
# Celebrity Solstice – Solar power plant

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# The Celebrity Solstice – Facts and figures

## Your ship has arrived.

Celebrity Solstice is a new class of ship in a class all its own. All the amenities you've come to expect combined with the delights and extraordinary service of a Celebrity cruise. The largest ship in the Celebrity fleet, Solstice features: new modern stateroom designs; increased storage; spacious bathroom designs; and amazing dining options.

| SHIP SPECIFICATIONS | | STATEROOM SPECIFICATIONS | |
|---|---|---|---|
| Double Occupancy: | 2,850 | Verandas: | 85% |
| Staterooms: | 1,425 | Oceanview: | 90% |
| Tonnage: | 122,000 | Inside: | 10% |
| Length: | 1,033 feet | STATEROOM HIGHLIGHTS | Flat Screen TVs |
| Beam: | 121 feet | | Wireless |
| Draught: | 27 feet | | Modern Space Saving Design |
| Cruising Speed: | 24 knots | | Enhanced Storage/Closets |
| Electric Current: | 110/220 AC | | Spacious Bathrooms |
| Ship's Registry: | The Bahamas | | Plush European Bedding |



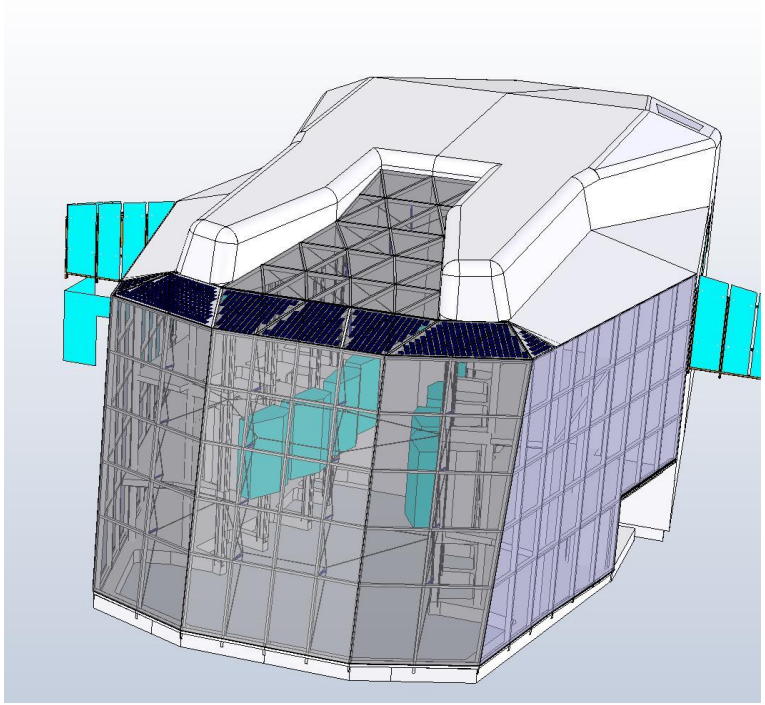
# System description –
# Example Solar Power Plant

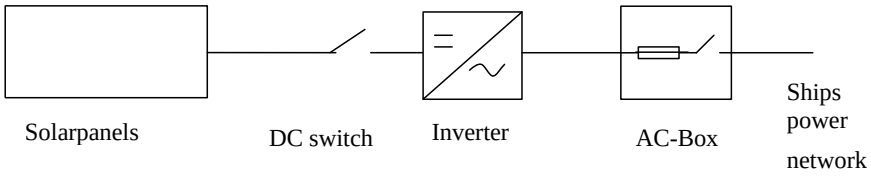
Some of the new built ships at the Meyer Werft are equipped with solar power plants. The power plant is divided into six areas. In the following a short description is given about the location, power, visualization and connection to the ships power network.

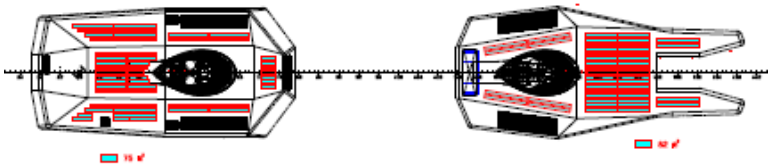
In general there are two different types of solar cells. One type consists of solar foils (see attached data sheet) and the second type is included into the glass roofs of the solarium and the atrium.

The drawing below shows the principal system design of each area. The panels supply the DC-power via a DC switch to an inverter. This inverter is connected to an AC-Box with fuses and breaker. From here the power is supplied to the ships power network (L-distribution).

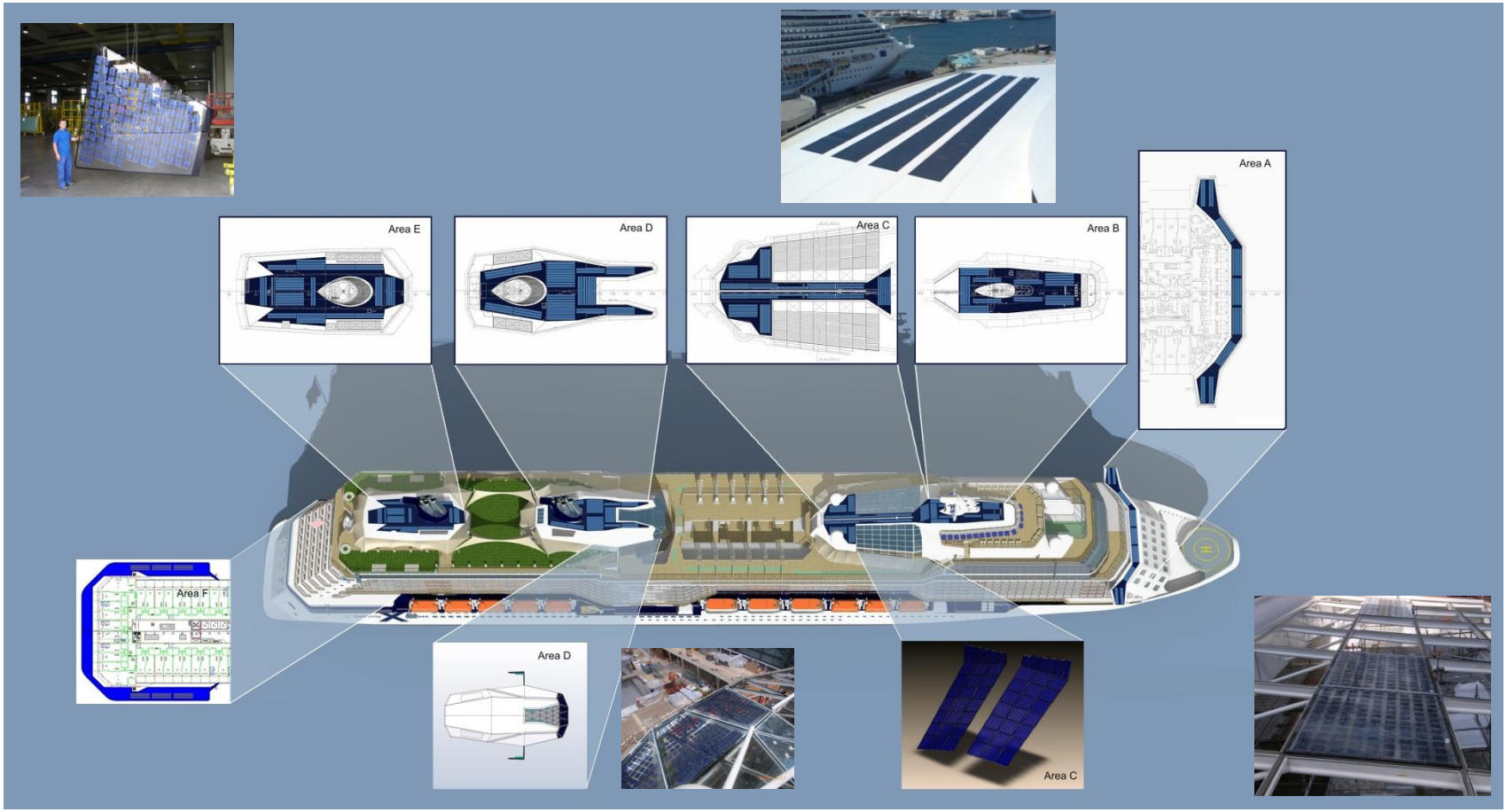
The total electric power of the solar power plant is approximately 46.9 kWp. Out of this a daily solar power of approximately 190 kWh to 240 kWh arises.





# Panel location “Solstice”
# Solar Power Plant

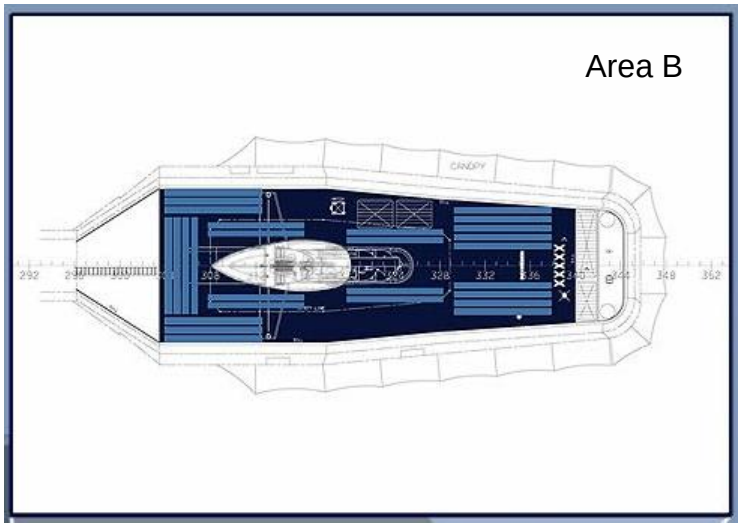


# Installed panels – amorphous thin film laminates


# Panel location “Area B” – Solar Power Plant

**Area B: Solar foils on deck 17, frame 304-338**

In this area 27 solar foils are located. These foils are connected together to 4 groups. The total power of this area is 3.672 kWp. The plus and minus cables of each group is passing through a watertight penetration to the room AC 2-16 on deck 16 where the DC switches, an Inverter and an AC-distribution box is located.




# Installed panels – insulated glass-glass modules

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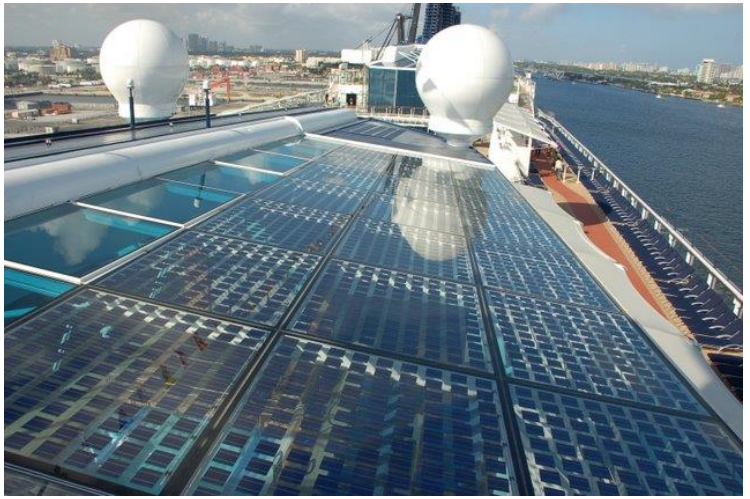
# Installed panels – glass-glass modules



# Installed panels – glass-glass modules

# Visualization and inverters – Solar Power Plant

**Visualization**

For the purpose of visualization all inverters are connected to a bus network. In the bridge equipment room the data's from all inverters are available and supplied to the ships IT network.

**Inverters**

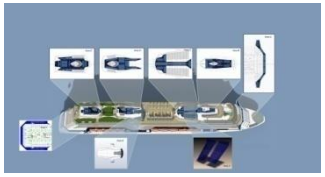
Electrically isolated solar inverters made by KACO meet all the demands placed on advanced state-of-the-art inverters. The Transformer inverters are predominantly used for thin-film modules, where they allow the grounding of the DC-minus terminal of thin-film PV generators. User-convenience, innovative technology, highest degrees of efficiency and maximum longevity are the characteristic features of these state-of-the art energy converters. Electrically isolated KACO inverters are the first ones to be operated with the new BiSi (bi-directional safety interface) grid monitoring.

**Alarms of inverter**

Each inverter is equipped with an potential free contact which is connected to the ships automation system. In case of a failure of an inverter an alarm is created.

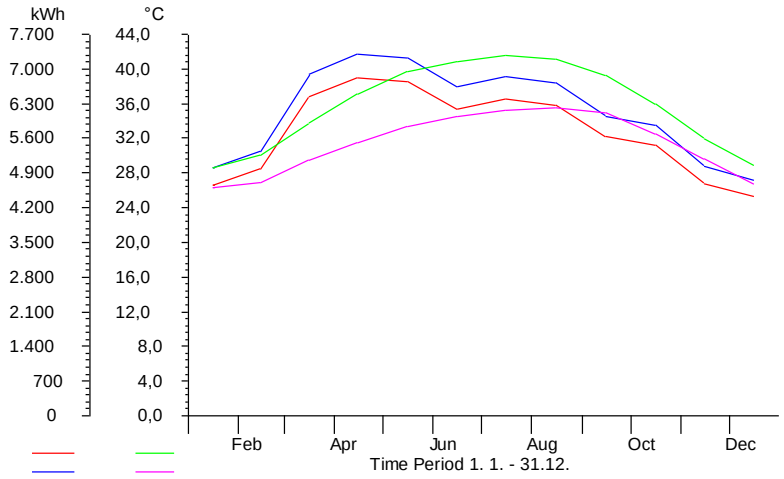
# Power generation “All areas in total”

**Total power : 46.9 kWp – Solar laminates and glass modules**

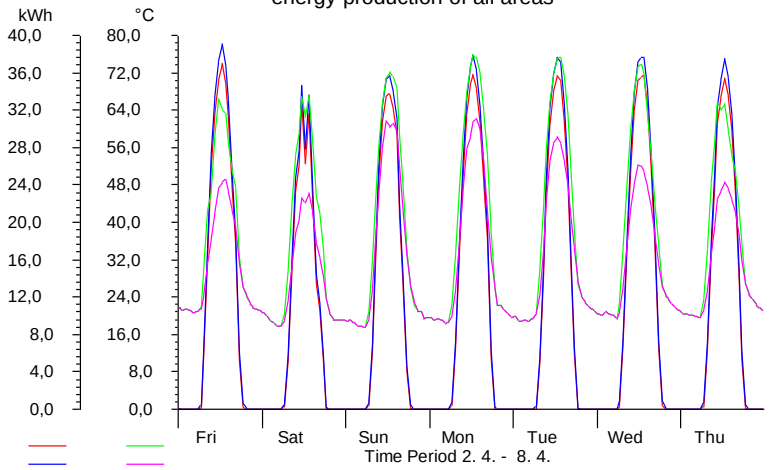


The total photovoltaic power of 46.9 kWp of all areas produces an annual electric power of approximately 68.713 kWh and avoids the emission of approximately 60.798 kg of carbon dioxide. The energy is feed-in into the ships electric network and is used for a lot of electric loads.

Example for the annual energy production of all areas




Example for the weekly energy production of all areas

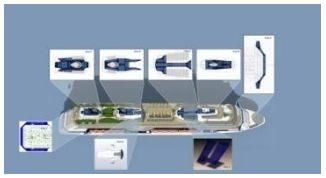



| | |
|---|---|
| Energy from Inverter (AC) 68.713 kWh | Energy Produced by PV Array 73.626 kWh |
| Module Temperature 1. TG 36 °C | Module Temperature 2. TG 31 °C |

| | |
|---|---|
| Energy from Inverter (AC) 1.759 kWh | Energy Produced by PV Array 1.875 kWh |
| Module Temperature 1. TG 37 °C | Module Temperature 2. TG 31 °C |

All energy data shown in this document depend on various boundary conditions like temperature, pollution, maintenance, weather conditions and so on and may diverge from this calculation.

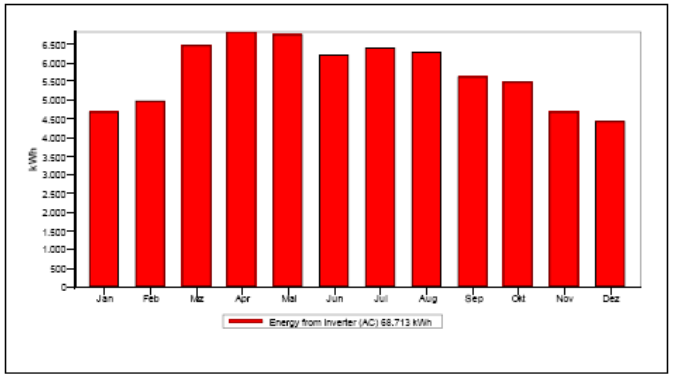
# Power generation “All areas in total”



## Irradiation and PV-system data

| | |
|---|---|
| Location: | Key West FL |
| Climate Data Record: | Key West FL |
| PV Output: | 46,96 kWp |
| Gross/Active PV Surface Area: | 586,21 / 586,97 m² |
| PV Array Irradiation: | 1.107.206 kWh |
| Energy Produced by PV Array (AC): | 68.713 kWh |
| Grid Feed-in: | 68.713 kWh |
| System Efficiency: | 6,2 % |
| Performance Ratio: | 77,5 % |
| Specific Annual Yield: | 1.461 kWh/kWp |
| CO2 Emissions Avoided: | 60.798 kg/a |

The results are determined by a mathematical model calculation. The actual yields of the photovoltaic system can deviate from these values due to fluctuations in the weather, the efficiency of modules and inverters, and other factors. The System Diagram above does not represent and cannot replace a full technical drawing of the solar system..




**Simulation Results for Total System:**

| | | | |
|---|---|---|---|
| Irradiation onto Horizontal: | 1.096.240 kWh | Own Use: | 92,5 kWh |
| PV Array Irradiation: | 1.107.206 kWh | Energy Produced by PV Array: | 73.626 kWh |
| Irradiation minus Reflection: | 1.054.719 kWh | System Efficiency: | 6,2 % |
| Energy from Inverter (AC): | 68.713 kWh | Performance Ratio: | 77,5 % |
| Consumption Requirement: | 0 kWh | Final Yield: | 4,0 h/d |
| Energy from Grid: | 91 kWh | Specific Annual Yield: | 1.461 kWh/kWp |