HeliosLite/THEnergy white paper

1.5-axis solar tracker technology for auto-consumption of hotels and resorts

HELIOSLITE

Content

1 Introduction

Many hotels and resorts are located in remote locations or areas in which the electricity grid is far away from perfect and the power supply is not reliable. Typically, hotels and resorts operate diesel gensets to auto-generate their electricity or as backup power to be prepared for power losses and outages. The falling prices of solar power plants present an attractive business case. Solar energy is often less expensive and more reliable than diesel and grid electricity.

In the basic approach, solar modules are mounted on a fixed mounting system and optimized for peak-power generation. In the northern hemisphere, the installation is facing towards the south, in the southern hemisphere vice versa. As a consequence, power generation is over-proportionally high around midday.

The electrical load curve of hotels and resorts only partially corresponds with this generation pattern. During breakfast and dinner hours, we also can observe increased electricity consumption. In order to converge to this consumption pattern, so-called trackers can be used. They follow the sun and allow for increased power generation in the morning and afternoon. Sophisticated 2-axis tracking systems are rather large, material intensive and expensive. Horizontal single axis trackers generate less power and are deployed for utility scale projects above 5 MWp. Typically, the energy output is around 35% less than for dual axis trackers. However, most cases they are still a more profitable investment due to lower capex.

A new 1.5-axis tracking technology by HeliosLite SAS can fill this gap. Performance tests have shown an astonishing 90% of the energy output of dual axis trackers while the installed price is only slightly higher than the price for single axis trackers. Additionally, the energy production more accurately matches the consumption of hotels.

This white paper shows the difference from a solar energy point of view between off-grid and on-grid hotels and briefly explains the concept of solar-diesel hybrid systems in the context power generation requirements of hotels. It also explains the concept of 1.5-axis trackers and shows how this new concept fits with the requirements for powering hotels and resorts.

2 Auto-consumption of solar energy for hotels and resorts

2.1 Grid-connected hotels and resorts

From a global perspective, the vast majority of hotels are connected to the grid. Depending on the prices for electricity from the grid and on incentive schemes like feed-in tariffs, net-metering, or tax incentives, investments are often already profitable from a pure cost perspective. In addition, green efforts from hotels have additional advantages like noise and emission reductions. The attractiveness of renewable energy solutions for hotels and resorts goes well beyond decreasing the energy costs and reducing noise and emissions. A 2013 study by McGraw-Hill Construction, entitled “Green Retail and Hospitality Report - Waste Management,” found that the core business of hotels, in general, is positively affected by green efforts.

A large percentage of hotels report higher customer satisfaction and improved worker well-being as a result of green investments. Nearly half of the respondents (46%) reported a higher hotel occupancy rate. The majority of them have observed an increase on the order of 15% or more. Over two-thirds of hotel owners have observed improved customer satisfaction. According to the report, 83% of hotel owners say that green buildings have a positive impact on worker health and well-being.

2.2 Off-grid hotels and resorts

Many remote hotels are not connected to the grid and generate electricity on-site, often with expensive diesel gensets. Most often, a diesel generator set (genset) serves as the primary source

of power. The cost of electricity is particularly elevated when the diesel fuel has to be shipped to islands or transported to remote hotels. Under these circumstances, solar energy allows for significant cost savings. The transportation costs only occur once, and operational costs are extremely low for solar energy. Diesel has additional problems because its emissions are hazardous to human health. In pristine locations, tourists and employees do not want to smell fumes. Furthermore, diesel gensets are normally loud and disturb the peaceful ambiance of a vacation.

In the basic case, solar or wind plants are added to the diesel gensets in a hybrid generation arrangement. The energy from renewable sources displaces diesel electricity, and the fuel consumption can be significantly reduced. The diesel gensets also serve to balance the variability and instability of renewable energy sources. For example, if clouds are shading the photovoltaic array, the load of the diesel gensets is increased and the share of diesel electricity is increased.

Traditional gensets are not very flexible and normally cannot run below 30% to 40% of their full load. In the base scenario, this limits the amount of renewable energy in the hybrid system. In a more advanced scenario, the intermittencies of renewable energy sources are balanced to a larger extent by energy storage systems, or so-called “low-load gensets.” Storage allows gensets to be switched off completely during the daytime if the solar irradiation is high. Shading of the PV array or fluctuations of the wind are first balanced by the storage system. Energy storage serves as a bridge until the diesel gensets are needed.

In comparison to grid-connected hotels, the business case for off-grid hotels and resorts that are powered by diesel gensets is normally even better from an economical perspective as in most locations of the world, the prices for electricity from diesel are much higher than for electricity from the grid. Most likely the vast majority of off-grid hotels and resorts that are still powered by diesel gensets will have an economic interest to at least partly replace diesel by solar power. Especially, when soft factors such as noise and emissions are factored into the equation, we also see that diesel gensets are completely replaced by solar plus storage.

2.3 Electricity consumption of hotels

The amount of electricity consumed varies from hotel to hotel. Some of the key drivers are:

- Size
- Location
- Air-conditioning technology
- Recreation amenities such as pool, sauna, golf-courses
- Restaurants
- Heating and warm water generation
- Insulation
- Business and leisure segment
- Lighting requirements and technology
- Laundry services
- Onsite water desalination

In addition, seasonality and weekday-weekend fluctuations have to be taken into consideration. In tropical climates, air-conditioning sometimes accounts for around 50% of the total electricity consumption.[1] Other major electricity consumers in hotels are the kitchen, lighting, water pumping and treatment. Structural differences in hotels make it almost impossible to drive a

[1] See for example, IFC-World Bank Group/PricewaterhouseCoopers (2013), Identifying Resource Efficiency Improvement Potential to Enhance Competitiveness of Sri Lanka's Hotel Industry, p. 3.

typical load curve. In many cases, the restaurant is the reason for demand increases in the morning, at midday and in the evening.

3 Advantages of 1.5-axis tracking for hotels and resorts

3.1 Concept of 1.5-axis trackers

1.5-axis trackers are based on a novel kinetic approach. Like dual axis trackers, the solar modules are rotated horizontally and vertically. In contrast to dual axis trackers, however, the solar modules are no longer strictly inclined along the two axes. The core of the system consists of a kinetic solution that swiftly integrates vertical and horizontal movements.

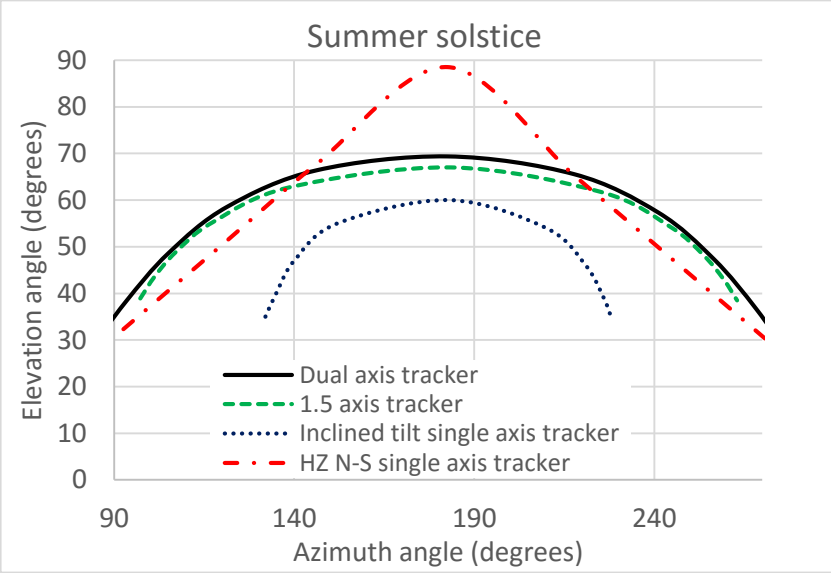

Figure 1: Trajectories of different types of solar trackers

Particularly in summer, the new 1.5-axis tracker almost approaches the performance of a dual axis tracker.

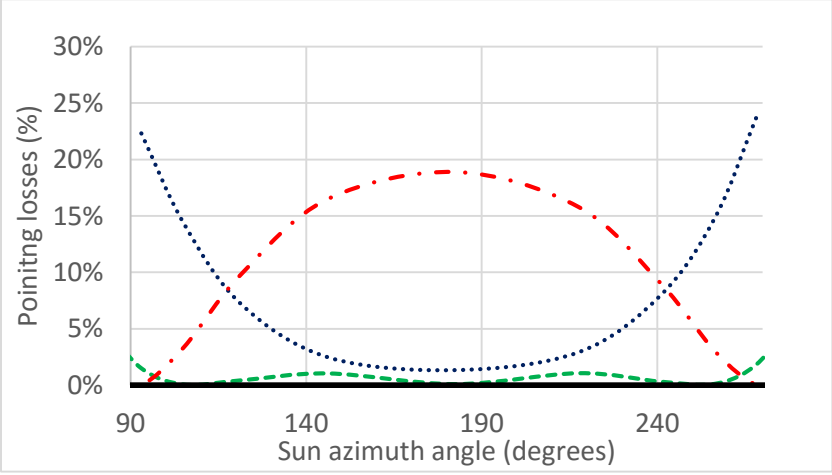

Figure 2: Pointing losses of different tracking systems

In comparison to perfectly adjusted dual axis trackers, the pointing losses are minimal under extreme summer conditions.[2] In comparison to inclined tilt single axis trackers, the simulation shows high power gains during winter time throughout the whole day and during summer time, especially in the morning and evening. The cost-effective design delivers higher power output than single axis trackers.

Performance attributes and features	Single axis horizontal tracker	HeliosLite dual axis tracker	HeliosLite 1.5-axis tracker
Energy gain in Southern France	20-22%	35-40%	>35%

Table 1: Energy gain of different tracker systems

The 1.5-axis tracker offers significant energy gains in other markets. On-line simulation tools such as PV-GIS can be used to compare PV mounting solutions.
The patent pending 1.5-axis tracker design reduces metal by 60% per square meter and installation cost by up to 80% compared to pylon-type dual axis trackers. This can be achieved without compromising rigidity and reliability.

3.2 Increased electricity output and better fit with the load profile of hotels and resorts

The new 1.5-axis tracking technology significantly increases the power output (kWh/kWp) in comparison to fixed mounting systems and single axis trackers. The more power allocated on a tracker, the bigger the power increase is. Typically, for tracking systems modules with higher efficiencies are used. As the price of the 1.5-axis tracker is in the same range as the price of single axis trackers, there is no obligation to use PV modules with higher efficiencies. However, this could add additional upside potential depending on the pricing of the modules.
The system power output is high in the morning and in the evening, time periods when hotels and resorts normally have increased electricity demand due to breakfast and dinner. The 1.5-axis tracker technology helps PV systems to approach to some extent the load-curve of hotels and resorts. The additional cost requirements are rather low. The same can be achieved with energy storage systems at a much higher price as storage systems are still rather expensive and more PV capacity has to be added. If hotels or resorts decide to use storage systems, 1.5-axis trackers will allow for the use of smaller storage systems and less additional PV for the load of the energy storage units.

3.3 Optimized land usage

Many hotels and island resorts are located in areas where land is scarce. Sometimes it is difficult to find a suitable space for solar power plants. Hotel managers are often concerned about the visual impact. Exclusive island resorts are a good example to illustrate this problem. Typically, the available space on the island is limited and part of the experience is the resort's location among nature. One of the main considerations is minimizing the impact of the PV system on the surroundings. The 1.5-axis tracker is highly adaptable as it can be placed on slopes, uneven terrains and irregular shapes. It can be mounted on flat roofs and on the ground. This flexibility allows for reducing the environmental impact to a large extent.
When positioning all types of mounting systems and trackers, the adverse effects of shading should be taken into consideration. Respecting minimum distances between rows of mounting

[2] The average performance losses of the tracker are actually much smaller than the instantaneous pointing losses. Still they are an excellent indicator for comparing different tracking systems under direct light conditions.

systems or different trackers optimizes electricity generation. The amount of PV capacity that can be allocated on a given space is for 1.5-axis trackers approximately in the same range as for single axis trackers.

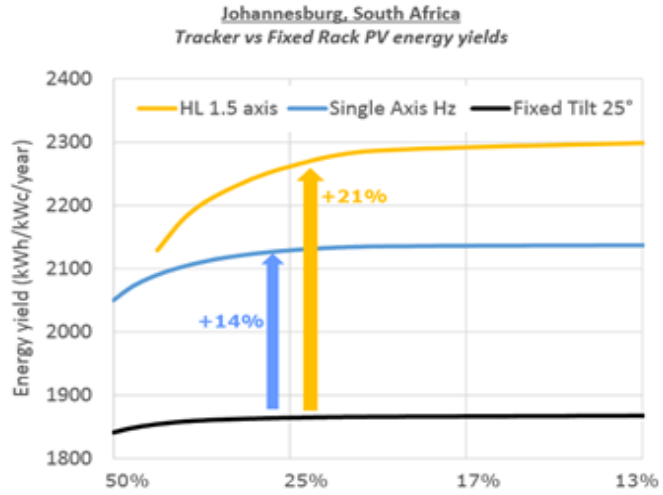

Figure 3: Plant ground coverage ratio (PV array area / land area used)

The increased electricity output, however, has the positive consequence that similar installed capacity per unit of land has a significantly higher output. The land use is optimized; less land is needed for generating the same electricity output or more energy is generated on the same area of land. For hotels and resorts, this means that the impact on the landscape is considerably smaller or that with the same impact more electricity can be generated. In the case of solar-diesel hybrid applications, this means that the hazardous impact of diesel consumption in the form of emissions and noise can be further reduced.

3.4 Decreased cost of energy in comparison to existing mounting systems and trackers

For many, the biggest advantage of the new 1.5-axis tracking concept is that it directly improves the economics of PV projects. The effect of significantly increased electricity output (kWh) in combination with only slightly higher investment costs improves the cost of energy (c€/kWh) in comparison with single axis trackers.

This argument is not only valid for relatively small auto-consumption solar power plants for hotels and resorts, but also for utility-scale solar farms. The 1.5-axis tracking technology is scalable. The modular deployment by multiples of 10 PV modules allows for a "build-as-you-go approach". In the case that only insufficient electricity consumption data is available, this can be very useful for off-grid applications. If solar installations are over-sized, the electricity cannot be fed back into the grid, and in a worst-case scenario it is dumped. If the electricity is not fully used, there also is an adverse effect on the cost situation.

3.5 Easy installability and relocatability of trackers and solar power plants

The 1.5-axis tracker has an innovative single anchor point solution which allows for simple and fast installation and requires no lifting of equipment, which is a big advantage especially in remote locations. The easy installation process also has a positive impact on installation costs, which can significantly reduce the investment costs in remote locations. The movable structures can also be beneficial if there is a need for relocating the PV plant. A PV plant always occupies space. Electricity generation normally is not the core business of hotels. It might be that reconstruction of the building or adjacent facilities make it necessary to relocate the solar plant. The situation is similar for hotels that are not connected to the grid. If the hotel infrastructure is completely abandoned, typically at remote locations there is a lack of alternative off-takers. The PV installation normally has a life-time of at least 25 years. As long as the PV plant is still functioning, it has a value and relocation of the equipment can be considered. A main obstacle for relocation is the mounting system respectively the trackers. The movable structures with a single anchor point per tracker make it relatively easier to dismantle and rebuild the power plant at another site. The relocatability aspect is also important for third party investors and banks financing off-grid solar power plants.

3.6 Robustness against external forces

The new 1.5-axis tracker is robust against external forces. Wind tunnel tests have proven its wind resistance. In addition, the mechanical design is highly resistant to dust and sand with no open-gear drive and maintenance free bearings. This influences the operation and maintenance costs in a positive way. Long-term robustness is particularly important for solar power plants as the expected lifetime is 25 years or more. The robustness and simple design also ensure that the technical staff of hotels can fulfill all O&M requirements.

4 Conclusions and outlook

Several developments in on-site renewable energy generation make solar power increasingly attractive for hotel and resort owners. These developments include new genset concepts, weather forecasting tools, the falling price of energy storage systems, and new control solutions for integrating different kinds of electricity. More and more hotels and resorts generate at least a part of their electricity from renewable resources onsite. Several studies show positive effects from green efforts on the satisfaction of hotel guests and also employees. The prices of renewable energy systems also have come down significantly in recent years. As more and more renewable energy systems have been built to power hotels and resorts, the advantages of solar solutions have spread through word of mouth. Hotel groups such as the Spanish Melia chain have announced plans for fully powering their hotels by renewable energy. At the same time, the pressure from hotel guests regarding green power is increasing. A further acceleration of this development is to be expected.

As the market segment is maturing, the demand for specialized solutions is increasing. One of these solutions will be 1.5-axis trackers that increase the electricity output and better fit with the load profile of hotels and resorts. The new tracking system also optimizes the use of land and improves the cost of energy generation of the solar power plant. At the same time, it can be installed easily and has advantages regarding the relocation of trackers and the solar power plant, while its robustness has been proven in many tests. In solar plus storage power plants, 1.5-axis trackers will influence the dimensioning of storage systems and decrease the investment costs.

It is no surprise that the developer of the new solution, HeliosLite SAS, and the global hospitality group Club Med have already formed a development partnership for their first tracking system. Among the main objectives of the partnership are the optimization of tracking solutions to meet the energy needs of hotels and resorts.

About HeliosLite

Based in the French Alps, HeliosLite adds value to traditional photovoltaic energy installations thanks to its disruptive tracking system. With conventional photovoltaic technology, HeliosLite's cost effective tracking solution boosts energy production to lower the cost of energy. HeliosLite strives to work with local partners for manufacturing, installation and operations through an elegantly simple design using standard & proven components and an informational system for complete performance monitoring. HeliosLite's disruptive technology opens new markets and accelerates the use of renewable energies. You will find more information at http://helioslite.com/

About Dr. Thomas Hillig Energy Consulting ("THEnergy")

THEnergy assists companies in dealing with energy-related challenges. Renewable energy companies are offered strategy, marketing and sales consulting services. For industrial companies THEnergy develops energy concepts and shows how they can become more sustainable. It combines experience from conventional and renewable energy with industry knowledge in consulting. In addition to business consulting, THEnergy advises investors regarding renewable energy investments in changing markets. It is also active in marketing intelligence and as an information provider in select fields, such as renewables and mining, through the platform th-energy.net/mining or renewables on islands through the new platform th-energy.net/islands. For more information, have a look at www.th-energy.net

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