



Possible impact of hydrological data on frequency response

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Problem Statement

Hydro generation not adequately and inaccurately represented in planning and operation studies:

- Water availability not updated seasonally or modeled in basecases
- No interdependencies between resources, environmental constraints ignored

The six-turbine Edward Hyatt Power Plant was taken offline after the water level in the Oroville Dam reservoir that feeds it sank to an historic low

As the river's biggest reservoirs, Lakes Powell and Mead, fall to one-third of their capacity, the dwindling flow threatens electricity generation.

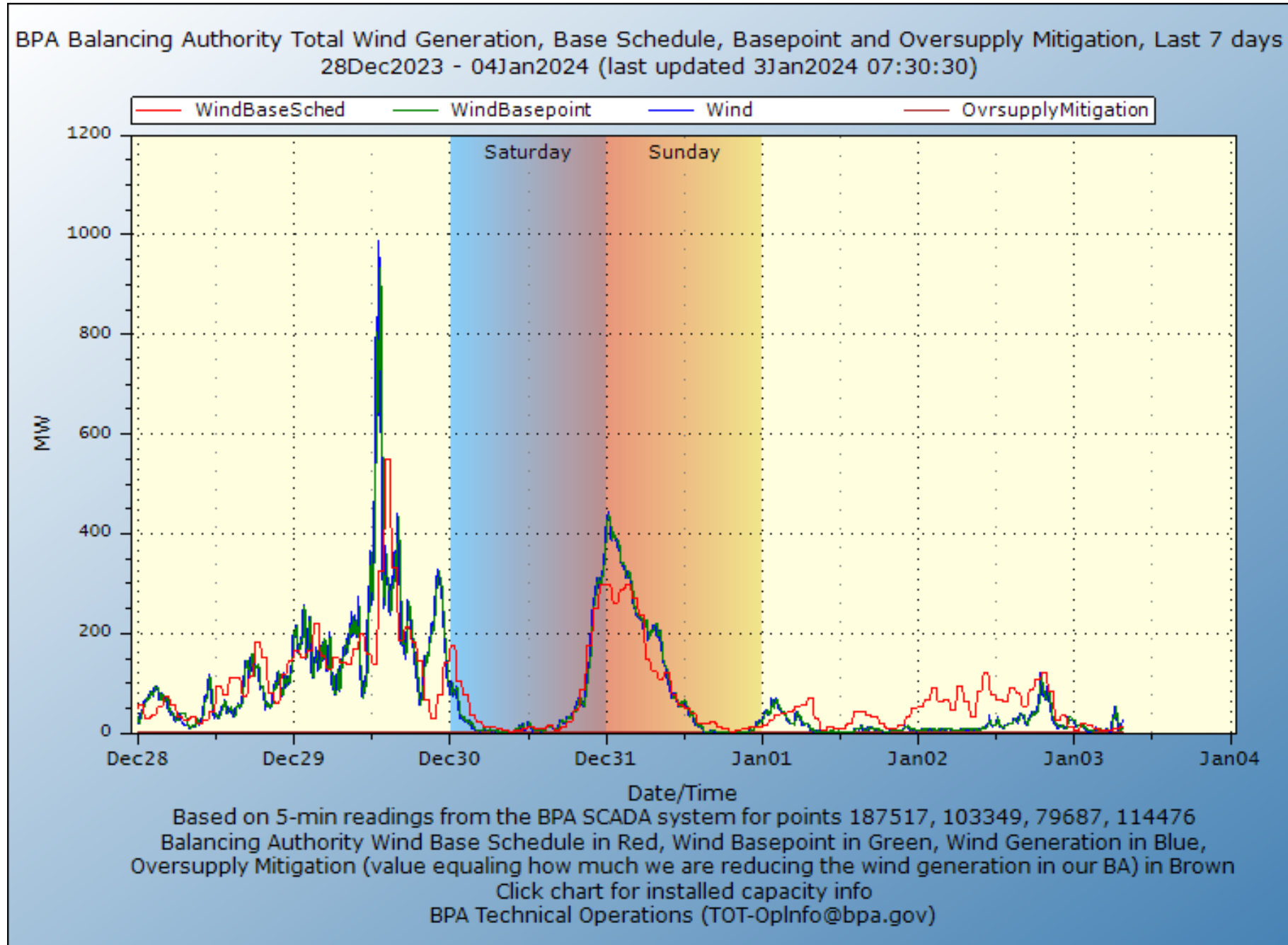


<https://www.cnn.com/2021/08/06/california-shuts-down-major-hydroelectric-plant-amid-severe-drought.html>

<https://insideclimatenews.org/news/08082021/colorado-river-water-power/#:~:text=The%20Colorado%20River%20is%20tapped,government%20will%20declare%20a%20shortage.>

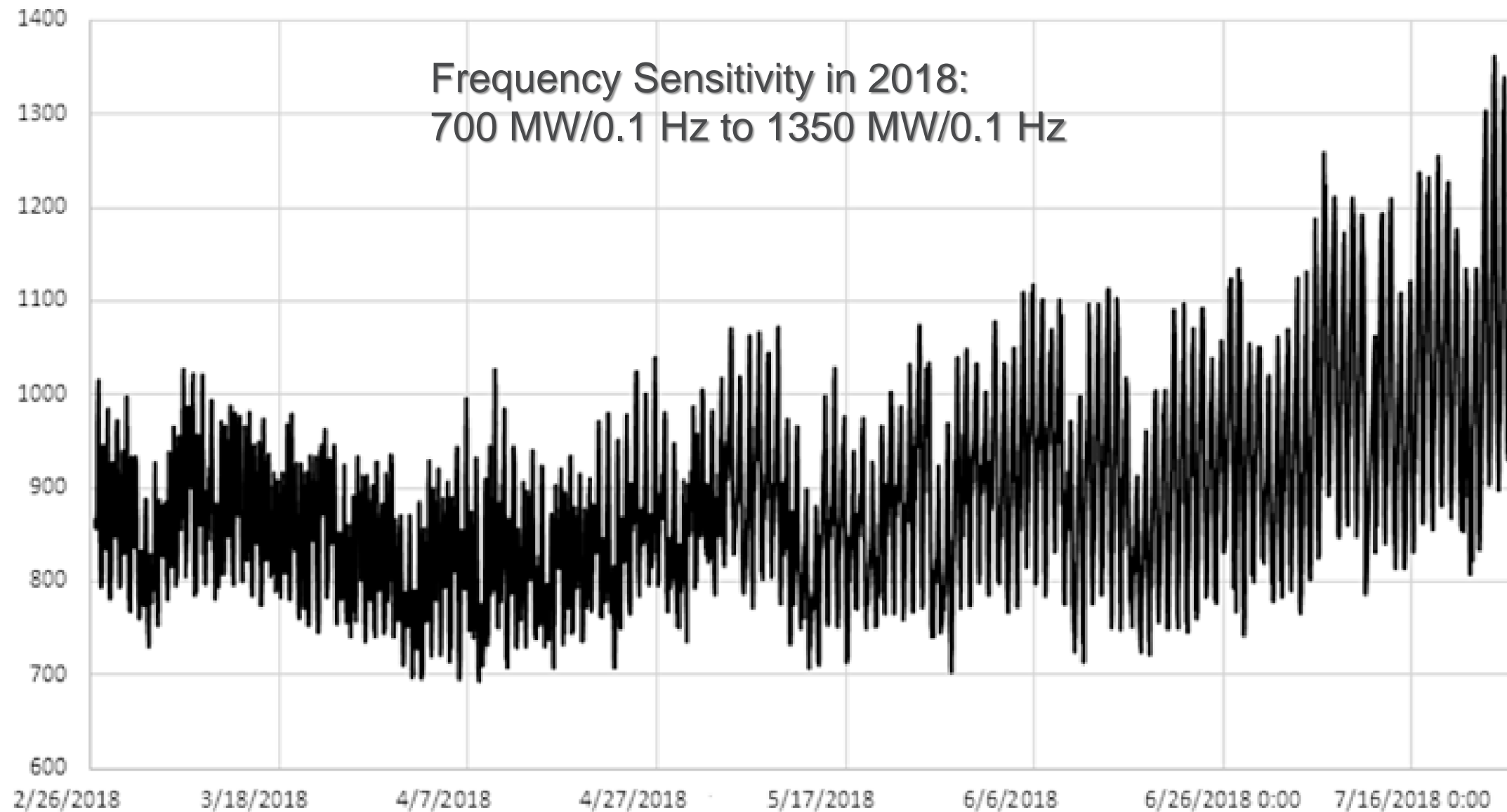
Case Study-Wind Variability

<https://transmission.bpa.gov/business/operations/wind/twndbspt.aspx>



Frequency Sensitivity

Frequency Sensitivity (MW/0.1Hz)



2019 Retirements			6581 MW		
Alamitos 1-6	NG	2010	CA	12/31/2020	
Boardman	Coal	550	OR	12/31/2020	
Centralia 1	Coal	670	WA	12/31/2020	
Huntington Beach 1,2 (Potential Delay)	NG	450	CA	12/31/2020	
Ormond Beach	NG	1491	CA	12/31/2020	
Nucla	Coal	100	CO	12/31/2020	
Redondo Beach (Potential Delay)	NG	1310	CA	12/31/2020	

2022 Retirements			2710 MW		
Diablo Canyon 1	Uranium	1080	CA	11/30/2024	
Centralia 2	Coal	670	WA	12/31/2024	
Cholla 4	Coal	387	AZ	12/31/2024	
Newman 1-3	NG	247	TX	12/31/2024	
Scattergood 1,2	NG	326	CA	12/31/2024	

2025 Retirements		910 MW			
Battle River 5	Coal	148	AB	12/1/2027	
Dave Johnston 1-4	Coal	762	WY	12/31/2027	

2027 Retirements		871 MW			
Harmac Biomass	BIO	55	BC	8/12/2028	
Sheerness 1,2	Coal	816	AB	12/31/2028	

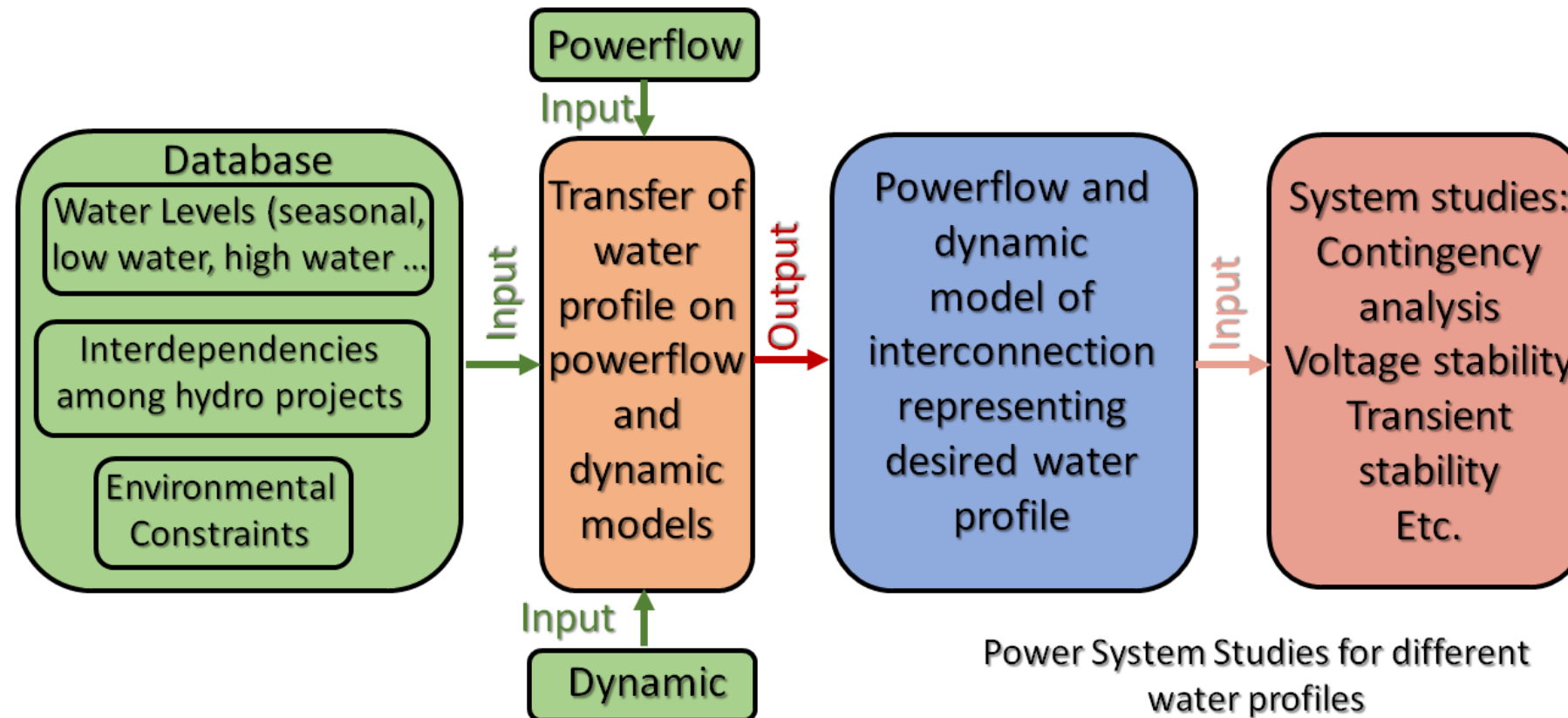
2020 Retirements			367 MW	
Fort Churchill 2	NG	113	12/31/2021	
North Valmy 1	Coal	254	12/31/2021	

2021 Retirements				2762 MW	
Oakland	NG	165	CA	10/1/2022	
Comanche 1	Coal	330	CO	10/31/2022	
San Juan 1,4 (Potential Retirement)	Coal	847	NM	12/31/2022	
Naughton 1,2 (Potential Retirement)	Coal	357	WY	2022	
Jim Bridger 1,2 (Potential Retirement)	Coal	1063	WY	2022	

2024 Retirements		4242 MW			
Comanche 2	Coal	330	CO	10/31/2025	
Diablo Canyon 2	Uranium	1080	CA	11/30/2025	
Battle River 4	Coal	148	AB	12/31/2025	
Craig 1	Coal	427	CO	12/31/2025	
Fort Churchill 1	NG	113	NV	12/31/2025	
Harry Allen 1	NG	76	NV	12/31/2025	
Intermountain GS 1,2	Coal	1800	UT	12/31/2025	
North Valmy 2	Coal	268	NV	12/31/2025	

Total: 18,433 MW

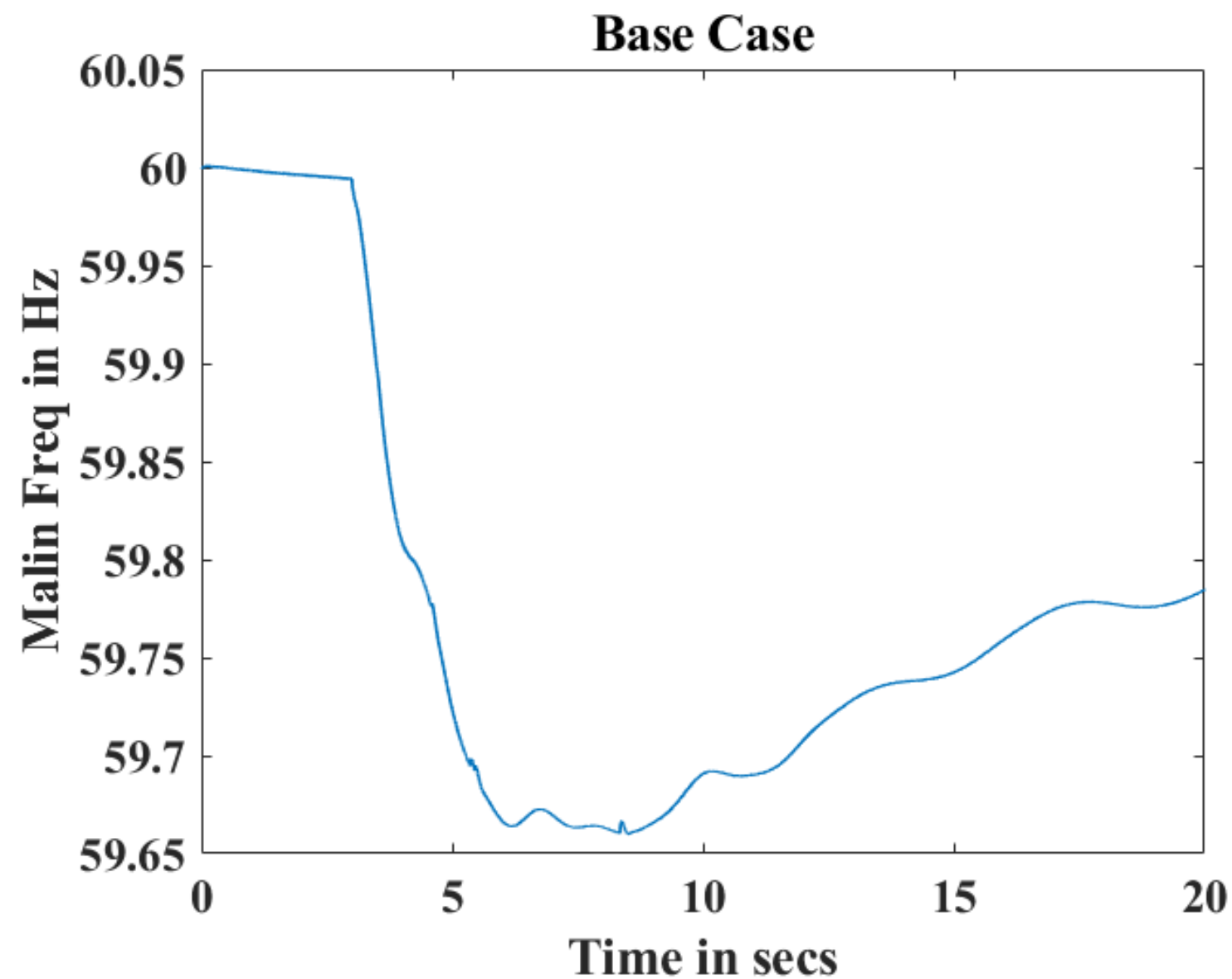
The software will update the existing steady state and dynamic model based on desired historical hydro conditions, allow modification while respecting interdependences and impose desired hydro profile, including dispatch constraints on hydro plants, as illustrated in Figure below:



Case Study

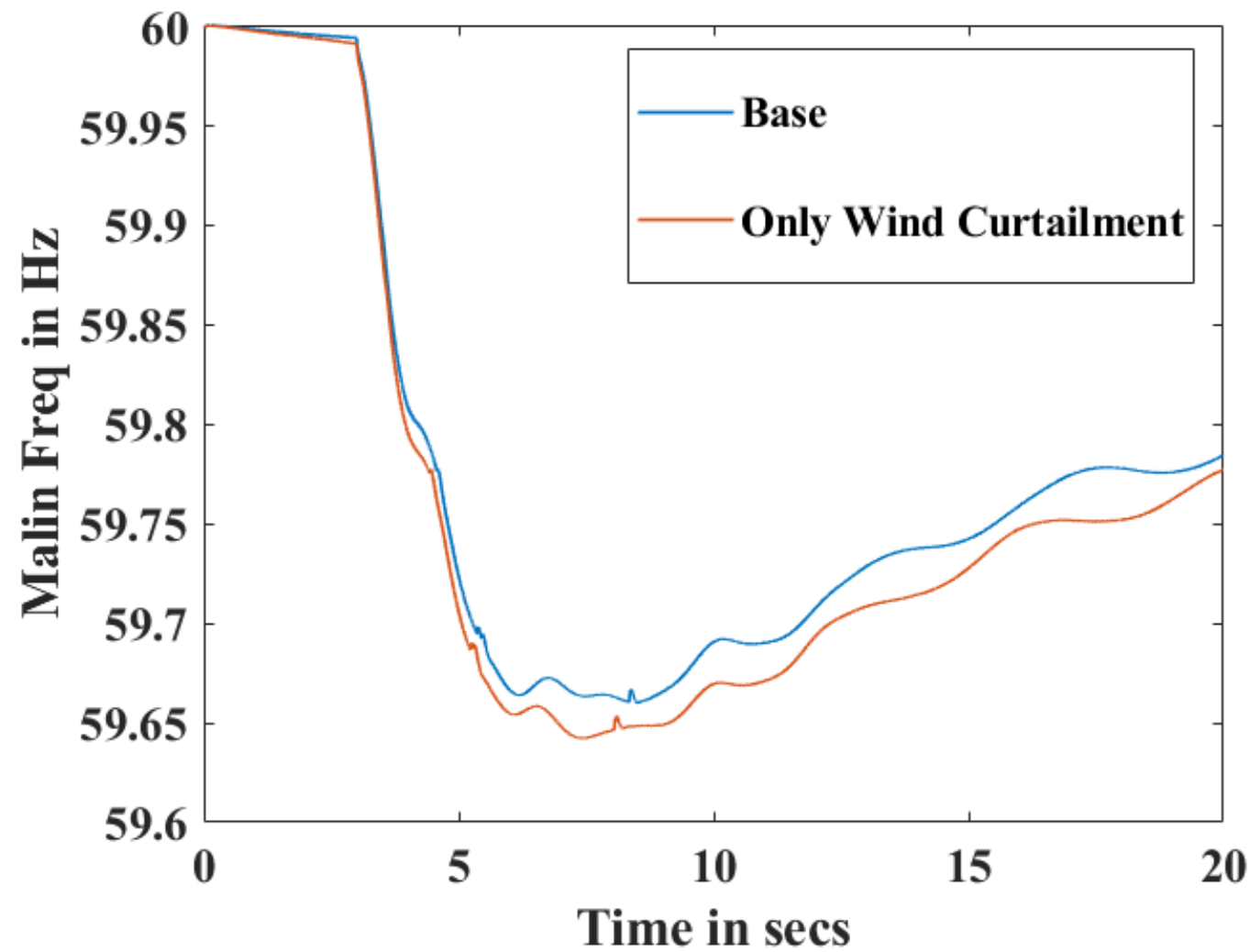
- 2022 Light Spring Case has been used as the base case
- Four scenarios have been simulated:
 - Scenario1: 'Base Case'
 - Scenario2: 'Only Wind Curtailment'
 - Scenario3: 'Only Hydro Update'
 - Scenario4: 'Wind Curtailment + Hydro update'
- Governor powerflow option in PSLF has been used to redispatch the changes in the generation made in the different scenarios considered using other resources throughout the system
- 'N-2' Palo Verde Trip Event has been simulated
- Wind units has been curtailed in the NORTHWEST area

Case Study



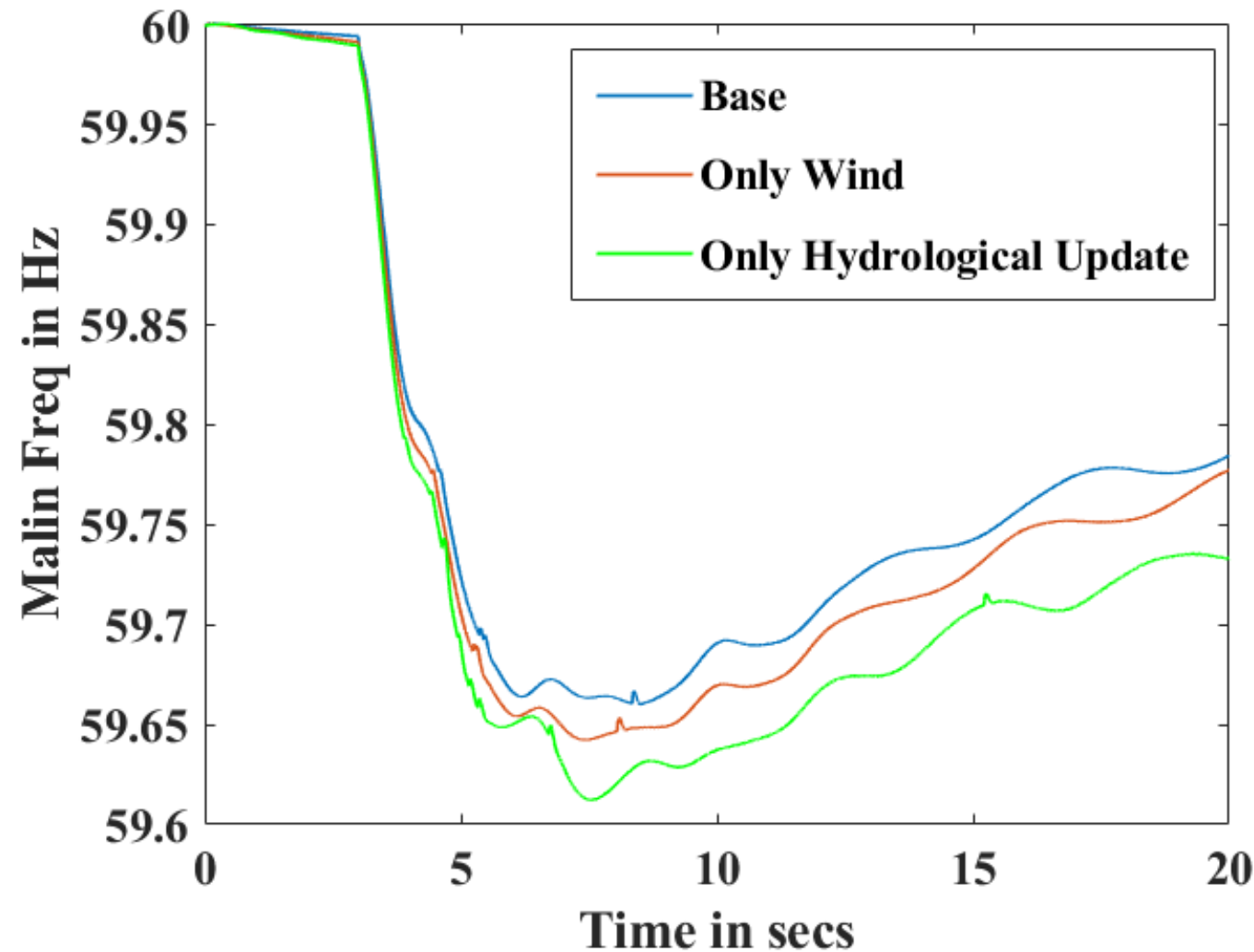
Observation: System recovers well

Case Study



- 20% of the total wind generation in the Northwest and California areas have been curtailed
- Wind units are only tripped in the Northwest area (~1500 MW)
- The hydro units whose generation data needs to be updated based on the new hydrological data are not utilized in the governor powerflow dispatch when wind generation is curtailed.

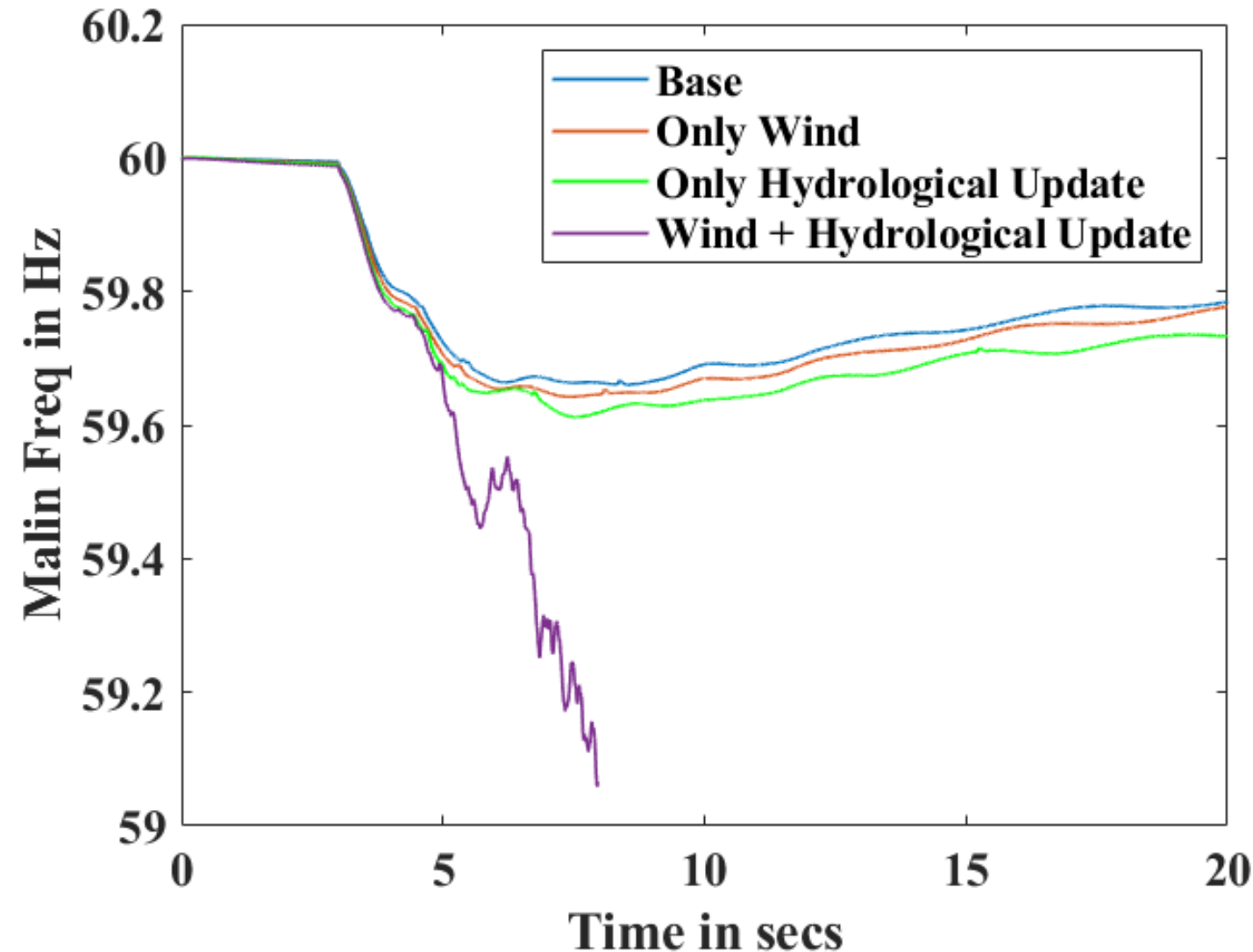
Case Study



- No wind generation has been curtailed
- The Pgen, Pmin and Pmax of the hydrounits have been updated based on the new hydrological data.
- Total of 4720 MW have been updated.
- 'Head' value in the corresponding dynamic governor models has been updated to 0.75 pu (default is 1 pu).

Observation: System recovers well similar to base case but has slightly lower nadir and much slower recovery rate compared to Scenario 1 and Scenario 2

Case Study



- Updates made in both Scenario 2 and Scenario 3 have been made in this Scenario

It should be noted that these simulations have also been redone by implementing the governor powerflow redispatch considering only units whose baseload flag value is 0.

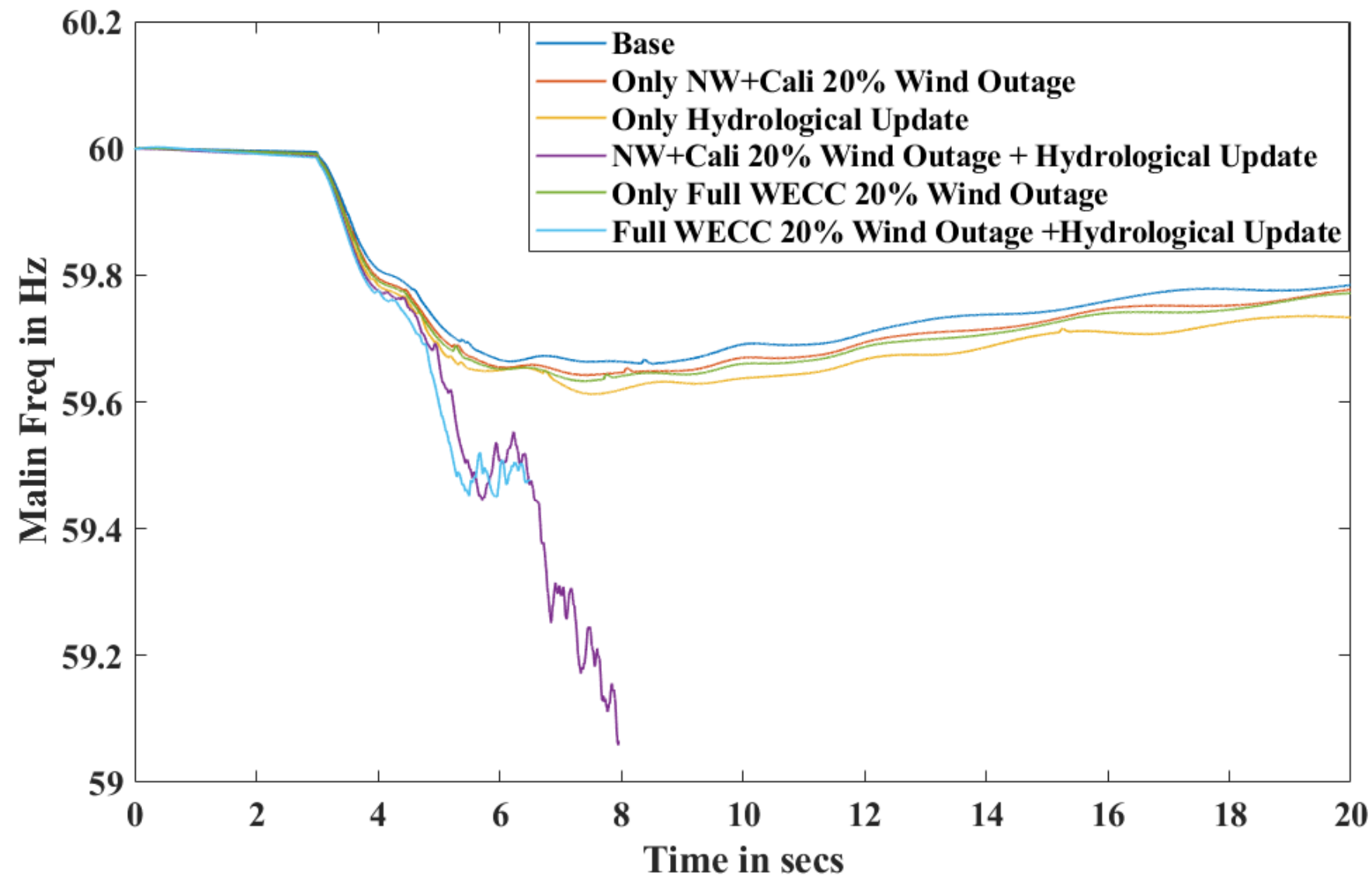
Noticed almost same behavior, in the results, as shown before without considering baseload flag constraint.

Observation: System doesn't recover which clearly shows the importance of having an accurate reflection of the hydro units generation based on the hydrological data

Wind Curtailment Cases Considering Full WECC

- Total wind generation of 10.52 GW is observed in the whole of WECC in the base case.
- 20% (2104 MW) of this total wind generation has been curtailed and has been re-dispatched via other sources in the system (except the hydro units in which hydrological update is to be made) using governor powerflow approach.
- Not significant difference in the system response has been observed when compared to Scenario 2 and Scenario 4 (when 20% wind is curtailed based on the total wind generation in only Northwest and Southern California areas).

Scenario 6: Result Comparison (20% Wind Curtailment based on Full WECC wind generation + Hydrological update) with Scenarios 1-5



Observation: System response in this scenario is very similar (does not recover) to Scenario 4 (20% wind outage based on NW & Southern Cali wind generation areas + hydrological update)