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Report Briefing
Winter 2022-2023 Southern California Gas Reliability Assessment

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California Public Utilities Commission

Presentation Outline

- Introduction
- Stochastic Daily Mass Balance Model (Developed by ERM)
- Reliability Assessment: Assumptions and Inputs
- Reliability Assessment: Summary of Findings
- Questions

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Introduction

Winter 2022-2023 Southern California Gas Reliability Assessment: Introduction

- Since the Aliso Canyon leak in 2015, the Gas Policy and Reliability team has been conducting seasonal reliability assessment of the SoCalGas system, for both the Winter and Summer as well as 1-in-10 peak day analysis.
- Using monthly gas balance sheets, the short-term reliability of the SoCalGas natural gas system was assessed primarily by tracking monthly storage inventories and pipeline capacity reserve margins.
- Having sufficient inventory levels throughout the winter to meet peak day demand is one indication of reliability.

Winter 2022-2023 Southern California Gas Reliability Assessment: Introduction

- The monthly balance sheets were usually done for 3-4 supply scenarios and different climate assumptions, e.g., cold and dry hydro or average year.
- One of the main drawbacks of the monthly mass balance model was relying on historical data especially injection capabilities, which is becoming increasingly inaccurate as restrictions on storage are added or storage retirements are considered.
- In addition, the monthly mass balance model assumes the same daily demand throughout a calendar month.

Winter 2022-2023 Southern California Gas Reliability Assessment: Introduction

- This year, the Energy Resource Modeling team is conducting the short-term reliability assessment using its newly developed Stochastic Daily Mass Balance model.
- The model was originally developed to validate the minimum, or feasible, inventory levels of the non-Aliso storage fields throughout a cold 2020 winter as well as the minimum required level at Aliso Canyon to maintain reliability during a 1-in-10 peak day within a cold and dry year.

Winter 2022-2023 Southern California Gas Reliability Assessment: Introduction

- The model is more computationally expensive but offers more insight to dynamics of the natural gas system owing to its stochastic nature. It also quantifies some of the uncertainties that already exist in the natural gas system.
- ED Staff intend to use the Stochastic Daily Mass Balance Model for all Southern California Gas Reliability Assessments going forward (Winter 2022 and onwards)

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New ERM Stochastic Daily Mass Balance Model

Stochastic Daily Mass Balance Model Overview

- The model builds on the monthly mass balance model by creating demand distributions using the forecasted monthly averages and historical variability.
- The model attempts a daily mass balance on each day of the study year instead of a monthly balance.
- Having daily values of supply and demand, injection and withdrawal rates, enables the calculation of new metrics such as the expected number of imbalance days and the expected daily inventory levels.

*and assume that customers are scheduling this capacity

Stochastic Daily Mass Balance Model Inputs and Methodology

- The model inputs are:
  - Forecasted daily demand using random draws from a known distribution.
  - Assumed pipeline capacity*.
  - Maximum withdrawal and injection curves.
  - Working gas capacity of storage fields.
- The model then determines whether there is excess or deficit in gas supply, then injects or withdraws accordingly, while respecting injection and withdrawal limits.
- If there isn't sufficient supply to meet the demand (mass imbalance) on a given day, the model flags that day as an imbalance day. EFOs (Emergency Flow Order) are used as a proxy for insufficient supply or imbalance.

*and assume that customers are scheduling 100 percent of this capacity

Stochastic Daily Mass Balance Model Summary of Methodology

1. Calculate the standard deviation (σ) from historical data and obtain the daily mean ($\bar{X}$) from CGR forecasts.

2. Forecast daily demand for the study year using a known statistical distribution.

3. Determine gas supply assumptions.

4. Calculate daily excess or deficit, withdrawing or injecting as needed.

5. Track inventory levels over the whole study year.

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Reliability Assessment: Assumptions and Inputs

Winter 2022-2023 Southern California Gas Reliability Assessment: Supply Assumptions

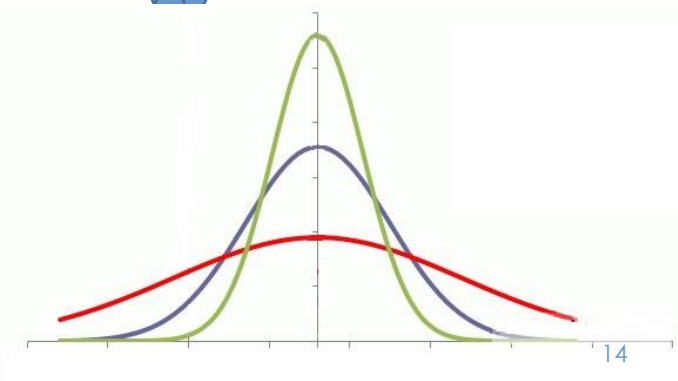
	System Receipt Capacity (MMcfd) for Scenario			2022-2023 Average Daily Demand (MMcfd) for	
	1	2	3	Cold Temp. Dry Hydro	Average Temp. Base Hydro
Month					
October, 2022	3,255	2,860	2,860	2,172	2,151
November, 2022	3,255	2,945	2,945	2,580	2,491
December, 2022	3,255	3,195	2,959	3,208	3,014
January, 2023	3,255	3,195	2,959	3,081	2,905
February, 2023	3,255	3,195	2,959	3,022	2,856
March, 2023	2,615	2,615	2,615	2,656	2,540
April, 2023	2,395	2,395	2,395	2,462	2,386
Average Daily	3,040	2,913	2,812	2,738	2,619
	Total Available Supplies (Bcf)			Total Forecasted Demand (Bcf)	
April-October	644	617	596	581	555

Assumed Capacity is lower than average forecasted demand for cold and dry hydro

Winter 2022-2023 Southern California Gas Reliability Assessment: Variability Assumption

	Expected Number of Days		
	Low SD	Normal SD	High SD
Demand Range (Bcfd)			
Higher than 4.672	Negligible	0.09	0.85
4.0 to 4.672	0.27	2.58	6.24
3.5 to 4.0	8.25	14.31	17.71
2.5 to 3.5	136.93	119.89	105.72
Lower than 2.5	66.55	75.13	81.48
Total	**212**	**212**	**212**
December percentile of 4,762 MMcfd	99.99897^{th}	99.78485^{th}	98.47995^{th}
December days above 4,762 MMcfd	Negligible	0.07	0.47

Higher standard deviation results in more days with higher demand because the distribution is "wider"



Winter 2022-2023 Southern California Gas Reliability Assessment: Other Inputs

- Withdrawal and injection curves
  - Forecasted monthly withdrawal and injection curves based on well availability and planned maintenance outages.
  - SoCalGas submitted these curves for the period from September to April.
- Initial inventory level
  - The initial or starting inventory level of all four storage fields was obtained from SoCalGas ENVOY on October 3, 2022.

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Reliability Assessment: Summary of Findings

Reliability Assessment: Summary of Findings
Winter is reliable – negligible imbalance days

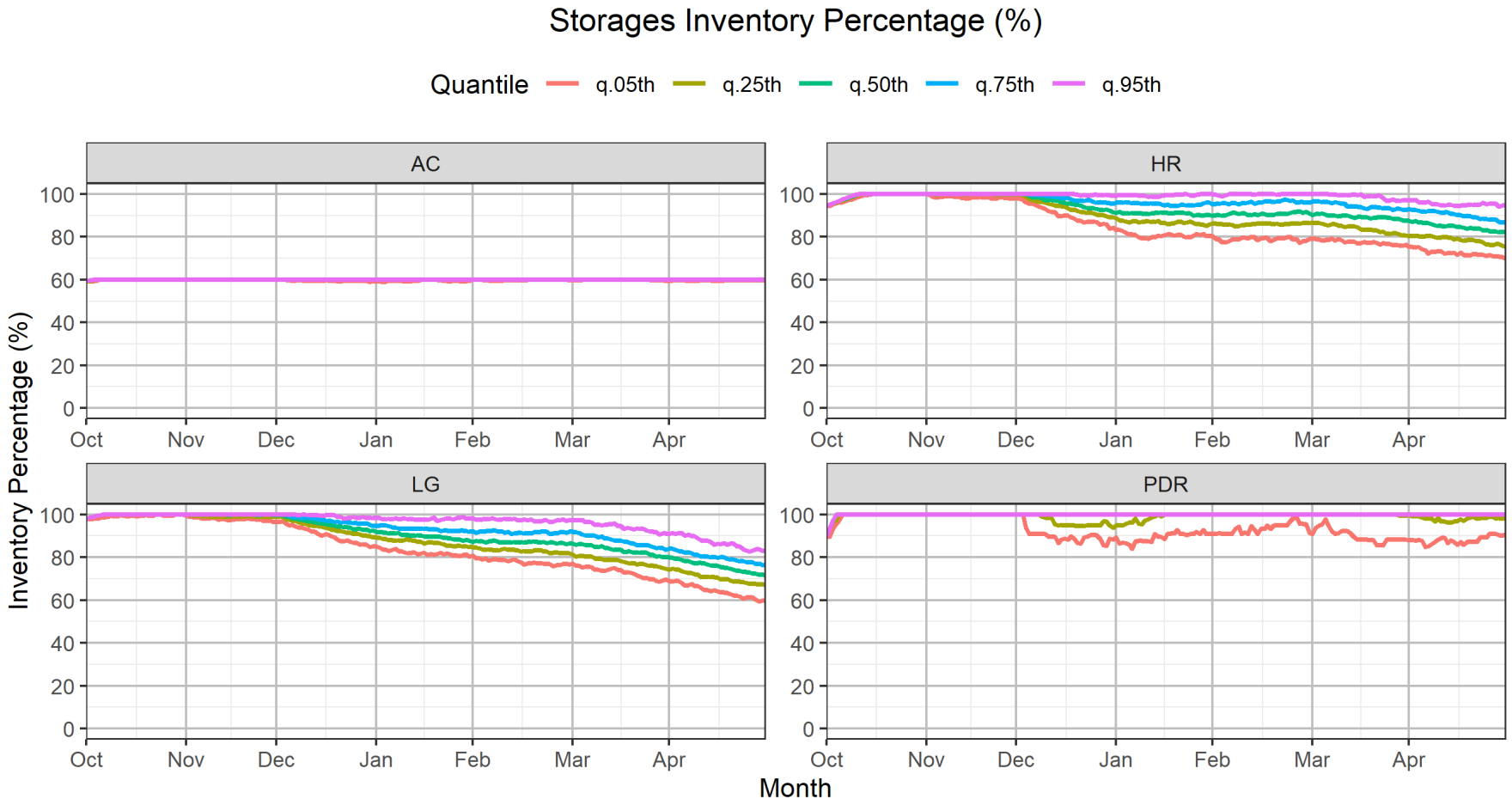
- The highest number of imbalance days is less than one per month for all months and all scenarios.
- If held to the same standard as the electric reliability (1 event in 10 years), imbalance days should be less than 0.058[+] per study period
- However, actual imbalance days could be lower than predicted when customers respond to OFO/EFO and penalties.

Number of imbalance days (days) for Scenarios 1-3

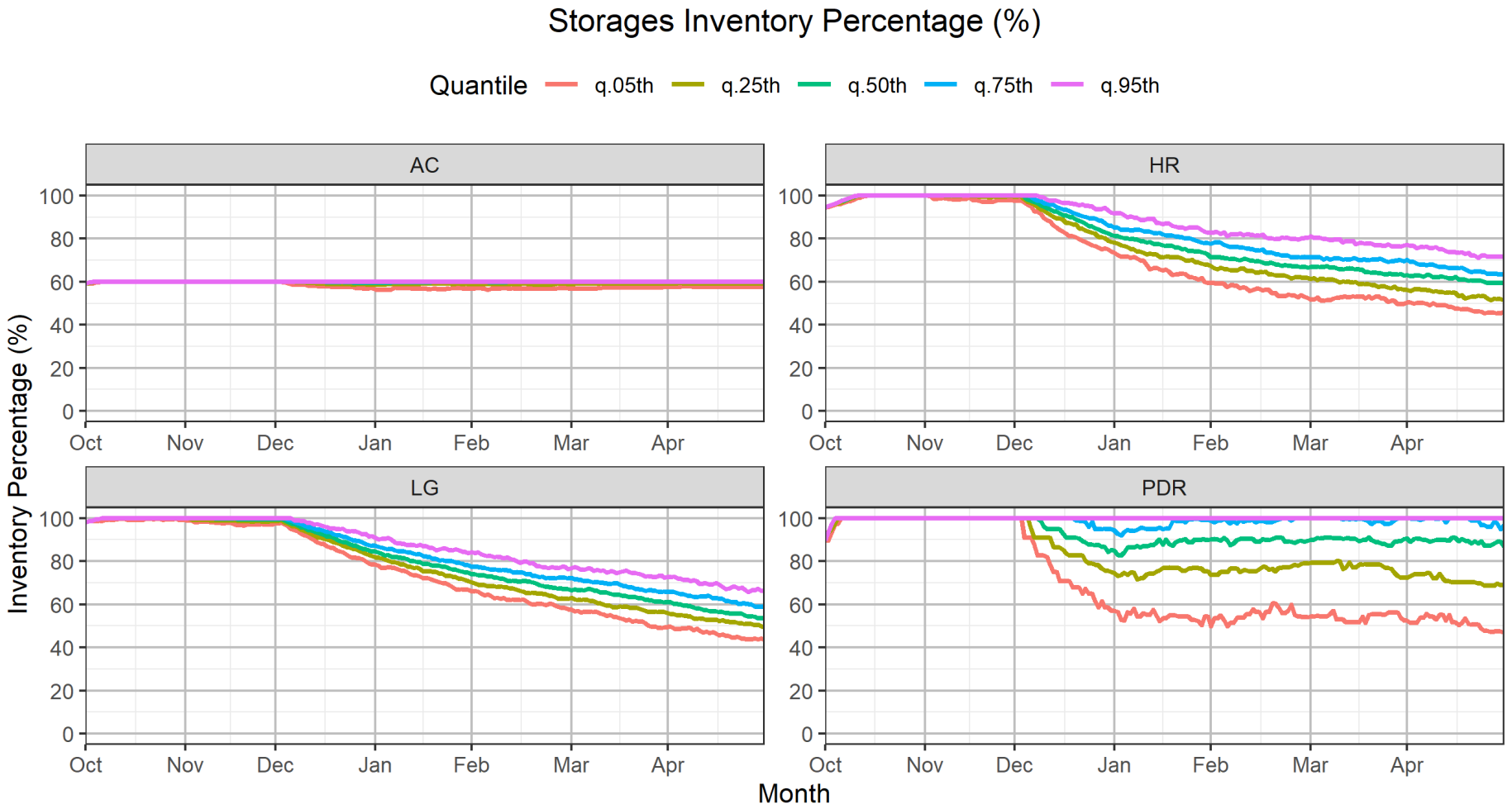
		Scenario		
		1	2	3
Month	October	0	0	0
	November	0	0	0
	December	0	0	0
	January	0	0	0
	February	0	0	0
	March	0	0	0
	April	0	0	0.02
	October-April	**0**	**0**	**0.02**

[+] 1*212/10/365.25 where 212 is the number of days in the study period

Reliability Assessment: Summary of Findings Inventory Tracking for Scenario 2



Reliability Assessment: Summary of Findings Inventory Tracking for Scenario 3



Reliability Assessment: Summary of Findings
Inventory Tracking: Month-end Inventory (median)

Scenario 2		Month						
		10	11	12	1	2	3	4
Storage Field	AC	41.16	41.16	41.16	41.16	41.16	41.16	41.16
	HR	27.00	27.00	24.67	24.35	24.53	23.59	22.29
	LG	21.50	21.41	19.91	18.85	18.59	17.20	15.34
	PDR	1.9	1.9	1.9	1.9	1.9	1.9	1.9
	Total	91.56	91.47	87.65	86.26	86.18	83.85	80.69

Scenario 3		Month						
		10	11	12	1	2	3	4
Storage Field	AC	41.16	41.16	40.75	41.12	41.04	41.16	41.1
	HR	27.00	27.00	22.07	19.59	18.00	16.94	16.02
	LG	21.5	21.38	18.18	16.06	14.39	13.13	11.49
	PDR	1.90	1.90	1.62	1.71	1.700	1.72	1.65
	Total	91.56	91.44	82.62	78.47	75.14	72.95	70.27

Reliability Assessment: Summary of Findings EUV and EUS

- EUV (Expected Unserved Volume) is 0, 0, and 3.32 MMcf for Scenarios 1-3, i.e., EUV is negligible for all three scenarios.
- EUS (Expected Unused Supplies) is the sum of supplies that couldn't be injected into storage due to injection limitations or inventory levels reaching their maximum allowed level, averaged over the study period.
- It could also be interpreted as additional supplies available at the border that never went into SoCalGas system.

Expected Unused Supplies (Bcf) for Scenarios 1-3

		Scenario		
		1	2	3
Month	October	30.1	18.4	18.3
	November	19.8	11.0	10.6
	December	4.48	3.66	0.98
	January	5.46	4.26	0.895
	February	6.16	4.56	0.93
	March	1.85	2.03	0.79
	April	1.06	0.99	0.41
	October-April	**68.95**	**44.77**	**32.92**

Additional Sensitivity Results
Summary of Findings: Storage Outages

- Sensitivity 1: Utilization factor of La Goleta is set to 50%
- Sensitivity 2: Utilization factor of all storage fields is set to 80%

	End of April Inventory Levels					
	AC	HR	LG	PDR	Total	EFO
	Bcf	Bcf	Bcf	Bcf	Bcf	#/day
Scenario 3	41.1	16.02	11.49	1.65	70.26	0.02
Sensitivity 1	40.5	14.48	15.50	1.40	71.88	0.05
Sensitivity 2	40.5	16.23	12.04	1.69	70.46	0.13

Winter 2022-2023 Southern California Gas Reliability Assessment: Summary of Findings

- With the current natural gas assets and withdrawal protocols in place, the stochastic daily mass balance model predicts no curtailments or emergency flow orders in the Winter of 2022-2023.
- The model captures some details about the dynamics of SoCalGas natural gas system that couldn't otherwise be captured using monthly mass balance sheets or hourly transient analysis. Specifically, the model shows withdrawals that are occurring in months where the available supplies are higher than the demand.
- Sensitivities show that storage outages cause a relatively slight decrease in reliability, but not to an alarming level.

Winter 2022-2023 Southern California Gas Reliability Assessment: Summary of Findings

- Note that the daily mass balance model tracks storage used for reliability only. Storage withdrawals used for price arbitrage and preventing local pressure drops is not captured by the model.
- An enhancement to the model would include demand elasticity or response to price and operating flow orders.
- Note that the 1-in-10 peak day demand drops from 4.987 Bcfd forecasted by the 2018 California Gas report to 4.672 Bcfd (-6.3%) forecasted by the 2022 California Gas Report primarily due to updating climate warming assumptions.

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Questions?

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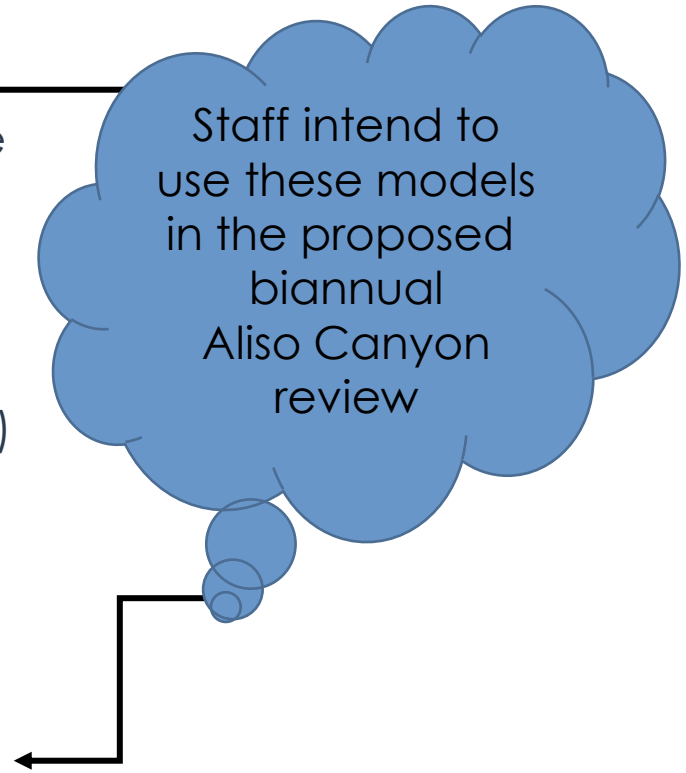
Overview of Natural Gas Models

Overview of Natural Gas Models ERM staff use

- Stochastic Daily Mass Balance (New)
  - Conserves mass only on a daily basis (using random sampling)
  - Simulates an entire season or year
  - Models daily inventory, withdrawal, and injection capacities available
  - Predicts the number and size of imbalances during the winter season
  - Developed by Energy Resource Modeling staff using R
- Monthly Mass Balance
  - Simplest model (Excel spreadsheet)
  - Conserves mass only on a monthly basis (using known monthly means)
  - Used widely to calculate seasonal storage needs
- Synergi Gas or NextGen (sub-hourly):
  - Conserves mass and momentum at each time step
  - Most detailed model, most computationally expensive, and laborious
  - Limited to no more than a few days
  - Simulates the transmission network of the IOU (or more if desired)
  - Multi-state models or multi-utility models do not exist



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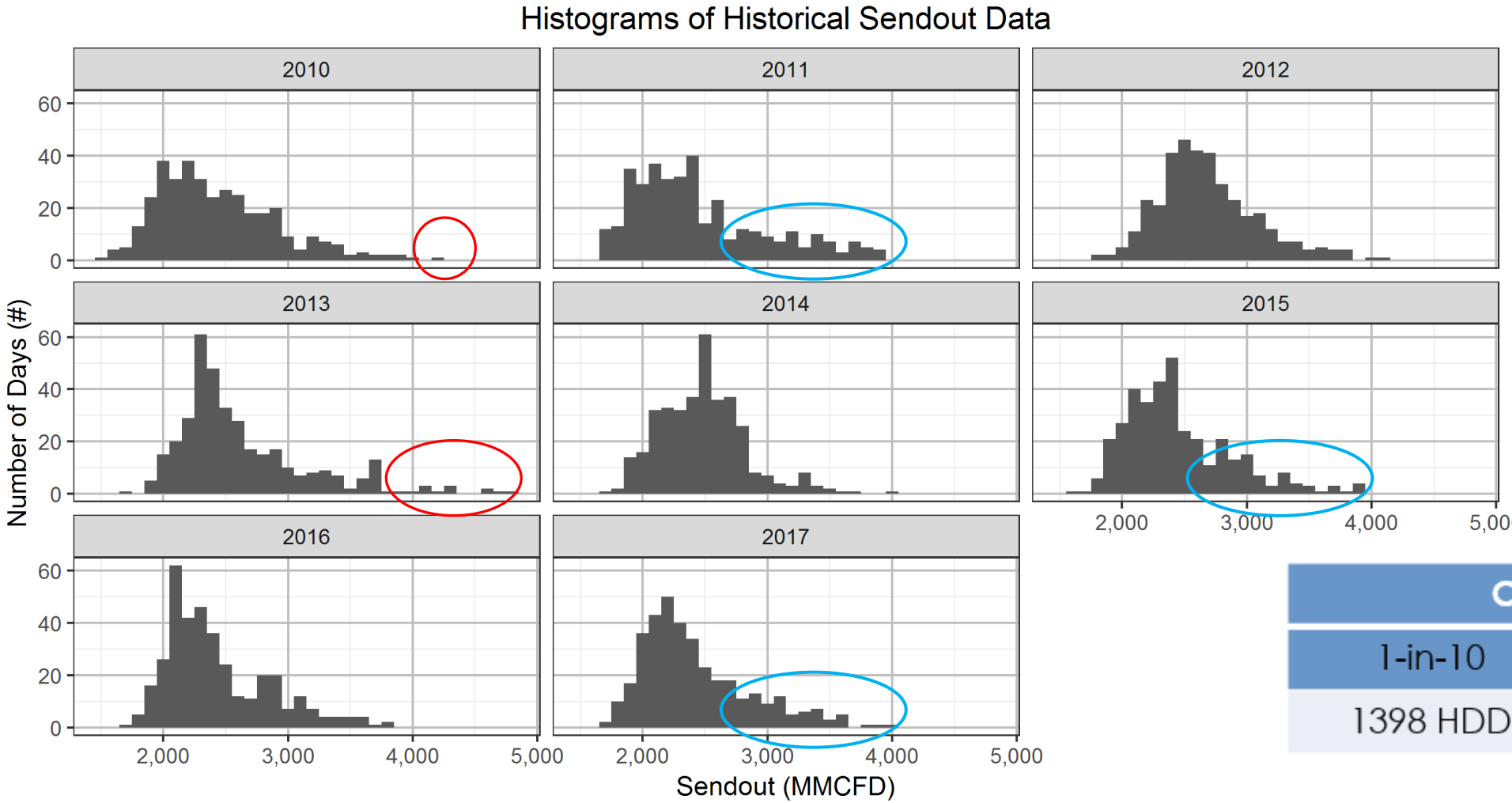
About Historical Variability

Historical Sendout by Year (2010-2017)



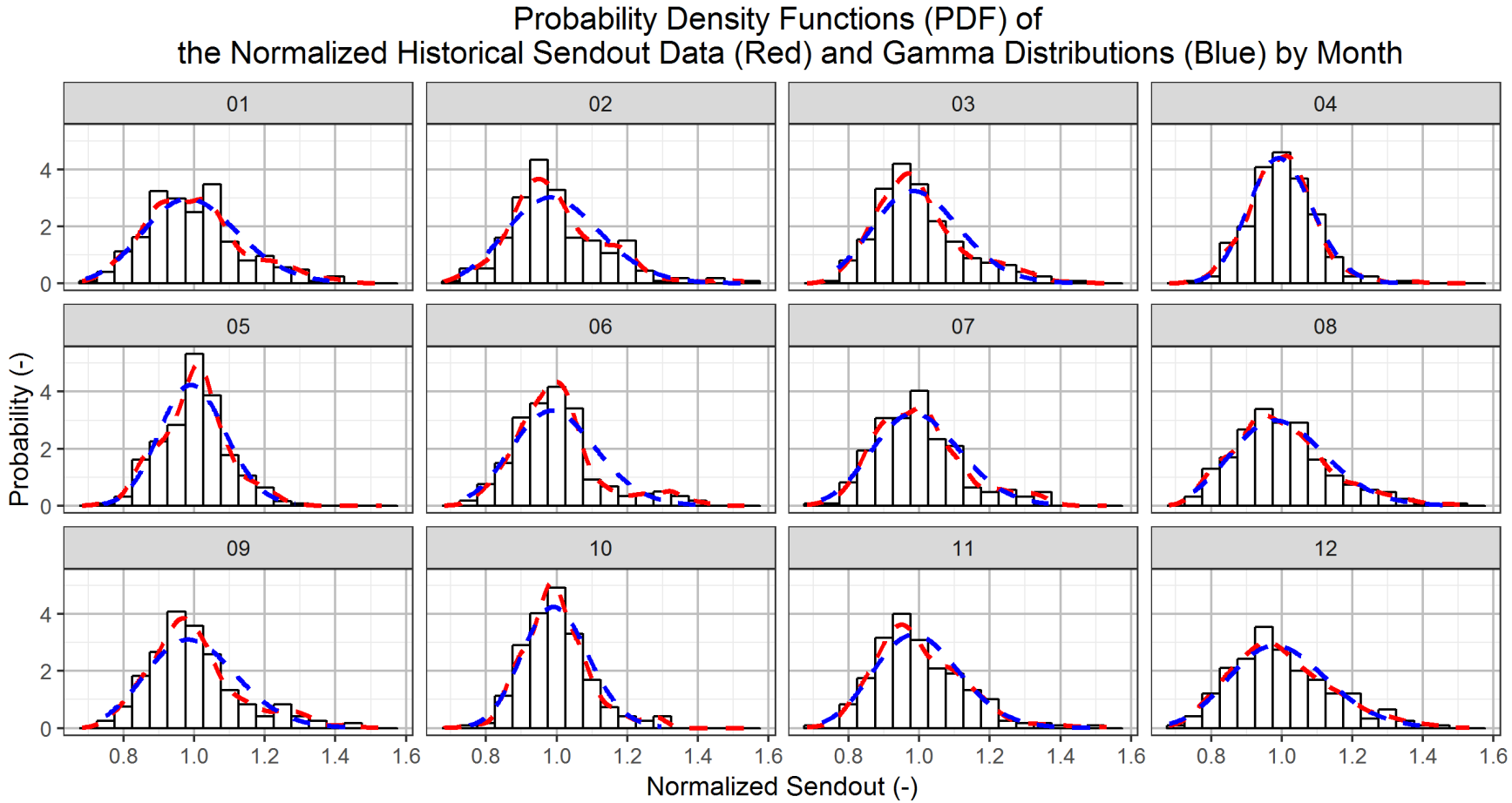
CGR 2022	
Year	HDD
2010	1440
2011	1587
2012	1283
2013	1212
2014	775
2015	963
2016	1009
2017	967

CGR 2022	
1-in-10	1-in-35
1398 HDD	1476 HDD

Bin width is 100MMCFD

Conclusion: HDD is not a measure of variability

Stochastic Daily Mass Balance Model Historical Sendout by Month (2010-2017)



Bin width is 0.05. Historical data is used to calculate the standard deviation and the mean of the normalized sendout and hence the Gamma distribution parameters.