

# Overview

## Analysis of GC0105 System Incident Data from 2022 to 2025

### Key Questions Answered

**When did most incidents occur?**

**How closely do ROCOF calculation methods align?**

**How does ROCOF relate to generation loss & how is the loss distributed across incidents?**

### Summary

- **Incident timing:** Incident counts vary strongly across weeks and months, with clear busy periods throughout the year.
- **Severity estimation:** Different ways of estimating ROCOF show similar overall behavior, with predictable differences for lower and higher ROCOF values.
- **Higher-severity incidents tend to come with larger generation losses**, but most events still fall in a mid-range with only a few large outliers.

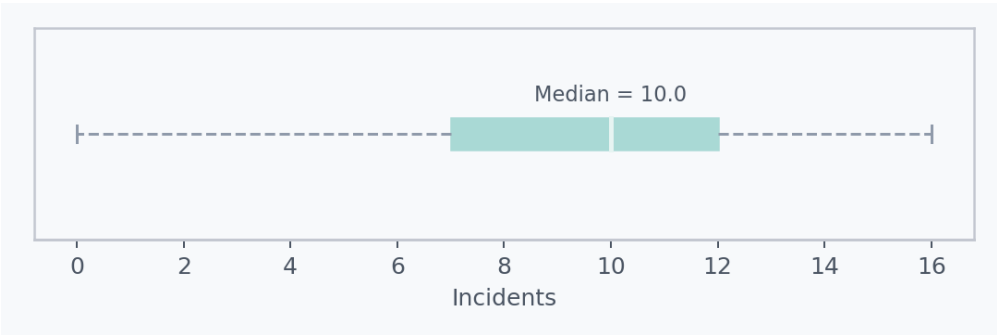
### Data

- Source: NESO monthly System Performance Reports (public) for 2022–2025; ~450 incidents
- Combined monthly files; removed incidents with missing values
- ROCOF and loss values were made positive using absolute values to keep the analysis consistent.

# How Incident Levels Vary Across Months

- **Incident counts vary widely by month**, as shown in both the distribution boxplot and the year-by-year table.
- **The median is 10 incidents per month**, with historical values ranging from 4 to 15, indicating moderate month-to-month volatility.
- **Higher counts in certain Months such as March, June and December** across multiple years.

Distribution of incidents per month across all years



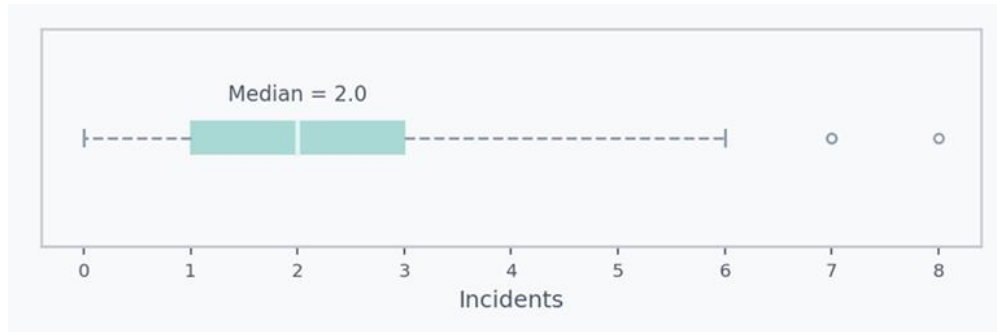
Monthly incidents by year

| Month       | 2022 | 2023 | 2024 | 2025* | Grand Total |
|-------------|------|------|------|-------|-------------|
| Jan         | 10   | 7    | 8    | 15    | 40          |
| Feb         | 11   | 4    | 6    | 11    | 32          |
| Mar         | 7    | 10   | 14   | 12    | 43          |
| Apr         | 10   | 8    | 8    | 8     | 34          |
| May         | 15   | 6    | 10   | 4     | 35          |
| Jun         | 9    | 12   | 13   | 15    | 49          |
| Jul         | 9    | 11   | 7    | 12    | 39          |
| Aug         | 15   | 5    | 5    | 10    | 35          |
| Sep         | 13   | 7    | 10   | 11    | 41          |
| Oct         | 8    | 15   | 10   | -     | 33          |
| Nov         | 11   | 12   | 7    | -     | 30          |
| Dec         | 15   | 11   | 15   | -     | 41          |
| Grand Total | 133  | 108  | 113  | 98    | 452         |

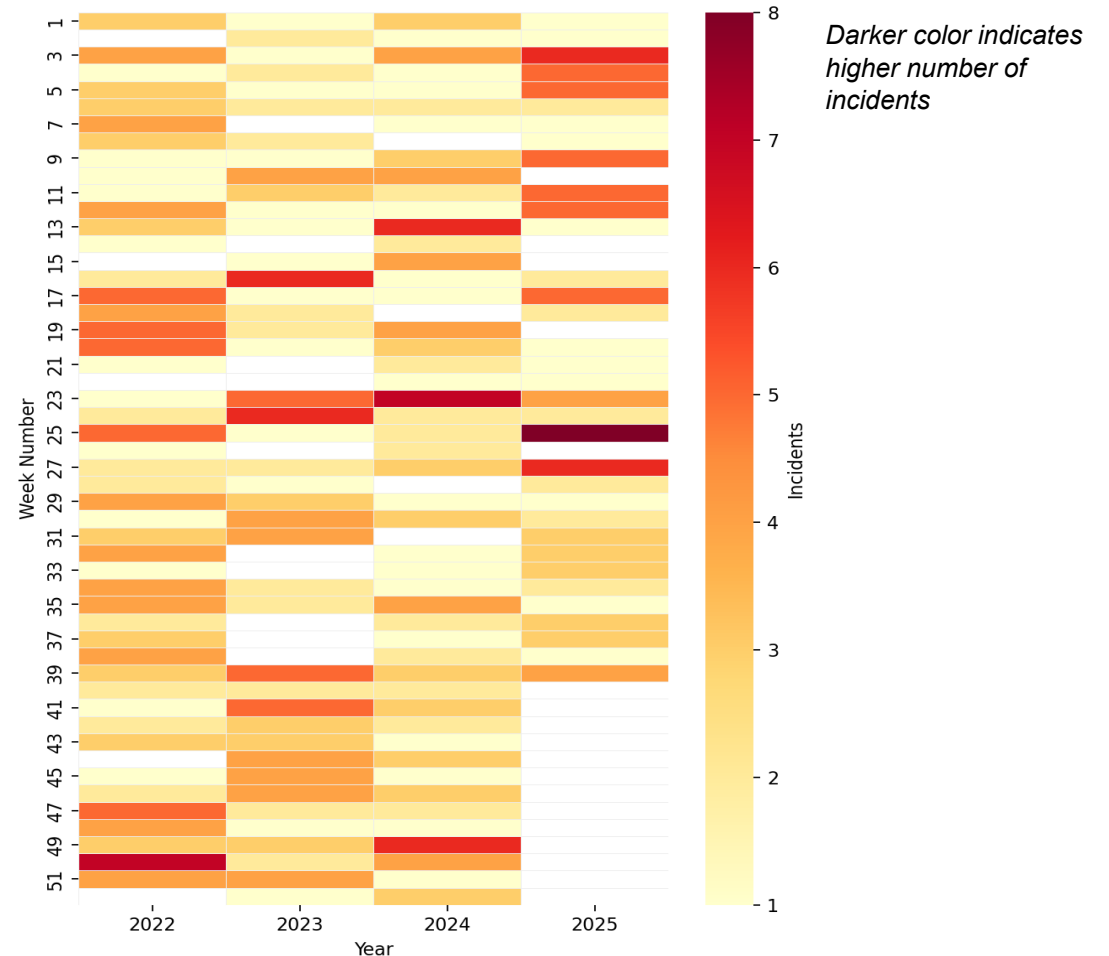
# How Incident Levels Vary Across Weeks

- **Incident counts vary by week and time of the year**, with peaks in weeks 23–25 across years
- **Most weeks show a low number of incidents** (median **2**) with typical ranges of 1–3 incidents
- **Few weeks show unusually high levels** (7–8 incidents, outliers).

Distribution of incidents per week across all years



Heatmap of Weekly Incidents Across Years



# Relationship between Frequency-Based and Inertia-Based ROCOF

- **A tight cluster along the diagonal** shows that both approaches give similar results for many incidents.
- **At lower ROCOF levels, points tend to lie above the diagonal**, meaning the inertia-based estimate tends to be higher than the frequency-based one.
- **At higher ROCOF levels, points more often appear below the diagonal**, indicating that the frequency-based estimate becomes higher for larger disturbances.

## Calculation Methods

### Frequency-based ROCOF (published by NESO):

calculated from Frequency measurements,  
using a 500 ms sliding window:

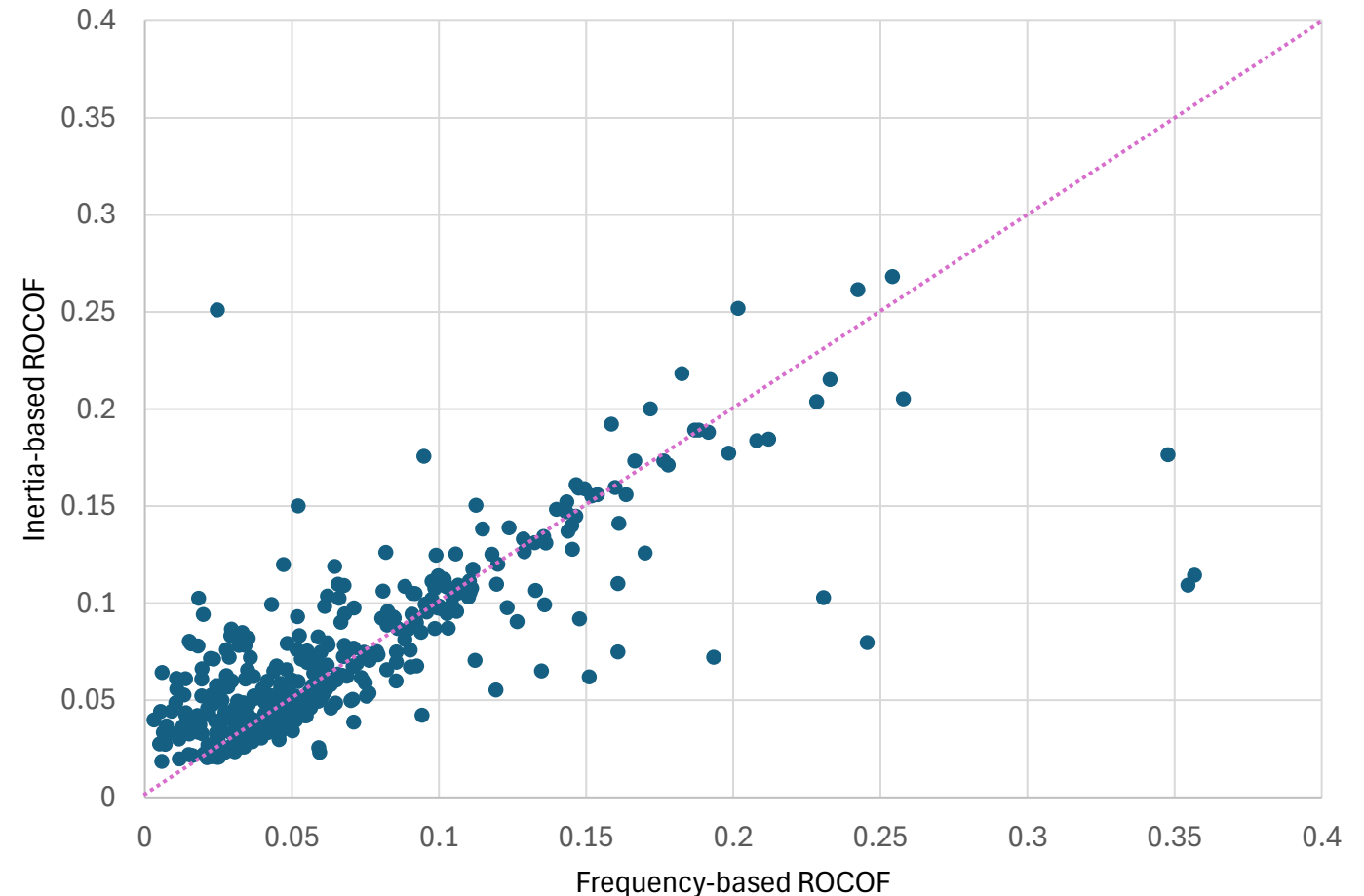
$$\text{ROCOF} = \frac{f_{500\text{ms}} - f_0\text{ms}}{0.5 \text{ s}}$$

### Inertia-based ROCOF:

calculated from system inertia and Loss

$$\text{ROCOF} = \frac{IP_{\text{loss}}^{1.50}}{2 \cdot H_{\text{system}} \cdot 1000}$$

Frequency-Based vs. Inertia-Based ROCOF<sup>1</sup>

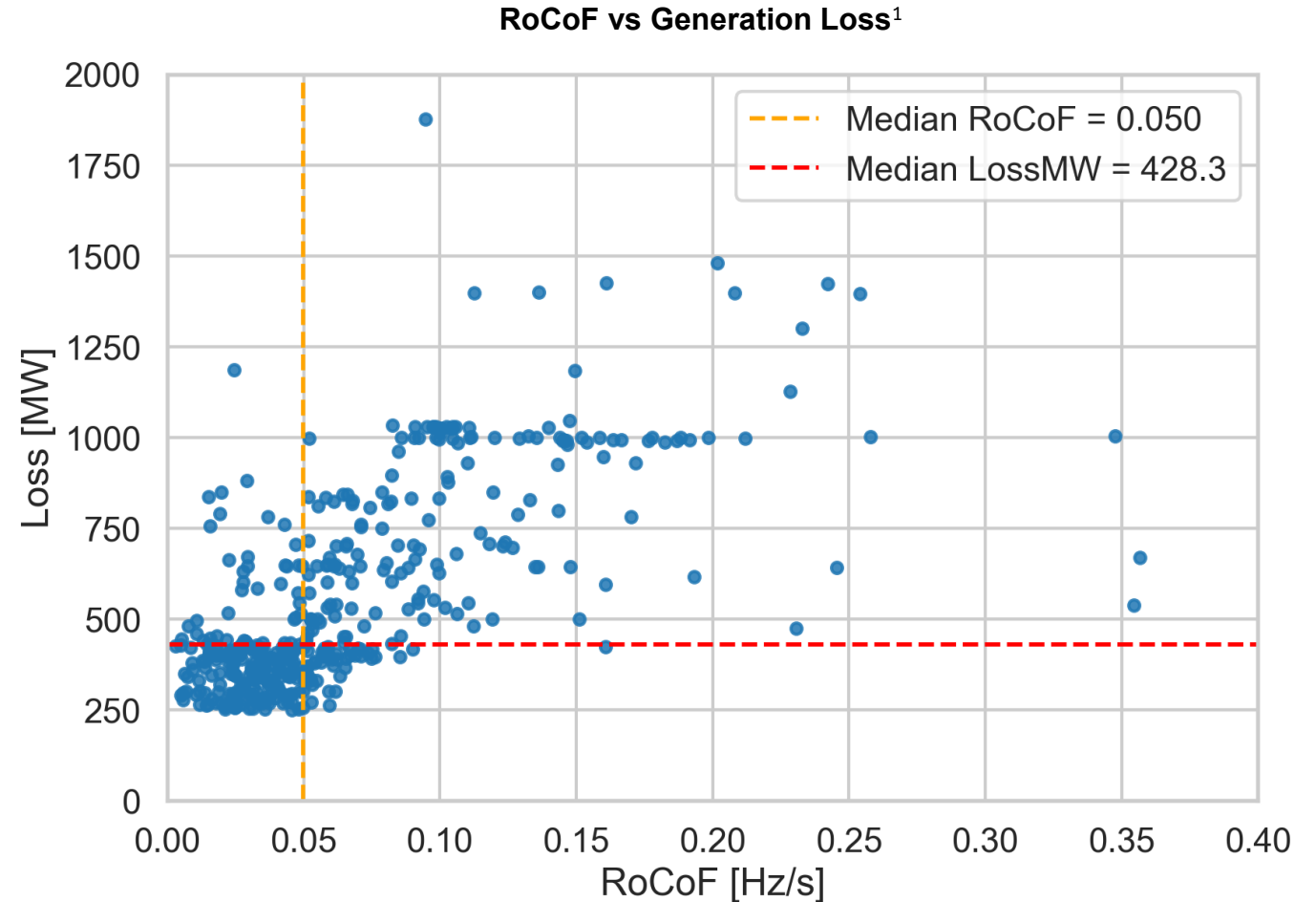


# Relationship Between RoCoF and Generation Loss

- **Concentration of incidents** at low RoCoF (0.02–0.08 Hz/s) and moderate generation losses (250–600 MW).
- **High-RoCoF events (>0.10 Hz/s) are associated with the largest losses**, indicating stronger system imbalance.
- **Median values (RoCoF = 0.050 Hz/s, Loss = 428 MW)** show the typical size of disturbance events.
- **RoCoF provides better separation of high-severity events** compared with MW-loss thresholds alone.

Summary Statistics for RoCoF and Generation Loss

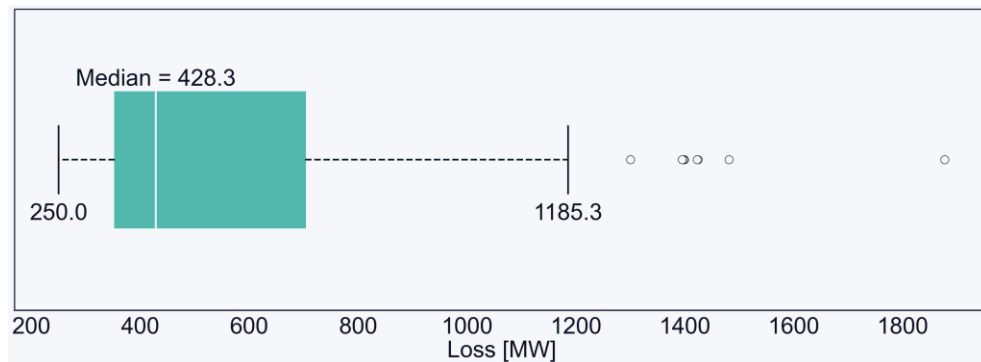
| Metric         | RoCoF [Hz/s] | Loss [MW] |
|----------------|--------------|-----------|
| N <sup>1</sup> | 424          | 424       |
| Mean           | 0.0664       | 555.1     |
| Median         | 0.05         | 428.28    |
| Std            | 0.0544       | 276.48    |
| Min            | 0.0031       | 250       |
| 25%            | 0.0307       | 352.9     |
| 75%            | 0.0866       | 702.62    |
| Max            | 0.3568       | 1876.97   |



# Distribution of Generation Loss Across Incidents

- **Most incidents fall between 300–700 MW**, forming the central mass of the distribution.
- **The distribution is right-skewed**, with a long tail of rare high-impact events extending up to ~1800 MW<sup>2</sup>.
- **Large outliers**, highlighted by both the boxplot and histogram.

Generation Loss median, range, and outliers



Histogram with density curve showing distribution of generation loss

