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TECHNICAL SPECIFICATION

colour inside

Recommendations for renewable energy and hybrid systems for rural electrification –
Part 1: General introduction to IEC 62257 series and rural electrification

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Part 1: General introduction to IEC 62257 series and rural electrification

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- 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 IEC technical committee 21 (Secondary cells and batteries), subcommittee

21A (Secondary cells and batteries containing alkaline or other non-acid electrolytes), IEC technical committee 64 (Electrical installations and protection against electric shock), IEC technical committee 88 (Wind turbines).

This third edition cancels and replaces the second edition issued in 2013. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

– Redefine the maximum AC voltage from 500 Va.c. to 1 000 Va.c., the maximum DC voltage from 750 Vd.c. to 1 500 Vd.c. and removal of the limitation of 100 kVA system size. Hence the removal of the word "small" in the title and related references in this technical specification.

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
82/942/DTS	82/979/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.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version 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 document 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 access to clean water, improved healthcare, education, personal advancement and economic development.

Several strategies can be adopted to implement rural electrification. Rural electrification can be completed through connection to a national or regional electrification grid. The IEC 62257 series 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 IEC 62257 provides technical specifications to different players involved in rural electrification projects (such as project developers, project implementers, installers, etc.) for the setting up of renewable energy and hybrid systems with AC voltage below 1 000 Vac and DC voltage below 1 500 Vdc.

These specifications are recommendations:

a) to choose the right system for the right place,
b) to design the system,
c) to operate and maintain the system.

The specifications focus on rural electrification concentrating on, but not specific to, developing countries. They must not be considered as all inclusive to rural electrification. That means that they could be used for rural electrification or electrification of remote sites in developed countries also. They try to promote the use of renewable energies in rural areas, but 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: renewable energy and hybrid off-grid systems.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 1: General introduction to IEC 62257 series and rural electrification

1 Scope

This part of IEC 62257 first introduces a methodology for implementing rural electrification using autonomous hybrid renewable energy systems.

Secondly, it provides a guide for facilitating the reading and the use of the IEC 62257 series for setting up decentralized rural electrification in developing countries or in developed countries, the only difference being the level of quality of service and the needed quantity of energy that the customer can afford.

The IEC 62257 series is designed as follows:

- Parts 2 to 6 are methodological supports for the management and implementation of projects.
- Parts 7 to 12 are technical specifications for individual or collective systems and associated components.

2 Normative references

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

IEC TS 62257-2:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 2: From requirements to a range of electrification systems*

IEC TS 62257-3:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 3: Project development and management*

IEC TS 62257-4:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 4: System selection and design*

IEC TS 62257-5:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards*

IEC TS 62257-6:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement*

IEC TS 62257-7, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 7: Generators*

IEC TS 62257-7-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic arrays*

IEC TS 62257-7-3, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 7-3: Generator set – Selection of generator sets for rural electrification systems*

IEC TS 62257-8-1:2007, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 8-1: Selection of batteries and battery management systems for stand-alone electrification systems – Specific case of automotive flooded lead-acid batteries available in developing countries*

IEC TS 62257-9-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-1: Micropower systems*

IEC TS 62257-9-2, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-2: Microgrids*

IEC TS 62257-9-3, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-3: Integrated system – User interface*

IEC TS 62257-9-4, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-4: Integrated system – User installation*

IEC TS 62257-9-5, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-5: Integrated system – Selection of stand-alone lighting kits for rural electrification*

IEC TS 62257-9-6:2008, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-6: Integrated system – Selection of Photovoltaic Individual Electrification Systems (PV-IES)*

IEC TS 62257-12-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Selection of self-ballasted lamps (CFL) for rural electrification systems and recommendations for household lighting equipment*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply. The main glossary used in the IEC 62257 series is given in Annex A.

3.1
Collective Electrification System
CES
micropower plant and microgrid that supplies electricity to multiple consumption points using a single or multiple energy resource points

3.2
GS
general specification

3.3
hybrid system
multi-energy sources system

3.4
Individual Electrification System
IES
micropower plant system that supplies electricity to one consumption point usually with a single energy resource point

3.5
micropower plant
power plant that produces less than 50 kVA through the use of a single resource or hybrid system

3.6
microgrid
grid that transfers a capacity level less than 50 kVA and powered by a micropower plant

3.7
RE
renewable energy

4 Methodology for rural electrification using hybrid renewable energy systems

4.1 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 shall 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 economic 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 colour 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.

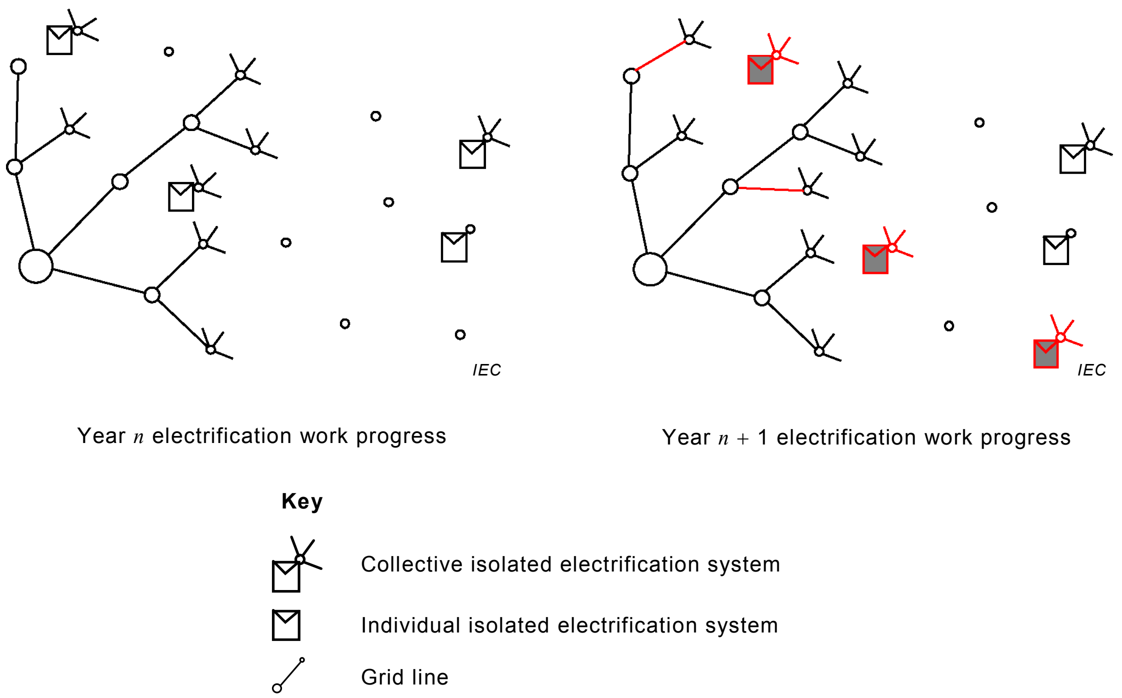

Figure 1 – Example of electrification progress following a master plan methodology

In the same way, the best strategy shall be determined for electrifying a village or a small town, according to its topography. Figure 2 shows a village with a densely populated core and a sparsely populated peripheral zone.

The economic calculation shows that the most economical solution is to electrify the centre of the village with Collective Electrification Systems (micropower stations and microgrids) and to electrify the peripheral zone with IES (Individual Electrification Systems) as the cost per consumer of the microgrid would be higher than the cost of the IESs in this zone.

This methodology provides the lowest electrification cost per customer.

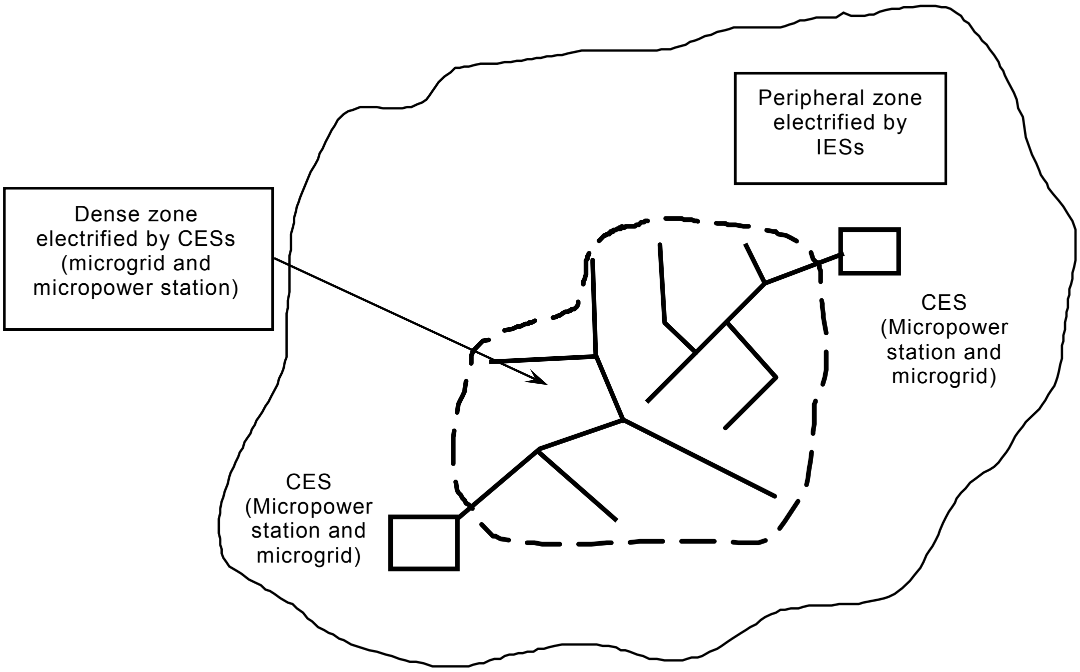

Figure 2 – Example of electrification of a village using both CESs and IESs

4.2 Decentralized electrification requiring a range of systems

Rural electrification using decentralized systems is 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 as “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 as “microgrid” where the prefix ‘micro’ refers to a modest transit capacity level,

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

The decision whether to utilize a CES or IES can be made by looking at the two technological solutions and calculating the discounted costs. Such an analysis, however, shall 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 are 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 gensets 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 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 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.

In both cases the electrical appliances used should be of the low power/energy efficient type, for example high efficiency fluorescent lighting. Using such appliances can be a drawback because this type of equipment can cost more than standard electrical appliances. For example, low consumption lighting is still considerably more expensive than tungsten incandescent lamps.

The use of low consumption or efficient loads should be compulsory in these projects. This means that supply of the demand items, as far as possible, may be best included as part of