Grid-Connected System: Simulation parameters

Project : **Department of Transportation**

Geographical Site	**Minneapolis-St Paul**		Country	**United States**
Situation	Latitude	44.88° N	Longitude	-93.22° W
Time defined as	Legal Time	Time zone UT-6	Altitude	262 m
	Albedo	0.20		
Meteo data:	**Minneapolis**	MeteoNorm 7.1 station - Synthetic		

Simulation variant : **As Built 86.9kwdc_72kwac**

	Simulation date	15/11/19 13h20

Simulation parameters	System type	**Unlimited sheds**			
Collector Plane Orientation	Tilt	10°		Azimuth	30°
Sheds configuration	Nb. of sheds	13		Unlimited sheds	
	Sheds spacing	1.50 m		Collector width	1.00 m
Inactive band	Top	0.02 m		Bottom	0.02 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 (2 kinds of array defined)

PV module	Si-mono	Model	**72M-365**		
Custom parameters definition		Manufacturer	Heliene Inc		
Sub-array "Sub-array #1"					
Number of PV modules		In series	17 modules	In parallel	8 strings
Total number of PV modules		Nb. modules	136	Unit Nom. Power	365 Wp
Array global power		Nominal (STC)	**49.6 kWp**	At operating cond.	45.0 kWp (50°C)
Array operating characteristics (50°C)		U mpp	607 V	I mpp	74 A
Sub-array "Sub-array #2"					
Number of PV modules		In series	17 modules	In parallel	6 strings
Total number of PV modules		Nb. modules	102	Unit Nom. Power	365 Wp
Array global power		Nominal (STC)	**37.2 kWp**	At operating cond.	33.7 kWp (50°C)
Array operating characteristics (50°C)		U mpp	607 V	I mpp	56 A
Total	Arrays global power	Nominal (STC)	**87 kWp**	Total	238 modules
		Module area	**462 m²**	Cell area	411 m²

Inverter		Model	**Symo 24.0-3 / 480**		
Original PVsyst database		Manufacturer	Fronius USA		
Characteristics		Operating Voltage	200-800 V	Unit Nom. Power	24.0 kWac
Sub-array "Sub-array #1"		Nb. of inverters	3 * MPPT 0.57	Total Power	41 kWac
				Pnom ratio	1.21
Sub-array "Sub-array #2"		Nb. of inverters	3 * MPPT 0.43	Total Power	31 kWac
				Pnom ratio	1.21
Total		Nb. of inverters	3	Total Power	72 kWac

PV Array loss factors

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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	137 mOhm	Loss Fraction	1.5 % at STC
	Array#2	183 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
LID - Light Induced Degradation			Loss Fraction	0.5 %
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: 3x120.0 mm²	51 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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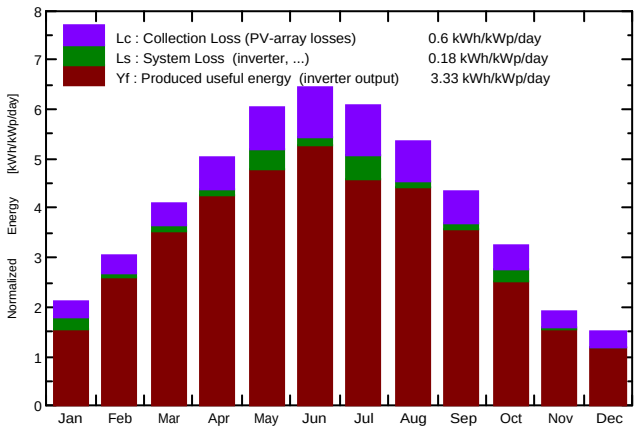
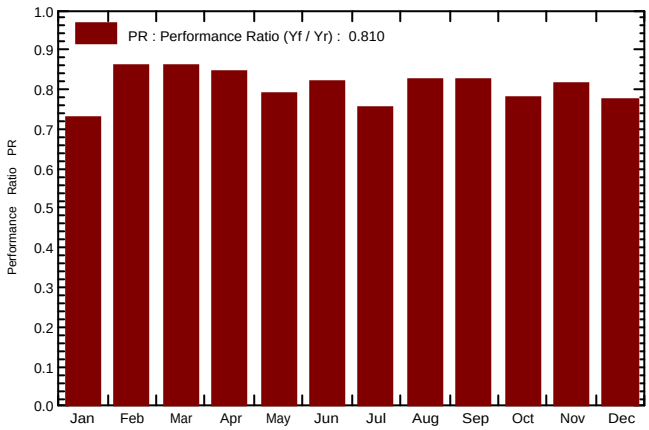
Main system parameters				
	System type	**Unlimited sheds**		
PV Field Orientation	Sheds disposition, tilt	10°	azimuth	30°
PV modules	Model	72M-365	Pnom	365 Wp
PV Array	Nb. of modules	238	Pnom total	**86.9 kWp**
Inverter	Model	Symo 24.0-3 / 480	Pnom	24.00 kW ac
Inverter pack	Nb. of units	3.0	Pnom total	**72.0 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**105.6 MWh/year**	Specific prod.	1216 kWh/kWp/year
	Performance Ratio PR	81.03 %		

Normalized productions (per installed kWp): Nominal power 86.9 kWp



Performance Ratio PR



As Built 86.9kwdc_72kwac

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	66.2	54.0	4.87	4.20	0.730
February	72.5	30.50	-6.62	85.1	73.1	6.54	6.37	0.861
March	114.4	46.30	0.43	127.4	114.1	9.81	9.55	0.863
April	142.9	63.10	8.97	151.2	139.1	11.44	11.13	0.847
May	182.9	75.20	14.91	187.5	176.6	14.02	12.91	0.793
June	192.5	80.70	20.53	193.1	183.8	14.18	13.78	0.821
July	186.5	80.80	24.01	188.4	179.3	13.65	12.35	0.755
August	160.1	78.00	22.23	165.8	157.1	12.21	11.87	0.824
September	120.7	53.50	17.44	130.4	120.9	9.63	9.36	0.827
October	87.3	37.50	9.62	100.4	89.3	7.43	6.83	0.783
November	47.8	23.20	2.45	57.6	48.9	4.21	4.09	0.816
December	37.5	20.20	-6.28	46.9	36.4	3.26	3.16	0.775
Year	1398.5	611.19	8.39	1500.2	1372.7	111.24	105.59	0.810

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

Grid-Connected System: Special graphs

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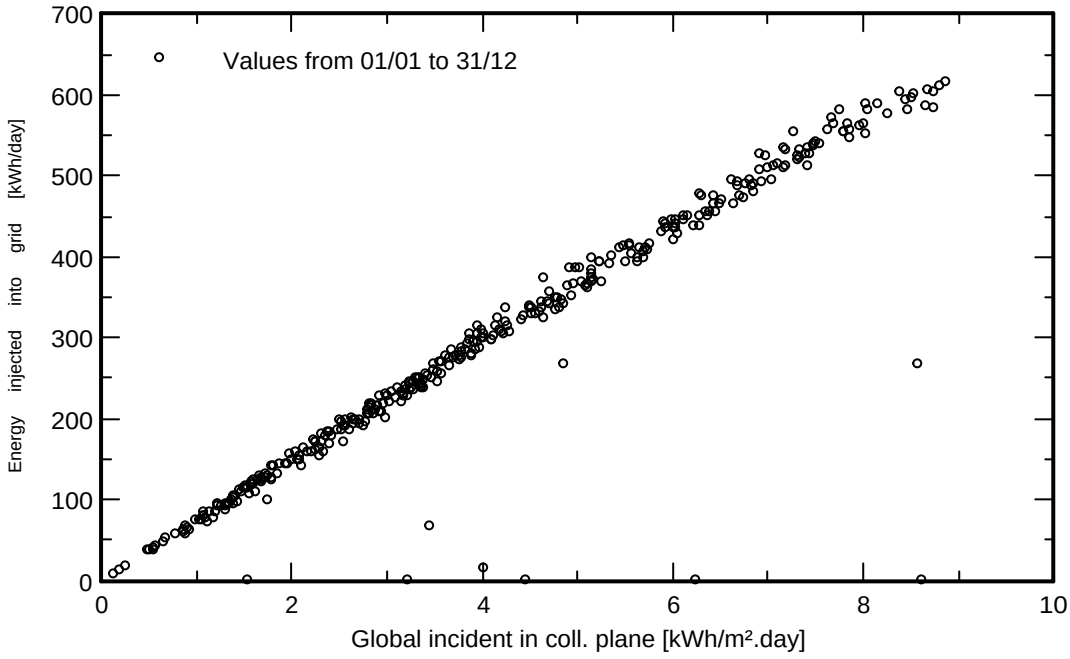
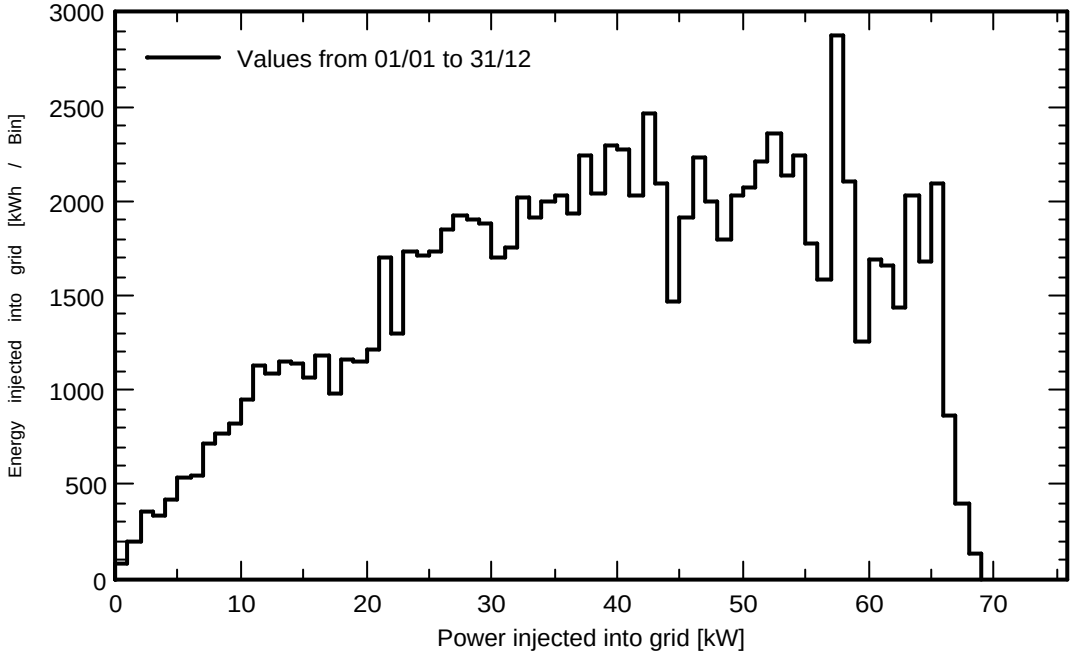
User's needs		Unlimited load (grid)			

Daily Input/Output diagram



System Output Power Distribution



Grid-Connected System: Loss diagram

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Loss diagram over the whole year