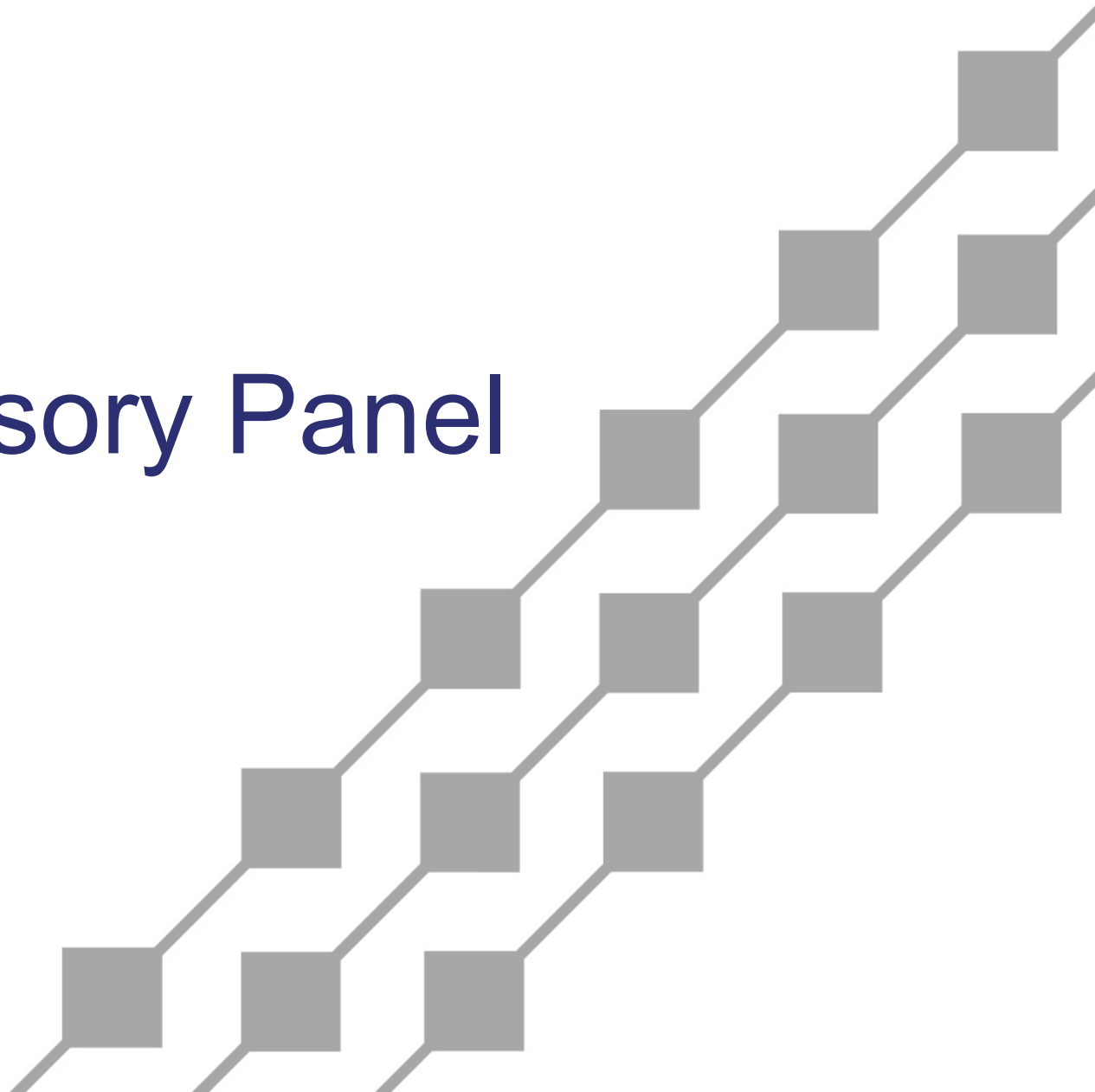




**Hawaiian
Electric**

IGP Technical Advisory Panel

January 20, 2022

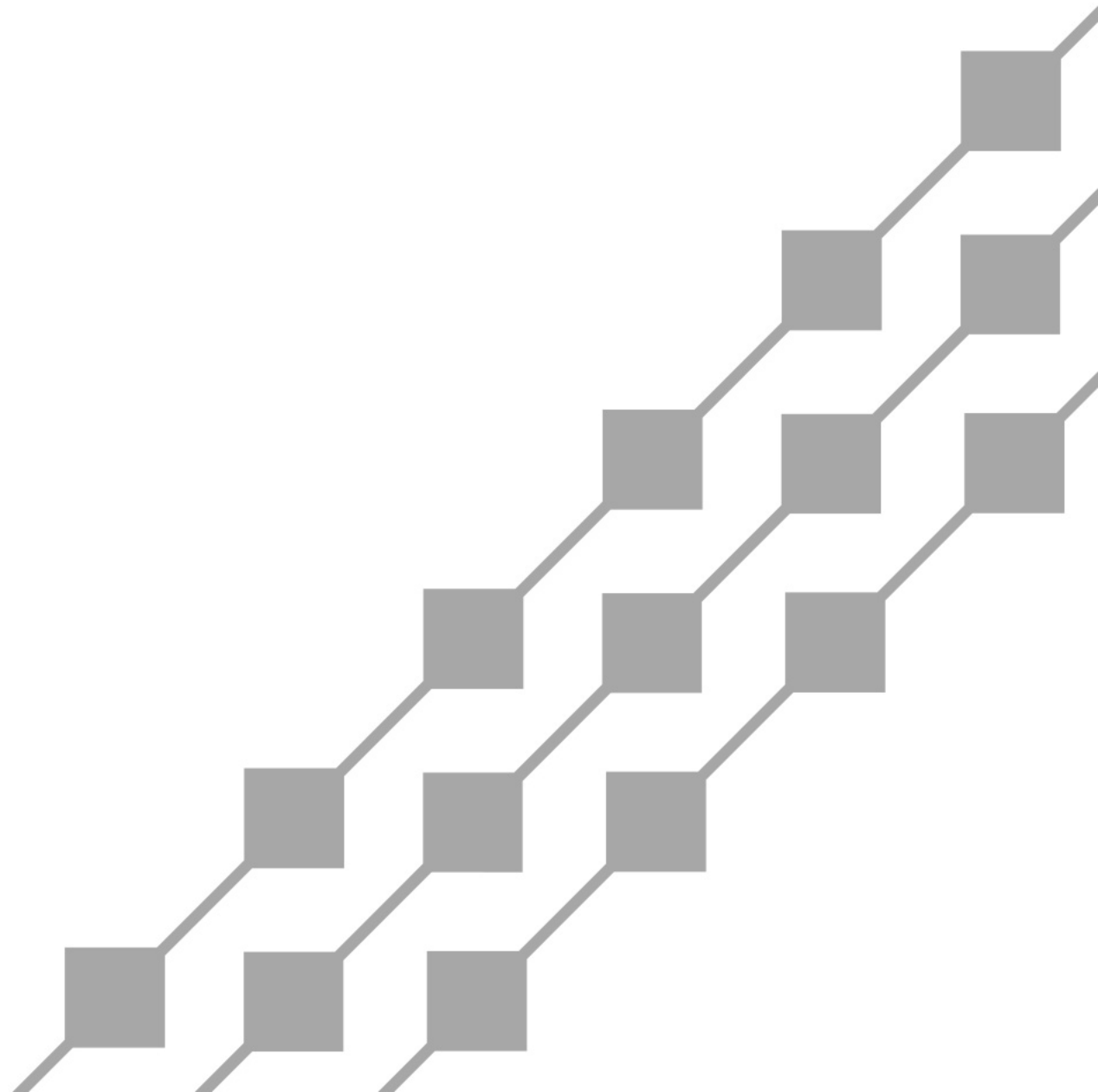


Agenda

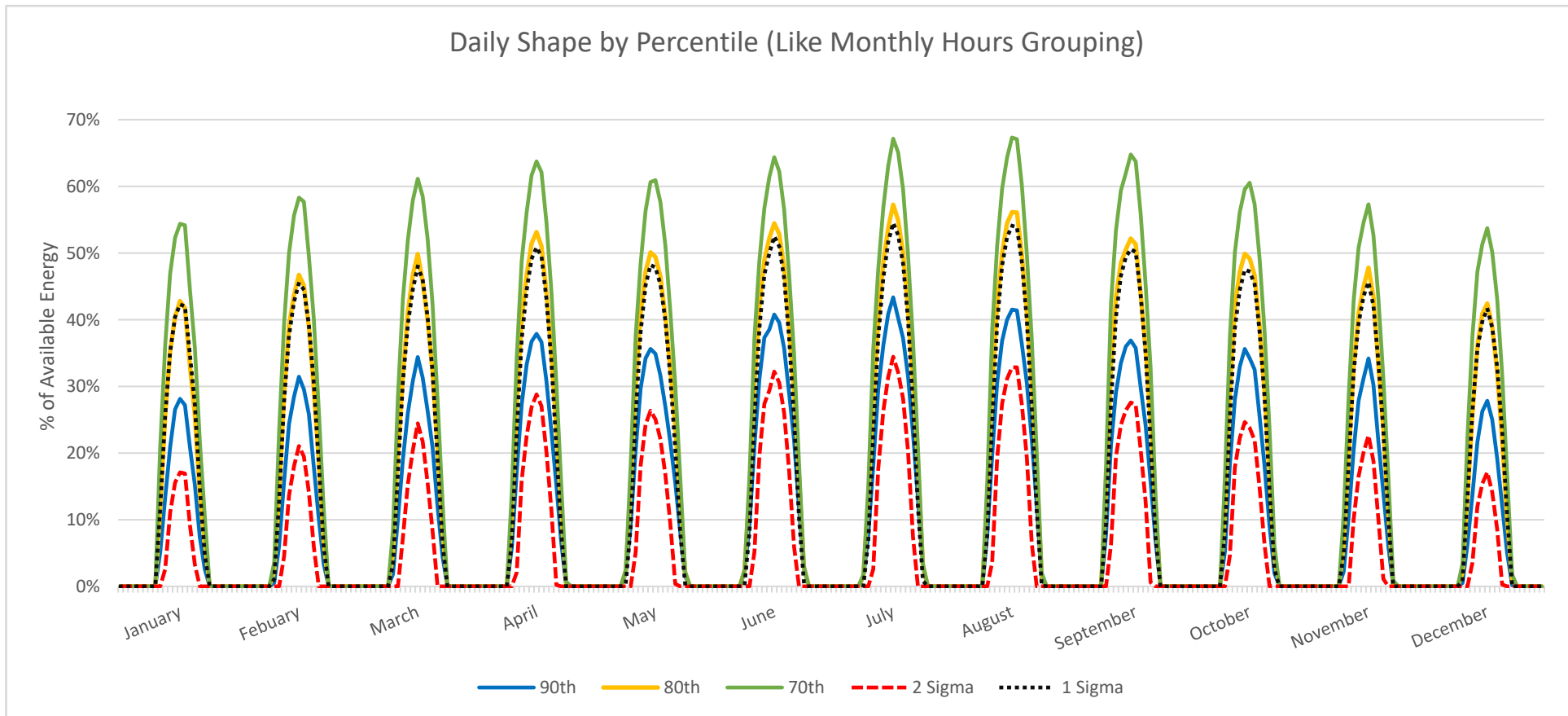
- ◆ Present recalculated HDCs based on TAP feedback
 - Use a monthly grouping of similar hours
 - Increase data samples with NREL data
 - Use percentiles to segregate data instead of exceedance probability



Solar HDC



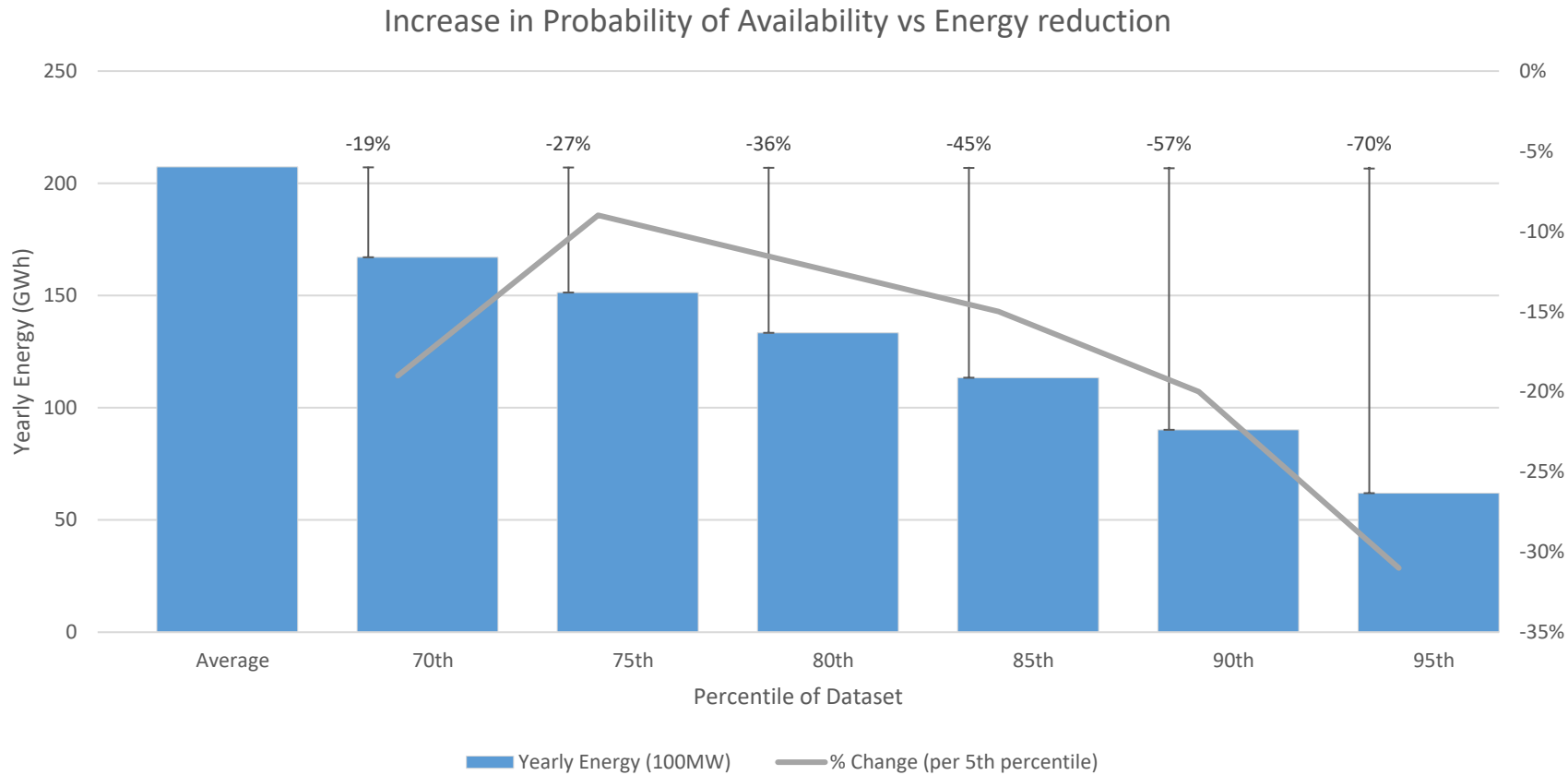
Oahu Solar HDC – Daily Shape



- ◆ Based on Oahu NREL dataset
- ◆ 23 years
- ◆ 27 locations
- ◆ Data grouped by similar hours in a month



Oahu Solar HDC – Energy

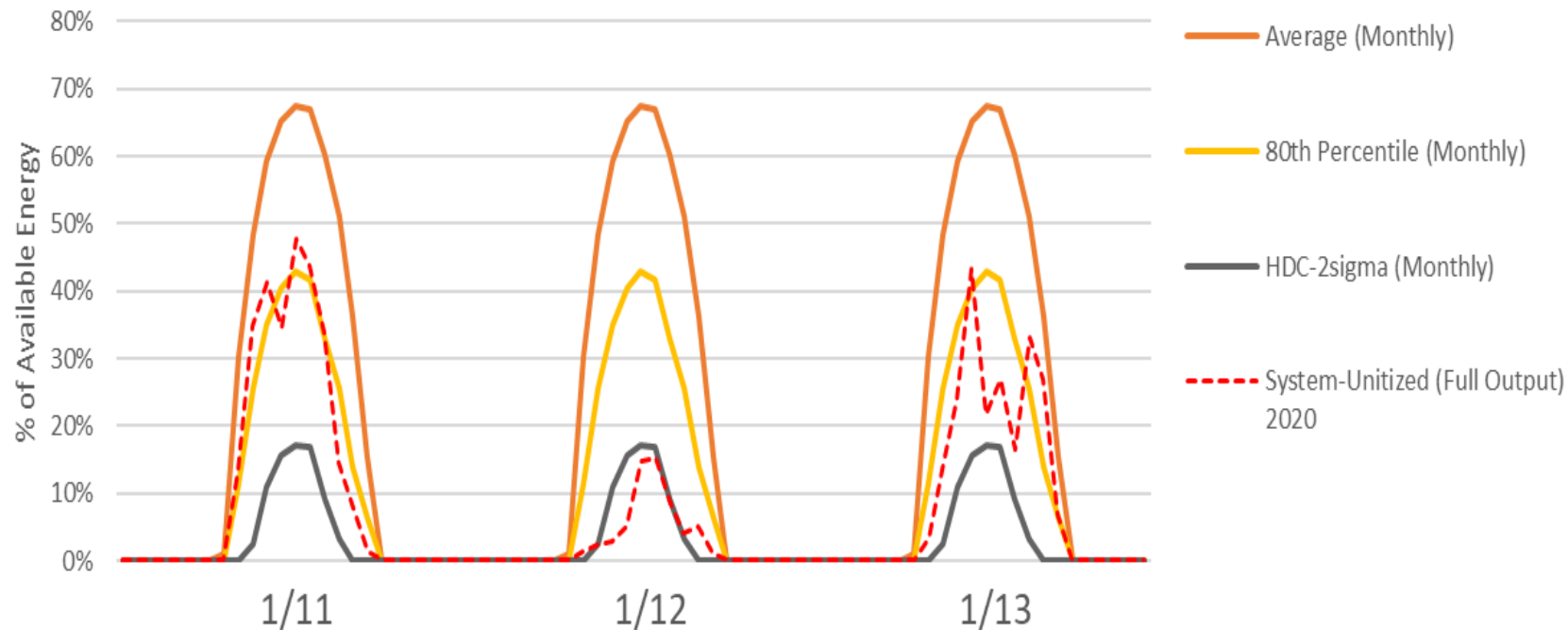


- ◆ Shown is the amount of yearly energy expected for each dataset (100 MW Generator)
- ◆ Average uses same monthly hour grouping
- ◆ Grey line shows rate of change per 5th percentile. 75th and 80th percentiles show deceleration.



Oahu Solar HDC Comparison – NREL Low Solar Day

Severe Weather Event Comparison
(Low Solar Generation 1/11/2020-1/13/2020)

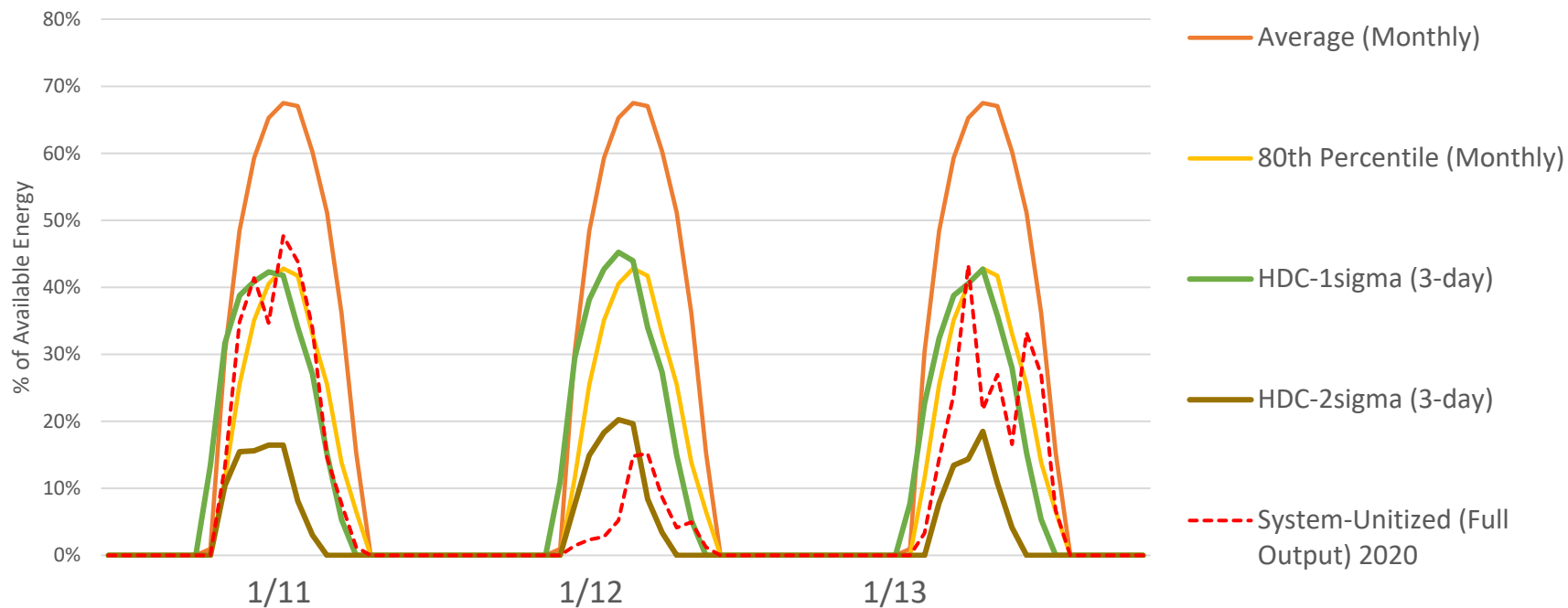


- ◆ Comparison of monthly average profiles with production from solar generators in-service during a 3-day low generation period
- ◆ 2 sigma profile calculated using same typical day in month (monthly)
- ◆ System-Unitized (Full Output) represents the average generation across the available solar generators for the specific day without monthly hour grouping



Oahu Solar HDC Comparison – NREL Low Solar Day

Severe Weather Event Comparison
(Low Solar Generation 1/11/2020-1/13/2020)

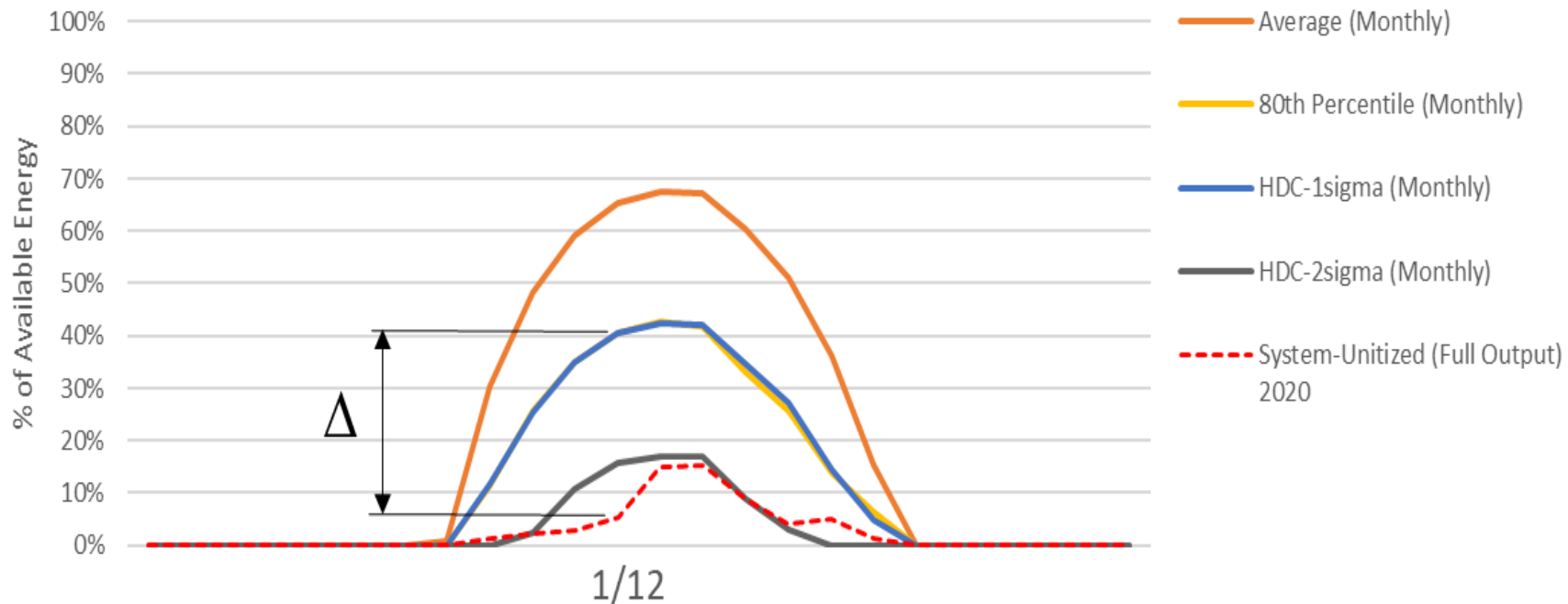


- ◆ 1 sigma and 2 sigma profiles calculated using previous HDC methodology (rolling 3 days)



Oahu Solar HDC Comparison – NREL Low Solar Day

Severe Weather Event Comparison
(Low Solar Generation 1/12/2020)

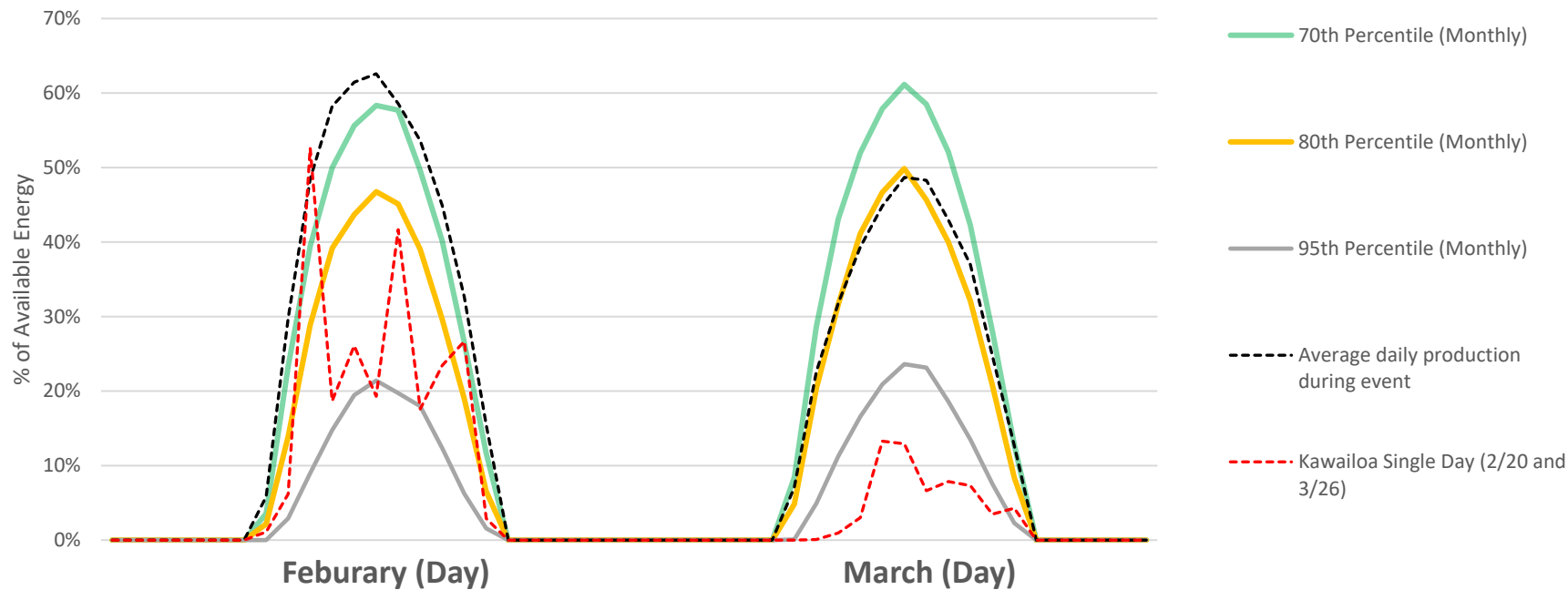


- ◆ Significant overlap of 1 sigma and 80th percentile profiles
- ◆ However, 1 sigma or 80th percentile would overstate the available energy on this day.



Oahu Solar HDC Comparison – NREL Low Solar Day

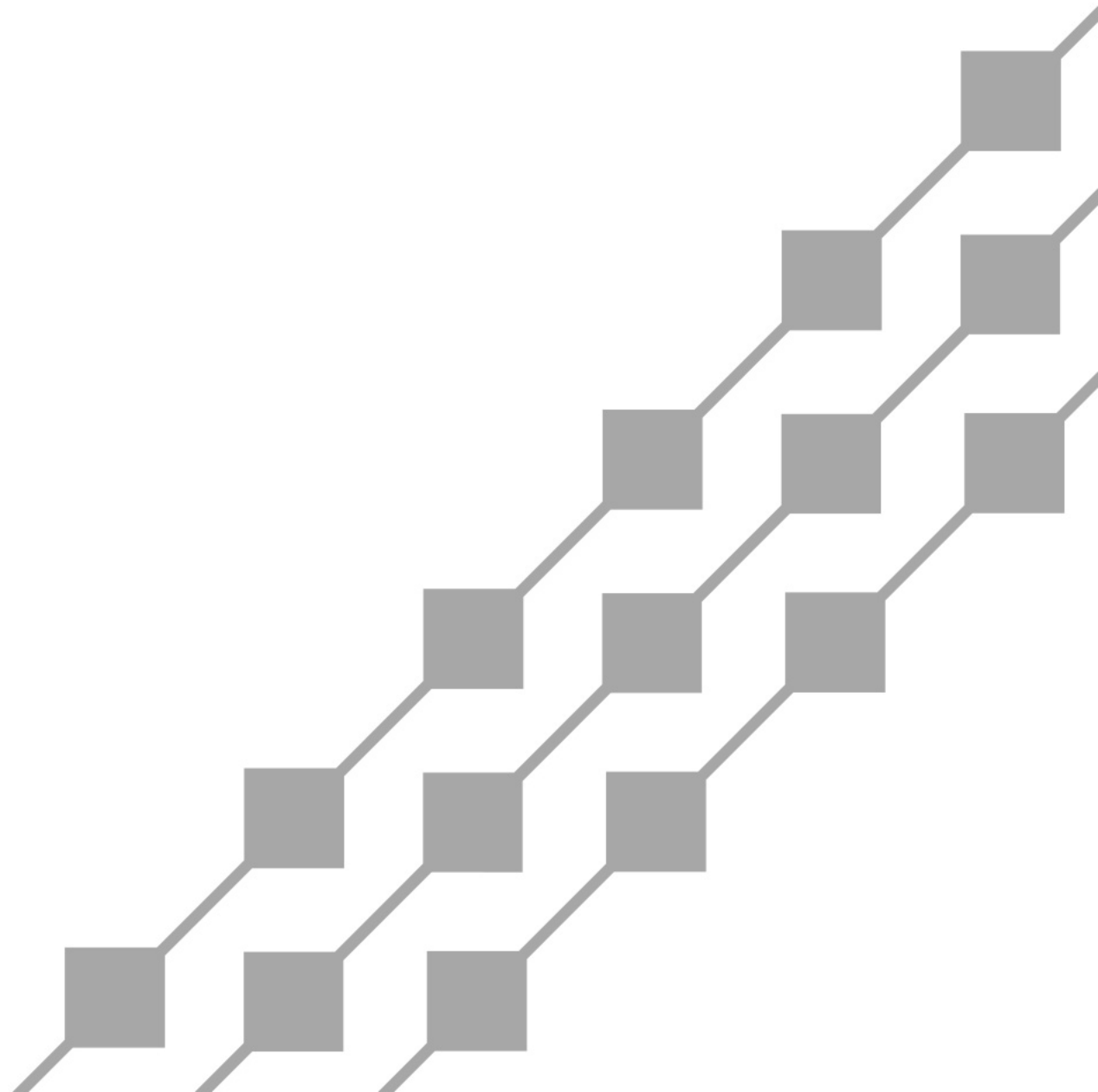
Severe Weather Event Comparison
(41 days of rain 2/19/2006 - 3/21/2006)



- ◆ Additional comparisons of the NREL data for the Kawaiiloa Solar project against various percentiles

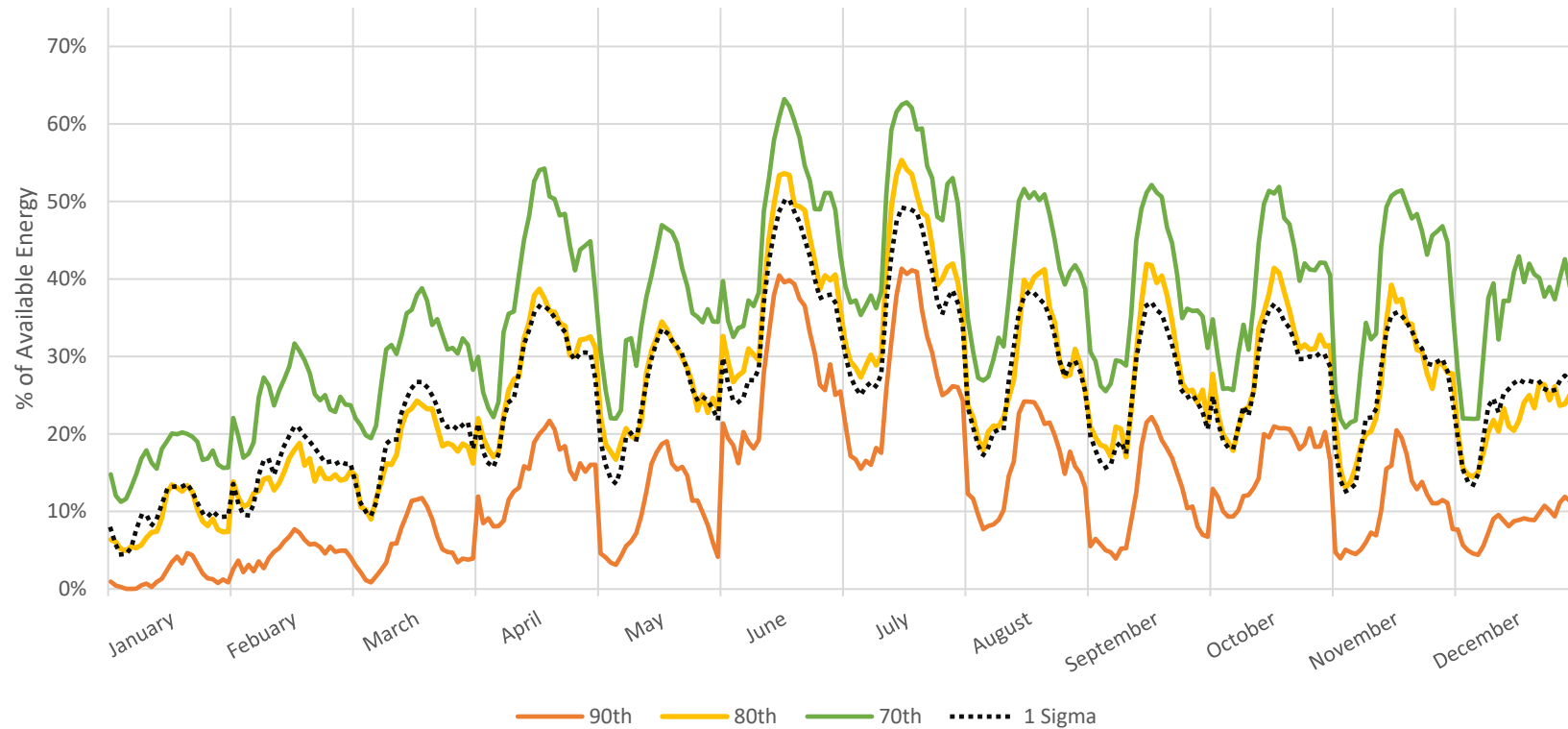


Wind HDC



Hawaii Wind HDC – Daily Shape

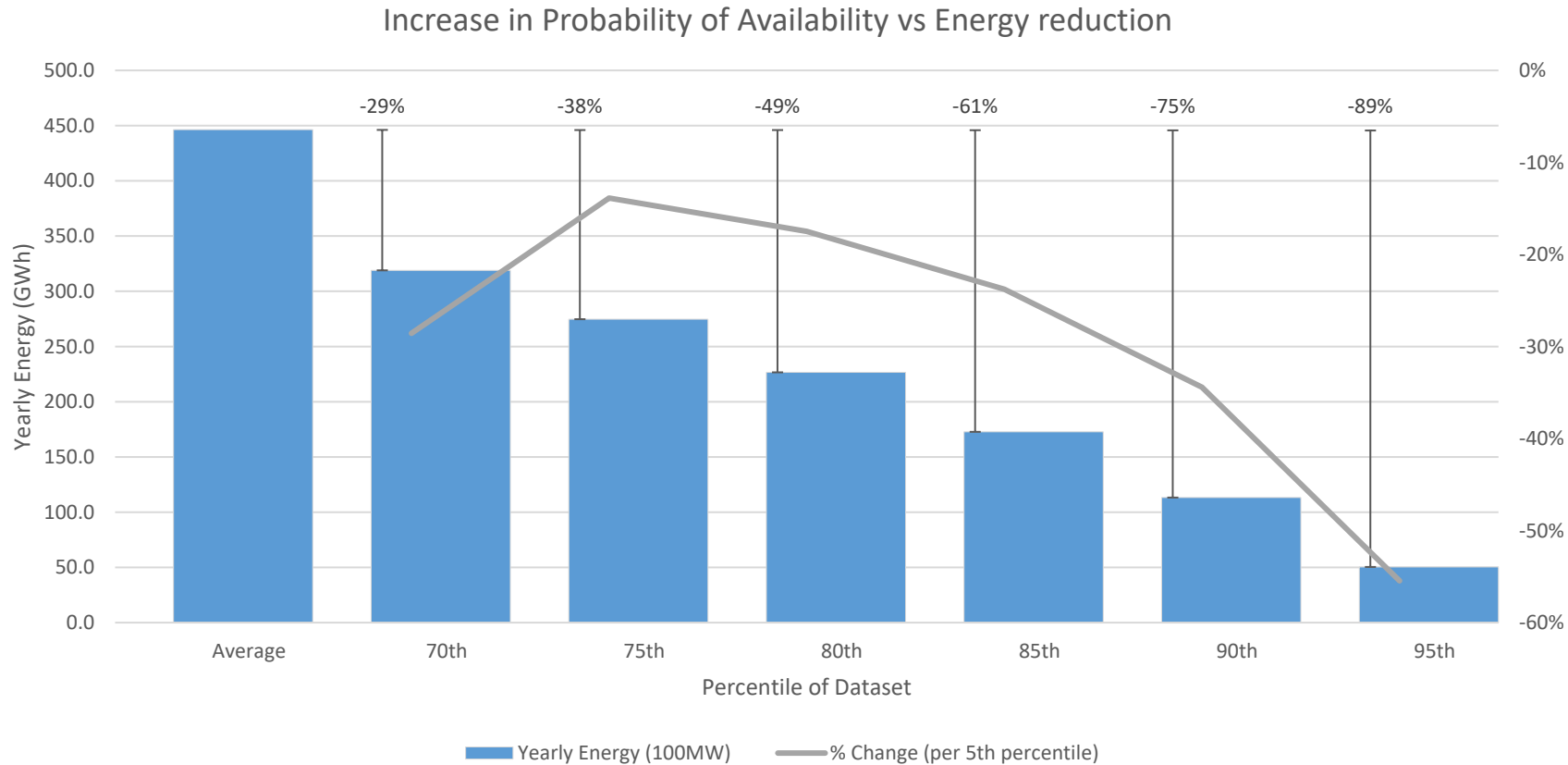
Daily Shape by Percentile (Like Monthly Hours Grouping)



- ◆ Based on Hawaii Island historical dataset
- ◆ 13 years
- ◆ 2 locations
- ◆ Data grouped by similar hours in a month



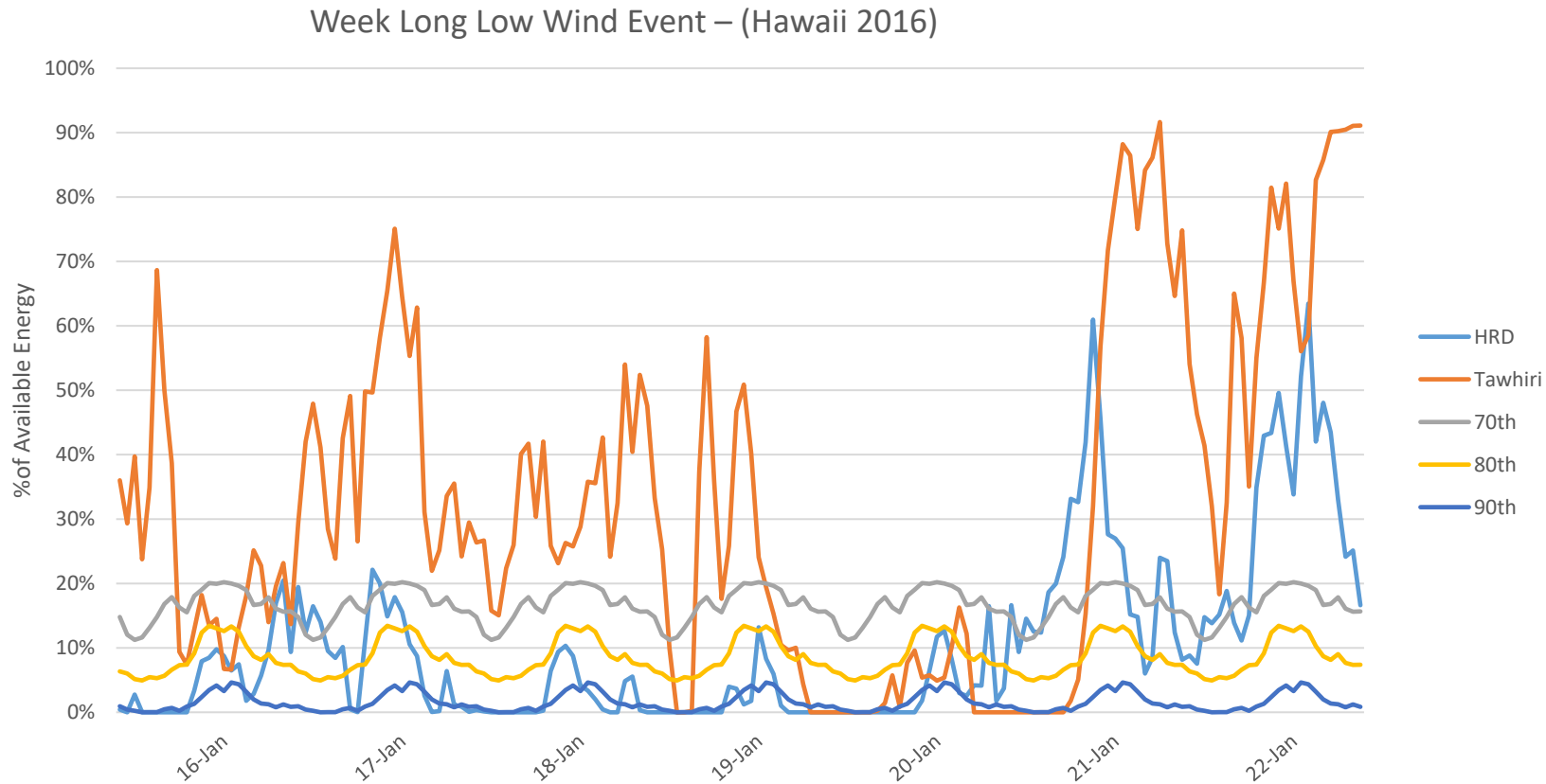
Hawaii Wind HDC – Energy



- ◆ Shown is the amount of yearly energy expected for each dataset (100 MW Generator)
- ◆ Average uses same monthly hour grouping
- ◆ Grey line shows rate of change per 5th percentile. 75th and 80th percentiles show deceleration



Hawaii Wind HDC – Actual Low Wind Day

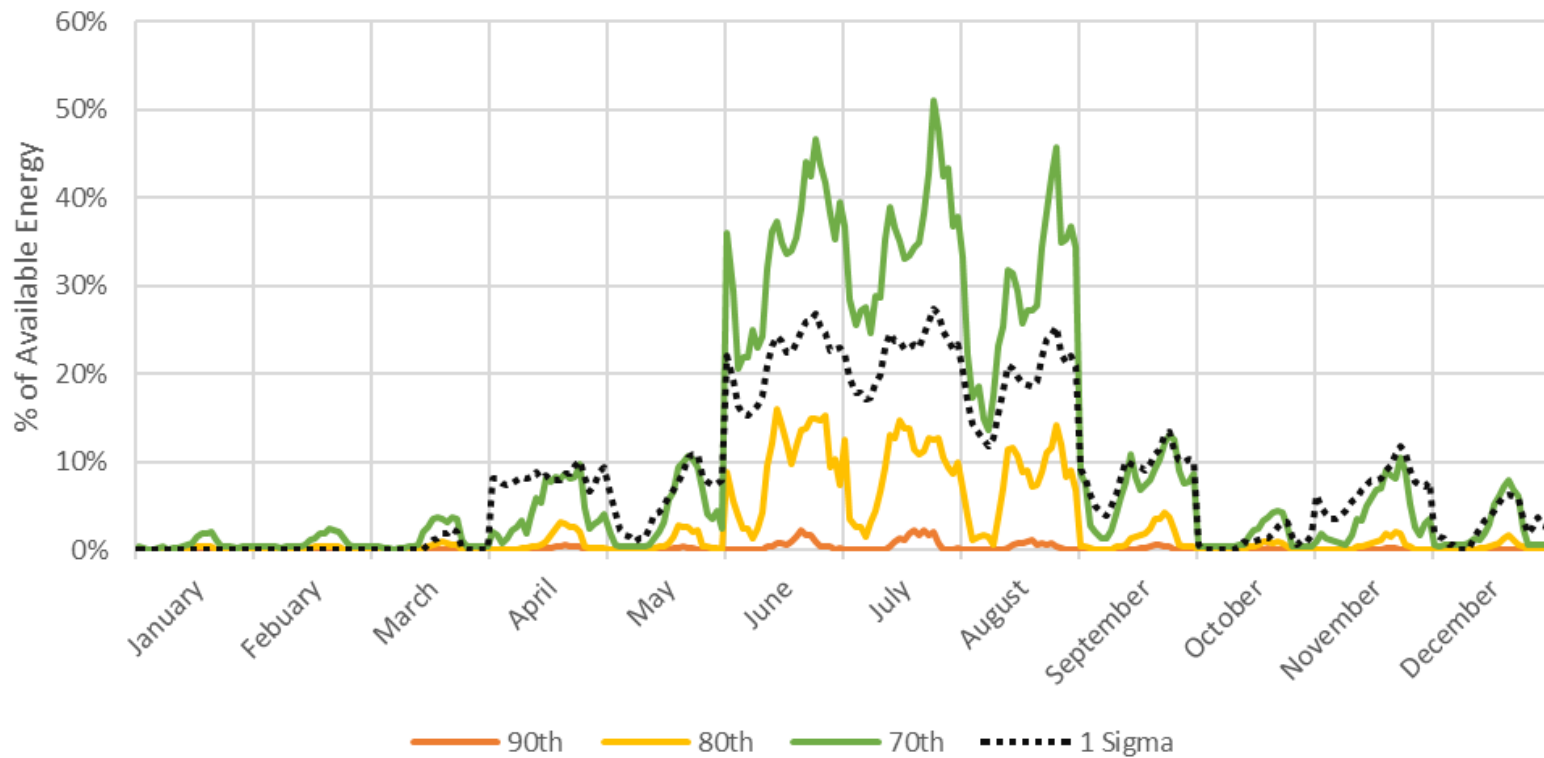


- ◆ Wind production from Hawaii Island HRD and Tawhiri wind farms
- ◆ Typical day in month reduces variability of historical data



Maui Wind HDC – Daily Shape

Daily Shape by Percentile (Like Monthly Hours Grouping)

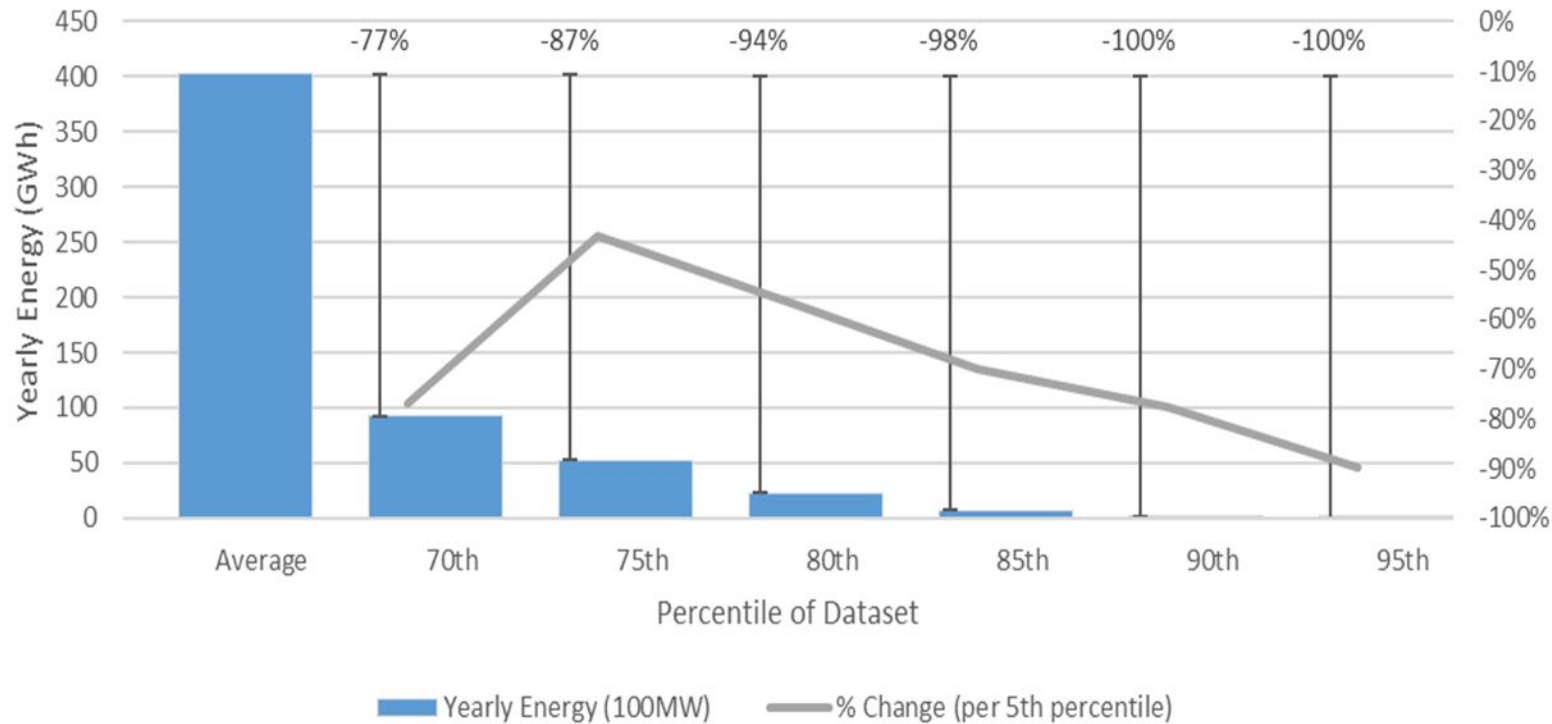


- ◆ Based on Maui historical dataset
- ◆ 8 years
- ◆ 3 wind farms
- ◆ Data grouped by similar hours in a month



Maui Wind HDC - Energy

Increase in Probability of Availability vs Energy reduction

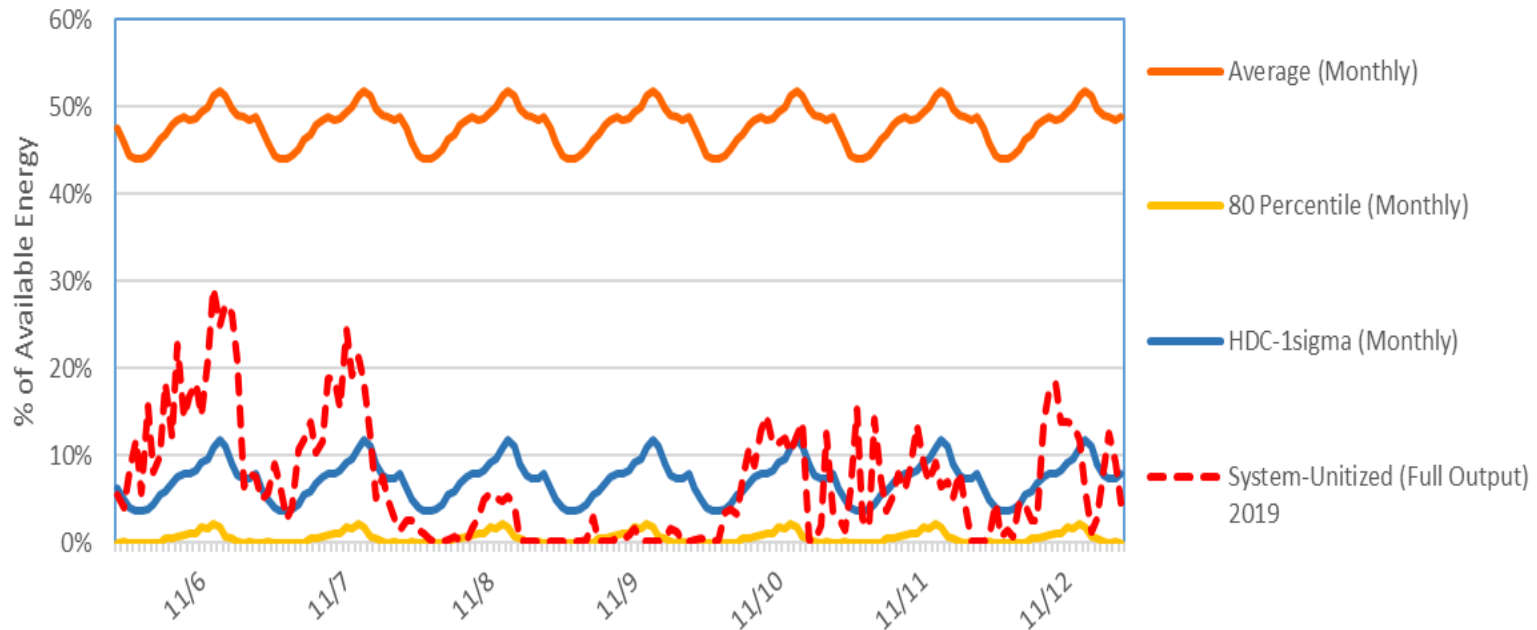


- ◆ Shown is the amount of yearly energy expected for each dataset (100 MW Generator)
- ◆ Average uses same monthly hour grouping
- ◆ Grey line shows rate of change per 5th percentile. 75th and 80th percentiles show deceleration



Maui Wind HDC – Actual Low Wind Day

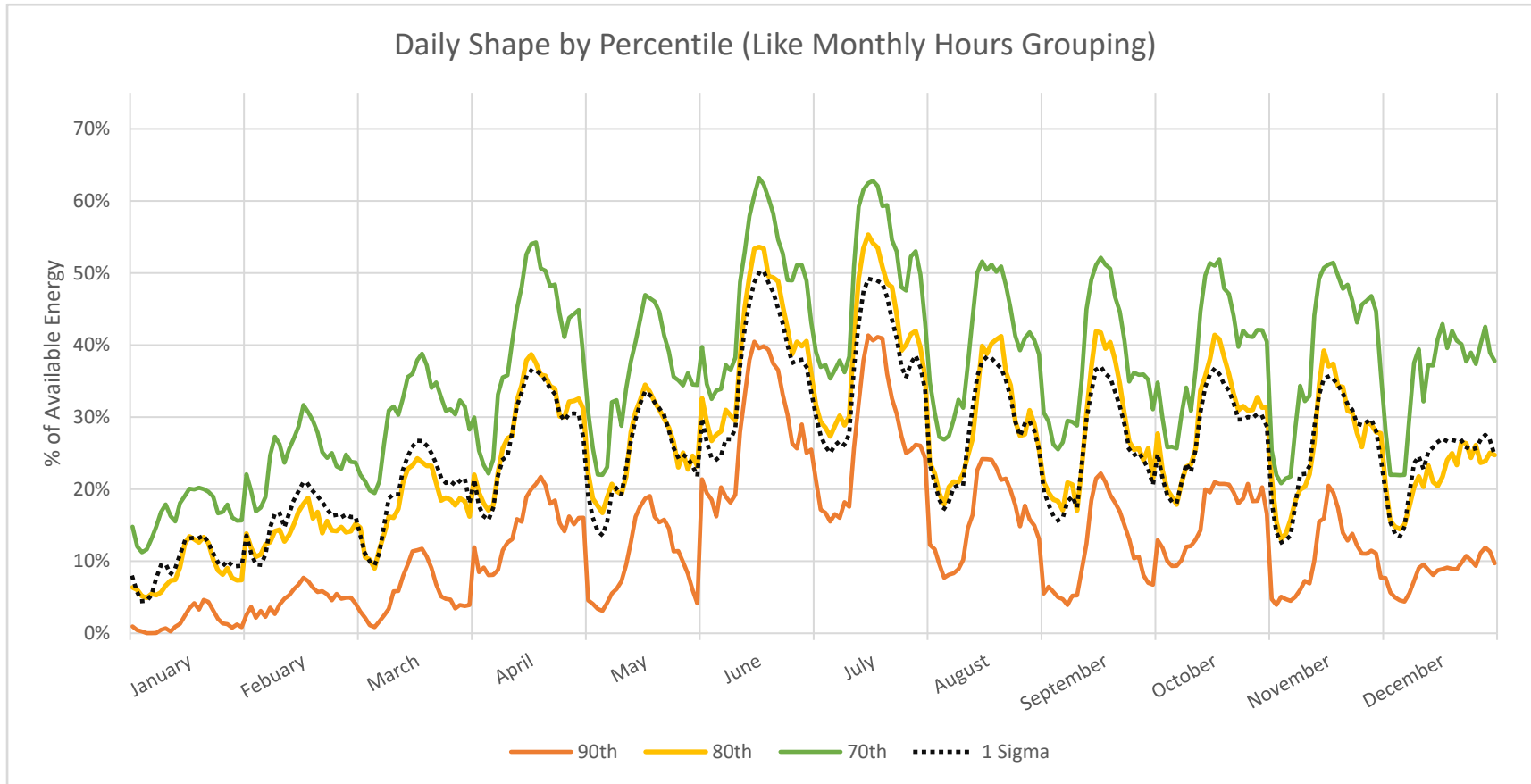
Severe Weather Event Comparison
(Low Wind Generation 11/6/2019-11/12/2019)



- ◆ Comparison of monthly average profiles for a low wind period



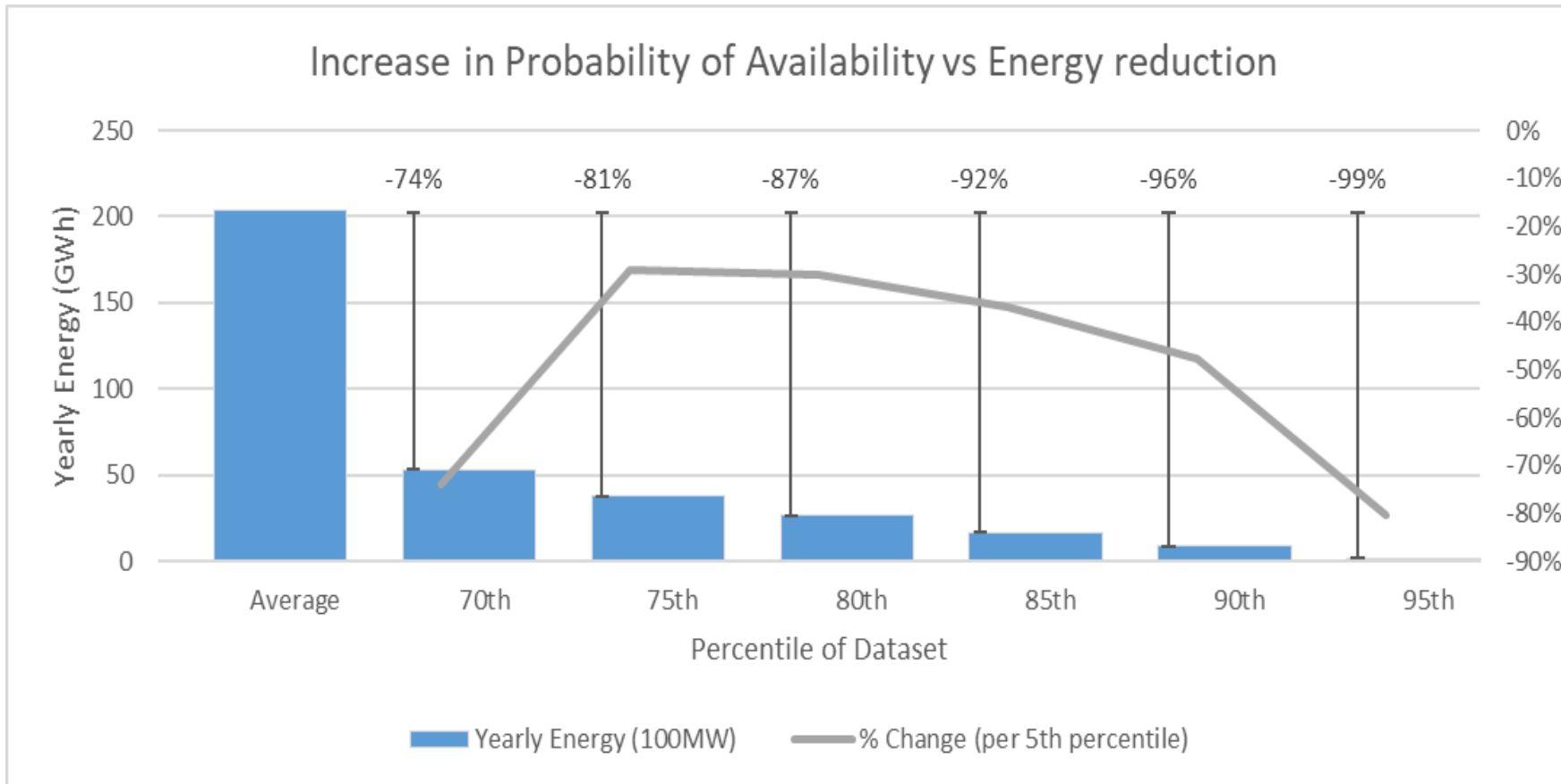
Oahu Wind HDC – Daily Shape



- ◆ Based on Oahu Historical dataset
- ◆ 8 years (2013-2020)
- ◆ 3 locations (NPM in-service from 12/11/20)
- ◆ Data grouped by similar hours in a month (one representative day per month)



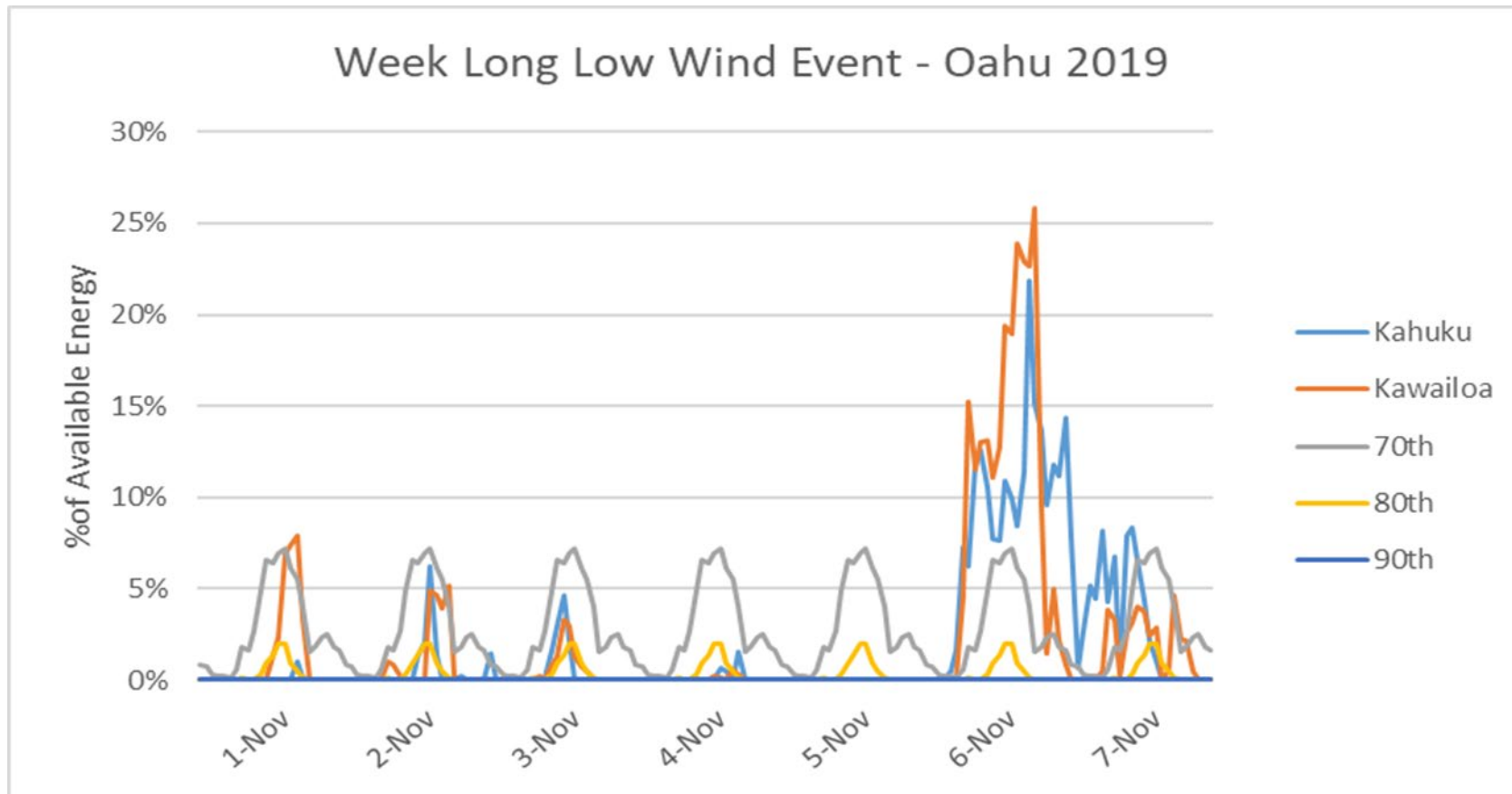
Oahu Wind HDC – Energy



- ◆ Shown is the amount of yearly energy expected for each dataset (100 MW Generator)
- ◆ Average uses same monthly hour grouping
- ◆ Grey line shows rate of change per 5th percentile. 75th and 80th percentiles show deceleration



Oahu Wind HDC – Actual Low Wind Day



- ◆ Wind production from Kahuku and Kawaiiloa wind farms
- ◆ Typical day in month reduces variability of historical data



Next Steps

- ◆ The Company proposes to adopt an 80th percentile HDC for solar and wind using the typical day in month approach based on data from the NREL NSRDB for solar and historical production data for wind
 - For solar, the 1 sigma HDC calculation shows agreement with the 80th percentile calculation
 - For wind, the 1 sigma HDC calculation shows agreement with the 80th percentile calculation on Hawai'i Island and O'ahu. The 80th percentile reduces risk of overstating wind availability on Maui.
 - This is consistent with TAP feedback to expand the data set used in the HDC calculation to include data available from NREL and to group similar hours within the month



