Sustainable Energy Advantage, LLC

RI Renewable Energy Growth Program:

Discussion of Carport Adder and Benefit-Cost Analysis

September 23, 2021

Sustainable Energy Advantage, LLC
Mondre Energy, Inc.

Carport Adder Analysis

Sustainable Energy Advantage, LLC

Context

PUC Decisions in Docket 5088 (2021)

- Approved one-year continuation of the Carport Solar adder pilot program (through 2021 PY) at an adder value of 5 ¢/kWh, subject to the following conditions:
  - That the distribution interconnection costs of selected projects during the 2021 PY be lower than a two-year rolling capacity-weighted average for that size category; and
  - That selected projects must produce documentation sufficient to verify final costs of the canopy structure and mounting system at the time of Certificate of Eligibility issuance;

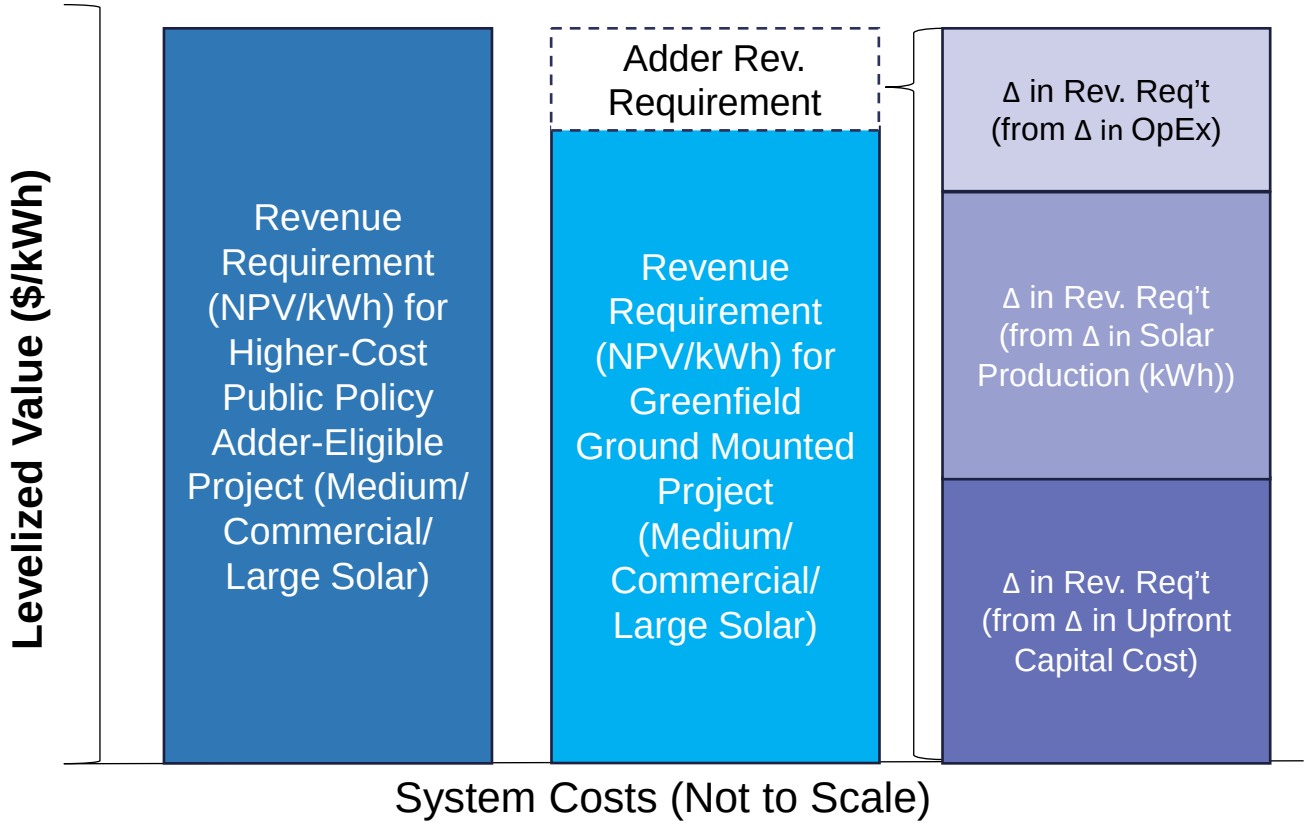
- Rejected expansion of Carport Solar adder pilot eligibility to Medium Solar projects

Carport Adder Scope for 2022 Program Year

- Scope: SEA and Mondre Energy were directed to update the 2020 PY Carport Adder program evaluation – including the Docket 4600-based Benefit-Cost Analysis (BCA).

- Objective: To capture new data (where available), provide an updated BCA analysis, and enable OER/ DG Board to make an informed decision on whether to support a permanent Carport Solar adder.

Methodology (1)
How SEA Calculates Proposed RI REG Public Policy Adders



- To set appropriate adder values, we compare the greenfield ground-mounted project to a project expected to create a certain degree of public policy value (e.g. rooftop, carport, LMI, etc.) of the same size
- Projects suspected to offer enhanced public policy value **tend to have incremental capital and operating costs relative to greenfield ground-mounted projects of the same size** (as well as reduced energy production)
- The adder revenue requirement is intended to represent **the net difference in capital costs, operating costs and production needed** to help preferred projects reach investor returns
- To establish these values, SEA undertook a survey of Rhode Island and regional market participants

Methodology (2)

- Case Matrix

Project Type	Size Category	Modeled Size (kW_{DC})	Case #1: Low Cost/ High Production	Case #2: Low Cost/ Low Production	Case #3: High Cost/ High Production	Case #4: High Cost/ Low Production
Carport, Commercial	251-999 kW	500	• **1st Quartile** Upfront Cost • Production @ **Highest End** of Carport Range **(14.6%)** • **Mean** OpEx % Increase	• **1st Quartile** Upfront Cost • Production @ **Lowest End** of Carport Range **(13.1%)** • **Mean** OpEx % Increase	• **3rd Quartile** Upfront Cost • Production @ **Highest End** of Carport Range **(14.6%)** • **Mean** OpEx % Increase	• **3rd Quartile** Upfront Cost • Production @ **Highest End** of Rooftop Range **(13.1%)** • **Mean** OpEx % Increase
Carport, Large	1-5 MW	4,500				

- SEA evaluated information gathered from:
  - National Grid (Open Enrollment data)
  - A survey of solar developers (cost data, permitting and IC information)

REG Carports Selected, & 2021 Cost Data

Enrollment Period	Facility	Location	kWdc	Actual or Target COD	Incremental Carport Cost/kWdc
2020-1	Project 1	[redacted]	[redacted]	4/23/2021 (Actual)	
2020-1	Project 2	[redacted]	[redacted]	8/2022 (Est.)	
2020-2	Project 3	[redacted]	[redacted]	4/2023 (Est.)	
2021-1	Project 4	[redacted]	[redacted]	7/2023 (Est.)	$744.81
2021-1	Project 5	[redacted]	[redacted]	7/2023 (Est.)	~~$1,597.65~~[1]

(1) Project excluded from carport adder analysis due to expected overstatement of “incremental” cost.

Carport Cost Input Assumptions

Commercial Category

Cost Case	Incremental Cost Input	Notes
Low	$1,011	Average of incremental cost from 2021 Open Enrollment bid and publicly available carport quote.
High	$1,277	Publicly available[1] carport quote for 500 kW system

Large Category

Cost Case	Incremental Cost Input	Notes
Low	$1,000	Average of incremental cost from 2021 Open Enrollment bid and publicly available carport quote.
High	$1,254	Publicly available[1] carport quote for 1,000 kW system

(1) https://www.solarelectricsupply.com/commercial-solar-systems/solar-carport

Carport Adder: Revenue Requirement Results

Required Adder Revenue, ¢/kWh

Size Category	Modeled Size (kW)	Low Cost/ High Production	Low Cost/ Low Production	High Cost/ High Production	High Cost/ Low Production
Commercial I	500	7.0	10.5	8.7	12.3
Commercial II	1,000	7.0	10.1	8.6	12.9
Large	5,000	7.5	10.1	9.0	11.8
Weighted Average		*7.4*	*10.1*	*8.9*	*11.9*
Required Adder, Rounded		**7.5**	**10.0**	**9.0**	**12.0**

Carport Adder: Willingness to Pay (WTP)

URI Study: Incorporating Resident Preferences into Policy Recommendations for Utility-Scale Solar Siting in Rhode Island

Table 6: Developing solar siting incentives justified by residents' preferences

			Aggregate WTP/kWh		
Policy Action	**Household WTP**	**Household WTP/kWh**	**Median households within 0.5 miles**	**Median households within 1 mile**	**Median households within 3 miles**
	(1)	(2)	(3)	(4)	(5)
Forest to Commercial	$68.36	$0.00029	$0.07	$0.27	$2.47
Forest to Brownfield	$63.95	$0.00027	$0.06	$0.26	$2.31
Farm to Commercial	$32.54	$0.00014	$0.03	$0.13	$1.18
Farm to Brownfield	$28.13	$0.00012	$0.03	$0.11	$1.02
Fully visible to partly visible	$6.47	$0.00003	$0.01	$0.03	$0.23
Fully visible to not visible	$8.43	$0.00004	$0.01	$0.03	$0.31

URI assumes a 2,000 kWac facility.

Aggregate WTP is a function of household WTP/kWh and # of households within a specified distance. Household WTP/kWh is a function of gross Household WTP and the monthly expected generation from a representative facility.

Benefit-Cost Analysis

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BCA Methodology: Costs

Docket 4600 "Level"	Docket 4600 Framework Category	Cost or Benefit?	Assessment Approach	Values Utilized	Units	Source
Power System	Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Cost	Quantitative	**Incremental upfront capital cost of Carport projects** (associated with Carport structure, and relative to greenfield projects)	$/kW$_{DC}$	Total project cost estimate supplied by developers to National Grid
Power System	Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Cost	Quantitative	**Incremental Carport O&M or other operating expenses** (relative to a greenfield project)	$/kW$_{DC}$-yr	Incremental research
Power System	Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Cost	Quantitative	**Incremental decrease in lifetime production associated with Carport projects** (relative to assumed production from all selected projects)	kWh/ MWh	Incremental research

BCA Methodology: Benefits

Docket 4600 "Level"	Docket 4600 Framework Category	Cost or Benefit?	Assessment Approach	Values Utilized	Input Units	Source
Power System	Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Benefit	Quantitative	**Avoided interconnection costs for Carports**, compared to all other REG projects selected in 2020 and the 1st enrollment of 2021	• IC costs on a $/kW$_{DC}$ basis	• 2020 National Grid IC cost databases • IC cost from 1st enrollment of 2021
Societal	Conservation and community benefits	Benefit	Quantitative	The **value of preserving forested acres/carbon sequestration**	• Metric Tons per Acre Disturbed	• Value of RI Forests, 2019 Report
Societal	Conservation and community benefits	Benefit	Quantitative	**Non-carbon value of open space/other "ecosystem services"**	Value of historical environmental/conservation easements (as separate from sink value)	SEIA
Societal	Conservation and community benefits	Benefit	Quantitative	**Social Cost of Carbon**	Avoided $/short ton	AESC 2021
Societal	Conservation and community benefits	Benefit	Quantitative	**Value of Ecosystem Services**	$/acre/year	Delaware Valley Regional Planning Commission
Societal	Conservation and community benefits	Benefit	Quantitative	**Avoided Property Value Loss**	$/affected property	University of Rhode Island Cooperative Extension, 2020

Benefits of Carports: Additional Explanation

- Land use benefits from avoiding development of a greenfield project
  - Carbon Sequestration: Use values from RI DEM Value of Forests Study
    - High and low benefit cases vary acreage of forests cleared
  - Ecosystem Services: Uses a study prepared for the Delaware Valley Regional Planning Commission (southeastern PA)
    - Low benefit assumes half the total value quantified in study
  - Avoided Property Value Loss: Based on recent research from URI estimating reduction in value of homes located near greenfield solar
    - Property Value Impacts of Commercial-Scale Solar Energy in MA and RI
    - Low benefit case assumes half of property value impact per home and half the number of homes impacted for Commercial Solar
    - For Commercial Solar, all values are weighted by percent of ground mount projects in past selections

Carport Research: Additional Findings

- Quantitative Findings:
  - “Steel prices have doubled since 2020.”
  - “Steel costs are up 30% since 2020.”
  - “Steel costs are about 13c/kWh.”
  - “Carport EPC costs are about $1.20 per watt.”
  - “The 5c/kWh REG adder is needed just to cover the steel costs for carport solar vs. rooftop.”
  - “Interconnection review took over a year and estimated cost was > $54K ceiling.”
  - “X has carport projects underway in Washington DC and in New Jersey because of higher incentive prices.”
  - “Current focus is on ConEd (20 to 22c/kwh for carport solar in year 1) and New Jersey (12 c/kWh to 15 c/kWh adder for 15 years).”
- Qualitative Findings:
  - “The developer bears interconnection costs, not the ratepayer. The ceiling interconnection cost threshold seemed arbitrary and discriminatory.”
  - “Everywhere is easier than Rhode Island except Washington D.C. Fire departments have full discretion to reject projects.”

NPV of Quantified Benefits

- Total net present value of quantified benefits, assuming a societal discount rate of 2.5%

	Commercial ($/kW)		Large ($/kW)	
	Low Benefits	High Benefits	Low Benefits	High Benefits
Interconnection Cost Savings	$107	$130	$107	$130
Carbon Sequestration	$17	$237	$46	$105
Ecosystem Services	$2	$3	$2	$3
Avoided Property Value Loss	$824	$3,295	$183	$366
Total (Weighted by Avoided Project Type)	**$949**	**$3,665**	**$338**	**$605**

Unquantified Benefits and Uncertainties

- Unquantified Benefits
  - Reduced utility operational expenses related to less complex and costly interconnections
  - Job-related benefits from increased labor-intensity of carports relative to greenfield
  - Avoided cost of snow clearing and other maintenance as a result of shelter from the elements
  - Improved community acceptance driven by lower or no adverse visual impacts and no clearing of trees
  - Branding and publicity value for commercial carport hosts
  - Willingness to pay to preserve open space
- Analysis Uncertainties
  - Very small data set of projects participating in Carport Adder Pilot
  - Assumptions of baseline: defining a hypothetical avoided ground-mount project
  - Non-market benefits that are difficult to quantify
    - Use proxy values from research in other geographies and contexts
    - Several non-quantifiable benefits excluded from BCA
  - Includes mix of societal level and system level costs and benefits

BCA Results

- 2.5% Societal Discount Rate, 7.5 cent Adder

Case	Project Category	NPV Total Benefits ($/kW)	NPV Total Costs ($/kW)	Benefit-Cost Ratio
Low Benefits, Low Costs	Commercial	$607	$1,253	0.48
	Large	$419	$1,285	0.29
High Benefits, Low Costs	**Commercial**	**$2,223**	**$1,253**	**1.77**
	Large	$684	$1,285	0.53
Low Benefits, High Costs	Commercial	$607	$1,396	0.43
	Large	$419	$1,432	0.26
High Benefits, High Costs	**Commercial**	**$2,223**	**$1,396**	**1.59**
	Large	$684	$1,432	0.48

BCA Results: Sensitivity Analysis

Case	Project Category	Benefit-Cost Ratio		
		9.0 ¢ Adder	10.0 ¢ Adder	12.0 ¢ Adder
Low Benefits, Low Costs	Commercial	0.40	0.36	0.30
	Large	0.24	0.22	0.18
High Benefits, Low Costs	**Commercial**	**1.48**	**1.33**	**1.11**
	Large	0.44	0.40	0.33
Low Benefits, High Costs	Commercial	0.36	0.33	0.27
	Large	0.22	0.20	0.16
High Benefits, High Costs	**Commercial**	**1.33**	**1.19**	0.99
	Large	0.40	0.36	0.30

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