PJM called 5 blackouts to prevent cascading outages during September heat wave

By Esther Whieldon

PJM Interconnection LLC ordered five blackouts in southern Michigan, northern Ohio and northwestern Pennsylvania during an unusual heat wave Sept. 9-11 over concerns there could otherwise be cascading outages, it said in a Sept. 23 analysis. The outages were "significant but limited both in scope and duration" and "prevented much more extensive customer outages," PJM said.

The RTO ordered power to customers, also known as load, be shed once on Sept. 9 and four times on Sept. 10. A total of 154 MW were shed and 44,000 customers were affected in the American Electric Power Co. Inc., American Transmission Systems Inc. and Mid-Atlantic zones of PJM. FirstEnergy Corp. is the parent company of ATSI.

Electricity demand in PJM is typically light to moderate in September compared to the prior summer months, which is why the season for planned transmission and generation maintenance outages begins in September.

When PJM saw the weather was forecast to be unusually warm starting Sept. 9, it initiated hot weather alerts. The alerts allow for scheduled maintenance of nonessential transmission and generation to be canceled and for available transmission and generation equipment that is out for maintenance to be recalled. The alerts also trigger PJM to carry additional generation reserves and develop related operational plans.

Some, but not all, facilities with outages leading into the heat wave were able to be restored to service, PJM reported. More than 80 transmission outages were canceled or rescheduled during the three-day heat wave.

Peak electricity use in PJM ranged from 119,969 MW on Sept. 9 to 147,450 MW on Sept. 11, which set a new regional record for September loads.

1st blackout lasted 24 minutes in southern Michigan

PJM called for a blackout at about 4 p.m. Sept. 9 in the Pigeon River substation area in the AEP zone in southern Michigan, which is close to the Indiana border.

PJM reviewed a relay limit, the outage of the Moore Park Tap-Industrial Park 69-kV line and the fact that there were high loads and flows on the 69-kV system between Lagrange in the Midcontinent Independent System Operator Inc. control area and Corey in the PJM AEP zone. PJM determined that if two nearby lines were to trip off, there was potential for "local area voltage collapse" and the loss of a 60-MW to 160-MW load pocket at Corey.

The RTO determined that it could relieve power flows on the constrained line if a 69-kV switch at the Howe station was closed. PJM asked MISO to contact Northern Indiana Public Service Co. to have the switch closed. NIPSCO is a subsidiary of NiSource Inc.

The RTO then directed AEP to shed 3 MW while it waited for a NIPSCO lineman to get to the station.

"The Pigeon River load in Michigan was chosen" for the blackout "because it was remotely controllable and had the largest impact (38.7% effect) on relieving power flows on the constrained line," the report said. "Once a NIPSCO lineman was dispatched and able to close a switch, providing a second feed into the area, the load was restored." The event had lasted 24 minutes.

2nd blackout was in same location

The system conditions that led PJM to call for load shedding on Sept. 9 were present the following day.

"Although the switching option used the previous day at the Howe 69-kV station was still employed, the additional feed into the area was not sufficient to mitigate the increased load concerns," the report said.

PJM, AEP, MISO and NIPSCO together looked for additional switching options but found none, the report said.

PJM also considered using sub-zonal emergency demand response but determined that the notification requirements and long lead time to implement demand response would "not allow the flexibility or provide the granularity required to identify sub-zonal demand response regions."

"With no other options available, at 12:49 [p.m.] on Sept. 10, PJM directed AEP to shed 5 MW of load. Pigeon River remained the remotely controllable location with the greatest impact to alleviate the constraint," the report said. "That amount of load shed was still not enough to alleviate the constraint, and PJM directed AEP to shed an additional 3 MW." The load-shedding directives remained in place until after 9 p.m., when electricity usage began to wane.
Behind-the-meter generation prevented 3rd day of Mich. blackouts

Prior to Sept. 11, PJM, AEP and others continued to look for solutions to prevent another day of load shedding in the region.

They identified 6 MW of behind-the-meter generation — units that are not connected to the bulk transmission system — that did not participate in PJM's markets. PJM was able to get the 6 MW of generation to voluntarily come online, which "eliminated the need" for any load shedding in the Pigeon River area on Sept. 11, the report said.

PJM's third load shedding event was on Sept. 10 in the ATSI zone near Warren, Ohio. It involved about 16 MW, began about 3 p.m. and lasted about an hour and a half.

The day prior, the South Canton #1 345/138-kV transformer had tripped out of service, which triggered the loss of four 345-kV lines at South Canton, the report said. Two of the 345-kV transmission paths were restored the morning of Sept. 10.

PJM modeled what would happen if it also lost the Hanna #1 345/138-kV transformer and determined that such an event would cause flows on the Highland-Tod 138-kV line to exceed its limits, which could trigger a cascading blackout. The RTO called for load shedding at 3:07 p.m. ATSI began restoring power to customers after its South Canton #1 transformer returned to service and completed restoration at 4:42 p.m.

4th blackout ordered after 345-kV line tripped

Also on Sept. 10, PJM ordered a total of 105 MW to be shed in the Mid-Atlantic zone near Erie, Pa., beginning at 5:49 p.m. All load was restored by 12:02 a.m. Sept. 11 after overall system electricity usage dropped "due to the time of day and lower temperatures."

Several hours before PJM called for load shedding, the Erie West-Ashtabula-Perry 345-kV line went out of service. It is believed that the line tripped offline for a fault caused by a conductor failure, the report said.

The unexpected 345-kV line outage, coupled with planned and unplanned outages of more than 400 MW of generation and other transmission in the area, meant that there could be "extreme low voltages throughout the area for the next contingency — loss of the Erie West-Wayne 345-kV line," the report said. When PJM later determined that there could be wide-area or cascading outages, it directed that 70 MW of load be shed and, when that was not enough, it ordered an additional 35 MW of load shedding.

Generation, DR not viable options to prevent 5th load-shedding event

The fifth load-shedding event was in northwest Indiana in the AEP zone, around the Industrial-Summit 138-kV line. PJM ordered AEP to shed 25 MW of load for about one hour the evening of Sept. 10.

That day, PJM and AEP operators both observed potential overloads on the Summit-Industrial 138-kV line for the simulated loss of the Robison Park transformer, the report said.

PJM then alerted AEP that it would need to shed load in the Summit area within five minutes if the Robison Park transformer were to trip, the report said. "AEP developed plans for exactly which load would be shed and ensured that plan was in place and ready to be executed."

As loads continued to climb that day, simulations showed that should the Robison Park transformer trip, "the transmission system in the area would collapse immediately," which eliminated PJM's option to call for load shedding only if the transformer tripped. "Action needed to be taken immediately to avoid a potential larger collapse," the report said.

"The Summit load was chosen" for load shedding "because it had the most impact relieving the constraint (61.3% effect)," the report said.

Demand response was not an option either, because the program requires two-hour notification and "load management is not mandatory after" 8 p.m.

Although 395 MW of generation in the area could have been called on to help, "it was not considered a viable option" because the units would have required from six to 13 hours to start up, the report said.

As in most of the other cases, power was restored after electricity usage reduced in the evening.

PJM to review demand response rules

In anticipation of even higher loads for Sept. 11, PJM called on about 6,000 MW long-lead and short-lead emergency load management.

*Although overall demand response performed well during this period, the restrictions such as the required two-hour notification for invoking demand response and the lack of granularity to utilize demand response on a more targeted sub-zonal basis limited the operator's flexibility in using demand
response as a tool in real time to prevent some of these events," PJM said.

It therefore plans to "examine that issue as well as other issues surrounding generator and transmission system performance through its stakeholder process."