

BELLWETHER, LLC

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Bellwether Canary

Electric Grid Monitoring via Acoustics

1 Overview

Transformers function as a loudspeaker for their electric grid circuit. Canary uses acoustic analysis to learn six things:

1. transformer efficiency
2. transformer winding deformation
3. degraded inverters
4. improperly configured inverters
5. degraded AC-to-DC rectifiers
6. partial discharge and bushing failure

Canary is currently deployed as a smartphone app, taking advantage of the microphones and processing power that are in readily-available hardware. **The real innovation is the accessibility of grid monitoring.** For the first time, it is now cheap and easy to monitor your entire grid.

2 How It Works

Fundamentally, the buzz of a transformer is a reflection of the underlying magnetic field. This is due to a physical phenomenon known as **magnetostriction** The underlying magnetic field is a reflection of the underlying electric current. This electric current is a reflection of the transformer, the electricity producers (i.e. turbine generators, inverters), and the consumers (e.g. rectifiers).

3 Research Methods

Computer models	Quickly test and predict problems for their acoustic signatures
Laboratory	Validate our theories in a controlled environment
Utility visits	Identify our theories in the real world

4 Deployment Methods

Hardware is expensive — phones are everywhere. In 30 seconds, an untrained user is able to get a recording of a transformer and find out its loading and health. This assessment is then able to be optionally uploaded to the cloud for later review by your organization. **Since processing is done locally, no cell service is required and results are delivered instantly.**

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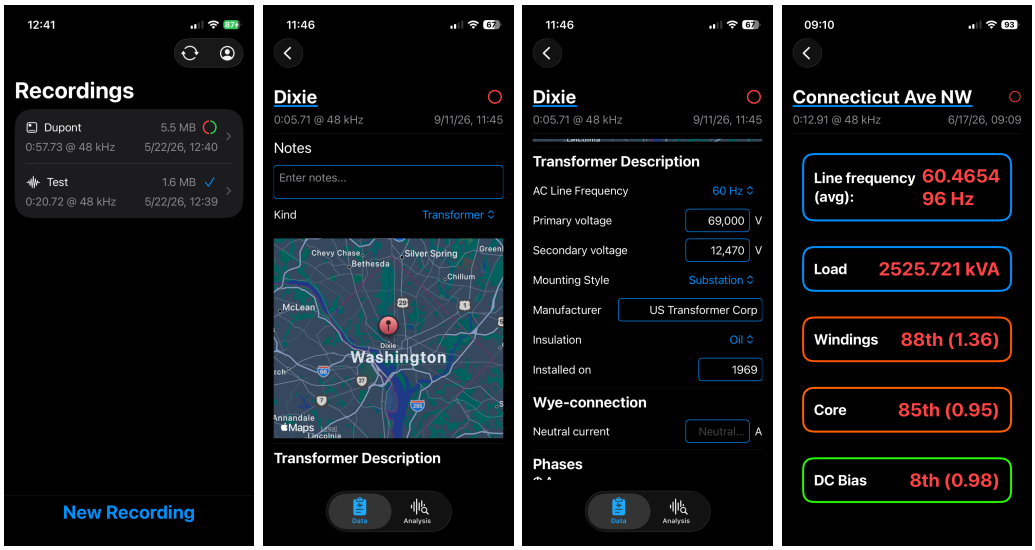

Figure 1: List of recordings; location; data entry; results

5 Use Cases

Lower cost	One smartphone can analyze infinite transformers, a significantly lower-cost method than monitoring individual assets
Shared grid	Monitor equipment you don't own by listening to a single location
Efficiency	Easily identify which transformers have high internal losses and need immediate replacement to save millions or dollars per year
Fire safety	Identify which transformers are at risk of causing a fire by listening to partial discharge

6 Partnerships

A research partnership includes three steps: a substation visit to record transformer acoustics, correlation with SCADA data, and a follow-on report of our findings. With only a 30-second recording, an untrained user can identify damaged transformers, inverters, and rectifiers. We currently work with:

6 utilities	Including cooperatives and municipal utilities
2 transformer OEMs	US- and India-based companies
2 rail agencies	
2 multinational energy companies	

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