Blackout in South Australia on 28 September 2016

Preliminary overview of events and consequences

On 29 September 2016 at 16:18:16, a power outage cut off electricity across South Australia (SA). On 5 October 2016, the Australian Energy Market Operator (AEMO) published a preliminary report on the incident.

This note is based on the preliminary report from AEMO. A new note will follow when the investigations are complete and a full report on the power outage has been published.

Fig. 1 - An Australian state

Pre-event Supply and Transmission

The total SA electricity load was 1826 MW. The three sources of supply:

Type	Sites	MW
Thermal	2 power stations	330
Wind	14 wind farms	883
Import	Victoria, 2 circuits	613

The design limit of the interconnection is unknown, but must be somewhere between 600 and 850 MW. The preliminary report says that normal operating limits are “up to 600 MW”. The interconnection seems to have been utilized very close to its limits.

Apparently, there were practically no operating reserves available. It is doubtful if the N-1 criteria was fulfilled. For instance could the loss of just one circuit of the interconnection have been critical.

This is speculation. No conclusion can be drawn until the final disturbance report has been published.

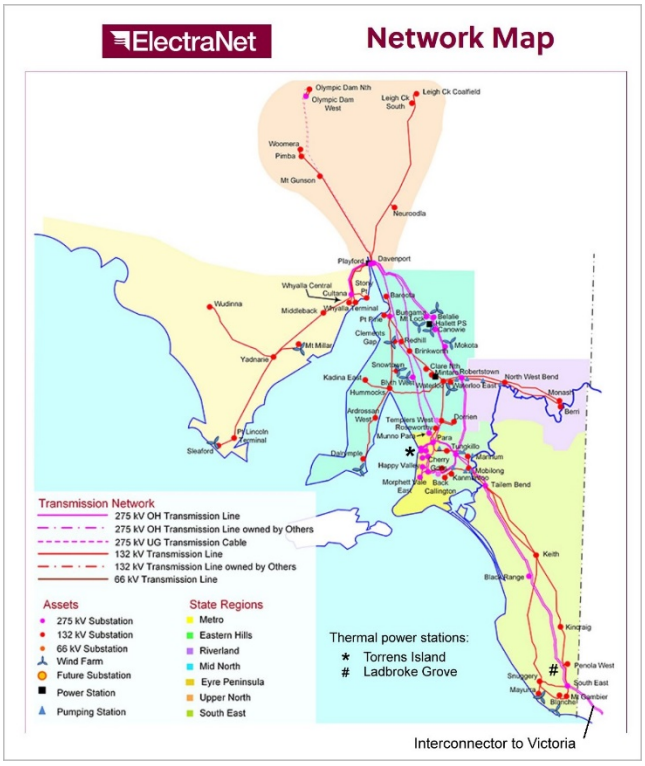

Fig. 2 – The South Australian Power Grid

Weather Conditions

There were several Severe Storm Warnings for SA from Wednesday morning, the 28th September.

Damaging winds, heavy rainfall and damaging hail were reported across South Australia. A tornado was reported in and around Blyth, coincident with the occurrence of super-cell thunderstorms in that area. Peak wind gusts of 90–110km/h were reported for locations across the state.

Under such conditions, heavy objects are flying through the air. When objects hit the power lines, they create faults, which disconnect the lines. After a certain delay, the lines reclose automatically. If a fault is still there, the line opens again and remains open. Such cases normally require a visual inspection of the line.

Events Resulting in Blackout

The weather resulted in multiple transmission system faults. In the short time between 16:16 and 16:18, system faults included the loss of three major 275 kV transmission lines north of Adelaide (T is the time of system collapse):

- Brinkworth – Templers West (T – 43s)
- Davenport – Belalie (T – 8s)
- Davenport – Mt Lock (T – 3s)

At T – 7s the output from four wind farms fell from 199 MW to 76 MW. Six seconds later the output from two other wind farms (Snowtown North and South) fell from 188 MW to -4 MW. The total loss of production was 315 MW.

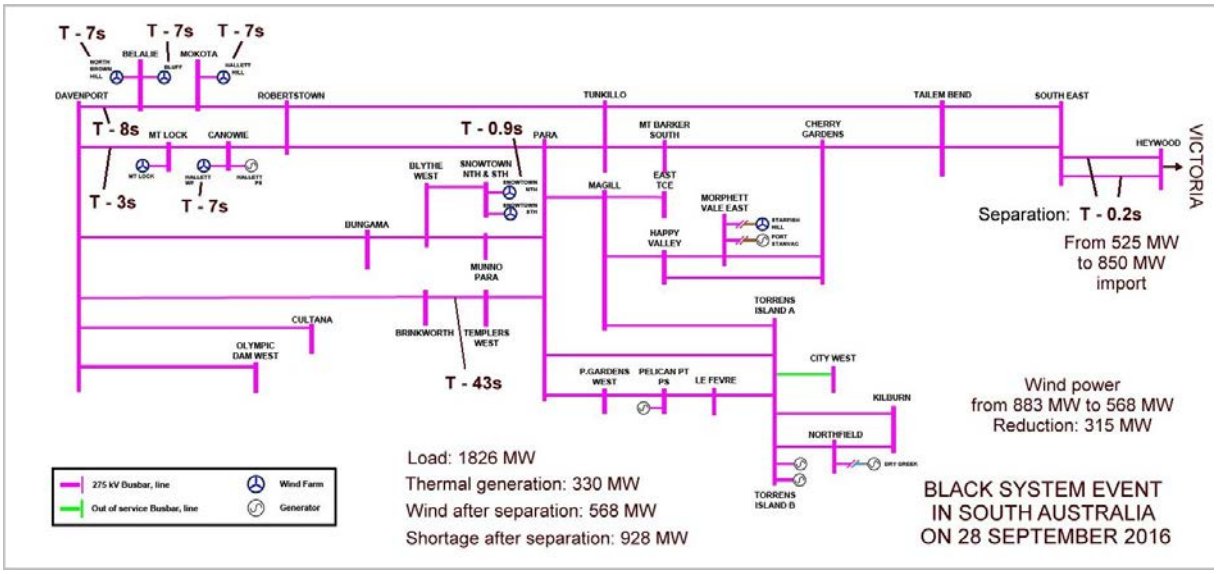

Fig. 4 - SA 275 kV grid

The lost production caused a corresponding increase of import from Victoria to above the overload limits. Both circuits tripped and left the SA power system with more than 900 MW shortage.

A total system collapse followed about 200 ms later.

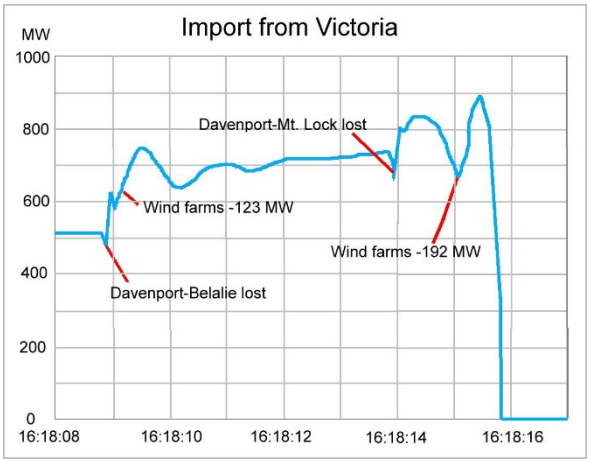

Fig. 3 - Exchange with Victoria

Network Damage

The storm damaged several towers of the following lines:

- Davenport – Belalie and Davenport – Mt Lock (275 kV, 5 double circuit towers)
- Brinkworth – Templers West (275 kV, 2 towers)
- Davenport – Brinkworth (275 kV, 14 towers)
- Port Lincoln – Yadnarie (132kV, 1 tower)

Data currently available indicates that the damage to the Davenport – Brinkworth 275 kV or the Port Lincoln – Yadnarie 132 kV lines occurred following the SA Black System.

Restoration of Supply

System restart ancillary services (SRAS) contracts had been made for restoration after blackouts.

The SRAS contract with SRAS Provider 1 was activated at 16:32 (T + 14min). At 17:13 (T + 55min) Torrens Island Power Station house load was supplied from SRAS Provider 1 unit.

Due to an issue currently under investigation, SRAS provider 1 was unable to supply sufficient capacity to restart any of the Torrens Island Power Station units.

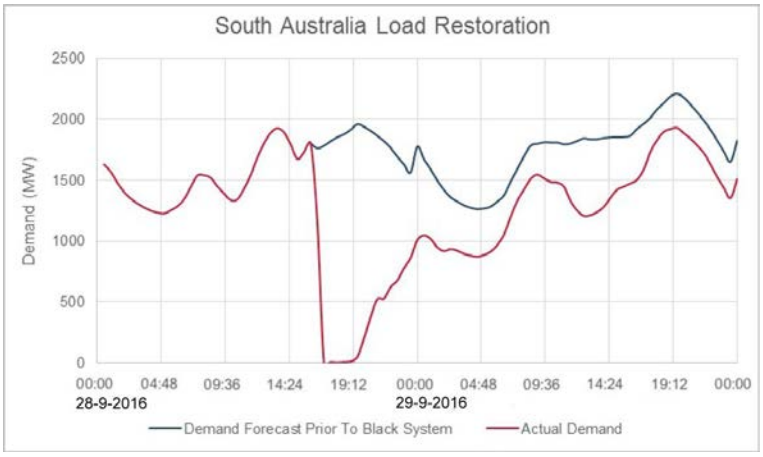

Fig. 5 - Resumption of supply started about 3 hours after the blackout.

SRAS provider 2 was not able to provide black start capability due to the damage caused by the storm to its auxiliary diesel units, which are necessary for the gas turbine to provide re-start capability. This service currently remains unavailable.

Rebuilding the 275 kV network from Victoria started at 17:23 (T + 1h 5min). At 18:28 (T + 2h 10min) Torrens Island East 275 kV busbar was energized via Para – Torrens Island 275 kV transmission line.

At 18:43 (T + 2h 25min) Torrens Island house supplies were changed over to supplies from interconnector and SRAS provider 1 unit shutdown to allow connection to the interconnected system.

ElectraNet commenced load restoration in the Adelaide area at 19:00. Load restoration continued based initially on supply from Victoria and then on generation in SA as it became available.

At 20:58 (T+4h 40min) Torrens Island power station A2 generating unit in service.

29 September 18:25 (T+2d 2h 7min) AEMO advised that that a Black System condition in the South Australia region is no longer current. AEMO has given clearance to restore the last load block in South Australia. AEMO notified that the Spot Market will continue to be suspended.

The electricity market in SA was suspended during the incident. The market remains suspended as of 4 October 2019.

The Importance of Shared Information on Power Incidents

Disturbance reports on major power cuts are shared worldwide. This tradition has made it possible to reach the present high security of supply without making the same experience in every power system.

The fluctuating energy sources (wind and solar) are changing the properties of many power systems. The SA power cut could be an opportunity to reconsider security criteria and protection systems in grids and wind farms.

Therefore, the complete investigation on the incident in SA will be anticipated with interest.