Power alert – reducing residential demand

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Power Alert is a residential load management tool that is unique to South Africa. It is extremely successful in creating measurable demand reductions, and has been awarded various national and international awards.

It has attracted international interest as a method to involve the public in reducing demand in the residential sector which is involved by providing it with information regarding the strain on the power supply network as well as giving suggestions on how to reduce the strain levels. The messages are provided in easy to understand colour coded messages depending on the strain experienced by the network.

Eskom's power stations are ageing and are being run hard to ensure that supply meets demand. The demand continues to increase due to economic activities which will put the supply under pressure. To reduce the pressure either the demand could be decreased or the supply could be increased. New power stations are added slowly with two base load power stations currently being constructed in South Africa. The first of the two to be completed, Medupi, will give some relief. Indications are that commissioning of the first unit of Medupi has been delayed from December 2012 to the second half of 2014. Commissioning of the final unit is expected to be three years after the commissioning of the first unit resulting in final commissioning in 2017.

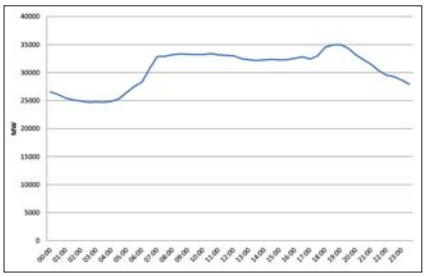

Fig. 1: Average demand profile.

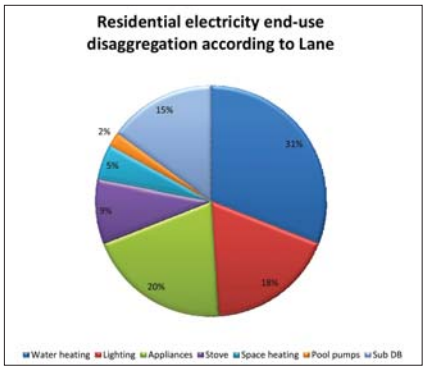

Fig. 2: Residential electricity usage as per Lane.

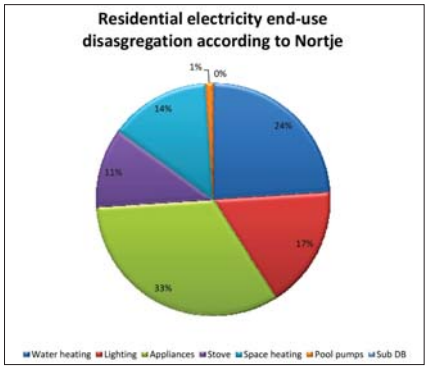

Fig. 3: Residential electricity usage as per Nortje.

The second power station, Kusile, is expected to start generating electricity from its first unit in 2015 whilst construction of the last five units continues until 2019. Expectations are that the power supply system will remain extremely tight for the foreseeable future. South Africans will therefore have to remain vigilant regarding their use of electricity.

The other option to reduce the pressure on the network is to reduce demand. South Africa has active demand-side management (DSM) programmes that focus on commercial, industrial and residential consumers. These activities all have a valuable contribution to make to reduce the demand. Residential consumers are expected to assist by way of changing their behaviour. One of the major challenges is that consumers do not always know how they could assist and when their participation is required.

This paper presents the operation, marketing, and impacts of Power Alert which addresses the evening peak load with the focus on residential consumers.

Design and operation of power alert

Power Alert was designed as an early warning system that tracks increasing electricity use and strain on the power supply system. It makes use of real-time electrical load data obtained from Eskom's National Control Centre (NCC) to identify and forecast periods when the power supply system would be under strain. Based on the level of strain consumers are requested to switch off specific electricity using items.

Why residential consumers?

Fig. 1 shows an average demand profile for electricity in South Africa. A clear peak is seen in the evening between 17h00 and 21h00. This is when people arrive home from work and start taking baths and using electricity for lights, televisions, stoves, ovens, and other appliances. It is therefore expected that any shortfall between electricity supply and demand will first appear in the evening peak. The focus of Power Alert is therefore to reduce the pressure on the electricity supply network by addressing the evening peak created mainly by the residential sector.

The challenge of power alert

To expect consumers to keep appliances switched off all the time is not reasonable, sustainable or viable. That was one of the major challenges – to ask only from the public what is required given a certain strain on the electricity supply network. Another challenge was that it was unlikely to expect all consumers to know exactly what to do and when to do it in order to reduce their electricity consumption without an intense awareness and educational campaign.

The aims of the service are therefore summarised as:

- Informing the public on the strain of the power supply system.
- Make suggestions on how the public could assist to alleviate the strain on the electricity supply network and thereby prevent load shedding.

The selected communication means presented another challenge to the design: presenting very technical information to the public to achieve load reductions through a non-technical message that is clear and easy to understand.

Electricity consumption in the residential sector

Various international studies have been undertaken to determine which appliances are the major users of electricity in residential dwellings. Two authors (Lane 2005, and Nortje 2005) provided such data for South Africa. Fig. 2 and Fig. 3 show the results of the study for Lane and Nortje respectively.

From the results of the two studies it was

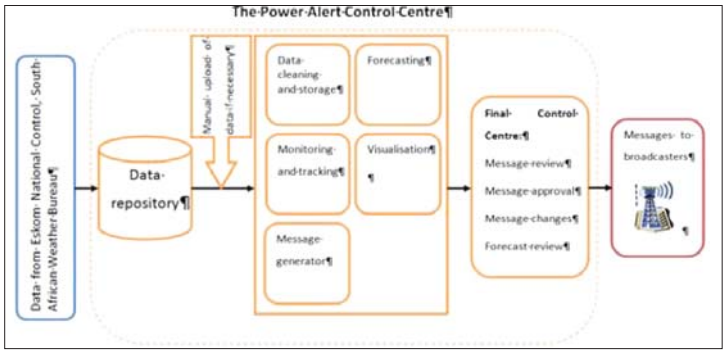

Fig. 4: Data processing.

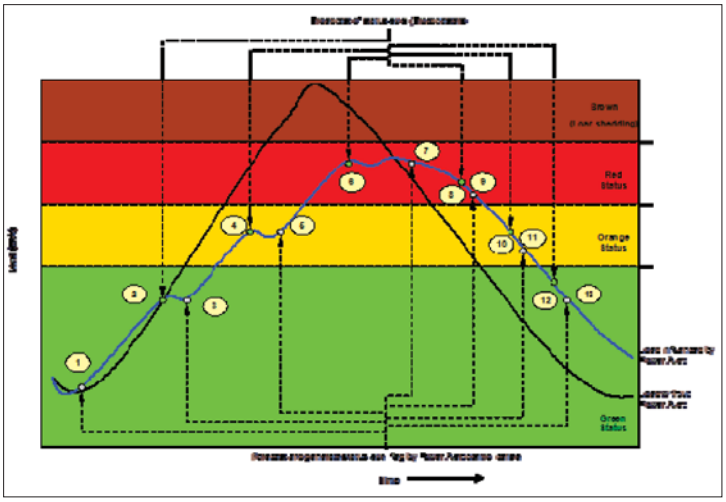

Fig. 5: Idealistic demand profile.

Fig. 6: Green power alert.

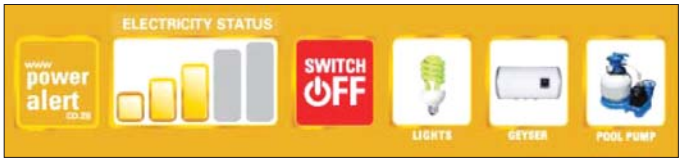

Fig. 7: Orange power alert.

Fig. 8: Red power alert.

Fig. 9: Black power alert.

concluded that the largest impact of Power Alert could be achieved if the following electricity users are targeted:

- Appliances
- Lighting
- Pool pumps
- Space heating
- Stoves
- Water heating

Calculating the strain on the network

Data is received from Eskom's NCC in 5-minute intervals through a live link between the Power Alert control centre and the NCC. The data is received and stored in a data repository before it is used. Fig. 4 shows of the data flow actions from receiving data to determining the messages that needs to be submitted:

- Load forecasting is used to forecast the expected loads for the evening.
- Monitoring and tracking of actual load compared to forecasted loads.
- Determine strain on the network and select correct message.
- Submit message to TV broadcasters.

Fig. 5 shows an idealistic demand profile as well as a demand profile influenced by the reaction to the alert.

At point 1 in Fig. 5, Power Alert forecasts that the load will have a green status and communicate it through to the TV broadcasters for the timeslot before the occurrence. The broadcasters then air the green status flag at point 2. The load is influenced, but at point 3 Power Alert forecasts that the load will continue to increase and then it will have an orange status level. The broadcasters then air an orange status level (point 4) which influences the load. At point 5 the load again gradually increases and the forecast shows when the load will be in the red zone. The broadcasters then air a red status level at point 6 on instructions from the control centre. The forecasts (point 7) then show that the load will be in the red zone and at point 8 in time a red status level is again broadcasted.

The next forecast (point 9) shows that the demand is decreasing and instructs the broadcasters to air a red flag in the next timeslot. At point 10 the orange status level is aired. Residential consumers can then start to switch some of their loads on again. This process of relaxation continues (points 11 and 12) until a green status level is broadcasted and after the forecast at point 13 indicates the fact.

Strain levels

The strain on the electricity supply network are categorised as green, orange, red, or black. Depending on the strain on the network, more appliances need to be switched off. The appliances requested to be switched off were determined above and are linked here to different strain levels. Fig. 6, 7, 8, and 9 respectively shows the green, orange, red, and black messages as well as the items requested to be switched off. Seen here is that as the strain on the network increases, the number of appliances requested to be switched off increases as well. The idea really is to get enough cooperation from the public as required.

Green – an alert that indicates limited strain on the network and asks residents to switch off lights in all unoccupied rooms.

Orange – an alert that indicates moderate strain on the electricity supply – asks residents to switch off lights in all unoccupied rooms, most importantly, the geyser and pool pump, plus the dishwasher and tumble dryer.

Red – an alert that indicates increasing strain on the electricity supply – asks residents to switch off lights in all

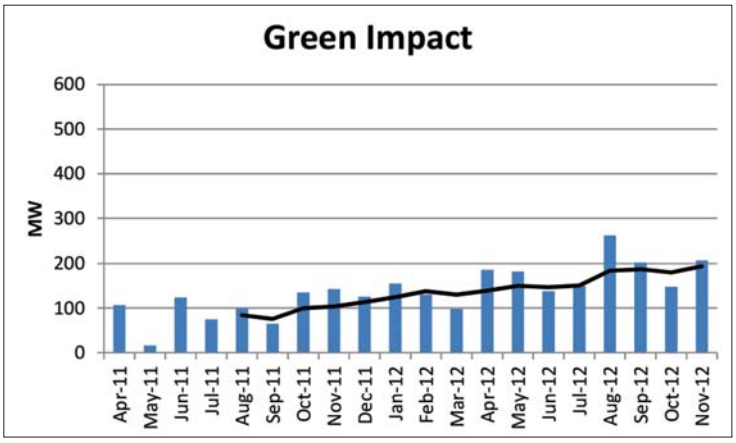

Fig. 10: Power alert green impact.

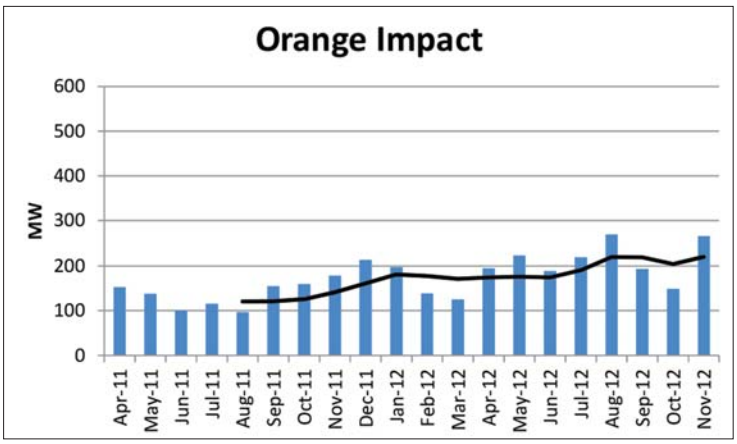

Fig. 11: Power alert orange impact.

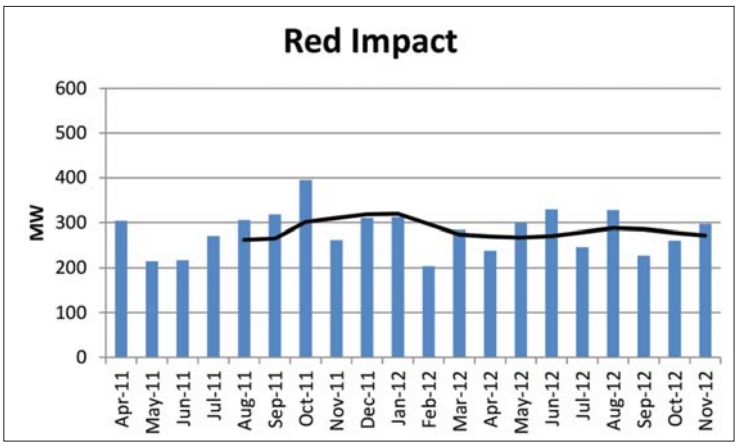

Fig. 12: Power alert red impact.

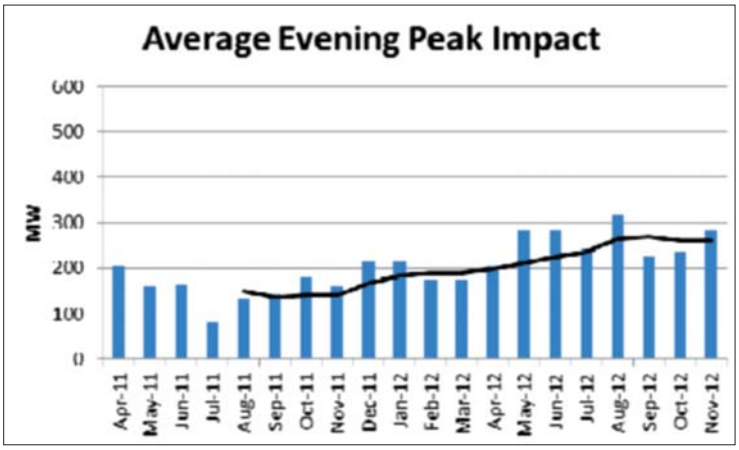

Fig. 13: Power alert average impact.

unoccupied rooms as well as the geyser, pool pump, air conditioner, dishwasher, tumble dryer and stove.

Black – an alert that indicates significant strain on the electricity supply – asks residents to switch off all appliances that are not absolutely essential, except for minimum lighting required in the room(s) currently occupied and, obviously, the television that displays the status of the Power Alert, to assist in avoiding load shedding.

Achievements

Power Alert has not only achieved substantial load reduction achievements, it has also achieved various national and international awards as a media tool as well as energy project.

National and international awards

The concept has been awarded various national and international awards in the fields of science and technology, energy, and is a valued communication tool utilising television.

- It project won the Roger Garlick gold award for the "Best Use of Television and Special Events/Stunts" from the Advertising Media Association of South Africa (AMASA) in 2007.
- It was awarded "International Energy Project of the Year" in 2007 by the Association of Energy Engineers (AEE).
- It was a finalist for the 2008/9 National Science and Technology Forum (NSTF) awards.
- It was a finalist in the Energy Project Award category of the South African National Energy Association (SANAE) of 2009.

Load reductions

IT is aimed at asking the residential consumers to reduce their demand and consequently it is important to measure the impact thereof. The official measurement and verification is done by the team located at the University of Cape Town.

The impacts calculated are extensive and provides the impact of all statuses (Red, Orange, and Green). Fig. 5, 6, and 7 show the impact of Green, Orange, and Red Power Alert messages respectively. Fig. 8 shows the average evening impact achieved through Power Alert.

The figures show the impact as calculated by the team between April 2011 and November 2012. From the graphs it is seen that:

The impact continues to increase over time when evaluating the green, orange, and average impacts.

The red impacts seem to be keeping constant at roughly 300 MW.

The increasing impact of green, orange, and on average might be an indication that the public are changing the way they use electricity. This could be that the public react on green and orange days the same way they would have reacted as on a red day. That is to switch off non-essential appliances during the evening.

Conclusions

Power Alert is an innovative tool that effectively uses media to inform the general public on the strain on the electricity supply network as well as to inform the public as to how they should assist in reducing the strain. The messages that are used are easy to understand and selected based on the strain on the network.

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