Data-Driven Enhancement of Power System Disturbance Magnitude Estimation: Integrating Two-Beta and RoCoF Methods

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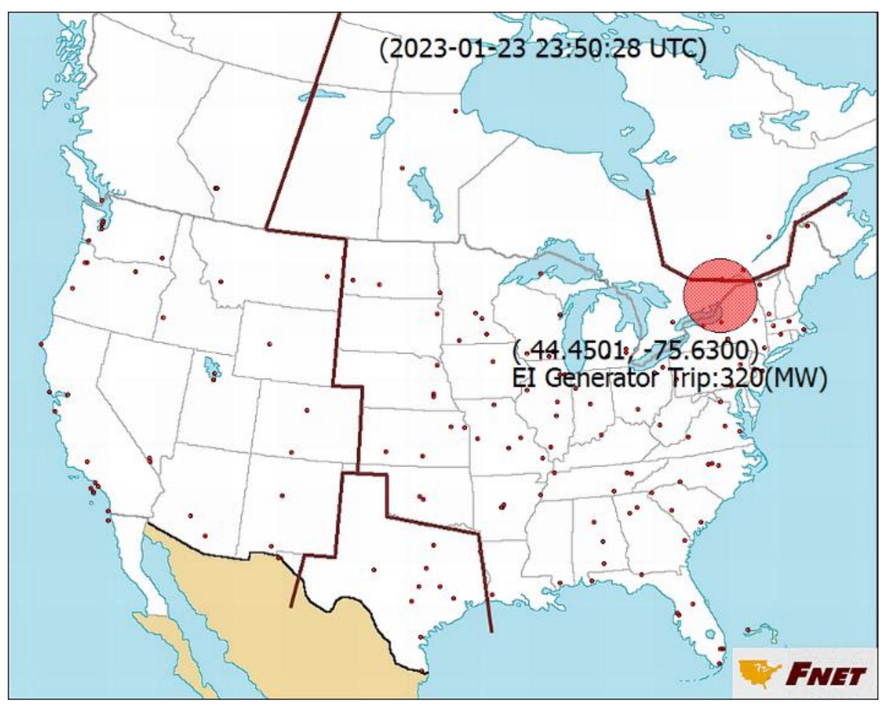
Disturbance Event Detection Workflow

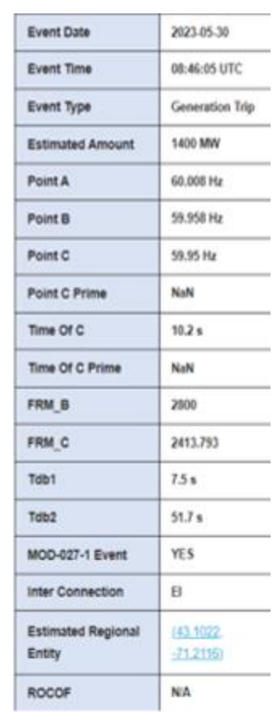
- When an event is detected, the system undertakes the task of calculating the system's median frequency. This involves determining the median frequency across a specified number (N) of Frequency Disturbance Recorders (FDRs). The resulting median frequency data is then used to generate a frequency curve which provides all the necessary indices for accurately estimating the disturbance amount.

- The current estimation method for disturbance magnitude may deviate significantly from the actual values, with errors sometimes exceeding 500MW. This discrepancy highlights the need for further research to enhance the accuracy of disturbance magnitude estimations, and to be more specific, large prediction error should be eliminated.

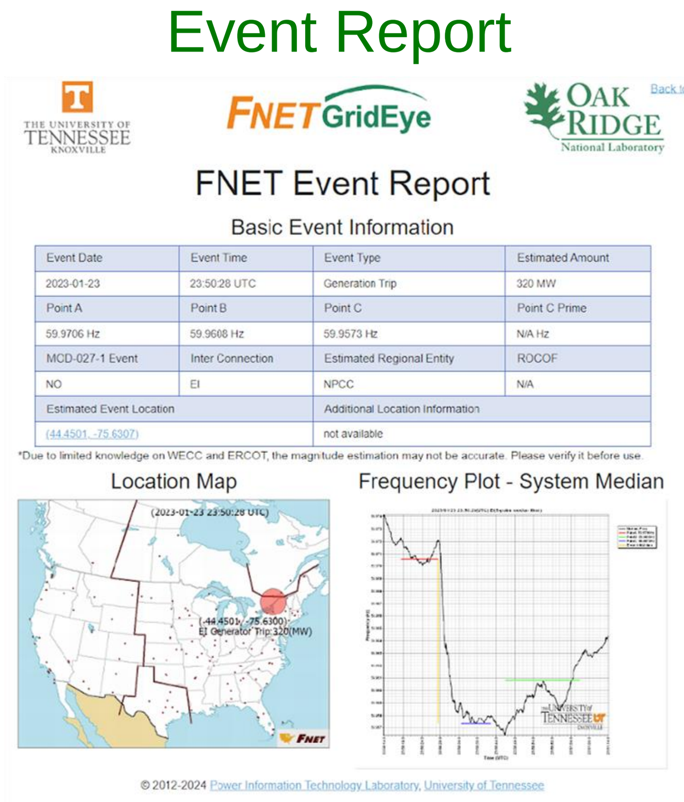
Event Detection



Indices Calculation



Event Report



Received Confirmation

Magnitude	Location
320MW	(44.4501, -75.6307)

Confirm Info:

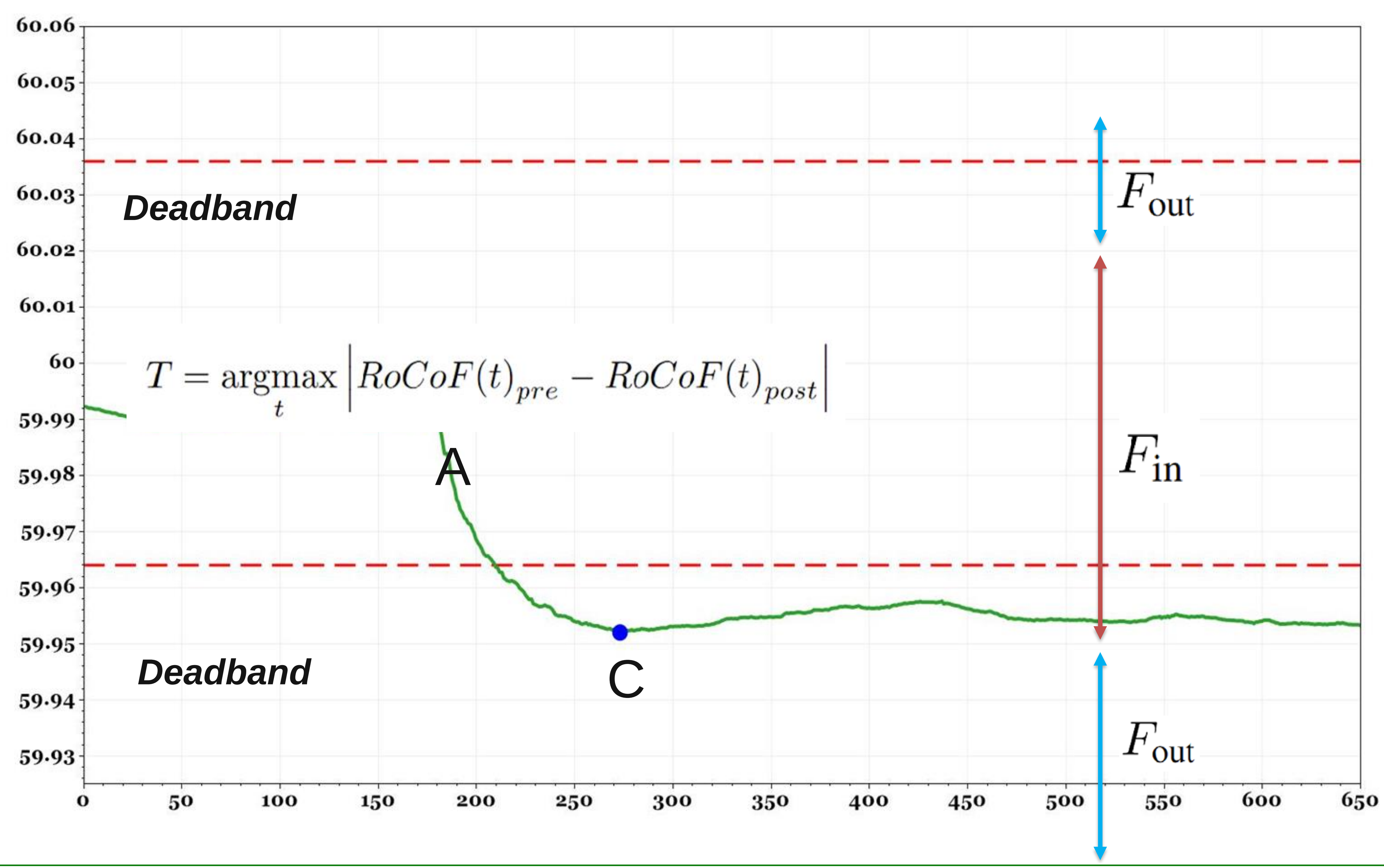
Xxxx unit 2 while loaded 994MW prior to its trip

Two-Beta & RoCoF Method

$$y = \beta_{\text{in}} F_{\text{in}} + \beta_{\text{out}} F_{\text{out}} + \alpha_0 RoCoF(t)$$

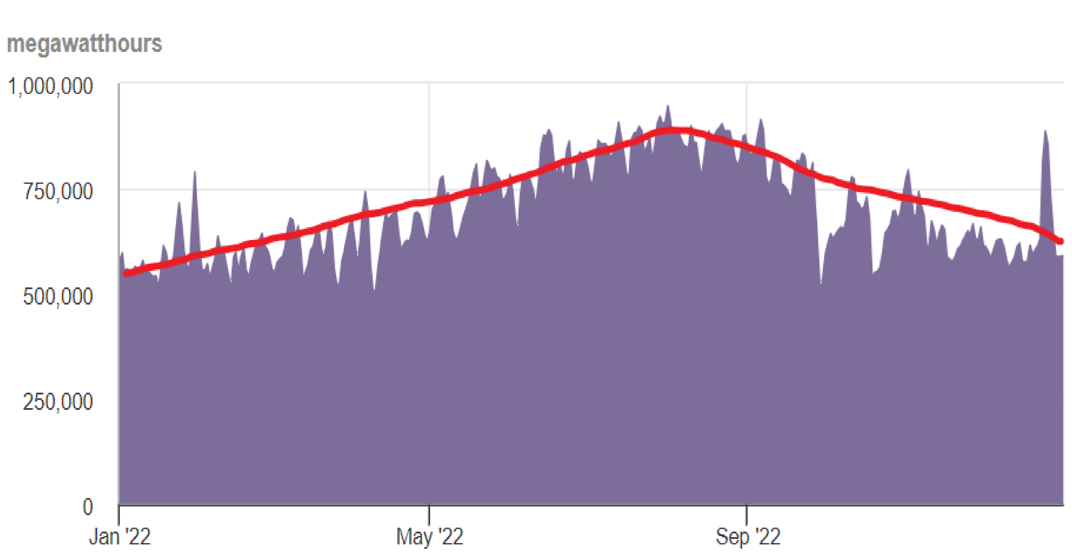
- This method segments the frequency range between points A and C into two distinct zones - within the deadband and outside the deadband, each zone is associated with a unique coefficient as βin and βout, where these coefficients are derived using a multiple linear regression model.

- α acting as a correction factor to adjust the disturbance estimation. This integrated approach aims to account for the variability in RoCoF, thereby refining the accuracy of our disturbance magnitude prediction.

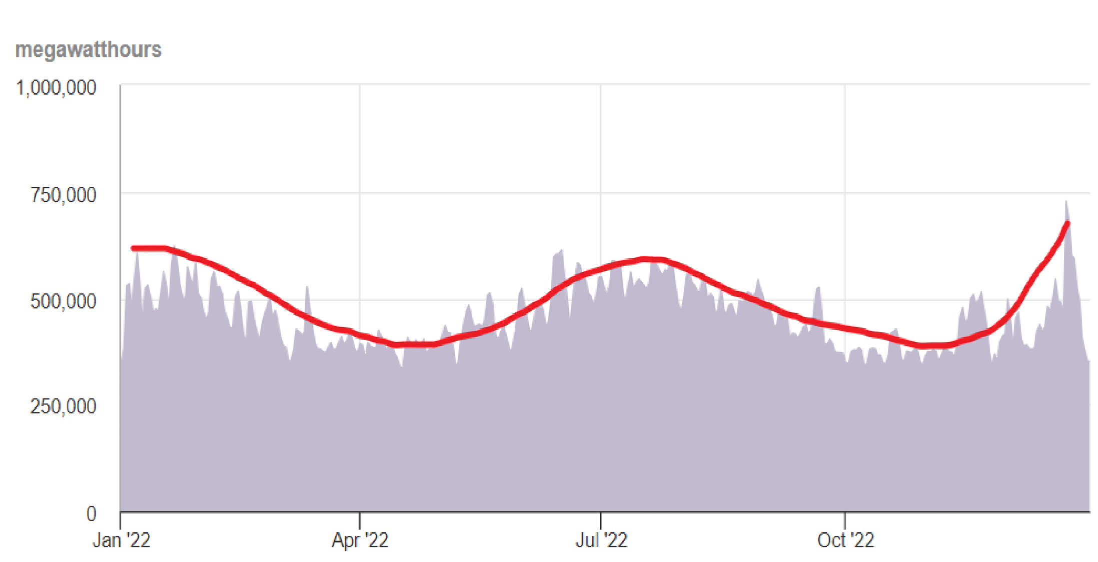


Load Impact

- A discernible pattern emerges from this data: the trends in coefficient variations closely mirror those of load variations as two figures demonstrated. For instance, coefficient tend to be larger during summer and winter, regardless of the method employed, except events from some particular region as Florida(FLA).
- Conversely, spring and fall consistently exhibit smaller coefficients. This trend likely reflects the varying power demands during peak and off-peak periods.



U.S. electricity daily demand for Florida of 2022



U.S. electricity daily demand for Tennessee of 2022

COEFFICIENT OF ROCOF METHOD FOR 2022 EI EVENTS

Coefficient	Spring	Summer	Fall	Winter
CENT	116,000	143,000	115,000	136,000
TEN	122,000	144,000	126,000	132,000
FLA	114,000	142,000	117,000	115,000
NY	126,000	143,000	113,000	13,8000

Conclusion

- The coefficient varies by the changing of demand of electricity.
- Due to the load variation every year, the coefficient need to be update accordingly.