THE NRS NATIONAL LOAD RESEARCH PROJECT: 1994-1996

1997/3/20

PROJECT EL9404

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Executive summary

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ABSTRACT

The current “electricity for all” drive in South Africa has placed pressure upon design criteria. Reference data and algorithms are not sufficiently well-established to address cost and technical-risk management needs.

This document describes an extensive project to derive estimates of Admd (and associated parameters) with reasonable accuracy, by monitoring of domestic consumer currents.

Contextual socio-demographic data has also been gathered, along with climatic data for each monitoring site. Approximately 1200 MB of load-current data has been accumulated from 6 project sites around South Africa towards this end.

Considerable attention has been devoted to improving the processes of the project, which is highly collaborative and widely dispersed in nature.

In the recommendations, stress is laid upon the need for a coordinated “Companion” research-programme using the collated data, in order to deliver cost-savings and technical risk-management philosophies back to the electrification programme.

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Executive summary

1. INTRODUCTION

This report describes the results of a project initiated to collect electrical-load and other data from domestic consumers in townships. The project has been under way since 1994. All results presented are complete until mid-August 1996.

The results of this project are important to electrification planners, since they indicate appropriate levels of supply, and support initiatives towards Admd design levels in the region of 0.6-0.9 kVA.
The results are likely to impact upon policy formulation in electrification, particularly in terms of design-level and quality of supply.

A sophisticated array of tools has been developed to aid future load-data gathering operations of this type.

A structured load research database has been established and is being updated continuously. This data is now being applied to further research in priority areas. Universities are involved.

2. AIM

The primary aim of this project is to supply Admd, Alpha and Beta parameters necessary for domestic electrification design to the NRS034[1] working group for inclusion in guidelines on reticulation design.

This was effected by carrying out this DMEA sponsored project to:

- Establish a database of electrical load data, sociometric data and climatic data from low-income domestic consumers.
- Derive best-estimate admd's and alpha & beta parameters for particular community types.
- Provide an evaluation of gaps, needs and develop a future strategy for this project.

This report explains the process undertaken and presents results from the NRS load research project, from winter of 1994 to winter of 1996. It explains what tools were developed in the process, and provides insight for future improvement of the project processes.

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[1] NRS034 "Guidelines for the provision of electrical distribution in residential areas", NRS project for the rationalisation of user specifications, 1996.

3. PROCESS

The NRS Load research project was initiated by a contract for the work between CSIR and DMEA, in 1994. The author was subsequently engaged by CSIR (Division of Manufacturing & aeronautical technology) to lead and manage the research project.

The following work was undertaken:

1. Definition of common standards for collection of data
2. CSIR workshop for role-players (ratification of standards).
3. Recruitment of Data Collector Organisations (DCO’s).
4. Development , distribution & revision of a load-research manual.
5. Development & distribution of a standard socio-demographic questionnaire.
6. Establishment of load research database (hardware & software).
7. Development & distribution of “Dataview” LR data quality-control tool.
8. Sourcing and distribution of data-logger hardware & software.
9. Support & coordination of 6 data-collection projects to a common standard.
10. Collation of all data from the above projects onto the NRS LR database.
11. Data analysis & report on all collected load data till August 1996 (this report).

This project was tackled as a collaborative effort between the NRS, CSIR, ESKOM and the DCO’s. Thus DCO’s provided most of the necessary equipment, and operating costs in order to maintain their projects. This collaborative approach reduced the funding required by this project quite considerably. Presently data from this project is being used to promote post-graduate study at 3 universities and a total of 5 projects are under way.

4. RESULTS

4.1 Relationship of observed Admd values to Income

A full version of the results for data collection projects from six townships are presented later in the body of the document.
Demand data in figure 1 shows an extreme envelope against which other projects may be compared.

Figure 1 indicates that sites with a higher average income tend to have a higher admd. This information very powerful if it is shown to be representative. Validation of this situation will require more information, particularly in the area R 1000-1200/household/month, the region of the mean national household income/month in South Africa.

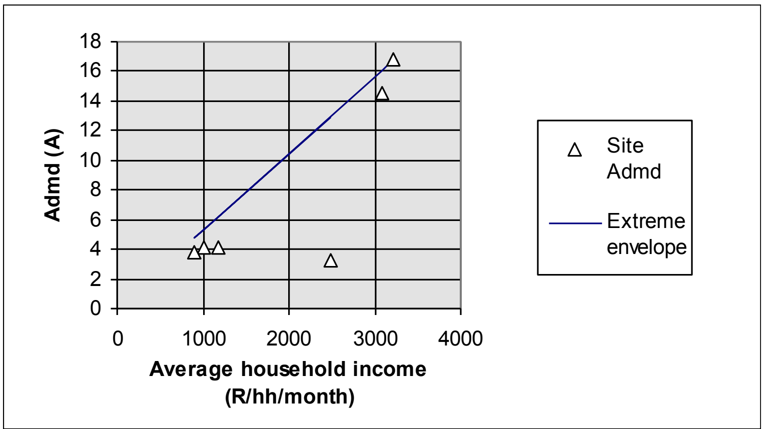

Figure 1: Admd relationship to mean monthly household income

At present, this relationship ignores time-since-connected and temperature effects. The result is Admd, expressed in Amps, on a five-minute basis.
A formula for the extreme envelope is presented in section 5.4.1 (main report).
The uncertainty attached to the presented measurements due to finite sampling is discussed in section 5.4.4 (main report).

Sample Alpha and Beta values for the readings in figure 1 are presented in section 5.3 (main report).

A more sophisticated model incorporating claimed income and time-since-connection is available[2], but needs verification.

4.2 Relationship of covariance of Admd to Income

Covariance is plotted against mean monthly household income in figure 2.
Covariance is an essential component to deterministic calculation of Alpha and Beta parameters for estimation of design voltage drop.

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[2] Dekenah, M. & Geldenhuys, H .J. “Pre-electrification research tool”, Eskom D.T. Internal report, June 1996.

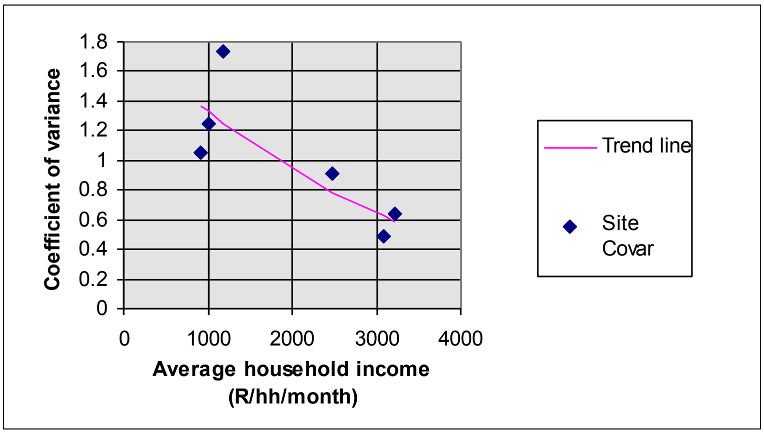

Figure 2: Covariance vs. mean household Income per month

A formula for the trend line is presented in section 5.4.2 (main report).

There is a negative correlation between covariance and mean household income. Poorer communities have higher coefficients of variance. This means special precautions must be taken when designing for this area, particularly where small numbers of consumers are concerned.

These results should be read in conjunction with all other data collected from the area (for the context), until such time as an objective model-based method of comparison is developed. Development of a model-based method for comparison is an area for further research.

4.3 Socio-demographic data

A socio-demographic questionnaire was designed to facilitate the building of a domestic-consumer demand-model.

This questionnaire was implemented as a standard, at most houses being monitored, throughout all the projects. A broad Socio-demographic description of those consumers monitored was gained from the socio-demographic questionnaires.

Enough data has been collected to develop a description of these consumers for reference purposes (in order to fix the context under which load readings are compared) as well as for model-building purposes.

4.4 Correlation's between socio-demographic data and load variables

An Analysis of variance study was carried out to determine the sensitivity of load to measured Socio-demographic parameters.

In general it was found that-within township sensitivities were not displayed across townships reliably, indicating that predictions of an individual household township load may be too situational to predict.

More success was encountered with the between township ANOVA, which indicated several useful predictors, excluding Income (not used). These predictors are shown in section 5.6.2 (main report).

One of these significant predictors was perceived-quality-of-supply, This carries the implication that poor supply quality may adversely affect electricity sales.

Socio-demographic data collected from most projects indicated that consumers were generally not happy with their quality of supply. Voltage-data accumulated with these projects makes it possible to calibrate this perception against field recordings.

This is an important area for further research, particularly since the definition of voltage regulation (a major design criterion) is in the process of revision, via the work of NRS034, and NRS048[3].

5. DATABASE & OTHER TOOLS DEVELOPED

A Load research data-base application has been set up , and uploaded with load, climatic and socio-demographic data from the projects.

More than 13 000 lines of code were written in the development of the database.

Sophisticated diagnostics and queries have been built into the package to facilitate quality control of load and sociometric data, management of projects and reporting on load-data collection projects.

The size of the database is currently greater than 1.2 GB. This should increase by about 1 GB every 6 months at the current rate of data accumulation.

Current hardware capacity is about 4 GB. This figure is however easily increased.

Other tools developed for this project were:

- A “Dataview” data logger file-viewer, for quality control of logger data in the field.
- A “Load data collection guide”, comprising most information needed establish & run an NRS data collection project.

Load and Socio-demographic data is presently exportable to other researchers as copy of the data-base structure, separable per township. The transfer mediums are presently digital audio tape (DAT) and CD ROM.

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[3] NRS048 “ELECTRICITY TRANSMISSION AND DISTRIBUTION- Minimum quality of supply standards”, NRS project for the rationalisation of user specifications, Draft 7 , June 1996.

6. FUTURE PLANS

During the course of the project, six distributed load-research projects collected data under a common standard for the data-base.
Seven projects are planned for 1997, and ESKOM TRI has undertaken to support the project in 1997.

As has been stated before, the NRS LR project is a collaborative research effort between several partners (See role players & acknowledgments later). Data from these projects is being used to fuel post-graduate research at the Universities of Stellenbosch, Durban-Westville, and Cape Town. This is expected to provide valuable spin-offs in future, particularly if these endeavors are managed centrally and funded adequately.

7. COST/BENEFIT ANALYSIS

The information provided by the project has enabled Eskom to design more cost-effectively, with consequent savings in the order of R 40 M/annum.

Operating under the current management model, the cost of maintaining this project is in the region of R 500 000/annum.

This amounts to a research return-on-investment of 8000 %/annum, excluding any of the following additional benefits:

- Value of load-database for decision-support
- Benefits generated by outputs from academic collaboration
- Benefits generated by increased research cost-effectiveness.
- Benefits to rest of ESI by incorporation of results into NRS 034 recommendations.

8. CONCLUSIONS & RECOMMENDATIONS

8.1 Achievement of objectives

The objectives set out for this project have been achieved:

- A database has been developed, and six projects have contributed towards the creation of this National resource. The database now contains about 1200 MB of structured load, climatic and socio-demographic data.
- A review of the process has been carried out, the lessons have lead to suggestions for improvement of the process.
- Estimates of Admd, alpha and beta values have been furnished.
- More work is needed in response to the results and justifies further project continuation.

8.2 Nature of Admd for unrestricted low-income consumers

Field measurements have indicated that poor communities (i.e. those earning the national average income per household) may yield an Admd in the region of 1.2 kVA/household after a period of three or more years. The standard deviation exceeded the Admd by 30 % in this region.
Previous research in South Africa and other countries has shown the opposite trend, where the standard deviation is less than the Admd.

Whilst great emphasis is currently placed upon “cutting the fat” out of designs, this trend in standard deviation of the Admd should be publicised, particularly with respect to possible effects upon QOS.

8.3 Sensitivity of Admd to perceived QOS

Admd has been shown to be sensitive at a township level to several socio-demographic variables, amongst these being quality of supply.
Since sales of electricity are also related to demand, a connection between power quality and sales has been implied.

This link is important to the understanding and prediction of electricity sales for low income consumers, and should be quantified.

8.4 Managerial issues

8.4.1 Selection of DCO’s: screening

A considerable amount of time has been absorbed in developing projects in unsuitable DCO’ s . It is recommended that a screening process be used, to develop projects only where they are viable. Criteria to be used in this screening process are:

- DCO manager computer literate & motivated.
- DCO project manager made accountable for results of his project.
- DCO project adequately budgeted (for equipment, manpower & travel)

8.4.2 Training indicated for DCO's

Data recovery rates from some sites is unacceptable. Data collector organisations are not familiar with research work, and training is required to carry out the tasks involved in running a LR project.

It is recommended that a feedback workshop be held once per year to spread learning amongst the DCO's.

8.4.3 Database Maintenance

Database maintenance has so far been the task of the Project manager. This has been effective, and no changes are required whilst the project is under way and adequately funded.

8.4.4 Continued software development

Software development carried out for this project allowed a relatively large amount of projects to be controlled by one person. It is recommended that a small amount of development work continue in order to strengthen this advantage, and provide more automated processes and error-checking.

8.4.5 Central collection of Socio-demographic data

Collection of socio-demographic data should be centralised, in order to control quality of returns. This task should be contracted to a Market Research organisation.

8.5 Requirements for continued project success

8.5.1 Project steering

The NRS LR project supplies data to satisfy many needs.
It is recommended that the project is always aligned by the needs of a steering group in order to stay relevant and focused.

8.5.2 Project team

Efforts expended by the project team have been effective. The team should be retained.

8.5.3 Project funding

Processes involved in this project have a long lead time, and continual project maintenance is required to gather data relevant to estimation of losses.

It is recommended that a sustainable mode of funding be established. This should run for a term of at least 3 years, contingent upon meeting agreed objectives annually.
Objectives should be based around site quality and data quality.

Funding requirements would be R436 000 per annum (inflation adjusted), for a growth-scenario aimed at establishing one additional new project per year (starting at six projects).

8.5.4 Reduce data collection volume

A massive amount of data is being handled presently. This volume should be reduced if at all possible, without negatively influencing results.
This recommendation ties in rather closely with the requirement to converge the sample design (which may cause an increase in sample size per site), and focus upon collection of parameters which matter.

8.5.5 Review Socio-demographic survey

The socio-demographic questionnaire was found to be in need of review. This should only be carried. This should only be carried out after it has been ascertained that data is redundant. A study to determine this is under way.

8.5.6 "Companion" processes needed

Companion processes are needed in order to derive and deliver more benefits to the electrification industry from the results of this project:

- Raw data must be shared with other researchers.
- Research in topics of high relevance to the electrification industry must be enabled.
- Results of this research must be broadcast back to the ESI.

It is recommended that a programme be initiated to beneficiate the data collected by the NRS LR project through tertiary research in a systematic manner. Coordination of such a programme will allow deliverable benefits from this project to be returned as savings to the "electricity for all" drive without delay. These savings could be substantial. The results can be expected to materially affect technical risk-management strategies.

8.6 Evaluation of this data collection process

Based upon initial feedback, applied results of this research will allow ESKOM to change its design philosophy, allowing planners to design electrical networks for low Admd's. This saves about R 40M per year.

It is recommended that the continued existence of this project should be justified in financial terms.

9. ROLE-PLAYERS & ACKNOWLEDGMENTS

The assistance of the following role-players is acknowledged in this project:

Project team
Mr. M Dekenah , Project manager (Marcus Dekenah Consulting CC)
Mr. C T Gaunt, Project consultant (Gibb Africa)
Dr. R Herman, Project consultant (University of Stellenbosch)
Dr. S J Maritz , Project consultant: Statistics (Private)

Project steering group (peer group)
Mr. A Gower, Chairman (Durban Electricity)
Mr. D Michie (Port Elizabeth Municipality)
Mr. R Stephen (Eskom DT)
DR W Barnard, (DMEA)

Data-collection project-managers (remote data-collection projects)
- Mr. D Baker & Mr. D Roblin (Pietermaritzberg Electricity)
- Mr. R Fourie (Conradie & Venter: Bloemfontein, assisted by Mr. R Van Buuren, Eskom , Bloemfontein distributor)
- Mr. D Pudney (Port Elizabeth Municipality)
- Mr. J Ross (Durban Electricity)
- Mr. D Prochassek (Johannesburg Electricity)

This information is included for future reference. It represents a body of available expertise for this field in Southern Africa. Detailed contact data for most of those mentioned above is included in the “Load data collection guide” (see appendix D). This also contains contact information for Eskom expertise in this area.

1. INTRODUCTION

This report describes the results of a project initiated to collect electrical-load and other data from domestic consumers in townships.
The report includes analysis of data collected from various township-monitoring sites and includes winter peaks from 1994-1996.

The NRS Load Research project is a collaborative effort initiated in 1994 between NRS, DMEA and CSIR. The aim of the project was to measure demand parameters and associated environmental information in low-income townships, for insertion into NRS 034 guidelines for electrification planners. Coincident five-minute-average data-logging was used.

The results of this project are likely to be important to electrification planners, since they provide a highly standardised bank of load and sociometric data collected from several low-income sites around the country. This provides a basis for decision-support, model-building and future research.

Results presented in this document take several forms:

- Load data gathered from six projects indicates an envelope of Admd values for different average household incomes. The coefficient of variance of the Admd's is negatively correlated to the household income. This implies special precautions must be taken when designing for low-income consumers, since they have high variance.
- Synopses of Socio-demographic data indicate that the townships monitored differ materially from each other. Detailed socio-demographic analyses for each township are included in the appendices.
- A detailed description and analysis of the data-collection process has been included, to ensure that the essential processes of the project may be improved in the future. This will lead to higher quality results.

Document development:
The report first gives a brief historical overview of the NRS LR project, and presents the analysed results of the project, inclusive of winter peak-periods of 1996.

Tools developed to facilitate this project are next described.
In the following chapter, a detailed evaluation of project processes is included, with recommendations for improvement. These recommendations are relevant to any research project involving several organisations.

Conclusions and recommendations follow.

The document is rounded off with several appendices which describe the site locations, and give a socio-demographic breakdown of the different sites (with photographs).
For completeness, the project socio-demographic questionnaire, data collection manual, and database entity-relationship-diagram are also included.

2. ABBREVIATIONS

The following abbreviations are used throughout this document, and a definition has been included here for future reference.

AD = Average demand. This is the sum of the loads of all monitored consumers divided by the number of consumers at a particular instant. The peak AD is called the Admd.

Admd = After Diversity Maximum Demand. For the purposes of this document, this is defined as the peak AD, measured on a 5-minute-averaged-basis.

BDE = Borland Database Engine. A database kernel which is Paradox compliant.
CSIR = Council for Scientific and Industrial Research

DAT = Digital Audio Tape. In this context, used to describe a tape cartridge with a 4GB storage capacity.

DCO = Data-collector organisation

DMEA = Department of Mineral and Energy Affairs.

Eskom EDD = Electricity demand department, a subsection of Marketing, Eskom.

ESKOM DT = Distribution Technology , Eskom.

ERD = Entity Relationship Diagram. A figure showing how a relational database is "connected".

LR = Load research (Electrical). Used in this project to describe load data gathering from domestic consumers.

3. KEY ASSUMPTIONS

In the beginning of this project, it was assumed (based upon best information at that time) the data, as collected under the current sample design, is usefully comparable to other situations (i.e. other contexts).

The testing of this assumption requires that two pieces of information are known:
1. Some other contexts
2. An objective comparison method.

The latter is not yet resolved, and is an area for further research, based upon the data collected.

4. PROGRESS OF THE PROJECT

This project followed the process displayed schematically below.

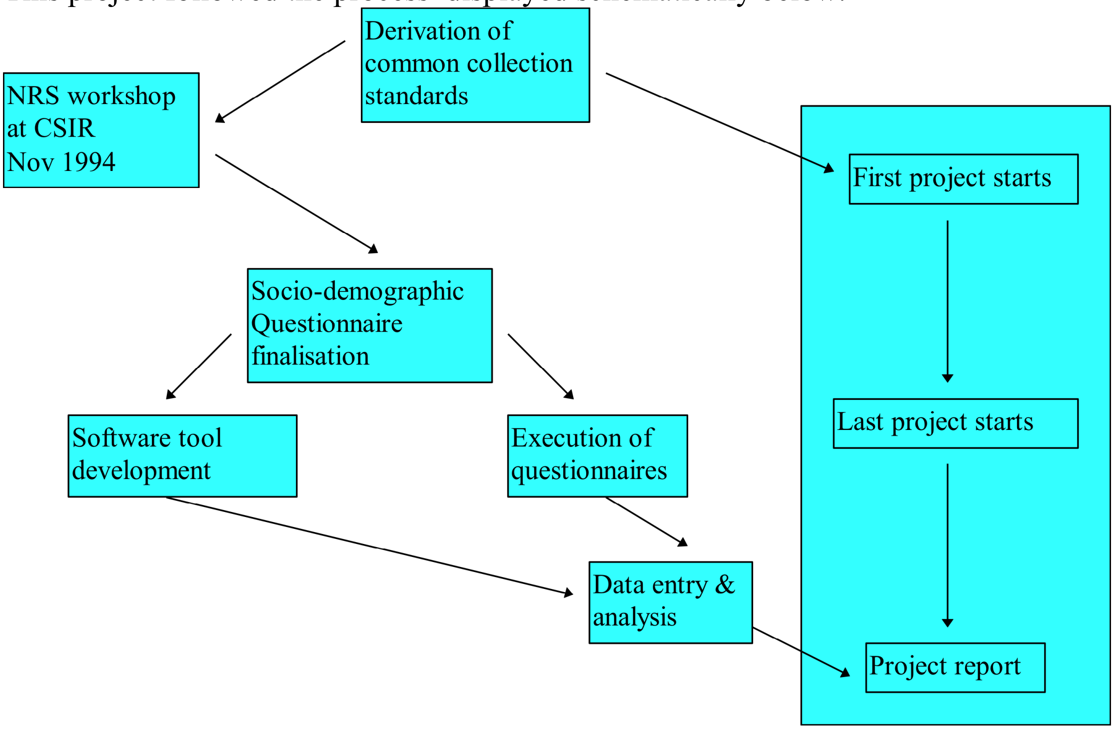

Figure 1: Schematic diagram for project process

Data collection started in June 1994.
The last project effectively started to yield results in May 1996.

The socio-demographic questionnaire was finalised by July 1995, and the last questionnaires were completed in May-June 1996.

Software tool development started in February 1996, and lasted about 4 months, during which time data entry ran as a parallel process.

There are presently five projects contributing data. Additionally one project (Cloetesville) has terminated, and another (Umgaga) is in the process of launching.

In magnitude, only one project (Umlazi) involves the logging of less than 60 consumers. Some projects are currently monitoring more than 90 consumers.

The project is on-going, and presently being run under funding supplied by ESKOM Technology Group. Seven LR projects are planned for the winter of 1997.

5. RESULTS

5.1 Measured demand values

Key:

20A :$I_{average}$ at peak (equivalent of Admd)

(0.5A) :Population std deviation at peak

N=70 : Number of consumers

Date/time : location of the peak

*****: Source data problem. This result under review**

****: Partial power-failure, "restore" peak.**

Notes:
"Peaks" are defined where the total measured load is at its highest. Thus "Peak 3" is the third-highest demand noted for this community during the period of logging. Each peak has been converted to an Admd simply by dividing by the number of consumers being measured at that time. All demands and standard deviations are quoted in Amps.

The Highest Admd for the period of measurement is shown shaded.

TOWNSHIP	1st Peak	2nd Peak	5 3rd Peak	4th Peak	5th Peak	Circuit breaker rating (A)
1 Claremont/ montclare **(Johnannesburg)** **22/3/96-22/8/96**	**16.8A (10.8A) N=75 17/7/96 @18h15**	**16.7A (11.3A) N=75 5/8/96 @19h20**	**16.4A (11.7A) N=75 8/7/96 @18h15**	**16.2A (11.3A) N=75 6/8/96 @20h15**	**16.0A (9.7A) N=75 25/7/96 @19h15**	**80A**
2 Cloetesville **(Stellenbosch)** **17/6/94-26/6/95**	**12.4A (7.7A) N=71 7/8/94 @11h45**	**14.5A (7.1A) N=59 24/7/94 @11h40**	**13.8A (8.3A) N=60 19/6/94 @11h50**	**13.4A (8.1A) N=60 26/6/94 @11h35**	**12.7A (8.3A) N=71 11/6/95 @12h10**	**60A**
3 Kwazakhele **(Port Elizabeth)** **17/7/95-12/8/96**	**5.4 (15.76) N=83 22/11/95 @17h25**	**4.1A (5.1A) N=84 19/7/96 @18h25**	**4.0A (4.1A) N=84 17/7/96 @18h15**	**3.9A (4.4A) N=84 1/8/96 @18h25**	**4.2A (4.5A) N=77 7/8/96 @19h00**	**80A**
4 Manyatseng **(Bloemfontein)** **3/5/96-21/8/96**	**3.8A (6.1A) N=66 15/8/96 @07h15**	**3.5A (5.1A) N=72 16/7/96 @06h55**	**3.7A (5.3A) N=66 13/8/96 @06h55**	**3.7A (5.1A) N=66 14/8/96 @20h15**	**3.0A (4.0A) N=76 17/6/96 @18h45**	**60A**
5 Sweetwaters **(P'Maritzberg)** **10/2/96-18/9/96**	**4.1A (7.1A) N=91 20/6/96 @18h30**	**4.0A (7.4A) N=91 9/8/96 @18h15**	**4.0A (7.2A) N=91 13/8/96 @18h15**	**4.0A (7.1A) N=91 5/8/96 @19h00**	**4.0A (7.6A) N=91 16/9/96 @18h50**	**60A**
6 Umlazi **(Durban)** **4/6/95-9/9/96**	**3.2A (2.9A) N=36 22/6/95 @17h54**	**3.1A (2.4A) N=36 16/8/95 @19h00**	**3.1A*** (2.4A) N=36 13/10/95 @19h00**	**3.1A (2.4A) N=36 30/6/95 @18h24**	**3.1A (2.0A) N=36 19/8/95 @18h30**	**80A**

Figure 2: Results of demand analysis: all projects

5.2 Discussion of results(1)

5.2.1 When peaks occur

Most of the Admd's occurred in the evening peak period, except Cloetesville, (Lunch-time peak), and Manyatseng (morning peak). What makes these communities different from any other is not obvious, and emphasises the difficulties encountered whilst trying to compare design parameters between communities.

5.2.2 Sizing of Admd for different climates

It is obvious from the aforementioned figures that some of these measures probably did not take place in the coldest months of the year. The assumption that an Admd will occur only in winter may be false.

Although no sizing will be attempted here, two suitable relationships do exist and could be adopted until such data becomes available:

1. The National demand "increases by 2% for each degree drop in temperature[1]".
2. A local measurement has shown similar results, but under the rule of " The Admd reduces by about 2% of its value at zero degree C, per degree fall of lowest maximum temperature noted" [2]. The correlation for this relationship was 0.95 .

It should be noted however that no sizing information regarding change in coefficient of variance is available for these relationships.

Air temperature data has been gathered from the S.A. weather bureau and is available for the sites under study, for the last two years.

5.3 Derived Alpha & Beta values

Township	Observed Admd and (Std deviation)	Estimated Alpha;Beta; Cb (A)	Coefficient of variance	Mean household monthly income (R/hh/month)	Climatic region[3]	Average daily temperature for July[3] (°C)
Claremont/ montclare	16.8 (10.8)A	1.70; 6.40; 80	0.64	3221	Temperate Sub-tropical	11.25
Cloetesville	14.5 (7.1)A	2.90; 9.20; 60	0.49	3081	Mediterranean	<7.5
Kwazakhele	4.1 (5.1)A	0.60; 10.40; 80	1.24	1013	Temperate Subtropical (coast)	8.75
Manyasteng	3.8 (4.0)A	0.78; 11.56; 60	1.10	905.5	Temperate Sub-tropical	8.75
Sweetwaters	4.1 (7.1)A	0.24; 3.30; 60	1.73	1185	Humid Sub-tropical	11.25
Umlazi	3.2 (2.9)A	1.10; 27.10; 80	0.91	2480	Humid Sub-tropical	11.25

Figure 3 : Derived Alpha, Beta values and related conditions

Based upon the above, the following Alpha, Beta, and Cb[4] values were derived for the monitored areas:

5.4 Discussion of results (2)

Several general conclusions from the data presented in more detail in the sections that follow:

5.4.1 Relationship of measured Admd to income

Admd is positively correlated to the mean monthly house income in the sample. An extreme-envelope approximation for this relationship is:

$$Admd(Income) = 0.00521 \cdot Income$$

This approximation does not include the effects of temperature extremes, nor time-since-connection. Result is the Admd expressed in Amps, on a five-minute basis as shown in figure 4.

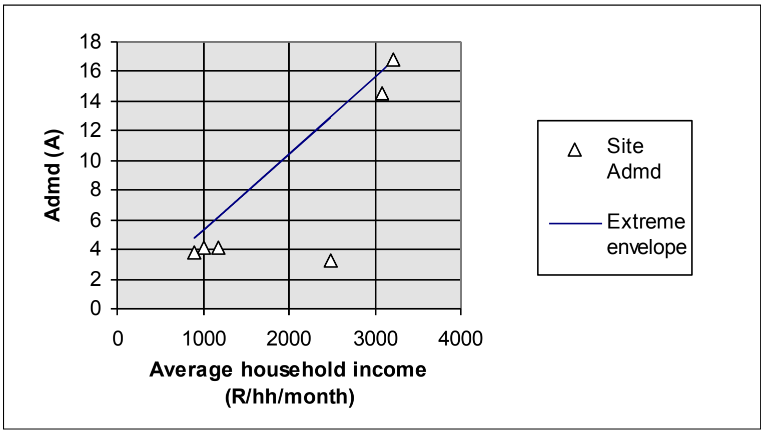

Figure 4: Admd as function of average community income

Income measures shown here are based upon the respondent's reactions.

An alternative dimensionless measure of income may better be in multiples of the National Average Income, during the year in which the data was collected. This would however necessitate a calibration of the current questionnaires to other market research information. This is an area for further research.

5.4.2 Relationship of covariance of Admd to income

"Poor" areas seem to have a high covariance, whilst "rich" areas seem to have a low coefficients of variance. A model for this relationship was derived as:

$$Cov(Income) = 1.91 \cdot e^{-0.00036 \cdot Income}$$

(Correlation = 0.78)

This relationship is shown in figure 5.

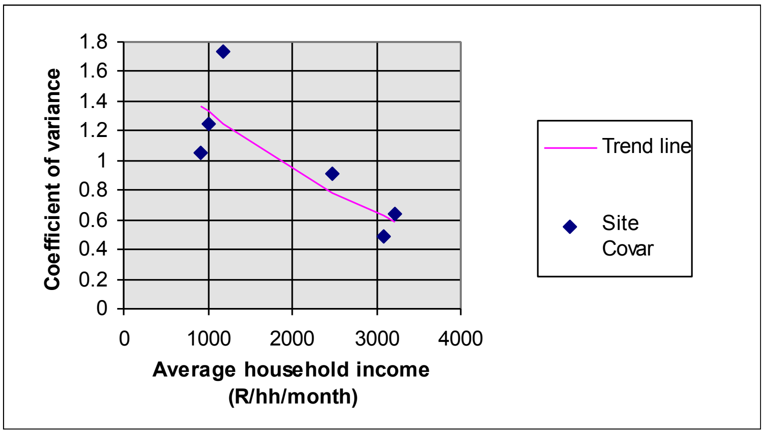

Figure 5: Covar as a function of Income

5.4.3 Effects of power failure on 5 minute demand

Power failures, even when short-term, can cause a major demand on the system. This is common knowledge. The Kwazakhele power failure the (see ** in Figure 2) caused a jump of about 50% in average maximum demand. The off-period of this peak was less than 10 minutes, and it appeared to settle to "normal" within 10 minutes.

5.4.4 Uncertainty in estimate of Admd

If it is assumed that the spread of individual consumer loads at the time of the peak is similar to that of the population, then the associated uncertainty in the measurement of Admd may be estimated with a particular confidence level.

This is described in figure 6:

Township	Observed Admd and (Pop. Std deviation) (A)	Sample size (N)	Associated uncertainty in estimation (90% confidence, two-tail) (A)
Claremont/	16.8 (10.8)A	75	2.04
Cloetesville	14.5 (7.1)A	71	1.38
Kwazakhele	4.1 (5.1)A	83	0.92
Manyasteng	3.8 (4.0)A	66	0.81
Sweetwaters	4.1 (7.1)A	91	1.21
Umlazi	3.2 (2.9)A	36	0.80

Figure 6: Associated uncertainty of Admd measurement

Since it was the aim of this project to assemble Admd measures with an error of less than 1A at 90% confidence, this has been moderately successful. Information gathered during this project will be used to guide sample design in further phases.

5.5 Socio-demographic synopses

This section presents a short breakdown of the full Socio-demographic study presented in the Appendices. The aim of these synopsis is to supply enough information to allow a township to be assessed in terms of these criteria, preferably without having to survey the dwelling internally.
For this purpose, Ownership of television sets(i.e. for aerials) is quoted.

5.5.1 Site description for Mont.-Clare/Claremont

This site features high % electrification, in a well-serviced environment with piped water, water-borne sewerage & tarred roads.

The site is close to a major centre.

Inhabitants are relatively wealthy (income of R3221/month/house, which is more than 3 times the national average) and generally own their houses. All houses electrified have hot-water geysers, and 95% own a television.
Built area of the houses generally cover 90m^2. These houses have mostly brick walls and corrugated iron roofs.

Very little alternative fuels are used.

5.5.2 Cloetesville

Cloetesville features 100% electrification., and in a well-serviced environment with piped water, waterborne sewerage, and tarred roads. The site is very close to a main centre.

This community is relatively wealthy, with a claimed house-income of 3 times the national average. Most houses have television, and geyser ownership is more than 95%.

Most houses are small ($50m^2$), and have asbestos roofs and brick walls.

Very few alternative fuel sources are in use.

5.5.3 Kwazakhele

This site features high % electrification, in a well serviced environment, close to a major centre. Water is mostly supplied to taps (in the yard, and there are consequently no geysers). Main roads are tarred, with secondaries of gravel (in the lanes between houses).

Inhabitants earn about the national average per house. Most own their dwellings.

About 90% of those electrified own a television set.

Built area of the houses is generally $30m^2$ and most houses have asbestos roofs, with about 50-50 brick or block walls.
Consumers are unhappy with their supply.

5.5.4 Manyatseng

This site has high electrification, and tarred main roads (secondary lanes between houses are gravel) This site is more than 100km from a city.

Water is supplied mostly to taps in the yard, and only 14% have water piped into the house.

Inhabitants are poor, earn about the national average per house.
Ownership of water geysers is very low, and just over half own a television set.

Three quarters of the inhabitants own their dwellings, and built area of the houses is of the order of $50m^2$.

There are a wide variety of building materials in use. About half of the roofs are either asbestos or tin, and walls are chiefly brick or concrete-block, (30-40%) followed by tin (17%).

Use of alternative fuels is high , and this appears to be part of the lifestyle. This site can get very cold in winter.

5.5.5 Sweetwaters

We are still awaiting the corrected information pack from this site.

The site is within 8 km of a major centre.
Inhabitants are as wealthy as the national average, own their own buildings.

About 36% of the population own a television set, and there are no geysers. Built-area of the houses is in the region of $50m^2$. Most houses have tin roofs. Most walls are of mud (90%) or concrete block (10%).

Over half the respondents use wood as an alternative fuel.

5.5.6 Umlazi

This site features high electrification (90%), in an area with 100% tarred roads.

The site is 20km away from a city center.
Inhabitants earn twice the national average and are thus relatively wealthy.

Ownership of buildings is high, and 20 % of the time a small business is being run from home.
Most houses have piped water, but geyser ownership is low at 10%.
85% of houses have a TV.
Built area of the houses is about $50m^2$, and most houses have asbestos roofs(90%) and brick walls (90%).
The climate is moderate, and only small portion of the sample uses any alternate fuel source (paraffin at 15%)

Consumers are unhappy with their supply.

5.6 Correlation of demand to Socio-demographic parameters

An investigative study was carried out to determine which socio-demographic parameters could be correlated to demand levels[5]. Such an investigation is an important step towards identifying important parameters which could be used in model-building for prediction of Admd by objective methods.

The identification of suitable load parameters was handled as an ANOVA (Analysis of Variance) exercise, at two levels. The Analysis of variance technique is useful for identifying the effect of components on a particular variable. Normally, analysis of variance works best for large samples from normally distributed populations. Since this is not the case here, the results should be treated as indicative of direction only.

Three townships were selected for this study:

- Kwazakhele
- Cloetesville
- Manyatseng

5.6.1 Within township ANOVA

This ANOVA exercise was conducted in order to establish any linkages between Individual Admd measures of demand and the variables shown:

General factors	Appliance-ownership

	factors
Highest education in house	Lights
Home ownership	TV
Presence of home business	Washing machine
Rooms in house	Geyser
Floor area of house	Iron
Roofing materials	Kettle
Wall materials	Heater
Water supply in house	Hotplate
Complaints re supply quality	Stove, 3 plate
Use of wood-fuel	Stove, 4-plate

Figure 7: Components of ANOVA investigation

Results of this investigation were inconclusive. Factors did not display similar levels of significance between townships, and were therefore unreliable. This indicates that prediction of an individual household load may require a highly situational function.

More success was noted with a between-townships ANOVA study

5.6.2 Between-townships ANOVA

The aim of this study was to find what factors, expressed at the township level, are significant in determining the load for the township. Variables identified by this method may be useful in formulation of a model for township-level Admd.

Figure 8 shows variables were indicated as significant:

General factors		Appliance-ownership factors	
Factor	Significance	Factor	Significance
Highest education in house		Lights	
Home ownership	✓	TV	✓
Presence of home business	✓	Washing machine	
Rooms in house	✓	Geyser	✓
Floor area of house	✓	Iron	✓
Roofing materials	✓	Kettle	✓
Wall materials	✓	Heater	
Water supply in house	✓	Hotplate	✓
Complaints re supply quality	✓	Stove, 3 plate	
Use of wood-fuel	✓	Stove, 4 plate	✓

Figure 8: Significance of variables from between-townships ANOVA

Significance for the above was determined by rejection at probability levels over 5% .

If substantiated by further work, the above indicators will provide a powerful basis for future model-building efforts, aimed at prediction of grouped consumer loads from gathered summary statistics. It should be noted that household income (not included in this survey) is probably highly correlated to most of the general factors, and should be included in future studies.

Customers perception of quality of supply is indicated as being a significant factor. This may carry great implications for electrification designers in the future, given the positive relationship between sales and township demand .

6. TOOLS DEVELOPED TO FACILITATE THIS PROJECT

Three types of tools were developed for this project:

- A reference guide, to standardise DCO actions
- Questionnaires to gather “soft” data
- Software tools to collate and manage “soft” data & load data

6.1 Load data collection guide

A load data collection guide was developed[6] to act as a reference work to guide DCO staff in launching and maintaining their projects according to the requirements of the project.

The following areas are covered in this document:

1. Why collect load data
2. How to get started
3. How to handle documentation
4. How to collect and quality control load data
5. How to go about collecting socio-demographic data
6. Whom to contact for what (and who else is involved)

   The first version of this document has been updated based upon the immense learning over the past year, and the revised version (i.e. revision 1) is included in the appendices.

6.2 Questionnaires to gather "soft" data

Questionnaires were handled at two levels:

1. A Socio-demographic questionnaire at household level
2. A Township level questionnaire

6.2.1 Socio-demographic questionnaire

A socio-demographic questionnaire was developed in order to capture all information relevant to the "context" of the environment where the information was collected. A copy of this questionnaire is attached in the appendices.

This questionnaire was executed at each household being monitored by a data logger channel. Socio-demographic data was date referenced upon entry onto the database.

6.2.2 Development of the socio-demographic questionnaire

After the period of research, it was decided to focus upon certain vectors which agreed with the cause & effect model displayed below, which was formulated to test the hypothesis;

"*People in an environment use appliances to create a demand*".

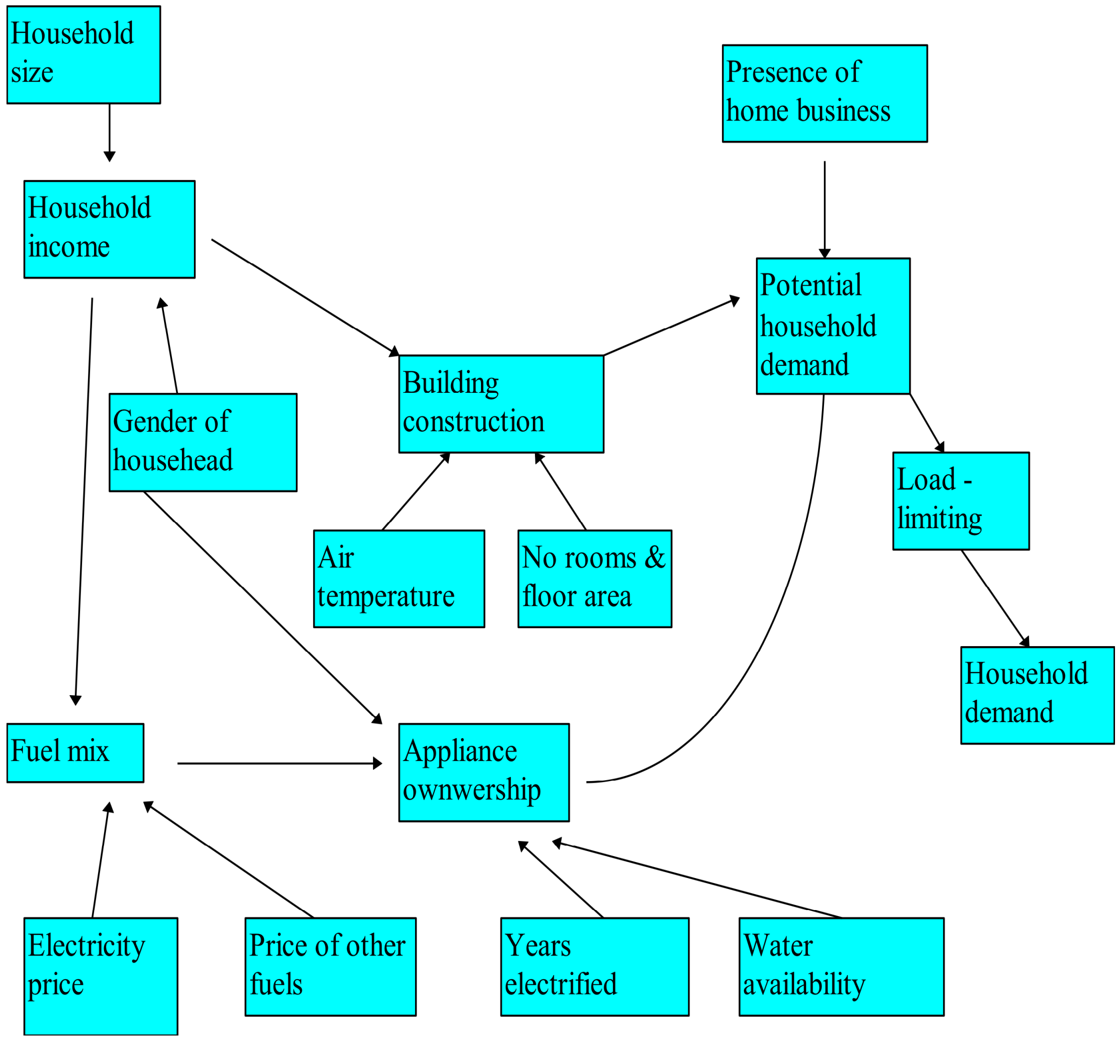

Figure 9: Hypothesis for electricity demand model

The research focused upon past literature surveys and correlation studies carried out in this area. Most connections shown are the result of relatively high correlation in previous studies[7] [8]. The directions of causality have been inferred by the author.

The socio-demographic questionnaire was based upon a previous Eskom framework[9], modified in accordance with the hypothesis set above. The final version of the questionnaire trapped the following information:

1. Personal details (inc. home language)
2. Household age breakdown
3. Employment breakdown
4. Income breakdown
5. Sex of household head
6. Building ownership
7. Presence of home business
8. Building construction, including roof & ceiling
9. Availability of water
10. Appliance ownership breakdown
11. Cooking habits breakdown
12. Use of alternative fuels
13. Supply of other buildings with electricity

14. Number of years electrified
15. Perceived continuity of supply and voltage regulation problems.

A copy of the questionnaire is included in the appendices.

6.2.3 Township-level questionnaire

In addition to the socio-demographic questionnaire described above, a township-level questionnaire was distributed to the DCO project managers in order to gather the following information on the environment:

1. Level of electrification in the area (% stands electrified)
2. Township size
3. Climatic description (annual rainfall & lowest temperature)
4. Local price of electricity
5. Distance to nearest city centre
6. Road types
7. Electricity meter-types in use
8. Description of any load-limiting in use
9. Local price of alternative fuels.

The aim of this questionnaire was to supply environmental information which could serve as a broad descriptor for the township site.

6.3 Software tools

Two software tools were developed:

1. A tool for quality-control of data, for use by the DCO's
2. A database application to store & manage the data.

Both of the above were developed by TLC software[10]

6.3.1 Description of "Dataview" quality-control tool

As part of this project, electrical load data was collected by DCO projects, and forwarded to the project manager by E-mail , post & courier.
This resulted in an unacceptably long delay before problems with data quality could be spotted and corrected.

As a solution to this, a data-viewer software package was developed to allow the DCO project mangers to view their own data and apply the necessary corrections immediately (i.e. quality-control was moved to the source).

The present version of this package allows large, multi-channel data files to be viewed graphically and also provides sophisticated statistics on a per-channel basis. The functional diagram of this tool is shown in figure 9.

The package is windows 3.x compliant, and the present version accepts the following three file formats:

- Eskom TRI 5001 logger (.xls format)
- Netelek 16 channel 8 bit logger (.prn format)
- Durban Electricity proprietary format (.dbn format)

The package includes on-line help. Development of this package involved more than 6000 lines of code.

A copy of Version 2 (interim) of this package has been distributed to each DCO site.

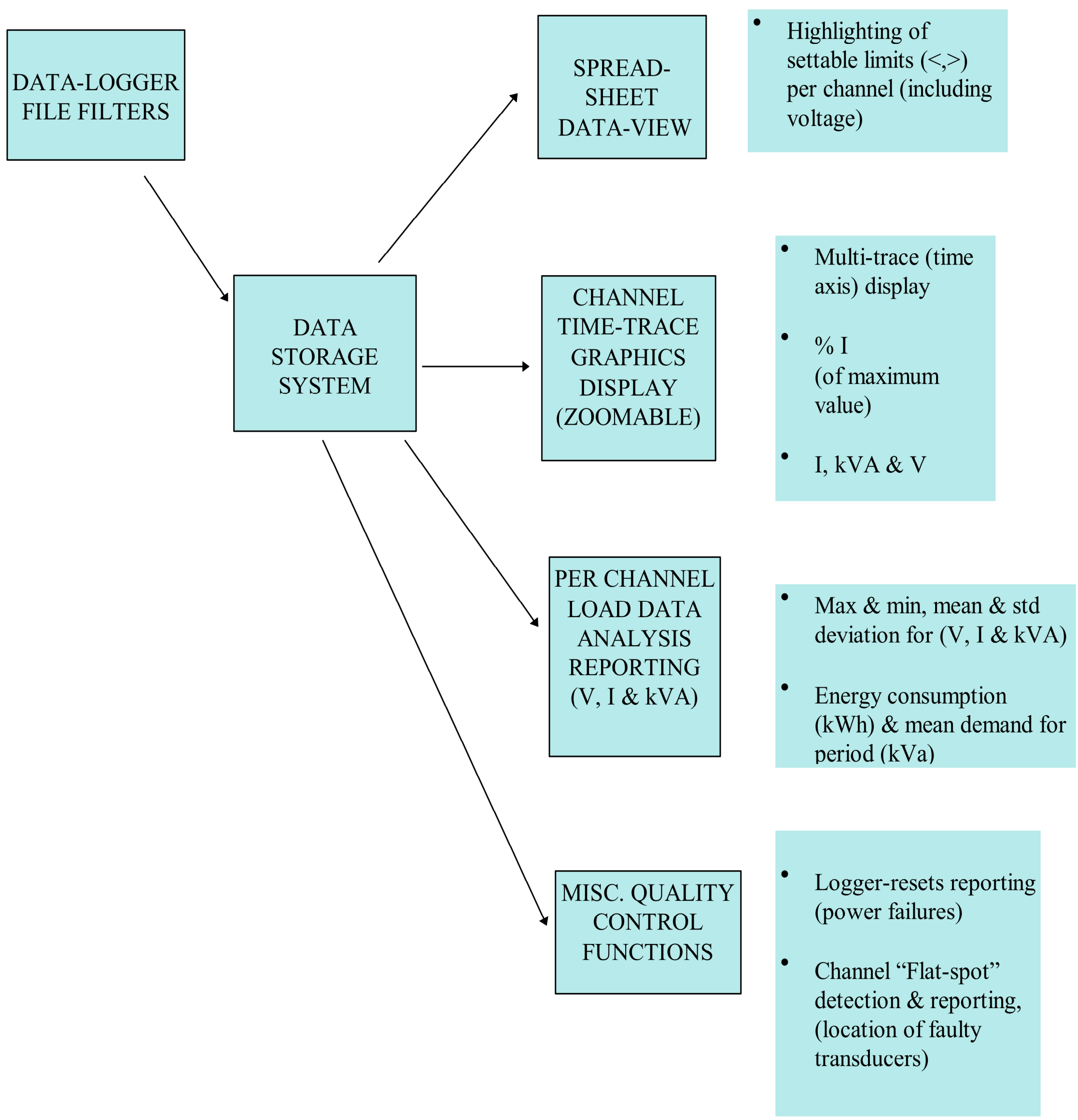

Figure 10: Schematic displaying the functionality of the NRS "Dataview" load-data quality control software package

6.3.2 NRS project-database

The NRS Project Database application was developed to manage the massive amounts of data which needed to be stored, retrieved, and analysed during the course of this project.

6.3.2.1 Description of stored data

The following information is currently stored on this relational database:

- Household-level load data for each DCO project (5 and 6 minute averaging intervals)
- Socio-demographic (per household) & township-level data for each DCO project
- Linking data (each household to it's logger & channel) for each DCO project.
- Results of the latest database queries (built-in)

Air temperature is additionally stored, but not as part of the structure. A viewer has been provided so that air temperature may be viewed graphically, and average hourly air-temperature statistics extracted for a defined time-region.

6.3.2.2 Functional description of the database

The functions of the database are illustrated in the following figure.

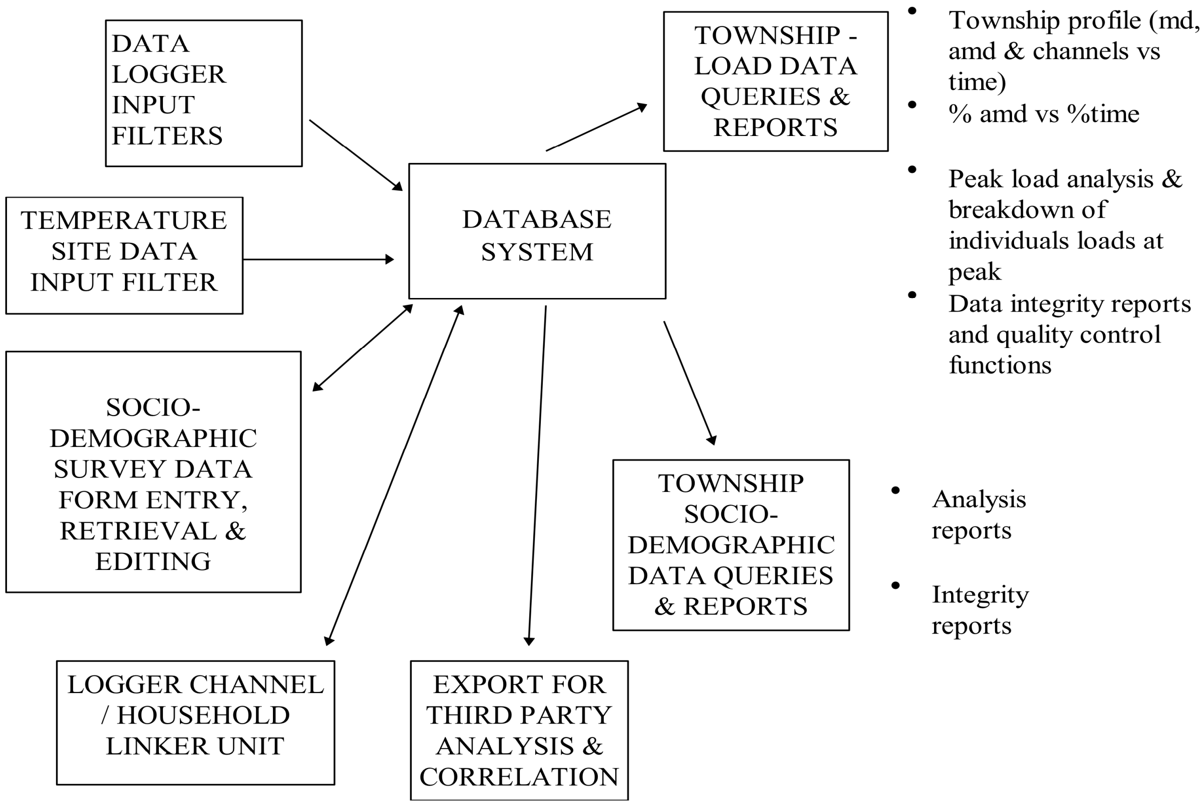

Figure 11: Schematic displaying the functionality of the NRS load research database package

The database allows storage, display, editing, and generation of analysis reports on most stored data.

Diagnostics are have been included to help identify the following common faults:

<u>Logger faults</u>

- Data logger not downloaded
- Data logger incorrectly initialised
- Data logger Identity code changed
- Data logger identity code duplicated
- Data logger file corrupted
- Data logger memory not cleared

Questionnaire faults

- Data field not filled-in
- Data field incorrectly filled-in

In one case a duplicate set of data was isolated from 1.5Million readings within 10 minutes (see Results: Durban corporation; peak 3).

6.3.2.3 Technical description of database

Software

This relational application consists of a family of 20 tables which store the socio-demographic information and linking information. A key feature of a relational database is the entity relationship diagram (ERD), which shows how the tables are connected. The ERD for this database is presented in the appendix.

Each DCO project is initialised as a separate small database, with one data-logger per table. This is done to allow the application to be secure ("accidents" are isolated to a logger) , manageable (program deals with smaller chunks), achievable per DCO project, and upscaleable (DCO projects can be "farmed-off" to additional hard-disk drives as the whole project grows).

The application was developed in Borland Delphi, and consists of more than 13 000 lines of code.
The Borland database engine (BDE) is used.

Hardware platform

The system is currently operating off a 120 MHz Pentium PC with a 4GB SCSI hard disk drive, 32 MB RAM and windows 3.11
A 4 GB digital audio tape (DAT) streamer has been added for archiving purposes.

7. GAPS, NEEDS AND FUTURE STRATEGIES

The following sections deal with shortcomings of the current phase of the project, and recommendations for the future.

7.1 Managerial deficiencies in the current scenario

There are several areas of concern which should be addressed in future projects of this type in order to ensure smooth running of the project.

7.1.1 Management & control of data-collector organisations

7.1.1.1 Power & control of the NRS project manager

The project manager has no effective control over the Data Collector Organisations (DCO's) taking part on the project, apart from excluding the output of their projects due to poor data quality.
Since the project manager has no direct control over the DCO organisation, he cannot reasonably be held responsible for poor data quality, one of the primary measures of project success. This is a problem which is not easily overcome.

7.1.1.2 Line control in DCO's over own project managers

In DCO's the project manager is often not under line-control of the authority-figure in the organisation who committed the DCO to the project. This leads to low accountability for results, and should be avoided. This problem may be minimised as follows:

It should be the duty of the DCO organisation to ensure that compliance with the Project managers requests is part of the DCO project manager's job-compact (i.e. part of his job-performance criteria).

7.1.1.3 Project planning & execution in DCO's

Most DCO's used in the NRS LR Project were municipalities. Many DCO's seemed to suffer from the similar pressures:

- Limited time
- Low man-power commitment

Some general problems related to project planning were:

- Project planning was generally intolerant of deadlines handed down by project management. For example, no organisations completed their socio-demographic questionnaires on time (Some organisations required up to six months to sub-contract an external market survey).
- No foresight was used to deal with foreseeable problems. For this reason tax-year-ends, local elections etc. were allowed to interfere with the quality of project data.
- Interrogation of data loggers was not accorded any type of priority over any other routine activity. This resulted in data downloads being deferred. Once the software tools were in place to monitor downloading activity, it became apparent that some sites had deferred downloading by considerable periods (i.e. a month or more).

This problem can be minimised by the identification and appointment of responsible line-managers with sufficient interest and information to ensure proper project planning and execution is therefore essential.

7.1.2 Maintenance of the database

A system needs to be devised whereby the database is always under the control of a body responsible for the quality of the data loaded onto it, and quality of data distributed from it.
Such a body should be appointed for a reasonable period of time.

It is recommended that the current project manager be appointed to this role for a period of at least three years.

7.1.3 Setting up a data-collection project: general

Several common faults associated with establishment of a load data collection project have been identified during the duration of this project, and are incorporated into the revised "Load data collection guide", in the appendices.

Some areas dealt with in the guide are:

- How to start a project (steps to be followed)
- How to handle documentation
- How to handle routine downloading.

As a general guideline, *it is improbable that a load research project can be established reliably in a municipal environment in less than four months, using the current methods. This lead-time is considerably faster for an educational institution however, and may be effectively limited to the delivery delay of the data-loggers (i.e. a matter of six weeks) in extremely favorable circumstances.*

7.1.4 Quality control of load data

Data is downloaded from data-loggers in the field and transmitted to the project manager either by E-mail, or stiffy diskettes (couriered).

Data loggers used in the field have varying amounts of memory. The largest data loggers (i.e. those equipped with 500kB memory) need only be downloaded every 67 days This long cycle-time is difficult to manage, and can result in significant data loss. The need to download-less-often is a DCO requirement, and conflicts to a certain extent with the need to control data quality.

It is recommended that data loggers be downloaded at least once per month. DCO's must ensure that sufficient manpower is budgeted to accommodate this, from the beginning of the project.

7.1.5 Collection of Socio-demographic data

Under the present system, DCO's are responsible for collection of socio-demographic data.

The collection of socio-demographics on a questionnaire is not a familiar task to DCO's, and approached with great caution, even though such insight into the customer is invaluable for local marketing purposes.

DCO data collection was handled in several different ways:
- Engage a professional market researcher.
- Use own personnel.
- Engage a local member of the community.
- Use university students to carry out the survey.

Professional market researchers generally provided good quality results.
It was found that the quality of field data was relatively poor in circumstances where internal DCO staff members were used to collect socio-demographic information, despite considerable DCO effort.
Quality of results from local community members and students was generally mediocre, and seems to depend largely upon how they are checked & managed.

It is recommended that Socio-demographic data collection is handled centrally, by contracting a professional Market Research (MR) organisation on behalf of the group of DCO projects.

Due to a certain amount of redundancy in the questionnaires, measures of data integrity were developed, and have been incorporated into data-base summary reports where possible. All statistics developed were programmed to avoid detectable errors.

7.2 Technical deficiencies in the current scenario

7.2.1 Supply & demand for data-loggers

There is invariably a rush on the supplier of data loggers towards the end of the calendar year, and there are very few alternative suppliers in South Africa, for this type of product.

It is recommended that data-loggers should be ordered with a lead-time of at least two months.

7.2.2 Failure of data loggers

Eskom TRI loggers were used at 80% of the data collection sites.
Any problems noted with this type of logger are currently being addressed by the manufacturer;

Power-supply-transformer insulation

At one site 50 % of loggers were perceived to fail. The problem was traced to a particular batch of power supply transformers, and the problem rectified by the supplier.

Internal fuse failure

Most problems with Eskom TRI data-loggers however turned out to be the rupturing of an internal fuse. The fuse is mounted under one of the printed circuit boards, and was therefore not obvious to the casual repair-man. This is rectified in future TRI models, where the fuse has been moved to a carrier on the outside of the case.

Plug orientation: blown input lines

Two plugs which fit into the side of the TRI logger, carrying power and current-transformer leads are identical, and are not individually keyed . These plugs are sometimes swapped in the field. Generally this destroys several input channels on the logger. The damage is often interpreted as "lightning strike" by the uninitiated, and requires repair and recalibration of the logger.

7.2.2.1 Insect intrusion (Netelek loggers)

During winter months, ants and other insects tend to invade ground-housed data loggers. Several loggers at the Stellenbosch site appeared to suffer from this problem. Loggers were treated with insecticide.

7.2.2.2 Data-bucket failure (Calmu loggers)

Calmu data loggers were in use at the Umlazi site. These loggers used a "data-bucket" electronic storage device to upload data from the field. This device had capacity to handle data from several data loggers simultaneously.
It was found that certain loggers managed to corrupt the data bucket. This problem was rectified by collecting the data from those loggers last in each uploading round.

Most of the above problems may be solved by a combination of technical modification and training. It is recommended that a training session is held once per year to deal with the logger problems. This should preferably take place on-site.

For the purposes of this project, special arrangements were made with the local supplier of the data loggers to hold a strategic-reserve of loggers for such eventualities, until expiration of the guarantee.

7.2.2.3 Theft of data loggers

Two loggers were stolen from the Bloemfontein site, and one from Umlazi. Both sites used mounting methods which placed loggers within easy reach of a person standing on the ground.

It is recommended that all data-loggers should be mounted either out of reach, or inside locked enclosures.

7.3 Research deficiencies in the current scenario

Several aspects of this project were handled “less-than-well”, and warrant further attention.

7.3.1 Sample design & sample size

The entire sample design for this project was based upon the premise that a DCO project sample-size in excess of 70 consumers would lead to a reasonable estimate of the Admd (An error of less than one amp, at a confidence of 90%) .

There are more efficient ways in which to guide the sample design towards a required precision.

It is recommended that, a model-based approach is used in future. This will need to be carefully managed in order to ensure integrity of the process at remote sites however.

7.3.2 Umlazi data collection site: Logger Modifications

The Umlazi DCO project currently has the following deficiencies:

- Data is being collected at 6 minute intervals.
- The number of consumers being logged (36 consumers) is too low.
- kVA is being monitored, as opposed to currents at all of the other sites.

In addition to the above, Umlazi has provided largely atypical readings (see Admd graph, section 5).

It is recommended that this site be upgraded (Plans are presently in place to rectify this situation in 1997).

7.4 Requirements for continued project success

There are several needs which must be addressed in order to assure sustained growth and quality from this project.

7.4.1 Project steering

This project was defined for two purposes

- Supply design parameters to NRS034 for inclusion in standards.
- Provide a ready & accessible database which would allow further research to be launched.

The data in this project has many uses for many parties, and is therefore valuable. Data from this resource will influence National standards.

For this reason it is recommended that a steering group is always in control, and the project is always aligned with the needs of the steering group.

7.4.2 Project team

The current project team was successful in planning and execution of this project. Members of the project team are still considered to be leaders in their areas.

It is recommended that the current project team be retained unchanged.

7.4.3 Project funding

Project funding from September 1994, to date has amounted to R465 000 (Vat inc.). This funding has been used to achieve all of the functions listed in the introduction of this document.
Present uncertainty in the provision of funding has severely hampered the year-on-year effectiveness of this project. For this reason, long term (3 year) funding is recommended.

7.4.4 Reduction in the amount of data collected

All data which was collected was backed by reference work which indicated that such information was relevant to the characterisation of a domestic consumer's demand or consumption.
Analysis by Dr. Maritz has shown that a number of these variables are significant.
It is recommended that the results of the above analysis be used to amend the sample design and socio-demographic survey.

7.4.5 Review of Sociodemographic questionnaire

Due to some redundancy of information throughout the questionnaire, it was possible to check the integrity of data collected in various areas.
This feature was programmed as a tool into the database to control the survey progress of the different projects, and avoid the occurrence of common mistakes which would require manual review of the results.
In some cases repeated mistakes were still made however. This indicates that the form of the questionnaire should be reviewed in future.

7.4.6 Companion processes required to beneficiate data

A Large mass of data has been collected as part of this project. Processes are now needed to allow the data to be beneficiated beyond the primary analyses presented in this report.

7.4.6.1 Servicing of data requests

The database is part of a National Resource, and should be maintained as a source for researchers in order stimulate analysis and model-building work in this area.

7.4.6.2 Distribution of regular analysis results to industry

A mechanism must be created whereby a standard abbreviated set of analysis results must be updated and distributed regularly to industry, as a resource for designers.

7.4.6.3 Calibration of existing data loggers

Three different designs of data logger were used in the field. Each data-logger type varied in accuracy, which may have been about 3%.

For the purposes of studies intended to estimate losses, it is important that the calibration of these loggers be investigated and a correction defined and built into the database.

7.4.6.4 Model for comparison of load parameters between sites

At present, results of load data analysis have to be read in conjunction with all other data collected from the area (for the context), until such time as an objective model-based method of comparison is developed.

It is recommended that a model-based method for comparison of load parameters is developed..

7.5 Other electricity-supply issues which can be addressed with the collected data

There are several issues which should be addressed with the current mass of data. The solution of these issues will lead directly to:

- Definition of a supply level which is acceptable to the consumer
- The capability to design a delivery system with good short and medium term sufficiency.
- The capability to evaluate the costing of a delivery system in terms of life-cycle cost, on a rigorous basis.

7.5.1 Verification of present voltage regulation policy

During this project, both voltage and current readings are collected at the consumer's point of supply. Those consumer's perceptions of supply quality have also been collected.

This is an important area for further research, particularly since the definition of voltage regulation (a major design criterion) is in the process of revision, via the work of NRS034, and NRS048.

Presently collected information allows consumer perceptions of supply quality to be correlated with the consumer's level of supply.

It is recommended that such a correlation study be carried out.

7.5.2 Verification of Admd and diversity figures

Distribution design for voltage criteria requires the choice of an Admd and diversity (or and Alpha, Beta) value. These values are contextual, and depend upon the built-environment etc. This database allows both the "context" and live data to be compared between organisations.
This process would be greatly enhanced by the development of an objective, model-based comparison method.

7.5.3 Definition of a socio-economic classification used to "Label" categories of design Admd.

The labels wealthy, well-off, and poor are subjective, and do not correspond with household income, or categories in NRS034.

A preferred nomenclature needs to be developed and applied.

7.5.4 Development & confirmation of consumer models

Consumer models have in the past been developed to estimate

- Demand and demand growth
- Consumption and consumption growth
- Thermal equipment loading
- Transmission losses

The data supplied here can be used to further this work.

It is recommended that the development of these models is carried out.

8. CONCLUSIONS & RECOMMENDATIONS

8.1 Achievement of objectives

The objectives set out for this project have been achieved:

- A database has been developed, and six projects have contributed towards the creation of this National resource. The database now contains about 1200 MB of structured load, climatic and socio-demographic data.
- A review of the process has been carried out, the lessons have lead to suggestions for improvement of the process.
- Estimates of Admd, alpha and beta values have been furnished.

More work is needed in response to the results and justifies further project continuation.

8.2 Nature of Admd for unrestricted low-income consumers

Field measurements have indicated that poor communities (i.e. those earning the national average income per household) may yield an Admd in the region of 1.2 kVA/household after a period of three or more years. The standard deviation exceeded the Admd by 30 % in this region.
Previous research in South Africa and other countries has shown the opposite trend, where the standard deviation is less than the Admd.

Whilst great emphasis is currently placed upon “cutting the fat” out of designs, this trend in standard deviation of the Admd should be publicised, particularly with respect to section 8.2 above.

8.3 Sensitivity of Admd to perceived QOS

Admd has been shown to be sensitive at a township level to several socio-demographic variables, amongst these being quality of supply.
Since sales of electricity are also related to demand, a connection between power quality and sales has been implied.

This link is important to the understanding and prediction of electricity sales for low income consumers, and should be quantified.

8.4 Managerial issues

8.4.1 Selection of DCO’s: screening

A considerable amount of time has been absorbed in developing projects in unsuitable DCO’ s . It is recommended that a screening process be used, to develop projects only where they are viable. Criteria to be used in this screening process are:

- DCO manager computer literate & motivated.
- DCO project manager made accountable for results of his project.
- DCO project adequately budgeted (for equipment, manpower & travel)

8.4.2 Training indicated for DCO's

Data recovery rates from some sites is unacceptable. Data collector organisations are not familiar with research work, and training is required to carry out the tasks involved in running a LR project.

It is recommended that a feedback workshop be held once per year to spread learning amongst the DCO's.

8.4.3 Database Maintenance

Database maintenance has so far been the task of the Project manager. This has been effective, and no changes are required whilst the project is under way and adequately funded.

8.4.4 Continued software development

Software development carried out for this project allowed a relatively large amount of projects to be controlled by one person. It is recommended that a small amount of development work continue in order to strengthen this advantage, and provide more automated processes and error-checking.

8.4.5 Central collection of Socio-demographic data

Collection of socio-demographic data should be centralised, in order to control quality of returns. This task should be contracted to a Market Research organisation.

8.5 Requirements for continued project success

8.5.1 Project steering

The NRS LR project supplies data to satisfy many needs.
It is recommended that the project is always aligned by the needs of a steering group in order to stay relevant and focused.

8.5.2 Project team

Efforts expended by the project team have been effective. The team should be retained.

8.5.3 Project funding

Processes involved in this project have a long lead time, and continual project maintenance is required to gather data relevant to estimation of losses.

It is recommended that a sustainable mode of funding be established. This should run for a term of at least 3 years, contingent upon meeting agreed objectives annually. Objectives should be based around site quality and data quality.

Funding requirements would be R436 000 per annum (inflation adjusted), for a growth-scenario aimed at establishing one additional new project per year (starting at six projects).

8.5.4 Reduce data collection volume

A massive amount of data is being handled presently. This volume should be reduced if at all possible, without negatively influencing results.
This recommendation ties in rather closely with the requirement to converge the sample design (which may cause an increase in sample size per site), and focus upon collection of parameters which matter.

8.5.5 Review Socio-demographic survey

The socio-demographic questionnaire was found to be in need of review. This should only be carried. This should only be carried out after it has been ascertained that data is redundant. A study to determine this is under way.

8.5.6 "Companion" processes needed

Companion processes are needed in order to derive and deliver more benefits to the electrification industry from the results of this project:

- Raw data must be shared with other researchers.
- Research in topics of high relevance to the electrification industry must be enabled.
- Results of this research must be broadcast back to the ESI.

It is recommended that a programme be initiated to beneficiate the data collected by the NRS LR project through tertiary research in a systematic manner. Coordination of such a programme will allow deliverable benefits from this project to be returned as savings to the "electricity for all" drive without delay. These savings could be substantial. The results can be expected to materially affect technical risk-management strategies.

8.6 Evaluation of this data collection process

Based upon initial feedback, applied results of this research will allow ESKOM to change its design philosophy, allowing planners to design electrical networks for low Admd's. This saves about R 40M per year.

It is recommended that the continued existence of this project should be justified in financial terms.

9. *ACKNOWLEDGMENTS*

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Project team
Mr. M Dekenah , Project manager (Marcus Dekenah Consulting CC)
Mr. C T Gaunt, Project consultant (Gibb Africa)
Dr. R Herman, Project consultant (University of Stellenbosch)
Dr. S J Maritz , Project consultant: Statistics (Private)

Project steering group (peer group)
Mr. A Gower, Chairman (Durban Electricity)
Mr. D Michie (Port Elizabeth Municipality)
Mr. R Stephen (Eskom DT)
DR W Barnard, (DMEA)

Data-collection project-managers (managers at remote data-collection projects)
Mr. D Baker & Mr. D Roblin (Pietermaritzberg Electricity)
Mr. R Fourie (Conradie & Venter: Bloemfontein, assisted by Mr. R Van Buuren, Eskom , Bloemfontein distributor)
Mr. D Pudney (Port Elizabeth Municipality)
Mr. J Ross (Durban Electricity)
Mr. D Prochassek (Johannesburg Electricity)

This information is included for future reference. It represents a body of available expertise for this field in Southern Africa. Detailed contact data for most of those mentioned above is included in the "Load data collection guide" (see appendix D). This also contains contact information for Eskom expertise in this area.

10. REFERENCES

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APPENDICES

APPENDIX A:

LOCATION OF SITES AND PERIODS OF LOGGING

NRS PROJECT SITES IN SOUTH AFRICA

Periods of logging for all projects

Site number	Township	Effective Duration of project	Current database size (readings)	Current sample size*	Collection efficiency**
1	Claremont/ Mont-Clare	96/3/22- 96/8/22	3.8 M	75	>75 %
2	Cloetesville (project finished)	94/6/17- 95/6/26	7.5 M	66	89 %
3	Kwazakhele	95/7/17- 96/8/12	8.5 M	70	>80 %
4	Manyatseng	96/5/3- 96/8/21	1.5 M	76	48 %
5	Sweetwaters	96/2/9- 96/9/18	4.0 M	86	45 %
6	Umlazi	95/6/4- 96/9/9	4.5 M	36	> 79 %

* = varies according to the effectiveness of data collection.
**= Taken as a measure of how much of all data possible is collected over the length of project to date. Since the last report on this project, the efficiency on all active sites has increased.
This trend is expected to continue.

APPENDIX B:

SOCIO-DEMOGRAPHIC SURVEY SUMMARIES

The per-project analyses are presented here in the following manner:

- Photographs from the site
- Summary site description
- A detailed multi-page socio-demographic analysis

1. Topics covered by the Socio-demographic surveys

The Socio-demographic survey which was used in this project is included in elsewhere in these appendices.

The analytic reports which follow cover the following areas:

a) **Township details**:
Information about the environment & climate of the township

b) **Database details**
The current database at the time of this report. Several descriptions of size are included.

c) **Occupant & dwelling description**
Occupant description covers characteristics of the occupants, their appliance ownership, and business activity.
Dwelling description covers details of house construction, size, and provision of water.

d) **Alternative fuel sources**
This section covers local price and reported usage of alternative fuel sources.

e) **Electricity supply**
This section covers the size of the main breaker, and complaints regarding quality of supply (Power failures, voltage problems & main switch capacity).

2. Claremont/Mont-Clare (Johannesburg)

2.1 Site description for Mont-Clare/Claremont

This site features high electrification, in a well-serviced environment with piped water, water-borne sewerage & tarred roads. The site is close to a major center.

Inhabitants are relatively wealthy (R7000/month/household) and generally own their houses. All houses have hot-water geysers, and 95% own a television.
Built area of the houses generally cover $90M^2$. These houses have mostly brick walls and corrugated iron roofs.

Very little alternative fuels are used.

2.2 Socio-demographic Analysis for Mont-Clare/Claremont

1 TOWNSHIP DETAILS:

Township Number	29
Stands percentage	100%
Number of homes	1298
Average rainfall	802mm
Minimum temperature	5 degrees C
Tarred roads	
Distance to nearest city	7km

2 DATABASE DETAILS:

Loggers uploaded	19
Total readings taken	3 856 523
Size	101 112 kB

3 OCCUPANT/DWELLING DESCRIPTION

3.1 Per Household criteria	**Mean**	**Median**	**Std. dev**	**Min**	**Max**
Household size [people]	4.343	4	5.966	1	14
Monthly income [R]	6986	5350	8517	0	44000
Highest education rating	10.59	11	2.184	0	13

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	80%
Small business presence	8.57%

3.1.2 Appliance ownership

Stove with oven (3 plate)	14.29%
Stove with oven (4 plate)	85.71%
Hotplate	4.29%
Heater	44.29%
Kettle	98.57%
Iron	100%
Geyser	100%
Washing machine	92.86%
Television	95.71%
Lights	100%
Fridge/fridge-freezer	91.43%
Freestanding deep freeze	38.57%

3.2 Dwelling description:

3.2.1 Size of housing:	**Mean**	**Median**	**Std. dev**	**Min**	**Max**
Rooms	6.457	7	1.729	5	15
Floor area [m^2]	89.96	100	27.17	50	175

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	71.43%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	0%
Blocks	0%
Plaster	0%
Concrete	1.43%
Tiles	27.14%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	0%
Outstanding roof materials	0%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	2.86%
Brick	82.86%
Blocks	14.29%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	0%
Outstanding Wall materials	0%

3.2.4 Water service:

Piped water in the house	94.29%
Tap in yard	5.71%
Communal tap	0%
Water sources outstanding	0%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.171 /kWh
Coal	R0.23
Paraffin	R2.3
Gas	R4.44
Wood	R0.37

4.2 Reported use of alternative fuels:

Coal	0%
Paraffin	1.43%
Gas	7.14%
Wood	0%
Charcoal	0%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	**Mean**	**Median**	**Std. dev**	**Min**	**Max**
Main switch size [A]	77.71	80	11.06	40	80

5.2 Quality of supply - complaints:	
Power failure	21.43%
Lights get dim at night	17.14%
Main switch trips	5.71%

3. Socio-demographic analysis for Cloetesville

3.1 Site description for cloetesville

Cloetescille features 100% electrification., and in a well-serviced environment with piped water, waterborne sewerage, and tarred roads. The site is very close to a main center.

This community is relatively wealthy, with a claimed house income of 4.3 time the national average. Most houses have television, and geyser ownership is none than 95%.

Most houses are small (50m^2), and have asbestos roofs and brick walls.

Very few alternative fuel sources are in use.

3.2 Cloetesville (Stellenbosch)

1 TOWNSHIP DETAILS:

Township Number	26
Stands percentage	100%
Number of homes	254
Average rainfall	727mm
Minimum temperature	10 degrees C
Tarred roads	
Distance to nearest city	4km

2 DATABASE DETAILS:

Loggers uploaded	7
Total readings taken	7511008
Size	295 506 kB

3 OCCUPANT/DWELLING DESCRIPTION:

3.1 Per Household criteria	Mean	Median	Std. dev	Min	Max
Household size [people]	5.516	5	9.351	2	10
Monthly income [R]	4286	4000	6801	450	18950
Highest education rating	10.73	11	2.134	3	13

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	98.39%
Small business presence	6.45%

3.1.2 Appliance ownership

Stove with oven (3 plate)	9.68%
Stove with oven (4 plate)	87.10%
Hotplate	4.84%
Heater	70.97%
Kettle	95.16%
Iron	98.39%
Geyser	96.77%
Washing machine	85.48%
Television	95.16%
Lights	96.77%
Fridge/fridge-freezer	95.16%
Freestanding deep freeze	38.71%

3.2 Dwelling description:

3.2.1 Size of housing:	Mean	Median	Std. dev	Min	Max
Rooms	5.903	6	0.4987	5	7
Floor area [m^2]	50.23	50	7.908	50	80

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	4.84%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	0%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	4.84%
Plastic	0%
Asbestos	90.32%
Daub/Mud/Clay	0%
Outstanding roof materials	0%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	1.61%
Brick	98.39%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	0%
Outstanding Wall materials	0%

3.2.4 Water service:

Piped water in the house	98.39%
Tap in yard	1.61%
Communal tap	0%
Water sources outstanding	0%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.2372 /kWh
Coal	
Paraffin	R1.15
Gas	R3.7
Wood	

4.2 Reported use of alternative fuels:

Coal	
Paraffin	0%
Gas	1.61%
Wood	3.23%
Charcoal	0%
	0%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	Mean	Median	Std. dev	Min	Max
Main switch size [A]	60	60	8.871	60	80

5.2 Quality of supply - complaints:

Power failure	3.23%
Lights get dim at night	6.45%
Main switch trips	6.45%

4. Kwazakhele (Port Elizabeth)

4.1 Site description for Kwazakhele

This site features high electrification, in a well serviced environment. Water is mostly supplied to taps in the yard and there are consequently no geysers. Main roads are tarred, with secondaries of gravel (in the lanes between houses).

Inhabitants are relatively well-off, earning three times the national average per house. Most own their dwellings.

About 90% own a television set.

Built area of the houses is generally $30M^2$ and most houses have asbestos roofs, with about 50-50 brick or block walls.

Paraffin is very popular alternative fuel here. The site does not get very cold.

4.2 Socio-demographic analysis for Kwazakhele

1 TOWNSHIP DETAILS:

Township Number	31
Stands percentage	94%
Number of homes	27650
Average rainfall	611mm
Minimum temperature	0 degrees C
Tarred roads	
Distance to nearest city	8km

2 DATABASE DETAILS:

Loggers uploaded	12
Total readings taken	8 544 222
Size	253 728 kB

3 OCCUPANT/DWELLING DESCRIPTION:

3.1 Per Household criteria	Mean	Median	Std. dev	Min	Max
Household size [people]	4.559	4	5.885	1	10
Monthly income [R]	3101	1300	5354	0	33000
Highest education rating	10.4	11	2.581	0	13

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	95.59%
Small business presence	2.94%

3.1.2 Appliance ownership

Stove with oven (3 plate)	25%
Stove with oven (4 plate)	20.59%
Hotplate	27.94%
Heater	19.12%
Kettle	54.41%
Iron	58.82%
Geyser	0%
Washing machine	1.47%
Television	89.71%
Lights	100%
Fridge/fridge-freezer	58.82%
Freestanding deep freeze	1.47%

3.2 Dwelling description:

3.2.1 Size of housing:	Mean	Median	Std. dev	Min	Max
Rooms	4.206	4	0.7963	2	7
Floor area [m^2]	30.19	42	25.81	30	99

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	0%
Blocks	1.47%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	1.47%
Asbestos	97.06%
Daub/Mud/Clay	0%
Outstanding roof materials	0%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	44.12%
Blocks	52.94%
Plaster	1.47%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	1.47%
Daub/Mud/Clay	0%
Outstanding Wall materials	0%

3.2.4 Water service:

Piped water in the house	22.06%
Tap in yard	77.94%
Communal tap	0%
Water sources outstanding	0%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.16 /kWh
Coal	R?
Paraffin	R1.6
Gas	R4.3
Wood	R0.6

4.2 Reported use of alternative fuels:

Coal	1.47%
Paraffin	80.88%
Gas	11.76%
Wood	1.47%
Charcoal	1.47%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	Mean	Median	Std. dev	Min	Max
Main switch size [A]	80	0	0	80	80

5.2 Quality of supply - complaints:

Power failure	25%
Lights get dim at night	39.71%
Main switch trips	33.82%

5. Manyatseng (Ladybrand)

5.1 Site description of Manyatseng

This site has high electrification, and tarred main roads (secondary lanes between houses are gravel) This site is more than 100km from a city.

Water is supplied mostly to taps in the yard, and only 14% have reticulation in the house.

Inhabitants are poor, earning only 1.5 times the national average per house.
Ownership of water geysers is very low, and just over half own a television set.

Three quarters of the inhabitants own thier dwellings, and built area of the houses is of the order of $50M^2$.

There are a wide variety of building materials in use. About half of the roofs are either asbestos or tin, and walls are chiefly brick or concrete-block, (30-40%) followed by tin (17%).

Use of alternative fuels is high , and this appears to be part of the lifestyle. This site can get very cold in winter.

5.2 Socio-demographic analysis of Manyatseng

1 TOWNSHIP DETAILS:

Township Number	27
Stands percentage	100%
Number of homes	4000
Average rainfall	400mm
Minimum temperature	-9 degrees C
Tarred roads	
Distance to nearest city	138km

2 DATABASE DETAILS:

Loggers uploaded	19
Total readings taken	1 488
	151
Size	51 120kB

3 OCUPANT/DWELLING DESCRIPTION

3.1 Per Household criteria	Mean	Median	Std. dev	Min	Max
Household size [people]	4.516	4	6.182	1	10
Monthly income [R]	1504	700	2425	0	11950
Highest education rating	10.03	10	1.995	2	13

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	69.35%
Small business presence	1.61%

3.1.2 Appliance ownership

Stove with oven (3 plate)	4.84%
Stove with oven (4 plate)	11.29%
Hotplate	32.26%
Heater	29.03%
Kettle	50%
Iron	67.74%
Geyser	3.23%
Washing machine	3.23%
Television	66.13%
Lights	93.55%
Fridge/fridge-freezer	37.10%
Freestanding deep freeze	4.84%

3.2 Dwelling description:

3.2.1 Size of housing:	Mean	Median	Std. dev	Min	Max
Rooms	3.452	4	1.512	1	7
Floor area [m^2]	55.33	42	40.13	6	180

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	53.23%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	1.61%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	37.10%
Daub/Mud/Clay	0%
Outstanding roof materials	8.07%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	16.13%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	38.71%
Blocks	29.03%
Plaster	1.61%
Concrete	6.45%
Tiles	0%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	0%
Outstanding Wall materials	8.07%

3.2.4 Water service:

Piped water in the house	14.52%
Tap in yard	77.42%
Communal tap	0%
Water sources outstanding	8.07%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.24 /kWh
Coal	R0.32
Paraffin	R1.5
Gas	R3.61
Wood	R0

4.2 Reported use of alternative fuels:

Coal	56.45%
Paraffin	50%
Gas	22.58%
Wood	33.87%
Charcoal	0%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	Mean	Median	Std. dev	Min	Max
Main switch size [A]	59.68	60	9.08	60	100

5.2 Quality of supply - complaints:

Power failure	6.45%
Lights get dim at night	9.68%
Main switch trips	9.68%

6. Sweetwaters (Pietermaritzberg)

6.1 Site description for Sweetwaters

We are still awaiting the corrected information pack from this site.

The site is within 10 km of a major centre.
Inhabitants are about twice as weathy as the national average, but appear to own their own buildings.
About 36% of the population own a television set, and there are no geysers.
Built-area of the houses is in the region of 50M^2 . Most houses have tin roofs. Most walls are of mud (90%) or concrete block (10%).

Over half the respondents use wood as an alternative fuel.

6.2 Socio-demographic analysis of Sweetwaters

1 TOWNSHIP DETAILS:

Township Number	33
Stands percentage	89%
Number of homes	4344
Average rainfall	750 mm
Minimum temperature	0 degrees C
Tarred roads	
Distance to nearest city	10km

2 DATABASE DETAILS:

Loggers uploaded	19
Total readings taken	4 041 425
Size	149 806kB

3 OCCUPANT/DWELLING DESCRIPTION:

3.1 Per Household criteria	Mean	Median	Std. dev	Min	Max
Household size [people]	6.4	6	10.63	1	19
Monthly income [R]	1563	1300	1942	0	15350
Highest education rating	9.169	11	3.95	0	12

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	100%
Small business presence	2.56%

3.1.2 Appliance ownership

Stove with oven (3 plate)	28.21%
Stove with oven (4 plate)	12.82%
Hotplate	10.26%
Heater	25.64%
Kettle	51.28%
Iron	74.36%
Geyser	0%
Washing machine	0%
Television	35.90%
Lights	89.74%
Fridge/fridge-freezer	53.85%
Freestanding deep freeze	12.82%

3.2 Dwelling description:

3.2.1 Size of housing:	Mean	Median	Std. dev	Min	Max
Rooms	5.07	5	2.17	2	12
Floor area [m^2]	57.04	60	44.35	3	240

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	100%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	0%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	0%
Outstanding roof materials	0%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	2.56%
Blocks	10.26%
Plaster	0%
Concrete	0%
Tiles	0%
Plastic	0%
Asbestos	0%
Daub/Mud/Clay	87.18%
Outstanding Wall materials	0%

3.2.4 Water service:

Piped water in the house	10.26%
Tap in yard	61.54%
Communal tap	15.38%
Water sources outstanding	5.13%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.24/kWh
Coal	R2/kg
Paraffin	R1.5/l
Gas	R2.8/kg
Wood	R0

4.2 Reported use of alternative fuels:

Coal	2.56%
Paraffin	25.64%
Gas	30.77%
Wood	61.54%
Charcoal	0%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	Mean	Median	Std. dev	Min	Max
Main switch size [A]	60	60	0	60	60

5.2 Quality of supply - complaints:

Power failure	0%
Lights get dim at night	7.69%
Main switch trips	100%

7. Umlazi (Durban)

7.1 Site description of Umlazi

This site features high electrification (90%), in an area with 100% tarred roads.
The site is 20km away from a city center.
Inhabitants earn 6 times the national average and are thus relatively wealthy.

Ownership of buildings is high, and 20 % of the time a small business is being run from home.
Most houses have piped water, but geyser ownership is low at 10%. 85% of houses have a TV.

Built area of the houses is about 50M^2, and most houses have asbestos roofs(90%) and brick walls (90%).

The climate is moderate, and only small portion of the sample uses any alternate fuel source (paraffin at 15%)

Consumers are unhappy with their supply.

7.2 Socio-demographic analysis of Umlazi

Sociometric demographics - Umlazi

1 TOWNSHIP DETAILS:

Township Number	32
Stands percentage	90%
Number of homes	4000
Average rainfall	1013mm
Minimum temperature	11 degrees C
Tarred roads	
Distance to nearest city	20km

2 DATABASE DETAILS:

Loggers uploaded	12
Total readings taken	4 502 516
Size	19 384 kB

3 OCCUPANT/DWELLING DESCRIPTION:

3.1 Per Household criteria	Mean	Median	Std. dev	Min	Max
Household size [people]	6.939	6	12.07	1	19
Monthly income [R]	6221	3800	10500	350	27500
Highest education rating	11.58	12	1.415	7	13

3.1.1 General (ownership of dwelling & small business presence)

Ownership of dwelling	84.85%
Small business presence	21.21%

3.1.2 Appliance ownership

Stove with oven (3 plate)	6.06%
Stove with oven (4 plate)	51.52%
Hotplate	45.45%
Heater	21.21%
Kettle	66.67%
Iron	78.79%
Geyser	9.09%
Washing machine	0%
Television	81.82%
Lights	96.97%
Fridge/fridge-freezer	81.82%
Freestanding deep freeze	18.18%

3.2 Dwelling description:

3.2.1 Size of housing:	Mean	Median	Std. dev	Min	Max
Rooms	4.182	4	0.575	4	6
Floor area [m^2]	53.21	50	10.64	50	100

3.2.2 Roof materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	3.03%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	3.03%
Plastic	3.03%
Asbestos	90.91%
Daub/Mud/Clay	0%
Outstanding roof materials	0%

3.2.3 Wall materials:

IBR/Corrugated Iron/Zinc	0%
Thatch/Grass	0%
Wood/Masonite/Board	0%
Brick	93.94%
Blocks	0%
Plaster	0%
Concrete	0%
Tiles	3.03%
Plastic	0%
Asbestos	3.03%
Daub/Mud/Clay	0%
Outstanding Wall materials	0%

3.2.4 Water service:

Piped water in the house	93.94%
Tap in yard	6.06%
Communal tap	0%
Water sources outstanding	0%

4 ALTERNATIVE FUEL SOURCES:

4.1 Local price of alternative fuels:

Electricity	R0.22 /kWh
Coal	R
Paraffin	R1.4
Gas	R4
Wood	R

4.2 Reported use of alternative fuels:

Coal	0%
Paraffin	15.15%
Gas	6.06%
Wood	0%
Charcoal	0%

5 ELECTRICITY SUPPLY:

5.1 Supply capacity:	Mean	Median	Std. dev	Min	Max
Main switch size [A]	79.09	80	5.143	50	80

5.2 Quality of supply - complaints:

Power failure	36.36%
Lights get dim at night	54.55%
Main switch trips	24.24%

APPENDIX C:

SOCIO-DEMOGRAPHIC SURVEY FORMS

PART A
NATIONAL LOAD RESEARCH TRACKING STUDY: 1995

GENERAL TOWNSHIP INFORMATION

1. Name of township where data logging operation is situated..

2. Proportion of stands that are electrified in the immediate area.............%

3. Number of homes in this community (ie township size)...............

4. Climate:
What is the average annual rainfall.........(mm)
What is the lowest temperature reached here this year ?...........

5. Roads: Are most of the roads here gravel or tarred ?...........

6. How far is this township from the nearest city centre ?.................... [km]

7. What price does the consumer pay for electricity here?.................... R/kWh

8. What type/s of metering is/are used here? - tick off where appropriate

Prepayment meter/ready board	
Conventional kWh meter	
Circuit breakers only	
Other (specify).........................	

9. Load limiting.
Is any form of load-limiting in use here?(ie circuit breaker, central geyser control, stove/geyser switching, etc)..................
If so please give details:

8. Price of other fuels:
What is the local price of

Fuel source	**Price per litre, or kg**
Coal	
Paraffin	
Gas	
Wood	
Charcoal	

PART B
NATIONAL LOAD RESEARCH TRACKING STUDY 1995

Respondent:	Interviewer:
Name:...........................M/F	....
Postal address:....................	Backcheck:...
Postal Code:..........	Edit:..
Residential Address:...............	Ext. No:...
Tel:code:........... Number:........................	Stand No:.................

1. DEMOGRAPHIC DETAILS

1.1 Home Language (tick)

English	
Afrikaans	
Zulu	
Xhosa	
N/S Sotho/Tswana	
Other	

1.2 Household size (indicate number of males or females in each category)

	Male	Female
<16		
16 - 24		
25 - 34		
35 - 49		
50 +		

1.3 Working Status (indicate for each individual in the household)

	Head	Spouse	Other adults (>16 yrs)	Children (<16 yrs)
Full time				
Part time				
Unemployed/ Retired / Student				

1.4 Education (indicate highest level achieved by each individual in the household)

	Head	Spouse	Other adults (>16 yrs)	Children (<16 yrs)
No schooling				
Grade 1				
Grade 2				
Standard 1				
Standard 2				
Standard 3				
Standard 4				
Standard 5				
Standard 6				
Standard 7				
Standard 8				
Standard 9				
Matric				
Tertiary				

1.5 Monthly income (indicate for each household member)

	Head	Spouse	Other adults (>16 yrs)	Children (<16 yrs)
R0000 (not earning)				
0-99				
100-199				
200-299				
300-399				
400-499				
500-599				
600-699				
700-799				
800-899				
900-999				
1000-1099				
1100-1199				
1200-1399				
1400-1599				
1600-1999				
2000-2499				
2500-2999				
3000-3999				
4000-4900				
5000-5999				
6000-6999				
7000-7999				
8000-8999				
9000-9999				
10000+				
Refused				
Don't know				

1.6 What sex is the head of this house?

Male	Female

1.7 Do you own or rent the dwelling in which you live?

Own	
Rent	

1.8 Is a business which uses electricity run from this home?

Yes	No

2. CONSTRUCTION OF HOUSE

Interviewer to observe the following:

2.1 What materials are the walls and roof of the main building made of?

Materials	Walls	Roof
IBR/Corrugated iron/Zinc		
Thatch/Grass		
Wood/Masonite/Board		
Brick		
Blocks		
Plaster		
Concrete		
Tiles		
Plastic		
Asbestos		
Daub/Mud/Clay		
Other (Specify)..........		

2.2 What is the total floor area of the main house on this stand?..................(m^2)

2.3 Does the main house have any of the following

	YES	NO
Ceiling		
Insulation		

2.4 How many rooms there are in your main dwelling?...........................rooms

2.5 Where do you get water?(tick)

From piped water in the house	
Tap in yard	
Communal tap	
Other(specify)...............	

3. APPLIANCES AND COOKING HABITS

Your electricity supplier would like to understand electricity consumption patterns of households like yours, and needs to gather information about no. of appliances you use as well as which people are at home.

3.1 Please indicate which of the following appliances you own

Appliance type	No. present
Stove with oven (3 plate)	
Stove with oven (4 plate)	
Hotplate	
Heater	
Kettle	
Iron	
Geyser	
Washing machine	
TV	
Lights	
Fridge or combined fridge/freezer	
Freestanding deep freeze	
Other (specify)	

3.2 Cooking times

Please indicate how many people you cook meals for at these times
(a) on week days, (b) on Saturdays. (c) on Sundays.

(a) Weekdays	Adults (>16 yrs)	Children (<16 yrs)
Breakfast		
Lunch		
Supper		

(b) Saturdays	Adults (>16 yrs)	Children (<16 yrs)
Breakfast		
Lunch		
Supper		

(c) Sundays	Adults (>16 yrs)	Children (<16 yrs)
Breakfast		
Lunch		
Supper		

3.3 Do you use any of these during winter, for cooking or heating?

Fuel	Cooking	Heating
Coal		
Paraffin		
Gas		
Wood		
Charcoal		

4. ELECTRICITY SUPPLY DETAILS

4.1 What is the size of the main switch?.................. (Amps)

4.2 Do you supply any out-buildings with electricity?

Yes	
No	

4.3 How long has this house had electricity?...................Years

4.4 Do you have any of these problems with your electricity?(tick)

Lights get dim at night	
Electricity goes off often	
Main switch trips	

CLOSE INTERVIEW

APPENDIX D:

THE NRS PROJECT
LOAD DATA COLLECTION GUIDE

THE NRS LR PROJECT:

LOAD DATA COLLECTION GUIDE

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June 1996 (1st Revision)

Table of Contents

1. INTRODUCTION

The NRS LR project is a co-ordinated effort amongst municipalities, Universities, and ESKOM to get collect data about poor domestic consumers in order to design electricity supplies for them which are sturdy, but cost effective.

Two types of data are collected:
1. Load data, from multi-channel electronic data-loggers attached to the consumers house-connection
2. Socio-demographic data, about the consumers living in those houses.

This data is collated and analysed together with climate data, by the project manager, who then feeds the data back to the NRS, and the various projects.

This allows the latest design data to be made available to organisations busy with electrification.

This brief guide is intended to give some assistance to all those participating in the NRS 034 National Load Research Programme - let's call it LR for short. In this guide you will find information on
- Why, where, and how load data must be collected
- How the data is to be collated, quality controlled and processed
- How the information will be made available to those taking part in the programme.

A list of contacts is included at the end of this document. If you have any queries, please do not hesitate to contact either the project manager, or one of the project specialists.

2. WHO WILL COORDINATE THE PROJECTS?

It is important for the LR project to be co-ordinated for maximum benefit. If all the load data are collected in the same way it will make it that much easier to compare classes.

This requires some standardisation in both the hardware and software of the data loggers. The demographic parameters of each load class must also be collected in a unified manner.

A dependable data-base must be constantly maintained at a central point. For this reason, a project manager is co-ordinating this project.

See the "who to call" section at the end of this document for important contact information.

3. WHY LOAD DATA IS COLLECTED

Some of you may not be convinced such an exercise is necessary. Here are a few reasons why the collection of residential electrical load data is important to the electricity supply industry.

3.1 Load data for electrical reticulation design

You are probably aware of the national drive to provide electricity to the large portion of our population who do not have this facility. The basic need here is to drive costs down, whilst still meeting the needs of the consumer. These systems can only be economically designed if adequate knowledge of the anticipated loads is known. In the past consumer load parameters have been a matter of guess-work. If we want exacting designs we need good load data on which to base our load estimates.

There are three particular areas in reticulation design that require statistical description of the electrical loads. They are:

- Calculation of voltage drops in feeders,
- Thermal sizing of feeders and transformers
- Calculation of transmission losses.

Voltage drop algorithms have been researched (by the NRS 034 Voltage Drop Task Force) and methods have been identified that use statistical models of the load currents. These methods are superior to the existing deterministic (i.e. non-statistical) methods. However, these statistical methods can only be used if the statistics of the design load parameters are known. And the statistics, in turn, rely on the collection of load data from a variety of representative areas. Research is continuing to find ways of using these load statistics for thermal sizing of conductors (particularly ABC's). A project is also underway to apply the knowledge of annual load shapes to the calculation of feeder losses.

3.2 Load data for formulating Tariffs

Tariffs are also receiving more attention in recent times. Time-of-use tariffs are either being applied in some areas or are under consideration. Suppliers of electricity must know what the load patterns look like when designing tariffs. These data can be supplied from an extensive LR project.

3.3 Load data for Demand Side Management

Although still in its infancy, demand side management, (DSM), i.e. the influence of load behaviour through external means, is becoming important. Strategies are being formulated by which load patterns can be manipulated to the advantage of the supplier and, ultimately, the consumer. On-going load surveys will give much needed input into the solution of the related DSM problems.

4. WHERE SHOULD THE INFORMATION BE COLLECTED?

The greatest need at the moment is for load information about the lower income groups. The focus right now is on low-income, informal and rural consumers, who have an average consumption of less than 250 kWh/month, and who have been electrified for about two years or more.

These load classes should therefore receive priority.

The project may later be expanded to include all the consumer classes. An emerging “middle class” of consumer is perceived to become important in the future.

There are a few issues which require consideration when targeting a community for a load survey. They are mentioned briefly below. The community should be **stable**, **moderately electrified** and be **co-operative** to the project.

4.1 Community Stability

By this we mean the way the community has responded to the supply of electricity. One should establish whether consumers have a record of paying for their supply. Confirmation of this may be obtained from the utility supplying the electrical power. The other question which requires an answer is whether there are illegal connections and the extent of the problem. There are several reasons for extracting this information. A community that has a bad record of payment could view the monitoring of loads in its area with some hostility. There would then be the danger of equipment damage. Demographic data collected from this type of community would also be unreliable because of suspicion from the consumers.

4.2 Extent of electrification

The target community should have a high degree of electrification. There should not be many gaps in connectivity. First-time consumers require a period of adjustment to the use of electrical power. Individual load patterns would be expected to be somewhat erratic for the first two years. So, even if the community is identified as "newly electrified", it should have been operative for at least 24 months before a load survey is done.

4.3 Level of consumption

Since we are initially looking for load models for the lower income groups, the target community should have an average consumption of less than 250 kWh per metered point. This can be established by taking the reading on a check meter and dividing by the number of connected households. Alternatively, if there is no check meter, monthly billing data can be used for this purpose.

4.4 Community co-operation

This is a very important facet of the load survey. Local leadership (civics and/or local authorities, or any other area leadership) should be approached before commencing with load data acquisition. The purpose of the load survey should be explained to these bodies.

5. GETTING STARTED

The process of starting on of these projects is the following:

- Identify a community, method of logging and number of data-loggers required
- Obtain funding
- Secure equipment
- Secure manpower
- Install the hardware, initialise it and document the site
- Down-load data regularly

Refer to the previous section for section of the community.

5.1 Method of logging: Sample selection

Having decided on the community to be monitored attention must be given to the selection of sites for installation of the data loggers.

5.2 Size of project: Number of consumers monitored

Try to monitor a minimum of 70 , but preferably 100 consumers (Error in sampling gets better as the number of samples increase. This number has been chosen for statistical significance).

The number of data loggers required to conduct a statistically significant load survey will depend on the number of channels on the logger.

It will also depend on whether it is possible to employ all the channels at each site. If, for instance, only 4 consumers can be monitored from each pole-mounted installation in a given community, then 25 loggers will be required for a sample size of 100.

5.3 How to select the logging sites

It is recommended that a random systematic method be used.

This is explained below:

1. List all the dwelling stand numbers from the township plans.
2. Divide the number of stands by the number of available loggers (call the resulting number Sl, say.)
3. Select a random starting point, say at stand Sp.
4. Add multiples of Sl to Sp to give the stand numbers at which to site the loggers.
5. Check (4) to ensure that all or most of the data channels can be used at the point under consideration.. If necessary move to one pole forward or backward.

The above process is repeated until all the loggers have been sited. Meticulous attention must now be given to identifying each monitored dwelling with its logger and channel. *See the section on project documentation..*

At this stage you will have a good idea of how many loggers will be required to run the project. Add 10% as a reserve, in case of problems or theft, and secure the funding.

5.4 Budget

Nothing happens without money.

A preliminary budget for a project would look like the following:

ITEM	**COST(R)**
Data loggers for 80+ consumers (depends on connection efficiency)	32 000 - 47 000
Lap-top computer & software '486	5 000 - 8 000
TOTAL CAPITAL COST (once per project)	37 000 - 55 000
Socio-demographic survey per year (If subcontracted externally)	12 000
Maintenance budget (per year, downloading at 1-2 times per month, excluding any analysis)	96 - 192 hours

Since embarking on this project will inevitably lead to lower capital costs, (overdesign may be in the order of 500%), as well as provide better knowledge of the consumer, his quality of supply, and his perception of the above, the cost is justifiable.

Type of logger

Loggers should be able to record voltage and current traces and store these values in memory, for downloading to a personal lap-top computer

Please check with the project manager to see if your type of logger can be accommodated.

Data loggers which can average over 5 minute intervals have been selected.
Our current supplier of preference is ESKOM (TRI 5001).
We have found this locally developed product to be suitable and affordable.

The price of these data loggers is in the region of R 2 350 per unit (500KB RAM), including software, cable, and manual. (See **contacts** at end of document)

5.4.1 Project timing

Experience has shown that the fastest time possible to get one of these projects under way is about 3 months:

- Delivery time on data-loggers is about 6 weeks
- Staff must to be seconded and trained
- Loggers have to be installed
- Start-up problems have to be solved
- The project must be documented
- A system for quality control of data must be established
- Management-control systems must be established

The amount of time necessary to accomplish this must not be underestimated.

5.4.2 Selection of staff

A particular type of person is needed to run this type of project. This person must be :

- Computer literate
- Meticulous (system oriented & organised)
- Motivated & interested.

  The selection of the right type of person is important because a huge mass of data are generated by this type of project, and a little disorganisation can very quickly lead to chaos.

5.5 Installation of hardware, initialisation & documentation

There are several types of logger. Please read the instruction manual to see what it can and can't take.

As a general rule, avoid any arrangements that allow the logger to be exposed to, **Moisture, Heat, Insects, Vandalism & theft**.

There are only two options for mounting of loggers:

- Inside street furniture
- Up a pole

5.5.1 Installation of a logger up a pole

The logger is housed inside a waterproof box out of reach about 9 m above ground. Ensure the pole-box is large enough to accommodate the logger safely.

The box is out of reach and this makes downloading difficult unless a long data cable is made up, and strapped permanently onto the pole, and terminated at head-height in a small pratley box, strapped to the pole. This arrangement means the person doing downloading need not carry a ladder to access the data logger.

The data logger is out of reach of vandals, and weather proofed. Prevent wasps & bees by plugging any external holes.

5.5.2 Installation of a logger in a street furniture

Usually, underground low voltage distribution systems are distributed from a pavement mounted distribution kiosk. These are generally fitted out with consumer circuit-breakers on one side and kWh meters on the other side.

The data logger should be placed in a position where it will not be affected by dampness from the ground. Insects can be problem here so make use of insecticide spray where necessary. It is best to place the logger on the circuit-breaker side.

5.5.3 Initialising the hardware

Read the data logger manual, and practice with the software before going on-site. Set the logger up, once in place, to the following settings:

- Reading averaging time = 300 seconds (5 minutes)
- Clock on the logger synchronised to the PC clock (which has the correct time).
- Logger identity code (ID) set to a unique two-digit number (see data handling later) .

  Write the logger ID onto the outside of the case. This will help with the downloading procedure.

  If the logger software has a diagnostic or monitor mode, use it to confirm the logger is reading the correct current sand voltages!

5.5.4 General tips for dealing with data loggers

Read the manual. Read the manual. Read the manual.

5.5.4.1 Plug-orientation

Be aware that plug orientation is important for some loggers (i.e. which plug in which socket). Labels on the instruments are generally clear with respect to connector details and indicate which is the voltage input. Make sure that connections are done correctly, otherwise it could lead to internal hardware damage!

5.5.4.2 Data transfer cables

The serial data transfer cables are not standard things. A lap-link-cable may not work. If extension cables are made, ensure they are pin-copies of the original. Read the manual.

5.5.4.3 Finger problems

Generally there are finger problems when a project starts out.
They are mostly related to using the downloading software. Practice before going into the field.

5.5.4.4 What to do if the logger refuses to communicate

If the logger is either dead, or has a communications problem.

- Check your serial cable (try another logger).
- Check the communications port on the computer.
- Check the fuse inside the logger (if any).
- Read the manual.

5.5.4.5 Further installation tips

- Make sure that connections are made properly and that screws terminals are tight.
- When conductor insulation material is stripped away for connection purposes, make sure that the screw terminal makes contact with the conductor.
- Remember that the CT's used may be of the "wedding ring" type and connection of the CT will require the conductor to be disconnected from the supply and fed through the centre of the CT. This will require the skill and qualification of a licensed wireman as an electric shock can occur while disconnecting the supply wire.

5.5.5 Documenting the site

During the installation of the loggers, ***it is imperative that the following is noted METICULOUSLY, for each logger in the following manner, typed up neatly, and kept in a safe place:***

Logger ID:	Logger street address:	
Logger channel No.	Erf served by channel	Street Address of Erf
1		
2		
3 etc.		

These tables are essential for record-keeping, and will be referred to repeatedly during the project. Check them to ensure they are right the first time!

Forward a copy of these documents to the project manager immediately after installation.

6. COLLECTION, PROCESSING & QUALITY CONTROL OF DATA

The download process normally involves going to each logger, with a lap-top computer, connecting a communications cable to it, and getting it to pass the stored data to the PC.

During this process, the operator must furnish a file name, manage a large amount of files, and carry out quality control of the data to see if the logger is operating OK.

6.1 Allocation of file names to data

Since a large amount of data is being centralised on the project database, a system must be used to ensure that:

- No two townships can supply different files with the same name
- File origin & age is easily recognised by the filename

Please use the following system for naming of files when downloading:
"Lxx_mmdd.zzz"

Where:
L = letter standing for the nearest major city. (W=Witbank, J= Johannesburg etc.)
xx = unique logger ID code (marked on outside of logger).
_ = underscore (or placeholder if more than 100 loggers).
mm = month of the year(ie June = 06).

dd = day of the month(ie 17th =17).
zzz= file extension automatically given to file by software.

Example: Downloading logger 03 near Johannesburg on 17th June will give J03_0617.

6.2 Quality control of data

Request a copy of the "Dataview" software from the project manager.

This software has been developed specifically to help with quality control of data, and will very quickly allow faulty loggers, power failures etc to be pin-pointed.

Use this software to scan each file which is downloaded and to look for any abnormalities.
As each file is scanned , draw its start and finish dates onto a chart. This will reveal immediately if a logger has been "missed" in the field (it easily happens).

6.3 Transmission of data to project manager

The collected data must be sent to the project manager as soon as possible after it has been retrieved from the field. Electronic mail is preferred, however the postal service is also acceptable.

It is customary to "zip" all of the file form a download onto a "stiffy" disk, keep a copy, and send one to the project manager via post or E-mail.

Please note on the data :

- Where it is from
- When it was downloaded.

7. COLLECTING SOCIO-DEMOGRAPHIC INFORMATION FROM CONSUMERS

Socio-demographic data about the logged consumers is essential for the LR project.

It is being used to relate such parameters as the type of house construction, the climate, family size etc. of the township to the expected electrical loading. The individual consumers who are being logged must supply this information. A special questionnaire has been prepared for this purpose - see parts A and B at the end of this document, as well as the interviewer's guide.

Please check with the project manager to see that you have the latest version of the questionnaire

This section covers advice on how to handle the surveys:

- What preparations must be undertaken.
- How to execute surveys.
  Evaluation and checking of the results.

It is strongly recommended that a professional market-research contractor is used to carry out the surveys. This will save a considerable amount of (start-up and running) time and increase the quality of results. The personnel are generally well-trained, and only need to be briefed.

Check with the project manager to see if central funding has been provided for the MR surveys.

7.1 Preparation phase

During this phase the whole "exercise" must be lined up. Community contact must be made and interviewers must be selected and trained.

7.1.1 Community contacts

If there are community channels, use them to ensure that the survey is supported.
Try not to ask for permission to carry out the survey. This may take a long time to obtain.

7.1.2 Selection & Training

Preparation is crucial to quality of results.

7.1.2.1 Selection

The surveyors should be picked specifically to fit in to the local environment. They should be of the same colour and language group as the sample population. Surveyors should be literate, meticulous, and outgoing.
Choose enough surveyors to work through the community in a day, because foreknowledge in the community can distort results. About fifteen surveyors should be acceptable.

7.1.2.2 Training of interviewers

Plan a training session amongst the surveyors for a couple of days before.

Interviewers must be briefed extremely well so that they know exactly why the interviews need to be done and what each question means. This will enable them to explain the questions if necessary.

Role-playing is an effective method of training, since it gives each surveyor a chance to practice and to be on the receiving end. Surveyors who cannot role-play successfully should not be used on the community.

Completeness of information is important for this questionnaire, and surveyor's should be briefed as to what actions to take in case of refusals, don't-knows and no-one-homes.

7.2 Execution of surveys

During the execution , the supervisor should equip each surveyor with his call list, giving sites to survey. He should manage the process to be finished within a day.

7.3 Evaluation of results & back-checking

Have all forms checked visually by one or two people. There are certain places in the "people" side of the form where the reported number of people in each question-table should be the same. See that they are.

7.4 Security of personnel

In poorer areas, it is not uncommon for interviewers to be assaulted or robbed.
Take a first-aid kit
Staff should be wary of highjackings.

8. FEEDBACK

A feedback session will be arranged (probably in December) each year. At this session the various participants will be able to share their experiences. A report will be issued soon after this. This should be available early in the next year.

9. NRS LOAD RESEARCH PROJECT: CONTACT LIST

(WHO TO CONTACT FOR HELP OR INFORMATION)

During the course of the data collection programme you may want to ask questions. In order to satisfy this need we have set up a contact list. Please do not hesitate to contact the project manager if you have any problems.

Role	Contact person	Telephone	Fax	E-mail
Project administration, file handling, data base and latest analysis	**Mr Marcus Dekenah** 25 Maluti Ave Doringkloof 0157	**012-667-1347** Pager: 011 8042777 code 76803	012-667-1347	mdekenah@pixie.co.za
Project consultant (General)	Mr C T Gaunt	021-4699100	021 245571	tgaunt@hkslg.mhs.compuserve.com
Project consultant (statistics)	Prof JS Maritz	021-808-3240	021 9380310	smaritz@eagle.mrc.ac.za
Project consultant (Research)	Dr R Herman	021-808-4323	021-808-4981	rherman@firga.sun.ac.za
Source: ESKOM data loggers	Mr Pierre Doman	011-629-5005	011-629-5366	--
Senior LR Engineer, ESKOM	Mr Chris Forlee	011-800-3948	011-8005970	chris@edd.eskom.co.za
Load researcher: Manyatseng Project	Mr R fourie	051- 4471636	051-4308316	cv@iafrica.com
Load researcher: Kwazakhele Project	Mr J Westraadt	041-3924139	041343789	--
Load researcher: Sweetwaters Project	Mr D Roblin Mr D Baker	0331-456211	0331-428802	dwayne.baker@pixie.co.za
Load researcher: Mon-Clare project	Mr D Prochassek	011-4907062	0114907590	--
Load researcher: Umgaga project	Dr N Ijumba	031- 8202186	031-8202696	nlijumba@pixie.udw.ac.za
Load researcher: Umlazi project	Mr J Ross	031-3001021	031-3001010	rossjw@elec.durban.gov.za

10. TERMINOLOGY

It will be an advantage if common terminology is used when referring to various aspects of load data collection. Here are a few definitions:-

10.1 Load data.

This refers to the collected electrical load currents drawn by residential consumers, recorded at regular intervals.

10.2 Data loggers.

These are stand alone devices which can be programmed to sample load currents at regular intervals.

10.3 Load samples.

These are the individual load currents stored by the data loggers.

10.4 Coincident logging.

All the loggers within a group survey should be synchronised with one another so that the loads are all sampled at the same time. This is known as coincident logging.

10.5 Sample size.

Sample size refers to the number of consumers monitored in a given area.

10.6 Sampling interval.

Load currents are sampled on a continuous basis by the data loggers at a rate determined by the logger design. This interval is small (about 0,5 seconds).

10.7 Averaging interval.

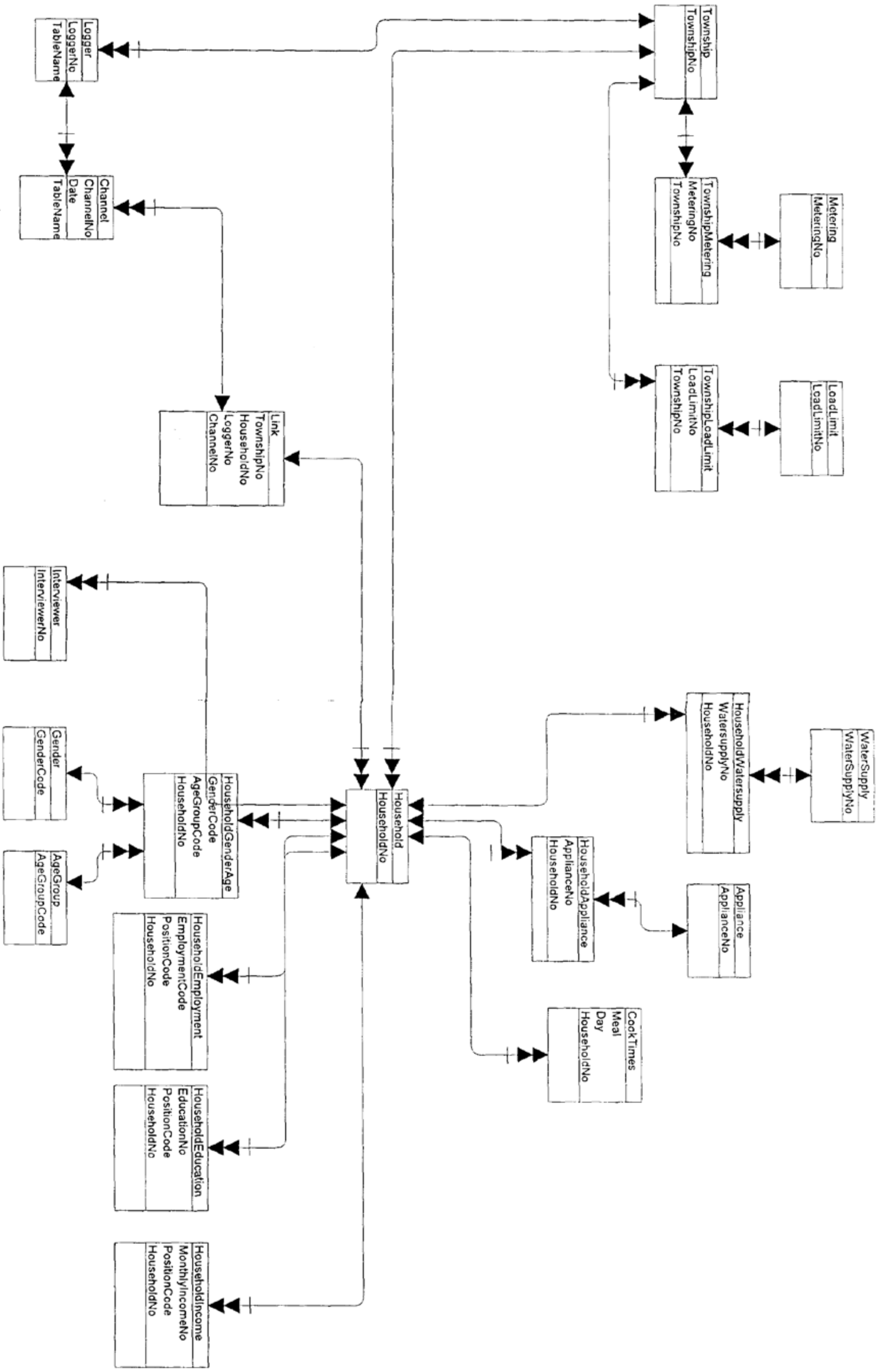
The sampled load currents are averaged over an averaging interval and these averaged values are stored in the memory of the data logger. This averaging interval may be set by the operator (usually from 0,5 minutes to an hour or longer).

10.8 Host computer.

Data are transferred from the memory of a logger to a host computer. This is usually a portable lap-top or "note-book" type of PC which uses a program especially coded for communicating with the logger. Dedicated software is required to perform this operation and will be supplied by the manufacturers of the data loggers. The host computer must have a "real-time-clock" which is set correctly before each data retrieval session. The host computer can also mean a table-top PC which is used for the same purpose but the loggers are then swapped on site and taken to the host computer for data retrieval. This may only be done if the data logger has a non-volatile memory.

10.9 Down-loading data.

This is the process that transfers the recorded load data from a logger to the host computer.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TownshipNo
HouseholdNo
LoggerNo
ChannelNo
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