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NEW JERSEY SOLAR TRANSITION

Successor Program Draft Capstone Report Modeling Review

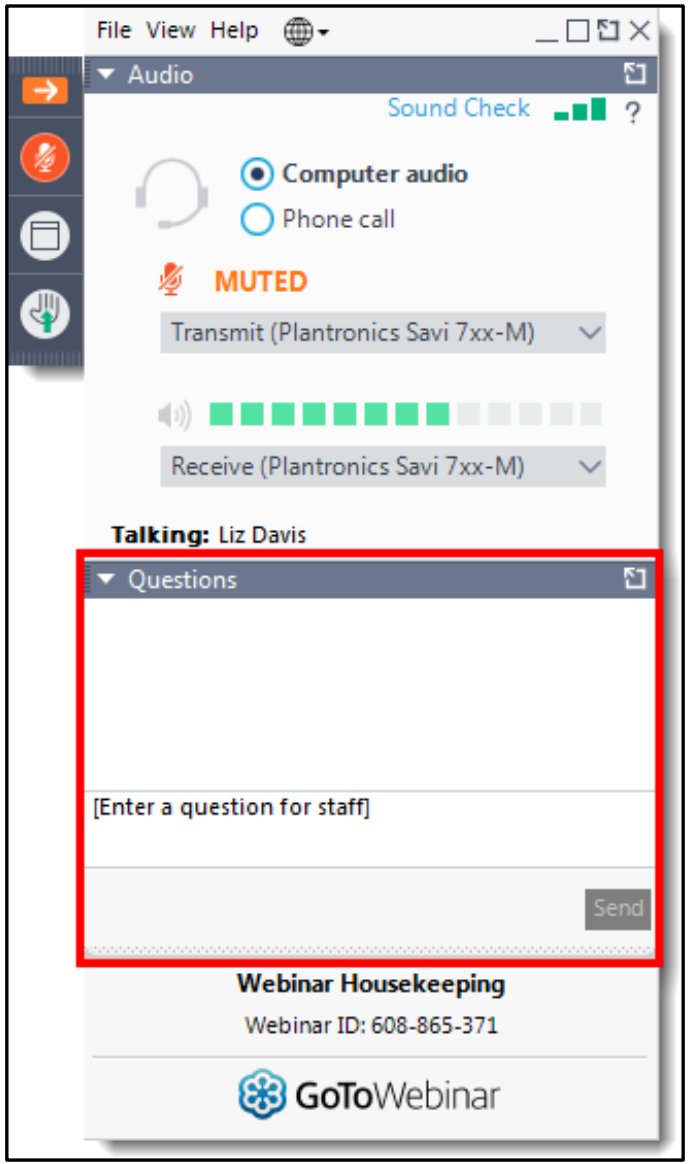
August 17, 2020

OPENING REMARKS

Webinar Logistics

Logistics:

- Please submit questions at any time during the meeting using the questions box on the right of your screen.
- The webinar is being recorded.



BPU New Jersey's cleanenergy program™

Agenda

- 2:00 p.m. Welcome, Introductions, and Stakeholder Meeting Logistics
- 2:10 p.m.

  Presentation by Cadmus of the Successor Program draft Capstone Report model and assumptions

  Discussion of the modeling and assumptions
- 5:00 p.m. Meeting Conclusion

Next Steps

- **Meeting #2: Thursday, August 20**
  - Time: 10:00 a.m. – 3:00 p.m.
  - Registration Link: https://attendee.gotowebinar.com/register/8326862550258162447.
- **Written Comments**
  - Due on or before 10:00 a.m. on Monday, August 31, 2020
  - Please see the Request for Comments for instructions on how to submit comments.

Disclaimer

This presentation is provided as background to the Draft Capstone Report dated August 10, 2020, and is delivered pursuant to Cadmus' obligations under a contract with the New Jersey Board of Public Utilities (BPU) in connection with the assessment of a successor solar program for the state. This document is provided "as is" based on information available as discussed below. The document is provided for information purposes only, and Cadmus and the BPU do not provide any representation or warranty, express or implied, as to the accuracy, completeness, reliability, or timeliness of any of the content or information contained herein, and Cadmus expressly disclaims all liability associated with the BPU's use of the report or information included therein. Any forecasts or projections contained herein are estimates only. This document does not provide a legal interpretation of any New Jersey statutes, regulations, or policies, nor should it be taken as an indication or direction of any future decisions by the BPU. In no event will Cadmus or the BPU be liable to you or anyone else for any decision made or action taken in reliance on the information in the report or for any special, consequential or similar damages, even if advised on the possibility of such damages.

Agenda

Modeling Overview

SAM Introduction

Derivation of SAM Cases

SAM Model Inputs

SAM Modeling Process

Market Model

Modeling Overview

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Modeling Overview

Two levels of Successor Program modeling

- **Project level**: NREL's System Advisor Model (SAM)
  - Multiple "cases" deployed to capture different financial models and installation types in the market
  - Range of inputs for costs, energy production, revenue streams, etc.
  - Solve for incentives that render each project economical
- **Market level**: Excel-based model
  - Forecasts capacity
  - Estimates aggregate energy production
  - Estimates costs
  - Tests cost cap

Project Model: SAM Introduction

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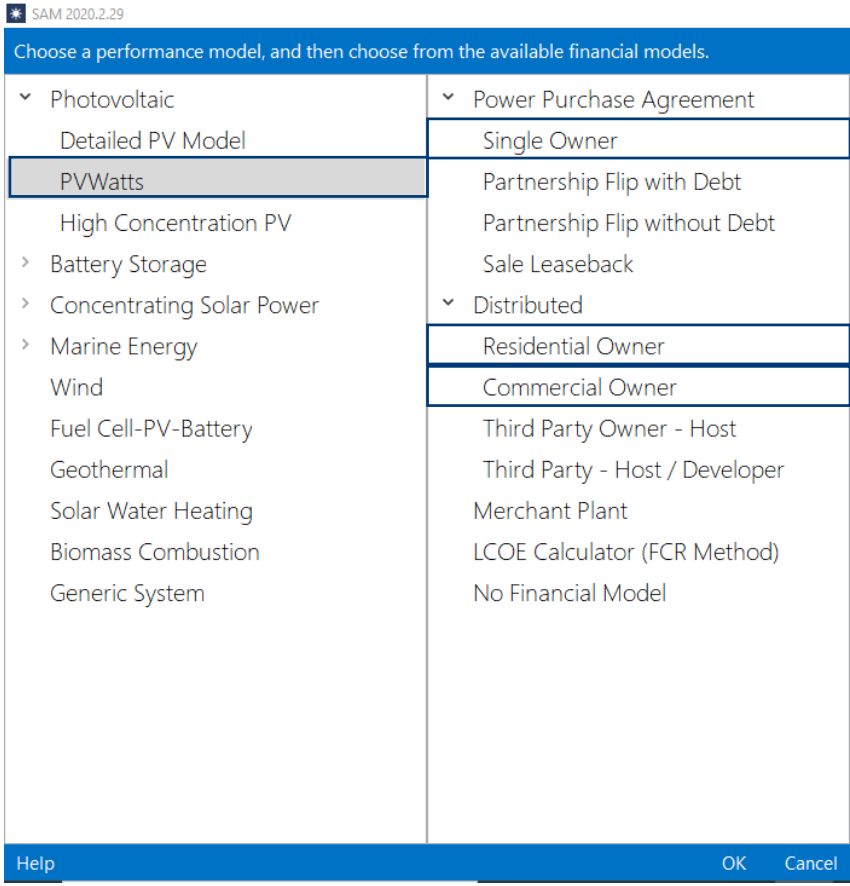
SAM Introduction

Overview

System Advisor Model (SAM)

- Open source, NREL software
- Multiple types of renewable energy technologies
- Flexibility of input granularity
- Combines PV design, weather, and cost inputs to model project performance and economics



SAM Introduction

Financial Models

- Three financial models used
  1. PPA (TPO projects)
  2. Commercial (DO projects)
  3. Residential (DO projects)

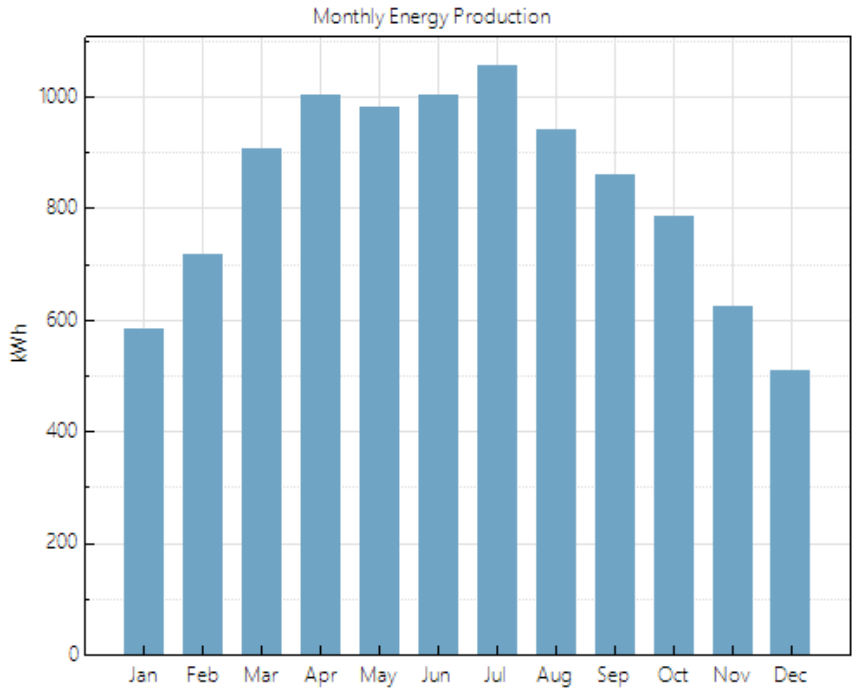
DO	TPO/PPA
PVWatts, Commercial	PVWatts, Single owner
Location and Resource	Location and Resource
System Design	System Design
Grid Limits	Grid Limits
Lifetime and Degradation	Lifetime and Degradation
System Costs	System Costs
Financial Parameters	Financial Parameters
Incentives	Revenue
Electricity Rates	Incentives
Electric Load	Depreciation

Note: Depreciation is included in the Direct Ownership type for commercial projects in the "Financial Parameters" tab, but depreciation is not included for direct ownership residential projects.

SAM Introduction

Outputs

- Energy Data
- Economic Metrics
- Customizable displays of data



TPO Example Summary Table

Metric	Value
Annual energy (year 1)	9,976 kWh
Capacity factor (year 1)	14.2%
Energy yield (year 1)	1,247 kWh/kW
PPA price (year 1)	15.04 ¢/kWh
PPA price escalation	2.50 %/year
Levelized PPA price (nominal)	18.89 ¢/kWh
Levelized PPA price (real)	18.89 ¢/kWh
Levelized COE (nominal)	16.11 ¢/kWh
Levelized COE (real)	16.11 ¢/kWh
Net present value	$3,271
Internal rate of return (IRR)	9.70 %
Year IRR is achieved	25

SAM Introduction

Additional Functions

- SAM Features more in-depth functions, for example
  - Parametrics
  - Scripting
  - Excel Exchange

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SAM Demonstration

Project Model: Derivation of SAM Cases

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SAM Case Derivation

SAM Cases overview

- SAM Financial Models are used to model various **SAM Cases**, each of which exhibits different cost or design profiles, e.g.,
  - Residential rooftop orientation is usually constrained by planes of roof
  - Ground mount has optimal orientation but some additional costs
  - Carport has additional costs for structural engineering and materials
  - Community Solar has additional costs for subscriber acquisition/churn, extra administration, etc.
  - Smaller projects tend to have higher costs on a $/W basis
- SAM Cases are meant to be representative but hypothetical
- Following slides review how we derived the current set of SAM Cases

SAM Case Derivation

Overview

- Analyze historical and pipeline equipment data
- Assess tiering for different installed costs
- Incorporate new SAM Cases

SAM Case Derivation

Review historical data

- NJCEP publishes equipment data for installed and pipeline projects
- Limited data to projects with Permission to Operate (PTO) dates in 2019-2020 + pipeline
- Performed several steps to clean and conform data
- Cadmus used several fields to create a first-cut list of SAM Cases:
  - **Customer Type** differentiates between residential (Resi) and commercial (Comm) customers
  - **Third Party Ownership** (TPO) vs direct ownership (DO)
  - **Grid/Behind the Meter** (BTM) shows Grid Supply vs. net metered projects
  - **Equipment Name** filtered to “Solar Panels” to use fields below
  - **Rating per Module * Module Quantity** provides record-level capacity
  - **Location of Equipment** identifies installation type (ground, roof, or carport)

SAM Case Derivation

Initial grouping

Major Category	Ownership	Installation Type	Preliminary SAM Case	Capacity (kW)	% Total	% Major Category
Commercial	Direct (Host)	Carport	Comm_DO_Carport	13,415	1.5%	3.1%
Commercial	Direct (Host)	Ground	Comm_DO_Ground	24,343	2.7%	5.6%
Commercial	Direct (Host)	Roof	Comm_DO_Roof	172,464	18.9%	39.5%
Commercial	Third Party	Carport	Comm_TPO_Carport	40,050	4.4%	9.2%
Commercial	Third Party	Ground	Comm_TPO_Ground	87,335	9.6%	20.0%
Commercial	Third Party	Roof	Comm_TPO_Roof	99,076	10.9%	22.7%
Grid	Third Party	Ground	Grid_Ground	191,306	21.0%	91.6%
Grid	Third Party	Roof	Grid_Roof	17,624	1.9%	8.4%
Residential	Direct (Host)	Ground	Resi_DO_Ground	5,077	0.6%	1.9%
Residential	Direct (Host)	Roof	Resi_DO_Roof	105,542	11.6%	39.5%
Residential	Third Party	Ground	Resi_TPO_Ground	2,259	0.2%	0.8%
Residential	Third Party	Roof	Resi_TPO_Roof	154,328	16.9%	57.8%
Total				**912,820**		
Aggregated Capacity (kW) by Major Category						
Commercial				436,683		
Grid				208,930		
Residential				267,207		
Total				**912,820**		

Excluded for low shares

Notes:

Based on analysis of March 2020 equipment lists for installed projects (PTO in 2019-2020) and pipeline projects.

SAM Case Derivation

Initial grouping

- Exclude several with low shares
- Recalculate shares

Preliminary SAM Case	Ownership	Installation Type	Capacity (kW)	% Total
Comm_DO_Ground	Direct (Host)	Ground	24,343	2.7%
Comm_DO_Roof	Direct (Host)	Roof	172,464	19.3%
Comm_TPO_Carport	Third Party	Carport	40,050	4.5%
Comm_TPO_Ground	Third Party	Ground	87,335	9.8%
Comm_TPO_Roof	Third Party	Roof	99,076	11.1%
Grid_Ground	Third Party	Ground	191,306	21.4%
Grid_Roof	Third Party	Roof	17,624	2.0%
Resi_DO_Roof	Direct (Host)	Roof	105,542	11.8%
Resi_TPO_Roof	Third Party	Roof	154,328	17.3%
Total			**892,068**	

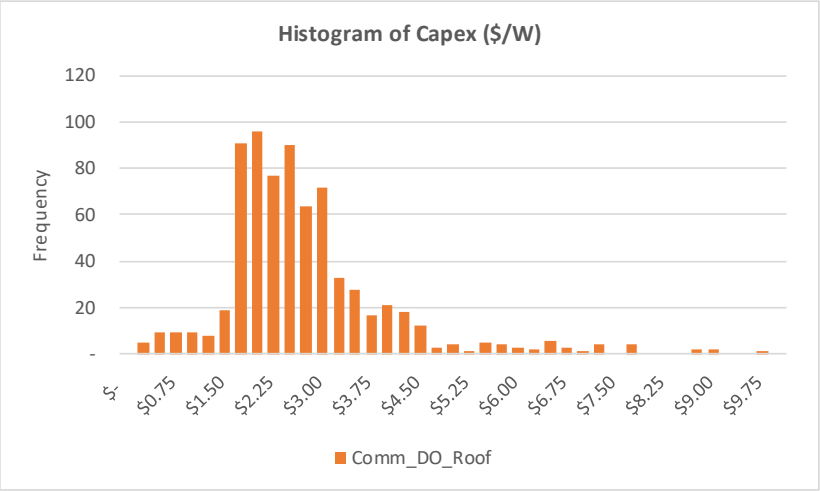
Notes:

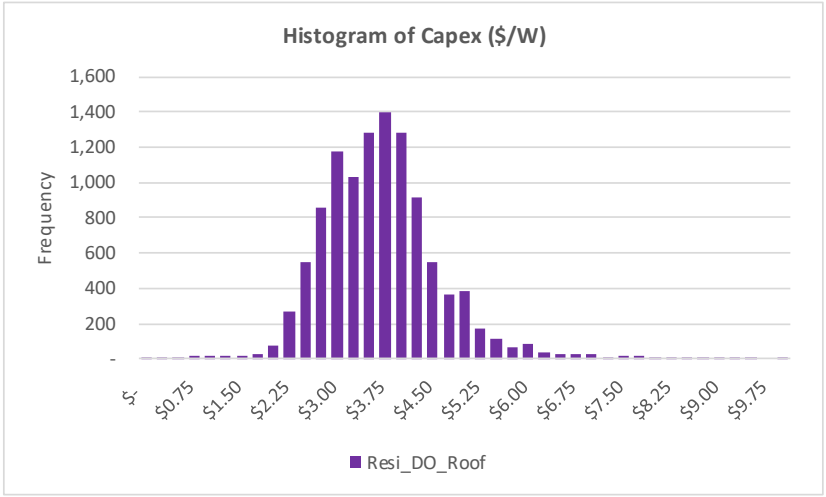
Based on analysis of March 2020 equipment lists for installed projects (PTO in 2019-2020) and pipeline projects.

SAM Case Derivation

Installed Cost Tiering

- Check if different capacity sizes exhibit materially different $/W
- Several steps to clean/conform data
  - Exclude “portfolios” of projects tied to a single cost
  - Exclude outliers, including evaluating histograms (examples below)
  - Assess cost “tiering” by capacity





Notes:
Based on analysis of March 2020 equipment lists for installed projects (PTO in 2019-2020) and pipeline.

SAM Case Derivation

Installed Cost Tiering

- Chose tiers in kind with CEP reporting capacity breakpoints

	Installed Cost ($/W)			
SAM Case [1]	Straight Average	Weighted Average	Median (50th Percentile)	Modeled Cost ($/W)
Comm_DO_Ground_lg	$ 1.89	$ 1.94	$ 1.88	$ 1.90
Comm_DO_Ground_med	$ 2.52	$ 2.37	$ 2.40	$ 2.40
Comm_DO_Roof_lg	$ 1.76	$ 1.70	$ 1.69	$ 1.70
Comm_DO_Roof_med	$ 2.13	$ 2.06	$ 1.98	$ 2.10
Comm_DO_Roof_sm	$ 2.67	$ 2.57	$ 2.59	$ 2.60
Comm_TPO_Carport	$ 2.69	$ 2.69	$ 2.65	$ 2.65
Comm_TPO_Ground_lg	$ 2.03	$ 1.83	$ 1.89	$ 1.85
Comm_TPO_Ground_med	$ 2.24	$ 2.35	$ 2.30	$ 2.30
Comm_TPO_Roof_lg	$ 1.75	$ 1.59	$ 1.75	$ 1.65
Comm_TPO_Roof_med	$ 2.09	$ 2.04	$ 2.22	$ 2.05
Comm_TPO_Roof_sm	$ 2.60	$ 2.48	$ 2.63	$ 2.55
Grid_Ground	$ 1.96	$ 1.88	$ 1.91	$ 1.90
Resi_DO_Roof	$ 3.56	$ 3.49	$ 3.52	$ 3.45
Resi_TPO_Roof	$ 3.48	$ 3.43	$ 3.51	$ 3.45

SAM Case Derivation

New SAM Cases

- Community Solar
  - Review conditionally approved projects from Program Year 1
  - Exclude small share
- Grid Supply roof
- Out of State (OOS)
  - PJM territory
  - Ground-mounted, Grid Supply
- Use “historical” SAM Cases as proxies for some inputs

Community Solar Projects

Installation Type		Total Capacity (kW)	% Total	Avg. Capacity (kW)
Ground	[1]	38,029	49%	3,457
Roof	[2]	36,756	47%	1,149
Carport	[2]	3,200	4%	1,067
Total		**77,985**		

Notes:

Source: BPU Order on the Community Solar Energy Pilot Program, December 20, 2019 (as amended February 25, 2020).

1. Comprised mostly (87%) of landfill projects.
2. One project indicated mixed rooftop and parking lot. Cadmus split capacity 50/50 between the two installation types.

SAM Case Derivation

Putting it all together

Final SAM Case	Major Category	Ownership	Installation Type	Capacity Tier if Applicable
SAM Cases Based on Historical Data				
Comm_DO_Ground_lg	Commercial	Direct (Host)	Ground	1 MW and greater
Comm_DO_Ground_med	Commercial	Direct (Host)	Ground	100 kW up to 1 MW
Comm_DO_Roof_lg	Commercial	Direct (Host)	Roof	1 MW and greater
Comm_DO_Roof_med	Commercial	Direct (Host)	Roof	100 kW up to 1 MW
Comm_DO_Roof_sm	Commercial	Direct (Host)	Roof	up to 100 kW
Comm_TPO_Carport	Commercial	Third Party	Carport	
Comm_TPO_Ground_lg	Commercial	Third Party	Ground	1 MW and greater
Comm_TPO_Ground_med	Commercial	Third Party	Ground	100 kW up to 1 MW
Comm_TPO_Roof_lg	Commercial	Third Party	Roof	1 MW and greater
Comm_TPO_Roof_med	Commercial	Third Party	Roof	100 kW up to 1 MW
Comm_TPO_Roof_sm	Commercial	Third Party	Roof	up to 100 kW
Grid_Ground	Grid	Third Party	Ground	
Resi_DO_Roof	Residential	Direct (Host)	Roof	
Resi_TPO_Roof	Residential	Third Party	Roof	
New SAM Cases				
Grid_Ground_OOS	Grid	Third Party	Ground	
Grid_Roof	Grid	Third Party	Roof	
CS_Ground	Community Solar	Third Party	Ground	
CS_Roof_lg	Community Solar	Third Party	Roof	1 MW and greater
CS_Roof_med	Community Solar	Third Party	Roof	100 kW up to 1 MW

Notes:

Based on analysis of (i) March 2020 equipment lists for installed projects (PTO in 2019-2020) and pipeline projects; (ii) conditionally approved Community Solar projects for Program Year 1 of that pilot program; and (iii) additional data for the out-of-state variant as discussed above.

Project Model:
SAM Model Inputs

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SAM Model Inputs

Overview

Organized generally per SAM's sections:

- Location and Resource
- System Design
- System Costs
- Financial Parameters
- Revenue/Electricity Rates
- Incentives

SAM Model Inputs

Location and resource

- Chose “new_jersey” resource file
- Station ID 1223508
- Location appears to be southeast of Trenton (see map)
- Data source: NSRDB
- GHI = 4.19 kWh/m^2/day

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SAM Model Inputs

System design: system parameters

- Nameplate capacity (kW DC)
  - Historical averages from installed/pipeline mentioned above
  - Community Solar from analysis of Project Year 1 data
  - OOS based on review of PJM GATS projects
- Inverter Load Ratio: 1.2x
- Inverter Efficiency: 97.1%

SAM Case		Capacity (kW) Median (50th Percentile)	Average	Modeled Project Capacity
Historical SAM Cases [1]				
Comm_DO_Ground_lg		3,448	3,316	3,500
Comm_DO_Ground_med		441	494	500
Comm_DO_Roof_lg		1,750	2,440	2,000
Comm_DO_Roof_med		261	355	350
Comm_DO_Roof_sm		31	37	35
Comm_TPO_Carport		624	1,679	1,500
Comm_TPO_Ground_lg		1,936	3,866	3,500
Comm_TPO_Ground_med		382	460	450
Comm_TPO_Roof_lg		1,971	2,281	2,000
Comm_TPO_Roof_med		121	257	250
Comm_TPO_Roof_sm		27	36	35
Grid_Ground		4,799	9,104	7,000
Resi_DO_Roof		9	10	8
Resi_TPO_Roof		8	8	8
New SAM Cases				
CS_Ground	[2]	3,150	3,457	3,500
CS_Roof_lg	[2]	1,907	2,061	2,000
CS_Roof_med	[2]	640	628	650
Grid_Ground_OOS	[3]	n/a	n/a	10,000
Grid_Roof	[4]	n/a	n/a	2,000

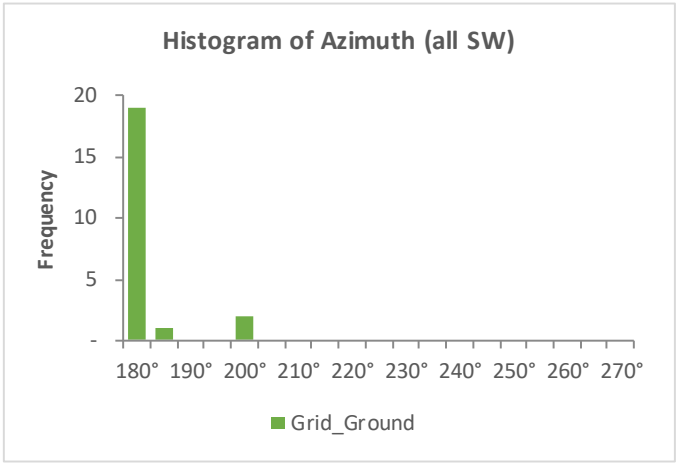
Notes:

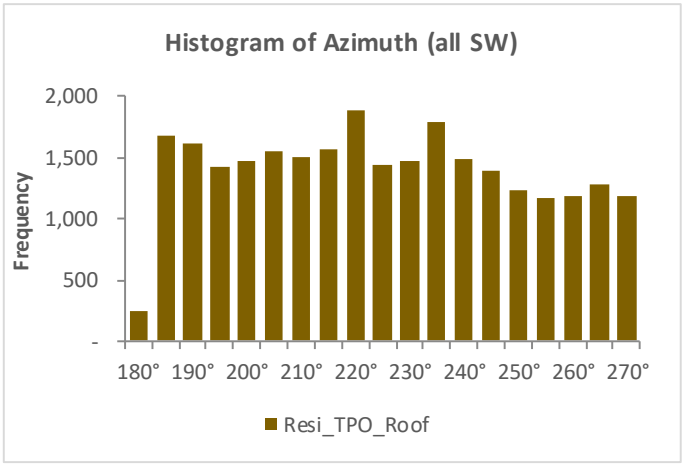
1. Based on an analysis of the March 2020 equipment and cost lists.
2. Based on an analysis of conditionally approved project data from BPU Order on the Community Solar Energy Pilot Program, December 20, 2019 (as amended February 25, 2020).
3. Based on analysis of solar projects registered in PJM GATS.
4. Since there were only three records for Grid_Roof (all from the pipeline), Cadmus adopted modeled capacity from the large commercial roof SAM Case (Comm_TPO_Roof_lg).

SAM Model Inputs

System design: orientation

- Same data from SAM Case derivation
  - Added back projects with >1 install type
- Sundry data “cleaning”/conforming
  - Tilt: excluded >60°
  - Azimuth: excluded <90° and >270°; converted all to SW
- Azimuth histogram examples to right





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SAM Model Inputs

System design: orientation

- Final orientations using broader project types shown to right
- Observations generally conform to expectations
  - Large, ground mount achieves optimal azimuth
  - Residential roof varies greatly, consigned to roof pitch/azimuth, generally worst orientation
  - Carport low tilt, also generally constrained to follow parking spines

Broad Project Type	Modeled Tilt	Modeled Azimuth
Commercial Carport	7°	215°
Commercial Ground	18°	195°
Commercial Roof	12°	200°
Grid Ground	18°	180°
Grid Roof	10°	200°
Residential Roof	26°	220°

SAM Model Inputs

System design: system losses

- Followed NJCEP's PVWatts guidelines; generally kept defaults, except
  - Inverter Efficiency: 97.1%
  - Module Mismatch: 0%
  - PV Module Nameplate Rating: 0%
  - Shading per sources
- SAM generated energy production estimates, shown below as specific energy production (SEP, kWh/kW)

Broad Project Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year 1	Capacity Factor
Commercial Carport	65	86	119	141	143	152	154	134	117	98	72	55	1,336	15.2%
Commercial Ground	80	100	129	144	140	147	151	136	124	111	88	70	1,419	16.2%
Commercial Roof	73	92	124	142	141	149	153	135	120	104	80	62	1,376	15.7%
Grid Ground	81	101	130	144	139	148	151	136	125	112	90	71	1,428	16.3%
Grid Ground (OOS)	87	100	120	141	148	146	147	148	126	115	88	76	1,442	16.5%
Grid Roof	69	89	120	140	139	148	151	133	117	100	76	59	1,340	15.3%
Residential Roof	73	90	113	126	123	126	132	118	107	98	78	64	1,247	14.2%

Notes:
All in kWh/kW

SAM Model Inputs

System costs: Capex

- New SAM Cases
  - Community Solar: applied adder to comparable historical cases
  - OOS analyzed several sources, including LBNL utility-scale report, New York project data
- Future capex
  - Inverter replacement year 13
  - Decommissioning year 25

SAM Case		Installed Cost ($/W) Straight Average	Weighted Average	Median (50th Percentile)	Modeled Cost ($/W)
Historical SAM Cases [1]					
Comm_DO_Ground_lg		$ 1.89	$ 1.94	$ 1.88	$ 1.90
Comm_DO_Ground_med		$ 2.52	$ 2.37	$ 2.40	$ 2.40
Comm_DO_Roof_lg		$ 1.76	$ 1.70	$ 1.69	$ 1.70
Comm_DO_Roof_med		$ 2.13	$ 2.06	$ 1.98	$ 2.10
Comm_DO_Roof_sm		$ 2.67	$ 2.57	$ 2.59	$ 2.60
Comm_TPO_Carport		$ 2.69	$ 2.69	$ 2.65	$ 2.65
Comm_TPO_Ground_lg		$ 2.03	$ 1.83	$ 1.89	$ 1.85
Comm_TPO_Ground_med		$ 2.24	$ 2.35	$ 2.30	$ 2.30
Comm_TPO_Roof_lg		$ 1.75	$ 1.59	$ 1.75	$ 1.65
Comm_TPO_Roof_med		$ 2.09	$ 2.04	$ 2.22	$ 2.05
Comm_TPO_Roof_sm		$ 2.60	$ 2.48	$ 2.63	$ 2.55
Grid_Ground		$ 1.96	$ 1.88	$ 1.91	$ 1.90
Resi_DO_Roof		$ 3.56	$ 3.49	$ 3.52	$ 3.45
Resi_TPO_Roof		$ 3.48	$ 3.43	$ 3.51	$ 3.45
New SAM Cases					
CS_Ground	[2][3]	n/a	n/a	n/a	$ 2.05
CS_Roof_lg	[2][3]	n/a	n/a	n/a	$ 1.85
CS_Roof_med	[2][3]	n/a	n/a	n/a	$ 2.25
Grid_Ground_OOS	[4]	n/a	n/a	n/a	$ 1.15
Grid_Roof	[5]	n/a	n/a	n/a	$ 1.65

Notes:

1. Based on an analysis of the March 2020 equipment and cost lists.
2. Based on an analysis of conditionally approved project data from BPU Order on the Community Solar Energy Pilot Program, December 20, 2019 (as amended February 25, 2020).
3. Modeled Costs based on comparable commercial TPO projects plus an adder of $0.20/W to reflect subscriber setup, utility interacction, and other setup tasks unique to these projects.
4. Based on analysis of other utility projects in the region.
5. Since there were only a few records for Grid_Roof, Cadmus adopted modeled cost from the large commercial roof SAM Case (Comm_TPO_Roof_lg).

SAM Model Inputs

System costs: opex

- Opex assumptions largely adopted from TI modeling
- Project management for similarly sized projects
- Property Tax/PILOT: $5,000/MW for projects with no onsite load
- Site lease payments per capacity similar to TI modeling, only for TPO
  - $0 for projects less than 60 kW
  - $10,000 for 60-250 kW
  - $20,000 for 250 kW to 1 MW
  - $55,000 for 1-5 MW
  - $65,000 in excess of 5 MW.
- O&M Fee:
  - $35/kW-Year 1 for projects with capacity less than 25 kW
  - $14/kW-Year 1 for 25-500 kW
  - $12/kW-Year 1 for projects with capacity greater than 500 kW
- Insurance costs: 0% <25 kW, 0.27% for 25-250 kW, 0.45% larger
- Adders for Community Solar

SAM Model Inputs

System costs: opex

	Operating Expenditures ($/Year)					
SAM Case	Project Mgt. Costs	Property Tax/PILOT	Site Lease	Total	O&M Fee ($/kW-yr)	Insurance
Comm_DO_Ground_lg	$ 5,000	exempt	n/a	$ 5,000	$ 12.00	0.45%
Comm_DO_Ground_med	$ 3,000	exempt	n/a	$ 3,000	$ 14.00	0.45%
Comm_DO_Roof_lg	$ 5,000	exempt	n/a	$ 5,000	$ 12.00	0.45%
Comm_DO_Roof_med	$ 3,000	exempt	n/a	$ 3,000	$ 14.00	0.45%
Comm_DO_Roof_sm	$ 17	exempt	n/a	$ 17	$ 14.00	0.27%
Comm_TPO_Carport	$ 5,000	exempt	$ 34,650	$ 39,650	$ 12.00	0.45%
Comm_TPO_Ground_lg	$ 5,000	exempt	$ 55,000	$ 60,000	$ 12.00	0.45%
Comm_TPO_Ground_med	$ 3,000	exempt	$ 15,000	$ 18,000	$ 14.00	0.45%
Comm_TPO_Roof_lg	$ 5,000	exempt	$ 55,000	$ 60,000	$ 12.00	0.45%
Comm_TPO_Roof_med	$ 1,625	exempt	$ 10,000	$ 11,625	$ 14.00	0.27%
Comm_TPO_Roof_sm	$ 17	exempt	$ 1,000	$ 1,017	$ 14.00	0.27%
CS_Ground	$ 5,000	$ 17,500	$ 55,000	$ 77,500	$ 37.00	0.45%
CS_Roof_lg	$ 5,000	exempt	$ 55,000	$ 60,000	$ 37.00	0.45%
CS_Roof_med	$ 3,000	exempt	$ 20,000	$ 23,000	$ 37.00	0.45%
Grid_Ground	$ 6,337	$ 35,000	$ 65,000	$ 106,337	$ 12.00	0.45%
Grid_Ground_OOS	$ 6,337	$ 50,000	$ 39,000	$ 95,337	$ 12.00	0.45%
Grid_Roof	$ 5,000	exempt	$ 55,000	$ 60,000	$ 12.00	0.45%
Resi_DO_Roof	$ 17	exempt	n/a	$ 17	$ 35.00	0.00%
Resi_TPO_Roof	$ 17	exempt	n/a	$ 17	$ 35.00	0.00%

See Capstone Report for additional details.

SAM Model Inputs

Financial Parameters

- Generally adopted from TI modeling

Financial Inputs for PPA Projects

SAM Case	IRR Target	Debt Share	Tenor (years)	Annual Interest Rate
Comm_TPO_Carport	9.7%	52.5%	12	6.0%
Comm_TPO_Ground_lg	9.7%	52.5%	12	6.0%
Comm_TPO_Ground_med	9.7%	52.5%	10	6.0%
Comm_TPO_Ground_sm	9.7%	52.5%	10	6.0%
Comm_TPO_Roof_Lg	9.7%	52.5%	12	6.0%
Comm_TPO_Roof_Med	9.7%	52.5%	10	6.0%
Comm_TPO_Roof_Sm	9.7%	52.5%	10	6.5%
CS_Ground	9.7%	52.5%	12	6.0%
CS_Roof_lg	9.7%	52.5%	12	6.0%
CS_Roof_med	9.7%	52.5%	10	6.0%
CS_Roof_sm	9.7%	52.5%	10	6.5%
Grid_Ground	9.7%	52.5%	12	6.0%
Grid_Ground_OOS	9.7%	52.5%	12	6.0%
Grid_Roof	9.7%	52.5%	12	6.0%
Resi_TPO_Roof	9.7%	47.5%	10	6.5%

Notes:
Source: TI Modeling assumptions.

Financial Inputs for DO Projects

SAM Case	Payback Year Target	Debt Share	Tenor (years)	Annual Interest Rate
Comm_DO_Ground_lg	10	52.5%	15	6.0%
Comm_DO_Ground_med	10	52.5%	15	6.0%
Comm_DO_Ground_sm	10	52.5%	15	6.0%
Comm_DO_Roof_lg	9	52.5%	15	6.0%
Comm_DO_Roof_med	9	52.5%	15	6.0%
Comm_DO_Roof_sm	9	52.5%	15	6.0%
Resi_DO_Roof	10	47.5%	13	5.5%

Notes:
Source: TI Modeling assumptions; Payback Year targets based on analysis of related IRR targets.

SAM Model Inputs

Financial Parameters – other assumptions

- Federal income tax: 35% for residential and 21% for commercial
- State income tax: 5.95% for residential and 9% for commercial
- All solar project costs assumed exempt from state sales tax
- Inflation assumed covered by the escalation rates discussed
- Host owners assumed to be taxable entities, so ITC and federal taxes apply, with appropriate step-downs in ITC percentages

SAM Model Inputs

Electricity Rates (DO)

- DO systems derive value from offset electricity costs
  - Only counting kWh-based, not demand (kW), charges
- Three customer classes
  - Residential
  - Commercial
  - Large C&I
- OpenEI integrated into SAM

Rates for Energy Charges

Import... | Export... | Copy | Paste

Period	Tier	Max. Usage	Max. Usage Units	Buy ($/kWh)
1	1	600	kWh	0.171509
1	2	1e+38	kWh	0.171509
2	1	600	kWh	0.174467
2	2	1e+38	kWh	0.188134

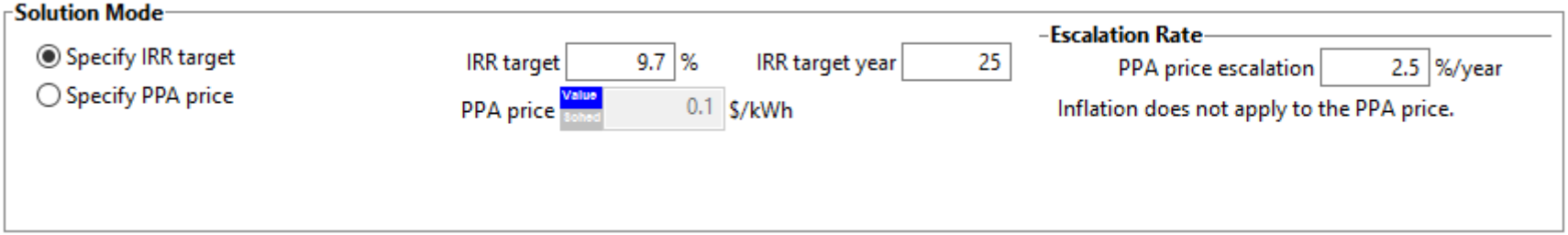
Weekday

	12am	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm
Jan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Feb	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Apr	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
May	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Jun	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Jul	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Aug	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sep	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Oct	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nov	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dec	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

SAM Model Inputs

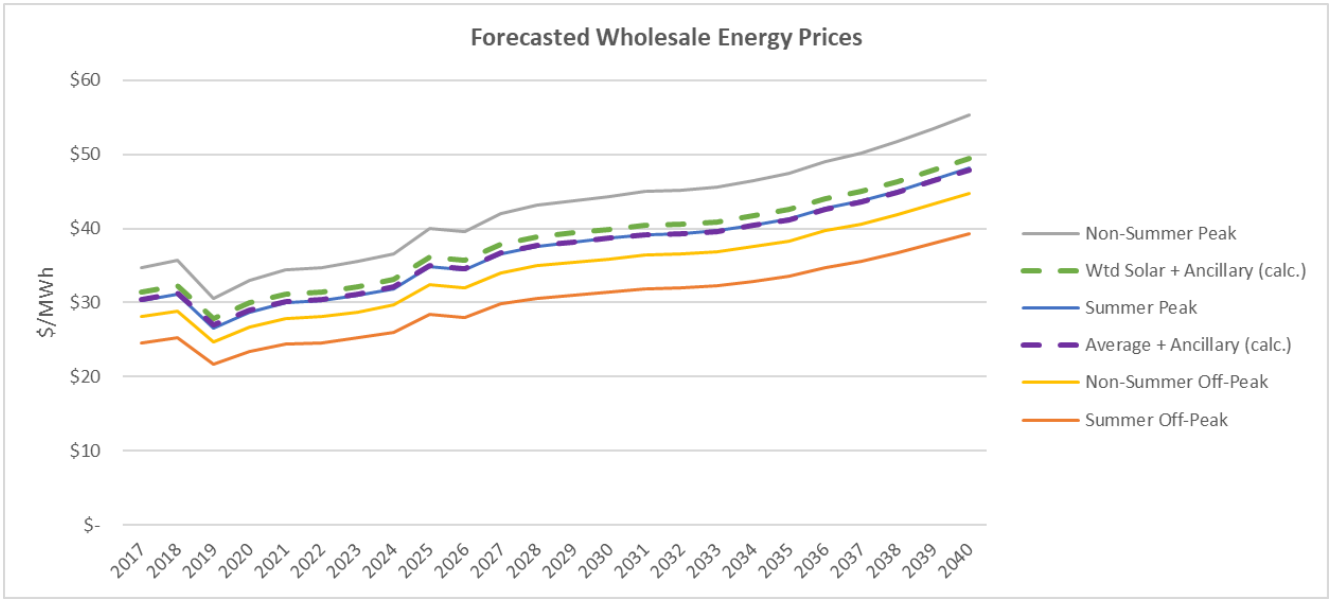
Revenue (PPA)

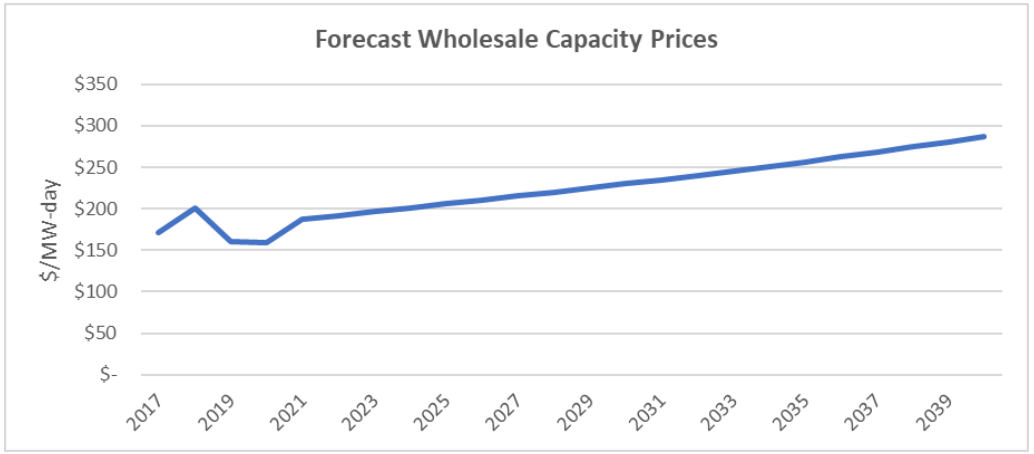
- TPO derives value from PPA revenue; three variants:
  - BTM assumed to be a 15% discount to customer service class rates
  - Community Solar base rate excludes certain kWh-based costs and is weighted 60% residential/40% commercial
  - Grid Supply based on wholesale rates



SAM Model Inputs

Revenue (PPA) – wholesale rates





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SAM Model Inputs

Incentives

- ITC steps down: 26% in 2020; 22% in 2021; and thereafter 10% for businesses and 0% for residential
- Bonus depreciation steps down: 100% through 2022, 80% in 2023, 60% in 2024, 40% in 2025, 20% in 2026, 0% thereafter
- State Performance-Based Incentive (PBI) is the proxy we use for the minimum incentive needed to achieve economic return

Project Model:
SAM Modeling Process

CADMUS

SAM Modeling Process

Overview – main steps

- Gather inputs in Excel for a SAM Case
- Export to CSV file
- Run script in SAM to find minimum incentive level
- Upload CSV output (primarily PBI) from SAM

SAM Modeling Process

Overview – SAM script

SAM script (macro) performs several functions:

- Populates SAM financial model with inputs from a specific SAM Case
- Sets State PBI array for each year of project life (25 years)
  - 15 years of incentive (generally)
  - 10 years of Class I REC
- Runs through “loop” to solve for economic target
  - Keeps adding $0.005/kWh to PBI until economic target is met
  - Once met, captures PBI and other information in output file
- Further capability to cycle through multiple years with updated inputs to account for changes in costs, electricity/PPA rates, incentives, etc.

SAM Modeling Process

Economic targets: TPO solves for IRR

- As discussed, the Revenue section in SAM's PPA model allows the user to target either PPA or IRR
- For TPO projects, Cadmus sets a target IRR in SAM
  - SAM will adjust the PPA to achieve the IRR
- We also have a target PPA rate we want to hit, again assumed to be a discount to the customer's electricity rate
- Our macro increases State PBI until the SAM-solved PPA rate matches our target PPA

SAM Modeling Process

Economic targets: TPO solves for IRR

- Example using SAM's parametric functionality in lieu of our script
- Residential weighted price of $0.1782, so target PPA is $0.1514
- Target IRR (solved for by SAM) is 9.7%
- Setup for parametric runs
  - 5 runs
  - Run #1 starts PBI at $0.075/kWh (first 15 years)
  - Each run adds $0.005/kWh to incentive
  - Run #3 simulation results approximately in target PPA

A State PBI of $0.085/kWh yields approximately the target PPA

_DO_Roof_med | Grid_Ground | Resi_TPO_Roof | Resi_DO_Roof

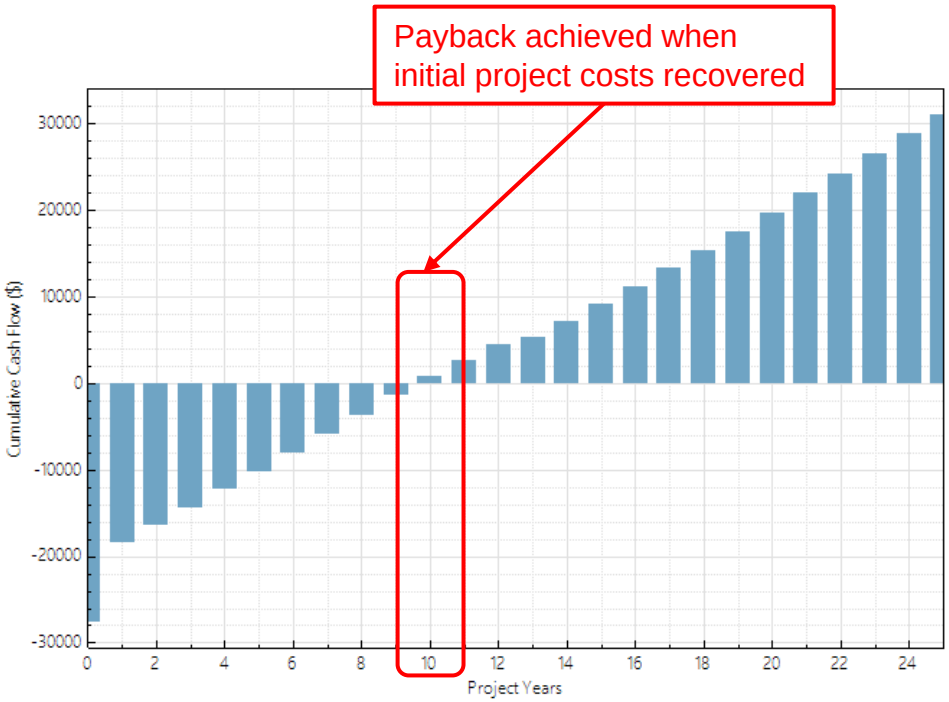
Quick setup... Inputs... Outputs... Run simulations Number of runs: 5 Import

	pbi_sta_amount ($/kWh)	flip_actual_irr (%)	ppa (cents/kWh)
1	0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.075;0.007;0.00	9.69999	15.7316
2	0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.08;0.007;0.007;0.007;0.007;0	9.69999	15.385
3	0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.085;0.007;0.00	9.69999	15.0383
4	0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.09;0.007;0.007;0.007;0.007;0	9.69999	14.6917
5	0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.095;0.007;0.00	9.69999	14.3451

SAM Modeling Process

Economic targets: DO uses Payback Period

- DO projects target Payback Period
- When investment paid back, i.e., cumulative cash flows turn positive
- Payback metric not as robust as IRR



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Market Model

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Market Model

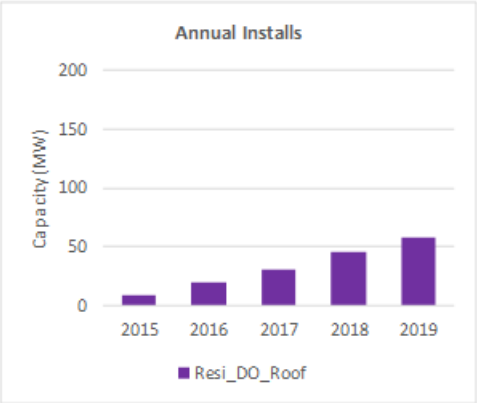
Overview: chief functions

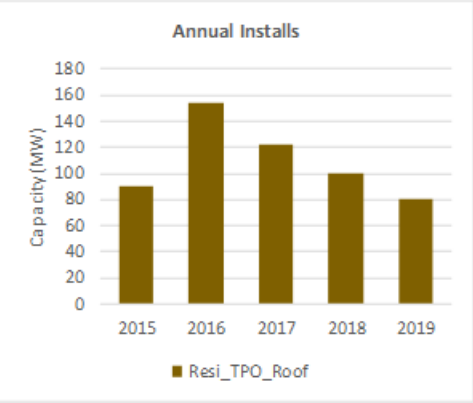
- Capacity forecasting
  - **Phase 1**: Monthly kW through the Transition Period
  - **Phase 2**: Annual % growth afterwards through 2030
- Energy and cost buildup
- Cost Cap test

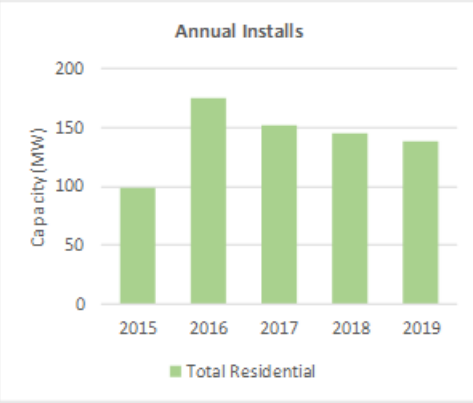
Market Model

Forecasting capacity: bottom-up method

- Analyze historical installation data to glean trends
  - Last five years for longer-term trends
  - Rolling, LTM monthly for more recent visibility
- Some observations
  - Residential: growth in DO vs. decline in TPO, but overall decrease in segment (see graphs below)
  - Emergence of carports and commercial ground segments







Notes

Based on an analysis of installed projects in the March 2020 Equipment List.

Market Model

Forecasting capacity: bottom-up method

- Historical, not including all “new” SAM Cases

Broad SAM Case	Phase 1 (kW/month)	Phase 1 Annualized	Phase 2 (Annual % Change)
Comm_DO_Ground	2,000	24,000	10%
Comm_DO_Roof	6,500	78,000	10%
Comm_TPO_Carport	2,500	30,000	10%
Comm_TPO_Ground	6,000	72,000	10%
Comm_TPO_Roof	4,000	48,000	0%
Grid_Ground	6,000	72,000	7%
Resi_DO_Roof	5,000	60,000	10%
Resi_TPO_Roof	5,500	66,000	-5%
Total	**37,500**	**450,000**	

Notes:
Based on an analysis of installed projects in the March 2020 Equipment List.

Market Model

Transition period modeling

- Model allocation of monthly capacity during next few months to appropriate solar “tranche”:
  - SREC Registration Program (Legacy SREC Tranche)
  - Transition Incentive Program (TREC Tranche)
  - Successor Program (Successor Tranche)
- Involves three main steps:
  - Forecast growth in installations, as discussed above
  - Pare down pipeline lists to projects more likely to be installed and “roll out” those installations
  - Allocate capacity to tranches

Market Model

Forecasting capacity: top-down method

- First step is to forecast aggregate, annual capacity additions
- One approach:
  - Start with state goals: milestone of 12.2 GW by 2030 for our purpose
  - Net out Legacy SREC and TREC installed and pared-down pipeline capacities
  - Evaluate capacity from early projects that may fall off
  - Derive “gap” for Successor Program to fill
  - Determine growth path

Derivation Steps	Capacity (MW)	Comments
2030 Total Installed Target	12,188	per 2019 IEP
Less: Installed Legacy SREC capacity end 2019	3,193	per June 2020 Installs report
Less: Incremental Legacy SREC installed	285	forecasts from Phase 1 of bottom-up method for Jan-Apr 2020 plus rollout of SRP pipeline, as reduced
Less: TREC Tranche	641	from Transition Period analysis
Add: Legacy SREC decommissioned capacity by 2030	14	assumes 25-year project life
Gap for Successor Tranche	**8,081**	

Market Model

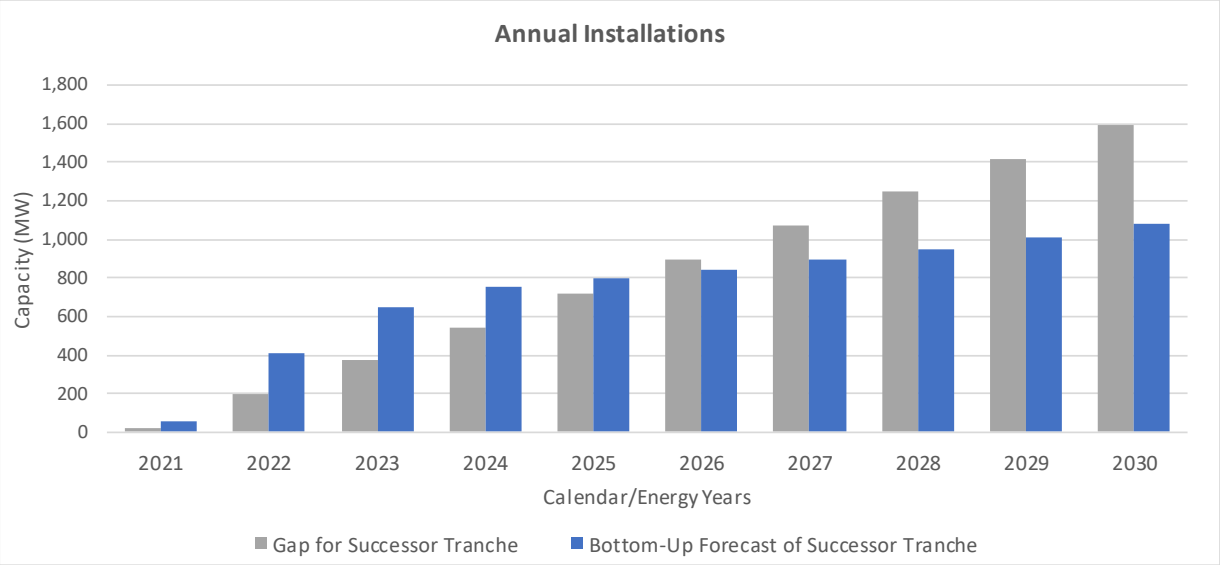
Forecasting capacity: top-down method

- Next step: allocate annual capacity among SAM Cases
- Three groups of SAM Cases
  - Historical SAM Cases based on historical market shares
  - Community Solar capacity prescriptive
  - Other new SAM Cases set separately
- Market shares recalibrated for full set of SAM Cases
- Ability to adjust one SAM Case's share to find impact on total costs

Market Model

Forecasting capacity illustration

- Bottom-up (blue bars) forecasts cover most of goals, reflected in top-down (gray bars)
- Potential study key in understanding growth possibilities



Notes

Successor Tranche growth forecasts based on an analysis of NJCEP installed projects as of March 30, 2020.

Annual "gaps" for Successor Tranche to achieve the 2019 EMP 2030 Target were allocated to show consistent, annual growth.

Of note, the Successor Tranche reflects Energy Years, whereas the gaps represent calendar years.

Successor Tranche

Energy and cost buildup

- Energy (MWh) is generated for each SAM Case based on estimates of its capacity, SEP, and incentive
- The energy is “built up” by Vintage Energy Year (EY), i.e., the EY in which a group of projects is installed
- The first year of estimated energy production is calculated with Year 1 SEP, then it is degraded annually
- The energy eligible for incentives is based on the incentive term, generally 15 years for modeling purposes
- Each Vintage EY is assigned its own incentive ($/MWh), which reflects changes in electricity prices, costs, etc.

Successor Tranche

Energy buildup example

Inputs

Variable	Units	Input
Incentive Life	*yrs*	**15**
Starting Specific Energy Production	*MWh/MW*	**1,300**
Annual degradation rate	*%*	**0.5%**

Capacity (MW)

Vintage EY	Incentive Years	Final Year	Annual MWs	Cumulative MWs
EY 2021	15	EY 2035	10.0	10.0
EY 2022	15	EY 2036	11.0	21.0
EY 2023	15	EY 2037	12.1	33.1
EY 2024	15	EY 2038	13.3	46.4
EY 2025	15	EY 2039	14.6	61.1
EY 2026	15	EY 2040	16.1	77.2
EY 2027	15	EY 2041	17.7	94.9
EY 2028	15	EY 2042	19.5	114.4
EY 2029	15	EY 2043	21.4	135.8
EY 2030	15	EY 2044	23.6	159.4
Total			**159.4**	

Energy (MWh)

Vintage EY	EY 2021	EY 2022	EY 2023	EY 2024	EY 2025	EY 2026	EY 2027	EY 2028	EY 2029	EY 2030	EY 2031	EY 2032	EY 2033	EY 2034	EY 2035	EY 2036	EY 2037	EY 2038	EY 2039	EY 2040
EY 2021	13,000	12,935	12,870	12,806	12,742	12,678	12,615	12,552	12,489	12,427	12,364	12,303	12,241	12,180	12,119	-	-	-	-	-
EY 2022	-	14,300	14,229	14,157	14,087	14,016	13,946	13,876	13,807	13,738	13,669	13,601	13,533	13,465	13,398	13,331	-	-	-	-
EY 2023	-	-	15,730	15,651	15,573	15,495	15,418	15,341	15,264	15,188	15,112	15,036	14,961	14,886	14,812	14,738	14,664	-	-	-
EY 2024	-	-	-	17,303	17,216	17,130	17,045	16,960	16,875	16,790	16,706	16,623	16,540	16,457	16,375	16,293	16,211	16,130	-	-
EY 2025	-	-	-	-	19,033	18,938	18,843	18,749	18,655	18,562	18,469	18,377	18,285	18,194	18,103	18,012	17,922	17,833	17,743	-
EY 2026	-	-	-	-	-	20,937	20,832	20,728	20,624	20,521	20,418	20,316	20,215	20,114	20,013	19,913	19,813	19,714	19,616	19,518
EY 2027	-	-	-	-	-	-	23,030	22,915	22,801	22,687	22,573	22,460	22,348	22,236	22,125	22,014	21,904	21,795	21,686	21,577
EY 2028	-	-	-	-	-	-	-	25,333	25,207	25,081	24,955	24,830	24,706	24,583	24,460	24,338	24,216	24,095	23,974	23,854
EY 2029	-	-	-	-	-	-	-	-	27,867	27,727	27,589	27,451	27,313	27,177	27,041	26,906	26,771	26,637	26,504	26,372
EY 2030	-	-	-	-	-	-	-	-	-	30,653	30,500	30,348	30,196	30,045	29,895	29,745	29,596	29,448	29,301	29,155
Total	**13,000**	**27,235**	**42,829**	**59,918**	**78,651**	**99,195**	**121,729**	**146,454**	**173,588**	**203,374**	**202,357**	**201,345**	**200,338**	**199,336**	**198,340**	**185,290**	**171,099**	**155,653**	**138,825**	**120,476**

Notes

This is for illustrative purposes only.

This does not adjust for partial year production, which is available in the Market Model.

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Thank You