

PMU-BASED DYNAMIC LINE RATING

How much power can a line safely carry right now?

LineID uses measurements utilities already collect to find the real temperature and the real capacity of a transmission line, with no new equipment on the towers.

The problem: a fixed limit for a changing world

Every power line has a limit on how much electricity it can carry. The limit is set by heat: the more current flows, the hotter the wire gets. A hot wire expands and sags closer to the ground, trees, and buildings, and too much heat can damage it.

Most lines are still run to a **fixed limit** that assumes a hot, still, sunny day, every hour of the year. On a cool or windy day the line could safely carry much more. That unused capacity shows up as grid congestion, higher power prices, and delays in connecting new power plants. Regulators now expect ratings that follow real conditions (FERC Order 881, and FERC's ongoing work on dynamic line ratings).

Why current approaches fall short

- **Weather-only estimates** guess the wire temperature from forecasts, but never actually look at the line.
- **Sensors clamped on the wire** measure one spot each and must be installed and maintained on live, high-voltage lines, often over long distances.

Utilities need to see the whole line, using a real measurement, without sending crews into the field.

The LineID idea: the wire is its own thermometer

A metal wire's electrical **resistance rises as it heats up**. If you know the resistance, you know the temperature, the way an old-fashioned thermometer reads temperature from the height of the liquid.

Many substations already have **phasor measurement units (PMUs)**: precise meters that record voltage and current many times per second, time-stamped by GPS. When there is a PMU at each end of a line, LineID compares the two ends to calculate the line's resistance, and from that its **average temperature**.

The hard part is that the meters at the two ends are never

perfectly matched. Their small errors can swamp the signal. LineID's patent-pending automatic calibration corrects for this from the data alone, with no access to the field equipment.

In short: LineID is software. It reads data utilities already have and turns it into a live temperature reading for the whole line.

From one reading to the hot spot

The same current flows through every part of a line, but each part sees different sun, air temperature, and wind. Wind blowing *across* a wire cools it far better than wind blowing *along* it, so a bend in the route can make one stretch run noticeably hotter than another.

LineID divides the route into short segments and combines local weather with the direction of each segment. The measured line temperature keeps these segment estimates anchored to reality, so the result is a **temperature map** of the entire line.

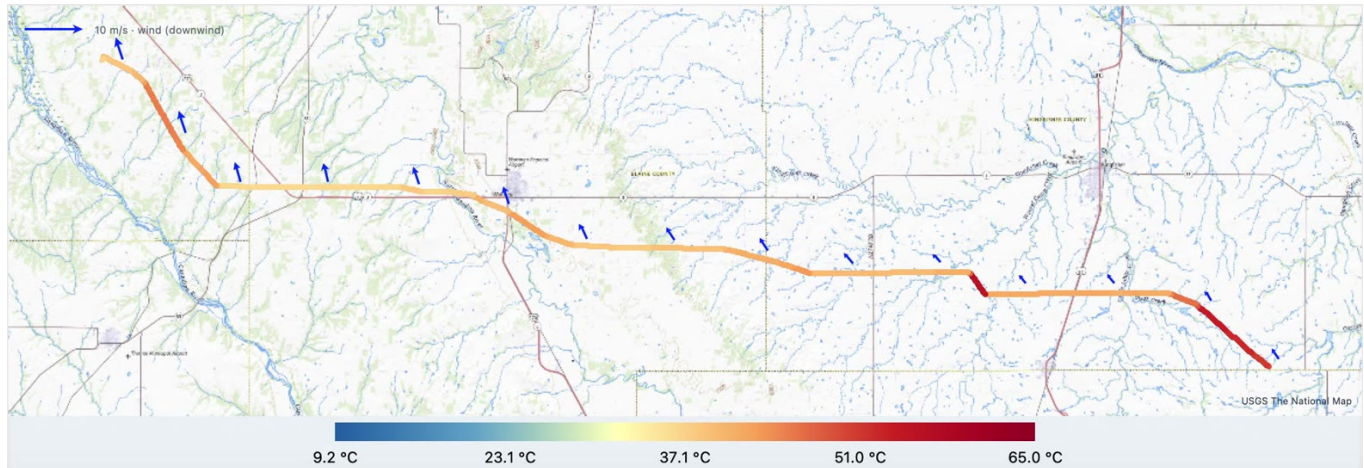
From temperature to a safe limit

For each segment, LineID calculates how much current it could carry before reaching its maximum safe temperature. The **weakest segment sets the limit** for the whole line. The rating is updated continuously, and operators can see *where* the limiting spot is. That location moves during the day as the sun and wind change.



Field experience

Topolonet completed a pilot with **Oklahoma Gas & Electric (OG&E)** on its 345 kV Mathewson–Tatonga line, using historical PMU data from both ends of the line. LineID produced the line's temperature, a temperature map along the route, and a limiting-segment rating.



Estimated conductor temperature along the Mathewson-Tatonga route (blue = cooler, red = hotter). Arrows show the wind. East-west stretches that face the wind run cooler; stretches running closer to the wind direction run warmer.

Two observations stood out:

- Parts of the same line, under the same air temperature and wind speed, ran at clearly different temperatures because of how they faced the wind.
- The segment that limits the line was not fixed. It moved as heating and cooling conditions changed, which a single sensor or a fixed rating would miss.

LineID's temperature reading is most reliable when the line is carrying meaningful load, which is exactly when an accurate rating matters most. The loading needed on a given line can be worked out before deployment.

What utilities get

- **More usable capacity** on cool and windy days, and a warning on hot, still days when the fixed limit may be optimistic.
- **A temperature map** showing where the line runs hottest.

- **Line health monitoring:** resistance that creeps up over time at similar conditions can point to a failing splice or joint.
- **Smarter field work:** recurring hot spots show where a few sensors or clearance checks give the most value.

What a pilot needs

- PMU data (historical or streaming) from both ends of a line.
- The conductor type and the route of the line.

No hardware is installed and no outage is needed. We return line temperatures, a segment temperature map, and a limiting-segment rating for your engineers to review.

Try out LineID on one of your lines.

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Common questions

Does LineID need new equipment?

No. It runs on PMU data that many utilities already collect at their substations.

Does it replace line sensors?

It can reduce the need for them. Where sensors exist, LineID adds a whole-line view and shows where sensors are most useful.

Does it rely on wind forecasts?

LineID's temperature comes from the line's own electrical behavior. Weather is used to find where along the route the line runs hottest.

Can it use past data?

Yes. A pilot can start from historical PMU records, so results arrive without waiting for a new season of data.