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Recommendations for small renewable energy and hybrid systems for rural electrification –

Part 2: From requirements to a range of electrification systems

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

RECOMMENDATIONS FOR SMALL RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 2: From requirements to a range of electrification systems

FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-2, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This technical specification is to be used in conjunction with IEC 62257 series.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/302/DTS	82/320/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2. It was developed in cooperation with other IEC technical committees and subcommittees dealing with renewable energies and related matters, namely technical committee 21 ("Secondary cells and batteries"), subcommittee 21A ("Secondary cells and batteries containing alkaline or other non-acid electrolytes"), technical committee 64 ("Electrical installations and protection against electric shock"), technical committee 88 ("Wind turbines"), and others.

This document is based on IEC/PAS 62111(1999); it cancels and replaces the relevant parts of IEC/PAS 62111.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The IEC 62257 series intends to provide to different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting up of renewable energy and hybrid systems with AC voltage below 500 V, DC voltage below 50 V and power below 50 kVA.

These documents are recommendations:

a) to choose the right system for the right place,

b) to design the system,

c) to operate and maintain the system.

These documents are focused only on rural electrification concentrating on but not specific to developing countries. They shall not be considered as all inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms development at this time (CO_2 emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems and at the lowest life cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application that is: small renewable energy and hybrid off-grid systems.

The purpose of this part of the IEC 62257 series is to propose a range of renewable energy based electrification systems able to meet the requirements of customers identified in the field of decentralized rural electrification projects.

RECOMMENDATIONS FOR SMALL RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 2: From requirements to a range of electrification systems

1 Scope

The scope of this part of the IEC 62257 series is to propose a methodological approach for the setting up and carrying out of socio-economic studies as part of the framework of decentralized rural electrification projects. It is addressed to project teams and in particular to experts in charge of socio-economic studies in international projects.

The amount of detail gathered and the requisite number of experts needed would depend on the scale of the proposed project. For large projects involving many households, a detailed study would be required, for a project which involves a single or few households, the study could be truncated.

The information coming from such preliminary studies could be used for several purposes, such as more complete economic and financial studies of the electrification project.

This part of IEC 62257 also provides some structures as technical solutions that could be recommended, depending on the qualitative and quantitative energy demands, consistent with the needs and financial situation of the customers.

Then, in relation with each model of the proposed range of systems, electrical architectures are proposed to technical project managers to assist in designing the systems.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60617 (all parts)[DB][1], *Graphical symbols for diagrams*

IEC 62257-1, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 1: General introduction to rural electrification*

IEC 62257-3, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 3: Project development and management* [2]

IEC 62257-4, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 4: System selection and design* [2]

IEC 62257-5, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 5: Safety rules* [2]

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1 "DB" refers to the IEC on-line database.

2 Under consideration.

IEC 62257-6, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement* [2]

IEC 62257-7, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7: Technical specifications: generators* [2]

IEC 62257-8, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 8: Technical specifications: batteries and converters* [2]

IEC 62257-9, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9: Technical specifications: integrated systems* [2]

IEC 62257-10, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 10: Technical specifications: energy manager* [2]

IEC 62257-11, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 11: Technical specifications: considerations for grid connection* [2]

IEC 62257-12, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 12: Other topics* [2]

3 Terms and definitions

For the purposes of this part of the IEC 62257 series, the following terms and definitions apply.

3.1
REN
renewable energy

3.2
hybrid system
multi-sources system with at least two kinds of technologies

3.3
dispatchable power system
source, generator, system is dispatchable if delivered power is available at any specified time (for example, a genset is a dispatchable system, REN generator is usually a non dispatchable power system)

3.4
non dispatchable power system
a non dispatchable system is resource dependent; power might not be available at a specified time

3.5
storage
storage of energy produced by one of the generators of the system and which can be reconverted through the system to electricity

3.6
micropower plant
power plant that produces less than 50 kVA through the use of a single resource or hybrid system

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2 Under consideration.

3.7
microgrid
grid that transfers a capacity level less than 50 kVA and powered by a micropower plant

3.8
Individual Electrification System
IES
micropower plant system that supplies electricity to one consumption point usually with a single energy resource point

3.9
Collective Electrification System
CES
micropower plant and microgrid that supplies electricity to multiple consumption points using a single or multiple energy resource points

3.10
isolated site
electric characteristic to define a specific location not currently connected to a national/regional grid

3.11
remote site/area
geographic characteristic to define a specific location far from developed infrastructures, specifically energy distribution

4 Methodology for non technical preliminary studies

4.1 Place and role of preliminary studies in a decentralized rural electrification project

It is strongly recommended that it is unwise to launch an electrification project against the wishes of the local institutions and populations. A good understanding of the needs and wishes of the local populations is recommended, to know what is their demand, their capacity and willingness to pay for a modern energy service.

If all the socio-economic data are available, they have to be properly collected and processed for this purpose.

If not, a preliminary study is recommended that will be the first stage in the establishment of a feasibility study for a decentralized rural electrification project. Its role is to allow a better understanding of the areas concerned by the various project experts and such a study would make available some of the data needed for technical evaluations, economic, financial and legal analyses, and for the carrying out of the project in general.

In this Clause, a method is suggested to obtain the various information needed.

Some of the information described in the following section might be obtained from governmental organizations prior to specific sites visits.

4.2 Specifications of the preliminary study

4.2.1 General

A socio-economic study shall provide a certain amount of data to the experts in charge of the financial, techno-economic and organizational studies. It also allows a better understanding of the global environment of the project and can provide information to the community about the scope of the project.

The following subclauses suggest some considerations concerning data to be collected and analyzed in consideration with:

- general information on the environment of the project,
- techno economic study,
- organizational study,
- financial analysis.

Figure 1 is an illustration of the main topics that should be investigated in the socio-economic study.

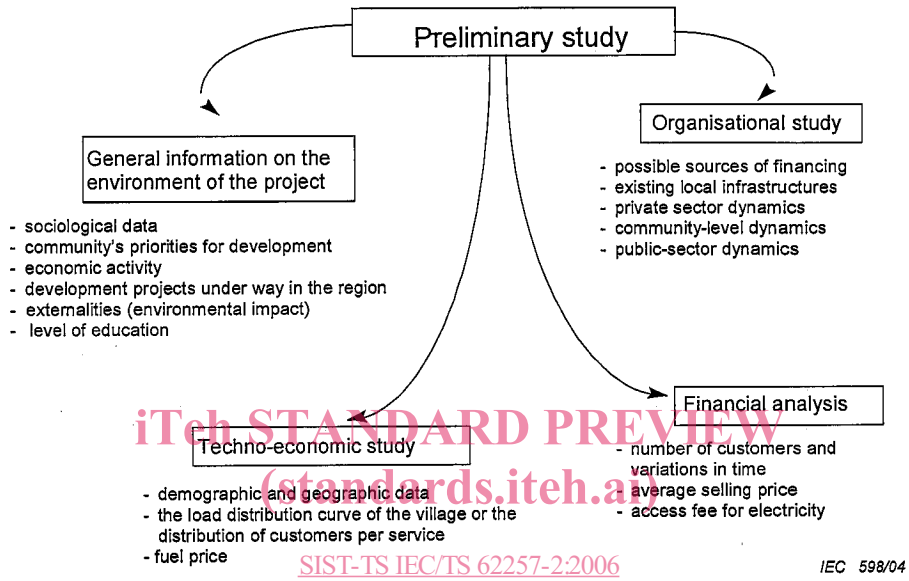

Figure 1 – Example of the content of a non technical preliminary study

4.2.2 General data for a better understanding of the project environment

The following topics should be considered by project contractors. It's their role to determine the relevant importance of each of these categories in regard to a specific project or programme.

4.2.2.1 Sociological data

This data is important for an understanding of the local population. It is essential to look at the organizational, cultural and ethnological structures of the society. In particular, one should investigate the way of life, the sanitary conditions, the national and local languages, the level of education and literacy, the technical sophistication level and the presence of organizations and associations. In addition, the role of male and female in the social organization of the village shall be taken into account.

4.2.2.2 The communities' priorities for development

It is important to understand the population's opinions of their village. What are their priorities for improvement in their daily life? (Such as water pumping, construction of a hospital, of a school, communications infrastructure, electricity, etc.).

In the case of a rural electrification project, what are the priorities for the village as expressed by the population and the local authorities?

4.2.2.3 Economic activities and possible development

Knowledge of the economic activities in the community allows a better general understanding of the environment of the project; it also helps in understanding the dynamics of local development, in order to evaluate the evolution of demand in energy in the coming years.

One can compile the economic activities of the village (commerce, handicrafts, animal husbandry, agriculture, etc.) and look at their relative importance. It would also be useful to look at potential activities due to electricity.

4.2.2.4 The development projects under way in the region

One should look at the local development projects under way, who are the instigators and who are the beneficiaries, what are the impacts on the population, and what would be the impacts on a future electrification project.

4.2.2.5 Environmental considerations

One of the clear drivers in the use of renewable technology is the favorable impact of these systems on the environment as compared to the conventional sources, primarily diesel and grid extension. The impact of any technology choice on the environment, from a carbon, plant footprint, noise and visual impact should be assessed. Understanding the desires of the local participants will be important in this endeavor.

4.2.3 Necessary data for the techno-economic study

Although this information is not strictly in the domain of the socio-economic expert, it shall be collected in the initial phases of any analysis as it is essential to the techno-economic study. The socio-economic expert is therefore asked to collect this data, being usually the first project person to visit a rural community.

4.2.3.1 Geographic and demographic data

In particular one shall obtain the geographical coordinates of the village, its topography, local fauna, and the geographical distribution of the inhabitants. The geographic layout of the community is important because it impacts the economics of meeting the power requirements for the community. If the community is widely dispersed, the cost of a local distribution network may be prohibitive, at which point individual home systems or small cluster systems may be the most cost-effective solutions. The analysis will require specification of the location, power, and energy requirements of each load. It is also important to obtain an understanding of the acceptance of different qualities of service that these electrification options offer. If possible, one should collect data on the climate, local natural resources, site transportation issues and other important sighting issues such as land ownership and right of way issues.

4.2.3.2 Human resources

The personnel resources available in the community, region and country shall be considered when conducting an analysis for renewable based power systems. The infrastructure required for the project installation, long term operation, and system maintenance shall be in place to insure its long-term sustainability. In most cases, a multi layer infrastructure is required, a local system operator who is able to address short term incidents, a regional service center capable of conducting system repair and component assessment and a country or globally regional center that can provide timely replacement of major components and detailed service. Without a specified institutional framework, it will be impossible to provide a quality level of service at a cost that can be sustainable over the life of the project. The whole infrastructure framework relies on people with the right level of training and equipment to perform their specified tasks in the right geographic area with enough systems to guarantee a successful business model. If the infrastructure is not currently in place, care shall be taken to investigate whether the resources are available to create one.

4.2.3.3 Energy, resources assessments

Data on the local (renewable) energy sources such as wind, insulation, biomass and hydraulic potential should be collected. If a sufficient amount of reliable data is not available, the project should be postponed until the necessary data have been collected. For wind and solar energy, a measurement program may be necessary. For wind measurements, a duration of at least one full year or the ability to comfortably correlate the data to other long-term data collection sites, is recommended. Information on the daily or seasonal resource pattern is also important in the assessment of the available resource. Modern site assessment techniques should be utilized to establish the best possible prediction of the resource and the energy production potential, including the use of resource assessment modeling techniques such as the Wind Atlas Analysis and Application Program (WASP) Riso National Laboratories, Denmark; MesoMap, True Wind Solutions, United States; and the Wind Resource Assessment and Mapping System (WRAMS), National renewable Energy Laboratory, United States. This data can then be used in performance simulation models such as RAPSIM, Australia; RETScreen, Canada; HOMER, Hybrid2, PVSYST, and Wattsun, United States. At locations without electric service, it will also be important to obtain an assessment of all of the electrification options for the community or dwelling in question. This would include information like the distance to any existing distribution network and the cost of diesel fuel transported to the site.

4.2.3.4 Environmental conditions, climate

Data on the local environment and climate should be collected. For warm climates with high temperatures, humidity and possibly corrosive environments may influence design criteria, choice of material and systems layout. For cold climates with low temperatures, icing and again possible corrosive environment may, in different ways, influence design criteria, choice of material, systems layout and performance. Altitude may also be an important parameter. Local conditions may also influence transport, installation and access to the site as well as operation and maintenance costs. Extreme conditions such as earthquakes, floods and hurricanes may influence design criteria and expected systems lifetime. Data on all these matters should be collected and, if possible considered in relation to any national and/or international standard.

4.2.3.5 Existing energy supply

The structure of the existing energy supply in terms of fuel, gas, wood, candles and other sources should be mapped with respect to sources, amounts, availability and costs. Existing infrastructure in terms of power plants, fuel storage and distribution lines should be listed and specified in considerable detail. Costs and metering principles should be accounted for, and subsidies, if any, on the existing energy supply should be accounted for. Special care should be taken in the determination the real cost of diesel fuel delivered to an existing diesel power station. The number of hours of service per day and the customer's impression of the level of service are important factors to consider for any existing power stations.

4.2.3.6 Present and future consumer demands

The expected loads in a community, as well as the projected growth, or reduction, of those loads will impact the specification and configuration of the hybrid system. Determining the initial loads and the growth projections can be very difficult, and is often based on historical values for similar situations. It is very clear that the load and projected growth have a clear relation to system design and the life-cycle cost of energy for systems providing various levels of service. The quality of the electric service, the number of hours per day the system is expected to operate, and whether there are large inductive loads, such as motors, need to be considered. Investigation should also be made into areas of potential power use, for example animal driven agricultural water pumps that could be electrified or grain drying operations that could be converted to biogas.

4.2.4 Necessary data for the financial analysis

The financial expert needs a number of data to make his analysis, and the socio-economic expert shall provide them. For the financial analysis, one shall know the following: