



System Simulation Report



File: Case 02 Hospital Critical-Power Microgrid.homer

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Location: CGM7+5Q7, Dambarta 702104, Kano, Nigeria (12°26.0'N, 8°30.9'E)

Total Net Present Cost: \$9,625,127.00

Levelized Cost of Energy (\$/kWh): \$0.123

Notes: Use HOMER to determine the lowest-NPC PV/BESS/grid/DG configuration that guarantees the 650-kW critical load during a four-hour grid outage. Compare load-following and cycle-charging dispatch. Then model the recommended architecture in ETAP and verify normal and islanded load flow.



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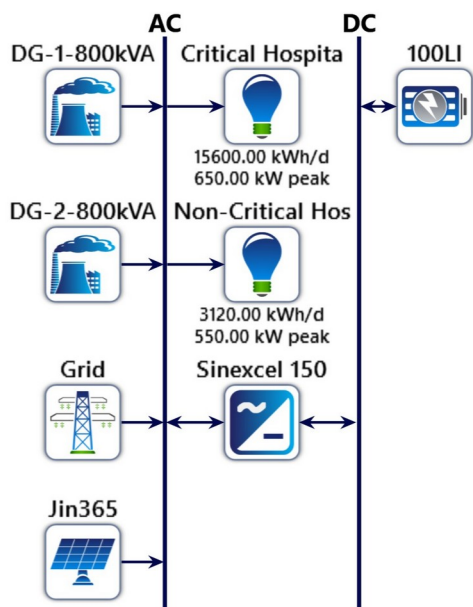
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System Architecture

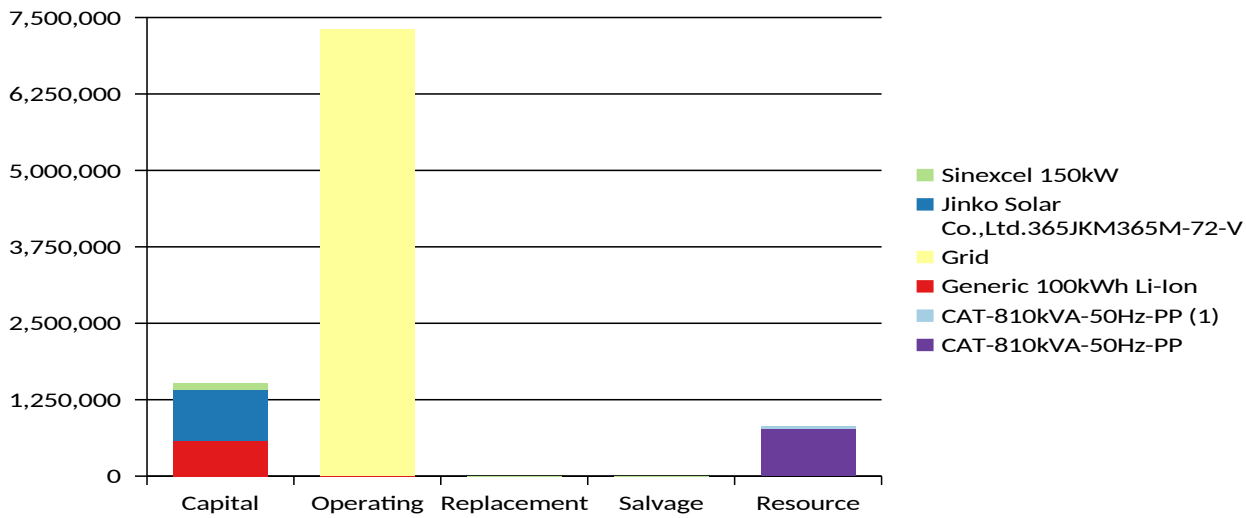
Component	Name	Size	Unit
Generator #1	CAT-810kVA-50Hz-PP	648	kW
Generator #2	CAT-810kVA-50Hz-PP (1)	648	kW
PV	Jinko Solar Co.,Ltd.365JKM365M-72-V	1,200	kW
PV dedicated converter	Jin365 inverter	1,000	kW
Storage	Generic 100kWh Li-Ion	22	strings
System converter	Sinexcel 150kW	704	kW
Grid	Grid	1,200	kW
Dispatch strategy	HOMER Cycle Charging		

Schematic





Cost Summary



Net Present Costs

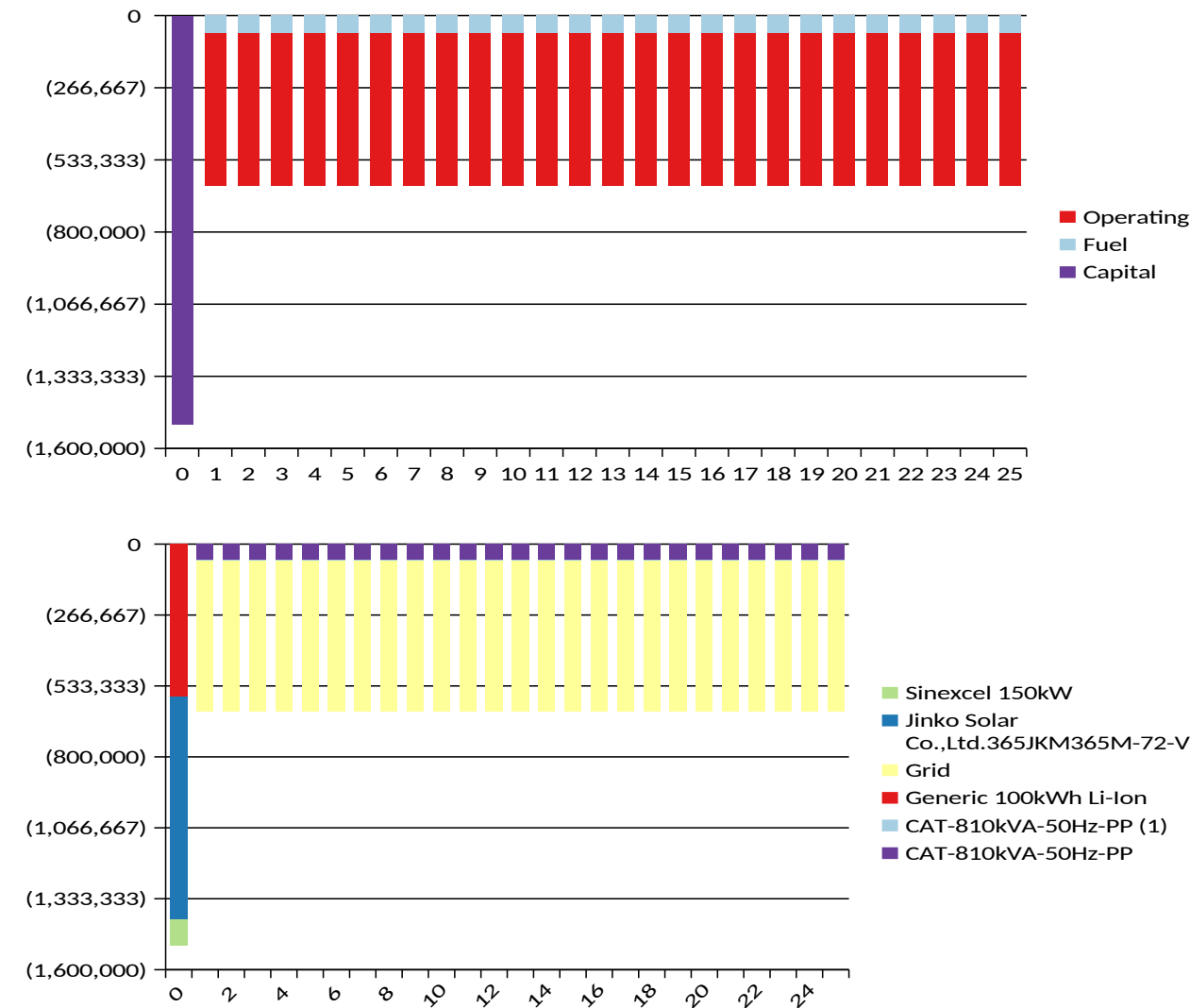
Name	Capital	Operating	Replacement	Salvage	Resource	Total
CAT-810kVA-50Hz-PP	\$0.00	\$0.00	\$0.00	\$0.00	\$782,258	\$782,258
CAT-810kVA-50Hz-PP (1)	\$0.00	\$0.00	\$0.00	\$0.00	\$33,650	\$33,650
Generic 100kWh Li-Ion	\$572,000	\$0.00	\$0.00	\$0.00	\$0.00	\$572,000
Grid	\$0.00	\$7.30M	\$0.00	\$0.00	\$0.00	\$7.30M
Jinko Solar Co.,Ltd.365JKM365M-72-V	\$840,000	\$0.00	\$0.00	\$0.00	\$0.00	\$840,000
Sinexcel 150kW	\$98,579	\$0.00	\$0.00	\$0.00	\$0.00	\$98,579
System	\$1.51M	\$7.30M	\$0.00	\$0.00	\$815,908	\$9.63M

Annualized Costs

Name	Capital	Operating	Replacement	Salvage	Resource	Total
CAT-810kVA-50Hz-PP	\$0.00	\$0.00	\$0.00	\$0.00	\$60,511	\$60,511
CAT-810kVA-50Hz-PP (1)	\$0.00	\$0.00	\$0.00	\$0.00	\$2,603	\$2,603
Generic 100kWh Li-Ion	\$44,247	\$0.00	\$0.00	\$0.00	\$0.00	\$44,247
Grid	\$0.00	\$564,582	\$0.00	\$0.00	\$0.00	\$564,582
Jinko Solar Co.,Ltd.365JKM365M-72-V	\$64,978	\$0.00	\$0.00	\$0.00	\$0.00	\$64,978
Sinexcel 150kW	\$7,625	\$0.00	\$0.00	\$0.00	\$0.00	\$7,625
System	\$116,850	\$564,582	\$0.00	\$0.00	\$63,114	\$744,546



Cash Flow





Electrical Summary

Excess and Unmet

Quantity	Value	Units
Excess Electricity	71,263	kWh/yr
Unmet Electric Load	0	kWh/yr
Capacity Shortage	0	kWh/yr

Production Summary

Component	Production (kWh/yr)	Percent
Jinko Solar Co.,Ltd.365JKM365M-72-V	1,983,098	31.9
CAT-810kVA-50Hz-PP	198,834	3.19
CAT-810kVA-50Hz-PP (1)	8,926	0.143
Grid Purchases	4,032,727	64.8
Total	6,223,585	100

Consumption Summary

Component	Consumption (kWh/yr)	Percent
AC Primary Load	6,076,247	100
DC Primary Load	0	0
Deferrable Load	0	0
Total	6,076,247	100

Generator: CAT-810kVA-50Hz-PP (Diesel)

CAT-810kVA-50Hz-PP Electrical Summary

Quantity	Value	Units
Electrical Production	198,834	kWh/yr
Mean Electrical Output	377	kW
Minimum Electrical Output	162	kW
Maximum Electrical Output	648	kW

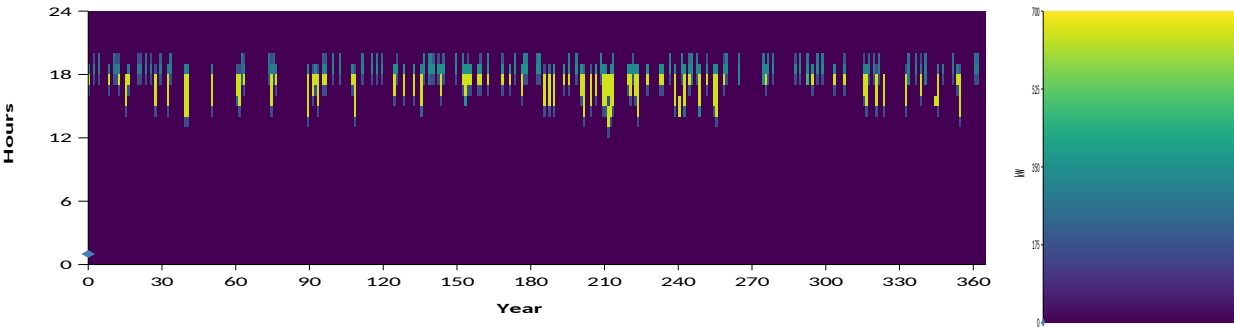
CAT-810kVA-50Hz-PP Fuel Summary

Quantity	Value	Units
Fuel Consumption	55,010	L
Specific Fuel Consumption	0.277	L/kWh
Fuel Energy Input	541,299	kWh/yr
Mean Electrical Efficiency	36.7	%

CAT-810kVA-50Hz-PP Statistics

Quantity	Value	Units
Hours of Operation	527	hrs/yr
Number of Starts	141	starts/yr
Operational Life	171	yr
Capacity Factor	3.50	%
Fixed Generation Cost	13.1	\$/hr
Marginal Generation Cost	0.270	\$/kWh

CAT-810kVA-50Hz-PP Output (kW)





Generator: CAT-810kVA-50Hz-PP (1) (Diesel)

CAT-810kVA-50Hz-PP (1) Electrical Summary

Quantity	Value	Units
Electrical Production	8,926	kWh/yr
Mean Electrical Output	595	kW
Minimum Electrical Output	418	kW
Maximum Electrical Output	648	kW

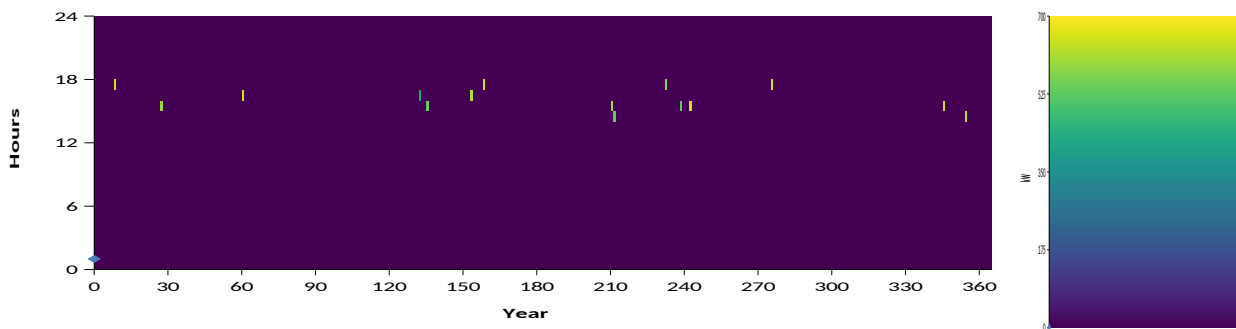
CAT-810kVA-50Hz-PP (1) Fuel Summary

Quantity	Value	Units
Fuel Consumption	2,366	L
Specific Fuel Consumption	0.265	L/kWh
Fuel Energy Input	23,285	kWh/yr
Mean Electrical Efficiency	38.3	%

CAT-810kVA-50Hz-PP (1) Statistics

Quantity	Value	Units
Hours of Operation	15.0	hrs/yr
Number of Starts	15.0	starts/yr
Operational Life	6,000	yr
Capacity Factor	0.157	%
Fixed Generation Cost	13.1	\$/hr
Marginal Generation Cost	0.270	\$/kWh

CAT-810kVA-50Hz-PP (1) Output (kW)



PV: Jinko Solar Co.,Ltd.365JKM365M-72-V

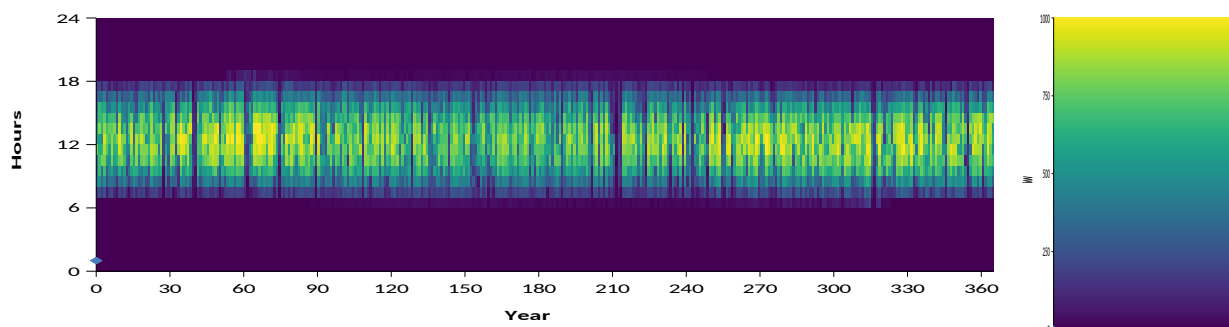
Jinko Solar Co.,Ltd.365JKM365M-72-V Electrical Summary

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	1,000	kW
PV Penetration	29.0	%
Hours of Operation	4,447	hrs/yr
Levelized Cost	0.0328	\$/kWh
Clipped production	0	kWh

Jinko Solar Co.,Ltd.365JKM365M-72-V Statistics

Quantity	Value	Units
Rated Capacity	1,200	kW
Mean Output	226	kW
Mean Output	5,433	kWh/d
Capacity Factor	18.9	%
Total Production	1,983,098	kWh/yr
Dedicated converter	1,000	kW

Jinko Solar Co.,Ltd.365JKM365M-72-V Output (kW)



Storage: Generic 100kWh Li-Ion

Generic 100kWh Li-Ion Properties

Quantity	Value	Units
Batteries	22.0	qty.
String Size	1.00	batteries
Strings in Parallel	22.0	strings
Bus Voltage	600	V

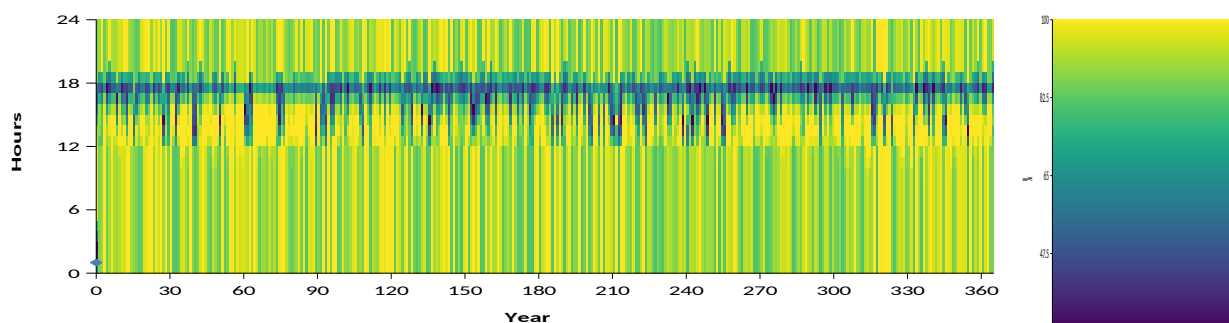
Generic 100kWh Li-Ion Result Data

Quantity	Value	Units
Average Energy Cost	0.166	\$/kWh
Energy In	394,706	kWh/yr
Energy Out	355,321	kWh/yr
Storage Depletion	90.4	kWh/yr
Losses	39,475	kWh/yr
Annual Throughput	374,541	kWh/yr
Annual EFCs	170	1/yr
Average Daily EFCs	0.466	1/day

Generic 100kWh Li-Ion Statistics

Quantity	Value	Units
Autonomy	1.97	hr
Storage Wear Cost	0	\$/kWh
Nominal Capacity	2,200	kWh
Usable Nominal Capacity	1,540	kWh
Lifetime Throughput	5,618,116	kWh
Expected Life	15.0	yr

Generic 100kWh Li-Ion State of Charge (%)



Converter: Sinexcel 150kW

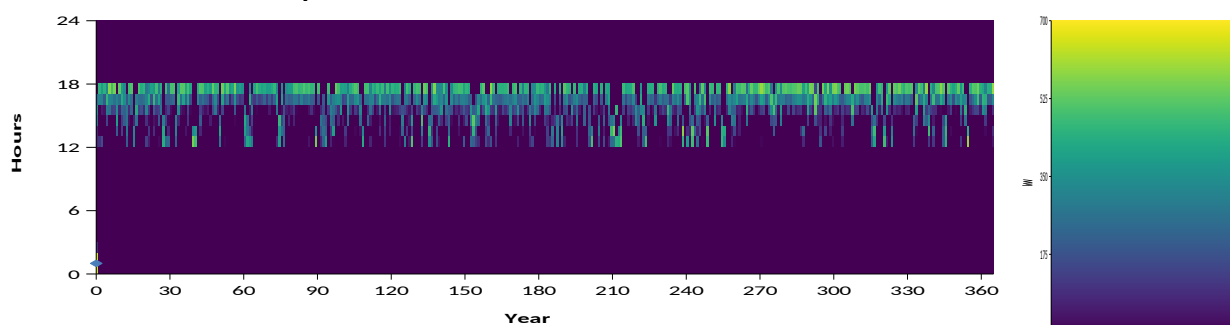
Sinexcel 150kW Electrical Summary

Quantity	Value	Units
Hours of Operation	1,263	hrs/yr
Energy Out	338,337	kWh/yr
Energy In	355,321	kWh/yr
Losses	16,984	kWh/yr

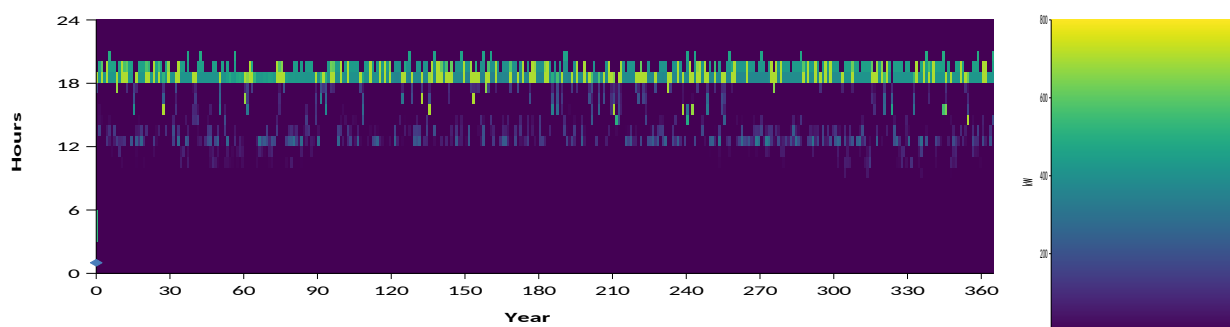
Sinexcel 150kW Statistics

Quantity	Value	Units
Capacity	704	kW
Mean Output	38.6	kW
Minimum Output	0	kW
Maximum Output	650	kW
Capacity Factor	5.49	%

Sinexcel 150kW Inverter Output (kW)



Sinexcel 150kW Rectifier Output (kW)





Grid: Grid

Grid rate: Demand 1

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge	Demand Charge
January	0	0	0	1,200	\$0.00	\$0.00
February	0	0	0	1,200	\$0.00	\$0.00
March	0	0	0	1,200	\$0.00	\$0.00
April	0	0	0	1,200	\$0.00	\$0.00
May	0	0	0	1,200	\$0.00	\$0.00
June	0	0	0	1,200	\$0.00	\$0.00
July	0	0	0	1,200	\$0.00	\$0.00
August	0	0	0	1,200	\$0.00	\$0.00
September	0	0	0	1,200	\$0.00	\$0.00
October	0	0	0	1,200	\$0.00	\$0.00
November	0	0	0	1,200	\$0.00	\$0.00
December	0	0	0	1,200	\$0.00	\$0.00
Annual	0	0	0	1,200	\$0.00	\$0.00

Grid rate: Rate 1

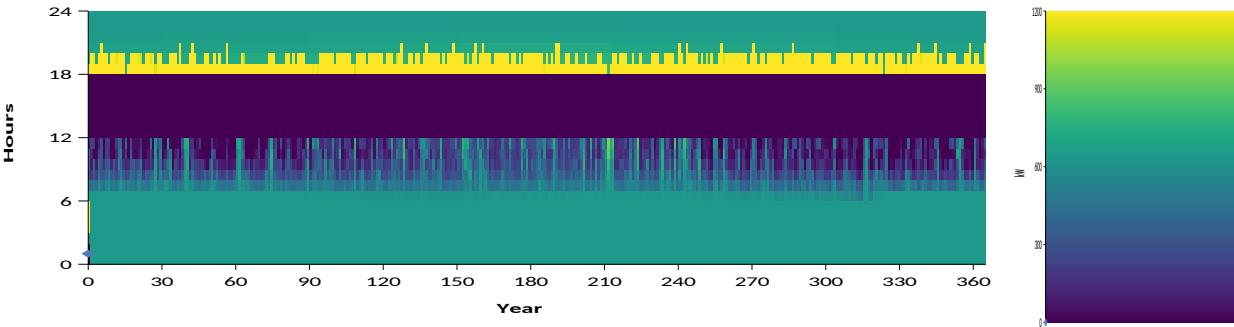
Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge	Demand Charge
January	339,831	0	339,831	0	\$47,576	\$0.00
February	301,316	0	301,316	0	\$42,184	\$0.00
March	335,417	0	335,417	0	\$46,958	\$0.00
April	332,067	0	332,067	0	\$46,489	\$0.00
May	349,941	0	349,941	0	\$48,992	\$0.00
June	346,439	0	346,439	0	\$48,501	\$0.00
July	355,421	0	355,421	0	\$49,759	\$0.00
August	354,103	0	354,103	0	\$49,574	\$0.00
September	332,865	0	332,865	0	\$46,601	\$0.00
October	335,092	0	335,092	0	\$46,913	\$0.00
November	317,841	0	317,841	0	\$44,498	\$0.00
December	332,394	0	332,394	0	\$46,535	\$0.00
Annual	4,032,727	0	4,032,727	0	\$564,582	\$0.00

Grid rate: All

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge	Demand Charge
January	339,831	0	339,831	1,200	\$47,576	\$0.00
February	301,316	0	301,316	1,200	\$42,184	\$0.00
March	335,417	0	335,417	1,200	\$46,958	\$0.00
April	332,067	0	332,067	1,200	\$46,489	\$0.00
May	349,941	0	349,941	1,200	\$48,992	\$0.00
June	346,439	0	346,439	1,200	\$48,501	\$0.00
July	355,421	0	355,421	1,200	\$49,759	\$0.00
August	354,103	0	354,103	1,200	\$49,574	\$0.00
September	332,865	0	332,865	1,200	\$46,601	\$0.00
October	335,092	0	335,092	1,200	\$46,913	\$0.00
November	317,841	0	317,841	1,200	\$44,498	\$0.00
December	332,394	0	332,394	1,200	\$46,535	\$0.00
Annual	4,032,727	0	4,032,727	1,200	\$564,582	\$0.00



Energy Purchased From Grid (kW)



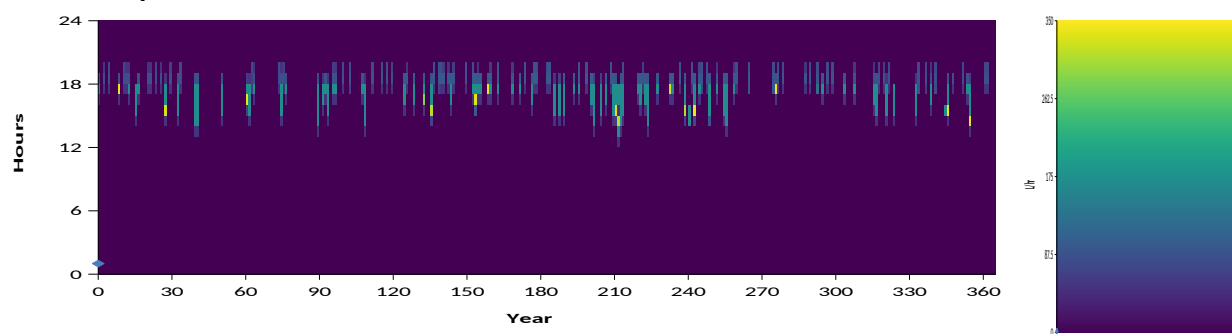
Energy Sold To Grid (kW)

Fuel Summary

Diesel Consumption Statistics

Quantity	Value	Units
Total fuel consumed	57,376	L
Avg fuel per day	157	L/day
Avg fuel per hour	6.55	L/hour

Diesel Consumption (L/hr)



Emissions

Pollutant	Quantity	Unit
Carbon Dioxide	2,700,254	kg/yr
Carbon Monoxide	66.6	kg/yr
Unburned Hydrocarbons	41.9	kg/yr
Particulate Matter	16.1	kg/yr
Sulfur Dioxide	11,426	kg/yr
Nitrogen Oxides	6,409	kg/yr

Compare Economics

IRR (%):**30.7**

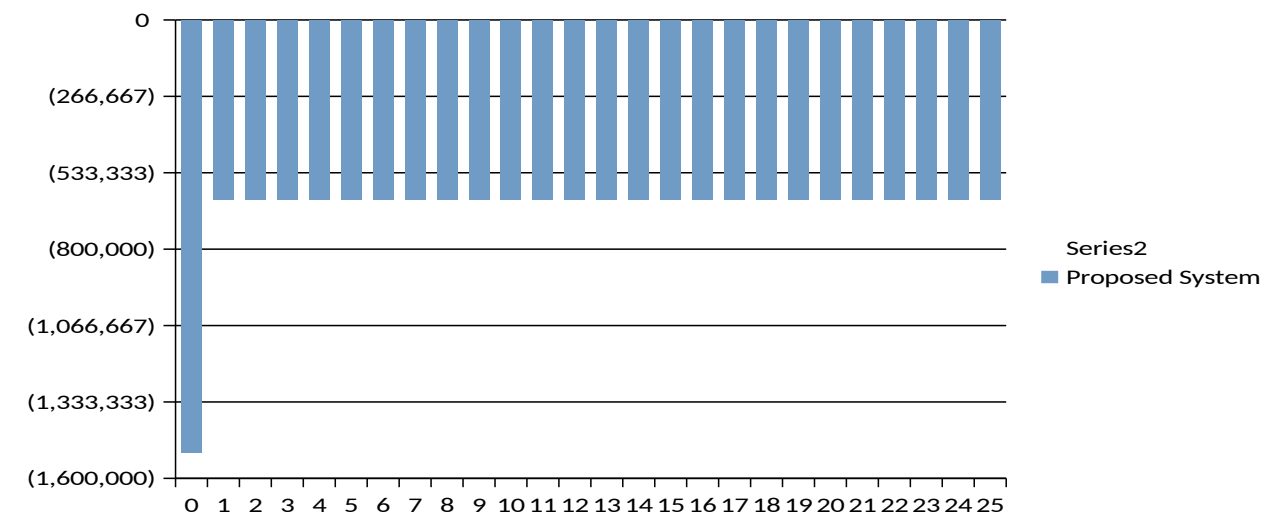
Discounted payback (yr):**3.72**

Simple payback (yr):**3.25**

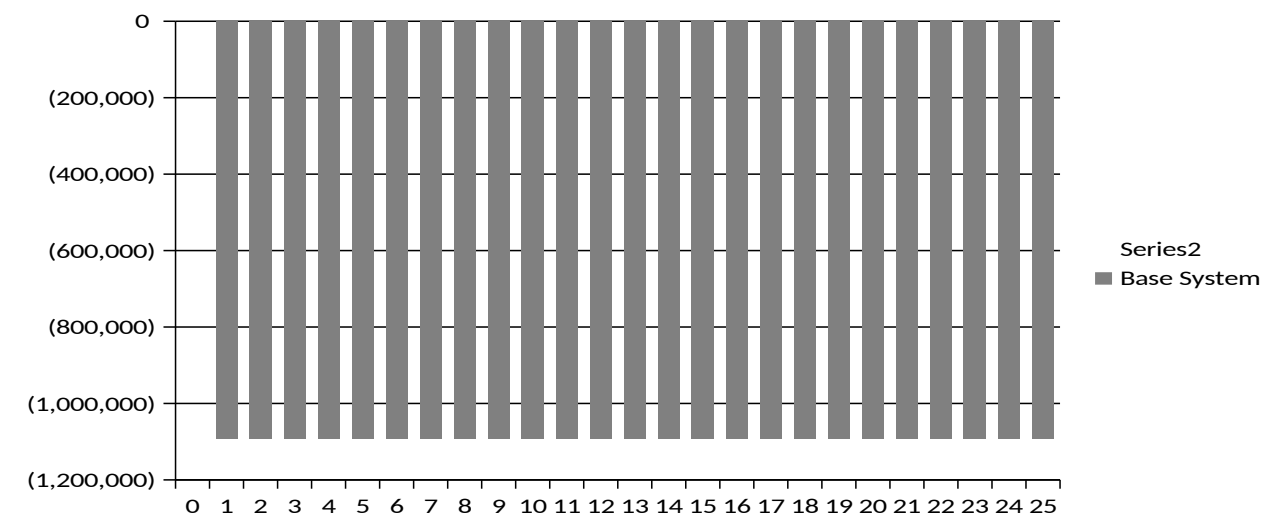
	Base System	Proposed System
Net Present Cost	\$14.1M	\$9.63M
CAPEX	\$0.00	\$1.51M
OPEX	\$1.09M	\$627,696
LCOE (per kWh)	\$0.180	\$0.123
CO2 Emitted (kg/yr)	4,000,036	2,700,254
Fuel Consumption (L/yr)	401,069	57,376



Proposed Annual Nominal Cash Flows



Base System Annual Nominal Cash Flows



Cumulative Discounted Cash Flows

