Non-Gaussianity in Frequency Distribution: FNET/GridEye's Observation of Worldwide Grids

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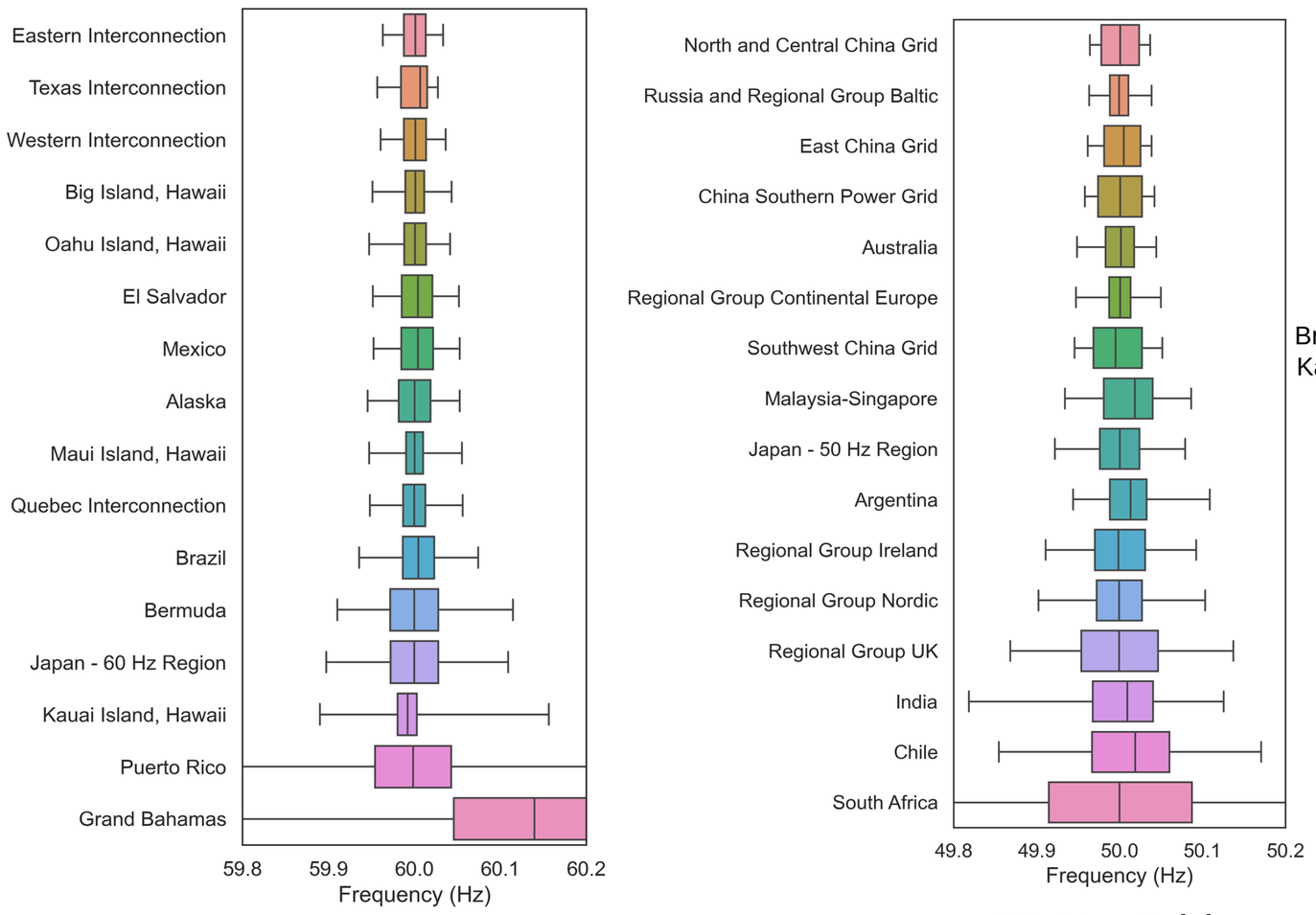
Introduction

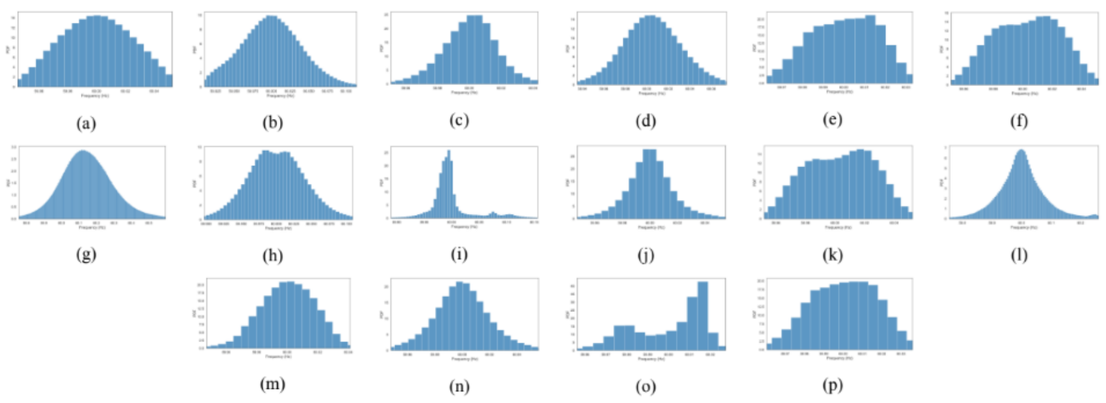
In the power grid, the frequency fundamentally indicates the health of the grid and shall stay within strict bounds to ensure reliable operation. Fluctuations arising from renewable energy sources pose an unprecedented challenge to the stability and quality of power grids. However, little research has been conducted regarding the difference between worldwide grids in terms of frequency. FNET/GridEye, as a wide-area monitoring system that collects frequency measurements from worldwide power grids, provides opportunities to study the characteristics of the worldwide grids. In this paper, 32 power grids, spreading over the world, are statistically analyzed and compared using 7-Month data. The presented cases reveal that the frequency distribution in most grids has strong non-Gaussian characteristics. Moreover, three categories of non-Gaussianity are proposed: multi-peak, skewed plateau, and heavy tail. Furthermore, these findings strongly suggest against assuming frequency distributions Gaussian prior to detailed investigation. The result should benefit future practice and research.

Statistics

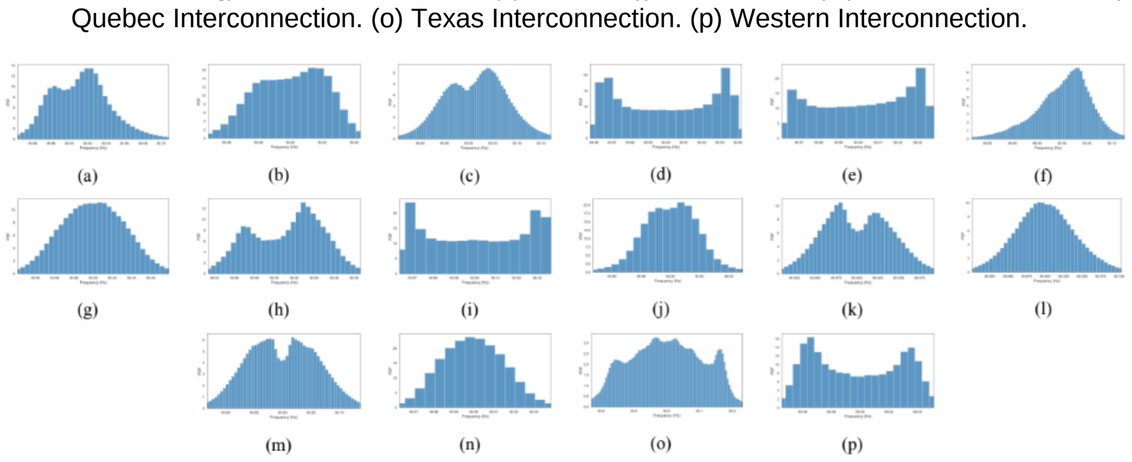


60 Hz Grids

50 Hz Grids

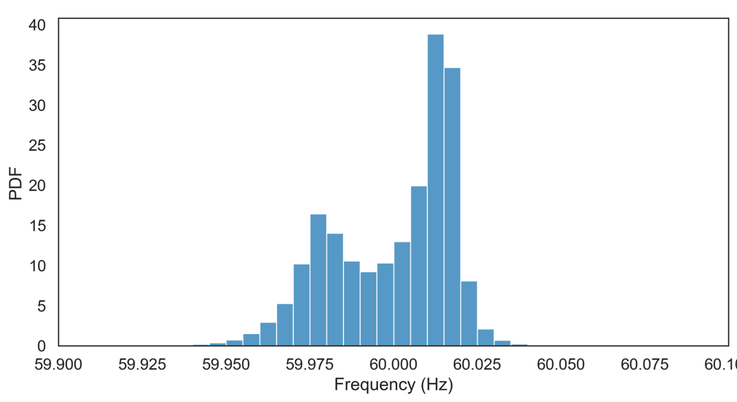


Frequency distributions of 60 Hz power grids. (a) Alaska. (b) Bermuda. (c) Big Island, Hawaii. (d) Brazil. (e) Eastern Interconnection. (f) El Salvador. (g) Grand Bahamas. (h) Japan - 60 Hz Region. (i) Kauai Island, Hawaii. (j) Maui Island, Hawaii. (k) Mexico. (l) Puerto Rico. (m) Oahu Island, Hawaii (n) Quebec Interconnection. (o) Texas Interconnection. (p) Western Interconnection.

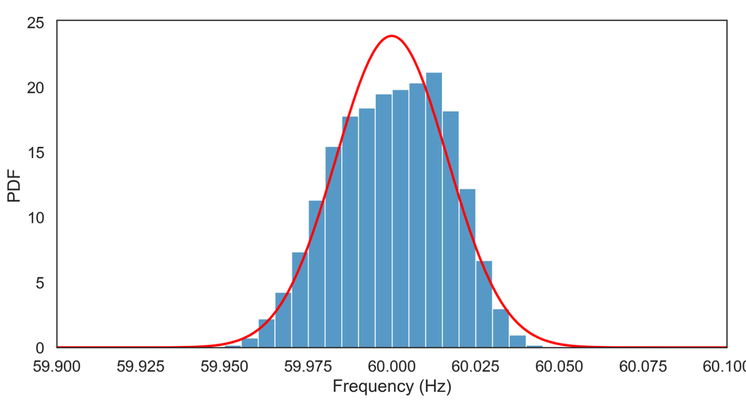


Frequency distributions of 50 Hz power grids. (a) Argentina. (b) Australia. (c) Chile. (d) China Southern Power Grid. (e) East China Grid. (f) India. (g) Japan - 50 Hz Region. (h) Malaysia-Singapore. (i) North and Central China Grid. (j) Regional Group Continental Europe. (k) Regional Group Ireland. (l) Regional Group Nordic. (m) Regional Group UK. (n) Russia and Regional Group Baltic. (o) South Africa. (p) Southwest China Grid.

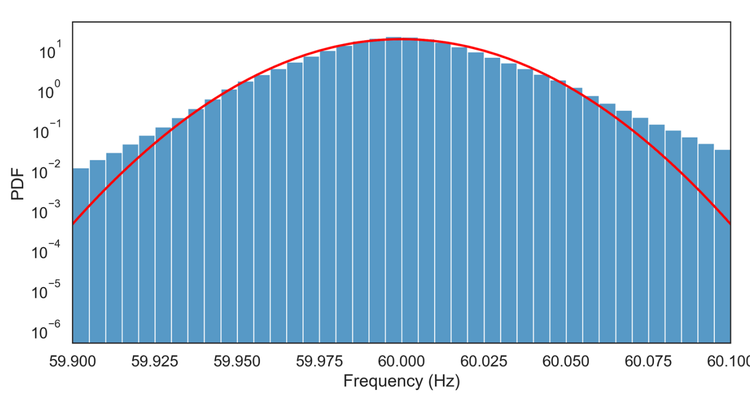
Non-Gaussian Distribution



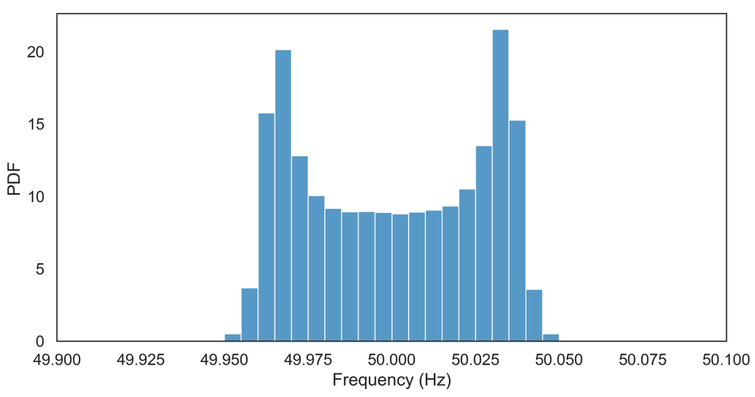
Texas



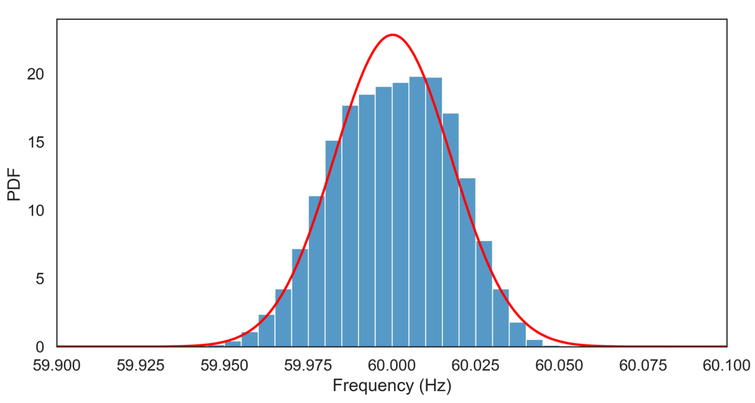
Eastern



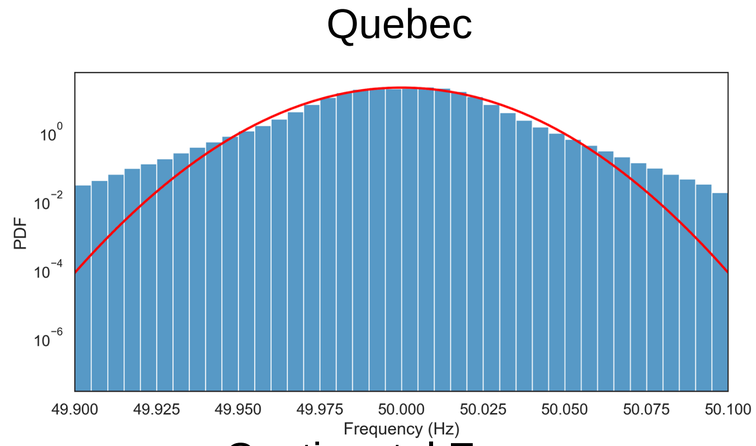
Quebec



China Southern



Western



Continental Europe