KOLKATA CUT: Life went on during the biggest blackout in history. This barber in the eastern city of Kolkata worked by candlelight.
PHOTO: BIKAS DAS/ AP PHOTO

Blackouts Illuminate India's Power Problems

Weak links in the grid prove difficult to fix

For two consecutive days in July, India experienced blackouts that took down large portions of the country's power grid. The second outage was the largest in history, leaving more than 600 million people, nearly a tenth of the world's population, without electricity. The blackouts brought renewed attention to the country's power sector, which is struggling to supply India's growing demand. They exposed weak links in the transmission system, inadequate fail-safe systems for preventing cascading failures, and a lack of proper outage planning.

The 30 and 31 July failures may have affected more people than any blackout ever, but it's tough to argue that they were the most disruptive. "I did not even know that there was some problem in the grid, because I was working from home, and in this building we have 100 percent backup," says Sivakumaran Govindarajan, a member of the India Smart Grid Forum, who lives just outside Delhi, the largest city affected by both blackouts.

Indeed, many commercial buildings, apartment complexes, and hotels in India have diesel generators that kick in automatically when the power goes out, which happens all too often. Although there hadn't been a grid-scale failure since 2001, rolling outages are common. In July, there was a gap of about 9 percent between the country's energy requirement and the amount available, according to the Central Electricity Authority.

Even when the grid is operating at peak capacity, 300 million or more people—more than in any other nation—still don't have electricity. "The power sector in India has been very badly handled," laments S.K. Anand, a retired power engineer who

update

Intoxicam

Engineers at the University of Patras, in Greece, have come up with software that can discern from a thermal image whether a person is drunk. Alcohol dilates the skin's blood vessels, creating a particular pattern of hot spots. The system uses the differences in temperature between certain areas of the face to figure out if the person is besotted. The inventors suggest that bars could use it to determine if a patron is too pickled to purchase more alcohol.

worked in Punjab for more than 40 years. Demand for electricity will only continue to grow: India's per capita electricity consumption was about 600 kilowatt-hours in 2009, leaving it far below the world average of 2700 kWh and behind regional competitors like China, where per capita consumption was around 2600 kWh.

Although new power plants are being built at a brisk clip—India added about 20 gigawatts of generation capacity in the past year—there hasn't been an equivalent investment in transmission and distribution networks, says R. Nagaraja, the managing director at Power Research & Development Consultants, in Bangalore. Increasing the network capacity will be critical, because most of India's demand is growing in the western states, while most of the suitable locations for new plants are in the east. It's politically difficult to secure right-of-way for new transmission lines, so power utilities have focused on upgrading existing corridors.

Just such an upgrade was at the heart of the July blackouts. Two days before the first outage, the Power Grid Corp. of India took off line one of the two transmission circuits near Agra, home of the Taj Mahal, to upgrade it from 400 to 765 kilovolts. India's power system is composed of five connected regional grids; four of the grids are synchronized and linked through transmission lines like the one in Agra. But because other interregional lines were already unavailable, the planned outage effectively left the remaining Agra circuit as the only link between the western and northern regional grids, according to a report issued by the committee formed to investigate the blackouts. Both outages began when this line tripped, and on the previous day, it also experienced what the National Load Dispatch Center called "a near-miss situation."

This weak link was also under a higher power load than normal. The end of July is planting season for farmers in the northern states, India's historical breadbasket. But this year's monsoon had delivered little rain, forcing farmers to rely on electric pumps to bring groundwater up from boreholes and increasing the demand for power in the northern region. Regional load dispatch centers tried to get states to reduce their consumption and generation to relieve the weak line, but the reductions weren't enough. The upgrade "should not have been done during the peak summer paddy season," says Anand.

In such a heavily loaded line, impedance at one end of the line can drop so low that it can cause a distant relay to trip, even though there is no actual fault in the system. According to the committee's report, such "load encroachment" caused the Agra line to trip prior to both blackouts, setting off a cascading failure as power swings in the system caused more circuits to trip.

But if the transmission line had proper compensation systems in place to manage reactive power, says Nagaraja, it should have been able to handle even the heavy load. The panel's report noted that flexible AC transmission systems and dynamic compensation technology could have helped prevent the trouble.

Even after the Agra line failed, it shouldn't have caused such widespread damage. The western region was able to survive both events by disconnecting some generators, and the committee's report noted that in the second blackout, after the western grid had separated itself, the remaining synchronized grid's frequency stabilized for about a minute. If some of the overdrawing regions could have been disconnected, a full blackout might have been avoided: "Trip only the one who is overdrawing," says Nagaraja, "and nothing would have happened." Relays that disconnect the line when the frequency gets too high or too low should have managed to shed enough generation or load to restore stability. India is supposed to have such systems in place, but they obviously didn't function as intended.

The blackouts have shown that even within India's large, interconnected grid, it's important to have some local generation in case of emergency. The west coast city of Mumbai, which was outside of the blackout zone, uses a scheme called islanding to dodge large outages: It has built up enough local generation to allow it to disconnect from the grid and keep essential services running. Now Delhi is considering a similar islanding scheme. The India Smart Grid Forum's Govindarajan agrees that even outside of cities, India would benefit from more such microgrids "so that we can actually manage the emergency consumption of power in a better way." —Joshua J. Romero

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