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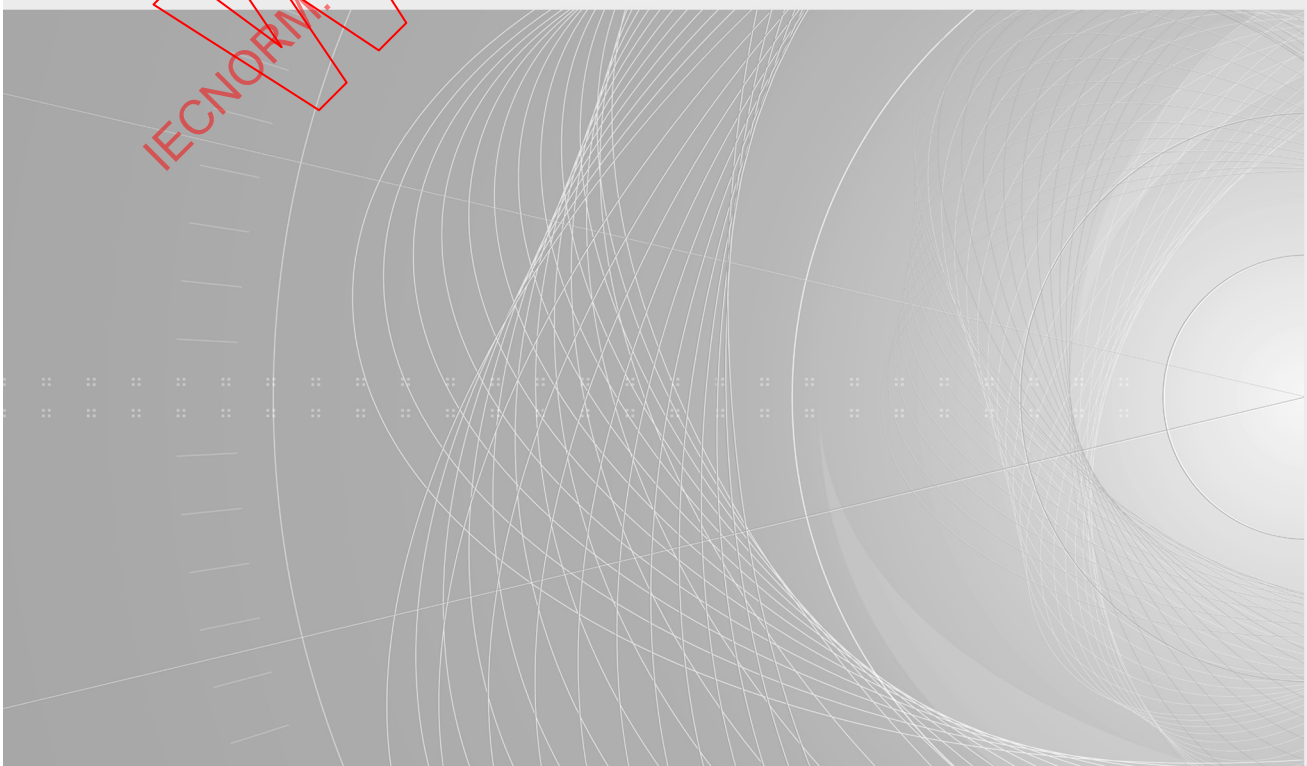
TECHNICAL SPECIFICATION

Recommendations for small renewable energy and hybrid systems for rural electrification –
Part 1: General introduction to rural electrification



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CONTENTS

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

Part 1: General introduction to rural electrification

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 62257-1, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. 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; it cancels and replaces the relevant parts of IEC/PAS 62111.

This technical specification shall be used in conjunction with the other documents of the IEC 62257 series.

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

Enquiry draft	Report on voting
82/300/DTS	82/318/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.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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- withdrawn;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

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

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

Rural electrification is one of the predominant policy actions designed to increase the well-being of rural populations together with improved healthcare, education, personal advancement and economical development.

The present document introduces general considerations on rural electrification and the IEC 62257 series. This series intends to provide to different players involved in rural electrification projects documents for the setting up of low voltage renewable energy and hybrid systems.

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

Part 1: General introduction to rural electrification

1 Scope and overview

Rural electrification is one of the predominant policy actions designed to increase the well being of rural populations together with improved healthcare, education, personal advancement and economical development. Rural electrification can be completed through connection to a national or regional electrification grid. This document applies to cases where the grid is too far away (too costly) or the individual demand centres are too small to make grid access economic, where autonomous power systems may be used to supply these services.

This series of documents intends to provide to different players involved in rural electrification projects (such as project developers, project implementers, 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 must 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.

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 62257-2, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 2: From requirements of users to a range of electrification systems* [1]

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

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[1] To be published.

[2] Under consideration.

IEC 62257-4, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 4: System selection and design* [3]

IEC 62257-5, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 5: Safety rules* [3]

IEC 62257-6, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement* [3]

IEC 62257-7, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7: Technical specifications: generators* [3]

IEC 62257-8, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 8: Technical specifications: batteries and converters* [3]

IEC 62257-9, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9: Technical specifications: integrated systems* [3]

IEC 62257-10, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 10: Technical specifications: energy manager* [3]

IEC 62257-11, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 11: Technical specifications: considerations for grid connection* [3]

IEC 62257-12, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 12: Other topics* [3]

3 Terms, definitions and abbreviations

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

3.1
REN
renewable energy

3.2
hybrid system
multi-sources system

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 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] Under consideration.

3.5
storage
storage of energy produced by one of the generator 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

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

4 Rural electrification: which solution to choose?

When developing a policy of electrification for a given country or region, there is a requirement to envision the target situation in the medium term (10 years) and long term (20 to 30 years). This means that a "master plan" for electrifying the country or this region should preferably be constructed in order to define the lowest life cycle cost solution. Essentially, this master plan must take into account both grid extension and autonomous systems solutions.

The master plan should allow selection between two modes of electrification (national/regional grids or decentralized system) and also, to determine the most suitable time frame to execute the work. Regarding the decentralized part, each village needs to be investigated to obtain a variety of sociological, economical and geophysical data. With this approach, the demand needs can be assessed for each village. This assessment should include possible changes in the power requirements as a function of the future economical development for each village. The urban development and the demographic characteristics of each village are also important to determine the best electrification solution and to assess the amount of capital investment needed.

Electrification can be achieved by installing decentralized systems if at some points the community can be (economically) interconnected. Provision can also be made for the integration or relocation of such systems. Obviously, the solution of using both a local (grid) and dispersed RE sources generation may be appropriate.

Geographical Information Systems (GIS) are readily available off-the-shelf today and allow a beneficial and useful graphical presentation of the master plan. In such a representation, each village can be identified on an appropriate map with color codes depicting the corresponding type of power supply.

Furthermore in such a master plan, villages can be prioritized for further scheduling of the electrification work on a yearly or 5 year basis. In this process, the cost effectiveness of the electrification per village would be taken as one of the most significant prioritizing criteria.

This criterion is less important in the developed world but is critical in developing countries. Simulations can also be made by varying all the relevant parameters to allow a comprehensive financial analysis of the selected system. Figure 1 is an illustration of electrification progress following such a master plan methodology.

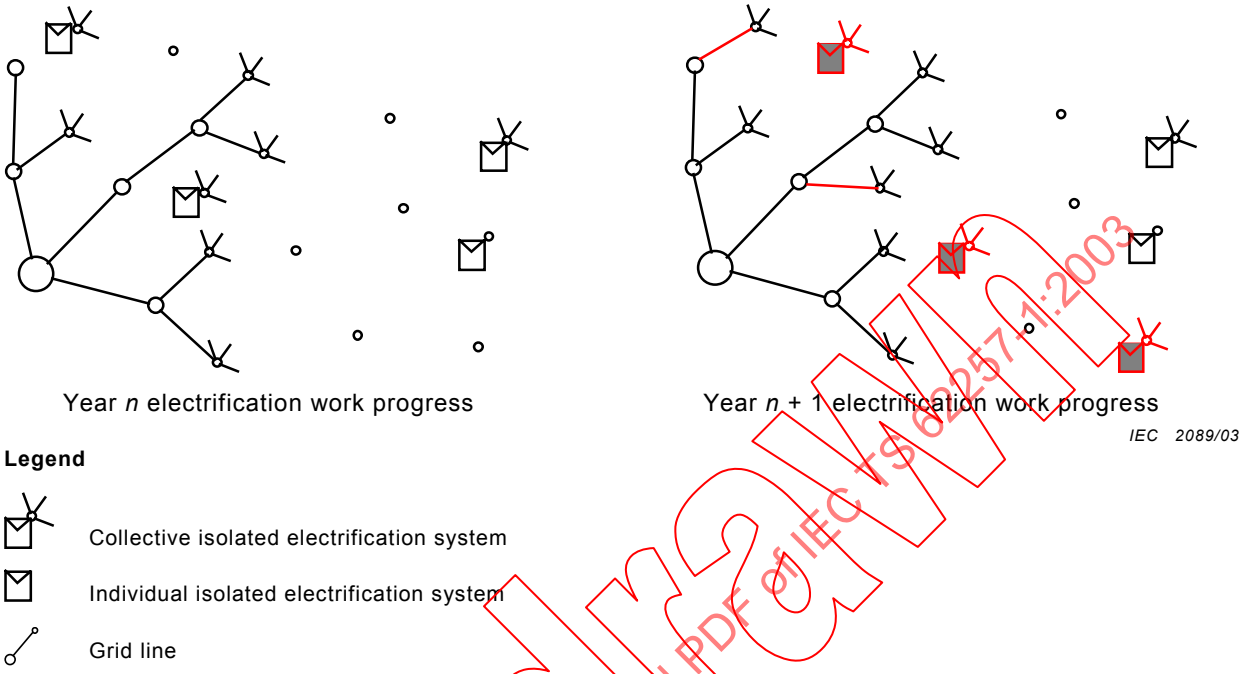

Figure 1 – Example of electrification progress following a master plan methodology

5 Decentralized electrification requires a range of systems

Rural electrification using decentralized systems are designed to supply power to demand points located in rural areas that cannot be easily (economically) connected to national grids.

In most cases, these consumption points would consist of the following types of demand:

- specific processes (for example public pumping, battery charging center),
- isolated homes,
- collective facilities (for example public lighting, schools, health and care center, places of worship, administrative buildings, etc.),
- business activities (for example workshop, micro industry, trade, etc.).

The decentralized system solution can have two basic topologies: Collective Electrification Systems (CES) which supply electricity to multiple consumption points using a single (or multiple energy resource points) and Individual Electrification Systems (IES) which supply electricity to one consumption point (usually with a single energy resource point).

CES systems may be appropriate for rural, relatively highly populated areas, for example, large villages whereas the IES may be appropriate for more sparsely populated regions and (or) isolated households.

Individual Electrification Systems (IES) for single users would incorporate two subsystems:

- one electrical power production subsystem,
- one subsystem for utilizing this electrical power.

Collective Electrification Systems (CES) for multiple users on the other hand would incorporate three subsystems:

- an electrical power production subsystem,

  by convention, this part is designated “micropower plant” where ‘micro’ refers to a modest production power level (from a few kVA to a few tens kVA),

- a secondary grid for sharing/distributing this power,

  by convention, this part is designated “microgrid” where the prefix ‘micro’ refers to a modest transit capacity level,

- one demand subsystem including the in house wiring and user’s electrical appliances.

The decision whether to utilize a CES or IES can be decided upon by looking at the two technological solutions and calculating the discounted costs. Such an analysis, however, must take into account the pertinent sociological and cultural aspects.

The final decision may also be influenced by other considerations, for example, the daily operating time. Simply designed systems making use of small gensets and a microgrid is required for sharing and distributing power among the users. Typically, gensets often are run for limited periods of time during the day, for example between 7 p.m. and 10 p.m.

The use of hybrid micropower plants can allow for a better reliability of the supply. Power is produced by renewable energy sources when available and stored in batteries. Power can be made available to the microgrid during a greater part of the day or even all day. Additional power may be supplied from the genset when renewable energies are insufficient.

In many developing countries, there is often a very low demand of electricity in rural households and a concurrent limited capacity for payment. The individual users requirements typically range between a few tens and a few thousands Wh/day. In developed countries, energy requirements may be larger as is the expected quality of service.

With very scattered houses, the IES solution may be the obvious choice. If the individual electricity demand is low, the cost of such small systems can also be relatively low – provided the systems can be produced in large quantities. Table 1 shows some of the advantages and disadvantages of collective and individual systems.

Table 1 – Some advantages and disadvantages of the proposed single and multiple user systems

	Advantages	Disadvantages
Individual Electrification Systems (IES)	• Power consumption is user managed. Consumption will be user determined from one day to another. • Systems failures imply just only one user. • Systems can be exchanged and returned to manufacturer.	• In case of inadequate management of the power, the user will be self impaired. • Failures. • Monitoring individual systems can be expensive and difficult. • Maintenance and repair service are not commonly organized in rural areas especially in developing countries.
Collective Electrification Systems (CES)	• Power saving can be practiced (possibly) using improved management tools without impairing the reliability of power supply. • Telemetry can be economic for monitoring system status.	• No possibility exists of exceeding the subscribed credit of power (assuming an automatic cut off?). • If the central system fails, everybody is cut off. • Systems generally need to be serviced on site.