# Grid-Connected System: Simulation parameters

**Project :** **Groningen**

| | | | | |
|---|---|---|---|---|
| **Geographical Site** | **Groningen** | | Country | **Netherlands** |
| **Situation** | Latitude | 53.22° N | Longitude | 6.57° E |
| Time defined as | Legal Time | Time zone UT+1 | Altitude | 11 m |
| | Albedo | 0.20 | | |
| **Meteo data:** | **Groningen** | Meteonorm 7.3 (1991-2010) - Synthetic | | |

**Simulation variant :** **New simulation variant**

| | | |
|---|---|---|
| | Simulation date | 29/06/20 21h12 |

| | | | | |
|---|---|---|---|---|
| **Simulation parameters** | System type | **No 3D scene defined, no shadings** | | |
| **Collector Plane Orientation** | Tilt | 35° | Azimuth | 0° |
| **Models used** | Transposition | Perez | Diffuse<br>Circumsolar | Perez, Meteonorm<br>separate |
| **Horizon** | Free Horizon | | | |
| **Near Shadings** | No Shadings | | | |
| **User's needs :** | Unlimited load (grid) | | | |

**PV Array Characteristics**

| | | | | |
|---|---|---|---|---|
| **PV module** Si-poly | Model | **TSM-320PEG14** | | |
| Original PVsyst database | Manufacturer | Trina Solar | | |
| Number of PV modules | In series | 19 modules | In parallel | 4 strings |
| Total number of PV modules | nb. modules | 76 | Unit Nom. Power | 320 Wp |
| Array global power | Nominal (STC) | **24.32 kWp** | At operating cond. | 21.82 kWp (50°C) |
| Array operating characteristics (50°C) | U mpp | 633 V | I mpp | 34 A |
| Total area | Module area | **149 m²** | Cell area | 133 m² |

| | | | | |
|---|---|---|---|---|
| **Inverter** | Model | **Sunny Tripower 25000TL-30** | | |
| Original PVsyst database | Manufacturer | SMA | | |
| Characteristics | Unit Nom. Power | **25.0 kWac** | Oper. Voltage | 390-800 V |
| Inverter pack | Total power | **25 kWac** | Pnom ratio | 0.97 |
| | Nb. of inverters | 1 units | | |
| **Total** | Total power | **25 kWac** | Pnom ratio | 0.97 |

**PV Array loss factors**

| | | | | |
|---|---|---|---|---|
| Thermal Loss factor | Uc (const) | 20.0 W/m²K | Uv (wind) | 0.0 W/m²K / m/s |
| Wiring Ohmic Loss | Global array res. | 310 mΩ | Loss Fraction | 1.5 % at STC |
| Module Quality Loss | | | Loss Fraction | -0.4 % |
| Module mismatch losses | | | Loss Fraction | 1.0 % at MPP |
| Strings Mismatch loss | | | Loss Fraction | 0.10 % |
| Incidence effect, ASHRAE parametrization | IAM = | 1 - bo (1/cos i - 1) | bo Param. | 0.05 |

# Grid-Connected System: Main results

**Project :** **Groningen**

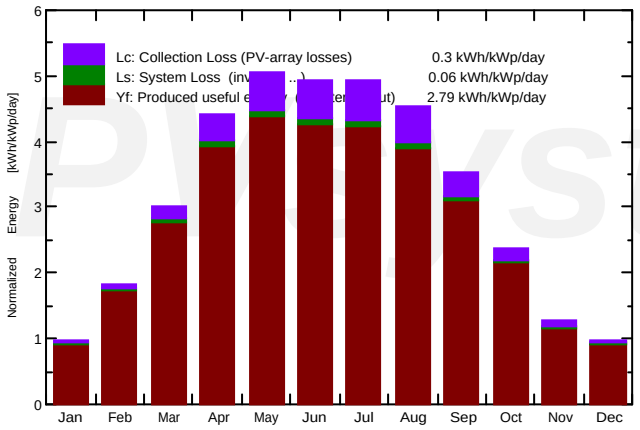
**Simulation variant :** **New simulation variant**

| **Main system parameters** | | | | |
|---|---|---|---|---|
| System type | | **No 3D scene defined, no shadings** | | |
| PV Field Orientation | tilt | 35° | azimuth | 0° |
| PV modules | Model | TSM-320PEG14 | Pnom | 320 Wp |
| PV Array | Nb. of modules | 76 | Pnom total | **24.32 kWp** |
| Inverter | Model | Sunny Tripower 25000TL-30 | | 25.00 kW ac |
| User's needs | Unlimited load (grid) | | | |

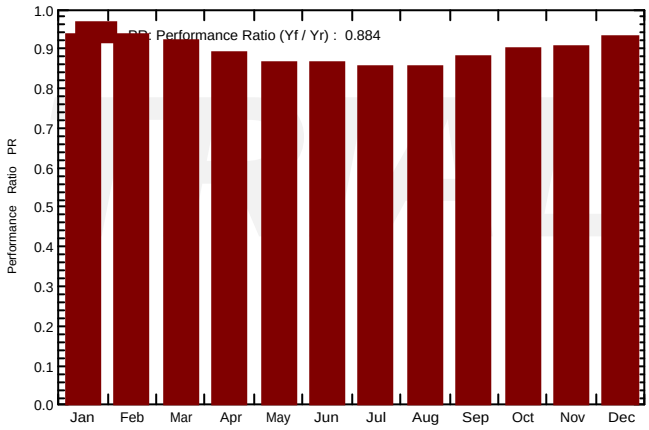
**Main simulation results**

| | | | | |
|---|---|---|---|---|
| System Production | **Produced Energy** | **24.80 MWh/year** | Specific prod. | 1020 kWh/kWp/year |
| | Performance Ratio PR | 88.37 % | | |
| Investment | Global | 0.00 EUR | Specific | 0.00 EUR/Wp |
| Yearly cost | Annuities | 0.00 EUR/yr | Running Costs | 0.00 EUR/yr |
| LCOE | | **0.00 EUR/kWh** | Payback period | **Unprofitable** |

**Normalized productions (per installed kWp): Nominal power 24.32 kWp**




**Performance Ratio PR**




New simulation variant

Balances and main results

| | GlobHor kWh/m² | DiffHor kWh/m² | T_Amb °C | GlobInc kWh/m² | GlobEff kWh/m² | EArray MWh | E_Grid MWh | PR ratio |
|---|---|---|---|---|---|---|---|---|
| January | 18.1 | 13.79 | 3.06 | 30.9 | 30.0 | 0.725 | 0.703 | 0.937 |
| February | 33.3 | 22.10 | 3.29 | 51.7 | 50.3 | 1.210 | 1.180 | 0.939 |
| March | 69.6 | 42.82 | 5.39 | 93.3 | 90.4 | 2.142 | 2.094 | 0.924 |
| April | 113.4 | 61.76 | 9.36 | 132.2 | 127.3 | 2.929 | 2.867 | 0.892 |
| May | 148.6 | 73.09 | 13.12 | 156.2 | 150.1 | 3.365 | 3.293 | 0.867 |
| June | 151.1 | 85.42 | 15.66 | 147.5 | 141.6 | 3.178 | 3.110 | 0.867 |
| July | 152.2 | 83.63 | 17.75 | 152.9 | 147.1 | 3.259 | 3.190 | 0.858 |
| August | 128.4 | 73.31 | 17.73 | 140.8 | 135.1 | 3.003 | 2.940 | 0.859 |
| September | 85.2 | 50.66 | 14.32 | 105.6 | 101.9 | 2.312 | 2.262 | 0.881 |
| October | 49.9 | 30.33 | 10.44 | 74.1 | 72.0 | 1.661 | 1.623 | 0.900 |
| November | 21.0 | 12.92 | 6.93 | 38.4 | 37.2 | 0.871 | 0.847 | 0.908 |
| December | 14.0 | 9.24 | 2.97 | 30.4 | 29.4 | 0.709 | 0.688 | 0.930 |
| Year | 984.9 | 559.06 | 10.04 | 1153.9 | 1112.4 | 25.362 | 24.798 | 0.884 |

Legends:

| | | | |
|---|---|---|---|
| GlobHor | Global horizontal irradiation | GlobEff | Effective Global, corr. for IAM and shadings |
| DiffHor | Horizontal diffuse irradiation | EArray | Effective energy at the output of the array |
| T_Amb | T amb. | E_Grid | Energy injected into grid |
| GlobInc | Global incident in coll. plane | PR | Performance Ratio |

# Grid-Connected System: Special graphs

**Project :** **Groningen**

**Simulation variant :** **New simulation variant**

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| PV Array | Nb. of modules | 76 | Pnom total | **24.32 kWp** |
| Inverter | Model | Sunny Tripower 25000TL-30 | | 25.00 kW ac |
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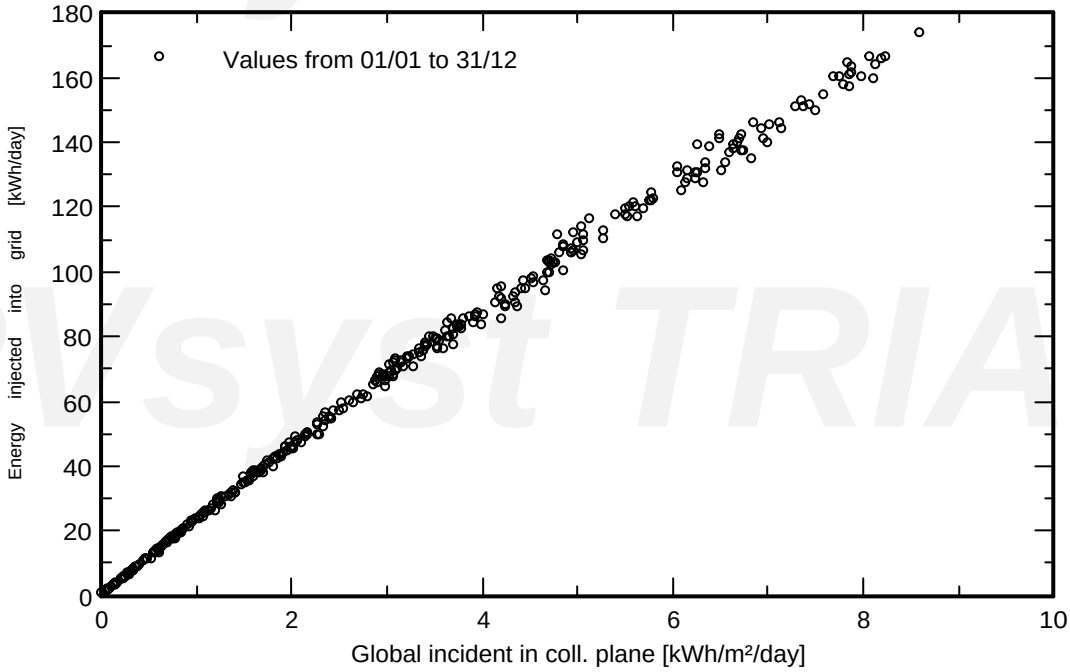
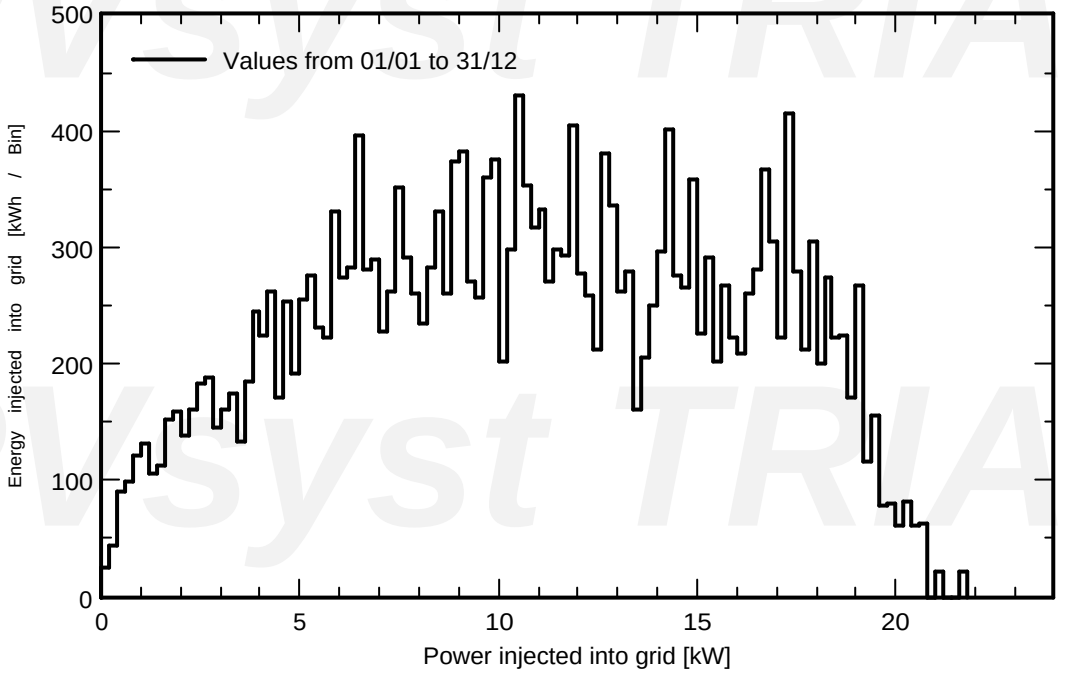
## Daily Input/Output diagram




## System Output Power Distribution



# Grid-Connected System: Loss diagram

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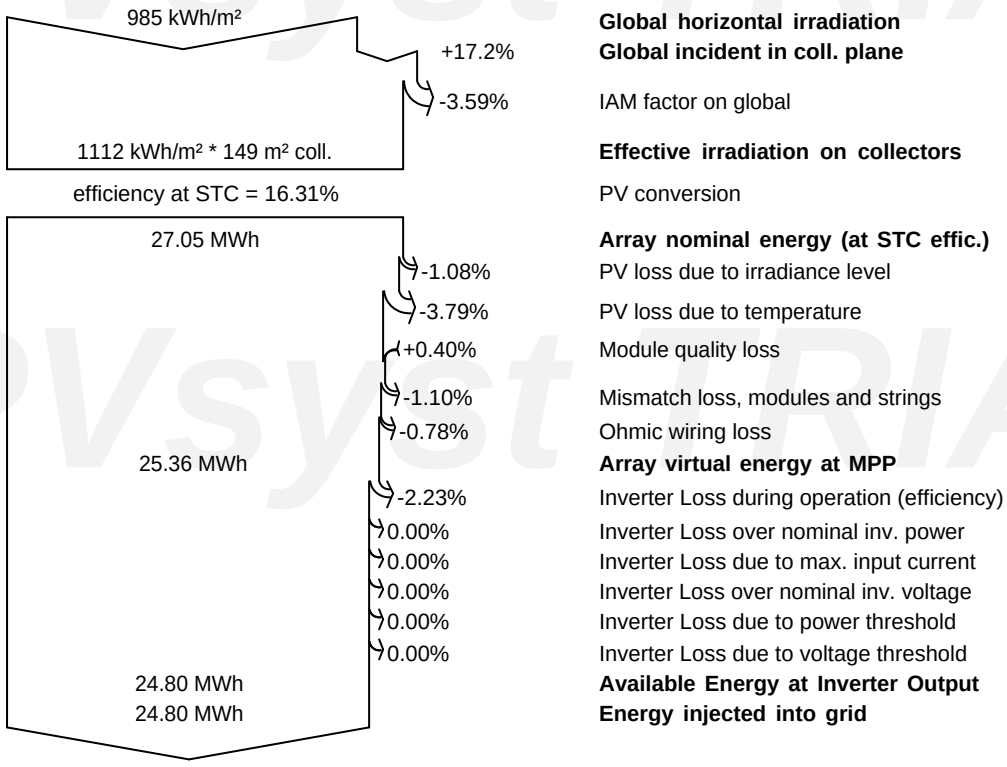
**Loss diagram over the whole year**




**Global horizontal irradiation**
**Global incident in coll. plane**
IAM factor on global
**Effective irradiation on collectors**
PV conversion
**Array nominal energy (at STC effic.)**
PV loss due to irradiance level
PV loss due to temperature
Module quality loss
Mismatch loss, modules and strings
Ohmic wiring loss
**Array virtual energy at MPP**
Inverter Loss during operation (efficiency)
Inverter Loss over nominal inv. power
Inverter Loss due to max. input current
Inverter Loss over nominal inv. voltage
Inverter Loss due to power threshold
Inverter Loss due to voltage threshold
**Available Energy at Inverter Output**
**Energy injected into grid**

# Grid-Connected System: Cost of the system

**Project :** **Groningen**

**Simulation variant :** **New simulation variant**

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| Inverter | Model | Sunny Tripower 25000TL-30 | | 25.00 kW ac |
| User's needs | Unlimited load (grid) | | | |

**Installation costs**

| | |
|---|---|
| **Total** | **0.00 EUR** |
| Depreciable asset | 0.00 EUR |

**Operating costs**

| | |
|---|---|
| **Total (OPEX)** | **0.00 EUR/year** |

**System summary**

| | |
|---|---|
| Total installation cost | **0.00 EUR** |
| Operating costs | **0.00 EUR/year** |
| Produced Energy | **24.8 MWh/year** |
| Cost of produced energy (LCOE) | **0.000 EUR/kWh** |

# Grid-Connected System: CO2 Balance

**Project :** **Groningen**

**Simulation variant :** **New simulation variant**

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| | | | | |
|---|---|---|---|---|
| **Generated emissions** | **Total:** | **43.81 tCO$_2$** | | |
| | Source: | Detailed calculation from table below: | | |
| **Replaced Emissions** | **Total:** | **316.2 tCO$_2$** | | |
| | System production: | 24.80 MWh/yr | Lifetime: | 30 years |
| | | | Annual degradation: | 1.0% |
| | Grid Lifecycle Emissions: | 425 gCO$_2$/kWh | | |
| | Source: | IEA List | Country: | Netherlands |
| **CO$_2$ Emission Balance** | **Total:** | **230.5 tCO$_2$** | | |

**System Lifecycle Emissions Details:**

| Item | Modules | Supports |
|---|---|---|
| LCE | 1713 kgCO2/kWp | 2.83 kgCO2/kg |
| Quantity | 24.3 kWp | 760 kg |
| Subtotal [kgCO$_2$] | 41653 | 2154 |

**Saved CO$_2$ Emission vs. Time**