

TECHNICAL SPECIFICATION

**Recommendations for renewable energy and hybrid systems for rural
electrification –
Part 2: From requirements to a range of electrification systems**

IEC TS 62257-2:2015

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RECOMMENDATIONS FOR RENEWABLE ENERGY
AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –****Part 2: From requirements to a range of electrification systems**

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

This second edition cancels and replaces the first edition issued in 2004. 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 V to 1 000 V, the maximum DC voltage from 750 V to 1 500 V;
- 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 is to 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
82/947/DTS	82/998A/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.

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 1 000 V and DC voltage below 1 500 V.

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 should 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 (CO₂ 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 aiming 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.

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.

This technical specification 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.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 2: From requirements to a range of electrification systems

1 Scope

This part of IEC 62257 proposes 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 technical specification 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 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 60617 DB¹, *Graphical symbols for diagrams*

IEC 62257-9 (all parts), *Recommendations for renewable energy and hybrid systems for rural electrification*

IEC 62257-12 (all parts), *Recommendations for renewable energy and hybrid systems for rural electrification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

¹ "DB" refers to the IEC on-line database, available at <<http://std.iec.ch/iec60617>>

3.1**Renewable Energy****REN**

energy from a source that is not depleted when used

3.2**hybrid system**

multi-sources system with at least two kinds of technologies

3.3**dispatchable power system**

power system is considered dispatchable if delivered power is readily available at any specified time. (e.g. a diesel generator)

3.4**non-dispatchable power system**

power system that is resource dependent and whose power might not be available at a specified time (e.g. solar grid connected system)

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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3.7**microgrid**

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

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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 subclauses might be obtained from governmental organizations prior to specific sites visits.

4.2 Specifications of the preliminary study

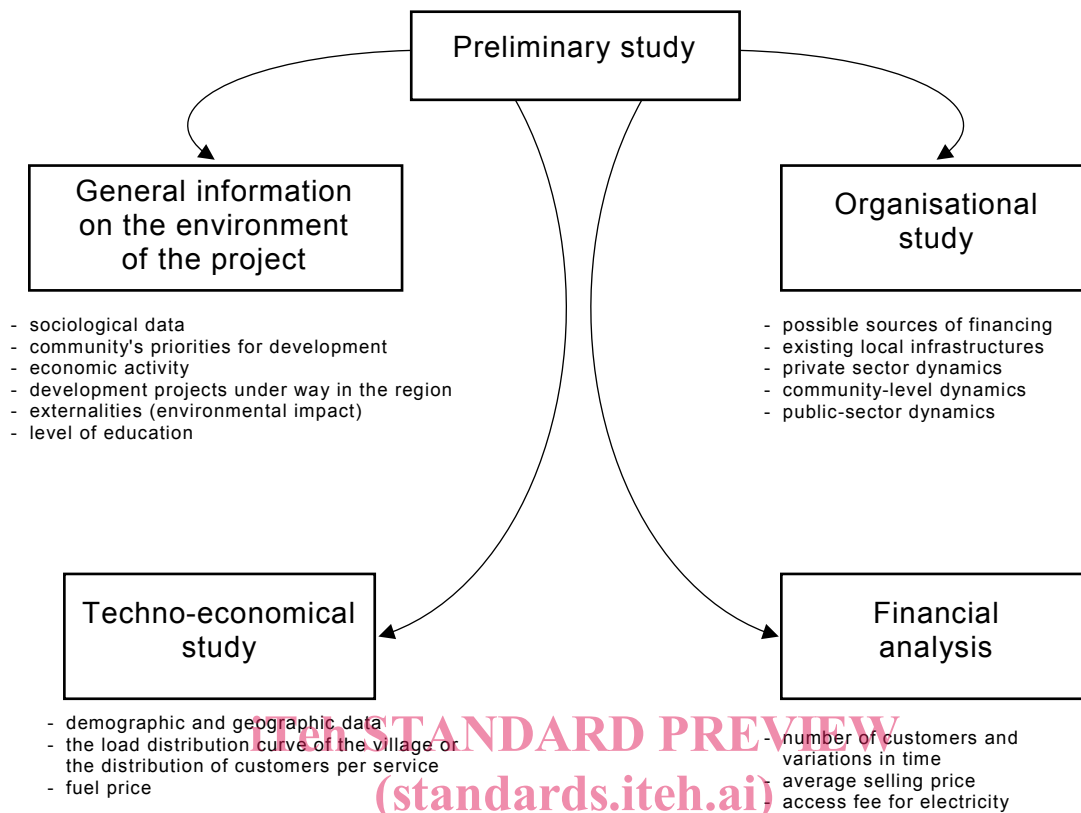
4.2.1 General

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 analysed in consideration with the following criteria:

- 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.



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

4.2.2 Data for a better understanding of the project environment

4.2.2.1 General

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

4.2.2.2 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.

4.2.2.3 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?

4.2.2.4 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.

4.2.2.5 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 the impacts on the population are, and what would be the impacts on a future electrification project.

4.2.2.6 Environmental considerations

One of the clear drivers in the use of renewable technology is the favourable 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 endeavour.

4.2.3 Necessary data for the techno-economic study

4.2.3.1 General

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.

4.2.3.2 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.

4.2.3.3 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 centre capable of conducting system repair and component assessment and a country or globally regional centre 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.

4.2.3.4 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 modelling 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 States².

This data can then be used in performance simulation models such as RAPSIM, Australia; RETScreen, Canada; HOMER, Hybrid2, PVSYST, and Wattsun, United States². 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.

4.2.3.5 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, snow load 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/typhoons 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.

4.2.3.6 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.

4.2.3.7 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

² This information is given for the convenience of users of this document and does not constitute an endorsement by IEC.