

LINE TEMPERATURE AND THERMAL CAPACITY

How much power can a line safely carry right now?

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

The problem: a fixed limit for a changing world

One of the main limits on how much electricity a line can carry is 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. Utilities also weigh other operating limits.

Many lines are still run to a **fixed or seasonal limit** set for hot, still, sunny conditions. On cooler or windier days, the same wire can often carry more current safely, and that unused capacity can add to congestion on the grid. A **dynamic line rating** is a limit that changes with conditions. FERC Order 881 now requires ratings that account for air temperature, and FERC is considering dynamic ratings.

Why current approaches fall short

- **Weather-based estimates** calculate the wire temperature from weather data, without measuring the line itself.
- **Sensors on the wire** measure conditions at their own location and must be installed and maintained in the field, often over long distances.

The LineID idea: the wire is its own thermometer

A metal wire's electrical **resistance rises as it heats up**, much as the liquid in an old-fashioned thermometer rises with temperature.

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 estimate the line's resistance, and from that its **average conductor temperature**.

The meters at the two ends are never perfectly matched,

and their small errors can swamp the signal. LineID's patent-pending technology handles this automatically, with no access to the field equipment.

In short: LineID is software. It uses existing PMU data to estimate the line's average conductor temperature, continuously.

From one reading to the hot spot

Even under the same electrical load, different stretches of a line see 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 turns this into a **temperature map** of the entire route, showing where the line runs hottest.

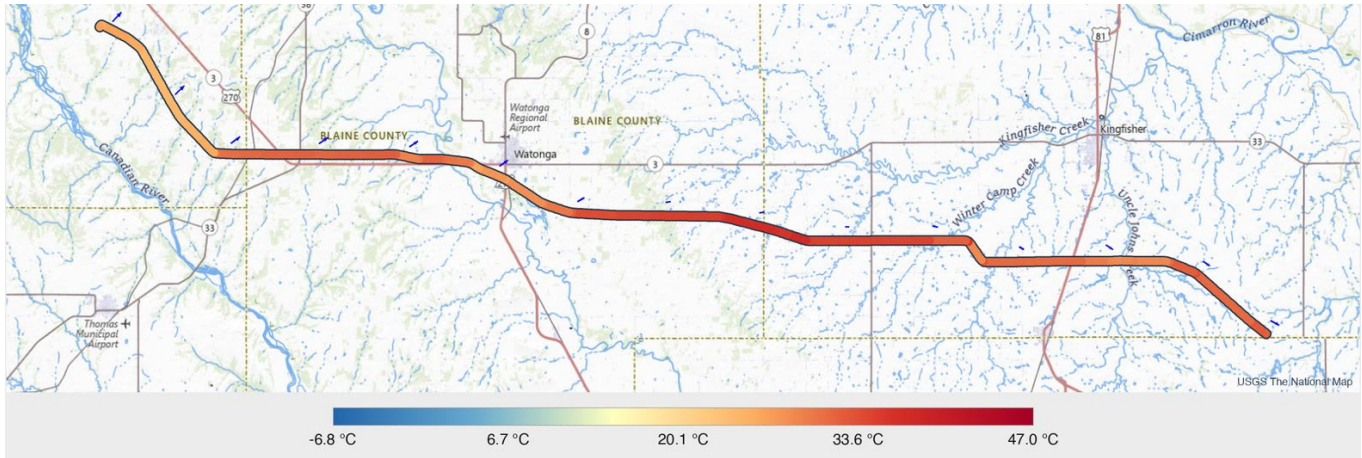
From temperature to a thermal limit

For each stretch of the route, LineID estimates how much current it could carry before reaching its maximum allowed temperature. The **weakest stretch sets the limit** for the whole line, and operators can see where it is. It is not always the hottest stretch, and it moves 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. LineID analyzed about a week of historical winter PMU data from both ends of the line and produced estimated line temperatures, a route temperature map, and thermal limits.



Historical example: estimated conductor temperature along the Mathewson–Tatonga route (blue = cooler, red = hotter). Arrows show the wind direction; the color bar is the display scale.

One observation stood out on Mathewson–Tatonga: at one point, a stretch of the line was estimated to run far hotter than the line’s average. The average alone would not have shown that local difference, and a sensor at one spot sees only that spot.

What utilities get

- **A view of capacity headroom:** when cooler or windier weather allows more current than the fixed limit, and when hot, still days leave less.
- **A temperature map** of the whole route.
- **Better-targeted field work:** recurring hot stretches show where extra measurements or clearance checks are most useful.

What a pilot needs

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

Where suitable PMU data already exist, no hardware is installed and no outage is needed. We return estimated line temperatures, a route temperature map, and thermal limits for your engineers to review.

Try out LineID on one of your lines.

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Common questions

Does LineID need new equipment?

Not for a pilot, where suitable PMU data are already available from both ends of the line, as at many substations.

Is LineID just a weather model?

No. Unlike weather-only tools, LineID also uses the line’s own electrical measurements.

Does it replace line sensors?

It complements them. LineID covers the whole route, and its map can help decide where a few sensors would be most useful.

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.