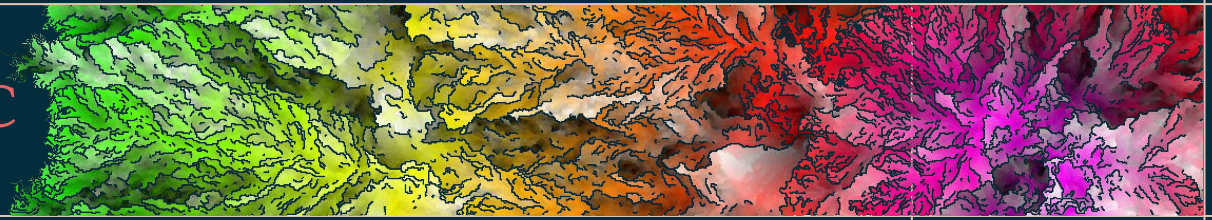
March 10, 2026 | Washington, DC

Canary in the Transformer

Predictive maintenance for the electric grid

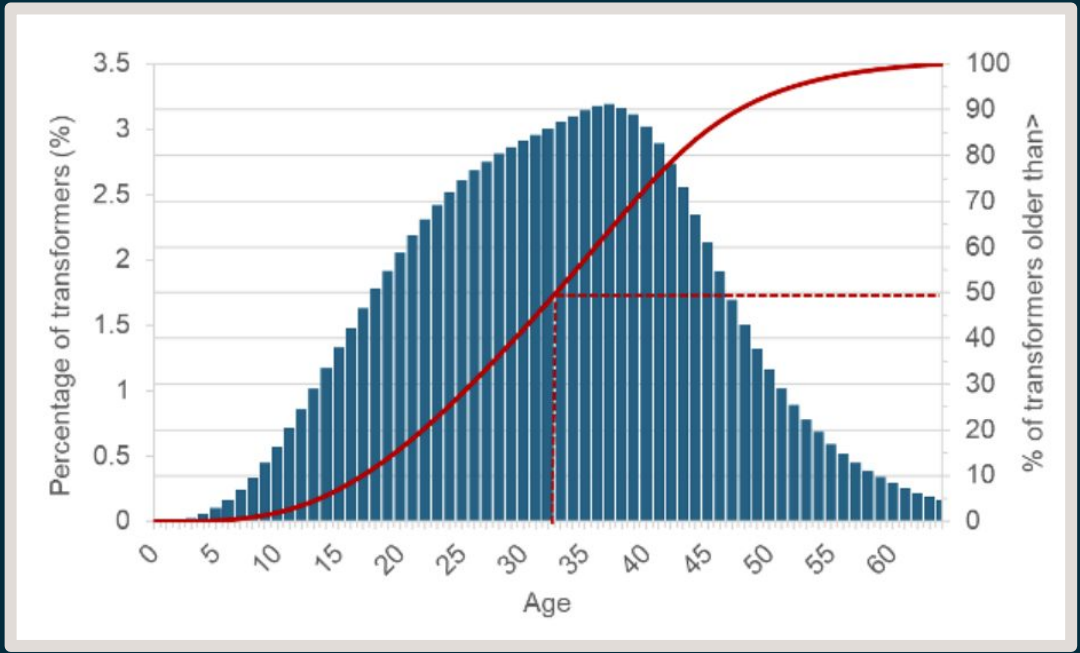
BELLWETHER, LLC



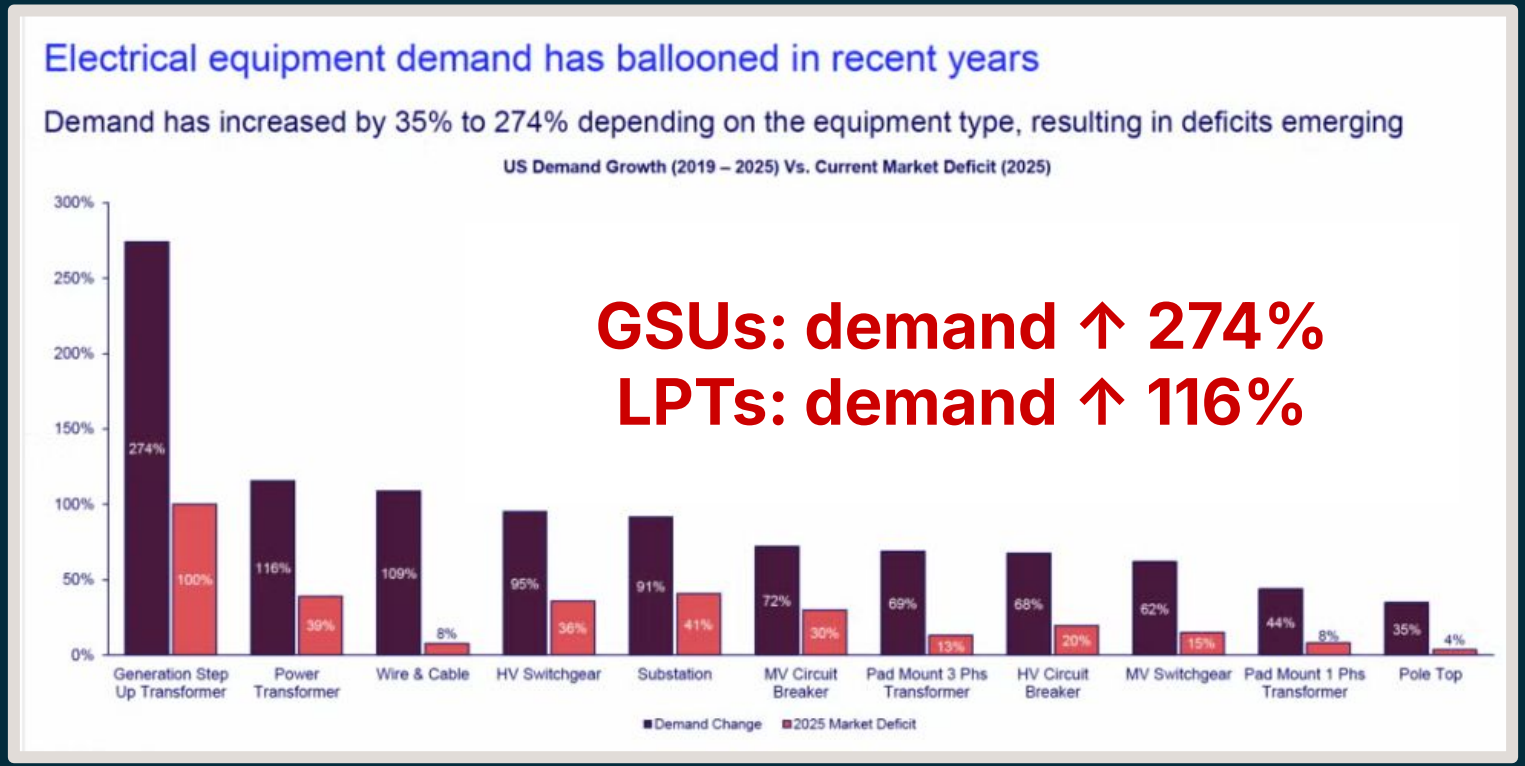
The Problem – *We can barely keep the lights*

Distribution transformers:
50% are 33+ years old

Transmission transformers:
70% are 25+ years old



The Problem – *Much less scale generation and distribution*



Technology

Which transformers to replace first?

Passive

Non-invasive

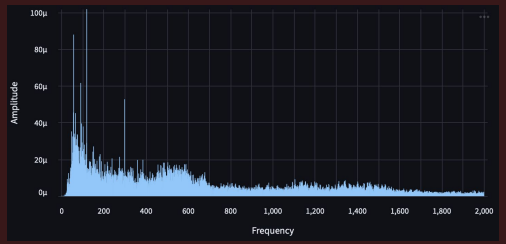
No AI

1

Listen to the transformer

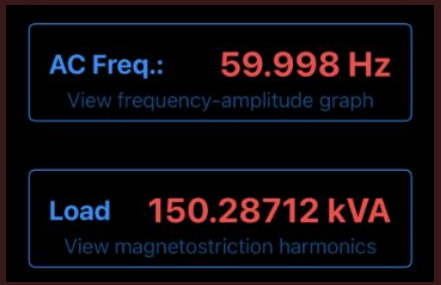
2

Analyze the acoustics



3

Get the assessments



How is my transformer doing?

1. What is the loading?
2. How long until the transformer fails?
3. Are you at risk of fire?

How is my transformer doing?

1. Can you support new generation?
2. How long until you are held hostage by your supply chain?
3. Are you at risk of a multi-million dollar settlement for a fire?

Just use your phone

Find out:

1. Loading in kVA
2. Transformer's "time left to live"
3. Risk of fire

in 60 seconds

Expensive O&M for unplanned replacements

$840k	**Value of lost load for 24 hours**
$108k	**O&M for an unplanned replacement**
$72k	**O&M for a planned replacement**
33%	**savings**

↑ Reliability

↓ Cost

Competition

Magnetometer

- Oktogrid
- Magnefy

Invasive installation	Canary is **passive and non-invasive**
Expensive	Install on your phone, **use endlessly**
Unable to be used by utilities	Allows for **online assessment**

Vibrational

- Traction
- Betavib
- Extech
- Fluke

Invasive installation	Canary is **passive and non-invasive**
Requires power source	Operates from your **phone in 60 seconds**
Complex analysis is required	Analysis is **done for you, without internet**

Ultrasonic

- Fluke
- UE Systems
- SDT 340
- Mistras

Unable to detect winding issues	Canary monitors **ultrasonic and audible**
Expensive	Affordable installation **by license seat**
Unable to detect loading	Automatic loading analysis **instantly done**

Competitive advantage

No internet required

Hardware costs inhibit adoption
Works in rural areas with poor connectivity

Passive, non-invasive

Transformers **stay online**
No interruption of service

Hardware already deployed

All on your **smartphone**

Future Development

Continuous monitoring device

1

Low-power

Operate in extreme environments for up to 6 months

2

Weather-proof

Survive the harshest of conditions with zero human input

3

No cloud required

Ideal for rural utilities with poor cell coverage

4

Easy to produce

There are 60 million distribution transformers in the US — this product needs to support rapid construction and installation

The only team who can do this

Ari

Nuclear Engineer | Acoustician
Submarine Officer

Chad

Former DoD AI Lead

Labstart

- **US Navy submariner**
- **Nuclear engineer** under DoE and Naval Reactors
- **12,000 hours** of acoustic analysis
- Previously led DoD AI incubator Project MAVEN

NRECA
America's Electric Cooperatives

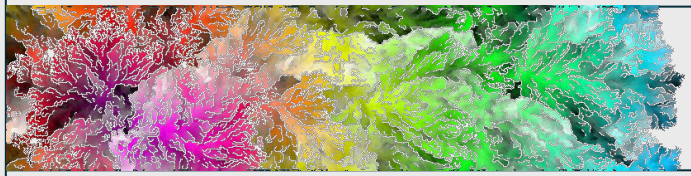
Contact

info@bellwether.llc

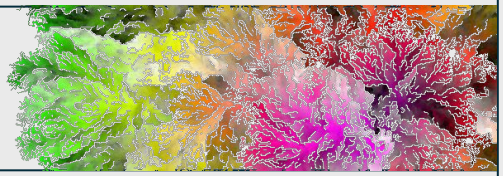
https://bellwether.llc

+1 (603) 729-7097

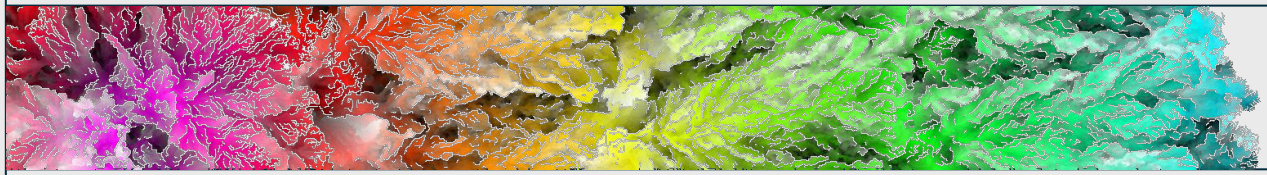
1733 20th St NW
#205
Washington, DC 20009



BELLWETHER, LLC
Washington, DC



Appendix



How much power are you using?

1. Data is **imprecise**
2. Data is **inaccurate**
3. Data is **closely guarded**
4. Requires **invasive meters**

Which areas have high loading?

Utilities ask...

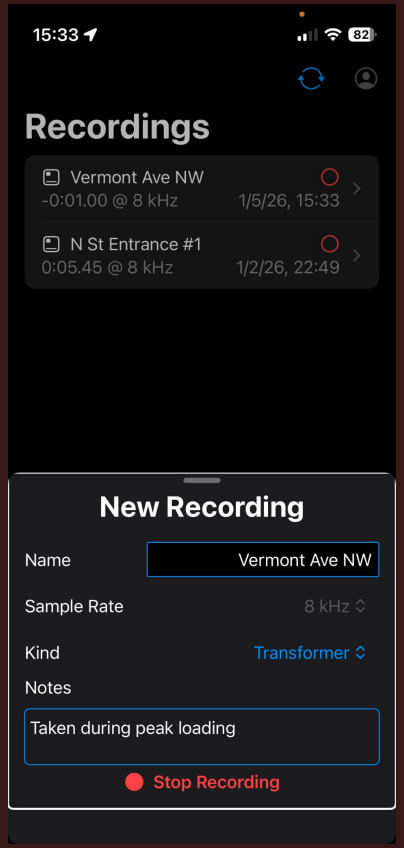
1. High loading increases **risk of failure**
2. Transformer health is **unknown**
3. Utilities need **3-5 years** to get new transformers
4. Identify a problem **before the blackout**

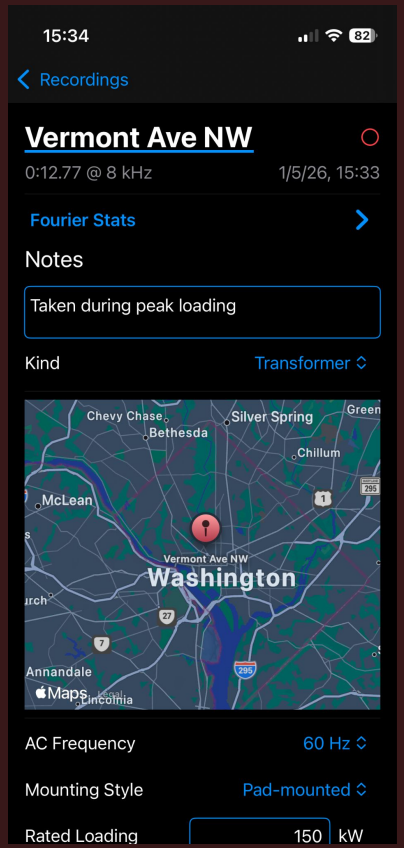
Which areas have **low loading**?

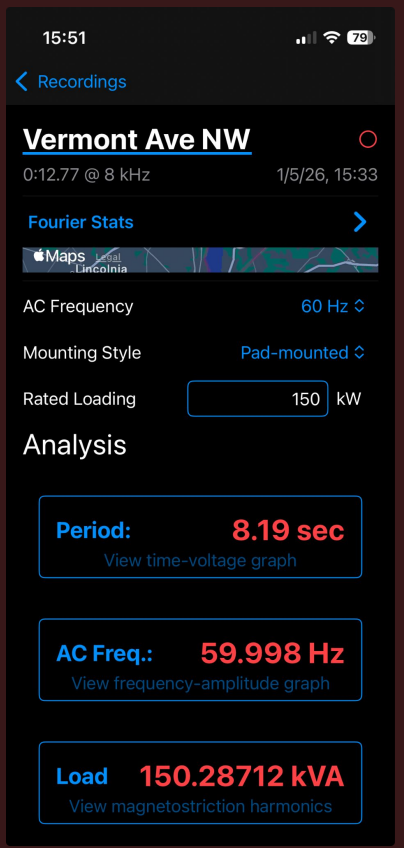
Distributed generators and data centers ask...

1. Transformer loading is **private knowledge**
2. Developers **want this knowledge**
3. Build where upgrades are **not required**
4. Eliminate unnecessary **upgrades**

Appendix: Screenshots







Appendix: Magnetostriction

60 Hz ac creates 120 Hz magnetostriction tone

2025 IEEE paper corroborates work

4 chinese scientists found this is a great way to determine loading

Causes of noise

- Magnetostriction
- Acoustic resonance
- Non-linear loads
- Core delamination
- Cooling fans
- Load conditions
- Overloading

Physical Phenomenon of Magnetostriction

- **60 Hz ac electricity**
- 60 Hz ac creates **60 Hz oscillating magnetic field**
- **Ferromagnetic grains expand/contract with peaks and nadirs**
- Expansion happens 2x/cycle, which creates a **120 Hz acoustic tone**

Appendix: Problem

Major transformer failure costs

Based on 7 days of downtime / major transformer failure
24 hrs of downtime / substation / year, based on a 2018 study

$14k/MVA	28 MVA	$392k	$56k
Major transformer failure Costs of a failure	**Standard substation** Average size	**Material costs** Only the material, capital expenditure costs per transformer — labor and overtime are all considered extra, O&M costs	**Cost / substation / year**

Appendix: Market (Substations)

20% figure comes from publicly available federal hydroelectric operators (PMAs)

Assume same 20% ratio holds for private grid operators

Material repairs are lessened by early identification

Private operators have significantly more capital available per substation

Rural utilities as a bloc have an outsized representation of federal operators

Rural utilities have trade association to pool resources (**NRECA**)

$5k/license seat/year

Train of Thought

- **20% of O&M budget** is for substations (based on federal hydroelectric operators)
- Substation O&M budget is: **~$130k/substation/year**
- 3% * $130k/subs. = **$3.9k/subs./year**
- Substations monitored by untrained worker 4-6x/year; **likely different employee every time**

Appendix: Market (Wind)

77,100 figure comes from a 2022 study

Average wind turbine capacity is 3.5 MW

$1,391/kW is average cost/kW for on-shore wind

Avg. cost is 3500 kW * $1,391/kW = $4.8M

O&M budget is $40/kW/year

3500 kW * $40/kW/year = $140k/year

71,000 turbines * $5k/turbine/year =
$355M/year TAM

$5k/turbine/year

Train of Thought

- **77,100 wind turbines**
- Average wind turbine **cost is $4.8M**
- O&M budget is **$140k/year**
- **Charge $5k/turbine/year;** only 3.5% of yearly O&M budget

Appendix: Market (Hydroelectric)

2024 study: **250 billion kWh generated** from hydroelectric dams

28 million kW capacity / 2800 kW/turbine = **10,000 turbines**

Assume Kaplan turbine, 8m pump head, 42 m^3/s

Based off Norwegian report

$20k/turbine/year is 3% of total cost

10,000 turbines * $20k/turbine/year = **TAM $200M**

$20k/turbine/year

Train of Thought

- **10,000 hydroelectric turbines**
- **Cost ~$700k/turbine** from Norwegian report
- Charge **$20k/turbine**

Appendix: Competition

Vibration	**Tractian**	Believed to be dependent upon savings Good for bearing assessment Unable to find evidence of it being used or working — **VAPORWARE**
Vibration	**Betavib**	$35,000 for total system (+ $12,000/machine) — **EXPENSIVE** Only does bearing assessment
Vibration	**Extech VB450**	$749 Manual operation
Vibration	**Fluke**	$15,000 for Fluke 810 — **EXPENSIVE** Fragile Extensive usage manual — **HARD TO USE**
Ultrasound	**Fluke**	$30,000 for Fluke 910 — **EXPENSIVE** Extensive usage manual — **HARD TO USE**
Ultrasound	**SDT 340**	$2,290 per unit Limited analysis
Ultrasound	**Mistras Group**	Monitors stray gassing and delamination No signature analysis Requires experienced operator

Appendix: Competition

Magnefy

- Magnetometer
- Ultrasonic microphone
- Temperature sensor
- Gas analysis

- Hardware licensed from Stanford
- Software licensed from UCF

Oktogrid

- Magnetometer
- Ultrasonic microphone
- Temperature sensor
- Gas analysis

- Danish company

Invasive installation	Invasive installation
Likely $5,000/transformer installation	Likely $5,000/transformer installation
No product yet	**Product deployed in limited quantities**
No signature analysis	No signature analysis
Requires de-energizing transformer for installation	**Requires de-energizing transformer for installation**