SOLERGY
40 Year Upgradeable Solar

Minimizing Thermal Losses for Maximal Solar Energy Yield– Newsletter No. 4

Solergy Italia's Cogem CPV achieves breakthrough thermal performance and captures waste heat for cogeneration applications

Thermal losses are the single, biggest factor that reduces the yield and performance of a solar energy system. As temperature goes up, solar cell conversion efficiency goes down. Depending on location and method of installation, higher silicon solar cell operating temperature can reduce power output by anywhere from 10 – 25% and also accelerate degradation of PV modules. This far outweighs the impact of other loss mechanisms such as soiling, cabling, electrical mismatch, shading, and inverters.

Paradoxically, PV systems in areas with less solar resource can outperform systems in sunnier areas due to the impact of temperature. For example, solar power plants installed in central Italy have exhibited higher performance ratios than similar plants located in the sunnier south. Also, PV has seen limited application in harsh desert environments due to concerns about low performance and reliability under high temperature.

Key factors that cause thermal loss

The first factor to consider is the intrinsic thermal performance characteristics of the solar cell material itself. Most polycrystalline and monocrystalline solar cells have a Maximum Power (P_{max}) temperature coefficient ranging from -0.40%/°C to -0.50%/°C. What this means is that for every degree increase in temperature above the nominal rating temperature of 25°C, the PV panel will lose 0.5% of its power output. Multijunction solar cells made of compound semiconductors (not silicon) on the other hand, the kind used in Solergy CPV, have a P_{max} temperature coefficient of -0.10%/°C; 4 to 5 times more resilient to temperature increases compared to silicon PV. In a hot, sunny location, the cell operating temperature in a traditional PV module can easily reach 65°C. At this temperature, PV can suffer up to a 20% reduction in output, whereas a multijunction cell will only lose 4%.

Other factors are related to how a panel is mounted and installed as well as the typical climactic conditions in the location of installation. Since PV panels are passively cooled, their performance is highly dependent on whether there is enough air flow behind the module to keep cells cool. If there is no breeze or panels are not properly ventilated, then operating temperature will increase and performance will suffer. Long term lifetime of the panel will suffer as well.

SolergyCPV's unique approach to thermal management uses active cooling

A fundamental tenet of Solergy's system design philosophy has been to minimize losses along the entire sunlight-to-electricity conversion pathway. As the most significant loss mechanism, particular attention has been dedicated to reducing temperature impacts by keeping the cells as cool as possible during operation.

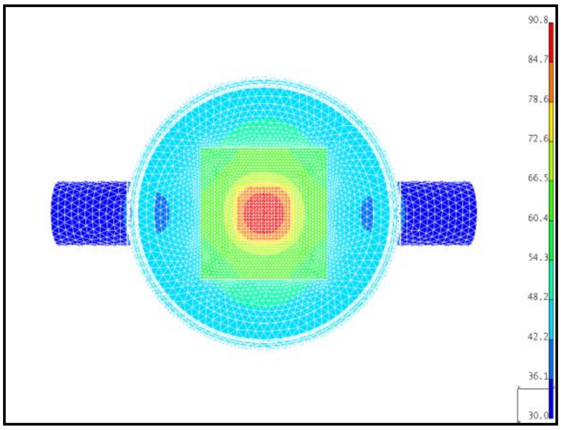
In CPV, where sunlight gets concentrated by a factor ranging from 500x – 1500x, on-cell temperatures can easily exceed 1000°C! Solergy has solved this problem by developing a patented, fluid-based cooling system. By controlling the flow rate, the system can guarantee steady cell operating temperature under any ambient condition. This becomes especially critical in the hot desert environments where CPV is supposed to perform best. As mentioned, passively cooled systems are highly dependent on airflow for cooling. Therefore, the cell operating temperature and performance of these systems can fluctuate dramatically over the course of the day and year. Finally, the system requires minimal water (or water-glycol mixture for environments with temperatures below freezing) because it is closed loop and sealed; this means it is filled only once during installation.

Solergy CPV offers a second benefit from its active cooling; it captures the efficiently removed heat and can deliver it as cogenerated thermal energy for applications such as hot water, industrial process heat, and higher efficiency desalination.

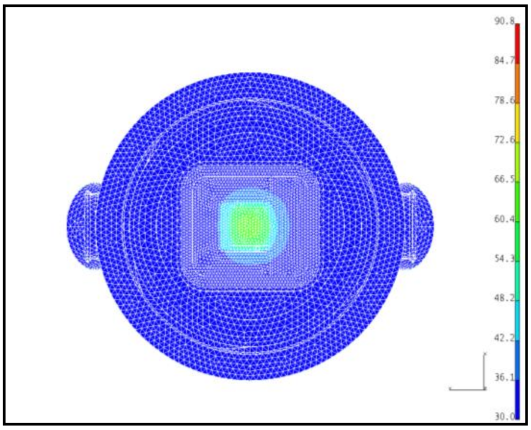
Latest Innovations in Solergy receiver technology limit thermal losses under3%

Solergy's patented innovations in thermal management (also referred to as the 'heat spreader'), developed within the context of its EU Horizon 2020, Cogem CPVTM project, guarantee high performance and maximal energy yield under any ambient temperature condition. Back in November, 2016, Solergy reported the first results from its Cogem CPV project (see press release http://www.solergyinc.com/en/news-archive/solergy-italia-srl-achieves-50-thermal-performance-improvement-with-new-concentrating-photovoltaic-cpv-receiver_69c5.html), achieving a thermal performance improvement of 50% and a module efficiency improvement of 12%. Now, further optimizing some heat spreader design details, these improvements have been pushed up to 62% and between 15% and 17% respectively in comparison to Solergy's pre-Cogem designs. The new receiver succeeds in limiting the temperature difference (ΔT) between cell and cooling fluid at 24°C, representing a thermal loss of 2.4% at nominal ambient temperature and DNI conditions.

The heat map below shows the difference between pre-Cogem and Cogem CPV heat spreader designs with typical ΔT figures for each design indicated above.



Pre-Cogem Heat Spreader heat map



Cogem Heat Spreader heat map

Finally, the new heat spreader design enables highly automated assembly and reduces the number of components. By combining lower cost with higher performance, Solergy is well on its way towards achieving a key Cogem project goal of reducing energy generation costs by 25%.

Thermal loss showdown: Comparing Solergy CPV to other CPV and traditional PV

To conclude our analysis, let's compare the thermal losses suffered by Solergy CPV, other CPV systems, and traditional PV. We will assume an ambient temperature of 40°C and insolation on cell surface of 1000W/m^2, representative of the type of high solar resource environments where solar energy should be highly productive, but instead suffers lower yields due to thermal losses. For PV, we will use high performance modules with a temperature coefficient of -0.40%/°C and a rated Nominal Operating Cell Temperature (NOCT) of 44°C.

Technology	Cell operating temperature (°C)	Thermal loss (%)
PV	70	18%
Other CPV	95	7%
Solergy CPV	65	4%

The table shows that Solergy CPV has 4.5x lower thermal loss than PV and almost 2x lower thermal loss than other CPV systems.

In conclusion, if your intended solar power plant lies in a sunny, hot area and/or you have an application for cogenerated heat you may want to consider Solergy CPV.

Developing a solar project? Want to learn more? Join HESCO

The **H**igh **E**fficiency **S**olar and Solar **Co**generation (**HESCO**) Special Interest Group is growing! This group, formed as part of Solergy Italia's COGEM CPV - Horizon 2020 project, aims to promote collaboration among renewable energy industry stakeholders who wish to develop energy efficiency projects based on Solergy HCPV technology. Special emphasis is placed on applications that involve **cogeneration of electricity and heat**. The HESCO group is the place to share information about technological developments, best practices, exchange ideas, seek solutions for energy efficiency projects, and Provide feedback for how Solergy HCPV can best serve market needs.

Subscribe here to receive updates on Solergy Technology developments and new applications.

Click here to submit specific energy efficiency project requirements or needs,

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