to changing their assumed capacity factors for eligible Small Solar I projects.<sup>6</sup> Therefore, under this task, SEA has budgeted for the development of a formula for arriving at appropriate capacity factors for Small Solar I projects based on changes to National Grid’s formula.<sup>7</sup>

If such a range of potential capacity factors based on system siting characteristics is developed by National Grid, SEA requests funding and budget to collect input from National Grid, market participants and other stakeholders (and conduct quantitative analysis) necessary to determine an appropriate approach.

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<sup>6</sup> National Grid Rhode Island. *Solar Capacity Factor Research and Recommendation*. 30 March 2021. Presented to Rhode Island Distributed Generation (DG) Board. Available at:

<https://opengov.sos.ri.gov/Common/DownloadMeetingFiles?FilePath=\Minutes\6154\2021\391354.pdf>

<sup>7</sup> This task would not include variance in system shading since such factors are highly site-specific and change over time with vegetation growth and cut-back.

### Task 1.3: Potential Further Subdivision of Solar Classes/Targeting of Compensation to Enhance Ratepayer Savings

At the hearing regarding the 2021 PY filing in Docket 5088, PUC Chairman Gerwatowski thanked OER and the Board for its proposal to subdivide the Commercial Solar class into 251-750 kW and 751-999 kW size ranges to reduce the cost of the program to ratepayers<sup>8</sup> and asked if it was possible to propose further subdivisions to enhance the cost-effectiveness of the program. The PUC also signaled its interest in this potential approach for the 2022 PY when issuing its rulings in Docket 5088. Under this task, SEA would develop a proposal for further subdivision of the REG Solar classes, and vet the proposal with OER, National Grid, the DPUC and market participants.

**Table 3: Task 1 Budget Summary**

<b>Tasks/Subtasks</b>	<b>Total</b>
Task 1.1: Feasibility of Incorporating Single-Axis Tracking into 2023 PY Ceiling Prices	\$18,547
Task 1.2: Sensitivity Analysis of Residential Ceiling Prices by Tilt/Azimuth	\$14,574
Task 1.3: Subdivision/Adjustment of Proxy (Modeled) Sizes for REG Solar Classes	\$21,582
<b>Task 1 Totals</b>	<b>\$54,703</b>

### Task 2: Carport Adder Support

On February 18, 2021, the PUC accepted OER and the Board’s recommendation to continue the Carport Solar pilot for one additional year to collect sufficient data to determine whether to propose the program on a longer-term basis. To determine whether doing so is likely to be cost-effective under the Docket 4600 Benefit-Cost Framework, SEA and Mondre Energy propose to update their 2020 PY Carport Adder program evaluation to capture data from new projects to provide OER and the Board with the information necessary to determine the shape of future compensation for Carport Solar projects beyond the 2021 PY. In addition, SEA would support the calculation of a proposed adder value, which would serve as the “cost” portion of the benefit-cost analysis SEA will independently undertake, and as the range of values within which National Grid can reasonably select a 2022 PY adder value (if it chooses to do so).<sup>9</sup>

#### Task 2.1 – Combined 2020 & 2021 PY Evaluation (If Approved by PUC)

Under this task, SEA and Mondre would:

- Develop a survey to determine what unanswered questions remain after the 2020 evaluation to include in a follow up survey to developers and municipalities. SEA also would identify any developers new to the program to collect data from;
- Conduct further research utilizing the survey developed in the above subtask. Surveying would likely be done by interviews (vs. filling out online questionnaires);
- Estimate the costs and benefits of the 2021 selected Carport projects utilizing the PUC’s Docket 4600 Benefit-Cost Framework. SEA would also use this opportunity to ensure that its analysis draws upon the most up-to-date sources regarding the societal benefits of Carport development, as well as collecting more information about benefits calculated in the 2020 review; and
- Draft a 4-5 page memorandum to attach to direct testimony summarizing our findings.

#### Task 2.2: Carport Incremental Cost Analysis/Adder Value Development

Under this task, SEA would collaborate with National Grid to collect data on the reported incremental upfront capital costs of developing a Carport Solar project from 2021 Program Year selected projects, as well as develop survey questions and collect data from the industry regarding incremental changes in Carport operating costs. SEA also would

<sup>8</sup> Ultimately, the cost of the program to ratepayers will be a function of both accepted bid prices (capped by category-specific ceiling prices) and MW allocation.

<sup>9</sup> As such, the calculation of this adder value is considered Core Scope within this proposal, rather than an activity conditional on National Grid’s decision regarding a 2022 PY Carport Adder.

consider incorporating additional data on capital costs if OER is interested in having sources to supplement the procured values. SEA would utilize the capital and operating costs calculated in the prior subtask to calculate a proposed Carport Adder value.

**Table 4: Task 2 Budget Summary**

Tasks/Subtasks	Total
Task 2.1: Combined 2020 & 2021 PY Evaluation	\$33,602
Task 2.2: Carport Incremental Cost Analysis/Adder Value Development	\$5,373
<b>Task 2 Total</b>	<b>\$38,975</b>

**Task 3: Low Income CRDG Program Development Support**

On February 18, 2021, the PUC rejected National Grid’s proposed Low Income CRDG Public Policy Adder pilot program for the 2021 PY in Docket 5088. As a result, SEA does not currently propose a budget for support relating to the evaluation and/or development of a Low Income CRDG adder or another program. However, in rejecting the adder, the Commission noted its interest in developing an alternative proposal to enhance the benefits of solar PV for low- and moderate-income (LMI) customers of National Grid for the consideration of the parties to Docket 5088. Since these parties include OER and the DG Board, OER has directed SEA to include a placeholder for potential support to OER, the Board and National Grid related to developing such an alternative program design.

**Task 4: Paired Solar and Storage (Solar+Storage) Adder Development Support**

At the outset of the budgeting process for SEA’s 2022 PY support activities, OER requested that SEA determine what activities (and what resources) would be required to develop a potential Public Policy Adder for the 2022 PY.

After further discussion with SEA (regarding resources needed for a full analysis) and with National Grid, OER and the Board have determined that the questions involved in developing such an adder were substantial enough to approach the question in two phases. In the first phase, SEA would collaborate with OER and National Grid to undertake threshold research and quantitative analysis during the 2022 PY to determine whether a Solar+Storage adder (which would compensate the solar component of a paired solar and storage project eligible for the REG program) has a credible chance of being considered cost-effective under the Docket 4600 Benefit-Cost Framework. Subsequently, if OER, National Grid and the Board determine that such a credible chance of cost-effectiveness exists (and the PUC agrees), OER will move to a second analysis phase, in which it would request the resources needed to engage in a more in-depth analysis of paired solar and storage resource economics needed to formally develop a potential Public Policy Adder during the 2023 PY.

**Task 4.1 – Data Collection/Market Participant Surveys Regarding Paired Solar+Storage Cost and Performance Data**

Under this task, SEA would assist OER and National Grid in making an initial determination regarding whether a Paired Solar+Storage Public Policy Adder would have sufficient “identifiable benefits to customers” to support a full analysis ahead of the 2023 PY. SEA would provide this support by engaging with stakeholders identified by OER, undertaking an analysis of the most promising residential and commercial use cases (maximum one per category) utilizing the CREST model, and writing a memorandum summarizing our findings for the Board’s (and PUC’s) consumption. Under Option A (where SEA would offer paired solar and storage-related support), this task would proceed as described in Table 5 below. Under Option B, in which SEA would not offer such support, the budget for this task would be \$0.

**Table 5: Task 4 Budget Summary**

Tasks/Subtasks	Total Cost

Task 4.1: Solar+Storage Feasibility Analysis (to Support Decision to Proceed During 2023 PY)	\$14,835
<b>Task 4 Total</b>	<b>\$14,835</b>

## Task 5: Supplemental Stakeholder Engagement Regarding 2022 Program Development

Under this task, SEA would conduct further stakeholder engagement in conjunction with National Grid.<sup>10</sup>

### Task 5.1: 2022 Program Development Meeting #1

SEA and National Grid would utilize one meeting to gather feedback regarding potential Solar+Storage use cases for SEA’s Task 4 analysis.

### Task 5.2: 2022 Program Development Meeting #2

SEA and National Grid would utilize one meeting to gather feedback regarding the design of a potential 2022 PY (and/or thereafter) Carport Solar incentive, as well as on the methodology for calculating its value.

### Task 5.3: 2022 Program Development Meeting #3

SEA and National Grid would utilize one meeting to follow up with stakeholders regarding a potential Carport Solar 2022 PY proposal and the Solar+Storage recommendation OER might make to the DG Board and/or PUC.

Under Option A (in which SEA would provide support related to paired solar and storage projects), the budget for three meetings would be retained to receive stakeholder feedback on the storage-related investigations (as shown in Table 6 below). Under Option B (in which SEA does not provide such support), this meeting would be removed (as shown in Table 7 below). However, SEA may propose to retain the budget needed to hold a third meeting at a later date, pending any proposals for SEA’s support related to a Low Income CRDG program.

**Table 6: Task 5 Budget Summary (Option A – With Solar+Storage Support, or if broader SEA Stakeholder Engagement Support Requested by PUC)**

Tasks/Subtasks	Total
Task 5.1: 2022 Program Development Meeting #1	\$4,652
Task 5.2: 2022 Program Development Meeting #2	\$4,652
Task 5.3: 2022 Program Development Meeting #3	\$4,652
<b>Task 5 Total</b>	<b>\$13,956</b>

**Table 7: Task 5 Budget Summary (Option B – No Solar+Storage Support)**

Tasks/Subtasks	Total
Task 5.1: 2022 Program Development Meeting #1	\$4,652
Task 5.2: 2022 Program Development Meeting #2	\$4,652
<b>Task 5 Total</b>	<b>\$9,304</b>

<sup>10</sup> OER and the Board will likely recommend additional stakeholder sessions regarding an LMI program if the PUC recommends consideration of a program that would “go live” during the 2022 PY.

## Task 6: Additional PUC Engagement

Under this task, SEA would develop additional testimony and supporting documents to support requests that fall outside the Task 0 (Ceiling Price) scope. Under Option A (in which SEA would provide support related to paired solar and storage projects), the budget for SEA’s support related to presenting the recommendation to proceed on developing an energy storage adder for the 2023 program year would be as shown in Table 8 below. Under Option B (where SEA would not provide such support), the budget for this task would be as proposed in Table 9 below.

**Table 8: Task 6 Budget Summary (Option A – With Solar+Storage Support)**

Tasks/Subtasks	Total
Task 6.1: Additional Carport Adder Pilot Evaluation Testimony/Data Requests	\$3,110
Task 6.2: Incremental Solar+Storage Related Testimony/Data Requests	\$3,257
Task 6.3: Incremental Ceiling Price Support (Task 1)-Related Testimony/Data Requests	\$6,534
<b>Task 6 Total</b>	<b>\$12,901</b>

**Table 9: Task 6 Budget Summary (Option B – No Solar+Storage Support)**

Tasks/Subtasks	Total
Task 6.1: Additional Carport Adder Pilot Evaluation Testimony/Data Requests	\$3,110
Task 6.2: Incremental Ceiling Price Support (Task 1)-Related Testimony/Data Requests	\$6,534
<b>Task 6 Total</b>	<b>\$9,644</b>

## Task 7: Project Management/Client Communication

Under this task, SEA will propose a regular schedule of check-in calls with OER, and a small amount of time needed to manage the expanded scope from an administrative perspective.

**Table 10: Task 8 Budget Summary**

Tasks/Subtasks	Total
<b>Task 7 Total</b>	<b>\$5,486</b>

## Task 8: Efforts Contingent Upon Enactment of New Laws/Adoption of New Policies

OER and the Board have determined that there are several activities that fall outside of SEA’s proposed 2022 PY program development “core scope” (contained in Tasks 0-7), but nonetheless have a material chance of being necessary to undertake. Specifically, these activities are contingent upon decisions made by National Grid, the federal government and/or the Rhode Island General Assembly. We describe these activities below.

### Task 8.1: New Public Policy Adder Development (If Passed by General Assembly)

Under this task, SEA would engage in the data collection, market participant surveys, quantitative analysis, and additional engagement with the PUC necessary to support any Public Policy Adders that might be enacted by the General Assembly during its 2021 session. The types of adders most likely to be enacted into law appear to be those that would incentivize siting projects on disturbed parcels of land.

### Task 8.2: Changes to Federal Policy Affecting REG-Eligible Projects

Given the end-of-year timing of most legislation affecting the federal tax code, SEA often is in the position of needing to re-propose the Ceiling Prices following a change in federal law or policy. Both SEA and OER have determined that there are increased odds that the current Congress and Administration could pursue significant changes to both the level and

structure of federal tax credits after the time by which the 2022 PY filings are due. Under this task, SEA will carry out the re-analysis and re-proposal of 2022 Ceiling Prices if and only if changes are made to federal policy at a time that falls after the DG Board approves the final recommended prices.

**Task 8.3: Incremental 2022 PY Public Policy Adder Development Testimony/Data Requests**

Under this task, SEA would support its findings before the PUC related to a 2022 PY Carport Solar adder, but only if recommended by National Grid.

**Table 11: Task 8 Budget Summary**

<b>Tasks/Subtasks</b>	<b>Total</b>
Task 8.1: Development of Public Policy Adders (If Required by New State Laws/Policies)	\$31,133
Task 8.2: Changes to Federal Policy Affecting REG-Eligible Projects (Contingent on Adoption Following Recommendation of 2022 PY Prices/Adders)	\$14,224
Task 8.3: Incremental 2022 PY Public Policy Adder Development Testimony/Data Requests (Dependent Upon National Grid Development of 2022 PY Public Policy Adders)	\$4,541
<b>Task 8 Total</b>	<b>\$49,898</b>

# Summary of 2022 PY Budget Options

*Comparison of Proposed Budgets With and Without  
Energy Storage Support Included*



# 2021 PY v. 2022 PY Budget Comparison

Task	Equivalent 2021 PY Task (& Approved Budget)	2022 PY Requested Budget (Option A – With Energy Storage Support)	2022 PY Requested Budget (Option B– No Energy Storage Support)
Task 0: Contracted Ceiling Price Analysis <sup>1</sup>	\$65,000	\$65,000	\$65,000
<b>Task 1: Incremental Ceiling Price Assistance</b>	N/A	\$54,703	\$54,703
Task 2: Carport Solar Adder Evaluation/Development	\$89,392	\$38,975	\$38,975
<b>Task 3: Low Income Adder or Program Evaluation/Development</b>	\$55,630 <sup>2</sup>	\$0 <sup>3</sup>	\$0 <sup>3</sup>
<b>Task 4: Energy Storage Adder Investigation</b>		\$14,835	<b>\$0</b>
<u>Task 5: Stakeholder Engagement</u>	\$11,806	\$13,954	<b>\$9,304</b>
Task 6: Incremental PUC Support	\$14,140	\$12,901	<b>\$9,644</b>
Task 7: Client Communication/Project Management	\$5,385	\$5,486	\$5,486
<b>Task 8: Efforts Contingent Upon National Grid Decisions and/or Enactment of New Laws and Policies</b>	N/A	\$49,898	\$49,898
<b>Total Core Scope</b>		<b>\$205,854</b>	<b>\$183,112</b>
<b>Total With Efforts Contingent on National Grid Decisions and/or New Laws and Policies</b>	<b>\$241,353</b>	<b>\$255,752</b>	<b>\$233,010</b>

<sup>1</sup>Represents annual contracted value for SEA Ceiling Price scope of services

<sup>2</sup>Represents sum of budget for of 2021 PY adder development tasks (2021 PY Tasks 2 and 3)

<sup>3</sup>Currently set to \$0, but may be revised based on PUC proposal regarding Low Income CRDG

**KEY: Bold Red Text Indicates Brand New OER-Requested Task for 2022 PY, Bold Green Text Indicates Difference in Option B (No Storage) Budget Request, Underline text indicates tasks with material OER-requested increases in efforts relative to 2021 PY (for Option A – With Energy Storage Support)**

# Appendix: Revised Task/Subtask Budgets for Option B - No Energy Storage Support

# Task 4 Budget Estimate (Option B – No Energy Storage Support)

Tasks/Subtasks	Total Cost
<del>Task 4.1: Initial Analysis to Support Decision to Proceed in 2023 PY</del>	<del>\$14,835</del>
<b>Task 4 Total</b>	<b>\$0</b>

# Task 5 Budget Estimate (Option B – No Energy Storage Support)

<b>Tasks/Subtasks</b>	<b>Total</b>
Task 5.1: 2022 Program Development Meeting #1	\$4,652
Task 5.2: 2022 Program Development Meeting #2	\$4,652
<del>Task 5.3: 2022 Program Development Meeting #3</del>	<del>\$4,652</del>
<b>Task 5 Total</b>	<b>\$9,304</b>

# Task 6 Budget Estimate

Tasks/Subtasks	Total
Task 6.1: Additional Carport Adder Pilot Evaluation Testimony/Data Requests	\$3,110
<del>Task 6.2: Incremental Solar+Storage Related Testimony/Data Requests</del>	<del>\$3,257</del>
Task 6.2: Incremental Ceiling Price Support (Task 1)-Related Testimony/Data Requests	\$6,534
<b>Task 6 Total</b>	<b>\$9,644</b>



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## Contacts:

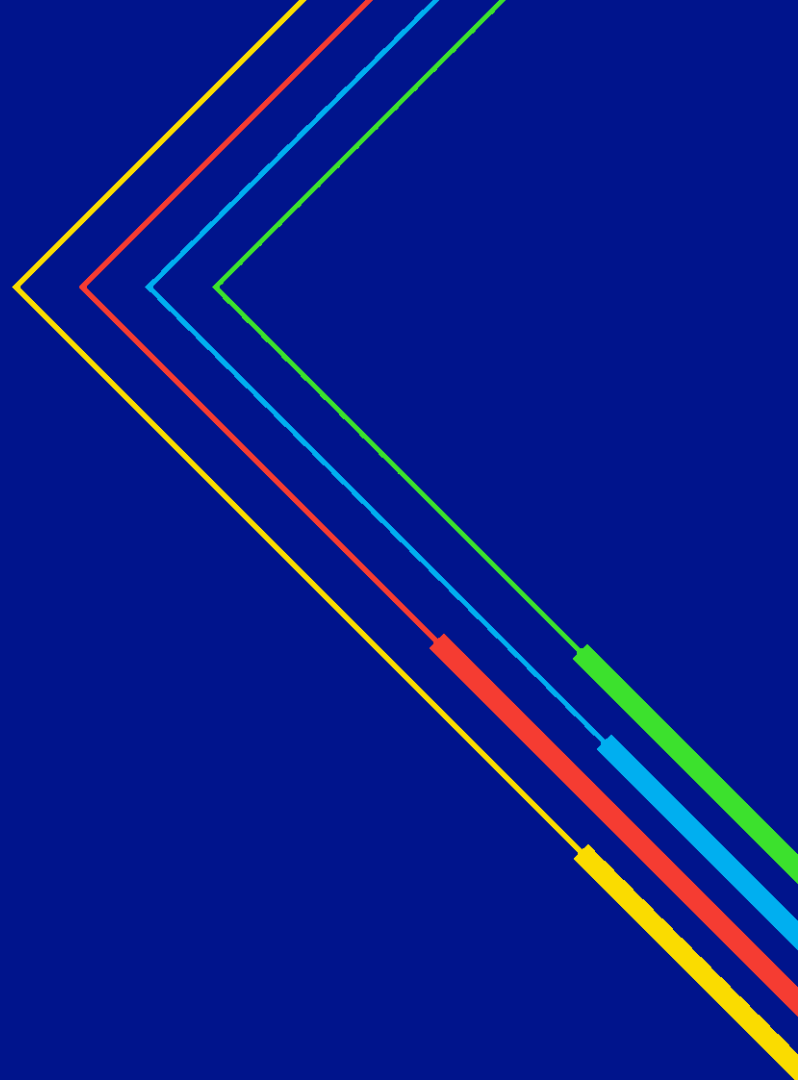
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# Solar Capacity Factor Research and Recommendation

Rhode Island DG Board Meeting  
March 30, 2021



# Why did we do this study?

Capacity factor is a percent number that the peak AC value of a electric generator is generating over the course of a year.

In RE Growth and Net Metering, DG resource size in RI is limited to produce the annual historic average usage of the customer.

Capacity factor is used to determine system size, and concern had been raised that the standardized use of 14% DC-to-AC does not allow some customers to size DG systems to their historic usage. The standard formula is:

*Usage (kWh) / Capacity Factor / 8760 = System Size (kW-dc)*



# Key Findings

- **The use of a calculator like PV Watts does provide more customized CF results, as expected.**
- **The average of the sample in PV Watts using project specific inputs resulted in an average CF essentially the same as 14%.**
- **Both the standard 14% and PV Watts, however, overestimate the production of systems compared to actual meter readings.**
- **National Grid is exploring the use of a table based on actual averages and PV Watts guidance to capture angle and azimuth variation of output, once implemented.**

# Study Details

- **Compared PV Watts estimates with NG Estimated Generation and actual generation reads for 303 roof mounted RE Growth projects <25 kW**
- **PV Watts Inputs: Tilt, Azimuth, DC-AC Ratio, type = roof mounted**
- **NG Estimate pulled from GridForce, actuals from billing system**
- **95% confidence interval with a 5.4% +/- margin of error based on sample size**
  - **With an average capacity factor of 12.78%, this means we can be 95% sure that the actual number is between 12.09% and 13.47%.**

# Sample Angle and Azimuth of Arrays

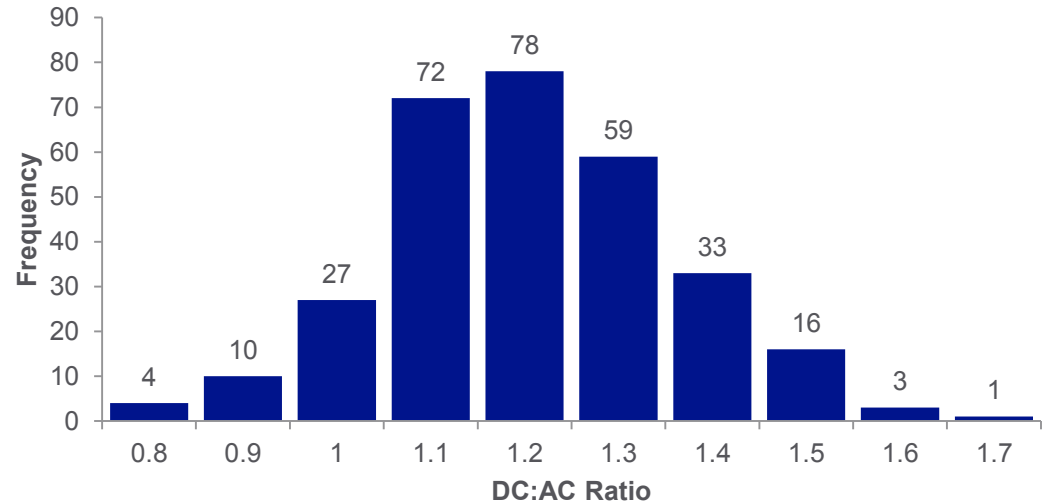
- **65% of systems fall between 120 and 239 degrees, southerly**
  - 25% of sample systems at 180°
- **Optimal tilt is ~41.45 +/-15 depending on the season**
- **72% of sample systems fall in the ideal range for RI**
- **Table: Darker green = higher count of systems meeting these conditions**

Count of Input Ranges Azimuth	Tilt				
	0-9'	10-19'	20-29'	30-39'	40-50'
0-39			1		1
40-79			1	3	1
80-119	2	3	26	4	6
120-159		6	13	12	3
160-199	2	17	59	34	13
200-239	1	7	15	9	6
240-279		10	20	17	7
280-319			1	2	
320-360					1

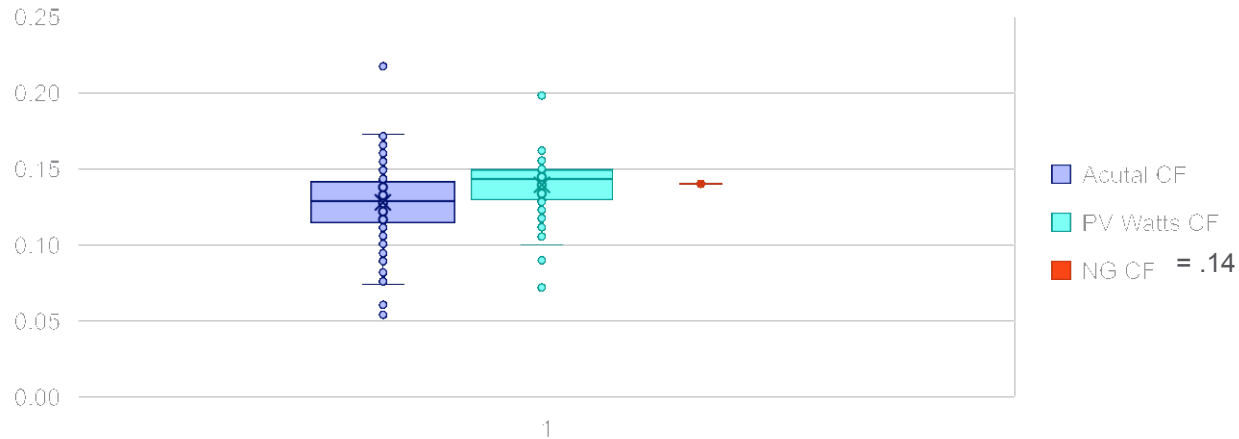
# DC:AC Ratio

- **49% of projects have DC:AC ratios between 1.1 and 1.2**
- **13% systems with a ratio less than 1**
- **7% systems with a ratio greater than 1.5**
- **Higher ratio systems can produce more kWh per \$ of installed cost, but have lower capacity factors**

## DC:AC Ratio of Systems



## Comparing Capacity Factors

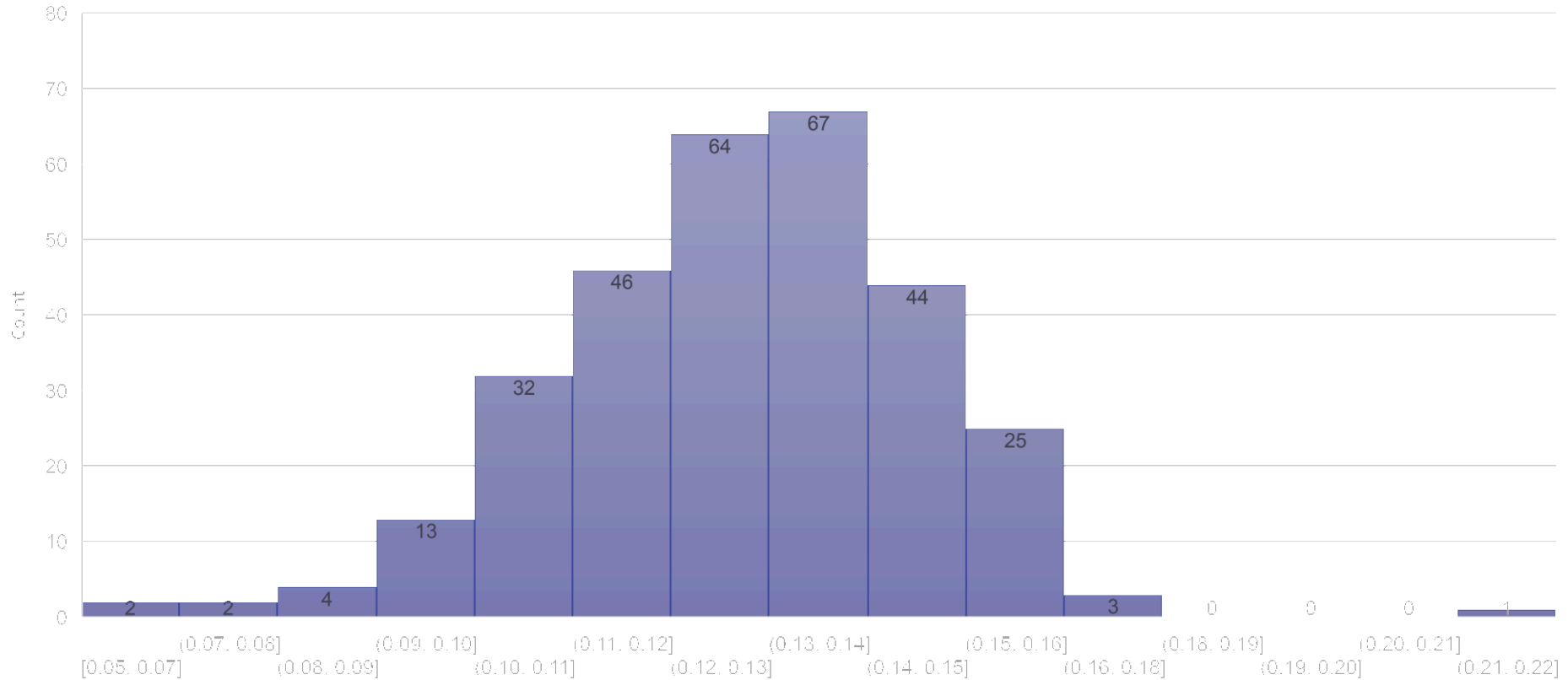


Actual CF	
Mean	.1278
Median	.1287
Min	.0541
Max	.2172

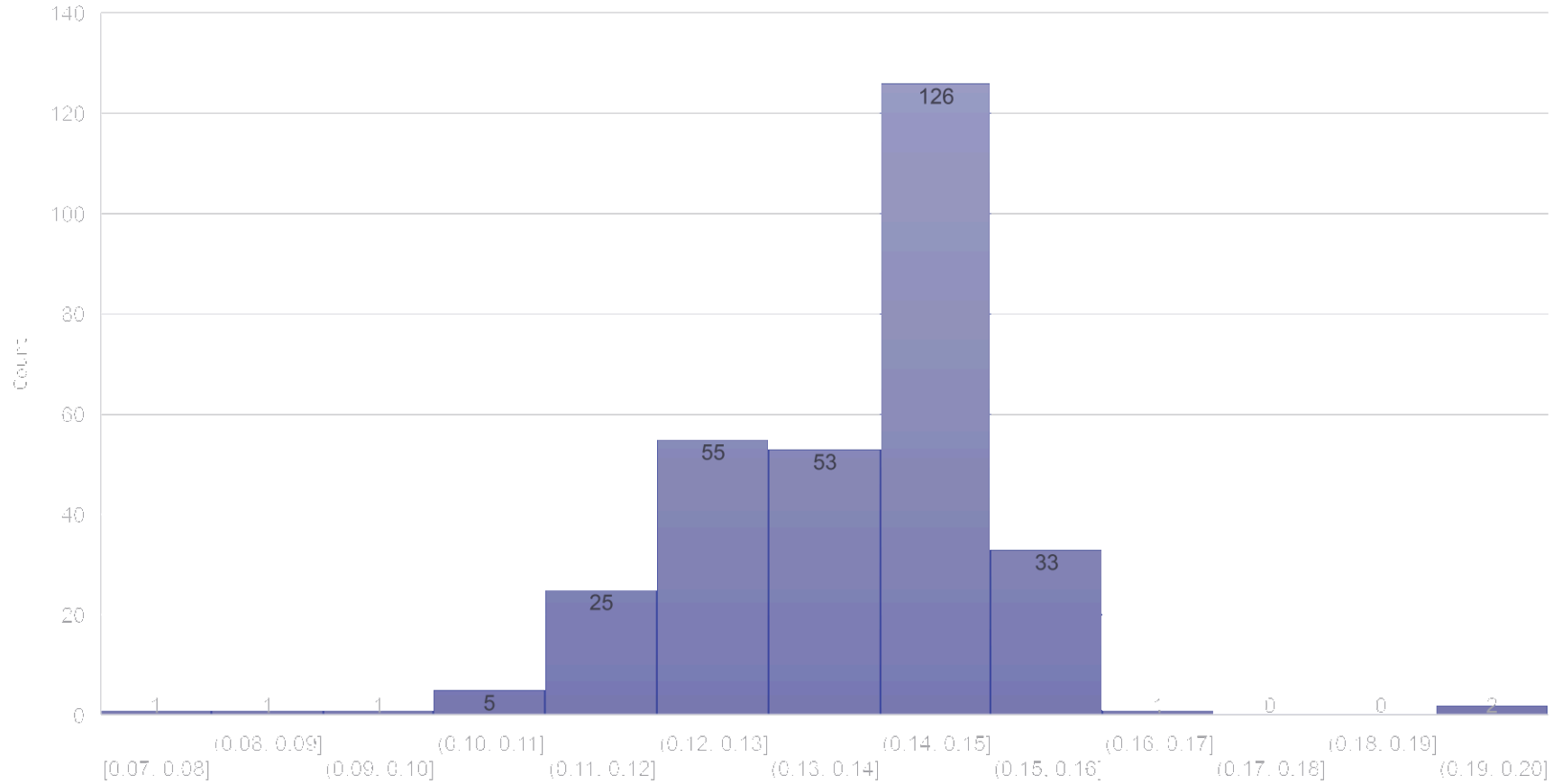
PV Watts CF	
Mean	.1394
Median	.1432
Min	.0718
Max	.1987

- **NG Estimate and PV Watts both appear to be overestimates**
- **Actual CF mean is 8.7% lower than 14%**
- **Actual CFs are more diverse and skewed downward, vs tighter and skewed upward with PV Watts**

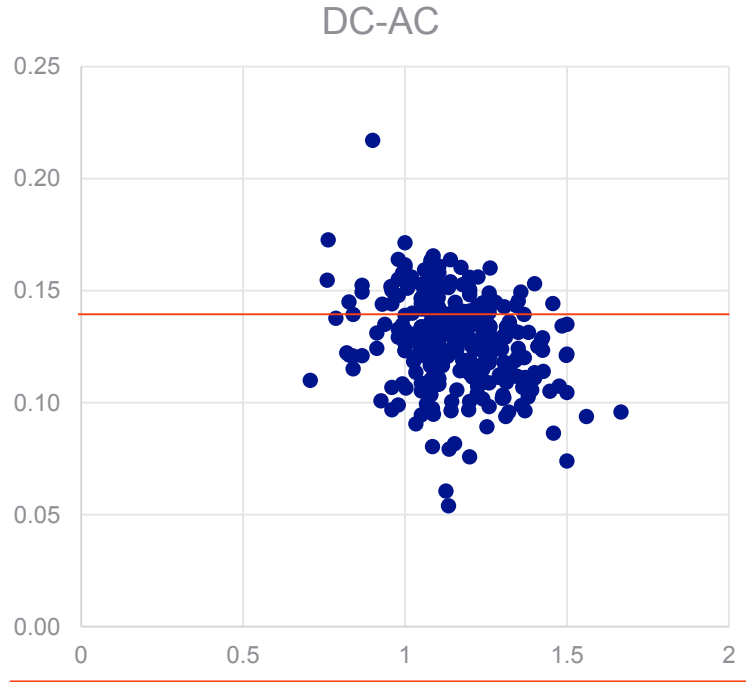
# Actual Generation Capacity Factor Distribution



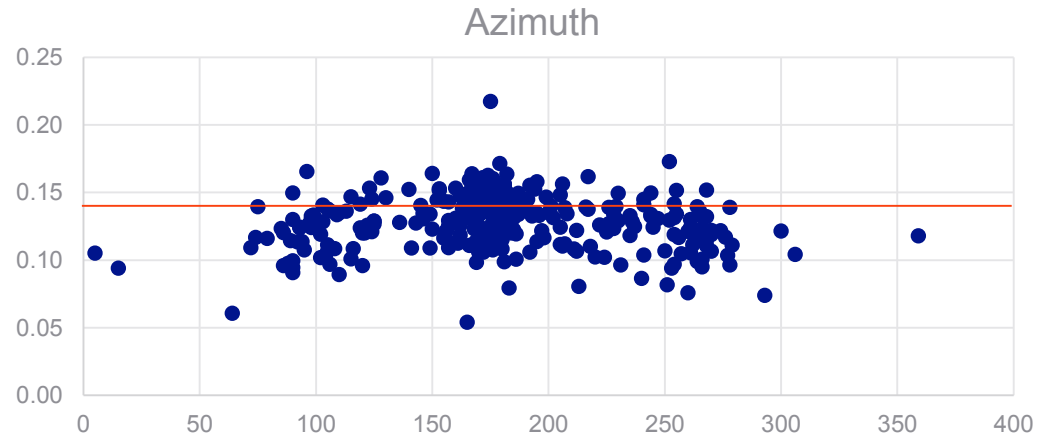
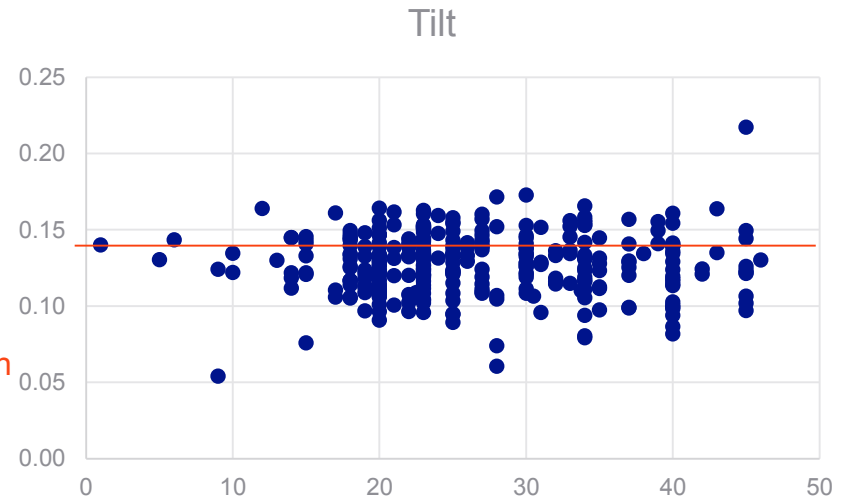
# PV Watts Capacity Factor Distribution



# How do inputs affect actual CF?



NG Estimate in orange





# Suggested Approach is a Table with CFs for Ranges of Angle and Azimuth

ACTUAL CFs Direction	Tilt		
	0-20	20-40	40-60
North	10.51%	9.37%	10.59%
East	12.76%	12.15%	11.50%
West	12.25%	12.15%	11.50%
SW & SE	12.54%	12.90%	13.21%
Due South	13.11%	13.57%	13.67%

PV WATTS Direction	Tilt		
	0-20	20-40	40-60
North	9.98%	8.37%	8.09%
East	12.80%	12.89%	12.60%
West	13.00%	12.83%	12.45%
SW & SE	14.15%	14.63%	14.38%
Due South	14.31%	15.14%	15.21%

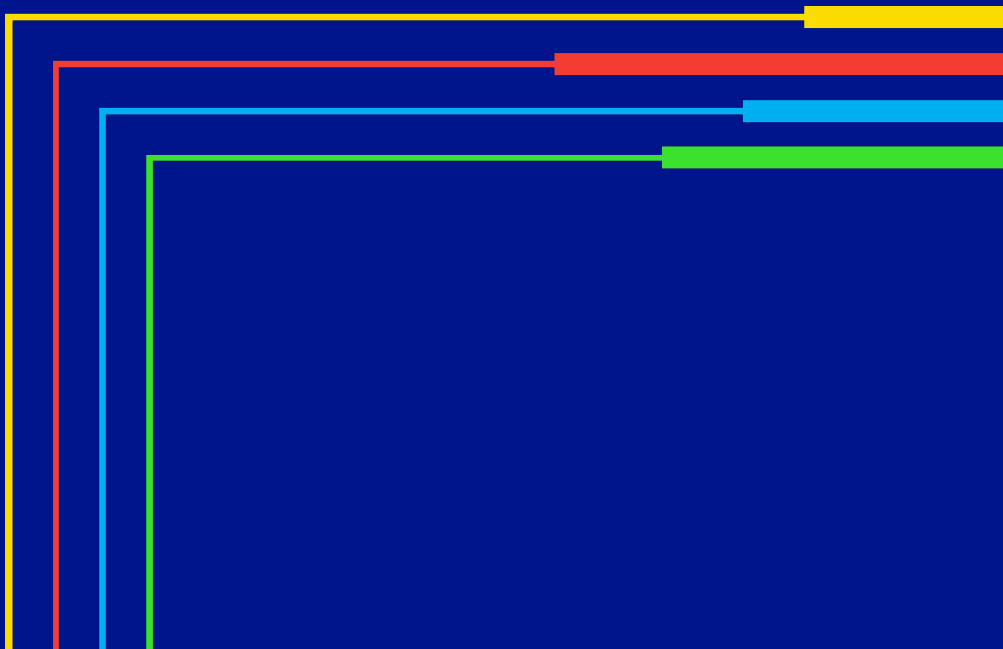
- **Actuals vary from PV Watts with modest variation**
- **Need to investigate higher CFs for northerly systems**
- **May suggest a minimum CF to account for shading, snow and other factors**

Difference	Tilt		
	0-20	20-40	40-60
North	-0.53%	-1.00%	-2.50%
East	0.04%	0.74%	1.10%
West	0.75%	0.68%	0.95%
SW & SE	1.61%	1.73%	1.17%
Due South	1.20%	1.57%	1.54%

# Takeaways and Next Steps

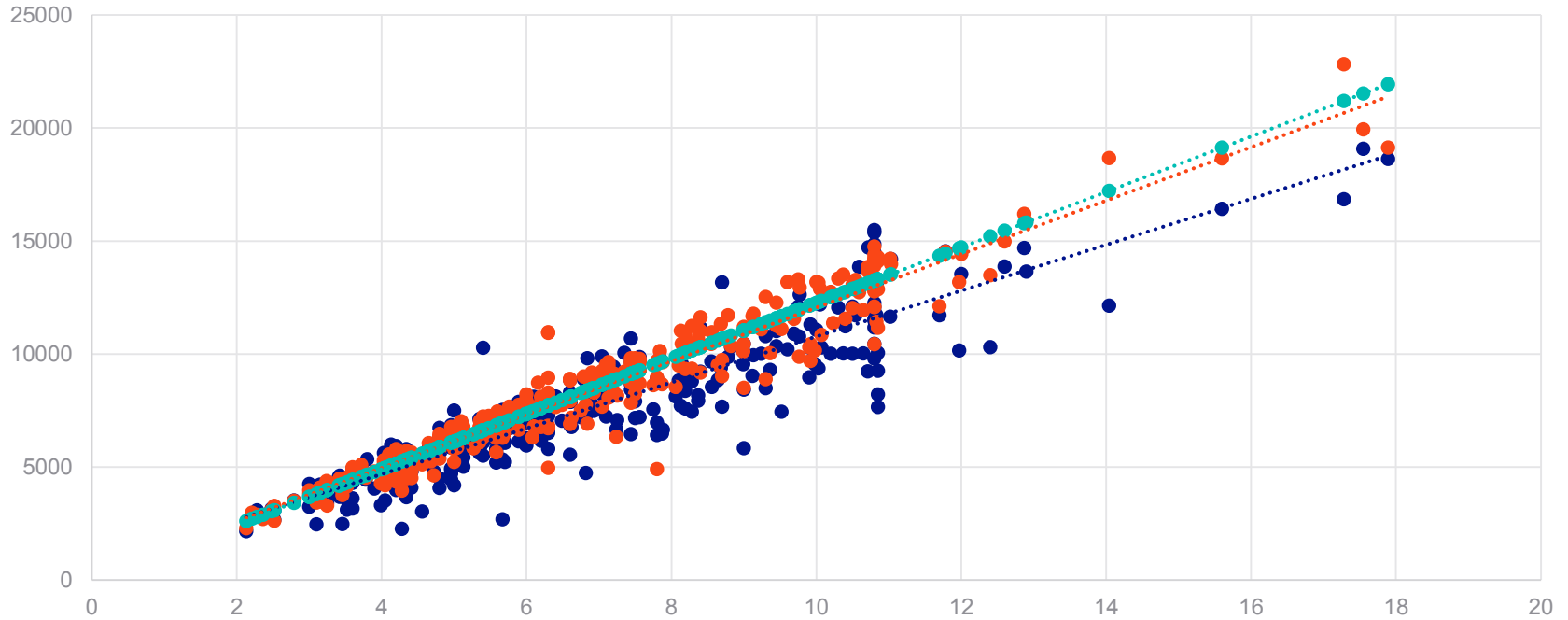
- **Other factors outside of angle and azimuth likely drive the downward measures of actual CFs vs PV Watts**
- **Use of lower CFs like in table above will generally allow for larger systems at customer locations**
- **Further analysis of outliers, use of a potential minimum CF, and adjustment of the bands/ranges will further refine this**
- **Use of an installer supplied CF, validated with the table, is another approach under consideration – CF is currently not collected**
- **NG is investigating the technical requirements to automate the use of CF based on angle and azimuth inputs in Grid Force**

# Appendix



# Annual Generation vs. DC Capacity (Revised NG)

- Actual Annual Gen 2019/2020
- PV Watts Estimated Generation
- Revised NG Estimate
- ⋯ Linear (Actual Annual Gen 2019/2020)
- ⋯ Linear (PV Watts Estimated Generation)
- ⋯ Linear (Revised NG Estimate)



# How do inputs affect actual CF for large systems? (systems > 10 kw)

