

Canary in the Transformer

Predictive maintenance for the electric grid

BELLWETHER, LLC



→ How much power are you using?

1

What is the loading?

2

How long until the transformer fails?

3

Are you at risk of fire?

→ How much power are you using?

1

Can you support a new data center?

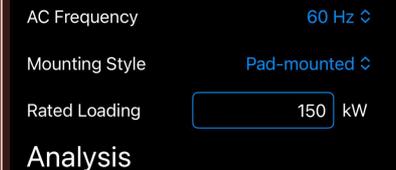
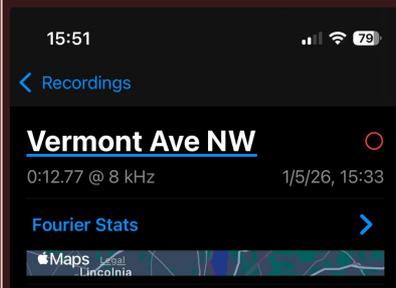
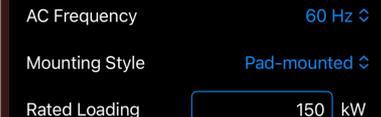
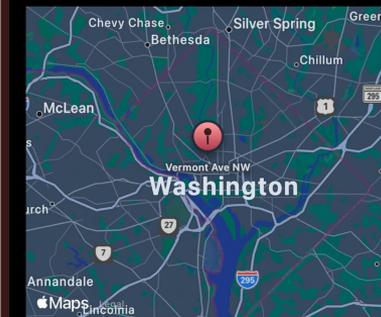
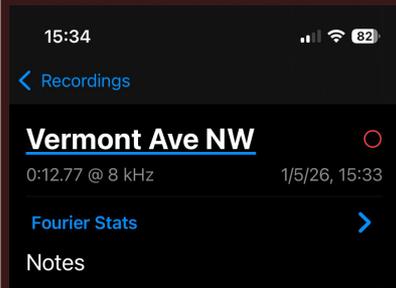
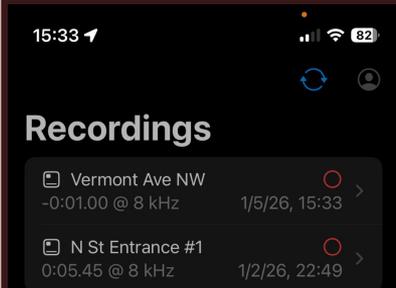
2

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

USA market highlights

Total US ARR

\$792M

Distributed solar ARR

\$198M

11,000 companies

Electric utility ARR

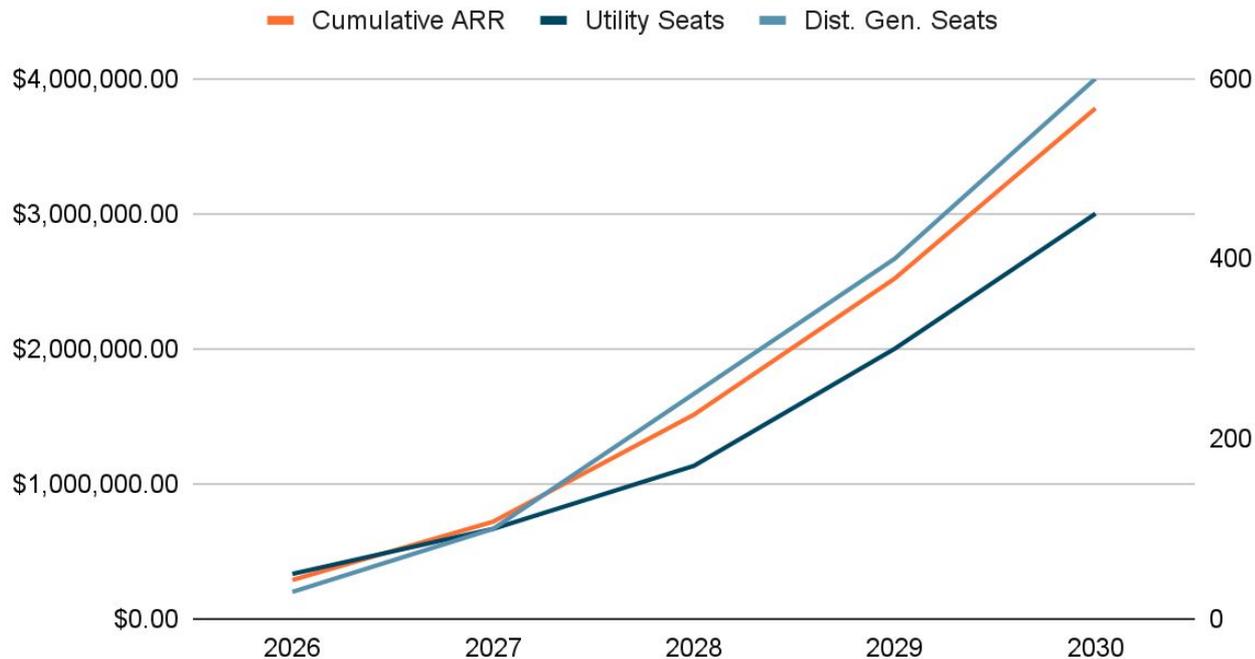
\$594M

55,000 substations

\$300/month/license seat

Year-over-year revenue growth

License and ARR Growth



+\$1M ARR YoY

Customers are:

- Electric utilities
- Distributed solar generation
- Wind generation
- Data centers
- Industrial plants

Utility use case

\$3B

in yearly damage to substations

\$280k

5-year cost *without us*

\$45k

5-year cost *with us*

84%

savings

↑ **Reliability**

↓ **Cost**

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 one else is doing this

Hardware costs keep competitors out
No one else uses acoustics like this
Most transformers completely unmonitored

Passive, non-invasive

Transformers **stay online**
No interruption of service

Hardware already deployed

All on your **smartphone**

Future Work



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

Internet connection

Connect and reconnect to the internet, despite outages and weather

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

Labstart





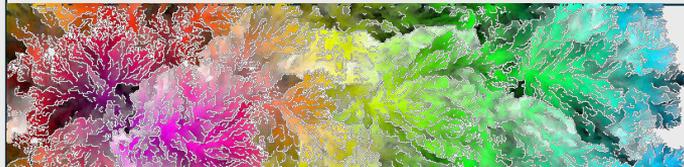
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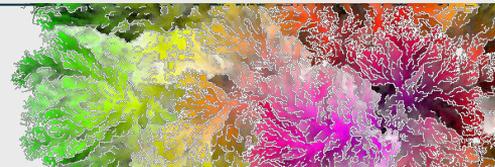
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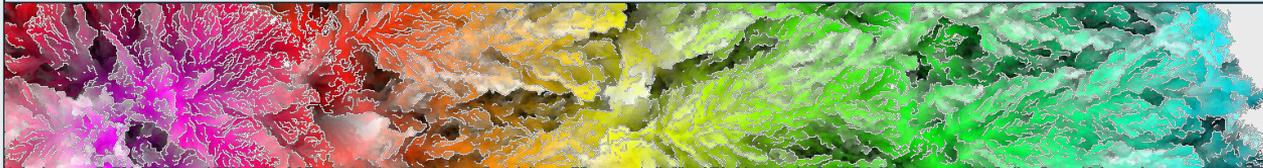
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Washington, DC



→ 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: 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: TAMs of Other Industries

\$180M

Commercial fishing

Classify species of fish based on sounds

Minimize bycatch and increase fishing efficiency

\$200M

Hydroelectric turbines

Predictive maintenance

Siting

Hydro-Québec has specifically asked for this

\$355M

Wind turbines

Predictive maintenance

Siting



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**)

Train of Thought



20% of O&M budget is for substations (based on federal hydroelectric operators)



Substation O&M budget is:
~\$130k/substation/year



$3\% * \$130\text{k}/\text{subs.} = \mathbf{\$3.9\text{k}/\text{subs.}/\text{year}}$



Substations monitored by untrained worker 4-6x/year; **likely different employee every time**

\$5k/license seat/year



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 \text{ kW} * \$1,391/\text{kW} = \4.8M

O&M budget is \$40/kW/year

$3500 \text{ kW} * \$40/\text{kW}/\text{year} = \$140\text{k}/\text{year}$

$71,000 \text{ turbines} * \$5\text{k}/\text{turbine}/\text{year} =$
\$355M/year TAM

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

\$5k/turbine/year



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 m³/s

Based off Norwegian report

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

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

Train of Thought



10,000 hydroelectric turbines



Cost ~\$700k/turbine from Norwegian report



Charge **\$20k/turbine**

\$20k/turbine/year



Appendix: Market (Fishing)

2023: 36,000 registered commercial fishing vessels

Fish identification is done through **active sonar** and **size identification**

Passive identification allows for **more reliable** identification at a **greater distance**

Furuno Omni Sonar is most popular tool
\$100k/vessel

$36,000 * \$5k/vessel/year = \text{TAM } \$180M/year$

Train of Thought



36,000 vessels



\$100k/vessel for sonar equipment



$5%/year * \$100k/vessel = \text{\$5k/vessel/year}$

\$5k/vessel/year

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