CalculationSolar.com

HELPS YOU TO CALCULATE, OF RAPID AND EASY WAY, AN ISOLATED PHOTOVOLTAIC SOLAR, LOCATED IN ANY PART OF PLANET.

FREE ONLINE APPLICATION OF CALCULATION

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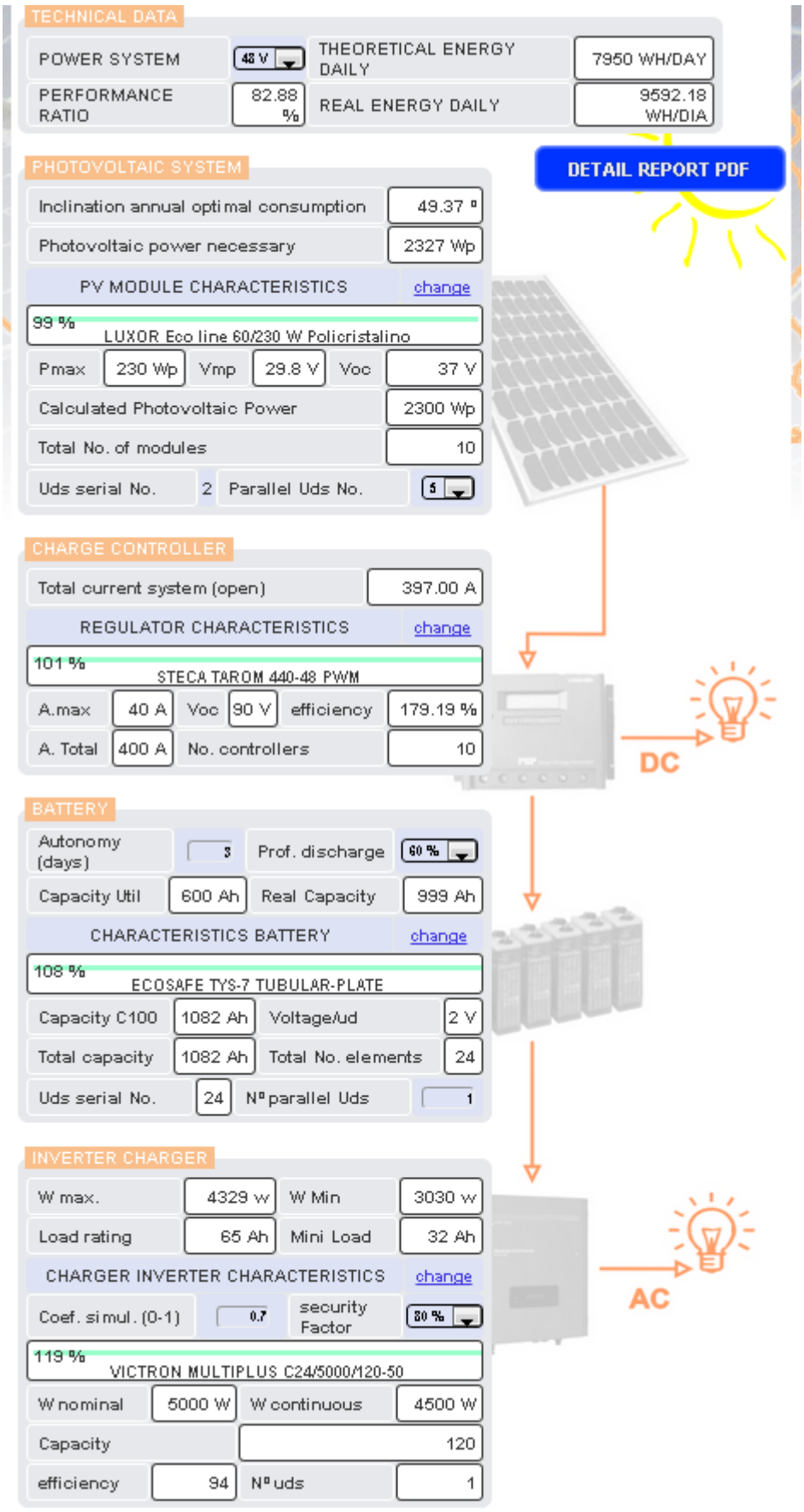
EXAMPLE 3: CALCULATION OF SOLAR PHOTOVOLTAIC INSTALLATION WITH AUXILIARY GENERATOR VANCOUVER (CANADA)

For this example we will calculate an installation on Vancouver, Canada. For an estimated consumption of 7950 Wh / day. With the support of auxiliary power. For home use from July to August vacation. With a system voltage of 48 Vdc, and an output voltage of 110 Vac.

The data input to the program are as follows:

After a preliminary calculation shows us the following results



As the data cover our needs do not change anything and proceed to print the report:

Calculation photovoltaic installation

It makes a report of a solar photovoltaic off-grid from the input data introduced considering the estimated consumption according to the needs and use of the same and solar radiation according to the location, orientation and inclination of the installation.

DETAILS OF LOCATION AND ORIENTATION

The installation is located:2500-2698 East 40th Avenue, Vancouver, Colombia Británica V5R 2V9, Canadá
The coordinates:49.233741, -123.055115
The PV array will be ready with the following features:
- inclination:37 º
- Disorientation regarding the South: 0 º

Used a system AC current with a voltage of 110 V
The system you have auxiliary generator

CONSUMPTION.

Consumption is calculated from the use of appliances and lighting per day. The following table shows the existing elements and their consumption:

Consumption by Lighting (day)				
Type	**Nº**	**Hours**	**Energy**	**Total**
fluorescent lamp	4	5	11 W	220 Wh
bulb	2	5	60 W	600 Wh
fluorescent tube	2	5	30 W	300 Wh
			TOTAL	**1120 Wh/d**

Consumer appliances (day)				
appliance	**Hours**	**Energy**	**F.Consumpt.**	**Total**
Television	3	70 W	100 %	21000 Wh
Refrigerator	24	195 W	50 %	234000 Wh
Microwave oven	0.8	800 W	100 %	64000 Wh
			TOTAL	**319000 Wh/d**

THEORETICAL TOTAL DAILY ENERGY 320120 WH/DAY

For the calculation of yield (Performance Ratio) have used the following parameters:

Coefficient battery losses	**5 %**
Battery self discharge coefficient	**0.5 %**
Battery discharge depth	**60 %**
Loss coefficient DC / AC conversion	**6 %**
Loss coefficient wiring	**5 %**
Autonomy System	**3 d**
Performance Ratio	**81.9 %**

What gives us the following results of energy.

TOTAL DAILY ENERGY REAL (WH/DAY): 9706.96

Is a (housing Typical use the following months consumption distributed along the year.

	Ene	Feb	Mar	Abl	May	Jun	Jul	Ago	Sep	Oct	Nov	Dic
% month	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
consumption (W)	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**	**9707**

PICO SUN HOURS

For the calculation of the time are pico, we used the NREL-NASA database, contemplating chosen inclination and orientation and location data instead.

The solar declination is calculated with the following formula:

$$[1]\ \delta = 23{,}45 \cdot \operatorname{sen}\left(360 \cdot \frac{284 + \delta_n}{365}\right)$$

δ: declination (degrees)
δ_n: day of year (1 ... 365, taken 1 for the day January)

They have chosen a day of each month, which coincides with a day in mid-month.

For the calculation of the solar elevation values ??are taken:

- $(90° - \varphi - \delta)$ on winter solstice
- $(90° - \varphi + \delta)$ on the summer solstice

φ being the latitude and declination δ.

To determine the optimal inclination have used the following assumptions:

- $\beta = \varphi - \delta$ on the summer solstice
- $\beta = \varphi + \delta$ on winter solstice

through the value $\beta = \varphi$ at the equinoxes
φ being the latitude and declination δ.

To rad_glo_op parameter estimation, we have used the following formula:

$$G_a(\beta_{opt}) = \frac{G_a(0)}{1 - 4{,}46 \cdot 10^{-4} \cdot \beta_{opt} - 1{,}19 \cdot 10^{-4} \cdot \beta_{opt}^2}$$

Ga(βopt): annual mean global irradiation optimally inclined surface (kW · h / m²)
Ga(0º): annual average global horizontal irradiation (kW · h / m²)
βopt:Optimum surface inclination (°)

For obtaining irradiance factor (FI) have been used the following expressions:

$$FI = 1 - [1{,}2 \times 10^{-4}(\beta - \beta_{opt})^2 + 3{,}5 \times 10^{-5}\alpha^2] \quad \text{for } 15° < \beta < 90°$$

$$FI = 1 - [1{,}2 \times 10^{-4}(\beta - \beta_{opt})^2] \quad \text{for } \beta \le 15°$$

FI:Radiation factor (unitless)
β: Actual surface inclination (°)
βopt: Optimum surface inclination (°)
α: surface azimuth (º)

Finally the peak sun hours (HSP) is the result of multiplying the optimal global radiation (Ga (ßopt)) by a factor of irradiation (FI).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days of month	31	28	31	30	31	30	31	31	30	31	30	31
Declination	-21.27º	-13.62º	-2.02º	9.78º	19.26º	23.39º	21.18º	13.12º	1.81º	-10.33º	-19.6º	-23.4º
Nº day/year	15	45	76	106	137	168	198	229	259	290	321	351
Solar elevation	19.5º	27.15º	38.75º	50.55º	60.03º	64.15º	61.95º	53.89º	42.58º	30.44º	21.16º	17.37º
optimal inclination	70.5º	62.85º	51.25º	39.45º	29.97º	25.85º	28.05º	36.11º	47.42º	59.56º	68.84º	72.63º
rad_glo_hor	1.13	2.03	3.13	4.53	5.37	5.66	5.97	5.18	3.99	2.2	1.27	0.92
rad_glo_op	3	4.05	4.71	5.68	6.1	6.23	6.68	6.25	5.61	3.99	3.13	2.71
FI	0.87	0.92	0.98	1	0.99	0.99	0.99	1	0.99	0.94	0.88	0.85
HSP/day	2.61	3.72	4.62	5.68	6.04	6.16	6.61	6.25	5.55	3.75	2.76	2.3
HSP/month	80.91	104.16	143.22	170.4	187.24	184.8	204.91	193.75	166.5	116.25	82.8	71.3
Temp day max	0.01º	1.57º	4.76º	8.35º	12.74º	16.42º	20.18º	20.23º	16.09º	9.17º	3.12º	-0.32º
Consu/HSP day	3719.14	2609.4	2101.07	1708.97	1607.11	1575.81	1468.53	1553.11	1749	2588.52	3517.01	4220.42

CALCULATIONS OF MODULES

To calculate the PV field is taken into account the inclination and orientation chosen, the HSP, the utilization ratio of the charge controller and daytime mean monthly temperatures chosen location. Providing the following values:

* The most unfavorable month as consumption: Diciembre
* Annual optimal inclination: 37.67º
* Inclination annual optimal consumption: 49.37º
* inclination chosen: 37º
* Azimuth modules: 0º
* Monthly average maximum daily temperature (3 months): 0.94º
* Pico Sun Hours worst in months: 2.3 HSP
* Daily from Real Energy modules: 9706.96 Wh/d
* Utilization ratio controller: 2
* Calculated Pico Power modules: 2355 Wp

The election of the module, takes into account the different electrical parameters that determine performance, the units required and their coupling with the regulator and battery.Then are observed details of the module and the load selected.

LUXOR Eco line 60/230 W Policristalino			
Open circuit voltage (Voc):	37 V	Voltage at maximum power (vmp):	29.8 V
Short circuit current (isc):	8.22 A	Current at Maximum Power (Imp):	7.73 A
Maximum power:	230 W	Temperature Coefficient of Pmax:	-0.45 %/ºC
Real power max Average temperature:	240.827 Wp	Serial Number of modules:	2
Total Pico Power modules:	2300 Wp	No. parallel series:	5
Optimization installation / needs most unfavorable month:	0.98	Total modules:	10
The degree of optimization election equipment / real needs is			98 %

CALCULATIONS REGULATORS

For the choice of the controller takes into account the voltage of the system, the parameters of photovoltaic modules, which gives us a certain degree of optimization. View following:

* Power system: 48 V
* Open circuit voltage modules: 37 V
* Maximum voltage power modules: 29.8 V
* Short circuit current module:8.22 A
* Current at maximum power module: 7.73 A
* No. of series modules installed: 2
* Number of parallel modules installed: 5
* Total modules installed:10
* Intensity module to system voltage (open): 16.55 A
* Current to voltage module system (closed): 15.56 A
* Total current system (open):166 A
* Total current system (closed)): 155.64 A

The choice of the regulator is as follows:

STECA TAROM 440-48 PWM			
Tension:	48 V	Voltage:	90 V
Rated power:	2400 Wp	Consumption:	14 mA
Capacity:	40 A	Utilization ratio:	1.79
The degree of optimization election equipment / real needs is	96 %	Number of Regulators:	4

CALCULATIONS BATTERIES

For the calculation of the battery, is taken into account, the energy, the system voltage and the depth of discharge and autonomy of the system in days.

* Battery nominal voltage: 48 V
* Depth of discharge of batteries: 60 %
* Autonomy System: 3day
* Real Energy Daily: 9707 Wh/día
* Battery Capacity calculated helpful: 607 Ah
* Actual capacity batteries calculated: 1011 Ah

In what follows, that, adapting to the manufacturer, use a battery with x series x x parallel vessels in C100 Ah, per set, for a total of x and x V. Ah in C100 With this accumulation have the storage capacity x days with theoretical consumption.

ECOSAFE TYS-7 TUBULAR-PLATE									
Capacities according to their hours of download:									
C 10:	786 Ah	C 20:	887 Ah	C 40:	1049 Ah	C 100:	1082 Ah	C 120:	1095 Ah

Tension	2 V	Serial No. elements:	24
Nominal capacity accumulator:	1082 Ah	No. parallel series:	1
Battery Nominal voltage:	48 V	Total elements:	24
The degree of optimization election equipment / real needs is			107 %

INVERTER-CHARGER

For sizing the inverter-charger have used the following data:

* Voltage DC system:: 48 V
* AC output voltage: 110 V
* Maximum power: 4329 W
* Coefficient Concurrency: 0.7
* Power requirement: 3788 W
* Safety factor: 0.8
* Power calculation: 3788 W

The choice of inverter-charger is as follows:

VICTRON MULTIPLUS C24/5000/120-50			
Tension:	24 V	Rated power:	5000 W
Continuous power:	4500 W	Instant Power:	10000 W
Consumption empty:	25 W	Efficiency:	94 %
Utilization ratio:	84 %	Number of investors:	1
The degree of optimization election equipment / real needs is			119 %

SUMMARY

Summary of the elements resulting from the calculation

Units	Elements
10	Module type - LUXOR Eco line 60/230 W Policristalino
4	Regulator type - STECA TAROM 440-48 PWM
24	Battery type - ECOSAFE TYS-7 TUBULAR-PLATE
1	Inverter type - VICTRON MULTIPLUS C24/5000/120-50

Consumptions with selected elements and components of the installation calculated comparative obtain the following estimated consumption and production over the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consumption	301	272	301	291	301	291	301	301	291	301	291	301
Production	333	429	590	702	772	762	845	799	686	479	341	294

Total consumption per year: 3543 Kw

Total production per year: 7032 Kw

Total kg / year CO2 avoided: 3811