Grid Planning for a Modern Power System in Hawaii

AES Retirement & Replacement Analysis | March 15, 2021

Docket 2021-0024

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Stochastic Analysis of Resource Adequacy to Address Interannual Resource Variability

- Historical inter-annual solar variability applied to future grid
- Uncertainty and timing of generator outages considered
- Each analysis evaluates capacity shortage across 2.5 million hours of possible operation.
- Methodology allows detailed month-by-month characterization of LOL events

Loss of Load Hours by Sample with Stage 1 Deployed

Outage Draws →

Solar Years ↕

Solar Year	1	2	3	4	5	6	7	8	9	10	11	12
1998	0	0	10	3	0	0	2	0	3	6	0	0
1999	2	0	9	0	3	0	0	0	0	0	3	0
2000	0	0	0	0	0	0	0	2	0	0	6	0
2001	0	0	0	2	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	6	0	0	0	0
2003	0	0	1	0	0	0	0	0	0	0	0	1
2004	0	2	0	0	0	1	0	0	0	0	0	0
2005	0	0	0	4	0	0	0	1	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	3	0
2007	0	3	0	0	0	2	0	0	0	0	0	0
2008	3	0	0	0	0	0	0	5	0	0	0	0
2009	0	0	2	0	1	0	0	1	0	0	3	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	11	0	2	0	0	0	0	0	1	0	3	0
2012	0	3	0	0	0	0	0	0	0	0	0	0
2013	2	0	3	3	0	2	0	0	0	0	0	7
2014	0	0	10	0	0	0	0	0	0	0	0	0
2015	1	0	0	0	3	0	8	0	0	0	0	0
2016	0	1	0	2	0	0	0	0	1	0	0	0
2017	0	0	0	0	0	0	1	1	0	0	0	0
2018	0	10	0	0	0	0	0	0	0	0	0	1

Average across 252 simulations yields LOLE for one specified grid conditions

Model Updates since the December PUC Briefing

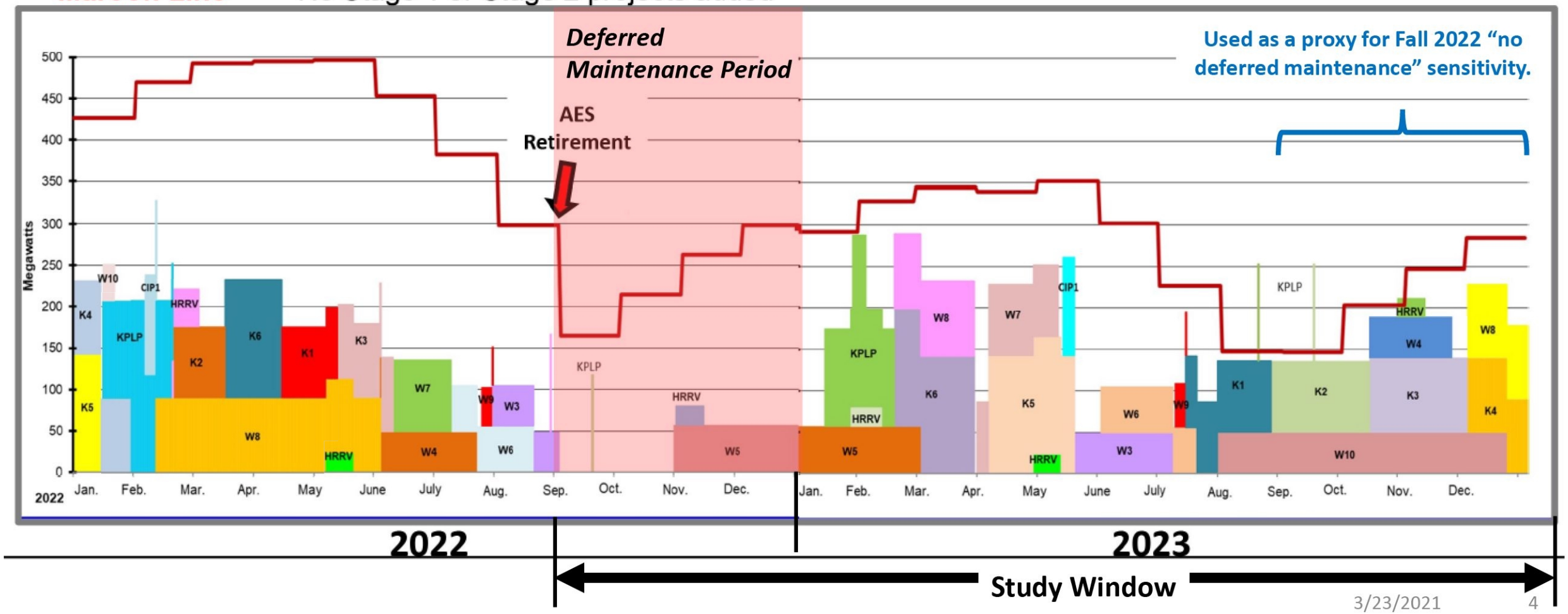
- Updated Peak and Energy target from IGP forecast for 2023
- Updated load profile to hourly value from IGP forecast for 2023
- Incorporated HECO's Demand Response programs (50 MW total, CIDLC, RDLC, Fast DR, Load Reduce)
- Incorporated HECO's planned outage schedule for 2022 and 2023
- Increased CIPCT capacity by 17 MW due to diesel fuel switch
- Added new DPV installations of ~30 MW based on 4Q installed data, no additions assumed yet
- Adjusted definition of *planned outages* vs. *maintenance outages*
- Model parameters for execution speed
- Does **NOT** include updates for additional 60 MW Grid Services RFP or CBRE projects

HECO Planned Outage Schedule, 2022-2023

- Prior to 9/1/2022: Reserve = Operating Capability (1753MW) – Largest Unit (180MW) – Predicted Peaks
- After 9/1/2022: Reserve = Operating Capability (1573MW) – Largest Unit (142MW) – Predicted Peaks

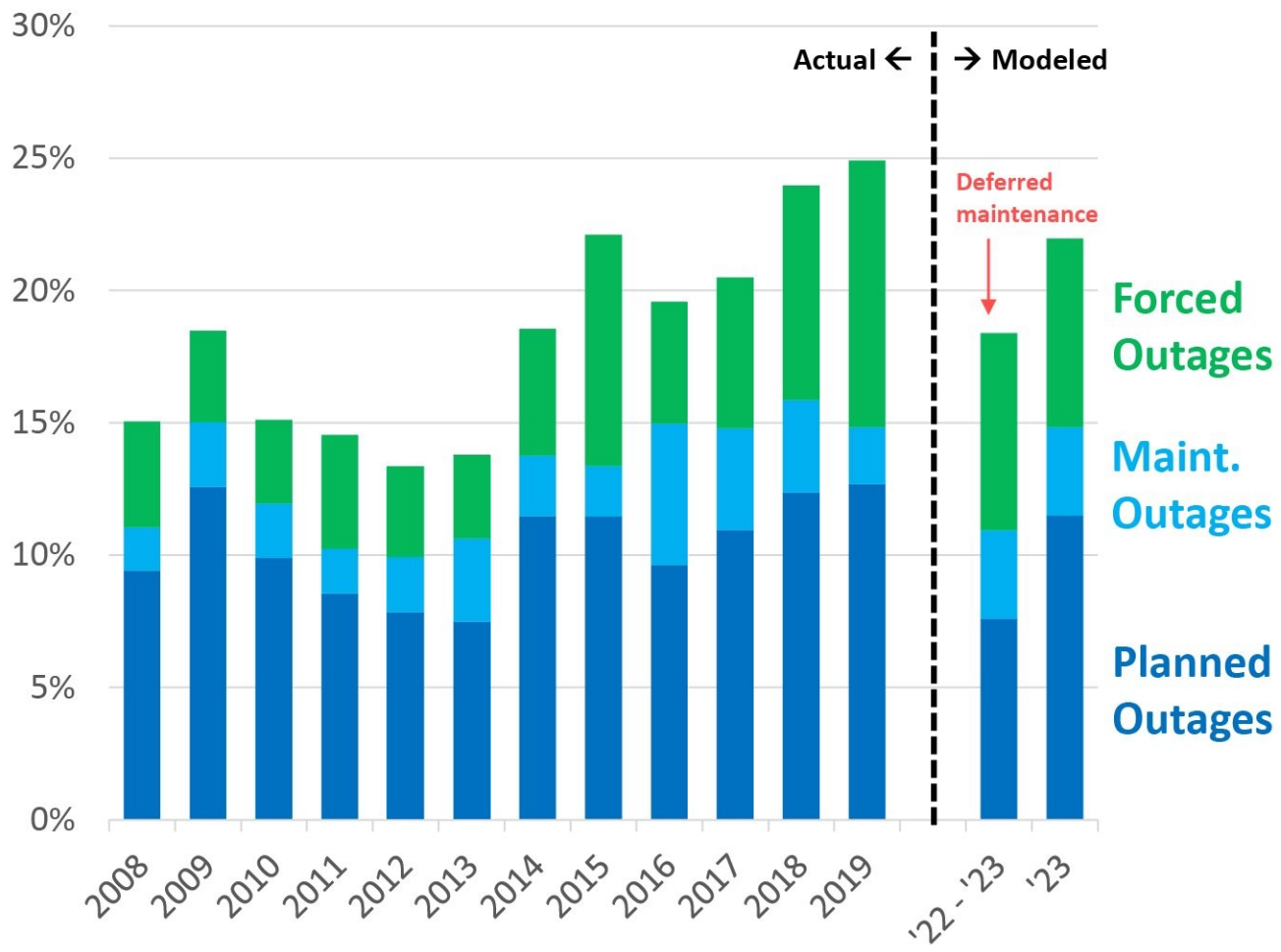
Maroon Line in Chart

Maroon Line – No Stage 1 or Stage 2 projects added



Source: HECO, HPUC Status Conference, Docket 2017-0352, 12/18/2020

Historic Outage Rates



- Increased outage rates after 2015 likely due to EPA MATS compliance
- Average forced outage rate from 2015 – 2019 used for this analysis
- Highest historical forced outage from 2019 used for sensitivity analysis
- HECO's 2023 planned maintenance schedule consistent with historical record
- '22 – '23 represents September 2022 to August 2023 with deferred maintenance for first four months

Average maintenance and forced outage rate between 2015 and 2019 used for this analysis

Study Horizon: September 2022 to December 2023

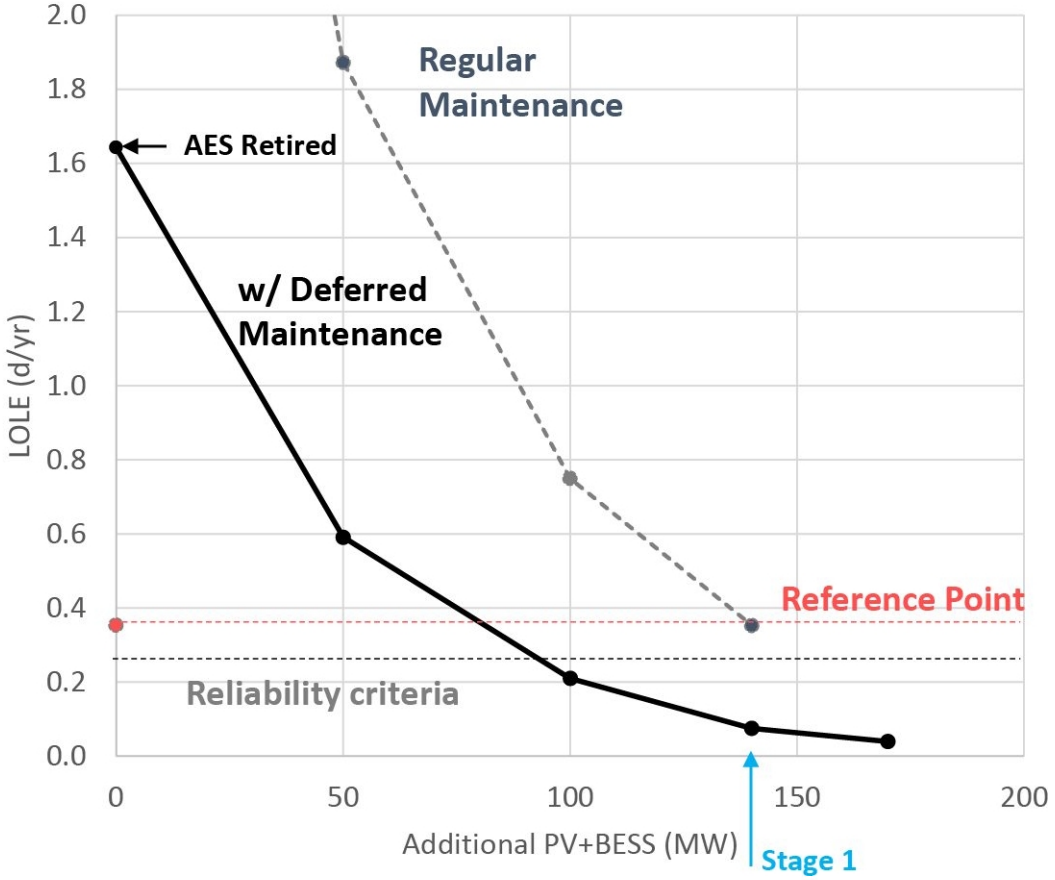
Reference Point: System reliability with current installed capacity, AES in operation, and HECO "normal' maintenance through 2023. (Assumes fall 2022 same as fall 2023)

PV+BESS Scenarios: System reliability with AES retired plus up to 170 MW of PV+BESS charged only from grid (ITC)

- **Base Case**: Assumes HECO proposed planned maintenance outage schedule including deferred maintenance thru Dec 2022 with 5-year average forced outage rate assumptions.
- **Maintenance Sensitivity**: Same as base case (AES retired, HECO 2023 planned maintenance schedule, 5-year average forced outage) but no deferred maintenance from September to December
- **High Forced Outage Rate**: Same as base case with higher 2019 forced outage rates for HECO fossil units (+30% EFOR)
- **Kapolei Battery**: Base case plus 135 MW, 540 MWh stand-alone, grid-connected, load shifting BESS

Neither reference of PV+BESS Scenarios include 60MW grid service RFP, CBRE or additional roof-top PV

Effect of Deferred Maintenance plus PV+BESS Build-out on Annual LOLE (AES retired)



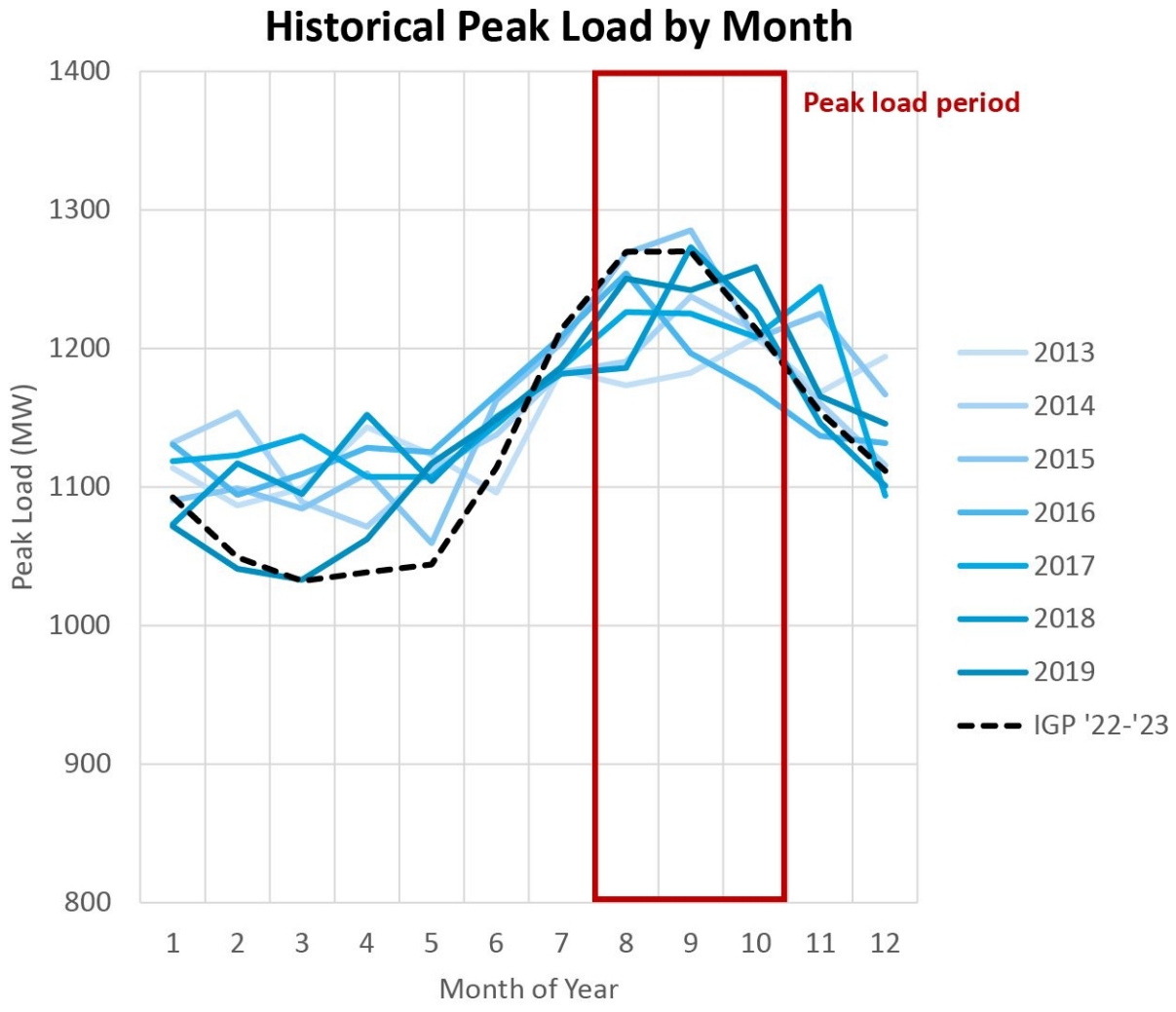
		Annual Metrics						
Scenario	Add'l Solar PV	LOLE	LOLH	LOLP	EUE	Max Shortfall	Avg Duration	Max Duration
Reference Point	0	0.353	0.698	0.097%	30.60	245.2	2.0	10
AES Retired	0	**1.643**	3.524	0.450%	164.88	276.7	2.1	10
	50	**0.591**	1.313	0.162%	62.22	333.0	2.2	10
	100	**0.210**	0.365	0.058%	13.53	175.3	1.7	6
	140	**0.075**	0.139	0.021%	5.36	176.6	1.8	7
	170	**0.040**	0.083	0.011%	3.02	71.0	2.1	6

Key Findings (annual metrics)

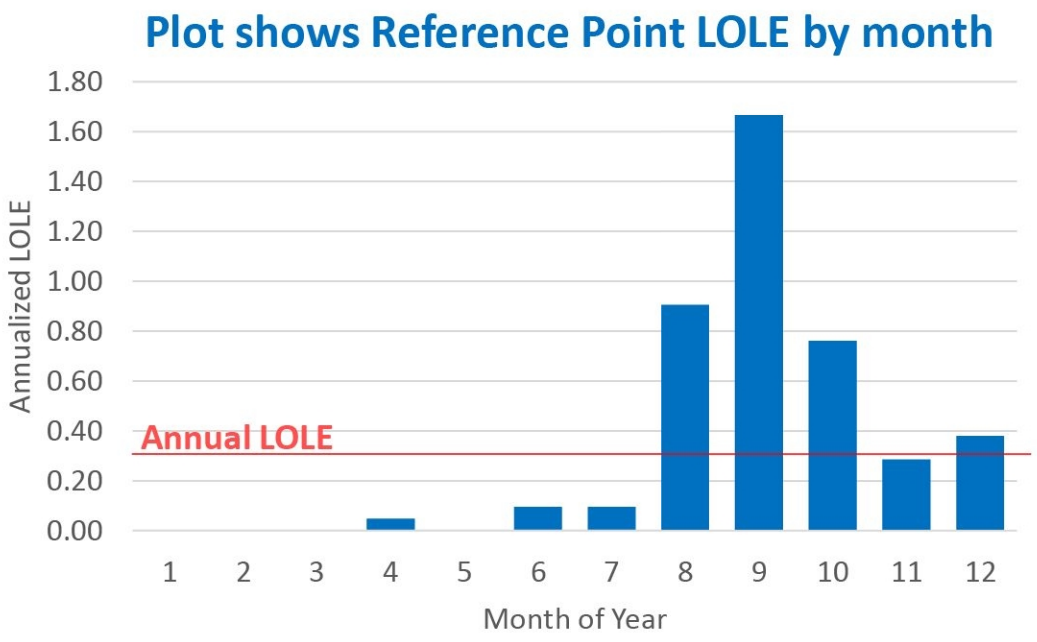
- Deferred maintenance significantly improves reliability but does not fully replace AES
- PV+BESS systems provide approx. 1-to-1 replacement capacity for AES
- Deferred maintenance plus 80 MW of PV+BESS returns annual LOLE to reference point value

Annual LOL metrics are not sufficiently discrete to characterize risk during critical months

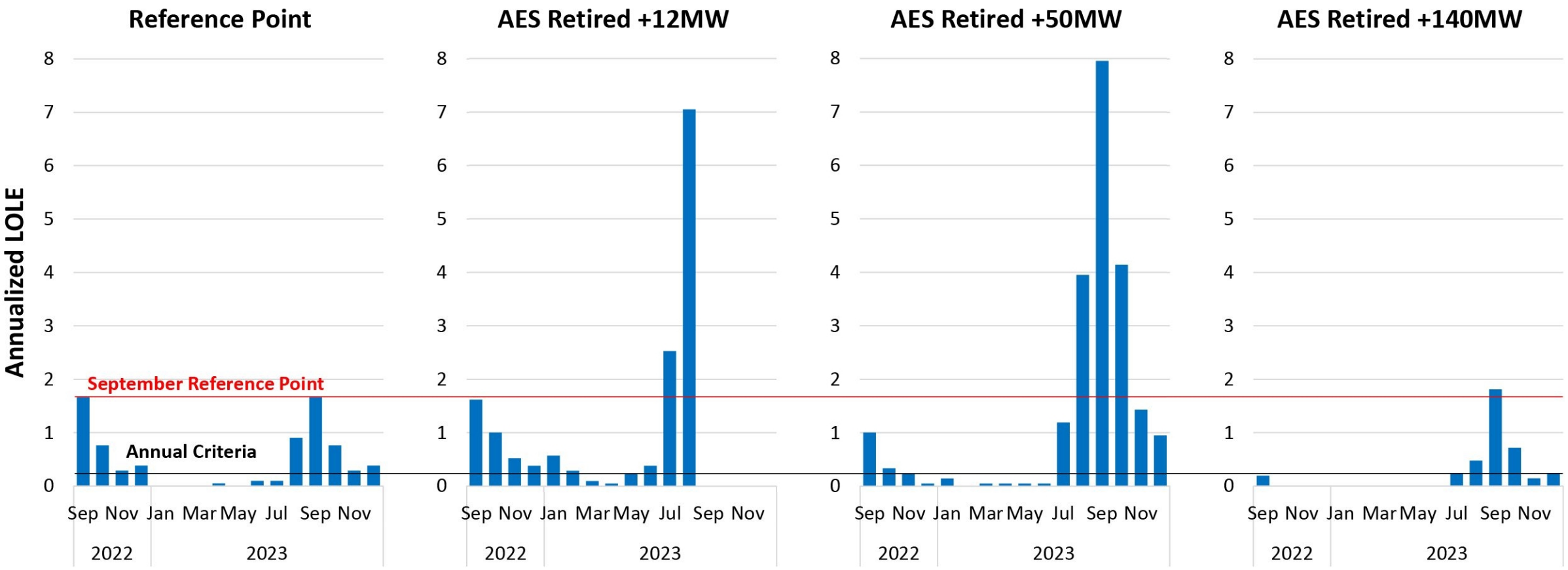
Fall Seasonal Load Assessment



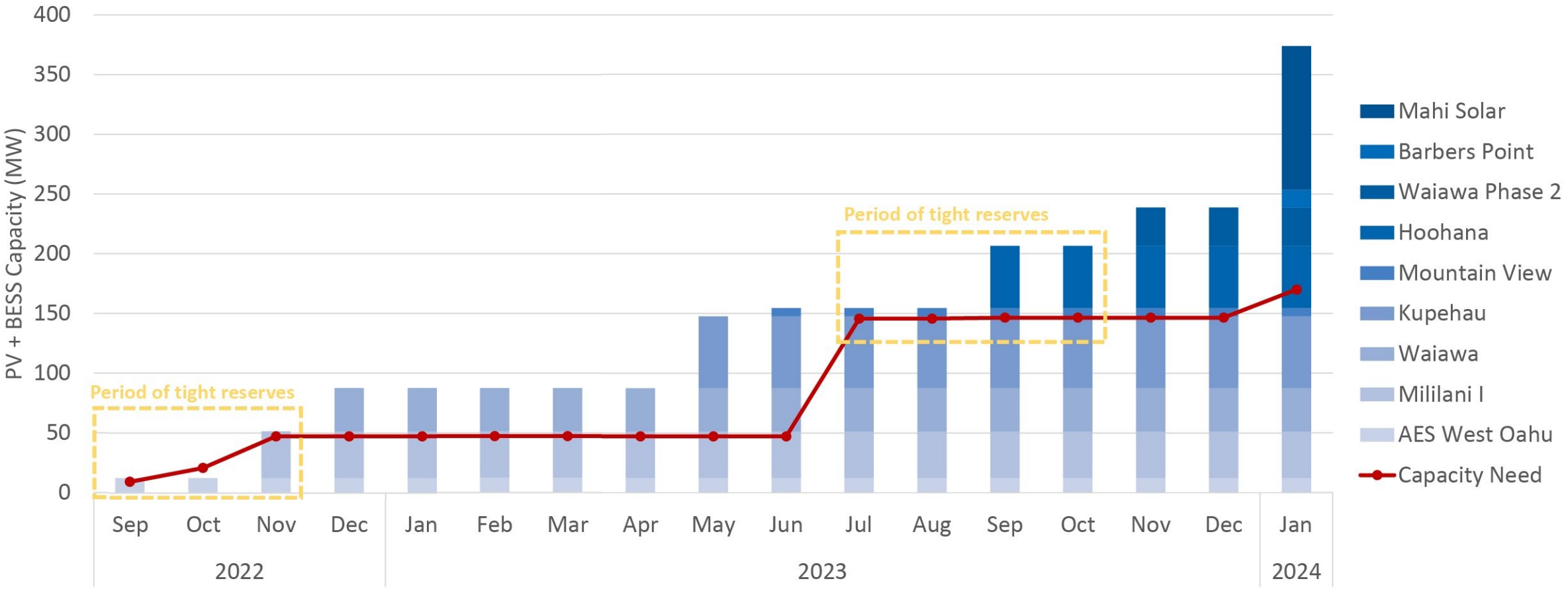
- Higher load months (August – October) correlate with periods of higher risk.
- Planned AES retirement (September 1st, 2022) occurs in the middle of Oahu peak load period



Annualized LOLE by Month with Increasing PV+BESS Deployment



Capacity Needs vs. Current Project Timelines



Annualized LOLE & Capacity Need by Month

(Data shown used in previous two slides)

Annualized LOLE (days)

	Add'l PV+BESS	Annual '22-'23	Annual '23	2022				2023											
				Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Reference Point	0	0.35	0.35	1.67	0.76	0.29	0.38	0.00	0.00	0.00	0.05	0.00	0.10	0.10	0.90	1.67	0.76	0.29	0.38
AES Retired	0	1.64	4.63	1.81	1.76	0.95	0.38	1.10	0.62	0.19	0.19	0.38	0.43	3.19	8.71	20.62	11.81	4.62	3.76
	12.5	1.23	1.40	1.62	1.00	0.52	0.38	0.57	0.29	0.10	0.05	0.24	0.38	2.52	7.05				
	36	0.81	0.91	1.43	0.33	0.48	0.14	0.38	0.00	0.05	0.05	0.05	0.05	1.95	4.76				
	50	0.59	1.66	1.00	0.33	0.24	0.05	0.14	0.00	0.05	0.05	0.05	0.05	1.19	3.95	7.95	4.14	1.43	0.95
	100	0.21	0.70	0.33	0.05	0.05	0.05	0.05	0.10	0.05	0.05	0.00	0.05	0.29	1.48	3.52	2.05	0.33	0.43
	140	0.08	0.30	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.48	1.81	0.71	0.14	0.24
	170	0.04	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.33	1.14	0.52	0.10	0.10

assumes deferred maintenance schedule

Capacity Need (MW)

	Add'l PV+BESS	Annual '22-'23	Annual '23	2022				2023											
				Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
AES Retired	12.5			9.4															
	36				20.9		12.5		17.9			14.7	23.8						
	50					47.2		45.5											
	100	81.3																	
	140		134.8												122.9		138.6	110.0	110.0
	170													145.7		146.4			

Color Code

Reference Point

Does not meet monthly reference point or annual reliability criteria

Meets monthly reference point or annual reliability criteria

Key Findings

- Seasonality is important. The most significant risk occurs from August to October. September 2022 and July - September 2023 are critical points on the timeline
- HECO reliability criteria (0.22 days/year LOLE) is based on the annual average but the analysis shows the high-load months have significantly higher risk than average. What monthly risk is acceptable during transition to PV+BESS?
- HNEI's analysis indicated that the most recent PV+BESS development timeline meets historical monthly LOLE levels but has periods of tight reserves. Additional analysis of these periods is warranted.
- After AES retirement, as little as 12.5MW of PV+BESS with the planned deferred maintenance keeps risk at or below current September values, until July/August of 2023.
- Completion of Stage 2 and/or additional mitigations has periods of tight reserves, but will be needed by Summer 2023
  - Kapolei BESS
  - Grid Service RFP and additional DER / demand response
  - Reactivation of Honolulu 8 and 9 as emergency backup
  - Temporary generation

Next Steps & Future Work

- Proposed Kapolei Battery project is a viable mitigation for reliability, but long-term economic benefits and need for future fossil unit retirements should be more clearly identified
- LOLE shows some dependence on sample size due to random draw of solar year & generator outage variability
  - Additional statistical analysis with larger sample size is warranted for periods shown to have limited reserves (e.g. high load months)
  - Load variability may also affect results so should also be incorporated into the stochastic model (along with solar variability and outage draw)

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