ELECTRICITY CONTROL BOARD

DEMAND SIDE MANAGEMENT STUDY FOR NAMIBIA

REPORT 2:
Implementation Plans for Six DSM Options

November 2006

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Table of Contents

TABLES AND FIGURES

TABLES

FIGURES

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
kVA – kilovolt-Ampere (measure of apparent power or demand)
kW – kilowatt (measure of real power or demand)
kWh – kilowatt-hour (measure of energy, also referred to as a “unit”)
LA – Local Authority
MME – Ministry of Mines and Energy
NAMREP– Namibian Renewable Energy Programme
QOS – Quality of Supply (Electricity Quality)
RC – Regional Council
RED – Regional Electricity Distributor
REEEI – Renewable Energy and Energy Efficiency Institute
RET – Renewable Energy Technology
RSA – Republic of South Africa
SENSE – Sustainable Energy Society of Namibia
SRF – Solar Revolving Fund
SWH – Solar Water Heater
TX – Transmission

1 EXECUTIVE SUMMARY

This demand side management study was commissioned by the Namibian Electricity Control Board. It follows a report tabled in May 2006 that provided Namibian electricity sector stakeholders with background information about contemporary demand side management issues, and presented a framework for ranking those demand side management measures that can be introduced in Namibia.

Following the presentation of the first study at a national workshop in May 2006, Namibian electricity sector stakeholders identified six demand side management options for further investigation which are:

- Launching a consumer education and awareness campaign
- Introducing time of use electricity tariffs
- Disseminating compact fluorescent lights
- Replacing electric water heaters with solar water heaters
- Expanding ripple control systems, and
- Conducting energy audits in the commercial and industrial sector.

This report summarises the findings of the investigation, detailing the cost, benefit and implementation requirement of each of the above demand side management options.

Demand side management measures in the electricity sector are designed to reduce the consumption of electrical energy by end-users, especially during peak electricity demand periods. Such measures are particularly useful to alleviate supply and/or network constraints. They are primarily motivated by the network operator's and/or distributors' desire to optimise the utilisation of the electricity network infrastructure, or to enhance the economic benefits of electricity, or both. An additional factor motivating the introduction of demand side management measures is the realisation that the entire electricity supply and distribution system has to be dimensioned to cope with peak electricity demand. Lowering and/or flattening the daily / seasonal demand curve therefore holds significant financial benefits for utilities - and if such savings are passed on - for consumers.

In Namibia, demand side management measures offer excellent opportunities to NamPower and the regional electricity distributors (REDs) to more effectively manage the supply and demand of electrical energy, thereby fulfilling their respective demand contracts, manage short- and long-term network constraints in a most cost-effective manner, and at the same time limit the consumer's exposure to rapidly increasing regional electricity prices. As such, demand side management measures

- allow for planned and optimised balancing of the electricity supply and demand
- contribute significantly to system reliability by preventing system overloads
- enable the network operator and distributors to optimise the utilisation and therefore the financial benefits of their network infrastructure
- allow the deferral of network augmentation and/or expansion,
- follow more closely the prevailing market conditions, and therefore
- make electricity prices more cost-reflective.

Namibia faces uncertain electricity supply conditions, particularly during peak demand times. In addition, the southern African region is faced with rapidly increasing electricity supply and distribution costs. In this situation, the six demand side management measures investigated in this report offer cost-effective and definite opportunities to balance a limited and volatile supply with an increasing local demand. The six options most favoured by Namibian electricity stakeholders are described in more detail below.

1.1 LAUNCHING A CONSUMER EDUCATION AND AWARENESS CAMPAIGN

Consumer acceptance and willing participation in demand side management are *the* key factors determining the success and sustainability of any demand side management implementation. An effective consumer awareness and education campaign is therefore an integral part of the implementation of demand side management in Namibia, and will play a critical role in ensuring that consumers are sufficiently capacitated to allow for the desired demand reductions to be realised.

It is recommended that a consumer education and awareness campaign be launched to disseminate relevant and practical information in regards to the various demand side management measures. This is to be achieved by effectively targeting and engaging the consumer segments benefiting from or being affected by the introduction of the measures. The campaign is to introduce the various demand side management options, explain their purpose and how the consumer can benefit from their introduction, clarify how such measures will be implemented, and educate consumers about their participation and the implementation requirements. The campaign is to ensure that the demand side management options discussed in this report are effectively disseminated to all beneficiaries, thus allowing each consumer segment to optimally participate and benefit through their introduction.

Depending on the scale and duration of the campaign, it is estimated that a basic campaign may cost N$800 000, which is assumed to be borne largely by NamPower and the REDs.

1.2 INTRODUCING TIME OF USE ELECTRICITY TARIFFS

Time of use electricity tariffs can provide consumers with a direct financial incentive to reduce their electricity consumption in peak demand periods by shifting their usage from peak to off peak periods. Such load shifting can have a significant impact on the total electrical energy consumption in peak demand periods. As peak demand periods substantially determine how national supply and demand requirements are met and whether the existing network infrastructure is adequate, tariffs can be designed to create incentives to more optimally time the usage of electrical energy.

It is recommended that time of use electricity tariffs be introduced by way of select trials in the commercial, industrial and residential sectors. The trials envisage the participation of some 10 to 30 commercial consumers, 20 to 40 industrial consumers, and 300 to 1,000 residential consumers during a one-year period. Following the successful completion of the trials, a national time of use tariff implementation plan is to be drafted, incorporating the lessons learnt during the trials.

The introduction of time of use tariffs are expected to realise the following benefits:

- A typical large power user with an annual consumption of some 1,752,000 kWh, may without significant investments, shift loads between 30 kW and 150 kW in peak demand periods (resulting from a 5% to 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 15 MW for 100 such consumers during peak demand periods.
- A three-phase commercial or industrial consumer with an annual consumption of some 182,000 kWh, may without significant investments, shift loads between 3 kW and 16 kW in peak demand periods (resulting from a 5% to 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 8 MW for 500 such consumers during peak demand periods.
- A one-phase commercial or industrial consumer with an annual consumption of some 60,500 kWh, may without significant investments, shift loads between 1 kW and 6 kW in peak demand periods (resulting from a 5% to 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 6 MW for 1,000 such consumers during peak demand periods.
- A medium- to high-usage residential consumer with an annual consumption of some 9,600 kWh may without significant investments shift loads between 0.4 kW and 2 kW in peak demand periods (resulting from a 5% to 25% load shift from peak to off peak periods respectively within two hours), which may reduce the aggregated load by this consumer group by up to 20 MW for 10,000 such consumers during peak demand periods.
- NamPower and the REDs are expected to benefit considerably by way of saved demand charges, higher off peak load factors and the delay of network augmentation charges.

It is estimated that the time of use trials will cost N$3.82 million, and are to be borne through a modest increase in consumption charges, or be shared by the ECB and the utilities. They are expected to result in an aggregated demand shift of approximately 7MW, which amounts to some N$0.55 million per MW. It is not expected that any significant energy savings will be made as a result of the trials.

1.3 DISSEMINATING COMPACT FLUORESCENT LIGHTS

The use of lights in the early evening hours coincides with the Namibian electricity demand peak, i.e. the time when system energy costs are the highest. Some 1.15 million light points exist in grid connected residential homes in Namibia's urban areas. It is estimated that of these lights, some 760,000 are switched on during the evening system peak time, resulting in a demand of some 45MW, which is more than 10% of the highest demand peak in 2005.

It is recommended that a programme be undertaken to exchange some 760,000 residential incandescent light bulbs free of charge for CFLs. Such a programme is to take place over a two-year period and exchanges are to be undertaken on a door to door basis in all larger towns in Namibia. The programme is to be funded by a temporary addition to the residential energy tariff rate of all REDs, calculated to pay for the CFL programme cost plus compensating the REDs for reduced profit due to the decrease in kWh sold. In view of the very short payback times of CFLs, payment by way of such an add-on residential energy tariff will still make consumers better off despite the increase in tariffs.

It is estimated that an investment of N$12.7 million is required to exchange 60% of the lights switched on during peak demand periods. This exchange programme will reduce national energy consumption by some 22GWh per annum, and reduce the demand by some 20MW, which amounts to approximately N$0.64 million per MW.

1.4 REPLACING ELECTRIC WATER HEATERS WITH SOLAR WATER HEATERS

There are an estimated 97,000 domestic electric water heaters in use in Namibia. At an average load of 2.5kW per heater they represent a connected load of 242MW. Assuming that some 50% of all electric water heaters are switched on during the winter evening peak, and deducting 24MW for existing ripple controlled loads, they contribute an estimated 106MW to the peak load. This is almost one-quarter of the national maximum demand. Reducing the electric water heater load can therefore bring about a substantial overall load reduction, both nationally and in urban distribution networks.

It is recommended that domestic, commercial and institutional electric water heaters be selectively exchanged for solar water heaters. As the major benefit of installing solar water heaters accrues to the consumer, such an exchange programme is to be consumer financed. To enhance its effectiveness, this process is to be actively supported by an education and awareness campaign, the ongoing monitoring and evaluation of its achievements, and a drive to ensure that the necessary finance mechanisms and vocational skills are available.

It is estimated that an investment of N$433 million is required to achieve a domestic penetration of solar water heaters of 33% over ten years. A complete implementation is estimated to reduce annual energy consumption by 156GWh over ten years, and reduce the demand by some 52MW, which equates to costs of N$8.3 million per MW, not taking the savings in electricity into account.

1.5 EXPANDING RIPPLE CONTROL MEASURES

Most Namibian households connected to the electricity grid use electric water heaters for the supply of hot water. Such heaters can easily be switched on or off remotely using ripple relays, and such switching can be undertaken without inconveniencing consumers. Ripple control technology has been in operation in Windhoek and Walvis Bay, and is saving the utilities significant moneys. Such savings are realised because the system electrical load and demand can be reduced when required, thereby allowing the utilities to influence the shape of their respective load curves by deferring electricity consumption from peak to off-peak demand periods.

It is recommended that ripple controls of electric water heaters be expanded into most larger Namibian towns. The installation and operation of ripple control systems is to be the responsibility of the system operator (NamPower) and the distributors (REDs). As the benefits of ripple controlling electric water heaters accrue to both NamPower and the REDs, it is recommended that the program be financed by them.

It is estimated that an investment of N$37 million is required to implement a full transmitter ripple control system (i.e. a system where all ripple receivers can be permanently reached by transmitter signals), while an investment of N$31 million is needed if an off-line ripple control system (i.e. where a single mobile transmitter is used to program ripple receivers instead of having permanently installed transmitters) is implemented. When implemented in all larger Namibian towns, such systems are expected to lead to demand shifts of approximately 19MW and 27MW, equating to N$1.9 million and N$1.2 million per MW respectively.

1.6 CONDUCTING ENERGY AUDITS IN THE COMMERCIAL AND INDUSTRIAL SECTOR

Energy audits are widely used internationally to assess and provide guidance with regard to the most energy efficient and cost-effective utilisation of energy. As such, energy audits can lead to a reduction of both energy consumption and maximum demand, mainly by enhancing the utilisation of energy and the introduction of more energy efficient technologies and processes. While energy audits can benefit both residential and commercial/industrial consumers, the financial benefit of the latter consumer segment is more significant as their numbers are small but their electricity consumption is mostly large. Many commercial / industrial electricity consumers in Namibia are not fully aware of the benefits that energy audits can deliver, and little detailed information of the commercial and industrial sectors' energy use is available.

It is recommended that a subsidised Energy Audit programme be launched, targeting some sixty commercial / industrial consumers over a period of three and a half years. The programme is to highlight the existing financial and awareness barriers, and demonstrate the viability of energy audits in bringing about energy and demand reductions. The programme is to be preceded by a trial phase during which 20 audits are to be performed with the aim of collecting better benefit data, demonstrating some replicable case studies and testing the willingness of the commercial/industrial sector to participate in such a programme.

It is estimated that the Energy Audit programme will cost N$2 million for the trial phase and N$4.75 million for the main phase with 60 audits, which is to be recovered through a modest increase in tariffs for commercial and industrial consumers. Costs associated with the implementation of specific demand side management technologies and/or processes are to be borne by those consumers benefiting from such measures. The Energy Audit programme will seek to demonstrate the savings that can typically be achieved by conducting energy audits and implementing their findings, and will target to establish clear replicable case studies to motivate consumers to undertake energy audits at own cost in future. It is expected that around 58GWh per annum could be saved through efficiency measures in the commercial and industrial sector, as well as 16MVA in consumer demand.

1.7 CONCLUSIONS

The report includes a description of the delivery, monitoring and reporting, long term sustainability, exit strategy, risks and key assumptions for each of the demand side management measures discussed above.

The following demand side management options investigated in this report have been shown to have definite financial benefits:

- Dissemination of CFLs
- Implementation of extended ripple control of EWH
- Replacement of EWH with SWH

The following two DSM options have been identified as being highly recommended as general measures to support all other initiatives even though they do not have direct financial benefits that can be calculated at this time:

- Consumer awareness
- Time of Use tariffs

Finally, the energy audits DSM option is recommended to be trialled with a view to establish better data that can prove the business case for undertaking further audits and realising savings in the commercial/industrial sector.

Table 1 below summarises the key numerical characteristics of the six options:

	Est Programme Cost N$	Est MW demand saved	Est GWH p.a. saved	Est N$/MW saved	Est c/kWh funding over implem years	Est payback years	Est Implemen-tation years	Funded By
Consumer awareness	700 000	n/a	n/a	n/a	0.02	n/a	2	Utilities - all kWh
Tariffs	4 500 000	n/a	-	n/a	0.11	n/a	2	NamPower - all kWh
CFL dissemination	13 000 000	19.91	22	652 804	1.30	1.16	2	NamPower - all kWh
SWH dissemination	88 000 000	52.00	115	1 692 308	1.76	n/a	10	MME/donors
Ripple control expansion	45 000 000	26.70	-	1 685 573	1.13	5.11	2	REDs - all kWh
Energy audits	6 750 000	16.00	58	n/a	0.17	n/a	5	Commercial/Industrial consumer kWh

Table 1: Summary of DSM Options

Table 2 below summarises the benefit to cost ratios of the DSM options discussed in this report (excluding energy audits):

	Benefit/Cost Ratio
Consumer awareness	**1.08**
TOU tariffs	**2.38**
CFL dissemination	**6.99**
SWH promotion	**1.10**
Ripple Control	**1.30**

Table 2: Benefit to Cost Ratios of DSM Options (excluding energy audits)

The MME and ECB, supported by the Namibian Electricity sector stakeholders are to agree jointly on taking these DSM options forward, since implementation and funding will require co-operation between all these entities.

In view of the financial and other benefits that the demand side management measures discussed in this report will yield, it is concluded that they constitute a cost-effective and quick way to improve the management of Namibia's electricity demand. In view of the nation's precarious electricity supply situation, their speedy implementation will benefit most electricity consumers in Namibia.

2 BACKGROUND

2.1 PURPOSE OF THIS REPORT

The purpose of this report is to provide the ECB and MME with a set of implementation plans for six DSM options which can be implemented in Namibia. These six options have been distilled from a review of internationally used DSM options through a listing and evaluation process. The review and evaluation have been summarised in a report (which has been disseminated to stakeholders) and have been discussed in detail with key stakeholders at a national workshop in Windhoek during May 2006. This report takes the six agreed upon preferred options forward, looking in more detail at the costs, benefits and possible implementation mode.

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.

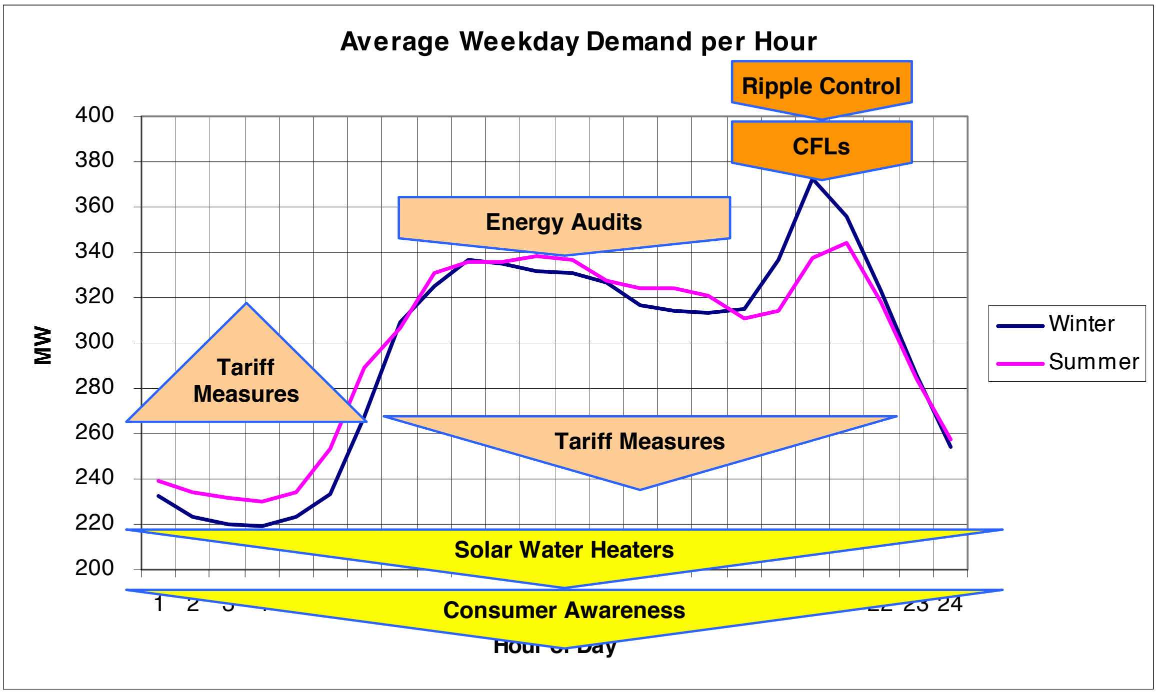
2.3.3.4 Voluntary Measures

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 OVERVIEW

3.1 OVERVIEW OF THE SIX SELECTED DSM OPTIONS

Figure 1 below illustrates the six DSM options which have been selected for further exploration for the Namibian ESI.



Implementation Time: 1-3 years 1 - 5 years 1-10 years

Figure 1: Overview of short listed DSM options

Figure 1 shows that the six chosen DSM options have different technical targets and different implementation timeframes. This feature is a direct consequence of the objectives of the initial ranking exercise, namely to arrive at a mix of DSM options that would address different issues and work over different time frames.

- Ripple control of EWH and residential dissemination of CFLs are both measures that can be implemented quite quickly, have a high impact and address the evening system demand peak which is mainly of residential origin. Both these measures are targeted at the residential consumer sector, although ripple control has an additional positive potential in the commercial and industrial sectors.
- Subsidised energy audits for commercial and industrial consumers can be implemented over the medium term, and will largely target the daytime demand level while also addressing power factor and overall energy consumption.
- Tariff measures will be implemented over a longer time period and seek to flatten the load profile, i.e. shift daytime consumption into the night-time consumption trough. Tariffs are expected to first be applied to large consumers in the commercial and industrial sector, but may well be extended down to residential consumers subject to acceptable technology costs.
- The implementation of solar water heaters to replace EWH is a long term measure which will take time to implement due to the significant capital cost involved, as well as the current limited implementation

resources available. SWH will significantly reduce energy consumption in the residential and commercial sectors, and will have a reducing effect on demand at all hours, although most prominently during the morning and evening peak demand periods.

- Consumer awareness is an accompanying activity of all DSM measures introduced in this report. It can be implemented quickly and needs to be sustained for a long time to ensure that awareness is thoroughly entrenched and finds its way into changing actual consumer behaviours. The awareness campaign is proposed to carry some general messages (mostly about reducing general energy wastage, which may not be covered by the individually focussed DSM options) as well as provide an awareness service to the other five DSM options.

Sections 4 to 9 of this report discuss each of these six options in greater detail.

Section 10 examines the interaction between the six DSM options, and summarises the detail sections.

The annexes contain discussions regarding the Namibian demand patterns (taken from the first report produced under this study) for ease of reference. The cost benefit analyses of the various DSM options presented in this report are based on these demand patterns.

3.2 OVERARCHING ISSUES

3.2.1 Environmental Benefits of DSM Measures

The main body of this report deals with the benefits and costs of the six selected DSM options. In calculating these benefits and costs, this report focuses on those factors which can be readily calculated and/or estimated using the available data. Any estimates use a generally conservative approach, which implies that benefits are likely to be underestimated while costs are likely to be overestimated. This method was used to avoid portraying an unrealistically positive picture of any one of the chosen DSM options.

This report does not attempt to calculate any environmental benefits that any of the DSM options may have. The international experience and body of available information clearly demonstrates the environmental benefits that arise from the efficient utilisation of energy, as well as the stimulating effect such utilisation can have on the country's economy.

Namibia does not utilise fossil fuel electricity generation for on-grid purposes within its borders for purposes other than emergency measures (van Eck coal power station and Paratus diesel power station). Therefore, within Namibia, the environmental benefits of increased efficiency in terms of reduced emissions would be minimal. However, on average at least half of Namibia's grid electrical energy is imported from South Africa, which generates most of its electricity from coal. Therefore any efficiency gains in Namibia will reduce emissions in South Africa, and have positive regional and global effects.

It should therefore be noted that all the DSM options investigated in this report do provide environmental benefits as described here, which accrue in addition to the calculated benefits of each option.

3.2.2 Utility Benefits Through Deferred Investments

Other benefits that have not generally been calculated in this report are those accruing to an utility because of a deferral of infrastructure investments as a consequence of one or several DSM measures. Any such benefits were not calculated because of the lack of substantiated data on which to base such calculations on.

Namibia has a mix of underutilised and highly utilised networks: sections of the transmission system and many parts of the rural medium voltage distribution systems are underutilised, while the distribution systems in a number of local authorities are highly utilised. It is therefore difficult to make generalisations with much accuracy or predictive power, and it was therefore decided not to attempt any such calculations as part of the present report.

However, it must be stated that the international experience clearly shows that benefits due to deferment of infrastructure investments do accrue, and can be quite substantial in case of highly utilised networks. Therefore, such benefits occur in addition to those benefits calculated in this report, except where stated otherwise.

The utilities are therefore encouraged to explicitly take the benefits of delaying infrastructure investments into account. Generally, utilities are in a good position to at least estimate the benefits that arise by deferring those infrastructure investments that are currently on their planning horizons. The utilities are also encouraged to consider the benefits of freeing up capacity on existing networks, which then becomes available for new consumers and/or the growth of consumption that occurs due to ongoing economic development. It is also submitted that savings through increased efficiency on the consumer side have a good potential for freeing financial resources for new consumption, i.e. a consumer whose electricity bill is reduced by implementing DSM may well choose to purchase new appliances which will consume electricity that was previously wasted through inefficiencies.

When viewed holistically, there are considerable benefits over and above those calculated in this report that can be realised by those utilities actively promoting and implementing DSM measures.

4 CONSUMER AWARENESS

4.1 OVERVIEW

The consumer awareness component as a demand side management measure is intended to strategically disseminate information concerning the DSM identified measure options accordingly and effectively to targeted consumer segments in such a way that it causes a gradual increase in efficient utilisation of electricity. The consumer awareness campaign will be carried out through various suitable implementation options such as print medium including and among others newspaper, posters, brochures, television, radio and outdoor advertising whilst taking into consideration the energy consumption patterns of the different consumers. The consumer awareness campaign is to incorporate an awareness as well as an education element through which the various demand side management options are introduced, explained and implemented in an easy to understand manner.

The consumer awareness component is a critical and necessary element in the overall process of implementing a successful demand side management program in Namibia. The campaign is to ensure that the DSM options discussed in this report are effectively disseminated to all beneficiaries.

The consumer awareness campaign will include the information needs of all residential, commercial and industrial consumers' electricity needs, and will take into account the economic and financial challenges, demographic issues (rural vs. urban) and accessibility of the various consumers to ensure that the information disseminated is useful and brings about the desired outcomes.

4.2 BACKGROUND

The background of the DSM study, and in particular the need for a consumer awareness campaign, is due to the fact that Namibia has a rapidly increasing demand for electricity, and relies heavily on imports from South Africa to cover its domestic energy consumption requirements. This situation prompted the Electricity Control Board (ECB) to investigate and identify Demand Side Management Measurement (DSM) that are suitable for Namibia.

Consumer awareness has been identified as a key barrier to the more efficient use of electricity in Namibia. A review of international experience with DSM programmes also shows that invariably consumer awareness is a central theme in any such programme.

A consumer awareness campaign undertaken as part of the implementation of DSM measures is linked to the fact that the country is facing a short to medium term energy crisis which necessitates a consumer education and awareness drive that will motivate and encourage the various consumers to utilise electricity more efficiently, and in a more cost-effective manner, and also advocates the targeted DSM measures.

Namibia has not made any recent investments in power station that could - in the event of power supply disruptions from South Africa - avert a power crisis. Despite the fact that the country is blessed with significant sunshine and almost ideal wind regimes along its coastline, Namibia has not embraced the potential of these renewable energy sources to supplement the existing supply sources and alleviate potential future supply shortfalls.

A consumer awareness and education campaign as part of the implementation of the DSM measures will therefore play a critical role in ensuring that the DSM options identified deliver the desired DSM outcomes for Namibia, thereby contributing towards the efficient reduction of the peak demand consumption of electricity consumers.

4.3 DEPENDENCIES

The consumer awareness and education campaign depends critically on the following:

- the government and relevant stakeholders in embracing the required DSM measures, and specifically Government leading by example in implementing DSM measures where appropriate
- the availability of the necessary financial resources to fund the awareness campaign
- the campaign being able to convince and encourage consumers on a broad base to change individual and collective energy usage
- on the campaign effectively engaging and reaching consumers, which requires the implementation to respect the social engagement rules in the different society and consumer segments
- the campaign's ability to change and sustain pro-DSM consumer perceptions, habits and behaviours

4.4 THE VALUE PROPOSITION

4.4.1 Customer value

The consumer value propositions are the intrinsic values that the consumer will directly benefit from the consumer awareness and education campaign including among others the following customer values

- That the consumer becomes aware of the different DSM options available for Namibia
- The consumer benefits directly through cost savings as a result of using alternative energy sources and technologies and becoming more energy aware
- That the consumer is now provided with more alternative energy sources and technologies to choose from.
- The industrial consumer can now through effective energy audits structure their energy consumption patterns in such ways that they eventually reduce their monthly bill.

4.4.2 Utility value / impact

The utility value or impact to NamPower and the Red's is that they will participate in the national effort to encourage electricity consumer to become more efficient in their energy consumption patterns as well as to encourage them to seek alternative energy technologies such as solar water heaters to supplement their energy needs.

Utilities have the opportunity to be seen as environment sensitive; interested in consumer benefits (i.e. what the consumer can save) while participating in consumer awareness programmes, and has the opportunity for branding and building an image of being interested in the wellbeing of the consumer.

Utilities can also influence consumer behaviour through information in ways that also benefit the utility by flattening the load profile. The utilities are therefore likely to be more interested in those parts of the consumer awareness drive that relate directly to DSM measures that hold significant benefits to the utilities themselves.

Some DSM initiatives will decrease utility turnover, and therefore could be perceived as a threat to utility profitability. The awareness around these may need to be done by someone other than the utilities since a) they will find it difficult to motive expenditure on advertising measures that will reduce their turnover and b) they will not be motivated to promote these measures for the same reason.

4.4.3 Customer segmentation and potential

As identified by the 1st demand side management study report presented in May 2006, customer segmentation is the categorisation of the different main consumer groups benefiting differently from DSM measures, namely

- Residential consumers, i.e. this segment represents a significant number of consumers and is a key focus in the consumer awareness campaign, encouraging residential consumers to limit their energy consumption, particularly in peak demand periods. The potential for these consumer is quite significant as is evidenced in the reduction on their monthly bill due to cost saving measures when utilising energy efficiency technologies such as solar water heaters as opposed to electric geysers in residential households.

- Commercial consumers, i.e. shops, hotels, government offices, etc. This segment is characterised by its diversity of energy usage and differences in size, type and timing of electricity consumption. The potential of switching to DSM measures such as energy audits will provide commercial consumers with an overview of their monthly electricity energy consumption patterns and thus assist them in managing this component more efficiently in order to reduce monthly electricity costs.
- Industrial consumer, i.e. the big manufacturers, mining companies and fishing sector that consume large quantities of electricity for production, manufacturing and processing. These consumer segments usually deals directly with the utilities, and generally have their own internal demand side management measures to control monthly billings. In times of imminent energy crisis industrial consumers can agree on special mutually beneficial energy supply agreements with utilities in such ways that the situation does not effectively disrupt production or operation of these consumers.

4.4.3.1 Low income Households

As reported in the first DSM study report domestic consumers contribute about 28 per cent to the total electricity consumption from the national grid. And in terms of consumer number an estimated 128,000 consumers consume electricity directly from the national grid. Out of this number a significant consumer are from the lower income groups.

Therefore the consumer awareness program will need to ensure that the needs of this consumer group are taken into consideration through mass communication mediums such as radio, print and television with the aim of making them aware of alternative efficiency energy technologies and through that advocate the benefits in simply terms to enable them to gradually switch to these technologies.

For this consumer segment the campaign will need to be simple and understandable and focus on savings that can be achieved by embracing energy saving technologies. Specifically this campaign element should build a basic understanding of the electricity value chain, the time of use cost of electricity and hence why it is important to save at certain times, and to increase awareness of how electricity tariffs are structured and what this implies for consumers. The campaign may also need to address some social/traditional perception aspects of low income consumer groups that pose barriers to the successful implementation of DSM measures. The design of these campaign elements will therefore need to take cognisance of such issues.

4.4.3.2 Medium to high income households

The medium to high income household have different spending patterns than those of the lower income consumer households. The consumer awareness campaign for this consumer group will be carried out through identified mediums such as print, radio and television and specialised magazines such as Insight and outdoor placements to promote the DSM measures.

The medium to income households are the ones out of a population of 128,000 estimated consumers that are contributing the most in terms of electricity spending from the national grid and would be a significant group to target in terms of consumer awareness creation of the DSM measures especially with the focus in encouraging them to switch to more energy efficient technologies such as solar water heaters from the electric geysers that are currently installed.

In this consumer segment the campaign will need to focus on more technical details and specifically address perception barriers, such as perceptions about CFL light quality or SWH durability. The campaign elements aimed at this segment will contain a fair amount of technical and economic information aimed at convincing consumers of the benefits of making energy efficient choices.

4.4.3.3 Commerce and Industry

The DSM consumer awareness campaign for the commercial and industrial sector is to introduce demand side management measures and energy efficient technologies that will enable these sectors to reduce their monthly electricity billing as well as encourage them to manage the electricity energy consumption more efficiently.

The consumer awareness campaign for the various commercial sector will also involve the print media such as newspapers, radio (when the drive to and from work) and television discussion forums on electricity related issues such as on “Talk of the Nation” and “Good Morning Namibia”.

The awareness campaign for the industrial segment can be driven by the utilities due to the fact that these consumers deal directly with them as well as that many large industrial business have implemented their own DSM measures.

4.4.4 Customer engagement

The consumer engagements are those dissemination points (method of communication) at which the consumer awareness campaign will either directly or indirectly engage with the targeted consumer groups taking into account their respective energy needs. The most effective engagement points for mass communication purpose will be the print, radio and television and disseminated at times at which the communicated information will be most effective in reaching these groups.

- Domestic consumers: The engagement point for this consumer group will be print such as newspapers, brochures, posters, general consumer magazines, radio and television.
- Commercial consumers' i.e. the commercial consumers are general businesses and government offices. The engagement point for these consumers will be newspapers, specialised magazines, radio and television as well as outdoor advertising e.g. billboards.
- Industrial consumers i.e. the engagement point for these consumers will generally be the utilities and municipalities and local authorities as well as the print media such as newspapers, specialise technical magazines. Due to the small number of these consumers (less than 2000 LPU consumers estimated to be in the country) it is also possible to use direct mail addressed to these entities, probably through the utilities.

The consumer awareness process should therefore be a nation wide campaign which should incorporate national communication mediums such as television, print and radio as the leading implementation options. As the fact that the campaign targets various consumer groups the campaign needs to be implemented in such a way that all targeted consumers are reached in an efficient and cost effective manner whilst advocating and promoting the available implementation options. For the purpose of the consumer education and awareness process the following implementation options were identified;

- Radio
- Print media i.e. looking at newspapers, brochures and commercial/industrial magazines
- Television
- Outdoor i.e. billboards, posters, stickers
- Dissemination of t-shirts & caps

4.4.4.1 Radio

In view of Namibia's current electricity situation (continuous media attention on the electricity supply industry) and the medium to long term electricity needs of the country, the consumer education and awareness campaign will predominately be carried out through the radio as most Namibian households have radios in their homes, information can be disseminated in different languages and at different times, the message is repetitive, and platform of discussion can be held to discuss the DSM measures and through that audiences can be requested to call in for clarification.

These radio campaigns are to be planned in terms of time of dissemination of information, location (at home, while driving, or simply listening at work) and duration. The duration of the radio campaigns are to be for a period of between 3 to 6 months depending on the level of the improvement of the electricity supply situation in the country, with periodic follow-up sessions afterwards. Namibians have more radio sets per household than television sets, which present an opportunity to meet the information needs of most domestic and commercial electricity consumers. The campaign will therefore use the following radio stations as a means to effectively reach its target consumers: NBC Radio stations, Radio Energy, Radio 99, Radio Kudu/Omulunga, Unam Radio and KCR.

There are popular forums on national radio which can be used very effectively to engage with consumers at large, and at very low cost since only the time of some specialists participating in the show need to be paid for.

4.4.4.2 Print Media

The print media especially in terms of newspapers could be an effective communication medium to disseminate the consumer awareness campaign due to the following factors: it is quick and regular, easily accessible and affordable, accommodates most common languages, and is the most widely used medium of distribution by most organisations in the dissemination of information for corporate and mass audience purpose. Special supplements and additional print options can be negotiated in such a way that consumers as are adequately informed about the electricity options/information as and when required.

The local print media is also available on the internet and is accessible to both local and international consumers. The print media is a source of media that can be stored for future use meaning that the information can be retrieved for use at later dates by the different consumers.

The duration of the print consumer education and awareness campaigns should be continuous especially taking into consideration the different identified demand side management options and their different impact on the different consumer segments as categorised above meaning that each DSM .

The print newspaper options available for the consumer awareness campaigns are as follows

- The Namibian: the leading flagship newspaper in Namibia in terms of number of readership, volume print as well as its ability to accommodate the language needs of the most Namibians. The Namibian newspaper is also widely distributed countrywide.
- The Republikein: a daily Afrikaans newspaper that caters to the communication needs of the Afrikaans community, also carries English supplements, and caters predominately for the Khomas, Erongo, southern and the northern regions of the country.
- New Era: an English daily that is also widely distributed as well as accommodating other indigenous languages.

Brochures and Posters: should be designed in various languages, and taking the requirements of the different main consumer groups into account. These prints once printed can be distributed nationwide, capitalising on the different institutional localities including schools, local authorities etc.

4.4.4.3 Television

The consumer education and awareness campaign also is to include exposure on television platforms such as “Talk of the Nation” and “Good Morning Namibia” are to be used as a means to effectively carry through the messages regarding Namibia’s electricity needs situation and possible solutions. These platforms will also present a good opportunity for the country to deliberate and review its current and long term electricity needs.

The role of Namibia’s television stations is critical, as TV reaches many different consumer groupings simultaneously. TV campaigns are to be planned in such a way that various options such as consumer education or simply awareness materials are inserted at key times.

4.4.4.4 Outdoor

Outdoor advertising is predominately advertisements that are positioned at external locations in and around towns in the full view of most motorist and pedestrians such as billboards, posters, etc An outdoor consumer education and awareness campaign as per our electricity energy situation will be a source of information dissemination especially in the field of general energy efficiency, available renewable energy sources as well as a constant reminder to the seriousness of the energy situation in the country. These outdoor campaigns will be placed at key places such as close to the Central business districts, shopping centre, entrance and exist of major town’s road network and other places deem suitable for the effective drive of the message to consumers.

Billboard outdoor advertising has the dual advantage that it’s accessible and visible to all consumer segments targeted by this consumer education and awareness campaign especially when the drive to and from work, doing their shopping.

4.5 DELIVERY

The aim of the DSM consumer awareness campaign is to effectively ensure that all consumer groups identified are sensitized on the different DSM measures including their benefits and through that encourage them to change their consumption behaviour and/or switch to efficient renewable energy technologies which will in the medium to long tem will benefit them through cost saving.

4.5.1 Awareness Campaign Key Aims and Objectives

The consumer awareness campaign should aim to achieve the following objectives:

No	Objective	Motivation
1	Sensitise to electricity supply situation	To inform consumers about the critical electricity supply situation and measures to counter act the shortages.
2	Sensitise consumers to typical energy consumption patterns and associated costs	Consumers will be aware of the energy consumption patterns of commonly used appliances as well as overall cost components of various energy technologies. Consumers will also be aware of typical utility tariff structures and their implications on the consumer.
3	Sensitise consumers to the DSM options available to consumers and benefits that consumers can get out of the options	To introduce the various identified DSM options for Namibia so that consumers can operate within that framework when it comes to choosing which options to use for their energy management. Consumers should also be fully aware of steps being taken that will affect them or that will require their participation or co-operation. Inform specifically about the benefits that consumers can get by participating / co-operating.
4	Counteract common consumer prejudices and known negative perceptions	To ensure that the acceptance of DSM measures is in the best interest of the country in the short to long term. Address negative consumer perceptions based on past performance of technologies or incorrect information about systems (e.g. SWH which did not perform well, ignorance about ripple control of EWH effects on the consumer).

Table 3: Awareness campaign objectives

The consumer awareness campaign should aim to drive through the following messages:

No	Message	Motivation
1	DSM empowers the consumer to deal with rising prices and supply shortages	Due to the rising cost of electricity the campaign aims to advocate to the consumers about methods of saving on their electricity bill as well as provide general reasons as to the rising costs (due mainly to the end of surplus capacity in the RSA).
2	Consumer should become energy aware - that wastages costs you money	The aim is to sensitise consumers to be more energy conscious and to use energy more efficiently. Also make consumers aware that they can do things to reduce their energy consumption, and make them aware at a basic level of the implications of life cycle costing, which makes many energy saving options viable (i.e. spend a bit more initially on better technology and get that money back through a lower electricity bill).
3	Energy awareness need not negatively affect your life style- it	The aim is to sensitise consumers that switching to more efficient energy technologies and co-operating

	can improve it	with utility driven DSM measures will not deteriorate your lifestyle but in fact enhance it and still enjoy the same benefits.
4	Utility peak management measures are good for you	That utilities will also benefit from the fact that resources can now be diverted to other projects or saved as a result of effective peak management measures such as load shifting, and that under the Namibian regulatory regime these benefits will ultimately be passed through to the consumer (i.e. the utilities should require lower future tariff increases if they have to invest less money in new infrastructure to supply energy which then gets wasted).

Table 4: Awareness proposed messages

4.5.2 Process and roles

4.5.2.1 Proposed Roles

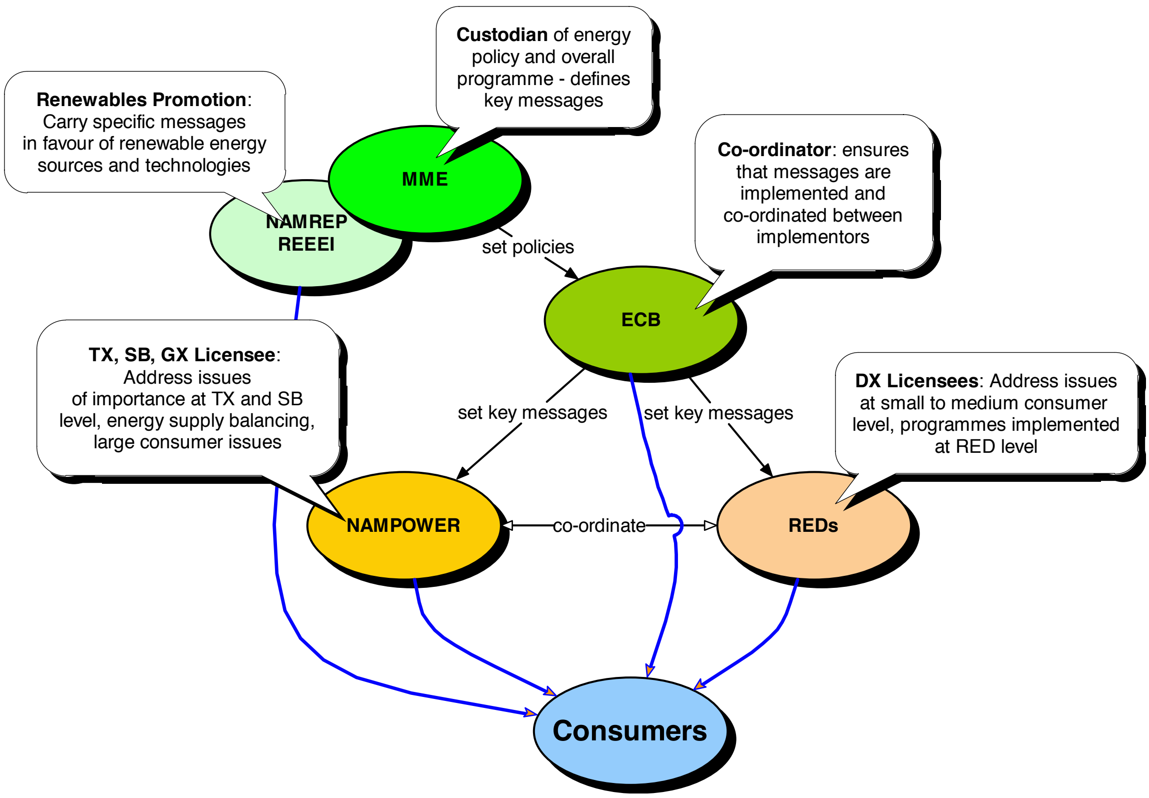


Figure 2: Awareness campaign role players

The implementation of the Namibian DSM program (including the consumer awareness campaign) is to be overseen by the line ministry, i.e. the Ministry of Mines and Energy, in collaboration with of the ECB. The REEEI has been identified as a good vehicle for implementation since energy efficiency is part of its mandate, it has a neutral position vis-à-vis the utilities and it is organisationally close to the MME. A transparent tendering process will ensure that an independent institution / agency implement the advocation of DSM measures. The ECB as the custodian of the regulation of electricity in Namibia is to ensure that a conducive environment is in place that will ensure that NamPower and the REDs participate meaningfully in the process before, during and after the implementation of the DSM program.

The key stakeholders could play the following roles:

- **Ministry of Mines and Energy:** The role of the Ministry of Mines and Energy is the ensure that the Government of Namibia approves and mandates its recommendation as provided by this report by the ECB of the implementation the overall DSM consumer awareness methodologies and through that mandates the ECB as the custodian of electricity in the country to implement its recommendations.
- **Electricity Control Board:** The role of the ECB is to oversee and guide the implementation of the DSM consumer awareness program, and to ensure that an experienced implementation agent is appointed. The role of the ECB before the consumer awareness campaign is to seek approval from the relevant authorities such as the Ministry of Mines and Energy as well as engage the involvement of key stakeholders on the recommended methodologies. The ECB can also play a significant role during the implementation of the DSM consumer awareness campaign by participating in discussion forums as organised at different platforms such as on radio, television of simply public discussion platforms such as at a university, hotel etc.
- **NamPower:** plays a critical role before and during the implementation of the DSM program, in particular in regard to its access to large power users and institutions, which will significantly assist during the envisaged consumer awareness and education campaign.
- **REDs:** to coordinate and implement DSM measures in their respective jurisdiction and to ensure that consumer in these areas are effectively reached. The REDs could also be point of contact to their respective consumers in terms of distribution of information brochures. The REDs representatives could also participate in the consumer awareness discussion forums that will be organised from time to time as a means to disseminate information to their respective jurisdictions.

4.5.2.2 Proposed Rollout

The rollout is proposed to be done in two distinct phases:

An initial intensive main rollout campaign

The different DSM measurements for the consumer awareness campaign will initially be rolled out through the various identified communication mediums on a nation wide basis targeting the respective consumer segments over a period of time harmonised with the needs of the individual DSM options. Through this process an awareness of all DSM measures and their benefits will be advocated.

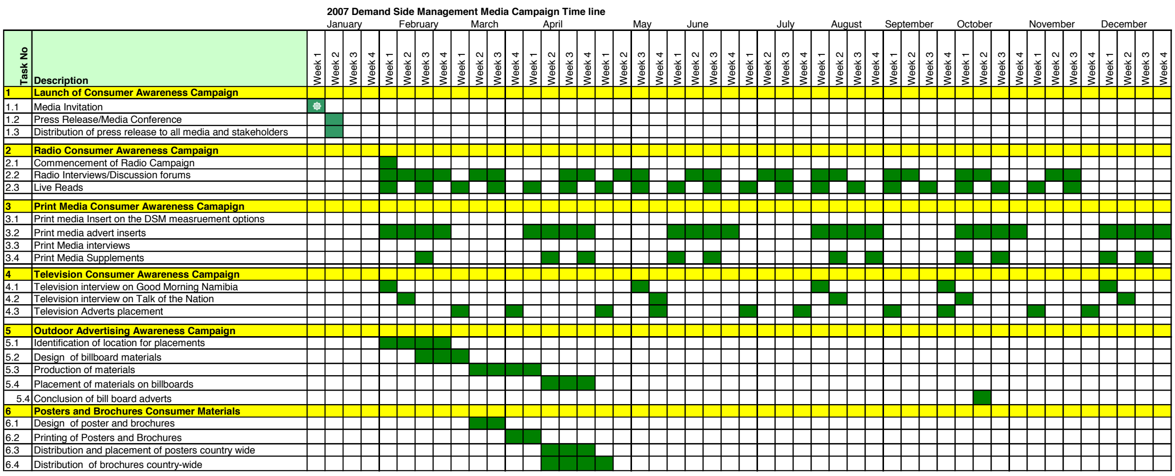


Figure 3: Consumer Awareness Timeline

Figure 3 above shows an indicative rollout programme. A more detailed programme should be developed by the implementing agent for the awareness campaign.

A follow through period

After the initial phase of rolling out the campaign a follow through of the impact of the campaign can be conducted by the implementing agency through consumer surveys (interviews, questionnaires, competitions) on the different consumer segments. The survey on the residential and commercial consumers can be done through the print media (the process can be advertised in the media), or through post discussion forums on radio and television.

The survey on the industrial consumers can also be conducted through questionnaires and direct interviews to determine the effectiveness or impact of the consumer awareness campaign on them.

4.5.2.3 Rollout Phase

The implementation phases should be aligned to the following sequence as a means to carry through the campaign in an effective manner. The sequential rollout is to ensure that a well thought out plan is followed for ease of monitoring and implementation.

- **Introduction**: focusing on the introduction of the different DSM options to all the electricity stakeholders, especially targeting each consumer segmented groups
- **The main campaign:** a detailed consumer awareness and education campaign, focusing on the detailed requirements and benefit of the different DSM options introduced, through the different communication channels per consumer segments.
- **Concluding phase**: is the gradual process through which the campaign is withdrawn from the public domain including a strong emphasis where different consumers can obtain the required financial and technical information which will assist them to install or implement demand side management measurements. The sustainability of the DSM is by the government of Namibia introduces some sort of benefits to encourage the various consumer segments to purchase and install efficient energy technologies or radically subsidised the purchase of these technologies. The sustainability will also depend on the number of renewable energy technologies purchased and installed, number of ripples installed, number of companies doing energy audits etc.

  The concluding phase will also include a follow up phase through consumer surveys upon which the effectiveness and impact on the different consumers is to be assessed. This process will be carried out through different formats such as consumer questionnaires, competitions or through discussion forums on radio and television.

4.5.2.4 Follow-Through Phase

The process is to take into account that the different DSM options will have different impacts on consumer groups, and will therefore also require different implementation periods before their impact is measurable. The follow through phase will need to establish relation with different stakeholders such as media institutions, renewable energy retailers and technicians and financial institution (Bank Windhoek) through which it can obtain information regarding purchases of renewable energy technologies.

4.5.3 Costs and investment

Due to the electricity situation in the country, the media could be consulted to become a partner in the consumer awareness campaign program through which all designated DSM media information could run for free.

This is a national consumer awareness campaign with much public interest and the media should therefore be encourage to act as platforms upon which to discuss Namibia's electricity energy options by inviting energy experts.

The campaign will still however have to be financed if the above suggestion is not embraced by the media institutions be required just in case the above does not fall through especially for materials such as posters, billboard placements, newspaper placement, direct mailing, etc.

An estimated consumer awareness campaign budget is presented below:

			Unit Price				
Implementation Options		Size	N$	Quantity	Monthly Cost	Duration	Estimated Budge
Radio Interviews	National Radio		Free	2 per month		6 months	-
	Radio '99		Free	2 per month		6 months	-
	Radio Energy		Free	2 per month		6 months	-
	Radio Radio Kudu		Free				
	Radio Omulunga		Free				
	Radio Unam		Free				
Radio Live Reads	National Radio		Free				
	Radio '99		280	20 per month	5 600.00	6 months	33 600.00
	Radio Energy		298	20 per month	5 960.00	6 months	35 760.00
	Radio Radio Kudu		285	20 per month	5 700.00	6 months	34 200.00
	Radio Omulunga		265	20 per month	5 300.00	6 months	31 800.00
	Radio Unam		160	20 per month	3 200.00	6 months	19 200.00
Print Media	The Namibian	Half Page	2615	4 per month	10 460.00	6 months	62 760.00
	The Republikein	Half Page	2780	4 per month	11 120.00	6 months	66 720.00
	New Era	Half Page	2560	4 per month	10 240.00	6 months	61 440.00
Design							8 000.00
Television							
Interviews	Good Morning Namibia		Free				
	Talk of the Nation		Free				
Adverts	20H00 News	30"	6418	2 per month	12 836.00	6 months	77 016.00
	22H00 News	30"	4790	2 per month	9 580.00	6 months	57 480.00
Advert Production							20 000.00
Outdoor	Bill Boards						
Design and Placements							15 500.00
Rental			2800	6	16 800.00	6 months	100 800.00
Print Materials							
Brochure	Design and Print	A5		10000			18 000.00
Posters	Design and Print	A2		5000			15 000.00
Distribution of materials							5 000.00
Direct Mail	Free						-
Total Budget							662 276.00

Table 5: Estimated consumer awareness budget

It must be noted that this budget is for the main rollout phase of the overall awareness programme. It does not include provision for specific needs of the individual DSM options. It is further assumed that the follow through phase awareness will be largely funded through existing communication budgets of the role players.

It is further expected that a professional media agency will be engaged to do a detail design of the campaign in collaboration with key role players, and to come up with a detailed campaign timeline designed to generate maximum impact and retention.

The importance of each media and relevance to target audience and budget allocation is shown in the table below:

Media Type	Motivation
Radio:	The importance of the radio is very crucial for the dissemination of information to a variety of consumer audience. The advantage of radio is that most household have access to radios and that it can reach many residents. Radio adverts or discussion platforms can be implemented as consumer awareness methods to disseminate information to consumers. The radio campaign can also be constructed in different languages and be disseminated at different times in such ways that the information is effectively disseminated to different consumers. There are a number of different radio stations in the country with varying frequencies. The campaign can select the most widely used radio (s) for the purpose of this campaign. We plan to run the radio consumer awareness campaign over a duration

	period of 2 months with at least 4 live leads per day and 5 times per week. Radio interviews or discussion platforms will be arranged within that duration period in order to create an interactive environment with the community.
Print Media:	The print media especially newspapers can be an effective communication media especially towards the residential and commercial consumers. The print media as mentioned above has various advantages. The print media consumer awareness campaign is planned to run for a duration of 2 months with at least 3 inserts per week including among others newspaper adverts, special supplements. The campaign will run through all the major national newspaper namely the Namibian, The Republikein and New Era as well as regional papers such as the Costal newspaper.
Television:	Television is an important communication media due to the fact that it can reach all consumer segments simultaneously and it frequency covers most if not all parts of the country. The television as mentioned above can be used as discussion forums on the various DSM measurements. Television will not be used as frequent as the other 2 medias (radio and print) but could be as effective. We plan to run at least 10 billboard inserts over a duration period of 2 month on television during the 2 news time slot especially taking into consideration that these are the most watched times on the national broadcaster.
Outdoor Advertising:	The placement of DSM measurements at key location in various towns can tremendously aid the dissemination of information to a wide variety of consumers. This is an excellent awareness creation media. This duration of billboards could be from 6 months to a year and the information can be changed from time to time depending on the needs at that time.
Posters and Brochures	We plan to design and print at least 10000 brochures and 5000 posters for distribution to all corners of the country as mean to create consumer awareness of the DSM. These items can be printed in various languages and formats to suit the varying needs of the different identified consumers
Direct Mail	The campaign plans to design and distribute about 20000 leaflets for direct mailing purpose to commercial and industrial consumers.

Table 6: Media type motivation

4.6 MONITORING AND REPORTING

The monitoring process of the consumer awareness will involve surveys of the target audiences to measure the penetration of the messages and information in the target segments. This is proposed to be undertaken during and after the campaign whereby various consumer segments will be interviewed and tested through other survey means.

Regular reporting by the implementation agency or institution as agreed with the ECB or the relevant institution will be done on the implementation of the campaign in order to ensure that things are running according to plan.

The survey process should be part of the overall consumer awareness design and must be included in the budget.

It will be the responsibility of the ECB or the appointed institution or agency to ensure that the demand side management measurement programs is being implemented in accordance with the sets aims and objectives keeping in mind the set expected targets.

The responsible institution will have to forge relationship with strategic retailers (renewable energy technologies suppliers, installers, general retailers) as a way to monitor the progressive implementation of the demand side management measures.

4.7 LONG TERM SUSTAINABILITY

It is expected that after the initial intensive awareness campaign periodic follow up will be required to ensure retention of the messages and information.

The main means of achieving the follow up is recommended to be inclusion of a requirement in the license conditions of all supply licences. The supply licensees should be required to periodically include specified message regarding energy efficiency, energy saving and ongoing demand side management programmes in their communication with consumers. Including these messages in routine communications should not attract significant additional costs.

Similarly the MME and ECB should include DSM related communication in their routine communications. The ECB has a regular publication, and periodically gives interviews or press releases to the media, which can all be used to keep conveying messages regarding energy efficiency. The ECB and MME senior staff could also be mandated to periodically make themselves available to participate in public forums (on radio and television) where they can put energy matters on the agenda.

Therefore is expected that if the initial intensive campaign is effective in significantly raising awareness on a broad level and energy efficiency is made a routine communication point for the ECB and the supply licensees then the awareness should be sustained at relatively minimal ongoing cost.

4.8 EXIT STRATEGY

Consumer awareness is an essential ingredient in any DSM programme and therefore it is very unlikely that the consumer awareness drive will need to be aborted.

There are risks of miscommunication and misunderstandings, so these should be guarded against, and it is recommended that the custodian of the DSM programme should develop baseline messages to be sent to consumers and set some basic communications standards for the awareness implementers to ensure that messages are consistent with specified central themes and do not confuse consumers.

4.9 RISK

Some of the major risks associated with the consumer awareness campaign are the following:

Risk	Possible Mitigation / Comments
Not securing adequate funding for the consumer awareness campaign	DSM should be put on the standard communications agenda of MME, ECB and the licensees insofar as this has not already happened.
Utilities not fully involved in the process	The ECB should be in a position to require licensees to participate in certain processes. Further the MME as custodian of the ESI has powers to drive the process.
Dissemination of wrong or irrelevant information to consumers & wrong interpretation by consumers	It is recommended that central themes and messages be agreed upon jointly by all role players, and that the ECB or ESI steering committee be mandated by the MME to exercise control over messages being sent.
Retailers selling inferior products to consumer (retailers taking advantage of the consumer awareness process to enrich themselves with inferior products)	It is recommended to deal with this issue specifically in the awareness campaign in the short term. In the long term standards should be developed that either forbid the import and selling of inferior products, and appliance labelling should be implemented to improve consumer information.

Table 7: Consumer awareness risks

A preliminary risks analysis is illustrated in Figure 4 below.

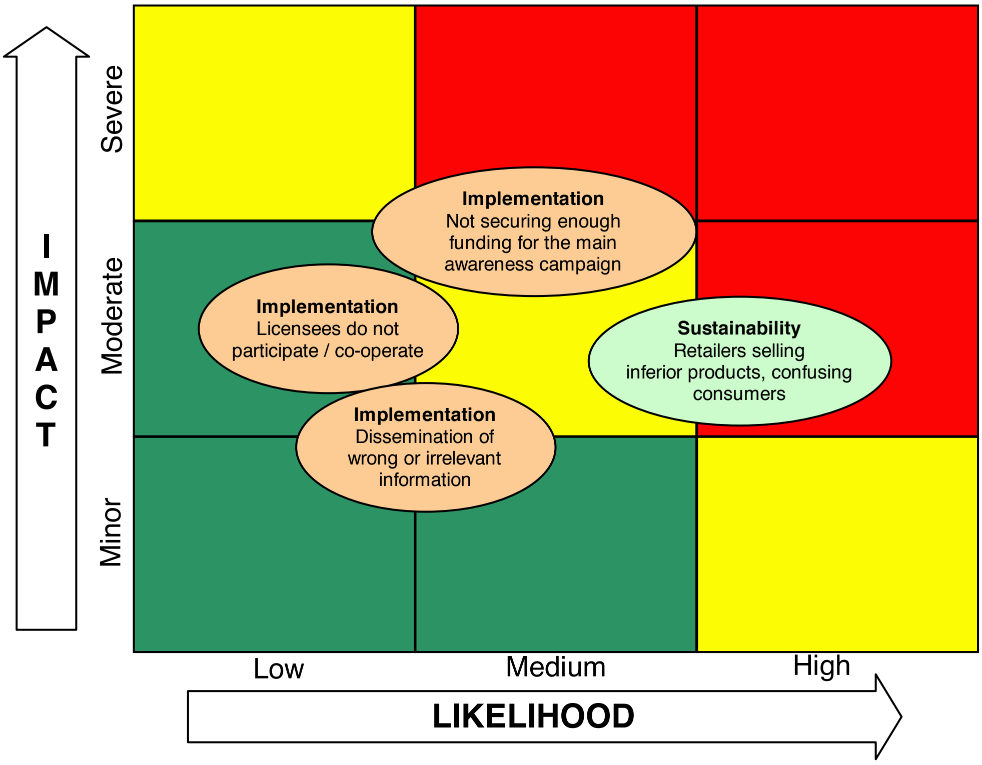


Figure 4: Consumer awareness risks

4.10 KEY ASSUMPTIONS

The following key assumptions are made:

- that sufficient finance can be found for the awareness campaign,
- that stakeholders will be prepared to spend money on 'soft messages' rather than technologies,
- that suitable agents can be found
- that messages can be cost effectively delivered to the target audiences
- that the messages reach their target and have an impact

5 TARIFF MEASURES

The price of electricity is a principal determinant of electricity consumption, and by implication, of demand for electrical energy. As such, electricity tariffs can have demand-limiting or demand-increasing effects on consumers, and provide direct price signals to consumers regarding their electricity consumption habits.

Internationally, electricity tariffs and their structure are recognised as critical ingredients of a broad-based portfolio of demand side management measures, as tariffs determine the effectiveness of most other DSM options and activities. Due to the regulatory dimension that electricity tariffs have, they constitute a direct intervention point where the regulator and utilities decide how the balance between short-term financial goals and longer-term societal needs is found. This aspect makes the design and implementation of electricity tariffs, as opposed to many other DSM options, a unique pricing instrument that critically determines aspects ranging from national economic competitiveness to social upliftment. Tariffs have very substantial macro- as well as micro-economic and political dimensions, which necessitates a judicious, balanced and maximally inclusive tariff determination process.

Many of the issues that are impacted upon by electricity tariffs in general, such as the sustainability of the electricity supply sector, social equity, as well as investment and growth issues in the electricity industry will not be discussed here. Nevertheless, they are and remain key issues to remain cognisant of, in particular for the Namibian Electricity Control Board, and the Namibian electrical utilities. One such pivotal issue, i.e. how low income connections can be maintained by life line tariffs that are peak demand friendly (e.g. by way of low capacity breakers incentivising consumers to have a flatter load profile) is very relevant but will not be discussed here.

This section focuses on the DSM aspects of electricity tariffs, and how existing tariff structures can be changed to promote peak electricity demand reductions. It does not, despite its relevance, include a discussion about general tariff reforms, and is limited to such electricity tariffs that are most likely to be an effective DSM tool that reduces peak electricity demand consumption.

5.1 BACKGROUND

Electricity retailers provide electrical energy to consumers at a certain price. Retailers, such as the REDs, purchase this energy from NamPower, and pay for it by way of maximum demand charges (MW or kW) as well as the amount of energy (MWh or kWh) supplied. This requires that REDs have to decide how energy prices are to be structured for the various consumer segments (for example large power users have a different tariff structure than have residential consumers), which happens *before* any energy is sold to any consumer. This procedure introduces an element of uncertainty in regards to the electricity supply prices on the one hand, and consumption levels on the other. This uncertainty is due to retailers generally not knowing exactly how much electrical energy each consumer will use, when they will demand such services, and how the price of electricity is going to change in the years to come. Yet every consumer expects that the retailer will offer firm demand and usage charges that do not change too often in any year.

The above dilemma is of particular significance for NamPower. The utility faces four major sources of risk when offering firm prices to retailers:

1. the variability of the total system load, i.e. total aggregated consumption, which is due to the uncertain timing and quantity of demand by consumers
2. the variability of the load on certain parts of the network as a result of changing consumer demand
3. the climatic variability and associated uncertainty of supply from Ruacana
4. an increasingly uncertain and constrained supply capacity from the Southern African Power Pool (SAPP).

NamPower has supply contracts with other SAPP utilities, even though no-one knows for sure whether the demand at any one time during the year can be met. NamPower matches the supply and demand by using Ruacana as a convenient peak load plant, while using bilateral supply contracts to cover a considerable part of the base load, while the remainder is covered by undertaking spot market transactions to purchase or sell over- or undersupplied electricity.

Namibian consumers are offered a guaranteed flat price per unit of electrical energy consumed (MWH or kWh), which is a constant price for every hour during the entire period of the contract between the retailer and themselves. Consumers may consume energy whenever they wish to do so, irrespective of whether the utility has made long-term provision for such consumption to occur. The utility is therefore exposed to the entire price risk associated with such volatile consumption, which implies that it will hedge itself for such events by including a risk premium in the price offered to consumers.

Two tariff structures address this inherent uncertainty by sharing it between the supplier and consumer:

- **time of use tariffs**, which are guaranteed prices for all demand periods, and take the long-term average macro-supply and demand situation into account
- **real-time tariffs**, which are prices that can change on an hourly or even shorter time basis to match the time-dependent demand with the time-dependent supply of electrical energy.

While guaranteed prices mostly include a price premium (it can be viewed as an insurance of supply), dynamic prices often do not include such premiums, and are therefore the more cost-reflective of the two.

Electricity tariffs that provide consumers with a price signal in relation to the timing of their electricity consumption are called time of use (TOU) tariffs, and are discussed in this section. TOU tariffs have been studied extensively, and considerable experiences exist in regard to the efficiency and economic gains that they bring[1]. For utilities, the main advantage of TOU tariffs is their increased control over the timing of consumers' electrical energy usage. Such control holds considerable value for the utility, as will be discussed in section 5.4.2. If tariffs are structured sensibly, they may reduce the overall cost of electricity to consumers (refer to section 5.4.1), even though they often do not reduce the total amount of electrical energy consumed.

However, unlike real-time tariffs discussed below, TOU tariffs are set in advance and are fixed for a specific period. This fixing, often over an entire year, limits the benefits that such tariffs offer, both for the utilities and the consumers. However, in a market with a very diverse consumer base and relatively inexperienced retailers, TOU tariffs offer a compromise solution that is both easy to understand and relatively easy to apply. In addition, they offer good planning perspectives to both the utilities and consumers, and allow for greater risk management than is possible through the traditional flat rate tariffs used today. Specifically, TOU tariffs do not expose consumers and REDs to the often dramatic and volatile price fluctuations that characterises dynamic real-time markets, such as the Southern African Power Pool.

Real-time tariffs on the other hand link the consumer price either directly (in its purest form) or indirectly (through the retailer) to the dynamic wholesale market price, where prices are determined by the total demand of other consumers participating in that market, and the supply offered to the market. The level of risk assumed by each participant is determined by market rules, which may offer the capacity to buffer prices for slow-response participants (mostly domestic retail), and offer highly time sensitive prices to fast-response participants (those having peaking plant or dynamic load shifting possibilities). The prices offered by a real-time market are the most cost-reflective, but require a considerable sophistication and participation of players. While NamPower is an active participant in SAPP, the REDs are not. In addition, the future Namibian electricity supply industry envisages a single buyer entity that would mostly eliminate the direct participation of REDs in the market. As a consequence, real-time tariffs cannot be considered a viable option for Namibian consumers, even though they provide the greatest economic benefit of all dynamic tariff regimes.

This section will therefore focus singularly on time of use tariffs. It should be noted that such tariffs cannot readily and cost-effectively be made available to every electrical energy consumer in Namibia. This is mainly due to the costs associated with TOU measurement technologies (i.e. interval meters) that have to be installed at the point of consumption. For some consumers, especially those on pre-payment meters and those having small loads and low electrical energy consumption, an exchange of their existing meters with interval meters may be too costly. Clearly, interval meters for such consumers could be subsidised by the government, or the supplying utility, although this may not be as economically attractive as many other investments are. The remainder of this section therefore assumes that only such consumers that have appreciable loads will have a sufficient incentive to switch from their existing tariff structure and metering equipment to interval meters when TOU tariffs are introduced.

Namibian consumers have not yet been exposed to TOU tariffs. The Namibian electricity market however is very price sensitive and expected to experience increasing electricity supply bottlenecks. These pre-requisites are well suited to introduce commercial, industrial and residential TOU tariffs.

[1] "The Economics of Real Time Pricing", Chris King, AEI, June 2001

Generally, TOU tariffs can either take the form of seasonal (i.e. time of the year) or daily (i.e. time of the day) tariffs. Superimposed on such tariffs can be special critical peak pricing tariffs, which would only be applicable during those times of the day when the national or regional electricity system is at a point where it cannot meet any additional demand, and is most effective for those consumers that can temporarily relieve the national system by postponing consumption, thereby shifting a part or all of their electrical load.

In Namibia it is anticipated that customers will be receptive to the introduction of TOU tariffs, which have the potential to deliver financial savings by way of lower electricity bills ***and*** can delay and/or reduce the requirement for investments into generation, transmission and distribution systems. The potential upsides of TOU tariffs – to consumers as well as the utilities – present beneficial opportunities to most stakeholders.

5.2 OVERVIEW

Electricity tariffs can provide consumers with a direct financial incentive to reduce peak electricity usage by shifting their consumption from peak to off peak periods. Such load shifting has an impact on the total electrical energy consumption in peak demand periods. Peak demand periods determine to a considerable degree how national supply and demand requirements are met, and whether the existing network infrastructure is adequate at all times.

This section recommends the introduction of time of use electricity tariffs by way of select trials that are limited in time and scale. The trials are to be undertaken in the commercial, industrial and residential sectors, and will allow both consumers and the utilities to better understand the viability and implications of a large-scale national implementation of time of use tariffs.

Time of use (TOU) electricity tariffs are price-signal based tariffs. As such, TOU tariffs distinguish between electricity consumption at different times of the day, and prices electricity consumption at different levels depending on when that consumption occurs. TOU tariffs are effective in changing the timing and demand of consumers' electricity consumption, and may lead to the reduction of a consumer's total electricity bill.

In order to implement TOU tariffs, consumers will have to have their electricity consumption measured by an interval meter that quantifies the electrical energy consumption in pre-determined time intervals, for example in peak and off peak periods.

A TOU tariff differentiates between electricity consumed during certain times, for example in a peak demand period and in off peak times. Such a simple two-tiered TOU tariff may, for example have the following components:

- Peak consumption rate: N$0.65 per kWh between 11:00 and 19:00 every day
- Off peak consumption rate: N$0.20 per kWh at all other times
- Service fee (covering the cost of both the connection and the interval meter): N$ X per supply point per month.
- Capacity fee: N$ X per ampere per month

A TOU tariff structure such as the above can create an incentive (which may be of interest to price-sensitive consumers) to save money by shifting demand for electrical energy from peak to off peak periods.

TOU tariffs require the installation of interval electricity meters at the point of consumption. Such metering devices allow the measurement of electrical energy consumption in pre-determined time intervals, for example in 15, 30 or 60 minute increments. Interval meters collect data that is of interest to the providing utility (i.e. to generate the monthly electricity bill), and can be used to determine specific individual consumption patterns, such as when and how much electrical energy was consumed during the month. The analysis of such data is therefore very important in order to ascertain whether TOU tariffs bring about the desired electricity consumption behaviours, such as shifting of peak demand to off peak demand, and whether such a shift yields sufficient short- and long-term benefits to both the consumer and the utility.

Preliminary modelling – please refer to the calculations and assumptions listed in section 5.4 – suggests that medium to high consumption residential customers can expect to save in excess of 13% (of the order of N$ 880 per annum) of their electricity bill per year for modest usage changes (for 10% reduction in peak usage over 2 hours), and some 17% (of the order of N$ 1,140 per annum) of the annual electricity bill for more significant usage changes (for 20% reduction in peak usage). Savings made by commercial and industrial consumers may be significantly higher or lower, and critically depend on the type of operation and any capital costs required to shift the timing of electricity usage.

A critical factor determining the effectiveness of TOU tariffs is the degree of consumer awareness and education in relation to the benefits and implications of their consumption habits. Consumption behaviours determine how much is spent on the electricity bill each month, which implies that consumers need to be aware of and understand the magnitude of savings that are possible when changing the time of use of their electrical energy consumption. It is therefore essential that consumers know that they have real consumption choices that can translate into cost savings when practiced correctly, and that such consumption decisions determine how much money they will have to spend on electricity.

Nationally, an understanding and the control of the level of peak electricity usage is vital for the planning of Namibia's future electricity supply, and associated transmission and distribution infrastructure. TOU tariffs are a key ingredient mitigating against the uncontrolled growth of consumers' peak electricity demand. They also enable the utilities to better plan sustainable investments in the generation, transmission and distribution sectors, thereby ensuring that the electricity sector remains viable.

5.3 DEPENDENCIES

In order for TOU tariffs to be of benefit to consumers as well as the utilities, a carefully planned implementation approach is required that will have the following key dependencies:

- That TOU generation tariffs are available for imports from the Southern African Power Pool
- That NamPower structures transmission network charges to reflect TOU usage
- That electricity distributors are both willing (requires negotiation with upstream suppliers) and able (requires downstream metering technologies and associated management processes) to implement TOU tariffs
- That national and consumer savings realised by the introduction of TOU tariffs warrant the costs associated with their implementation (costs are mainly driven by technology and human resource requirements, and amendments to management and processes)
- That consumers can be identified that can benefit from TOU tariffs (i.e. those consumers that are willing and able to shift a tangible portion of their peak electricity usage to off peak periods and have sufficient consumption to justify the installation and maintenance of an interval meter)
- That current barriers that prevent consumers from meaningfully participating and reaping the benefits from TOU tariffs can effectively be recognised and addressed during the implementation process
- That an implementation approach can be devised that respects existing consumer consumption behaviours and provides targeted and adequate awareness, education and ongoing support.

5.4 VALUE PROPOSITION

5.4.1 Consumer value proposition

The consumer value proposition of TOU tariffs rests on the realisation that consumers can save money by choosing the time and quantity of their electrical energy usage. Such a choice holds potential cost saving benefits and is therefore of value.

Electricity consumers most likely to benefit from TOU tariffs are

- commercial and industrial consumers with discretionary electricity consumption, e.g. for heating, cooling or time-insensitive processes
- commercial and industrial consumers who would, following an investment to upgrade existing technologies or amend their processes, be able to change current peak or near-peak electricity consumption patterns

- residential consumers with discretionary electricity consumption, as is often the case for air-conditioning loads, the use of certain electrical appliances (water heating and cooking), pool pumps and other non-essential electricity consuming equipment.

This section differentiates between the following consumer groups most likely to benefit from TOU tariffs:

- large power users in the commercial, industrial or mining sector
- three-phase commercial / industrial electricity users
- one-phase commercial/industrial electricity users
- residential users.

5.4.1.1 Large power users in the commercial, industrial or mining sector

International experiences indicate that TOU tariffs, in combination with other energy efficiency measures, can save between 5% and 15% of the total electricity bill of typical commercial / industrial clients. Such savings however are critically dependent on how the TOU tariff is structured, and how flexible the commercial / industrial consumer is in terms of the discretionary and overall electricity consumption.

Figure 5 illustrates the potential electrical energy savings (kWh) that large power users (LPU) can make when on TOU tariffs, as well as the magnitude of load (kW) that can be shifted by such consumers. It should be noted that the consumption, load profile and tariffs used to compute the savings and load shifting potential are for illustrative purposes only. The cost of the TOU meter is assumed to be recovered through the tariff charges to the consumer.

Annual consumption

40%	load factor
1,752,000	kWh per annum

Maximum demand rating

500	kW maximum demand rating

Old tariff structure

$500.00	monthly basic charge
$0.40	per kWh flat rate
$75.00	per kW maximum demand fee

Old annual bill

$6,000.00	annual basic charge
$700,800.00	annual consumption charge
$1,350,000.00	annual maximum demand charge
$2,056,800.00	**TOTAL (excl GST)**

New TOU tariff structure

$500.00	monthly basic charge fee
$0.65	per kWh in peak demand periods
$0.20	per kWh in off peak demand periods
$75.00	per kW per month PLUS interval meter fee
50.0%	load in off peak period before TOU tariffs
15.0%	load shift from peak to off peak as a result of introduction of TOU tariffs

New annual bill

$6,000.00	annual basic charge
$483,990.00	annual peak period consumption fee
$201,480.00	annual off peak period consumption fee
$1,350,000.00	annual maximum demand charge PLUS interval meter fee
$2,035,470.00	**TOTAL (excl GST)**

$21,330.00	annual saving as a result of TOU tariff and load shift
1.0%	percentage annual saving

4	hours per average day that load is shifted

131,400	kWh shifted to off peak periods due to TOU
10,950	kWh shifted per month to off peak periods

90	kW of average load shift
18.0%	percentage of average load shifted as a function of MD rating

Figure 5: Typical LPU consumer savings and load shifting potential

Commercial and industrial consumers have widely differing electricity consumption needs and patterns. Consumers in this category will generally benefit if TOU tariffs are introduced as part of an overall energy audit (refer to section [on energy audits]). Such an audit is to quantify the actual costs and benefits given the introduction of energy efficient technologies and/or processes, and/or changes in the timing and intensity of consumption.

5.4.1.2 Three-phase commercial / industrial electricity users

TOU tariffs may bring about monthly and annual cost savings, particularly for commercial / industrial consumers willing to acquire and/or change existing technologies and consumption patterns. Internationally it has been shown that electricity consumers may only decide to switch to TOU tariffs if additional incentives are offered. One such incentive, particularly for commercial and industrial consumers, could be in the form of a subsidised energy audit, as is discussed in more detail in section [on energy audits] of this report. Generally however it will be important for all consumers wishing to be on TOU tariffs to understand the requirements and financial implications of such a switch, which necessitates an adequate consumer awareness and education campaign (refer to section [on consumer awareness]).

Figure 6 illustrates the potential electrical energy savings (kWh) that three-phase commercial or industrial consumers could make when on TOU tariffs, as well as the magnitude of load (kW) that can be shifted by such consumers. It should be noted that consumption, circuit breaker rating per phase and tariffs used to compute the savings and load shifting potential are for illustrative purposes only. The cost of the TOU meter is assumed to be recovered through the tariff charges to the consumer.

Annual consumption

30%	load factor
182,073	kWh per annum

Circuit breaker rating

100	amp circuit breaker per phase

Old tariff structure

$10.00	per ampere per month per phase
$0.50	per kWh flat rate

Old annual bill

$36,000.00	annual basic charge
$91,036.59	annual consumption charge
$127,036.59	**TOTAL (excl GST)**

New TOU tariff structure

$12.50	per ampere per month per phase PLUS IM
$0.65	per kWh in peak demand periods
$0.20	per kWh in off peak demand periods
50.0%	load in off peak period before TOU tariffs
15.0%	load shift from peak to off peak as a result of introduction of TOU tariffs

New annual bill

$45,000.00	annual basic charge
$50,297.72	annual peak period consumption fee
$20,938.42	annual off peak period consumption fee
$116,236.13	**TOTAL (excl GST)**

$10,800.46	annual saving as a result of TOU tariff and load shift
8.5%	percentage annual saving

4	hours per average day that load is shifted

13,655	kWh shifted to off peak periods due to TOU
1,138	kWh shifted per month to off peak periods

9	kW of average load shift

Figure 6: Typical 3-phase consumer savings and load shifting potential

5.4.1.3 One-phase commercial / industrial electricity users

Figure 7 illustrates the potential electrical energy savings (kWh) that one-phase commercial or industrial consumers could achieve on TOU tariffs, as well as the magnitude of load (kW) that can be shifted by such consumers. It should be noted that consumption, circuit breaker rating and tariffs used to compute the savings and load shifting potential are for illustrative purposes only. The cost of the TOU meter is assumed to be recovered through the tariff charges to the consumer.

Annual consumption

30%	load factor
60,444	kWh per annum

Circuit breaker rating

100	amp circuit breaker

Old tariff structure

$10.00	per ampere per month
$0.50	per kWh flat rate

Old annual bill

$12,000.00	annual basic charge
$30,222.00	annual consumption charge
$42,222.00	**TOTAL (excl GST)**

New TOU tariff structure

$12.50	per ampere per month PLUS int. meter
$0.65	per kWh in peak demand periods
$0.20	per kWh in off peak demand periods
40.0%	load in off peak period before TOU tariffs
15.0%	load shift from peak to off peak as a result of introduction of TOU tariffs

New annual bill

$15,000.00	annual basic charge
$20,037.19	annual peak period consumption fee
$5,923.51	annual off peak period consumption fee
$40,960.70	**TOTAL (excl GST)**

$1,261.30	annual saving as a result of TOU tariff and load shift
3.0%	percentage annual saving

4	hours per average day that load is shifted

5,440	kWh shifted to off peak periods due to TOU
453	kWh shifted per month to off peak periods

4	kW of average load shift

Figure 7: Typical 1-phase consumer savings and load shifting potential

5.4.1.4 Residential users

Figure 8 illustrates the potential electrical energy savings (kWh) that medium- to high usage residential consumers could achieve when on TOU tariffs, as well as the magnitude of load (kW) that can be shifted by such consumers. It should be noted that consumption, circuit breaker rating and tariffs used to compute the savings and load shifting potential are for illustrative purposes only. The cost of the TOU meter is assumed to be recovered through the tariff charges to the consumer.

Annual consumption

800	kWh per month
9,600	kWh per annum

Circuit breaker rating

60	amp circuit breaker

Old tariff structure

$0.55	per kWh flat rate
$2.00	per ampere per month

Old annual bill

$5,280.00	annual consumption charge
$1,440.00	annual circuit breaker charge
$6,720.00	**TOTAL (excl GST)**

New TOU tariff structure

$0.65	per kWh in peak demand periods
$0.20	per kWh in off peak demand periods
$2.20	per amp per month PLUS interval meter fee
40.0%	load in off peak period before TOU tariffs
20.0%	load shift from peak to off peak as a result of introduction of TOU tariffs

New annual bill

$2,995.20	annual peak period consumption fee
$998.40	annual off peak period consumption fee
$1,584.00	annual circuit breaker PLUS interval meter fee
$5,577.60	**TOTAL (excl GST)**

$1,142.40	annual saving as a result of TOU tariff and load shift
17.0%	percentage annual saving

2	hours per average day that load is shifted

1,152	kWh shifted to off peak periods due to TOU
96	kWh shifted per month to off peak periods

1.6	kW of average load shift

Figure 8: Medium- to high usage residential consumer savings and load shifting potential

Medium- to high usage residential consumers may be easier to convince to switch to TOU tariffs than the other consumer categories discussed above, especially when the associated short- and long-term financial benefits are emphasised. A frequently used incentives to make residential consumers switch to TOU tariffs may include a free in-home consumption display panel that provides real-time electricity consumption, cost and tariff information. Such a display makes TOU tariffs and their cost-saving potential a transparent and tangible savings tool, and allows consumers to instantaneously decide whether or not to change their current electricity consumption behaviour.

5.4.2 Utility value proposition and impact

Tariffs are a potent tool in the arsenal of the utility to manage demand. TOU tariffs are particularly useful to incentivise consumption shifts away from peak demand periods, thereby achieving peak demand reductions.

TOU tariffs have the potential to add value to the operations of a utility, principally because

- NamPower can – if DSM measures bring about a flatter national load curve – negotiate for lower demand and in particular peak demand charges from the Southern African Power Pool
- NamPower as the Namibian monopoly network operator can introduce TOU network charges to make such charges more cost-reflective, thereby optimising investments where the largest returns are to be realised
- the REDs or other distribution agents can charge true infrastructure utilisation costs, as opposed to average costs which do not create any savings advantages for consumers
- such tariffs may significantly delay network expansion and infrastructure augmentation costs, and in areas showing good DSM responses such cost savings may be realised for a very substantial time
- they allow the utilities – through individual consumption data from interval meters - to better understand the factors driving electricity demand, and therefore plan accordingly, underpinned by real-time consumption data
- they allow NamPower, and the REDs outsourcing their retail function, to better understand the role that retailers play in the roll-out of demand response measures and demand management, thereby fostering closer collaborative ties that should minimise any unexpected peak demand by such retailers
- they allow the utilities to better cater for specific consumption needs and characteristics of consumers.

Broadly speaking, a large power user (refer to section 5.4.1.1) with an annual consumption of some 1,752,000 kWh, may without significant investments, shift loads between 30 kW and 150 kW in peak demand periods (resulting from a 5% and 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 15 MW for 100 such consumers during peak periods. Additional peak shifting may be realised with some investment in technology and/or process changes.

Three-phase commercial or industrial consumers (refer to section 5.4.1.2) with an annual consumption of some 182,000 kWh, may without significant investments, shift loads between 3 kW and 16 kW in peak demand periods (resulting from a 5% and 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 8 MW for 500 such consumers during peak periods. Additional peak shifting may be realised with some investment in technology and/or process changes.

In contrast, one-phase commercial or industrial consumers (refer to section 5.4.1.3) with an annual consumption of some 60,500 kWh, may without significant investments, shift loads between 1 kW and 6 kW in peak demand periods (resulting from a 5% and 25% load shift from peak to off peak periods respectively), which may reduce the aggregated load by up to 6 MW for 1,000 such consumers in on peak periods. Additional peak shifting may be realised with some investment in technology and/or process changes.

Medium- to high-usage residential consumers (refer to section 5.4.1.4) with an annual consumption of some 9,600 kWh may without significant investments shift loads between 0.4 kW and 2 kW in peak demand periods (resulting from a 5% and 25% load shift from peak to off peak periods respectively within two hours), which may reduce the aggregated load by this consumer group by up to 20 MW for 10,000 such consumers in on peak periods.

Given that new thermal generation capacity costs some N$ 8 million per MW of firm capacity alone (i.e. excluding the additional fuel and associated network and distribution infrastructure costs), TOU tariffs can effectively postpone or even avoid such expenses, while at the same time create incentives amongst consumers leading to a flattening of their respective demand profiles.

Clearly, the potential savings due to the introduction of TOU tariffs and the effect on peak demand reductions are dependent on the number of participants and their specific consumption behaviours. As such, it is beyond the scope of this report to quantify the dynamic aggregation effects, as well as the resulting costs and benefits that the introduction of TOU tariffs may have for utilities. It is therefore recommended that NamPower, either alone or in collaboration with the REDs, commission a study to identify the opportunities and quantify the scale of investments required and benefits that the introduction of TOU tariffs would bring about.

5.4.3 Customer segmentation and potential

The introduction of TOU tariffs is of particular interest (from the utility perspective) in areas offering the greatest potential to defer network extension or augmentation costs. NamPower and the REDs have first-hand knowledge about the location of such 'hotspots', and will know where such areas/localities are most likely to arise in the coming years. In general, one can assume that most areas having experienced moderate or even significant economic developments and/or above-average demographic growth, are likely to require network augmentation and/or expansion.

Consumers most likely to benefit from the introduction of TOU tariffs are:

- commercial consumers with fluctuating load and a medium to high percentage of discretionary electricity use, e.g. for air-conditioning plant, other heating or cooling, or time-insensitive production equipment
- industrial consumers, including those in the mining and manufacturing sector, that have non-continuous processes and/or operating plant and equipment that can be re-scheduled with or without the introduction of additional technologies or processes, e.g. electrical machinery including pumps, compressors and conveyors, as well as heating and cooling devices operating periodically
- consumers who would, with some investment to upgrade existing technologies or amend current consumption patters and processes, be able to shift their present peak electricity consumption to near- or off peak consumption
- residential consumers with discretionary and/or periodic electricity use, e.g. for air-conditioning, water heating, pool pumps and/or electrical machinery.

Clearly, it will be beneficial for NamPower and the REDs to have a good understanding of the above consumer segmentation and their respective peak electricity consumption and load shifting potential. This report assumes that the utilities will undertake a detailed analysis of this potential.

Not every consumer has a load profile that benefits from TOU tariffs, and it is therefore important that the utilities develop a good understanding of those consumer profiles that are most likely to benefit from such tariffs. The utilities' existing market research and customer information capabilities, in addition to surveys undertaken by suitable agents should provide the basis and establish the viability of TOU tariffs and identify those potential customer segments that may be predisposed to respond beneficially to price signals for peak electricity consumption. Here, the utilities should develop a set of indicative screening and selection criteria to assess the suitability of potential customers, which may include

- the magnitude of realisable consumption shifts per customer category
- the ability and willingness to shift discretionary or non-periodic peak electrical loads
- a load consumption pattern that is skewed towards peak electricity usage
- the consumers' desire to have better control over their energy expenditures
- the consumers' willingness to invest in the design of new processes or technologies in order to shift consumption away from peak demand times.

5.4.4 Customer engagement

Introducing TOU tariffs requires a multi-pronged implementation approach, and the way in which consumers are engaged will significantly determine how successful the implementation will be. TOU tariffs will have to take cognisance of existing consumer habits and consumption behaviours, as well as their intrinsic process requirements. This implies that the introduction of such tariffs will need to meaningfully address such behaviours and the barriers that may prevent consumers from shifting their electricity demand to off peak periods.

The key to a well-planned and executed implementation plan hinges on adequate consumer awareness and education in regard to consumption behaviours and tariffs. Because there are different potential consumer groups possibly embracing TOU tariffs, such a programme will have to separately cater for the particular needs and wants of each segment

It is recommended that a consumer engagement plan – as part of a TOU implementation plan – is to focus on the benefits that TOU tariffs can deliver, and the losses that will be incurred if TOU tariffs are not adopted. As such, demonstrating how best to shift consumption and thereby reduce peak demand will be critical. Emphasising the benefits on the national electricity grid, and the overall cost advantages that are benefiting everyone is important if a reduction in the pressure on the national electricity infrastructure is to be achieved. Consumers will have to understand that reducing peak usage is part of the solution to a wider problem that affects everyone in Namibia, and that real electricity bill reductions are possible if consumers are prepared to change consumption habits.

In addition to the broad-based awareness and education program, consumers will need to be provided with ongoing support, which could consist of the following:

- newspaper advertisements – by the ECB and the utilities – announcing the introduction of TOU tariffs, providing information in relation to the implementation of this new tariff structure, and explaining how to gain the greatest benefit from such tariffs
- information material, such as specialist brochures and on a website, summarising the do’s and don’ts of TOU tariffs, including frequently asked questions, savings tips, and a kWh, kW and N$ savings calculator
- a support hot line (possibly as part of wider utility support services, to be hosted either at the ECB or the utilities)
- information brochures mailed out as part of the monthly invoices, highlighting the success stories that were achieved by introducing TOU tariffs or other demand management practices.

It is recommended that the services of a reputable marketing or public relations company be sought in order formulate an approach that will ensure that consumers making the switch to TOU tariffs become engaged, educated and informed. Such a pre-implementation effort will need to focus on how to best persuade consumers, identify the potential benefits of TOU tariffs, and educate consumers in regard to the most beneficial consumption behaviours and habits.

5.5 DELIVERY

TOU tariffs have never before been available in Namibia. This implies that a considerable investment will have to be undertaken to raise consumer awareness, educate consumers, create a demand for such services and ensure that proper systems and processes are in place to make their introduction a success. Also, there is a clear lack of tried and tested capabilities required to devise, introduce and manage TOU tariffs in Namibia. This implies that an implementation process has to build the required capacity without exposing consumers or the utilities to excessive risks and/or costs.

This section – in the absence of a clear champion that will drive the design and subsequent implementation of TOU tariffs in Namibia, and without the explicit support by utilities to introduce such tariffs – summarises a broad set of recommendations on what should be undertaken to assess the viability, and devise an implementation process introducing TOU tariffs in Namibia.

In order to successfully introduce TOU tariffs in Namibia, the following critical activities need to be undertaken:

- agree about the necessity, timing and key steps for the introduction of TOU tariffs

- assess the viability of TOU tariffs for all stakeholders and participants
- identify financing options and requirements for pre-, implementation and post-implementation activities
- design, test and trial the new tariff regime
- gather pre-implementation market and consumption intelligence
- test consumer sentiments in regard to TOU tariffs
- identify the various consumer segment awareness and education requirements
- identify the required technologies, field testing and trialling
- install trial technologies
- provide installation and maintenance support
- transfer consumers from existing to new tariff structure
- change the utilities' metering and billing systems
- provide ongoing customer support
- monitor in-trial developments, and assess trial outcomes

Evidently, the above efforts will necessitate the availability of dedicated human and financial resources, and it is recommended that the ECB and key stakeholders are to agree on suitable agents that can be commissioned to undertake one or several of the above tasks.

5.5.1 Process and roles

While the ECB – by virtue of the Electricity Act – is the regulator of the Namibian electricity sector and is charged with approving tariff structures, the utilities are responsible to devise and submit suitable tariff regimes to the ECB for approval. Consequently, it is the responsibility of the utilities, in collaboration with the ECB, to investigate and decide on a course of action resulting in the successful design, testing and the implementation of TOU tariffs in Namibia.

As the introduction of TOU tariffs will require investments in both human resources and technologies, it is recommended that the key stakeholders agree on a phased step-by-step implementation approach, thus limiting the associated risks and exposure to adverse consumer reactions, as well as unforeseen cost blowouts.

It is therefore recommended:

a) that stakeholders agree on the necessity to further investigate the introduction of TOU tariffs in Namibia

b) that the initial scale and area of application of TOU tariffs be limited

c) that a TOU tariff trial be undertaken before a national roll-out is contemplated

d) that the scale of the trial and its initial application is limited to a statistically significant number of trial participants from the following core consumer segments:

   i. commercial consumers, including government ministries and institutions

   ii. industrial consumers including the mining and manufacturing sector

   iii. residential consumers

e) that the areas in which the trial is undertaken are geographically limited to allow for quick access and easy communications amongst the key participants

f) that partnership agreements between the utility and the consumer (only for commercial, industrial and government consumers) be entered into that spell out the ground rules of the trial and the roles and responsibilities of the partners

g) that suitable metering technologies be identified and sourced, and the ownership of such technologies be decided upon within the aforementioned partnership. It should be noted that interval meters are not cheap, especially those with bi-directional communication capabilities. Such sophistication however will be of great advantage during a trial as such devices enable the remote monitoring of real-time consumption patterns possible.

h) that the ECB remains actively engaged in all planning and implementation phases before and during the trial, as many decisions which have direct implications for consumers will have to be made, which is best done under the auspices of the regulator.

i) that the trial's primary purpose is to collect detailed consumption information for the various consumer groups, so as to better understand where the most significant peak demand savings can be effected, and what the real costs and benefits are.

j) that a comprehensive data acquisition plan be formulated in order to ensure that the information collected yields the required data. In this regard, and as a minimum, baseline data, as well as consumption data, the timing of consumption, the effect of behavioural interventions and the effect on demand growth in peak periods ought to be collected, and data is to be of sufficient quality to allow for statistically significant deductions.

k) that a detailed analysis of the trial results be undertaken and presented to key electricity supply and distribution stakeholders, as well as during public meetings where consumers are informed about the trial and its outcomes.

l) that a broader national implementation plan is only drafted once the lessons of the implementation, analysis and evaluation of the trial have been learnt.

5.5.2 Approximate Costs

The process described in the previous section has the following core elements and approximate costs:

TASK	APPROXIMATE COST & RESPONSIBILITY
initial stakeholders workshop	± N$ 15,000; ECB
conceptualisation and drafting of a TOU tariff trial plan, having the following core elements ▪ time- and geographically limited with 10 – 30 commercial consumers, including government ministries and institutions, 20 – 40 industrial consumers including the mining and manufacturing sector, and between 300 – 1,000 residential consumers o consumer viability assessment o financing options o design of suitable TOU trial tariffs o gathering of market and consumer intelligence o testing of pre-trial consumer sentiments o identifying suitable control group	± N$ 150,000, amount depends critically on the scope and detail of the plan; utilities & ECB
public presentation of TOU tariff plan for trial	± N$ 15,000; ECB
partnership agreements between utility and key consumers	± N$ 50,000; utilities
Identification, sourcing and field-testing of metering technology	± N$ 600,000, but this figure depends critically on the ▪ quantity of technologies to be acquired ▪ type and sophistication of technologies selected (i.e. one- or bi-directional communication capabilities, remote monitoring capacity etc) ▪ degree of clustering of trial participants (which limits the number of additional monitoring equipment) ▪ degree of aggregation ▪ degree of field tests required utilities and partners with oversight by ECB, possibly having third-party agent undertake activities as specified by the utilities
identification and sign-up of suitable consumers for trial	± N$ 30,000; utilities
clarification of ownership of such metering technologies	± N$ 20,000; utilities
drafting of a data acquisition plan	± N$ 75,000; utilities & ECB
implementation of trial	± N$ 2,500,000 ++, this figure depends critically on ▪ the design of the trial ▪ the number of participants ▪ cost sharing arrangements ▪ duration of trial (recommend one year) ▪ incentives offered to participate ▪ management of trial ▪ metering technologies selected ▪ aggregation to be undertaken ▪ degree of real-time data collection ▪ detail of analysis utilities to implement with oversight by ECB, possibly with third-party project management
ongoing consumer support during trial	± N$ 120,000, depends on level of support to be provided and required (may be much higher if technology is problematic); utilities
Ongoing monitoring and data acquisition during trial	± N$ 120,000; utilities
analysis of trial results after six and twelve months	± N$ 100,000; utilities & ECB
presentation of trial outcomes to key electricity supply and distribution stakeholders and consumers	± N$ 25,000; utilities & ECB
Drafting of a national implementation plan	± N$ 750,000 ++, this figure depends critically on which resources will be made available by key stakeholders; utilities & ECB

5.5.3 Milestones

Figure 9 shows the key milestones of a TOU tariff trial, and its approximate timing.

Task	month 1	month 2	month 3	month 4	month 5	month 6	month 7	month 8	month 9	month 10	month 11	month 12	month 13	month 14	month 15	month 16	month 17	month 18	month 19	month 20	month 21	month 22	month 23	month 24
initial stakeholders workshop	■																							
drafting of TOU trial plan	■	■	■																					
public presentation of TOU trial plan			■																					
partnership agreements			■	■																				
identification & sourcing technologies				■	■																			
identification of suitable trial consumers					■	■																		
technology ownership clarified						■	■																	
drafting of data acquisition plan							■	■																
implementation of trial								1	2	3	4	5	6	7	8	9	10	11	12					
consumer support								■	■	■	■	■	■	■	■	■	■	■	■					
monitoing and data acquisition								■	■	■	■	■	■	■	■	■	■	■	■					
analysis of trial													■	■					■	■				
presentation of trial results																				■				
drafting of national TOU tariff strategy																					■	■	■	■

Figure 9: Preliminary schedule for the trial of TOU tariffs in Namibia

5.6 MONITORING AND REPORTING

Interval meters measuring and recording a consumer's electrical energy consumption in pre-determined time increments, e.g. in 15, 30 or 60 minute intervals, are at the heart of TOU tariffs. Interval meters

- record the actual consumption of electrical energy per time interval, which forms the basis of the monthly invoice issued by the providing utility and received by the consumer
- yield valuable consumption data in real time, which is necessary to understand when and how much electrical energy was consumed on a particular day, an analysis of which can lead to increasingly cost-reflective tariffs
- provide feedback to customers by way of their monthly bill and in some cases an in-house display about their energy consuming behaviours, thereby discouraging peak energy consumption behaviours and identifying when consumption behaviours coincide with peak / off peak demand, and how much that cost
- provide meaningful statistical data, both in individual and in aggregated form, indicating when peak and off peak consumption occurs in Namibia, and how effective consumer education and awareness messages are in changing and/or reducing peak consumption behaviours over time.

Before the commencement of the trial it will be essential to collect as much information as possible regarding current customer values and attitudes, so as to establish meaningful baseline consumption data. Here, market research should complement the more technical aspects of the data acquisition and monitoring drive, in order to monitor changes in consumer understanding, attitudes, behaviour and motivations in relation to peak electricity demand.

The above implies that both quantitative and qualitative data will have to be acquired before and during the TOU trial. While quantitative data is in principle easy to obtain by way of data loggers positioned strategically at the consumer premises or a particular distribution point, qualitative data is best obtained by way targeted consumer surveys. Such surveys are to include questions assessing particular behavioural changes and responses to public and targeted information material, and should monitor attitudes to peak reduction habits in response to media alerts, the effects of the seasons, and the effectiveness of support materials provided by the utilities.

In addition to the data collected by the interval meters installed in consumer premises, the following data should be acquired as part of the monitoring and reporting functions during the TOU tariff trial:

- number and consumer group of participating customers
- baseline peak / off peak consumption split per customer
- socio-economic and demographic details of residential consumer

- proportion of peak load shifted to off peak
- timing and nature (i.e. permanent or temporary) of load shift
- educational input provided and attitudinal change of consumer achieved
- awareness provided and behavioural change achieved
- extent to which overall load is reduced (by comparing with historic bills)
- extent to which electronic displays impact on changes in consumption patterns
- consumer satisfaction with TOU tariffs and the overall benefits they bring about.

The use of a control group (equipped with interval meters but not having access to TOU tariffs) in each consumer group is recommended, as such controls provide meaningful statistical data on the impact of the tariffs on the consumption patterns and overall use of electrical energy. It is noted however that it may well be difficult to find a representative number of participants for each control group. Also, the additional costs of establishing and monitoring a control group per consumer category may be prohibitive, but should be investigated as part of the pre-trial planning activities.

A cost-effective alternative to control groups (even though not as instructive as a pure control) is to aggregate local consumption, for example by way of street level interval metering via a NamPower / RED SCADA system, or through larger aggregates which could be suburb wide or on a substation basis (this is particularly useful in the residential sector if one or several entire suburbs are targeted for TOU application).

5.7 LONG TERM SUSTAINABILITY

Internationally, TOU tariffs are increasingly embraced by both regulators and utilities, and are viewed by many as a core element in a well-balanced portfolio of demand side management practices. TOU tariffs are set to become a pricing instrument of choice for many utilities struggling with volatile consumer demand. For example, in a TOU trial in California, some 76% of participants indicated their interest to continue on TOU tariffs without additional incentives, and 65% of participants expressed a strong interest in having TOU tariffs offered to other consumers[2]. The Australian Government on the other hand has recently indicates that interval metering is to be rolled out throughout Australia, following the successful TOU experiences in Victoria and New South Wales.

There are a number of pre-requisites to ensure the long term sustainability of TOU tariffs. These include

- ensuring that consumers are given real choices with regard to the tariff regime they are on
- ensuring that the introduction of TOU tariffs is broadly supported by all major stakeholders prior to their introduction. Here it is of particular importance to gain the support of key players in the commercial and industrial sector, which emphasises the need for a carefully crafted trial involving a small subset of the total number of eligible TOU consumers. In this way, the lessons learnt during the trial can form the basis on which a national roll-out of TOU tariffs is built.
- minimising the potential conflict of interest that is inherent between participating stakeholders, both during the trial and beyond. Here, NamPower's role as the monopoly generator, network operator single buyer and significant participant in the REDs will demand particular attention by the ECB.
- emphasising the benefits of introducing TOU tariffs, and communicating them as clearly as possible to all potential participants. Such awareness and consumer education will create a natural demand for TOU services, and there are positive indications that Namibian consumers are eager to embrace TOU tariffs. If at all possible a utility-driven push for TOU tariffs or a regulatory requirement should be avoided.
- the ongoing implementation of TOU tariffs, and the associated roll-out of technologies and processes, will require that they quickly become self-funding. If the implementation of TOU tariffs requires ongoing financial support, e.g. by way of special subsidies or incentives, they are most likely to fail in creating the desired benefits, even though they may achieve load shifting outcomes.

[2] California's Statewide Pricing Pilot, Charles River Associates, 7 January 2005 (http://www.sierraclub.ca/national/postings/spp-summary.pdf), 4 May 2005 (http://www.mtpc.org/RenewableEnergy/public_policy/DG/resources/2005-05-04_CRA_CA-Pricing-Pilot_MADRI.pdf), and 16 May 2006 (http://www.iscr.org.nz/worksinprogress/work_80.pdf).

- TOU tariffs are to be (or become) as cost-reflective as possible. This is not as straight forward as it sounds, as it requires the long-term matching of costs (i.e. local generation and electricity import costs, network augmentation and upgrading costs, distribution costs, metering technology costs, as well as the management of the required processes including the necessary generation, transmission, distribution, retail and regulatory requirements) with the benefits (i.e. direct and indirect revenues) generated by such tariffs. This necessitates an ongoing evaluation of the costs and revenue drivers, which introduces additional burdens on existing management structures in both the regulator and the utilities. This is of particular importance in the recently established REDs who may not have additional human or financial resources and capacity to cope with such demands.
- TOU tariffs are most beneficial if they apply in unison (or as close as possible) with existing national generation capacity outputs and supply imports. Ruacana's generation output is seasonally dependent and can provide on-demand system peak capacity, and Namibia's electricity imports are substantially time of use dependent. Having TOU sensitive generation (local and imports) provides greater incentives for NamPower to make such tariffs available to consumers.
- Creating and maintaining incentives to introduce and sustain TOU tariffs will be essential. This necessitates the close collaboration of all Namibian ESI participants, which will be most comfortable if the interests of all parties are and continue to be taken into account.
- Keeping costs of the required new technology, as well as associated human resource requirements to a minimum.

In light of the above it is recommended that NamPower makes available its internal study of TOU tariffs. Such transparency will ensure that the financial, technical, regulatory, human resource and contractual aspects that a trial with TOU tariffs places on electricity sector participants are understood by all, and that sector participants can make the required adjustments.

5.8 EXIT STRATEGY

This section has recommended that TOU tariffs be first introduced in Namibia in a time- and scale-limited trial, and that an in-detail evaluation of the real costs and benefits of such tariffs be undertaken before designing and implementing TOU tariffs nationally.

This recommendation is specifically formulated to minimise any risks associated with the large-scale implementation of TOU tariffs, and allows for broad-based learning as well as rational experience-based decision-making during and following the trial. Inherent in this recommendation are two exit strategies:

- either to completely abandon TOU tariffs,
- or introduce them selectively only

in case the trial has shown that stakeholders have too few tangible benefits, or in case the trial shows that such tariffs are not an effective way to manage the Namibian demand of electrical energy.

5.9 RISKS

Generally, the DSM measures considered in this report offer expeditious and risk-limited options to address Namibia's constrained supply situation. The risks inherent in the introduction of TOU tariffs include:

- **Supply risks**
    - 1. Dependence on volatile supply. Namibia's dependence on electricity imports from the Southern African Power Pool, and its own volatile (as it is dependent on seasonal variations beyond the control of the generator) supply capacity constrains the benefits that TOU tariffs hold. These external conditions very substantially influence the choice and benefits that any tariff regime has, and TOU tariffs are not immune to these effects. Accordingly, they constitute a risk that Namibia will have to live with until other base-load generating capacities are either built nationally, or within the SAPP region
    - 2. Future import supply charges are not TOU sensitive
    - 3. Future network charges do not reflect TOU usage

- **Regulatory risks**
  - 1. Changes in policy and regulations may impact on implementation
  - 2. Resistance in electricity supply sector
  - 3. REDs overwhelmed
- **Economic risks**
  - 1. Benefits may not accrue to all participants
  - 2. Significant medium and long term costs
  - 3. Macro-economic conditions deteriorating reduces national consumption and therefore reduces the incentive (particularly to the utilities) to introduce TOU tariffs
- **Implementation risks**
  - 1. Suitable implementation agent ("the champion") cannot be identified
  - 2. Take up rates lower than anticipated
  - 3. Service underperformance
  - 4. Data delivery problematic
  - 5. Cost and budget overruns
  - 6. Third part delivery failure, e.g. technology supply partners over-promise and/or under-deliver

Figure **10** shows a graphical depiction of the expected risks that the introduction of TOU tariffs hold, or could impact on the introduction of TOU tariffs; risks are categorised according to their likelihood and impact.

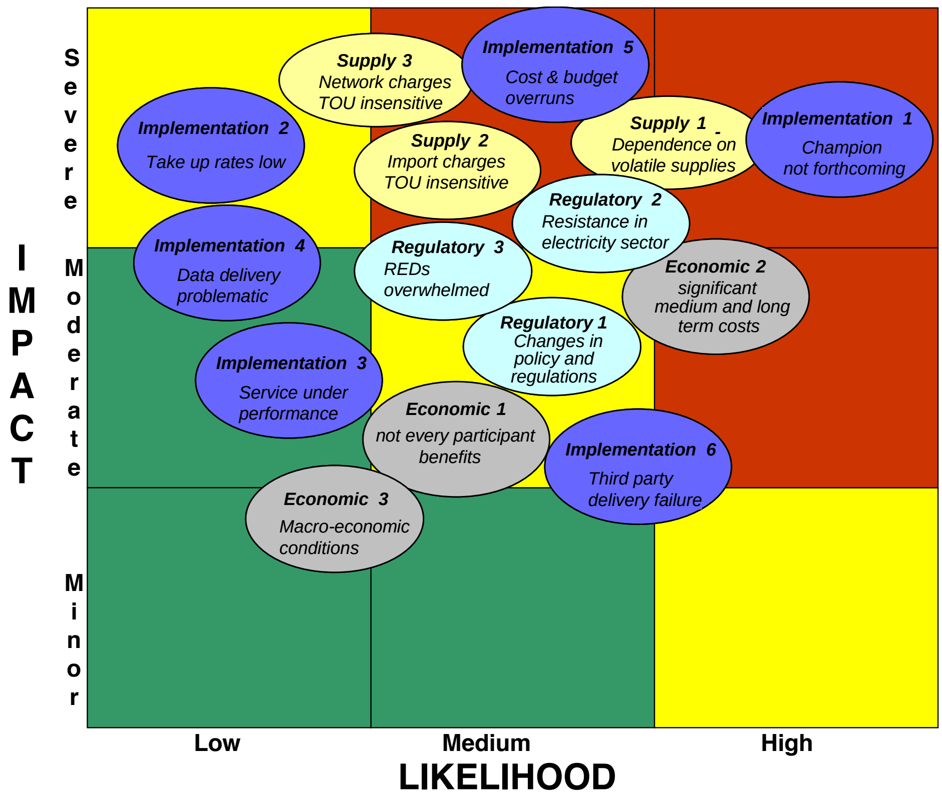


Figure 10: Preliminary classification of TOU tariff risks

TOU tariffs have not been available to consumers in Namibia, which makes their introduction risk-prone. The recommended TOU trial allows for a time-limited introduction and experimentation, which by way of its design will limit the financial, technical and other risks that the full-scale introduction of such tariffs will be associated with. The trial allows ESI participants to successively learn about the implications of such tariffs without abandoning existing well-functioning (yet peak demand intensive) tariff schemes. In addition, the trial allows ESI participants to develop much-needed organisational and technical capacity, without abandoning any revenue generating activity.

5.10 KEY ASSUMPTIONS

The assumptions listed below can also be viewed as implementation risks and constraints. This implies that the key assumptions underpinning the implementation of a TOU trial in Namibia introduces a degree of duplication between the risk section (refer to section 5.9) and the content below:

- A national implementation champion can be identified, and will initiate and sustain the momentum of the trial
- NamPower and the REDs recognise that the potential advantages of introducing TOU tariffs outweigh any potential supply losses which may result as a consequence of consumers learning to switch loads and use a combination of DSM practices. For example, if a commercial consumer decides to adopt energy efficiency practices (e.g. following an energy audit, refer to section [on energy audits]), or a residential consumer acquires energy efficient technologies (e.g. CFLs, refer to section [on CFL dissemination], or energy efficient appliances such as a solar water heater, air conditioning equipment or fridges), or a consumer reduces the electrical energy use as a result of increased awareness and education (refer to section [on consumer awareness]), the total sale of electrical energy per annum may decrease, which impacts on the sales volumes (and profitability - unless planned and managed) of NamPower and the REDs.
- The ECB, NamPower and the REDs agree to trial TOU tariffs
- Trial finances can be secured
- NamPower and the REDs can muster the human, financial and technical resources to design, implement, monitor and evaluate the trial
- Import tariffs from the SAPP are TOU sensitive
- NamPower provides a TOU network tariff
- Residential consumers with an existing pre-payment electricity meter will not benefit from TOU tariffs unless they are willing (switching cost will be the main motivator) to exchange the PPM for an interval meter
- Residential consumers having their electric hot water system(s) controlled by municipal ripple control (refer to section [on ripple control]) do not have the ability to personally influence when their hot water device is switched on or off. This implies that the overall load that can be shifted is considerably reduced. External direct load control therefore limits the benefits that such a residential consumer will have when on TOU tariffs, and the benefits associated with shifting the load from one time period to another accrue to the RED / municipality undertaking the load control function.
- Many consumers may be unable to reduce their total annual electrical energy consumption, which limits the potential savings to those made by shifting loads from peak to off peak periods.

6 DISSEMINATION OF COMPACT FLUORESCENT LIGHTS

The use of lights in the early evening hours coincides with the Namibian electricity demand peak, i.e. the time when system energy costs are the highest. It is therefore advantageous for NamPower (as the system operator and trader) to invest in measures to reduce this peak. The use of CFL lights will also have considerable benefits to the consumers who use them as well as the distributors whose demand purchases will decrease and whose networks will be freed up during peak times, so it is not unrealistic to expect these beneficiaries to also make come investments in such technology. This section describes the rationale and approach of a national programme to disseminate compact fluorescent lights to residential electricity users.

6.1 OVERVIEW

Some 760 000 incandescent light bulbs are to be exchanged free of charge for compact fluorescent lights used in the residential sector on a door to door basis in all larger towns in Namibia. The programme is to be funded by NamPower (seen as an investment in place of investing in stand-by emergency generating capacity), possibly supported by an increase in tariffs to residential consumers who will be the end use beneficiaries of the campaign.

From census information correlated with distribution customer number information it is estimated that there are around 1 150 000 light points in grid connected residential homes in major urban centres in Namibia. It is estimated that of these around 760 000 would be switched on during the evening system peak time, and therefore contribute to the evening peak. Assuming an average rating of 60 Watts per light for most lights results in a demand of 45MW, or more than 10% of the highest peak in 2005. If around 60% of such lights are replaced with CFLs, a peak reduction of around 20MW is achieved.

CFL technology has progressed over the last few years and high quality and reliable CFLs are readily available on the market, although there are also numerous dubious makes available. The introduction of warm white CFLs has extended their usefulness in settings where ambience is important, which includes many household applications. From a light quality perspective CFLs can therefore fully replace incandescent bulbs in most household applications. Consumers will need to be educated regarding the energy saving benefits to them, which make up for the slight adjustment required since CFLs often need a few seconds to start and a few more seconds to reach full light output. Consumer education will also be needed to make users aware that these lights should not be switched off for short periods.

The major reason why most people do not readily purchase CFLs is their high price compared to incandescent bulbs. If consumers were to pay for the CFL DSM option through an add-on to residential energy tariffs, they would still be better off despite such a tariff increase.

It is therefore recommended that the programme be funded by a temporary addition to the residential energy tariff rate of all REDs, calculated to pay for the CFL programme cost over a period of two years plus compensating the RED for reduced profit due to the decrease in kWh sold. It is expected that on average consumers will still be better off financially than they were before.

6.2 BACKGROUND

Households in Namibia typically use incandescent bulbs for lighting. The main reasons for this are that

- The cost of a CFL is at least N$13 vs. N$ 2 paid for a typical incandescent bulb
- Consumers are not aware that the cost difference is easily recovered over the life of the CFL
- Consumers are often not aware that CFLs are available in warm white which comes close to the ambience of incandescent bulbs, and
- Consumers are often not aware that CFLs have various other benefits, such as a reduced heat output (although this may be perceived as a disadvantage during winter).

6.2.1 Environmental Issues

CFLs contain small amounts of mercury, and hence their disposal (especially if they are mass disseminated in Namibia) warrants some attention. An excerpt on this issue from eartheasy.com reads as follows:

"*Compact fluorescent bulbs contain small amounts of mercury. The mercury poses no threat while in the bulb, but if you break one be careful not to inhale the mercury - immediately use a wet rag to clean it up and put all of the pieces, and the rag, into a plastic bag.*

Although household CFL bulbs may legally be disposed of with regular trash (in the US), they are categorized as household hazardous waste. As long as the waste is sent to a modern municipal landfill, the hazard to the environment is limited. However, CFLs should not be sent to an incinerator, which would disperse the mercury into the atmosphere.

The best solution is to save spent CFLs for a community household hazardous waste collection, which would then send the bulbs to facilities capable of treating, recovering or recycling them. For more information on CFL disposal or recycling, you can contact your local municipality.

Although CFLs have these handling and disposal issues, the large energy savings of CFL bulbs compared to incandescents is of greater overall environmental benefit."

This implies that as part of the CFL programme the implementers should arrange for the return of spent CFL bulbs and make arrangements for the proper disposal thereof.

6.3 DEPENDENCIES

A CFL dissemination programme depends critically on the following:

- to convince consumers throughout Namibian towns to exchange their existing incandescent bulbs for CFLs, thereby overcoming perceptions that CFLs do not offer the same light quality and possible other perception, tradition and attitude barriers
- to reach consumers when they are at home and willing to engage with the dissemination team, being sensitive to social engagement rules in the different society segments
- to sustain the change in perception, i.e. that consumers will in future choose to replace CFLs with CFLs, and not revert to incandescent bulbs, particularly after the withdrawal of subsidies or funding mechanisms
- to raise sufficient short term funding for the dissemination campaign
- to reassure the utilities that their profitability will not be negatively affected by the programme.

6.4 THE VALUE PROPOSITION

6.4.1 Customer value proposition

The consumer will benefit immediately through a reduced electricity bill, and will benefit in the medium to long term by not having to replace the CFLs as often as would have been the case for incandescent bulbs.

At a current retail price of 70 cents per kWh (prepaid tariff), and assuming a 60W incandescent bulb is replaced with a 13W CFL, and assuming 4 hours usage per day for 30 days in a month, 5.6 kWh or N$ 4 are saved per month. This implies that a CFL costing N$15 will pay for itself within 4 months.

Viewed from another angle, a consumer who buys N$75 worth of electricity per month and uses two lights for 4 hours per day would save 11.2 kWh or almost N$8 per month, thus saving 10% on the monthly electricity bill.

The significance (and therefore visibility) of this reduction is completely dependent on the percentage of electricity consumption by lights vs. the total household consumption. Very low income households, where lights are a significant consumption contributor, will experience a tangible saving – in the order of N$6 per month based on two 60W lights for 3 hours a day. Medium to high income households are not likely to experience significant savings on the total electricity bill. It therefore becomes important that the consumer education accompanying the distribution campaign clearly demonstrates the savings and explains the savings calculation in a manner that is understandable to as many people as possible.

The consumer may also benefit by being able to use more lights or for longer times, which may improve safety and security around the home in addition to improving quality of life by increasing lighting levels in the home. below shows the estimated benefit for consumers, coming to a total of N$10.9 million per annum.

Town	Est DOM consumers	Est PPM consumers	Lights Penetration	Est DOM lights	Est PPM lights	Est light points	Est light kW saved	est light kWh saved p.a.	Est Consumer N$ saved p.a.
Windhoek	19 546	20 829	70%	246279.6	72901.5	319181.1	8 346	9 138 685	4 569 343
Okahandja	1 691	-	60%	18262.8	0	18262.8	455	497 722	248 861
Gobabis	1 800	744	60%	19440	2232	21672	552	604 104	302 052
Rehoboth	890	4 258	70%	11214	14903	26117	732	801 710	400 855
Mariental	888	1 316	70%	11188.8	4606	15794.8	418	458 257	229 128
Keetmanshoop	-	2 683	60%	0	8049	8049	245	267 935	133 968
Luderitz	707	1 410	60%	7635.6	4230	11865.6	319	348 904	174 452
Walvis Bay	9 000	70	70%	113400	245	113645	2 830	3 098 684	1 549 342
Swakopmund	5 800	300	70%	73080	1050	74130	1 851	2 026 626	1 013 313
Henties Bay	1 900	300	70%	23940	1050	24990	628	687 397	343 699
Otjiwarongo	1 512	927	60%	16329.6	2781	19110.6	491	537 610	268 805
Tsumeb	2 628	1 000	60%	28382.4	3000	31382.4	798	873 379	436 690
Grootfontein	1 068	500	60%	11534.4	1500	13034.4	333	364 283	182 141
Oshakati, Ondangwa, Ongwediva	150	15 000	50%	1350	37500	38850	1 174	1 285 092	642 546
Rundu	-	5 700	50%	0	14250	14250	433	474 354	237 177
Katima Mulilo	-	4 100	50%	0	10250	10250	312	341 202	170 601
	47 580	**59 137**		**582 037**	**178 548**	**760 585**	**19 914**	**21 805 943**	**10 902 972**

Table 8: Estimated consumer benefit for CFL option[3]

6.4.2 Utility value proposition and impact

NamPower would benefit directly through the reduction of the evening peak, reducing the need to procure peaking power. This is a major issue currently with supply from the RSA being potentially constrained and NamPower contemplating investing in a open cycle gas turbine power plant of some 24MW which will be very expensive to operate. **One can therefore argue strongly that investing in the DSM option instead of a OCGT plant should be a very good value proposition for NamPower**. NamPower would also benefit through the improvement of the system load factor, and free up network capacity, and defer network upgrades that might otherwise be necessary to match increases in demand.

RED companies would benefit financially directly through the reduction of its billing demand invoiced by NamPower, since the demand reduction is likely to occur during the evening peak which is in many cases also the time of billing demand peak in the RED area.

On the other hand, both NamPower and the RED companies will experience a reduction in energy sales – estimated at 22 000 MWh per annum, or around 4% of residential energy consumption. Such a reduction however can be taken into account in sales volume forecasts underpinning tariff calculations, and can therefore be compensated for by electricity tariffs. The ECB's approved tariff methodology allows for such adjustments and the result should be neutral financially for the RED / NamPower.

In fact the calculation below shows a small overall direct benefit to NamPower. If one in addition considers that especially on the distribution side one can reasonably expect to defer investments in infrastructure since asset utilisation is in peak hours is significantly reduced, the picture for the REDs is also likely to be positive overall (these investment deferment benefits have not been included in the calculation since they are difficult to quantify at the level of scope of this report). Also considering the projected RED profit reduction in relation to the turnover of the entire distribution sector the loss is not very significant.

In addition the investment in the CFL campaign will bring a very fast reduction in the evening peak, whereas a slower and far less costly approach of only increased consumer awareness might bring similar results but over a far longer time.

Table 9 below shows the estimated benefit to NamPower and the REDs per annum. This disregards the possibility of NamPower not being able to supply, in which case the cost of unserved energy will be very high and the benefit of avoiding such cost through DSM will substantially add to the benefits of this option.

[3] Lights penetration % is an estimate of how many households will actually be reached by the dissemination campaign.

DOM customers are conventional metered, and the majority of these are assumed to be middle to high income households. PPM customers are prepayment customers, the majority of which are assumed to be low to medium income households.

Town	Est light kW saved	est light kWh saved p.a.	Est NamPower benefit p.a. on peak kWh	Est NP benefit on capacity bought	Est NP loss on sold kWh	Est NP loss on sold demand	Net NP benefit	Est RED kWh based N$ loss	Est ave demand saving available kW	Est RED demand cost saving	Net RED benefit
Windhoek	8 346	9 138 685	3 533 625	751 125	- 1 833 220	- 1 569 330	882 199	2 736 122	3 500	1 569 330	- 1 166 792
Okahandja	455	497 722	192 453	40 909	- 99 843	- 112 095	21 423	149 018	250	112 095	- 36 923
Gobabis	552	604 104	233 587	49 652	- 121 183	- 112 095	49 961	180 869	250	112 095	- 68 774
Rehoboth	732	801 710	309 995	65 894	- 160 823	- 224 190	- 9 125	240 032	500	224 190	- 15 842
Mariental	418	458 257	177 193	37 665	- 91 926	- 89 676	33 255	137 202	200	89 676	- 47 526
Keetmanshoop	245	267 935	103 602	22 022	- 53 748	- 44 838	27 038	80 220	100	44 838	- 35 382
Luderitz	319	348 904	134 909	28 677	- 69 990	- 134 514	- 40 918	104 462	300	134 514	30 052
Walvis Bay	2 830	3 098 684	1 198 158	254 686	- 621 596	- 1 268 847	- 437 599	927 746	3 600	1 268 847	341 101
Swakopmund	1 851	2 026 626	783 629	166 572	- 406 541	- 291 447	252 213	606 772	650	291 447	- 315 325
Henties Bay	628	687 397	265 794	56 498	- 137 892	- 89 676	94 724	205 807	200	89 676	- 116 131
Otjiwarongo	491	537 610	207 876	44 187	- 107 845	- 100 886	43 333	160 960	225	100 886	- 60 075
Tsumeb	798	873 379	337 707	71 785	- 175 200	- 179 352	54 939	261 490	400	179 352	- 82 138
Grootfontein	333	364 283	140 856	29 941	- 73 075	- 67 257	30 465	109 066	150	67 257	- 41 809
Oshakati, Ondangwa, Ongwediva	1 174	1 285 092	496 902	105 624	- 257 789	- 526 219	- 181 482	384 757	1 200	526 219	141 462
Rundu	433	474 354	183 417	38 988	- 95 155	- 89 676	37 573	142 022	200	89 676	- 52 346
Katima Mulilo	312	341 202	131 931	28 044	- 68 445	- 67 257	24 273	102 156	150	67 257	- 34 899
	19 914	**21 805 943**	**8 431 631**	**1 792 269**	**- 4 374 272**	**- 4 967 355**	**882 274**	**6 528 699**	**11 875**	**4 967 355**	**- 1 561 345**

Table 9: Estimated utility benefit for CFL option

Table 8 and Table 9 are based on the following assumptions:

light hours per day average	3.00	
average consumer tariff / kWh	0.50	
NamPower average selling price	0.20	2006/7 tariff
RED demand cost kVA	74.73	
RED lights bill demand impact	50%	
CFL demand correlation with RED billing peak	50%	50% will reduce RED billing peak
total payback (all benefits)	0.77	
consumer payback	1.16	years
nampower payback	1.83	years
RED payback	- 9.17	years
residential kWh p.a.	500 000 000	
price increase to fund dsm c/kWh	1.33	i.e. if we increase all residential kWh rates by this amount we can fund the programme in two years
price increase to balance RED c/kWh	0.28	i.e. if we increase all residential kWh rates by this amount we compensate the RED for the reduction in kWh sales
benefit remaining for consumers p.a.	3 176 994	i.e. consumer benefit - dsm cost / 2 - RED loss
% of residential kWh saved	4%	

Assumptions:
kWh saved are mostly peak time kWh
End consumers do not pay demand and do not reduce capacity, i.e. save kWh only
CFL is the first choice DSM measure due to its low cost per kW and hence the full demand saving reduces the evenign peak and saves capacity purchases.

The benefit to cost ratio can be compared with the alternative of installing new generation plant to supply this peak. New thermal generation plant costs around N$8 million per MW capacity – taking into account only capital cost for the plant and ignoring fuel cost which is also significant for thermal plant. The DSM alternative of CFLs is estimated to cost less than N$1 million per MW. The equivalent of a fuel cost to sustain the peak reduction would be any efforts undertaken after the initial dissemination to ensure that consumers replace CFL with CFL in future and do not revert to incandescent bulbs on a significant scale.

6.4.3 Customer segmentation and potential

Table 10 below illustrates the calculation of the average saving that could be expected per household. Note that DOM (conventional metered households) are taken as a proxy for medium to high income households, and PPM (prepayment metered) are taken as proxy for low to medium income households.

	DOM rooms	PPM rooms	DOM lights / room	PPM lights / room	DOM lights	PPM lights	DOM on at peak	PPM on at peak	DOM on at peak	PPM on at peak	kW saved / lamp	DOM kW saved	PPM kW saved
Bedrooms	3	1	2	2	6	2	50%	50%	3	1	0.048	0.144	0.048
Kitchen	1	1	2	1	2	1	75%	75%	1.5	0.75	0.048	0.072	0.036
Living	2	1	3	2	6	1	50%	75%	3	0.75	0.064	0.192	0.048
Garage	1	0	2	0	2	0	0%	0%	0	0	0.08	0	0
Other	2	1	1	1	2	1	25%	25%	0.5	0.25	0.08	0.04	0.02
					18	**5**			**8**	**2.75**		**0.448**	**0.152**

Table 10: Calculation of lights per household[4]

6.4.3.1 Low income households

Low income households typically have only a handful of installed lights. Most of these however will be switched on during peak time, since most rooms will be occupied at that time.

[4] Note that 60W incandescent bulbs are assumed for bedrooms and kitchen while a mix of 60W and 100W are assumed for living areas and 100W for garage and other.

Electricity consumption of the lights make up a significant part of total electricity consumption in low income households, and it is estimated that a saving of around 10% on the monthly electricity bill is possible by switching to CFLs. The majority of low income households have prepayment meters, which increases the incentive to save kWh and reduces the pay back period for CFLs because of the high energy rate being charged.

It is expected that the savings that can be made will overshadow any negative perceptions regarding any issues with regard to light quality, and with a good consumer education and information campaign aimed at this segment, consumer resistance is expected to be low.

6.4.3.2 Medium to high income households

Medium to high income households mostly live in bigger houses having more rooms and more installed light points than found in low income households. This implies that a lower percentage of installed lights will be switched on during peak time, since not all rooms are occupied, and lights installed in garages, outbuildings or around the perimeter may not be switched on. Hence a higher number of CFLs are likely to be distributed in relation to actual kW demand reduction than in low income households. However there is also a high probability that a larger number of lights will be on during peak time, and many of these lights will have a higher wattage than those used in low income households. Therefore the demand saving potential per medium to high income household is larger than for low income households. It is however recommended to limit the number of CFLs to be disseminated per household to ten, which should be sufficient to replace all bulbs switched on during peak time.

Electricity consumption by lights is a less significant part of the total electricity bill of medium to high income households than is the case in low income households. This implies that the money saving motivation is significantly lower, and other perceptions become far more important. Also, a significant number of these households have credit meters and are billed at much lower energy rates than prepayment meter customers, so the payback period is longer.

It is expected that perceptions about light quality may play a significant role in this consumer segment, and there may be significant resistance in this regard, which needs to be addressed specifically in the consumer awareness campaigns.

6.4.4 Customer engagement

It is recommended to engage customers as follows:

- A professional marketing company is to be engaged, to devise the consumer awareness campaign with specific messages and target groups. Care should be taken to engage with the utilities to ascertain their needs regarding involvement and branding in their areas.
- Before commencement of any dissemination activity a consumer awareness campaign is to be launched, aimed at informing consumers about the savings that can be realised with CFLs, and that safety or light quality will not be compromised by making the switch. This specific awareness component is in addition to the general awareness campaign contemplated in section 4 of this report.
- The dissemination drive is to be done in an entertaining manner. The aim could be to create a festive atmosphere around the dissemination trucks to draw people out of their homes, get their attention and create interest. Consumers should be informed through the media when to expect dissemination in which areas. Dissemination should be done primarily during times when people are expected to be at home.
- The follow-up phase is to see continued dissemination through selected retail outlets and utility customer service centres. Continued consumer awareness through the media is to inform consumers that they can still obtain the benefit from these sources.

6.5 DELIVERY

6.5.1 Dissemination options

The following are some options of how the CFL distribution drive could be funded:

- Subsidies at wholesale level – may be problematic to ensure that benefits reach consumers
- CFLs could be partly subsidised (in exchange for incandescent bulbs), e.g. consumers pay the same cost as for an incandescent bulb. This would reduce the capital cost, but would also reduce the impact and penetration. It would also increase the risk of rogue traders collecting and on-selling CFLs – this would have to be dealt with through enhanced control mechanisms or other provisions.
- CFLs could be disseminated free of charge in exchange for incandescent bulbs
- A mix of the above in different phases of roll-out or in parallel.

The following are some options of how CFLs could be disseminated:

- Dissemination via utility outlets – would reduce dissemination logistics costs to a minimum, but would also reduce impact because people have to make an effort. It would also increase the risk of abuse as people may start to collect bulbs and on-sell, so control mechanisms would have to be devised to reduce this risk
- Dissemination on a house to house basis – high logistics costs, but gives high impact and maximum penetration
- Dissemination via selected retail outlets – would reduce logistics costs, but control is likely to be difficult
- A mix of the above in different phases of roll-out or in parallel.

A very high impact and penetration is desired considering the immediate need to reduce demand in facing the current supply shortages. This leads to the follow recommendation:

It is recommended to have an initial intensive campaign in which CFLs are disseminated on a house to house basis, free of charge, in exchange for incandescent bulbs (limited to ten or less per household) in all larger urban centres. In parallel, CFLs should be made available on the same free exchange basis through utility outlets in all other areas of the country. After the initial roll-out CFLs should be made available on an exchange basis at a cost equivalent to incandescent bulbs, through utility outlets for a limited time, e.g. one to two years.

6.5.2 Recommended process and roles

The envisaged dissemination programme would be trialled in a mix of residential suburbs, possibly in a mix of towns spread across the REDs. This is to test the effectiveness of the preceding consumer awareness campaign as well as the assumptions made in determining the detailed dissemination method, e.g. time of day and general approach to get consumer attention and participation. It is expected that the dissemination will be done in a way that will elicit consumer excitement and willing participation, and will be accompanied by activities designed to achieve this effect. Such auxiliary activities will probably have to be tailored for key consumer segments, e.g. medium to high income areas vs. low income areas.

6.5.2.1 Recommended roles

The following allocation of roles is recommended

- MME – to provide the political backing and approval of campaign parameters
- ECB – to oversee and manage the process, approve appropriate tariff adjustments
- NamPower – project manage and fund the main campaign elements, disseminate CFLs through their service outlets
- REDs – disseminate CFLs through their service outlets, and participate in awareness campaign
- Private sector agents – to implement the main campaign (to be allocated on open tender basis)

6.5.2.2 Preparation

- Agree on campaign funding through residential tariffs
- Agree on obtaining pre-funding through loans
- Allocate responsibility for managing the campaign. It is recommended that the ECB and the utilities develop a detailed roll-out strategy which would deal among others with the following issues:

- Determine how the collected bulbs will be destroyed and recycled
- Conduct a mini survey of lamp fittings to estimate BC and ES split as well as 60W vs. 100W split for purchasing
- Design controls to combat theft

6.5.2.3 Consumer Awareness Phase

- Appoint marketing agent to design and implement awareness campaign
- Ensure that awareness and education campaign takes cognisance of other DSM measures (to be) rolled out

6.5.2.4 Trial Phase

- Run trials in Windhoek – select various suburbs to get a mix of income groups
- Engage marketing company to run the trial under supervision of ECB or its project management agent
- Test access to consumers – test consumer engagement techniques – refine and adjust where necessary
- Measure impact where possible (choose target areas and timing so that they can be measured)

6.5.2.5 Rollout Phase

- Purchase CFLs (possibly by international tender)
- Tender out dissemination agent(s), tendered out on competitive basis, possibly per region or per set of towns – performance based tender, pay per CFL disseminated or per HH reached, based on HH head details recorded and signed.
- Ensure that controls combat theft.
- Undertake nationwide roll-out based on successful trial(s)
- Disseminate CFLs on a house to house basis in larger urban centres, using dissemination teams in branded vans with accompanying intense media campaign
- In parallel, disseminate CFLs from utility (RED) service centres on same free of charge exchange basis to reach consumers outside major centres and those who miss the main campaign.

6.5.2.6 Follow-Through Phase

- Disseminate CFLs through utility service centres at an incandescent bulb equivalent cost on exchange basis for at least one year after completion of initial main campaign.
- Run a follow-up awareness campaign aimed at entrenching CFLs as the right choice to save money even if they have to be paid for.
- Evaluate consumer attitudes through a survey to determine whether the campaign can be ended or whether the follow-through phase must be extended.

6.5.3 Costs and investment

Table 11 and Table 12 below illustrate the estimated costs of the CFL campaign (excluding the follow-through phase):

RED	Town	Lights	HH	Cost	Cost/MW
CRED	Windhoek	319 181	40 375	5 176 746	620 279
CRED	Okahandja	18 263	1 691	275 551	606 219
CRED	Gobabis	21 672	2 544	344 911	625 186
SORED	Rehoboth	26 117	5 148	485 098	662 562
SORED	Mariental	15 795	2 204	263 045	628 543
SORED	Keetmanshoop	8 049	2 683	186 071	760 435
SORED	Luderitz	11 866	2 117	212 993	668 456
ERED	Walvis Bay	113 645	9 070	1 666 240	588 809
ERED	Swakopmund	74 130	6 100	1 093 005	590 558
ERED	Henties Bay	24 990	2 200	373 254	594 580
CENORED	Otjiwarongo	19 111	2 439	310 672	632 774
CENORED	Tsumeb	31 382	3 628	497 589	623 852
CENORED	Grootfontein	13 034	1 568	208 708	627 357
NORED	Oshakati, Ondangwa, Ongwediva	38 850	15 150	971 478	827 776
NORED	Rundu	14 250	5 700	361 104	833 574
NORED	Katima Mulilo	10 250	4 100	259 742	833 574
		760 585	**106 717**	**12 686 205**	**637 046**

Table 11: Estimated CFL main programme costs

	Est DOM consumers	Est PPM consumers	Est total consumers	Teamdays	Proposed teams	Days expected	Months
CRED	23037	21573	44 610	744	4	186	8
SORED	2485	9667	12 152	203	2	101	4
ERED	16700	670	17 370	290	4	72	3
CENORED	5208	2427	7 635	127	2	64	3
NORED	150	24800	24 950	416	4	104	4
	47580	**59137**	**106717**	**1 779**	**16**	**186**	**22**

time per HH minutes	5	
hours campaign per day	5	from 15h00 to 20h00 weekdays, Saturday mornings from 08h00 to 13h00
consumers / day / team	60	
days per week	6	
weeks maximum	31	
persons per team	3	
hourly rate per person N$	50	
weekly rate per person	1500	
total dissemination staff cost	**1 333 963**	

	qty	weight	volume	days on vol	days on kg	days
Average CFL team/day	428	43	0.20	15	21	15
Max CFL/team/day - DOM	1 080	108	0.51	6	8	6
Min CFL/team/day - PPM	300	30	0.14	21	30	21

weight per CFL kg	0.1	based on Osram 13W ministwist
volume per cfl m^3	0.000468	based on Osram 13W ministwist
transporter volume m^3	3	total load volume 6m^3, allow half for CFLs, other half for seat, bulb disposal etc.
transporter payload kg	900	based on VW transporter
transporter cost / month	25000	based on Avis quote with maximum insurance, including 3000km per month
transporter branding cost	76 800	based on estimates per sqm from Sign shop and Premier Signs Africa
transporter hire	549 063	
Fuel cost @ 6l/h	293 472	
Total transport cost	**919 334**	

Talk show participation x 10 - expert	12 000
Newspaper ads	50 000
TV ads	50 000
Radio ads	50 000
Awareness design	45 000
Other awareness	50 000
Total Awareness Campaign cost	**257 000**

Staff costs	1 467 359	add 10% to above for additional work items
Transport costs	1 011 268	add 10% to above for additional transport
Awareness campaign costs	257 000	
Project management	500 000	expert full time for one year
Contingencies	323 563	10% on all above
Total dissemination costs	**3 559 189**	

Lights purchase cost	9 127 016
Total main drive costs	**12 686 205**

Table 12: Details of estimated CFL campaign costs

The costs of the main dissemination campaign are estimated in Table 12 above. This assumes that CFLs can be purchased at N$12 each (14W Osram, budget price provided by Osram RSA), and that it will cost in the order of N$33 per household to disseminate the CFLs, including consumer awareness campaign costs.

The total cost of the CFL dissemination programme therefore amounts to around N$12 million, at a cost of around N$640 per kW saved. This is less than 10% of the installation cost per kW of new thermal generation capacity.

6.5.4 Milestones

Description	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Month 13	Month 14	Month 15	Month 16	Month 17	Month 18	Month 19	Month 20	Month 21	Month 22	Month 23	Month 24	Month 25	Month 26	Month 27	Month 28	Month 29	Month 30	Month 31	Month 32	Month 33	Month 34	Month 35	Month 36	Month 37	Month 38
Programme Management																																						
Procure CFLs	X	X	X	X																																		
Assemble dissemination teams & fleet	X	X	X	X	X																																	
Consumer Awareness																																						
Initial preparation campaign			X	X	X																																	
Accompanying campaign						X	X	X	X	X																												
Follow-up campaign											X				X				X			X	X															
Main CFL Dissemination																																						
NORED							X	X	X	X	X																											
CENORED							X	X	X																													
Erongo RED							X	X	X	X																												
Central RED							X	X	X	X	X																											
SORED							X	X	X	X	X																											
Follow -up																																						
Make exchanges available through outlets								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X													
Verify impact													X	X												X	X										X	X

Table 13: Estimated CFL implementation timeline

The dissemination costs have been estimated based on the number of teams require to complete the dissemination in half a year, and that is what the timeline above is based on.

6.6 MONITORING AND REPORTING

The following monitoring and reporting steps are recommended:

- Details of households reached during the dissemination campaign are to be recorded, e.g. street address or erven number (GPS co-ordinate in areas without such data), name, telephone number, number of CFL disseminated. This paves the way for a sample survey a year or so after the initial dissemination to determine how many of the CFL given to the HH are still in operation.
- Consumers are to sign a receipt for CFLs received.
- The dissemination records are to be compiled into a database for later analysis and included as part of a campaign completion report.
- A statistically significant sample survey is to be conducted between one and two years after completion of the initial campaign on households that have received CFLs during the main campaign. The survey is to ascertain how many CFL are still in operation, and whether the consumer experience and attitude regarding future bulb purchases has changed.
- Based on the outcome of the survey, a decision can be taken whether the programme can be discontinued or whether further follow-through is required.

6.7 LONG TERM SUSTAINABILITY

- Continued consumer awareness follow up will be required, probably incorporated in the REDs' awareness campaigns. The ECB could include this as part of the license requirements.
- Higher electricity prices will provide a natural incentive for consumers to opt for CFLs.
- Standards for CFL should be developed to ensure that low quality CFL are kept off the market or consumers are at least aware of them.

- It is to be ensured that original issue of CFLs is of high quality so that consumers experience long life and good performance.

6.8 EXIT STRATEGY

- The proposed campaign is designed to make a high initial impact through free dissemination, followed by a highly subsidised follow through phase, aimed at getting consumers to realise that they need to be prepared to pay for CFLs in future.
- If the campaign is fully successful at raising awareness of how quickly CFLs pay for themselves, it should be possible to discontinue all subsidies after some two to three years, provided that the REDs maintain the level of consumer awareness afterwards

6.9 RISKS

Table 14 enumerates some of the risks that the CFL dissemination option faces, together with some possible mitigation measures.

Risk	Possible Mitigation / Comments
Low quality CFLs exist and may enter the market after the initial dissemination drive.	This is to be managed through standards and/or consumer awareness.
The dissemination programme may find it difficult to reach a high percentage of households, resulting either in lower penetration or higher dissemination costs.	Careful design of the awareness campaign and learning from the dissemination trial run should mitigate these risks.
Users may revert to incandescent bulbs after some time	This is to be managed by way of an intensive consumer education program focussing on the savings generated by CFLs, i.e. that they pay for themselves in a short time and generate real savings thereafter. Rising electricity prices will naturally aid this process.
A free exchange programme including high income households may stir some political controversy, especially in light of many rural households not having any access to electricity.	This risk needs to be managed in the education campaign, and the programme needs to have proper political backing to succeed.
Trade in newly exchanged CFLs may start, i.e. people trying to sell CFLs that were obtained free of charge.	This is to be managed by limiting the number of CFLs disseminated per household, as well as recording dissemination details including names and addresses of recipients and raising awareness that this information will be used for a follow-up survey. Stock of CFLs must also be strictly controlled to prevent dissemination agents from selling them elsewhere.
Environmental concerns around the disposal of CFLs based on them containing small quantities of mercury and other chemicals.	It is recommended that the campaign include for environmentally correct disposal of CFLs through a) educating consumers in this regard and b) if warranted collect expired CFLs through utility outlets (possibly in exchange for replace CFLs in an extended subsidy campaign) and dispose of them properly.

Table 14: CFL risks

Figure 11 below illustrates a high level assessment of the risks in terms of probability of occurrence and impact if they do occur.

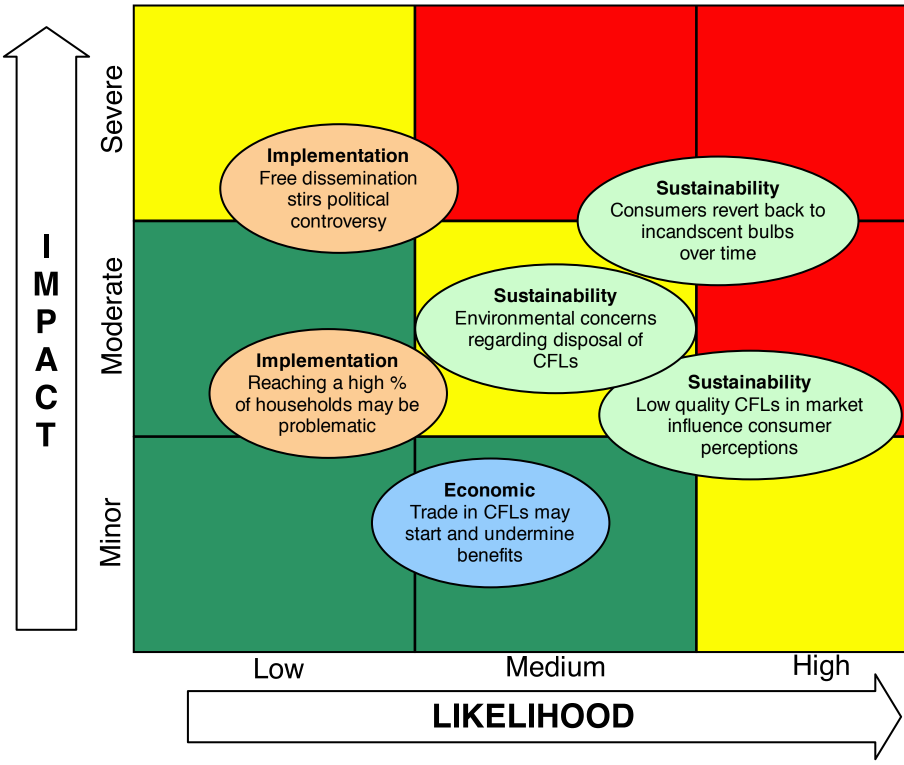


Figure 11: CFL risks

6.10 KEY ASSUMPTIONS

- That residential consumers can be convinced on a broad scale to exchange their bulbs for CFLs.
- That residential lights are used mainly during system peak hours in the early evening.
- That the main benefits accrue to the recipients of the CFLs, and that it is therefore fair and reasonable that they should fund the campaign through a small energy rate increase.
- That the ECB's tariff methodologies will allow the utilities to predict and compensate for reduced kWh sales through an additional small increase in tariffs.

7 SOLAR WATER HEATERS

7.1 OVERVIEW

The conversion of domestic EWH to SWH, as well as commercial and institutional use of SWH in preference to EWH is proposed. As the major benefit of SWH accrues to the consumer and the capital costs are high, this activity should be consumer financed. However, this process must be actively supported by: awareness creation; ongoing monitoring and research; and ensuring that finance and skills are available until such time that SWH becomes the mainstream water heating solution. Therefore it is proposed that the SRF be expanded to make financing available to those consumers not able to or wanting to finance a SWH through their bonds. A domestic penetration of 33% of all formal dwellings over a period of 10 years is proposed. Government adoption of SWH for all facilities will be essential. Awareness creation and energy audit support for commercial entities is proposed.

There are an estimated 97,000 domestic EWHs[5] in use in Namibia. At a conservative average load of 2.5kW[6] per EWH this represents 242MW of connected load. If it is assumed that during the winter evening peak 50% of all EWH are on, and deducting 24MW for existing ripple controlled load, the contribution to peak load is estimated at 106MW, or 23% of national maximum demand (410MW-2005). The contribution of domestic EWH to national maximum demand is therefore significant.

In terms of energy consumption, domestic EWH are estimated to consume approximately 10% of the annual energy consumption (kWh) of Namibia. This is based on the Namibian average 5-person household consuming 30 litres of hot water per person per day.

The total capital cost of converting 97,000 domestic EWHs to SWHs is approximately N$1.3 billion, at an assumed reduced unit cost (due to high demand) of N$13,500 per SWH. Despite the fact that economic viability of SWH for domestic water heating is proven, only homeowners will consider conversion to SWH, while tenanted dwellings where the tenant pays the electricity account would not convert. The 2001 Census indicates that only 76% of homes are owner occupied. Assuming that only 50% of homeowners actually decide to convert means that only 34,000 homes (about 35% penetration) will voluntarily convert to SWH. Short term or instantaneous conversion to SWH for a high capital cost item is clearly not feasible. This would only occur if legislative action combined with a 100% subsidy were applied. However, in a democracy with a free market system such action would be vigorously resisted. Voluntary conversion will therefore be a slow process as it will take time for individuals to be convinced. For the purposes of this analysis, a 10-year timeframe is used, as this is considered a reasonable period for awareness to grow. The costs of financing 50% of the proposed SWH installations through the SRF is estimated at N$ 88 million (i.e. interest and fund transaction costs).

A simulation of the potential adoption of SWH has been generated to provide an indication of the effect on demand and energy. Research shows that the historical growth of SWH adoption over the last 5 years has been 16% annual compound growth and that in 2005 the domestic penetration was about 2.3% of the market. A simulation based on 2.5% of existing homes and 40% of new homes adopting a SWH over a period of 10 years is shown in Figure 12 This indicates a business-as-usual domestic penetration of 9% after 10 years, or the alternative of aggressive promotion resulting in a 33% penetration after 10 years.

[5] The number of existing domestic EWHs in Namibia is estimated at 97,636, based on the following approach and assumptions:

Only “semi-detached”, “detached” and “flat dwellings” counted in the 2001 Population and Housing Census, projected to 2006 at a census household growth rate of 2.5%. This results in a total of 174,040 dwellings or 44% of all households.

Only 56.1% of these households are assumed to have electrically heated water. This is based on the number of urban households that use electricity for cooking, as it is assumed that there is a reasonable correlation between the luxuries of electrical cooking and water heating.

Only one EWH per household is assumed. Although more affluent households will have more EWHs, this is ignored.

[6] The most common 150 litre EWH has a 3kW element.

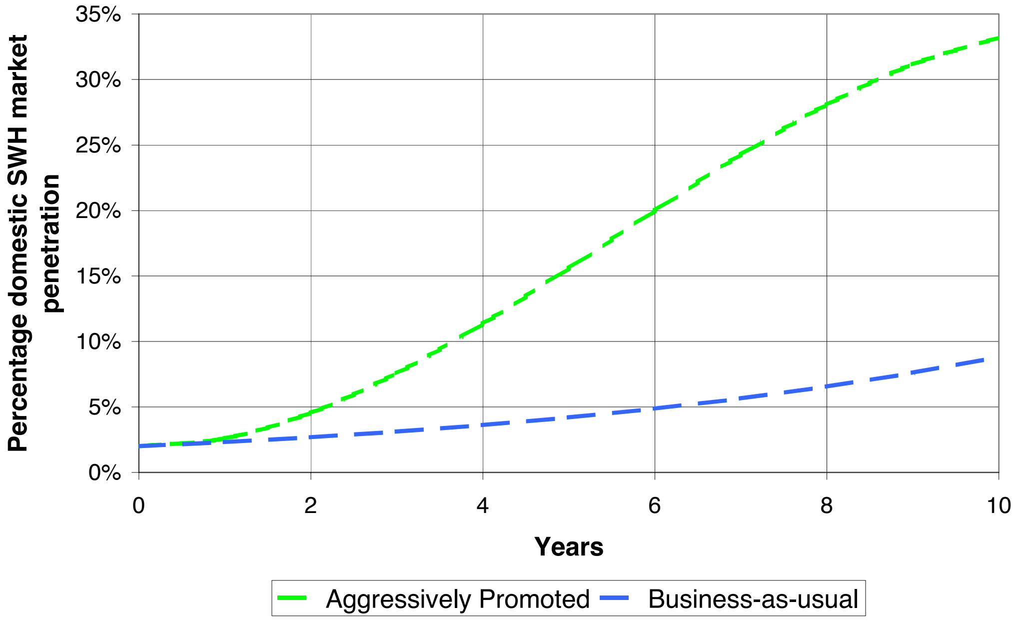


Figure 12: Simulated Penetration of SWH into Domestic Market

Figure 13 shows the effect of the above SWH penetration scenarios on electrical demand growth. A business-as-usual demand growth of 3% is assumed. This indicates that a 6% saving (52MW out of 624MW) in demand over a 10-year period can be realised if SWH were to be aggressively promoted in the market.

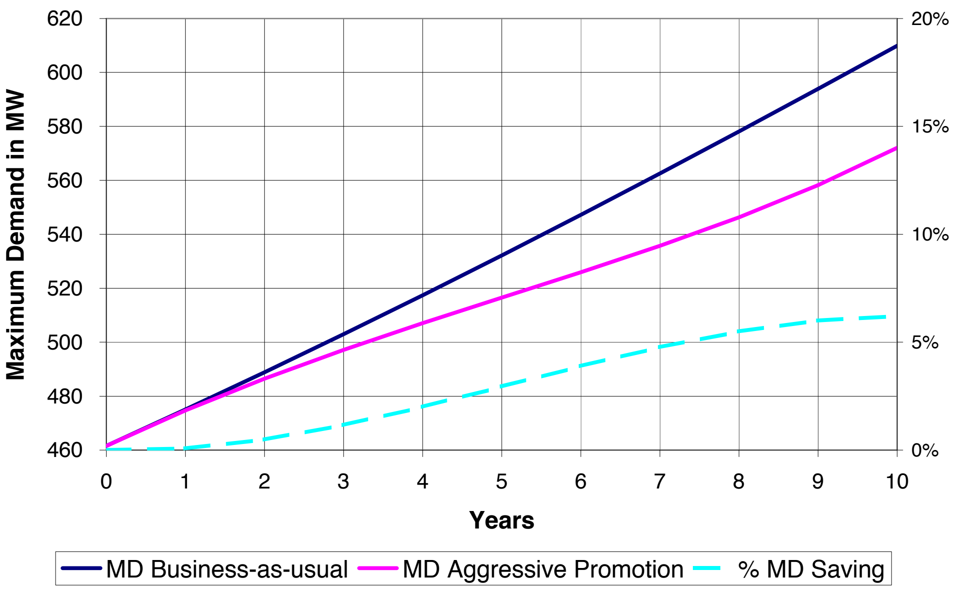


Figure 13: Simulated Demand Saving from Domestic SWH Penetration

Figure 14 shows the impact on energy consumption growth. A 3% business-as-usual growth in energy consumption is assumed. A saving of only 3% in energy consumption (156GWh out of 3,756 GWH) over a 10-year period can be realised if SWH are aggressively promoted.

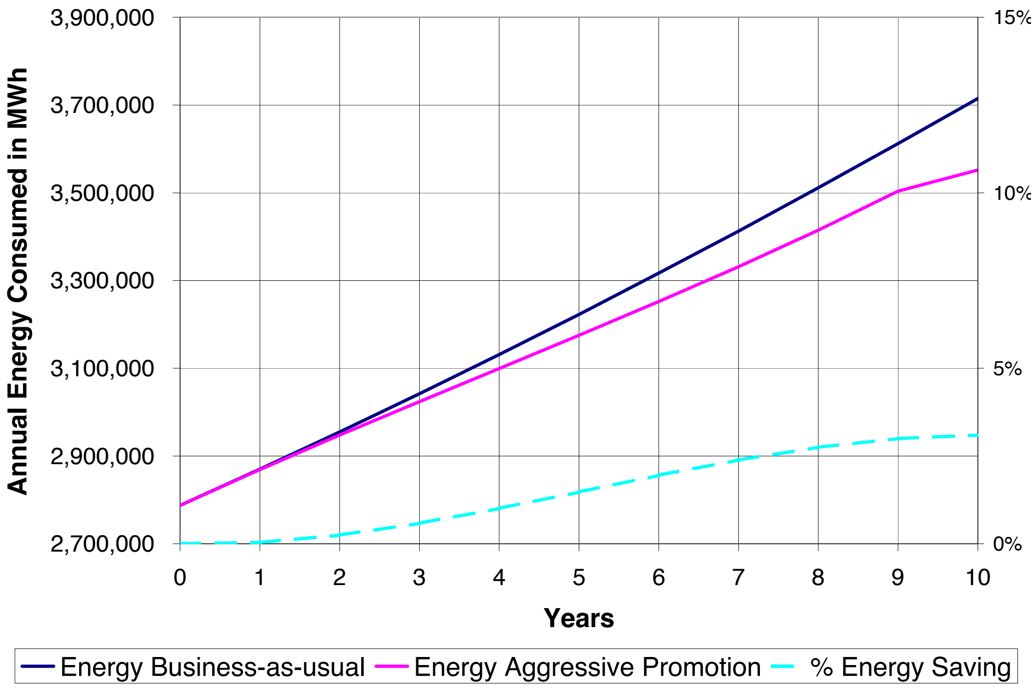


Figure 14: Simulated Energy Saving from Domestic SWH Penetration

The above analysis for domestic water heating excludes commercial and institutional (public sector) consumers. Unfortunately commercial/institutional EWH usage statistics are not readily available.

Commercial users of EWH comprise facilities such as:

- Old Age and Children's Homes
- Private Hospitals
- Accommodation establishments (Hotels, B&Bs, Lodges, etc.)

Institutional users, essentially Government facilities, who use EWH include:

- School hostels
- Military bases
- Hospitals, health centres & clinics
- Prisons & police cells

An estimate of the potential demand and energy savings from conversion from EWH to SWH in the public and commercial sectors has been performed. These rough yet conservative estimates are intended for illustration only, as data regarding these facilities is not readily available.

Table 15 indicates the potential peak demand savings or almost 9MW for the public and commercial sectors. Public and commercial EWH represent approximately 4% of national peak maximum demand.

Public Sector	EWH Max Demand (MW)	SWH Max Demand (MW)	Potential savings Max Demand (MW)
Education (Hostels)	10.0	4.0	6.0
Health (Hospitals & Health Centres)	2.5	1.0	1.5
Prisons	1.2	0.5	0.7
Sub-total public sector	13.7	5.5	8.2
Commercial			
Old age & Children Homes	0.36	0.14	0.22
Private Hospitals	0.09	0.04	0.05
Hospitality Industry (HAN)	0.59	0.24	0.35
Sub-total commercial	1.04	0.42	0.62
Total Public & Commercial	**14.7**	**5.9**	**8.8**

Table 15: Estimated potential demand savings in Public and Commercial Sectors

Table 16 shows the potential energy savings for commercial and institutional entities. Commercial and institutional EWH represent about 1.5% of national annual energy consumption, and approximately 1% of national energy consumption can be saved by these entities converting to SWH.

Public Sector	EWH Energy (MWh pa)	SWH Energy (MWh pa)	Potential savings Energy (MWh pa)
Education (Hostels)	26,767	5,353	21,413
Health (Hospitals & Health Centres)	6,756	1,351	5,405
Prisons	3,310	662	2,648
Sub-total public sector	36,833	7,367	29,466
Commercial			
Old age & Children Homes	964	193	771
Private Hospitals	241	48	193
Hospitality Industry (HAN)	1,587	317	1,270
Sub-total commercial	2,791	558	2,233
Total Public & Commercial	**39,624**	**7,925**	**31,700**

Table 16: Estimated potential energy savings in Public and Commercial Sectors

Achieving demand and energy savings for commercial and institutional entities is believed to be easier, for the following reasons:

- The owner of the facility derives the benefit directly, as compared with domestic where tenanted accommodation or practical considerations (e.g. block of flats) make adoption more difficult.
- Commercial entities have more ready access to finance at favourable rates.
- The public sector (Government) can allocate funds to capital projects if feasible.
- These facilities in general show a high return on capital investment because of their being subject to maximum demand charges.
- Implementation of conversion to SWH can be achieved faster because less entities are involved.

The combined domestic, commercial and institutional predicted savings from SWH are indicated in Table 17.

	Demand Saving MW	Energy Saving GWh pa
Domestic	52.0	156
Public Sector/Institutional	8.2	29
Commercial	0.6	2
Total	60.8	187

Table 17: Predicted Demand and Energy savings from SWH

7.2 BACKGROUND

A study[7] into the feasibility of replacement of EWH with SWH conducted in 2005 revealed that the economics of SWH have improved dramatically since a similar study[8] completed in 1999. This is ascribed mainly to real increases in electricity tariffs coupled with real cost reduction in SWH equipment. The recent study showed that the microeconomics of SWH make them the technology of choice. Table 18 shows how the average breakeven period for SWH versus EWH has reduced over the 6-year period between the two studies, averaged across the different tariffs of various electricity distributors. The latest study assumed that electricity tariffs in the medium term would continue to escalate above inflation. This assumption has been borne out by the recent bulk tariff increase, which exceeds the assumptions made. The economic viability of SWH may therefore be expected to improve further.

Tariff	Breakeven year	
	2005	1999
Pre-payment meter	4.9	9.1
Credit meter	6.4	13.1

Table 18: Average Results of Breakeven Period between SWH and EWH

Case studies in the commercial and institutional sectors have shown that SWH had an even shorter breakeven period, of between 19 months and 4 years, depending on individual circumstances. Hence the case for SWH for commercial/institutional situations is even stronger than is currently the case for domestic SWH.

The previous barrier of high capital cost of SWH equipment has been countered with the paradigm change in approach used in the 2005 study[7]: while breakeven is a valuable measure, it does not represent reality. Most houses are equipped with a EWH, which implies that homeowners finance their EWH through their home finance arrangements. Thus, the comparison between SWH and EWH should rather be made based on such a financing scenario. If a SWH is financed, e.g. by way of its inclusion in a mortgage loan, then the high initial capital cost ceases to be a barrier. Figure 15 shows the comparison for a financed SWH compared with a financed EWH, including full life-cycle operating and maintenance costs. This shows how the homeowner saves in terms of cash flow from day 1 with a SWH compared with an EWH, hence making a SWH the technology of choice.

The study revealed that property valuators did not necessarily recognise that a SWH added more value to a home than an EWH. This matter is being addressed by the present promotion of SWH project. Financiers must be encouraged to recognise a SWH as adding value to a home and to finance SWH systems. Some progress has been made in this regard with an agreement between MME and Bank Windhoek for a RET finance scheme at preferential rates.

[7] Emcon (August 2005), *Assessment of Feasibility for the Replacement of Electrical Water Heaters with Solar Water Heaters*, UNDP, GEF, NAMREP.

[8] Emcon (1998), REEE 2/98 *Technical and Micro-Economic Comparison between Solar Water Heaters and Electrical Storage Water Heaters*, MME, GTZ.

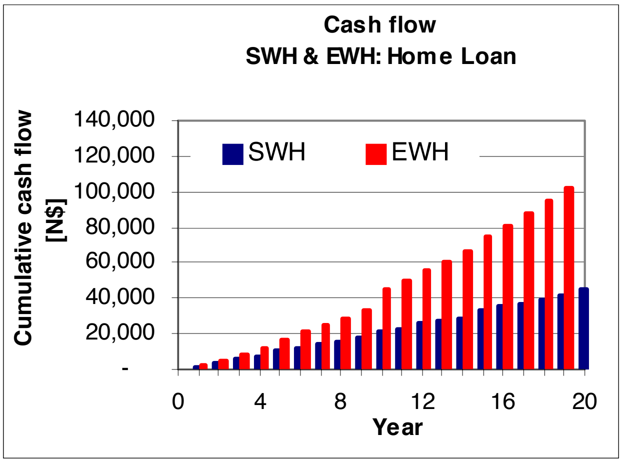


Figure 15: Financing cash flow for SWH vs. EWH[9]

The study also found that SWH technology has matured to the point where it is highly reliable and has similar maintenance requirements to EWH, yet with a considerably longer life expectancy often exceeding 20 years if well maintained. Users of SWH reported no difference in quality of hot water supply, particularly as most SWH are provided with an electrical backup element.

Essentially the main problem remaining with the technology was a lack of awareness, and the study recommended that awareness creation should be addressed, among other activities, including that the government should embrace SWH technology as their technology of choice.

As a result of the study, NAMREP commissioned a once-off project to promote awareness of SWH. At the time of writing the awareness creation project is nearing completion, but sustained awareness of SWH solutions should be addressed in the medium term in order to ensure success, as a single awareness creation programme will not ensure a sustained promotion of solar water heating. NAMREP and the MME are also in the process of implementing compulsory SWH for all Government buildings.

Attention will also have to be given to expanding financing options and monitoring the economic viability and uptake of SWH.

7.3 DEPENDENCIES

Adoption of SWH technology will depend on and be driven by the following factors:

- Awareness creation on an ongoing basis to all stakeholders as identified in the 2005 Report.
- Trust in the technology.
- Access to finance.
- Cost of electricity.
- Cost of SWH technology.
- Scale of the market.
- Public sector uptake.

Awareness is the largest barrier. Consumers purchase water-heating solutions based mainly on capital cost rather than life-cycle costs, as life-cycle-cost information is not readily available. Thus awareness programmes must offer convincing arguments of the economics of SWH.

[9] For a household consuming 150 litres hot water per day, pre-payment tariff for Windhoek, August 2005. Finance at 11.5% interest rate, 20-year period and no deposit.

Many people perceive SWH technology to be unreliable, either through misinformation or historical bad experience. It is crucial that good quality equipment is used, and good installation practise is followed to ensure that consumer trust in the technology is maintained and enhanced. Convincing the public of the reliability of the technology must also be part of an awareness campaign. Certification of SWH system performance to international standards will be of benefit to ensure that consumers can make more informed choices.

As SWH have a high capital cost, few can afford them as a cash purchase. However, as a financed solution SWH have been shown to save in terms of cash-flow from the first day. Access to affordable finance is therefore crucial.

Electricity tariffs together with the cost of SWH equipment dramatically affect the economics of SWH vs. EWH. While SWH will not drop to the same upfront capital cost level as EWH, increased competition in the midst of an expanding market should result in lower costs while tariffs are expected to increase in the short- and medium term.

Public sector adoption of SWH technology will act as a strong motivator for the private sector. Because of its size the public sector will be the largest participant in the industry, which will assist with the lowering of capital cost of equipment through economies of scale. While adoption of SWH will require a small increase in capital budgets, in general the increase is a small percentage of overall budget cost. Operational budgets will see a significant reduction in both maintenance replacement costs and electricity overheads. It will also be crucial to the public sector that quality equipment is purchased, and the public sector must therefore follow the list of approved products set up by Namrep.

Considerations for the particular customer segment is as follows:

Domestic/Residential Market

- Only motivated individuals (owner occupied homes) will readily convert. This excludes cases such as:
  - Rented dwellings.
  - Buildings with practical problems (e.g. Blocks of flats).
  - Government housing, unless Government adopts a conversion programme of its own.
- Knowledge of the economics of SWH will be a driver, but requires awareness creation.
- Access to affordable funding.
- Customer awareness to ensure that consumers demand SWH solutions from housing developers.

Commercial Market

- Institutions who understand that there is a business case for conversion. This will be aided by energy audits which: a) provide a convincing business case and b) provide bankable information to secure commercial finance.
- Access to suitable finance.

Institutional Market

- The institutional (Government) market will be a strong motivator. If the public sector standardises on SWH technology, this will be a strong motivator for private sector adoption.
- The adoption of SWH by the public sector will require additional capital investment. Experience where SWH has been motivated for and used for public sector projects shows that capital budgets can accommodate SWH as it forms only a small percentage of project costs. For example, the cost of the addition of SWH to a typical secondary school represents about 3.5% of capital cost.

7.4 THE VALUE PROPOSITION

7.4.1 Residential consumer value proposition

The main beneficiary is the user of the technology, through a saving over the project life-cycle and cash-flow improvement if financed.

As hot water is essentially a luxury, it may be assumed non existent in low-income households. Instead, hot water is a feature in medium to high-income households. Depending on the individual household, an EWH can represent between 30% to 50% of the monthly household energy consumption.

A typical 'average' Namibian household[10] in Windhoek would pay N$ 40,286.84 over 15 years for EWH, compared with less than half at N$ 18,311.85 for SWH. The initial investment would pay for itself in 4.9 years.

Seen another way, for a financed installation the average household would pay N$206/month for EWH (including finance, operation and maintenance costs) in the first year, compared with N$120/month for SWH[11]. Thus a SWH solution saves the prepayment consumer N$86/month in the first year. (For a credit tariff the savings would be N$9/month in the first year). As tariffs are expected to escalate above inflation, the savings can reasonably be expected to escalate in subsequent years.

The domestic sector will need to hear convincing arguments to convert to SWH and will require easy access to favourable finance. NAMREP has created the Solar Revolving Fund (SRF) (5% deposit, 5% interest, 5 years, N$30,000 limit) and has entered into an agreement with Bank Windhoek to provide RET finance (5% deposit, Prime-5%, 6 years max, theoretically no limit). However, the SRF is experiencing cash flow problems as capital returns will take time to accumulate while demand for finance is higher than what can be provided.

The short-term nature of the SRF and Bank Windhoek loans places a heavier cash-flow burden on households compared with normal home loan finance or continuing to operate an EWH. Table 19 compares the monthly payment for a typical 180 litre SWH system using different sources of finance[12]. The monthly finance repayment must be compared with a monthly expense on EWH of N$206 for finance, operation and maintenance costs. (N$130 per month on credit tariff) Both the SRF and Bank Windhoek RET scheme place a higher cash-flow burden on a consumer. The middle-income household with cash-flow restrictions would benefit most when financing a SWH via their home loan. Thus the SRF may be perceived to be a cheap source of finance for a high-income homeowner, while the Bank Windhoek RET scheme would be more applicable for the commercial sector.

Loan	Capital	Deposit	Loan	Interest	Term	Payment
Homeloan	N$15,000	10%	N$13,500	10.75%	20	N$137.06
SRF	N$15,000	5%	N$14,250	5%	5	N$268.92
Bank Windhoek	N$15,000	5%	N$14,250	6.8%	6	N$241.24

Table 19: Comparison of Typical Financing Options for SWH

The construction of a new domestic dwelling or addition to an existing dwelling is VAT exempt. The inclusion of a SWH in a new dwelling is therefore also VAT exempt. This lowers the cost of a SWH to the domestic customer by N$1,957 on a N$15,000 average installed SWH system. The Receiver of Revenue should be approached to obtain a ruling of whether a retrofitted SWH to a domestic home can also be considered as an 'addition' rather than renovation or maintenance. A positive ruling will mean that the retrofitting of SWH is more affordable to existing homeowners, and this will constitute an indirect subsidy for SWH.

7.4.2 Commercial & institutional consumer value proposition

Commercial and institutional entities experience an even greater value, with a reduced payback period resulting from reduced maximum demand charges. However, each case is unique, depending on hot water consumption, practicality of the installation and their tariff regime.

A small 14-room Windhoek hotel was recently converted from EWH to SWH at a capital cost of N$160,000, which included the plumbing retrofit of N$90,000. The repayment period is 3.9 years but immediate operational savings are realised with commercial finance. The hotel's maximum demand dropped from 64kVA (June 2005) to 28 kVA (June 2006) while energy consumption dropped by approximately 40%.

A feasibility study was completed for the University of Namibia in 2005. Unam uses EWH in some buildings and a heavy fuel oil boiler to generate steam to heat water for a hostel and kitchen. It was found that an

[10] 5-person household, 2006 Windhoek prepaid tariff, hot water consumption of 30 litres per person per day, 200L SWH replacing a 150L EWH.

[11] Based on 2005 Windhoek tariffs. Recent tariff increases will improve these figures.

[12] Standard Namibian household, 5 persons, 150L hot water use per day, 200L SWH, Windhoek, pre-payment tariff.

investment of N$3 million would have a repayment period of 19 months. Unam will save in excess of N$60 million over a period of 20 years.

Commercial entities that can make a business case for SWH should have ready access to commercial finance at favourable market rates. The only barrier for commercial entities will be awareness and the completion of an energy audit. Commercial entities resist the cost of an energy audit as a result of mistrust that the audit will not show value to the business. In reality the audit cost is a small percentage of the savings that can potentially be achieved. A subsidised audit should therefore ensure that more commercial businesses would convert to SWH.

The estimated

Institutional value for some Ministries who consume larger quantities of hot water were estimated based on conservative assumptions. Table XXX shows how

7.4.3 Utility value proposition and impact

If all 97,000 EWH were to be replaced with SWH at a total cost of N$1.3 billion (100% subsidy), this represents an investment of N$13.5 million/MW saved. This does not compare favourably with new thermal generation plant costing around N$8 million per MW capacity excluding fuel and other costs.

The present Solar Revolving Fund (SRF) finance, when compared to commercial finance over the same term, represents a subsidy level of 8% of the total financed cost of a SWH. At this subsidy level, it compares with CFL implementation of N$1 million/MW saved. Thus it can be argued that SWH currently receives a subsidy equivalent to what is proposed for CFL implementation.

The scenario outlined in Section 7.1 showing the impact of a gradual penetration of SWH to 33% for domestic dwellings shows that the uptake of SWH will have the effect of gradually lowering demand and energy consumption growth. In this scenario the impact on NamPower's business will not be dramatic and could easily be accommodated in normal tariff adjustments over the medium to long term. This should also be offset by savings than can be made on deferring or avoiding investments in infrastructure. Conversion to SWH will significantly reduce the daytime demand (in addition to its impact on evening peak demand) and thus increases scope for other measures to reduce the evening peak.

Similarly, the uptake of SWH will also impact gradually on REDs. REDs should be able to benefit from lower cost of new infrastructure if SWH is broadly implemented if the REDs can agree to design a lighter urban electricity infrastructure. However, without any assurance of uptake of SWH and with the potential that SWH elements are connected, REDs may consider this to be risky – however this risk will be counteracted by implementation of the ripple control DSM option which will allow the REDs control over the SWH . Lower demand in residential areas may also extend the life of network infrastructure, especially the existing networks and transformers, many of which are nearing the end of their nominal lives.

7.4.4 Commercial value proposition

Commercial entities that stand to benefit from the SWH industry include suppliers, installers and financial institutions. Secondary beneficiaries will include housing developers and the fiscus. If the market grows substantially, local manufacture is possible which would increase commercial activity with a variety of economic benefits and this may lower the cost of SWH equipment. However, local manufacture is risky given competition with existing high quality equipment and the small local market. Local manufacture will have to compete with a global market.

Financial institutions, including commercial banks and the NHE stand to benefit from increased loan books if they actively engage in promoting the uptake of SWH to new loan customers and to existing customers who have a good payment record. Financial institutions must be convinced that a SWH adds real value – both in the short and the long term – to a property over an EWH.

Developers traditionally compete on price and a survey shows that they are averse to SWH as it has a high capital cost. However, if informed customers start to demand SWH then developers who offer this can increase their profit margins, as can plumbers.

The fiscus stands to benefit from increased SWH uptake, as the commercial activity on a higher value product will translate into higher profitability for suppliers, installers and financial institutions and hence indirectly into tax revenue benefits.

7.4.5 Value Conclusions

From the above it becomes clear that most benefit accrues to consumers rather than to utilities. As a DSM objective SWH has medium to long-term impact. Thus consumers may reasonably be expected to pay for the benefit, however, at the same time the encouragement of SWH uptake must receive support.

From the above it is clear that most of the short term benefit accrues to the consumers through savings on their electricity bill. However substantial savings accrue in the long term to the utilities through reduced need for investment in infrastructure (or increased available capacity on existing infrastructure to deal with projected normal growth). From a national perspective there will be clear benefits through reduced wastage of resources (or increase in utilisation of renewable resources while reducing utilisation of non-renewable resources which are based on polluting generation capacity in RSA).

Since much of the benefit accrues to the consumer it is recommended that the consumer should carry much of the cost of the SWH, and that interventions should focus on removing barriers only. It is recommended that these barrier removal activities should be funded as a first choice by Government, who should solicit donor funds as far as possible and further investigate CRM measures.

7.4.6 Customer segmentation and potential

7.4.6.1 Domestic households

The private residential sector is the most significant customer segment for SWH, contributing significantly to the national system demand. The energy savings made have been shown to pay for the SWH over its life cycle, and depending on the funding mechanism used and tariff regime of the customer it is possible to achieve immediate cash flow savings by installing a SWH in a house.

The main barrier in this sector has been identified as the high capital cost of the SWH when compared to the EWH alternative, as well as lack of consumer awareness about the reliability and savings potential of the SWH. Existing funding mechanisms and awareness campaigns have partially addressed these issues, but if high impact is to be achieved then the barriers need to be lowered further.

This report asserts that by appropriate measures it should be possible to covert around one third of all households from EWH to SWH over a period of ten years. A maximum demand saving of 52MW is estimated, which represents 6% of estimated maximum demand 10 years hence.

7.4.6.2 Commercial Sector

Case studies have shown that the commercial sector (old age homes, private hospitals, accommodation establishments) will adopt SWH technology if a business case is shown for their adoption. The benefits and return on investment vary depending on the individual circumstances, but the commercial sector is generally reluctant to engage a consultant for an energy audit, as they are not necessarily convinced that substantial savings are possible.

The lack of detail data on the existence of EWH in this sector makes it difficult to calculate with a high level of accuracy the savings in demand that could be realised, but the fact that conversions in this sector have already been shown to have short payback times are a clear motivation to include this sector at the very least in any awareness campaigns and in an energy audit programme.

It is estimated that approximately 1MW of maximum demand can be saved by this sector.

7.4.6.3 Public Sector

Significant savings on operation and maintenance costs are possible for the public sector, particularly for facilities such as: school hostels; military bases; hospitals, health centres & clinics; prisons & police cells.

The government should therefore engage in a programme of adopting SWH technology for all new facilities, while also engaging in a programme of converting existing facilities to SWH, starting with those facilities where the largest saving is achievable. This will require capital funding, but as many public sector facilities operate on a maximum demand tariff, it is anticipated that the capital expenditure can largely be financed out of operational savings.

Government has been attempting to move away from providing government housing in urban centres, so it is unlikely that investment in SWH for government housing will occur. However, where new government housing in regions is constructed, these should be provided with SWH.

A rough analysis of conversion implications for only the following institutional facilities that have high hot water requirements has been performed:

- School Hostels
- Hospitals and Health Centres
- Prisons

Based only on the number of occupants/beds in these facilities, their occupancy rates and hot water capacity assumptions, the capital cost of conversion and potential dollar savings to these institutions can be roughly estimated in terms of order of magnitude. A capital investment of approximately N$70 million into retrofit conversion from EWH to SWH in only these facilities is predicted to result in an annual operating budget saving of around N$22 million. Thus the break even period will be approximately 3 years. The figures related to this analysis are summarised in Table 20.

	EWH	SWH	Saving
Capital Budget	N$0	N$67,370,000	
Maintenance pa	N$1,853,000	N$1,684,000	N$169,000
Electricity MD pa	N$11,559,000	N$23,000	N$11,536,000
Electricity Consumption pa	N$12,707,000	N$2,541,000	N$10,166,000
Total Annual Operation Costs	**N$26,119,000**	**N$4,248,000**	**N$21,871,000**

Table 20: Estimated capital requirements and savings potential for Government implementation

7.4.7 Customer engagement

7.4.7.1 Domestic households

Convincing homeowners to adopt SWH will take time and perseverance. The natural driver of increasing tariffs alone will not drive consumers to adopt SWH, in the absence of reliable information on which to base an informed choice. An awareness creation campaign will require sustained awareness creation and promotion over a long period of time in order to ensure success.

The awareness creation programme should target both prospective new homeowners, whether it be a new construction or by inclusion in the purchase of an existing structure, and existing homeowners.

An awareness programme should include the following modes of communication:

- Dissemination of information regarding the economics of SWH via print, radio and television media. This will be in addition to the general campaign proposed in section 4.
- Publish results of actual cases, particularly domestic cases, in the print media.
- Engage in regular consultation with role players.
- Make simple tools, such as the existing LCC Tool, available to practitioners and the public to allow a simple calculation of benefit to the individual household.

Other beneficiaries of a SWH programme (Financiers, Suppliers & Installers) also have an awareness role to play:

- Financial Institutions: Can promote the adoption of SWH to their home loan market, which will increase their loan book.
- Suppliers & Installers: Will have to market their products and services more actively in a competitive market, as it will benefit their business.

7.4.7.2 Commercial Sector

A business case showing how capital and operational expenses can be lowered will be the main driver of the commercial sector introducing SWH. This can be stimulated through support for subsidised energy audits. The commercial sector must be targeted directly and via:

- The media as part of the awareness campaign.
- Through umbrella organisations such as the Namibian Manufacturer's Association (NMA) and Hospitality Association of Namibia (HAN)

7.4.7.3 Public Sector

The Public Sector is a crucial partner to achieve promotion of SWH, as government support for a SWH industry will promote the expansion of the industry, which in turn should lower costs as a result of volume and competition and most importantly, government support of SWH will provide a strong motivator for the individual consumer and the commercial sector to believe in SWH technology and economics.

It is therefore essential that the Government is encouraged to undertake a programme to equip all new facilities with SWH, together with a programme for the conversion of existing facilities to SWH. This is currently in the process of being implemented.

Equally important will be to encourage state owned enterprises, particularly NWR and NHE to adopt SWH solutions.

The acceptance of SWH technology by the Department of Works is crucial, but this should be supported through a directive from the Cabinet. It is understood that the Ministry of Mines and Energy is preparing a submission to cabinet in this regard. There is a clear mandate in the energy policy paper in favour of renewable energy solutions to be promoted and implemented by Government[13].

7.5 DELIVERY

7.5.1 Process and roles

In terms of DSM objectives, the driver for implementation of these recommendations should be the MME/REEEI/NAMREP, who must engage with the parties identified to encourage these activities.

SWH delivery requires the following activities:

- Subsidy:
    - It is recommended to increase and restructure the subsidies available for the purchase of SWH through the SRF to make the fund more accessible for lower to medium income households. It is recommended that if possible the repayments should be such that the consumer has a positive cash flow from the start, i.e. repayments should be lower or equal to the electricity bill savings that an average household can achieve by installing a SWH.
- A increased tax on EWH imports must be considered to limit the risk of EWH dumping on the local market.
- Awareness creation on a continuous basis: NAMREP is recommended to manage this although specific functions can be delegated to the REEEI or contracted out to the private sector.
- Ensure easier access to finance: This to be driven by NAMREP, as is presently the case.
    - Finance for RETs is recommended to be expanded to other financial institutions to provide a broader source of funds.
    - Financial institutions should be engaged and encouraged to provide finance for SWH through existing home loan arrangements. Financial institutions must recognise the value added to homes which use a SWH.
    - The capital allocation to the SRF and other financing requires review to ensure that sufficient finance is available to meet the increasing demand.
    - The SRF terms should be reviewed to ensure that it does not exclude lower income consumers.
- Subsidised Energy Audits: Energy audits should be provided to commercial entities to encourage them to adopt SWH. Refer to Section 9 on Commercial and Industrial Energy Efficiency for this topic.
- Public Sector Promotion: The MME, as the custodian of the Energy White Paper, must drive the process to promote the uptake of SWH technology for all new capital projects and for retrofitting of existing hot water installations, wherever feasible. This will require that:

[13] White Paper on Energy Policy, Ministry of Mines and Energy, 1998: Sections 3.5.5, 3.5.8, 4.3.4

  - The Department of Works accepts SWH technology as a standard for all new capital projects.
  - An energy audit study of all major public facilities must be undertaken to identify the most beneficial facilities for conversion to SWH and the budget requirements for such conversion.
  - All public facilities should be converted to SWH where appropriate.
- Monitoring and reporting: The new REEEI is recommended to be tasked by NAMREP with continuously monitoring and reporting on the uptake of SWH and the status of the economics thereof.
- Training: The MME should continue to work in partnership with the Ministry of Higher Education and specifically with Vocational Training Centres (VTCs) and the NTA to ensure that training on the installation of SWH becomes a mainstream core subject for plumbers who qualify in their trade tests, to ensure that the installation of a SWH is a standard installation for all qualified plumbers. In the short term MME should encourage the VTCs to offer SWH installation courses to the private sector to upgrade the skills of existing qualified plumbers to ensure short-term technical capacity.
- Standards: The MME, acting together with the Ministry of Trade and Industry, should act as the custodian of minimum standards for SWH technology, with appropriate delegation to the REEEI. The present list of approved products recently established by MME, must be maintained and expanded as necessary and appropriate. Only approved products and qualified installers should be used for installations where public funds are involved. This includes the SRF, Bank Windhoek RET scheme and the installation of SWH for public facilities. The MME should enter into discussions with regional counterparts with the aim to establish a regional test facility according to an international standard so that price/performance information is available to consumers.
- Building Codes: The inclusion of energy consumption regulations in local authority building codes requires further investigation. This process should be facilitated by the ECB together with the Ministry of Mines & Energy. Implementation must ultimately form part of RED and Local Authority functions. For example, standard energy/demand consumption rates (e.g. W/m²) can be applied to buildings by occupancy type. Should a building exceed an allowed demand or consumption rate, punitive tariffs can be applied.

7.5.2 Costs and investments

The costs of SWH promotion are due to an awareness campaign and subsidy towards the SRF and other RET funding schemes.

The awareness campaign should initially be undertaken for a 5-year period, with an annual review of progress, in which the awareness campaign is evaluated and redesigned based on research of market response. This aggressive promotion drive to achieve a 33% penetration of SWH into the domestic market over 10 years will require substantial financing, illustrated in Figure 16 in present value terms. This shows that in the first year finance of N$9 million will be required, with a peak requirement of N$77 million in year 7, after which penetration starts to reach the maximum of owner occupied homes. If the present subsidy level of approximately 8% is increased to (say) 10%, this would mean that the initial contribution to the SRF and other financing mechanisms in the first year would have to be N$900,000 purely for SWH, peaking at N$7.7 million in year 7. The present annual contribution to the SRF for all RETs is approximately N$1.5 million. Thus, either the present contribution to the SRF will have to be increased or the entire financing and subsidy approach requires review.

Figure 16 does indicate that there is a substantial market for SWH financing, which should be attractive to financial institutions, as such loans are well secured and at relatively low risk

The capital investment cost to the Government for conversion to SWH will be substantial, but if new installations and the more economically viable existing installations are converted first, should not place an undue burden on the capital budget, as immediate operational savings will accrue to the fiscus. There is no data available to estimate the number of public EWH so an estimate of these costs is not presently possible. However, the cost of an energy audit of public facilities is estimated at approximately N$400,000, from which capital budget allocations can be made.

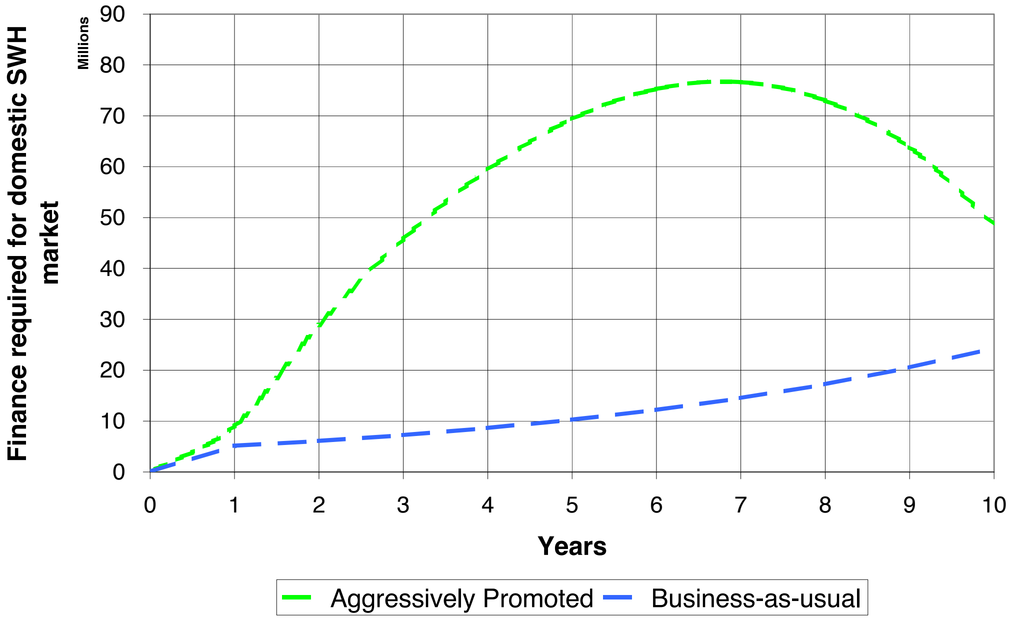


Figure 16: Finance requirements for domestic SWH

An annual budget of N$500,000 towards the awareness campaign promotion activities should be adequate, bearing in mind that other promotion activities will be undertaken by, for example:

- Financial institutions – who should promote SWH themselves at own cost to existing home loan customers to expand their financing book.
- Suppliers and installers – who will promote SWH at their own cost to expand their own businesses.
- REEE Institute – as part of their normal activities and within their budget allocation.
- SENSE – a non-profit private initiative of individuals who promote RETs.

The annual subsidy towards the SRF or other means of supporting SWH will have to be increased as the awareness creation programme gains momentum.

The budget for energy audits is covered in Section 9. A subsidised energy audit should be sufficient support for the commercial sector, as they will be capable of raising commercial finance if a business case exists.

7.5.3 Implementation time frame

Since the implementation of SWH is predicted to be a medium to long term programme, with medium to long term results, a target project life of 10 years is proposed with the ultimate goal of achieving a 33% domestic penetration level, which includes 50% of all owner occupied domestic dwellings.

Government implementation can be faster as this is more manageable. Here, an energy audit for government facilities, particularly in terms of EWH/SWH and lighting, must be conducted. From this budget allocations can be made, following which a conversion programme should be undertaken with the target of converting all viable water heating installations to solar within 5 years.

Commercial penetration will follow with the awareness programme and the availability of subsidised energy audits. A target for maximum penetration to commercial entities should be 5 years.

Task No	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1	**Domestic SWH**										
1.1	Sustained support and promotion of domestic SWH	■	■	■	■	■	■	■	■	■	■
2	**Public Sector/Institutional SWH**										
2.1	Cabinet directive for SWH	■									
2.2	Energy audit of major institutional facilities	■									
2.3	Capital budget for conversion of large facilities		■								
2.4	Conversion of large facilities to SWH			■	■	■					
2.5	Conversion of small installations from operational budgets		■	■	■	■					
2.6	All new facilities to be provided with SWH										
3	**Commercial SWH conversion**										
3.1	Sustained awareness creation	■	■	■	■	■					
3.2	Subsidised energy audits for commercial entities	■	■								
3.3	Implementation by commercial entities	■	■	■	■	■					
4	**Support activities**										
4.1	Annual review of:										
4.2	Subsidy levels, finance mechanisms, penetration levels										
4.3	Training support										
4.4	Standards, Research, Testing										

Table 21: Estimated SWH Implementation Timeline

7.6 MONITORING AND REPORTING

The 2005 SWH study referenced in footnote 7 obtained sales information from local suppliers/importers of SWH. This formed a useful basis for predicting the number of installed SWH systems. Such statistics should be collected on an annual basis by the REEEI to monitor the progress with SWH implementation.

A prediction of where SWH are installed (domestic, commercial, institutional, urban/rural) can be obtained from anecdotal information obtained from the more active installers. As SWH becomes a standard plumbing installation, such information will become unreliable, and random inspection surveys should rather be undertaken.

The economic status of SWH systems should be monitored on an ongoing basis, and such information provided to the general public and commercial and institutional stakeholders as part of the ongoing awareness campaign.

Future national census surveys should also include data capture on domestic water heating.

7.7 LONG TERM SUSTAINABILITY

Once SWH has obtained Government adoption and as a higher level of penetration is achieved in the domestic and commercial sectors, SWH technology will gradually become the automatic choice for consumers and SWH activity should become self-sustaining. The point at which subsidies and awareness campaign support is no longer necessary will depend on the success of the promotion campaign.

As an example, Israel initially legislated for and subsidised SWH technology, but subsidies and legislation is no longer required now that a mature and self-sustainable SWH market exists.

Building regulation strategies that support the uptake of SWH technology for markets which are difficult to penetrate (e.g. tenant accommodation, blocks of flats) should be investigated to extend the penetration of SWH.

7.8 EXIT STRATEGY

The exit strategy will comprise deciding when to abandon awareness, monitoring and subsidy support for SWH. It is recommended that a SWH support campaign, comprising awareness creation, subsidies and financial support should continue until a target of at least 25% domestic penetration is achieved or the market clearly shows that such support is no longer needed.

This exit strategy benchmark should, however, be reviewed based on monitoring of the progress made and the economic circumstances.

7.9 RISKS

The following risks with SWH are perceived, with mitigation action where appropriate:

Risk	Possible mitigation / comments
Poor quality SWH equipment and installation practise leading to a poor reputation for the technology.	Only approved quality systems and qualified short-listed installers must be supported by government programs and the subsidised financing mechanisms. Information in this regard must be disseminated to consumers so that they can make informed choices.
Availability of second-hand EWH on the local market as a result of retrofit activity. Low-income households might be lured into adopting EWH for their homes as a result of the low cost.	While increasing electricity tariffs will be an automatic 'tax' on EWH, second-hand EWH will also become their own problem as they will have a shorter life expectancy than new EWH units. This should be brought to consumers' attention through the awareness campaigns.
A substantial price reduction on EWH systems by RSA manufacturers to combat a threat from SWH systems.	This situation should be monitored and appropriate action taken if necessary. It is recommended that import duties on EWH should be increased to pre-empt such a situation and to act as additional motivation for SWH.
Technical skills shortage as a result of the demand for SWH installation.	Appropriate training of plumbers is crucial. VTCs must be encouraged to run conversion training courses for qualified plumbers to upgrade their skills for SWH installation.
Serious exchange rate fluctuation, which may drive up SWH costs.	This risk is now minimised as a result of a number RSA manufacturers of good quality systems. An increasing market will also mitigate SWH price increases and might motivate local production.
Domestic consumers and commercial entities that finance SWH solutions may be subject to risk of dramatic interest rates increases in the short term.	In general, increasing interest rates are related to inflation, so the economics of SWH/EWH systems should generally keep pace, particularly in an environment where tariffs are predicted to increase above inflation for the medium term.
Risk to the utility and REDs in terms of loss of energy sales revenue.	This risk is low, however, as SWH uptake will be a gradual process and tariff adjustments to offset the loss can be made.

Table 22: SWH Risks

A high level ranking of these risks is illustrated in Figure 17 below.

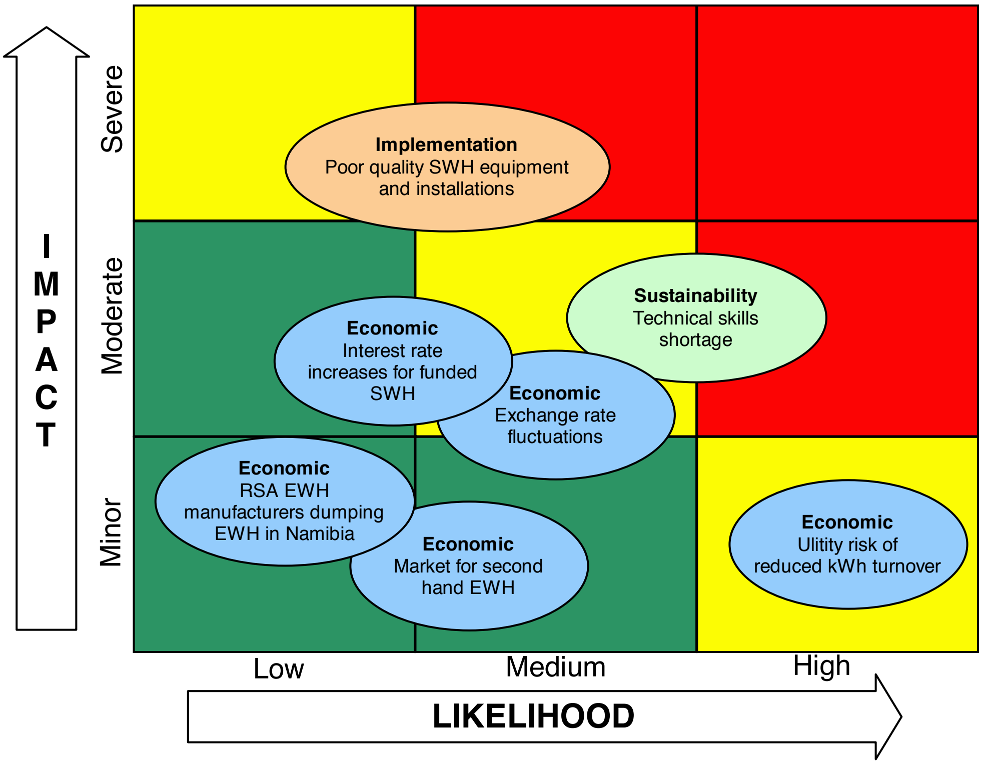


Figure 17: SWH risk assessment

7.10 KEY ASSUMPTIONS

- That Government:
  - adopts SWH as their main water heating solution, and
  - implements SWH installations both for new facilities and for existing facilities.
- That an awareness campaign will be successful in convincing residential consumers to use SWH;
- That subsidised energy audits will convince commercial businesses to use SWH;
- That sufficient finance (from funds and financial institutions) will be available to the expanding SWH market;
- That sufficient installation skills will be in place to ensure that delivery of SWH can occur;

8 RIPPLE CONTROL EXPANSION

8.1 OVERVIEW

Ripple control of electric water heaters (EWH) is a well established means for utilities to defer electricity consumption from peak to off-peak times. Most of Namibia's larger towns have the potential to beneficially implement ripple control on EWH to control billing demand peaks, as well as national demand peaks and the timing of peak consumption. It is recommended that this DSM option be rolled out in most of the larger Namibian towns.

Ripple control of electric water heaters (and other non-essential and switchable loads, both domestic and commercial) presents utilities with a means to control peak demand on the grid. This holds a capacity cost benefit to both NamPower and the REDs. It also holds an energy cost benefit to NamPower under the current scenario where NamPower buys energy at TOU rates but sells it at a flat rate. Further the investment in ripple control systems will form part of the utilities' allowable infrastructure investments and will thus qualify for inclusion in the asset base for tariff calculations.

This DSM option recommends that NamPower and the REDs jointly invest in ripple control for EWH in most larger Namibian urban centres, using local transmitters where economically viable and a mobile transmitter to program receivers outside the reach of fixed transmitters. It is estimated that between 20 000 and 30 000 EWH can be reached in this way at an average cost of under N$2 million per MW capacity.

The operation of the system is proposed to be undertaken centrally from an existing control centre under the joint control of NamPower and the REDs, based on an operations agreement specifying switching priorities and regimes.

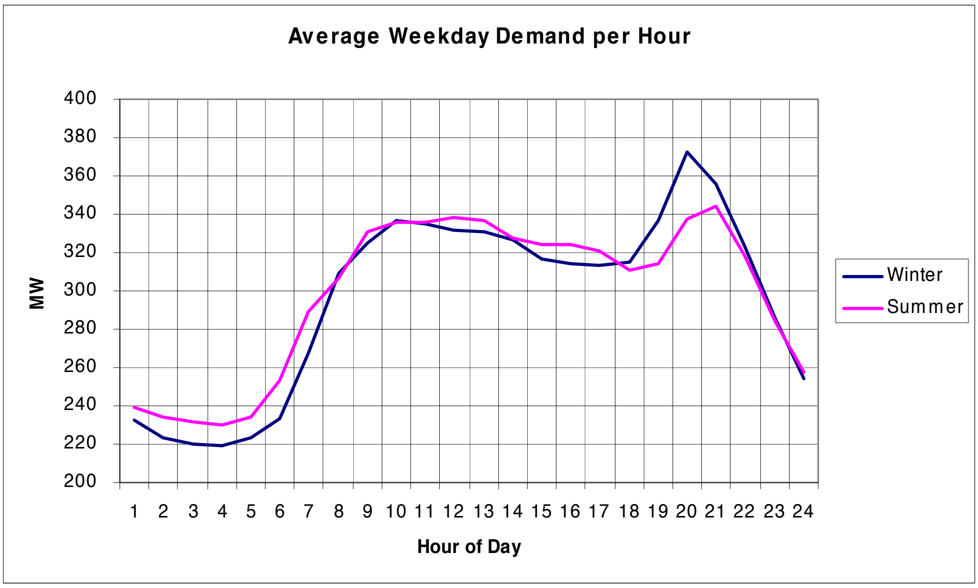
It is estimated that such a system could pay for itself from savings in a period of between five and seven years, depending on transmitter options used. This estimate includes provision for operating costs and is based on a high estimated cost for transmitters. The estimate also excludes benefits that may be derived from installing a small number of additional ripple receivers to switch larger commercial and institutional loads in addition to the projected residential EWH loads.

8.2 BACKGROUND

Despite Namibia's excellent sunshine regime, most houses use electric water heaters for the supply of hot water. This presents an opportunity for demand management, since EWH have thermal storage (therefore consumers are not inconvenienced by EWH being switched off for relatively short time periods, e.g. less than two hours) and can easily be switched remotely using ripple relays. Ripple control technology is proven and well understood, and has been in operation in Windhoek and Walvis Bay for a number of years. It has been shown to save the municipal utilities significant amounts of money, primarily because it reduces the system electrical load and firm demand when needed.

Despite the installed ripple systems, Namibia still has a marked evening system peak, particularly in winter. On average, the summer evening peak is close to the daytime peak, which implies that the opportunity to reduce such loads and the corresponding peak demand in summer is less pronounced than in winter.

Figure 18: Average Hourly Demand Profile on Weekdays



Ruacana is NamPower's existing economically viable generation plant, with a maximum capacity of 249MW. The thermal power stations, i.e. van Eck and Paratus, are not economical under normal operation, and are only used in emergency situations. Since the evening demand in both summer and winter substantially exceeds 249MW, demand at those times always has to be complemented by either imports or local thermal plant generation. NamPower's import prices for peak demand periods range between 13c/kWh in summer to 46c/kWh in winter, while standard imports range from 8c/kWh in summer to around 12c/kWh in winter. The short run marginal generation cost for the van Eck power station is just under 50c/kWh, while the equivalent Paratus cost is at 80c/kWh. The NamPower selling price is around 20c/kWh, irrespective of the time of day, or season. In addition, Ruacana is a run of river station, and the very limited upstream storage capacity does not normally hold sufficient water to operate the plant at full capacity during much of the year. Importantly, it does not normally have sufficient water for full capacity all-day-operation during winter, which is the season with the highest system peak.

From an energy purchase and sales perspective, one can argue that any reduction of the evening peak consumption will mostly hold cost advantages for NamPower. A reduction to the level of daytime peak will in addition reduce the system capacity requirement. As long as NamPower purchases capacity from Eskom, this remains a relevant issue.

Demand after the day's evening system demand peak drops substantially, on average this decrease amounts to 38MW from the peak hour to the hour thereafter. This rapid drop-off in demand is important for ripple control, because is allows for a deferment of energy consumption from EWHs, and a larger load is switched back than what was switched off. Here, Windhoek's experience is that some 20MW can be shed, and typically 28MW is switched back on because of EWHs have gone below their thermostat switch-on threshold in the meantime.

8.3 DEPENDENCIES

- A key issue with ripple control is obtaining access to households for the installation of receivers. The success of the programme depends critically on arranging installation such that a) people are at home when installation is planned, and b) people are prepared to allow the installers into their house. These aspects need to be carefully managed.
- The economic model underpinning an extended EWH ripple control roll out is based on the premise that peak energy remains expensive, and that the current generation scenario continues without any significant new local power stations, such as may be the case if the Kudu power station or Epupa becomes available. Macro-economics will change as soon as such additional generation plant is taken into account.

- The cost-benefit calculations for ripple control have been done under the assumption that the CFL dissemination DSM option (refer to section 8) will be implemented as a first choice, and therefore calculates the impact taking the CFL programme into account. This assumption mostly reduces the financial benefit that an extended ripple system brings about. This is mostly due to the capacity purchase reductions available by reducing the evening peak to the level of the daytime peak are projected to be largely utilised by the CFL programme, leaving limited scope for additional savings in this specific area. Since the CFL program presents a significantly lower capital cost per MW demand saving, it has been given preference in the calculations.

8.4 THE VALUE PROPOSITION

8.4.1 Ripple Control Options

Two main options for ripple control implementation have been identified, being:

- Comprehensive installation of ripple transmitters to reach all ripple receivers that will be installed – this option allows for full on-line and real-time control of all receivers
- Acquisition of one mobile ripple transmitter, to be used to reprogram ripple transmitters for independent operation – this limits an on-line and real-time control to areas with existing transmitters and necessitates the operation of pre-programmed receivers in areas without transmitters.
- A mix of the above, i.e. install transmitters in areas where they can reach enough customers to warrant the cost, and have one mobile transmitter to be able to reprogram receivers in the remaining areas.

Ripple receiver relays can be programmed to operate off-line, switching EWHs off and on at pre-determined times. Such an off-line operation could make the installation of relays in smaller towns more feasible, and merely requires the programming or occasional re-programming using a mobile transmitter. This would save the costs of transmitters, but reduces the overall impact since switch-off occurs at pre-determined times and cannot be undertaken on-demand, i.e. in critical peak demand times or emergency situations.

8.4.1.1 Full Transmitter Ripple Control Option

The full transmitter control option assumes that all installed receivers can be permanently reached by transmitter signals, and are therefore fully controllable at all times. This implies that in addition to normal peak operation, they can be used to switch off EWHs during unexpected critical peak periods or system emergencies, which reduces the amount of emergency energy that has to be purchased and avoids other load shedding measures.

RED	Town	Transmitter	Est DOM consumers	Est PPM consumers	Est DOM Geyser	Est PPM Geyser	Est geysers available	Est % reached	est max kW dropped by ripple	Est RED ave demand saving available kW after CFL
CRED	Windhoek (after existing ripple relays)	Windhoek	19 546	20 829	80%	33%	2 510	90%	2 259	-
CRED	Okahandja	Windhoek	1 691	-	80%	33%	1 353	90%	1 218	-
CRED	Gobabis	Gobabis	1 800	744	80%	33%	1 686	90%	1 517	-
SORED	Rehoboth	Windhoek	890	4 258	80%	33%	2 117	90%	1 905	868
SORED	Mariental	Mariental	888	1 316	80%	33%	1 145	90%	-	-
SORED	Keetmanshoop	Keetmanshoop	-	2 683		33%	885	90%	-	-
SORED	Luderitz	Luderitz	707	1 410	80%	33%	1 031	90%	-	-
ERED	Walvis Bay (after existing ripple relays)	Walvis Bay	4 900		20%	33%	980	90%	882	770
ERED	Swakopmund	Walvis Bay	7 800		50%	33%	3 900	90%	3 510	-
ERED	Henties Bay	Henties Bay	2 600		45%	33%	1 170	90%	-	-
CENORED	Otjiwarongo	Otjiwarongo	1 512	927	80%	33%	1 516	90%	-	-
CENORED	Tsumeb	Tsumeb	2 628	1 000	70%	33%	2 170	90%	1 953	-
CENORED	Grootfontein	Tsumeb	1 068	500	70%	33%	913	90%	-	67
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	150	15 000	70%	33%	5 055	90%	4 550	26
NORED	Rundu	Rundu	-	5 700		33%	1 881	90%	1 693	67
NORED	Katima Mulilo	Katima	-	4 100		33%	1 353	90%	-	-
			46 180	**58 467**			**29 664**		**19 486**	**1 799**

Table 23 shows the estimated impact of the full transmitter control option, with a threshold of N$2,500/kW used to identify towns that are suitable for ripple control (the threshold of N$2,500/kW was chosen on the basis of a high level inspection of values calculated fro all above areas, attempting to find a cut-off which would exclude those areas where the cost/kW rises more steeply). It estimates that some 20,000 new ripple receivers will achieve a maximum load drop of just under 20MW.

RED	Town	Transmitter	Est DOM consumers	Est PPM consumers	Est DOM Geyser	Est PPM Geyser	Est geysers available	Est % reached	est max kW dropped by ripple	Est RED ave demand saving available kW after CFL
CRED	Windhoek (after existing ripple relays)	Windhoek	19 546	20 829	80%	33%	2 510	90%	2 259	-
CRED	Okahandja	Windhoek	1 691	-	80%	33%	1 353	90%	1 218	-
CRED	Gobabis	Gobabis	1 800	744	80%	33%	1 686	90%	1 517	-
SORED	Rehoboth	Windhoek	890	4 258	80%	33%	2 117	90%	1 905	868
SORED	Mariental	Mariental	888	1 316	80%	33%	1 145	90%	-	-
SORED	Keetmanshoop	Keetmanshoop	-	2 683		33%	885	90%	-	-
SORED	Luderitz	Luderitz	707	1 410	80%	33%	1 031	90%	-	-
ERED	Walvis Bay (after existing ripple relays)	Walvis Bay	4 900		20%	33%	980	90%	882	770
ERED	Swakopmund	Walvis Bay	7 800		50%	33%	3 900	90%	3 510	-
ERED	Henties Bay	Henties Bay	2 600		45%	33%	1 170	90%	-	-
CENORED	Otjiwarongo	Otjiwarongo	1 512	927	80%	33%	1 516	90%	-	-
CENORED	Tsumeb	Tsumeb	2 628	1 000	70%	33%	2 170	90%	1 953	-
CENORED	Grootfontein	Tsumeb	1 068	500	70%	33%	913	90%	-	67
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	150	15 000	70%	33%	5 055	90%	4 550	26
NORED	Rundu	Rundu	-	5 700		33%	1 881	90%	1 693	67
NORED	Katima Mulilo	Katima	-	4 100		33%	1 353	90%	-	-
			46 180	**58 467**			**29 664**		**19 486**	**1 799**

Table 23: Full Transmitter Ripple Control Impact

RED demand cost N$/kVA	74.73	
average kW dropped per geyser	1.00	As per Windhoek experience
assumed hours switch off	2	
cumulative MW saved in low season	1266	MW
cumulative MW saved in high season	1394	MW
high season hour before peak	90%	
low season hour before peak	95%	
hours p.a. emergency energy avoided	24	hours
NamPower benefit capacity high season N$	851 648	
NamPower benefit capacity low season N$	1 716 831	
NamPower benefit high season kWh N$	1 297 787	
NamPower benefit low season kWh N$	1 299 540	
NamPower benefit for emergency energy N$	795 041	
Country benefit p.a. N$	**5 960 847**	
Less lost demand charges income = RED benefit N$ -	1 552 468	
Nett NamPower benefit p.a. N$.	**4 408 379**	
Less estimated operating costs N$ -	544 000	
cost payback - straight - REDs	17.80	years
cost payback - straight - nampower	9.66	years
cost payback - straight - all	6.89	years

Table 24: Full Transmitter Ripple Control Benefits

Table 24 presents the benefits of the full transmitter control option. The following can be observed:

- The main benefit of the full transmitter control option accrues to NamPower (system operator) as a result of deferring peak kWh used to the standard rate kWh, as well as a reduction of capacity purchases due to the evening peak being reduced to below the daytime peak (assuming ripple is used every weekday evening for two hours).
- The REDs have a smaller demand cost advantage, assuming that existing demand costs have already been reduced through the implementation of the CFL dissemination option (refer to section 6). Should the CFL option not be implemented, the overall benefits that REDs have from introducing ripple control will increase, and decrease NamPower's benefit, since the demand cost saved by the REDs reduces NamPower's revenue by the same amount.

8.4.1.2 Off-line Operation Option

The off-line ripple control option is designed to reduce the transmitter cost by using a single mobile transmitter instead of many permanently installed transmitters. This implies that the relays not reachable by existing transmitters will be pre-programmed for automatic and autonomous peak reduction switch-off/on operation. These pre-programmed off-line operated relays are therefore not available in critical peak periods or for emergency operation, which reduces their overall benefit but limits the overall capital expenditure.

Table 25 shows that the off-line operation option makes the installation of household ripple receivers feasible for smaller towns, which is not the case if a permanent transmitter has to be installed as well. Having smaller towns undertake off-line ripple control increases the overall peak shifting capacity of the system while recognising that the flexibility that such off-line operations introduce is limited when compared with the full transmitter option discussed in section 8.4.1.1.

RED	Town	Transmitter	Est DOM consumers	Est PPM consumers	Est DOM Geyser	Est PPM Geyser	Est geysers available	Est % reached	est max kW dropped by ripple	Est RED ave demand saving available kW after CFL
CRED	Windhoek (after existing ripple relays)	Windhoek	19 546	20 829	80%	33%	2 510	90%	2 259	-
CRED	Okahandja	Windhoek	1 691	-	80%	33%	1 353	90%	1 218	-
CRED	Gobabis	Gobabis	1 800	744	80%	33%	1 686	90%	1 517	-
SORED	Rehoboth	Windhoek	890	4 258	80%	33%	2 117	90%	1 905	868
SORED	Mariental	Mariental	888	1 316	80%	33%	1 145	90%	1 030	-
SORED	Keetmanshoop	Keetmanshoop	-	2 683		33%	885	90%	797	-
SORED	Luderitz	Luderitz	707	1 410	80%	33%	1 031	90%	928	-
ERED	Walvis Bay (after existing ripple relays)	Walvis Bay	4 900		20%	33%	980	90%	882	770
ERED	Swakopmund	Walvis Bay	7 800		50%	33%	3 900	90%	3 510	-
ERED	Henties Bay	Henties Bay	2 600		45%	33%	1 170	90%	1 053	-
CENORED	Otjiwarongo	Otjiwarongo	1 512	927	80%	33%	1 516	90%	1 364	-
CENORED	Tsumeb	Tsumeb	2 628	1 000	70%	33%	2 170	90%	1 953	-
CENORED	Grootfontein	Tsumeb	1 068	500	70%	33%	913	90%	821	67
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	150	15 000	70%	33%	5 055	90%	4 550	26
NORED	Rundu	Rundu	-	5 700		33%	1 881	90%	1 693	67
NORED	Katima Mulilo	Katima	-	4 100		33%	1 353	90%	1 218	-
			46 180	**58 467**			**29 664**		**26 697**	**1 799**

Table 25: Off-line Ripple Control Impact

RED demand cost N$/kVA	74.73	
average kW dropped per geyser	1.00	As per Windhoek experience
assumed hours switch off	2	
cumulative MW saved in low season	1365	
cumulative MW saved in high season	1652	
high season hour before peak	90%	
low season hour before peak	95%	
hours p.a. emergency energy avoided	24	
NamPower benefit capacity high season N$	1 009 455	
NamPower benefit capacity low season N$	1 850 659	
NamPower benefit high season kWh N$	1 778 031	
NamPower benefit low season kWh N$	1 780 434	
NamPower benefit for emergency energy N$	255 583	Only in places reachable by existing transmitters
Country benefit p.a. N$	**6 674 160**	
Less lost demand charges income = RED benefit N$ -	1 612 839	
Nett NamPower benefit p.a. N$.	**5 061 321**	
Less estimated operating costs N$ -	544 000	
cost payback - straight - REDs	14.53	years
cost payback - straight - nampower	6.94	years
cost payback - straight - all	5.11	years

Table 26: Off-line Ripple Control Benefits

Table 26 shows that the financial benefit of the off-line option is greater than the full transmitter option discussed previously, because of smaller capital expenditure requirements. It therefore has a shorter payback period.

It must be noted however that the benefit calculation shown in Table 26 made assumptions with regard to the figures used, and includes only high level calculations on demand profiles. A more detailed study should be undertaken before the implementation of ripple control is commissioned, to ascertain which option yields the best results. **It is possible that a combination of the full and off-line ripple control options may turn out to be optimal.** It is recommended that NamPower undertake a more detailed analysis of the benefits that can be attained under the different options and a final decision be taken on that basis.

8.4.1.3 Mixed Mode Operation Option

The mixed mode ripple control option is designed to reduce the transmitter cost by using a single mobile transmitter for smaller areas and permanent transmitters for those areas with a cost/kW of less than

N$2,500. This implies that the relays in off-line areas will be pre-programmed for automatic and autonomous peak reduction switch-off/on operation. These pre-programmed off-line operated relays are therefore not available in critical peak periods or for emergency operation, which reduces their overall benefit but limits the overall capital expenditure.

Table 27 shows that the mixed mode operation option makes the installation of household ripple receivers feasible for smaller towns, which is not the case if a permanent transmitter has to be installed as well. Having smaller towns undertake off-line ripple control increases the overall peak shifting capacity of the system while recognising that the flexibility that such off-line operations introduce is limited when compared with the full transmitter option discussed in section 8.4.1.1., however this options gives a much larger controllable load than the off-line option as per section 8.4.1.2.

RED	Town	Transmitter	Est DOM consumers	Est PPM consumers	Est DOM Geyser	Est PPM Geyser	Est geysers available	Est % reached	est max kW dropped by ripple	Est RED ave demand saving available kW after CFL
CRED	Windhoek (after existing ripple relays)	Windhoek	19 546	20 829	80%	33%	2 510	90%	2 259	-
CRED	Okahandja	Windhoek	1 691	-	80%	33%	1 353	90%	1 218	-
CRED	Gobabis	Gobabis	1 800	744	80%	33%	1 686	90%	1 517	-
SORED	Rehoboth	Windhoek	890	4 258	80%	33%	2 117	90%	1 905	868
SORED	Mariental	Mariental	888	1 316	80%	33%	1 145	90%	1 030	-
SORED	Keetmanshoop	Keetmanshoop	-	2 683		33%	885	90%	797	-
SORED	Luderitz	Luderitz	707	1 410	80%	33%	1 031	90%	928	-
ERED	Walvis Bay (after existing ripple relays)	Walvis Bay	4 900		20%	33%	980	90%	882	770
ERED	Swakopmund	Walvis Bay	7 800		50%	33%	3 900	90%	3 510	-
ERED	Henties Bay	Henties Bay	2 600		45%	33%	1 170	90%	1 053	-
CENORED	Otjiwarongo	Otjiwarongo	1 512	927	80%	33%	1 516	90%	1 364	-
CENORED	Tsumeb	Tsumeb	2 628	1 000	70%	33%	2 170	90%	1 953	-
CENORED	Grootfontein	Tsumeb	1 068	500	70%	33%	913	90%	821	67
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	150	15 000	70%	33%	5 055	90%	4 550	26
NORED	Rundu	Rundu	-	5 700		33%	1 881	90%	1 693	67
NORED	Katima Mulilo	Katima	-	4 100		33%	1 353	90%	1 218	-
			46 180	**58 467**			**29 664**		**26 697**	**1 799**

Table 27: Mixed Mode Ripple Control Impact

RED demand cost N$/kVA	74.73	
average kW dropped per geyser	1.00	As per Windhoek experience
assumed hours switch off	2	
cumulative MW saved in low season	1365	
cumulative MW saved in high season	1652	
high season hour before peak	90%	
low season hour before peak	95%	
hours p.a. emergency energy avoided	24	
NamPower benefit capacity high season N$	1 009 455	
NamPower benefit capacity low season N$	1 850 659	
NamPower benefit high season kWh N$	1 778 031	
NamPower benefit low season kWh N$	1 780 434	
NamPower benefit for emergency energy N$	795 041	Only in places with transmitters
Country benefit p.a. N$	**7 213 618**	
Less lost demand charges income = RED benefit N$ -	1 612 839	
Nett NamPower benefit p.a. N$.	**5 600 779**	
Less estimated operating costs N$ -	544 000	
cost payback - straight - REDs	20.65	years
cost payback - straight - nampower	8.81	years
cost payback - straight - all	6.68	years

Table 28: Mixed Mode Ripple Control Benefits

Table 28 shows that the financial benefit of the off-line option is greater than the full transmitter option discussed previously, because of smaller capital expenditure requirements. It therefore has a shorter payback period.

It must be noted however that the benefit calculation shown in Table 28 made assumptions with regard to the figures used, and includes only high level calculations on demand profiles. A more detailed study should be undertaken before the implementation of ripple control is commissioned, to ascertain which option yields the best results. It is recommended that NamPower undertake a more detailed analysis of the benefits that can be attained under the different options and a final decision be taken on that basis.

8.4.2 Customer value proposition

The end customer is the residential electricity consumer in the larger urban centres in Namibia. The consumer does not directly benefit from ripple control, since energy consumption is not reduced. Under existing flat rate tariffs it is very unlikely that consumers will reduce circuit breaker capacities as a result of geyser load being shifted in time. However, if time of use tariffs, as discussed in section 5, are available, the consumer may well benefit financially from the timing of the electricity consumption associated with their EWH provided usage takes place within the off peak tariff period.

Under normal operation of ripple control, and assuming that existing tariffs prevail, consumers will not be negatively affected, due to the thermal storage capacity that an EWH provides. In other words, provided that the EWH is switched off for short periods, and the hot water consumption within the switch-off period is less than the capacity provided by the EWH, the consumer will not notice any difference in the availability of hot water.

In case critical peak conditions or system emergency situations prevail for longer than anticipated, the EWH may be switched off for extended periods. In this case, consumers may not have the benefit of an almost unlimited hot water service, as is the case on normal days. On a more positive note however, consumers have to understand that they may not have hot water, but at least they will benefit from a continuous supply of electricity, which they otherwise may not have had.

In addition, consumers may benefit indirectly through lower tariffs, provided that the utilities benefit financially and pass on this saving to consumers.

8.4.3 Utility value proposition and impact

8.4.3.1 NamPower

The introduction of more ripple control systems will benefit NamPower in three areas:

- It will reduce peak energy purchases – NamPower pays more at peak times than during off-peak times. Using ripple control during peak periods NamPower can reduce the purchase of peak kWh, and instead purchase off-peak kWh which are less expensive. Calculations on the 2005 hourly system demand profile indicate that the demand drop-off after the system evening peak is steep enough so that the rippled EWH can be switched back within a few hours, even though the switch-back may have to be staggered to avoid system load peaks.
- NamPower can reduce its capacity purchases from Eskom to the extent that the evening peak can be reduced below the daytime peak, implying substantial savings. The calculations have been based on the assumption that the CFL option has already been implemented, but have not taken into account any added benefits such as if the energy audit programme leads to a reduction of the daytime peak (from a capacity perspective this makes an additional reduction of the evening peak beneficial).
- The ability to load shed in critical peak periods and system emergency situations – if NamPower has access to the ripple system it can be used in emergency situations to load shed, possibly as much as 50MW (which includes the existing receivers in Windhoek and Walvis Bay).

NamPower's revenue is reduced in terms of demand sales to the REDs, because the ripple control system (assuming its operation is shared by NamPower and the REDs) will minimise the billing demand of the REDs. A high level analysis shows that the REDs may benefit in the order of N$1.5 million per annum from reduced demand costs at current rates (2006/7 approved rates for NamPower Transmission). This revenue would therefore be lost by NamPower. However, NamPower should be able to recover at least part of the lost revenue through deferring infrastructure investments, or through extending its expected pay-back time for this DSM option, assuming that NamPower is the sole investor.

NamPower's energy sales will not be affected since no material energy savings are made and NamPower does not sell electrical energy at TOU tariffs.

8.4.3.2 REDs

The REDs are expected to be affected as follows:

- No difference in energy sales since kWh are deferred and not reduced (provided TOU tariffs are not introduced as well).
- Reduction in billing demand purchased from NamPower to the extent that rippling can reduce the evening demand below daytime demand. Assuming that CFL implementation is done first, the potential for further reducing the billing demand with ripple control is limited, but has been calculated to be approximately N$1.5 million per year.
- No difference in demand sold since residential consumers do not have demand charges, and it is not likely that consumers will significantly reduce their existing circuit breaker capacity.
- Ripple control can delay distribution network expansions, e.g. increased line capacity and transformer upgrades, which is very capital intensive. Postponing such upgrades saves capital, and is therefore very beneficial, especially to those REDs having cash flow limitations in their first few years of operation, and would therefore have to use borrowed capital. Technically the load factor (and load curve) for most RED supply areas will be improved, improving asset utilisation indices.

In summary therefore the REDs are likely to benefit, however the financial benefit does not justify the investment in ripple systems by the REDs alone. This is mainly due to the assumption that the dissemination of CFLs will be undertaken before the ripple DSM option (because of lower cost/MW), which implies that the CFL implementation has considerably reduced the evening (and billing) peak, thus leaving only a limited evening peak reduction capacity for the RED supply points. This assessment is based on a first-order review of the typical load curves for most towns where ripple control and CFL dissemination is expected to be implemented, considering the average difference between the daytime peak and the evening peak which is a good approximation of the potential billing demand savings at each supply point. The results of this assessment are indicated in Table 23, and show that only a small number of towns have a significant potential for evening peak reduction of billing demand after CFLs are disseminated. It is also the main reason why the City of Windhoek has not invested in more ripple receivers – because there is no firm potential for further reducing the billing demand below current levels over the entire year.

Another aspect of significance is the substantial capital cost requirement of transmitters, which can not be justified if the number of receivers (and therefore the total load switched) reached by a transmitter is too small. The present calculation uses a cost of N$2500/kW as the cut-off above which a transmitter is not considered feasible. It should be pointed out however that this figure is quite arbitrary (based on the range of calculated values), and may be changed as it is well below the cost of new thermal generation (N$8000/kW).

8.4.4 Value Conclusions

From the above it can be argued that the main benefit of ripple control will accrue to the utilities, in particular to NamPower. The main benefit under current tariff scenarios (i.e. without TOU tariffs in Namibia) will accrue to NamPower through its SAPP trading and import activities, as well as the way that the Ruacana power station is used as a peaking plant. It is therefore recommended that the ripple control DSM programme is to be funded primarily by NamPower, and that the REDs participate financially to obtain co-ownership so that the benefits to the country are maximised.

8.4.5 Customer segmentation and potential

The proposed ripple control system is motivated by and targeted at EWH in residential applications. Significant additional potential for ripple control exists for commercial and institutional EWH installations (as well as other switchable loads in commercial and institutional buildings), and it is highly recommended that these be exploited by the implementers of the ripple control programme. However due to a) the absence of reasonably accurate data on such installations and b) the fact that residential EWH ripple control is likely to reduce the evening peak below the daytime peak in most places already these additional options have not been included in the benefit calculations in this report. It can therefore be safely assumed that if these options are utilised the benefit scenario can be improved over the figures provided in this report.

Ripple control requires transmitters and receivers. Transmitters are capital cost intensive, while receivers are low cost items (in relation to the transmitters). The aim is therefore to maximise the number of receivers that can be reached with a single transmitter to optimise the benefit to cost ratio. This implies that only larger urban areas can be reached economically. This fact combined with the low penetration of EWH in rural areas excludes many smaller villages and settlements.

The target customer segment is therefore residential households with EWH, predominantly in larger urban centres.

Ripple control however has other possible applications besides the residential EWH sector. Once transmitters are installed it becomes possible to control other electric appliances, such as pumps, pool pumps or even ripple enabled air conditioners. These are options that are highly recommended to be explored by the implementer of the ripple systems. The commercial and industrial sector may also offer significant potentials for the introduction of ripple controlled loads, and it is recommended that this potential be investigated in more detail in future.

8.4.6 Customer engagement

Customers will be engaged through a targeted education and awareness campaign focussing on the following aspects:

- Explaining what ripple control does, how it works and how it saves the utilities money;
- Explaining how the consumer benefits if the utilities save money, i.e. lower tariff increases;
- Explaining that under normal operation the consumer will not experience any negative effects, and will not even notice that ripple controlled switching is taking place;
- Encouraging consumers to facilitate access for installations, and informing them that failure to grant access may result in higher tariffs or other measures.

8.5 DELIVERY

The installation of ripple control is to be undertaken by the utilities, and they need to be the operators of the system. As the benefits of ripple control can accrue to both the system operator (NamPower) as well as the distributors (REDs), it is recommended that the ripple control project be implemented and owned jointly by NamPower and the REDs (in which NamPower has varying degrees of shareholding).

8.5.1 Process and roles

The following recommendations are made:

- The project should be a joint NamPower and REDs undertaking, based on all parties having access to the control system in accordance with operating procedures, which should be governed contractually. It is recommended that the ECB facilitates a meeting of these parties with the aim to agree on the key aspects and issues, and to give a mandate to the utilities to implement ripple control. The ECB may need to facilitate the drafting of the agreement that governs such a joint project.
- It is recommended that a ripple management committee (RMC) be established with representatives of NamPower and the REDs, who will be mandated to manage the implementation and operation of the national ripple system. It is recommended that the ECB facilitates the establishment and is a permanent representative of such a committee.
- It is recommended that the implementation project be pre-funded by NamPower and project managed under the auspices of NamPower, if necessary by an externally appointed project manager. It is furthermore recommended that the REDs contribute to the capital costs either through an up-front contribution (in proportion to their projected benefits vs. NamPower's), or that NamPower recover such costs through retaining part of the demand savings that REDs make as a result of having ripple control systems.
- A joint operations centre will need to be established, and could be located at one of the existing control centres (City of Windhoek, NamPower or other). This would imply that existing communications infrastructure and staff is optimally utilised. Depending on the operational complexity of the ripple systems it may be necessary to employ additional staff at such a control centre. Ideally however, the system should be largely automated and only require human intervention for monitoring and verification purposes. The intention is that a master control station be established, and that slave control stations are installed at all transmitter locations, thus enabling local control in case of emergencies or

communications failures. This recommendation assumes that remote readable meters are installed at all NamPower/RED interfaces (which is a programme that NamPower is rolling out), and that the necessary communication costs (to link the control stations) is lower than having multiple staffed control centres.

- The ECB should mandate the RMC to undertake a more detailed assessment of the most cost-effective ripple configuration (i.e. whether the full transmitter control option, the off-line option or a mix of the two is most beneficial). The outcome of this assessment will determine the numbers of transmitters and receivers required, and allow the ECB to participate in decisions leading to a system configuration that has the greatest benefits to all, and does not favour one utility over another (this is particularly important to ensure that the ESI provides an equitable access to all participants)
- Once funding has been secured, the appointed project manager should compile tender documents (to be approved by the ripple management committee) and issue an international tender for the supply and installation of the required ripple systems.
- The installation should proceed by the successful tenderer, under supervision of the project manager. Special care should be taken in the tender specifications to ensure that the contractor proposes a workable and credible strategy for gaining access to households for installation of the ripple relays, as this can represent a significant issue during the roll-out process.
- The roll-out process should be accompanied by a targeted information campaign to sensitise consumers about the following issues (in addition to the awareness campaign contemplated in section 4)
  - Highlight the benefits and purpose of the system
  - Explain how the consumer will ultimately benefit through lower tariffs
  - Inform consumers that they will not be negatively affected by having their EWH ripple controlled
  - Inform consumers that under emergency operation the ripple system may prevent total power outages, which benefits everyone
  - Raise consumer awareness in regard to the installation programme, what access the installers will need, when they are likely to need access, how they will identify themselves, where and how complaints can be lodged, what rights the consumer has in regard to the ripple system and the installation process.
- It is recommended that a survey be conducted a year after completion of the initial installation in order to determine the rate of disconnections / relay failures / bypassing that may have taken place. This will put the RMC in a position to devise appropriate follow-up actions if necessary.
- It is further recommended that installation of ripple relays for all new EWH installations be made mandatory in ripple enabled towns.

8.5.2 Costs and investment

Two main options for ripple control implementation have been identified above, namely

- Installation of ripple transmitters to reach all ripple receivers that will be installed – this allows for real-time control of all receivers
- Acquisition of one mobile ripple transmitter, which can be used to reprogram ripple transmitters for independent operation – this allows the on-line control in areas with existing transmitters, and the pre-programmed operation of receivers in areas without transmitters.

8.5.2.1 Full Transmitter Ripple Control Option

Table 29 below provides an overview of the quantities of transmitters and receivers that may be installed under this option.

RED	Town	Transmitter	66kV TX	11kV TX	Receivers	Cost/kW	Select	kW	Cost/kW
CRED	Windhoek	Windhoek			2 259	1 000	1	2 259	1 000
CRED	Okahandja	Windhoek			1 218	1 000	1	1 218	1 000
CRED	Gobabis	Gobabis		1	1 517	2 494	1	1 517	2 494
SORED	Rehoboth	Windhoek			1 905	1 000	1	1 905	1 000
SORED	Mariental	Mariental		1	1 030	3 200	0	-	-
SORED	Keetmanshoop	Keetmanshoop		1	797	3 845	0	-	-
SORED	Luderitz	Luderitz		1	928	3 443	0	-	-
ERED	Walvis Bay	Walvis Bay			882	1 000	1	882	1 000
ERED	Swakopmund	Swakopmund		1	3 510	1 646	1	3 510	1 646
ERED	Henties Bay	Henties Bay		1	1 053	3 153	0	-	-
CENORED	Otjiwarongo	Otjiwarongo		1	1 364	2 662	0	-	-
CENORED	Tsumeb	Tsumeb		1	1 953	2 161	1	1 953	2 161
CENORED	Grootfontein	Grootfontein		1	821	3 760	0	-	-
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	1		4 550	2 495	1	4 550	2 495
NORED	Rundu	Rundu		1	1 693	2 339	1	1 693	2 339
NORED	Katima Mulilo	Katima		1	1 218	2 861	0	-	-
			1	11	26 697	2 189		19 486	1 814

Table 29: Full Transmitter Ripple Control Option Quantities

The following comments pertain to Table 29:

- Costs are in N$.
- The number of receivers is based on the estimated number of households with EWH, reduced by a percentage that is likely to not be reached due to access problems.
- The column "select" identifies towns on the basis of cost/kW, the filter threshold in the above table is set at N$2,500/kW, as explained in section 8.4.3.2.
- It is assumed that a single 66kV transmitter can reach Oshakati, Ongwediva and Ondangwa. All other areas need 11kV transmitters except Rehoboth and Okahandja. The latter two towns are to be reached by the existing 66kV transmitter at Windhoek (as per discussions with the supplier of the existing City of Windhoek ripple system).
- The estimated costs for transmitters and receivers are based on verbal estimates provided by the supplier of the ripple system used by the City of Windhoek.

cost / kW cut-off N$	2 500
proj man cost / receiver N$	25
proj man cost / transmitter N$	50 000
basic proj man cost N$	500 000
Transmitter costs N$	15 866 667
Receiver costs incl installation N$	19 486 287
Awareness campaign N$	200 000
Project management cost N$	1 767 429
Total N$	**37 320 383**
Capital cost N$/kW installed	1 915

Table 30: Cost Summary for Full Transmitter Ripple Control Option

8.5.2.2 Off-line Operation Option

Table 31 below provides an overview of the quantities of transmitters and receivers that may be installed under this option.

RED	Town	Transmitter	Receivers	Cost N$
CRED	Windhoek	Windhoek	2 259	2 259 333
CRED	Okahandja	Windhoek	1 218	1 217 520
CRED	Gobabis		1 517	1 516 968
SORED	Rehoboth	Windhoek	1 905	1 905 426
SORED	Mariental		1 030	1 030 212
SORED	Keetmanshoop		797	796 851
SORED	Luderitz		928	927 810
ERED	Walvis Bay	Walvis Bay	882	882 000
ERED	Swakopmund		3 510	3 510 000
ERED	Henties Bay		1 053	1 053 000
CENORED	Otjiwarongo		1 364	1 363 959
CENORED	Tsumeb		1 953	1 952 640
CENORED	Grootfontein		821	821 340
NORED	Oshakati, Ondangwa, Ongwediva		4 550	4 549 500
NORED	Rundu		1 693	1 692 900
NORED	Katima Mulilo		1 218	1 217 700
			26 697	**26 697 159**

Table 31: Off-line Ripple Control Option Quantities

The following comments pertain to Table 31:

- The number of receivers is based on the estimated number of households with EWH, reduced by a percentage that is likely to not be reached due to access problems. The existing ripple controllers (around 20000 in Windhoek and 4000 in Walvis Bay) have been deducted.
- The estimated costs for transmitters and receivers are based on verbal estimates provided by the supplier of the ripple system used by the City of Windhoek.

cost / kW cut-off N$	3000
proj man cost / receiver N$	25
proj man cost / transmitter N$	50 000
basic proj man cost N$	500 000
Transmitter costs N$	3 266 667
Receiver costs incl installation N$	26 697 159
Awareness campaign N$	200 000
Project management cost N$	1 167 429
Total N$	**31 331 255**
Capital cost N$/kW installed	1 174

Table 32: Cost Summary for Off-line Ripple Control Option

8.5.2.3 Mixed Mode Ripple Control Option

Table 33 below provides an overview of the quantities of transmitters and receivers that may be installed under this option.

RED	Town	Transmitter	66kV TX	11kV TX	Receivers	Select	kW	Cost	Cost/kW
CRED	Windhoek	Windhoek			2 259	1	2 259	2 259 333	1 000
CRED	Okahandja	Windhoek			1 218	1	1 218	1 217 520	1 000
CRED	Gobabis	Gobabis		1	1 517	1	1 517	3 783 635	2 494
SORED	Rehoboth	Windhoek			1 905	1	1 905	1 905 426	1 000
SORED	Mariental	Mariental		1	1 030	0	1 030	1 030 212	1 000
SORED	Keetmanshoop	Keetmanshoop		1	797	0	797	796 851	1 000
SORED	Luderitz	Luderitz		1	928	0	928	927 810	1 000
ERED	Walvis Bay	Walvis Bay			882	1	882	882 000	1 000
ERED	Swakopmund	Swakopmund		1	3 510	1	3 510	5 776 667	1 646
ERED	Henties Bay	Henties Bay		1	1 053	0	1 053	1 053 000	1 000
CENORED	Otjiwarongo	Otjiwarongo		1	1 364	0	1 364	1 363 959	1 000
CENORED	Tsumeb	Tsumeb		1	1 953	1	1 953	4 219 307	2 161
CENORED	Grootfontein	Grootfontein		1	821	0	821	821 340	1 000
NORED	Oshakati, Ondangwa, Ongwediva	Oshakati	1		4 550	1	4 550	11 349 500	2 495
NORED	Rundu	Rundu		1	1 693	1	1 693	3 959 567	2 339
NORED	Katima Mulilo	Katima		1	1 218	0	1 218	1 217 700	1 000
			1	11	26 697		26 697	42 563 826	1 594

Table 33: Mixed Mode Ripple Control Option Quantities

The following comments pertain to Table 33:

- Costs are in N$.
- The number of receivers is based on the estimated number of households with EWH, reduced by a percentage that is likely to not be reached due to access problems.
- The column "select" identifies towns on the basis of cost/kW, the filter threshold in the above table is set at N$2,500/kW, as explained in section 8.4.3.2.
- It is assumed that a single 66kV transmitter can reach Oshakati, Ongwediva and Ondangwa. All other areas need 11kV transmitters except Rehoboth and Okahandja. The latter two towns are to be reached by the existing 66kV transmitter at Windhoek (as per discussions with the supplier of the existing City of Windhoek ripple system).
- The estimated costs for transmitters and receivers are based on verbal estimates provided by the supplier of the ripple system used by the City of Windhoek.

cost / kW cut-off N$	2500
proj man cost / receiver N$	25
proj man cost / transmitter N$	50 000
basic proj man cost N$	500 000
Transmitter & receiver costs N$	42 563 826
Awareness campaign N$	200 000
Project management cost N$	1 767 429
Total N$	**44 531 255**
Capital cost N$ / kW installed	1 668

Table 34: Cost Summary for Mixed Mode Ripple Control Option

8.5.2.4 Ongoing Operating Costs

The ripple system will have ongoing operational costs, which have been estimated as follows:

- It is assumed that one additional system controller has to be employed at an existing control centre to centrally manage the system, oversee programming and operations, and produce reports
- Communications costs will be incurred by having online access from the master control station to each transmitter, possibly by way of a slave control station. This implies that at least one dedicated line has to be available to each slave station.
- It is assumed that system management will constitute some 15% of a manager's activity.
- It is assumed that the ECB will to ensure the transparent use of the system, and avoid gaming behaviour by the utilities, which is estimated to require some 15% of a full-time manager's time.

The resulting cost estimate is summarised in Table 35 below:

One system controller p.a. N$	250 000
Estimated comms costs p.a. N$	144 000
Management time p.a. (15% time) N$	75 000
Regulatory time 15% time N$	75 000
Total estimated annual cost N$	**544 000**

Table 35: Annual Cost Estimate for Ripple Operations

The operating costs estimated in Table 35 have been included in the pay-back calculations shown in section 8.4.

8.5.3 Milestones

Figure 19 below illustrates a high level implementation timeline.

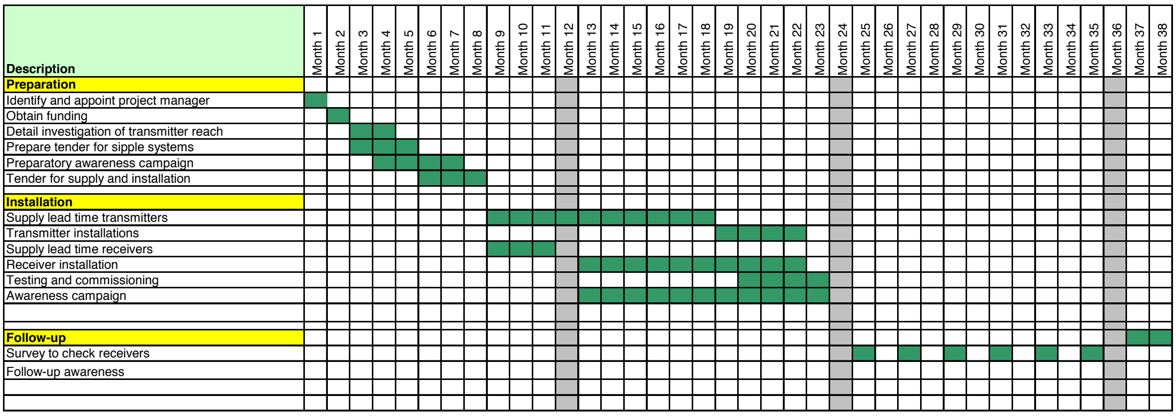


Figure 19: Ripple Control Illustrative Timeline

8.6 Monitoring and Reporting

The effects of on-line ripple control can be measured quite accurately. Since it is known exactly when signals were sent and signals are normally sent on the basis of real-time half-hourly demand predictions, the benefits can be calculated. It will also be vital that the operations of the ripple system are recorded in detail for later analysis by the regulator, so as to ensure that the system is used in the best national interest and does not exhibit any gaming behaviour by the utilities.

It is recommended that the control centre be tasked with publishing periodic reports summarising the benefits derived through the use of the system. These reports should be distributed as a minimum to the utilities involved as well as the ECB. Selected portions should be made publicly available as part of ongoing consumer education campaigns.

It is further recommended that after a period of at least two years an assessment should be made as to the viability of installing ripple receivers in smaller towns.

It is further recommended that the ECB ensures that the utilities submit monthly reports about their load switching activities, and that strict guidelines be developed to ensure that the utilities cannot play games with the ripple control system, or use the system merely to boost their profits. This requires that the ECB understand how to spot gaming behaviour, and implies training and ongoing monitoring costs. The ECB should require a switching schedule and explanations by the utilities if and when the schedule was not followed. When TOU tariffs are in place this becomes even trickier, because switching a few minutes earlier/later may suddenly generate substantial windfalls for the utilities, which therefore requires an even more stringent & regulated switching regime. This all requires substantial procedural guidance to be developed in concert with the utilities. Ripple control has substantial regulatory implications which the ECB will need to deal with effectively.

8.7 LONG TERM SUSTAINABILITY

Once commissioned, ripple control systems are low in maintenance and operations costs, and therefore should sustain themselves. What will however be required are the following:

- Periodic surveys should be undertaken on ripple receivers to ensure that bypassing or removal does not become a wide spread problem.
- The implementation of time of use tariffs may reduce the benefits of the ripple system, and enhance the likelihood of utility gaming. This should be considered when TOU tariffs are designed and implemented, and will require a detailed consideration by the ECB.
- The wide spread introduction of solar water heaters will reduce the effectiveness of the ripple system over time. However it is recommended that the system be maintained since most SWH will most likely have an electric backup element, which the utilities will want to be able to switch off in emergencies, or unexpected environmental conditions such as overcast winter days. While new ripple systems are probably not viable when SWH are widely used, it is expected that the maintenance and upkeep of existing systems (which have already paid for themselves before SWH were introduced) should be beneficial.
- Including loads other than domestic EWHs, for example non-essential domestic loads such as pool pumps, or discretionary loads in the commercial and industrial sector will widen the application and benefit that ripple control systems provide, which creates important opportunities to ensure the continued sustainability of the ripple system.

8.8 EXIT STRATEGY

The ripple system is projected to pay for itself within a period of less than ten years. It is however a utility owned and operated system which is expected to remain in place and be maintained for much longer. Therefore no medium term exit strategy is required.

In a scenario where EWH are almost entirely displaced by SWH in the long term it is likely that a time will come when the maintenance and operation of the ripple systems will no longer be justifiable, in which case it may have to be decommissioned.

However ripple control can also be used for the remote control of ripple-enabled devices such as air conditioners, pumps, pool pumps etc. With the introduction of TOU this option could become much more pronounced because some interval meters can be ripple enabled and can communicate in real-time the load per household / business, and the utility can then decide what types of appliances to switch off remotely in each household / business using a pre-determined and agreed ripple power-down and power-up schedule. This opens the way for select load aggregation in certain areas and is an additional benefit that ripple PLUS TOU brings for utilities. If one also integrates distributed generation, e.g. the emergency gen-plants of the various consumers, then the DSM is almost complete because the utilities can then decide remotely when to switch off and switch on certain gen facilities and / or loads, giving them much more room to manoeuvre than before. This also holds significant benefits to consumers with emergency generation plant because suddenly emergency gen-sets that would otherwise be used for 10 – 30 hours per annum are suddenly used for 150 hours or so, and the owners of such generator sets are then substantially remunerated for providing this peak capacity on demand. This opens the way for extended synergies in DSM, because suddenly both utilities and distributed generators have the ability to save and/or make money – and this in a liberalised energy market can extend right down to owners of a 1 KW PV generator, who would suddenly benefit from feed-in tariffs at certain times.

8.9 RISK

The extension of a ripple control system gives rise to the following risks:

Risk	Possible Mitigation / Comments
That NamPower and the REDs cannot reach agreement on implementing this DSM option	The ECB should facilitate the process of reaching agreement on implementation.
That significant consumer resistance may prevent the installation of receivers in more homes than anticipated, thereby reducing the benefits of the system	This must be managed carefully through consumer awareness. If major resistance is encountered tariff measures may provide additional pressure on households which refuse to allow installation.
That an unexpected SWH uptake beyond the relatively slow and long term uptake scenario anticipated in this report is eventuating	Unlikely to happen within the projected pay-back period for the ripple system.
That the utilities are gaming with the ripple system	ECB needs to monitor this carefully and be aware of how to spot such behaviour.
That inadequate and/or costly ECB controls may be required to manage of the ripple control system operation and switching behaviour by the utilities	ECB to develop adequate trained human resources, rules and monitoring mechanisms.
That technology costs are escalating thus jeopardising the continued viability of the ripple system	Late cost estimates received place the capital cost of transmitters well below those used in this report, hence risk is small.
That NamPower uses Ruacana and the ripple system to optimise their profits at the expense of consumer and/or the REDs	ECB needs to monitor this carefully and be aware of how to spot such behaviour.
That the establishment of the single buyer influences the roll-out and/or operation of the ripple system	Formalising of the single buyer should not materially affect the overall benefit of the ripple system, although it may shift the benefit between players.
That the control of the ripple system, especially when used for other devices as well, complicates the regulation and overall control of the system (a gaming utility can shadow the effect of ripple control), which requires stringent and often costly guidelines and procedures to be put in place	ECB to develop adequate trained human resources, rules and monitoring mechanisms.
That system wide TOU tariffs may change the viability of the ripple system	The effects of the ripple system must be taken into account in the design of TOU tariffs.
That NamPower and REDs may not agree on how to operate and share the responsibilities of an extended ripple control system, which requires detailed agreements who will decide at which point what the action is to be, and who will bear the costs of such actions, which is not trivial	The ECB should facilitate the process of reaching agreement on these issues.

Table 36: Ripple System Risks

The risks enumerated in Table 36 have been subjected to a high level impact assessment, the results of which are illustrated in below:

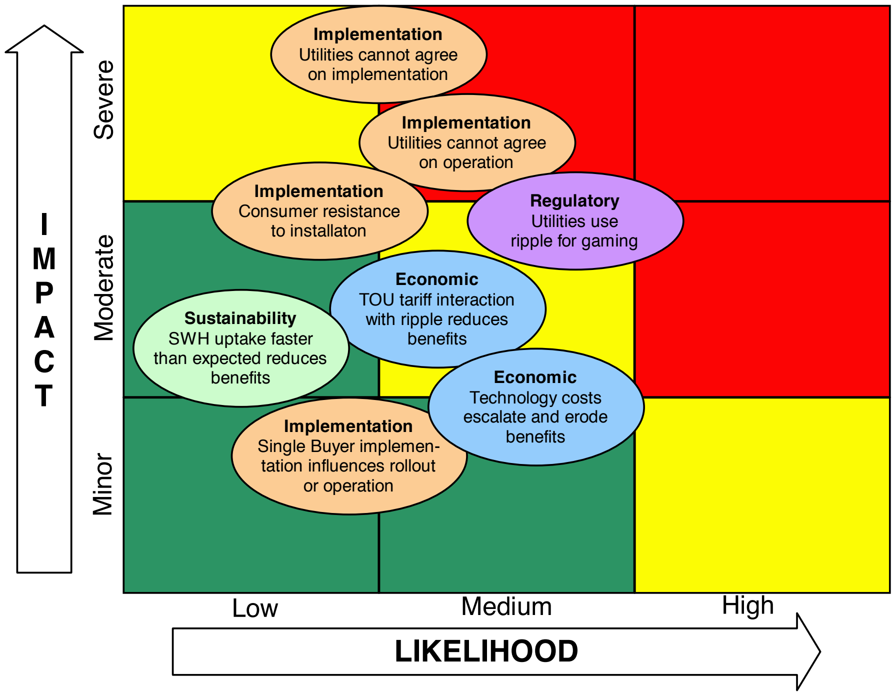


Figure 20: Ripple Risk Analysis

8.10 KEY ASSUMPTIONS

- It is assumed that the City of Windhoek and the Erongo RED are prepared to participate in a joint ripple project with the other REDs and NamPower and are willing to allow their existing ripple systems to be integrated into the proposed national ripple control system.
- It is assumed that all REDs and NamPower are willing to participate in the joint ripple project and can reach agreement on how the system is to be funded, managed and operated, to maximise the benefits on the national system and the country as a whole.
- It is assumed that the cost advantage of a ripple system is and remains favourable, which needs to be checked for each and every town unless remote control can be undertaken
- It is assumed that the preliminary extension of the ripple system will be focused on domestic EHW systems, but it is noticed that both the financial viability and the long term sustainability may benefit if other domestic and discretionary loads in the commercial and industrial sector are eventually included as part of a national ripple system.

9 COMMERCIAL AND INDUSTRIAL ENERGY AUDITS

Energy audits are widely used throughout the world to assess and guide viable DSM options, both in the residential and the commercial/industrial sectors. In Namibia, with low levels of consumer awareness regarding the benefits of energy audits and little detailed information on the commercial and industrial sectors' energy use, a subsidised energy audit programme may be an effective tool to overcome both financial and awareness barriers and demonstrate the viability of energy savings and the demand reduction potential.

This section will focus on energy audits in the commercial and industrial sector. Residential energy audits are less beneficial due to the generally low consumption and high number of customers. Furthermore it is expected that the introduction of TOU tariffs (refer to section 5), the conversion to CFLs (refer to section 6), the solar water heater conversions (refer to section 7), and the ripple control implementation (refer to section 8) will have a more significant impact on residential consumers. In addition, the education and awareness campaign (refer to section 4) will provide residential consumers with information on how and when best to reduce their energy consumption by way of behaviour change and the use of energy efficient appliances.

Namibia has seven mining customers, of which five mines are confirmed to have conducted their own energy audits and have implemented their own DSM programmes.

9.1 OVERVIEW

The envisaged subsidised Energy Audit programme is targeting the commercial and industrial sector. It will:

- Identify viable energy and daytime demand savings measures and associated capital cost and payback periods
- Reduce/remove financial barriers in Energy Audits
- Generate replicable case studies
- Create awareness of the potential savings which can be identified through Energy Audits.

An energy and demand savings scenario was compiled (without access to detailed data) for the commercial and industrial sector. The scenario estimates a 7% (57GWh per annum of 809GWh) energy savings potential and a consumer demand savings potential of 15MVA. The demand savings from the NamPower perspective is 6.8MW because NamPower purchases peak demand from Eskom in MW and not in MVA. Power factor improvements are therefore of no or little direct financial benefit to NamPower, although they assist with voltage control.

Once the DSM measures are in place the consumer sector saves N$ 33 million in electricity purchases per annum. The REDs and NamPower would show profit reductions of N$ 6.7 million and N$ 9.2 million respectively. The net annual country gain for the savings is N$ 17 million.

Since the benefits of such a programme are difficult to gauge, it is suggested that the Energy Audit programme starts with a trial phase that conducts twenty thorough Energy Audits at selected LPU facilities. Depending on the success of the trial phase this can be followed by a more formal energy audit programme which conducts approximately sixty energy audits over a period of three and a half years.

The cost of the trial phase is estimated at N$ 2 million and the cost of the formal programme is estimated to be N$ 4.75 million. It is recommended to recover these costs through an increase in the LPU and business electricity tariffs. The costs associated with the implementation of consumer-specific DSM measures are to be carried by the individual consumer implementing the measure. The required increase in tariff for the commercial and industrial sector to fund the above phases is estimated at 0.18 c/kWh. It is expected that the trial phase will develop a knowledge base of replicable experience which can then be made available to all consumers in these segments so that they can implement those measures which may apply to their operations.

9.2 BACKGROUND

Energy Audits are conducted to identify energy and demand saving opportunities and advise on energy management practices. The main objectives of an Energy Audit are to:

- Assess the **status** of energy and demand utilisation within a facility in detail
- Identify areas of energy and demand **savings** and to assess the capital costs/management processes associated with the recommended changes, thereby developing a business case for investing in savings measures
- Develop a detailed and prioritised **implementation plan** to realise the savings and recoup any investments

An Energy Audit is usually initiated by the energy consumer with the aim of reducing the utility bill. The consumer typically enters into a contract with an energy auditor to conduct the audit. Such a contract is generally a straight fee appointment, or based on a performance contract whereby the consultant is paid in relation to the savings achieved through the implementation.

The first step of an Energy Audit is to conduct a **Walk Through Audit** which can provide immediate insights into inefficient use of energy, and point towards the main focus areas in a follow-up, detailed diagnostic Energy Audit[14]. A detailed Energy Audit usually includes the following activities[15]:

- Establish current energy consumption and demand requirements – identify quantity, maximum demand and cost
- Determine how and where the energy and demand is currently being used on a system basis
- Identify energy wastage and the conservation potential for energy
- Identify processes/appliances that contribute to the maximum demand charges and consideration of power factor improvements and load shifting
- Prepare a cost-benefit analysis for the identified savings measures
- Identify realistic goals that can be achieved through an energy management programme and hardware changes
- Identify a prioritised list of energy and demand conservation measures which can be implemented to achieve the programmes objectives

Depending on the savings opportunities identified a payback calculation will ultimately determine the viability of the proposed measures.

Energy Audits in the commercial and industrial sector predominantly identify the following areas for energy efficiency improvements and demand reduction/shifting (with the measure in brackets):

- Air conditioning (efficiency, insulation, office appliances with lower heat emissions, conversion to evaporative cooling where feasible, ventilation, future ripple control)
- Lighting (lighting medium, electronic ballast with power factor correction, variable lighting levels, ambient lighting, timers, occupancy sensors)
- Refrigeration (insulation and seals, ambient environment, compressor efficiency)
- Electric water heating (fuel switching to solar water heaters, timer, time of use rescheduling, insulation, pipe losses)
- Electric heating systems (insulation, timer, time of use, fuel switching, hybrid heating systems)
- Power factor correction
- Electric motors (power factor compensation, rescheduling processes)
- Compressed air systems (leakages, pressure settings, compressor efficiency)

[14] "How to save energy and money: The 3E strategy". Energy Research Institute.

[15] Based on "Audit Procedures Manual". Southern African Development Coordination Conference.

From the above it is clear that this DSM intervention takes various forms, and includes electrical, structural, material, fuel switching, rescheduling/reorganisation, management and consumption behaviour aspects.

9.3 DEPENDENCIES

The successful implementation of an Energy Audit programme in the commercial and industrial sector will require the following factors to be in place:

- An Energy Audit agent who will drive the Energy Audit programme and ensures that identified and viable energy and demand savings are implemented
- Commercial / industrial consumer buy in, participation and acceptance of the Energy Audit programme and the changes necessitated by its implementation
- Cost reflective electricity tariffs (cheap electricity removes the financial incentives for implementing DSM) – Namibia is moving rapidly towards more cost reflective electricity tariff structures
- Competitive commercial/industrial environment – this exists in most sectors in Namibia, except in public entities
- Local capacity for conducting Energy Audits – exists only to a limited extent in Namibia
- Realisation of business opportunities in DSM with the required know-how and availability of suitable DSM technologies
- Funding for the procurement of Energy Audit services
- Funding and / or cost-effective financing options of capital costs for the acquisition of the required DSM hardware
- Consumer awareness of energy cost developments and savings potentials – a barrier being addressed by this DSM option in particular, and also as part of the overall DSM programme

9.4 THE VALUE PROPOSITION

The primary benefit of Energy Audits within the commercial and industrial sector is the financial gain (or savings) for the particular consumer. The utilities stand to benefit from a flattening of the daytime demand profile but will experience profit losses.

It is anticipated that the subsidised Energy Audit programme will reduce/remove the initial financial barriers that some commercial and industrial sector consumers are likely to experience. Furthermore the subsidy will be an effective tool to create a demand for energy audits in a sector that may not be aware of the full benefits of such assessments.

The benefits and impacts are discussed in more detail in the following subsections.

9.4.1 Customer value proposition

The beneficiaries of the envisaged Energy Audit programme are the commercial and industrial sector. There are approximately 17,000 commercial and industrial customers consuming some 45% of Namibia's energy (809 GWh per annum) with a maximum demand of some 128 MVA[16].

Customers will derive benefits from Energy Audits mainly due to:

- Reduced energy and demand consumption, which in turn reduces the utility bill
- Improvements. Many of the technologies and practices identified as part of an Energy Audits may lead to improvements and/or replacements of existing hardware (e.g. energy efficient lighting,

[16] Demand Side Management Study for Namibia: Report 1 – Overview for DSM options and ranking framework, 2006, Emcon for the Electricity Control Board.

compressed air systems), which introduces new operating conditions that lead to improved operational efficiencies, cost savings and reliability.

A scenario has been developed that projects potential savings in energy and demand for main consumer categories, based on the above energy consumption and demand. Due to the lack of available electricity consumption data and statistics for this sector these figures are based on estimates and experiences from selected Energy Audits and case studies. The figures may thus have a considerable margin of error. The breakdown for energy savings is listed in Table 37and the breakdown for demand savings is listed in Table 38.

Category	**Break-down** [%]	**Break-down** [GWh/pa]	**Energy portion targeted** [%]	**Savings potential** [%]	**Savings potential** [GWh/pa]	**Consumer savings** Tariff [c/kWh] 0.30 [N$/pa]	**RED profit/loss** Tariff [c/kWh] 0.20 [N$/pa]	**NamPower profit/loss** Tariff [c/kWh] 0.08 [N$/pa]
HVAC	20%	162	70%	5%	5.7	1,698,900	-566,300	-679,560
Lighting	20%	162	70%	10%	11.3	3,397,800	-1,132,600	-1,359,120
Office/IT equipment	5%	40	70%	10%	2.8	849,450	-283,150	-339,780
Refrigeration	10%	81	50%	20%	8.1	2,427,000	-809,000	-970,800
Electric water heating	5%	40	50%	95%	19.2	5,764,125	-1,921,375	-2,305,650
Electric motors	20%	162	20%	15%	4.9	1,456,200	-485,400	-582,480
Compressed air units	5%	40	70%	20%	5.7	1,698,900	-566,300	-679,560
Other	15%	121	0%	0%	-	0	0	0
TOTALS	**100%**	**809**			**57.6**	**17,292,375**	**-5,764,125**	**-6,916,950**
Energy savings potential					**7.1%**	**Net profit/loss [N$/pa]**		**4,611,300**

Table 37: Potential energy savings identified through Energy Audits on LPU consumers

Table 37 proposes a break down of the energy consumption within the commercial and industrial sector. In order to estimate the overall energy savings potential, consumer participation levels have to be assumed through the energy portion targeted (i.e. what portion of the overall energy for a particular load category will be impacted upon through Energy Audits). As such it is assumed that for example the consumers responsible for 70% of the energy consumed by lighting will partake in the conversion to energy efficient lighting, while only 40% of the energy consumed by refrigeration will reasonably undergo energy efficiency improvements. This assumption is made because changes in lighting are cheaper than corresponding changes in refrigeration.

The energy savings scenario proposes that the highest energy saving gains are, in descending order, from electric water heating (19 GWh), lighting (11 GWh) and refrigeration (8 GWh).

As indicated by the first part of Table 37 the potential energy savings made from the envisaged Energy Audit programme is estimated to be about 7% for this sector.

The second part of Table 37 calculates the savings/losses for the consumer, the REDs and for NamPower. Based on an average energy tariff of 30 c/kWh the consumer savings are estimated to reach N$ 17 million per annum once the DSM measures reflecting the above scenario have been implemented.

Category	**Load Factor** [%]	**Break-down** [MW]	**Demand portion targeted** [%]	**Consumer savings potential** [%]	**Consumer savings potential** [MVA]	**NamPower savings potential** [%]	**NamPower savings potential** [MW]	**Consumer savings** MD [N$/kVA] 80.00 [N$/pa]	**RED profit/loss** MD [N$/kVA] 75.00 [N$/pa]	**NamPower profit/loss** MD [R/kW] 55.00 [N$/pa]
HVAC	75%	25	70%	5%	0.9	5%	0.9	827,470	-51,717	0
Lighting	70%	26	70%	20%	3.7	10%	1.8	3,546,301	-221,644	-443,288
Office/IT equipment	70%	7	70%	0%	-	0%	-	0	0	0
Refrigeration	70%	13	50%	10%	0.7	2%	0.1	633,268	-39,579	-126,654
Electric water heating	50%	9	50%	80%	3.7	80%	3.7	3,546,301	-221,644	0
Electric motors	80%	23	20%	10%	0.5	5%	0.2	443,288	-27,705	-55,411
Compressed air units	80%	6	70%	5%	0.2	0%	-	193,938	-12,121	-48,485
Other	75%	18	0%	0%	-	0%	-	0	0	0
TOTALS		**127**			**9.6**		**6.8**	**9,190,567**	**-574,410**	**-673,837**
Demand reduction potential					**7.5%**		**5.3%**	**Net profit/loss [N$/pa]**		**7,942,320**

Table 38: Potential daytime demand reduction identified through Energy Audits on LPU consumers

The demand breakdown is based on the energy breakdown of Table 37 in conjunction with estimates for the load factor of the load category (refer to column 2 of Table 38). The load factor has been selected on the estimated duty cycle of the appliance. It is important to note that these are first order estimates only, which is due to the lack of data and the diversity of customers within that sector. The potentially high margin of error justifies this approach, which is designed to estimate the overall impact on the sector.

The demand portion targeted (4th column) reflects the portion of the overall demand that can reasonably be reached with Energy Audits and can be implemented. These values are the same as for Table 37.

The demand savings are calculated for the consumer and for NamPower and exclude power factor correction at this stage as these calculations are all in MW. It has to be noted that NamPower's demand purchases are based on MW meaning that NamPower derives no direct financial benefits from power factor correction measures. In fact extensive power factor correction on the consumer side poses technical challenges and costs to NamPower in terms of network resonance and the need for additional reactance to counteract the capacitance in the network, stemming from the long transmission lines in the country – however this issue is being addressed also by rising demand and hence rising utilisation of the networks.

The savings listed in Table 38 address daytime peak as the commercial and industrial sector is pre-dominantly active during daytime. Furthermore it is expected that the other DSM measures discussed in this report (i.e. domestic CFL, Solar Water Heaters and ripple control) will have more significant impact on the evening peak than the reduced evening activities of the commercial and industrial sector.

The consumer savings are listed in MVA as some of the measures also address power factor correction (e.g. lighting, refrigeration). The percentages reflect the impact of the measure. The impact of converting electrical geysers to solar water heaters will have a significant impact on demand (estimated at 80%) whereas the demand reduction from the HVAC load category is not expected to have a significant impact (estimated here at 5%).

The overall impact of power factor correction at the consumer meter has not been included above as it is not linked to one load category on its own. In fact, power factor correction is often implemented at the electricity supply meter and therefore changes the overall consumer profile. The scenario for calculating the impact of extensive power factor correction implementations is assumed to affect about 50% (64MW) of the demand in this sector and improve the power factor from 0.85 to 0.95 (from 74MVA to 67MVA). This 11% improvement results in MVA savings of approximately 7MVA.

Measure	**Consumer savings** MD [N$/kVA] 80.00 [N$/pa]	**RED profit/loss** MD [N$/kVA] 75.00 [N$/pa]	**NamPower profit/loss** MD [R/kW] 55.00 [N$/pa]
Power factor correction	6,467,368	-404,211	-1,616,842
	Net profit/loss [N$/pa]		**4,446,316**

Table 39: Savings and losses due to power factor correction implementations

The cumulative financial gains from demand savings (Table 38 & Table 39) for the commercial and industrial consumers are approximately N$ 15.6 million per annum (N$ 9.2 million and N$ 6.4 million).

With reference to Table 39 it must be noted that the RED and NamPower losses in **profit** are calculated on the difference in price per kVA purchased and sold, and assuming that the full demand saved by the consumer also leads to the same reduction in demand between the RED and NamPower and between NamPower and its capacity suppliers (ignoring losses).

9.4.2 Utility value proposition and impact

9.4.2.1 Regional Electricity Distributors

It is estimated that anticipated energy savings of 55GWh per annum in this sector will result in revenue losses of N$ 5.5 million, based on a purchases against a tariff of 20c/kWh and sales against a tariff of 30c/kWh (Table 37). The financial impact of demand savings (Table 38) and power factor correction (Table 39) will have a comparatively negligible effect resulting only in a N$ 0.9 million loss of revenue. This is based on a demand purchase rate of N$ 75/kVA and on a demand sales rate of N$ 80/kVA.

Although the REDs will experience losses on the revenue side, it will potentially benefit from freeing-up existing overburdened distribution network capacities, and see improvements in the quality of supply in affected networks due to power factor correction measures. Network losses may also be reduced, especially if the demand profile is flattened.

9.4.2.2 NamPower

NamPower has identified DSM measures as an important instrument to immediately cope with the capacity bottlenecks experienced in the region. From a utility perspective this is where the primary value of an Energy Audit programme lies - freeing up capacity that it is currently unable to provide.

NamPower purchases energy against an average tariff of 8c/kWh (standard rate, low season) and sells to the REDs against a tariff of 20c/kWh (refer to Table 37). In terms of the financial impact of the above scenario NamPower stands to loose significant revenue from energy savings (N$ 6.6 million).

The NamPower demand savings percentages listed in Table 38 are in parts different to the consumer demand savings percentages. This is the case when the DSM measure for a particular load category also has power factor improvement implications (e.g. lighting, refrigeration). The percentages are the same if the demand reduction is resistive (e.g. electrical geysers).

NamPower purchases demand at approximately N$ 55/kW and sells to the REDs at N$ 75/kVA. The anticipated demand reduction, in particular power factor correction, will result in approximate revenue losses of N$ 2.3 million per annum (Table 38 and Table 39).

The net effect of the anticipated energy and demand savings is calculated by subtracting the revenue losses of the REDs and NamPower from the reduced purchases of the consumers (Table 37, Table 38 and Table 39). The resulting financial benefit from DSM measures are therefore N$ 4,6 million for energy savings and N$ 12.4 million for demand savings totalling N$ 17 million per annum.

The above implies that the utilities need to be part of the decision making body determining the prioritisation of energy audits if the entire electricity sector value chain is to benefit. Such participation will ensure that those audits that positively impact on the entire chain (in terms of demand flattening) have priority, or that overall benefits will at least find consideration in the evaluation process. This recommendation may surprise, because energy audits usually focus solely on consumer benefits; however the prevailing Namibian capacity shortages demand a more collaborative solution that comprehensively addresses the severity of the situation.

9.4.3 Customer segmentation and potential

The commercial and industrial sector falls into three electricity consumer categories. These are single phase business, three phase business and large power user (LPU). The LPU customers consume approximately 74% (595GWh) of the 809GWh consumed in this sector and utilise approximately 70% (90MW) of the 128MW demand. In total, there are about 1,600 LPU customers compared to the 15,600 customers in the business category (single and three phase). This clearly indicates that the starting point for an Energy Audit programme must be the LPU consumer category in order to maximise the savings impact. However to ensure fairness it is recommended that some business consumers also be included in the trial phase so that for that consumer segment a knowledge base is also developed which can then be made available to all consumers in that segment for replication.

In considering the savings impact in relation to the customer segment, the typical loads are considered for each particular segment.

It is expected that office/administrative buildings using HVAC, lighting, office equipment, and possibly electric geysers can effect savings due to lighting and some HVAC changes. Office buildings are not expected to offer many opportunities for converting to SWHs, mainly due to their existing structural constraints.

Commercial and institutional establishments’ housing people, such as hotels, hostels, hospitals, prisons etc, are expected to realise savings from converting electric water heaters to SWHs, and from converting to energy efficient lighting. Replacing for example ten electrical hot water geysers with SWHs saves approximately 30MWh per annum, and reduces the maximum demand by approximately 15kW.

Commercial enterprises with shop floors (lighting, IT equipment, possibly refrigeration) stand to benefit mainly from conversion to energy efficient lighting with resulting power factor improvements. Demand savings on refrigeration have only a small impact due to the low power requirements of these units, and shifting load is expensive and has therefore marginal benefits only.

Industrial consumers using inductive loads stand to benefit primarily from power factor corrections (i.e. resulting in demand savings), and to a lesser degree from improving maintenance of compressed air systems where applicable. Power factor correction in an industrial environment relying heavily on inductive loads is a most effective DSM measure and usually has a payback period of less than a year.

Example: John Meinert Printing installed a power factor correction unit at its printing facilities in 2002[17]. Its approximate maximum demand was 128kVA and with installation of a power factor correction unit was reduced to 103kVA (this was one particular scenario and was equivalent to improving a power factor of 0.77 to a power factor of 0.96). At a MD cost of N$ 63.75/kVA (2002) this resulted in savings of about N$ 19,000 per annum. The cost of the power factor installation was N$ 16,000. The repayment period for the capital cost investment was therefore less than one year.

9.4.4 Customer engagement

In order to effectively engage customers in the commercial and industrial sector, it is recommended that the principal driver of the Energy Audit programme compiles information on the potential for energy/demand savings and the associated costs and pay back periods, based on local and international experiences. A number of case studies of relevance to the Namibian commercial and industrial sector will provide the necessary examples and figures that can serve to illustrate success stories which in turn will attract interest in the sector. This necessitates a coherent and convincing presentation, focusing on the potential costs and benefits for different users, how an organisation can participate in the programme, how an audit is undertaken and how to benefit from the subsidy, and is to be provided as part of the information campaign of the Energy Audit programme.

It is proposed that this information be disseminated primarily through existing associations like the NCCI and NMA, supported by a limited public campaign through the print media.

9.4.5 Secondary benefits

Secondary benefits of energy audits include the development of an information database on energy consumption patterns in a sector that has very little actual and detailed consumption data, and the development of an energy efficiency sector within a country that is able to provide energy audit services and implement DSM measures.

It is also expected that the first energy audits to be done will distil a number of replicable cases which can be applied to many other consumers with very little additional energy audit cost.

9.5 DELIVERY

This section describes the essential elements which need to be put in place for implementation of a subsidised Energy Audit programme. Due to the uncertainty of the impact from Energy Audits, this section differentiates between a trial phase and a formal phase. The trial phase presents the opportunity to gather some first hand data and then decide on whether to launch into a more formal energy audit programme.

9.5.1 Process and roles

9.5.1.1 Trial phase

The trial phase is seen as the phase which establishes the business case for subsidised Energy Audits and which provides first real auditing data for replicable case studies. This is considered necessary due to the high degree of uncertainty in the benefit calculations undertaken for this report. Although international experience speaks clearly of the benefits of energy audits it is felt that the benefit case for Namibian conditions needs to be proven more convincingly than has been the case in the tentative calculations for this report before a full subsidised energy audit programme can be properly motivated.

The trial phase would consist of:

[17] Energy Audit at John Meinert Printing. 2002, Emcon Consulting Group.

- An information campaign aimed at commercial and industrial consumers to raise awareness of the programme
- Approximately twenty thorough Energy Audits of LPU customers
- A project coordinator (contracted consultant) who writes the TOR for the audits, identifies enterprises with large energy and demand saving potential, oversees audits reporting and compiles case studies
- Identification of other LPU consumers with large DSM potential (for the EA formal phase)
- Evaluates and reports to the ECB on the viability of subsidised energy audits and the commencement of the EA formal phase.

9.5.1.2 Formal phase

The implementation of a formal subsidised Energy Audit programme consists of an establishment phase, and an implementation / operationalisation phase. The high level description below highlights these various elements within the programme. This is followed by a more in depth description of the processes and roles:

1. Approval of programme and secure funding
2. An information campaign aimed at commercial and industrial consumers to raise awareness of the programme
3. Determination of driver/agent for the Energy Audit programme
4. Definition and setting of priorities for the expected demand reduction outcome to be provided through a first pass audit, and design of an Energy Audit subsidy application form
5. Identification of local energy auditors with the necessary credentials and experience, and possibly the design of a programme to further develop energy auditors, which presents an opportunity to target SMME/BEE
6. Identification and approach of large commercial and industrial consumers, using information gained from the trial phase
7. Conducting walk through audits of commercial/industrial customers, and compilation of the obligatory information as set out in the Energy Audit subsidy application form
8. Invitation and subsequent evaluation of applications according to defined evaluation criteria
9. Conducting energy audits at selected facilities (assuming that the application for the energy audit subsidy is approved) which will provide the baseline information, a projection of the anticipated savings, the costs of the implementation and an action plan
10. Implementation of those recommendations that meet the pre-defined cost-benefit criteria of the programme, it is recommended that the implementation is to occur within a certain timeframe

Figure 21 below shows the different actors that are part of such a programme.

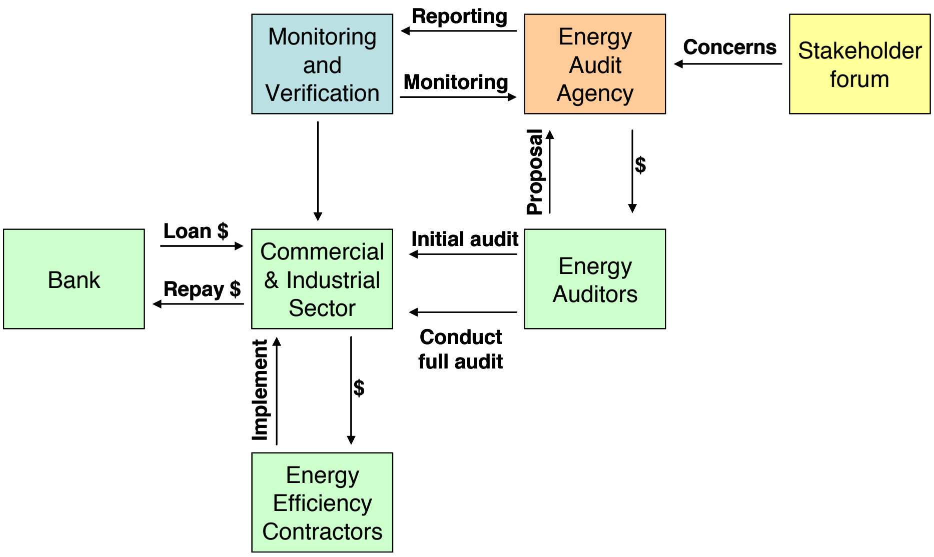


Figure 21: Functional diagram for the subsidised Energy Audit programme

The basis of the programme described in this section is a demand driven approach that incentivises the participation of commercial and industrial consumers by way of a subsidised energy audit and the potential cost savings resulting from energy and/or demand savings. The consumer may consider contracting in the services of a qualified Energy Auditor to conduct a high level Walk Through Audit, or alternatively, the programme may consider paying a small fee (N$ 1,000 to N$ 2,000) for Energy Audit proposals that meet certain energy and demand saving criteria.

The requirements and the roles of actors are described in more detail below:

Energy audit agent

The agent driving the Energy Audit programme has to define national priorities and desired programme outcomes in line with Government policy. This includes securing and administering the programme finances, evaluation of applications, defining the format for the data collection, compiling consumer data, drafting and compiling case studies, disseminating information, and reporting to a Monitoring and Verification body. The Agent should preferably be part of an existing institute/entity, as its scope of work is fairly limited and is most likely to be of short duration only. The potential driver for the Energy Audit Agency could be housed at:

- The Electricity Control Board
- The Ministry of Mines and Energy
- NAMREP
- The REEE Institute
- A private commercial entity, similar to Konga Investments which is running the Solar Revolving Fund

NamPower, the REDs and the NCCI are not considered here because of potential conflict of interest. In addition the NCCI may lack the capacity to operate and run such an Agency.

The Energy Audit Agency interacts with the stakeholder forum, which will include representatives of NamPower and the REDs.

It is essential that the selected Agent for this task has the necessary technical, financial and administrative capacity as well as autonomy, and does not have a conflict of interest in its role and interactions with any of the stakeholders.

DSM priorities

The priorities for DSM measures need to be clearly defined, and must serve the needs of the Namibian electricity sector. Setting these priorities will be the task of the Energy Audit Agent, in close collaboration with the sector's key stakeholders, namely the MME, ECB, NamPower, REDs, REEE Institute, and NCCI.

The following priorities may form a discussion a basis for discussion:

Short term:

- Reductions in daytime demand (to create more scope for other DSM options to reduce evening peak)
- Identification of switchable loads which could be ripple controlled
- Identification of load shifting which could be done either permanently or on demand
- Significant reductions in energy consumption through energy efficiency, especially with focus on peak demand times
- Savings areas with a high impact in terms of both energy and demand
- Savings areas with the best pay back periods

Medium term:

- Power factor correction
- Significant reductions in energy consumption through energy efficiency including standard and off-peak times
- Savings areas with a high impact in terms of either energy or demand or both
- Savings areas with the best pay back periods

Although limiting the current regional capacity shortages needs to be high on the priority list of the Agent, it needs to be ensured that the Energy Audit programme is not solely focused on overcoming these short- to medium term constraints. Therefore the programme should for example give a higher priority to long term demand reductions rather than demand shifting activities.

The DSM priorities need to take the broad impact that the various measures have on the socio-economic needs of the country into account, especially considering the continued affordability of electricity for low income households, increasing access to electricity, lowering cost for the commercial and industrial sector, and improving Namibia's security of supply.

Evaluation criteria for subsidy applications

Interested parties within the commercial and industrial sector can submit an application to the Energy Audit Agency for a subsidy. The basic information that is required is as follows:

- Energy consumption figures and demand requirements from the last twelve months
- An approximate breakdown of the load
- Identification of areas where energy and demand savings can be realised
- Anticipated savings and resulting reduction in energy and demand
- Motivation for the estimated savings (reference to case studies)
- A first pass estimate of the capital costs to be incurred to realise the savings, and hence a first pass estimate of pay back periods
- Commitment by the audited entity to enter into an agreement with the Agency to implement viable energy savings options (for example, if the entity is willing to implement an audit recommendation having a payback of less than a year and costs less than a set percentage of the turnover of the entity, then the subsidy for such an audit has a higher ranking compared to an application where the entity does not make that commitment)

The qualifying factors for approving the audit subsidy depend on:

- the determined DSM priorities

- the expected reduction in energy consumption (kWh saved)
- the demand reduction (MW saved)
- the cost category of the implementation of the DSM measure (the higher the cost of the DSM measure in relation to the savings, the longer the payback period, which reduces the likelihood of beneficial implementation).

The above criteria will result in ranking consumers according to their savings potentials.

As an example refer to Table 40 below:

	Enterprise A	Enterprise B
Average energy consumption	30MWh	5MWh
Potential savings	10% (3MWh per month)	30% (1.5MWh per month)
Demand	120kVA	100A
Potential demand savings	20%	20% (30A)

Table 40: Example of energy savings scenario

The industrial enterprise A has an energy consumption of 30MWh per month and a maximum demand of 120kVA. The Energy Audit proposal projects a 10% saving in energy (3MWh/month) and a 20% demand reduction (24kVA). Commercial enterprise B has an energy consumption of 5MWh per month and a basic charge (circuit breaker limit of 100A, single phase). The Energy Audit proposal projects a 30% saving in energy (1.5MWh/month) and demand (30A). Although the energy savings percentage is higher in enterprise B, the overall savings are higher in enterprise A. In addition, enterprise A has more substantial demand savings than enterprise B, and the relatively "cheap" capacity charge of the circuit breaker-limited-consumer does not provide the necessary financial incentive to implement the demand specific DSM measures. Therefore the energy audit of enterprise A should get preference over enterprise B.

Process for awarding Energy Audits contracts

Once a number of applications for subsidised Energy Audits have been approved, the Agency solicits bids, possibly in batches of three audits, by way of a Request for Quotation (RFQ) process that invites local Energy Auditors to bid. The RFQ specifies the bid's Scope of Work, output requirements, time completion requirements, submission requirements and evaluation criteria.

It is advisable to pre-qualify Energy Auditors in order to ensure quality standards and to keep execution times as short as possible. The pre-qualification should not bar Auditors from pre-qualifying at a later stage. If demand for audits justifies an expansion of existing audit capacity then the Agent should consider arranging appropriate training with a focus on SMME/BEE development.

Energy Audit report requirements

The Energy Audit report will report on the status of the energy and demand utilisation in the respective facility, and identify, assess and provide the costs for anticipated savings, and develop a prioritised implementation plan.

In addition, the report needs to provide the required baseline figures for monitoring and verification of the overall energy audit programme. The baseline figures need to state the energy and demand usage in relation to the output of the facility (for example: the energy required to bottle a certain amount of liquid, or the throughput of paper at a printing establishment). The report needs to state whether there are seasonal variations and whether the energy/demand is dependent on the number of persons working at the facility.

It is suggested to make use of templates (available internationally) and develop these to be coherent with the database design and to create a standard prescribed reporting format to ensure that energy audits are executed to a common standard at least in terms of report output.

Obligations to implement

In order for the Energy Audits to be effective, it needs to be ensured that the relevant commercial and industrial entities partaking in the programme enter into an agreement which obliges them to implement the most viable energy and demand saving DSM measures identified in the audits. Therefore, obligations to implement need to be specified as percentage energy and demand savings in relation to the overall baseline consumption. In addition, financial parameters such as the maximum investment cost and the maximum payback period of the DSM measure must be stated and reflected in the contract between the Energy Audit Agency and the commercial/industrial entity.

A timeframe for the implementation of the DSM measures has to be determined in the agreement between the Agency and the commercial/industrial entity. This has to be decided on a case by case basis, as some implementations may be of significant size thus warranting a longer implementation period.

Failure to implement the DSM measures meeting the above requirements obliges the audited entity to repay the larger part of the cost of the energy audit. This could be in the order of 70 to 100% of the energy audit cost, depending on the benefits of the energy audits, and their value in terms of information gathered for the sector.

A word of caution: Although the above obligations are justified when it comes to spending public money, they can also lead to significant amount of red tape, making it less attractive for commercial/industrial entities to engage with the programme. Furthermore, should the funding for this programme be financed from tariff increases within the commercial/industrial sector, then the Energy Audit Agency should refrain from insisting on participants meeting the obligations, since the participants are paying for the audits. The Energy Audit Agency should in any event adjust its evaluation criteria for applications over time to select those audits with highest probability for implementation.

9.5.2 Milestones

9.5.2.1 Trial phase

The trial phase for twenty energy audits can commence after:

1. funding has been secured for the amount of approximately N$ 2 million and
2. after Terms of References describing the components and activities for the Trial phase have been compiled and a suitable bid has been received and awarded.

Depending on the sources of funding this could take about three months to reach this stage and to be able to launch the Trial Audit phase.

9.5.2.2 Formal phase

A tentative timeline for the commencement and implementation of the formal subsidised Energy Audit programme is presented in Table 41 below.

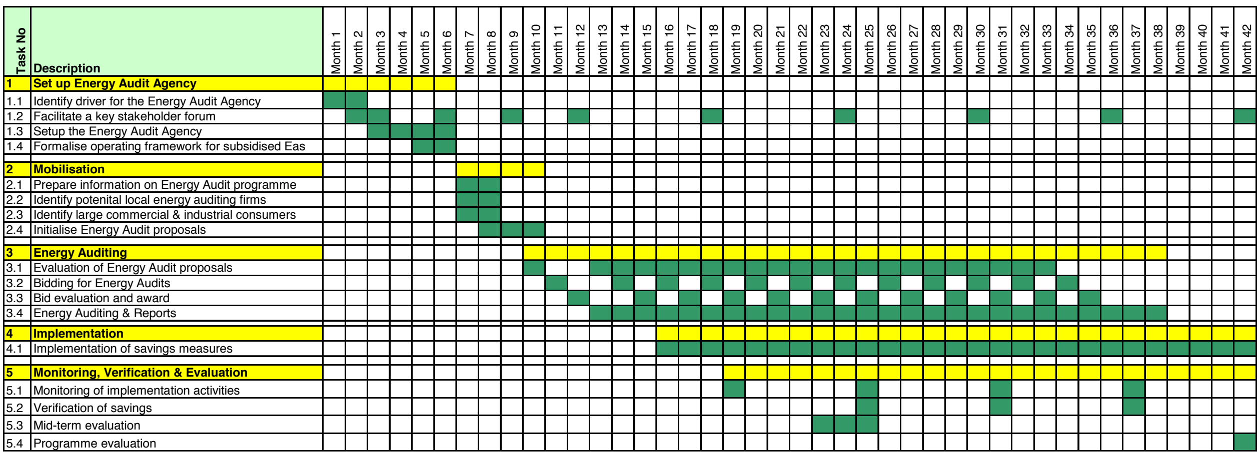


Table 41: Timeline for the subsidised energy audit programme

Since it is recommended that the Energy Audit Agency is attached to an existing institution, it is anticipated that the establishment of the Agency can be fast tracked, and be operational within half a year. It is expected to take a further 4 month to establish the Energy Audit programme, which implies that the first energy auditing activities can commence towards the end of the first year. If it was decided to initially commence with a Trial phase then the setting up phase should be shorter. The second and the third year will see the bulk of the energy audits undertaken, followed by the implementation of those DSM measures that have been shown to be viable.

It is suggested to have a mid-term review of the programme and to revaluate the selected criteria. A final review should be conducted after the third year to establish whether its outcomes have been reached. This will ensure the transparency and effectiveness of the programme, and can serve to highlight the programme's success stories, and identify those measures that brought about the most dramatic energy and demand savings. The final review should also assess whether the programme should be extended or whether enough momentum has been built up and benefits demonstrated that consumers are willing to fund further audits themselves.

9.5.3 Costs and investments

9.5.3.1 Trial phase

The cost of an energy audit arises due to the fees for an energy expert, and measurements of power and energy, which depends substantially on the level of detail. The energy auditor will list all loads with their electrical specifications, their operating patterns and their function within the establishment. Utility bills are analysed, and interviews are conducted with key staff. Depending on the size and complexity of the operation, an energy audit can take from one to three months and cost between N$ 10,000 and N$80,000.

In this case the larger LPUs will be selected and it is therefore assumed that one audit will cost N$ 80,000. The cost of twenty audits is therefore N$ 1.6 million. The cost of a consultant to coordinate the audits and oversee the reporting has an estimated cost of N$ 400,000. This results in a total cost of N$ 2 million.

The timeframe of this trail phase is approximately 1 year. The increase in the business and LPU tariff is therefore 0.25 c/kWh if this is to be funded from the tariffs.

9.5.3.2 Formal phase

Programme activities that have financial implications are the establishment and operation of the Energy Audit Agency, undertaking the actual energy audits, and the implementation of the recommended DSM measures.

Energy Audit Agency Cost Budget

The Energy Audit Agency will require funding to cover once off establishment expenses, and ongoing staff and operating costs. The budgets for these costs are estimated at:

- Once off costs: office equipment (tables, computers, copier etc): N$ 50,000 and software (in particular a purpose designed database and query form) of N$ 100,000
- Staff: One administrator and a part-time energy specialist: N$ 400,000 per annum with a once-off fee for setting up the framework during the first half year of N$ 250,000.
- Operating expenses (communications, media reproductions etc): N$ 100,000 per annum

The cost of an energy audit can cost between N$ 10,000 and N$80,000 depending on complexity and size of company under investigation.

It is anticipated that about five companies in Namibia will initially have the necessary background to conduct energy audits. At an average of two months per audit, five companies could conduct about thirty audits per annum. At an average cost of N$50,000 per energy audit, this results in a total annual budget of N$ 1.5 million.

Matching the costs to the timeline discussed in section 9.5.2 results in the following tentative budget over a three and a half year period:

	№ of Energy Audits	**Budget [N$ per annum]**
Year 1	None	500,000[1)]
Year 2	30	2,000,000
Year 3	30	2,000,000
Year 4	None	250,000
Total	**60**	**4,750,000**

[1)] Half the staff and operational cost assuming that there is a lead time of half a year before the Agency employs staff.

The overall budget for the Energy Audit programme therefore amounts to approximately N$ 4.75 million. Depending on the outcome from the evaluation, the programme can either be extended for another period, or terminated or restructured.

The technology and implementation costs associated with the DSM measures identified during the energy audits in the commercial and industrial sector will vary from one entity to another. These costs are assumed to be recovered through energy and demand savings, and will not be discussed in further detail in this report.

Funding

It is essential that funding for the establishment and operation of the Energy Audit Agency as well as the energy audits be secured. The potential benefits of the audits and the DSM measures implemented accrue primarily to the entities in commercial and industrial sector.

It is recommended that the Energy Audit Agency and audits be funded by way of an increase in the business and LPU tariffs, since the benefits of the DSM programme mainly accrue to the commercial and industrial sector as shown in section 9.4.2. Such a tariff increase is therefore implemented at the RED level. Based on an annual cost of N$ 1.4 million (N$ 4.75 million divided by 3.5 years) the increase in the energy tariff is the order of 0.18 c/kWh.

It is recommended that all technology costs associated with the implementation of the energy audit recommendations are borne by the respective commercial/industrial entity themselves. It should be mentioned that in the DSM programme launched by Eskom in South Africa, the utility makes capital contributions towards energy efficiency and demand reduction implementations, and recovers these through the electricity tariffs (Eskom has expressed a clear preference for demand reduction programmes through the allocation of a 100% capital subsidy for demand reduction projects, and a 50% capital subsidy for energy efficiency projects). This option however is not pursued any further in this report, because:

- A DSM programme should be guided by financial viability, sustainable resource management and broader socio-economic benefits, and not solely by short to medium term needs of a utility
- The financial viability of DSM measures is increasing in Namibia as electricity tariffs increase
- The commercial and industrial sectors will take real ownership if they are the owners of the DSM assets, which will also lead to the necessary maintenance and monitoring of the DSM assets and operations. Ownership will further ensure that choices are made that have long term benefits as well as short term ones.

A preliminary preference request channelled through the NMA indicated that the Namibian commercial and industrial sector supports a programme that makes subsidised energy audit available while remaining responsible for implementing energy efficiency technologies and/or demand reduction measures.

9.6 MONITORING AND VERIFICATION

The key question that a subsidised Energy Audit programme has to answer is whether the commercial and industrial sector participants that have benefited from an audit are implementing the recommended DSM measures, and whether it yields the expected energy and demand savings. The Energy Audit programme will therefore have to have a monitoring component that compiles the following information:

- Number of energy audits conducted within a two year time frame
- Implementation of viable energy and demand savings measures within the agreed timeframe
- Energy and demand savings realised;

and in a broader context:

- Improved awareness of the potential and benefits of energy audits
- Information database on usage profiles in the commercial and industrial sector
- Information database on case studies for replication.

Collection of this information will be essential for the ongoing evaluation of the programme, as well as a programme assessment at the end of a three and a half year project period.

Verification of the effectiveness of the programme is achieved through:

- Analysis of the utility bill and activities/production logbook of the entities which have implemented the viable recommendations as per Energy Audit
- Increased demand for energy audits and number and effect of energy audits implemented without subsidies.

It is recommended that monitoring and verification task be conducted by the REEEI provided that this institute is not the implementing agent. Should the REEEI be the Agent, it is recommended that the MME becomes the programme's monitoring and verification authority.

It may be possible to involve tertiary institutions (Polytechnic of Namibia, UNAM) or the REEE Institute (provided the necessary capacity is available) in the verification process as this presents practical capacity building opportunities for students.

9.7 LONG TERM SUSTAINABILITY

The long term sustainability of the programme is enhanced by increasing electricity prices. As electricity is becoming a larger proportional expense on the income statements of commercial and industrial participants, energy audits are likely to be seen as a way to cap or even decrease such costs. It is therefore envisaged that the proposed subsidy will remain a short term tool to reduce and overcome some of the financial barriers that persist in the commercial and industrial sector. Also, it is likely that the programme's success stories and associated word of mouth will provide added momentum to the campaign.

Once a number of energy audits have been conducted and documented as case studies (where the replication potential is given) the information campaign that accompanies this DSM programme will utilise the existing channels, for example through the Namibian Chamber of Commerce and Industry, and the Namibian Manufacturers Association, to disseminate the information and thus provide an impetus for continued energy auditing.

9.8 EXIT STRATEGY

The primary exit strategy lies in the proposed trial phase, the purpose of which will be to solidify the business case for a subsidised energy audit programme. Should the trial phase not be successful then the formal main phase should be aborted. This implies that the trial phase should be large enough and diverse enough to allow proper conclusions to be drawn from the results.

It is recommended that subsidised energy audits be made available for a period of two years (Year 2 and Year 3 of the programme's implementation), after which the programme should be reviewed and assessed. This will allow sufficient time to undertake the anticipated sixty energy audits, and for a review to take place to indicate whether this measure is achieving the necessary results and energy/demand outcomes .

Should the initial approach to the Energy Audit programme not be successful, the Energy Audit Agency needs to halt the bidding process and respond to the problems experienced. However, in view of the generally positive feedback received during the compilation of this report, the likelihood that the commercial and industrial sector is unwilling to participate as expected is low.

A further exit strategy is the insistence on reports and case studies to build a clear case for Energy Audit viability so that some momentum is established and a formal framework is no longer required.

9.9 RISKS

The risks that a subsidised Energy Audit programme faces include:

Risk	Possible Mitigation / Comments
The driver for the subsidised Energy Audit programme is ineffective	A clear mandate for the programme should be obtained, which will empower the programme custodian (probably MME) to take action if performance of the agent is not acceptable. If a private sector agent is appointed then the contract should be performance based.
Subsidy funds are insufficient, or cannot be found at all	A clear commitment for the programme must be obtained from the custodian (MME), which must include a mandate to obtain the required funding.
The commercial and industrial sector responds unfavourably to the envisaged tariff increases	Since the envisaged increases to fund the programme are relatively minor significant resistance is not anticipated.
Time delays extend the implementation period: getting the Agency operational, getting proposals for subsidy applications for attractive energy audits, and implementing viable DSM measures are processes that require adequate staffing and funding in order to be undertaken on time	A competent agent must be appointed and suitably empowered to undertake the work.
Costs are underestimated and/or savings overestimated	This will be mitigated by first undertaking a trial phase to prove the benefits and costs to an acceptable degree of certainty
Commitments by commercial and industrial sector participants do not translate into DSM measures implemented	This can be mitigated by a) extensive communication with stakeholders to ensure their buy-in during programme design and start-up and b) by contractually binding beneficiaries to implement measures
Loss of programme funds due to ineffective energy audit (improper implementations and/or poor repayment of energy audit fees by commercial/industrial entities)	A competent agent must be appointed and suitably empowered to undertake the work in a professional manner, including accreditation of energy auditors.

Table 42: Energy audit risks

The ranking of the above risks is illustrated in the following figure:

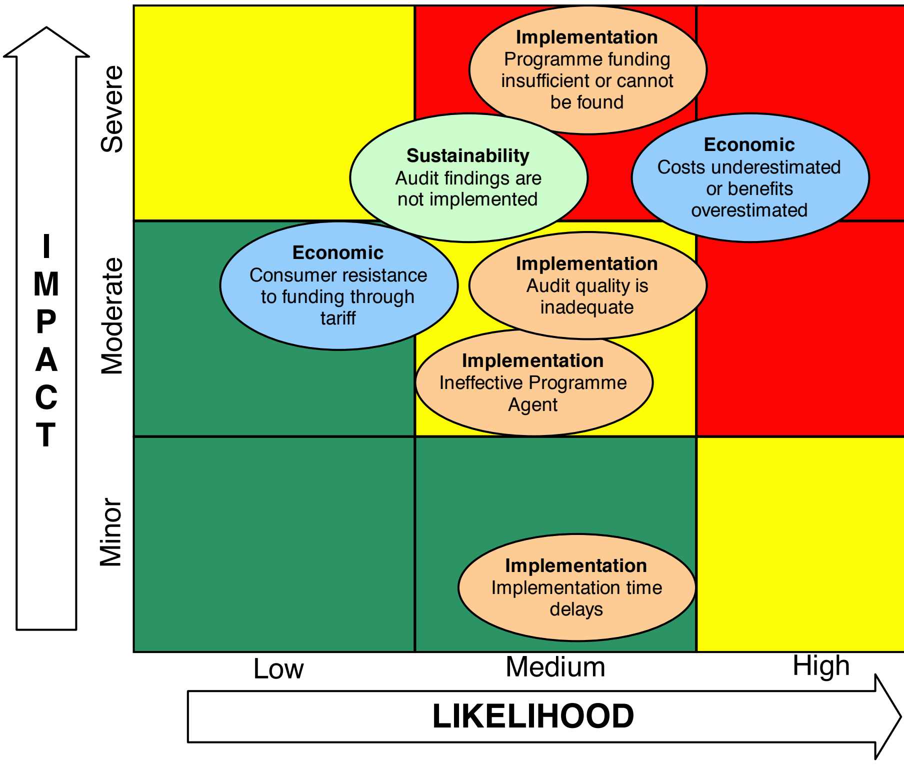


Figure 22: Energy audit risks

9.10 KEY ASSUMPTIONS

The key assumptions made for the energy audit programme are:

- The ECB is prepared to approve funding through a tariff increase for the business and LPU consumer groups
- The creation of an Energy Audit Agency is supported by the key stakeholders
- The commercial and industrial sector needs an external agent to initiate an energy audit programme
- A subsidised programme and the intrusive nature of such a programme is positively accepted by participants
- There is a real need in regard to commercial and industrial energy audits
- The implementation of DSM measures will save sufficient funds to allow participants to recoup the associated expenses within commercial timeframes
- There is a substantial energy and demand savings potential in the commercial and industrial sector
- There is sufficient capacity and experience in Namibia to conduct thirty energy audits per annum
- There is sufficient contracting capacity and know-how for implementing the viable energy and demand savings measures identified in the Energy Audits
- The costs of the energy audits range between N$ 10,000 and N$ 80,000
- The Energy Audit Agency can operate on an annual budget of N$500,000
- The once-off fees for the office and the software is N$ 150,000

10 SUMMARY AND CONCLUSIONS

10.1 BENEFITS AND COSTS

10.1.1 Overview

A benefit/cost calculation has been performed for all DSM options elaborated in this report except energy audits, which has not been investigated because of a lack of applicable data. As suggested in the section dealing with energy audits, these should be trialled in order to get more realistic cost and savings figures on which a future benefit cost analysis can be based.

A summary of the benefit cost calculations based on the base case scenario of each option is shown in Table 43 below.

	Benefit/Cost Ratio	Years	Present Value Benefits N$		Present Value Costs N$
Consumer awareness	**1.08**	10	27 026 072	-	25 124 283
TOU tariffs	**2.38**	10	33 010 417	-	13 896 607
CFL dissemination	**6.99**	10	84 564 323	-	12 095 238
SWH promotion	**1.10**	30	258 392 230	-	233 854 588
Ripple Control	**1.30**	15	64 611 089	-	49 892 130

Table 43: Summary of Benefit Cost Analysis

Table 43 indicates that all five DSM options have a benefit/cost ratio greater than 1. The assumptions underlying the benefit and cost calculations of each option are discussed in the following sections. All calculations use a discount rate of 5%, and exclude population and household demand growth, while tariffs are assumed to remain constant in real terms.

The benefit/costs analyses have been largely based on the benefits and costs calculated in the sections discussing each DSM option in detail. Some refinements and further calculations have been made where appropriate.

10.1.2 Consumer Awareness

The consumer awareness DSM component can be regarded on its own, however it is recommended that this option be seen as a necessary complement to all other measures. If however it were to be implemented on its own then it is still highly likely to result in change in consumer behaviour, which is what has been modelled here.

Year	User Advantages N$	User disadvantages N$	Benefits N$	Sponsor Costs N$	Licensee profit forfeit N$	Sponsor Savings N$	Costs N$
1	3 500 000		3 500 000	750 000	3 111 500	-	3 861 500
2	3 500 000		3 500 000	100 000	3 111 500	-	3 211 500
3	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
4	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
5	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
6	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
7	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
8	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
9	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
10	3 500 000		3 500 000	50 000	3 111 500	-	3 161 500
			27 026 072			**-**	**25 124 283**

Benefit / Cost	1.08

Table 44: Consumer Awareness Benefits and Costs

Table 44 shows the calculated benefits and costs for the consumer awareness option. This calculation is based on the following assumptions:

- Consumers are assumed to save 0.5% of their kWh consumption, at an average marginal cost of 50c/kWh.
- All RED consumers in the country are taken to be the users, at an estimated total consumption of 1.4TWh per annum.
- It is assumed that NamPower and the REDs are the joint sponsors of this option.
- Sponsors pay for the costs of the awareness campaign at a calculated rate for the first year, and estimated follow-up costs for the period up to 10 years, to maintain savings and awareness.
- The "licensee profit forfeit" column estimates the profit lost by NamPower and the REDs through the decline in consumption.

Table 45 below shows an analysis of how the benefit/cost ratio changes with increasing savings of energy.

	Benefit/Cost Ratio	Years	Present Value Benefits N$		Present Value Costs N$
Consumer awareness @ 0.5% kWh saved	**1.08**	10	27 026 072	-	25 124 283
Consumer awareness @ 2% kWh saved	**1.11**	10	108 104 289	-	97 202 818
Consumer awareness @ 5% kWh saved	**1.12**	10	270 260 723	-	241 359 887

Table 45: Sensitivity Analysis for Consumer Awareness Benefit/Cost

Due to the increasing losses in profit that the licensees will experience (which closely follows the savings by the consumers), the benefit/cost is hardly sensitive to the percentage of total energy saved. However, it should be pointed out that the assumptions regarding the decline in profits of the licensee are rather pessimistic since savings from postponed network strengthening has not been taken into account at all.

10.1.3 TOU Tariffs

The implementation of time of use tariffs is intended to improve system utilisation and efficiency and thereby bring about savings. The benefit cost analysis is shown in Table 46 below:

Year	User Advantages N$	User disadvantages N$	Benefits N$	Sponsor Costs N$	Licensee profit forfeit N$	Sponsor Savings N$		Costs N$
1	4 275 000		4 275 000	3 000 000			-	3 000 000
2	4 275 000		4 275 000	2 000 000			-	2 000 000
3	4 275 000		4 275 000	2 000 000			-	2 000 000
4	4 275 000		4 275 000	1 500 000			-	1 500 000
5	4 275 000		4 275 000	1 500 000			-	1 500 000
6	4 275 000		4 275 000	1 500 000			-	1 500 000
7	4 275 000		4 275 000	1 500 000			-	1 500 000
8	4 275 000		4 275 000	1 500 000			-	1 500 000
9	4 275 000		4 275 000	1 500 000			-	1 500 000
10	4 275 000		4 275 000	1 500 000			-	1 500 000
			33 010 417				**-**	**13 896 607**

Benefit / Cost	2.38

Table 46: TOU Tariffs Benefits and Costs

The above calculation is based on the following key assumptions:

- All users are RED business consumers on either Business or LPU tariffs. The above base case assumes they will be able to save 1% on their electricity bill.
- Sponsors are the REDs and NamPower jointly.
- The introduction of TOU tariffs will (at worst) be financially neutral to licensees.
- The cost of interval meters and their installation will be recovered through the TOU tariff rates, and is therefore not shown as a cost to the sponsors.
- The costs to the sponsors is the trial implementation cost (as per the estimates made in this report) plus a running cost of the TOU systems calculated for 6 entities (NamPower plus 5 REDs) each having a

specialist resource working on the TOU implementation on a half time basis at an annual cost of N$250 000.

A sensitivity analysis was made to determine how sensitive the benefit/cost ratio is to increased savings.

	Benefit/Cost Ratio	Years	Present Value Benefits N$	Present Value Costs N$
TOU tariffs @ 0.5% saved on bill	**1.19**	10	16 505 208 -	13 896 607
TOU tariffs @ 1% saved on bill	**2.38**	10	33 010 417 -	13 896 607
TOU tariffs @ 5% saved on bill	**11.88**	10	165 052 084 -	13 896 607

Table 47: Sensitivity Analysis for TOU Tariffs Benefit/Cost

Table 47 shows that the benefit/cost for TOU tariffs is sensitive to the savings realised by consumers. However, even a 0.5% saving still has a benefit/cost ratio exceeding 1 indicating that this DSM option should certainly be pursued.

10.1.4 CFL Dissemination

The CFL dissemination DSM option targets household lighting and has been shown in this report to have a very short payback period. The benefit/cost analysis for this option looks as follows:

Year	User Advantages N$	User disadvantages N$	Benefits N$	Sponsor Costs N$	Licensee profit forfeit N$	Sponsor Savings N$	Costs N$
1	10 900 000			10 900 000	12 700 000		- 12 700 000
2	10 791 000	1 534 500	6 831 000	16 087 500			-
3	10 355 000	1 472 500	6 555 000	15 437 500			-
4	9 265 000	1 317 500	5 865 000	13 812 500			-
5	8 175 000	1 162 500	5 175 000	12 187 500			-
6	7 085 000	1 007 500	4 485 000	10 562 500			-
7	5 995 000	852 500	3 795 000	8 937 500			-
8	4 905 000	697 500	3 105 000	7 312 500			-
9	3 815 000	542 500	2 415 000	5 687 500			-
10	2 725 000	387 500	1 725 000	4 062 500			-
				84 564 323			**- 12 095 238**

Benefit / Cost	**6.99**

Table 48: Benefit/Costs Analysis for CFL Dissemination

Table 48 is based on the following assumptions:

- The sponsor is NamPower.
- The users are residential consumers.
- User advantages, sponsor costs and sponsor benefits are derived from the calculations shown in the relevant section of this report.
- User advantages and sponsor costs are assumed to deteriorate because it is assumed that consumers revert back to incandescent lights if no follow up is made. It is assumed that only a retention of 25% is achieved after 10 years.
- It is assumed that the disadvantage to users is an increase in tariffs which is required to compensate the REDs for lost profits due to reduced consumption.
- The sponsor savings accrue due to saved capacity and peak energy purchases.

An alternative scenario has been developed under the assumption that in future subsidies for CFLs would continue in order to maintain the benefits (assuming that a 50% cost buy-down will be sufficient to keep people from reverting to incandescent lights).

Year	User Advantages	User disadvantages	Sponsor Savings	Benefits	Sponsor Costs	Licensee profit forfeit	Costs
1	10 900 000			10 900 000	12 700 000		- 12 700 000
2	10 900 000	1 550 000	6 900 000	16 250 000	300 000		- 300 000
3	10 900 000	1 550 000	6 900 000	16 250 000	300 000		- 300 000
4	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
5	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
6	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
7	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
8	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
9	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
10	10 900 000	1 550 000	6 900 000	16 250 000	1 500 000		- 1 500 000
				120 382 955			- 20 124 229

Benefit / Cost	5.98

Table 49: CFL Dissemination Benefit/Cost with Continued Subsidies

Table 49 shows that under this alternative scenario the benefit/cost ratio is lower. However the demand savings will be sustained.

Under either scenario however it is clear that the benefits far outweigh the costs.

10.1.5 Solar Water Heater Promotion

Solar water heaters are to be promoted at greater intensity than is currently the case. The benefit/cost analysis for this option looks as follows:

Year	User Advantages N$	User disadvantages N$	Benefits N$	Sponsor Costs N$	Licensee profit forfeit N$	Sponsor Savings N$	Costs N$
1	686 899	991 313	- 304 414	591 625	317 031	147 176	- 761 480
2	4 699 178	6 468 528	- 1 769 350	2 881 915	2 168 851	1 006 849	- 4 043 917
3	11 490 614	14 440 351	- 2 949 737	5 526 999	5 303 360	2 461 986	- 8 368 373
4	20 444 475	24 265 778	- 3 821 303	8 208 195	9 435 912	4 380 446	- 13 263 661
5	30 868 067	35 226 331	- 4 358 264	10 612 687	14 246 800	6 613 811	- 18 245 676
6	41 986 845	46 070 850	- 4 084 005	12 390 337	19 378 544	8 996 128	- 22 772 753
7	52 938 032	54 181 957	- 1 243 925	13 104 287	24 432 938	11 342 536	- 26 194 689
8	62 763 688	58 927 755	3 835 934	12 658 148	28 967 856	13 447 787	- 28 178 217
9	70 403 165	59 617 615	10 785 550	10 948 677	32 493 768	15 084 626	- 28 357 819
10	74 684 851	55 497 280	19 187 571	7 865 137	34 469 931	16 002 023	- 26 333 046
11	74 684 851	46 274 102	28 410 749	3 524 983	34 469 931	16 002 023	- 21 992 891
12	74 684 851	39 112 735	35 572 116	1 312 080	34 469 931	16 002 023	- 19 779 988
13	74 684 851	32 687 391	41 997 460	- 325 926	34 469 931	16 002 023	- 18 141 983
14	74 684 851	27 691 668	46 993 183	- 1 371 195	34 469 931	16 002 023	- 17 096 714
15	74 684 851	24 891 722	49 793 129		34 469 931	16 002 023	- 18 467 908
16	74 684 851	24 891 722	49 793 129		34 469 931	16 002 023	- 18 467 908
17	74 684 851	24 891 722	49 793 129		34 469 931	16 002 023	- 18 467 908
18	74 684 851	24 891 722	49 793 129		34 469 931	16 002 023	- 18 467 908
19	73 997 952	24 891 722	49 106 230		34 152 901	15 854 847	- 18 298 053
20	69 985 674	24 662 785	45 322 889		32 301 080	14 995 174	- 17 305 906
21	63 194 238	23 325 532	39 868 705		29 166 571	13 540 037	- 15 626 534
22	54 240 376	21 062 014	33 178 362		25 034 020	11 621 577	- 13 412 443
23	43 816 784	18 077 781	25 739 003		20 223 131	9 388 211	- 10 834 919
24	32 698 006	14 603 700	18 094 305		15 091 387	7 005 895	- 8 085 492
25	21 746 819	10 897 922	10 848 897		10 036 993	4 659 487	- 5 377 506
26	11 921 163	7 248 000	4 673 163		5 502 075	2 554 236	- 2 947 839
27	4 281 686	3 973 206	308 481		1 976 163	917 397	- 1 058 766
28	-	1 427 044	- 1 427 044		-	-	-
29	-	-	-		-	-	-
30	-	-	-		-	-	-
			258 392 230	87 927 948			- 233 854 588

Benefit / Cost	1.10

Table 50: SWH Benefit/Cost

Table 50 is based on the following assumptions:

- A thirty year time horizon has been used because the programme is assumed to extend over 10 years, and contemporary SWHs last approximately 20 years.
- It is assumed that SWH are not replaced when they expire after 20 years.

- Users are residential consumers.
- The sponsor is assumed to be GRN/NAMREP.
- 50% of new SWH are financed through commercial banks (assuming that banks make a profit) through bonds, and 50% are funded through the solar revolving fund (SRF), assuming that the GRN carries the costs associated with this.
- The GRN supplies sufficient capital to the SRF, and is responsible for the administration of the fund as well as the cost differential between SRF interest rate and bank rates.
- The licensees forfeit profit due to reduced kWh sales, however they realise savings through reduced capacity purchases as well as deferred network investments (assuming they save depreciation and return on N$ 6 million / average MW saved).
- Growth in SWH, savings in energy and SWH costs are taken as depicted in the relevant section of this report.
- Utility profit rates and consumer tariffs have been taken as constant. While utility profit rates are not predicted to increase significantly in real terms consumer prices are predicted to increase. A sensitivity analysis has been done to test for the effects of such an increase (see Table 51).

The analysis shows a benefit/cost ratio greater than 1, but it is clear that large sums of funding are required. The SRF will need to be capitalised with at least N$50 million at its peak to sustain such a growth path.

A sensitivity analysis testing for sensitivity to domestic kWh tariff is shown in Table 51 below. This indicates that the benefits are very sensitive to the tariff paid by consumers. Considering that tariffs are predicted to increase significantly over the next few years (with a 20% real increase being quite possible) the benefits are very likely to improve considerably over the base case.

	Benefit/Cost Ratio	Years	Present Value Benefits N$	Present Value Costs N$
SWH promotion @ 65c/kWh tariff	**1.10**	30	258 392 230	- 233 854 588
SWH promotion @ 70c/kWh tariff	**1.33**	30	311 243 340	- 233 854 588
SWH promotion @ 80c/kWh tariff	**1.78**	30	416 945 560	- 233 854 588

Table 51: Sensitivity Analysis for SWH Benefit/Cost

10.1.6 <u>Ripple Control Expansion</u>

The expansion of ripple control systems on electric water heaters will enable the licensees to actively manage demand and provides the unique feature among the DSM options contemplated in this report that it allows active intervention/switching by the utilities. As has been discussed in the relevant section in this report, this is a very attractive feature for dealing with power supply emergency situations. The benefit/cost analysis for this option looks as follows:

Year	User Advantages N$	User disadvantages N$	Benefits N$	Sponsor Costs N$	Licensee profit forfeit N$	Sponsor Savings N$	Costs N$
1			-	22 250 000			- 22 250 000
2	3 600 000		3 600 000	22 250 000			- 22 250 000
3	7 200 000		7 200 000	1 000 000			- 1 000 000
4	7 200 000		7 200 000	1 000 000			- 1 000 000
5	7 200 000		7 200 000	1 000 000			- 1 000 000
6	7 200 000		7 200 000	1 000 000			- 1 000 000
7	7 200 000		7 200 000	1 000 000			- 1 000 000
8	7 200 000		7 200 000	1 000 000			- 1 000 000
9	7 200 000		7 200 000	1 000 000			- 1 000 000
10	7 200 000		7 200 000	1 000 000			- 1 000 000
11	7 200 000		7 200 000	1 000 000			- 1 000 000
12	7 200 000		7 200 000	1 000 000			- 1 000 000
13	7 200 000		7 200 000	1 000 000			- 1 000 000
14	7 200 000		7 200 000	1 000 000			- 1 000 000
15	7 200 000		7 200 000	1 000 000			- 1 000 000
			64 611 089				**- 49 892 130**

Benefit / Cost	**1.30**

Table 52: Ripple Control Benefit/Cost

Table 52 is based on the following assumptions:

- Sponsors and users are NamPower and the REDs jointly.
- Sponsor costs include the initial implementation of ripple control systems, and the operating costs for managing the systems in the longer term.
- User advantages are as calculated for this option assuming a mix of on-line and off-line operated systems, depending on consumer densities

The analysis shows that under the given assumptions a period of more than 10 years is required for a benefit/cost ratio exceeding 1. On the one hand this is not surprising considering the large capital cost of the initial installation, however actual experience by local distributors has shown a much shorter payback period. The much longer period (or lower benefit/cost ratio) calculated above is due to the very conservative assumptions underpinning the calculations. However, in the case of NamPower, the benefits are difficult to calculate since they depend critically on the specific operating regimes.

10.2 Summary of Results

Figure 23 below recaps the six DSM options described and discussed in this report, indicating the estimated magnitude of potential demand reductions.

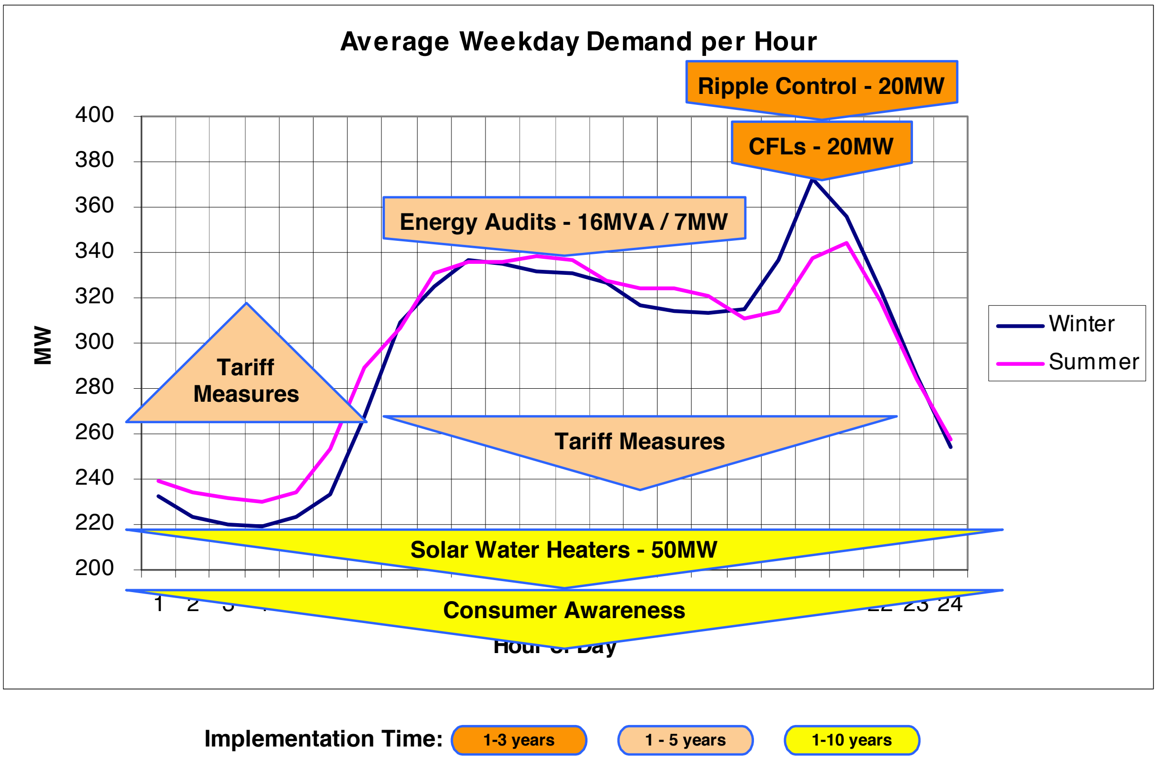


Figure 23: Overview of short listed DSM options and effects

Seen against the 2005 maximum interconnected system demand of 410MW it is clear that significant savings can be made, although some of the savings require large investments.

Table 53 below summarises some of they key characteristics of the DSM options.

	Est Programme Cost N$	Est MW demand saved	Est GWH p.a. saved	Est N$/MW saved	Est c/kWh funding over implem years	Est payback years	Est Implemen-tation years	Funded By
Consumer awareness	700 000	n/a	n/a	n/a	0.02	n/a	2	Utilities - all kWh
Tariffs	4 500 000	n/a	-	n/a	0.11	n/a	2	NamPower - all kWh
CFL dissemination	13 000 000	19.91	22	652 804	1.30	1.16	2	NamPower - all kWh
SWH dissemination	88 000 000	52.00	115	1 692 308	1.76	n/a	10	MME/donors
Ripple control expansion	45 000 000	26.70	-	1 685 573	1.13	5.11	2	REDs - all kWh
Energy audits	6 750 000	16.00	58	n/a	0.17	n/a	5	Commercial/Industrial consumer kWh

Table 53: Summary of DSM Options

The following notes pertain to Table 53:

- The SWH dissemination cost is calculated as the interest cost of funding 32333 SWH over ten years at a rate of 12% per annum, and assuming that any interest recovered from consumers is used for administration and to cover losses due to failure to repay loans. It therefore assumes that the full capital cost of the SWH is borne by the consumer.
- The estimated cost/kWh to fund the options (assuming that at the end of the day the consumers pay) has been calculated by taking the programme cost, dividing into the approximate annual kWh for the relevant consumer segment and dividing into the number of years over which the option is to be implemented. This shows that many options have very small c/kWh implications if they were to funded from tariffs. The only two large ones are CFL and SWH. CFL (approximately 5% of the average residential consumer kWh rate) has however been shown to be offset by the energy savings made by the participating consumers, so even if the tariff is increased by the amount shown the average participating consumer will not be worse off. The SWH cost/kWh is relatively high (around 15% increase on the current average residential kWh rate) and does not include the increase that the REDs and NamPower will have to pass through due to reductions in kWh turnover. However if one assumes that in the average household with an EWH the EWH consumes more than 30% of all kWh, then the consumer should again be better off, even with a 15% to 20% tariff increase.
- CFL, SWH and ripple options all have capital costs below the nominal cost/MW of constructing a new thermal power plant, which is around N$8 million / MW. A thermal power plant obviously also has fuel cost in addition to the capital cost, and since the maintenance costs for these three DSM options are expected to be relatively small compared to the kWh saved this should also be well below the fuel cost / kWh of a thermal power station. This shows that these DSM options are an alternative worth considering from a utility perspective instead of creating new generation plant.
- The benefit calculation has not been done for the energy audits since the cost of implementing the audit recommendations must be included in such a calculation and these are not available at the time of writing. For this reason a trial phase has been recommended for the energy audits to establish some typical total cost and benefit information on which a full rollout can be decided upon.

10.3 Interaction Between Options

The sections dealing with the individual options have some assumptions on the interaction between the options:

- For addressing the evening peak CFL dissemination will be implemented before ripple control because of the lower cost per kW saved
- Solar water heater implementation will be relatively slow and will not significantly reduce savings available through ripple control during the likely pay back period for ripple (five to seven years). Additionally SWH implementation will reduce daytime peak also (which ripple control of EWH cannot do because there is no significant demand trough close enough in time to defer consumption to), increasing potential for ripple reduction of the evening peak.
- SWH dissemination will in the long term reduce the effects of ripple control of domestic EWH, although ripple systems should be retained to be able to ripple a) the backup elements of SWH during climatic exceptions and b) other devices.
- Commercial and industrial savings through energy audits will mainly be during the daytime. This will increase the scope for the other measures targeting the evening peak.

- TOU tariff implementation will mainly have the effect of reinforcing the other DSM measures and filling the night time trough with energy otherwise consumed during the day.
- Consumer awareness will mainly have the effect of reinforcing the other DSM options.

Figure 24 below illustrates the expected approximate effects of ripple control and CFL on the evening peak. It is expected that the CFL options can save close to 20MW off the evening peak, which will not be utility controllable and will happen all year round. In addition the utilities can ripple between 20MW and 27MW of EWH load for a limited time in the evening (in addition to existing ripple systems which can switch around 24MW).

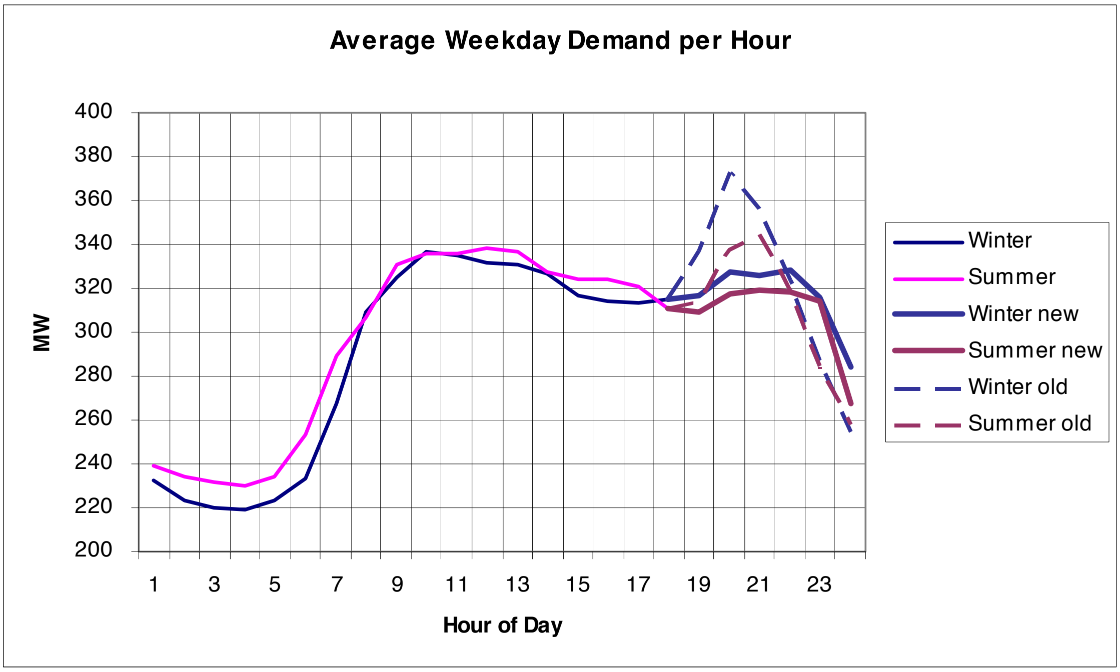


Figure 24: Illustration of expected ripple and CFL effect

Table 54 shows an estimate of the RED billing demand (i.e. the demand billed to the REDs by NamPower) which could be saved by reducing the evening peak at larger urban areas to the level of the daytime peak. This is an indication of how much demand the REDs can save by reducing the evening peak only without reducing the daytime peak as well. The table shows that it is expected that the CFL options should utilise most of this potential, leaving only around 2MW for ripple to benefit the REDs directly. However the combined potential of ripple and CFL is between 40MW to 47MW so there is a substantial upside to the REDs as well as NamPower if the daytime peak can be reduced (through energy audits and SWH implementation).

RED	Town	Est ave RED demand saving available kW	Est CFL kW saved	Est ave demand saving available kW for ripple after CFL	Est ripple max kW reduction potential
CRED	Windhoek	3 500	8 346	-	2 259
CRED	Okahandja	250	455	-	1 218
CRED	Gobabis	-	552	-	1 517
SORED	Rehoboth	1 600	732	868	1 905
SORED	Mariental	200	418	-	1 030
SORED	Keetmanshoop	100	245	-	797
SORED	Luderitz	300	319	-	928
ERED	Walvis Bay	3 600	2 830	770	882
ERED	Swakopmund	650	1 851	-	3 510
ERED	Henties Bay	200	628	-	1 053
CENORED	Otjiwarongo	225	491	-	1 364
CENORED	Tsumeb	400	798	-	1 953
CENORED	Grootfontein	400	333	67	821
NORED	Oshakati, Ondangwa, Ongwediva	1 200	1 174	26	4 550
NORED	Rundu	500	433	67	1 693
NORED	Katima Mulilo	150	312	-	1 218
		13 275	**19 914**	**1 799**	**26 697**

Table 54: Ripple and CFL peak reduction potential

10.4 Conclusion

10.4.1 Summary of Findings

- Five of the DSM options proposed in this report have been shown to have a benefit to cost ratio of greater than 1.
- The six DSM options have limited interaction with one another (except for the consumer awareness component which is complementary to all others) and it is likely that all of them could be implemented in parallel or staggered sequentially without degrading one another's benefits substantially.
- The six options address the major energy consumer groups, engage the utilities and provide a mix of short to long term implementation paths as well as a mix of peak management and energy efficiency measures which will benefit both consumers and utilities.
- The options should be implemented by the entity most capable to undertake or oversee the work, but also with no or limited conflict of interest in implementing the option.
- The options should be paid for from the recipients of the major benefits. In this way consumers or utilities who pay for the options also stand to reap the benefits.

10.4.2 Key Results of Second Stakeholder Workshop – The Way Forward

A draft version of the present report was circulated before the second stakeholder workshop which was held in August 2006. The key responses were received during and after the workshop:

10.4.2.1 Overall Feedback

The workshop participants agreed that a national DSM steering forum should be established under the stewardship of the ECB (at least initially). This forum would initially comprise members from all those stakeholders which have also been invited to participate in the DSM workshops. The first meeting of the steering forum will be called by the ECB before the end of 2006. The ECB will try to co-ordinate such a meeting with other forums which have a similar membership, e.g. the quality of supply and service steering committees.

The stakeholders generally agreed that the DSM programme should go ahead and be implemented.

10.4.2.2 Consumer Awareness

It was agreed that the driver for the awareness framework should be the ECB and/or MME with a view to ensuring co-ordinated communication approaches and messages. The funding and implementation responsibilities should be NamPower's, the REDs and other mandated entities such as NAMREP and REEEI.

10.4.2.3 TOU Tariffs

The ECB noted its disagreement with the proposal to have an extensive trial phase for TOU tariffs, however the stakeholders supported the consultant's proposal. It will therefore be necessary for the ECB and licensees to meet and come to an agreement regarding the timing and implementation mode for TOU tariffs, which will ensure that the industry is not destabilised by this development.

It was suggested that the ECB should become the national champion responsible for driving TOU tariffs forward, since electricity tariffs are part of the core mandate of the ECB. A partnership agreement should be reached between the ECB, licensees and key consumers to pave the way for the implementation of TOU tariffs.

This item should be placed high on the agenda of the DSM steering forum.

10.4.2.4 CFL Dissemination

It was suggested that NamPower is to give due consideration to the motivation put forward for this DSM option, and strongly consider implementing it.

The following issues will need to be addressed:

- How loss of profit for the REDs will be handled
- What approach will be taken regarding tariff implications of the CFL option
- What power factor influence the CFLs will have (e.g. ensuring that the type of CFL chosen has a good power factor)
- Identification of an entity to take responsibility for ensuring that only quality CFLs enter the Namibian market (ECB to take this issue forward).

10.4.2.5 Solar Water Heaters

It was felt that NAMREP who is currently the custodian of the national SWH campaign through the SRF, should be mandated (and funded) to take this issue forward at an accelerated pace.

The following issues were raised for further attention:

- The lack of awareness among plumbers and consumers with respect to life cycle costing must be addressed
- MTI should be approached to consider supporting the establishment/strengthening of a local SWH manufacturing or assembly industry
- Maintenance of SWH and training of maintenance personnel needs attention, especially for Government installations
- There is a concern that increased demand for SWH may increase prices (and not decrease them as hoped), especially if demand is higher than supply capacity.

10.4.2.6 Ripple Control

The REDs expressed scepticism regarding the proposal of a joint operations centre for the proposed ripple system. The feeling of the stakeholders was that the REDs should each implement their own systems, but that NamPower should look at establishing a demand participation market which would enable the REDs to sell demand reductions to NamPower and thereby realise the full national benefit of ripple control.

The following issues were identified as needing attention:

- Consumer education & awareness need to be done with much sensitivity to counteract current negative perceptions.

- TOU tariffs would probably help with making ripple systems more acceptable to consumers, even though the dangers of using a combination of TOU and ripple control systems for ‘gaming the system’ were clearly recognised by stakeholders.

10.4.2.7 Energy Audits

The meeting agreed that the REEEI should advance this issue. They should prepare an implementation approach and obtain a mandate and funding to proceed.

The utilities were encouraged to re-think their position on energy efficiency and its broader benefits (i.e. not just worry about short drop in sales volumes).

It was also felt that the role of financial institutions should be enhanced, since funding will play a significant role in the implementation of the findings of energy audits.

11 ANNEXES

Note: The contents of annexes 1 and 2 are taken from the DSM study report 1. They are repeated here as reference material for readers who may not have read the report 1.

11.1 ANNEX 1: THE MAIN DSM APPROACH CATEGORIES

11.1.1 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.

11.1.1.1 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.

11.1.1.2 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.

11.1.2 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.

11.1.2.1 kWh and Demand Impact

The discussion under 11.1.1 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.

11.1.2.2 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.

11.1.3 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.

11.1.3.1 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.

11.1.3.2 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.

11.2 ANNEX 2: 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

11.2.1 Contributions by Main Consumer Classes

Figure 25 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):

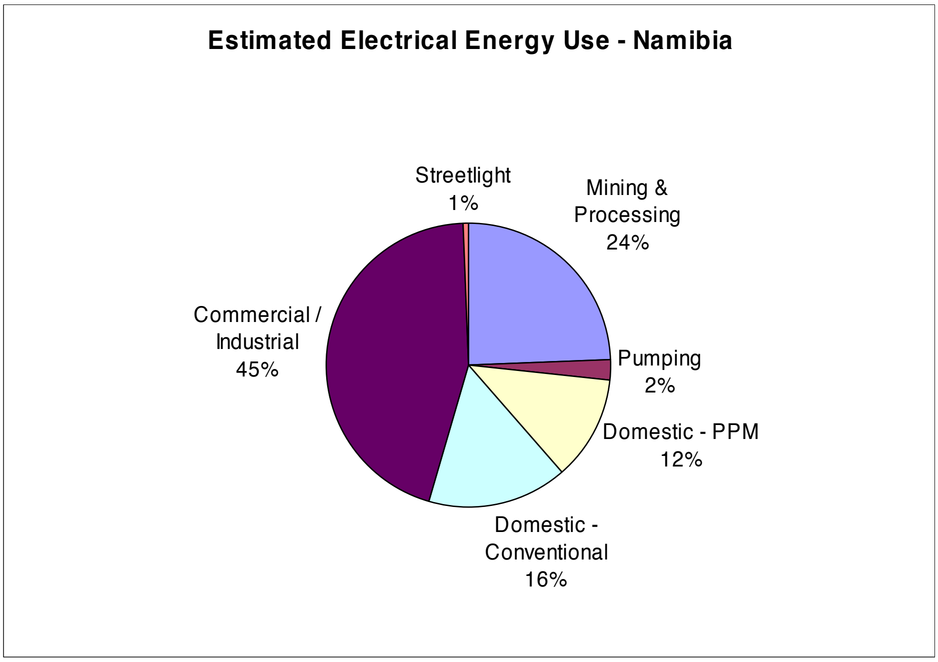


Figure 25: Estimated National Electrical Energy Consumption by User Group

The consumer groups depicted in Figure 25 have the following characteristics::

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.

Table 55: Observations Regarding Electrical Energy Consumption

The following figures Figure 26 and Figure 27 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.

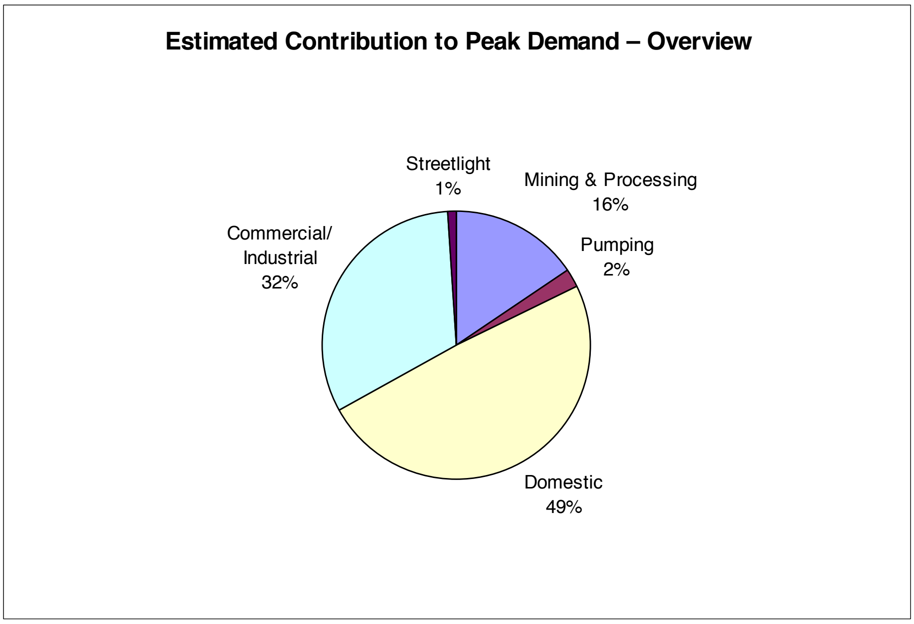


Figure 26: Estimated Contribution to Peak Demand -– Overview

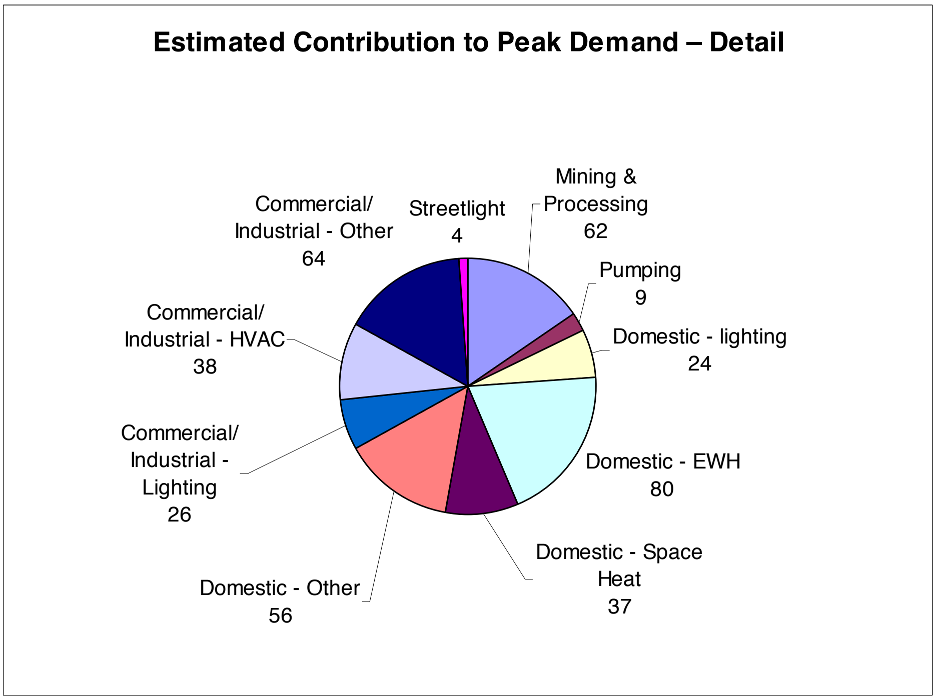


Figure 27: Estimated Contribution to Peak Demand – Detail

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 31 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 is only 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.[18]
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 27 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.

Table 56: Observations Regarding Peak Demand Contribution

[18] 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 reliable 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.

Figure 28 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.

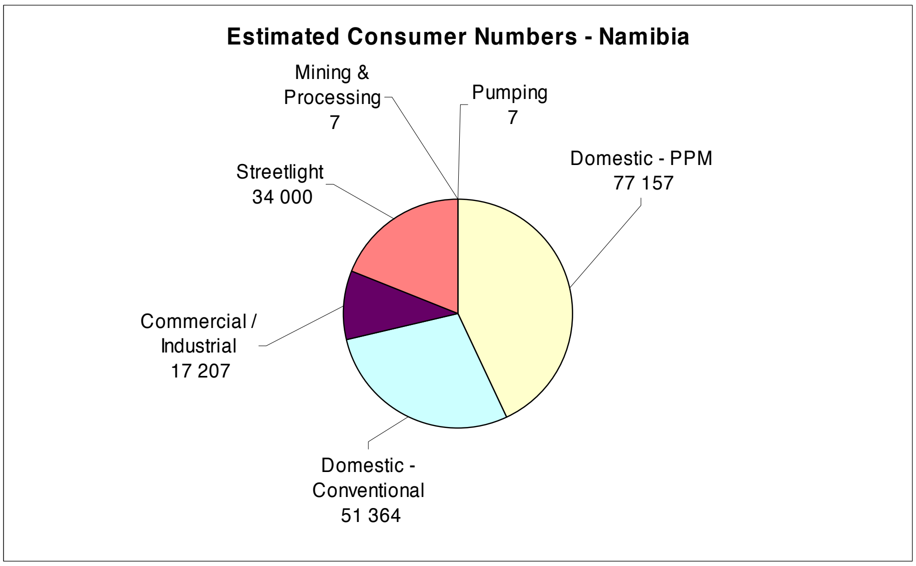


Figure 28: Estimated Consumer Numbers

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 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.

Table 57: Observations Regarding Consumer Numbers

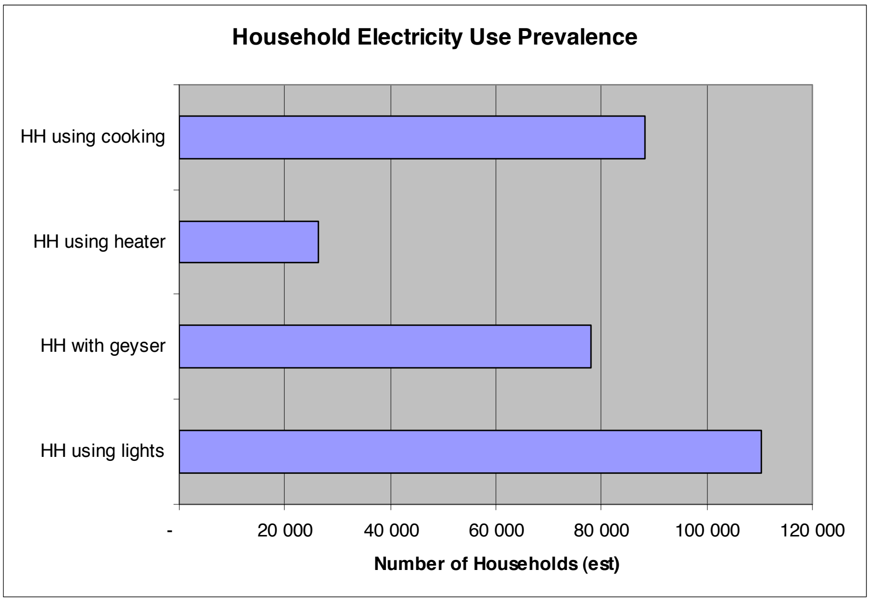


Figure 29: Household Electricity Use Prevalence

Figure 29 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.

11.2.2 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 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).

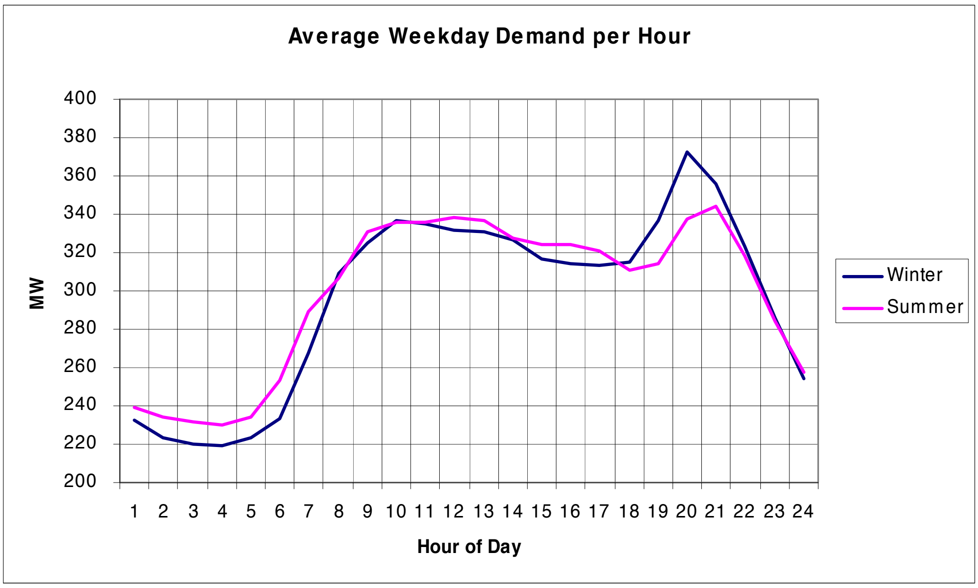


Figure 30: Average Hourly Demand Profile on Weekdays

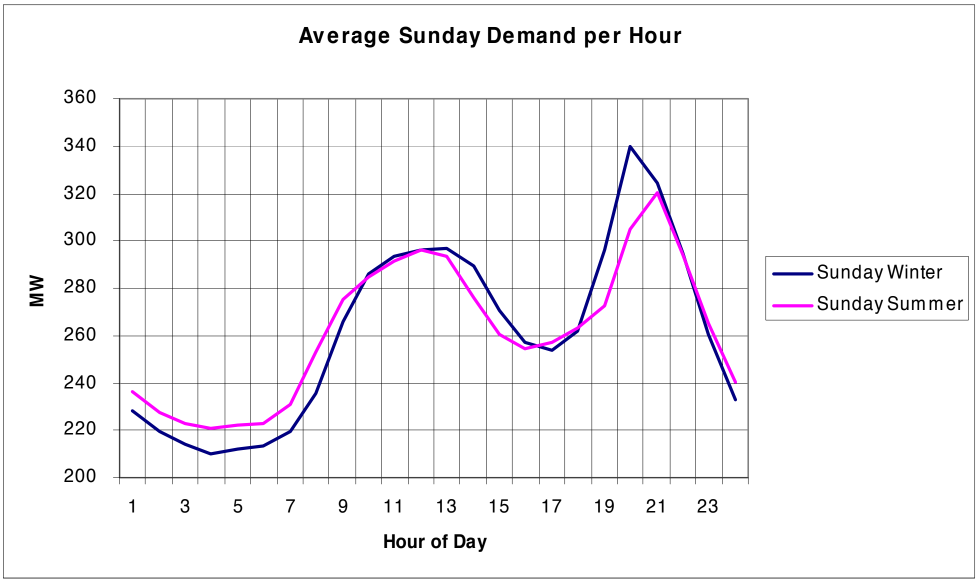


Figure 31: Average Hourly Demand Profile on Sunday[19]

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 32, which shows the time of day of the daily peak throughout the year (data for 2005). Figure 32 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

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

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.

Table 58: Observations Regarding National Demand Profiles

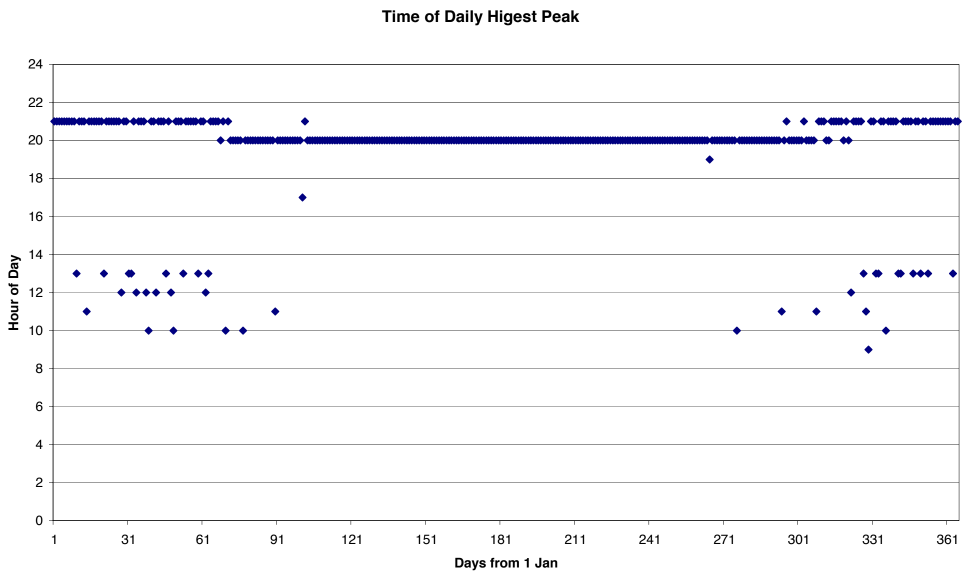


Figure 32: Time of Day of Daily Peak[20]

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 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.

Table 59: Observations Regarding Time of Daily Peak

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

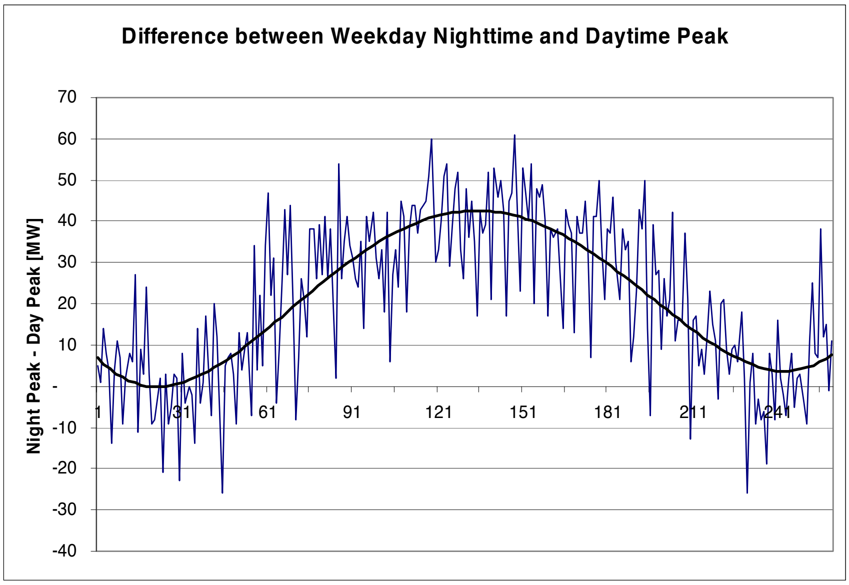


Figure 33: Difference Between Night- and Daytime Peak (Weekdays)[21]

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.

Table 60: Observations Regarding Difference between Night and Day Peaks

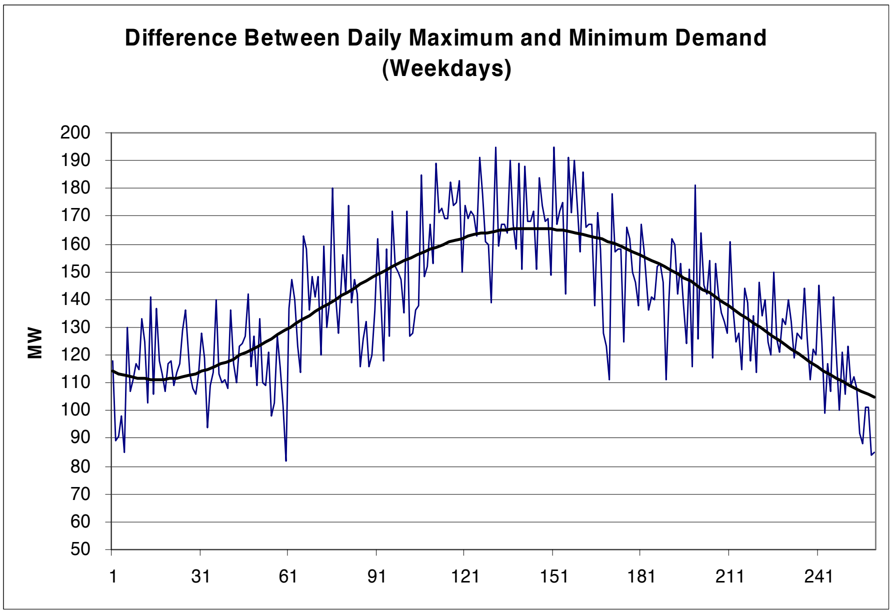


Figure 34: Difference Between Daily Maximum and Minimum Demand

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

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.

Table 61: Observations Regarding Difference between Daily Maxima and Minima

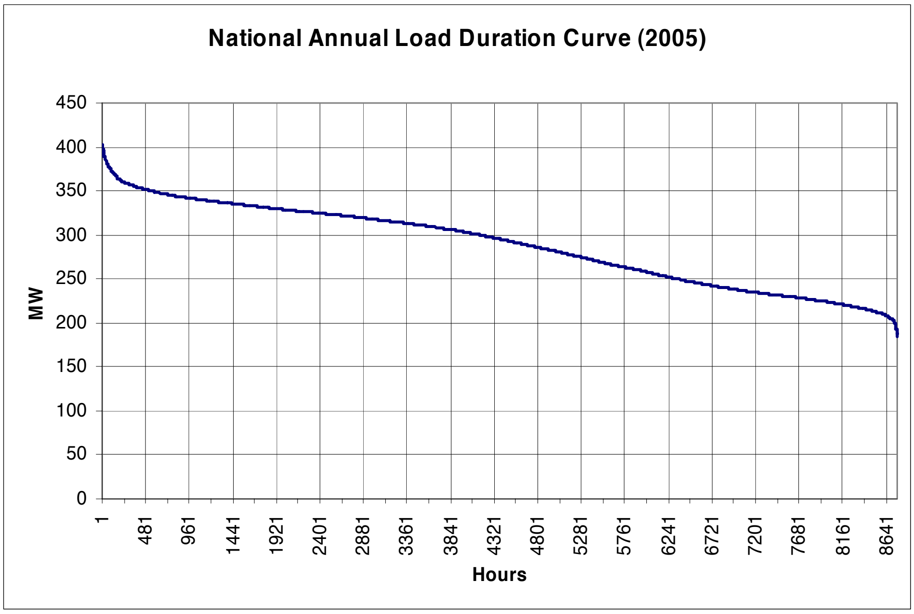


Figure 35: National Load Duration Curve

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. 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.

Table 62: Observations Regarding National Load Duration Curve