ELECTRICITY CONTROL BOARD

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DEMAND SIDE MANAGEMENT STUDY FOR NAMIBIA

REPORT 1:
OVERVIEW OF DSM OPTIONS AND RANKING FRAMEWORK

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Compiled for the ECB by

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ABBREVIATIONS

AC	– Air Conditioning
CFL	– Compact Fluorescent Light
COW	– City of Windhoek
DSM	– Demand Side Management
DX	– Distribution
ECB	– Electricity Control Board
EDI	– Electricity Distribution Industry
EE	– Energy Efficiency
ESI	– Electricity Supply Industry
EU	– European Union
EWH	– Electric Water Heater
GRN	– Government of the Republic of Namibia
GX	– Generation
HVAC	– Heating, Ventilation and Air Conditioning
HWC	– Hot Water Cylinder
kW	– kilowatt (measure of power or demand)
kWh	– kilowatt-hour (measure of energy, also referred to as a “unit”)
LA	– Local Authority
MME	– Ministry of Mines and Energy
QOS	– Quality of Supply (Electricity Quality)
RC	– Regional Council
RED	– Regional Electricity Distribution
RSA	– Republic of South Africa
SWH	– Solar Water Heater
TX	– Transmission

1 EXECUTIVE SUMMARY

Namibia is expected to experience both electricity supply bottlenecks and a substantial increase of electricity prices in the near future. Under this scenario, demand side management offers excellent opportunities to utilities to more effectively match the supply and demand of electricity and deal with short- and long-term network constraints, while limiting consumer exposure to increasing regional electricity prices. Demand side management in the electricity sector is aimed at reducing the consumer's demand for electricity and/or the timing of such usage. It is principally achieved through energy conservation and energy efficiency measures and technologies, as well as load shifting and load shedding.

This report is the first output of a demand side management study commissioned by the Namibian Electricity Control Board. Its purpose is to provide sufficient information to key Namibian electricity supply industry stakeholders to understand contemporary demand side management issues, and document the opportunities that demand side management holds for Namibia. The report is also meant to inform discussions between electricity supply industry stakeholders, and to focus stakeholders on the costs, benefits and implications of implementing demand side management options in future.

The report considers and is based on international, regional and local experiences in demand side management as applied in the electricity sector. It provides definitions of the main demand side management practices, i.e. energy efficiency, load shifting and load shedding, and discusses international, regional and Namibian demand side management practices. A brief overview of Namibian electricity consumption and demand characteristics is provided and serves to define the practicability and suitability of future demand management measures.

A comprehensive summary and discussion of international demand management options is presented. A ranking framework is developed to prioritise the suitability of such measures, based among others, on cost, impact on stakeholders and implementation requirements. The application of the ranking scheme results in a shortlist of recommended and prioritised demand side management options for Namibia, complemented by broad estimates of the impacts of such measures on Namibian utilities and consumers. The shortlisted recommendations include

1. Subsidising the dissemination of compact fluorescent lights
2. Increasing the dissemination of solar water heaters in the residential sector
3. Increasing the dissemination of solar water heaters in commercial / industrial buildings
4. Undertaking subsidised energy audits
5. Redesigning the current tariff structure, to include future time of use tariffs and possibly critical peak pricing arrangements
6. Enhancing consumer awareness
7. Promoting commercial energy efficient lighting
8. Introducing ripple control technologies, especially in smaller Local Authorities, and expanding existing schemes in Windhoek and Walvis Bay
9. Enhancing commercial / industrial air conditioner efficiencies, and promoting associated load control measures
10. Investigating the financial arrangements to promote demand side management activities.

The implementation requirements of the above options are investigated, as are the broad financial implications and stakeholder benefits. Three Annexures provide additional details of the demand side management options considered, as well as some calculations and a list of references used in this study.

The shortlist will be discussed at an upcoming stakeholder workshop, where up to five suitable demand side management options of relevance to Namibia will be identified. These options in turn will form the basis of an upcoming in-detail investigation, which is to be undertaken as part of the second phase of the present demand side management study.

2 INTRODUCTION

2.1 PURPOSE OF THIS REPORT

This report is the first output from a Demand Side Management (DSM) study commissioned by the Namibian Electricity Control Board (ECB).

The purpose of this report is to provide an information base about DSM for discussion, and short-listing of DSM options of relevance for Namibia by

- Summarising international and regional experience in DSM and examining its relevance to Namibia
- Providing a list of DSM options used internationally
- Examining the list of DSM options regarding their relevance and suitability for Namibia
- Estimating the impact that the various DSM measures may have in Namibia
- Proposing a short-list of DSM options to be examined in more detail in the second phase of this DSM study

The audience for this report are the ECB and key Namibian Electricity Supply Industry (ESI) stakeholders who will be invited to a workshop at which the contents of this report will be presented and discussed.

This report will form the basis for discussion at the stakeholder workshop planned for May 2006. The key focus of the workshop will be to come up with up to five priority DSM options for Namibia which will then be developed in detail during the second phase of the DSM study.

2.2 BACKGROUND

This study has been commissioned by the ECB in the light of Namibia facing imminent electricity shortages in the short to medium term, and with the intention to promote long-term energy efficiency in the country.

With more than 50% of Namibia's electrical energy being imported from South Africa, the country must be regarded as highly dependent on the RSA. This high import rate has been based on historical over-capacity in generation capacity in the RSA, which however is rapidly diminishing. Coupled with a transmission constraint between the North Eastern regions of the RSA (where most generation capacity is situated) and the Cape this has put the Cape (and Namibia) at risk in the event of Koeberg nuclear power station not being available. This has become reality in 2006 with damage occurring to one of Koeberg's generators and the other being due for refuelling. Eskom's supply to Namibia has been drastically reduced, forcing NamPower to run its own generators at the van Eck (coal) and Paratus (heavy fuel oil) power stations. This is incurring significant losses for NamPower since these stations generate at a higher rate than NamPower's average selling rate. In the short-term, issues may well come to a head and load shedding may become necessary.

In the medium to long-term Namibia is faced with rising generation costs and hence retail prices are projected to increase in real terms by maybe as much as 50% above the levels currently being experienced. Namibia as a country also wishes to promote conservation of resources and environmental consciousness. These factors have led the ECB to promote energy efficiency, and demand side management has an important role in this endeavour.

The Energy Policy of Namibia provides a clear basis for the ECB to undertake this study and drive the implementation of its results. Sections 3.5 and 4.3 of the Energy Policy specifically address energy efficiency and renewable energy use. This mandate is further strengthened by the Electricity Act, which specifically empowers the ECB to act in this area.

Section 3 of the Act 2 of 2000 reads as follows: *"(1)The objects of the Board are to exercise control over the electricity supply industry and to regulate the generation, transmission, distribution, use, import and export of electricity in accordance with prevailing Government policy so as to ensure order in the efficient supply of* *electricity.*". This clearly includes the use of electricity. This mandate is maintained and strengthened in the revised Bill being tabled in 2006.

2.3 WHAT IS DSM?

DSM can be broadly defined as measures taken on the **consumer side of the meter** to reduce energy consumption.

This applies to any form of energy. For the purpose of this study only electricity is considered, i.e. the matter of interest is the reduction of **electricity** consumption **from the grid** through measures implemented on the consumer side of the electricity meter.

2.3.1 Consumption Dimensions

Electricity consumption is generally seen as having two main "dimensions":

- The quantity of energy (kWh) consumed in a given period of time
- The profile of how much power (kW or kVA) is taken at any given point in time

2.3.2 Main DSM Approach Categories

DSM addresses the two dimensions above in broadly three ways:

2.3.2.1 Energy Efficiency

Reduction in the overall energy consumption (i.e. use less grid kWh to undertake the same activities as before and thereby reducing the demand from the grid at those times) on a **permanent** basis.

This can be achieved through (among others)

- Using energy efficient technologies
- Using renewable energy sources instead of non-renewable ones
- Reducing losses in processes

2.3.2.2 Load Shifting

Shifting of the demand peaks from one time slot to another (i.e. use the same kWh to do the same thing, but do it at a different time) on a **permanent** basis.

This can be achieved through (among others)

- Tariff setting (e.g. time of use tariffs)
- Ripple control of EWH or other devices
- Industrial demand management strategies

2.3.2.3 Load Shedding

Temporary reduction of consumption and demand from the grid through load shedding or other measures on an **ad-hoc** basis (i.e. reduce demand from the grid at certain times, on demand from the utility)

This is typically achieved through forced load shedding in emergency situations or through pre-arranged voluntary load shedding agreements between the utility and specific consumers.

2.3.3 Categorising DSM Measures

DSM is typically achieved through a range of measures, and many DSM programmes employ a mix of these to achieve the desired outcomes.

2.3.3.1 Economic Measures

Economic measures provide financially based incentives for consumers to change their consumption. These may be positive incentives (subsidies, rewards) or negative incentives (penalties).

2.3.3.2 Regulatory Measures

Regulatory measures set rules and regulations that have to be adhered to and include specifications relating to energy use. Examples are building regulations and standards for appliances/equipment.

2.3.3.3 Information Measures

Information measures reply on provision of information to consumers as a driver for them to alter their energy consumption patterns. Examples include dissemination of information on energy efficient technologies, appliance labelling and energy audits.

2.3.3.4 Voluntary Measures

Voluntary measures are typically agreements entered into between utilities and consumers on a voluntary basis, which are usually based on mutual benefits derived form specified activities. An example of this are voluntary load shedding agreements with large power consumers which can help the utility manage peak demand and in return offer the consumer a better tariff.

3 DSM EXPERIENCE & OPTIONS

3.1 THE MAIN DSM APPROACH CATEGORIES

3.1.1 Energy Efficiency

Energy efficiency - for the purposes of this report - is defined as "reduction in the overall energy consumption (i.e. use less grid kWh to do the same thing at the same time, thereby also reducing grid demand at those times) on a **permanent** basis".

This implies that less kWh are used, not just temporarily, but long-term through better technology, better process design, better building design, better practices and other measures. Deferring the use of kWh from one time to another is considered as load shifting and not energy efficiency.

3.1.1.1 kWh and Demand Impact

Energy efficiency thus has the dual effect of reducing the total kWh consumed as well as reducing the demand from the grid. The kWh reduction normally produces a direct financial benefit to any consumer since normally every kWh is billed and thus kWhs not consumed equate directly to money saved.

The effect of demand reduction due to energy efficiency measures is more complex than the reduction in kWh consumption, because the benefits depend largely on the time in the day, week and year where the reduction occurs. Demand reduction occurring as a result of energy efficiencies is based on probabilities and the actual reduction size and timing thereof, and is not within the direct control of the utility. The accuracy of predictions in this regard will vary significantly between cases.

If the consumer is billed for demand and the demand reduction occurs at a time when the consumer's billing demand peaks, then there is a direct financial saving for the consumer. If the consumer is not billed for demand then no direct benefit is derived from the demand reduction, unless this allows the consumer to reduce the incoming circuit breaker rating and thereby reduce capacity and/or basic charges.

Demand reduction however also has effects in the supply chain that the consumer may not be aware of. On the grid there are a large variety of consumers who place different demand on the system at different times. It is the **system** peak demand that ultimately drives the generation requirements. From a utility perspective it is therefore most interesting to reduce demand at system peak times (which may be different from the time at which consumers would benefit directly). So depending on the time at which the consumer saves kWh this is worth more or less to the utility. It would therefore make sense for the utility to provide incentives for consumers to implement measures that reduce kWh consumption at the times when the utility benefits most.

3.1.1.2 Drivers

The main driver for a consumer to strive for energy efficiency is economic, based primarily on energy cost with demand cost savings occurring mostly as an added benefit. By investing in more energy efficient equipment, better maintenance practices or better loss control the consumer saves on his/her electricity bill, and this saving is expected to pay for the investments in energy efficiency.

Industrial consumer would be expected to approach this from a business perspective, and the return on investment in DSM measures needs to be of a magnitude that is interesting to the private sector. Such consumers typically pay for both energy and demand, so the potential saving if both can be addressed is usually significant.

Domestic consumers have different issues to the industrial consumers. They are usually on an energy only tariff (no demand charges), but credit metered consumers usually also have a capacity charge, i.e. they pay for the size of connection. Savings can therefore be realised for domestic consumers in energy consumption and potentially also in capacity charges (breaker size related basic charges) if the demand profile of the consumer is reduced such that a smaller breaker could be selected. However domestic consumers are generally little informed about these issues and will need major amounts of awareness creation for such benefits to become apparent. Domestic consumers also face other wide spread barriers, such as poverty which affects the ability of individuals to respond to incentives by investing money in DSM activities.

High energy costs are a significant driver for energy efficiency. In Namibia energy costs have been very low compared to world standards, and therefore the incentive for savings has been limited. With regional electricity prices projected to rise significantly in the coming years, energy efficiency is expected to become the prime means for consumers to cope with increased costs.

From a utility perspective energy efficiency typically raises some discomfort, since the utility's business is to sell kWh and selling less kWh does not sound like a good idea. This may explain some of the reluctance visible in DSM programmes driven by utilities to drive energy efficiency options as much as load shifting. Rather, utilities will more likely support energy efficiency measures, which will have significant demand savings during system peak time, since this will benefit the utility by decreasing investment needs for infrastructure (both generation, transmission and distribution) required only to serve short peaks.

It is important to note that in the Namibian distribution tariff regime utilities need to know ahead what impact DSM measures can be expected to have on their sales volume so that this can be incorporated in the sales volume forecast on which tariff calculations are based. If this information is known during tariff reviews then the utility need not sacrifice profitability – however the effect will be an increase in tariffs. This in turn should strengthen the signal for consumers to save, which makes it a self-reinforcing driver.

3.1.2 Load Shifting

Load shifting for the purposes of this report is defined as "permanently shifting the demand peaks from one time to another (i.e. use the same kWh to do the same thing, but do it at a different time)".

This implies that demand (and kWh consumption) is shifted from one time to another time on a regular basis. A common example of this is electric water heater ripple control, which shifts consumption to a later time, but does not save any kWh.

3.1.2.1 kWh and Demand Impact

The discussion under 3.1.1 above regarding the impact on system demand applies to load shifting as well, the only differences being that the utility has direct control over the time at which demand is reduced, the extent to which demand is reduced (within the limits of installed controllers) and the duration of the interruption.

Utility controlled load shifting is usually designed to minimise inconvenience to the consumer to such an extent that under normal operating conditions the consumer is not supposed to notice that load shifting has or is taking place. However the utility has the ability to use its control systems in an emergency to an extent that consumers do notice. This gives the utility a powerful demand management tool, the impact of which it can use to its discretion.

3.1.2.2 Drivers

Load shifting is primarily driven by economic considerations, based primarily on demand cost. The consumer and/or utility purchase energy either on a time of use (ToU) tariff or demand tariff, both of which provide incentives to use energy in a certain manner. The ToU tariff provides an incentive to use less kWh (and less demand) during certain times. A demand tariff provides an incentive to have a high load factor, i.e. have as little variation in the demand profile as possible. Both these tariff signals provide a clear incentive for load shifting.

Other drivers for load shifting may relate to system constraints, i.e. where the utility or the consumer does not wish to invest in its network, which may be highly loaded under certain circumstances, and load shifting may at least defer investments to strengthen the system.

3.1.3 Load Shedding

Load shedding for the purpose of this report is defined as "the temporary and ad-hoc reduction of consumption and demand from the grid (i.e. reduce demand from the grid at certain times on demand from the utility)".

Load shedding can take various forms. In some places during generation shortages consumer groups are switched off on a rotating basis around the day. This usually has the impact that businesses depending on electricity install their own generation capacity. Domestic consumers may also install own generation or switch to alternative energy sources.

Load shedding can also take the form of switching off individual consumers having their own standby generation plant, thereby switching them to their own generators and reducing the load on the system.

Load shedding can also be implemented where industrial consumers have processes, which are interruptible without negatively impacting on the production. These processes can then be interrupted on utility request for previously agreed durations and frequencies.

The latter two examples could be referred to as voluntary agreements, whereas the first is not voluntary.

3.1.3.1 kWh and Demand Impact

Voluntary load shedding normally has only a demand impact, since its sole purpose is the temporary reduction of demand on the system. It is used in times of system demand constraints, either due to larger than expected consumption, or planned or unplanned generation shortages.

Involuntary load shedding primarily has a demand impact, but is also very likely to have a significant kWh impact if such load shedding occurs over extended periods and/or with regular frequency.

3.1.3.2 Drivers

From a utility perspective load shedding is usually driven by technical and to a lesser degree economic considerations. It is usually costly to the utility and therefore mostly used in emergency cases, or where alternatives are even more costly.

From a consumer perspective, voluntary load shedding needs to go hand in hand with some incentives (often financial), e.g. the utility offers the consumer more attractive pricing or other benefits for providing voluntary load shedding facilities.

3.2 INTERNATIONAL AND REGIONAL TRENDS

There is a wealth of information available on the Internet about DSM programmes all over the world. A fair amount of such information resources have been tapped and reviewed (refer to the literature list in 7). In doing so we have concentrated mainly on the following resources:

- International Energy Agency (IEA) DSM website – which provides a framework for evaluating DSM measures, case studies from a number of member countries of the IEA
- Eskom DSM website and other reports on DSM from the RSA, including various presentations, case study summaries, independent reviews
- A number of reports and proposals from Australia
- Miscellaneous other international reports

A two-fold approach has been taken to summarise this information:

- firstly, a tabular summary of case studies was compiled providing an overview of international DSM programmes, experiences and approaches
- secondly, a summary of key observations has been compiled to highlight interesting observations and learning points from the literature review.

Table 1: Summary of Case Studies

Country	Implementing Agent	Location	Description	DSM Implementation
South Africa	Iskhus Power	Carlton Centre, Johannesburg	The Carlton Centre is the highest building in Africa and was built in the 1960's, back then it was state of the art, but 40 years later needed a modern energy audit.	Fluorescent with ECG

Country	Implementing Agent	Location	Description	DSM Implementation
South Africa	Lemay Electrical cc	FNB Bank City, Johannesburg	A large 5 block building in the CBD.	Air-Conditioning Efficiency Analysis
South Africa	Lighting Innovations	Pick and Pay Nation-wide	Lighting renovations were implemented on Pick&Pay nationwide with capex payback of less than 2 years.	Fluorescent with ECG
South Africa	Eskom DSM	Minerals and Energy Department and NER Building	Some state building were used as a demonstration for the DSM program	Building management system
South Africa	Eskom DSM	New building for Central Energy Fund, JHB	285 new CFL fittings and 107 motion sensors	Fluorescent with ECG
South Africa	Eskom DSM	Union Building, Pretoria	The largest DSM implementation in this project was the introduction of Energy Efficient Lighting.	Fluorescent with ECG
South Africa	Cape Town Municipality	Cape Peninsula	Cape Town Municipality used to have a very flat load profile this was mainly due to pump storage at Steenbras dam and gas power station at Athlone	Pumped Storage & Distributed Generation
South Africa	Cape Town Municipality	Cape Peninsula, Western Cape	Cape Town Municipality receives a time of use tariff from Eskom, they the use the low cost off-peak kWh to pump water up the Steenbras reservoir to then use it later during peak. CTM also offers ToU tariff to some 600 larger industrial consumers.	Time of use tariffs
South Africa	Ceres Town Municipality	Ceres, Western Cape	Ceres has a 10MW hydro power station that runs during winter months, and is one of only 3 small towns that has generation capacity	Distributed Generation
South Africa	Ceres Town Municipality	Ceres, Western Cape	Ceres has a ToU tariff from Eskom and makes ToU tariffs available to their industrial consumers	Time of use tariffs
South Africa	Durban Municipality	Durban, KZN	Durban has the largest number of ToU customers in SA and is looking to implement ToU for all customers. They receive ToU tariffs from Eskom. The only large consumer with no generation capacity, thus electricity prices are of the most expensive in the RSA.	Time of use tariffs
South Africa	Kimberly Municipality	Kimberly, Eastern Cape	Kimberly has one of the oldest RC networks in SA, it is used mainly to control HWC but can also control street lights	Ripple Control
South Africa	Greater Pretoria Metropolitan Council	Pretoria Region, Gauteng	The Pretoria Metro is a consolidation between Pretoria, Centurion and Akasia municipalities. They buy electricity in bulk from Eskom and manage their peaks by means of 2 power station namely Pretoria North and Rooiwal. This leads to interesting tariff agreement with Eskom.	Distributed Generation

Country	Implementing Agent	Location	Description	DSM Implementation
South Africa	Centurion Municipality	Centurion, Gauteng	Centurion has an established RC network; it is used to control 20,000 HWC but can also control streetlights. Customers can ask to have there RC disconnected this comes with an additional service charge of R70-00 Interestingly they also use RC to synchronize traffic lights.	Ripple Control
South Africa	Pretoria Municipality	Pretoria, Gauteng	Pretoria has little DSM used to own Pretoria North power station to manage peak. Looking at implementing RC for 200,000 HWC, Currently use ToU for most large consumers. Does not wish to make any large capital investments with impending restructuring (REDs).	Time of use tariffs
South Africa	Kimberly Municipality	Worcester, Western Cape	Worcester has a radio RC system that can control about 3,500 HWC. They are also looking at implementing ToU tariffs.	Ripple Control
South Africa	Eskom DSM	Nation Wide Initiative	EFFICIENT LIGHTING INITIATIVE - mainly to promote CFL and to promote BEE. Focuses mainly on awareness and additional financing. Also to include quality control.	CFL (Compact Fluorescent Lamps)
Belgium	Different for Region	Nation Wide Initiative	Belgium has introduced building standards mainly regulating thermal performance of buildings (Insulation and Heating Efficiency). This produces about a 30% decrease in energy consumption for heating. Program experiencing difficulties because building standards are not being enforced.	Building Standards
Belgium	Different for Region	Nation Wide Initiative	Belgium has experienced the most success of any European country regarding the labelling of energy efficient appliances, promoted by grants and subsidies from the federal government.	Standards for EE Appliances and Labelling
Belgium	Different for Region	Nation Wide Initiative	Belgium put a lot of funds into awareness and free consulting. Most regions have Energy Information Desks that undertake awareness campaigns and also act as consultants for energy surveys.	Awareness & Subsidized Energy Audits
Canada	Different for Region	Nation Wide Initiative	Canada is heavily promoting labelling of energy consuming appliances. It is mandatory for all appliances used in the residential and industrial sectors to receive an EnerGuide rating and label. This is to help consumers make a more informed choice.	Standards for EE Appliances and Labelling
Canada	Different for Region	Nation Wide Initiative	Canada has introduced the R-200 building standard which although not mandatory is promoted by the federal government.	Building Standards

Country	Implementing Agent	Location	Description	DSM Implementation
Canada	Different for Region	Nation Wide Initiative	Canada has introduced intensive awareness campaigns including subsidized energy audits for residential, commercial and industrial customers.	Awareness & Subsidized Energy Audits
Denmark	Danish Energy Authority	Nation Wide Initiative	Denmark is the in the process of making energy audits mandatory for all buildings. They believe that the potential savings could easily cover the costs of these audits. They have also introduced awareness campaigns to reduce stand-by consumption, which are estimated to constitute about 10% of domestic load.	Awareness & Subsidized Energy Audits
Denmark	Danish Energy Authority	Nation Wide Initiative	Demark is considering efficiency standards of their HVAC systems	HVAC Efficiency
France	ADEME	Nation Wide Initiative	The French government is promoting energy audits across all sectors. It was found that 52% of all audits lead to implementation and that 75% of all implementation requires capital investment. They have also started an awareness campaign to be implemented by local energy information Centers, they will also provide energy advice and audits.	Awareness & Subsidized Energy Audits
Italy	AEEG	Nation Wide Initiative	Substitution of incandescent lamps with EE CFL	CFL (Compact Fluorescent Lamps)
Italy	AEEG	Nation Wide Initiative	Italy is considering other ways of water heating, including natural gas, boiler and solar water heating	Solar Water Heaters
Italy	AEEG	Nation Wide Initiative	Italy is considering the implementation of better thermal insulation in new buildings and revamping old buildings.	HVAC Efficiency
Italy	AEEG	Nation Wide Initiative	Italy is going to use photo-voltaic generators to stabilise the network.	Distributed Generation
Korea	KEPCO	Nation Wide Initiative	Korea has implemented ToU tariffs since 1994 and uses this measure extensively for load shifting. Power costs about 25% of the peak price off-peak. They implemented ice storage for cooling, so-called Midnight Power Services (heating appliances heat up during off-peak time and only sustain heat during peak times). This is implemented for HWC, UF heating and other.	Time of use tariffs
Korea	KEPCO	Nation Wide Initiative	Korea has a large RC system for A/C units and for HWC.	Ripple Control
Korea	KEMCO	Nation Wide Initiative	Korea has implemented an energy efficient lighting initiative mainly for residential users with limited success.	CFL (Compact Fluorescent Lamps)
Korea	KEMCO	Nation Wide Initiative	Korea is promoting and subsidising the use of EE motors and compressors.	EE Motors and Compressors

Country	Implementing Agent	Location	Description	DSM Implementation
Netherlands	SBR	Nation Wide Initiative	The Netherlands introduced Energy Performance Standards for buildings in 1998, and revised these in 2000. Today these are included in the legislation and are mandatory.	Building Standards
Netherlands	Ministry of Economy	Nation Wide Initiative	The Netherlands is offering rebates and incentives for buying more energy efficient appliances.	Standards for EE Appliances and Labelling
Netherlands	Ministry of Economy	Nation Wide Initiative	This program is aimed at making industry more aware of EE and promoting energy efficiency.	Awareness & Subsidized Energy Audits
Sweden	STEM	Nation Wide Initiative	The Swedish Energy Agency (STEM) puts a lot of funds into awareness campaigns. They established Municipal Information Centres, which undertake awareness campaigns and also act as consultants for energy surveys.	Awareness & Subsidized Energy Audits

Table 2: Summary of Key Lessons

Country	Info Source	Example	Implication for Namibia
RSA	Eskom website	• Eskom as implementing agent clearly favours peak shifting measures as opposed to energy efficiency measures since they want to sell kWh. No mention of SWH here – only some discussions on thermal insulation of EWH.	Having a utility as programme leader has the disadvantage that the utility's own mandate and views may dominate, leading to DSM implementation and/or some promising DSM measures being ignored due to the utility not wishing to loose sales volume.
USA		• Some reports note that DSM has lost momentum when electricity prices fell due to competition.	The projection of sharply rising electricity prices in Namibia should greatly aid any DSM implementation since consumers are now incentivised to reduce energy and demand.
RSA	DSM- Pilot Energy Savings	• Amazing Amanzi (Paraffin Water Heater) to reduce consumption by 300MW over next 4 years. • The Efficient Lighting Initiative aims to save 800MW over next 20 years.	Efficient lighting can make significant contributions to DSM. Alternatives to electric water heating can also make significant contributions to DSM.
RSA	Hot Water Load Control presentation	• Report concludes that insulation for HWC (Hot Water Cylinders) is the best solution when looking at efficiency.	Interesting to note the RSA has not seriously considered SWH.
RSA	Barriers inhibiting investment in DSM	• It was found that a 4kW saving of the lighting load resulted in a 1kW saving in the cooling load.	High likelihood that this will also apply to Namibia.

Australia	Demand Management for Electricity Distributors - NSW Code of Practice	• Looks at 3 areas of DSM • 1) Energy Efficiency • 2) Load Shifting • 3) Distributed Generation	Note that distributed generation is included in DSM.
Australia	Electricity Demand Side Measures Task Force	• South Australia has a peak of 2,833MW • ToU tariff to produce a drop of 250MW (almost 10%) • DSM has helped avoid generation cost of A$250M	Times of Use tariffs are a strong driver in DSM.
Australia	NSW DSM - Hunwick Consultants	• NSW is running out of generation and transmission, i.e. facing a similar situation as Namibia. • Mostly considers new generation options, found coal to be the best option due to vast local reserves. •	New generation appears to be is favoured above DSM – possibly as a result of a strong coal lobby and the abundance of local coal reserves.
Australia	Facilitating Air Conditioning Demand Management	• This report looks at incorporating interruptability into A/C systems so that remote control can easily be implemented.	Air conditioning is also a major load in Namibia, especially in summer where some 70% of demand of office buildings is due to air conditioning.
RSA	Barriers inhibiting investment in DSM in South Africa	• It describes the greatest barriers as a lack of finances for initial capital expenditure associated with most DSM implementations. • There is some scepticism that the initial capital expenditure will have an acceptable rate-of-return. • Many businesses view DSM as too risky.	This is likely to also be an issue in Namibia.

3.3 DSM CURRENTLY IN NAMIBIA

3.3.1 Energy Efficiency

3.3.1.1 Energy Efficient Lighting

Consumer Category	Status
Domestic	CFL prices have dropped significantly in the last few years, and CFLs are available at all major retail stores. There are no existing programmes that actively promote CFLs, which implies that the consumers purchase decision is solely based on economic and marketing considerations. It is assumed that the vast majority of households still use mainly incandescent bulbs because they are significantly cheaper.
Commercial/Industrial	Fluorescent lighting has long been the dominant form of commercial lighting. Older commercial buildings still use a lot of incandescent bulbs and old fluorescent fittings

	with non-energy inefficient ballasts.
Streetlights	The majority of streetlights in Namibia are relatively modern types with higher energy efficiency, such as mercury vapour and high-pressure sodium lamps.[1]

3.3.1.2 Solar Water Heaters

Consumer Category	Status
Domestic	The market has, until recently, developed free of incentives or subsidies. More recently SWH have been added to the Solar Revolving Fund, a micro-credit facility at 5% p.a. interest rate, which has increased their dissemination – a trend which is expected to continue further[2].
Commercial	SWH have been used significantly in rural public buildings such as clinics and hostels, especially where grid power supply was not available. There are few urban commercial buildings that use SWH.
Industrial	No information available.

3.3.1.3 Industrial and Commercial Energy Efficiency

Consumer Category	Status
Commercial / Industrial	▪ Namibia Breweries have implemented a host of energy efficiency measures in their plant and are currently operating at an energy level per hectolitre of output that compares well with the best plants in the world. ▪ Most commercial enterprises surveyed seem to have some awareness of energy efficiency issues and their benefits. However, many lack the capacity and/or understanding to really do something about DSM. ▪ New building designs generally strive for energy efficiency with regard to lighting and HVAC. There are no standards that must be adhered to. There is no reliable data on the extent to which efficient technologies have been implemented in Namibia.
Mining	Mines reported as follows: ▪ Skorpion Namzinc – has extensive DSM measures in place, is a new operation and regards itself at highly energy efficient. Amongst other they look at process energy efficiency and billing demand management. ▪ Rossing Uranium – has over the years had various DSM initiatives. They have long had a maximum demand management system, which warns operators when the billing demand is projected to exceed the previous monthly maximum so that load reduction can be undertaken if possible. ▪ Ongopolo Mining and Processing – have their own co-generation plant at Tsumeb using furnace exhaust gas for driving a steam turbine. This usually meets their local demand. ▪ Rosh Pinah Zinc – are currently busy with an investigation into DSM. ▪ Namdeb Oranjemund – have for many years used a billing demand management system to load shed when the monthly billing peak is forecast to exceed an agreed level. They have trained energy managers responsible for managing plant and process efficiencies.

[1] Based on the findings of an asset survey for NORED (NORED, 2005). It is expected that the same picture is applicable in the remainder of the country.

[2] NAMREP – EMCON Study into Solar Water Heaters, 2005.

3.3.2 Load Shifting

3.3.2.1 Ripple Control of Electric Water Heaters

Consumer Category	Status
Domestic	Windhoek has approximately 20,000 ripple receivers installed on EWH (controlling 20MVA). It is estimated that there is potential for an additional 13,000 installations in Windhoek. COW estimates that they save approximately N$500,000 per month by using ripple control. Ripple control is used primarily for controlling billing peak demand. Walvis Bay has installed 2,500 ripple receivers on EWH (4MVA) to control billing peak demand. Erongo RED intends to expand ripple control to other towns within its area.

3.3.2.2 Industrial and Commercial Load Shifting

Consumer Category	Status
Mining	The major mines reported as follows: ▪ Rossing Uranium – have a demand management system for limiting billing peak demand ▪ Okorusu Fluorspar – is implementing a demand management system for limiting billing peak demand ▪ Rosh Pinah Zinc – are investigating DSM and will implement measures to reduce demand by 2MW ▪ Namdeb Oranjemund – have had peak demand management systems for at least 20 years for limiting billing peak demand

4 ELECTRICITY CONSUMPTION AND DEMAND

This section explores the use of electricity in Namibia focusing on consumer groups and energy use groups that relate to identified DSM measures.

The data sources used are:

- Household Census 2001 for household numbers
- RED consumer numbers and sales projections
- NamPower sales statistics for 2002/3 and 2004/5
- NamPower hourly system demand for the 2005 calendar year
- NamPower hourly metering statistics for selected transmission supply points, typical summer and winter days, 2005

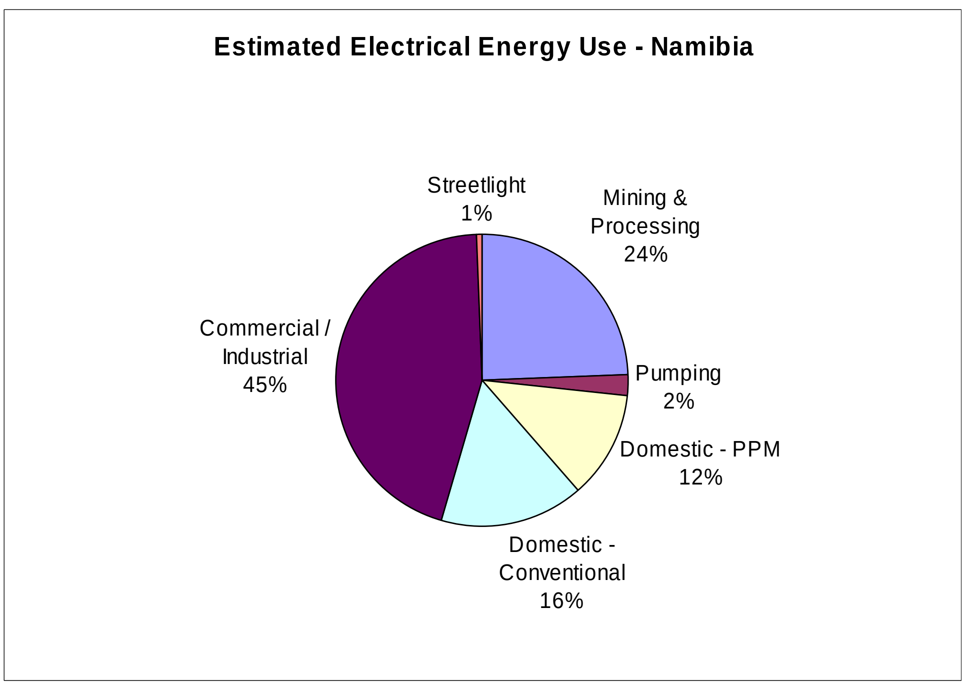
The following notes apply to the data used:

- NamPower sales statistics used is for the interconnected system only, i.e. excludes Oranjemund and Caprivi
- RED numbers excludes Oranjemund

4.1 CONTRIBUTIONS BY MAIN CONSUMER CLASSES

Figure 1 shows the national consumption of electrical energy (kWh) as derived from data provided by NamPower for the period between July 2004 and June 2005, (augmented by estimates for the five REDs, and excluding Namdeb-Oranjemund and Skorpion-Namzinc):

Figure 1: Estimated National Electrical Energy Consumption by User Group



The consumer groups depicted in Figure 1 have the following characteristics::

Table 3: Observations Regarding Electrical Energy Consumption

Category	Observations

Mining & Processing	• The majority of consumers in this category have implemented energy efficiency programmes. Electricity is a major cost factor in their operations and they already have significant incentives to optimise. It is unlikely that substantial energy savings can be made and/or justified easily.
Pumping	• Impact on the energy profile is relatively small, and consumption is driven by the need to move water around which is determined by the demand and supply situation. Namwater's designs are generally well considered and reasonably efficient. It is unlikely that major energy savings can be realised.
Domestic	• Domestic consumption contributes about 28% to the national total. In Namibia little has been done in the past to promote domestic energy efficiency, hence it is expected that significant gains can be made here.
Commercial/Industrial	• This is the single biggest energy consumer category with around 45% of consumption and can therefore not be ignored. It is expected that significant gains can be made in this category, although such savings are difficult to quantify. Unfortunately there is no more detailed breakdown available within this category. Once the REDs have properly categorised their customer databases it will hopefully be possible to obtain more detailed information.
Streetlights	• Luminaires are generally efficient types; hence limited gains can be expected here. • Streetlight maintenance in Namibia is generally good; one does not regularly observe energy wastage through streetlights being on during the day. Hence little gain can be expected from improving maintenance of streetlight switching devices. • Streetlight operating hours could theoretically be reduced. There are examples of some streetlights being switched off during the early morning hours based on reduced traffic volumes (e.g. every second light switched off). However with the crime situation experienced in Namibia street lighting is considered a security and crime prevention measure and reducing street lighting is therefore not likely to be effective.

The following figures Figure 2 and Figure 3 show a high level estimate of how the peak system demand is built up. The quantities underpinning the figures are rough estimates for illustrative purposes.

Figure 2: Estimated Contribution to Peak Demand -– Overview

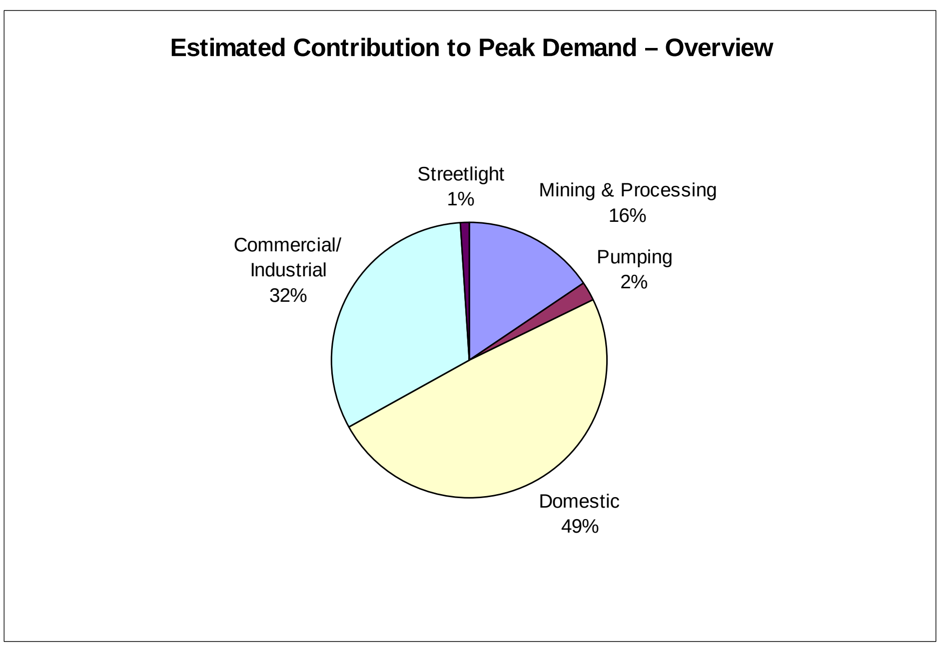


Figure 3: Estimated Contribution to Peak Demand – Detail

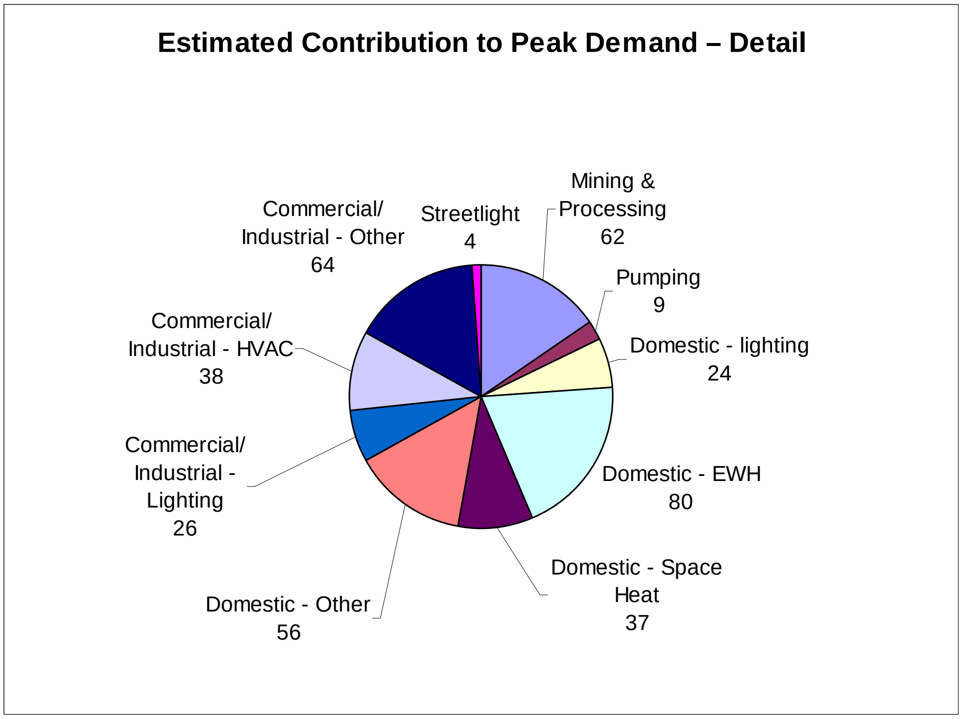


Table 4: Observations Regarding Peak Demand Contribution

Category	Observations
Mining & Processing	• The majority of consumers in this category have implemented demand management programmes that are expected to minimise their **billing** demand very effectively. However gains should be possible in periods that do not affect an individual operation's billing demand. Implementation of such measures may be complicated and would have to bring additional financial or other benefits to the consumer to be of interest. Voluntary agreements could be explored.
Pumping	• Namwater's pumping schemes are dominated by an operating regime that is dictated by the prevailing water supply and demand and therefore offers only limited potential to be changed on demand. However pumping schemes usually have some redundancy built in (e.g. designed for less than 24 hour operation and could therefore be scheduled). • Impact on the **average** demand profile is relatively small – but impact on the demand on individual days is likely to be much larger if major pumping systems run during peak hours. This presents an opportunity for co-operation between Namwater and their electricity suppliers to identify a beneficial approach to scheduling pumping.
Domestic	• It is estimated that domestic loads contribute as much as 50% to the peak (evening) demand of the country. Cross referencing with Figure 7 also indicates that on a Sunday the evening peak vs. early morning trough differs by 120MW, most of which can probably be attributed to domestic loads and makes up close to one third of the Sunday evening peak demand. • Since little has been done to control this load (except EWH ripple control) one can expect major gains to be possible in this area. It must also be considered that Windhoek and Walvis Bay control EWH mainly to manage their **billing** demand, i.e. if the Sunday evening peak is below the weekday evening peak then they will not switch off any EWH since from their perspective they will not benefit. Time of use tariffs to the distributors could address this issue. • The split between lighting, EWH, space heating and others isonly estimated, as

	no scientific measurements are currently available in Namibia. The split will also differ significantly between summer and winter. However the contribution by lighting and EWH is considered a relatively good estimate since some actual numbers are available to arrive at these estimates.[3]
Commercial/Industrial	• Commercial and Industrial load is estimated to contribute around 32% to the peak demand. Demand management measures taken by consumers are likely to vary significantly, as do consumption patterns, since this category includes a range of diverse consumers (retail shops, manufacturers, office buildings, schools, hostels, hotels and others). • Little reliable information is available regarding more detail within this category. The split in Figure 3 between lighting, HVAC and other is a broad estimate only.
Streetlights	• Demand contribution from streetlights is very small, and since the national peak currently occurs after sunset it is very unlikely that significant gains can be made in this area.
Export	• This is disregarded for this study since consumers outside the country cannot be influenced readily.

Figure 4 below shows the distribution of customer numbers between the main categories for which data is available. The main information sources are the NamPower sales for 2005 and the customer number figures of the existing and future REDs.

Figure 4: Estimated Consumer Numbers

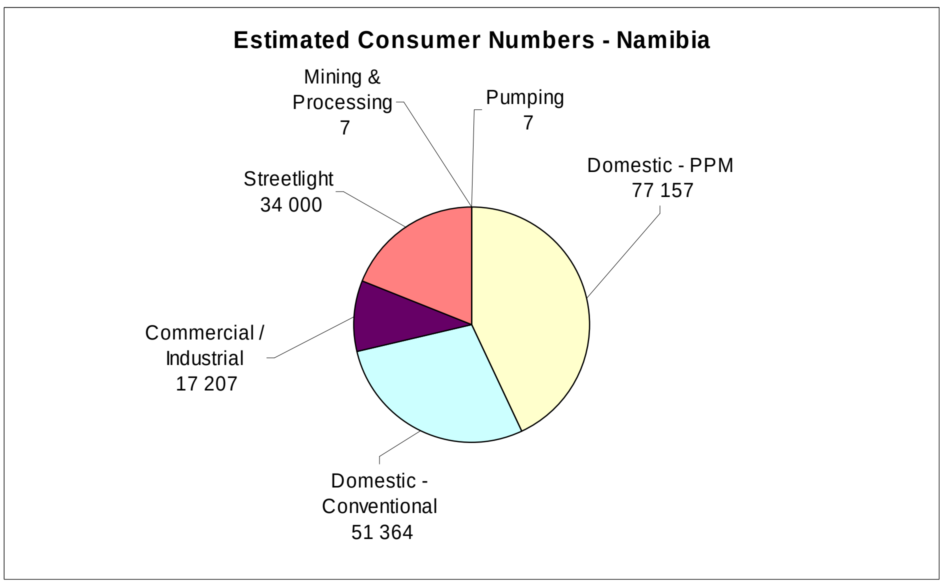


Table 5: Observations Regarding Consumer Numbers

Category	Observations
Mining & Processing	• This category has a very small number of consumers, which can be easily addressed individually. Programmes aimed at this group should therefore be individualised.
Pumping	• At transmission level this is a very small consumer group. They are in reality even less since all supplies are Namwater take-offs, as are the vast majority of distribution (RED) level pumping supplies. There is therefore only one major

[3] From Census data and RED customer number estimates it is possible to derive a relatively good estimate of households connected to the grid as well as numbers of such households using electricity for cooking, lighting and heating. From the EMCON-NAMREP study on SWH it is possible to obtain relatively realiable figures regarding EWH. Combining this with information from the COW's ripple control is becomes possible to make a good estimate of peak demand contribution by EWH.

	consumer to deal with – Namwater. • There are also a small number of significant pumping consumers "hidden" in the RED consumer base (e.g. at Aussenkehr, Etunda and a small number of similar large irrigation projects). These should also be addressed individually.
Domestic	• There are an estimated 130 000 domestic grid consumers in Namibia. This is by far the largest consumer group in numbers. Programmes that are to significantly impact on this group therefore need to have mass appeal.
Commercial/Industrial	• There are an estimated 17 000 commercial and industrial consumers in Namibia. Based upon the results of further study (aimed at gaining better understanding of the major energy consuming and demand contributing processes within this group) it would be possible and appropriate to design mass programmes to reach this group. In addition, individualised programmes (such as energy audits) would be appropriate to at least the top 10% in terms of consumption and/or demand.
Streetlights	• Although there are between 30,000 and 40,000 streetlights in Namibia, these are under the control of the five REDS and some 70 Local Authorities. Therefore any programme aiming to reduce energy consumption by streetlights would best be approached by addressing the relevant REDs and Local Authorities, either in groups or individually.

Figure 5: Household Electricity Use Prevalence

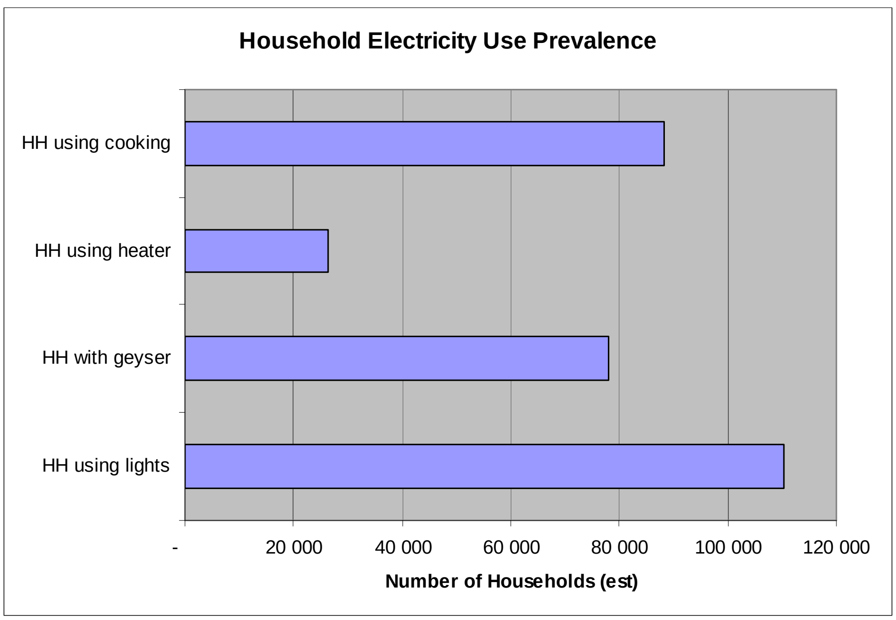


Figure 5 shows the estimated number of households using electricity for specific activities. Household numbers have been derived from Census data using certain assumptions and have been used to estimate the impact of DSM measures affecting these consumption categories.

4.2 THE NATIONAL DEMAND PROFILE

The figures shown in this section, as well as the observations made have been derived from data supplied by NamPower.

The underlying underlying data has the following characteristics:

- it is in hourly intervals

- it is for the interconnected system, and therefore excludes cross border individual feeds such as Oranjemund and Caprivi
- it excludes the Skorpion mine and processing plant (the power for which is only wheeled by NamPower and is therefore not regarded as contributing to the national demand picture)
- demand data is in megawatt
- it is for the 2005 calendar year
- it includes the effects of ripple control by both the City of Windhoek and Walvis Bay (maximum effect approximately 24MW dropped when switching off).

Figure 6: Average Hourly Demand Profile on Weekdays

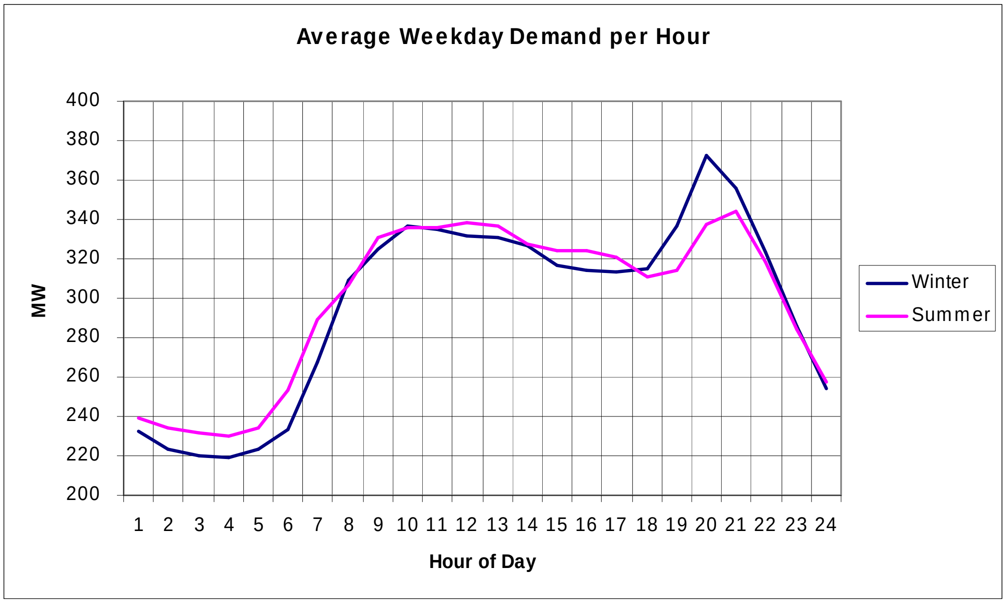
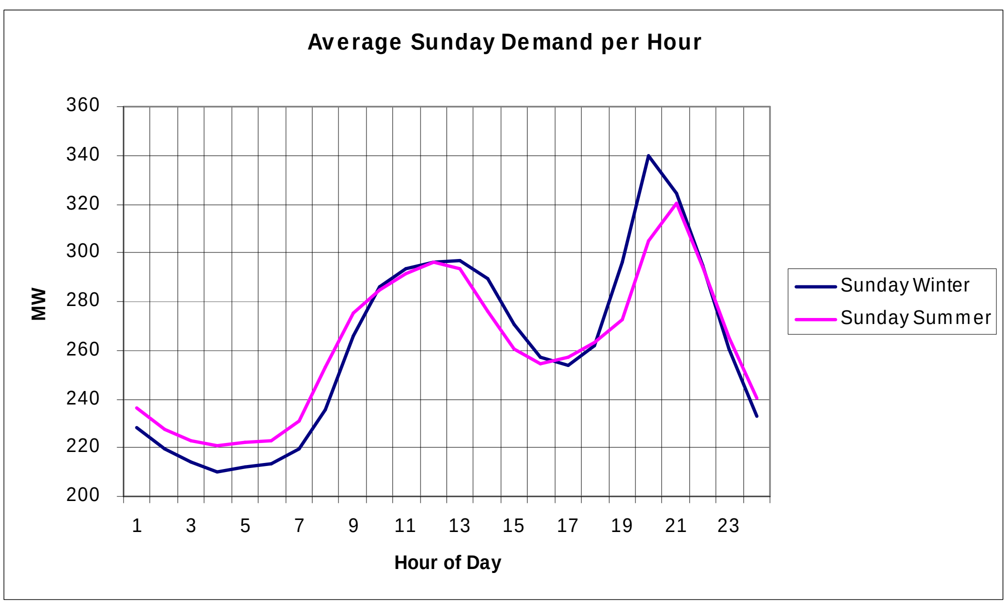


Figure 7: Average Hourly Demand Profile on Sunday[4]



[4] Summer has been defined as October through March, Winter as April through September.

Table 6: Observations Regarding National Demand Profiles

Observations
• Namibia has a daytime demand plateau which builds from around 06h00 in the morning, plateau's around 10h00, which shows a slight drop-off until around 17h30.
• There is a clear evening peak, rising from around 18h00 (19h00 in summer) and dropping sharply after 20h00 (21h00 in summer). Refer also to Figure 8, which shows the time of day of the daily peak throughout the year (data for 2005). Figure 8 also shows that there is a significant number of days in summer where the daily peak does not occur in the evening but instead around mid-day. This supports the idea that in summer air conditioning loads present a significant opportunity for DSM. Unfortunately there is little reliable data on which estimates of possible reductions can be based.
• In summer the evening peak is on average not much higher than the daytime plateau. In winter the evening peak is around 40MW higher than the daytime plateau, presenting a clear opportunity for peak reduction. Any demand reduction beyond this needs to apply to all daytime hours if it is to reduce the national maximum demand further – or be combined with other measures that reduce daytime demand by other means.
• The winter evening peak is very likely to be mainly due to heating – space heating and higher probability of EWH being on because of lower ambient temperatures.
• Early morning demand in summer is about 10MW higher than in winter. This can probably be attributed to a higher need for refrigeration (commercial & industrial) and air conditioning (although it is expected that not much air conditioning runs at night). This may also imply that domestic electric space heating in winter is not used significantly after midnight.
• The difference between lowest and highest demand during weekdays is about 150MW in winter and 110MW in summer.

Figure 8: Time of Day of Daily Peak[5]

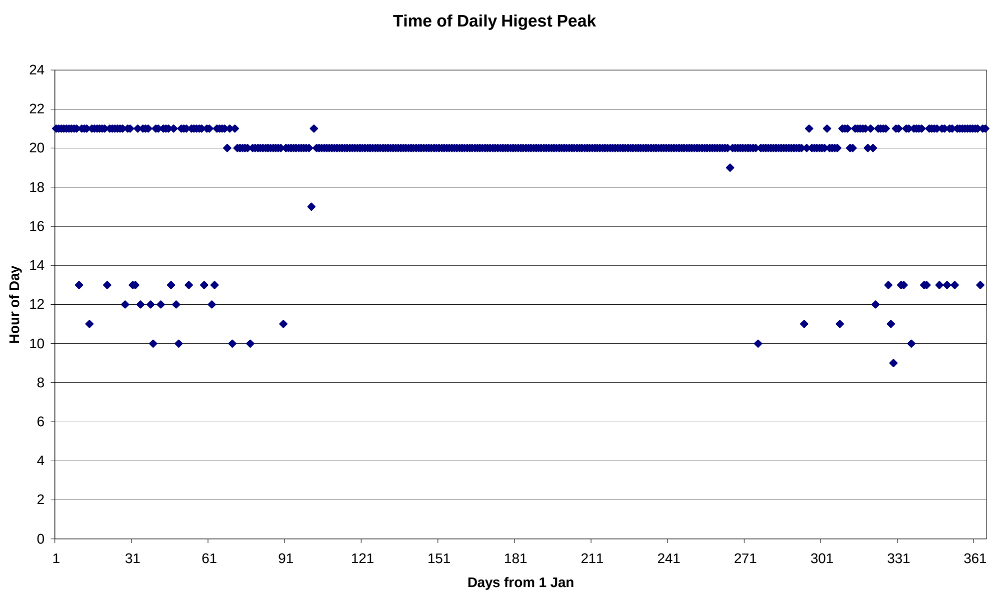


Table 7: Observations Regarding Time of Daily Peak

Observations
• There is a clear tendency for an evening peak during the entire year. However during summer months there are also a significant number of days with a peak around the middle of the day. This

[5] Time in CAT for entire year, no adjustments made for Namibian Winter Time

can probably be attributed to the air conditioning load in combination with commercial and industrial load.

- The evening peak is very consistent between 20h00 and 21h00. This is clearly a domestic peak.

Figure 9: Difference Between Night- and Daytime Peak (Weekdays)[6]

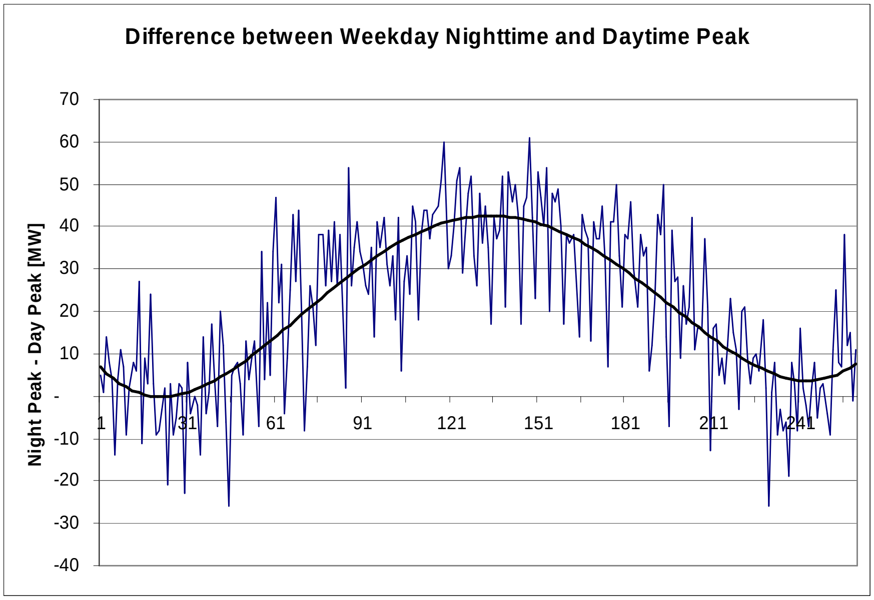


Table 8: Observations Regarding Difference between Night and Day Peaks

Observations
• In winter there is a clear evening peak that regularly exceeds 40MW above the daytime peak. This presents a clear DSM opportunity. • In summer the peak can occur either in the evening or during the day, with significant individual swings either way. DSM during this time would have to look at reducing demand both during the day and evening to have an effect on the average peak.

[6] Daytime taken as 06h00 to 18h00, nighttime as 00h00 to 06h00 and 18h00 to 24h00.

Figure 10: Difference Between Daily Maximum and Minimum Demand

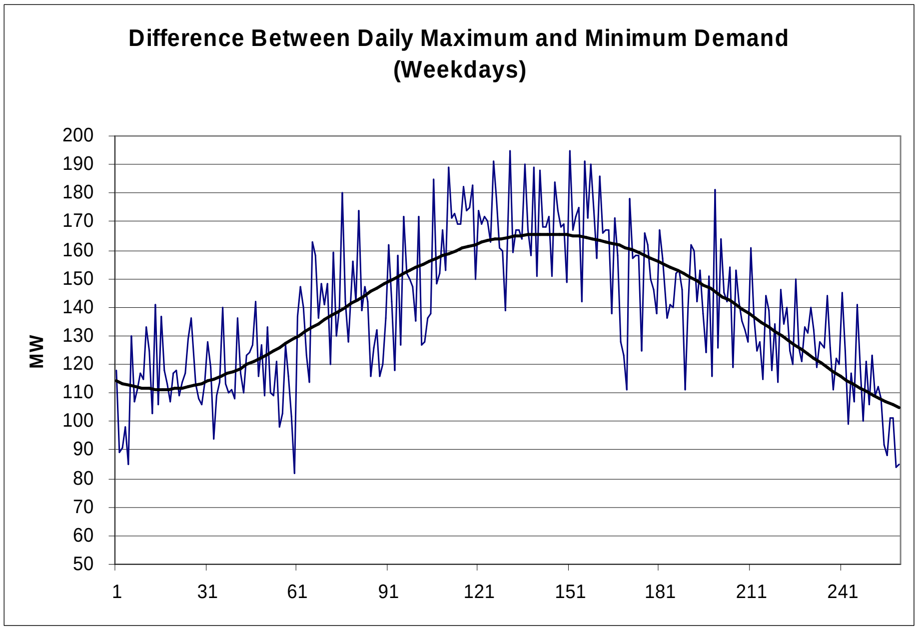


Table 9: Observations Regarding Difference between Daily Maxima and Minima

Observations
The difference between minimum demand and maximum demand is typically 120MW in summer and rises to typically 170MW in winter. This presents multitude opportunities for DSM. However there are a multitude of factors that contribute to this difference, and these must be carefully considered before measures are taken. (??such as??)

Figure 11: National Load Duration Curve

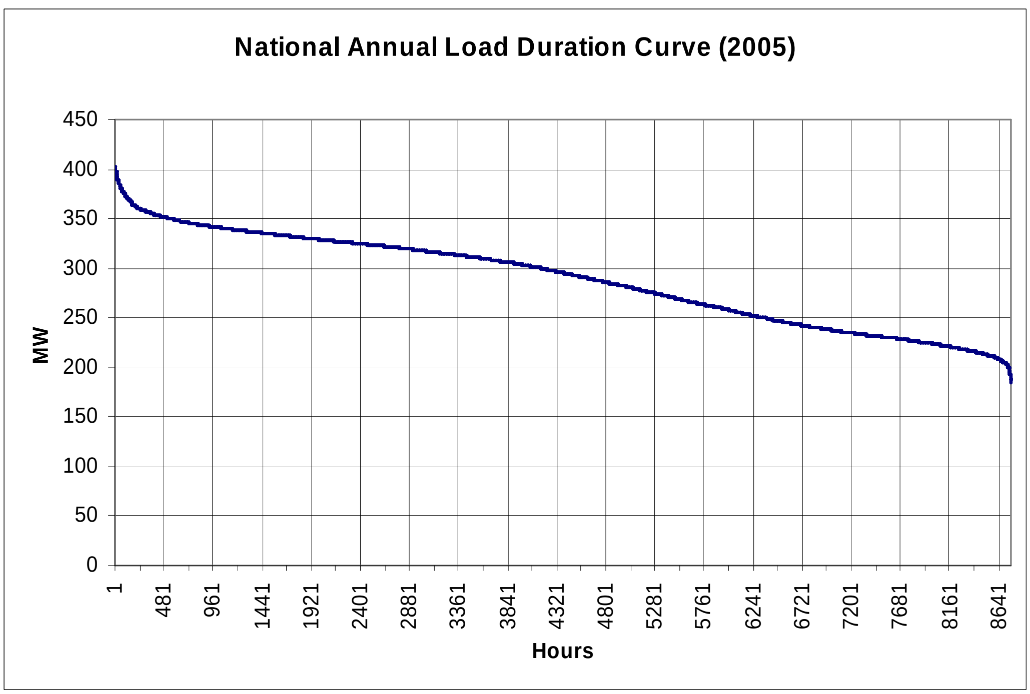


Table 10: Observations Regarding National Load Duration Curve

Observations
• The country has a base load in of some 200MW, which includes all continuous processes such as mining and processing as well as other industrial processes which run 24 hours a day.
• The base load also includes a contribution from other loads that are statistically spread over the day, such as refrigeration plant (both domestic and commercial), electric water heaters (both domestic and commercial) and a certain amount of lighting (streetlights and some commercial at night, commercial during the day).
• The peak above 350MW occurs for about 550 hours a year (??figure shows 480??). This is where big financial gains are possible because peak energy and demand are most expensive in most systems. This is typically where load shifting measures are aimed at.
• In the regime beyond the peak load the load duration curve drops off almost linearly. This indicates that energy efficiency and load reduction measures will be most effective in lowering the overall demand. Here, load shifting and load shedding will not contribute much because the time that loads would have to be switched off would be too long to be acceptable to consumers.
• Some 40 to 50MW can be gained through load shifting alone, and energy efficiency measures would increase the gains after that.
• It must be noted that all measures will alter the above load curve, which implies that it will have to be re-evaluated after some initial measures have been implemented. This will ensure that all further measures are guided by the new load curve data.

5 DSM OPTIONS FOR NAMIBIA

5.1 THE OPTIONS LONG LIST

A long list of DSM options has been developed through study of international DSM experience. Table 11 presents the list of common options that are employed in other countries.

Table 11: DSM Options Long List

DSM Option	Description	Residential	Commercial	Industrial	Energy efficiency	Load shifting	Load shedding	Energy Source Switching	Other	Regulation	Information	Economic	Voluntary
Subsidised dissemination of CFL	CFL dissemination	X			X						X	X	
Commercial energy efficient lighting	motion sensors, electronic ballasts		X	X	X						X	X	
Streetlight switch-off	Partial reduction in street lighting		X		X							X	X
Residential SWH dissemination	Replace EWH with SWH	X			X			X		X	X	X	
Commercial/Institutional buildings SWH dissemination	Replace EWH with SWH		X		X			X		X	X	X	
Expand ripple control for WHK & Walvis		X				X						X	
Implement ripple control for smaller local authorities		X				X						X	
Distributed generation (installed, currently off-line)	Back-up generators for grid connection or consumers to move over to genset; pumped storage			X		X						X	X
Water pumping "ripple" control	Namwater; agri schemes			X		X	X						X
Voluntary load shedding				X			X						X
Power factor correction			X	X					X		X		
Commercial and industrial air conditioning efficiency and load control			X	X	X	X					X		
Compressed Air Systems	Design, maintenance, consumer awareness			X	X						X		X
Equipment specifications	elec motor efficiency, design (over-design) rules		X	X	X					X	X		
Energy audits (subsidised)			X	X	X	X						X	
Building energy regulations, energy density (W/sqm), thermal efficiencies		X	X	X	X	X		X		X	X	X	
Cooking energy use		X			X			X			X		
Appliances: Refrigeration		X	X		X					X	X		
Electric space heating		X	X					X			X		
Capital funding of DSM initiatives (e.g. Eskom)			X	X	X	X						X	
Tariff structure design	Tariff increases; Tariff decreases for low energy consumers and increases above threshold; Demand charges for domestic customers > 20A; ToU tariffs, critical peak pricing	X	X	X	X	X	X	X		X		X	

DSM Option	Description	Residential	Commercial	Industrial	Energy efficiency	Load shifting	Load shedding	Energy Source Switching	Other	Regulation	Information	Economic	Voluntary
Consumer awareness, education and behaviour change	Targeted information for domestic, commercial and industrial consumers; CFL, SWH, parasitic loads,	X	X	X	X	X		X			X		

The list has been categorised according to three main criteria, being

- Consumer category
- DSM measure category
- Policy type

The high level economic evaluation and implementation evaluation of the options are presented in Annexure 1: Details of DSM Options Long List.

5.1.1 Consumer Category

This report distinguishes between three consumer categories as used internationally, they are:

- Residential (i.e. domestic, household consumption)
- Commercial (i.e. offices, shops, hotels, schools and hostels, institutions, businesses)
- Industrial (i.e. mining and processing, manufacturing, water pumping)

The quality of residential consumption data in Namibia is relatively good, as household numbers are known and electricity uses in households has been quantified in the latest Census.

Data regarding the major mines and water pumping is also available since it is categorised in NamPower's sales data.

However commercial and smaller industrial load data (embedded within Local Authorities / REDs) is not readily available and is limited to estimated sales data for single and three phase business connections in the REDs – and this includes both commercial and industrial. Rough estimates have therefore been made in these categories.

5.1.2 DSM Measure Type

The three common DSM measure types are

- Energy efficiency
- Load shifting and
- Load shedding

For clarity we have added two additional types to Table 11 above:

- Energy source switching (usually energy efficiency from the electricity perspective)
- Other, which includes measures such as power factor corrections.

5.1.3 Policy Type

The policy classification used in Table 11, as per IEA publication "*Evaluating Energy Efficiency Policy Measures & DSM Programmes*", adds another dimension of how DSM measures can be categorised. .

The policy types considered are

- Regulation – top-down enforcement of rules, regulations, standards, codes
- Information – encourage adherence by way of awareness, education and the provision of information to consumers
- Economic – encourage adherence through economic incentives or penalties
- Voluntary – adherence through beneficial voluntary arrangements, usually between utility and consumer, and including voluntary behaviour change measures as a result of targeted information and behaviour change campaigns

5.2 Namibian DSM Evaluation Criteria

A simple quantitative ranking of DSM options applicable in Namibia does not adequately address the multitude of factors impacting on such decisions. Instead it is necessary to consider a wide number of factors in a holistic manner to arrive at those options that provide an appropriate overall approach to DSM.

The factors considered are:

- Costs and benefits from the perspective of
  - NamPower
  - REDs and Local Authorities
  - Consumers affected
  - Broader economy
- Implementation considerations
  - Cost
  - Timeframe
  - Funding requirements and funding arrangements
  - Capacity to implement
  - Constraints to implementation
  - Risks
- Expected socio-economic impacts
- Projected impact (kWh reduction and/or peak demand reduction)

Each of the long list of DSM options has been evaluated against the above criteria (see Annexure 1: Details of DSM Options Long List), although in the first high-level evaluation some criteria have not been examined in detail.

5.3 Ranking of Available DSM Options

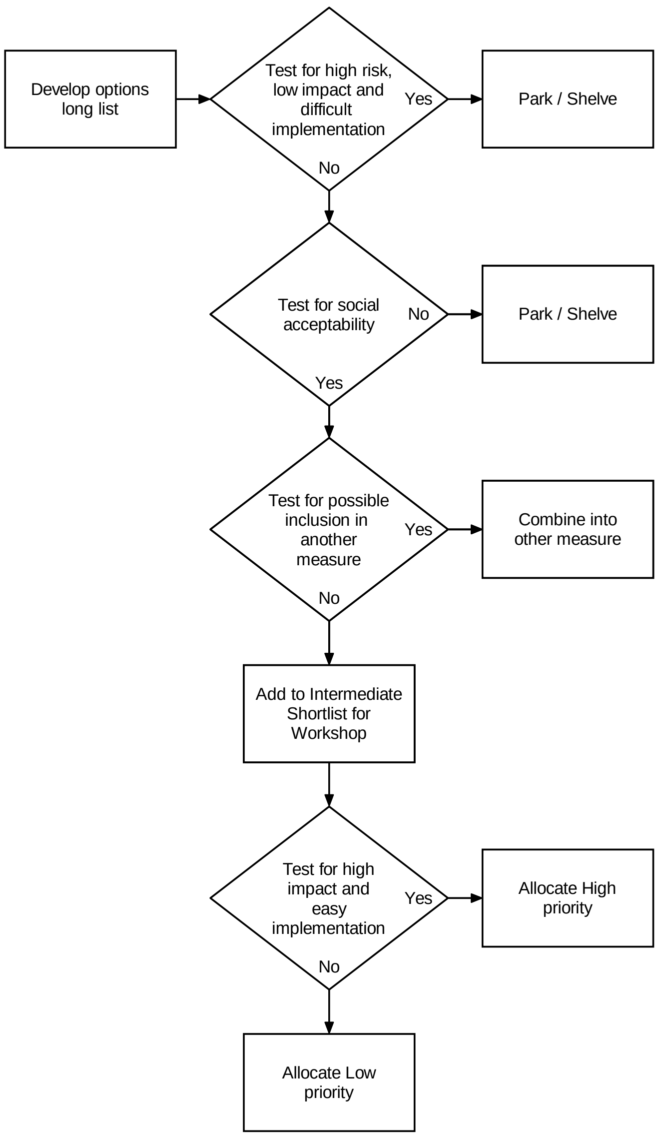
It is recommended that a mix of short and longer-term DSM measures is selected to obtain a diverse project base that will relieve the short/medium term supply shortages and take longer-term requirements into account. The priority options should therefore present a mix of options that can be implemented fast (e.g. within one year) and those that are more long-term measures.

One DSM measure, information dissemination, consumer education and voluntary behaviour change, is a necessary pre-requisite to practically any other DSM measure to succeed. It is therefore proposed that a multi-faceted consumer awareness and education campaign be undertaken as one of the priority DSM programmes, and that the necessary information and education elements of the other priority options be incorporated into such a programme.

Furthermore, it is proposed to make use of such options that have a significant impact in terms of their kWh and/or kW demand savings and/or temporary reductions, ranked in order of their benefit and cost, and deselecting options with an unmanageable risk profile particularly in terms of implementability, socio-economic side effects or where implementation capacity constraints are likely.

The ranking process used in this report is illustrated in Figure 12 below.

Figure 12: Ranking Framework



5.4 RANKING RESULTS

Table 12 shows the results of the initial ranking, and ranks options by a score.

The other columns of the table provide very preliminary estimates of possible impacts and costs, which may change substantially depending on how such options are implemented.

Table 12: Initial Ranking Results

DSM Option	MW peak reduction	MWh/annum saving	# of consumers involved	Cost [million]	Preliminary verdict	Preliminary Rating
Subsidised dissemination of CFL	14.4	33 603	54 857	5.8	Good potential, high probable success rate - shortlist	5
Residential SWH dissemination	21.6	227 486	31 162	311.6	Good potential, high probable success rate - shortlist	5
Commercial/Institutional buildings SWH dissemination	1.0	2 920	100	5.0	Good potential, high probable success rate - shortlist	5
Energy audits (subsidised)					Good potential - shortlist	5
Tariff structure design					Necessary - shortlist with top priority	5
Consumer awareness					Necessary - shortlist with top priority	5
Commercial energy efficient lighting	2.9	8 479	8 604		Good potential, high probable success rate - shortlist	4
Implement ripple control for smaller local authorities					Good potential impact in some places - shortlist with high priority	4
Commercial and industrial air conditioning efficiency and load control	8.7	-			Good potential, but much input needed to realise on large-scale - shortlist	4
Capital funding of DSM initiatives (e.g. Eskom)					To be considered - shortlist	4
Expand ripple control for WHK & Walvis Bay	21.6	-	-		Needs more detail study of load profiles - shortlist with medium priority	3
Compressed Air Systems	-	79	300		Unknown potential - include in energy audits if prioritised	3
Building energy regulations, energy density (W/sqm), thermal efficiencies					Difficult to determine impact and to implement - park or combine with other programmes	2
Distributed generation (installed, currently off-line)	8.0	-	20	8.0	Limited potential with significant logistical challenges - park with low priority	1
Water pumping "ripple" control	0.9	-	1		Unknown potential - park as suggestion for NamPower to explore	1

DSM Option	MW peak reduction	MWh/annum saving	# of consumers involved	Cost [million]	Preliminary verdict	Preliminary Rating
Voluntary load shedding					Unknown potential - park as suggestion for NamPower to explore	1
Equipment specifications					Unknown potential and difficult to implement - park	1
Cooking energy use	3.5	32 176	17 630	14.1	Possibly controversial, difficult to get results - park	1
Power factor correction	1.5	-			Should be included in other information programmes aimed at commercial /industrial consumers	0
Appliances: Refrigeration	0.2	3 751	7 941	47.6	Possibly controversial, difficult to get results - incorporate in general information campaign	0
Electric space heating	4.9	10 731	5 226	2.1	Possibly controversial - incorporate in general information campaign	0
Streetlight switch-off	-	1 862	11 220	9.0	High social risks and small benefit - discard	0

Please note the following in connection with Table 12 above:

- The assumptions underpinning the above numbers are given in Annexure 2: Calculations.
- The ranking scale is from a maximum 5 to minimum 0, where 5 means highly recommended for short listing and 0 means not recommended for short listing.
- "Park" means the option is recommended to be deferred into the future for consideration once the first phase of DSM implementation has taken place, i.e. it is not recommended to be entirely discarded forever but is proposed not to be investigated further as part of the present study.

6 INTERIM RECOMMENDATIONS AND RESULTS

6.1 THE SHORT LISTED DSM OPTIONS

This section provides some initial thoughts on what could be done within each of the proposed short listed DSM options.

6.1.1 Subsidised Dissemination Of CFLs

One of the main barriers to widespread use of CFLs in domestic applications is the high upfront cost, particularly in comparison to incandescent bulbs. There are also other factors, for example the type of light (ambience) does not suit some applications, as well as limited awareness of products and saving potentials. A programme designed to disseminate subsidised CFLs would therefore have to address these issues plus others that may be identified during a more detailed analysis.

Thoughts about this option:

- There are an estimated 570 000 key light points in residential applications (of which about 380 000 are estimated to be switched on at peak demand time).
- A programme could disseminate CFLs free of charge in exchange for incandescent bulbs (one for one).
- At a cost of around N$10 per CFL the capital cost of the CFLs would be around N$4 million.
- A dissemination programme on the basis of a road show visiting all larger towns and villages could be done over a period of a few months, in parallel with an information campaign and some branding (use of CDL icon instead of a bulb),
- This once off “big bang” implementation would need to be preceded and followed by information and awareness programmes, and possibly some longer term way of reducing the retail cost of CFL needs to be looked at.
- A temporary subsidy, whereby consumers would become eligible to receive a bonus on other sales or a cash-back scheme may also be considered, and could possibly be undertaken in collaboration with the major retail chains throughout Namibia. Such an option would substantially reduce the associated distribution costs of CFLs and the associated dissemination into the community.

6.1.2 Residential SWH Dissemination

There are an estimated 78 000 EWH in use in Namibia. The target market is therefore significant. Even at an average 2kW this would represent 156MW in load (although all would never be on at the same time and few are switched on in times of peak electricity demand).

This option would be a long-term programme, with a number of different facets:

- Looking for ways of driving down the capital cost of SWH
- Expanding the revolving solar fund to handle larger quantities of funding
- Information and awareness campaigns (some already being done)
- Building regulations that promote SWH installation, or enforce the inclusion of SWH for residences above a certain threshold value
- Consider the possibility of punitive tariffs for houses with EWH
- Subsidise SWH which cannot be fitted with a backup element

6.1.3 Commercial/Institutional Buildings SWH Dissemination

Recent experience shows that replacement of institutional EWH with SWH can have a relatively short pay back period. This opens the way for

- Information campaigns
- Considering the possibility of expanding the solar revolving fund to allow institutions and commercial buildings (such as hotels) access to preferential funding
- Providing reduced cost or no cost energy audits to target organisations with the aim of quantifying costs and pay back periods.

6.1.4 Energy Audits (Subsidised)

Energy audits are widely used throughout the world to assess and guide viable DSM options, both in the residential and the commercial/industrial sectors. Especially in Namibia where little reliable and detailed information on the commercial and industrial sectors' energy use is available, an energy audit programme could open up this consumer segment to DSM. This would lead to better information on what can be achieved, and after some time a clearer picture can emerge as to the potential for DSM in this sector. It is assumed that the potential is sufficiently significant to warrant a programme including some of the following elements:

- Financial support for energy audits for commercial and industrial consumers
- Information (and possibly training of entrepreneurs) on how to conduct energy audits, both at the residential and commercial/industrial scale
- Establishment of energy service companies (ESCOs) as per the RSA example should be investigated
- Facilitation of commercial loans for consumers to enable investments in energy saving measures identified during energy audits
- Provision of subsidies to co-fund investments or buy down the cost of loans

6.1.5 Tariff Structure Design

This is a mandatory consideration that ties in with all other options. It may be feasible to undertake tariff reforms as part of the ongoing ECB mandate. Tariff designs need to be guided by a macro-economic perspective that takes account of actual generation cost, imports, cost of capacity shortages (blackouts), cost of DSM measures and the socio-economic impacts of such measures. Issues, which need to be addressed, include:

- Implementation of time of use tariffs by NamPower and REDs
- Consideration of special tariffs, such as a critical peak tariff for large electricity consumers, so as to incentivise the introduction of DSM within the commercial and industrial sectors
- Consideration for low income connection options on life line tariff that are DSM friendly (e.g. low capacity breakers incentivising consumers to have a flatter load profile)

6.1.6 Consumer Awareness

Consumer education and awareness is an essential element in any national DSM program, and is also an integral part of all other options. It is suggested that any consumer awareness and education programme be undertaken separately to the implementation of other DSM options so as to have a better focus on the various consumer segments and their individual DSM requirements. Such a programme may set up a skills and resource base that can be utilised for the information component of the other programmes, and may also include a behaviour change program which teaches people by way of practical examples of what can and should be done to reduce their energy consumption). In addition, such a programme may include

- General energy efficiency awareness raising and consumer information about energy
- Promotion of energy efficient appliances

- Promotion of renewable energy sources
- Information on rising regional tariffs, tariff options, how to save on the electricity bill
- Information on the energy supply situation and how consumers can change their energy usage to help at national level

6.1.7 Commercial Energy Efficient Lighting

Internationally, commercial energy efficient lighting is a commonly used DSM option. Lack of detail information makes it difficult to predict results for Namibia. This option would go hand in hand with energy audits, but could stand on its own since it is easier to determine possible savings and pay back. Possible activities could include:

- Awareness campaigns aimed at this consumer sector
- Development of lighting models (spreadsheets) to assist consumers in assessing the potential gains of using energy efficient lighting
- Special purpose loan facilities to encourage the switch-over to more efficient lighting

It is suggested that this option be incorporated as a special focus area as part of the energy audit option (if selected).

6.1.8 Ripple Control for Smaller Local Authorities, Expand for WHK & Walvis

Ripple control of EWH has been implemented by Windhoek (to the extent that the summer evening peak is reduced close to the daytime peak) and by Walvis Bay. There is scope to expand EWH ripple control to the other larger towns on a RED basis, although careful consideration must be taken of the existing load profiles of the towns involved. In total there could be as many as 50 000 EWH with ripple control with an estimated theoretical load of 100 to 150 MW. As other DSM measures reduce the daytime demand, scope for ripple control during the evening peak may increase. Activities promoting this DSM measure may include:

- Detailed study to determine possible impact of ripple control in towns, i.e. compile business case
- Possibly funding (grants and/or soft loans and/or facilitation of commercial funding) and technical assistance to the REDs for implementing the ripple control
- Investigate ripple control from a national perspective, not just LA or RED perspective

6.1.9 Commercial And Industrial Air Conditioning Efficiency And Load Control

It is estimated that air conditioning accounts for up to 70% of the electrical load of office buildings, with commercial buildings and hotels having a similar profile. This implies that significant gains can be made by improving the efficiency of air conditioners and possibly load control them. Commercial load contributes a large part of the daytime national peak, so efficiency gains made here will increase opportunities for EWH ripple control for the evening peak.

It is suggested that this option be incorporated as a special focus area as part of the energy audit option (if selected).

6.1.10 Capital Funding Of DSM Initiatives

Eskom in the RSA has taken the approach of financing the implementation of DSM measures and recovering these funds through general tariff increases, i.e. all consumers effectively pay for the DSM programme. Such a measure could also be considered in Namibia, although one can argue that where clear business cases are developed through energy audits (possibly funded from a DSM fund) and commercially acceptable payback periods can be shown, and then such subsidies may not be required. But on the other hand such a programme provides an opportunity for the utility to drive projects which it benefits from, and the financing mechanism through the tariff may well be one of the most realistic ways of raising funds for DSM.

This option could be pursued on its own or in conjunction with the energy audits option.

6.2 IMPLEMENTATION CONSIDERATIONS

6.2.1 Implementing Responsibility and Agents

Any DSM programme needs a driver and implementing agent. In Namibia the Ministry of Mines and Energy (MME) is the custodian of energy matters and as such the natural driver of such activities. The MME may elect to appoint the ECB or another agent to drive the programme on its behalf, but ultimately the authority and drive needs to come from the MME.

The ECB is well placed to deal with at least some specific issues, the most obvious being electricity tariffs as means of promoting and driving DSM. Through the licensing regime the ECB also has an existing relationships with all utilities (NamPower, the REDs) and therefore considerable powers to make and enforce rules. These factors may well position the ECB as a good overseer and strategic driver for the national DSM programme.

Implementing agents for the selected DSM options could be NamPower, the REDs, and an agency created for that purpose (possibly within NamPower or the ECB), private sector players or any combination of these, but preferably an agent with a minimum of conflict of interest. The best constellation can only be looked at when a final short list of selected options has been compiled.

6.2.2 Implementation Funding

All DSM options will require funding in order to be implemented. The main sources of funding are generally seen as being:

- State funds (GRN funding, probably through MME budget acquisition)
- Donor Funds (it may be possible to solicit donor funding of DSM initiatives)
- Utility funding (usually instead of investing in generation or network assets)
- Funding through CDM mechanisms
- Electricity consumer funding by way of a “tax” or surcharge on tariffs (i.e. collected through tariffs by the utilities, may be a transparently shown tax/surcharge, or as an embedded tax/surcharge)
- Electricity consumer funding through own investment in DSM measures (motivated by pay-back through savings from the DSM measures)

The Government of Namibia’s Energy Policy is clearly committed to energy efficiency, and it should therefore be realistic to expect some contribution from that source. It is in fact unlikely that much will be achieved if GRN is not prepared to make at least some seed funding available to initiate a national DSM process.

Donor funding, possibly in connection with CDM funding, may be possible to obtain. This needs to be investigated further.

Funding through electricity tariffs is a distinct possibility. For example, a tax on households with EWH would have a dual purpose of collecting revenue while also incentivising households to switch to SWH. Arguments against this are likely to centre around the facts that a) electricity is already taxed significantly by local authorities and b) prices are rising due to the regional supply shortage, and adding taxes would worsen the impact on the consumer (although this would also drive DSM and make it more attractive, hence it may not be a bad thing).

Utilities, specifically NamPower, may also be able to justify expenditure on DSM in savings that they can make from such measures.

If clear business cases can be devised showing adequate return on investment then businesses should be amenable to funding in-house DSM measures that will have financial benefits in future. If some barriers can be removed (specifically around reducing risks and obtaining commercial loans) then it must be possible to have some measures funded from this source. In view of the substantial increases in grid electricity prices should provide a very conducive environment for the introduction of DSM programmes.

6.3 CONCLUSION

This report examines international trends in DSM, and presents a long list of DSM options derived from such experience. These options were evaluated and ranked using a set of criteria, arriving at a preliminary short list of ten options that can be further reduced in future.

The intention is to workshop the short list of options with stakeholders in May 2006, with the aim

- To solicit stakeholder reviews of all options and evaluation criteria
- To solicit stakeholder input regarding assumptions and data
- To reduce the preliminary short list to a final set of no more than five options which are then developed in more detail in phase 2 of the present DSM study.

Stakeholders are therefore encouraged to critically review this report, and to actively participate in the upcoming workshop to ensure that the most viable options are chosen for the next phase of the DSM study, and their ultimate implementation.

7 ANNEXURES

ANNEXURE 1: DETAILS OF DSM OPTIONS LONG LIST

Table 13: Economic Impact Evaluation of DSM Options Long List

DSM Option	Macro-economic impact	NamPower impact	RED impact	Consumer impact
Subsidised dissemination of CFL	Reduction in poverty through reducing lighting electricity bill of all, including poor, households.	Reduced kWh sales reduced evening peak. Sales reduction mainly in peak hours, if NamPower buys on time of use the net impact may well be positive.	Reduced kWh sales. In current scenario RED tariff may have to rise slightly to compensate for lower kWh sales. Net impact on RED bottom line should be negligible if approached correctly in tariff design.	Reduced electricity bill, more significant for poor consumers whose consumption is more dominated by lights than higher income consumers.
Commercial energy efficient lighting		Reduced kWh sales, mostly during daytime but to some extent during nighttime. May require small tariff increase to recover costs adequately.	Reduced kWh sales. Probably reduced daytime demand level, which would open up further opportunity for evening peak reduction.	Reduced electricity bill.
Streetlight switch-off	Minimal	Minimal reduction in kWh sales.	Minimal reduction in kWh sales.	n/a
Residential SWH dissemination	Medium to long-term positive impact through wide spread energy savings. Switch to renewable energy source implies emissions reduction regionally. Generally positive impact.	Significant reduction both in kWh sales and round the clock demand, most marked demand reduction during morning and evening peak times. Likely to mean increase in kWh tariff to recover costs over less kWh. Depending on time of use import scenario increase may not be necessary.	Significant reduction in kWh sales and demand bought from NamPower. Will require increase in kWh tariff to recover costs (may be mitigated if REDs buy on ToU tariff), will require increase in c/kWh LA surcharge.	Significant reduction in electricity bill for users with EWH who switch. Higher construction costs for new houses if consumer has to pay for SWH - but offset by saved electricity.
Commercial/Institutional buildings SWH dissemination	Similar to residential SWH.	Similar to residential SWH.	Similar to residential SWH.	Similar to residential SWH.
Expand ripple control for WHK & Walvis	Peak demand reduction reduces electricity costs to the economy. Specifically Local Authorities and REDs benefit and this can free up funds for development or benefits can be passed through to consumers	Reduced peak demand should have positive impact.	Reduced peak demand should have positive impact, but may be limited if evening peak drops below daytime peak in which case management becomes more complicated and benefits are reduced.	Indirect impact - see macro-economic impact
Implement ripple control for smaller Local Authorities	Peak demand reduction reduces electricity costs to the economy. Specifically Local Authorities and REDs benefit and this can free up funds for development or benefits can be passed through to consumers	Reduced peak demand should have positive impact.	Reduced peak demand should have positive impact, but may be limited if evening peak drops below daytime peak in which case management becomes more complicated and benefits are reduced.	Indirect impact - see macro-economic impact
Distributed generation (installed, currently off-line)	Better use of existing assets, hence positive impact.	Positive - presents an emergency alternative.	Positive or neutral - presents an emergency alternative	Positive - offers better return on investment in standby generation.
Water pumping "ripple" control	Peak demand reduction reduces electricity costs to the economy.	Reduced peak demand should have positive impact.	Reduced peak demand should have positive impact.	Should be neutral or positive, depending on arrangement reached between supplier and consumer

DSM Option	Macro-economic impact	NamPower impact	RED impact	Consumer impact
Voluntary load shedding	Should be al least neutral if agreements are mutually beneficial to consumer and utility	Should be beneficial.	Should be beneficial.	Should be beneficial.
Power factor correction	Reduces unnecessary network loading and improves asset capacity, hence positive but difficult to determine significance of impact	Positive - but presents risks regarding system stability and therefore needs to be managed carefully	Positive	Positive if on kVA tariff - savings on electricity bill, normally has short pay-back time.
Commercial and industrial air conditioning efficiency and load control	Significant positive impact possible, savings possible across the supply chain.	Reduced demand and kWh, demand reduction most likely during summer daytime peak, opens up further opportunity for evening peak reduction.	Reduced demand and kWh, demand reduction most likely during summer daytime peak, opens up further opportunity for evening peak reduction.	Reduced electricity bill, but requires some investment.
Compressed Air Systems	Significant positive impact possible, savings possible across the supply chain.	Reduced demand and kWh, demand reduction most likely during summer daytime peak, opens up further opportunity for evening peak reduction.	Reduced demand and kWh, demand reduction most likely during summer daytime peak, opens up further opportunity for evening peak reduction.	Reduced electricity bill, but requires some investment.
Equipment specifications	Can be a mixed bag by eliminating some low cost equipment (with low specifications), increasing project capital costs	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Likely to increase capital cost but decrease operating cost - overall should be positive
Energy audits (subsidised)	Should be a good investment.	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Should reduce electricity bill - positive.
Building energy regulations, energy density (W/sqm), thermal efficiencies	Positive impacts through better efficiency, but may increase building costs so barriers may need removal and net benefits determined.	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Difficult to estimate, likely to reduce kWh sales as well as demand. Insufficient data for predictions.	Will reduce electricity bill but also likely to increase capital costs. Benefits likely to be long-term.
Cooking energy use	Using modern fuels for cooking is encouraged for environmental reasons. Programmes need to be very carefully designed to not have negative impacts.	Reduced evening peak demand - but limited benefit if below daytime peak.	Reduced evening peak demand - but limited benefit if below daytime peak.	May not bring significant savings if other fuel sources are same or higher cost (e.g. gas)
Appliances: Refrigeration	Positive impacts through better efficiency, but may increase appliance costs so barriers may need removal and net benefits determined. Would negatively affect enterprises importing cheap (low spec) appliances. May negatively affect poor population's ability to afford appliances	Would reduce kWh sales and demand.	Would reduce kWh sales and demand.	Would reduce electricity bill but probably increase appliance cost - may raise barriers to acquiring appliances
Electric space heating	Economic impact comparison needs to be made to assess the alternatives to electric space heating. With rising electricity prices alternatives are likely to be better economically.	Reduced winter evening peak and winter daytime peak, reduced winter kWh sales. Net impact may be positive due to demand being in peak times.	Reduced winter evening peak and winter daytime peak, reduced winter kWh sales. Net impact may be positive due to demand being in peak times.	Should reduce energy costs if it to be successful.
Capital funding of DSM initiatives (e.g. Eskom)	Needs a clear cost-benefit model that demonstrates the benefit	Will increase tariffs if funding is procured from existing electricity consumer base.	Will increase tariffs if funding is procured from existing electricity consumer base.	Will carry primary benefit from such funding.

DSM Option	Macro-economic impact	NamPower impact	RED impact	Consumer impact
Tariff structure design	Cost reflective pricing is generally regarded as a healthy measure for the economy	Positive if prices are cost reflective - changes will bring some risks which need to be managed	Positive if prices are cost reflective - changes will bring some risks which need to be managed	Likely to have both positive and negative impacts, depending on consumer category.
Consumer awareness	Positive - better informed consumers can make wiser choices	Difficult to predict without details of campaign targets being known	Difficult to predict without details of campaign targets being known	Should be positive

Table 14: Implementation Issues for Options Long List

DSM Option	Implemen-tation time[7]	Funding Issues	Practical Constraints/Issues	Implementation Capacity Issues	Socio-economic impacts/issues
Subsidised dissemination of CFL	Short-term	Needs significant amount of capital, depending on level of subsidy and mode of dissemination. Funding probably not recoverable	Consumer prejudice may have to be overcome through information. Retailers of CFL's may be affected short-term and may need to be consulted.	Could be implemented in a short time using limited human resources, using a road show kind of approach. Implementation capacity not a significant issue.	Should contribute to poverty reduction through lowering the lighting electricity bill of poor consumers significantly.
Commercial energy efficient lighting	Short-term	Likely to require funding of at least some sample energy audits showing typical payback. May require access to medium term capital funding for consumers to make the changes. Funding probably recoverable through savings	None foreseen	Limited existing local capacity for energy audits as well as installation changes - opportunity for growing these sectors.	Has possibility of job creation through growing installation sector. May be temporary benefit.
Streetlight switch-off	Medium	Would need significant funding for control circuitry and/or changes in streetlight wiring.	May be difficult to implement on existing streetlight circuits in an economically justifiable manner due to disruptions in service and need to dig up cables.	Limited technical capacity available in REDs and private sector to make large-scale changes. New streetlight circuits could incorporate provision at little extra effort.	Likely significant resistance to reduced lighting due to link between lighting and crime. General trend is to improve nighttime lighting to help fight crime. Hence high probability that this would not be acceptable.
Residential SWH dissemination	Medium	Large-scale programme to accelerate dissemination requires significant capital amounts (see MME revolving fund), which may be recoverable if packaged as loans. This project would lend itself to CDM funding!	Limited existing capacity for installing will impede very fast large-scale implementation - capacity could be expanded with time. Must ensure that low quality systems are either kept off the market or consumers correctly informed about choices and implications.	Contracting capacity not available or very limited.	Significant long-term benefits through wide spread electricity bill reduction (although limited in poor sector of community), reduced emissions. Likely to create jobs since SWH installation more labour intensive than EWH installation.

[7] Time frames are meant approximately as follows: Short term = 1 to 3 years, medium term = 2-6 years, long term > 5 years

DSM Option	Implementation time[7]	Funding Issues	Practical Constraints/Issues	Implementation Capacity Issues	Socio-economic impacts/issues
Commercial /Institutional buildings SWH dissemination	Medium	Change to SWH generally has good payback time. May require barrier removal for institutions to access medium term capital funding that can be paid back from savings in electricity bill.	None foreseen	Limited capacity available in terms of installers qualified in working with SWH installations.	More money available in e.g. education due to reduced electricity bills for hostels. Generally small and indirect benefits can be expected.
Expand ripple control for WHK & Walvis Bay	Short-term	Requires significant up-front capital funding. REDs may need assistance to raise such funding. Funding probably recoverable through savings	Delays in implementing CRED likely to affect implementation.	None foreseen	Not likely to be significant.
Implement ripple control for smaller local authorities	Short-term	Requires significant up-front capital funding. REDs may need assistance to raise such funding. Funding probably recoverable through savings	Delays in implementing SORED and CRED likely to affect implementation.	None foreseen	Not likely to be significant.
Distributed generation (installed, currently off-line)	Short-term	Requires funding for a feasibility investigation. Requires funding of changes in wiring, synchronisation gear, and protection. Likely to require funding other than from owners of generating sets. Requires an incentive model to encourage participation.	Deployment logistics may be very difficult except if only the largest standby generators are included.	Capacity should be available due to small number of larger generators.	Not likely to be significant.
Water pumping "ripple" control	Short-term	May not require large amounts of capital.	Communication and joint understanding between supplier and consumer needs to be good and may need to be supported.	Should be manageable due to small number of large pumping consumers	Little direct impact expected.
Voluntary load shedding	Short-term	Should not require significant funding	Requires structured identification of interruptible loads and sensible negotiations to find areas where mutual benefit is possible.	Should be manageable due to small number of large consumers	Little direct impact expected.
Power factor correction	Short to medium term	Requires capital investment on a case-by-case basis. May need barrier removal for consumers to obtain commercial loans. Funding probably recoverable through savings	Energy audits required	Limited capacity available locally, may be augmented with outside capacity.	Little direct impact expected.
Commercial and industrial air conditioning efficiency and load control	Medium to long-term	Is likely to require significant funding - firstly for energy audits, secondly for implementation. Funding probably recoverable through savings	Air conditioners not designed for "ripple" controlled operation.	Limited local capacity for energy audits and implementation. Opportunity to expand this sector.	Opportunity for employment creation and development of small entrepreneurs

DSM Option	Implementation time[7]	Funding Issues	Practical Constraints/Issues	Implementation Capacity Issues	Socio-economic impacts/issues
Compressed Air Systems	Medium	Is likely to require significant funding - firstly for energy audits, secondly for implementation. Funding probably recoverable through savings.	Energy audits required	Limited local capacity for energy audits and implementation. Opportunity to expand this sector.	Opportunity for employment creation and development of small entrepreneurs
Equipment specifications	Long	Will require funding for research, standards setting. Funding non-recoverable.	Independent body to drive such work is non-existent. Namibia dependent on imported equipment, difficult to influence manufacturers.	Little capacity available to tackle the issues. Expected to be a difficult project.	Difficult to assess without additional data.
Energy audits (subsidised)	Medium	Will require significant funding for audits. Probably non-recoverable.		Limited local capacity available to undertake audits. Potential to grow entrepreneurs.	Potential to create work and opportunities for entrepreneurs, both short and long-term.
Building energy regulations, energy density (W/sqm), thermal efficiencies	Long	Will need funding (non-recoverable) to develop standards and codes.	Reliance on imported building materials may mean limited availability of cost effective solutions unless RSA has parallel developments. May receive significant resistance from building industry.	Limited local capacity to develop standards and codes. Long times taken to approve and implement standards and codes.	May be a mixed bag if not handled carefully. Benefits should accrue to users of buildings in the medium to long-term, but building sector may be depressed if building costs go up significantly.
Cooking energy use	Long	Funding difficult to estimate with nature of programme drive unknown. Education campaign would require limited non-recoverable funds. Subsidy of e.g. LPG or appliances would require significant non-recoverable funding, probably over long time.	Prejudice against LPG, LPG cost. Large customer base to "convince". Not enough benefits as perceived by the customer.	Should not present implementation capacity problems.	May meet with significant resistance and must be carefully considered to ensure no significant negative effects are procured.
Appliances: Refrigeration	Medium	Education and possible import regulation developments will require non-recoverable funding.	Likely to meet with significant resistance from low cost appliance importers and retailers.	Should not present implementation capacity problems.	May meet with significant resistance and must be carefully considered to ensure no significant negative effects are procured.
Electric space heating	Medium	Research and consumer education will need non-recoverable funding	Some safety issues associated with alternatives, e.g. gas. Consumers needing to invest in new appliances will resist such changes, which may impede the activity.	Should not present implementation capacity problems.	Safety of LPG may be an issue.
Capital funding of DSM initiatives (e.g. Eskom)	Medium to long-term	Will require significant capital funding, probably non-recoverable for funding agency.	If ESCO approach is followed, this needs to be set up and managed which will take time.	Limited local capacity to implement (e.g. ESCO's as in RSA).	Positive impacts generally.
Tariff structure design	Short to medium term	Will require some funding for tariff design. Should be recoverable through tariff if done by utilities.	ToU tariffs need different meters which will be an issue if to be implemented on large consumer base	Limited local capacity - likely need to import specialist skills.	Possible political/social opposition, depends on how measures affect consumers
Consumer awareness	Short-term	Information campaigns need funding (probably non-recoverable, depending on who pays for it)	None foreseen	Should not present implementation capacity problems.	Languages, Education - should have positive impacts throughout.

ANNEXURE 2: CALCULATIONS

An attempt has been made to keep the assumptions **conservative** in general, i.e. it is expected that at least the resulting kW demand and/or kWh could be saved.

The tables in this annexure are provided to give the reader insight into some key assumptions and estimates made in calculating potential impacts. Feedback and opinions would be welcomed by the Consultant.

Table 15: Key Assumptions – Household Uses

INPUTS		
Lights ave power [W]	60	W
Est lights - mid-hi income HH	4	
Est lights - low income HH	1	
CFL lights ave power [W]	13	W
Lights ave use per day [h]	4	
Geyser on-factor at peak [%]	50%	
Ave geyser power [kW]	2	kW
Ave geyser duty cycle [h]	4	h
Elec heater on-factor at peak [%]	60%	
Ave elec heater power per HH [kW]	1.5	kW
Ave heating period [h]	3	h
Days per year for heating	90	days
Cooking on-factor at peak [%]	20%	
Ave hot plate power (kettle is 2kW)	1	kW
Ave cooking time (incl kettle)	1	h

Table 16: Calculation based on Census Data

BASELINE DATA contribution kW to peak		**Lights**	**Geyser**	**Heater**	**Cooking**
house		21 440	70 527	21 158	15 986
flat		960	6 738	1 895	1 516
traditional		-	-	-	-
shack		616	641	462	128
other		-	-	-	-
Total		**23 016**	**77 906**	**23 515**	**17 630**
Less already switched Windhoek			20 000		
Less already switched Walvis			4 000		
Remaining		**23 016**	**53 906**	**23 515**	**17 630**
Potential demand reduction					
Potential demand saving CFL	80%	14 423			
Potential demand saving ripple	40%		21 562		
Potential demand saving SWH	40%		21 562		
Potential demand saving heaters	20%			4 703	
Potential demand saving cooking	20%				3 526
BASELINE DATA contribution to MWh pa		**Lights [MWh]**	**Geyser [MWh]**	**Heater [MWh] WINTER Only**	**Cooking [MWh]**
house		31 303	205 938	9 521	29 175
flat		1 402	19 676	853	2 767
traditional		-	-	-	-
shack		899	1 872	208	234
other		-	-	-	-
Total		**33 603**	**227 486**	**10 582**	**32 176**
Potential energy reduction					
Potential energy savings CFL	80%	21 058			
Potential energy savings SWH	40%		90 994		
Potential electrical energy savings heaters	20%			2 116	
Potential elec energy savings cooking	20%				6 435

Table 17: Other Assumptions

Lighting: Com/Ind		
Demand estimate for lighting	27 738	kVA
Previous unit consumption	58	W
EE unit consumption	36	W
Power decrease from 100%	62%	
Percentage of lighting not yet EE	60%	
Scope for EE conversions	50%	
Streetlighting		
Demand estimate	4 250	kVA
Reduction during peak	0%	
Energy estimate	12 410	MWh/a
Energy savings: Every 3rd on off	33%	
Average On time per day	11	h/day
From 0:00 to 06:00	6	h
Water heating: Com/Ind		
Number of boilers	200	
Number to be converted to SWH	50%	
Ave power required	10	kW
Ave duty	8	h
Diesel Genset's		
Ave power of large diesel generators	500	kVA
Power factor	0.8	
Number of units in grid areas/towns	20	
Water pumping		
Demand estimate for large scale pumping	9 000	kVA
Factor for load-shifting implementation	10%	
Power factor: Com/Ind		
Demand estimate for commercial/industrial	69 346	kVA
Percentage inductive loads	20%	
Current power factor	0.75	pf
Power factor correction	0.95	pf
Scope for power factor correction implementation	50%	
Air conditioning: Com/Ind		
Demand estimate for HVAC	41 607	kVA
Percentage air conditioning	70%	
Percentage of AC on ripple control	30%	
Compressed air systems: Com/Ind		
Industry using compressed air	1 000	
Power consumption	1.5	kVA
Hours per day	8	h
Duty cycle	20%	
Percentage of national low efficiency systems	30%	
Improvements on systems after conversion	30%	
Appliances: Refrigeration		
Residential		
Conventional refrigerator nominal power	0.25	kW
EE refrigerator nominal power	0.10	kW
On-peak factor	20%	
Conventional refrigerator ave. consumption	2.5	kWh
EE refrigerator	1.2	kWh
HH with geysers	77 906	
Estimated HH with refrigerators	77 906	
Penetration	10%	
Commercial		
Conventional refrigerator ave. consumption	3.0	kWh
EE refrigerator	2.0	kWh
Commercial businesses with refrigeration	1 000	
Average number of refrigeration units	3	
Penetration	5%	
Air conditioning: Com/Ind		
Demand estimate for HVAC	41 607	kVA
Percentage for space heating	5%	
Reduction through fuel switching (e.g. LPG)	10%	
Hours of use	8	h
Days per year	90	days

Table 18: Impact Calculation based on RED Data

	NP TX	NORED	CENORED	ERED	CRED	SORED	ALL				
	Customer Numbers										
PPM		33 157	4 000	3 000	23 000	14 000	**77 157**				
DOM		264	7 000	18 000	23 000	3 100	**51 364**				
BUS-1		748	1 200	2 000	2 600	1 400	**7 948**				
BUS-3		872	1 300	1 300	3 000	1 200	**7 672**				
LPU		302	200	280	680	125	**1 587**				
Streetlight		4 500	4 500	5 500	13 500	6 000	**34 000**				
	-	**39 843**	**18 200**	**30 080**	**65 780**	**25 825**	**179 728**				
est demand purchase		32000	30 000	40 000	130000	30 000	262000				
	NP TX	**NORED**	**CENORED**	**ERED**	**CRED**	**SORED**	**ALL**		**ave kW**	**est peak ratio**	**est peak kW**
	MWh per annum										
PPM		59 263	7 080	7 236	106 450	34 000	**214 029**		24 433	25%	97 730
DOM		1 509	20 592	86 400	165 000	12 000	**285 501**		32 591	33%	98 762
BUS-1		6 950	5 148	9 600	24 500	18 000	**64 198**		7 329	66%	11 104
BUS-3		16 508	27 600	26 808	53 000	26 000	**149 916**		17 114	66%	25 930
LPU		52 603	45 684	113 652	332 000	51 000	**594 939**		67 915	75%	90 554
Streetlight		1 643	1 643	2 008	4 928	2 190	**12 410**				4 250
	-	**138 476**	**107 747**	**245 704**	**685 878**	**143 190**	**1 320 994**		**149 382**		**328 330**
ave streetlight watts	125										
ave streetlight h/day	8										
PPM % low income	50%										

Table 19: Calculation of Estimated DSM Impacts

DEMAND REDUCTION [MW]	**MW**	Lighting	Street-lighting	SWH	Ripple control	Diesel on-line Gx	Water pumping	Voluntary	Power factor	Air con	Compressed Air	Equipment specification
Residential	196	14.4	-	21.6	21.6							
Commercial/Industrial	203	4.8		1.0		8.0	0.9		1.3	8.0	-	
Total	**399**	**19.2**	**-**	**22.6**	**21.6**	**8.0**	**0.9**	**-**	**1.3**	**8.0**	**-**	**-**
Percentage		4.8%	0.0%	5.6%	5.4%	2.0%	0.2%	0.0%	0.3%	2.0%	0.0%	0.0%
ENERGY REDUCTION [MWh/annum]	**MWh of Namibia's total**											
Residential	499 531	33 603	1 862	227 486								
Commercial/Industrial	1 302 903	13 874		2 920							79	
Total	**1 802 433**	**47 478**	**1 862**	**230 406**	**-**	**-**	**-**	**-**	**-**	**-**	**79**	**-**
Percentage		2.6%	0.1%	12.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

ANNEXURE 3: LITERATURE LIST

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