Measurement-Based Approach for Inertia-Trend Analysis of the US Interconnections

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BACKGROUND AND MOTIVATION

- Renewable energy integration degrades Rate of Change of Frequency(RoCoF) levels due to reduced rotating inertia.
- In the US Eastern Interconnections, the renewable generation constitute over 10 % of total generation while in the Western Interconnection, it constitute over 22 %.
- Generation mix changes including gas-coal swap and fast frequency response from inverter-based resources (IBRs) are complex, leaving the actual trend of the inertia of the system an open question.

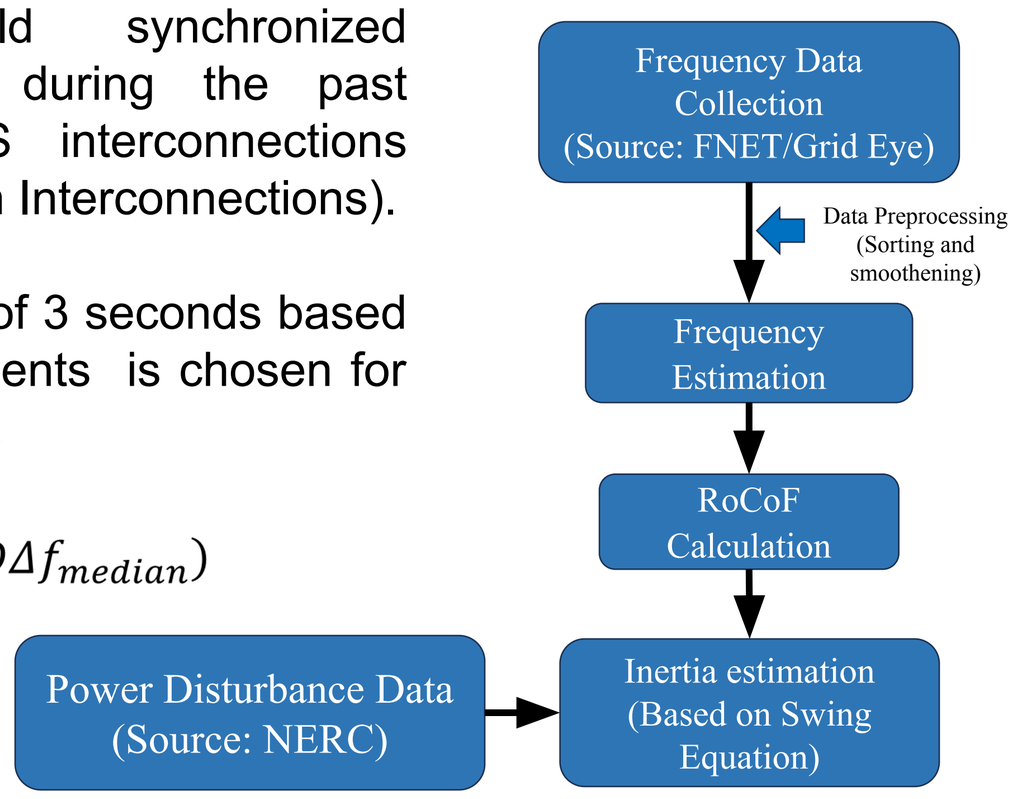
METHODOLOGY

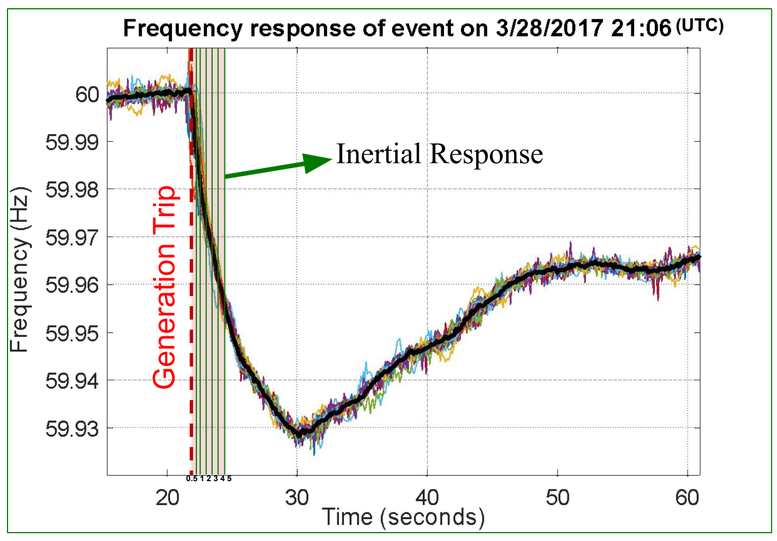
- Utilizes the field synchronized measurement data during the past decade in the US interconnections (Eastern and Western Interconnections).

- RoCoF time window of 3 seconds based on correlation coefficients is chosen for the inertia calculation.

$$2H\frac{df_{median}}{dt} = (\Delta P - D\Delta f_{median})$$

$$\frac{df_{median}}{dt} = \frac{\Delta P}{2H}$$





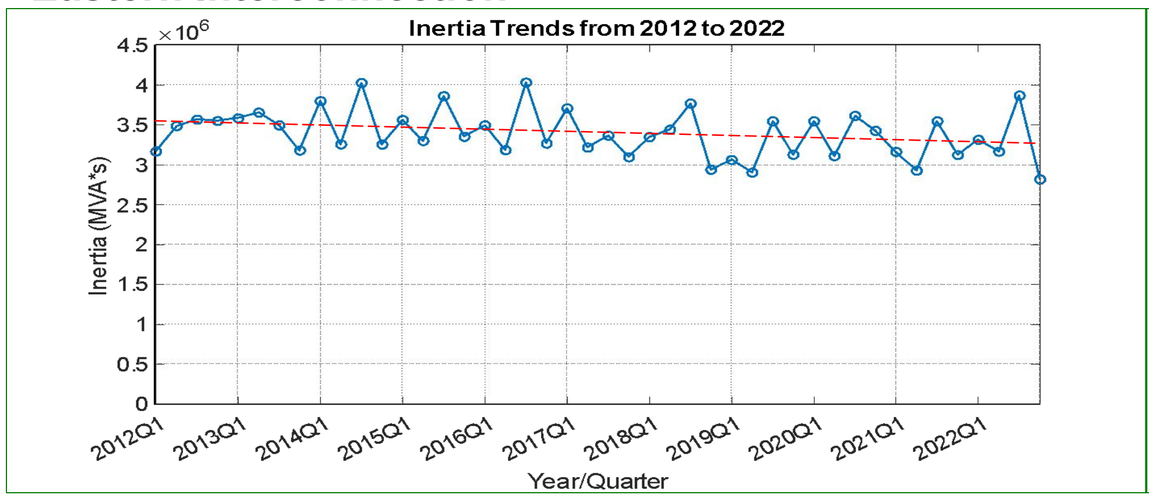
$$2\hat{H} = (RoCoF^T RoCoF)^{-1} \cdot RoCoF^T \cdot MW$$

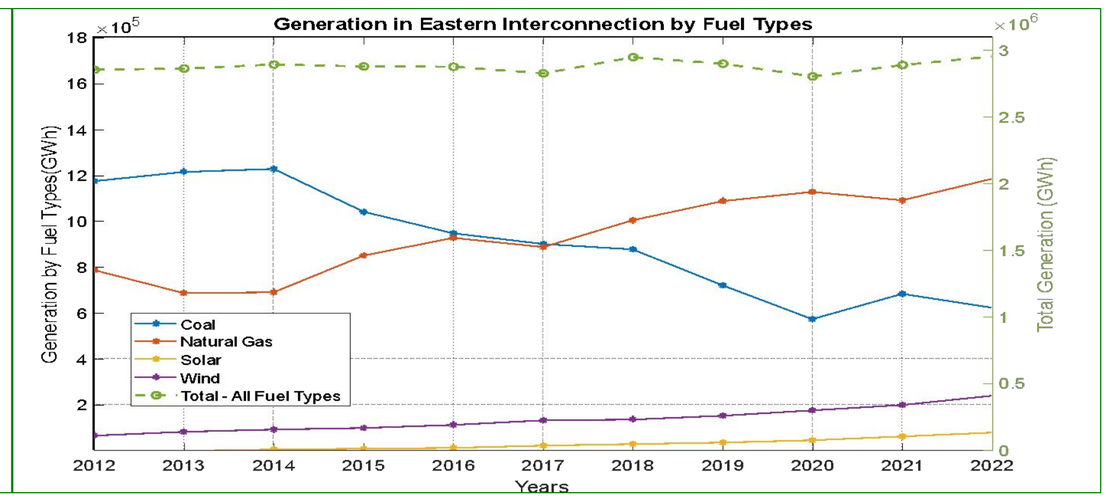
$$RoCoF = \left[\frac{\Delta f_1}{\Delta t}, \frac{\Delta f_2}{\Delta t}, \ldots, \frac{\Delta f_n}{\Delta t}\right]^T$$

$$MW = [MW_1, MW_2, \ldots MW_n]^T$$

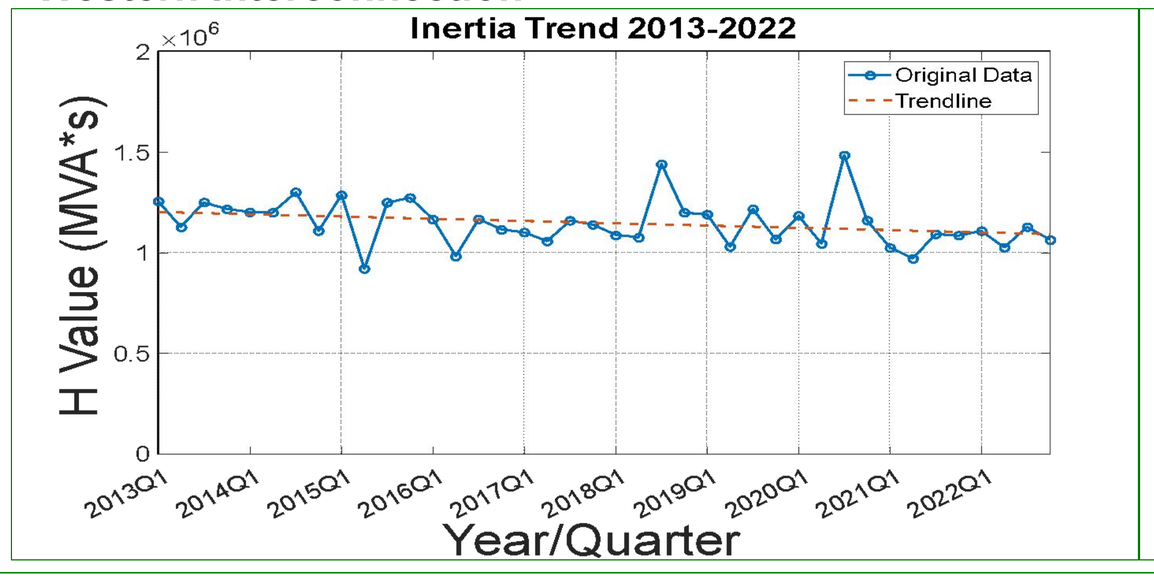
INERTIA TREND RESULTS FOR THE PAST DECADE

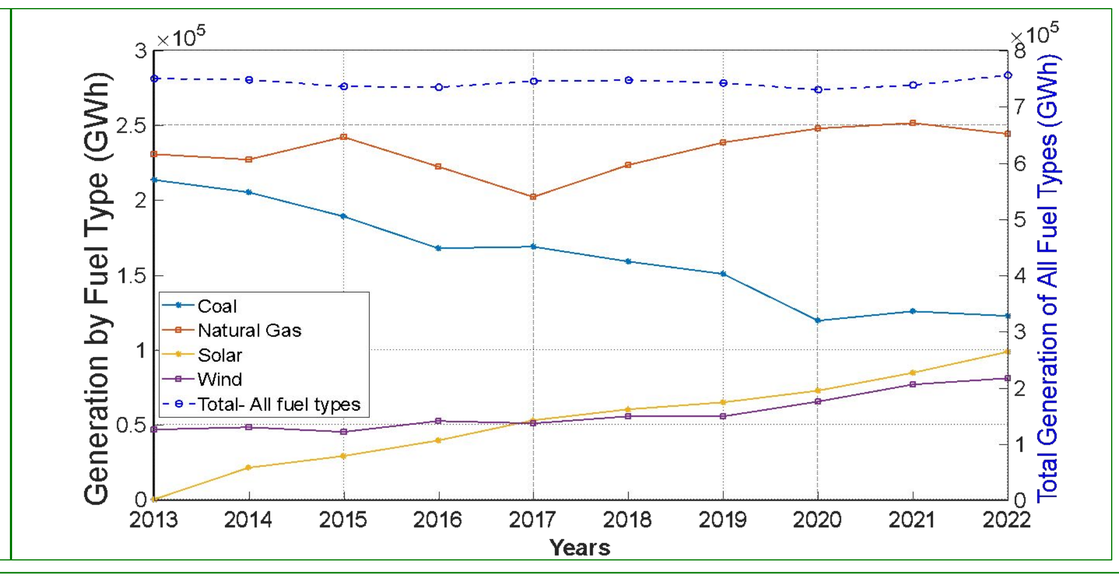
- **Eastern Interconnection**





- **Western Interconnection**





CONCLUSION AND FUTURE WORK

- Inertia trend analysis over the last decade is carried out utilizing historical field data measured throughout the US Interconnections.
- Future works include study on the inertia trend of Texas Interconnection.