NO HOT WATER or INTERMITTENT POWER INTERRUPTIONS

The lesser of two evils?

Author and Presenter: Barry Bredenkamp – Marketing Manager, (Energy Efficiency Services (EES), (Technology Services International (TSI)), Resources and Strategy Division, Eskom Holdings Ltd.

1. Introduction

The picture of South Africa exceeding its installed peak demand capacity by 2007 and base load capacity by 2010/11 has been widely publicised over the last few months, (refer to Figure 1). *'Simunye'* (the recommissioning of mothballed power stations), Pebble Bed Modular Reactors *(PBMR),* imported hydro-power from *Cahorra Basa* and many other supply-side options have all been eluded to as possible solutions, for the provision of a *'comfort zone'* to those pessimists out there who have expressed there dismay at this looming crisis in the energy sector in South Africa.

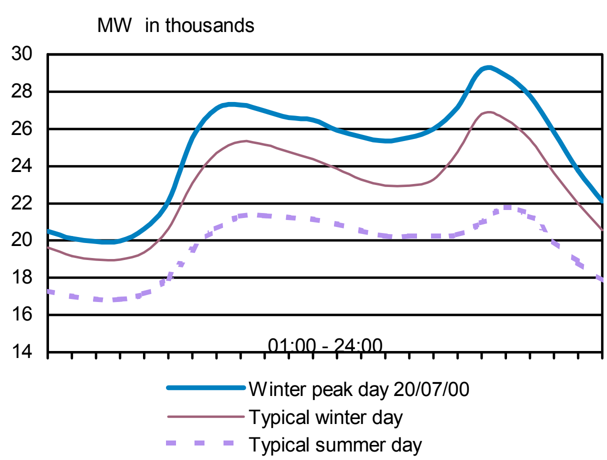
So what can local authorities do to help this situation, which in the main, is a problem for the national utility (Eskom) to deal with, (although Municipalities generally have to bear the brunt of widespread power outages in the residential sector of the South African market)?

Residential hot-water load management (geyser control), is probably the quickest, easiest and most economical option for a municipality to implement. So why aren't all municipalities entertaining this concept? The answer is probably simply: "***History***, ie. bad experiences with unreliable technology, high initial capital requirements, insufficient resources to monitor and maintain the systems, irate customers with 'cold water complaints', no direct financial benefit for domestic consumers, inappropriate tariff signals from Eskom, and the list just goes on and on". Some politicians will even go as far as saying that it is *unconstitutional* to *'control'* someone's geyser and/or hot water supply

Fortunately, there now exists a number of solutions to overcome the technological, financial and institutional barriers referred to above. Furthermore and since 'hot water load' inevitably makes up the major portion of small-to-medium sized municipal peak loads, a *'win-win-win'* solution can be achieved for all stakeholders, by developing and implementing an appropriate ***'Residential Hot Water Load Management Strategy'*** for local authorities in South Africa!

This paper will therefore attempt to address the barriers mentioned above, with a specific focus on the ***technological challenges/ solutions*** and lessons learnt during the development and implementation of a ***'Residential Hot Water Load Management Strategy'*** in the areas of Table View, Mmabatho and Worcester. The paper will then go on to illustrate how this solution can and should contribute to the question referred to in the title of the paper: ***"No Hot Water or Intermittent Power Interruptions – the lesser of two evils?"***

Figure 1: Typical Winter/ Summer National Load Profile.



2. Barriers

The widespread implementation of residential load management (geyser control), has over the years, been clouded in controversy and this has subsequently increased the barriers to entry for this particular option to shift load. These barriers include the following:-

- the capital, installation and maintenance costs associated with the various technologies available for controlling geysers on a wide scale;
- the security and control measures required to ensure that the equipment is not by-passed, which in turn, makes it almost impossible to accurately forecast load requirements;
- **the relatively cheap price of electricity associated with the *'all electric'* household phenomenon, which is common in South Africa;**
- limited and/ or incorrect tariff signals/ options available to municipalities and/ or domestic users of electricity;
- surplus capacity and co-generation *'special offers'* to municipalities, as a result of this;
- more recently, the *'shared savings'* option, offered by Eskom (DSM), to implement municipal geyser control projects;
- customer and political resistance to the concept of 'controlling' electricity consumption.
-

3. A Customer Perspective

From a customer's point-of-view, the only real electricity cost saving achievable from the geyser, is to use less hot water, limit the thermostat temperature, or reduce heat losses from the geyser, ie. by using *'low-flow'* showerheads, installing geyser blankets and pipe insulation, sharing of baths/ showers or generally adapting one's lifestyle, eg. taking a shower instead of a bath!

Furthermore, a vertical geyser could be installed, resulting in less heat losses from the smaller *'vertical plane'* (surface area) of the geyser, than the typical conventional 3 kW horizontal geyser.

However, the most important thing to note, is that the customer generally does **NOT** benefit directly from a large-scale municipal hot water (geyser) load control project, **UNLESS** the particular municipality offers a *'Time-of-Use (TOU)',* tariff to its residential customers, or passes on the financial benefit (savings), to those customers through tariff rebates, deflated increases, etc..

4. Municipal Requirements

For a municipality to contribute to alleviating the problem referred to in the Introduction to this paper, and to access the DSM/NER funding mechanism available for projects of this nature, it is imperative that the following information is readily available:-

Customer data:

The feasibility of an energy management system is heavily dependent on the number of geysers utilized in the feasibility analysis. Obviously, Municipalities expand and new customers are added to the financial system on a continuous basis. Therefore, regular, updated and accurate information is crucial, in determining the viability and contribution that a municipality can make, to alleviating the peak load problem in South Africa, eg.:-

- Total number of existing housing stock.
- Total number of *'switches'* already existing, where applicable.
- Current Business Plan, (expansion/load forecasting, etc.).
- What technology to be used (radio/ripple), and why?
- If ripple, what type of injection sets are suitable ie.132kV, 66kV or 11kV, (and why)?

Furthermore, there are two general approaches that can be used to verify the current geyser control deployment status in a municipality, ie.:-
Method one – geographic approach:

Most municipal areas can be easily classified into their different respective socio-economic categories. From the different demographic classifications, it is generally known whether the domestic homes in a respective area would have geysers or not. Sample audits can also be executed, to verify the category classification assumptions. Accurate information is essential to ensure reliable results. This can only be accomplished, if the following general information can be ascertained:-

- Accurate area maps of the different wards (suburbs), in the municipality, as well as their respective demographic classifications.
- Commission an audit of the following:
  - Is there running water and/ or geysers installed?
  - If so, how many?
  - Rated consumption of each, ie. amps.
  - Is it on at the distribution board?
  - What size geyser is being used, (in liters)?
  - Horizontal or vertical?
  - Type of distribution board (old or new)?
  - Is there space in the distribution board for a hot water load control switch?
- How many houses (representative sample), were used for the audit and why that many?

Method two – consumption/ demographic approach:

The presence or not of a geyser in a residential home can easily be established from the average monthly electrical consumption data available. This is very important, especially in the prepayment customer sector. Accurate information is essential to ensure reliable results. This can only be accomplished, if the following information can be provided:- Analysis per ward (suburb), of the average consumer consumption data. This information can usually be obtained from the municipal

- financial system. Further sample audits can be executed, to verify the category classification assumptions.

Single line diagram of the supply:

A single line supply diagram is essential to determine:-

- possible supply (control), areas per supply point;
- points of supply to use as reference when controlling the geysers, (maximum demand control);
- supply voltages;
- different transformers and number of each and how they are linked, to determine the number of injection sets required;
- substation space available for the installation of additional equipment;
- Municipal electricity accounts (one winter and one summer month), of each point of supply;
- Current and/ or planned tariff structures and half hourly load profiles, (kW, kVAr and kVA).

5. Basic Information Requirements

However, and in order to expedite applications of this nature, the following basic information requirements should also be considered:-

- Brief background and history of the municipality in question.
- A comprehensive analysis of the Municipal area, which includes all the sub-divisions, electricity supply points, residential area maps, as well as sample audits per ward (suburb), to verify the number of geysers installed in the respective residential areas.
- A comprehensive analysis of the Municipal billing data, to determine the number of households per ward (suburb), as well as their average electrical consumption. Sample audits per category or per ward should also be done, to confirm the geyser presence criteria from within the respective consumption categories.

- The geyser counts from the above analysis will then be consolidated, to provide a geyser count per ward, which is generally deemed to be accurate to within ten percent (10%), of the actual data.
- Risk identification and possible mitigation factors.
- The preferred sequence of installation, eg. areas where capacity, cables and equipment are the most constrained, etc..
- Availability and identification of possible 'redundant' municipal/ local resources that could be trained, for installation purposes, ie. job creation opportunities.
- Size of existing load management system, if any, eg. number. of injection sets, controllers, relays, metering points, etc..
- Potential for expansion, if existing, or in the case of greenfields projects, the total estimated number of geysers within the supply area.
- Makeup of supply area, eg. one metropolitan town or number of smaller towns consolidated into one metropolitan council.
- Current Bulk Purchase Tariff of each town within the supply area, if more than one, eg. Nightsave, Megaflex, etc..
- Plans/timeframes for Bulk Purchase Tariff migration, if any.
- Number of supply points.
- Level of Notified Maximum Demand (NMD), for each supply point, (a copy of a winter bill per supply point would suffice).
- Project Approval Level/ Delegation of Authority, ie. Management Committee, Executive Mayoral Committee or Local Council approval or alternatively, what steps need to be followed for final contract signature/s, project implementation and estimated approval timeframes.

6. Project Options

The scope of projects generally include one of the following two options:-

- The refurbishment and/or expansion of existing load management systems;
- Greenfields implementation (completely new systems), where no existing load management systems are presently in existence.

Where functional systems already exist, expansion/refurbishment can, as far as possible, be implemented, using the existing equipment as a foundation for the more efficient systems presently available on the market. In the case of greenfields sites, an open tender based on the *'Generic Load Management Specification'*, provided by Eskom (DSM), is followed. However, it is possible to allocate preferred supplier status to one or other technology/manufacturer, if required by the Municipal Tender/ Procurement Policy, provided that such equipment meets the required minimum technological/ quality requirements.

The cost of each project will be funded through a grant provided by Eskom DSM. The release of grant monies is subject to the overall project meeting the minimum criteria laid down by Eskom (DSM) and the NER, which is measured by looking at the R/ MW , resulting from the implementation of such a project. (This money/ budget is administered by Eskom DSM on behalf of the National Electricity Regulator (NER)).

The entire process is managed/ regulated by two *back-to-back* performance contracts between the parties involved. The first will be between the municipal-appointed/ authorised *'Energy Service Company (ESCo)'*/ Project Manager/ Consultant, and the Municipality/ Local Supply Authority concerned, and the second ,between Municipality and Eskom (DSM), ie. the channel through which the NER-funding will flow. These contracts will cover aspects of system operation, maintenance and performance, with *committed Mega-watt (MW) reduction targets.*

7. Procurement

In the case of greenfields projects, Eskom (DSM) will supply a generic load management system specification for evaluation. Eskom (DSM), the ESCo and the Municipality will develop the tender technical specification jointly, for issue on open tender. The ESCo will develop the final specification document for ratification by Eskom (DSM), and the municipality.

Where an existing, functional system is in place, similar/compatible equipment will be utilised as far as possible, for the expansion/refurbishment of the existing system.

8. Marketing/ Customer Education

All parties generally consent to liaise and co-operate with each other, to ensure that the project is properly communicated to all stakeholders in the value chain and that customers are thoroughly informed (educated), on the reasons for, and the implications, of such a project in their area. Eskom (DSM) may even cover/ contribute towards the marketing costs, inline with pre-approved budgets and guidelines.

9. Environmental Issues

Detailed information is available on the installed capacity, efficiency and operating characteristics of Eskom's generating facilities; fuel consumption by facility; and generation facility dispatch policies. Eskom prepares annual estimates of fuel consumption, water used, ash produced and emissions released due to the production of electricity from each of its facilities.
Estimates of reductions in emissions can be calculated by multiplying emissions factors per kWh of electricity by the number of kWh of electricity produced by each generation facility. In South Africa there is a mix of nuclear, hydro and coal-based thermal generation. However, it is widely accepted that coal is the marginal generation source, so emissions reductions are based on an assumed reduction in coal use. This, in turn, will assist in calculating the potential *'Carbon Credits'*, as a result of the reduction in *'Greenhouse Gas Emissions (GHG)*, as a result in the reduction in *'peak demand'* on the national grid.
However, if funded through this mechanism, *Carbon Credits* emanating as a result of the reduction in emissions as a direct result of the implementation of the DSM residential hot water geyser/ load control project in the Municipality in terms of the UN Framework Convention on Climate Control/ Kyoto Protocol, will accrue solely for Eskom's benefit.

10. Ownership, Operation and Maintenance of Equipment

The participating municipality will retain ownership of all equipment acquired by the ESCo on behalf of the municipality, using NER/Eskom funding in respect of the proposed DSM project and installed by the ESCo and/ or municipality, that reduces the electricity consumption of the Municipality.

The daily operation and maintenance of the entire load management system will be the responsibility of the Municipality, unless otherwise negotiated with the ESCo. These costs will be borne by the Municipality, using the savings accrued by the project, or by the Manufacturer/ Supplier of the equipment, in terms of any guarantees that may be applicable or negotiated between the parties concerned. Daily operational procedures and system parameters will be performed according to agreed guidelines between the ESCo, Eskom (DSM) and theparticipating Municipality.

11. Measurement and Verification

The monthly savings will be calculated by way of a predetermined methodology, which roughly involves the establishment of a baseline to which the actual measured load profile is compared, to determine the savings.

A Measurement and Verification (M&V) plan is then developed by an independent M&V body, which has been established by Eskom (DSM), for this purpose. The plan will cover all aspects of the M&V process, from baseline calculation methodologies to metering to periodic plan review points (Notch Testing), and if necessary, dispute resolution mechanisms.

This plan must be ratified by all parties and executed by the National Monitoring and Evaluation Centre, (NMEC). The NMEC will also perform daily/monthly data retrieval and verify the monthly savings calculations. All parties will then ratify/approve the monthly savings according to a pre-approved process and review the actual against the planned or calculated savings submitted in the original proposal.

12. Energy and Peak Savings

The national DSM Plan presently indicates a target of 43 MW of shifted peak demand per annum, over the next 10-years, (2004-2004). Although this target could change depending on prevailing circumstances, the information gathered from some of the initial work in the Mafikeng and Mmabatho projects, indicate that these targets are quite easily attainable.

13. Benefits, Risks and Lessons Learnt

The lessons learnt from the projects referred to in point 12 (above), also highlighted a number of additional benefits and risks.

The **Table View (1998)** project, which was one of the initial DSM-related initiatives in this area, has emphasised the need for proper control and monitoring interventions to be put in place, to ensure success, as it now *''appears'* that the majority of relays in the area have either been by-passed or failed over time.

Similarly, the recently approved **Worcester** (2003/2004) project has been a 'test-case' for overcoming the immense and time-consuming bureaucracy and protocol to deal with, when so many roleplayers (and fairly large budgets), are involved. This project also provided valuable lessons in terms of making provision for long-and-exchange rate-related procurement processes that need to be adhered to, in streamlining the entire process.

The **Mmabatho (2002/ 2003)** project emphasised the need for post-implementation commitment to utilising, optimising and maintaining the network, which in itself, is a huge asset for any municipality, ie. from senior management, right down to the call centre and clerical/ billing staff involved in the process. Training of local staff responsible for maintaining the system and dealing with customer-related enquiries, is crucial for the overall success of the projects of this nature.
An obvious risk from a municipal perspective, could be where larger commercial enterprises like hotels, hostels, etc., and who are billed on a Time of Use (TOU) tariff, could result in a net 'revenue loss', ie. depending on the structure of such a tariff.
However, the overall benefits definately outweigh the risks, and could *potentially* provide participating municipalities with a *competitive advantage*, during the transitions towards *Regional Electricity Distributors, (REDS).*

14. Conclusion

South Africa is no different from the rest of the world, in as far as the increasing demand (and rising costs), of energy is concerned. Taking the 2003/ 2004 winter unplanned outages into consideration, then we see more similarities with California, New York, Italy and other major/ developed countries, who have also recently experienced serious 'brown-and- black outs'

However, what does differentiate South Africa from most other energy intensive countries, is the phenomenon of the 'all electric' home, ie. we do not have access to natural gas for heating purposes, and solar water heating still remains a relatively unknown and uneconomical option for residential water heating.
This scenario, coupled with the latest innovations in technological development in the field of residential hot water load management equipment, presents this country with a unique opportunity to take the lead in this area of *'Demand Side Management, (DSM)'*, worldwide. Add to this, the 100% financing option available from the NER/ Eskom (DSM), for this

activity, then there should be no reason why *ALL municipalities* **are not taking full advantage of this unique opportunity, in a rapidly evolving electricity distribution sector, ie. *BEFORE* the capacity situation in South Africa necessitates** *legislation* **in this regard! The only remaining question begging an answer relates to what should be done in the unlikely event of something going wrong and customers experiencing cold water? Well, in the short to-medium term, the choice remains: 'Limited hot water shortages, or regular and intermittent power interruptions.........*which is the lesser of two evils?***

15 References

[1] Delport, J. and Sebaeng, C.: "Eskom DSM's reaction to decentralised Hot Water Cylinder (geyser) Control and control gadgets," *Specification Document,* Rev. 0, August, 2004.

[2] van Geems, F.: "Audit Requirements for Residential Hot Water Load Management Projects": Eskom, Technology Services International (TSI)," *Internal documentl,* Rev. 02, August, 2003.

[3] Horowitz, M. and Haeri, H.: "Economic Efficiency versus Energy Efficiency: Do Model Conservation Standards Make Good Sense?," *Energy Economics,* Vol. 12, No. 2, 1990.

[4] Jaffe, A. and Stavins, R.: "Dynamic Incentives of Environmental Regulations: The Impact of Alternative Policy Instruments on Technology Diffusion," *Journal of Environmental Economics and Environment,* Vol. 29, 1995.

[5] Newell, R., Jaffe, A., and Stavins, R.: "The Induced Innovation Hypothesis and Energy-Saving Technological Change," *The Quarterly Journal of Economics,* Vol. 114, 1999.

[6] Forlee, C., Pillay, P., and van Geems, F. (1998 to 2004). Internal Eskom Reports, *(various).*