Using Reliability Metrics to Improve Performance

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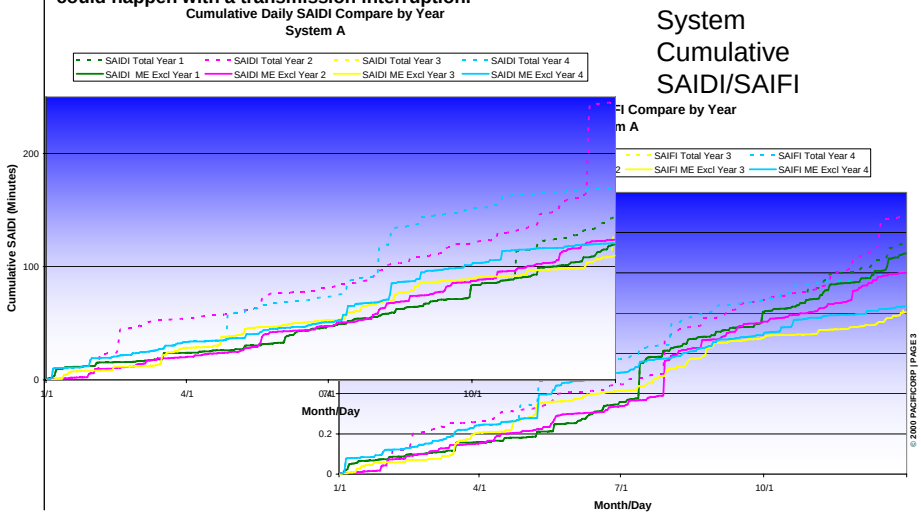
Metrics can be used to target…

- System,
- Region,
- Substation/breaker,
- Circuit,
- Device,
- Line Segment,
- Transformer/Customer-level performance and
- Improvement effectiveness.
- Understanding of how to view these metrics can evolve reliability management into the organization, such that operational staff, engineers and management all understand how their decisions can impact these results.

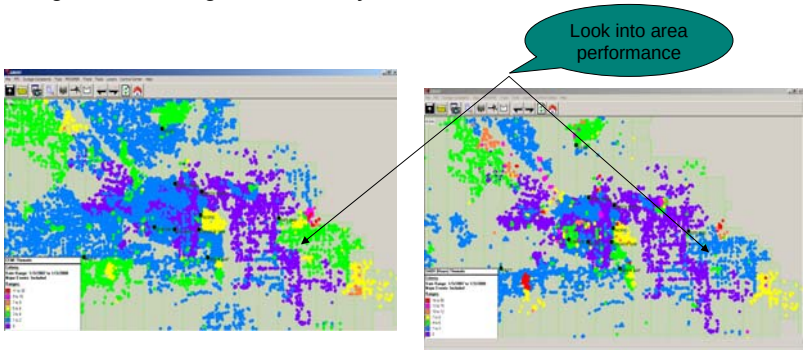
Examples of how these metrics can be used follow…

At a system level, the cumulative daily SAIDI/SAIFI curves can show the unusual days of performance. Dotted includes major events, solid is underlying only. "Stair-step days are worth digging into. When SAIFI stair-steps more than SAIDI, it means a low CAIDI day occurred, as could happen with a transmission interruption.

System Cumulative SAIDI/SAIFI

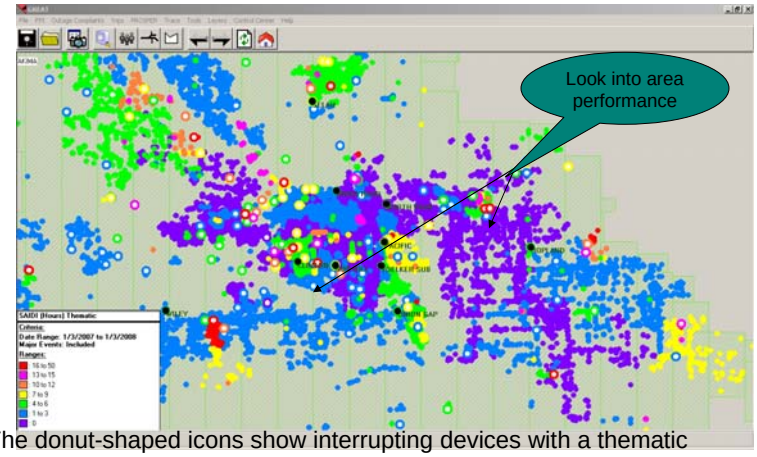


Rather than the prior tabular-sort of view, sometimes a geospatial rendering of the metrics can show important trends. Using both SAIDI and CEMI0, certain areas can be distinguished, and are worth investigating further. Selection of the breakpoints is important, because it targets areas for greater scrutiny.



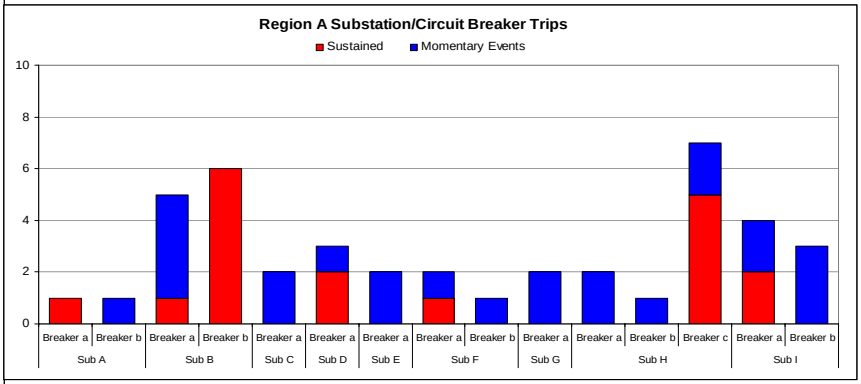
Regional view of GREAT SAIDI/CEMI$_0$

Regional view of DEMI (devices experiencing multiple interruptions)



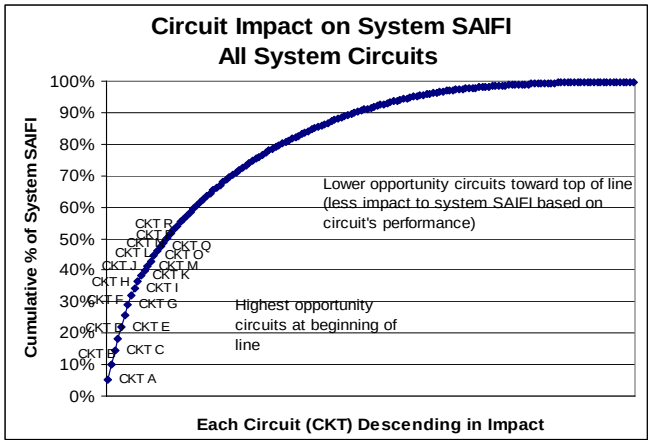
The donut-shaped icons show interrupting devices with a thematic interruption count; i.e. blue circles have operated once during the period, green twice, yellow three times, orange four times, pink five times and red more than five. Transformer-only interruptions have been filtered out.

Substation & breaker interruptions



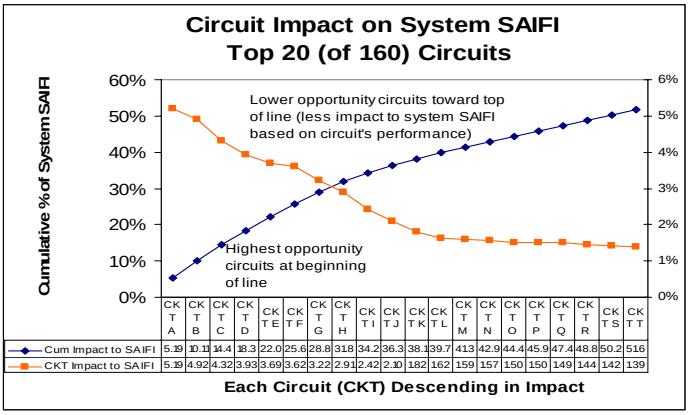
Using a bar chart of breaker interruptions, specifically their sustained and momentary interruptions, assessment of trends can be done. By comparing this period's chart to a longer or previous period, particular device assessment can be done. Is the breaker experiencing more events than expected? Is it clearing them as designed. Is the relationship of momentary to sustained interruptions consistent with history? Should all interruptions be either momentary or sustained?

Circuit's Impact within the System



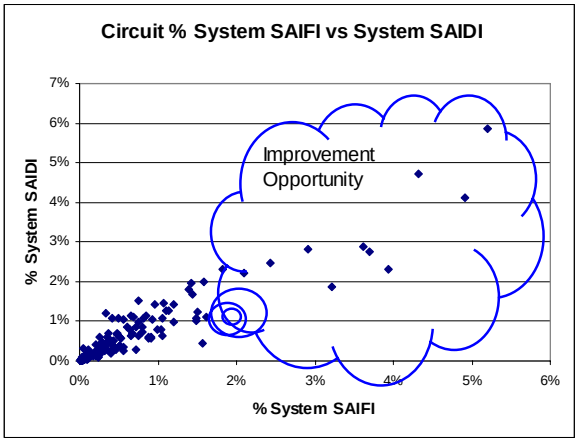
Circuit's percent of the system SAIFI, sorted in descending order. If there's a nice curve to the chart, there's a big opportunity for impact with a relatively small percent of circuits; if the curve is close to linear there's much less opportunity for impact.

Shown another way…



Two axes are used to show cumulative impact versus each circuit's impact on system performance. Orange line is individual circuit, while blue is cumulative. As can be seen, about 10 of the circuits account for 35% of the system's SAIFI.

Looked at another way…



In this view, the SAIFI versus SAIDI impact is shown. If the circuit has a corresponding high percentage of SAIFI to SAIDI, circuit improvements may make sense. If a high percentage of SAIDI, lower percentage of SAIFI, outage responsiveness should be looked at. If a high percentage of SAIFI, lower percentage of SAIDI, consider transmission interruptions.

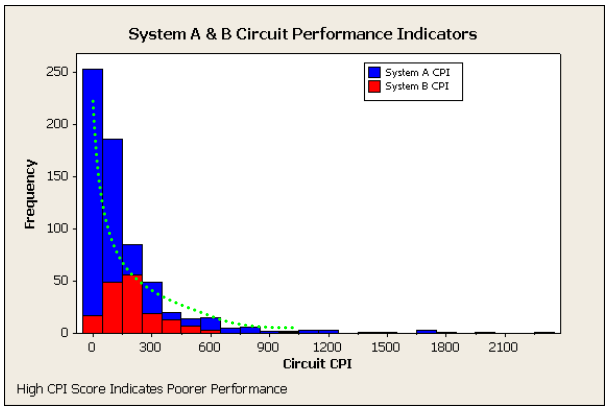
Circuit Ranking Blending Metrics

CPI = (SAIDI* W1* E1)+(SAIFI* W2* E2)+(MAIFI* W3* E3)+(LO* W4* E4)* Index

- LO = Circuit Lock-Outs (the number of substation circuit breaker Lock-Outs).
- W = Weighting factors used to set the degree of importance for each factor.
  - W1 = 0.30
  - W2 = 0.30
  - W3 = 0.20
  - W4 = 0.20
- E = Equalizing factors used to put each weighed factor within a consistent scale.
  - E1 = 0.02900261
  - E2 = 2.43902439
  - E3 = 0.69930069* total number of customers on the circuit
  - E4 = 5.26315789
- Index = indexing factor used to magnify the scale for each CPI.
  - Index =10.65

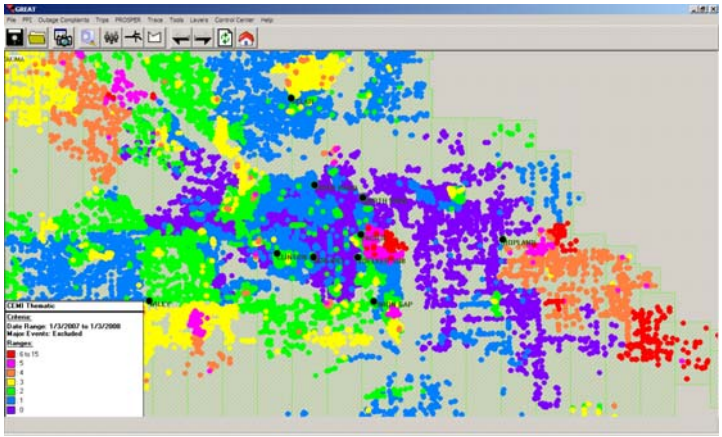
In order to compare circuit performance across a variety of interruption types, CPI is used. It also helps to moderate time volatility. After calculation, each circuit's score can be used to assess circuit ranking, the system performance distribution and identify areas for targeting.

CPI Frequency Plot (Histogram)



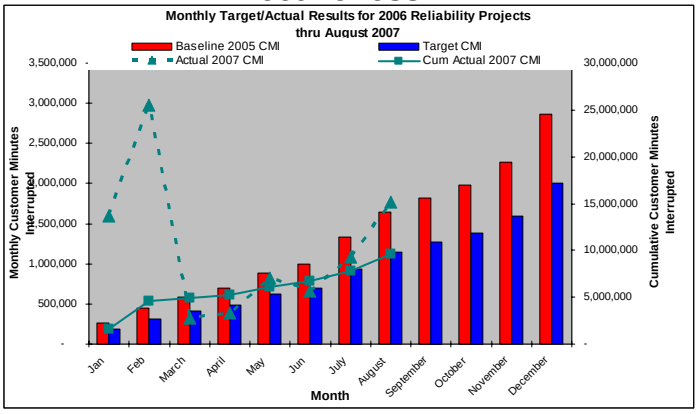
The dotted green line shows the ideal distribution of performance. System A compares pretty consistently with that distribution, which appears to be exponentially-shaped. System B is not consistent with that curve. Instead it appears to be a normal distribution with a bit of skewing toward the right.

$CEMI_0$ (Customer experiencing multiple interruptions)



Using a geospatial view, showing transformers by how often they've been interrupted during a time period. The redder the area, the more it's been performance challenged. The more purple, the better.

Using Metrics to Determine Improvement Effectiveness



Shown here is how pre- versus post-improvement metrics on a significant population of circuits have changed. The baseline period (of customer minutes interrupted) is established as a one-year period prior to any improvements, while the comparison is made in the year after the improvements have been made. Each month and cumulative year results are compared. Any one month can be erratic, however, on a cumulative basis should become less important.

In summary…

- The strategic use of reliability data, including derived metrics and indices can be revealing in determining:
  - How the system has operated,
  - When it experienced stressed,
  - Which areas performed more poorly than others,
  - Which devices interrupted most often,
  - What each customer's reliability experience would have been.
- Use of this data helps support improved performance across the system.