Grid-Connected System: Simulation parameters

Project : **Dept of Admin**

Geographical Site	**Minneapolis**		Country	**United States**
Situation	Latitude	44.88° N	Longitude	-93.22° W
Time defined as	Legal Time	Time zone UT-6	Altitude	251 m
	Albedo	0.20		
Meteo data:	**Minneapolis**	MeteoNorm 7.1 station - Synthetic		

Simulation variant : **As Built 65.5kwdc / 61.7kwac**

	Simulation date	19/11/19 15h19

Simulation parameters	System type	**Unlimited sheds**		
Collector Plane Orientation	Tilt	10°	Azimuth	0°
Sheds configuration	Nb. of sheds	5	Unlimited sheds	
	Sheds spacing	1.50 m	Collector width	1.00 m
Inactive band	Top	0.02 m	Bottom	0.20 m
Shading limit angle	Limit profile angle	19.7°	Ground cov. Ratio (GCR)	66.7 %
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Mutual shadings of sheds			
User's needs :	Unlimited load (grid)			

PV Arrays Characteristics (5 kinds of array defined)

PV module	Si-mono	Model	**72M-370**	
Custom parameters definition		Manufacturer	Heliene Inc	
Sub-array "Sub-array #1"				
Number of PV modules		In series	16 modules	In parallel 3 strings
Total number of PV modules		Nb. modules	48	Unit Nom. Power 370 Wp
Array global power		Nominal (STC)	**17.76 kWp**	At operating cond. 16.18 kWp (50°C)
Array operating characteristics (50°C)		U mpp	581 V	I mpp 28 A
Sub-array "Sub-array #2"				
Number of PV modules		In series	15 modules	In parallel 1 strings
Total number of PV modules		Nb. modules	15	Unit Nom. Power 370 Wp
Array global power		Nominal (STC)	**5.55 kWp**	At operating cond. 5.06 kWp (50°C)
Array operating characteristics (50°C)		U mpp	545 V	I mpp 9.3 A
Sub-array "Sub-array #3"				
Number of PV modules		In series	16 modules	In parallel 3 strings
Total number of PV modules		Nb. modules	48	Unit Nom. Power 370 Wp
Array global power		Nominal (STC)	**17.76 kWp**	At operating cond. 16.18 kWp (50°C)
Array operating characteristics (50°C)		U mpp	581 V	I mpp 28 A
Sub-array "Sub-array #4"				
Number of PV modules		In series	15 modules	In parallel 2 strings
Total number of PV modules		Nb. modules	30	Unit Nom. Power 370 Wp
Array global power		Nominal (STC)	**11.10 kWp**	At operating cond. 10.11 kWp (50°C)
Array operating characteristics (50°C)		U mpp	545 V	I mpp 19 A
Sub-array "Sub-array #5"				
Number of PV modules		In series	12 modules	In parallel 3 strings
Total number of PV modules		Nb. modules	36	Unit Nom. Power 370 Wp
Array global power		Nominal (STC)	**13.32 kWp**	At operating cond. 12.13 kWp (50°C)
Array operating characteristics (50°C)		U mpp	436 V	I mpp 28 A

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Total	Arrays global power	Nominal (STC)	**65 kWp**	Total	177 modules
		Module area	**343 m²**	Cell area	306 m²

Sub-array "Sub-array #1" : Inverter	Model	**Symo Advanced 22.7-3 / 480_OND**		
Custom parameters definition	Manufacturer	Fronius USA		
Characteristics	Operating Voltage	200-800 V	Unit Nom. Power	22.7 kWac
Inverter pack	Nb. of inverters	1 * MPPT 0.57	Total Power	12.9 kWac
			Pnom ratio	1.38
Sub-array "Sub-array #2" : Inverter	Model	**Symo Advanced 22.7-3 / 440_OND**		
Custom parameters definition	Manufacturer	Fronius USA		
Characteristics	Operating Voltage	200-800 V	Unit Nom. Power	22.7 kWac
Inverter pack	Nb. of inverters	1 * MPPT 0.43	Total Power	9.8 kWac
			Pnom ratio	0.57
Sub-array "Sub-array #3" : Inverter	Model	**Symo Advanced 24.0-3 / 480_OND**		
Custom parameters definition	Manufacturer	Fronius USA		
Characteristics	Operating Voltage	200-800 V	Unit Nom. Power	24.0 kWac
Inverter pack	Nb. of inverters	1 * MPPT 0.57	Total Power	13.7 kWac
			Pnom ratio	1.30
Sub-array "Sub-array #4" : Inverter	Model	**Symo Advanced 22.7-3 / 440_OND**		
Custom parameters definition	Manufacturer	Fronius USA		
Characteristics	Operating Voltage	200-800 V	Unit Nom. Power	22.7 kWac
Inverter pack	Nb. of inverters	1 * MPPT 0.43	Total Power	9.8 kWac
			Pnom ratio	1.13
Sub-array "Sub-array #5" : Inverter	Model	**Symo 15.0-3 / 440**		
Original PVsyst database	Manufacturer	Fronius USA		
Characteristics	Operating Voltage	200-800 V	Unit Nom. Power	15.0 kWac
Inverter pack	Nb. of inverters	1 * MPPT 0.57	Total Power	15.0 kWac
			Pnom ratio	0.89
Total	Nb. of inverters	3	Total Power	61 kWac

PV Array loss factors

Array Soiling Losses — Average loss Fraction 5.8 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
12.0%	9.0%	6.0%	4.0%	2.0%	1.0%	1.0%	1.0%	3.0%	6.0%	9.0%	15.0%

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	347 mOhm	Loss Fraction	1.5 % at STC
	Array#2	975 mOhm	Loss Fraction	1.5 % at STC
	Array#3	347 mOhm	Loss Fraction	1.5 % at STC
	Array#4	487 mOhm	Loss Fraction	1.5 % at STC
	Array#5	260 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
Serie Diode Loss	Voltage Drop	0.7 V	Loss Fraction	0.1 % at STC
LID - Light Induced Degradation			Loss Fraction	2.0 %
Module Quality Loss			Loss Fraction	-0.3 %
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

System loss factors

	Wires: 3x70.0 mm²	42 m	Loss Fraction	0.9 % at STC
Unavailability of the system	7.3 days, 5 periods		Time fraction	2.0 %

Grid-Connected System: Main results

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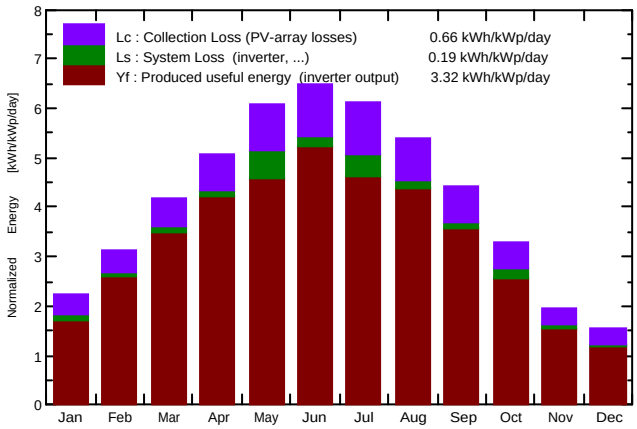
Simulation variant : **As Built 65.5kwdc / 61.7kwac**

Main system parameters				
System type	**Unlimited sheds**			
PV Field Orientation	Sheds disposition, tilt	10°	azimuth	0°
PV modules	Model	72M-370	Pnom	370 Wp
PV Array	Nb. of modules	177	Pnom total	**65.5 kWp**
Inverter	Symo Advanced 22.7-3 / 480_OND		Pnom	22.70 kW ac
Inverter	Symo Advanced 22.7-3 / 440_OND		Pnom	22.70 kW ac
Inverter	Symo Advanced 24.0-3 / 480_OND		Pnom	24.00 kW ac
Inverter	Symo 15.0-3 / 440		Pnom	15.00 kW ac
Inverter pack	Nb. of units	3.0	Pnom total	**61.1 kW ac**
User's needs	Unlimited load (grid)			

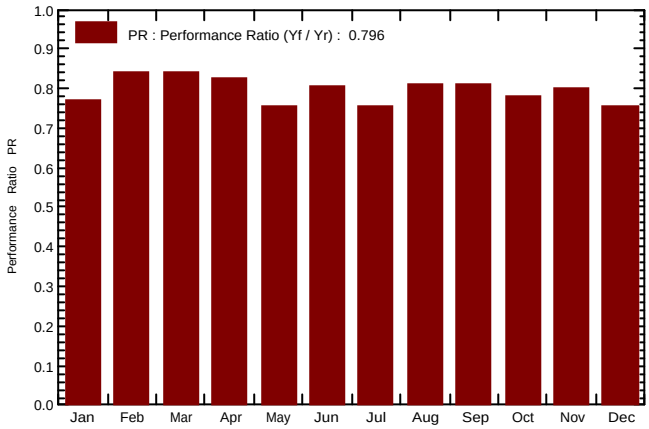
Main simulation results

System Production	**Produced Energy**	**79.29 MWh/year**	Specific prod.	1211 kWh/kWp/year
	Performance Ratio PR	79.63 %		

Normalized productions (per installed kWp): Nominal power 65.5 kWp



Performance Ratio PR



As Built 65.5kwdc / 61.7kwac

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
January	53.4	22.20	-7.98	69.0	56.8	3.75	3.49	0.771
February	72.5	30.50	-6.62	87.2	75.4	4.95	4.79	0.839
March	114.4	46.30	0.43	129.2	116.2	7.36	7.13	0.842
April	142.9	63.10	8.97	152.7	140.7	8.56	8.28	0.828
May	182.9	75.20	14.91	188.3	177.2	10.46	9.32	0.756
June	192.5	80.70	20.53	195.0	185.6	10.67	10.31	0.807
July	186.5	80.80	24.01	190.0	180.9	10.27	9.38	0.754
August	160.1	78.00	22.23	167.4	159.0	9.20	8.89	0.811
September	120.7	53.50	17.44	132.5	123.1	7.28	7.04	0.811
October	87.3	37.50	9.62	102.1	91.4	5.62	5.22	0.780
November	47.8	23.20	2.45	58.7	50.3	3.18	3.07	0.799
December	37.5	20.20	-6.28	48.2	37.7	2.48	2.39	0.755
Year	1398.5	611.19	8.39	1520.3	1394.3	83.77	79.29	0.796

Legends:

GlobHor	Horizontal global 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

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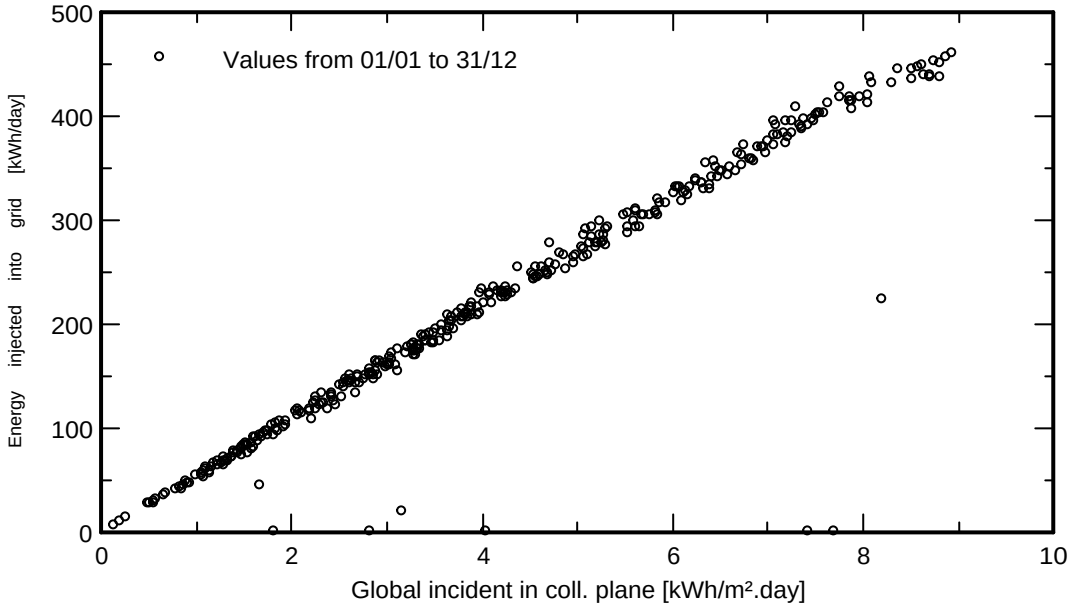
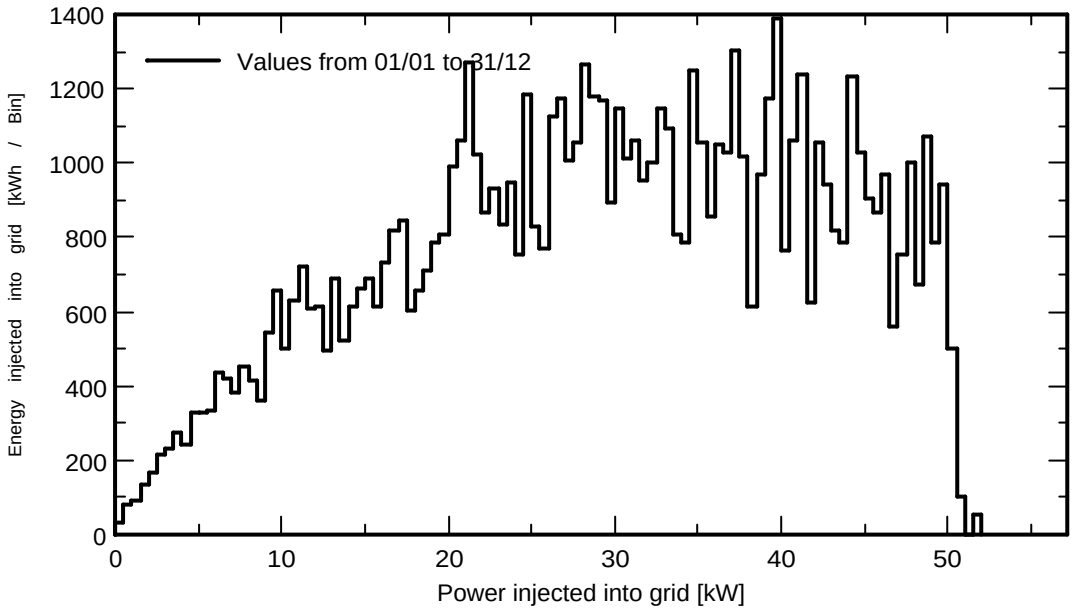
Inverter	Symo Advanced 24.0-3 / 480_OND		Pnom	24.00 kW ac
Inverter	Symo 15.0-3 / 440		Pnom	15.00 kW ac
Inverter pack	Nb. of units	3.0	Pnom total	**61.1 kW ac**
User's needs	Unlimited load (grid)			

Daily Input/Output diagram



System Output Power Distribution



Grid-Connected System: Loss diagram

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Inverter	Symo Advanced 22.7-3 / 440_OND		Pnom	22.70 kW ac
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Inverter	Symo 15.0-3 / 440		Pnom	15.00 kW ac
Inverter pack	Nb. of units	3.0	Pnom total	**61.1 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year