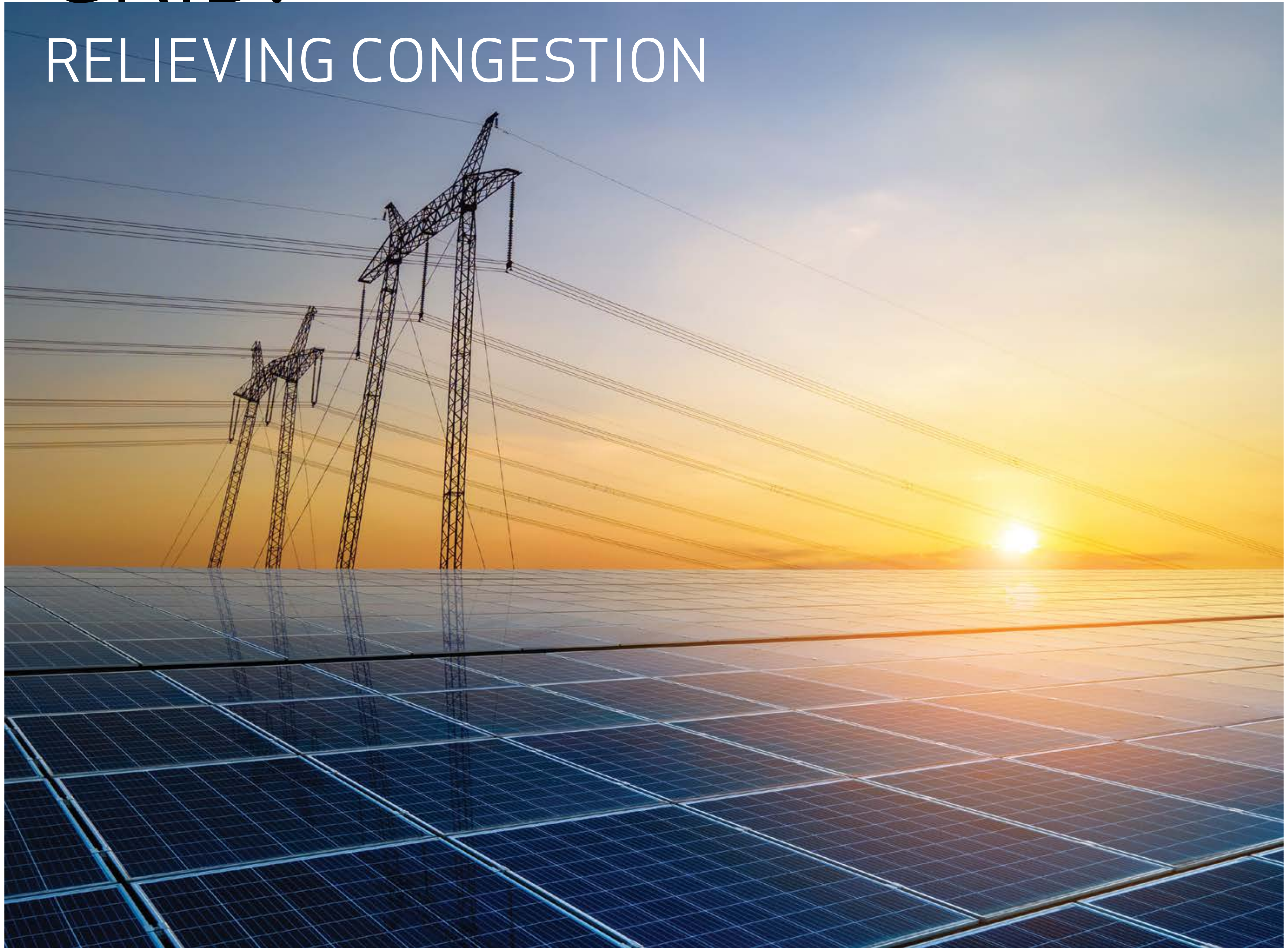
OUR OVERLOADED GRID:

RELIEVING CONGESTION



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You can't open a newspaper or magazine, or listen to a podcast these days without hearing about the dire circumstances our electric power grid — grids, actually — are in. Even in regions with sufficient generation, limits on the capacity of the transmission system may make it impossible to get electricity from where it's generated to where it's needed. This is especially concerning given the urgency of the transition to a clean economy.

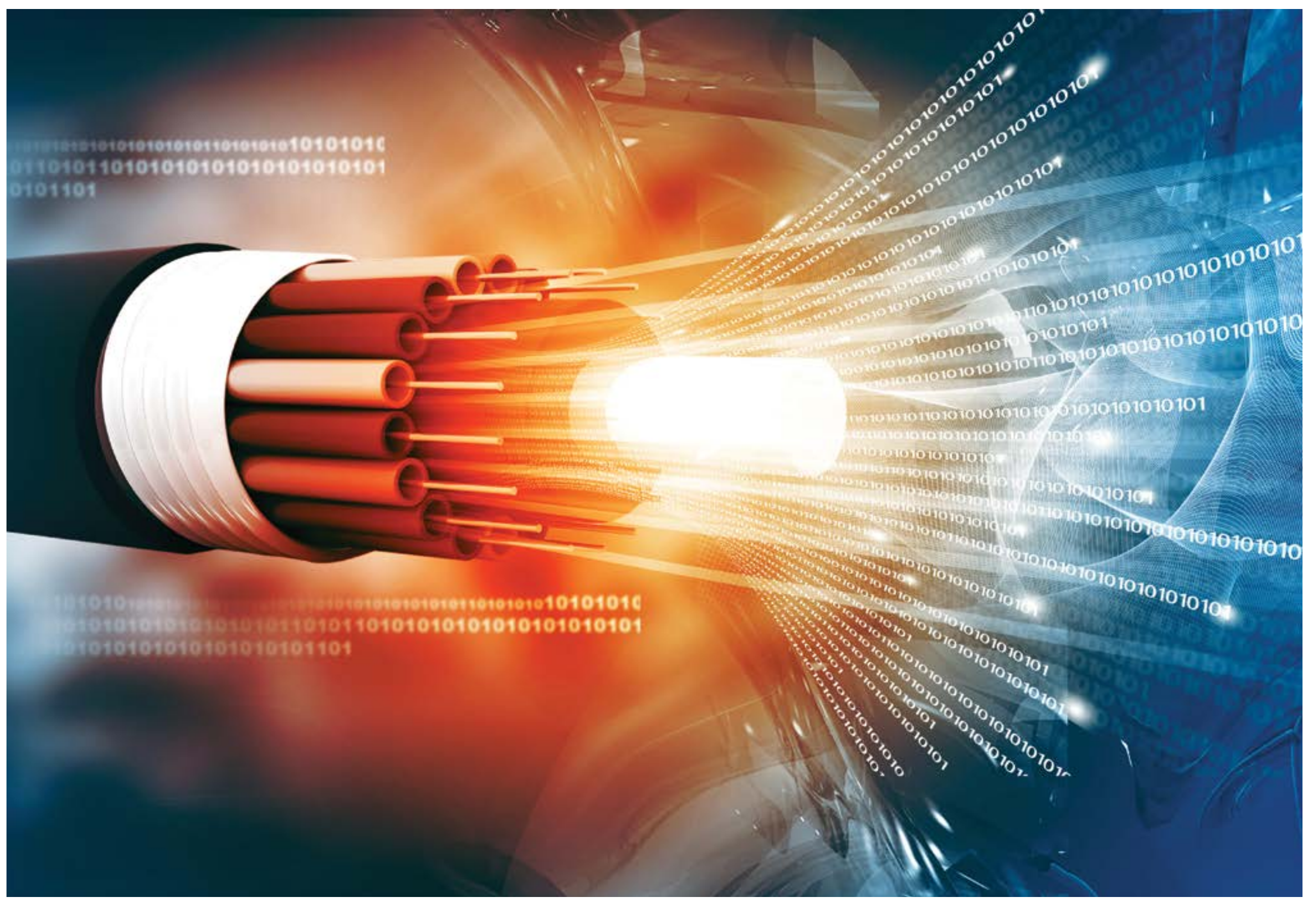
Beyond location, the U.S. is well into the early stage of the energy transition, slowly but consistently closing coal plants, adopting the use of electric vehicles and "electrifying" society: replacing technologies or processes that use fossil fuels, such as gas boilers, with electrically powered equipment such as heat pumps. On the power side, there is a large number of new generation projects — the majority of them renewables — waiting in so-called interconnection queues in regional transmission areas to plug into the grid. If even a fraction of them is built, it will overtax an already inadequate grid. That will result in "stranded electrons:" electricity that's available but cannot be transmitted. →

A third, pressing issue is simply the age of the bulk power system, the series of steel towers and heavy transmission lines that form the backbone of our energy infrastructure across the country, often clear-cutting through wide swathes of forest. Much of it was built in the 1960s and 1970s, and some are even older; most of its lines, called conductors, are from earlier generations. This limits the amount of electricity that can be imported into certain areas, causing problems with supply in "load pockets" and costing ratepayers millions in transmission congestion costs. That has created what the U.S. Department of Energy called our grid's "vulnerability."

The solution may sound as simple as "build more transmission," but that is expensive, can take a decade or more if it happens at all and requires hundreds of miles of easements ("rights-of-way") and other state and federal permits. Apportioning new transmission costs, which are inevitably passed along to ratepayers, often pits utilities against each other, state regulators and ratepayer advocates, a very contentious and time-consuming process. And that's to say nothing of withering local NIMBY opposition, which can upend even financed and permitted projects.

Recognizing that challenge, in December 2021 the Federal Energy Regulatory Commission promulgated Order 881, which requires that transmission providers use a conductor rating methodology called *Ambient Adjusted Ratings* (AAR), a more granular set of temperature assessments, to help determine more accurately how much electricity can be transmitted across overhead power lines. AAR is a welcome start in expanding grid capacity, while another real-time, sensor-driven technology, Dynamic Line Ratings (DLR), goes a step further in determining a transmission line's actual safe carrying capacity. But neither go far enough — literally as well as figuratively, as they can typically assess conductor conditions only from tower to tower — one span.

Fortunately, a new, sensor-free technology is available that can "see" up to 100 circuit miles of transmission in either direction. This system uses the installed fiber-optic ground wire (OPGW) running along conductors and connects it to an optical interrogator that analyzes signals from the fiber to "sense" what's happening on the grid. The analyzer detects and classifies events, pinpointing them down to individual tower locations in real-time with unprecedented accuracy, removing the serious nuisance of false alarms. The Interrogator transmits optical pulses that propagate down the fiber, reflecting a minute fraction of the light along each point. It then measures the reflected light to determine the strain, temperature, pressure and other line attributes over hundreds of kilometers, with < one-meter resolution, turning the fiber into a continuous acoustic sensor, as though there were tens of thousands of microphones spanning hundreds of kilometers.



Unlike other, purely DLR systems attached to towers or mounted on power lines, this technology provides unparalleled scalability, continuity and verifiability. It measures the wind on every power line span, covering 100% of the network, as opposed to other technologies which cover 5%-10%. This way DLR is calculated accurately, taking changing wind patterns into account in real time. The quality and quantity of the signals that the systems gather and provide to the analyzer unit allow the AI engine to accurately classify events rather than just detect excursions. This provides utilities with a cutting-edge tool to identify specific problems and plan preventative maintenance, improving both reliability and resilience. Analyzers can identify power lines' health at an impressively granular level including weather-related conditions — line galloping, sagging and icing; high winds; and even vandalism and wildfires. They also identify potentially catastrophic events including flashovers, short circuits, partial discharges, vegetation strikes and even tower climbing. Analyzers are placed at substations, and units can connect to a single command and control interface, while operators can integrate existing or new SCADA, Digital Twins, or other central control systems.

In March of this year, a detailed story in *The New York Times* acknowledged the severity of the surge in power use threatening U.S. grids and climate goals: "Over the past year, electric utilities have nearly doubled their forecasts of how much additional power they'll need by 2028 as they confront an unexpected explosion in the number of data centers, an abrupt resurgence in manufacturing driven by new federal laws and millions of electric vehicles being plugged in. Many power companies were already struggling to keep the lights on, especially during extreme weather, and say the strain on grids will only increase."

The bottom line? We need to maximize the efficiency of our existing grid, as we electrify society, fight climate change, and move the energy transition forward.

ABOUT THE AUTHOR:

Dr. Eran Inbar has been the founder of Prisma Photonics since 2017. Previously, he founded and managed V-Gen (2001-2016), a dominant player in the fiber laser field. Eran holds a Ph.D. in physical electronics from Tel-Aviv University with many novel laser patents. He is also an enthusiastic triathlete in his diminishing free time.