Customized Energy Solutions

Spreadsheet and Homer Modelling :Comparison

Presented at Asia Clean Energy Forum 2015

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Emerging Technologies

Customized Energy Solutions

- Customized Energy Solutions (Customized) started as an electric energy consulting company in 1998 to provide wholesale market services to load interests
- Company has over 110 staff members located in Philadelphia (headquarters), Massachusetts, Indiana, Texas, New York, California, and India
- Diverse staff
  - Varied educational backgrounds including business administration, finance, electrical engineering, and law
  - Varied backgrounds focused on regulatory compliance, retail services, transmission, generation, demand response, operations, and planning

Customized is objective and independent--not affiliated with any trading, marketing, distribution or transmission companies

Customized Energy Solutions Value Chain

Evaluation

- Evaluate Technologies
- Evaluate Economics
- Transmission Studies

Implementation

- Selection of Suppliers
- Site Selection
- Interconnection
- Partner with engineers to commission project

Communication

- Fully Operational SCADA system
- Communication on as little as 4 second basis

Participation

- Facilitate participation in ISO/RTO markets
- Assist Clients in Buying and Selling energy, capacity, ancillary services and REC

Operations

- Provide active management through 24 hour operations center
- Bid to Bill

Customized Energy Solutions Provides a Full suite of Services to Project Developers

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Agenda

- Project Description
- Excel Modelling
  - Excel Results
- Porting Excel based model to Homer
- Homer Modelling
  - Homer Results
- Conclusions

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Project Description

- Island in India
  - Peak Demand: 35 MW
    - Off Peak : 19 MW
- Installed Capacity: 65 MW (all diesel)
  - Diesel transportation by boats
- Installed Solar: 5 MW
  - Goal reduce the cost of diesel
- Feasibility of ESS for Smoothing Solar Output

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Spreadsheet Model

- Ramp Analysis
- State of Charge Modelling
- Manually curtailed generation
  - One of the three generators for reserves taken off line
- Minute by Minute Optimization modelling
  - Model to use storage
    - Ramp-up Threshold 1000 KW
    - Ramp-down Threshold 1000 KW
    - Minimum SOC 10%
    - Maximum SOC 90%
- No load analysis

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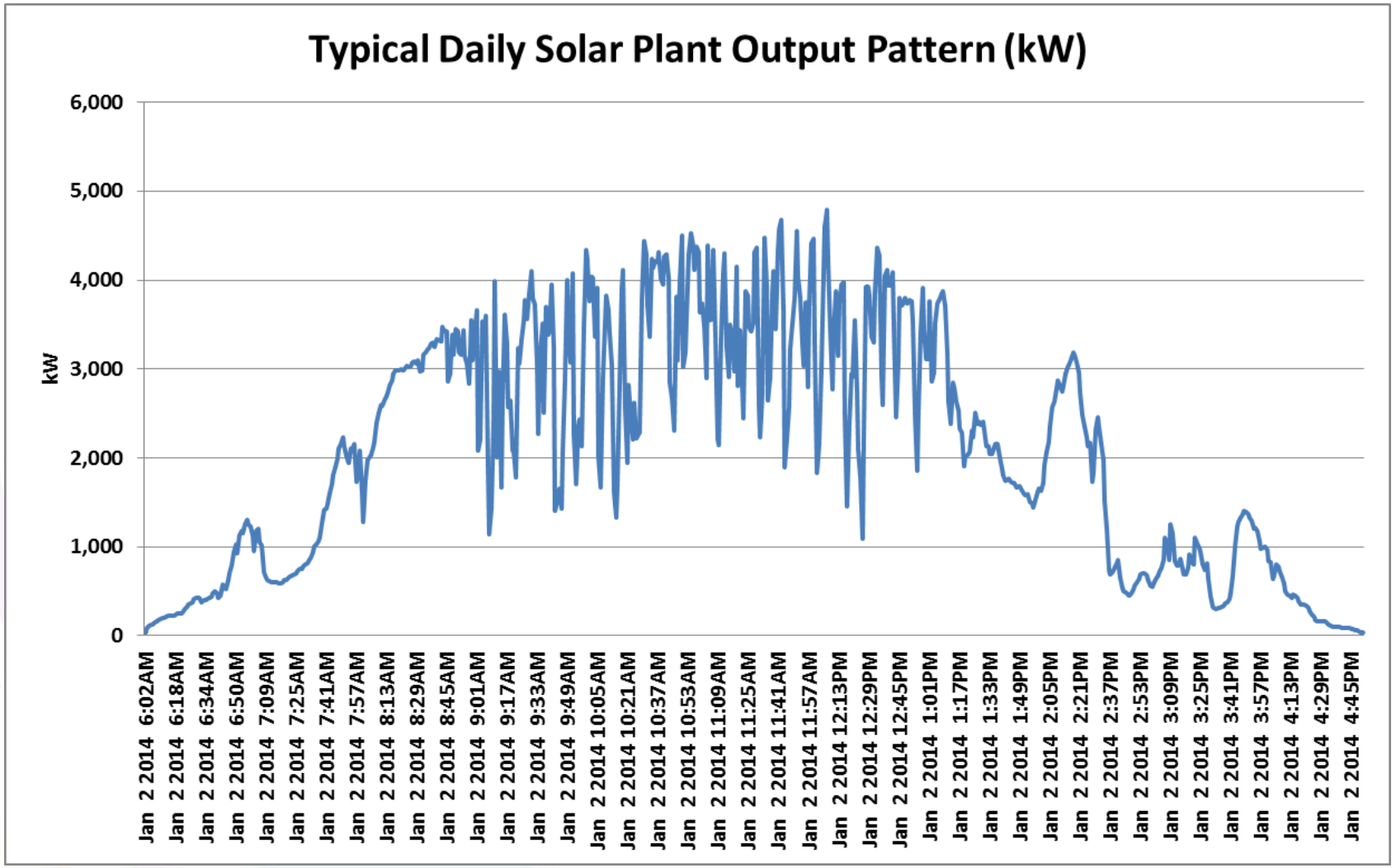
Solar Output Pattern (kW)



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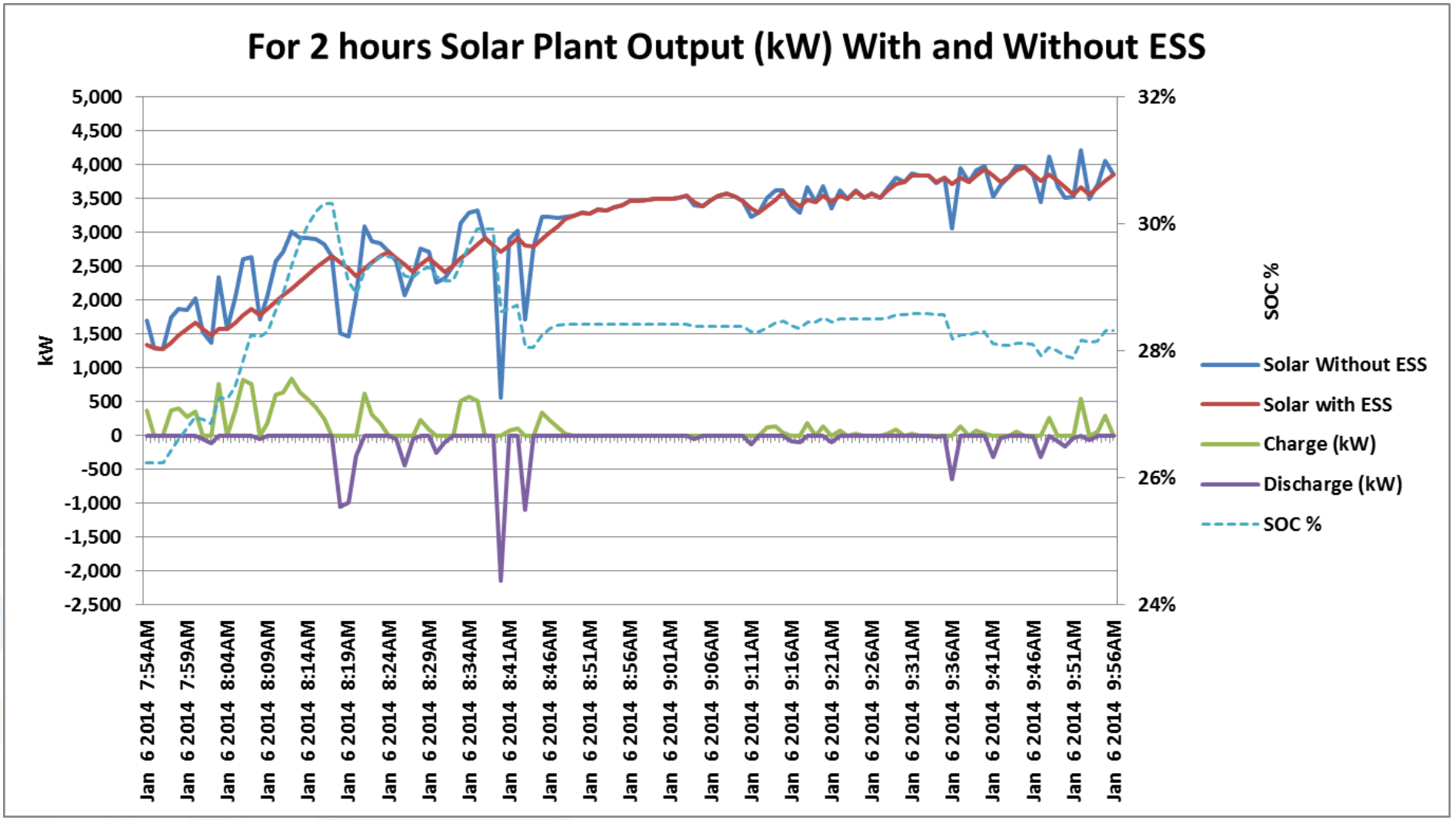
Solar plant output (kW) with & without ESS



ESS: 3000 kW, 1 Hr. 1-min Ramp tolerance = 100 kW, 5-min Ramp Tolerance 1000 kW

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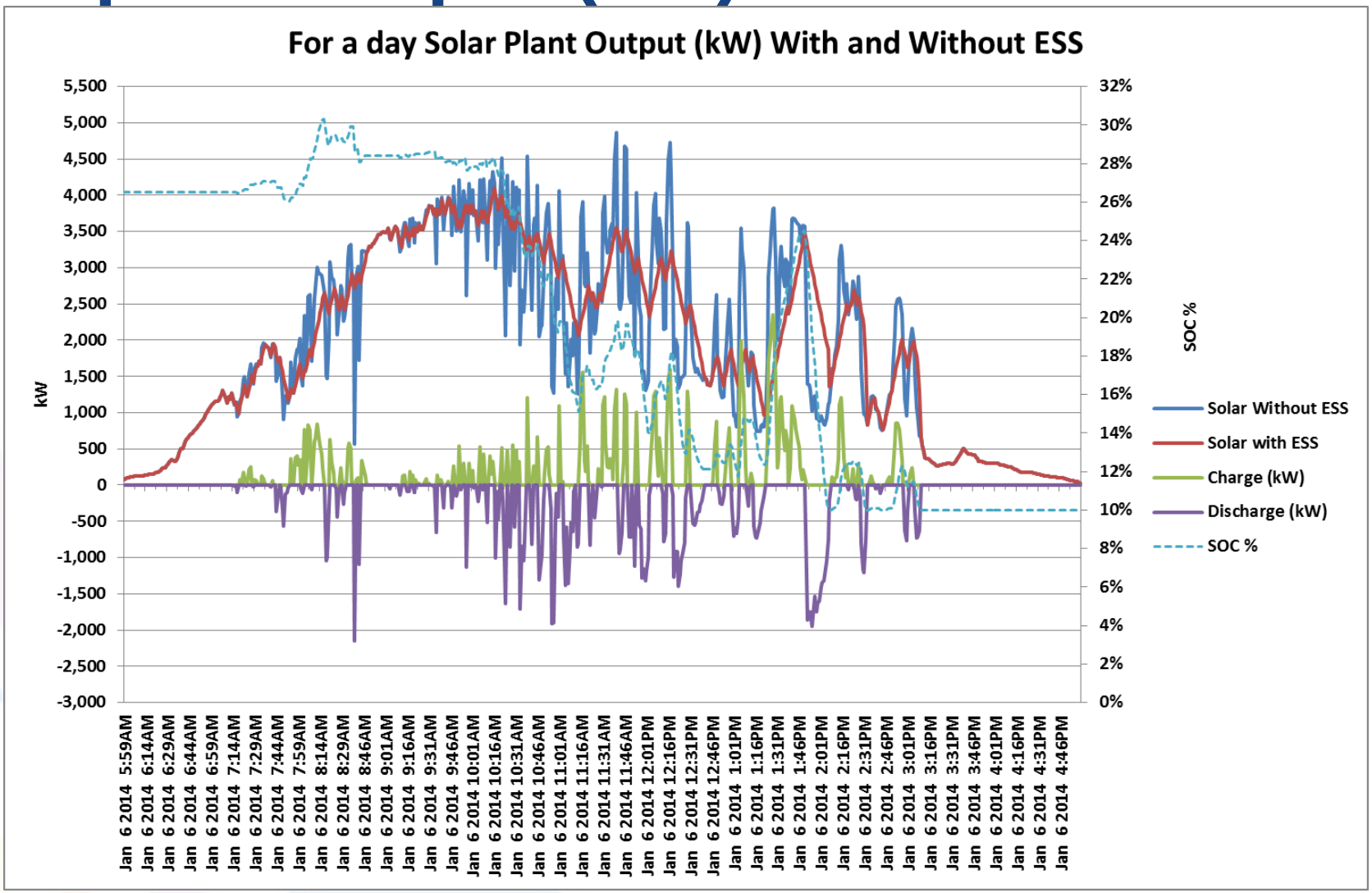
Solar plant output (kW) with & without ESS



ESS: 3000 kW, 1 Hr. 1-min Ramp tolerance = 100 kW, 5-min Ramp Tolerance 1000 kW

Ramps with and without ESS

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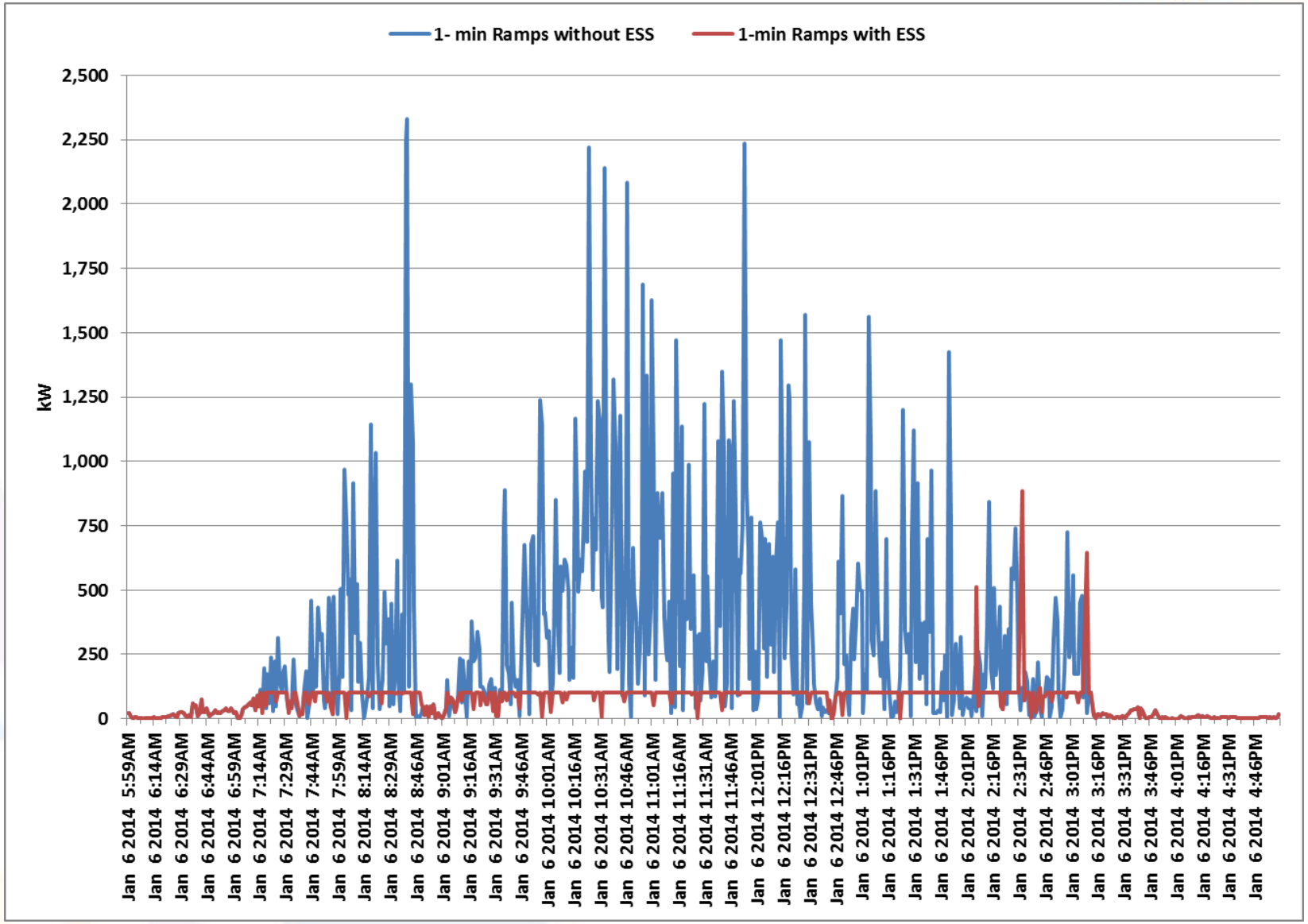

ESS: 3000 kW, 1 Hr. 1-min Ramp tolerance = 100 kW, 5-min Ramp Tolerance 1000 kW

Ramps with and without ESS

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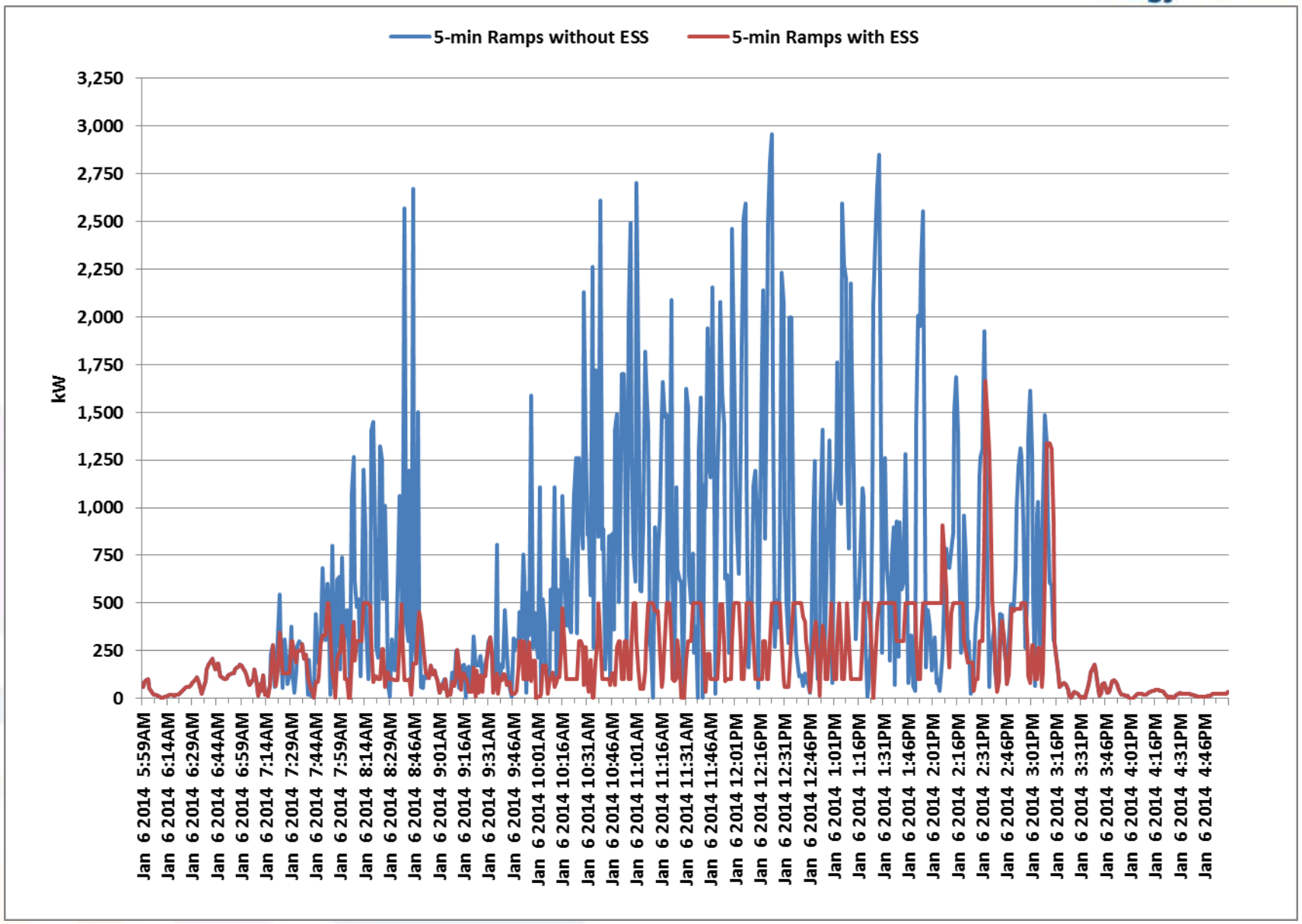

ESS: 3000 kW, 1 Hr. 1-min Ramp tolerance = 100 kW, 5-min Ramp Tolerance 1000 kW

Summary – Li Ion

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Ramps with 3 MW, 1 Hr ESS

# of 1-min interval ramps		
Ramp Range (kW)	W/o ESS	With ESS
0 to 500	32,537	36,997
500 to 1000	2,893	91
1000 to 1500	1,108	32
1500 to 2000	423	8
2000 to 2500	129	2
2500 to 3000	31	0
3000 to 3500	6	0
3500 to 4000	3	0
Total	37,130	37,130

# of 5-min interval ramps		
Ramp Range (kW)	W/o ESS	With ESS
0 to 500	28,730	36,487
500 to 1000	4,106	320
1000 to 1500	2,057	190
1500 to 2000	1,147	88
2000 to 2500	634	27
2500 to 3000	314	11
3000 to 3500	114	4
3500 to 4000	27	3
4000 to 4500	1	0
Total	37,130	37,130

Key Takeaways

- ESS reduces number of 1-minute interval ramps above 100 kW from 12,046 to 317
- ESS reduces number of 5-minute interval ramps above 100 kW from 4,294 to 323
- ESS also reduces the magnitude of ramps
- Annual equivalent of full DOD cycles are only 121 hence the battery will last for long

Annual Diesel Savings (INR Crores)	**1.68**
Annual Diesel Consumption Savings (Liter)	**2,95,592**
Return on Capital	**10%**

$$\text{Return} = \frac{\text{Annual Diesel Savings (INR Crores)}}{\text{ESS Capex (INR Crores)}}$$

Summary – Advanced Lead Acid

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Ramps with 3 MW, 1 Hr ESS

# of 1-min interval ramps		
Ramp Range (kW)	W/o ESS	With ESS
0 to 500	32,537	36,981
500 to 1000	2,893	98
1000 to 1500	1,108	37
1500 to 2000	423	13
2000 to 2500	129	1
2500 to 3000	31	0
3000 to 3500	6	0
3500 to 4000	3	0
Total	37,130	37,130

# of 5-min interval ramps		
Ramp Range (kW)	W/o ESS	With ESS
0 to 500	28,730	36,377
500 to 1000	4,106	377
1000 to 1500	2,057	226
1500 to 2000	1,147	106
2000 to 2500	634	32
2500 to 3000	314	6
3000 to 3500	114	4
3500 to 4000	27	2
4000 to 4500	1	0
Total	37,130	37,130

Key Takeaways

- ESS reduces number of 1-minute interval ramps above 100 kW from 12,046 to 374
- ESS reduces number of 5-minute interval ramps above 100 kW from 4,294 to 376
- ESS also reduces the magnitude of ramps
- Annual equivalent of full DOD cycles are only 119 hence the battery will last for long

Annual Diesel Savings (INR Crores)	**1.68**
Annual Diesel Consumption Savings (Liter)	**2,95,592**
Return on Capital	**21%**

$$\text{Return} = \frac{\text{Annual Diesel Savings (INR Crores)}}{\text{ESS Capex (INR Crores)}}$$

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Homer Model

- Add components
  - Generators
    - Diesel
    - Solar PV (Import Solar Data)
    - Battery
  - Load
- Project Constraints
- Sensitivities

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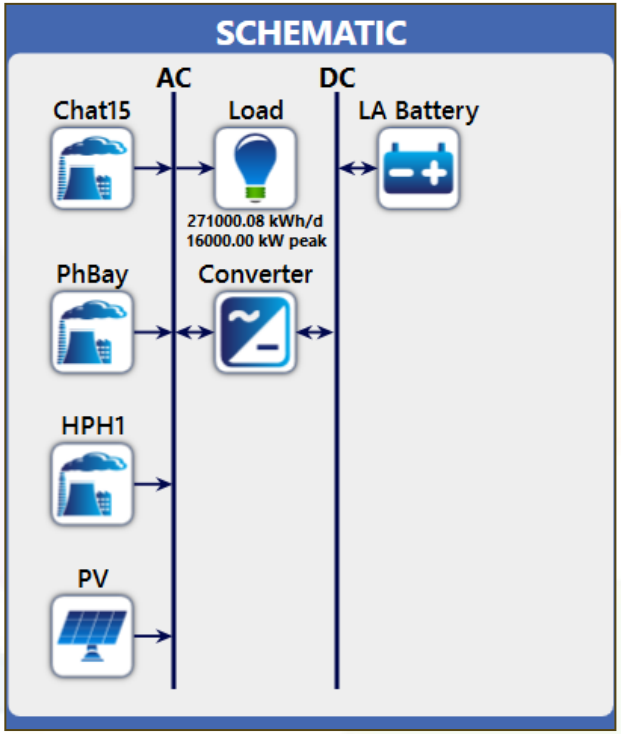
Homer Modelling



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Results

Export... Column Choices... **Sensitivity Cases: Left Click on sensitivity case to see optimization cases.**

Sensitivity	Architecture															
Operating Reserve (%)								PV (kW)	Chat15 (kW)	PhBay (kW)	HPH1 (kW)	LA Battery	Converter (kW)	Dispatch	COE ($)	NP ($
10.00	⚠	■	■	■	■	■	■	5,000.0	15,000	8,000	5,000	8	500	CC	$0.368	$269
15.00	⚠	■	■	■	■	■	■	5,000.0	15,000	8,000	5,000	20	500	CC	$0.372	$272
20.00	⚠	■	■	■	■	■	■	5,000.0	15,000	8,000	5,000	20	500	CC	$0.400	$292
5.00	⚠	■	■	■	■	■	■	5,000.0	15,000	8,000	5,000	20	500	CC	$0.367	$268

Export... **Optimization Cases: Left Double Click on simulation to examine details.**

Architecture															
							PV (kW)	Chat15 (kW)	PhBay (kW)	HPH1 (kW)	LA Battery	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cos ($)
⚠	■	■	■	■	■	■	5,000.0	15,000	8,000	5,000	8	500	CC	$0.368	$269,762,600	$36,427,440
⚠	■	■	■		■	■	5,000.0	15,000	8,000		4	500	CC	$0.399	$292,351,500	$39,479,650
⚠	■	■		■	■	■	5,000.0	15,000		5,000	4	500	CC	$0.400	$292,564,600	$39,508,430

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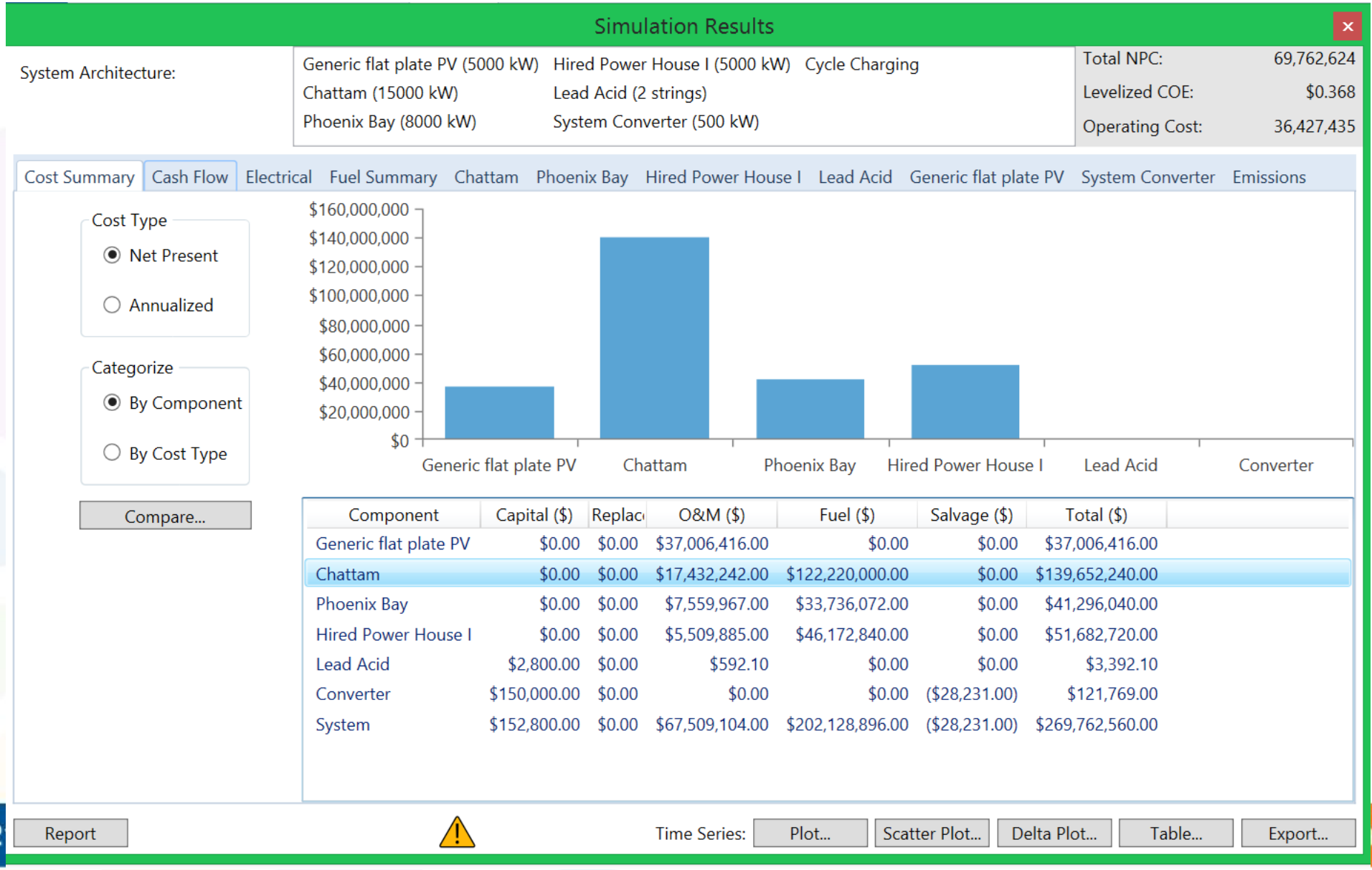
Simulation Results



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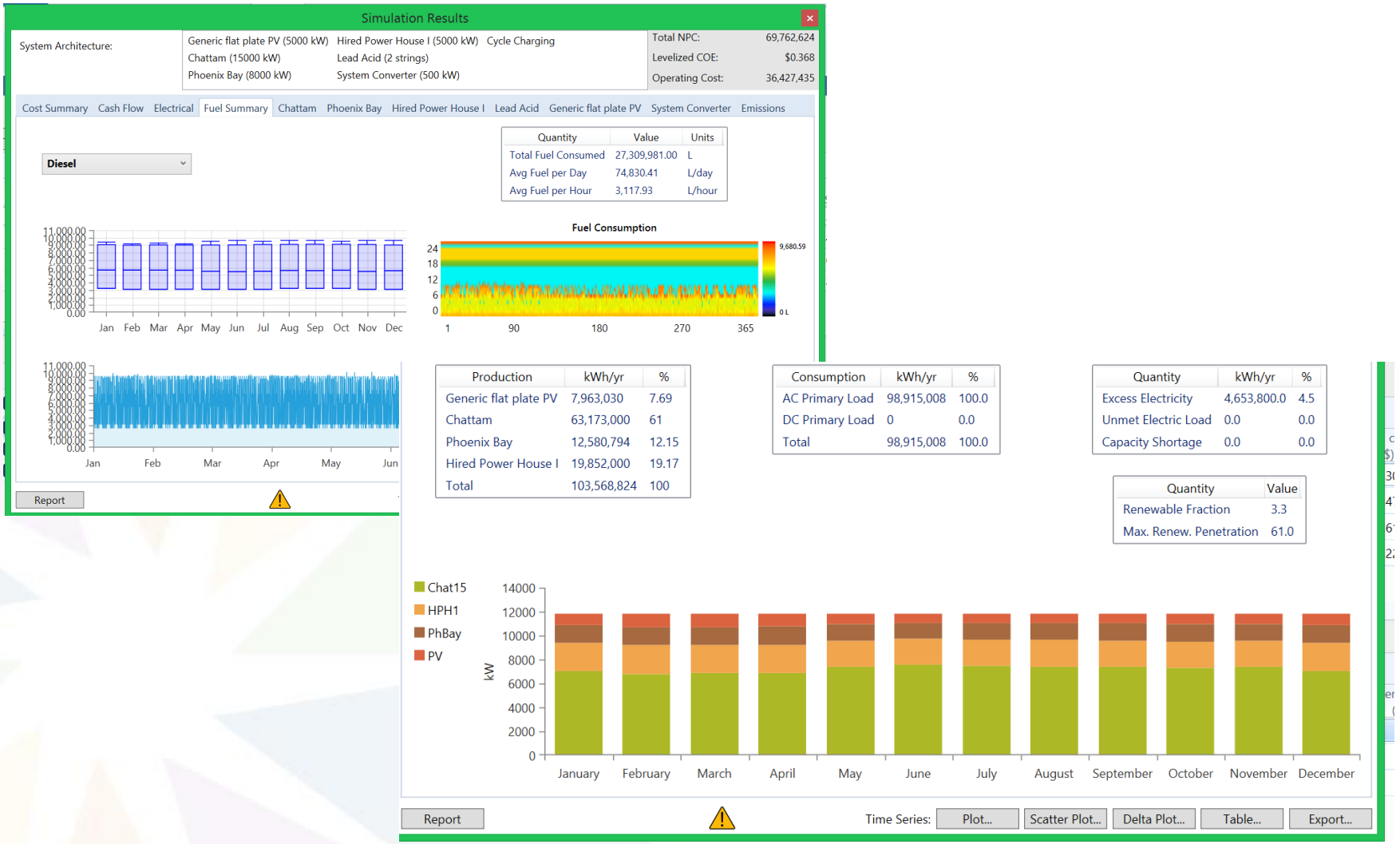
Simulation Results



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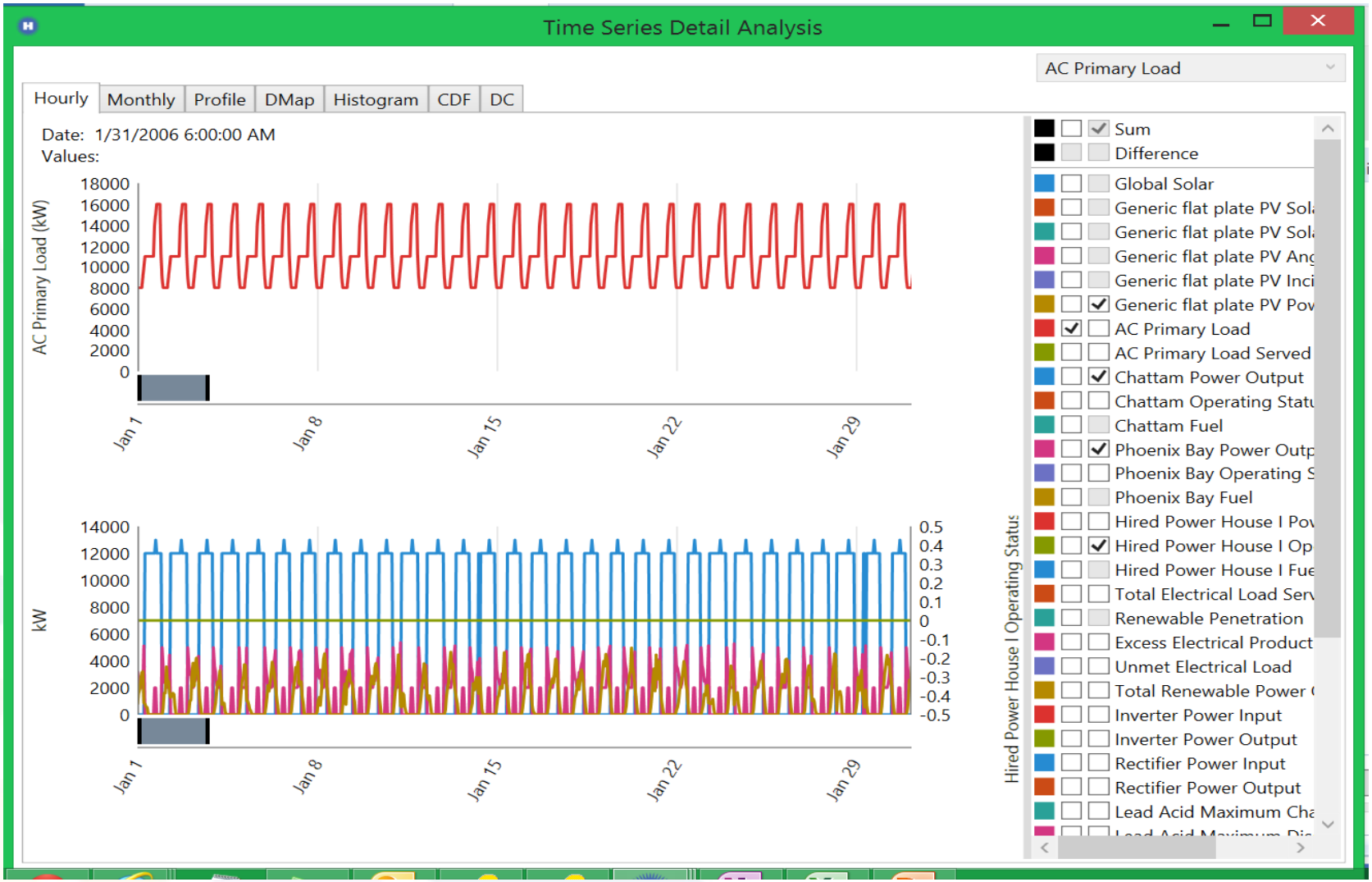
Simulation Results



Conclusions

- Spreadsheet model was labor intensive for the same output
  - Limited by the results that we could see
  - Limited by the optimization that we can do
  - However, it helps with good grasp of the concept
- Homer modelling
  - Robust and Easy to use
  - Ability to model various scenarios
  - Ability to view the operations scenarios through various color coded charts, graphs etc.

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