

PV systems

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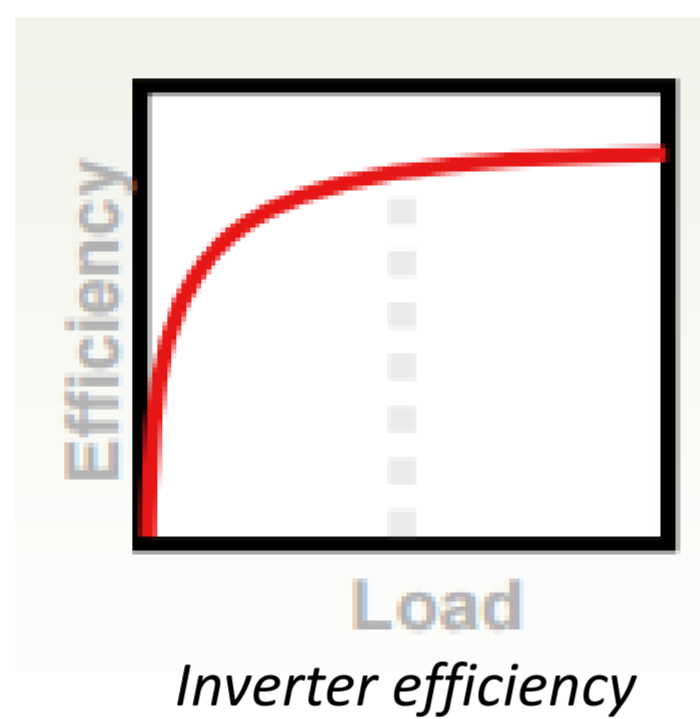
Introduction

In recent years, environmental problems have become a worldwide issue. While the energy demand is increasing significantly, fossil fuel reserves are decreasing rapidly. One of the solutions to this problem is photovoltaic (PV) energy as an inexhaustible and clean source of energy that could be able to meet the energy demand. The possibilities of integration of PV systems are endless, considering grid-connected and stand-alone systems, applicability of various materials in solar cells and the addition of valuable elements such as MPPT and storage units.

Efficiency

The efficiency of PV systems is determined by:

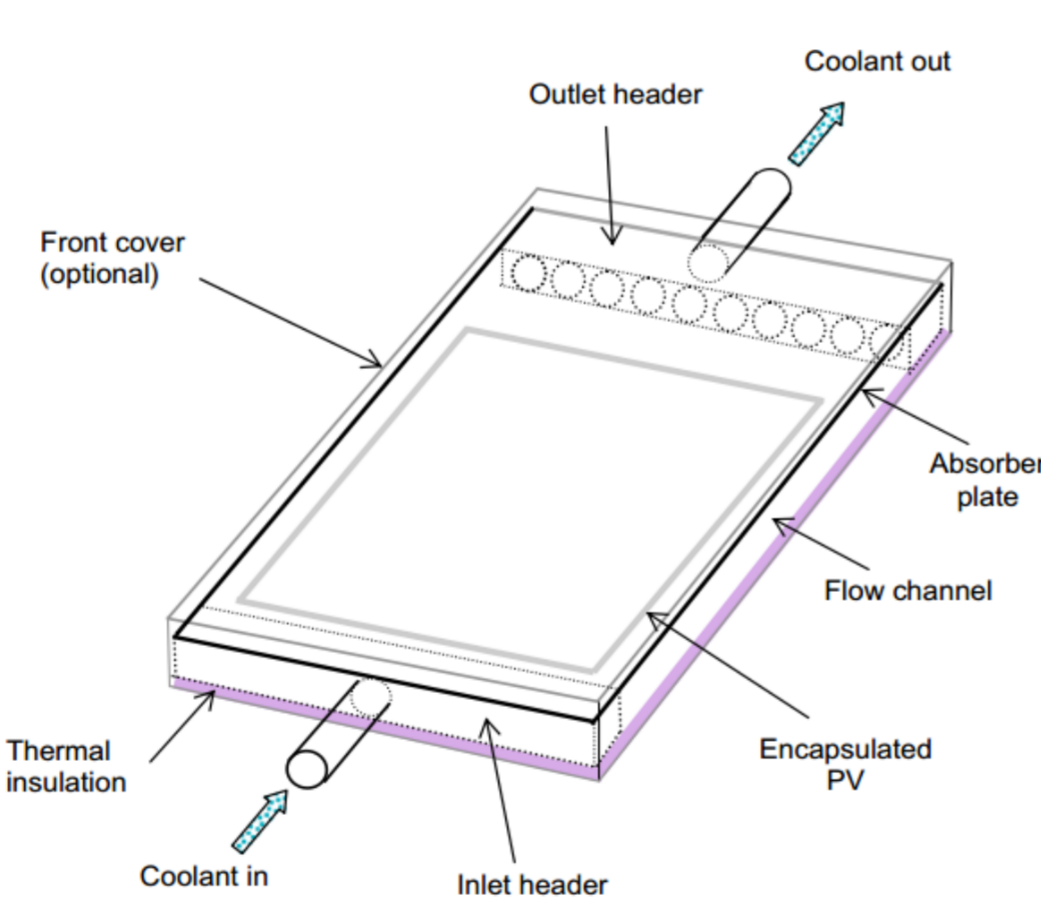
- Solar cells, approximating its theoretical limit of 33.7% nowadays in experiments.
- DC/AC inverter (including MPPT), which is around 90-95%
- Wiring, which is dependent on the characteristics of the wires.
- Temperature: the higher the temperature, the lower the efficiency.
- Irradiance: the higher the irradiance, the higher the efficiency.



Developments

The amount of energy generated by solar panels has increased exponentially over the past years and is expected to increase even more in the coming years.

An important development is photovoltaic/thermal technology, or PVT. It was developed to overcome efficiency reduction by rising temperature. The PVT system is cooled by water or air that absorbs heat from the system.



Conclusion

- PV systems can be applied in numerous ways, whereby its performance is determined by several crucial components such as the material of the solar cells, the inverter, MPPT and storage units.
- The efficiency of a PV system is highly dependent on the efficiency of its components, but also on other factors such as orientation of the PV system, irradiance and temperature effects, and the weather.
- The energy generated by PV systems has increased exponentially, while the price of PV systems has dropped. It is expected this trend will proceed, although new ways to improve efficiency and to integrate PV technology in society have to be developed.

Research Question

In what way do critical components influence the performance and efficiency of PV systems?

PV systems

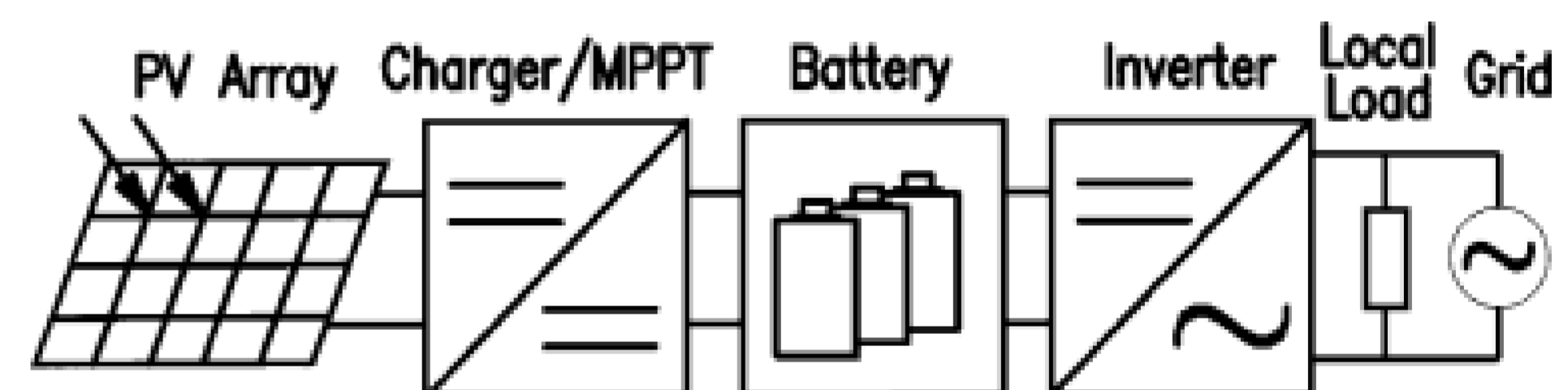
Grid-connected

VS

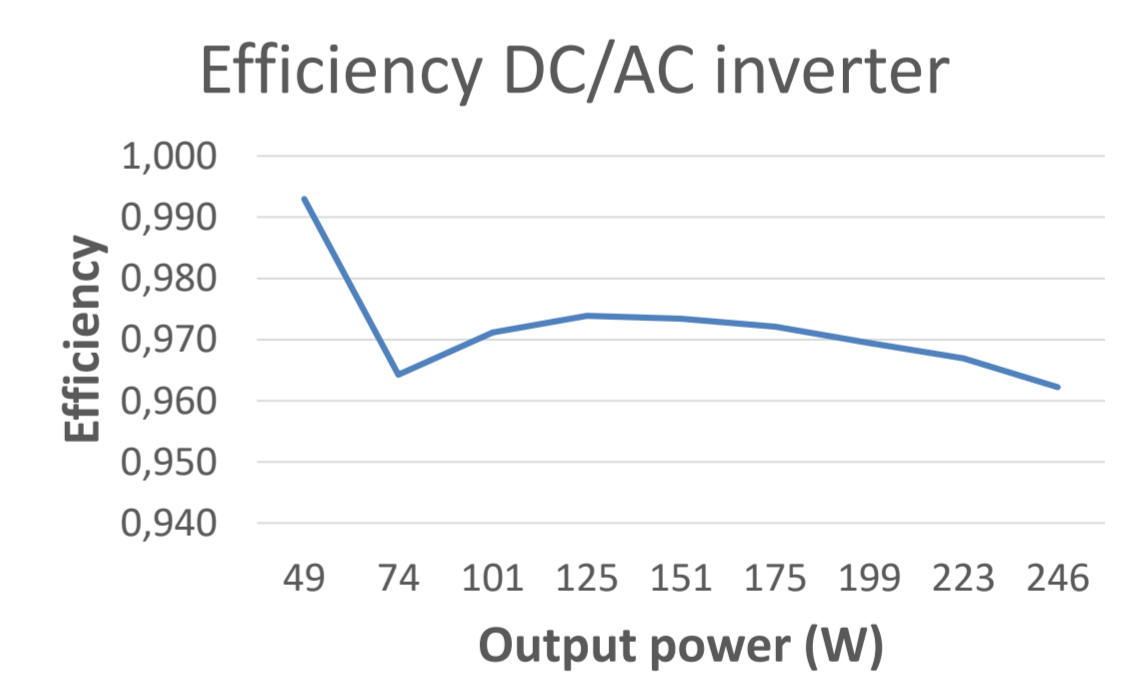
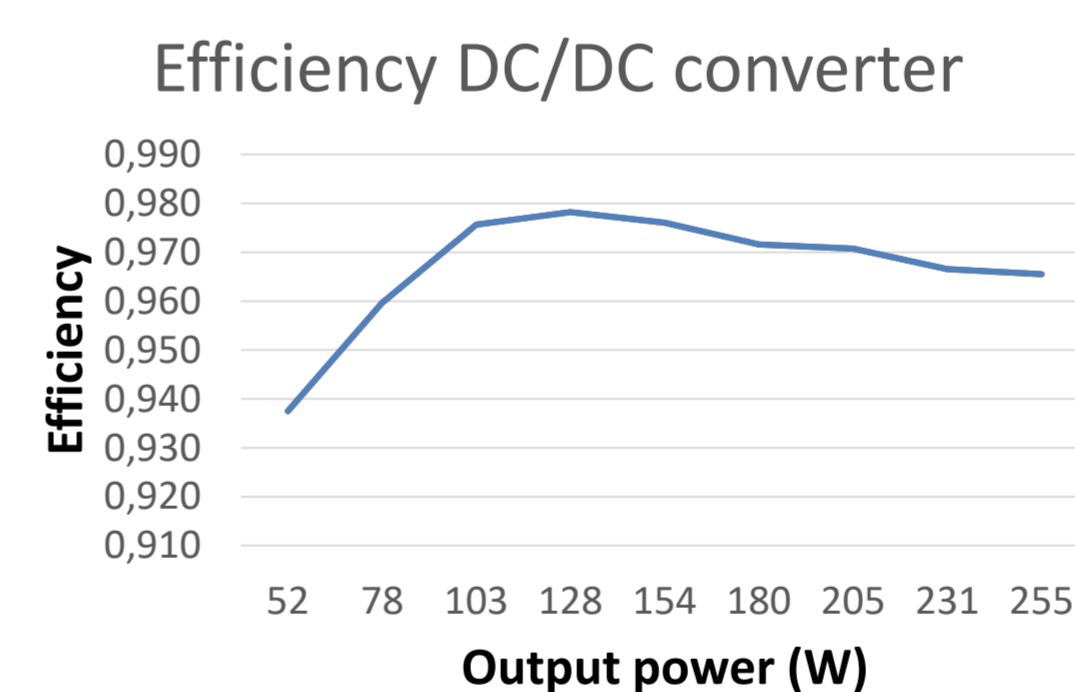
Stand-alone

- Designed to operate in parallel with the utility grid.
- The inverter is the most important component.

- Designed to operate independent from the utility grid.
- Batteries are commonly used for energy storage.

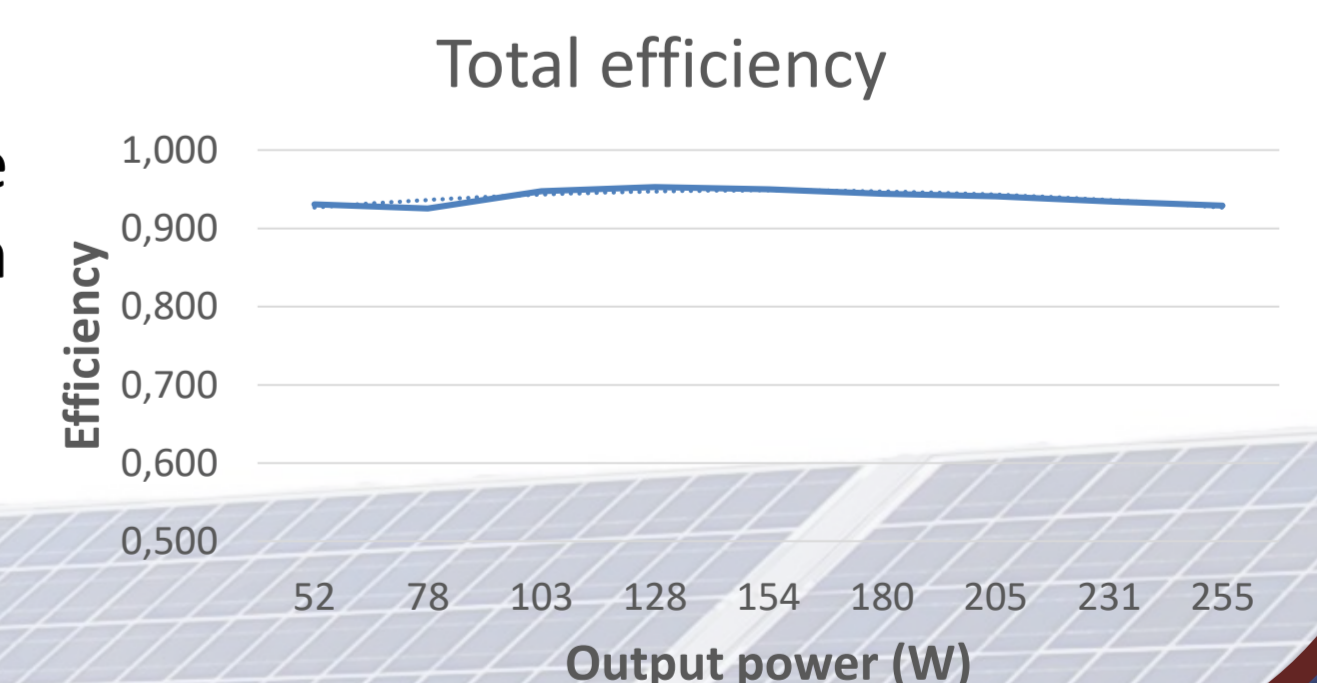


Experiment on the inverter



For the experiment a set-up of a solar micro inverter from Texas Instruments was used. The output power was measured for several values of input power to eventually determine the efficiency. Above the obtained results for the separate DC/DC and DC/AC inverters are given. For the DC/AC inverter it was not possible to obtain a nice curve, although the experiment was repeated several times.

For the measured total efficiency a nice curve was obtained, with a maximum efficiency approximating 95%.



Future prospects

- Costs of PV systems are expected to decrease even more in the future
- The application of organic solar cells in customized products can stimulate the integration of PV in society in the future