PHOTOVOLTAIC TRANSPORTABLE MEANS

Ivan KOPECKÝ[1*] - Peter LIPTÁK[2]

[1]*Ing. Ivan Kopecký, PhD., Faculty of Special Technology, Alexander Dubcek University of Trencin, Pri parku 19, 911 06 Trencin, Slovakia*
[2]*doc. Ing. Peter Lipták , CSc., Faculty of Special Technology, Alexander Dubcek University of Trencin, Pri parku 19, 911 06 Trencin, Slovakia*
*Corresponding author E-mail address: ivan.kopecky@tnuni.sk

Abstract
Traditionally, sustainability has been framed in the three-pillar model: Economy, Ecology and Society are all considered to be interconnected and relevant for sustainability. This view subscribes to an understanding where a certain set of actions e.g. substitution of fossil fuels with renewably energy sources can fulfil all three development goals simultaneously. The relationship between renewable energy and sustainability involve both global and regional or local considerations. Implementation of renewable energy –based energy access programs is expanding quite rapidly, but research on the sustainability-related aspects is still quite limited. Photovoltaic (PV) materials and devices convert sunlight into electrical energy. A single PV device is known as a cell. An individual PV cell is usually small, typically producing about 1 or 2 watts of power. To boost the power output of PV cells, they are connected together in chains to form larger units known as modules or panels. Modules can be used individually, or several can be connected to form arrays. One or more arrays is then connected to the electrical grid as part of a complete PV system. Because of this modular structure, PV systems can be built to meet almost any electric power need, small or large.

Keywords: photovoltaic cell, PV systems, solar power,

1 Introduction

Solar power is cheap. The generators promise at least 20 years of low-costs electricity. Solar photovoltaic modules are where the electricity gets generated, but are only one of the many parts in a complete photovoltaic (PV) system. PV modules and arrays are just one part of a PV system. Systems also include mounting structures that point panels toward the sun, along with the components that take the direct-current (DC) electricity produced by modules and convert it to the alternating-current (AC) electricity used to power all of the appliances in your home. In order for the generated electricity to be useful in a home or business, a number of other technologies must be in place.

2 Mounting structures

PV arrays must be mounted on a stable, durable structure that can support the array and withstand wind, rain, hail, and corrosion over decades. These structures tilt the PV array at a fixed angle determined by the local latitude, orientation of the structure, and electrical load requirements. To obtain the highest annual energy output, modules in the northern hemisphere are pointed due south and inclined at an angle equal to the local latitude. Rack mounting is currently the most common method because it is robust, versatile, and easy to construct and install. More sophisticated and less expensive methods continue to be developed.

For PV arrays mounted on the ground, tracking mechanisms automatically move panels to follow the sun across the sky, which provides more energy and higher returns on investment. One-axis trackers are typically designed to track the sun from east to west. Two-axis trackers allow for modules to remain pointed directly at the sun throughout the day. Naturally, tracking involves more up-front costs and sophisticated systems are more expensive and require more maintenance. As systems have improved, the cost-benefit analysis increasingly favors tracking for ground-mounted systems. Solar panels installed on the roof have countless benefits, but many applications need something a bit more portable.

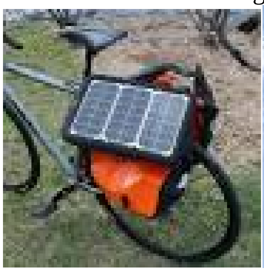
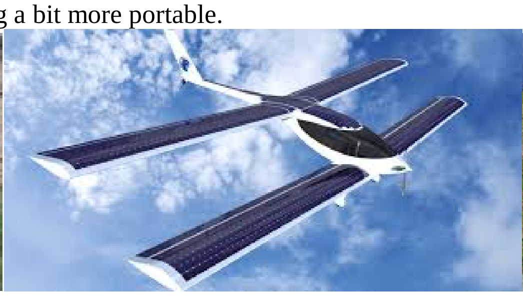


Fig. 1 *Solar panel on a bike* *Solar plane* *Shiping container with PV panels*

Fuelled by high power photovoltaic panels that store energy in on board batteries, the shipping container solution can be used for disaster relief and humanitarian efforts, as well as residential, retail, and industrial projects.
Designed to be transported by truck, train, boat, and plane, the unit's solar panels inside a patented drawer system that protects them during transportation, shipping, and inclement weather. Electricity generated can be used to power on board systems that provide Internet connectivity, satellite communications, and clean water. Power can also be diverted to external locations such as hospitals and schools.

Once fully unfolded, the generator has three times the footprint of a regular shipping container, which translates to a power output that is 400 percent higher, up to 15 kilowatts, than if you just put solar panels on top of a regular container.
If you just used a normal given footprint of a shipping container, you won't have enough solar power to provide major systems, because there's just not enough square footage of solar. Through enlarging a footprint, provision of life-sustaining systems whether it's telecommunications, electricity, Internet, or water treatment systems can be ensured.
In addition to the fact the solar system can be controlled and monitored from any given location, it also has plenty of extra space internal space that can be put to use. A school could be placed underneath it, a hospital, sleeping quarters, whatever you can come up with.

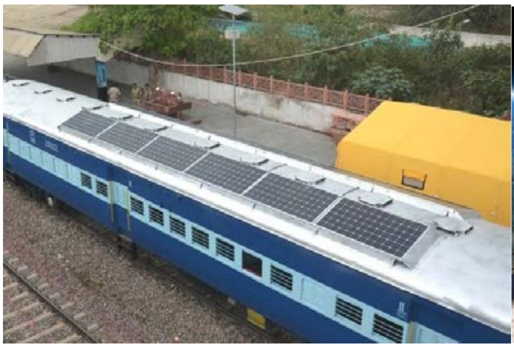

Fig. 2 *Solar panels on a train car*

Fig. 3 *Solar panels in space*

3 Inverters

Inverters are used to convert the direct current (DC) electricity generated by solar photovoltaic modules into alternating current (AC) electricity, which is used for local transmission of electricity, as well as most appliances in our homes. PV systems either have one inverter that converts the electricity generated by all of the modules, or microinverters that are attached to each individual module. A single inverter is generally less expensive and can be more easily cooled and serviced when needed. The micro inverter allows for independent operation of each panel, which is useful if some modules might be shaded, for example. It is expected that inverters will need to be replaced at least once in the 25-year lifetime of a PV array. Inverters are an important part of any solar installation; they are the brains of the system. Although the inverter's main job is to convert DC power produced by the solar array into usable AC power, its role is only expanding. Inverters enable monitoring so installers and owners can see how a system is performing. Inverters can also provide diagnostic information to help O&M crews identify and fix system issues. These important components are increasingly taking on decision-making and control functions to help improve grid stability and efficiency. With the growth of solar+storage, inverters are also taking on responsibility for battery management. Solar inverters can be of different types.
Solar panels are installed in rows, each on a "string." For example if you have 25 panels you may have 5 rows of 5 panels. Multiple strings are connected to one string inverter. Each string carries the DC power the solar panels produce to the string inverter where it's converted into usable AC power consumed as electricity. Depending on the size of the installation, you may have several string inverters each receiving DC power from a few strings.
String inverters have been around for a long time and are good for installations without shading issues and in which panels are positioned on a single plane so do not face different directions. If an installation uses string inverters and even one panel is shaded for a portion of the day reducing its performance, the output of every panel on the string is reduced to the struggling panels' level. Though string inverters aren't able to deal with shading issues, the technology is trusted and proven and they are less expensive than systems with microinverters. String inverters are commonly used in residential and commercial applications.

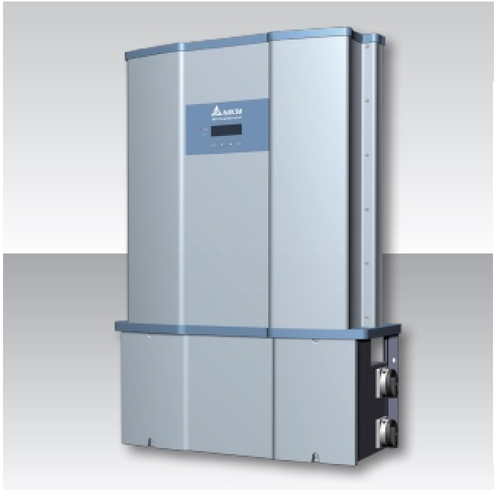

Fig. 4 *Delta strain inverter*

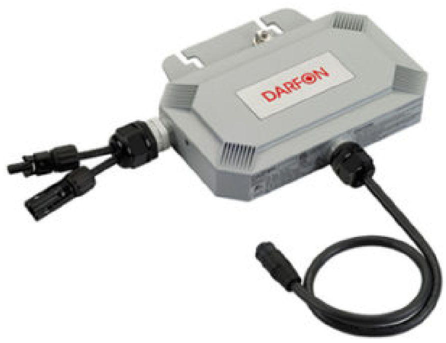

Fig. 5 *Micro inverter*

Advanced inverters, or "smart inverters," allow for two-way communication between the inverter and the electrical utility. This can help balance supply and demand either automatically or via remote communication with utility operators. Allowing utilities to have this insight into (and possible control of) supply and demand allows them to reduce costs, ensure grid stability, and reduce the likelihood of power outages.

Micro inverters are also becoming a popular choice for residential and commercial installations. Like power optimizers, micro inverters are module-level electronics so one is installed on each panel. However, unlike power optimizers which do no conversion, micro inverters convert DC power to AC right at the panel and so don't require a string inverter. Also, because of the panel-level conversion, if one or more panels are shaded or are performing on a lower level than the others, the performance of the remaining panels won't be jeopardized. Micro inverters are also monitor the performance of each individual panel, while string inverters show the performance of each string. This makes micro inverters good for installations with shading issues or with panels on multiple planes facing various directions. Systems with micro inverters can be more efficient, but these often cost more than string inverters.

4 Storage

Batteries allow for the storage of solar photovoltaic energy, so we can use it to power our homes at night or when weather elements keep sunlight from reaching PV panels. Not only can they be used in homes, but batteries are playing an increasingly important role for utilities. As customers feed solar energy back into the grid, batteries can store it so it can be returned to customers at a later time. The increased use of batteries will help modernize and stabilize our country's electric grid.

With the growth of solar+storage, battery-based inverter/chargers are becoming increasingly important. Battery based inverter/chargers are bi-directional in nature, including both a battery charger and an inverter. They require a battery to operate. Battery-based inverter/chargers may be grid-interactive, standalone grid-tied or off-grid, depending on their UL rating and design. The primary benefit of inverter/chargers is that they provide for continuous operation of critical loads irrespective of the presence or condition of the grid. UL1741 requires the grid-tied generation source to stop generating power in the event of a grid outage. This de-powering is known as anti-islanding, as opposed to 'islanding' which is defined as generating power to power a location in the event of a grid outage. Therefore, UL1741 grid-tie inverters will not generate power in the event of a grid outage, so a user will experience an outage irrespective of the availability solar harvest. Battery-based inverter/chargers will power the critical loads in the event of a grid outage, but will do so in a manner to not create the islanding condition. Further, UL1741 inverter/chargers may be rated as either interactive or standalone. The former export excess power to the grid, while the latter do not–by rating and by definition. In all instances, the battery based inverter/charger manages energy between the array and the grid while keeping the batteries charged. They monitor battery status and regulate how the batteries are charged.

5 Military portable applications

Military plays a special role with respect to photovoltaic energy applications. The environmental aspect transfers into forces security consideration. Overseas operations, in particular reconnaissance and intelligence operations need to maintain autonomous character and seek for avoiding unnecessary contacts with local commercial or supplying bases. Movements of small units or individuals in unpopulated areas make the operation dependable on sources of energy not only for humans, but mostly for advanced technologies as GPS, computer systems.

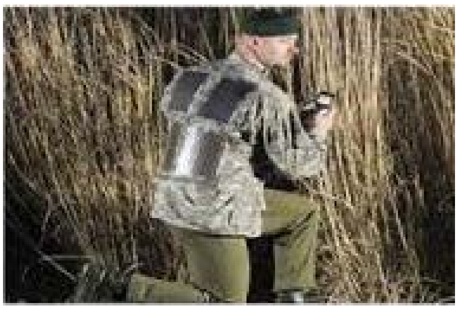

Fig. 6 *PV panel charging GPS*

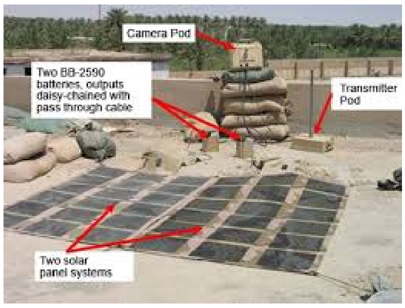

Fig. 7 *PV panel chained with a cable*

6 Conclusion

An intense growth of a commercial employment of power technologies using renewable sources recently has moved on this power alternative into a centre of economic and political consideration. There is a proposed hybrid set of sources of electric energy, suitable for a large application by combining external mains and a complementing source by a photovoltaic system placed on movable assets, from very simple up to really complex ones, from civic sector to public up to military sectors.

The important thing is, that it is one of options how to provide a sufficient amount of energy for future generations with no negative impact on environment.

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