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Grid Scale and DER Resources: Technical Potential of Wind and Solar

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Study Assumptions

Land Exclusions for Wind and Solar

- National Parks, Fish and Wildlife Service, Flood Zones, Urban Areas, Lava Flow Hazard, Wetlands

Utility-Scale On Shore Wind Power

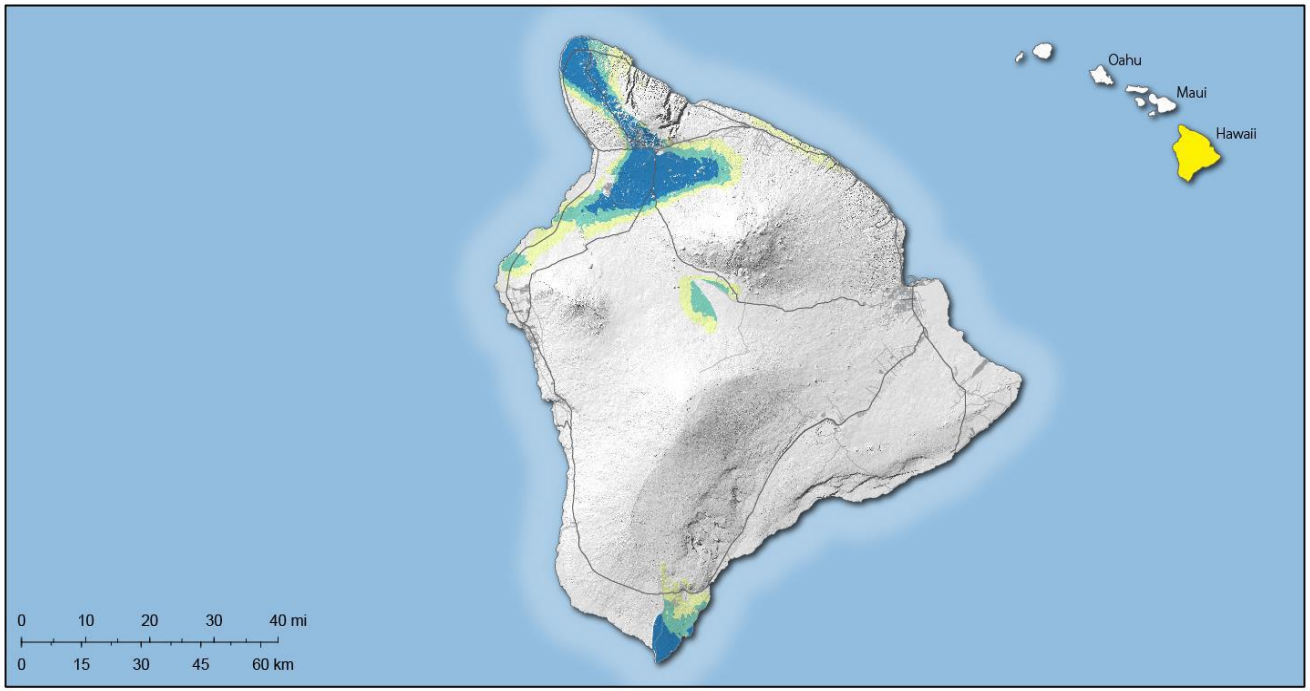
- 80 m Hub Height
- Power Density: 3 MW/km^2
- 20% Slope, Minimum Wind Resource

Utility-Scale Solar PV

- DC/AC Ratio: 1.5
- Single Axis Tracking
- 8.7 $Acres/MW_{ac}$
- 3%, **5%** & 10% Slope, Minimum Area of 1 km^2

All credits to NREL researchers: Carlo Brancucci Martinez-Anido, Billy Roberts, Erol Charlton, Andrew Weekley, Anthony Lopez, Bri-Mathias Hodge

Wind Resource Potential: Hawaii



Shown is annual average wind speed for resource available considering the following geographic constraints:

- terrain slope is not more than 20%
- has minimum resource threshold of 6.5 m/s
- is not part of the National or State Park system
- is not Fish & Wildlife Service land
- has not been zoned as an urban area*
- is not classified as Important Agricultural Land*
- is not within an "A" level flood zone*
- is not within a lava flow hazard zone 1 or 2*
- is not classified as a wetland*

**data downloaded from the Hawaii Office of Planning website*

Onshore Wind Speed at 80 meters

Analysis of the Hawaiian Islands – Hawaii

Speed (m/s)	Area (km²)	MWac
≥8.5	445	1,334
≥7.5	745	2,236
≥6.5	1,177	3,532

Speed (m/s)

- 8.5+
- 7.5–8.5
- 6.5–7.5

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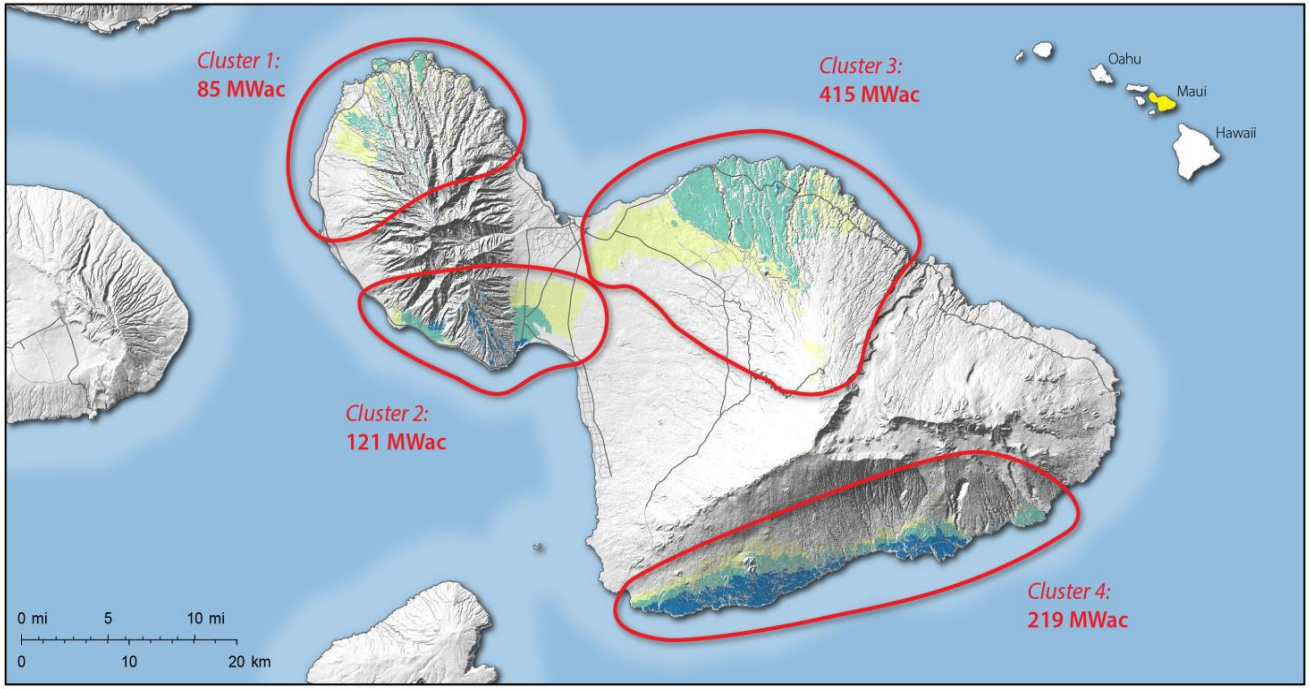
Wind Resource Potential: Maui



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data downloaded from the Hawaii Office of Planning website

Onshore Wind Speed at 80 meters

Analysis of the Hawaiian Islands – Maui

Speed (m/s)	Area (km²)	MWac
≥8.5	39	118
≥7.5	150	448
≥6.5	280	840

Speed (m/s)
8.5+
7.5–8.5
6.5–7.5

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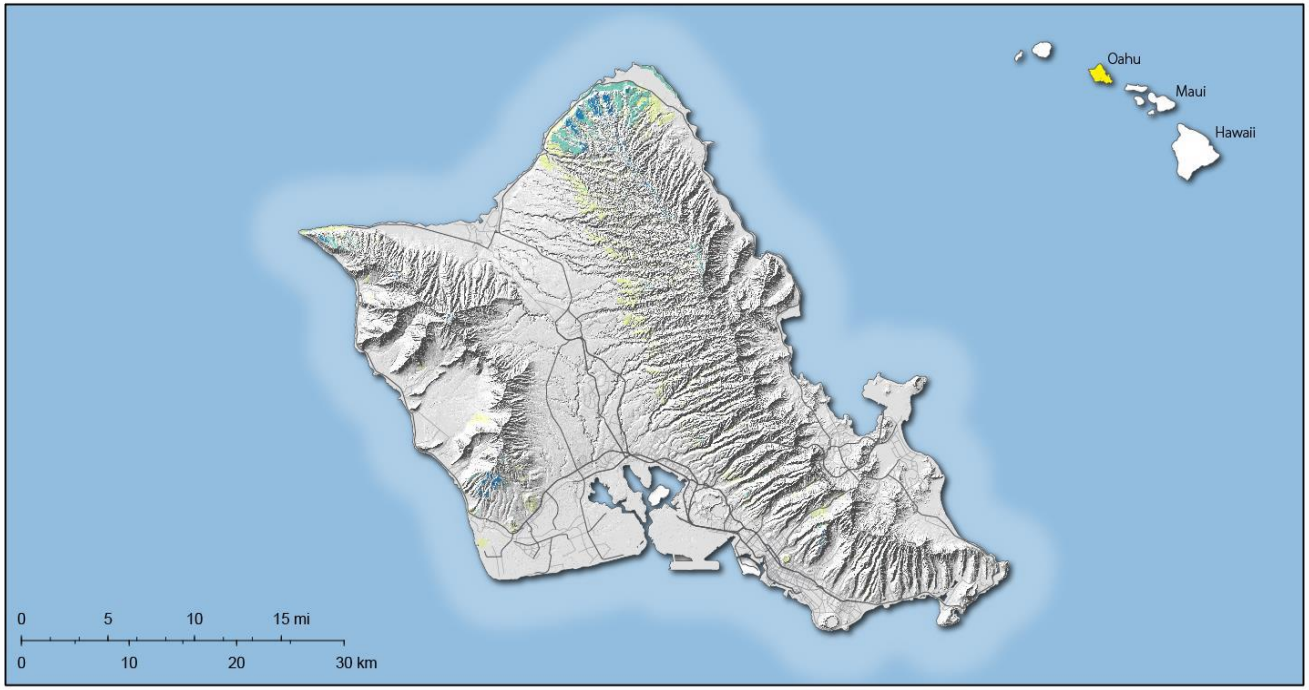
Wind Resource Potential: Oahu



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Onshore Wind Speed at 80 meters

Analysis of the Hawaiian Islands – Oahu

Speed (m/s)	Area (km²)	MWac
≥8.5	5	16
≥7.5	23	68
≥6.5	54	162

Speed (m/s)
- 8.5+
- 7.5–8.5
- 6.5–7.5

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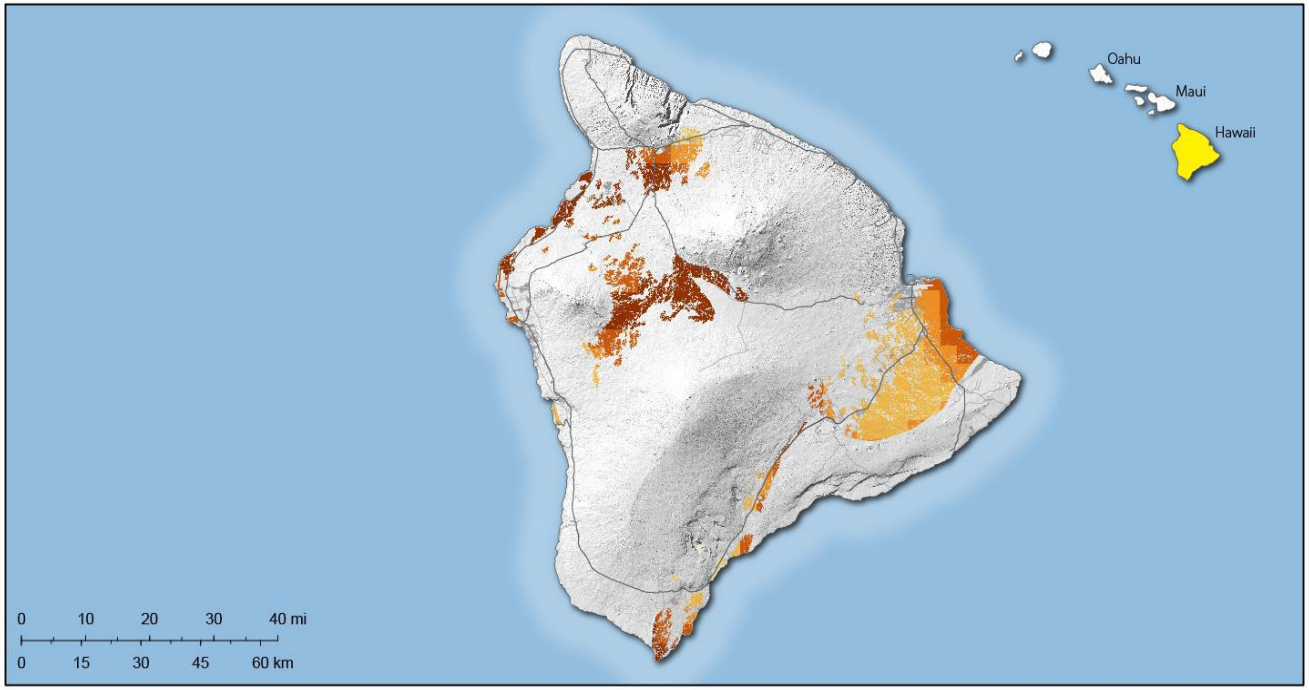
Solar Resource Potential: Hawaii



Capacity factor calculated from average modeled solar irradiance from 1998-2014 for a 1-axis system with a dc/ac ratio of 1.5. Development potential was determined by applying the following geographic constraints:

- terrain slope is not more than 5%
- has a contiguous area of at least 1 km^2
- is not part of the National or State Park* system
- is not Fish & Wildlife Service land
- has not been zoned as an urban area*
- is not classified as Important Agricultural Land*
- is not designated agricultural zone A*
- is not within an "A(x)" level flood zone*
- is not within a lava flow hazard zone 1 or 2*
- is not classified as a wetland*

**data acquired from the Hawaii Office of Planning*

Utility Scale PV Development Potential

Analysis of the Hawaiian Islands – Hawaii

CF(%)	Area (km^2)	MWac
≥20	324	9,189
≥18	555	15,757
≥16	715	20,312
≥14	1,058	30,039
≥12	1,071	30,421
≥10	1,073	30,484

Capacity Factor (%)

- 20-22
- 18-20
- 16-18
- 14-16
- 12-14
- 10-12

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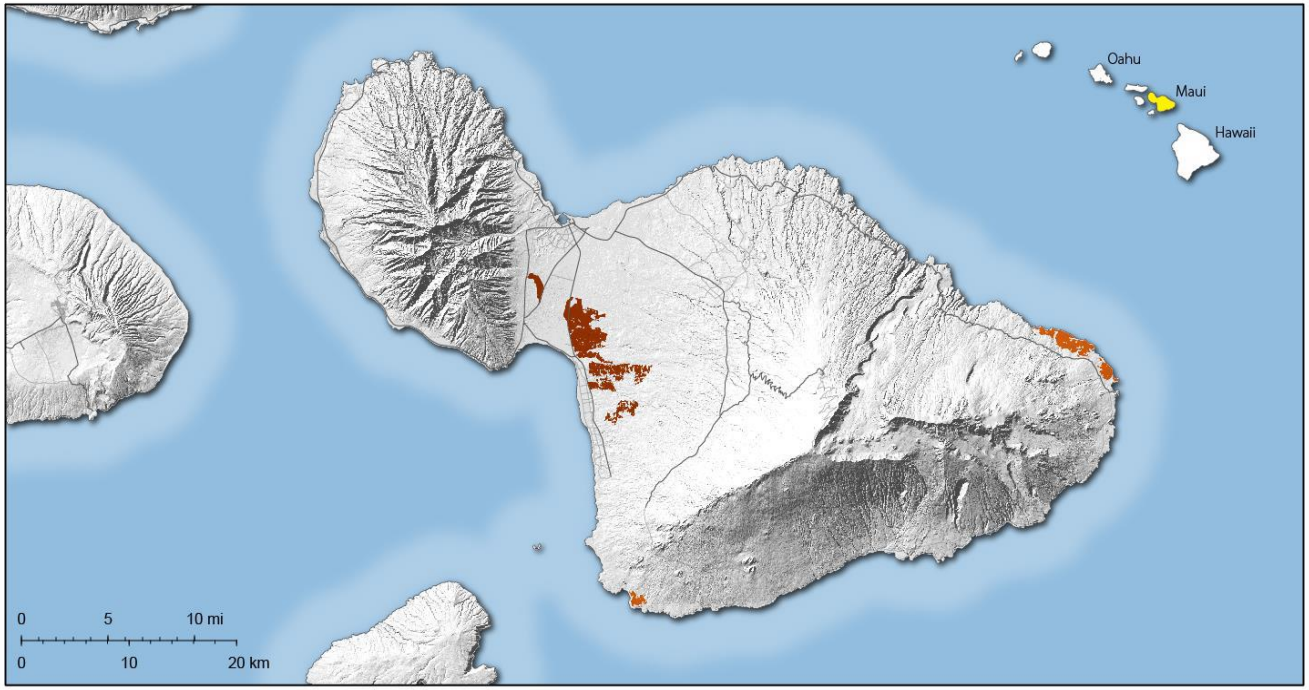
Solar Resource Potential: Maui



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- is not within a lava flow hazard zone 1 or 2*
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**data acquired from the Hawaii Office of Planning*

Utility Scale PV Development Potential

Analysis of the Hawaiian Islands – Maui

CF(%)	Area (km^2)	MWac
≥20	20	576
≥18	28	783
≥16	28	783
≥14	28	783
≥12	28	783
≥10	28	783

Capacity Factor (%)

- 20-22
- 18-20
- 16-18
- 14-16
- 12-14
- 10-12

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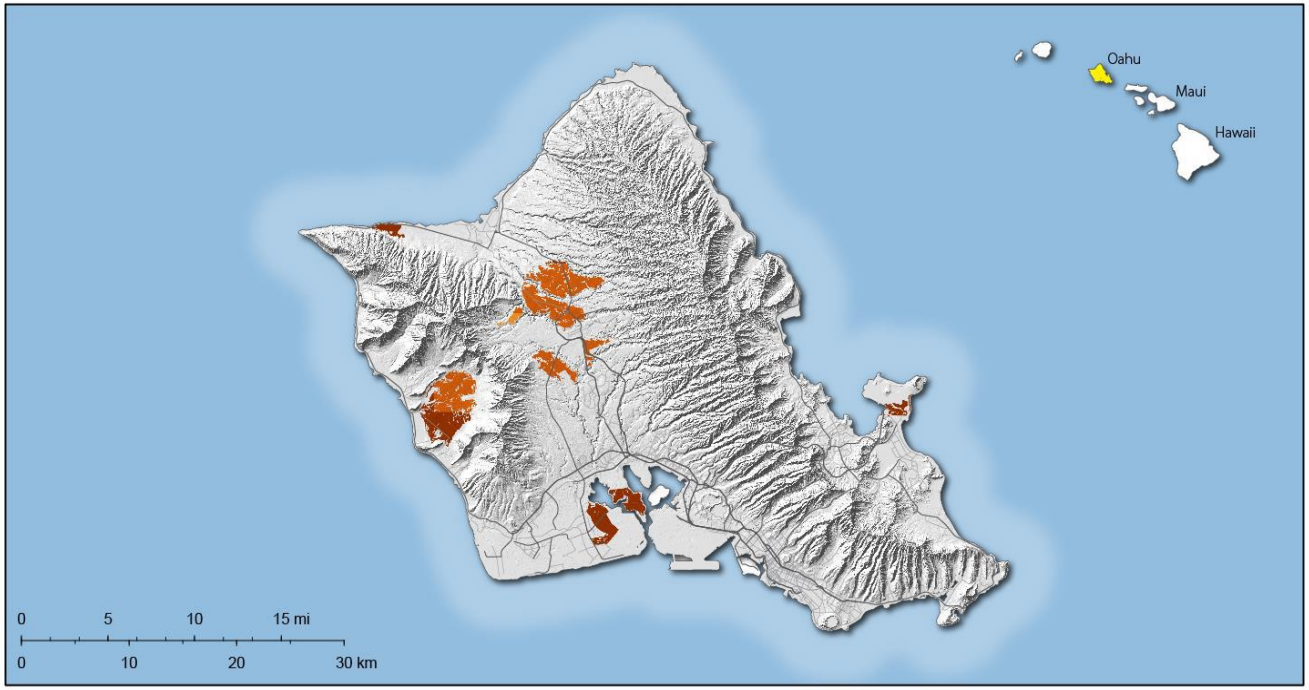
Solar Resource Potential: Oahu



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- is not Fish & Wildlife Service land
- has not been zoned as an urban area*
- is not classified as Important Agricultural Land*
- is not designated agricultural zone A*
- is not within an "A(x)" level flood zone*
- is not within a lava flow hazard zone 1 or 2*
- is not classified as a wetland*

**data acquired from the Hawaii Office of Planning*

Utility Scale PV Development Potential

Analysis of the Hawaiian Islands – Oahu

CF(%)	Area (km^2)	MWac
≥20	14	397
≥18	28	793
≥16	28	796
≥14	28	796
≥12	28	796
≥10	28	796

Capacity Factor (%)

- 20-22
- 18-20
- 16-18
- 14-16
- 12-14
- 10-12

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The Real Data: Maui

Wind

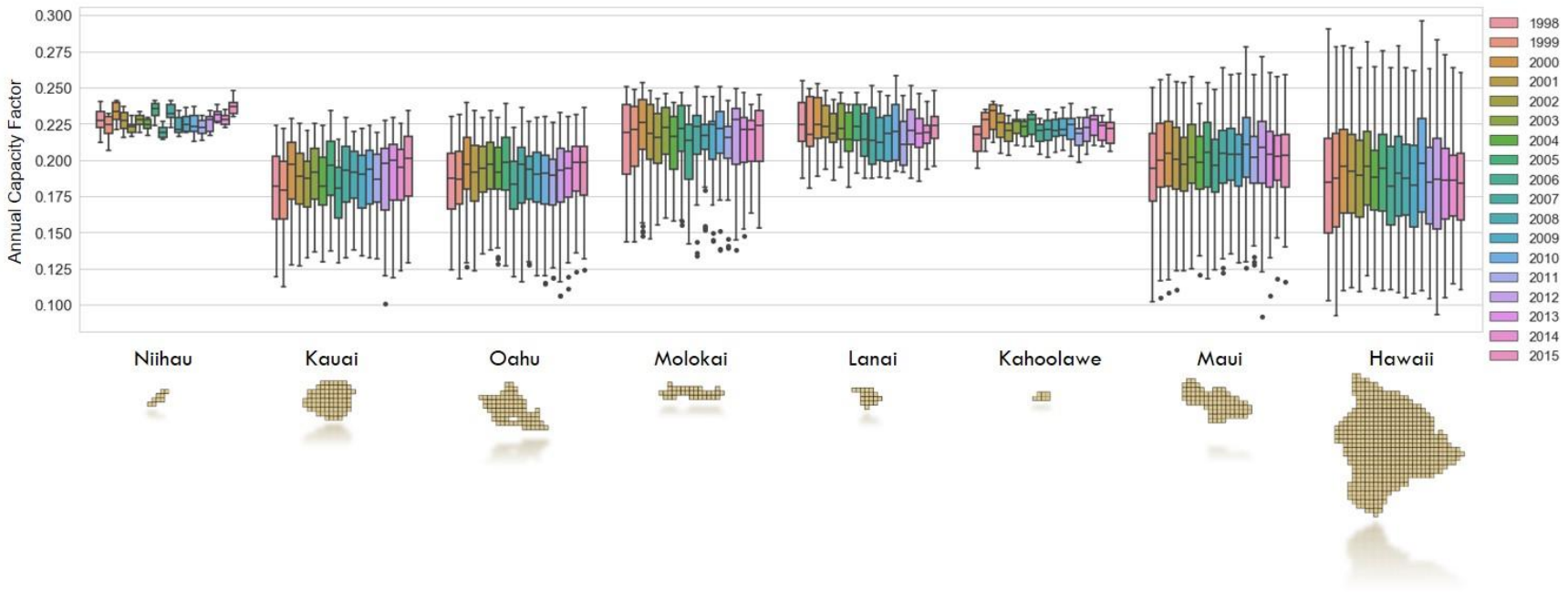
Mean Wind Speed (m/s) at 80m	Analysis 1 (MW)	Analysis 2 (MW)	Analysis 3 (MW)	Analysis 4 (MW)
>= 6.5	698	698	700	840
>= 7.5	412	412	417	448
>= 8.5	117	117	121	118

Solar PV

Capacity Factor (%)	Analysis 1 (MW)		Analysis 2 (MW)		Analysis 3 (MW)		Analysis 4 (MW)	
	Slope 3%	Slope 5%	Slope 3%	Slope 5%	Slope 3%	Slope 5%	Slope 3%	Slope 5%
>= 10	0	1,321	0	1,321	697	1,443	272	783
>= 12	0	1,321	0	1,321	697	1,443	272	783
>= 14	0	1,321	0	1,321	697	1,443	272	783
>= 16	0	1,321	0	1,321	697	1,443	272	783
>= 18	0	1,321	0	1,321	697	1,443	272	783
>= 20	0	1,110	0	1,110	697	1,230	272	576

- Analysis provides insight into the ease/cost of transitioning to wind/solar

Inter-Annual Variability of Solar Resource



- Quartiles shown for annual capacity over 1998-2015

"Characterizing Inter-Annual Variability of Solar Resource & Capacity Factor of Photovoltaic Power Systems Across the Hawaiian Islands", Richard Bryce, Ignacio Losada Carreño, Andrew Kumler, Bri-Mathias Hodge, Billy Roberts, Carlo Brancucci Martinez-Anido – soon to be published.

Thank you for your attention

Contact:

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