System approach

Introduction

The world-wide awareness and utilisation of solar photovoltaic (PV) energy for industrial applications increases steadily at ca 15% growth a year. As a proven reliable power supply option, PV systems can be used for a large number of applications in remote areas.

The requirements for the systems can differ to a great extent and depending on the nature of the application. In order to provide a reliable cost-effective electrical power supply a system approach with a one-source responsibility is imperative.

State of the art application technology and product compatibility are prerequisites to assure customers of the major advantages of PV**: "*low life cycle costs and high reliability".***

Harsh environmental conditions in the desert or at sea pose special demands on the components of a PV system.

Ease of installation, operation and maintenance are important in remote areas.

The high technical and economical requirements ask for a system approach wherein know-how of all aspects is being combined.

Stand-alone photovoltaic energy systems

A stand-alone PV solar energy system generally consists of:

a) one or more **SOLAR MODULES**
Solar modules convert (sun) light directly into electrical energy. Solar modules are very reliable having an expected lifetime of more than 25 years.

b) **BATTERY (BANK)** for energy storage
The battery is the storage medium for the electrical energy to be used during the night and to cover periods with low or no insolation. In general special lead-acid batteries are used.

c) **CONTROL EQUIPMENT**
The control equipment has several functions. The most important ones are protection of the battery against overcharge and too deep discharge. A good design of the controller is of great importance.

d) **HOUSING**
For the use in harsh/hostile environments special care has to be taken to the housing of the system components (IP rating).

e) **CABLING**
Most stand-alone PV systems are DC-systems operating at a voltage of 12, 24 or 48 Volts. Cabling of low electrical resistance is very important in order to avoid extensive voltage drops.

f) **SUPPORT STRUCTURE**
Solar modules are mounted on a support structure. This structure should be simple, strong, modular and easy to install.

System approach

Competitiveness

Comparison with competing energy systems such as gas, primary cells, diesel generators, Thermo Electric Generators (TEG), wind engines or electricity from the grid should be based on the following characteristics:

- capital costs (hardware and installation)
- operating and maintenance costs (including logistics and disposal)
- system reliability and lifetime
- match of the power supply profile with the load demand
- security and vulnerability
- environmental aspects

Technical aspects (software)

Starting point for the design of a PV system is the provision of the required amount of energy with predetermined reliability. Only in this way PV systems can be sized in the right way.

To carry out system sizing procedures, Tss4U developed its own sizing and simulation computer program. In this program all operational features of the different system components are modelled. To verify its computer program Tss4U regularly carries out experiments in the field where PV systems are monitored under different conditions over a long period of time. The results of these field tests provide the input to further improve the computer models.

Engineering, assembly and installation practices are performed according our high quality standards in order to ensure proper operation whilst keeping maintenance to a minimum and reliability to a maximum. The right match between the system components, including the load, is of paramount importance to compose a system that operates at the lowest possible costs.

Maintenance requirements for PV systems are very low. Normally only once or twice a year a visit to the site is required to check all the system functions, to clean the solar modules and to top up the battery. (only in case a vented or open battery is used).

Proper maintenance will benefit the reliability and the life cycle costs of the PV system.

Technical aspects (hardware)

A) Solar Modules

The solar modules are the least sensitive and most reliable components of the PV system.

They have a long lifetime expectancy i.e. more than 25 years depending on the environmental conditions. The range includes versions, which are especially designed for MARINE environments and for EXPLOSION PROOF requirements.

To withstand harsh marine environments Tss4U provides solar modules with corrosion resistant frames and maritime junction boxes.

To meet the requirements for use in hazardous areas, e.g. offshore platforms, Tss4U PV Systems are ex-proof certified for zone 1 and/or 2, in compliance with the latest IEC and ATEX standards.

B) Batteries

Batteries in PV systems have a limited lifetime. The PV batteries are operated under a daily charge and discharge profile. An optimum recharge is not always possible on a day with no or low insolation.

Our selected PV batteries meet the following requirements:

- Good cycle performance at low to medium daily depth of discharge.
- Capable of operating at partial state of charge for longer periods of time.
- Low self discharge.
- Suitable behavior at extremely high or low temperatures.
- Low maintenance.

Tss4U battery knowledge is based on research, together with a long practical experience of battery behavior under various environmental conditions. This same knowledge has been implemented in our controllers, our “system-sizing concept”, and our system design.

C) Control Equipment

Tss4U provides its own range of charge regulators to ensure optimized operation of the battery. These regulators are characterized by low energy consumption, a high reliability, standard fit with temperature compensation and offer a selection of complementary features.

Temperature compensation of the charge voltage is of crucial importance to maintain maximum battery life. Tss4U controllers are therefore equipped with external temperature sensors that are mounted on the batteries to measure actual battery temperature.

Application

Expertise and know how in system application technology are important in composing a solar power system for successful operation.

The range of tailor made solar power systems that Tss4U staff has been involved with bear witness to a large number of satisfied users.

Remote industrial stand-alone solar power systems are employed in telecommunication, instrumentation, monitoring, security, signaling, navigational aids (maritime and aeronautical), cathodic protection and lighting.

Hardly any other power supply technology can match the exceptional reliability and low maintenance characteristics of solar power supply systems.

As a consequence solar systems are employed as a single power supply on offshore platforms, where systems can be found offshore in the Persian Gulf, off West Africa and in South East Asia.

Telecom repeater stations on mountaintops in Iran, in the deserts of the Middle East and North Africa, in the swampy areas of West Africa and in river valleys in South America are powered by solar power systems.

Solar power systems operate safety control panels and instrumentation equipment on remote onshore and offshore oil/gas wells of O&G opco’s all over the world.

System approach

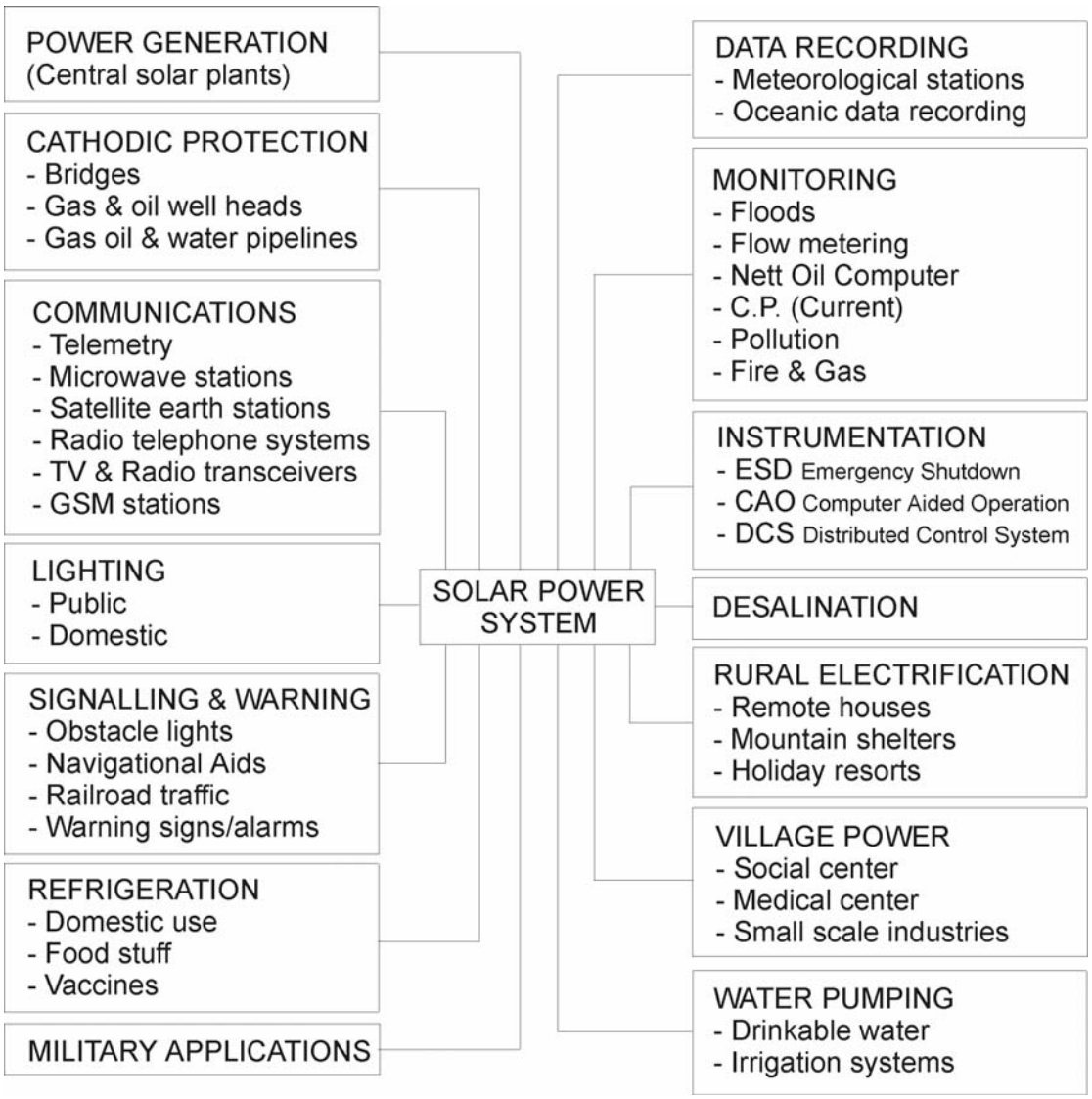
Solar energy is used in systems for light-buoys, beacons and lighthouses in coastal waters all over the world.

Solar energy powers obstacle light systems on HV line transmission towers.

Cathodic protection systems are employed to protect underground metal parts, e.g. pipelines and well casings, from corrosion by running low currents along the metal. Solar power systems provide these low currents in an efficient and reliable way in many “oil & gas countries” all over the world.

Also in existing applications solar power systems can often provide a cost competitive and more reliable alternative to conventional power supplies.

In the Dutch “Lighthouse Authorities' Solar Conversion Program” (non-rechargeable) batteries in light-buoys were replaced by solar systems to reduce costs and to enhance safety. See below graph of applications that can be powered by solar power systems.



Economical aspects

The costs of a PV system comprises of:

- investment costs
- costs of operation and maintenance
- costs of failure

The investment costs depend upon the site requirements and the specifications of the application as well as technical aspects.

The operational costs of a PV system are close to zero. The only costs incurred during the lifetime of a system are minor maintenance costs and battery replacement costs. In practice this maintenance can be performed during the inspection/maintenance visits.

The total costs (initial investment, depreciation, operating costs) are very low for PV systems in terms of ***overall life cycle costs.***

Reliability is an important criterion in the choice of power supply for remote locations.

A failure in any system can be costly. The simple overall design, the absence of moving parts, the direct conversion of energy and no need for fuel, make PV systems highly reliable for use at remote sites and under harsh environmental conditions.

Concluding remarks

The principal value of PV solar energy is the ability to provide a reliable, independent and cost effective electrical power source at those locations where other power supplies cannot be made economically available or lack sufficient reliability.

Tss4U is able to meet customer demands and to design and construct tailor made products and systems.

Tss4U staff has successfully demonstrated its complete "solar power system" concept by state-of-the-art technology and reliable solar energy products.