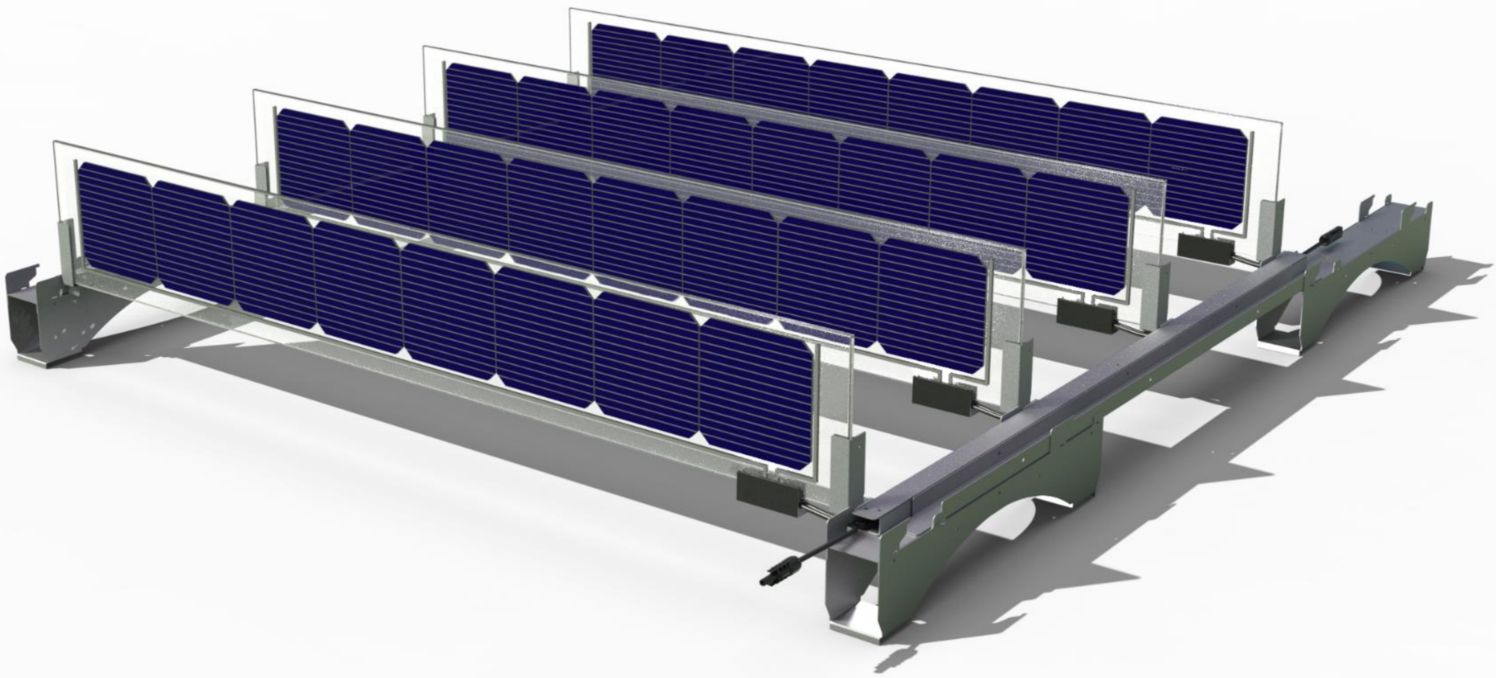
Over **Easy** Solar AS

String and Inverter onboarding



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www.overeasy.no
info@overeasy.no

Designing a solar PV system involves understanding several technical components, particularly when it comes to string sizing and inverter selection. Properly calculated string sizes are essential for efficient system performance and inverter longevity, as well as for maximizing energy production.

Understanding Key Components

1. **Inverter:**
   - The inverter converts DC electricity from the VPV units into AC electricity, which powers appliances and is compatible with the electrical grid.
2. Inverters optimize energy yield and manage DC input using **Maximum Power Point Trackers (MPPTs)** and by connecting to **strings** of solar panels.**Strings:**
   - A string is made up of VPV units connected in series (one after the other), which means the voltages add up with each VPV unit.
   - To calculate the string voltage, multiply the number of VPV units by the open-circuit voltage (V_{OC}) of each unit. At the time of writing, the V_{OC} for a VPV unit is 24.4 V. For example, with 10 VPV units, the total string voltage would be approximately 242 V. However, always refer to the latest datasheet to ensure you are using the current V_{OC} value.
3. **MPPTs:**
   - MPPTs are inputs that connect the strings to the inverter. An inverter may have multiple MPPTs (e.g. 12 per inverter in some models), with each MPPT handling up to two or three strings. Strings are connected in parallel to the MPPTs, ensuring they operate at the same voltage while allowing for different currents.
   - MPPTs continuously track and adjust the voltage and current of the VPV units to find the Maximum Power Point (MPP) and optimize power output.

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- For optimal efficiency, strings with different conditions (e.g., sunlight or orientation) should have separate MPPTs. Mixing them reduces performance as the MPPT can't fully optimize any one string's output. Additionally, all strings on the same MPPT must have the same number of VPV units.

Steps for Calculating Solar PV String Size

1. Maximum String Size Calculation

The maximum number of VPV units per string is limited by the inverter's input voltage limit, which should not be exceeded, especially on cold days when voltage rises, for safety and performance reasons.

- **Temperature Coefficient:** The voltage of the VPV units (V_{OC}) varies with temperature. As temperature decreases, the V_{OC} increases according to the unit's temperature coefficient (-0.27 %/°C).
- **Lowest Expected Temperature:** Use weather data or a standard source (e.g., SolarABCs in the USA) to find your area's lowest average annual temperature.
- **Calculate Maximum VPV Unit Voltage:**
    - V_{OC} (STC) = 24.2 V
    - Temp coefficient = -0.27 %/°C
    - Lowest expected temperature (example of Norway) = -25°C
    - Difference from STC (25°C): 25−(−25) = 50°C
    - Maximum Voltage: $24.2V \times \left(1 + \frac{50 \times 0.27}{100}\right) = 27.47V$
- **Determine Maximum VPV Units per String:** Divide the inverter's max voltage by the calculated Voc.
    - For a 1000 V inverter, max VPV units per string would be: $\frac{1000V}{27.47V} \sim 36$ VPV units per string.

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2. Minimum String Size Calculation

The minimum string size is determined by the inverter's minimum input voltage to avoid shutdown during high temperatures. As voltage decreases with increasing temperature, we must choose the maximum ambient temperature of the site.

- **Temperature Coefficient:** As temperature increases, the V_{OC} decreases according to the unit's temperature coefficient (-0.27 %/°C).
- **Maximum Ambient Temperature:** Use weather data or a standard source (e.g., SolarABCs in the USA).
- **Solar Cell Temperature:** Solar panels operate at temperatures much higher than ambient. How much hotter they get depends on the mounting method, since this affects the ventilation of the panels.
- **Minimum Inverter Voltage:** This information can be found from the inverter´s datasheet. In the case of a 1000 V inverter, it is approximately 120 V.
- **Determine Minimum VPV Unit Voltage (V_{MP}):** Calculate based on unit data, using the power temperature coefficient. For example:
  - V_{OC} = 24.2 V
  - Temp coefficient for power = -0.27 %/°C
  - Solar cell temperature = 64°C (34°C ambient + 30°C rooftop addition)
  - Difference from STC (25°C): 64−(25) = 39°C
  - Maximum Voltage: $24.2V \times \left(1 - \frac{39 \times 0.27}{100}\right) = 21.65V$
- **Minimum VPV Units per String:** Divide the inverter's minimum MPPT voltage by the minimum V_{OC}, rounding up.
  - For a 1000V inverter, min VPV units per string would be: $\frac{120V}{21.65V} \sim 6$ VPV units per string.

The calculations for maximum and minimum VPV units per string are done through the sheet ¨String 200W¨in the Excel 25-02-25 VPV-xM2 String 200W.xlsx

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Summary

1. **Verify Electrical Specifications:**

   - **String Voltage**: Must fall within the inverter's input voltage range.
   - **String Current**: Each string's short-circuit current should not exceed the inverter's input current. Check that the short-circuit current matches the inverter's capabilities.

Datasheet	MID 30KTL3-X2	MID 33KTL3-X2	MID 36KTL3-X2
Input data (DC)			
Max. recommended PV power (for module STC)	45000W	49500W	54000W
Max. DC voltage			1100V
Start voltage			200V
Normal voltage			600V
MPPT voltage range			200-1000V
No. of MPP trackers	2	3	3
No. of PV strings per MPP tracker	2/3	2	2
Max.input current per MPP tracker	32A/48A	32A	32A
Max. short-circuit current per MPP tracker	40A/60A	40A	40A

Figure 1: Example of inverter data sheet

2. **Managing Multiple Strings per MPPT:**

   - Each MPPT can support multiple strings, but check the maximum power and current limitations. Overloading an MPPT can reduce efficiency and risk overheating.

3. **Optimal String Connection for MPPT Performance:**

   - Connect strings with different conditions to separate MPPTs, maximizing output by reducing performance compromises between strings with different sunlight exposure or orientation.

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For any questions contact Over Easy Solar info@overeasy.no

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