100% renewables

EXCEPT ONLY
Only information that is relevant to the site has been provided

Northern Beaches Council

Renewable Energy Options Study

Final Report

Date:

31 August 2017

2.3 Aquatic Centre, Boy Charlton, Manly

2.3.1 Summary

Due to not having a full year interval data and the delayed starting of the cogeneration unit the load profile for March 2017 has been used for modelling as a standard month's load across the year.

Within this month there is a variance of 100kW up to 180 kW from day to day, and modelling takes this potential for high variance into account.

Peak demand savings from solar PV will be impacted by winter late afternoon (5-6pm) demand, which is seen in March 2017 to reach 202 kW at a time when solar PV would only be generating 5 kW.

In order to find a balance of self-consumption to energy offset 4 system sizes were modelled against the load profile. In all cases a threshold level of 90% self-consumption was targeted. A more detailed shading analysis would be undertaken at installation/design stage to verify this level. All roof structures appeared suitable upon visual inspection, with no obvious issues identified. Confirmation from a structural engineer's report could be obtained if required.

A suggested system that maximises offset within the capacity of the roof is a 224 kWp system that can achieve a 91% self-consumption level and offset more than 31% of the site's electricity demand. It is noted that this is modelled based on the assumption the cogeneration unit is running, and there is no impact on cogeneration from the solar PV system. When there is surplus solar energy this will be exported rather than require the cogeneration unit operation to be modified. When planning for solar PV it will be prudent to engage with Ausgrid so that any relevant issues in terms of grid protection can be identified and included within any works.

In the event that accessing STCs is considered important Council can install a 100 kWp system across the front three north-facing roofs.

TABLE 5: SUMMARY OF SOLAR PV MODELLED RESULTS FOR BOY CHARLTON POOL

System size	Energy offset	Self-consumption
180kWp	28.53%	96.01%
202kWp	30.86%	93.24%
224kWp	**31.24%**	**91.11%**
239kWp	35.65%	86.95%

2.3.2 Retail energy rates used

The following retail energy rates and escalation rate were used in the assessment of the costs and benefits.

- Peak/Shoulder 6.103¢/kWh in 2017, rising to 6.155 ¢/kWh in 2018 and 6.24 ¢/kWh in 2019
- Offpeak 4.133¢/kWh in 2017, rising to 4.17 ¢/kWh in 2018 and 4.231 ¢/kWh in 2019
- 2.5% annual rise thereafter

These are in addition to regulated network rates as per Ausgrid's published tariffs, which are assumed to escalate at 2.5% per year.

The rates used are lower than recent trends in wholesale electricity markets owing to the timing of Council's procurement for sites in the former Manly LGA. More recent trends have seen electricity retail prices increase by more than 200% for some end users. Both the Pittwater and Warringah areas will experience rises in energy rates of this magnitude from January 2018.

Modelled solar generation was overlaid onto interval data for the site and the combined electricity rate (retail + network + envoronmental + market) applied for each hour of the year. This analysis enables both a weighted value for solar PV energy savings and peak demand / capacity savings to be estimated. These are site-specific values, and following the implementation year 2019/20 are estimated to be:

- Weighted value of solar kWh savings: 18.14 ¢/kWh
- Expected reduction in peak demand / capacity: 4.5 kVA at the applicable Ausgrid rate

2.3.3 Layout of proposed solar PV system

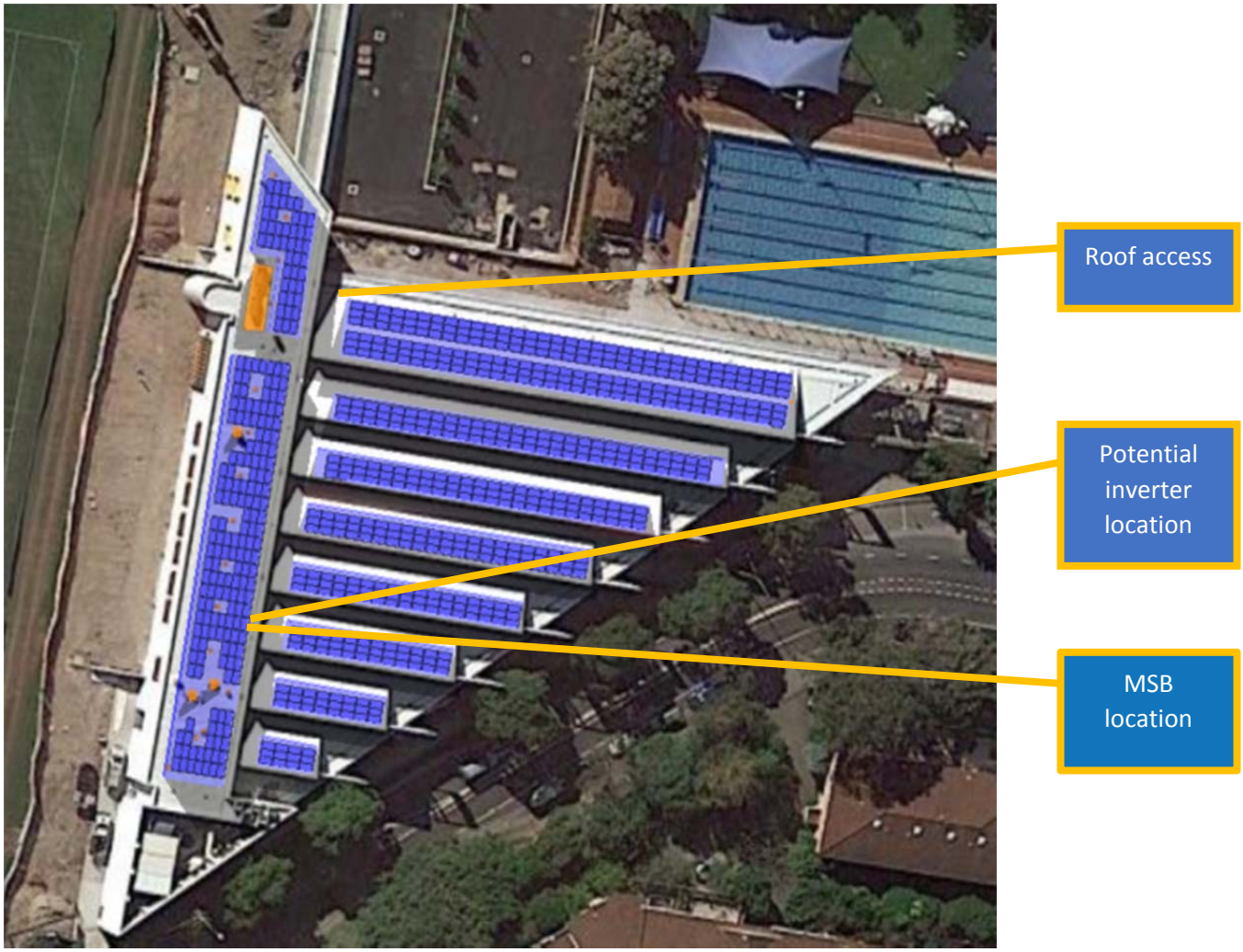

FIGURE 11: LAYOUT OF A 224 KWP SOLAR PV SYSTEM ON BOY CHARLTON POOL

The blue sections in the above image are solar panels in the suggested configuration. Orange polygons refer to existing roof structures.

A number of photos were taken at the site to highlight:

- Main switch room and space in the distribution board in the main switchroom to accommodate solar,
- Potential inverter location,
- Shading impact example,
- Roof structure and example of suitable screw lines for mounting

Main switch room

Space in DB board in Main switch room

Potential inverter location

Shading impact at 8.30am

Front roof with suitable screw lines for mounting

Internal roof sructure

FIGURE 12: PHOTOS OF KEY FEATURES THAT SUPPORT THE IMPLEMENTATION OF SOLAR PV AT BOY CHARLTON POOL

2.3.4 Energy flows

The expected energy flows (from grid, from solar, excess solar) were compiled by plotting the load profiles for the site and the hourly output from solar PV systems alongside one another. The two graphs below illustrate the flows in sample summer and winter weeks.

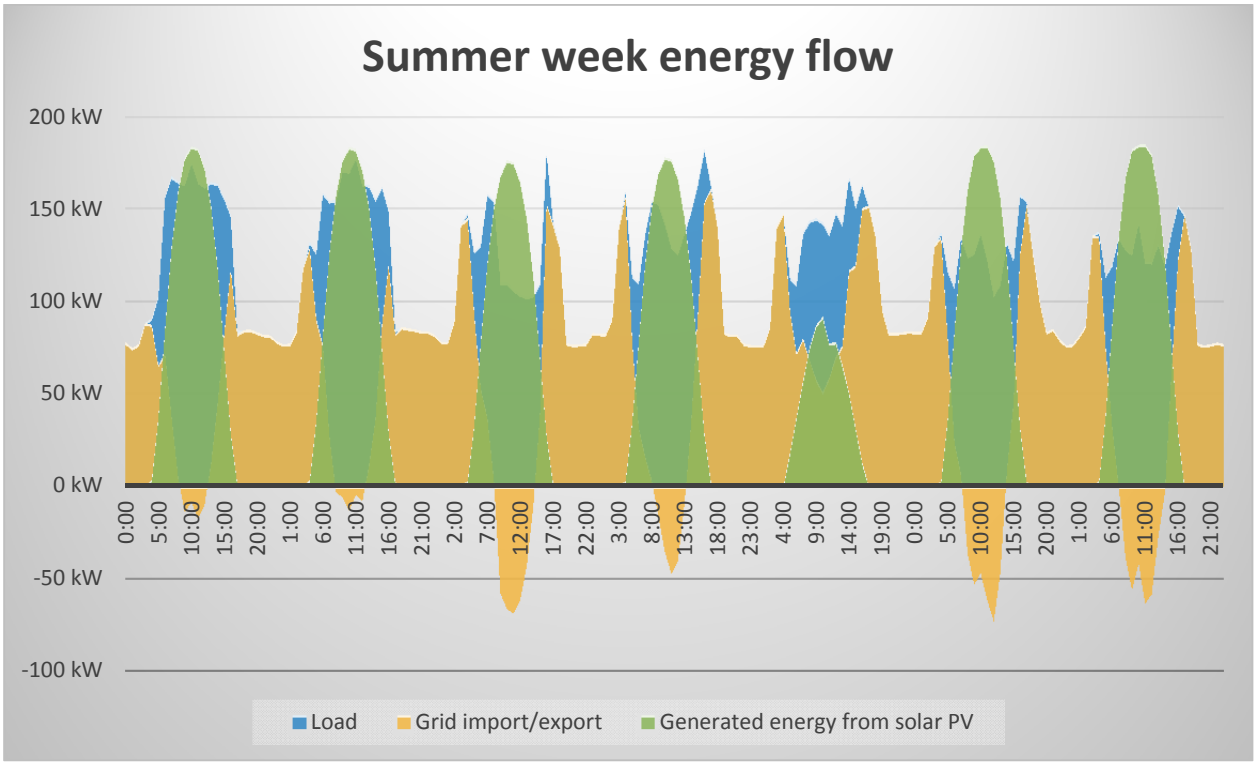

FIGURE 13: SUMMER ENERGY FLOWS WITH SOLAR PV AT BOY CHARLTON POOL

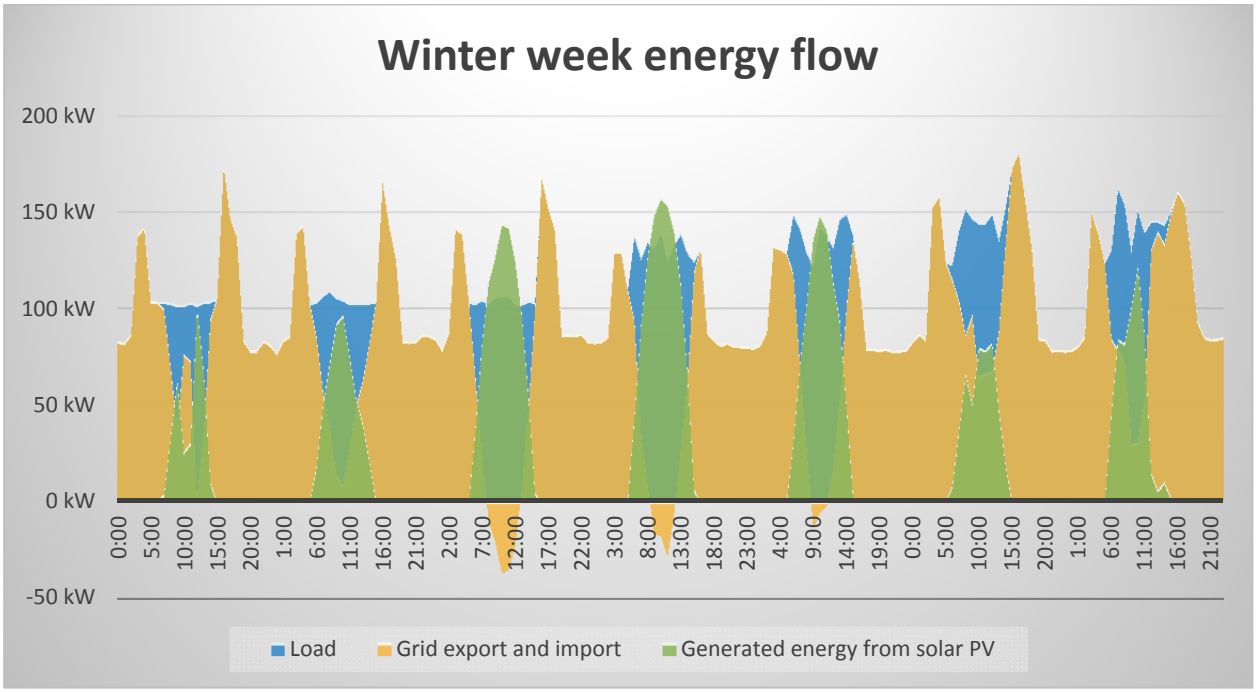

FIGURE 14: WINTER ENERGY FLOWS WITH SOLAR PV AT BOY CHARLTON POOL

2.3.5 Business case results

Modelled solar PV outputs were mapped against the energy rates and escalation rates noted above, and together with estimated capital costs was used to estimate the payback for solar PV and the performance of the project over its expected 25 year life. The results of this are summarised below.

TABLE 6: SUMMARY OF SOLAR PV BUSINESS CASE PROJECTIONS FOR BOY CHARLTON POOL

Return on Investment	
Payback period (years)	6.10
Estimated energy usage savings year 1	$58,526
Estimated peak demand savings year 1	$629
Estimated total savings year 1	$59,156
Cash flow of 25 year system life (excludes capital cost)	$1,744,429
IRR	16%
NPV	$371,380
% of energy supplied by solar	31.24%
% of solar energy consumed	91.11%
System upfront cost	
Gross system cost fully installed ex GST	$425,600

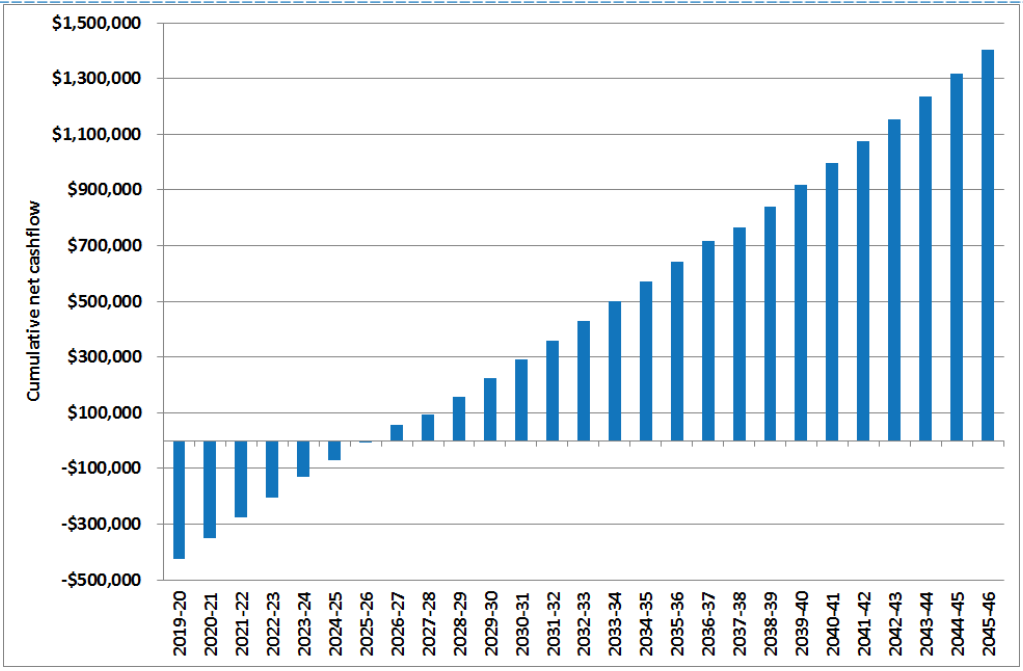

FIGURE 15: SYSTEM LIFE CASH FLOW PROJECTION FOR BOY CHARLTON POOL

2.3.6 Components used in modelling

Modules	LG 300W Mono X
Inverter	Fronius ECO 27-3-M
Warranty	25 year Module o/p to 83%
	12 module structural warranty
	10 year inverter warranty

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Grid-Connected System: Simulation parameters

Project : **NBC Aquatic centre**

Geographical Site	**Sydney**		Country	**Australia**
Situation	Latitude	33.9°S	Longitude	151.2°E
Time defined as	Legal Time	Time zone UT+10	Altitude	4 m
	Albedo	0.20		
Meteo data:	**Sydney**	MeteoNorm 7.1 station - Synthetic		

Simulation variant : **New simulation variant**

Simulation date 20/06/17 13h06

Simulation parameters

2 orientations	Tilts/Azimuths	25°/-10° and 10°/80°		
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	No Shadings			

PV Arrays Characteristics (2 kinds of array defined)

PV module Si-mono	Model	**LG 300 N1C-A3**		
Original PVsyst database	Manufacturer	LG Electronics		
Sub-array "Sub-array #1"	Orientation	#2	Tilt/Azimuth	10°/80°
Number of PV modules	In series	22 modules	In parallel	9 strings
Total number of PV modules	Nb. modules	198	Unit Nom. Power	300 Wp
Array global power	Nominal (STC)	**59.4 kWp**	At operating cond.	53.3 kWp (50°C)
Array operating characteristics (50°C)	U mpp	628 V	I mpp	85 A
Sub-array "Sub-array #2"	Orientation	#1	Tilt/Azimuth	25°/-10°
Number of PV modules	In series	22 modules	In parallel	25 strings
Total number of PV modules	Nb. modules	550	Unit Nom. Power	300 Wp
Array global power	Nominal (STC)	**165 kWp**	At operating cond.	148 kWp (50°C)
Array operating characteristics (50°C)	U mpp	628 V	I mpp	236 A
Total Arrays global power	Nominal (STC)	**224 kWp**	Total	748 modules
	Module area	**1227 m²**	Cell area	1073 m²

Inverter	Model	**ECO 27.0-3-S**		
Original PVsyst database	Manufacturer	Fronius International		
Characteristics	Operating Voltage	580-850 V	Unit Nom. Power	27.0 kWac
Sub-array "Sub-array #1"	Nb. of inverters	2 units	Total Power	54 kWac
Sub-array "Sub-array #2"	Nb. of inverters	5 units	Total Power	135 kWac
Total	Nb. of inverters	7	Total Power	189 kWac

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	124 mOhm	Loss Fraction	1.5 % at STC
	Array#2	44 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

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Grid-Connected System: Simulation parameters (continued)

User's needs : Unlimited load (grid)

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Grid-Connected System: Main results

Project : **NBC Aquatic centre**

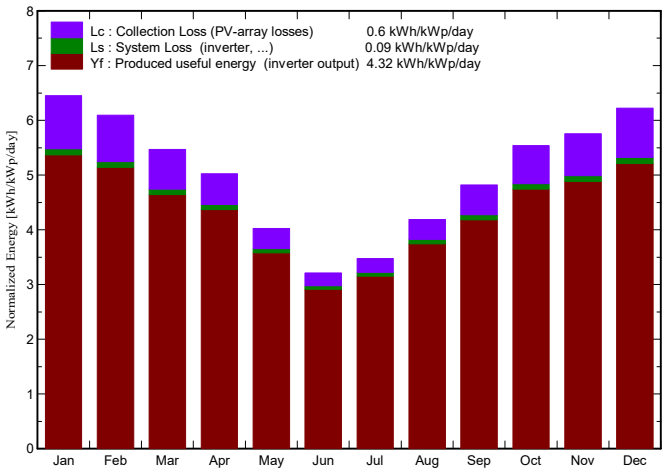
Simulation variant : **New simulation variant**

Main system parameters				
System type		**Grid-Connected**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 25°/-10° and 10°/80°		
PV modules	Model	LG 300 N1C-A3	Pnom	300 Wp
PV Array	Nb. of modules	748	Pnom total	**224 kWp**
Inverter	Model	ECO 27.0-3-S	Pnom	27.00 kW ac
Inverter pack	Nb. of units	7.0	Pnom total	**189 kW ac**
User's needs	Unlimited load (grid)			

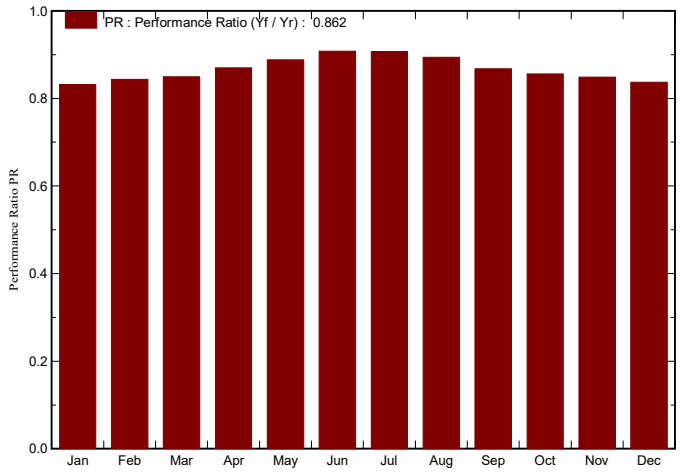
Main simulation results

System Production	**Produced Energy**	**354.2 MWh/year**	Specific prod.	1578 kWh/kWp/year
	Performance Ratio PR	86.18 %		

Normalized productions (per installed kWp): Nominal power 224 kWp



Performance Ratio PR



New simulation variant
Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	205.9	23.32	200.0	193.6	38.13	37.35	15.54	15.22
February	167.9	22.64	170.6	165.0	32.98	32.30	15.76	15.44
March	154.0	20.81	169.5	164.4	33.01	32.32	15.87	15.54
April	125.3	17.70	150.7	146.1	30.04	29.42	16.25	15.92
May	93.7	14.53	124.8	120.8	25.44	24.89	16.61	16.25
June	72.0	11.82	96.3	93.1	20.06	19.62	16.98	16.61
July	80.3	10.97	107.8	104.2	22.43	21.94	16.97	16.59
August	104.2	12.72	129.8	125.6	26.61	26.04	16.71	16.35
September	128.8	16.05	144.7	140.3	28.78	28.16	16.21	15.87
October	165.0	18.52	171.7	166.4	33.69	32.98	16.00	15.66
November	176.4	20.16	172.6	166.9	33.59	32.88	15.86	15.53
December	201.6	22.31	193.0	186.6	37.03	36.26	15.64	15.32
Year	1675.1	17.60	1831.5	1773.1	361.78	354.17	16.10	15.76

Legends:
GlobHor Horizontal global irradiation
T Amb Ambient Temperature
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
EffArrR Effic. Eout array / rough area
EffSysR Effic. Eout system / rough area

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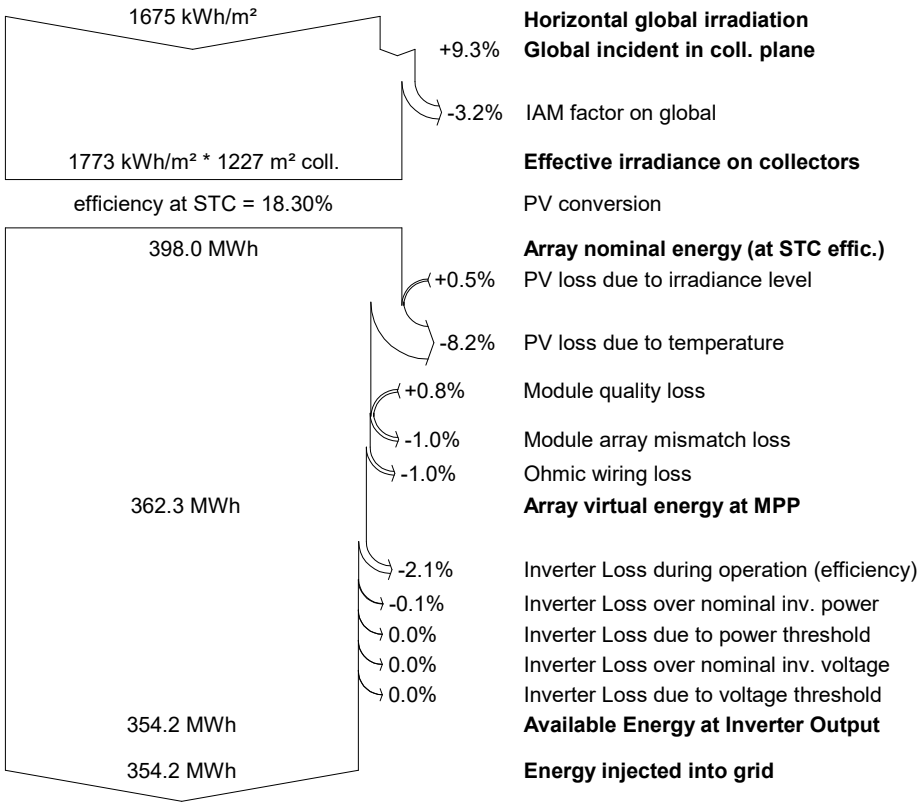
Grid-Connected System: Loss diagram

Project : **NBC Aquatic centre**

Simulation variant : **New simulation variant**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	2 orientations	Tilt/Azimuth = 25°/-10° and 10°/80°		
PV modules	Model	LG 300 N1C-A3	Pnom	300 Wp
PV Array	Nb. of modules	748	Pnom total	**224 kWp**
Inverter	Model	ECO 27.0-3-S	Pnom	27.00 kW ac
Inverter pack	Nb. of units	7.0	Pnom total	**189 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



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