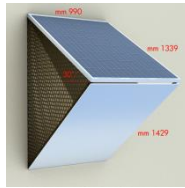


RETROFIT

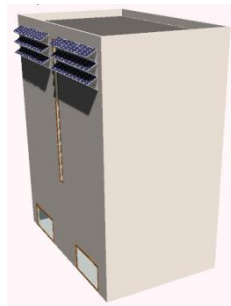


Simulation Assumptions:

- ✓ Location: Rome, 41°53'25" North, 12°29'39" East, Elevation: 34 m a.s.l.
- ✓ Inclination: 30°
- ✓ Orientation: 0°
- ✓ Panel: producer Solsonica s.p.a - model S608 S – nominal power 180W – dimension 1347x998x45
- ✓ Number of panels: 60
- ✓ Nominal power of the PV system: 10.8 kW (crystalline silicon)

.SIMULATION 1

.Row distance: 0m

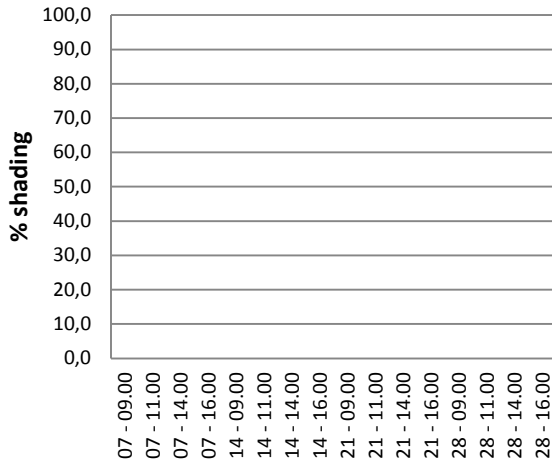


.Shading Table: Shadow percentage referring to random periods

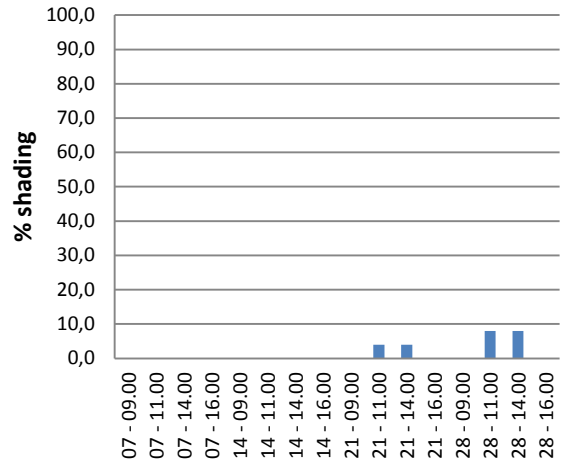
day	hour	January	February	March	April	May	June	July	August	September	October	November	December
7	09.00	0,0	0,0	8,0	41,0	66,0	78,0	82,5	66,0	37,0	8,0	0,0	0,0
	11.00	0,0	0,0	16,5	37,0	53,5	62,0	62,0	53,5	33,0	12,0	0,0	0,0
	14.00	0,0	0,0	16,5	37,0	53,5	62,0	62,0	57,5	33,0	12,0	0,0	0,0
	16.00	0,0	0,0	8,0	45,5	70,0	82,5	82,5	66,0	41,0	4,0	0,0	0,0
14	09.00	0,0	0,0	16,5	49,5	70,0	78,5	78,5	57,5	33,0	0,0	0,0	0,0
	11.00	0,0	0,0	20,0	41,0	57,5	62,0	62,0	49,5	37,0	4,0	0,0	0,0
	14.00	0,0	0,0	20,0	41,0	57,5	66,0	62,0	49,5	29,0	4,0	0,0	0,0
	16.00	0,0	0,0	12,0	49,5	74,0	82,5	78,0	62,0	33,0	0,0	0,0	0,0
21	09.00	0,0	0,0	32,0	54,0	70,0	82,5	74,0	53,5	24,0	0,0	0,0	0,0
	11.00	0,0	4,0	24,0	55,0	57,5	62,0	57,5	45,5	24,0	2,0	0,0	0,0
	14.00	0,0	4,0	24,0	45,0	57,5	66,0	41,0	45,5	24,0	0,0	0,0	0,0
	16.00	0,0	0,0	24,0	57,5	78,0	82,5	74,0	54,0	24,0	0,0	0,0	0,0
28	09.00	0,0	0,0	33,0	57,5	74,0	82,5	70,0	49,5	16,5	0,0	0,0	0,0
	11.00	0,0	8,0	33,0	49,5	57,5	62,0	53,5	37,0	20,0	0,0	0,0	0,0
	14.00	0,0	8,0	29,0	49,5	62,0	66,0	41,0	41,0	20,0	0,0	0,0	0,0
	16.00	0,0	0,0	33,0	62,0	82,5	82,5	70,0	49,5	16,5	0,0	0,0	0,0

.Shading Graphics

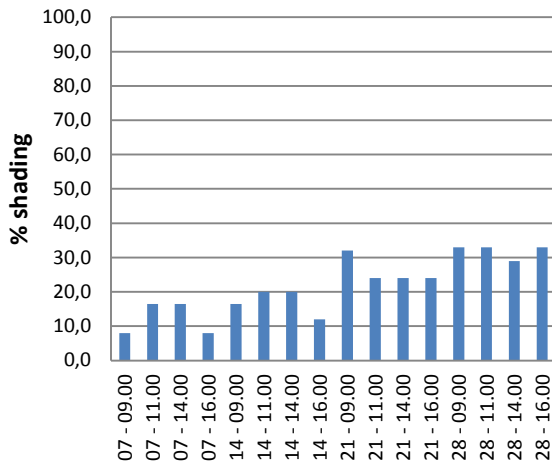
January



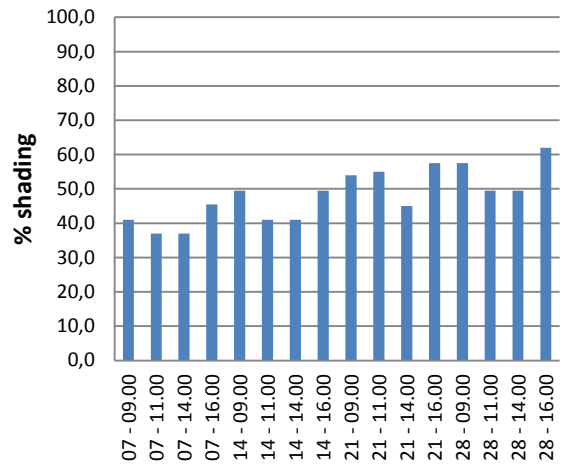
February



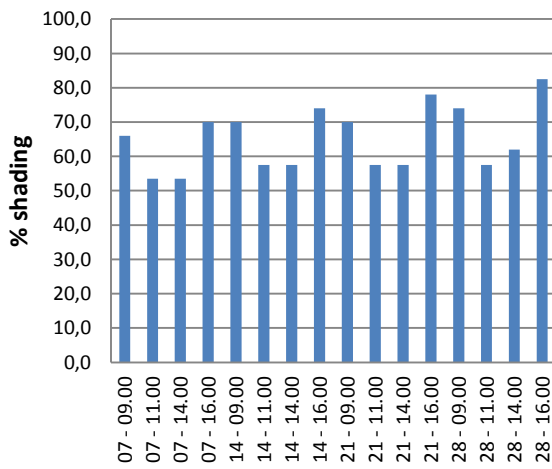
March



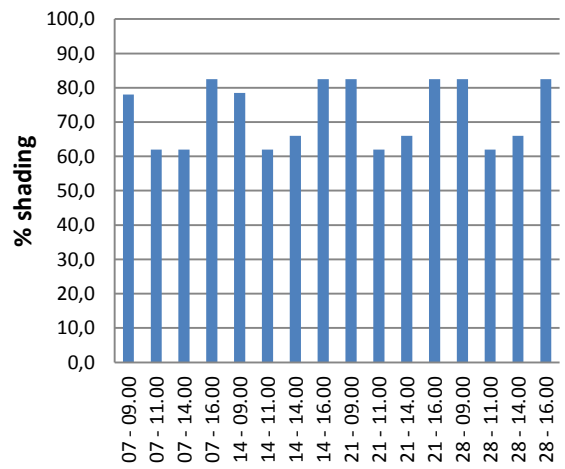
April



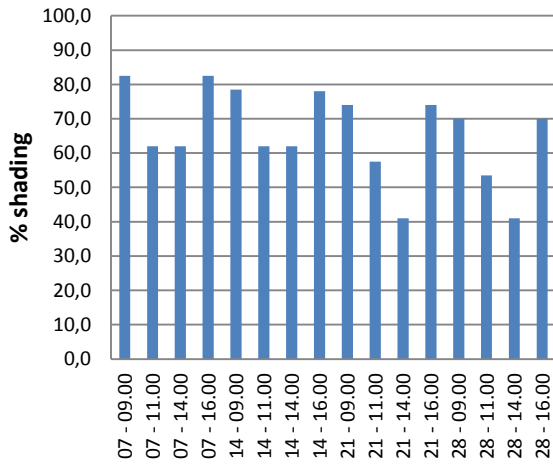
May



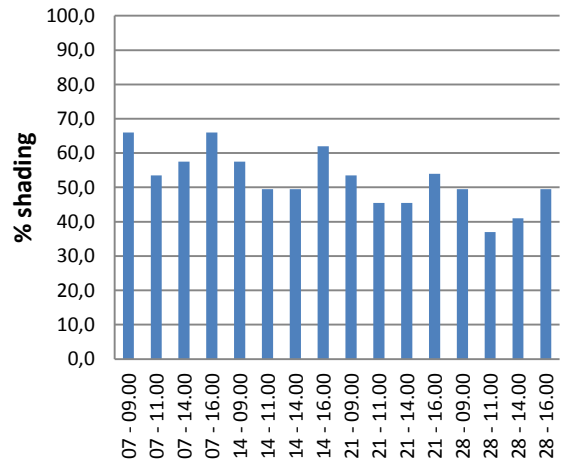
June



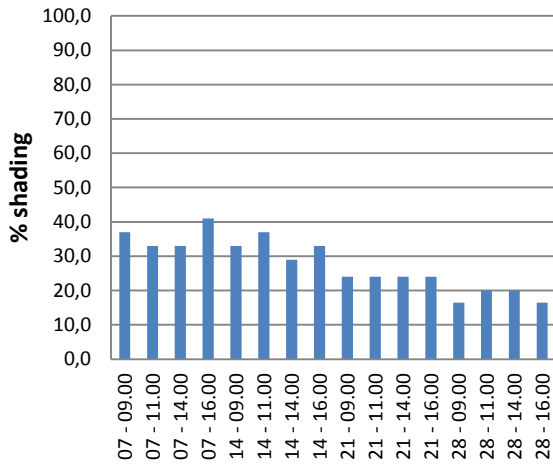
July



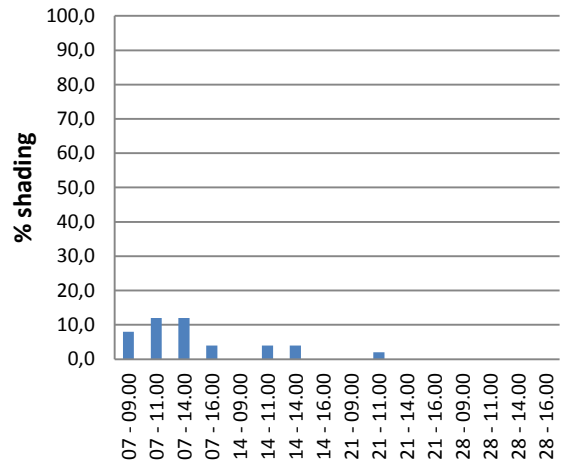
August



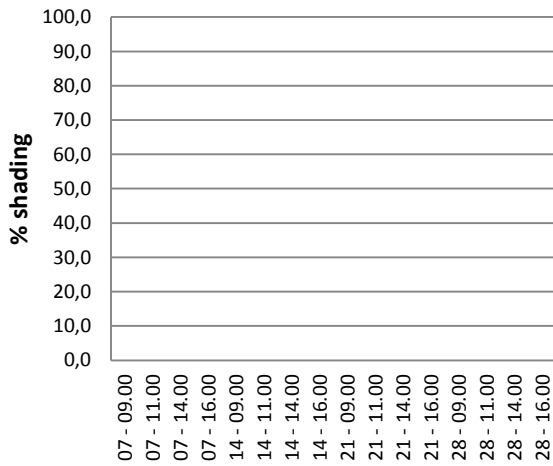
September



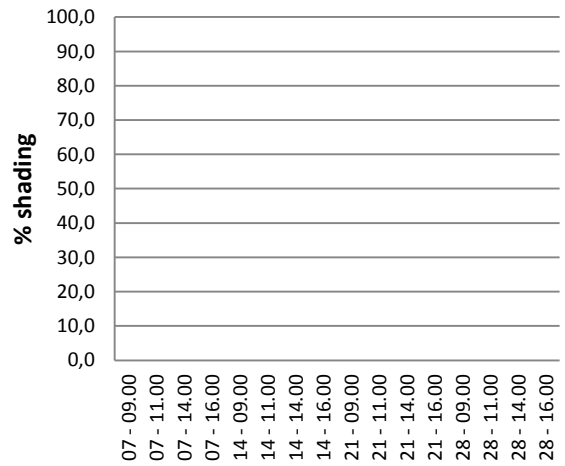
October



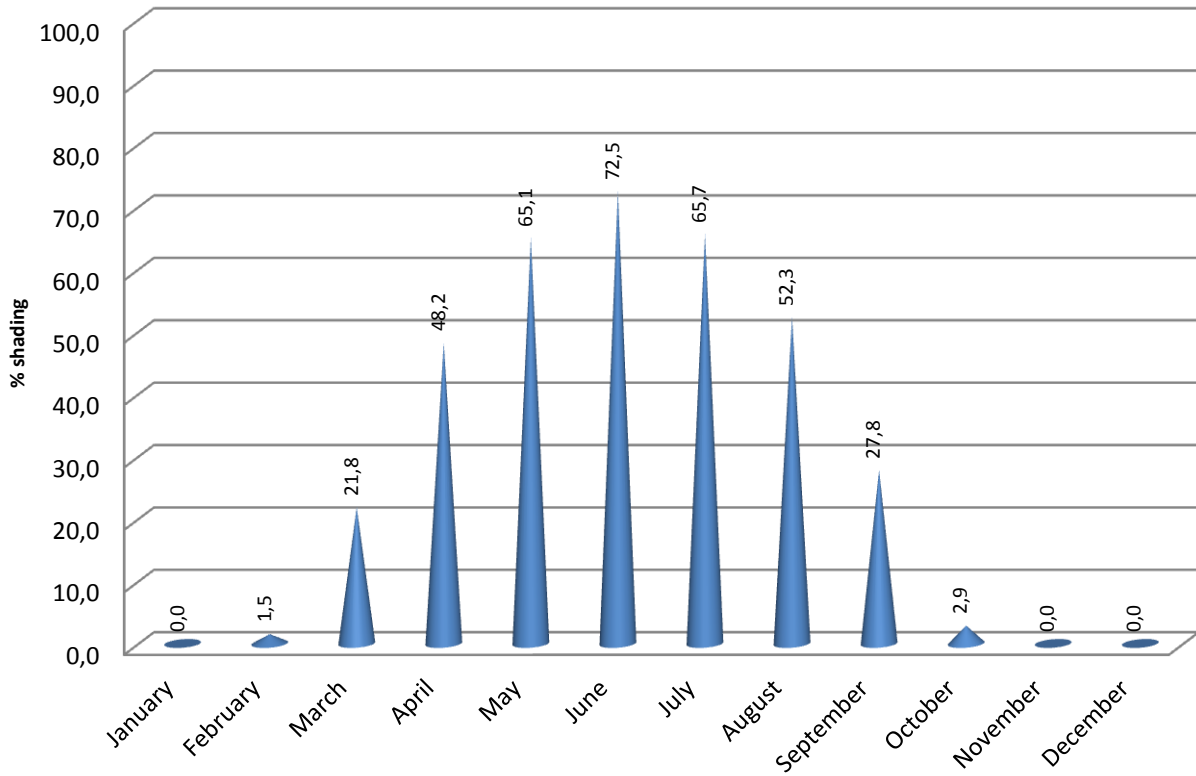
November



December



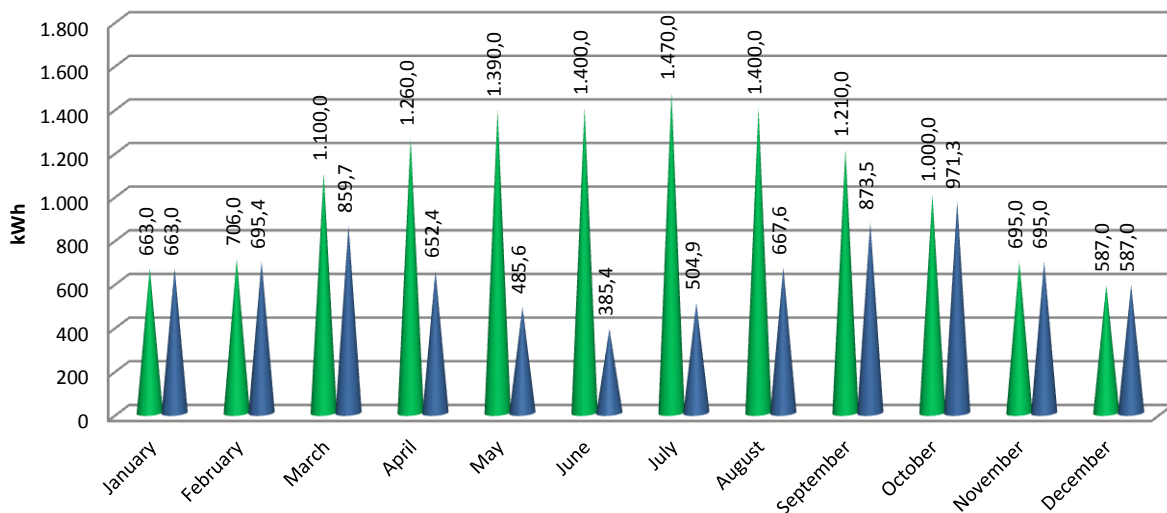
.Average Shading



.Performance of Grid-connected PV

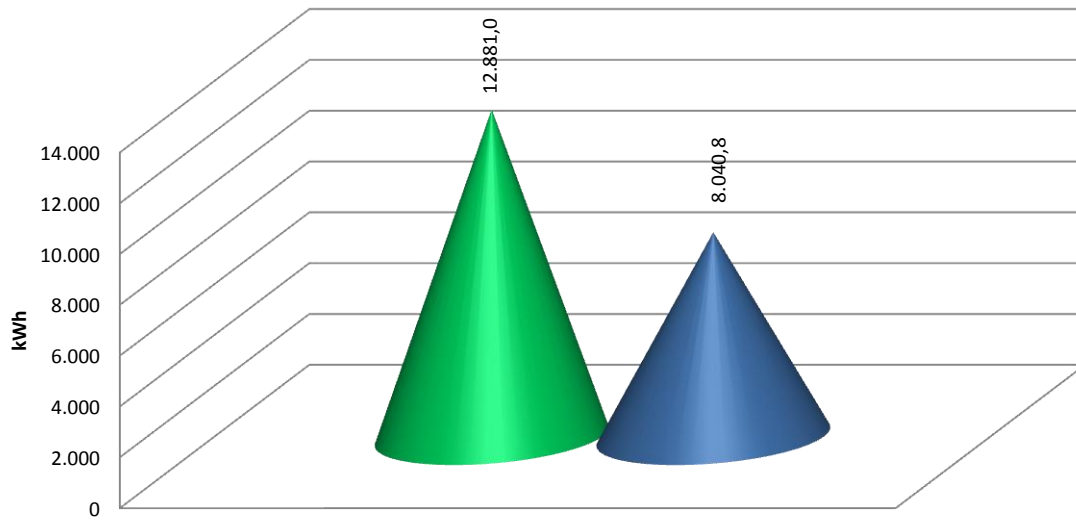
Simulation Assumptions:

- ✓ Solar radiation database used: PVGIS-classic
- ✓ Estimated losses due to temperature: 14.7% (using local ambient temperature)
- ✓ Estimated loss due to angular reflectance effects: 2.7%
- ✓ Other losses (cables, inverter etc.): 14.0%
- ✓ Combined PV system losses: 28.6%



Green bar: Average monthly electricity production from the given system [PVGIS Estimation]

Blue bar: Average monthly electricity production minus the percent shade

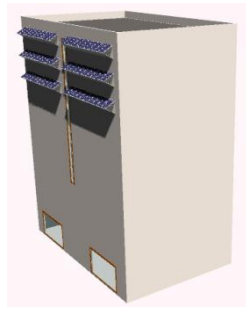


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

Blue bar: Average yearly electricity production minus the percent shade

..SIMULATION 2

..Row distance: 1,5m

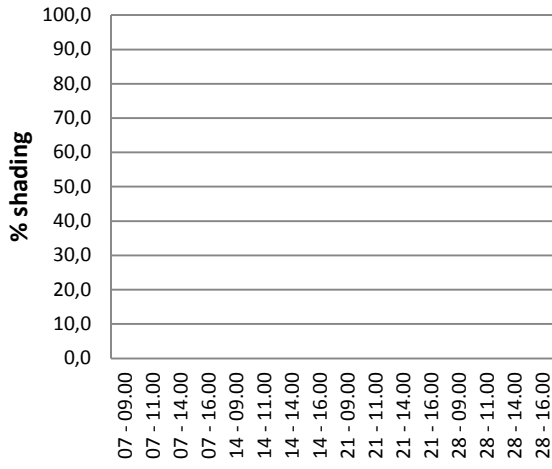


..Shading Table: Shadow percentage referring to random periods

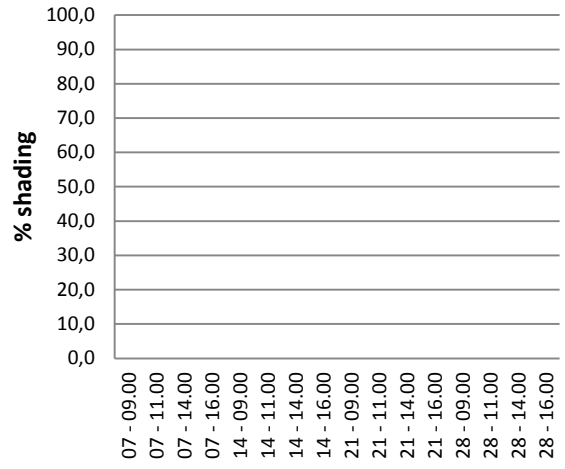
day	hour	January	February	March	April	May	June	July	August	September	October	November	December
7	09.00	0,0	0,0	0,0	0,0	17,5	33,0	36,0	17,5	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	12,0	24,5	22,0	10,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	29,5	50,0	48,0	24,0	0,0	0,0	0,0	0,0
14	09.00	0,0	0,0	0,0	0,0	22,0	35,0	31,5	10,5	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	14,5	25,5	19,5	2,5	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	5,0	36,0	51,0	46,0	14,5	0,0	0,0	0,0	0,0
21	09.00	0,0	0,0	0,0	16,0	18,0	36,0	29,0	6,5	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	26,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	20,0	26,0	17,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	14,5	39,5	51,0	37,5	8,0	0,0	0,0	0,0	0,0
28	09.00	0,0	0,0	0,0	10,5	28,5	36,0	24,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	4,5	22,0	24,5	24,5	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	20,5	44,0	50,0	32,5	4,0	0,0	0,0	0,0	0,0

..Shading Graphics

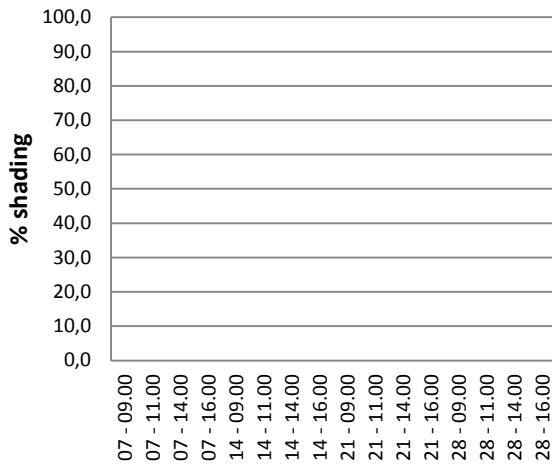
January



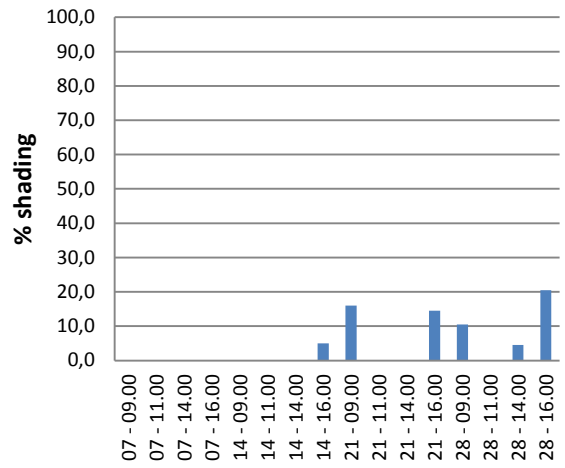
February



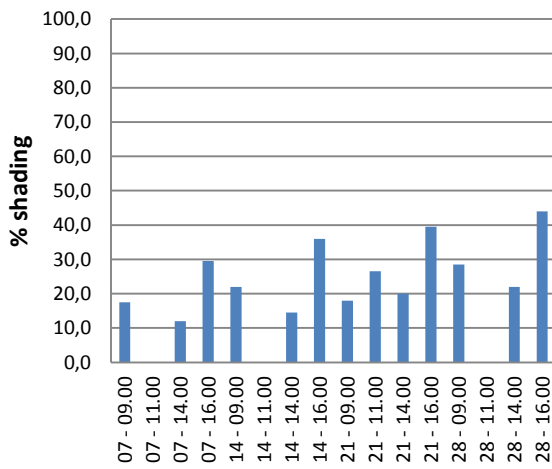
March



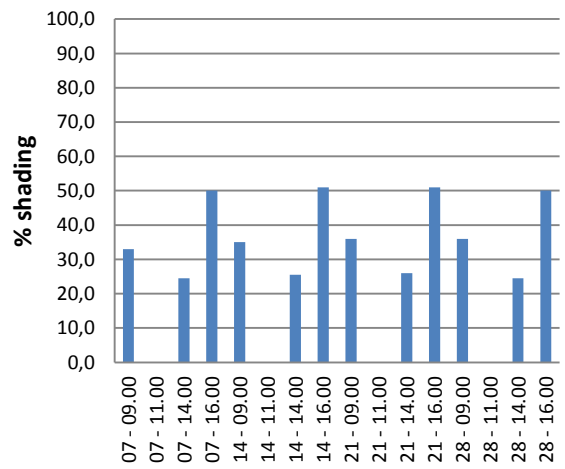
April



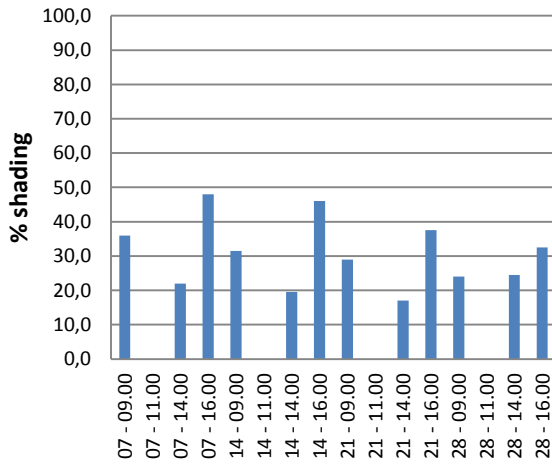
May



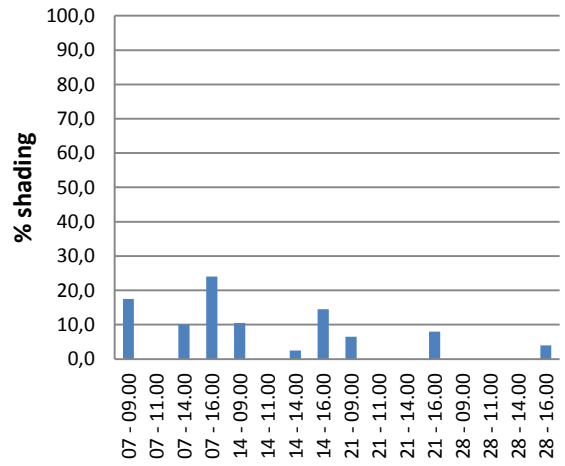
June



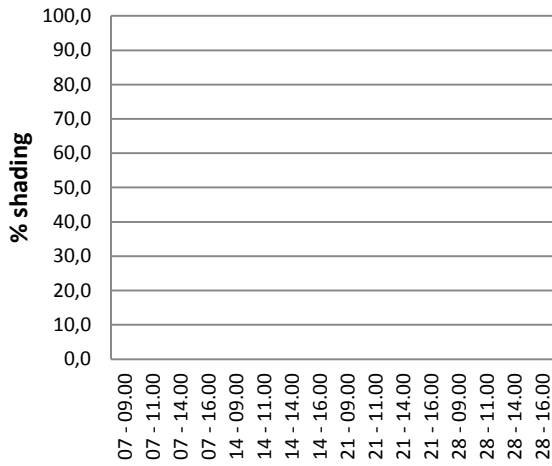
July



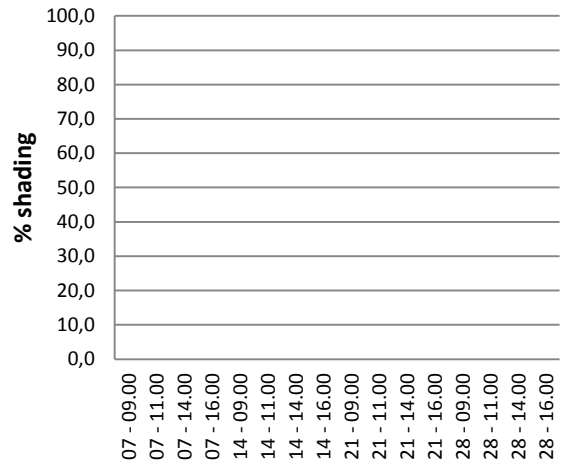
August



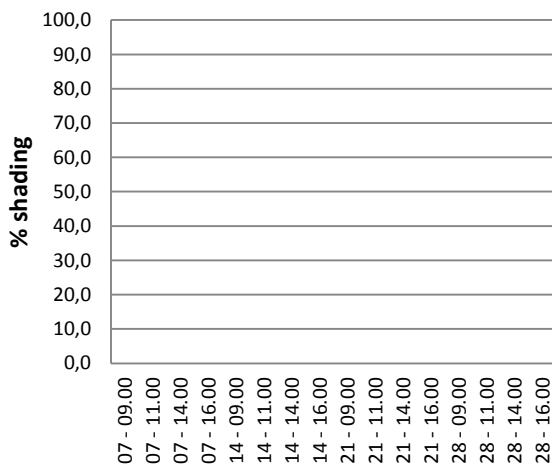
September



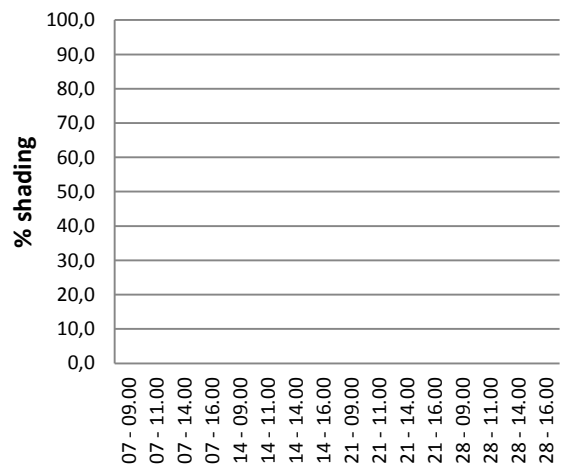
October



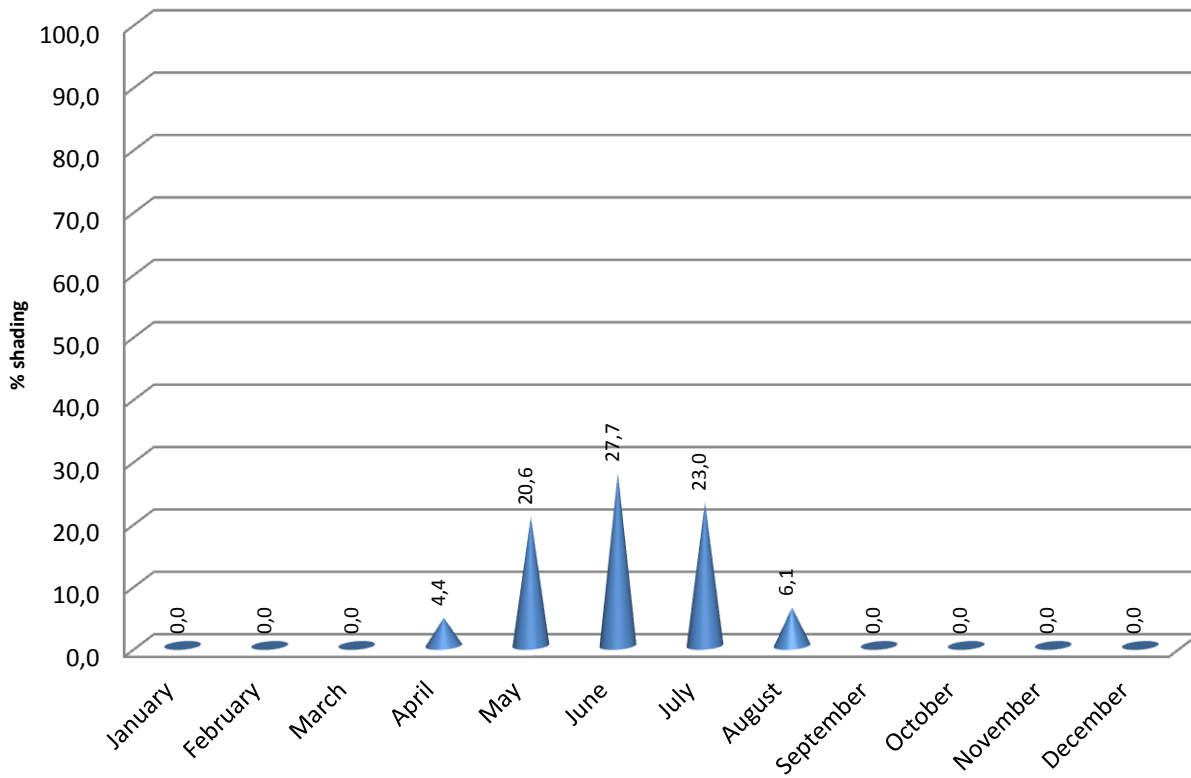
November



December



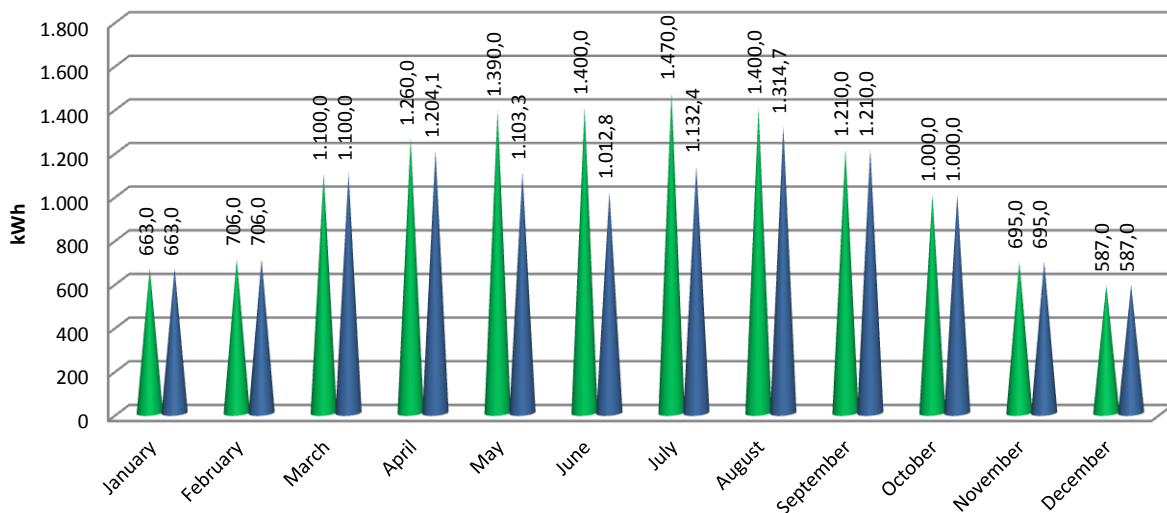
..Average Shading



..Performance of Grid-connected PV

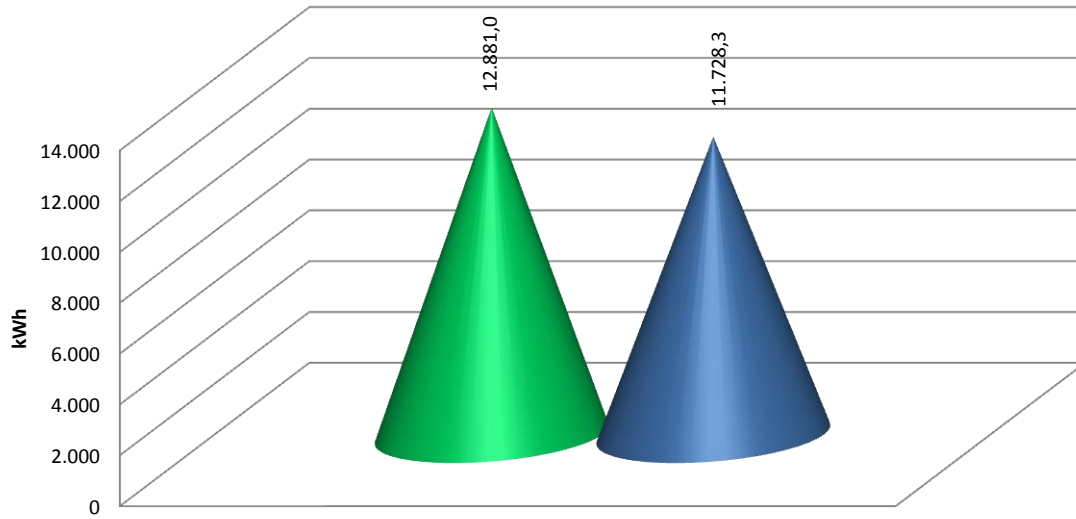
Simulation Assumptions:

- ✓ Solar radiation database used: PVGIS-classic
- ✓ Estimated losses due to temperature: 14.7% (using local ambient temperature)
- ✓ Estimated loss due to angular reflectance effects: 2.7%
- ✓ Other losses (cables, inverter etc.): 14.0%
- ✓ Combined PV system losses: 28.6%



Green bar: Average monthly electricity production from the given system [PVGIS Estimation]

Blue bar: Average monthly electricity production minus the percent shade

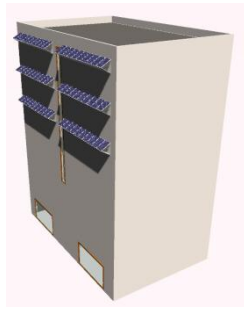


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

Blue bar: Average yearly electricity production minus the percent shade

...SIMULATION 3

...Row distance: 3m

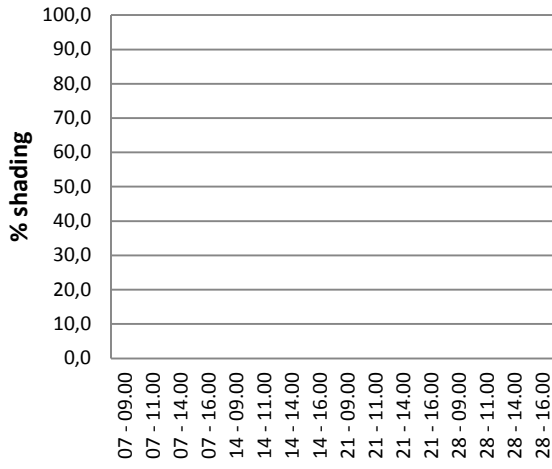


...Shading Table: Shadow percentage referring to random periods

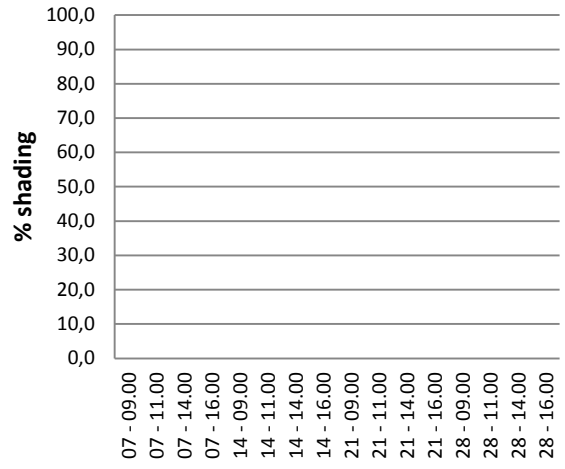
day	hour	January	February	March	April	May	June	July	August	September	October	November	December
7	09.00	0,0	0,0	0,0	0,0	0,0	28,5	22,5	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	4,0	2,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	16,0	44,0	35,0	9,0	0,0	0,0	0,0	0,0
14	09.00	0,0	0,0	0,0	0,0	3,7	24,5	18,5	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	6,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	25,0	47,0	31,0	2,0	0,0	0,0	0,0	0,0
21	09.00	0,0	0,0	0,0	0,0	12,0	25,0	16,5	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	6,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	34,0	46,0	27,0	0,0	0,0	0,0	0,0	0,0
28	09.00	0,0	0,0	0,0	0,0	16,5	26,0	10,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	2,0	6,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	5,0	37,0	41,0	20,5	0,0	0,0	0,0	0,0	0,0

...Shading Graphics

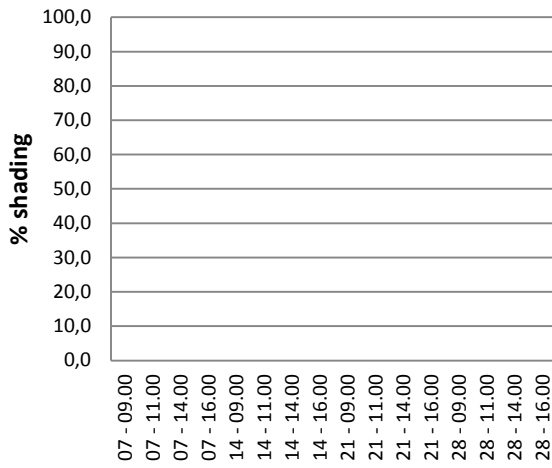
January



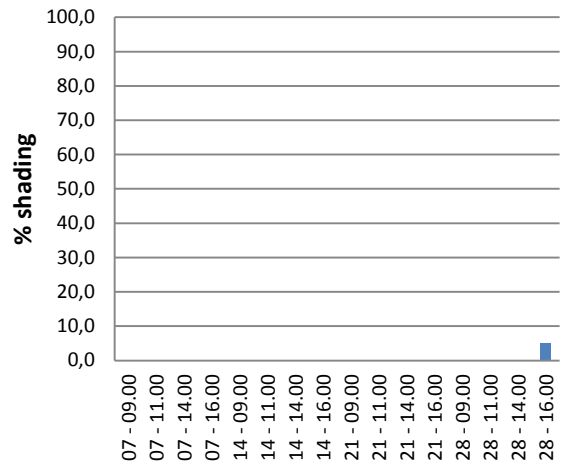
February



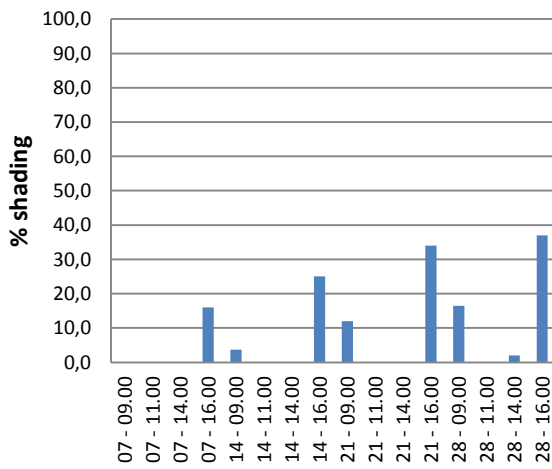
March



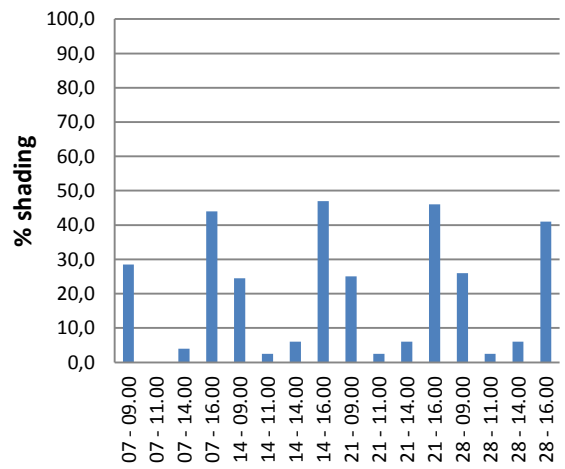
April



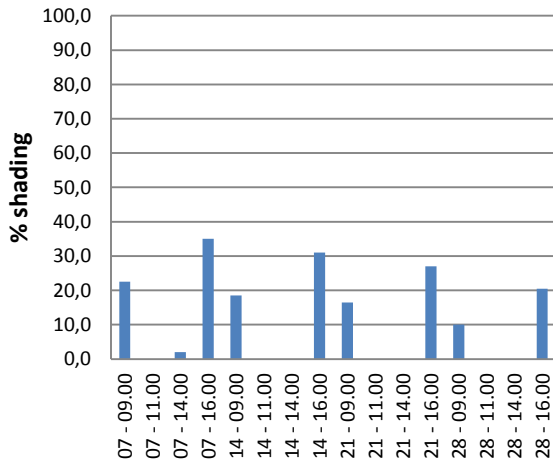
May



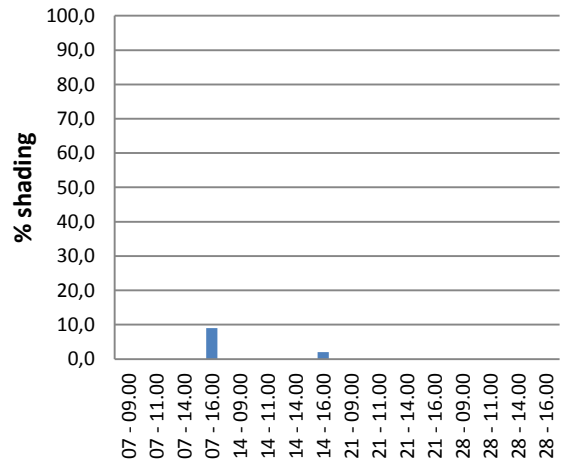
June



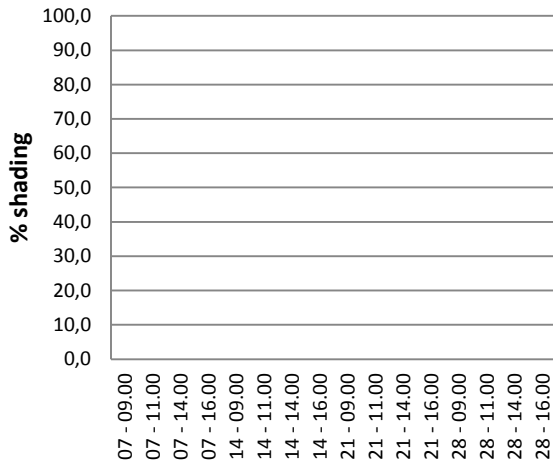
July



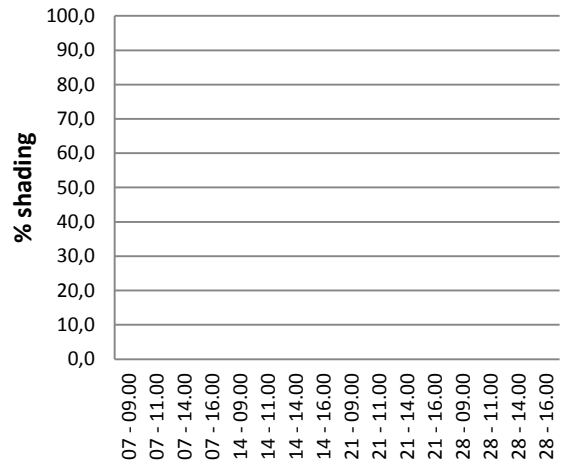
August



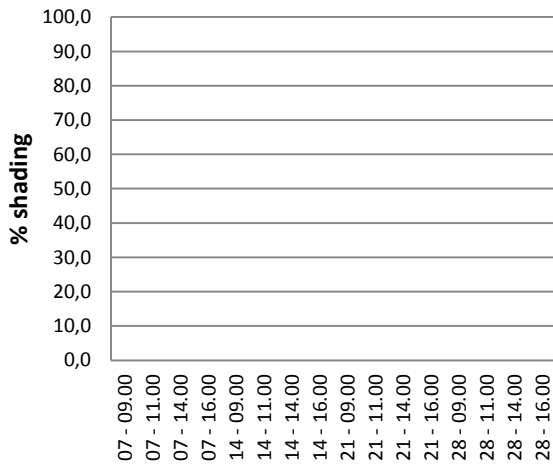
September



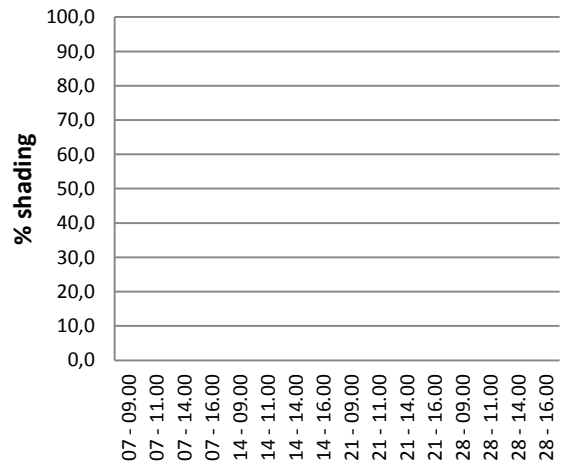
October



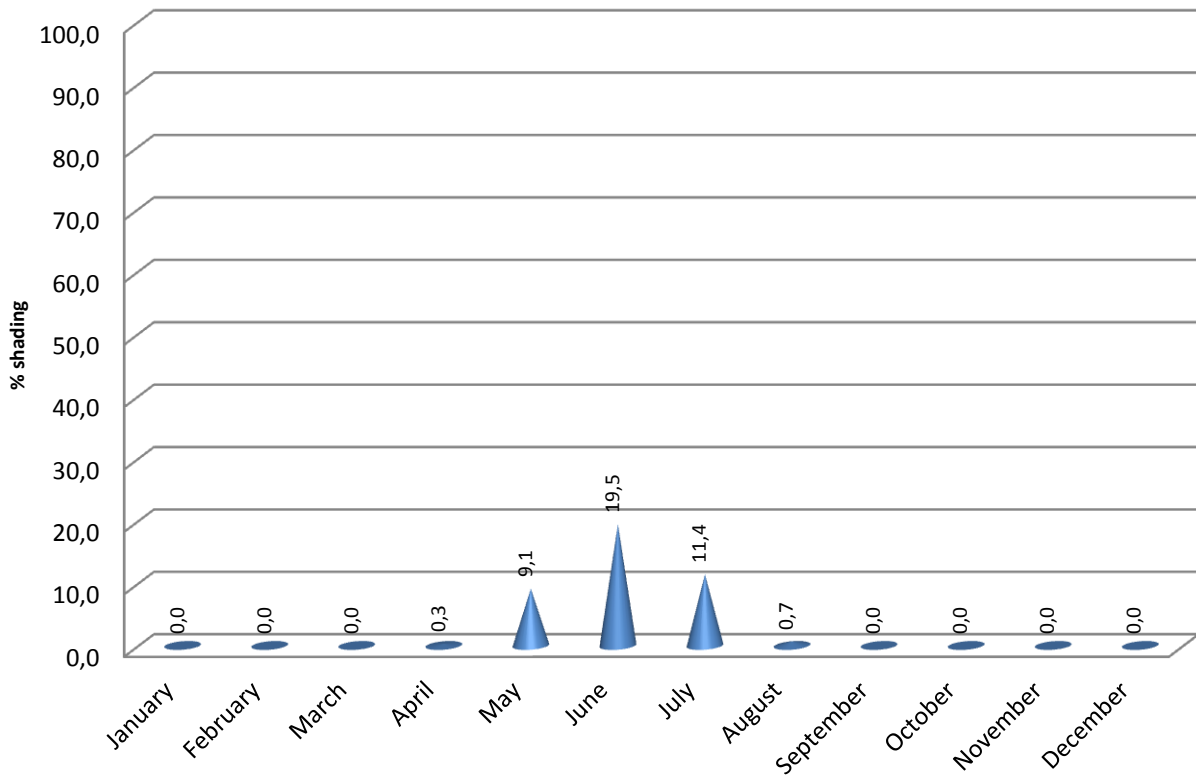
November



December



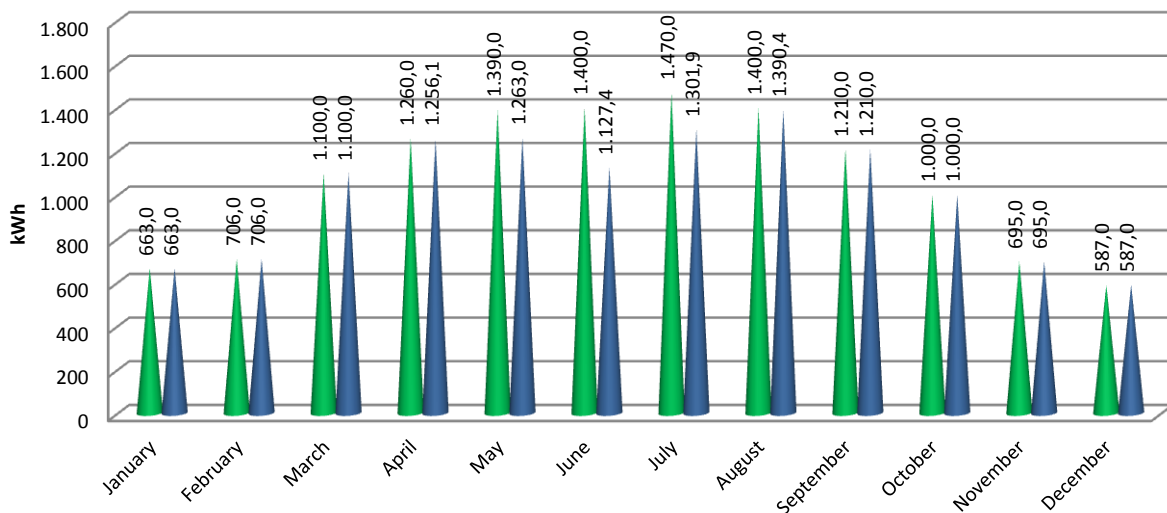
...Average Shading



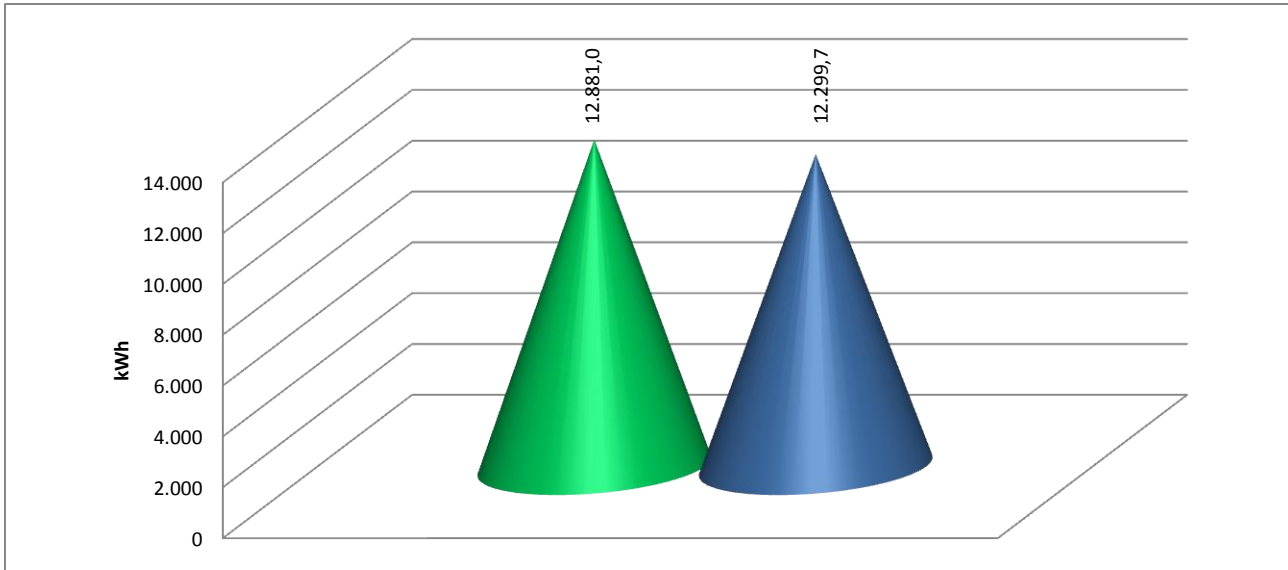
...Performance of Grid-connected PV

Simulation Assumptions:

- ✓ Solar radiation database used: PVGIS-classic
- ✓ Estimated losses due to temperature: 14.7% (using local ambient temperature)
- ✓ Estimated loss due to angular reflectance effects: 2.7%
- ✓ Other losses (cables, inverter etc.): 14.0%
- ✓ Combined PV system losses: 28.6%



Green bar: Average monthly electricity production from the given system [PVGIS Estimation]
 Blue bar: Average monthly electricity production minus the percent shade

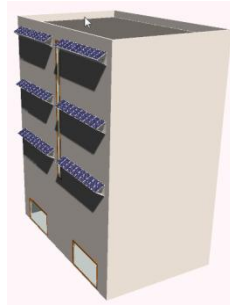


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

Blue bar: Average yearly electricity production minus the percent shade

....SIMULATION 4

....Row distance: 6m

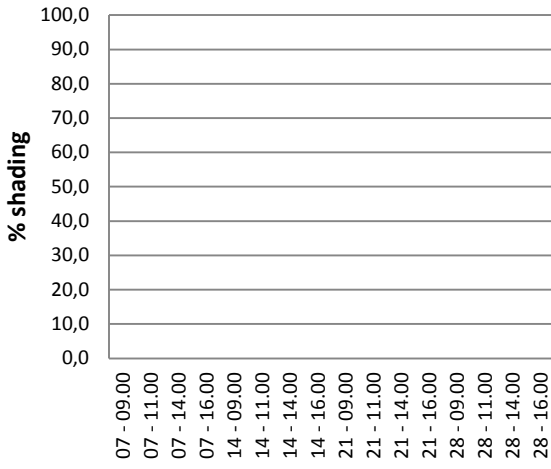


....Shading Table: Shadow percentage referring to random periods

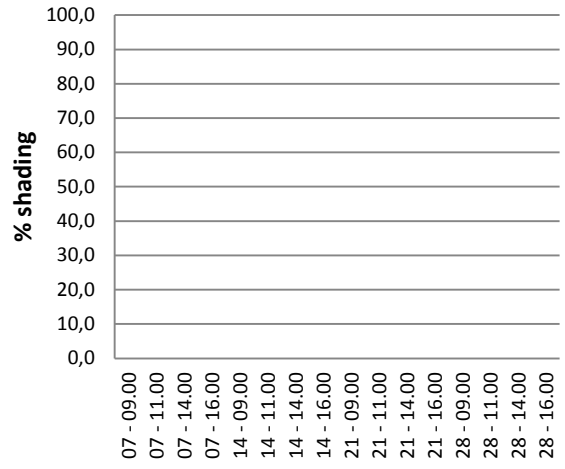
day	hour	January	February	March	April	May	June	July	August	September	October	November	December
7	09.00	0,0	0,0	0,0	0,0	0,0	1,5	3,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	0,0	25,5	17,8	0,0	0,0	0,0	0,0	0,0
14	09.00	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	6,0	27,0	12,0	0,0	0,0	0,0	0,0	0,0
21	09.00	0,0	0,0	0,0	0,0	0,0	6,5	0,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	13,5	27,0	6,5	0,0	0,0	0,0	0,0	0,0
28	09.00	0,0	0,0	0,0	0,0	0,0	6,5	0,0	0,0	0,0	0,0	0,0	0,0
	11.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	14.00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	16.00	0,0	0,0	0,0	0,0	26,0	25,5	0,0	0,0	0,0	0,0	0,0	0,0

....Shading Graphics

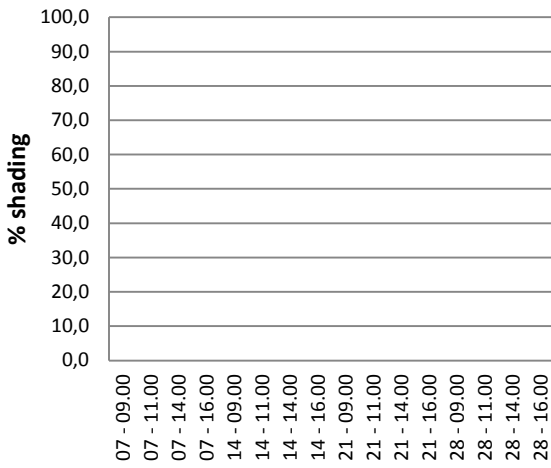
January



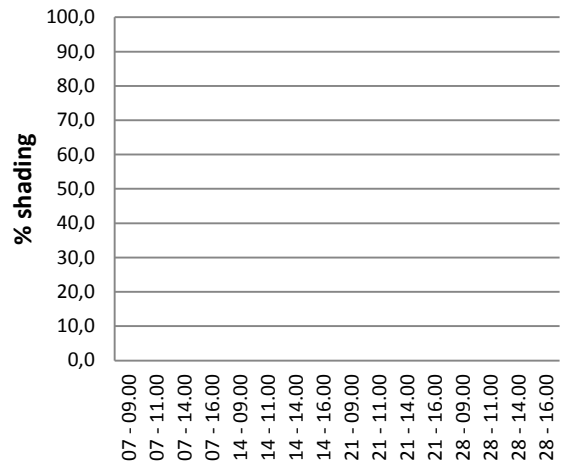
February



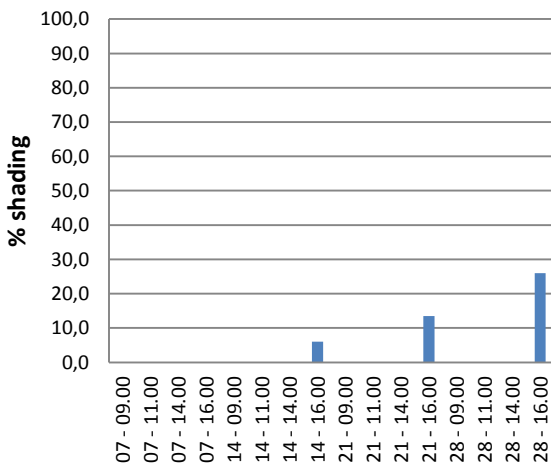
March



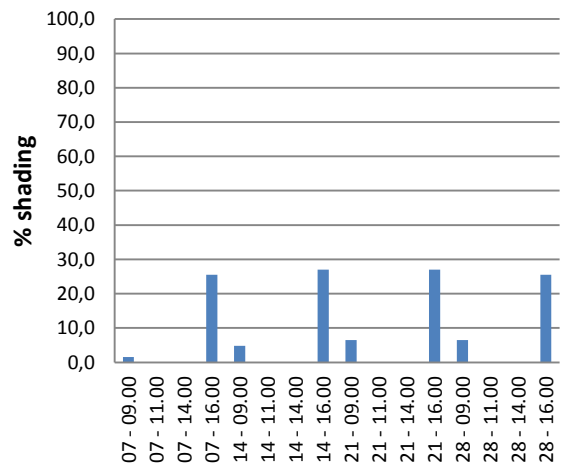
April



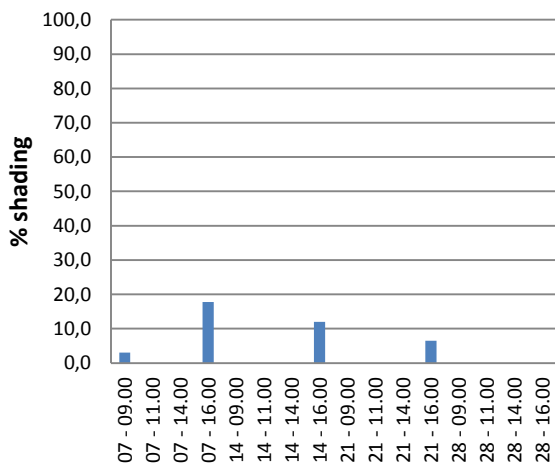
May



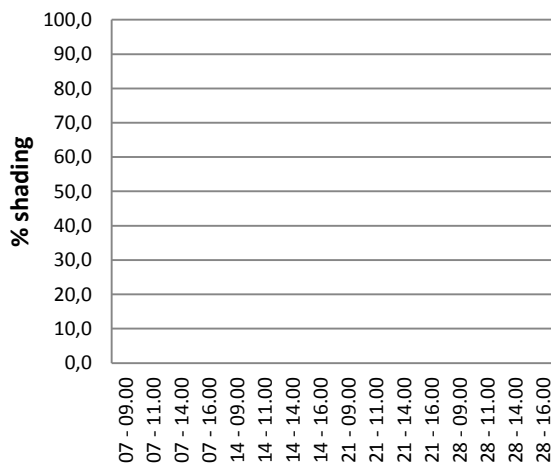
June



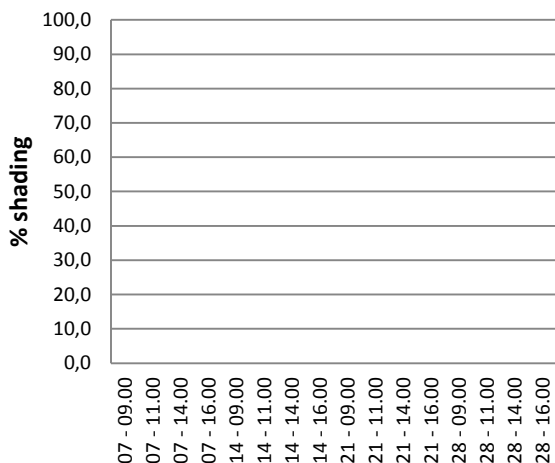
July



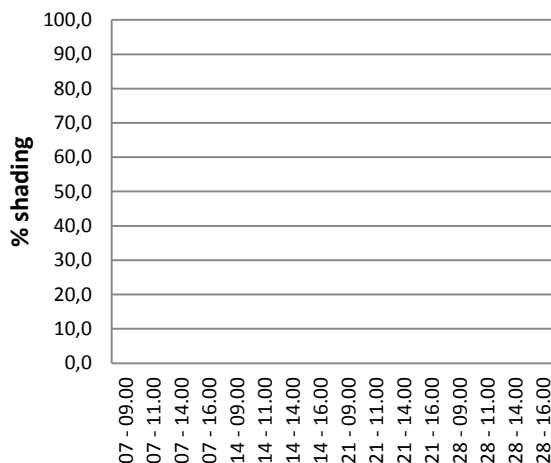
August



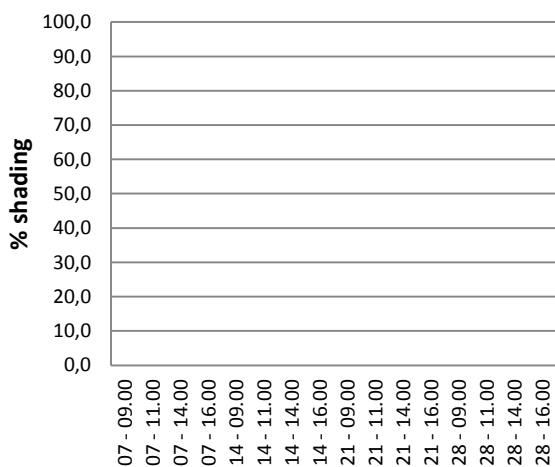
September



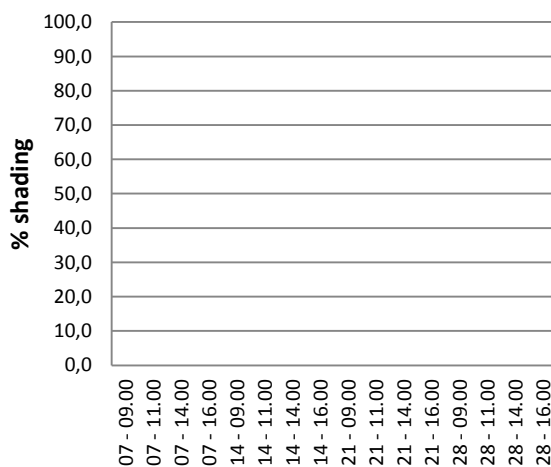
October



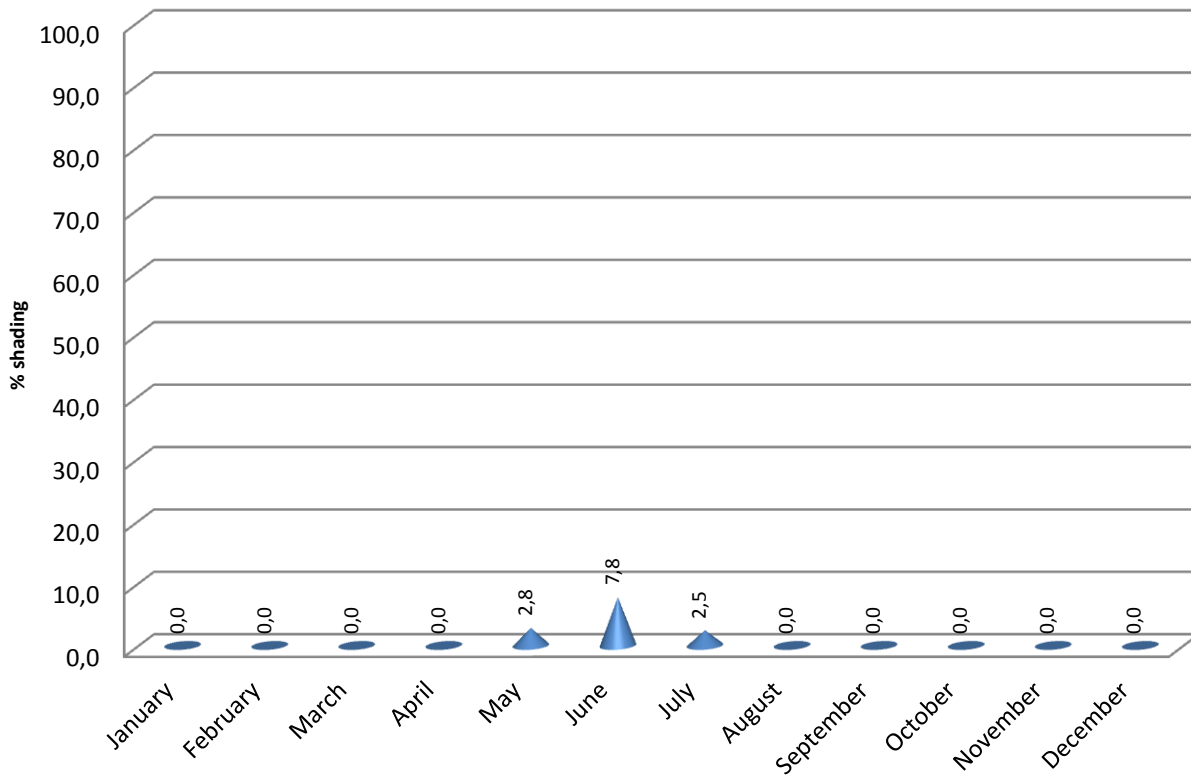
November



December



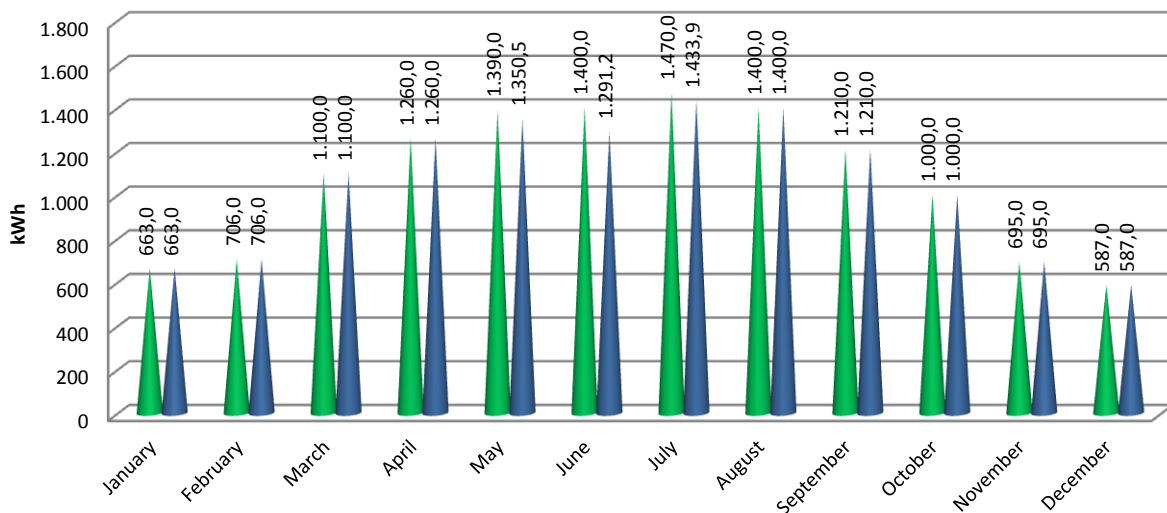
....Average Shading



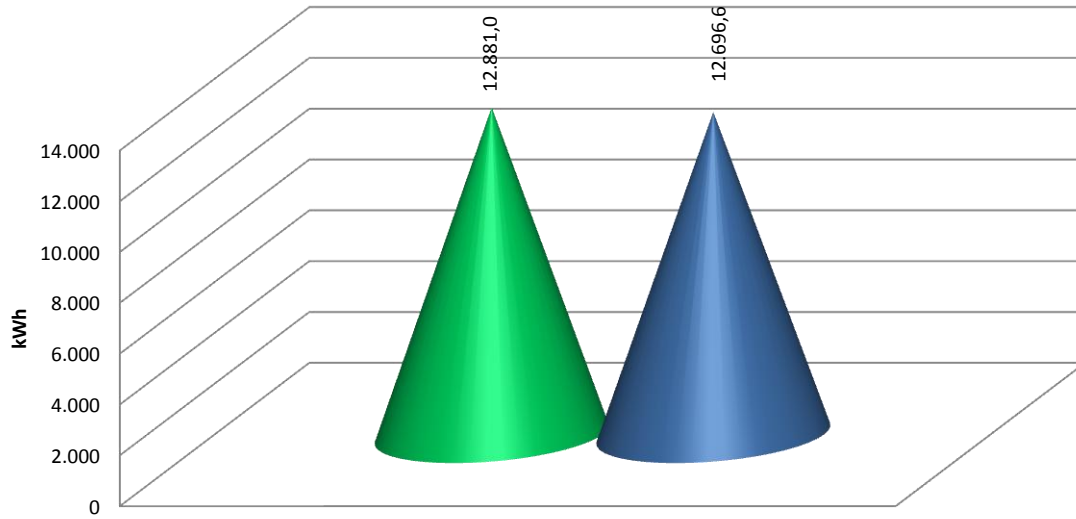
....Performance of Grid-connected PV

Simulation Assumptions:

- ✓ Solar radiation database used: PVGIS-classic
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- ✓ Other losses (cables, inverter etc.): 14.0%
- ✓ Combined PV system losses: 28.6%



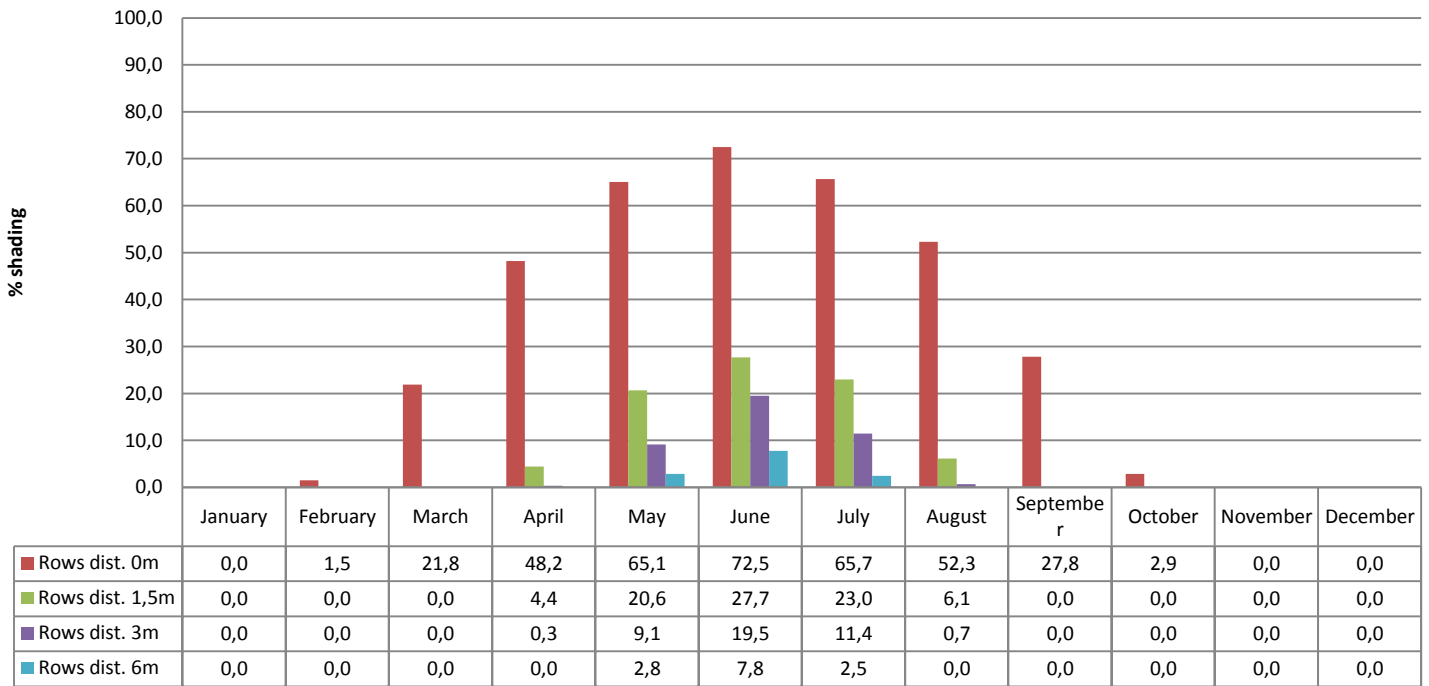
Green bar: Average monthly electricity production from the given system [PVGIS Estimation]
 Blue bar: Average monthly electricity production minus the percent shade



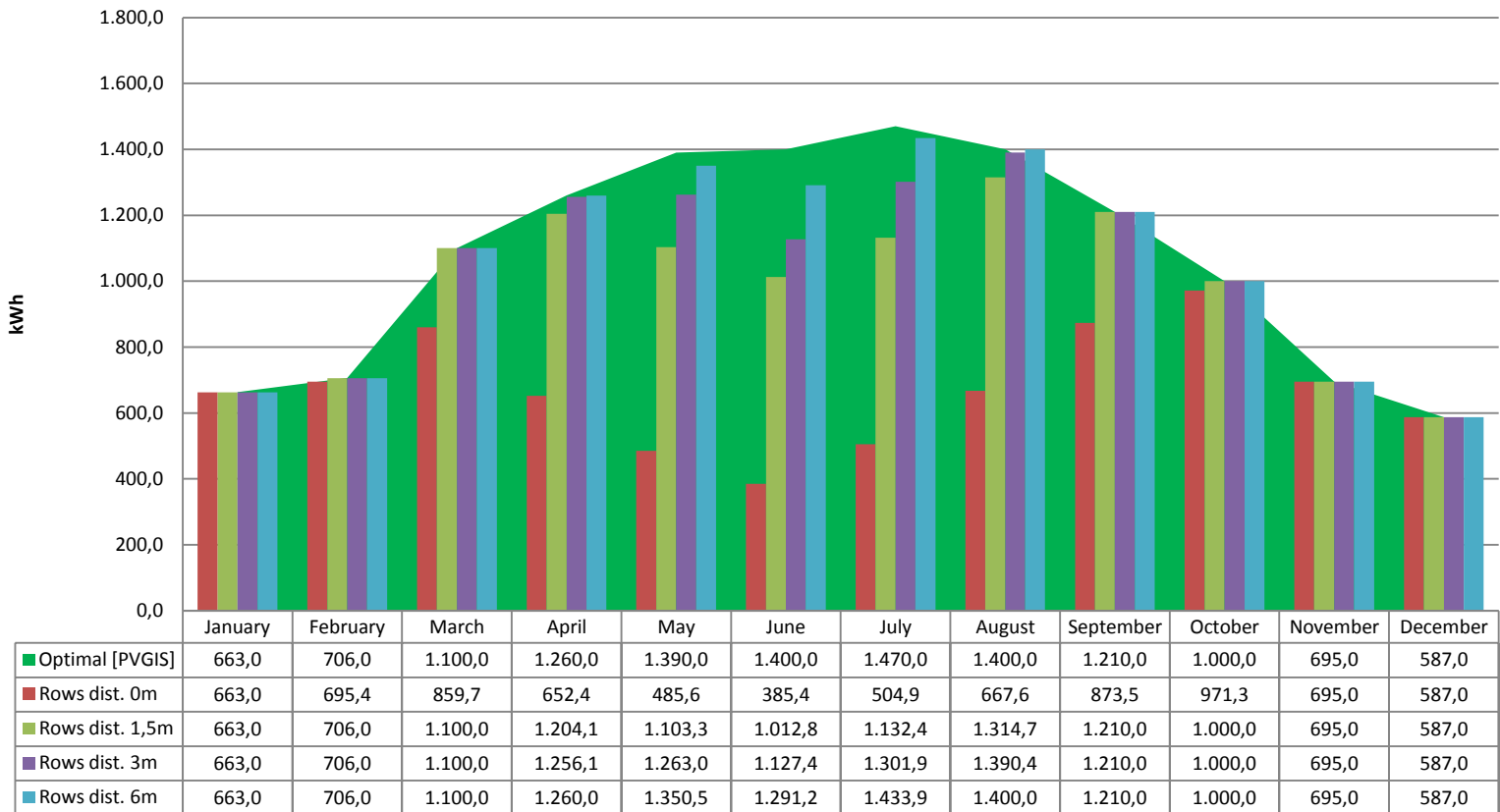
Green bar: Average yearly electricity production from the given system [PVGIS Estimation]
 Blue bar: Average yearly electricity production minus the percent shade

RETROFIT SUMMARY

Compare average shading for simulation 1,..,4

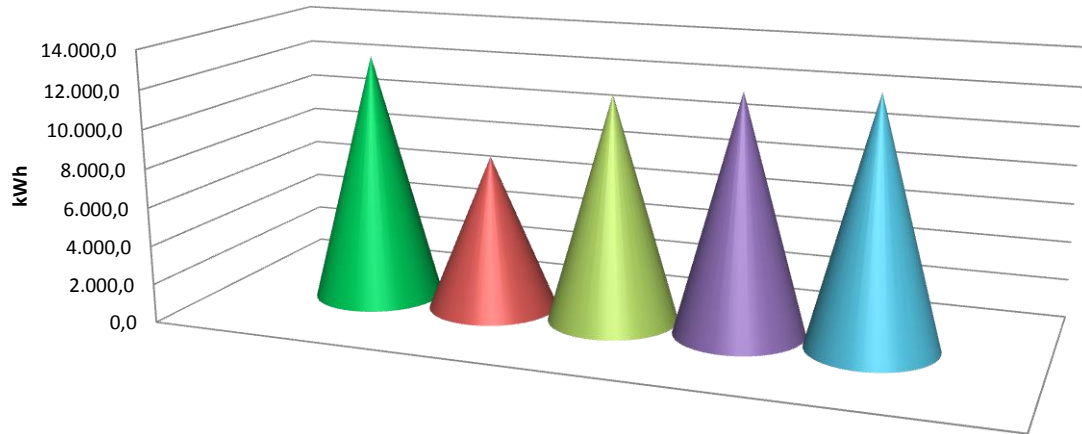


Compare Performance of Grid-connected PV for simulation 1,..,4



Green area: Average monthly electricity production from the given system [PVGIS Estimation]

Other colors bar: Average monthly electricity production minus the percent shade for simulation 1,..,4

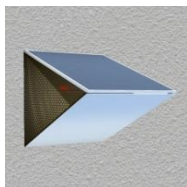


	Average yearly electricity production
■ Optimal [PVGIS]	12.881,0
■ Rows dist. 0m	8.040,8
■ Rows dist. 1,5m	11.728,3
■ Rows dist. 3m	12.299,7
■ Rows dist. 6m	12.696,6

Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

Other colors bar: Average yearly electricity production minus the percent shade for simulation 1,..,4

RETROFIT SMALL



Simulation Assumptions:

- ✓ Location: Rome, 41°53'25" North, 12°29'39" East, Elevation: 34 m a.s.l.
- ✓ Inclination: 30°
- ✓ Orientation: 0°
- ✓ Panel: producer SUNergie - model SUMO – nominal power 75W – dimension 1468x340x9
- ✓ Number of panels: 144
- ✓ Nominal power of the PV system: 10.8 kW (crystalline silicon)

.SIMULATION 1

.Row distance: 0m

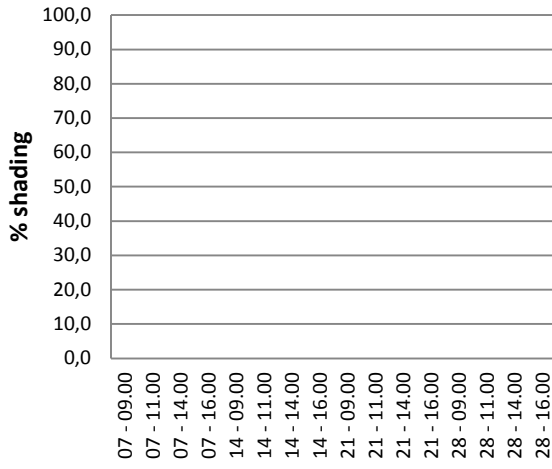


.Shading Table: Shadow percentage referring to random periods

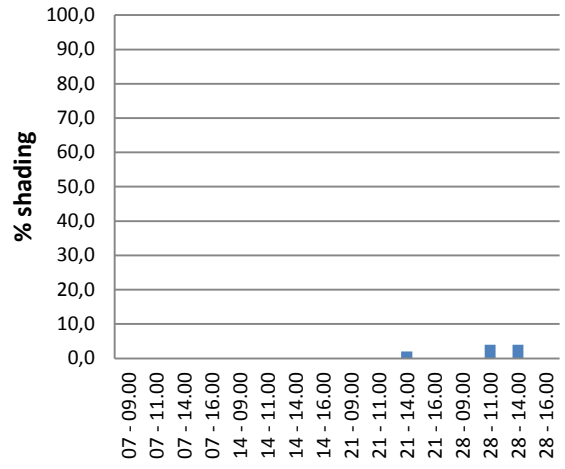
day	hour	January	February	March	April	May	June	July	August	September	October	November	December
7	09.00	0,0	0,0	4,0	41,0	66,0	78,0	82,5	62,0	37,0	4,0	0,0	0,0
	11.00	0,0	0,0	8,0	35,0	49,0	62,0	66	49,5	33,0	8,0	0,0	0,0
	14.00	0,0	0,0	8,0	37,0	54,5	66,0	66	54,0	33,0	4,0	0,0	0,0
	16.00	0,0	0,0	8,0	45,0	78,0	90,5	88	70,0	40,0	2,0	0,0	0,0
14	09.00	0,0	0,0	14,0	49,5	70,0	82,5	80	60,0	35,0	0,0	0,0	0,0
	11.00	0,0	0,0	16,5	37,0	53,0	57,5	62	49,5	29,0	4,0	0,0	0,0
	14.00	0,0	0,0	12,0	40,0	62,0	68,0	64	49,5	28,0	2,0	0,0	0,0
	16.00	0,0	0,0	16,5	54,0	78,0	90,5	86	66,0	37,0	0,0	0,0	0,0
21	09.00	0,0	0,0	20,0	54,5	74,0	84,5	78,5	53,5	24,0	0,0	0,0	0,0
	11.00	0,0	0,0	22,0	45,0	57,5	58,0	57,5	45,5	20,0	0,0	0,0	0,0
	14.00	0,0	2,0	20,0	45,0	66,0	70,0	62	45,0	24,0	0,0	0,0	0,0
	16.00	0,0	0,0	29,0	62,0	82,0	90,5	82,5	57,5	24,0	0,0	0,0	0,0
28	09.00	0,0	0,0	29,0	57,5	77,0	82,5	74	49,5	16,5	0,0	0,0	0,0
	11.00	0,0	4,0	31,0	49,5	58,0	54,0	53,5	37,0	18,0	0,0	0,0	0,0
	14.00	0,0	4,0	29,0	49,5	66,0	71,0	60	40,0	16,5	0,0	0,0	0,0
	16.00	0,0	0,0	33,0	70,0	86,0	90,5	78	49,5	12,0	0,0	0,0	0,0

.Shading Graphics

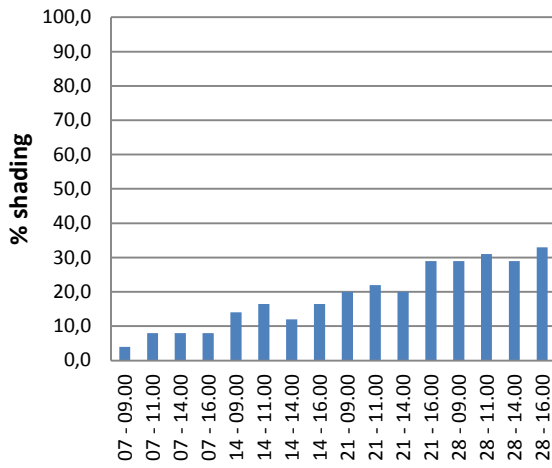
January



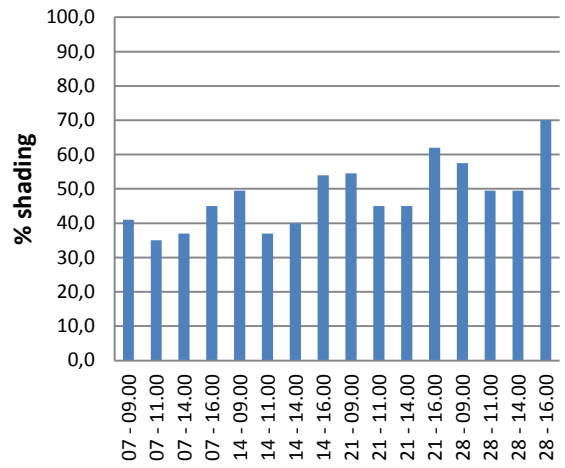
February



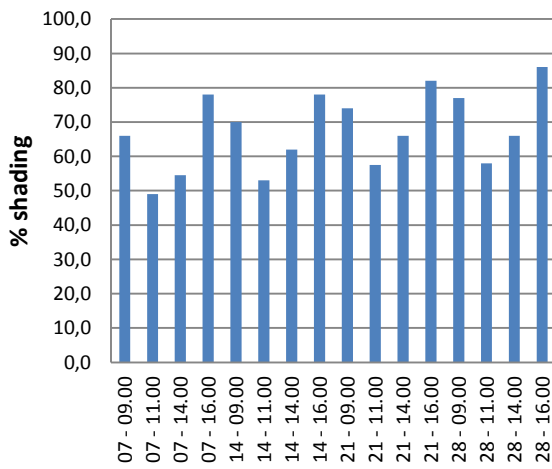
March



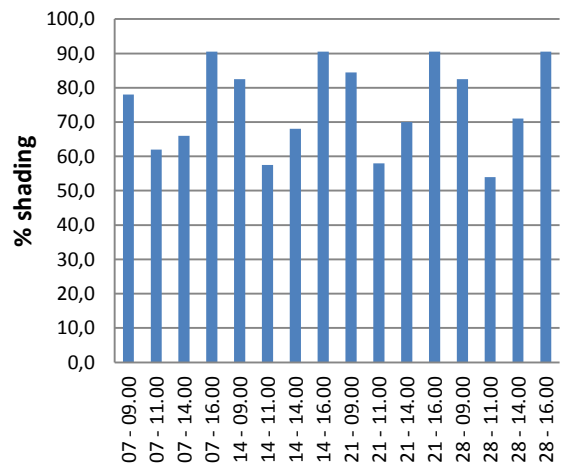
April



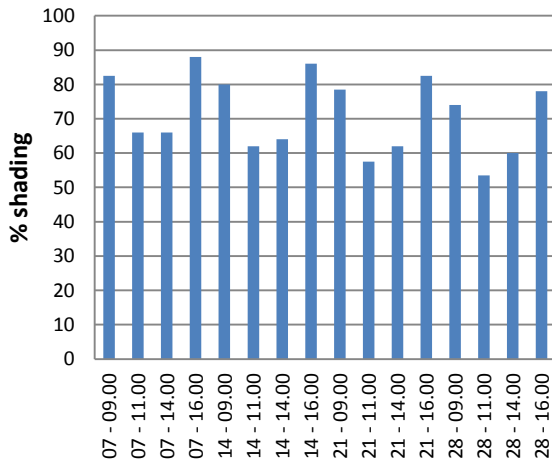
May



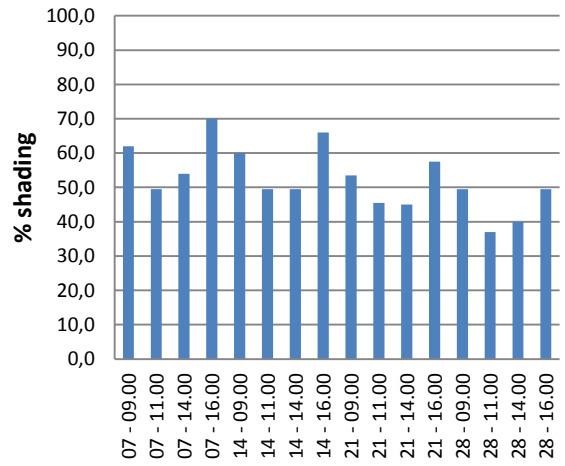
June



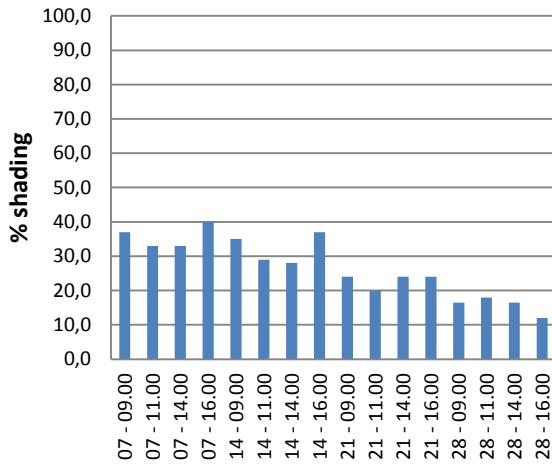
July



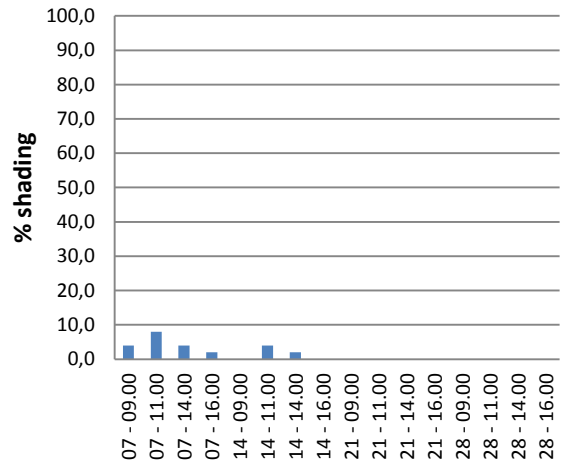
August



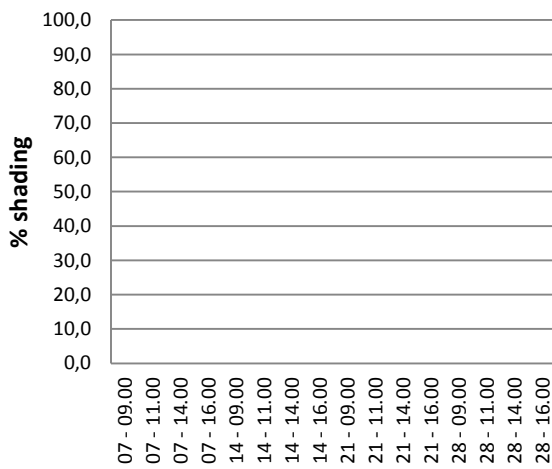
September



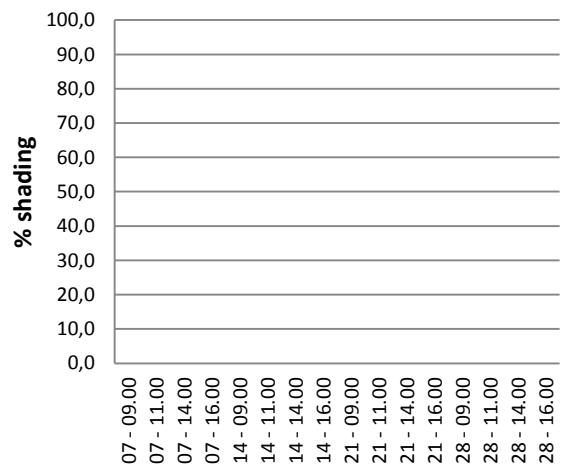
October



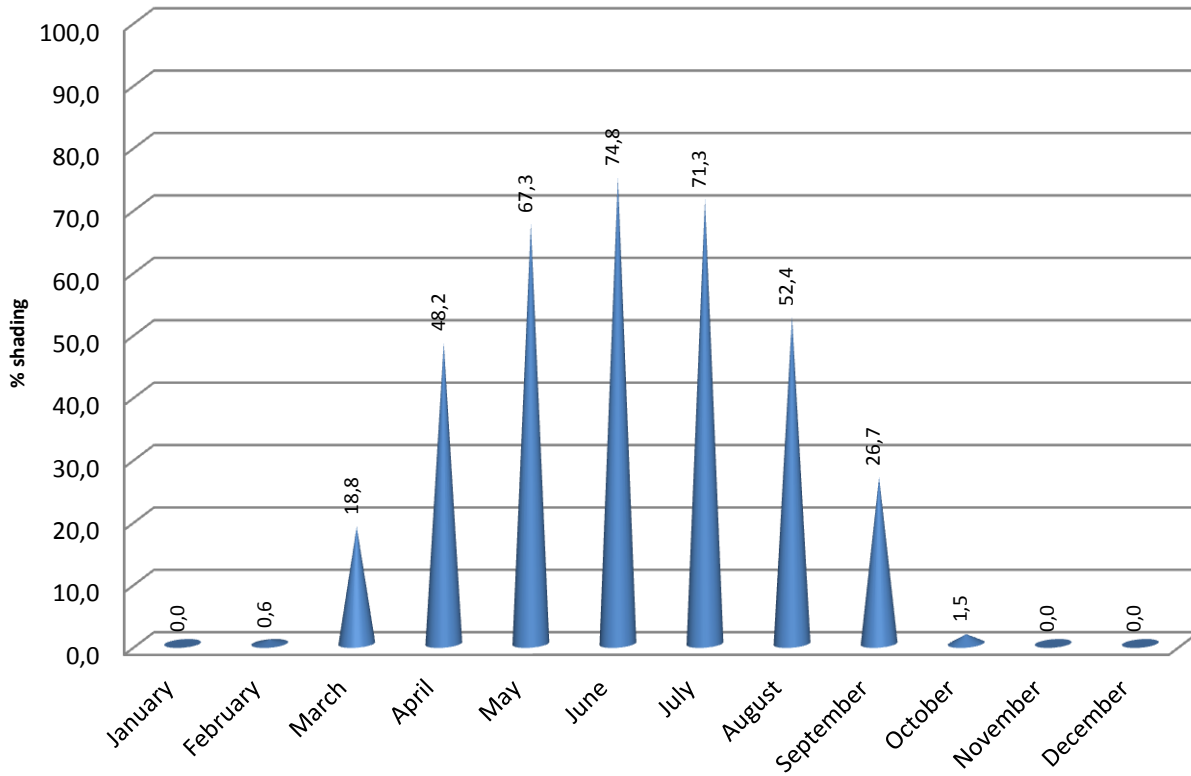
November



December



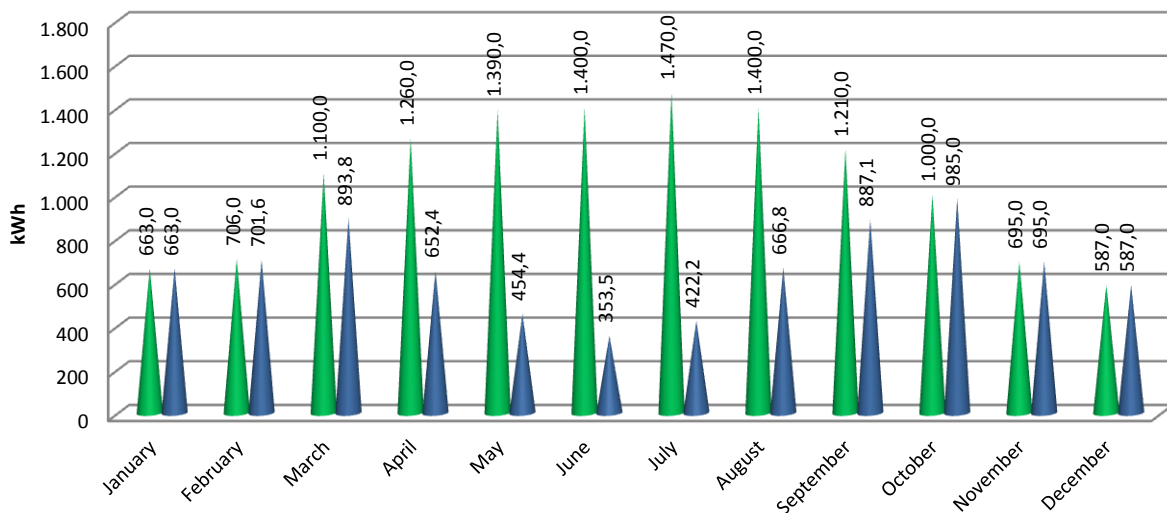
.Average Shading



.Performance of Grid-connected PV

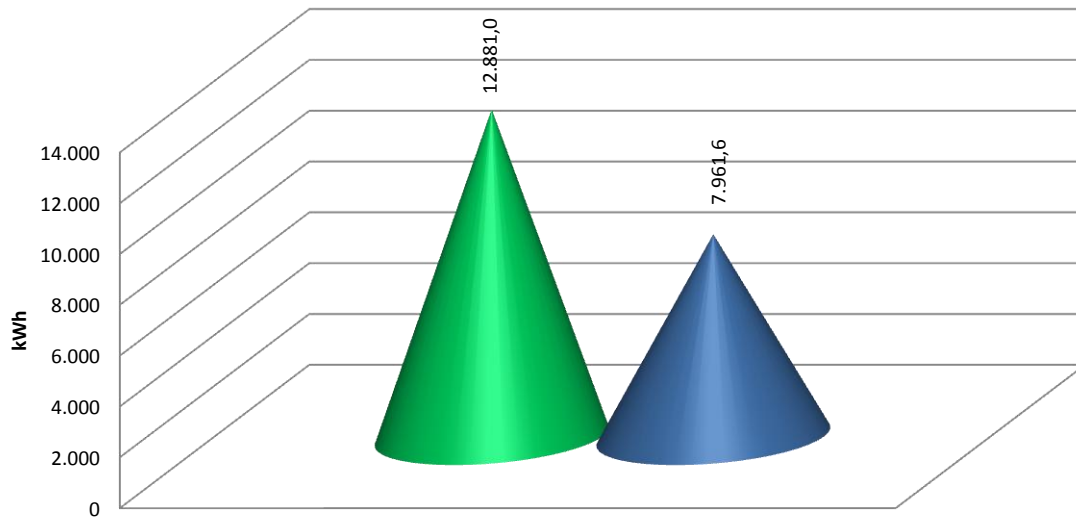
Simulation Assumptions:

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- ✓ Estimated losses due to temperature: 14.7% (using local ambient temperature)
- ✓ Estimated loss due to angular reflectance effects: 2.7%
- ✓ Other losses (cables, inverter etc.): 14.0%
- ✓ Combined PV system losses: 28.6%



Green bar: Average monthly electricity production from the given system [PVGIS Estimation]

Blue bar: Average monthly electricity production minus the percent shade

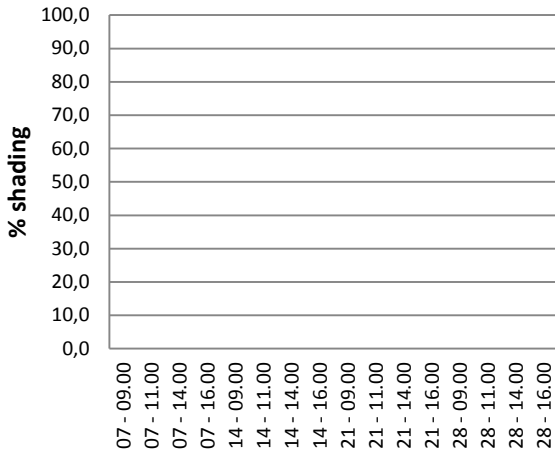


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

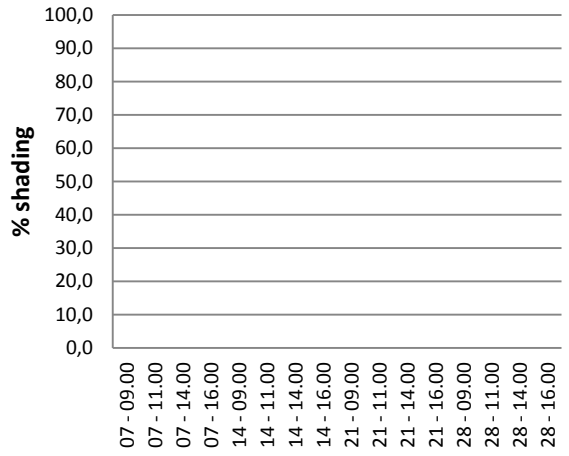
Blue bar: Average yearly electricity production minus the percent shade

..Shading Graphics

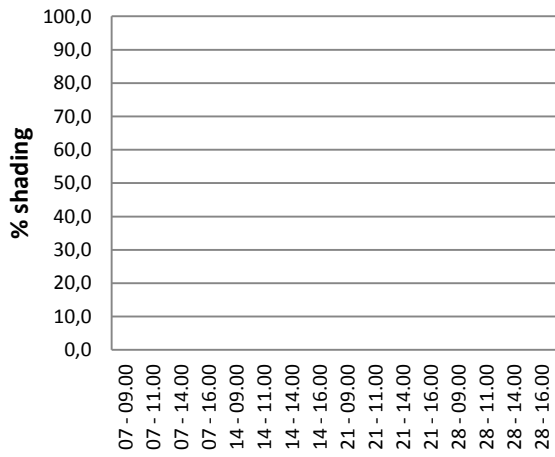
January



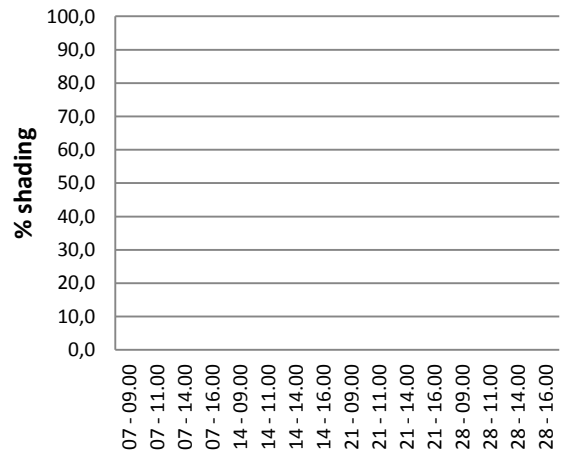
February



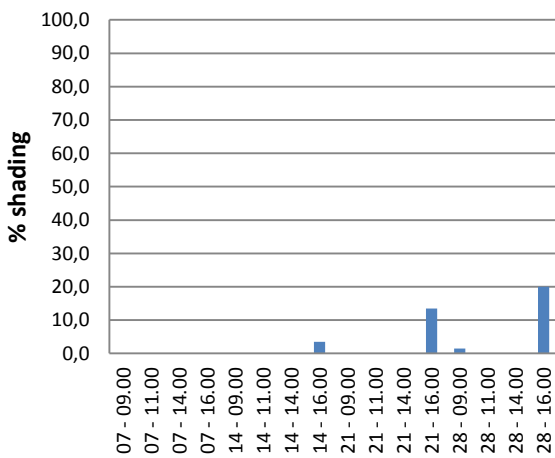
March



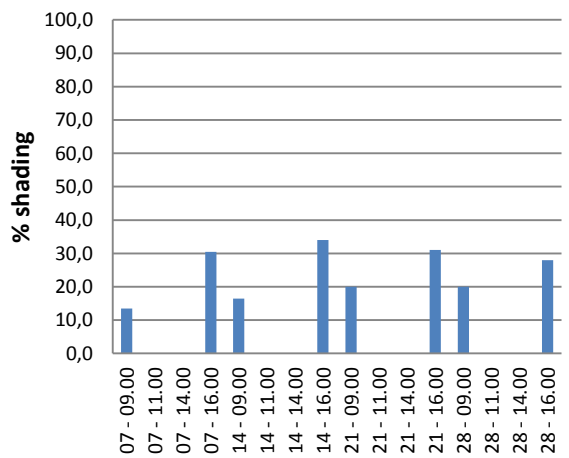
April



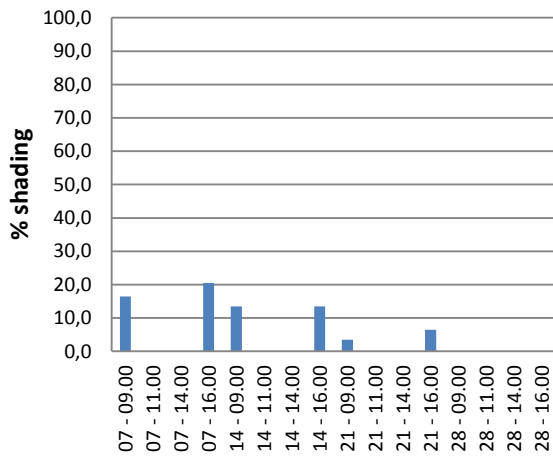
May



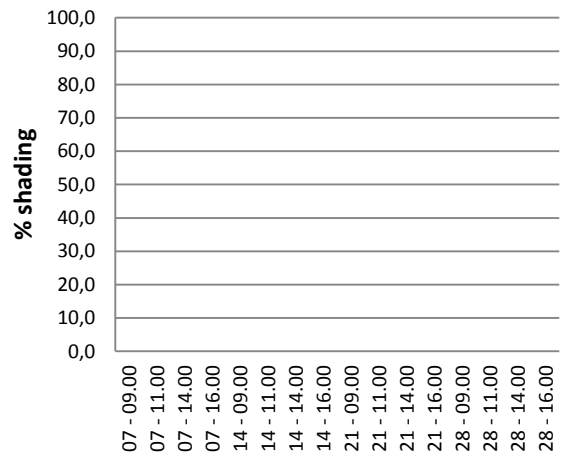
June



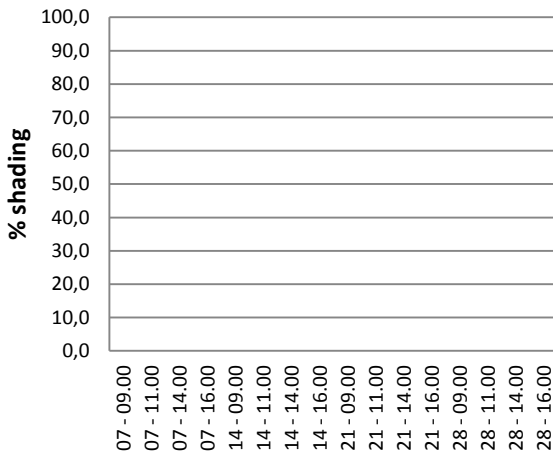
July



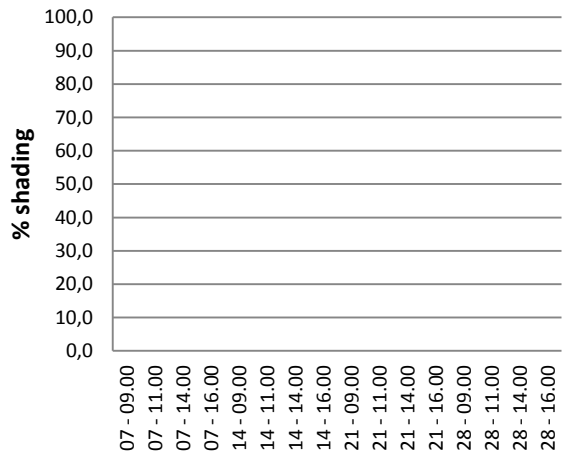
August



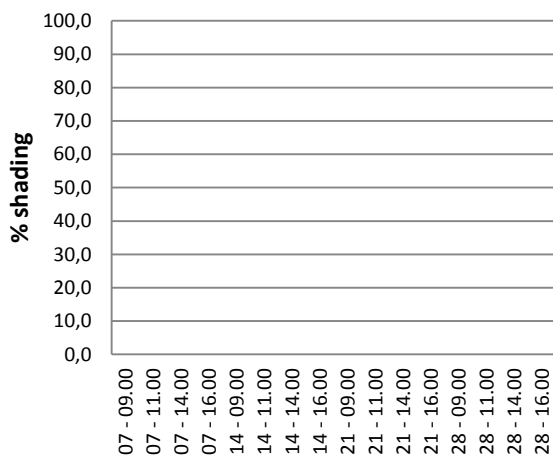
September



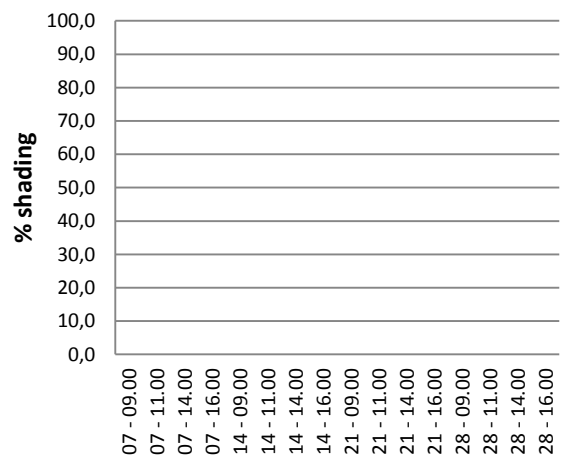
October



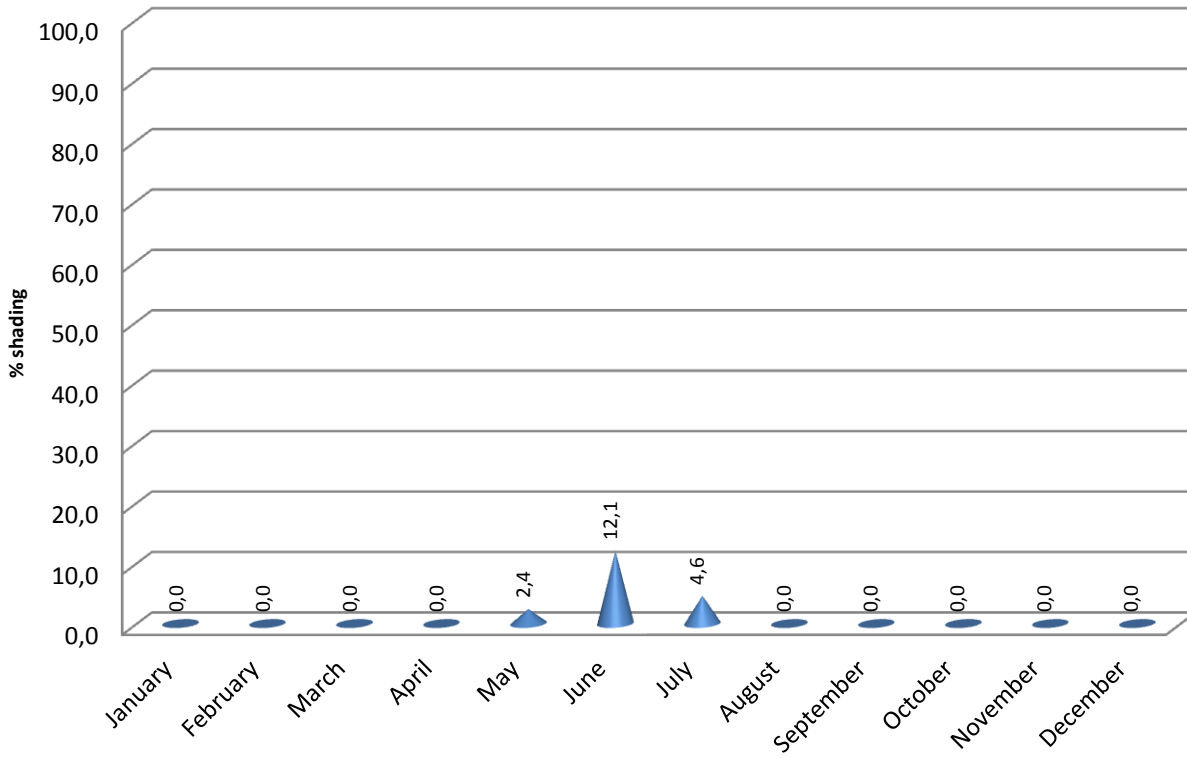
November



December



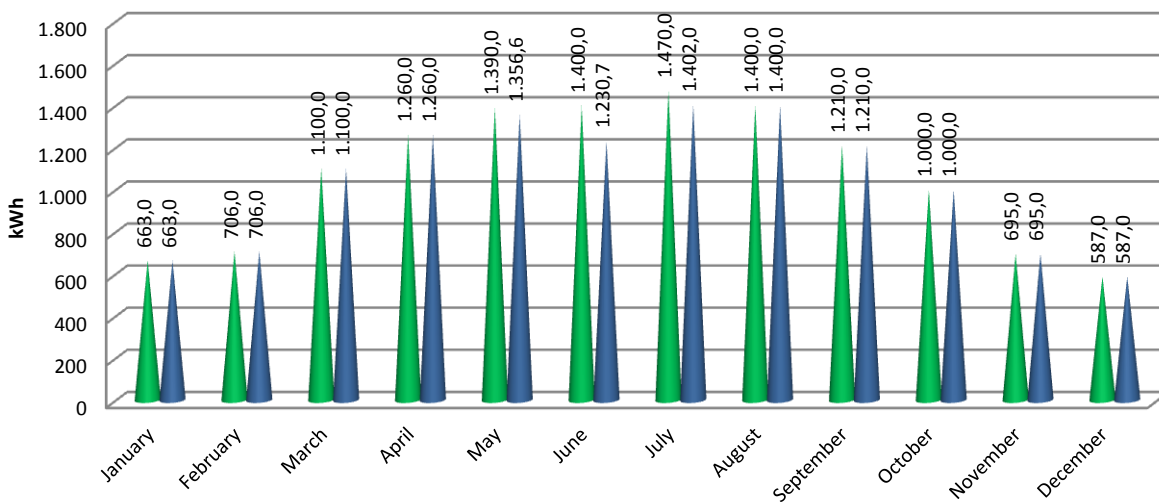
..Average Shading



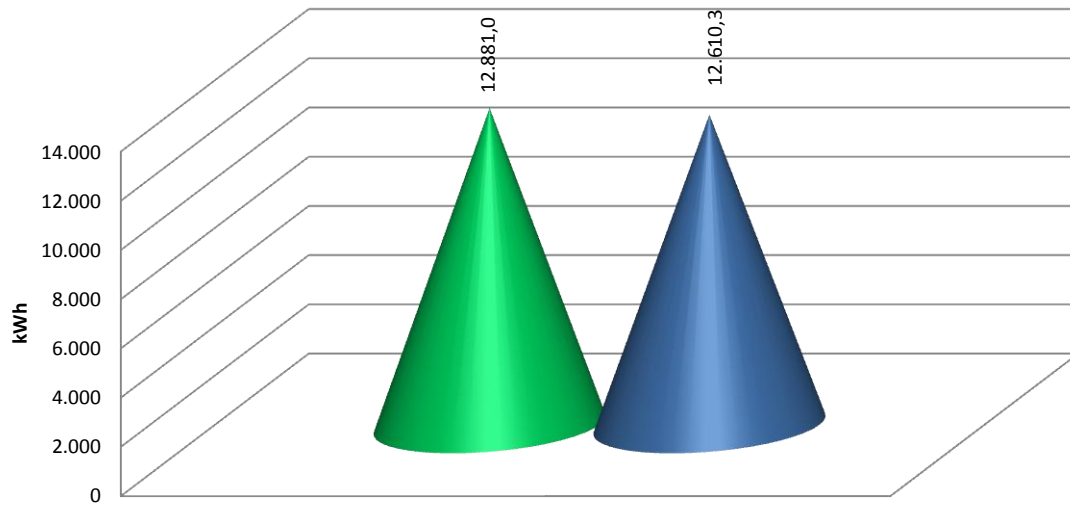
..Performance of Grid-connected PV

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 Blue bar: Average monthly electricity production minus the percent shade

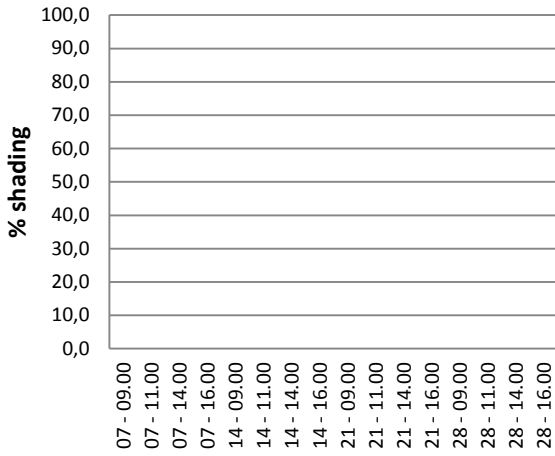


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

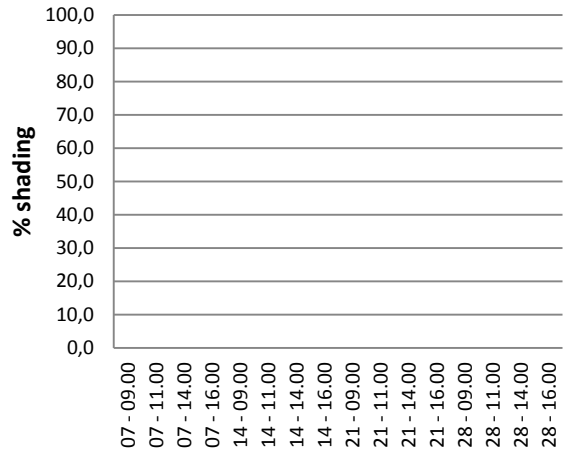
Blue bar: Average yearly electricity production minus the percent shade

...Shading Graphics

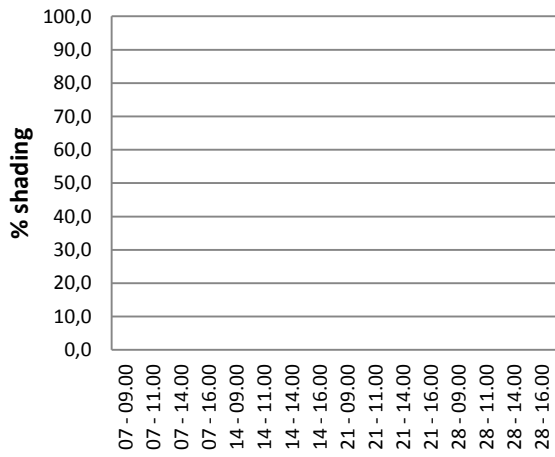
January



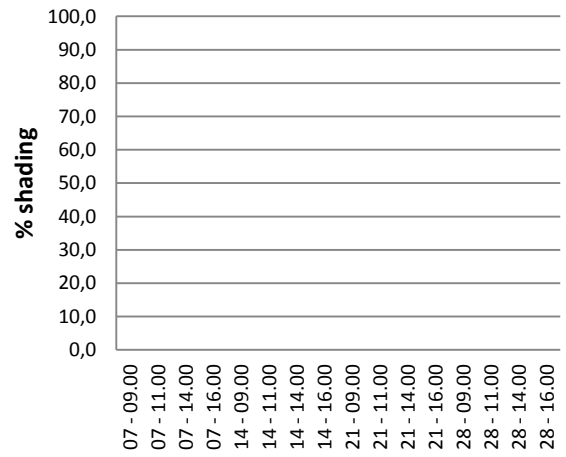
February



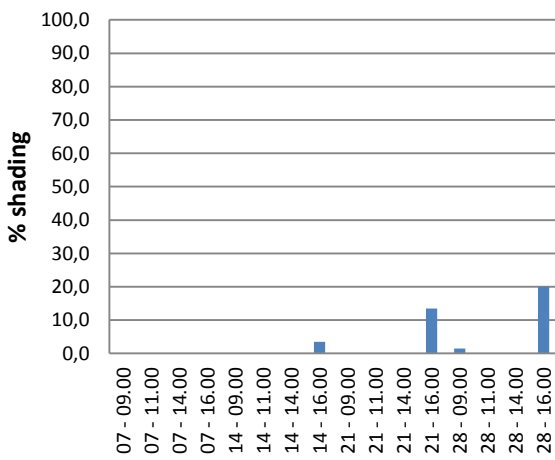
March



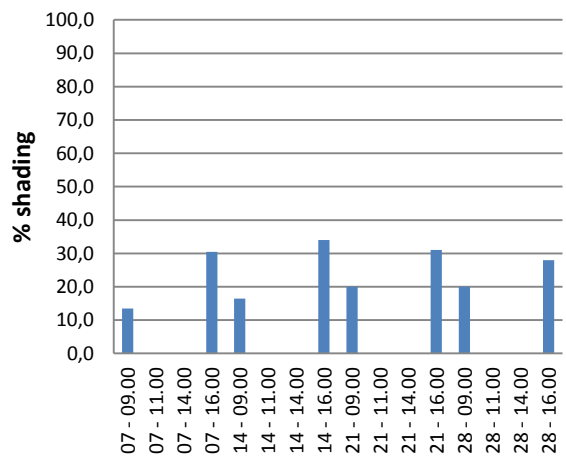
April



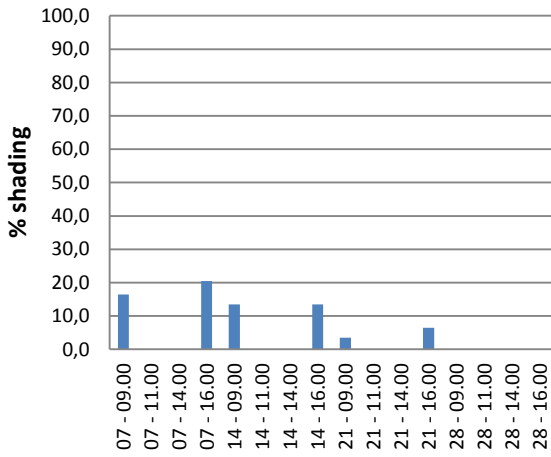
May



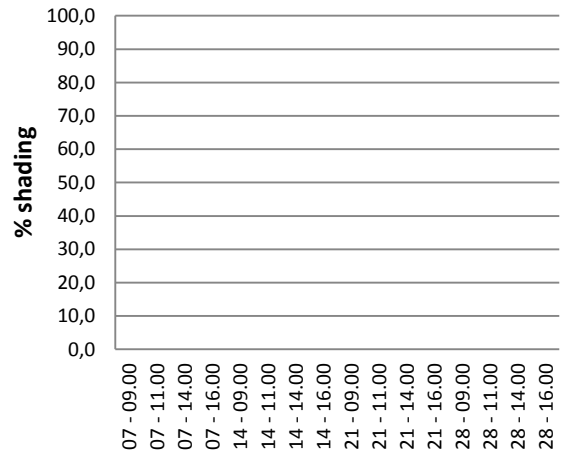
June



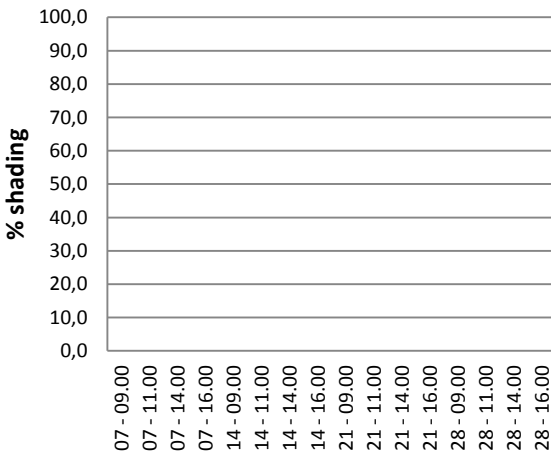
July



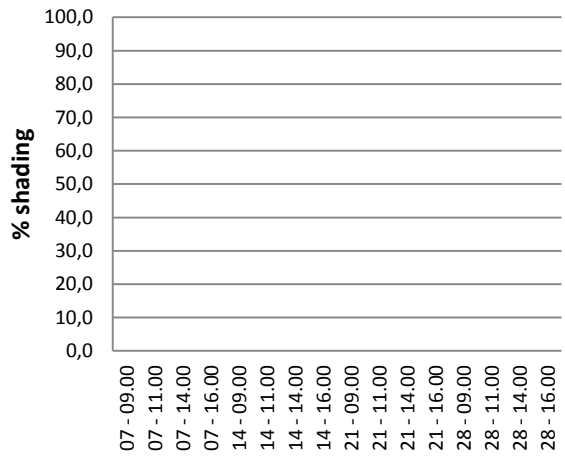
August



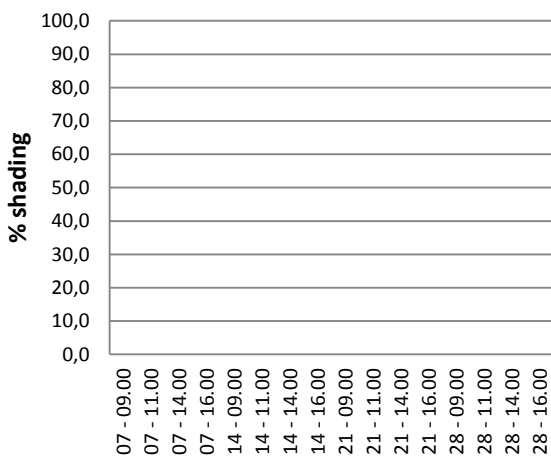
September



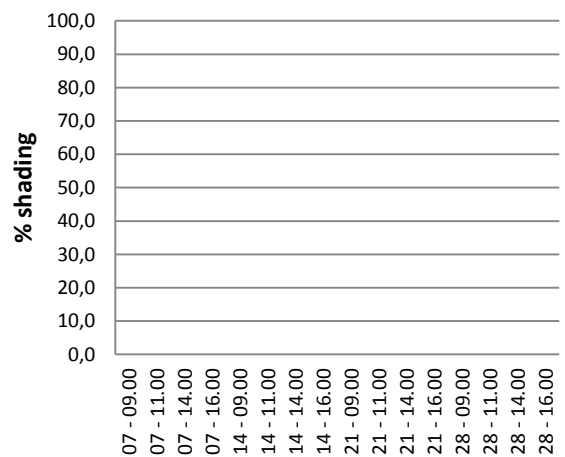
October



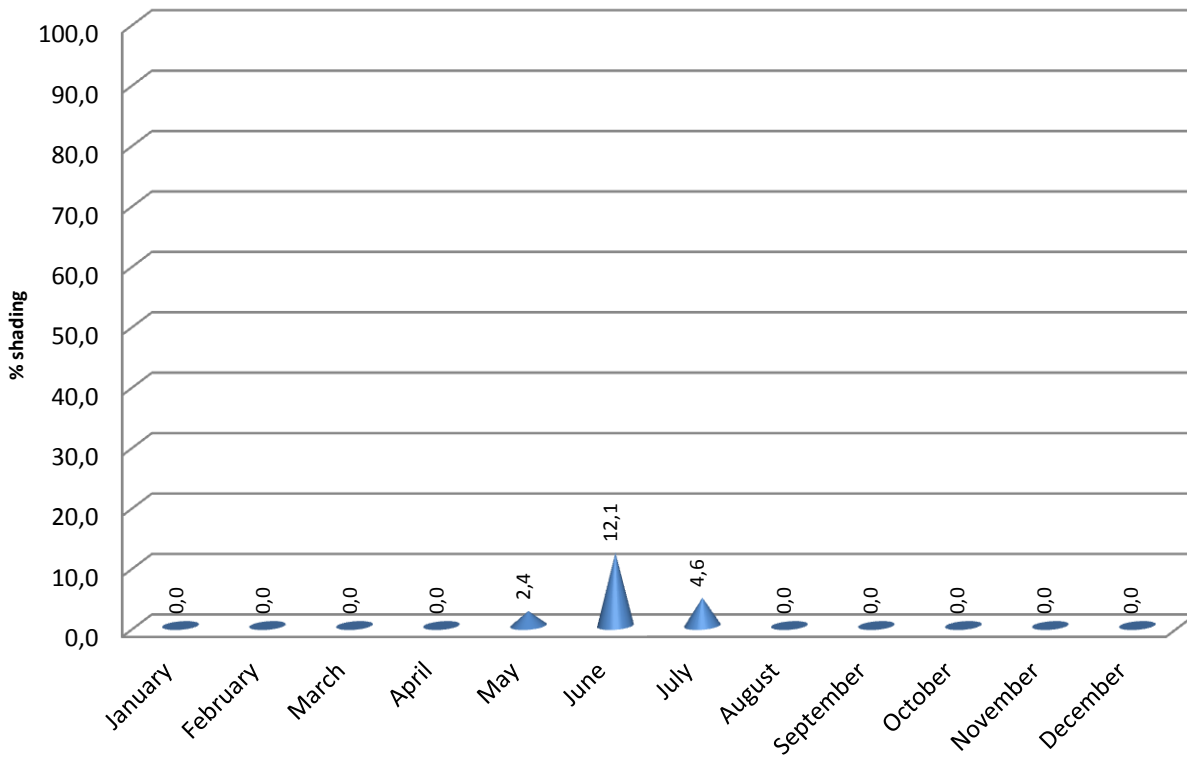
November



December



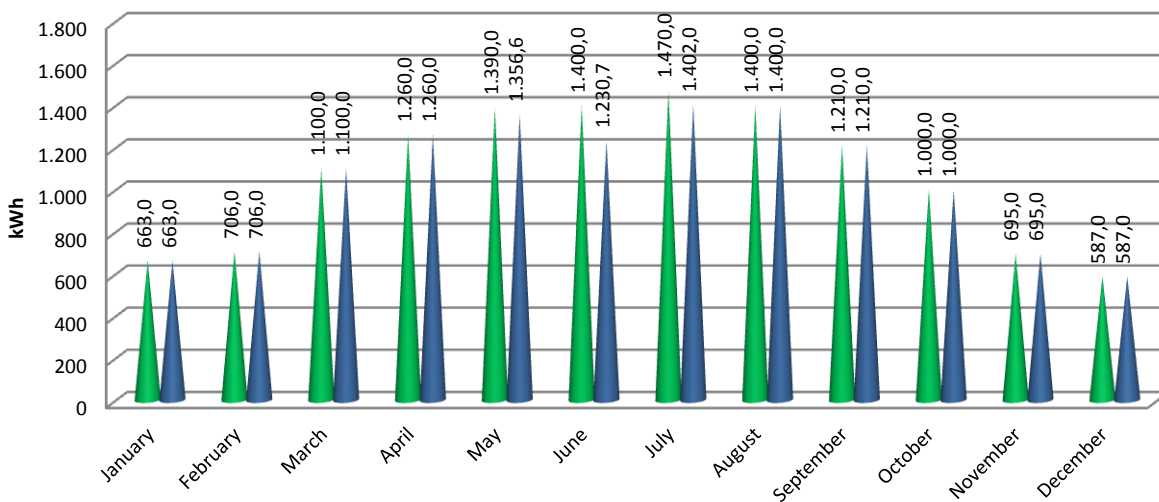
...Average Shading



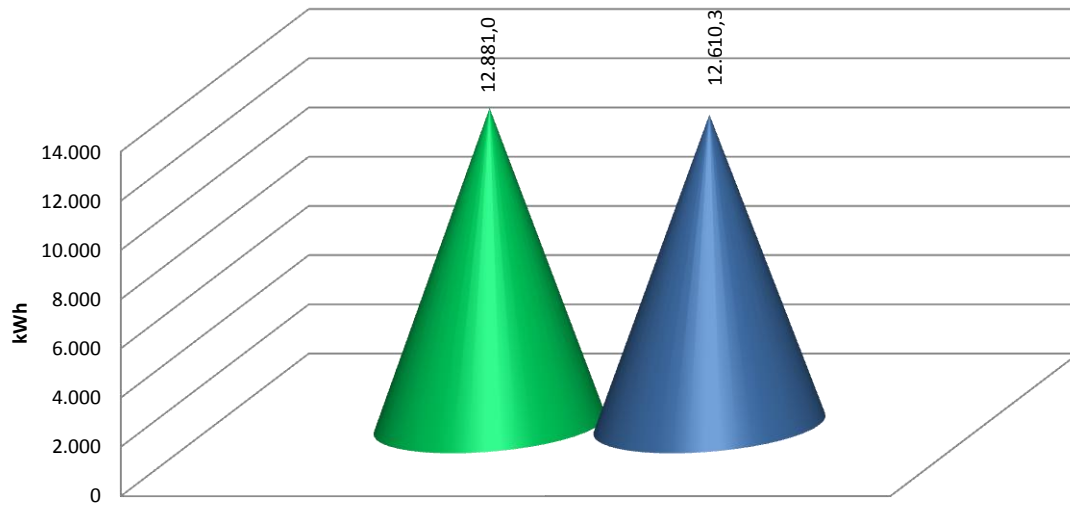
...Performance of Grid-connected PV

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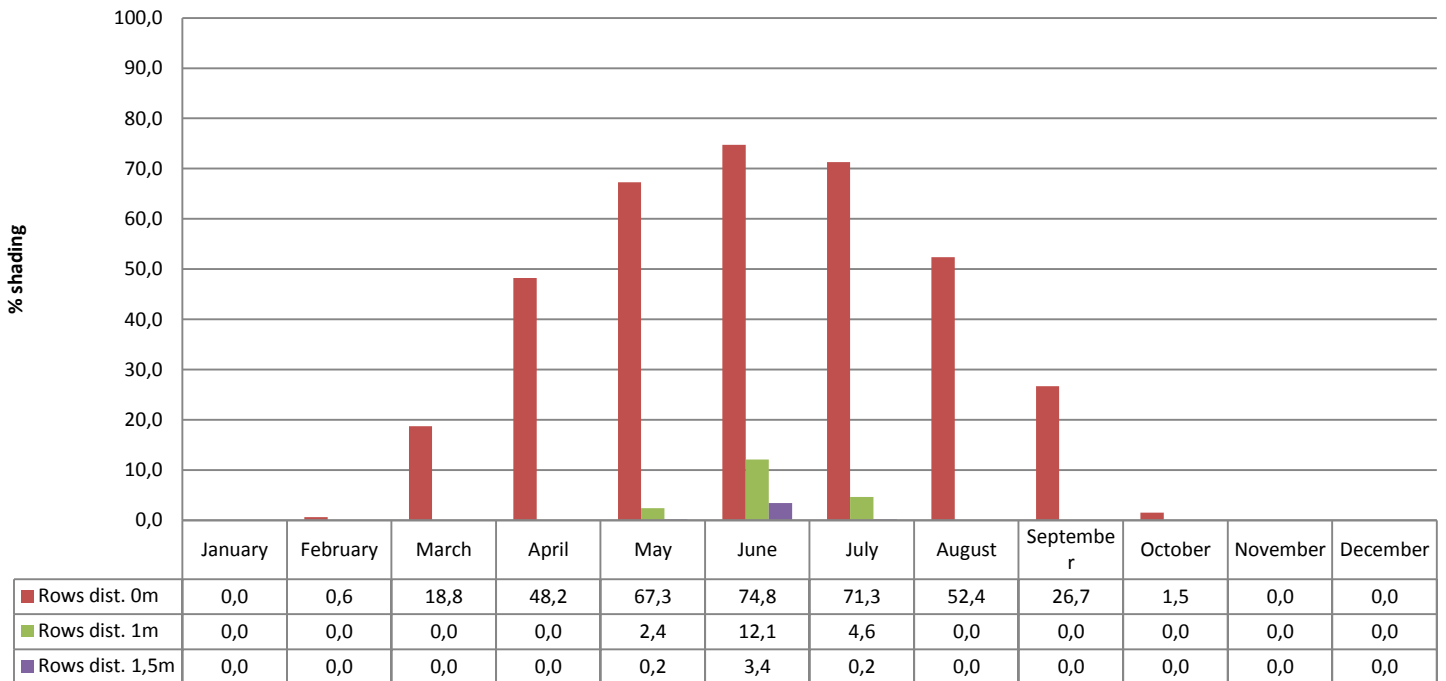


Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

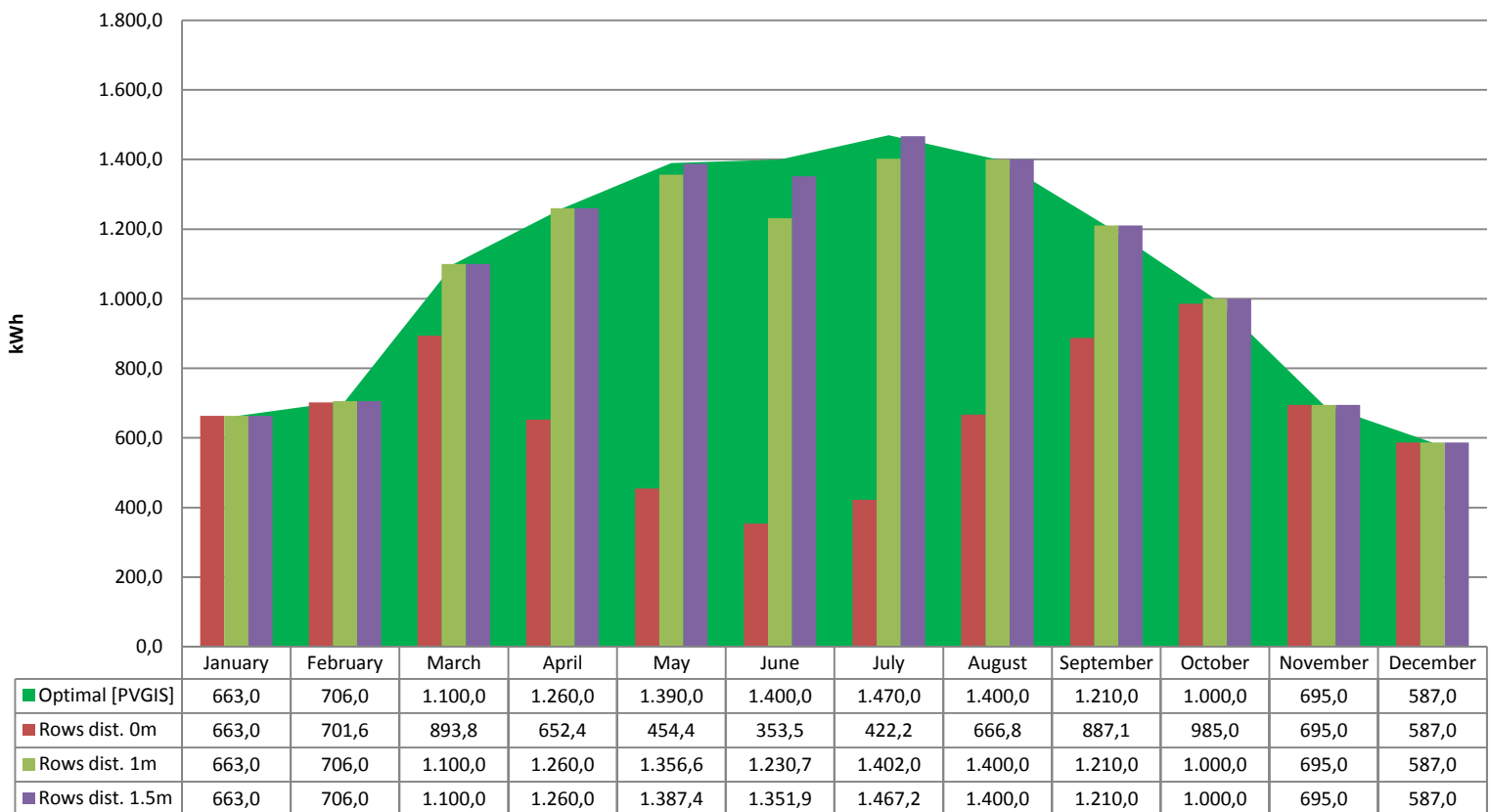
Blue bar: Average yearly electricity production minus the percent shade

RETROFIT SMALL SUMMARY

Compare average shading for simulation 1,..,3

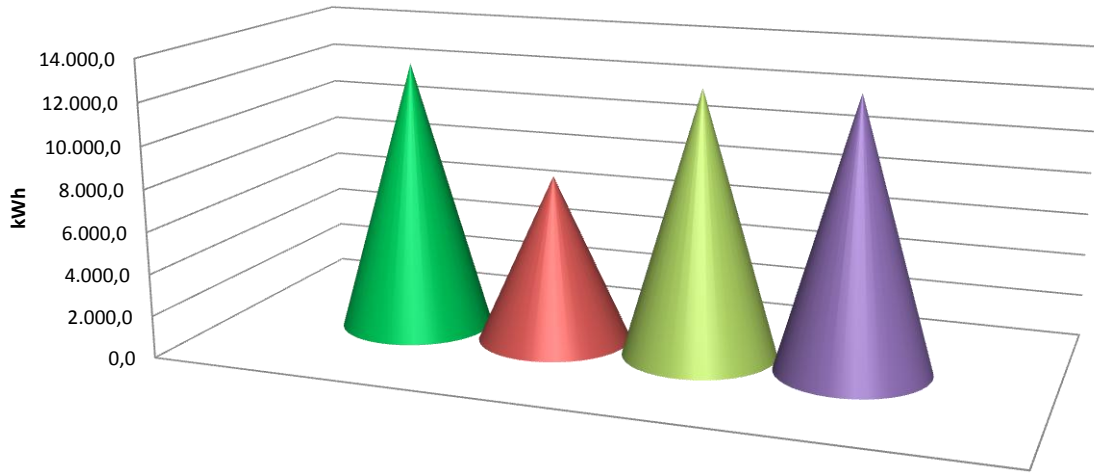


Compare Performance of Grid-connected PV for simulation 1,..,3



Green area: Average monthly electricity production from the given system [PVGIS Estimation]

Other colors bar: Average monthly electricity production minus the percent shade for simulation 1,..,3



	Average yearly electricity production
■ Optimal [PVGIS]	12.881,0
■ Rows dist. 0m	7.961,6
■ Rows dist. 1m	12.610,3
■ Rows dist. 1,5m	12.827,5

Green bar: Average yearly electricity production from the given system [PVGIS Estimation]

Other colors bar: Average yearly electricity production minus the percent shade for simulation 1,...,3