

# PVsyst - Simulation report

## Grid-Connected System

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Project: Slatinne lazne

Variant: New simulation variant

Tables on a building

System power: 432 kWp

Trebon - Czechia

**Author**

REWIX ELEKTRO (Czech republic)

**PVsyst V7.2.21**

VC0, Simulation date:  
15/11/22 08:07  
with v7.2.21

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REWIX ELEKTRO (Czech republic)

**Project summary****Geographical Site**

**Trebon**  
Czechia

**Situation**

Latitude 49.00 °N  
Longitude 14.77 °E  
Altitude 429 m  
Time zone UTC+1

**Project settings**

Albedo 0.20

**Meteo data**

Trebon  
Meteonorm 8.0 (1996-2017), Sat=100% - Synthetic

**System summary****Grid-Connected System****PV Field Orientation**

Fixed planes 4 orientations  
Tilts/azimuths 10 / 0 °  
10 / 90 °  
10 / -90 °  
0 / 0 °

**Tables on a building****Near Shadings**

According to strings  
Electrical effect 100 %

**User's needs**

Ext. defined as file  
Lázně Aurora - křivka.csv

**System information****PV Array**

Nb. of modules 962 units  
Pnom total 432 kWp

**Inverters**

Nb. of units 10 units  
Pnom total 333 kWac  
Pnom ratio 1.298

**Results summary**

Produced Energy	432.3 MWh/year	Specific production	1000 kWh/kWp/year	Perf. Ratio PR	85.56 %
Used Energy	2364.5 MWh/year			Solar Fraction SF	17.09 %

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### General parameters

#### Grid-Connected System

#### PV Field Orientation

##### Orientation

Fixed planes 4 orientations  
Tilts/azimuths 10 / 0 °  
10 / 90 °  
10 / -90 °  
0 / 0 °

#### Horizon

Free Horizon

#### Tables on a building

#### Sheds configuration

Nb. of sheds 282 units  
Several orientations

#### Models used

Transposition Perez  
Diffuse Perez, Meteonorm  
Circumsolar separate

#### Near Shadings

According to strings  
Electrical effect 100 %

#### User's needs

Ext. defined as file  
Lázně Aurora - křivka.csv

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
196612	186146	193742	180352	197136	195702	209149	209097	188718	169812	227917	210148	2364531	kWh

### PV Array Characteristics

#### PV module

Manufacturer CSI Solar  
Model CS3W-455MS  
(Original PVsyst database)

Unit Nom. Power 455 Wp  
Number of PV modules 748 units  
Nominal (STC) 340 kWp

#### SolarEdge Power Optimizer

Model S440 Worldwide  
Unit Nom. Power 440 W  
Input modules One module

#### Array #1 - G1 a

Orientation #1  
Tilt/Azimuth 10/0 °  
Number of PV modules 175 units  
Nominal (STC) 79.6 kWp  
Optimizer Array 7 Strings x 25 In series

#### At operating cond. (50°C)

Pmpp 72.7 kWp  
Output of optimizers  
Voper 750 V  
I at Poper 97 A

#### Array #2 - G1 b

Orientation #1  
Tilt/Azimuth 10/0 °  
Number of PV modules 26 units  
Nominal (STC) 11.83 kWp  
Optimizer Array 1 String x 26 In series

#### At operating cond. (50°C)

Pmpp 10.80 kWp  
Output of optimizers  
Voper 750 V  
I at Poper 14 A

#### Inverter

Manufacturer SolarEdge  
Model SE66.6K/SE100K-EU-APAC/AUS Unit (400V)  
(Original PVsyst database)

Unit Nom. Power 33.3 kWac  
Number of inverters 8 units  
Total power 272 kWac

Operating voltage 750 V  
Pnom ratio (DC:AC) 1.18

Number of inverters 0.3 unit  
Total power 9.1 kWac

Operating voltage 750 V  
Pnom ratio (DC:AC) 1.18



## PV Array Characteristics

**Array #3 - G3**

Orientation	#1		
Tilt/Azimuth	10/0 °		
Number of PV modules	81 units	Number of inverters	1 unit
Nominal (STC)	36.9 kWp	Total power	33.3 kWac
Optimizer Array	3 Strings x 27 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	33.6 kWp	Operating voltage	750 V
Output of optimizers		Pnom ratio (DC:AC)	1.00
Voper	750 V		
I at Poper	45 A		

**Array #4 - Jih**

Orientation	#1		
Tilt/Azimuth	10/0 °		
Number of PV modules	80 units	Number of inverters	1 unit
Nominal (STC)	36.4 kWp	Total power	33.3 kWac
Optimizer Array	4 Strings x 20 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	33.2 kWp	Operating voltage	750 V
Output of optimizers		Pnom ratio (DC:AC)	0.99
Voper	750 V		
I at Poper	44 A		

**Array #5 - VZ - Z a**

Orientation	#2		
Tilt/Azimuth	10/90 °		
Number of PV modules	160 units	Number of inverters	1.7 units
Nominal (STC)	72.8 kWp	Total power	56.1 kWac
Optimizer Array	5 Strings x 32 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	66.5 kWp	Operating voltage	750 V
Output of optimizers		Pnom ratio (DC:AC)	1.11
Voper	750 V		
I at Poper	89 A		

**Array #6 - VZ - Z b**

Orientation	#2		
Tilt/Azimuth	10/90 °		
Number of PV modules	33 units	Number of inverters	0.3 unit
Nominal (STC)	15.02 kWp	Total power	11.6 kWac
Optimizer Array	1 String x 33 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	13.71 kWp	Operating voltage	750 V
Output of optimizers		Pnom ratio (DC:AC)	1.11
Voper	750 V		
I at Poper	18 A		

**Array #7 - VZ - Va**

Orientation	#3		
Tilt/Azimuth	10/-90 °		
Number of PV modules	160 units	Number of inverters	1.7 units
Nominal (STC)	72.8 kWp	Total power	56.1 kWac
Optimizer Array	5 Strings x 32 In series		



## PV Array Characteristics

**At operating cond. (50°C)**

Pmpp	66.5 kWp
Output of optimizers	
Voper	750 V
I at Poper	89 A

Operating voltage	750 V
Pnom ratio (DC:AC)	1.11

**Array #8 - VZ - V b**

Orientation	#3
Tilt/Azimuth	10/-90 °
Number of PV modules	33 units
Nominal (STC)	15.02 kWp
Optimizer Array	1 String x 33 In series

Number of inverters	0.3 unit
Total power	11.6 kWac

**At operating cond. (50°C)**

Pmpp	13.71 kWp
Output of optimizers	
Voper	750 V
I at Poper	18 A

Operating voltage	750 V
Pnom ratio (DC:AC)	1.11

**PV module**

Manufacturer	SUNMAN
Model	SMF430F-6X24UW

(Custom parameters definition)

Unit Nom. Power	430 Wp
Number of PV modules	214 units
Nominal (STC)	92.0 kWp

**Inverter**

Manufacturer	SolarEdge
Model	SE66.6K/SE100K-EU-APAC/AUS Unit (400V)

(Original PVsyst database)

Unit Nom. Power	33.3 kWac
Number of inverters	2 units
Total power	70.9 kWac

**SolarEdge Power Optimizer**

Model	S440 Worldwide
Unit Nom. Power	440 W
Input modules	One module

**Array #9 - Tělocvična a**

Orientation	#4
Tilt/Azimuth	0/0 °
Number of PV modules	52 units
Nominal (STC)	22.36 kWp
Optimizer Array	2 Strings x 26 In series

Number of inverters	0.5 unit
Total power	17.2 kWac

**At operating cond. (50°C)**

Pmpp	20.23 kWp
Output of optimizers	
Voper	750 V
I at Poper	27 A

Operating voltage	750 V
Pnom ratio (DC:AC)	1.09

**Array #10 - Telocvicna b**

Orientation	#4
Tilt/Azimuth	0/0 °
Number of PV modules	162 units
Nominal (STC)	69.7 kWp
Optimizer Array	6 Strings x 27 In series

Number of inverters	1.5 units
Total power	53.7 kWac

**At operating cond. (50°C)**

Pmpp	63.0 kWp
Output of optimizers	
Voper	750 V
I at Poper	84 A

Operating voltage	750 V
Pnom ratio (DC:AC)	1.09



## PV Array Characteristics

## Total PV power

Nominal (STC)	432 kWp
Total	962 modules
Module area	2127 m <sup>2</sup>

## Total inverter power

Total power	333 kWac
Number of inverters	10 units
Pnom ratio	1.30

## Array losses

## Thermal Loss factor

Module temperature according to irradiance	
Uc (const)	20.0 W/m <sup>2</sup> K
Uv (wind)	0.0 W/m <sup>2</sup> K/m/s

## Module mismatch losses

Loss Fraction (Fixed voltage) 0.0 %

## Module Quality Loss

## Array #1 - G1 a

Loss Fraction -0.6 %

## Array #2 - G1 b

Loss Fraction -0.6 %

## Array #3 - G3

Loss Fraction -0.6 %

## Array #4 - Jih

Loss Fraction -0.6 %

## Array #5 - VZ - Z a

Loss Fraction -0.6 %

## Array #6 - VZ - Z b

Loss Fraction -0.6 %

## Array #7 - VZ - Va

Loss Fraction -0.6 %

## Array #8 - VZ - V b

Loss Fraction -0.6 %

## Array #9 - Tělocvična a

Loss Fraction -0.3 %

## Array #10 - Telocvicna b

Loss Fraction -0.3 %

## IAM loss factor - Array #1

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

## IAM loss factor - Array #2

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

## IAM loss factor - Array #3

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000



## Array losses

**IAM loss factor - Array #4**

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

**IAM loss factor - Array #5**

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

**IAM loss factor - Array #6**

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

**IAM loss factor - Array #7**

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

**IAM loss factor - Array #8**

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

**IAM loss factor - Array #9**

Incidence effect (IAM): Fresnel smooth glass, n = 1.526

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000

**IAM loss factor - Array #10**

Incidence effect (IAM): Fresnel smooth glass, n = 1.526

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000



### DC wiring losses

Global wiring resistance 10 mΩ  
Loss Fraction 1.5 % at STC

#### Array #1 - G1 a

Global array res. 106 mΩ  
Loss Fraction 1.5 % at STC

#### Array #3 - G3

Global array res. 229 mΩ  
Loss Fraction 1.5 % at STC

#### Array #5 - VZ - Z a

Global array res. 116 mΩ  
Loss Fraction 1.5 % at STC

#### Array #7 - VZ - Va

Global array res. 116 mΩ  
Loss Fraction 1.5 % at STC

#### Array #9 - Tělocvična a

Global array res. 377 mΩ  
Loss Fraction 1.5 % at STC

#### Array #2 - G1 b

Global array res. 713 mΩ  
Loss Fraction 1.5 % at STC

#### Array #4 - Jih

Global array res. 232 mΩ  
Loss Fraction 1.5 % at STC

#### Array #6 - VZ - Z b

Global array res. 561 mΩ  
Loss Fraction 1.5 % at STC

#### Array #8 - VZ - V b

Global array res. 561 mΩ  
Loss Fraction 1.5 % at STC

#### Array #10 - Telocvicna b

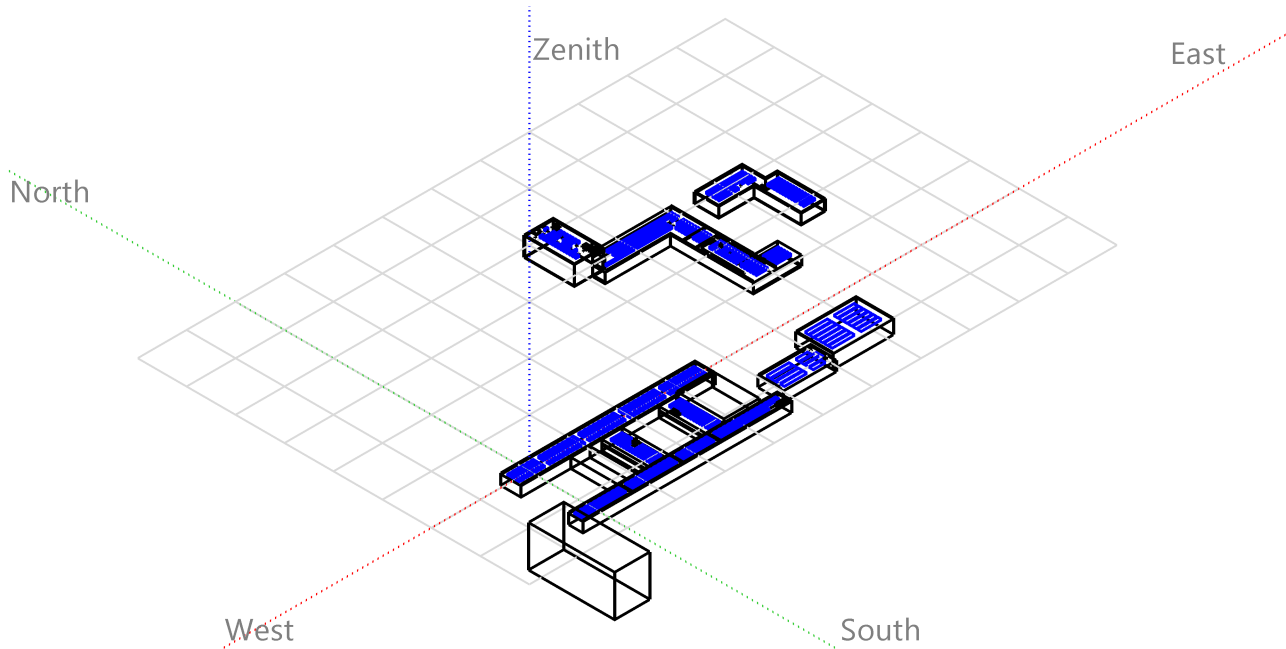
Global array res. 121 mΩ  
Loss Fraction 1.5 % at STC





### Near shadings parameter

#### Perspective of the PV-field and surrounding shading scene

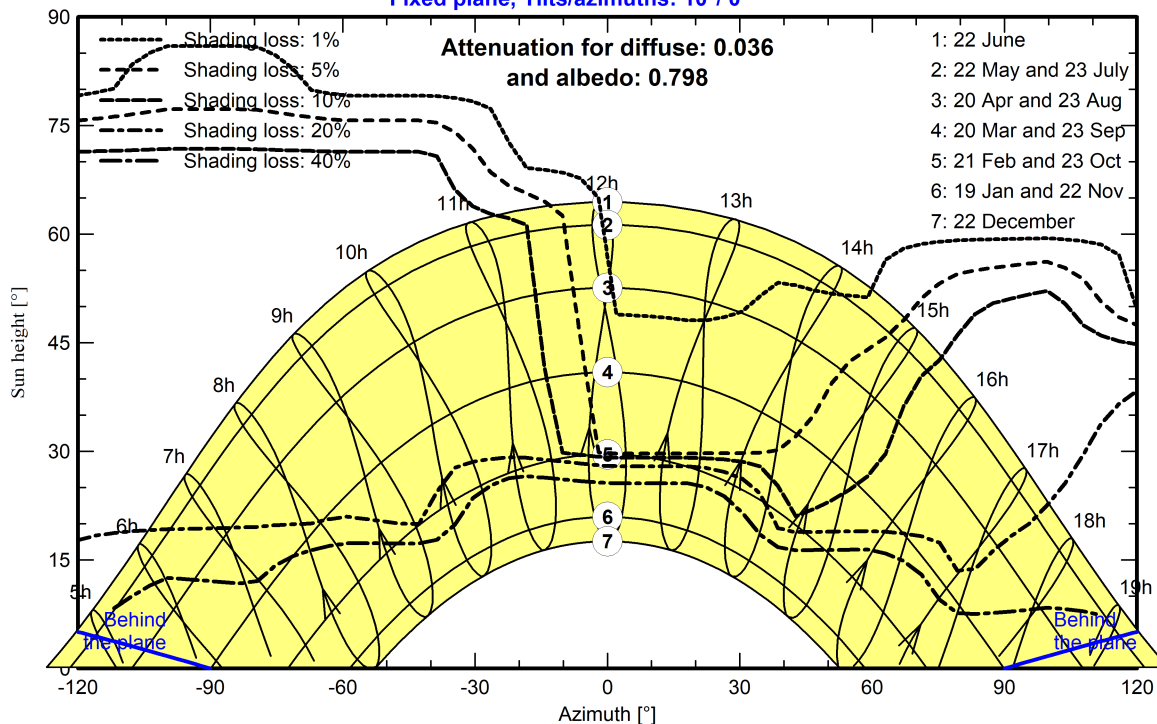




### Iso-shadings diagram

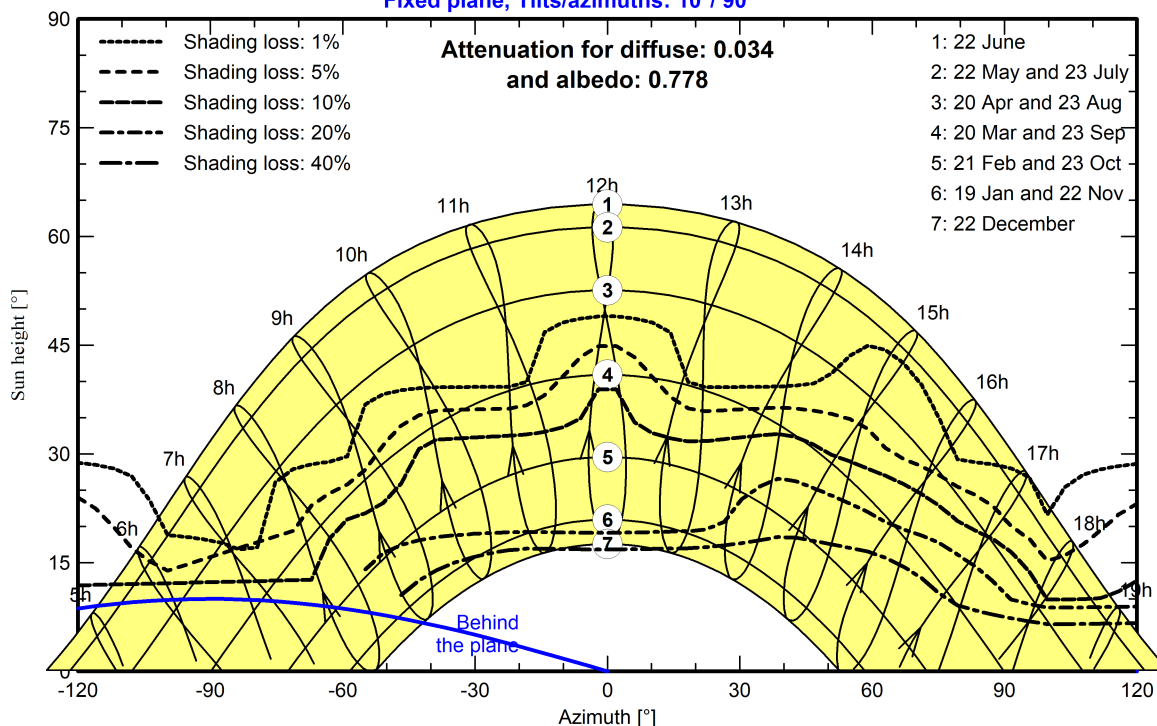
#### Orientation #1

Fixed plane, Tilts/azimuths: 10°/ 0°



#### Orientation #2

Fixed plane, Tilts/azimuths: 10°/ 90°





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## Main results

### System Production

Produced Energy 432.3 MWh/year  
Used Energy 2364.5 MWh/year

Specific production 1000 kWh/kWp/year  
Performance Ratio PR 85.56 %  
Solar Fraction SF 17.09 %

### Economic evaluation

#### Investment

Global 11232000.00 CZK  
Specific 26.0 CZK/Wp

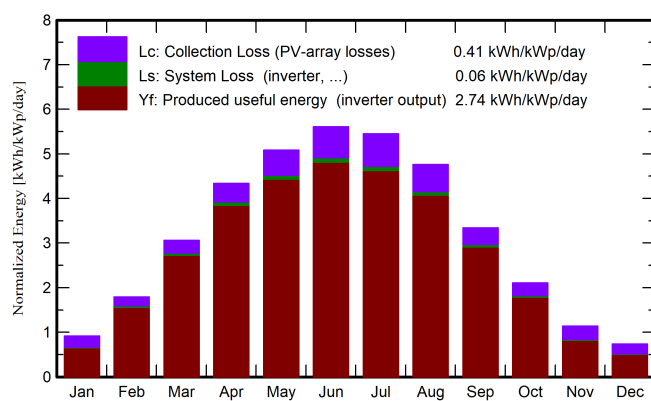
#### Yearly cost

Annuities 0.00 CZK/yr  
Run. costs 45000.00 CZK/yr  
Payback period 4.5 years

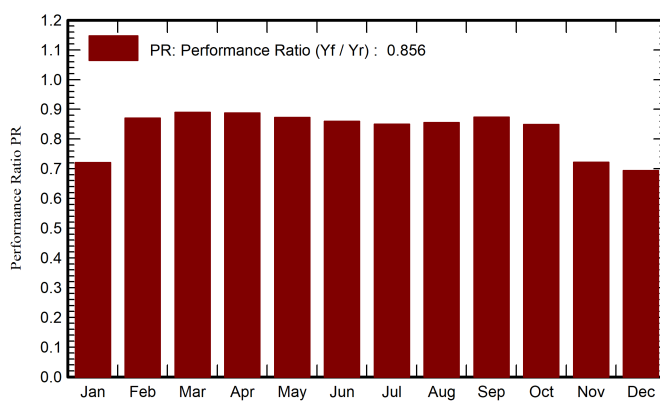
#### LCOE

Energy cost 1.40 CZK/kWh

### Normalized productions (per installed kWp)



### Performance Ratio PR



## Balances and main results

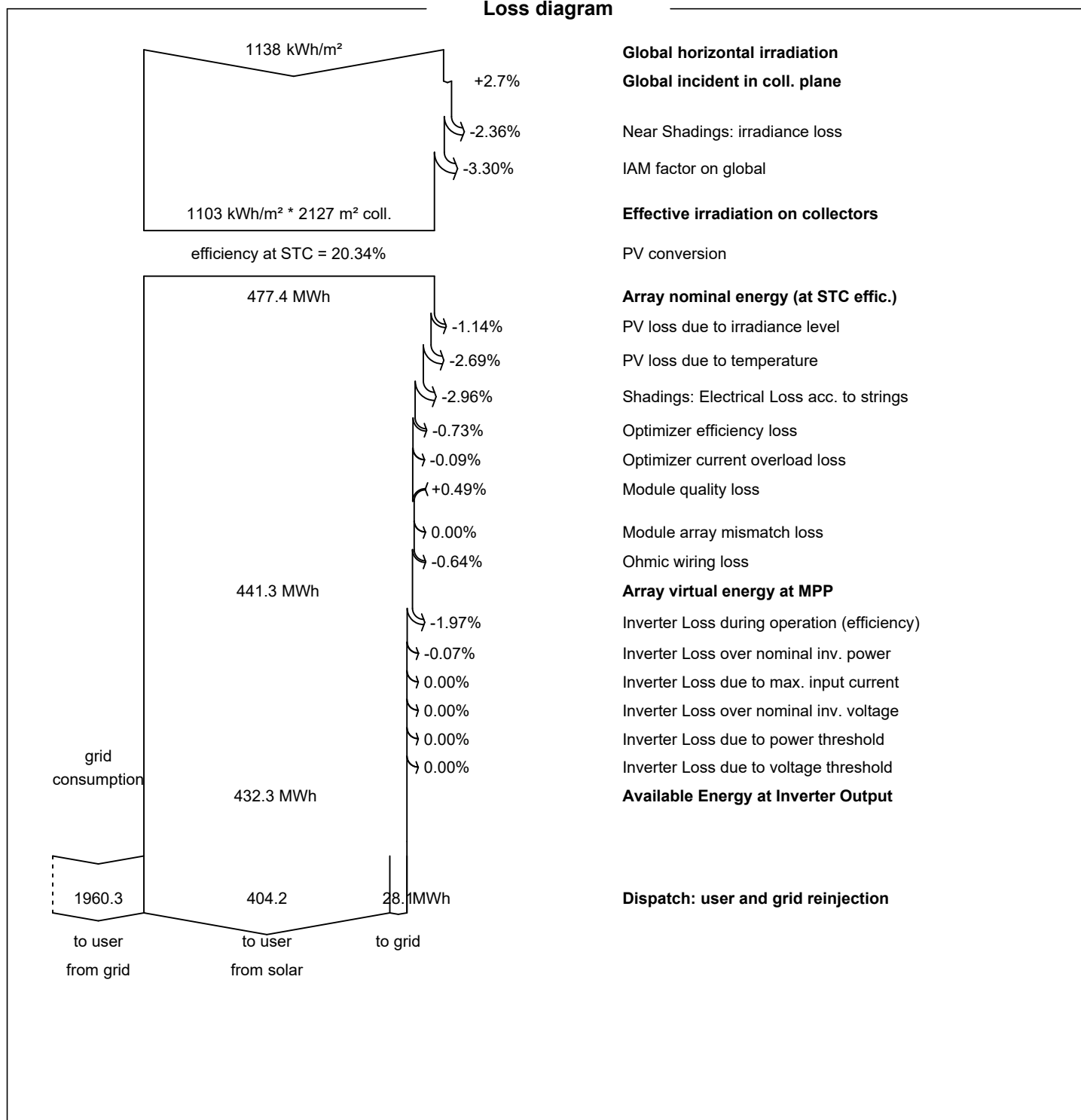
	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_User	E_Solar	E_Grid	EFrGrid
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	MWh	MWh	MWh	MWh	MWh
January	25.9	16.03	-2.15	28.3	24.6	9.04	196.6	8.82	0.000	187.8
February	47.1	28.18	-0.90	50.2	45.9	19.29	186.1	18.90	0.000	167.2
March	90.7	46.82	3.30	95.0	89.0	37.29	193.7	34.62	1.944	159.1
April	126.7	54.39	8.53	130.1	124.0	50.94	180.4	43.11	6.843	137.2
May	156.2	79.65	13.19	157.5	150.9	60.63	197.1	53.47	5.994	143.7
June	167.7	79.89	16.67	168.3	161.6	63.80	195.7	58.62	3.932	137.1
July	168.1	76.72	18.57	168.9	162.0	63.31	209.1	56.76	5.320	152.4
August	145.0	67.34	18.16	147.7	141.4	55.74	209.1	52.49	2.167	156.6
September	97.2	55.39	12.99	100.2	94.6	38.59	188.7	36.43	1.415	152.3
October	61.7	34.81	8.35	65.4	60.0	24.47	169.8	23.50	0.485	146.3
November	31.0	15.24	3.52	34.2	29.8	10.92	227.9	10.67	0.000	217.2
December	20.8	13.53	-0.60	22.7	19.5	7.00	210.1	6.82	0.000	203.3
Year	1138.1	568.00	8.36	1168.6	1103.4	441.02	2364.5	404.21	28.102	1960.3

### Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective Global, corr. for IAM and shadings	EFrGrid	Energy from the grid



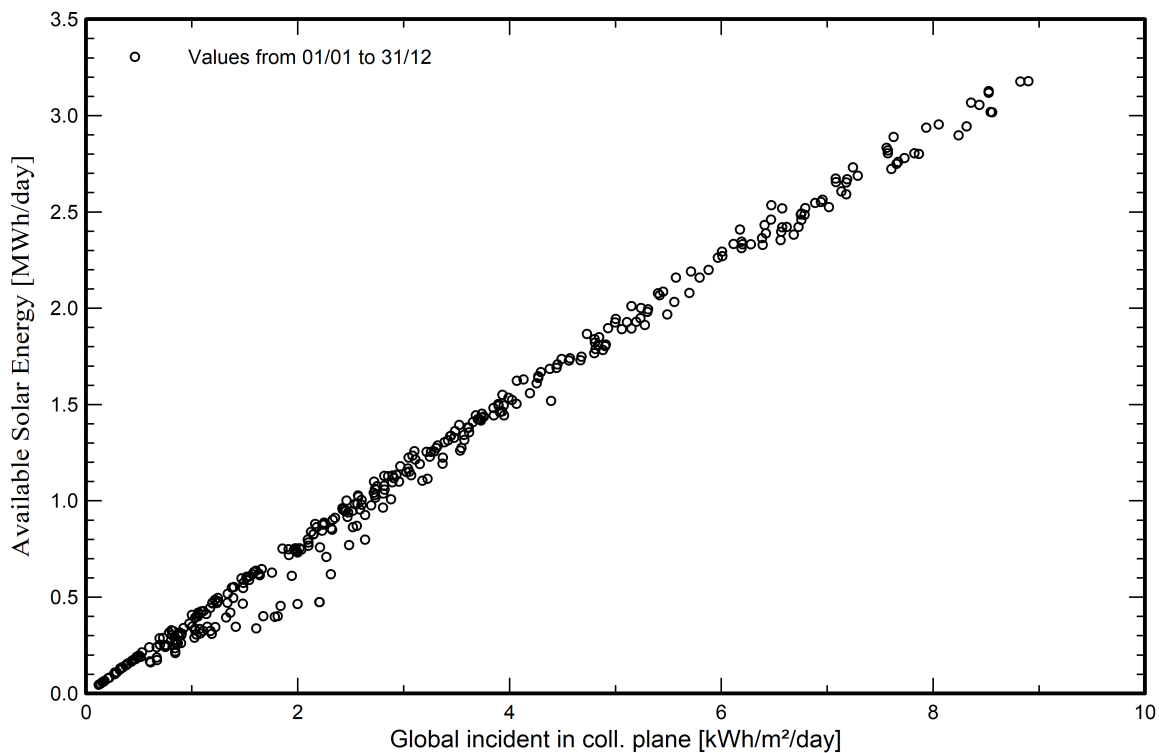
### Loss diagram



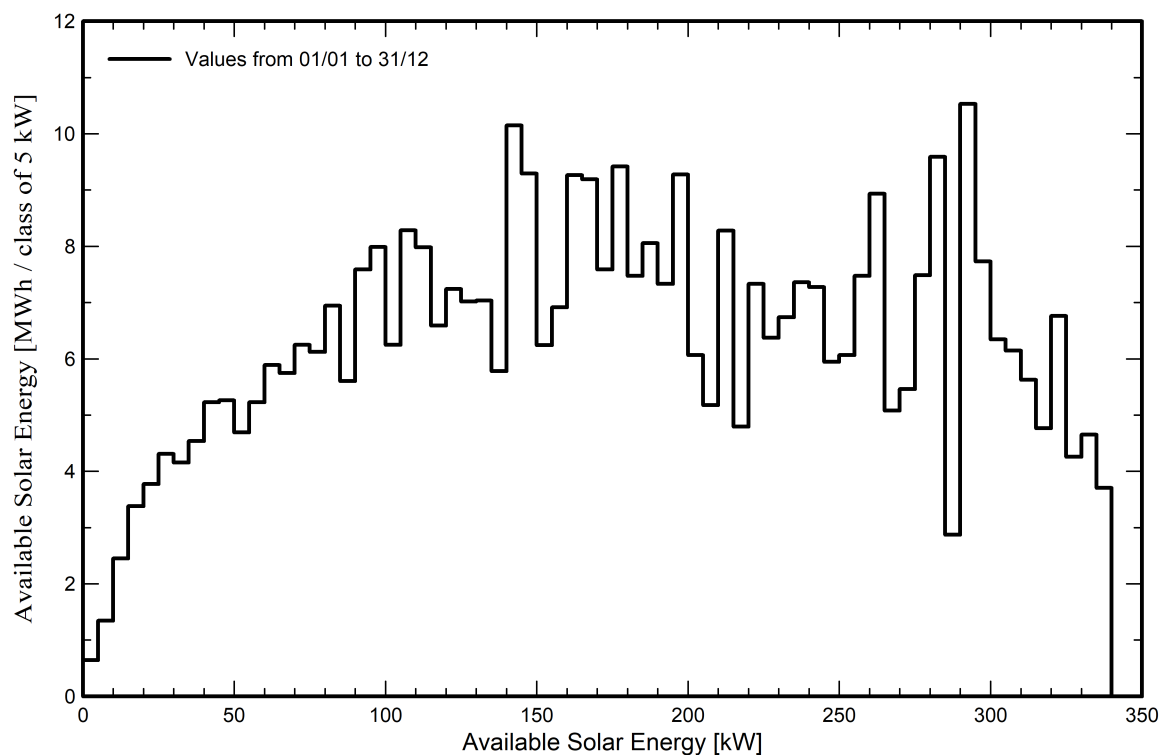


### Special graphs

Daily Input/Output diagram



System Output Power Distribution



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**Cost of the system****Installation costs**

Item	Quantity units	Cost CZK	Total CZK
FVE	432	26000.00	11232000.00
Total			11232000.00
Depreciable asset			0.00

**Operating costs**

Item	Total CZK/year
Maintenance	
Repairs	45000.00
Total (OPEX)	45000.00

**System summary**

Total installation cost	11232000.00 CZK
Operating costs	45000.00 CZK/year
Unused energy	404 MWh/year
Energy sold to the grid	28.1 MWh/year
Cost of produced energy (LCOE)	1.403 CZK/kWh



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## Financial analysis

### Simulation period

Project lifetime 20 years Start year 2023

### Income variation over time

Inflation 0.00 %/year  
Production variation (aging) 0.00 %/year  
Discount rate 0.00 %/year

### Income dependent expenses

Income tax rate 0.00 %/year  
Other income tax 0.00 %/year  
Dividends 0.00 %/year

### Financing

Own funds 11232000.00 CZK

### Electricity sale

Feed-in tariff 3.5000 CZK/kWh  
Duration of tariff warranty 20 years  
Annual connection tax 0.00 CZK/kWh  
Annual tariff variation 0.0 %/year  
Feed-in tariff decrease after warranty 0.00 %

### Self-consumption

Consumption tariff 6.0000 CZK/kWh  
Tariff evolution 0.0 %/year

### Return on investment

Payback period 4.5 years  
Net present value (NPV) 38341129.82 CZK  
Return on investment (ROI) 341.4 %

## Detailed economic results (CZK)

	Electricity	Run.	Deprec.	Taxable	Taxes	After-tax	Self-cons.	Cumul.	%
	sale	costs	allow.	income		profit	saving	profit	amorti.
2023	98356	45000	0	53356	0	53356	2425301	-8753344	22.1%
2024	98356	45000	0	53356	0	53356	2425301	-6274687	44.1%
2025	98356	45000	0	53356	0	53356	2425301	-3796031	66.2%
2026	98356	45000	0	53356	0	53356	2425301	-1317374	88.3%
2027	98356	45000	0	53356	0	53356	2425301	1161282	110.3%
2028	98356	45000	0	53356	0	53356	2425301	3639939	132.4%
2029	98356	45000	0	53356	0	53356	2425301	6118595	154.5%
2030	98356	45000	0	53356	0	53356	2425301	8597252	176.5%
2031	98356	45000	0	53356	0	53356	2425301	11075908	198.6%
2032	98356	45000	0	53356	0	53356	2425301	13554565	220.7%
2033	98356	45000	0	53356	0	53356	2425301	16033221	242.7%
2034	98356	45000	0	53356	0	53356	2425301	18511878	264.8%
2035	98356	45000	0	53356	0	53356	2425301	20990534	286.9%
2036	98356	45000	0	53356	0	53356	2425301	23469191	308.9%
2037	98356	45000	0	53356	0	53356	2425301	25947847	331.0%
2038	98356	45000	0	53356	0	53356	2425301	28426504	353.1%
2039	98356	45000	0	53356	0	53356	2425301	30905160	375.2%
2040	98356	45000	0	53356	0	53356	2425301	33383817	397.2%
2041	98356	45000	0	53356	0	53356	2425301	35862473	419.3%
2042	98356	45000	0	53356	0	53356	2425301	38341130	441.4%
<b>Total</b>	<b>1967116</b>	<b>900000</b>	<b>0</b>	<b>1067116</b>	<b>0</b>	<b>1067116</b>	<b>48506014</b>	<b>38341130</b>	<b>441.4%</b>



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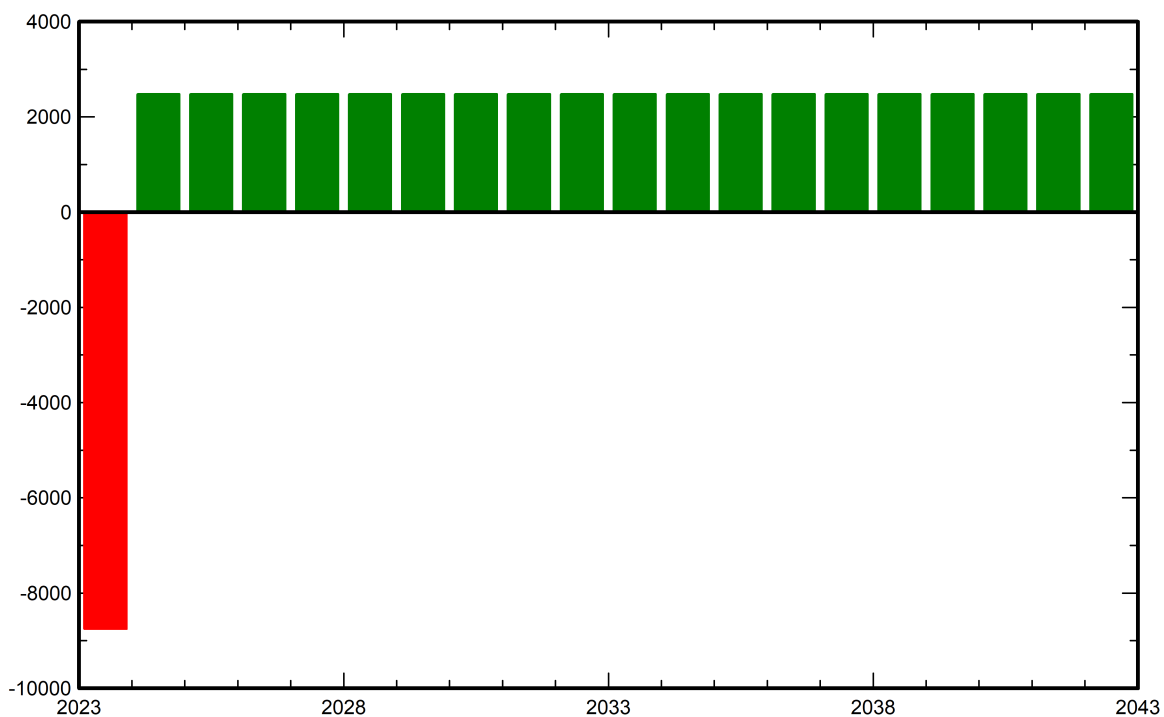
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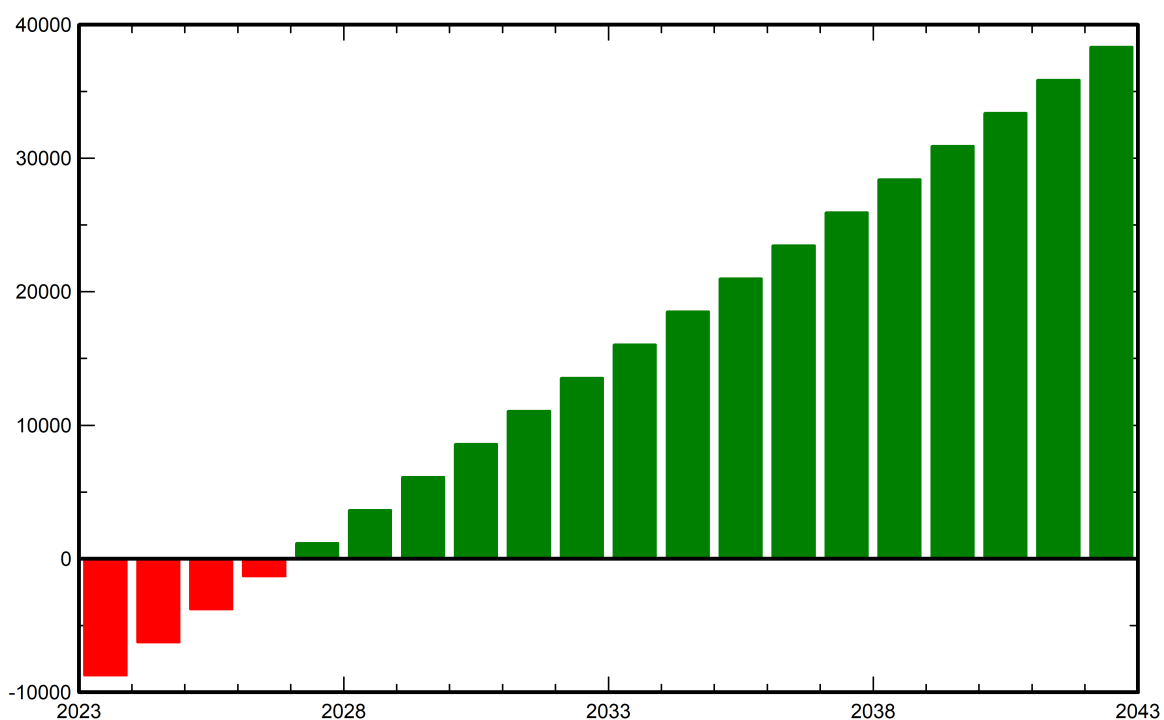
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### Financial analysis

#### Yearly net profit (kCZK)



#### Cumulative cashflow (kCZK)







### CO<sub>2</sub> Emission Balance

Total: 10657.2 tCO<sub>2</sub>

#### Generated emissions

Total: 787.22 tCO<sub>2</sub>

Source: Detailed calculation from table below:

#### Replaced Emissions

Total: 13189.9 tCO<sub>2</sub>

System production: 432.31 MWh/yr

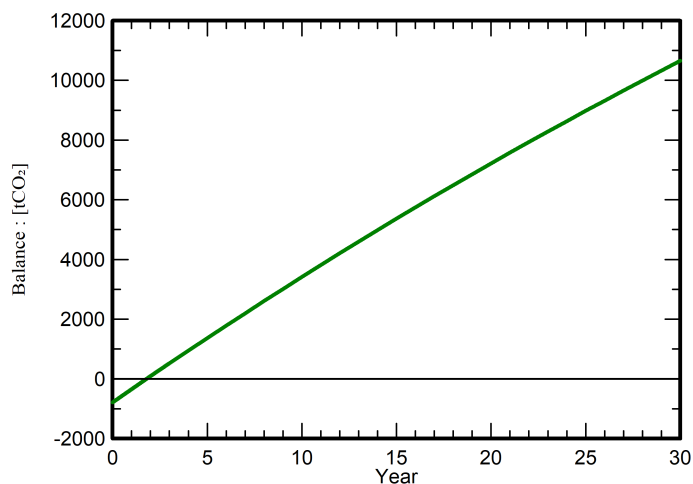
Grid Lifecycle Emissions: 1017 gCO<sub>2</sub>/kWh

Source: Custom value supplied by user

Lifetime: 30 years

Annual degradation: 1.0 %

#### Saved CO<sub>2</sub> Emission vs. Time



#### System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[kgCO <sub>2</sub> ]
Modules	1713 kgCO <sub>2</sub> /kWp	432 kWp	740512
Supports	4.40 kgCO <sub>2</sub> /kg	9620 kg	42349
Inverters	436 kgCO <sub>2</sub> /units	10.00 units	4361