

Smart Load Management

1. Problem statement

In 2022 and 2023, South Africa faced worsening electricity supply shortages and system constraints. To keep the power system stable, demand had to be finely balanced with the available supply. Demand response and loadshedding – or rotational power cuts – are two available tools that were used to maintain this balance. Loadshedding is however not popular as no power supply is available to the impacted area and customers are required to find alternate solutions for essential equipment such as security systems or medical equipment.

2. Solution

Smart meters are steadily being rolled out in South Africa, driven by government legislation, demand-side management requirements and the national transition to a smart grid. Smart meters offer a range of functionality¹ for managing demand, which can help improve system efficiency, reduce demand during expensive peak periods and lower distribution system management costs.

Eskom recognised that smart meters could also help ease the demand on the power system while allowing the consumer to power basic needs. It offers the option to curtail the power usage by limiting the amperage² to the metered premises. The power supply automatically reverts back to 'normal' after the predefined load limiting period. The customer decides what equipment³ to prioritise for use during these times. If the customer fails to respond, the meter will temporarily disconnect supply and display an error message⁴ on the Customer Interface Unit (CIU).

From the utility's perspective, this is called 'load limiting' since power is available but load is constrained.

1 Including remote reading and control of meters; implementation of time-of-use tariffs; and managing quality of supply.

2 Strength of the electric current measured in amperes (Amps)

3 The supply is meant to be adequate for basic services such as lights, internet, television, laptops; of essential services such as security systems or medical equipment.

4 The error message will show the reason for the disconnection, i.e. "Power Overload".

5 Costs are highly dependent on economies of scale and load reduction yield per household. Economies of scale relate to both the number of installations and the number of smart meters procured, with higher volumes reducing the per unit costs. The load reduction (MW) yield per household depends on the socio-economic profile of the area, the time of day and the season. The indicated range does not include the capex for a meter data management system (MDMS) or other operational costs that might also need to be part of the final cost calculation.

6 For example, if load was not adequately reduced by the customer, supply would be cut completely for a predetermined period.

Quick Facts	
Name of Utility:	Eskom
Year(s) implemented:	Piloted from June to September 2023
Implementation status:	Extended to a national rollout in January 2024
Policy driver:	Residential demand response programme to maintain system stability on a constrained power network
Funding amount:	Ranges from R2.4 m/MW to around R3.5 m/MW ⁵
Funding source(s):	Internal funding
Impact: Average load reduction of 15.3 MW; typical load reduction of 1 kW per smart meter	

A pilot project was introduced in Fourways, a suburb of Johannesburg, to test this solution with residential customers. The suburb is an Eskom supply area where smart meters were already rolled out in 2015/2016. It is also an affluent area with higher per capita power use and a typical 'peaky' residential load profile – ideal conditions in which to test the value of load limiting.

Because smart meters were already installed, the rollout intervention focused on stakeholder engagement, awareness and education. The concept was introduced at community meetings (Figure 1) that were facilitated by the local councillor, followed by one-on-one engagements if customers had specific questions. Pamphlets with suggestions of what equipment to switch off and details of load limiting procedures were distributed.⁶

3. Achievement, impact and/or benefits

In June 2023 Eskom implemented the load limiting pilot project in Fourways, expanding to include Riversideview at the end of September. Participating customers could have their load limited to 10 Amps⁷ rather than a complete power cut during loadshedding stages 1 to 4. This exemption fell away for higher levels of loadshedding.

Initially approximately 9 000 smart meters were part of the pilot, with this number growing to 12 506 by September 2023 with the inclusion of Riversideview. Load limiting follows the same schedule as loadshedding, and therefore the load reduction impact depends on the time schedule and corresponding power usage at that time. During the last week of June 2023, an average demand reduction of 15.3 MW was achieved over seven



Load Limiting Project Community Meeting

Eskom is implementing load limiting nationally to customers with smart meters. The load limiting project aims to allow customers to have access to minimal usage of electricity during lower stages of loadshedding. This means that customers can still use essential appliances such as lights, TV, Wi-Fi router, fridge and security systems during stages 1 to 4 of loadshedding. Customers in Potchefstroom area under the Britskop Rural Mooirivier (BRMR) feeder are selected for the rollout.

You are invited to a meeting where further details of load limiting and the project rollout will be outlined.

The meeting will be held as follows:

Venue: Office of the Potchefstroom Fire Protection
89 Chris Hani Street
Potchefstroom

Date: Monday, 18 March 2024

Time: 12:00

Enquiries may be directed to:

Busisiwe Cindi, Customer Service Area Manager

Email: CindiB@eskom.co.za

Phone: 018 464 6743



Figure 1. Example notification of community meeting (national rollout)

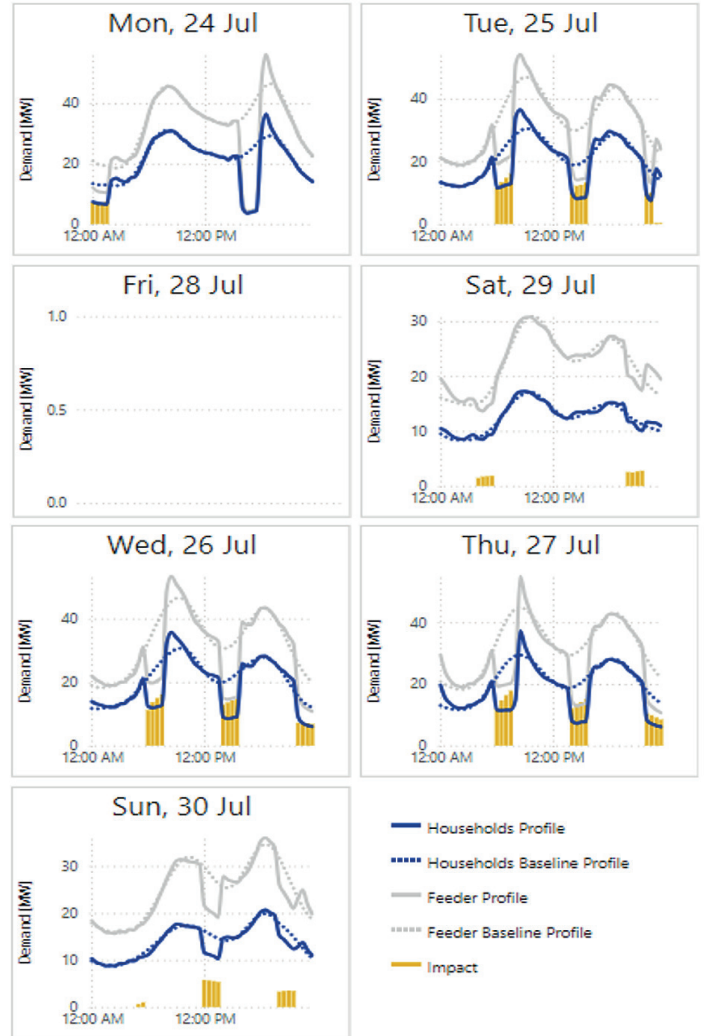


Figure 2: Load limiting impact on the Fourways load profile, Monday 24 to Sunday 30 July 2023.

loadshedding/load limiting events. The achievable impact is however dependent on the socio-economic profile of the suburb, day of the week, the time of day and the season. With this variability taken into consideration, it was established that a load reduction of 1 kW could be relied on per meter point.

In Figure 2 the impact of load limiting in Fourways can be seen for a week in July 2023.⁸ This demand reduction impact was achieved at an estimated cost of between R2.4 million and R3.5 million per MW. This compares well with the reported cost of peak clipping projects that were previously funded by Eskom's Integrated Demand Management programme at R3.5 million/MW⁹.

⁷ The typical residential power connection in South Africa is for a maximum of 60 or 80 Amps.

⁸ The graphs show that for this week in winter the demand reduction impact during weekdays ranges between 10 and 20MW but varies depending on the time of day. During the weekend this is considerably lower. Friday 28 July had no load limiting implemented.

⁹ Peak clipping is a traditional Demand Side Management (DSM) strategy that curtails energy demand during periods of peak system load.

4. Key role players

The pilot project required several internal approvals before inception. A strong project sponsor or champion who recognise the strategic value of the intervention, was a critical proponent of the project from a business perspective, to help advance the project through internal processes, approvals and hurdles.

Once approved, collaboration with key stakeholders included:

- Obtaining buy-in and support from the Network Management Centre (NMC) who would be responsible for coordinating the loadshedding and load limiting schedule for the participating substation, feeders and customers.
- Preparation of the customer call centre and customer services responsible to support customers with questions or concerns.
- Working with Eskom Distribution's marketing and public relations team, responsible for developing and implementing the communication and education campaign.
- Briefing of the Customer Network Centre (CNC) who is responsible for operations and maintenance in the participating area. Faults reported by customers participating in the load limiting pilot needed to be checked against the schedule.
- Extensive engagement with the participating community and customers to ensure requirements and operating procedures are fully understood.
- Appointment of an internal measurement¹⁰ and verification team responsible to assess and verify the impact of the intervention.

5. Expert tips and learnings

Initially, the response rate to load limiting commands was lower than anticipated. The shortfall was traced to faulty data concentrators, faulty meters, low signal strength and faulty SIM cards. Once resolved, the response rate improved to at least 70%. Achieving higher response rates needs to be supported by consistent mobile phone networks.

¹⁰ Remote data collection and automated data aggregation from smart meters made it easy to analyse and quantify the impact of the load limiting intervention and the benefit to the network. This was of particular interest to the CNC responsible for network operations and maintenance.

¹¹ Which includes early fault detection, network visualization,

The pilot also identified the ability to communicate effectively with the customer as a critical success factor. This included:

- Having CIUs in place for all participating customers so they were aware when they have exceeded the allowed limit.
- Bolstered communication using different channels, such as text messages sent 30 minutes in advance as reminder.
- Supporting customers to effectively respond by providing a list of appliances to switch off – preferably showing the typical power usage for each appliance.
- Honouring the agreement with load limiting customers; ensure that load limiting customers are exempted from loadshedding in exchange for their participation.

Practically, this last point means that load limiting should be implemented on a feeder where all meters are smart to ensure the combined load reduction is adequate for the feeder to be exempted from load shedding.

For an accurate assessment of the impact of load limiting, it is important to have the following in place:

- Meters that are configured to read data at 30-minute intervals (or shorter) for accurate measurement of the load reduction.
- A meter data management system (MDMS) that can store and accurately analyse measurement data.

6. Key takeaways

In addition to the many conventional benefits¹¹ of smart meters, load limiting proved to be an effective way to cushion customers from loadshedding and power essential services while protecting the constrained power system. It was well received and favoured by customers over loadshedding, but requires significant investment in awareness, education, and active engagement with participating customers.

Box 1. Additional use cases for demand control from smart meters

The value of 'load limiting' is self-evident in the context of loadshedding, but it also offers other use cases.

- Outside of loadshedding, load limiting is being considered for mitigating localised network constraints, temporarily deferring network or sub-station upgrades.
- It furthermore allows for staggered reconnection of meters, which can be used to prevent a sudden surge in power demand, called 'comeback load' or 'cold pick up', after any power outage.
- Load limiting can be employed to contain demand spikes that could trigger Notified Maximum Demand penalties.
- It can also help mitigate against the use of expensive flexible generation options to supply short-term demand requirements.
- Lastly, it is also being investigated for an aggregated response to Demand Response, where large power users are compensated to reduce load in response to signals from the network operator. An aggregator platform would enable multiple small power users to participate in the Demand Response programme and receive compensation.

7. Future steps

The pilot project confirmed the use of smart meters to safeguard the power system. Moreover, their potential use for supporting future power system needs was recognised, with load control functionality a valuable complement to the growing share of variable renewable energy. Based on the pilot study results, a national rollout of smart meters and load limiting was approved by Eskom for their customers in January 2024. The pace of implementation will depend on the availability of both funding and smart meters.

Contact information

For further information please contact:

Eskom Distribution:

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<https://www.eskom.co.za/distribution/load-limiting/>

Disclaimer: This document is meant for informational purposes only. Though the accuracy and validity of information and recommendations given have been checked thoroughly, GIZ and the authors cannot be held liable for the content of this document.

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