

Sistema HYBRIDNET per la produzione di energia elettrica e termica da biomasse, ibridizzato con fotovoltaico e sistema di accumulo

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Ordine degli Ingegneri di Roma

HYBRIDNET

«HYBRIDNET» è una rete di imprese di ingegneria istituita nel 2013.

Ha ottenuto un cofinanziamento di circa € 530.000,00 da Sviluppo Lazio (oggi Lazio Innova) tramite il Fondo Europeo Sviluppo Regionale (FESR) per la realizzazione di un impianto ibrido in grado di produrre energia elettrica e termica utilizzando unicamente fonti rinnovabili (solare e biomassa)

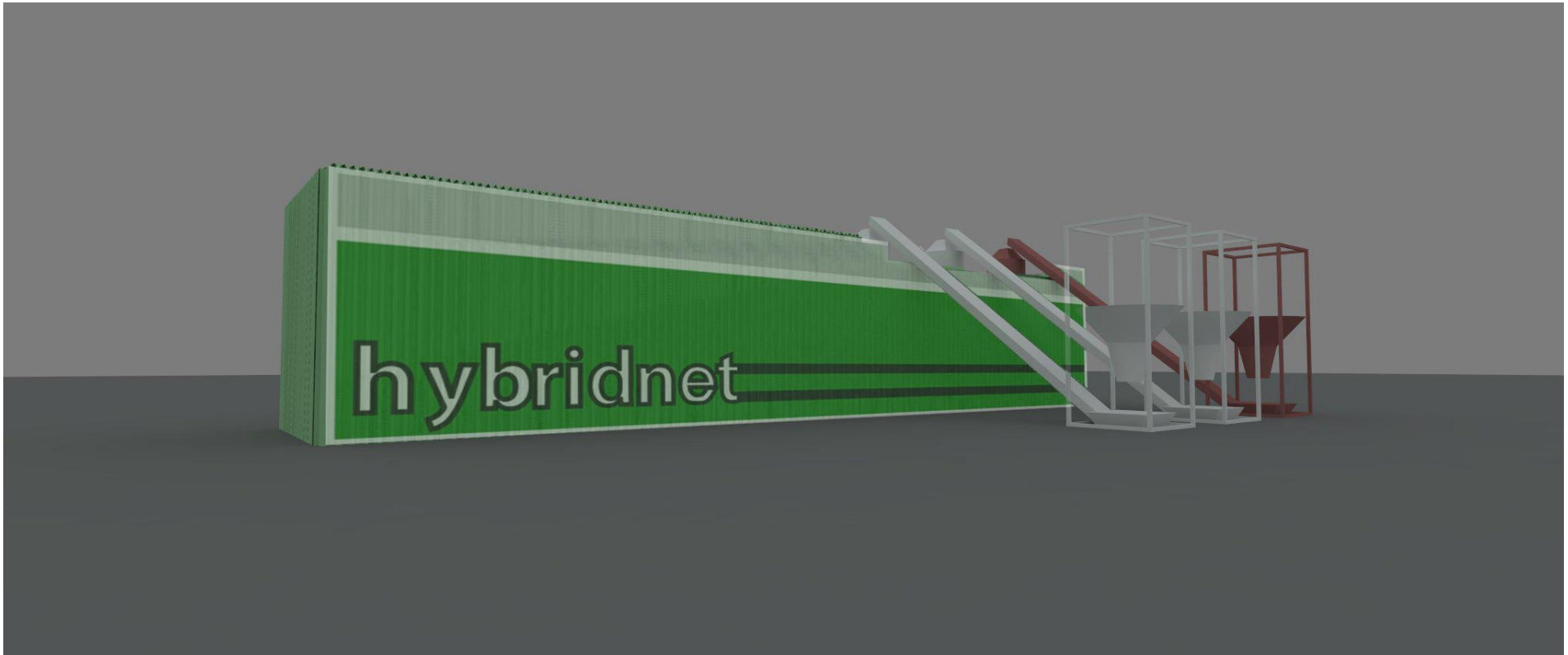
L'importo complessivo del progetto cofinanziato è di € 992.560,00 ed è attualmente in fase di realizzazione in località Pie di Moggio (Rieti)



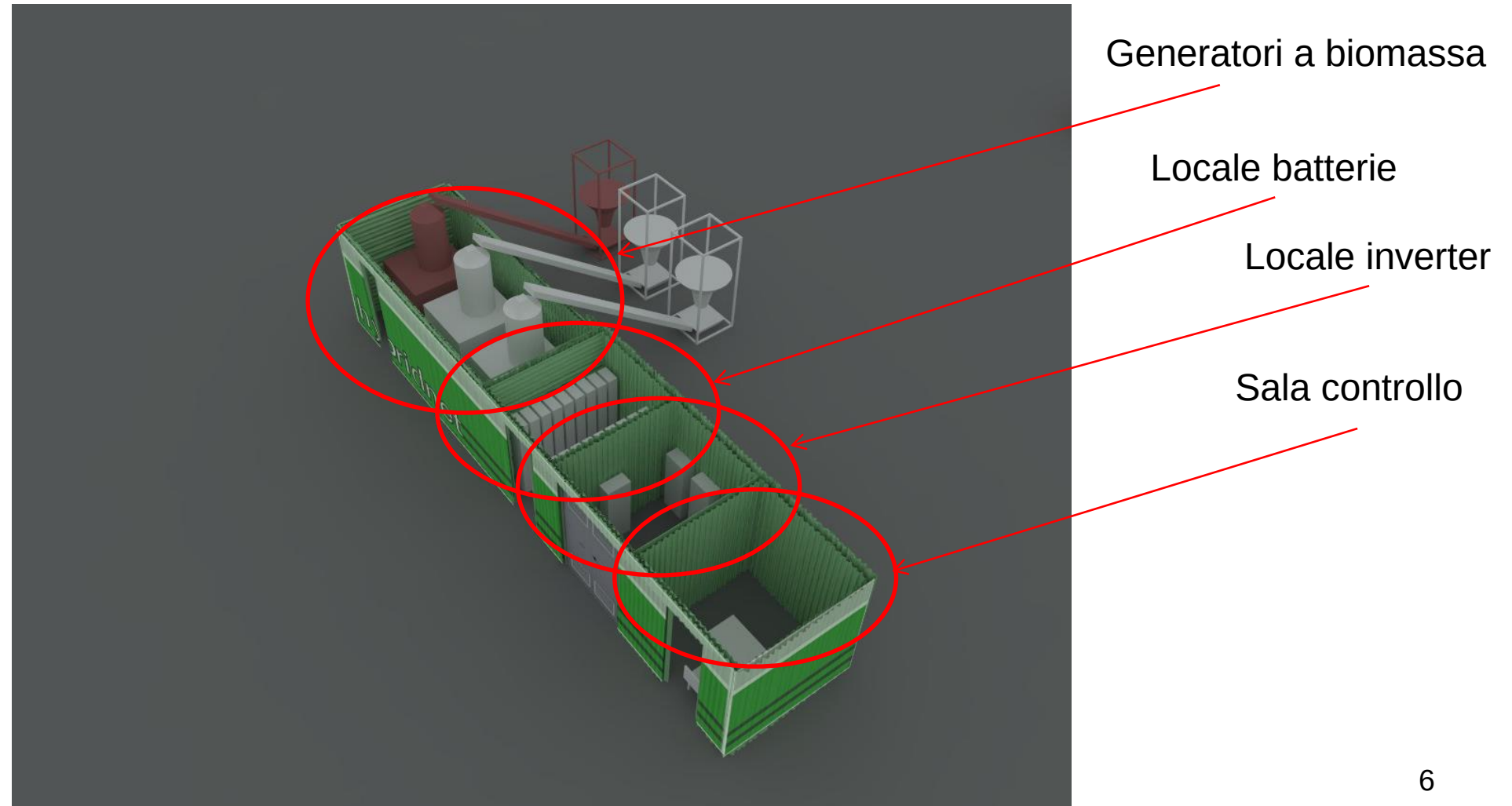
Obiettivi che si prefigge HYBRIDNET

- Realizzazione di un sistema (microgrid) che possa essere facilmente costruito in realtà dove la rete elettrica è scarsa, carente o addirittura assente
- Realizzazione di un sistema modulare facilmente trasportabile e assemblabile in sito
- Realizzazione di un sistema «customizzabile» che si adatti alle fonti di energia rinnovabile presenti sul sito di installazione
- Sviluppo e ottimizzazione dell'impianto pilota nella gestione delle varie fonti di produzione di energia in funzione del carico
- Costo attualizzato dell'energia prodotta (LCOE) inferiore rispetto a quello ottenuto tramite l'utilizzo di fonti fossili

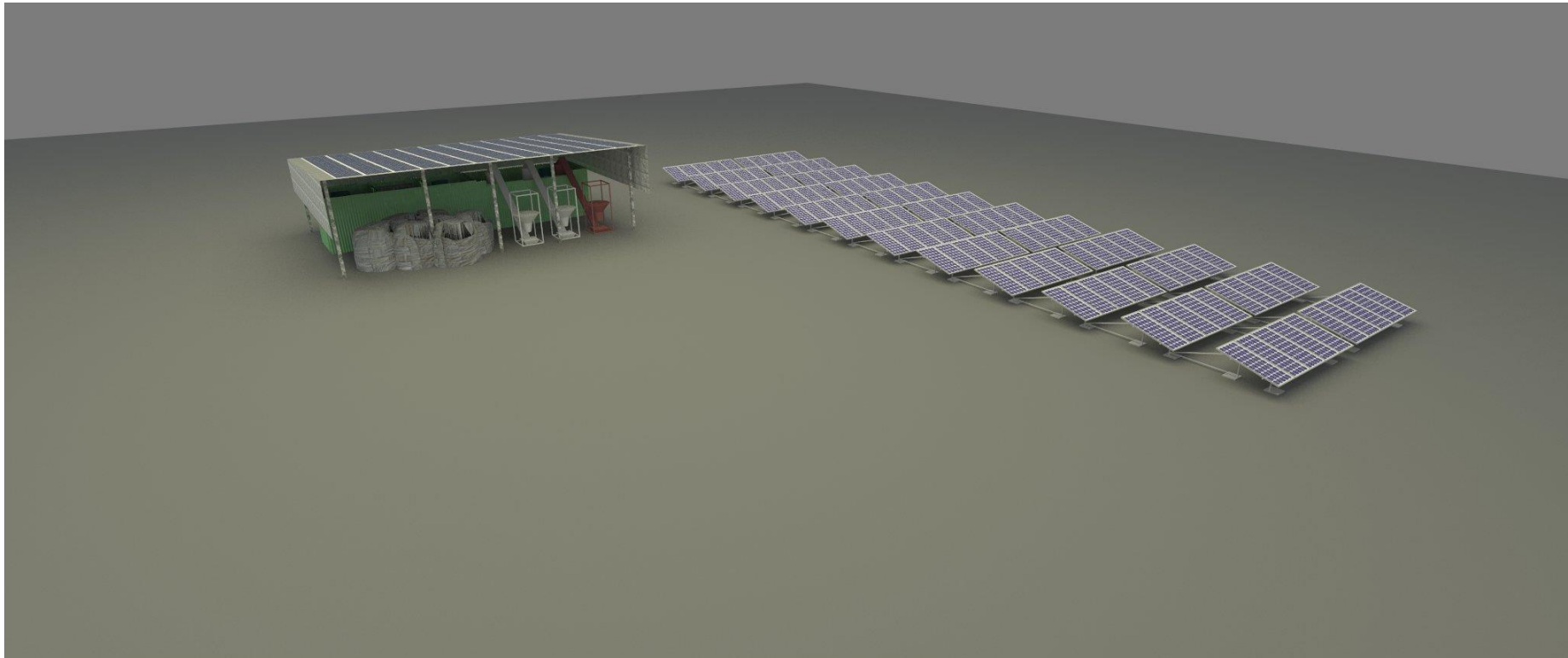
Sistema HYBRIDNET



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Sistema HYBRIDNET



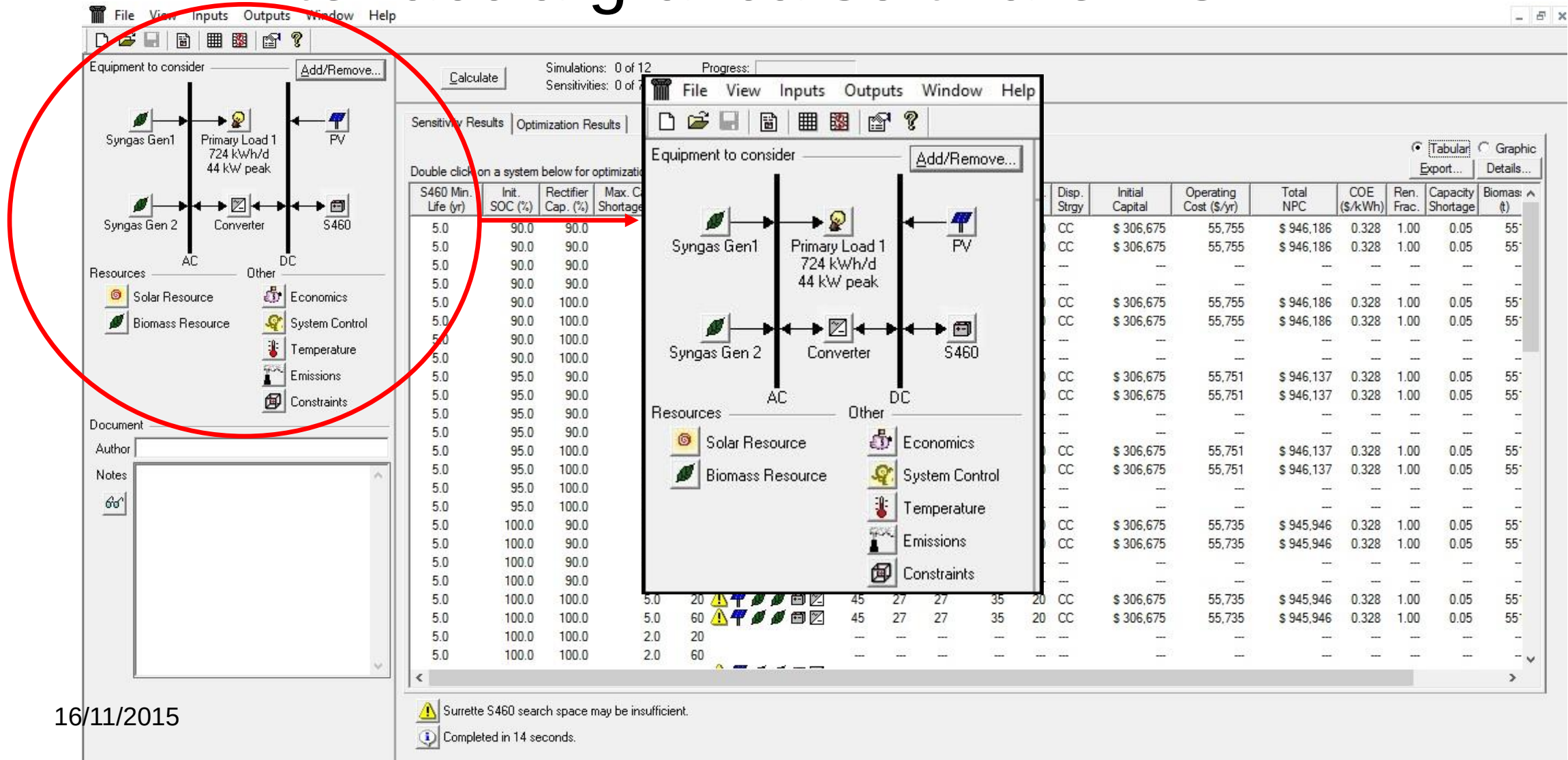
Studio di fattibilità tramite software HOMER

Per la realizzazione dell'impianto ibrido è stato impiegato il software HOMER che ha permesso un'analisi sia dal punto di vista tecnico e sia dal punto di vista economico.

HOMER è un software sviluppato dal laboratorio di energie rinnovabili del Colorado (USA) ed è basato sulla modellazione di microgrid alimentate da una combinazione di fonti rinnovabili di energia a cui si aggiunge lo stoccaggio e la generazione di origine fossile.

Link: <http://www.homerenergy.com/software.html>

Interfaccia grafica software HOMER



The screenshot displays the HOMER software interface, which is used for designing and optimizing hybrid energy systems. The interface is divided into several main sections:

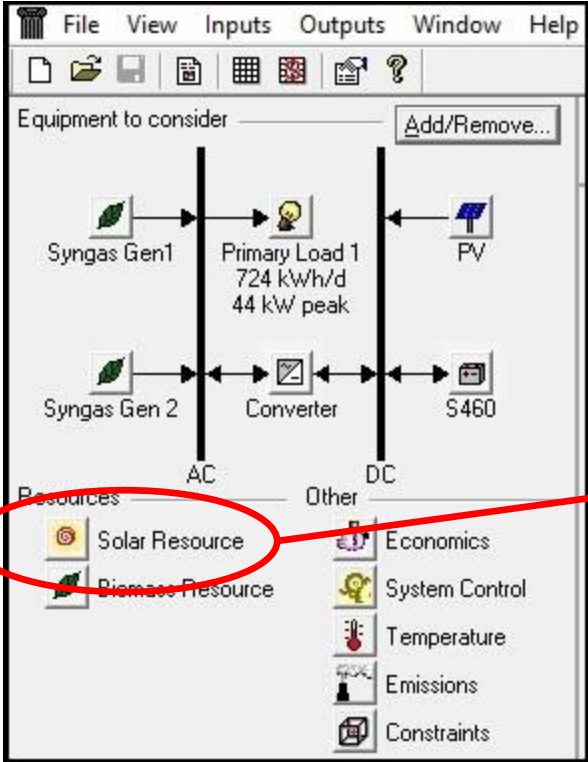
- Equipment to consider:** This section allows users to select and configure components for their system. It includes:
 - AC:** Syngas Gen1, Syngas Gen2, Primary Load 1 (724 kWh/d, 44 kW peak), Converter, and S460.
 - DC:** PV.
 - Resources:** Solar Resource and Biomass Resource.
 - Other:** Economics, System Control, Temperature, Emissions, and Constraints.
- Optimization Results:** A table showing the results of the optimization process. The table has columns for S460 Min. Life (yr), Init. SOC (%), Rectifier Cap. (%), and Max. C Shortage. A red arrow points from the 'Equipment to consider' section to this table.
- Simulation Results:** A table showing the results of the simulation. The table has columns for Disp. Strgy, Initial Capital, Operating Cost (\$/yr), Total NPC, COE (\$/kWh), Ren. Frac., Capacity Shortage, and Biomass (\$).

The interface also includes a menu bar (File, View, Inputs, Outputs, Window, Help) and a toolbar with various icons for file operations and simulation controls.

At the bottom of the screen, there are two status messages:

- Warning: Surette S460 search space may be insufficient.
- Completed in 14 seconds.

Interfaccia grafica software HOMER



Solar Resource Inputs

File Edit Help

HOMER uses the solar resource inputs to calculate the PV array power for each hour of the year. Enter the latitude, and either an average daily radiation value or an average clearness index for each month. HOMER uses the latitude value to calculate the average daily radiation from the clearness index and vice-versa.

Hold the pointer over an element or click Help for more information.

Location

Latitude ° ' ☒ North ☐ South Time zone

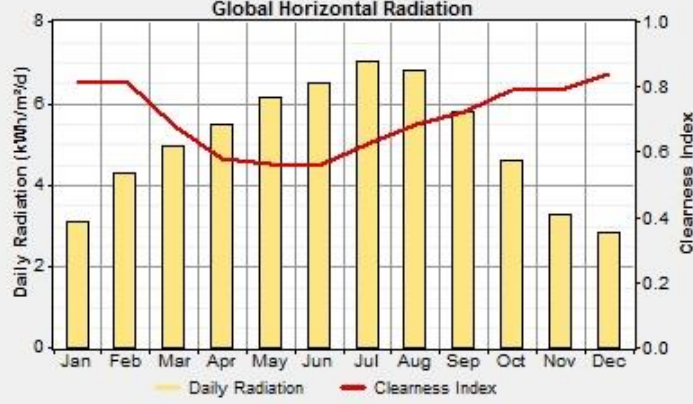
Longitude ° ' ☒ East ☐ West

Data source: ☒ Enter monthly averages ☐ Import time series data file

Baseline data

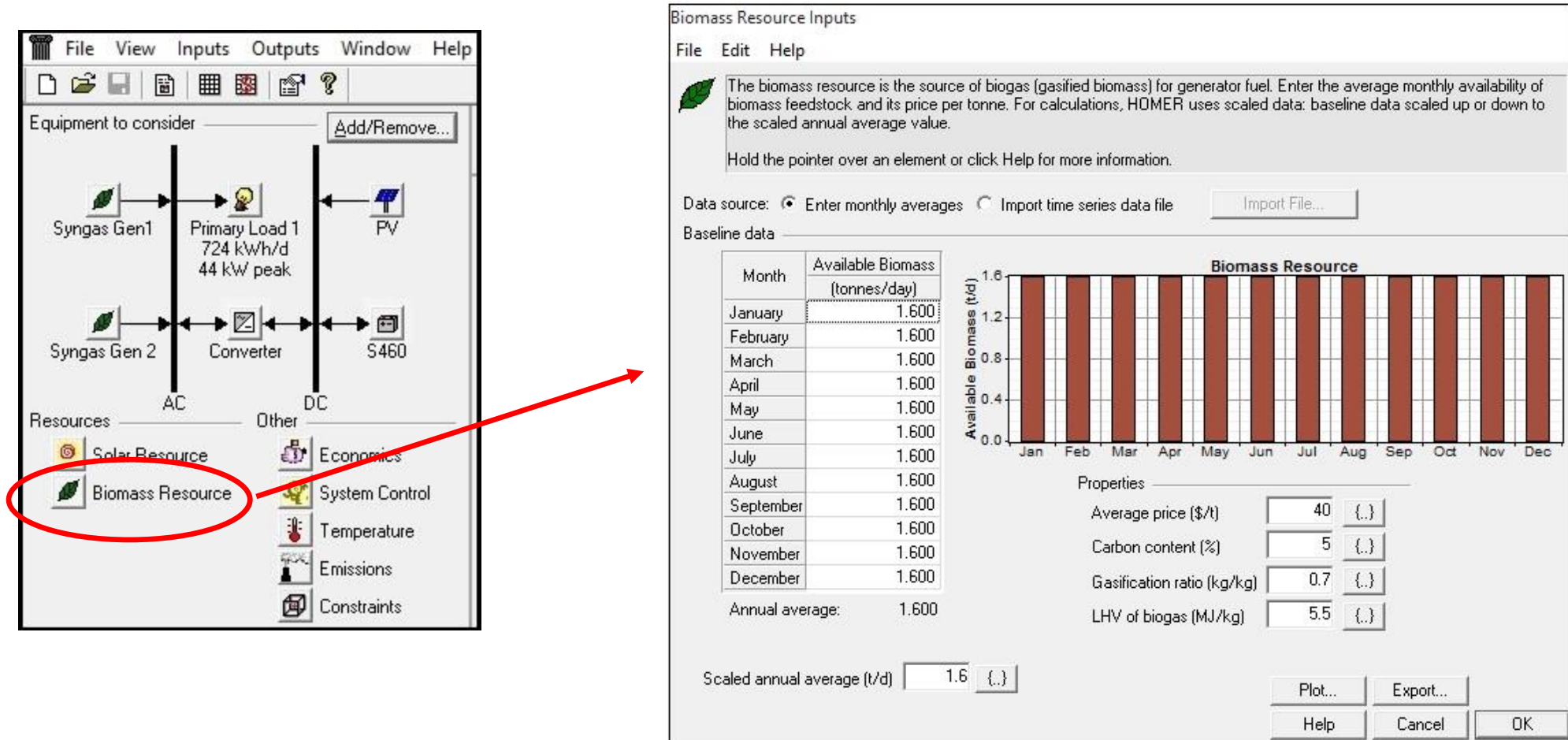
Month	Clearness Index	Daily Radiation (kWh/m ² /d)
January	0.813	3.090
February	0.817	4.270
March	0.680	4.960
April	0.579	5.460
May	0.562	6.160
June	0.560	6.500
July	0.625	7.040
August	0.683	6.810
September	0.726	5.810
October	0.791	4.610
November	0.790	3.250
December	0.838	2.830
Average:	0.669	5.070

Global Horizontal Radiation



Scaled annual average (kWh/m²/d)

Interfaccia grafica software HOMER



The image shows the HOMER software interface. On the left is the main project view, and on the right is the 'Biomass Resource Inputs' dialog box. A red arrow points from the 'Biomass Resource' icon in the main view to the dialog box.

Main Project View:

- Equipment to consider:** Syngas Gen1, Primary Load 1 (724 kWh/d, 44 kW peak), PV, Syngas Gen 2, Converter, S460.
- Resources:** Solar Resource, Biomass Resource (highlighted with a red circle).
- Other:** Economics, System Control, Temperature, Emissions, Constraints.

Biomass Resource Inputs Dialog Box:

The biomass resource is the source of biogas (gasified biomass) for generator fuel. Enter the average monthly availability of biomass feedstock and its price per tonne. For calculations, HOMER uses scaled data: baseline data scaled up or down to the scaled annual average value.

Hold the pointer over an element or click Help for more information.

Data source: ☒ Enter monthly averages ☐ Import time series data file

Baseline data

Month	Available Biomass (tonnes/day)
January	1.600
February	1.600
March	1.600
April	1.600
May	1.600
June	1.600
July	1.600
August	1.600
September	1.600
October	1.600
November	1.600
December	1.600
Annual average:	1.600

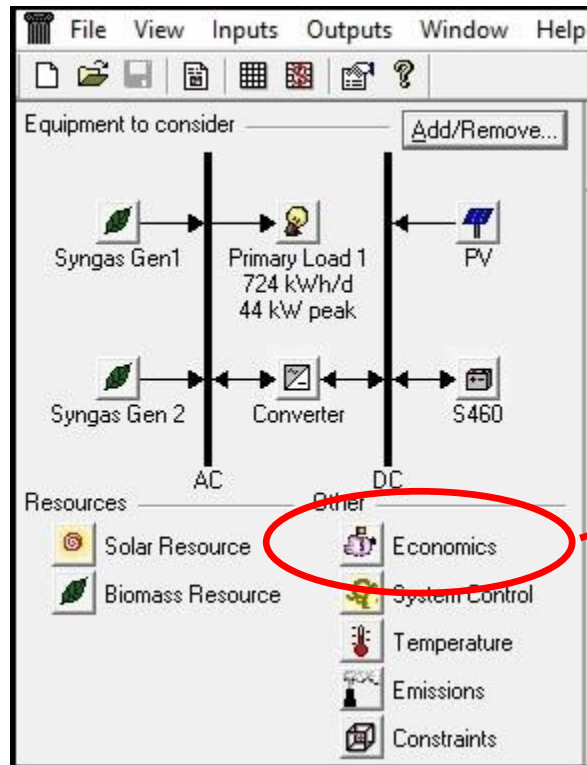
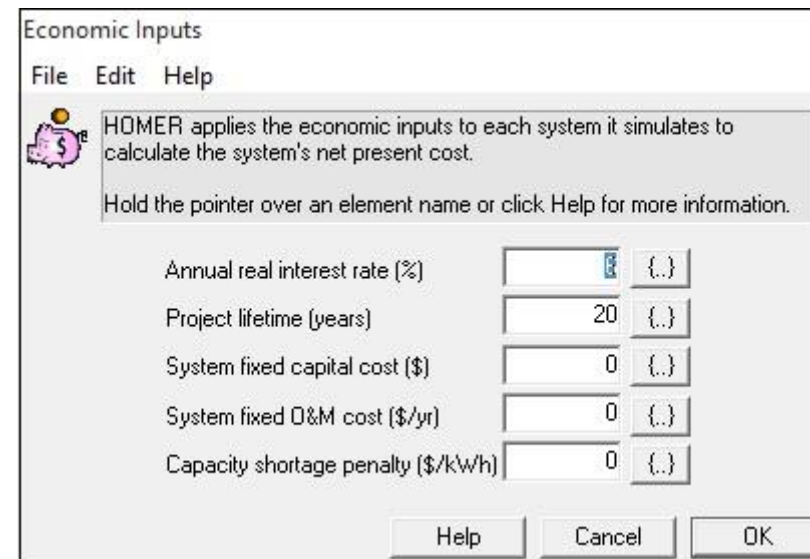
Properties

- Average price (\$/t): 40 {..}
- Carbon content (%): 5 {..}
- Gasification ratio (kg/kg): 0.7 {..}
- LHV of biogas (MJ/kg): 5.5 {..}

Scaled annual average (t/d): 1.6 {..}

Buttons: Plot..., Export..., Help, Cancel, OK

Interfaccia grafica software HOMER

The 'Economic Inputs' dialog box is shown. It has a menu bar with 'File', 'Edit', and 'Help'. Below the menu bar is a text area that says: 'HOMER applies the economic inputs to each system it simulates to calculate the system's net present cost. Hold the pointer over an element name or click Help for more information.'

Below the text area are several input fields with corresponding units and a help icon (a small question mark in a circle):

- Annual real interest rate (%)
- Project lifetime (years) with a value of 20
- System fixed capital cost (\$)
- System fixed O&M cost (\$/yr)
- Capacity shortage penalty (\$/kWh)

At the bottom of the dialog box are three buttons: 'Help', 'Cancel', and 'OK'.

Casi studio considerati

Utilizzando il software Homer è stato simulato il comportamento di due tipologie di impianti:

- Microgrid con profilo di carico industriale
- Microgrid con profilo di carico residenziale

Microgrid con profilo di carico industriale

Elementi del sistema:

- N.2 generatori a biomassa da 27 kW
- Impianto fotovoltaico da 60 kWp
- Banco di 25 batterie collegate in serie con capacità complessiva di circa 70 kWh
- Carico industriale avente picco di assorbimento massimo di circa 60 kW
- Inverter fotovoltaico stand alone da 25 kW

Microgrid con profilo di carico industriale



Quadro riassuntivo carico industriale



Cash flow profilo industriale

Sensitivity case

Surrette S460 Minimum Life:	5 yr
Battery Initial State of Charge:	90 %
Relative Rectifier Capacity:	90 %
Maximum Annual Capacity Shortage:	5 %
Minimum Renewable Fraction:	20 %

System architecture

PV Array	60 kW
Syngas Gen1	27 kW
Syngas Gen 2	27 kW
Battery	25 Surrette S460
Inverter	25 kW
Rectifier	22.5 kW
Dispatch strategy Load Following	

Cost summary

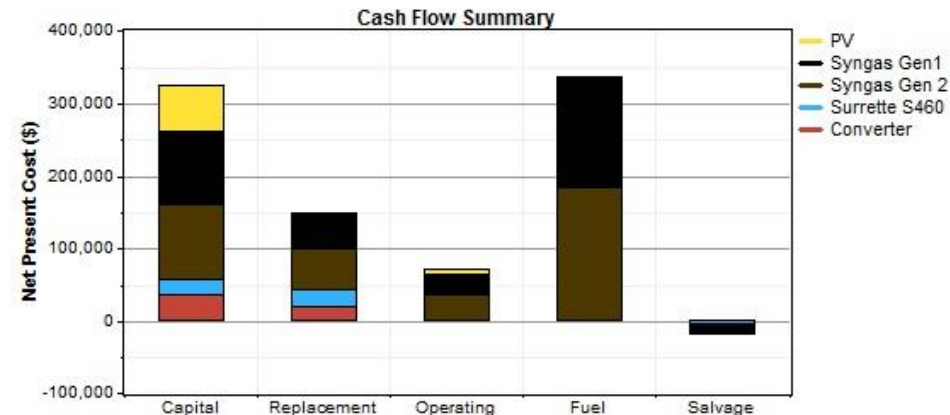
Total net present cost	\$ 863,571
Levelized cost of energy	\$ 0.262/kWh
Operating cost	\$ 46,953/yr

Net Present Costs

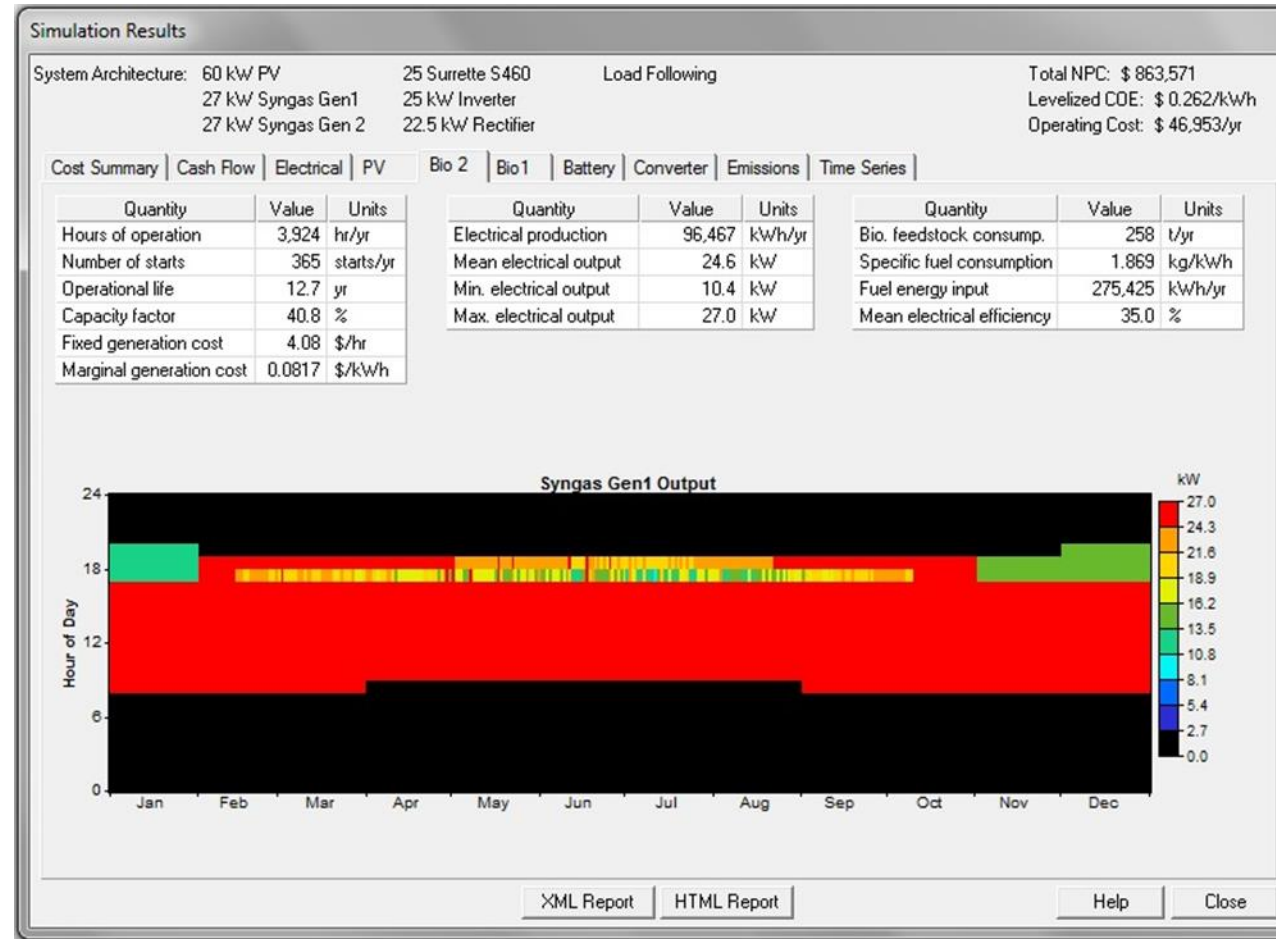
Component	Capital (\$)	Replacement (\$)	O&M (\$)	Fuel (\$)	Salvage (\$)	Total (\$)
PV	62,400	0	6,882	0	0	69,282
Syngas Gen1	102,600	48,831	27,950	153,606	-13,769	319,218
Syngas Gen 2	102,600	56,806	35,101	183,394	-921	376,980
Surrette S460	22,425	22,897	287	0	-3,496	42,113
Converter	35,000	19,544	1,434	0	0	55,978
System	325,025	148,078	71,654	337,001	-18,186	863,571

Annualized Costs

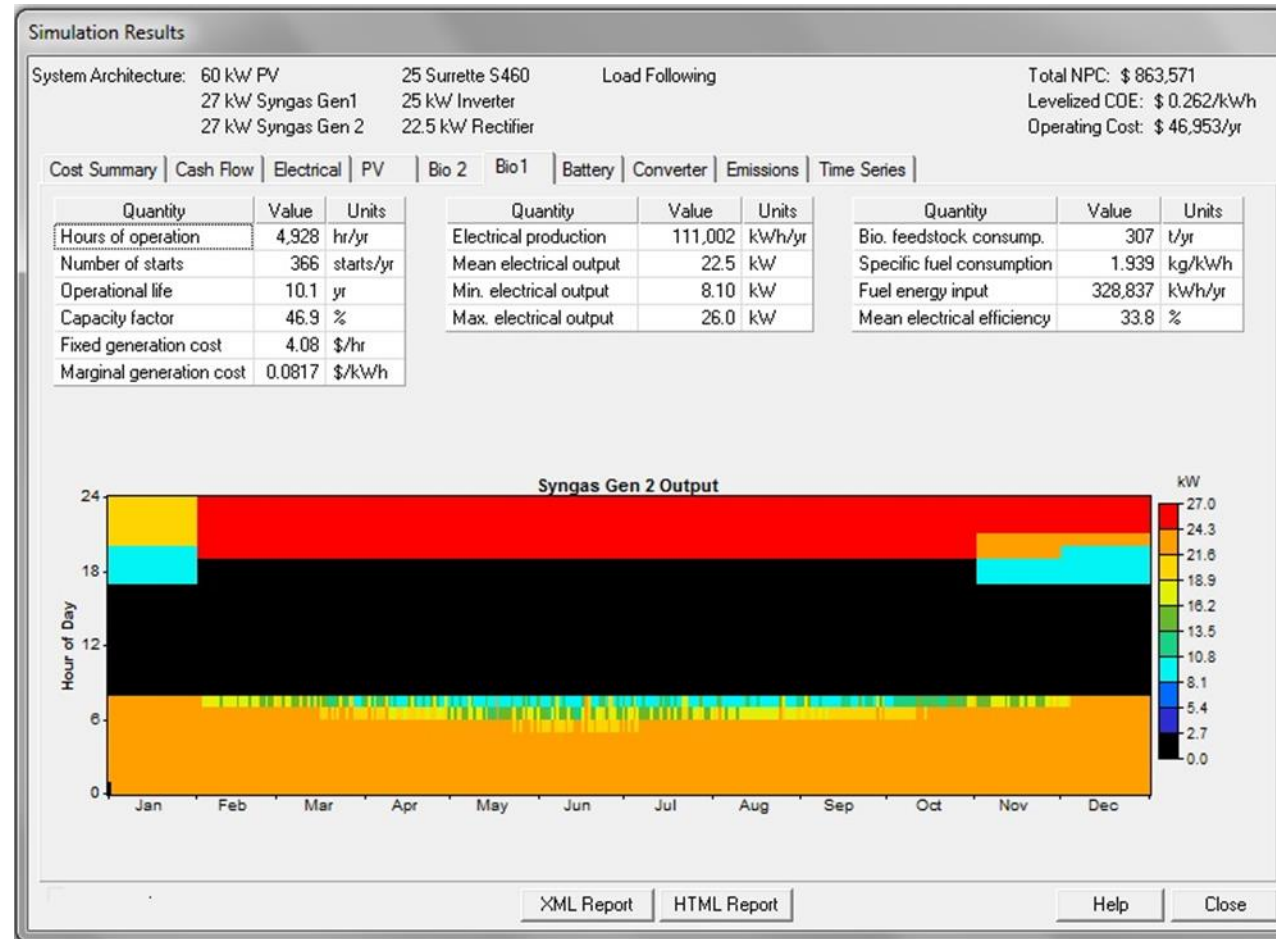
Component	Capital (\$/yr)	Replacement (\$/yr)	O&M (\$/yr)	Fuel (\$/yr)	Salvage (\$/yr)	Total (\$/yr)
PV	5,440	0	600	0	0	6,040
Syngas Gen1	8,945	4,257	2,437	13,392	-1,200	27,831
Syngas Gen 2	8,945	4,953	3,060	15,989	-80	32,867
Surrette S460	1,955	1,996	25	0	-305	3,672
Converter	3,051	1,704	125	0	0	4,880
System	28,337	12,910	6,247	29,381	-1,586	75,290



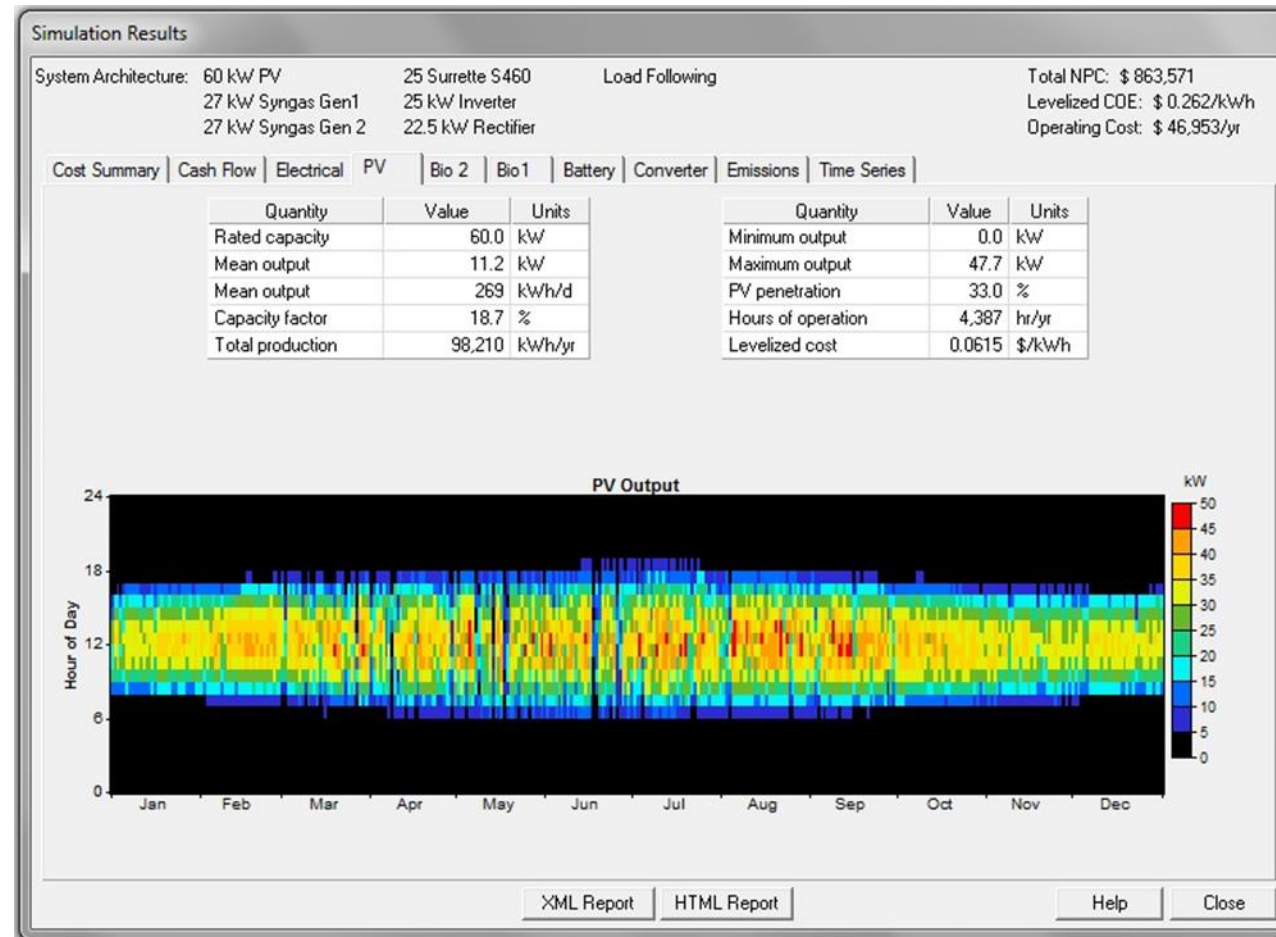
Report simulazione Syngas n.1



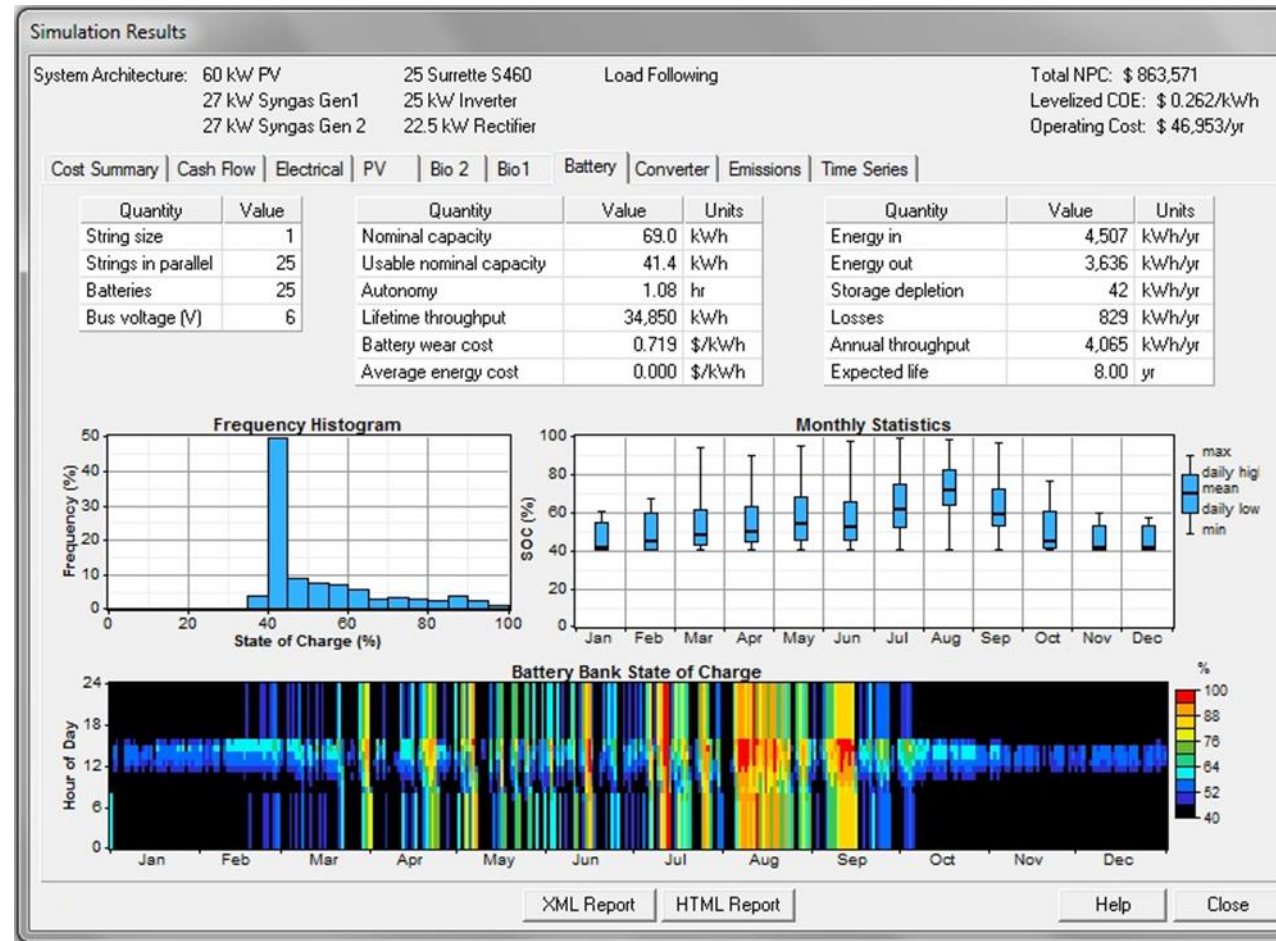
Report simulazione Syngas n.2



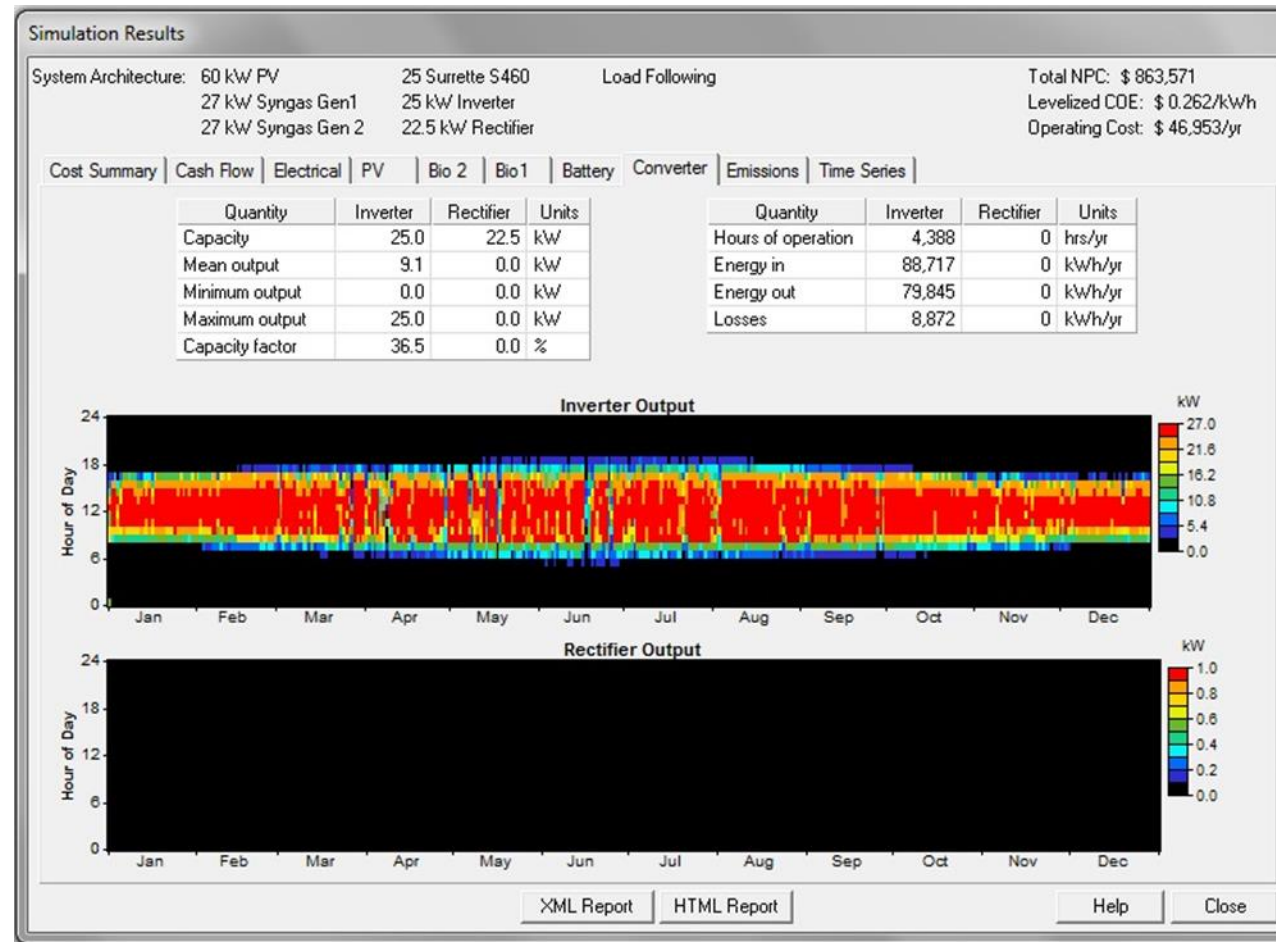
Report simulazione impianto FV 60kWp



Report simulazione batterie 70kWh



Report simulazione inverter off grid 25 kW



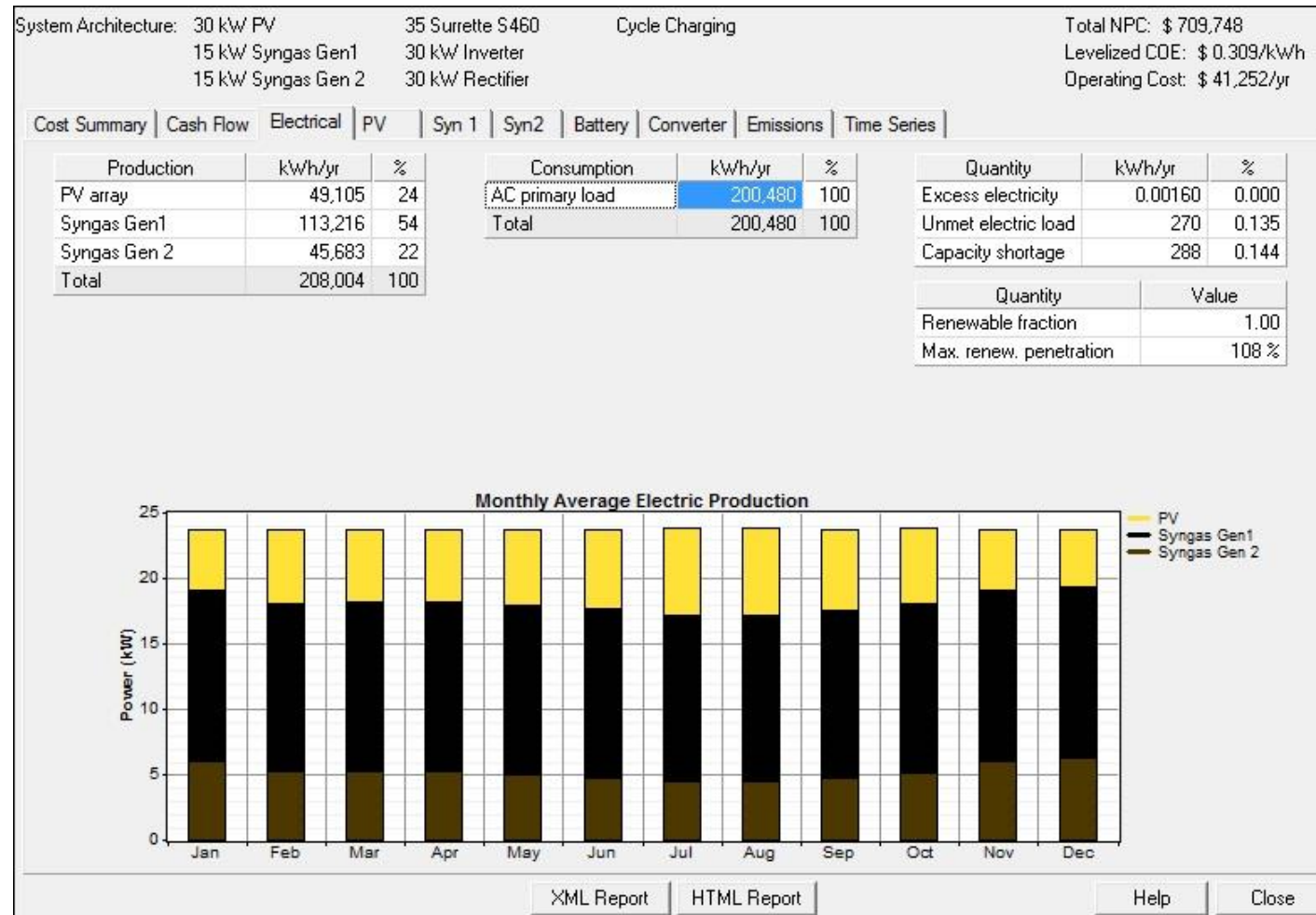
Microgrid con profilo di carico residenziale

Impianto pilota in fase di realizzazione a Rieti – Località Piè di Moggio

Elementi del sistema:

- N.2 generatori a biomassa da 15 kW
- Impianto fotovoltaico da 30 kWp
- Banco di 50 batterie collegate in serie con capacità complessiva di circa 100 kWh
- Banco di carico da 50 kVA $\cos\phi$ 0,8 per simulare il profilo di carico
- Inverter fotovoltaico stand alone da 30 kW

Quadro riassuntivo carico residenziale



Microgrid con profilo di carico residenziale



Cash flow profilo residenziale

Sensitivity case

Surrette S460 Minimum Life:	6 yr
Battery Initial State of Charge:	100 %
Relative Rectifier Capacity:	100 %
Maximum Annual Capacity Shortage:	2 %
Minimum Renewable Fraction:	60 %

System architecture

PV Array	30 kW
Syngas Gen1	15 kW
Syngas Gen 2	15 kW
Battery	35 Surrette S460
Inverter	30 kW
Rectifier	30 kW
Dispatch strategy	Cycle Charging

Cost summary

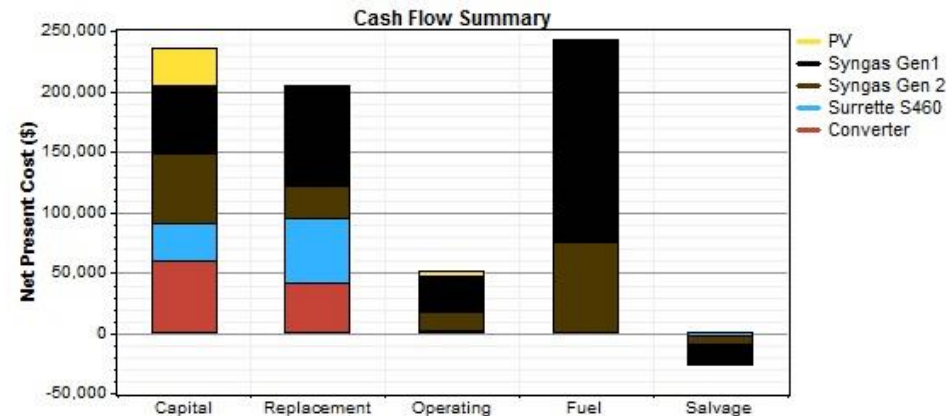
Total net present cost	\$ 709,748
Levelized cost of energy	\$ 0.309/kWh
Operating cost	\$ 41,252/yr

Net Present Costs

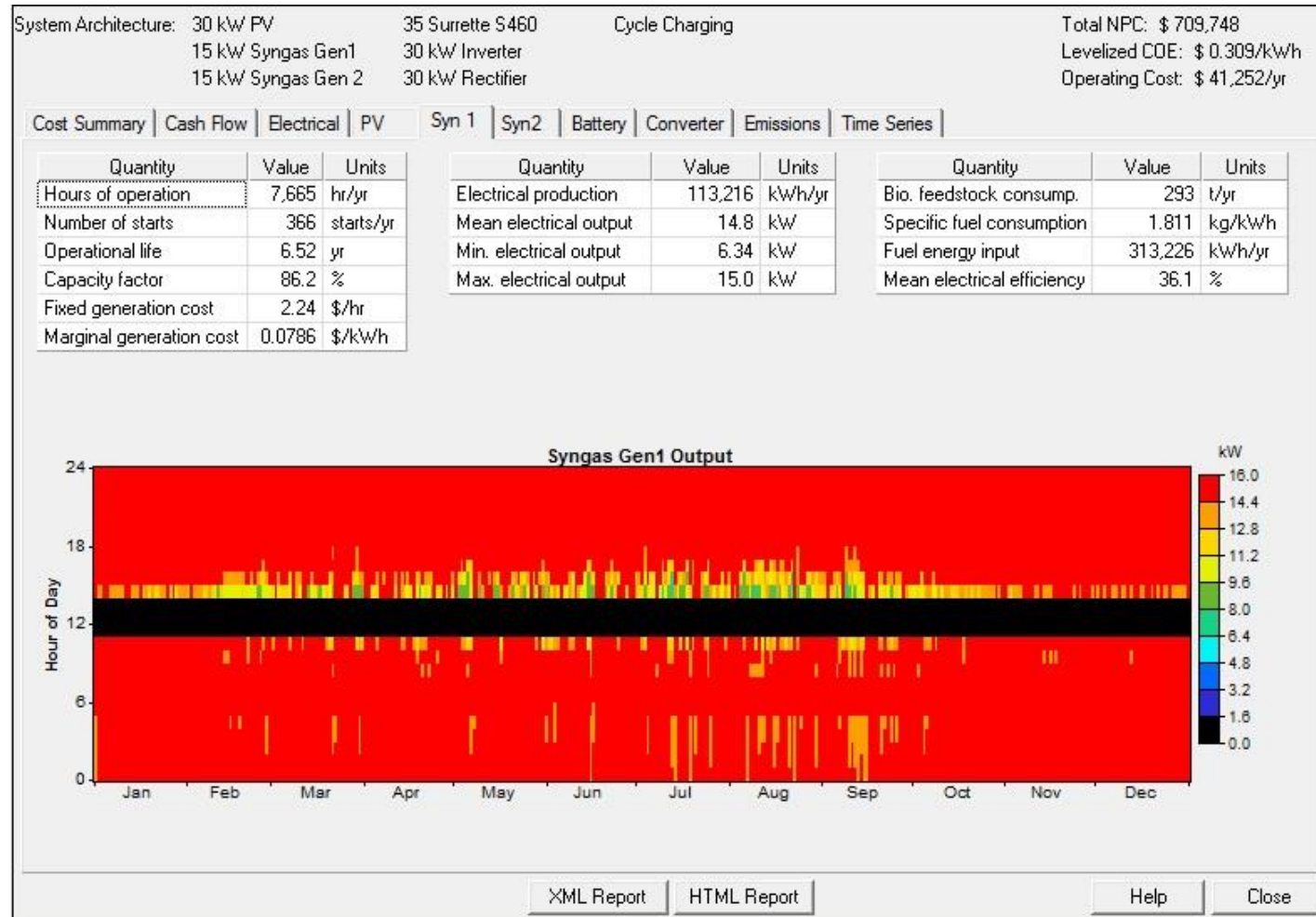
Component	Capital (\$)	Replacement (\$)	O&M (\$)	Fuel (\$)	Salvage (\$)	Total (\$)
PV	31,200	0	3,441	0	0	34,641
Syngas Gen1	57,000	83,853	30,331	167,969	-16,600	322,553
Syngas Gen 2	57,000	26,963	15,401	74,651	-7,877	166,138
Surrette S460	31,395	52,774	401	0	-1,754	82,816
Converter	60,000	41,880	1,720	0	0	103,600
System	236,595	205,469	51,295	242,620	-26,231	709,749

Annualized Costs

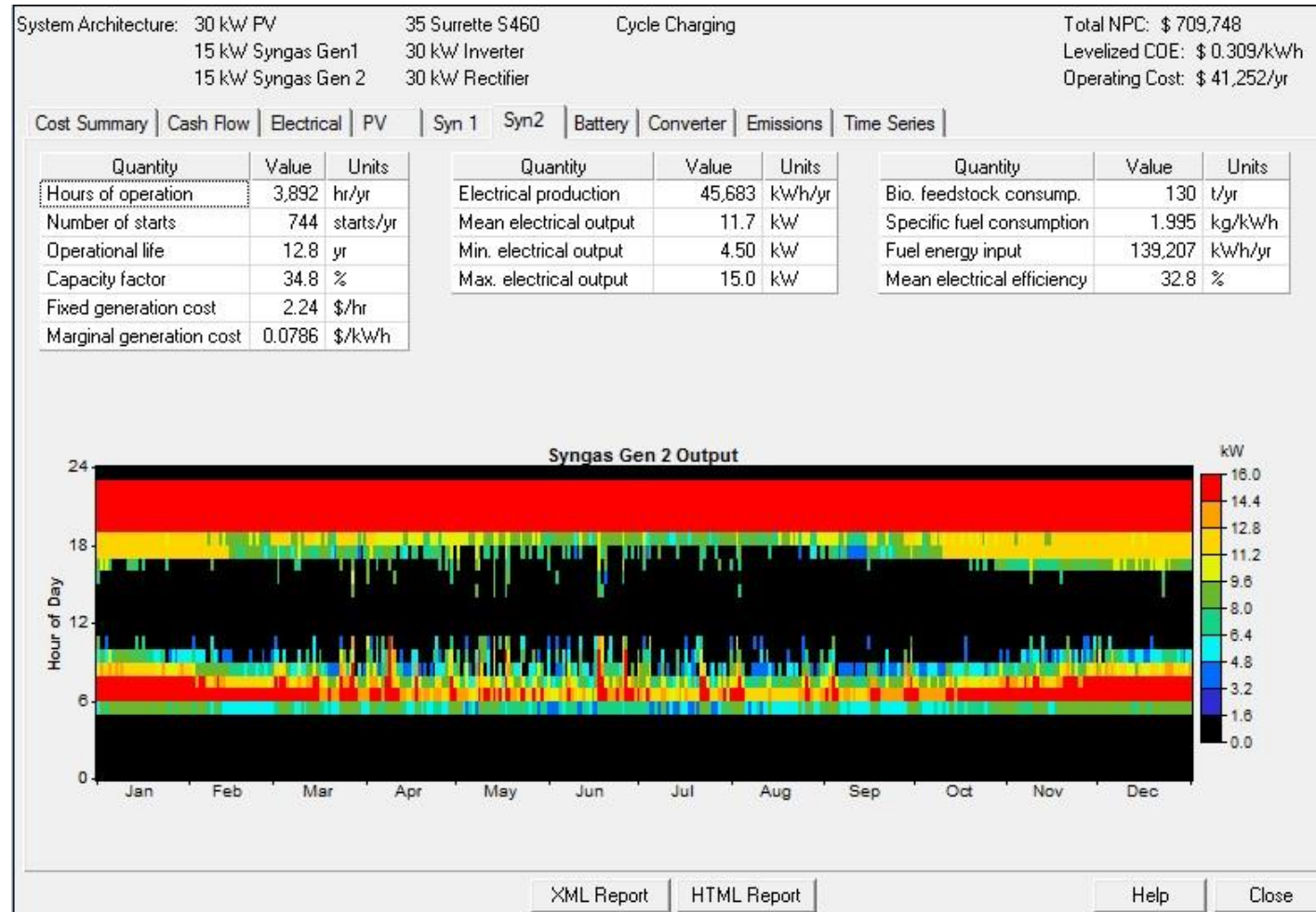
Component	Capital (\$/yr)	Replacement (\$/yr)	O&M (\$/yr)	Fuel (\$/yr)	Salvage (\$/yr)	Total (\$/yr)
PV	2,720	0	300	0	0	3,020
Syngas Gen1	4,970	7,311	2,644	14,644	-1,447	28,122
Syngas Gen 2	4,970	2,351	1,343	6,508	-687	14,485
Surrette S460	2,737	4,601	35	0	-153	7,220
Converter	5,231	3,651	150	0	0	9,032
System	20,627	17,914	4,472	21,153	-2,287	61,879



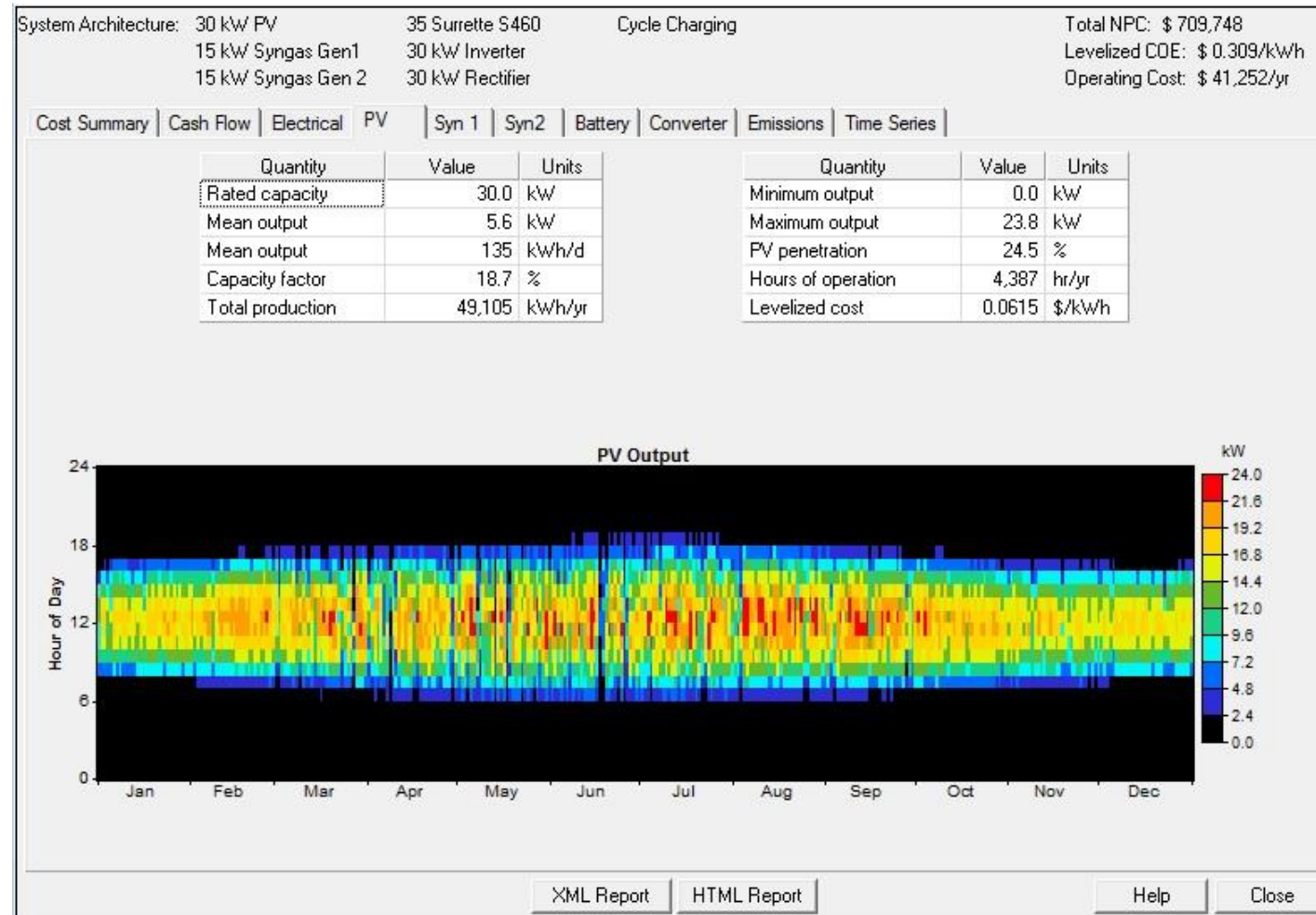
Report simulazione Syngas n.1



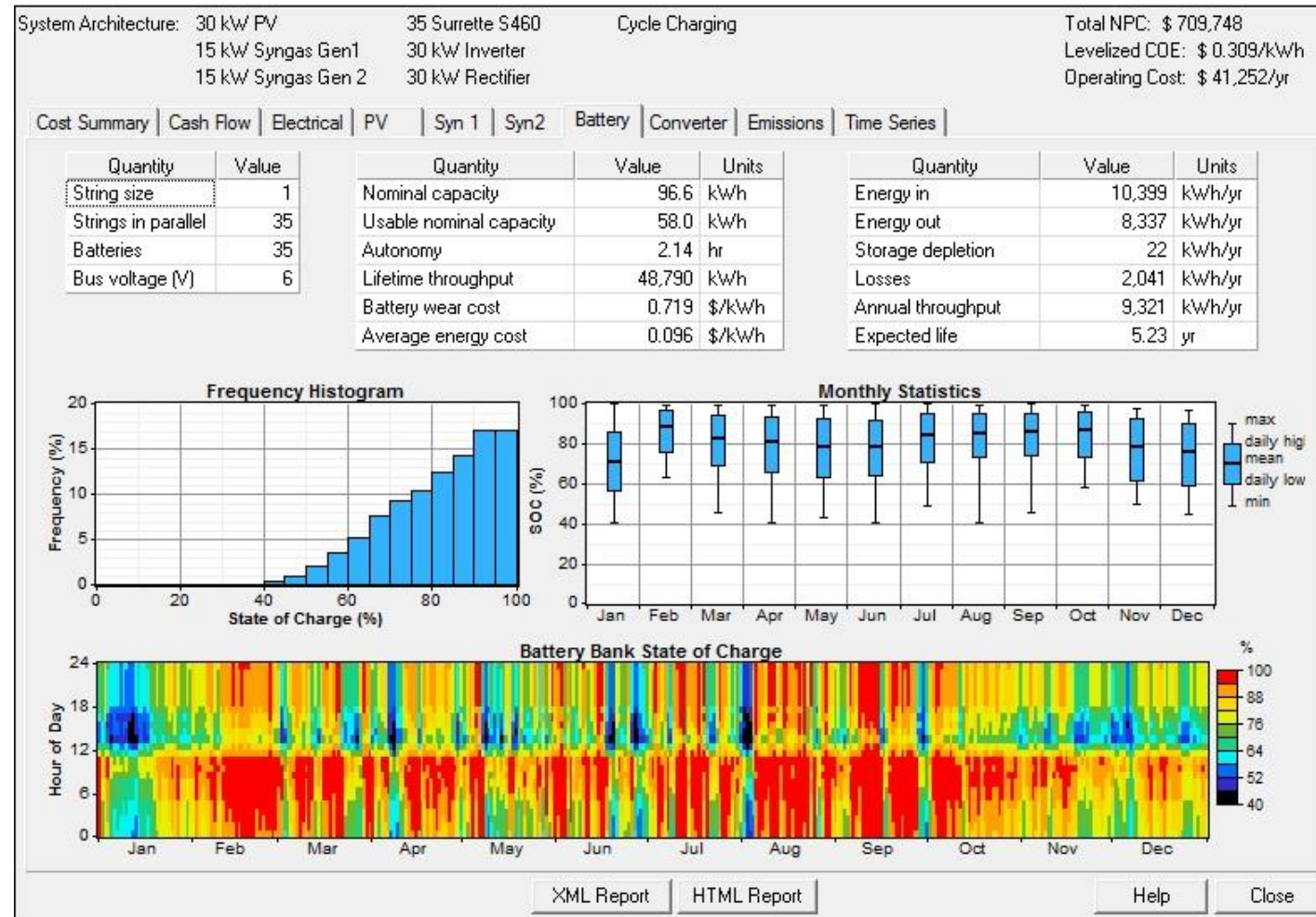
Report simulazione Syngas n.2



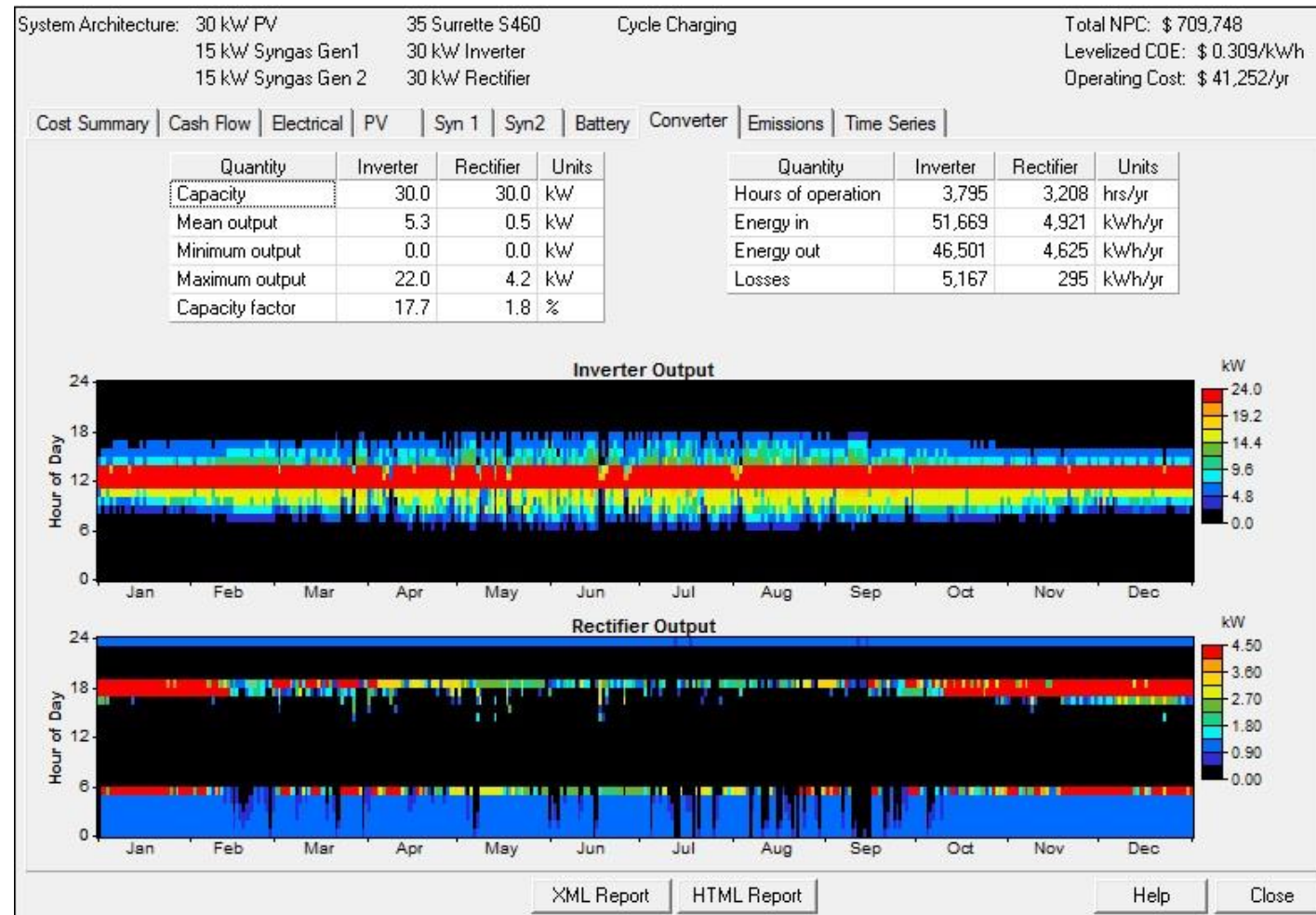
Report simulazione impianto FV 30kWp



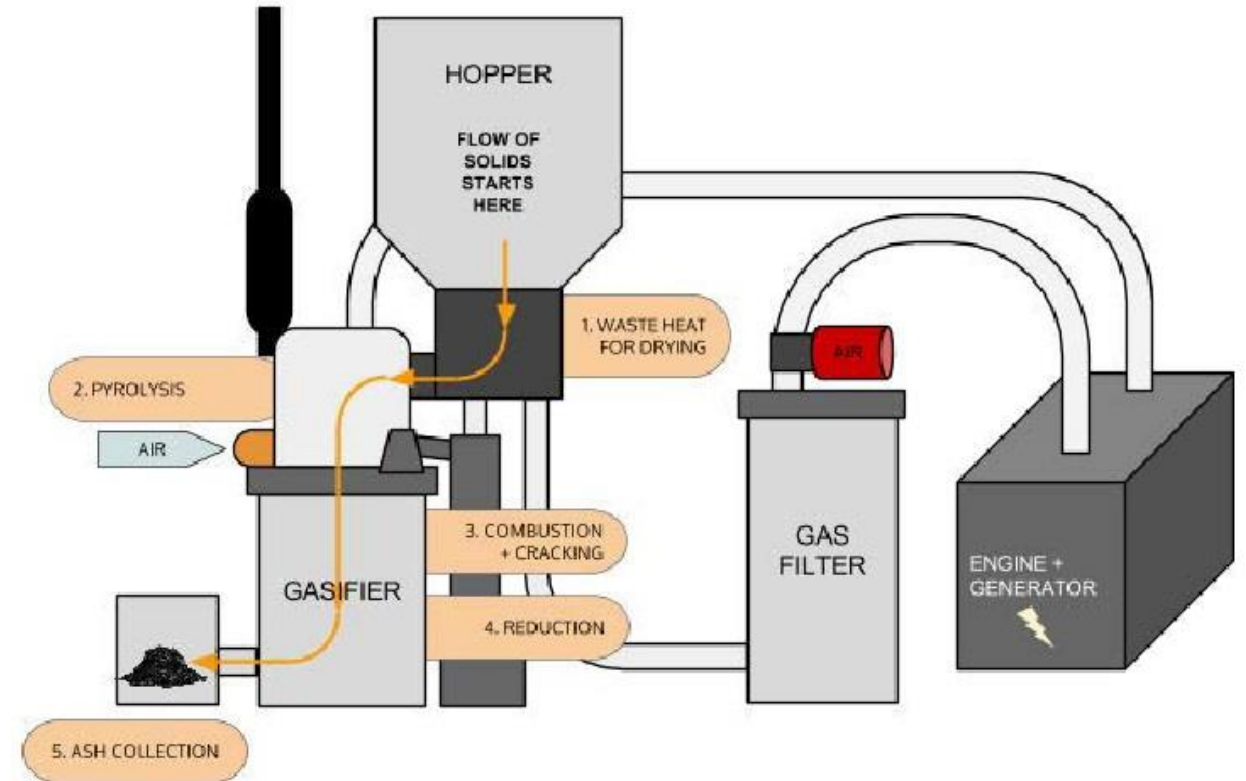
Report simulazione batterie da ~100 kWh



Report simulazione inverter 30kWp



Generatore a biomassa



Report fotografico elementi installati



Report fotografico elementi installati



Report fotografico elementi installati



Report fotografico elementi installati



Report fotografico elementi installati



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