Peak Demand Management

Facility Case Study

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To understand the concept of Demand Management, we have to refresh our memory of electricity basics a little.

Remember... Power is the rate at which energy is consumed by a load at any instant in time. In other words, the load 'demands' a certain rate at which the energy is transferred. Watt is the measurement of Power, describing the rate at which electricity is being used at that particular moment. For example, a 100 Watt (W) light bulb 'demands' 100 W of electricity at any moment when turned on.

On the other hand, energy or consumption is measured in watt-hours which describes the total amount of electricity used over time. Watt-hours are a combination of how fast the electricity is used (watts) and the length of time it is used (hours). For example, a 100 W light bulb, which demands 100 W at any one moment, uses 100 watt-hours of electricity in the course of one hour.

A simple way to determine the difference between demand and consumption is by examining these two examples.

In *Figure 1*, a 100 W light bulb burning for 10 hours consumes 1 000 watt-hours or one kilowatt-hour (kWh). The entire time it is turned on, it 'demands' 100 W from the power station. That means the power station is required to have 100 W available whenever the customer switches on the light.

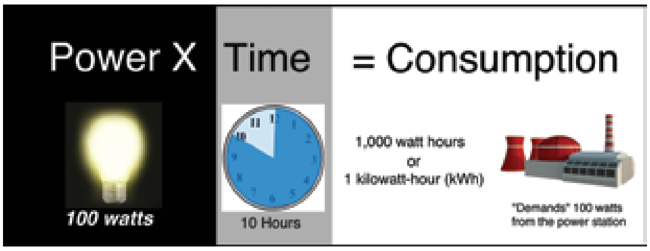


Figure 1: One 100-watt light bulb burning for 10 hours consumes 1 000 watt-hours or 1 kilowatt-hour (1 kWh).

Similarly in *Figure 2*, ten 100 W light bulbs burning for one hour also consume 1 000 watt-hours or 1 kWh, but it now requires or 'demands' 1 000 W or 1 kW. Observe that in both instances the consumption is 1 kWh. However, take a look how differently the second scenario impacts the power station from a demand point of view. It is now required to supply ten times as much power in response to the 'demand' of the 10 light bulbs operating at the same time. These two clients will receive identical bills because both of them used 1 kWh of energy. However, the utilities have an ace up their sleeve, as we shall see shortly.

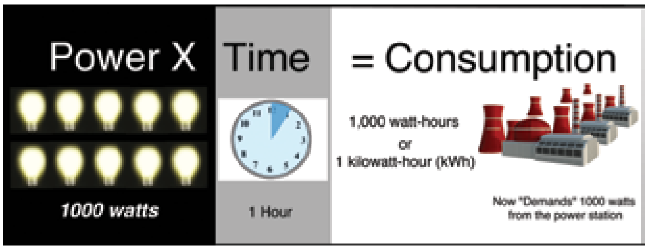


Figure 2: Ten 100 watt light bulbs burning for one hour also consume 1 000 watt-hours or one kilowatt-hour (1 kWh.)

Demand is measured in kilovolt-amps (kVA), which is broadly speaking the same as kilowatt (kW) but a phenomenon known as Power Factor complicates the equation. This article is not the forum to explain that, so for the sake of this discussion we will assume a Power Factor of 1, which makes kW = kVA.

In most instances the amount of electrical energy (kWh) required, is not the problem. The biggest problem arises when the demand (kVA) escalates. Consumers are frequently requested to turn off their geysers and other unnecessary equipment during the morning and evening peak (see *Figure 3*). When the demand outstrips the supply, load shedding occurs, which is Eskom's style of Demand Management, albeit an inefficient, but necessary, method.

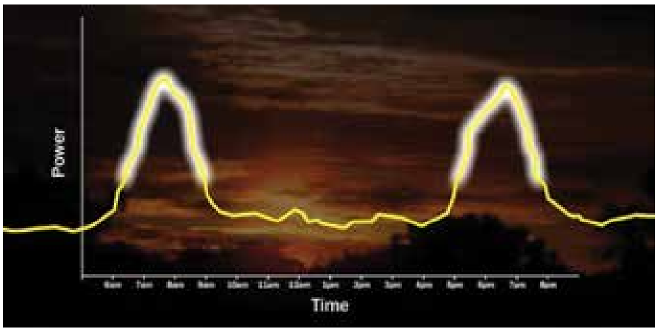


Figure 3: Daily Peak demand occurs between 06:00 and 09:00 (mornings) and 17:00 and 20:00 (evenings).

Playing the Ace

A consumer that creates a high demand needs more facilities from the electricity supplier. This includes a vast array of expensive equipment like transformers, wires, substations and even generating stations. Peak consumption, when the need for electricity is at its highest, must be met. To recover their additional expenses, the utilities play their ace. They charge liberally for the high peak demand that most of us help create and of which many consumers are totally unaware.

Eskom and municipalities usually charge commercial and industrial customers for both demand (1 000 W in the example given) and consumption (1 kWh). Business account holders that generate a demand in excess of 100 kVA will typically find this item on their bills.

> *'If you cannot measure it, you cannot manage it'.*

Measuring the demand

Customers are charged for the highest peak registered during a billing cycle, usually a calendar month, and the demand is usually measured as an average over a period of 30 minutes.

For instance, if most of the electrical equipment is used during that 30 minute interval, the demand charge will be close to the maximum. Just one high peak demand in any of those short 30 minute intervals (1 440 in a 30 day month) will mean a substantially higher bill.

The chart in *Figure 4* illustrates the concept. The shaded area depicts how much electricity this client used, and he will get charged for that in kWh. The red line on top indicates the 'maximum demand', the point where the consumption reached a peak during this 24 hour cycle.

The smart meter measures these peaks and the highest 30 minute period recorded during a month will be the figure that determines the demand charge for that particular month.

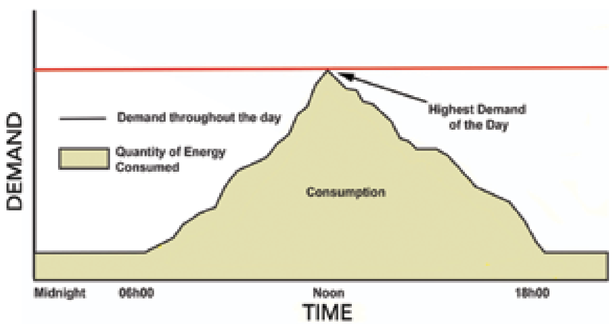


Figure 4: The maximum 'demand' recorded during this 24 hour cycle.

Because the client gets charged as described, a considerable amount of money could be saved by spreading the electricity usage throughout the day and night. Running equipment one after the other rather than at the same time would reduce his demand. Broadly speaking, that is the concept that the company that the author represents, uses to manage the electrical load, consequences of which are meaningful savings.

Automated Peak Demand Management

PowerGuard is an established, IEC certified peak power demand management technology. It utilises intelligent load shifting of non-essential devices, such as electric water heaters or geysers, boilers, air conditioners, swimming pool pumps, etc. It does it in such a way that substantial peak power reductions can be achieved without any impact or inconvenience to the end user.

Case Study at Avianto Hotel, Wedding & Function Venue

This case study is the result of an installation of the automated Peak Demand Management equipment used at the very upmarket Avianto Hotel, Wedding & Function Venue in Muldersdrift, Krugersdorp (South Africa). This intervention was intended to curb the unacceptably high demand that was generated by the hotel's normal activities, without affecting operational efficiency.

Since it had already been established that Demand Management would be the only energy management opportunity that would be considered, a 'Walkthrough' energy audit was conducted. During the energy audit the following non-critical loads that could be controlled, were identified:

- Fourteen 2 500 W air conditioners and fans
- Thirty-seven 3 000 W geysers
- Three sets of 1 000 W elements for underfloor heating
- Total kW that could be controlled: 149
- Total number of channels: 75

For Measurement and Verification purposes an attempt was made to access the data stored in Eskom's smart meter. High-resolution historical data would have been very helpful in developing an accurate baseline from which to determine actual energy savings. This attempt was abandoned because of numerous administrative difficulties.

In almost any kind of energy efficiency programme, it is essential to have accurate data before starting a savings project. Furthermore, it is essential to have steady and ongoing data as soon as projects are implemented to ensure energy savings are sustained. In a nutshell, 'If you cannot measure it, you cannot manage it'.

Unless you know what your baseline is, you will neither be able to identify the most beneficial areas for the greatest gains nor would you have the ability to verify whether your interventions are working or not. For that reason, a smart meter that serves an online graphic user interface was installed about six weeks before the PowerGuard switch-on. The data gathered during those six weeks proved to be invaluable.

All data is readily available via a web-based online system where the authorised user has round the clock access. In addition to the load profile and billing data, additional statistics can easily be generated for a given load profile. These statistics provide accurate billing information for the period selected, allowing a customer to directly measure the financial implication of a specified period.

Since this project concerned demand only, and also because the Eskom meter data was unavailable, it was decided to use historical billing data for the 12 month period prior to the intervention for creating a baseline. It was established that the kVA figures reported on the Eskom bills were actual readings and were assumed to be accurate (see *Figure 5*).

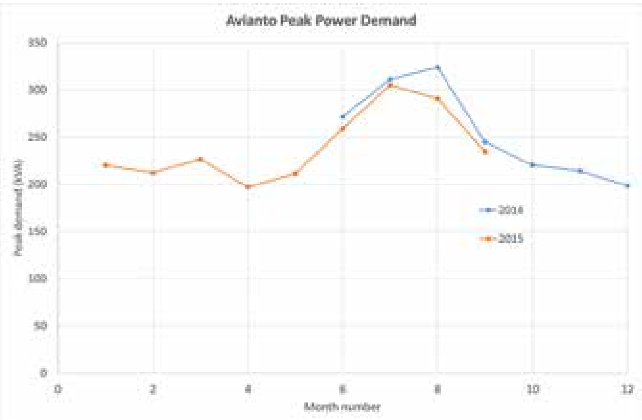
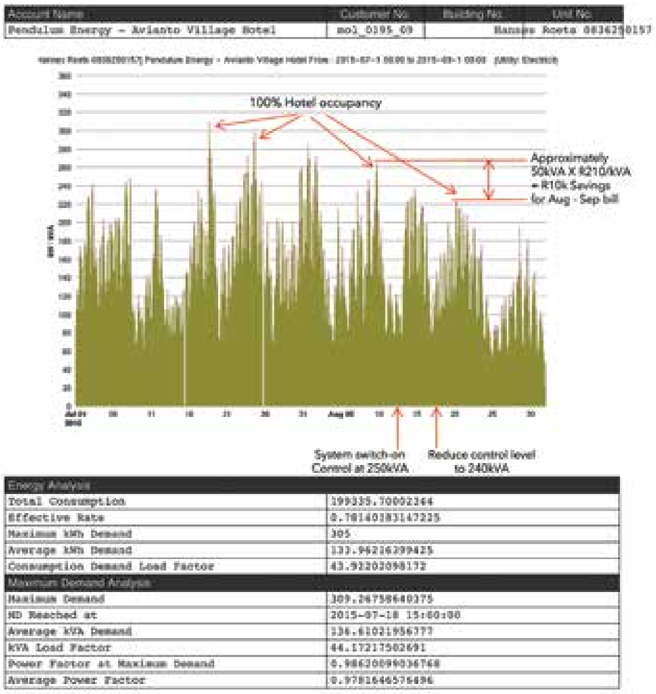


Figure 5: Maximum Demand (kVA) readings on Eskom bills for a 12 month period.

The system was commissioned on 12 August 2015 and initially calibrated to limit the demand to 250 kVA. Some days later it was reduced to 240 kVA after it was confirmed that it was operating well within its operating range.

Figure 6 is a graph and analysis produced by the online interface of the smart meter that was installed prior to PowerGuard. It clearly shows that peaks occurred around the 300 kVA mark before switch-on, with a maximum of 309 kVA reached on 18 July. A comparison between the demand figures for 100% hotel occupancy just prior to switch-on and immediately after that, shows a reduction of approximately 50 kVA. This particular bill falls in the high season with a kVA tariff of R210,66 which means the savings for that month alone came to approximately R10 000.

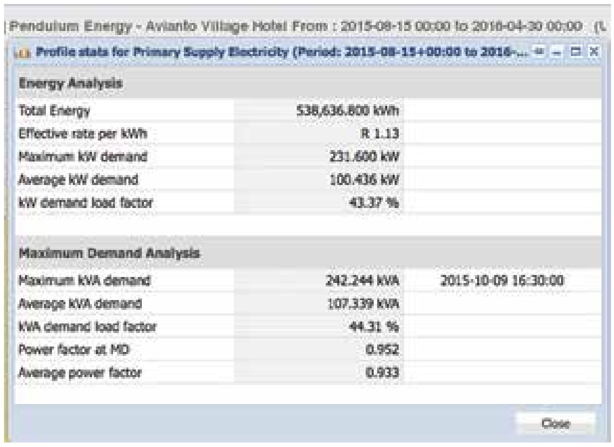
The client reported a seamless transition with no adverse effects on operations detected for the eight and a half months from switch-on. Since the calibration setting was reduced from 250 to 240 kVA, the system has required no attention and has been operating as predicted.



Account Name	Customer No.	Building No.	Unit No.
Pendulum Energy – Avianto Village Hotel	mol_0195_09		Hannes Roets 0836250157

Energy Analysis	
Total Consumption	199335.70002244
Effective Rate	0.78140183147225
Maximum kWh Demand	305
Average kWh Demand	133.96216399425
Consumption Demand Load Factor	43.92202098172
Maximum Demand Analysis	
Maximum Demand	309.26758640375
MD Reached at	2015-07-18 15:00:00
Average kVA Demand	136.61021956777
KVA Load Factor	44.17217502691
Power Factor at Maximum Demand	0.98620099036768
Average Power Factor	0.97816465756496

Figure 6: Graph showing electrical profile and demand analysis, before and after switch-on.



Pendulum Energy - Avianto Village Hotel From : 2015-08-15 00:00 to 2016-04-30 00:00

Profile stats for Primary Supply Electricity (Period: 2015-08-15+00:00 to 2016-...

Energy Analysis		
Total Energy	538,636.800 kWh	
Effective rate per kWh	R 1.13	
Maximum kW demand	231.600 kW	
Average kW demand	100.436 kW	
kW demand load factor	43.37 %	
Maximum Demand Analysis		
Maximum kVA demand	242.244 kVA	2015-10-09 16:30:00
Average kVA demand	107.339 kVA	
kVA demand load factor	44.31 %	
Power factor at MD	0.952	
Average power factor	0.933	

Close

Figure 7: Profile statistics for the period 15 August 2015 to 30 April 2016.

The profile statistics (see *Figure 7*), acquired from the smart meter shows that the control level set at 240 kVA had been maintained for the period that the system was operational.

Financial analysis

Assuming a conservative reduction in demand of 50 kVA for Winter and 30 kVA for Summer, the following savings could be realised.

Eskom 2016 – 2017 kVA tariff

High season (June, July, August):	R262,72 X 50 = R13,136 X 3	= R39,408
Low season (September – May):	R139,06 X 30 = R4 171,80 X 9	= R37,546,20
Estimated total saving for 2016 – 2017 year:		**R 76 954,20**

Simple Payback

Capital cost of Project:	R80 000
Net Annual Savings:	R 76 954 (first year, likely escalating 8 – 10% per year)
Payback period:	**11,5 months**

Return on Investment

Capital cost of Project:	R 80,000
Net Project Value	R 76,954
ROI	**96%**

Notified maximum demand reduction

This facility is served by a connection that carries a maximum notified demand of 500 kVA. That means that it may never exceed that demand, and if it does it faces a heavy penalty or in some instances even disconnection.

In 2016, Eskom charges R13,28 per kVA for access to the connection, which results in a monthly charge of R6 640.

In *Figure 7*, it can be seen that, since the PowerGuard intervention the facility constantly operates at a demand of 240 kVA, which is less than 50% of the notified demand. That affords the opportunity to safely reduce the notified demand to 300 kVA, which leaves a generous safety margin of 60 kVA.

Additional savings

Reduction of 200 kVA X R13,28 = R2 656 X 12 = R31 872 per year additional potential savings!

Conclusion

Considering that the benefits far outweigh the disadvantages, an exceptional Return On Investment (ROI) and a payback period of less than 12 months, it is clear to see the economic benefits of investing in Peak Demand Management. It allows all participants, customers, and utilities to benefit from the efficient use of the network and generation without adversely affecting the energy service.

Bibliography

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[4] Electricity+Control. October 2012. http://www.eandcspoton.co.za/resources/docs/Energy/Peak_demand_management_benefits_environment.pdf

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