

Asset League Tables

An independent analysis of the top performing solar projects in the United States.

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To highlight accomplishments in the solar industry and encourage adoption of data best practices, kWh Analytics partnered with the Solar Finance Council to present the Asset League Tables series. Drawing from kWh Analytics' data repository, this report includes an overview of solar project performance and a list of the industry's top performing solar projects and their sponsors.



Overview

From the state-level challenges of PURPA reform to the national-level challenges of import tariffs, the solar industry has faced years of uphill battles. But through it all, the industry has proven resilient, having now installed more than 50GW of capacity in the United States. To continue to build investor confidence in this new asset class, kWh Analytics manages the industry's largest data repository of solar project performance, now encompassing approximately 20% of the operating solar power plants.

In this report, we share the top 100 performing assets, as well as first-to-be-published benchmarks on system performance characteristics.

The following report was designed with three goals in mind:

1. To avail the industry of quality performance metrics necessary for investors, developers, operators, and other stakeholders to properly benchmark their projects and portfolios,
2. To highlight accomplishments in the solar industry, and
3. To encourage adoption of data best practices that support the industry's continued growth.

To develop the following yield curves and evaluate the top performing assets, kWh Analytics mined the industry database of operating solar projects and ranked each project by its specific yield: the actual production for a given site divided by its DC capacity.

Specific yield is a frequently used metric to analyze asset performance. However, a few additional considerations were made when preparing this report:

- Given the large improvement in production attributed to the use of trackers, which can increase specific yield for a facility by up to 20%, the list of National Awardees is divided into two categories: one for fixed-tilt projects, and another for single-axis tracker projects.
- Insolation, or the amount of sunlight hitting the solar panels over the course of a year, is a large driver of specific yield, and thus sunnier regions are naturally preferred by this metric. Yield curves were developed for five geographic regions and the U.S. as a whole. To accommodate these regional fluctuations, we are complementing the National Awardees with a set of Regional Champions from lower-insolation regions.

These lists reflect the best performing projects at both the national and regional levels. We are using 2016 results for the purposes of this inaugural report, and the Asset League Tables will be refreshed later this year to include 2017 data. **Asset owners are encouraged to submit data for consideration as a National Awardee or Regional Champion (see page 5).**

Yield Benchmarks

In an industry first, kWh Analytics is providing indices of specific yields of actual performing projects at both the regional and national level. Until now, benchmarked industry results to establish a baseline of performance have been unavailable against which to compare operating assets in the field; with the introduction of this ongoing series, any operational plant in the United States has an objective benchmark against which to evaluate technical performance.

Summary Points:

- The top quartile of fixed-tilt solar projects produced at least 1,500 MWh / MWp.
- The top quartile of tracker projects produced at least 2,180 MWh / MWp.
- Tracker projects are dominant in the Southwest and South, while fixed-tilt installations are more geographically distributed.

Table 1: Median Production of Fixed-Tilt and Tracker Projects by Region (MWh / MWp):

	FIXED-TILT	TRACKER
SOUTHWEST	1,662	2,005
SOUTH	1,432	1,513
NORTHWEST	1,241	1,547
NORTHEAST	1,273	1,433
MIDWEST	1,224	1,410
NATIONAL	1,385	1,910

The charts on the next page show the distribution of projects' specific yield for both tracker and fixed-tilt projects. The bars are color-coded by region. Projects are also evaluated on Capacity Factor: The net capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity continuously over the same period of time.

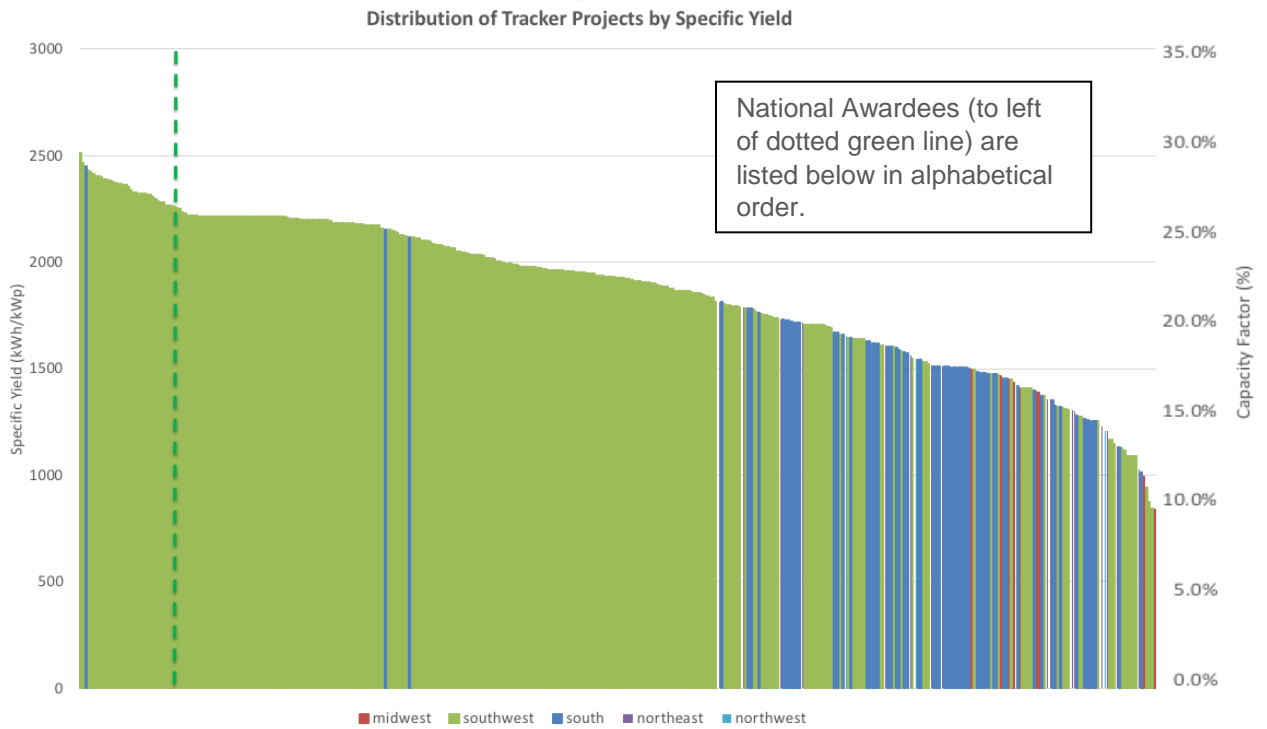


Exhibit 1: Single-axis tracker projects in the United States, measured by specific yield and capacity factor, and sorted by region

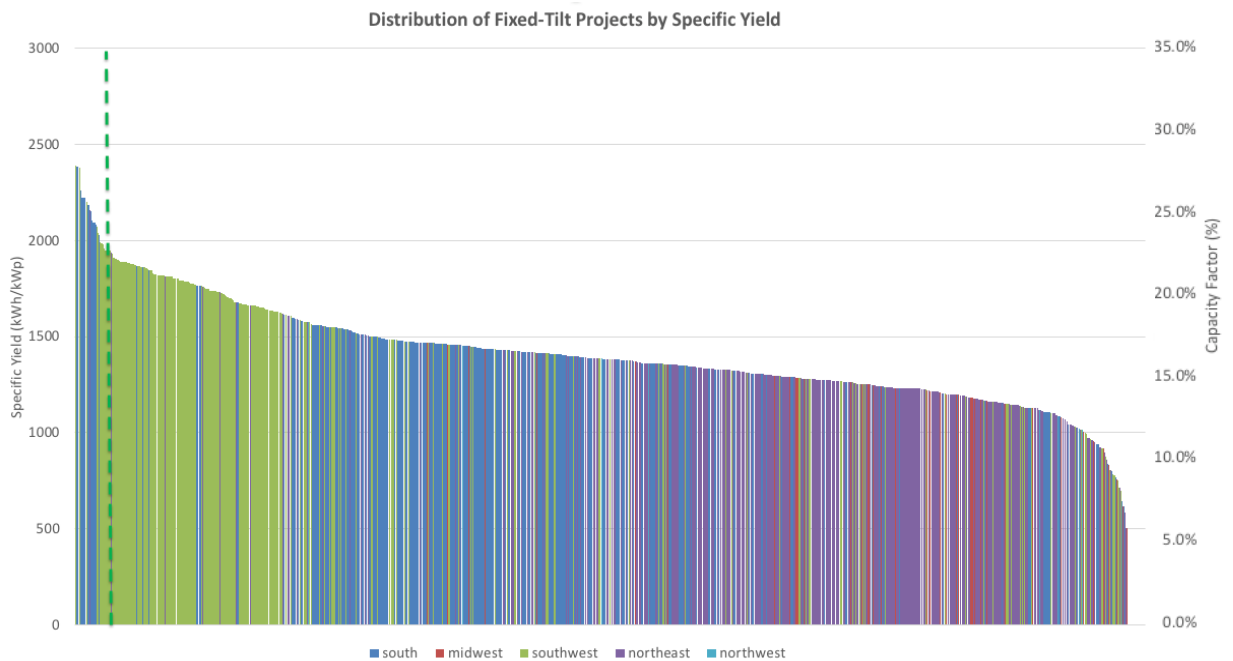


Exhibit 2: Fixed tilt projects in the United States, measured by specific yield and capacity factor, and sorted by region

Asset League Tables

The Asset League Tables are presented below.



While one of the primary drivers of performance is the amount of insolation at a given location, we are pleased to report that representatives from all major regions (including the Southeast and New England) have achieved the top accolades for performance.

This inaugural study analyzes data from the 2016 calendar year of operation. In an effort to promote the Department of Energy's Orange Button data standard, sponsors are encouraged to submit data to be considered for inclusion in our updated Asset League Tables which will incorporate 2017 production results. Data should be submitted in a format that can easily be translated to an Orange Button-compliant format, as found at <http://www.kwhanalytics.com/AssetLeagueTables>. From now until **July 2nd, 2018**, sponsors should contact leaguetales@kwhanalytics.com in order to:

1. Verify that the kWh Analytics' data record of their assets is accurate and complete, or
2. Submit performance data for review and inclusion in the updated Asset League Tables and consideration as a National Awardee or Regional Champion.

All assets submitted directly for consideration will receive more detailed benchmarking about your own assets; only the top assets will be included in the next revision of the Asset League Tables.

The updated Asset League Tables will be published in the Fall of 2018.

Summary Points:

- The Top Performing projects represent more than 2,000 MW (DC) of distributed and utility-scale PV systems.
- Unsurprisingly, the Southwest and South regions dominate the national rankings for both fixed-tilt and tracker projects. These areas are known for their higher levels of insolation and, accordingly, have a disproportionate quantity of solar projects.
- Regional Winners reflect the best assets in each region of the country.

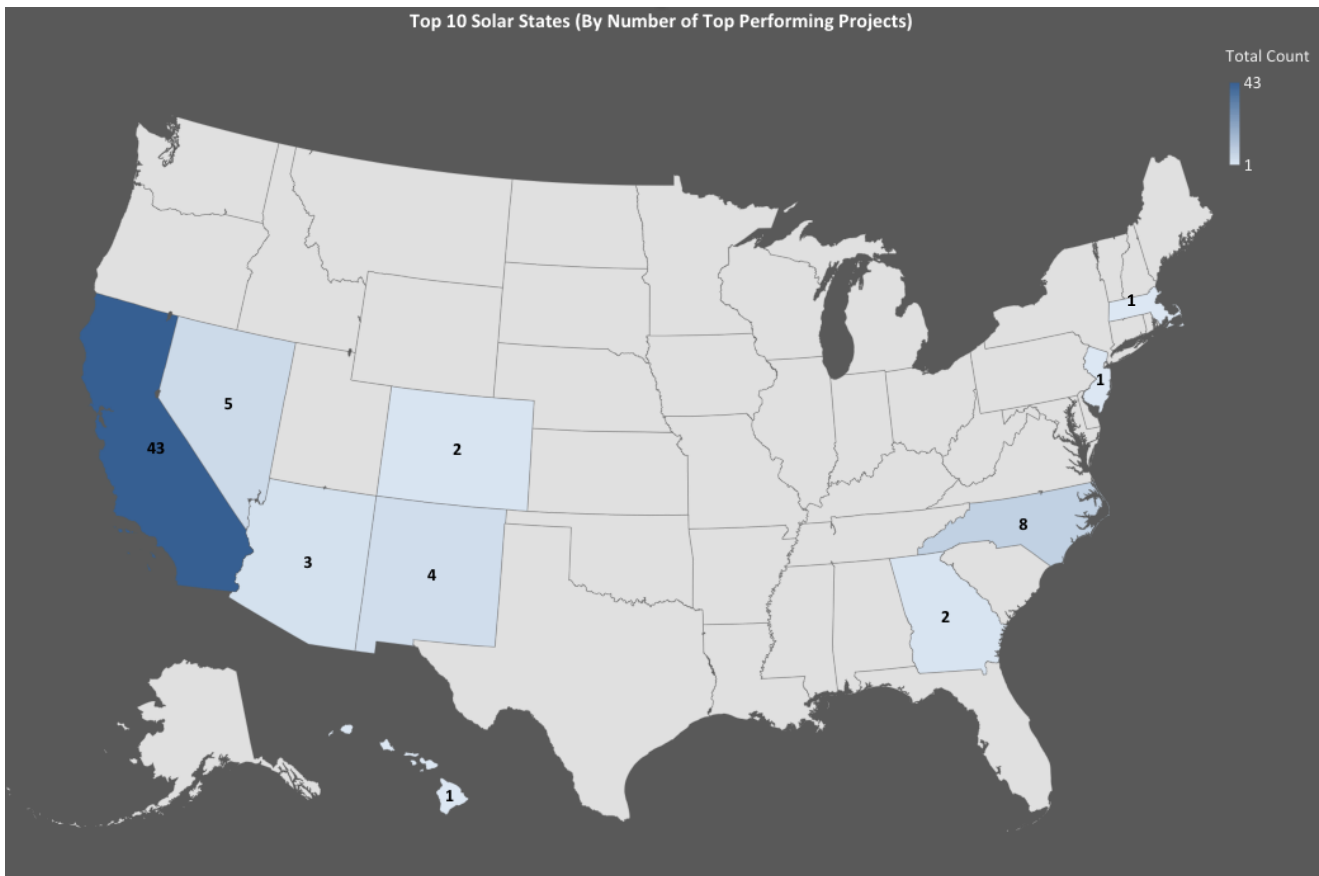


Exhibit 3: The geographic distribution of National Awardees for solar project performance. These represent the assets with the highest specific yields nationally throughout the entirety of 2016.

National Awardees: Fixed-Tilt Projects

Project Name	Sponsor	State	DC Capacity (MW)
Alpine Solar	NRG Energy	CA	86.4
AV Solar Ranch One	Exelon Corporation	CA	279.0
BearPond Solar Center	TerraForm Power	NC	6.5
Catalina Solar	EDF Renewable Energy	CA	143.0
Copper Mountain Solar 2	Sempra Renewables / Consolidated Edison	NV	187.6
Copper Mountain Solar 3	Sempra Renewables / Consolidated Edison	NV	311.2
Desert Sunlight 250	NextEra Energy Resources	CA	330.1
Dessie Solar Center	TerraForm Power	NC	6.5
Division 1	Tesla	CA	1.7
Division 3	Tesla	CA	1.1
Dorchester Solar Site	National Grid	MA	1.3
Foxfire Solar Farm	Strata Solar	NC	5.0
Graham Solar Center	TerraForm Power	NC	6.7
Hesperia	TerraForm Power	CA	1.7
Imperial Valley Solar Co 2	Dominion Energy / Novatus Energy	CA	26.0
Kettering Solar 1	Tesla	CA	1.1
KRS II Koloa Solar	Tesla	HI	12.0
Lakeland Solar Energy	Invenergy	GA	2.0
Lancaster Solar 1	PFMG Solar	CA	1.8
Las Virgenes Municipal Water District	Tesla	CA	1.1
Mount Olive Farm	Strata Solar	NC	5.0
Otero Solar	PNM Resources	NM	9.6
Otoe Solar Power Plant	sPower	CA	1.9
Progress Manis I	Greenbacker Renewable Energy Corporation	NC	1.2

Redmon Solar Farm	Strata Solar	NC	2.0
Rio Rancho High School	WGL Energy Systems, Inc	NM	1.2
SEPV Palmdale East	sPower	CA	11.5
Shankle Solar Center	TerraForm Power	NC	6.6
Sierra Solar Greenworks	sPower	CA	22.5
Sue Cleveland High School	WGL Energy Systems, Inc	NM	1.2
Univ of California San Diego Solar	AMsolar	CA	1.2
Victor Dry Farm Ranch A	sPower	CA	5.6
Victor Dry Farm Ranch B	sPower	CA	5.0
Western 102 Power Plant	Barrick Goldstrike Mines	NV	1.3
William Paterson University	TerraForm Power	NJ	1.4

National Awardees: Tracker Projects

Project Name	Sponsor	State	DC Capacity (MW)
Adelanto Solar II	NextEra Energy Resources	CA	7.4
Avalon Solar	Clenera Renewable Energy	AZ	35.0
Bakersfield 111	ET Solar	CA	1.4
Camelot Solar	Dominion Energy / Novatus Energy	CA	59.1
Catalina Solar 2	Dominion Energy / Novatus Energy	CA	24.3
CDCR (CA) - Pleasant Valley State Prison	TerraForm Power	CA	1.6
Columbia 2	Dominion Energy / Novatus Energy	CA	19.4
Columbia 3	KKR	CA	11.1
Copper Crossing Solar	Iberdrola Renewables	AZ	23.7
Decatur Parkway Solar Project	Southern Power	GA	110.0
Edwards Air Force Base - North	Ahana Renewables	CA	1.1
Edwards Air Force Base - South	Ahana Renewables	CA	1.1
Greater Sandhill I	SunPower Corporation	CO	20.0
Highlander Solar 1	Duke Energy	CA	14.6
Industry Solar Power Generation Station 1	sPower	CA	1.9
Kit Carson	WGL Energy Systems, Inc	NM	1.3
Lone Valley Solar Park I	EDP Renewables	CA	10.0
Lone Valley Solar Park II	EDP Renewables	CA	20.0
McHenry Solar PV Plant	Axium Infrastructure	CA	31.1
Navajo Solar Power Generation Station 1	sPower	CA	1.9
Nellis Solar PV II	SunPower Corporation	NV	18.0
Powhatan Solar Power Generation Station 1	sPower	CA	1.9
Rio Grande Solar	KKR	CA	5.0
Rosamond One	KKR	CA	26.2

Rosamond Two	KKR	CA	20.9
RV Colorado State Univ. Power	Longroad Energy	CO	2.0
Searchlight Solar	Undisclosed	NV	21.4
SEPV 1	CleanCapital	CA	2.3
SEPV 2	CleanCapital	CA	2.2
Seville 1	Duke Energy	CA	27.0
Seville 2	Duke Energy	CA	40.0
Snowline-Duncan Road (South)	TerraForm Power	CA	1.1
Snowline-White Road (Central)	TerraForm Power	CA	1.7
Snowline-White Road (North)	TerraForm Power	CA	1.7
Snowline-White Road (South)	TerraForm Power	CA	1.7

Northwest Regional Champions

Project Name	Sponsor	State	DC Capacity (MW)
Black Cap Solar Plant	PacifiCorp	OR	2.6
Old Mill Solar	NextEra Energy Resources	OR	6.8
Oregon Inst. of Technology, Klamath Falls	Tesla	OR	1.9
Outback Solar at Christmas Valley	NextEra Energy Resources	OR	5.7
Wild Horse Solar	Puget Sound Energy	WA	0.5

Midwest Regional Champions

Project Name	Sponsor	State	DC Capacity (MW)
Butler Solar Farm	MC Power Companies	MO	3.2
Domino's Farms	DTE Energy	MI	1.1
Exelon City Solar	Exelon Corporation	IL	10
Indiana Municipal Power Agency	Indiana Municipal Power Agency	IN	1.2
Indy Airport Solar Project II	General Energy Solutions / Novatus Energy	IN	9.8
Indy Airport Solar Project III	General Energy Solutions / Novatus Energy	IN	11.9
Lake County Solar	Community Energy Solar	IN	4.6
Lanesville Solar	Hoosier Energy	IN	1.3
Napoleon Solar I	SunEdison	OH	9.8
Pastime Farms	Cypress Creek Renewables	IN	7.0

Northeast Regional Champions

Project Name	Sponsor	State	DC Capacity (MW)
Atlantic Coast Freezers	KDC Solar	NJ	2.2
Cornerstone Power Vineland	Altus Power America	NJ	3.7
Heller Industrial Parks	Marina Energy	NJ	2.7
Lawrenceville School	KDC Solar	NJ	6.1
L'Oreal Piscataway	Marina Energy	NJ	1.0
Murray Hill Solar	Consolidated Edison Development	NJ	1.0
Solar Star New Jersey VI	TerraForm Power	NJ	1.7
Titusville Solar (Janssen Pharmaceuticals)	SunPower Corporation	NJ	4.1
Vineland Mays Landing Solar	NJR Clean Energy Ventures	NJ	4.1
Warren County Solar	Energy Power Partners	NJ	2.0

South Regional Champions

Project Name	Sponsor	State	DC Capacity (MW)
Apple Data Center	Apple, Inc.	NC	21.9
Bryan Solar	SunEdison	TX	12.1
DeSoto Next Generation Energy Center	Florida Power & Light	FL	27.6
Mustang Solar	Oklahoma Gas & Electric	OK	3.0
Newman Solar	Undisclosed	TX	13.1

Legal Disclaimer

This white paper is a work product of kWh Analytics, Inc. and the Solar Finance Council. kWh Analytics is the leading firm in solar risk management, with a HelioStats database encompassing operating data from over 13GW of solar projects in North America. This analysis drew from kWh Analytics' data repository, complemented by publicly available reports. Orange Button is an initiative of the Department of Energy to provide data standard formats and definitions for solar industry stakeholders. More information may be found at <http://www.orangebuttondata.org/>. All rights reserved and each company's name or likeness are copyright the respective owner. Any data set submitted under this project shall be evaluated for inclusion in the next version of the 'Asset League Tables' report and may be used by the authors for other analytical and market evaluation purposes. The authors have taken their best efforts to use reliable data sources when available, but do not guarantee the accuracy or completeness of the data used for this study.